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World Social Science Report

2013

Changing Global Environments

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You Can Buy My Heart and My Soul, 2006 by Andries Botha

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Preface

by
Irina Bokova

The *World Social Science Report* captures a world undergoing deep change, rocked by multiple crises, including in the environment. It builds on the previous *World Social Science Report*, published in 2010, which addressed the challenge of knowledge divides in the social sciences. On this foundation, the present Report tackles the key theme of "Changing Global Environments". Like its predecessor, the new Report highlights knowledge divides – not just within the sciences, but also between the sciences and the social transformations required to achieve sustainable development. The gap between what we know about the interconnectedness and fragility of our planetary system and what we are actually doing about it is alarming. And it is deepening.

Just as divided knowledge undermines the solidarity of humanity, so current environmental challenges – if inadequately understood and inappropriately managed – can impede achievement of the internationally agreed development goals, through their negative impacts on poverty eradication and social inclusion as well as on realisation of human rights for all. The major role of environmental change in shaping migration patterns is just one of the key linkages that need to be understood and managed in this regard – recognising both the potential contribution of voluntary migration to adaptation and its potentially negative impacts if not set within appropriate policy frameworks, as the UN Global Migration Group stated in 2011.

It was the geologists who first proposed to call our current age the "Anthropocene" – an age in which human activity is the major force shaping the planetary system. With roots in scientific understanding, the idea is essentially social and human. At its core, it is a call to action, to better understand the world, to choose the future we want and to shape global dynamics in this direction.

This *World Social Science Report* examines the social dynamics of the Anthropocene and provides an overall vision to make sense of it. Environmental issues must no longer be seen as peripheral or impacting externally on societies. Quite the contrary, environmental change is interconnected with a multitude of other crises, risks and vulnerabilities which confront every society today. These must be understood together in order to be addressed together. The social, economic and environmental dimensions of sustainable development are a single agenda. Water, forests, cities, agriculture, transport, housing, energy – in each of these processes of contemporary society, aspects of the environment are intertwined with human values, beliefs and behaviour. We shape our environment as it shapes us.

To move forward, we need scientific approaches that overcome barriers between disciplines and methods. This *World Social Science Report* meets this imperative and builds movement towards more integrated knowledge systems – towards what is sometimes called "sustainability science". It reviews trends and their consequences, the conditions for change in social practices and interpretations, along with responsibilities and ethics, decision-making and governance issues. The Report also shows how much more remains to be done, especially to ensure equitable global participation in the creation and use of knowledge.

Action to address global environmental change requires strong, dynamic and wide-ranging contributions from across the social sciences – to mitigate negative phenomena, to adapt to others, and, more generally, to enhance social resilience in the face of uncertain pressures. Technological, financial or economic solutions are not enough. Values, beliefs and behaviours are essential foundations for shaping greater sustainability. This is also why the humanities are so important, alongside the social sciences, to help us imagine the shape of a more sustainable future.

Knowledge is vital for effective action – but for this, we must more tightly link science, policy and society and integrate scientific understanding with action. Ultimately, achieving sustainable development is a political challenge that involves making fundamental choices about how we understand ourselves and the world we wish to inhabit and leave for future generations. The social sciences have an important contribution to make in supporting positive social transformations. This requires moving beyond the obstacles of vested interests, the politicisation of science, and entrenched habits of thought and behaviour.

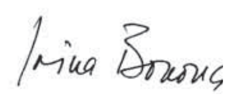
This is why the *World Social Science Report* is so important – to understand changing global environments and to formulate stronger policies in response. This is especially important now, as the international community shapes a new sustainable development agenda to follow 2015.

Linking knowledge to action is the objective of UNESCO's intergovernmental Management of Social Transformations (MOST) programme, which has made the social dimensions of global environmental change one of its two thematic pillars, along with social inclusion. In supporting this *World Social Science Report*, MOST has taken forward a core objective – to mobilise social science for social change that is conducive to sustainable development. Strengthening the knowledge base without applying it would not be enough – which is why UNESCO's activities under MOST also focus on bringing together experts and policymakers to develop shared, scientifically-informed and politically relevant agendas.

This Report is the result of strong collaboration with the International Social Science Council on global environmental change, for which I am deeply grateful. It also reflects a new partnership with the Organisation for Economic Co-operation and Development (OECD), which, as co-publisher, will take our messages to audiences across the world. I welcome this opportunity for UNESCO and the OECD to work together to achieve common objectives.

At a time when the world is seeking a new vision of sustainable development, the *World Social Science Report* must be required reading – for scientists, policymakers, activists, and all concerned citizens. To move forward, we must rally around a new vision of global environmental change as a core part of the crises facing the world today. Poverty and environmental issues are integral to the sustainability challenge that must be addressed – including through a new international sustainable development agenda. This agenda must simultaneously protect human well-being and life-supporting ecosystems in ways that are socially inclusive and equitable. This is our responsibility and our aspiration.

Irina Bokova
Director-General of UNESCO



Preface

A lighter carbon footprint, a greener world

by
Olive Shisana

As one of the most pressing of today's global environmental problems, climate change presents a complex and controversial challenge to industrialised and emerging economies. Climate change is a recent concern, but has become one of the most critical issues for the current generation. Since the Rio Earth Summit in 1992, it has evoked a strong response at both the community and governmental levels. Evidence of climate change is abundant, yet a degree of denial persists at the community and government levels, and in many countries, about its causes and consequences. Sceptics question whether climate change results primarily from human activity, believing instead that it results only from natural events independent of a human-caused carbon footprint.

Despite these doubts, a new and independent assessment of the evidence by Berkeley Earth led to a series of papers in the period 2010 to 2013 that systematically addressed each of the five foremost concerns expressed by climate change sceptics, and concluded that they did not unduly bias the record (Berkeley Earth, 2013).

Berkeley Earth confirmed what previous studies had claimed: planet Earth is warming. The global mean land temperature had increased by 0.911 °C since the 1950s, which is consistent with the findings from the Intergovernmental Panel on Climate Change (IPCC) and with other studies. The scientific community has now achieved broad consensus regarding the reality and threats of climate change (Frumkin et al., 2008). The major cause of climate change is understood as the emission of greenhouse gases, which trap the sun's heat within the Earth's atmosphere and lead to increases in global land and ocean surface temperatures. Though greenhouse gas emissions have many sources, the major area of concern is the burning of fossil fuels. This happens predominantly in the North, though China and India's recent industrial development has contributed significantly.

Climate change presents many complex problems, ranging from increased morbidity caused by excess heat to the spread of infectious diseases and to ethical concerns, because climate-change-related policy could limit economic development in both emerging economies and resource-poor nations. Perhaps of greatest concern is the reality that while high-income nations in the North are the leading contributors to climate change, its effects disproportionately impact middle- and low-income nations in the South. This creates the challenge of finding a sustainable path towards development. High-income nations, having already developed, have the infrastructure to withstand and the means to respond to the many issues related to climate change:

higher temperatures, extreme weather events, floods and droughts, sea level rise, infectious diseases, and a variety of other pertinent issues.

Increases in average and extreme temperatures, higher sea surface temperatures, rising sea levels, and the growing frequency and intensity of extreme weather, all present nations with complex logistical, social and political problems. Still, it was not until the 1980s that the broader scientific community began to address the issue of climate change. The first significant international effort to address the issue took place in 1992 with the signing of the United Nations Framework Convention on Climate Change (UNFCCC), which has 194 signatories to date, including the world's biggest greenhouse gas emitter, the United States. A lack of substantial progress following the UNFCCC led to a series of efforts, including the Berlin Mandate in 1995 and the Kyoto Protocol in 1997, which called for a 5.2% reduction in greenhouse gas emissions from 1990 levels from industrialised countries by 2012. Unfortunately in 2001, the United States rejected the Kyoto Protocol. But in 2009 world leaders, including US President Barack Obama, negotiated the Copenhagen Accord. This called for a long-term goal of limiting increases in average land temperature to 2 °C. To date, many targets and objectives set forth in the Kyoto Protocol and Copenhagen Accord remain unmet, and nations seem to lack the social and political movements needed to force their leaderships to address climate change adequately.

One of the major challenges to addressing global climate change is that its primary cause, for better or for worse, remains linked to current approaches to and patterns of economic development. Fossil fuels, specifically coal, natural gas and oil, are used for cooking, for cooling and heating households and workplaces, for transportation, and for industrial development (EPA, 2013). This means that essential activities necessary in the development of any nation remain highly dependent on the increased burning of fossil fuels. These activities comprise an unsustainable model of economic development that originates in the North and has set a trend for the wider world.

However, the recent global financial and economic crises seem to have shifted the North–South balance in carbon emissions, albeit slightly. For example, carbon emissions grew in the EU countries by only 2.2% after the financial crisis, and by 4.1% in the United States and 5.5% in the Russian Federation. These rates of growth are now lower than those of China, which increased by 10.4%, and India, which grew by 9.4% (Peters et al, 2012).

Public perceptions of climate change seem to be connected to levels of economic development. Evidence generated by a study of 46 countries suggests that there is a negative association between public concern for global warming and gross domestic product. In addition, there is a negative association between per capita carbon dioxide emissions and public concern for global warming (Sandvik, 2008). This suggests that poor people are more concerned about the effects of climate change than people in affluent societies. Their concerns are warranted, as a study published in *Eco Health* demonstrated that morbidity and mortality associated with climate change disproportionately impact resource-poor nations, those least responsible for greenhouse gas emissions (Patz, Gibbs and Foley, 2007).

Popular discourse in the South tends to view a call for reduction of greenhouse gas emissions as placing limitations on development at a time when the South is rising out of poverty and beginning to enjoy similar socio-economic benefits to those that the North continues to experience. Arguments for allowing the South to pollute until it achieves the same level of economic development as the North are common, yet they are also oblivious to the obvious consequences of this race to the bottom. While it is true that emerging economies in the South are least responsible for climate change, the negative impact of a changing climate on these nations and ultimately on their economic development is undeniable.

Communities and governments of the South recognise the impact of climate change on their ability to earn a living, yet few are willing to address the deleterious effects of increased population growth on carbon emissions. Perhaps the most obvious preventive measure to a growing carbon footprint is to slow population growth. Still, few nations have effective family planning policies and programmes aimed at slowing population growth, which would reduce the need to extract resources to feed, clothe, transport, house, and warm or cool growing populations without accelerating climate and environmental change. Slowing population growth is the elephant in the room of climate change and global sustainability more generally.

Still others in the South argue that because the North has contributed disproportionately to greenhouse gas emissions, the South should not be prevented from reaching the same levels of emissions as the North. They argue that they need more time to develop and lift their populations out of poverty before they can be held to the same emission standards as the North. While it is understandable that they too need to develop, the model of development that they adopt need not necessarily mimic that of the North; instead a new development path is needed that emphasises human well-being in its broadest sense rather than focusing primarily on physical infrastructure development.

The disadvantages of the current dominant model of development should serve as an impetus for the South to seek alternative growth and development models that include harnessing renewable energies, slowing population growth, finding alternative ways of transporting, cooking, heating and cooling the population, and ultimately leading to better lives.

What is more, having recognised the negative impact of relying too heavily on fossil fuels, and understanding the exponential growth in demand for them, economic powers such as the United States and China have begun to invest heavily in green alternatives to development. These efforts are viewed as a means to avert future economic crises for economies that are too dependent upon fossil fuels. If nations in the South ignore this shift in development, they may relegate themselves for several more generations to an unsustainable and unsuccessful development path.

In either case, nations should question any economic model that defines prosperity as simply an accumulation of material resources. A challenge to social scientists is to help redefine prosperity, focusing more on the qualitative aspects of human development, such as the provision of better education, learning how to promote health, and learning regenerative approaches to the use of resources.

North or South, human behaviour contributes significantly to climate change. And demands to maintain the lifestyles of the North and achieve similar lifestyles in the South only complicate the issue. This suggests that reducing greenhouse gas emissions is inextricably linked with human behaviour and the model of development we choose to follow. The question before social scientists is how we direct human behaviour and social practice away from a well-established development model and lifestyle that continues to add to global greenhouse gas emissions. Transforming emissions from industry is one thing, and by no means simple, but changing an entire nation’s lifestyle is another. Perhaps before this question can be answered, social scientists must first ask why human behaviours which add to greenhouse gas emissions are so resistant to change. A Swiss study attempted to do just that, and found that although people were anxious about the consequences of climate change, they erected a series of psychological barriers against taking individual or collective action to mitigate it, arguing that they wanted to maintain their comfortable and energy-intensive lifestyles (Stoll-Kleemann, O'Riordan and Jaeger, 2001).

The fundamentals of this model of development, which depends on generating carbon emissions as a means to prosperity, continue to be emulated by emerging economies. In a rush to get populations out of poverty in the 21st century, there is a move in some of the emerging economies to promote policies that increase carbon emissions. Examples include the Medupi project in South Africa, which will burn coal to generate energy, reductions in the tax for buying cars in Brazil, which increase the car to population ratio, and the introduction of fracking in South Africa to generate natural gas for heating and cooling. Recent evidence suggests that governments in the North are taking steps to reduce emissions, including Germany's Energie-Wende, which aims to transform the national energy system to low-carbon sources, and the United States introducing energy-saving measures. But the past several years have seen an increase in carbon emissions in the emerging economies of China and India, offsetting any greenhouse gas reductions in Europe and the United States.

A simple question put to all nations is whether more concrete, more buildings, more cars, more roads and more industry is really the best model we have for development. If there is a better model, then the challenge before social scientists is to help define and understand it, and to contribute knowledge about effecting a shift in human behaviour and social practice towards a model of development and a lifestyle that leaves a much lighter carbon footprint and, it is to be hoped, a much greener world.

The social sciences are best placed to study the reasons why people who experience the deleterious effects of climate change continue to participate in activities that accelerate it. The context in which such decisions are taken needs to be studied and understood if social and economic behaviours are to change. This will require a systematic effort with global leadership. Such an initiative is currently being championed by the International Social Science Council (ISSC), a global organisation representing the social, economic and behavioural sciences at an international level. Through its efforts it has begun to bring the pressing challenges of global environmental change and sustainability to the heart of the social sciences, as reflected in this *World Social Science Report*.

Underscoring the importance of these ISSC efforts, social scientists can be certain of three things. First, the current model of economic development is simply unsustainable. Second, human behaviour is paramount in achieving any significant progress and in averting a continuing, growing global crisis. And third, social scientists are uniquely positioned to help shift the current development paradigm to a more sustainable path by understanding and influencing human behaviour and the institutions and cultural systems within which it emerges and finds expression.

Olive Shisana
President, International Social Science Council

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Human Elephant Foundation, South Africa
"Think big, tread lightly"

The elephant is a metaphor that awakens the yearning for forgotten conversations between humans, the Earth and all living things … we made these life-size elephants out of recycled materials … they represent the world of nature from which we have removed ourselves and for which we increasingly yearn.

The elephant is the largest land mammal and thus a symbol of the threat of our ever-increasing industrial and commercial development to life on Earth. The elephant is strong and powerful yet also very vulnerable. Elephants and human beings share many characteristics and traits. They both have a highly developed sensibility, a deep-rooted attachment to family, and similar emotional responses.

The Human Elephant Foundation tries to reignite and keep alive the relationship between humans and nature that has been lost, and to encourage everyone to do something meaningful with his or her life. It initiates and facilitates discussion and innovative problem-solving for a more respectful and sustainable world. It aims to bring individuals and businesses together to stimulate their imagination and creativity: the huge problems we face, as this report shows, require the ability and desire to break new ground and generate fresh ideas. Life-size elephants, made out of recycled materials in different regions of the world, could help mobilize communities to get involved in broader human and environmental issues.

The artist and creator of the elephants featured in this report, **Andries Botha**, lives and works in Durban, KwaZulu-Natal, South Africa. He is very conscious of the fragile coexistence of people with other forms of life, and has tried to unravel the mystery and responsibilities of living alongside plants and animals. This led to the formation of the Human Elephant Foundation in 2006. *www.humanelephant.org*

ACRONYMS AND ABBREVIATIONS

10YFP	Ten-year Framework of Programmes
AASSREC	Association of Asian Social Science Research Councils
ACCC	Adapting to Climate Change in China
ACSS	Arab Council for the Social Sciences
AIACC	Assessments of Impacts and Adaptations to Climate Change
AIDS	Acquired immunodeficiency syndrome
ALLEA	European Federation of National Academies of Sciences and Humanities
AR	Assessment report
BRIC	Brazil, Russia, India and China
CASS	Chinese Academy of Social Sciences
CBD	Convention on Biological Diversity (United Nations)
CCKM	Center of Excellence for Climate Change Knowledge Management
CCS	Carbon (dioxide) capture and storage
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CEDARE	Center for Environment and Development for the Arab Region and Europe
CEPT	Centre for Environmental Planning and Technology, Ahmedabad
CFCs	Chlorofluorocarbons
CJA	Climate Justice Action
CLACSO	Latin American Council of Social Sciences
CNCCP	China's National Climate Change Programme
CNKI	China National Knowledge Infrastructure
CNPq	National Council for Scientific and Technological Development (Brazil)
CO_2	Carbon dioxide
CODESRIA	Council for the Development of Social Science Research in Africa
CONACyT	National Council of Science and Technology (Mexico)
CONICYT	National Commission for Scientific and Technological Investigation (Chile)
COP	Conference of the Parties
CRS	Creditor Reporting System
CSIR	Council of Scientific and Industrial Research (India)
CSSCI	Chinese Social Sciences Citation Index
CWTS	Centre for Science and Technology Studies, University of Leiden
CYCLES	Children and Youth Lifestyle Evaluation Survey
DAC	Development Assistant Committee
DFID	Department for International Development (United Kingdom)
DG CLIMA	Directorate-General for Climate Action (European Union)
DG ENV	Directorate-General for the Environment (European Commission)

DoA	Discipline of anticipation
DOE	Department of Energy (United States)
EC	European Community/executive committee
ECLAC/CEPAL	UN Economic Commission for Latin America and the Caribbean
EEA	European Environment Agency
ELSA	Ethical, legal, social aspects
EMERCOM	Ministry of Civil Defence, Emergencies and Disaster Relief (Russia)
ESCWA	UN Economic and Social Commission for Western Asia
ESF	European Science Foundation
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FAPESP	São Paulo Research Foundation
FORIN	Forensic Investigations of Disasters
FP	Framework Programme (European Union)
FSC	Forestry Stewardship Council
GCP	Global Carbon Project
GDP	Gross domestic product
GEC	Global environmental change
GECAFS	Global Environmental Change and Food Systems
GECHH	Global Environmental Change and Human Health
GECHS	Global Environmental Change and Human Security
GEF	Global Environmental Facility
GFCS	Global Framework for Climate Services
GGCA	Global Gender and Climate Alliance
GHG	Greenhouse gas
GIZ	Gesellschaft für Internationale Zusammenarbeit (Germany)
GLP	Global Land Project
GM	Genetic modification
GNP	Gross national product
GRB	Gender-responsive budgeting
GSSL	Global Survey on Sustainable Lifestyles
GWSP	Global Water System Project
HDGEC	Human Dimensions of Global Environmental Change
IAC	Integrative agent-centred
IAC	InterAcademy Panel Council
ICARDA	International Center for Agricultural Research in the Dry Areas
ICMR	Indian Council of Medical Research
ICSSR	Indian Council for Social Science Research
ICSU	International Council for Science
IDRC	International Development Research Centre (Canada)
IEA	International Economics Association
IFPRI	International Food Policy Research Institute
IGBP	International Geosphere Biosphere Programme
IGU	International Geographical Union
IHDP	International Human Dimensions Programme on Global Environmental Change
IHOPE	Integrated History and Future of People on Earth

ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
IPSA	International Political Science Association
IRDR	Integrated Research on Disaster Risk
ISA	International Sociological Association
ISDR	International Strategy for Disaster Reduction
ISSC	International Social Science Council
ISSP	International Social Survey Program
IT	Industrial Transformation
IUPsyS	International Union of Psychological Science
IWR	Inclusive Wealth Report
IYGU	International Year of Global Understanding
JSPS	Japan Society for the Promotion of Science
JST	Japan Science and Technology Agency
JWC	Joint Water Committee
LA RED	Network of Social Studies in the Prevention of Disasters in Latin America
LERU	League of European Research Universities
LOICZ	Land–Ocean Interactions in the Coastal Zone
MDG	Millennium Development Goal
MENA	Middle East and North Africa
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MNCS	Mean normalised citation score
MOE	Ministry of Education
MOST	Ministry of Science and Technology (China)
MOST	Management of Social Transformations, UNESCO
MSA	Mean species abundance
MSC	Marine Stewardship Council
NDRC	National Development and Reform Commission (China)
NELSI	Nano, ethical, legal, social implications
NE³LSI	Nanoethical, environmental, economic and legal and social issues
NEPA	National Environmental Policy Act (United States)
NEPO	Ningxia Ecological Planning Office
NGO	non-governmental organisation
NIES	National Institute of Environmental Studies (Japan)
NRF	National Research Foundation (South Africa)
NSF	National Science Foundation (United States)
NSFC	Natural Science Foundation of China
NXDRC	Ningxia Development and Reform Commission
OECD	Organisation for Economic Co-operation and Development
OSSREA	Organization for Social Science Research in Eastern and Southern Africa
PERL	Partnership for Education and Research about Responsible Living
PES	Payments for ecosystem services
PRECIS	Providing Regional Climates for Impacts Studies
PTS	Post-traumatic stress
REDD	Reducing Emissions from Deforestation and Forest Degradation
RESCUE	Responses to Environmental and Societal Challenges for our Unstable Earth

RIA	Risk Interpretation and Action
RIHN	Research Institute for Humanity and Nature
Roshydromet	Federal Service for Hydrometeorology and Monitoring of Environment (Russia)
SCJ	Science Council of Japan
SCP	Sustainable consumption and production
SDGs	Sustainable Development Goals
SEIN	Social, ethical implications or interactions of nanotechnology
SLRG	Sustainable Lifestyles Research Group
SMS	Short message service
SSFC	Social Sciences Foundation of China
STI	Science, technology and innovation
TB	Tuberculosis
TERI	The Energy and Resources Institute (India)
TRC	Truth and Reconciliation Commission
UGC	University Grants Commission (India)
UGEC	Urbanization and Global Environmental Change
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGC	United Nations Global Compact
UNICEF	United Nations Children's Fund
UNISDR	United Nations Office for Disaster Risk Reduction
UNU	United Nations University
USGCRP	US Global Change Research Program
VARC	Vulnerability assessment for rural communities
WCED	United Nations World Commission on Environment and Development
WCRP	World Climate Research Programme
WHO	World Health Organization
WMO	World Meteorological Organization
WoS	Web of Science
WRF	Weather research and forecasting
WWF	World Wide Fund for Nature

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Changing global environments

1. Social sciences in a changing global environment

General introduction

by
Heide Hackmann and Susanne Moser

Global environmental change is linked to and exacerbates other social, economic and political crises such as poverty and inequality. Global sustainability requires urgent action to protect the planet and ensure human equity, dignity and well-being. The social sciences need to research the human causes, vulnerabilities and impacts of environmental change more effectively and inform responses to the challenges society faces. Social scientists need to work with each other and with colleagues from the natural and physical sciences to deliver credible, useful knowledge to help solve the world's problems.

The International Social Science Council (ISSC) is proud to present the second in its series of *World Social Science Reports*. The first, in 2010, was entitled *Knowledge Divides* (UNESCO and ISSC, 2010). It provided an overview of social science knowledge production, dissemination and use across the world, addressing the capacities of the social sciences to respond to fast-changing global realities. The ISSC decided that subsequent editions in the series should each have a thematic focus, directing the social gaze onto specific problems of global significance and taking stock of social science contributions to solving them.

The issue confronted in this *World Social Science Report 2013* is global environmental change, a phenomenon that encompasses all the biophysical changes occurring on the planet's land areas and in its oceans, atmosphere and cryosphere. Many of these changes are driven by human activities such as fossil fuel consumption, deforestation, agricultural intensification, urbanisation, the over-exploitation of fisheries, and waste production. Global environmental change includes biodiversity loss, large-scale shifts in water resources, fundamental changes in the nitrogen and phosphorus cycles, ozone depletion and ocean acidification. It also includes climate change, which according to the Intergovernmental Panel on Climate Change (IPCC), is the most serious of today's global environmental issues for humanity. All these changes are intimately connected to accelerating production and consumption, a growing population, socio-economic and cultural globalisation, and widespread patterns of inequality. Together they comprise a major feature of contemporary life, requiring innovative policy and social transformation.

Why a social science report on global environmental change?

Global environmental change has potentially grave consequences for the well-being and security of people all over the world. They are so grave, in fact, that warnings about an impending global humanitarian emergency are proliferating (e.g. Rockström et al., 2009; Brito and Stafford Smith, 2012; Ehrlich and Ehrlich, 2013). Such warnings are indeed pertinent: most environmental trends are negative, accelerating and in some cases mutually reinforcing, and the consequences of these changes are real and unfolding, affecting individuals and communities everywhere. When it is recognised how these problems interact with and exacerbate other social, economic and political crises – including persistent poverty, increasing inequality and socio-political discontent – a clear sense of urgency emerges. Equally clear is the challenge before society: to secure a sustainable world through effective responses to today's interacting processes of environmental and social change.

Global sustainability requires concerted action to protect the planet's bounty and, simultaneously, to safeguard social equity, human dignity and well-being for all

The *World Social Science Report 2013* picks up this challenge by issuing an urgent and decisive appeal to the social sciences[1] to research more effectively the human causes, vulnerabilities and impacts of environmental change, and thus to inform societal responses to the sustainability challenges that society now faces. It urges social scientists to work closely not only with each other, but also with colleagues from the natural, physical, engineering, health and human sciences on accelerating the delivery of credible and legitimate knowledge for real-world problem solving.

Today's global environmental problems are shared problems that require joint effort, not only across the sciences but also between science and its many stakeholders and users. In this collaborative context, the burden of today's unrelenting pressure on science to be relevant falls particularly heavily on the social sciences.

What makes it so? There are three defining attributes of today's changing global realities that call for a fundamental rethinking of how we understand and address global environmental change. Each calls for intensified, and in many instances refocused, social science research.

The inseparability of social and environmental systems and problems

Environmental problems cannot be separated from the other risks and crises that comprise current global realities. They are not disconnected challenges; they do not occur in discrete, autonomous systems rooted in the environment on the one hand, and in society on the other. Instead, they are part of a single, complex system where the environmental, political, social, cultural, economic and psychological dimensions of our existence meet and merge. Consequently, global environmental change is simultaneously an environmental and a social problem.

For this reason, researchers across the disciplinary spectrum have for some time spoken of "social-ecological" or "coupled human-natural" systems. Social science research helps us to comprehend the complex dynamics of these systems. It examines how problems are connected: for example, how climate change interacts with water and food security, economic development, social inequality, poverty, migration and conflict. It explores how people's vulnerabilities to different types of change are interrelated, and what human consequences the actions taken in response to one set of problems may have for another.

If society is to be serious about slowing or reversing global environmental trends, about reducing vulnerabilities, minimising impacts and improving human well-being, the social sciences must step forward more forcefully to inform understanding of these social-ecological systems. Social science can help explain how these systems unfold and interconnect across space, from the local to the global, and in time, from the past and present into the future. These insights will help unblock the inherent limitations of our current thinking and language about these systems, articulate new narratives that transcend the nature–society dichotomy, and identify opportunities for new and more effective solutions.

A human condition without precedent

Humans are living at a time when the Earth's land surface and climate, its elemental cycles, oceans, fresh water, ice, air and ecosystems have all been altered fundamentally from the state they were in even just a few centuries ago. This is a remarkable and unique trait of the conditions in which society now finds itself. And scientists know with great confidence that these changes are attributable primarily to human activity. The Nobel Prize-winning chemist Paul Crutzen (2002) proposed calling this unprecedented time the Anthropocene: a new geological era in Earth's history, in which humans are the defining geological force, and the first in which that force is "actively conscious of its geological role" (Palsson et al., 2013).

In the Anthropocene, people assume centre stage. This makes the causes, consequences and responses to global environmental change fundamentally social in nature. Global environmental change is about humans changing global environments, and about humans, individually and collectively, shaping the direction of planetary and social evolution.

The social sciences thus have a vital role in enriching society's understanding of what it means to live – and maybe thrive – in the Anthropocene, and in raising awareness of the opportunities, accountabilities and responsibilities this brings with it. The social sciences need to help answer questions about how the role of humans as environmental culprits can be reconciled with their role as inheritors and even victims of the environmental problems we create. They must also help society understand what defines or increases the human potential to break out of either mould, and explore what makes people into agents of deliberate change. Finally, the social sciences can help explain how people find the will and creativity to deploy their agency to safeguard human security in an equitable and environmentally sustainable manner.

Urgent and fundamental social transformation

The third defining trait of this time pertains to the fundamental nature of change that society may either seek out deliberately, or be subjected to involuntarily. If society takes seriously the fact that the planet's systems are under rapidly growing and unsustainable pressures, and that human systems are inextricably linked to their fate, it becomes clear that human security is at stake. Human security is understood here in the broadest sense. It involves people having the options they need to reverse, mitigate or adapt to threats to their basic needs and rights, and the capacity, freedom and sense of responsibility to pursue these options (GECHS, 1999). Deep social transformation is needed if societies are to maintain or establish human security, and pursue the larger quest for global sustainability in the face of human-caused degradation of essential life support systems.

The social sciences are uniquely placed to clarify what this means. Through engaged research, they can help society as a whole understand the nature and scope of the changes required at individual, organisational and systemic levels, and how such changes could be realised in politically feasible and culturally acceptable ways.

A further important task for the social sciences is to understand the role of science in fostering deliberate, inclusive, democratic and hence deliberative processes of transformation. And it is equally vital for the social sciences to advance society's understanding of how scientific and other forms of knowledge can be integrated to achieve culturally sensitive, locally appropriate, yet globally effective transitions to sustainability.

Given these features of today's global realities, the case for greater engagement by the social sciences is clear. Their knowledge is indispensable for a clearer understanding of the causes and consequences of global environmental change, and for informing more effective, equitable and durable solutions to today's broader sustainability problems. This is what makes the *World Social Science Report 2013* on global environmental change both relevant and timely.

Objectives of the Report

The *World Social Science Report 2013* has five specific objectives.

First, to ***develop a social science framing of global environmental change and sustainability.*** It highlights how the questions change, the understanding deepens, and the options for interventions open up when critical social science questions are posed and when the challenges at hand are viewed through a social lens.

Second, to ***showcase some unique contributions that the social sciences can make***, taking different disciplinary and interdisciplinary perspectives into account, and writing from or about different regions of the world. While this cannot be an exhaustive review of all the social science work being done, it does illustrate how the social sciences shed light on a range of global environmental challenges. It reveals important aspects and differences about how environmental change unfolds in context, and how attempts to transition to a more sustainable way of living on Earth are experienced across the globe.

Given the urgent need to curtail destructive human impacts on the planet and enable people to adapt to already changing circumstances, a third objective of the Report is to ***explore and assess how well social science knowledge about changing global environments is linked to policy and action***. The social sciences have much to contribute to a better understanding of how research (from any discipline) and policy are linked, and to reflect on the challenges that this linkage poses to the production and use of knowledge. The Report offers insights into these dynamics, alongside examples of how the social sciences are attempting to change their own interactions with the world of policy and practice.

The two final objectives move from description and analysis to action. As the contributions to this Report reveal, particularly in Part 2, the present capacity of the social sciences is highly uneven across the globe, and inadequate everywhere, to deliver the knowledge of global environmental change and sustainability which is now called for. In this light, the Report aims to show the need for more environmental social science and for more environmental social scientists, and in this way, to ***influence research programming, science policy-making and funding at national, regional and international levels***.

Finally, and perhaps most importantly, this Report aims to ***mobilise the wider social science community to engage more effectively, and take the lead in developing a more integrated and***

transformative science of global change and sustainability. This is directed at all social scientists, those already working on these issues, and particularly those whose work is relevant to this topic but not labelled "environmental". For example, social scientists researching social movements, other historical periods of deep social transformation, or human responses to existential threats, can offer highly relevant insights on the environmental challenges at hand.

The more than 150 authors of this Report are drawn from across the globe. They all speak in their own voices to these five objectives, though none alone can meet all of them. And while the individual contributions to the seven parts that follow come from the full range of social science disciplines, from some of the human sciences (philosophy, history and the arts), and from interdisciplinary fields of study, the Report is organised around core themes rather than disciplines. Disciplinary knowledge provides an important foundation for understanding different aspects of lived reality. Yet on their own, disciplines are limited in their ability to grasp the full complexity of what was, is and might be. Experiences, practices, geographically and socially situated actions and interactions, policies and decisions, are always multilayered, and defy such bounded perspectives. At the same time, viewing a single issue from different disciplinary vantage points can deepen and enrich our understanding, and inform policy or programmatic interventions. Thus disciplinary contributions and more interdisciplinary and synthetic perspectives all have a place in this Report.

The context: A changing environment for global environmental change research

A brief history of social science research on global environmental change

Systematic research on global environmental change by social, behavioural and economic scientists, and by the humanities, dates back to the 1950s. Apart from human geographers, anthropologists pioneered the study of the human–environment interaction, with "cultural ecology" emerging in the 1950s and "ecological anthropology" in the 1960s. "Ecological economics", "environmental sociology", "environmental history", "environmental philosophy", "literary ecocriticism" and "ecolinguistics" all followed in the 1970s, and "environmental psychology" emerged in the 1980s, followed by "ecopsychology" and "historical ecology" in the 1990s (Palsson et al., 2013; Gardner and Stern, 2002; Roszak, Gomez and Kanner, 1995).

Today, environmental problems, particularly climate change, are acknowledged research domains in most social science disciplines, and increasingly in the humanities. These important efforts are highlighted in the contributions to this Report from the international social science associations, research consortia and related organisations that are members and partners of the ISSC.

In 1990, the ISSC established what is today known as the International Human Dimensions Programme on Global Environmental Change (IHDP). The aim was to assist in building the capacity and critical mass among social scientists which was needed to contribute to a better understanding of the social and human dimensions of global environmental change. Through the voluntary commitments of leading social scientists across the world and by the organisation of internationally collaborative research projects, the IHDP contributed significantly to building the social science knowledge base on global environmental change and indeed to bringing the social sciences to the heart of international global environmental change and sustainability research. The achievements of its international projects are highlighted in Part 7 of this Report.

From margin to centre: The call for knowledge integration

Despite these efforts, the social sciences have remained marginal to global environmental change research in the post-war era. As contributions to Part 2 show, it is a field that has been and continues to be dominated by the natural sciences. At the same time, and as further discussed in Part 7, global environmental change has failed to capture the attention and imagination of the more traditional, mainstream social sciences, the core of the disciplines which view the social and human world as their focus. For them, social phenomena, relationships, interactions and human behaviours may take place on an environmental stage, but they tend to be understood as being determined by humans alone.

To remedy their marginality, social scientists and their supporters face a dual task: to secure a space for the environment within the social sciences, and an equally important and central space for the social sciences within the broad field of global environmental change research.

Environmental change research now aims more than ever to integrate the social, natural, human, engineering and health sciences. Integration in this case does not imply the loss of disciplinary strengths or identity. On the contrary, it means being confident in one's disciplinary base whilst remaining open to other ways of viewing and studying the world, open to asking new and different kinds of questions that emerge from an appreciation of the contributions that different disciplines and perspectives bring. Integration means engaging with colleagues from other disciplines and fields in the joint, reciprocal framing of problems and research questions, and in the collaborative design, execution and application of research.

Obstacles to knowledge integration

This emphasis on integrated science is dictated by two related facts: the complexity of the interconnected environmental and sustainability challenges that society faces, and the inability of any single discipline or scientific domain to understand, let alone address, such complexity. This emphasis is not new. Appeals for closer collaboration, particularly between the social and natural sciences, date back to at least the 1970s (Tsuru, 1970; UNESCO and ISSC, 2010; Mooney, Duraiappah and Larigauderie, 2013). Yet despite the progress that has been made by many academic groups and in many scientific institutions across the world – reflected in a number of the contributions to this Report – the task of bringing the different sciences together in integrated global change research remains difficult. As a result, the track record on which to draw remains limited.

There are many reasons for this difficulty (see Part 7 of this Report and Chapter 10, *World Social Science Report 2010*). Generally, disciplines still dominate academic and funding practices, and differences persist in the research cultures, standards and norms of different fields. Integration depends on the effective building of relations of trust. Trust is emergent and cannot be imposed. It requires time and supportive rather than competitive institutional environments. Global environmental change research brings yet further challenges. Researchers from different fields frequently accuse each other of naiveté regarding their understanding of the social or the physical world, and while the natural sciences often give preference to analysis at the global scale, the social sciences tend to work at a local or even individual level.

Another obstacle to integration stems from the fact that assessments of what knowledge is or is not relevant to the question at hand have traditionally been determined by the natural sciences. Much work remains to be done beyond this Report, to clarify what integration means in practice, find effective ways of implementing it, and adjust institutional practices to support it.

New opportunities in integrated, solutions-oriented research for sustainability

Such work is now being undertaken within Future Earth, an ambitious new ten-year international programme of research for global sustainability (see Box 1.1).

This initiative seeks to deliver a step change in the way science for sustainability is produced and used. Central to this ambition is a commitment to engage a wider scientific community and to effectively integrate efforts across scientific fields, in order to find the best scientific solutions to complex, multifaceted problems. Equally important within the Future Earth vision is an emphasis on bringing policymakers, practitioners, business and industry, as well as other sectors of civil society, into the co-design, co-production and co-delivery of knowledge for sustainability.

Future Earth marks significant progress in securing a real commitment from researchers, science policymakers and funders to integrated, solutions-oriented research. It provides a unique and robust institutional basis for accomplishing something that has long been called for: research that brings the natural, social, human and engineering sciences together in timely, meaningful dialogue and collaboration around joint agendas. It fosters knowledge production guided by a vision of science working with society to find solutions for global sustainability. This approach defines the context within which this Report has been prepared and within which the challenges it poses to the social sciences must be understood.

Box 1.1. **Future Earth and the Science and Technology Alliance for Global Sustainability**

Future Earth was launched during Rio+20, the 2012 United Nations Conference on Sustainable Development held in Rio de Janeiro, Brazil. The programme seeks to provide the knowledge required for societies to respond effectively to the risks and opportunities posed by global environmental change and to support transformation towards global sustainability. It will bring together and build on the strengths of more than three decades of global environmental change research promoted and coordinated by the World Climate Change Research Programme, the International Geosphere-Biosphere Programme, DIVERSITAS (an international programme on biodiversity), the IHDP, and the Earth System Science Partnership.

Future Earth will provide an international hub for the coordination of research on three themes: Dynamic Planet, Global Development, and Transformation towards Sustainability.

Future Earth is sponsored by the Science and Technology Alliance for Global Sustainability. The Alliance, which was established in 2010, is an international partnership based on a shared commitment to promoting the use of science and technology in informing equitable, sustainable solutions to the most pressing questions currently confronting humankind. Its membership includes the ISSC, the International Council for Science (ICSU), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environmental Programme, the United Nations University, a group of major funders of global change research known as the Belmont Forum, and the World Meteorological Organization.

www.futureearth.info
www.stalliance.org

The framework for the Report: Transformative cornerstones of social science research for global change

The engagement of the social sciences will be critical to the success of initiatives such as Future Earth. What can the social sciences bring to integrated global environmental change research? And what are the unique contributions they can and must make to deliver solutions-oriented knowledge for global sustainability?

These are the questions that the ISSC set out to answer in a 2012 report entitled *Transformative Cornerstones of Social Science Research for Global Change* (Hackmann and St. Clair, 2012).[2] The knowledge framework presented in that report identifies six sets of questions that have to be answered if research on concrete environmental problems is to inform actions that result in ethical and equitable transformations to sustainability. These questions are critical social science questions, bringing the full spectrum of theoretical and empirical, qualitative and quantitative, and basic and applied social science knowledge to bear on the urgent challenges of today (see Box 1.2).

The six transformative cornerstones form the thematic framework for the *World Social Science Report 2013*. This framework was used to solicit contributions to the Report and provides the structure according to which submissions have been selected and organised in the sections that follow.

Box 1.2. **Transformative Cornerstones of Social Science Research for Global Change**

The *Transformative Cornerstones* report (Hackmann and St. Clair, 2012) provides a research framework for understanding climate and other environmental changes as social processes embedded in specific social systems. The framework provides tools to question and rethink the shape and course of those processes and systems through time. They are called transformative because answers to the questions raised in each cornerstone should inform actions that result in ethical and equitable transformations to sustainability. Below is a summary of the full report.

Cornerstone 1 Historical and contextual complexity

The first cornerstone concerns the complexity of global change. Social science needs to understand the political economy of these processes, and how they relate to other social problems, including persistent poverty. The task here is to distinguish between the interconnected drivers of global change, and to clarify the interdependencies of people's vulnerabilities to these and other social processes, such as migration or conflict. In-depth historical analyses are needed to explain the complex trajectories that have led to today's unsustainable lifestyles and models of progress, and to draw lessons from earlier instances of transformative change. It is also important to understand the influence of context: to address how global change risks, impacts, perceptions, experiences and responses differ across the world, across social classes, gender, race or faith, and between personal or professional identities.

Cornerstone 2 Consequences

Identifying and mapping current and future threats from global environmental change and their impacts on people and communities is the work of the second cornerstone. It is about exposing the diverse realities of living with such change, and calls for a special focus on poor and vulnerable communities. Research on the consequences of environmental change

Box 1.2. **Transformative Cornerstones of Social Science Research for Global Change** *(cont.)*

advances our understanding of the lives of those affected by processes such as climate change, including their coping mechanisms, responses, innovations and limitations. It raises important questions about social boundaries and tipping points related to environmental pressures on human systems, economies and the social fabric of life. This cornerstone also requires study of the outcomes of policy solutions and technologies, and how both can be improved.

Cornerstone 3 Conditions and visions for change

This cornerstone is about social change: how it happens, at what levels and scales, and what directions it might take. The purpose is to understand what drives individual and collective change, including changing social practices. It identifies what kind of leadership and what other capacities are required for successful change to occur, while being absolutely clear about the limitations and democratic pitfalls of deliberate intervention. Another goal is to shed light on criteria for successful, transformative actions towards equitable sustainability at the local, community level, and on how to scale these up into transformative global thinking. Feasible visions for change matter, but so do the methods and procedures by which they are built and the ways in which global change and its consequences are framed. This cornerstone raises questions about different narratives of socially desirable change, lifestyles and alternative futures. It also addresses concerns about social engineering, and asks about the feasibility of participatory approaches to achieving alternative visions of the future. Building consensus in ways that include marginalised and non-scientific views is a key challenge.

Cornerstone 4 Interpretation and subjective sense-making

This cornerstone confronts the values, beliefs, interests, worldviews, hopes, needs and desires that underlie people's experiences of and responses (or lack thereof) to global change. These in turn shape personal narratives and social discourses about the nature of the world and the environment, and so drive people's views on the necessity for a transformation to global sustainability. It challenges social scientists to make sense of the assumptions and blind spots that underlie choices and priorities. These assumptions can block awareness of what needs to change and keep systems deadlocked in inaction. This cornerstone raises questions about the nature and role of transformative learning, and investigates the reasons for indifference, scepticism and denialism in the face of potential cataclysms such as climate change.

Cornerstone 5 Responsibilities

The double injustice imposed by the effects of environmental change on already vulnerable populations and on those without a voice calls for urgent work on what it takes to foster global and intergenerational solidarity and justice. It cannot be assumed that all responses will be "just" interventions. This cornerstone foregrounds obligations, duties and responsibilities to poor and vulnerable people and to future generations, bringing these concerns into the legitimate space of scientific inquiry, policy and practice. It addresses methods, evaluation systems and policy mechanisms, and ensures ethical approaches in the development of new visions and the building of new social systems. It focuses an ethical lens on all interpretations of and responses to environmental change, be they of a technical, political, economic or discursive nature.

Box 1.2. **Transformative Cornerstones of Social Science Research for Global Change** *(cont.)*

Cornerstone 6 Governance and decision-making

Many of the policy processes related to environmental change are poorly understood. Social science knowledge is needed on how decisions are made in the face of uncertainty; what pathways are available for influencing decision-making; what determines the success or failure of political agreements; and what drives political will. Knowledge is also needed of the possible effects of different ways of framing environmental change on policymakers and practitioners. Not all expert input has the same policy appeal or is given an equal hearing by those in power. It is important to understand the role of science in policy processes, to know what makes knowledge work, whose knowledge counts, and where the limits of expert knowledge lie. This cornerstone focuses on institutional design and reform, and on building structures to enable dialogue across competing interests, values and worldviews, under conditions of uncertainty.

Source: Hackmann, H. and A. L. St. Clair (2012), *Transformative Cornerstones of Social Science Research for Global Change*, International Social Science Council, *www.worldsocialscience.org/documents/transformative-cornerstones.pdf*.

Development of the Report

The ISSC developed this Report as part of its strategic partnership with UNESCO and under the guidance of a Scientific Advisory Committee composed of renowned scholars from different scientific disciplines and geographical regions of the world.

In 2012, the ISSC issued a global call for contributions via the networks of the Council's membership and partners, including UNESCO. A large number of abstract submissions were received and reviewed by the Report's editorial team. Full papers were requested on the basis of quality and fit. Where gaps in the coverage emerged, the ISSC commissioned authors to write on specific topics. A bibliometric analysis of the production of social science research on issues of climate change and global environmental change was also commissioned. In addition, the ISSC invited its regional social science councils and professional disciplinary associations, unions and co-sponsored programmes, as well as the Organisation for Economic Co-operation and Development (OECD) and UNESCO, to prepare brief overviews of their contributions and accomplishments in global environmental change research. All commissioned and invited contributions were submitted for external peer review. Throughout the selection and commissioning process, attention was paid to the geographical, gender and disciplinary distribution of the more than 150 authors of this Report.

Members of the editorial team wrote the introductions to each section of the Report, and the entire Report was externally reviewed by four prominent scholars from different regions of the world.

Structure and audiences of the Report

Part 1 sets the stage for the Report, with a number of social science perspectives on the big picture complexities of global environmental change and sustainability. These contributions address aspects of Cornerstone 1. Part 2 augments this global introduction with a review of social science capacity and research activity in different regions of the world. In Part 3, the Report turns to the consequences of global environmental change (Cornerstone 2), providing a number of examples of how the social sciences study them across issue areas and regions of the world. Part 4 focuses on visions and conditions for change, as well as subjective interpretations and sense-making (Cornerstones 3 and 4). Part 5 picks up the difficult topic of ethics and responsibilities (Cornerstone 5), while Part 6 addresses the increasingly important issue of governance and decision-making (Cornerstone 6). Part 7 provides an overview of the contributions made to global environmental change research by ISSC members, programmes and partners, including international disciplinary associations and projects of the IHDP. The conclusions draw out the larger findings and messages of this Report. They recommend a range of priority action steps that could strengthen social science's ability to help shape effective, equitable and durable solutions to global environmental change and sustainability.

The annexes give more detail of the bibliometric analysis undertaken in support of the regional assessments discussed in Part 2. In line with the ISSC's commitment to provide regularly updated information on the state of global social science knowledge production in each *World Social Science Report*, statistical indicators of such production are also provided in the annexes.

The *World Social Science Report 2013* was prepared with multiple audiences in mind. All have a crucial role to play in promoting understanding of the human dimensions of global environmental change, developing the requisite social scientific knowledge base, building the necessary research capacities, mobilising the social science community to become engaged, and ultimately applying the resulting knowledge. All are crucial to realising the new charter for the social sciences promoted in the conclusions of this Report.

Social scientists themselves are the first audience. So are colleagues in the natural, engineering, medical and human sciences concerned with global environmental change and sustainability. Both need to reach out to the other. But they will do so more often and faster if they find support from several of the other audiences for this Report. These include international scientific councils like the ISSC and ICSU, the professional associations they bring together, global programmes such as Future Earth, as well as international organisations including UNESCO and other relevant UN agencies and programmes. Then there are universities and academies in all fields of science, and those agencies and foundations that are financing and evaluating research at the international, regional and national levels, and in the public and private sectors. And finally, this Report aims to speak to those who might look towards and work with the social sciences to produce new knowledge and generate new insights: decision-makers, policy shapers, practitioners, civil society organisations, and the rapidly changing world of the media and other science translators.

Moving forward

The *World Social Science Report 2013* is a truly collaborative effort. Contributions from across the world have been brought together into a unique and rich overview of how researchers from different social science disciplines, and interdisciplinary teams, are applying the transformative cornerstones of social science research to concrete global change challenges.

The Report does not represent a single, unified social science voice, nor should it. And while it makes an effort to cover some of the biggest problems of global environmental change, and related social challenges confronting contemporary society today, it cannot cover everything. The contributions reflect current preoccupations and trends in a constantly changing and expanding area of work, as much as existing and growing capacities to pursue them. It is indicative of past accomplishments but does not limit future possibilities. The field is growing, wide open, and rife with opportunity to broaden and deepen what social scientists do on the topic of global environmental change and sustainability.

Much like an artful elephant installation appearing unexpectedly on an urban plaza or at the edge of the sea, this Report invites its readers to consider new or unusual perspectives, gather new insights and understandings, and perhaps walk away thinking differently. The implications of using a social lens to examine global environmental change and sustainability, and taking the insights resulting from that changed perspective seriously, are indeed profound.

Notes

1. Throughout this Report, and in line with the ISSC's scientific membership base, reference to the "social sciences" should be understood as including the social, behavioural and economic sciences.
2. This was conducted in partnership with UNESCO, the IHDP and the United Nations Research Institute for Social Development, and supported by the Swedish International Development Cooperation Agency and the Belmont Forum.

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2. Global environmental change changes everything

Key messages and recommendations

by
Susanne Moser, Heide Hackmann and Françoise Caillods

Drawn from the more than 150 authors in the World Social Science Report 2013, the key messages and recommendations call for a new kind of social science – one that is bolder, better, bigger, different. There is a need to reframe global environmental change as a social process, infuse social science insights into problem-solving processes, encourage more social scientists to address global environmental change directly, and change the way the social sciences think about and do science to help meet the interdisciplinary and cross-sector changes society faces.

"The fact is that, with the ecological crisis, we are trapped in a dual excess: we have an excessive fascination for the inertia of the existing socio-technical systems and an excessive fascination for the total, global and radical nature of the changes that need to be made. The result is a frenetic snails' race. An apocalypse in slow motion. Changing trajectories means more than a mere apocalypse and is more demanding than a mere revolution. But where are the passions for such changes?" (Latour, 2010)

We live in extraordinary times. The environmental challenges that confront society are unprecedented and staggering in their scope, pace and complexity. Planetary and social crises are converging. Knowledge of their interactions is often uncertain and incomplete, and our responses are incomplete at best. While these immense problems may in fact only ever be addressed piecemeal through partial, incremental and adaptive solutions, there are growing calls for grand solutions. These calls emerge from growing anxiety, social discontent, and distrust of precisely those institutions previously entrusted with managing the affairs of society: governments, businesses, organised religion, and indeed science and technology.

This paradoxical situation defines today's global environment for science. It is a time of urgency and of unrelenting pressure on scientists to make a difference: to provide better understanding and more precise predictions of the challenges societies face, and to accelerate the delivery of relevant, credible and legitimate knowledge that can inform solutions to the world's accumulating sustainability crises. Yet at the same time, many view traditional ivory tower science, defined and practised by discipline, as unable to assist with these daunting tasks. Business as usual science is increasingly distrusted and questioned even by scientists themselves. So not only are there ever-louder calls for science to help with real-world problem solving, there is also a demand for science itself to change.

The reality that emerges from the *World Social Science Report 2013* is that global environmental change changes everything. It is the "elephant in the room" that can no longer be overlooked. Global environmental change changes our life support systems, the very basis of life humans depend on. In myriad and differentiated ways, it affects our chances of survival, our livelihoods, ways of life, actions and interactions. It changes everything for those of us making decisions that affect the human-made and natural environment, and for those of us trying to understand, scientifically or not, the profound changes unfolding around us.

Transformative knowledge for global sustainability: A new charter for the social sciences

This call on science to make a difference, to help solve global problems, speaks to the social sciences no less than it does to the natural, physical, human or engineering sciences. The concrete environmental challenges that societies face – water scarcity, the loss of biodiversity, the transition to a low-carbon society, food security, or greater preparedness for extreme events – are shared challenges, requiring joint scientific effort and priority setting. Today's increasing emphasis on the need for integrated science repeatedly stresses the critical importance of bringing the social sciences more fully on board. Social science knowledge is being recognised as indispensable knowledge. The causes of global environmental change are partly or mainly social; the consequences of such changes affect human lives, livelihoods and well-being, and interventions aimed at addressing them will create complex processes of societal transformation that require further study. Clearly, "progress in understanding and addressing both global environmental change and sustainable development requires better integration of social science research" (Reid et al., 2010).

But what kind of social science is needed? The "transformative cornerstones" framework developed by the International Social Science Council (ISSC) (Hackmann and St. Clair, 2012) articulates the unique contributions that the social sciences – theoretical and empirical, quantitative and qualitative, basic and applied – must now make to the issues at hand. The framework identifies a set of fundamental social science questions that, if answered, should increase society's understanding of the causes, consequences and responses to the problems of environmental change and sustainability, and help to ensure that decision-makers in all sectors, and ranging in scale from the international arena to local communities, find more effective, legitimate and durable solutions to these problems (see the introduction to this Report for an overview of the transformative cornerstones).

The *World Social Science Report 2013* builds on this framework by providing examples of social science work on different environmental challenges for each cornerstone, from different parts of the world and from different disciplines. It does not present a comprehensive review of social science research on global environmental change, nor does it cover the full spectrum of challenges confronting societies in different regions of the world. Instead it shows examples of social science research that examines, understands and interprets global environmental change, climate change and transitions to sustainability.

It explains them as fundamentally social processes taking place within complex social-ecological systems.

For many, the need to work within the transformative cornerstones framework to view global environmental change and sustainability through the social lens is already a central and self-evident necessity. For many others, however, this shift in perspective remains difficult. Many in the social sciences still consider environmental issues – even those that threaten the very foundation of modern society – as marginal to the core of their disciplines. Others prefer to stay away from what they see as policy-relevant and sometimes politicised issues and subjects, and even criticise colleagues who choose practical engagement in and through their work. Sometimes those criticisms are indeed pertinent; the involvement of researchers in policy and practice necessitates constant reflection and critical self-awareness of their role as experts influencing opinions and outcomes. This self-awareness and reflexivity are not always a given. Meanwhile, many in the physical, natural and engineering sciences still cannot see the importance of social science insights to real-world solutions. And many decision-makers either do not know what the social sciences could bring, or conversely, hold unrealistically high expectations of what they should be able to deliver.

So what is needed? Social scientists and their advocates need to explain why a social science perspective on environmental issues matters, how environmental change and sustainability are deeply and fundamentally social, and what social science brings to the search for solutions. Social scientists working on environmental issues need to engage much more with social scientists whose work in the mainstream disciplines is relevant to the field yet remains untapped. Social scientists must also show the difference that their science can make. They are responsible for contributing social science that helps shape novel solutions, or which makes existing solutions more effective, fairer and more durable. And social science research systems around the world need to grow their strengths. This involves growing in numbers and capabilities to build a more engaged and effective workforce, which in turn can bring the crucial social science perspective to the understanding and management of environmental problems and sustainability challenges.

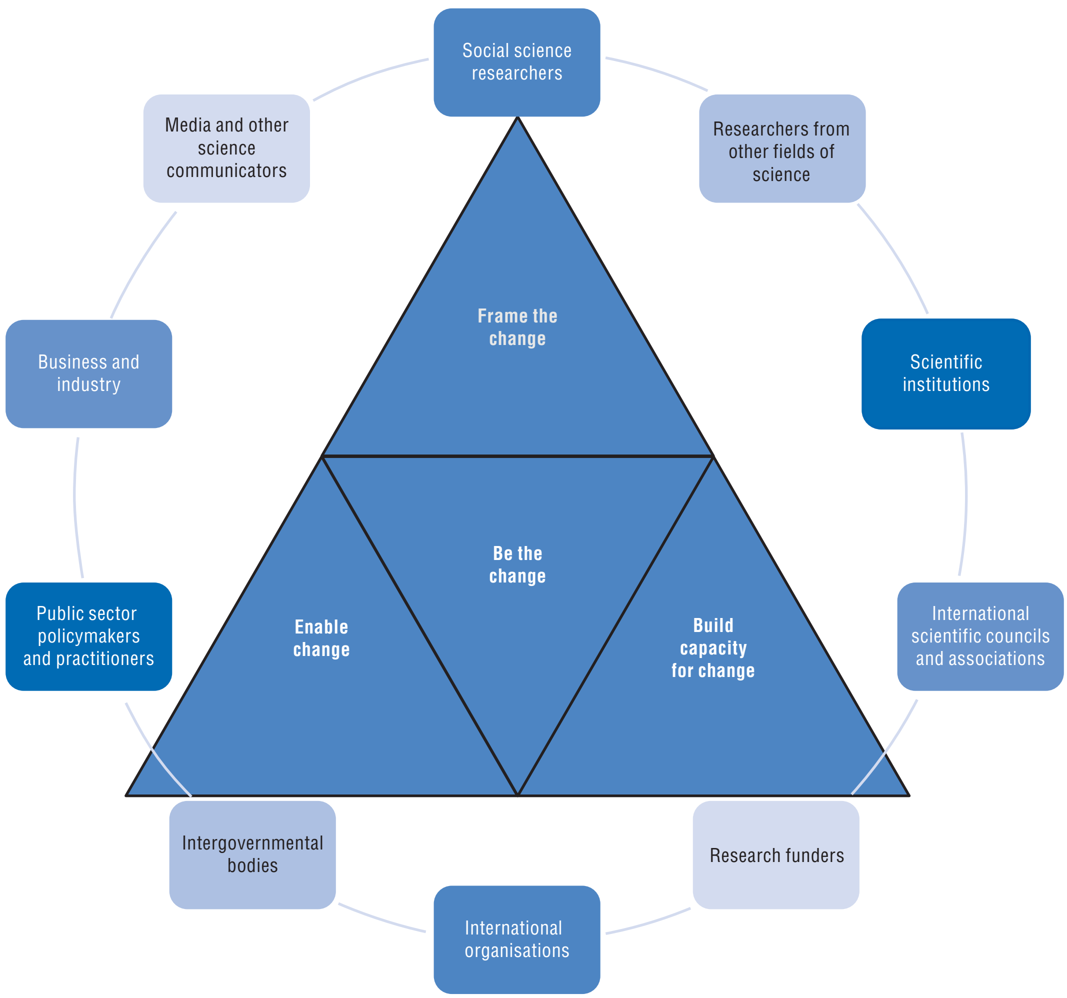
What is needed, in other words, is a new kind of social science, one that is bolder, better, bigger and different. This does not mean that the well-honed traditions of classic social science research are no longer needed; on the contrary, such social science will continue to provide an important knowledge-creating function that moves forward our fundamental understanding and ways of thinking. But when it comes to tackling environmental change and sustainability, those working in this tradition should feed into and be complemented by a social science that is:

- **bold** enough to reframe and reinterpret global environmental change as a fundamentally social process
- **better** at infusing social science insights into real-world problem solving
- **bigger**, in terms of having more social scientists to work on addressing head on the challenges of the Anthropocene era
- **different**, in the sense of reflecting upon and changing its own ways of thinking and doing science – its theories, assumptions, methodologies, institutions, norms and incentives – in order to contribute effectively to meeting the vexing interdisciplinary and cross-sector challenges that society faces.

The Report issues an urgent call to action to the social sciences, and to their supporters, funders, collaborators and users, to make such a bolder, better, bigger and different social science a reality

The call is detailed in four key messages that have been crystallised out of the Report's many and varied contributions. In setting out each key message, this section highlights selected findings from the Report to demonstrate how the social sciences are contributing, and in some cases to challenge them to step up to the plate more fully. Each key message comes with a set of high-priority actions for social scientists and the stakeholders in social science to take up in response to each call.

Figure 2.1. **The four main messages of the *World Social Science Report 2013* and the stakeholder communities to whom they are addressed**



Frame the change

For the past few decades, the physical, natural, and later the economic sciences have led the way in detecting, diagnosing and framing the challenges and solutions for every type of global environmental change. They have provided a particular lens through which to view and understand the problem, and have shaped the ways in which policymakers and society at large think about its causes, consequences and solutions. The reasons are at once methodological, epistemological and ontological, and as such are deeply historical and cultural. Yet framing global environmental change as matters of physics, molecules and species, or of unimaginably large or imperceptibly small quantities of far-away or invisible substances, provides a limited perspective that does not capture most people's imagination or attention. Such frames obscure the social, economic, political, cultural and ethical nature of the issues at hand. They obscure the role of people, behaviours, practices and institutions. And they limit which analyses and solutions are deemed possible and relevant (Connell, 2011). For example, social frames of environmental and sustainability issues might point as much to problematic governance, economic injustice, political disenfranchisement, destructive behaviours and social norms as positive levers of change, in addition to the technological solutions that are often sought. Inevitably such reframing involves and makes visible the normative judgements involved in all forms of interpretation and sense-making, and itself becomes an instance of social negotiation among all those involved.

The social sciences must help to fundamentally reframe climate and global environmental change from a physical into a social problem

Authors in this Report find repeatedly that problems such as biodiversity loss, climate change and changing nutrient cycles cannot fully be grasped without understanding the human drivers of change. Nor can the importance of such problems be judged without understanding what they mean for people and in what contexts they unfold. Sustainability challenges, including the eradication of poverty, cannot be solved without understanding human aspirations, institutional constraints, social conflicts, value choices or power dynamics (and vice versa). The resilience or collapse of systems cannot be understood by measuring temperature increases, predicting earthquakes or tracking tropical storms alone. Regional differences in economic stagnation or development are not adequately explained by climate conditions, the number of species or the quantity of natural resources. Statements about the planet's finite resources will not lead to reduced consumption or to a more equitable distribution of resources without a better understanding of how to transform international markets, more equitable access to them, and a fairer distribution of finite resources. A policy or technology cannot be valued without understanding its social impacts and uses. And technology does not exist in an economic, policy or social vacuum. Indeed, the introduction of new technologies without an understanding of their sociocultural contexts, social consequences and possible risks is at the heart of the troubles society now finds itself in.

A bold first step which many social scientists are now taking is to claim the space of the problem framers. This involves understanding how climate and environmental changes have come about, what they mean for people, and what people can do about them (Box 2.1 below). Causes, vulnerabilities, impacts and solutions are human; they are embedded in institutions, market structures, behavioural norms, social relationships and practices, which enable and constrain the action space for change. This is the focus the social sciences bring.

Beyond the overarching frame of climate and environmental change as a social problem, there will be a multitude of more specific framings. Climate change might be framed, for example, as a symptom of a dysfunctional society; global environmental change as the unprecedented rise of a single species affecting the entire planet; biodiversity loss and resource depletion as a market failure (in other words, as inadequately internalised costs of the human use of the environment); and global change as an opportunity for fundamental transformation and creative innovation. For social scientists, claiming the right to frame these issues through a social lens will involve transdisciplinary approaches that engage

Box 2.1. **Framing the change**

Selected examples from the Report show how the social sciences can change perspectives on, questions about, and understandings of global environmental change.

- Social sciences reveal the complex ways in which global environmental change and other social crises including poverty are deeply interconnected, and cannot be understood or addressed separately from each other.
- Social boundaries of social-ecological systems, defined as the limits beyond which human well-being is endangered, complement the notion of planetary boundaries, the maximum amount of pressure humanity can place on critical Earth systems. Together they define a "safe and just space" within which humanity can thrive.
- Visions and visioning are essential tools to frame hopeful, possible, feasible futures, and counteract despair and fatalism. If placed in constructive tension with visions of plausible but darker futures, and accompanied by persuasive measures, they can inspire and move society in a positive direction.
- The humanities and the arts are essential in exploring what it means to be human in the Anthropocene. Communicators and cultural builders can be particularly effective in reframing climate change as a cultural challenge, and in offering critical reflections on the human condition.
- Anthropology and other social science disciplines offer a holistic, long-term perspective on the human story, and an awareness of the importance of local, cultural knowledge as a resource for sustainable living and for climate change mitigation and adaptation.
- As with many resource scarcity issues, social scientists reveal how such crises are fundamentally matters of governance and fairness. The water crisis, for example, has been unmasked as a governance crisis. The most essential features of good water governance are polycentric governance structures, effective legal frameworks, the reduction of inequality, open access to information, and meaningful stakeholder participation.

with stakeholders, decision-makers and other scientists. This approach will allow them to show that this refocusing makes broader and more effective solutions possible, and will ensure that the implications of global environmental change are meaningful to affected communities.

Priority action steps

Several priority action steps would help support the move toward framing global environmental change and the difficult path to sustainability as a complex and demanding social process.

- The broader social science community, including researchers, the institutions in which they work, international scientific councils and associations, and research funders, should promote the understanding that global environmental change is a priority domain *par excellence* of the social sciences, and thus, that more social science, and more integrated (multidisciplinary and interdisciplinary) research that includes the social sciences is required.
- Social scientists in academic institutions, civil society organisations, government or business should respond proactively to the ever-growing demand for social science knowledge on global change and sustainability, and take the lead in deepening the understanding of global environmental change as a social problem requiring social responses. This is also a call to those social scientists who may not label their research as being about the environment, but who are nevertheless doing work on cultural

systems and institutions, behavioural change, social transformations, decision-making, or science–society relations, that is relevant to the field.

- Social scientists need to develop new and modify existing concepts, tools and methods to better understand the dynamics of complex social-ecological systems, and reveal the connections between environmental, sociopolitical, economic and cultural vulnerabilities and crises.
- Everyone concerned with designing and delivering research agendas, programmes and projects, including funders, scientific institutions, international councils and associations and research teams, needs to ensure that social scientists are included from the beginning. They are needed to identify socio-environmental priorities and hotspots and to ensure the success of a solutions-oriented, integrated science of global change for sustainability.
- Decision-makers at all levels, in the public and private sectors, international and intergovernmental organisations, and civil society organisations, should prioritise the appointment of social scientists from across all disciplines (not only from economics and geography) to scientific advisory bodies, expert committees and working groups intended to provide counsel on global environmental change and policy options for responding to it.

Enable change

The pace of global environmental change is rapid and accelerating, yet societal responses remain sluggish. Sustainability has become a household word, an industry, and yet most global-scale environmental, social and even economic indicators point to a society stuck on an unsustainable pathway. Path-dependencies in large-scale socio-technical systems, policy lock-ins, behavioural habits, social norms and engrained power structures, all have their role in making it so, mirroring the unforgiving lags in the Earth system.

Many of the articles in this Report suggest a widening disconnect between the pace with which environmental conditions worsen and that with which society tries to slow, halt and reverse these trends, or attempts to keep up with them in preparing for a radically different, more dynamic and less predictable world. Many call for this gap to be closed. The social sciences can and must respond to this call through solutions-oriented research.

A solutions-oriented social science would help society to rethink the shape and course of social systems, to contest them, to connect disparate insights on levers for change, and inform and provoke action for deliberate transformation

The contributions in this Report begin to point the way (Box 2.2 below). The social sciences reveal the range of forces and historical dynamics at play at different levels of social organisation that create vulnerabilities (Escobar, 2011). They help represent the voices of unheard groups and individuals, and offer social diagnoses of situations that account for the cognitive, affective, interpersonal, systemic and cultural dimensions of human behaviour. The social sciences dissect seemingly intractable political dilemmas and help discern how people make sense of the world around them. They inform behaviour change campaigns and help design effective educational and empowerment programmes. Social scientists also bring to light opportunities for engagement with youth, and ways to break vicious cycles of poverty, marginalisation and environmental degradation. In all of these instances, the social sciences perform a dual role, being a critical observer and independent messenger (in other words, providing explanatory knowledge) on the one hand, and participating in open knowledge arenas to co-design solution strategies together with research users (in other words, providing and testing solutions knowledge) on the other.

Box 2.2. **Enabling change**

Selected examples from this Report show how social science insights can make a real difference in solving problems:

- Social science research on innovation and industrial transformation shows that developing countries do not have to follow conventional development trajectories, relying on heavy resource extraction and other outdated technologies. It also shows, however, how replacing old technology with new alternatives is not a panacea.
- Alternative development pathways require instead new conceptions of growth and prosperity, focused on more than material wealth. The social sciences help advance such ideas and show how globalised markets, free knowledge flows and effective governance will be critical in stimulating carbon-neutral, more sustainable development pathways.
- Alternative pathways to sustainability involve different actors, interests and values, and imply different winners and losers, opportunities and risks, choices and trade-offs. Social scientists have proposed three guiding principles to evaluate the consequences of different policy options within a "safe and just operating space": *direction* – what and who drives action; *diversity* – the range of solutions available; and *distribution* – the equitable sharing of risks, burdens and resources.
- Social scientists reveal the deeply held values, beliefs and worldviews that underpin attitudes towards environmental problems, and towards the policies that address them. This enables policymakers to shape solutions that are more acceptable to those affected by them.
- Social science research is contributing to people's capacity to anticipate the unknowable future through processes that expose the assumptions we bring to planning exercises and enable us to integrate complexity into our thinking, invent novel frames for thinking about the future and shift our understanding of the conditions of change.
- Economists can help design preferable and better policy mechanisms, by calibrating the costs and benefits of various policy and regulatory measures, by valuing environmental damage and the non-market values of nature, and by providing some perspective on the substitutability of different types of capital and resources on which human development and well-being depend.
- As members of social groups, networks, communities, societies and cultures, individuals are deeply embedded social actors. Their behaviours are influenced by many internal and external forces. Social science insights into why and how people change can be used by change programme designers to ensure that policy interventions are more effective.
- Social scientists have shown that education has a significant role to play in shaping the values of future generations, redirecting societal preferences and inclinations, and instilling the empowering skills to enact them.
- Social sciences document and enable the empowerment of disadvantaged people. For example, social scientists have traced how indigenous peoples in Colombia have become active, visible political actors in ecosystem and biodiversity conservation. In Southeast Asia, indigenous people are now politically and legally recognised along the Lower Mekong River. Communal education and awareness raising have helped mobilise people there to fight for their rights where dam-building damages the environment and undermines livelihoods.

This is not to say that social science interventions will always improve processes, or inevitably lead to better outcomes. Some contributions to this Report ring warning bells. Even when overall vulnerability to hazards is reduced, adaptation choices may not always be socially acceptable or culturally appropriate. Some may turn out to be maladaptive. Another example involves the adverse effects on farmers' adaptive capacities of well-intentioned but poorly conceived and managed communication and engagement between scientists and farmers. Such examples serve as important reminders to social scientists, engineers, weather forecasters, ecologists and public health experts alike: engagement with a world that is not neatly compartmentalised and predictable, but interconnected in complex ways across time and space, will entail uncertainties, surprises and ethical dilemmas. This makes working in open knowledge systems, and at the science–policy–practice interface, at once deeply challenging and rewarding.

Despite these challenges, many argue that social science engagement in real-world problem solving should go beyond what has been achieved to date, say, on recycling, conservation, and climate change mitigation and adaptation. In addressing global environmental change, social scientists should be leading the engagement with decision-makers more often than at present. While engineers and biologists, public health experts and hydrologists will continue to be needed, social scientists have to become central players, as knowledge producers and brokers, in the quest for solutions that work for people and the planet. They should not only study what is, but more boldly and actively help shape what can and will be, in full ethical awareness of the implications of their intervention.

Priority action steps

Several priority action steps would help the social sciences to engage more effectively at the science–policy–practice interface to enable action and change.

- Together with their colleagues in the natural, engineering and human sciences, social scientists must find more effective ways of identifying strategic opportunities to align compelling research with knowledge needs in global change and sustainability. International scientific councils such as the ISSC, and organisations such as UNESCO, should combine their scientific and political convening powers more effectively to create and facilitate such opportunities.
- Social scientists should take on the challenge of getting involved in and leading research, development and demonstration projects and programmes that focus on social transformation and innovative sustainable development. Central to this is the engagement of social scientists in the design and assessment of new technologies, programmes and policies before implementation, to minimise the risk of unsustainable path-dependencies and maladaptation. This can be realised through their participation in research strategy development, placements in industry, and the creation of more social science positions in public sector agencies.
- Collaboration between scientists, policymakers and practitioners, community and business representatives, civil society organisations and the media throughout the research process is crucial to fostering a solutions-oriented social science. Existing efforts should be strengthened and scaled up. It will be important to find new ways for social scientists to become part of and support multi-actor, place-based learning networks addressing concrete global change and sustainability challenges. These processes

should be championed by international scientific councils and organisations, and need to be factored into the funding, management and evaluation practices of research funders and scientific institutions.

- Decision-makers engaged in evidence-based policy-making, whether in international organisations, intergovernmental bodies, or the public or private sectors, must recognise that information derived from natural science and economics contains many uncertainties, and is often based on flawed assumptions about people and societies. What counts as evidence must include context-sensitive and qualitative social science knowledge about the human world, including its cultural, socio-economic and intellectual diversity, as well as the psychological and spiritual significance of the more-than-human world to human well-being.
- Global systems of social science information monitoring, analysis and sharing must be developed and funded sustainably. This will require the joint efforts of scientific institutions, funders and international scientific councils and organisations. This will allow small-scale, place-based social science studies of people's experiences of and responses to environmental change to be used in national, regional and even global contexts for comparative research and policy purposes.

Build capacity for change

Calls for the social sciences to help meet the challenges of global environmental change and social transformation do not ask only for the production of new knowledge. They also involve bringing existing knowledge into the decision-making process, presenting it in ways that are more resonant, and making it accessible, credible and actionable. In addition to requiring social scientists to come forward with such knowledge, this is also about building greater capacity within the social sciences and among users of social science research to make faster progress in using it. As this Report illustrates (Box 2.3), the social sciences already hold profound and extensive relevant knowledge, but all too often it remains invisible and unused. In addition to challenges of communication internal to the social science community, limited human capital and institutional resources are among the deep-rooted reasons why this may be so. Addressing this will go a long way to meeting growing knowledge needs, building society's ability to use what is already known, and showing that when that knowledge is used in policy and practice, it makes a positive difference.

To meet the diverse and complex challenges of global environmental change and societal transformation, social science capacity needs to grow radically across the world

Thus, an important third message about capacity and scaling up cuts across the pages of this Report. The global challenges which society faces are too big, too numerous, too complex and too difficult to be addressed by a cottage industry of engaged social scientists skilled in interdisciplinarity (working with colleagues from other disciplines), and transdisciplinarity (designing, producing and delivering knowledge in collaboration with decision-makers, practitioners, business leaders and communities). These issues cannot be addressed adequately if most social scientists learn, teach and research in socio-economic, cultural and epistemic contexts that differ from those in which most of the world's population live, struggle and suffer.

To better illustrate the many ways in which greater capacity is needed, where the opportunities lie to build it, and how this can be accomplished, "capacity" is defined here in the broadest sense (ISSC and UNESCO, 2010).

Box 2.3. **Building capacity for change**

Selected examples from this Report show how the social sciences need and are building greater capacity:

- There is a wide disparity between regions in the production of social science articles, as a bibliometric analysis of the Web of Science indicates. The regional divide in social science production on global environmental change appears at least as big as for the social sciences overall.
- Funding is an enabling prerequisite for social science research, as is a supportive political environment. Where funding for overall social science research is low, where governments underestimate the potential future consequences of climate change, or where they see these impacts as economic or strategic opportunities, social scientists do not carry out research, despite increasingly urgent problems locally. This contributes to widening regional divides in social science research and to a lack of local studies of local problems.
- The United Kingdom and the United States produce the largest number of publications on global environmental change (both in absolute terms and in terms of publications per researcher), followed far behind by Australia, Canada, Germany and the Netherlands. In China, social science research on global environmental change has increased enormously over the last 20 years. The number of Chinese articles in Chinese journals is considerable, but they remain largely invisible to the broader research community.
- Interdisciplinary research is growing worldwide, as are co-authorship and international collaboration. Social scientists writing on global environmental change are publishing in natural science or interdisciplinary journals, although the extent to which this happens is difficult to measure in bibliographic databases. Articles and books published in languages other than English are also not well measured, thus under-representing contributions from the Global South and elsewhere.
- Many social science research projects on global environmental change, urbanisation, human health and sustainability are strongly committed to building research skills and providing professional development opportunities for young scholars and practitioners.
- Social scientists are calling attention to the challenges and opportunities that radical interdisciplinary and transdisciplinary research processes pose for researchers, and for those responsible for organising, funding, evaluating and rewarding research. This calls for a fundamental transformation of the institutional set-up and practices of science. The social sciences are central to stimulating innovative thinking about the individual and institutional responses such change will entail.

Capacity for social science research at the individual, institutional and systems levels involves building critical mass and putting in place the enabling conditions to make environmental change more central to the social sciences. This is required throughout the international social science community, even in comparatively rich nations. Yet particular attention has to be paid to building social science research capacities in countries with less well-resourced knowledge production systems (Box 2.4 and Part 2). It also means addressing underlying knowledge divides and the deeper social forces that affect educational preparation, professional prestige and aspirations among young people.

Capacity for international, integrated research and development collaboration must be based on relations of equality and mutual respect. Here the focus is on bringing together socio-geographic and socio-biospheric agendas, perspectives, approaches, methods and models; incorporating bodies of knowledge from the majority world into the global knowledge repository; and counteracting historically institutionalised knowledge monopolies, hegemonic systems and practices to avoid imposing particular agendas, framings, approaches, methods and theories and ignoring others.

Capacity for embracing global environmental change and sustainability: In most of the social sciences, as described above, problems framed as environmental remain marginal to the central canon of the discipline. In unconsciously accepting the imposed natural science framings, the social sciences are perhaps set to miss their greatest opportunity. Meanwhile, a rich stock of incisive social science theories and insights is not always picked up by those social scientists who are engaged in environmental research. This means that relevant social science knowledge is often not brought to bear on the momentous challenges at hand, and that a smaller number of experts is available to address them. To tap into existing expertise and to mobilise a wider social science community drawn from the mainstream social sciences will require effective lobbying and leadership. Leaders from the research, funding and science policy communities can help build capacity by helping social scientists to recognise the stakes and to see opportunities unparalleled in the history of the social sciences.

Capacity for engagement in solutions-oriented work: Many social scientists still claim their academic autonomy as intellectual licence to remain distant from societal interests and from politics. A solutions-oriented science, whose knowledge production entails an open, engaged and collaborative relationship with society, clearly breaks with this tradition (Cash et al., 2003). Whether through boundary organisations or a more fundamental change in engaged research practice, greater capacity for solutions-oriented science is needed to co-create credibility, legitimacy and relevance. As the social sciences work to overcome biases against the status of applied and policy-relevant research (without abandoning theoretical, curiosity-driven research, or indeed the possibility of being critical of policy itself), they will find that work on global environmental change and sustainability frequently involves use-inspired, fundamental social science challenges (Stokes, 1997). While these originate in real-world problems, they demand foundational work that is no less challenging and exciting than basic science without immediate application.

Priority action steps

Several priority action steps can help support the building of the different types of social science capacities outlined above around the world:

- Funders, national and international scientific councils, associations and organisations should help build capacity for social science research on environmental change by assisting the development of clear national and regional science policies that prioritise global change and sustainability as a grand challenge, and allocate appropriate levels of funding support to it.
- Universities and other scientific institutions in which social scientists work should develop better support mechanisms, incentive structures, rewards and evaluation systems, to provide enabling conditions for the pursuit of engaged, solutions-oriented research for global sustainability.
- A special focus on young or early-career researchers should be central to capacity building for the kind of social science called for in this Report. Funders, scientific institutions and international organisations should work together to develop educational approaches, from primary education to postdoctoral levels, that prepare students for interdisciplinary

and transdisciplinary research. The aim should be to train people who can communicate across disciplines and fields of science, and between science and other sectors of society. Active participation in ably led projects of this sort has proven to be an effective way to build such skills and capacities among young researchers. Strong project management skills and a grounded understanding of policy and practice are also essential.

- National and international funders, scientific institutions, councils and associations must multiply and sustain mechanisms that support truly global networking and collaboration between social scientists engaged in global change and sustainability research.
- At regional and national levels, funders and scientific institutions, councils and associations should also support the development and maintenance of structures such as centres of excellence or graduate schools to help build the critical mass and communities of practice which are needed to reduce the isolation that social scientists experience in some parts of the world. Such arrangements are essential to realising the longer-term benefits of international networking. They should also draw on the experience of bottom-up approaches to building capacity and networks of researchers, in collaboration with local communities, civic society organisations and development agencies.

Be the change

The final and central message of this Report is – drawing on the famous words of Mahatma Gandhi – that the social sciences in their attempt to help transform the world must *be the change*. The challenges that global environmental change poses to society call for transformative social change, and this will only be possible if the social sciences themselves change. At stake here is the commitment of social scientists to situate themselves in concrete contexts of application, and to change the practice of their craft in ways that support the production, with their colleagues and with society, of solutions-oriented knowledge for sustainability.

The still-common, self-deprecating image of the social sciences as somehow inferior in the pantheon of scientific disciplines, envying the research budgets, professional esteem and societal mystique of their natural science cousins, remains a stumbling block. Equally undermining of success is the flip side of this attitude, a sense of superiority among some social scientists, who seem comfortable commenting on and theorising about the social world from detached perches, finding fault with the messy work of politics, engagement and action, without actually engaging and acting themselves. As the overwhelming majority of contributions to this Report show (Box 2.4), it is not enough to offer partial answers from the narrow window of any single discipline, and it does not suffice to stay outside the social and political processes that scientists may wish to inform.

How then should, or can, the social sciences change themselves? Social science should not be afraid of taking up space among the sciences. Being the change implies that social science disciplines welcome contributions from other fields of science to deepen understanding, rather than rejecting them as a dilution of fragile, partial knowledge. It also implies that the social sciences need to become expert at integrating across scales and across different forms of knowledge. Social science has to be grounded in theory and understanding of sufficient breadth and depth to engage with specific practices, people and situations. This will involve the social sciences in helping to frame the ethical implications of proposed actions, and in grappling themselves with their engagement in a rapidly changing world.

Box 2.4. **Being the change**

Selected examples from this Report show how the social sciences are understanding and responding to the need for changing their theories and research approaches:

- Social science research on processes of scientific knowledge production and use has contributed to a better understanding of the complex relationship between science, public debate, policy and practice, and the extent to which power relations and economic interests mediate that relationship. The failure to find political agreement and advance policies to address sustainability is therefore not indicative of a lack of sufficient high-quality scientific information or understanding.
- To advance the role of knowledge – scientific and otherwise – in contributing to real-world solutions, social scientists are not only theorising about, but also participating in, open and inclusive processes that draw policymakers, practitioners, local communities, non-governmental organisations (NGOs) and private sector actors into the co-design, co-production and co-delivery of knowledge. Such processes foster mutual learning and trust, and increase the relevance and use of knowledge in specific social-ecological contexts.
- Social scientists in the South often have more extensive experience with inclusive and participatory research approaches than their colleagues in the North. For example, they link up different epistemic communities, such as climate modelling experts with disaster risk management and bottom-up development processes, at local and regional levels. Social scientists elsewhere have much to learn from this experience as they undertake to work with policymakers, managers and other stakeholders.
- The social sciences increasingly go beyond disciplinary boundaries (within and beyond the social sciences) to advance the understanding of the human dimensions of global environmental change. For example, social scientists are working with ecologists to provide early warnings of disasters, and to assess and recommend conservation and management strategies for communities to help them adapt to climate change more effectively.

If the social sciences are serious about wanting their science to make a difference, they themselves must change

Interdisciplinarity within the social sciences is just as important as interdisciplinarity among the social, human and natural sciences. Despite progress on this front, it remains no small challenge. In a broad sense the challenge is methodological. It involves statistical competence on the part of social and human scientists, and an appreciation of qualitative research findings on the part of natural scientists. But there are also conceptual and epistemological issues that relate to levels and units of analysis, and to standards of evidence. In particular, integrated science is often about new kinds of systems approaches that are likely to clash with methodological individualism in ways that many social scientists will find uncomfortable, if not unacceptable. Yet the challenge is exactly to illustrate how a systems rather than an individualised perspective fosters a better understanding of the relationship between social, economic, political and cultural institutions and practices, and human behaviour.

But even overcoming these challenges is not enough. Engaged social scientists must test their understanding of the human dimensions of environmental change in transdisciplinary efforts and teams. Contributions to this Report illustrate a number of examples where practitioners, policymakers and decision-makers, civil society and private sector actors are brought together with academic researchers in the co-design, co-production and co-delivery of knowledge and action (Box 2.4). Such work recognises that there are multiple sources of relevant knowledge and expertise, a plurality of perspectives to be harnessed, and that at different times, all participants are both producers and users of knowledge. Relevant and robust knowledge has never been only in the hands of scientific experts. Scientists are increasingly recognising the folly of that assumption, as well as the limitations it imposes on the possibilities for innovation, and thus on the acceptability and realisation of better solutions.

In transforming how knowledge is produced and used, social scientists will be building what might be called a "translational social science": one that reaches across campus and community to deliver knowledge that can make a difference to real-world problems.

Priority action steps

Several priority action steps can help support the social sciences in the process of changing themselves:

- Universities and other scientific institutions should be more active in providing creative platforms for dialogue and for the co-framing of research projects, involving natural, social and human sciences, before projects are fixed and teams apply for funding. Involving a greater range of researchers may require a diversification of funding sources for global change and sustainability research.
- Scientific organisations seeking the contribution of social scientists in informing global change policies and management solutions should invest in processes that enable the regular interaction of researchers with decision-makers, practitioners, civil society and private-sector representatives, as well as with the media and other science communicators. Such interactions need to start early on and be sustained throughout the research process to facilitate collective problem framing, knowledge production and mutual learning around solutions for concrete environmental and sustainability challenges.
- Research funders should develop innovative funding practices that support safe spaces for experimentation with open and inclusive co-design, co-production and co-delivery of knowledge. This should include support for identifying and reaching out to relevant stakeholder communities, and developing the requisite communication, management and leadership skills.
- At the same time, scientific institutions, councils and associations at all levels can motivate social scientists to engage in open knowledge processes through recognition and incentive mechanisms. The latter could include career advancement incentives and prestigious awards. Equally important is support in the form of training in communication and engagement, practical and systemic outlooks, ethical sensibilities, strategic and cross-disciplinary thinking, and effective management of the partnerships involved.
- The scientific community, funders, science policymakers in international scientific organisations and knowledge users must support ways of monitoring and evaluating transdisciplinary processes of knowledge co-design, co-production and co-delivery. It is important to understand their implications, usefulness and effectiveness, and their associated ethics, and to develop appropriate guidelines and training modules. Social scientists themselves have a particularly important contribution to make in this regard.

Conclusions

The *World Social Science Report 2013* uses a number of important and concrete challenges in environmental change and sustainability as case studies or research sites. They illustrate the unique contributions that the social sciences make to this field of research and action. Such contributions lie in addressing a very specific set of questions, answers to which are urgently needed if scientific knowledge is to inform more effective, equitable and durable solutions. These questions speak directly to critical social science concerns – theoretical and empirical, quantitative and qualitative, fundamental and applied – and together comprise the transformative cornerstones of social science research for global change.

The Report draws attention to the variable conditions – constraints and opportunities – under which social science knowledge on global environmental change is being produced, and to the capacities and imbalances in the research systems that comprise the international social science community at the present time.

The action steps proposed are necessarily broad in the way they are formulated here, but if taken seriously and applied in specific contexts, can make a meaningful difference, fill real gaps, and ultimately lead to transformative change within the social sciences. This would allow the social sciences to take the lead in developing a new, translational social science of global change and sustainability. It would be solutions-oriented, integrated, sometimes multidisciplinary and at other times interdisciplinary and transdisciplinary. As the social science community and its stakeholders step up to respond to these calls for action, the real challenge – and indeed opportunity – lies in acknowledging that in any transformative process, there is a need to experiment, to be creative, and to remain open to learning from initial shortfalls and occasional failures.

This Report is intended as a vehicle for mobilisation: a starting point for rallying the engagement of social scientists in all disciplines, in academia, research centres, think tanks, NGOs and government agencies, and in all parts of the world. And it is intended as a basis for the critical discussion and development, by the ISSC and its members and partners, of a longer-term strategy to sharpen the social science knowledge base for sustainability and to support social science leadership in research on global change and social transformation.

This work comes at a time when a unique and robust new institutional framework for advancing integrated, solutions-oriented sustainability research has been secured at the international level. That framework is provided by Future Earth, a new ten-year programme and flagship initiative of the International Science and Technology Alliance for Global Sustainability, of which the ISSC is a member (see Article 1, the overall introduction to this Report, for an overview).

But success in realising a bolder, better, bigger and different social science in this field, and in securing the positive knowledge outcomes envisioned here, will depend on more than having enabling institutional frameworks in place. It will be just as necessary for the ISSC and partner organisations like UNESCO to continue to engage in advocacy and strategic science policy work aimed at securing spaces for social science leadership on the global stage of sustainability research, and in enlarging the visibility of social science knowledge, not least through improved relationships with the media and other communicators.

At the same time, social scientists from all parts of the world need support to work collaboratively on building the social science knowledge base; in taking the lead to bring such knowledge into the framing and execution of global change research; in experimenting with and developing transdisciplinary approaches; and in bringing existing social science knowledge into the research–policy–practice arena. This requires complementary national and regional strategic and lobbying support, right into the hallways of universities and research institutions.

As the capacity of social scientists to frame, understand and help tackle global environmental challenges grows – and the greater their ability to engage with partners in other disciplines, national, cultural and socio-economic contexts, and professional and practical spheres – they will find themselves increasingly in the cross-hairs of fame and blame. As they engage more frequently and effectively with policymakers and practitioners, as well as with other scientists and stakeholders, their increased power and access will entail greater responsibility and the need for reflexivity about this engagement. These are not new challenges, however. For better and for worse, science has contributed to social, cultural, political, economic, technological and environmental change ever since the Enlightenment of the 17th and 18th centuries. Nothing will spare the social sciences the need for ethical practice or societal scrutiny. This price seems worth paying, given the stakes involved and the disengaged alternative. Now is not the time to stay on the sidelines, as climate and global environmental change force society to face staggering human-made crises, and as the world struggles to find a path toward a more secure and sustainable future.

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Nomkhubulwane, 2009 by Andries Botha
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Part 1

The complexity and urgency of global environmental change and social transformation

3. Social and environmental change in a complex, uncertain world

Introduction to Part 1

by
Heide Hackmann and Susanne Moser

Global environmental change is a potentially catastrophic and increasingly urgent problem for humanity. It is relevant to individuals, organisations and governments everywhere. But what exactly makes it so? How is the world changing around us, and how and where can the course and conditions of such change be altered? What role can and must the social sciences play in such efforts? These are the "big picture" questions tackled in Part 1, questions that expose the complexity and urgency of global environmental change, and locate it at the centre of the quest to secure a sustainable future for all.

Society has an abundance of scientific data and knowledge about the gravity of current environmental changes, as well as possible future scenarios should those changes be left unmitigated. Yet society's response remains frustratingly slow and inadequate. There is a tendency to see the environment as one of a larger set of discrete and disconnected global problems. From this perspective, environmental concerns compete for attention with other issues, and too often lose out in the priority rankings.

However, from a broader, systems point of view, environmental change is connected in complex ways to the multitude of other social crises, risks and vulnerabilities confronting society today. Poverty is a good example. Some believe that we need to solve the poverty problem before worrying about environmental issues, including climate change. Yet, despite progress on a number of fronts, Sachs reminds us that the Millennium Development Goals (MDGs) have not delivered the end of extreme poverty, and that both poverty and environmental issues are integral to the sustainability challenge that must now be addressed at the global level, including through the post-2015 Sustainable Development Goals (SDGs). Those goals have to protect human well-being and life-supporting ecosystems simultaneously, in ways that are socially inclusive and equitable.

Understanding action within complex social-ecological systems

Social scientists have contributed to a social-ecological systems perspective on global environmental change by bringing the social and human dimensions into natural science-based conceptions of the Earth system. Much work remains to be done on this front, and several authors in this part contribute to that effort in important ways.

Deepening our understanding of the role of humans

O'Brien stresses the importance of approaching global environmental change from a systems perspective, which draws attention to nonlinear relationships and the potential for irreversible changes and surprises. Critical to this perspective is the role of humans as reflective and creative agents of deliberate change. Understanding how values, attitudes, worldviews, beliefs and visions of the future influence system structures and processes is critical, and challenges the idea that global environmental change is inevitable (see also Part 4). Developing a deeper, human perspective on global environmental change directs attention to arenas for action – human agency and the structures and processes that facilitate or constrain it.

Identifying a safe and just operating space for humanity

Within the arena of action, it is imperative to understand what Leach, Raworth and Rockström call the safe and just space towards (and within) which pathways to sustainability must be steered. It is a space defined by the outer limits of social-ecological systems: the planetary and social boundaries within which humanity can thrive without endangering the ecological resilience of the planet or the well-being and security of its inhabitants. The precise contours of that space vary across different contexts. So too do the social and political consequences of different policy choices. An effective approach to evaluating such choices is needed. The authors provide this approach in the form of three guiding principles: focusing on what and who drives action (direction); nurturing multiple solutions (diversity); and safeguarding equitable sharing of the safe and just space (distribution).

Understanding well-being, finding new measures for growth

Dominant conceptions of human well-being and societal development essentially focus on material wealth and use gross domestic product (GDP) to track progress. From a social-ecological systems point of view, such conceptions are inadequate. In their work on new indicators of societal progress, Duraiappah, Muñoz and Darkey draw on research that reveals the importance of social and ecological factors, including education, health and stable ecosystems, in determining well-being. This broader conception of well-being underlies the Inclusive Wealth Index – a comprehensive measure of economies' manufactured, human and natural capital. It is a theoretical framework for sustainable development, one that provides policymakers and planners with information on the interventions and investments needed to achieve well-being improvements and ensure societies' sustainable productive base.

Understanding the difference that gender makes

Several contributions to this section indicate that the drivers and impacts of change vary between regional, cultural and socio-economic settings. In addition, personal identities contribute to the contextual complexity of global environmental change. Agarwal accentuates the importance of context by analysing processes of environmental degradation and regeneration through a gender lens. She reveals both the differential impacts of environmental degradation on men and women, and the potentially positive effects of women's involvement in environmental governance. Here gender differences in interests, preferences and knowledge of local ecosystems are of particular relevance. The analysis also draws attention to the heterogeneity of interests among women depending on their class, caste, faith, race or ethnicity, age and family status, thus highlighting the nested contexts of gender itself (see Head et al. in Part 4 and Chimanikire in Part 3).

Moving towards transformation

Research on global sustainability (including sustainable production and use of energy) increasingly goes hand in hand with calls for profound social transformation, and for the production of relevant knowledge to help deliver it. Yet despite the urgency of both processes, researchers are far from agreeing – or even fully understanding – what either of them entails, conceptually and practically. What would it mean to alter social-ecological systems in such profound ways as to put society on a fundamentally different trajectory, one towards sustainability; not just surviving, but possibly thriving? And what kind of knowledge – and knowledge production processes – would this require?

Brown, O'Neill and Fabricius provide an essential starting point for thinking on this front. They offer an overview of the current landscape of research on social transformation, reviewing existing social science theories, approaches and observations. The picture that emerges is one of diversity, ambiguity, fragmentation and often contestation. Transformation emerges as a process of change to the fundamental attributes of a system; change that is multi-dimensional, occurs at different rates and different scales, involves multiple actors, and can be either deliberate or unplanned.

This complexity raises a number of questions, perhaps most basically about our capacity to imagine futures that are not based on hidden, unexamined and sometimes flawed assumptions about present and past systems. Miller's work on "futures literacy" offers an approach that systematically exposes such blind spots, allowing us to experiment with novel frames for imagining the unknowable future, and on that basis, enabling us to critically reassess actions designed in the present.

And in imagining alternative futures and pathways toward sustainability, what is the role of the sciences – natural, social and human? Can they do anything but investigate, monitor and document rapidly changing global environments? Tàbara problematises prevalent interpretations of the links between science, policy and practice as being linear and simplistic. For him, transformative knowledge production requires open information and knowledge systems that facilitate collaborative learning and problem solving, around specific concrete challenges and in specific social-ecological contexts. In such systems, multiple sources of expertise are mobilised: scientists work with non-academic knowledge-holders to co-design, co-produce and co-implement knowledge outcomes as well as new priorities and mutual learning processes. In this way, open knowledge systems are arenas for the democratisation of science, a process which, as O'Riordan points out, is increasingly facilitated by cyberspace and new digital technologies.

As Sachs rightly argues, the development of sustainable development goals will necessitate such transdisciplinary open knowledge processes. This poses significant challenges and opportunities for the scientific community and to those responsible for organising, funding, evaluating and rewarding research. It calls for a fundamental transformation of the institutions and practices of science itself.

Conclusion

The contributions to this part offer big, integrative perspectives to help us understand the complexity and urgency of global environmental change through a social science lens. They point to its multiple drivers, its variable outcomes, its roots in the worldviews and value systems underlying individual behaviour and social practices, and its connectedness to a host of other social problems. A systems perspective also makes sense of the pace at which these interlinked issues are unfolding: a rapidly degrading Earth system and a lagging human response. But instead of paralysis in the face of such complexity, this part also opens up possibilities for steering society away from the disastrous future scenarios many all but take for granted. Within complex social-ecological systems lies the nature of society's biggest challenge, as well as society's wellspring of visions and capacity to address it.

Committing ourselves to act towards global sustainability is a shared responsibility, one in which all the sciences – natural, social and human – have a key role to play. The tasks for social scientists are numerous and pressing: deepening our understanding of how the social and the environmental are connected, identifying levers of change within social-ecological systems, fostering novelty and innovation in our thinking about options for action, and realising the conditions for politically astute, transformative knowledge production. This may involve changes in our own practice as social scientists, in the institutions that facilitate or constrain such change, and in the way the social sciences are viewed by others. Traditional social sciences focus on human agency, worldviews, identities, social relations, practices and systems, as well as the action spaces they create. Their insights have often been dismissed as value-laden, contextual, and therefore unreliable. Yet they may be precisely what is needed to direct attention to the possibilities and levers for change that can lead humanity out of its current predicament. The growing engagement of the social sciences in global change research is a sign of their readiness to deliver. Such engagement now needs to be accelerated.

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World Social Science Report 2013
Changing Global Environments

4. What's the problem? Putting global environmental change into perspective

by
Karen O'Brien

Why worry about the global environment? Are the financial crisis and poverty not far more urgent? And will technological innovation not solve global warming? Looking at problems as separate and discrete can be misleading. Global environmental changes are systemic issues that are closely related to human activities. The solutions thus lie in human actions that address the systems and structures that contribute to global environmental change. Are broader and deeper understandings needed to ensure transformative action?

Introduction

We are living in an era of profound environmental change, and society has yet to fully grasp its significance. Scientific research draws attention to problems such as climate change, biodiversity loss, land cover changes, ocean acidification, ozone depletion, changes to nitrogen and phosphorus cycles, and a myriad of other issues that together have implications for the future of humanity. These issues are serious, urgent and downright alarming. They call for decisive responses (see Box 4.1). Yet society is not responding to these findings at the rate and scale believed necessary to avoid catastrophic future scenarios.

Why not? The problem of insufficient action, one could argue, is largely about perspectives. Individuals and groups interpret the science of global environmental change through many different lenses and in a variety of social contexts. It is incredibly difficult to grasp the scope and urgency of global environmental change when faced with problems such as unemployment, poverty, violent conflicts, epidemics and a disregard for human rights. Some people maintain that only after we have addressed economic crises, expanded democracy and increased human development will we be able to respond adequately to environmental change. Others are convinced that solutions to all problems, including climate change and biodiversity loss, lie in technological innovation. It is just a matter of time before we can solve them. With genetic engineering, nanotechnology, advances in computing and artificial intelligence, and geoengineering (CO_2 removal and solar radiation management), why worry about the global environment?

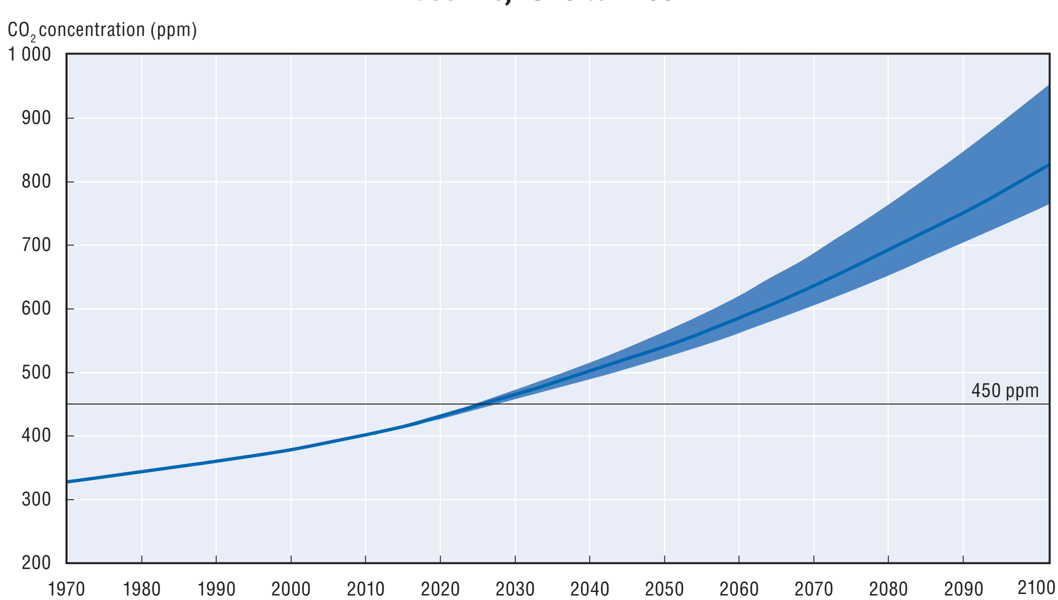
Box 4.1. **Why global environmental change matters**

Scientific journals are full of research findings that draw attention to dramatic environmental trends. They also point to the profound consequences of global environmental change for society. The facts and figures speak for themselves. Global temperatures are close to an 11 000 year peak (Marcott et al., 2013), and OECD baseline scenarios for increasing carbon dioxide (CO_2) concentrations suggest potential temperature increases of 3.7–5.6°C by the end of the 21st century (see Figure 4.1). Given current trends in greenhouse gas emissions, significant reductions are needed by 2020 to limit warming to 2°C (Peters et al., 2013).

Estimates of global biodiversity, which is decreasing at an unprecedented rate, highlight the need for effective conservation measures (Barnosky et al., 2012). The effects of different pressures on terrestrial mean species abundance (MSA) as projected over time are shown in Figure 4.2. Climate change, in addition to land use change, is likely to represent an increasingly important pressure on biodiversity in the future. Such changes affect the functioning of ecosystems, which will have significant implications for societies that depend on these for goods and services (Cardinale et al., 2012).

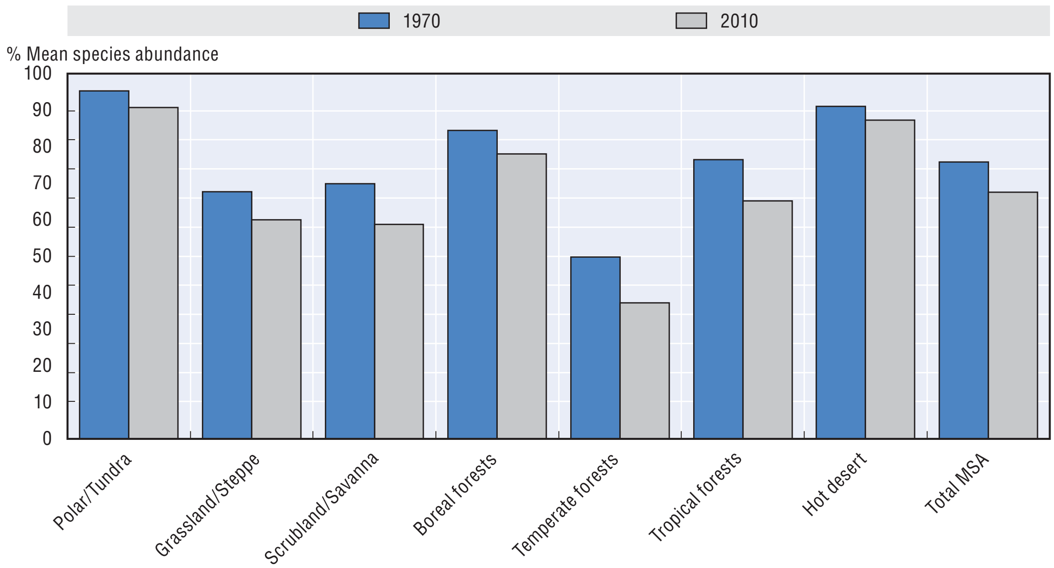
New issues are emerging as well, including changes to the nitrogen cycle and ocean acidification. Together, global environmental changes are transforming ecosystems that are essential to human well-being, with implications for food security and water security (see Figure 4.3). The OECD Environmental Outlook Baseline projects an intensified competition between agricultural land use and other types of land use in the coming decade. Global agricultural area is expected to increase in the coming decades, then level off and decline to about today's levels by 2050. Meanwhile, global water demand is expected to increase significantly by 2050, as is water stress in most major river basins (see Figure 4.4). Such trends will interact with global environmental change, including climate change, posing increasing threats to human security for both present and future generations.

Figure 4.1. **Long-run CO_2 concentrations and temperature increase: Baseline, 1970 to 2100**



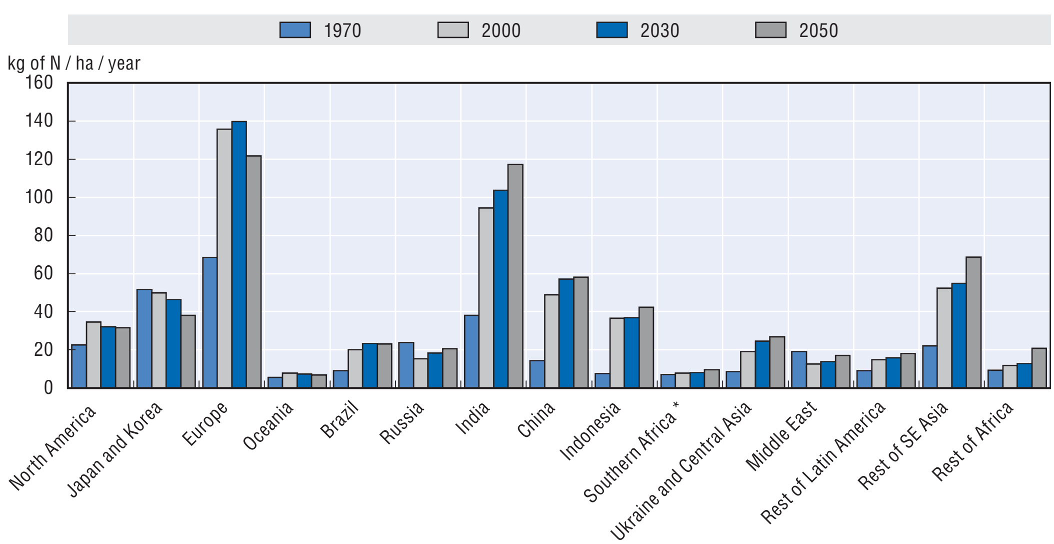
Source: The OECD Environmental Outlook Baseline projections, IMAGE (PBL).

Figure 4.2. **Global mean species abundance per biome, 1970 to 2010**



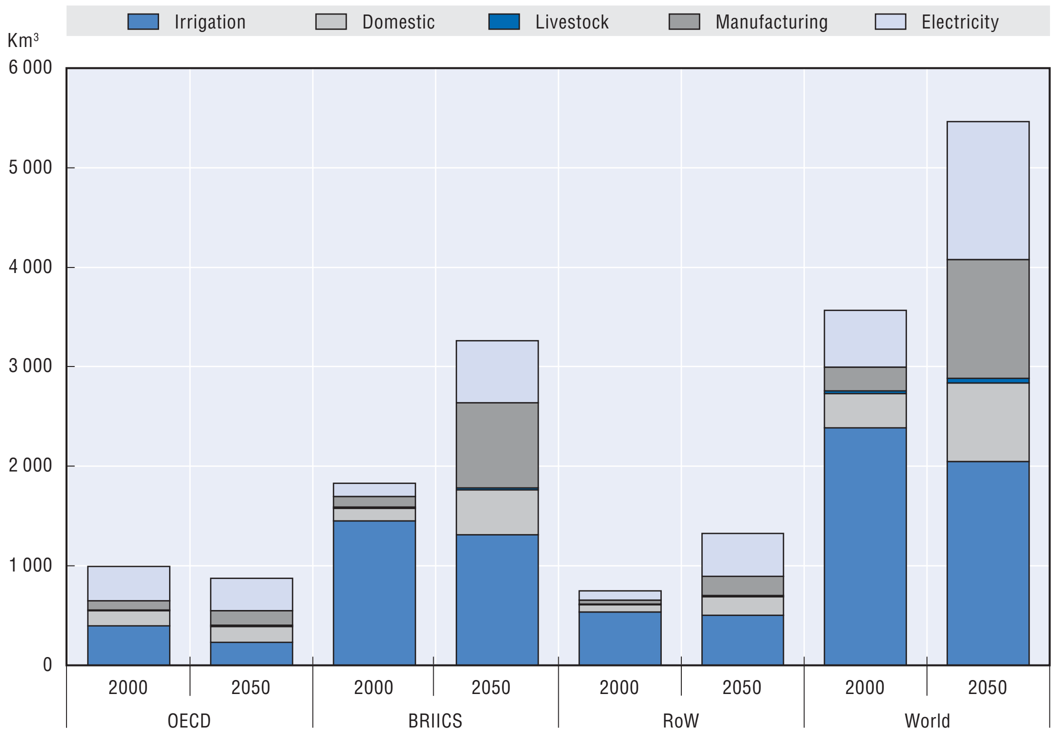
Note: If the mean species abundance is 100%, this implies an undisturbed state. A decreasing mean species abundance value reflects increasing human pressure on ecosystems and a decline in intactness or naturalness.
Source: OECD Environmental Outlook Baseline; output from IMAGE.

Figure 4.3. **Nitrogen surpluses per hectare from agriculture: Baseline 2000 and 2050**



Note: * In the IMAGE model the Southern Africa region includes ten other countries in this geographical area including the Republic of South Africa, when dealing with land use, biodiversity, water and health. For energy-related modelling the region has been split into the Republic of South Africa and "Rest of Southern Africa".
Source: OECD Environmental Outlook Baseline; output from IMAGE.

Figure 4.4. **Global water demand: Baseline scenario, 2000 and 2050**



Source: OECD Environmental Outlook Baseline; output from IMAGE.
Note: This graph only measures blue water demand and does not consider rain-fed agriculture.

There are many good reasons to worry about global environmental change. This short article considers a key perspective from which global environmental issues are considered urgent and problematic. This perspective emerges from a broad, interdisciplinary field of research known as Earth systems science, which emphasises characteristics of complex systems such as non-linearity, irreversibility and surprise. From this broader perspective, the changes that are now occurring over a very brief period of time pose unprecedented challenges for humans and other species. Furthermore, they suggest that fragmented approaches are no longer sufficient to deal with interrelated, systemic problems.

However, this article also explores a perspective from which these complex challenges might be successfully addressed – a perspective emerging from the social sciences and humanities that recognises the potential of individual and collective agency to transform the systems and structures that contribute to environmental change. This deeper perspective draws attention to the potential and capacity of humans to recognise, understand and respond to environmental change by addressing the social structures that promote and perpetuate these changes (Tibbs, 2011). Social science research focuses on issues such as power, politics, interests, identities, social practices, cognition, values, beliefs and worldviews, and their effects on the environment. Such research reveals how and why these factors differ within and between cultures and historical contexts. The article concludes that broader and deeper understanding of global environmental change may be necessary to catalyse transformative human and social responses.

The importance of a broader perspective

More than data and graphs are needed to understand why global environmental change is an urgent concern for society. This type of change must be interpreted within a broader systems perspective. Humans have always influenced the environment and over the past few centuries have dramatically transformed the planet (Turner et al., 1990; UNEP, 2012). In earlier periods, changes to the environment were considered impressive signs of progress – whether clearing the forests in the Midwestern United States, eradicating mosquitoes in Panama, damming rivers to produce hydro-electric power in Norway, establishing industrial tree plantations in Indonesia or reclaiming land in the Netherlands. Nevertheless, many of these changes are now considered serious threats to the global environment. What has changed?

A potential answer lies in the speed and scale of change, and in its systemic nature. A "system" is a set of interacting components that form an integrated whole. Most of the significant findings about environmental change come from an Earth systems perspective that focuses on interconnected components and processes, for example flows between the atmosphere and the biosphere. This approach draws attention to feedbacks, thresholds and tipping points, and their implications for social and ecological resilience (Steffen et al., 2004). For example, human-induced (anthropogenic) climate change is occurring as a result of increasing concentrations of greenhouse gases in the atmosphere. These gases have systemic effects through changing atmospheric and ocean circulation patterns, ice cover, mean sea levels and many other parameters. These changes influence risk and vulnerability, which are unevenly distributed across communities and regions. Similarly, biodiversity loss is about the systemic loss of genetic, species and ecosystems diversity as a result of widespread changes in land use, the introduction of new species, the exploitation and trafficking of species, the homogenisation of production, and climate change. A systems perspective shows how small and large-scale changes interact and influence the context in which humans and other species have evolved (Hetherington and Reid, 2010). Three characteristics of systemic global environmental change have particularly important implications for society: non-linearity, irreversibility and surprises.

Non-linearity

Outcomes within complex systems are difficult to predict with certainty because small changes can have large consequences. For example, a small increase in winter temperatures in temperate latitudes may enable bark beetles to survive the winter. This could lead to a population outbreak that kills pine trees, which can affect the forestry sector and increase the risk of wildfires that may endanger human settlements. Despite sophisticated efforts at modelling Earth system processes, it is not easy to anticipate the thresholds and tipping points, for example, those that may alter the behaviour of monsoons or ocean circulation (Scheffer et al., 2012; Lenton, 2011). Consequently, the impacts of each increment of change cannot be extrapolated from existing relationships. There are vast differences between global average temperature increases of 1°C, 2°C, 3°C or more. The impacts of a 4°C warming are exponentially more serious than the impacts of the widely accepted goal of 2°C or less warming. This raises challenges for social responses, particularly if complex, non-linear problems are addressed in a discrete, linear manner.

Irreversibility

Systems can be pushed towards outcomes that can no longer be reversed, whether through changes in policies, new technologies, or altered behaviours. The climate system is already considered to be moving into a non-analogue state unprecedented in human history. It may eventually stabilise at a new state, but is unlikely to return to "what it was". The idea of irreversible change, such as extinctions, loss of ice sheets or dramatic sea level rise, can be difficult to contemplate, particularly with billions of people living in vulnerable coastal areas. While many criticise modelling exercises for their uncertainties and the difficulty of predicting future outcomes, the alternative of conducting real-world experiments on a global scale without control is risky and, some might say, irresponsible. Yet these are precisely the types of experiments that seem to be taking place right now. This raises important questions about values, interests and power. Who decides which irreversible outcomes are acceptable? Whose values count most in shaping the future?

Surprises

Complex systems do not always act in ways that are expected, despite human efforts to consider all types of contingencies. While the notion of "surprise" is always relative to the viewpoint from which it is considered and the viewer considering it, there is little doubt that global environmental change at the scale, rate and magnitude that is now occurring will lead to new and unexpected outcomes. Issues such as ocean acidification, unanticipated biological responses, novel extreme events, and even more "surprising" surprises, will present society with new challenges. Society has to prepare not only for environmental surprises, but also for potential social surprises – the unexpected, non-linear social responses that may emerge in reaction to global environmental change. Such responses may have unintended consequences, for example for democracy.

The importance of a deeper perspective

Current analyses of global environmental change under-represent the role of humans in the larger system. The potential of people to be deliberate and reflective agents of transformative change is seldom acknowledged, and this leads in turn to a sense of deterministic inevitability about global change. Although attention is given to "the social" in analyses of coupled social-ecological systems, this research has rarely integrated social science perspectives on the complexity and non-linearity of human development and social change. In particular, little attention has been paid to the growing role that human reflexivity plays in systems dynamics. In other words, global environmental change research seldom considers that when humanity, a central part of the system, becomes sufficiently aware that it is changing the system, the capacity for response may no longer follow linear, deterministic trajectories.

A deeper perspective on global environmental change draws attention to the beliefs and world views that influence the way that the system is "seen": in other words where the boundaries lie, what causes what, how changes come about, who has influence and who can respond effectively. The recognition that people perceive problems and solutions differently suggests that a diversity of responses and approaches is needed, each appropriate for different belief systems and world views (Vermeij et al., 2006). The seriousness of global environmental change for society also suggests that the conscious and unconscious assumptions and beliefs associated with contemporary world views need to be examined closely. Attention to beliefs and worldviews is as relevant for scientists researching social-ecological systems as it is for activists trying to shape them, and for politicians and practitioners trying to design policies to manage them.

From a deeper perspective, humans are not just the antagonists driving global environmental change. They are also the protagonists who can influence the future. Recognising this capacity for social change calls for a new type of collaboration that can bring together people with different beliefs, interests, motivations and capacities. In this way, we can create alternatives to imminent changes that are potentially catastrophic for humanity. This will mean transforming the systems and structures that favour some interests over others; recognising and responding skilfully to the systemic pushback and resistance that result when vested interests are challenged; and developing new types of power and leadership for change.

Conclusion

In considering broader and deeper perspectives on global environmental change, two conclusions may be drawn.

First, it is likely to be more effective to prioritise actions rather than issues. Given the systemic relationships between problems such as poverty, environmental degradation, violations of human rights, conflicts, epidemics, and the overconsumption of food and resources, prioritising one issue over another makes little sense. Given competition for resources and attention, as well as very real time constraints to respond to global environmental change, it may be better to prioritise actions that address multiple issues and which act as strong leverage points for systems change.

According to Meadows (2008), leverage points could include actions that influence the feedback loops in the system (such as the connection between global interest rates and oil prices); increase information flows (such as how much of national budgets is spent annually on weapons research in comparison with renewable energy research); promote self-organisation (such as encouraging diversity and creativity); influence the system's objectives (such as by defining sustainable development goals); or change paradigms by addressing unstated assumptions (such as that humans lack the capacity to transform global systems rapidly in an ethical, equitable and sustainable manner). A focus on actions rather than issues may mobilise coalitions with shared common interests, which may itself be an important leverage point for social change.

Second, a new type of research may be needed to capture broader and deeper perspectives on global environmental change. While there is currently a move to promote transdisciplinary research through programmes and initiatives such as Future Earth, the quality of collaborations between physical scientists, social scientists, decision-makers, artists, activists, private sector actors and citizens could be improved vastly by recognising that each comes with a different perspective on what the system looks like, what the real problems are and where the solutions lie. At a time when natural scientists are pointing out that the largest threat to humanity may be humans themselves, and when social scientists are emphasising that alternatives can be created through collective action, there is clearly a need for better integration of the different perspectives. Addressing global environmental change at the rate and scale that is called for by the scientific evidence is no small feat. It requires, first and foremost, that we put it into perspective.

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5. The challenge of sustainable development and the social sciences

by
Jeffrey D. Sachs

The challenge of sustainable development will soon be enshrined in a new set of global Sustainable Development Goals (SDGs). Like the Millennium Development Goals (MDGs) before them, they are likely to constitute an active work programme for governments, non-governmental organisations (NGOs), businesses and academia. The social sciences will have a key role to play in designing and assessing critical pathways to achieve the new goals.

Learning from the Millennium Development Goals

Global goal setting is a distinctive contributor to global problem solving. The Millennium Development Goals (MDGs) exemplify the strengths and weaknesses of this approach. The MDGs were part of the Millennium Declaration adopted by world leaders in September 2000. They were followed a year later by a more specific roadmap put forward by UN Secretary-General Kofi Annan in September 2001.[1]

The eight MDGs set targets for reducing extreme poverty by 2015. Here extreme poverty is defined according to income, hunger, disease burden, and access to key infrastructure such as safe water and sanitation. Rich countries pledge to be partners in this effort. The goals are applied at the national level, meaning that each developing country attempts to achieve the targeted reductions of poverty, hunger and disease relative to its own baseline.

The MDGs are not a global treaty and carry no means of enforcement. They are normative, exhortatory and aspirational. They are meant to inspire action, motivate partnerships, set targets and provide a lever for civil society to engender action by laggard, neglectful or even malign governments. They are also meant to inspire a more constructive partnership between rich and poor countries.

The results to date have been illuminating. The targets have been widely praised for successfully directing increased global attention to the fight against poverty. Bill Gates called them "the best idea for focusing the world on fighting global poverty that [he has] ever seen."[2] They put a label on fighting poverty that has stuck. More than 12 years after their adoption, the MDGs still have considerable staying power, as well as strong awareness by governments, international organisations, non-governmental organisations (NGOs) and the poor themselves. This awareness is not perfect, to be sure, but then again, little about extreme poverty is "perfect". Struggling to make ends meet, the poor find it hard to get their plight noticed, let alone alleviated, by the rest of society.

The MDGs have helped to broaden the concept of extreme poverty, and thereby the general understanding of possible remedies. Until the MDGs came along, the main policy conception of extreme poverty was about money alone, specifically the famous USD 1 per day threshold used by the World Bank (currently USD 1.25 per day in 2005 prices adjusted for purchasing power parity). With the MDGs, an alternative conception of extreme poverty was operationalised: the inability of households to meet their basic needs. In essence, the MDGs defined extreme poverty as some combination of income poverty (MDG 1a), hunger (MDG 1b), lack of schooling (MDG 2), discrimination against women and girls (MDG 3), a lack of access to primary health care for children (MDG 4) and mothers (MDG 5), vulnerability to epidemic diseases (MDG 6) and the lack of access to basic infrastructure, notably safe water and sanitation (MDG 7). Extreme poverty is ended when households can meet their basic needs in income, food, education, non-discrimination, health care and infrastructure.

Crucially, the MDGs helped unleash major conceptual and practical efforts by various expert (or "epistemic") communities, who proposed specific solutions, interventions, policies and pathways to achieve the MDGs. This was probably most notable in the field of public health, where the global quest to achieve MDGs 4-6 led to an outpouring of research and advocacy on best practices to reduce child and maternal mortality and to control epidemic diseases, including acquired immunodeficiency syndrome (AIDS), tuberculosis (TB) and malaria.

The United Nations (UN) Millennium Project, which I directed during 2002-06 on behalf of UN Secretary-General Kofi Annan, worked to promote such epistemic communities (in gender, farming, education, disease control, infrastructure and more). In each area, a global task force was created to produce analytical studies and to suggest specific policy recommendations. In total, 13 reports were produced on specific goals, which in turn formed the basis of a synthesis volume.[3] Many of the recommendation of the task forces were adopted by the UN General Assembly at a special MDG session in September 2005. The *Lancet* (a leading medical journal) has published many extremely important survey articles on best practices in public health.[4] These articles have been motivated in no small part by the MDG policy agenda and timetable, and have given a boost to the progress of that agenda.

Of course, the MDGs did not end extreme poverty. Because of the MDGs, the fight against extreme poverty has risen higher in the public's awareness, but it is still not high enough on the rich-country list of priorities. However, substantial progress has been achieved on many of the MDGs. Taking the developing countries as a whole, the rate of extreme income poverty has declined by more than half since 1990. The biggest gains have been in East Asia, notably in China. Public health has also improved, although not enough in most of Africa to reach the MDG targets.

Why, then, have MDG achievements been limited? The rich countries made many promises to help the poor countries achieve the MDGs, starting with the "partnership goal" (MDG 8). Those promises were also solemnly made at the Conference on Financing for Development in Monterrey, Mexico (March 2002); the G8 Gleneagles Summit (June 2005); and at several subsequent summits. But they were not fulfilled. And there was no practical recourse to enforce the fulfilment of these commitments, other than the relatively weak lever of public opinion. Public embarrassment surely has some motivating power, but not enough to achieve the MDGs.

Goals versus law? Insights from other approaches to reach sustainability goals

We can usefully contrast the MDGs with an alternative approach to global problem solving: global treaty law. It is best to regard them as complementary methods, not substitutes for one another. Global treaty law has been vital and somewhat effective in areas that include nuclear testing, nuclear non-proliferation, and environmental issues in counteracting human-induced destruction of stratospheric ozone. Typically, relatively successful global treaties have had relatively clear pathways to success (such as stopping nuclear testing or replacing ozone-destroying chlorofluorocarbons (CFCs) with safer compounds), and have had the backing, or at least acquiescence, of the major powers.

Yet in more complicated cases, global treaty law has often fallen far short of its goals. This has certainly proved true in the case of the global environmental challenges addressed at the 1992 Rio Earth Summit. On that occasion, the world's governments adopted three major environmental agreements: on climate change (the UN Framework Convention on Climate Change, UNFCCC), biodiversity (the UN Convention on Biological Diversity, CBD) and desertification (the UN Convention to Combat Desertification, UNCCD). Yet 20 years later, by the time of the Rio+20 Summit, the three treaties had proven to be barren ground for action. *Nature* magazine harshly, but fairly, graded all three treaties an "F" (for failing) in terms of their actual results.[5]

It is useful to compare the fate of the main Rio treaties with the progress of the MDGs. The Rio treaties were complex and contentious in content. Several influential countries, notably the United States, were not prepared to abide by the terms of the treaties they themselves had signed. It was perhaps predictable, therefore, that instead of promoting action, the treaties promoted legal and diplomatic wrangling. They did not promote global awareness, social support for the treaties, or practical problem solving.

In summary, the MDGs, by their public and motivational nature, successfully promoted worldwide awareness and considerable expert-led analysis and problem solving. The three main environmental agreements – in part because of their legal nature and contentious agenda – promoted endless bickering about who should move first (for instance, regarding climate change mitigation), what is legally binding, and how each nation's actions should be monitored and enforced. In practice, the treaties have caused 20 years of legal bickering, while very little of note was accomplished in actually slowing or reversing human-induced climate change, the loss of biodiversity and the encroachment of deserts.

The quest for Sustainable Development Goals and related social science needs

Sustainable development activists inside and outside government took note of this crisis of implementation at the Rio+20 Summit, and in response prompted the adoption of the Sustainable Development Goals (SDGs) for the post-MDG period. They aimed to put some of the public force of the MDGs – in terms of public awareness, mobilisation of epistemic communities and practical problem solving – behind the broader, flagging agenda of sustainable development. In the final outcome document of the Rio+20 conference ("The Future We Want"), the conferees put it this way:

> We recognize that the development of goals could also be useful for pursuing focused and coherent action on sustainable development …These goals should address and incorporate in a balanced way all three dimensions of sustainable development (economic, social, and environmental) and their inter-linkages.
>
> (para 246)
>
> We also underscore that SDGs should be action-oriented, concise and easy to communicate, limited in number, aspirational, global in nature and universally applicable to all countries while taking into account different national realities, capacities and levels of development and respecting national policies and priorities …
>
> (para 247)

The new SDGs are now being negotiated, and the intergovernmental agreements on their content and timeline will probably stretch into 2015 before they are finalised. Still, the emerging shape of the SDGs, which presumably will help steer global policies during the 2015-2030 period, can already begin to set the social science agenda in sustainable development.

Four broad categories of social science work on the SDGs stand out. The first should be the work of epistemic communities on each of the SDGs. On the basis of initial consultations as well as agreements reached at Rio+20, it seems clear that the SDGs will include, among other goals, the end of extreme poverty and hunger; de-carbonisation of the world's energy systems; universal access to primary health care; universal access to secondary education; food security; and the protection of key biomes and ecosystems. Expert communities for these themes will help nations and international agencies chart practical pathways to SDG success.

The second social science contribution should be to launch new research, development and demonstration programmes to promote specific innovations needed for sustainable development and the fulfilment of the SDGs. Social scientists can and should design on-the-ground field-testing, real-time information systems, monitoring and evaluation, and novel business and organisational models.

The third agenda item should be an improved understanding and design of intentional global social, economic and technological change, whether to eradicate poverty or to head off environmental catastrophes. The complementary roles of global goals, such as the MDGs and SDGs, and international treaty law, raise many questions about global change processes. What will be the most effective ways to mobilise long-delayed actions against human-induced climate change? What tools of advocacy, law and business design can finally produce the public awareness, political response and actions in all sectors and at all levels of government that are needed to mitigate global greenhouse gas emissions? How should SDGs best be designed and implemented to have the maximum desired impact? These are questions for social science analysis.

The fourth agenda item concerns the organisation of the social sciences themselves so that they can best contribute to global problem solving. We have entered a new planetary era, christened the "Anthropocene" by the geological community.[6] Humanity now threatens the planet, yet seems mostly unaware of the dire risks caused by humanity itself. We need urgent, large-scale and directed change to protect humanity, other species and the Earth's ecosystems. Sustainable development, as a discipline, should aim to achieve economic development that is also environmentally sustainable and socially inclusive.

Conclusion

It should be clear by now that the main institutions of social science – as organised at the world's leading universities – have failed to grasp the size and urgency of the sustainable development challenge. Economics, which is in practice the most influential policy field in the social sciences, has so far contributed relatively little to practical problem solving regarding sustainable development. Universities sometimes view themselves as spectators and analysts of the Earth's crises rather than as agents of practical problem solving.

The social sciences and universities have a moral and practical imperative to take on the problem-solving mantle more actively. Universities are critical and unique aggregations of the cross-disciplinary knowledge needed for sustainable development solutions. No other social institutions – governments, businesses, think tanks, social enterprises, or NGOs – can or should duplicate the universities' quest for "universal" knowledge. Many have started down that path, often organising multidisciplinary teaching and training initiatives on sustainable development. Much more can and should be done in this regard. Governments that ignore potential help from their universities will find themselves adrift.

UN Secretary-General Ban Ki-moon has recently called for a global knowledge network, built by universities, scientists, technologists and technologically advanced businesses, to promote the cause of sustainable development. The newly established UN Sustainable Development Solutions Network,[7] which I am honoured to direct under the auspices of the Secretary-General, aims to implement that vision. It will help universities and scientific communities around the world to promote the cross-disciplinary knowledge and participation in practical problem-solving that is needed to achieve the SDGs. It will encourage the social sciences, natural sciences and policymakers to join hands in a vital, complex and urgent co-operative undertaking of unprecedented scale and importance.

Notes

1. The official MDGs and targets are at *http://mdgs.un.org/unsd/mdg/host.aspx?Content=indicators/officiallist.htm*. The Secretary-General's roadmap to implement the Millennium Declaration is at *www.un.org/documents/ga/docs/56/a56326.pdf*.
2. *www.brookings.edu/research/papers/2012/04/17-milliennium-dev-goals-mcarthur*.
3. These various reports may be found at *www.unmillenniumproject.org/index.htm*.
4. See e.g. the *Lancet* series on maternal survival, *www.thelancet.com/journals/lancet/article/PIIS0140-6736(06)69854-1/fulltext* and the *Lancet* series on neonatal survival, *www.jhsph.edu/research/affiliated-programs/global-research-activity/Research/Maternal_Neonatal_Health/lancet.html*.
5. *www.nature.com/news/earth-summit-rio-report-card-1.10764*.
6. *http://e360.yale.edu/feature/living_in_the_anthropocene_toward_a_new_global_ethos/2363/*.
7. *www.unsdsn.org*.

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6. Between social and planetary boundaries: Navigating pathways in the safe and just space for humanity

by
Melissa Leach, Kate Raworth and Johan Rockström

Rapid environmental change in the face of enduring poverty and social inequality has brought unprecedented attention to the challenge of achieving social equity and environmental sustainability, at all levels from the local to the global. There is a clear need for conceptual approaches that enable these challenges to be addressed together, so that options for pathways to equitable and sustainable development can be identified and debated. The concept of social and planetary boundaries, integrated with the three "Ds" agenda – direction, diversity and distribution – provides one such framework. This can be used to identify alternative pathways and inform consideration of their social and political implications.

Planetary boundaries

The concept of planetary boundaries proposes that there is a set of critical Earth system processes – such as climate regulation, the freshwater cycle and the nitrogen cycle – which, together, maintain the planet in Holocene-like conditions. This preserves a "safe operating space for humanity", given that the Holocene is the only era in the planet's history in which it is known that humanity can thrive (Rockström et al., 2009). Identifying these critical Earth system processes, understanding their dynamic interactions at local, regional and global scales, and proposing boundary levels that avoid key "tipping points", or biophysical thresholds, is an ongoing process, based on advancing our understanding of the interacting dynamics of environmental processes in the Earth system.

Initial proposals for where the boundary levels should be placed indicate that humanity's use of natural resources is putting significant and increasing pressure on many of them. Three are estimated to have been exceeded – for climate change, biodiversity loss, and nitrogen and phosphorus use – increasing the risk of unprecedented ecological turbulence (Rockström et al., 2009; Carpenter and Bennett, 2011).

Complementary social boundaries

Planetary boundaries propose the outer limits of pressure that humanity should place on critical Earth systems in order to protect human well-being. Yet at the same time, human well-being also depends upon each person having access to the resources needed to meet their human rights, such as food, water, health and energy. Just as there are planetary boundaries beyond which lies environmental degradation that is dangerous for humanity, so too there are social boundaries below which lie resource deprivations that endanger human well-being (Raworth, 2012). Both kinds of boundaries draw on objective and subjective criteria. Planetary boundaries aim to avoid biophysical thresholds which can be objectively measured, but the process of setting the boundaries involves judgements about what constitutes an acceptable risk. Some social boundaries aim to avoid human biological thresholds (such as malnutrition, dehydration and death) which can likewise be objectively measured, but the process of setting these and other social boundaries also involves judgements about what constitute acceptable human outcomes.

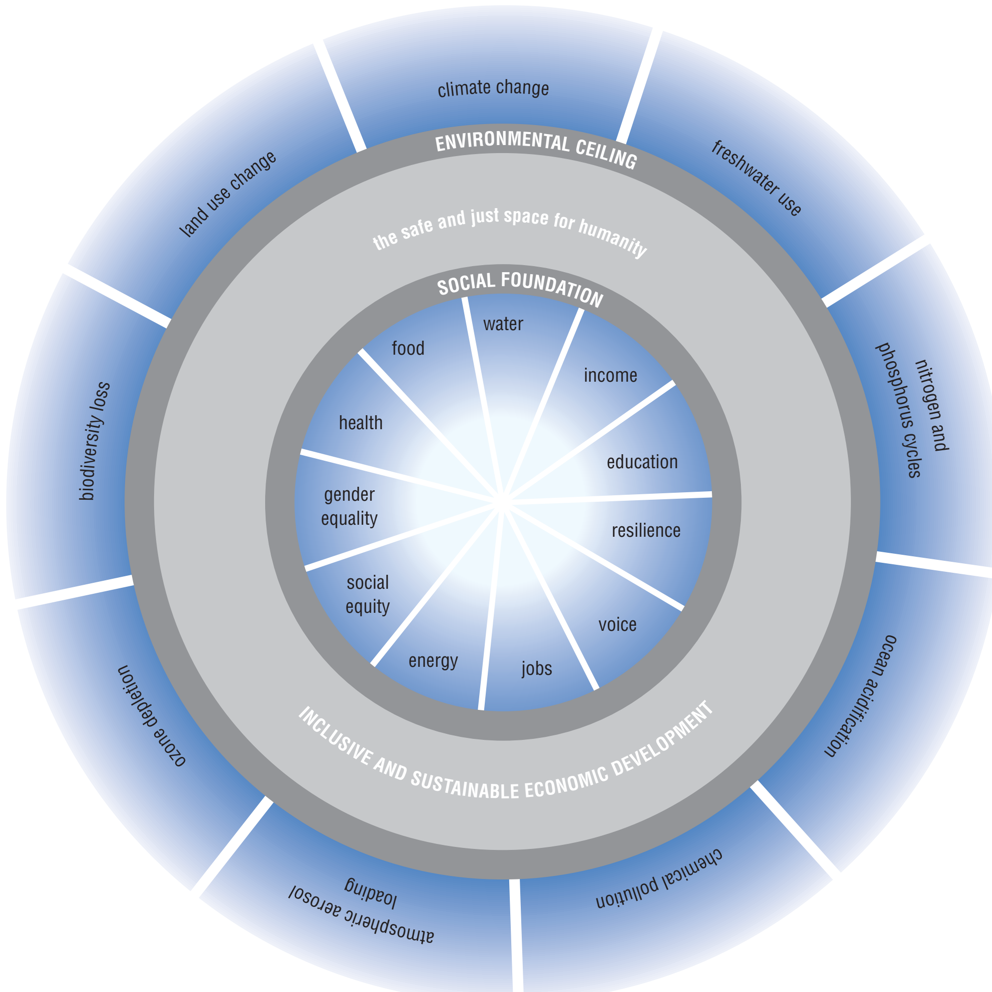
The 11 social boundaries proposed below are illustrative. They are based on the social issues raised as priorities in more than half of all government submissions to the United Nations Rio+20 Conference on Sustainable Development in June 2012. Internationally comparable data indicate that humanity is falling far below this social foundation. Nearly 13% of people are undernourished; 19% have no access to electricity; and 21% live on less than USD 1.25 per day (FAO, n.d.; IEA, 2011; Chen and Ravallion, 2008).

Combining the inner limits of social boundaries and the outer limits of planetary boundaries in this way creates a doughnut-shaped space within which all of humanity can thrive by pursuing a range of possible pathways that could deliver inclusive and sustainable development (see Figure 6.1).

This framework makes clear one of humanity's major challenges in the 21st century: to ensure that the use of Earth's resources achieves the human rights of all – 7 billion people, rising to at least 9 billion – while simultaneously ensuring that the total pressure on Earth systems remains within planetary boundaries.

The framework can be adapted and explored on local, national, regional and global scales. It invites further research into understanding how geographic scales and social contexts interact; better understanding the complex dynamics and feedbacks across and between the various planetary and social boundaries; and exploring the social inequalities and power relations that leave many millions of people without the essential resources they need, while allowing excessive resource use by others to push humanity across planetary boundaries.

Figure 6.1. **Social and planetary boundaries**

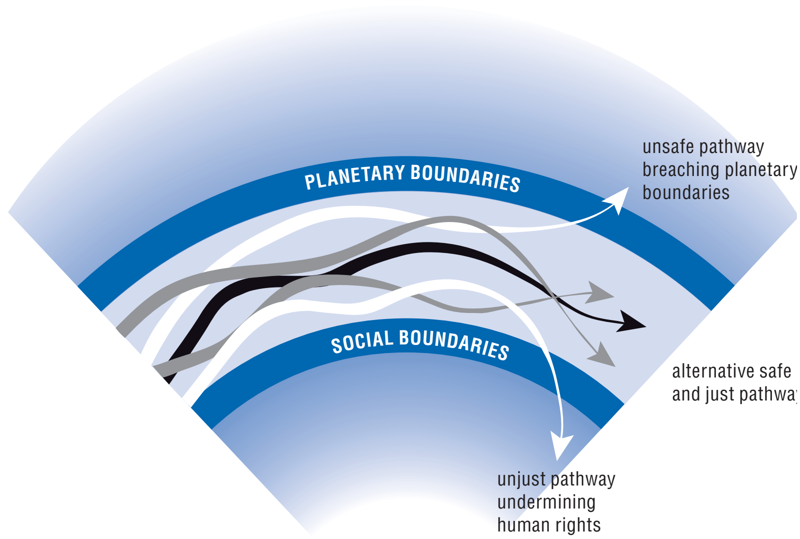


Source: K. Raworth (2012), "A safe and just space for humanity: Can we live within the doughnut?" discussion paper, Oxfam, Oxford, based on J. Rockström et al. (2009), "A safe operating space for humanity", *Nature*, Vol. 461, pp. 472-475.

Negotiating pathways within the safe and just space for humanity

This framework aims to specify the social and planetary boundaries between which humanity can thrive, but does not suggest specific pathways for getting into that safe and just space, or for thriving there. The precise configuration of the space will depend on the scale and boundary definitions chosen. There are likely to be many possible pathways in that space, which will be aligned with different cultures, visions and values, and with different costs, risks, and distributions of power and benefits between social groups. So there will be a range of outcomes for social justice. This makes the process of adjudicating between them a deeply political one (see Figure 6.2).

Figure 6.2. **Possibilities within the safe and just space**



Note: graphic design by Lisa Dittmar.

Take a particular challenge: ensuring the right to food for all within global and regional boundaries of climate change, land use change, biodiversity loss and nitrogen use. Proposals for meeting this challenge include raising the productivity of small-scale food producers; promoting agro-ecological techniques that sequester carbon in soils; promoting large-scale, input-intensive industrial agriculture; creating high-yielding, pest-resilient, genetically modified crop varieties; and a variety of other possible approaches. Such alternative pathways involve different actors, interests and values, and imply significantly different winners and losers, opportunities and risks. Some are compatible and could be pursued together, but others involve clear choices and trade-offs.

In adjudicating between such alternative pathways within the safe and just space for humanity, three questions or principles – described by the three "Ds" of direction, diversity and distribution – can help ensure that sustainable development challenges are met in ways that are compatible with social justice (Leach, Scoones and Stirling, 2010; STEPS Centre, 2010). These can be applied to any sustainability challenge or geographical scale, or used to explore the linkages and trade-offs between them.

The first D asks in which **directions** different current and potential pathways are heading. Is a particular pathway moving in the space between the boundaries, or veering towards either of them – or perhaps it has already moved outside them? What directions do other possible pathways offer? Being clear about directions brings attention to the goals, values, interests, behaviours, practices and power relations driving particular pathways. What would it take to "re-steer" pathways heading outside the safe and just space, and to support those steering within it?

Second, is there a sufficient **diversity** of approaches? Is a wide enough range of approaches being explored and tried out to ensure that at least one of them offers a promising way forward in any particular context? Fostering many solutions through diversity helps provide respect for and response to the values and needs of different people and places. Nurturing a diversity of possible pathways is also valuable because of the uncertainties and surprises that complex environmental and social processes bring, keeping several options open in case some should prove infeasible.

Third, what are the implications for **distribution**? Who stands to gain or lose from the current or proposed pathway, or from the alternatives? Who is likely to benefit from a particular pathway in terms of resource access, well-being or power – and who will bear responsibility for the associated costs and risks? This involves asking how a choice between different pathways will affect inequalities in wealth, power, resource use and opportunity, regardless of whether those inequalities are vertical (across income groups) or horizontal (across social groups defined by factors such as gender, ethnicity, class and location). Clarity about the distributional implications is essential, as it is the basis for identifying pathways and choices that promote social justice and enable a more equitable sharing of the safe and just operating space.

Integrating these three Ds highlights the point that inclusive and sustainable development within social and planetary boundaries requires exploration of and debate about which combinations of pathways to pursue at different scales. Such debates will need to be as open and inclusive as possible, giving voice to the knowledge, values and priorities of women and men who are marginalised, so that they are able to challenge powerful groups and interests.

Rising to the challenge

To meet these challenges, a strengthened interdisciplinary, inclusive and politically astute science of sustainability and sustainable development is needed. Depending on the particular issue and context, it will be important to bring together social and natural scientists from different fields. But this new science would also be vitally enriched by the knowledge and expertise of citizens, resource users, policymakers and practitioners. The framework outlined here offers a shared set of concepts and guiding questions around which such interdisciplinary, science-policy-practice debate might happen, in order to explore and build pathways towards genuinely sustainable and equitable development.

What roles might social scientists play in fostering such approaches? The roles and tasks are many. They range from characterising actors, systems, boundaries and pathways, to understanding the political, behavioural and power-knowledge processes that shape current directions and distributional outcomes and their related social inequalities and injustices. Their findings might help re-steer and diversify these outcomes. This involves working across disciplines, as well as engagement between research, action and policy. This means moving beyond simply producing knowledge for instrumental purposes, whether to inform and solve puzzles for academic audiences, or to solve problems for policymakers, practitioners or groups of activists. As our approach emphasises, reflexivity and dialogue about goals and values are also central (Leach et al., 2012). This points to the importance of reflexive knowledge-making which engages critically with the assumptions of science and social science, and which communicates with the wider public sphere.

A new interdisciplinary science for sustainability needs to encompass all these concerns, and move nimbly amongst them. It needs to recognise sustainability as political, requiring inclusive debate and multiple voices. Seen in this way, science and knowledge-making become integral to wider conceptions of society and democracy; and a politics of sustainability is necessarily a politics of knowledge in which our own research, engagements and communications are deeply implicated.

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7. Inclusive wealth and the transition to sustainability

by
Anantha Kumar Duraiappah, Pablo Muñoz and Elorm Darkey

Inclusive wealth aims to measure the natural, human and manufactured capital of nations. Understanding changes in this productive capital base provides guidance to policymakers on the sustainability of economic welfare.

The congruence of the economic, social and environmental crises of the past decade has forced political, business and civil society leaders around the world to question our present model of fostering human well-being, and particularly our focus on material wealth as the most important element of well-being and development. Economic growth is undoubtedly an important determinant, but just one of many. Social and ecological factors are significant and, in some cases, the most essential elements of well-being (MA, 2005; Dasgupta, 2003; Stiglitz, Sen and Fitoussi, 2010). Education, health and stable ecosystems are examples of these.

The Inclusive Wealth Report (IWR) identifies various determinants of well-being and explores the productive base that a country needs to ensure that the well-being of future generations is maintained or improved. The results should be regarded as an exploratory exercise to estimate empirically the capital assets that form a nation's productive base and to examine the interplay between them. These are critical for the maintenance and improvement of well-being.

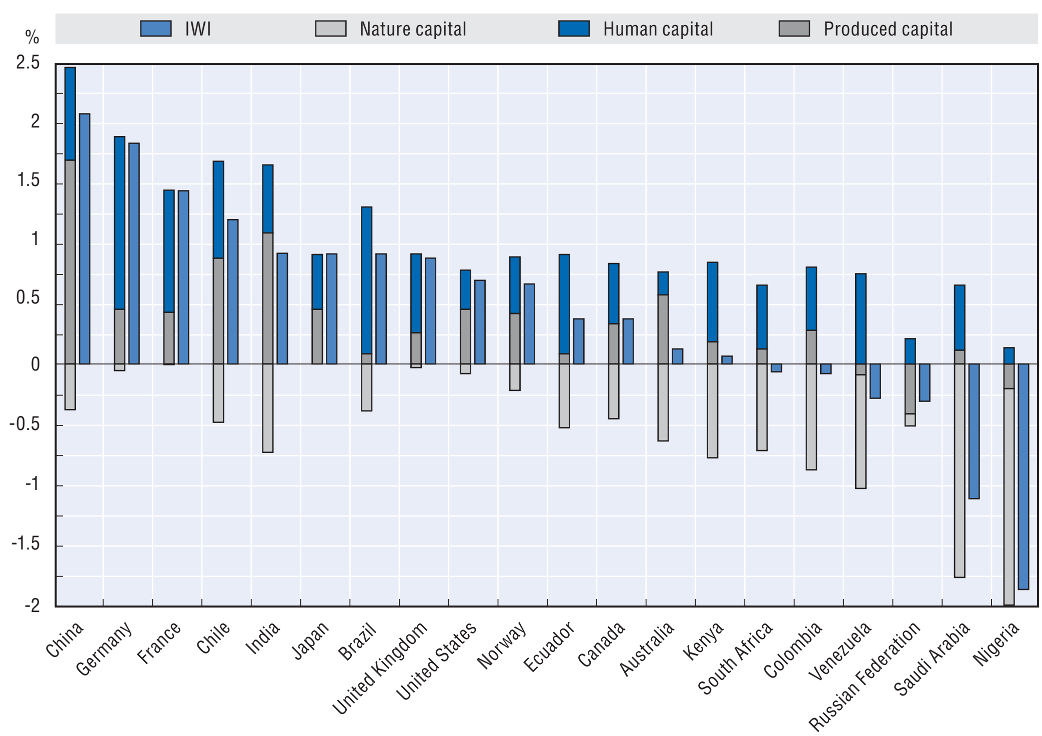
The Inclusive Wealth Report

The concept of sustainable development is not new. The most recent expression at an international level, resolution A/RES/38/161, established a special UN commission to address the rapid deterioration of human and ecological environments. This commission called for a new era of socially and environmentally sustainable economic growth, but did not provide guidance on how to quantify progress and support policymakers' interventions and responses. In the run-up to the 2012 Earth Summit (Rio+20), the UN Secretary-General's high-level panel report on global sustainability repeated the call for sustainable economic growth, and the need for new measures to track progress.

In response to this urgent need for new indicators of societal progress, the Inclusive Wealth Report 2012 (UNU-IHDP and UNEP, 2012) presents a promising economic yardstick. It assesses economies from a capital asset perspective in an inclusive way, considering not only manufactured capital but also human and natural capital. Grounded in theory and research, the index proposes a radical shift in the way we measure progress. Instead of focusing on monetary flows as GDP does, it focuses its attention on the stock of assets as a country's wealth. This is a tangible measure that governments can use and track over time. Even more importantly, the framework provides policymakers – particularly planning authorities – with information on the required forms of capital investment to ensure the sustainability of the economy's productive base.

Twenty countries – high, middle, and low-income economies from all continents – were assessed in the Inclusive Wealth Report over 19 years (1990-2008). Figure 7.1 illustrates the contribution of different forms of capital to the per capita changes in the Inclusive Wealth Index (IWI). While the IWR 2012, the first of a series of reports to be published every two years, focuses on natural capital, the IWR 2014 will focus on human and health capital.

Figure 7.1. **Average annual growth rates (per capita) disaggregated by capital form**



Source: UNU-IHDP and UNEP (2012). Inclusive Wealth Report 2012: Measuring Progress toward Sustainability. Cambridge: Cambridge University Press, UK.

Important findings

- While 19 of the 20 countries experienced a decline in natural capital, six also saw a decline in their inclusive wealth per capita, indicating an unsustainable track.
- 25% of assessed countries showing a positive trend when measured by GDP per capita and the Human Development Index were found to have a negative IWI.
- The primary driver of the difference in performance was the decline in natural capital.

- Estimates of inclusive wealth can be improved significantly with better data on the stocks of natural, human and social capital, and their values for human well-being.

Key messages

Inclusive wealth offers policymakers a comprehensive accounting tool for measuring available assets in the economy. The understanding of such asset portfolios and their changes over time has important implications for sustaining the consumption needs of present and future generations.

The measurement of inclusive wealth does not require the arbitrary assignment of weights on the different constituents of well-being. The weights assigned to the various determinants are instead derived from the individual social (shadow) prices of the various capital assets.

The framework also allows the analysis of trade-offs that emerge across the various determinants of well-being and allows policymakers to gain a better understanding of how these trade-offs take place, and their evolvement over space and time.

Countries witnessing diminishing returns on their natural capital should build up their investments in renewable natural capital, to increase their inclusive wealth and the well-being of their citizens.

Governments should move away from GDP per capita and instead evaluate their macroeconomic policies – such as fiscal and monetary policies – on the basis of their contribution to their countries' IWI.

Governments and international organisations should establish research programmes to evaluate important components of natural capital, particularly ecosystem services.

The Inclusive Wealth Report 2012 is an important theoretical framework for sustainable development. Rather than focusing on the complex constituents of well-being, it focuses on the productive base of observable, non-subjective and comprehensive determinants needed to achieve improved well-being.

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8. Gender and environmental change

by
Bina Agarwal

Whether assessing the impact of environmental degradation and climate change, or building effective governance institutions, rigorous gender analysis will deepen and broaden our understanding of environmental problems, and help find relevant, effective, equitable solutions.

It is now commonplace to view economic growth through the lens of environmental sustainability and social equity, including gender equity. But it is still relatively uncommon to view sustainability through a gender lens. Rigorous empirical work on gender and environmental change is even more rare. Why is a gender perspective important in addressing environmental change, especially in developing countries?

The costs of environmental degradation

To begin with, a gender perspective is critical for assessing the economic and social costs of environmental degradation. Such an assessment is imperative today in the context of accelerating natural resource depletion and climate change. The costs of such change fall differentially on men and women in developing countries, for at least two major reasons. First, due to a pre-existing gender division of labour, rural women and girls are mainly responsible for gathering and fetching from forests, village commons, rivers and wells. In subsistence contexts, they obtain firewood, fodder and supplementary food items from forests and commons, while men mainly procure timber for agricultural implements, house repairs and related needs. This creates gender differences in the nature of people's dependence on these resources. Moreover, women's dependence is a daily one; men's is sporadic.

Second, women are more dependent on common property resources than are men, because of gender inequality in access to private property resources. Women seldom own agricultural land, for example, and usually have a systematically disadvantaged position in the labour market.[1] They tend to have fewer employment opportunities, are less occupationally mobile and are often paid less for the same or similar work. They therefore have to depend much more on the commons, such as community forests, village pastures and water bodies, on which they often have claims as members of a rural community.

As a result, when the commons decline or degrade, it tends to cost women more than men in terms of their time, income, nutrition and health (Agarwal, 2010). The degradation of local forests, for instance, increases the time women and girls take to collect basic needs, especially firewood – their single most important source of rural domestic energy. Globally, 2.4 billion households still use conventional biofuels, especially firewood, which they gather, for cooking and heating (Modi et al., 2005). The extra time spent gathering firewood reduces the time women have for other economic activities, including crop production. This can reduce their incomes and sources of food from agriculture.[2] Incomes and nutrition can also be adversely affected, with a decline in the availability of non-timber forest products (such as wild fruits, vegetables, flowers and herbs), which again are largely collected by women. Although men's incomes can also be affected negatively to the extent that they depend on forests for a livelihood, their occupation options are greater.

Negative income effects and a reduction in gathered food can, in turn, have adverse nutritional consequences. Women and girls bear the main burden of these effects given that in many regions (especially in South Asia) there are gender biases in the distribution of nutrition and health care within the family (Dreze and Sen, 1995).

Moreover, even when plentiful, firewood is not a clean fuel. It is linked to greenhouse gas emissions (Crutzen and Andreae, 1990) and smoke-related indoor air pollution. Firewood and other unprocessed biofuels are globally responsible for 36% of lower respiratory infections, caused by inhaling smoke from indoor cooking (WHO, 2002: 70). Women, who do most of the cooking, suffer disproportionately from such infections and other diseases. As a result, their mortality risk from indoor air pollution is assessed to be 50% higher than men's (Goldemberg et al., 2004: 6). In countries such as India, thousands of infants also die annually from this cause (Misra, Smith and Retherford, 2005).

Similarly, the impact of falling water tables, the drying up of streams and the deterioration of water quality can affect women disproportionately, given the nature of tasks they perform. They end up spending more time fetching water for household use where no piped water is available. They are also more exposed than men to rivers and ponds polluted with fertiliser and pesticide runoffs. In Asia, agricultural tasks such as transplanting rice are done mainly by women, and are associated with diseases such as arthritis and gynaecological infections (Mencher and Sardamoni, 1982). Working in cotton fields also exposes women to high levels of pesticides. In the 1980s there were already warning signs of adverse health effects from these activities; Wagner (1987) reported several times higher than acceptable levels of the pesticides dichlorodiphenyltrichloroethane (DDT) and β-hexachlorocyclohexane (beta HCH) in the milk of nursing agricultural workers in China.

Falling water tables caused by the overuse of ground water for irrigation have also increased the risk of contamination from toxic elements, including arsenic, as reported in parts of Bangladesh and India (Chowdhury, Biswas and Chowdhury, 2000), with particularly negative implications for women (Sultana, 2008). Moreover, the care of children who fall sick from water-borne diseases, or from chemically induced ailments, is mainly women's responsibility.

The intensity of these effects of environmental degradation can vary with ecology, technology, land distribution, income class and social structure, but they nevertheless remain distinct and therefore create differential gendered stakes in environmental conservation.

Climate change, food security and ecological knowledge

The impact of climate change is also likely to be gender differentiated and would be revealed in greater depth through a gender lens (Skinner, 2011). Besides the potential negative effects of climate change on the availability of water and forest products, women are found to suffer more from the adverse impact of floods and natural disasters, such as tsunamis.[3] Moreover, the predicted adverse effects of climate change on agricultural yields and food security are likely to have gendered implications. Given the feminisation of agriculture in recent decades, household and global food security will depend increasingly on the productivity of women farmers and their ability to adapt to climate change (Agarwal, 2011). Attention will thus need to be paid to the constraints they face in accessing essential inputs and technologies. For instance, women's lesser access to irrigation will affect their ability to cope with delayed or failed rain. Without technological support, they will be less able to access new, more heat-resistant crop varieties. And the absence of crop insurance will leave them more economically vulnerable to crop losses. In contrast, enhancing women farmers' access to land, credit and other critical inputs could raise agricultural growth rates in developing countries by as much as 2.5% to 4%, by some estimates (FAO, 2011).

Knowledge of ecosystems also has a gender specificity, stemming from differences in the products that women and men extract from forests, how often they extract them, and the distances they travel to do so. Women tend to know more about fuel, grass and food species growing near their home, while men know more about timber and other products in distant locations. Food items, in particular, require an elaborate knowledge of the nutritional and medicinal properties of plants and biodiversity. This knowledge is critical for tiding families over prolonged shortages, for example during extended droughts or other climatic disasters (Agarwal, 2010). A gendered analysis is necessary for a comprehensive picture of ecological knowledge systems and their potential use in such disasters, and to promote conservation and biodiversity.

Since their dependence on ecosystems differs, men and women can also differ in their preferences, priorities and valuation of different elements of an ecosystem. Exercises to determine men and women's "willingness to pay" for conservation or ecosystem services (commonly carried out by environmental economists) could thus yield different results depending on whether a researcher talks to men or to women.

Institutional effectiveness and sustainability

Research on environmental change is a key element in framing effective policies and building sustainable institutions to govern natural resources. The Nobel Laureate Elinor Ostrom, among others, spelled out several conditions ("design principles") that could be conducive to building enduring institutions for managing common pool resources (Ostrom, 1990). However, her analysis, as that of most others, takes no account of the gender composition of such governance institutions. Insofar as men and women have different interests and preferences in relation to a resource, men cannot represent women effectively in institutional decision-making. An institution of green governance with few or no women would be found wanting in relation to Ostrom's design principles. An ungendered analysis of such an institution would be unable to capture the reasons for its failure or success.

The gendered structure of institutions matters not only instrumentally but also intrinsically, to ensure social inclusion and voice. Some forms of exclusion can be inherent in the conditions of formal membership, such as specifying that only household heads (typically men) can be members. Other methods are more subtle, such as exclusion based on social norms which silence voices. Women's ability to be effective in a public forum requires both presence and voice. These "participatory exclusions" can have a negative effect on equity and institutional efficiency. A gendered approach would indicate the need to include representatives of both genders.

At the same time, it is also important to ask a further question: what difference would women's inclusion in institutions of green governance make? Much existing analysis (mainly by non-economists) of gender and green governance confines itself to equity concerns and women's limited participation in governance. This leaves a major knowledge gap on the impact of women's presence.

Gender and conservation outcomes

Recent research, based on primary data on community forestry in Nepal and India, demonstrates that the gender composition of forest management groups can have a significant impact on many aspects of how these institutions function. This applies especially to effective participation, formulating rules, and equity and forest conservation outcomes (Agarwal, 2010). Women are found to participate more effectively in forest governance when they constitute a critical mass, around 25 to 33% of the executive committees (ECs) of these groups. Their higher presence in mixed gender groups, or the forming of all-women management groups, significantly improves conservation outcomes.

In Nepal, for instance, forests managed by all-women EC groups are found to have a 51% greater likelihood of improvement in condition, as measured by a range of indicators, than do groups with men. Women-only ECs consistently outperform other groups in regenerating the forest and in increasing its canopy cover, despite starting with poorer and smaller forests than ECs with men. Similarly, in the research sites in India, as in Gujarat, ECs with more than the mandatory two women (compared with ECs with two women or fewer) are found to have better conservation outcomes, again as measured by several indicators.

A number of factors underlie these positive gender effects, the most important being the improvement in protection that women's presence brings. Women's inclusion enlarges the pool of people committed to forest protection. They can apprehend female intruders more effectively than men, who face cultural constraints in physically catching intruders. And if women are part of the rule-making process, they are found more likely to comply with the rules themselves, as well as to persuade others to do so, even if the rules that the EC eventually makes are tough on women. In addition, women's presence enlarges the pool of knowledge about the local ecology and of ecologically sound extraction practices.

What needs to be done?

These insights from existing analysis highlight the many challenges of bringing a gender perspective to social science research on environmental change.

First, it requires questioning standard assumptions regarding intra-household dynamics that underlie much of theory, data collection and policy. Theoretically, a shift away from the unitary household model toward a bargaining approach has important implications for gender analysis (Agarwal, 1997). The unitary model assumes a congruence of interests and preferences within households and an altruistic household head who ensures equitable distribution. A bargaining approach allows for a divergence of interests and preferences, and the prevalence of self-interest (alongside altruism) within families.

Here, the allocation of resources and tasks within households emerges from the relative (implicit or explicit) bargaining power of household members. A growing body of empirical evidence has helped challenge the unitary model and held up the validity of the bargaining model (see e.g. Quisumbing and Maluccio, 2000; Haddad, Hoddinott and Alderman 1997). This theoretical shift, however, has yet to permeate most empirical social science research on the environment.

How we view the household is not a trivial question. It can affect our conceptualisation of the research problem, the questions we ask, the data we collect, the empirical analysis we undertake and the policies we formulate.

Gender-disaggregated data, for instance, are rarely collected on resource use, the impact of environmental change or on green institutions. Data collected only at the household level which ignore intra-household differences implicitly reflect the assumptions of a unitary household model. Similarly, while qualitative assessments provide rich insights, gender analysis also needs more rigorous empirical testing of propositions than is found in the existing literature.

Second, even within gender analysis, whether it relates to environmental issues or is more general in scope, different formulations can lead to different results and policy directions. Several versions of the eco-feminist formulation, for instance, conceptualise women as biologically closer to nature than men. By contrast, the feminist environmentalist approach locates people's relationship with nature, their interest in protecting it, and their ability to do so effectively in their material reality. In this formulation, what matters is people's everyday dependence on nature for survival, as well as the social, economic and political tools they have at their disposal to further their concerns (Agarwal, 2010; see also Braidotti et al., 1994).

The eco-feminist perspective, which many have argued is ahistorical and non-contextual in its approach, gives centrality to women as the main conservators of the environment. The feminist environmentalist perspective (formulated by the author: Agarwal, 1992) recognises that both women and men share an interest in environmental conservation, insofar as both use local resources, such as forests and water bodies, for daily subsistence. But their interest stems from different and at times conflicting concerns. Interests can diverge along gender lines for at least three reasons: the nature of the product that men and women obtain from the commons, the time within which it has to be obtained, and the gestation period needed for it to grow.

Depending on these factors, men and women can differ on what to conserve, what to replant, what to extract and when to extract. Moreover, men's main interest is usually in timber, which is needed sporadically and takes more time to mature than women's main interests – firewood, fodder and non-wood products. In a newly regenerating forest, men will thus have a low time preference. They will want to delay extraction to allow the tree to mature and can afford to wait, given that theirs is not an everyday need.[4] Women, on the other hand, need firewood and fodder daily, and tend to have a higher time preference than men; they want the products sooner, and because these products have a shorter gestation period, they can be extracted earlier and more frequently. All these aspects impinge on the incentive to conserve.

In addition, timber extraction involves heavy lopping or felling, which can be much more destructive environmentally than firewood extraction, as firewood is typically collected as dry wood or fallen twigs and branches. Hence, although women's keenness to extract forest products early might appear potentially to be environmentally damaging, in practice their forms of extraction tend to be less destructive than those of men.

Third, a nuanced gender analysis requires the recognition that women are heterogeneous and their interests can differ, depending on their class, caste, race or ethnicity. Poor landless women, for instance, share an interest in forest regeneration with well-off women because both draw upon forests for their daily needs. But since landless women are more dependent on local resources, they tend to have a higher time preference and want more and earlier extraction than women from land-owning households. The priority they attach to different forest products or to different uses of the same product can also differ. Here, a shared interest in forest improvement among women of all classes could provide scope for co-operation. But class differences in the immediacy and extent of their needs can create conflict. These class–gender dualities can affect women's commitment to protect, and the pressure to extract. It is important to recognise these potential complementarities and conflicts if we are to understand more fully gendered responses to environmental change.

Hence, whether we are assessing the costs of environmental degradation or the potential for regeneration, a rigorous gender analysis can not only deepen and broaden our understanding more fully of the problems, it can also lead to more relevant and effective solutions.

Notes

1. On gender inequalities in access to land, see especially Agarwal (1994), Deere and de Leon (2001), and FAO (2011).
2. Kumar and Hotchkiss (1988) found significant negative effects from the additional time women in Nepal spend collecting firewood as a result of forest degradation, and on their production of wheat, maize and mustard, crops which are dependent mainly on women's labour in the hills.
3. A 2005 survey of 388 Indonesian households displaced by the December 2004 tsunami in Aceh province found the highest risk of death among the youngest and oldest persons, and females (see Rofi, Doocy and Robinson, 2005).
4. Here we are focusing on forests for subsistence needs and not for commercial exploitation, such as timber extraction for sale.

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9. Social science understandings of transformation

by
Katrina Brown, Saffron O'Neill and Christo Fabricius

Society must adapt and learn to live in a world that is 4°C warmer. Many encourage profound changes in the way society is organised and responds to change, often using the language of transformation. How is transformation understood in the context of environmental change? What can be learned from a case study of transformative social and political change? The authors identify challenges for social science to inform, guide and reflect critically on the transformation concept, and to contribute to debates on reshaping society to cope with environmental change.

Transformation in the social sciences

The concept of transformation is used increasingly in the environmental change literature, and in policy and public debates on global change. However, social science understandings of transformation are diverse, fragmented and contested. Transformation is a problematic term for many social scientists, as it can be used to further specific agendas, involving highly questionable means. This contribution brings together social science understandings of transformation and identifies important questions that can be used in the application of transformation in contemporary debates, and in emerging policy, on environmental change. The objective is to provide insights from social sciences to inform current applications of transformation.

Transformation is generally understood to mean a profound, substantial and irreversible change. Although we intuitively recognise major historic and contemporary transformations – the Industrial Revolution in Europe, the fall of the Berlin Wall, the historic collapse of ancient civilisations, the Arab Spring – many questions remain about how to understand, analyse and ultimately apply transformation in the context of environmental change. When is a change a transformation? Is a transformation just a very large-scale change? Does it happen quickly or slowly? Table 9.1 distils definitions of transformation from different social science domains.

Transformation has ambiguities and multiple meanings in social science, and can imply shifts in structures (changes to institutions or cultures) and in agency (empowering people to envisage and implement alternative pathways). Very often, discussions of transformations conflate individual, collective, and broader system or regime-scale change.

Table 9.1. **Definitions of transformation from the social sciences**

Domain[1]	Definition
Environmental social sciences	A process of altering the fundamental attributes of a system, including structures and institutions, infrastructures, regulatory systems, financial regimes, as well as attitudes and practices, lifestyles, policies and power relations (Hackmann and St. Clair, 2012).
Anthropology	Reforming the basis on which we think about the world. A dynamic process that emerges from many small individual actions that manage to grow (Nelson, 2009).
Economics	Economic transformation has fundamental impacts on human life, with important changes to values, norms, beliefs and customs. Adjustments in society and institutions may be seen as a “controlled revolution” (Breisinger, Clemens and Diao, 2008).
Education	Transformative learning is the process of effecting change in a frame of reference, meaning the structures of assumptions through which experiences are understood. It has cognitive, affective and conative dimensions, and enables a more inclusive, discriminating, permeable and integrative perspective and process of decision-making (Mezirow, 1997).
Leadership studies	Transformational leaders are those who stimulate and inspire followers to both achieve extraordinary outcomes and, in the process, develop their own leadership capacity (Bass and Riggio, 2005).
Geography	Fundamental change in systems (cultural, political, economic and so on) involving multiple actors across interlinked levels; operate at the level of epistemology, which is concerned with deep shifts in values, behaviour and rights (Pelling, 2010).
Natural resource management	A discrete process that fundamentally (but not necessarily irreversibly) results in change in the biophysical, social or economic components of a system from one form, function or location (state) to another (Park et al., 2012).
Business	Organisational transformation means substantially changing an organisation's structure and practices, often consisting of multiple and interrelated changes across the whole system; the creation of new organisations; the reconfiguration of power relations; and a new culture, ideology and organisational meaning (Ashburner, Ferlie and Fitzgerald, 1996).

1. The domain column shows where definitions have emerged, not that there is consistency in applying this definition across the domain.

These domains show a general agreement that transformation is a process of change that involves the alteration of fundamental attributes of a system. For example, Chapin et al. (2010) refer to transformation as a fundamental change in a social ecological system resulting in different controls over system properties, new ways of making a living and often changes in the scale of crucial feedbacks. Adjustments are interlinked and occur at all scales: for individuals, society, institutions, technology, economy and ecology. They may also involve changes to practices, lifestyles, power relations, norms and values. There is often an emphasis on learning, and transformation requires a commitment to innovation, novelty and diversity in order to imagine alternatives and possible futures (Schoon et al., 2011).

Many of these definitions also emphasise the importance of critically questioning transformation as a process, and how it is shaped by and ultimately shapes our understanding of the world. Transformation, like all societal change, is politically charged, often contested and sometimes involves conflict. This begs the question, what is the subject of transformation? In other words, what is being transformed? Who is or are the main agent or agents of transformation: the state, civil society, corporations or individuals? To what extent is transformation planned or deliberate (O’Brien, 2012)? It also highlights how transformation incorporates changes in the ways in which people understand the world (Pelling, 2010).

The drivers and catalysts of transformation act on many spatial and temporal scales. They may take the form of gradual shifts or fast changes, and may be punctuated by surprises or episodic events. The interplay between fast and slow drivers of transformation, operating at global, national and subnational scales, results in unpredictable and messy transformative processes. Transformation is seldom a neat "flip" from one state to another. In most instances, many elements of the pre-transformed systems linger on as memory in the new system, ready to revive themselves when a combination of events creates conducive conditions. This is exemplified in Box 9.1, which examines South Africa's transformation to peaceful democracy. It gives a sense of the multidimensional and historic nature of transformation that is largely absent from analyses of environmental change.

Box 9.1. **Transformation in South Africa**

After the Dutch colonisation of South Africa in 1652 and the introduction of inequality and segregation on the basis of race, South Africa became tightly organised around ideology, state control and institutionalised race-based inequality. The country's transition from an undemocratic to a democratic state in the early 1990s was a result of a complex interplay between fast, slow and episodic factors on global, national and subnational scales (see Figure 9.1). Together, these factors eroded the inertia of the previous era.

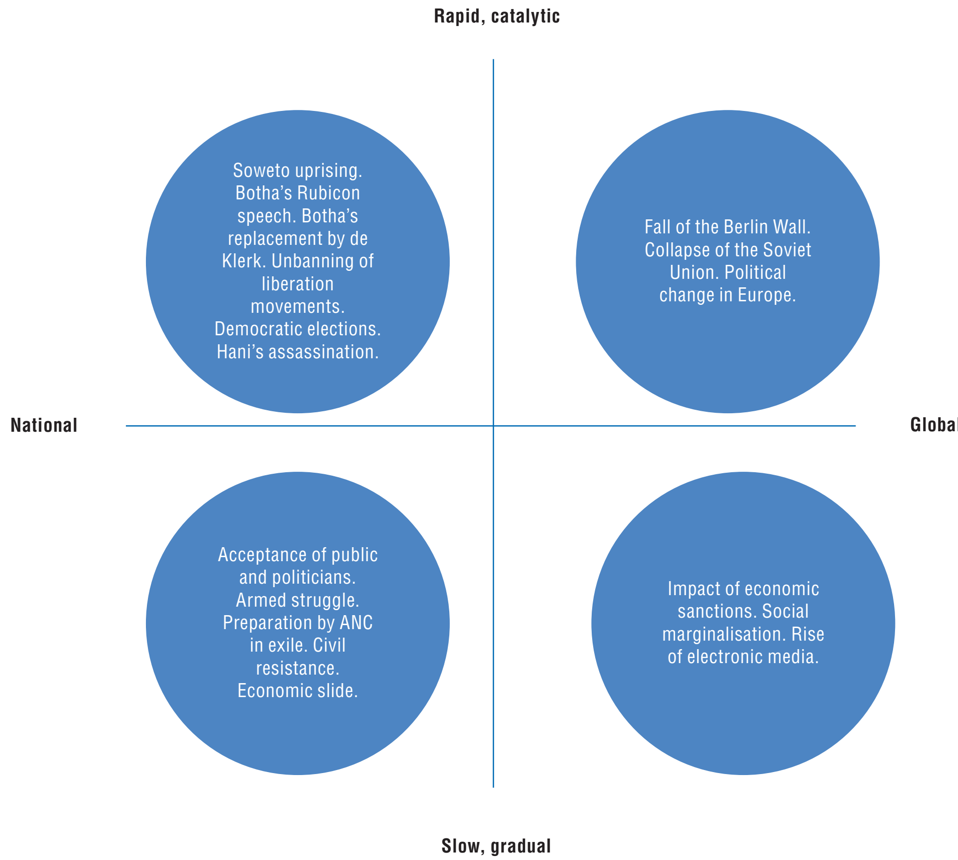
Gradual processes that compelled transformation included the increasing acceptance by the public and politicians of alternatives to apartheid; growing internal resistance by black youth and civil rights activists; intensification of the armed struggle by freedom movements; and a steady downward trend in the country's economy. A lengthy process of multi-party negotiations after 1990 to formulate the South African constitution was crucial in the final stages of the peaceful transition.

Fast, catalytic local events included the atrocities during the 1976 Soweto and Cape Flats civil resistance, P. W. Botha's infamous "Rubicon" speech, which precipitated an almost overnight collapse of the Rand, an all-white referendum giving F. W. de Klerk the go-ahead to explore democratic alternatives for the country, and the removal of the ban on liberation movements in 1990.

Other examples of global catalytic events include the fall of the Berlin Wall, the collapse of the Soviet Union and political change in Europe. These pro-transformation processes and events were mirrored by counter-events such as attempts by right-wing forces to disrupt the process of transformation, the assassination of Chris Hani – one of South Africa's most promising young politicians – and heightened township violence before elections.

After the 1994 democratic elections, which brought the African National Congress to power, a series of reinforcing processes consolidated the transition. These include the Truth and Reconciliation Commission, South Africa's victory at the 1994 Rugby World Cup, the Nobel Peace Prize jointly awarded to Nelson Mandela and F. W. de Klerk, the lifting of economic sanctions, the resumption of international trade and the rapid strengthening of the South African economy. However, the memory of past injustices – ghosts of the past – remains, and economic, political and social processes on multiple scales currently threaten the transition.

Figure 9.1. **South Africa's transformation was driven by complex fast and slow processes on national and international scales**



Transformation observed

The difficulty of defining transformation, the common elements which transformations often share, and the entangling of different meanings and approaches, are evident in how transformations are represented in the environmental change field. Table 9.2 summarises examples from the environmental change literature, highlighting how transformations are described and understood. Defining elements of these examples include the extent to which change is planned, deliberate, unplanned or forced; the scale of change; the type of reconfiguration that occurs; and the important actors.

These documented cases illustrate the multi-scale character of transformation in diverse domains. They describe transformations in institutions and governance, social and ecological systems, communities and landscapes, energy use and farming systems, and include adaptation and mitigation actions. They include archaeological and historical studies that provide valuable insights into how societies have undergone large-scale transformations.

Table 9.2. **Examples of transformation within environmental change**

Documented example	What transformed?	Key characteristics: scale, key actors, degree of anticipation
Great Barrier Reef, Australia (Olsson, Folke and Hughes, 2008)	The transformation saw the focus of governance shift from protection of selected reefs to stewardship of the larger-scale seascape.	A transformation process was induced because of increased pressure on the Great Barrier Reef (from terrestrial runoff, overharvesting and climate change). Reformulation of governance was supported by changes in legislation.
Flood management, the Netherlands (Van der Brugge, Rotmans and Loorbach, 2005)	Coastal defence, river flood abatement and water supply are transformational because of their enlarged scale and intensity, and integrated combinations of adaptations. These include novel approaches such as artificial islands, evacuation of some areas, new institutions and funding mechanisms.	Planned government intervention in response to experienced and anticipated sea level rise and flooding.
Energy systems, Germany (Monstadt, 2007)	New technologies, regulatory regimes, management styles, marketing strategies and environmental priorities have emerged. They dramatically reconfigure patterns of governance within cities and regions such as Berlin.	Transformation triggered by new technology, economic conditions and legal frameworks. But constrained by inter-policy coordination and regional co-operation, entrepreneurial governance and contract management.
Energy systems, China (Bai et al., 2009).	Energy generation has been transformed in Rizhao, a coastal city of nearly 3 million people in northern China: rapid and widespread adoption of renewable energy, for instance 99% of households in the central districts use solar water heaters, and public infrastructure is powered by photovoltaic cells.	State-led, rapid and intentional wide-scale transformation.
Transformations in prehistoric American societies (Schoon et al., 2011)	Archaeological research shows rapid and severe transformations of social ecological systems in prehistoric American societies, and collapse through conflict, large-scale emigration and mortality.	Comparison of the Hohokam, Mimbres and Zuni societies explores trade-offs between short-term efficiency and long-term persistence.

These cases show that transformation is rarely a discrete and tidy event. It may be a process triggered by a specific event but which develops messily over time and space. This makes it more difficult to say when a series of changes constitutes a transformation. For example, Tiffen, Mortimore and Gachuki's documentation of landscape-scale transformation in upland Kenya (1994) shows that it is the result of a series of discrete changes on different scales: individual migration decisions, farm-scale land-use decisions, changes in markets and information, and in government infrastructure. Olsson et al. (2006) analysed five case studies of the transformation of the governance of social ecological systems. They found that these transformations involved shifts in social features such as perception and meaning, network configurations, social co-ordination, and associated institutional arrangements and organisational structures. This analysis also shows that transformation may be triggered by dramatic events.

A critical issue for environmental change is to distinguish between adaptation and transformation. Some authors have developed the notion of "transformational adaptation" (O'Neill and Handmer, 2012), while others view transformation at the end of a continuum of adaptation (Schoon et al., 2011) or as something quite distinct from adaptation (Marshall et al., 2012). The literature often conflates adaptation and transformation. For Nelson, Adger and Brown (2007), transformation is distinguished from incremental adjustments by its outcome, which involves crossing a social or ecological threshold and creating a fundamentally new social-ecological system. The agricultural collapse of Jordan and the shift from agriculture to tourism in Arizona, United States, are examples of unplanned and planned transformation respectively.

Key issues for the social sciences

This review of the theories and observations of transformation raises important questions for environmental social sciences:

- Who is able to define, shape and ultimately benefit from transformation? How are individual, collective and institutional agency constructed? What kind of institutions can endure desirable change, and which can actively facilitate it?
- How can society navigate and deliberate trade-offs and concerns about social engineering, democracy, equity and legitimacy?
- How should we understand non-linearities in social systems? What constitutes or even triggers "tipping points" for inducing transformative change?
- How do we distinguish between transformation and transition? How do their literatures relate to each other?

Ultimately, the possibility of a world that is 4°C warmer, or a "4°C world", means we will be transformed. Our challenge is to shape, define and effect deliberate transformation in ways that will enhance human well-being and sustainability.

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10. Changing the conditions of change by learning to use the future differently

by
Riel Miller

The world's current problems call for better thinking about the future. While model-based and data-driven scenarios have their place, there is scope for people and organisations to use a freer anticipatory approach – the emerging discipline of anticipation – or futures literacy, which can help reduce fear of the unknown, and is a more systematic and accurate way of using the future to understand the present.

Consciously or not, humans are always using their capacity to anticipate and make choices in the present. In our anticipatory universe (Miller and Poli, 2010) the processes and systems required to use the inherently imaginary future are abundant. Yet it is not common to consider in explicit terms what kind of future is being anticipated, or how anticipation occurs.

There are many reasons for this. One of the most powerful is the success story in which winners are usually depicted as good anticipators, lauded for their visionary grasp of the future. Stories of effective planning take a similar perspective. In all of these tales, the point of evoking the future is to predict it – to try to know it in advance.

In many ways this approach is not surprising. From earliest infancy, humans grasp two out of three basic categories or models of the future: contingent futures, when something happens due to an external force; and optimisation futures, when something planned comes to pass. In both cases the future is treated as if it exists and just needs to be uncovered. Consequently, the third basic category of the future is given little attention: it is the novel future (Bergson, 1946), one that is unknowable today. In part, it is ignored because it seems pointless. If the aim is to know the future and novel futures are unknowable, why bother?

The trouble is that the unknowable future cannot be grasped from the point of view of the search for probable futures. This is because the probable depends on the already known whereas the novel arises from the previously unimaginable. The power of imagining non-probablistic futures is that it enlarges our understanding of the present by providing access to novelty – the emergent new (different). Taking on the challenge of inventing non-probabilistic futures, outside the constraints of seeking what is likely or desirable, opens up the boundaries of our imagination. Imagining such novel futures makes it easier to understand the present in new, more precise ways that are not circumscribed by yesterday's idea of the future or the search for what is probable, general or durable. The aim is to expand humanity's conscious anticipatory systems in order to more fully embrace the constant and highly specific (time-space) creativity of our universe.

There are now powerful incentives for humanity to address the problem of unsophisticated anticipatory systems. Indeed, this is a topic of critical interest to UNESCO, which is why UNESCO is engaged in a global exercise to assess anticipatory capacities.

The first incentive is that such systems make it easier to reduce the cost for people and organisations of taking into account the novelty that surrounds us. The goal here is to reduce the fear, disappointment and confusion created by novelty. When people are unable or unwilling to incorporate novelty into the way they imagine the future, or to find a place for the emergence of the rich potential of the unknowable, then the lived experience of change becomes disorienting, promoting defensive and nostalgic reactions (Beck, 1992).

The second incentive for developing and diffusing more sophisticated conscious anticipatory systems is to take greater advantage of the otherwise invisible novelties that surround us. Here the greatest gain may come from overcoming the danger of "poverty of the imagination," a risk flagged by Karl Popper in the mid-20th century. The goal is to improve humanity's capacity to take into consideration "changes in the conditions of change." This would let people move beyond deterministic futures that obscure the hope that novelty offers in the present. A better understanding and appreciation of the promise of changes in the conditions of change as identifiable novelties in the present could help to stave off the appeal of totalitarian methods and colonial approaches that promise to deliver a specific future.

The challenge today is to incorporate "unknowability" into the way we anticipate and, on this basis, to engage in ongoing processes of discovery and invention in the present. This is an approach to the future that has been relatively absent from humanity's conscious anticipatory systems (Poli, 2010; Rossel, 2010; Tuomi, 2012). This is partially because questions about what the future is and how best to think about it have been peripheral to the social sciences, but also because it challenges well-established anticipatory concepts and practices (Poli, 2012). Any approach that welcomes unknowability and uncertainty as a source of novelty, and as a stimulus for creativity and improvisation, runs contrary to most people's desire for certainty and continuity, and their wish to know the future in advance. An insistence on using the unknowable future also runs foul of the established faith that experts can take the guesswork out of decision-making.

Why welcome and use the unknowable, open future? Why not just improve the models that use the past to think about the future, uncover even more data that can only come from the past, and generate ever more detailed, all-encompassing plans on how to colonise tomorrow more fully? In particular, when uncertainty "threatens", as with today's talk of "global transformations", why not succumb to the temptation to seek reassurance by only making "evidence-based" choices that depend on knowing what worked in the past and what will happen in the future?

The answer is the poverty of these limited ways of using the future. Such approaches to anticipation are all too easily stripped of novelty and drained of uncertainty. As a result, it is hard to use them to make sense of the novelty-infused repetitions and differences that make up the present, or to appreciate uncertainty as a resource for changing the nature of current problems and nourishing our freedom. Being locked into narrow ways of thinking about the future restricts the ability of the human imagination to invent futures that change the way we see and act in the present.

Is there an alternative? Yes, to develop and deploy the emerging discipline of anticipation (DoA) (Miller, 2012). This provides a more systematic and accurate way of using the future to understand the present. It provides guidance and techniques (for instance Inayatullah, 1998) for applying collective intelligence processes using different kinds of future, including the unknowable future (Fuller and Loogma, 2009). It also provides ways to expose anticipatory assumptions, quickly and accurately revealing the social processes and systems used to invent and describe imaginary futures (O'Brien et al., 2013). It helps detail the differences between futures that are imagined on the basis of established anticipatory assumptions, and those that rest on the invention of novel models, systems and processes. By doing so, it offers the social sciences effective ways to research "changes in the conditions of change".

Across a wide range of fields, including economics, sociology, political science, anthropology and policy-making, there is considerable experience of using models to "explain" past data and then using the results to conduct "what if" extrapolations. This offers insights into different paths based on the model's fixed set of goals, rules and resources. As a result, the anticipatory systems used by many social scientists and policymakers are confined to a deterministic approach that makes it difficult to recognise and then suspend the conventional or currently popular anticipatory assumptions that underlie and shape imagined futures. This restricts the set of phenomena identified in the present as possible, important and actionable (Ogilvy, 2011). Inventing changes in the conditions of change is hard precisely because our existing frames either hide or cannot make sense of novelty.

The situation humanity finds itself in today is far from being the result of conscious choices or prescience-based planning. But it is fair to say that up until now, many of humanity's efforts to exercise its volition, to act now to realise aspirations in the future, have been based on efforts to impose the "best guesses" of the present on the future. Although no one intended to create a world where human activity alters the planet's climate, the collective outcome of our "best-laid plans" helped to make it happen. The question is: can we redress the situation by ramping up the methods and attitudes of the past, or do we need to seek a radically different anticipatory framework for thinking about how to make a difference? Can we and should we find a way to combine open and closed ways of using the imaginary future to understand the present, to reinforce the human capacity to imagine discontinuity, and to put more effort into inventing futures that help to reveal more of the novelty that surrounds us?

This is where developing futures literacy comes into the picture. Futures literacy rests on the knowledge created by deploying the nascent discipline of anticipation more effectively. Its use helps researchers and decision-makers to identify existing anticipatory assumptions. It equips them to invent discontinuous or even novel frames for imagining the future, to integrate fundamental complexity into their thinking and on that basis, to reassess the present. A scientific consensus that we live in a non-deterministic universe is not enough to tell us how to put this understanding into practice. Nor does the acceptance of potential danger and the need for prudence necessarily change behaviour. But perhaps developing a greater capacity to take advantage of the spectacular nature of the emergent present, rich with novelty and serendipity, might enable us, as the French philosopher Edgar Morin put it, to become civilised by integrating complexity into our thinking.

A small thought exercise might illustrate the point. Imagine that the world becomes futures literate. This would be a radical change in the conditions of change, on a par with the once unimaginable idea that most people would be able to read and write. Could a futures literate world better integrate the richness of novelty and creativity into human agency, fostering agility and improvisation at the service of our values? Could the generalisation of a futures literate way of using the future make fuller use of the previously unknowable emergent novelty that surrounds us? Has the time come to rethink our anticipatory systems, to take on the pragmatic scientific challenge of making sense of the experiments the universe sends us in a profusion of unique space and time phenomena?

We do not know whether augmenting humanity's conscious anticipatory capacities will create a better future. There is no way to know if by being futures literate we will manage to modify what we consider harmful human-induced consequences in the world around us. But at least if we fail, it will not be because we refused to find ways to embrace the wonder of unknowability, or remained stubbornly insistent on taking an exclusively probabilistic and arrogantly colonising view of the future. Maybe this time we can decide to make a difference differently?

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11. A new vision of open knowledge systems for sustainability: Opportunities for social scientists

by
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In the new open knowledge landscape, social scientists have a unique opportunity to take on a more influential role in accelerating global sustainability learning and transformation. Decisions concerning sustainability are not to be made by policymakers or experts alone, but by different knowledge holders organised around context-specific needs and transdisciplinary practices.

Introduction

The process of producing, organising and using knowledge in science, education and policy is often depicted as a matter of "filling gaps" in an imaginary closed container. Experts may pour in their exclusive ideas on what needs to be known until it is full (Figure 11.1). Of course, this is a caricature of how knowledge systems function and the type of objectives they are meant to accomplish. It hardly fits with what people need to tackle today's global societal challenges. The increasing interconnectedness of knowledge, the speed of change, and the complexity of global systems make it difficult to support the view that any single type of knowledge, practice or even learning process alone is sufficient to deal with the major global environmental challenges of today. In addition, local structures are subject to continuous reconfiguration.

A new view is required of how human information and knowledge systems operate, how they should be organised and how they should relate to the functioning of social ecological systems in the organisation of science, education and policy (Figure 11.2). This world view should unveil the contradictions, deficiencies and misconceptions that particular modes of knowing and learning create, and that are not embodied in specific social-ecological contexts and practices. In this regard, we talk about knowledge *systems* – not simply "knowledge" – because this concept refers to multiple sets of interrelated knowledge components and their interactions which have their own internal boundaries, dynamics and logic, and which are the result of social-ecological processes.

Figure 11.1. **Knowledge from a single type of source poured into a closed container**

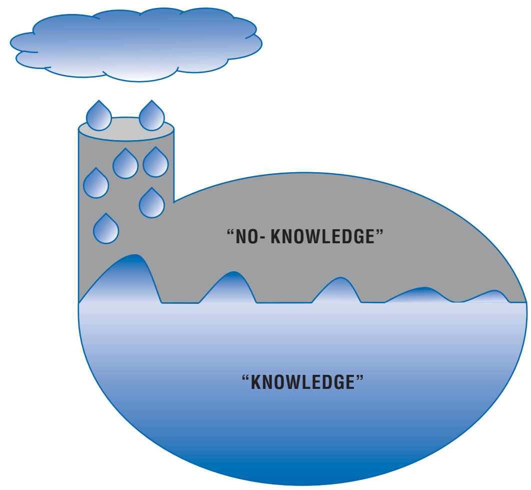

Figure 11.2. **Knowledge from many sources, all organised around concrete needs and practices, operating in a social-ecologically coupled open space**

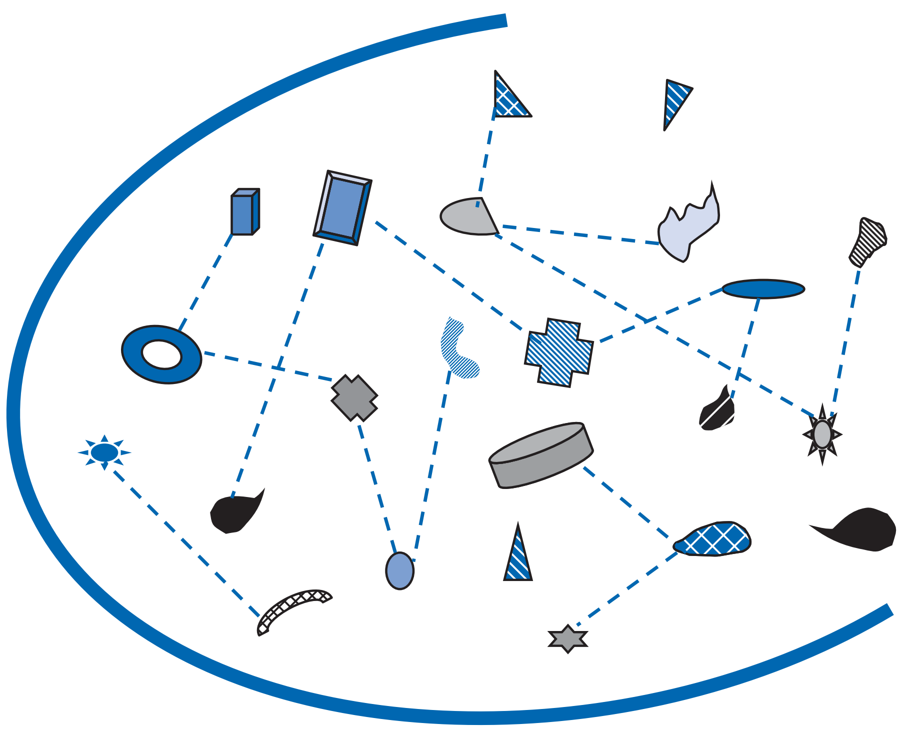

Figure 11.1 depicts knowledge as being constituted from a single type of source poured into a closed container; Figure 11.2 shows knowledge made up from many sources, all organised around concrete needs and practices, operating in a social-ecologically coupled open space.

Encouragingly, this new world view of knowledge systems – an alternative to the view that tries to overcome information and knowledge "deficits" – is trickling down to science planning, education and policy. The Foresight exercise run by the European Science

Foundation (ESF), "Responses to Environmental and Societal Challenges for our Unstable Earth" (RESCUE; ESF, 2012), synthesised the contributions of approximately 100 experts from 30 countries engaged in developing a transformative vision of science and knowledge practices in the face of global environmental change. The RESCUE vision was built on an open knowledge systems view whereby multiple forms of knowledge are generated from many diverse sources clustered around specific practices and needs. These sources can then be shared among multiple knowledge holders at many levels of action around the world (Cornell et al., 2013).[1]

Many such practices and ways of organising knowledge for sustainability already exist. They range from developing collaborative programmes for climate adaptation in the Andes, to implementing a large-scale project for ecosystem restoration in Niger, to mobilising social expertise and networks of trust in a transition town in the United Kingdom, and to developing new education and research schemes across the globe.[2] These knowledge-building initiatives are not designed or evaluated by experts alone. Instead they are co-decided, co-produced and co-validated in partnership, by knowledge holders in different social-ecological contexts in which specific needs and demands are to be fulfilled. An important aspect of this vision is that information and knowledge systems operating in an open space must be coupled with social-ecological systems dynamics. This will allow feedback that encourages the modification of behaviours and practices (Tàbara and Chabay, 2013).

This calls for new capacities to deal with social-ecologically situated problems and needs, which usually requires the empowerment of new agents as well as the redistribution of rights and responsibilities. This process is even more central in the open knowledge landscape. This means that criteria and capabilities to deal with "boundary objects" are important in finding innovative ways in which social scientists can help link context-specific needs with generalisable research outcomes (see Clark et al., 2011). Social scientists could then use such results, and perhaps organise them in the form of theories and models to support sustainability-oriented transformations.

Grounded transformation theory for sustainability

One of the major contributions social scientists could make from an open knowledge perspective is to develop a solid theory about how to transform global social-ecological systems interactions to meet the sustainability predicament. This could clarify ways to improve the quality of such interactions at various levels and domains of human action; and try to explain the structural constraints and opportunities to doing so. However, such an endeavour cannot be undertaken by one person or discipline alone. A plausible, grounded transformational theory must be built on the civic involvement of many people around the world. They must be committed to contribute to the documentation, classification and analysis of numerous experiences and cases to unravel what works and what does not in terms of changing current arrangements and institutions toward sustainability.[3]

A grounded transformational theory should help us understand how to expand our collective perceptual and cognitive capabilities, and sharpen our moral judgement to deal with the complexities of sustainability transformations. It should enable us to identify the types of incentives, options and resources most conducive to triggering this global transition, and foster the institutional and structural social changes needed to deal with the most urgent challenges. If we place learning at the heart of transformation, recognising that we can only transform in the right direction through learning, a transdisciplinary, integrative, open approach that blends insights from theory and practice, and from multiple disciplines and sources of knowledge and expertise, becomes essential.

New opportunities for social scientists, policymakers and funders

This alternative vision offers a multitude of professional development and innovation opportunities for social scientists. They can play a decisive role in identifying key knowledge-holders relevant to meeting particular needs, and ensuring the sustainable management of a given social-ecological system of reference; and they can contribute to ensuring a fairer distribution of rights and responsibilities in knowledge generation, interpretation, integration and ownership.

The following areas of action may be of interest and relevance to social scientists. Their individual selection of priorities will depend on their own interests, capabilities and institutional commitments.

Methodological innovation

- Developing new concepts, tools and methods that go beyond simple representation of social-ecological systems dynamics and support their transformation (Tàbara et al., 2010). These new tools could be oriented towards stimulating broad public engagement and creating a sense of ownership of knowledge processes and outcomes, for example by including the arts and other forms of knowledge production and representation.
- Providing robust, integrated methodologies to improve our understanding of the implications of global environmental change and map out what needs to be done in each particular social-ecological situation.
- Designing new criteria for the scientific robustness and validation of sustainability-oriented research and knowledge building, for example by considering the potential effects of research processes and outcomes on social-ecological systems and on agents' capacities to cope with global environmental change and the challenges of unsustainability.
- Improving our epistemology of the production, collection and integration of knowledge about global environmental change and sustainability, in ways that contribute to global social reflectivity and learning.
- Placing special emphasis on institutional transformation and on innovation processes for sustainability: for example, the most important factors for collective action that allow us to improve our understanding of what needs to be pursued and how societies can "learn what not to do".

Research and education programming and funding

- Integrating agenda-setting processes in national research plans and programmes with other political agendas, in order to mainstream institutional transformative sustainability.
- Fostering new forms of transnational collaboration in science and education, organised around common needs and practices related to environmental change and sustainability.
- Contributing to diversified research funding sources by encouraging those who use social-ecological research to become more involved in the overall processes of research design, implementation and evaluation.

- Supporting the development of new research and educational competences and professional careers for young students, so that they can deal with global environmental challenges and sustainability. Career pathways should allow social scientists to work on sustainability, using an open, social-ecologically coupled knowledge systems approach.[4]
- Developing new criteria for scientific excellence and evaluation in research policies. These may not necessarily be incompatible with existing ones, but should be extended and reframed following a reflective process in which context-based processes, goals and capacities to deal with sustainability and institutional transformation are introduced.

Cultural and societal transformation

- Carrying out participatory processes to explore place-based transformation pathways that go beyond partial solutions that create greater systemic problems; encouraging reflection on the systemic effects of technological innovation *before* technologies and processes are implemented, to prevent unsustainable path dependencies.
- Supporting the formation of learning networks of action that can show the value of transformative sustainability research, while encouraging new agents to become involved and participate in these networks; enhancing the reflexivity and transformational potential of learning networks based on information and communication technologies used in science, education and policy.
- Supporting reframing processes concerning societal goal-setting and collective sense-making. This can be done by embedding knowledge production processes within concrete social-ecological contexts of action in which stakeholders' needs and perspectives have been identified and taken into account.
- Counterbalancing existing power structures and inequalities, as inequality is a major driver of unsustainability. This could be done by supporting the redistribution of institutional rights and responsibilities derived from new forms of coupled knowledge production and use. Attention ought also to be drawn to oppressed groups, such as women, ethnic minorities and young people, and giving them the opportunity to speak out.
- Developing and implementing economic and social incentives to support sustainability. Here conflict situations may be reframed and turned into win-win, systemic and sustainability-oriented strategies, perhaps linking climate change mitigation, adaptation and sustainable development.
- Helping contemporary societies to extend our perceptual, cognitive and moral systems of reference to include the rights of future generations, and promote respect for the value of non-human forms of life. These should be considered from a global perspective and in a relational way, in order to overcome many of the false modern dualisms that hinder sustainability learning (Tàbara and Pahl-Wostl, 2007).[5]

Concluding remarks

Humankind is now engaged on a "learning race" against the speed and intensity of global environmental change. Social scientists have unique opportunities to play an increasingly decisive role in accelerating learning and transformation directed towards global sustainability. In the new open knowledge landscape, the rules of engagement between scientists, policymakers and citizens are likely to be transformed. We can envisage radically new forms of collaboration between social scientists in transdisciplinary teams and communities. Social scientists have to take part increasingly in decisions about new networks of action for sustainability, in repositioning research in this open and ecologically embodied knowledge space, and in sharing and upscaling local successful experiences. These experiences could be communicated and made visible in communities around the world, which in turn could share and improve such knowledge to speed up sustainability transformations. The new situation demands internal changes within the social science disciplines. It will involve new mind-sets, new practices and new professional norms, new institutional incentives, and imaginative ways of rethinking the validity and the quality in social-ecological interactions.[6]

This daunting task requires fresh theoretical and methodological perspectives on knowledge systems. But above all, it calls for specific policies, resources and measures designed to transform the existing interactions between knowledge production and sustainability-oriented actions. A new vision of open but social-ecologically coupled knowledge systems could help us appreciate the value of local knowledge and experience that is crucial for sustainability. It might also help us abandon the idea that one single kind of knowledge fits us all. Multiple and novel ways of learning, knowing and sharing science, education and policy-making responsibly are urgently required, as are new forms of civic engagement; and they are also attainable, in this increasingly complex but morally challenging world.

Notes

1. See the EU project VISIONRD4SD *www.visionrd4sd.eu* and the Future Earth initiative *www.icsu.org/future-earth*. Here, I regard knowledge holders as people who actually have the expertise to contribute positively to and deal with a given problem, or to meet a given need in a particular social-ecological context.
2. See, for instance, the Niger case, *www.ecologyandsociety.org/vol16/iss3/art1/main.html*; with regard to the transition towns: *www.transitionnetwork.org*; and for sustainability innovation in education, see the Barefoot College: *www.barefootcollege.org* and also the CEMUS centre at Uppsala University: *www.csduppsala.uu.se*.
3. Elinor Ostrom's efforts to examine the conditions for the sustainable governance of common pool resources are perhaps the best example of such approaches that link empirical evidence with sustainability theory (see Ostrom, 2009).
4. This could benefit from collaborative learning processes involving problems and projects combined with visioning and modelling techniques and other models of systems learning.
5. Among these cultural dualisms are those related to our contemporary concepts and values about time and space as well as our basic ideas about what constitute social-ecological system processes. Dichotomies between human and non-human information systems, interactions and structures are instances of these; for example, we are in nature as much as nature is in all of us.
6. In this regard, the emergence of "global systems science" could make this possible, with the extensive use of participatory information and communication tools *www.gsdp.eu* and *http://blog.global-systems-science.eu*.

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Viewpoint

12. Open knowledge and learning for sustainability

by
Tim O'Riordan

Open knowledge and learning are spreading across the world and across domains from science to political power. This shift opens up the possibility for citizens, experts, children and others to work together in new ways for their own benefit, for the benefit of others, and for the good of the planet as a whole.

Open knowledge flourishes through open learning. We are passing through a revolution in the ways in which forms of knowing take place. This is in part a function of technology, especially the Internet and the interactive phone. It is also due to a more active scrutiny, exposing deceit and denial. And more than ever, it is the product of different approaches to learning, where teaching and listening share roles. Teacher and pupil, indeed all producers and users of knowledge, are blurring their relationships: we learn in the fields and the streets, the workplace and the household. Schools are creating capacities for leadership. For example in Norfolk, England, schools are embarking on a programme called "eco-incubators" where youngsters are learning how to cut energy and carbon and water usage, and then encourage those in other schools to follow suit.

Leadership now stems from the middle, rather than from the top or the bottom. This means that confidence building, adaptability and teamwork are being brought out in young people. Courage, commitment, compassion and cooperation: these are the hallmarks of leadership. Future generations throughout the globe will have to acquire such competencies in order to adapt, to build resilience, and to leave room for the betterment of their successors. Our task is to give them the capabilities and the freedom to act.

Open knowledge (see Article 11, Tàbara) means open forms of learning and listening. In the world of established science, this process of accumulated learning will be more difficult to achieve. Science is tribal, and is shaped by power and ethics. The tribal component buttresses dependence on provability, peer acceptance, discipline-bound authority, and presumed neutrality. Political and commercial power enters through funding dependencies and the need to be endorsed by leaders. Yet political and commercial power also frame the processes through which scientific research is interpreted and tolerated.

Nowhere is this more evident than in the climate change domain, where almost every aspect of global climate modelling and policy advice is challenged. Almost all climate change science is on the defensive. Researchers of the emerging generation are still discouraged from entering into interdisciplinarity – let alone transdisciplinarity – should they seek credibility for their career enhancement.

Yet the shift to open science and open knowledge cannot be stopped. Cyberspace, together with the advent of cloud computing, enables global scientific discourse to span nations, cultures of learning and disciplines. The cascade of mobile phone apps enables data to be collected from the field and street in myriad ways. Interviews, protests, drama, storytelling, scenarios, human, animal and plant behaviour and responsiveness, innovation, community-based action, the vast scope of the Internet and social media: all of these combine to create enormous learning libraries (as well as means of global interaction) which can be catalogued by the very latest in data retrieval techniques. For example, it is possible for observations gathered by farmers, fishermen, protesters and campaigners to be organised and made relevant for researchers and modellers.

There are many ways in which this revolution of open knowledge can be harnessed. On the global scale there is the role of "tipping thresholds", points of tension and possible abrupt change linked to planetary boundaries. In the world of the Anthropocene, we are entering an age where the human hand is squeezing the lifeblood of the planet ever more tightly. Tipping elements combine the very real evidence of abrupt phase changes in ice, marine life, rainforest burning and drying, monsoonal diversions and other weather-related hazards, with tensions in social well-being from corruption to civil rights abuses, to wealth hoarding to forced migration. Here the two great forces of human intervention, the impact on planetary processes and the creation of economic malaise, can combine to undermine the capacity of future generations to live in peace and prosperity.

Open knowledge enables us to examine possible early warnings of such thresholds. This is where the combination of formal science and informal "people's observations" leads to far more powerful prognoses. The responses to look out for relate to increasingly sluggish responses to recovery, to shifts in genetic structures which reduce the inherent adaptability of animals and plants, to the possible debilitating effects on species' survival from alien invasions, to trigger points for uprisings, and to fundamental despair fostering vulnerability and exploitation.

Open knowledge also enables us to fashion responses to tipping thresholds which are heartening, hopeful and transformational. It may well be through open knowledge that the science needed for sustainability can flourish. The initiative of the international science community in promoting "Future Earth: research for sustainability" is very encouraging. With its emphasis on the need for co-designed and co-produced knowledge, Future Earth seeks to foster synergies between teaching and learning, between formal and informal ways of gathering evidence, between structured analysis and ground-level leadership, all of which has the capability to connect the local to the regional and to the global.

Open knowledge is also capturing the mood of the times. Governments have to show responsiveness and embrace inclusiveness to restore their credibility. Paradoxically, the more governments share their power, the more they gain authority. And the more local the province of governing, the more effective governments will be for promoting sustainability. The continuing economic recession reveals that after five generations of economic surety in what were known as developed economies, these nations are shifting into localism and the pursuit of individual and collective betterment. Nature is finally being awarded value, not just for economic necessity, but for human comfort, mental strength and moral repositioning. The child is becoming the teacher, and all over the world, the well-being of the child's child will be the benchmark of the success of international scientific effort and the furtherance of open knowledge upon which its ultimate achievement rests.

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Loxodonta Africana, 2011 by Andries Botha
© Photographer, Patrick Mcgee

Part 2
Social science capacity in global environmental change research

13. Regional divides in global environmental change research capacity

Introduction to Part 2

by
Françoise Caillods

Part 1 presented the urgency and complexity of global environmental change and highlighted the role social sciences should play in analysing the problems and in suggesting solutions. But do social sciences have the capacity to play that role – particularly where people are most vulnerable to the consequences of global environmental change? Part 2 analyses the state of social science research on global environmental change in different parts of the world, and its capacity to address the many complex issues that it raises.

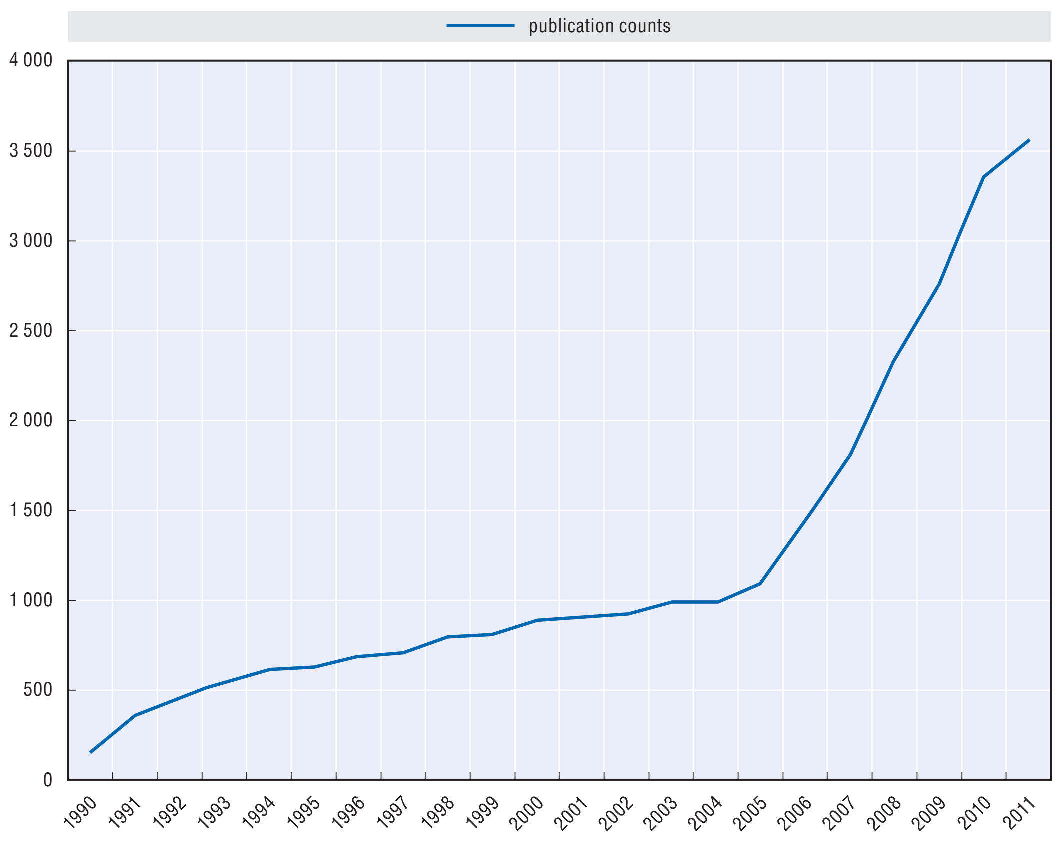
The *World Social Science Report 2010* (ISSC and UNESCO, 2010) outlined the differences between regions and countries in terms of social science research, including its scale, overall condition and ability to produce new knowledge. It showed that countries and institutions in the North Atlantic region enjoyed fairly good research conditions and funding opportunities. Lower-income countries faced a much more critical situation, characterised by inadequate capacity, unsatisfactory research conditions in many universities except the top ones, limited and unstable funding, low priority with national funding agencies, and generally low institutional support. This resulted in an astounding discrepancy in the number of articles registered in the Web of Science (WoS) database, and the hegemony of the North in social science production. Does global environmental change social science research show the same trends as social science research in general? Or have the internationalisation of research and the increasing impact of climate and environmental change on people and communities in different locations resulted in more research being conducted in different countries?

The authors of Part 2 are all social scientists working in the field of global environmental change, and contribute knowledge of its standing in their region or country. Some work for their national research council; others have contributed to the drafting of Intergovernmental Panel on Climate Change (IPCC) assessment reports, or are involved in the global environmental change-related work of regional councils for social sciences. They all benefited from the bibliometric analysis carried out for the International Social Science Council (ISSC) by the Centre for Science and Technology Studies (CWTS) at the University of Leiden (as presented in Annex B).[1] Regional social science research councils (and ISSC members) also present their perspectives on how global environmental change affects their societies and how far their councils help shape research agendas and promote social science research on global environmental change in their regions.

The Latin American Council of Social Sciences (CLACSO), the Council for the Development of Social Science Research in Africa (CODESRIA) and the Organization for Social Science Research in Eastern and Southern Africa (OSSREA) are very active in this area. This is less true of the Association of Asian Social Science Research Councils (AASSREC) and even less so for the Arab Council for the Social Sciences (ACSS).

Social scientists in the United States and Europe have been studying global environmental change issues for several decades. But the emergence of climate change as a global issue in the 1990s – before and after the Rio Earth Summit of 1992 – stimulated a rapid growth of social science analysis throughout the world (see Figure 13.1). Since 2005, the number of publications on global environmental change in WoS social science journals has increased even more rapidly.[2]

Figure 13.1. **Social science publications on global environmental change per year, 1990 to 2011**



Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science, Annex B, Table B1.

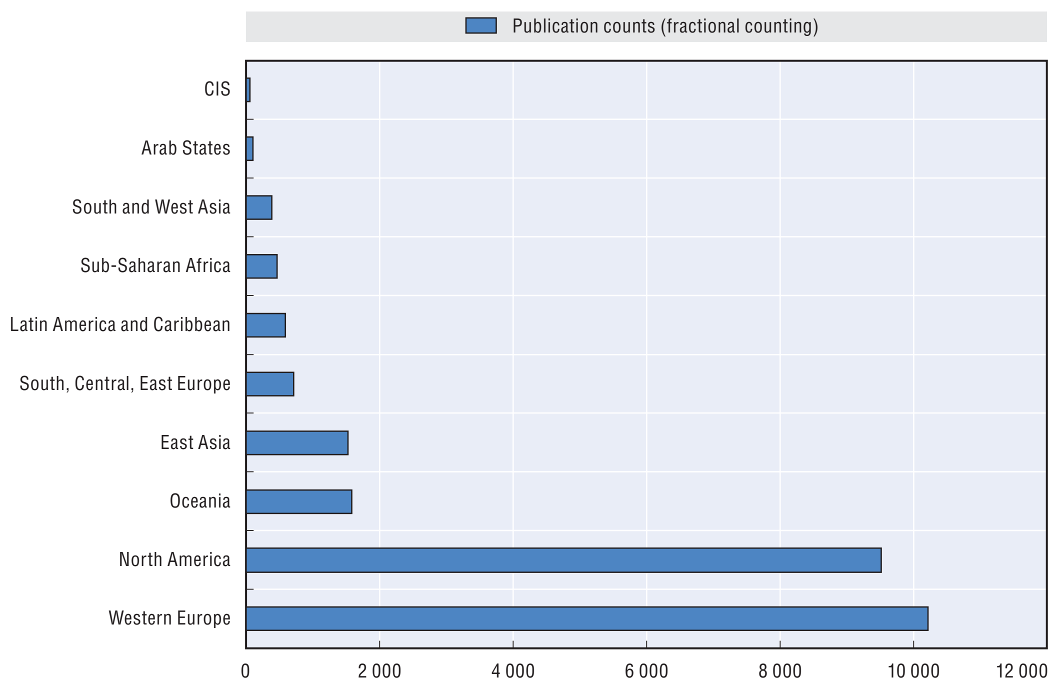
The consequences of global environmental change affect all regions, in different ways. The drivers of research include water and air pollution, dramatic nuclear accidents (Europe, Japan), the consequences of the El Niño oscillation and the geopolitical importance of Amazonia (Latin America), droughts, desertification and deforestation (Arab states, Africa), heat waves, storms and hurricanes that impact economies (United States, South Asia), the consequences of glacier melting (India, Latin America), permafrost thawing (Russia) and sea-level rises (India, Bangladesh).

Natural scientists have long dominated research into global environmental change issues. With the partial exception of the United States and some European countries, social scientists remain relatively marginal in this area.

Formidable disparities between and within regions in the number of global environmental change publications

There is wide disparity in social science research and outputs on global environmental change in the different regions (see Figure 13.2).

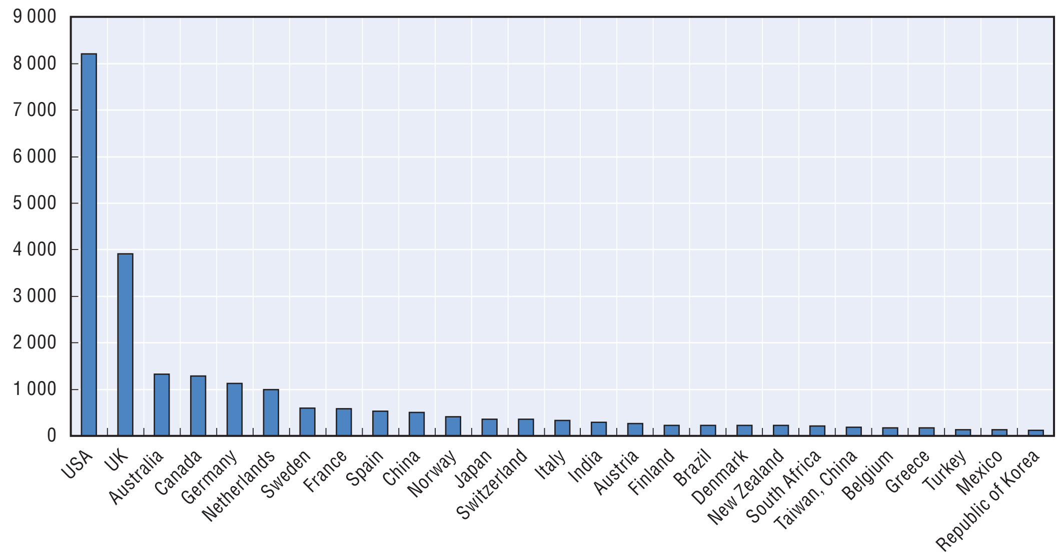
Figure 13.2. **Number of social science publications on global environmental change per region, 1990 to 2011**



Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B.4.

The regional divide in social science production on global environmental change is at least as big as for the social sciences overall. This is clear from the data on the number of publications in international social science journals registered in the WoS database. Europe – particularly Western Europe – produces the most publications, followed closely by North America. Far behind, yet with a significant production, come Oceania[3] and East Asia. Further behind are Latin America and the Caribbean, sub-Saharan Africa and South and West Asia. The figures for two regions are particularly low: the Arab States and the Commonwealth of Independent States (CIS). These two regions are strongly affected by global environmental change but their economies are highly dependent on the sale of oil or gas.

Figure 13.3. **Number of social science publications on global environmental change per country, 1990 to 2011**



Note: Fractional counting. See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B.3.

Even within regions, considerable differences exist between countries. The countries producing the largest number of publications on global environmental change are the United States (by far) and then the United Kingdom (Figure 13.3); next – but far behind – are Australia, Canada, Germany and the Netherlands. Outside Europe and North America, Australia, China, India, Brazil and South Africa are the most prolific centres of research on global environmental change in their regions.[4] This is not a surprise, since these countries generally have the best resourced science systems in their respective region. China surpassed Japan towards the end of the period 2005-2009. In the past 20 years China has seen the fastest growth in social science research on global environmental change (see Annex B, Table B3).

The WoS is known to be biased in favour of English-language journals, and favours articles over books and monographs.[5] Indeed, the top producers are all from English-speaking countries. Nevertheless, the articles in Part 2 confirm the bibliometric findings that wide disparities exist between regions and nations. This is because of a lack of public funding for social science research in general, and global environmental change in particular, in the South and emerging economies (India, Russia, the Arab States, Africa and until recently China) as well as a lack of interest in these issues among national research funding agencies (see the contributions by Revi and Sami; and Yanitsky, Porfiriev and Tishkov). It may also reflect a lack of interest and motivation among mainstream social scientists, who tend to prefer to study topics on economic growth and development, poverty alleviation and the reduction of inequality, which are considered more central to the core of traditional social sciences.

Again, China is a significant exception. Its production of social science articles on global environmental change in the WoS database increased 30-fold between 1990-94 and 2005-09. The number of articles registered in the national China National Knowledge Infrastructure (CNKI) database has also increased drastically, with a tenfold increase in four years (2006-10). The CNKI articles, published in Chinese in Chinese journals, are invisible at the international level and their quality and impact are difficult to assess. But the high numbers are an indication of the Chinese government's recent change of priorities, and show the importance of being published in obtaining an academic position.

What topics are social scientists working on?

The variety of global environmental change issues investigated by social scientists in the United States and Europe is considerable. They include the causes and effects of global environmental change on societies, and the complex interaction between these realities (Adler and Rietig). Researchers work at local, national and global levels, and deal with both specific and cross-cutting issues. They devise new theoretical frameworks and paradigms as well as new methodologies (Wilbanks, Dietz, Moss and Stern). The scale and diversity of this knowledge production underline the domination of North Atlantic research in this area.

A bibliometric analysis of the content of articles carried out for this Report identified 13 clusters of research themes.[6] Figure 13.4 shows that research covers a variety of topics, but is mostly concerned with modelling energy systems (Western Europe, North America and Asia), the vulnerability and resilience of socio-ecological systems (North America, Western Europe, Oceania as well as Africa and Latin America) and environmental governance (North America, Europe).

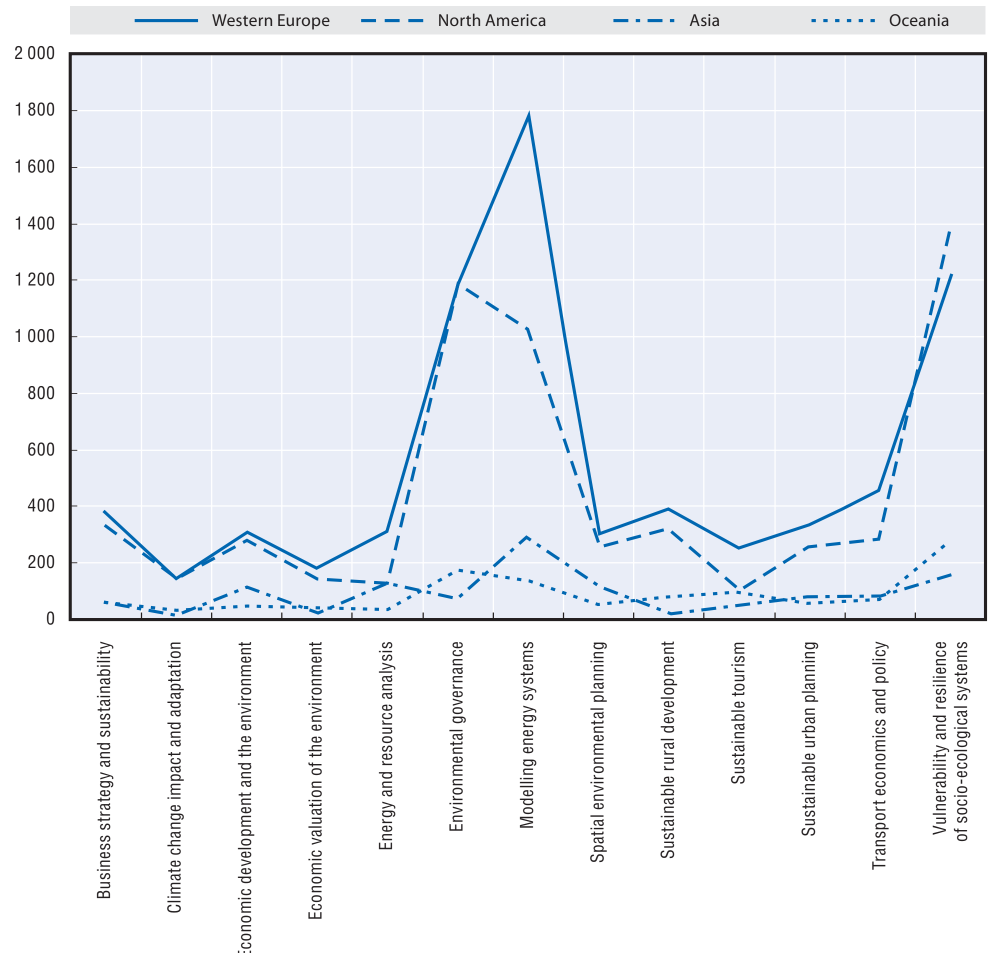
The first social scientists to become involved in global environmental change research in emerging and Southern countries were often geographers and economists, sometimes in co-operation with researchers from developed countries or from international organisations. Geographers analyse among other things the impact of climate change on local populations and the economy, and examine possible forms of adaptation. Economists look at the costs of adapting to and mitigating against climate change, future energy development scenarios, greenhouse gas emission scenarios or carbon trading systems. This kind of research, largely driven by government demands, predominates in China and Russia.

Social scientists in Latin America and Africa look at a wider variety of issues, including the complex pathways and loops of deforestation (Postigo, Blanco Wells and Chacón Cancino) and equitable forest management for environmental sustainability (Vogel). In addition, they revisit themes such as inequalities from a global environmental change perspective (Lampis; Postigo et al.) and highlight work on social movements (Alonso and Maciel). In Africa, the relationship between land ownership, land tenure and resource degradation continues to be a well-researched topic. Social scientists are also prominent in work on "green grabs", land grabs and new forms of land and resource expropriation through carbon sequestration (Murombedzi).

Slow move to interdisciplinary research

The social sciences have grown beyond traditional disciplinary boundaries in most developed countries. Interdisciplinary research is increasing across the social sciences and with the natural sciences, and is encouraged by funding agencies (Wilbanks et al.; Uyar). In Japan, interdisciplinary research has been very much promoted since the triple Fukushima disaster, which cast doubts on natural science's capacity to anticipate or solve problems (Uyar). Yet a good number of publications remain single-authored (30% in 2011), even though this decreased substantially from 1990 to 2011. Outside Europe and the United States,

Figure 13.4. **Number of social science publications on global environmental change by cluster of themes and region, 2000 to 2011**



Note: Only the top-producing regions are shown. See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B.7.

interdisciplinary research seems rare. Social scientists may co-operate across their own disciplines – but still work only rarely with natural scientists (Chen and Xie; Revi and Sami).

Research involving local people and non-academic stakeholders has been practised in Africa and Latin America for some time. Social scientists in Africa work with local people and representatives to create a shared understanding of forestry management systems for climate change (Murombedzi; Vogel; Serageldin; Revi and Sami). Others in Latin America involve local actors and indigenous people in their research processes, so giving them a voice (Lampis; Lavell et al, Part 6). The slow move to interdisciplinary and transdisciplinary research is often attributed to the fact that most decisions concerning hiring and promotion of staff remain within disciplinary departments. The lack of adequate training is also seen as a factor. Funding agencies in the North regret researchers' lack of capacity to conduct transdisciplinary research. Researchers in the North could learn from research practices in Latin America and Africa as they seek to engage at the science-policy-practice interface.

Funding and science policy divide on global environmental change research

Lack of funding for social science research in Southern countries, and lack of support from national funding agencies, weaken their research capacity. In most Southern and emergent countries there is virtually no dedicated funding for social science research on global environmental change issues, and institutional support is limited. Russia and India invest heavily in science and technology research, but devote far fewer resources to the social sciences. Even China, which has recently changed its policy in this respect, supports only a limited number of social science research projects on climate change.[7] To a limited degree, bilateral and multilateral development agencies make up for this shortfall through specific and short-term project funding, which in turn allows them to influence national research agendas in South Asia, the Arab States and Africa. The situation in developed countries is very different: research funding opportunities do exist in Europe and in the United States.

In Europe, there is a diverse and layered structure of funding schemes at regional and national levels as well as public, private and institutional ones. Having adopted a leadership role in international climate negotiations, the European Union makes significant targeted funding available to natural and social science researchers (Adler and Rietig). Research findings on global environmental change feed into EU policy processes in various ways. By contrast, Wilbanks et al. deplore the relative lack of funding for capacity building and research on global environmental change in the United States. They underline the absence of a national commitment to reduce human impacts on the global environment, which would go a long way to guarantee sustained support for research. It would also increase the likelihood of social science research informing policies.

Funding agencies increasingly regard the impact of research on society as a criterion to assess research quality. But the link with policymakers and society differs widely from country to country. While research may be specifically funded to inform policy in some countries (China; the European Union to some extent), in others, government programmes are prepared with very little involvement by social scientists (Russia, India). Social scientists are possibly responsible for this. They rarely try to share their findings with users of the knowledge they produce, or to communicate their research more effectively to non-academics in general (Wilbanks et al.). Non-governmental organisations (NGOs) and activist movements have, on the other hand, been instrumental in mobilising public opinion in Europe and Latin America, and have played a big role in making things happen.

Overcoming barriers

The articles in Part 2 highlight the many barriers to increasing social science involvement in global environmental change research. These barriers differ from country to country but they encompass the need for stronger political commitment at the highest level. In Southern and emerging countries, lack of adequate funding, and insufficient skills and research capacity is a serious problem. Stronger incentives related to career development and advancement are also badly needed. The lower status of social science research than natural science research is another obstacle. Social scientists feel they are asked to support a research agenda framed by others, with their role limited to areas such as how to change behaviour or how to bridge the science–policy divide.

All the papers below conclude with recommendations for ways forward, and they share many common features. Many emphasise the need for the social science community to integrate environmental issues into its core research agendas. They also encourage stronger advocacy and more effective communication of social science knowledge of global environmental change. The social science community has to take up the challenge. Social science researchers, disciplinary associations, universities and other institutions need to be much more engaged and involved in what is possibly humanity's biggest challenge ever.

Notes

1. The number of publications was assessed using the WoS bibliographic database produced by Thomson Reuters. The method used to identify social science publications on climate change and global environmental change is presented in Annex B1. Publications are considered as social science publications if they appear in a journal classified as social science in the WoS database. Some social scientists, however, publish in journals that are classified as science journals by WoS. This may have led to an underestimation (around 6 to 7%) in the number of social science articles published on global environmental change. There is no reason, however, that this would affect the trend identified by country or discipline.
2. The steep increase in the number of publications appearing after 2005 could be because the WoS has expanded its coverage of the scientific literature.
3. Australia produces by far the most in Oceania.
4. See Annex B.
5. An analysis of Brazil's Scientific Electronic Library Online database (SciELO) was carried out for this Report. SciELO is an open access programme of the São Paulo Research Foundation launched 15 years ago to index and publish national journals, whose model was progressively adopted by other countries in the region. The analysis indicates that 141 social science articles on climate change and global environmental change were written by Brazilian authors and published in Latin American online journals for the period 2005-10. Meanwhile, WoS counted 104 publications by authors based in Brazilian institutions for the period 2005-09. It is not known exactly how much the two databases overlap but many SciELO journals are not registered in the WoS. This gives an indication of the underestimation of the production of social science articles that are not published in English language periodicals in the WoS.
6. See Annex B7.The method used to identify clusters of research themes is presented in Annex B1.
7. Table A6 in Annex A, which compares the number of publications in science, social science and arts and humanities, reflects to some extent what the research priorities are in different countries.

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World Social Science Report 2013
Changing Global Environments

14. The social sciences and global environmental change in the United States

by
Thomas J. Wilbanks, Thomas Dietz, Richard H. Moss and Paul C. Stern

The United States is the largest producer of social science publications on global environmental change, which has been studied by United States social scientists for more than a century. The emergence of climate change as a global issue during the 1990s has also led to a growing body of social science (and multidisciplinary) analysis and assessment of causes and consequences of global environmental change. Despite the progress and achievements, challenges still exist to expanding social science research on environmental change issues, including building capacity and improving communications and advocacy.

Introduction

Global environmental change has been an important theme in the social sciences in the United States for more than a century, dating back to George Perkins Marsh's *Man and Nature* in 1864. A benchmark event was a symposium in 1955 at Princeton University on "Man's role in changing the face of the Earth," which included many of the leading research contributors of the preceding decades and led to a book with that same title published in 1956 (Thomas, 1956).

Historically, many scholars in anthropology, geography and other disciplines conducting field research in the developing world have tied their work to environmental change issues. Fields such as demography have long been associated with nature–society relationships. Social science research on land use issues, especially on human responses to hazards, has also built rich traditions related to environmental change, following in the footsteps of pioneers such as Gilbert White and Kenneth Boulding.

Several developments of the past half-century have been catalysts for social science to pay attention to nature–society issues. Triggered by the growing severity of environmental pollution observed in the 1960s, the United States enacted the National Environmental Policy Act (NEPA) in 1969, which led to new research on the risks to human systems, and to public participation in public-sector decisions with environmental risk implications.

Nearly two decades later, the Brundtland Commission report on sustainable development in 1987 (WCED, 1987) stimulated new attention to issues related to nature–society interactions, and led to a number of multidisciplinary initiatives of which social scientists were the leaders. More recently, the emergence of climate change as a global issue during the 1990s has led rather slowly to a growing body of social scientific (and multidisciplinary) analysis and assessment of the causes and consequences of this kind of global environmental change.

Even so, United States social science research on global environmental change research is a dramatic case of unrealised opportunities, primarily because of a history of very limited access to funding support, and reflecting some internal obstacles. At present, social science research on environmental change is facing particular challenges including the absence of a national commitment to reduce human impacts on the global environment and the effects of global environmental change on human well-being. Such a commitment would increase the likelihood that social science would engage in informing policies related to global environmental issues. The lack of bipartisan commitment in this area at a time of political polarisation, combined with concerns about government budget deficits, makes the prospects of sustained research support uncertain.

This article briefly summarises the critical global environmental change issues in the United States from a social science perspective, the priorities for social science research on these issues, and the current status of the research – both where there is progress and where there are obstacles. It covers the social sciences as they are usually defined in the United States, including anthropology, economics, geography, psychology, political science and sociology. It does not discuss the applied fields of social work, labour and industrial relations or criminology, because these fields have not yet taken up the environment as a central theme. We note, however, that some criminology scholars are beginning to consider environmental crime in various forms.

Nor does the article discuss the traditional humanities. Environmental ethics is an active area of scholarship and has contributed to discussions of environmental decision-making (e.g. NRC, 1999b). Environmental historians examine environmental politics and the history of human-environment interactions. The work that historians have done on environmental politics and the environmental movement complements work by sociologists and political scientists. Work on the history of human–environment interactions – how environmental change affects humans and how they generate environmental change – is beginning to contribute to our understanding of these dynamics, but is still the product of a very small community. We hope that future assessments of this sort will have a wider scope and will cover a growing body of humanities research on the environment.

Critical global environmental change issues in the United States

Environmental change issues in the United States are widespread and diverse. Many are especially complex because they occur at the global as well as the national scale. They vary in where they occur, their spatial and temporal scale, and in the populations or systems at risk. At a very general level they include:

- resource consumption relative to the sustainability of environmental services
- environmental and socially acceptable approaches to waste disposal as resource consumption continues to rise
- managing risks associated with environmental stresses and disasters

- mitigating emissions and land use changes that contribute to climate change
- adapting to multiple environmental stresses including climate change, invasive species, changing disease vectors, and habitat fragmentation
- developing more environmentally sustainable approaches to water use and food production
- improving institutional capacities to resolve tradeoffs between socio-economic and environmental priorities
- effective application of science in environmental governance and the implementation of environmental strategies: in other words, not just what to do, but how to do it effectively
- improving communications between producers and users of scientific and social science research.

Priorities for social science research on global environmental change issues

There is a long history of discussions of social science research priorities in the United States in terms of global environmental change, catalysed by the Committee on the Human Dimensions of Global Change (CHDGC) of the United States National Research Council (e.g. NRC, 1992, 1994, 1999a).

In 2011, the CHDGC was elevated to the status of a National Research Council (NRC) board, named the Board on Environmental Change and Society (BECS). Its priorities are advancing the science of human–environment interactions linked to action, limiting environmental degradation and adapting to environmental changes.

Two years earlier, in an NRC report on *Restructuring Federal Climate Research to Meet the Challenges of Climate Change*, an appendix had summarised the "Fundamental Research Priorities to Improve the Understanding of Human Dimensions of Global Change" (NRC, 2009). This summary identified five priorities:

- environmentally sustainable consumption
- risk-related judgement and decision-making under uncertainty
- understanding of how social institutions affect resource use
- socio-economic change as the context for climate change impacts and responses
- valuation of climate consequences and policy responses.

It also identified three cross-cutting priorities: observations, indicators and metrics; nonlinearities, feedbacks and thresholds in system responses to climate change in a multi-causal setting; and scale dependencies and cross-scale interactions.

In 2010, the CHDGC again emphasised the need for valuation research and added the following priorities:

- science for vulnerability, adaptation and resilience
- informing human choice through climate services and decision support
- adoption and governance of technologies
- managing the carbon cycle for multiple benefits
- understanding responses to global change in individuals, organisations and networks
- fostering co-operation and compliance in environmental regimes

- livelihoods, ecosystem services and resilience to global change
- the psychological and community impact of global change.

As these lists demonstrate, the research needs are numerous and sizeable. Any selection of a few of the highest priorities would be at best a narrow sample from the varied and serious existing gaps in social-science knowledge.

The current status of social science research on global environmental issues in the United States

Describing the current status of such research is complicated by the fact that there is both good news and not-so-good news.

Where there is progress

There are encouraging signs of growing interest in, and support for, social science research on environmental issues. Several positive trends are evident at the US National Academies of Science/National Research Council (NAS/NRC). As we have seen, human dimensions research has recently been elevated to the status of a board (BECS). In addition, an important advisory committee established to review and provide advice to the United States Global Change Research Program (USGCRP) contains roughly equal numbers of social and natural scientists, and its vice-chair is a social scientist. At the request of the USGCRP, the first committee meeting convened to provide advice on programme implementation focused on helping the programme deliver its objective to better integrate social sciences.

Another indication that social science knowledge and perspectives are receiving more recognition was the huge Congressionally mandated *America's Climate Choices* study, 2009-11, which included four panels: limiting the magnitude of climate change, adapting to impacts of climate change, advancing the science of climate change and informing an effective response to climate change. The vice-chair of all four panels was a social scientist, as were 7 of the 24 members of the oversight committee.

Another positive signal is the USGCRP *National Global Change Research Plan for 2012-2021* (GCRP, 2012). Its goals and objectives include:

- advancing the fundamental understanding of the physical, chemical, biological and human components of the Earth system and the interactions among them
- advancing understanding of the vulnerability and resilience of integrated human–natural systems
- integrating natural and human observations
- improving and developing models that integrate natural and human components of the Earth system
- informing decisions
- improving communication and education.

This is the closest the United States government has come to defining an agenda for nature–society research. Whether these aims are likely to be implemented is not clear (see below).

Most of the progress in this area, however, has been brought about not by these top-level interventions but through bottom-up achievements in social science and multidisciplinary scholarship, supported by the United States National Science Foundation (NSF) and some individual programmes in mission agencies such as the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA) and the Department of Energy (DOE). A prominent example is land cover and land use change. These emphasise climate change and hydrology in many areas and are crucial for understanding the dynamics of ecosystems. The ability to link data collected "on the ground" at local level with remotely sensed data means this is perhaps the only area of environmental social sciences that is data rich; it has also been consistently funded by several federal agencies. As a result, substantial progress has been made, particularly in understanding the dynamics of forests interconnected with human systems. Other examples include the following.

Disaster and natural hazards research

A long-standing and robust research tradition examining natural hazards is now being used for environmental hazards, including technological risks, but also climate change and other aspects of global environmental change (e.g. NRC, 2012b).

Risk

Risk analysis has expanded from a mostly technical exercise in engineering, economics and kindred fields to a broader understanding of the responses of individuals and organisations to uncertainty, and to practical advice about how to link scientific analysis with public deliberation to inform decision-making, including decision-making under uncertainty (e.g. NRC, 2011).

Commons management and institutional design

The problem of collective or public goods has been studied in many fields for decades. In the past 40 years a common language and conceptual framework have emerged. There have been great advances in understanding what institutional arrangements and contexts facilitate or hamper the effective management of common pool resources (NRC, 2002). Progress in this field was highlighted by the awarding of the Nobel Prize in Economic Sciences to Elinor Ostrom.

Driving forces

The roles of population, affluence and consumption, urbanisation, institutions, culture and other potential drivers of environmental change have been debated for decades. But since the 1970s, this debate has been disciplined by empirical work at scales ranging from individuals and households to nation-states. This line of work is now turning attention to policy design, by identifying factors that have both high plasticity, in the sense that they can be changed, and high elasticity, in the sense that changes will lead to substantial environmental changes.

Environmental valuation

Work on ecosystem services and environmental change is and will remain a centre-piece of environmental and ecological economics. With the Millennium Assessment's renewed attention to the role of ecosystems services in shaping human well-being, interest in this topic has intensified. Other disciplines have become increasingly involved and perspectives other than utilitarianism are informing ongoing work.

Environmental decision-making, including deliberative processes

Nearly all the social science disciplines have engaged in studying how decisions are made by individuals, organisations, governments and the global political systems, and in exploring sound processes and tools for decision-making. This work overlaps with work on commons and institutional design, environmental valuation and risk. Increasingly it also examines ways to link scientific analysis effectively with public deliberation (e.g. NRC, 2008).

Integrated assessment research

Integrated assessment analysis and modelling have produced numerous greenhouse gas emission scenarios to serve as the basis for research on possible climate change futures. More attention has recently been paid to climate change policy options, climate change impacts and to adaptation options at national and regional scales (e.g. DOE, 2009; Nordhaus, 2008).

Adaptation science

Partly as a result of recent extreme events and the development of an ongoing national climate change assessment process, practical climate adaptation science is increasingly seen as important. This may avoid maladaptation and improve decision-making, by ensuring that social and natural scientists engage with stakeholders and decision makers.

Sustainability science

Through the NAS Roundtable on Science and Technology for Sustainability and major programme initiatives in several United States universities, sustainability science has begun to mature as a crossdisciplinary area of research and practice (e.g. Kates, 2010).

A few consistent sources of institutional support have always existed for this research. The NSF has supported relatively large programmes related to biocomplexity, long-term urban ecological research and decision making under uncertainty. NOAA's Regional Integrated Sciences and Assessments (RISA) programme has conducted research on high-priority regional environmental management issues related to climate change. The Department of Energy has supported integrated assessment research and modelling and is primarily concerned with understanding climate change mitigation pathways. It is increasingly keen to address impact and find adaptation alternatives. Elsewhere, the US National Parks Service has supported the development and use of innovative scenarios of alternative socioeconomic futures as well as some social science and multidisciplinary perspectives. Originally developed for more general programmes, these agency programmes are now been applied to environmental issues and range in scope from public attitude surveys to risk management and resilience issues.

Where there are challenges

The challenges to expanding social science research in the United States on environmental change issues are external and internal.

External challenges are primarily rooted in a history of limited support for social science and multidisciplinary research on environmental issues, especially for large, multiyear projects and long-term data collection efforts. Generally speaking, funding from the federal government has been a combination of support from a few NSF programmes and scattered funding from mission agency programmes that tend to be isolated from other activities. This funding adds up to a very small and declining proportion of the national investment in global change research.

In many cases, a particular obstacle is a lack of understanding of social science research by research programme managers in environment-related mission agencies. It is often only seen as an applied field useful mainly for implementing ideas from natural science, engineering or policy. The value of fundamental research on human–environment interactions identified in this article is often not recognised. This narrow view may relate to the general absence of social science expertise in these agencies. In addition, the social sciences are sometimes seen as being driven by political agendas, a view that has sometimes fuelled political opposition to social science research. For these reasons, the hurdles can be high. An NRC review of the draft USGCRP strategic plan expressed concern about the prospect of its apparent commitments to social science research being implemented (see Box 14.1).

Another challenge related to the federal agency programme is a glaring shortage of data to support research on vulnerability, adaptive capacity and risk framing. This applies especially to time series data for social indicators. Few natural scientists would consider data points at decadal census intervals a satisfactory basis for good science.

In some respects, however, the challenges are within the social sciences themselves. United States social science disciplines differ in the degree to which work on coupled human and natural systems is part of their tradition. In anthropology, economics and geography, environmental subdisciplines have a long history, while in decision sciences, including psychology and sociology, they emerged as substantial communities only in the 1970s. A standard complaint is that the disciplines and universities do not support the kind of interdisciplinary work required to address environmental issues. Most United States universities have championed interdisciplinary work for decades, but most hiring and promotion decisions remain within disciplinary departments. However, this balance continues to shift towards interdisciplinary units, and joint faculty appointments across disciplinary and interdisciplinary units.

In addition, the common practices of many social scientists are an obstacle. Many have experience only with small, single-investigator projects rather than larger multi-investigator efforts. Social science research is rarely formulated to support specific decision needs. Rather, the pattern is to fund highly applied analysis, often by consultants, to meet very specific mission requirements, or to fund social science research to advance general disciplinary knowledge. Meanwhile, social science communication efforts tend to be a matter of transmitting information to an audience rather than starting with an aim of communicating with users of the knowledge on the basis of understanding their current mental models. There is little understanding of their information needs, how they process information, and where and how they look for information. Too little is done to reach audiences beyond fellow-scholars.

Box 14.1. **United States Global Change Research Program**

Goals versus implementation challenges

In 2012, a review of a new draft strategic plan for the United States federal government's multi-agency Global Change Research Program (USGCRP), by an independent committee organised by the National Research Council, praised its stated intention to better integrate the social sciences, but had far less praise for its implementation planning (NRC, 2012a). The review indicated that the new plan would probably repeat the two-decade "history of failures to make good use of social science knowledge in global change research, both by the USGCRP and its member agencies" (p. 20) unless changes were made. The report emphasised that "research in the social sciences and effective integration of social science knowledge are essential if the USGCRP is to achieve the goals stated in the Strategic Plan" (p. 19). It added that the plan is almost entirely silent about how social science research would be implemented, how it would be coordinated with research in the physical and ecological sciences, and who would lead these efforts. Without clear targets and identified parties to be held accountable for meeting these targets, the plan was likely to repeat its earlier, unsuccessful efforts to integrate the social sciences (p. 20).

The report traced the "small and declining share of investment in social science in the USGCRP, despite the continually expressed need and the far lower cost of social science research compared with capital-intensive physical observing systems" to two factors: the limited capacity and understanding of the social sciences in the USGCRP member agencies, and the slow development of the social science community focusing on environmental questions, due to "limited and unreliable funding and … by a lack of common data resources (relative to the substantial investments in training and data resources that have been made in other areas of global change science, and in other areas of social science)".

The committee expressed particular concern with the draft plan's implementation priorities, which indicated that "newer" priorities, including social science research, would not be phased in until an unspecified time in the future. The committee noted that "given that there has not been significant progress in integrating the social sciences in the 20 year history of the USGCRP, it seems likely this point may not come in the next 10 years either".

Conclusion

Given this combination of promising achievements and daunting challenges, where is social science research on environmental issues going in the coming years and decades?

There has been much progress, both in terms of recognising the need for social science and in the participation of social scientists in key research institutions. The biggest hurdle will continue to be the lack of funding to build capacity, and for research to meet demands and expectations. Institutions such as the NAS/NRC will need to continue to monitor progress to demonstrate the importance of social science research for improved decision making on global change. The funding agencies will need to improve their level of commitment and create specific programmes to support social science. The opposing forces at play could result in the improved development and application of insights from social science research to benefit society, but only if the social science research community itself remains committed to realising this potential, and improves the communication and advocacy of its research.

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15. Social sciences at the crossroads: Global environmental change in Latin America and the Caribbean

by
Julio C. Postigo, Gustavo Blanco Wells and Pablo Chacón Cancino

Global environmental change in Latin America and the Caribbean ranges from urbanisation to deforestation and melting glaciers. The understanding of relations between nature and society in this context requires coupled human–environmental frameworks across spatial and temporal scales. Transdisciplinarity and co-production of knowledge from the social to the natural sciences and to traditional knowledge will result in more effective solutions.

Global environmental change is low on the list of priorities for policymakers in Latin America and the Caribbean. The social sciences have been involved to some extent in work on social movements, socio-environmental conflict and environmental degradation since the 1970s. However, social science research on global environmental change in the region is still in its infancy. The rise of the Anthropocene era and the overarching character of global environmental change – in which social change forces physical and biochemical transformations – present the social sciences, governments and society with a major challenge. Social science research in the region is at a crossroads: it has to embrace transdisciplinarity, critically analyse the relationship between nature and society under capitalism, produce sound science to advise policymakers, link social and physical vulnerabilities, and contribute to building a less unequal social system.

Although extreme weather and climate events are prioritised by governments, priorities differ across the region; when and where these issues originally emerged also varies from country to country. In Caribbean states, policymakers are paying increasing attention to tropical storms and rising sea levels. The El Niño Southern Oscillation is a long-standing problem for countries south of the equator, on the Pacific coast and more recently in north-eastern Brazil. The Andean countries emphasise glacier recession and decreasing water supplies for farming, human consumption and energy generation, especially during the dry season.

Countries located in the Amazon are increasingly involved in global programmes to mitigate climate change, such as Reducing Emissions from Deforestation and Forest Degradation (REDD+) and the Clean Development Mechanisms. However, their benefits are few compared with the effects of Brazil's mega-projects: hydropower plants, dams and highways, for example. Furthermore, in Argentina, Brazil and Paraguay, strong international markets have led to widespread land conversion to grow soy beans, which is attracting media and policy attention. International demand for minerals, oil and energy is driving the expansion of extractive industries and triggering social-environmental conflict across the region. Again, industrial expansion, coupled with extreme weather events, means that access to, and the control of, water is embroiled in conflict and politics.

The relationship between social science research and global environmental change in the region has two aspects: the production of science[1] and the conditions of such a production. We focus on the different elements of this relationship. First we briefly summarise some of the contributions that social science makes to understanding the issues raised by global environmental change; second we explain some of the components involved in producing social science knowledge; and finally we outline ways to develop social science research on global environmental change in the region.

Thematic scope

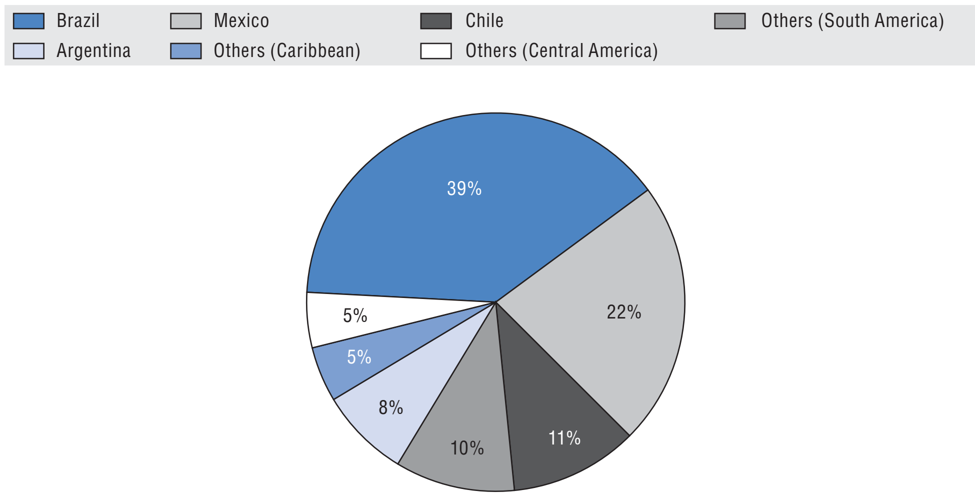
There is social science research in the region on the social causes, effects of, and responses to global environmental change. This research is driven by the geopolitical importance of the Amazon, the importance of biodiversity, glacier water and underground natural resources, and the fact that human beings live there. Research encompasses the interactions between global environmental change and former and current societies from Mexico to Patagonia, and from the Atlantic to the Pacific (e.g. Butzer, 2012; Marquet et al., 2012).

The annual number of social science publications on global environmental and climate change from the region increased between 1990 and 2011. Latin America ranks sixth in the world, above sub-Saharan Africa, South and West Asia, the Arab States, and the Commonwealth of Independent States.[2] Academic production is not homogenous. Whereas Brazil and Mexico account for 60%, Central America and the Caribbean account for 10% of publications (see Figure 15.1). Moreover, there are differences of focus across the region. Deforestation, for example, is extensively analysed in the Amazon; urbanisation is studied in most countries in the region; tropical storms are researched in Central America and the Caribbean; rising sea levels are monitored because of the threat to coastal cities and island states; because of salt water intrusion, the Mar del Plata basin is studied; glacier retreat and water availability are investigated in the Andes (in Colombia, Ecuador, Venezuela, Peru and Bolivia) and the Southern Cone (Argentina and Chile).

Addressing complex issues

Land use and land cover change are some of the main causes of global environmental change. The most significant change is in forest areas which are being cleared for agricultural use. Deforestation is a huge problem in the Brazilian Amazon and beyond, east of the Andes and between Manaus and Venezuela. Deforested areas are also found in the Chaco, coastal south-central Chile, and Atlantic forests; Central America has lost forests in the Yucatan and on Nicaragua's border with Honduras and Costa Rica.

Figure 15.1. **Social science publications on global environmental change in Latin America and the Caribbean, 1990 to 2011**



Note: Fractional counting. See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B-3.

Research, particularly in the Amazon, has shown the complex pathways and feedback loops of deforestation (Lambin et al., 2001). Colonists with more capital settled there after initial timber extraction and colonisation. The subsequent accumulation of land and capital led to larger land holdings and the displacement of the local population to the forest fringes. The profitability of the cattle industry encouraged the conversion of land into pasture. This drove land prices up, bringing about the consolidation of land into large estates.

This is the most urbanised region in the world: almost 80% of people live in cities (ONU-Habitat, 2012). Urban expansion and the location of economic centres have changed major cities into regions. Despite this polycentric urban expansion pattern and the increasing use of private cars, per capita carbon dioxide (CO_2) emissions in Latin American cities are minuscule compared with those from the urban areas of affluent nations. In addition, the low gross domestic product (GDP), taxation and per capita expenditure of the region's cities illustrate the limited application here of ecological modernisation and the "eco-cities" model[3] used in urban areas of affluent countries (Romero Lankao, 2007). Regional socio-economic conditions hamper the use of market-based mechanisms to mitigate climate change. So curbing carbon emissions becomes a low priority whereas vulnerability and adaptive capacity are at the top of the agenda. However, mechanisms have been adopted, such as carbon markets and climate stock markets (in Chile), and corporations and economic elites are already profiting from them. Similarly, mitigation policies are in place in Brazil, Mexico, Chile, Peru and Costa Rica. The tension between what is needed (adaptation) and what is done (mitigation) shows the influence that the international agenda has on national decisions and local agendas.

Combining old themes with new approaches

Social scientists have for a long time studied social inequalities across different social groups, places and territories, emphasising in particular the high levels of inequality in cities and between urban and rural areas. Latin American scholars have influenced the development–environment relationship through structuralism and political ecology. Structuralism influenced the model of import substitution industrialisation from the 1950s to the 1980s, a model which fostered intensive natural resource use. Political ecology critically analysed capitalist development and the role of Latin America and the Caribbean as a supplier of raw materials in the international division of labour.

The legacy of dependency theory might be traced in development models and in governments challenging neoliberal policies. By doing this, nation-states can regain control of their strategic productive sectors, and encourage their domestic markets and intra-regional alliances. Furthermore, other influences can be seen in a current analysis of global markets driving local transformations (Rueda and Lambin, 2013).

The environmental inequalities which stem from the social disparities in urban areas are themselves the focus of social science research, which shows a significant overlap and feedback between social inequality and environmental risks. The broad effect that the ecological footprint of the city has on the environment, different consumption patterns, and socio-economic differences all inform policy design and resource allocation. This includes the provision of public services to improve the quality of life and limit the ecological impacts of high-income life styles. Socio-environmental conflicts in the region result from local people dispossessed of their resources through growing capitalism (for example from mining, hydrocarbons, agroindustry and protected areas) (Eguren, 2006; Bebbington, 2007). Moreover, climate change will increase rural inequality and poverty (Solís Medrano et al., 2013).

Social-environmental conflicts are clashes between different uses of, and different stakeholders' agendas for, natural resources (see Article 16 by Alonso and Maciel on environmental activism in Brazil). Social science has been particularly useful in showing the varied nature of conflict, by linking global drivers of expansion for the extractive industries to local struggles (e.g. Alimonda, 2011). Research has found that in the link between the global and the local, the state plays an important role by determining norms that make foreign investment easier and weaken local institutions' ability to manage resources. This in turn compromises local sustainability (Bebbington and Bury, 2009; Bridge, 2004; Postigo, 2012).

Biodiversity has been a hot topic for research and action in the region. Initially, social science addressed this topic from a critical perspective, analysing how local populations lost access to, and control and use of, their resources as a consequence of extractive industries and conservation rules. Unfavourable evaluations of the impacts of conservation without regard for humans[4], and growing pressure from social movements, led to co-management schemes for protected areas. More recently, social scientists have identified a causal mechanism by which the initial conditions of land holding in rural Amazonian households influence future forest cover and welfare (Coomes, Takasaki and Rhemtulla, 2011). This original approach links livelihoods with poverty dynamics and land use or land cover change. Further, it also shows how the landscape (and biodiversity) hinges on the land-holding's size and use. Concern over biodiversity loss and the importance of the Amazon as a carbon sink have given this area a new geopolitical importance within the region and in terms of the relationship between Latin America and the Global North (Estenssoro Saavedra, 2010).

The valuation of ecosystem goods, services and functions is another aspect of the interaction between the natural and social systems tackled by social scientists. Although natural scientists and ecological and environmental economists have worked together on this area, the problem of evaluating the various services and uses involved has given way to a relationship between economists, anthropologists and sociologists. The participation of the latter two allowed the valuation of cultural and entertainment ecosystem services. Further, the existence of overlapping multiple and interdependent uses, services and values raises questions about ecosystem governance schemes and stakeholders on many spatial scales. For instance, in Costa Rica, the avoidance of deforestation and the reduction of poverty through the protection of very poor areas are enhanced in areas located 40-80 km from major cities and on poor to moderate agricultural land (Ferraro, Hanauer and Sims, 2011). Social science has challenged protected areas that exclude human populations, and has shown cases of improved conservation through sustainable use of protected areas. In Brazil, there is twice as much land available for sustainable use as strictly protected land, and nearly five times as much if indigenous land is included (Naughton-Treves, Holland and Brandon, 2005). However, federally protected areas balance strict protection (48%) with sustainable use (52%), whereas only 16% of states are strict protection areas and 83% of the land is for sustainable use (Rylands and Brandon 2005).

Emerging issues

Glacier melting, tropical storms (including flooding), droughts, desertification and rising sea levels are among the most conspicuous effects of global environmental change in Latin America and the Caribbean. They are also issues that social scientists are increasingly researching, for instance through an analysis of the effects that the Cordillera Blanca's melting will have on local livelihoods, water availability, energy provision and national economies (Mark et al., 2010). Social scientists have also improved the exposure model drawing on the risk of and vulnerability to environmental change by including the concepts of place and social vulnerability. Diseases driven by climate change (such as dengue fever) provide areas for transdisciplinary science for social scientists, health care specialists and epidemiologists, among others.

A more comprehensive understanding of vulnerability allows policymakers to tackle the physical conditions of vulnerability as well as the structural social conditions that make places and people more vulnerable and less resilient and adaptable to environmental change. The United Nations Economic Commission for Latin America and the Caribbean (ECLAC/CEPAL) has assessed the vulnerability of the region's coasts to climate change (CEPAL 2012). The main findings include the impacts on the region's economy – with higher costs for the Andean countries, Central America and the Caribbean – increasing pressure on water, more forest fires, declining productivity of agriculture and ecosystem services, and increasing morbidity and mortality as a result of extreme events (CEPAL, 2010).

Conditions of social science production

These conditions are explored through a synthetic analysis of the funding, institutions and researchers that allow the social sciences to analyse global environmental change in Latin America and the Caribbean.

Funding

Funding agencies on the international and local level decide the research priorities for global environmental and climate change in the region. Two-thirds of its countries have signed the United Nations Framework Convention on Climate Change (UNFCCC), which is a basic official commitment to national public policies on climate change. The UNFCCC has therefore gained a great deal of influence through international agreements and by funding mitigation programmes; however, the countries have started to demand more funds for adaptation. National agencies have followed, and have shown their countries' commitments by adding to the UNFCCC programmes. Multilateral institutions such as the World Bank are increasing their influence through funds and loans.

Research on climate change in Latin America and the Caribbean has two main sources and aims: applied and basic research that national and subnational governments finance and use, and action research funded by international organisations and non-government organisations (NGOs). An example of the first is the Inter-American Institute for Global Change Research, an intergovernmental institution that funds research to inform policy. Action research is carried out by the Swiss Agency for Development and Cooperation, which is funding a project on generating knowledge and building local governments' capacity to respond to environmental changes in the Andean countries. Latin American research agencies are funded in a range of ways. Some have few funds, others sufficient, while Brazil has rich federal and state agencies (such as São Paulo's Fundação de Amparo à Pesquisa do Estado de São Paulo, FAPESP). However, the increasing funds of the national agencies for science, such as the National Council for Scientific and Technological Development (CNPq) (Brazil), the National Commission for Scientific and Technological Investigation (CONICyT) (Chile), Colciencias (Colombia) and the National Council of Science and Technology (CONACyT) (Mexico), are driving universities to analyse global environmental change. Examples are the CONICyT-funded Center for Climate and Resilience,[5] which addresses global environmental problems in Chile, and the 2007-10 multidisciplinary project "Socio-environmental effects of global climatic change in the Bio Bio Region: Challenges for sustainability in the 21st century" at the University of Concepción in Chile, which aimed to understand the socio-ecological effects of climate change in the Bio Bio region of Chile.

Although social science has a poor record of obtaining funds in most of the area's countries, where the biophysical sciences dominate spending, it has received funds to analyse the impacts of global environmental and climate change, which is reflected in the high percentage (40.1%) of publication counts focusing on environmental studies. Economists have also done research on the costs of climate change and global environmental change, which has resulted in a publication count of 11.3%. Furthermore, mitigation or adaptation projects include social scientists to allow the local context to be understood and participatory methods to be applied. The publications counts of geography (11.3%), urban studies (7.1%) and planning and development (5.9%) suggest that this research is occurring.[6]

The need for transdisciplinary research

Although the need for transdisciplinary research is acknowledged and formally encouraged, Latin America and the Caribbean lack the means to implement this goal. In spite of examples of multidisciplinary research teams and some publications, the social and biophysical sciences have not built shared research questions, common methodologies or epistemologies, so disciplinary barriers are prevalent. Universities do not create interdisciplinary programmes, provide multidisciplinary chairs or train students to engage in multidisciplinary research. Interdisciplinary job opportunities are slim. This explains the low publication count (2.9%) of interdisciplinary social science research on global environmental and climate change.

There are few efforts to co-produce knowledge between the scientific community and traditional communities. These efforts have chiefly concerned ethnobotany and traditional ecological knowledge, which pharmaceutical companies sometimes fund. But there has been a recent surge in research on traditional and local practices which might help nations and communities respond or adapt to climatic changes (see Ulloa, 2011). This research is based on the understanding that local institutions and perceptions of global environmental and climate change are important contributions to adaptive responses and improved system resilience. In Bolivia, public policies foster a multidisciplinary approach, the participation of multiple stakeholders (government and non-governmental agencies and universities) and the integration of traditional and scientific knowledge.

The opportunistic relationship between social science, media and policy

The media report on environmental and climate change issues when they become a threat, an extreme event or a disaster. Moreover media reports on social environmental conflicts have increased in the past two decades. Their focus on newsworthy events may make it difficult to engage the media in long-term campaigns to encourage research. The relationship between social scientists and the media is opportunistic, and is driven by the media's need to provide background to their stories, so they only quote social scientists when they cover extreme events or a disaster. They are particularly interested in impacts on vulnerable populations. More recently, media priorities include the effects of global environmental and climate change on agriculture, hydropower and ecosystems such as forests, *paramos* (alpine tundra ecosystems) and mountain ranges.

The increasing importance of global environmental and climate change in public opinion has led a range of stakeholders to argue for a continuous, effective and robust science–policy interface. Social scientists' relationship with policymakers is weak and uneven. If policymakers hire researchers, they set the scope, focus and questions of the research, not the researcher. Furthermore, there is no guarantee that the policy-maker will use the results of research, or how. Most policy-making is not related to sound, independent research.

Steps forward

Social science research on global environmental change in the region needs improved conditions in order to move forward. Natural and biophysical sciences have established the planetary boundaries and the tipping points for critical transitions in the Earth's life support systems under the current socio-environmental dynamics. Social science research has failed to assess the boundaries and thresholds of human systems, possibly because of humankind's faith in technology and innovation, and the hegemony of capitalism. Latin America and the Caribbean cannot afford to have this faith because it is very vulnerable to global environmental change. It has scarce financial resources, and low scientific and technological development. Its vulnerability is emphasised by its economic model of agro-mineral exports and its place within the international labour system as a supplier of raw materials for international markets.

International funding for social science research on global environmental change could decrease as a result of the financial crisis and because global environmental change is not a research challenge for First World social science (Giles, 2011; NSF, 2011). Transdisciplinary science might be a good way to bridge this gap. However, major institutional changes are needed in universities, research centres and funding agencies to overcome disciplinary barriers, methodologies, jargons and epistemologies. Similarly, the academic tenure system should not punish transdisciplinary work, even if does not reward it. Support for this research within the academic world (for instance, endowing chairs or recognising publications outside a scholar's basic discipline, and research funding) should extend to students' professional development and to the job market.

The development of infrastructure and human capital is critical to advance social science's understanding of global environmental change. Observations, models and projections of the social dimensions of global environmental change in Latin America and the Caribbean have to be developed and linked to those of the natural and biophysical sciences. This joining is typical of transdisciplinary and collaborative research projects that are data-intensive and problem-driven. Social science's reflexivity and discussion of the existing data and social processes should be encouraged to plan future pathways for society. Funding agencies could play an important role in promoting research on global environmental and climate change as they affect livelihoods; on the social drivers of global environmental change; on the links between global environmental change, climate change and social systems; on the design of common research questions, methods and products; and on forming research programmes and teams.

A major challenge for social science research on global environmental change in Latin America and the Caribbean is the tension between new and traditional theoretical frameworks. Traditional frameworks chiefly see the environment as a backdrop or outcome of social relations, whereas newer ones have the nature–society relationship at the core of their reflection, putting them closer to a holistic framework. Furthermore, social scientists have to harmonise these frameworks, given the many socio-economic problems in the region which undermine the ability to adapt and the resilience of human and natural systems.

Social scientists are uniquely equipped to analyse the human dimensions of global environmental change, while also understanding the legacies and path-dependencies of previous nature–society interactions. However, global environmental change's drivers, causes and effects operate at many scales and levels, leaving the social sciences at a challenging crossroads. Transdisciplinary science has to tackle these complex interactions by linking observations and models with qualitative assessments of global environmental change and climate change effects, and by developing common research questions and methods from multiple disciplines. Social science's engagement in transdisciplinary science could provide understanding for the design of policies that lessen social and physical vulnerability and strengthen social-ecological resilience.

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Notes

1. Most of this research is published in English and was carried out by foreign researchers and institutions. The prevalence of non-Latin American research raises questions concerning the "politics of knowledge" including who decides the research agenda? How are topics and regions selected? Who benefits from the research outcomes?
2. These estimates are based on data from the Web of Science (WoS) and the Centre for Science and Technology Studies, Leiden University. WoS data are, however, biased towards journals written in English, leading to an under-representation of non-English publications.
3. Eco-cities and ecological cities are intended to lessen their carbon footprint and pressure on the environment, for instance through recycling and alternative transportation systems.
4. Conservation without humans was the original and most radical approach to conserving nature. It involves the belief that the best way to protect the environment is to exclude humans. Examples are national parks where the only human activity permitted is "visiting".
5. *www.dgf.uchile.cl/CR2/?page_id=1550&lang=en*.
6. Source: Table B5 in Annex B based on the Web of Science. See Waltman in Annex B1 of this Report for information on methodology used and definitions.

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16. Brazilian studies on environmental activism

by
Angela Alonso and Débora Maciel

In the 1970s, the Brazilian government valued development more than environmental protection, even at the UN Conference on the Human Environment in June 1972. Today, however, Brazil has advanced environmental legislation in many areas and a huge environmental bureaucracy. The growth of the Brazilian environmental movement was mainly responsible for this turnaround.

During the political re-democratisation of Brazil in the late 1970s, a small network of informal and urban protest groups focused on social and cultural criticism of capitalist society. In the following decade, they grew stronger and shifted from protest to ensuring that environmental issues were at the top of the national political agenda. An example of this was the new Brazilian Constitution, which in 1988 guaranteed the protection of huge environmental areas such as the Pantanal. These groups also led public policy, for example by ensuring that the control of wood extraction from the Amazonian forest was strengthened.

This success changed the environmental movement's purpose. Rather than protesting, environmental groups are now involved in entrepreneurial environmental management activities. They work alongside professionals and specialised activists, and work with – rather than against – the state and the private sector. They have a neo-conservationist approach, focusing on forestry and countryside issues. Many of these groups are now internationalised – a process accelerated by the opening of the World Wide Fund for Nature (WWF) and Greenpeace offices in Brazil in the early 1990s. Brazilian environmental activism has become more conventional, following in the footsteps of counterparts in other countries.

What do the current students of environmental activism in Brazil think about this change in direction? Based on earlier studies,[1] we distinguish three stages of understanding in the literature.[2] The first stage was in the late 1980s and early 1990s, just after environmental activism began. Then, most publications were case studies, including only rare comprehensive analyses of the beginnings of the environmental movement, its development, history and internal dynamics.

The second stage was in the 1990s, which produced studies on environmental and leadership organisation as well as case studies. Some of these had a national range (surveys of environmental perception, environmental organisations and leadership profiles), while others had a local basis (mobilisation and activism in cities). Sustainable development became more important than studies on political mobilisation built on the new social movements theory – particularly on Melucci's work (1989) on collective identities and the cultural dimensions of activism.

A third stage started in the late 1990s, and has two strands. One is concerned with increasing political participation in the environmental decision-making process. Here, Habermas's theory (1996) of the "public sphere" and Cohen and Arato's (1994) redefinition of civil society were influential. They shifted the research focus from environmental movements to civil society's participation in democratic processes of environmental policy and decision-making (Jacobi, 2003; Medina, 2012). The other strand is concerned with environmental activism itself. New studies examined activists' careers and the political use of their expertise (Oliveira, 2008), the development of environmental movements and the dilemmas they faced (Alonso, Costa and Maciel, 2007; Urban, 2001) as well as the professionalisation of environmental activism (Alonso and Maciel, 2010). An increasing number of studies examined the globalisation of environmental debates, particularly the participants, outcomes and the problems that arose. These include the connections between local, regional, national and transnational patterns of activism which focus on Amazonia (Zhouri, 2000; Alonso, 2009; Almeida, 2004; Bentes, 2005; Acselrad, 2010). Lately, this second trend seems to be more influential than the first.

Some topics have received more attention than others in the recent literature. Forestry, mainly in Amazonia, appears more frequently than urban environmental problems and climate change. The focus on different geographical areas has shifted: from urban issues in the south and south-east of Brazil (in the 1970s and 1980s), to sustainable development in the country's main ecosystems (in the 1990s), to forestry issues, mainly in Amazonia (in the 2000s). Studies on civil society participation in political institutions currently outnumber those on social mobilisation in public spaces. The number and diversity of case studies has grown, while their approaches have become more comprehensive.

Notes

1. *www.drc-citizenship.org/search?keyword_ids=103210531&researcher_ids=187858397*.
2. A survey of 35 articles and books published as bibliographies (SCIELO, Brazil, Redalyc and CLACSO virtual library), from the late 1980s to 2012. Only the most representative of this literature is mentioned in this article. We thank Maria Mercedes Salgado, our research assistant, for her support with the survey.

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17. Social sciences and global environmental change research in Latin America

by
Andrea Lampis (for CLACSO)

The Latin American Council of Social Sciences (CLACSO) reports on challenges faced in Latin America and the Caribbean. Social and natural scientists need to collaborate and work together more closely and research needs to include indigenous, local and community level perspectives of socio-environmental issues.

The climate and global environmental change challenges facing Latin America reflect the reconfiguration of the region's integration into the global economy. The current alliance between local and global capitalist interests fosters the pervasive influence of the capitalist economic model across the region, based on the export-oriented extraction and processing of natural resources (Alimonda, 2011). This also allows the middle classes the space and freedom to increase their consumption (Eakin and Lemos, 2010). On the other hand, the region's high dependence on natural resources is matched by persistent poverty and widespread inequality (Lampis and Fraser, 2012). From 2010 onwards, aggregate poverty decreased, although not everywhere in the region, while inequality fell only marginally (ECLAC, 2012).

Latin America is expected to face two main climate change trends. In the north, closer to the Caribbean, annual mean precipitation is projected to decrease, as it will in Brazil, Chile and Patagonia too. In Colombia, Ecuador and Peru, mean precipitation is projected to increase (Christensen et al., 2007). Models also seem to suggest that as Amazonia gets drier, anthropogenic global warming will increase. As Magrin and colleagues (2007) illustrate, the single most relevant climate change driver is the El Niño oscillation, which shapes climate variability and climate-related socio-economic impacts in the region.

The challenge posed by the double exposure to economic and environmental crises (O'Brien and Leichenko, 2007) is an important research and policy agenda for the region. New environmental and climate-related hazards reshape old inequalities by creating more widespread risks and new forms of vulnerability at the local level (Lampis, 2013).

Because of the climatic and geographic heterogeneity of the region, future climate scenarios will inevitably vary from place to place. In addition, the significance of these scenarios, the impact of climate change, and the importance of governance and adaptation policies will depend on the power balance that national governments and local actors can strike in relation to mainstream scientific discourses (Blanco and Fuenzalida, 2013).

Central to the research interests of the Latin American Council of Social Sciences (CLACSO) regarding climate and global environmental change is the need to recast the long-standing debate between conservation and development into a new conceptual framework. Unfinished development tasks – such as universal access to human-rights-related basic services, the guarantee of equal access to asset accumulation, and greater entitlement to food sovereignty and security – have to be combined with a greater control of local environmental resources. This will guarantee a greater number of people more equal and sustainable access to the potential benefits of a globalised economy. Interdisciplinary research on these issues is still in its infancy in the region.

Recent research within CLACSO has examined the relationship between poverty and climate change in Paraguay (Fogel, 2012); has produced an overview of the political economy of mining in Latin America (Alimonda, 2011); and inquired into the relationship between climate change, social movements and public policy (Postigo, 2013). All these studies are based on the programme of the CLACSO working group created in 2010. Social science research on climate and global environmental change is therefore growing. Ulloa's work (2011) on the cultural perspective of climate change, which includes the voices of indigenous people as co-authors, deserves a special mention.

There are three main global environmental change-related research challenges for social sciences in the region. First is a need to overcome the mainstream vision shared by most national institutions working on climate and global environmental change issues, which sees them as solely natural science problems, and which regards the potential contribution of the social sciences as negligible.

Second, social sciences perspectives on climate and global environmental change (including economic, cultural, political, ethnic and gender issues) will need to carve out a space of greater legitimacy and importance over the next decade, and engage in a more fruitful dialogue with their natural science counterparts (Palacio, 2013).

Finally, a failure to include the voice and perspectives of local actors and communities may lead to the loss of a great opportunity to mainstream a more useful perspective of the region's socio-environmental issues.

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World Social Science Report 2013
Changing Global Environments

18. Quo vadis? The state of social sciences and climate and global environmental change in Europe

by
Carolina E. Adler and Katharina Rietig

Demands for a better understanding of the human dimensions of global environmental change have led to an increase in social science and humanities research in Europe. New strategies and reforms are improving opportunities. Furthermore, research is becoming more relevant for policy and wider societal needs. However, the recognition of the role of social sciences and the humanities in leading and framing global environmental change research agendas has still not been fully realised.

Introduction

Since the *World Social Science Report 2010* (ISSC and UNESCO 2010) social science and humanities research in Europe has grown in scope and interdisciplinarity. However, these trends do not adequately reflect the difficulties that researchers have had in leading and framing research agendas on global environmental change issues. Furthermore, these trends have not been uniform across Europe, reflecting different degrees of development and capacity at individual, national and institutional levels.

This article describes some of these trends within Europe, primarily the European Union (EU). While we are aware that global environmental change encompasses numerous processes of change (to land, oceans and the atmosphere, and to society), we focus on climate change to illustrate three particular issues that link to these trends in context. They are:

- the European context of social science and humanities research on climate change
- research policies and priorities: key climate change issues in the social sciences and humanities
- obstacles to social science and humanities research on climate change issues.

The article concludes with suggestions for further work to address the gaps identified.

The European context

Europe's role in facilitating research

Climate change is increasingly important in European policy-making circles and for the wider European public. Broader environmental issues and sustainable development concerns laid the foundation for this focus and served as important incentives for further European integration. "Sustainable growth respecting the environment" was a major objective of the 1992 Maastricht Treaty[1] (Article 2). The treaty also introduced the "polluter pays" principle, the "precautionary principle" and "environmental policy integration" as minimum environmental standards (Article 130 r-t). The 1997 Amsterdam Treaty[2] added sustainable development (Article 1.2) as a key objective.

Global environmental change appeared on the international agenda during the 1972 UN Conference on the Human Environment in Stockholm, Sweden, after which the United Nations set up the World Commission on Environment and Development (WCED). Following extensive public consultation, the Brundtland Commission provided the highly influential definition of sustainable development in its report, *Our Common Future* (WCED, 1987). It centred upon combining economic development with environmental and social protection. These developments resulted in the institutionalisation of environmental issues within non-governmental organisations (NGOs) and political parties in Western Europe.

However, this change was not uniform across Europe. In Central and Eastern Europe, environmental studies and research remained technocratic disciplines under communist rule. Because "nature" and "the environment" were detached from social contexts, social-scientific research on global environmental change was an alien concept, although opposition and dissident movements viewed environmental issues from a social and political perspective. They began to voice concerns regarding global environmental change issues in the 1980s, inspired by emerging green movements in Western Europe.

The Chernobyl disaster in 1986 was fundamental in raising awareness of environmental issues in Central and Eastern Europe. It was also an important basis on which post-communist environmental NGOs and, in part, the growing social science and humanities research community on the environment were built. Yet for many nations in Central and Eastern Europe, environmental issues were off the political agenda for many years.

While transnational problems such as water and air pollution were key issues of concern in Europe, the UN Conference on Environment and Development (Rio Earth Summit) in 1992 marked a second peak of European and international concern. The conference led to the creation of the UN Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity, and the Convention to Combat Desertification. During the 1990s and early 2000s, political leaders and wider society – including NGOs, the media, and social and natural scientists – recognised climate change as a major challenge of the 21st century. The increasing evidence presented by the Intergovernmental Panel on Climate Change (IPCC) and the effect on the public, for example, of Al Gore's documentary *An Inconvenient Truth* enabled this development. In 2007, the IPCC and Al Gore were awarded the Nobel Peace Prize for their role in increasing awareness of climate change as a policy priority.

Following the negotiation of the Kyoto Protocol in 1998, the European Union assumed a leadership role in international climate negotiations. At the 2011 UNFCCC conference in Durban, South Africa, the European Union agreed to a second commitment period for the Kyoto Protocol. To continue negotiations towards a post-Kyoto treaty, to take effect by

2020, the European Union also agreed to provide finance for mitigation and adaptation in developing countries (Rajamani, 2012).

Under pressure to implement the Kyoto Protocol's international emissions reduction, the European Union set up the "20-20-20 by 2020" strategy (Jordan et al., 2010) to:

- reduce EU greenhouse gas emissions by 20% from 1990 levels
- increase by 20% the share of EU energy consumption from renewable resources
- improve energy efficiency by 20%.

These targets also contribute to prioritising sustainable growth as a key objective of the Europe 2020 strategy, the European Union's vision for a social market economy in the 21st century.

Environmental NGOs have a strong presence in the European Union and receive financial support for their activities. They carry out campaigns to raise awareness among the public, and lobby European and national policymakers to consider and strengthen environmental objectives in their legislative proposals. Environmental and climate change concerns are increasingly recognised by businesses in their corporate social responsibility activities and via the increasing uptake of corporate environmental strategies.

The importance of climate and global environmental change issues in politics, society and business is also reflected in research agendas. Concerns about environmental degradation have motivated and influenced natural and social scientists' research. Research funding agencies have also adapted their funding frameworks to reflect increasing socio-political concerns. Furthermore, the high profile of the IPCC's assessment reports is an important way in which environmental science can contribute to the decision-making process. Having joined the European Union between 2004 and 2007, and thus having access to EU research funding, has motivated some countries in Central and Eastern Europe to carry out more global environmental change research.

Public research-funding institutions have set up further funding opportunities for research on global environmental change issues, including climate change. These include the Sixth and Seventh Framework Programmes (FPs) for research of the European Commission, the European Research Council, the European Science Foundation (soon to be Science Europe), and national funding bodies. EU member states' government departments and the Directorates-General of the European Commission are supporting more policy-relevant research. Many social scientists continue to co-ordinate their efforts through research programmes such as the Earth System Governance project.[3]

How has social science and humanities research influenced decision-making in Europe?

The European Commission proposes environmental legislation and contributes to decision-making in the Council of the European Union and in the European Parliament. Research findings are especially relevant in the early stages of drafting policy proposals. The Directorates-General for Climate Action (DG CLIMA) and Environment (DG ENV) commission studies when specific input is needed, connect with researchers in meetings and conferences, collect scientific evidence, and reflect on its usefulness for specific policy proposals. Research findings are integrated as a formal input to Green Papers, White Papers, Impact Assessments and Communications of the European Commission to the Council of the European Union and European Parliament. The EU

Chief Scientific Advisor also provides input before policy proposals are put forward by the European Commission.

Members of the European Parliament report that they make extensive, but selective, use of scientific input given their time and resource constraints. However, the timely contribution of scientific knowledge as evidence to support climate and global environmental change policy processes has not always been as effective as it might be in influencing policy (e.g. see Lövbrand, 2011).

Decision makers also use research findings from government institutions such as research institutes and expert commissions. Examples include the Joint Research Centre of the European Commission, the Fraunhofer Institute in Germany and the Royal Commission on Environmental Pollution in the United Kingdom, which contributed to the development of the United Kingdom's climate targets (Owens, 2010).

While researchers are frequently included in environmental and climate decision-making via formal and informal channels, their engagement with the media is less active. Academic literature is still the dominant form of dissemination for research findings, although it can be inaccessible to the mass media. Social media, blogs, and the fact that research funding criteria now include the need to consider wider impacts, are providing increasing incentives for researchers to disseminate their findings more widely and to engage more actively with society. More research institutes and universities are employing media experts who focus on communicating research findings and their policy implications.

Type of research and research practices

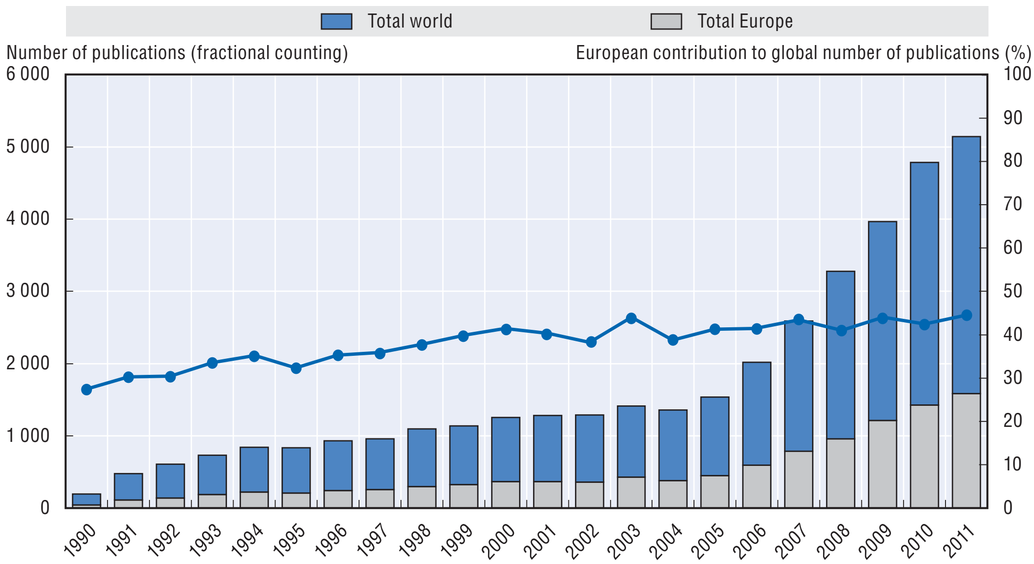
Globally, research on climate and global environmental change has grown rapidly over the past two decades, for instance when referring to the number of publications as a measure of research output (see Figure 18.1).

Since 2005 a marked increase in the number of publications on climate and global environmental change is observable across the globe, yet the rate of increase in Europe has been slightly more gradual (see Figure 18.1).[4] A gradual increase is also observable in the proportion of publications originating from Europe, with contributions to global numbers increasing from 27% in 1990 to 44% in 2011 (Figure 18.1).

While the contribution of European publications to the global total is considerable, the proportion of publications within the two broad European regions is markedly different (see Figure 18.2). Despite an increase in publications originating from Southern, Central and Eastern Europe, particularly since 2006, the total is small in absolute numbers compared with publications originating from Western Europe.

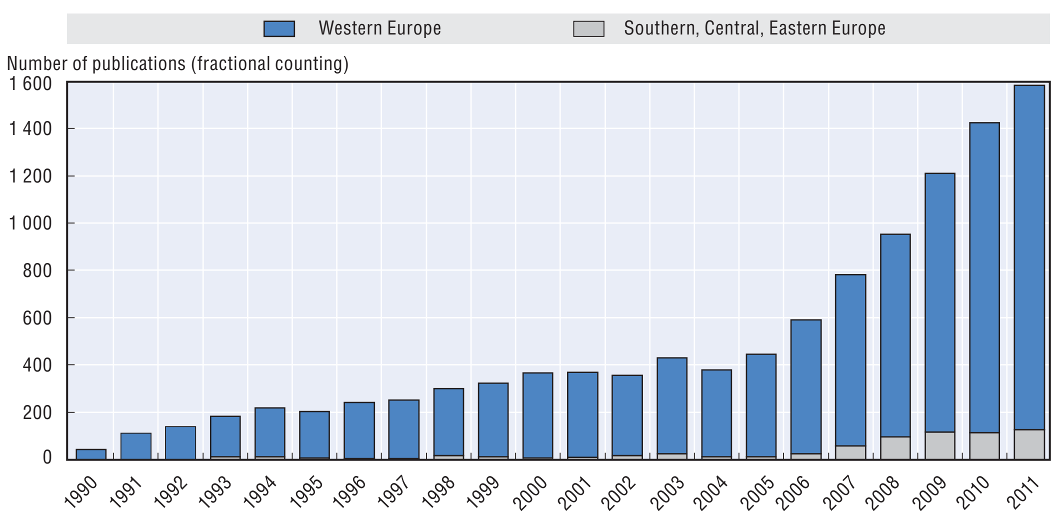
Despite the multilingual and multicultural context that defines Europe, the publication and dissemination of scientific knowledge is primarily conducted in English. This is a long-standing trend, particularly since the Second World War (Truchot, 2002), reinforced by developments in science communication and digital technologies, and the career incentives to publish in top-tier journals. These journals serve as "reference" in any given field, are predominantly in English, and receive priority indexing in the databases that are largely relied upon for evaluating scientific output and impact (Truchot, 2002).

Figure 18.1. **Proportion of European social science publications worldwide on global environmental change, 1990 to 2011**



Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B-4.

Figure 18.2. **Number of social science publications on global environmental change, regional proportions within Europe, 1990 to 2011**



Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B-4.

Funding for climate and global environmental change research in Europe

European funding has a diverse and layered structure. It increasingly involves mixed funding models, which include public and private streams at national and regional levels (van Langenhove, 2010). Overall, European efforts to provide funding for social science and humanities appear promising. These efforts, however, are still small compared with funding in other fields. For example, the EU FP7's theme of Socio-economic Sciences and Humanities was one of the world's largest research funding schemes in this field, yet it was proportionally smaller than the ten theme-oriented programmes identified by the League of European Research Universities (LERU, 2012). EU-based funding schemes are the most popular sources of funding in terms of the number of applications submitted, followed by national research funding agencies. However, most researchers receive funds at the national level, resulting in a diverse mix of public, private and institutional funding throughout Europe (Marimon et al., 2011).

In future, Horizon 2020 is expected to play a major role in facilitating a more streamlined funding process in Europe. Climate action is one of the priorities identified in the European Commission's 2011 proposal. At least 60% of the total Horizon 2020 budget is earmarked for research on sustainable development, which will address climate and environmental objectives (European Commission, 2011). Around 35 per cent of the Horizon 2020 budget is expected to be spent on climate and related issues (European Commission, 2011). The European Parliament and European Council have been negotiating the content and budget for Horizon 2020 since early 2013; laws regulating it are expected to be adopted by the end of 2013. (See more on Horizon 2020 below.)

Research policy and priorities

Social science and humanities research in the area of climate and global environmental change concentrates on the human dimensions at all levels. It addresses the social, behavioural, cultural, economic and political factors of how climate and broader global environmental change impact societies, and vice versa, as well as the complex links between them.

The International Human Dimensions Programme conducted a survey of researchers involved in the social dimensions of global environmental change research, and identified four research areas of primary importance:

- equity and equality, including wealth and resource distribution
- policy, political systems, governance and political economy
- economic systems, economic costs and incentives
- globalisation and social and cultural transitions (Duraiappah and Rogers, 2011).

Although the survey included the views of scholars from all over the world, almost a third (32.5%) of respondents were based in Western and Central Europe. It does therefore partly reflect views found in Europe and the relative importance and prevalence of global environmental change research in Europe.

Most research on the human dimensions of global environmental change focuses on describing the impacts and people's vulnerability and adaptation to climate change (Rosenzweig and Wilbanks, 2010). These are also reflected in the types of research projects that European-based researchers have completed or are still working on. Other demands for research include requests for scientific advice, evidence-based energy and climate policy, and climate change mitigation technologies (Mejlgaard et al., 2012). However, there are also increasing calls to broaden the scope of this research, by focusing on the links between mitigation and adaptation (EEA, 2012), and by tackling fundamental societal transformation to achieve sustainable development as envisaged by the ten-year initiative Future Earth.[5]

Horizon 2020 is also shaping the agenda of future research in Europe. Horizon 2020 is a financial instrument intended to implement the "Innovation Union" strategy and to provide support to EU efforts to secure global competitiveness within Europe.[6] The European Commission's legislative proposal to regulate Horizon 2020 involves six social challenges: health, food security, energy, transport, climate action and societies. All six are highly relevant for human dimensions of global environmental change research (ALLEA, 2011; LERU, 2012). It is expected that these research priorities will give a more prominent role to the social sciences and humanities in the agenda-setting process for all six challenges, not just those deemed to be most significant for the field (LERU, 2012).

Obstacles to social science and humanities research on climate and global environmental change issues

In addition to funding, the main obstacles to social science and humanities research on climate and global environmental change mainly involve status and recognition. They are often seen mainly as a support for research agendas and problems framed in the natural sciences. Interdisciplinary collaboration between these fields is still hierarchical, with natural scientists calling on social scientists to help communicate findings and bridge the divide between science and policy (Hackmann and St. Clair, 2012; Holm et al., 2012). The onus is mostly on social scientists to justify their research and priorities. Low sensitivity towards societal values, culture and cognitive factors has slowed down efforts to drive policy and societal change, often resulting in confusion and distrust regarding the accuracy and legitimacy of climate science (Mejlgaard et al., 2012).

Social sciences unavoidably reflect the social, political, cultural and historical contexts in which they are carried out. In Europe, they inevitably mirror the substantial geospatial and geopolitical differences between Western and Eastern Europe, which have resulted in differences in the field (ESF, 2010, 2012). Historical developments before and after the 1990s have posed unique challenges for global environmental change research in Central and Eastern Europe, particularly regarding ideological pressure and censorship under communist rule (ESF, 2010, 2012). Since the 1990s, and since some of these countries became part of the European Union in the 2000s, climate and global environmental change research on human dimensions have received some recognition and have developed. However, local interest in the social dimensions of global environmental change research remains relatively limited. Research institutions in Central and Eastern Europe are not considered as important as their counterparts in Western Europe. Despite these differences, EU funding instruments are allowing greater flexibility and mobility, thus helping to build capacity (Marimon et al., 2011) as well as disseminating the value of social science and humanities research for global environmental change research in the region (Laursen, 2012).

In conclusion

Demands for greater understanding and knowledge of the human dimensions of global environmental change have resulted in opportunities for social science and humanities research in Europe to develop and increase. While this is a promising trend, challenges remain that also offer important opportunities for future improvement and development.

The main challenges identified here are a lack of recognition for social science and humanities research in framing problems in global environmental change, and differences in research practices within Europe. These appear to disadvantage social sciences and humanities research, especially in Central and Eastern Europe. While adequate funding options to sustain current efforts and support new initiatives to remedy these shortcomings are imperative, other options also need to be considered.

To strengthen the role of social science and humanities research in setting priorities and agendas, research communities need to identify strategic opportunities where they can present compelling evidence that serves the knowledge requirements relevant within a given stage in the policy process. Closer examination, assessment and evaluation of the quality and impact of the knowledge produced is also needed. The standards, criteria and processes used to assess and evaluate knowledge also need attention, since new knowledge is increasingly interdisciplinary and transdisciplinary, and often combines the natural and social sciences. This would help ascertain the relevance of current evaluation practices in assessing the value of interdisciplinary and transdisciplinary knowledge for policy.

Finally, studies that clarify the importance of multilingual, interdisciplinary co-production of knowledge may help social scientists consider the implications – positive and negative – for the wider multicultural European context in which the human dimensions of climate and global environmental change unfold.

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Notes

1. *http://eur-lex.europa.eu/en/treaties/dat/11992M/htm/11992M.html*.
2. *http://eur-lex.europa.eu/en/treaties/dat/11997D/htm/11997D.html*.
3. *www.earthsystemgovernance.org/*.
4. Here, the number of publications (fractional) refers to publications that belong to multiple countries, where a "count" is assigned fractionally to each of the countries (or fields). For instance, a publication co-authored by a Dutch and a German author would count as 0.5 publication for the Netherlands and 0.5 publication for Germany. (See Annex B for further information.)
5. *www.icsu.org/future-earth*.
6. *http://ec.europa.eu/research/horizon2020/*.

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19. The state of social sciences and global environmental change in Russia

by
Oleg Yanitsky with boxes by Boris Porfiriev and Arkady Tishkov

Despite public support for environmental issues, in Russia policymakers, social scientists and the media in particular do not prioritise them. Indeed Russian elites view the planet as a resource to be exploited. Trust between social and natural scientists and across disciplines is needed if collaborative interdisciplinary research is to succeed.

Introduction

According to the Barcelona Manifesto adopted by the International Sociological Association in 2008, "humankind faces two comprehensive dilemmas in this troubled age" (ISA, 2008). The first is financial and economic uncertainty, and developing countries are particularly vulnerable in this respect. The second is the lack of security regarding future energy sources, notably oil and gas, and including the global prospect of climate change and the need to reduce carbon dioxide and other greenhouse gases. The world is also facing severe shortages of fresh water; soil erosion, the destruction of inshore and offshore fisheries, a growing number of megacities, the loss of healthy spaces for social and environmental interaction, and the loss of diverse landscapes and habitats. In addition, paying off the world's enormous national debts would require huge economic growth, which will in turn rely on increasing quantities of energy and raw materials, including water.

Despite these risks and threats, Russia is still a steadfastly resource-oriented society. In turn, this exacerbates the "environmentalism of the poor" in remote parts of Russia, and heightens the risk of natural and human-made catastrophes.

The environmental research context

Politics and the media

Russian policymakers and social scientists do not consider global climate change and environmental issues a priority. The government and *Yedínaya Rossíya*,[1] the ruling political party, are primarily interested in political and economic stability, and modernisation through resource extraction and fossil fuels to ensure industrial and infrastructure development. After the social and industrial disaster of the 1990s and the shock of economic reforms, the country could only survive globalisation as a resource-based economy. This has led to the gradual transformation of Russia into an all-embracing risk society in which there are no absolutely safe spaces, only more or less risky places (Yanitsky, 2000a, 2000b). Geopolitical issues, such as mutual security, top the national agenda. An example is the development of intergovernment alliances such as the Shanghai Co-operation Organization.[2] In an ecological doctrine adopted by the Russian government in 2002, the theme of climate change was absent.

In recent years, environmental issues have received more attention. An assessment report on climate change and its consequences for the Russian Federation (Roshydromet, 2008) – modelled on the Intergovernmental Panel on Climate Change (IPCC) report – covered several social issues related to climate change. A number of policy documents and programmes have been adopted.[3] Yet policymakers and business organisations remain primarily concerned with world market prices for gas and oil.

The mass media discuss climate change, natural disasters and technological catastrophes, but only inform readers of the immediate consequences of such events, rather than analysing them. They do not specifically discuss the causes or long-term consequences of climate change.

Most Russians are intent on earning a living and raising their living standards. They are not interested in global warming and its consequences. They often believe, as do some academics, that global warming is fabricated by politicians. They also believe – based on the Russian media and expert opinion – that Russia is the safest place on the planet, and that if global warming does happen they would have to defend Russia against an influx of millions of refugees.

Yet surveys show that people are becoming concerned about environmental issues: indeed in urban and industrial areas, “ecological concern” is ranked third or fourth place on the list of issues of concern, after unemployment and low living standards.

Science, policy and society

Local research has minimal influence on policymakers or the general public. Research on internationally renowned areas or issues, on the other hand, is more influential, as is the case with Lake Baikal, which is discussed in academic circles and at international conferences.

Networks of environmental nongovernmental organisations (NGOs) and other Russian civil society organisations play an important role in informing the population, functioning as alternative media, but they are not equipped to carry out their own research on global environmental change. They collaborate with experts from other NGOs or research institutes. At best, they rely on studies by the State Committee of Hydrometeorology.

Russian environmental NGOs, on the whole, do not have the right to be involved in political decision-making. The Forest Stewardship Council and its Russian branch are an exception as they work, for example, with timber merchants to ensure compliance with international standards. In the Russian top-down system of government, there is no place for consultation, feedback, or the inclusion of ideas, suggestions or projects relating to environmental issues from NGOs or the public. Russian NGOs do not carry out their own scientific research, but collaborate with experts from other NGOs or research institutes. Stakeholders are rarely involved.

Environmental NGOs prefer to work with local people, teaching them, for example, how to map resources to protect their immediate environment or to organise nursery gardens. In some respects, the tradition of *Khozdenie v narod* – going to the people to publicise a cause – is still alive. There are five types of environmental advocacy in Russian society:

- *neutral* – advising from a distance
- *aware* – advising with a comprehensive understanding of the issues
- *involved* – partly involved in resolving a problem
- *partner* – close collaboration with a local organisation or NGO
- *fully integrated* – advocates who have left their academic position and have become members of local organisations or NGOs (Yanitsky, 2005).

Environmental research in Russia

High interest in climate change in natural sciences, but not in social sciences

V.I. Vernadskii's (1865-1945) concept of the biosphere[4] and his supposition that humanity had become a mighty geological force (Vernadskii, 1980) became the theoretical basis for studies of climate change in Russia. Later, in the early 1970s, Budyko (1977) introduced the energy-balanced climatic model of the Earth, which in turn became the basis for further investigations of global warming and greenhouse effects. Klimenko (2008: 93) calculated the world fuel balance and predicted that by the 2000s, average global temperatures would have increased by no more than 1 °C, lower than the increase predicted by the IPCC.

Today, research on climate change in Russia is still driven by natural scientists working on global challenges.[5] There are funding channels from overseas and Russian foundations, local and regional governments, private sponsors and other sources, but only the government or international organisations have sufficient funds for climate change research on a global scale. This could be instigated by one of the international scientific organisations.

Climate change studies are conducted at the institutes of the Federal Service for Hydrometeorology and Monitoring of Environment (Roshydromet) of the Russian Academy of Sciences and at the Ministry of Civil Defence, Emergencies and Disaster Relief (EMERCOM). These institutions employ physical geographers as well as some human geographers and economists (see Box 19.1 and Box 19.2).

Social scientists in Russia, in contrast to natural scientists, have not paid attention to the problem of climate change. Indeed, it is the natural scientists, rather than social scientists, who initially revealed local social-ecological crises.

Universities have no faculties or departments to produce professional social ecologists, or specialists in the theory and practice of environmental sociology, and in particular global environmental change policy. Social ecology is still not well established or institutionalised as a separate discipline, nor does environmental sociology exist in the Ministry of Higher Education certifying commission's official list of humanities professions.

Social science research on environmental change today

WWF-Russia, one of the largest international NGOs in the country, began to comment on climate change issues in the early 2000s, but could not carry out independent research given the constraints of the Russian situation (see below). On the basis of research by Russian and foreign climatologists, some NGOs tried to estimate the economic consequences of global environmental change locally. However, businesses and most Russian people, especially in remote rural areas, are not concerned with these issues.

The political motto "First – stability, then – all the rest" has never been publicly articulated in Russia, but lies at the root of its *realpolitik*. Russia is gradually reverting to a state-controlled economy that aims to regulate the market in natural resources.

Some social science research has examined the impact of natural disasters on vulnerable groups in Russia, and shows that people tend to rely entirely on state support (Yanitsky, 2012). In the past decade, volunteers and others (NGOs, charities, concerned professionals, lay people and groups that have organised themselves via social media) have begun to help those affected by disasters and their immediate environment with the process of rehabilitation (Yanitsky, 2010). Research (Kostyushev, 2012: 9) shows that trust is a key indicator of the efficacy of rehabilitation, and that people will trust volunteers and neighbours most (4.3-4.2), then physicians and state rescuers (3.4-3.5), then the police, journalists and business people (2.9-2.8). They trust regional and local administrations least of all (2.4-2.1).

A community's ability to adapt to increased risks depends on the availability of resources. A resourceful population might migrate to safer places, whereas poor people will have to stay put and rely on state aid. As the few studies of the consequences of forest and peat fires in Russia show, people adapt well in a material sense, as a result of state aid (providing, for instance, new houses and financial support). Psychologically, however, they suffer from the breakdown in human relations and the loss of their home environment, or "small Motherland" as participants in the studies called it (Yanitsky, 2012).

The case of sociology and climate change

Russian sociology examines many different kinds of social conflict, but ignores the growing struggle between nature and society. The apparent logic, for the Russian government, is that social development is based on resource extraction, primarily fossil fuel production, which means that environmental sociology languishes at the bottom of the research agenda. Russian environmental sociology focuses on socio-ecological conflicts and environmental movements, public participation to resolve local and regional environmental issues, risk research and studies on human ecology (Lemeshev, 1990; Khalyi, 2004; Yanitsky, 2010). Around ten environmental sociology research teams are based at different institutions such as the Russian Academy of Sciences, Moscow State University, the Higher School of Economics (State University) and some regional universities.

The large umbrella NGOs, such as WWF-Russia and Greenpeace Russia, also research these issues, but occasionally and in an ad hoc way. They also prefer to work independently as it is cheaper and quicker, and the results might be checked by the independent professionals with whom they collaborate or by citizens-turned-experts. This type of research is mainly small-scale, related to a specific conflict, or undertaken at the request of a local community.

Barriers to interdisciplinary research

Links across and between the social sciences are weak, in the same way that disciplinary and institutional links between the sciences, university faculties, state research and educational organisations and NGO research units are weak. Geographers are the exception, as some are leading politicians and public figures.

As soon as academics from different institutes and disciplines begin to form an interdisciplinary team to work on a joint research project, serious bureaucratic barriers are raised. Some academics therefore prefer to work for NGOs where they feel less constrained. It is far easier to organise multidisciplinary research on local environmental issues than on global problems such as climate change. Although the international flows of money, goods, people and information, and their socio-ecological metabolism in the biosphere, are among the most challenging problems of interdisciplinary research (Fisher-Kowalski, 1997), Russian social scientists (notably sociologists) do not consider them a priority.

Further barriers to interdisciplinary research

Trust is a key issue: natural scientists are wary of the work of social scientists, with the possible exception of historians, who have a much longer-term perspective (see e.g. Korotaev, Myalkov and Khalturina, 2005; Ionov, 2009) and use a holistic, crossdisciplinary approach in their work and database organisation – as do those working in archaeology and palaeontology, for example.

There are also clear institutional and interdisciplinary barriers between climatologists and social scientists: some disciplines see themselves as self-sufficient and therefore feel no need to collaborate with others. Their worldviews and research methods also differ.

Social scientists are equally wary of cooperating with each other. Divisions between disciplines have become institutionalised over time, and the grant system for funding research organisations contributes to this problem.

The pressures of the market economy mean that quick public opinion surveys are preferred to long-term analysis of the biosphere–humankind system.

Interdisciplinary research is promoted by environmental sociologists because the very object of their research, the biosphere, has a "hybrid nature" (Latour, 1998). The institutional systems that regulate society are, however, monodisciplinary. Russian research can be characterised as a collection of monodisciplinary articles or reports gathered, for example, in readers and textbooks. The monodisciplinary approach is seen as more efficient and economical; it can be more profitable when commissioned and funded by the private sector; it is politically safe because the results are academic rather than political.

Given the hybrid nature of climate change research, academics experience enormous difficulties from the start in the shape of the grant application process.[6]

As a result, there is interdisciplinary desk-based research and even field-based research on various ecological issues, but very little on global environmental issues. The main drivers of multidisciplinary research are those academics who support this type of research, such as eco-sociologists or sociologically inclined environmentalists. They only succeed up to a point – as academics, but not as politicians or public figures – because corporatism is the distinguishing feature of the state machinery and science.

Conclusion

The prevailing view of Russia's ruling elite that the environment – local, regional and global – is a resource to use and exploit rather than a shared living space is the main reason why Russian social scientists and other scholars lag behind in the study of global environmental change. It is not because of a lack of good data or database systems.

Looking to the future, policies aimed at the prevention of climate change must be based on isomorphism. If processes that impact on the climate are global in scale, policy needs to match this and be global in terms of its structure and function, including its aims, goals and practical efforts. Policy and politics must also be responsive to the challenges of nature and human beings. If the processes of global socio-ecological metabolism are durable over time and space, policy has to be prognostic; above all, win-win policies are essential.

The challenge will be to construct such a supporting network and to examine real possibilities for collaboration between the state, businesses, and a range of public and private actors interested in promoting such policies. It will also be important to increase the educational and research capacity of actors worldwide to contribute to sustainability, particularly in the form of global research projects and open training programmes. The Russian branch of the Forest Stewardship Council with its three chambers (social, economic and ecological) is a good example for future intersectoral and interdisciplinary research.

Global "socio-futurology" is still in its infancy, however. What we really need is to develop a global systemic world view – a full restructuring of a "body of science". Are we prepared for such a transformation in our turbulent world?

Oleg Yanistky

Box 19.1. **Economic studies of climate change in Russia**

In Russia, economic issues related to climate change are primarily studied in the economic research institutions of the Russian Academy of Sciences, in the economic departments of the national universities, in special departments of Roshydromet, and in the Ministry of Civil Defence, Emergencies and Disaster Relief.

Most economic studies have focused for a long time on industrial greenhouse gas emissions, in view of the major role the energy sector plays in the Russian economy. Two more research areas have recently emerged: evaluating the impact of climate change on the economically active population (mostly human health), and the analysis of infrastructure and the cost of adaptation to climate change.

The first strand focuses on measuring losses caused by hazards and disasters such as storms, floods, wildfires and melting of the permafrost. Most of this damage is due to "creeping" impacts; "burning-type" disasters, such as storms, flash floods and hurricanes, make up less than 10% of the total. In terms of impact on its national economy, Russia is not likely to be among the nations worst affected by climate change. A comprehensive study produced in 2011 by a joint team of Russian Academy of Sciences economists and Roshydromet human geographers confirmed earlier findings, including those of international experts, that global warming may actually benefit a number of industries, such as agriculture, tourism and heating, and will generally provide a window of opportunity for future economic development (Kattsov and Porfiriev, 2011). Using this opportunity in practice is, however, a different story.

Box 19.1. **Economic studies of climate change in Russia** *(cont.)*

The second research area to emerge in recent years concerns adaptation to climate change. This tackles policies, economic actors – for example, the state, businesses and households – and the funds that are necessary to reduce hazards, disaster risks and other climate change impacts on communities and industries. The findings reveal that the Arctic region is the most vulnerable, and will be the most affected by climate change. Yet it is also likely to benefit from the windows of opportunity provided by global warming. It is expected to consume a significant part of future climate investment in order to develop infrastructure in the region by 2030.

Boris Porfiriev

Box 19.2. **Geography and the study of climate change in Russia**

Geographers are heavily involved in climate change studies conducted at numerous institutes of Roshydromet, of the Russian Academy of Sciences and at EMERCOM. The Roshydromet organisations have monitored global climate change by means of large databases compiled from observations for over 100 years at meteorological stations across Russia. They can therefore develop up-to-date mathematical models, and have done so annually since 1983. The results are published online[7] and in Roshydromet's annual report on the state of the climate in Russia.[8]

Institutes of the Russian Academy of Sciences and leading state universities also explore climate change in various ways. Studies of the ice kernels from deep drilling at the Russian "Vostok" station in Antarctica, and direct observations at the North Pole stations in the Arctic Ocean, have led to conclusions of world importance (Petit et al., 1997). These institutes also assess the influence of climate change on populations, settlement systems and the economy.

Studies on climate change show that today Russia's climatic conditions are changing considerably, and that these trends will not alter in the next ten years. The changes are characterised by increasing temperatures in the cold seasons, increased evaporation despite similar or even decreasing rainfall during the warm season, more frequent droughts, changing river flows and altered glacial conditions in the Arctic Ocean basin. These tendencies have a considerable impact on living conditions and the social and economic processes of the country. For instance, rapid climate change has led to more frequent natural disasters – spring floods, mud flows, hurricanes and avalanches – which cause economic damage in the energy, agriculture, transportation and municipal economy sectors. In some regions, climate change has contributed to a decrease in heating demand. but in others it has increased it.

Studies of the impact of climate change on the population and economy, and on possible ways to adapt to this, integrate work by geographers as well as applied studies. New data received at the Institute of Geography of the Russian Academy of Sciences and at other geographical institutes in Moscow, Saint Petersburg and Syktyvkar show the impact of climate change on the Russian economy through the so-called "cascade effect". The northern regions and mountains with decreasing populations are the most vulnerable. Global warming accelerates the destruction of their traditional economies and destroys their life support systems because thawing permafrost levels damage the foundations of the buildings and road infrastructure, and affect the water supply.

Arkady Tishkov

Notes

1. Yedínaya Rossíya (United Russia), a centrist political party, currently holds 238 of the 450 seats in the Duma (parliament).
2. An intergovernmental, mutual-security organisation founded in 2001 by the leaders of China, Kazakhstan, Kyrgyzstan, Russia, Tajikistan and Uzbekistan.
3. For example, the Implementation Plan of the Climate Doctrine of the Russian Federation (RF) (adopted by the RF Government on 25 April 2011), and the Basic Principles of the State Policy in the Field of Environmental Development of the Russian Federation until 2030 (adopted by the RF President on 30 April 2012).
4. The biosphere, or planet Earth, is a global ecological system integrating all living beings and their relationships with one another.
5. Including geographers, who are considered natural scientists in Russia.
6. A number of international and national funding agencies do, however, fund multidisciplinary research. The government's Rossiiskii Fond Fundamental'nykh Issledovanii (the Russian Foundation for Basic Research) is the main national agency that does so.
7. *www.climatechange.su*.
8. *www.meteorf.ru*.

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20. Global environmental change and the social sciences in the Arab world

by
Ismail Serageldin

The social sciences in the Arab States have largely neglected global environmental change. Local citizens are concerned by and interested in these issues, however, and international studies point out the possible disastrous consequences of this neglect. Local studies deal with social aspects of environmental problems but are not linked directly to global environmental change. Nor are they influencing decision-makers, the media and society.

Introduction

Social sciences in the Arab world have a rich history of detailed and useful studies. However, environmental issues – especially climate change and global environmental change – have not elicited sufficient interest from social scientists. Until two years ago, there were relatively few local initiatives to study the likely impacts of global environmental change; any that did exist were undertaken by natural scientists, and had scant impact on public opinion or governments (El-Raey et al., 1995). However, issues of water and food security are recurrent themes in research and public discussions (see e.g. Abou-Hadid, 2006; Abu-Ismail, Moustafa and Masri, 2009).

However, international agencies have in the past sponsored important initiatives that have mobilised Arab social science around development issues, and they have done so more recently on climate change and global environmental change. The 2012 World Bank Report dealing with Arab responses highlighted the need for governments, non-government organisations (NGOs), and networks of local specialists – social scientists in particular – to face climate change and its negative impacts, and to promote resilience (Verner, 2012).

According to the World Bank, climate change and climate variability are likely to have dismal effects:

> The message is clear: over the next century this variability will increase and the climate of the Arab countries will experience unprecedented extremes. Temperatures reach new highs, and in most places there will be less rainfall. Water availability will be reduced and with a growing population, the already water scarce region may not have sufficient supplies to irrigate crops, support industry, or provide drinking water (Verner, 2012: 1).

The report cites three case studies on the likely economic impacts of climate change, all of whose findings were uniformly negative: over the next 30 to 40 years, climate change is likely to lead to a 7% cumulative reduction in household income in Syria and Tunisia, and a reduction of 24% in Yemen.

A 2013 UN Development Programme (UNDP) study on the impact of climate change on the Egyptian economy also concludes:

> … about 2-4% of future Gross Domestic Product, could be lost from effects [of climate change] on water resources, agriculture, coastal resources, and tourism; thousands could die from air pollution and heat stress, and millions could lose jobs in agriculture as the result of climate change (Smith et al., 2013: 13).

Yet the attention of social scientists is mostly elsewhere. In a 2009 review of all social science research in Morocco (Saaf, 2009), the authors categorised 2 705 studies (977 in French and 1 828 in Arabic) classified across 20 different subfields, not one of which deals with global environmental or climate change. The bibliometric analysis in this Report also clearly shows that the number of articles by social scientists from the Arab region on climate change and global environmental change in peer-reviewed journals is very small (Annex B, Table B4).

Some studies do exist, however. Although their work is not published in the best-known international journals, local social scientists have produced some studies on issues that directly address the connections between the environment and society. They do not necessarily link specifically to climate change or global environmental change, unlike work by natural scientists in the Arab world (e.g. Elshinnawy, 2008; Elshamy, Seierstad and Sorteberg, 2009). However, they provide the basis for designing local actions that could benefit Arab societies and help them confront current problems that climate and global environmental change are likely to make more acute.

What have Arab social scientists been studying? To what extent are existing studies relevant to global environmental change and climate change issues, or could they be made more relevant?

The current pattern of Arab social science research

Economic studies in the Arab region have been driven largely by the World Bank-supported Economic Research Forum. Macroeconomic policies, competitiveness and income distribution inequalities have tended to be the most important themes. Insufficient effort has been made to generate living standard studies based on household income and expenditure surveys similar to the World Bank-supported Living Standards Measurement Studies.

Where governments and social scientists have focused on the environment, they have tended to examine pollution, solid waste management and access to water and sanitation rather than global environmental change. Water for irrigation, drought and food security have largely been tackled as agricultural production and marketing issues, with the associated issues of subsidies, credit and poverty as the dominating themes; the rural–

urban divide is also studied. All these topics feature the environment and society in some way, but few look at the impact of climate change or global environmental change.

Arab researchers at national agencies and universities work of local water and agricultural issues across the region, sometimes in collaboration with specialised research centres such as the International Center for Agricultural Research in the Dry Areas (ICARDA), or with international partners and universities in Europe and the United States.

In the non-economic social sciences, issues of identity, minorities, gender and poverty dominate. Sociocultural studies have tended to focus on identity issues and the role of religion. There has also been an increase in concerns about minorities since Saad Ibrahim (1994) published his major study of minority groups in the Arab world nearly 20 years ago.

Education and gender have received much attention in social science research, and deserve special mention given their importance in the Arab world. In a review of studies on gender issues in the region, Nadereh Chamlou (2012) says, "The two main gender issues in the MENA region are about women's extremely low labor force participation and nearly negligible share in political leadership." Some work on the role of women on farms exists. But few, if any, gender-related studies in the region have focused on links with climate or global environmental change.

The many studies that deal – albeit broadly and locally – with environment and society, and which have involved social and natural scientists, include issues related to rural communities and desertification, water sharing and water management, urban growth and its impacts on the well-being of citizens, pollution and health, poverty, and food security in the light of global environmental change impacts on agricultural production. Other papers have introduced new concepts such as social and natural capital into a framework of wealth accounting, or virtual water when assessing national agricultural strategies, which includes the pattern of water import and export.

As we can see, Arab social scientists have addressed several aspects of the complex relationships between societies and the environment. But they have not attempted sufficiently to connect the observations made in their local case studies to the global dynamics of environmental change, or to the international research and debates on these topics. In particular, despite, or perhaps because of, the enormous role that some Arab countries play in the energy domain, studies on alternative fuels and sustainable development have elicited but feeble responses.

Methods used

By and large, and whatever the topic, social science research in Arab countries remains too impressionistic, lacking a strong basis in data. The paucity of publicly available data, and the low capacity of many research institutions to generate their own data, may explain this. Even basic data on climate change phenomena are very weak. The World Bank report notes that "… climate stations across most of the Arab region are very limited compared to most other parts of the world, and what data exists is often not digitised or publicly available" (Verner, 2012: 5). Even when studies in the Arab world do rely on quantitative data, most researchers tend to use available and published government statistics. They undertake only minimal analysis and seldom generate their own data from independent fieldwork, which is rarely encouraged by government or official agencies, in a world where secrecy is the norm and transparency the exception.

Economic and social studies based on quantitative analysis are usually of the cross-sectional variety. Longitudinal studies are rare. Modelling or scenario building is even rarer. Sometimes researchers hide behind the "qualitative" label to avoid the rigours of quantitative analysis. Opinion surveys are still embryonic and sampling methodologies very weak, offering results of dubious reliability.

The 2013 UNDP study on Egypt offers an example of how global, regional and local approaches can be combined and can provide a full range of options for adaptive strategies for a particular context. That study links a number of global models with regional and local studies[1] to create an analytical framework and scenarios of global environmental change impacts in Egypt. Scenarios estimate, for instance, that a decrease in agricultural production of between 8% and 47% is likely to occur, which could result in a reduction of employment by up to 39% and an increase of food prices by 16-68%. They also reveal that a rise in particulate matter concentrations and heat stress could lead to 2 000 to 5 000 more deaths per year, while the higher temperatures could reduce annual revenues from tourism by up to EGP 110 billion (Egyptian pounds) (Smith et al., 2013).

Such studies should encourage social scientists throughout the Arab world to look at the economics of global environmental change. They should measure the costs of inaction, the resilience of communities in the face of change as a result of drought, sea level rise and the increase in the salinity of soils, the problems of constructing indicators of social cohesion or of social change, and the many other complex and significant problems of global environmental change and its impacts.

Public awareness of the challenges of global environmental change in the Arab countries is far greater than it is among the media and governments. These remain largely mute despite sporadic declarations about the issue and the risks for society. A 2009 survey cited in the 2012 World Bank report (Verner, 2012) found most people (90%) agree that climate change is occurring and 84% believe that it is an important challenge. This points to a collective need for good social science studies on global environmental change and its societal dimensions in the Arab countries. In order to reach this goal, some conditions are required.

Recommendations

For the Arab world's social science research to reach the highest international standards, five sets of actions are needed, some of which were discussed in the *World Social Science Report 2010* (ISSC and UNESCO, 2010). These recommendations are mutually reinforcing, and build a coherent policy that is more than the sum of its parts.

Strengthen social science research capacity

Clear national policies need to prioritise certain topics through a "grand challenges" approach. In this framework global environmental change would be identified as a priority for public policy and research, including in social science. At present, many government-sponsored reports on climate and global environmental change are produced for regional and international meetings but do not seem to register effectively with the social science community and the public.[2]

Human resources need strengthening: better education systems from pre-school to post-doctoral level are required. Better training should be offered in problem solving and interdisciplinary approaches and in methodology, including field techniques and quantitative methods of analysis. Turning the brain drain into a brain gain by building strong links with the diaspora and enabling returning researchers to find an attractive research environment would be helpful. Establishing closer links with international programmes would also be beneficial.

In terms of institution building, research institutions must be autonomous, and managed efficiently. They should be allowed to lead the research they want, without fear or pressure. The formation of networks of centres of excellence in the Arab countries and beyond could reduce the isolation of many Arab social scientists. Institutions should have access to data sources, to regional and international expertise and to digital library resources.

Links between the public and private, government-sponsored and NGO-driven academia and think tanks, need to be strengthened.

Funding should be based in part on national priorities, and also emerge in part from the grand challenges approach.

Social science research agenda

The inputs of the social sciences are needed to design proper policies and programmes for the environment.

Local and national environmental matters: social science research is needed to help design sound policies and programmes on many issues including access to clean water and sanitation, solid waste management, air and water pollution, and soil erosion. To protect our environment and move towards sustainable development, individuals need to change their behaviour and society needs to shift its attitudes. Policy and programme design needs to take into account people's perceptions and behaviours, and the way in which they interact within communities, if it is to be effective.

The World Bank report (Verner, 2012) and the manner in which it was prepared and disseminated is a good start. Likewise, the quantification and modelling work done and the economic impacts examined for the UNDP 2013 study are important examples of what could be done. However, we need much more. We must understand how social solidarity for community responses can be enhanced, how involuntary displacement can be turned from a liability into an opportunity, and how the resilience of local communities can be strengthened to face the challenge brought on by drought, soil salinity, surges, storms and sea level rise, to name just a few of the areas that need social science expertise to meet the challenges of global environmental and climate change.

Envoi

The social scientists of the Arab world need our support. Much needs to be done to allow them to achieve their full potential and to contribute the full measure of their talents to society. But they need to go beyond the important issues they are currently focused on, beyond democratic transition and the economy, beyond gender, poverty, youth and social mobility, beyond religion and culture, minorities and cohesion. We must encourage them to link these important local problems to the overarching environmental issues of climate and global environmental change, and to bring their studies to the attention of decision-makers, the media and society at large.

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Notes

1. Such as the Red Sea and its corals, an important tourist draw for Egypt (see Cantin et al., 2010).
2. The momentum of intergovernmental meetings has been carrying existing institutions such as the Center for Environment and Development for the Arab Region and Europe (CEDARE). The UN Economic and Social Commission for Western Asia (ESCWA), which is based in Beirut, addresses the sustainable development and green economy concept. It summarises the challenges and opportunities related to the green economy, linking it to sustainable development and the eradication of poverty. It also covers the reservations that many developing countries have about the concept. But the UN agency's reports still focus mostly on economies, gender, and matters such as the outcome of the UN cycle of conferences on sustainable development, the contributions of the Arab States to these sessions, and how they prepare for international conferences such as Rio+20.

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21. Social science perspectives on global environmental change in sub-Saharan Africa

by
Coleen Vogel

Climate change and climate variability in sub-Saharan Africa tend to expose existing environmental risks and opportunities. Despite some noted social science interest and work in this field, including good examples at the continental and local levels, much more can still be done by and with Africans, including at the local community level.

Introduction

Global environmental change research requires interaction between social and natural sciences in order to understand the complex Earth system and the mix of competing development and environment interests better (Rockström et al., 2009; Raworth, 2012). There has been a strong focus, internationally and from African natural sciences, on explaining some of the drivers of environmental change – such as land use and agricultural change – with arguably fewer social scientists engaging actively in Earth system science teams.[1]

Traditionally, social scientists seldom initiate research on global environmental change themes, although exceptions do exist (see Odada et al., 2008). One example is that despite the slow interaction between the sciences, the nature–society relationship and the question of how we begin to frame and negotiate future sustainability pathways are becoming active research and policy concerns for the United Nations University and the International Human Dimensions Programme on Global Environmental Change (Duraiappah and Rogers, 2011). Social scientists are increasingly asked to help frame research themes and understand the contested environmental spaces, values, views and meanings of environmental and transformative change in various contexts (Hackmann and St Clair, 2012).

This article examines some of the benefits of trying to improve our understanding of various global environmental change challenges, including socio-ecological complexity, by using a social science lens. The article also identities the opportunities and incentives for undertaking this kind of research, particularly in sub-Saharan Africa. Finally, the author suggests how social scientists could play a more active role in global environmental change research and action in this part of Africa.

Environmental challenges facing Africa

The current development realities facing the continent – including the fact that Africa is experiencing a new optimism, with rising consumer spending, innovation opportunities and a growing, youthful population – cannot be ignored when addressing global environmental change issues (Swilling and Annecke, 2012). Researchers, many from the natural sciences, have identified significant challenges (Odada et al., 2008), including poverty, desertification, disease, deforestation and hunger.

Climate change and climate variability is a particular sustainability challenge for Africa (Christensen et al., 2007; UNEP, 2012; Bhaskar et al., 2010):

> All of Africa is very likely to warm during this century. The warming is very likely to be larger than the global, annual mean warming throughout the continent and in all seasons... Annual rainfall is likely to decrease in much of Mediterranean Africa and northern Sahara… Rainfall in southern Africa is likely to decrease in much of the winter rainfall regions and on western margins.
>
> (Christensen et al., 2007)

Fluctuating temperatures, and rainfall in particular, are critical for rural and urban livelihoods. This means that mitigation of and adaptation to climate change and climate variability are important development priorities, given the risks that climate may have for resources such as energy, water, health and food. A central concern for Africa, as in other regions, is to reduce the possible consequences of climate change, including increased disaster risks at the regional, district and municipal levels, and to ensure that people can live with climate change amidst other pressing challenges (Christensen et al., 2007).

Social sciences and environmental change in Africa

African social scientists have added to these priorities by including other dimensions, for example complex neoliberal globalisation, intercultural relations, poverty, gender and intergenerational relations, the evolution of spirituality and religion in the modern world, and emerging powers in the South (CODESRIA, 2011). The range and variety of these issues are central to the global environmental change discourse, calling attention to social phenomena and processes that need to be understood when identifying environmental drivers, conditions or states. The key challenge, however, is to ensure that such social science approaches are included when the key challenges of global environmental change (e.g. Rockström et al., 2009) are framed, and that social scientists are included from the outset in designing and framing research agendas with Earth systems scientists.

Given this potentially rich field, what has been the social science research role in global environmental change in recent years in sub-Saharan Africa? Publications on climate change and broader global environmental change themes have increased significantly over the past decade (see Table 21.1). These themes include "vulnerability and resilience", "modelling energy systems" and "environmental governance". There were noticeable gains between the periods 1990-99 and 2000-11: 405 articles were published on "vulnerability and resilience" from 2000 to 2011 compared with 28 from 1990 to 1999, for example.

Table 21.1. **Social science publications (full counting) on climate change and global environmental change by themes in the sub-Saharan region**

Articles (1990-99)		Articles (2000-11)	
Climate change impacts	7	Climate change impacts	48
Energy resources	1	Energy resources	33
Modelling energy systems	4	Modelling energy systems	146
Sustainable rural development	5	Sustainable rural development	30
Sustainable urban development	22	Sustainable urban development	66
Vulnerability and resilience	28	Vulnerability and resilience	405

Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B.7.

Identifying the reasons for this increase in these global environmental change themes in sub-Saharan Africa is difficult, likewise it is not easy to determine the total proportion of social science funding by country. Available science outputs for all sciences show that South Africa dominates all scientific publications (46.4% of the subcontinent's share) followed by Nigeria (11.4%) and Kenya (6.6%) (Urama et al., 2010b: 26). For example, although the social sciences are being promoted in South Africa, much remains to be done. Over the period 2009-12, 499 projects were supported in the social sciences and 842 in the humanities by two directorates of South Africa's National Research Foundation compared with 2 056 in the natural sciences. In global environmental change research (society and sustainability), less than half the projects (4 of 13) are in the social sciences, with about ZAR 40 million provided in 2012-14, less than half of the total funding.[2]

Science is driven by a number of factors, including curiosity and collaboration. Themes of interest are usually clustered along dominant constellations (Hajer, 1997) and often mirror "Northern" science practice. External funders, including those funding international development, also fund research on global environmental change and play a key role in stimulating global environmental change research in Africa. The Climate Change Adaptation in Africa Programme was funded by Canada's International Development Research Centre (IDRC) and the United Kingdom Department for International Development (DFID); the Climate and Development Knowledge Network (CDKN) is also funded by DFID; other funders include the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the European Union and the United States National Science Foundation (NSF). These efforts tend to focus on science and development, which includes the Millennium Development Goals, poverty reduction and building resilience to climate change.

While funding is limited for social sciences and training, some funders are making noteworthy contributions. A small survey was undertaken for this article to understand better what drives social science research on global environmental change and climate change in Africa, and sub-Saharan Africa in particular.[3] The issues probed included funding support for social sciences, social sciences and their role in global environmental change in Africa, and the barriers and challenges for social science research and engagement. The survey respondents included social scientists, organisations facilitating global environmental change social science engagement (such as START – Grants for Global Environmental Change Research in Africa[4]) and international funding agencies and organisations operating at national and local levels such as DFID, IDRC, the International Council for Science and its regional African office, the World Bank and the South African National Research Foundation (NRF).

Most respondents, many with notable experience of supporting global environmental change research globally, reported that support for social science research is usually linked to the mandate and agenda of the funder and the aid agency. Many focus on practical efforts – described by one respondent as "taking the pulse" of what is occurring in a particular area, such as agriculture, poverty, green jobs, employment creation or capacity building. Where the science products (such as publications and other reports) and capacity development are both measurable research outputs, these are usually specified in funding calls and often require work from multidisciplinary teams. Notwithstanding this support, measuring the success of outcomes remains difficult. Several respondents noted this as a major challenge, particularly for sustained capacity in social science research. Moreover, donors and funders of social science work are often driven by project-based funding that provides support for a specific period of time. Sustained funding is often very limited for ongoing multidisciplinary and transdisciplinary social science research. As outlined earlier, national funding for social sciences research on global environmental change was also noted as weak in many cases (with some noting the exceptions of South Africa, Ghana and Nigeria).

Consultancy firms are also used to undertake social science research linked to development problems. Some respondents noted that consultants could be hindering sustained social science efforts in this field by not feeding their results back into an overall body of social science knowledge.

This suggests that the development requirements of Africa may be attracting more social development science than deeper thinking around the sociology of the issues (Urry, 2009) confronting Africa. The tendency for social science research bodies to be driven by the latest emerging theme could result in a more superficial understanding of social relations in complex areas such as climate change, for example simply identifying risks and neglecting the social meanings of risk. Better use is therefore needed of the "…arsenal of social theory and methodological approaches" (Agrawal et al., 2012: 330).

Notwithstanding this strong development focus, there seem to be few detailed, nuanced in-depth studies of global environmental change in sub-Saharan Africa from African social science perspectives that include local knowledge, local "framings" of climate change and variability, power and justice. Nor are there detailed studies of cultural meanings, human rights and the ethical dimensions of climate change. Where are the systematic, comprehensive systemic critiques that take us beyond a predominant focus on local case-based research (see Bhaskar et al., 2010)? Despite the significant increase in studies on vulnerability and resilience (Table 21.1) and sustainability, there remains more to be done in African-led, social science-instigated studies focusing on social sciences, global environmental change and climate change.

Challenges and opportunities for social science research excellence

As in other international cases, the interaction between the biophysical and socioeconomic drivers of change operates on several scales: international, regional, national and local. It is not straightforward to investigate such complex issues in the African context. Intellectual capacity is not lacking, but the skills and equipment needed to undertake research on environmental change (such as field and laboratory equipment and technologies) are not always available. There is also a serious shortage of capacity building, and too little training of the next generation of scientists.

At the launch of the Royal Society/DFID Africa Capacity Building Initiative in November 2012, the Chief Scientific Advisor and Director of Research and Evidence at DFID, Chris Whitty, pointed to sub-Saharan Africa's notable growth in GDP in recent years. This growth is estimated at 6-8% per year, meaning an approximate doubling each decade. He suggested that some of this growth could have been used to support scientific research in Africa and to grow its limited pool of scientists. In most African countries there are, however, up to 1 000 times fewer scientists than in Asian countries at a comparable stage of development (Tatalović, 2012). African scientists often move to Europe, America or Australia, seeking better opportunities. In addition, younger, early-career scholars are not usually inclined to pursue crossdisciplinary and transdisciplinary science, preferring to gain a solid training in specific job-related disciplines such as information technology or economics.

An African future for social science and sustainability?

Despite this mixed review, new and interesting social science themes are emerging. These tend to have their roots in critical social issues such as land tenure, the economics of adaptation, behaviour and conflict. A further theme is the benefits of legal and governance systems such as reducing emissions from deforestation and forest degradation (REDD+) (see e.g. Beymer-Farris and Basset, 2012). Understanding the politics of environmental and forest management is important when seeking equitable forest management practices for environmental sustainability. Notions of "forests", baselines of forest cover and how forests are changing all need to be understood from wider and deeper social science perspectives. Such research raises critical questions about the kinds of approaches we use in the practice of global environmental change and sustainability science, such as transdisciplinarity (Thompson Klein, 2009).

Transdisciplinarity and other approaches

Social scientists have recently been articulating what is needed to achieve a better understanding of the social processes – past and present – that drive global environmental change and influence how we respond to change (Hackmann and St Clair, 2012). While many international scientists agree that the climate is changing and that urgent action is needed (Christensen et al., 2007), there are some who contest the conclusion that climate change is driven by human activity. Climate change science is also uncertain. In this context, and with a view to developing solutions to the challenges posed, it is necessary to establish appropriate communication channels and safe spaces for multi-actor dialogue on shared knowledge production, contestation and validation in Africa. Such processes could benefit from more social science research and wider civil society engagement.

Expanding the reach and usefulness of global environmental change and climate change research in Africa and elsewhere will, however, require big shifts in how we do things, including more transformative social science attention to global environmental change (Hackmann and St Clair, 2012). Transdisciplinary approaches could help achieve this (see Thompson Klein, 2009; Boyle and Harris, 2009; Reeger and Bunders, 2009; Chilisa, 2012). Some African social scientists (for example, Urama et al. 2010b; Swilling and Annecke, 2012) are embarking on research that includes local communities, policymakers, city councils and local actors from the outset, and work with a co-designed research agenda. The Council for the Development of Social Science Research in Africa, the International

Union for the Conservation of Nature, and the University of Illinois at Urbana-Champaign (with Swedish International Development Agency support), support a responsive forest governance programme that is examining REDD+. This programme includes local people and local representatives to create a shared understanding of forestry management systems for climate change (Agrawal et al., 2012).[5] Some African-wide research driven by Africans with donor aid is also exploring new research opportunities, using action research and social learning approaches. Examples of these opportunities are the START African capacity-building efforts and the African Climate Policy Centre, focusing on climate science and services, urbanisation and disaster risk reduction.

Concluding thoughts

This article has explored some of the progress made in identifying the important environmental challenges facing Africa. Several conclusions can be drawn from this analysis.

First, and despite notable efforts in some areas, there is still a need for the social sciences to engage more vibrantly in global environmental issues in Africa, emphasising the larger, systemic challenges and aiming for a deeper sociology of science. A specifically African-influenced social science agenda that can improve the understanding of global environmental change challenges in Africa must be supported and strengthened. This could include the role of local knowledge, cultural traditions and resource use, and consciousness and "meaning making" for climate change and global environmental change in Africa. Funders are crucial to stimulate social science research and support a more fundamental, critical social science engagement in environmental issues. Of course development-focused research support in Africa is essential, but this cannot be decoupled from the need for stronger support to examine the sociology of global environmental change themes.

Second, social sciences can and must add value by providing a more nuanced understanding of climate change.

Third, the challenges facing Africa will also require an expanded way of doing science. The co-production of knowledge, and transdisciplinary approaches (e.g. Thompson Klein, 2009; Boyle and Harris, 2009) that address challenges, provide critical realism approaches (e.g. Bhaskar et al., 2010), while indigenous research methodologies (e.g. Chilisa, 2012) offer opportunities to infuse African perspectives into global environmental change research.

There is an overwhelming need for sharpened efforts in education and training in science and technology across all fields (Urama et al., 2010a).

Finally, the lack of useful meta-theories – including those that enable us to critically engage with the complex systems challenges that climate change presents – remains a challenge, globally and for Africa (Bhaskar et al., 2010; Urry, 2009; Swilling and Annecke, 2012).

"Radical intellectuals need to show in detail how alternative futures can be coherently grounded in the deep structures of what already exists, of what people already know and have" (Bhaskar, in Bhaskar et al., 2010).

Notes

1. *www.icsu.org/future-earth*, for example.
2. Personal communication with Achuo Enow, Programme Director for Global Change, National Research Foundation, in 2013.
3. Please note that this survey was a very small and preliminary research effort – an attempt to feel the pulse of African social science research on global environmental change and climate change.
4. START: *http://start.org/programs/africangec*, Global Change System Analysis for Research and Training.
5. Personal communication with Ribot in 2012.

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22. African perspectives needed on global environmental change research

by
James Murombedzi (for CODESRIA)

Environmental concerns are central to the daily lives of ordinary people across Africa: land grabbing, mining, environmental degradation, commoditisation of natural resources. How can social sciences face up to the challenges of the 21st century? The Council for the Development of Social Science Research in Africa (CODESRIA) provides insights into the challenges global environmental change research in Africa is facing.

Environmental issues are taking centre stage in local, national and global discourses and policies. In Africa, the list of environmental challenges is long: the Sahelian drought of 1968-73, drought in southern Africa in the 1990s, famine in East Africa, conflicts over natural resources, natural resources financing armed conflicts, deforestation and desertification, the degradation of agricultural land, biodiversity loss, and the large-scale expropriation of land and natural resources. These issues have catapulted environmental issues into policy and public debates, and have attracted the attention of social scientists in the past few decades.

However, research into global environmental change in Africa has historically been dominated by the natural sciences, with little reference to the social sciences. Consequently, environmental challenges are understood mostly in terms of their technical details and dynamics. Proposed solutions have paid scant attention to the socio-political, economic and cultural dimensions, or to the consequences of and responses to environmental change. Moreover, the little social science research into environmental issues that does exist in Africa relies mostly on Northern paradigms (Salau, 1992).

Environmental social science in Africa today

Settler colonialism, imperial rule, the commercialisation of agriculture and industrial growth have had profound effects on societies and the natural world (Beinart and Coates, 1995). African social sciences and humanities have engaged with these issues to varying degrees. The historical causes of environmental degradation in processes such as colonialism, Africa's participation in the global capitalist system, and the imposition of new land tenure systems have been well researched (e.g. Page and Page, 1991). The ecological impacts of colonialism, and in particular colonial land expropriation and the introduction of cash crops such as groundnuts, cotton and maize, have been similarly well documented (Franke and Chasin, 1980; Zeleza, 1997; Moyo and Yeros, 2005). Because of its political and social salience, the relationship between land distribution, ownership, tenure and resource degradation continues to be the subject of much social science research in Africa.

Class and other struggles for social change increasingly focus on environmental and natural resource issues. Economic decline – associated with structural adjustment programmes, failed rural development interventions and increasing poverty – have increased the dependence of peasants and small farmers, in particular, on natural resources. This in turn has fostered the emergence of movements that contest the expropriation of natural resources, resist the regulation of natural resources, and fight for women's rights to own land and access other natural resources (e.g. Moyo, 2002). These struggles for equity and justice are increasingly framing social and political relations, and have forced policymakers to pay greater attention to environmental concerns.

Evolving social science research on environmental issues

Contemporary environmental debates by African social scientists focus on issues such as land and related agrarian issues, the poverty–environment nexus, climate change mitigation and adaptation, the relationship between global political forces and environmental change, environmental security and justice, environmental policy and governance, environmental movements and political parties, local–global interactions, multilateral environmental agreements, and demography.

Climate change now dominates contemporary environmental debates and is shaping development policy. African social scientists, usually in collaboration with scholars from other continents, are now addressing the climate crisis and are focusing particularly on its implications for livelihoods and development. Current thinking continues to be dominated by sustainable development issues, usually viewed from an ecological perspective. African social scientists have been at the forefront of investigating the links between environmental governance, sustainability and livelihoods (e.g. WCED, 1989; Murphree, 1996).

Climate change has also generated an interest in understanding local adaptation strategies, which in turn has rejuvenated interest in advancing scientific understanding of the relationships between African local knowledge and adaptation to global environmental change (e.g. Eguru, 2012).

Most African countries are increasingly focusing their strategies on state and private investment in natural resource extraction concessions (mining, forest and agriculture). Environmental expropriation and the commoditisation of land are taking place on an unprecedented scale; the environment too is being commoditised and privatised as the crisis of neoliberal accumulation of wealth intensifies. Examples include "green grabs", land grabs, new forms of land and resource expropriation through carbon sequestration, water privatisation, the creation of protected areas on land taken from poor and marginalised people, and the suppression of indigenous forms of production and consumption. Many environmentalists have classified payments for environmental services schemes, such as carbon sequestration (for example REDD+) as a form of "green grabbing", because they allow land and resources to be taken away from poor and vulnerable people, and ownership is transferred into the hands of the powerful (White et al., 2012; Fairhead, Leach and Scoones, 2013).

Land grabbing is common in different contexts across Africa where governance structures are weak. They can feature incomplete, inequitable and ambiguous policy and legal frameworks; weak and competing jurisdictions of national and local government institutions; limited (and limited use of) land and forest information to guide policy and management; judicial systems that tend to be disconnected from poorly understood customary tenure systems; and limited public awareness, dialogue and participation in decision-making processes regarding the allocation and reallocation of land and resource rights (Murombedzi, 2012). The representation of local interests in developing environmental policies and implementing interventions is increasingly a central issue for social science inquiry in Africa.

The way forward and CODESRIA's role?

Environmental concerns are central to development agendas and to the daily lives of ordinary African people. While there is much research into environmental issues in the humanities and social sciences in Africa, it is disaggregated, piecemeal and generally ancillary to the natural sciences. Even as environmental concerns have been incorporated into social science disciplines, their treatment and place within those disciplines is marginal and sometimes even contested (Foster, 1999). The incorporation of environmental concerns into the mainstream of these disciplines is hindered by the absence of a theoretical model of the relationship between the environment and development. Further, environmental issues remain marginalised in social theory. Despite the centrality of the "environment question" to the development process, society–environment–development interactions remain relatively under-researched within the social sciences in Africa. While social scientists have achieved considerable success in stimulating crossdisciplinary engagement with natural scientists in understanding resource management challenges, environmental issues have not been integrated with social science's intellectual and research agendas.

A coherent social science of the environment capable of delivering evidence-based research that can feed into African policy processes addressing environmental challenges is urgently needed. Policy responses will only be effective with an African social science perspective. New impetus is also needed to ensure that disciplines are better integrated. The need to develop appropriate paradigms concerning the links between the environment and development also requires deeper recognition.

For the past year, CODESRIA has hosted a research programme examining decentralised forest governance in Africa. It seeks to understand the relationships between forest governance and the democratisation of local government systems. It is also facilitating the development of an epistemological community of young African researchers working on environmental governance. CODESRIA has also initiated training institutes for young researchers in 2013, one on gender and climate change and another on environmental politics and governance.

In the longer term, CODESRIA is developing an environmental governance programme to explore social science perspectives in Africa to help inform theoretical and empirical developments in social science research on environmental issues.

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23. Global environmental change and the social sciences in eastern and southern Africa

by
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The Organization for Social Science Research in Eastern and Southern Africa (OSSREA) reports on the global environmental and climate change challenges facing this region such as land degradation, deforestation, soil erosion, and declining soil fertility. But is social science research doing enough and does it have the capacity to help the region cope more effectively with these challenges?

The Organization for Social Science Research in Eastern and Southern Africa (OSSREA) conducts research on global environmental and climate change in eastern and southern Africa with early career social scientists. With OSSREA's technical and financial support, studies have been conducted in the following four key areas.

Climate change impacts

Rainfall patterns, temperature changes, humidity and wind are important areas of research for OSSREA. Equally, it is crucial to understand the impact of climate change on the most vulnerable, people whose livelihoods are particularly sensitive to climate change and who depend daily on local natural resources – pastoralists, farmers, people living on islands and in coastal areas. Some studies link climate change with people's vulnerability to HIV and AIDS, migration and ethnic conflict. New insights and policy recommendations focus on:

- enabling local communities to manage local resources
- harnessing indigenous knowledge to plan for and achieve resilience
- building and diversifying local livelihood options
- accessing material resources (improved and suitable crop varieties, microscale irrigation schemes, new breeds of livestock, rural credit)
- building technical knowhow concerning crop and livestock production, and land and water use, and raising awareness of appropriate land and water conservation measures, rangeland management and animal health issues.

Long-term trends

OSSREA also supports and conducts research on the history of human–environment interactions. It seeks to provide evidence of major climate and vegetation changes in Africa over the long term to help assess current trends in drought and food security. These studies use various methods including the normalised difference vegetation index, standard precipitation index parameters, and information gathered from remote sensing, geographical information systems and meteorological stations. Alternative approaches include palaeoclimatic and linguistic evidence to examine historical climate change where long-term data are not available.

Mainstreaming gender

Gender equity in natural resource management programmes is still on the agenda. Studies of the gender differences in people's perceptions of afforestation and the distribution of benefits from forest resources show that men benefit more from forest resources than women, and that men discourage women from planting trees because of the customary gendered division of labour. Researchers also examine the gender-differentiated impacts of traditional local coping and adaptation mechanisms, and bigger interventions by government and non-government organisations. They assess the differences between male and female farmers' perceptions of climate change, their acceptance and adoption (or not) of land management and soil and water conservation technologies, and their willingness to pay to protect the environment.

Human-induced environmental change

OSSREA is involved in studying pastoral and farming land-use strategies and their impact on environmental resources: land degradation, deforestation, soil erosion, declining soil fertility and the trampling of soils.

These studies examine the lived experiences of local people, and focus on their vulnerability and their coping mechanisms in the face of climate change, as well as possible policy responses. Most of them, however, lack methodological rigour, are not comparative, and do not clearly address the real challenges and implications of global environmental change. Many researchers in the region lack adequate methodological skills and knowledge, and the financial resources to conduct field research.

OSSREA tries to deal with these challenges by providing modest grants for researchers and research methodology training, and by seeking opportunities for researchers to publish and disseminate their findings.

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24. Social science research and global environmental change in India and South Asia

by
Aromar Revi and Neha Sami

Policy debates in South Asia have only recently started to focus on climate change, even though it is a major concern for civil society and the media. More broadly, social science research on global environmental change needs to break out of traditional disciplinary boundaries if it is to have greater impact. This will only happen with appropriate institutional and funding support and incentives.

Introduction

Global and national environmental issues have been part of South Asia's political and policy debates since the 1970s.[1] India's then prime minister, Indira Gandhi, first linked development outcomes and poverty alleviation to the global environmental agenda during the 1972 Stockholm Environment Conference. India has since maintained a relatively consistent international stance, arguing that developing countries need to concentrate on poverty alleviation and improve their living conditions, while addressing challenges of national and global environmental and ecological conservation.

Environmental conservation has been a consistent focus in India's public policy arena since the 1970s. High points include the passing of important environmental protection and pollution control legislation; creation of a series of "end of pipe" regulatory agencies (agencies that try to fix the problem at the point of impact, rather than at the source); multiple landmark court judgments; and many conflicts between citizens and environmental groups, the government and domestic and international firms on environmental questions.

Global environmental change appeared in the South Asian policy and social science landscape in the late 1980s, just before the 1992 UN Conference on Environment and Development in Rio. The impacts of climate change on South Asian countries include sea level rise, deforestation, desertification and an increased incidence of hurricanes, floods and landslides. Climate change only became a theme of active policy debate in India in the early 2000s, with relatively weak interest from social scientists (Planning Commission, 2011).

The Indian government now officially recognises the climate vulnerability of the country's population and economy, and is committed to an equitable global solution to climate change challenges. It has initiated a series of policy responses, including setting up a Prime Minister's Advisory Council and developing a National Action Plan on Climate Change (Prime Minister's Council on Climate Change, 2010), which was formally adopted in 2008 (Dubash, 2012). It includes current initiatives and future programmes aimed at climate change mitigation and adaptation. All of these allow only limited space for social science questions, such as the relationship between human development and climate change, disaster risk and vulnerability. Eight technical missions have been launched to promote renewable energy, energy efficiency, sustainable habitat, green growth and other priorities. In addition, some state governments are developing action plans aimed at climate change mitigation and adaptation. Local city and regional projects also attempt to roll out various interventions, including photovoltaic installations, solar water-heating systems and village electrification programmes. Most of these initiatives do not have a strong social science orientation (Townshend et al., 2013).

Media attention has grown in line with this increase in government activity on climate change. According to Dubash (2012), a random Internet search for media articles on climate change in major Indian newspapers increased from tens of hits a year in 2000-06 to tens of hits a day by 2009-10. Dubash (2012: 1) also notes that newspapers' opinion and editorial pages show that deliberations and discussions on climate change have become part of the "necessary repertoire of the economic and political commentariat". Civil society groups and non-governmental organisations (NGOs) working on environmental issues are trying to establish substantive political linkage between the issues on which they work and national and global climate change debates (Townshend et al., 2013).

Other South Asian countries have taken similar steps. Bangladesh, which is particularly prone to increasingly frequent floods, has invested with development partners in several sectors related to climate and global environmental change since the 1960s. These include flood management and protection, disaster management, irrigation, cyclone shelters and coastal green belt projects (World Bank, 2010). The government of Bangladesh produced its *National Adaptation Programme of Action* (*NAPA*) in 2005 (Ministry of Environment and Forests, 2005). This was followed by the adoption of the *Bangladesh Climate Change Strategy and Action Plan 2008* (updated in 2009), which focuses on adaptation as well as mitigation measures. It identifies areas of action, including better management of water resources, minimising the impact of floods and addressing vulnerability, particularly the displacement of populations (Ministry of Environment and Forests, 2009).

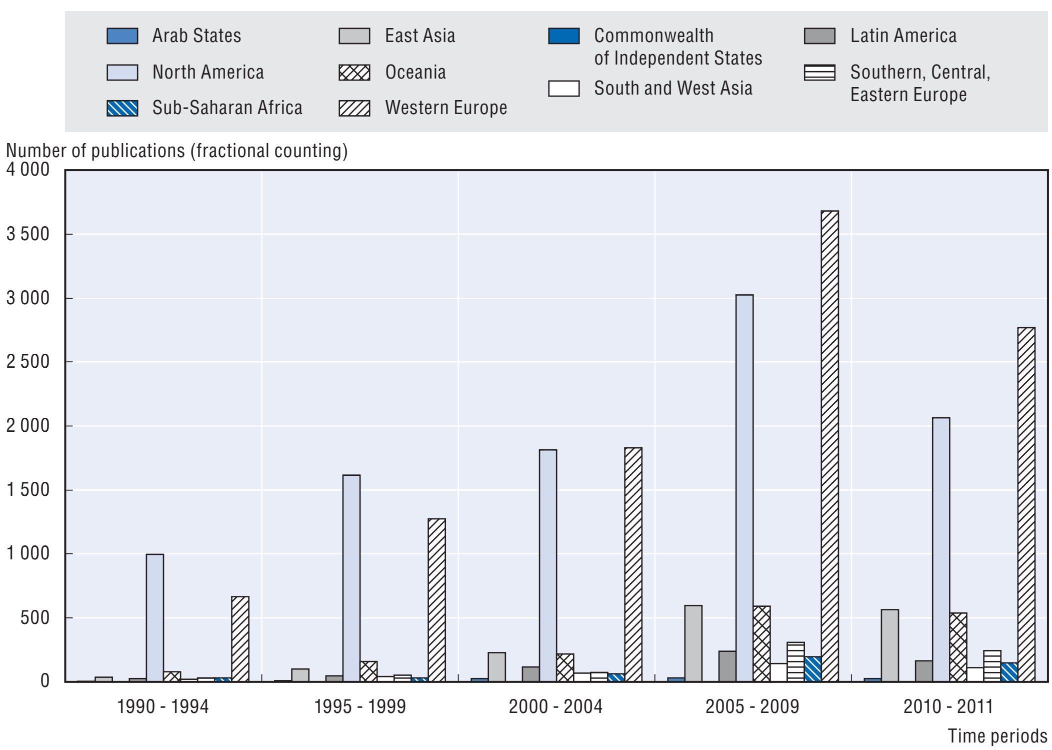
Research priorities

The social sciences in India have grown far beyond their traditional disciplinary boundaries over the past two decades. They now include diverse areas such as education and health, globalisation and sustainable development (DFID, 2011). According to a Department for International Development (DFID) report on social science research in India (2011), agriculture and rural development have been focus areas, with a growing emphasis on inclusive development. The study of economics in India has a more utilitarian bent, with several applied empirical research projects seeking to inform government policy and contribute to economic growth. While the caste system has always been of interest to Indian social scientists, there is a growing body of new work on its economic, social and political implications. This is also largely true of research on gender issues.

The expansion of social science research interest in global environmental change and climate change has been slow. However, there are indications that policy initiatives may be taking the lead on this front: the United Nations Development Programme (UNDP) is currently funding and developing a three-week training programme that will sensitise government officials and bureaucrats to the linkages and overlaps between human development, climate change and disaster risk. This programme will also provide the participants with toolkits to help them integrate these concerns into their planning processes.

Both global environmental change and climate change are areas of relatively low interest to social scientists in India, where the volume of social science research on these areas since the 1990s is typically lower than in other parts of the world. Although the number of South Asian articles has grown since 2000, it remains lower than in other world regions: see Figure 24.1.

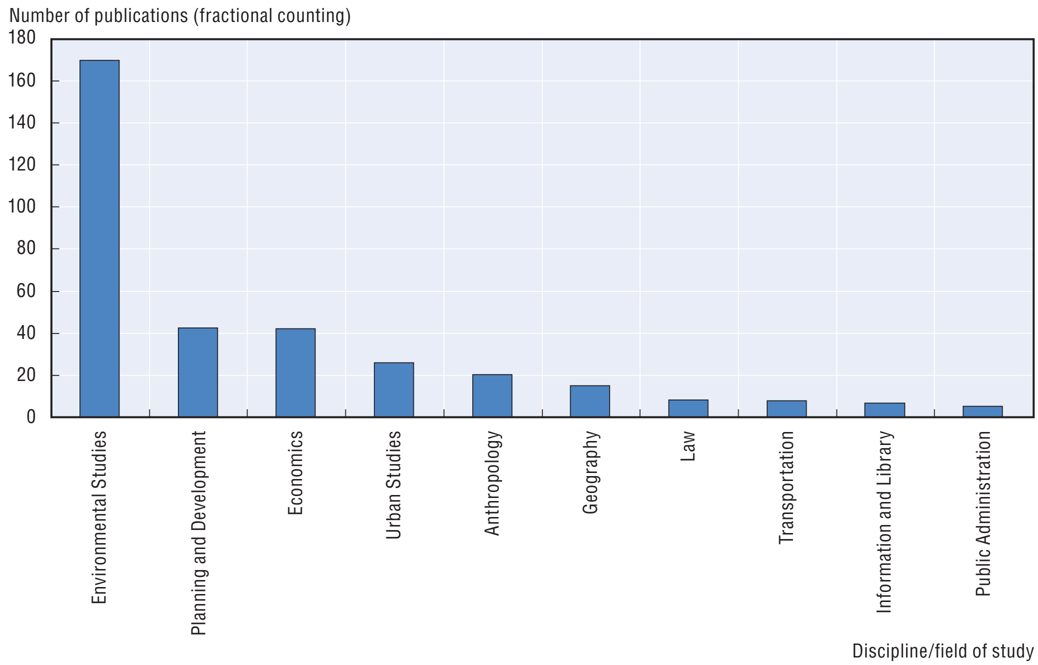
Figure 24.1. **Number of social science articles on climate change and global environmental change by region, 1990 to 2011**



Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B-4.

When this output is disaggregated by discipline and thematic area, the highest proportion of social science research that focuses on climate change and global environmental change is unsurprisingly seen to be in the environmental studies domain (Figure 24.2). Other important thematic areas with a number of social science research articles concentrating on climate change include urban studies, planning and economics. A scan of recent social science research and writing in India suggests that research concentrates largely on the connections between human development and climate change, and on understanding the areas of overlap between these two fields of study.[2]

Figure 24.2. **Number of social science publications on climate change and global environmental change in South and West Asia for the ten most prolific Web of Science fields of study, 1990 to 2011**



Note: See article by Ludo Waltman, Annex B1, for information on methodology used and definitions.
Source: Web of Science. Annex B, Table B-5.

Recent social science research on climate change in India concentrates on the impact of sea level rise on human settlements along the Indian coastline, the socio-economic impacts of climate change on tropical storms and the monsoon, and the impacts of climate variability on agricultural production. There is also some work on the climate change impact on Himalayan glaciers, especially on the water security of settlements dependent on glacier-fed water. Drought and flooding, which are India's most serious contemporary hydro-meteorological hazards, do not feature as important areas for social science research on climate and global environmental change (ISDR, 2009, 2011). Neither do deforestation and other similar themes that form an expanding body of African social science scholarship on climate change.

A broad examination of research on climate and global environmental change in Bangladesh reveals some differences from Indian research. Significant work is being done on adaptation to climate change in Bangladesh, as well as on the impact of flooding from major rivers such as the Ganges and the Meghna and the effects of sea level rise. A similar examination of Pakistan shows most papers taking a regional perspective rather than being Pakistan-specific. Important themes include climate change impacts on food security and vector-borne diseases.

Funding for research

Domestic funding for social science research in India is limited. Despite a relatively strong academic tradition in the humanities and social sciences, the bulk of India's research expenditure on higher education focuses on science and technology. This is also true of research on climate change and global environmental change. There are no specific grants available for social science research on these issues.

Internal funding for social science research in India comes from government organisations such as the University Grants Commission (UGC) and the Indian Council of Social Science Research (ICSSR). Less than 12% of the UGC's total expenditure on research was allocated to research on social and basic sciences in 2009-10. During 2006-10, the ICSSR grant was 2.3% of the total awarded to the Council of Scientific and Industrial Research (CSIR) and approximately 11% of the funding of the Indian Council of Medical Research (ICMR). The institutions providing the awards set the funding priorities and research areas. Neither of these institutions currently identifies climate change and global environmental change as primary areas of research in either the natural or the social sciences. The direction of research on these issues is driven largely by individual research interests and to a lesser extent by international funding organisations. These tend to focus on policy and practice initiatives.

It is difficult to arrive at an accurate picture of allocations for research in general and for social science research in particular in India. Of the total funds allocated to the ICSSR, only 20% are used for research, and the rest for administrative purposes. Similarly, the UGC funds for higher education are largely used for administrative purposes and salaries, and only secondarily for research programmes. No disaggregated and reliable data is available on how much of the allocation is spent on research. A search of government records suggests that various government departments and agencies allocate about USD 120 million annually to different social science research institutions.

The UGC encourages research by providing grants to researchers affiliated with recognised Indian universities. Particularly important are fellowships for young researchers (UGC, 2012). There are several other general schemes, grants and fellowships, some of which might be available for social science research, but there is no specific mention of support for social science research in climate change and global environmental change in the various calls for proposals for funds or in documents found on the websites of the ICSSR or the UGC. The ICSSR awards senior fellowships to social science scholars to conduct research on specific themes and issues proposed by applicants. It also provides grants to scholars to work in various fields of social sciences with a theoretical, conceptual, methodological or policy orientation.

Little data is available on levels of research support at individual universities or academic institutions. However, a few scattered examples show research support for climate change and global environmental change in India. UNESCO has established a chair for Climate Change and Policy at The Energy and Resources Institute (TERI) in Delhi (TERI, 2012). The Sustainable Environment and Climate faculty at the Centre for Environmental Planning and Technology in Ahmedabad conducts research and runs training workshops on the impact of climate change on various sectors, and teaches postgraduate programmes in climate change and sustainable development (CEPT University, 2012a, 2012b).

There is little information on the role of donor institutions and the extent to which they commission research on climate change and global environmental change in India. However, personal experience and anecdotal evidence indicate that over the past two decades, the volume of climate change funding from international sources such as UN agencies, multilateral and bilateral donors and international NGOs has increased, raising concerns that research is often closely aligned with the donor agency's interests and may not be independent. Very little of this research takes place in local institutions or is undertaken by local scholars. Most is carried out by scholars at universities outside South Asia, and results are often not published in regional journals. Consequently, very little may find its way back to regional research, domestic policy debates or popular discourse.

What are the obstacles?

In addition to the lack of funding, a major obstacle to social science research in India is the lack of institutional support. The massive and expanding volume of undergraduate enrolment in the social sciences also limits research activities in Indian universities. Fewer than 20% of Indian universities combine teaching and research activities (DFID, 2011). There are few professional or financial incentives to undertake research. Furthermore, university administrations are often not research-friendly, limiting the scope and quality of research activities at typical Indian universities. The quality of the faculty and the rigour of doctoral research are often below average, so that this work cannot be published. In addition, research on climate change and global environmental change is largely perceived to fall under the domain of the natural sciences. Apart from a few isolated instances, there is little indication of attempts to align social science research with work on climate change. *The Mapping Report* on *Social Science Research in India* adds that:

> While the country has the highest volume of research in the region, and is significantly ahead of other countries in south Asia, there is wide disparity in research activity and output across the country, both in terms of quantity and quality. Only about 15-20% of 433 universities have achieved an international standard in teaching and research. There is wide variation across the country in the institutional nature, ambition and resources as well as in individual research leaders' orientation and capability (DFID, 2011).

A 2007 ICSSR review adds that the scale and range of social science research in the country have been expanding. But it also notes that the quality of the research output of the majority of institutions, and their contribution to a better understanding of socio-economic processes and to the shaping of public policy, have fallen short of expectations and do not match the resources spent (DFID, 2011; Krishna and Krishna, 2010). Consulting firms are increasingly emerging as alternative places to work for researchers, but their preference is for policy papers or briefs rather than papers for peer-reviewed journals.

Language is another concern in India. Most provincial colleges use the local or regional language for education up to undergraduate level, but the language of communication for most postgraduate and advanced research is usually English. Although primary research is usually carried out in local languages, the critical disciplinary material is typically in English, including the international literature on climate change and global environmental change. Many students find it difficult to make this linguistic transition.

A comparative study of social science research between India, China and Brazil by Gupta, Dhawan and Singh (2009) found that only 19 Indian institutions have high productivity in social sciences. India ranks 13th among the 26 most productive countries by percentage share of global publications. The top 19 Indian social science institutions published 50 or more publications each during 1996-2007, contributing 3 860 papers, or 28% of the Indian output in social sciences. "Individually, these institutions contributed 59 articles to 779 publications, with an average of 230 publications per institute" (Gupta et al., 2009: 20). The average citation count per paper was 1.17 (Gupta et al., 2009; Krishna and Krishna, 2010).

Types of research

Academic research in India is conducted in a variety of institutions and by diverse individuals. There are three key institutional sectors in which social science research is conducted: universities and postgraduate colleges, government research institutes, and autonomous research institutes. An increasing amount of research also takes place outside academia. Centres for action and advocacy research, such as non-profit organisations, often produce practice-based research that focuses on specific subject areas or issues. Policy research networks made up of academic and government research organisations play an important role in bringing together expertise from different sectors and institutions, although their value as research initiatives is yet to be established. Consulting firms also conduct applied and action research, to produce policy briefs or action items rather than academic papers.

A few disciplines dominate social science research in India. According to the DFID report (2011), economics has traditionally attracted the most funding among the social sciences. Sociology also has a large following among postgraduate research students, partly due to the employment opportunities in the non-profit sector. Although disciplines like history and political science are among the most popular at the undergraduate level, interest in conducting postgraduate research in these areas is declining, partly because of the lack of employment opportunities. Teaching and research at Indian universities are typically within traditional disciplines, including sociology, economics, history, anthropology, geography, psychology, public administration and political science. In addition, some universities and academic institutions in India provide teaching in "non-traditional" areas such as social work, women's studies, community medicine, law and governance, educational studies and gender studies, all of which draw on conventional social sciences. The expansion of these communities into the climate change and global environmental change space has been limited.

Research and decision-making

The relationship between research and decision-making in India is difficult to establish. For the most part, independent research conducted at universities in India has little impact on decision-making and policy. However, a significant amount of directed social science research is carried out to inform government policy- and decision-making. In particular, there are several government research institutes such as the Indian Institute of Tropical Meteorology, the Indian Institute of Technology Delhi and the Indian Institute of Science, Bangalore that are mandated to produce research-based reports that are supposed to inform decision-making. However, these reports are technical in nature, focusing on the sciences rather than social science.

Consulting firms are increasingly acting as advisors to municipal, state and national governments in India. In addition, non-profit organisations and advocacy groups use research to pressure government to take action on particular issues. Since little of this action-oriented research is published outside the grey literature, it is difficult to evaluate its quality or its impact on policy- and decision-making.

Conclusion

Climate change is a relatively recent theme of policy debate in South Asia, but it has become an important area of media and civil society concern. While social science research in the region, especially in India, has diversified into many development-related themes, its engagement with global environmental change and climate change is limited. It is focused on the established terrain of environmental studies, planning and development, economics and urban studies. There is little research funding for the social sciences and virtually no dedicated funding or institutional support for this area. It is not surprising that the region lags behind others in social science research output. In addition, the linkage of academic social sciences research with policy-making is weak. Consulting and advocacy groups have moved into this area, although the quality of their research and its impact may be questionable. In short, there is considerable potential for the development of social science research in this important area, but only if appropriate institutional and funding support and incentives are available.

Acknowledgement

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Notes

1. The South Asia sub-region here includes Afghanistan, Pakistan, Bhutan, Nepal, India, Bangladesh, Sri Lanka and the Maldives.
2. An examination of articles in the *Handbook of Climate Change in India* and Google Scholar citations for themes such as "climate change research in India", "social science research in India" and "social science research and climate change in India" yields useful insights.

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World Social Science Report 2013
Changing Global Environments

25. Social science research on climate change in China

by
Ying Chen and Laihui Xie

In China, climate change and global environmental change are much higher on the political and social science agenda than ten years ago. Although economists are heavily involved, other disciplines are less visible and progress is slow. For interdisciplinary research to flourish, incentives and stronger institutional structures are needed as well as better education and training opportunities.

Introduction

In China, climate change is more prominent than other global environmental change issues such as biodiversity and protection of the ozone layer. The Chinese government ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 2002, and plays an important role in promoting negotiations regarding related climate regimes.

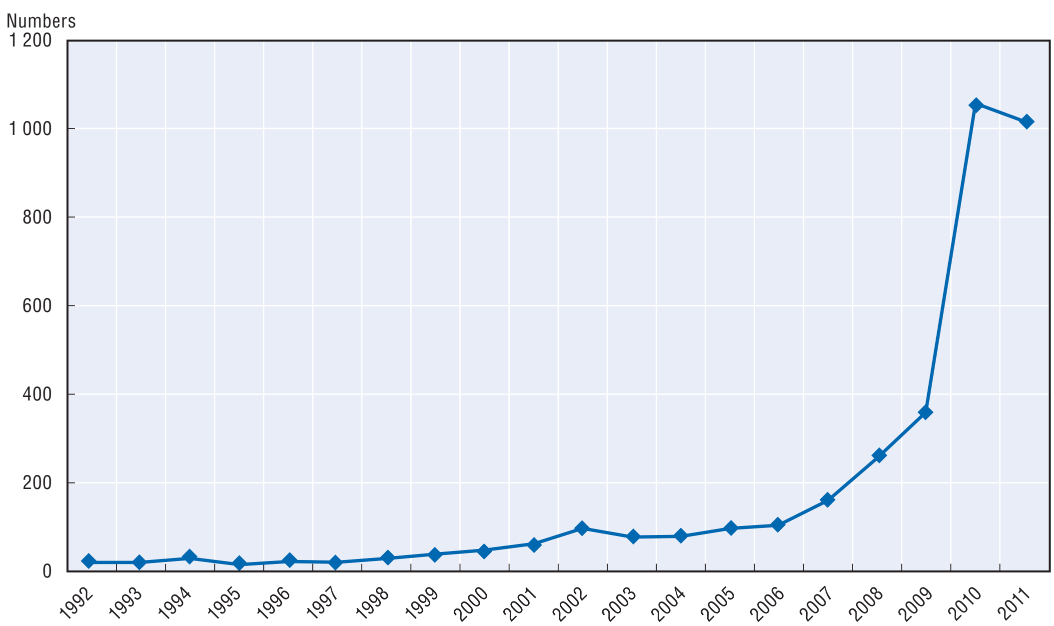
In May 2007, the State Council discussed and approved China's National Climate Change Programme (CNCCP) (NDRC, 2007), the first in a developing country. Since the 11th Five-year Plan period in 2006-10, which required a 20% reduction in energy intensity,[1] climate change has attracted the attention of national and local government leaders. Media coverage of climate change has also increased since then. Many local and international non-government organisations (NGOs) have been set up around the country to concentrate on this problem. In December 2009, many Chinese NGOs attended their first climate change conference in Copenhagen, where they advocated more international action on climate change.

Climate change is an important topic for academic researchers. It was initially seen as a scientific rather than a social issue; therefore natural scientists carried out most of the research in the 1990s (Lin, 2002). Prominent Chinese scientists, such as Qin Dahe, have been lead authors of Intergovernmental Panel on Climate Change (IPCC) reports since then.

Social sciences and climate change research in China

Some social scientists have also been involved in cutting-edge research on climate change since the 1990s. As an environmental economist, Jiahua Pan was a co-editor of the Intergovernmental Panel on Climate Change (IPCC) *Third Assessment Report* (2001). Generally, however, climate change has not been an important topic for social scientists until recently. Figure 25.1 and Table 25.1 show the results of an electronic database search of academic journals published in China from 1992 to 2011. Social science contributions to climate change publications increased rapidly from 2007, peaking in 2010. The media and intellectuals designated 2007 "climate change year", which increased the number of social scientists studying and working on climate-change-related problems. The 2010 peak is rather surprising, but can be explained by the collective learning that took place and the subsequent inertia. In 2011, the number of publications remained at about 1 000, which can be interpreted as a signal that the number of social scientists focusing on climate change had stabilised. Besides factors such as international and domestic policy dynamics, media coverage, government attitudes and the research funding system in China, Chinese social scientists were also following international trends in thinking seriously about climate change.

Figure 25.1. **Number of articles on climate change in social science journals in China, 1992 to 2011**



Note: These statistics are from the China National Knowledge Infrastructure database, the largest database of Chinese academic journals, doctoral dissertations, yearbooks and newspapers. Publications were identified by the relevance of their titles and abstracts. Only articles on social science topics published in academic journals listed in the Chinese Social Sciences Citation Index are included, so for example human geography is included while natural geography is not. Not all these journals are peer-reviewed, although journals are increasingly taking on the peer review approach. This index is seen as the most important standard for publishing scientific papers in the social science field in China.

Source: China National Knowledge Infrastructure. *www.cnki.net.*

Table 25.1. **Numbers of articles on climate change research in Chinese social science journals by discipline, 2005 to 2011**

	2005	2006	2007	2008	2009	2010	2011	Total
Economics	17	10	26	51	68	259	295	726
Education	0	1	0	0	3	1	3	8
Environmental studies	24	21	42	78	67	117	151	500
History	4	3	5	3	4	7	6	32
Human geography	3	1	5	4	6	32	27	78
Law	11	11	12	14	12	38	38	136
Linguistics	0	0	0	0	1	4	2	7
Management	6	8	5	11	31	144	122	327
Philosophy	1	2	5	3	5	7	9	32
Political science (including international relations)	15	15	26	48	64	159	88	415
Psychology	0	0	0	0	0	0	1	1
Sociology	1	1	3	2	3	26	17	53
Others	14	31	30	41	95	261	258	730
Total	96	104	159	255	359	1055	1017	3045

Note: This data originates from the China National Knowledge Infrastructure database with only Chinese Social Sciences Citation Index journals selected (the discipline category is based on its classification). “Others” refers to articles published in multidisciplinary journals which cannot be easily classified into the other disciplines. The data was accessed on 27 January 2013.

Political support for action on climate change

The year 2007 marked a substantial change in political support for action on climate change in China. At the international level, the IPCC was awarded the Nobel Peace Prize (jointly with former United States Vice-President Al Gore), and the IPCC released its *Fourth Assessment Report*. Both received wide media coverage around the world and influenced China considerably. President Hu Jintao, then General Secretary of the Central Committee of the Communist Party of China, referred to building an ecological civilisation as a way to implement the “scientific development concept”, including dealing with climate change, in his report to the Party’s 17th National Congress.[2] Prior to that, in early 2006, the *Outline of the National Programme for Medium- and Long-Term Science and Technology Development (2006-2020)* (State Council of the People's Republic of China, 2006) had been issued by the Ministry of Science and Technology of the People’s Republic of China (MOST). This identified energy and the environment as important areas of science and technology development, including the monitoring of global environmental change and the strengthening of research on response strategies to climate change. This sent strong signals to scientists, who prioritised these fields in their funding strategies, mainly for the natural sciences. CNCCP,[3] issued in 2007, indicated that China’s response to climate change had to rely on innovation in science and technology. In March 2007, MOST and 13 other governmental agencies – such as the National Development and Reform Commission (NDRC) – officially initiated *China’s Scientific and Technological Actions on Climate Change* (MOST et al., 2007).

Research policy and priorities

Since the early 1990s, through its efforts to implement the national science and technology programmes organised by MOST, and through international co-operation, China has achieved huge progress in climate change and related fields. These include basic scientific research on climate change; the impacts of climate change and adaptation measures; technological developments and applications to control greenhouse gas emissions; climate change mitigation; and analyses of the social and economic impacts of climate change. Social scientists mainly study strategies and policies related to mitigation, although they also do joint research in other fields, such as simulating emissions and growth scenarios, adaptation measures and technology application. The first *National Assessment Report on Climate Change* was published in 2006.

Scientific research infrastructure for climate change has been established, including monitoring networks and important state and sectoral laboratories for research on climate change. Some are run jointly by natural and social scientists. Many scientific instruments and facilities for climate change studies were developed independently or introduced from other countries. In the last two decades, China has established a core team of experts in social sciences, energy, meteorology, climatology, ecology, the environment and other cross-cutting disciplines, and has trained over a thousand research scientists who are now focusing on basic studies and application-oriented research on climate change. Natural scientists and social scientists – mainly environmental economists – work together closely.

China's Scientific and Technological Actions on Climate Change, formulated by MOST and 13 other ministries, state that research priorities for social scientists should include climate change and energy security strategies, the future international climate change framework, China's future energy development and greenhouse gas emission scenarios, the Clean Development Mechanism (CDM) and carbon trading systems, international commodity trade and greenhouse gas emissions, and science and technology responses to climate change. Government research funding mainly reflects these priorities, as does the number of articles published (see Figure 25.1 and Table 25.1). There have been few studies related to climate change in other disciplines besides economics, public management and environmental studies. Studies by scholars of law, sociology and political sciences have only appeared in recent years. Even economists have produced few studies on climate change at the microlevel, such as greenhouse gas scenarios involving behavioural sciences, as most of them prefer research on a macro and industry level. This is typical of policies which reflect the need and urgency common in developing countries but which are quite different from what happens in developed countries. Chinese social scientists beyond economics need to narrow this gap in future.

Funding for social science research on climate change

Research funding is one of the critical incentives that encourage and facilitate social science research on climate change and global environmental change. China has provided large-scale funding in this field. According to estimates (Luo and Zhou, 2008), the National Natural Science Foundation of China (NSFC) funded 506 projects related to climate change research between 1986 and 2007 and provided Chinese Yuan Renminbi 243 043 million for this activity (about USD 39 million).[4]

Unfortunately, similar statistics on funding for social science research on climate change do not exist. But it is clear that support from official funds for social science research is far less than for natural sciences. In addition, social science research is conducted separately from natural science research, although social and natural scientists are increasingly being encouraged to co-operate on a multidisciplinary level. Because funding in China is always more limited for social scientists, social scientists from different disciplines work on multidisciplinary projects together, rather than doing so with natural scientists.

Two major funds have been specially set up for social scientists, and can be seen as major initiators of social science research on climate change in China.

The first is the National Social Sciences Foundation of China (SSFC), which provides the most influential support for social science research. It supported 3 291 research projects in 2012 on all themes with a total of CNY 359.65 million (USD 57 million). The grant for each project is relatively low – CNY 80 000 to 250 000 (USD 12 700 to USD 39 700). In 2011, the average support for projects increased from CNY 100 000 to 150 000 (USD 16 000 to 24 000).

The SSFC only recently began to consider climate change as a key subject that urgently needs more support. According to the SSFC statistics, the number of climate-change-related projects that it supports has increased significantly over the past five years (see Table 25.2). It is clear that the distribution of grants to different disciplines has become more balanced, although most grants still go to scholars in economics, management and law. The SSFC has also encouraged some projects in sociology, politics and philosophy. Further examination of the projects reveals that more mainstream social scientists in China have become interested in climate change, although the number is still relatively low.

Table 25.2. **Number of climate-change-related projects supported by the National Social Sciences Foundation of China**

Year	2008	2009	2010	2011	2012	Total
Demography	0	0	2	2	1	5
Economics	5	9	29	27	25	95
History	0	0	1	1	1	3
International studies	2	3	0	4	1	10
Law	2	3	6	7	2	20
Linguistics	1	0	0	0	0	1
Management	0	0	9	11	4	24
Philosophy	0	0	1	2	0	3
Political science	0	0	1	1	0	2
Sociology	0	0	1	2	0	3
Total	11	15	50	59	34	169

Note: The categories here are based on the SSFC classification. The funding for climate change research as discussed in the text may not be related to the number of articles published as shown in Figure 25.1 and Table 25.1; many articles are published without any government or institutional support, and many projects have to publish more than one academic article.

Source: National Social Sciences Foundation of China, Inventories of Granted Research Projects, 2008-12, *www.npopss-cn.gov.cn*.

The SSFC's research priorities for the 12th Five-year Plan period (2011-15) focus on climate-change-related topics in disciplines such as economics (low-carbon economy, global political economy of climate change and China's strategy), demography (population and climate change) and international studies (the geopolitics of climate change, a low-carbon economy and the global development path).

The Ministry of Education's (MOE) Research Projects for the Humanities and Social Sciences is another important fund. This fund is only open to scholars at colleges and universities in China, and the average funding per project is only about CNY 50 000

(USD 8 000), much lower than the SSFC fund. According to SSFC statistics, researchers at colleges and universities contribute about 85% of social sciences research, so the MOE fund plays an important role in facilitating social sciences research on climate change. In 2012, it supported 4 476 projects in total, about a thousand more projects than the SSFC supported.

Of the 2012 projects, 84 related to climate change, an increase of 30% over the 64 projects in 2011. The number is still rather low, but support has increased sharply in the past few years: only two projects were related to climate change in 2007. More importantly, many involve multidisciplinary research. Crossdisciplinary, climate change-related research is therefore relatively more popular among academics. Nevertheless, economics, management and law still account for most research projects (see Table 25.3), which reflects the SSFC trend.

Table 25.3. **Number of research projects supported by the Ministry of Education's fund for research in the humanities and social sciences in China**

Year	2007	2011	2012	Total
Art	0	0	1	1
Economics	0	28	27	55
History	0	0	1	1
International studies	1	2	1	4
Law	0	7	5	12
Management	0	10	26	36
Multidisciplinary studies	0	15	22	37
Political science	0	0	0	0
Statistics	1	0	1	2
Sociology	0	2	0	2
Total	2	64	84	150

Source: Inventories of Research Projects in Humanities and Social Sciences, Ministry of Education (2007, 2011, 2012).

In addition, the Ministry of Finance and the NDRC set up the CDM Fund – with funds collected from CDM projects under the Kyoto Protocol – in August 2006. This fund also plays an important role in providing funds for research in fields such as CDM-related policy and mechanisms, carbon financing, international negotiations on climate change, and international co-operation. Social scientists have been involved in paving the way for designing and implementing CDM projects in China.

Support from international organisations and foundations is also important for social science research on climate change. The Ford Foundation, the World Wide Fund for Nature (WWF), the United States Energy Foundation and the British Embassy, for example, actively support climate-change-related social science research, including multidisciplinary research. Although it is difficult to evaluate whether this strategy is successful, most researchers seem to agree that there should be more researchers from different disciplines involved in social science research on climate change.

Furthermore, more and more universities and local academies now carry out self-funded research independently of government policy. With climate-change-related issues gradually becoming a mainstream field for social science research in China, and since all levels of government, enterprises and social organisations are paying more attention to related knowledge and participate in related policy debates, its social scientists will certainly play a more active role in this area.

Obstacles to further social science research

On a global scale, social science research on climate change is developing slowly and is lagging behind the natural sciences. The IPCC reports in 2007 called for more social science research on climate change, in particular on the evolution of human behaviour, on scenarios for how societies will develop in the future, and on other social science topics. There has also been little research on the interconnections between altered beliefs and values, changing social and economic structures, new behaviours, and socially and environmentally sustainable societies (Rogers and Norgaard, 2011).

In China, social scientists started working on climate change issues in the late 2000s. Most of this research is policy oriented, and is driven by government demand and official funding. Several institutions, such as Tsinghua University, the Chinese Academy of Social Sciences (CASS), the Energy Research Institute of the NDRC and the State Council's Development Research Centre, have led social science research on climate change. They have also contributed to decision-making at the national level. Other universities and local social science academies also provide suggestions for local government decision-making.

However, their research is mainly conducted for policy formulation and decision-making, and researchers usually lack the capability to formulate research questions or to undertake knowledge production. The Social Sciences Literature Press (once owned by CASS) translates and publishes a series of books on the relationship between climate change and society. Social scientists are therefore sufficiently aware of the topic to strengthen their research, and have started to catch up.

The research results and other information provided by environmental NGOs mostly appear in the media. Chinese media have identified climate change as an important topic with which to attract readers and journalists, and reporters are in contact with relevant social scientists for information on climate change.

Although it seems that more mainstream social scientists in China have begun to think about climate change research, progress is slow (Hua, 2011). Young scholars are willing and eager to undertake this research, but some senior researchers find it difficult. Training on climate change would help social scientists become more familiar with and involved in the topic. Some social scientists may also lack interest in climate change research and may be sceptical about its importance.

At the institutional level, many research organisations are not sufficiently qualified to manage or carry out climate change research. Many lack incentives, structures and appropriate scholars for interdisciplinary research. A shortage of qualified researchers might be the most prominent obstacle. Education and training opportunities are concentrated in a few cities such as Beijing and Shanghai; promotion opportunities for researchers involved in interdisciplinary research are also limited. However, several research centres with multidisciplinary teams have been set up in Nanjing and other cities, which will contribute to narrowing the gap. The 2010 peak in academic publications on climate change may be a positive signal that more authors from diverse institutions around China are becoming interested in the topic.

At the system level, more research should be encouraged in philosophy, sociology and political science, as the IPCC report also suggests. Under the current research system, there is, however, a lack of demand for social science research in these areas.

Notes

1. Calculated as units of energy per unit of global domestic product.
2. "The Scientific Outlook on Development, which puts people first and calls for comprehensive, balanced and sustainable development", *www.china.org.cn/english/congress/229162.htm*.
3. *http://en.ndrc.gov.cn/newsrelease/P020070604561191006823.pdf*.
4. Approximate exchange rates as of 14 May 2013.

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World Social Science Report 2013
Changing Global Environments

26. Social sciences in Japan after Fukushima

by
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Social sciences in Japan altered course after the earthquake, tsunami and nuclear accidents of March 2011 near Fukushima. This prompted new research trends, challenges and directions. Two years on, Japanese social science research is more interdisciplinary and includes work on critical global environmental change issues.

Introduction

Social sciences in Japan altered course as a direct response to the Great East Japan earthquake and the ensuing disasters.[1] Political, economic and societal changes have always influenced the direction and priorities of social research. In recent years, social scientists in Japan have focused on the fast economic growth since the Second World War, the past two decades of stagnation, the impacts of globalisation, rising multiculturalism, changing family relations, the ageing population, and historical issues with neighbouring countries.[2]

Prior to March 2011, an emphasis on climate change and global environmental change within academic communities and policy processes had already started to affect the social sciences. Before the earthquake, it was generally agreed that to fully understand the global, regional and local impacts of global environmental change, we need to examine the social and cultural roots of these changes as well as their political and economic impacts.

Social science research trends and policies

Social sciences in Japan have long been considered as a group of fields to be promoted and backed through various policy initiatives, given the dominant position of the natural sciences within the Japanese academic community. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) is responsible for educational and scientific policies. Three organisations work with MEXT to promote the social sciences: the Science Council of Japan (SCJ) represents the science community and provides the necessary scientific consultation; the Japan Science and Technology Agency (JST) works to foster science and technology policies and promote international co-operation by means of science communication in science and technology research; and the Japan Society for the Promotion of Science (JSPS) deals with research funds, theme-specific frames, and bilateral and multilateral international programmes.

General policies and strategies for science and technology are usually set in five-year plans. Until 2011, there was a continuation in the strategies and priorities set for the social and natural sciences. The *Third Science and Technology Basic Plan* of 2006 had identified demographic change as a top priority, alongside revitalising the economy, building a spiritually strong society and the capacity to face economic and social changes well into the future (MEXT, 2006). Sustainability was on the list of priorities but not at the top.

Critical issues on global environmental change and natural disasters

Social scientists in Japan – particularly those in environmental economics, environmental anthropology and area studies – have always worked on environmental issues. Indeed, Japanese research bodies have long accepted that human beings and the environment are inextricably linked. Many faculties and graduate schools at leading universities have developed global or integrated environmental studies programmes. Kyoto University has a graduate school for Global Environmental Studies with a multidisciplinary faculty; and the Graduate School of Environmental Studies at Tohoku University has a programme called Regional Environment and Socio-Cultural Studies where students with a social sciences background can work towards a degree in environmental studies. The Society for Environmental Economics and Policy Studies was founded in 1997, and the Japanese Association for Environmental Sociology in 1990.

Earthquake, tsunami and nuclear disaster

The earthquake in March 2011, the subsequent tsunami and the nuclear accidents they caused, affected Japanese society immensely. They also influenced Japan's science and technology policies heavily. The immediate reaction within the social sciences was to observe society more closely, especially in the disaster-stricken areas, and to carry out surveys on social adaptation, resilience and sustainability strategies in the local, regional and national political and economic structures. After March 2011, researchers in all the sciences started to pay more attention to environmental disasters and change, and were especially concerned about resilience, sustainability and future scenarios, as well as the coping mechanisms required to deal with natural or human-induced disasters.

The *Fourth Science and Technology Basic Plan* was approved by the Cabinet in August 2011 as an immediate reaction to the March 2011 disasters. To cope with the immense and complex realities of post-disaster social transformation in Japan, the new plan (MEXT, 2011, 2012a) focused on promoting the integration of science, technology and innovation (STI), on the role of human resources, and on implementing STI policies in accordance with society's needs.

Since then, issues of sustainability such as social innovation, reconstruction and resilience after disasters, green innovation, secure energy resources, sustainable climate and environmental change strategies, scientific and technological innovation, and medical services and nursing care, have become central to research strategies within the social sciences. After the triple disaster of 2011, people started to question the reliability of scientific data and their trust in scientific communities. Demand for more participatory research and better engagement of STI policies with stakeholders grew in policy circles.

This drastic shift within social science policy processes had immediate consequences for institutions promoting science. SCJ committees focusing on specific social science topics have been set up to examine issues needing immediate attention. The list of topics reveals the current research agenda's focus on the reality of environmental concern in Japan: the disposal of high-level radioactive waste, the design and implementation of Japan's economic policy, and dual-use issues in science and technology.[3] There is also pressure from the scientific authorities to direct the scientific community's attention towards societal issues. Social scientists are expected to be core members of new projects on the causes and impacts of environmental change, and to help prepare for possible future disasters. This will require further multidisciplinary and interdisciplinary research, and research collaboration across all science disciplines has been strongly encouraged in recent policy discussions by the science community.

Multidisciplinary and interdisciplinary research on environmental change

A re-evaluation of the contribution of social sciences to society was one of the first reactions to the triple disasters by the authorities and the scientific community. A recent MEXT report on the promotion of the humanities and social sciences presents the challenges: interdisciplinarity and scientific integration, promoting the integration of science and society, and acknowledging the impacts of globalisation and the need for international co-operation across the social sciences (MEXT, 2012a).

Interdisciplinarity is an effective means of involving the social sciences in the field of environmental science, where the natural sciences are dominant. Universities and research institutions with a multidisciplinary basis need to adopt more interdisciplinary research frameworks. The Research Institute of Economy, Trade and Industry, the National Institute for the Humanities, the National Institute for Environmental Studies, the National Institute of Science and Technology Policy, and the Research Institute of Science and Technology for Society all stress the need for the social sciences to be more involved in interdisciplinary research on climate and global environmental change issues. The SCJ committee on environmental studies and its subcommittees working on Future Earth processes are examples of this recognition.

Box 26.1. **Research Institute for Humanity and Nature (RIHN)**

The Research Institute for Humanity and Nature (RIHN) usually hosts around 12 large research projects running for up to five years. Each project includes 60 to 80 project members from Japan and abroad as core or collaborative members, experts on the project topic, and local collaborators. Projects are organised by a core management team and a project leader, and are implemented through working groups. Each working group might have a natural or social science specification, but the main hypothesis, research organisation and projected outcomes are expected to be produced by integrating all the groups' findings and discussions. For example, 51% of the research members of the "Global Warming and the Human–Nature Dimension in Siberia" project have backgrounds in anthropology, history, urban life or sociology (RIHN, 2013).

The research activities of some of these leading research institutions reveal the immediate results of MEXT's promotion of interdisciplinary environmental change research. For example, RIHN was established in 2001 as a funding and hosting institute to mobilise the Japanese science community to practise integrated environmental studies along interdisciplinary lines. Proposals for new research projects have to be interdisciplinary (involving academics with backgrounds in the natural and social sciences and the humanities) and must examine the impact of environmental change on human–nature interactions.

The National Institute for Environmental Studies works on natural science-related projects including environmental and earth system science. It now has sustainable social systems and policy programmes that introduce social science perspectives to the institute's research (NIES, 2009, 2013). This new interdisciplinary trend of involving social scientists has had consequences for training and for new educational and research programmes at universities. Global 30 is a programme initiated by MEXT to offer undergraduate and graduate degrees to international students at 13 selected universities in Japan. Of the 104 degree programmes, 38 are on environmental studies and 21 of these are interdisciplinary programmes combining courses from the natural and social science faculties (MEXT, 2012b).

A recent report by JSPS on its future vision emphasises the need for transdisciplinary research: social scientists need to co-operate with other researchers, business groups, government officers and other political entities (JSPS, 2012). JSPS now supports leading young social scientists to initiate their own interdisciplinary projects.[4]

Although there is a growing interest from policymakers and research organisations in environmental change research, and more support from funding agencies, the involvement of social scientists in interdisciplinary research will remain limited, unless the following measures are put in place:

- a significant increase in interdisciplinary research programmes
- improved mechanisms and programmes to welcome and integrate social scientists at research centres and universities more effectively
- better funding opportunities and special support mechanisms for social scientists willing to join interdisciplinary research projects
- training for young researchers, and steps to get them interested and involved in interdisciplinary research
- improved mechanisms to support international collaboration, and the involvement of Japanese social scientists in international research projects
- better evaluation mechanisms to improve the quality of interdisciplinary research and research findings (MEXT, 2012a).

After the 2011 disasters, a new public discourse emerged in Japan that stressed the importance of social sciences to society. This brought new challenges for social scientists: the emergence of new research issues to foster sustainable societies, the need to conduct new research on an interdisciplinary basis, and the mandate to develop and manage new degree and training programmes in interdisciplinary research. There is already a new momentum for more participatory, interdisciplinary and integrated research projects and educational programmes involving social and natural sciences. The impacts of these new challenges will soon be seen in the research results of future social scientists.

Notes

1. *www.jma.go.jp/jma/en/2011_Earthquake/Information_on_2011_Earthquake.html*.
2. A further analysis of the development of social sciences in Japan after the Second World War can be found in Brisson and Tachikawa (2010).
3. Other issue-centred committees are the Committee for Promotion of Area-Specific Quality Assurance of University Education, the Committee for Considering Measures for Fostering Future Generations in Science and Technology, the Committee for Evaluation of Academic Research and the Committee for the Professional Autonomy of Doctors (SCJ, 2012).
4. Via the Programme for Promotion of Humanities and Social Sciences to Satisfy Policy and Social Demands and the Funding Program for Next Generation World-Leading Researchers.

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27. Social science research on global environmental change in the Asia-Pacific region

by
John Beaton (for AASSREC)

Despite the many problems which global environmental change poses for the Asia-Pacific region, the social sciences have been slow to develop research on the issues it raises. New ways of working are starting to emerge, however, partly driven by the awareness that many Asia-Pacific populations are highly vulnerable to climate change, as the Association of Asian Social Science Research Councils (AASSREC) reports.

The Asia-Pacific region, as in other parts of the world, faces the possibility of huge environmental and climate change. Examples of its effects may include the disappearance of low-lying Indo-Pacific islands, flooding outwash from the Himalayas, and monsoonal destruction of low-lying agricultural and pastoral lands. These problems have already challenged citizens, nongovernmental organisations (NGOs), and local and national governments for generations, and are still at the top of social science agendas aiming to address poverty, food security, health problems, disaster recovery and other instabilities.

People living in the Asia-Pacific region frequently experience environmental disruption. Predictions of more climate variability and more powerful climatic events are of huge concern, especially as support for people's capacity to adapt and recover is barely met by national or even international assistance.

The Association of Asian Social Science Research Councils (AASSREC) represents the interests of social science disciplines for its member organisations throughout Asia and the western Pacific. Despite concerns over environmental and climate change, these issues have not yet been key topics for discussion at its biennial conferences, which focus instead on issues of long-standing and more immediate concern such as youth, migration, natural disasters (World Bank, 2013), and ageing.

However, AASSREC member organisations are involved in research on global environmental change to varying degrees depending on where they are based.[1] Just as natural sciences are increasingly focusing on environmental issues, social science research is also growing on issues related to the environment, including demography, urbanisation, poverty reduction, food security, migration and governance. Collaborative and multidisciplinary approaches acknowledge regional and global concerns, although the focus typically remains within national boundaries.

Recognising the need for broad, vertically articulated and horizontally integrated research, social scientists now seem less constrained within their disciplinary boundaries than in earlier times. The cross-cutting nature and global scale of global environmental change demands that social scientists work in new multidisciplinary, cross-sectoral ways, examining the problems from all disciplinary angles and perspectives.

There are signs that research governance in the Asia-Pacific region is heading in the right direction. Funding bodies are increasingly interested in integrated environmental research (Belmont Forum, n.d.). Institutional barriers, such as unrealistic research-quantum measurements for collaborators, seem to be lessening. This augurs well for the future.

Yet progress in Asia and the south Pacific is likely to be patchy and slow. The need for new ways of working will be a challenge for individual researchers, their institutions and governments. Funding is also a perennial challenge.

At the individual level researchers will need to alter their methods, perspectives and research language across disciplines and between the social and natural sciences.

Granting institutions and universities need to fully recognise multidisciplinary research.

Platforms are needed where social and natural scientists in a range of disciplines can discuss, plan and scope collaborative research opportunities before applying for funding, and for designing and implementing research projects.

Greater public and private support for international social science bodies could ensure strategic integrated collaboration to drive the type and scale of research needed.

Notes

1. For example see Marks (2011) and Brown (2012).

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The author is writing on behalf of the Association of Asian Social Science Research Councils (AASSREC).

Three Elephants, 2010 by Andries Botha
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Part 3
The consequences of global environmental change for society

World Social Science Report 2013
Changing Global Environments

28. The consequences of global environmental change

Introduction to Part 3

by
Diana Feliciano and Frans Berkhout

This section identifies current and future consequences of global environmental change events for people and communities, with special attention to the poorest and most vulnerable. Understanding how global environmental change events will impact on the different groups and sectors within societies is essential to improving current policy measures and to design effective solutions.

To many, "global environmental change" is still an impenetrable and distant concept, and projections of doom and gloom – however often repeated – fail to make it more meaningful. Yet droughts kill crops that undermine farmers' livelihoods. Storms wipe out homes that families have occupied for generations. Loss of species and land can mean loss of food, clean water, medicines, landscape, access to ancestral grounds, and essential income.

Social science research is essential to understand how changes in our water, air, climate, environment and oceans influence individuals and communities, organisations and businesses in society, through time and in very different social contexts around the world. Social science also plays a role in the development of responses that can build resilience and reduce risks and vulnerabilities for people. Parry, Canziani and Palutikof (2008) define resilience as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning; the capacity to adapt to stress and change. Climate change resilience requires flexibility, skills and capabilities, redundancy, collaborative multisector approaches, planning and foresight, diversity and decentralization and plans for failure (Parry et al., 2008). This combination of capacities and activities will reduce the risk of climate change affecting natural and human systems and regions, and the extent to which climate change may damage or harm a system. In other words, it will reduce the vulnerability of the system to new conditions.

Environmental and natural resource management, and hazard and disaster risk management, have long been studied by social scientists. They tell us that we cannot fully understand the risks and benefits that arise from the environment without understanding the role of people in causing, making sense of and responding to these risks and benefits. Nor is it possible to identify effective solutions without understanding social interactions and practices. To put this differently, the consequences of global environmental change will always remain unclear if we study the physical environment alone. Resilience is the capacity of people and ecosystems to cope with and respond to changes in their environment and the resources available to them. New risks may emerge through the interaction of social change with environmental changes.

The consequences of global environmental change

Part 3 looks at global environmental change around the world, including droughts in China (Zheng, Pan and Zhang) and North Africa (Bédrani and Benhassine), floods in Nigeria (Oluwatayo), biodiversity loss (Cortes and D'Antona), coral reef bleaching (Abdullah), and extreme events and disasters more generally (Silbereisen, van Ijzendoorn and Zhang). These contributions illustrate how the consequences of climate and environmental change for society can be direct or indirect. Direct impacts often entail familiar, but more frequent or severe, hazards, but may also involve challenges that are new, at least in the affected region. Indirect impacts include changes to underlying biophysical systems which generate benefits to society (so-called ecosystem services) and which form the basis for social and economic activities. By exploring these linkages in social-ecological systems, the social sciences offer essential contributions to our understanding of vulnerability, impacts and resilience, people's capacity to cope and respond to risk and change.

The perpetual challenge: The social basis and context of risk

Contemporary analysis of the impacts of climate and environmental change is concerned with the factors that underpin risk, vulnerability and human resilience, and how these are perceived, framed and managed in different social contexts. In the quest for more reliable interventions to reduce risk and vulnerability, many researchers attempt to define them absolutely, for instance as a basis for standard setting. Such studies often use relatively common, geo-referenced socio-demographic information to identify the most vulnerable groups. Others contend that such data are inconclusive, and instead focus greater attention on the extent to which risk, vulnerability and resilience are shaped by the social relations and the social context in which they emerge.

Two contributions illustrate the first approach. Zheng, Pan and Zhang develop a vulnerability assessment for rural communities to measure the vulnerability of a community in China, and find it a useful index to guide policy interventions. Similarly, Oluwatayo measures households' vulnerability to floods in relation to social parameters such as household size and income level, as climate change contributes to an increased frequency of these events. Ahmed's contribution, by contrast, illustrates the second approach with a focus on social capital, which is considered a good predictor of risk and resilience by many. In this case study of Dhaka, Bangladesh, a metropolitan area with more than 10 million people, the research shows how limited social capital is contributing to the low resilience of residents as natural hazards increase as a result of climate and global environmental change. Developing vulnerability indicators for urban areas is highly relevant considering that the great majority of the world's future population growth is predicted to take place in cities and urban landscapes. The United Nations (2006) estimates a global increase of 2.9 billion urban residents to 5 billion by 2030, with most of this growth occurring in Africa and Asia. The impacts of climate change on cities already affected by poverty, pollution and disease are currently threatening quality of life and economic and social development in urban areas. UN-Habitat (2011) argues that urban areas have a pivotal role in both climate change mitigation and adaptation, through for example the adoption of changes in transportation, land-use patterns, and production and consumption patterns of people living in cities.

The ways in which social and environmental factors interact to create risk, vulnerability and resilience are specific to place and context. Social and economic change itself is often an important driver of vulnerability and resilience, with climate and environmental change playing not a leading but a reinforcing role. Because of societies' variable social basis and because climate and environmental change is not uniform, risk, vulnerability and resilience are highly differentiated over social, spatial and temporal scales. It remains difficult for scientists to aggregate countless case studies into overarching conclusions, just as it remains problematic for policymakers to design effective context-sensitive interventions on the basis of overall indicators of risk, vulnerability or resilience, globalising risk, vulnerability or resilience indicators.

The crucial role of resilience

Resilience and adaptive capacity are always present to some extent even in the least well-resourced groups and societies. They enable them to respond to environmental risks and vulnerabilities, and to adapt to change. Depending on their level of available human, social, natural and financial capital, such responses can involve a portfolio of strategies. They might include resource sharing (informal and formal), self-organisation and co-operation to manage risk, market mechanisms such as insurance, the development of social norms and public policies (rule setting, distributive policies and information provision), and other forms of managing or living with risk, such as migration. Since the distribution of risks and the capacity to cope with risk are uneven, they are the subject of debate at all levels of social organisation. Differential responsive capacity also raises many questions of rights, responsibilities, governance and equity, with a range of principles and approaches being suggested for handling them (see Parts 5 and 6).

A theme of Part 3 is the importance of people's choices in their responses to climate change, their capacities to moderate their experience of these hazards, and how environmental change can itself impinge on people's ability to respond. Adger and Adams suggest that environmental change affects patterns of migration because it influences the location and mix of economic activities. They also argue that migration could mitigate risks associated with global environmental change through the changed spatial organisation of economic activities internationally. However, for Baldwin and Gemenne vulnerable populations do not have the resources, networks or information needed to migrate, and are trapped; exposed to the consequences of global environmental and climate change. Abdullah points out that in the case of coral reef degradation, the populations of countries with high levels of economic development have greater adaptive capacity to deal with the problem than those with fewer resources.

Keskitalo emphasises that adaptation is most needed and cost-effective where risks associated with climate change result in economic vulnerability, even in the short term. Silbereisen, van Ijzendoorn and Zhang argue that children's vulnerability to disasters is not only directly influenced by exposure and greater sensitivity, but also indirectly by an extreme event's impact on parental care, as well as by genetic factors influencing children's resilience. Turmoil in a disaster-affected region is translated into a range of adversities experienced by victims, such as the breakdown of established family relationships and routines. Chimanikire shows that Zimbabwean women in rural areas are more vulnerable to the effects of climate change than men, as they provide water and fuel for cooking. Reduced rainfall means they have to walk farther to collect these resources. However, women can also be active agents of change, as they possess unique knowledge and adaptation skills (see also Agarwal, Part 1). Farmers and indigenous peoples in the Amazonian region are also adapting by re-learning how to predict the weather by observing modifications in animal behaviour due to weather changes (Mesquita). These cases illustrate the universal and flexible interaction of people with nature as vulnerability and resilience are socially constructed and lived.

The contribution of social science research

Social science research is essential for understanding the risks, vulnerabilities and social response capacity in light of climate and global environmental change. Social science researchers can translate indigenous knowledge to decision-makers (Mesquita), establish how the equity and identity dimensions of climate change-induced migration intersect with wider issues of ethnicity, gender and age (Baldwin and Gemenne), and reveal the links between human migration and environmental change (Adger and Adams). Social science researchers can also provide adaptation and disaster response guidelines (Oluwatayo; Silbereisen, van Ijzendoorn and Zhang), help create collaborative resiliency and adaptive capacity (Ahmed), help understand strategies for marine ecosystems by accounting for their resiliency (Abdullah), or create indicators of vulnerability to climate change (Zheng, Pan and Zhang).

A century and a half after George Perkins Marsh's seminal work on how people shape, and are shaped by, their environment, and more than six decades after Gilbert White's foundational work on the social dimensions of hazards and risk, the all-too-real and emerging consequences of environmental change bring home in tangible experiences what we all now must grapple with. We are responsible for the consequences of climate change, now we have to find a way of mitigating the impacts. With more than 7 billion of us having the economic and technological power to alter the planet, the social sciences have the task of untangling the complex, multi-scale and dynamic processes. Processes whereby people in one part of the world suffer the consequences of climate change due to the behaviour of people in another part of the world.

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29. Are Algerian agro-pastoralists adapting to climate change?

by
Slimane Bédrani and Mohamed El Amine Benhassine

Climate change in Algeria has led to increasing drought and erosion, damaging the livelihoods of agro-pastoralists trying to eke out a living on the steppe. In trying to adapt, herders have altered their traditional practices and behaviour over the years. Government policies – mainly subsidies – have had largely negative consequences. This is a good example of maladaptation.

Introduction

The Algerian steppe, which covers about 300 000 km^2 with 100 to 400 mm per year of rain (MARA, 1974), is pastoral feeding ground for 15 to 23 million livestock animals. It has experienced recurrent droughts since the 1970s and is highly exposed to wind and water erosion, mainly as a result of overgrazing and unregulated land clearing. Agro-pastoralists have had to change their farming practices to adapt to these increasing droughts. Their changed practices are not entirely because of climate change, however; they may be related to altered consumption patterns and to government policies regarding subsidies. This article explores Algerian agro-pastoralists' perceptions of climate change, whether they have changed their behaviour to adapt to climate change and other contextual changes, and the different types of behaviour they exhibit.

Methods

A survey was undertaken at the weekly livestock markets in the northern province of Laghouat during the summer of 2011. Approximately 600 agro-pastoralists from the 12 isolated communities in this region agreed to answer the questionnaire. An agro-pastoralist typology was created with the logistical tool *STATISTICA 8* by means of the principal component analysis method. Three criteria were selected, each with a significant weight in the correlation analysis of the quantitative and qualitative variables: herd size, the size of the tilled area and the size of the areas used for grazing.

Four types of agro-pastoralists were identified (see Table 29.1).

Table 29.1. **Characteristics of the average holdings of a sample of pastoralists in rural Algeria, per agro-pastoralist type**

	Number of agro-pastoralists	Herd size (number)	Tilled area (ha)	Grazing areas (ha)
Type 1	416	16	44	67
Type 2	138	33	91	176
Type 3	34	32	109	562
Type 4	12	38	55	2 000
Total	600	22	58	159

Perceptions of climate change

About 55% of the respondents had heard about climate change and knew what it is about. Of these, 70% had heard about it on the radio. Those who had heard about climate change saw it as lack of rain, higher temperatures, more frequent sand storms, sand accumulations and a decrease in the land cover. About 88% added that climate changes had led to a lack of water in freshwater springs and wadis.[1]

Changes over the last 60 years

Several changes, which are not all related to climate change, have occurred over the last 60 years and increased pressure on the land:

- Population density has increased, which, combined with weak job creation in the non-agricultural sectors, has put pressure on the land.
- The increase in purchasing power due to the wide-scale redistribution of oil revenues – mainly to city dwellers – has led to an increase in the demand for lamb, the most popular meat for festive purposes in Algeria.
- Government policy has maintained free-to-harvest natural fodder units on state grazing land, which has led urban investors to invest in extensive sheep farming. This has resulted in an increase in livestock and, consequently, in overgrazing.
- Various government subsidy schemes, aimed at maintaining livestock numbers, have also led agro-pastoralists to change their practices.

Changing practices of different agro-pastoralists

There have been various changes in farming practices. The reaction of some agro-pastoralists to increasingly frequent droughts, which have caused a decrease in the vegetation-covered area, is – if they can afford it – to increase the size of the areas previously used for grazing and clear them to produce cereals (Bédrani, 1995). The questionnaire shows that 45% of the agro-pastoralists cultivate a broader area now than they did before. Only 30% of the respondents said they cultivated a smaller area, probably because of the impact of soil erosion on the available areas of arable land.

Most respondents (95%) said that the land supports fewer cattle than it did in the 1960s: of the respondents, 52% – mostly small-scale agro-pastoralists – reported having fewer sheep than before. Nevertheless, 28% mentioned that they owned more sheep and, of these, 67% were large-scale agro-pastoralists (type 4). The growing demand for meat and the state policy of providing low-price fodder during periods of scarcity could explain this anomaly.

Sheep fattening was traditionally undertaken in the north of the country, but 16% of the respondents now buy fodder to fatten their sheep directly on the steppe. This new fattening practice started in the 1980s and 1990s, when the state started to import and distribute livestock feed at subsidised rates or at prices much below market prices.

Irrigation is another new agro-pastoralist practice on the Algerian steppe. About 37% of the respondents irrigated their land. Although droughts have been frequent since the 1970s, about 79% of those who are currently irrigating only started doing so in the 2000s, when the state started to subsidise irrigation. Only 12% of those who irrigate the land produce fodder to feed their own animals. It has become more profitable for agro-pastoralists to produce vegetables than fodder, as buying imported fodder is less expensive.

Livestock feeding methods have also changed: of the respondents, 40% reported supplementing their cattle's yearly regimen with bought fodder rather than with grazing as they had done before. Of the agro-pastoralists, 60% said they only resorted to imported fodder in bad years.

Since the 1960s, the most relevant change in farming management has been the decrease in transhumance. In the 1960s, about 65% of the agro-pastoralists practised transhumance, but in 2011 only 22% did so. These were mainly small and medium-scale agro-pastoralists. This change is causing overgrazing, as the pastures now support sheep all year round.

Poor agro-pastoralists are abandoning cattle breeding along with their nomadic lifestyle. To mitigate the negative effects of frequent droughts, the poorest agro-pastoralists herd the cattle of others in exchange for wages. Of the respondents, 29% reported doing this, most of whom (76%) were small-scale agro-pastoralists. Of these, 44% had been doing so since the 1960s and 1970s, with only 9% starting after the 1990s and in the 2000s. Herding the cattle of others is therefore a traditional practice that is slowly decreasing in popularity as the poorest agro-pastoralists are increasingly settling down.

Conclusion

Most of the survey respondents appeared to know about climate change and its consequences for their land and livelihoods. In response to increased droughts, they have been altering their approaches to managing their herds, by increasing the area of cleared pasture and their herd size, buying more subsidised imported fodder and decreasing transhumance. It is nevertheless difficult to say to what extent these new herd-managing practices follow from climate change, or from other processes and contextual changes.

Increased irrigation and subsidies have not resulted in increased fodder production, which might have reduced overgrazing. These strategies have led to an increase in wind and water erosion and a decrease in vegetation or land cover on the steppe. Government measures and subsidy policies have not only failed to achieve what they were supposed to, but have to some extent exacerbated the situation. These maladaptation strategies are unlikely to lead to the sustainability of pastures and livestock, as Barnett and O'Neill (2010) point out.

To reverse this trend and ensure sustainable conservation of the Algerian steppe, the government needs to abandon its undifferentiated policy of supporting fodder production, and instead target the poorest agro-pastoralists. It should also require the large agro-pastoralists, who are primarily urban investors, to pay for the use of natural pasture. In addition, such a "grazing tax" would allow the government to invest more in effective policies to conserve grazing land.

Finally, participatory research methods are needed to design and experiment with sustainable rangeland management, while increasing the income of the poorest agro-pastoralists.

Notes

1. A valley, gully or streambed that remains dry except during the rainy season.

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30. Relocation as a policy response to climate change vulnerability in northern China

by
Yan Zheng, Jiahua Pan and Xiaoyu Zhang

Taking the Ningxia Autonomous Region in China as an example, and applying participatory social research, this article assesses the important determinants of vulnerability to climate change in rural communities and the relative degree of spatial vulnerability. Over the past decades, rural households have undertaken self-initiated adaptation, while the local government is in the process of permanently relocating some inhabitants to less vulnerable regions.

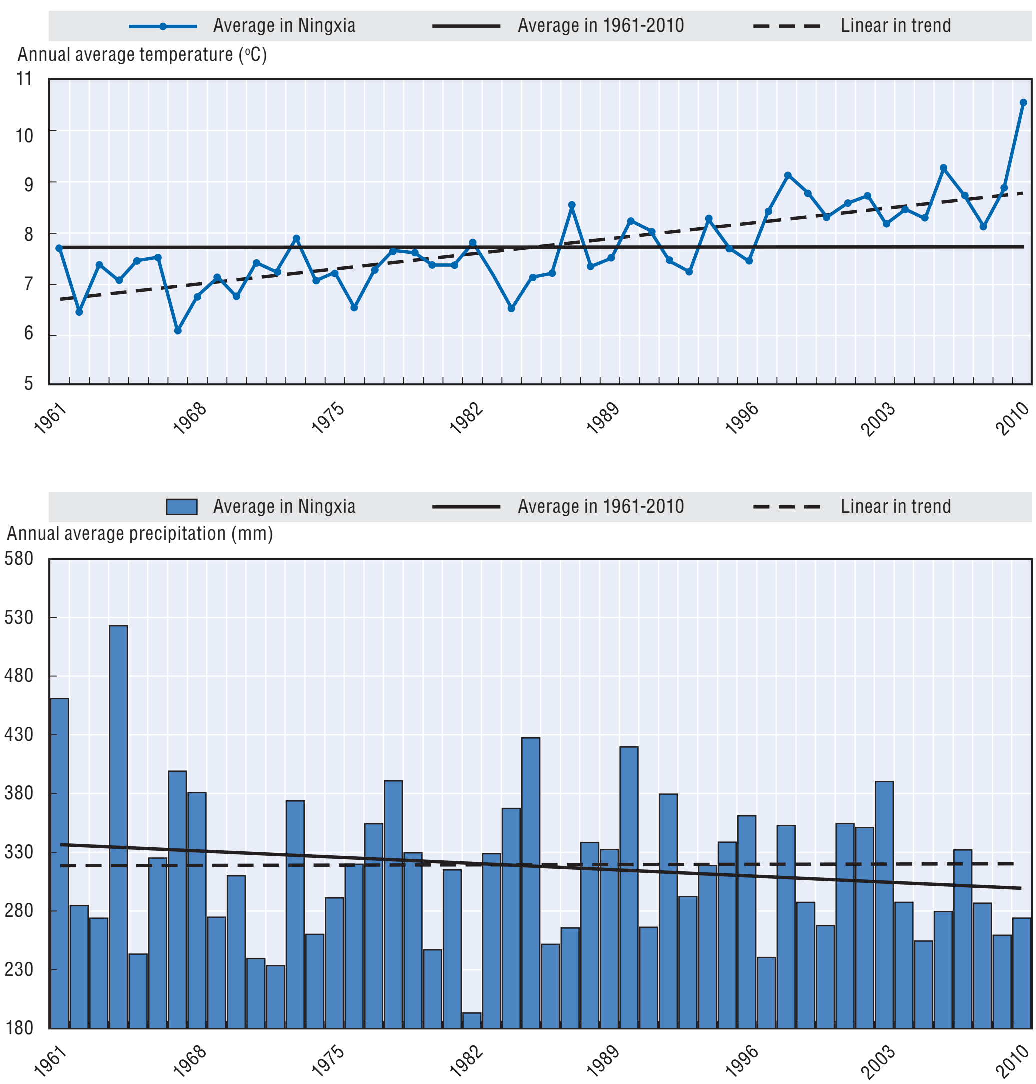
Introduction

The severity of climate change impacts depends on the level of exposure and vulnerability (IPCC, 2012). In China, poverty-stricken areas are ecologically fragile and therefore prone to such risks (Xu and Ju, 2009).[1] These underdeveloped areas have to deal with a "development deficit" and an "adaptation deficit" (Pan, Zheng and Markandya, 2011).

With an annual average precipitation below 400 mm, the Ningxia Autonomous Region is situated in the arid and semi-arid north-western part of China. Except for the narrow areas along both banks of the Yellow River, 80% of the land suffers from ecological fragility and desertification. Topographically, Ningxia is divided into three subregions: the Northern Yellow River Irrigation Region, the Central Semi-Arid Region and the Southern Arid Mountainous Region. Ningxia is one of the poorest provinces in China, with a per capita gross domestic product of USD 3 800 and a rural income of USD 535 per capita in 2010. Of the 6.33 million residents in 2010, 3.37 million lived in rural areas.

In the past decades, Ningxia has experienced a noticeable warming trend and declining rainfall (see Figure 30.1), which are consistent with the overall characteristics of global climate change. Rainfall has decreased by 5.5 mm every ten years, and by 12.6 mm every ten years in the central arid area (Zhang et al., 2012). An increase in temperature exacerbates the reduced rainfall further, intensifying water scarcity, and leads to more frequent droughts and land degradation. The livelihood of the rural community in Ningxia has become increasingly unsustainable, leading people to relocate to better areas (Li et al., 2008; Sjögersten et al., 2013).

Figure 30.1. **Variation in annual temperature and precipitation in Ningxia, 1961 to 2010**



Source: X. Y. Zhang et al., 2012

Vulnerability assessment of the Ningxia rural community

Vulnerability is “a propensity or predisposition to be adversely affected”, depending on economic, social, geographic, institutional, and environmental factors (IPCC, 2012). A vulnerability assessment is widely used to address climate change impacts, to identify risks and to support policy-making (Adger, 2006; Patt et al., 2011; Preston, Yuen and Westaway, 2011).

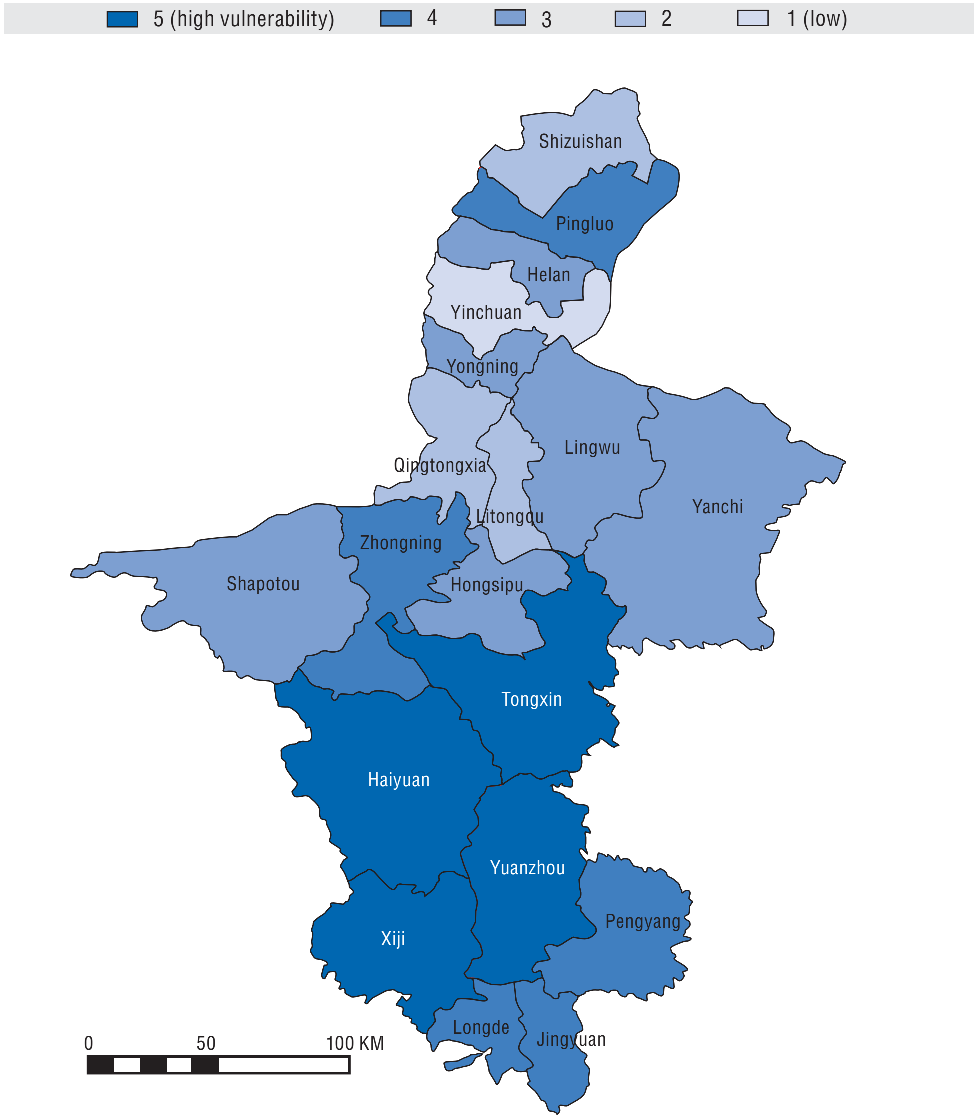
To understand the complex causes of environmental change in Ningxia’s rural community, an integrated vulnerability assessment for rural communities (VARC) was designed. This was used to gather and assess qualitative and quantitative information, and consisted of a three-step process. First, a conceptual framework, which includes the physical, ecological, social, livelihood and institutional dimensions of vulnerability, was developed using the Sustainable Livelihood approach (Chambers and Conway, 1992)[2] to identify the most important determinants. This framework was used during field visits to survey more than 300 farmers from 15 villages in seven counties. Qualitative and quantitative data were obtained from stakeholder meetings with local officials, group interviews with villagers, a questionnaire survey, and visits to rural households. Second, the relative weight of each vulnerability dimension was quantified at a stakeholder meeting in Ningxia.[3] The important indicators were identified by means of a literature review, an expert evaluation, and statistical analysis (Table 30.1). The third step was to quantify the VARC Index at the county level and to visualise the results on a map (see Figure 30.2).[4]

Table 30.1. **Determinants and indicators to understand the vulnerability of the Ningxia rural community to climate change**

Dimensions (weights/importance)	Determinants	Indicators
Physical vulnerability (0.20)	• Water accessibility • Transport facilities • Communication	• Tap water coverage rate in villages[1] • Bus route coverage rate in villages[1] • Mobile phone users per 1 000 rural households[1]
Ecological vulnerability (0.27)	• Ecological sensitivity • Water resources availability • Climatic disasters	• Ecological sensitivity index[2] • Water resources per capita[2] • Climate-related disasters index[2]
Livelihood vulnerability (0.165)	• Climate-dependent livelihood • Livelihood diversity	• Farming-based income[1] • Percentage of migrant workers[3]
Social vulnerability (0.175)	• Health • Education • Public medical service	• Mortality rate[1] • Illiteracy rate[3] • Number of doctors per 1 000 people[1]
Institutional vulnerability (0.18)	• Financial support	• Financial expenditure per capita[1]

Sources: 1 Ningxia Statistical Yearbook 2010; 2 Ningxia Ecological Planning Office 2012; 3 Ningxia Social Survey Data 2010.

Figure 30.2. **Ningxia rural community vulnerability mapping**



Policy implications

The results indicate that the central and southern parts of Ningxia have a high level of vulnerability. The regions are ecologically vulnerable, as evidenced by climatic disasters (drought, flooding, freezing weather and so on), desertification and a low level of per capita freshwater resources. The northern counties, which have easier access to water from the Yellow River, are much less vulnerable to drought and water scarcity. Rural communities in the mountainous areas are more vulnerable because of more climatic hazards, poor crop yields, shortage of freshwater supply and public transport infrastructure. The findings also show that poverty is closely linked to an area's ecological status, and also to social indicators, such as higher illiteracy, birth and mortality rates, inadequate public medical services and less financial support.

On the basis of Providing Regional Climates for Impacts Studies (PRECIS) modelling, it is projected that the surface runoff in the middle and southern areas of Ningxia will decrease at a rate of 1-2% and 8-16% respectively between 2020 and 2040, compared with a benchmark of the annual average surface runoff between 1961 and 1990 (Fang, Yang and Chen, 2012). It is also clear that the livelihoods of the rural population will deteriorate because of variations in temperature and precipitation and through other climate extremes in the future.

Relocation planning has become an effective adaptation policy option to reduce climate-induced vulnerability and poverty. Based on group interviews of rural communities in the southern counties, many farmers had to seek seasonal jobs in urban areas to supplement family income in the severe drought years. However, this situation has become routine practice in many middle and southern rural communities in the past decade because of increasing frequency of drought and unsteady crop yields. In the southern mountains, 35.4% of households in rural communities are migrant workers, while the rate in the northern plain area is only 28% (Ningxia Provincial Bureau of Statistics, 2010a). The Ningxia government helped 786 000 rural people living in the central and southern arid areas to resettle in regions with better access to water between 1983 and 2010 (see Table 30.2). Another 346 000 rural people will be moved out of the vulnerable areas (NXDRC, 2010). The four most vulnerable counties (VI=5) in Figure 30.2 (Haiyuan, Xiji, Yuanzhou and Tongxin) are also the top four priority counties in the new relocation plan. This indicates that the government has already identified the link between climate change adaptation and migration.

Table 30.2. **Stages of Ningxia government-sponsored relocation projects since the 1980s**

Stage/period	Number of rural people relocated	Responsible agency	Objectives or concerns
Stage1: 1983-1997	198 000	Poverty Alleviation Office	Poverty alleviation
Stage 2: 1998-2000	301 000	Yellow River Diversion Irrigation Project Office NX Water Bureau	Development project, poverty alleviation
Stage 3: 2001-10	286 800	Relocation Office NXDRC	Development project, poverty alleviation, ecological restoration
Stage 4: 2011-15	346 000	Relocation Office NXDRC	Poverty alleviation, ecological restoration, adaptation to climate change

Source: Adapted from J. S. Zhang et al. (2012)

Conclusion

Water availability, ecological degradation and poverty demonstrate the connections between climate change and the vulnerability of rural livelihoods in arid areas. In climatically constrained areas, relocation to reduce people's exposure to climatic extremes in the most vulnerable areas is the best form of adaptation. The local government relocation schemes implemented over the past decades have proved this in Ningxia. Future relocation plans have to be based on future climate trends with evidence from vulnerability and risk assessments.

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Notes

1. According to the Ministry of Environmental Protection, 95% of people in absolute poverty (annual expenditure income per capita of rural households below national poverty line at RMB 785) were living in ecologically vulnerable and degraded areas in 2005.
2. The components of well-being, which include physical capital, economic capital, natural capital, social capital and financial capital, are used to evaluate sustainable livelihood.
3. This meeting was attended by representatives from the Ningxia Development and Reform Committee, the Ningxia Ecological Planning Office, the Ningxia Agro-livestock Agency, the Ningxia Education Bureau, the Ningxia Forestry Bureau, the Ningxia Poverty Alleviation Office, the Ningxia Water Resources Bureau, the Ningxia Meteorological Bureau, the Ningxia Economic Development Research Centre, the Ningxia Meteorological Science Institute and other bodies.
4. Weights mean the relative importance of each dimension in terms of the integrated VARC Index. The indicators were selected to reflect all the determinants indicated as the most important driving factors in each dimension. The VARC Index = $V = \sum_{1}^{5} \text{weights} * \{\frac{1}{n}\sum_{1}^{n} \textit{indicator.index}\}$.

   The formula of each Indicator Index is: $x_{ij}^{*} = \dfrac{x_{ij} - \min\limits_{1\le i\le n}\{X_{ij}\}}{\max\limits_{1\le i\le n}\{X_{ij}\} - \min\limits_{1\le i\le n}\{X_{ij}\}}$.

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World Social Science Report 2013
Changing Global Environments

31. Climate change, flooding and economic well-being in Nigerian cities

by
Isaac B. Oluwatayo

Climate-induced flooding has a severe effect on the livelihoods and economic well-being of households in urban Nigeria. Data from 350 households in urban Nigeria reveals that education levels, household size, poverty, membership of co-operatives and distance from canals are important determinants of vulnerability. Education and information sharing are two important ways to help households face or reduce climate-induced risk.

Introduction

The intensity and frequency of natural disasters such as flooding and landslides have been increasing for several decades. This has resulted in loss of life, damage to property and destruction of the environment. The number of people at risk from natural disasters in developing countries has continued to increase because of increasing poverty and limited income opportunities (ISDR, 2004).

Poor people, according to Grunfest (1995), have become more vulnerable to natural disasters because they live in hazardous areas such as slums, flood plains and steep hills. They have fewer resources to cope with such shocks and to reduce the losses they cause, which in turn makes them even more vulnerable. They are also less likely to receive warning signals because of their poor access to basic weather information and infrastructures.

Nigerian cities have a long history of flooding (Odemerho, 1988), with devastating effects on lives and properties. Urban Nigeria is particularly vulnerable to climate change and flooding because of its geography, the increasing influx of people and the inadequate capacity of its drainage facilities. Changes in its ecosystem, resulting from soil being replaced with concrete and from the deforestation of hillsides, have led to increased runoff of water, increased erosion and the silting up of drainage channels (Adedeji, Odufuwa and Adebayo, 2012). According to ActionAid (2006), flood hazards are natural phenomena, but damage and losses from floods are the consequences of human activities.

Nigeria has a 5.5% annual urbanisation rate (Babanyara, Usman and Saleh, 2010), which, together with the increasing rural–urban drift, means that its cities face serious problems in relation to the changing climate (Adefolalu, 2007; Gupta, 2007). It is therefore important to examine the impact of climate-induced flooding on the livelihood, security and economic well-being of Nigeria's urban dwellers.

Household vulnerability to flooding

Climate change leads to dangerous increases in sea levels that threaten many urban coastal areas (Dodman, 2009). This risk is exacerbated because in an urbanising environment like Nigeria, the land's ability to absorb water is reduced by the replacement of ground cover with water-resistant urban surfaces (Odemerho, 1988). According to the UN International Strategy for Disaster Reduction (ISDR) (2009), urbanisation and a lack of good local governance are the main causes of urban flooding.

The findings presented in this article are based on data collected from a random sample of 350 households in two cities in Nigeria, Ado-Ekiti and Ibadan. The survey covered 130 households in Ado-Ekiti and 220 in Ibadan, where there are more residents. Analysis of the data revealed that flooding had been reported in these cities, especially within the past two years, with devastating effects on the inhabitants' well-being. Artisans in Ado-Ekiti and Ibadan lost an average of NGN 81 070.29 (Nigerian nairas; USD 529) and NGN 273 000.55 (USD 1 750) respectively to flooding. Farming households in the two cities lost an estimated NGN 125 210.67 (USD 816) and NGN 105 321.08 (USD 675) respectively. These disparities indicate the relative importance of these types of livelihood in the study area. Besides climate change making the weather less predictable, rains more uncertain and heavy storms more likely (ActionAid, 2006; Darteh, 2010), notable contributors to flooding include blocked drains, poor channelling of water, building along waterways, uncontrolled deforestation (because of the high cost of cooking fuel), the poor economic circumstances of residents, and reservation areas or forest belts being turned into event and recreation centres. All this leads to flooding, which has led to the loss of livelihood opportunities, wastage, and the destruction of lives and properties.

Once the causes of household vulnerability to flooding had been determined (measured by the difference in their income before and after the shock), the results of the statistical analysis (in the form of a Tobit model[1]) revealed the following aspects as important:

- level of education attained
- household size
- poverty (expenditure below two-thirds of mean per capita expenditure)
- membership of co-operatives
- awareness of and distance from canals.

The coefficients for education, membership of co-operatives and awareness were negative, meaning they reduce household vulnerability to climate-induced flood risk as they enable respondents to prepare for it. Poverty, household size and the distance of their homes from canals were positive, so that these increase household vulnerability.

Conclusion and recommendations

Climate-induced flooding is a major environmental challenge for urban Nigeria and for other countries in sub-Saharan Africa. Nigerian cities are particularly vulnerable because of their geography and their poor infrastructure, which can no longer cope with the increasing influx of rural people. The deteriorating economic situation has made matters worse for many urban dwellers, with negative consequences for their livelihood, security and economic well-being.

The government and other relevant agencies need to provide residents in high-risk areas with information on climate change and flooding patterns to allow them to prepare properly and take preventive measures to reduce, or at least mitigate, the negative impacts of climate change. In particular:

- Local and state governments need to build the capacity of urban Nigeria's residents to understand and interpret simple weather forecasts. This will make them more active in managing or at least mitigating the negative impacts of climate change. This would in turn translate into improved standards of living.
- Urban dwellers should be encouraged to form or join co-operative societies which can help provide up-to-date information on the weather and on risk sharing, especially in the absence of accessible social protection or social safety nets.
- Urban residents should be constantly sensitised to the dangers of blocking waterways and dumping refuse in streams and water bodies. The government and relevant agencies should enforce and prioritise the rules and regulations governing urban planning and construction work to curb indiscriminate building of houses, shops and kiosks along waterways.

Note

1. A Tobit model is an econometric model in which the dependent variable is censored; in the original model of Tobin (1958), for example, the dependent variable was expenditures on durables, and the censoring occurs because values below zero are not observed.

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32. Resilience and adaptation in Dhaka, Bangladesh

by
Saleh Ahmed

Megacities in the South are particularly at risk from climate change. They are poor, with weak social and physical infrastructures that can barely cope with the negative effects of climate change, including migration. Collaborative resilience and the social and physical capacity to adapt are at the heart of human survival strategies. What Dhaka needs are flexible institutions, good governance and transparency, and strong social systems and networks.

Background

Poorer countries are often dependent on foreign aid. Their political structures and economic stability may be weak, their populations huge, illiteracy common and their institutional and financial capacity feeble. Megacities – those with more than 10 million inhabitants – often face similar challenges.

Dhaka has 15.4 million inhabitants. By 2025, it is likely to be the world's eighth largest city with a population of nearly 23 million (United Nations, 2011). The city authorities cannot provide essential urban services, such as housing and water, to most of its poor citizens. Climate change will worsen the situation. Migration into the city will increase, putting even more pressure on Dhaka's capacity to provide urban services. Increasingly common urban climate events, such as flooding or increased summer temperatures, will strain its infrastructure further.

How many people will migrate as a result of climate change is not known, but most of those who come to Dhaka will originate from the southern coastal region of Bangladesh, where people are already heavily exposed to extreme climate events. Climate change impacts will often be felt beyond the city limits. For example, rising sea levels, increased water salinity and riverbank erosion are likely to affect 25-35% of southern Bangladesh. Many people will have no choice but to become climate refugees.

People's experience of climate change will be different in northern Bangladesh, where the inhabitants are likely to see increased desertification and riverbank erosion. These changes are already happening.

Most migrants are likely to head for Dhaka, seen as a beacon of hope with livelihood opportunities. Part of the reason is that effective decentralisation has never happened. The state has also failed to create opportunities in education, rural employment, health and industrialisation across the country.

The migrants will need places to live, means to earn a living, and opportunities to progress. In the absence of adequate urban services and employment opportunities, concerns that social structures and infrastructure will collapse are real. Climate challenges are thus important for local people. In this context, interdisciplinary, multidisciplinary and transdisciplinary thinking and research are necessary. They need to focus on how Dhaka can become resilient and develop capacity to adapt despite the region's lack of financial, social and institutional ability to do so.

Resiliency, adaptation and adaptive capacity

The climate crises experienced in the megacities of the developing world are complex. A transformational approach is needed rather than mere recovery. Resiliency, adaptation and the capacity to adapt form the core of survival mechanisms.

Resiliency is the capacity of a system to retain its function, its structures or the core values of its major features upon experiencing shocks (Walker et al., 2006). It is the ability to bounce back following a human-made or natural crisis and to learn to adapt to reduce future risks and vulnerabilities (Bojorquez-Tapia and Eakin, 2012). Resiliency is strongly linked to adaptation, the ability of a system to cope better with change or stress (Smit and Wandel, 2006). The adaptive capacity of megacities such as Dhaka depends largely on their governance and financial capacities. Adaptation requires financial commitment and good governance, above all. Furthermore, social capital, engaged civil society and social innovations can play critical roles in enhancing adaptive capacity.

A climate-resilient society (or megacity) should be able to respond to unexpected and unwelcome extreme climate events. Communities, groups and individuals should be able to work together to lessen the negative impacts of crises and retain a city's core functions without external intervention. Achieving this type of resilient capacity is complex. It requires large-scale public engagement, continuous social innovation and the social and institutional flexibility to adapt to changing dynamics.

Scholars have found that megacity resiliency combines physical and social resiliency. Physical resilience is the capacity of physical infrastructure to be flexible and adapt to climate shocks and crises. Social resilience is about how quickly individuals, groups, organisations and institutions can respond (Zellner, Hoch and Welch, 2012). With increased physical and social resilience, there will be less damage and fewer negative effects. Social capital may be a good predictor of social resilience. Poor social capital is likely to mean that communities have inadequate social capacity to deal with the negative effects of climate change.

Dhaka's physical infrastructure does not have the capacity to cope with additional influxes of people into the city. It has already reached a tipping point and might collapse if further stress or burden is added. Neither can its social structures cope. Illiteracy, poverty and confrontational national politics also have a direct impact on community-level social capital. And the city is divided by two hostile political ideologies, making it difficult to reach consensus on any issue.

Megacities in the South often have limited capacities to adapt to, and reduce the risks and vulnerabilities associated with, climate change (McBean and Ajibade, 2009). Their priorities are more often related to acute problems of poverty, equity and distributive justice. Indeed, it is impossible to address climate change without dealing with these issues, for example by reducing consumption and adopting more sustainable lifestyles. Changing the global environment will require social processes to be embedded in our social systems. It is critical to understand how we can improve physical and social resiliency through socially supported or generated mechanisms. Collaborative resiliency is an extension of this idea.

Collaborative resiliency and improved adaptive capacity

Given Dhaka's weaknesses and challenges, collaborative resiliency could contribute to improving the city's capacity to adapt. It would allow the city to identify its own problems, prioritise the challenges it faces and contribute to articulating strategies to cope with changing climate scenarios. Mechanisms need to be collaborative, and include wider goals of sustainable development (McBean and Ajibade, 2009). This would allow the city to increase its adaptability and contribute to developing the best opportunities for social and human development.

How can Dhaka rise to the challenge? First, the city needs a high degree of social and institutional flexibility to accept the new views and perspectives required for decision-making and interaction in the relevant agencies and stakeholder groups. This will help local social innovation, and enable society to respond appropriately from different perspectives to different climate challenges. The state must ensure (and invite) bottom-up, grassroots development, rather than colonial-style, top-down development.

Second, good governance and transparency are crucial at all stages of climate resiliency and adaptation planning. People need access to a continuous flow of information on local initiatives. They need to be able to participate within the larger governance framework, and access relevant information. This would contribute to inclusive development and prevent citizens from feeling alienated; it would also decrease corruption.

Social and physical resiliency and adaptation measures should focus on Dhaka, but also reach beyond the city's geographical boundaries. Climate impacts will be felt further afield. Resiliency and adaptation measures need to be put in place in the regions so that people can adapt locally rather than migrate to Dhaka. The government needs to encourage climate-resilient farming practices, create rural employment opportunities, strengthen rural infrastructure and promote growth-centred development.

The framework of collaborative resiliency in Dhaka requires a high level of governance capability to put local decisions into practice. Collaborative resiliency and improved adaptive capacity will also enhance distributive development opportunities. Post-colonial megacities have traditionally suffered from a lack of democracy. By contrast, the core ethos of collaborative resiliency and adaptation planning builds consensus innovatively by changing conventional assumptions, behaviours, processes and structures for the greater good. Collaborative resiliency can strengthen local democratic and distributive systems (Sassen, 2009) and ensure that poor and marginalised people participate in, and have a greater chance of benefiting from, local development initiatives.

The role of the social sciences

In Dhaka, the negative impacts of the changing climate are already being felt and seen in daily life. More and more people from the southern and northern regions of Bangladesh are coming to the city. The societal, economic and political effects are enormous. The response should be holistic, involving citizens, scientists, development practitioners, politicians and the international development community. This will provide opportunities to analyse local realities from interdisciplinary, transdisciplinary and multidisciplinary social science perspectives. Megacities like Dhaka will benefit from the transformative role of social sciences, which will create collaborative resiliency and build local resilience capacity through innovative collaboration. The processes and capacity needed to confront climate change effects are mostly embedded in society's collective capability. A transformative role of social science research is therefore critical. But if citizens and policymakers fail to address this, the impacts could be enormous, with immense human and economic losses.

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Changing Global Environments

33. Population and land-change dynamics in the Brazilian Amazon

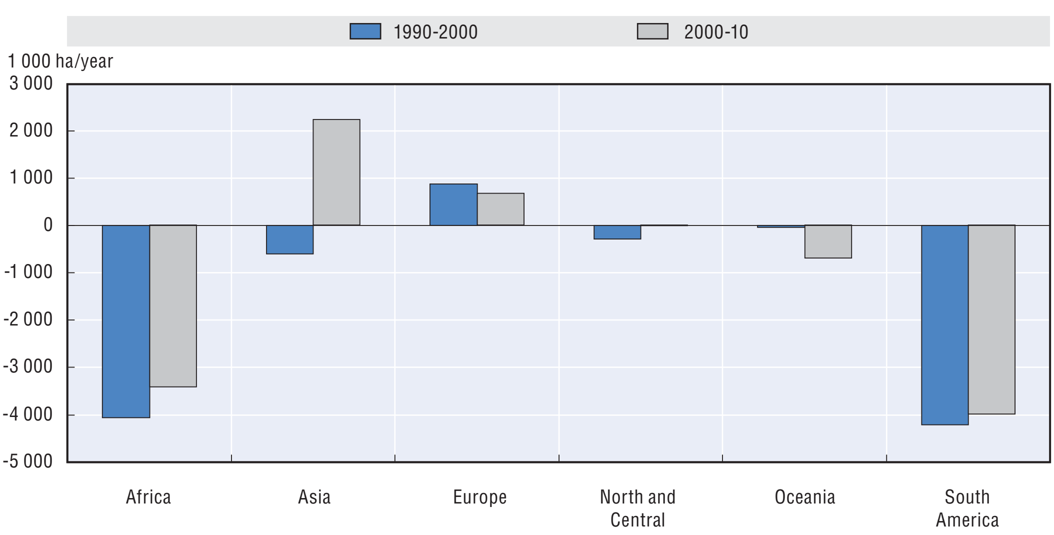
by
Julia Cortes and Álvaro D'Antona

This paper presents a synthesis of the theoretical and methodological insights that the social sciences bring to land-change science, using the example of deforestation in the Brazilian Amazon. Social sciences were crucial in moving across scales – from regional to local – in incorporating rural smallholders in the land-change studies and in enhancing the discussion about the strategic role of farming families in forest conservation and food security.

Deforestation and land-change science

Deforestation is occurring at an alarming rate, particularly in South America where an average 410 000 km^2 a year was cleared between 1990 and 2010 (see Figure 33.1). Deforestation in Brazil is decreasing, but it still suffered an annual loss of 250 000 km^2 of primary forest from 2000 to 2010, 170 000 km^2 of which was in the Amazon (FAO, 2011).

Figure 33.1. **Annual change in forest area by region**



Source: Data from the Food and Agriculture Organization of the United Nations (2011), *State of the World's Forests*, Rome, *www.fao.org/docrep/013/i2000e/i2000e00.htm*.

Deforestation has widespread effects on ecosystem services, including the climate, the hydrological cycle, biodiversity and carbon stock. It was one of the three main sources of Brazil's greenhouse gas emissions in 2010. In 1980, concerns about the effects of deforestation motivated the first studies on land use and land cover change. Initially the main objective was to identify the causes of deforestation, but more recently studies have included other aspects such as biodiversity, soil degradation, greenhouse gases, agriculture, urbanisation and human dynamics.

Land-change science is an interdisciplinary field based on environmental, social and economic theories and methodologies. It aims to make sense of the complex relationships between the causes and consequences of land-change. In this article we present a synthesis of the theoretical and methodological insights of land-change science which have been gained from social sciences. We explore how populations fit into land use dynamics, and discuss its perspectives and challenges.

The role of population in land-change transitions

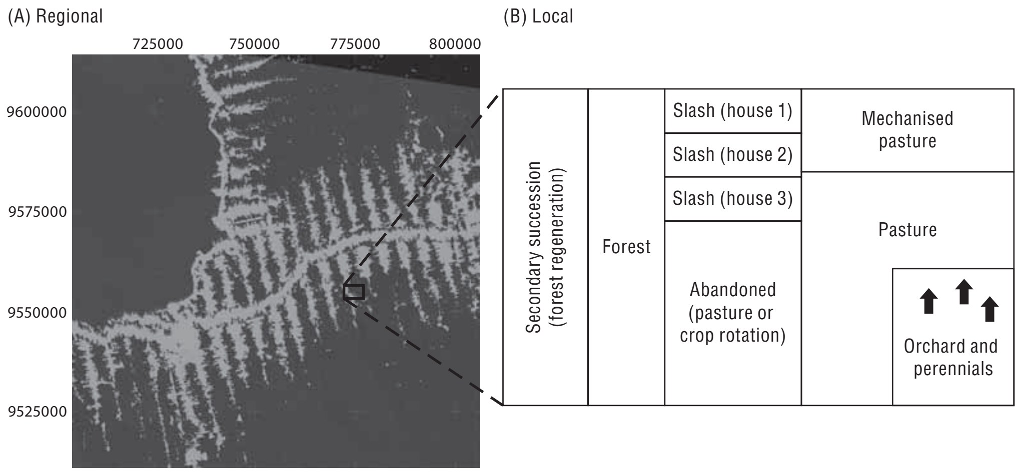
The social sciences approach brings a range of different perspectives to land-change science. At first the focus was on processes at regional levels, and recently it has shifted to local levels. Populations played a secondary role for many decades, because economic and political structures were considered crucial to land-change (Lambin and Geist, 2006). When demographic elements were included in the discussion, population growth and volume were considered the main drivers of deforestation (Bilsborrow and Hogan, 1999). This regional approach to deforestation, however, reveals gaps in our understanding of the impacts of individual actions, and of sociological factors driving land use at local levels.

In the 1970s, the Amazon had a low population density and its severe deforestation was attributed to intense human migration. The "lot turnover" hypothesis was adopted to explain the effects of the new population dynamics on deforestation. The hypothesis is that settlers abandon their lots, for various reasons, and migrate to urban or new areas. People with capital then take over, bringing with them large-scale agriculture and cattle production. Deforestation thus gains a political and economic context (Alston, Libecap and Schneider, 1996).

This regional model was applied throughout the Amazon and replicated until recently. Although smallholders occupy a considerable portion of the Amazon basin, they are absent from regional discussions about land-changes. Their invisibility, maintained in the theoretical models, simplifies the debate about forest conversion and compromises public policies.

In the mid-1990s, social scientists brought a fresh perspective by adopting a local approach that focused on household dynamics. It was clear that understanding the many interacting causes and consequences of these dynamics on land-change is a challenging task, and requires studies that take the local, regional (Figure 33.2) and global levels into account (Carr, Suter and Barbieri, 2005).

Figure 33.2. **The fishbone land pattern along the Amazonian highways (A) and property with multiple land uses and cover (B)**



Note: The Amazonian highways are Transamazônica (BR240) and Cuiabá-Santarém (BR163), Pará State in the Brazilian Amazon. Understanding regional (A) and local (B) land use change requires that different approaches be applied at each scale.
Source: Landsat Imagery (2001) conceded by National Institute for Space Research and processed by Division of Generating Images in (Cachoeira Paulista-SP/Brazil) (A) and a property sketch map made during fieldwork of the project "Deforestation and Household Structure in Amazon" (University of Indiana, United States, and University of Campinas, Brazil) (B).

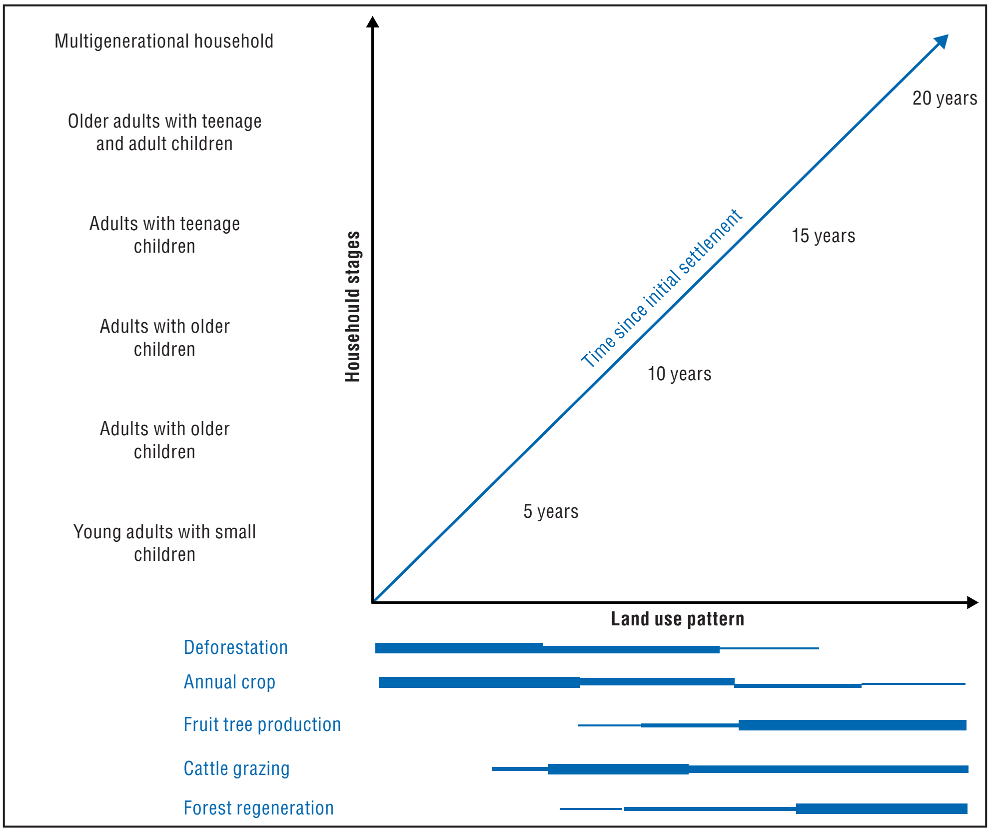
Recent social science contributions to land-change science

The social sciences have contributed to the theory and methods of land-change science. In the 1990s, social scientists started to survey households in order to better understand the demographic, economic, social and environmental processes occurring at the local level. Household lots were geographically located, which allowed the data to be directly linked to satellite and aerial imagery. The surveys generated additional variables and led to new hypotheses, resulting in a different view of the relationship between the population and the environment, which until then had only been interpreted from a regional perspective.

The local approach culminated in the household lifecycle model. This attempts to correlate the patterns of land use on a property with information on household members, such as their ages and number of children (Figure 33.3). Each household stage is associated with a specific labour force, which depends on the number of older children, and correlates with the strategies employed on the land, including different deforestation pathways and land use patterns. If the household is young, deforestation is high so that it can use the land. These households would choose to grow annual crops which provide a rapid return and do not need hard labour. Older households, with a larger labour force of family members and more savings, may choose other types of land use, such as perennial cropping, agroforestry or cattle ranching (McCracken et al., 1999).

The lifecycle model has been tested in a range of places and with variable results, suggesting that areas vary widely and that the processes are more complex than previously expected (VanWey, D'Antona and Brondízio, 2007; Guedes et al., 2011). For instance, the model was not corroborated in old settlement areas, and in places with more advanced household stages, land use was less dependent on the population and more dependent on external factors. Despite the difficulties experienced with fitting the model to different realities and the linear idea implicit in it, the household lifecycle model has provided

Figure 33.3. **Association between household stage and type of land use in the household lifecycle model**



Source: Adapted from S. D. McCracken et al. (1999)

useful insights for land-change science. It shows that land-change is a process with multiple causes occurring on many spatial levels, and that changes in land use are not only a product of the activities of large landowners and enterprises. There is in fact a set of relevant demographic factors that will remain invisible if a regional perspective alone is taken into consideration.

Social science challenges

One of the main challenges is to ensure that the recent social science approaches are used consistently in regional land-change science. The integrative nature of land-change science can be maintained by clarifying the role of the population in land-use change dynamics. The influence of local processes on regional patterns, and vice versa, should be examined. This will require studies to take different spatial scale levels into consideration and integrate distinct science disciplines.

The models used so far show that a new demographic and sociological approach should take into consideration population mobility, spatial configuration, urbanisation, family relationships, and the values and identities created with the place of settlement. Research tools, such as surveys, should be constantly updated to capture these variables.

A more realistic regional model needs to consider the many differences within the Brazilian Amazon. A more comprehensive understanding of the dynamics of land use change and cover can be gained if all relevant actors and variations in the demographic, environmental and economic processes are combined. Adding the role of smallholders to the deforestation debate will help us better understand and manage the various functions that rural smallholders contribute to forest conservation and food security.

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34. The risks of global warming to coral reef ecosystems

by
Sabah Abdullah

Coral reefs are said to be the world's most biodiverse environments. Many coastal communities are highly dependent on the ecosystem services they provide. But rising water temperatures contribute to their degradation. The BIOCORE project works to devise policy suggestions to minimise these losses and ensure sustainable management and conservation of coral reefs.

Threats such as natural and anthropogenic stress are compromising the ocean's ability to provide ecosystem services. Combinations of stressors such as climate change, overfishing and pollution are overwhelming the ocean's inherent resilience and natural balance, making it harder to reverse this damage, while the degradation of marine and coastal ecosystems results in the loss of goods and services to coastal and inland communities (UNEP, 2006).

As the Intergovernmental Panel on Climate Change (IPCC, 2007) has highlighted, coral reefs are under great stress as a result of global warming. Their low adaptive capacity results in particular vulnerability to thermal change. They are also sensitive to other effects of global warming such as ocean acidification, and can suffer in coral bleaching events.

Most coral reef areas are in developing countries where people are poor. They are highly dependent on these ecosystems for food, employment in fishing, shoreline protection, recreational services through tourism, and cultural and spiritual benefits. Burke et al. (2011) point out that the adaptive capacity of countries to avoid reef degradation and loss is greater for nations with high levels of economic development and resources, for example oil producers or those that offer offshore financing schemes, as do the Caribbean islands, than for countries in conflict areas. It is vital, when mapping these ecosystems, to consider the socio-economic and political drivers in order to assess the vulnerability of the community and ecosystem.

As part of the Seventh Framework Programme for Research, funded by the European Union, the BIOCORE project – Risks of global warming: The case of coral reef ecosystems in developing countries – aims to assess the contribution of coral reefs to human well-being under the effects of climate change.

This project has again revealed that high-income countries adapt better after bleaching events. This means that their adaptation efforts have improved over time. This shows the importance of adaptation plans and strategies when assessing the vulnerability of communities in low-income and emerging countries to climate change. The project is in its last phase, during which analysis will estimate the impact of coral reef ecosystem quality on the socio-economic and cultural values of countries. The findings were presented in early June 2013.

One recommendation identified by BIOCORE is to bridge the gap between policy and science in marine ecosystems and in communities facing the challenges of climate change. The idea is to develop a co-ordinated approach to examine the ecological, socio-economic and cultural issues. Specifically, there is an enormous opportunity for social science researchers to investigate the resilience and recovery of marine ecosystems and human communities. This can be done by identifying key vulnerable ecosystem states and areas, evaluating how increases in global temperature affect them, providing early warning of disaster, and recommending conservation and management strategies for communities to help them adapt to climate change effectively and efficiently. Moreover, the governance challenges in the ecological and social context cannot be ignored. Awareness-raising and information dissemination programmes concerning marine ecosystems should be tailored to suit policymakers and other stakeholders. They should also be based on scientific evidence, and provide fair and unbiased ways to manage the adverse effects of climate change on human and ecosystem well-being.

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35. Vulnerable and resilient children after disasters and gene–environment interplay

by
Rainer K. Silbereisen, Marinus van Ijzendoorn and Kan Zhang

The World Health Organization (WHO) estimates that disaster doubles the occurrence of mental distress. Yet certain children show huge resilience, despite losing their homes and parents, while others suffer enormous mental distress. Gene–environment interdependence plays a crucial role in children's different reactions: experience of disasters is genetically influenced, and may influence the rest of a victim's life.

Disasters affect a large share of the world's population, but hit some regions more than others. In the past decade, about 40% of natural disasters took place in the Asia-Pacific region, bringing untold damage, loss of life and hardship, especially to countries with less well-developed infrastructures and weak rescue systems. Beyond physical and infrastructural devastation, disasters and their aftermath have psychological consequences related to the loss of family and friends, property, environment and personal injury, as well as many other stressors.

According to World Health Organization (WHO) estimates, a disaster doubles the prevalence of mental distress. Research syntheses on children and youth (Furr et al., 2010) have demonstrated associations between exposure to disaster of various kinds (proximity, perceived threat, distress at the time) and broad indices of psychopathology, particularly post-traumatic stress symptoms and disorder (PTSD). The specific mechanisms by which such stressors impact human behaviour and development have so far been attributed to the breakdown of the family, local communities and other social mechanisms. Such a breakdown makes it hard to satisfy the basic emotional needs of children and adolescents, which is necessary for their healthy development toward a balanced and productive adulthood. Skills that are fundamental for adequate social relationships and the regulation of impulses are especially likely to be underdeveloped when such stress is prevalent (Norris et al., 2002).

Looking at the impact of such disasters on young people, scientists and practitioners have long wondered about the great range of responses to such misfortune. Individuals can exhibit anything from devastating psychopathologies to almost intact functioning, or resilience, despite a seemingly equal level of exposure to disaster-related stressors. Now recent cross-disciplinary research on the heterogeneity of response demonstrates pathways of behavioural, brain-related and genome activity that may shed new light on the various ways in which humans respond to disasters, and especially on the risk of lasting adverse psychosocial conditions or the ability to survive such disasters in a resilient way (Masten and Osofsky, 2010).

At the core of this new research are three concepts of the interdependence between genes and the environment that play a crucial role in normative or psychopathological development (for an overview, see Rutter, 2012).

The first is the gene–environment correlation, which addresses the various environmental risk factors that ultimately derive from human behaviour mediated by genetics. This means that the experience of disasters is itself influenced in part by genetics.

The second is the gene–environment interaction, which means that genes moderate environmental effects, making people more or less susceptible to negative or positive environmental effects. Interest in this kind of interaction in disaster research was prompted not only by the limited prevalence of PTSD following exposure, but also by the fact that it runs in families. It is now well known, for instance, that genes related to serotonin production (5HTTLPR, a contributor to feelings of anxiety and depression) interact with particular early environments, such as child maltreatment. More specifically, some less effective polymorphisms of the gene (those with short alleles) promote the development of lasting clinical depression in later life if individuals are exposed to maltreatment (Caspi et al., 2003). Likewise, early exposure to child abuse in interaction with polymorphisms on the FKBP5 gene – an important regulator of the stress hormone system – increases adults' vulnerability to PTSD in response to disaster. It may not be the initial event so much as its consequences, perhaps involving displacement promoting physical and emotional neglect, that imply aggravated risks for genetically vulnerable children.

The third new strand of research on gene–environment interdependence – and maybe the most relevant for human response to disaster – refers to the modulation of gene expression at the molecular level through environmental stressors. These so-called "epigenetic" processes do not represent a change of the structural DNA sequence, but instead concern biochemical changes, such as DNA methylation, which alter the expression of particular DNA segments, or their "readability", in the regulation of protein and enzyme production. Recent research with animal and plant models shows that these changes, induced by environmental forces, are reversible but can be transmitted to future generations (Yehuda and Bierer, 2009).

With regard to disasters, the best example is probably the following pathway: turmoil at the aggregate level of a disaster-affected region is translated into a range of particular adversities experienced by the victims in their own contexts, such as the breakdown of established and secure family relationships and routines. The subsequent trauma experienced by parents may result in a sharp decline in the quality of parenting and even atypical, neglectful parental behaviours that are damaging to the child.

Such experiences, especially concerning maternal care and attachment relationships during the first few years of life, lead to individual differences in the expression of genes involved in the regulation of the cortisol levels in the brain and body – such as FKBP5 – which may provoke differences in habitual stress response. More specifically, drastic changes in parent–infant interaction may modify epigenetic markers or regions of DNA that regulate the HPA axis response to stress, with enduring effects on biological, psychological and social development. Recent research has gone beyond earlier animal models, and has shown that differences in DNA methylation in FKBP5 or 5HTTLPR resulting from early trauma (such as child maltreatment) may have a persistent influence on PTSD and even on propensity to suicide (van Ijzendoorn, Bakermans-Kranenburg and Ebstein, 2011).

Such processes offer new explanations for the role of family history of PTSD, the cumulative effects of exposure to disasters, and intergenerational effects in general. The core pathway seems to be triggered by deficits in maternal care. This has an enduring effect on gene expression that underlies individual differences in endocrine functioning and ultimately how offspring respond to environmental challenges, including disasters.

Questions for further research relate to which particular environmental influences bring about the largest epigenetic changes, in which body tissues, and at what stage of development. Thus far, the effects of some adverse events and treatments concerning small children have been studied on the HPA axis with cortisol as its product, but other pathways can be imagined, for example using the dopamine system. The reason we focus on stress is because several models of individual consequences of negative societal change, including disasters, have put the experience of adverse conditions and coping with ensuing stress in the foreground (Meaney, 2010).

It is not new for genetic endowment and environmental processes to work interdependently in human development. But now, for the first time, the biochemical processes which translate experiences into modifications of physiological and brain processes can be addressed specifically. This means that we are able to create a full picture, from the objective environment, via psychological experience and the biochemical modifications of the genes involved in the production and transfer of major neurotransmitters and hormones, to behaviour. From a basic science perspective, this brings psychology and its allied disciplines back to the middle of recent progress in the natural sciences. From an applied point of view, many years of talking about the ecology of human behaviour and development have led to a specific focus on where and how to intervene early in the chain of processes leading to maladjustment (Silbereisen, Ritchie and Overmier, 2010).

In spite of their biochemical nature, adverse DNA methylation and similar processes may be influenced by changing a specific environmental trigger, such as disaster-induced inept parenting. More specifically, it has been shown that it is possible to reprogramme methylation through later positive experiences, at least in animal models. It is even imaginable that in the distant future, protective medication will be able to prevent biochemical modification. Further, as the three facets of gene–environment interdependence do not work in isolation, their interaction can be used for prevention and intervention. Exposure to potentially damaging experience by particular genetically influenced behaviours might be reduced at the beginning of the process. Further, knowledge about genetic susceptibility to environmental effects may be used to reduce risks, for instance, by offering positive alternative environments with less risk potential.

This exciting new research on gene–environment interdependence should be the start of a new collaboration between the various fields of social and behavioural science, especially with the aim of improving mental health and the adaptive development of competence under extremely adverse conditions. It will be a point of departure for more research on how the environment, with its challenges and opportunities, leaves traces on human behaviour and development. This research will provide a new scientific underpinning of disaster response guidelines that will demand priority in nurturing adaptive systems for human development, and restoring the secure base of attachment relationships.

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36. Migration as an adaptation strategy to environmental change

by
W. Neil Adger and Helen Adams

Environmental change affects patterns of migration by altering the location and mix of economic activity. While immobility leaves vulnerable populations at increased risk, the trend to migrate to cities as an adaptation strategy also involves risk for migrant populations.

Migration as an adaptation to environmental change

Changes to global environmental systems are already causing disruption by altering the landscape of risk and opportunity. Projected changes in climate, sea level and ecosystem service provision may profoundly alter the world's economic geography. For example, the changed productivity of agricultural land, the loss of settlements on eroding or inundated coasts, the altered liveability of cities and the opening of the Arctic to shipping as a result of the loss of sea ice, could all change to flow of capital and alter settlement patterns (Foresight, 2011).

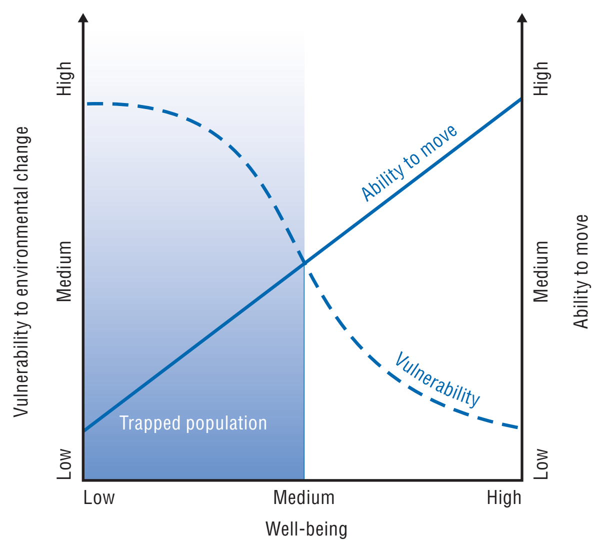
Analysis from social science has already demonstrated that adaptation to such environmental risks seeks to prevent adverse impacts on society. This adaptation includes land use planning processes that take environmental changes into account; guidelines for designing and implementing adaptation activities; and enhanced understanding by policymakers of personal values and ways of life at risk (Adger, Lorenzoni and O'Brien, 2009). But to date, these analyses have under-emphasised the role migration plays in mediating global environmental risks. Migration will, we argue, be critical to the readjustment and evolution of this economic geography.

There has been a renaissance in environmental and migration research. This work moves beyond neo-Malthusian predictions of large-scale human displacement, to reveal the complexity of the relationship between economic migration and environmental risks and resources (Piguet, Pécoud and de Guchteneire, 2011). Migration is a well-known strategy to spread risks under difficult environmental conditions. However, research shows that migration may not be an outcome of environmental change if people do not have sufficient economic resources, networks and capital; that individuals may choose to remain in a risky location due to high levels of attachment to place; and that migration can lead people into situations of increased risk instead of away from them.

Immobility under environmental change

Empirical evidence shows that certain populations do not have the resources to migrate when their well-being is reduced by environmental change. Figure 36.1 illustrates these dynamics and shows that vulnerability is inversely correlated with mobility: that is, people who are most exposed and vulnerable to the impacts of climate change are least capable of migrating. It has therefore been suggested that people who are trapped by their lack of mobility (Black et al., 2013) suffer a significant injustice. Furthermore, communities where populations are in decline can have difficulties sustaining themselves and maintaining community unity and adaptive capacity. Here diaspora links and networks are increasingly important in dealing with many environmental risks.

Figure 36.1. **Relationship between vulnerability to environmental change and mobility**



Note: Lack of mobility and high vulnerability are positively correlated.
Source: Adapted from R. Black et al. (2013).

Migration is embedded in identity and culture. Recognising these dimensions is critical for planning and governing mobility to adapt to future risks. While the economic benefits of migration are well documented, its social and psychological costs and benefits are not so well understood. It is often these less visible psychological and emotional trade-offs that keep a person in a specific location. New research demonstrates the importance of attachment to place for those facing decisions to relocate because of environmental risks. Such resistance is also apparent in the conflicts about planned resettlement proposed by governments and other institutions. People object to these schemes even if they believe the risks of remaining are high (de Sherbinin et al., 2011).

Migration under environmental change

Some dimensions of the relationship between environment and migration remain under-analysed. They relate to the vulnerability of migrants in receiving locations; the mobility of natural resources (ecosystem services) on which people depend; and some of the negative consequences of a more mobile, interconnected world.

Mobility has a significant potential to generate new risks and vulnerabilities, including vulnerability to environmental harm of migrants themselves (McMichael, Barnett and McMichael, 2012). Environmental change is likely to strengthen existing migration trends. Recent decades have seen population drift to cities and to coastal zones, which are also at risk (de Sherbinin et al., 2012). In addition, migrants to cities are often more vulnerable than longer-term residents. They cluster in high-density areas, often on steep hillsides or flood plains, where there is vacant and cheap land, and many low-income migrants lack access to health services and political representation. However, well-established networks and social capital can counter this vulnerability, as can selecting migrants from healthy and adaptable members of the population.

The existence and mobility of ecosystem services, the aspects of ecosystems that ensure human well-being (Fisher et al., 2009: 645), are affected by the same environmental changes that affect human activities. All biological resources change over time and space, and are likely to affect human migration and the sustainability of resource use. For example, climate change is already affecting ocean fisheries. This means lower yields in the tropics, a changing range of important commercial species in temperate regions, and greater variability in productivity and species composition in virtually all oceans (MacNeil et al., 2010). As a result, fishers often have to relocate to continue to access such resources. Other natural resources fluctuate seasonally (for example, agricultural output or the availability of products such as dry fuel wood or honey), and people migrate to access different ecosystem services at different times of the year. The social practices and lifestyles created around such ecosystem services can contribute significantly to people's sense of place and identity.

The increasingly connected nature of the world presents new challenges and produces new risks, making vulnerabilities to environmental change increasingly interdependent. Processes of economic globalisation have altered the rate and scope of environmental change and its associated vulnerabilities. The global reach of capital and the swifter spread of technologies challenge the competences of institutions and governance. Vulnerabilities are therefore linked between distant places and communities (Adger, Eakin and Winkels, 2009). Migration, together with systemic environmental change and global economic integration, is the primary mechanism of this interdependence. International migration has remained stable in recent decades – at around 3% of the global population – but the level of migration within national boundaries has increased many times, as have flows of goods and materials around the world, increasing the connectivity of risks.

Conclusion

New and exciting social science reveals a complex set of relationships between human migration and environmental change. We highlight the emerging issue of vulnerability in this context, such as the case of populations who cannot migrate from risk, and those who are migrating into risk. All this happens in a world where our natural resources are also mobile across time and space, and where increased mobility means our vulnerabilities are interconnected across the globe. The social sciences have a unique role in pointing to mobility as a significant, sometimes dominant, but always under-emphasised response to environmental change.

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37. The paradoxes of climate change and migration

by
Andrew Baldwin and François Gemenne

Human migration is often seen as one of the most serious consequences of climate change. Indeed, it can be seen as a security or humanitarian issue. But might it also be a positive adaptation response to climate change?

Until recently, social scientists have largely overlooked the migration effects of climate change. But given its growing policy significance, more social scientists are now taking an interest. Research on the topic is primarily empirical and normative, but social scientists are beginning to examine the broader implications that climate change-induced migration may have for political, cultural and social life. Current research is therefore moving in new and innovative directions. Nevertheless, more research is needed to appreciate how this migration overlaps with issues of governance, development, security and risk management, and wider issues regarding identity, gender and equity.

Earlier empirical research in this field often tried to predict the number of migrants who might be displaced by environmental or climate change. Today, researchers seem less persuaded by the predictive reasoning approach (Gemenne, 2011a), and are more inclined to use scenario forecasting to understand this phenomenon. A recent study on migration and global environmental change undertaken by Foresight (2011) makes effective use of scenarios to assist in policy development. Previous research also tended to imply a strong causal relationship between environmental factors and human mobility (Myers, 2002), an approach which has since been largely discredited.

Most researchers now argue that migration has many causes, and that climatic variability is just one of several factors that explain migration. The Foresight Report adopts this kind of reasoning, as does a recent United Nations University study (Warner et al., 2012), which examines the conditions under which households use migration to mitigate risks associated with rainfall variability.

As an adaptive strategy, migration is often unavailable to the most vulnerable, which has led some to argue that large populations will be trapped by climatic variability and exposed to danger (Black et al., 2011), especially if the global average temperature increases by 4°C (Gemenne, 2011b). This unequal access to migration as an adaptive strategy raises wider empirical questions about how issues of poverty, marginalisation and inequality affect adaptive strategies such as migration.

Policy responses to climate change and migration remain difficult to design in the absence of a consistent terminology and robust empirical research, and confusion about numbers and pathways. Following some early attempts to create a specific status for climate refugees in international law, proposals to revise the 1951 Geneva Convention or devise a specific climate change displacement treaty (Biermann and Boas, 2010) have given way to more policy-oriented discussions (McAdam, 2011). Many of these discussions have taken place within the framework of the international negotiations on climate change (Warner, 2011). A significant milestone was reached in 2010 with the adoption of paragraph 14(f) of the Cancun Adaptation Framework agreed at the United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) 16 in Cancun, Mexico. This commits parties to develop "measures to enhance and improve understanding, co-ordination and co-operation with regard to climate change-induced displacement, migration and planned relocation, where appropriate, at national, regional and international levels". Paragraph 14(f) is indicative of a conceptual shift. While migration was generally considered as a failure to adapt to climate change impacts, it is now increasingly recognised as a powerful adaptation strategy.

A number of international organisations have taken steps to address the issue and develop policy measures, including the International Organization for Migration, the UN High Commissioner for Refugees and the Asian Development Bank. More recently, the governments of Norway and Switzerland have launched the Nansen Initiative, an intergovernmental consultation process aimed at defining a global protection agenda. The African Union has adopted the Kampala Convention for the protection and assistance of internally displaced persons in Africa, which acknowledges those displaced because of environmental changes. However, to date, no universal legal regime exists to address the protection gaps for those who have relocated or may need to relocate due to climate change. Obstacles to migration remain extremely important, and large vulnerable populations remain trapped in highly vulnerable regions. In the absence of a global solution, it is likely that most policy responses will remain regional and humanitarian in nature.

Those who face potential displacement by climate change – especially those who live on small, low-lying islands – are often portrayed as the human faces of climate change, the canaries in the coalmine or early-warning systems of global warming (Gemenne, 2011b; Farbotko, 2010). The term "climate refugee" is regularly used to describe a person who will need to relocate as a result of climate change. However, the term has no formal legal designation or meaning. Instead, it is mainly used as a rhetorical device to sensitise governments to the need to address climate change and reduce greenhouse gas emissions. A growing number of scholars now argue that the term "climate refugee" is a social construct. Some have used post-colonial theory to show how so-called "climate refugees" are constructed through Eurocentric systems of power and knowledge (Farbotko, 2010) and are subordinate to Western institutions. Other researchers observe that climate refugees are frequently portrayed as both threats and victims (Baldwin, 2013), and warn that using such crisis-laden language may result in the militarisation or securitisation of climate change policy (Hartmann, 2010). Some theorists argue that climate change-induced migration must be reframed as an issue of development, governance and adaptation in order to counter arguments that favour militarism and security approaches (White, 2011).

Recent critiques echo many of these concerns about the socially constructed nature of the climate refugee and climate change-induced migration. The claim is sometimes made that public concern about climate refugees expresses a desire for security and is often xenophobic (Bettini, 2013). It has also been said that the use of apocalyptic images of so-called climate refugees to gain political support for climate change measures may have the paradoxical effect of limiting public debate on climate change-induced migration. Other research cautions that the discourse of climate change-induced migration is constructed using racialised language, and suggests that scholars need to be aware of this in order to properly analyse the politics of climate change and migration (Baldwin, 2013).

Conclusion

The foregoing synopsis covers only a fraction of the social sciences literature on climate change-induced migration. However, this literature points to the idea that environmental and climate-induced migration is both an empirical reality and a political construct. Its empirical quality is evident in the various future-conditional knowledge practices that produce it, practices that include scenario forecasting and stochastic modelling. But its constructed nature is evident in the way that it exists as a speculative, virtual phenomenon. Consequently it remains a paradox for researchers and policymakers. As migration becomes more visible in climate change policy, it is essential that we expand our understanding of the phenomenon as an empirical reality and a political construction, and try to appreciate the social, political, cultural and economic implications of this paradox.

To better appreciate our understanding of the phenomenon, we propose several areas for further investigation.

- Researchers need to better understand the empirical contours of the phenomenon. This means developing sophisticated quantitative methods and modelling techniques, including agent-based modelling.
- It is necessary to build on the strong body of ethnographic research that seeks to identify the field-level complexities involved in migration decisions.
- Researchers also need to understand the constructed nature of this phenomenon. We propose more research on the political economy and history of climate change-induced migration, as well as research on how the equity and identity dimensions of this migration intersect with wider issues of ethnicity, gender and age.

Research on environmental and climatic migration is still a niche area. However, at its heart there are deep issues concerning the relationship between people and their environments. Understanding this relationship should be a top priority for research if we are to understand the social dimensions of climate change properly.

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38. The role of the social sciences in adapting to climate change in northern Europe

by
Carina Keskitalo

Social sciences have an important role to play in studies of adaptation to climate change, as all such adaptations will need to be implemented within socio-political and economic systems. This paper looks at cases in northern Europe.

Introduction

Emissions released into the atmosphere are already having an impact on our climate. We need to mitigate or limit these emissions. But we also need to know how to adapt to the consequences of climate change. In northern Europe, changes may include modifications in precipitation and temperature patterns, which may in turn lead to changes in the seasons. Other potential impacts include shorter winters with periods of thaw and increasing incidence of extreme events. The need to adapt is reflected in many countries' recent development of adaptation strategies at national and lower levels. In addition, the European Union (EU) is working towards Union-wide adaptation strategies. How can social science research on adaptation in northern Europe help us understand the broad socio-economic and political systems within which such adaptation priorities have to be incorporated?

What can social science studies tell us?

Social science studies on adaptation focus partly on vulnerability. These studies aim to identify the socio-economic and political contexts that are vulnerable to environmental change. One approach is to review adaptation in specific cases, such as the development of adaptation strategies (Smit and Wandel, 2006; Berrang-Ford, Ford and Patterson, 2010).

Understanding adaptation requires an understanding of current socio-economic and political systems and their capacity to adapt to climate change, or in other words, an understanding of the resources that may limit or enable the development of adaptation, whether planned and strategic or shorter term (e.g. Smit and Wandel, 2006). Case studies on community vulnerability are common in North America, where northern settlements are often quite small and adaptation can be assessed at the community level, for example, in hunting-based communities (e.g. Ford et al., 2012).

In northern Europe, on the other hand, studies have often targeted adaptation at the municipal or local government level (see for instance articles in the *Local Environment* special issue, Vol. 17, Nos 6-7) or at the community, municipal or county levels in sectors that rely on renewable natural resources (see Keskitalo, 2008; Hovelsrud and Smit, 2010 for a comparison of northern areas). A number of studies have reviewed the development of adaptation policy at different levels (e.g. Swart et al., 2009; Keskitalo, 2010). In general, studies use semi-structured interview material, sometimes combined with focus groups or observations. Their findings are integrated with policy and other documents outlining adaptation policies or describing the priorities and processes within which adaptation concerns need to be integrated. These mainly qualitative studies contribute to an understanding of how climate change may impact different areas and sectors and how they may adapt to it, although climate change is only one of several simultaneous stresses. These qualitative studies also provide an understanding of institutions and how they set priorities, which is after priorities the context within which adaptation priorities need to be developed and integrated.

Suggestions from the literature

Learning from social science research more broadly, the field of climate change studies has accepted that adaptation to climate change depends on social vulnerability. This means that higher-level governance, economics and the reality of local livelihoods largely determine the local adaptation context. Multiple studies have shown that adaptation to climate change occurs in response to the perceived risks, and that adaptation is most striking where the risks associated with climate change result in economic vulnerability. For instance, studies on adaptation to climate change in forestry indicate that companies and entrepreneurs have focused mainly on adaptation to changes such as more difficult weather conditions, which have a direct economic impact. This has often resulted in the avoidance of more costly and extensive adaptations, such as considering which tree species should be planted, even though forest areas planted today will be subject to more severe and changed climate conditions in the longer term (Keskitalo, 2008; Hovelsrud and Smit, 2010). Furthermore, the literature suggests that adaptation will not necessarily be new or specific to climate change; instead, it will draw upon existing adaptation or coping measures.

Understanding current adaptation, and the resources required to address future change, requires a sound assessment of potential adaptation paths and future resource requirements. Given how significant the socio-economic and political contexts are for understanding adaptation, it is important to appreciate that adaptation differs enormously in different national, regional and local contexts. Accordingly, the northern European Union and North America's northern or Arctic political developments should not necessarily be directly compared, as these areas are qualitatively different in terms of development and organisation. Instead, it is important to understand the institutional context for adaptation (Keskitalo, 2010; Adger, Lorenzoni and O'Brien, 2009).

In this regard, studies also indicate that it is important to review adaptation in a multi-level context. For example, EU and national regulatory frameworks will influence what kind of adaptation is possible at local and regional levels. Adaptation in the water sector – often highlighted because climate change increases flood risks in some areas – calls for policies that can be integrated into existing water and emergency management systems. Within the EU, the Water Framework and Floods Directives, which partly establish new management systems and which are also concerned with climate change, require an added layer of integration. In this case, supranational requirements may become even more important than national ones. This is, for example, as national adaptation policies in Sweden and Finland largely allow the municipalities to determine the extent to which adaptation concerns are integrated (Keskitalo, 2010; Swart et al., 2009). Incorporating climate change adaptation into existing systems may thus mean taking planning systems in different sectors and at different levels into consideration. As integration may require knowledge, funding and personnel, responses to extreme events such as flooding may help develop adaptation by indicating how systems respond to stress and point to ways of developing improved responses (see *Local Environment*, Vol. 17, Nos 6–7; compare examples in Adger, Lorenzoni and O'Brien, 2009).

Conclusion

Adaptation requires long-term strategic planning and its integration into existing structures. In this, it poses many questions about the planning and integration capabilities of socio-economic and political systems. Social science research allows us to interpret how well existing measures and systems function in changed weather conditions during which we might face extreme events. The social sciences provide key insights into the consequences of climate and environmental change, but also into how governmental and other decision-making systems can start to address these effects. Since adaptation is largely a social science problem in that environmental problems are often social problems of organisation, established social science theories may play an even more important role in future studies on adaptation. Examples from political science are studies on environmental policy integration, government behaviour and agenda setting that illustrate how well and in what cases adaptation is integrated into political decision-making and implementation.

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39. Women and climate change adaptation in Zimbabwe

by
Donald Chimanikire

Drawing on the literature on gender and climate change in Zimbabwe, this contribution outlines important links between climate change and gender inequality, focusing particularly on women and adaptation.

Consequences of climate change in Zimbabwe

According to the Intergovernmental Panel on Climate Change (IPCC) (2012), Africa will soon experience the consequences of climate change. The consequences of climate change will be familiar since most of the population of Africa already experiences a variety of stresses and shocks on a regular basis (Conway, 2009). Among these consequences are increased water stress, lower yields from rain-fed agriculture, increased food insecurity and malnutrition, a rise in sea levels and more land becoming arid and semi-arid. According to Conway (2009), the scale and nature of these consequences will dramatically increase as the pace of climate change increases. In Zimbabwe, rainfall variability and extreme events, combined with warming trends, are limiting the country's socio-economic development, because of its heavy dependence on rain-fed agriculture and climate-sensitive resources (Brown et al., 2012). The most affected regions are the drier parts of the country, namely the Midlands, Masvingo and Matebeleland, where rainfall has declined by 15% since 1960.

Although most farmers in dryland areas have experienced changes to the climate and have a good understanding of local climate patterns, they will be vulnerable to future climate uncertainty (Kurukulasuriya and Rosenthal, 2003). Local practices and infrastructure that have adapted to a greater or lesser degree to the current climate conditions will no longer be suitable, and may be inadequate because of different farmers' interpretations of climate variability (Brown et al., 2012). Besides affecting agriculture, changing environmental conditions are also expected to affect the quality and quantity of the drinking water in rural and urban areas. There may also be health effects because of the increasing geographic range of infectious diseases such as malaria. Climate change will significantly restrain Zimbabwe's ability to meet the Millennium Development Goals by 2015, especially those aiming to eradicate extreme poverty and hunger, combat HIV and AIDS, malaria and other diseases, and ensure environmental sustainability (Brown, Dodman and Zvigadza, 2013).

Gender and climate change

Climate change impacts men and women differently because of the differences in their social positions and in the roles they play (Chowdhury et al., 1993). According to the World Health Organization (WHO) (2012), natural disasters such as droughts, floods and storms kill more women than men globally, and especially young women. This is because women make up 70% of the world's poor (Brown et al., 2012). In addition, women are more dependent on natural resources for their livelihoods, and these are threatened by natural disasters. According to the Food and Agriculture Organization of the United Nations (FAO) (1997), women are responsible for producing 60-80% of food in developing countries and for half the world's food production, but only recently has their importance for household food security been recognized.

In Zimbabwe, women living in rural areas are in charge of finding water, food and fuel for cooking and heating. Since many rivers have dried up, women must walk longer distances every day to find water. Similarly, the government's deforestation control policies mean that wood is becoming more difficult to find, increasing the distances women have to walk to find it. In addition, most Zimbabwean smallholder farmers are women who depend on rain-fed agriculture and climate-sensitive resources. This means that they are particularly vulnerable to climate change (Madzwamuse, 2010).

Women's roles in adapting to climate change

According to the IPCC (2001), adaptation refers to changes in "processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate". It involves adjustments to reduce the vulnerability of communities and regions to the effects of climate change and climate variability. The United Nations Development Programme (UNDP) and Global Gender and Climate Alliance (GGCA) (2009) think some degree of adaptation is already necessary. The United Nations Framework Convention on Climate Change (UNFCCC) (2007) recommends that developing countries prioritise climate change adaptation due to the higher percentage of vulnerable people there.

The Zimbabwean government has developed national frameworks in response to climate change, to guide adaptation projects and programmes (Brown et al., 2013). An example is the Chiredzi District's five-year pilot project (2007-12) led by the government of Zimbabwe, UNDP and the Global Environmental Facility (GEF). It used a community-based adaptation approach to evaluate the area's vulnerability and find key adaption strategies for herders and small farmers. The project focused on food security and the sustainable management of the area's natural resources (Brown et al., 2013). They stress that the main merit of this project was that it formed a partnership between the national government and civil society to learn from and scale up local adaptation approaches across the country.

As Zimbabwean small farmers are mostly female, women are central to adaptation strategies. They possess invaluable indigenous knowledge and skills that should be recognised and embedded into programmes that develop resilience. This knowledge is important to manage climate-related risks regarding agricultural production and to inform adaptation policies. Women also have better access to social networks, which is important for disseminating adaptation practices. So women should not be regarded as victims of climate change. They can contribute to finding solutions to cope with it (Nelson and Stathers, 2011).

Gender-sensitive approaches

Despite the recognized importance of women in responding to climate change consequences, they are largely absent from decision-making processes on climate change adaptation and disaster risk reduction (Brown et al., 2012). According to Chagutah (2010), it is essential for climate adaptation planning to incorporate a gender-sensitive perspective in order to address the inequalities between men and women. Brown et al. (2012) recommend that Zimbabwean policymakers use participatory and inclusive decision-making processes during planning in order to take women into account.

These authors also recommend the adoption of a climate change finance system to allow equal access to funding. It is important to include women and men equally in all aspects of climate change projects, including possible payments for technology. This applies especially to technologies aimed at tasks that women perform most frequently. Technologies should be designed so that they are relevant in women's circumstances; women thus need full access to knowledge, information and technologies related to adaptation (UNDP and GGCA, 2009). According to the UNDP and GGCA (2009), empowering and investing in women are essential to combat the effects of climate change and to alleviate poverty in developing countries.

The Zimbabwean government has adopted a gender-responsive budgeting[1] approach. Its climate change policy should incorporate these values and should be linked to the country's rural development policies.

Note

1. Gender-responsive budgeting (GRB) is government planning, programming and budgeting that contributes to improving gender equality and the fulfilment of women's rights.

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40. Ex-rubber tappers' and small farmers' views of weather changes in the Amazon

by
Erika Mesquita

How do people living in the Amazon forest, and to be precise in the Alto Juruá region of Brazil, understand climate change? Indigenous forest dwellers make their own observations and interpretations from changes in animal behaviour.

Many forest dwellers in the Alto Juruá in Brazil used to work as rubber tappers and are descendants of migrants and indigenous people from the region. This research examined the climate variations they have observed and how they have processed this information.

An impression of the weather is arrived at by observing a combination of weather types, which together comprise a representation of the weather. This article is a phenomenological study of meteorology and climate, and of the forest dwellers' interpretation and representation of these phenomena.

Today most inhabitants have an agricultural lifestyle and pay close attention to the relationship between agriculture and the weather cycles, or their perceptions of them. There is now no rubber production in the region, and agriculture provides income for most local people. The deforested areas are greater in size and are increasing as a result of cattle farming.

The forest dwellers' perception has been transformed in recent years, and they speak of "the old weather" in the forest and "today's weather".

Most of those questioned perceive some changes in the region's winter and summer weather characteristics. The elderly speak about these changes through their life stories. They convey their observations and experiences of what they refer to as "the heat" with authority. Some residents believe that the changes in the weather, and increasing heat, have been getting worse since rubber tapping ended. Deforestation for non-subsistence agriculture and for cattle is mentioned as one of the main causes of the changes in the weather and the reason for "the heat".

Some residents say the current weather causes "sadness in the jungle" because of the heat and the absence of cold spells in summer. They also talk about "smog" or "the veil in the sky", caused by smoke from the increasing number of local fires. This "veiled sky" occurs day and night, with the "smog" blocking out the stars. This means that the sky can no longer be used to forecast the weather by observing the sun's colour and the position of the stars, which causes errors in prognoses and forecasts. Besides the "smog", residents believe that the position of the stars in the sky has changed.

The inhabitants interpret these changes via Christian eschatology. Indigenous and non-indigenous people also attribute the changes to human agency: for example, those who cut the forest down, which is not "respectful". Local people analyse natural phenomena and the environment in which they live in their own way.

Animal professors

Lévi-Strauss (1989) noted the meteorological role of animals in some mythologies. The people of Alto Juruá compare their loss of reference animals with the changes they notice in the dry and rainy seasons. Other residents link the loss of the animals that could foresee meteorological phenomena to deforestation, pollution, and the end of the world.

Knowledge relating to the stars is common, and is closely linked to the lives of the forest dwellers. Marshall Sahlins (1990: 191) maintains that no event or thing has movement in human society except in the meaning that people give it. Thus, "an event is not only a happening in the world". There is also a relationship between an event and a given symbolic system. In this local cosmology, it is common to use methods to "divine" the weather. Beside the stars, cosmology also involves "animal professors". The behaviour of animals is mentioned in relation to forecasting the weather in the short and medium term. Forest dwellers accumulate this type of knowledge through their practical life in the forest (Mesquita, 2012).

Many people we questioned said the animals had changed their behaviour because of the current "messiness of the weather". They believe animals "have [had] science" or a particular understanding of the weather since the start of the rubber producing era, but are currently "making mistakes". This did not happen before the current changes in the weather. Without their normal references, animals can no longer inform humans about the weather, and are having to "learn everything anew, just like everyone else, because the weather has changed and no longer determines the actions of the animals, poor things".

The forest dwellers attribute ethos and sociability to certain animals, as they do to humans. Many animals are understood as people might be, because they act like them. Many inhabitants report that they have learned the language of a particular animal. Some even understand the language of a particular toad or a monkey species. This allows them to gain some knowledge from these animal "professors", who are currently themselves in the process of relearning new local realities.

This could be termed native science. Lévi-Strauss wrote in *Totemism* (1962) that people may be moved by the necessity or desire to understand the world around them, its nature, and the society in which they live, and that to achieve this objective, they act via intellectual means as a philosopher would or as scientists do.

Conclusion

Governments should take this native science into consideration to give them a better understanding of local realities before taking action, and before putting into practice mitigation and other policies related to climate change.

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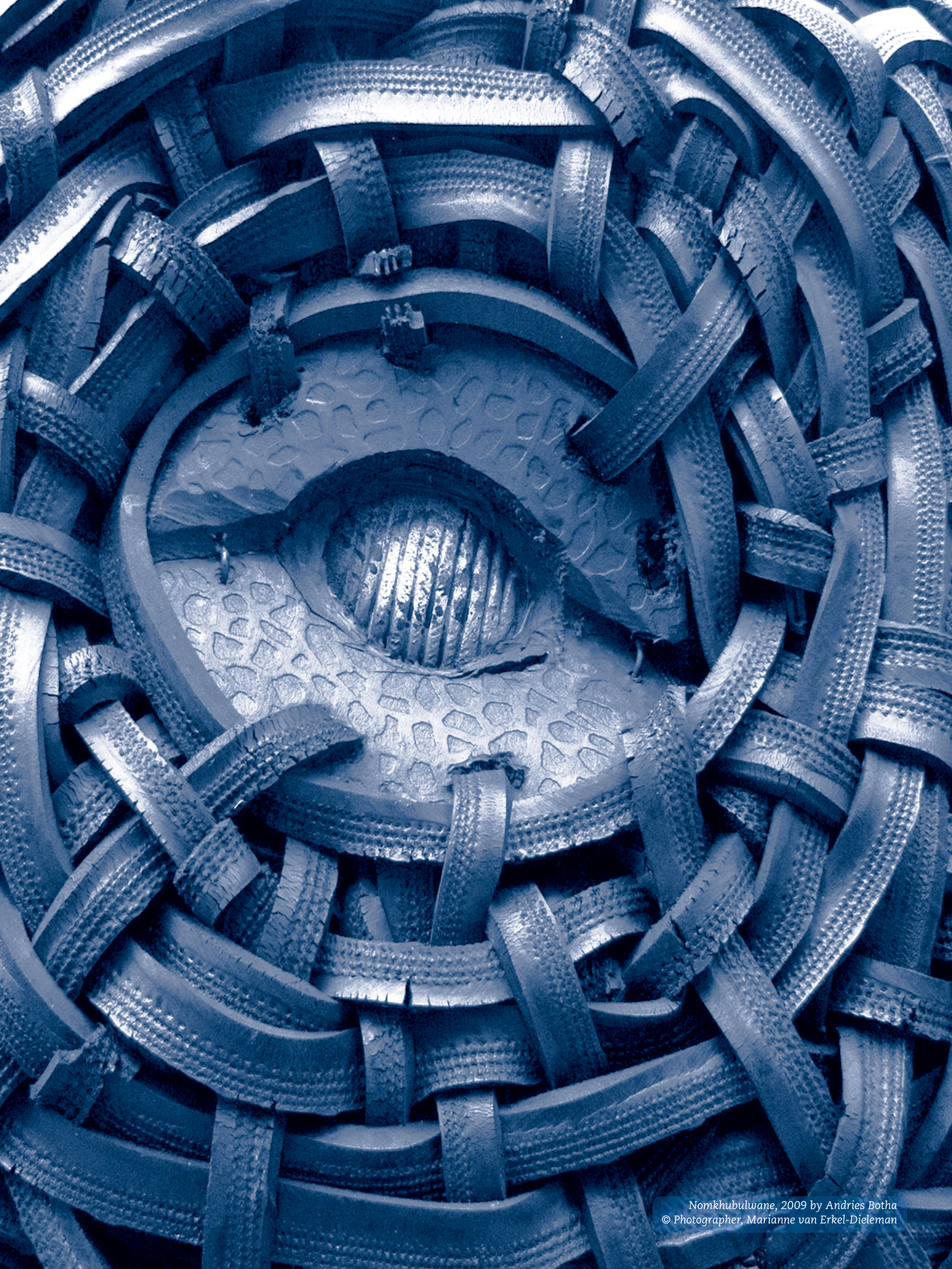

Nomkhubulwane, 2009 by Andries Botha

Part 4

Conditions and visions for change and sense-making in a rapidly changing world

World Social Science Report 2013
Changing Global Environments

41. Possibilities and prospects of social change in response to the environmental crisis

Introduction to Part 4

by
Susanne Moser

Part 4 focuses on visions of change, particularly the role of technology and shifts in economic policies in shaping the future; conditions of change: that is, the drivers and barriers to changes in human behaviour; and interpretation and subjective sense-making, exploring how individuals and societies perceive and understand the changes occurring around them.

Humans are living a paradox. The global environment and its constituent parts are changing at an accelerating rate, all because of the collective impact of more than 7 billion people consuming the planet's bounty – albeit at different rates – with seemingly little regard for its long-term sustainability. At the same time, society's progress in reducing that impact is "glacially" slow – a metaphor the English language must soon let go of.

Part 4 focuses on understanding the processes of social change that drive, are impacted by, and respond to these environmental changes, and on how we make sense of change in the world around us. The very diverse contributions to this part are grouped under three headings. The first – visions of change – addresses the first component of Cornerstone 3. Contributions here imagine the role of technology and shifts in economic policies in shaping a better future. The second heading – conditions for change – integrates perspectives on personal and local change to global and systemic shifts in human behaviour, drawing largely on psychology, sociology, and integrative studies for human behaviour and social practices. The third heading – making sense of change – includes a number of articles on interpretation and subjective sense-making (Cornerstone 4) that provide a sketch of how individuals and societies perceive and understand the changes occurring around them.

Part 4 – while unable to be comprehensive – brings together a number of contributions that point to important progress being made by the social sciences. But it also points to the challenges that remain in understanding social change and in making this knowledge useful and actionable to decision-makers.

Visions of change

The first set of contributions speaks to visions of change, the images of a future we may want to strive for and that may inspire and guide us. Turok and Borel-Saladin, in their critical assessment of three major documents on the "green economy", speak to the need for an inspiring, positive vision of the future that is inclusive of North and South. Vision and implementation tools and measures are needed, they argue, to show that it is possible to benefit economically from transitioning to a low-carbon, highly efficient economy without degrading environmental and social conditions. Yet how incremental or radical a socially emancipatory "green economy" really is will depend on nations' interests, willingness, and commitment to making the necessary tough choices.

The contribution from Muchie and Demissie focuses on the promise of nanotechnology, while Maguire and colleagues take an optimistic but critical look at green chemistry. They explore the potential of advancing green chemistry as a design philosophy in which the production, use and disposal of chemical substances no longer results in toxic hazards. The authors call on the social sciences to help chemists become more reflexive about their enterprise, and produce more socially robust knowledge, superior product design, more effective communication between industry and citizens, and greater policy support among stakeholders.

Many other technologies (such as information communication technology, biotechnology, robotics, new sources of energy) and social interventions, besides economic policies and measures (such as democratisation, education, empowerment or political strategy) could be subject to social analysis. Many social scientists in fact have done just that (e.g. Dryzek, 2011; Giddens, 2009; Jasanoff, 1995). Thus, the contributions included here are limited and selective. Moreover, perhaps by accident, the visions of change presented are all positive, maybe even utopian. They do not break with past paradigms and dominant beliefs, but represent continuations and evolutionary enhancements. Such cultural narratives are seductive, socially reinforced and powerful, especially at a time when many trends are not encouraging. But as O'Brien (2012) urged, the social sciences, not questioning these paradigms and beliefs or envisioning possible alternatives, can create blind spots which can give rise to unanticipated negative consequences, social dispute and stalemate. Historically the social sciences have played this much-needed role: for example, questioning the technocratic implementation of new and risky technologies (Jasanoff, 1986), over-confidence in grand techno-economic experiments such as the Green Revolution (Shiva, 1991; Glaeser, 2011), or the inherent contradictions in modernity's promise of a controllable future (Beck, 1992) and "sustainable growth" (Mol, Sonnenfeld and Spaargaren, 2009). Much could be gained from bringing this traditional capacity to bear on possible interventions to mitigate global environmental change.

Conditions for change

The largest set of contributions to Part 4 addresses the questions of what motivates behaviour and social change, what the barriers are, and how change unfolds. Perspectives offered here range from the individual, household and local levels to the national, international and global or systemic levels. Collectively, they suggest that the social sciences actually do understand much about how complex and embedded human behaviours and practices are (e.g. Shove, 2003) and why and how they can be changed (e.g. Gifford, Kormos and McIntyre, 2011; Whitmarsh, O'Neill and Lorenzoni, 2011; APA, 2009).

Weber reviews major psychological theories on individual behaviour change. She lays out a set of coherent and mutually reinforcing insights into the innermost drivers of change, information processing and decision-making in individuals, as well as the range of inner and outer barriers to realising a particular behaviour. Recent work in evolutionary psychology (van Vugt and Griskevicius) looks at the deepest causes of human behaviour, adding considerable explanatory power to our understanding of why humans think and act the way they do, and how behaviour change interventions can be made more effective. Head and colleagues then place individuals in the social and structural contexts in which they exist. They unpack the household unit to better understand household dynamics, everyday practices, and linkages between individuals and wider influences, and uncover possibilities for more effective behaviour change interventions. Similarly, Feola examines the behaviour of individual smallholders in their socially and environmentally embedded structures, in the context of the use of agricultural pesticides. Using process-based modelling, Feola brings social-ecological systems approaches to life with insights into decision-making, capturing the feedbacks from peers, the environment and macro-scale influences that affect an individual's choices (see also O'Brien, Part 1).

Gutberlet and Song both take behaviour change to the neighbourhood and community levels. Song examines a neighbourhood-based effort in Shanghai, China, to increase participation in recycling, and highlights individual, structural and cultural obstacles to behaviour change as well as social influences that help overcome them. Gutberlet describes a community-based co-operative engaged in waste recovery in Brazil, emphasising the social and economic co-benefits that can motivate behaviour change and support more fundamental empowerment and social change.

Urry takes a systems perspective on the carbon-intensive socio-technical systems that underlie the "Western lifestyle", and the potential to halt and reverse their environmentally destructive momentum. He shows how the path-dependencies in these systems constrain the options and effectiveness of individual behavioural choices, and argues that the way out of such system lock-in is to develop a vision of feasible, attractive and visible low-carbon lifestyles and systems to replace current outdated models.

Together, the contributions to this thread show that there is no one all-determining independent driver or scale from which to initiate social change. Nor is there any monolithic constraint on change. Instead, change is always the result of complex interactions and is affected by multidirectional and multifaceted influences, motivations and barriers, as well as direct and indirect feedbacks from the social and natural environment (see Part 2). No single intervention, and certainly not the provision of scientific information alone, will suffice to bring it about.

Making sense of change

The contributions on sense-making give a bird's-eye view of how individuals perceive, understand and interpret what is happening in their environment, and provide interesting comparative insights across the world. As such, they touch on the personal and collective values, beliefs and worldviews that underlie people's experiences of, and responses – or lack of response – to, processes of global environmental change. However, they do not fully reflect the existing and emerging social science research on the psychological and social processes that shape and change cultural values and worldviews on the environment (e.g. Dietz, Fitzgerald and Schwom, 2005; Leiserowitz, Kates and Parris, 2006; Crompton, 2011).

Smith, and Johnstone and colleagues, begin with cross-national surveys investigating concerns and attitudes toward environmental issues in general, and climate change in particular. Smith finds limited concern for environmental issues in general, though climate change has risen to the top of concerns in many countries. Johnstone, Serret-Itzicsohn and Brown's findings illustrate variable, but in general positive, attitudes towards pro-environmental behaviour changes. Many studies have shown that such positive attitudes and concerns are essential but insufficient to guarantee political or behavioural engagement, given the barriers that exist and the common observation that individuals tend to pass on responsibility for tackling climate change to policymakers.

Abbas and colleagues report on two international surveys of youth to understand young people's concerns, interests, aspirations, fears and hopes for the future, and the barriers they face to living more sustainable lives. UNESCO's educational efforts and those in French schools (Arnould) hint at the possibilities of affecting young people's abilities and aspirations. Many of their findings mirror those emerging from Rogers' report on the Field Hearings project, conducted in 34 communities in Asia, Africa and Europe, which aims at having poor people's voices included in high-level policy processes. Findings reflect important improvements in poor people's lives (see also Sachs, Part 1), but also a long list of worsening trends in the environment, governance, and economic and social conditions. Finally Buckland, in summarising the creative work of the innovative project Cape Farewell, describes the crucial role artists can play in articulating and visualising scientific findings and how people vision and make sense of the future.

Together, these contributions suggest that sense-making takes place as each of us is embedded and steeped in certain social and cultural environments (media, education, upbringing, organisations, neighbourhoods, peers and so on) that reinforce some values and worldviews, and contest or reject others. Much remains to be learned about how rapid environmental and socio-technical change will affect our ways of sense-making, and how these social processes interact with personalised experiences and psychologies. The contributions here also hint at indications of "useful" social discontent, particularly among youth. They point to the role of education in shaping the values of future generations from an early age, which can help redirect preferences and inclinations while instilling empowering skills to enact them.

Conclusion: Call on the social sciences

Taken together, the contributions to Part 4 reveal rich insights into the visions and conditions of change, but also show that no single discipline or level of investigation can capture the complexity of how change occurs. In this synthesis, a coherent story of individuals richly and dynamically embedded in households, communities, socio-technical systems, economies and cultures begins to emerge. This story goes a long way toward explaining the paradox of how the social drivers of global environmental change persist, or at least change only slowly, while the environmental crisis continues to unfold rapidly. Yet so much empirically rich social science research is still small-scale or single-scale and monodisciplinary. More research is needed on the power and embeddedness of individuals and the cross-scale connections in processes of change.

Similarly, there is a need to better understand how both deliberate and unintended changes unfold. For example, we see the power of participation, social capital and community engagement at small scales, but why is there not more investment in proven ways of empowerment and social capital building? How can they be scaled up? Is there a social tipping point beyond which big transformational change can occur?

The contributions collected here also suggest the question of whether there may be an implicit call for a "theory of change in everything" here. Is an overarching theoretical framework for social change (driven by hierarchy theory, systems thinking and the like) required at all levels, whereby change processes at different levels of social organisation are somehow linked together?

Particularly in the area of sense-making, there are important knowledge gaps to close through closer collaboration and integration of the "mainstream" social sciences with subdisciplines which are currently considered marginal to the core (eco-psychology, depth psychology, political ecology, political psychology and many more). Such integration could bring to the surface deeper drivers of change and sense-making, as well as the inadequately considered power dynamics of everyday life and big-stage politics. Finally, there is significant opportunity for the social sciences to work more closely with the humanities, for example to better understand historical social change processes and cultural narratives.

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42. Promises and pitfalls of the green economy

by
Ivan Turok and Jacqueline Borel-Saladin

The green economy is an important feature of policy discussions around the world. It is portrayed as part of the solution to the global economic crisis, and as an innovative, efficient means of advancing the climate change agenda. It promises a targeted economic stimulus to launch the transition to a low carbon economy and spur long-term prosperity based on radical new technologies and improvements in resource efficiency. Clearly, this is a seductive idea worthy of careful scrutiny by social scientists.

Introduction

The green economy encompasses the development potential of interlinked natural and human systems. Natural systems are fundamental to regional economies based on agriculture, forestry, fisheries and tourism. Manufacturing and advanced service economies also depend on natural resource inputs in the form of energy, raw materials, clean water and fresh air. The green economy focuses on improving rather than undermining the material conditions upon which human systems depend.

This article explores the arguments of three major intellectual contributions by leading global institutions aimed at setting the agenda for environmental and economic policy in the years ahead: The United Nations Environment Programme's (UNEP) *Towards a Green Economy* (2011), the Organisation for Economic Co-operation and Development's (OECD) *Towards Green Growth* (2011), and the World Bank's *Inclusive Green Growth* (2012).

A bold vision

The green economy offers a positive vision of the future (Hallegatte et al., 2011; Pollin et al., 2008), in contrast to the apocalyptic perspective common in the environmental literature (Jackson, 2009; Meadows, Randers and Meadows, 2004; WCED, 1987). By identifying opportunities for progress, it is likely to have more potential for inspiring change in citizens and decision-makers than the paralysis that often stems from fear and negativity. The basic point is that something can be done to reduce the degradation of natural resources and ecosystems, while simultaneously improving human well-being. The emphasis is on pursuing the combined benefits of interactions between the economy and the environment, rather than accepting trade-offs and compromises.

The notion also includes ideas about how progressive change may be brought about: that is, the policies and instruments that will achieve green growth, including taxes, subsidies, direct investment, regulations and capacity building, which may be aimed at producers or consumers. A fundamental principle is that attaching a more appropriate monetary value to natural capital should help reduce its exploitation and degradation (UNEP, 2011; World Bank, 2012). The use of pricing instruments is apparent in carbon taxes, tradable carbon permits and the removal of fossil-fuel subsidies. Pricing strategies may encourage firms or households to substitute green products for brown. Green products are less harmful to the environment, less resource-intensive to produce, and generate lower levels of waste, pollution and greenhouse gas emissions. Better information, awareness raising and the enforcement of tougher standards and regulations may also be required to influence perceptions and reduce behavioural resistance to greening measures. Where markets are weak or nonexistent, as in impoverished rural communities, investment in building new institutions may be required to launch more sustainable forms of development.

Another feature of the green economy is that its basic principles are applicable to developed and developing economies alike. Both share an interest in harnessing the potential of improved environmental outcomes to enhance human welfare and raise living standards, and so to reap the synergies of economic and environmental action. The green economy is a kind of umbrella concept that could draw together diverse sectoral, economic and territorial interests around a common agenda.

The staunchest supporters suggest that greening the economy could launch the next wave of global growth (Moody and Nogrady, 2010; von Weizsäcker et al., 2009), or even the next industrial revolution (Rifkin, 2011). They argue that the rising prices of energy and mineral resources will lead to dramatic improvements in efficiency and productivity through better designs and new operating systems. A simple example is the Internet-enabled 3-D printing process that allows cost-effective manufacturing in small batches anywhere in the world. Other examples may emerge from new disciplines such as green nanotechnology, industrial ecology, green chemistry and biomimicry. A co-ordinated international green growth strategy involving investment in research and development and support for practical applications could in principle generate a profusion of disruptive new products and processes with transformative economic and environmental effects.

The OECD is more restrained, but endorses the idea that "the core of transforming an economy is innovation" (OECD, 2011: 51). It gives examples of solar power, microhydro power and biofuels that have resulted in important increases in energy supply and self-sufficiency in developing countries. The World Bank (2012) supports green industrial policies to develop new technologies that help to decarbonise the economy. Both organisations recognise the need for complementary financial instruments, such as long-term loans and equity funds, which can take a patient and broad view of the returns from such investments.

Because of the need for early and far-reaching action to mitigate climate change (OECD, 2011), the speed and scope of technology diffusion and adoption are just as important as the development of new products and systems. In the past, environmental technologies tended to be exchanged between developed countries in the North, which limited their impact. Green technology transfers between countries in the South will become increasingly important, given the greater similarities in their circumstances and their need for more appropriate and affordable solutions. Various forms of international financial support and collaborative pacts between governments could facilitate such arrangements.

Creative thinking also extends to the protection and restoration of natural ecosystems. New systems of planning and management are needed that respect and value the services they offer, such as clean water and fresh air (OECD, 2011). Ingenuity is also essential in large-scale, long-lasting physical infrastructure, because it may lock in unsustainable patterns of material flows and consumer behaviour for decades (World Bank, 2012). This is vital in the rapidly urbanising countries of Asia and Africa, where the biggest environmental effects can be expected in the next few decades. Innovation is required in constructing energy-efficient buildings, retrofitting existing structures and introducing mass transportation systems. Greening the construction sector, waste recycling, and low-tech renewable energy generation could all generate substantial numbers of jobs because they are labour intensive (UNEP, 2011). The necessary tools for change include setting new norms and standards, creating financial incentives for producers and consumers, and raising awareness through demonstration projects and promotional campaigns.

Questions about the green economy

A fundamental question is whether greening the economy will achieve enough to alter the current unsustainable trajectory of the global economy and enable it to stay within the "safe operating boundaries" of the planet (Rockström et al., 2009; Bina and Camera, 2011; Victor and Jackson, 2012). In other words, will the scale of change from "business as usual" be sufficient to prevent excessive global warming and other environmental catastrophes, bearing in mind continuing population growth and pressures to increase consumption? Can a new sustainable development path be engineered by manipulating resource prices and stimulating new technologies? Or does the underlying market-based, short-term, growth-oriented paradigm of the global economy need to be replaced?

This is a hugely important but complicated set of questions. One answer is that there are different versions of the green economy, each implying different levels of intervention and different outcomes. They range from minor incremental reforms to major restructuring and transformation of the system. The three reports discussed here do not address the questions explicitly. They provide a range of policy approaches and tools from which governments can choose, depending on their economic conditions and political ambitions. The simple answer to the questions, therefore, depends on what aspect of the green economy is pursued, and how vigorously. The concept is not inherently conservative or radical, but is open to different forms and degrees of action, depending on local, national and international support and commitment.

A second question concerns the social pillar of sustainability. Can greening the economy have a substantial impact on poverty and inequality? The three reports maintain that the green economy can address all three dimensions of sustainable development, although the social aspects are least developed conceptually. All three advocate pro-poor policies in particular situations. One response involves the better management of natural ecosystems, such as soils, forestry and fisheries, on which the welfare of many subsistence communities depends. Another is to improve access to basic services, such as drinking water and sanitation, in order to improve the quality of life. These actions are discussed mainly in terms of poverty relief rather than sustainable routes out of poverty through decent jobs and livelihoods.

The issue of equity between social groups and territories is a related concern. The continuing importance of competition and market forces in most versions of the green economy means that inherited strengths and assets offer sizeable advantages to individual firms, households, communities and nations; some economic agents and interests are bound to benefit, while others will lose out in the transition to a green economy.

These reports tend to minimise the impact of job losses in industries and localities dependent on fossil fuels, arguing that they would be balanced out by growth and the creation of new jobs in new green industries. This assumption ignores the likelihood that the new industries would emerge in places better suited to their specific needs, and may call for different occupations and skill-sets. There are few reasons why industries based on renewable energy (solar, wind and hydropower) would be sited alongside those based on coal, oil and other minerals. There would also be sizeable adjustment costs for those affected by the restructuring and for future generations within their local communities.

Without a substantial transfer of resources to developing nations, most will struggle to raise the funds required to invest in the transition to a green economy. Many of the new technologies have high upfront capital costs. Mature brown production techniques (those with more damaging consequences for ecosystems) tend to be more cost effective in the short term because they externalise their environmental costs. Considerable effort will be required to develop new collaborative solutions, such as voluntary patent pools to leverage intellectual property (OECD, 2011). Multilateral action may also be necessary to give poorer countries access to other green technologies, such as new medicines to fight infectious diseases. Experience suggests that measures that threaten powerful commercial interests encounter fierce resistance.

There is a technocratic slant to these reports which verges on assuming that if natural resources are priced correctly, the economy will green itself. There should be operating-cost savings from some green technologies and more efficient systems of production and distribution, but these do not mean that the green economy will emerge automatically. In the face of considerable inertia, vested interests and investments already made, it is likely that co-ordinated political action will be required to achieve the systemic changes envisaged. Dedicated efforts will also be needed to restore and regenerate natural environments that are already degraded. The green economy discourse is rather disconnected from the realities of climate change, the disruption caused to communities, and the considerable costs involved in preventing disasters, recovering from extreme events and adapting to shifting weather conditions.

The reports recognise that governments have important roles to play in establishing the conditions for the green economy to emerge. However, there is little discussion of the need for leadership across all sectors of society. Leadership will be necessary to avoid self-interest, advocate higher business costs in some instances, and encourage consumer sacrifices and lifestyle changes for those with large ecological footprints if society is to achieve the collective good of a low-carbon economy. There is also little consideration of the strategic capabilities needed to negotiate the transition, by means of social contracts and other binding agreements between key economic stakeholders within and between nations.

Conclusion

The green economy offers an intriguing vision of change, with potential practical solutions to some of the major challenges of our time. The concept has probably raised the profile of environmental concerns in mainstream economic and development policy more than the idea of sustainability ever did. In other words, it appears to be an idea whose time has come. Yet it also needs further development, including conceptual clarification and a stronger evidence base grounded in our already degraded environment (MEA, 2005; IPCC, 2007). The extent to which there are genuine synergies rather than trade-offs between economic and environmental objectives is a particular gap in knowledge. Greening the economy in ways that are inclusive and equitable are further challenges. Understanding the diverse possibilities of the green economy in different local and national circumstances is also crucial. Integrating different elements of the green economy to create a new vision of sustainable cities would be particularly worthwhile. Finding the means to scale up effective action to achieve systemic global change is, of course, the biggest challenge of all.

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Viewpoint

43. Making sense of techno-optimism? The social science of nanotechnology and sustainability

by
Mammo Muchie and Hailemichael T. Demissie

Using nanotechnology, scientists can change the atomic configuration of matter. New materials have seemingly magical applications, with promise that ranges from harnessing energy from the sun to eternally recycling materials by breaking them down into their atomic building blocks and reassembling them. It is vital, as UNESCO has urged, that social scientists engage fully in debates on nanoethics, and contribute to policy and decision-making processes concerning the use of nanotechnology in achieving sustainability.

Introduction

Our geological calendar is changing fast. The end of the Holocene period and the beginning of the Anthropocene, as the current geological time is known, should have long been official. Paul Crutzen, the Nobel Prize winner who coined the term Anthropocene, is convinced of the power humanity is wielding over nature: "It is no longer us against nature; instead, it's we who decide what nature is and what it will be" (Walsh, 2012).

In nanotechnology, Crutzen's words appear even more literal. Nanotechnology gives humanity unprecedented control of matter at the level of atoms and molecules. It gives us the capability to change the atomic configuration of matter; the new substances and materials it produces have seemingly magic applications. Nanotechnology products – ranging from stain-proof outfits to scratch-proof paints, from smart water filters to space elevators, from self-cleaning glasses to printable, self-healing body tissues – are already available on the market, or soon will be. As another Nobel Prize winner and nanotechnology pioneer, Richard Smalley, said, "[t]he list of things you could do with such a technology reads like much of the Christmas Wish List of our civilization" (Schummer, 2006).

At the top of this wish list for humanity are solutions to achieve sustainability. Attempts to use sustainable development to resolve the tensions between economic growth and environmental protection, between profit- and market-led development, and between intragenerational and intergenerational equity, have yielded little or no result.

Nanotechnology offers the potential to reconcile the three sustainability issues: economic prosperity, environmental quality and social equity. Promises range from harnessing energy from the sun via super-efficient solar energy harvesters installed in offices, houses or even painted on roads, to removing carbon from the atmosphere, or eternally recycling materials by breaking them down to their building blocks and rebuilding them again, and to constructing materials that will never deteriorate in quality or functionality.

The list is inexhaustible, with new applications appearing on a regular basis. However, trying to generalise about specific applications of nanotechnology will only give an incomplete picture of its potential. Nanotechnology promises greater control of matter, and solutions to many of our problems (Fogelberg and Glimmel, 2003).

As noted by the UN Millennium Project Task Force (2005), the relevance of nanotechnology for sustainability is based not on any one application, but on the nanotechnology method and its general features:

> [Nanotechnology] involves little labor, land, or maintenance; it is highly productive and inexpensive; and it requires only modest amounts of materials and energy. Nanotechnology products will be extremely productive, as energy producers, as materials collectors, and as manufacturing equipment.

These features validate the claim that nanotechnology, if properly handled, will lead the next industrial revolution, ushering in a new, ecologically sound logic for industrialisation and manufacturing.

Definitions

Nanotechnology has been defined in various ways, and with varying degrees of stress on the elements of the definition. The elements that feature most prominently are the scale at which the technology operates and the unique properties of matter at this scale. Nanotechnology is broadly defined as science and technology operating at the nanoscale – mostly confined to 1-100 nanometres. A nanometre is one-billionth of a metre, and the diameter of a human hair is said to be about 80 000 nanometres. It is widely held that it is at the range of 1-100 nanometres that matter exhibits strange properties that do not exist at larger scales. However, this not always true, as some new attributes emerge at a larger scale. No clear definition of nanotechnology has yet been agreed; even the need for such a definition is questioned (Maynards, 2011). Because of this, a UNESCO report warned that "nanotechnology will be defined by the corporations and nations that pursue their own interests most vigorously" (UNESCO, 2006).

Despite the lack of a precise definition, nanotechnology is on the verge of attaining the status of a broad "protodiscipline", with several disciplines taking the "nano" prefix: nanomedicine, nanobiotechnology, nano-electronics and so on. While nanotechnology itself is a science and engineering field, its focus extends to other disciplines, the social sciences included. Given the lack of agreed nomenclature, the social science aspects employ an awkward terminology simplified by the use of acronyms, including NELSI (nano, ethical, legal, social implications), ELSA (ethical, legal, social aspects), SEIN (social, ethical implications or interactions of nanotechnology) and even NE^{3}LSI (nanoethical, environmental, economic and legal and social issues).

However, nanoethics is the more widely used term for the social science of nanotechnology, and refers to nanotechnology issues in general. Allhoff and Lin (2007) describe nanoethics simply as "something like the ethical, social, environmental, medical, political, economic, legal issues and so on, arising from nanotechnology". The scope of nanoethics is broad, and would profit from refocusing on sustainability. It is rightly argued that nanoethics should be treated as "another angle on the question of sustainable development" (Hunt, 2006).

Weighing up the risks

As nanotechnology continues to deliver on its promises, sceptical views of the claims made on its behalf are giving way to other issues such as the ownership of the technology and distribution of the risks and benefits of it the technology. The role of the social sciences as a means of analysis and articulation of uncertain situations is especially pronounced with respect to nanotechnology. The expectations are high that the social sciences will provide the knowledge base and critical analysis for attitudes towards nanotechnology, that they will nurture and raise public understanding of emerging technologies, and promote and facilitate the sustainability solutions that nanotechnology promises. The social sciences will need to challenge sceptical attitudes towards nanotechnology. The blanket labelling of new technology as "risky" is a conventional precautionary measure taken when we face uncertainty, but this assumption, and the regulation based on it, have caused undue delays in the use of beneficial technologies. The cost of delaying nanotechnology needs to be balanced against the cost of maintaining the status quo as a precautionary measure.

The chances of achieving environmental sustainability without new technologies are disappearing fast. The many international environmental laws dealing with issues ranging from biodiversity to climate change, from ozone protection to stopping desertification, reiterate the significance of technological solutions. Indeed, it may be asked whether environmental conventions are anything more than the embodiment of techno-optimism?

The social science of nanotechnology needs to take advantage of this optimism. It should avoid the usual debates on risk regulation by elevating concern about the distribution of benefits to the level at which risk issues are treated. These new technologies have so much potential that the previous risk-based regulation of technology is now asked to explore ways to manage the benefits. Indeed, the social sciences will need to ensure the equitable distribution of the benefits of nanotechnology. The answer to the question "Who benefits from the technology?" is critical when deciding the course the technology should take. The bad publicity that greeted genetic modification (GM) technology was not so much about risk as it was about the question of who benefits from its use. The GM story demonstrates that it was essentially politics and public attitude – the issues belonging to the social sciences – that were in dispute rather than the physical science behind the technology. The recent shift in attitudes towards GM technology is largely due to the role the social sciences have played in fuelling the debate.

The lessons from the GM experience have been learned. The risk-wary European Union (EU), for example, has a far more positive attitude towards nanotechnology than it did towards GM technology. EU regulation is clear that there will be none of the blanket risk-management decision that campaigners are demanding (European Commission, 2012). It has rejected the oversimplification that the smaller materials get, the more reactive and toxic they are. The EU approach avoids the assumption that all nanotechnology products may not be safe, opting instead to carry out risk assessments on a case-by-case basis.

This is not the first time that risk management concerns have been used as an excuse to resist new technology. This approach highlights important tensions between using the technology for societal benefits, and the desire of shareholders to maximise profits. Through public policies, laws and regulations, the state will need to provide guidance on using emerging technologies, and negotiate a pathway between such tensions.

The social sciences have a key role to play here. They will need to analyse the convergence between the goals of global social movements, of which the sustainability movement is the most important, and the promises of nanotechnology and related public policy, and then communicate this analysis widely. Key issues to resolve include setting the right priorities, identifying the goals the technology is pursuing, and addressing key questions such as why we need nanotechnology and how best it might be used. Social science research should explore, examine and theorise on its role in catalysing the development of useful nanotechnology and in protecting it as a global social asset from narrow interests determined to control it as a means of power.

Conclusions

Social science scholarship accepts the need to move from "research as usual" towards research that is more involved and has greater impact and relevance (O'Brien, 2010). Science and technology provide solutions for societal challenges and help set values. They are often ahead of the social sciences, which are sometimes said to suffer a "cultural lag". According to Habermasian critique, social sciences have not developed as quickly as natural sciences (McCarthy, 1996: 5), and scientists have a tendency to exploit this. The social sciences respond by reasserting their key role in guiding the public's interpretation of technology and in setting the values that need to be pursued (Lee, 2009: 245, 251). Indeed, UNESCO has urged social scientists to take the initiative and become more engaged in nanoethics, without waiting to be asked or being forced to do so in response to the public or to new technological developments (ten Have, 2007).

A more compelling reason for the social sciences to become involved is to open up technological trajectories and influence policy decisions in achieving sustainability. While humanity made do without sufficient ethical, legal and regulatory tools for new technologies in the past, it may not be so lucky in the future with respect to nanotechnology. Nanotechnology, which is converging with other technologies, marks the transition from the "age of discovery" to the "age of mastery", leading to profound and comprehensive impacts (Kaku, 1998). The exponential changes happening now are so radical that they "put the future quite literally beyond our capacity to foresee it" (Broderick, 2001). Besides, the notion of finality – a trend towards a "final theory of everything" – keeps recurring in analyses of the nanotechnology pathway.

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World Social Science Report 2013
Changing Global Environments

44. Bringing new meanings to molecules by integrating green chemistry and the social sciences

by
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Megan R. Schwarzman and Michael P. Wilson

The chemical industry, perhaps more than any other, needs to change if it is to be acceptable and viable in a greener, more sustainable world. Chemists and chemical engineers are taking up this challenge through "green chemistry," and social scientists with backgrounds in economics, politics and law, along with environmental health scholars, are increasingly collaborating with them to produce socially robust knowledge through interdisciplinary scholarship.

Green or sustainable chemistry[1] is "the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances" (Anastas and Warner, 1998: 1). It is a "design philosophy" (Mulvihill et al., 2011) that focuses on preventing – at the molecular level – the health and environmental problems associated with industrial chemicals. Green chemistry is the science of developing chemicals and materials that not only require less energy, water and raw materials in their production but also are *inherently* safe for biological and ecological systems. It marks a sharp departure from the current industrially embedded approach to risk assessment and management, which seeks to control risks through controlling exposures rather than eliminating inherent hazards.

Green chemistry is mainly associated with the fields of chemistry and chemical engineering. However, we argue that it will require the efforts of a much broader community, including environmental health scientists, policy and legal scholars, political scientists, economists and others in the social sciences to fully realise its transformative potential. We therefore advocate new research practices that bring social scientists, chemists and environmental health scientists together in interdisciplinary scholarship.

Introducing green chemistry

The origins of green chemistry can be traced back to chemists' critiques of the definition of "success" in chemical processes. Traditionally, success was based on percentage yields and satisfactory costs, with remediation of waste left as an (often costly) afterthought.

Beginning in the 1970s, increasingly stringent environmental regulation led to greater prominence for new voluntary industry criteria, such as input efficiency and zero-waste processes. Following the United States Pollution Prevention Act of 1990, these ideas were codified in *Green Chemistry: Theory and Practice* (Anastas and Warner, 1998). This defined the field and outlined 12 non-regulatory design principles that address the lifecycle of industrial chemicals, focusing primarily on the perspectives of working chemists.

Guided by these principles, green chemistry has found a home in many academic and industrial settings. Because chemistry is central to most economic sectors, green chemistry technologies have potential applications far beyond the chemical industry itself, for example in pharmaceuticals, food processing, energy, electronics, packaging, and consumer products for cleaning and personal care. Examples of green chemistry applications in industry include replacing organic solvents with condensed carbon dioxide in semiconductor manufacturing, doing dry cleaning without the use of perchloroethylene, and developing processes to manufacture plastics from biomass instead of oil as a feedstock (Manley, Anastas and Cue, 2008).

In contrast to the exposure reduction approach which dominates the risk assessment and management paradigm of present-day regulators and business, green chemistry aims to reduce or eliminate any chemical that poses a hazard. Further, within green chemistry the notion of hazard is interpreted broadly. Along with traditional toxicological concerns such as carcinogenicity and mutagenicity, and new ones such as endocrine disruption, it also includes damage to public goods, such as a substance's ozone-depleting and global-warming potential. The principles of green chemistry therefore also aim to maximise efficiency by reducing the consumption of energy, water and non-renewable feedstock materials. As a result, green chemistry is a fundamental component of sustainable development (NRC, 2006; Mulvihill et al., 2011). It provides conceptual integration for a wide range of seemingly disparate global issues, such as occupational and environmental health, energy and resource efficiency, and climate change.

Recognising green chemistry's transformative potential

If every chemical technology that relies on a hazardous substance is a target for a green chemistry solution, how should priorities be established, and how should the success of new green chemistry technologies be defined? Who should make these value-laden decisions? The approach taken in the United States to developing green chemistry has reinforced the autonomy of chemists, chemical engineers and industry actors, while explicitly endorsing market forces and eschewing regulation (Woodhouse and Breyman, 2005; Iles, 2011). "Unlike regulatory requirements for pollution prevention, Green Chemistry is an innovative, non-regulatory, economically driven approach toward sustainability" (Manley et al., 2008: 743).

This approach may have seemed apolitical to chemists, who on average may be less comfortable than social scientists with issues that are regarded as political. However, as social scientists have long noted, choices that deliberately avoid apparently political activities are themselves inherently political because they arise from socially and culturally embedded value judgements.

In this case, green chemists' preferred approach, via voluntary measures decided by industry, is an implicit endorsement of the status quo. It also positions chemists, chemical engineers and industry actors, inappropriately we argue, as the main arbiters of the direction and pace of change in the mix and distribution of chemical risks.

In contrast, many social scientists and environmental health scientists, who recognise green chemistry's potential to transform, may be sceptical of relying solely on a market-driven approach. They recognise that markets are structured by regulatory frameworks which, in the case of chemicals, are deeply flawed. Some have argued that "Existing policies have produced a United States chemicals market in which the safety of chemicals for human health and the environment is undervalued relative to chemical function, price, and performance" and that this has led to:

> A chemical *data gap*, because producers are not required to investigate and disclose sufficient information on chemicals' hazard traits to government, businesses that use chemicals, or the public; a *safety gap*, because government lacks the legal tools it needs to efficiently identify, prioritize, and take action to mitigate the potential health and environmental effects of hazardous chemicals; and a *technology gap*, because industry and government have invested only marginally in green chemistry research, development, and education.
>
> (Wilson and Schwarzman, 2009: 1202)

As a result, social scientists from a range of disciplines – such as science and technology studies, law, policy studies, and management – along with environmental health scientists, citizens, non-governmental organisations (NGOs) and policymakers, have joined forces "to propose credible tax incentives, regulations, and mandates; foster public debate; and begin to use the state's legitimate coercive role to reshape innovation in line with public purposes" (Woodhouse and Breyman, 2005: 219). States such as California, Washington and Oregon are passing new, if imperfect, regulations to shift the investment and innovation priorities of chemical producers away from known toxic substances and toward greener chemistries. The debate in California, for example, has focused on industrial innovation in green chemistry as a forward-looking strategy to achieve health and environmental protection as well as increased economic competitiveness (Matus, 2010). As a result, "[g]reen chemistry is beginning to emerge as a key battleground for shifting technologies toward greater sustainability," and has become a site for "epistemic politics" (Iles, 2011: 17).

In some ways, these tensions are unsurprising. They are foreshadowed by green chemists' own definition of their field, which emphasises hazard and risk, concepts that are frequently contested and which have a rich social science literature. We do not take a position on the merits of establishing regulatory regimes that would motivate investment in green chemistry. We do, however, believe it is important to recognise the way in which social scientists and environmental health scientists have engaged with green chemistry to investigate the levers available beyond the chemistry laboratory that might speed the adoption of green chemistry technologies.

Engaging social scientists as important stakeholders for advancing green chemistry

Green chemistry can benefit from collaboration between chemists and experts from other sciences and from the social science disciplines, because "sustainability demands the *integration* of multiple forms of knowledge, including natural scientific, health, social scientific, commercial, and policy, across the entire life cycle of chemicals" (Iles and

Mulvihill, 2012: 5644). An awareness of green chemistry's multi-stakeholder community (Iles and Mulvihill, 2012) enables chemists, chemical engineers and industry actors to engage with social scientists, environmental health scientists, workers, NGOs and policymakers to shape the direction of economic activity in a more acceptable and viable form. This type of collaboration has the potential to provide enormous benefits beyond what might be achieved in the laboratory alone.

Knowledge from the social sciences, and from other scientists engaged in advancing sustainability, can inform choices about what kind of research and development to undertake within a chemical enterprise. It can also shape the social parameters within which green chemistry will either flourish or remain on the margins of industrial activity. At the same time, interdisciplinary work of this nature presents inherent challenges which stem from the cultural and epistemological differences that characterise different academic disciplines.

Fruitful initiatives are emerging, however. The Berkeley Center for Green Chemistry at the University of California, in the United States, facilitates interactions among scholars from chemistry, business, engineering, natural resources, public health policy and the environmental health sciences. It continues to work on overcoming historical differences, but has collaborated successfully on joint research grants, academic and public seminars, conferences, and on building a curriculum of interdisciplinary courses. Similarly, the Green Product Design Network at the University of Oregon in the United States brings together academics and practitioners with expertise in green chemistry, business, product design and communication to catalyse innovation and commercialisation of sustainable products. At McGill University in Canada, the Centre for Green Chemistry and Catalysis includes social scientists along with chemists, and the faculties of Management and Chemistry collaborate on a sustainable innovation workshop that brings together students from the two disciplines to evaluate the environmental performance and commercial viability of actual green chemistry technologies. Linking these and similar initiatives, the Interdisciplinary Network for Green Chemistry provides a forum for dialogue among social scientists, public health scholars and chemists who seek to catalyse the implementation of green chemistry principles throughout the global chemical enterprise through innovative research and education (IN4GC, 2012).

Integrating social sciences with green chemistry

These experiences suggest that the emergence of green chemistry in the context of a multi-stakeholder community has a number of potential benefits. The first is that by working more closely with social scientists, green chemists are likely to develop a greater awareness of their own discipline and of its role in shaping the chemical enterprise – one that recognises science as a socially embedded activity permeated with value judgements. Because any technology is a mixture of benefits and risks, none of which is evenly distributed across time, space or social groups (Maguire and Ellis, 2003), chemists must take their design decisions and responsibilities seriously by exposing and questioning the trade-offs and value judgements they make. These judgments can be masked by "taken-for-granted" assumptions, heuristics and routines. Chemists and engineers, working with social scientists, can reveal and critique these assumptions using social scientific knowledge. Such a reflexive stance is especially important given the significant uncertainties and controversies that surround many chemical risks, a situation that increases the scepticism that citizens feel towards experts' claims (Iles, 2011).

Second, significant policy and industrial advances can be attained. A multi-stakeholder community brought together around green chemistry is more likely to produce "socially robust knowledge" (Nowotny, Scott and Gibbons, 2001) that can withstand both scientific *and* societal testing, because it has emerged from a transparent and participatory process (Iles, 2011). Despite its difficulties, we believe that interdisciplinary collaboration which examines problems using multiple perspectives is more likely to enable academics, industry and policymakers to produce successful interventions in sustainable technologies that support a life-affirming economy.

Experience at the University of California suggests that new ties between previously disparate actors can enable the building of new, broad coalitions to support public policies that alter the nature of economic incentives in the chemical industry by addressing demand-side issues – i.e. the data and safety gaps that are so prominent in today's chemicals markets. Such policies would increase the requirements for companies to generate and disclose information about hazards and to take greater responsibility for their products across their full lifecycle. This in turn would encourage action on supply-side issues through increased investment in green chemistry education, research and innovation, thereby eventually closing the technology gap (Wilson and Schwarzman, 2009).

Finally, the inclusion of social scientists in interdisciplinary teams engaged in the design of new chemical technologies can produce superior designs. During the design phase of a new chemical technology, "the scope of possible innovation ranges from incremental or superficial design improvements to completely redesigning the system of production – a much deeper form of innovation" (Mulvihill et al., 2011: 275). Social scientific knowledge can, for example, contribute to a more realistic understanding of how businesses and members of the public use and dispose of products. This can improve lifecycle analyses and ensure more effective priority setting in chemical policy and in green chemistry research and development. Because social scientists are sensitive to the meanings attached to molecules by different social groups, and to the distributive and ethical implications of the trade-offs between various types of hazards, they can make significant contributions to design deliberations.

Final words

Encouraging the emergence and success of green chemistry in the context of a multi-stakeholder community will present challenges and tensions, such as those associated with the debate on the merits of regulatory versus voluntary approaches to greening the chemical enterprise. Debate is healthy, and given the stakes involved in achieving sustainability, appropriate. There is evidence that the challenges of communicating and sharing information across disciplines can be overcome (Iles and Mulvihill, 2012). Green chemistry can realise its potential to transform the global chemical enterprise towards sustainability.

Note

1. Some social actors and scholars distinguish between *green chemistry* and *sustainable chemistry*, while recognising that they overlap significantly: "The term green chemistry is used commonly by academics because of the historical development of the field. The term sustainable chemistry is often preferred by industry as a way to distinguish technological innovation from the potential political overtones of the word green" (Mulvihill et al., 2011: 272). Here, we use "green" as including both.

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45. Individual and collective behaviour change

by
Elke U. Weber

Negative consequences normally lead people to change their behaviour, but the timelag between behavioural cause and many environmental impacts makes it hard for people to see the connection. Other barriers to change include lack of a fear response and habits. To promote change, new behavioural routines need to be established using default options and social imitation. Existing goal conflicts need to be minimised by better communication of the co-benefits of environmental goals. Since many people in developing countries aspire to a western lifestyle that adversely affects the global environment, different models of human happiness need to be explored.

Successful responses to global environmental challenges such as climate change will require enormous individual and collective behaviour change, on a timescale far more rapid than evolutionary change. Reluctance to change has been documented as status quo bias (Samuelson and Zeckhauser, 1988). The familiar has been tested over time, whereas change involves uncertainty and risk. Routine behaviours, including those that impact environmental resources, are automatic and require no attention, whereas change requires effort. This means that behaviour change needs to be motivated by providing positive incentives for the change, a credible threat to business as usual, and information about both the need and the means to align current reality with a desired target state.

Learning to change

Reinforcement learning (Sutton and Barto, 1998) – a form of learning from personal experience through the consequences of one's actions – is an effective way to shape behaviour, and is commonly used by parents and animal trainers alike. In the environmental domain, personal experience with the adverse consequences of climate change appears to increase people's willingness to change their behaviour (Mozumder, Flugman and Randhir, 2011), especially for those without strong prior beliefs about climate change (Weber, 2013a). People prefer, and find it easier, to make decisions when they receive information about the consequences of their potential options through personal experience rather than statistical description (Hertwig et al., 2004; Marx et al., 2007). Unfortunately for many environmental challenges, the lag times between behaviour and its consequences are long and the process is non-linear, making the relationship difficult to detect (Weber, 2013).

In addition, adaptation to slowly changing environments itself reduces the perceived need for behaviour change; this is referred to as shifting baseline syndrome (Pauly, 1995). Reinforcement learning may also be too slow in this domain, as widespread personal experience of negative consequences will only come at a time when behaviour change may no longer be able to prevent serious impacts.

Rational economic models of choice assume an ideal decision-maker. Yet human decisions are constrained by finite attention and processing capacity, making them at best boundedly rational (Simon, 1982). Cognitive and emotional limitations make humans myopic as decision-makers, with short time horizons or present bias (Hardisty et al., 2009; Laibson, 1997) and with a narrow focus on the self rather than collective well-being. Benefits of changing behaviour so that it becomes environmentally more sustainable tend to accrue over longer periods of time, but not primarily to the decision-makers themselves, and thus are not very effective motivators.

Barriers to change

Different types of barriers to behaviour change have been identified. Kollmuss and Agyeman (2002) contrast external (such as structural) and internal (such as psychological) obstacles. Lorenzoni, Nicholson-Cole and Whitmarsh (2007) distinguish between individual- level (such as uncertainty and lack of knowledge) and social-level barriers (such as social norms and expectations). Gifford (2011) lists limited cognition, ideologies, social comparisons, miscredence (distrust, reactance and denial) and perceived risks.

Weber (2013) classifies barriers by three qualitatively different processing modes that decision-makers use to arrive at an environmentally relevant decision, namely calculation-, affect-, and rule-based decisions. Risk and loss aversion (Kahneman and Tversky, 1979) as well as present bias (Laibson, 1997) discourage behaviour change when people calculate the costs and benefits of different actions, whether formally or by means of heuristic shortcuts. Affect-based processing fails to change people's behaviour, when people do not naturally worry about a hazard, for example the gradual and future risks of climate change (Slovic, 1987; Weber, 2006). Other feelings, including the impression that personal behaviour change is ineffective in the face of collective challenges that require coordinated change, also play important roles (Böhm, 2003).

Even when it is effective, behaviour change motivated by a negative affect can result in single-action bias (Weber, 1997), the propensity for a single action in response to a threat, even in situations where a broader set of remedies is called for. This is because the first action seems to remove the worry and with it the motivation for further actions. Response patterns consistent with the single action bias have been identified. In the context of changes in energy behaviour, these are often called psychological rebound effects (Ehrhardt-Martinez and Laitner, 2010). Moral balance theory (Merritt, Effron and Monin, 2010) also explains such rebound effects, where one behaviour change (such as switching from carbon to renewable electricity) provides a moral licence to decrease other energy-saving behaviour (Monin and Miller, 2001).

Instilling behavioural routines or rules that are consistent with people's personal values, and that get triggered when the decision-maker's social role or self-identity is activated, may offer the most promising route towards behaviour change (Whitmarsh and O'Neill, 2010). Role-consistent behaviour can be demonstrated and encouraged in the first instance by prominent trusted and admired sources that will be imitated until repetition turns the behaviour into a habit that no longer requires conscious attention (Weber, 2013).

Widespread social observation of new behaviours or the communication of descriptive norms by other means can lead to tipping points (Griskevicius, Cialdini and Goldstein, 2008). See Article 46 in this Report.

Barriers to behaviour change are responsible for the widely documented gap between attitudes and observed behaviour (Gifford, Kormos and McIntyre, 2011). Other predictors of behaviour, as well as attitudes in models, such as Ajzen's (1991) theory of planned behaviour, point to barriers to change and also to solutions that promote behaviour change. This includes behavioural intentions, which translate the goals provided by a decision-maker's attitudes into the means of achieving those goals. Construal-level theory (Trope and Liberman, 2010) predicts the attitude–behaviour gap, in the sense that plans for behaviour change (such as more environmentally sustainable food consumption) are initially construed on an abstract goal level that emphasises their benefits. As the time for implementation approaches, however, the construal becomes more concrete and moves to a means level, where structural and psychological barriers to change are encountered. Gollwitzer (1999) shows that it helps to anticipate and circumvent at least the structural barriers, so as to have decision-makers consider and articulate the implementation of their intentions – the specific "when", "where" and "how" of achieving their goals – at an early stage.

In the context of the global environment, attentional, cognitive and motivational limitations and material constraints are more important barriers to behaviour change than knowledge deficits about environmental challenges and their relation to human behaviour (Weber and Stern, 2011). An important exception is the lack of sufficient information about what is most effective in modifying behaviours to achieve sustainability goals (Attari et al., 2010; Gardner and Stern, 2008). This lack of knowledge is not restricted to the general public. Most social science studies of how to reduce barriers to behaviour change in the environmental domain examine high-frequency but low-impact behaviour (such as recycling or refusing plastic bags in shops) rather than high-frequency, high-impact behaviours (such as food choices or travel behaviour) and low-frequency, high-impact behaviour (like buying a car or insulating one's home) (Gifford et al., 2011).

Goal conflicts

Individuals and collectives have a wide range of often conflicting goals (Krantz and Kunreuther, 2007). The cultural context and decision-specific physical and social environment influence decisions through selective goal activation (Weber and Johnson, 2006). However, goal conflict is a barrier to change. Most individuals would endorse fighting climate change or species depletion as a goal, even when their collective action has large negative global environmental consequences, because existing behaviour patterns originate in other, widely endorsed, goals such as comfort or physical security at the individual level, or economic development at the collective level. Change designed to achieve environmental sustainability goals is seen as detracting from these more immediate and personal goals. Better communication of the associated benefits of actions that achieve environmental goals (for instance, health benefits at the individual level, or energy security and job creation at the collective level) contributes to a more accurate benefit–cost analysis of environmental policies. It is also a way of allowing people to align multiple goals, reducing the perception of losing certain, immediate and personal benefits in return for uncertain, distant and collective ones.

Tools to change behaviour

Most studies of behaviour change focus on the actions of citizens or consumers: for example, purchase or consumption decisions that affect water use or carbon emissions. While this is an important target group by virtue of its prevalence, behaviour change in other segments of the population (such as politicians, or designers of building and transportation infrastructure) may have larger impacts. Their decisions shape the regulatory, economic and physical infrastructure, which in turn influences the decisions of the general public. A better understanding of the fact that preferences are often constructed at the time a decision is made, and therefore behaviour is malleable (Lichtenstein and Slovic, 2006), has provided additional tools to achieve behaviour change. Previous tools were restricted to regulation, a paternalistic intervention that prohibits choice options that reduce individual or public welfare; policies that materially incentivise desirable behaviour by offering material rewards, thus changing the cost–benefit calculation; and information and persuasion campaigns designed to shape active decisions through facts and arguments.

Recent advances based on understanding how choices are made have suggested ways to change decisions and behaviour without conscious awareness by shaping people's choice environment (Thaler and Sunstein, 2008; Johnson et al., 2012). This includes the priming or activation of important but possibly under-attended goals, for example legacy concerns or moral imperatives (Weber, 2013). It also includes tools that guide people's attention and choices towards actions that typical processing (and myopia) would ignore, but that have greater long-term individual and social utility (Johnson and Goldstein, 2003).

Behaviour change and happiness

Research on affective forecasting shows systematic biases in people's predictions of what will make them happy (Wilson and Gilbert, 2003). Adaptation to new increases in material welfare at the individual level and in economic development at the collective level put people on a hedonic treadmill. However, positive psychology and other social sciences have been working on reconceptualising human happiness and its drivers in a more sustainable way (Seligman, 2004). As Western consumption behaviour and lifestyles serve as aspirations to the large proportion of the human population living in developing economies, widespread significant and observable behaviour change by citizens in developed countries on dimensions that impact environmental outcomes may be a very important first step towards global sustainability.

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46. Going green? Using evolutionary psychology to foster sustainable lifestyles

by
Mark van Vugt and Vladas Griskevicius

Polls show that very few people purchase green products or curb their consumption to become more green. Owing to natural selection, most humans tend to prioritise their self-interest, disregard the future, desire status, imitate others, and ignore evolutionary threats such as global climate change. All of these obstacles can, however, be overcome, or be used to promote sustainability.

Environmental polls show that while an overwhelming majority of individuals are very keen to be green, only a small minority actually purchase environmentally friendly products or curb their household consumption (Home Depot, 2010). Clearly, changing people's environmentally significant behavioural patterns is a huge challenge. Evolutionary psychologists look deep into humans' evolutionary roots for possible answers and solutions.

Natural selection has endowed humans with a psychology best suited for a hunter-gatherer lifestyle (Dunbar and Barrett, 2007). This means that a large portion of human-inflicted ecological damage may well be caused, or exacerbated, by innate psychological tendencies to prioritise self-interest, discount the future, prefer relative over absolute status, imitate others, and ignore novel evolutionary threats such as global climate change (Penn, 2003). Yet research suggests that these evolved preferences can be harnessed to help develop sustainability policies and behaviour change campaigns that can foster environmentally sustainable action (Griskevicius, Cantu and van Vugt, 2012).

Take the all-too-human concern with self-interest. Evolutionary theory sees self-interest not as being equal simply to the interest of an individual person, but as extending to kin who share our genes. Research shows that a message urging people to conserve is more effective if it emphasises that there may not be enough left for our children or grandchildren (Neufeld et al., 2011). Kin appeals will always win over non-kin appeals. Even fake labels or slogans such as "Mother Nature" or "We are family" may produce pro-environmental change.

Then there is the human tendency to discount the future. Research shows that people prefer immediate smaller rewards over future larger rewards (Penn, 2003). But evolutionary life history theory suggests that people vary in how much they discount the future. Their behaviour here depends on how certain they believe that future to be. People discount the future less if they see their environments as safe and predictable (Griskevicius et al., 2012b). This implies, for example, that interventions to encourage individuals to develop a more sustainable lifestyle should focus on making neighbourhoods safer and crime-free, and keeping families and communities together (Van Vugt, 2009). Findings also suggest that local gender ratios influence the discount rates (Griskevicius et al., 2012). When women are perceived to be scarce, and men are less certain they can find a mate, our research has shown that men become more impulsive and engage more in conspicuous consumption. Conveying to men that women prefer mates with a sustainable lifestyle could help encourage them to take the future more seriously.

A third evolved tendency is the desire for status, which fuels the excessive purchase of luxury goods with significant costs to the environment (Frank, 1985). Psychological and econometric studies show that an increase in status does not necessarily make people happier. The average United States income has increased by 140% since 1946, but the average happiness has not changed (Diener and Suh, 2000). A more effective strategy would take relative status into account in one or more ways. For example, a desire for relative status can promote environmentalism through the use of competition. “Competitive environmentalism” has been shown to work when lists of the greenest companies are published (Griskevicius et al., 2012). After all, no company wants to be the last on the list. Our research also shows that naming and shaming campaigns are great ways to get companies, cities and private individuals to act in more sustainable ways (Hardy and Van Vugt, 2006).

A fourth contributor to environmental problems is the human tendency to imitate what others around us do. Research shows that even when people say that the behaviour of their neighbours has little effect on their own environmental behaviours, it is actually one of the strongest predictors of their energy and water use (Van Vugt, 2001). Because of this copying tendency, asking households to consume less energy or water will fail if they are not convinced many others will do the same (Van Vugt, 2009). This also mean that depicting bad environmental practices as occurring frequently is counterproductive. Research in hotels shows that when guests are told that most guests re-use their towels at least once during their stay, re-usage increases (Goldstein, Cialdini and Griskevicius, 2008). OPOWER, a United States utility company, already uses this social imitation strategy by providing householders with information on how their electricity usage compares with that of their neighbours (Cuddy and Doherty, 2010). A “smiley” emoticon appears on their bill if usage is lower than average and a “frowney” if it is higher. Governments and councils could oblige utility companies to provide this kind of feedback.

The fifth evolved psychological trait undermining effective behaviour change is the tendency to ignore evolutionary novel threats. Humans are poor at taking on board the severity of environmental risks unless we can detect them with our senses (Slovic, 1987). We tend to respond more readily to environmental threats that we can see, hear, feel or smell (Griskevicius, Cantu and Van Vugt, 2012). If there is no tangible link between our behaviours and environmental outcomes, few of us change our habits. At the same time, we should recognise that humans evolved in natural environments, and this may have instilled an innate love of nature, of life and living systems (what is known as biophilia) (Penn, 2003; Van Vugt, 2009). Our research shows that when city-dwellers are exposed to nature, they discount the future less (Steentjes and Van Vugt, 2011).

Evolutionary psychology has important insights for the way we approach environmental behaviour change campaigns. Working against evolved human nature guarantees low effectiveness, while working with it increases the likelihood of intervention success.

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47. Environmental issues and household sustainability in Australia

by
Lesley Head, Carol Farbotko, Chris Gibson, Nick Gill and Gordon Waitt

The complex and variable structure of households makes it difficult to design policies to help them behave in a greener way. Cultural research methods, particularly ethnography, provide survey research with the necessary extra depth. These perspectives illustrate pathways towards sustainable results and the problems of achieving more sustainable outcomes.

Households in affluent societies are crucial for environmental outcomes

Households make sense to the people who live in them, and to government policymakers, as foundational social units. They are also regarded as sites through which it is logical to understand the consumption of energy, water, and other materials that have implications for sustainability issues such as climate change. In wealthy urban societies, with a high per head ecological footprint, government policy is increasingly focusing on households regarding sustainability issues. A growing research literature considers the household an important social organisation for pro-environmental behaviour (Reid, Sutton and Hunter, 2009). Global change science is starting to recognise that solutions to planetary problems must be sought on a variety of smaller levels, including the household (DeFries et al., 2012).

However, environmental policies directed at households in the affluent world do not always have the intended outcomes. Households' attitudes and practices often do not match (Lorenzoni, Nicholson-Cole and Whitmarsh, 2007) and their daily routines are influential (Gram-Hansen, 2008). Electricity smart meters do not challenge practices that householders consider non-negotiable (Hargreaves, Nye and Burgess, 2010; Strengers, 2011). Water tanks do not save as much water as predicted (Moy, 2012).

In this article, we contend that the conceptualisation of the household in environmental policy needs to be more sophisticated. Many policy approaches treat households as black boxes, freestanding social units operating at the domestic level, and involve little conceptualisation of their internal politics and practices, or their connections to the wider world. We argue instead for a conceptualisation of connected households, which we illustrate with an overview of our collaborative research in a series of projects in urban Australia.

The importance of cultural environmental research

We draw on collaborative research in the Illawarra region of eastern Australia (Waitt et al., 2012; Gibson et al., 2013). Our work combines ethnographic and practice-based methods with quantitative surveys. This cultural environmental research makes four potential contributions to sustainability research.

Identification and understanding of norms

Cultural research helps explain that promoting public awareness of climate change cannot change behaviour, because cultural norms determine household consumption in complex and uneven ways. Norms of cleanliness, for human bodies and their clothes, mean increasing levels of water consumption in the bathroom and laundry. Take teenagers who may change their clothes several times and take more than one shower a day, because they exercise, attend university, have part-time jobs and go out at night (Sofoulis, 2005).

The importance of everyday practice

Most incentive and education programmes pay little attention to the ways household energy, water and other resource consumption practices form part of the rituals, rhythms, habits and routines of everyday life (Shove, 2003; Gregson, Metcalfe and Crewe, 2007). Programmes emphasising that "it's easy being green" understate the amount of domestic labour involved, and sidestep the question of who does the work (Organo, Head and Waitt, 2012).

Households are not similar, socially or geographically. They may be nuclear families within which parents argue with teenagers about leaving lights or heaters on; they may be baby boomers approaching retirement who argue over what to keep and what to throw out; they may be single-person households, couple households in old age, families struggling to survive, blended families, or same-sex couples with children or without them. Nowhere do households consume things or approach environmental issues in identical or predictable ways. In Gibson et al. (2013), however, trends are summarised that may have relevance for policy, with examples shown in Table 47.1.

Contradictions between attitude and practice

Research on extended family households shows that younger generations identify with sustainability by recycling and affirming their belief in the importance of tackling climate change. They therefore claim to have stronger green credentials than their parents and grandparents. Yet it is their grandparents, who grew up with frugality and thrift, who are least likely to consume large amounts of clothing and appliances. Instead, they keep and store old "stuff", maximizing its use value (Klocker, Gibson and Borger, 2012). Baby boomers are the least likely to doubt climate change, but the most likely to fly five times or more annually. The poorest households are most likely to say that they are "uninterested" in climate change as an issue, but they are also the least likely to own liquid-crystal display (LCD) or plasma screen televisions or clothes dryers (Waitt et al., 2012).

Capturing knowledge and capacity

In households where frugality is a necessity rather than a choice, creativity and adaptability are needed to make ends meet. Families find ways to achieve quality of life without storing material things, without air-conditioners or sports utility vehicles. There are still people who grew their own food or mended clothes during wartime – a reminder that there are effective systems of provision besides the industrial capitalist system, and stocks of knowledge that have not yet been lost (Gibson et al., 2013).

Connected households: traction and friction

Connections refer to processes within the household, and between the household and wider society. The breadth of these connections means that in-depth ethnographic analysis should not examine only the local and domestic levels. There are wider economic spaces in which people access, use, exchange and value financial and material resources. Energy and materials flow through households. Some systems of provision are very fixed, and some are fluid. Where they are fixed, any changes that a household makes may be limited unless these changes are connected to larger-scale change in infrastructure and technology. Where they are fluid, households may be able to contest wider patterns of consumer capitalism through bargaining networks and informal sharing with friends, relatives and neighbours.

We draw on Shove's (2003) use of the ratchet to discuss the role of tools and technologies in making and remaking everyday household practices. She illustrates how changing social norms, for example in terms of cleanliness and washing clothes, may counteract efficiency improvements in provision systems. In many ways, what we call zones of traction and zones of friction are two sides of the same coin, but we use them here to trace less and more sustainable pathways (Table 47.1). The framework of the connected household helps pick out a constructive path between two negative extremes: giving up on the household as a powerless unit and ascribing all power to wider economic and political forces, or making households totally responsible for sustainability, without expecting any from industry and business.

Table 47.1. **Examples of traction towards sustainability and friction against sustainability in the household context**

Zones of traction
Substantial changes in consumption often occur around lifecycle changes: having babies, getting married (or divorced), retiring. Transitions between these stages suggest productive times for policy intervention.
A high level of acceptance of stringent water restrictions during recent drought, and water savings equal to domestic water tank installation.
Experience of water scarcity in early life creates lifelong practices of not wasting water.
Non-energy-using heating and cooling practices, especially in the home, where sweat is tolerated.
Combined – although gendered – contributions to household sustainability transitions in families with young children (where fathers tend to contribute project investment, mothers embed habits in household life).
Zones of friction
Cultural norms of cleanliness in which sweat is anathema – particularly in the contexts of business and of young adults' socialising.
Need for automobility – people love their cars, and current lifestyles demand seamless use of time.
Desire for privacy in extended family households contributes to multiple television ownership.
Subsidised water tanks can be used to maintain high levels of mains water consumption.

Sources: C. Moy (2012), "Rainwater tank households: Water savers or water users?", *Geographical Research,* Vol. 50, pp. 204-216; V. Organo, L. Head and G. Waitt (2012), "Who does the work in sustainable households? A time and gender analysis in New South Wales, Australia", *Gender, Place and Culture;* G. Waitt et al. (2012), "Sustainable household capability: Which households are doing the work of environmental sustainability?", *Australian Geographer,* Vol. 43, pp. 51-74; C. Gibson et al. (2013), *Household Sustainability: Challenges and Dilemmas in Everyday Life,* Edward Elgar, Cheltenham, UK.

Conclusion

These qualitative approaches place a new emphasis on research, and in our experience they are yet to have a significant policy impact. However, our collaborations with engineers working on sustainable buildings indicate considerable potential; the engineers understand the necessity for a nuanced and contextual understanding of human experience. We suggest that friction and traction will help decision-makers think through the possibilities and constraints of working at the household scale – why some policy approaches do not work and others do. Identifying friction does not mean that education campaigns or the provision of information can simply overcome it. Wider cultural and economic change may be necessary. This can be in the form of changed relations between home and work, changed regulation, changed cultural norms of cleanliness or changed expectations of seamless mobility.

Where traction is identified, there is considerable policy value in letting people know they are already making a difference. Campaigns could usefully sustain or encourage existing practices rather than attempting to change behaviour.

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World Social Science Report 2013
Changing Global Environments

48. Models of human behaviour in social-ecological systems

by
Giuseppe Feola

Environmental change research often relies on simplistic, static models of human behaviour in social-ecological systems. This limits understanding of how social-ecological change occurs. Integrative, process-based behavioural models, which include feedbacks between action, and social and ecological system structures and dynamics, can inform dynamic policy assessment in which decision making is internalised in the model. These models focus on dynamics rather than states. They stimulate new questions and foster interdisciplinarity between and within the natural and social sciences.

Human behaviour in social-ecological systems

The intensity and pace of environmental change mean that social scientists need to identify existing weak spots and new approaches to providing knowledge for action (e.g. O'Brien, 2012). Too often, global environmental change policy relies on a limited understanding of the social world (Shove, 2010) and tends to be based on oversimplified and unrealistic models of social systems and their interactions with biophysical systems (Feola and Binder, 2010).

New social theoretical approaches can contribute to environmental change research with regard to human behaviour. Decision-making determines behaviour, which can be regarded as an action or a series of actions that mediate the interactions between the social and biophysical components of social-ecological systems (Liu et al., 2007; Feola and Binder, 2010; An, 2012).

Human actions drive anthropogenic environmental change and convey the responses, such as adaptation and mitigation, to its effects. These actions interact dynamically at different spatial and temporal scales with social structures (such as values, social norms) and biophysical ones (such as infrastructure, technology and ecosystems). This is a process of reflexive self-regulation during which actions influence structures and vice versa. The social-ecological change that policymakers and scientists invoke to deal with environmental change involves deep-rooted structures (O'Brien, 2012). Understanding how actions drive the dynamic interactions in socio-ecological systems is thus critical to support adaptive change.

Conceptual issues

While significant theoretical and methodological progress has been made in understanding human action in social-ecological systems, three issues need to be addressed: the theoretical basis, interdisciplinarity, and the ability to represent the process-based nature of human behaviour (Feola and Binder, 2010).

First, simulation or econometric models that claim to represent human actions often lack a solid theoretical foundation or are inadequately based on reductionist theories (like that of "economic man", or *homo oeconomicus*) that tend to be prescriptive rather than descriptive. A solid theoretical model is necessary to avoid oversimplification and environmental determinism (O'Brien, 2012; Schlüter et al., 2012; Shove, 2010).

Second, while the added value of interdisciplinarity is increasingly recognised, theoretical decision-making models are often based on the insights of single disciplines that assume that one factor constantly causes change or persistence explanations and the inability to represent heterogeneity of actors (Feola and Binder, 2010; An, 2012). Interdisciplinarity allows multi-dimensional explanations through the systematic, but flexible, integration of a variety of factors and processes (Gifford, Kormos and McIntyre, 2011).

Third, while the contribution of individual actions to processes that occur at the macro level has received significant attention, the ways in which feedbacks from the macro to the individual level influence human behaviour are still not well understood. Most theoretical models of human behaviour conceptualise actions as a linear sequence of causes, decisions and consequences (Gifford et al., 2011; Shove, 2010). Only when the process nature of the adaptive interactions between individual decisions, social structures and biophysical structures is considered, is it possible to understand how system structures are reproduced or changed (Feola and Binder, 2010; Gifford et al., 2011; Schlüter et al., 2012).

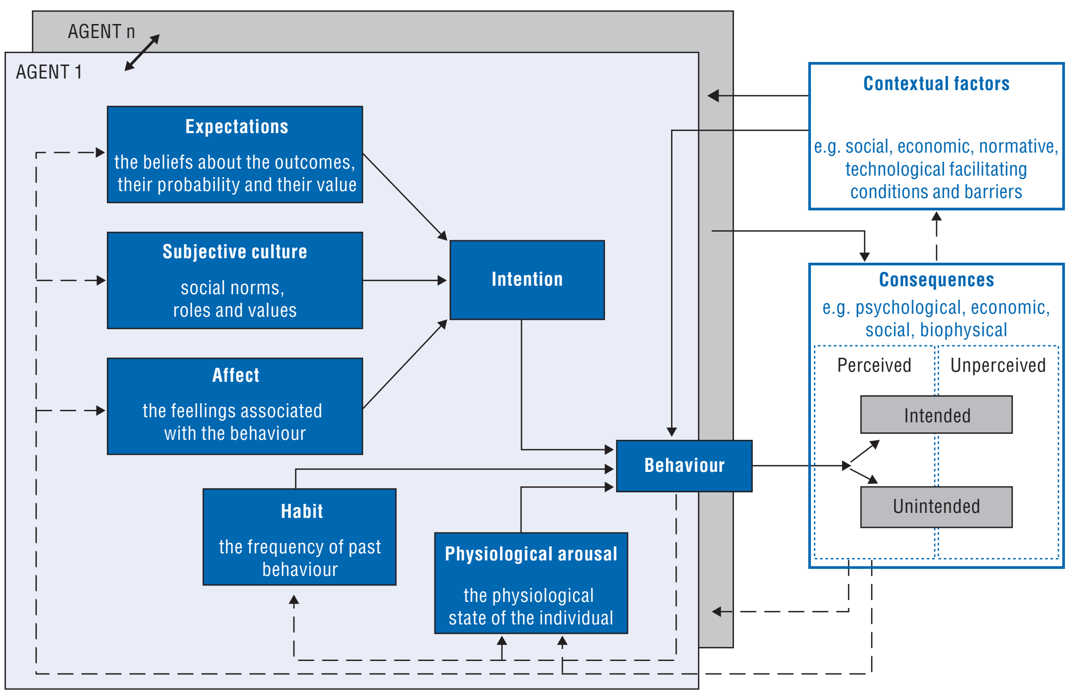
Integrative process-based models of human behaviour

It is important to embed human action in social-ecological systems models if we are to clarify the complex interactions between the social and biophysical components of such systems (Liu et al., 2007; An, 2012; Schlüter et al., 2012).

Integrative process-based models have recently been proposed and implemented, mostly through agent-based computational models. These differ radically from the linear thinking of mechanistic empirical models (An, 2012; Schlüter et al., 2012). They are grounded in social theory, and include feedbacks between individual behaviours, social dynamics and ecological system dynamics. They therefore help users to understand what drives individual and collective changes, and to explore alternative pathways. They are also integrative in terms of the social and ecological system components, the different social levels and the types of human agency considered. This allows representation of different dynamic responses to environmental change. These models can therefore reveal persistence or change, for example in the beliefs and values underpinning the responses to environmental change (Feola and Binder, 2010; An, 2012). They also bridge traditional disciplines. Researchers have been exploring this class of models in environmental change studies in various fields, including land use change, natural resource management and conservation (An, 2012; Schlüter et al., 2012). However, because these issues are not fully understood, very few general models have been developed from specific case studies.

The integrative agent-centred (IAC) framework is one such integrative, process-based theoretical model (Feola and Binder, 2010) (Figure 48.1). It combines Giddens' structuration theory (Giddens, 1984) and Triandis' theory of interpersonal behaviour (Triandis, 1980) to provide an understanding of human behaviour in social-ecological systems. This framework combines different behavioural drivers, and therefore depicts a potentially varied model of agency. In the framework, an agent's decision to enact a specific behaviour is influenced by external and internal drivers. The behaviour can have intended or unintended, and perceived or unperceived, social and biophysical consequences. These in turn can feed back to the agents through social, psychological or physical processes. The feedback processes can reinforce the current state or activate change, and can occur in the short or long term. Agents' interactions happen either directly or indirectly. Direct interactions depend on the agents' social network while indirect interaction happens through the aggregation of the consequences of behaviour that are perceived and reinterpreted by the actor.

Figure 48.1. **The integrative agent-centred framework**



Source: Modified from G. Feola and C. R. Binder (2010), "Towards an improved understanding of farmers' behaviour: The integrative agent-centred (IAC) framework", *Ecological Economics*, Vol. 69/12, pp. 2323-2333.

The IAC framework was applied empirically to Colombian smallholders' use of pesticides (Feola and Binder, 2010). It revealed the socially and environmentally adaptive value of farmers' behaviour in relation to static factors (the share of pesticide application) as well as the system dynamics in the social domain (such as conformity with social norms, the social definition of health) and the biophysical domain (such as response to pesticide-related health effects) of the local social and ecological system. It also informed a simulation model that was used as a learning platform for policymakers to discuss policy options for the safer use of pesticides (Feola, Gallati and Binder, 2012).

New mixed methods needed

In practice, integrative process-based models call for new mixed-method approaches whereby different methods (such as quantitative, qualitative and social experiments) can be adopted to collect data on the various components (such as social networks, social norms, cognition, biophysical barriers) and integrate this data. The IAC framework, for example, was applied in a mixed-methods approach that included survey research, secondary data and simulation modelling. (Feola et al., 2012.)

Integrative process-based models shift the research focus from states to dynamics – from explaining one-off decisions to understanding how and why social and biophysical structures and patterns of social actions persist or change over time. Adaptation behaviours, for example, are usually modelled in a linear way, as a sequence of causes (such as risk perception, climate information, or resource availability), decisions, and consequences (Shove, 2010). However, adaptation to climate change mostly entails decisions that are cyclically repeated over time. In addition, they are made at least partly in response to changes and pressures that are the result of previous behaviours and their consequences in the social and ecological system. For instance, in agriculture, adaptive crop management strategies are cyclical and depend on climatic and social pressures (such as market pressure and peer pressure) as well as on long-standing social structures, previous experience, habit, and potential technological lock-in.

This means that integrative process-based models are policy-relevant because they explain the process-based nature of human behaviour in social and ecological systems. They can help explain variation in behavioural patterns and responses, such as why some farmers adapt and others do not, and help understand how and why behaviour patterns such as crop management adaptation persist over time or are dropped. They can also show how behaviours influence, and are influenced by, change or persistence in social and ecological systems and in social and biophysical structures. Policies informed by such understanding advise and can speed up change by identifying the best places to intervene in a system, which might involve biophysical, economic or normative barriers or belief systems, and by facilitating the creation of conditions for change in specific social and ecological systems.

Conclusions

Integrative process-based theoretical models such as the IAC framework help overcome the limits of models that have weak theoretical foundations, are monodisciplinary and do not represent the process-based nature of human behaviour. They help in selecting the relevant factors and social and ecological processes that need analysing, and in identifying the relationships between them. These relationships will be tested in specific cases, in order to support flexible, context-specific understanding of the complexity of social-ecological systems.

Integrative process-based models are policy relevant because they can support the analysis of the dynamics of change, including change activated by interventions or policies. They can also inform dynamic vulnerability and sustainability assessment by internalising the human component of social and ecological system models. Understanding how human actions mediate and drive dynamic interactions in social and ecological systems and explore different pathways for change is critical to support adaptive change.

These models of human behaviour also require new ways of "doing" science. First, by shifting the focus from statics to dynamics, they stimulate new types of question that are relevant for transforming social and ecological systems. They support a shift from explaining one-off decisions to understanding persistence or change in social and biophysical structures and patterns of social actions over time. They also support a shift from a focus on the individual decision-maker to the feedbacks between actions and their social and biophysical bases and constraints, in spatially and temporally defined social and ecological systems.

Second, while these models tend to be comprehensive and therefore difficult to test, they can serve as conceptual frameworks to integrate knowledge on decision-making and social action that is traditionally kept separate in subdisciplines. They facilitate integrative approaches and collaborative research to bridge the natural and social sciences, but also the more subtle differences within the social sciences.

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World Social Science Report 2013
Changing Global Environments

49. Social aspects of solid waste in the global South

by
Jutta Gutberlet

Municipal solid waste is seen either as a nuisance or as a commodity and social dimensions are less important. Waste problems require an integrated, multifaceted, interdisciplinary approach. Informal but organised recycling in Brazil is an example of an innovative, inclusive resource recovery and environmental awareness strategy that has many benefits for the environment and for the waste collectors. Policies need to safeguard the social dimension and the ecological and economic aspects of waste management.

Introduction

Definitions of waste range from "all material unwanted by the generator" (Statistics Canada, 2005), to "any substance or object … which the holder discards or is required to discard" (European Union, 2006: 5), and to waste as a resource recovered through reuse and recycling or as a culturally determined material perception (Pongracz and Pohjola, 2004). According to Gregson and Crang, "waste is seen as historically mutable, geographically contingent, and both expressive of social values and sustaining to them" (2010: 1027). The waste we generate has increased in volume, has a complex material composition and brings associated health risks.

Humans generate more waste than ever because of population growth and as a consequence of increased consumption and discard levels. In particular, discarded plastics are a global problem. Waste is a nuisance when proper treatment or waste prevention strategies are lacking, which results in serious challenges for municipal governments. All waste treatment techniques have some environmental impact, for example by releasing toxins, air pollutants or toxic ash as final residues from incineration, or through contaminated leachate from landfilling (Allsopp, Costner and Johnston, 2001). Although recycling and reuse also create environmental impacts, when energy and water are needed, they spare virgin resources. All other modes of waste management require continuous extraction of new raw materials to maintain the production/consumption cycle.

Waste management following linear techno-economic, end-of-pipe approaches usually falls within the remit of engineering. The social sciences are more often concerned with related environmental policies, environmental education or urban planning, and with ensuring that the social aspects of waste are visible. For example, Daly (1996), Layard (2005), Victor (2008) and others realised that unlimited economic growth would generate the current environmental and natural resource crisis. According to Schor (2010), humans are already consuming more than the Earth can supply, and generating more waste than it is able to absorb. A one-sided technocratic perspective does not explain the other social aspects of waste, nor does it provide a sustainable solution.

Social theory of solid waste management

It is therefore critical to reduce the amount of waste generated, and to recover all possible re-usable resources from discarded materials. This article focuses on municipal solid waste. This forms only a small part of the problem, since most waste is generated by industrial, agricultural and construction activities. However, waste avoidance and more responsible consumption will tackle these other forms of waste generation indirectly as well.

Not generating waste in the first place, as suggested in *On The Road to Zero Waste* (GAIA, 2012), and focusing on recycling, seem like natural ways forward, and yet they appear to be the most difficult adaptation activities for society to carry out. Reliable information, and creative forms of knowledge mobilisation and environmental education, should require people to voluntarily alter their consumption habits and participate in resource recovery programmes. However, lifestyle changes and waste reduction activities need to be integrated into government strategy and policy.

Importantly, resource recovery creates jobs in waste collection and sorting, and in education and recycling; indeed reuse and recycling create more employment than landfilling and incineration. According to Tangri (2003), recycling 10 000 tonnes of materials per year employs 296 people in the computer sector, 85 in textiles, 18 in paper recycling, 26 in glass recycling and 93 in plastics recycling. Incineration and landfill create only one job per 10 000 tons of material incinerated or landfilled per year.

It is crucial to include different stakeholders from civil society (non-governmental organisations, universities, community groups) and the recycling business itself when designing waste recovery and consumption strategies or policies for a new perception. Examples from the global South reveal the contribution that organised, co-operative recycling has made and how important these stakeholders' participation in waste management programmes and policies is. Inclusive waste management has developed in Brazil as a concept based on principles of solidarity economy and ecological economy (Gutberlet, 2009, 2012). The purpose is to value and empower the workers involved and ultimately reduce, reuse and recycle, thus addressing responsible lifestyles and refusing to waste resources in general (Barr and Gilg, 2006).

The benefits of co-operative recycling

Informal, selective waste collection is common in poorer countries of the South. It is partly done in organised co-operatives or associations, with or without municipal support. Sometimes they add value by creating new products from the materials collected and separated, for example, recycled paper products, washing lines from PET (polyethylene terephthalate) bottles, and roof tiles and furniture from TetraPak packaging (Gutberlet, 2012). In Brazil, approximately 800 000 people are involved in informal, often co-operative, recycling. Most of these individuals live in poverty and work under hazardous conditions.

Although the activity of selective waste collectors, or *catadores*, in Brazil, is a recognised profession, most of this work is still informal. Not all co-operatives or associations are formalised and not all collectors have access to workers' rights. Regional co-operative networks have emerged that promote collective commercialisation and engage in other collective actions to improve working and remuneration conditions (Singer, 2003).

The resource recovery rate per recycler and per co-operative depends on different factors including the quality of the material separated at the source; the mode of transport; the equipment used at the processing centre where waste is separated, baled and stored; the topography; the distances in the serviced neighbourhood; and the level of training. On average, a recycler carries up to 200 kg of recyclable material a day or approximately 4 tonnes a month (Conceição, 2005). They often work 12-hour days and, on average, push their carts 20 km per day. Informal and organised recyclers recover an estimated 60% of the paper and cardboard that is recycled in Brazil and up to 90% of all materials used in the recycling industry. Conceição (2005) estimates that informal and organised recyclers recover up to 20% of the municipal solid waste generated in urban Brazil, although the official recycling rate in most Brazilian cities remains very low. Only 1.3% of the total 15 000 tons of solid waste generated daily in the megacity of São Paulo is officially collected for recycling (Arini, 2012).

Recyclers who belong to a co-operative or association supported by the local government often experience previously unknown opportunities for development, training and education. These experiences have contributed to building leadership and empowering the recyclers, thereby playing an important role in the restoration of their full citizenship (Tremblay and Gutberlet, 2011). The participants have a say in decision-making processes within their co-op and in stakeholder meetings to negotiate with government and business. Co-op leaders participate in public events, conferences and exhibitions. These practices further empower the recyclers, and open new avenues for social development (Couto, 2012).

Most importantly, co-operative-run selective waste collection schemes generate social capital by providing these individuals with meaningful work. They contribute to improving the neighbourhood, cleaning up waste materials and demonstrating resource recovery behaviour, thus creating opportunities for greater community cohesion. This effect has been widely observed in cities in Brazil and in other countries, for example, Nicaragua (Zapata Campos and Zapata, 2013) and Argentina (Carenzo, 2011; Carenzo and Fernández Alvarez, 2011). Recyclers are often invited to speak at schools, community centres and universities to educate the public about waste and their resource recovery practices.

The new federal solid waste legislation[1] (Politica Nacional de Resíduos Sólidos) provides opportunities for municipalities to collaborate with recycling groups (Brazil, 2010). The law requires municipalities to adopt selective waste collection and composting. It supports the involvement of *catadores* in shared responsibility for product lifecycles,[2] and prioritises recycling co-operatives in formal recycling programmes. Nevertheless, the same legislation also allows for waste incineration with energy recovery (waste-to-energy). The law does not set out the waste hierarchy clearly, or give precedence to waste prevention, re-use and recycling over waste-to-energy and disposal, as for example the EU Framework Directive[3] on waste does. A recent proposal to build new incineration plants has generated conflicts in many

Brazilian cities and in other countries in the poor Southern part of the world (GAIA, 2012). The national and local recyclers' movement is aware of the risk of a "vacuum cleaner effect" in favour of waste-to-energy – a danger that has also been outlined by the European Commission. Consequently the movement has called for action to promote selective waste collection and recycling rather than incineration.

Incineration might be an effective way to reduce the volume and weight of waste, but it destroys materials that could generate new products, create employment and save natural resources. Furthermore, waste-to-energy technology is very expensive, it pollutes and produces by-products, is energy inefficient and, above all, does not provide incentives for zero-waste behaviours, because the more waste is incinerated, the higher the cost–benefit ratio.[4]

Despite the increased level of organisation and the international extent of the recyclers' movement, there are many hurdles still to overcome. Probably the biggest challenge is related to the extreme poverty and socio-economic vulnerability of most recyclers, as demonstrated by the *catadores*. Furthermore the lack of political will from most local governments to include the recyclers in their waste management programmes, the threat from corporate waste management, including waste-to-energy schemes, the low prices for recyclable resources and the low remuneration for selective waste collection and organised groups' lack of financial resources, remain as persistent threats to recyclers.

Conclusion

This article highlights the benefits of engaging recycling co-operatives in resource recovery in the global South. Including *catadores* and their equivalents elsewhere in collecting, separating and transforming recyclable material and in re-educating consumers is an opportunity that can help ensure their livelihoods are sustainable. As environmental stewards they can make ground-breaking contributions by spreading information and using knowledge about waste reduction, resource recovery and the many social benefits of organised, selective waste collection. Incineration is not a viable option, given the environmental, social and economic impacts it has. In countries such as Brazil, household waste is high in organic matter, and thus low in heating value for energy recovery through incineration. Shekdar (2009) also highlights the difficulties of maintaining the necessary operating conditions in Asian countries. Organised and informal selective waste recovery and recycling activities are widespread and need to be expanded to recover most of the recyclable resources from the waste. Increasing awareness of what is recyclable at the household level is also important to enhance waste treatment efficiency. These issues, combined with higher costs relative to other municipal solid waste management options (Dijkgraaf and Vollebergh, 2004) mean that incineration is an unsustainable and inefficient method for household waste treatment.

The benefits from recycling are greenhouse gas reduction and, ultimately, climate change mitigation through the recovery of materials that would otherwise end up in landfills, generating detrimental gases and leachate (Sunil et al., 2004; King and Gutberlet, 2013). As highlighted in the European Commission's Green Paper (2013), plastics recycling and the consequent material savings alone contribute most to preventing climate change impacts, resource depletion and freshwater aquatic ecotoxicity. Reuse and recycling reduce the pressure on natural resources, diminishing environmental damage and contamination in developing countries (Troschinetz and Mihelcic, 2009).

The author suggests a bottom-up approach to achieving sustainable communities where citizens become responsible consumers, concerned with avoiding and reducing waste and providing an appropriate final destination for materials that need discarding. Inclusive resource recovery generates income and addresses poverty mitigation (one of the United Nations Millennium Development Goals). Moreover, inclusive waste management targets a reduction in public spending on conventional waste management practices and generates carbon credits.

Appropriate practices and efficiency in logistics and scale are fundamental to reducing the ecological footprint of resource recovery practices. Organised selective waste collectors such as those in Brazil contribute to these benefits. Capacity building for effective and efficient resource recovery, adaptive policy design, and public awareness building for efficient stakeholder collaboration in source separation are all critical and should be addressed with research. Community engagement, environmental stewardship and social economy can take endless creative and different forms. The organised activity of the *catadores* is important for waste reduction, zero waste and the creation of a more balanced and responsible society.

Notes

1. Law No. 9 12.305, 2 August 2010.
2. Chapter II, Art. 6, XII.
3. 2008/98/EC.
4. For discussion of the contested nature of waste incineration, see, for example Allsopp, Costner and Johnston (2001), Corvellec, Zapata Campos and Zapata (2012), Gutberlet (2011), Ngoc and Schnitzer (2009), Rocher (2008), Shekdar (2009), Themelis and Millrath (2004) and Weaver (2005).

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50. Incentives for low-carbon communities in Shanghai, China

by
Lei Song

It is essential for China's fast-growing cities to reduce their environmental impact. Vanke, a major housing development in Shanghai, has been a test case of what is possible in the area of waste reuse and recycling. It shows that considerable issues remain unsolved in terms of altering the behaviour of Chinese householders.

Around half of all people in China live and work in cities (Wenyuan, 2012). Their involvement in global solutions for climate change mitigation is essential. It could have an enormous impact on policies at many levels, including the city level (Abrahamse et al., 2005). Low-carbon community development could empower local people by supporting them to become increasingly self-reliant (Heiskanen et al., 2010). However, community-based approaches lack resources and effective decision-making processes (Kollmuss and Agyeman, 2002). Local actors and institutions do not have legislative or regulatory powers. The central government still leads most low-carbon community projects in terms of providing funds, new technologies and mandatory policies. If the local level is not allowed to provide these, sustainable collective action is impossible (Jackson, 2005).

In Shanghai it is the Vanke Corporation, the largest residential real estate developer in China, rather than the government or non-government organisations, that is piloting a low-carbon community: the Vanke Green Community Project. There are several reasons for the lack of refuse sorting in China, including the fact that residents are not used to sorting their refuse for recycling, institutional failures such as the lack of a garbage classification processing system, and the lack of quality control. Where residents do sort their refuse, it can get mixed again later. Even in communities where a refuse-sorting service is provided, the residents are still not willing to sort their refuse themselves.

The Vanke Green Community Project set out to establish the following process:

- Residents sort their own refuse in their homes.
- Vanke then sorts and compresses the refuse.
- Food waste is disposed of by biochemical treatment equipment.

According to social learning theory, behaviour change can be reinforced through social interaction, especially in groups with strong social networks (Jones et al., 2012). Besides providing free refuse bins, educational lectures and other resources, Vanke employs administrators in every building who are responsible for helping the residents understand the sorting process, helping them sort their refuse, and helping with the second sorting. The administrators' bonuses are linked to positive results.

Initially, the residents were not interested in taking part. But gradually, as the administrators built up a rapport with residents and as a social network developed between the residents within a building, they felt more inclined to become involved. They may have felt too embarrassed if they did not take part, or if they did not comply with the first stage of sorting, as this would create extra work at the second stage. In addition, the administrators monitored the results and accuracy rates. Over time, the residents' behaviour gradually changed, to the extent that a culture emerged in which anyone not conforming with the rules would lose their neighbours' trust. The residents supporting the project were given cash obtained from selling recycled goods and materials to recycling centres, or prizes from refuse-sorting community activities.

The activities of the Vanke Green Community Project have reduced refuse disposal by 46% from 2006 to 2012. The annual reduction in 2012 was over 0.7 million tonnes, compared with 0.5 million tonnes in 2008; the average annual reduction since 2008 is 25%. Participation has also increased; survey results from 2006-10 indicate that in 2006 the participation rate was below 30%, but that this had risen to 70% by 2010, with a more than 80% sorting rate accuracy.

The development of green industries and low-carbon technologies is slow. This slow progress is hindering market-based refuse disposal, making it prohibitively expensive. It is uncertain how long the project can keep going or if it can be replicated elsewhere. These problems need to be investigated and resolved.

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51. Climate change education and Education for Sustainable Development

by
UNESCO

Under the auspices of the UN Decade of Education for Sustainable Development (2005-2014), UNESCO is leading efforts to integrate educational responses to climate change, mitigation and adaptation. Education for Sustainable Development (ESD), which is growing in schools around the world, encourages pupils to think broadly about pressing scientific, technological and human issues. It also recognises that a sustainable environment is essential if children are to live a secure and rewarding life.

Introduction

Education is widely conceived as a catalyst for sustainable development. Yet our education systems are not always prepared for or responsive to challenges such as climate change. Accelerating geopolitical, demographic and environmental changes, and their associated uncertainty, risks and disasters, mean that there is an urgent need to reorient education systems to empower everyone to make informed decisions for environmental integrity, economic viability and a just society, and to respond to current and future challenges.

Climate change education

UNESCO promotes climate change education as part of Education for Sustainable Development (UNESCO, n.d.). Sustainable development cannot be achieved through political agreements, financial incentives or technological solutions alone. It requires changes in how we think and act. This is where Education for Sustainable Development is a critical lever for the global transition to sustainability. Its importance was reaffirmed in the Rio+20 outcome document, "The future we want", in which governments agreed to "promote Education for Sustainable Development and to integrate sustainable development more actively into education beyond the UN Decade of Education for Sustainable Development" (paragraph 233) (Rio+20, 2012).

Integrating educational responses to climate change

As the lead agency of the UN Decade of Education for Sustainable Development (2005-14), UNESCO is leading the effort to integrate the various educational responses to climate change, including educational strategies for mitigation and adaptation.[1]

Promoting children's rights

Climate change education now goes beyond its original focus on climate science. Most climate change education aims to increase understanding of the causes and consequences of climate change, and encourages people to take action to reduce greenhouse gas emissions. Climate change disproportionately affects developing countries, and vulnerable citizens in those countries. So it is important to use education as a means of safeguarding and promoting children's rights to survival, development and protection, as well as their right to participate in decision-making processes that affect their lives. Several international children-focused organisations are already doing this.

Enhancing climate responses through education

UNESCO is developing policy guidelines on climate change education, which have two strands, mitigation and adaptation. The idea is to help establish a common framework to enhance climate responses through education, and to advocate education as a largely untapped strategic resource for building resilient and sustainable societies.

Enhancing climate responses through education will involve specific dedicated measures as well as the integration of Education for Sustainable Development into existing education and development processes. The immediate tasks are to promote education for sustainable consumption in developed countries, and to ensure safe learning environments in countries which are most vulnerable to climate change impacts, integrating disaster risk reduction into their education systems. The longer-term task – common to all countries – is to improve and reorient education systems to foster the knowledge, skills and dispositions needed to deal with current and future challenges. This may not appear entirely new. Indeed, it has always been at the heart of a quality education agenda. It nevertheless emphasises that climate change education in the context of Education for Sustainable Development has to go far beyond inserting new thematic content into overcrowded curricula. Instead it stresses the importance of participatory and solution-oriented learning that encourages systems and critical thinking, engages with uncertainty and complexity, and draws on learners' cognitive, affective and practical potential both in and out of the classroom.

Note

1. In 2012, the Conference of the Parties to the United Nations Framework Convention on Climate Change, "recognizing that a goal of education is to promote changes in lifestyles, attitudes and behaviour needed to foster sustainable development and to prepare children, youth, women, persons with disabilities and grass-root communities to adapt to the impacts of climate change", adopted the eight-year Doha work programme on UN Framework Article 6, which focuses on education, training and public awareness (UNFCCC, 2012).

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52. Education, science and climate change in French schools

by
Guillaume Arnould

Education for Sustainable Development in France is taught at all levels across all subjects in state schools. Climate change is not taught as a subject in its own right, until secondary level. Good teacher training is essential to enable teachers to teach this controversial issue in an interesting and scientific way.

Teaching climate change is a challenge for education for at least two reasons. First, what is the best way to help pupils understand complex research on climate change? Second, climate change is the subject of intense debate over ideologies and opinions in the mass media. Teachers are not necessarily well prepared or willing to teach such controversial issues (Latour, 2005).

In the United States, new science education guidelines were adopted in April 2013 which introduced climate change as a central aspect of science education for middle- and high-school students. Although the guidelines are not mandatory and are somewhat vague, they are meant to allow teachers to discuss climate change in the classroom. In England, recent discussions could mean that teachers start teaching climate change only when pupils are 14 years old and can understand the basic science.

This article focuses on teaching climate change in the French education system, and the challenges it poses for educators. Climate change is not taught explicitly in France until secondary school, or Grade 6, when pupils are about 11. But it is taught at all levels within the topic of Education for Sustainable Development. Here it is treated as a cross-cutting issue, whereby several disciplines integrate the consequences of human actions for sustainable development into their syllabuses. This approach gives teachers enormous freedom in how they might teach the subject in class.

A multidisciplinary issue

Education for Sustainable Development includes climate change, which is inherently multidisciplinary. Geography, the life sciences, Earth science, economics and technology all include aspects of climate change in their syllabuses. In disciplines such as philosophy or history, teachers can highlight the ethical aspects of climate change and put relevant issues into perspective.

However, the idea of bringing several disciplines together to work jointly on a common topic has not yet been realised. Institutional and disciplinary divides remain: each discipline has its own agenda and its own approach to the subject. Lange (2008) underlines the role of teachers and their perceptions; their concept of sustainable development as a school subject is highly dependent on each teacher's subject specialisation. In addition, it is difficult to teach a contested subject, such as climate change. Should the teacher begin with pupils' preconceptions – so-called common sense – or with the latest scientific knowledge? This would involve popularising complex issues while maintaining rigour.

One starting point could be the conflict between the scientific evidence that human action is causing climate change, and doubts about whether everyday individual action can change things. This approach could, for example, lead students to rethink their consumption patterns and production practices.

Teaching climate change and sustainable development ultimately requires an educational approach that fosters citizenship, guides young people towards appropriate environmental actions, and empowers them to deal with risk and uncertainty. It is necessary to teach climate change in all its dimensions: cognitive (the state of knowledge in the field), psychological (representations that lead to opinions being formed about the issue) and behavioural (what to do and what decisions to take). Qualified teachers are necessary if students are to deal with these questions: good teacher training is thus more relevant than ever (Urgelli, 2007).

The subject matter of climate change ranges from daily action, such as sorting waste in a school, to international negotiations on climate change. But the overall ambition of education to train pupils in citizenship is hampered by the lack of consensus on climate change science, which affects the way in which the subject can be treated in the classroom. However, the research suggests that the fear of teaching controversial subjects is largely unfounded, and that students are very interested in the political dimensions of an issue (Albe, 2010-11), as are people more generally (Pruneau et al., 2003).

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World Social Science Report 2013
Changing Global Environments

53. Are increasing greenhouse gas emissions inevitable?

by
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Western development over the past century involves the interdependent development of a cluster of high-carbon socio-technical systems and related social practices. Reversing these systems will be a massive challenge. Instead a set of low-carbon models or systems are needed, using new practices of low-carbon innovation. This article explores the likelihood of these developing as more than tiny niches, and ends by noting some green shoots of such alternatives.

This article uses systems thinking to examine how a high-carbon world was initiated, established, and globally diffused over the course of the 20th century, and to consider how to reverse those locked-in high-carbon processes.

Various systems were trialled and developed in the United States in the 20th century, and then spread and formed the "Western" way of life. These included electrical power, national grids, oil-based car and truck transportation, aeromobility, industrial food production, suburban homes and a general zoning of development, as well as distant places of shopping, leisure and pleasure (Urry, 2011). These systems were not just technological, but involved social values and practices, and were often characterised by long-term path-dependence as many elements were locked into the system and were very difficult to shift (on the automobility system, see Geels et al., 2012).

Such systems cluster together, thus reinforcing each other and engendering high-carbon practices and lives. Nye describes how in the United States, the "high-energy regime touched every aspect of daily life. It promised a future of miracle fabrics, inexpensive food, larger suburban houses, faster travel, cheaper fuels, climate control, and limitless growth" (1998: 215). Various social practices extended over various societies, including a daily shower, the school run, foreign holidays, climate control, dining out, global friendships, project work in a global team, the weekly shop and so on (see Shove, Panzar and Watson, 2012 on social practices).

This cluster of Western practices spread during the second half of the last century as the population, income, consumption and energy use grew exponentially. This led to the problem of the systemic, clustered and path-dependent nature of high-carbon systems and practices (see Urry, 2013 for more detail). From a systems perspective, merely slowing down the rate of emissions will not be sufficient to reduce future temperature rises. Rather, what is needed is the rapid global growth of an alternative cluster of low-carbon systems. This is not just a question of different individual values, beliefs or behaviour. Nor is it just a question of the economy. The requirement is to reverse the apparently inexorable growth of high-carbon systems and related social practices, thus reducing, eliminating or replacing many high-carbon worlds with an interdependent cluster of low-carbon systems. This reversal has to be both social and economic.

This requires "reversing" most systems set in motion during the 20th century, finding the equivalent of a reverse gear while going forwards very fast. However, there are many reasons why finding a reverse gear is so troublesome.

First, there is the power of the carbon interests which generate rising greenhouse gas emissions and which are complicit in the over-use of energy (as documented in Oreskes and Conway, 2010). And yet these interests are also expected to solve these issues by systematically reducing emissions. This is a kind of wicked problem in which the interests generating system problems are also those that are seen as crucial to the development of solutions.

Further, low-carbon systems will reduce the short-term levels of measured income and consumption, which will make it difficult to persuade people to embrace low-carbon social practices. And yet research shows that beyond a level of income in a society, increasing personal incomes do not necessarily turn into more human well-being. Wilkinson and Pickett (2009) document how life expectancy, the well-being of children, literacy, social mobility and trust are all higher in societies that are more equal. Many extra goods and services are "wasted" in unnecessary products, extra car journeys, goods that become prematurely obsolescent or building temperatures kept too high (Shove, Chappells and Lutzenhiser, 2009; Offner, 2006). Societies need to be measured in terms of their quality of life, or "prosperity", and not through gross domestic product (GDP) measures of "growth" (Jackson, 2009).

Third, systems are often characterised by their momentum, which makes it more difficult to reverse those systems in which most people in a society are embedded. Societal change can be surprisingly slow. An example is seen with the enduring car system, which dates from the late 19th century and which has so far "driven out" potential competitors (see Dennis and Urry, 2009; Geels et al., 2012).

There is a lack of time to make the seismic shifts necessary, given that changes in the atmosphere and a decline in energy security are already locked into systems. To some degree these will happen whatever changes happen now or in the immediate future (Hansen, 2011). Some would say that we should prepare to adapt to such atmospheric changes, since climate transformations are more or less inevitable.

There are also difficulties in organising a global polity that can reset global agendas, especially as resources are in short supply and contested. Latouche (2009) suggests that the World Trade Organization should be replaced by the World Localization Organization in order to disrupt the momentum of increasing globalisation, which is partly the cause of rising greenhouse gas emissions.

In addition, even if there were global agreements, states are rarely able to enforce change from the top, because of people's understandable resistance to being instructed to move to low-carbon practices. The global media circulate stories and accounts of how corporate, political and media celebrities live ultra-high-carbon lives, which make them especially inappropriate to lecture others on reducing their carbon footprint. One element of celebrity lives is tax evasion or avoidance, resulting from the "offshore world" of 70 or so tax havens or "secrecy jurisdictions" (Shaxson, 2011). This offshore world is disastrous for reducing carbon emissions and for moderating energy use. These havens limit the taxation available to the societies where income and wealth are mostly created. This is an especially pertinent issue in societies where many people's basic needs are not met and where people are especially vulnerable to climate change impacts. Low-carbon systems cannot develop if resources are not brought onshore, and made public and much more accountable.

Indeed a low-carbon world requires people around the globe to feel a strong mutual indebtedness, especially by current generations towards future generations, including those not yet born. This public or social indebtedness is expressed in the UNESCO Declaration of 12 November, 1997 on the responsibilities of present to future generations (UNESCO, 1997). However, this social indebtedness has been overlain by financial debt for people, states and corporations (Dienst, 2011). In the neoliberal decades since the 1980s, social indebtedness has been distorted by financial indebtedness and greater inequality through the large-scale offshoring of income and wealth, especially by major corporations, societal leaders and celebrities.

Global inequality has probably never been higher, which makes low carbonism even more difficult to implement. In China, India and the other "BRIC" countries, there are generally large increases in fossil-fuel dependency and a striking resurgence of "King Coal" as these countries become even more unequal (see Hansen, 2011). In societies in which many people do not have access to adequate resources to meet their basic human needs, there are strong aspirations to improve access to energy for power, heating or cooling, and transportation as elements of a development strategy. But there are also opportunities for development through new low-carbon systems, to bypass the fossil-fuel-intensive path of traditional development. This is partly why futurist Richard Buckminster Fuller once maintained, "You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."[1]

This points to the need for a cluster of new models that use less energy but which sustain many of the pleasures of contemporary wealthy societies. Societies could be as happy, with high life expectancy, but not as rich as measured by GDP. It is not so much a reverse gear that is needed, as a different set of gears altogether to make innovations in "developing societies" productive. There would be no smooth progression from the present to a lower-carbon future. If we consider where other big changes have occurred across large populations, it took something like 50 years for the rich North to bring about significant reductions in tobacco smoking, although the scientific evidence for its dire health consequences was clear-cut (Oreskes and Conway, 2010).

There are many models that explore the possibilities of low-carbon societies or "de-growth" (Latouche, 2009). The important question is how to get to such a powered-down future, and how to get there fast enough. It will require engineering "systems" of low carbon social practice, a matter of technical, economic and social development. It would involve innovation, with users of commodities and services modifying products, making fashionable alternatives and developing new, collective innovations. Various analysts, such as von Hippel (2006), increasingly emphasise the importance of "democratising innovation". He describes how many "users" of goods and services engage in and develop new products and services. The development of apps for mobile phones is a good illustration of widespread consumer innovation, some of which is – most strikingly – found in the developing world where the costs of innovation are reducing quickly.

Similarly, sustainable innovation requires consumer communities that highlight, advocate and develop low-carbon actions and objects, and make them fashionable. Consumers would have to innovate low-carbon local goods and services on a vast scale, while states and corporations would have to provide the conditions for these to start and then be scaled up. *The Transition Companion* (Hopkins, 2011), based on the "transition towns" movement , describes many different aspects of how this can be engineered by starting out, deepening, connecting and building new products and services. Some of the innovation features of this transition movement are that it is viral, open source, self-organising, iterative, historic and enjoyable.

It is possible that some tiny green shoots of such a future are developing in the rich North. Analysis shows that travel has reached its peak, with various surveys reporting declining numbers of car journeys, distances travelled by car, and of young people acquiring driving licences (Millard-Ball and Schipper, 2011; Geels et al., 2012). It also seems that the amount of material goods that consumers in the rich North are now using is peaking. This quantity seemed to peak before the 2007-08 financial crisis, and so suggests increased material efficiency, which could mean that a low-carbon cluster is beginning to emerge. Perhaps at long last, at least in the rich North, there are some green shoots of a different set of practices and systems developing (as shown in Urry, 2013).

Note

1. *http://challenge.bfi.org/movie,* accessed 4 November 2011.

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World Social Science Report 2013
Changing Global Environments

54. The human dimensions of global environmental change

by
Tom W. Smith

Cross-national surveys indicate that environmental issues are not the main concern in any country or region, and from 1993-2010 there were, on average, no large or consistent trends in public concern with climate change. Climate change is the environmental issue mentioned as the most important in ten of the 33 countries and regions surveyed in 2010. There is no international consensus, although in general, richer nations are more concerned than poorer nations are. Younger generations mention global warming more often than older generations.

Introduction

Scientific consensus has emerged that global warming is occurring and that human activity is an important cause of climate change. It is increasingly recognised that the social sciences need to become more deeply involved in understanding the human dimensions of global environmental change and in crafting solutions (Nawrotzki, 2012). To do this, and given the global nature of climate change, cross-national data are essential. There are considerable cross-national and inter-regional differences in attitudes towards environmental issues in general, and climate change in particular. Trend data are also vital, since environmental conditions and the public's assessment of climate change are constantly changing.

The International Social Survey Programme (ISSP) provides valuable comparative and temporal data and has conducted three rounds of studies on global environmental issues. Nationally representative probability samples were carried out in 22 countries/regions in 1993 (n=28 301), in 37 in 2000 (n=31 042), and in 33 in 2010 (n=45 199). Different sampling frames were used, depending on the available sampling information such as population registers, electoral rolls and small-area census data.[1]

Ranking of environmental problems

In 2010, the ISSP rated the importance of eight issues: health care, education, crime, the environment, immigration, the economy, terrorism and poverty (see Box 54.1 on survey questions at the end of this article). The economy was ranked highest in 15 countries/regions, followed by health care in eight, education in six, poverty in two, and terrorism and crime in one each. Immigration and the environment were not ranked first in any country or region.

In terms of averages across nations, the overall order of concern was: the economy (25.0%); healthcare (22.2%); education (15.6%); poverty (11.6%); crime (10.3%); environment (4.7%); immigration (4.1%); and terrorism (2.6%). For earlier rankings in the United States, see Leiserowitz (2007).

As Table 54.1 shows, environmental concern is greatest in Scandinavia, Switzerland and Canada. They are followed by other West European countries/regions (France, Austria, Flanders, Finland, the former West Germany) and East Asia (Taiwan, Republic of Korea, Japan), and New Zealand. Towards the bottom of the table are ex-socialist states (the former East Germany,[2] Russia, Slovenia, Slovakia, Bulgaria, Croatia, Latvia and Lithuania) and developing countries[3] (Mexico, the Philippines, South Africa, Chile, Turkey and Argentina). The greater concern in wealthier nations is consistent with some past research (Franzen and Meyer, 2010; Gelissen, 2007), but other studies have found an inconsistent relationship between development and pro-environmentalism (Dunlap and York, 2008; Marquart-Pyatt, 2012).

Table 54.1. **Most important problems by country, 2010**

Country/region	% selecting "environment"	Ranking "environment" out of 8 problems
Norway	15.0	3
Switzerland	13.1	4
Canada	12.7	3
Denmark	10.3	4
Sweden	10.2	5
Taiwan, China	8.8	5
New Zealand	8.7	5
Republic of Korea	7.6	5
France	7.5	5
Austria	7.4	6
Flanders	7.4	4
Finland	6.9	4
Germany – West	6.8	5
Germany – East	4.8	5
Mexico	4.8	6
Russia	4.8	6
Czech Rep.	4.7	6
Japan	4.1	5
United States	3.6	6
Great Britain	3.4	6
Israel	3.0	7
Spain	3.0	8
Slovenia	2.9	5
Philippines	2.7	6
Slovakia	2.5	6
Bulgaria	2.3	6
South Africa	2.3	7
Croatia	2.0	6
Latvia	1.8	6.5
Chile	1.7	6
Turkey	1.1	7
Lithuania	1.0	7
Argentina	0.4	7.5

The ISSP also inquired about the importance of nine environmental problems facing the respondents' countries as a whole. Air pollution was ranked first in 13 countries/regions, climate change in ten, water pollution in three and water shortages in three. Chemicals and pesticides, nuclear waste, domestic waste disposal and depleting natural resources were each first in one country. Genetically modified foods never appeared in the top position. The order of environmental concerns was air pollution (20.5%), climate change (14.6%), water pollution (11.5%), using up our natural resources (10.8%), chemicals and pesticides (9.4%), domestic waste disposal (8.2%), water shortages (7.0%), nuclear waste (6.9%) and genetically modified foods (5.2%). For another ranking of environmental concerns across countries, see GlobeScan (2013).

Table 54.2 indicates large cross-national differences in mentioning climate change as the most important environmental problem. It is ranked first, with 49.2%, in Japan, followed by West Germany, Norway, Denmark, the former East Germany, Canada, Finland, Sweden and Britain (18.6-25.8%). With the exception of the former East Germany, it is ranked much lower in ex-socialist states. It is also ranked lower in most developing countries. Israel rated it the lowest.

Table 54.2. **Most important environmental problems by country, 2010**

Country/region	% selecting "climate change"	Ranking of "climate change" out of 9 problems
Japan	49.2	1
Germany – West	25.8	1
Norway	25.4	1
Denmark	23.9	1
Spain	23.3	1
Germany – East	23.2	1
Austria	23.0	2
Canada	21.8	1
Finland	20.2	1
Sweden	20.2	1
Taiwan, China	18.9	2
Great Britain	18.6	1
Switzerland	16.8	3
Philippines	16.6	2
Flanders	12.9	2
Republic of Korea	12.9	5
New Zealand	12.5	2
Croatia	10.1	5
Mexico	9.9	4
United States	9.0	5
Czech Rep.	8.6	5
France	8.4	6
Slovenia	8.4	5
Slovakia	7.9	5
Russia	7.7	6.5
Latvia	7.6	7
South Africa	7.1	4
Bulgaria	6.7	6
Argentina	5.9	7
Chile	5.7	7.5
Turkey	5.6	7
Lithuania	5.0	7
Israel	2.4	9

One reason for the relatively low ranking of climate change is that people often believe it does not affect them directly (Leiserowitz, 2006; Lorenzoni et al., 2007). While, on average, 14.6% cited it as the most important environmental issue for their country, only 9% rated it first for themselves. It ranked lower as a personal problem than as a national problem in 20 of the 33 countries. The 12 largest differences were all declines from perception of a national to a personal problem (Table 54.3). Warmer and ex-socialist states tended to show more personal than national concern, while East Asia and cooler countries tended to have lower personal than national concern.

Table 54.3. **Most important environmental problems by country versus self and family; percentage selecting climate change, 2010**

Country/region	Climate change as a problem
Israel	+4.8
Philippines	+4.7
Argentina	+3.1
Russia	+2.6
Turkey	+2.6
Mexico	+1.8
Lithuania	+1.6
Chile	+1.5
France	+1.1
Czech Rep.	+0.9
Bulgaria	+0.8
Croatia	+0.7
South Africa	+0.6
Slovakia	-0.1
Slovenia	-0.9
Latvia	-1.6
Switzerland	-2.8
Republic of Korea	-3.0
United States	-3.1
New Zealand	-3.7
Flanders	-4.3
Austria	-5.0
Germany – East	-6.0
Germany – West	-7.5
Taiwan, China	-8.0
Denmark	-8.6
Finland	-8.7
Spain	-8.7
Great Britain	-9.1
Sweden	-9.1
Canada	-11.4
Norway	-12.4
Japan	-23.5

Note: The percentage of respondents saying climate change is the environmental problem that "affects you and your family the most" minus the percentage saying climate change is the biggest problem for their country. A positive score indicates climate change is seen more as a personal problem than a national problem. A negative score indicates that climate change is regarded as a national problem rather than a personal problem.

The ISSP also asked how respondents rated the level of dangerousness to the environment of "a rise in the world's temperature caused by climate change" and six other environmental problems. Nuclear power plants were rated as the most dangerous in 12 countries, industrial air pollution in 8.5, water pollution in 5.5, chemicals and pesticides in farming, as well as rising temperatures as a result of climate change, in 3, and genetically modified foods in 1. As Table 54.4 below shows, climate change was rated more dangerous than the average of the other 6 environmental problems in 17 countries, tied in one country, and was rated less dangerous in 15. It was ranked as the most dangerous environmental problem in Japan, the Republic of Korea and Great Britain. Taiwan, China also rated it well above average in dangerousness. In contrast to its higher than average ratings in East Asia, it was rated lower than average in dangerousness in all ex-socialist countries except the former East Germany. Developing countries and other parts of Europe showed a wide dispersion in their rating of the danger of climate change.

Table 54.4. **"Dangerousness" of climate change, 2010**

Countries/regions	Climate change is extremely dangerous – average of other 6 environmental problems[1]	Ranking of climate change among 7 environmental issues	% climate change extremely dangerous
Japan	+20.2	1	38.0
Taiwan, China	+14.3	2	33.9
Republic of Korea	+ 8.4	1	26.4
Germany – East	+ 6.9	3	27.8
Mexico	+ 6.9	2	42.1
Finland	+ 5.2	2	19.4
Great Britain	+ 4.7	1	16.3
Chile	+ 4.6	2	49.7
Philippines	+ 4.6	4	39.6
Germany – West	+ 4.1	3	28.4
Spain	+ 4.1	3	27.8
Canada	+ 2.7	3	27.8
Switzerland	+ 2.7	2	14.9
Sweden	+ 1.9	3	17.3
Denmark	+ 1.6	3	18.0
Norway	+ 0.8	2	11.8
South Africa	+ 0.6	5	33.8
United States	0.0	4	19.6
Croatia	- 0.7	5	35.1
Flanders	- 1.0	5	13.4
Slovakia	- 1.0	4.5	24.3
Bulgaria	- 1.1	5	28.5
New Zealand	- 1.4	3.5	20.6
Argentina	- 2.0	5	26.7
Austria	- 2.8	3	24.6
Czech Rep.	- 3.2	4	15.2
Turkey	- 3.2	5	43.8
Israel	- 4.2	4	23.6
Slovenia	- 4.2	6	18.7
Lithuania	- 5.8	6	18.3
Latvia	- 6.7	6	15.0
France	- 10.2	6	19.2
Russia	- 13.2	7	29.6

Note: The percentage of respondents saying climate change is "extremely dangerous" minus the average saying the following six environmental concerns are "extremely dangerous": air pollution caused by cars; air pollution caused by industry; pesticides and chemicals used in farming; pollution of their country's rivers, lakes and streams; modifying the genes in certain crops; nuclear power stations. A positive score indicates that climate change is seen as more dangerous than the average of the other six environmental concerns. A negative score indicates that the other concerns (average) are seen as more dangerous than climate change.

Trends in ratings of climate change

As Table 54.5 indicates, there has been no clear or substantial change in the public's assessment of the danger of climate change over time. Between 1993 and 2000, nine countries showed more concern and eight showed less, while in 2000-10 concern had risen in 13 and fallen in ten. From 1993 to 2010, it increased in eight countries and declined in seven (overall +30 and -25). The average number of respondents in the 15 countries surveyed between 1993 and 2010 who believed climate change was extremely dangerous increased by +1.8 percentage points. The greatest gains were in the Philippines (+21.6), Japan (+15.8), Spain (+15.1) and Russia (+10.7). The largest declines were in East and

Table 54.5. **Trends in saying global warming or climate change is extremely dangerous, 1993 to 2010**

Country/region	1993	2000	2010
Bulgaria	23.9	19.0	28.5
Canada	24.1	24.3	27.8
Czech Rep.	24.1	25.2	15.2
Germany – East	39.4	40.6	27.8
Germany – West	38.2	27.2	28.4
Great Britain	24.5	22.7	16.3
Israel	17.3	25.4	24.5
Japan	22.2	29.2	38.0
New Zealand	24.9	27.7	20.6
Norway	16.4	11.6	11.8
Philippines	18.0	43.9	39.6
Russia	18.9	17.5	29.6
Slovenia	26.2	24.4	18.7
Spain	12.7	24.1	27.8
United States	16.9	15.8	19.6
Ireland	25.0	17.4	----
Netherlands	8.3	8.6	----
Austria	----	26.7	24.6
Chile	----	34.3	49.7
Denmark	----	15.8	18.0
Finland	----	12.5	19.4
Latvia	----	20.1	15.0
Mexico	----	24.6	42.1
Sweden	----	13.6	17.3
Switzerland	----	32.4	14.9

West Germany (-11.6 and -9.8), the Czech Republic (-8.9) and Great Britain (-8.2). This mixed pattern is consistent with other recent trends regarding environmental issues and with cross-national research showing little, mixed or no increase in pro-environmental positions (Franzen and Meyer, 2010; GlobeScan, 2013; Hadler and Wohlkoenig, 2012; Humphrey and Scott, 2012; Leiserowitz, 2007; Sabio, 2012).

Age differences in climate change concerns

As Table 54.6 shows, younger adults are more likely to regard climate change as extremely dangerous than are older adults. In 26 of 33 countries/regions, respondents under 30 believed it was more dangerous than those aged over 70. Age differences ranged from +30.8 percentage points in Taiwan, China to -14.2 in the Philippines, and averaged +8.8. Previous research across countries has found that younger adults are more pro-environmental on most issues (Franzen and Meyer, 2010; Hadler and Wohlkoenig, 2012; Humphrey and Scott, 2012; Marquart-Pyatt, 2012).

The differences were larger in East Asia, with the notable exception of the Philippines, and Scandinavia. With the exception of the former East Germany, the differences were smaller than average, and often negative, in ex-socialist states. They were generally smaller than average, and usually negative, in developing nations.

Table 54.6. **Age or cohort difference on the "danger" of climate change, 2010**

Country/region	% aged under 30 –% aged over 70
Taiwan, China	+30.8
Republic of Korea	+24.8
Sweden	+19.2
Germany – East	+19.1
Finland	+17.5
Canada	+15.4
Austria	+14.9
Flanders	+14.6
Chile	+14.5
Denmark	+14.3
New Zealand	+14.3
Norway	+13.4
France	+13.0
Great Britain	+12.7
Spain	+12.6
Israel	+10.8
Czech Rep	+10.1
Slovakia	+9.8
United States	+9.6
Switzerland	+9.5
Lithuania	+9.3
Japan	+7.9
Germany – West	+7.4
Argentina	+5.7
Croatia	+2.1
Slovenia	+0.9
South Africa	-2.8
Russia	-2.9
Latvia	-2.9
Mexico	-3.9
Bulgaria	-8.1
Turkey	-9.0
Philippines	-14.2

If the age differences reflect cohort rather than ageing effects, this suggests that concern about climate change will increase as younger generations replace the older, less concerned generations. As others have noted, cohort effects are those that occur across generations due to historical developments and period effects that affect generations differently. Ageing effects are biological or physiological changes that come from ageing and lifecycle changes associated with ageing. It is impossible to separate ageing and cohort effects definitively at a single point in time. While the 2010 data cannot distinguish between cohort and ageing effects, it is plausible that cohort effects, due to the rising discussion of and growing scientific consensus about climate change, are the main determinants of the age differences, especially as there is no compelling reason to expect ageing effects.

Box 54.1. **Survey questions**

Which of these issues is the most important for [your country] today?

Health care	The economy
Terrorism	Poverty
Education	Crime
The environment	Immigration
None of these	Can't choose

Here is a list of some different environmental problems:

Air pollution	Chemicals and pesticides	Water shortage
Nuclear waste	Domestic waste disposal	Climate Change
Genetically modified foods	Using up natural resources	
None of these	Can't choose	

Which, if any, do you think is most important for [your country]?

Which, if any, affects you and your family the most?

In general, do you think that [a rise in the world's temperature caused by the greenhouse effect/ climate change**] is:*

- extremely dangerous
- very dangerous
- somewhat dangerous
- not very dangerous
- not at all dangerous ... for the environment?

Other issues rated on the same scale were: air pollution caused by cars; air pollution caused by industry; pesticides and chemicals used in farming; pollution of [your country's] rivers, lakes, and streams; modifying the genes in certain crops; nuclear power stations.

*used in 1993 and 2000 surveys; **used in 2010 survey

Conclusion

Environmental issues are not the top concern in any country/region, ranking only sixth of eight general problems. But among environmental issues, climate change ranks rather high – it is mentioned most in ten countries, and overall is only second to air pollution. However, climate change is seen as a country-level problem rather than as a pressing personal problem. This is because many people believe climate change will have impacts in the future rather than today, while others believe the effects are mostly happening elsewhere, in other places or in the polar regions. Neither is climate change regarded as the most dangerous environmental problem. It is ranked first in only three of 33 countries/regions. But it is seen as more dangerous than the average of six other environmental problems in half of the countries surveyed.

There is no international consensus on climate change; there is a rather large national and regional variation in attitudes. East Asia (Aoyagi-Usui, Vinken and Kuribayashi, 2003) and Scandinavia generally show the most concern, while ex-socialist and developing countries express the least concern. Both the former East and West Germany often have distinctive profiles, with the former East Germany often resembling other ex-socialist states. However, these patterns do not emerge regarding climate change and related environmental issues. People in wealthier countries/regions generally indicate greater concern than those in poorer ones.

On average, there were no large or consistent trends in public concern over climate change from 1993-2010, although large shifts in both directions occurred in particular countries/regions. The respondents under 30 years of age mention global warming due to climate change more often than those over 70, which probably reflects cohort effects and, if so, should increase the levels of concern in the future.

Notes

1. For more methodological detail see *www.issp.org*.
2. The ISSP finds that the former East Germany and West Germany still differ in many respects, although the differences are declining over time.
3. Based on per capita gross national product (GNP)/gross domestic product (GDP).

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World Social Science Report 2013
Changing Global Environments

55. Environmental attitudes and demographics

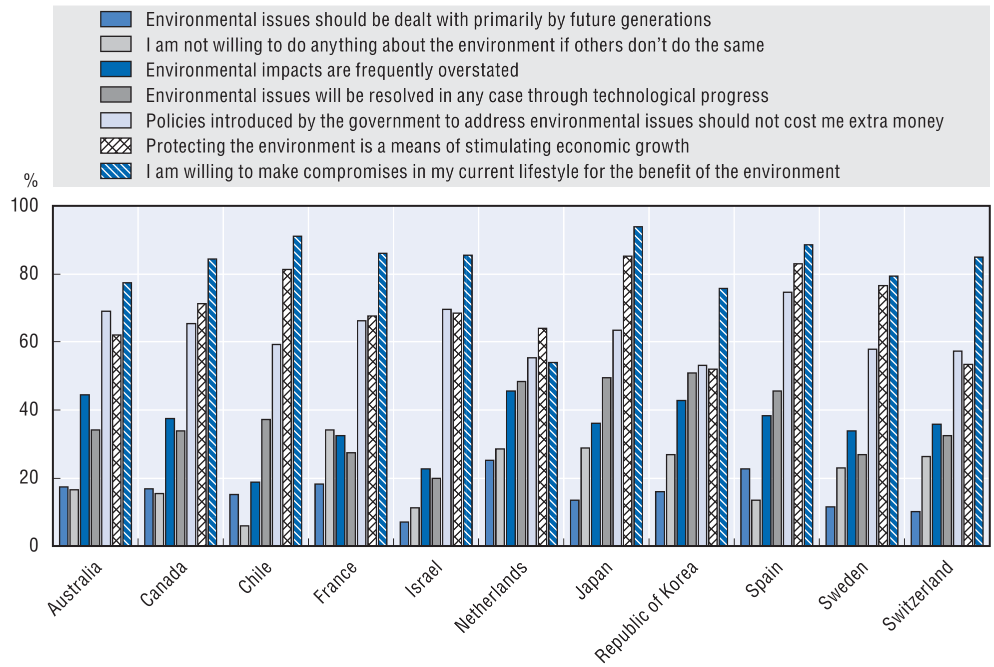
by
Nick Johnstone, Ysé Serret-Itzicsohn and Zachary Brown

An OECD survey, carried out every three years, assesses the effects of environmental policy on people's attitudes and behaviour concerning the environment.

The Organisation for Economic Co-operation and Development (OECD) Survey on Environmental Policy for Individual Behaviour Change is carried out every three years to assess the effects of environmental policy on environmental attitudes and behaviour. The most recent round was implemented in 2011 (OECD, 2013). This survey included responses from over 12 000 respondents in 11 OECD countries: Australia, Canada, Chile, France, Israel, Japan, Republic of Korea, the Netherlands, Spain, Sweden and Switzerland. In order to be included in the sample, the respondents had to have partial or full responsibility for important environment-related decisions in the household. The countries included are representative of conditions in the OECD as a whole. The in-country samples were stratified by age, gender, region and socio-economic status.

Environmental attitudes formed an important part of the survey questionnaire, since they can determine habitual behaviour and investment decisions. Respondents were asked whether they agreed with seven statements addressing different aspects of the environment which are thought to have an important effect on behaviour (see Figure 55.1). In 10 of the 11 countries, the statement with which respondents agreed the most was "I am willing to make compromises in my current lifestyle for the benefit of the environment." Agreement with this statement was highest in the Republic of Korea, where nearly 95% of respondents expressed a willingness to make such sacrifices. The exception was Japan, where the statement garnering the most agreement was "Protecting the environment is a means of stimulating economic growth." In all countries, most respondents agreed with this statement, and that "Policies introduced by the government to address environmental issues should not cost me extra money".

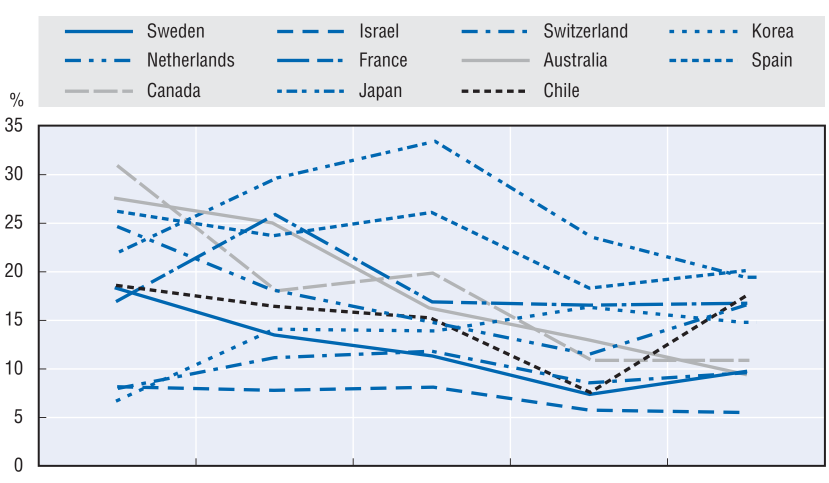
Figure 55.1. **Levels of agreement with seven statements about environmental policy**



Source: OECD (2013), *Greening Household Behaviour: Results of the 2011 Survey,* Organisation for Economic Co-operation and Development, Paris.

The statements with the least agreement also exhibit the most international variation. In seven countries, the respondents most often disagreed with the proposition that "Environmental issues should be dealt with primarily by future generations." In the other four countries – Australia, Canada, Chile and Spain – the respondents disagreed most with the notion that "I am not willing to do anything about the environment if others don't do the same" for them to help improve the environment.

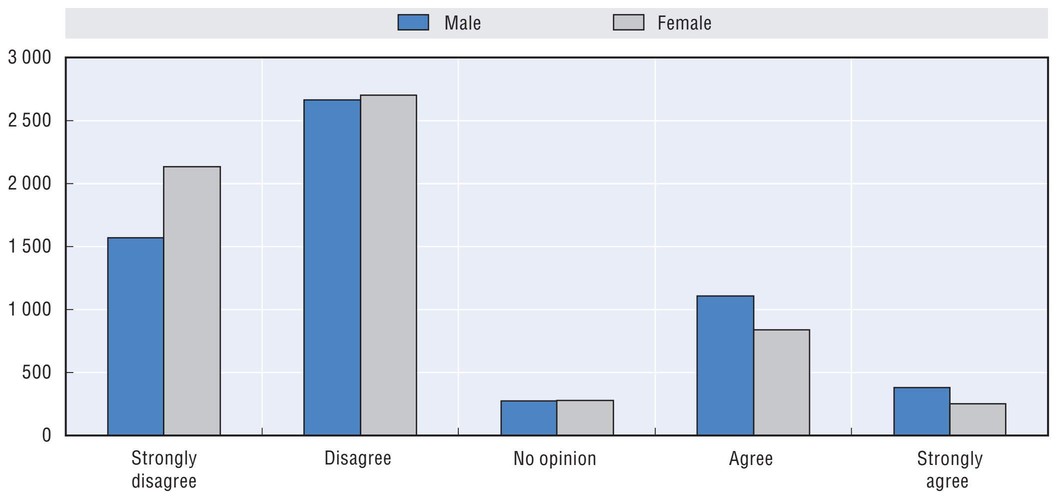
Figure 55.2. **Views on intergenerational equity across ages**



Note: Australia, Canada, Israel, the Netherlands and Sweden have a statistically significant relationship between age and attitude.
Source: OECD (2013), *Greening Household Behaviour: Results of the 2011 Survey,* Organisation for Economic Co-operation and Development, Paris.

In 6 of the 11 countries, concerns about intergenerational equity appear to be greater among older respondents (see Figure 55.2). That is, older respondents more frequently expressed the belief that such problems should not simply be left for future generations. This finding may reflect a degree of regret about their putative responsibility for the current state of the environment.

Figure 55.3. **Views on need for reciprocity across genders**



Source: OECD (2013), *Greening Household Behaviour: Results of the 2011 Survey*, Organisation for Economic Co-operation and Development, Paris.

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56. Sustainable consumption and lifestyles? Children and youth in cities

by
Khairoon Abbas, Ian Christie, Fanny Demassieux, Bronwyn Hayward,
Tim Jackson and Fabienne Pierre

This article focuses on one of the world's first online qualitative global surveys of young consumers and their lifestyles. The discussion highlights how the survey has informed subsequent planning for a new mixed-method global study of urban youth, CYCLES for sustainability. This research aims to equip young people, local and national governments to support flourishing young lives and sustainable consumption more effectively.

Understanding young urban consumers and their visions of sustainability

Consumption by urban youth is not well understood. Nor are their diverse aspirations and attitudes to sustainable living. The environmental impacts and consumption behaviour of young people have only recently been scrutinised (e.g. Belk, Ger and Askegaard, 2003; Cohen, 2010; Fondapol, 2011; Mead et al., 2012; Schor, 2011; UNEP, 2011). There is still much to learn about the complex motivations and drivers of youth consumption, including the way consumption is influenced by youth identities, aspirations, relationships, habits and norms as well as by social practices. Further lessons include the opportunities and constraints that the producers of urban environments impose and that the urban environments in which young people live provide (CERG/IRG, 2011; Euromonitor International, 2012). In addition, the richer North has undertaken much of the existing research, which only examines affluent youth. The complex issues confronting nine out of ten young people living in developing countries have been overlooked (UNICEF, 2012).

Many young city residents can exercise significant "agency" (or the ability to imagine and effect desired change), in this case for sustainable outcomes. However, cities are also the sites of some of the most serious experiences of growing inequality. Some youth experience unemployment and severe material deprivation, including food, fuel and financial insecurity, which erodes their agency (Hart, 1997; Hayward, 2012; Jackson, 2009; Nussbaum, 2011; UN Habitat, 2011).

In this light, this article has two functions. First, it briefly summarises the results and insights from one of the first global qualitative surveys of sustainable lifestyles to focus on youth – the United Nations Environment Programme's (UNEP) Global Survey on Sustainable Lifestyles (GSSL) (UNEP, 2011). It explains why the authors of this survey call for the social sciences to rethink the conditions of youth consumption, and to examine young people's experiences in their own words and images more effectively. Then it introduces the research aims and approach of a new CYCLES for Sustainability, a mixed-method, repeated cross-sectional global survey focused on children and youth (aged 12 to 24) that builds on the GSSL.

Insights from the Global Survey on Sustainable Lifestyles

In 2011, UNEP and the International Marrakech Task Force on Sustainable Lifestyles, led by Sweden under the Marrakech Process on Sustainable Consumption and Production, published a report called *Visions for Change: Recommendations for Effective Policies on Sustainable Lifestyles* (UNEP, 2011). This publication reported on the results of the GSSL, an online survey based on qualitative research principles, involving 8 000 young urban adults aged 18 to 35 years from 20 countries. The survey, conducted in co-operation with research partners in each country, examined how young people talk about the sustainability of their everyday lifestyles, their expectations, socio-cultural identities and visions for their future. A special partnership was formed with the International Association of Universities and 13 of its members participated in the GSSL.

The GSSL had four secondary aims:

- to investigate how young adults (predominantly tertiary educated, mid- to high-income consumers) evaluated their life satisfaction and the sustainability of their daily mobility, food and home life
- to interrogate young people's reactions to alternative, animated scenarios of sustainable mobility, food and housekeeping
- to determine young respondents' self-reported knowledge of the implications of climate change on their lives
- to understand the opportunities, actors and responsibilities for a sustainable future identified by the respondents.

Against the background of the 2008 financial crisis and significant media debate about youth consumption and personal debt, the respondents were questioned about their hopes, fears and dreams. The results of the GSSL revealed surprisingly modest aspirations for material security, closer personal relationships and fulfilling employment. Well-being, agency and meaning-making, often referred to as "making a difference", were frequently cited as the cornerstones of the respondents' ideal futures (UNEP, 2011).

Most respondents agreed that poverty and environmental degradation were the world's "most important global challenges", but many had difficulties linking these to their local conditions. Self-reported life satisfaction ranged from a median of 6 out of 10 (Ethiopia) to 9 out of 10 (Colombia). The sample median score was 8. However, a significant minority of respondents in industrialised economies also noted stress as a result of exam pressure, long working or commuting hours and concerns about finding a life purpose, a significant relationship or financial security. In developing economies, physical insecurity as a result of drug wars, conflict and poverty were important concerns.

Despite their comparatively high income and education, a significant minority also felt their lives were more stressful than those of their grandparents (although many young women in particular reported having more education and employment options). When asked to describe the worst way of living they could imagine, many expressed concern about loss of freedom, summed up as a loss of their human rights or personal agency.

The GSSL also tested young people's responses to scenarios for more sustainable living. The results revealed significant gaps between the reactions of respondents to some policies and activities that might be conducive to sustainable living, and the expectations of policymakers and other actors such as businesses and urban planners. The negative reactions in some communities to suggested policy scenarios underscores why we need more research into the complex ways in which young people engage in consumption to achieve their life aspirations in their local communities.

Why CYCLES, why cities?

The GSSL experience has prompted the development of a major mixed-method study of changing consumption and well-being: CYCLES for Sustainability. This is a new global survey developed by UNEP and the Sustainable Lifestyles Research Group (SLRG) at the University of Surrey in the United Kingdom in collaboration with important partner organisations.[1] Youth unemployment is approaching record levels in Europe, Africa and the Middle East, threatening to blight the prospects of young adults (ILO, 2012). Widespread concern has been expressed about a "lost generation" and a broken social contract between the generations and between communities and governments.

As nearly half of the world's population are under the age of 25 and an estimated seven in every ten young people are expected to be living in urban communities by 2050 (UNICEF, 2012), CYCLES will concentrate on young people living in cities. While cities occupy only 2% of the Earth's surface, they consume 75% of its natural resources.

The objective of CYCLES is to understand the consumption experiences and life aspirations of children and young people aged 12 to 24 using cross-sectional, repeated cohort sampling (Bryman, 2012). The first cohort survey will be ready in 2014. The research methodology aims to identify the drivers of sustainable lifestyles, sociocultural identities and habits over time and in local communities. It will also examine the ways in which built infrastructure and policy initiatives help or hinder young citizens to effect lifestyle change.

The GSSL focused on the energy-intensive aspects of mobility, food and housekeeping. The CYCLES survey will examine these areas as well as leisure and communication, which are closely related to fundamental rights, basic needs and social interactions, and which also influence pollution, waste production, greenhouse gas emissions, health and well-being. Analysis of the survey's results, in consultation with an international advisory panel including urban policymakers, youth advocates and social researchers, will help ensure that targeted policy recommendations support more sustainable outcomes for urban youth.

CYCLES for Sustainability will be implemented in 21 cities in 21 countries at five-year intervals to capture public imagination at a grassroots community level. This survey will highlight the significance of Agenda 21, a blueprint for sustainable development, development that promotes economic growth, improved quality of life and environmental protection – adopted by countries at the 1992 UN Conference on Environment and Development. The study will be conducted in two parts. First will be discussions with city focus groups, including youth photo diaries about consumer behaviour and perceptions. These will feed into the second part, a global online survey (Barry and Proops, 1999) to probe attitudes regarding consumption habits, self-reported well-being, material quality of life and people's aspirations and experiences in urban environments.

Rethinking youth consumption in cities

The initial GSSL research indicated that contrary to widely reported media expectations of "selfish me" consumers, many young people approach their aspirations and future prospects with an attitude that could be well aligned with a more sustainable future. This includes modest material hopes and desires, a strongly internalised sense of agency expressed as a desire to "make a difference", and fear of loss of freedoms such as human rights. Yet younger generations now face ecological and economic challenges that threaten to limit their ability to exercise agency and freedom. And at present, their values and attitudes are not always translated into concrete sustainable behaviours.

In order to live well within the boundaries of the planetary and local ecosystems, we need to understand the youthful visions of more sustainable lives, and the challenges that confront this rising urban generation. We argue that social science research can and must support young people in dealing with the threats and dilemmas of 21st-century urban living, and should identify opportunities for greater co-operation and sustainable and social innovation.

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Note

1. United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Children's Fund (UNICEF), the Partnership for Education and Research about Responsible Living (PERL), the International Social Science Council (ISSC), Consumers International and the SEEDS Youth Research Group, University of Canterbury, New Zealand.

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57. Bringing poor people's voices into policy discussions

by
Deborah S. Rogers

The Equity and Sustainability Field Hearings project set out to ensure that poor communities have the opportunity to share their views on sustainable development and poverty issues. Coordinated by the Initiative for Equality, civil society and research groups are working to find out what poor and disadvantaged communities think about their future. Their responses will be compiled and included in the Sustainable Development Goals dialogue and decision-making processes.

How do poor people experience inequality? How do they envisage moving towards sustainability? Marginalised communities and poor people are rarely asked their opinion about their lives or aspirations for the future (Chambers, 1997; Narayan et al., 2000). The Equity and Sustainability Field Hearings project (Initiative for Equality, 2012) set out to do this by asking people living in impoverished and disempowered communities around the world what they think about poverty, sustainability, and the future for their families and communities. A global collaboration between social scientists and non-governmental organisations (NGOs), the Field Hearings project aims to ensure that poor people's voices are included in discussions on environmental and social sustainability such as Rio+20 and the Post-2015 Sustainable Development Goals processes. It is important to find out what people in disempowered communities think, and then to ensure that strategies address these issues in ways that are relevant, effective and collaborative.

In early 2012, following a broad call for partners around the world, the NGO Initiative for Equality embarked on this global project with 18 academic and civil society organizations. The aim is to conduct "Field Hearings" in 34 communities in Asia, Africa and Europe: Bangladesh, China, India, Kyrgyzstan, Mauritius, the Philippines, Malawi, Nigeria, South Africa, Uganda, Hungary and Scotland.

The questionnaire

The project developed a questionnaire in English, which partners then translated and modified to be culturally appropriate for their own communities. Using public meetings, focus groups, and individual interviews, respondents were asked to:

- assess trends in their community in health, education, the economy, politics, conflict, families, happiness, circumstances for women, and other areas (are things getting better, worse, or staying the same?)
- speculate about the causes of these trends
- propose changes needed for their community to become sustainable (what is needed for a good life for family and community that would last into the future?)
- describe your perceptions of privilege and deprivation (how are privilege and deprivation experienced in your community? Where do you see yourself?)
- articulate their wishes for the future of their family and community.

The preliminary results of these interviews are published in *Waiting to Be Heard: Preliminary Results of the 2012 Equity and Sustainability Field Hearings* (Initiative for Equality, 2012), with 60 co-authors and based on interviews with over 2 700 individuals. The results were presented at Rio+20 events in Brazil, and will be brought into the Sustainable Development Goals (SDG) dialogue through contributions on various official online platforms, presentations at United Nations SDG policy meetings, and national media releases in the surveyed countries.

Trends

Several communities reported improvements over the past five years in health care, education, access to technology and the position of women, although many problems remain for women. The list of worsening trends was long, but surprisingly strong common themes emerged, including environmental degradation, corruption, inequality, economic insecurity, social problems and conflict.

Causes

Respondents offered many explanations for the problems they face in their communities, including:

- Corruption and a lack of accountability and transparency on the part of government officials mean that lower-income people are deprived of economic opportunities. This is a major way in which inequality is perpetuated and increased.
- Social, economic and gender inequality, as well as prejudice and discrimination, and selfishness on the part of those with money and power, lead to a dearth of economic opportunities for poor people and for women.
- Environmental degradation, competition for scarce resources, growing populations and changing weather make life much more difficult, especially for the poor.
- Lack of appropriate planning, training, education and access to knowledge constitute barriers to problem solving in communities.
- Lack of trust and unity among community members blocks the dialogue and collaboration necessary for effective problem resolution and new approaches to development and sustainability (Wilkinson and Pickett, 2009; World Economic Forum, 2011).

Most Field Hearing participants see the gap between the wealthy and the poor as increasing. Wealth and poverty are viewed as being directly associated with access to political decision-making and economic opportunities, or a lack of them. Several groups cited racial or ethnic discrimination as a root cause of these problems, while others blamed the selfishness of the rich, or the entanglement of political power and business opportunities.

Aspirations

The wishes articulated by most respondents were simple, basic, and compatible with sustainability. They would like:

- stable incomes and a secure future
- food, health care and education for their children
- more responsive and accountable governments that work to create opportunities for all, regardless of ethnicity or economic class
- access to opportunities and to decision-making.

The Field Hearings project is important for several reasons. First, it provides human-centred and policy-relevant results that contribute new perspectives in the search for pathways towards sustainability. Second, in working with local partners to gather the voices of poor people, it represents an inclusive approach to knowledge, and broadens the constituencies given an effective voice in discussions on sustainability. Third, it takes an interdisciplinary approach to answering these urgent policy questions, rather than a narrow disciplinary one. In so doing, the project reveals the connection between environmental problems and the underlying disparities in social, economic and political empowerment. These disparities prevent local communities from protecting themselves from resource exploitation and environmental degradation, and mean that they cannot develop and implement their vision of a decent life in which human needs are met over the long term.

The project is currently expanding its global coverage, with over 250 partners in 67 countries, for a second round of Field Hearings designed to better understand the similarities and differences in the experiences and perspectives of the poor.

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58. Climate is culture

by
David Buckland

The Cape Farewell project brings environmental scientists and creative artists together to consider the challenges posed by climate change. It has sent over 200 artists to places and communities around the world to produce responses, in music, verse, prose and other forms, to human-induced environmental change.

Storytellers, C. S. Lewis said, carry meaning in a way that rational truth tellers cannot: "For me, reason is the natural organ of truth; but imagination is the organ of meaning. Imagination, producing new metaphors or revivifying old, is not the cause of truth, but its condition."

For the past 12 years, the Cape Farewell project[1] has embedded climate scientists with artists, writers and film makers to address what has been described as humanity's greatest challenge: our overheating planet and anthropogenic climate change. Working with scientists to witness and interrogate the frontlines of environmental damage, over 200 artists have gone on nine expeditions to the Arctic and one in the Peruvian Andes. Cape Farewell has also led expeditions to the islands of western Scotland, working alongside local communities as they evolve into resilient social and physical societies that are sustainable and culturally vibrant.

This pioneering programme has inspired artistic activity on an unprecedented scale, creating new music, books, films, sculptures, inspiring the arts and artists to become the brokers and narrators of environmental change. Cape Farewell's mission is to bring this creative expression into the public domain. Three touring exhibitions have been shown in London, New York, Chicago, Tokyo and Paris. There have been music festivals in the United Kingdom and Canada, and creative forums for debate and exchange. We have made two films for the BBC and Sundance USA; Ian McEwan's novel *Solar* (2010) was inspired by his journey to the high Arctic; there are new poems, pop songs and operas. Millions of people have looked at the art, read the books and poetry, listened to the music and engaged emotionally through the power of art to tell the stories of our time.

Anthropogenic climate change is stressing our environment and human communities. Extreme weather events are more frequent than ever, they are global, they threaten our livelihoods, and they cost billions of dollars. The legacy we are building for our children is likely to lead to sea level rise, widespread pressure on food production, and severe economic upheaval and conflicts over resources.

What if?

A lost number in the equation.
A simple, understandable miscalculation.
And what if, on the basis of that,
the world as we know it changed its matter of fact?

Let me get it right.
What if we got it wrong
What if we weakened ourselves getting strong
What if we found in the ground a vial of proof
What if the foundations missed a vital truth
What if the industrial dream sold us out from within
What if our impenetrable defence sealed us in
What if our wanting more was making less,
And what if all this wasn't progress?

Let me get it right.
What if we got it wrong
What if we weakened ourselves getting strong
What if our wanting more was making less
And what if all this wasn't progress
What if the disappearing rivers of Eritrea,
The rising tides and encroaching fear,
What if the tear inside the protective skin of earth
Was trying to tell us something?

Let me get it right.
What if we got it wrong
What if we weakened ourselves getting strong
What if the message carried in the wind
Was saying something
From butterfly wings to the hurricane,
It's the small things that make great change,
And the question towards the end of the lease is
No longer the origin but the end of species.

Let me get it right.
What if we got it wrong
What if the message carried in the wind was saying something?

Lemn Sissay

In November 2011,[2] Cape Farewell organised a unique gathering on the shores of Lake Ontario where 20 artists and creators from Canada, the United States and Mexico worked with eight cultural informers, scientists, economists, sociologists, eco-theologians, technologists and politicians from around the world at a two-day “workshop/expedition”. How can we reform our societies and learn how to live together on this planet without destroying it? Do we need constant growth? How can we produce the energy we need without polluting our atmosphere? How can we build a faith and belief that are symbiotic? For the past year the artists have continued to interrogate and create, and their work will become the bedrock of a four-month climate festival starting in October 2013. Entitled Carbon 14, it will reach out with art, digital and social media, theatre and music at the Royal Ontario Museum in Toronto.

The arts, at their best, articulate social and emotional trends and give expression to individual passions. When launched into the public domain as a book, a poem, a film or a painting, these objects of communication inspire and create visions; they also experiment. Good stories and narratives can change people's perceptions and help societies become more democratic.

Art has the power to move people.

The Cape Farewell experiment is to focus the creative spirit, enable our artists, communicators and cultural creatives, and harness their energy to reframe climate as a cultural challenge.

Climate is culture.

Notes

1. *www.capefarewell.com*.
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David Buckland is an artist, designer and film maker, and has exhibited in galleries in London, Paris and New York. He is the founder and director of the Cape Farewell project, which brings together scientists and educators to raise awareness about climate change and address the issues involved.

You Can Buy My Heart and My Soul, 2006 by Andries Botha
© Photographer, Jean Debras

Part 5

The responsibilities and ethical challenges in tackling global environmental change

59. Towards greater fairness in sharing the risks and burdens of global environmental change

Introduction to Part 5

by
Diana Feliciano and Susanne Moser

Global environmental change is one of the most challenging problems facing the world today. This section illustrates how global environmental change threatens fundamental values, and how action to address it raises serious concerns of ethics and responsibility.

Global environmental change raises deep challenges of ethics and equity. Many argue that it will particularly affect populations who are already vulnerable and who are not the most responsible for it. Global environmental change is especially dangerous for people who are overwhelmed by existing economic problems and other social and ecological stresses because they are highly exposed and particularly sensitive to risk, lack coping resources, and have only a limited capacity to defend themselves against the loss and harm that environmental change may bring (Dow, Kasperson and Bohn, 2006).

There are several reasons why global environmental change should be a matter of ethical responsibility. They range from taking responsibility for the harmful effects that humans cause, to a fair distribution of consequences, to assuming responsibility on the basis of a commitment to a general harm prevention principle or to the humanitarian requirements of solidarity with the most vulnerable (Gardiner, 2004; Garvey, 2008).

The atmospheric concentration of greenhouse gases is still growing and these will remain in the atmosphere for years or centuries, meaning that the greatest problems are yet to come. This raises important ethical issues because the mitigation of greenhouse gas emissions might require the adoption of technological interventions and market mechanisms that affect the environment or the economy in unequal and unjust ways, and involve unequal burden sharing within societies. Thus, one important question is: who will bear the responsibility for the legacy of environmental problems such as climate change, resource extraction and depletion, or the irreversible loss of species?

In relation to climate change there are two main challenges. One is that climate change is a truly global phenomenon, and the other is that greenhouse gas emissions can have climate effects anywhere on the planet, independently of their source (IPCC, 2007). The contributions to this part offer insights into the ethical dimensions of global environmental change and bring them to life in specific cases.

Equity in what?

Many argue that the uncertainties that surround global environmental change should not eliminate the ethical obligation to act sooner rather than later, especially because the potential costs to society may not be fairly compensated for by subsequent responses. Others argue that future societies will be richer and thus more capable of dealing with environmental challenges if and when they unfold. Practitioners and policymakers may be tempted to postpone politically inconvenient and possibly expensive actions, but will also need to understand the ethical implications of their choices. Social scientists can offer methods and evaluative systems to help with such choices, and can help to understand the trade-offs and identify policy mechanisms for sharing rights and responsibilities fairly. They can also help identify opportunities for safeguarding the most vulnerable from serious risks, and ways to stimulate intergenerational solidarity and justice.

To this end, Kasperson and Dow (1991) offer an analytical framework to clarify the range of equity issues associated with global environmental change, including climate change, based on an extensive review of the literature. They define equity as "the fairness of both the process by which a particular decision or policy is enacted and the associated outcomes" (Kasperson and Dow, 1991: 151). This definition suggests that two major types of equity need to be considered in an analytical framework for this issue:

- Distributional equity refers to the fairness of the distribution of the impacts of a particular project, set of activities, developmental path, or impacts of environmental change. It can be subdivided into geographical equity, cumulative geographical equity, intergenerational equity, and social equity.
- Procedural equity refers to the fairness of the procedures used for policy-making and decisions on the management of global environmental change. The critical issues will be the determination of legitimate interests, the process by which they are considered, and the allocation of rights and responsibilities between them.

Contributions to this part address both types of equity concerns.

Distributional equity

With regard to distributional equity, Pillay is concerned with the harms associated with a particular set of activities in the Lower Mekong Basin, stemming from large-scale landscape modification and resource extraction. In this part of the world, building a dam will cause loss of land and the inundation of villages located along the riverbank, requiring local communities to bear an inequitable share of the burden while they will not benefit from this development of energy resources.

Vanderheiden writes about cumulative geographical inequities, particularly the additional impacts from the increase in greenhouse gas emissions on disadvantaged societies and marginal groups who are already suffering the most. He argues that equity and responsibility should be considered in international climate policy design, but recognises that a just global climate change policy remains a difficult challenge for policymakers. In his opinion, climate change mitigation should be considered a shared problem. National greenhouse gas emissions should be subject to principles of distributive justice and developed countries should lead climate change mitigation actions, given their greater current capacity and their historical benefits from emission-intensive economic development.

Another set of contributions to this section of the Report focuses on distributional equity over time, or intergenerational equity. The ethical principle of intergenerational equity is well-established as central to sustainable development (Beder, 2000). Similarly, Weiss (1990) argued for equality among the generations and for members of any given generation to share fairly both the rights to use and benefit from the planet and the obligation to care for it. Macer and Feliciano's contributions can be linked to issues of intergenerational equity. Macer discusses the right to universal access to energy to reduce poverty, the potential increase in greenhouse gas emissions that this will cause, and the responsibility and moral obligation towards future generations. Feliciano highlights the unknown risks for future generations posed by geoengineering, but also touches on procedural equity issues, which arise because decision-making and fair governance mechanisms for potential geoengineering interventions are yet to be determined.

Monreal Gonzalez, Godazgar, and Aversano-Dearborn, Freyer and Leipold's contributions on sustainability issues can also be grouped with those concerned about intergenerational equity, given the well-established understanding of sustainability as "meeting present needs without undermining the ability of future generations to meet their needs". Monreal Gonzalez describes the José Martí Project, which aims to ensure that ethics are the core driver of sustainability in the Caribbean. The identification of central ethical issues pertinent to the formulation of sustainability policies at national and regional levels by academics has been an outcome of this project. It heeds Beder's (2000) finding (and warning) that sustainable development policies are implemented all over the world that tend to remove decision-making powers from the community and promote inequity between different sections of the community. One of the recommendations of the José Martí Project is to foster social learning through participatory engagement at the community level, to create greater social inclusion and more equitable sustainability.

A successful example of the effectiveness of participatory approaches in promoting sustainability is then given by Aversano-Dearborn, Freyer and Leipold. They find that transdisciplinary research processes have increased awareness of the sustainability dimensions of the Bible and the Rule of St. Benedict among monks in four Austrian and two German monasteries. Similarly, Godazgar claims that in Iran, where religion is strongly embedded in government policies and people's lives, Islam should play a more transformative role in giving attention to the importance of environmental problems and sustainability.

Procedural equity

Other contributors to this part focus more on procedural equity. Mabon and Shackley stress the importance of effective public engagement in decision-making about carbon capture and storage technologies, in order to have a fairer implementation process for this mitigation option. Monks focuses on the impact of businesses on the environment, especially extractive industries that largely depend on natural resources to operate and make a profit (for instance, fishing, forestry and the pharmaceutical industry). He examines the impact and effectiveness of the UN Global Compact, a policy initiative that commits businesses to respect the environment for its biodiversity. Considering that companies have responsibilities to address the needs and wishes of society, while shareholders and owners do not necessarily prioritise those responsibilities, he finds that companies committed to the UN Global Compact have fewer negative impacts on biodiversity than those that do not commit.

The resolution of global environmental problems through science can also raise issues of procedural equity. The issues here are concerned partly with the adequacy and appropriateness of the decision processes that lead to these problems, but also with the development of the research agenda and other responses to climate change. St. Clair's contribution revolves around procedural equity in science. She argues that science should be moral, political and public, and responsive to the needs of society. This would involve framing scientific questions about climate change through the lens of the social sciences, or better still, through the lens of societal needs (through a process of co-production of frames and relevant research questions). At present, however, the traditional concept of knowledge is still separated from action, leaving climate change framed first and foremost by the physical sciences.

The role of the social sciences in addressing the ethical challenges of global environmental change

Global environmental change raises several challenging ethical issues, especially those concerned with sharing fairly the benefits and burdens of climate change, and policy responses to it. Social science research is essential to understanding the values, ethical judgements and trade-offs that influence policy design and choices, and consequently the fairness and equity of living with the consequences of environmental change and the possibilities of true sustainability. Throughout this part, several contributors point out the key role of social sciences in addressing equity issues of global environmental change mitigation and adaptation strategies. Public engagement in decision-making (Mabon and Shackley), the open publication of research results (Feliciano), the construction of alternative futures under incomplete information conditions (St. Clair), the socio-economic impacts of natural resource exploitation (Monks) and the effectiveness of co-operation between different stakeholders (Pillay) are some of the examples given in this part. The methods highlighted in these contributions are mostly directed towards education and policy. They aim to ensure that the ethical dimensions of global environmental change are understood by policymakers and the general public, that people around the world, especially the most vulnerable to global environmental problems, participate in ethical inquiry about responses to global environmental change, and that interdisciplinary approaches are adopted towards ethical inquiry into global environmental change.

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Diana Feliciano is an early career researcher with a Ph.D. in geography from the University of Aberdeen, Scotland. She works on climate change mitigation, forest policy and economics, and rural development. She has taught global environmental change at the University of Aberdeen and is on the *World Social Science Report 2013* editorial team.

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World Social Science Report 2013
Changing Global Environments

60. Winning environmental justice for the Lower Mekong Basin

by
Cassandra Pillay

Construction of a mega dam in Southeast Asia's Lower Mekong Basin has had detrimental effects for biodiversity and millions of people who depend on it. The use of successful case studies, and collaboration with non-governmental organisations (NGOs) to empower people and increase awareness of their rights, may help win environmental justice for the people of the Lower Mekong Basin.

Shifting the balance of power

The Xayaburi Dam in Laos – one of Southeast Asia's least developed nations – is being built to supply electricity to Thailand. Its construction on the Lower Mekong Basin, one of the world's longest and most resource-rich rivers, will instigate the construction of ten more dams (Cronin, 2012). This will have a hugely detrimental effect on the lives of the poorest and most marginalised people of Laos, Viet Nam, Thailand and Cambodia. Millions of these people depend on the river for their livelihoods.

The decision to build the Xayaburi Dam was the first significant breach of the 1995 Mekong Agreement, signed by Cambodia, Laos, Thailand and Viet Nam, and intended to promote the shared use and management of the river basin (Hebertson, 2013). In November 2012, Laos decided to continue constructing the Xayaburi Dam, and to ignore concerns by Viet Nam and Cambodia that this project breached the agreement.

The Lao government's decision to continue with the project is negligent. The finished dam will impact heavily on local people who depend on the river's rich natural biodiversity and who rely on fishing for food and to earn a living. According to the United Nations Declaration on the Rights of Indigenous Peoples (UN, 2007) and the World Bank's corporate responsibility standard (2005), this is a violation of human and environmental rights.

A way forward

Social science studies in disciplines such as sociology have found that learning with others has a powerful effect on attitudes and behaviour (Denrell, 2003). Sharing relevant knowledge and spreading awareness of previous cases could empower local people to exercise their rights. A possible benchmark case comes from Ecuador. Here people won a judicial case worth USD 18 billion against the oil company Chevron (Handelman, 2011). A shift in the balance of power may also be possible in Laos, if local NGOs work with people living along the Mekong Basin who would be affected by the new dam. What is needed is education, awareness raising and positivism of attitude and behaviour.

How effective is such co-operation with local NGOs and with their learning approaches? To find out, a random sampling of two groups of people would be carried out. The first group would include people selected to work with the NGOs, but who have yet to undergo the necessary training; the second would serve as the control group and would not undergo training. Each group would be asked questions on their belief in their ability to change a situation; a post-measurement test would ask the first group the same questions again after having co-operated with the NGOs. The results could reveal differences in people's level of belief in their ability to bring about change.

Measuring the effectiveness of such social tools can provide sound evidence within the social sciences on their use in similar environmental conflicts. As the Chevron case in Ecuador shows, joint efforts by NGOs to empower people by encouraging greater awareness of their rights may help win environmental justice for the Lower Mekong Basin.

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Cassandra Pillay is a Ph.D. candidate in environmental science at the Universitat Autònoma de Barcelona. She is particularly interested in researching how to achieve climate change consensus.

World Social Science Report 2013
Changing Global Environments

61. Climate change mitigation, a problem of injustice

by
Steve Vanderheiden

Climate change can be seen as an issue of intergenerational justice, and the ideals of equity and responsibility identified by the 1992 UN Framework Convention on Climate Change are a useful framework for debating the architecture of international climate policy. Theories of justice from philosophy and political science allow competing proposals and objectives for climate justice to be evaluated.

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) identified anthropogenic climate change as a problem of injustice, and proposed international co-operation, bounded by ideals of justice, as a response. Signatories agree to "protect the climate system for the benefit of present and future generations of humankind". The convention also states that international action should be agreed on the basis of equity and in accordance with the "common but differentiated responsibilities" of nation-state parties (Article 3, Principle 1). Identifying the climate system as an international and intergenerational public good, the UNFCCC maintains that protecting the climate system is imperative in the name of justice, and that failure to do this would harm those most vulnerable to climate change but least responsible for causing it. To determine who is responsible for lessening the damage, equity and responsibility require remedial liability principles, based on specific theoretical accounts of justice, which have served as the main points for international policy debates.

Given the range of environmental, social and economic impacts expected as a result of the accumulation of greenhouse gases (IPCC, 2007), the UNFCCC identified the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2) as its "ultimate objective". One way to set the threshold of what is dangerous involves setting limits to maximum global temperature increases. Indeed, the unratified 2009 Copenhagen Accord aimed to limit warming to 2°C this century. Scientists estimate that this would require a reduction in greenhouse gas emissions of approximately 80% by 2050, meaning that every country would have to take significant action soon. Decarbonisation targets far higher than the average 5% decrease in emissions demanded by the 1997 Kyoto Protocol would be necessary.

Equity

The failure to mitigate climate change and avoid its most serious negative impacts would disproportionately harm those most vulnerable to changes in rainfall patterns or sea levels. Poor people are the most vulnerable to climate change and contribute relatively little per capita to greenhouse gas emissions. Similarly, future generations have not yet contributed to climate change but are expected to suffer from its effects: their protection can be described in terms of equity imperatives.

In this way, mitigating climate change can be seen as a resource-sharing problem in which national emissions are subject to principles of distributive justice (Caney, 2005; Vanderheiden, 2008). With climate change, the resource to be shared between and within states is the absorptive capacity for emissions, in other words the capacity of the Earth to absorb greenhouse gas emissions so that they do not accumulate in the atmosphere and affect the climate. This would also determine the level beyond which further emissions would have a detrimental impact on the climate. Much of this capacity lies within national borders in the form of carbon sinks (such as forests), which can be improved or supplemented with artificial sequestration technologies. However, these resources are shared in the sense that carbon sinks absorb greenhouse gases no matter where the gases originate. Determining at what level national emissions should be capped can be seen in terms of allocating shares of this resource, informed by principles of justice.

Carbon dioxide emissions absorbed by sinks are benign, while other greenhouse gas emissions accumulating in the atmosphere are harmful. Equitable access to carbon sinks is therefore concerned with equity in terms of the levels of emission, often stated in terms of per capita national emissions entitlements under an international regulatory scheme. Alternatively, equity could refer to the sharing of decarbonisation burdens, in terms of mitigation costs or of percentage reductions in relation to a baseline.

The Kyoto Protocol is a modified version of this burden-sharing approach, with national emissions caps assigned an average reduction of 5% from 1990 baselines. This equity imperative from the UNFCCC is rejected by most climate justice scholars, as it does nothing to change the highly inequitable resource sharing among developed countries and between developed and developing countries. Whether this is a problem of the equitable allocation of a common resource, or of burdens in trying to protect the climate system, assigning national emissions targets implies the application of justice principles to one or the other. The problem is how (if at all) such principles can justify inequality in the benefits or the burdens.

Responsibility

However, the UNFCCC language that immediately follows the reference to equity identifies a second criterion for assigning remedial obligations, by apportioning responsibility. Responsibility focuses on past and present contributions to climate-related harm. This requires the costs associated with avoiding or correcting the harm to be assigned in proportion to the role played by each party in it (Shue, 1999). The UNFCCC takes this to mean that the more responsible developed countries should take the lead in mitigation efforts, or in other words, that the differences in developed countries' responsibilities warrant differentiated remedial burdens. Those with higher emissions may have to pay more to lessen the damage, given their greater responsibility for it.

Countries have different views on the role that historical emissions should play in assessing current liability. India embraces the idea of "climate debt", which bases current liability on a country's full historical emissions and applies a strict liability standard. Under this scheme, recently industrialised countries appear less responsible than they would under schemes based on current or recent emissions only. The United States rejects the concept of differentiated responsibilities even when based on current or recent past emissions only. Others only take into account current and recent emissions, not including those emitted prior to the first Intergovernmental Panel on Climate Change (IPCC) assessment report, in 1990. The question remains whether or how much a country's past emissions record requires it to pay for future remedial obligation, through either mitigation or adaptation.

Conclusion

Whether responsibility for climate change should be determined by a country's full emissions or just some of them, and whether equity is a resource-sharing problem of distributing national entitlements to absorptive capacity or a burden-sharing exercise, determines how we should measure climate change and helps us identify potential solutions. Research into climate justice has highlighted the distributive questions that mitigating climate change raises, as well as the key issues involved in linking remedial action to past responsibility. Research has also offered various ways to examine fairness and responsibility. Yet there is still no agreement that climate justice requires significant action to mitigate climate change, because such justice demands that developed countries take action to decarbonise to a far greater degree than other nations.

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62. Ethics and energy consumption

by
Darryl Macer

Climate change casts the issue of equitable access to energy in a new light, because fossil fuel use damages poor communities that use little oil, coal or gas themselves. A range of approaches exist to thinking about these issues and developing more ethical and just patterns of energy use.

Energy security as a human right

This *World Social Science Report 2013* could not have been produced without energy; academic reflection and dialogue require energy to allow communication. However, one-sixth of the world's population lacks access to electricity and struggles to meet basic and essential needs fundamental to health and well-being, such as heating, lighting, cooking and hygiene, let alone to reflect on social science policy. Electricity has enhanced global reflection on social science.

How can we respond to global ethical dilemmas?

Some people find it difficult to identify with the problem of climate change. In response, Markowitz and Shariff (2012) have proposed strategies for communicators to use to appeal to our moral reasoning and persuade people to take action to address climate change. The recognition that we are one cause of climate change is the first step towards modification of our ethical choices.

Rai et al. (2010) found that although international normative texts (such as those from the United Nations) agree on a number of ethical principles, most communities find it difficult to adopt them, because ordinary citizens have a different perspective on life from that expressed in UN rhetoric. However, every society has some ethical concept of justice and of responsibility to future generations. A growing number of publications reflect on these issues for our future and help policymakers combat global environmental change.

The problem of access to essential energy services for all can be viewed through a human rights perspective. Access to energy is important for a reasonable quality of life. Many poor people are dependent on traditional biomass fuels (wood, dung and so on) for their heating and cooking needs. Indoor air pollution from the burning of solid fuels is responsible for more than 1.6 million premature deaths each year (Wilkinson et al., 2007). Access to reliable and affordable supplies of modern energy – liquid fuels such as kerosene, liquid gas or electricity – enhances public health.

The concept of human security relates to multiple dimensions of human freedom. Human security encompasses more than the possibility of military threat: it includes food, health, personal, political, community, economic and environmental security (UNESCO, 2008). The Asian Development Bank (2009) lists important energy security concerns as:

- a lack of energy access
- a lack of diversification of energy resources
- high dependence on traditional fuel
- an increasing gap between energy supply and demand
- an overdependence on imported energy
- a lack of adequate infrastructure.

The risks to human security posed by dangerous climate change are not only the result of ecological risk. Existing global inequalities in the distribution of power, opportunities and resources mean that climate change will have a greater impact in some countries than in others (Moss et al., 2011). Social scientists have also questioned the necessity of people's overdependence on consumerism, high levels of energy use, and widespread use of industrial products (Illich, 1973).

Social justice and energy policy

Inequality raises important questions of social justice. Those who will be most adversely affected by climate change are also the least responsible for creating the threat to human security from greenhouse gas emissions. The poorest 1 billion people are responsible for only 3% of emissions (World Bank, 2010). All cultures also attach a high value to biodiversity (Bosworth et al., 2011). However, the survival of many plant and animal species and the integrity of entire ecosystems are also at risk from pollution and the burning of fossil fuels. Environmental security encompasses far more than just human security.

It is essential to ensure that everyone's basic and essential energy needs are met, whilst also reducing our carbon footprint and energy consumption levels and changing behaviour (Schroeder and Pisupati, 2010). We have to consider the rights of others in the pursuit of our choices, arguing for a more frugal lifestyle than most of us adopt.

Energy poverty therefore should be a matter of social justice. Egalitarianism implies the need for redistributive justice, given that it is not right for some people to have poorer life chances than others through no fault or choice of their own. Welfare egalitarians argue that being disadvantaged means reduced opportunities for well-being. Resource egalitarians argue that being disadvantaged means having fewer resources than others. The capability approach views disadvantage as having fewer opportunities to achieve various "functionings"[1] which are seen as critical for people to flourish and be free (Moss et al., 2011).

A "sufficientarian" approach permits a limited level of inequality in people's access to energy resources. This ensures that everyone has the opportunity to lead a minimally decent life. Once this is achieved, it is of no moral consequence if some are better off than others. "Ability security" points out that people with disabilities are especially vulnerable to energy price increases and to supply shortages. For example, a household in Australia where one member suffers from multiple sclerosis will spend almost ten times as much on air-conditioning as the average (Moss et al., 2011).

The challenge of adopting an equity-based approach to energy policy is to agree on a workable understanding of what constitutes a decent minimum of well-being (Moss et al., 2011). An egalitarian or sufficientarian approach to energy equity will favour some level of government intervention in the energy sector to protect essential energy usage, for example by providing concessions on electricity tariffs for low-income households or through rural electrification programmes. An egalitarian energy policy would impose obligations on governments to reduce energy poverty and to promote universal access to an affordable and reliable supply of electricity. These goals could come into conflict with the targeted approach that many governments currently adopt for rural electrification and grid extension projects. If we apply the ethical principle of autonomy, local alternatives – such as solar or wind energy operated at the local community level – could empower communities and free them from future increases in the price of grid electricity.

Energy policy initiatives must target the reduction of energy poverty in existing generations while taking the interests of future generations and of other species into consideration. Carbon-intensive energy use involves risks to human and environmental security (World Bank, 2010). This means that not all ways of reducing energy poverty are sustainable, or consistent with the moral obligations we have towards future generations and the environment. Moss et al. (2011) review several ethical approaches that help explain the responsibility and moral obligation we have towards future generations.

Who should pay?

For example, if person A has taken unfair advantage of person B by imposing costs on them, person A should take responsibility for those costs – this is the polluter-pays principle. Applying this principle in distributing the costs of climate change mitigation is problematic. One issue is that many people now living in affluent, developed countries are migrants with little in common with the earlier citizens of these countries (Caney, 2006).

People who benefit the most from polluting activities should be obliged to pay for climate change. But this approach faces a number of difficulties. One is the issue of how to divide the costs of pollution among beneficiaries if many of them are no longer alive.

A further motivation for requiring affluent countries to contribute to the costs of sustainable development in developing countries is their greater ability to pay for it. Rich countries can help developing countries in various ways, ranging from technology transfer, to knowledge transfer, to capacity building and resource transfers.

Ecocentric approaches to environmental security

The interests of future generations and other living organisms, as well as the integrity of ecosystems, suggest that global and local energy needs should be met when possible through sustainable technologies.[2] Environmental security takes an ecocentric ethical approach towards the value of the living and non-living environment. This suggests that the damage done to nature by energy production and use should be minimised. By contrast, the anthropocentric approach to human security underestimates human integration into ecosystems. It is important to appreciate that ecosystems are also crucial for human survival.

Individual lifestyles and attitudes have to become more austere and frugal. The consumerist myths of market economies have to be questioned. Social scientists have played important roles in exploring the linkages between happiness, quality of life and greater consumption, although there is solid evidence that greater socio-economic empowerment generally enhances the well-being of vulnerable groups, such as women (Blumberg, 1995). If we want everyone to have equal access to energy, we have to understand that there are limits to sustainable energy provision. Intergenerational equity requires us to secure the energy needs of future generations and consider the injustices done to those alive in our own generation. In every culture and tradition, the social sciences and humanities have a strong role to play in challenging assumptions of what a good life consists of and our reliance on energy to achieve it.

Notes

1. "Functionings" include various things that people can be or do, like being nourished or being part of a community. It includes things that people are actively able to do, such as reading and writing, and things that are passive states such as being free of disease.
2. *www.eubios.info/repository_of_ethical_world_views_of_nature*.

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63. The ethics of geoengineering

by
Diana Feliciano

This is a brief literature review of the ethics of geoengineering – the intentional manipulation of the climate system to counteract greenhouse gas emissions. The social sciences have a role to play in clarifying the moral hazards associated with geoengineering, given that future generations may have no other choice but to implement such projects.

Over the past two decades, climate change has emerged as a major challenge to the planet. The Intergovernmental Panel on Climate Change (IPCC)'s *Second Assessment Report* (AR2) showed compelling evidence that much recorded climate change is anthropogenic in origin (IPPC, 1996). The Stern review concluded that the benefits of taking strong early action to reduce greenhouse gas emissions outweigh the costs of climate change effects considerably (Stern et al., 2006). However, most technical solutions to mitigate climate change have environmental, social and economic effects, and raise additional issues regarding ethics, justice and moral hazard.[1] Geoengineering is one example.

According to Scott (2012), geoengineering is the intentional manipulation of the climate system to mitigate global climate change, which is itself the effect of anthropogenic greenhouse gas emissions. Geoengineering methods and technologies seek either to reduce the amount of absorbed solar energy in the climate system or to increase carbon removal from the atmosphere, at a scale sufficiently large to alter the climate.

The first group of such technologies are referred to as solar radiation management. This includes pumping sulphates into the stratosphere to simulate volcanic eruptions and so brightening clouds to reflect more sunlight back into space. Fertilising the ocean with iron to remove carbon dioxide from the air is an example of the second approach.

Given the increasing scientific interest in geoengineering, the IPCC's *Fifth Assessment Report* (AR5) will evaluate its ethics, feasibility, effectiveness, side effects, efficiency, legal and social acceptability, regulation, monitoring and verification (IPCC, 2012).

A report launched in 2009 by the Royal Society and entitled *Geo-engineering the Climate: Science, Governance and Uncertainty*, identified three main ethical positions regarding these techniques: consequentialist (value of the results), deontological (the issue of duty and "right behaviour") and virtue based (dilemmas of pride and arrogance) (Royal Society, 2009). These ethical positions have shared concerns regarding the governance of research and its possible deployment, the unbalanced sharing of risks, the distributions of harms and benefits, the possibility of one-sided deployment and possible effects on the environment.

According to Scott (2012), the philosophers Dale Jamieson and Stephen Gardiner have provided the two most extensive treatments of the ethical issues to date. Jamieson proposed a list of difficult-to-meet ethical preconditions to allow the implementation of geoengineering projects (cited in Scott, 2012). Gardiner argues that it would be sensible to develop these technologies, as future generations might have no choice but to implement them in order to avoid the catastrophic consequences of climate change (cited in Scott, 2012). The Royal Society (2009) considers that in terms of justice and moral hazard, the mitigation of greenhouse gas emissions is preferable to geoengineering, but advises that research should continue.

Rayner et al. (2009) maintain that governance structures should be in place to guide research in this area and to ensure that any decisions ultimately made regarding deployment occur within an appropriate governance framework. They believe that such a framework should support transparent decision-making, public participation and the open publication of research results. Furthermore, it should take the views of scientists, policymakers, the public and civil society groups into account. The "Oxford Principles" (Oxford Geoengineering Programme, 2013) regarding the governance of geoengineering were drawn from the work of Rayner et al. (2009) and submitted to the British government in 2009:

- geoengineering to be regulated as a public good
- public participation in geoengineering decision-making
- disclosure of geoengineering research and open publication of results
- independent assessment of impacts
- governance before deployment.

The Royal Society (2009) also emphasises that the possible use of geoengineering will depend upon the public's perception of the risks, their level of trust in researchers and practitioners, the transparency and purposes of geoengineering actions, and the vested interests involved. It argues that many of the ethical issues associated with geoengineering are likely to be specific and technology dependent. If research shows that moral hazard is unlikely in some types of projects, the public's objection to the implementation of these projects might disappear. Therefore one of the objectives of the social science research agenda should be to clarify the existence or extent of any moral hazard associated with geoengineering projects. Scott (2012) argues that as a pragmatic approach it might be sensible to research other options generated by geoengineering while political efforts are still inadequate.

Note

1. *Ethics*: how humans should act; *justice*: the concept of moral rightness based on ethics, rationality, law, natural law, religion, equity or fairness; *moral hazard*: a situation in which a party has a tendency to take risks because the costs that could incur will not be felt by the party taking the risk.

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64. Ethics as a core driver of sustainability in the Caribbean

by
Pedro Monreal Gonzalez

The José Martí Project for World Solidarity is addressing environmental issues in the Caribbean from a political and ethical perspective. The region is especially vulnerable to climate change. Concern about the environment varies even at the community level, depending on how close people live to the resources they rely on for their livelihoods. Yet local islanders have been excluded from devising responses to environmental degradation.

Ethics and sustainability

Sustainability is a political process and cannot be achieved by applying scientific knowledge alone. Many individuals and groups are involved, including national and local government, academics, the private sector and civil society, all with conflicting social and economic interests. Sustainability is also shaped by our values and belief systems and the moral outcomes we each want to achieve. Diverse and contradictory perspectives are inevitable. There will always be competing views of what is "right" or "wrong" concerning decisions about the environment and subsequent public action and development outcomes.

We do, of course, need decisions on sustainability and global environmental change. Garvey (2008) maintains that the problem is how to identify a rationale for action, and that while scientific, economic and social factors are important, the "right" answer is largely shaped by ethical considerations. Ethics should be the core driver of sustainability.

Focus on Caribbean states

According to UNESCO (2011), global environmental change is having a disproportionate impact on Caribbean states. Food security, housing, agricultural production, coastal ecosystems, tourism – the very fabric of social, economic and cultural life – are all affected.

José Martí Project

Several institutions in the region are working holistically to achieve sustainability, including the Jose Marti Project for World Solidarity. The project was set up in 2002, with support from UNESCO, to address the serious problems confronting humanity.

It includes representatives of different regions and is open to all religions, philosophies and beliefs of universal humanism. A Cuban national hero, Martí was an important social and political thinker in the late 1800s and forefather of independence in the region. He aimed to develop a more harmonious relationship between humans and nature, and supported public education, social justice and inclusion. Freedom, liberty and democracy are prominent in his work. His ideas about what is now called sustainable development offered a rich foundation for collaboration between the societies of North and South America in tackling environmental problems (Castro, 2001).

Since 2012, the José Martí Project has focused on improving policy responses to global environmental change in the Caribbean. It assists social science networks and civil society to rethink development processes in relation to climate change. Collaboration between social scientists, civil society and policymakers speaking different languages in distinct regions and sub-regions is an important part of the process.

The José Martí project prioritises participatory, community-based thinking, and aims to integrate environmental, social and economic issues within a long-term perspective. There are many different ways to achieve this based on multiple goals and perspectives, but the crux is to have a strong moral and ethical foundation.

The project has identified the following ethical issues as being pertinent to formulating policy on sustainability at national and regional levels:

- A rights-based perspective is crucial to transcending the limited but still dominant economic approach to development (Puig, 2013), as Amartya Sen's work shows (1999).
- Given the serious impact that climate change is having on people's livelihoods and the environment, a concerted effort at the international level is morally imperative (Naraine, 2013).
- Ethical concerns about scientific knowledge relate to the use or misuse of scientific knowledge and to people's moral duty to act, or not act, on available knowledge. Who is responsible for improving data-gathering networks to ensure information is accurate? Should we mitigate against the risk of information not being accurate enough? What do we do about knowledge gaps (Naraine, 2013)?

The project recommends that at regional and national level, island states consider the following key ethical issues in formulating policy for sustainability:

- A process of political negotiation on sustainability outcomes that articulates the relevant ethical issues at the island, or even community, level is preferable to a universal approach across the Caribbean. Public authorities, business managers and other decision-makers must consider citizens' attitudes toward new, large-scale economic activities when planning resource management. This is essential because people's beliefs, concerns and behaviours vary according to how close they are to the resources critical for sustaining their livelihoods, such as coastal zones and wetlands (Baptiste and Nordenstam, 2009).
- Socially inclusive and equitable sustainability with solid ethical foundations requires new forms of social learning, such as participatory engagement at the community level.
- More people are getting involved in devising responses to environmental degradation in the Caribbean states. This should mean that people who have traditionally been excluded from decision-making processes now have more opportunities to share their opinions.
- Everyone, no matter where they live, has a responsibility towards the environment. However, their obligations may differ, reflecting uneven social and economic

circumstances, diverse historical contributions to global environmental problems, and various levels of ability to address environmental issues. Given this generally accepted concept of common but differentiated responsibilities (United Nations, 1992), the unique vulnerabilities of Caribbean island states should be weighed in any model of shared responsibilities.

- To be effective, international co-operation for sustainability needs to focus on individual island states within the Caribbean. Capacity building should be about developing knowledge and expertise, strengthening links between local organisations, engaging the local community, and involving academia and industry in community life.
- Caribbean island governments need to assess environmental and social demands from civil society – including marginalised groups – effectively through participatory policy processes, as Castro (2013) has pointed out.

The development of a shared vision is essential to allow Caribbean states to pursue effective sustainability policies. This will require integrating the complex processes of ecological degradation with the similarly intricate processes of human development. It must include philosophical and moral judgements to help define the relationship between humanity and nature.

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65. The role of religion, education and policy in Iran in valuing the environment

by
Hossein Godazgar

Iran faces many environmental challenges, including air pollution in cities and sand storms exacerbated by progressive drying out of the land. As a result, the government now has more sympathy for environmental concerns and there are some active green non-governmental organisations. The picture is complicated by varying interpretations of the Qur'an advice on human responsibility for the Earth. School textbooks refer very little to nature and with a dominant Islamic political ideology. Little space is left to discuss the environment in the classroom.

Environmental concerns are growing in Iran, and of these, air pollution in Tehran and other large cities is probably the most urgent. Tehran is one of the ten most polluted cities in the world. According to the Office for the Control of the Quality of the Atmosphere, the number of polluted days in Tehran has "increased greatly during the last six years and reached its peak with 218 [non-standard and unhealthy] days in 2011" (BBC Persian, 2012a).

As a result, the number of days in which schools, offices and factories have had to close has risen, as have the number of deaths related to pollution (BBC News, 2010). According to the deputy health minister, some 4 460 people died due to pollution in Tehran in the first nine months of 2012 (Asgari, 2013). The former president, Mohammad Khatami, recently mentioned that "It is not acceptable to have atmospheric conditions that lead to a state of emergency and danger in Tehran and other large cities for two-thirds of a year … the one person who can identify these most crucial issues and who can address them must step forward [as President]" (Khatami, 2013).

The main causes of pollution are population growth, migration to cities, the poor-quality fuels used by the mostly old cars on the road, industry, and most importantly, a lack of awareness and disregard of the environment. Economic sanctions have also made industry more polluting.

Air pollution is not the only problem. The Zayandeh-rood River in Isfahan dries up more frequently than in the past, as Foltz (2005) has described, and dryness has now penetrated areas once described as wet. For example Lake Urmia, situated in West Azerbaijan province, is also now drying. This has sparked anti-government demonstrations and discussions at government and parliamentary level. Sandstorms are no longer limited to arid provinces, such as Sistan and Baluchestan, Kerman and Yazd in eastern and central Iran (Zakeri and Forghani, 2012; Omidvar and Khosravi, 2012). In 2012, sandstorms twice caused the closure of schools and offices in Tabriz in north-west Iran.

Government policies on dealing with these concerns have not always been systematic. Early Islamic governments in the 1980s paid considerable attention to rural development. They built roads to help rural people take their agricultural products to the cities. Ironically, this contributed to record rural–urban migration (Velayati, 2011).

Later, during Khatami's presidency, a vice-presidency for the environment was established, encouraging the growth and recognition of about 300 local environmental non-governmental organisations (NGOs). This increased the role of the media, academic journals and the press in discussing issues of sustainability. Khatami allocated a "Green Day" on which the use of private cars was discouraged, although in practice people did not welcome this idea (Foltz, 2005).

Policies in support of civil society, including the Environmental NGO Network, were however questioned during the presidency of Mahmoud Ahmadinejad (2005-13) in the name of economic development. Indeed, Parviz Dawoudi, a former vice-president, has stated that support for sustainability and environmental preservation constitutes "colonialism" (Godazgar, 2011). The policy change appears directly related to the high incidence of urban air pollution in Tehran in recent years.

Iran under the presidencies of Rafsanjani and Khatami had been praised for aiming to reduce the rate of population growth from 4% per annum in the 1980s to 1% per annum by 2013 (Foltz, 2005: 5). This policy has continued, and according to a World Bank report (2012), the population growth rate reached 1.11% in 2011. However, the former president, Mahmoud Ahmadinejad, who called birth control "wrong and Western" in 2010, began to reverse the policy in favour of increasing population growth rate in 2012 (BBC Persian 2010, 2012b; *USA Today*, 2012). This new policy became even more inevitable when the Supreme Leader of the Islamic Republic, Ayatollah Ali Khamanei, publicly supported Ahmadinejad's view of population growth in October 2012 and declared that "One of the mistakes we made in the 1990s was population control. Government officials were wrong on this matter and I, too, played a part. May God and history forgive us" (Khamanei, 2012).

The Islamic government's disregard for the environment is also reflected in the state education system. Education in general, and religious education in particular, barely deal with these concerns. Of the 225 chapters written for Muslim pupils and 73 chapters produced for pupils belonging to the Christian, Judaic and Zoroastrian religious minorities in 2010-11, only three at the primary school level contain elements on the importance of the environment.

The environment or nature does not figure in the modern sense in the Islamic tradition. However, the Qur'an describes the Earth (*ardh*), its components and surroundings as signs of God (*ayat allah*) or as his gifts (*na'amat*).[1] Shi'ite jurists have interpreted these verses as addressing unbelievers (*koffar*), asking them why they do not believe in God even though they see these signs (*e.g.* Makarem-Shirazi, 2008: 153-8, 203-10; Tabatabaei, 2003: 91-139, 170-86). However, in the *ijtihad*,[2] these verses also have implications for contemporary understanding of the environment – *tanqih-i manat* in Shi'ite jurisprudence – and could mean that no one is allowed to change the environment (Earth) for the worse;

it is there for everyone of all generations and has to be valued and protected. Any damage to the environment may result in the peace of nature being disturbed. This would lead to "corruption on Earth" (*fasad fi al-ardh*), which is strictly forbidden under *Shari'a* law. This view has, however, never been adopted by Islamic or other religious education textbooks, the government, or Shi'ite jurists in Islamic seminaries.

Apart from a limited period during Khatami's presidency, and to some extent during Rafsanjani's presidency, post-revolutionary Iran – particularly under Ahmadinejad – has suffered from unfavourable policies for and attitudes towards the environment in general. Change in environmental practices will not happen without an increased awareness of the value of the environment among Iranian religio-political elites and people. As was mentioned above, Islam *can* be interpreted by the jurists in a way that it values the environment, at least instrumentally. If this interpretation of Islam is adopted by the Islamic government, it can also be reflected in the state-provided Islamic or religious education textbooks and curricula. This may lead to the contribution of Islamic education to the promotion of awareness and good practices towards the environment in most sectors of Iranian society. Aspects of these issues might be addressed during the presidency of the moderate conservative Rouhani in the years ahead.

Notes

1. "Who made the Earth a resting place for you and the heaven [atmosphere] a canopy…" (2: 22), or "He it is who created for you *all* that is in the Earth…" (2: 29) (author's italics).
2. *Ijtihad*, in Islamic law or *Shari'a*, means an effort to understand or independently address an issue not explicitly covered in the Qur'an or Sunnah (the tradition of the Prophet). In Sunnism, the gate of *ijtihad* closed in the 9th century (3rd century of Islam), but it has remained open in Shi'ism.

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66. Sacred sustainability? Benedictine monasteries in Austria and Germany

by
Valentina Aversano-Dearborn, Bernhard Freyer and Sina Leipold

The focus of the transdisciplinary research project, Dealing with the Divine Creation, was to investigate the role of religion, spirituality[1] *and ethics in promoting sustainable development and the environment in four Austrian and two German Benedictine monasteries.*

Religion, spirituality and ethics have received increasing attention from researchers all over the world, since many sustainability processes seem to have failed because of a lack of appropriate ethics (Inauen et al., 2010; McDaniel, 2002; Orr, 2002).[2] For this reason, this research project studied the role of ethical principles transmitted through the Christian faith in promoting sustainable practices.

While monasteries are predominantly seen as centres of spirituality and charity (e.g. Carroll, 2004), they have also developed sustainable models for agriculture, food processing, forestry, tourism and employment. As Benedictine monastic communities are strongly guided by Christian ethics, we investigated to what extent their initiatives towards ecological sustainability (such as organic agriculture and renewable energy production) were predominantly guided by their spirituality and associated ethics.

As the Bible and the Rule of St. Benedict are the two central ethical references of Benedictine monks, we analysed their inherent connections to sustainable lifestyles and economic practices. These ranged from the responsibility for resources (such as sufficiency as a guiding principle) to the management of staff (for example, social responsibility) and governance strategies (see Feldbauer-Durstmüller, Sandberger and Neulinger, 2012; Rosenberger, 2011). We undertook 40 qualitative and semi-quantitative interviews, which documented that the monks identified multiple overlaps between their Benedictine ethics and spirituality, and the concept of sustainability. In contrast to these more general interrelationships, mainly connected to economic and social engagements, an ecologically responsible approach to dealing with the Divine Creation has only recently started to gain momentum in the monasteries studied.

The adoption of ecologically oriented practices very much depends on individuals with access to certain capacities and resources. As with other units of society, the capacities necessary to establish new organisational practices encompass access to relevant information and knowledge, an actor network of supporters from outside and inside the monasteries, the ability to use institutional options and foundations (such as the Benedictine Rules) to shape the monastic discourse, and access to technical and economic benefits and requirements (adapted from Jänicke and Weidner, 1997).

Ecologically oriented concepts of sustainability were rarely reflected or established at an organisational level, but rather were found within the fields of activity of individual monastic actors. Accordingly, ecological practices were driven less by a collective ethical or spiritual mission than by economic or technical considerations, which were more readily accepted by the responsible councils and the abbot. Consequently, we conclude that while the central presence of ethical and spiritual principles provides entry points and interfaces for reflections and practices tackling sustainable organisational development, they are not in themselves a guarantee of sustainable ecologically oriented practices and their institutionalisation. Throughout the transdisciplinary-oriented research process, however, the participating monks and secular employees signalled that they became increasingly aware of the sustainable dimensions of the Bible's ethics and the Rule of St. Benedict (the monks' major frames of reference).

With respect to the role of ethics and spirituality for sustainable development in the overall societal debate, our results indicate that their mere presence is not sufficient to successfully accomplish sustainability processes. Ethical values need to be complemented by capacities and resources for intense organisational learning (see e.g. Argyris, 1990) as well as by far-reaching and participatory transdisciplinary discourses.

Notes

1. Here understood as internalized and practised faith based on certain religious value sets contained in the Rule of Benedict and the Bible.
2. For example, Forum on Religion and Ecology, Yale University, United States, *http://fore.research.yale.edu*.

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67. Public engagement in discussing carbon capture and storage

by
Leslie Mabon and Simon Shackley

Carbon dioxide (CO_2) capture and storage has significant climate change mitigation potential, yet has struggled to gain public acceptance. For it to become socially acceptable, underlying ethical issues need to be addressed. This involves engaging the public in ways that keep the terms of discussion open, that allow a range of possible outcomes, and manage expectations effectively.

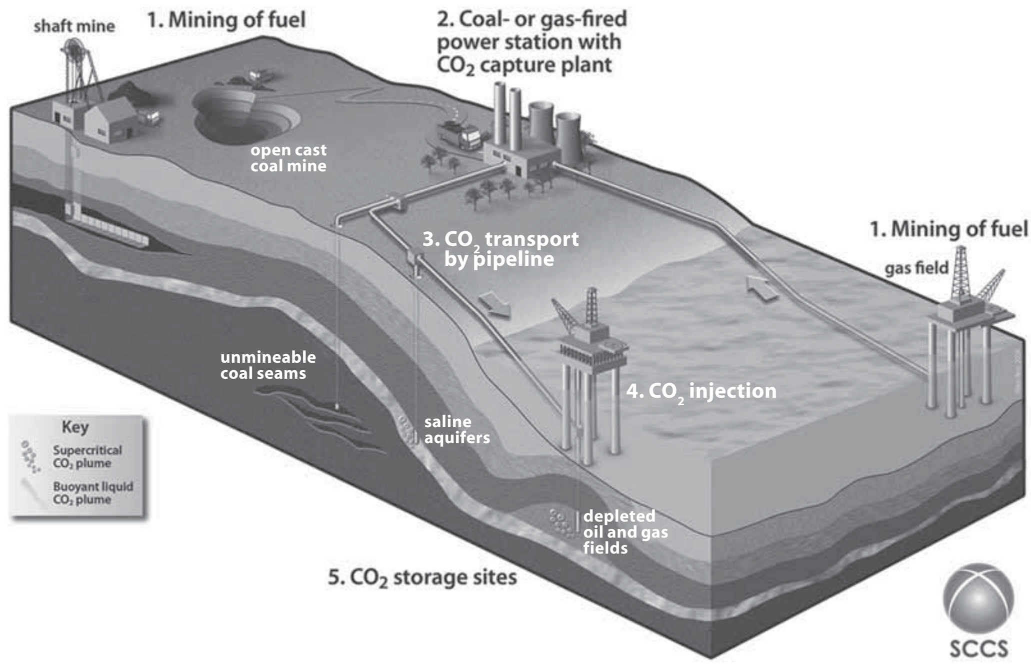
It started in Holland ...

Few people will have heard of Barendrecht in the Netherlands. For carbon dioxide (CO_2) capture and storage (CCS) developers, however, the town signifies a massive shift in how this low-carbon energy technology is considered. Barendrecht witnessed sustained and aggressive public opposition to a proposed CCS development, which partly led to its cancellation in 2010. Since then, public interest and engagement in this area have soared. It is clear that public support is vital for the successful use of this technology. In this article, we argue that despite the CCS community's growing interest in public participation, key ethical issues still need to be addressed.

What is carbon capture and storage?

CCS is a process designed to trap the CO_2 formed by the burning of fossil fuels before it enters the atmosphere, and to store it underground in rock formations (see Figure 67.1).

Figure 67.1. **Carbon capture and storage system (not to scale)**



Source: Peter Reid/Scottish Carbon Capture and Storage, reproduced with kind permission.

CCS is best adapted to single-point sources of large amounts of CO_2. These might be power stations that burn fossil fuels, or industrial sources of CO_2 such as steelworks. One of the first CCS power stations is being built at Boundary Dam in Canada, with possibly another in Maasvlakte in the Netherlands. Many other projects are working on part of the process, including pioneering CO_2 storage under Norwegian waters and at onshore projects in Algeria and Canada. Many energy and fossil-fuel-extraction companies, national governments and certain environmental non-governmental organisations (NGOs) support development of the technology.

Why do ethical issues matter in energy production?

Energy is a fundamental aspect of people's lives. The energy generation choices that society makes can have economic, environmental and practical effects. Such decisions can profoundly affect the way people live their lives. Ethical issues – what is socially acceptable and how decisions should be made – will inevitably be part of this.

Energy production is not alone in this regard. New technologies such as information technology and genetic modification can also have far-reaching effects, and the concept of responsible innovation has emerged in response. Von Schomberg (2011) explains that responsible research and innovation involve early societal involvement in the research and innovation process, to reduce the chances of a technology emerging that is unacceptable to society. Here we consider the ethical issues that need to be addressed to allow people to participate fully from an early stage and more broadly in discussions on CCS and low-carbon energy.

Locking up more than CO_2? Closing down the discussion

Perhaps because of events such as those at Barendrecht, the CCS community has in recent years shown a strong interest in how to communicate CCS and climate change to the public. The reasoning is, first, that if people understand the need for climate change mitigation, they will also understand and accept the rationale for it. In addition, the hope is that increasing this understanding will help to dispel concerns about the safety risks of storing CO_2 underground. In the past few years, the Global Carbon Capture and Storage Institute, the Commonwealth Scientific and Industrial Research Organisation (Australia), the United States National Energy Technology Laboratory, the World Resources Institute and others have all published detailed guidelines on how to ensure effective public engagement in these issues.

However, this approach limits the terms of public engagement to a discussion about the science of climate change and CCS. It arguably leaves little room for members of the public who want to discuss, say, the fairness of leaving future generations with the moral hazard of continuing fossil fuel use. Research with the general public in the United Kingdom and Italy, as part of the interdisciplinary European Union Seventh Framework Programme (FP7) ECO_2 project on the effects of sub-seabed storage of CO_2 – has found that people often express concerns about CCS in terms of issues such as trust, fairness and morals, rather than the technological detail (Mabon et al., 2013).

The limitations of the guidelines could be seen as unethical if, by closing down the discussion from the outset, they exclude those who might want to discuss CCS in different terms. This could lead to injustice. More ethical public engagement in the issues should allow for different framings of the discussion so that people can discuss concerns that may go beyond technical risks and safety. This leads to a second ethical point: what is the purpose of engagement?

Is public acceptance acceptable?

The concept of public acceptance underpins much of the public engagement in CCS. In other words, there is an implicit assumption that the best outcome is that the public accept the technology. There seems to be little room for other results, such as a community perhaps deciding that it is not appropriate for their area. This is arguably logical and to be expected. A project developer's goal is to implement a project. Even in academic research, the industries and governments that become involved are keen to develop knowledge that will allow CCS to progress.

Difficulties arise, however, when the general public take part in an engagement process – whether for a real-world development or an academic research project – and believe they can choose whether a technology such as CCS should be implemented, when in fact the major decisions concerning its location and technical characteristics have already been made. Indeed, citizens in Moray, Scotland, who participated in a discussion group for the European Union-funded SiteChar project, were surprised to discover that the Scottish government's plans for CCS were at a much more advanced stage than they had expected. They questioned the purpose of their engagement, and were left with the impression that the fundamental decisions had already been taken (Moray Citizens, 2012). Increased public engagement needs to be more open to a range of possible outcomes, including accommodating alternative views, and including the realisation that some people might not want such projects to go ahead in their area. This leads on to a third, equally important, ethical imperative: managing public expectations.

Managing expectations

Public understanding of decision-making processes can often differ from reality. For example, people may believe that participating in government-funded research means that high-level decision-makers will be reading their contributions and acting on them. This can lead to an ethical dilemma regarding the gap between what people feel they can achieve by participating and what they are actually able to achieve. People's expectations of their engagement in low-carbon energy issues may exceed the level of influence they would expect via democratic processes in other areas of their lives. Provoking feelings of disappointment or dashed expectations could be viewed as unethical, and may reduce a community's trust in other low-carbon energy approaches that may be developed in the future.

To reduce the chances of this happening, it is important to be clear from the start what participation can and cannot achieve. Ashworth et al. (2010) believe that the community's unmet expectations regarding their engagement contributed to opposition to the Barendrecht project in the Netherlands, and suggest that expectations need to be discussed as early on in the process as possible.

Social scientists too have a moral responsibility in this regard. Social science researchers often work with the general public, and need to be honest with consultation participants about the challenges of bringing about change. It is also important for social science researchers to reflect on what members of the public expect from them, and to encourage low-carbon energy developers to apply more rigorous and ethical public engagement procedures.

Conclusion

The development of CCS continues, and more recent projects under way in Australia, North America and Europe seem to be learning from the public engagement in earlier projects. There is now greater emphasis on building relationships with stakeholders and local communities at an early stage. These relationships are based not only on CCS issues but also on related wider contexts. Nonetheless, the empirical research reviewed here suggests that ethical questions regarding which energy options society should pursue, and how, still play a vital role in shaping the public's views. Paying attention to these ethical considerations and ensuring effective public engagement are vital if projects are to achieve social acceptability.

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68. Biodiversity loss and corporate commitment to the UN Global Compact

by
Chris Monks

Companies operating in fields that have a significant impact on biodiversity often perform poorly in terms of their managerial response to this challenge. However, those businesses that commit to supporting the UN Global Compact's principles perform significantly better in terms of biodiversity policies or systems than a wider sample of global, publicly listed, Financial Times Stock Exchange (FTSE) All-World Developed (AWD) Index companies.

Protecting biodiversity and the role of business

Evidence is growing that company activity has an impact on biodiversity loss and environmental degradation. The 2010 *Global Biodiversity Outlook* progress report on the UN Convention on Biological Diversity stated that businesses need to provide effective action to address biodiversity loss and the underlying causes or indirect drivers of this decline (CBD Secretariat, 2010: 11-12).

The Convention on Biological Diversity is based on the conviction that biodiversity has practical implications for business, directly and indirectly, and that biodiversity is important for the sustained delivery of environmental services for economic activity. Many businesses, such as forestry and fishing, depend directly on natural biological resources. The destruction of biodiversity is therefore a risk to their business models. In addition, diverse flora and fauna provide resources for a wide range of products. These include fibres and pharmaceuticals, and form the building blocks for biotechnological innovation. Biodiversity is also relevant for agriculture because it ensures a variety of crops and livestock.

Other businesses may depend on the quality of the local environment or require ecosystem services, such as the purification of sewage discharges by river systems. Some businesses operate near habitats that are under statutory protection; many own or occupy large land holdings which have the potential to conserve biodiversity. In addition, diverse ecosystems have environmental functions such as carbon absorption and cycling, the maintenance of soil fertility for agriculture, wider climate and surface atmospheric temperature regulation, and ensuring water flows. It is in the best interests of society that these interconnections be recognised and strengthened so that they become sustainable.

The UN Global Compact and stakeholder theory

The UN Global Compact (UNGC) is an independent standard of consensus building between different stakeholders, including corporations, non-governmental organisations (NGOs), trade unions and the public sector. It is a strategic policy initiative for businesses committed to aligning their operations and strategies with ten universally accepted principles pertaining to human rights, labour, environmental protection and anti-corruption. The UNGC includes over 8 700 corporate participants and stakeholders from more than 130 countries, who have all promised to support the ten principles.

Principles 7 to 10 of the UNGC require companies to act in an environmentally responsible way by reducing pollution, using environmentally friendly technologies, and understanding and respecting the connections between their operations and the natural environment locally and globally.

Stakeholder theory approaches view corporate activities as being fundamentally based on a theoretical "licence to operate" granted by society. This means that firms are responsible for addressing society's needs, and that their shareholders and owners are no more important than any other group – employees, shareholders, suppliers, government organisations, trade unions and associations, local citizens and communities, and so on. Corporate commitment standards – such as the UNGC – support this principle, whereby companies maximise profits within an overarching commitment to corporate citizenship.

Additionally, companies demonstrating poor attitudes to corporate citizenship in areas such as protecting biodiversity can have significant implications in the issue of justice for affected communities and environments. For example, a 2012 Oxfam report on justice in the food system considers the effects of environmental degradation such as soil depletion and desertification caused by large food manufacturing activities on communities in some of the world's poorest regions (Bailey, 2012).

Assessing company impacts on biodiversity

A number of assessments of companies' approaches to biodiversity have been undertaken.[1] Researchers typically consider a number of responses to be acceptable. A good assessment means the company has developed all of the following responses:

- a group-wide policy
- a biodiversity action plan, either site-based or group-wide
- a policy with a formal commitment according to the most important Convention on Biological Diversity principles
- evidence of a biodiversity policy relating to supply-chain sourcing, or a commitment to suppliers that belong to a relevant certification scheme, such as the Forestry Stewardship Council (FSC) or Marine Stewardship Council (MSC).

Analysis shows that companies operating in sectors with significant biodiversity impacts mostly perform poorly according to these assessment criteria. Only 6% of companies achieve a good assessment, while 44% achieve none of the above criteria (which means they are classified as poor).

Sector classifications – high- and medium-impact sectors

The assessment outlined in this article used a sample set of 2 611 companies in the FTSE[2] All-World Developed (AWD) Index. Of the sample, 26% of companies are in a high-impact sector, 16% in a medium-impact sector and 58% are in neither (see Table 68.1). Of the 863 companies identified as being in a high- or medium-impact sector, 119 are signatories to the UNGC.

Companies are defined as being in a high-impact sector if their corporate operations typically impact directly on the quality of the surrounding natural environment. The impact is largely negative (for instance, a property development company building in a previously undeveloped wildlife habitat, or an open-cast mine or resource extraction site).

Medium impact occurs in sectors whose activities affect biodiversity indirectly, perhaps through supply chain management or their control of large land holdings. An example is the product-sourcing policies of supermarket chains. All other sectors are classed as having a low impact on biodiversity, and are outside the assessment parameters for this research.

The high- and medium-impact sectors are categorised as shown in Table 68.1.

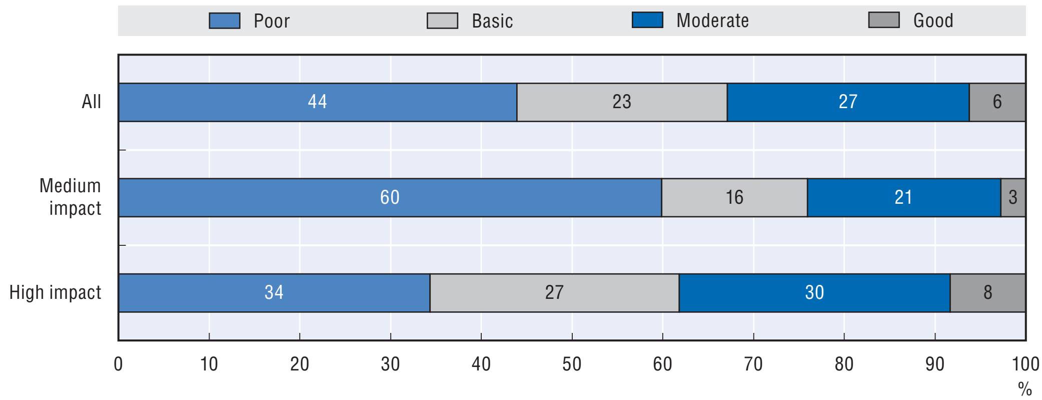
Table 68.1. **Biodiversity impact by economic sector**

High impact	Medium impact
Airports	Air transport
Building materials	Chemicals and pharmaceuticals
Construction	Building supplies
Power generators	Supermarkets
Energy and fuel distribution	Property developers
Agriculture	Public transport
Food, beverages and tobacco	
Forestry and paper	
Mining and metals	
Oil and gas	
Ports and shipping	
Road distribution and shipping	
Waste	
Water	

A company is considered "good" when it has publicly shown evidence of (i) a written policy commitment relating to biodiversity, (ii) a group-wide biodiversity action plan, and either (iii) a voluntary commitment to CBD principles (for high-impact companies), or (iv) a commitment to only use suppliers with commitments to certified sustainable sourcing commitments, such as the FSC or MSC. Where a company has only demonstrated site-level biodiversity action plans, it is given a moderate score. A written policy only merits a basic grade. Finally, no evidence of any of the above results in a "poor" assessment.

High-impact sector companies do better than medium-impact sector companies (see Figure 68.1). In a subcategory based on impact, 8% of companies in high-impact sectors achieved a good assessment compared with 3% in medium-impact sectors, while 34% of high-impact companies had a poor assessment compared with 60% of those in medium-impact sectors.

Figure 68.1. **Corporate biodiversity assessment results**



UN Global Compact participation versus non-participation

Companies that participate in the UNGC do significantly better than the wider sample of FTSE AWD companies at meeting the biodiversity response criteria and in how they respond to the potential impact of their operations on biodiversity.

Very few major publicly listed global companies participate in the UNGC. Of the sample of publicly listed companies in high- or medium-impact sectors, only 14% have voluntarily committed to the UNGC. However, comparing UNGC participants and non-participants side-by-side shows a considerable contrast in performance.

Although only 4% of non-participating companies produce good assessments, 22% of UNGC participants do so. This disparity continues in the moderate category, in which 50% of UNGC participants were graded moderate compared with 15% of non-UNGC participants. To look at the issue the other way round, 53% of non-participators achieved a poor biodiversity assessment, but only 13% of UNGC participants.

Table 68.2. **Comparison of UN Global Compact participators and non-participators**

	Poor		Basic		Moderate		Good	
Sector impact	**UNGC**	**Non-UNGC**	**UNGC**	**Non-UNGC**	**UNGC**	**Non-UNGC**	**UNGC**	**Non-UNGC**
High	8	177	13	135	43	118	24	21
Medium	8	186	5	47	16	53	2	7
All	16	363	18	182	59	171	26	28
	13%	53%	15%	28%	50%	15%	22%	4%

Conclusions

Companies that support the UNGC are better at handling their potential operational impact on biodiversity than non-UNGC companies, offering us a glimpse of how UNGC signatories compare with non-signatories in the area of biodiversity protection.

Our consideration of the impact of business activities on biodiversity in the natural world, in a world of finite natural resources, shareholder demand for continuous profits and political desire for steady economic growth, is a useful starting point for understanding how economic practices compound and promote global inequality. Earlier, this article touched on the issue of justice and implications for affected communities, as a consequence of companies failing to protect the natural environment. This issue is particularly apposite to the "responsibilities and ethics" cornerstone of social sciences.

Notes

1. Data for this analysis has been provided by EIRIS Responsible Investment Solutions (*www.eiris.org*).
2. Top 100 companies listed on the London Stock Exchange.

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World Social Science Report 2013
Changing Global Environments

69. Towards responsible social sciences

by
Asuncion Lera St. Clair

Deciding how to respond to climate change involves value choices and dealing with constantly changing uncertainties and realities. A holistic view of knowledge is needed, where knowledge is seen as tentative, and in need of constant refining. It is also necessary to reclaim the transformative role of science in making decisions and co-producing policy. Responsible science can respond to these changing realities, but only if knowledge is co-designed and co-produced across the sciences, collaboratively with non-expert sources of knowledge.

Introduction

John Dewey (1930) argued that understanding knowledge should be a process of framing and reframing issues that are of central importance for society. Science is both theoretical and practical; knowing is always imperfect, requiring constant testing and refinement. Dewey (1930) advocated knowledge with clear normative purposes – to improve society, which requires awareness of how others interpret reality and of their needs and demands. It also requires the acknowledgement that science has limits, and that many societal issues entail value choices which need to be made not by experts only but through public debate and discussion. In this article, I use John Dewey's conception of knowledge as action to argue for the need for responsible science: action-oriented, public, deliberatively normative, but aware of its limits and able to direct the transformations needed to respond to climate change.

Social action and visions of progress

The gap between science and action in dealing with climate change is not solely caused by the poor communication of scientific facts, or by a lack of understanding of Earth system science by the public and policymakers. We also lack a social science framing that tells us what climate change implies in human and social terms.

Interpreting climate facts as a human challenge helps us view climate change as the result of unsustainable models of progress and development, including individual and collective choices, values, beliefs and assumptions about what it is to be progressive, modern and developed. This differs from the dominant view that climate change is an environmental crisis that Earth system science discovered and that new technologies can solve. A social and human framing shows the causes, the risks involved and the opportunities. It forces us to acknowledge that past and present development pathways have led to highly uneven results, including massive inequalities in people's voice and access to resources, and in the power within and between countries, all of which combine to create vulnerabilities.

Viewing it from a social and human perspective, climate change is also revealed as the negative effect of a particular notion of growth – of understanding quality of life and well-being as consumption and the accumulation of material possessions through the use of fossil fuels. Many persist in maintaining that we need more growth of this kind to reduce poverty and that poor countries have a right to develop. This argument hides the social dimensions of growth and of environmental degradation, disregarding the relationship between wealth creation and poverty, and the interaction between human action and the natural environment (Lawson and St. Clair, 2013).

Knowledge as action

The gap between climate risks and current responses is often seen as being the result of the perception that science is distanced from users and other non-scientific sources of knowledge, experience and meaning. This perception leads to a view of science as being dislocated from the world of action. It is seen as being produced in a fragmented way, often in isolation from the "real" world. Rather than co-operating and producing integrated research to solve concrete problems, scientists often compete with each other to create valid descriptions of the world. This produces a haphazard array of scientific and disciplinary "information", telling us little about what to do (McMichael, 2012).

Drawing on a literature review of the links between climate science and policy, Lemos, Kirchhoff and Ramprasad (2012) argue that the interplay and interactions between science and users are the most important characteristics in narrowing the gap between climate information and its usability.

I suggest that incentives should be created that defragment and recouple knowledge and action. This will allow the co-production of knowledge and policy, and will reclaim the role science has in making decisions and implementing policy. Climate change is urgent and uncertain: we have to respond to a reality that is constantly in flux, where the associated knowledge is always tentative and in need of refinement. Science needs to be linked directly to action. It should be informed by and knowledgeable of the insights, demands and characteristics of decision-takers and users.

Mechanisms are needed to co-produce knowledge and policy that are based on trust (Jasanoff, 2005). Innovation is crucial, as is exchange between policy, civil society and research institutions, which should lead to co-designed research that offers responses and engages people in action. In these processes the social and human sciences are central. Take climate adaptation: many donors use civil society organisations as their only intermediary between policy and action, because policymakers feel pressed to act quickly, and use whatever evidence is easily available. Scientific knowledge is seen as slow, distant and removed from action. Methodologies do exist, such as action research, for practical action and policy-oriented research, but they tend to be marginal in climate change discussions, which are still dominated by quantitative methods and theories. Moreover, bypassing scientific research may lead to misguided policy, inefficiency or outright wrongdoing. There is a danger that the distance between scientific results and action may result in society disregarding results that could have led to better policy decisions. Improving mechanisms for co-production and co-design could enable responsible knowledge to emerge. Such knowledge would respond to real needs, take responsibility for its usability and help society to achieve transformative processes.

The Global Framework for Climate Services (GFCS) is an example of current interest in producing scientific knowledge that is helpful for users. A climate service is "climate information prepared and delivered to meet a user's needs" (WMO, 2011: 8). The GFCS views climate information as natural science research results that meteorological offices provide and share with users. But while the GFCS is an important initiative, it still makes the traditional assumption that knowledge is separated from action. It excludes the central role of the social sciences in identifying prerequisites for decision-making, especially when scientific results, such as hydro-meteorological information, are still uncertain.

From the perspective of responsible science, the GFCS needs to be expanded to include social science "services" and the co-production of information from the bottom up. It requires more contextual and nuanced assumptions of real-world action, and the power implicit in the ability to decide what is or is not useful information, for whom and for what purpose. The social sciences, and the humanities, need to be included in climate services, as do other sources of knowledge such as indigenous knowledge, and people's assumptions and perceptions of risks and of desirable futures. Two-way interaction between researchers and research users, instead of delivering research to users in one direction, will be essential.

A process-oriented, sociologically aware conception of knowledge that goes beyond research-as-usual requires integrated research across the sciences, working together to co-produce knowledge and politics. In this way, we can rethink climate services so that knowledge is not only shared with users, but also allows a shift in decision-making and in management strategies concerning user-relevant context. The goal of climate services is normative: to increase adaptive capacity and promote sustainability.

Responsible science

Producing knowledge to address climate change is a normative exercise, as solving the climate crisis presumes valuing some risks and some visions of the future over others, judging what is feasible, directing societies along particular pathways, and identifying and considering alternative choices. But the uncertain character of Earth system processes, the many unknown feedback loops and the uncertain nature of social consequences combine to make responses tentative. Solving the climate crisis calls for an iterative learning process where new co-created knowledge is constantly being fed into policy processes and is tested, which then generates new needs and new responses. If the value choices embedded in these processes are transparent, this may help identify and build consensus on the direction that change processes should take. The normative dimensions of seeking a sustainable future can be made visible through self-reflection and identifying who loses and wins, whose values are considered more important and whose visions of the future will succeed. It also requires identifying the limits of expert knowledge and decoupling value choices from expert recommendations. Responsible science then becomes responsible in an ethical sense too, because paying attention to scientific uncertainty and value conflicts may be the best way to prevent the politicisation of the moral worth of people, actions or institutions (St. Clair, 2007). Responsible solutions to climate change require democratic deliberation and – precisely because of their complexity – more rather than less democracy.

The term "responsible science" also implies an ethical content to scientific work. Scientists and knowledge institutions, as an elite constituency, are responsible for using their skills and privilege for the benefit of humanity, and in particular for protecting those who are most vulnerable. Responsible social science is moral, political and public. These characteristics do not compromise the quality of science; rather they ensure that science responds to societies' needs, that it is more effective and aware of its limits. Responsible science recognises the role of the sciences as crucial in building alternative futures.

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You Can Buy My Heart and My Soul, 2006 by Andries Botha
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Part 6
New approaches to governance and decision-making

70. Dealing with "wicked" environmental problems

Introduction to Part 6

by
Diana Feliciano and Frans Berkhout

Part 6 presents key debates about environmental governance and decision-making. "Wicked problems" become more pressing to resolve as the pace and scale of global environmental challenges grow and the underlying social problems become more apparent. The contributions examine the role of the social sciences and other types of knowledge in the governance of environmental change and sustainability.

How shall societies govern the distribution of risks and benefits arising from global environmental change? What are the best ways to reduce the causes of risk and hazard, while enabling groups and societies to pursue more sustainable development paths? How can the interests of those suffering the impacts but not benefitting from resource use be best protected? The question of how societies manage (or fail to manage) this imbalance between private goods and public "bads" forms the central problem for environmental and sustainability governance.

Over time, sustainability governance issues have expanded from the local, tangible and immediate (urban water pollution) to the distant, intangible and delayed (stratospheric ozone depletion and climate change). Such complex, systemic problems, which are always imperfectly understood and have no easy solutions, are characterized as "wicked problems" (Rittel and Webber, 1973).

Some contributions address the challenge of co-design and co-production of knowledge and policy; others question where decision-making power should reside for problems that are at once local, regional and even global; and a third group address the conundrum by which the scope, scale and speed of governance may not match the pace and complexity of environmental change. This threatens to leave us with inadequate and incremental responses, when transformative change is needed.

Co-design and co-production of knowledge and policy

The natural sciences, and increasingly too the social sciences, have played an important role in defining sustainability problems and risks at all scales. Yet science alone cannot adequately define all sustainability problems or provide solutions to them, partly because they mean different things to different people, and partly because science does not have universally accepted legitimacy for framing sustainability problems. One way of making the knowledge claims underpinning environmental governance more salient and legitimate has been to pay greater attention to the co-production of knowledge by the users and producers of knowledge claims.

The co-design and co-production of science, policy and practice call for new procedures. They need to be undertaken in ways that facilitate the production of robust knowledge claims, while supporting mutual learning and problem-solving by science and practice (see Tàbara, Part 1). More attention needs to be focused on the learning benefits of these processes in different social settings. For this to be assured, effective leadership and adequate resources in the facilitation of inclusive and participatory processes are essential.

On this first theme, several authors contribute insights. Beck asks whether the Intergovernmental Panel on Climate Change (IPCC) has proven to be effective in enabling learning at the science–policy interface. Since its inception, the IPCC and similar global assessments have been influential in the international political process. Within the scientific community, the IPCC is seen as a model for successful work at the boundary between science and policy. This has increased public scrutiny of its activities, leading to strong critiques of the procedures it has adopted to secure scientific quality and internal transparency. But questions of public trust and expert credibility remain. These are serious challenges for science, particularly when there are increasing calls for more open knowledge systems and the democratisation of science amidst great cultural uncertainty and anxiety about the future. For Guimarães, who reflects on failures in translating international environmental agreements into action, a political lens shows the tenuous linkages between science, public debate, policy and practice, as well as the defining role that power and economic interests play in facilitating or impeding knowledge claims in policy debates.

Lavell, Brenes and Girot present the successful case of a network for the study of disaster prevention and management, LA RED,[1] in Latin America, which has helped establish an understanding of the social construction of disaster risk in science, policy and public awareness. Community resilience in the face of extreme events and disasters is based on the social capital and community identity that exists and how it can be rebuilt in the period of recovery after a disaster. While much progress in research and policy has been made in Latin America, Fra.Paleo argues that the experience of major disasters elsewhere in the 20th and 21st centuries (such as the Chernobyl nuclear disaster in Ukraine and Hurricane Katrina in the United States) has not yet been translated into effective risk-management strategies by policymakers in these regions.

In engaging with public debates about climate and environmental change, science and scientists have become entangled in social controversies. Disagreement is fed by the complexity of the causal mechanisms involved and by a lack of consensus about the scientific evidence base for many of these problems and their solutions. Other sources of knowledge and experience are essential for sense-making and action by citizens and policymakers. These might include knowledge systems embedded in the cultural traditions of indigenous, traditional or local communities. Evidence from conventional natural and social science complements these other forms of knowledge in understanding and responding to environmental change. Sanchez Betancourt and Reusser emphasise that both natural and social scientists need to use and integrate available scientific evidence on global environmental change to propose a set of practicable solutions to the pressing questions.

Several authors underline the importance of indigenous knowledge and local communities in the co-design of research and policy. In the cases presented, local communities are increasingly involved in joint investigations with social and natural scientists to analyse and respond to climate change. Srang-iam and Borja describe cases where the integration of indigenous knowledge in research and policy-making has taken place. Rajão, Odok and Jordan recommend taking indigenous knowledge into account in the design of Amazonian environmental policies, in the development of adaptation programmes in Nigeria, and in natural resource management policies in Canada, respectively. In the Mercosur[2] countries, policies that engage citizens in water management are proving effective by building on the local knowledge and interests of stakeholders (Gugliano and Carbonai).

While the state has traditionally been seen as the guarantor of public and collective goods, there is now a growing role for the private sector, civil society, citizens and consumers. Payments for Ecosystem Services (PES) are a flexible, incentive-based instrument intended to promote the sustainable use of natural resources. They involve payments for the preservation of biodiversity, natural beauty, carbon sequestration, water flows and other national but endangered services of value to humanity (Karousakis and Perry). This shift from government to governance is important for social science's understanding of who governs and how governance happens. As the role of government is redefined, there are new practical questions about how the vitality and capacity of other groups in society can be aligned and coordinated to achieve sustainability goals, while ensuring openness and equity in the distribution of environmental goods and bads.

Combining top-down and bottom-up decision-making processes

Top-down decision-making processes often fail because they are ignorant of realities on the ground and are not sensitive to local capabilities, perceptions and interests. Bottom-up, participatory approaches, by contrast, are intended to lead to legitimate and effective decisions, but can get stuck because they do not have the power, legitimacy or scope needed to achieve change. This dichotomy has become particularly acute in the context of sustainability. Many sustainability problems and solutions span different scales of governance. It remains a challenge to find the right combination of top-down and bottom-up governance, along with public, private and public–private arrangements appropriate to go with them. The problem is especially acute at a time when the focus is on learning and adaptation in the face of uncertainty. According to Lamhauge and Mullan, monitoring and evaluating adaptation measures can help identify which are the most effective with a view to making mid-course adjustments as necessary.

In addition, the increasingly regional and global character of many environmental problems intensifies the need for political and economic coordination to manage global change. International coordination of nation-states through treaties requires very different institutions, capabilities and instruments from the management of local commons. This is made even more difficult in regions already experiencing political tensions or even military conflicts. Jägerskog gives the example of three states in the Jordan River Basin (Israel, the Palestinian Authority and Jordan) where ongoing conflicts are undermining co-operation in transboundary water management, and the just and equitable sharing of resources.

Non-governmental organisations and social movements are crucial actors in governance through their roles in influencing the policy agenda, raising public consciousness about the management of environmental problems, monitoring environmental quality, and exposing bad government and corporate practices (Martinelli). Grassroots organisations have repeatedly called attention to climate change hazards, and have shown that they are linked to the erosion of social and economic rights. For social movements, there are opportunities to use international law and governance to turn emerging economic, legal and cultural norms toward creating climate justice (Ioris). An example of the creation of justice from bottom-up decision-making processes is given by Sood. Indian national policies aimed at protecting informal workers, for example in the reuse and recycling sector in urban areas, have not been implemented successfully because of a fragmentation of national and city-level jurisdictions. In Pune, India, a city-level initiative called Solid Waste Collection and Handling emerged to ensure that informal workers are less exposed to health and safety risks in waste handling and collection.

Incremental versus transformative change

The final challenge taken up in this part concerns the pace and scope of governance. Many social organisations, including governments, favour incremental changes. But many of the greatest challenges now call for a more fundamental and far-reaching transformation of social systems (see also Parts 3 and 4).

The prospect of global environmental change associated with major long-term risks has generated a new debate about how to stimulate, and govern, radical social and economic transformations over the longer term. According to Brand, Brunnengräber and colleagues, social science can contribute to a better understanding of crisis strategies, normative perceptions, and profound societal changes from the local to the global scale. This understanding can help strengthen the possibility of an intentional and broadly acceptable transformation towards low-carbon, sustainable and just societies (see Part 5).

Conclusion: Struggling and negotiating together

Much remains to be explored and learned about how to govern global environmental change and deal with its social consequences. As Future Earth gets underway, the co-design and co-production of knowledge is a central design feature of the new research programme. Those searching for adequate and acceptable responses to global environmental change the world over are struggling to find new forms of governance that engage interested parties appropriately and effectively while avoiding fatigue, stalemate and disenfranchisement. Understanding how to encourage radical novelty (see Miller, Part 1), remove obstacles to transformation, dismantle old systems, and create and embed new, more sustainable forms of provision (see Sachs, Part 1) is a huge research and social challenge. While much is to be learned from history, transformative change is not easily understood and shaped while society is in the midst of it. Barriers to transformative change include uncertainties about global environmental change, the high costs of transformational actions, and institutional and behavioural inertia that tends to maintain the incumbent resource systems and policies.

Notes

1. LA RED or the Network of Social Studies in the Prevention of Disasters in Latin America (La Red de Estudios Sociales en Prevención de Desastres en América Latina).

2. Mercado Común del Sur (Southern Common Market). Economic and political agreement between Argentina, Brazil, Paraguay, Uruguay and the Bolivarian Republic of Venezuela. The plurinational State of Bolivia, Chile, Colombia, Ecuador and Peru are associate members; Mexico and New Zealand are observers.

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World Social Science Report 2013
Changing Global Environments

71. Is the IPCC a learning organisation?

by
Silke Beck

The Intergovernmental Panel on Climate Change (IPCC) provides the scientific basis for climate policies globally, and has raised political and public awareness of climate change. An independent evaluation in 2010 resulted in changes to IPCC procedures, processes and governance structure. But what has it learned, and how can it maintain political relevance and scientific integrity in the face of intense political pressure and an evolving, multidisciplinary scientific field?

Introduction

What can we learn from the Intergovernmental Panel on Climate Change (IPCC) in terms of designing global environmental assessments? Is it an adaptive and learning organisation? How has it adjusted its governance processes and structures to meet novel challenges? Here we reconstruct the processes and institutional arrangements that are instrumental (input performance) to improving the organisation's reflexivity and adaptive capacity (output performance).

IPCC achievements

The IPCC was established in 1988 by the World Meteorological Organization in co-operation with the United Nations Environment Programme (UNEP).[1] Its mandate is to provide policy-relevant information to decision-makers involved in the conferences of the UN Framework Convention on Climate Change (UNFCCC). Between 1990 and 2007 it produced four assessment reports (AR), and several specific reports (for instance on scenarios, renewable energy and extreme events). The 2007 AR4 demonstrated that the scientific evidence for global warming is overwhelming, even if scientific projections of future climatic changes are uncertain. The IPCC has brought together more than 3 000 scientists and referenced over 40 000 publications. In recognition of its work, the IPCC (jointly with Al Gore) was awarded the 2007 Nobel Peace Prize: "The IPCC's 2007 Nobel Peace Prize is a tribute to what is the largest and most complex orchestration of sustained international scientific co-operation the world has ever seen" (Royal Society, 2011: 80).

The IPCC is regarded as the most significant expert body on global climate change, and the Nobel Prize was seen primarily as an acknowledgment of its political achievements. It has played a key role in providing the epistemological foundations for climate policies and in raising political and public awareness of climate change (Hajer, 2012). It has also influenced the science agendas of many nations (IAC, 2010: 63) and has prompted calls for comparable global environmental assessment institutions to be established in other areas, the most recent being the Intergovernmental Panel on Biodiversity and Ecosystem Services.[2]

Under the public microscope

During the 15th UNFCCC conference in 2009, more than 1 000 private emails were leaked from the University of East Anglia in Norwich, United Kingdom, including emails from climate scientists at leading science institutions.[3] Allegations of errors in the 2007 IPCC *Fourth Assessment Report* surfaced in 2010, focusing on the Working Group II analysis of the potential impacts of global warming. The IPCC then corrected a controversial statement that the Himalayan glaciers might disappear by 2035. However, subsequent reviews have upheld the core science behind global warming. The controversies received lots of attention, in the blogosphere and in the United Kingdom and United States media in particular (Schiermeier, 2010). In response, evaluations were undertaken of the IPCC's procedures and governance structure (PBL, 2010; IAC, 2010).

The InterAcademy Panel Council (IAC) in its independent evaluation identified various problems:

- There has been a lack of access to data.
- There is a lack of transparency "in several stages of the IPCC assessment process, including scoping and the selection of authors and reviewers, as well as in the selection of scientific and technical information considered in the chapters" (IAC, 2010: 65).
- There are problems with the way scientific uncertainty was handled, and the IAC recommended that procedures for using and labelling "grey literature" that has not been peer reviewed should be clarified (Tollefson, 2010b).
- The IPPC operates under a public "microscope", and intense scrutiny from policymakers and the public is likely to continue. Consequently, "accountability and transparency must be considered as a growing obligation" (Shapiro, 2010; PBL, 2010: 32).

The IAC evaluation focused on processes of assessment and quality assurance rather than on the content and quality of the IPCC reports. The discovery of some errors and other problems raised important questions about the transparency of IPCC processes but did not seriously challenge the substance of that knowledge (Hulme, 2010). Evaluating the IPCC's processes and management structure, the IAC report concluded that "The IPCC has succeeded time and again by adjusting the processes and procedures surrounding its assessments both in response to scientific developments and as a result of lessons learned over the years" (IAC, 2010: viii). Nevertheless, it acknowledged that some fundamental changes to these systems were essential to ensure its continued success. The IAC found that the IPCC lacked the organisational capacity to cope with the complexity and scope of the assessment task, along with new demands for increased transparency and accountability (IAC, 2010: 63). Its organisational capacities have remained largely unchanged and are very rudimentary (IAC, 2010: 39).

Procedural adjustments and adaptive capacity

In order to evaluate the performance of the IPCC as a learning organisation, we need to consider the nature of the tasks facing the IPCC as a hybrid organisation. It includes scientists and experts, and representatives from other areas of society – politics, business and global civil society – all of whom play different roles within it. It is accountable to rather different communities in each sphere, and needs to maintain credibility, trust and legitimacy for all. The IPCC also has to maintain political relevance and scientific integrity in the face of intense political pressures, tight deadlines and a continually evolving, multidisciplinary scientific field. It has to reconcile political demands (relevance, legitimacy, geopolitical representation) with the need for expert decision-making, such as integrity and the relative autonomy of scientific self-organisation.

When the IPCC was created in 1988, ozone and acid rain assessments were already under way. Atmospheric science assessment panels on stratospheric ozone played a particular role in establishing international agreements in this field. Climate change was seen as a new type of environmental problem, more complex and controversial than ozone depletion and acid rain. While some of the design features of existing assessments could be applied (Dessler and Parson, 2010), the complexity of climate issues also required experimentation with novel processes and design features (Hulme, 2010). The IPCC has had to make numerous choices about selecting and organising scientific advice, establishing criteria for legitimising scientific evidence, selecting experts, organising review procedures and specifying its own mandate.

The formal work of the IPCC is governed by its rules of procedure. These are critical for the governance of the expert panels. They are designed to ensure that its reports include the best scientific knowledge available, and that it is represented fairly and accurately. The rules of procedure also define how expert authors and reviewers are to be recruited and how government and non-government experts are to be integrated into the assessment and review processes. The IPCC has become a pioneer in developing rules of procedure for producing and evaluating policy-relevant knowledge at the global level (Beck, 2012).

The IPCC maintains its scientific credibility and political relevance and legitimacy partly through its capacity to enact and adapt procedures to respond to different challenges (Beck, 2012; Gupta et al., 2012). It has revised its rules three times, in 1993, 1999 and 2010. Despite its cumbersome size, political and institutional constraints and its highly politicised context, the IPCC has readjusted its processes and governance structure to the specific needs of its collaborations. How?

First, the IPCC decided to speak "with one voice" on behalf of the global scientific community, delivering unequivocal statements to political leaders and the public (Agrawala, 1998). It is conducting one of the most complex and inclusive exercises in international scientific consensus building ever undertaken. Its active consultation process has done much to iron out differences, distil common understanding and marginalise opposition.

Second, the IPCC responds to calls to improve its political relevance and legitimacy by involving experts from all relevant stakeholder groups and countries in the assessment process (scoping, preparation, peer review, and outreach and communication). Participation and inclusion enhance the legitimacy of its processes and the political salience of its policy conclusions. Early on, conflicts arose regarding the initially low number of experts from developing countries, the extent to which non-English and non-traditional publications were included, and the inclusion of experts from advocacy or private sector organisations.

Innovative procedures have helped enhance its legitimacy across the world. Studies show that there is still a notable bias towards Western and other developed countries (Vasileiadou, Heimeriks and Petersen, 2011). However, if most knowledge originates from a small number of nations, that knowledge will be limited in geographical scope and political legitimacy.

Next, peer review became a fundamental formal principle of IPCC self-governance and a basic informal principle of its consensus-building process. It forms the backbone of all IPCC processes (Edwards and Schneider, 2001). Over time, the IPCC has developed a widely inclusive, extremely intensive and differentiated peer review process.

Recent IPCC reforms: improving the quality of science

In October 2010, the IPCC initiated steps to implement the IAC recommendations. The latest revisions, following the November 2011 plenary session, endeavour to ensure that IPCC internal procedures are more transparent to parties already participating in the organisation, such as contributing scientists and national governments. As a result, the IPCC processes – ranging from intergovernmental negotiations and review procedures to government approvals – remain confidential and are not open to the public. Current reform efforts do not make the IPCC democratically accountable (see Hulme, 2010).

Are these revisions sufficient to maintain public trust and expert credibility, even though their focus is on improving scientific quality and internal transparency (Hajer, 2012; PBL, 2010; Shapiro, 2010)? Are IPCC policies and procedures appropriate and robust enough? Public attention is likely to increase given that the organisation is advising on highly contested issues, such as alternative energy supplies and geo-engineering, which may affect stakeholders differently across the world. These are empirically open questions, but it is fair to assume that the IPCC's future performance will depend on how thoroughly it responds to demands for increased transparency and accountability from those affected by its advice (Revkin, 2012).

Notes

1. *www.ipcc.ch/organization/organization.shtml*.
2. *www.ipbes.net*.
3. *http://e360.yale.edu/feature/climategate_anatomy_of_a_public_relations_disaster/2221/*.

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World Social Science Report 2013
Changing Global Environments

Viewpoint

72. Failing to translate science into policy? From Stockholm 1972 to Rio+20

by
Roberto P. Guimarães

Since the 1972 UN Conference on the Human Environment in Stockholm, there has been a clear failure to put the international environmental agenda into practice, particularly in areas such as climate change. Science is not produced in a policy vacuum, nor does policy operate in a void of knowledge, which is precisely why politics is embedded in this interplay from the outset.

An adequate understanding of the process by which decisions based on scientific findings bear fruit requires three things. First is an understanding of how social concerns are incorporated into the agenda of public decisions. Second, once societal challenges are fully integrated into political discourse, an understanding of how policies change is required, so that scientific knowledge feeds into concrete actions. Third, we must pose the question how policy results change the scientific agenda by identifying new knowledge gaps that require further research.

The belief that science speaks for itself is problematic. Assuming that science does respond to real challenges faced by society, we might mistakenly expect that due to their intrinsic value for the common good, research findings require no more than powerful and brilliant breakthroughs to be translated into action, as most decisions adopted since the Stockholm conference indicate. Nothing could be further from reality. As Francis M. Cornford (1908) indicated in his razor-sharp *Microscomographia Academica: Being a Guide for the Young Academic Politician* in 1908:

"You think (do you not?) that you have only to state a reasonable case, and people must listen to reason and act upon it? At once. It is just this conviction that makes you so unpleasant. There is little hope of dissuading you; but has it occurred to you that nothing is ever done until everyone is convinced that it ought to be done, and has been convinced for so long that it is now time to do something else?"

This view later became prominent in the literature on public policy formulation and implementation (Lindblom, 1980).

Any issue can only be incorporated into political processes if it is firmly connected to the dominant public debate and social context (Guimarães, 2004). For example, research existed in areas such as environmental change and racial and gender discrimination long before these became concerns for public policy, thanks to their association with demands for human rights, democratisation and social equality. It was no historical coincidence that environment and gender policies gained strength in the late 1960s. They were part of the anti-war, pro-freedom of expression counter-culture movement in most western countries at that time. Conversely, it should be no surprise that, even after environmental issues gained legitimacy through four World Summits, internationally adopted decisions in areas such as climate change have been the hardest to translate into action. Why is this? Is it due to a lack of scientific data? Of course not. Climate change has so far been the only issue to benefit from an institutionalised channel through which the world's science community can "communicate" with policy: the Intergovernmental Panel on Climate Change (IPCC), created in 1988. The answer to this paradox does not lie in the failure of science to convey the gravity of climate change to policy. Rather, it can be found in the fact that the actions proposed by the scientific community run against the dominant economic yardstick for public policy (Mooney, 2005; Fredenburg et al., 2008).

The more scientists, governments and others accepted climate change as an established scientific fact, the more the Washington Consensus[1] spread its wings throughout the world (Williamson, 1990). From a political perspective, this cannot be ascribed to pure chance. Barely one year after the IPCC came into being, two of the ten commandments of neoliberal economics prescribed privatisation and deregulation as a cure-all recipe to solve the profound external debt crises of the 1980s. Thus, science did not fail, as Aaron Wildavsky (1987) maintained in his book *Speaking Truth to Power*. It was, and remains, a fact that power is not willing to listen to a policy challenge which requires government intervention and more regulatory mechanisms to correct the failure of the market's addiction to fossil fuels. The world had to wait for the increased occurrence and severity of "natural" disasters, the corresponding economic loss and the awakening of insurance companies to take action. The actual increase of a couple of degrees in mean temperatures is having more policy effect than all the scientific evidence, particularly now that the Washington Consensus is apparently receding at a faster pace than the glaciers.

However, the fact that an issue is successfully incorporated into the policy discourse does not guarantee real policy change. Decisions that require societal responses, such as climate change, involve much more than the simple organisation of public action in one area. It is the very concept of development itself that is being called into question. This means that issues which are often regarded as technical and scientific (standards, regulations, norms) will have to be negotiated politically. The Kyoto Protocol is a perfect illustration of this predicament.

It is therefore easy to summarise the limits within which environmental conflicts can be negotiated. National leaders do not acknowledge that a nation's security depends on an environmentally sound development strategy. Instead, environmental decisions are consistently subsumed either by national security interests or by economic criteria, and economic growth enjoys priority over conservation. On top of that, the techno-bureaucracy and the corporate elite share an ideological orientation towards the private allocation of natural resources and of the "commons"[2] in general.

Economic elites and their proxies in government have also learned the lessons of coping with the institutional and policy innovations posed by global change. Faced with this new challenge, markets and governments have continually adopted what Donald Schon, in his brilliant *Beyond the Stable State* (1973), calls "dynamic conservatism". First, people accept a discourse that incorporates the new issue. This principle has been demonstrated successfully from Stockholm 1972 to Rio+20. Then follows the institutional stage of "containment and isolation", when people literally throw the discourse into a bureaucratic box in the governmental structure or in an internationally adopted agreement. Care should be taken not to provide adequate resources to this new national or international agency. Just enough people should be employed to give the impression that something major is being done, and to serve as scapegoats when things do not get done, as we know they will not. Just enough resources should be allocated for a couple of works to be built and, it should not be forgotten, for studies: dozens and dozens of scientific studies.

In short, people should promote the minimum change possible to guarantee that nothing major will actually change, as the lack of implementation of international decisions on the environment shows. This is dynamic conservatism, and is termed dynamic because it is not the result of a carefully conceived scheme of overt resistance. There is no conspiracy theory at work here. This brand of societal conservatism develops out of the synergistic effect of special interests. The individual, group or class is able to establish a connection between their special interests and the inertial interests of the social system as a whole. Because the hard policy choices needed to respond to global change are bound to affect everyone, there is no need to conspire against taking them seriously. It is simply a question of letting the bureaucratic process run its course.

Many proposals can be put forward to address the failings of science in its attempts to speak truth to policy since Stockholm 1972. Among these is the much-needed involvement of policymakers early on in the endeavours of the science community. More should also be done to disseminate science and build capacity. Yet if I had to derive a single proposal, it would simply be to suggest that the scientific community take a hard look at its own faults before scrutinising those of policymakers. Instead of hiding behind science, it would do no harm to translate relevant findings into the political and bureaucratic logic of those whose attention is needed. In other words, whatever research projects produce, their findings should be expressed in entirely different terms depending on whether the audience is the United Nations or another intergovernmental body; an industrialised country such as the United States or Japan; a resource-rich and socio-economically unequal country such as Brazil or Mexico; a poverty-stricken country such as Haiti; or a "post-material" nation such as Norway. Finally, decisions on the environment adopted at world summits should have enforcement mechanisms to put teeth into the resulting agreements if the world wants to overcome their blatant lack of implementation so far. The future of sustainable development lies in politics working hand in hand with science. Neither can bring it to fruition alone.

Notes

1. The term "Washington Consensus" refers to a strong market-based approach, market fundamentalism or neoliberalism.
2. Natural resources and public goods which are shared, used and enjoyed by all.

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73. The role of LA RED in disaster risk management in Latin America

by
Allan Lavell, Alonso Brenes and Pascal Girot

LA RED, Network of Social Studies in the Prevention of Disasters in Latin America, has played a central role in the shift from physical to social interpretations of disaster risk in Latin America and elsewhere. Since 1990, the notion that disaster risk is socially constructed has been recognised increasingly by academics and practitioners around the world. LA RED, through its robust cross-disciplinary and integrated approach to research, has contributed significantly to this paradigm shift.

Introduction

The Network of Social Studies in the Prevention of Disasters in Latin America (LA RED)[1] is a network comprising researchers from multiple scientific and professional backgrounds. Using different modalities to integrate research and practice, co-operation and political advocacy, LA RED has been successful in promoting a development-based, vulnerability-linked paradigm for disaster risk.[2] The network was established in 1992 and has striven to place human and social vulnerability at the centre of its analysis of disaster risk over the past 21 years. It regards disasters as an extension of everyday life, and places disaster risks along a continuum from small to medium to large disasters. Prioritising human welfare and seeking to understand the impact that disaster has on people is paramount for LA RED. This approach has led to a paradigm shift from physical[3] to social-based interpretations of risk, and from technocratic, centralised views of risk management, to more participatory, local and community-based approaches. This article seeks to portray LA RED's distinct contribution to this change, particularly in Latin America.

Over 20 years ago, LA RED introduced new social science concepts and insights on disaster risk to countries in Latin America. These have influenced practitioners and researchers around the world. They include:[4]

- that disasters are not natural (Maskrey, 1993)
- risk as a social construction (Maskrey, 1993; Mansilla, 1996)
- that small- and medium-scale disasters are important (Lavell, 1994; ISDR, 2009)
- extensive and intensive risks (ISDR, 2009)
- socio-natural hazards[5] (Fernandez, 1996)

- corrective, prospective and compensatory risk management (Lavell and Franco, 1996)
- the intrinsic relationship between risk, development and the environment (Maskrey, 1993; Fernandez, 1996)
- the importance of local-level risk management (Wilches-Chaux, 1998; Lavell et al., 2003).

Shifting paradigms

Before 1990, a physical notion of disaster risk dominated global discourse on hazards and disasters. Disasters were seen as a direct product of adverse physical conditions, and were regarded as being virtually inevitable and unmanageable. However, the idea that disaster risk is socially constructed, and that human activity (cultural and social) can influence the way it is perceived or defined, has gained ground since its early beginnings in writing produced in the 1970s and 1980s, and particularly since the 1990s. Academics and practitioners in Latin America and elsewhere are increasingly recognising this idea.

This shift in the conceptual understanding of risk and disaster grew out of the increased involvement of social scientists working on disaster risk, and the impacts that their involvement has had on public and policy understanding. Hurricane Mitch in Central America (October 1998), for example, revealed the huge significance that poverty, environmental degradation and inadequate land-use practices have on levels of damage and loss.

Building on work by social scientists from developed countries,[6] the founding members of LA RED brought new ideas and a collective approach to the concept of risk. LA RED membership was characterised from the start by an eclectic mix of academics and non-academics, including government officials, practitioners and consultants. It avoided the traditional rigid boundaries between science, policy and practice that still exist in similar initiatives elsewhere in the world.[7] This collective, participatory approach played a significant, if not catalytic, role in transforming the concept of risk. Openness to new ideas allowed different methods, forms of enquiry and data (quantitative and qualitative) to flourish. This resulted in a more holistic perspective for analyses of the relationship between society and development.

LA RED activities

In the 2000s, LA RED promoted new approaches to disaster risk reduction and to helping to identify intervention options in Latin America, based on conceptual and methodological developments in the 1990s (Cardona, 2007). They were shaped by social scientists, and included land use and environmental planning schemes, local-level risk management, public investment decisions informed by disaster risk analysis, insurance for poor and vulnerable communities, and disaster risk and risk management indexes designed to help governments and international organisations prioritise their interventions. More recently, innovations in governing disaster risk management were introduced, with instruments such as the Central American Integral Policy for Disaster Risk Management in 2010 and new laws on disaster risk management in Peru in 2011 and in Colombia in 2012.

LA RED also created DesInventar,[8] an innovative disaster information management system for analysing disaster trends. DesInventar allows the capture, analysis and graphic representation of information on disaster occurrence as well as on economic and social loss. It has been developed and improved continuously, both methodologically and data-wise, since its conception in 1993. It allows users to visualise disaster impacts at the local (town, municipality, district or equivalent) level, and facilitates dialogue between individuals, institutions and provincial and national governments on risk management approaches and issues. National emergency agencies use DesInventar for risk analysis, mitigation and to formulate early warning systems. It can also record and help assess the success and development of an area's preparedness and its mitigation plans over time. It is now the basis of the United Nations Office for Disaster Risk Reduction's (UNISDR) analysis of extensive risk patterns in over 35 countries. DesInventar now has several international partners including the European Commission.

LA RED has organised many conferences, workshops and meetings over the years, allowing wide dissemination of its new ideas. It has also developed methodologies for local-level risk management training schemes (Wilches-Chaux, 1998; Zilbert, 1998), which, together with DesInventar, have translated new concepts and views of risk into practical instruments. LA RED has produced 15 books, and nine volumes of the first-ever social science journal on disaster in the region, *Desastres y Sociedad*, which it launched over 20 years ago.

The impact of LA RED

The success of LA RED can mostly be explained by three factors: cross-continental integration, co-operation, and political action and advocacy.

Cross-continental integration

First, LA RED's work on disaster response and reconstruction (Maskrey, 1996), urban risk (Lavell, 1994; Fernandez, 1996), historical and social processes (Mansilla, 1996; Garcia Acosta, 1997) and institutional development (Lavell and Franco, 1996) is comparative between and within countries and regions, moving beyond the traditional approach of examining a single country or region. This has helped identify common topics and social processes, unearthed new issues, and initiated new debates across Latin America.

Second, LA RED's emphasis on the social dimensions of risk does not contradict the physical facts of risk or the relevance of disciplines such as engineering, geology or climate science. LA RED follows an integrative approach that includes academic, practitioner, policy and activist perspectives, building bridges across disciplines and co-producing knowledge in joint projects and initiatives across Latin America. This mostly happens in an ad hoc fashion by sharing different approaches and practical knowledge gained through projects and initiatives managed by members of LA RED. Scientific communities from different countries work together with new methodologies, leading to a more robust, holistic approach towards risk management.

Third, the original core group of LA RED has been strengthened continuously over the years by the collaboration and presence of young, early career scientists and professionals who have contributed to different initiatives and projects, an essential part of LA RED's agenda.

Co-operation

LA RED uses projects to create a culture of co-operation between scientific networks, individuals and institutions, in order to ensure sustainability, and the completion of structural changes in how society faces risk. Co-operation is an important and practical way of coping with regional constraints in science funding and institutional modernisation. For instance, several members of LA RED were involved in the recent Special Report on *Extreme*

Events and Disasters for the IPCC (IPCC, 2011). This enabled them to pool their regional knowledge and contribute to an influential global risk assessment report.

Political action, advocacy and education

Political action and commitment to the development agenda have been important drivers of LA RED's work. Its practice of sharing its research and theoretical framework means that LA RED has influenced political and regulatory instruments across Latin America, as well as research, consultancy and practice. Communicating research findings to broader audiences (through the LA RED journal publications) has been regarded as critical since the early days. LA RED has supported formal and informal education and training initiatives, especially at the local and community levels.

The role of the social sciences in disaster risk management

The physicalist approach to disasters still survives despite the advances described above. Much global debate on climate change (in many ways, an extension of disaster risk concerns) focuses on extreme physical events and impacts, which explains why most climate research funding goes to climate modelling and scenario building. More recently, the social sciences have become more visible and vocal in global programmes and initiatives such as the IPCC and Future Earth, a new international programme on research for global sustainability.

LA RED is an important platform to present disaster risk research undertaken in Latin America, and strongly shaped by the social sciences, to a wider audience and debate it with them. The important contributions that Latin American countries make to global discussions of this nature are often not recognised adequately, partly because of the dominance of English as the international language of science. Despite these language barriers, LA RED influenced the formulation of the Yokohama Strategy at the first UN World Conference on Natural Disaster Reduction in 1994[9] and has continued to have global influence. Apart from its conceptual and practical contributions to non-governmental organisations, international development agencies and governments, and its development of the DesInventar database, LA RED has influenced key documents such as the UNISDR Global Assessment Reports in 2009 and 2011, and will influence the next one in 2015.[10]

Greater awareness of socially informed disaster risk research, including that of LA RED, will help us understand better the challenges of adapting to climate change, and avoid having to reinvent well-established risk construction principles which already exist.

Notes

1. La Red de Estudios Sociales en Prevención de Desastres en América Latina (LA RED).
2. *www.desenredando.org*.
3. The physicalist paradigm was a term coined by Hewitt in *Interpretations of Calamity: From the Viewpoint of Human Ecology*, 1983.
4. The authors are all LA RED members.
5. For example, landslides, flooding, land subsidence and drought that arise from the interaction between natural hazards and overexploited or degraded land and environmental resources.
6. See the works of Wisner, O'Keefe, Davis Cuny, Hewitt, Oliver-Smith, Woodrow and Anderson, amongst others, between 1974 and 1989. See Wisner et al. (2003) for a summary of the work of these authors.
7. The idea of "epistemic communities" – developed by Peter Haas (1992) – probably captures the concept and nature of LA RED best.

8. Sistema de Inventario de Desastres, or Disaster Inventory System: *www.desinventar.net*.
9. The Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action ("Yokohama Strategy") was adopted in 1994 and provides landmark guidance on reducing disaster risk and the impacts of disasters.
10. *www.unisdr.org/we/inform/publications/19846*.

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74. A functional risk society? Progressing from management to governance while learning from disasters

by
Urbano Fra.Paleo

The intensive use of technology, accelerated urbanisation, and use of natural resources and ecosystems services that disregard the dynamics of extreme natural processes are leading to recurrent and increasingly costly disasters. These need to be understood as the result of past decisions combining multiple interests, the consequences of exposure in hazard-prone areas, and of vulnerability in human settlements and activity. The concept of risk society provides a framework for understanding the complex links between contemporary society and risk.

Risk as change

Change is intrinsic to human and natural systems. However, its occurrence is confusing when hazards suddenly alter everyday life and business, and demand further adjustment in behaviour. Such new conditions are the effect of past human actions, recent or ancient, of processes in the natural environment, or a combination of both. Slow change allows for gradual adaptation. However, when change is abrupt, the social structure and production system do not adapt easily, particularly when such events do not occur frequently, because memory decays and risk perception weakens. However, policy leaps may occur.

This change is better understood in the context of socio-ecological systems (Berkes and Folke, 1998), where the bidirectional and complex interactions between human and natural systems are recognised. This approach acknowledges that society cannot develop in isolation without considering the limits that the natural environment defines or the diversity of exchanges.

Risk society

The increasing exposure of populations, urban areas, economic activity, food systems and infrastructures to rapid or slow-onset environmental processes leads to risk playing an increasing role in daily life, as does the emergence of new risks caused by the endless development of advanced technologies. This led to the notion of risk society (Beck, 1992). Not surprisingly, human development commonly leads to an increasing risk from technological hazards and higher economic costs of disasters.

Every disaster brings losses but also gains. Particularly notable is the improved understanding of the processes involved. This advances our awareness of the interactions between human and ecological systems, and the effects of past decision-making processes. Ultimately, it allows us to examine how risk society unfolds. Table 74.1 describes the knowledge and awareness gained after different kinds of major global events in the 20th and early 21st centuries. Each learning has been translated to risk theory, but apparently not sufficiently transferred to policy-making practice.

Table 74.1. **Principal lessons from major selected disasters**

Major event[1]	Nature of learning
Kobe earthquake 1995	Megacities are highly vulnerable and develop mega-risks in some hotspots. The loss is predominantly economic in developed regions.
Indian Ocean tsunami 2004	Disasters in less-developed regions claim high losses in human lives. Monitoring is critical to activate early warning and to avoid major losses.
Hurricane Katrina, New Orleans 2005	Certain cities have a reduced range of options for mitigation and thus need to better adapt and develop better resilience.
Haiti earthquake 2010	Weak governance in poor countries and cities leads to an absolute lack of response capacity and diminished resilience after major disasters.
Black Saturday bushfires, Australia 2009 California wildfires 2007-10	The interface between cities and rural areas has become blurred by urban sprawl. This increases the vulnerability of suburbs in particular and urban areas in general.
European heatwave 2003	Silent low-onset disasters are difficult to identify, monitor and address, and may cause a very large number of victims.
Influenza pandemic 1918	Pandemics are one of the most threatening natural hazards on a global scale.
Influenza pandemic 2009	The risk perception of different social groups differs. While the precautionary principle is a useful instrument to deal with uncertainty, it may lead to decision-makers over-reacting.
San Francisco earthquake and fire 1906 Tōhoku tsunami and Fukushima nuclear accident 2011	The interaction between the natural and technological dimensions of disasters seems to be apparent when they develop into complex natural and technological disasters.
Chernobyl disaster 1986	Mismanagement of technology may lead to critical failures and threaten the survival of humans.
Ozone-depleting substances, since mid-20th century	Generalised and diffuse use of a technology may lead to dramatic changes in the global environment. The Montreal Protocol (1989) is an example of the successful governance of a global risk.

1. From natural to technological disasters.

The knowns and unknowns

Uncertainty is the lack of reliability and validity in the causal relationships between the agent and the effect (Renn, 2008). It is also an inherent property of risk. This is due to the elusive spatial or temporal dimensions of all types of hazard, despite past monitoring and the fragmentary understanding it has yielded. But it is also due to the unpredictable consequences of any event. In some instances, we can estimate some dimensions – such as the spatial pattern or the time frame – but we cannot anticipate the timing of a specific hazardous event. In other instances – such as earthquakes – we are unable to forecast at all. Managing known knowns seems straightforward, but societies have to deal with recognised known unknowns, intangible unknown unknowns, and even concealed unknown knowns (Zizek, 2008). Do societies have appropriate policy instruments to confront risks by adopting integrated and adaptive strategies? Probably not. Current risk governance usually tackles the first two types, but for differing reasons of uncertainty or choice, has made little progress in dealing with the last two.

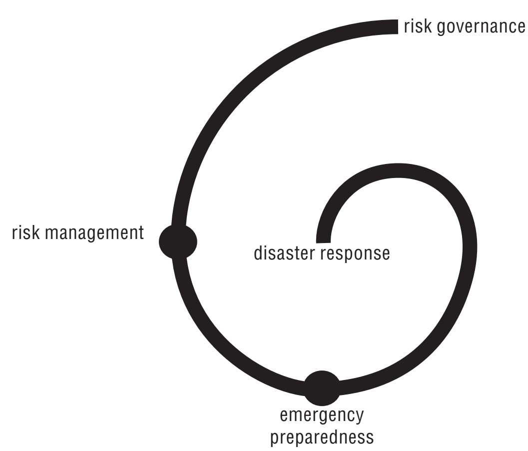
Risk governance as an unfolding approach

Various approaches have been developed to deal with uncertainty. Disaster response provides a very limited level of certainty, since it involves community action that only manages to relieve the impact of disaster and facilitate return to normal life. The possible recurrence of disasters is usually disregarded during recovery. Further, emergency management policy anticipates the unknown by focusing its planning on prior and ulterior actions, and by making human and material resources accessible when disaster strikes. But have the specificity of hazards and the nature of vulnerability been considered? Plans have often been hazard-specific, but also redundant. They have not taken the interactions between diverse risks into consideration.

Risk management has addressed these weaknesses through detailed risk analysis and assessment to identify and deal with known knowns and unknowns. The Hyogo Framework for Action (ISDR, 2005) was a major step towards managing risk globally through principles agreed by policymakers, practitioners and experts. It emphasises transition at the local scale, exemplified by the Making Cities Resilient (ISDR, 2010) campaign. But what about the complexity of governing a complete society and its uncertainties?

Risk governance (Renn, 2008) is a conceptual framework that focuses on examining the components, interactions and structure of a decision-making system – and not just that of the government, which excludes social and private actors. This approach may contribute to the conventional governance mode being reformulated. It needs to adapt to continuous social, economic and environmental change. Risk governance should therefore be multi-level, cross-sectoral and participatory to deal with the challenges of a risk society. This evolution towards a greater integration of the interactions and interferences between risk management and other sectoral policies is illustrated in Figure 74.1. But how can risk governance become an operational reality?

Figure 74.1. **The unfolding of risk governance**



Source: U. Fra. Paleo (forthcoming 2013).

Functional risk governance

Risk theories, paradigms and approaches have been developing complementarily or dialectically (for examples, see Table 74.2) since the pioneering study of adjustment to floods by Gilbert F. White (1945), and are increasingly uniting in a new concept. Simultaneously, the social sciences have gained growing relevance with the shift from the early study of hazards to the interest in disasters (see for example Quarantelli, 1998), the development of the notion of vulnerability, and particularly with the formulation of the theory of risk society. The previously dominant paradigm of vulnerability has been replaced by resilience, which is shaping contemporary policy-making (National Academies, 2012). This also illustrates the relentless evolution of the field.

Table 74.2. **Some dialectic approaches in risk governance and convergence**

Approach A	Approach B	Convergent approach
Risks from natural hazards	Risks from technological hazards	Natural and technological risks Socio-ecological systems
Reactive	Proactive	Integrated cycle of risk
Risk aversion	Risk propensity	Societies demonstrate combined or contingency-related attitudes
Command	Co-operate	Participatory governance
Vulnerability	Resilience	Resilience as a component of coping capacity
Mitigation	Adaptation	Mitigation as a human adaptation strategy
Insurance-based	Plan-based	Integrated mode of societal risk transfer

Making separate studies of natural and technological hazards seems an unsuitable approach to examining either the earthquake and urban fire in San Francisco (1906) or the 2011 Tōhoku tsunami and Fukushima nuclear disaster. A comprehensive approach that considers the complex interactions between the natural and the human systems is more appropriate in addressing disaster risk and human development. In particular, spatial planning seems to be the most appropriate comprehensive policy instrument with which to gain influence on exposure to hazards (Fra Paleo, 2009), as it can integrate the social, economic and environmental dimensions.

Accordingly, policy-making should focus on the systemic integration of the different phases of the risk cycle of response–recovery–monitoring–assessment–mitigation–preparedness–response, and not on its individual constituents separately. Simultaneously, citizens and decision-makers' knowledge and interests should be combined (Burby and May, 2009), and incorporated into the processes of policy design and evaluation in order to overcome the persistent implementation gap. This requires the integration of the vertical (levels of government) and the horizontal (sectoral) components; formal and informal norms, institutions and settings; and formal, scientific knowledge with local knowledge.

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World Social Science Report 2013
Changing Global Environments

Viewpoint

75. Transition to sustainable societies – was Rio+20 a missed opportunity?

by
Diana Sanchez Betancourt and Dominik Reusser

Six talented early-career scientists participated in the UN Conference on Sustainable Development in June 2012 with a grant from the International Social Science Council, supported by the Swedish International Development Agency. Two of them, Diana Sanchez Betancourt from the Human Sciences Research Council of South Africa and Dominik Reusser from the Potsdam Institute for Climate Impact Research in Germany, share their views on the outcome of Rio+20.

Finding solutions to climate and global environmental change is a shared responsibility among the world's people, and it was the topic at the Rio+20 conference. However, the complex discussions among global leaders, scientists and civil society illustrate the challenges posed by our fragmented realities and the poor understanding of our planetary boundaries. It was apparent that there was a lack of political will to address some of the fundamental questions facing humanity to make sustainable development possible in the Anthropocene era, such as reducing consumption and pollution, addressing wealth concentration and inequalities, and interrogating economic and social systems.

While at the first Sustainable Development meeting in 1992, technology was seen as crucial to solving environmental problems, at Rio+20 country leaders and the major groups realised the need to adapt lifestyles and knowledge production systems to address global environmental change. Technology offers no lasting solutions without fundamental social, political and economic changes.

Rio+20 failed to discuss ways in which human beings' extractive relationship with the Earth, and with each other, could be transformed through localised solutions linked to global processes. Although *The Future We Want* outcome document (United Nations, 2012) is an important attempt to establish an agenda for sustainable development, this was a missed opportunity to move away from technology as the alleged pre-eminent solution and seriously interrogate the limitations of the predominant development paths. The challenges posed by current forms of unrestricted capitalism were not addressed. This was the elephant in the room.

While the evidence of global warming served as a reminder of the necessity to act on issues of consumption and the urgency to implement strategies such as the ten-year

Framework of Programmes (10YFP) on sustainable consumption and production (SCP), such programmes remained voluntary while issues of wealth concentration and inequality were ignored. Furthermore, although issues of access and distribution of resources such as water, land, fossil fuels and carbon sinks were raised, equally important questions concerning wealth and power redistribution were completely absent. Instead, a new "green growth" path was (im)posed as the most radical solution. This was disappointing; global environmental change cannot be addressed by only greening technology, and not addressing underlying drivers like high levels of consumption, poverty and wealth concentration.

We need to find alternative solutions grounded in local initiatives that go beyond "greening" our current system and are linked to international dynamics. Social and natural scientists have a major role to play, as societies embark on this journey. Scientific communities need to join together as one, building on the strength of their diversity, and knowledge production systems need to provide incentives to ensure young scientists in particular can follow this path. Both natural and social scientists need to use and integrate available scientific evidence on climate and environmental change to quickly propose a set of practicable solutions to the pressing questions. Emerging scientists need to be more engaged in ensuring that scientific progress is rooted in the real social world of people, that questions are relevant to humanity, and that they are able to co-produce knowledge with different stakeholders, using tools such as backwards planning, and trans-disciplinary research methods.

The *Transformative Cornerstones* report (Hackmann and St Clair, 2012) provides valuable ideas on how to re-energize the knowledge production system. With scientists, citizens, policymakers and the private sector finding better ways to communicate and work together, we will be better placed to develop shared solutions. The enthusiastic participation of (young) scientists at Rio+20 showed we are ready to contribute to make the transition to sustainable societies a reality. However, science cannot do this on its own. Let's not wait until Rio+40. Join us now!

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76. Social learning and climate change adaptation in Thailand

by
Witchuda Srang-iam

The Community Climate Center in Thailand aims to bridge the awareness gap between local people, especially farmers, and experts such as climate scientists, helping them to understand each other's view of the weather and how it is changing. The results include better farming practices, and more understanding by scientists of how climate information is appreciated and used.

Global climate change is often associated with unexpected and extreme events in locally managed socio-ecological systems. Social learning can help us cope with uncertainties, build resilience, and ensure a system's ability to retain its functions when faced with shocks and disturbances (Holling, 1973). Under such complex conditions, the ability of a system to adapt depends partly on access to resources (Smit and Wandel, 2006), but also on its understanding of information: in this case, on the climate and related subjects (Folke et al., 2005). Of particular importance – mostly not addressed in the literature – is the role of cognitive and cultural factors that underpin individual and societal adaptation to climate change (Grothmann and Patt, 2005; Strauss and Orlove, 2003).

The emphasis on human cognition and culture in social learning assumes that social groups vary in their appreciation of what is happening to the climate and themselves. Climate scientists model climate, taking a long-term, globally dynamic, essentially objective perspective. Farmers, on the other hand, conceptualise local weather subjectively and adapt to it within a shorter seasonal or annual timeframe (Hansen, Marx and Weber, 2004). This is why integrating science with local knowledge through social learning is viewed as a valuable exercise (Raymond et al., 2010). However, the cross-cultural differences in perceptions of uncertainty (Wynne, 1992) could themselves shape social learning processes and outcomes. The following sections elaborate on this argument by examining the links between cognition, culture and climate adaptation as they unfold in the Community Climate Center initiative in Thailand.

Community Climate Center: A platform for social learning

Since 2011, the Community Climate Center has served as a platform for collaborative learning between scientists and farmers, and informs their individual and collective responses to climate change. It enables three stages of social learning: generating and verifying local weather information from general circulation models, interpreting and disseminating weather data to farmers, and adapting this information and hybridising it with local systems and practices.

Learning for more accurate prediction

Climate scientists have long struggled to provide predictions of climate change at higher resolution, to inform adaptation at the local level. The Center of Excellence for Climate Change Knowledge Management (CCKM) – an expert climate-modelling organisation in Thailand – has generated local weather forecasts based on weather research and forecasting models. These models use local geographical data to localise the low-resolution forecast data from general circulation models. In addition, the scientists have used the inverse modelling technique to incorporate local data into their weather research and forecasting models, yielding better local estimates. The model forecasts are distributed to the local farmers yearly and weekly via text messages, along with news of special weather events. In return, selected farmers have provided the scientists with information such as weather observations and their level of satisfaction. This information is used as feedback to verify predictions and improve the communication of the modelling results.

Through its interactions with farmers, the CCKM has established practices that differ from scientific norms in a number of ways. The scientists experimented with various data sources and specifications for climate models, and chose between them on the basis of the farmers' evaluation. For instance, they adopted a 10 km resolution that received the highest satisfaction score from the farmers, although the models allow more accurate predictions at higher resolution. Moreover, the scientists have recently changed from the inverse model, which local observations verified, back to the old downscaled model. This is because the farmers found the inverse model's estimations less accurate. According to the scientists, the inaccuracy in these forecasts resulted from errors in the initial observational data.

When communicating with the farmers, the scientists have chosen simplified and deterministic predictions instead of conventional probabilistic terms. For instance, "heavy rainfall expected at the weekend" replaced "60 per cent chance of moderate to heavy rain, a high of 28-30 degrees Celsius expected at the end of the week". However, the scientists run the risk of providing incorrect predictions by specifying levels of uncertainty. If there are too many failed forecasts, the farmers' trust could be undermined. In order to minimise this risk, the scientists have learned, for example, not to use the "moderate" category in predictions, because the farmers only recognise "light" and "heavy" rainfall.

Learning for better adaptation

Farmers have long experienced and adapted to climate change, even without knowing how the climate will change. For example, an increase in buffers against climate change, such as the available water and seed, has allowed rice farming to continue despite unusually dry weather. In rice-based farming communities in north-eastern Thailand, farmers also make short-term weather predictions based on natural weather indicators such as ground lizards and dragonflies. However, the changing landscape of modern agriculture makes it increasingly difficult for farmers to rely on their conventional knowledge. Climate models' predictions have therefore impressed farmers and changed their ways of adapting. They use the annual weather summaries to plan their rice cultivation cycle, and the weekly forecasts to confirm their planned activities. However, not all farmers have access to the forecast data. Their lack of knowledge of mobile short message service (SMS) technology and the disorganisation of the farmer networks have prevented the majority of them from obtaining this information about the weather.

The introduction of climate-related information has led to the resurrection of farmers' knowledge about weather predictions in a new form. This knowledge relies on their objective understanding of climate change by means of observations on a longer timescale and in a restricted, private domain. Those farmers whose task it is to observe and record weather data have started to deduce information from their own graphical representation of the annual rainfall patterns or by collecting figures on these patterns. This is information that they believe is accurate. Their predictions also involve different observations, such as the first day of rain or winter wind in the year, which farmers believe occur in predictable, cyclical patterns over a long period of time.

Information-based learning has also contributed to reducing the adaptability of these cultivation systems. Because the farmers observe that there is a high degree of informational certainty, they follow a specific adaptation that optimises the trade-off between production and survival. Such a planned adaptation diverts their attention from improving their systems' resilience, and away from coping with the remaining uncertainty. This has the consequence that incorrect predictions have caused great damage to their production. An example is the unexpected November 2012 rainfall, which decreased the quality of the harvested rice. Similarly, unpredicted long droughts have caused farmers to bear unnecessary losses from transplanted seedlings.

Conclusion

The example of the Community Climate Center reveals important phenomena whereby science and local knowledge have been integrated through social learning and adaptation. The co-production of knowledge has perversely altered both scientists' and farmers' learning practices, and their perceptions of uncertainty. This has resulted in adaptations that increase their vulnerability to climate change.

Scientists have ignored uncertainty in probabilistic decision-making in order to obtain socially desirable results. Their focus on the subjective accuracy of weather prediction has resulted in the climate information that they provide to farmers being increasingly uncertain. Farmers have not taken this informational uncertainty into consideration in their decision-making. Instead they have shifted to planned adaptation, making them even more vulnerable to the effects of climate change.

Through their planned adaptation, the farmers have inevitably underestimated the risk associated with uncertain information and overestimated their adaptive capacity. The more accurate predictions become, the more inaccurately farmers perceive their risk and adaptive capacity, choosing to depend instead on the highest-probability prediction, and the more adversely they are affected by unexpected climate events.

These findings emphasise the cognitive and cultural gaps in social learning at the interface between scientists and local communities. In facilitating social learning for climate change adaptation, the main challenge is to manage perceived uncertainties in scientific and other learning systems. For example, scientists and farming communities could work mutually to interpret the results derived from climate models. Mutual understanding, rather than the linear communication of climate-related information, is necessary to close these perception gaps and facilitate social learning for climate change adaptation.

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World Social Science Report 2013
Changing Global Environments

77. Indigenous groups and climate change in Colombia

by
Miguel Borja

Indigenous groups in Colombia contribute to solving the problems of climate change and create new perspectives for social sciences. If their knowledge, practices and experience were fully considered at the national governance level, real change in terms of ecological practices would be possible.

Introduction

Latin America's social science contributions to climate change research are often neglected, even though they frequently include indigenous knowledge, traditional practices and ways of managing natural resources. New approaches to social science, however, recognise the value of these sources for devising solutions to environmental challenges.

Indigenous knowledge is key to orienting the social sciences towards addressing climate change challenges. This article discusses indigenous peoples' proposals for restoring their territories and traditions, as well as their leadership in conservation practice. Indigenous communities are involved in government activities, climate change adaptation programmes, and in developing a new social science based on the participatory research action methodology.

Indigenous proposals and action

According to the United Nations High Commissioner for Refugees, there are 87 indigenous communities in Colombia, distributed mainly in Amazonas, the Eastern Plains, Guajira, Sierra Nevada de Santa Marta and the Pacific Coast (ACNUR, 2013). Their main aim is to restore their ancestral territories, so that they can preserve their traditional habitat practices, including respect for the environment and the sustainable use of natural resources. They are seeking the right to govern their own territories and create a platform for the preservation of the ecosystem and biodiversity of their land, and to protect it from being plundered by settlers and agricultural entrepreneurs.

They also propose returning to sustainable economies, for example as practised in the past by the inhabitants of Sierra Nevada de Santa Marta. Today, local people are working to rehabilitate this territory and preserve the soil fertility using crop rotation, forest preservation techniques and organic fertilisers (Herrera, 1985). Some communities also propose returning to their indigenous roots and practising swidden agriculture (slash and burn), fishing, hunting and gathering wild fruits and other materials (Echeverry, 2009: 15). They believe they can mitigate climate change using their own models of production, distribution, exchange and consumption, as determined by the cycles of nature.

Further suggestions include legal measures to prevent the exploitation of natural resources from affecting their culture, economy and livelihoods. Examples of such action include the long struggle the Uwa[1] waged against Shell and Oxy to prevent energy projects in their territories; the opposition of the indigenous inhabitants of the Sierra Nevada de Santa Marta to building hotels and docks in their area; the Embera Katío in northern Colombia who opposed the construction of hydropower plants; and finally, indigenous communities in the Amazon who have succeeded temporarily in stopping mining projects.

Indigenous peoples, society and government

Over the past 25 years, indigenous peoples have become active and visible, political actors in Colombia. Their presence and voice are recognised in governance and Colombian public administration (Laurent, 2001). They have made valuable contributions to the discussion and implementation of public policies in the search for new styles of economic development and better government at the national level. Their contributions range from the guidance they have provided to environmental institutions to their role in safeguarding nature reserve areas.

Indigenous people played a leading role in developing the 1991 Colombian Constitution and in drafting the Indian Law. Their ability to participate in these activities has been promoted by a new and welcoming attitude from other sectors of society, by new policies, and by indigenous people's own struggles to become accepted in national politics. Indigenous groups and communities, such as the Colombian Indigenous National Organisation, the Indigenous Regional Council of Cauca, and the Indigenous Authorities of Colombia, are now considered an integral part of society and the state. Their role as leaders and rulers of the ecosystems and biodiversity in their areas is legally recognised (Constitutional Court of Colombia, 2012).

Indigenous perspectives

For indigenous communities, fighting climate change is about achieving sustainable economies and opposing unsustainable ones (especially mining, hydro-electric power and drilling for oil). Their main objectives are to recover their land and culture, and protect their ecosystems and biodiversity through political action and community practices that follow sustainable development practices.

The location of indigenous groups in the mountains, deserts, forests, jungles and plains, and their knowledge of the natural environment, means that they are crucial participants in action-led research to mitigate against climate change. An example is the Amazon Consolidation Programme, which supports indigenous peoples to take the lead in preserving the Amazon.[2] Similarly, the UN programme on the Integration of Ecosystems and Adaptation to Climate Change in the Colombian Massif is an indigenous initiative (Monje, 2011). The importance of indigenous communities is recognised in other projects undertaken by the United Nations and others, which seek to consolidate indigenous environmental practices in the Sierra Nevada de Santa Marta and help reduce the impacts of climate change (Pabón, 2008: 10).

These activities between indigenous communities, scholars and policymakers have brought together different types of knowledge and resources, and have created political relations to manage the environmental resources of the country.

Conclusions

Social scientists and policymakers worldwide find that indigenous communities produce creative proposals to solve the problems associated with climate change, including changed weather cycles, flooding, the drying-up of rivers and increased temperatures (Echeverry, 2009: 15). These proposals will result in lifestyles that are in harmony with the environment and which mean effective action to mitigate global warming.

Indigenous peoples' efforts to preserve their ecosystems and biodiversity include important strategies for dealing with environmental challenges. Recovering degraded areas, protecting water sources and forests, and generating only low levels of waste will go a long way towards solving the environmental challenges for Colombia.

Notes

1. Inhabitants of Serranía del Cocuy, north-eastern Colombia.
2. *www.gaiaamazonas.org* (accessed 13 September 2013).

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78. Fighting to include local voices in environmental policy-making in Brazil

by
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Local voices and opinions are seen as important in formulating environmental policies, but in reality oral accounts, metaphors and symbols play only a marginal role, while scientific representations still dominate. This problem is deeply rooted in governance discourses that value satellite imagery and other scientific data above local views and experience. This paper focuses on policy-making in Brazil in relation to deforestation in the Amazon rainforest.

Introduction

The entities involved in formulating environmental policies, such as land, people, pollution and biodiversity, cannot be physically present at the discussion. In facing this challenge, policy processes need to create and use representations – words, utterances, symbols or images – to stand in for what cannot be brought into the room (Brown, 2009). Historically, the task of creating representations in environmental policy-making has largely been left to scientists (Peet and Watts, 1996). Re-evaluating indigenous and other forms of local knowledge to construct effective environmental governance systems has been an important social science contribution to policy debates in recent decades (Agrawal, 1995; Harris et al., 1995). But despite the recognised need for these contributions, local representations still play only an insignificant role in formulating and enforcing environmental policies.

This article aims to explore the challenges involved in including local representations of reality in environmental policy-making. It does so by examining the relation between satellite imagery – as a type of scientific representation – and local accounts of deforestation in formulating environmental policies in the Brazilian Amazon rainforest. In order to capture this relation, this article pays particular attention to the governmental discourses that policymakers and scientists in Brazil use.

Michel Foucault suggested that discourses are statements that "define, describe, and delimit what is possible to say and not possible to say (and by extension – what to do or not to do)" (Hajer, 1995; Kress, 1985: 7). This implies that in a specific policy context, only the statements that conform with established discourses are deemed "truthful". Representations rely on the dominant discourses to become valid, while the representations that do not fit are silenced (Foucault, 2002). By expanding the understanding of how the state uses discourses, Foucault proposed the notion of governmentality: that is, "the ensemble formed by institutions, procedures, analyses and reflections, calculations, and tactics that allow the exercise of this very specific, albeit very complex, power" (Foucault, 2007: 144).

The characterisation of a specific governmentality and the delineation of its relationship to different discourses and representations are not trivial tasks. They often require the adoption of different research methods. The data for this analysis come from textual sources (such as news articles, government reports, historical accounts and scientific studies) and from 85 interviews conducted with government officials, scientists and local groups in Brazil between June 2007 and August 2009. The next section of this article outlines the main findings of the study (for a more extensive version, see Rajão, 2013).

Governmental discourses and representations

The 1980s was an intense period for environmental activism in the Amazon. An alliance between grassroots movements, scientists, politicians, journalists and celebrities made globally important an issue which had previously been largely invisible. Local representations of deforestation led the activism. Examples include striking images of burned fields and the voices of prominent local activists such as the Indian chief Raoni Metuktire and the rubber tapper Chico Mendes. Three decades later, the situation could not be more different. Instead of local representations, distant and objective assessments in the form of satellite images, maps and graphs now dominate news reports and policy documents. This prompts us to question why representations of the Amazon featuring local voices and images have been sidelined in recent decades in favour of remotely sensed and numeric representations.

We have examined the ways in which policymakers referred to local and scientific representations in their discourses. It emerges that governance in Brazil reflects partially overlapping discourses that shape the relationship between representation and policy-making.

Within the Brazilian government, the first discourse that helps explain the diffusion of scientific representations at the cost of local ones can be defined as the visibility discourse. This discourse is dominated by policymakers' pronouncements which privilege the sense of sight over other ways of representing and knowing the Amazon. It incorporates the idea that it is crucial to "see" the territory in order to govern it. The influence of the visibility discourse is particularly evident when we consider that government officials disqualified the non-visual local representation of the Amazon after the introduction of satellite-based remote sensing technology.

The local inhabitants of the Amazon have for centuries found ways to represent their territory through the use of oral accounts that highlight the characteristics of the landscape as they see and live it. For instance, while referring to the scarcity of bush meat in nearby forests and the location of his current hunting grounds, a native Indian would use references such as the names of rivers (such as Rio do Sangue, Blood River), aspects of the landscape (such as *mata fechada*, dense forest) and talk about distances in terms of walking days. Nonetheless, policymakers and scientists insist that only with the arrival of satellite imagery has the Amazon became knowable. Pereira (1971) commented that the use of remote sensing technology in the Amazon was essential for "separating the legend from reality [... and revealing] the secrets that nobody knows". It is possible that Brazilian policymakers excluded local representations not because of their inability to represent the territory, but because they conflict with a visibility discourse that seeks to favour the government. This aims to know and control the Amazon in a centralised way, without the need for local, background knowledge that would otherwise be required to interpret local, culturally bound representations.

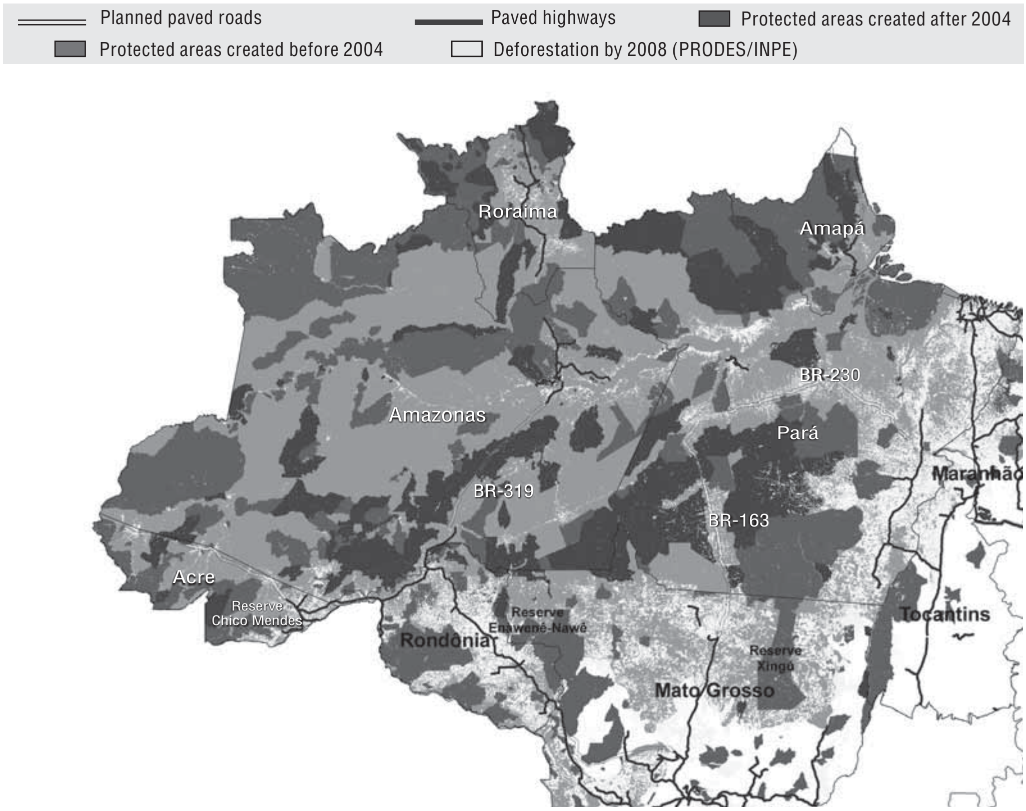
The perceived importance of a comprehensive understanding of the territory reveals another way in which scientific representation is valued above local representation. The so-called comprehensiveness discourse describes the tendency of officials and scientists to refer to the entire legal entity of the Amazon, the largest socio-geographic division of Brazil, rather than to specific areas or populations. In addition, despite recent efforts to allow state governments to get involved, key policy decisions concerning the Amazon are still made by the federal government, in a way that tends to treat the region as a homogeneous whole. Here, scientific representations such as satellite images play a key role due to their ability to show the entire picture, while local representations are sidelined for their limited geographical range.

During the 1970s and 1980s, local representations helped create protected areas (see below), yet they were unable to stop the expansion of Brazilian colonisation policies in the early 1980s. This may be because they only focused on deforestation in a restricted portion of the Amazon. Policymakers and scientists consequently dismissed the relevance of these representations by claiming that they were "speculative [...] excessive and misdirected" (Clayton, 1982: 2). They did not feel a need to change policies that applied to the whole of the Amazon.

A third discourse that helps explain the success of satellite technology and related scientific representations in Brazil concerns the search for deterministic statements, representations that can simultaneously explain reality and mathematically control the outcome of policies. This we term the determinacy discourse. It was evident in the importance that policymakers have attached to mathematical models that could generate future deforestation scenarios for the Amazon. The positivist underpinnings of scientific representation match the deterministic discourse closely, whereas local representations mostly rely on contextual and experience-based presumptions about the future. So they are deemed unfit, and excluded from policy-making.

This helps explain why prediction models that promise specific results in terms of reducing deforestation (see Figure 78.1) have increasingly guided the creation of new protected areas since 2004, rather than demands from local groups based on oral accounts of the cultural significance of the territory. An ex-director of the Ministry of the Environment has suggested that local representations were often used only to justify a decision that had already been taken, based mainly on deterministic representations of satellite images and mathematical models.

Figure 78.1. **Map showing deforestation patterns, main roads and protected areas in the Amazon. It illustrates the ability of scientific representations to provide visual, comprehensive and deterministic accounts of the Amazon.**



Source: R. Rajão (2013), "Representations and discourses: The role of local accounts and remote sensing in the formulation of Amazonia's environmental policy", *Environmental Science and Policy,* Vol. 30, pp. 60-71.

Conclusion

To include local representations in environmental policy-making, we must be ready to challenge some of the assumptions embedded in current government practices. An intervention can only be successful if it is aimed at revaluing local representations. It should challenge not only the inherent superiority of science, but also the discourses that support the exclusive use of scientific representations. To position local representations at the heart of environmental policy-making, we need to challenge the discourses of visibility, comprehensibility and determinacy that undermine their legitimacy.

It is therefore important to go beyond the "seeing is believing" attitude that is typical of current evidence-based approaches to policy-making. The accounts of the people who face environmental problems directly should also be accepted as valid. This implies the adoption of participatory approaches and the creation of a new form of governmentality that acknowledges the validity of different epistemologies in environmental policy-making.

It should also be possible to challenge the idea that the "whole" is the only scale on which valid environmental policies can be created. This implies abandoning large-scale and top-down approaches to policy-making. Decentralised governance systems should allow local groups the autonomy to set priorities and regulate their relationship with the environment. The idea that environmental policies should always be deterministic should also be challenged. Governments need to accept the unruly nature of environmental problems, and create solutions in an inclusive, experimental and emerging manner.

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79. The need for indigenous knowledge in adaptation to climate change in Nigeria

by
Godwin Odok

Most solutions dealing with climate change in rural Nigeria are biased in favour of a modern or Western worldview. Local indigenous knowledge of forest management and of adaptation to climate change is seen as irrelevant.

Introduction

Forest areas in Nigeria are a significant part of the West African Guinean forests, which are themselves important for biodiversity. Nigeria's forests fall into three categories: open-tree savannah in the drier middle and northern latitudes; lowland rainforest in the southern humid zone; and coastal mangroves and fresh water swamp forests, also known as high forests. Nigeria's forests form a significant part of the rainforest belt of West and Central Africa, representing about 15% of the world's remaining tropical forests (Babalola, 2012).

Traditional forest management practices were based on indigenous knowledge and were especially significant in response to natural disasters. They were mainly derived from folklore and people's traditions (see Table 79.1). Modern forest management activities started in the late 18th century with the establishment of regional forestry authorities (Babalola, 2012). The broad policy objectives at that time were to protect and maintain nature, while allowing for the sustainable ecological use of forest resources (Cross River State, 2011).

Table 79.1. **Indigenous forest management practices in rural Nigeria**

Practice	Reason
Preservation of special tree species such as iroko and cotton	They are the home of spirits
Preservation of portions of land with big rocks	They are the home of spirits
Not eating new yam during the "new yam festival"	The gods have to be appeased first
Shifting cultivation and crop rotation	
Not felling certain trees	They are agents of the gods
Preservation of forestland around drinking water sources	
Land inheritance from parents to children	
Prohibition of outright land sale, especially to external and non-communal interests	

Communities in rural Nigeria no longer maintain behavioural patterns that promote the sustainable use of forests. Indigenous habits and practices for forest management have all but disappeared. The destruction of forests is a main cause of climate change (World Bank, 2008). Sustainable forest governance, based on an ecologically sustainable culture, has also been identified as the best solution to climate change (IPCC, 2007). The disappearance of indigenous practices that sustain forests therefore presents a challenge for climate change adaptation in rural Nigeria.

Forest diversity and the possible extinction of indigenous forest management

Indigenous knowledge is local people's knowledge of a particular geographical area; it is knowledge that has survived for generations (Vansina, 1985). It is unique to a specific society and is embedded in the people's practices, institutions, relationships and rituals. During the 1970s and 1980s, a growing number of researchers explored how indigenous knowledge and institutions could contribute to more culturally appropriate and sustainable development (Boedhihartono, 2010). This research recognised that capitalist transformation threatened local communities and ecological systems, and was unsustainable (Olutayo and Odok, 2011; Oladele and Braimoh, 2010). It also acknowledged that indigenous people are more keenly aware of their needs than outside "developers", and have culturally defined needs which demand a substantive rather than a formal appreciation (UNDP, 2011).

Results that emerged from 459 questionnaire respondents, 33 in-depth interviews, 12 key informant interviews and other do-it-yourself participatory research activities (including social mapping, transects, seasonal calendars and institutional profiling) confirmed the absence and near extinction of indigenous practices for forest management in rural Nigeria. These conditions are believed to have negatively affected sustainable livelihoods in these areas. Modernity is blocking the oral paths through which indigenous knowledge of basic survival skills is communicated. This means that the forest-dependent peoples of rural Nigeria no longer learn from each other and no longer form common "attack-and-defence" units to protect local forest resources. In addition, the indigenous knowledge systems of these communities are rarely documented. In sum, these findings have established that modern climate change adaptation in rural Nigeria is detached from the people's local ecology, human geography, gender and class.

Conclusion and policy recommendations

Climate change adaptation programmes need to be culturally relevant if they are to be sustainable. In this context, the value of indigenous knowledge of forest management to climate change adaptation is clear. The social sciences undoubtedly have a role to play in reconciling modern Western knowledge and indigenous knowledge.

Adaptation projects and programmes must adopt approaches that inspire the highest level of local participation in forest areas. This would provide valuable insights into how people interact and share ideas, what their traditional knowledge and experience consists of, and how their ancestors managed forested areas and other related natural resources. It would also allow local communities to develop the skills and practices necessary to maintain new projects in a sustainable manner. While the importance of indigenous knowledge is clear, it is equally important that indigenous and modern techniques and approaches complement and learn from one another to produce best practices for climate change adaptation.

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80. Quebec's *Plan Nord* and integrating indigenous knowledge into social science research

by
Steve Jordan

In the context of the Quebec government's Plan Nord *(2011), this article discusses the contributions that social scientists can make to constructing new forms of research that are sensitive to the traditions of Canadian aboriginal communities. It argues that these new ways of working might inform the organisation, principles and practices of the current social sciences.*

The government of the Canadian province of Quebec formally launched *Plan Nord* in May 2011. The plan envisioned broad and encompassing resource development – through mining, water, hydro-electric power, forestry and tourism – of vast areas of Quebec's arctic regions, which indigenous peoples still inhabit. The *Société du Plan Nord* was created as a joint venture to draw on the goals and expertise of a range of stakeholders, including First Nations and Inuit communities,[1] multinational corporations and the Quebec government. In addition, Quebec sought the participation of Canadian universities to contribute research and policy to develop the social networks needed to support *Plan Nord*. The provincial government's expected investments were approximately CAN 2.6 billion by 2016.

Plan Nord was to be implemented on indigenous territories and was envisaged as a "participatory organisation" (Government of Quebec, 2011). Both factors have significant implications for the research methodologies that natural and social scientists from the collaborating universities will adopt.

In this context, it is important to note that although the Liberal government of Jean Charest originally created and promoted *Plan Nord*, the minority government elected in September 2012, which Pauline Marois' nationalist Parti Québécois leads, has retained it as a policy for the development of the Canadian North. Despite their very different political ideologies, there appears to be an emerging consensus between the two dominant political parties of Quebec that *Plan Nord* should proceed.

This article outlines the possibilities that *Plan Nord* offers to researchers for exploring alternative research paradigms when working with aboriginal communities.

The Quebec and Canadian governments have a long history of colonial rule of Canada's First Nations. Despite this legacy, Canadian indigenous peoples' struggles for self-determination and autonomous government over the past two decades continue, and are evidenced by the ways in which these struggles are now influencing the conduct of research. This new emphasis stems from recent developments in the Canadian socio-political landscape.

First, the "Idle No More" movement (a movement of indigenous peoples demanding equal civil and political rights), currently sweeping Canada in response to the federal government's Bill C-45 (Government of Canada, 2012), addresses the divide between aboriginal histories and knowledge, and current institutional policies. Members of First Nations communities – and many from the wider population – view Bill C-45 as an attempt to revoke traditionally held rights over land and resources, particularly waterways.

Similarly, Canada's Truth and Reconciliation Commission hearings (TRC), currently under way in Amos, Quebec, are giving voice to the appalling legacy of the Canadian residential school system[2] and other assimilative forces, as well as the aboriginal peoples' efforts to reclaim respect and dignity.

Although mainstream Canadian social scientists have been slow to recognise the complex effects that Canada's colonial legacy has had on aboriginal people, awareness is growing. Moreover, new ways of working with indigenous communities take into consideration ways in which indigenous knowledge and community values might mediate urgent social challenges. These challenges include responses to climate and other environmental changes (Wolf, Allice and Bell, 2012); sustainable development (Cajete, 2012); food security, particularly the effects of "nutrition transition" (Kuhnlein et al., 2004); and the rising incidence and prevalence of *diabetes mellitus* (Boston et al., 1997; Jordan et al., 2000). Through participatory research, which repositions aboriginal people as co-investigators rather than viewing them as "objects of research", current approaches attempt to acknowledge and respect First Nations' cultural traditions regarding knowledge-producing practices (Jordan et al., 2009).

These relatively recent shifts have even influenced the earliest formulations of *Plan Nord*. In contrast to Bill C-45, which aims to exclude them, *Plan Nord* places the aboriginal peoples at the heart of their land and communities, and makes them participants in the construction of new socio-economic realities. According to its original presentation and early commentary, this initiative regards aboriginal communities as "partners" and aims at creating "participatory organisations". In these organisations, they will ultimately participate fully in planning and decision-making with regard to their territories (Government of Quebec, 2011). In this way, *Plan Nord* may be seen as a marker on a continuum of Canada's evolving relationship with its aboriginal cultures and knowledge.

As yet, *Plan Nord's* historical effect – the value and authenticity of its aims, the ethics of its approaches and the extent of its potential – is not known. Sceptics may rightly observe that it is not clear whose needs are ultimately being served. Furthermore, there is no certainty that the plan will make any difference. Experience from earlier development projects, such as the Great Whale (River) hydroelectric-generating scheme of the 1990s, suggests that aboriginal interests may well be ignored. Only time will tell.

Nevertheless, approaches which are consensual, participatory and founded on First Nations' values and worldviews are being developed and incorporated into current social science research in Canada and globally. More importantly, aboriginal scholars are beginning to explore an indigenous research methodology. They are drawing on the social sciences to stimulate this methodology, while aboriginal epistemologies, knowledge-producing practices and worldviews are informing it (Chilisa, 2012; Kovach, 2009; Porsanger, 2004; Smith, 1999).

The following general principles can guide new ways of working within the social sciences regarding indigenous populations. First, in order to develop novel and promising ways of working, the social sciences need to become open to new and perhaps unorthodox ways of conceptualising and investigating the social. Indigenous research methodologies might offer one model for this process. Other models might be alternative forms of leadership, social organisation, decision-making and knowledge creation.

The social sciences have historically tended towards knowledge-producing practices that can seem abstract, decontextualised and inaccessible to lay populations, especially those on the margins of society. This has especially impacted work involving indigenous peoples, whose literacy levels in colonial or settler languages are often low. A new social sciences research model could address this by insisting on an educational function that draws upon indigenous epistemological principles being incorporated into research collaborations with indigenous people. This idea is based on the belief that for true collaboration to occur, aboriginal peoples' knowledge-producing practices need to be recognised and that collaborative research should be conducted from a viewpoint that respects their traditions, customs and communities (Jordan, 2003; Kapoor, 2009).

The significance of the approach that *Plan Nord* proposes for social science research is that it espouses participatory ways of working with indigenous groups. It links aboriginal epistemologies and marginalised social science research to the front line: that is, to fieldwork practices and to theory and concept building. In this respect, it is important to acknowledge that social scientists who have been working in the Canadian North for a decade or more are already exploring new research methodologies to inform and stimulate *Plan Nord*.

Notes

1. First Nations, Inuit and Métis are Canada's aboriginal peoples.
2. The 1876 Indian Act established residential schools for aboriginal Canadians. They are now widely viewed as having been responsible for sexual, physical and psychological abuse while supposedly undertaking a "civilising mission". The last school closed in 1996.

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World Social Science Report 2013
Changing Global Environments

81. Participatory water governance in Mercosur countries

by
Alfredo Alejandro Gugliano and Davide Carbonai

Water is crucial to existence, and is getting scarcer. Participatory governance and involving citizens and social movements in the various stages of managing access to water in Mercosur countries increases access to water and is an important means of democratising natural resource policy-making.

Introduction

According to the UNESCO *World Water Development Report* in 2012, a combination of rising world temperatures, the growing demand for food as a consequence of demographic change, and the needs imposed by economic growth and market expansion, point to a potential threat of water scarcity in the near future.

Water allocation and management, or water governance, is an important debate, crucial for policy-making across states and civil society. In the 1980s and 1990s, large parts of Latin America chose to privatise their water supply services. These policies have changed more recently to broaden the public nature of water supply services and to increase community involvement in their management.

Privatisation and nationalisation are not necessarily mutually exclusive. The experience of Brazil during the Fernando Henrique Cardoso administration (1994-2002) is an interesting example. The 1995 *Lei de Concessão dos Serviços Públicos* on the concession of public services included legislation to permit the privatisation of water resources. But two years later, in the proclamation of the National Policy for Water Resources (Law 9433/1997), water was recognised as a public good.

The Mercosur countries – Argentina, Brazil, Paraguay, the Bolivarian Republic of Venezuela and Uruguay – witnessed the development of mechanisms valuing civic engagement in policy-making in the late 1990s. Many researchers suggest that participatory policies redirect public spending towards the poorer sectors of the population, generate public transparency and accountability, and in general, stimulate higher levels of social participation. But others point to the difficulties involved in developing effective participatory processes. Some also criticise the state and traditional populist leaders' frequent control of such processes (Cortez and Gugliano, 2010).

Experiences of participatory water management

In the Mercosur region, different approaches have been adopted to strengthen community engagement in water management. Some are characterised by more representative mechanisms to encourage the involvement of organisations believed to represent water management interests (such as the state, consumers and the private sector), while the people's increased direct involvement characterises others.

The Brazilian experience is a good example of the development of a channel for institutional representation. The country has had the National Water Resources Integrated Management System in place since 1997. It consists of a national council for water resources, 23 state councils and 120 water basin committees. The committees are made up of public officials, water basin-related civil society organisations, and consumers. The committees are primarily responsible for debating water-related issues at local and regional level, ratifying water basin management plans and monitoring their implementation (Jacobi, 2006).

Other Mercosur countries have also developed water management mechanisms to open up the possibility of direct civic involvement. In the Bolivarian Republic of Venezuela, a law[1] on water supply and sanitation created water boards, *mesas de concertación*. These include water users, who discuss and assess water policy projects, investments and implementation at the national, local and regional levels. Building on existing civic public assemblies, it is estimated that there are nearly 7 500 such boards across the country (Lacabana and Cariola, 2007).

In Paraguay, civic involvement in water management occurs via water management boards.[2] These are also based on public assemblies, and their main duty is to manage the many aspects of water supply and public sanitation in small communities, those with fewer than 10 000 inhabitants. Other tasks they undertake include tackling sanitation-related issues, the planning and delivery of services, and the representation of water users in other public or private bodies. Legally registered as companies, it is estimated that some 2 000 *juntas* function across Paraguay (Moreno, 2008).

Even though a considerable part of its water supply services are in private hands, in Argentina too there are various experiences in water management, especially through the *cooperativas de agua* (water co-operatives). The co-operatives, which supply drinking water primarily to small localities, can be considered an alternative to the privatisation or statist models, in that water supply is carried out by the membership of a private association created for the purpose of managing water (Muñoz, 2005).

Civic involvement in the Mercosur region has also contributed to strategic management: the constitutional referendum on public ownership of water-related services held in Uruguay in October 2004 and approved by 62.75% of voters is a good example (Moshman, 2005).

Limits and prospects

Despite the positive results of these approaches, they are still heavily criticised. In Brazil, some point out that gathering social organisations onto a committee does not necessarily make the experience participatory. They also criticise the ineffectiveness of committee discussions. In the Bolivarian Republic of Venezuela, criticism is similar to that levelled at participatory policies in the Plurinational State of Bolivia – that populist government policies are appropriating citizen involvement. In Paraguay, the difficulty is that various *juntas* have had to solve technical problems, because of a lack of infrastructure or of funds, thus jeopardising implementation. In Uruguay, the government's slowness to implement the results of the referendum has also led to criticism. In Argentina, the emphasis is on the risk that some co-operatives will adopt strategies similar to those of private companies (Arenas, 2005; Moreno, 2008; Moshman, 2005; Abbers and Keck, 2009).

While these may be valid criticisms, the key issue is to determine whether they obstruct the development of participatory models as alternatives to public policy-making and management, and specifically to water policies. It is worth stressing that since there are many participatory experiments in place in the region, some will succeed while others will inevitably fail. Uncertainty should not invalidate the perception that community engagement in policy-making can improve the results of public policies (Narayan, 1995; Kliksberg, 2001).

In the Mercosur area, change is perceptible after nearly two decades of participatory policies in water management. Paraguay and the Bolivarian Republic of Venezuela have increased access to piped drinking water, to a coverage of 69.3% (a 27% increase) and 84% (a 22% increase) respectively. In Brazil, 90% of the population has access to piped drinking water (an 8% increase). In Argentina the figure is 78% (a 10% increase), while in Uruguay coverage is nearly universal (98%).

This does not mean that all the difficult hurdles have been overcome. There is still huge inequality in water access and distribution between urban and rural areas; poor social sectors are often excluded, and large urban centres are favoured over small villages (UNDP, 2006). Similarly, progress still has to be made in broadening the region's laws on water management. New laws should unite and co-ordinate the various participatory instruments that each country has set in place. Furthermore, they should create mechanisms for citizens to be involved in the management of their common environmental legacy, such as the Guarani Aquifer System – an important underground water reservoir stretching across the entire Mercosur area, except for the Bolivarian Republic of Venezuela.

Conclusions

For Albert Hirschman (1984), one of the interesting points about community engagement in policy implementation is that besides the concrete outcomes, the process itself yields important intangible results. For example, the feeling of citizenship and sense of belonging, for so long numbed by conditions of extreme exclusion, can return.

Of the various strategies available to manage water resources, policies that involve citizens in public management are an opportunity to expand government management capacity and harness community knowledge and experience, using them to solve social issues and increase the effectiveness of public policy. In the Mercosur area, the experiments that have been conducted are proving effective in engaging local communities and citizens in setting the water agenda and managing it. They work by building on the interests of the users themselves, especially those with basic public policy needs.

Notes

1. *Ley orgánica para la prestación de los servicios de agua potable y saneamiento* (2001).
2. *Juntas de Saneamiento Ambiental* or Environmental Sanitation Boards, Law 369/72.

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82. Glass half full or half empty? Transboundary water co-operation in the Jordan River Basin

by
Anders Jägerskog

Extreme water scarcity and political conflict in the Middle East mean that transboundary water can be a source of conflict. Yet conflict and co-operation do exist side by side between Israel and the Palestinian Authority and between Israel and Jordan. A social science perspective is instrumental in understanding how water co-operation in the Jordan River Basin has developed.

Introduction

As the 2006 United Nations Development Programme (UNDP) *Human Development Report* noted, managing hydrological interdependence is "one of the great human development challenges facing the international community". The Middle East and North Africa (MENA) is the region with the smallest per capita share of fresh water in the world (Allan, 2001). The region has only 1% of the available fresh water on the planet, and more than 5% of the population. In addition, much of the available water is found in rivers and aquifers shared by two or more countries, making conflict likely (Jägerskog, 2003).

Twenty years ago, researchers and politicians identified water as the next reason for war in the MENA region (Starr, 1991; Bulloch and Darwish, 1993; Homer-Dixon, 1994). However, none of the wars and conflicts that have occurred since were fought primarily over water (Wolf, 1995; Allan, 2001; Jägerskog, 2003). The analysts who predicted war over water did not take into account the water footprint of imported food. This covers the "deficit" of water in the region, and has led to a reduced risk of conflict as the global food market made more water available in its virtual form (Allan, 2001). Another reason for the decrease in the risk of conflict is that the states realised they had to co-operate over their shared waters, and did so despite other conflicts (Jägerskog, 2003). However, water still remains an issue of contention (Jägerskog, 2008).

Zeitoun and Mirumachi (2008) have shown that in transboundary systems, conflict and co-operation often exist side by side, and there is continuous negotiation even in periods of apparent disagreement (Earle, Jägerskog and Öjendal, 2010). This article discusses the quality and strength of the co-operation between the parties, which in turn permits ongoing dialogue and negotiation. A social science perspective (primarily that of political science and international relations, but also sociology and discourse analysis) is instrumental in understanding how water co-operation in the Jordan River Basin has developed (Jägerskog, 2003).

Israeli–Palestinian and Israeli–Jordanian water conflict and co-operation

Since the 1950s, Israel and Jordan have co-ordinated issues pertaining to their shared waters from the River Jordan. Under the auspices of the UN Truce and Supervision Organization, the parties have discussed their common concerns in the so-called "picnic table talks" since the 1970s (Wolf, 1995).

In some respects, this technical co-operation was later codified in the 1994 Israeli–Jordanian peace agreement, of which water was a central aspect. Some previously informal water arrangements became central to the agreement, which takes many of the aspects relevant for proper transboundary water management into account. However, it is still unclear on other aspects. One of these concerns water allocation during drought years, which are frequent. The peace agreement specifies that the Joint Water Committee (JWC) should deal with this matter, instead of having a clear formula within the agreement to address recurring droughts (Jägerskog, 2003). In spite of the challenges, the agreement has functioned relatively well since it was signed. Jordan even stores its winter water inside Israel by pumping Jordanian water from the Yarmouk tributary to Israel's Lake Tiberias; this water is returned to Jordan during the dry summer (Earle et al., 2010).

Israeli–Palestinian co-operation regarding water follows a different pattern. Before the Oslo process, there had primarily been unofficial dialogue between academics. Negotiations only started formally with the Oslo process. Further, the Declaration of Principles agreed on in 1993 and the subsequent Oslo II Accords in 1995 were never a full agreement on water – or any other issues – but dealt only partially with the water issue. The thinking was that negotiations about water would be concluded during the final negotiations between the two states, which were supposed to happen within five years of the Declaration of Principles. It was, however, agreed that the Palestinians had water rights, although these were not defined (Jägerskog, 2003). As with Israel and Jordan, a JWC has been institutionalised. This operates on a consensus-based approach, deals with West Bank water projects, and allows Israel to veto Palestinian projects. The original academic-level co-operation has rarely moved up to the political level (Jägerskog, 2003). While common norms and a certain degree of trust have been established between the professionals, political co-operation has been challenging. Selby's analysis (2013) of the JWC since its inception reveals a rather damning picture of a failing structure that prevents the Palestinians from developing their own functioning water sector.

A political analysis of Jordanian–Israeli water relations shows that discourse and understanding at the technical level have provided improved co-operation, and that the political level generally accepted the discourse and development of norms that occurred at the technical level. This did not happen in the Israeli–Palestinian case, as entrenched political conflict overshadowed both water relations and efforts to build joint academic knowledge (Jägerskog, 2003). From a social scientific perspective, the conclusion is that in a situation in which the discourse affects co-operation positively – as was the case between Israel and Jordan but not to the same extent between Israel and the Palestinians – technical understanding can develop into a certain level of co-operation (Ryan, 1998).

Conclusions

The process of establishing and maintaining co-operation in the Jordan River Basin is challenging. In this short article, only part of the basin has been analysed, with Syria and Lebanon excluded. One important observation is that establishing co-operation is a process. It takes time and patience. Providing scientific material in order to gather data on flows and other aspects can contribute to improved decision-making. In regions that are "securitised", as is the Jordan River Basin, politics is more important than scientific knowledge. However, joint research and projects can prepare the ground for when a political situation is ready for a solution.

A second observation is that while establishing co-operation is important, the analysis cannot end there. It is essential to analyse the quality of co-operation. Is it robust, and does it improve justice and the equitable sharing of resources? In the case of Israel and the Palestinian Authority, the institutionalisation of co-operation via the JWC has maintained a structure that allows Israeli domination of its Palestinian counterparts (Selby, 2013).

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83. Global governance and sustainable development

by
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Global climate change is one of a number of issues, including business globalisation, that raise the need for global governance. There are many possible models for government on a world scale, all involving a growing role for new and existing global organisations.

Globalisation raises the question of global governance, the development of a set of norms and institutions concerning the entire world as a single system. Today's world is characterised by the contradiction between growing social, economic and technological interdependence, and increasing political fragmentation and cultural heterogeneity. As these networks of interdependence intensify, it becomes less feasible to see global issues – global environmental change, sustainable development, trade, finance and security – as separate problems. They no longer have their own institutions, nor can they be solved at national or subnational government levels. The world system increasingly resembles a polity, or an organised society, albeit one with fragmented institutions. Governance at the global level needs formal and informal institutions and processes that regulate, guide and integrate global activities through which rules and norms governing the world order are made and sustained (Martinelli, 2002).

Models of democratic global governance

Democratic global governance can be summarised in five major overlapping models:

- international liberal democracy
- radical democracy
- deliberative democracy
- cosmopolitan democracy
- multi-level governance of supranational unions.

I will add a sixth: polyarchic governance, as the most viable and effective (Martinelli, 2008).

International liberal democracy maintains that in order to face the threats to social cohesion of globalisation, and the ecological and political risks it involves, the model of liberal democracy should be extended beyond the boundaries of the nation-state (Commission on Global Governance, 1995; Rosenau, 1997; Ikenberry, 2001). In this model, nation-states are still the most important actors, although international organisations and regimes play a growing role. This raises the fundamental question of accountability. Most international conventions and agreements do not mention to whom, and how, powerful global actors should be held accountable, nor do they specify which measures should be applied or by whom if international norms are ignored.

Radical democracy argues that alternative mechanisms of economic, social and political organisation should be created worldwide, and be based on the principles of self-government, equal rights, the common good and harmony with the environment. It aims to create the conditions necessary to empower people to take control of their own lives and create self-governing communities (Falk, 1995; Gret and Sintomer, 2002; Laclau and Mouffe, 2001). In this model, new global movements are the most important actors. This model is open to the criticism that innovative examples of direct democracy, such as participatory budgets, deliberative polls and mini-caucuses, become increasingly difficult to implement as the polity to which they apply becomes larger.

Deliberative democracy is rooted in Habermas' theory of communicative reason (1981), and has been developed in the works of Fishkin (2011), Dryzek (2010), Elster (1998) and Gutmann and Thompson (1996). It fits between the two models described above. It can be seen as a variant of liberal and radical democracy with the specific aim of improving democracy.

Cosmopolitan democracy is based on a cosmopolitan law that entrenches a few universally shared principles. It implies the development of a global civil society in which democratic cosmopolitan institutions and public discourse can develop among individuals enjoying multiple citizenship in diverse, overlapping political communities (Archibugi, Held and Kohler, 1998; Held, 2002). It underestimates the power dimension, the persisting importance of nation-states and their conflicts. It also fails to identify the most important actors to make the project of cosmopolitan law real. This model is at present limited to "enlightened minorities".

Multi-level governance argues that global governance can only be the result of the gradual development of supranational unions, based on the European Union model. Supranational unions are formed by national governments voluntarily transferring portions of their independence to supranational institutions (Hix, 1999; Zeitlin and Pochet, 2005). However, interstate rivalries and different views of the national interest are serious obstacles to the development of union building, even in the European Union, the most advanced experiment of this kind to date. There are serious doubts that European "exceptionalism" can be reproduced in other regions of the world.

Polyarchic, mixed-actor governance for sustainability

All models have strengths and weaknesses. But taken together, these examples suggest that a viable democratic global governance project is possible. For global governance to be achieved, it should take seriously the continuing importance of nation-states as key actors when making policy on global issues. It should also incorporate some features of the main models outlined above.

Global governance can realistically be achieved through a polyarchic, mixed-actor, multipolar and multilayered system, in which the anarchy of sovereign nation-states is reduced. Three types of non-state actors could control them: international organisations around a reformed United Nations Organization, community-type and market-type associations of world civil society, and supranational unions like the European Union. The basic underlying principles would be democratic accountability, individual and community empowerment, multiple identities, contextual universalism and supranational institutions. In this polyarchic mixed-actor system – the product of many actors pursuing different strategies, both competitive and co-operative – global governance is the result of a set of institutions and collective actor-governments, markets and communities whose actions are based on the principles of authority, exchange and solidarity (Martinelli, 2002, 2008). The most important actors in global governance for sustainability will be democratic governments, United Nations agencies, socially responsible corporations, non-governmental organisations (NGOs) and collective movements, as well as scientific and epistemic communities.

The governing role of nation-states and international organisations in environmental policy has been widely studied (Evans, 2012). Strong democratic policies and cultures favour global governance for sustainability. Democratic governments can play a major role by being open to the public's concerns. The urgent changes in attitudes and institutions required for sustainable development should take place in a widened democratic public space and with strengthened citizen participation. International governmental organisations can also play a significant role (through the United Nations Environment Programme [UNEP] and similar agencies). They can do this by offering a space for dialogue and co-operation, incentives for policy implementation, and resources for ecological education and specialised training, as well as by monitoring and evaluating policy (Karns and Mingst, 2009).

NGOs and collective movements also need consideration. These actors have been relevant for setting policy priorities, raising awareness of the issues, exposing governments and corporations' worst practices, and monitoring trends. They appear to be less effective in setting standards and rules, and at implementing specific policies (Keohane, 2002).

Greater recognition is needed of corporations and epistemic communities, and their role in governing global sustainability issues. Corporations are often only regarded as part of the problem, not of the solution. This view neglects the significant differences between corporations operating in different sectors. For example, the market for clean technologies, both hardware and software, is worth about EUR 500 billion. It also overlooks different managerial cultures and organisational structures, and the growing theory and practice of corporate social responsibility.

Two contradictory developments are taking place in capitalism today. First, there is increasing pressure from financial markets, which demand high short-term profitability and greater attention to stock values. Second, there is the development of a multi-stakeholder theory of the firm, according to which top managers and boards of directors take their responsibilities and fiduciary duties seriously with regard to a variety of stakeholders. These include stockholders and financial investors, but also employees, customers, suppliers, local and national communities, and future generations. The financial model of corporate control is strong, but stakeholder capitalism is here to stay too, and can contribute significantly to sustainable development.

As far as epistemic communities are concerned, the importance of scientists in international policy communities has already been acknowledged in cases like ozone layer depletion and climate change. But scientists' general influence is also increasing. The main reason is that the problems that decision-makers – government and business, domestic and international – must address are becoming less familiar and more complex. Decision-makers are unable to integrate new scientific knowledge claims whenever they have to make a decision, and must rely on existing shared knowledge. A more fundamental reason for greater involvement of epistemic communities in policy-making exists, however. Democratic deliberation needs knowledge, theoretically robust and methodologically rigorous analysis, open debate of alternative interpretations, and the free production and exchange of ideas, in order to make sound choices among policy options. The role of open and independent science here is invaluable.

Epistemic communities of scientists and policy professionals can play a decisive role in implementing domestic policies and – in a growing number of countries – in encouraging national governments to implement international programmes. Knowledge regimes – in other words, the scientific disciplines and scientifically based assumptions which have a dominant influence on policy – have undergone significant changes (Haas, 1997). They have evolved through phases, with the social sciences joining the natural sciences and economics in the present phase of environmental policy, as the Future Earth project shows. This shift implies the active involvement of social science experts, which their recognition by the Intergovernmental Panel on Climate Change demonstrates.

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World Social Science Report 2013
Changing Global Environments

84. The politics of climate change and grassroots demands

by
Antônio A. R. Ioris

There is a pressing need to counter the dominant mode of commodity production and economic growth, which is responsible for the negative and unfair impacts of climate change. The political ecology critique emphasises the role of grassroots organisations and affected communities in the production of more inclusive public policies and mitigation strategies. The climate justice approach is a good example of the political ecology approach.

Climate change issues are at the centre of the current debate on socio-economic development and the future of humankind. However, despite a growing volume of environmental legislation, constant technological improvement and intense multilateral diplomacy, questions related to the allocation of natural resources and the conservation of ecosystems remain only partially resolved.

Anthropogenic climate change offers a unique entry point to assessing public and private responses to global environmental problems. One of the main paradoxes of science and policy-making today is that although government and society increasingly recognise the magnitude of environmental impacts, reactions to these problems are usually fragmented and inadequate. Environmental degradation and social conflicts continue to disregard most responses, especially because these are normally based on techno-bureaucratic approaches and market-driven solutions (Leff, 2004).

In this context, the work of political ecologists inquires into the causes of environmental degradation, the asymmetric distribution of opportunities, and the unfair sharing of negative impacts. Political ecologists have emphasised the historical and geographical currency of environmental problems, the double exploitation of nature and society, and the expansionist nature of the dominant relations of production. "Political ecology is the politics of the social reappropriation of nature" (Leff, 2004: 267). Special attention has been paid to the limits of mainstream environmental management, and the politicised nature of technical assessments and policy implementation.

The political ecology critique is even more important if the slow progress of the negotiations on implementing the UN Framework Convention on Climate Change is taken into account. Many policymakers and neoclassical economists have recommended stabilising greenhouse gas concentrations by allocating nations or administrative units appropriate emission reduction responsibilities. They then need to achieve the relevant reduction through market-based mechanisms. The basic assumption is that this should be pursued to the level where the marginal benefit of reducing emissions by one additional unit is equal to the marginal cost of curbing such emissions.

However, from a political ecology perspective, this calculation of the costs of emissions and effects is inadequate, because it presumes that the greenhouse gas reductions will have a global welfare function. This reasoning ignores the differences between poor and rich countries (Anthoff and Tol, 2010). On the whole, these mainstream responses have largely maintained the interests of landowners, industrialists, construction companies and real estate investors at the expense of the majority of the population and of the recovery of ecological systems.

Despite the current rate of technological and logistical innovation, there are still a billion hungry and undernourished people worldwide. This is partially because of the failures of agricultural production, and partially because of market speculation, trade barriers and rising prices. Food supplies will be further reduced as agricultural production fails as a result of cyclical droughts and floods associated with climate change. In particular, smallholder and subsistence farmers are expected to suffer progressively worse localised effects of climate change (IPCC, 2007). In addition, the increased demand for biofuels such as sugar-cane ethanol is another threat to the food supply, because producing biofuels increases the competition for land and resources (Ioris, 2011). At the same time, the global food economy as it exists today is a significant contributor to humanity's carbon footprint (Weis, 2007).

An important step towards understanding this complexity is to develop a clear appreciation of the socio-ecological interactions involved, the uncertainty and contested knowledge of the causes and consequences of climate change, and the interdependency between the diverse and unequal interests which are involved (Fish, Ioris and Watson, 2010).

The heart of the matter is the ongoing inability of governments and the representatives of the hegemonic agroindustrial sectors to formulate more inclusive and sound climate change policies. Their highly inconsistent ways of thinking, and the lack of effective responses to the risks that climate change poses, are a direct reflection of global and local political inequalities (Parks and Roberts, 2010). Those least responsible for climate change are usually the ones who experience its greatest effects. For instance, deprived communities are more likely to live in unsafe areas along river courses, to have more difficulty adapting to a changing environment, and to have fewer opportunities to influence government decisions. Yet the difficulty of incorporating the demands of grassroots groups meaningfully is not trivial. Existing decision-making systems are reluctant to recognise that those social groups with less political influence are likely to feel the effects of anthropogenic climate change most intensely.

The political ecology critique stresses that without fundamental shifts in the structure of production, and more inclusive public policies, there is a serious risk that climate change will affect different social groups unevenly. This will aggravate the hardship that low-income sectors already experience, and siphon off the results of the adaptation and mitigation measures to those who benefit more from the current economic model. Responses to climate change need to go beyond the techno-bureaucratic reductionism of most contemporary interventions, and deal with the connections between the practices (such as subsistence agriculture) of marginalised groups (such as urban poor people), social institutions, and the discursive, symbolic and material aspects of climate change. At the same time, marginalised groups and grassroots activists need to address their failure to counterbalance the dominant tendencies, and to link their campaign strategies to a more broad-based political movement.

Fortunately, the past decade saw a broadening of environmental and social concerns from a political ecology perspective (Schroeder, 2000). Successful cases of mobilisation demonstrate that climate change policies should be related transformatively to the problems of poverty and marginalisation in the Southern part of the world, and overconsumption and fuel dependency in the Northern part. Partly through the conceptualisation of “just sustainability”, this led to sustainability and environmental justice discourses coming together (Agyeman and Evans, 2004). Similarly, wider developments in justice theory have moved beyond the distributional to emphasise the role of process, procedure and recognition in the production of unequal outcomes. Claims with regard to justice have routinely extended beyond the distributional to include matters of fairness in processes and regulations, inclusion in decision-making, and access to environmental information related to climate change (Schlosberg, 2004). On the ground, organisations such as La Via Campesina (the international peasant movement) have tried to connect access to land, and food insecurity, with climate change and environmental injustice.

The campaign for “climate justice” is a positive example of the political ecology approach. This mobilisation includes a network of local and global organisations which emphasise that the causes and effects of climate change are related to concepts of social and environmental justice. Many grassroots organisations have repeatedly pointed out the politicised interactions between climate change threats and the erosion of social and economic rights. An example is Climate Justice Action (CJA), a global network of groups and individuals formed as part of the mobilisation around the 2009 United Nations Climate Change Conference in Copenhagen. CJA aims to promote the rights and voice of indigenous and other affected peoples.

These critical social movements want to disentangle the complexities of international law and governance, to find ways to turn economic, legal and cultural norms toward climate justice. The lesson is that the climate change controversy is not only an environmental and economic issue, but primarily a human rights problem (Haines and Reichman, 2008). Creating and funding international institutions for adaptation to, or mitigation of, climate change undeniably involves questions of justice. Because it believes that current responses to climate change maintain or aggravate discrimination and injustice, the global movement for climate justice has fiercely criticised the ineffectiveness of top-down responses, as well as the opportunities for capital accumulation that the environmental crisis has created in the form of “green capitalism”.

Overall, the main task ahead is to counter politically the effects of the dominant mode of production, which are responsible for climate change and for the unequal distribution of its impacts. Reactions to anthropogenic global warming should prioritise human welfare and environmental sustainability before compensating states and economic sectors as the prevailing approach does. A new paradigm built on the principles of ecological productivity and cultural creativity should embody grassroots, local communities and campaign groups which demand environmental and climate justice (Leff, 2004). Effective and fair responses to anthropogenic climate change require the organised reaction of marginalised communities and social groups. They should take any opportunity to take part in policy-making, establish alliances with other movements around the world, and carry out creative social learning and substantive political and economic transformation.

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85. Green informal services in India? Rickshaws, rag picking and street vending

by
Ashima Sood

Are informal services greener than their formal or organised counterparts? Beyond their employment potential, non-motorised transport, street vending and waste sorting or rag picking use fewer resources and energy; they also tend to reuse and recycle materials. These possible benefits have been little recognised and rarely calculated. In India, supportive policy frameworks face many hurdles, and protection for workers also needs more attention.

Informal employment includes self-employment in small and unregistered enterprises, as well as wage employment in conditions of insecure contracts and without benefits or social protection. In the year 2000, it accounted for 65% of non-agricultural employment in Asia (ILO, 2002). A decade later in India, it encompassed 79% of urban male employment and 81% of urban female employment (Chen and Raveendran, 2011: 6). India's National Sample Survey shows that informal services such as street vending and waste picking nearly doubled their share of urban employment between 2004 and 2009 (Chen and Raveendran, 2011: 12).

Although informal services continue to be a major segment of developing economies, policymakers and development economists have largely associated them with low productivity and low-quality jobs (Sood, 2012). Over the past few decades, however, concerted activist and advocacy work in India has tried to correct this impression. In so doing, these campaigns have highlighted not only the livelihood potential of these activities for the poorest and most disadvantaged sections of the workforce, but also their contribution to sustainable practices that emphasise reuse, recycling and low energy intensity (WIEGO, n.d.).

Are informal services the missing link between inclusion and sustainability in economic development? Interestingly, the economics literature has largely viewed the informal sector's environmental effect as negative, primarily because of the difficulty of enforcing environmental regulations (Blackman, 2000). Research has only very recently balanced this "deregulation effect" against a "scale effect", which acknowledges that the high labour intensity and low capital intensity of informal activities can be associated with lower energy use as well as lower carbon dioxide emissions (Elgin and Oztunali, 2013).

This article takes an alternative approach by focusing on case studies from three informal service sectors in India – non-motorised cycle rickshaws, street vending and informal waste processing – that offer distinct environmental benefits. It first attempts to analyse the pathways that help achieve these benefits and the knowledge gaps that continue to hinder academic and policy understanding. Then it shows how these environmental effects have found recognition in policy processes in India, and outlines a policy agenda to support green informal services.

Advocacy and knowledge

The knowledge base on informal services and their environmental contributions has often emerged from close contact between advocacy and research. Perhaps the most successful example comes from solid waste management. Here the central role that the small army of often very poor, informal waste-sorting “rag pickers” and traders plays in boosting recycling rates and reducing greenhouse gas emissions has to some extent been quantified (WIEGO, n.d.). Despite data limitations and methodological issues, one calculation suggests that through recycling and composting, their contribution to the decrease in greenhouse gas emissions far exceeds that of state and corporate technologies (Chintan, 2009).

Although the pollution and greenhouse gas mitigation effects of the non-motorised cycle rickshaw sector have not been estimated, they can again be traced to labour intensity and energy use patterns. Both the Delhi Master Plan 2021 and the National Urban Transport Policy have acknowledged the cycle rickshaw’s role in a sustainable public transport system (Sood, 2012) that feeds into the cross-city Metro system.

Street vending, which accounts for 14% of urban informal employment in India (Chen and Raveendran, 2011: 12), suggests other pathways to lessen the environmental impact. These include the use of strong local supply chains to minimise transportation costs, less use of paper and plastic packaging materials, less use of electricity (WIEGO, n.d.) and lower capital intensity. Yet despite strong activist networks and a growing academic knowledge base (Bhowmik, 2010), there is little documentation or data on the supply chains, packaging, reuse and recycling practices, or energy use patterns of this sector.

Finally, rich traditions of repair and reuse in occupations such as shoe cobbling and tailoring have received little advocacy or academic attention.

Putting policy into practice

Although informal services have seen some policy and regulatory victories – often due to judicial intervention – converting these achievements into practice has proved challenging. This is primarily because of the gaps between the central, state and city-level jurisdictions in which policy is formulated and implemented.

For instance, judicial rulings in response to a sustained campaign in New Delhi have mandated an overhaul of the punitive regulatory regime that governs the cycle rickshaw sector, and instigated the drafting of more supportive legislation (Sood, 2012). However, until there is a national policy, this new framework is restricted to Delhi.

In contrast, the National Policy for Urban Street Vendors 2004, which was one of the earliest policy triumphs for informal service workers, has often been badly implemented because of the indifference or active hostility of the responsible municipal authorities.

Partly at the direction of the Supreme Court (Bhowmik, 2010), the central government has now introduced the relevant bill.

On the other hand, the recent debate on foreign direct investment in Indian retail illustrates how macroeconomic decisions are often made with little empirical policy analysis of the ground-level conditions that affect millions of livelihoods. While commentators have noted that the growth of organised retail is a serious threat to the informal retail trade, much remains to be done to identify and quantify how this is affecting street vendors' supply chains and market access (Sood, 2012). Such research is critical in order to measure and compare the greenhouse gas emissions and energy use effects of large-scale, capital-intensive retail with those of informal retail.

The downside of labour-intensive and low-resource services lies in the seasonality and income uncertainty that informal workers face. The environmental contributions of these services further strengthen the case for comprehensive social security and protection for these workers. The recommendations of the National Commission for Enterprises in the Unorganised Sector led to the Unorganised Workers' Social Security Act 2008, but since the legislation targets workers "below the poverty line", this limits those it covers (Dutta and Pal, 2012).

The health and safety risks in waste work and other hazardous industries pose a more tricky regulatory challenge. Addressing these issues without compromising the livelihoods of informal service workers requires a responsive regulatory apparatus that draws on a deep knowledge of local ground-level processes and on connections with local actors (Sood, 2012). City-level initiatives – such as Solid Waste Collection and Handling (SWaCHCoop), contracted by the Pune Municipal Corporation – demonstrate that the effective integration of informal waste workers under superior working conditions is possible (Schindler, Demaria and Pandit, 2012).

Are informal services the frontier of inclusive and sustainable development? Economists have been sceptical of the environmental impact of informal activity. But the literature in this area often focuses on informal manufacturing and not on services (Blackman, 2000). The economic incentives and constraints for informal services encourage low-impact resource and energy use and high labour intensity. The Indian experience shows the role of judicial intervention in protecting livelihoods that depend on these activities. However, the gaps between national and local policy and implementation, and the lack of worker protection and social security, remain barriers.

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86. Debating transformation in multiple crises[1]

by
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Robust political and social action is required for humanity to stay within planetary boundaries and ensure socially just and sustainable development. The challenges that this involves are increasingly discussed in terms of socio-ecological and sustainable transformation. The term "transformation" is an appropriate one because it points to the complex financial, economic, social, political, resource and climate dimensions of the crisis.

The social sciences are active in developing the novel approaches to social innovation which are needed to address today's great challenges. This priority is also a central pillar in the European Commission's strategy for Horizon 2020, the EU programme for research and innovation for 2014-20. In its Strategic Research Agenda, the European Joint Programming Initiative, JPI Climate, describes its aim as "[s]ynthesizing knowledge for a climate-friendly and climate-proof Europe". Europe needs integrated scientific support for policy development and decision-making informed by knowledge.[2]

The transformative contribution of the social sciences in this field results from their role in reflecting on the processes leading to global environmental problems, their driving forces, and attempts to deal with them. They have a role in examining differing interpretations of crises, institutional innovations, successful experiments, and change that pioneers induce in specific areas. Different forms of knowledge as well as their interdisciplinary and transdisciplinary co-production also need to be considered (O'Brien, 2010). Moreover, social sciences contribute by exploring visions of the socio-ecological or socio-technical system. These visions have the potential to shape existing markets and institutional structures, attitudes, and everyday practices. In this way, social sciences can contribute to improved societal and political reflexivity, and have a high value for decision-making processes.

Different meanings of transformation

The concept of transformation has different meanings. The term is often used in a normative-strategic sense (e.g. WBCSD, 2010; NEF, 2010; WBGU, 2011) but it is also applied in an analytical-descriptive sense (Haberl et al., 2009; UNEP, 2011; World Bank, 2011). The normative usages identify problems and show effective and socially desired ways of dealing with them (e.g. *www.gtinitiative.org*). This is especially true of discourses on a new type of economy (such as a green economy) but also relates to different understandings of prosperity (such as de-growth), a greater and progressive role for the state, and the expansion of local production and consumption patterns.

The analytical usage, by contrast, tries to analyse past and present changes to assess and explain them.

A detailed review of the literature about transformation can help identify both shared aspects and differing ones, whether transformation is a concept or a paradigm, and whether and how it forms a part of scenarios and visions. A review can help us understand increasingly complex social science perspectives on global environmental change in times of a multiple crisis, which are usually based on the natural sciences and the humanities.

There is no one best way to realise a climate-friendly, sustainable and just society (Hulme, 2009). Policymakers might be able to formulate better aims and strategies if they had better knowledge of the explicit and implicit ontological assumptions about problems, of the drivers of non-sustainable change, of visions and pathways, of progress and barriers, and of actors and practices. In this sense, policymakers' levels of insight into current contexts and processes empower them to try to realise a better society.

Common ground

What can be identified as common ground so far? First, it is obvious that the literature on socio-ecological transformation – and the related one on transition and transition management – differs from scientific diagnoses of the state of natural, socio-economic and cultural environments and their interaction. The need to generate profound changes to production and consumption patterns is broadly acknowledged (Kates, Travis and Wilbanks, 2012).

Transformation research goes beyond incremental change and towards particular policy fields such as climate change or biodiversity policies. This is important given the multiple character of the current crisis. So it is acknowledged, secondly, that transformation involves non-linear processes because it deals with dynamic, multidimensional and complex systems as well as potential tipping points. Third, it is acknowledged that technical innovation is important but not enough; social innovations are central to socio-ecological transformation. A fourth common consideration is that analyses of unsustainable developments and necessary changes take place unevenly over time. Both of these elements relate to multiple spatial scales and system levels, including for example the international level, which overlies the national, regional and local levels, and functional levels such as markets, states and civil society. The literature does not favour any scale or level.

Open questions

What issues can a review and careful interpretation of the literature clarify? First, the social sciences can conceptualise the subjects of environmental transformation – that is, the state and the intergovernmental system in conjunction with private and civil society actors (e.g. Fischer-Kowalski and Rotmans, 2009; Geels, 2010, in his outstanding contribution) – via a range of different approaches:

- What are the constituents of the state and governance structures?
- What is their range of action? Which interests, rationalities and kinds of knowledge are the most important?
- What is the role of values, meanings, beliefs and belief systems?
- What roles are played by the pioneers of change, social experiments, innovation and best practices?
- In what way do networks contrast with or complement states, governance, markets and civil society?
- Does transformation indicate more power-driven processes or is it a result of deliberation? What is the logic according to which these governance processes are organised?
- And what is their relation to normative aims of transformation? How is change constructed, managed or even blocked between state, corporate and civil society actors?

The same questions apply to the object of transformation, in other words society and its relation with natural systems. How should we conceptualise and investigate societal relations to global environmental changes, multidimensional problems, and unsustainable social and natural subsystems? What are the megatrends and drivers of change?

Some approaches consider long timescales to analyse the transformations of socio-metabolic systems, while approaches like transition management (Fischer-Kowalski and Rotmans, 2009) or the multi-level perspective (Geels, 2010) need shorter timescales. In other approaches, implicit assumptions should be made more explicit in order to sharpen the evolving social scientific discourse on transformation. By bringing the subject and object dimensions of transformation together, insights and possible policies will be fostered, irrespective of how manageable, if at all, particular aspects of transformation turn out to be.

One strength of the social sciences is that they encompass different worldviews, each with its own specific characteristics. For example, they reflect on the insight that climate change is not a discrete problem that can be solved, but instead rather forms a condition that requires humanity to make choices (Hulme, 2009). Feminist or postcolonial approaches to existing and desired transformation emphasise other aspects than institutionalist or rational choice viewpoints.

Despite recognition of the current multiple crisis, the danger remains of unintended effects, in Robert K. Merton's sense of the "unanticipated consequences of purposive social action" (1936), and of shifts in crisis strategies. For instance, the production of agrofuels might promote the use of renewable energy and capital market investments in the real economy (here, a new strand of literature on the "financialization of nature" emerges). At the same time, competition between different land-use strategies and the disempowerment of local people might be a consequence of other approaches, perhaps framed as "food versus fuel", or through counter-effects caused when European policy supports the automobile sector mainly to retain employment.

Furthermore, we know that there is no energy supply system without side effects – whether this is centralised, based on large-scale nuclear power and fossil sources, or whether it relies on more decentralised systems. Examples of such side effects include the environmental pollution generated by the fabrication of solar panels in China, which are used as an energy source in Europe.

Social science can make a crucial contribution to our understanding of the multiple crisis and of socio-ecological transformations, for example through scientific descriptions and analyses of the ongoing crisis strategies, different normative perceptions and societal changes, on a local to a global scale. This helps us to understand and enhance the possibilities of making a normatively desired and strategic transformation towards low-carbon, sustainable and just societies.

Notes

1. This article is based on a literature review activity in the framework of the European Joint Programming Initiative JPI CLIMATE (*www.jpi-climate.eu*), financed by the Austrian Federal Ministry for Science and Research (BMWF). Some of the contributors are affiliated to Working Group 3 of JPI CLIMATE.
2. *www.jpi-climate.eu/_img/article/JPI-CLIMATE_Strategic_Research_Agenda-adopted_111109.pdf.*

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87. Payments for ecosystem services in biodiversity conservation

by
Katia Karousakis and Edward Perry

Payments for ecosystem services (PES) are an increasingly applied tool for the conservation and sustainable use of natural resources. Over 300 PES schemes are known to be operational around the world. They involve payments for the conservation of biodiversity, carbon sequestration, water flows and other natural but endangered services of value to humanity.

Projected trends in biodiversity loss mean that there is an urgent need for the greater application of policies and incentives to promote biodiversity conservation and sustainable use. With the Organisation for Economic Co-operation and Development (OECD) *Environmental Outlook to 2050* projecting a further 10% loss in biodiversity by 2050, governments need to use the full range of policy tools available: regulatory approaches, economic mechanisms and information instruments (OECD, 2012).

Payments for ecosystem services (PES) are an important part of the toolkit that is increasingly used around the world. PES are a flexible, incentive-based instrument intended to promote conservation and the sustainable use of natural resources. They have the potential to deliver large cost-effectiveness gains compared with indirect payments or regulatory approaches.

Biodiversity and ecosystems provide invaluable services to society, including food, clean water, genetic resources, flood protection, nutrient cycling, climate regulation, and aspects of cultural, aesthetic and spiritual significance. However, as these are often public goods, they are not fully reflected in market prices and are undervalued and underprovided. Private companies and policymakers do not always consider the social (external) costs and benefits of natural resources, ecosystem conservation and sustainable use; instead they only consider their private costs and benefits. To promote the provision of ecosystem services, users pay incentives (PES) to individuals or communities whose management decisions influence the provision of these services. The payments compensate service providers for the additional costs of conservation and sustainable use over and above what is required by existing regulations.

PES programmes have proliferated over the past decade, with more than 300 programmes worldwide. They are used to address biodiversity, watershed services, carbon sequestration and landscape beauty, and are implemented at local, regional and national levels. The programmes have mobilised a substantial amount of finance: five national programmes alone (in China, Costa Rica, Mexico, the United Kingdom and the United States) channel over USD 6.5 billion per year into landscape and ecosystem conservation and sustainable use.

The achievement of the potential gains from PES depends on how they are designed and implemented. The experience of existing PES programmes suggests the following overarching guidelines. Payments should target sites with the highest biodiversity and ecosystem service benefits, the highest risk of loss or potential for improvement, and the lowest opportunity costs (Wunscher et al., 2006).

A number of approaches and tools, such as metrics and indicators, help achieve this. They have been used, for example, to identify areas where benefits are highest and for inverse auctions, for example, where potential ecosystem service providers submit bids indicating the minimum payment they are willing to accept in order to provide an ecosystem service, to prioritise payments to sites with low opportunity costs (OECD, 2010). By implementing such approaches, the Tasmanian Forest Conservation Fund in Australia, which aims to secure the protection and management of high-conservation-value forests on private land, achieved cost-effectiveness gains of more than 50% compared with a programme where payments would not have been targeted (OECD, 2010).

Other features that need to be considered for effective PES design include clearly defined and enforced property and land tenure rights, as well as measures to address permanence. For example, the risk of events such as forest fires or illegal logging may undermine a landholder's ability to provide an ecosystem service for the length of time stipulated in a PES agreement. Other features that must be addressed include leakage (when the provision of ecosystem services in one location increases pressures on ecosystems in another), the putting in place of a robust monitoring and reporting framework to assess and evaluate the programme over time, and strong enforcement.

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88. Monitoring the effectiveness of adaptation investments

by
Nicolina Lamhauge and Michael Mullan

Development projects often have the reduction of vulnerability to climate change as a key objective. Monitoring and evaluation methods are now being introduced to analyse the effectiveness of such measures. Remaining challenges include the long timescales of climate change, and the role of climate change adaptation within many major development initiatives.

The reduction of people's vulnerability to climate change is a common aim of development programmes, policies and plans. Given the wide range of possible measures to achieve this goal, it is important to understand the approaches to adaptation that reduce climate vulnerability effectively. Monitoring and evaluation can help identify which measures are the most effective, and can facilitate mid-course adjustments that may improve the effectiveness of adaptation initiatives. Although monitoring and evaluation frameworks for adaptation are in their infancy, development agencies have a long record of evaluating projects and programmes with adaptation-related components.

The Organisation for Economic Co-operation and Development (OECD) examined 106 projects from six development agencies to identify common challenges, and to learn from the different approaches used to assess project components related to adaptation (Lamhauge, Lanzi and Agrawala, 2011). While some of the projects were funded through specific climate change funds and programmes, most were development projects with activities identifiable as adaptation in the OECD Creditor Reporting System.[1] These projects have been under way for some time and are more likely to have completed their monitoring and evaluation than more recent adaptation initiatives, which are often still in the early planning or implementation phases.

The study identified a number of challenges to the monitoring and evaluation of adaptation. They can be grouped into three broad categories. First, the effects of climate change may only appear over several decades, which makes it difficult to evaluate outcomes in the short and medium term. To address this challenge, the study recommends differentiating between short- and medium-term activities (such as the number of adaptation workshops conducted) and outputs (such as the percentage of households with more climate-resilient livelihoods) which can be directly attributed to a project, and by contrast, long-term outcomes (such as reduced climate vulnerability) to which a project may contribute but which cannot be regarded as direct outcomes of it (Lamhauge et al., 2011).

The second challenge is how to measure the causal linkages between an intervention and actual change on the ground. This problem is compounded by the call for climate change to be integrated into all development projects and programmes (OECD, 2009). This means that adaptation is often a relatively small component of a specific development initiative. To get around this challenge, qualitative, quantitative and binary indicators are used. For example, the development of a policy framework (a binary indicator) does not ensure its implementation or sustainability. It needs to be complemented by a qualitative indicator that assesses the change brought about by the policy, and by quantitative indicators of the number of initiatives introduced as a result of the policy (Lamhauge et al., 2011).

A third challenge is the difficulty of setting baselines and targets. It has been argued that baselines and targets for adaptation should be based on climate projections. However, the localised nature of most adaptation projects means that appropriate climate projections are not always available. Even when they are, a certain level of technical expertise is required to use them. In most of the projects examined by the OECD, development agencies formulated the baselines and targets on the basis of the current climate (Lamhauge et al., 2011).

These challenges are not unique to adaptation; they are also found in other development fields. Valuable lessons can be learned by examining how they have been addressed elsewhere – in education, health or fragile states, for example. Increasingly, development agencies are also looking beyond the success of individual projects towards monitoring and evaluating the success of broader national programmes. This is partly in response to the 2011 Cancun Adaptation Framework, which called on least-developed countries to move from national adaptation programmes of action towards more strategic national adaptation plans, with the support of developed countries.

Note

1. The OECD Creditor Reporting System (CRS) is a database that brings together financial statistics on projects and programmes funded by members of the OECD Development Assistant Committee (DAC), non-DAC development partners, EU institutions and other international organisations and private donors. Since 2009, the CRS has also been tracking development assistance in support of climate change adaptation.

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You Can Buy My Heart and My Soul, 2006 by Andries Botha
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Part 7
Contributions from International Social Science Council members, programmes and partners

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89. Contributions from International Social Science Council members, programmes and partners

Introduction to Part 7

Part 7 features contributions from the International Social Science Council's (ISSC) members, programmes and partners, including international disciplinary associations and unions, the International Human Dimensions Programme on Global Environmental Change (IHDP) and the Integrated Research on Disaster Risk (IRDR) programme.

Views from the disciplines

The disciplinary associations, unions and research groups that have contributed to this part take stock of how their respective fields have approached global environmental change research in recent decades, and how they have facilitated this.

Six of the disciplines profiled represent the historical mainstream of the social sciences, including behavioural and economic sciences: anthropology, economics, geography, political science, psychology and sociology. Part 7 also includes a contribution from a group of researchers representing environmental humanities, an interdisciplinary field not represented by the International Social Science Council (ISSC) but whose contributions to the study of global environmental change are recognised as being increasingly important.

What are they telling us?

First, they make it clear that each discipline has a unique role in the observation, analysis and conceptualisation of global environmental change in its social and human dimensions.

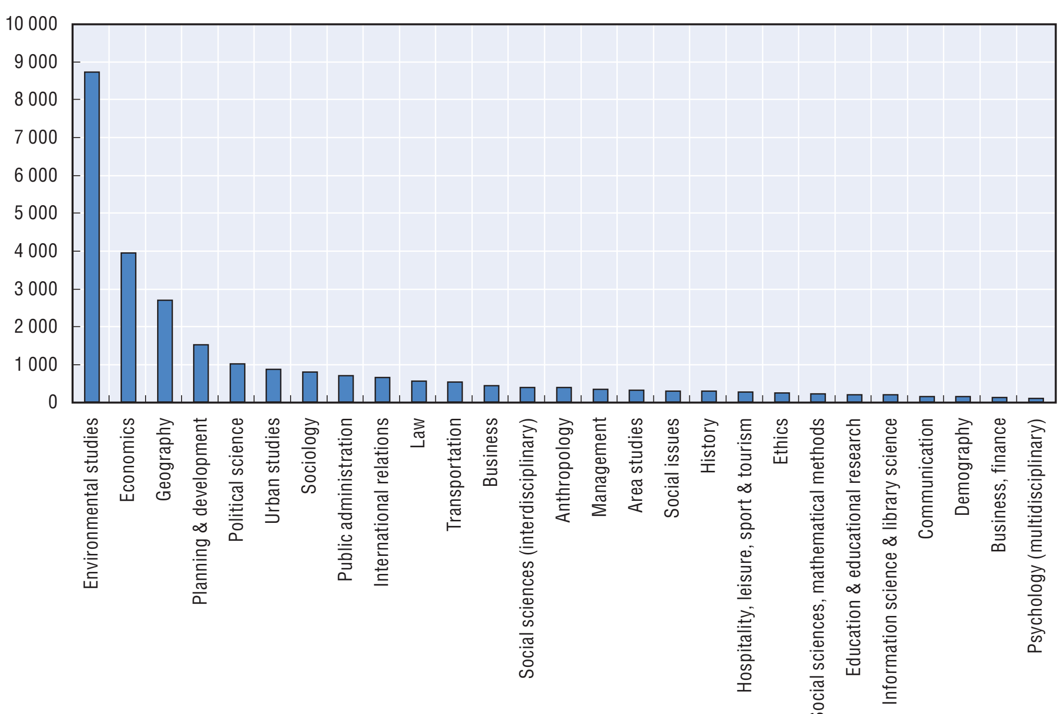
- **Sociology** (Lockie) permits the analysis of complex social and technological systems.
- **Psychology** (Pawlik and Steg) looks at the vital role of individual human perceptions and behaviours.
- **Anthropology** (Reuter) highlights the diversity of human knowledge systems, languages, beliefs, forms of social transformation, and livelihoods.

- **Economics** (Steer) studies the uses and exploitation of natural resources and tries to provide insights into alternative paths of development such as low-carbon growth without impeding economic growth.
- **Geography** (Meadows) is at the interface between the natural and social sciences, putting it in a unique position to study the relations between societies and their environment.
- **Political science** (Lachapelle) lets us analyse and conceptualise global phenomena.
- **Environmental humanities** (Braidotti, Bhavnani, Holm and Ping-chen) focus on the human dimensions, including cultural representations and interpretations, of environmental change.

Second, these contributions show that these disciplines have been discussing global environmental change for some time. Societal-environmental relationships are the basic "playground" for some (Reuter, Meadows). In others, the discipline has created new sub-specialties to address the issues raised by global environmental change, including environmental diplomacy, environmental psychology, environmental and ecological sociology, and environmental and ecological economics. These subjects have their own subgroups within their disciplinary organisations, and their own international meetings.

Notwithstanding these efforts, the bibliometric analyses of social science production in the Web of Science (WoS) (see Figure 89.1) reveal an interesting and somewhat different picture.

Figure 89.1. **Number of social science publications (fractional counting) on climate change and global environmental change by Web of Science fields of study, 1990 to 2011**



Source: Web of Science. Annex B, Table B2.
Note: See Annex B1, article by Waltman, for information on methodology used and definitions.

Figure 89.1 shows the number of publications on the topics of climate change and global environmental change produced by social scientists from different disciplines in the period 1990 to 2011. Some social science disciplines and fields of study – notably environmental studies, economics and geography – have fared better than others during this time. Others – including political science, sociology, anthropology and psychology – have lagged significantly behind. This can be partly explained by topical foci, partly by the methodological and epistemological affinity of disciplines like geography and economics to the natural sciences. A further possible explanation is the domination of natural science-based perspectives, frames and associated environmental research agendas that do not speak to the interests, motivations and skills of many mainstream social scientists.

Third, the contributors agree that more work is needed in this area, and that the disciplines should develop their interest in global environmental change and the analytical tools for researching it more effectively. Interdisciplinarity within the social sciences, and between them and the humanities and natural sciences, will be essential for solutions-oriented knowledge on the challenges of global environmental change and sustainability.

The International Human Dimensions Programme on Global Environmental Change

In 1990 – over two decades ago and just two years after the founding of the Intergovernmental Panel on Climate Change (IPCC) – the ISSC established the Human Dimensions Programme. It aimed to bring together international, multidisciplinary groups of researchers to study the human and social dimensions of environmental problems. In 1996, the Programme was re-established as the International Human Dimensions Programme on Global Environmental Change (IHDP),[1] in collaboration with the International Council for Science (ICSU) – the ISSC's counterpart in the natural sciences. The United Nations University (UNU) joined ICSU and the ISSC as a co-sponsor of the IHDP in 2006 (Mooney, Duraiappah and Larigauderie, 2013).

Since its inception, the IHDP has sought to complement and support research fostered in other international global environmental change programmes co-sponsored by ICSU and other international partners. These programmes include the World Climate Research Programme (WCRP)[2] launched in 1979, the International Geosphere-Biosphere Programme (IGBP)[3] launched in 1986, and DIVERSITAS,[4] the biodiversity programme established in 1991.

The IHDP's mission is to produce, promote and co-ordinate innovative social science research that informs and improves societal responses to global environmental change. Its three clusters of action are to advance international, interdisciplinary social science research, develop research capacities, and facilitate effective dialogue between science and policy. The programme has developed and promoted international projects on a range of pressing issues, including Earth systems governance, urbanisation, oceans and carbon. These projects have generated cutting-edge research, promoted international co-operation, including between the social and natural global change research communities, and built linkages between policymakers and researchers.

In 2014 the IHDP will merge into Future Earth,[5] a new ten-year sustainability research initiative established by the Science and Technology Alliance for Global Sustainability[6] (see Article 1, Introduction to this Report). Future Earth provides a new international framework for fostering integrated global change research that is co-designed and co-produced in partnership with the users of research. It will build on more than three decades of work by the existing international global change research programmes mentioned above. Future Earth seeks to provide the knowledge required for societies in the world to face the risks posed by global environmental change and to seize opportunities in a transition to sustainability. The full integration of the social sciences will be key to the success of this new initiative. This task will have to build on and accelerate the work that the IHDP has been undertaking.

Integrated Research on Disaster Risk programme

The Integrated Research on Disaster Risk (IRDR) programme[7] is an integrated, ten-year research programme, started in 2008 and co-sponsored by the ISSC, ICSU and the United Nations International Strategy for Disaster Reduction (UNISDR). It has adopted a global and multidisciplinary approach to dealing with the challenges of natural disasters, mitigating their impacts, and improving policy-making. The IRDR works by developing transdisciplinary, multisectoral alliances which promote research on reducing disaster risk, and on devising effective, evidence-based policies and practices for disaster risk. This requires the full integration of research expertise from the natural, socio-economic, health and engineering sciences as well as policy-making. It also requires an understanding of the role of communications, and of public and political responses which can reduce disaster risk.

Notes

1. *www.ihdp.unu.edu*.
2. The World Climate Research Programme (WCRP) *www.wcrp-climate.org/* is co-sponsored by the ICSU, *www.icsu.org/*, the World Meteorological Organization, *www.wmo.int/pages/index_en.html*, and the Intergovernmental Oceanographic Commission of UNESCO, *http://en.unesco.org/*.
3. The International Geosphere-Biosphere Programme *www.igbp.net/* is sponsored by the ICSU, *www.icsu.org/*.
4. DIVERSITAS, *www.diversitas-international.org/*, is co-sponsored by the ICSU, *www.icsu.org/*, the International Union of Biological Sciences, *www.iubs.org/*, the Scientific Committee on Problems of the Environment, *www.scopenvironment.org/*, and UNESCO, *http://en.unesco.org/*.
5. *www.futureearth.info*.
6. *www.stalliance.org*.
7. *www.irdrinternational.org*.

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90. Anthropology and environmental change from a holistic and cultural perspective

by
Thomas Reuter

Planet Earth has entered a new epoch, the Anthropocene, in which human influence dominates nature, even on global and geological scales. This reinforces the importance of anthropology. Anthropology studies the human species, from its co-evolution, genetics and biology, to our prehistory and early civilizations, and onwards to contemporary human cultures. It examines social settings from hunter-gatherer, pastoralist and subsistence agricultural communities to multinational corporations and global institutions. It is a vital part of efforts to limit the catastrophic effects of anthropogenic environmental change, as the World Council of Anthropological Associations (WCAA) and the International Union of Anthropological and Ethnological Sciences (IUAES) report.

Anthropology is making a difference. It brings a holistic, long-term perspective on the human story to the global debate on environmental change, and an acute awareness of the importance of local cultural knowledge as a resource for sustainable living, climate change mitigation and adaptation.

Holistic cultural understanding is a prerequisite for addressing the ecological challenges now shaking the foundations of our way of life (Crutzen and Stoermer, 2000). We need a critique of the cultural underpinnings of modern industrial society – which first emerged in Europe and is leaving unprecedented environmental destruction in its wake – if we are to stand a chance of stopping this suicidal process (Baer, 2008; Sayre, 2012). Anthropologists can do this best. They are trained to study and compare cosmologies and look at their own cultural cosmology from the outside, as one perspective among many, rather than seeing the modernist philosophy and way of life as an inescapable, natural state of affairs. The challenges and opportunities of today's world call for a new metacultural awareness, an evolutionary leap that will enable humanity to become conscious creators of its future and responsible stewards of planet Earth (Reuter, 2010).

Anthropology shows that one of the greatest assets of our species is the immense diversity of human knowledge systems, languages, beliefs, social formations and livelihoods. They are a testimony to our unique ability to learn and adapt to variable historical and environmental conditions. Humans have adapted, or fallen victim, to environmental change since prehistoric times (Potts, 2012; Sandweiss and Kelley, 2012). Global co-operation may be essential to reduce the present environmental crisis, but the key to change is still local action, in accordance with the specific circumstances of localised human-environment dynamics (Rayner and Malone, 1998). These circumstances have become the subject of numerous ethnographic observation studies.

More studies are also needed to address local differences in people's receptivity to climate change science (Rudiak-Gould, 2011). For example, the global need to curb methane emissions implicates cattle farmers in the United States and irrigated-rice farmers in Thailand, but they have different needs and require different capabilities for the task, and each has a unique pattern of change resistance to overcome. And while local effects and responses vary widely, there are also similarities that provide enormous scope for reciprocal knowledge transfers (Hornidge and Antweiler, 2012). This is why local adaptation and mitigation studies that use anthropology's holistic ethnographic methods are essential.

Anthropologists are keenly aware of climate justice issues affecting disadvantaged countries or regions. Examples of this include Agarwal and Narain's (1991) distinction between survival and luxury emissions, Nuttall's (2004) work on the plight of indigenous people in the Arctic, and Lazrus' (2012) work on island communities threatened by sea-level rises. Crate (2011: 186) notes that climate change is a human rights and human security issue, and alerts us to the need for a "continuous dialectical reflection between local and global discussions of climate change". Similarly, Warren (2006: 213) includes inequality, social justice, globalisation impacts and challenges in her list of issues for an engaged eco-anthropology.

Major anthropology organisations are trying to co-ordinate research at national and international levels. The American Anthropological Association established a section for "anthropology of the environment" in 1996. Its concerns have entered the mainstream, eroding the long-held misconception of a nature–culture dualism (Descola and Pálsson, 1996). The 2013 anthropology world congress in Manchester, United Kingdom,[1] featured a symposium and debate on climate disaster to establish an international scientific commission on environmental change and produce a manifesto for global change.

Notes

1. *www.iuaes2013.org/.*

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91. Psychological approaches and contributions to global environmental change

by
Kurt Pawlik and Linda Steg

Psychology offers valuable insights into human appreciation of climate change and ways of encouraging desirable environmental behaviour. Research includes understanding perceptions of global environmental change, motivation and strategies to encourage pro-environmental action, as the International Union of Psychological Science (IUPsyS) reports.

The 1960s saw a growing interest in environmental psychology, both conceptually and methodologically. The International Union of Psychological Science (IUPsyS) alerted the discipline to this new development (Pawlik, 1991). In 1986, it became an active partner in the founding and running of the International Social Science Council's (ISSC) first programme, Human Dimensions of Global Environmental Change (HDGEC[1]) (Jacobson and Price, 1990). Research focused on human behaviour as an important cause of global environmental change, and its consequences for human behaviour, were given high priority in the HDGEC Framework Plan.

Research on global environmental change and environmental behaviour has grown substantially in the past two decades. A growing body of psychological global environmental change research, on which public policy and educational initiatives can build, demonstrates this. Recent overviews of this work can be found in textbooks (e.g. Clayton, 2012; Steg, Van den Berg and De Groot, 2012), a special issue on “Psychology and global climate change” in the *American Psychologist* (Anderson, 2011), and a special issue on “Human behavior and environmental sustainability” in the *Journal of Social Issues* (Vlek and Steg, 2007).

National and regional research agencies followed suit and offered funding for research on the human dimensions of global environmental change and on ways to promote pro-environmental actions. Psychologists usually study these issues at the individual level: how people perceive and solve everyday ecological-social dilemmas, how they understand global environmental change mechanisms and its consequences, or how cognition and motivation interact when people learn about it and consider whether to act upon it (Stern, 1992). Three main research themes can be identified: the perception of global environmental change, factors predicting environmental actions, and the effects and acceptability of strategies that encourage pro-environmental actions.

Research has shown that most people are concerned about global environmental change, although they do not understand the causal mechanisms well. An ISSC-IUPsyS project, PAGEC (Perception and Assessment of Global Environmental Change), revealed substantial cross-regional differences in respondents' evaluation of the behavioural causes, consequences and risks of global environmental change (Pawlik, 1992).

Various factors have been identified that encourage or inhibit pro-environmental actions. Research shows that the seriousness of global environmental change can easily be underestimated, as many people do not experience its consequences personally. Take global warming: the annual increase in the average global surface temperature amounts to 0.1°C or less. This is about one hundredth of the normal night–day temperature variation in many places. Global environmental change thus seems imperceptible to the individual and must be mediated to be recognised. Also, transient variations hide the causes and consequences of global environmental change and are separated in time and place, inhibiting learning that links cause to effect.

In addition to perceptual factors, research shows that different motivational factors affect environmental behaviour. Considerations such as environmental values, environmental concern and personal norms promote pro-environmental actions, but play a less significant role when the relevant behaviour is costly. Cost–benefit considerations also play a role: pro-environmental actions become less likely when they are associated with high behavioural costs (for instance, in money, time or effort). When environmental behaviour becomes habitual, perceptual and motivational factors become less predictive of such behaviour.

Various interventions have been developed and tested to promote pro-environmental actions. The effects of informational strategies have been studied, showing that just offering information on global environmental change is not sufficient to develop environment-friendly behaviour, let alone maintain it (with respect to energy consumption, waste, traffic and so on). Such information has to be combined with a contingent reinforcement of behaviour in order to be effective. Among the most effective social and motivational strategies are the provision of tailored information, feedback provision, behavioural commitments, social norm information (providing information on the pro-environmental behaviour of others), modelling (showing the right example) and community approaches such as the use of block leaders. Research on the acceptability of global environmental change policies shows that it increases when people believe the relevant policy is effective in reducing environmental problems, and when it is believed to be fair.

Note

1. Today, this has become the International Human Dimensions Programme on Global Environmental Change co-sponsored by the International Social Science Council (ISSC), the International Council for Science (ICSU) and the United Nations University (UNU).

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92. The economics of climate and environmental change

by
Andrew Steer

Environmental economics studies the use of the Earth's natural resources, in particular those not valued in the marketplace and which therefore tend to be overused – such as clean air, water, ecosystems, oceans and the atmosphere. Economists try to provide insights into alternative paths of development such as low-carbon growth without imposing extra costs and impeding economic growth, as the International Economics Association (IEA) reports.

The dramatic increase in concern for the environment in the 1960s and 1970s led to an explosion of research on the valuation of environmental assets, and the costs and benefits of various policy and regulatory measures. While early legislation in the United States, such as the Clean Air Act (1970) and Clean Water Act (1972), explicitly prohibited cost–benefit analysis in the setting of standards, later regulation insisted on it. Academic economists have been closely engaged in policy debates in almost all countries, as governments have sought to address growing environmental damage at minimum economic and political cost.

Over the past four decades, economists have shed light on a range of critical questions, many of which remain alive in the literature today. Research in the 1980s and 1990s tried to refine techniques for measuring the value of environmental damage, including the difficult issue of the costs of the health impacts of pollution, the amenity values of nature (including techniques such as contingent valuation), and the ethically challenging issue of the value of a human life. At the same time, empirical studies showed the cost savings that could be gained by market-based solutions (such as road congestion pricing and sulphur dioxide emissions trading) (Stavins, 1998) as opposed to regulatory command-and-control approaches, and specified the institutional conditions required for the successful applications of different types of policy.

Other important research topics have included the link between environmental damage and the level of economic development. A large literature on "environmental Kuznets curves" has explored the hypothesis that environmental problems rise with economic growth at an early stage of development, but then begin to fall as governments and households can afford to address them (World Bank, 1992). Simple pollutants appear to support the hypothesis, while several more complex problems show no such tendency.

The acceleration of growth of the world economy has raised bigger issues for environmental economists, as it appears that the human economic footprint may now be overwhelming the Earth's carrying capacity. Technological change and supply responses outpaced the 20-fold increase in the demand for commodities in the 20th century, leading to a real decline in commodity prices. But in the past ten years, this position has been reversed as commodity prices have soared. A major conference volume (Heal, 2010) produced for the International Economics Association (IEA) in 2010 raises important and difficult questions regarding the meaning of sustainability. Economic theory (and common sense) suggest that depleting resources can be sustainable as long as the revenues from this depletion are invested in an alternative capital stock that will continue to yield benefits that are at least as large as those previously obtained. Efforts have been made to measure different forms of capital and their substitutability (Hamilton and Clemens, 1999; Arrow et al., 2010), but there is still a large unfinished agenda.

The rapid advance of climate change has raised four issues with a new intensity. First, what are the best policies for reducing greenhouse gas emissions? What price should carbon be? What are the relative merits of carbon taxes and cap-and-trade regimes? (Ellerman, Convery and De Perthuis, 2010; Goettle and Fawcett, 2009; Metcalf, 2009).

Second, given the scale and global nature of the market failure that causes climate change, what kind of global arrangement would satisfy the needs of equity, efficiency and political feasibility?

Third, because the costs of addressing climate change occur today, but the benefits of these actions will only be felt decades from now, the issue of how we should value these future gains (the "discount rate") has become very important, particularly following the 2006 Stern Report on *The Economics of Climate Change* (Stern, 2007). Related to this is the question of how relevant traditional cost–benefit analysis is in a situation in which there are immense downside risks with unknown probabilities.

Fourth, is "green growth" really possible? Is it feasible to put in place smart policies that will move the economy to a new low-carbon growth trajectory that will result in an overall increase in investment, jobs, trade and incomes, rather than imposing extra costs and hindering the economy?

These are crucial questions for people and for the planet – and the environmental economics community is trying to provide insights.

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93. The humanities and changing global environments

by
Rosi Braidotti, Kum Kum Bhavnani, Poul Holm and Hsiung Ping-chen

The environmental humanities make an important and original contribution to environmental issues by investigating the human dimension in global environmental change. Environmental humanities research questions what it means to be human in the age of the Anthropocene and helps develop a better understanding of human agency and human beings' relationship with their natural and built environments.

Over the past decade, a scientific consensus has emerged about the need for the interdisciplinary field of environmental humanities to address the complexity of societal relationships with the natural and built environments. This complex context requires a fluid understanding of the interaction between nature and culture, challenging the disciplinary separation between the human, social and natural sciences.

The environmental humanities question the basic concept and reference points in our shared understanding of the human condition, humans' place in planetary history, and our ability to self-destruct, as well as our motivation to construct sustainable futures. Methodologically, they raise the necessity for new transdisciplinary tools and interdisciplinary values to deal with the complexity of the issues involved. Socially, they ask what concrete actions can be taken to raise public awareness of the threats and challenges involved in adapting to global environmental change, and what institutions can best fulfil the task of introducing systemic change in the way in which citizens interact with social ecological systems and resources.

The specific and original contribution of the humanities consists of the following elements (Pálsson et al., 2013).

The human dimension

First is an increased understanding of the human dimension in sustainability issues. The humanities, notably philosophy, history, literature and media studies, have a long tradition of scholarly research on individual and collective identity, cultural landscapes and memory, cultural and art practices, gender and postcolonial issues, human values, moral and political philosophy, environmental ethics, and old and new media technologies.

The questions here are, what does it mean to be human in the Anthropocene (Crutzen and Stoermer, 2000)? How have humans impacted the biosphere in the past, and what adjustments do we need to make to the existing social, economic, political and cultural systems that regulate human behaviour in order to improve environmental resilience? What are the implications of environmental insights into the new human condition for different disciplines, in terms of theory, practice and approach? How can current research, funding and education systems drive the radical interdisciplinarity and transdisciplinarity required to address the challenges of global environmental change (Holm et al., 2012)?

Cultural representations

Second, the environmental humanities assume that modes of social belonging and participation are mediated by cultural representations and interpretations of them. Because cultural representations help develop social imagination, they are crucial for the awareness of sustainability issues and have the potential to affect the public's response to them. The humanities can help us enhance changes in individual and social behaviour that promote sustainability. They do so by developing a better understanding of the cultural factors that construct the social imaginary, and so shape public representations of sustainability. This is achieved through the history and analysis of language, literature (ecocriticism), cultural images and representations in the arts and media, documentaries, films, computer games and Internet applications.

The emerging questions here are, how do representation systems, ideologies and beliefs condition reactions to problems in the Anthropocene? What forms of cultural representation are best suited to address sustainability issues? How can we speed up the social change necessary to move towards sustainable, equitable societies, and how do we guarantee that such change will advance global justice? What will urge people to change "unsustainable" behaviour? What are the cultural, social and political incentives and disincentives for sustainable lifestyles? What ethical systems and values are best suited to intergenerational justice?

Interfaces with the sciences

Last but not least, the humanities can play their part in redefining the complex relationship between the two cultures of human and natural sciences at a time when the distinction between them has been challenged.

The emerging questions here are, what specific new forms of interaction are emerging between the humanities, the social sciences and the Earth sciences on this theme? How can a culture of mutual respect be developed across the disciplines in relation to environmental issues? What modes of knowledge constitute the specific contribution of the humanities to this discussion? What kinds of interdisciplinary alliances are possible and desirable within the humanities, and between the humanities and other disciplinary fields, in order for them to rise to the challenges of social and environmental sustainability?

These aims are central to the work of international humanities organisations, such as the Consortium of Humanities Centers and Institutes' Humanities for the Environment Initiative and the European Consortium of Humanities Institutes and Centres *Sustainable Humanities Project*. Other examples of international interdisciplinary research networks and forums in the field of the humanities and the environment are the Nordic Network for Environmental Studies and the European Association for the Study of Literature, Culture, and the Environment. All these organisations aim to provide an international forum for the promotion of research on and education in the environmental humanities.

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94. Sociology and global environmental change

by
Stewart Lockie

Sociologists are moving beyond concern with green issues with a distinctive social aspect, and are posing transdisciplinary questions about ecological, social and technological systems. But they need to challenge existing power relations more deeply, and should be more involved in debates and decisions on climate change, as the International Sociological Association (ISA) reports.

Sociology has traditionally focused on environmental issues that allow distinctly social explanations. For example, how do economic and political processes cause environmental degradation? Who has the authority to diagnose and develop responses to environmental problems? What are people's attitudes towards environmental protection and policies? How do these attitudes differ across social and political boundaries? And what conditions enable the emergence and influence of social movements focused on the environment?

While these questions are critical for our understanding of global environmental change, it is conceptually flawed and practically limiting to treat environmental attitudes, knowledge, politics and movements as exclusively social phenomena (Dunlap, 2010). Instead, environmental sociologists have tried to "ecologise" sociology in at least two broad ways. First, they have involved themselves in interdisciplinary and transdisciplinary fields such as sustainability science (Tàbara, 2013). Second, they have developed conceptual tools which retheorise the social as a domain in which technological systems and ecosystem processes enable and constrain human action, in much the same way that social structures, power relations and institutions enable and constrain it. For example:

- Multiple attempts have been made to theorise the ways in which environmental change drives macro-societal reorganisation (e.g. Beck, 2010; Mol, Spaargaren and Sonnenfeld, 2009; Urry, 2011).
- Concepts such as ecologically unequal exchange are being used to investigate the material connections between social inequality and exposure to environmental hazards (Jorgenson and Clark, 2011).

- More sophisticated theories of risk are being used to explore relationships between risk management institutions, scientific uncertainty, public risk perceptions and value conflicts (Renn and Klinke, 2012).
- Theories of social practice are being applied to understand the ways in which everyday routines and techno-social systems interact with sociological categories such as gender and class to shape consumption behaviours (Wilhite, 2013).
- Research on the social and institutional processes involved in the scientific modelling of environmental change is being turned around to ask how social scientific knowledge is itself drawn into "diagnosing, forecasting and planning" environmental futures (Yearley, 2009: 402).

Inevitably, gaps remain in the sociological enterprise as applied to global environmental change. The polarisation of climate debates – and in particular, the market-based approach to policy in the Kyoto Protocol – has discouraged it from dealing critically with climate policy (Grundmann and Stehr, 2010). Sociological insight is needed to understand the social and ecological consequences of dominant policy settings, and the implications these have for policy effectiveness. Similarly, sociological research into the underlying causes of vulnerability and resilience on various scales is needed if these concepts are to inform the development of climate adaptation strategies. The willingness of sociologists to consider global environmental change is not the issue. It is their willingness to question policy orthodoxies in public forums (Grundmann and Stehr, 2010; Lockie, 2013), along with a tendency within the wider discipline to see environmental change as a subdisciplinary concern for environmental sociologists rather than as an important dimension of current social transformation and inequality (Nagel, Dietz and Broadbent, 2010).

The International Sociological Association's Research Committee on Environment and Society[1] is the peak disciplinary group for environmental sociologists. National and regional associations[2] for environmental sociology cover Australia, Brazil, Canada, Europe, France, Germany, India, Japan, Republic of Korea, Spain and the United States. Sociologists also make major contributions to interdisciplinary groups such as the International Association for Society and Natural Resources.[3]

There is a widespread perception within the discipline that sociologists are under-represented in key climate research and policy networks and in institutions such as the Intergovernmental Panel on Climate Change (IPCC) (Nagel et al., 2010). Attempts to redress this by articulating the importance of distinctly sociological contributions more clearly include the British Sociological Association's Climate Change Study Group[4] and the American Sociological Association's Taskforce on Sociology and Global Climate Change.[5] This taskforce will present a major report on sociological contributions to climate research and policy in 2014.

Notes

1. *www.isa-sociology.org/rc24.htm*.
2. *www.esf.edu/es/sonnenfeld/envsoc_assoc.htm*.
3. *www.iasnr.org*.
4. *www.britsoc.co.uk/study-groups/climate-change.aspx*.
5. *www.asanet.org/about/taskforces/sociology_and_global_climate_change.cfm*.

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95. Geography and global environmental change

by
Michael Meadows

Geography explores how environments emerge through natural processes, how societies produce, organise, use and misuse such environments, and how society is influenced by the environments it occupies. It sits at the interface of the natural and social sciences, and is thus in a unique position to understand global change and its implications for humanity and the environment. Geographers can help bridge and even close the gap between the social and natural sciences to resolve the global environmental crisis, as the International Geographical Union (IGU) reports.

The International Geographical Union (IGU) has more than 40 commissions, with members drawn from across the continents.[1] Their objectives vary, but many are working on elements of the human–environment interface and some are engaged directly in research relating to global climate and environmental change, from scientific, socio-economic and cultural perspectives. A fundamental goal is to involve geographers from around the world in developing global reach by participating in commission events and activities.

The commissions are engaged in organising scientific meetings and publications on topics ranging from climatology, geoparks and cold regions in the realm of the physical environment, to socio-economic and cultural fields, including urbanisation, tourism, indigenous knowledge, political geography, population and vulnerability. Some activities and outputs relate very strongly to global environmental change. The Commission for Climatology, for instance, promotes research on many scientific and technical aspects of climate change, while the one on cold region environments focuses on environmental change, integrating knowledge from social and physical sciences in understanding long-term change and responses to it. Cold-climate regions face increased climate change impacts, the consequences of which are not purely physical. These issues require the integration of social, economic and environmental approaches.

Other IGU commissions have a strong social science perspective on environmental change. A key aim of the commission on hazards and risks is to highlight the role of geography in living with, responding to and mitigating so-called natural disasters. Small island states are, of course, especially vulnerable to the impacts of climate change. The commissions on islands and on marginalisation, globalisation, and regional and global responses explore the complex nature of marginality, given that marginality persists and is manifesting itself globally in new ways. Commissions also engage with major global research agendas, such as Future Earth; they are encouraged to form partnerships and affiliations with other IGU commissions to ensure that the interdisciplinary nature of research on global climate and environmental change is fully embraced.

UN International Year of Global Understanding

Global action requires a global level of understanding. The International Year of Global Understanding (IYGU) aims to bridge the gap in awareness between local actions and their global effects. This IGU initiative[2] in 2016 is specifically related to the need for interdisciplinary research on global environmental change. It aims to facilitate understanding of global processes, to encourage people to make daily decisions in light of global challenges, and to contribute to bottom-up initiatives that connect individual, local action to global sustainability. It should enable people to move from knowing about sustainability to living sustainably; it also intends to strengthen collaboration between the natural, social and cultural sciences.

Humans are responsible for creating worldwide challenges such as climate change; they can also bring solutions. If individuals are aware of what their daily activities mean for the planet, they can take appropriate action. The IYGU thus encourages a transdisciplinary perspective, starting with everyday actions rather than scientific disciplines, first learning how human action produces ecological problems and then seeking appropriate science-based solutions.

Notes

1. See *www.igu-online.org/site/?page_id=558*.
2. IYGU's global partners include the International Social Science Council, the International Council for Science, the International Council for Philosophy and Humanistic Studies, and the International Human Dimensions Programme on Global Environmental Change. See *www.global-understanding.de/* for further information.

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96. Political science, global environmental change and sustainable development

by
Guy Lachapelle

Political science is key to understanding national and organisational responses to climate change by states and other actors. Recent learning about globalisation has many applications for political scholarship in the context of global environmental change, as the International Political Science Association (IPSA) reports.

Only recently have political scientists started to inquire and reflect on environmental change, mostly by analysing the emergence of international environmental policy and the political impacts of climate change. Certainly these are important fields: the development of environmental diplomacy, for example, is a striking recent evolution that modifies traditional international alliances, the role of knowledge in multilateral negotiations, and even the training of civil servants and diplomatic corps.

International environmental policy and the political impacts of climate change are two crucial, lively and central research topics, but they are only two angles from which to approach a complex set of social-environmental issues and challenges that could attract much wider attention from political scientists worldwide. Many other issues remain marginal, and deserve to become part of the mainstream research and teaching agenda in political sciences.

The International Political Science Association (IPSA) is beginning to take steps in this direction. Its most recent congress in Madrid in 2012 included several panels on social-environmental issues. Four dealt with climate change in a comparative, global context; two touched on the theoretical aspects of climate change; one discussed the rescaling of environmental governance; and another tackled international environmental politics. The IPSA World Congress in Montreal in 2014 will focus on contemporary governance, and includes global change as a main topic. But despite this growing interest, none of IPSA's 52 international research committees deal primarily with global change. National associations are probably doing more than IPSA in this respect. International research groups are already active and are paving the way for future endeavours.

More can be done, and more will be done by international political sciences in the coming years. Despite limited attention thus far, the political sciences are in a strong position to address the many important issues raised by global environmental change. More specifically, the vast amount of research on globalisation carried out over the last few decades is highly relevant to this area and can be further developed.

Three questions need to be debated and considered. What methods of effective and applicable development strategies can nation-states shape today? What role can civil societies play in redefining world governance? How can changes at the global scale satisfy the needs and aspirations of human beings?

Let us begin with the state. The emergence of globalisation and the internationalisation of policy issues never meant the extinction of traditional governments. Recent decades have shown that the reorganisation and restructuring of state power, however protracted, demanding and conflicting it may have been, remains (Lachapelle, 2005; Lachapelle and Trent, 2000). In its 2004 report, *Fair Globalization: Creating Opportunities for All*, the World Commission on the Social Dimension of Globalization emphasised the need for a renewed role for the state (World Commission, 2004: 14).

If states continue to play an important role, it is nonetheless undeniable that they are no longer in a position to single-handedly direct economic and social regulation in this new context, which is characterised by global competition (Strange and Stopford, 1991). New alliances of actors are also emerging – a typical feature of globalisation – and research has linked it with the rapid development of new forms of partnership between governments, the private sector and civil society. This dynamic has been obvious during recent international summits on environmental issues, where nation-states remained central but the discussions included new political actors, involved new partnerships, and offered new multi-level governance opportunities.

In theoretical terms, some notions used to approach globalisation can be mobilised for research on global change. An analytical category such as subsidiarity is key to studying the territorial pacts and joint treaties between nations, multi-level and sub-state entities, and the ratification of transnational and cross-border co-operation agreements, typical of globalised politics. It could be just as valuable in analysing the new forms of partnership between governments, corporations, labour unions, local authorities, co-operatives and other stakeholder entities currently emerging to address the social and political impacts of environmental change.

A condition for political participation and decision-making processes in the globalised era is information, and methods for the steady dissemination of information on policies. A Global Environmental Policy Forum, composed of international organisations and set up to analyse the policy impact of national and international regulations, would be helpful in this regard. It could provide a new model for global governance of the social impacts of environmental change.

This last proposal raises the question of potential "solutions", and what political sciences can contribute to answering global change. Any solution would require the fulfilment of at least three conditions: the reassessment of established government practices, the strong participation of civil society in the evaluation of the impact of global change, and the greatest respect for each and everyone's cultural habitat.

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97. Earth System Governance

The Earth System Governance project is a project of the International Human Dimensions Programme on Global Environmental Change. It is a major social science research network whose members look beyond current government and political systems and towards the structures needed to manage human societies in the Anthropocene. Their many international activities work towards social justice as well as ecological sustainability.

Introduction

The Earth System Governance project, set up in 2009, has seen rapid growth in its members, affiliated institutions and activities. It is now one of the larger social science research networks in the area of governance and global environmental change. This international research programme explores political solutions and novel, more effective governance systems to cope with the current transitions in the planet's biogeochemical systems. The normative context of the research network is sustainable development: its members see Earth system governance not only as a question of governance effectiveness, but also as a challenge for political legitimacy and social justice.

Earth system governance is a relatively new paradigm. It conceptualises a system of formal and informal rules, rule-making mechanisms and actor networks at all levels of human society from the local to the global, to steer societies towards preventing, mitigating and adapting to global and local environmental change and Earth system transformation. It builds on earlier notions of environmental policy and nature conservation, but puts these into the broader context of human-induced transformations of the entire Earth system.

The concept of governance differs from government in that it brings together numerous forms of societal steering that are often non-hierarchical, decentralised, open to self-organisation, and inclusive of non-state actors. These actors range from industry and non-governmental organisations to scientists, indigenous communities, city governments and international organisations.

The Earth System Governance project builds on a conceptual framework, developed in its science plan, that is organised according to five analytical problems: the overall architecture of Earth system governance; its agency within and beyond the state; the adaptiveness of governance mechanisms; the accountability and legitimacy of governance mechanisms; and the modes of allocation and access in Earth system governance.

Research and key findings

The project has generated new research findings, including:

- Fragmentation of governance is often problematic but in many cases can be improved by well-designed management of the interplay of different institutions.
- Agency in Earth system governance: private institutions are unlikely to have a major impact on Earth system governance, even though a few individual partnerships have proven effective. This includes more than 300 multisectoral public-private partnerships agreed at the time of the 2002 Johannesburg Summit on Sustainable Development.

Activities

The Earth System Governance project's activities are characterised by an international, bottom-up, member-driven, networked structure, which has developed into a broader global research alliance. For example:

- The project was highly active in the scientific support for the 2012 UN Conference on Sustainable Development (Rio+20). It created a website which included an online discussion forum on how to improve the institutional framework of sustainable development. Before the conference, it drafted a comprehensive policy assessment which argued for an overhaul of the UN system and a "constitutional moment" in world politics. A short version was published ahead of the Rio+20 Conference in *Science*.
- The project has pioneered a number of network structures and activities that differentiate it from more traditional international research projects. The network now includes a number of Earth System Governance research centres, a group of select lead faculty, and more than 200 research fellows.
- The project has held numerous international conferences on Earth system governance.
- Smaller workshops, summer schools and training programmes are being organised in many places in Europe, Asia, Africa and North America.[1]

Chair: Frank Biermann
Executive officer: Ruben Zondervan
www.earthsystemgovernance.org

Note

1. *www.earthsystemgovernance.org*.

98. Global Water System Project

The Global Water System Project (GWSP) produces evidence on the scientific and human aspects of water use in an era of global environmental change. It looks at water governance, water conflict and water shortages, and aims towards sustainable and equitable water use.

Introduction

The Global Water System Project (GWSP) was launched in 2003 as a joint project of the Earth System Science Partnership and its four Global Environmental Change programmes: DIVERSITAS, the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), and the World Climate Research Programme (WCRP). Its central tenet is that human-induced changes to the global water system are now globally significant, and the system is being modified without adequate understanding of how it works.

GWSP's main research aim is to answer several fundamental research questions. How are humans changing the global water cycle, the associated biogeochemical cycles, and the biological components of the global water system? And what are the social feedbacks arising from these changes?

The project's research activities are organised around three core themes that attempt to answer the following core questions:

- What are the magnitudes of anthropogenic and environmental changes in the global water system, and what are the key mechanisms involved?
- What are the main linkages and feedbacks within the Earth system arising from changes in the global water system?
- How resilient and adaptable is the global water system to change, and what water management strategies are sustainable?

Activities and outcomes

GWSP activities include a focus on water governance issues such as:

- studies of water basins and the development of a global database on multi-level governance regimes
- the establishment of a framework for the analysis of global water governance, including global–regional interactions
- the establishment of a global professional network of water governance scholars

- a series of focused workshops and conferences
- stronger links with the UN system.

The project describes the water crisis as a governance crisis, and calls for critical evaluation and rethinking of water use: what for, how much, where and how?

Research findings derived from a comparison of water governance around the world indicate that the most essential features of good governance include:

- polycentric governance structures
- effective legal frameworks
- the reduction of inequality
- open access to information, and meaningful stakeholder participation.

On researching transboundary issues and water conflict, GWSP identified at least 300 international water agreements, often among parties that are otherwise at odds.

While finding sustainable solutions for water problems is a joint obligation for science and policy, the water crisis cannot be solved without societal engagement and political will. In the 2012 Rio+20 Policy Brief: *Water Security for a Planet Under Pressure* (Planet Under Pressure, 2012), GWSP says that more equitable access to water should be pursued through a sustainable approach to water management. Besides documenting the physical, biological and chemical aspects of the hydrological cycle:

> we also need to understand the social and political dynamics as well as the aspirations, beliefs and values that affect human behaviour relating to water use. Solutions for a sustainable "water world" will be founded on interdisciplinary science but will need the involvement of all stakeholders. This presents a considerable challenge but is the only viable way ahead.
>
> (Planet Under Pressure, 2012)

These ideas are echoed in the 2013 Bonn Declaration on Global Water Security (GWSP, 2013) issued during the GWSP conference on "Water in the Anthropocene", which calls for a strategic partnership of scientists (environmental and social), engineers, public stakeholders, decision-makers and the private sector. This partnership should draw up a blueprint based on a set of core recommendations to promote the adoption of science-based evidence in finding sustainable solutions to the water crisis.

Co-chairs: Claudia Pahl-Wostl, Charles Vörösmarty
Executive officer: Anik Bhaduri
www.gwsp.org

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99. Global Environmental Change and Human Security

Global Environmental Change and Human Security (GECHS) was a core project of the International Human Dimensions Programme on Global Environmental Change (IHDP). It examined the interaction between environmental and human security, linked to climate-induced migration, disease and poverty. It also examined how people and societies can address these problems and influence their future development.

Introduction

The Global Environmental Change and Human Security (GECHS) project ran from 1999 to 2010. Its research focused on the ways in which social processes associated with globalisation, poverty, disease, conflict and migration combine with global environmental change to affect human security, defined by GECHS as "a state that is achieved when and where individuals and communities have the options necessary to end, mitigate or adapt to threats to their human, environmental and social rights; have the capacity and freedom to exercise these options; and actively participate in pursuing these options" (IHDP, n.d.). The concept of human security brings together many of the systemic threats of the present, together with a strong recognition of human agency and capacity to influence the future.

Research and results

There is little doubt that global environmental change has dramatic implications for human security. These changes lead to uneven outcomes across groups and generations. The GECHS project focused on the ways in which relationships between global environmental change and human security are conceptualised, and how individuals and communities respond to multiple stressors. It emphasised the socio-economic and political context as central to understanding the causes and consequences of biophysical changes. The project contributed to a large body of empirical research, carried out throughout the world, on how human security is transformed by environmental change. It also developed strong links between research and policy and practitioner activities, in order to identify ways of enhancing human capabilities to respond to environmental change and create positive social change.

Key insights and achievements

Human security has become a key theme within global environmental change research. It has helped move discussions beyond biophysical and technical approaches to global environmental change. The concept considers the role that social, economic and political relations play in terms of both problems and solutions. For example, human security approaches to global environmental change emphasise how access, entitlement and power influence processes, responses and outcomes, including the potential for violent conflict.

Recognising that environmental problems are closely linked to human insecurity, GECHS research emphasised the importance of addressing root causes of environmental challenges. The research pointed out that environmental issues are also political, social, economic and development issues. Most contemporary strategies to address global environmental change consider problems within this wider social context.

Many practical actions and measures can be taken to reduce the risks associated with climate variability and change, or to protect species and genetic diversity. However, when taken to an extreme, these technical and managerial approaches may reinforce the values and interests that underlie environmental, social and development problems.

The way forward: Creating human security in a changing environment

The results of the GECHS project draw attention to the potential for developing individual and collective capacity to transform the structures that contribute to global environmental change and human insecurity. They also point to a need to engage with the deeper human dimensions of global environmental change. This includes improved understanding of how values and worldviews influence perceptions of and responses to multiple threats. This may involve overcoming entrenched attitudes to human–environment relationships, reconsidering the boundaries between “us” and ”the other”, and redefining the relationships between personal and collective responsibility. The GECHS project shows that the social and human dimensions of global environmental change can no longer be ignored.

Chair: Karen O’Brien
Executive officer: Linda Sygna
http://www.ihdp.unu.edu/article/read/gechs-science-plan

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100. Integrated History and Future of People on Earth

Integrated History and Future of People on Earth (IHOPE) is a joint project of the International Human Dimensions Programme on Global Environmental Change (IHDP). It links the human and environmental histories of the Earth – too often kept separate – into an integrated whole. This will help improve understanding of the past and produce new tools to cope with present and future change.

Introduction

The Integrated History and Future of People on Earth (IHOPE) project supports the integration of knowledge and resources from the biophysical and social sciences and the humanities, to address issues associated with the coupled dynamics of the human–Earth system. The integration of human history and Earth system history is a timely and important task; IHOPE creates frameworks that can be used to help achieve this integration. The goal is to produce a rich understanding of the relationships between environmental processes and human activities, focusing on the past several millennia. IHOPE recognises that a major challenge to reaching this goal is to assemble a flexible toolbox of methods and concepts that can be broadly accepted. The specific objectives for IHOPE are to identify slow and rapidly moving features of complex social-ecological systems, on local to continental scales, which induce resilience, stress, or collapse in linked systems of humans in nature.

Human history and Earth system history

Human history has traditionally been cast in terms of the rise and fall of great civilisations, wars and specific human achievements. This history omits the important ecological and climate contexts that shaped and mediated these events. Human history and Earth system history have traditionally been developed independently, with little interaction between their respective academic communities. Separate ways of describing these histories were developed, and few attempts were made to integrate these histories with information from other fields of study.

The recent recognition that current changes to the Earth system are strongly associated with change in the coupled system of humans and the environment makes the integration of these two histories an important step in understanding the factors leading to global change, and in developing coping and adaptation strategies for the future.

The Earth system and human societies are the most complex systems we know. Complex systems are densely connected networks with several features that distinguish them from simpler systems. They have both linear (predictable) and non-linear (unpredictable) characteristics. Much of what we know about these complex adaptive systems cannot be based on extrapolation from present conditions. Nevertheless, such systems not only characterise human societies and their environments, they are also remarkably historical, by which we mean that the initial conditions of the system are a strong predictor of later states. Past decisions shape and constrain subsequent ones; this is called path-dependency, and can impede the search for solutions to problems. A complex systems approach, which allows system behaviour to be studied over time, is a useful way to extract information from the past and apply it to the future.

Key findings

Combining archaeology, history, anthropology, engineering, geology, ecology, cartography, architecture, linguistics and more, the IHOPE-Maya research group has been able to trace the 1 500-year history of water allocation and land use at the ancient Maya city of Tikal in Guatemala. It unearthed and studied the largest dam in the Maya area, which revealed how water was successfully supplied to and managed in the urban complex despite the region's frequent droughts.

IHOPE has identified low-technology adaptations (at least by current standards) that were nonetheless remarkable for their resilience and sustainability over deep time. These simple systems are consistent with today's conservation efforts. They can prove useful in situations where energy sources are limited and state-of-the-art technologies are expensive, and they may have a greater environmental impact.

Such research can offer more sustainable solutions to today's growing cities in similar environmental circumstances.

Co-chairs: Robert Costanza, Sander van der Leeuw
Executive officer: Carole L. Crumley
www.ihopenet.org

101. Industrial Transformation

The Industrial Transformation (IT) project aims to develop industrial activity without malign environmental effects. It sees industry in its social and technological setting. It is especially active in Asia, where rapid economic growth offers the potential for green choices about industrial development.

The Industrial Transformation (IT) project was initiated in 1999, with a mandate to stimulate and organise research on alternative development trajectories that could decouple economic development from environmental degradation. The project, now completed, was the first worldwide institutionalised initiative concerned with systems innovations towards sustainability. Over the past decade, the theme of transformation to sustainability has become an important element of research and policy debates in industrialised and newly industrialising economies. The IT project played a particular role in connecting these debates.

The IT project brought together international scientists who wanted to understand major systemic change and its drivers. They used case studies and scientific research and analysis to contribute a number of insights and messages.

First phase activity insights

The first phase of the project, which lasted five years, focused on concepts and case studies related to transforming unsustainable systems. One of its first and most fundamental insights about sustainability transformation was the realisation that change involves more than technology alone. Rather, technical changes need to be seen in their institutional and social contexts: the socio-technical system. For instance, the automobile "system" is much more than the car alone. It includes production and waste management systems, road and fuelling infrastructures, laws and regulatory systems for roads, insurance and finance systems, driver skills and many symbolic and cultural meanings. These socio-technical systems are usually resistant to change. They are highly ordered, stable and locked-in,[1] and therefore resistant to change. Under certain conditions and over time, however, relationships within socio-technical systems can become reconfigured and replaced, in a process that may be called system innovation.

Second phase activities and insights

The second phase of the IT project focused on areas of Asia that are urbanising and industrialising quickly and in a way that differs qualitatively from the industrial and economic changes in the Organisation for Economic Co-operation and Development (OECD) countries. The project connected sustainability transition debates with current understandings of the economic development processes in these areas. A significant insight was that Asian countries that are only now industrialising have the option of following alternative, sustainable pathways that use local resources and capabilities in the context of global networks. A second important insight was that there are a great number of so-called sustainability experiments in instigating change in the region and in transforming current systems of provision.

Ultimately, the IT project concluded that: technology will not save the world; developing countries do not have to follow conventional development trajectories; and globalised markets, knowledge flows and governance will be critical in stimulating carbon-neutral and more sustainable trajectories.

Chair: Frans Berkhout
Executive officer: Anna J. Wieczorek
www.transitionsnetwork.org/
www.journals.elsevier.com/environmental-innovation-and-societal-transitions/
www.transitiepraktijk.nl/en

Note

1. Technology lock-in is a form of economic and institutional path-dependency whereby a technological standard is selected and a system built around it. Because of network effects, the market gets locked in, or stuck with that standard, even though participants may be better off with an alternative.

102. Urbanization and Global Environmental Change

The Urbanization and Global Environmental Change project is internationally known for identifying, coordinating and synthesising important research related to the interactions and feedbacks between urbanization and global environmental change at local and regional levels.

Established in 2005, Urbanization and Global Environmental Change (UGEC) is a core project of the International Human Dimensions Programme on Global Environmental Change. Since more than half of the world's population lives in cities, scientists and non-scientists are increasingly recognising that urbanisation and urban areas are affected by, and contribute to, global environmental change problems, and present opportunities for sustainable solutions.

UGEC seeks to improve understanding of the regional and global implications of urbanisation and the complex dynamic systems of urban areas that affect, and are affected by, global environmental change. UGEC is a leader in creating new conceptual and methodological approaches to achieve a better understanding of these bidirectional interactions. The project fosters dialogue and collaboration on major research and societal needs on how cities can be (re)built in ways that best respond to the constraints and opportunities of global environmental change processes. It provides international workshops and training events that bring together stakeholders from national, regional and local governments, universities, research centres, international organisations, and development banks and agencies. Findings from recent UGEC publications that have implications for urban sustainability are detailed below. For more detailed information see *www.ugec.org*.

Urbanisation trends

Urban areas have been expanding at least as fast as urban populations have been growing for the past three decades. This suggests that urban areas are spreading out rather than becoming more compact.

Urbanisation and biodiversity

Future urban expansion will affect global biodiversity hotspots and carbon pools. Policy changes will be needed that affect growth trajectories to minimise the loss of global biodiversity, vegetation biomass and carbon storage.

Cities as systems

Urban areas can only be understood if they are analysed as dynamic and complex systems, which, in addition to the built and physical environment, include institutions, governance and social processes.

Urban ecology, environmental justice and global environmental change

New insights into pathways to urban sustainability can be gained by combining the global environmental change research framework, which aims to link local, global, human and natural processes, with scientific work on urban ecology and environmental justice.

Coastal cities

Coastal cities face challenges that require unique adaptation strategies. High concentrations of people and the varied and complex infrastructure on which they depend make low-lying coastal zones vulnerable. Comprehensive approaches, such as the methods and tools designed for New York City, can be adapted and applied to many urban coastal areas.

Global environmental change and human security in the urban context

Important urban challenges here relate to overall ecological footprints, maintaining institutional and infrastructural integrity, and safeguarding shelter, utilities, economic activities and livelihoods. Action is needed to meet increasing awareness of the links between global environmental change and human security in cities. Research is needed to support this priority.

Urban adaptation responses to climate change

Many current and future urban inhabitants of low, middle and high-income countries will benefit from well-tailored adaptation strategies. Top-down combined with bottom-up approaches need to consider formal and informal urban growth processes. This type of integrated framework will help create efficient and flexible adaptation processes in the short and longer term, to which local officials, stakeholders and inhabitants can relate.

The wider UGEC network now consists of more than 1 000 scientists and practitioners working at the urban-environmental interface. UGEC will continue to build on its portfolio of activities which includes fostering international and regional collaborations by participating in conferences and workshops, training and capacity building programmes for young and emerging scholars in the field of UGEC.

Co-chairs: Roberto Sánchez Rodríguez and Karen C. Seto
Executive officer: Corrie Griffith
www.ugec.org

103. Land–Ocean Interactions in the Coastal Zone

The Earth's coastal zones contribute significantly to our life support systems. Yet they are changing rapidly, in particular as a result of human activity. Land–Ocean Interactions in the Coastal Zone (LOICZ), a core project of the International Human Dimensions Programme on Global Environmental Change (IHDP), aims to understand regional and global changes affecting coastal systems, to guide management and decision-making and achieve a more sustainable future.

Introduction

Coastal zones have been "society's edge" – the cradle of social, cultural and economic development – for centuries. Globally, they are a major source of environmental goods and services. Human intervention, including climate change, has resulted in coastal zones being affected by global change processes such as erosion, subsidence, the salinisation of aquifers, eutrophication,[1] invasive species and the over-exploitation of natural resources. Few coastal zones are left unaffected. In addition, accelerated coastal urbanisation and the transformation of shelf seas and the sea floor, through oil and gas extraction, shipping, power cables and renewable energy, contribute to the coastal squeeze.

Activities and results

Land–Ocean Interactions in the Coastal Zone (LOICZ) focuses on informing societal responses to these problems by designing governance frameworks to address coastal vulnerability. This includes developing scientifically credible and harmonised means of gauging success or failure when responding to environmental change. LOICZ has also integrated the human dimensions of research into its global assessments, science innovations and syntheses since the early 2000s.

LOICZ works at conceptual and case study levels. It brings fundamental process studies together with theories and concepts regarding coastal zone management and sustainability. The role that institutions and individual actors play in improving the governance of coastal systems and adaptive capacity is also important.

Underpinning the work of LOICZ is the social–ecological system perspective, which examines how humans interact with nature and the ensuing feedbacks. The interplay of drivers, pressures, states, impacts and human welfare from source to sea determines the range of coastal scales that LOICZ works with. Since drivers that affect coastal systems may be far upstream, or include shelf processes, these scales are flexible over space and time.

Social science research themes of projects affiliated to LOICZ include:

- The influence of lifestyles and futures scenarios on environmental quality and on water-related goods and services in European seas.
- The development of Arctic social indicators to examine influences on the future of circumpolar societies.
- Understanding governance and resource use and how to facilitate a long-term transition to coastal sustainability.
- Valuing coastal ecosystem goods and services. This raises questions of equity versus environmental efficiency and the value attached to nature by society.
- The need for a paradigm shift towards an "ecological economics" of oceans and coasts. This includes sustainability as a normative goal, approaching the socio-economic system as a subsystem of the global ecological system, the use of a complex systems approach, and relying on transdisciplinary and methodological pluralism.

Chair: Ramachandran Ramesh
Vice-chair: Bruce Glavovic
Chief executive officer: Hartwig Kremer
www.loicz.org/projects/index.html.en

Note

1. A high concentration of nutrients, such as phosphates and nitrates, in water, which may lead to an excessive growth of algae, and eventually high levels of organic matter, which in turn can deplete available oxygen in the water and at the sea bottom.

104. Global Carbon Project

The Global Carbon Project (GCP) is a joint project of the International Human Dimensions Programme on Global Environmental Change (IHDP), the International Geosphere-Biosphere Programme (IGBP), DIVERSITAS and the World Climate Research Programme (WCRP). It aims to model carbon flows on all scales in the Earth system and to help guide policy and behaviour to reduce and stabilise greenhouse gas emissions.

Introduction

The Global Carbon Project (GCP) was established in 2001 in recognition of the major scientific challenges of the carbon cycle, and its critical role in the Earth's sustainability. Its scientific goal is to develop a complete picture of the global carbon cycle, including its biophysical and human dimensions, together with the interactions and feedbacks between them. GCP was formed to establish a framework for internationally co-ordinated research that advances fundamental understanding of how greenhouse gases in the atmosphere might be stabilised, and supports policy development towards this aim. It integrates the atmospheric, oceanic, terrestrial and human components of the carbon–climate–human system.

GCP focuses on the following research areas:

- patterns and variability, in order to find the current distribution of major pools and fluxes in the global carbon cycle
- processes and interactions, in order to unveil anthropogenic and non-anthropogenic control and feedback mechanisms that determine the dynamics of the carbon cycle
- carbon management, in order to understand the dynamics of the carbon–climate–human system in the future, the points of intervention, and the windows of opportunity for human societies to manage the system.

Activities and findings

GCP produces "The Carbon Budget", an annual update on the global carbon budget and trends, which attracts wide attention from scientific and policy communities.

The Regional Carbon Cycle Assessment and Processes initiative, a large global co-ordination effort, is intended to establish the mean carbon balance of regions of the globe. Bottom-up estimates are compared with the results of top-down atmospheric inversions to evaluate the regional hotspots of interannual variability.

Urban and Regional Carbon Management is a place-based and policy-relevant scientific initiative aimed at supporting carbon management and sustainable urban development.

As part of the first ten-year project activity review, a collection of high-level synthesis GCP papers was published in the *Journal of Current Opinion in Environmental Sustainability* in 2010. Research findings[1] include:

- There is a need for more knowledge of the societal and individual decisions which lead to greenhouse gas emissions and land use change, and of the responses of the carbon cycle.
- There is a need to focus on the drivers of fossil fuel emissions and land use emissions at the point of production, but also to consider consumption and lifestyles as key emissions drivers.
- There is a need to assess development models that allow countries to reach a high level of life satisfaction without replicating the high per capita emissions of developed countries.
- The coupling of carbon cycle and climate models with socio-economic models allows for a move towards whole-system assessment of vulnerabilities, in which human and biophysical components act as interactive drivers of change.
- Research on and the development of governance are critical for successful policy outcomes to address climate change, food security and energy.
- Important research is being done on the urban world to understand and quantify how changes to the existing urban infrastructure, lifestyles and governance institutions can drive reduced emissions. Changes in urban dwellers' behaviour – for example, their choice of transport, the "walkability" of urban spaces, and the use of household and community gardens for food and aesthetics – will be of increasing importance.

Co-chairs: Philippe Ciais, Corinne Le Quéré
Executive directors: Josep Canadell, Ayyoob Sharifi
www.globalcarbonproject.org

Note

1. These findings are drawn from Canadell et al. (2010).

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105. Global Environmental Change and Food Systems

The Global Environmental Change and Food Systems (GECAFS) project, part of the International Human Dimensions Programme on Global Environmental Change (IHDP), was a pioneer on global food challenges in the context of environmental change. It worked with a wide range of stakeholders at global and regional levels, to examine how changing food systems will affect future food security.

Introduction

The Global Environmental Change and Food Systems (GECAFS) project was a ten-year international research project launched in 2001 to "determine strategies to cope with the impacts of global environmental change on food systems and to assess the environmental and socioeconomic consequences of adaptive responses aimed at improving food security".

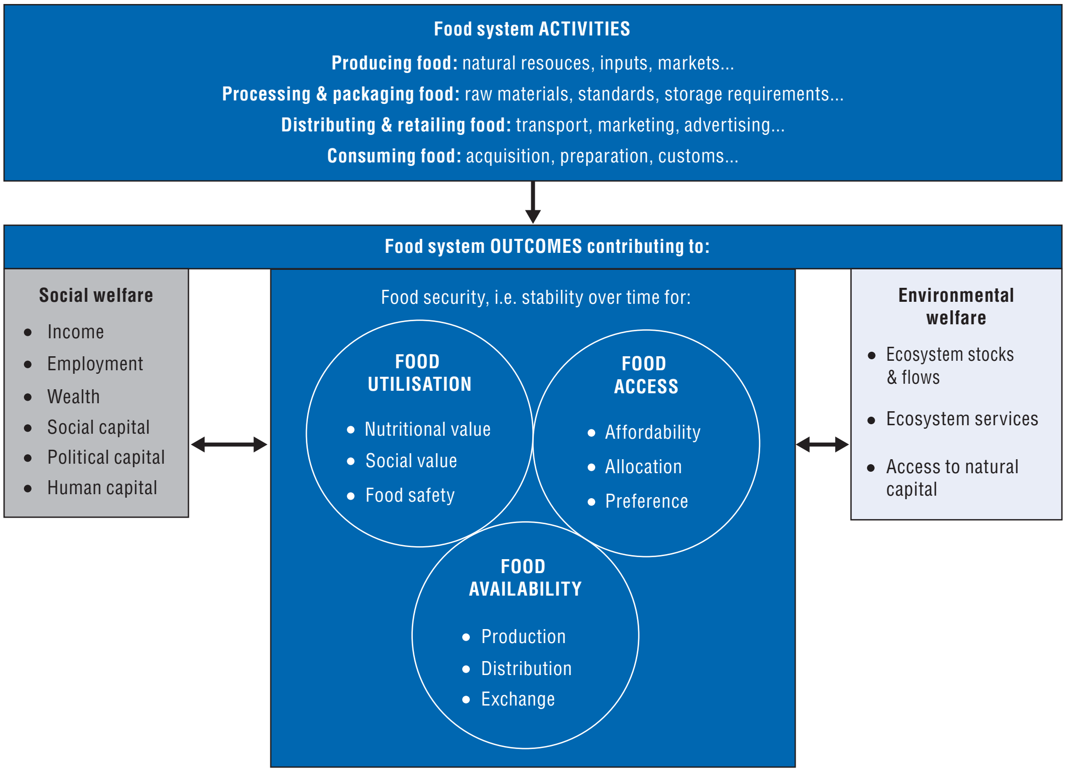
Adopting the Food and Agriculture Organization of the United Nations' definition of food security, that people "at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996), GECAFS set out to:

- Consider the whole food system in the context of environmental change, and not just food production. This includes all the factors that allow or impede access to food. It relates not only to what people produce themselves but also to the disposable income and other assets which people have to trade for food in relation to its cost: in other words, the affordability of food.
- Build on a range of social and natural science topics, given that the food system is driven by social, economic, political and biophysical forces.
- Recognise the interactions between food systems and global environmental change, including how climate change affects food systems, and how food systems affect the environment, for example through land use or greenhouse gas emissions.

Main achievements

GECAFS developed a concept of food systems specifically designed for global environmental change research. This built on the substantial literatures on the food chain and on food security (see Figure 105.1).

Figure 105.1. **Food system activities and their outcomes**



Note: The nine elements (bullet points) are derived from the FAO World Food Summit definition and all nine need to be satisfactory and stable if food security is to be met.
Source: J. S. I. Ingram (2011), "A food systems approach to researching interactions between food security and global environmental change", *Food Security*, Vol. 3, pp. 417-431 (based on P. J. Ericksen [2008], "Conceptualizing food systems for global environmental change research", *Global Environmental Change*, Vol. 18, pp. 234-245).

GECAFS recognised the need to address the many viewpoints and objectives of different stakeholders in the food system. These were identified through various methods, including participatory scenario development, interviews, questionnaires and the use of "boundary organisations".

A further innovation was to target the regional level (multinational or subcontinental), a spatial resolution not commonly found in social sciences research on global change. The regions included the Caribbean, southern Africa, the Indo-Gangetic Plain and Europe, and their associated regional and national food institutions. This promoted interaction with relevant policy bodies, and required close contact with local and global-level interests. A better understanding of the institutional interplay between such bodies at a range of levels is crucial for a better understanding of food system "successes" and "failures".

Chair: Diana Liverman
Vice-chair: Anne-Marie Izac
Executive officer: John Ingram
www.gecafs.org/publications/index.html

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106. Global Environmental Change and Human Health

Global environmental change poses hazards to human health, as does major social change, such as the current rapid rate of urbanisation around the world. The Global Environmental Change and Human Health (GECHH) project, part of the International Human Dimensions Programme on Global Environmental Change (IHDP), examines these issues and develops mitigation strategies to maintain human health under conditions of environmental stress.

Introduction

It is widely understood, often intuitively, that human societies, and the well-being and health of their populations, depend on a flow of materials, services and cultural enrichment from the natural world. The Global Environmental Change and Human Health (GECHH) project aims to study the relationships between global environmental change and human health. GECHH primary goals are to:

- identify, characterise and quantify health risks due to global environmental change
- describe the spatial and temporal differences in health risks to better understand the vulnerabilities and priorities for intervention
- develop adaptation strategies to reduce health risks, assess these strategies' cost-effectiveness, and communicate the results to decision-makers and the broader community
- foster training programmes to boost networked international research capacity.

The researchers who participate in GECHH have worked towards these goals through a series of symposia, publications and training workshops for young scientists.

Activities and results

At its first symposium in 2010, and in partnership with the United Nations University (UNU) Institute for Water, Environment and Health, researchers from the social, natural and health sciences, legal scholars, physicians and policymakers from around the world focused on the links between water and health. Highlights included:

- identifying the need for a new international scientific monitoring and research platform to lead efforts and to disseminate best practices to improve water quality and human health at the global level

- identifying changes in the spread of malaria in Colombia linked to climate change, and how they are being managed
- analysing at the community level the challenges of supplying clean water in developing countries' rural regions.

"Healthy Forest for Life" was the theme of a follow-up symposium in 2011. Three key findings followed:

- the importance of how forests foster human health directly (for example, by providing food, shelter, energy and medicinal compounds) and indirectly by providing ecosystem goods and services (for example, regulating water regimes, acting as a natural pest control, filtering air, providing psychological rehabilitation and recreation and acting as a buffer against extreme events)
- the challenges of valuing the health benefits of forests
- how research on global environmental change and health can contribute to multisector international dialogue.

Since 2009, GECHH has been an active partner of the Chinese Academy of Sciences Institute for Geographic Sciences and Natural Resources in symposia and student training workshops. These meetings bring together young scientists from across the natural and social sciences to examine issues regarding health and the environment in megacities, focusing specifically on the Beijing-Tianjin megacity. Between 2009 and 2012, 109 research students, mainly from Chinese Academy of Science institutes, and 42 international research students from 17 countries participated in these workshops.

In partnership with the UNU Institute for Water, Environment and Health, GECHH organised a symposium and training workshop for young scientists on extreme events, urbanisation and health in the Asia-Pacific region.

In 2012, members of GECHH participated in key meetings such as the One Health Conference organised by the Global Risk Forum in Davos and the Planet Under Pressure conference in London, for which GECHH members produced *Global Health for a Planet Under Pressure, Rio+20 Policy Brief* (Planet Under Pressure, 2012).

Co-chairs: Ulisses Confalonieri, Mark Rosenberg
www.gechh.unu.edu

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107. Global Land Project

The Global Land Project (GLP) is a joint project of the International Human Dimensions Programme on Global Environmental Change (IHDP). It looks at human and ecological aspects of land use, including current and future land use change.

Introduction

The Global Land Project (GLP) is a joint ten-year project of the International Human Dimensions Programme on Global Environmental Change (IHDP) and the International Geosphere-Biosphere Programme. Derived from the previous Land Use/Cover Change project, GLP started its activities in 2005, with publication of the GLP science plan (GLP, 2005).

The focus of GLP is largely "land-centric" and includes people, biota[1] and natural resources. It aims to understand complex feedbacks between the societal and environmental components of the land system, and to improve understanding of local and regional processes in order to achieve global knowledge of land change.

GLP has a long tradition of local-based land studies, including social and demographic aspects of land use configurations, land management and planning, and design. These provide a basis for strong future links between research and practice.

Research and results

Since 2005, the GLP community has made considerable progress in understanding land use change. It focuses on empirical land use studies and modelling, and on managing land resources to support the transition towards sustainable development. The community now understands some of the interdisciplinary issues affecting land science. These issues include the behaviour of people and society, the multi-level character of decision-makers and land units, the ways in which people and land units are connected to the broader world within which they exist, and relevant aspects of the past, present and future.

GLP has produced dynamic and innovative research in areas such as global tele-coupling effects and the drivers of indirect land use change, policy issues regarding large-scale land acquisitions (land grabbing[2]), competing claims on land for food production, and alternative strategies to manage land resources in the discussion of land sparing versus land sharing.

Interactions between people and their environment have been at the core of GLP research. Its recent results have led to opportunities to bridge the gap between natural and social science. They have also improved understanding of the contribution of social practices to global climate change. The research includes understanding of changes in land use practice, in land cover (for instance, deforestation and afforestation), and in climate and carbon dioxide fluxes between the land surface and the atmosphere.

From a social science perspective, GLP has added to the understanding of:

- contemporary urban and rural transformations
- post-industrial revitalisation
- increasing mobility and migration
- demographic and lifestyle changes related to changes in agriculture, food, fibre and biomass production and consumption
- food quality and security
- functioning of ecosystems.

It also examines the cultural aspects of landscape patterns and their effect on decision-making processes, institutions and governance structures for land management.

Key findings

- A basic understanding of the historical processes and transitions underlying present and possible future land change, in many nations and regions.
- Tried, tested and updated methodologies such as the use of meta-analyses in land change research, and the incorporation of human behaviour and decision-making processes into land use and climate system models.

Chair: Peter Verburg
Executive officer: Giovana Espindola
www.globallandproject.org
www.glp-osm2014.org

Notes

1. The collective animal and plant life of a particular geographical region or period.
2. *http://landportal.info/landmatrix*.

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108. Integrated Research on Disaster Risk programme

The Integrated Research on Disaster Risk (IRDR) programme uses a range of scientific, technological, health and policy approaches to cope with hazards and disasters. It aims to improve and standardise disaster research, to devise approaches that prevent hazards turning into disasters.

Introduction

The Integrated Research on Disaster Risk (IRDR) programme is a decade-long international and interdisciplinary research programme created to address the major challenges of natural and human-induced environmental hazards. The complexity of these challenges requires the full integration of research expertise from the natural, socio-economic, health and engineering sciences as well as from policy-making. The IRDR mission is to develop transdisciplinary, multisectoral alliances for in-depth, practical disaster risk reduction research studies, and to implement effective, evidence-based disaster risk policies and practices. This is being accomplished through working groups and partner activities. Two examples of such working groups are Risk Interpretation and Action (RIA) and Forensic Investigations of Disasters (FORIN).

Risk Interpretation and Action

RIA focuses on how people – decision-makers and ordinary citizens – take decisions in the face of risk. Several broad fields of work have progressed in this area, somewhat independently of each other. This has led to a number of discontinuities in how the issue of risk reduction is conceptualised, and to gaps in the areas where research activity and funding are concentrated. The result is a number of questions which IRDR is attempting to answer in an integrative way:

- How much emphasis should be placed on risk forecasting versus communication?
- Why and when do local citizens' evaluations of risk diverge from scientific forecasts?
- How do people's decisions diverge from their evaluations of such risks?

To find answers, the RIA project group is working to advance interdisciplinary research on how decision-making relates to hazards, and to encourage various organisations to support this area of research.

Key accomplishments

- Publishing a framework for responses to natural hazards (IRDR, 2012). The framework presents the need for a better understanding of human decision-making in the face of risk, a priority for disaster risk reduction. It offers a critical overview of research and theory on the relationships between how people interpret risks and the decisions they make as a consequence of such interpretations.
- Identifying activities to develop the network of researchers engaged in RIA-related projects, and searching for relevant funding opportunities.

Forensic Investigations of Disasters

The IRDR's FORIN project aims to develop, disseminate and implement a radical new approach in disaster research that seeks to identify and explain the underlying causes of disasters, including the growth in magnitude and frequency of very large disaster events. Thoroughly analysing cases, including both success stories and failures, will help build an understanding of how natural hazards do, or do not, become disasters.

Key accomplishments

- Developing a standardised but flexible framework to guide investigations across regions to study natural hazards and uncover the root causes of disasters. The investigations are designed to go beyond reports and case studies conducted after disasters. Thorough analysis of both success and failure stories will help build an understanding of how natural hazards do, or do not, become disasters.
- Leading the 2012 FORIN Advanced Institute, hosted by the IRDR Centre of Excellence in Taipei.
- Advanced seminar on forensic investigations of disasters at the International Union of Geodesy and Geophysics GeoRisk Commission Conference, Extreme Natural Hazards and their Impacts. This included a plenary discussion on the future work of FORIN and 11 papers on FORIN studies. This was an opportunity for reports and commentary on current and proposed FORIN research. Consideration was also given to the future development of FORIN research and collaboration.

Chair: David Johnston
Vice-chairs: Sálvano Briceño, Susan Cutter, Kuniyoshi Takeuchi
Executive director: Jane E. Rovins
www.irdrinternational.org

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Wounded Elephant, 2008 by Andries Botha
© Photographer, Jimmy James

Annexes

Annexes

World Social Science Report 2013
Changing Global Environments

Annex A

Basic statistics on the production of social science research

Table A1. **Socio-economic indicators, 2012**

Country	Population millions	Gross domestic product PPP$ billions	Gross domestic product/capita PPP$ thousand	Gross national income PPP$ billions	Gini index	Human Development Index
Arab States						
Algeria	38.5	327.7	8.5	285.0^{-1}	…	0.713
Egypt	80.7	542.7	6.7	536.3	31^{-4}	0.662
Iraq	32.6	138.3	4.2	140.2	31^{-5}	0.590
Jordan	6.3	38.8	6.1	38.8	35^{-2}	0.700
Kuwait	3.3	153.1^{-1}	49.0^{-1}	147.3^{-2}	…	0.790
Lebanon	4.4	64.6	14.6	63.7	…	0.745
Libya	6.2	105.4^{-3}	17.7^{-3}	104.7^{-3}	…	0.769
Morocco	32.5	171.7	5.2	166.6	41^{-5}	0.591
Palestine	4.0	…	…	…	36^{-3}	0.670
Oman	3.3	81.7^{-1}	27.0^{-1}	71.7^{-2}	…	0.731
Qatar	2.1	165.3^{-1}	86.5^{-1}	161.8^{-1}	41^{-5}	0.834
Saudi Arabia	28.3	682.1^{-1}	24.6^{-1}	694.4^{-1}	…	0.782
Sudan	37.2	81.7	2.2	75.3	35^{-3}	0.414
Syrian Arab Republic	22.4	121.8	5.4	116.5	36^{-8}	0.648
Tunisia	10.8	105.6	9.8	100.9	36^{-2}	0.712
Central and Eastern Europe						
Albania	3.2	29.9	9.4	29.7	35^{-4}	0.749
Belarus	9.5	147.4	15.6	143.9	26^{-1}	0.793
Bosnia and Herzegovina	3.8	35.4	9.2	36.0	36^{-5}	0.735
Bulgaria	7.3	116.4	15.9	112.4	28^{-5}	0.782
Croatia	4.3	87.6	20.5	84.3	34^{-4}	0.805
Czech Republic	10.5	277.9	26.4	258.2	26^{-16}	0.873
Estonia	1.3	30.8	23.0	29.5	36^{-8}	0.846
Hungary	9.9	214.5	21.6	200.8	31^{-5}	0.831
Latvia	2.0	42.5	21.0	42.6	35^{-3}	0.814
Lithuania	3.0	70.1	23.5	67.9	38^{-4}	0.818
Montenegro	0.6	8.8	14.2	8.7	29^{-2}	0.791
Poland	38.5	844.2	21.9	806.4	33^{-1}	0.821
Republic of Moldova	3.6	12.2	3.4	13.1	33^{-2}	0.660
Romania	21.3	352.3	16.5	347.8	27^{-1}	0.786
Russian Federation	143.5	3 380.1	23.5	3 267.3	40^{-3}	0.788
Serbia	7.2	83.4	11.5	80.8	30^{-2}	0.769
Slovakia	5.4	134.7	24.9	131.9	26^{-3}	0.840
Slovenia	2.1	55.2	26.8	54.5	31^{-8}	0.892
The former Yugoslav Republic of Macedonia	2.1	24.7	11.7	24.4	44^{-2}	0.740
Turkey	74.0	1 306.2	17.7	1 294.6	40^{-2}	0.722
Ukraine	45.6	338.2	7.4	332.5	26^{-2}	0.740
Central Asia						
Armenia	3.0	19.7	6.6	20.8	31^{-2}	0.729
Azerbaijan	9.3	98.8	10.6	87.5	34^{-4}	0.734
Georgia	4.5	26.6	5.9	26.4	42^{-2}	0.745
Kazakhstan	16.8	233.4	13.9	200.7	29^{-3}	0.754
Kyrgyzstan	5.6	13.4	2.4	12.6	33^{-1}	0.622
Mongolia	2.8	15.3	5.5	14.3	37^{-4}	0.675
Tajikistan	8.0	18.0	2.2	17.8	31^{-3}	0.622

Table A1. **Socio-economic indicators, 2012** *(cont.)*

Country	Population millions	Gross domestic product PPP$ billions	Gross domestic product/capita PPP$ thousand	Gross national income PPP$ billions	Gini index	Human Development Index
Uzbekistan	29.8	106.9	3.6	111.6	37^{-9}	0.654
East Asia and the Pacific						
Australia	22.7	1 008.5	44.5	979.2	…	0.938
Cambodia	14.9	37.1	2.5	35.1	36^{-3}	0.543
China	1 350.7	12 471.0	9.2	12 435.4	42^{-3}	0.699
China, Hong Kong Special Administrative Region	7.2	371.6	51.9	379.6	43^{-16}	0.906
Indonesia	246.9	1 223.5	5.0	1 188.0	38^{-1}	0.629
Japan	127.6	4 490.7	35.2	4 633.1	…	0.912
China, Macau Special Administrative Region	0.6	48.9	87.8	37.5^{-1}	…	…
Malaysia	29.2	501.2	17.1	483.2	46^{-3}	0.769
Myanmar	52.8	…	…	…	…	0.498
New Zealand	4.4	139.6	31.5	132.0^{-1}	36^{-15}	0.919
Philippines	96.7	426.7	4.4	425.2	43^{-3}	0.654
Republic of Korea	50.0	1 536.2	30.7	1 544.8	32^{-14}	0.909
Singapore	5.3	328.3	61.8	324.6	42^{-14}	0.895
Taiwan, China	23.2^{-1}	875.2^{-1}	37.8^{-1}	900.1^{-1}	…	…
Thailand	66.8	655.5	9.8	630.0	39^{-2}	0.690
Viet Nam	88.8	322.7	3.6	305.6	36^{-4}	0.617
Latin America and the Caribbean						
Argentina	41.1	469.2^{-6}	12.0^{-6}	457.8^{-6}	44^{-2}	0.811
Bolivia (Plurinational State of)	10.5	55.4	5.3	52.1	56^{-4}	0.675
Brazil	198.7	2 365.8	11.9	2 328.8	55^{-3}	0.730
Chile	17.5	395.7	22.7	377.0	52^{-3}	0.819
Colombia	47.7	505.0	10.6	482.2	56^{-2}	0.719
Costa Rica	4.8	62.2	12.9	60.5	51^{-3}	0.773
Cuba	11.3	…	…	…	…	0.780
Ecuador	15.5	150.9	9.7	148.5	49^{-2}	0.724
El Salvador	6.3	44.5	7.1	42.8	48^{-3}	0.680
Guatemala	15.1	76.9	5.1	74.8	56^{-6}	0.581
Mexico	120.8	2 015.3	16.7	2 009.2	47^{-2}	0.775
Panama	3.8	63.2	16.6	67.8	52^{-2}	0.780
Paraguay	6.7	41.0	6.1	37.5	52^{-2}	0.669
Peru	30.0	328.1	10.9	306.9	48^{-2}	0.741
Puerto Rico	3.7	…	…	…	…	…
Trinidad and Tobago	1.3	35.6	26.6	30.0	…	0.760
Uruguay	3.4	54.4	16.0	52.9	45^{-2}	0.792
Venezuela (Bolivarian Republic of)	30.0	403.6	13.5	393.0	45^{-6}	0.748
North America and Western Europe						
Austria	8.5	366.6	43.3	365.7	29^{-12}	0.895
Belgium	11.1	433.3	38.9	437.4	33^{-12}	0.897
Canada	34.9	1 489.2	42.7	1 489.2	33^{-12}	0.911
Cyprus	1.1	26.7	30.6	25.7	…	0.848
Denmark	5.6	231.4	41.4	238.3	25^{-15}	0.901
Finland	5.4	207.0	38.2	206.9	27^{-12}	0.892
France	65.7	2 354.9	35.8	2 395.3	…	0.893
Germany	81.9	3 307.9	40.4	3 387.6	28^{-12}	0.920

Table A1. **Socio-economic indicators, 2012** *(cont.)*

Country	Population millions	Gross domestic product PPP$ billions	Gross domestic product/capita PPP$ thousand	Gross national income PPP$ billions	Gini index	Human Development Index
Greece	11.3	278.2	24.7	279.6	34^{-12}	0.860
Iceland	0.3	12.0	37.5	10.7	…	0.906
Ireland	4.6	195.8	42.7	161.1	34^{-12}	0.916
Israel	7.9	223.7^{-1}	28.8^{-1}	218.0^{-1}	39^{-11}	0.900
Italy	60.9	1 980.6	32.5	1 966.2	36^{-12}	0.881
Luxembourg	0.5	46.9	88.3	33.5	31^{-12}	0.875
Malta	0.4	12.1	29.0	11.3	…	0.847
Netherlands	16.8	720.0	42.9	727.1	31^{-13}	0.921
Norway	5.0	315.0	62.8	321.4	26^{-12}	0.955
Portugal	10.5	266.4	25.3	259.7	38^{-15}	0.816
Spain	46.2	1 485.0	32.1	1 468.6	35^{-12}	0.885
Sweden	9.5	401.8	42.2	410.8	25^{-12}	0.916
Switzerland	8.0	416.4	52.1	438.8	34^{-12}	0.913
United Kingdom of Great Britain and Northern Ireland	63.2	2 264.8	35.8	2 263.5	36^{-13}	0.875
United States of America	313.9	15 684.8	50.0	15 887.6	41^{-12}	0.937
South and West Asia						
Bangladesh	154.7	291.3	1.9	319.9	32^{-2}	0.515
India	1 236.7	4 793.4	3.9	4 749.2	34^{-2}	0.554
Iran (Islamic Republic of)	76.4	838.0^{-3}	11.4^{-3}	759.3^{-3}	38^{-7}	0.742
Maldives	0.3	3.1	9.1	2.6	37^{-8}	0.688
Nepal	27.5	40.8	1.5	41.1	33^{-2}	0.463
Pakistan	179.2	517.9	2.9	543.6	30^{-4}	0.515
Sri Lanka	20.3	127.0	6.2	124.5	36^{-2}	0.715
Sub-Saharan Africa						
Benin	10.1	15.9	1.6	15.8	39^{-9}	0.436
Botswana	2.0	34.0	17.0	33.1	…	0.634
Burkina Faso	16.5	24.9	1.5	24.9	40^{-3}	0.343
Burundi	9.8	5.5	0.6	5.5	33^{-6}	0.355
Cameroon	21.7	50.8	2.3	50.3	39^{-5}	0.495
Central African Republic	4.5	3.9	0.9	3.9	56^{-4}	0.352
Côte d'Ivoire	19.8	40.5	2.0	38.8	42^{-4}	0.432
Ethiopia	91.7	104.5	1.1	104.2	34^{-1}	0.396
Gabon	1.6	26.3	16.1	23.3	41^{-7}	0.683
Gambia	1.8	3.5	1.9	3.3	47^{-9}	0.439
Ghana	25.4	51.9	2.0	49.2	43^{-6}	0.558
Kenya	43.2	76.0	1.8	76.1	48^{-7}	0.519
Madagascar	22.3	21.8	1.0	21.2	44^{-2}	0.483
Malawi	15.9	14.3	0.9	13.9	44^{-2}	0.418
Mali	14.9	18.0	1.2	17.2	33^{-2}	0.344
Mauritius	1.3	20.2	15.6	20.4	…	0.737
Mozambique	25.2	25.8	1.0	25.7	46^{-4}	0.327
Niger	17.2	11.4	0.7	11.2	35^{-4}	0.304
Nigeria	168.8	449.3	2.7	409.1	40^{-1}	0.471
Rwanda	11.5	15.5	1.4	13.9^{-1}	51^{-1}	0.434
Senegal	13.7	26.7	1.9	26.3	40^{-1}	0.470
South Africa	51.2	585.6	11.4	572.6	63^{-3}	0.629

Table A1. **Socio-economic indicators, 2012** *(cont.)*

Country	Population millions	Gross domestic product PPP$ billions	Gross domestic product/capita PPP$ thousand	Gross national income PPP$ billions	Gini index	Human Development Index
Togo	6.6	7.0	1.1	6.1	39^{-1}	0.459
Uganda	36.3	49.1	1.4	41.4	44^{-3}	0.456
United Republic of Tanzania	47.8	74.3	1.6	73.6	38^{-5}	0.476
Zambia	14.1	24.1	1.7	22.8	57^{-2}	0.448
Zimbabwe	13.7	…	…	…	…	0.397

Notes:
… Data not available
-n Data refer to n year(s) prior to the reference year
+n Data refer to n year(s) in advance of the reference year

Sources: World Bank, World Development Indicators, as of July 2013; UNDP, Human Development Report, 2013.

Table A2. **Expenditure on research and development, 2011 or latest available year**

Country	GERD PPP$ millions	GERD/capita PPP$	GERD/GDP %	GERD by field of science		
				"GERD in NSE"/ GERD %	"GERD in SSH"/ GERD %	"GERD in NEC"/ GERD %
Arab States						
Algeria	157.0[-6,g]	4.6[-6,g]	0.07[-6,g]	...	...	...
Egypt	2 230.6[g]	28.1[g]	0.43[g]	...	...	...
Jordan	138.8[-3]	23.5[-3]	0.43[-3]	...	...	...
Oman	105.4[e]	34.9[e]	0.13[e]	69.0[e]	7.9[e]	23.0
Saudi Arabia	495.2[-2,g]	18.5[-2,g]	0.08[-2,g]	...	...	...
Central and Eastern Europe						
Belarus	1 074.1	113.7	0.76	95.7	4.3	...
Bulgaria	632.6[r]	86.3[r]	0.57[r]	93.1[-1]	6.9[-1]	...
Croatia	642.9	148.7	0.75	83.7[-1]	16.3[-1]	...
Czech Republic	5 086.5	479.4	1.84	93.5	6.5	...
Estonia	700.4[r]	541.1[r]	2.38[r]	40.2[-1]	9.6[-1]	50.2[-1]
Hungary	2 581.9	258.3	1.20	88.1[-1]	10.2[-1]	1.7[-1]
Latvia	273.8[r]	132.0[r]	0.70[r]	88.1[-1]	11.9[-1]	...
Lithuania	598.2[r]	196.5[r]	0.92[r]	49.5[-1]	21.1[-1]	29.4[-1]
Montenegro	34.7	55.9	0.41	74.8	25.2	...
Poland	6 227.9	163.0	0.77	89.7[-1]	10.3[-1]	...
Republic of Moldova	48.7	13.7	0.41	85.3	14.7	...
Romania	1 646.4	75.5	0.48	88.4[-1]	11.6[-1]	...
Russian Federation	35 045.1	244.3	1.12	96.0[-1]	4.0[-1]	...
Serbia	633.9	66.0	0.73	72.8	27.2	...
Slovakia	882.3	162.2	0.68	83.9	16.1	...
Slovenia	1 387.8[r]	673.0[r]	2.51[r]	90.7[-1]	9.3[-1]	...
The former Yugoslav Republic of Macedonia	49.6[-3]	23.6[-3]	0.23[-3]	80.7[-3]	19.3[-3]	...
Turkey	9 713.4[-1]	134.7[-1]	0.84[-1]	83.9[-1]	16.1[-1]	...
Ukraine	2 400.0	52.4	0.73	87.6	6.8	5.6
Central Asia						
Armenia	48.0[g]	16.2[g]	0.27[g]	76.4[g]	23.6[g]	...
Azerbaijan	202.4	22.0	0.22	85.8	14.2	...
Georgia	27.8[-6]	6.2[-6]	0.18[-6]	...	...	...
Kyrgyzstan	20.7	3.8	0.16	90.6	9.4	...
Mongolia	36.4[g]	13.2[g]	0.27[g]	72.4[g]	16.4[g]	11.2[g]
Tajikistan	19.7	2.5	0.12	53.3	46.7[e]	...
East Asia and the Pacific						
Australia	20 578.1[-1,e]	918.5[-1,e]	2.38[-1,e]	92.5[-3]	7.5[-3]	...
China	207 418.0	151.6	1.84	97.9[-4]	1.4[-4]	0.7[-4]
China, Hong Kong Special Administrative Region	2 496.6[-1]	354.1[-1]	0.75[-1]	...	...	...
Indonesia	804.3[-2,e,g]	3.4[-2,e,g]	0.08[-2,e,g]	...	...	...
Japan	139 626.2[-1]	1 096.4[-1]	3.26[-1]	94.7[-10]	5.3[-10]	...
Malaysia	4 953.4	172.2	1.07	93.8	6.2	...
China, Macau Special Administrative Region	18.9[g]	34.7[g]	0.04[g]	39.9	17.5	42.6
New Zealand	1 680.9[-2]	388.8[-2]	1.30[-2]	...	...	...
Philippines	341.0[-4]	3.8[-4]	0.11[-4]	...	...	...
Republic of Korea	52 843.7[-1]	1 090.6[-1]	3.74[-1]	96.0[-1]	4.0[-1]	...
Singapore	6 140.5[-1]	1 209.0[-1]	2.09[-1]	94.6[-1]	...	5.4[-1]
Taiwan, China	23 872.4[-1]	1 031.7[-1]	2.90[-1]	96.1[-1]	3.9[-1]	...
Thailand	1 355.8[-2]	20.5[-2]	0.25[-2]	85.2[-4]	14.8[-4]	...

Table A2. **Expenditure on research and development, 2011 or latest available year** *(cont.)*

Country	GERD PPP$ millions	GERD/capita PPP$	GERD/GDP %	GERD by field of science		
				"GERD in NSE"/ GERD %	"GERD in SSH"/ GERD %	"GERD in NEC"/ GERD %
Latin America and the Caribbean						
Argentina	3 980.2$^{-1,e}$	98.5$^{-1,e}$	0.62^{-1}	81.8^{-1}	17.5^{-1}	0.7^{-1}
Bolivia (Plurinational State of)	71.6^{-2}	7.2^{-2}	0.16^{-2}	99.0^{-2}	1.0^{-2}	...
Brazil	25 292.1^{-1}	129.6^{-1}	1.16^{-1}	...	...	...
Chile	1 155.1^{-1}	67.3^{-1}	0.42^{-1}	83.5^{-1}	16.5^{-1}	...
Colombia	856.7	18.2	0.18	...	...	...
Costa Rica	274.8	58.0	0.48	48.8	10.8	40.4
Cuba	...	...	0.61^{-1}	...	...	...
El Salvador	27.6^{-1}	4.4^{-1}	0.07^{-1}	63.9^{-1}	36.1^{-1}	...
Mexico	8 691.7	72.8	0.46	82.0^{-8}	18.0^{-8}	...
Paraguay	21.6	3.3	0.06	87.9	11.7	0.4
Trinidad and Tobago	17.5^{-1}	13.1^{-1}	0.05^{-1}	82.8^{-1}	17.2^{-1}	...
Uruguay	189.8^{-1}	56.3^{-1}	0.40^{-1}	70.6^{-1}	14.8^{-1}	14.7^{-1}
North America and Western Europe						
Austria	9 761.9^{e,r}	1 157.6^{e,r}	2.75^{e,r}	90.6^{-13}	9.4^{-13}	...
Belgium	8 719.4^{r}	792.2^{r}	2.04^{r}	...	...	...
Canada	24 289.3^{r}	704.3^{r}	1.74^{r}	88.8$^{-1,f,r}$	8.4$^{-1,f,r}$	...
Cyprus	126.0^{r}	112.9^{r}	0.49^{r}	75.0^{-1}	25.0^{-1}	...
Denmark	7 052.4^{e,r}	1 265.0^{e,r}	3.09^{e,r}	...	...	...
Finland	7 634.8	1 416.7	3.78	...	...	...
France	51 891.0	816.1	2.25	...	...	...
Germany	91 736.8^{e}	1 106.7^{e}	2.84^{e}	94.8$^{-12, f}$	5.0$^{-12, f}$	...
Greece	1 866.8$^{-4,e}$	168.7$^{-4,e}$	0.60$^{-4,e}$	...	...	...
Iceland	333.6$^{-3,r}$	1 078.2$^{-3,r}$	2.65$^{-3,r}$	72.9^{-6}	10.9^{-6}	16.2^{-6}
Ireland	3 277.2^{e,r}	724.6^{e,r}	1.75^{e,r}	94.6$^{-1,e,f}$	8.5$^{-1,e,f}$	...
Israel	9 822.7^{d}	1 302.3^{d}	4.39^{d}	...	...	...
Italy	24 812.1^{r}	408.6^{r}	1.25^{r}	...	...	...
Malta	84.7^{r}	198.6^{r}	0.74^{r}	85.2^{-1}	13.1^{-1}	1.7^{-1}
Monaco	...	...	0.04$^{-6,g}$	...	...	...
Netherlands	14 581.5^{r}	874.9^{r}	2.04^{r}	...	...	...
Norway	4 970.1^{r}	1 005.3^{r}	1.66^{r}	85.9^{-2}	14.1^{-2}	...
Portugal	4 037.6^{r}	381.0^{r}	1.50^{r}	81.6^{-1}	18.4^{-1}	...
Spain	19 763.1	424.9	1.33	92.3^{-9}	7.7^{-9}	...
Sweden	13 216.2^{e}	1 398.7^{e}	3.37^{e}	...	...	...
Switzerland	10 525.2^{-3}	1 375.3^{-3}	2.87^{-3}	11.0^{-3}	3.0^{-3}	86.0^{-3}
United Kingdom of Great Britain and Northern Ireland	39 627.1^{r}	634.8^{r}	1.77^{r}	...	...	...
United States of America	415 193.0^{c,r}	1 318.4^{c,r}	2.77^{c,r}	...	...	...
South and West Asia						
India	24 305.9$^{-4,e}$	21.0$^{-4,e}$	0.76$^{-4,e}$	95.2^{-6}	3.0^{-6}	1.8^{-6}
Iran (Islamic Republic of)	6 432.2^{-3}	88.5^{-3}	0.79^{-3}	...	...	...
Pakistan	1 618.5	9.2	0.33	...	...	...
Sri Lanka	164.9^{-1}	7.9^{-1}	0.16^{-1}	71.3^{-1}	6.6^{-1}	22.1^{-1}
Sub-Saharan Africa						
Burundi	6.4^{g}	0.7^{g}	0.12^{g}	95.2^{-1}	...	4.8^{-1}
Democratic Republic of the Congo	27.9$^{-2,p}$	0.5$^{-2,p}$	0.13$^{-2,p}$	...	...	...
Ethiopia	208.3^{-1}	2.4^{-1}	0.24^{-1}	74.1^{-1}	10.1^{-1}	15.8^{-1}

Table A2. **Expenditure on research and development, 2011 or latest available year** *(cont.)*

Country	GERD PPP$ millions	GERD/capita PPP$	GERD/GDP %	GERD by field of science		
				"GERD in NSE"/ GERD %	"GERD in SSH"/ GERD %	"GERD in NEC"/ GERD %
Gabon	135.0^{-2}	88.9^{-2}	0.64^{-2}	...	...	...
Gambia	4.3^{h}	2.5^{h}	0.13^{h}	...	...	...
Ghana	72.8^{-4}	3.2^{-4}	0.23^{-4}	...	...	...
Kenya	$241.5^{-4,g}$	$6.4^{-4,g}$	$0.42^{-4,g}$	...	...	...
Lesotho	$0.5^{g,q}$	$0.2^{g,q}$	$0.01^{g,q}$	$76.9^{-2,g}$	$13.8^{-2,g}$	$9.3^{-2,g}$
Madagascar	21.8^{g}	1.0^{g}	0.11^{g}	75.1	12.1	12.7
Mali	$33.9^{-4,g}$	$2.7^{-4,g}$	$0.25^{-4,g}$	...	...	...
Mauritius	$47.0^{-6,h}$	$38.8^{-6,h}$	$0.37^{-6,h}$	...	...	...
Mozambique	99.3^{-1}	4.1^{-1}	0.47^{-1}	74.1^{-1}	25.9^{-1}	...
Nigeria	645.3^{-4}	4.4^{-4}	0.22^{-4}	85.8^{-4}	14.2^{-4}	...
Senegal	81.3^{-3}	6.6^{-3}	0.37^{-3}	...	...	...
Seychelles	4.5^{-6}	51.9^{-6}	0.30^{-6}	...	...	...
South Africa	$4\,434.9^{-2}$	87.1^{-2}	0.87^{-2}	87.0^{-2}	13.0^{-2}	...
Uganda	164.2^{-2}	5.0^{-2}	0.41^{-2}	70.8^{-2}	29.2^{-2}	...
United Republic of Tanzania	$213.0^{-4,g}$	$5.2^{-4,g}$	$0.43^{-4,g}$	...	...	...
Zambia	58.4^{-3}	4.7^{-3}	0.34^{-3}	...	...	...

Notes:

... Data not available
-n Data refer to n year(s) prior to the reference year
+n Data refer to n year(s) in advance of the reference year
c Excluding most or all capital expenditure
d Excluding Defence (all or mostly)
e Estimation
f The sum of the breakdown does not add to the total
g Underestimated or partial data
h Overestimated or based on overestimated data
p Government only
q Higher education only
r Provisional data

Please note that, for some countries, the reference year of the distribution of GERD by field of science (%) differs from the reference year of GERD.

Abbreviations:

GDP Gross Domestic Product
GERD Gross Domestic Expenditure on Research and Development
PPP$ Purchasing Power Parity Dollars (dollar amounts are in current prices)
NSE Natural Sciences and Engineering (this includes the following fields: Natural Sciences, Engineering and Technology, Medical and Health Sciences, and Agricultural Sciences)
SSH Social Sciences and Humanities (this includes the following fields: Social Sciences, and Humanities)
NEC Not elsewhere classified

For more information, please refer to the UIS Data Centre (*http://stats.uis.unesco.org*).
For a discussion of the indicators which are used to measure R&D and to quantify research in social sciences at the national level, see Michael Kahn's article on "Measure for measure: quantifying the social sciences" in the ISSC and UNESCO (2010), *World Social Science Report 2010*.

Sources: GERD data: UNESCO Institute for Statistics (UIS), July 2013.

GDP and PPP conversion factor (local currency per international $): World Bank, *World Development Indicators,* as of April 2013.

Population: United Nations, Department of Economic and Social Affairs, Population Division, 2013, *World Population Prospects: The 2012 Revision*.

Table A3. **Researchers by sector of employment and field of science (headcounts**

Country		TOTAL					Business enterprise				
		TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC
Arab States											
Algeria	FTE	5 593[-6,g]	...	4 510[-6,g]	1 083[-6,g]	...[-6]	...[-6]	...	...[-6]	...[-6]	...[-6]
	HC	13 805[-6,g]	...	10 829[-6,g]	2 976[-6,g]	...[-6]	...[-6]	...	...[-6]	...[-6]	...[-6]
Egypt	FTE	41 568[g]	...	...	...	...	85[g]	...	...	...	...
	HC	90 990[g]	96 481[-4,g]	88 761[-4]	...[-4]	7 720[-4]	123[g]	...[-4]	...	...	...
Iraq	FTE	13 559[h]	...	8 473[h]	5 081[h]	5	...	...	...	...	...
	HC	40 521[h]	...	23 646[h]	16 868[h]	7	...	...	...	...	...
Jordan	FTE	9 090[-13]	...	...[-13]	...[-13]	...[-13]	...[-13]	...	...[-13]	...[-13]	...[-13]
	HC	11 310[-3,b,g]	15 891[-8]	4 810[-3]	2 502[-3]	3 998[-3]	...[-3]	5 653[-8]	...[-3]	...[-3]	...[-3]
Kuwait	FTE	411[g,p]	...	386[p]	25[p]	...	...	...	...	...	...
	HC	411[g,p]	...	386[p]	25[p]	...	...	...	...	...	...
Morocco	FTE	27 714[g]	20 703[-3,g]	14 317	13 397	...	...	151[-3]	...[-3]	...[-3]	151[-3]
	HC	36 732[g]	29 276[-3,g]	19 638	17 094	...	...	151[-3]	...[-3]	...[-3]	151[-3]
Palestine	FTE	1 312[-1]	...	...[-1]	...[-1]	...[-1]	...[-1]	...	...[-1]	...[-1]	...[-1]
	HC	2 348[-1,b]	992[-3,g]	843[-1]	1 505[-1]	...[-1]	...[-1]	236[-3]	106[-3]	130[-3]	...[-3]
Oman	FTE	484[e]	...	384[e]	93[e]	6[e]	35[e]	...	34[e]	1[e]	...[e]
	HC	1 446[e]	...	917[e]	519[e]	11[e]	89[e]	...	87[e]	2[e]	...[e]
Saudi Arabia	FTE	...	...	...	...	...	...	...	...	...	...
	HC	1 271[-2,g,p]	...	802[-2,p]	6[-2,p]	463[-2,p]	...[-2]	...	...[-2]	...[-2]	...[-2]
Sudan (pre-secession)	FTE	...	...	...	...	...	...	...	...	...	...
	HC	11 208[-6,e]	...	8 218[-6,e]	2 708[-6,e]	282[-6,e]	224[-6,e]	...	164[-6,e]	54[-6,e]	6[-6,e]
Tunisia	FTE	19 086[-3,h]	...	4 952[-3]	2 301[-3]	11 833[-3,h]	829[-3,e]	...	...[-3]	...[-3]	829[-3]
	HC	33 199[-3,h]	...	13 376[-3]	6 450[-3]	13 373[-3,h]	2 369[-3,e]	...	...[-3]	...[-3]	2 369[-3]
Central and Eastern Europe											
Albania	FTE	467[-3,g]	...	414[-3,g]	53[-3,g]	...[-3]	...[-3]	...	...[-3]	...[-3]	...[-3]
	HC	1 721[-3,g]	...	873[-3,g]	848[-3,g]	...[-3]	...[-3]	...	...[-3]	...[-3]	...[-3]
Belarus	FTE	...	...	...	...	...	...	...	...	...	...
	HC	19 668	...	17 871	1 797	...	11 622	...	11 251	371	...
Bosnia and Herzegovina	FTE	745[-4,g]	...	...[-4]	...[-4]	...[-4]	...[-4]	...	...[-4]	...[-4]	...[-4]
	HC	2 953[-4,g]	...	...[-4]	...[-4]	...[-4]	...[-4]	...	...[-4]	...[-4]	...[-4]
Bulgaria	FTE	11 902[r]	10 979[-1]	8 336[-1]	2 643[-1]	...[-1]	1 547[r]	1 538[-1]	1 515[-1]	23[-1]	...[-1]
	HC	14 138[-1]	...	10 115[-1]	4 023[-1]	...[-1]	1 672[-1]	...	1 646[-1]	26[-1]	...[-1]
Croatia	FTE	6 847	7 104[-1]	5 380[-1]	1 724[-1]	...[-1]	1 230	1 281[-1]	1 269[-1]	12[-1]	...[-1]
	HC	12 527[-1]	...	9 258[-1]	3 269[-1]	...[-1]	1 387[-1]	...	1 370[-1]	17[-1]	...[-1]
Czech Republic	FTE	30 682	...	26 586	4 095	...	13 958	...	13 816	142	...
	HC	45 902	...	38 112	7 789	...	16 698	...	16 485	213	...
Estonia	FTE	4 437[r]	...	1 954	1 053	1 430[e,r]	1 430[r]	...	...	...	1 430[e,r]
	HC	...	7 491[-1]	3 410	2 062	...	...	2 021[-1]	...[-1]	...[-1]	2 021[-1,e]
Hungary	FTE	23 019	21 342[-1]	17 025[-1]	4 317[-1]	...[-1]	11 773	10 274[-1]	10 072[-1]	202[-1]	...[-1]
	HC	35 700[-1]	...	25 703[-1]	9 997[-1]	...[-1]	12 220[-1]	...	11 928[-1]	292[-1]	...[-1]
Latvia	FTE	3 947[r]	3 896[-1]	3 039[-1]	857[-1]	...[-1]	553[r]	632[-1]	595[-1]	37[-1]	...[-1]
	HC	6 517[-1]	...	3 648[-1,e]	1 968[-1,e]	901[-1,e]	901[-1]	...	...[-1]	...[-1]	901[-1,e]
Lithuania	FTE	8 390	8 600[-1]	4 417[-1]	2 941[-1]	1 242[-1,e]	1 369	1 242[-1]	...[-1]	...[-1]	1 242[-1,e]
	HC	14 056[-1]	...	6 545[-1]	5 740[-1]	1 771[-1,e]	1 771[-1]	...	...[-1]	...[-1]	1 771[-1,e]
Montenegro	FTE	474	...	266	141	67[e]	85	...	85	...	
	HC	1 546	...	946	600	...	125	...	111	14	...
Poland	FTE	64 133	64 511[-1]	47 457[-1]	17 054[-1]	...[-1]	10 567	11 730[-1]	11 601[-1]	129[-1]	...[-1]
	HC	100 934[-1]	...	71 405[-1]	29 529[-1]	...[-1]	13 798[-1]	...	13 625[-1]	173[-1]	...[-1]

(HC) and full-time equivalents (FTE)), 2011 or latest available year

Government					Higher education					Private non-profit				Not elsewhere classified (NEC)	
TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	TOTAL	TOTAL*
730[-6,g]	...	700[-6,g]	30[-6,g]	...[-6]	4 863[-6,g]	...	3 810[-6,g]	1 053[-6,g]	...[-6]	...[-6]	...	...[-6]	...[-6]	...[-6]	...
730[-6,g]	...	700[-6,g]	30[-6,g]	...[-6]	13 075[-6,g]	...	10 129[-6,g]	2 946[-6,g]	...[-6]	...[-6]	...	...[-6]	...[-6]	...[-6]	...
21 630	...	...	...	...	19 853	...	13 359	6 494	...	...	...	...	...	...	...
21 630	29 183[-4]	...	...	...	69 237	66 764[-4]	47 494	21 743	...	...	...[-4]	...	...	...	534[-4,e]
2 338	...	2 298	35	5	11 221[h]	...	6 175[h]	5 046[h]	...	...	...	...	...	...	...
3 117	...	3 064	46	7	37 404[h]	...	20 582[h]	16 822[h]	...	...	...	...	...	...	...
...[-13]	...	...[-13]	...[-13]	...[-13]	...[-13]	...	...[-13]	...[-13]	...[-13]	...[-13]	...	...[-13]	...[-13]	...[-13]	...
11 310[-3,b,i]	2 892[-8]	4 810[-3,i]	2 502[-3,i]	3 998[-3,i]	...[-3,b,k]	6 918[-8]	...[-3,k]	...[-3,k]	...[-3,k]	...[-3]	428[-8]	...[-3]	...[-3]	...[-3]	...[-8]
411	...	386	25	...	...	...	...	...	...	...	...	...	...	...	...
411	...	386	25	...	...	...	...	...	...	...	...	...	...	...	...
1 410	1 175[-3]	1 323	87	...	26 304	19 377[-3]	12 994	13 310	...	...	...[-3]	...	...	...	...[-3]
1 410	1 175[-3]	1 323	87	...	35 322	27 950[-3]	18 315	17 007	...	...	...[-3]	...	...	...	...[-3]
234[-1]	...	...[-1]	...[-1]	...[-1]	760[-1]	...	...[-1]	...[-1]	...[-1]	318[-1]	...	...[-1]	...[-1]	...[-1]	...
334[-1,b]	...[-3]	85[-1]	249[-1]	...[-1]	1 611[-1,b]	615[-3]	657[-1]	955[-1]	...[-1]	403[-1,b]	141[-3]	101[-1]	301[-1]	...[-1]	...[-3]
171	...	161	8	2	278	...	190	84	4	...	...	...	...	...	...
216	...	199	16	2	1 141	...	631	501	9	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 271[-2]	...	802[-2]	6[-2]	463[-2]	...[-2]	...	...[-2]	...[-2]	...[-2]	...[-2]	...	...[-2]	...[-2]	...[-2]	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 242[-6,e]	...	1 644[-6,e]	542[-6,e]	56[-6,e]	8 742[-6,e]	...	6 410[-6,e]	2 112[-6,e]	220[-6,e]	...[-6]	...	...[-6]	...[-6]	...[-6]	...
1 630[-3]	...	1 505[-3]	105[-3]	20[-3]	16 627[-3]	...	3 447[-3]	2 196[-3]	10 984[-3,h]	...[-3]	...	...[-3]	...[-3]	...[-3]	...
3 460[-3]	...	3 264[-3]	176[-3]	20[-3]	27 370[-3]	...	10 112[-3]	6 274[-3]	10 984[-3,h]	...[-3]	...	...[-3]	...[-3]	...[-3]	...
271[-3,g]	...	258[-3,g]	13[-3,g]	...[-3]	196[-3,g]	...	156[-3,g]	40[-3,g]	...[-3]	...[-3]	...	...[-3]	...[-3]	...[-3]	...
376[-3,g]	...	296[-3,g]	80[-3,g]	...[-3]	1 345[-3,g]	...	577[-3,g]	768[-3,g]	...[-3]	...[-3]	...	...[-3]	...[-3]	...[-3]	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5 966	...	4 883	1 083	...	2 078	...	1 736	342	...	2	...	1	1	...	...
...[-4]	...	...[-4]	...[-4]	...[-4]	...[-4]	...	...[-4]	...[-4]	...[-4]	...[-4]	...	...[-4]	...[-4]	...[-4]	...
...[-4]	...	...[-4]	...[-4]	...[-4]	...[-4]	...	...[-4]	...[-4]	...[-4]	...[-4]	...	...[-4]	...[-4]	...[-4]	...
5 776[r]	5 757[-1]	4 769[-1]	988[-1]	...[-1]	4 504[r]	3 608[-1]	2 006[-1]	1 602[-1]	...[-1]	75[r]	76[-1]	46[-1]	30[-1]	...[-1]	...
5 877[-1]	...	4 871[-1]	1 006[-1]	...[-1]	6 472[-1]	...	3 511[-1]	2 961[-1]	...[-1]	117[-1]	...	87[-1]	30[-1]	...[-1]	...
2 048	2 097[-1]	1 381[-1]	716[-1]	...[-1]	3 558	3 716[-1]	2 730[-1]	985[-1]	...[-1]	11	10[-1]	...[-1]	10[-1]	...[-1]	...
3 123[-1]	...	2 206[-1]	917[-1]	...[-1]	8 003[-1]	...	5 682[-1]	2 321[-1]	...[-1]	14[-1]	...	...[-1]	14[-1]	...[-1]	...
6 235	...	4 906	1 329	...	10 289	...	7 772	2 518	...	199	...	92	107	...	...
8 220	...	6 449	1 771	...	20 732	...	15 057	5 675	...	251	...	122	130	...	...
536	...	299	237	...	2 398	...	1 622	776	...	73	...	33	40	...	...
733	745[-1]	398	335	...	4 638	4 624[-1]	2 961	1 677	...	101	101[-1]	51	50	...	...
5 271	5 027[-1]	3 361[-1]	1 666[-1]	...[-1]	5 975	6 041[-1]	3 592[-1]	2 449[-1]	...[-1]	...	...[-1]	...	...	...	...
6 148[-1]	...	3 915[-1]	2 233[-1]	...[-1]	17 332[-1]	...	9 860[-1]	7 472[-1]	...[-1]	...[-1]	...	...	...	...	...
686[r]	635[-1]	613[-1]	22[-1]	...[-1]	2 708[r]	2 629[-1]	1 831[-1]	798[-1]	...[-1]	...	...[-1]	...	...	...	...
784[-1]	...	755[-1]	29[-1]	...[-1]	4 832[-1]	...	2 893[-1]	1 939[-1]	...[-1]	...[-1]	...	...	...	...	...
1 376	1 468[-1]	1 044[-1]	424[-1]	...[-1]	5 645	5 890[-1]	3 373[-1]	2 517[-1]	...[-1]	...	...[-1]	...	...	...	...
1 599[-1]	...	1 116[-1]	483[-1]	...[-1]	10 686[-1]	...	5 429[-1]	5 257[-1]	...[-1]	...[-1]	...	...	...	...	...
137	...	90	19	29[e]	242	...	92	113	37[e]	9	...	...	9	...	...
494	...	475	19	...	918	...	360	558	...	9	...	...	9	...	...
13 824	13 553[-1]	12 067[-1]	1 485[-1]	...[-1]	39 677	39 170[-1]	23 779[-1]	15 391[-1]	...[-1]	65	59[-1]	10[-1]	49[-1]	...	...
16 236[-1]	...	14 415[-1]	1 821[-1]	...[-1]	70 829[-1]	...	43 354[-1]	27 475[-1]	...[-1]	71[-1]	...	11[-1]	60[-1]	...	...

Table A3. **Researchers by sector of employment and field of science (headcounts**

Country		TOTAL					Business enterprise				
		TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC
Republic of Moldova	FTE	2 767	...	2 197	570	...	212[g]	...	212[g]	...[g]	...
	HC	3 372	...	2 608	764	...	267[g]	...	267[g]	...[g]	...
Romania	FTE	16 080[b]	19 780[-1]	15 771[-1]	4 009[-1]	...[-1]	3 518[b]	5 853[-1]	5 821[-1]	32[-1]	...[-1]
	HC	30 707[-1]	...	23 640[-1]	7 067[-1]	...[-1]	6 182[-1]	...	6 135[-1]	47[-1]	...[-1]
Russian Federation	FTE	447 579	...	...	...	...	214 744	...	...	...	...
	HC	368 915[-1,g]	...	343 266[-1,g]	25 649[-1,g]	...[-1]	197 785[-1,g]	...	194 867[-1,g]	2 918[-1,g]	...[-1]
Serbia	FTE	11 720	...	7 995	3 726	...	149	...	144	5	...
	HC	13 609	...	9 273	4 336	...	165	...	160	5	...
Slovakia	FTE	15 326	...	11 030	4 296	...	2 058	...	1 931	128	...
	HC	24 711	...	16 880	7 831	...	2 709	...	2 569	140	...
Slovenia	FTE	8 774[b,r]	7 703[-1]	6 480[-1]	1 223[-1]	...[-1]	4 510[b,r]	3 389[-1]	3 298[-1]	90[-1]	...[-1]
	HC	11 056[-1]	...	9 042[-1]	2 014[-1]	...[-1]	3 887[-1]	...	3 782[-1]	105[-1]	...[-1]
The former Yugoslav Republic of Macedonia	FTE	968[-3]	...	548[-3]	420[-3]	...[-3]	64[-3]	...	64[-3]	...[-3]	...[-3]
	HC	2 056[-3]	...	1 185[-3]	871[-3]	...[-3]	67[-3]	...	67[-3]	...[-3]	...[-3]
Turkey	FTE	64 341[-1]	...	51 682[-1]	12 659[-1]	...[-1]	25 342[-1]	...	25 014[-1]	328[-1]	...[-1]
	HC	124 796[-1]	...	91 950[-1]	32 846[-1]	...[-1]	29 800[-1]	...	29 390[-1]	410[-1]	...[-1]
Ukraine	FTE	57 387[g]	...	46 895	5 895	4 597	21 595	...	20 831	316	449
	HC	70 378	...	57 425	6 881	6 072	27 091	...	26 178	376	537
Central Asia											
Armenia	FTE	...	...	...	...	...	...	...	...	...	...
	HC	4 458[g]	...	3 662[g]	796[g]	...	...	...	...	...	...
Azerbaijan	FTE	...	...	...	...	...	...	...	...	...	...
	HC	11 891	...	9 109	2 782	...	1 378	...	1 318	60	...
Georgia	FTE	...	...	...	...	...	...	...	...	...	...
	HC	8 112[-6]	...	5 315[-6]	2 309[-6]	488[-6]	...[-6]	...	...	...	...
Kazakhstan	FTE	10 493	...	...	...	...	...	...	...	...	...
	HC	11 488	...	9 887	1 601	...	3 052	...	2 907	145	...
Kyrgyzstan	FTE	...	...	...	...	...	...	...	...	...	...
	HC	2 224	...	1 765	413	46[e]	299	...	289	4	6[e]
Mongolia	FTE	...	...	...	...	...	...	...	...	...	...
	HC	1 799[g]	...	1 443[g]	356[g]	...	141[g]	...	141[g]	...[g]	...
Tajikistan	FTE	...	...	...	...	...	...	...	...	...	...
	HC	1 565	1 895[-5]	1 509[-5]	386[-5]	...[-5]	...	...[-5]	...	...	...
Uzbekistan	FTE	15 029[h]	...	5 954[h]	958[h]	8 117[h]	1 931[h]	...	1 835[h]	96[h]	...
	HC	30 890	...	17 423	13 467	...	1 931	...	1 835	96	...
East Asia and the Pacific											
Australia	FTE	92 649[-3]	73 173[-9]	...	...	...	28 313[-1,b]	20 451[-9]	...	...	...
	HC	...	...	...	...	...	...	...	...	...	...
Cambodia	FTE	223[-9,e,g]	...	...	...	...	35[-9,e,g]	...	...	...	...
	HC	744[-9,e,g]	...	...	...	...	113[-9,e,g]	...	...	...	...
China	FTE	1 318 086[b]	1 592 420[-3]	1 484 481[-3]	73 217[-3]	34 722[-3]	818 811[b]	1 092 213[-3]	1 092 213[-3]	...[-3]	...[-3]
	HC	1 905 899	...	...	...	...	1 072 087	...	...	...	...
China, Hong Kong Special Administrative Region	FTE	20 622[-1]	...	...	...	...	8 447[-1,j]	...	...	...	...
	HC	24 470[-1]	...	...	...	...	11 163[-1,j]	...	...	...	...
Indonesia	FTE	21 275[-2,b,e,g]	...[-5]	...	...	...	...[-2,b]	...[-5]	...	...	...
	HC	41 143[-2,b,e,g]	35 564[-6,g]	15 242[-6]	9 069[-6]	11 253[-6]	2 042[-3,b]	673[-6]	273[-6]	288[-6]	112[-6]
Japan	FTE	656 032[-1,b]	684 311[-4]	...	...	...	490 538[-1]	483 728[-4]	...	...	...
	HC	894 138[-1]	...	761 439[-1]	104 624[-1]	28 074[-1]	537 293[-1]	...	530 234[-1]	7 058[-1]	...[-1]

(HC) and full-time equivalents (FTE)), 2011 or latest available year *(cont.)*

Government					Higher education					Private non-profit				Not elsewhere classified (NEC)	
TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	TOTAL	TOTAL*
1 987	...	1 587	400	...	568[g]	...	398[g]	170[g]	...	...	...	...	...	...	...
2 108	...	1 684	424	...	997[g]	...	657[g]	340[g]	...	...	...	...	...	...	...
5 846[b]	5 590[-1]	4 853[-1]	737[-1]	...[-1]	6 563[b]	8 245[-1]	5 039[-1]	3 206[-1]	...[-1]	153[b]	92[-1]	58[-1]	34[-1]	...	...
5 831[-1]	...	5 009[-1]	822[-1]	...[-1]	18 540[-1]	...	12 418[-1]	6 122[-1]	...[-1]	154[-1]	...	78[-1]	76[-1]	...	...
141 572	...	...	...	...	89 938	...	...	...	...	1 325	...	...	...	...	...
131 734[-1,g]	...	119 015[-1,g]	12 719[-1,g]	...[-1]	38 640[-1,g]	...	28 747[-1,g]	9 893[-1,g]	...[-1]	756[-1,g]	...	637[-1,g]	119[-1,g]	...	...
2 869	...	2 278	591	...	8 700	...	5 573	3 127	...	3	...	...	3	...	...
2 929	...	2 312	617	...	10 506	...	6 801	3 705	...	9	...	...	9	...	...
2 892[d]	...	2 246[d]	646[d]	...	10 339	...	6 839	3 500	...	37	...	13	23	...	...
3 519[d]	...	2 715[d]	804[d]	...	18 363	...	11 526	6 837	...	120	...	70	50	...	...
1 817[b,r]	2 036[-1]	1 487[-1]	550[-1]	...[-1]	2 431[b,r]	2 262[-1]	1 686[-1]	576[-1]	...[-1]	16[b,r]	16[-1]	9[-1]	7[-1]	...	...
2 457[-1]	...	1 851[-1]	606[-1]	...[-1]	4 696[-1]	...	3 400[-1]	1 296[-1]	...[-1]	16[-1]	...	9[-1]	7[-1]	...	...
441[-3]	...	186[-3]	255[-3]	...[-3]	463[-3]	...	298[-3]	165[-3]	...[-3]	...[-3]	...	...[-3]	...[-3]	...[-3]	...
800[-3]	...	303[-3]	497[-3]	...[-3]	1 189[-3]	...	815[-3]	374[-3]	...[-3]	...[-3]	...	...[-3]	...[-3]	...[-3]	...
6 087[-1]	...	5 698[-1]	388[-1]	...[-1]	32 913[-1,a]	...	20 969[-1]	11 943[-1]	...[-1]	...[-1]	...	...	...	...	...
7 099[-1]	...	6 607[-1]	492[-1]	...[-1]	87 897[-1,a]	...	55 953[-1]	31 944[-1]	...[-1]	...[-1]	...	...	...	...	...
30 047	...	24 182	5 233	632	5 744	...	1 882	346	3 516	1	...	1	...	...	...
35 751	...	29 056	5 982	713	7 534	...	2 189	523	4 822	2	...	2	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 452[g]	...	2 908[g]	544[g]	...	1 006[g]	...	754[g]	252[g]	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8 471	...	6 441	2 030	...	2 042	...	1 350	692	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 692[-6]	...	3 361[-6]	1 181[-6]	150[-6]	3 420[-6]	...	1 954[-6]	1 128[-6]	338[-6]	...[-6]	...	...	...	...[-6]	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 144	...	2 783	361	...	4 410	...	3 346	1 064	...	882	...	851	31	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 172	...	963	170	39[e]	753	...	513	239	1[e]	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 521	...	1 189	332	...	137[g]	...	113[g]	24[g]	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1 291	1 285[-5]	937[-5]	348[-5]	...[-5]	274	610[-5]	572[-5]	38[-5]	...[-5]	...	...[-5]	...	...	...	...[-5]
4 926[h]	...	4 077[h]	849[h]	...	8 117	...	...	...	8 117	55[h]	...	42[h]	13[h]	...	...
4 926	...	4 077	849	...	23 978	...	11 469	12 509	...	55	...	42	13	...	...
8 285[-3]	8 036[-9]	...	...	...	60 631[-1]	42 780[-9]	25 462[-9]	17 317[-9]	...[-9]	3 051[-3]	1 906[-9]	1 814[-9]	94[-9]	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
113[-9,e,g]	...	...	...	...	28[-9,e,g]	...	...	...	...	47[-9,e,g]	...	...	...	...[-9]	...
394[-9,e,g]	...	...	...	...	88[-9,e,g]	...	...	...	...	149[-9,e,g]	...	...	...	...[-9]	...
250 250[b]	238 970[-3]	196 096[-3]	8 152[-3]	34 722[-3]	249 025[b]	261 237[-3]	196 172[-3]	65 065[-3]	...[-3]	...	...[-3]	...	...	...	...
320 814	...	...	...	...	512 998	...	...	...	...	...	...	...	...	...	...
503[-1]	...	...	...	...	11 672[-1]	...	...	...	...	...[-1,m]	...	...	...	...[-1]	...
1 105[-1]	...	...	...	...	12 202[-1]	...	...	...	...	...[-1,m]	...	...	...	...[-1]	...
...[-2,b]	6 291[-5]	...	...	...	7 470[-2,b]	...[-5]	...	...	...	...[-2]	...[-5]	...	...	...[-2]	...[-5]
11 114[-5]	11 141[-6]	...[-6]	...[-6]	11 141[-6]	22 411[-2,b]	23 750[-6]	14 969[-6]	8 781[-6]	...[-6]	...[-2]	...[-6]	...	...	...[-2]	...[-6]
32 422[-1]	32 705[-4]	30 925[-4]	1 780[-4]	...[-4]	125 263[-1,b]	159 512[-4]	87 468[-1]	37 795[-1]	...[-1]	7 809[-1]	8 366[-4]	7 325[-4]	1 041[-4]	...	...
35 693[-1]	...	32 894[-1]	2 799[-1]	...[-1]	312 099[-1]	...	190 610[-1]	93 415[-1]	28 074[-1]	9 053[-1]	...	7 701[-1]	1 352[-1]	...	...

Table A3. **Researchers by sector of employment and field of science (headcounts**

Country		TOTAL					Business enterprise				
		TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC
China, Macau Special Administrative Region	FTE	260^{g}	...	73	154	33	...	...	...	...	...
	HC	612^{g}	...	164	380	68	...	...	...	...	...
Malaysia	FTE	47 242	...	39 000	8 242	...	5 857	...	5 844	13	...
	HC	73 752	...	60 626	13 126	...	6 325	...	6 310	15	...
Myanmar	FTE	837$^{-9,g}$	...	...	...	...	...$^{-9}$	...	...	...	...
	HC	4 725$^{-9,g}$	...	2 600^{-9}	2 125^{-9}	...$^{-9}$	...$^{-9}$	...	...	...	...
New Zealand	FTE	16 600^{-2}	...	...	...	...	4 900^{-2}	...	...	...	...
	HC	27 400^{-2}	...	...	...	...	8 200^{-2}	...	...	...	...
Philippines	FTE	6 957^{-4}	...	6 024^{-4}	857^{-4}	77^{-4}	2 715^{-4}	...	2 691^{-4}	21^{-4}	3^{-4}
	HC	11 490^{-4}	...	9 319^{-4}	2 016^{-4}	155^{-4}	3 217^{-4}	...	3 187^{-4}	25^{-4}	5^{-4}
Republic of Korea	FTE	264 118^{-1}	...	...	...	...	202 079^{-1}	...	...	...	...
	HC	345 912^{-1}	...	306 064^{-1}	39 848^{-1}	...$^{-1}$	226 168^{-1}	...	216 949^{-1}	9 219^{-1}	...$^{-1}$
Singapore	FTE	32 031^{-1}	...	30 662^{-1}	...$^{-1}$	1 369^{-1}	16 508^{-1}	...	16 260^{-1}	...$^{-1}$	248^{-1}
	HC	36 561^{-1}	...	34 847^{-1}	...$^{-1}$	1 714^{-1}	17 908^{-1}	...	17 642^{-1}	...$^{-1}$	266^{-1}
Taiwan, China	FTE	127 768^{-1}	...	118 240^{-1}	9 528^{-1}	...$^{-1}$	80 532^{-1}	...	79 148^{-1}	1 383^{-1}	...$^{-1}$
	HC	164 874^{-1}	...	146 297^{-1}	18 577^{-1}	...$^{-1}$	90 268^{-1}	...	88 642^{-1}	1 626^{-1}	...$^{-1}$
Thailand	FTE	22 000^{-2}	20 506^{-6}	8 927^{-6}	6 404^{-6}	5 175^{-6}	6 513^{-2}	5 167^{-6}	...$^{-6}$	...$^{-6}$	5 167^{-6}
	HC	38 506^{-2}	34 084^{-6}	16 999^{-6}	10 131^{-6}	6 954^{-6}	7 704^{-2}	6 954^{-6}	...$^{-6}$	...$^{-6}$	6 954^{-6}
Viet Nam	FTE	9 328^{-9}	...	...	...	...	968^{-9}	...	...	...	...
	HC	41 117^{-9}	...	...	...	...	9 675^{-9}	...	...	...	...
Latin America and the Caribbean											
Argentina	FTE	47 580^{-1}	...	...	...	...	4 251^{-1}	...	...	...	...
	HC	74 020^{-1}	...	51 304^{-1}	22 716^{-1}	...$^{-1}$	5 157^{-1}	...	5 122^{-1}	35^{-1}	...$^{-1}$
Bolivia (Plurinational State of)	FTE	1 646^{-1}	...	1 301^{-1}	345^{-1}	...$^{-1}$	6^{-1}	...	...	...	...
	HC	2 153^{-1}	...	1 675^{-1}	478^{-1}	...$^{-1}$	6^{-1}	...	...	...	...
Brazil	FTE	138 653^{-1}	...	...	...	...	35 970^{-1}	...	...	...	...
	HC	234 797^{-1}	...	...	...	...	41 317$^{-1,f}$	...	...	...	...
Chile	FTE	5 440$^{-1,g}$	...	4 229$^{-1,g}$	1 211$^{-1,g}$	...$^{-1}$	1 298^{-1}	...	1 292^{-1}	6^{-1}	...$^{-1}$
	HC	9 453$^{-1,g}$	10 582^{-3}	8 097^{-3}	2 483^{-3}	...$^{-3}$	1 588$^{-1,b}$	1 831^{-3}	1 698^{-3}	133^{-3}	...$^{-3}$
Colombia	FTE	7 160^{-1}	...	3 897^{-1}	3 039^{-1}	224^{-1}	78^{-1}	...	51^{-1}	19^{-1}	9^{-1}
	HC	16 123^{-1}	...	9 059^{-1}	6 575^{-1}	488^{-1}	192^{-1}	...	108^{-1}	39^{-1}	45^{-1}
Costa Rica	FTE	6 107^{b,h}	527^{-6}	410^{-6}	117^{-6}	...$^{-6}$	4 225^{b,h}	30^{-6}	31^{-6}	...$^{-6}$	...$^{-6}$
	HC	8 848^{h}	...	2 771	949	5 128	4 686^{h}	...	...	...	4 686
Cuba	FTE	...	...	...	...	...	...	...	...	...	...
	HC	4 618	...	...	...	...	...	...	...	...	...
Ecuador	FTE	1 491$^{-3,b}$	645^{-8}	582^{-8}	63^{-8}	...$^{-8}$	223^{-3}	...$^{-8}$	...	...	...
	HC	2 623^{-3}	...	1 911^{-3}	712^{-3}	...$^{-3}$	811^{-3}	...	...	...	...
El Salvador	FTE	...	...	...	...	...	...	...	...	...	...
	HC	533	...	431	102	...	17	...	15	2	...
Guatemala	FTE	363$^{-1,g}$	...	226$^{-1,g}$	137$^{-1,g}$	...$^{-1}$	...$^{-1}$	...	...	...	...
	HC	592$^{-1,g}$	...	401$^{-1,g}$	191$^{-1,g}$	...$^{-1}$	...$^{-1}$	...	...	...	...
Mexico	FTE	46 125^{b}	33 558^{-8}	25 334$^{-8,f}$	8 150$^{-8,f}$	...$^{-8}$	18 954^{b}	8 663^{-8}	8 276$^{-8,f}$	450$^{-8,f}$	...$^{-8}$
	HC	46 125	44 577^{-8}	33 016^{-8}	11 561^{-8}	...$^{-8}$	18 872$^{-2,b}$	10 688^{-8}	10 136^{-8}	552^{-8}	...$^{-8}$

(HC) and full-time equivalents (FTE)), 2011 or latest available year *(cont.)*

Government					Higher education					Private non-profit				Not elsewhere classified (NEC)	
TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	TOTAL	TOTAL*
...	...	...	...	...	257	...	70	154	33	3	...	3	...	...	...
...	...	...	...	...	609	...	161	380	68	3	...	3	...	...	...
2 552	...	2 370	182	...	38 833	...	30 786	8 047	...	...	...	...	...	...	...
3 174	...	2 947	227	...	64 253	...	51 369	12 884	...	...	...	...	...	...	...
...$^{-9}$	...	...	...	...	...$^{-9}$	...	...	...	...	...$^{-9}$	...	...	...	...$^{-9}$	...
...$^{-9}$	...	...	...	...	...$^{-9}$	...	...	...	...	...$^{-9}$	...	...	...	...$^{-9}$	...
2 400^{-2}	...	...	...	...	9 300^{-2}	...	...	...	...	...$^{-2}$	...	...	...	...	...
3 000^{-2}	...	...	...	...	16 200^{-2}	...	...	...	...	...$^{-2}$	...	...	...	...	...
1 973^{-4}	...	1 826^{-4}	126^{-4}	21^{-4}	2 214^{-4}	...	1 468^{-4}	693^{-4}	53^{-4}	55^{-4}	...	38^{-4}	17^{-4}	...$^{-4}$	...
2 480^{-4}	...	2 295^{-4}	159^{-4}	26^{-4}	5 622^{-4}	...	3 720^{-4}	1 778^{-4}	124^{-4}	171^{-4}	...	117^{-4}	54^{-4}	...$^{-4}$	...
19 753^{-1}	...	...	...	...	39 265^{-1}	...	...	...	...	3 021^{-1}	...	...	...	...	...
22 018^{-1}	...	18 853^{-1}	3 165^{-1}	...$^{-1}$	93 509^{-1}	...	66 833^{-1}	26 676^{-1}	...$^{-1}$	4 217^{-1}	...	3 429^{-1}	788^{-1}	...	...
1 757^{-1}	...	1 658^{-1}	...$^{-1}$	99^{-1}	13 766^{-1}	...	12 744^{-1}	...$^{-1}$	1 022^{-1}	...$^{-1}$	...	...	...	...	...
2 309^{-1}	...	2 099^{-1}	...$^{-1}$	210^{-1}	16 344^{-1}	...	15 106^{-1}	...$^{-1}$	1 238^{-1}	...$^{-1}$	...	...	...	...	...
15 131^{-1}	...	14 258^{-1}	873^{-1}	...$^{-1}$	31 567^{-1}	...	24 494^{-1}	7 073^{-1}	...$^{-1}$	538^{-1}	...	340^{-1}	198^{-1}	...	...
18 810^{-1}	...	17 822^{-1}	988^{-1}	...$^{-1}$	55 053^{-1}	...	39 356^{-1}	15 697^{-1}	...$^{-1}$	743^{-1}	...	477^{-1}	266^{-1}	...	...
3 455^{-2}	3 121^{-6}	2 539^{-6}	581^{-6}	1$^{-6,e}$	11 987^{-2}	12 085^{-6}	6 320^{-6}	5 758^{-6}	7$^{-6,e}$	45^{-2}	133^{-6}	68^{-6}	65^{-6}	...$^{-2}$	...$^{-6}$
6 855^{-2}	5 847^{-6}	4 758^{-6}	1 089^{-6}	...$^{-6}$	23 867^{-2}	21 101^{-6}	12 139^{-6}	8 962^{-6}	...$^{-6}$	80^{-2}	182^{-6}	102^{-6}	80^{-6}	...$^{-2}$	...$^{-6}$
5 272^{-9}	...	...	...	...	3 020^{-9}	...	...	...	...	68^{-9}	...	...	...	...	...
11 082^{-9}	...	...	...	...	20 132^{-9}	...	...	...	...	228^{-9}	...	...	...	...	...
21 452^{-1}	...	...	...	...	21 190^{-1}	...	...	...	...	687^{-1}	...	...	...	...$^{-1}$	...
22 257^{-1}	...	17 900^{-1}	4 357^{-1}	...$^{-1}$	45 508^{-1}	...	27 515^{-1}	17 993^{-1}	...$^{-1}$	1 098^{-1}	...	767^{-1}	331^{-1}	...$^{-1}$	...
73^{-1}	...	...	...	...	1 370^{-1}	...	...	...	...	197^{-1}	...	...	...	...$^{-1}$	...
140^{-1}	...	...	...	...	1 776^{-1}	...	...	...	...	231^{-1}	...	...	...	...$^{-1}$	...
7 667^{-1}	...	...	...	...	94 003^{-1}	...	...	...	...	1 013^{-1}	...	...	...	...$^{-1}$	...
7 667$^{-1,f}$	...	...	...	...	188 003$^{-1,f}$	...	...	...	...	1 013$^{-1,f}$	...	...	...	...$^{-1}$	...
292^{-1}	...	132^{-1}	160^{-1}	...$^{-1}$	3 274^{-1}	...	2 277^{-1}	997^{-1}	...$^{-1}$	576$^{-1,g}$	...	528$^{-1,g}$	48$^{-1,g}$	...$^{-1}$	...
505^{-1}	883^{-3}	697^{-3}	186^{-3}	...$^{-3}$	6 659^{-1}	7 372^{-3}	5 342^{-3}	2 028^{-3}	...$^{-3}$	701$^{-1,g}$	496^{-3}	360^{-3}	136^{-3}	...$^{-1}$	...$^{-3}$
77^{-1}	...	39^{-1}	30^{-1}	9^{-1}	6 399^{-1}	...	3 354^{-1}	2 866^{-1}	179^{-1}	586^{-1}	...	435^{-1}	123^{-1}	20^{-1}	...
145^{-1}	...	71^{-1}	48^{-1}	26^{-1}	14 453^{-1}	...	7 982^{-1}	6 237^{-1}	234^{-1}	1 293^{-1}	...	858^{-1}	247^{-1}	39^{-1}	...
858	49^{-6}	49^{-6}	1^{-6}	...$^{-6}$	920	421^{-6}	309^{-6}	113^{-6}	...$^{-6}$	104	27^{-6}	24^{-6}	4^{-6}	...	...$^{-6}$
1 427	...	...	...	...	2 623	...	...	...	...	112	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...$^{-3}$	...$^{-8}$	...	...	...	1 268^{-3}	...$^{-8}$	...	...	...	...$^{-3}$	...$^{-8}$	...	...	0^{-3}	...$^{-8}$
...$^{-3}$	...	...	...	...	1 812^{-3}	...	...	...	...	...$^{-3}$	...	...	...	...$^{-3}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
22	...	20	2	...	391	...	294	97	...	12	...	11	1	91	...
112$^{-1,g}$	...	99$^{-1,g}$	13$^{-1,g}$	...$^{-1}$	251$^{-1,g}$	...	127$^{-1,g}$	124$^{-1,g}$	...$^{-1}$	...$^{-1}$	...	...	...	...$^{-1}$	...
175$^{-1,g}$	...	160$^{-1,g}$	15$^{-1,g}$	...$^{-1}$	417$^{-1,g}$	...	241$^{-1,g}$	176$^{-1,g}$	...$^{-1}$	...$^{-1}$	...	...	...	...$^{-1}$	...
9 154	6 397^{-8}	5 889$^{-8,f}$	487$^{-8,f}$	...$^{-8}$	16 691	17 135^{-8}	10 137$^{-8,f}$	6 654$^{-8,f}$	...$^{-8}$	1 326	1 363^{-8}	1 032$^{-8,f}$	559$^{-8,f}$	...	...
...	7 217^{-8}	6 666^{-8}	551^{-8}	...$^{-8}$	16 691	24 183^{-8}	14 599^{-8}	9 584^{-8}	...$^{-8}$	1 326	2 489^{-8}	1 615^{-8}	874^{-8}	...	...

Table A3. **Researchers by sector of employment and field of science (headcounts**

Country		TOTAL					Business enterprise				
		TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC
Panama	FTE	410^{-1}	379^{-3}	...	...	...	...$^{-1}$	4^{-3}	...	...	...
	HC	501^{-1}	463^{-3}	223^{-3}	83^{-3}	157^{-3}	...$^{-1}$	...$^{-6}$	...	...	...
Paraguay	FTE	317	466^{-3}	...	...	...	...	...$^{-3}$	...	...	...
	HC	1 283	850^{-3}	522^{-3}	282^{-3}	46^{-3}	21	...$^{-3}$	...	...	...
Peru	FTE	...	...	...	...	...	...	...	...	...	...
	HC	4 965^{-7}	...	...	...	...	688^{-7}	...	...	...	...
Puerto Rico	FTE	2 508^{-2}	...	...	...	...	1 553^{-2}	...	...	...	...
	HC	3 883^{-2}	...	...	...	...	2 288^{-2}	...	...	...	...
Trinidad and Tobago	FTE	...	...	...	...	...	...	...	...	...	...
	HC	951^{-1}	...	746^{-1}	205^{-1}	...$^{-1}$	...$^{-1}$	...	...	...	...
Uruguay	FTE	1 801	...	1 243	557	1	20	...	...	...	...
	HC	2 631	...	1 743	887	1	38	...	...	...	...
Venezuela (Bolivarian Republic of)	FTE	5 209$^{-2,g}$	...	3 376$^{-2,g}$	1 833$^{-2,g}$	...$^{-2}$	20$^{-2,g}$	...	18$^{-2,g}$	2$^{-2,g}$	...$^{-2}$
	HC	6 829$^{-2,g}$	...	4 355$^{-2,g}$	2 474$^{-2,g}$	...$^{-2}$	46$^{-2,g}$	...	38$^{-2,g}$	8$^{-2,g}$	...$^{-2}$
North America and Western Europe											
Austria	FTE	37 084^{e,r}	34 664^{-2}	...	...	...	23 107^{e,r}	21 599^{-2}	...	...	...
	HC	59 341^{-2}	...	...	...	...	26 682^{-2}	...	...	...	...
Belgium	FTE	40 498^{r}	38 225^{-2}	...	...	...	18 640^{r}	17 872^{-2}	...	...	...
	HC	55 858^{-2}	...	...	...	...	21 942^{-2}	...	...	...	...
Canada	FTE	149 060$^{-1,r}$	...	125 460$^{-1,r}$	23 600$^{-1,r}$	...$^{-1}$	89 270$^{-1,r}$	...	89 270$^{-1,r}$	...$^{-1}$	...$^{-1}$
	HC	...	...	...	...	...	...	...	...	...	...
Cyprus	FTE	905^{r}	905^{-1}	625^{-1}	280^{-1}	...$^{-1}$	185^{r}	200^{-1}	174^{-1}	26^{-1}	...$^{-1}$
	HC	1 776^{-1}	...	1 153^{-1}	623^{-1}	...$^{-1}$	377^{-1}	...	326^{-1}	51^{-1}	...$^{-1}$
Denmark	FTE	37 480^{e,r}	37 601^{-1}	...	...	...	23 083^{e,r}	22 967^{-1}	...	...	...
	HC	54 731^{-1}	...	...	...	...	28 597^{-1}	...	...	...	...
Finland	FTE	40 003	...	...	...	...	22 949	...	...	...	...
	HC	57 163^{-1}	53 420^{-4}	...	...	...	27 849^{-1}	26 608^{-4}	...	...	...
France	FTE	239 613^{-1}	...$^{-4}$	...	...	...	139 885^{-1}	...	...	...	...
	HC	319 051^{-1}	...$^{-4}$	...	...	...	178 552^{-1}	...	...	...	...
Germany	FTE	...	327 953$^{-1,e}$	...	...	...	191 000^{e}	185 815$^{-1,e}$	...	...	...
	HC	...$^{-1}$	484 566^{-2}	...	...	...	...$^{-1}$	210 995^{-2}	...	...	...
Greece	FTE	21 013$^{-4,e}$	19 593^{-6}	...	...	...	6 286^{-4}	6 033^{-6}	5 824^{-6}	207^{-6}	2^{-6}
	HC	...$^{-4}$	33 396^{-6}	...	...	...	6 885^{-4}	6 357^{-6}	6 610^{-4}	274^{-4}	...$^{-4}$
Iceland	FTE	2 861^{-2}	1 859^{-10}	...	...	...	1 126^{-2}	853^{-10}	...	...	...
	HC	4 134^{-2}	...	...	...	...	1 302^{-2}	...	...	...	...
Ireland	FTE	15 460^{e,r}	14 175$^{-1,e}$	...	...	...	8 946^{r}	7 884$^{-1,e}$	...	...	...
	HC	21 226$^{-1,e}$	...	...	...	...	9 136$^{-1,e}$	...	...	...	...
Israel	FTE	...$^{-12}$	...	...	...	...	26 900$^{-12,d}$	...	...	...	...
	HC	...$^{-1}$	...	...	...	...	43 939$^{-1,d}$	...	...	...	...
Italy	FTE	106 848^{r}	103 424^{-1}	...	...	...	41 283^{r}	38 297^{-1}	...	...	...
	HC	...	149 807^{-1}	...	...	...	...	45 901^{-1}	...	...	...
Luxembourg	FTE	2 636^{e,r}	2 396^{-2}	...	...	...	1 460^{r}	1 371^{-2}	...	...	...
	HC	...$^{-1}$	2 951^{-2}	...	...	...	...$^{-1}$	1 753^{-2}	...	...	...
Malta	FTE	755^{r}	599^{-1}	466^{-1}	129^{-1}	5^{-1}	492^{r}	341^{-1}	331^{-1}	8^{-1}	4^{-1}
	HC	...	1 077^{-1}	728^{-1}	340^{-1}	9^{-1}	...	359^{-1}	346^{-1}	8^{-1}	5^{-1}
Netherlands	FTE	53 633^{b,r}	46 958^{-2}	...	...	...	26 108^{b,r}	20 477^{-2}	...	...	...
	HC	64 829^{-1}	54 505^{-2}	...	...	...	33 479^{-1}	24 212^{-2}	...	...	...

(HC) and full-time equivalents (FTE)), 2011 or latest available year *(cont.)*

Government					Higher education					Private non-profit				Not elsewhere classified (NEC)	
TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	TOTAL	TOTAL*
...$^{-1}$	221^{-3}	...	...	...	...$^{-1}$	115^{-3}	...	...	...	...$^{-1}$	39^{-3}	...	...	...$^{-1}$	...$^{-3}$
...$^{-1}$	243^{-6}	...	...	...	...$^{-1}$	193^{-6}	...	...	...	...$^{-1}$	71^{-6}	...	...	...$^{-1}$	...$^{-6}$
...	116^{-3}	...	...	...	...	282^{-3}	...	...	...	...	32^{-3}	...	...	...	36^{-3}
64	...$^{-3}$	...	...	...	861	...$^{-3}$	...	...	...	93	...$^{-3}$	...	...	244	...$^{-3}$
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2 276^{-7}	...	...	...	...	1 996^{-7}	...	...	...	...	5^{-7}	...	...	...	...$^{-7}$	...
76^{-2}	...	...	...	...	817^{-2}	...	...	...	...	62^{-2}	...	...	...	...$^{-2}$	...
140^{-2}	...	...	...	...	1 320^{-2}	...	...	...	...	135^{-2}	...	...	...	...$^{-2}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
110^{-1}	...	101^{-1}	9^{-1}	...$^{-1}$	841^{-1}	...	645^{-1}	196^{-1}	...$^{-1}$	...$^{-1}$	...	...	...	...$^{-1}$	...
217	...	...	...	...	1 361	...	...	...	...	51	...	...	...	152	...
315	...	...	...	...	1 874	...	...	...	...	68	...	...	...	336	...
443$^{-2,g}$	...	420$^{-2,g}$	23$^{-2,g}$	...$^{-2}$	4 698$^{-2,g}$	...	2 900$^{-2,e,g}$	1 798$^{-2,e,g}$	...$^{-2}$	25$^{-2,g}$	...	16$^{-2,e,g}$	9$^{-2,e,g}$	23$^{-2,g}$	...
669$^{-2,g}$	...	624$^{-2,g}$	45$^{-2,g}$	...$^{-2}$	6 028$^{-2,g}$	...	3 626$^{-2,g}$	2 402$^{-2,g}$	...$^{-2}$	46$^{-2,g}$	...	36$^{-2,g}$	10$^{-2,g}$	40$^{-2,g}$	...
1 668^{e,r}	1 559^{-2}	815^{-2}	744^{-2}	...$^{-2}$	12 048^{e,r}	11 262^{-2}	8 324^{-2}	2 938^{-2}	...$^{-2}$	260^{e,r}	243^{-2}	217^{-2}	26^{-2}	...	...
3 145^{-2}	...	1 555^{-2}	1 590^{-2}	...$^{-2}$	29 039^{-2}	...	19 954^{-2}	9 085^{-2}	...$^{-2}$	475^{-2}	...	406^{-2}	69^{-2}	...	...
2 959^{r}	2 820^{-2}	2 423^{-2}	397^{-2}	...$^{-2}$	18 619^{r}	17 252^{-2}	12 111^{-2}	5 141^{-2}	...$^{-2}$	279^{r}	282^{-2}	279^{-2}	3^{-2}	...	...
3 251^{-2}	...	2 773^{-2}	478^{-2}	...$^{-2}$	30 354^{-2}	...	21 309$^{-2,e}$	9 045$^{-2,e}$	...$^{-2}$	311^{-2}	...	307^{-2}	4^{-2}	...	...
9 610$^{-1,r}$	...	7 990$^{-1,f,r}$	1 630$^{-1,f,r}$	...$^{-1}$	49 780$^{-1,r}$	...	27 810$^{-1,r}$	21 970$^{-1,r}$	...$^{-1}$	390$^{-1,r}$	...	390$^{-1,r}$	...$^{-1}$	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
95^{r}	102^{-1}	62^{-1}	39^{-1}	...$^{-1}$	540^{r}	527^{-1}	320^{-1}	208^{-1}	...$^{-1}$	85^{r}	76^{-1}	69^{-1}	7^{-1}	...	...
206^{-1}	...	129^{-1}	77^{-1}	...$^{-1}$	1 081^{-1}	...	598^{-1}	483^{-1}	...$^{-1}$	112^{-1}	...	100^{-1}	12^{-1}	...	...
1 162^{e,r}	1 181^{-1}	587^{-1}	594^{-1}	...$^{-1}$	13 040^{e,r}	13 258^{-1}	9 868^{-1}	3 390^{-1}	...$^{-1}$	196^{e,r}	195^{-1}	152^{-1}	43^{-1}	...	...
1 948^{-1}	...	1 003^{-1}	945^{-1}	...$^{-1}$	23 919^{-1}	...	16 404^{-1}	7 515^{-1}	...$^{-1}$	267^{-1}	...	216^{-1}	51^{-1}	...	...
4 630	...	...	...	...	11 964	...	...	...	...	460	...	...	...	...	...
5 970^{-1}	5 714^{-4}	5 136$^{-4,f,j}$	1 106$^{-4,f,j}$	...$^{-4}$	22 732^{-1}	20 570^{-4}	13 342^{-4}	7 229^{-4}	...$^{-4}$	612^{-1}	528^{-4}	...$^{-4,k}$	...$^{-4,k}$	...	...
26 739^{-1}	...	...	...	...	70 189^{-1}	...	...	...	...	2 799^{-1}	...	...	...	...	...
27 519^{-1}	...	...	...	...	109 199^{-1}	...	...	...	...	3 781^{-1}	...	...	...	...	...
...	51 783^{-1}	44 525^{-1}	7 258^{-1}	...$^{-1}$	...	90 355^{-1}	64 174^{-1}	26 181^{-1}	...$^{-1}$	...	...$^{-1}$	...	...	...	...
61 342^{-1}	58 098^{-2}	52 527^{-1}	8 814^{-1}	...$^{-1}$	230 406^{-1}	215 474^{-2}	156 401^{-1}	74 005^{-1}	...$^{-1}$	...$^{-1}$	...$^{-2}$	...	...	...	...
2 201$^{-4,e}$	2 076^{-6}	...	...	...	12 382$^{-4,e}$	11 356^{-6}	...	...	...	145$^{-4,e}$	128^{-6}	...	...	...	...
...$^{-4}$	2 916^{-6}	...	...	...	...$^{-4}$	23 984^{-6}	...	...	...	...$^{-4}$	139^{-6}	...	...	...	...
547^{-2}	424^{-10}	...	...	...	1 125^{-2}	515^{-10}	365$^{-10,f}$	154$^{-10,f}$	...$^{-10}$	64^{-2}	68^{-10}	21^{-10}	47^{-10}	...	...
1 230^{-2}	...	...	...	...	1 504^{-2}	...	...	...	...	98^{-2}	...	...	...	...	...
547^{r}	562^{-1}	485^{-1}	77^{-1}	...$^{-1}$	5 967^{e,r}	5 729^{-1}	4 444$^{-1,f}$	1 662$^{-1,f}$	...$^{-1}$	...	...$^{-1}$	...	...	...	...
607^{-1}	...	530^{-1}	77^{-1}	...$^{-1}$	11 483$^{-1,e}$	...	7 270^{-1}	4 213^{-1}	...$^{-1}$	...$^{-1}$	...	...	...	...	...
...$^{-12}$	...	...	...	...	...$^{-12}$	...	...	...	...	...$^{-12}$	...	...	...	...	...
...$^{-1}$	...	...	...	...	...$^{-1}$	...	...	...	...	...$^{-1}$	...	...	...	...	...
17 559^{r}	17 496^{-1}	15 708^{-1}	1 788^{-1}	...$^{-1}$	43 828	43 470^{-1}	26 608^{-1}	16 673^{-1}	189^{-1}	4 178^{r}	4 162^{-1}	3 267^{-1}	895^{-1}	...	...
...	22 336^{-1}	19 926^{-1}	2 410^{-1}	...$^{-1}$	74 749	75 690^{-1}	47 338^{-1}	27 967^{-1}	385^{-1}	...	5 880^{-1}	4 474^{-1}	1 406^{-1}	...	...
658^{e,r}	597^{-2}	488^{-2}	109^{-2}	...$^{-2}$	518^{e,r}	428^{-2}	195^{-2}	233^{-2}	...$^{-2}$	...	...$^{-2}$	...	...	...	...
715^{-1}	648^{-2}	531^{-2}	117^{-2}	...$^{-2}$	650^{-1}	550^{-2}	252^{-2}	298^{-2}	...$^{-2}$	...$^{-1}$	...$^{-2}$	...	...	...	...
41^{r}	34^{-1}	25^{r}	16^{r}	...	222^{r}	224^{-1}	114^{r}	105^{r}	2	...	...$^{-1}$	...	...	...	...
57^{r}	47^{-1}	38^{r}	19^{r}	...	665^{r}	671^{-1}	343^{r}	316^{r}	6	...	...$^{-1}$	...	...	...	...
6 825^{j,r}	6 820$^{-2,j}$	...	...	...	20 700^{r}	19 661^{-2}	14 260^{-2}	5 400^{-2}	...$^{-2}$	...^{k}	...$^{-2,k}$	...	...	...	...
7 900$^{-1,j,r}$	7 736$^{-2,j}$	...	...	...	23 450^{-1}	22 557^{-2}	15 928^{-2}	6 629^{-2}	...$^{-2}$	...$^{-1,k}$	...$^{-2,k}$	...	...	...	...

Table A3. **Researchers by sector of employment and field of science (headcounts**

Country		TOTAL					Business enterprise				
		TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC
Norway	FTE	27 212[r]	26 273[-2]	21 574[-2]	4 699[-2]	...[-2]	12 851[a,r]	12 504[-1,a]	12 434[-1,a]	70[-1,a]	...[-1]
	HC	44 774[-1]	...	33 794[-1]	10 868[-1]	112[-1]	17 081[-1,a]	...	17 043[-1,a]	38[-1,a]	...[-1]
Portugal	FTE	47 301[r]	46 256[-1]	32 724[-1]	13 532[-1]	...[-1]	10 587[r]	10 572[-1]	9 888[-1]	684[-1]	...[-1]
	HC	96 234[-1]	...	62 272[-1]	33 962[-1]	...[-1]	19 235[-1]	...	17 785[-1]	1 450[-1]	...[-1]
Spain	FTE	130 235	134 653[-1]	...	...	...	44 915	45 377[-1]	...	...	...
	HC	224 000[-1]	...	...	...	...	59 714[-1]	...	...	...	...
Sweden	FTE	49 053[b,e,r]	45 995[-10]	...	...	...	29 620[b,e,r]	27 884[-10,a]	...	...	...
	HC	72 692[-2]	71 055[-4]	...	...	...	32 819[-2]	32 932[-4]	...	...	...
Switzerland	FTE	...[-1]	25 142[-3]	...	...	...	...[-1]	10 332[-3]	...	...	...
	HC	...[-1]	45 874[-3]	...	...	...	...[-1]	11 237[-3]	...	...	...
United Kingdom of Great Britain and Northern Ireland	FTE	262 303[r]	254 009[-5,e]	...	...	...	85 948[r]	93 844[-5]	...	...	...
	HC	394 755[-1,e]	385 489[-2,e]	...	...	...	90 178[-1,e]	86 307[-2,e]	...	...	...
United States of America	FTE	1 412 639[-4,e]	1 342 454[-9,e]	...	...	...	1 130 500[...]	1 075 300[-9]	...	...	...
	HC	...	...	...	...	...	...	...	...	...	...
South and West Asia											
Bangladesh	FTE	...	...	...	...	...	...	...	...	...	...
	HC	6 097[-14]	...	...	...	...	...[-14]	...	...	...	...
India	FTE	154 827[-6]	...	113 379[-6]	2 796[-6]	38 652[-6]	57 360[-6,j]	...	56 082[-6,j]	1 278[-6,j]	...[-6,j]
	HC	...	...	...	...	...	...	...	...	...	...
Iran (Islamic Republic of)	FTE	54 268[-3]	...	41 369[-3]	11 840[-3]	1 059[-3]	8 121[-3]	...	7 954[-3]	139[-3]	28[-3]
	HC	107 810[-3]	...	77 164[-3]	28 067[-3]	2 579[-3]	9 669[-3]	...	9 446[-3]	189[-3]	34[-3]
Nepal	FTE	1 500[-9,e]	...	...	...	...	...	...	...	...	...
	HC	5 123[-1,g]	...	...	...	...	543[-1]	...	...	...	...
Pakistan	FTE	26 223	...	19 745	5 759	719	...	...	...	...	...
	HC	51 954	...	37 093	13 065	1 796	...	...	...	...	...
Sri Lanka	FTE	2 140[-1]	...	1 883[-1]	122[-1]	135[-1]	678[-1]	...	527[-1]	25[-1]	126[-1]
	HC	5 162[-1]	...	4 502[-1]	403[-1]	257[-1]	1 169[-1]	...	887[-1]	113[-1]	169[-1]
Sub-Saharan Africa											
Benin	FTE	...	...	...	...	...	...	...	...	...	...
	HC	1 000[-4,e,g]	...	...	...	...	...[-4]	...	...	...	...
Botswana	FTE	...	...	...	...	...	...	...	...	...	...
	HC	1 732[-6,g]	...	...	...	...	159[-6,g]	...	...	...	...
Burkina Faso	FTE	742[-1]	...	628[-1]	75[-1]	40[-1]	...[-1]	...	...	...	...
	HC	1 144[-1,b]	187[-4,g]	950[-1]	156[-1]	38[-1]	...[-1,b]	...[-4]	...	...	...
Burundi	FTE	...	...	...	...	...	...	...	...	...	...
	HC	379[g]	...	75	4	300[i]	...	...	...	...	...
Cameroon	FTE	...	...	...	...	...	...	...	...	...	...
	HC	4 562[-3]	...	...	...	...	156[-3]	...	...	...	...
Central African Republic	FTE	...	...	...	...	...	...	...	...	...	...
	HC	134[-2,g]	...	84[-2,g]	45[-2,g]	5[-2,g]	5[-2,g]	...	...[-2]	...[-2]	5[-2]
Côte d'Ivoire	FTE	1 269[-6,g]	...	...	...	...	...[-6]	...	...	...	...
	HC	2 397[-6,g]	...	...	...	...	...[-6]	...	...	...	...

(HC) and full-time equivalents (FTE)), 2011 or latest available year *(cont.)*

Government					Higher education					Private non-profit				Not elsewhere classified (NEC)	
TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	TOTAL	TOTAL*
4 601	4 479^{-1}	3 006^{-1}	1 473^{-1}	...$^{-1}$	9 760	9 468^{-1}	6 247^{-1}	3 221^{-1}	...$^{-1}$	...	...$^{-1}$	...	...	...	...
6 050$^{-1,a}$	...	3 979^{-1}	2 071^{-1}	...$^{-1}$	21 643^{-1}	...	12 772^{-1}	8 759^{-1}	112^{-1}	...$^{-1}$	...	...	...	...	...
2 218^{r}	2 440^{-1}	2 126^{-1}	314^{-1}	...$^{-1}$	29 058^{r}	28 591^{-1}	16 833^{-1}	11 758^{-1}	...$^{-1}$	5 438^{r}	4 653^{-1}	3 878^{-1}	776^{-1}	...	...
5 101^{-1}	...	4 386^{-1}	715^{-1}	...$^{-1}$	64 652^{-1}	...	34 449^{-1}	30 203^{-1}	...$^{-1}$	7 246^{-1}	...	5 652^{-1}	1 594^{-1}	...	...
22 893	24 377^{-1}	22 119^{-1}	2 258^{-1}	...$^{-1}$	62 185	64 590^{-1}	39 687^{-1}	24 903^{-1}	...$^{-1}$	242	309^{-1}	231^{-1}	78^{-1}	...	...
33 884^{-1}	...	30 704^{-1}	3 181^{-1}	...$^{-1}$	129 696^{-1}	...	79 043^{-1}	50 653^{-1}	...$^{-1}$	706^{-1}	...	556^{-1}	151^{-1}	...	...
2 097^{b,r}	2 260$^{-10,a}$	...	...	...	17 143^{b,e,r}	15 851^{-10}	10 488^{-10}	3 639^{-10}	1 724^{-10}	193^{b,r}	...$^{-10}$	...	...	...	...
2 217^{-2}	2 843$^{-4,g}$	1 322$^{-4,g}$	867$^{-4,g}$	654$^{-4,g}$	37 566^{-2}	35 162^{-4}	23 437^{-2}	13 961^{-2}	168^{-2}	90$^{-2,b,g}$	118^{-4}	...	...	...	...
471^{-1}	488^{-3}	...	...	...	16 810$^{-1,e}$	14 322$^{-3,e}$	...	...	...	...$^{-1}$	...$^{-3}$	...	...	...	...
955^{-1}	1 034^{-3}	...	...	...	38 309$^{-1,e}$	33 603$^{-3,e}$	...	...	...	...$^{-1}$	...$^{-3}$	...	...	...	...
8 812^{r}	8 936^{-5}	7 946^{-5}	990^{-5}	...$^{-5}$	163 506^{r}	147 304$^{-5,e}$	...	...	...	4 038^{r}	3 925$^{-5,e}$	...	...	...	...
9 714^{-1}	9 821^{-2}	8 339^{-2}	1 482^{-2}	...$^{-2}$	290 736$^{-1,e}$	271 360^{-4}	184 793$^{-4,f}$	105 991$^{-4,f}$	17 969$^{-4,f}$	4 127$^{-1,e}$	5 084$^{-2,e}$	...	...	...	...
...$^{-4}$	47 822$^{-9,d}$	...	...	...	...$^{-4}$	186 049^{-12}	...	...	...	...$^{-4}$	11 800$^{-12,g}$	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4 082^{-14}	...	...	...	...	2 015^{-14}	...	...	...	...	...$^{-14}$	...	...	...	...$^{-14}$	...
75 367^{-6}	...	57 297^{-6}	1 518^{-6}	16 552^{-6}	22 100$^{-6,e}$	...	...$^{-6}$	...$^{-6}$	22 100^{-6}	...$^{-6,m}$	...	...$^{-6,m}$	...$^{-6,m}$	...$^{-6}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
18 217^{-3}	...	12 805^{-3}	4 976^{-3}	436^{-3}	27 930^{-3}	...	20 610^{-3}	6 725^{-3}	595^{-3}	...$^{-3}$	...	...$^{-3}$	...$^{-3}$	...$^{-3}$	...
23 089^{-3}	...	15 670^{-3}	6 842^{-3}	577^{-3}	75 052^{-3}	...	52 048^{-3}	21 036^{-3}	1 968^{-3}	...$^{-3}$	...	...$^{-3}$	...$^{-3}$	...$^{-3}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3 803^{-1}	...	...	...	...	478^{-1}	...	...	...	...	258^{-1}	...	...	...	41^{-1}	...
9 046	...	8 126	523	397	17 177	...	11 619	5 236	322	...	...	...	...	...	...
9 046	...	8 126	523	397	42 908	...	28 967	12 542	1 399	...	...	...	...	...	...
878^{-1}	...	804^{-1}	68^{-1}	6^{-1}	579^{-1}	...	549^{-1}	27^{-1}	3^{-1}	5$^{-1,g}$	...	3^{-1}	2^{-1}	...$^{-1}$	...
1 673^{-1}	...	1 415^{-1}	182^{-1}	76^{-1}	2 315^{-1}	...	2 197^{-1}	106^{-1}	12^{-1}	5$^{-1,g}$	...	3^{-1}	2^{-1}	...$^{-1}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...$^{-4}$	...	...	...	...	...$^{-4}$	...	...	...	...	...$^{-4}$	...	...	...	...$^{-4}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
692$^{-6,g}$	...	...	...	...	859$^{-6,g}$	...	...	...	...	22$^{-6,g}$	...	...	...	...$^{-6}$	...
...$^{-1}$	...	...	...	...	...$^{-1}$	...	...	...	...	...$^{-1}$	...	...	...	...$^{-1}$	...
...$^{-1,b}$	165^{-4}	115^{-4}	50^{-4}	...$^{-4}$	...$^{-1,b}$	1^{-4}	1^{-4}	...$^{-4}$	...$^{-4}$	...$^{-1,b}$	15^{-4}	8^{-4}	7^{-4}	...$^{-1,b}$	6^{-4}
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
68	...	68	...	...	298	...	...	...	298	13	...	7	4	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
298^{-3}	...	...	...	...	4 108^{-3}	...	...	...	...	...$^{-3}$	...	...	...	...$^{-3}$	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
29$^{-2,g}$	...	24$^{-2,g}$	5$^{-2,g}$	...$^{-2}$	90$^{-2,g}$	...	50$^{-2,g}$	40$^{-2,g}$	...$^{-2}$	10$^{-2,g}$	...	10$^{-2,g}$	...$^{-2}$	...$^{-2}$	...
29$^{-6,g}$	...	...	...	...	1 240$^{-6,g}$	...	...	...	...	...$^{-6}$	...	...	...	...$^{-6}$	...
38$^{-6,g}$	...	...	...	...	2 359$^{-6,g}$	...	...	...	...	...$^{-6}$	...	...	...	...$^{-6}$	...

Table A3. **Researchers by sector of employment and field of science (headcounts**

Country		TOTAL					Business enterprise				
		TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC
Ethiopia	FTE	3 701[-1,b]	1 615[-4]	2 447[-1]	797[-1]	457[-1]	250[-1]	…[-4]	…	…	…
	HC	7 283[-1,b]	2 377[-4]	4 825[-1]	1 571[-1]	887[-1]	411[-1]	…[-4]	…	…	…
Gabon	FTE	…	…	…	…	…	…	…	…	…	…
	HC	531[-2,b,g]	150[-5,g,p]	162[-2,g]	188[-2,g]	181[-2,g]	…[-2]	…[-5]	…	…	…
Gambia	FTE	59[b,g]	179[-2]	59	…	…	…[b]	…[-2]	…	…	…
	HC	60[b,g]	179[-2]	60	…	…	…[b]	…[-2]	…	…	…
Ghana	FTE	392[-4]	…	…	…	…	38[-4]	…	…	…	…
	HC	636[-4]	…	499[-4]	137[-4]	…[-4]	88[-4]	…	…	…	…
Kenya	FTE	2 105[-4,g]	…	…	…	…	…[-4]	…	…	…	…
	HC	3 509[-4,g]	…	…	…	…	108[-4]	…	…	…	…
Madagascar	FTE	1 106[g]	…	746	278	82	…	…	…	…	…
	HC	2 364[g]	…	1 524	688	152	…	…	…	…	…
Malawi	FTE	406[-4]	…	…	…	…	7[-4]	…	…	…	…
	HC	733[-4]	…	…	…	…	27[-4]	…	…	…	…
Mali	FTE	513[-5,g]	…	411[-5,g]	102[-5,g]	…[-5]	…[-5]	…	…	…	…
	HC	877[-4,b,g]	1 236[-5,g]	990[-5,g]	246[-5,g]	…[-5]	472[-4,b,g]	…[-5]	…	…	…
Mozambique	FTE	912[-1]	…	579[-1]	334[-1]	…[-1]	…[-1]	…	…	…	…
	HC	1 588[-1]	…	1 007[-1]	581[-1]	…[-1]	…[-1]	…	…	…	…
Nigeria	FTE	5 677[-4,g]	…	…	…	…	…[-4]	…	…	…	…
	HC	17 624[-4,b,g]	28 533[-6,g]	…	…	…	…[-4]	…[-6]	…	…	…
Senegal	FTE	4 527[-3]	…	2 346[-3]	2 181[-3]	…[-3]	13[-3]	…	13[-3]	…[-3]	…[-3]
	HC	7 859[-3]	…	4 014[-3]	3 845[-3]	…[-3]	13[-3]	…	13[-3]	…[-3]	…[-3]
South Africa	FTE	19 793[-2]	…	…	…	…	6 059[-2]	…	…	…	…
	HC	40 797[-2]	…	…	…	…	8 366[-2]	…	…	…	…
Togo	FTE	216[-4]	…	97[-4]	75[-4]	44[-4]	…[-4]	…	…	…	…
	HC	834[-4]	…	292[-4]	224[-4]	318[-4]	…[-4]	…	…	…	…
Uganda	FTE	…	…	…	…	…	…	…	…	…	…
	HC	1 703[-2]	…	1 049[-2]	654[-2]	…[-2]	100[-2]	…	27[-2]	73[-2]	…[-2]
United Republic of Tanzania	FTE	…	…	…	…	…	…	…	…	…	…
	HC	2 755[-4,g]	…	…	…	…	…[-4]	…	…	…	…
Zambia	FTE	536[-3]	…	…	…	…	26[-3]	…	…	…	…
	HC	612[-3]	…	…	…	…	35[-3]	…	…	…	…

Notes:

… Data not available
-n Data refer to n year(s) prior to the reference year
+n Data refer to n year(s) in advance of the reference year
a University graduates instead of researchers
b Break in series with previous year for which data are available
d Excluding Defence (all or mostly)
e Estimation
f The sum of the breakdown does not add to the total
g Underestimated or partial data
h Overestimated or based on overestimated data
i Including higher education
j Including private non-profit organisations
k Included in government sector
l Included in higher education
m Included in business enterprise sector
o Including government sector
p Government only
q Higher education only
r Provisional data

(HC) and full-time equivalents (FTE)), 2011 or latest available year *(cont.)*

Government					Higher education					Private non-profit				Not elsewhere classified (NEC)	
TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	NEC	TOTAL	TOTAL*	NSE	SSH	TOTAL	TOTAL*
1 583^{-1}	1 361^{-4}	1 332^{-4}	29^{-4}	…$^{-4}$	1 868^{-1}	254^{-4}	202^{-4}	52^{-4}	…$^{-4}$	…$^{-1}$	…$^{-4}$	…	…	…$^{-1}$	…$^{-4}$
1 602^{-1}	1 361^{-4}	1 332^{-4}	29^{-4}	…$^{-4}$	5 270^{-1}	1 016^{-4}	808^{-4}	208^{-4}	…$^{-4}$	…$^{-1}$	…$^{-4}$	…	…	…$^{-1}$	…$^{-4}$
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…$^{-2}$	150$^{-5,g}$	86$^{-5,g}$	60$^{-5,g}$	4$^{-5,g}$	…$^{-2}$	…$^{-5}$	…	…	…	…$^{-2}$	…$^{-5}$	…	…	…	…
33^{b}	150^{-2}	33	…	…	…^{b}	8^{-2}	…$^{-2}$	8^{-2}	…$^{-2}$	26^{b}	…$^{-2}$	26	…	…^{b}	21^{-2}
33^{b}	150^{-2}	33	…	…	…^{b}	8^{-2}	…$^{-2}$	8^{-2}	…$^{-2}$	27^{b}	…$^{-2}$	27	…	…^{b}	21^{-2}
307^{-4}	…	…	…	…	47^{-4}	…	…	…	…	…$^{-4}$	…	…	…	…$^{-4}$	…
393^{-4}	…	…	…	…	155^{-4}	…	…	…	…	…$^{-4}$	…	…	…	…$^{-4}$	…
…$^{-4}$	…	…	…	…	…$^{-4}$	…	…	…	…	…$^{-4}$	…	…	…	…$^{-4}$	…
1 077^{-4}	…	…	…	…	2 210^{-4}	…	…	…	…	114^{-4}	…	…	…	…$^{-4}$	…
…^{l}	…	…^{l}	…^{l}	…^{l}	1 106^{0}	…	746^{0}	278^{0}	82^{0}	…	…	…	…	…	…
…^{l}	…	…^{l}	…^{l}	…^{l}	2 364^{0}	…	1 524^{0}	688^{0}	152^{0}	…	…	…	…	…	…
173^{-4}	…	…	…	…	147^{-4}	…	…	…	…	79^{-4}	…	…	…	…$^{-4}$	…
247^{-4}	…	…	…	…	349^{-4}	…	…	…	…	110^{-4}	…	…	…	…$^{-4}$	…
227$^{-5,g}$	…	182$^{-5,g}$	45$^{-5,g}$	…$^{-5}$	286$^{-5,g}$	…	229$^{-5,g}$	57$^{-5,g}$	…$^{-5}$	…$^{-5}$	…	…	…	…$^{-5}$	…
…$^{-4,b}$	257$^{-5,g}$	206$^{-5,g}$	51$^{-5,g}$	…$^{-5}$	405$^{-4,b,g}$	979$^{-5,g}$	784$^{-5,g}$	195$^{-5,g}$	…$^{-5}$	…$^{-4}$	…$^{-5}$	…	…	…$^{-4}$	…$^{-5}$
324^{-1}	…	276^{-1}	48^{-1}	…$^{-1}$	556^{-1}	…	284^{-1}	272^{-1}	…$^{-1}$	32$^{-1,g}$	…	18$^{-1,g}$	14$^{-1,g}$	…$^{-1}$	…
564^{-1}	…	481^{-1}	83^{-1}	…$^{-1}$	968^{-1}	…	495^{-1}	473^{-1}	…$^{-1}$	56$^{-1,g}$	…	31$^{-1,g}$	25$^{-1,g}$	…$^{-1}$	…
1 112$^{-4,g}$	…	…	…	…	4 564$^{-4,g}$	…	…	…	…	…$^{-4}$	…	…	…	…$^{-4}$	…
1 885$^{-4,b,g}$	1 051$^{-6,g}$	810$^{-6,g}$	99$^{-6,g}$	142$^{-6,g}$	15 739$^{-4,b,g}$	27 482$^{-6,g}$	…	…	…	…$^{-4}$	…$^{-6}$	…	…	…$^{-4}$	…$^{-6}$
167^{-3}	…	144^{-3}	23^{-3}	…$^{-3}$	4 241^{-3}	…	2 122^{-3}	2 119^{-3}	…$^{-3}$	106^{-3}	…	67^{-3}	39^{-3}	…$^{-3}$	…
167^{-3}	…	144^{-3}	23^{-3}	…$^{-3}$	7 573^{-3}	…	3 790^{-3}	3 783^{-3}	…$^{-3}$	106^{-3}	…	67^{-3}	39^{-3}	…$^{-3}$	…
2 932^{-2}	…	…	…	…	10 614^{-2}	…	…	…	…	188^{-2}	…	…	…	…	…
3 655^{-2}	…	…	…	…	28 552^{-2}	…	…	…	…	224^{-2}	…	…	…	…	…
26^{-4}	…	…$^{-4}$	…$^{-4}$	26^{-4}	190^{-4}	…	97^{-4}	75^{-4}	18^{-4}	…$^{-4}$	…	…	…	…$^{-4}$	…
264^{-4}	…	…$^{-4}$	…$^{-4}$	264^{-4}	570^{-4}	…	292^{-4}	224^{-4}	54^{-4}	…$^{-4}$	…	…	…	…$^{-4}$	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
808^{-2}	…	610^{-2}	198^{-2}	…$^{-2}$	631^{-2}	…	319^{-2}	312^{-2}	…$^{-2}$	164^{-2}	…	93^{-2}	71^{-2}	…$^{-2}$	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
601^{-4}	…	…	…	…	2 000^{-4}	…	…	…	…	154^{-4}	…	…	…	…$^{-4}$	…
142^{-3}	…	…	…	…	356^{-3}	…	…	…	…	12^{-3}	…	…	…	…$^{-3}$	…
198^{-3}	…	…	…	…	366^{-3}	…	…	…	…	13^{-3}	…	…	…	…$^{-3}$	…

Please note that, for some countries, the sum of the breakdowns by sector and/or by field of science does not correspond to the total because of changes in the reference year.

Abbreviations:

NSE Natural Sciences and Engineering (this includes the following fields: Natural Sciences, Engineering and Technology, Medical and Health sciences, and Agricultural Sciences)
SSH Social Sciences and Humanities (this includes the following fields: Social Sciences, and Humanities)
NEC Not elsewhere classified
HC Headcounts
FTE Full-time equivalents
TOTAL Total figure for the latest available year
TOTAL* Total figure, if the reference year of the figure presented under 'TOTAL' differs from the reference year of sum of breakdowns (either by sector and/or field of science).

For more information, please refer to the UIS Data Centre (*http://stats.uis.unesco.org*).

Source: UNESCO Institute for Statistics (UIS), July 2013.

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011**

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
Arab States								
Algeria	2001	549 009	m	m	m	m	m	UIS
	2006	817 968	318 136	39	m	m	m	UIS
	2011	1 188 562	m	m	m	m	m	UIS
Egypt	2001	2 118 675	m	m	22 760	m	33	UIS
	2006	2 402 860	m	m	27 201	m	35	UIS
	2011	2 246 244	m	m	35 746	m	42	UIS
Jordan	2000	142 190	m	m	398	m	25	UIS
	2006	220 103	57 186	26	2 318	308	31	UIS
	2011	252 446	78 992	31	2 319	859	m	UIS
Lebanon	2000	116 014	48 391	42	809	183	32	UIS
	2006	173 123	77 103	45	1 574	165	38	UIS
	2011	216 851	97 035	45	1 608	516	40	UIS
Oman	2000	m	m	m	a	m	a	UIS
	2006	55 956	m	m	2	m	50	UIS
	2011	89 230	18 862	21	41	n	61	UIS
Palestine	2000	71 207	m	m	n	m	a	UIS
	2006	150 128	m	m	a	m	a	UIS
	2011	213 973	72 337	34	n	n	a	UIS
Saudi Arabia	2000	404 094	30 542	8	1 298	35	44	UIS
	2006	636 445	105 734	17	2 410	184	46	UIS
	2011	1 021 288	233 312	23	4 784	290	34	UIS
Tunisia	2000	180 044	m	m	10 334	m	m	UIS
	2006	325 325	57 062	18	m	m	m	UIS
	2011	383 951	86 182	22	7 909	m	62	UIS
Central and Eastern Europe								
Belarus	2000	411 861	m	m	4 927	m	46	UIS
	2006	544 328	210 359	39	5 173	1 128	54	UIS
	2011	584 846	219 905	38	5 043	928	55	UIS
Bulgaria	2000	261 321	105 198	40	3 091	547	47	UOE
	2006	243 464	103 395	42	5 163	1 094	50	UOE
	2010	287 086	122 791	43	3 850	903	50	UOE
Croatia	2000	96 798	m	m	n	m	a	UOE
	2006	136 646	55 341	40	1 316	95	47	UOE
	2010	149 853	59 329	40	3 072	558	53	UOE
Czech Republic	2000	253 695	59 782	24	15 222	2 768	35	UOE
	2006	338 009	93 217	28	22 646	3 682	38	UOE
	2011	446 158	144 048	32	26 361	4 449	42	UOE
Estonia	2000	53 613	21 859	41	1 251	126	55	UOE
	2006	68 286	26 605	m	1 971	419	53	UOE
	2010	68 985	25 112	36	2 653	541	58	UOE
Hungary	2000	307 071	114 763	37	4 302	748	42	UOE
	2006	438 702	182 453	42	7 965	1 640	47	UOE
	2011	381 927	152 109	40	7 167	1 500	49	UOE
Latvia	2000	91 237	42 819	47	1 003	224	52	UOE
	2006	131 125	71 049	54	1 809	606	60	UOE
	2011	103 856	47 775	46	2 418	757	58	UOE

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
Lithuania	2000	121 904	37 456	31	2 023	685	55	UOE
	2006	198 868	83 165	42	2 878	909	57	UOE
	2011	187 117	86 883	46	2 974	941	58	UOE
Poland	2000	1 579 571	681 454	43	22 239	m	44	UOE
	2006	2 145 687	877 299	41	32 725	7 901	49	UOE
	2010	2 148 676	852 809	40	35 671	7 227	52	UOE
Romania	2000	452 621	189 723	42	n	n	a	UOE
	2006	834 969	417 599	50	21 694	3 800	48	UOE
	2010	999 523	549 369	55	28 963	4 248	48	UOE
Russian Federation	2000	6 331 324	m	m	111 024	m	43	UOE
	2006	9 167 277	m	m	147 181	m	43	UOE
	2011	m	m	m	m	m	m	UOE
Serbia	2000	m	m	m	m	m	m	UIS
	2007	238 710	96 635	40	944	480	55	UIS
	2011	228 531	86 914	38	5 206	747	57	UIS
Slovakia	2000	135 914	34 722	26	7 173	1 351	38	UOE
	2006	197 943	56 056	28	10 739	2 125	43	UOE
	2011	226 305	70 071	31	12 182	2 589	48	UOE
Slovenia	2000	83 816	35 186	42	n	n	a	UOE
	2006	114 794	49 903	43	1 057	167	46	UOE
	2011	107 134	37 134	35	3 985	888	53	UOE
The former Yugoslav Republic of Macedonia	2000	36 922	7 972	22	n	n	a	UOE
	2006	48 368	15 758	33	n	n	a	UOE
	2010	61 764	23 828	39	270	70	57	UOE
Turkey	2001	1 607 388	805 681	50	21 789	5 045	36	UOE
	2006	2 342 898	1 110 426	47	32 575	7 914	39	UOE
	2010	3 529 334	1 900 334	54	44 768	11 495	43	UOE
Ukraine	2000	1 811 538	m	m	22 487	m	49	UIS
	2006	2 740 342	1 157 556	42	31 181	9 371	54	UIS
	2011	2 566 279	983 503	38	36 825	12 013	59	UIS
Central Asia								
Azerbaijan	2000	117 077	m	m	962	m	30	UIS
	2006	131 507	m	m	1 559	m	27	UIS
	2011	181 057	50 579	28	877	227	40	UIS
Georgia	2000	137 046	44 400	32	1 907	601	55	UIS
	2006	144 991	43 924	30	1 112	231	63	UIS
	2011	110 557	m	m	3 825	m	58	UIS
Kyrgyzstan	2000	160 684	m	m	1 475	m	61	UIS
	2006	233 463	80 468	34	2 368	909	60	UIS
	2011	258 869	110 614	43	2 299	681	61	UIS
Mongolia	2000	74 025	23 152	31	687	m	54	UIS
	2006	138 019	54 401	39	1 980	485	58	UIS
	2011	171 165	58 649	34	2 476	698	60	UIS
Tajikistan	2000	103 142	m	m	810	m	28	UIS
	2006	165 139	m	m	980	265	36	UIS
	2011	191 198	m	m	1 606	542	33	UIS

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
Uzbekistan	2000	305 409	m	m	4 228	m	40	UIS
	2006	280 837	59 001	21	2 163	337	45	UIS
	2011	277 437	43 452	16	2 917	1 021	42	UIS
East Asia and the Pacific								
Australia	2000	845 132	277 980	33	27 615	5 192	47	UOE
	2006	1 040 153	394 673	38	40 417	9 264	50	UOE
	2010	1 276 488	487 129	38	47 054	10 786	50	UOE
China	2000	7 364 111	m	m	m	m	m	UIS
	2006	23 360 535	m	m	m	m	m	UIS
	2011	31 308 378	m	m	m	m	m	UIS
China, Hong Kong Special Administrative Region	2000	m	m	m	m	m	m	UIS
	2006	155 324	56 194	36	5 508	894	42	UIS
	2011	270 512	m	m	8 031	m	44	UIS
Indonesia	2000	3 126 307	m	m	m	m	m	UIS
	2006	3 657 429	m	m	64 600	m	35	UIS
	2011	5 364 301	2 722 070	51	m	m	m	UIS
Japan	2000	3 982 069	1 183 013	30	59 007	7 133	25	UOE
	2006	4 084 861	1 198 169	29	75 028	9 927	30	UOE
	2010	3 836 314	1 116 846	29	73 734	9 349	32	UOE
China, Macau Special Administrative Region	2000	7 471	m	m	18	m	39	UIS
	2006	23 291	16 137	69	492	414	25	UIS
	2011	30 519	19 044	62	648	416	32	UIS
Malaysia	2000	549 205	m	m	5 398	m	42	UIS
	2006	737 267	201 040	27	17 824	2 248	48	UIS
	2010	1 061 421	359 001	34	21 522	7 018	40	UIS
Myanmar	2001	553 456	126 566	23	1 185	67	m	UIS
	2007	507 660	m	m	3 769	m	84	UIS
	2011	659 510	229 535	35	2 971	449	80	UIS
New Zealand	2000	171 962	50 387	29	3 336	n	47	UOE
	2006	237 784	82 690	35	5 325	1 089	51	UOE
	2010	266 232	92 852	35	7 779	1 690	51	UOE
Republic of Korea	2000	3 003 498	624 265	21	31 787	4 507	25	UOE
	2006	3 204 036	691 884	22	43 443	8 449	34	UOE
	2010	3 269 509	737 356	23	53 533	10 332	38	UOE
Singapore	2000	m	m	m	m	m	m	UIS
	2006	m	m	m	m	m	m	UIS
	2011	236 881	92 033	39	7 794	787	39	UIS
Thailand	2000	1 900 272	m	m	2 348	m	50	UIS
	2006	2 338 572	m	m	11 462	m	54	UIS
	2011	2 497 323	1 337 273	54	22 823	5 819	50	UIS
Latin America and the Caribbean								
Argentina	2000	1 766 933	m	m	5 973	m	58	UIS
	2006	2 202 032	872 820	40	10 880	2 554	57	UIS
	2010	2 520 985	938 750	37	18 248	5 893	56	UIS

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
Brazil	2000	2 781 328	m	m	87 083	m	54	UOE
	2007	5 272 877	2 133 113	40	49 668	n	51	UOE
	2011	6 929 324	m	m	71 890	m	52	UOE
Chile	2000	452 177	m	m	7 705	m	40	UOE
	2006	661 142	170 129	26	2 753	266	41	UOE
	2011	1 061 527	271 553	26	3 955	483	44	UOE
Colombia	2000	934 085	m	m	55 911	m	49	UIS
	2006	1 314 972	563 394	43	1 131	251	34	UIS
	2011	1 849 466	842 179	46	2 784	485	39	UIS
Cuba	2000	158 674	m	m	1 428	m	53	UIS
	2006	681 629	m	m	4 129	m	43	UIS
	2011	664 775	204 779	31	5 776	3 029	48	UIS
El Salvador	2000	114 675	m	m	12	m	17	UIS
	2006	124 956	58 828	47	10	n	10	UIS
	2011	160 374	64 203	40	179	n	49	UIS
Mexico	2000	1 962 763	783 409	40	8 407	1 733	38	UOE
	2006	2 446 726	968 044	40	13 458	3 308	41	UOE
	2011	2 981 313	1 247 139	42	23 122	5 922	46	UOE
North America and Western Europe								
Austria	2000	261 229	m	m	24 531	9 610	42	UOE
	2006	253 139	88 589	35	16 819	6 379	46	UOE
	2011	361 797	132 203	37	26 031	9 966	47	UOE
Belgium	2000	355 748	119 172	33	5 916	965	35	UOE
	2006	394 427	108 352	27	7 482	1 465	41	UOE
	2010	445 309	130 913	29	13 410	2 762	45	UOE
Canada	2000	1 212 161	m	m	26 221	m	45	UOE
	2006	m	m	m	m	m	m	UOE
	2011	m	m	m	m	m	m	UOE
Cyprus	2000	10 414	3 673	35	n	n	a	UOE
	2006	20 587	9 763	47	302	64	49	UOE
	2010	32 233	16 665	52	487	94	51	UOE
Denmark	2000	189 162	44 335	23	4 648	613	42	UOE
	2006	228 893	67 618	30	4 751	610	46	UOE
	2010	240 536	76 645	32	7 849	1 083	48	UOE
Finland	2000	270 185	62 727	23	19 750	4 008	47	UOE
	2006	308 966	69 459	22	22 145	4 994	52	UOE
	2011	308 336	70 978	23	20 895	4 469	52	UOE
France	2000	2 015 344	m	m	94 327	m	47	UOE
	2006	2 201 201	759 984	35	69 831	21 423	46	UOE
	2011	2 259 448	828 003	37	71 121	20 222	47	UOE
Germany	2000	m	553 346	26	m	m	m	UOE
	2006	m	m	m	m	m	m	UOE
	2011	m	m	m	m	m	m	UOE
Greece	2000	422 317	m	m	2 096	m	40	UOE
	2006	653 003	m	m	22 483	m	44	UOE
	2010	641 844	206 689	32	22 705	4 811	45	UOE

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
Iceland	2000	9 667	3 278	34	18	n	33	UOE
	2006	15 721	5 969	38	156	27	58	UOE
	2010	18 051	6 661	37	313	50	57	UOE
Ireland	2000	160 611	m	m	2 904	m	45	UOE
	2006	186 044	m	m	5 146	m	48	UOE
	2011	196 321	48 695	25	8 658	1 400	50	UOE
Israel	2000	255 891	85 921	34	6 647	1 076	51	UOE
	2006	310 014	119 923	39	9 715	1 609	52	UOE
	2010	360 378	136 519	38	10 546	1 748	53	UOE
Italy	2000	1 770 002	712 872	40	13 177	2 393	49	UOE
	2006	2 029 023	741 190	37	38 262	7 535	52	UOE
	2010	1 980 399	m	m	38 227	m	53	UOE
Luxembourg	2000	2 437	m	m	a	m	m	UOE
	2006	2 692	1 218	45	m	m	m	UOE
	2010	5 376	2 540	47	358	105	42	UOE
Malta	2000	6 315	2 182	35	15	3	7	UOE
	2007	9 811	3 474	35	72	13	35	UOE
	2010	10 840	3 594	33	69	12	30	UOE
Netherlands	2000	487 649	195 952	40	4 556	n	42	UOE
	2006	579 622	217 163	37	7 475	m	41	UOE
	2010	650 905	248 574	38	8 044	n	45	UOE
Norway	2000	190 943	52 338	27	2 133	457	47	UOE
	2006	214 711	m	m	5 047	m	46	UOE
	2010	224 706	71 030	32	7 442	1 323	50	UOE
Portugal	2000	373 745	133 011	36	11 680	3 775	52	UOE
	2006	367 312	115 808	32	20 512	6 189	56	UOE
	2010	383 627	121 926	32	16 877	4 034	54	UOE
Spain	2000	1 828 987	673 970	37	65 675	15 931	51	UOE
	2006	1 789 254	570 202	32	77 056	18 422	51	UOE
	2011	1 950 482	608 467	31	68 865	15 306	51	UOE
Sweden	2000	346 878	88 311	25	20 714	2 836	43	UOE
	2006	422 614	110 665	26	21 377	2 651	49	UOE
	2011	463 530	125 130	27	20 642	2 542	49	UOE
Switzerland	2000	156 879	55 999	36	12 933	3 309	34	UOE
	2006	204 999	76 022	37	17 234	4 531	40	UOE
	2011	257 696	92 129	36	20 953	5 138	44	UOE
United Kingdom of Great Britain and Northern Ireland	2000	2 024 138	m	m	74 242	m	41	UOE
	2006	2 336 111	630 423	27	94 180	19 653	45	UOE
	2010	2 479 197	683 235	28	85 179	18 450	47	UOE
United States of America	2000	13 202 880	m	m	293 002	m	42	UOE
	2006	17 487 475	m	m	388 685	m	52	UOE
	2010	20 427 709	5 655 736	28	479 422	99 187	50	UOE
South and West Asia								
Bangladesh	2000	726 701	m	m	1 192	m	23	UIS
	2006	1 053 566	m	m	3 183	m	20	UIS
	2011	2 036 443	968 951	48	7 090	1 949	39	UIS

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
India	2000	9 404 460	m	m	m	m	m	UIS
	2006	12 852 684	m	m	m	m	m	UIS
	2010	20 740 740	m	m	92 211	m	41	UIS
Iran (Islamic Republic of)	2000	1 404 880	m	m	13 412	m	25	UIS
	2006	2 398 811	645 824	27	19 309	2 387	28	UIS
	2011	4 117 208	1 319 252	32	39 525	4 636	37	UIS
Nepal	2000	94 401	m	m	m	m	m	UIS
	2006	202 076	72 731	36	246	51	15	UIS
	2011	385 454	123 855	32	508	61	11	UIS
Pakistan	2000	m	m	m	m	m	m	UIS
	2006	820 347	m	m	10 389	m	27	UIS
	2011	1 572 664	m	m	19 720	m	26	UIS
Sri Lanka	2000	m	m	m	m	m	m	UIS
	2006	m	m	m	m	m	m	UIS
	2011	232 333	41 691	m	2 858	69	40	UIS
Sub-Saharan Africa								
Burkina Faso	2000	11 100	m	m	m	m	m	UIS
	2006	30 472	16 211	53	n	m	a	UIS
	2011	60 998	32 397	53	2 163	283	28	UIS
Cameroon	2000	65 697	m	m	m	m	m	UIS
	2006	120 298	77 588	64	2 169	655	m	UIS
	2011	244 233	84 741	m	m	m	m	UIS
Côte d'Ivoire	1999	96 681	m	m	4 363	m	23	UIS
	2007	156 772	75 363	48	10 755	2 495	26	UIS
	2011	m	m	m	m	m	m	UIS
Ghana	2000	m	m	m	m	m	m	UIS
	2006	110 184	m	m	123	m	17	UIS
	2011	285 862	144 444	51	721	280	22	UIS
Madagascar	2000	32 046	m	m	648	m	48	UIS
	2006	49 680	28 667	58	2 351	773	42	UIS
	2011	85 548	48 258	56	2 027	791	44	UIS
Mali	2000	19 751	m	m	m	m	m	UIS
	2007	59 428	m	m	m	m	m	UIS
	2011	87 653	57 183	65	343	130	13	UIS
Mauritius	2000	12 130	m	m	148	m	45	UIS
	2006	22 221	m	m	260	m	35	UIS
	2011	35 906	18 643	52	92	52	29	UIS
Mozambique	2000	11 619	m	m	a	m	a	UIS
	2005	28 298	12 424	44	a	a	a	UIS
	2011	113 464	50 192	44	5 999	1 603	31	UIS
Niger	2000	m	m	m	m	m	m	UIS
	2006	11 208	4 335	39	n	n	a	UIS
	2011	18 328	10 538	57	285	43	12	UIS
Nigeria	1999	699 109	m	m	n	m	a	UIS
	2005	1 391 527	m	m	8 385	m	24	UIS
	2011	m	m	m	m	m	m	UIS

Table A4. **Student enrolments, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	All fields ISCED 5-6	SSBL ISCED 5-6	% SSBL ISCED 5-6	All fields ISCED 6	ISCED 6 SSBL	% Female ISCED 6	Source/Note
South Africa	2000	m	m	m	m	m	m	UIS
	2006	m	m	m	m	m	m	UIS
	2011	m	m	m	m	m	m	UIS
United Republic of Tanzania	2001	21 960	m	m	m	m	m	UIS
	2005	51 554	m	m	3 318	m	30	UIS
	2012	166 014	68 391	41	9 209	3 695	47	UIS

Notes:
1. Symbols used: m = data missing or not available; n = quantity nil; a = not applicable.
2. UOE = UNESCO-UIS, OECD and Eurostat data collection on education systems. UNESCO-UIS, the OECD and Eurostat (UOE) have jointly administered this annual data collection since 1993. The UOE questionnaire compiles data from high- and middle-income countries that are generally members or partner countries of the OECD or the European Union.
3. UIS = UNESCO Institute for Statistics; SSBL = Social Science, Business and Law.

ISCED 5-6 corresponds to tertiary education and includes the first stage of tertiary education: ISCED 5A (e.g. Bachelor's and Master's degree programmes in English-speaking countries) and ISCED 5B (i.e. practical or occupationally specific tertiary programmes), and the second stage of tertiary education (doctorate progammes).
ISCED 6 corresponds to the second stage of tertiary programmes that leads to the award of an advanced research qualification, such as a doctorate. (*www.uis.unesco.org/Library/Documents/isced97-en.pdf*)
Source: UNESCO Institute for Statistics Online Data Centre. (*http://stats.uis.unesco.org*)

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011**

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
Arab States										
Algeria	2000	m	m	m	m	m	m	m	30 533 827	UIS
	2007	120 168	56 525	47	62	m	m	m	33 906 605	UIS
	2011	208 536	85 531	41	67	m	m	m	35 980 193	UIS
Egypt	2000	m	m	m	m	m	m	m	67 648 419	UIS
	2006	m	m	m	m	m	m	m	75 568 453	UIS
	2011	m	m	m	m	m	m	m	82 536 770	UIS
Jordan	2000	31 329	m	m	m	41	m	m	4 827 096	UIS
	2006	47 110	m	m	m	295	4	n	5 495 117	UIS
	2011	60 686	9 405	28	42	473	69	19	6 330 169	UIS
Lebanon	2000	14 393	7 151	50	52	656	23	4	3 742 329	UIS
	2006	30 462	14 845	49	52	911	66	35	4 097 457	UIS
	2011	34 007	15 811	46	51	171	56	14	4 259 405	UIS
Oman	2000	m	m	m	m	m	m	m	2 264 163	UIS
	2007	9 129	1 562	17	64	n	n	n	2 561 187	UIS
	2010	13 734	3 377	25	56	n	n	n	2 782 435	UIS
Palestine	2000	10 160	3 453	34	38	a	a	a	3 198 560	UIS
	2007	21 851	7 226	33	45	a	a	a	3 728 259	UIS
	2011	31 702	9 778	31	47	1	a	a	4 152 369	UIS
Qatar	2000	1 365	481	35	64	a	a	a	590 957	UIS
	2007	1 484	731	49	60	a	a	a	1 178 192	UIS
	2011	2 100	716	34	69	a	a	a	1 870 041	UIS
Saudi Arabia	2000	55 837	4 338	8	24	137	39	7	20 045 276	UIS
	2006	94 837	16 859	18	55	228	18	17	24 799 436	UIS
	2011	120 780	20 005	17	55	394	31	21	28 082 541	UIS
United Arab Emirates	2000	m	m	m	m	m	m	m	3 033 491	UIS
	2006	m	m	m	m	m	m	m	m	UIS
	2011	16 690	8 267	50	57	n	n	n	m	UIS
Central and Eastern Europe										
Belarus	2000	77 646	m	m	m	942	m	m	10 057 810	UIS
	2006	105 273	39 985	38	m	1 325	265	m	9 776 823	UIS
	2011	122 134	46 111	38	75	912	218	146	9 559 441	UIS
Bulgaria	2000	46 718	22 493	48	68	399	65	24	8 006 158	UOE
	2007	45 353	21 700	48	65	583	99	57	7 640 283	UOE
	2010	60 523	31 230	52	67	596	132	67	7 494 332	UOE
Croatia	2000	14 339	3 560	25	m	338	49	24	4 505 533	UOE
	2006	20 687	8 153	39	68	439	67	36	4 433 791	UOE
	2010	34 293	15 150	44	67	838	143	75	4 403 330	UOE
Czech Republic	2000	38 376	12 852	33	59	895	147	66	10 242 890	UOE
	2006	69 312	19 914	29	64	2 023	290	120	10 258 796	UOE
	2010	102 898	35 041	34	68	2 228	310	139	10 492 960	UOE
Estonia	2000	7 045	3 143	45	70	117	7	2	1 370 749	UOE
	2006	11 546	4 226	37	74	143	18	7	1 344 038	UOE
	2010	11 439	4 302	38	75	175	21	12	1 341 140	UOE

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
Hungary	2000	59 883	23 640	39	54	717	121	41	10 210 545	UOE
	2006	72 154	30 833	43	70	1 012	165	86	10 064 274	UOE
	2011	67 857	27 661	40	70	1 234	211	115	9 966 116	UOE
Latvia	2000	15 260	6 320	41	67	40	9	3	2 384 972	UOE
	2006	26 414	14 792	56	72	106	24	13	2 293 080	UOE
	2011	24 853	11 809	48	73	297	56	47	2 243 142	UOE
Lithuania	2000	25 241	7 431	29	67	442	147	85	3 500 028	UOE
	2006	43 343	17 739	41	74	326	77	52	3 397 895	UOE
	2011	43 419	20 426	47	73	353	104	67	3 307 481	UOE
Poland	2001	431 104	m	m	m	4 400	m	m	38 266 810	UOE
	2006	504 051	214 939	43	69	5 917	745	377	38 170 330	UOE
	2010	624 799	266 162	43	69	3 317	m	m	38 276 660	UOE
Romania	2000	67 940	28 215	42	59	n	n	n	22 191 683	UOE
	2006	174 821	84 205	48	63	3 180	619	294	21 705 175	UOE
	2010	305 360	183 143	60	68	4 764	948	510	21 486 371	UOE
Russian Federation	2000	1 190 567	m	m	m	m	m	m	146 757 517	UOE
	2006	1 870 973	847 023	45	m	34 978	n	m	143 510 059	UOE
	2011	m	m	m	m	m	m	m	142 835 555	UOE
Serbia	2000	m	m	m	m	m	m	m	7 504 739	UIS
	2007	31 473	10 213	32	61	401	77	29	7 365 507	UIS
	2011	46 162	15 811	34	61	596	119	45	7 241 295	UIS
Slovakia	2000	22 699	6 301	28	56	446	62	21	5 404 845	UOE
	2006	40 190	11 026	27	64	1 218	202	105	5 422 122	UOE
	2011	74 556	25 375	34	69	1 672	355	193	5 471 502	UOE
Slovenia	2001	11 991	5 127	43	66	298	49	31	1 988 385	UOE
	2006	17 145	8 504	50	68	395	76	41	2 006 903	UOE
	2011	20 461	8 945	44	71	523	89	48	2 035 012	UOE
The former Yugoslav Republic of Macedonia	2000	3 875	772	20	65	34	11	3	2 009 091	UOE
	2006	6 501	1 746	27	69	85	19	9	2 043 091	UOE
	2010	10 792	4 071	38	57	157	56	32	2 060 563	UOE
Turkey	2000	190 080	52 165	27	47	2 124	376	111	63 627 862	UOE
	2006	373 375	140 672	38	47	2 594	493	185	69 063 538	UOE
	2010	573 159	256 558	45	48	4 684	1 006	406	72 752 325	UOE
Ukraine	2001	424 610	156 309	37	m	5 533	1 212	m	48 448 267	UIS
	2006	521 772	230 567	44	m	6 717	1 816	m	46 591 797	UIS
	2011	670 080	283 693	42	m	8 918	2 737	1 773	45 190 180	UIS
Central Asia										
Azerbaijan	2000	20 484	m	m	m	454	m	m	8 114 347	UIS
	2006	32 833	m	m	m	325	m	m	8 666 071	UIS
	2011	47 345	13 566	29	26	468	107	24	9 235 085	UIS
Georgia	2000	21 433	6 812	32	35	615	180	96	4 745 765	UIS
	2006	28 733	6 338	22	44	604	144	17	4 442 825	UIS
	2011	26 589	m	m	m	917	m	m	4 329 026	UIS
Kyrgyzstan	2001	18 292	8 453	46	46	396	50	37	4 987 944	UIS
	2006	32 577	14 070	43	51	566	179	98	5 083 724	UIS
	2011	45 420	20 212	45	57	592	191	126	5 392 580	UIS

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
Mongolia	2000	10 333	2 664	26	69	45	n	n	2 411 369	UIS
	2006	23 628	10 210	43	67	111	17	6	2 584 143	UIS
	2011	35 847	14 544	41	65	94	17	10	2 800 114	UIS
Uzbekistan	2000	m	m	m	m	m	m	m	24 775 610	UIS
	2006	58 697	13 209	23	26	852	181	57	26 213 729	UIS
East Asia and the Pacific										
Australia	2000	168 913	62 318	37	52	3 802	630	282	19 164 351	UOE
	2006	282 854	122 812	42	55	5 559	1 207	628	20 744 295	UOE
	2011	m	m	m	m	m	m	m	22 605 732	UOE
China	2000	1 775 999	m	m	m	m	m	m	1 269 116 737	UIS
	2006	5 622 795	m	m	m	m	m	m	1 314 581 402	UIS
	2011	8 733 298	m	m	m	m	m	m	1 347 565 324	UIS
China, Hong Kong Special Administrative Region	2000	m	m	m	m	m	m	m	6 783 317	UIS
	2006	41 079	13 450	33	64	1 746	268	145	6 832 989	UIS
	2011	m	m	m	m	m	m	m	7 122 187	UIS
Indonesia	2001	476 971	m	m	m	8 710	m	m	216 203 499	UIS
	2006	492 802	m	m	m	m	m	m	229 918 547	UIS
	2010	811 455	316 318	39	m	2 260	m	m	239 870 937	UIS
Japan	2000	1 081 435	271 710	25	33	12 192	1 197	336	125 720 310	UOE
	2006	1 067 939	288 599	27	39	15 979	1 686	586	126 464 789	UOE
	2010	966 635	258 321	27	39	15 867	1 631	612	126 535 920	UOE
China, Macau Special Administrative Region	2000	1 956	m	m	m	n	m	m	431 867	UIS
	2006	6 014	4 344	72	40	40	30	11	493 267	UIS
	2011	5 525	2 880	52	58	131	108	19	555 731	UIS
Malaysia	1999	125 337	m	m	m	148	m	m	22 867 698	UIS
	2006	208 998	51 391	25	65	687	164	44	26 586 287	UIS
	2010	226 303	69 017	30	69	1 268	362	134	28 401 017	UIS
Myanmar	2000	m	m	m	m	m	m	m	44 957 660	UIS
	2007	104 590	m	m	m	2 561	m	m	46 915 826	UIS
	2011	134 624	22 014	16	65	569	49	42	48 336 763	UIS
New Zealand	2000	42 791	11 419	27	55	464	1	n	3 858 032	UOE
	2006	59 320	22 301	38	57	638	136	81	4 184 903	UOE
	2010	60 719	21 525	33	57	987	268	150	4 368 136	UOE
Republic of Korea	2000	519 719	110 035	21	48	6 143	755	106	45 987 624	UOE
	2006	605 160	120 580	20	47	8 657	1 351	287	47 267 733	UOE
	2011	m	m	m	m	m	m	m	48 391 343	UOE
Viet Nam	2000	m	m	m	m	m	m	m	78 758 010	UIS
	2007	242 026	66 886	28	51	m	m	m	85 007 447	UIS
	2010	273 301	89 763	33	54	m	m	m	87 848 445	UIS
Latin America and the Caribbean										
Argentina	2001	140 099	m	m	m	171	43	12	37 302 116	UIS
	2006	223 116	70 371	32	59	825	136	58	39 023 850	UIS
	2010	208 964	71 261	34	62	1 518	327	166	40 412 376	UIS

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
Brazil	2000	347 978	m	m	m	m	m	m	174 425 387	UOE
	2007	820 473	312 151	38	54	9 919	m	m	m	UOE
	2011	1 072 267	m	m	m	12 321	m	m	m	UOE
Chile	2000	53 417	m	m	m	m	m	m	15 419 820	UOE
	2006	73 203	22 931	31	52	294	39	1	16 468 677	UOE
	2010	120 694	34 092	28	56	423	28	15	17 113 688	UOE
Colombia	2000	m	m	m	m	m	m	m	39 764 166	UIS
	2006	115 488	60 092	52	50	46	3	1	43 696 540	UIS
	2011	235 203	116 229	49	60	208	21	12	46 927 125	UIS
Costa Rica	2000	m	m	m	m	m	m	m	3 919 180	UIS
	2006	m	m	m	m	m	m	m	4 381 820	UIS
	2011	38 163	15 320	40	60	117	21	7	4 726 575	UIS
El Salvador	2000	71 707	m	m	m	m	m	m	5 940 305	UIS
	2006	13 665	5 991	44	59	m	n	n	6 074 487	UIS
	2011	20 284	6 941	34	63	81	13	4	6 227 491	UIS
Mexico	2000	299 146	132 372	44	55	1 036	219	79	99 959 594	UOE
	2006	414 838	174 034	42	59	2 800	732	312	107 835 259	UOE
	2011	499 303	228 909	46	59	3 795	1 256	519	114 793 341	UOE
Uruguay	2001	6 459	m	m	m	m	m	m	3 324 810	UIS
	2006	8 485	2 796	33	66	11	n	n	3 327 451	UIS
	2010	7 551	3 086	41	67	39	6	3	3 368 786	UIS
North America and Western Europe										
Austria	2000	24 981	6 892	28	50	1 790	588	219	8 004 712	UOE
	2006	34 825	m	m	m	2 158	m	m	8 273 208	UOE
	2011	63 754	22 389	35	56	2 359	679	315	8 413 429	UOE
Belgium	2000	68 225	20 768	30	54	1 147	138	45	10 175 684	UOE
	2006	81 546	23 060	28	58	1 718	261	99	10 474 993	UOE
	2010	102 693	31 555	31	58	2 126	341	161	10 712 066	UOE
Canada	1999	225 050	77 341	34	60	3 978	757	391	30 383 823	UOE
	2006	m	m	m	m	4 608	993	564	32 627 978	UOE
	2011	m	m	m	m	m	m	m	34 349 561	UOE
Cyprus	1999	2 597	1 091	42	60	n	n	n	690 497	UOE
	2006	3 858	1 687	44	61	29	7	2	778 684	UOE
	2010	5 053	2 477	49	57	30	6	1	839 751	UOE
Denmark	2000	33 188	8 278	25	45	m	m	m	5 339 501	UOE
	2006	47 539	14 463	30	52	910	125	57	5 442 644	UOE
	2010	54 271	17 770	33	52	1 388	134	62	5 550 142	UOE
Finland	2000	36 141	8 228	23	68	1 797	332	169	5 173 370	UOE
	2006	40 472	9 451	23	71	1 846	m	m	5 265 936	UOE
	2011	51 441	12 675	25	65	1 850	365	228	5 384 770	UOE

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
France	2000	500 079	187 185	37	63	9 903	1 889	770	59 047 795	UOE
	2006	622 937	254 601	41	63	10 650	1 984	941	61 378 065	UOE
	2011	m	m	m	m	m	m	m	63 125 894	UOE
Germany	2000	302 095	62 263	21	43	25 780	3 606	1 111	82 349 027	UOE
	2006	359 365	m	m	m	24 946	4 451	1 628	82 536 138	UOE
	2010	493 249	128 164	22	54	25 629	4 167	1 735	82 302 465	UOE
Greece	2001	38 963	m	m	m	875	m	m	11 032 395	UOE
	2007	60 475	15 419	25	65	2 436	163	65	11 255 717	UOE
	2010	65 096	19 715	30	65	1 892	213	101	11 359 346	UOE
Iceland	2000	1 779	550	31	55	2	n	n	281 210	UOE
	2006	3 397	1 160	34	59	15	1	n	301 010	UOE
	2010	4 105	1 517	37	59	36	1	n	320 136	UOE
Ireland	2000	42 009	13 039	31	58	501	44	26	3 803 780	UOE
	2006	59 184	20 566	35	59	979	115	65	4 226 428	UOE
	2010	58 837	18 134	31	55	1 222	132	73	4 469 900	UOE
Israel	2000	62 363	20 928	34	58	688	81	42	6 014 953	UOE
	2006	m	m	m	m	1 210	190	93	6 755 143	UOE
	2011	m	m	m	m	m	m	m	7 562 194	UOE
Italy	2000	202 309	74 235	37	55	4 044	670	308	56 986 329	UOE
	2006	400 860	134 644	34	58	10 188	1 877	970	59 082 100	UOE
	2011	m	m	m	m	m	m	m	60 788 694	UOE
Malta	2000	1 978	634	32	50	6	1	n	397 420	UOE
	2007	2 729	1 285	47	56	9	2	n	412 608	UOE
	2010	3 032	1 160	38	61	12	2	1	416 515	UOE
Netherlands	2000	79 416	27 439	35	48	2 489	548	201	15 862 825	UOE
	2006	117 392	44 892	38	52	2 993	566	247	16 377 959	UOE
	2010	131 545	49 433	38	53	3 736	720	336	16 612 988	UOE
Norway	2000	29 935	7 717	26	51	658	96	35	4 490 859	UOE
	2006	33 529	m	m	m	882	m	m	4 668 802	UOE
	2010	37 844	11 136	29	56	1 202	109	45	4 883 111	UOE
Portugal	2000	58 456	21 578	37	65	1 586	473	245	10 336 209	UOE
	2006	71 828	23 102	27	66	5 342	1 574	950	10 577 630	UOE
	2010	78 609	23 012	29	63	2 927	805	483	10 675 572	UOE
Spain	2000	260 225	91 195	35	62	6 007	1 143	536	40 288 457	UOE
	2006	285 957	80 830	28	64	7 159	1 342	623	44 017 887	UOE
	2011	381 926	99 556	26	62	8 747	1 585	756	46 454 895	UOE
Sweden	2000	42 390	8 830	21	58	3 049	334	125	8 860 153	UOE
	2006	62 774	15 227	24	63	3 781	352	147	9 090 707	UOE
	2011	69 322	17 958	25	62	3 356	373	187	9 440 747	UOE
Switzerland	2000	55 970	19 792	35	35	2 733	469	122	7 167 908	UOE
	2006	68 607	27 022	39	44	3 381	602	231	7 468 350	UOE
	2010	84 965	31 599	37	48	3 800	708	297	7 664 318	UOE

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
United Kingdom of Great Britain and Northern Ireland	2000	504 078	138 427	27	55	11 566	1 551	628	58 874 117	UOE
	2006	640 246	195 516	31	56	16 465	2 977	1 529	60 538 143	UOE
	2010	709 880	219 551	31	55	18 756	3 804	2 120	62 035 570	UOE
United States of America	2000	2 150 954	877 707	41	56	44 808	10 637	5 548	282 496 310	UOE
	2006	2 639 006	1 005 047	38	56	56 067	10 912	6 221	299 564 470	UOE
	2010	2 997 614	1 138 830	38	56	69 570	12 769	7 412	310 383 948	UOE
South and West Asia										
Bangladesh	2000	138 824	m	m	m	m	m	m	129 592 275	UIS
	2006	m	m	m	m	m	m	m	142 353 501	UIS
	2011	302 965	129 528	43	m	1 134	n	n	150 493 658	UIS
India	2000	m	m	m	m	m	m	m	1 053 898 107	UIS
	2006	m	m	m	m	m	m	m	1 157 038 539	UIS
	2011	m	m	m	m	m	m	m	1 241 491 960	UIS
Iran (Islamic Republic of)	2000	m	m	m	m	m	m	m	65 342 319	UIS
	2006	357 031	78 876	22	51	2 537	159	23	70 582 086	UIS
	2010	607 121	161 372	27	44	4 788	466	91	73 973 630	UIS
Nepal	2000	m	m	m	m	m	m	m	24 400 606	UIS
	2006	28 928	9 554	33	m	50	5	m	m	UIS
	2011	48 162	13 350	28	m	65	7	m	m	UIS
Pakistan	2000	m	m	m	m	m	m	m	144 522 192	UIS
	2006	m	m	m	m	m	m	m	161 513 324	UIS
	2011	m	m	m	m	m	m	m	176 745 364	UIS
Sri Lanka	2000	m	m	m	m	m	m	m	18 745 084	UIS
	2006	m	m	m	m	m	m	m	20 062 070	UIS
	2011	28 285	6 209	m	55	291	m	m	21 045 394	UIS
Sub-Saharan Africa										
Angola	1999	279	123	44	42	a	a	a	13 511 575	UIS
	2006	m	m	m	m	m	m	m	17 010 366	UIS
	2010	5 727	736	13	37	239	96	36	19 081 912	UIS
Burkina Faso	2000	m	m	m	m	m	m	m	12 294 012	UIS
	2006	m	m	m	m	m	m	m	14 622 202	UIS
	2011	14 782	8 213	56	34	m	m	m	16 967 845	UIS
Burundi	2001	762	349	46	45	n	n	n	6 499 653	UIS
	2006	m	m	m	m	m	m	m	7 474 363	UIS
	2010	2 786	1 104	40	36	m	m	m	8 382 849	UIS
Cameroon	2000	m	m	m	m	m	m	m	15 678 269	UIS
	2006	27 838	17 454	63	m	888	241	m	17 948 395	UIS
	2011	36 310	10 498	m	m	m	m	m	20 030 362	UIS
Ghana	2000	m	m	m	m	m	m	m	19 165 490	UIS
	2006	m	m	m	m	m	m	m	22 170 556	UIS
	2012	72 071	34 727	48	38	109	51	12	25 545 939	UIS
Madagascar	2000	m	m	m	m	m	m	m	15 364 272	UIS
	2006	10 109	6 222	62	52	439	151	48	18 426 870	UIS
	2011	20 966	11 984	57	52	879	335	160	21 315 135	UIS

Table A5. **Student graduation, by level, total, social science, business and law, and gender, selected years, 2000 to 2011** *(cont.)*

	Year	ISCED 5-6 All fields	ISCED 5-6 SSBL	ISCED 5-6 % SSBL	ISCED 5-6 % F SSBL	ISCED 6 All fields	ISCED 6 SSBL	ISCED 6 F SSBL	Population	Source
Mauritius	2000	m	m	m	m	m	m	m	1 196 027	UIS
	2006	m	m	m	m	m	m	m	1 266 684	UIS
	2011	6 715	1 890	28	56	9	4	n	1 306 593	UIS
Mozambique	2000	m	m	m	m	m	m	m	18 200 656	UIS
	2005	3 615	1 288	36	38	a	a	a	20 770 013	UIS
	2011	10 070	3 200	32	50	503	289	138	23 929 708	UIS
Nigeria	1999	58 455	m	m	m	m	m	m	120 784 408	UIS
	2006	m	m	m	m	m	m	m	143 338 939	UIS
	2011	m	m	m	m	m	m	m	162 470 737	UIS
South Africa	2000	m	m	m	m	m	m	m	44 760 380	UIS
	2006	m	m	m	m	m	m	m	48 330 914	UIS
	2011	m	m	m	m	m	m	m	50 459 978	UIS

Notes:
1. Symbols used: m = data missing or not available; n = quantity nil; a= not applicable.
2. UOE = UNESCO-UIS, OECD and Eurostat data collection on education systems. UNESCO-UIS, the OECD and Eurostat (UOE) have jointly administered this annual data collection since 1993. The UOE questionnaire compiles data from high- and middle-income countries that are generally members or partner countries of the OECD or the European Union.
3. UIS = UNESCO Institute for Statistics.
4. Population data from United Nations Population Division. SSBL = Social Science, Business and Law.

ISCED 5-6 corresponds to tertiary education and includes the first stage of tertiary education.
ISCED 5A (e.g. Bachelor's and Master's degree programmes in English-speaking countries) and ISCED 5B (i.e. practical or occupationally specific tertiary programmes) and the second stage of tertiary education (i.e. doctorate degree progammes).
ISCED 6 corresponds to the second stage of tertiary programmes that leads to the award of an advanced research qualification, such as a doctorate.(*www.uis.unesco.org/Library/Documents/isced97-en.pdf*)

Source: UNESCO Institute for Statistics online Data Centre. (*http://stats.uis.unesco.org*)

Table A6. **Number of publications of the highest-producing countries in science, social sciences, arts and humanities, 2007 to 2011**

Science			Social Sciences			Arts and humanities		
2007-2011			2007-2011			2007-2011		
Country	No. pub. full	No. pub. frac.	Country	No. pub. full	No. pub. frac.	Country	No. pub. full	No. pub. frac.
United States of America	1 498 826	1 229 894	United States of America	221 918	199 752	United States of America	50 578	48 908
China	621 456	544 102	United Kingdom of Great Britain and Northern Ireland	67 374	54 854	United Kingdom of Great Britain and Northern Ireland	18 770	17 599
Japan	376 564	322 063	Canada	31 989	25 406	France	7 519	7 002
Germany	412 090	290 820	Australia	27 858	23 007	Germany	7 483	6 903
United Kingdom of Great Britain and Northern Ireland	399 318	277 169	Germany	27 366	21 431	Canada	7 338	6 869
France	299 588	208 141	Netherlands	20 985	16 155	Spain	5 449	5 137
Italy	242 966	179 900	Spain	17 650	14 799	Australia	4 985	4 609
Canada	243 397	176 968	France	14 040	10 671	Italy	3 821	3 551
India	196 878	174 310	China	13 493	9 876	Netherlands	2 640	2 353
Republic of Korea	183 362	156 127	Italy	11 198	8 471	Belgium	2 430	2 219
Spain	199 615	147 253	Taiwan, China	8 204	7 202	China	2 263	2 072
Brazil	148 209	126 178	Sweden	8 627	6 787	South Africa	2 146	1 920
Australia	168 634	121 999	Japan	7 422	6 181	Israel	1 872	1 741
Russian Federation	135 485	109 497	Israel	6 799	5 497	Brazil	1 502	1 401
Taiwan, China	111 282	97 569	Belgium	7 649	5 481	Turkey	1 422	1 360
Turkey	100 184	90 588	Turkey	6 141	5 470	Chile	1 290	1 237
Netherlands	132 704	88 418	Switzerland	7 483	5 167	Switzerland	1 339	1 175
Poland	92 328	73 418	South Africa	5 825	4 817	Sweden	1 260	1 152
Iran, Islamic Republic of	73 434	65 295	Norway	5 900	4 634	Russian Federation	1 194	1 152
Switzerland	102 199	61 216	Republic of Korea	5 790	4 335	Japan	1 138	1 012
Sweden	91 404	59 151	New Zealand	5 563	4 202	Poland	958	888
Belgium	76 052	47 534	Brazil	4 877	4 118	Denmark	985	887
Israel	53 418	39 000	Finland	4 543	3 619	New Zealand	965	856
Greece	49 426	37 182	Denmark	4 447	3 349	Republic of Korea	901	827
Denmark	53 523	33 922	India	3 405	2 750	Norway	884	813
Mexico	44 699	33 321	Singapore	3 560	2 492	Austria	891	796
Austria	53 066	32 953	Ireland	3 273	2 479	Argentina	819	757
Finland	45 588	30 482	Austria	3 517	2 470	Taiwan, China	780	742
Czech Republic	41 158	29 022	Greece	2 745	2 215	Croatia	756	737
Portugal	40 820	28 055	Croatia	2 295	2 100	Czech Republic	764	737
Singapore	39 133	27 708	Portugal	2 644	1 943	Slovenia	739	711
Norway	41 146	26 604	Russian Federation	2 207	1 904	Finland	790	710
Argentina	33 887	25 004	Czech Republic	2 010	1 785	Ireland	777	708
Romania	28 183	22 172	Poland	2 088	1 738	Romania	683	651
South Africa	31 849	21 764	Mexico	2 202	1 684	Lithuania	620	612
New Zealand	30 490	20 552	Chile	1 975	1 545	Mexico	632	567
Egypt	24 829	18 836	Romania	1 716	1 530	Greece	632	543
Ireland	28 249	18 808	Slovenia	1 510	1 330	Hungary	549	509

Table A6. **Number of publications of the highest-producing countries in science, social sciences, arts and humanities, 2007 to 2011** *(cont.)*

Science			Social Sciences			Arts and humanities		
2007-2011			2007-2011			2007-2011		
Country	No. pub. full	No. pub. frac.	Country	No. pub. full	No. pub. frac.	Country	No. pub. full	No. pub. frac.
Hungary	26 641	17 739	Argentina	1 434	1 148	Slovakia	479	467
Malaysia	22 885	17 349	Malaysia	1 350	1 085	Portugal	503	437
Thailand	24 062	17 201	Iran, Islamic Republic of	1 289	1 065	Estonia	417	386
Ukraine	22 982	16 848	Hungary	1 196	888	Singapore	413	386
Pakistan	19 362	15 392	Ukraine	936	875	India	419	377
Chile	21 026	13 705	Lithuania	935	843	Colombia	255	221
Serbia	16 464	13 092	Nigeria	888	767	Iran, (Islamic Republic of)	219	199
Slovenia	14 416	10 427	Slovakia	747	639	Nigeria	164	151
Croatia	13 442	10 303	Colombia	818	593	Serbia	154	143
Saudi Arabia	15 114	9 920	Estonia	702	568	Malaysia	158	133
Slovakia	13 417	8 846	Thailand	846	525	Cyprus	124	112
Tunisia	11 781	8 632	Serbia	600	508	Venezuela (Bolivarian Republic of)	118	110

Note: This table is a synthesis of tables prepared by the Centre for Science and Technology Studies (CWTS), Leiden University, the Netherlands. It compares the number of publications that focus on natural sciences, social sciences, and the arts and humanities from 2007 to 2011. Only publications of document types article, note and review are included. The distinction between natural sciences, social sciences, and the arts and humanities is based on the Web of Science standard classification system. Some publications cannot be classified uniquely, as they belong to both the natural sciences and the social sciences. These publications can be handled using either a full or a fractional counting approach. In Table A6, the full counting approach (No. pub. full) is consistent with the ISSC and UNESCO *World Social Science Report 2010*. It counts the same publication as belonging fully to the sciences and fully to the social sciences.

Source: Web of Science.

Table A7. **Number of social science publications per country for 2002 to 2006 and 2007 to 2011, Scopus and Web of Science**

	Scopus 2002-2006		Scopus 2007-2011		WoS 2002-2006		WoS 2007-2011	
Country	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.
Afghanistan	24	16	66	45	4	3	29	15
Algeria	77	69	259	204	9	4	39	29
Argentina	808	660	2 176	1 839	514	393	1 434	1 148
Armenia	53	44	94	76	10	7	26	15
Australia	16 704	14 564	32 157	27 455	12 995	10 902	27 858	23 007
Austria	2 374	1 937	4 396	3 325	1 670	1 268	3 517	2 470
Azerbaijan	11	9	95	81	8	6	20	12
Bahrain	50	37	92	69	28	22	32	24
Bangladesh	307	235	586	418	144	97	300	189
Barbados	61	48	67	51	31	25	56	42
Belarus	52	37	139	107	31	25	59	49
Belgium	4 425	3 486	9 054	6 987	3 703	2 721	7 649	5 481
Bolivia (Plurinational State of)	68	40	111	58	36	20	93	43
Bosnia and Herzegovina	70	43	356	265	43	23	206	138
Botswana	226	192	352	290	111	95	223	179
Brazil	3 188	2 739	12 289	11 234	1 444	1 150	4 877	4 118
Bulgaria	196	143	550	453	70	42	163	104
Burkina Faso	44	23	94	53	31	13	64	31
Cambodia	44	29	90	49	28	16	47	26
Cameroon	110	85	200	148	59	43	98	63
Canada	22 866	19 543	37 316	31 326	20 350	16 777	31 989	25 406
Chile	904	748	2 736	2 301	545	424	1 975	1 545
China	6 310	5 449	42 254	38 828	5 225	3 940	13 493	9 876
China, Hong Kong Special Administrative Region	3 421	2 762	5 749	4 451				
China, Macau Special Administrative Region	29	22	128	92	6	4		
Colombia	366	270	1 650	1 322	194	139	818	593
Costa Rica	132	86	167	112	65	39	114	67
Croatia	1 656	1 559	3 286	3 064	970	898	2 295	2 100
Cuba	163	127	427	359	41	29	106	66
Cyprus	261	204	869	690	217	150	570	411
Czech Republic	1 147	1 027	2 480	2 211	925	833	2 010	1 785
Denmark	2 622	2 158	4 956	3 887	2 180	1 730	4 447	3 349
Ecuador	61	42	118	65	24	15	62	32
Egypt	271	212	838	640	125	91	317	212
Estonia	332	258	863	717	237	184	702	568
Ethiopia	141	96	361	234	99	59	252	154
Fiji	116	88	144	106	39	27	132	90
Finland	3 396	2 866	6 014	4 927	2 482	2 040	4 543	3 619
France	12 804	11 243	24 560	21 002	7 539	6 027	14 040	10 671
Georgia	81	58	161	125	33	20	62	36
Germany	20 163	17 550	33 547	27 812	15 133	12 706	27 366	21 431
Ghana	187	133	471	341	99	64	289	194
Greece	2 256	1 932	4 467	3 750	1 477	1 194	2 745	2 215
Hungary	1 164	964	2 754	2 380	548	390	1 196	888

Table A7. **Number of social science publications per country for 2002 to 2006 and 2007 to 2011, Scopus and Web of Science** *(cont.)*

	Scopus 2002-2006		Scopus 2007-2011		WoS 2002-2006		WoS 2007-2011	
Country	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.
Iceland	206	148	442	307	163	110	360	242
India	3 662	3 313	10 297	9 327	1 703	1 429	3 405	2 750
Indonesia	329	219	715	471	198	123	386	219
Iran, Islamic Republic of	536	459	4 132	3 770	272	218	1 289	1 065
Iraq	25	18	113	89	11	7	37	22
Ireland	1 944	1 618	4 382	3 558	1 266	972	3 273	2 479
Israel	5 427	4 717	8 374	7 130	4 672	3 859	6 799	5 497
Italy	7 423	6 194	15 561	12 720	5 177	3 981	11 198	8 471
Jamaica	80	65	189	154	36	26	99	70
Japan	7 051	6 233	12 575	10 955	4 661	3 966	7 422	6 181
Jordan	193	166	666	567	74	57	179	133
Kazakhstan	30	21	76	58	17	14	47	31
Kenya	355	238	802	514	233	138	544	320
Kuwait	260	226	347	273	183	148	171	121
Latvia	65	44	179	149	43	27	119	87
Lebanon	223	179	490	372	127	93	279	193
Lithuania	221	182	1 201	1 098	138	107	935	843
Luxembourg	77	55	304	209	62	36	290	166
Macedonia (the Former Republic of)	37	24	205	177	14	6	41	26
Malawi	60	38	191	113	39	26	158	85
Malaysia	540	452	4 711	4 237	236	182	1 350	1 085
Malta	70	52	148	110	36	26	79	53
Mauritius	38	29	82	72	17	14	52	44
Mexico	1 774	1 438	3 962	3 293	1 011	779	2 202	1 684
Morocco	110	80	246	187	50	31	97	67
Mozambique	37	23	90	47	21	13	68	31
Nepal	109	76	211	134	53	29	99	55
Netherlands	11 879	9 879	21 323	16 982	11 072	8 964	20 985	16 155
New Zealand	3 903	3 233	6 470	5 105	2 976	2 349	5 563	4 202
Nigeria	748	666	1 935	1 785	310	264	888	767
Norway	3 244	2 721	6 813	5 547	2 730	2 232	5 900	4 634
Oman	61	46	186	141	22	16	62	47
Pakistan	429	367	1 423	1 235	130	97	480	386
Palestine	56	40	120	90				
Peru	166	109	362	222	79	44	295	180
Philippines	378	280	769	594	189	128	441	302
Poland	1 770	1 567	4 138	3 633	699	551	2 088	1 738
Portugal	1 150	903	3 729	2 943	813	599	2 644	1 943
Puerto Rico	189	146	271	192				
Qatar	23	16	228	153	13	9	68	43
Republic of Korea	2 574	2 084	7 127	5 826	2 276	1 752	5 790	4 335
Romania	211	151	2 674	2 429	104	70	1 716	1 530
Russian Federation	2 095	1 811	3 321	2 910	2 025	1 801	2 207	1 904
Rwanda	12	7	80	48	6	4	48	23
Saudi Arabia	190	160	643	485	105	83	216	145
Senegal	95	70	121	77	32	20	72	42
Serbia	28	26	1 164	1 012	67	47	600	508

Table A7. **Number of social science publications per country for 2002 to 2006 and 2007 to 2011, Scopus and Web of Science** *(cont.)*

	Scopus 2002-2006		Scopus 2007-2011		WoS 2002-2006		WoS 2007-2011	
Country	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.	No. pub. full	No. pub. frac.
Singapore	1 784	1 493	4 025	3 132	1 638	1 251	3 560	2 492
Slovakia	390	337	939	796	596	545	747	639
Slovenia	1 025	937	1 964	1 752	384	323	1 510	1 330
South Africa	3 437	2 951	7 033	5 918	2 337	1 939	5 825	4 817
Spain	7 594	6 581	20 711	17 798	6 213	5 230	17 650	14 799
Sri Lanka	173	135	301	206	75	50	158	103
Sudan	33	20	90	61	13	7	50	28
Sweden	5 539	4 648	9 700	7 785	4 683	3 889	8 627	6 787
Switzerland	4 332	3 302	8 175	5 952	3 428	2 487	7 483	5 167
Syrian Arab Republic	31	18	95	63	9	5	24	12
Taiwan, China	2 991	2 658	8 845	7 925	2 755	2 384	8 204	7 202
Thailand	608	445	1 971	1 543	348	223	846	525
Trinidad and Tobago	107	83	201	153	58	42	113	80
Tunisia	156	122	518	405	45	29	210	141
Turkey	2 484	2 199	9 503	8 812	1 744	1 475	6 141	5 470
Uganda	187	113	452	284	124	72	332	176
Ukraine	419	377	911	793	102	74	936	875
United Arab Emirates	290	235	755	586	156	125	492	352
United Kingdom of Great Britain and Northern Ireland	52 101	46 178	81 673	70 144	43 341	37 157	67 374	54 854
United Republic of Tanzania	162	97	406	239	115	61	304	159
United States of America	160 857	150 499	243 160	223 495	168 286	156 606	221 918	199 752
Uruguay	89	67	192	144	60	43	117	77
Venezuela (Bolivarian Republic of)	370	323	720	627	95	71	416	352
Viet Nam	206	120	492	301	101	51	288	156
Zambia	47	26	140	80	40	20	122	67
Zimbabwe	139	100	231	147	87	52	180	110

Note: Table A7 is a synthesis of tables prepared by the Centre for Science and Technology Studies, Leiden University, the Netherlands. It compares the number of social science publications per country following the Web of Science database and the Scopus database for two periods 2002-2006 and 2007-2011. From the Web of Science, only publications of document types article, note and review are included; from Scopus, only publications of document types article, conference paper and review are included. Scopus main fields Psychology (All Science Journal Classification code 32*) and Social Sciences (All Science Journal Classification code 33*) jointly define what are considered as social sciences.

The full and fractional counting results are provided. The fractional counting approach assigns for example a weighting of a third to each of three countries that co-authored a publication. The full counting approach assigns the same publication fully (a weighting of one) to each of the three countries. The countries to which a publication is assigned are the those mentioned in the address list of the publication (not necessarily the countries of origin of the publication authors).

Annex B

Bibliometric analysis of social science research into global environmental change

B1
Bibliometric analysis of social science research into climate and global environmental change

by
Ludo Waltman

The Centre for Science and Technology Studies (CWTS) at Leiden University carried out a bibliometric analysis of social science research on climate change and global environmental change as background information for this World Social Science Report 2013. This article describes how publications dealing with global environmental change were identified, the methodological challenges involved in producing a map of social science research on this domain, and the limitations of the analysis.

Introduction

The bibliometric analysis of social science research on climate change and global environmental change poses significant methodological challenges. The first is to identify the social science literature itself. The second is to identify those publications that deal with the topic of global environmental change from within this literature. The third is to identify the main topics studied within this literature. This article presents the approach that we have taken to deal with these problems.

It is not feasible to identify all relevant publications with perfect accuracy. This would require a group of experts to read many thousands of publications in many social science as well as science journals, and to determine for each of these publications whether or not they are relevant. Although our algorithmic approach does not achieve perfect accuracy, we do believe that in many respects it provides a reasonable approximation. Here we discuss how we have addressed the identification of main topics studied in social science literature on global environmental change and show the 13 main topics identified within the global environmental change literature.

Our analysis is based on the Web of Science (WoS) bibliographic database produced by Thomson Reuters and licensed by CWTS. The period of analysis is 1990-2011. This database covers a significant portion of the international scientific literature in the sciences, the social sciences and the humanities. Together with the Scopus bibliographic database produced by Elsevier, the WoS is the only bibliographic database available for large-scale multidisciplinary bibliometric analyses. A major advantage of this database over others, such as Scopus or Google Scholar, is that the data offered by the WoS is of higher quality (there are fewer errors and missing elements in the data). In most of the sciences, the WoS is also known to have a good coverage of the international scientific literature (Moed, 2005).

The WoS does, however, have some well-known limitations. In the humanities and some of the social sciences, it has a considerably less comprehensive coverage of the literature.[1] In addition, it covers only a relatively small proportion of the scientific output in journals with a national or regional focus. Non-English-language journals especially are covered only to a very limited extent. It should also be mentioned that publications outside the journal literature, in particular book publications, are not included in the WoS. Although the WoS nowadays includes a book citation index, because of technical reasons[2] it was not possible to use this index in the analysis presented in this report.

We shall first discuss the approach that we have taken to delineate the social science literature on global environmental change. We shall then describe our methodology for identifying the main topics within the selected literature. Some results of the analysis will then be presented together with the different tables.

Relevant literature

Delineation of the social science literature on global environmental change was done in the following three steps.

Step 1. We started by identifying all WoS-indexed social science publications in the period 1990-2011. A publication was considered to be part of the social sciences if the journal in which it has appeared is classified in one or more social science fields in the database. Multidisciplinary journals such as *Nature, Proceedings of the National Academy of Sciences of the USA*, and *Science* do not have a social science classification in the WoS, and their publications were not included. This may have led to a certain underestimation of the number of social science articles, discussed in Appendix 1, below.

We took into account not only ordinary research articles, but also other types of publications, such as review articles, letters and editorials.

For the purpose of our specific analysis of global environmental change, publications in journals classified in the fields of History and Philosophy were added to the social sciences database (even though in the WoS these are arts and humanities fields). The 51 WoS fields included in the analysis are listed in Table 1.

Table 1. **Web of Science fields included in the identification of social science publications**

Anthropology	*Gerontology*	*Psychology, developmental*
Area studies	*Health policy and services*	*Psychology, educational*
Business	History	*Psychology, experimental*
Business, finance	History of social sciences	*Psychology, mathematical*
Communication	Hospitality, leisure, sport and tourism	*Psychology, multidisciplinary*
Criminology and penology	Industrial relations and labour	*Psychology, psychoanalysis*
Cultural studies	Information science and library science	*Psychology, social*
Demography	International relations	Public administration
Economics	Law	Social issues
Education and educational research	*Linguistics*	*Social sciences, biomedical*
Education, special	Management	Social sciences, interdisciplinary
Environmental studies	Philosophy	Social sciences, mathematical methods
Ergonomics	Planning and development	*Social work*
Ethics	Political science	Sociology
Ethnic studies	*Psychology, applied*	Transportation
Family studies	*Psychology, biological*	Urban studies
Geography	*Psychology, clinical*	*Women's studies*

Note: The fields shown in italics are related to psychology, education, and health, and as discussed in step 3 below, are treated differently in the analysis.

In total, 3.3 million publications were identified in these fields. We shall discuss below the sensitivity of our analysis to the way in which we defined the social sciences.

Step 2. In the second step, we calculated for each social science publication a score that indicates the degree to which the publication appears to be related to the topic of global environmental change. To calculate the score of a specific publication, we looked at the terms occurring in the title and abstract of the publication. The presence of certain search terms related to global environmental change in the title or abstract of a publication increases the score of the publication. The higher the score of a publication, the more strongly the publication was considered to be related to the topic of global environmental change. We used 40 different search terms, which are listed in Table 2. These search terms were based on suggestions received from a number of social science experts who were asked for their input. Many different search terms were suggested by the experts. To get an impression of the effect of using certain search terms, so-called term maps were produced, which visually indicate the consequences of the use of certain terms (see Appendix B1, below). On the basis of the term maps, some terms were rejected since they yielded too many non-relevant publications. To determine the scores of the remaining terms, the effect of different scores on the final selection of global environmental change publications was examined for each term, and the score that appeared to give the most satisfactory precision-recall trade-off was chosen. This means that in the trade-off between accuracy and comprehensiveness, we preferred to possibly exclude some relevant articles rather than have too many false positives, publications incorrectly considered to be related to global environmental change. Precision was estimated by taking random samples of publications and by inspecting their titles in order to assess the relevance of the publications to the topic.

Table 2. **The 40 search terms and their scores**

Search term	Score	Search term	Score
climate change	4	emission	1
climate policy	4	energy	1
climatic change	4	environment	1
CO_2 emission	4	environmental problem	1
global environmental change	4	environmental quality	1
global warming	4	global change	1
greenhouse gas	4	land use	1
Kyoto Protocol	4	mitigation	1
sustainable development	2	natural resource	1
environmental change	2	pollution	1
environmental policy	2	population growth	1
adaptation	1	resilience	1
agriculture	1	sustainability	1
biodiversity	1	tourism	1
carbon	1	toxic	1
city	1	transport	1
climate	1	vulnerability	1
conflict	1	waste	1
CO_2	1	water quality	1
ecosystem	1	water resource	1

Note: The term “environment” is counted only if a publication does not contain the terms “business environment”, “competitive environment”, “cultural environment”, “family environment”, “learning environment”, “market environment”, “regulatory environment”, “school environment”, “social environment”, “virtual environment”, or “work environment”. There turn out to be a substantial number of publications that are not related to the topic of global environmental change and that contain these terms.

Table 2 shows for each search term the score that is obtained by a publication if the term occurs in the title or abstract of the publication. For instance, if a publication has both the term "climate policy" and the term "sustainable development" in its title or abstract, the publication has a score of 4 + 2 = 6.

Step 3. In the third and final step, publications were classified as being related to the topic of global environmental change if their score was above a certain minimum value. A distinction was made between social sciences related to psychology, education and health, and other social sciences. The WoS fields considered to be related to psychology, education and health are shown in italics in Table 1, above. In these fields, a publication was classified as global environmental change-related if it had a score of at least 4. In the other fields, a score of 3 was sufficient to be classified as global environmental change-related. The reason for requiring a higher score in the psychology, education and health-related social sciences is that in these fields, there turned out to be considerably more false positives (publications incorrectly considered to be relevant) than in other fields. To reduce the effect of false positives, we decided to have a higher threshold for publications in these fields. As an example, consider a publication with the terms "environmental change" (score 2) and "conflict" (score 1) in its title and abstract. This publication has a score of 3. If the publication is in a psychology field, this would not be sufficient to be counted as a global environmental change-related publication. On the other hand, if the publication is in a field such as economics, this score would be sufficient for it to be classified as global environmental change-related. It was found that there were 27 499 social science publications classified as being related to global environmental change during the time period in question.

Identification of the main topics

The main topics in the social science literature on global environmental change were identified on the basis of the 27 499 global environmental change-related social science publications selected using the methodology discussed in the previous section. The identification was done using an algorithmic approach which can be summarised in three steps. In the first step, the relatedness of publications is determined on the basis of citation relations. In the second step, related publications are grouped together into clusters. And in the third step, each cluster of publications is given a label. We now discuss each of the three steps in more detail.

Step 1: Determining the relatedness of publications based on citation relations. Three types of citation relations were considered: direct citation relations, co-citation relations and bibliographic coupling relations. Two publications have a co-citation relation if there is a third publication that cites both publications. The other way around, two publications have a bibliographic coupling relation if there is a third publication that is cited by both publications. In our approach, a citation from a citing publication to a cited publication is taken into account only if the cited publication appeared less than ten years before the citing publication. Citations going back more than ten years often point to "citation classics", and these citations are assumed to be less informative for the purpose of establishing the relatedness of publications.

Step 2: Grouping together related publications using a clustering technique. The approach taken in this step is similar to the approach introduced by Waltman and Van Eck (2012). The clustering technique that was used has two parameters: a resolution parameter that determines the level of detail of the clustering, and a parameter that determines the minimum number of publications per cluster. The minimum number of publications per cluster was set to 500. The resolution parameter was set to a value of 0.00004, which resulted in the identification of 14 clusters of publications. Tests were also performed with smaller (about 5) or larger (about 30) numbers of clusters, but the results with 14 clusters were found to be the easiest to interpret. In addition, out of the 27 499 publications, 5 304 could not be assigned to a cluster, as they did not have sufficient citation relations with other publications within our selection.

Step 3: Labelling the clusters of publications. The clusters were labelled with the help of a domain expert. For each cluster, we showed the expert a list of 20 characteristic terms extracted from the titles and abstracts of the publications belonging to the cluster. We also showed lists of the five authors and the five journals with most publications in the cluster, as well as a list of the five most frequently cited publications in the cluster. Based on this information, the domain expert was able to label the clusters. However, in the case of one cluster, the expert indicated that he actually did not consider the publications in the cluster to be related to social science research on the topic of global environmental change[3] It was decided to leave out the 711 publications in this cluster from all further analyses. This then reduced the number of publications from 27 499 to 26 788. The labels given by our domain expert to the 13 remaining clusters of publications are listed in Table 3 below. For each cluster, the table also reports the number of publications belonging to the cluster. In the next section, we will refer to the clusters of publications as "topics".

Table 3. **Main topics identified in the social science literature on global environmental change and number of publications concerned**

Topic	Number of publications
Modelling energy systems	4 430
Vulnerability and resilience of socio-ecological systems	4 071
Environmental governance	3 492
Sustainable urban planning	1 177
Sustainable rural development	1 154
Transport economics and policy	1 151
Business strategy and sustainability	1 149
Economic development and the environment	1 077
Spatial environmental planning	1 011
Energy and resource analysis	831
Climate change impacts and adaptation	725
Sustainable tourism	678
Economic valuation of the environment	538

Results

The results of the analysis are presented in Tables B1 to B7.[4] Some definitions and explanations of the terms used are needed to facilitate understanding and avoid misinterpretation.

Publication counts. In general, there are two ways in which scientific publications can be counted, a full or a fractional counting approach (e.g. Aksnes, Schneider and Gunnarsson, 2012). The difference between the two approaches is important when publications are counted at different levels of aggregation, for instance at the level of individual countries and at the level of the world as a whole. Suppose we have a publication with four countries in the address list: People's Republic of China, France, Germany and the United States. In the full counting approach, this publication is fully attributed to each of the four countries. In the fractional counting approach, on the other hand, the publication is attributed to each country with a weight of 1 / 4 = 0.25. In the fractional counting approach, the sum of the weights with which a publication is attributed to countries always equals one.

The full counting approach leads to integer publication counts and is therefore relatively easy to understand. However, the disadvantage of the full counting approach is that publication counts at different aggregation levels cannot be compared with each other. This is illustrated by the following example. Consider a world in which there are just three publications: a Chinese publication, a US publication, and a publication co-authored by authors from China and the United States. In the full counting approach, China and the United States each have 2 publications while the total number of publications in the world equals 3. We now have two aggregation levels that do not properly match with each other. At the higher aggregation level, the level of the world as a whole, we have fewer publications than at the lower aggregation level, the level of individual countries. At the former level we have 3 publications, while at the latter level we have 2 + 2 = 4 publications. Comparing the publication counts at the two levels would lead to the odd result that China and the United States have each contributed 2/3 = 66.7% of the worldwide publication output, making their joint contribution 133.3%.

In the fractional counting approach, publication counts at different aggregation levels can be compared without such problems. In the above example, the publication co-authored by China and the United States would be attributed to each of the two countries with a weight of 1 / 2 = 0.5. Each country would therefore have a fractional publication count of 1 + 0.5 = 1.5. This means that both at the level of the world as a whole and at the level of the individual countries, the total number of publications would be 3. In addition, each of the two countries would have contributed half (1.5 / 3 = 50%) of the worldwide publication output.

Because the full counting approach easily leads to difficulties when comparing publication counts at different aggregation levels, our general recommendation is to focus on publication counts calculated according to the fractional counting approach.

We further note that the distinction between the two counting approaches is relevant when counting publications per field of science in much the same way as when counting publications per nation. When publications are assigned to fields based on the journal subject categories in the WoS database, some publications will belong to more than one field. Counting publications per field then has similar difficulties to counting publications per country, and again the use of fractional publication counts is recommended.

Mean normalized citation scores. The mean normalised citation score (MNCS) of a set of publications indicates the average number of times the publications have been cited, normalised for the field and the age of each publication (Waltman et al., 2011). An MNCS value above (below) 1 indicates that on average the publications have been cited more (less) frequently than would be expected based on their field and age. For instance, if the MNCS value of a set of publications equals 1.5, the publications have been cited 50% more frequently than the average of their field and publication year. In the calculation of MNCS values, fields are defined by journal subject categories in the WoS database. (The journal subject categories in the social sciences are listed in Table 1) This for instance means that the citation frequency of a publication in the WoS subject category Economics is compared with the average citation frequency of all publications in the Economics subject category in the same publication year.

As in the case of publication counts, MNCS values can be calculated using either a full or a fractional counting approach. When working with fractional publication counts, for consistency reasons fractionally calculated MNCS values should also be used. When a fractional counting approach is used to calculate the MNCS value of a country, publications co-authored with other countries have less weight in the MNCS calculation than publications that have not been co-authored with other countries.

Time trends. The period of analysis used is 1990-2011. In some of the results, this period is split into a number of subperiods: 1990-1994, 1995-1999, 2000-2004, 2005-2009 and 2010-2011. When working with WoS data (or data from any bibliographic database), it is important to remember that time trends may be caused partly by changes in the WoS coverage of the scientific literature (e.g. Michels and Schmoch, 2012) rather than by true scientific developments. The number of journals indexed in the WoS has increased substantially, and more and more national scientific journals as well as international journals are now being indexed. This means that even if the actual publication output on a particular topic has not increased over time, there may appear to be an increasing trend when looking at WoS data.

General results

As mentioned above, the final number of publications included in the analysis is 26 788. Some general results based on these publications are presented in Part 2 of this Report. The full results are presented in Annex B, Tables B1 to B7 – see list in Table 4 below.

Table 4. **List of tables in Annex B**

Table B1	Number of social science publications on global environmental change per year, 1990 to 2011
Table B2	Number of social science publications (fractional counting) on global environmental change per Web of Science field of study and time period, 1990 to 2011
Table B3	Number of social science publications (fractional counting) on global environmental change per region, country and time period, 1990 to 2011
Table B4	Number of social science publications (fractional counting) on global environmental change per region and time period, 1990 to 2011
Table B5	Number of social science publications (fractional counting) on global environmental change per Web of Science fields of study and region for the entire period, 1990 to 2011
Table B6	Number of social science publications (fractional counting) on global environmental change per topic for different time periods, 1990 to 2011
Table B7	Number of social science publications (fractional counting) on global environmental change per topic and region for two time periods 1990 to 1999 and 2000 to 2011

In all cases, both full and fractional publication counts are provided. When interpreting the results per main topic, it is important to keep in mind that there are 5 304 publications that have not been assigned to a topic (see above).

Limitations

There are limitations to the analysis presented, the most important of which are discussed below. In the interpretation of the results of our analysis, it is essential to take these limitations into consideration. As with any bibliometric analysis, the reader should be aware of possible biases caused by the limitations of bibliographic databases, methodological limitations, and possible subjective choices from experts.

Web of Science database

As noted above, the coverage of the WoS database in the social sciences is far from comprehensive. In particular, national journals and non-English-language journals have a limited coverage. Also, the WoS does not cover publications outside the journal literature, for instance book publications.

Definition of the social sciences

As noted above, a publication is considered to belong to the social science literature in our analysis if it has appeared in a journal that is classified as a social science journal in the WoS database. However, some social science publications appear in journals that do not have a social science classification in the WoS database. These publications have not been included in our analysis. The consequences of this limitation are discussed in more detail in Appendix 1, below.

Possible biases resulting from expert input

The core of the methodology adopted in our analysis consists of computer algorithms for the large-scale analysis of bibliographic data. These algorithms rely on input provided by social science experts, for instance regarding the search terms for delineating the global environmental change literature, the thresholds for determining whether a publication is considered to be part of the global environmental change literature, and the labelling of clusters of publications. The involvement of a limited number of experts who may be more specialised in certain areas than others inevitably introduces the risk of biases. For instance, the choice of appropriate search terms (and the associated scores; see Table 2 above) has been a highly complex element of our analysis. Although considerable attention has been paid to making a careful choice of search terms, there remains the possibility of biases toward certain research areas.

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Appendix 1. Identifying social science publications

It is not always easy to identify social science publications. As described above, a publication has been considered to be part of the social sciences in our analysis if the journal in which it has appeared is classified in one or more social science fields in the WoS database. However, some social science publications appear in journals that do not have a social science classification in the WoS database. This may happen especially in the case of publications in multidisciplinary journals. For instance, multidisciplinary journals such as *Nature, Proceedings of the National Academy of Sciences of the USA*, and *Science* do not have a social science classification in the WoS, and publications in these journals therefore have not been included in our analysis. Below, we try to measure the sensitivity of our analysis to the way in which we define the social sciences, and we make an attempt to estimate the bias that was introduced by doing our analysis only based on journals classified as social sciences in the WoS.

With the help of an expert, a list of 30 science or multidisciplinary journals was compiled that are known to publish social science research on global environmental change. Out of these 30, ten did not have a social science classification in the WoS, and publications in these journals had therefore not been included in our analysis. The list consists of the following ten journals:

- *Bioscience*
- *Climatic Change*
- *Current Opinion in Environmental Sustainability*
- *Environmental Conservation*
- *Environmental Research Letters*
- *Environmental Science and Policy*
- *Mitigation and Adaptation Strategies for Global Change*
- *Proceedings of the National Academy of Sciences, United States*
- *Science*
- *Sustainability Science*

We applied the same search strategy as described in step 2 above to the publications in the above ten journals. This yielded 4 590 publications that appeared to be related to global environmental change. These publications have a score of at least 4 based on the search terms listed in Table 2 above. Some of these publications have a clear social science focus, while many others deal with research topics from the natural sciences. It turned out to be somewhat difficult to make a precise distinction between the two categories of publications. However, based on an inspection of the titles of the publications, we roughly estimate that about one-third of the publications can be considered to be of a social science nature. Given that in the analysis reported in the main text we have 26 788 publications, this means that about 5 or 6% of the relevant publications are missing in the analysis because of inaccuracies in the definition of the social sciences. Since we looked at only ten journals, this should be seen as a lower bound for the true percentage of missing publications.

Appendix 2. List of countries by region

Arab states

Algeria
Egypt
Jordan
Kuwait
Lebanon
Morocco
Oman
Qatar
Saudi Arabia
Syrian Arab Republic
Tunisia
United Arab Emirates

East Asia

Brunei Darussalam
Cambodia
China, Hong Kong Special Administrative Region
Indonesia
Japan
Lao People's Democratic Republic
Malaysia
Mongolia
Myanmar
China
Philippines
Republic of Korea
Singapore
Taiwan, China
Thailand
Viet Nam

Commonwealth of Independent States

Kazakhstan
Kyrgyzstan
Georgia
Russian Federation
Tajikistan
USSR (former)
Uzbekistan

Latin America

Argentina
Bahamas
Barbados
Belize
Bolivia (Plurinational State of)
Brazil
Chile
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
French Guyana
French Guadeloupe

Guatemala

Guyana

Haiti

Honduras

Jamaica

Mexico

Nicaragua

Panama

Paraguay

Peru

Saint Lucia

Trinidad and Tobago

Uruguay

Venezuela (Bolivarian Republic of)

North America

Canada

United States of America

Oceania

Australia

Fiji

Micronesia (Federated States of)

New Caledonia (France)

New Zealand

Papua New Guinea

Solomon Islands

South and West Asia

Afghanistan

Bangladesh

Bhutan

India

Iran (Islamic Republic of)

Nepal

Pakistan

Sri Lanka

Southern, Central and Eastern Europe

Albania

Bosnia and Herzegovina

Bulgaria

Croatia

Czech Republic

Czechoslovakia (former)

Estonia

Hungary

Latvia

Lithuania

Macedonia (the former Republic of)

Poland

Romania

Serbia

Slovakia

Slovenia

Turkey

Ukraine

Yugoslavia (the former Republic of)

Sub-Saharan Africa

Benin

Botswana

Burkina Faso

Burundi

Cameroon

Congo

Democratic Republic of the Congo

Eritrea

Ethiopia

Ghana

Côte d'Ivoire

Kenya

Lesotho

Malawi

Mali

Mauritius

Mozambique

Namibia

Niger

Nigeria

Reunion (French)

Rwanda

Senegal

Seychelles

Sierra Leone

South Africa

Swaziland

Togo

Uganda

United Republic of Tanzania

Zambia

Zimbabwe

Western Europe

Austria

Belgium

Cyprus

Denmark

Finland

France

Germany

United Kingdom of Great Britain and Northern Ireland

Greece

Iceland

Ireland

Israel

Italy

Luxembourg

Malta

Monaco

Netherlands

Norway

Portugal

Spain

Sweden

Switzerland

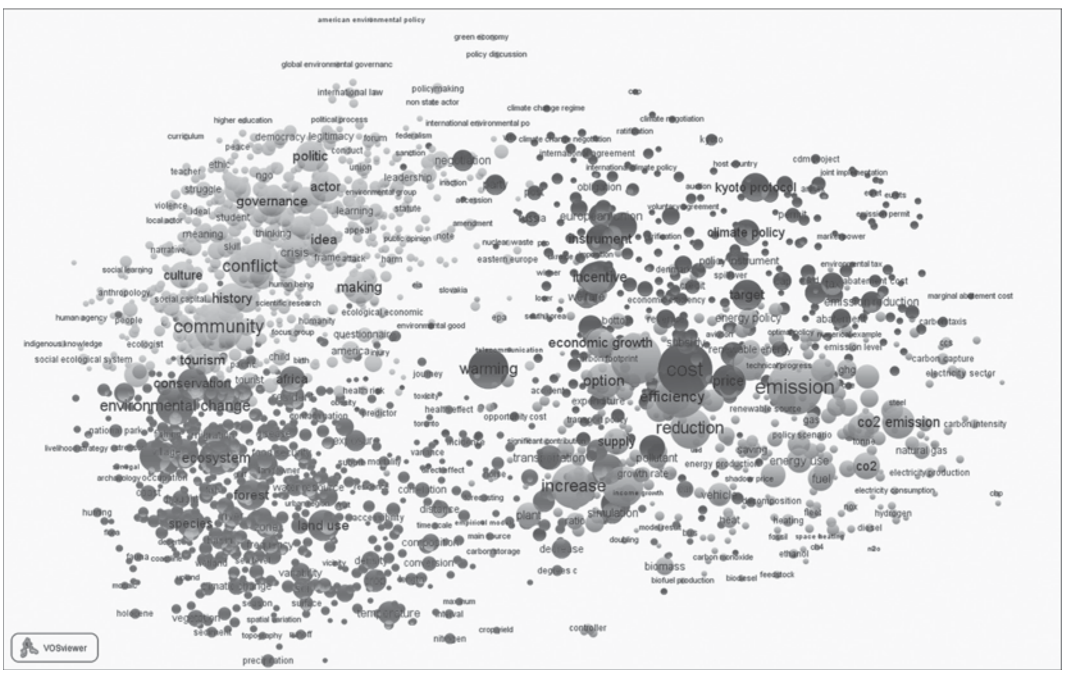
Appendix 3. Term map

A term map visualises the most important terms occurring in the titles and abstracts of a set of publications. In our analysis, term maps were used to support the process of selecting search terms for delineating the social science literature on global environmental change. Here, we present a term map that illustrates the final selection of 27 499 publications that resulted from the delineation of the literature on global environmental change as described above. The term map is shown in Figure B1.1. To create this map, the 2 000 most relevant terms were identified in the titles and abstracts of the 27 499 publications. Each term occurs in at least 25 publications.

The interpretation of the term map is as follows. The map displays 2 000 circles. Each of these circles represents a term. (Because of space limitations, not all terms are shown on the map.) The larger the number of publications in which a term occurs in the title or abstract, the larger the size of the corresponding circle. Terms that often occur together in publications are shown close to each other in the map. Terms with no or almost no co-occurrences are shown further away from each other. In this way, the grouping of terms in the map provides an indication of the main topics in the social science literature on global environmental change. It is important to be aware that in the interpretation of the map, only the distances between terms are important. The horizontal and vertical axes have no special meaning. Based on co-occurrence relations, terms have also been grouped together using a clustering technique. Four clusters of terms have been identified, each indicated using a different colour in the term map.[5]

The construction and visualization of the term map was done using the VOSviewer software for bibliometric mapping (Van Eck and Waltman, 2010). An interactive version of the map is available online at *http://tinyurl.com/bjgv9aj*. The interactive map allows one to zoom in on specific areas of the map in order to get a more detailed insight into the map's structure.

Figure B1.1 **Term map based on the titles and abstracts of the 27 499 selected social science publications on global environmental change**



Notes

1. According to Moed (2005), the WoS has a good coverage in psychology, in health-related social sciences, and in economics-related social sciences. In other social sciences, including sociology, political science, education, and anthropology, the WoS has a moderate coverage. Refer to Archambault and Larivière (2010) for a further discussion of the limitations of the use of bibliometrics in the social sciences.
2. The raw data is not yet directly available for large-scale bibliometric analysis.
3. The five most characteristic terms for this cluster were "climatic change", "holocene", "sediment", "human evolution", and "late holocene", and more than two-thirds of the publications in the cluster were from the WoS field Anthropology.
4. Others- not directly quoted in this article - will be made available on ISSC website.

5. Note that these clusters of terms are different from the clusters of publications described earlier. The two clusterings have been produced based on different methodologies, one based on co-occurrences of terms and the other based on citation relations between publications.

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Table B1. **Number of social science publications on global environment change per year, 1990 to 2011**

Years	Number of publications
1990	154
1991	366
1992	462
1993	548
1994	620
1995	629
1996	687
1997	707
1998	793
1999	812
2000	888
2001	913
2002	929
2003	983
2004	980
2005	1 087
2006	1 424
2007	1 806
2008	2 323
2009	2 758
2010	3 358
2011	3 561

Note: See Annex B1, article by Waltman, for information on methodology uses and definitions.
Source: Web of Science.

Table B2. **Number of social science publications (fractional counting) on global environmental change per Web of Science field of study and time period, 1990 to 2011**

field	1990-2011	1990-1994	1995-1999	2000-2004	2005-2009	2010-2011
Anthropology	392.3	37.7	56.3	81.5	129.2	87.6
Area Studies	329.1	23.3	52.7	72.0	99.7	81.5
Business	456.7	30.2	60.2	64.0	161.8	140.5
Business, Finance	141.2	12.7	13.7	23.0	71.8	20.0
Communication	161.3	0.3	19.8	29.5	60.8	50.8
Criminology and Penology	7.2	0.0	1.0	0.5	1.3	4.3
Cultural Studies	47.3	1.0	1.5	5.0	9.3	30.5
Demography	148.5	15.0	38.0	30.0	34.0	31.5
Economics	3 947.8	320.6	647.7	755.5	1 359.7	864.4
Education and Educational Research	203.0	8.0	9.0	15.0	76.5	94.5
Environmental Studies	8 737.8	536.8	826.0	1 325.6	3 329.4	2 720.0
Ergonomics	10.2	1.2	3.8	0.3	3.0	1.8
Ethics	261.8	21.0	47.0	65.5	84.0	44.3
Ethnic Studies	7.8	1.2	1.0	1.5	2.7	1.4
Family Studies	3.7	0.0	0.3	2.8	0.5	0.0
Geography	2 708.4	339.3	481.2	449.7	834.4	603.8
Gerontology	12.5	0.0	1.0	1.0	5.0	5.5
Health Policy and Services	69.2	4.3	11.7	2.3	28.2	22.7
History	307.8	6.0	35.7	66.3	121.7	78.2
History of Social Sciences	43.2	1.7	4.3	8.5	20.8	7.8
Hospitality, Leisure, Sport and Tourism	273.8	4.7	14.3	11.5	103.7	139.7
Industrial Relations and Labour	20.5	4.0	5.5	4.2	6.0	0.8
Information Science and Library Science	195.5	14.3	35.3	43.5	57.0	45.3
International Relations	670.7	78.7	85.3	116.2	243.8	146.7
Law	553.8	49.7	56.8	86.3	216.0	144.9
Linguistics	5.8	0.0	0.0	0.0	3.0	2.8
Management	339.0	10.3	31.7	56.0	115.5	125.5
Philosophy	53.3	2.0	11.5	4.5	18.7	16.7
Planning and Development	1 521.0	150.9	261.0	323.8	494.1	291.3
Political Science	1 013.5	90.8	145.0	194.2	366.7	216.9
Psychology, Applied	15.5	3.2	1.5	2.3	4.7	3.8
Psychology, Biological	8.3	1.3	2.0	1.0	2.0	2.0
Psychology, Clinical	17.0	1.0	0.5	7.0	2.5	6.0
Psychology, Developmental	5.5	1.0	2.0	1.0	0.5	1.0
Psychology, Educational	10.0	0.0	1.0	1.0	4.0	4.0
Psychology, Experimental	9.5	2.0	1.0	0.0	4.0	2.5
Psychology, Mathematical	0.5	0.0	0.0	0.0	0.5	0.0
Psychology, Multidisciplinary	108.5	12.8	14.8	18.0	35.5	27.3
Psychology, Psychoanalysis	3.0	1.0	0.0	1.0	1.0	0.0
Psychology, Social	34.0	4.0	5.0	6.0	7.5	11.5
Public Administration	713.2	52.0	106.7	171.8	257.2	125.5
Social Issues	308.6	61.0	52.8	61.8	79.5	53.4
Social Sciences, Biomedical	34.3	4.2	7.8	2.0	13.8	6.5
Social Sciences, Interdisciplinary	400.1	34.9	53.8	89.0	146.5	75.9

Table B2. **Number of social science publications (fractional counting) on global environmental change per Web of Science field of study and time period, 1990 to 2011** *(cont.)*

field	1990-2011	1990-1994	1995-1999	2000-2004	2005-2009	2010-2011
Social Sciences, Mathematical Methods	235.2	26.5	42.5	59.0	76.2	31.0
Social Work	23.0	1.0	6.5	3.5	4.5	7.5
Sociology	795.5	85.5	145.3	154.3	249.9	160.4
Transportation	541.7	32.2	69.8	90.3	177.0	172.3
Urban Studies	868.9	60.8	152.0	181.1	270.9	204.1
Women's Studies	12.0	0.0	4.5	3.0	2.0	2.5

Note: See Annex B1, article by Waltman, for information on methodology used and definitions.

Source: Web of Science.

1 2 *http://dx.doi.org/10.1787/888932895425*

Table B3. **Number of social science publications (fractional counting) on global environment change per region, country and time period, 1990 to 2011**

Country	1990-2011	1990-1994	1995-1999	2000-2004	2005-2009	2010-2011
Arab states						
Egypt	17.0	1.0	3.0	2.5	6.0	4.0
Jordan	11.6	1.0	1.0	2.6	3.0	4.0
Lebanon	12.0	0.0	0.8	5.6	1.0	4.5
Saudi Arabia	19.0	1.5	5.0	6.0	7.0	0.0
United Arab Emirates	10.0	0.0	0.0	2.5	2.5	5.0
East Asia						
China, Hong Kong Special Administrative Region	11.5	1.5	9.0	1.0	0.0	0.0
Indonesia	41.0	1.8	6.0	6.0	13.0	13.0
Japan	366.0	11.8	29.0	71.3	136.0	118.0
Malaysia	38.3	1.3	0.0	7.0	13.0	16.0
China	511.0	7.0	15.5	50.0	203.0	235.0
Philippines	34.0	0.5	3.0	6.0	13.0	10.5
Singapore	97.0	5.5	7.0	19.5	30.3	35.0
Korea (Republic of)	124.5	2.0	6.0	19.0	47.0	49.0
Taiwan, China	194.0	3.5	10.0	28.0	93.0	59.0
Thailand	87.0	4.0	10.0	16.0	36.0	20.0
Viet Nam	13.0	0.0	2.0	2.0	5.0	3.0
Commonwealth of Independent States						
Russian Federation	49.5	7.3	11.5	9.0	13.0	7.0
Latin America						
Argentina	45.0	6.5	5.0	6.0	20.0	8.0
Brazil	229.0	10.0	17.0	50.0	80.0	70.0
Chile	64.0	2.5	0.5	10.0	31.0	19.0
Colombia	22.0	1.0	1.0	3.0	11.0	5.0
Costa Rica	15.5	0.0	4.0	4.0	4.8	2.8
Mexico	133.0	4.0	9.0	27.8	58.0	33.0
Venezuela (Bolivarian Republic of)	13.0	1.0	0.0	2.5	4.0	5.5
North America						
Canada	1 285.0	133.0	203.5	204.0	427.0	317.0
United States of America	8 202.0	864.5	1 411.0	1 603.0	2 582.7	1 739.0
Oceania						
Australia	1 329.0	61.0	137.0	180.0	488.0	462.0
Fiji	12.5	1.5	1.0	3.0	4.0	2.0
New Zealand	224.0	16.5	19.0	31.0	93.7	63.5
South and West Asia						
Bangladesh	19.0	2.0	2.0	1.0	4.0	9.0
India	296.0	15.0	37.0	58.0	105.0	80.0
Iran (Islamic Republic of)	32.0	0.0	2.0	1.0	18.0	11.0
Pakistan	12.0	1.0	0.0	1.3	5.0	5.0

Table B3. **Number of social science publications (fractional counting) on global environment change per region, country and time period, 1990 to 2011***(cont.)*

Country	1990-2011	1990-1994	1995-1999	2000-2004	2005-2009	2010-2011
Sri Lanka	14.0	1.0	0.5	2.0	7.0	3.0
Southern, Central, Eastern Europe						
Croatia	48.0	2.0	6.0	13.5	17.0	9.5
Czech Republic	72.0	2.0	14.5	12.5	27.0	16.0
Estonia	14.0	0.0	5.5	1.0	3.0	4.5
Hungary	36.0	8.5	4.0	3.3	14.0	6.0
Lithuania	96.0	0.0	1.0	1.0	57.0	36.0
Poland	111.7	7.0	2.0	3.0	53.0	45.0
Romania	37.6	0.0	0.0	0.0	15.1	22.5
Serbia	14.5	0.0	0.0	0.0	4.0	10.5
Slovakia	50.0	5.0	11.0	19.0	13.0	2.0
Slovenia	40.0	2.0	1.0	2.0	20.0	15.0
Turkey	142.0	0.0	4.5	16.6	73.0	48.0
Ukraine	14.0	0.0	0.0	0.0	3.0	11.0
Sub-Saharan Africa						
Botswana	19.0	1.0	1.0	4.0	6.0	6.0
Ethiopia	18.0	1.0	1.5	1.0	7.0	6.5
Ghana	24.0	4.0	5.5	3.0	9.0	3.0
Kenya	50.0	4.0	5.0	8.0	22.0	11.0
Nigeria	45.0	8.0	3.0	7.5	16.5	10.0
South Africa	210.0	3.5	9.0	23.0	98.9	75.0
United Republic of Tanzania	21.0	0.0	3.0	2.5	10.0	5.0
Zimbabwe	12.0	2.0	2.5	2.0	4.5	0.8
Western Europe						
Austria	272.0	20.3	43.8	44.0	101.0	62.0
Belgium	175.0	7.0	16.0	29.0	62.0	59.0
Cyprus	16.0	0.0	1.0	0.6	9.0	5.5
Denmark	224.0	13.0	27.0	63.5	69.0	50.0
Finland	231.0	7.0	30.8	55.5	82.3	55.0
France	584.0	23.0	54.5	84.0	243.0	178.0
Germany	1 125.0	55.5	103.0	182.0	432.0	352.0
United Kingdom of Great Britain and Northern Ireland	3 914.0	361.0	641.0	792.4	1 251.0	866.0
Greece	173.0	9.0	18.5	25.0	70.0	49.0
Ireland	123.0	1.0	6.5	12.0	60.0	43.0
Israel	89.2	8.0	12.5	15.5	35.0	18.0
Italy	331.0	15.5	40.3	33.0	128.0	113.0
Netherlands	1 000.0	72.0	136.0	201.0	352.0	237.0
Norway	412.0	25.8	48.0	71.3	132.0	134.0
Portugal	73.0	2.0	2.0	8.0	24.0	35.0
Spain	530.0	4.5	15.0	61.0	249.0	200.0
Sweden	603.0	24.0	48.0	106.0	243.0	180.0
Switzerland	360.0	13.0	27.0	46.0	143.0	130.0

Note: See Annex B1, article by Waltman, for information on methodology used and definitions.
Source: Web of Science.

1 2 *http://dx.doi.org/10.1787/888932895444*

Table B4. **Number of social science publications (fractional counting) on global environmental change per region and time period, 1990 to 2011**

Region	1990-2011	1990-1994	1995-1999	2000-2004	2005-2009	2010-2011
Arab states	98.0	3.5	11.0	23.0	32.0	27.0
East Asia	1 529.0	38.0	99.0	228.8	596.0	566.0
Commonwealth of Independent States	60.0	13.0	13.0	10.5	14.8	9.0
Latin America	590.0	27.0	45.0	115.5	237.0	164.9
North America	9 516.0	998.3	1 615.0	1 812.2	3 024.0	2 064.0
Oceania	1 582.0	80.0	157.0	216.0	590.0	537.2
South and West Asia	388.0	21.0	42.0	67.5	144.0	113.0
Southern, Central and Eastern Europe	708.0	32.0	50.5	73.0	309.0	241.0
Sub-Saharan Africa	470.0	30.0	33.5	63.0	196.2	146.4
Western Europe	10 216.0	665.0	1 273.0	1 829.5	3 678.0	2 769.0

Note: See Annex B1, article by Waltman, for information on methodology used and definitions.

Source: Web of Science.

1 2 *http://dx.doi.org/10.1787/888932895463*

Table B5. **Number of social science publications (fractional counting) on global environmental change per Web of Science field of study and region for the entire period, 1990 to 2011**

Field	Arab states	East Asia	Commonwealth of Independent States	Latin America	North America	Oceania	South and West Asia	Southern, Central, Eastern Europe	Sub-Saharan Africa	Western Europe
Environmental Studies	39.0	681.0	19.0	236.0	2 645.0	461.0	169.0	192.0	182.0	3 793.0
Economics	8.0	219.0	4.3	66.5	1 420.0	252.0	42.0	214.0	38.9	1 519.0
Geography	6.0	103.4	9.0	66.0	798.0	214.0	15.0	35.0	62.0	1 257.0
Planning and Development	15.0	80.0	2.0	35.0	493.0	80.0	42.0	24.3	47.9	598.6
Political Science	0.5	13.8	3.5	5.0	388.0	65.3	4.5	8.3	5.0	351.0
Urban Studies	13.3	80.0	1.0	41.0	331.0	40.0	25.8	22.0	21.0	255.0
Sociology	0.1	13.0	6.0	16.0	400.0	42.0	4.5	50.5	6.8	215.5
Public Administration	0.6	19.0	1.0	10.1	323.0	36.0	5.4	13.5	9.0	267.0
International Relations	0.0	42.0	1.5	3.0	207.0	41.0	4.0	3.5	3.0	229.0
Transportation	1.0	45.0	0.0	13.0	157.0	45.0	7.8	6.0	3.0	248.0
Law	0.0	24.0	1.3	5.0	326.0	10.0	8.3	0.0	1.8	81.0
Business	0.6	24.0	0.3	7.9	204.0	17.0	4.0	16.0	4.0	156.0
Anthropology	0.5	9.0	3.0	12.0	195.0	27.0	20.0	20.0	11.5	64.0
Social Sciences, Interdisciplinary	1.5	21.0	0.0	17.3	158.0	12.0	3.0	7.0	13.8	119.0
Management	1.8	22.0	0.0	9.0	106.0	21.0	5.0	12.3	7.0	138.0
Area Studies	1.0	33.8	1.0	5.5	106.9	20.0	0.6	4.5	21.0	88.0
Hospitality, Leisure, Sport and Tourism	3.0	25.0	0.5	4.0	69.0	68.0	1.0	4.0	5.0	90.0
History	0.0	4.5	0.0	5.5	150.0	7.0	3.0	5.0	4.0	79.0
Ethics	0.0	6.0	0.0	3.3	124.0	7.0	3.3	4.3	2.0	105.0
Social Issues	0.0	4.8	1.0	1.0	158.0	9.0	2.5	14.3	2.5	41.0
Social Sciences, Mathematical Methods	0.0	5.0	0.3	1.8	154.0	1.0	0.8	1.0	0.0	62.0
Education and Educational Research	1.0	9.0	0.5	2.0	48.8	19.0	3.0	19.0	3.8	82.0
Information Science and Library Science	1.5	10.8	0.0	5.8	109.0	4.5	6.8	1.0	3.0	39.0
Communication	0.5	3.5	0.0	1.5	83.0	13.0	0.0	0.0	0.5	52.0
Demography	0.5	5.0	0.0	3.0	71.0	8.0	1.0	0.5	2.0	38.3
Business, Finance	0.0	3.5	0.0	0.3	42.0	10.0	0.3	7.0	0.1	49.0
Psychology, Multidisciplinary	0.0	2.0	1.3	1.0	46.0	5.0	0.2	0.5	0.5	44.0
Health Policy and Services	0.0	0.8	1.0	2.0	33.0	11.0	1.0	1.0	1.0	12.0
Philosophy	0.0	0.3	1.0	0.0	15.5	0.3	0.0	14.5	1.0	14.0
Psychology, Social	0.0	2.0	0.0	0.0	15.5	1.0	0.0	1.0	0.0	14.5

Note: See Annex B1, article by Waltman, for information on methodology used and definitions.
Source: Web of Science.

1 2 *http://dx.doi.org/10.1787/888932895482*

Table B6. **Number of social science publications (fractional counting) on global environmental change per topic for different time periods, 1990 to 2001**

Time periods	1990-2011	1990-1994	1995-1999	2000-2004	2005-2009	2010-2011
Topic						
Business strategy and sustainability	1 149	51	151	218	415	314
Climate change impacts and adaptation	725	169	159	99	167	131
Economic development and the environment	1 077	70	174	248	361	224
Economic valuation of the environment	538	38	84	122	192	102
Energy and resource analysis	831	24	121	158	302	226
Environmental governance	3 492	247	397	535	1 273	1 040
Modelling energy systems	4 430	261	487	729	1 739	1 214
Spatial environmental planning	1 011	52	135	186	373	265
Sustainable rural development	1 154	112	165	242	414	221
Sustainable tourism	678	31	84	89	249	225
Sustainable urban planning	1 177	60	200	265	430	222
Transport economics and policy	1 151	47	128	173	430	373
Vulnerability and resilience of socio-ecological systems	4 071	162	389	685	1 547	1 288

Note: See Annex B1, article by Waltman, for information on methodology used and definitions.

Source: Web of Science.

Table B7. **Number of social science publications (fractional counting) on global environmental change per topic and region for two time periods, 1990 to 1999 and 2000 to 2011**

Time period and region	Business strategy and sustainability	Climate change impacts and adaptation	Economic development and the environment	Economic valuation of the environment	Energy and resource analysis	Environmental governance	Modelling energy systems	Spatial environmental planning	Sustainable rural development	Sustainable tourism	Sustainable urban planning	Transport economics and policy	Vulnerability and resilience of socio-ecological systems
1990-1999													
Arab states	0.0	2.8	0.0	0.0	0.0	0.0	2.8	2.7	0.0	0.5	0.0	0.3	0.0
East Asia	3.3	2.6	8.2	0.5	8.8	6.3	24.0	6.8	3.0	3.2	9.8	7.4	17.0
Commonwealth of Independent States	1.5	2.2	0.0	0.0	0.0	3.5	1.5	1.0	0.0	2.0	0.2	0.0	2.3
Latin America	2.0	2.5	2.8	0.0	3.0	1.0	11.7	1.6	1.0	3.0	11.1	4.7	12.6
North America	111.8	177.8	116.9	67.3	57.0	388.5	326.3	112.6	119.8	39.1	85.3	55.3	280.8
Oceania	8.5	10.8	7.4	8.5	7.5	24.2	15.5	8.3	15.5	8.7	19.3	14.7	25.8
South and West Asia	0.0	2.3	2.0	0.0	4.0	4.2	13.4	4.5	0.5	0.0	5.0	1.0	8.7
Southern, Central and Eastern Europe	2.0	0.0	0.0	3.0	0.0	3.0	3.7	6.0	3.5	2.8	1.9	1.3	2.0
Sub-Saharan Africa	0.8	6.0	1.0	1.0	1.0	0.0	3.0	1.0	2.4	2.0	11.7	1.5	14.0
Western Europe	63.2	109.0	99.7	36.7	56.7	183.4	318.2	42.5	123.3	51.8	104.7	82.8	150.8
2000/2011													
Arab states	4.0	1.7	3.3	0.5	7.2	1.0	15.8	8.3	1.0	2.7	9.3	3.7	6.6
East Asia	59.7	16.0	115.7	20.6	140.6	67.9	293.3	115.3	19.6	41.3	79.4	87.1	151.9
Commonwealth of Independent States	2.0	4.1	0.4	1.0	0.0	2.7	4.4	0.5	0.6	0.0	3.4	0.0	2.3
Latin America	18.0	10.1	7.3	4.1	15.0	14.6	85.5	27.9	15.9	8.9	26.1	22.0	124.6
North America	327.2	146.2	280.9	146.0	126.3	1 188.1	1 024.9	253.9	321.0	106.0	250.6	285.2	1 382.1
Oceania	57.7	33.0	46.4	33.9	34.6	172.4	136.1	49.2	81.4	100.0	58.3	69.5	280.4
South and West Asia	8.6	13.2	16.3	6.3	21.0	17.9	54.4	13.2	6.4	7.6	13.9	18.6	53.2
Southern, Central and Eastern Europe	43.7	1.9	35.0	8.4	13.5	36.1	146.6	32.8	17.9	16.2	86.8	13.3	19.4
Sub-Saharan Africa	16.2	17.8	7.1	4.0	11.5	17.9	54.2	11.6	9.8	11.9	26.8	4.8	130.4
Western Europe	377.9	147.0	308.7	184.3	310.4	1 180.6	1 782.0	306.3	392.3	253.6	336.4	458.0	1 217.2

Note: See Annex B1, article by Waltman, for information on methodology used and definitions.

Source: Web of Science.

1 2 *http://dx.doi.org/10.1787/888932895501*

Glossary

Anthropocene

A period in which human activities have become a significant, even dominant force impacting the functioning of the Earth system. It is suggested that this began with the onset of the Industrial Revolution, a point in time which coincides with the first signals of increasing global concentrations of carbon dioxide and methane, as measured in air trapped in polar ice. The impact of human activity has begun to equal the measurable impact of geological forces, in speed and intensity, creating a novel situation that poses new questions and requires new ways of thinking and acting.

www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf

Co-production of knowledge

Processes by which scientific and societal actors negotiate how different sources of knowledge can be brought together into new and mutual understandings. Sustainable development requires knowledge that is integrated in appropriate ways with scientific and other forms of knowledge.

http://spp.oxfordjournals.org/content/37/4/267.full.pdf

Global environmental change

Multiple, often interacting, environmental changes and biophysical transformations to the Earth's system of human and natural processes. They include climate change and changing trends in biodiversity, land-use, urbanisation, and changes in the oceans and are closely linked to processes of socio-economic and cultural globalisation.

www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf

Interdisciplinarity

Interdisciplinary studies involve two or more academic disciplines with the same or different research paradigms, approaches, and methods which cross subject boundaries and integrate their knowledge in ways that result in new insights, knowledge, theories and methods, and solve common research questions. Interdisciplinary research might involve differing qualitative and quantitative methods and different analytical and interpretative approaches.

Evel, A. C., et al (2010), 'Defining and evaluating the impact of cross-disciplinary conservation research' *Environmental Conservation,* Vol 37: 4.

Knowledge

They way society and individuals apply meaning to experience; facts, information and skills acquired through experience or education; creating, selecting, developing and transforming information emerging from complex and ongoing processes. Knowledge is inextricably linked to the social, environmental and institutional contexts in which it is created and reproduced.

www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf

Open knowledge system

Knowledge generated from multiple sources (scientific, traditional, experience) and shared at every stage of its development. Problems and solutions are defined by all relevant stakeholders, not just researchers. An open knowledge system requires collective problem-framing, joint agenda-setting and a corresponding institutional framework. It also requires comprehensive peer- and stakeholder-review, broad and transparent metrics for research evaluation, good consideration of uncertainty and values, procedures to ensure that knowledge is 'placed in context', flexibility of research funding, cooperation of public and private organisations, and meaningful stakeholder engagement. New media and new forms of public participation and greater access to information, are crucial.

www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf

Social change

Significant alteration in the social order, functions, actions and interactions of a society. This may include changes in social institutions, social behaviours, or social relations at different levels of social organisation. The basis of social change typically involves a change in consciousness and belief systems, and/or the structural basis that guides or influences human behaviour.

Socio-ecological systems

Systems in which people and nature are recognised as being linked. They are increasingly understood as complex adaptive systems. Essential features of these complex adaptive systems – such as nonlinear feedbacks, cross-scale and strategic interactions, individual and spatial heterogeneity, and varying time scales – pose substantial challenges for modeling, understanding and management.

Levin et al. (2013) Environment and Development Economics, 2013, Vol. 18:02

Social transformation

Large-scale social change involving a shift in the collective consciousness of a society - local, state, national or global. Deep social transformation can occur as a result of a significant stimulus, as a result of aggregate small-scale changes and can be brought about intentionally. Scientific discoveries and technological breakthroughs have triggered social transformations throughout history, as have religious and royal edicts. They can require, as a precondition, or result in deep shifts in attitudes, values and belief systems.

http://en.wikipedia.org/wiki/Social_transformation

Sustainability

The capacity of a socio-ecological system to be maintained in conditions that allow for its continued functioning in perpetuity. In development and global environmental change contexts, it refers more specifically to the ability to maintain human well-being, social equity and environmental quality indefinitely, meeting current needs and desires while ensuring that future generations will still have coupled human-environment systems available to them capable of providing goods and services for their needs and desires, without degrading these systems in the long term.

www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf

Transdisciplinarity

Studies which integrate academic research from disciplines with different research approaches as well as non-academic participants (such as public or private sector decision-makers and other stakeholders) to research a common goal and create new knowledge, new theories, and new options to solve societal problems. Transdisciplinarity combines interdisciplinarity with a participatory approach. All involved parties, academic and non-academic, define and develop the research goals and methods together to reach a common goal. This approach integrates disciplines and sub-disciplines and non-academic knowledge, to share power equally.

Evely, A. C., et al (2010), 'Defining and evaluating the impact of cross-disciplinary conservation research' *Environmental Conservation,* Vol 37: 4.

Transformational change

A systems approach to social change and social transformation which attends equally to the inner life of human beings, human behaviour, and the social systems and structures in which they exist. Research that investigates transformational change can be disciplinary or multi-disciplinary and integrates a range of approaches and methodologies. It can be irreversible.

http://transform.transformativechange.org/2010/06/robertgass/

Vulnerability

The degree to which a system is susceptible to, and unable to cope with, adverse effects, including those of climate change, climate variability and extremes. It is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, and of its sensitivity and adaptive capacity.

www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=22

Wicked problems

Large and enduring policy dilemmas in which multiple and compounding risks and uncertainties combine with sharply divergent public values to generate contentious political stalemates; wicked problems in the environmental arena typically emerge from conflicts over natural resource management and the prioritisation of economic and conservation goals more generally, typically combined with imperfect scientific knowledge.

Balint, P.J, et al. (2011), 'Wicked Environmental Problems: Managing Uncertainty and Conflict'. Washington DC: Island Press.

The International Social Science Council (ISSC) is an independent non-governmental organisation established by UNESCO in 1952. It is the primary body representing the social, economic and behavioural sciences at an international level. Our mission is to increase the production and use of social science knowledge for the well-being of societies throughout the world.

The ISSC is a membership-based organisation governed by a General Assembly and an elected Executive Committee. Our members include international professional associations and unions, regional and national social science research councils and academies, universities and institutes with major interests in the social sciences.

The Paris-based Secretariat manages a dynamic portfolio of activities aimed at strengthening the social sciences to help solve global priority problems and secure a sustainable future for all.

The ISSC works to:

- identify and mobilise resources for international research priorities
- facilitate research collaborations across regions, disciplines and scientific fields
- foster innovative talent and build social science research capacities
- provide access to global social science expertise, resources and networks
- connect research, policy and practice

The World Social Science Report is one of the ISSC's flagship activities. The Council also convenes a World Social Science Forum every two years. These events provide a global platform for researchers, policy makers and other stakeholders to debate topics of world significance, and to determine future priorities for international social science. The World Social Science Fellows Programme seeks to foster a new generation of globally-networked research leaders to collaborate on addressing global problems with a particular relevance for developing countries.

Strengthening the social sciences to help solve global problems

www.worldsocialscience.org

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World Social Science Report

Changing Global Environments

Global environmental changes, including climate change, are intricately linked to other social, political and economic crises, from poverty and inequality to social discontent. The consequences of these interacting changes are rapidly unfolding across the world and already affect our life support systems, livelihoods and lifestyles. Society must now find ways to simultaneously protect the planet's bounty and safeguard social equity and well-being for all. In this urgent quest, social science knowledge is indispensable for understanding the causes and consequences of global environmental change and informing more effective, equitable and durable solutions for a sustainable future.

In this third edition of the *World Social Science Report,* 150 authors from all over the world and a wide range of disciplines offer insights that help us understand the challenges before us. The report issues an urgent call to action to the international social science community to collaborate more effectively with each other, with colleagues from other fields of science, and with the users of research to deliver solutions-oriented knowledge on today's most pressing environmental problems. It calls for a transformative social science that is:

- **bolder** in reframing and reinterpreting global environmental change as a social problem;
- **better** at infusing social science insights into real-world problem-solving;
- **bigger** in terms of having more social scientists to focus on global environmental change; and
- **different** in the way it thinks about and does research that helps meet the vexing sustainability challenges faced today.

World Social Science Report 2013: Changing Global Environments was prepared by the International Social Science Council and is co-published with the Organisation for Economic Co-operation and Development (OECD) and UNESCO.

Content of the Report

- *Introduction: Social sciences in a changing global environment*
- *Key messages and recommendations: Global environmental change changes everything*
- *The complexity and urgency of global environmental change and social transformation*
- *Social science capacity in global environmental change research*
- *The consequences of global environmental change for society*
- *Conditions and visions for change and sense-making in a rapidly changing world*
- *The responsibilities and ethical challenges in tackling global environmental change*
- *New approaches to governance and decision-making*
- *Contributions from International Social Science Council members, programmes and partners*

The Report is available at

www.oecd-ilibrary.org
http://dx.doi.org/10.1787/9789264203419-en

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