United Nations
Educational,
Scientific and Cultural
Organization

A World of SCIENCE

Natural Sciences
Quarterly Newsletter

Vol. 10, No. 2
April–June 2012

IN THIS ISSUE

EDITORIAL

Water too has a tipping point

In 2009, Rockström *et al.* proposed the concept of 'planetary boundaries', beyond which lay the point of no return, or tipping point. They estimate that humanity has already transgressed three out of nine boundaries, those for climate change (greenhouse gas levels), the rate of biodiversity loss and the global nitrogen cycle. Humanity may even have transgressed a fourth boundary, they suspect, the limit for freshwater use, or may be close to doing so. Current consumption is estimated at 2 600 km^3 per year – and rising.

This study is cited in the Fourth World Water Development Report, *Managing Water under Uncertainty and Risk*, launched by UNESCO on 12 March on behalf of the 28 agencies comprising UN-Water. Rockström *et al*. suggest that the social cost of transgressing the planetary boundaries will depend upon how resilient and green our societies are. Going green will not alone ensure more water-friendly policies, however, as exemplified by the controversies over biofuels and large-scale foreign acquisitions of arable land. Above all, the report observes, we need to acknowledge the cross-cutting nature of water across the entire development spectrum. Food and energy production, industry, human and environmental health are *all* dependent on water, *all* essential for socio-economic development and *all* increasingly interdependent.

Forgetting that water flows over sectoral boundaries can be a costly mistake. The Mississippi Delta in the USA has been radically modified to supply agriculture and hydropower. By reducing risks to agriculture upstream, the scheme has amplified risks downstream, exacerbating the impact of Hurricane Katrina on New Orleans in 2005. Where is the link? The dam constructed on the river interrupts sediment transfer. Without the constant deposition of sediment, tidal and wave action is gradually eroding the delta on which New Orleans is built, causing the city to sink and thus to flood more easily. The pumping of groundwater, oil and natural gas in the delta has caused further subsidence.

This example illustrates a wider problem. The lack of interaction between sectors, as well as between users, decision-makers and managers, has allowed water resources to become seriously degraded around the world, threatening all the sectors that depend on water and thus compromising development. With climate change likely to make water resources less abundant in future, even as demand for water grows, humanity finds itself on an unsustainable development path.

At a time when humanity is facing an uncertain and perilous future, *Managing Water under Uncertainty and Risk* drives home the point that a 'business-as-usual' approach to water management is not an option. We must adapt our development planning and management to reflect the bigger picture. And we don't have much time. Herein lies the key message of the report, extracts from which you will find overleaf. The Earth Summit in Rio in June should offer an ideal occasion to drive this message home.

Gretchen Kalonji
Assistant Director-General for Natural Sciences

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Planning for an uncertain future

Demand for water will soar in the coming decades, as the human population swells and becomes both more urban and more affluent. This will lead to increasingly difficult trade-offs between water for food security versus water for energy security. To compound matters, climate change is expected to make water resources less abundant in many places, as well as less predictable. In order to pre-empt the growing risk of future food, water and energy insecurity, many countries are taking the precaution of acquiring large tracts of land abroad and importing 'virtual water' in the form of foodstuffs.

Technological progress should go some way towards reconciling supply and demand but, ultimately, the solution will lie in better water governance. In order to satisfy competing demands, the water, agriculture and energy sectors will need to work together on policy design. In the face of uncertainty, managers will need to learn how to plan not for *one* future but for several. The speed with which we take up these challenges could make all the difference between achieving global sustainability and a future blighted by water scarcity, pollution and flooding for hundreds of millions of people.

These are some of the key messages of *Managing Water under Uncertainty and Risk*. Produced by the World Water Assessment Programme (WWAP), this fourth report in the triennial series was launched by UNESCO on 12 March at the World Water Forum in Marseilles (France), on behalf of the 28 agencies comprising UN-Water. Here, we examine some of the trends highlighted by the report.

How will we feed another 2 billion?

The world population is expected to grow from 7 billion in 2011 to 9.1 billion by 2050. In parallel, economic growth and individual wealth are shifting diets from predominantly starch-based to meat- and dairy-based, requiring more water. Producing 1 kg rice, for example, requires about 3500 litres of water, 1 kg of beef 15 000 litres of water and a cup of coffee about 140 litres. This dietary shift has had the greatest impact on human water consumption over the past 30 years and is showing no sign of abating. The combination of rapid population growth and changing diets may increase the demand for food by 70% by 2050.

The main challenge facing the agriculture sector will not be so much to grow 70% additional food in the next 40 years as to make 70% more food available on the plate. Reducing losses in storage and along the value chain would go some way towards offsetting the need for more production – and water.

Livestock not only provides food, of course, but also wool, hides and other products. It now contributes 40% of the global value of agricultural output. The expansion of land for livestock has created acute environmental concerns. It has led to deforestation in countries like Brazil, for instance,

and, in countries belonging to the Organisation for Economic Co-operation and Development (OECD), intensive livestock production has become a major source of pollution. In 2008, 3 350 million ha were used as permanent meadows and for pasture, more than twice the area used for arable cropping and permanent crops.

Recent estimates suggest that nearly 2 billion hectares of land worldwide – an area twice the size of China – are seriously degraded, some irreversibly. Innovative technologies will be needed to improve crop yields and drought tolerance and deliver more efficient ways of using fertilizer and water.

Among these figure water-harvesting technologies and drip irrigation, as well as technologies that recycle grey water in peri-urban agriculture. Grey water is produced by non-sanitary use of water in the home, such as in dishwashing or showering. FAO estimates that 70% of urban households in developing countries already participate in agriculture.

The development of biofertilization techniques would also increase water use efficiency by promoting higher nutrient absorption and crop growth rates (*see box*). Timely agro-climatic information to help deal with increasing climate and rainfall variability, early warning systems and mechanization – which is still lagging behind in many countries – could also lead to an overall increase in water use efficiency.

Agriculture accounts for about 70% of all water withdrawals and as much as 90% in some fast-growing economies. Best estimates of future global agricultural water consumption – including both rainfed and irrigated agriculture – forecast an increase of about 19% by 2050. Much of the rise in water consumption for irrigation will affect regions already suffering from water scarcity.

© Photoshare/Gaurav Gaur

Livestock contributes less than 2% of GDP worldwide, yet produces 18% of greenhouse gases in the form of methane. Critics argue that the disadvantages far outweigh the benefits but others counter that this argument seriously underestimates the socio-economic importance of livestock, particularly in low-income countries.

Global energy consumption will climb steeply by 2035

Global energy consumption will increase by 50% between 2007 and 2035, with non-OECD countries accounting for 84% of the increase. In 2009, 1.4 billion people lacked access to electricity, 20% of the world's population. All sources of energy and electricity require water in their production processes: the extraction of raw materials, cooling in thermal processes, cleaning processes, cultivation of crops for biofuels and powering turbines. Energy is itself required to make water resources available for human use and consumption through pumping, transportation, treatment, desalination and irrigation.

Cuba adopts organic agriculture

The Cuban government responded to a food crisis in September 1993 by turning over much of the 80% of all farmland held by the State to the workers and re-establishing worker-owned enterprises. Although peasants did not own the land, they were allowed to rent it indefinitely free of charge, as long as they continued to meet production quotas for their key crops. Food crops produced in excess of these quotas could be freely sold at farmers' markets. This provided a price incentive for farmers to use new organic technologies effectively, such as biofertilizers, earthworms, compost and the integration of grazing animals. Farmers also revived traditional techniques such as intercropping and manuring in order to increase production yields.

Public policies also supported urban organic agriculture. Through the Programa Nacional de Agricultura Urbana (1994), Havanans were encouraged to transform their vacant lots and backyards into small farms and grazing areas for animals. This resulted in 350 000 new, well-paying jobs – out of a total workforce of 5 million –, annual production of 4 million tons of fruit and vegetables and a city of 2.2 million inhabitants self-sufficient in food.

Cuba's transition to organic agriculture has ensured food security and a steady income for the population under a trade embargo. The lack of chemical pesticides should also have a positive long-term impact on Cuban health.

Source: WWAP (2012) Managing Water under Uncertainty and Risk.

© Yanet Toirac/UNESCO La Habana

Vegetable garden in Havana

Forest ecosystems could be a casualty of land conversion to grow biofuels, unless policy-makers and managers recognize that these ecosystems do not consume water but rather supply and recycle it – making them an extremely valuable resource.

Even investment in clean energies to mitigate climate change will affect water, as biofuels and hydropower are both water-intensive. Demand for energy from renewable resources should rise by 60% by 2035. Biofuels are already an increasingly prominent component of the energy mix, as exemplified by the 2007 EU target for biofuels to constitute 10% of transport fuel by 2020. This target has been hotly debated, as it acts as a driver for land conversion from food to biofuel production, placing upward pressure on food prices and, in some cases, leading to the conversion of forest ecosystems to grow biofuels.

A number of international organizations highlight the water–food–energy nexus as illustrating the most difficult choices, risks and uncertainties facing policy-makers today. Examples abound of the various intended or unintended consequences of favouring one pillar over the other, such as food security over energy security. For example, the OECD's International Energy Agency predicts that 'at least 5% of global road transport will be powered by biofuel [by 2030] – over 3.2 million barrels per day. However, producing those fuels could consume 20–100% of the total quantity of water now used worldwide for agriculture if the production processes and technology don't evolve.

Another example is shale gas, a form of natural gas found in fractures in sedimentary rock (shale) deep underground. Although shale gas promises access to new reserves of fossil fuels, it is slightly more water-intensive than conventional gas because its extraction method – hydraulic fracturing (fracking) – injects millions of litres of water into each well. If current policies do not change, shale gas production should expand in Asia, Australia and North America, despite its environmental drawbacks.

Another inefficient technique is desalination, which causes pollution and oversalinization of the immediate coastal ecosystem. Desalination is also energy-intensive, demonstrating another trade-off between water supply and energy production. Solar-powered desalination plants, currently being tested in Saudi Arabia and elsewhere, may provide a more suitable avenue for sun-drenched countries.

There is obviously an urgent need to harmonize water and energy policies, which often overlap, yet are often made in different government departments or ministries. Water is used to cool power plants in the USA, for example, where it represents 40% of the country's industrial water use. This proportion is expected to reach 30% in China by 2030.

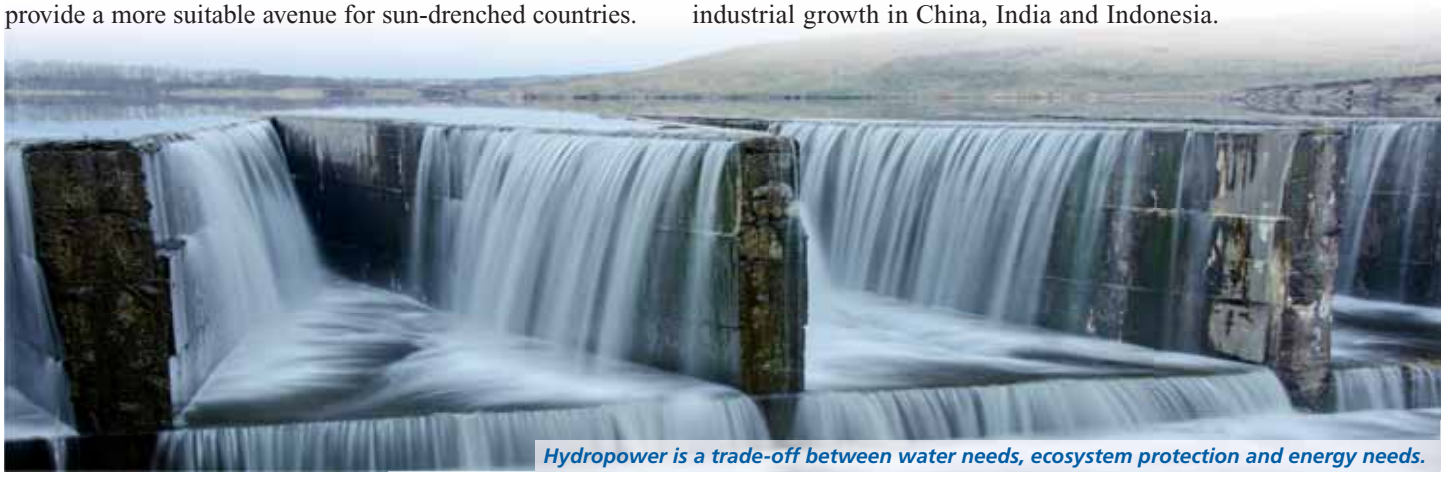
Industry is cleaning up its act

On a global scale, industry uses relatively little water (about 20% of total withdrawals, *see map*) but it does require an accessible, consistent supply of adequate quality. It is estimated that only about 30–40% of this water is actually used for industry, the balance being used for various forms of power generation.

Water is becoming a critical factor in companies' choice of location for their economic activities. In water-stressed regions, companies are becoming aware of how their 'water footprint' could impede their operations or damage their reputation with local communities. Another issue concerns the release of toxic waste from industrial enterprises; this remains a major threat to the provision of safe water to populations in developing countries.

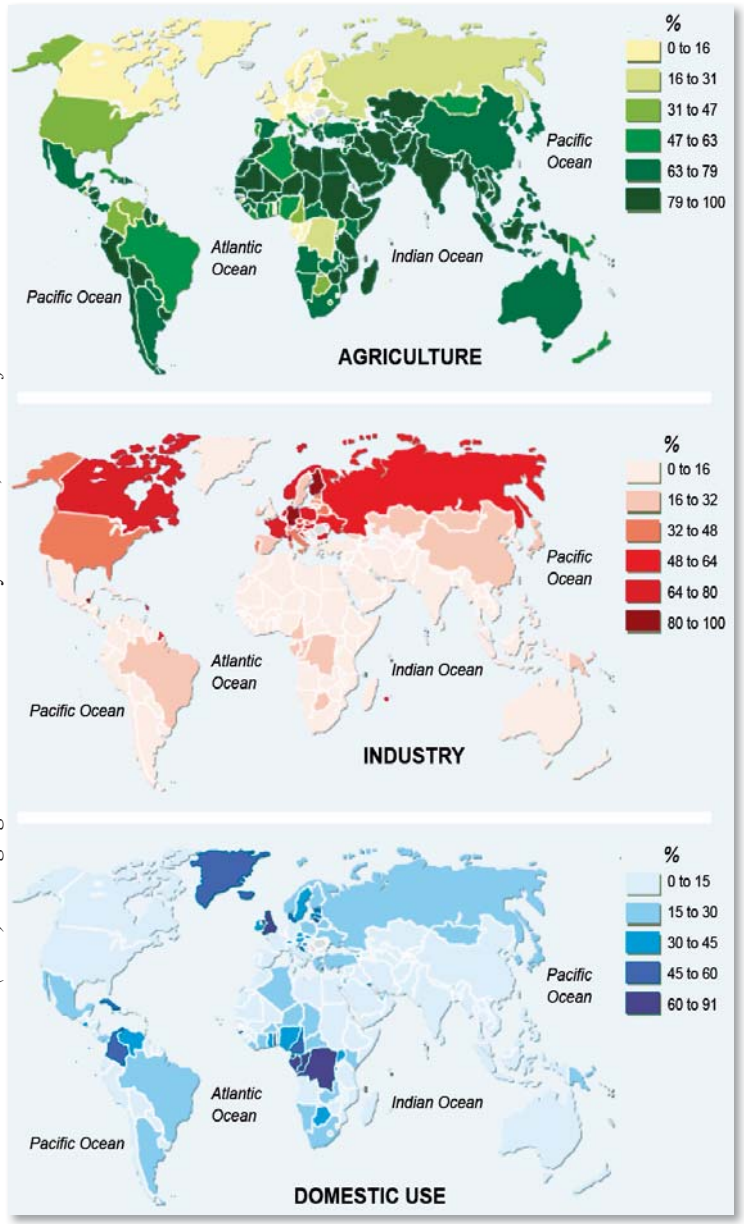
There is a need to decouple industrial development from environmental degradation by moving towards cleaner production processes like zero discharge via the adoption of advanced technologies. Effluent that would otherwise be discharged could be recycled or sold to another user. Many industries are finding that water of lesser quality may be adequate for their needs and that reducing water consumption can be an economical way of saving costs; that in turn can be good for business, especially in light of the risk of future water scarcity.

Industry will find itself competing more and more for limited water resources as demand and consumption increase in all areas. According to the United Nations, if present consumption patterns continue, two-thirds of the world's population will live in water-stressed conditions by 2025. Lack of water is already a major constraint to industrial growth in China, India and Indonesia.



Hydropower is a trade-off between water needs, ecosystem protection and energy needs.

Global freshwater use by sector at the beginning of the 21st centry



Source: WWAP (2012) Managing Water under Uncertainty and Risk, with data from World Resources Institute

Although the world is on track to meet the Millennium Development Goal target of halving the proportion of people without access to safe drinking water by 2015, sub-Saharan Africa and the Arab region are lagging behind. The same target for basic sanitation currently appears out of reach, as half the population in developing regions still lacks access.

Fewer urban dwellers have access to clean water and sanitation than in 2000

The main source of human demand comes from urban communities requiring water for drinking, sanitation and drainage. The urban population is forecast to nearly double to 6.3 billion in 2050 from 3.4 billion in 2009.

The number of people in cities who lack access to a clean water supply and sanitation is estimated to have grown by 20% since the Millennium Development Goals were established in 2000. WHO estimates that the overall economic benefits of halving the proportion of people without sustainable access to improved drinking water and sanitation by 2015 would outweigh the investment cost by a ratio of 8:1. For instance, diarrhoeal diseases are estimated to kill more than 1.5 million children under the age of five every year. Studies have shown that the provision of improved sanitation and safe drinking water could reduce diarrhoeal diseases by nearly 90%.

Efforts are being made to provide sanitation facilities but many social programmes are incompatible with the needs of women. For example, a lack of segregated toilets in schools can directly affect how frequently pubescent girls attend school.

It is estimated that over 80% of wastewater worldwide is not collected or treated and urban settlements are the main vectors of pollution at the source. The public needs better information on the impact of its consumption on the quantity and quality of water resources. Tools are being developed to manage the growing urban demand for water, particularly integrated urban water management, which links freshwater, wastewater and stormwater management within a common resource management structure.

A silent revolution at the pump

Over the past 50 years, the rate of global groundwater abstraction has at least tripled, significantly boosting food production and rural development. Today, groundwater abstraction accounts for about one-quarter of all water withdrawals worldwide, nearly half of all drinking water and about 43% of water used in irrigation. The growing use of groundwater has also considerably modified local and global water cycles, environmental conditions and ecosystems.

Groundwater has enabled people to settle and survive in dry areas where rainfall and runoff are scarce or unpredictable. It is crucial for the livelihoods and food security of over 1 billion rural households in the poorer regions of Africa and Asia and for domestic supplies of much of the population elsewhere in the world.

Specific challenges for the world's regions

Africa

Sub-Saharan Africa uses barely 5% of its annual renewable freshwater. Coverage of the drinking water supply in rural areas had grown to 47% by 2008 but remains static at just over 80% in urban areas since 1990. Only 31% of the population uses improved sanitation facilities; although the proportion practising open defecation is declining, the actual number increased from 188 million people in 1990 to 224 million in 2008.

From the mid-1990s to 2008, the number of malnourished persons grew from 200 million to 350–400 million. Since the mid-1960s, agricultural production has increased by an average of less than 2% annually, while the population has grown at a rate of 3%. Drought affects GDP growth in one-third of countries.

Only one in four Africans has access to electricity. Hydropower supplies one-third of Africa's energy but could meet all the continent's electricity needs. Only 3% of renewable water resources are currently exploited for hydroelectricity. African countries have begun to address transboundary water issues related to hydrodevelopment, such as through power pools like the South African Power Pool and West African Power Pool.

Arab States and Western Asia

About two-thirds of available surface water originates from outside the region, leading to conflict with upstream countries at times. Past conflicts have created hordes of internally displaced persons and destroyed water infrastructure in places like Iraq, Kuwait and Lebanon, absorbing resources needed for rehabilitation. To defuse potential conflict over water resources, attempts have been made to share scarce waters across the region. The League of Arab States has created the Arab Ministerial Water Council and adopted an Arab Water Security Strategy.

Water scarcity has spawned concerns about food security. Imported foodstuffs, particularly grain, account for a sizeable amount of virtual water consumption in this region. Local cereal production has been boosted by the rise in groundwater use for irrigation. However, as aquifers are drawn down, pumping water is becoming increasingly expensive and unsustainable. The economic cost of poor quality water in the Middle East and North Africa ranges from 0.5% to 2.5% of GDP. Water governance urgently needs strengthening to deal with these challenges.

Climate change should raise temperatures, increase soil aridity and shift seasonal rainfall patterns. This can already be seen in Syria and Tunisia, for instance. The region should also expect more frequent floods and droughts, less snowfall and snow melt in some mountainous regions and sea-level rise and water salinity in coastal aquifers.

Asia and the Pacific

The region is experiencing rapid urbanization, economic growth, industrialization and extensive agricultural development. Two-thirds of the world's hungry live in Asia.

Between 1990 and 2008, 1.2 billion people gained access to safe drinking water, raising the total proportion of Asians from 73% to 88%. China and India together account for three-quarters of the total. However, Asia is also home to 72% of the 2.6 billion people worldwide who do not use improved sanitation facilities.

The region is the most vulnerable to natural disasters, with much of the population living in coastal and flood-prone areas. The Pacific's small island states are particularly vulnerable to tropical hurricanes, cyclones and earthquakes and would be highly exposed to sea-level rise from global warming.

A number of countries are shifting from an emphasis on the short-term development of water infrastructure to a more strategic approach that recognizes the ecological impact of economic development.

Europe and North America

North Americans are the highest per capita water users in the world, consuming 2.5 times more than Europeans. About 3.5 planet Earths will be needed to sustain a global population mimicking the current lifestyle of the average European or North American. However, pockets of water deprivation do exist, particularly among indigenous people: more than 10 000 homes on reserves in Canada have no indoor plumbing and the water or sewer systems are substandard on one in four reserves. In Europe, some 120 million people lack access to safe drinking water and even more to sanitation.

An important problem in Europe and North America is the pollution of water courses by agrochemicals, namely nitrogen, phosphorus and pesticides. While legal frameworks exist to regulate this problem, in the drainage basins of the Mediterranean Sea, the East Atlantic Ocean and the Black Sea, anti-pollution enforcement is lagging.

In terms of transboundary water management, the European Union's Water Framework Directive (2000) and more recent directives on standards and groundwater represent the only supranational water arrangements in the world.

The IPCC predicts that summer flows will decline by up to 80% in Southern Europe and some parts of Central and Eastern Europe by the 2070s. Europe's hydropower potential is expected to drop by an average of 6% over this period. In North America, climate change will cause heightened competition among users for over-allocated water resources.

Latin America and the Caribbean

The region's population grew by over 50% between 1970 and 2009, although birth rates are now declining rapidly. The urban population has tripled over the past 40 years, with a trend recently towards the rapid growth of intermediate and small cities as opposed to larger ones before. An estimated 35% of the population (189 million people) still live in poverty, 14% of whom are desperately poor.

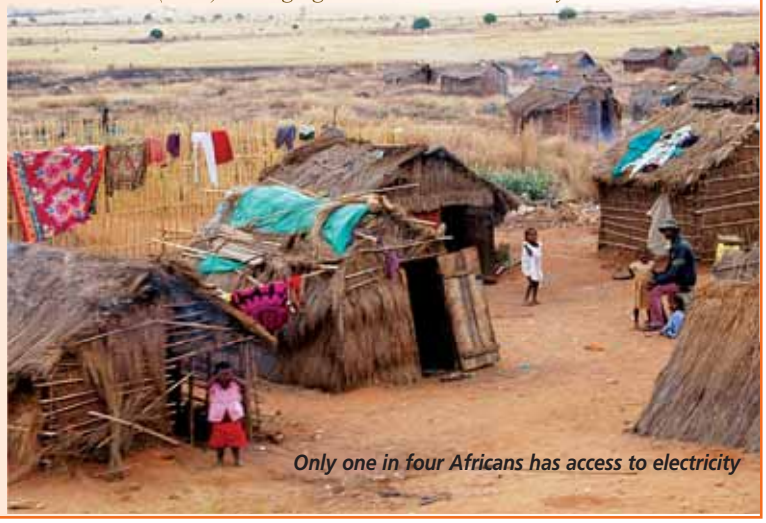
Many countries have benefited from the surge in global demand for minerals, food, timber, fish and tourism, as they are dependent on the 'virtual' export of water via these goods and services.

Although most countries enjoy good coverage for improved water and sanitation, almost 40 million people still lack access to improved water and nearly 120 million access to proper sanitation facilities. Most of them are poor rural dwellers.

The region has 61 basins and 64 aquifers that cross national borders. Many countries have entered into transboundary water agreements, typically to manage hydropower, but political obstacles have often led to conflict. Examples of agreements for managing shared groundwater are few and far between.

With relatively weak water management capabilities, the region's poorest countries in Central America, the Caribbean and the Andes will be at greatest risk from the impact of climate change. On the positive side, lessons learned from adapting to the consequences of El Niño events have driven technological innovation and capacity-building that should help to deal with climate change.

Source: WWAP (2012) Managing Water under Uncertainty and Risk

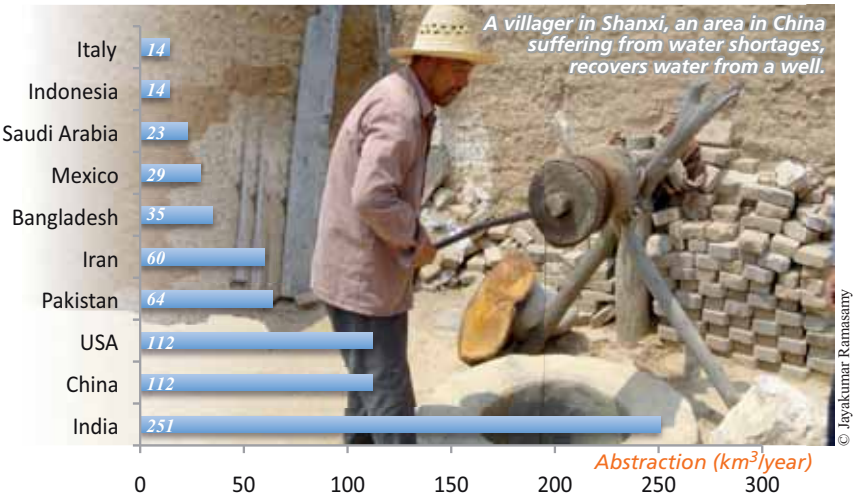


Only one in four Africans has access to electricity

Groundwater depletion is so intensive in some arid and semi-arid zones that the aquifer is unable to replenish the water. Examples are the Highland Plains and Central Valley aquifers in the USA, the north-west India plains aquifers, the North China Plain aquifer and the Australian Great Artesian Basin. Meanwhile, the availability of fossil (non-renewable) water contained in large aquifer systems on Earth that have received little replenishment for millennia has reached critical limits in some hotspots, such as the Middle East and Western USA. With 273 of the world's aquifer systems crossing national borders, growing competition for groundwater will no doubt put the solidity of existing transboundary agreements to the test.

A study by Döll (2009) concludes that groundwater recharge is likely to increase in the northern latitudes by the 2050s but decrease by 30–70% or more in certain currently semi-arid zones, including the Mediterranean, northeastern Brazil and south-western Africa.

Top 10 groundwater-abstracting countries, 2010



A villager in Shanxi, an area in China suffering from water shortages, recovers water from a well.

© Jayakumar Ramasamy

About 72% of the global groundwater abstraction (1 000 km³/ year) takes place in these ten countries. Of the total, about 67% is used for irrigation, 22% for domestic purposes and 11% for industrial purposes. Estimates of the global volume of stored groundwater range from 15.3 million km³ to 60 million km³ [Source: Data from IGRAC (2010), Aquastat (2011) and Eurostat (2011).]

A booming trade in virtual water

The term 'virtual water' refers to the volume of water used in the production of a good or service, the most water-intensive being agricultural produce. Countries engage in water trading through the products they import rather than through the physical transportation of water itself, which is a difficult and costly exercise. The virtual water trade could represent 20% of food consumed globally by 2020.

Some water-poor countries have become net importers of virtual water. Imported grain accounts for a large share of virtual water consumed in the Middle East and North Africa, which was already importing 50 million tons of grain annually by 2000. If countries in Europe and elsewhere have also become net importers, this is not because they are water-poor but simply because it satisfies consumer tastes for imported foodstuffs and other products. Rich nations are tending to maintain or even increase their consumption of natural resources but are exporting their footprint to the producer. For example, 62 % of the UK's water footprint is virtual water embedded in agricultural commodities and products imported from other countries.

The virtual water trade can either improve or worsen the state of a country's water resources. It can provide opportunities for water-rich developing countries to stimulate their economies by exporting greater amounts of food, as long as they can afford the infrastructure to harness the water and there are no artificial barriers in international trade. Unfortunately, many countries still require some kind of financial support to develop this infrastructure and remain competitive on global markets.

Another troubling issue concerns developing countries that are water-scarce and whose people are too poor to buy imported food. As with most globalization processes, the virtual water trade could further marginalize the world's poorest.

A growing appetite for large land acquisitions

In their efforts to ensure domestic food security, a number of countries are investing in agricultural land abroad (*often referred to as 'land grabs'*). The report defines 'land acquisition' as the gaining of tenure rights to large areas of land through purchase, lease, concession or other means.

In developed countries, domestic law protects domestic stakeholders and governments and sets obligations for all investors. When this is not the case, as in many developing states, a weak or incomplete domestic legal base on social, economic or environmental issues can allow international contracts and treaties to enjoy much more liberal rights and entitlements. This is particularly relevant to foreign investments in agriculture, where domestic land tenure rights, water rights, environmental management regimes relating to chemicals, labour law on farms and so on can be weak or absent.

Some of the most active investors in large-scale transnational land acquisitions are oil-rich but food-insecure Gulf States, land-scarce, populous Asian countries and developed countries. Non-state investors include Western food producing, processing and exporting companies new actors attracted by biofuel demand and opportunities related to investment funds

Saudi Arabia, one of the Middle East's largest cereal growers, announced in 2007 that it would be cutting cereal production by 12% a year to reduce the unsustainable use of groundwater. In order to protect its water and food security, the government issued incentives to Saudi corporations the following year to lease large tracts of land in Africa for agricultural production. Saudi investors have already leased land in Egypt, Ethiopia, Kenya and Sudan. India is growing maize, sugarcane, lentils and rice in Ethiopia, Kenya, Madagascar, Senegal and Mozambique to feed its domestic market, while European firms are seeking 3.9 million ha of African land to meet their 10% biofuel target by 2015.

The past is a poor guide to an uncertain future

The report innovates by establishing scenarios for how the world's water resources may evolve in the decades to come. Traditionally, past climate records have offered water managers a fairly reliable guide to future trends, thereby helping them to predict extremes like drought and floods, as well as other threats to water security. However, the past is becoming a less reliable guide to the future as humanity as a whole embarks on a trajectory it has never encountered before: a growing demand for water, even as climate change looks set to threaten its availability.

In order to assess the risks and consequences of different development paths, the World Water Assessment Programme has come up with a World Water Scenarios Project. Before constructing three scenarios for the future, the experts surveyed first identified the most likely drivers of change, both positive and negative:

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A home in the Australian State of Queensland during megafloods last year. Two billion people are expected to be vulnerable to flooding by 2050, owing to population growth in floodprone lands, climate change, deforestation, wetland loss and rising sea levels.

Greater use of water in agriculture
Between 1961 and 2001, water use for agriculture increased by nearly 100%. It will most likely increase another 100% by 2040.

Deforestation will not disappear
Regions may seek to increase their agricultural areas by continuing to expand deforestation, albeit more slowly. This development is more likely to occur than a slowing of expansion of agricultural lands as a result of ecological concerns.

Climate change will increase water stress
The number of people at risk from water stress is likely to reach 1.7 billion before 2030 and 2.0 billion by the beginning of the 2030s. A 50% increase in delta land vulnerable to serious flooding is likely by the early 2040s.

Most people will have access to safe drinking water and sanitation
As a result of infrastructure development, 90% of the global population will probably have reasonable access to safe drinking water and 90% to appropriate sanitation facilities by the beginning of the 2040s. (*See also below* Demographic growth will not let up)

Rainwater harvesting will become widespread
It is likely that rainwater harvesting will be widely adopted between 2020 and 2030, in combination with simple, cheap ways of purifying the collected water.

Better use will be made of affordable technology
Better use of affordable technology by agriculturalists to check crops and soil moisture will increase the efficiency of irrigation schedules.

Demographic growth will not let up
Estimates put the world population at almost 8 billion by 2034, 9 billion by the early 2050s and over 10.46 billion beyond this. Population growth could overwhelm past gains in water and sanitation accessibility, particularly in developing countries where recent improvements in access to water supply and sanitation could be negated.

Demand for water will grow
The demand for water in developing countries could increase by 50% over 2011 levels. Over 40% of countries, most of them low-income countries or situated in sub-Saharan Africa and Asia, could experience severe freshwater scarcity by 2020. An important risk is that unequal access to water will create new economic polarities and give rise to political tensions.

Information sharing will improve
The development of online forums on water issues could help reduce the asymmetry of information between user, provider and policy-maker. Networked co-ordination at the national level to share information and best practices between local water agencies could be achieved in at least 95% of countries between 2020 and 2030. There is concern that resistance from government and vested interests in responding to these information flows could prevent the necessary flexibility, participation and transparency in governmental policy-making.

Three possible futures

In one possible future, the statusquo continues. Growth in food demand resulting from population growth and changes in nutritional habits combines with greater urbanization to push up demand for water dramatically. Expanding human settlements encroach on fragile or marginal lands and there is increased deforestation and pollution. Climate change results in less water availability in many regions, exacerbating economic polarities between water-rich and water-poor countries, as well as between sectors or regions within countries. Much of the burden is likely to fall on the poor.

In a second possible future, technological advances are fully exploited, particularly the trend towards desalinization. Technological developments in agriculture lead to sizeable water conservation, while those in urban water production and waste handling contribute further to reducing absolute water withdrawals and waste. Rapid uptake of these technologies is paired with a growing acknowledgment of water scarcity among the population.

A third possible future extrapolates current demographic and technological trends, together with a set of potential policy interventions. A legally binding international agreement to combat climate change is in place by 2040, along with significant funding for awareness-raising and adaptation in low-income countries. Recognition that the greatest impact of climate change will be felt through water fosters high levels of investment in water infrastructure, leading to reductions in waste, a more sustainable water supply and broader coverage by the sanitation network.

Investment in water management, conservation and sanitation reduces poverty, thanks to the development of solid property regimes, documented land tenure arrangements and clearly established water rights and allocation systems. Subsidies encouraging inefficient use of land, water and fertilizers, which creates a bias in favour of high-water users, are gradually replaced by flexible, index-based insurance schemes that allow producers to make short-term cropping decisions based on climate variability and extremes. Water-basin institutions and decentralized authorities are given more power and resources to manage water effectively within countries. This promotes a local, climate-responsive allocation of water among users, facilitated by well-regulated pricing and innovative water rights trading mechanisms.

Source: WWAP (2012) Managing Water under Uncertainty and Risk

There may be unforeseen negative consequences in many of the African states where these transactions are taking place. For instance, India has purchased 1 million ha of land in Ethiopia, one of the most food-insecure countries in the world. Poorly regulated foreign investments in lands that could otherwise be used to feed local populations could potentially have devastating consequences on the fragile state of domestic food security.

Other consequences include the displacement of populations, the dispossession of land, potential conflicts and instability as various groups are uprooted. There are also considerable negative environmental consequences, as large-scale industrial agriculture requires fertilizers, pesticides, herbicides and large-scale transport, storage and distribution. Many of the states where 'land grabs' are taking place also have weak governance structures, with little legal protection for local communities and no benefit-sharing mechanisms.

To implement its biofuel policy, China has invested heavily in land in Indonesia, Thailand, Malaysia, Mozambique and the Democratic Republic of Congo, among others. By 2020, the Chinese government anticipates that 15% of China's transport energy needs will be met by biofuels. As part of a massive plan to reduce greenhouse gases, China will replace 12 million tons of oil with 2 million tons of biodiesel and 10 million tons of bioethanol each year. Despite the positive goal of investing in 'green and clean' energy, China's interventions have caused deforestation, threatened biodiversity via monocultures, increased food prices and decreased food stocks: the International Monetary Fund estimates that that the rise in demand for biofuels accounted for 70% of the hike in maize prices and 40% of that for soya bean prices between 2006 and 2008. The interventions have also caused population displacement as land is converted into plantations, and water scarcity. The amount of water required for biofuel plantations is particularly devastating to regions where water is already scarce, as in West Africa. For example, 1 litre of ethanol from sugarcane requires 18.4 litres of water and 1.52 m^2 of land.

The lack of any supranational regulating or monitoring mechanism for land acquisitions has enabled the acreage of transnational land acquisitions to rise from 15–20 million ha in 2009 to more than 70 million ha in 2012. Africa consistently appears to be the prime target for these deals, with sub-Saharan Africa accounting for two-thirds of their acreage. It is typical for there to be no explicit mention of water in the disclosed land deals. In the few cases where water is referred to, the amount of permitted water withdrawals is not specified. Evans (2009) quotes the Chief Executive Officer of packaged food manufacturer Nestlé as saying, 'with the land comes the right to withdraw the water linked to it, in most countries essentially a freebie that increasingly could be the most valuable part of the deal. And, because this water has no price, the investors can take it over virtually free.' The consequences of this trend are harmful for the rural poor when they are forced to compete for scarcer water with actors who are more financially powerful and technically better equipped (*see interview, page 15*).

The current pace of land acquisitions and the related concessions of water rights to investors also carry great threats for transboundary co-operation in many river systems, including those of the Nile, Niger and Senegal basins.

The vitual water trade can enable water-rich developing countries to stimulate their economies by exporting greater amounts of food.

The way forward

Water and land have become vitally strategic resources, more interlinked than ever before. Confronted with competing demands, policy-makers are faced with a dilemma: how can they ensure food security without penalizing energy security, or satisfy both industrial and agricultural demands for water?

The key to rational management will be to consider different uses of water alongside each other, including domestic use, land management, agriculture, mining and energy production. The best way to do this is to create a structure within which competing interest groups – such as water utilities, farmers, industry and mining, communities and environmentalists – can hammer out coherent strategies for meeting future challenges and uncertainties. To be fully inclusive, a broad group of stakeholders should also be involved in the rule-setting process for the management of both domestic and transboundary water resources. Combine these twin elements and you have what is called integrated water resource management.

Water management has always been underpinned by uncertainty but global trends in demography, consumption patterns, industrial development, migration and climate change are driving the level of uncertainty to unprecedented levels, exacerbating risk. Integrated water resource management offers stakeholders the flexibility they need to be able to adapt strategies for water management when the future doesn't go according to plan.

This will be the challenge for water authorities: to move from planning for one defined future to the use of plans that are responsive to a range of possible future scenarios, all uncertain but presenting varying degrees of probability. In this new paradigm, technical specialists will need to interact with government decision-makers and society more broadly, on the basis of reliable, objective information and data about the state of water resources and how they are used and managed.

As part of preparations for the Rio+20 conference this June, the UN Commission on Sustainable Development invited UN-Water to conduct a global survey last year to determine the extent of progress towards sustainable management of water resources using integrated approaches. Preliminary findings from over 125 countries show that 64% of respondants have developed plans for the implementation of integrated water resource management, as recommended in the *Johannesburg Plan of Implementation* (2002), and that 34% are at an advanced stage of implementation. The only cloud on the horizon is that progress appears to have slowed in countries with a low and medium Human Development Index since an earlier survey in 2008.

This article has been compiled by the editor from Managing Water under Uncertainty and Risk, *the Fourth World Water Development Report, with grateful thanks to the report team.*

To read or purchase the full report, see page 24

Venice *will* succumb to sea-level rise, the question is when

The newly published report of a workshop run by UNESCO's Venice Office on 22–23 November 2010 has concluded that 'the planned mobile barriers (MOSE) might be able to avoid flooding [of the World Heritage site of Venice and its Lagoon] for the next few decades but the sea will eventually rise to a level where even continuous closures will not be able to protect the city from flooding. The question is not if this will happen, but only when it will happen.'

In order to avoid flooding, the Italian authorities have authorized the construction of an underwater barrier system, referred to as the MOSE Project, which should be operational by 2014. During the project planning phase, three scenarios for sea-level rise by 2100 were considered: 16.4 cm, 22.0 cm – the scenario recommended for the MOSE project – and a pessimistic scenario of 31.4 cm. Today, even the pessimistic scenario is considered overoptimistic.

The Intergovernmental Panel on Climate Change (2007) forecast global sea-level rise of 18–59 cm to 2100 but excluded ice melt from its calculations, as this parameter could not be modelled. Observed global sea-level rise actually exceeded the model projections for the period 1961–2003 by 50% and for 1990–2008 by 80%.

Other uncertainties stem from the insufficiently understood dynamics of heat uptake by the oceans, which causes oceans to swell and thus sea level to rise, as well as from the variety of possible scenarios for future carbon emissions and the consequential heating of the atmosphere.

Some recently published papers give higher estimates of global sea-level rise: Vermeer and Rahmstorf (2009) give a range of 75–190 cm, Horton *et al*. (2008) a potential lower limit of 54–89 cm and Jevrejeva *et al*. (2010) a range of 60–160 cm. Looking farther ahead, the Delta Committee (2008) gives a range of 1.5–3.5 m for the year 2200, while the German Advisory Council on Global Change (2006) estimates sea-level rise of 2.5–5.1 m by 2300. 'This means that sea-level rise will be governed in the coming centuries by a delayed response to 21st century anthropogenic (human-induced) warming.'

As for sea level in the Mediterranean, it has shown strong variability over the past century, rising by approximately 1.2 mm/year, which is 'significantly lower than the global average.' Based on measurements from tide gauges, it even dropped a few centimetres between 1960 and 1993 before rising 4–5 cm between 1993 and 2000, after which there was no change.

One factor affecting regional sea level is atmospheric pressure: a drop in pressure of 1 millibar (mbar) is equal to about a 1 cm rise in sea level. A rise in atmospheric pressure linked to the North Atlantic Oscillation was responsible for the drop in sea level in the Mediterranean between 1960 and 1993. Climate models indicate that atmospheric pressure could rise in future in the Mediterranean, causing a drop of 2 cm by 2100, or -0.2 mm/year on average.

Photo: Wikipedia Commons

Visitors to Venice in September 2009 watch a young boy taking a dip in flooded St Mark's Square.

The workshop was organized by UNESCO in partnership with Georg Umgiesser from the Italian Institute of Marine Sciences of the National Research Council, lead author on the report. UNESCO has since organized three other workshops to evaluate environmental, cultural and socio-economic challenges faced by Venice and its Lagoon in relation to global change.

To read the report, see page 24

Another factor controlling sea-level change is the steric effect, by which higher temperatures raise sea level, whereas higher salinity lowers it. Scientists conclude from this that, although there has been a rise in both temperature and salinity, the latter could dominate in the Mediterranean.

As the Mediterranean Sea is linked to the Atlantic Ocean through the Strait of Gibraltar, one crucial uncertainty concerns how exchanges through the strait will influence sea level in the Mediterranean. The latest findings indicate that the difference between both basins should not be greater than 10 cm, with an adjustment process that should not take longer than a few months. 'Sea-level rise in the Mediterranean will thus be dominated by the global trend, even if some local differences might continue to exist,' states the report. 'The fact that the steric change in the level of the Mediterranean Sea could be much less (or even negative) simply indicates that the contribution of the Mediterranean to global sea-level rise will be much smaller than that of the other oceans. However, in the long run, the Mediterranean will follow the global ocean.'

As the exchanges between the Adriatic and Mediterranean Seas are not restricted by a narrow strait, it is 'conceivable that the Adriatic Sea should follow very closely the trends in the Mediterranean.'

Mean sea level is basically identical between the Adriatic Sea and the Venice lagoon, despite the strong hydraulic control exerted by the inlets. The city begins to flood when the water level reaches 110 cm. Over the past century, the lagoon has been gradually sinking, owing to natural subsidence and sea-level rise, combined with industrial extraction of groundwater. In the 1980s and 1990s, the average water level was about 23 cm above the zero datum. This level is now closer to 30 cm above the datum. This means that sea-level rise of 80 cm would bring the mean water level to the critical threshold of 110 cm. In this case, Venice would experience regular flooding twice a day at high tide.

Over the past three years, mean sea level in the lagoon has risen by about 10 cm during the summer months and by as much as 20 cm during the winter months. This rise correlates with a drop in atmospheric pressure from 2020 mbar to 2013 mbar in the past three years. It is doubtful that these trends will continue but mean sea level in the Adriatic Sea and close to the Venice lagoon will likely be extremely variable.

Mexican wins Kalinga Prize

On 4 January, Mexican scientist René Raúl Drucker Colín was awarded the 2011 UNESCO Kalinga Prize for the Popularization of Science, at a ceremony in Bhubaneswar (India).

A specialist in physiology and neurobiology, René Raúl Drucker Colín holds a degree in psychology from the National Autonomous University of Mexico and a doctorate in medicine from the University of Saskatchewan (Canada). He is renowned for his work in identifying the role played by neurotransmitters during sleep.

Prof. Drucker Colín is also an ardent promoter of science. His work is published regularly in *La Jornada*, a leading Mexican daily, and he has participated over the past 12 years in the science programmes of Televisa, a national broadcaster.

Prof. Drucker Colín was selected by UNESCO Director-General Irina Bokova on the recommendation of an international jury.

The prize consists of US$20,000, together with a silver UNESCO Albert Einstein medal and certificate. It also includes the Kalinga Chair established by the Indian Department of Science and Technology, comprising a two-week visit to India by the laureate to meet with scientists and science communicators.

The UNESCO Kalinga Prize was created by UNESCO in 1951 and is awarded every two years. Financed jointly by the Kalinga Foundation in India, the Government of the State of Orissa and the Government of India, the prize rewards the efforts of writers, editors, lecturers, radio/television programme directors or film producers who have made a significant contribution to presenting science and technology to the general public.

For details: (Delhi) a.fahmi@unesco.org; (Paris) y.nur@unesco.org

Laureates find **new ways** of looking at old problems

In a ceremony at UNESCO headquarters in Paris on 29 March, five laureates will receive the L'Oréal-UNESCO Award for Women in Science, which comes with prize-money of US$100,000. They will be joined by this year's 16 fellows in life sciences (*see map*). The focus of the laureates' research is on medicine and on 'resurrection plants.' As Günter Blobel, President of the jury and Nobel laureate in Medicine (1999), put it, 'they have all uncovered new ways of looking at old problems.'

Prof. Jill Farrant (South Africa)

Prof. Ingrid Scheffer (Australia)

Prof. Frances Ashcroft (United Kingdom)

Prof. Susana López (Mexico)

Prof. Bonnie Bassler (USA)

Prof. Jill Farrant is the laureate for Africa and the Arab States. She holds the Research Chair in Plant Molecular Physiology at the University of Cape Town (South Africa) and has been recompensed for discovering how plants survive under dry conditions. Prof. Farrant is the world's leading expert on resurrection plants, which 'come back to life' from a desiccated, seemingly dead state when given water. Her team's ultimate goal is to develop drought-tolerant crops to nourish populations in arid, drought-prone climates, notably in Africa. Her research may also have medicinal applications.

Prof. Ingrid Scheffer is the laureate for Asia–Pacific. A paediatric neurologist at the University of Melbourne (Australia), she has been recompensed for identifying genes involved in certain forms of epilepsy, a brain disorder characterized by seizures and other symptoms that can be extremely disruptive to the lives of the 50 million sufferers. She has also described several new forms of epilepsy. She and her colleagues were the first to show that sodium channel genes caused febrile seizures, for instance, leading to a Belgian discovery that mutations to these genes caused Dravet Syndrome, a severe form of epilepsy. Her findings have already improved diagnosis and treatment for many patients and may lead to new therapies.

Prof. Frances Ashcroft is the laureate for Europe. A Fellow of Trinity College at the University of Oxford (UK), she has been recompensed for advancing our understanding of insulin secretion and neonatal diabetes. In 1984, she discovered a protein that acted as the link between blood–glucose levels and insulin secretion. As a result, people with a rare inherited form of diabetes can now simply take an existing drug in pill form, rather than enduring daily insulin injections. The drug has improved their blood glucose control and thereby reduced the risk of diabetic complications such as blindness and kidney disease; she is now studying why 25% of these patients also have neurological problems. Prof. Ashcroft is also exploring what goes wrong with insulin secretion in adult-onset (type 2) diabetes, which affects 336 million people worldwide.

Prof. Susana López is the laureate for Latin America. Based at the National University of Mexico, she has been recompensed for her studies on rotaviruses, which cause gastroentiritis and

Photos for the L'Oréal Foundation (Laureates) Julian Dufort; (fellows) Melanie Frey/CAPA Pictures

affect nearly every child on Earth under the age of five. Every year, 600 000 children in developing countries die from the resulting diarrhoea. The rotavirus was discovered in 1973 but there is still no antiviral drug to control the infection, antivirals being available so far only to prevent the replication of such viruses as HIV, herpes and influenza A and B. With her colleagues, Prof. López has developed new diagnostic tests, isolated several new rotavirus strains and contributed to efforts to find a vaccine.

Prof. Bonnie Bassler is the laureate for North America. A Howard Hughes Medical Institute Investigator and Squibb Professor at Princeton University (USA), she has been recompensed for showing that bacteria 'talk' to one another using chemicals as their words. About 1 250 g of bacteria live in the gut and on the skin of every human body. Although bacteria live as single cells, Prof. Bassler was convinced that bacteria were ineffective on their own and had to work as co-ordinated 'armies' to keep us healthy (such as by digesting food) or make us sick (by causing disease). To act in unison, groups of bacteria had to communicate with one other. Her startling discoveries may someday lead to new antibiotics that interfere with bacterial conversations as well as many other applications, such as infection-resistant surgical implants.

For details: www.forwomeninscience.com; s.bahri@unesco.org

ICTP takes **seismology course** to epicentre of Haitian tragedy

From 15 to 28 January, the Science Faculty of the Université d'État du Haiti (UEH) in Port-au-Prince played host to a seismology school run by Karim Aoudia from UNESCO's Abdus Salam International Centre for Theoretical Physics (ICTP).

The intensive two-week course covered the full spectrum of earthquake sciences, from physics to risk reduction, with the support of the university's rector, Jean Vernet Henry.

Aoudia was able to secure 20 computers with a steady power supply for the workshop, with the help of UEH staff. Originating mostly from UEH's engineering programme, participants learned earthquake theory and how to read and analyse datasets on the minor earthquakes that shook Haiti during the workshop. They also learned how to save lives in the event of an earthquake. 'The students told me that one of the first things they would do after the workshop would be to visit all of the schools in Port-au-Prince to instruct young Haitians on what to do if there is an earthquake,' Aoudia explains.

In addition to sponsoring the Port-au-Prince workshop, ICTP has donated 150 science books to UEH's new library and is actively recruiting Haitian students for its Postgraduate Diploma Programme.

But much more is needed. Although the 2010 earthquake may have focused the world's attention and much-needed funding on the Caribbean island, 'momentum from that wave of goodwill is slowing,' worries Aoudia. Even though

Photo K.Aoudia/ICTP

Makeshift classrooms at the Université d'État du Haiti

'science can play an important part in Haiti's long-term sustainable development.'

'The situation for science in Haiti is bad,' says Aoudia, a seismologist with the ICTP's Earth System Physics group. 'There is no money to support it, no local expertise and few incentives to keep professors in the country. What few professors they do have will be retiring in the next few years, presenting an urgent need to train their replacements.' Perhaps most surprisingly – for a country straddling the intersection of the North American and Caribbean tectonic plates –, there are no seismologists in Haiti.

Aoudia hopes to change that. 'The long-term issue will be to build basic science capacity,' he says, noting that currently there is no possibility to earn a science degree in Haiti. Two years after a 7.0-magnitude earthquake claimed the lives of a staggering 316 000 people and left almost another million homeless, efforts are still focusing on rebuilding education infrastructure. At UEH, classes meet in hangar-type structures open to the elements (*see photo*). There are no walls between classrooms and a bustling market in front of the campus adds to the background noise competing for the students' attention.

For details: aoudia@ictp.it

A graduate diploma in nanoscience for **Arab universities**

When the new academic year gets under way in October, four universities in Egypt and Sudan will be offering a new graduate diploma in nanoscience. The curriculum has been developed by UNESCO's Network for the Expansion of Converging Technologies in the Arab Region (NECTAR) and will first be proposed by the Egyptian–Japanese University for Science and Technology, Helwan University (Egypt), Khartoum University and the Future University (Sudan), before being replicated in other Arab countries.

UNESCO's Regional Bureau for Science in the Arab States has been collaborating with renowned scientists for the past year to develop the curricula for the graduate diploma.

These scientists include Prof. Mustapha Alsayed from Georgia Tech University (USA), Prof. Samy Elshal from the Virginia Commonwealth University (USA), Prof. Osama Awad Elkarim from Penn State University (USA) and Prof. Mona Bakr from Cairo University (Egypt). UNESCO is running a two-month training course in Cairo from 15 June to 15 August for the university faculty who will be teaching the course.

UNESCO's Cairo office is also developing minor undergraduate degree programmes in nanotechnology and nanoscale biotechnology for the same universities. Future University may even be ready to launch its undergraduate programme as early as October.

Nor have students from technical colleges been overlooked. From October onwards, NECTAR will be offering them a semester in nanoscience at nearby research universities, to give them marketable skills required by industry.

Launched in June 2011, NECTAR[1] was born of the realization that Arab countries would only be able to embrace the knowledge economy and sustainable development if they coulsd strengthen their capacity for innovation. The *UNESCO Science Report 2010* found that university research in the Arab world often served purely academic purposes, even though the higher education sector was considered the 'Arab world's engine room for discovery and innovation'. Innovation was further hindered by the weak linkages between academia and industry. Nor were universities equipping graduates for the knowledge economy; the authors observed 'a dire mismatch between the skills companies are seeking and what most universities in the region are producing.'

By developing a partnership between academia and industry, NECTAR plans to reorient academia towards problem-solving and remove the barriers between disciplines that currently hinder innovation in the Arab world. Nanotechnology, for instance, is at the crossroads of a broad range of disciplines that include biology, chemistry and physics, materials science, engineering and computer science. Nanotechnology is one of the fastest-growing fields in science, with applications ranging from health care to microelectronics, renewable energies and water purification, yet nanotechnology research is still in its infancy in the Arab world.

Three centres of excellence participating in NECTAR have already created an Innovation Centre in Converging Technologies within their walls. The first is affiliated with the Science and Technology Centre for Excellence of the Egyptian Ministry of Military Production; the second is the Faculty of Engineering at Khartoum University and the third is the École normale supérieure de l'enseignement technique in Rabat (Morocco), part of Mohamed V–Souissi University. Other centres of excellence in Bahrain, Iraq, Jordon and Syria should follow suit. All intend to develop research partnerships with public institutes and industry.

For details (Cairo): n.hassan@unesco.org

1. *See* A World of Science, *July 2011*

Mission accomplished for Lady Amber

Lady Amber in full sail

After 12 months spent criss-crossing the Indian Ocean, the Lady Amber made landfall in Western Australia on 4 January. Since setting sail from Durban (South Africa) in December 2010, the captain and four crew members of the 20-metre schooner had deployed 57 drifting robots in the southern Indian Ocean, a zone rarely visited by research ships. Upon arrival in Perth, the captain and his crew were greeted by scientists from the local office of UNESCO's Intergovernmental Oceanographic Commission (IOC).

The 57 drifting robots are part of an arsenal of 3 500 Argo drifting robots, 1 250 drifting buoys and 500 anchored buoys (including tsunametres) covering every ocean of the planet. Since the Argo project's inception in 2001, these buoys have been deployed by 3 000 volunteer ships on their routine crossings. This was the first time, however, that a private yacht had contributed to the global effort.

Argo drifting robots gather data about the state of the oceans, especially as concerns temperature and salinity. These data are then transmitted by satellite to reception stations on terra firma and used for numeric modelling for weather forecasting and climate research. Each robot has a lifespan of about four years before its batteries fail and it sinks to the ocean bottom, although their life expectancy is expanding thanks to new technologies.

The whole operation is co-ordinated by the Joint WMO–IOC Technical Commission for Oceanography and Marine Meteorology's Observing Platform Support Centre (JCOMMOPS), based in Toulouse (France). All countries participating in the Global Ocean Observing System (GOOS) co-ordinated by the UNESCO-IOC are now involved in the project, with 30 countries donating Argo floats. GOOS was set up in 1992, in the wake of the first Earth Summit in Rio.

The Indian Ocean adventure began in June 2010 when Peter Flanagan, a retired captain, got in touch with the GOOS team. He offered to put his experience and his schooner at the disposal of the international community.

Rapidly realizing the benefit of such a partnership, JCOMMOPS recruited a crew to deploy the drifting robots. Australia was the first country to participate in the adventure, with hopes now of attracting more volunteers.

'So far, Member States have, first and foremost, asked merchant and research ships to deploy the 2 000 drifting robots and buoys needed to maintain the network,' explains Mathieu Belbeoch of JCOMMOPS. 'These days, we are looking for more ecological and flexible solutions, using volunteers where possible, so we are developing partnerships with the sailing community, especially with NGOs.'

For details: www.argo.net; www.imos.org.au; www.jcomm.info; http://iocperth.org; www.ioc-goos.org

Madiodio Niasse

‘Land given for a 99-year concession is land almost lost for good’

From Sudan to the South Pacific, the rush for land is on. In a growing trend, foreign interests are acquiring vast expanses of farmland to feed their populations back home and produce biofuels. Jacques Diouf, former Director-General of FAO, has evoked a risk of agrarian neocolonialism. Just how big a threat does the phenomenon pose to national sovereignty and how can its excesses be avoided? We spoke to Madiodio Niasse, Director of the International Land Coalition based in Rome (Italy) and one of the contributors to the Fourth World Water Development Report.

Are governments selling large tracts of land to foreigners in most cases or leasing them?

In most cases, they are leasing the land. In the 28 land deals totalling 2.64 million ha covered in a survey carried out last year by Norwegian People Aid[2] in what is today largely South Sudan, there were no land sales with transfer of full ownership rights but rather long-term leases of between 30 and 60 years.

Similarly, a 2011 review by the International Institute for Environment and Development of the terms of 12 contractual land deals in Africa showed that none of these agreements were about land sales *per se* but rather about long-term leases, concessions and contract farming[3].

Even in Ethiopia, one of the prime recipients of land-based foreign direct investment in Africa, the law does not allow private ownership of the land, which belongs to the State. The investor therefore typically accesses the land on the basis of lease agreements. I think the notion of *concession* is more accurate than lease contract here. This is because, in a normal lease agreement, the lessee is expected to use the land more or less as it is with minimal investment in the land itself, while paying rent to the lessor.

In the case of large-scale land deals, one of the primary justifications given by governments in developing countries is that they need investments in order to develop the land and make it more productive. The recipient is therefore expected to invest in the land, in the form of water and irrigation infrastructure, roads, storage facilities and so on. This is more or less made explicit in the agreement between the State and the investor, known as the concessionaire. Concessions vary in duration from 15 to 99 years and are often renewable. The sale of freehold land rights is more common in contexts where the land is already under private ownership, which is the case in many Latin American countries.

This begs the question: is there a fundamental difference between granting concessions to investors or selling the land with freehold rights? I think not. Where heavy physical investments are foreseen, the concessionaires demand that the agreement with the host government include types of guarantee and levels of tenure security that are very similar to those associated with freehold rights, at least for the duration of the concession. Even when such guarantees are not explicitly given, the profound transformation of the land and the heavy investments made by the concessionaire are such that the host government often has no option but to keep the land in the hands of the concessionaire or transfer it to another investor under similar contractual terms. Land given for a 99-year concession is land almost lost for good.

Therefore, decisions to give away the land either through sales or concessions should never be taken lightly by governments. Unfortunately, this advice might fall on deaf ears, as many of the large-scale land acquisitions take place in countries with very weak governance. Reading a 2011 World Bank study[4] on this phenomenon, one has the impression that the weaker the governance, the more attractive the country to large-scale land-based foreign land investments. This means that corrupt practices, behind-the-door negotiations, illegal evictions of traditional land-owners and violence against communities are all common features of the current phenomenon of large-scale land acquisitions.

Do you know of cases where foreign ownership has deteriorated the environment or otherwise penalized the local population?

As the phenomenon of large-scale foreign land acquisitions is very recent, it is difficult to assess their full environmental and social impact at this early stage. The land deals we are talking about often relate to hundreds of thousands of hectares each. Developing the acquired land takes many years. Many land deals are only at the stage of negotiations or basic infrastructure development, such as canals and roads. In a few cases, farming has begun on small portions and we are already seeing rivers being diverted through the construction of canals. This is the case of the 100 000 ha Malibya farm project promoted by a Libyan sovereign wealth fund in the Inner Delta of the Niger River in Mali.

Another type of early impact relates to dispossession and forced displacement of small farmers, pastoralists and indigenous peoples. According to the USA-based Oakland Institute, the 325 000 ha investment scheme in Tanzania by US company AgriSol Energy is expected to displace more than 160 000 people, posing extremely complex resettlement challenges[5]. Large-scale land concessions often generate a planning *blight effect*, which here refers to the uncertainty and deleterious effects on the social fabric and economic activities in targeted areas once a land allocation decision is made, or once negotiations between government and prospective investors have begun.

We can project ourselves into the future on the basis of experience with existing agrobusiness schemes. The likely impact includes forest conversion to agricultural land, a drop in biological diversity as a result of monocropping and the massive use of chemical fertilizers, pesticides and herbicides, unsustainable levels of water abstraction and a greater risk of water-related conflicts with local communities and neighbouring States sharing the same transboundary river systems.

Ethiopia has sold more than 1 million ha of fertile land to foreign investors from India, Saudi Arabia and elsewhere, displacing tens of thousands[6] of subsistence farmers. The government argues that the investors will grow more food, not all of which will be exported. What is your view?

Let me start by recognizing that Ethiopia, like many other sub-Saharan countries, including mine – Senegal –, faces serious development challenges. Subsistence family farming, which is the backbone of Ethiopia's rural economy, is essentially rainfed, as only about 10% of the cereal cropland is irrigated. Farming is thus highly vulnerable to climate variability and change. Frequent rainfall deficits have translated in recent years into severe droughts and famine. Ethiopia is the world's biggest recipient of food aid.

I think any responsible government facing a problem of this nature is compelled to act. But governments have several options. The Ethiopian government seems to have elected to bet on large-scale concessions of fertile arable lands to foreign investors. This option carries risks, while it remains to be seen if the expected benefits will materialize, such as rural infrastructure, jobs and the contribution to domestic food needs.

One of the less risky but not fully explored options is for the government to invest in modernizing family farming. This will require devoting a substantial share of public resources to the agricultural sector and improvements to the legal and institutional environment to encourage Ethiopian farmers to invest in their land and innovate. As this option has worked in countries like Vietnam, why couldn't it work in Africa? In instances where foreign investment is justified, priority could be given to arrangements that do not imply transfer of arable land to foreign investors. These arrangements − which include contract farming and joint ventures − pose their own challenges but at least allow farmers and government to keep their destiny in their own hands.

How can indigenous populations secure their claim to land without property deeds?

Indigenous peoples tend to be disproportionately affected by dispossessions resulting from large-scale land acquisitions. There are many reasons, including the fact that they occupy and use land that is often considered by governments as vacant, unowned and/or underexploited.

Indigenous peoples also tend to be politically marginalized and thus not in a position to oppose government decisions. What can be done? Firstly, push governments to recognize as indigenous peoples all communities meeting the criteria that define indigenous peoples under international law. Secondly, promote full respect of the land-related provisions of the ILO 169 Convention on Indigenous and Tribal Peoples, notably the general principle that indigenous people should not be removed from the land they occupy and, in the exceptional cases where their relocation is considered, that it should be conditioned to their free prior informed consent.

Last December, Argentina's Senate voted 62-1 to limit land ownership by foreign individuals or companies to 1000 hectares and foreign land holdings to 15% of farmland. Currently, an estimated 7% is in foreign hands. What is your view of this development?

As I said earlier, in Argentina, as elsewhere in Latin America, most of the arable land is privately owned by individual farmers and corporations. Large-scale farms are an integral part of the rural landscape.

The fear of large-scale farms is real, however, among small farming communities and indigenous peoples in Latin America. The process of land concentration tends to be amplified by large-scale foreign land acquisitions, resulting in growing inequalities in farm size.

An even bigger concern in Argentina and the rest of Latin America seems to about the *extranjerización de la tierra*, or *foreignisation* of the land. In the current global context, which has seen land prices soar, international land transactions could easily get out of hand and result in foreign interests taking control of most of the land in Latin America, threatening the national sovereignty of States over their territory. This has driven Argentina, Bolivia, Brazil, Paraguay and Uruguay to enact a series of laws preventing or limiting the sale of land to foreign investors.

Interview by Susan Schneegans

2. *See: www.npaid.org/filestore/NPA_New_Frontier.pdf*
3. *Crop production purchase agreement between the investor and farmers, who continue to own and farm their land.*
4. *Deininger and Byerlee (2011) Rising Global Interest in Farmland: Can it Yield Sustainable and Equitable Benefits?*
5. *See: ww.oaklandinstitute.org/sites/oaklandinstitute.org/files/OI_brief_myths_and_facts_agrisol_energy_1.pdf*
6. *According to Human Rights Watch*

Sandwatchers find **a market for a weed**

Lampshade made from water hyacinth

Water hyacinth has been a thorn in Kenya's side for decades. Capable of doubling its biomass in just 15 days, the weed has resisted all attempts to eliminate it from Lake Victoria, including those of the World Bank. Now, a group of Sandwatch Club members have come up with an ingenious solution. They are encouraging local entrepreneurs to use the robust weed to make a wide variety of products that include rope, bags, pulp, cards, lampshades, furniture, baskets, footwear, animal fodder and biogas.

The Kenyan branch of Sandwatch is based at Kisumu High School in the country's third-biggest city. Kisumu City lies on the shores of Lake Victoria, the second-largest freshwater lake in the world after Lake Superior on the US–Canadian border, shared by Kenya, Uganda and Tanzania.

For years, Kenyan Sandwatchers have cleaned and conserved the beaches and shores of the lake. Our job has become particularly difficult in recent years, however, as water hyacinth has reinvaded the lake.

The weed is wreaking havoc with Kisumu's water supply systems, marine transport and fishing industry, and could ultimately threaten food security by blocking access to fishing grounds. As the vegetation mats block sunlight from penetrating into the lake, the weed also threatens plant and animal life. Moreover, by preventing water flow, it creates an ideal breeding ground for mosquitoes and other insects. While there are other threats to the lake, such as overfishing and pollution, water hyacinth has been the hardest to eradicate.

A weed that keeps coming back

Known by its scientific name of *Eichhornia crassipes*, water hyacinth is believed to have been brought from the Amazon Basin to East Africa as a pot plant that later found its way into the lake. Its rapid proliferation has been blamed on the dumping of untreated industrial effluents and fertilizers in the lake. The green plant produces beautiful purple flowers and has long fibrous roots. The spongy tissues in its stem enable it to float in water. It grows in clusters that form floating mats in the lake and thrives best in polluted waters. The weed spreads at an alarming rate, doubling its biomass every 15 days according to scientists.

Government officials contemplating the weed's progression on the lake

Sandwatch adds climate change to the school menu

Sandwatch was launched in the Caribbean in 2001, during a UNESCO workshop on environmental education. Since its inception, Sandwatch has expanded into the Pacific and Indian Oceans and is now active in about 40 nations worldwide. Young people living on lakes or rivers have also become Sandwatchers, as in the case of the Kenyan club in Kisumu.

One of the most recent countries to join this UNESCO project is Kiribati in the Pacific. In March last year, the Curriculum Development Resource Centre of the Ministry of Education embarked on a revision of the primary school curriculum. This revision will integrate Sandwatch into four school subjects by the end of 2012: English language, Kiribati studies, mathematics and environmental studies. A revision of the secondary school curriculum is likely to follow.

The second edition of the *Sandwatch Manual* was launched in October 2010, after being tested in 2009 by teachers from the Bahamas, Dominican Republic, Puerto Rico and the Turks and Caicos Islands, at a Sandwatch workshop in the Bahamas.

Developed jointly by UNESCO, the Sandwatch Foundation and the Government of Denmark, the revised manual integrates topics related to climate change into the existing Sandwatch methodology. New topics include: how beaches respond to climate change; ways in which Sandwatch can contribute to climate change adaptation; simple ways to measure weather; beach erosion and sea-level rise; beaches and ocean acidification; climate change and beach users; coral bleaching; and enhancing beach resilience to climate change.

Other new sections of the manual cover monitoring beaches for nesting turtles and how to launch a Sandwatch project or create a Sandwatch network via websites, newsletters, social networks like Facebook and other free web-based resources.

This latest edition of the *Sandwatch Manual* is available from UNESCO in English and French, with Spanish and Portuguese editions due out later this year.

Download the manual: www.sandwatch.org;
or request copies: www.unesco.org/csi/field-offices

Some conservationists argue that the weed could be controlled by mechanical means but this approach has tended to fail because the weed grows so fast. Various herbicides are also effective but imperil wetland biodiversity. The continued presence of the weed in the lake causes water shortages, as the plants block irrigation canals and pipes carrying water into the city. Light steamers are often unable to dock at the port of Kisumu when it becomes clogged with the weed.

A plan to save the lake was launched in 1994, with funding from the World Bank and the Global Environment Facility, but it has unfortunately not made a lasting impact. Through the plan, *Neochitina* weevils were introduced into the lake to eat the plants but, by 2007, water hyacinth was back with a vengeance. According to NASA satellite imagery, the lake appeared to be clear by the end of 2005, until unusually heavy rains in November and December 2006 swept agricultural fertilizers and nutrient-rich sediment into the water, feeding a fresh outbreak.

The Sandwatch Club discovers the virtues of a weed

For the Sandwatch Club, enough was enough. 'What can we do to stop this weed from spoiling our lives?' asked Lillian at a club meeting in December 2008. 'Nothing', retorted Jacob with a sigh. 'If the World Bank with all its money has failed, how can we, mere students with no income, achieve anything?'

The weed invades water collection points on Kisumu's shores.

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(Left) Sandwatch Club members harvesting water hyacinth in Kisumu to make rope (Above) Chair made from water hyacinth.

But one member of the club refused to give up. Known affectionately as Wizard for his aptitude in browsing the Internet for ideas, he came across a group in South America who use the water hyacinth to make paper and boards. Since water hyacinth gives an easily digestible pulp, it serves as a readily available raw material for the manufacture of paper.

Using Internet, our group made a list of all the uses for water hyacinth they could find. We discovered that water hyacinth can be used as a food for humans because its leaves are rich in protein and vitamin A. It can be used as a green fertilizer and as mulch and compost to regenerate degraded soils. It can remove different pollutants from water and nourish fish populations in the wild or in artificial enclosures. It can easily replace straw as a substrate for mushroom-growing or serve as animal fodder. It can be used as a source of energy by burning the weed to produce biogas, thereby combating deforestation. The plant can also be used to make fuel briquettes for cooking and lighting.

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Furniture can be made from the water hyacinth's dried fibres, like this coach seat with a back rest.

Since our club lacked the money to invest in harvesting the weed for commercial purposes, we decided that the best thing would be to encourage youth groups, women's groups and groups for the handicapped to form community-based organizations to harvest and process water hyacinth and manufacture a variety of exotic products. We suggested to them that they could capitalize on the hyacinth's tough but flexible composition by weaving baskets, chairs and other pieces of furniture – even biodegradable sanitary napkins – to sell for extra income.

Several of the groups took our club's advice. Now, all over Kisumu, markets and shops sell a variety of products made from water hyacinth. 'Even my current diary is made of water hyacinth paper!', observes club member Mark. Other products on sale in the city include pulp, cards, lampshades, sturdy furniture, baskets, footwear, cordage, animal fodder and gas.

We have been amazed by the creativity of people. 'Recently, we visited a hotel near the lake where they use water hyacinth as a substitute for tea and coffee', says club member Timothy. 'It tasted…wow!'

Twice a month, Sandwatch Club members harvest the weed manually from the lake to make rope. This rope is then used to tie up domesticated animals like cows, goats and sheep. 'We are helping farmers and fishermen around the lake shores not only to improve their income and livelihood but also to make at least a small difference to their local surroundings,' says Timothy. 'People are turning a devastating situation into a life-improving one.'

The Sandwatch Club is now trying to convince the population that, while water hyacinth may be viewed by many living on the shores of Lake Victoria as a menace that must be removed, it also has its merits. That is our club's new message', he says, 'water hyacinth is a double-edged sword.'

Peter Amunga[7]

7. *Patron of the Kenyan Sandwatch Club: peteramunga@gmail.com*

Striving for **a better tomorrow in Mujib**

Last September, people gathered in the Hashemite Kingdom of Jordan to celebrate the designation of Mujib Biosphere Reserve by UNESCO. They had come from The Royal Society for the Conservation of Nature (RSCN), the Jordanian Ministry of the Environment and UNESCO's Amman office to laud the management of a nature reserve spanning 212 km^2 that encompasses not only the lowest points on Earth – it lies 420 m below sea level in places thanks to its proximity to the Dead Sea – but also scores of endangered species.

Pseudotrapelus siniatus, *commonly known as blue agama, is a common sight in the steep sandstone mountains of Mujib Biosphere Reserve.*

For the population living in and around Mujib Biosphere Reserve, however, the impact of the biosphere reserve extends well beyond these two days of festivities. As almost all local residents live below the national poverty line with an average monthly income of 330–370 JOD ($US465–522) for a family of ten, the jobs created by the reserve since its establishment in 1985 mark the first time in generations that many local residents have been afforded viable economic opportunities that are also sustainable.

A family of Nubian Ibex

When the Royal Society established a captive-breeding programme in the reserve in 1989 to save the endemic Nubian Ibex (*Capra ibex nubiana*) from imminent extinction, the programme didn't stop at enforcing a hunting ban. Instead, RSCN worked with the hunters and their families to create alternative livelihoods. Today, many of the sons of those traditional hunters are employed as reserve staff and their unique and intimate knowledge of the land has greatly benefited dozens of initiatives ranging from ecotourism to scientific research.

Ten years after the captive-breeding programme began, 160 Ibex were released back into the wild. Today, nearly 100 Ibex roam the reserve but they remain threatened by poachers.

Oleander shrub

Rock Hyrax

A fragile cohabitation between people and nature

Poaching continues throughout the reserve and nearby areas, jeopardizing not only the survival of the Nubian Ibex but also that of game species such as hares, the Rock Hyrax (*see photo*), doves and the chukar, a gamebird from the pheasant family.

Over the past decade, local herdsmen have seen their grazing lands eroded by uncontrolled development in the surrounding area, pushing them and their herds onto the rangelands of Mujib and resulting in overgrazing. To combat this, RSCN has instituted a comprehensive programme of rangeland rehabilitation and grazing management in the buffer zone, with the full support and involvement of local communities.

Partly warm desert and partly semi-desert, Mujib Biosphere Reserve counts five types of vegetation: steppe, Mediterranean non-forest, saline, tropical and aquatic. These habitats house many threatened species, including 95 rare plant species, 24 species of mammal and eight bird species. The wadi beds are home to the richest vegetation, including palm trees, wild fig, tamarix trees and colourful oleander shrubs. Among the mammals roaming the reserve, Rock Hyrax, Eurasian Badgers and Nubian Ibex tend to prefer the steep mountain slopes.

Mujib is an important passageway for migratory birds. Huge numbers of White Storks pass through every year from August onwards, as well as Black Storks, buzzards, Honey Buzzards and Levant Sparrow Hawks, among others. The globally threatened Lesser Kestrel breeds in the reserve each spring.

The freshwater running through Mujib is a precious commodity in a country that counts among the most arid in the world. The reserve includes major parts of the Mujib River, one of the largest and cleanest rivers in Jordan. Stretching for approximately 70 km – 13 km of which lie within the reserve – *Wadi Mujib* (Arabic for Mujib Valley) hosts a variety of riverbed wildlife, including one fish species endemic to the Dead Sea Basin.

The Crested Lark is commonly found in dry open landscapes. It nests on the ground, laying two or three eggs at a time, and feeds on insects and the seeds of weeds.

Three large catchments produce flowing water all year round, making the area a wetland. Numerous springs along the wadis (valleys) provide unique habitats for wildlife and contribute to the reserve's designation as one of the most important bird areas in the Jordan Rift Valley.

Unfortunately, recent surveys conducted by the Integrated Water Resources Management and Conservation in Mujib Reserve Project have revealed that all samples collected from water springs, the Mujib dam and areas of water flow in the wadi are contaminated with *E. coli* and have total coliform values that exceed the permissible limits of Jordan Standards and WHO guidelines. This contamination has been attributed to water runoff from local agriculture. While the concentration of the bacteria was diluted during the rainy season, the overall increase in pollution in Mujib Biosphere Reserve threatens to disrupt the fragile ecological balance.

Taking the Ibex Trail to visit Lot's wife

The breathtaking scenery and wildlife have turned Mujib into a popular tourist destination. 'The most common comment we get when people visit Mujib is, "I had no idea this kind of wildlife existed in Jordan,"' says Reef Fakhouri, Director of Marketing at Wild Jordan, the division within RSCN responsible for developing ecotourism in the country's eight reserves, including Dana Biosphere Reserve,

RSCN has established a pilot farm in the reserve to show local communities how to generate income by growing crops with lower water consumption, with funding from Wildlife International and the Canadian International Development Agency.

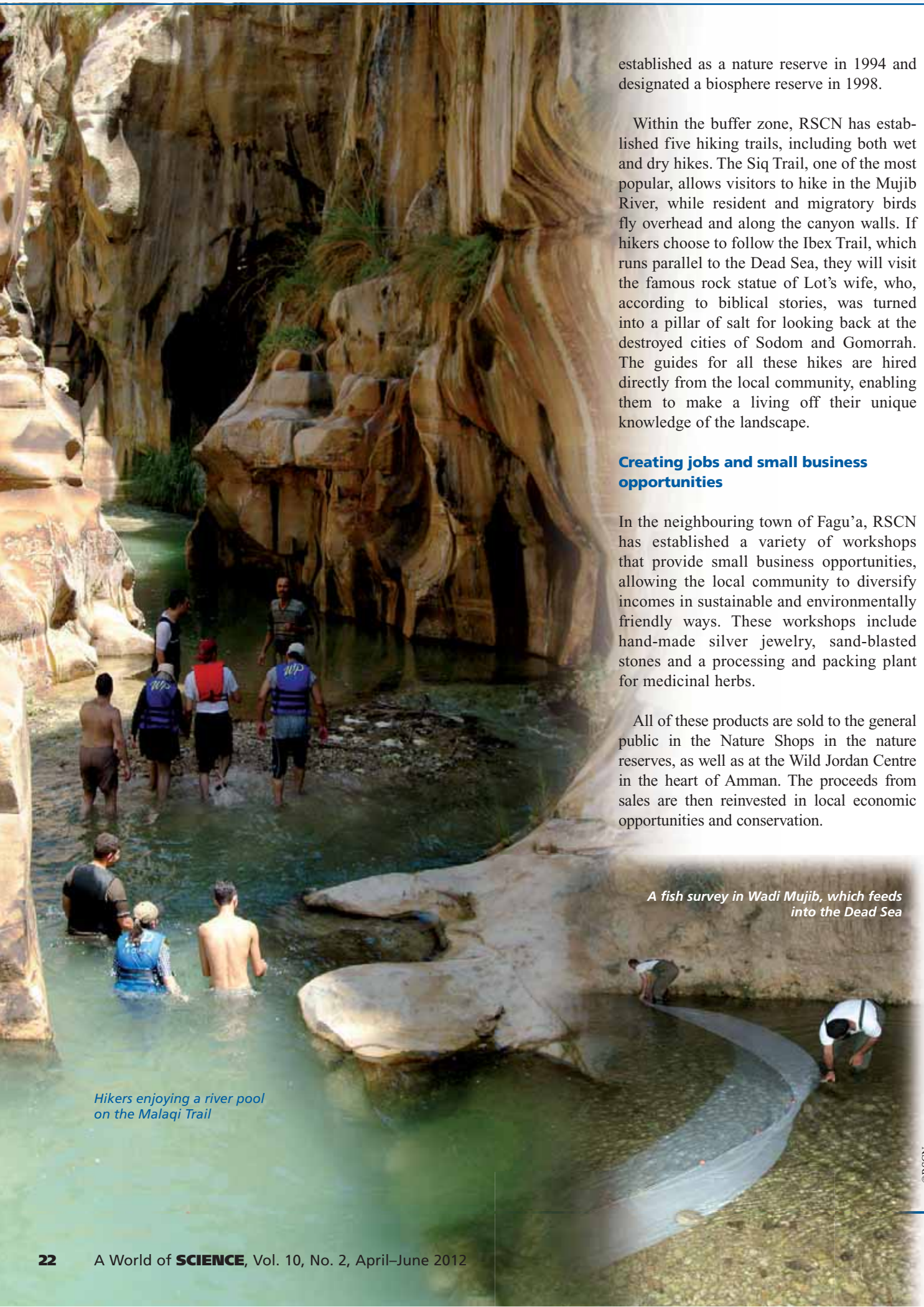
established as a nature reserve in 1994 and designated a biosphere reserve in 1998.

Within the buffer zone, RSCN has established five hiking trails, including both wet and dry hikes. The Siq Trail, one of the most popular, allows visitors to hike in the Mujib River, while resident and migratory birds fly overhead and along the canyon walls. If hikers choose to follow the Ibex Trail, which runs parallel to the Dead Sea, they will visit the famous rock statue of Lot's wife, who, according to biblical stories, was turned into a pillar of salt for looking back at the destroyed cities of Sodom and Gomorrah. The guides for all these hikes are hired directly from the local community, enabling them to make a living off their unique knowledge of the landscape.

Creating jobs and small business opportunities

In the neighbouring town of Fagu'a, RSCN has established a variety of workshops that provide small business opportunities, allowing the local community to diversify incomes in sustainable and environmentally friendly ways. These workshops include hand-made silver jewelry, sand-blasted stones and a processing and packing plant for medicinal herbs.

All of these products are sold to the general public in the Nature Shops in the nature reserves, as well as at the Wild Jordan Centre in the heart of Amman. The proceeds from sales are then reinvested in local economic opportunities and conservation.



A fish survey in Wadi Mujib, which feeds into the Dead Sea

Hikers enjoying a river pool on the Malaqi Trail

©RSCN

In the educational lab, RSCN uses eco-games like dressing up as local wildlife to teach children about species, habitats and the importance of conservation.

On the left, *girls are being introduced to the values of organic versus non-organic agriculture by weighing different concepts to determine which are environmentally friendly.*

Thousands of people in Mujib have benefited directly or indirectly from these initiatives, like Handicrafts Workshop Supervisor Samira Hamaideh. Hamaideh admits that, when she first came to RSCN, she lacked the skills to become economically independent. 'I did not know anything about these products or how to make them,' she admits, 'but RSCN trained me. Now, I am a supervisor and can teach these skills to other women to help them improve their financial situation as well.'

When asked how the designation of Mujib as a biosphere reserve would impact her directly, Hamaideh replied, 'I have already noticed more visitors to our workshops than ever before. I am excited about this new publicity. Hopefully, it will mean continued work for us, *inshallah*.'

Misha'al Amarean, Mujib Biosphere Reserve Manager from 1990 to 2004, echoed these sentiments in his speech at the official launch of Mujib Biosphere Reserve. 'Declaring Mujib a biosphere reserve is exciting because it not only means international recognition but also the possibility of creating more jobs for our local community,' he said.

An educational lab for the community

Located on the outskirts of the reserve, the educational laboratory established by RSCN offers courses for school pupils when it is not hosting local community meetings. Currently, the lab is teaching students and their teachers about the importance of medicinal plants and how to utilize these in a sustainable way.

Helping nature by helping people

In the 25 years since its establishment as a nature reserve, Mujib has become a model for the integration of conservation with sustainable development. As Mohammed Yousef, Director of RSCN's Conservation Division, puts it, 'We are not just working to conserve our environment for the next generation. We are working to develop our communities so that there is a next generation to appreciate the beautiful landscapes and unique habitats that we have here in Jordan. You cannot separate the two; it is impossible. You have to help nature by helping people. This recognition by UNESCO shows that, in Mujib, we are doing just that.'

Rhyannon Curry

For details: pr@rscn.org.jo; http://bit.ly/s6MNh8

Diary

1–3 April
African forum on STI

for youth employment, human capital development and inclusive growth. African Development. Bank, AU, UNESCO, UNECA, with ADEA. Nairobi (Kenya): *www.unesco.org/science/psd*

2–4 April
Tsunami system for Caribbean

7th session of Intergov. Coordination Group for Tsunami and Other Coastal Hazards Warning System for Caribbean and Adjacent Regions. Hosted by Met. Depart. Curaçao. Willemstad, Curacao : *b.aliaga@unesco.org; http://ioc-tsunami.org*

3–4 April
Higher education and professional responsibility

in chemical-, biological-, radiological- and nuclear-focused applied sciences and technology across the sub-Mediterranean region. UNESCO Venice with ISESCO, Landau Network-Centro Volta (Italy). Venice: *m.scalet@unesco.org*

10–11 April
Sustainable energy for researchers and industrialists

ICSU regional workshop to initiate dialogue between scientists and industrialists. With support from UNESCO Montevideo. Ocho Ríos (Jamaica): *e.fernandez-polcuch@unesco.org.uy; secretariat@icsu-latin-america-caribbean.org*

16–21 April
IPBES

2nd session of plenary to operationalize Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services. Panama: *www.ipbes.net; s.arico@unesco.org*

18–20 April
Groundwater governance

1st regional consultation within project for A Global Framework for Country Action. See A World of Science, January 2012. GEF, UNESCO, FAO, IAH, World Bank, Montevideo (Uruguay): a.aureli@unesco.org; *c.abdalla-iskandar@unesco.org ; www.groundwatergovernance.org*

18–20 April
Public communication of science and technology

12th intl conf. Organized by PCST Academy, UNESCO, SISSA, University of Padua, etc. UNESCO session on the quality of science communication in Southeast Europe. Florence (Italy): *r.santesso@unesco.org; www.pcst2012.org*

23–27 April
Women and geosciences for African integration

6th conf. of Association of African Women Geoscientists, supported by UNESCO within its Earth Science Education Initiative in Africa. Yaoundé (Cameroon): *aawg6_cameroon@yahoo.fr*; *contact@aawg.org*; *www.aawg.org*; *sf.toteu@unesco.org*

23–27 April
Water sciences for sound Africa water policies and governance in a changing environment

4th regional conf. of UNESCO-IHP Africa national committees. Dar es Salaam (Tanzania): *a.amani@unesco.org* ; *www.unesco.org/water*

2–3 May
IOC Sub-Commission for Africa and Adjacent Island States

1st session. Nairobi (Kenya): *m.odido@unesco.org*

12–15 May
Geoparks

5th intl conf. Shimbara (Japan): *m.patzak@unesco.org*

15–19 May
The effects of climate change on the world's oceans

2nd intl symposium.Sponsored by UNESCO-IOC, Intl Council for Exploration of Sea, North Pacific Marine Science Org. in first week of Expo 2012. Yeosu (Rep. Korea: jl. *valdes@unesco.org; www.pices.int; www.ioc-unesco.org*

29–31 May
Groundwater governance

2nd regional consultation within project for A Global Framework for Country Action. See A World of Science, January 2012. GEF, UNESCO, FAO, IAH, World Bank. Nairobi (Kenya) *c.abdalla-iskandar@unesco.org; www.groundwatergovernance.org ; a.aureli@unesco.org;*

15 June – 15 August
Training in teaching higher diploma in nanoscience

Workshop for university faculty staff due to teach courses within NECTAR's Higher Diploma from October 2012. With Full Bright Agency, Egypt-Japan University for S&T, Nano-Tech Egypt, S&T Centre for Excellence. Cairo (Egypt): *n.hassan@unesco.org*

20–22 June
UN Conference on Sustainable Development (Rio+20)

Rio de Janeiro (Brazil) : *www.unesco.org/new/en/rioplus20/*

New **Releases**

Managing Water under Uncertainty and Risk
World Water Assessment Programme hosted by UNESCO and comprising 28 UN agencies. UNESCO Publishing, ISBN: 978-92-3-104235-5, €55.00. English only, 904 pp (three volumes). Download: *www.unesco.org/water/wwap*. For details, *see page 2*.

Water, Life and Civilisation
Climate, Environment and Society in the Jordan Valley

Steven Mithen and Emily Black (eds). International Hydrology Series involving UNESCO-IHP and Cambridge University Press. ISBN: 9780521769570, £80.00, English only, 520 pp.
An interdisciplinary study of the relationship between climate, hydrology and human society from 20 000 years ago to the present day. To order: *www.cambridge.org*

Climate Change Starter's Guidebook
Co-ordinated by Seraphine Haeussling (UNEP) and Julia Heiss (UNESCO). Published by UNESCO and UNEP, ISBN 978-92-3-101001-9. English only, 72 pp.
Provides an overview for education planners and practitioners.
Download: *http://unesdoc.unesco.org/images/0021/002111/211136E.pdf*

Challenging HIV and AIDS
A New Role for Caribbean Education

Michael Morrissey (ed.) with Myrna Bernard and Donald Bundy. UNESCO Publishing/ Ian Randle Publishers. ISBN: 978-92-3-104151-8, 24.00€, 380 pp.
After sub-Saharan Africa, the Caribbean has the highest HIV prevalence in the world. There remains no cure for HIV and AIDS. The authors address the root causes of the epidemic and extol the virtues of reducing ignorance and the accompanying stigma and discrimination, as well as of addressing sexuality through health and family life education in schools.

Harmful Algae News: 20 years!
20th anniversary issue of the UNESCO-IOC newsletter on toxic algae and harmful algal blooms. N°45, English only, 28 pp.
May be read on a tablette. Download: *www.e-pages.dk/ku/542*
To subscribe to the e-edition (E-Han): *HAN_subscribe.list.iode.org*, with copy to: *hab.ioc@unesco.org*. Libraries may subscribe to the print edition (print HAN): *hab.ioc@unesco.org*

Urban Water Conflicts
Bernard Barraqué (ed). Urban Water series, UNESCO Publishing, ISBN: 978-92-3-104121-1, €38.00,English only, 346 pp.
A collection of essays summarizing the output of a project by UNESCO's International Hydrological Programme on socio-economic and institutional aspects of urban water management. Examines interdisciplinary approaches to understanding and analysing conflicts arising from inadequate urban water management. Also discusses the issue of institutional conflicts between different levels of government.

Planning in the Context of Globalization
Michaela Martin and Mark Bray (eds). IIEP Studies series, ISBN: 978-92-803-1358-1, 12.00€. English only, 288 pp.
Takes stock of recent reforms in the tertiary education of selected small states, where enrollment has often grown rapidly, the institutional fabric has been diversified and technology-based and networked models developed. Concludes with a discussion of policy issues, including sustainable funding and technological solutions to overcome the constraints of small states.

Water, Cultural Diversity and Global Environmental Change
Emerging Trends, Sustainable Futures?

Johnston, B.R.; Hiwasaki, L (UNESCO).; Klaver, I.J.; Ramos Castillo, A.; Strang, V. (eds), Springer Publishing. Hardcover, ISBN 978-94-007-1773-2 (€105,45) ; Softcover, ISBN 978-94-007-1866-1 (€52,70), English only, 560 pp.
Go to: www.springer.com/environment/aquatic+sciences/book/978-94-007-1773-2##
Summarizes a project of UNESCO's International Hydrological Programme exploring the linkages between water, cultural diversity and environmental change. The core concepts draw upon a larger trend in sustainability science, a recognition of the synergism and analytical potential in utilizing a coupled biological and social systems analysis, as the functioning viability of nature is both sustained and threatened by humans.

The Future of Venice and its Lagoon in the Context of Global Change
Georg Umgiesser et al. Workshop report produced by UNESCO's Venice office, English only, 24 pp. See page 10. For details: *p.pypaert@unesco.org*
Download: *http://unesdoc.unesco.org/images/0021/002151/215105e.pdf*

A World of Science *is a quarterly newsletter published in English, French and Spanish by the Natural Sciences Sector of the United Nations Educational, Scientific and Cultural Organization (UNESCO), 1, rue Miollis, 75732 Paris Cedex 15, France.* *ISSN 1815-9583*
Director of Publication: Gretchen Kalonji; Editor: Susan Schneegans; Lay-out: Yvonne Mehl.
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