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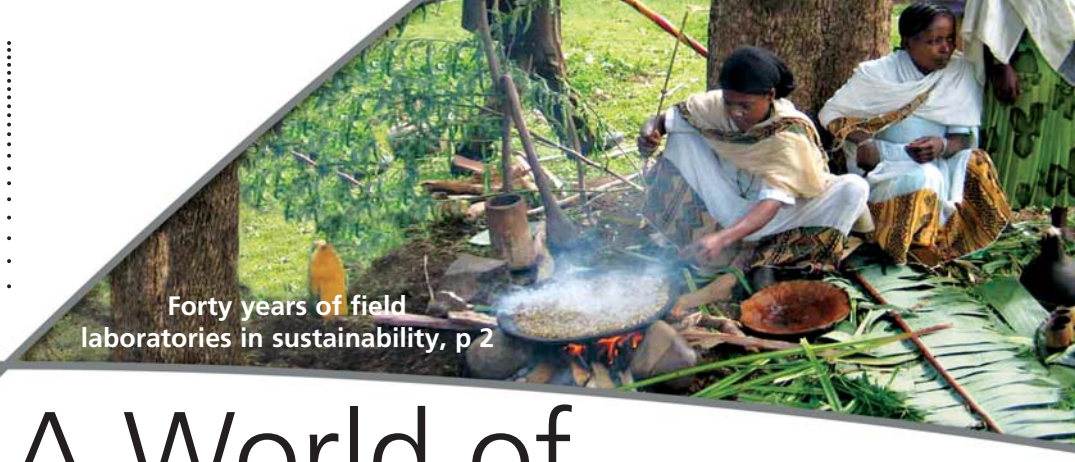

A World of SCIENCE

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Laboratories with a difference

In this issue, we celebrate the 40th anniversary of UNESCO's Man and the Biosphere (MAB) Programme, whose first meeting in 1971 took place against a backdrop of Cold War tensions, a Cultural Revolution in China and nation-building in Africa following independence from colonial powers.

A lot has changed since, not only in geopolitics but also in the way in which we perceive our natural world. The MAB Programme was initially invited by René Maheu, then Director-General of UNESCO, to focus on the 'general study of the structure and functioning of the biosphere' and the 'changes brought about by Man in the biosphere and its resources.' This was a groundbreaking concept, for, as retired UNESCO staff member Malcolm Hadley relates overleaf, 'the underlying philosophy behind many national parks [at the time] was that, in order to protect nature, you needed to make it off-limits to the human population.' Here was a programme that set out to reconcile humanity with the rest of the natural world.

The flagship product of the MAB Programme has been the constitution of a vast network of 580 biosphere reserves in 114 countries. Forty years on, the initial focus on scientific research has broadened to include experimentation in sustainable development, with the growing participation of the private sector. Japanese car-maker Honda, for instance, today supplies complimentary hybrid vehicles to the management teams of Germany's biosphere reserves to promote its clean, futuristic technology.

Concerns about climate change have come to the fore in recent years, as reflected in the theme of the conference held in Dresden (Germany) in June this year to mark MAB's 40th anniversary: For life, for the future: biosphere reserves and climate change.

Climate change, biodiversity loss, poverty, deforestation, land degradation: the MAB Programme's approach to solving these problems can be summed up in two words: sustainable development. Each biosphere reserve is unique, so its approach to sustainable development will also be unique, even if they can also learn from one another. This is the network's added value.The Sierra Gorda Biosphere Reserve of Mexico, for example, is beginning to attract investors to a project linking more than 260 small-scale farmers, who earn carbon income in exchange for planting trees. The scheme blends efforts to improve farmers' livelihoods with forest conservation and climate change mitigation.

A survey of more than 100 biosphere reserves by the German National Commission for UNESCO in preparation for the Dresden conference found that these reserves were experimenting in fields as varied as education, natural and social sciences research and renewable energy development for small, local communities.

UN Secretary General Ban-Ki-Moon has made sustainable development his overarching priority for his second term in office beginning in January 2012.

The first test for countries will come in June next year, when the world meets in Rio de Janeiro (Brazil) for the 20th anniversary of the Earth Summit. Let's hope that UNESCO's biosphere reserves receive the attention they deserve as experimental grounds for sustainable development.

Gretchen Kalonji
Assistant Director-General for Natural Sciences

Forty years of field laboratories in sustainability

It is now four decades ago that the Man and the Biosphere Programme was set up by UNESCO to provide a better scientific basis for the management of natural resources. Perhaps the programme's greatest achievement has been the constitution of a World Network of Biosphere Reserves which now number 580 in 114 countries. Under the guidance of local management teams, these sites have progressively developed into open-air laboratories for experimentation in sustainable development. Little by little, the initial focus on scientific research has broadened to include policies fostering sustainable development at the local level, via the introduction of eco-industries, ecotourism, ecofarming and the like. To mark the programme's 40th anniversary, we take stock of how the programme has evolved over the past four decades.

Swimming with filter-feeding whale sharks at Ningaloo Reef in Australia. There is great potential for ecotourism around the reefs of Baa Atoll in the Maldives too, which teem with marine life, including whale sharks. The atoll has only 12 170 inhabitants but is visited by 350 000 tourists each year. Baa Atoll became a biosphere reserve this year.

In 1971, the year UNESCO launched its Man and the Biosphere (MAB) Programme, Rachel Carson's landmark book, *Silent Spring*, had been published for nine years. At the time of publication, her book alerting to the destructive power of chemical pesticides had resonated with the public and politicians alike, in whom pollution and rapid population growth[1] were beginning to inspire concern. Carson's book prompted the US government to assess the impact of chemicals on both the environment and human beings. Her book shook the conventional wisdom of the time, for it suggested that human beings had more in common with the rest of nature than they were willing to admit.

For many, the late 1960s mark the dawn of the modern environmental movement. The images of the Earth rising above the moon's horizon and others sent back from space inspired awe and reflection on the place of human beings in our planet's future. At the same time, environmental awareness developed in a climate of fear over the prospect of nuclear war and mass annhilation. The Cold War was in full swing, with the Soviet Union and USA brandishing the nuclear deterrent to keep the peace. The Cold War polarized East and West, influencing politics on every continent. With the USA embroiled in an increasingly unpopular war against the communist regime in Viet Nam, youth in the West embraced a counterculture advocating peace and a greater communion with nature, the so-called 'hippie movement'.

The 'biosphere' makes its international début

It was in this climate that UNESCO's Biosphere Conference took place in Paris (France) in September 1968. The meeting's full title was quite a mouthful: the Intergovernmental Conference of Experts on the Scientific Basis for Rational Use and Conservation of the Resources of the Biosphere.

Science journalist Daniel Behrman described the title as 'a proclamation in itself; it helped launch the then radical assertion that we could go on using our planet only as long as we did not misuse it. (...).' Twenty-four years before the UN Conference on Environment and Development [or Earth Summit] in Rio de Janeiro (Brazil) recognized the concept and advocated it at the highest political level, the Biosphere Conference was therefore the first intergovernmental forum to discuss and promote what is now called sustainable development.

Perhaps the single most original feature of the Biosphere Conference was to have firmly declared that the utilization and conservation of our land and water resources should go hand in hand. At the time, the underlying philosophy behind many national parks was that, in order to protect nature, you needed to make it off-limits to the human population.[2]

The first of the Biosphere Conference's 20 recommendations called for an 'international programme of

research on man and the biosphere' that should take into account the particular problems of developing countries. This was thus when the now familiar word 'biosphere' made its international début, having previously been confined to the writings of Vernadsky and Teilhard de Chardin.[3]

More importantly, four years before the UN Conference on the Human Environment in Stockholm (Sweden) in 1972, the Biosphere Conference was the first global scientific meeting at the intergovernmental level to adopt a series of recommendations concerning environmental problems and to highlight their growing importance. In his 1995 review of the global environmental movement, John McCormick has commented that the 'significance of the Biosphere Conference is regularly overlooked' and that 'the initiatives credited to Stockholm were in some cases only expansions of ideas raised in Paris.'

> Science has the dreadful task of trying to unravel the … processes that for thousands of years have placed Man increasingly in opposition to, and divided from, nature. […]. This is why … such an immense task as that inaugurated by MAB borders on the [im]possible.
>
> Valerio Giacomini, chair of the Italian MAB Committee, 1978

Man and the Biosphere is born

At UNESCO's biennial General Conference in November 1970, Member States unanimously decided to launch the new international research effort that was to become the Man and the Biosphere Programme.[4] Each country was invited to establish a national committee and to consider national priorities for its participation in the programme.

Overall supervision was entrusted to an International Co-ordinating Council (ICC). At its first session in November 1971, the Council suggested that the programme's objective should be 'to develop the basis within the natural and social sciences for the rational use and conservation of the resources of the biosphere and for the improvement of the global relationship between Man and the environment; to predict the consequences of today's actions on tomorrow's world and thereby to increase Man's ability to manage efficiently the natural resources of the biosphere'.

Urban connections

It was the MAB programme which promoted the first worldwide international research initiative on ecological approaches to urban systems and other human settlements. This approach has used ideas both from autoecology (the study of the relationship of an individual organism to its environment) and synecology (the study of groups of organisms), as well as from systems ecology with its emphasis on energy budgets, nutrient cycles and, above all, the concept of the ecosystem.

The starting point was a pioneering study in the mid-1970s on the ecology and metabolism of the city of Hong Kong, combined with a survey of the quality of life of individuals and human adaptation. More than 20 field projects followed, on such themes as energy flows and recycling in Lae (Papua New Guinea), urban flora and fauna in Berlin (Germany) and in Xalapa (Mexico), children in the city of Toronto (Canada), urban green spaces in Dayton (USA), Seoul (Rep. Korea) and Valencia (Spain) and linkages between the urban and rural environments in Bangkok (Thailand) and Rome (Italy).

More recent work has focused on applying the biosphere reserve concept to urban areas. Examples of urban biosphere reserves in the vicinity of large urban areas are Cuenca Alta del Rio Manzanares (Madrid, Spain), Arganeraie (Agadir, Morocco), Cibodas (Bogor–Jakarta, Indonesia), Can Grove Mangrove (Ho Chi Minh City, Viet Nam), Cape West Coast and Kogelberg (Cape Town, South Africa), Cerrado (Brasilia, Brazil), Golden Gate (San Francisco, USA), Laplandskiy (Moncgegorsk, Russian Federation), Mata Atlantica (Rio de Janeiro and São Paulo, Brazil), Montseny (Barcelona, Spain), Mont Saint-Hilaire (Montreal, Canada), Mornington Peninsula (Melbourne, Australia), North Bull Island (Dublin, Ireland), Pays de Fontainebleau (Paris, France), Pereyra Iraola (Buenos Aires, Argentina), Puszcza Kapinoska (Warsaw, Poland) and Wienerwald (Vienna, Austria).

In October 2010, an international symposium on urban futures and human and urban well-being elaborated plans for a new three-year initiative to promote sustainable urban development and improve the relationship between cities and the ecosystems of which they are a part. The symposium was organized in Shanghai (China) by MAB, in co-operation with the Scientific Committee on Problems of the Environment. An international expert group has since been set up to assist in the design and implementation of this Urban Futures Programme.

Panoramic view of Brasilia

Photo: Wikipedia/Sier

Coffee versus coca in Colombia

Designated in 1979, the Sierra Nevada de Santa Marta Biosphere Reserve in Colombia stretches from the Caribbean coast up to the Sierra Nevada de Santa Marta. Independent of the Andean chain, the mountain rises to a height of 5 775 m above sea level, sporting snowy peaks called 'tundra' that are considered sacred.

Of the estimated population of 211 000 (1999), just over 10% live in indigenous reserves, particularly the Arhuaco, Kogui and Wiwa peoples. Ethnic groups are attempting to develop a policy for the recovery of their ancestral lands.

Since the 1950s, about 85% of the region's forest cover has been removed. Deforestation for agriculture and cattle-grazing continues to pose the principal threat, reducing the volume of water generated within the 35 watersheds; two of the rivers originating in the mountains have completely run out of water, compromising the future of the animals, plants and 1.5 million people who rely on these watersheds for survival.The ecosystem's degradation has been exacerbated by livestock breeding, banana plantations in the lowlands, as well as the illegal cultivation of marihuana in the 1970s and 1980s and of coca nowadays. The air-borne campaign against illegal drug cultivation has increasingly contributed to this degradation.

There is no management policy for the reserve as a whole and the zoning is not clear. However, scientific diagnosis and technical assessments have contributed to the elaboration of a sustainable development plan, with programmes in the Sierra Nevada National Park in agro-ecology, fish-farming and environmental health.

Moreover, the Colombian NGO Alianza para Ecosistemas Criticos (ALPEC) has designed and implemented a certification system in close co-operation with the producers known as the Critical Ecosystem Alliance which acknowledges sustainable agricultural production protective of wild flora and fauna. ALPEC is also aiming to create ecological corridors and to build environmental awareness among local communities.

Coffee-growing is one of the most promising and sustainable economic activities in the Sierra Nevada de Santa Marta. *Coffea arabica* is perfectly adapted to the region's altitude, precipitation, soils and temperature, with the rainforest canopy providing shade for the plants. The German NGO Partnerschaftsprodukte e. V. is promoting and distributing the coffee in German-speaking European countries to help protect the rainforest and improve local income levels.

Source: Austrian MAB Committee (ed.) Biosphere Reserves in the Mountains of the World: Excellence in the Clouds? *(2011)* See page 24.

The ICC did not use the term 'sustainable development' in 1971 but the concept sounds remarkably familiar in the description above. The term would have to wait until 1987 to enter the international lexicon, when the International Commission for Environment and Development (the Brundtland Commission) defined sustainable development in its report on *Our Common Future* as being development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[5]

An initial list of nearly 100 research areas for the MAB Programme had been whittled down to 14 by 1973 and, as the 1970s unfurled, to a more realistic concentration on four priorities: humid and sub-humid tropical zones; arid and semi-arid areas; development of the biosphere reserve network and; urban areas considered as ecological systems (*see* Urban connections *page 3*). Substantive field projects were nonetheless also undertaken in ecosystems with a particular physical geography, especially in mountains and island regions, often with a focus on how humans interacted with different ecosystems. Given that there was no central source of funding, countries tended to focus on environmental or resource management problems of priority interest to them when undertaking field projects within the MAB Programme.

The biosphere reserve concept gradually emerged. In 1974, a task force drew up a set of objectives and characteristics for biosphere reserves that are by and large still valid today. They defined the three basic needs of each biosphere reserve: conservation, development and logistic support. A simple generalized zoning pattern was proposed combining a strictly protected core area, a delineated 'inner buffer zone' where people lived and worked and an unde-lineated 'outer buffer zone', corresponding roughly to what is now known as the 'transition area' (*see diagram next page*).

The first biosphere reserves come into being

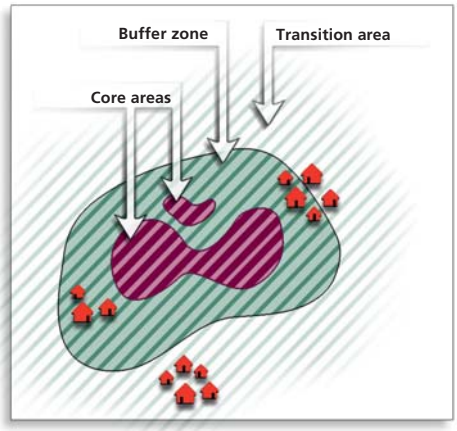
Countries began proposing areas for designation as biosphere reserves. In some cases, this process attracted high-profile political backing. At the 1974 summit between Brezhnev and Nixon in Moscow, for instance, the two countries declared that 'desiring to expand co-operation in the field of environmental protection [...] and to contribute to the implementation of the MAB Programme of UNESCO, both sides agreed to designate, in the territories of their respective countries, certain natural areas as biosphere reserves for protecting valuable plant and animal genetic strains and ecosystems, and for conducting the scientific research needed for more effective actions concerned with global environmental protection.'

Photo: US government

Soviet and US leaders Leonid Brezhnev and Richard Nixon during talks in the USA in 1973, a year before the summit in Moscow at which they undertook to designate certain natural areas as biosphere reserves. The first 27 biosphere reserves in the USA were approved in 1976, including Yellowstone, already a national park. The first seven Soviet biosphere reserves were approved in 1978 in the Belarussian, Kirghiz, Russian and Turkmen Soviet Socialist Republics.

This declaration doubtless came as something of a surprise to the chancelleries of many countries.

The designation of biosphere reserves was delegated by the MAB Council to its six-member Bureau. The main criterion for approved biosphere reserves was their conservation role, together with the presence of research facilities or a particular history. In fact, the Bureau adopted a very flexible approach, considering it sufficient for the areas proposed by the MAB national committees to appear of interest for the conservation of ecosystems, possess appropriate legal protection and be the object of a reasonable amount of research work.



The biosphere reserve zoning pattern

The first 57 biosphere reserves were approved in 1976 in nine countries.[6] A further 61 were added to the network in 1977. By 1981, 208 biosphere reserves had been designated in 58 countries.

In this first phase of programme implementation, however, the conservation role remained prominent, the logistic role minimal and the development role largely forgotten. Almost all designated biosphere reserves were already protected areas, such as national parks or nature reserves, and in most cases the designation did not add new land, new regulations or even new functions. Research was conducted in these protected areas but was in many cases of a rather academic character rather than clearly related to ecosystem and resource management. Nor did the research explicitly address the relationship between environment and development. Moreover, the linkages between biosphere reserves and the exchange of information on this research remained very limited. Not only had a proper balance between the three central concerns of biosphere reserves not been reached but the biosphere reserves themselves did not constitute a truly functioning network.

There were exceptions. One example was Mapimí Biosphere Reserve in Mexico, designated in 1977. Here, scientists and managers increasingly experimented with using the biosphere reserve to contribute to local economic development.

Challenging times

In March 1983, US President Reagan announced the construction of a space-based anti-missile system, a project rapidly dubbed 'Star Wars'. Fearful that the system would enable the USA to launch a pre-emptive strike against them, the Soviets reacted vehemently. Ultimately, the technology would prove too complex to implement but, in 1983, the proposal exacerbated East–West tensions. It was in this tense geopolitical climate that UNESCO and UNEP organized the first International Biosphere Reserve Congress in Minsk (Belarus) later the same year.

The congress was motivated by a 10-year review of the MAB Programme in 1981 via a conference on Ecology in Practice which had highlighted the complexity of implementing the biosphere reserve concept in such diverse situations around the world, even as it noted that the programme was beginning to make an impact. Despite East–West tensions, the congress managed to draw up an *Action Plan for Biosphere Reserves*. Among its proposals was the setting up of a Biosphere Reserve Scientific Advisory Panel comprised of independently nominated scientists to refine the criteria for the selection of new biosphere reserves. Two years later, a General Scientific Advisory Panel organized jointly with the International Council for Science (ICSU) concluded that the MAB Programme remained dispersed over too many subject areas – and promptly proposed four new research orientations: the impact of human activities on ecosystems, human investment and resource use, the restoration of degraded land and water ecosystems, and the human response to environmental stress!

These recommendations were to remain largely theoretical, however, as the sudden withdrawal of the USA and United Kingdom from UNESCO in 1984 amputated


© Riding Mountain Biosphere Reserve

Archaeological dig in Riding Mountain Biosphere Reserve in Manitoba, Canada, where schoolchildren get to uncover animal bones, glass and pottery placed in the soil for them to find. In this outdoor classroom, they learn about the people and animals that lived in the biosphere reserve thousands of years ago, including giant sloths and beavers.

©Wuyishan Biosphere Reserve

From bamboo to tea

Established in 1987, Wuyishan Biosphere Reserve is also a World Heritage site. The site is exceptional for Mount Wuyi's unique sub-tropical forests and the mountain's status as the birthplace of Confucianism.

In 1994, the biosphere reserve set up the Joint Protection Committee for Fujian Wuyishan National Nature Reserve to involve all the villages in environmental protection schemes. In parallel, it supported the development of alternative livelihoods in the transition area like the planting of bamboo. In recent years, bee-keeping, eco-tourism, catering, transportation and other industries have also begun to bring good returns.

In 1998, China revised its Forest Law by imposing a logging ban on forests in natural reserves. The administrative bureau of the biosphere reserve subsequently convened meetings with every village to discuss how to use the ban to foster environmentally responsible economic development. From 1998 to 2001, funds from the Global Environment Facility (GEF) were used to allot grants to villagers for ecological forest management and to compensate them for the loss of the right to exploit the forest. More than 150 villagers were employed as wardens by the reserve.

By the turn of the century, the biosphere reserve was seeking to reduce its dependence on bamboo. In January 2002, it set up a research group to study the origins of Lapsang Souchong tea, only to find that the Wuyishan Nature Reserve was the birthplace of this tea variety. Almost overnight, the economic structure of the biosphere reserve changed, with local tea production rapidly improving villagers' income levels by about US$1 000 a year. Moreover, as the tea plantations occupy the same sites on which the original tea was grown, no new land has had to be reclaimed.

Source: Building an Ecologically Harmonious Civilization *(2010), produced in English and Chinese by the Wuyishan Biosphere Reserve, UNESCO Beijing Office, Chinese National MAB Committee and East Asian Biosphere Reserve Network: http://unesdoc.unesco.org/images/0018/001880/188020M.pdf*

©Wuyishan Biosphere Reserve

Tea-picking in Wuyishan Biosphere Reserve

one-quarter of the Organization's funding overnight.[7] Former Assistant Director-General Michel Batisse looked back on this period in 1993. 'While those two countries nevertheless maintained their participation in the MAB Programme through active co-operation of their national committees and continuing biosphere reserves and other projects, they were no longer contributing to the budget,' he observed. 'More importantly, a number of people in the scientific establishment and elsewhere were no longer sure that co-operating with a UNESCO programme was the right thing to do. At the same time, some scientists, being more interested in the cutting-edge of their disciplines than in the little rewarding interdisciplinary efforts to solve land use problems, became more attracted by new, sophisticated research initiatives where striking results and clear synthesis could be expected.'

Hence, even as biosphere reserves were gaining ground as a conceptual alternative to the national park and other conventional protected areas, the solidarity that should have bound the international community was undermined. In spite of these difficulties, the biosphere reserve concept continued to capture the imagination throughout the 1980s as an opportunity for testing sustainable development at the local level. Scientists began applying the concept to coastal zones and marine areas and to underline the sacred and spiritual dimensions of biosphere reserves. In parallel, countries began establishing multiple-site biosphere reserves to ensure ecological continuity. Ten annual awards for the research projects of young scientists working in biosphere reserves were also instigated in 1989.

Missing the first boat on climate change

One casualty of the withdrawal of the USA and United Kingdom was UNESCO's substantive absence from discussions within the international scientific community on issues related to global climate change, at least in terms of terrestrial ecosystems, at a time when climate change, sustainable development and biological diversity were entering the political and public arenas.

In the early 1980s, UNESCO was involved in discussions within the international scientific community on a fledgling international research programme on global change. Ultimately, however, UNESCO decided not to pursue possible partnership with ICSU in the new International Geosphere–Biosphere Programme (IGBP) in 1986. Some argue that MAB was right to opt for

concentration rather than expansion into new areas. Later, MAB would participate in ten IGBP projects funded partially by the US government, including one project on soil fertility and global change.

*A family of Nubian Ibex (*Capra ibex nubiana*)*

UNESCO did choose to become one of the five founding members of the Global Terrestrial Observing System, together with FAO, UNEP, WMO and ICSU. During the 1990s, individual biosphere reserves started to take part in experiments and pilot monitoring schemes within this system, such as that on terrestrial carbon sources (e.g. deforestation) and sinks (e.g. forests). Four biosphere reserves in the broader Saharan–Sahelian region figured in the first phase of a regional monitoring scheme known as the *Réseau d'observatoires de surveillance écologique à long terme* (ROSELT[8]), which used remote sensing and other technologies to measure progress in combating desertification. Over the past decade, a series of assessments have also focused on the implications of global change for the sustainable development of mountain regions. A network of existing mountain biosphere reserves was even set up between 2004 and 2007 to monitor global change.[9]

If UNESCO missed an opportunity when it declined the invitation to cosponsor the Intergovernmental Panel on Climate Change (IPCC) with WMO and UNEP in the mid-1980s, it has continued to contribute to each of the IPCC reports produced since, via the Global Ocean Observing System co-ordinated by UNESCO's Intergovernmental Oceanographic Commission, which submits its findings to the World Climate Research Programme for inclusion in the IPCC report.

The challenge of our times: limiting our ecological footprint

As the Greek philosopher Heraclites (c. 535–475 BC) and many other sages since have reflected, the only constant in the world in which we live is change. The last two decades have seen immense changes. The development of Internet has revolutionized the way in which we communicate with one other. The global population has grown from 5.3 billion to nearly 7 billion and with it our ecological footprint. Today, it would take 1.5 Planet Earths to support our lifestyle, compared to about 1.2 Planet Earths in the early 1990s. In other words, the human species is living beyond its means; humanity is spending the Earth's resources faster than the Earth can renew them. We are the only species on Earth which has developed the capacity – albeit involuntarily – to influence climate change. Whether we succeed in limiting our ecological footprint to 1.0 Planet Earths is the single most important challenge of the 21st century, for the survival of our species depends upon it. So far, the results have not been encouraging, despite a battery of international agreements that include the Convention on Biological Diversity adopted at the Earth Summit in 1992, the Kyoto Protocol (1997) and the Nagoya Biodiversity Compact (2010).

Rock-climbing in the new Mujib Biosphere Reserve in Jordan, which extends along the eastern shores of the Dead Sea. It includes the lowest terrestrial point on earth: 420 m below sea level.


©Cesar Laura

Yompor Yompere sanctuary in the Oxapampa-Ashaninka-Yanesha Biosphere Reserve of Peru was added to the network last year. Indigenous management of resources within biosphere reserves is a growing focus.

This compass has incited the MAB Programme to strengthen the 'development dimension' in biosphere reserves, with a move towards 'quality economies' and 'green economies'. As early as 1995, the *Seville Strategy for Biosphere Reserves* advocated using biosphere reserves as learning places for sustainable development. *The Strategy* may not be formally binding for States but it nevertheless outlined the new 'rules of the game.' Concertation and dialogue among stakeholders are to be promoted, for example.

Just a year after the IPCC's 2007 report unequivocally confirmed the human influence on climate change, MAB adopted the *Madrid Action Plan*. Covering the period 2008–2013, it urges biosphere reserves to 'serve as open-air laboratories for sustainable development and … for adaptation and mitigation to climate change.'To this end, the *Action Plan* encourages biosphere reserves to develop partnerships with the private sector, as has been done in Canada, Egypt, Germany[10], Indonesia and South Africa, for example.

On 27–28 June this year, the MAB Programme organized an international conference on biosphere reserves and climate change in Dresden (Germany), entitled For Life, for the Future. In the *Dresden Declaration*, participants call on States 'to give greater weight to biosphere reserves in their strategies on climate change mitigation and adaptation, and to transfer approaches developed in biosphere reserves to other regions' (*see* Leaving

Leaving oil in the ground

In the heart of the Amazonian forest, oil companies, scientists, environmentalists and indigenous communities are holding their breath. President Rafael Correa of Ecuador has made perhaps the most ambitious proposal yet to fight climate change, conserve a biodiversity hotspot and protect indigenous rights.

He is appealing to the international community to provide US$3.6 billion over 13 years in partial compensation for the loss in revenue if Ecuador undertakes not to exploit just under 1 billion barrels of oil lying beneath Yasuni Biosphere Reserve. The reserve is home to the Huaorani people, as well as to the Tagaeri and the Taromenani who are both living in voluntary isolation.

Oil companies are currently exploiting some parts of the reserve, including a block bordering the Yasuni Ishpingo Tambococha Tiputini area, licensed to the Brazilian company Petrobras.

In announcing the scheme to the UN General Assembly in September 2007, President Correa explained that Ecuador's proposal was accompanied by the establishment of the Yasuni Ishpingo Tambococha Tiputini Environmental Fund – for the name of the area the government is proposing to spare. This fund includes 'the diversification of energy sources, the development of capacities and investment in eco-tourism and the application of an integral agenda that includes health, education and environmental remediation.' President Correa has also taken steps 'to guarantee the physical and cultural integrity' of peoples in voluntary isolation 'while respecting the sovereignty of their territories.'

The initiative reportedly obtained 75% approval ratings in a recent poll in Ecuador. NGOs have also come out in favour of the plan, among them Amazon Watch, the Quito-based Acción Ecológica and Scientists Concerned for Yasuni, a network of independent researchers. The scheme also has the support of several governments.

However, *Science* reported in June this year that, 'since establishing a UN-administered trust fund in August 2010, Ecuador has only received roughly US$40 million in multiyear commitments from an assortment of countries, including Italy, Spain, and Chile […]. Germany had tentatively pledged up to US$50 million a year but *Die Zeit* reported [in early June] that the country was withdrawing its support.'

The Yasuni proposal was discussed at the MAB conference on biosphere reserves and climate change held in Dresden last June. The *Dresden Declaration* implicitly refers to Yasuni when calling upon States to 'support innovative economic instruments and activities that combine climate change mitigation and adaptation, with maintenance of the integrity of ecosystems and biodiversity as well as social development, including the needs of local and indigenous communities, in particular in the context of extraction of natural resources and the generation of energy.'

As one observer remarked, when push comes to shove, the MAB Programme does not yet seem to wield sufficient influence in international circles to push through such an audacious funding scheme as Yasuni. He felt that intensifying networking within MAB would no doubt soon improve its leverage.

Ecuador has also proposed that OPEC levy a carbon tax at the oil wellhead, a concept devised by environmental economist Herman Daly. The earnings from the carbon tax would be used to give countries like Ecuador financial incentives to leave oil underground in vulnerable ecosystems.

Susan Schneegans

oil in the ground). This is already the case in China, for instance, where experience gained in the country's 29 biosphere reserves is being used to help upgrade the country's 700 nature reserves (*see* From bamboo to tea *page 6*).

The success of the IPCC in carrying climate change to the top of the political agenda, coupled with the international community's failure to reach the 2010 Biodiversity Target, spawned a new platform last year modelled on the IPCC, the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services, which will be sponsored by UNESCO, UNEP and possibly other UN agencies. Its first plenary meeting is taking place on 3–7 October this year.

The MAB Programme has also contributed to a number of international assessments, including the *Millennium Ecosystem Assessment* published in 2005 and the *International Assessment of Agricultural Knowledge, Science and Technology for Development*[11] published in 2008.

Upsizing to improve effectiveness

Over the past 40 years, the size and configuration of individual reserves have changed. Many first-generation biosphere reserves were considered too small to contribute in any meaningful way to addressing sustainable development issues. In 1996, a periodic review process was put in place, inviting countries to submit a status report on their biosphere reserves every ten years.

> A biosphere reserve is not just a pretty place, it's an idea and an approach to management. In an ideal world, all protected areas would be managed in a 'biosphere reserve manner'.
>
> Jeffrey A. McNeely, International Union for the Conservation of Nature, 1982

One of the results of this ten-year periodic review has been a complete revision and wholescale extension and rezoning of certain biosphere reserves, such as Omayed (Egypt), the Archipelago Sea (Finland), Fakarava in French Polynesia, Camargue and the Pays de Fontainebleu (France), Bialowieza (Poland) and, most recently, Cat Tien in Viet Nam this year (since renamed Dong Nai). In other periodic reviews carried out by countries, it was considered unfeasible to adapt the site to the 'Seville Criteria.' This has incited Australia, Norway, Sweden and the United Kingdom to ask for a particular biosphere reserve to be removed from the network.

A fair number of the biosphere reserves designated since the early 1990s have been very large. In Brazil, for example, the six existing biosphere reserves together cover more than 1.28 million km^2, about 15% of the national territory, more than double the area of metropolitan France.

Over the past decade or so, upsizing has taken multiple forms. The establishment of transboundary reserves to promote collaboration between countries has come into vogue following the creation of the Palatinat-Vosges du Nord Biosphere Reserve between Germany and France in 1998. Today, there are ten cross-border biosphere reserves worldwide. These include the first trinational biosphere reserve in Central America, Trifinio Fraternidad, straddling El Salvador, Guatemala and Honduras, approved just this year (*see page 12*), and the Intercontinental Biosphere Reserve of the Mediterranean linking Morocco and Spain.

Another innovation concerns twinning arrangements between biosphere reserves, such as between the Riverland (Australia) and Xilingol (China) Biosphere Reserves, or between the Peninsula de Guanahacabibes (Cuba) and Sian Ka'an (Mexico) Biosphere Reserves. A third example involves the Malindi–Watamu (Kenya) and North Devon (United Kingdom) Biosphere Reserves.[12]

Strollers reading a panel on the different vegetation zones in Rhön Biosphere Reserve. One of the first products of German reunification, it was designated in 1991, just two years after the fall of the Berlin Wall heralded the end of the Cold War. The biosphere reserve extends across the former border between East and West Germany.

The lucrative business of saving East African forests

Only 40 years ago, some 40% of Ethiopia was occupied by forests; today, less than 3% remains, much of it in the Kafa and Yayu Coffee Biosphere Reserves, designated in 2010. These forests contain 25 million tons of carbon in above-ground biomass. Some 600 000 tons of carbon could be removed from the atmosphere annually through natural forest growth, as long as the forest remains intact. The forests are endangered, however, by clear-cutting for smallholder agriculture and industrial coffee and tea plantations. Harvesting wild coffee, on the other hand, does not harm the forest.

A 3 million euro project funded by the German Ministry for the Environment as part of its International Climate Initiative is being implemented from 2009 until 2013 by NABU, a local NGO. The project's main goal is to increase carbon sequestration in the Kafa Biosphere Reserve through reforestation and rehabilitation of fragmented forests and degraded areas.

At the same time, community plantations with fast-growing tree species for use as fuelwood are being introduced, as well as 10 000 efficient wood-burning stoves. Tourism opportunities and jobs are also being created via the construction of a model lodge and a microcredit system, among other initiatives.

From 1 to 20 April this year, a training course in assessing carbon storage was organized in Yayu Coffee Forest Biosphere Reserve. The course was run by the Environment and Coffee Forest Forum, in collaboration with UNESCO's Nairobi office and the Nature Conservation Research Center for West Africa in Ghana, which provided the training via theoretical lectures and field assessments. Applying their newfound knowledge of how to collect forest carbon data, the 17 trainees from Ethiopia, Kenya, Tanzania and Uganda estimated the amount of carbon stored in their countries' forests. This information was required, for instance, to complete the feasibility study of the Yayu Coffee Forest REDD+ project. The trainees were able to complete the feasibility study and, together with the trainers, also drafted a carbon assessment manual for practitioners. The course wound up with a half-day seminar at Jimma University on climate change and REDD+ carbon as a potential source of conservation finance.

The ultimate goal of the course was to enable these four forested countries to take advantage of the opportunities offered by REDD+ for generating sustainable funding for conservation and poverty alleviation. The global carbon market trades emissions via cap-and-trade schemes and credits that offset reductions in carbon emissions. Countries that can prove they store carbon, such as via their forests, can sell these credits on the market to businesses that have exceeded the agreed cap on their own allowable carbon emissions.

Source: on Kafa Biosphere Reserve: German National Commission for UNESCO (2011) For Life, for the Future: Biosphere Reserves and Climate Change *(see page 24); on the training course: n.raondry-rakotoarisoa@unesco.org*

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Roasting coffee beans in Kafa Biosphere Reserve (Ethiopia)

There are now about a dozen regional networks, involving geographical groupings of countries like AfriMAB. Cross-cutting networks have also been put in place, such as that fostering South–South Co-operation in the Humid Tropics. In some cases, the network covers the MAB Programme as a whole; in others, the focus is on biosphere reserves specifically.

Biosphere reserves: myth or reality?

One challenge arising from the rapid expansion of the network has been the difficulty in monitoring whether or not the biosphere reserve concept is being respected at such a large number of sites. This challenge was already encapsulated in the title of the workshop organized as part of the IUCN World Conservation Congress in Montreal (Canada) in 1996: Biosphere Reserves: Myth or Reality? More recently, in *Biosphere Reserves in the Mountains of the World*: *Excellence in the Clouds?* (2011), edited by the Austrian MAB Committee, researchers Diana Borowski and Catalina Munteanu claim that, judging from their own survey of biosphere reserves in European mountains and a study of those in Central Europe by Schlief and Stoll-Kleemann, 'at the moment, many [mountain biosphere reserves in Europe] appear to be not much more than "paper reserves". Off the record, some protected area managers … admit that the MAB label is just a "cosmetic add-on" without content in many national parks.' The suggestion is that 'UNESCO might raise the profile of biosphere reserves by more strict enforcement of the criteria in the Statutory Framework.' The Statutory Framework does indeed stipulate that, if a biosphere reserve does not satisfy the necessary criteria, 'the area will no longer be referred to as a biosphere reserve which is part of the network'. In any event, the approach of the Statutory Framework is essentially to provide encouragement and incentives, reflected through such means as the creation of the Michel Batisse Award for Biosphere Reserve Management in 2006.

This year, the MAB secretariat is involved in a new stocktaking exercise of the vast field laboratory that the World Network of Biosphere Reserves has become over the past 40 years. The results of this process will plug into UNESCO's overall contribution to the assessments associated with the 20th anniversary of the Earth Summit – the so-called Rio+20 process – culminating in an international conference in Rio de Janeiro in June next year.

Malcolm Hadley[13]

For details: www.unesco.org/mab
Dresden Declaration*: www.mab40-conference.org*

Running on renewable energy

The Grosses Walsertal valley is situated in the western part of the Austrian Alps. Home to 3500 inhabitants spread across six villages, it registers 180 000 overnight stays by tourists every year.

One of the main objectives of this biosphere reserve is to supply 100% of its energy from regional renewable sources. It has already attained 84%, thanks mainly to hydropower and photovoltaics. The biosphere reserve is improving energy efficiency via better heating systems and the development of public transport. In parallel, it is attempting to raise awareness via public education programmes.

Since 2001, the biosphere reserve has taken part in the Austrian certification programme for energy-efficient communities. In 2008, it received the fourth of five possible e-certificates. Projects which contributed to this success include low-energy municipal buildings, the obtention of the Austrian Ecolabel for Schools, buses for hiking tourists, rapid biomass exploitation thanks to the construction of a biomass converter in Raggal and championships in energy-saving.

Source: German National Commission for UNESCO (2011)
For Life, for the Future: Biosphere Reserves and Climate Change *(see page 24)*

1. *There were 2.5 billion human beings in 1950 and 3.7 billion in 1970.*
2. *The oldest national park in the world may be Bogd Khan Uul (1783) in Mongolia. The first national park in the West was Yellowstone, in the USA (1872).*
3. *A Russian geochemist, Vladimir Ivanovich Vernadsky wrote* The Biosphere *in 1926. Teilhard de Chardin was a French priest, philosopher and palaeontogist who wrote* The Phenomenon of Man *(1955), among other titles.*
4. *As humanity lives well between the upper and lower limits of the biosphere, some suggested at the time that it would have been more appropriate to call the programme Man* in *the Biosphere.*
5. *The term 'sustainable development' started to appear within MAB in 1984, such as in the recommendations of the* Action Plan for Biosphere Reserves *(1984).*
6. *Iran (9), Norway (1), Poland (4), Thailand (1), UK (11), Uruguay (1), USA (28), Yugoslavia, in what is now Montenegro (1), Zaire, now the Democratic Republic of Congo (1).*
7. *The UK and USA returned to UNESCO in 2003.*
8. *The biosphere reserves of Boucle du Baoulé (Mali), Djebel Bou Hedma (Tunisia), Tassili N'Ajjer (Algeria) and El Omayed (Egypt). See: www.oss-online.org*
9. *See* A World of Science, *January 2006*
10. *On Rhön Biosphere Reserve, see* A World of Science, *January 2008*
11. *See* A World of Science, *July 2008*
12. *See* A World of Science, *October 2009*
13. *Biologist, retired member of MAB Secretariat, UNESCO Division of Ecological Sciences*

The new biosphere reserves

Bras d'Or Lake (Canada)	In Nova Scotia, home to 14 000 people. Encompasses a salt-water estuary watershed 'inland sea' with three passages to the Atlantic Ocean. First Nation representatives, government agencies, citizens and academics are working together within the Bras d'Or Lake Biosphere Reserve Association created in 2005, which has already developed a management plan for the lake.
Mao'er Mountain (China)	Features peaks over 2000 m above sea level. An abundance of sub-tropical broad-leaved, coniferous and bamboo forests provide habitat for two rare, endemic salamander and frog species (*Hynobius Mao'er Mountainensis* and *Rana Mao'er Mountainensis*). Inhabited by Han Chinese and ethnic minorities, including Miao, Yao, Zhuang, Dong, Yi and Hui. Thanks to a GEF-funded project, environmental protection, eco-tourism and the like are well developed.
Corredor Biológico Nevados de Chillán-Laguna del Laja (Chile)	Located in northern Patagonia within the Central Chilean zone, which is a global biodiversity hotspot, also characterized by an abundance of endemic species. This biological corridor connects three core areas.
Songor (Ghana)	Covers 51 113 ha on Ghana's southern coast. A unique combination of brackish/estuarine, freshwater and marine ecosystems with mangroves, islands and small patches of community-protected forests. Some portions of the marine ecosystem serve as breeding sites for fish, turtle and migratory birds. Subsistence farming, fishing and salt-mining predominate. The main settlement, Ada Foah, is already a popular tourist destination.
Mujib (Jordan)	Part of the Dead Sea basin and Jordan Rift Valley landscape. Habitats shaped by agriculture, fishing, hunting, grazing and quarrying in small areas at the reserve's boundaries, small -scale settlements, wood-cutting for fuel and herbal and medicinal plants. More than 90 rare plant species, one fish species endemic to the Dead Sea Basin and 24 species of mammals of conservation importance.
Zuvintas (Lithuania)	Located in the southern Middle Lithuanian Lowlands with a population of about 11 000. Covers about 59 000 ha, including lakes, wetlands, mires, peatbogs and pine tree stands. Biodiverse. Slated for special status in national nature conservation legislation. Agriculture, forestry and fishing predominate, with the recent development of eco-farming and tourism.
Baa Atoll (Maldives)	Covering 139 700 ha of coastal/marine areas, is representative of the Maldives' high diversity of reef animals, with stony and soft corals, reef-associated fish species, marine turtles, manta rays and whale sharks. Only 12 170 inhabitants but 350 000 tourists visit every year. As part of a GEF project, the site has great potential for demonstrating a green economy.
Berlengas Archipelago (Portugal)	Includes the Berlengas, a group of small islands and rocks. The archipelago is regularly visited by tourists, fishermen and scientists leaving from the city of Peniche on the mainland. Peniche stakeholders help to manage the site.
Volga-Akhtuba Floodplain (Russian Federation)	Comprises a unique ecosystem in the Volga valley, with high-yielding floodplain meadows, spawning grounds, oak groves and internationally important wetlands. The population of 45 000 practices agriculture and fishing and tourism primarily.
Saint Mary's (Saint Kitts And Nevis)	Biodiverse, comprising cloud forests, mangroves and coral reefs, from the marine area and beaches near Canada, Keys and Cayon to the surrounding tropical forests of the mountain ridgeline. One of the first sites of small Caribbean island countries.
Blekinge Archipelago (Sweden)	In southeast Sweden, covers over 200 000 ha of granite coastline with the accompanying archipelago containing islands and islets. A strong commitment to innovative thinking and entrepreneurship, alongside the development of energy-efficient and eco-friendly technologies (*see photo*).
Nedre Dalälven River Landscape (Sweden)	Covers 308 000 ha with a mixture of wetlands, rivers, lakes, flood plains and productive forests. Includes Lake Hovran and Färnebofjärden Bay Ramsar site. Biodiverse. The river forms a clear border zone between the northern and southern flora and fauna of Northern Europe. Agriculture and forestry have evolved as a result of changes in the steel and iron industries.
Oti-Keran/Oti-Mandouri (Togo)	Includes Keran National Park and the Reserve de Faune l'Oti-Mandouri, covering 179 000 ha, with 16 710 inhabitants. Helps to maintain connection with the W (Niger), Arly (Burkina Faso) and Pendjari National Park (Benin), acting as a transboundary migratory corridor for elephants and other big mammals. Communities have been involved in the design and management of the reserve.
Roztochya (Ukraine)	On northwestern edge of the Podillya Upland, 20 km from the city of Lviv. Covers 74 800 ha with agriculture, stock-breeding and fish farming. The site attracts visitors to its sanatoria and there are plans for developing business and tourism, as well as intensifying co-operation with Poland in the Roztochya region.
Bura'a (Yemen)	Named after the region's impressive granite massif, Jabal Bura'a, peaking at 2 200 m, intersected by several deep valleys rich in rare, vulnerable and endemic plant species. Provides habitat for a large number of bird species and several reptiles, including fresh water turtles and the Yemeni monitor lizard. Traditional agro-forestry systems still flourish.
Santana Madeira (Portugal)	The first in the Madeira Archipelago. Despite an active tourist industry, agriculture dominates the economy. A high degree of endemism. from the marine and coastal ecosystems to the high altitude vegetation, through the laurel forest. The Madeira Archipelago is part of the Macaronesian region, which also includes the Canary and Azores islands.
Ramat Menashe (Israel)	This 17 000 ha site was established after a bottom-up consultation involving 13 agricultural settlements and 10 000 inhabitants. Comprises the Meggido World Heritage site and co-operates with adjacent Mount Carmel Biosphere Reserve. Practices drip irrigation with mostly recycled, treated wastewater collected from rural settlements and maintains the integrity of the 'batha' ecosystems, with a pastoral livelihood generating sustainable income.
Trifinio Fraternidad (El Salvador/Guatemala/ Honduras)	A major contribution to the implementation of the Mesoamerican Biological Corridor. The Lempa River crosses the three countries before reaching the Pacific Ocean: 3 million people depend on the river waters. Co-ordinated by the Plan Trifinio, an interstate coordination agency, under the direct supervision of the Vice-Presidents of the three countries concerned.

18 new biosphere reserves

Meeting in Dresden (Germany) from 28 June to 1 July, the International Co-ordinating Council of UNESCO's MAB programme has added 18 new sites to the World Network of Biosphere Reserves, bringing the total to 580 sites in 114 countries. For the first time, biosphere reserves were inscribed in Lithuania, Maldives, Saint Kitts and Nevis, and Togo. The first trinational biosphere reserve was also approved in Central America (*see table*).

Meanwhile, Australia decided to withdraw Macquarie Island from the global network because the site is uninhabited by humans and human presence has been a criterion for inclusion in the network since 1995.

There is also one extension: two new core zones have been added to Dong Nai Biosphere Reserve in Viet Nam, designated in 2001, under the name of Cat Tien Biosphere Reserve.

This year's Michel Batisse Award for Biosphere Reserve Management (US$6,000) goes to Nizar Hani (Lebanon) for his case study on Creative and Innovative Approaches to fighting Poverty, improving Subsistence Resources and ensuring Sustainability in the Chouf Biosphere Reserve.

The names of the 10 laureates of this year's Young Scientists Awards and their studies are:

- **Aah Ahmad Almulqu (Indonesia)**: appraisal of carbon storage in tropical dry forests, a case study in the Komodo National Park, Nusa Tengarra East;
- **David Paz-Garcia (Mexico)**: morphological and genetic diversity status of coral reefs and their symbionts in three Mexican biosphere reserves;
- **Raimundo Elias Gomez (Argentina)**: practices and local representations of sustainability and conservation among inhabitants of protected areas in the buffer zones of the Yaboti Biosphere Reserve;
- **Iordan Hristov (Bulgaria)**: improving the balance between residents and their environment in the biosphere reserves of the Central Balkan National Park;
- **Elizabeth Kearsley (Belgium)**: foliage biomass study in the Yangambi Biosphere Reserve in the Democratic Republic of the Congo;
- **Maria Pukinskaya (Russia)**: the long-term dynamics of damage caused by a storm in a spruce forest in the Central Forest State Nature Biosphere Reserve;
- **Heriosa Razakanirina (Madagascar)**: climate change and the ecomorphology and viability of mangroves in northwestern Madagascar;
- **Laura Riba-Hernandez (Costa Rica)**: diversity and altitudinal variation of owls in the secondary tropical forest of southern Costa Rica's Pacific watershed and their relations with vegetation structure;
- **Jariya Sakayaroj (Thailand)**: conifer disease in Thailand's mangrove;
- **Juan Carlos Silva Tamayo (Colombia)**: a Holocene palaeoclimatic reconstruction of the northwest of Latin America: a multiproxy and multiscale approach.

Special fellowships funded by the Austrian MAB Committee have been awarded to:

- ✓ Choe Yong Min (Democratic People's Republic of Korea): appraisal of environmental change linked to climate change in the forest ecosystem of Mount Paekdu Biosphere Reserve;
- ✓ Horacio Sirolli et Luciano Iribarren (Argentina): a sustainable production and environmental education strategy aimed at fostering endemic forest conservation in the Parana Delta Biosphere Reserve.

For details: www.unesco.org/mab

UNESCO and ICTP join iTunes U

On 1 September, UNESCO's Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste announced it was making its recorded lectures, seminars, workshops, and colloquia available to scientists around the world, via iTunes U. Recordings include talks by Nobel Laureates and Fields Medallists. The move came three months after UNESCO joined iTunes U.

'UNESCO has an incredible wealth to share and joining iTunes U is a fabulous way to do this,' UNESCO Director General Irina Bokova declared in June. A dedicated area of the iTunes Store, iTunes U offers free audio and video content from leading educational institutions.

UNESCO's collections on iTunes U will be regularly updated with new content from UNESCO's programmes in education, science, culture and communication, as well as from its 65 years of archives. Available in English, French and Spanish, the collections range from training support materials to policy reports, journals and lectures, interviews and film documentaries. All can be downloaded free of charge to a computer, iPad, iPhone or iPod touch.

ICTP hosts more than 50 conferences and schools each year on such topics as high energy, cosmology and astroparticle physics; condensed matter and statistical physics; Earth system physics; mathematics; and applied physics.

For details: www.unesco.org/itunes; http://itunes.ictp.tv;
iTunes store: www.itunes.fr

Grey seals in Blekinge Archipelago in Sweden, one of the new biosphere reserves

© UNESCO/Maria Gropa

One of the Archaeological Sites of the Island of Meroe (Sudan), Musawwarat es-Sufra (the lion temple), showing reliefs and inscriptions in hieroglyphic and Meroitic languages. The Kingdom of Kush was a major power from the 8th century BC to the 4th century AD.

Space tech for heritage gets its own centre

On 25 July, one of UNESCO's partners in space, the Chinese Academy of Sciences, inaugurated the International Centre on the Use of Space Technologies for Cultural and Natural Heritage in Beijing, which will operate under the auspices of UNESCO.

The centre is being hosted by the Centre of Earth Observation and Digital Earth (CEODE), an institution of the Chinese Academy of Sciences bringing together satellite data reception, satellite date processing and the Digital Earth initiative under the same roof.

'We consider that space technologies can significantly assist in the protection of our heritage that is common to all humankind', said Prof. Guo Huadong, Director-General of CEODE, at the launch.

Upon request, the centre will provide UNESCO Member States with technical assistance in the area of space technologies, as applied to the monitoring, documentation, modelling and presentation of cultural and natural heritage sites.

Initiated by the European Space Agency and UNESCO in 2001, the Open Initiative for the Use of Space Technologies to support World Heritage today counts 53 partners among space agencies and space research institutions worldwide. One project involves the Calakmul Biosphere Reserve and Cultural World Heritage Site on the Yucatan Peninsula in Mexico. Information derived from satellite imagery is included in a geographical information system used by the Mexican government to help manage the site. Belgian research organizations have used Earth observation data from the Formosat 2 and SPOT satellites to analyse the evolution of land use in the area and detect evidence of additional archaeological ruins in the surrounding tropical forest, with support from the Belgian Science Policy Office.

In its report published this year, the Space Foundation describes the Open Initiative as an outstanding example of space for governance, education and infrastructure.

For details: www.unesco.org/new/en/natural-sciences/science-technology/space-activities/

World Heritage gains **25 sites**

Between 19 and 29 June, the World Heritage Committee inscribed three natural properties, 21 cultural properties and one mixed site, bringing the number of properties on the World Heritage List to 936. Of these, 183 are natural sites, 725 cultural and 28 mixed.

In parallel, the sites of the Primeval Beech Forests of the Carpathians and the Ancient Beech Forests of Germany (Slovakia, Ukraine, Germany) have been extended.

The Government of Honduras also requested the World Heritage Committee to place the Río Plátano Biosphere Reserve on the List in Danger, to mobilize support for its preservation, in light of the combined threats of illegal logging, fishing and land occupation, poaching and the State's reduced capacity to manage the site, notably due to the deterioration of law and order, owing to the presence of drug traffickers.

The Tropical Rainforest Heritage of Sumatra (Indonesia) was also added to the List in Danger to help overcome threats posed by poaching, illegal logging, agricultural encroachment and plans to build roads through the site.

The Manas Wildlife Sanctuary (India) was removed from the list of endangered sites.

The new natural properties are Ningaloo Coast (Australia, *see photo page 2*), the Ogasawara Islands (Japan) and the Kenya Lake System in the Great Rift Valley (*see photo opposite*). The new mixed property is the Wadi Rum Protected Area (Jordan).

The 21 cultural sites are the Historic Bridgetown and its Garrison (Barbados), the West Lake Cultural Landscape of Hangzhou (China), the Coffee Cultural Landscape of Colombia (Colombia), the Persian Garden (Iran), Konso Cultural Landscape (Ethiopia), The Causses and the Cévennes, Mediterranean Agro-pastoral Cultural Landscape (France), Fagus Factory in Alfeld (Germany), Longobards in Italy – Places of Power (568–774 AD), Hiraizumi – Temples, Gardens and Archaeological Sites Representing the Buddhist Pure Land (Japan), Fort Jesus, Mombasa (Kenya), Petroglyph Complexes of the Mongolian Altai (Mongolia), León Cathedral (Nicaragua), Saloum Delta (Senegal), the Cultural Landscape of the Serra de Tramuntana (Spain), Archaeological Sites of the Island of Meroe (Sudan), Prehistoric Pile Dwellings around the Alps (Austria, France, Germany, Italy, Slovenia, Switzerland), Ancient Villages of Northern Syria, Selimiye Mosque Complex at Edirne (Turkey), Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and Oases Areas) [United Arab Emirates], The Residence of Bukovinian and Dalmatian Metropolitans (Ukraine) and the Citadel of the Ho Dynasty (Viet Nam).

The World Heritage Committee also reaffirmed the need to protect the Temple of Preah Vihear World Heritage site in Cambodia from damage. In February this year, Ms Bokova had sent her special envoy, Koichiro Matsuura, to Thailand and Cambodia, following

clashes between Thai and Cambodian soldiers outside the 11th century temple over a border dispute. The site was inscribed on the World Heritage list in July 2008.

For details: http://whc.unesco.org/en/list; and more photos: www.unesco.org/new/en/media-services/multimedia/photos/whc-2011/

A project to **improve flood alerts** in Pakistan

UNESCO, the Government of Pakistan and the Japan International Cooperation Agency (JICA) launched a US$3.5 million project funded by the Japanese government on 12 July to upgrade early flood warning in Pakistan. A year after disastrous floods[14] killed 1 961 Pakistanis, the project is part of UNESCO's wider effort to help Pakistan tackle natural disasters.

In July 2010, exceptionally heavy monsoon rains battered the Khyber Pakhtunkhwa, Sindh, Punjab and Baluchistan regions, causing the worst flooding in 80 years. Approximately 20 million people were affected by these floods, which left 1.9 million homeless.

Implemented by UNESCO, in co-operation with JICA and the Government of Pakistan, the project aims to reduce the human and socio-economic impact of the floods; improve the potential benefits of floods for the environment and the economy; and encourage the development of safer dwellings close to flood plains.

The flood forecasting and early warning system will take a holistic approach. There are also plans to draw up detailed maps of areas vulnerable to flooding in the Indus valley. Given that most of the headwaters of the Indus's main tributaries are in neighbouring countries, the project also aims to establish local and international platforms for sharing hydrometeorological observations.

The project will benefit from the technical expertise of the International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM), which has developed an integrated flood analysis system using data provided by satellites.

UNESCO is also playing a leading role in the Friends of Democratic Pakistan Water Sector Task Force. This task force is preparing a national water sector strategy co-ordinated by the Asian Development Bank, in consultation with the Government of Pakistan.

For details: s.khan@unesco.org; t.sonoda@unesco.org;

UNESCO-IHP International Flood initiative: www.unesco.org/new/en/natural-sciences/environment/water/ihp/; www.icharm.pwri.go.jp; www.unesco-ihe.org/

First test of Mediterranean Tsunami Warning System

The communication network of the Tsunami Early Warning and Mitigation System for the Northeastern Atlantic, the Mediterranean and Connected Seas was tested successfully for the first time on 10 August.

The system was initiated in 2005 under the aegis of UNESCO's Intergovernmental Oceanographic Commission (IOC). It is one of four regional early warning and mitigation systems; the other three operate in the Pacific and Indian Oceans and in the Caribbean.

The test involved sending a test message to the Tsunami Warning Focal Points of 31 countries[15] at 10.36 Co-ordinated Universal Time (UCT[16]), via electronic mail, fax and WMO's Global Telecommunications System, from the Kandilli Observatory and Earthquake Research Institute (KOERI) in Turkey. Early results show the messages were received within a few minutes of being sent.

The success of this first test paves the way for the establishment of regional tsunami warning centres. The first two centres, KOERI in Turkey and the Atomic Energy and Alternative Energies Commission in France, should be operational by 2012 when a more exhaustive test will be conducted. Others are planned for Greece, Italy and Portugal at a later date.

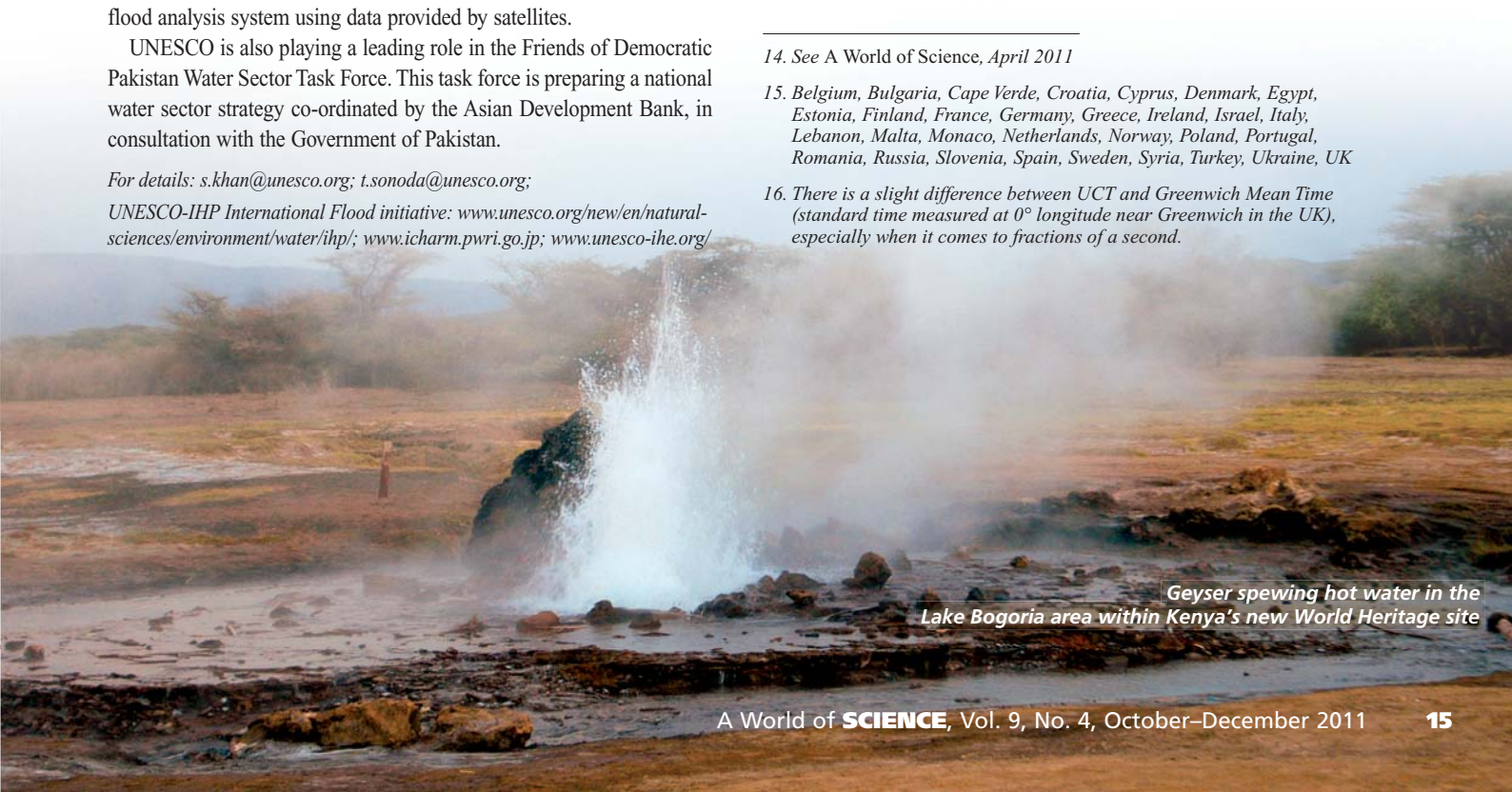
Historically, strong seismic activity has been observed in the Mediterranean and North-eastern Atlantic, albeit less frequently than in the Pacific Ocean. A powerful earthquake in the Azores–Gibraltar Fault Zone and subsequent tsunami destroyed the city of Lisbon in 1755. In 1908, a sub-sea earthquake near Messina and the subsequent tsunami took the lives of more than 100 000 people in Sicily and Calabria (Italy). Weaker tsunamis have been observed more recently, notably one generated off the coast of Algeria in 2003.

For details: www.ioc-tsunami.org/

14. See A World of Science*, April 2011*

15. Belgium, Bulgaria, Cape Verde, Croatia, Cyprus, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Ireland, Israel, Italy, Lebanon, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Syria, Turkey, Ukraine, UK

16. There is a slight difference between UCT and Greenwich Mean Time (standard time measured at 0° longitude near Greenwich in the UK), especially when it comes to fractions of a second.



Geyser spewing hot water in the Lake Bogoria area within Kenya's new World Heritage site

Tebello Nyokong

'As chemists, we are designers'

What is the common thread running through denim jeans, cancer and pesticides? None springs to mind, yet when chemist Tebello Nyokong describes her fascinating research, a link begins to emerge: light. A specialist in nanochemistry, Nyokong is using laser in ways that could revolutionize not only the diagnosis and treatment of cancer but also water purification.

Born in Lesotho, Tebello Nyokong is Professor of Medicinal Chemistry and Nanotechnology at Rhodes University in South Africa and Director of the Nanotechnology Innovation Centre for Sensors (Mintek). In 2009, she was one of the five Laureates of the 2009 L'Oreal–UNESCO Awards for Women in Science.

You are involved in research into an alternative to chemotherapy for cancer patients. Can you explain your work in simple terms?

As chemists, we are designers. My research deals with the development of drugs from compounds called phtalocyanines. We call them dyes because their molecules are similar to those of dyes you use to colour jeans blue. These dyes are used to treat cancer via a process called photo-dynamic therapy, or PDT. The approach is multi-disciplinary, with chemists, biologists and biotechnologists all working together.

As a chemist, I am at the centre of this work because I am the one who makes the molecules. I have a big team of about 30 people, plus others all over the world who are doing the preclinical testing in their own laboratories.

Molecules that dye blue jeans can also treat cancer?

Look at a plant: its leaves are green because of chlorophyll. Blood is red because of haemoglobin. Those molecules are actually almost the same, except that the one in leaves has magnesium at the centre and the one in blood has iron at the centre. A small change like that can make the difference between non-medicine and medicine. The molecule in blue jeans is the same as the one I am using to develop a treatment for cancer, with a slight change in its composition, a different metal at the centre, to make it do what you want.

PDT is a new treatment?

No, what is new are the drugs we are developing. PDT is already available for use on some cancers in the USA, Europe and Russia. The drug is introduced into the body and activated using light. The problem is that the side effects are very strong. The drugs currently available tend to hone in on healthy tissue as well as on cancerous tissue once they have been introduced into the body. The problem with chemotherapy is that the patient has to stay indoors out of the sun to prevent the healthy tissue from being killed along with the cancerous tissue.

Can this treatment be used for all forms of cancer?

It cannot replace surgery. The light used to activate the drug is transported by tubes; we are using a combination of laser and fibre optics. If the cancer has spread throughout the body, this cannot work. It is a localized treatment. You have to direct the laser to exactly where the cancer is.

Are your molecules safer than current PDT drugs?

That is the whole aim. We are making molecules that are cancer-specific, so they will not attack healthy tissue. Also, with my own drugs, you need very small quantities in order to absorb light. I have gone much further than my peers because I am now combining my drugs with drug delivery, which has never been done before.

This is the nanotechnology aspect. The molecules have nanomaterials called quantum dots attached to them that can penetrate any part of the body very easily. They are good at drug delivery and, secondly, they give off light, enabling us to see more easily where the cancer is located.

How did you come to choose this domain for your research?

It was accidental – that is the beauty of chemistry. Once you have developed an interest, you are always thinking: 'what more can I do with molecules?'

The bottom line for me is that I started working with laser because I just really love light. I love laser. It is bright, direct and offers a wide spectrum of colours. I started finding different applications for it. That was wonderful. My interest was in laser, not cancer.

Is nanochemistry dangerous?

I am afraid so because something that can penetrate any part of the body *is* dangerous. Secondly, at the centre of the molecules we have made so far, known as nanoparticles, are heavy metals. If they leak out, they can attach themselves to your haemoglobin or to other parts of the body and become a danger to you.

With the help of biologists, we are testing these nanoparticles to gauge their level of toxicity and trying to develop molecules that are the least toxic possible. In parallel, we are conducting research on applications and their toxicity.

How long do you think it will take before your drugs are in general use?

There are many variables when it comes to using these drugs on people. One thing which is problematic for oncologists is that lasers are expensive and difficult to maintain. I can do nothing on my own. I am a chemist; we can develop things but collaboration is important to see if they work.

The Centre for Scientific and Industrial Research is doing preclinical testing for me in South Africa. Beyond that, a group in Switzerland has developed a very interesting way to test the methodology using egg embryos. To test the dye's activity, you inject the dye into the veins around the embryo.

What environmental applications does your research have?

These molecules are really magic. They can do so many different things. The process can be used to purify water that has been polluted by pesticides, in particular. In Lesotho and South Africa, people still have to fetch water from open sources; run-off from the fields ends up in household water. We have to deal with that.

Throughout history, light has been used to purify water. You expect bacteria to be killed by light. But if you put the nanoparticles we have developed in the water, they accelerate the process and the end products are less toxic. If you purify water solely with biological means using the sun, the bacteria can form molecules that are more harmful to the body than the original ones you set out to kill. By using our drug, combined with light, we have managed to make nanoparticles that are no longer toxic at all to human beings. This is much closer to success. We have just patented this process.

Your goal is to develop a product?

That is my mission. Product development will come more quickly in the area of depollution. Drug development will take much longer. Dealing with people implies so many rules to ensure the drug is safe.

I plan to persevere, however, in order for young people to see that, in South Africa, they can take science and develop a product. They cannot imagine this; they believe anything new *must* come from somewhere else.

Did you imagine when you were younger that chemistry would be your life's work?

Not in a million years. We had no role models but I was always ambitious – I always thought I could be a doctor or a dentist.

Teachers are very important. I met a lecturer in my first year at the University of Lesotho who was in the US Peace Corps. He made chemistry so much fun. He made me feel that chemistry was the place to be. After that, I was hooked.

The University of Lesotho gave me the opportunity to train as an academic. I then won a scholarship to train in Canada, where I completed my masters and doctorate. I am doing the same for others now. I have lecturers training with me from all over Africa – from all over the world, in fact – who will later return to their universities.

As the first woman in your department at Rhodes University, you have said you feel challenged by doing the 'impossible.'

This is the reality. It was very difficult for me to progress with little support. Many women give up because of this. You have got to be a little mad to do what I have done. But I vowed that I would help other women as much as I could. Their confidence levels are not as high as men's. I don't know why but men feel confident even when what they are saying does not make much sense!

Interview by Cathy Nolan

A variant of this interview was published in the January 2011 issue of the UNESCO Courier on the theme of Chemistry and Life: www.unesco.org/courier

Professor Nyokong with a student next to a laser in her laboratory at Rhodes University

Chemical contaminants: those invisible additives in our drink

More than 60 million organic and inorganic substances have been documented by the Registry of the American Chemical Society, the most up to date and comprehensive database on chemicals worldwide. Every day, 12 000 new chemical products join the market. Of this ever-expanding universe, more than 49 million chemicals are commercially available, yet less than 1% of them are inventoried or regulated.

The life cycle of these chemical compounds extends well beyond the use for which they were originally intended. Many seep into the soil, air, rivers and sea. Moreover, early research indicates that many chemicals that have not historically been considered as contaminants – such as pharmaceuticals – are now present in water and the wider environment. As a result, humans and ecosystems are being continuously exposed to these invisible contaminants. How extensive is the problem and what kind of threat does it pose to our health and ecosystems?

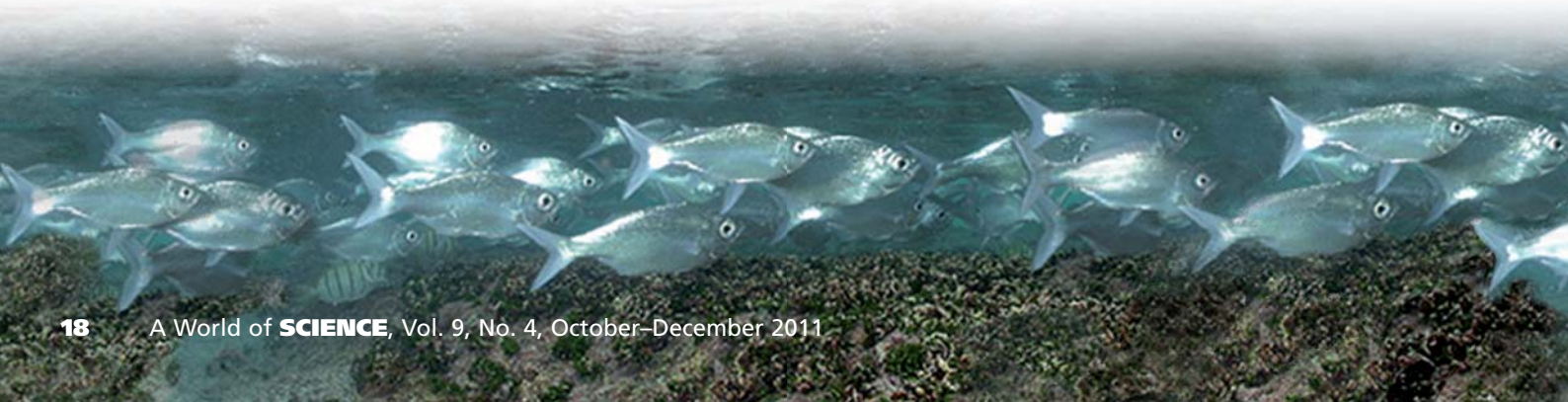
That is the question which UNESCO's International Hydrological Programme has decided to tackle, by promoting research and scientific exchanges on the topic and fostering public awareness. For the first case study within this new project, UNESCO partnered with the National Autonomous University of Mexico (UNAM). Between 2009 and 2011, researchers assessed the presence of emerging pollutants in wastewater, surface waters and groundwater and soil in the Tula Valley, an area that has been irrigated with untreated domestic wastewater since 1912. The study revealed that emerging contaminants were present in the soil and water in relatively low concentrations. Although the results are reassuring, more research will be needed to understand the extent of this invisible threat.

Over the past century, the chemical industry has shifted its focus from heavy chemical processes to organic chemistry. Organic chemistry originally relied on carbon and other substances produced by living organisms but its scope has since been extended to include substances synthesized artificially, such as plastics and drugs. Extraordinary progress in drug manufacture and other industrial processes has eliminated diseases and made our lives much more comfortable. But it has also made our modern societies overdependent on technologies that involve a myriad of chemical compounds spanning every economic sector and sphere of life.

What are these new contaminants?

New and emerging contaminants comprise a wide variety of chemicals used in our daily lives. These include pharmaceuticals and personal care products, pesticides, industrial and household chemicals, metals, surfactants,[17] industrial additives and solvents. Many of these chemicals are toxic to humans and aquatic animal species.

Within these complex chemicals, there is a large group known as endocrine disruptors. These chemicals interfere with the endocrine (hormonal) system in humans and animals. Endocrine disruptors include diverse synthetic compounds which are used as the active ingredients in pharmaceuticals but also comprise naturally occurring hormones such as phytoestrogens (estrogenic substances from plants) and mycoestrogens (estrogenic substances from fungi). Endocrine-disrupting compounds are found in pesticides, industrial chemicals and heavy metals. They are also found in some medicines, such as phytoestrogens, used for protection against various forms of cancer, cardiovascular disease and brain disorders, as well as osteoporosis in post-menopausal women.



Pharmaceuticals and personal care products like cosmetics, shampoos and soaps are also of concern. A variety of drugs given to both humans and animals for therapeutic and diagnostic purposes have been detected in wastewater and rivers, even if the concentration has been almost undetectable in some cases. The most commonly detected drugs include analgesics, caffeine, antibiotics, cholesterol-reducing drugs and antidepressants.

Persistent organic pollutants have been widely recognized as a threat to human and ecosystem health. They are used as pesticides or to produce a range of industrial goods that include solvents and polyvinyl chloride (PVC), polychlorinated biphenyls (PCBs) and dioxins, as well as two banned pesticides, chloridane and dichlorodiphenyltrichloroethane (DDT). Despite its toxicity, PVC is a ubiquitous product, as this durable plastic can be used to make windows and other structures, or softened for use in clothing, inflatable boats, upholstery and so on. Even if PCBs, DDT and other contaminants have been banned, their residues still remain in the environment.

How do they find their way into water bodies?

Emerging contaminants are found in varying concentrations in treated and untreated municipal wastewater, industrial effluents and agricultural run-off that seeps into rivers, lakes and coastal waters. Untreated sewage is a major source of pharmaceuticals and endocrine-disrupting chemicals in surface waters and groundwater.

People can be exposed to these contaminants via drinking water, as conventional water and wastewater treatment facilities are not designed to remove them. As wastewater is also used to irrigate crops in water-scarce areas, people in these regions may be exposed to these contaminants via the agricultural produce they eat.

Contaminants may also be finding their way onto our plates through seafood and fish. As most of these complex chemicals are persistent and fat-soluble, they most likely last a long time in the aquatic environment, accumulating in the fatty tissue of fish and other aquatic animals.

Researchers have found that some fish from both farmed and wild fisheries contain organic compounds produced by humans. Persistent toxic substances and heavy metals like lead have been found in fish and seafood in lakes and coastal areas around the world, such as fish and mussels from the Baltic Sea, Southeast Asian waters and the Great Lakes bordering the USA and Canada.

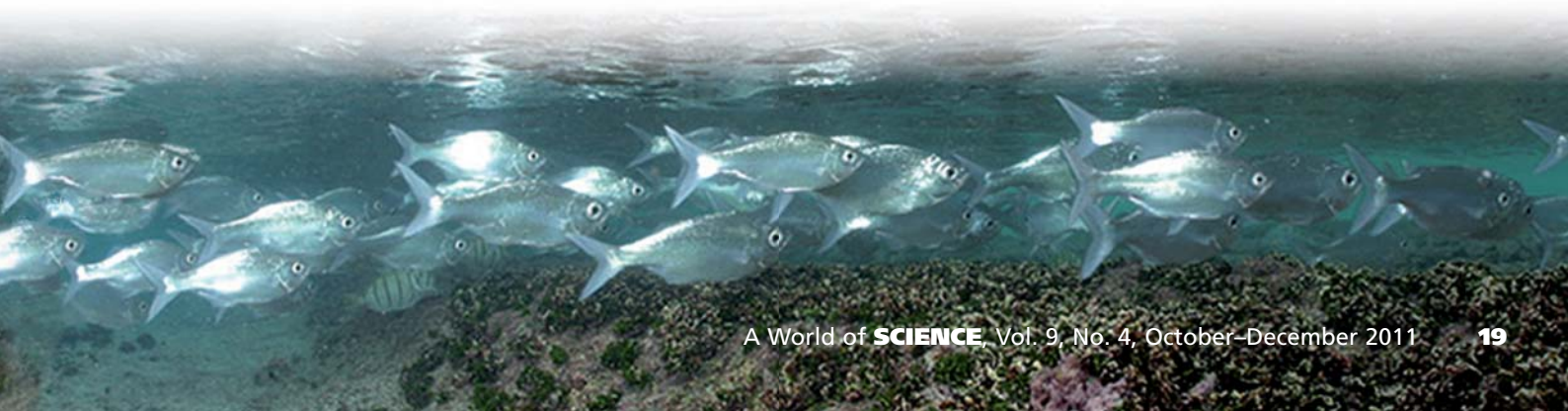
What are the repercussions for human and ecosystem health?

There is scientific evidence that many chemicals recognized as emerging contaminants may cause cancerous tumours, birth defects and developmental disorders, and affect fertility and reproductive health. Endocrine disruptors are believed to cause infertility and perturb sexual development. Cases have been reported of a feminization of males and a masculinization of females in both humans and animals. According to WHO, there has been a drop in male fertility rates in recent decades owing to a decrease in the human sperm count in several populations. More research will be needed, however, to settle the debate as to whether there is a direct link between endocrine-disrupting compounds in the environment and male infertility.

Changes have been observed in the sex ratios of perch species in European rivers. Male fish downstream of wastewater treatment facilities have also been found to produce female egg protein in UK rivers. There is also debate as to whether the high prevalence of disease and larval malformations in fish taken from the Northeast Atlantic is due to marine pollution. Studies are under way to determine whether there is a causal link between human obesity and the presence of endocrine-disrupting compounds in fish and other sources of food: hormones are fed to cattle and poultry, for example, to put more meat on their bones.

Although little is known of the effects of residual pharmaceuticals on aquatic wildlife, research has shown that analgesics, anti-inflammatory non-steroidal drugs and blood fat-regulating agents found in anti-cholesterol pills may be toxic to phytoplankton, zooplankton and fish, given their high level of exposure over time. Antidepressants are suspected to affect the development, spawning and behavior of some crustaceans and molluscs. For example, studies on the effect of the antidepressant drug fluoxetine have found that, when it is used in large amounts on freshwater muds-nails and clams, the deposit of spawn and their breeding time and behaviour change, possibly due to the action of fluoxetine on the neurotransmitter serotonin, which regulates reproductive processes in molluscs.

If the effects of individual emerging contaminants on human and ecosystem health have been evaluated only



marginally, their cumulative effects in the aquatic environment and on the human body have not been studied at all.

Why are emerging contaminants not being monitored?

At present, there is no mention of new and emerging contaminants in regulations on water and the environment, as they are not considered priority pollutants. This has the spin-off effect that monitoring of wastewater and drinking water excludes these contaminants from testing, even though the technology exists. Generally, water quality monitoring and standards focus on a handful of basic physical and chemical parameters, such as pH, temperature and turbidity, as well as on key 'indicator bacteria', commonly total coliform, fecal coliform, *E. coli* and enterococci.

Even if the technology exists, it is costly and time-consuming to test and remove a wide range of these complex compounds. Conventional wastewater treatment techniques are not up to the task, although advanced techniques, such as membrane filtration, ultrafiltration, nano-osmosis and reverse osmosis technologies, can remove, at least partially, some endocrine-disrupting chemicals and pharmaceutically active compounds. The task is further complicated by the possibility that as-yet unknown chemicals may be present in the water.

For all the reasons outlined above, the extent of human exposure to pharmaceuticals and chemicals in drinking water has not yet been evaluated, despite concerns over the effects of long-term or lifetime exposure to drugs at even low concentrations, particularly as concerns foetuses, children and those in poor health. Nor has the impact of endocrine disruptors and other industrially produced chemicals on wildlife and the environment been systematically assessed or monitored. There are also concerns that constant exposure to antibiotics may reduce the effectiveness of these drugs in combating bacteria and pathogens, requiring a new generation of antibiotics.

What needs to be done?

It is obvious that policies and regulations are urgently needed to control the masses of chemicals polluting our water today and prevent the new generation of pharmaceuticals from adding to these in the future. Given the scientific uncertainties regarding the effect on health and the environment of emerging contaminants, approaches based both on the precautionary principle and end-of-the-pipe techniques need to

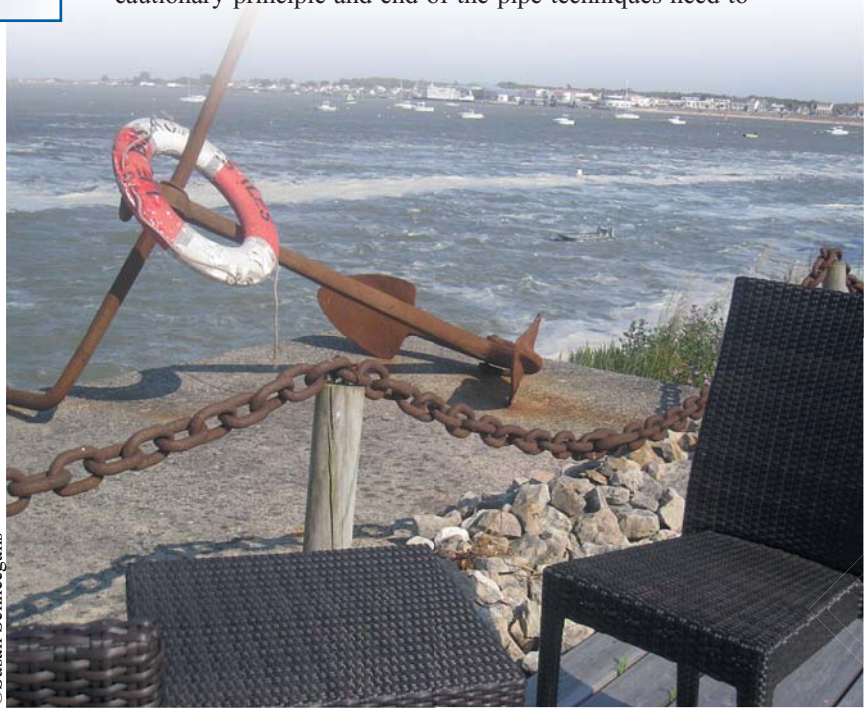
Practical ways to help

Public authorities can:

- raise consumer awareness of the health and environmental risks linked to the abuse of non-prescription medicines for minor, temporary ailments;
- implement policies to ensure that pharmacists dispense the quantity of medication that corresponds to the prescribed duration of treatment rather than to the size of preconfectioned packaging;
- set up disposal (take-back) points at pharmacies for unused and expired medicines to encourage consumers to take them in for recycling;
- encourage the widespread use of disposal (take-back) points for used batteries, electrical appliances and so on, common in developed countries;
- promote traditional and home remedies, whenever available, as alternatives to non-prescription (over the counter) self-medication for minor ailments;
- provide separate municipal collection bins for different types of waste to facilitate recycling of paper and cardboard, glass, plastic and metal.

Consumers can:

- carry a foldaway, reusable bag with them for their purchases to avoid taking home single-use, plastic packaging like supermarket and shop bags;
- reuse and recycle goods at home;
- return unused and expired medicines to the local pharmacy for recycling;
- take used batteries, electrical appliances and similar goods to disposal points;
- opt for recycled and eco-labelled products, whenever available and affordable.
- separate waste in the home into paper and cardboard, glass, plastic and metal ready for collection.



©Susan Schneegans

Untreated human effluent flowing past a hotel on France's Atlantic coast in June this year, at the start of the summer holiday season. Untreated sewage is a major source of endocrine-disrupting chemicals.

A recent UNESCO study found small concentrations of emerging contaminants in the untreated wastewater farmers use to irrigate their fields in Mexico's Tula Valley

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be adopted – although the latter is less effective than preventive measures because of the high costs involved in removing pollutants once they have been discharged into water.

The situation is most urgent in developing countries. As technology-based economies grow and the standard of living improves in these countries, so too is the production and use of chemicals. Numerous industries in the North, chemical companies among them, have moved their operations to the South where less is known about chemical hazards and regulations are weak, if they exist at all. Large quantities of insufficiently treated or untreated municipal wastewater and industrial effluents are discharged into surface waters and coastal zones in these countries every day.

One of the key objectives of UNESCO's new project will be to help developing countries strengthen their knowledge base on emerging contaminants by providing a forum for scientific exchange, collaboration and the sharing of experiences through seminars and workshops. For example, during World Water Week in Stockholm (Sweden) in September last year, UNESCO organized a seminar on Emerging Pollutants in Water Resources – A New Challenge for Water Quality, jointly with the Stockholm International Water Institute and European Federation of National Associations of Water and Wastewater Services. The seminar brought together researchers from Western and Eastern Europe, Latin America and Africa to share their findings and discuss possible solutions.

Policies and regulations also need to go beyond the water sector to tackle the source of pollution. Measures are needed to ensure the clean, safe and sustainable production, use and disposal of all chemicals. This can take the form of recycling pharmaceuticals, investing in organic agriculture or avoiding the discharge of hazardous chemicals into water bodies, for instance. The use of chemicals of particular concern should be severely restricted by adopting the principle of substitution with safer alternatives, where available. In parallel, both the authorities and consumers need to be made aware of what they can do to use and dispose of pharmaceuticals and chemicals safely (*see table*).

Lessons from the Tula study

The findings of UNESCO's study in Mexico's Tula Valley suggest several directions for further research. Some medicines found in Mexico City's wastewater, such as salicylic acid and naproxen, which are anti-inflammatory drugs commonly used to reduce pain, fever and inflammation, were found in lower concentrations than in European wastewater, reflecting different cultural attitudes to pharmaceuticals. The study also found the same medicines in drinking water, along with ibuprofen, carbamazepine and others, as well as phthalates and nonylphenols. Phthalates are used as coatings in pharmaceuticals and in a wide range of other agricultural, personal care and household products. Modern detergents contain nonylphenols. Concentrations of these products were found to be lower in drinking water than in wastewater and below the level at which they might present a risk. The concentration did vary, though, depending on the type of chemical and whether it was the wet or dry season.

This indicates that, although these pollutants can be retained in soil as a result of soil adsorption, some take a long time to biodegrade or even persist in certain soils, ultimately ending up in groundwater where they may contaminate drinking water. The report of the Tula Valley case study is due to be published in UNESCO's Technical Documents in Hydrology series next year.

By promoting research in this area, UNESCO hopes to develop appropriate solutions for tackling emerging pollutants that are also affordable, as currently available technologies are expensive for both developed and developing countries. UNESCO is planning a workshop on this very topic for next year.

Sarantuyaa Zandaryaa[18]

17. Surfactants make products more soluble in water or oil, or less so, depending on the need. They are found in detergents, insecticides, laxatives, paint, shampoo, spermicides, toothpaste, etc.

18. Programme Specialist in Urban Water Management and Water Quality at UNESCO: s.zandaryaa@unesco.org

Hot ice

Planets are like clever puppets with hidden strings. Pictures of the icy giants, Neptune and its near-twin, Uranus, always reveal soft shapes that are both unchanging and interchangeable. Those serene orbs are a mask, though, for a complex, multi-layered system.

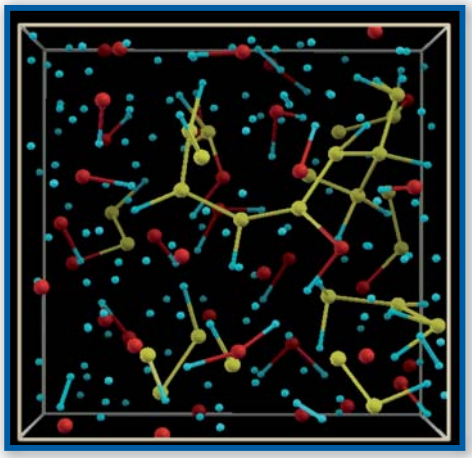
Sandro Scandolo, a researcher at UNESCO's Abdus Salam International Centre for Theoretical Physics, took hold of some of those puppet strings, variables like pressure and temperature, in order to understand better why common chemicals like water and methane sometimes behave in surprising ways on the icy giants, which are almost identical in size and internal composition. His theoretical calculations may improve our understanding of the interior of exoplanets and the role methane plays in the Earth's oceans. They are already challenging our understanding of chemicals we thought we knew.

©NASA

The Voyager 2 spacecraft took this image of Uranus on 17 January 1986 from a distance of 9.1 million km, no mean feat when you consider that Uranus lies nearly 2.9 billion km from the Sun. Only Neptune lies farther from our star, at 4.5 billion km. Uranus and Neptune are nearly four times the size of Earth. It is the presence of methane which explains their blue hue.

Icy giants' mantles are paradoxically referred to as ice, even though the dense mixture of water, methane and ammonia inside a planet can reach temperatures as high as 4700°C and pressures as high as 600 Gigapascals. At temperatures of 1500°C and 5 Gigapascals, graphite can be turned into diamonds, so it should come as no surprise that, in the mantles of Neptune and Uranus, molecules like water and methane behave quite differently than they do on the Earth's surface. With enough heat and pressure, they become conductive and start exerting influence over the planets' external environment, including their magnetic fields.

Understanding the planets' magnetic fields requires studying how the components of their ices interact with each other under various parameters but recreating those conditions on Earth is currently impossible. Although the temperature at the centre of the Earth – about 4000°C – is fairly similar to that on the icy planets, pressure levels on Uranus and Neptune are much higher than on Earth. Scandolo grins as he puts the problem into perspective. 'The pressure at the centre of the Earth is 360 Gigapascals,' he explains, roughly 60% the pressure inside the mantles of the icy giants. Although the techniques used in high-pressure experiments are improving, Scandolo estimates it will be several more years before anyone has the technology to simulate the extreme environments seen on the icy giants. In the meantime, scientists who want to know what kind of chemical reactions are happening inside the planets rely on models based on quantum and statistical mechanics.[19]



©Sandro Scandolo/ICTP

Models show that, at high pressure, the atoms in methane and water interact differently than they do on Earth. The three elements involved here are carbon (yellow), oxygen (red) and hydrogen (blue).

Theoretical models also have their limitations, such that previous calculations have only dealt with a single chemical at a time. 'It's very complicated,' Scandolo says. He is referring to the calculations but he could just as easily mean the mantle itself. A model of how water or methane behave under extreme conditions cannot say much, if anything, about the interactions between compounds. So Scandolo took on the challenge of simulating a mixture of the two.

Familiar chemicals can behave in uncharacteristic ways

On Earth, methane is hydrophobic, meaning that it mixes with water about as well as oil does. Previous models of Neptune's interior have assumed that the components of the planetary ice will behave independently of each other. These new calculations challenge that assumption by showing that the methane and water will, in fact, mix, which disrupts the chemical reactions that either pure substance would experience at high temperature and pressure. These findings could

spawn a complete revision of composition models of the planets' interiors.

Based on experiments done with pure substances, the interior of the icy giants was once believed to contain diamonds made from methane. This is because, at high temperatures, pure methane breaks down into its constituent atoms, carbon and hydrogen. The high pressure then squeezes the carbon atoms to form a diamond. However, with water also present, these reactions would be impossible, as the water would start interacting with the methane and forming bonds that would prevent it from breaking apart. Also, the magnetic fields of the planets probably originate at a much shallower depth than scientists previously assumed because the combination of methane and water becomes electronically conductive under milder conditions than water alone.

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Methane deposits in the deep ocean on Earth may someday be tapped as a source of fuel, in which case a better understanding of how water and methane interact at high pressure will be vital to designing an extraction process.

An interesting concept for astrobiology and exoplanetary research

In finding that methane is not always hydrophobic, the study is a great reminder that most of our assumptions about the ways chemicals interact are based on a specific and rare set of circumstances: ambient conditions on Earth. Under a different set of conditions, familiar chemicals could take on surprising new characteristics, which is an important concept for astrobiology and the search for extraterrestrial life.

The study could be of interest to researchers in other specialties as well. A growing number of astronomers are taking interest in exoplanets, those that lie beyond our own Solar System. 'We know very little about the composition of exoplanets as of now,' Scandolo says, but since most of those observed have been giant planets, rather than small, dense planets, the chances are good that the composition will be more similar to Uranus and Neptune than to Earth.

A new frontier for the energy industry on Earth?

Lessons drawn from studying methane–water interactions are also important for less extreme environments. Most of Earth's methane is stored under high pressure, deep in the ocean, in solid crystals of water molecules known as gas hydrates. Those deposits may someday be tapped as a source of fuel, in which case a better understanding of the non-standard interactions between water and methane at high pressures will be vital to designing an extraction process.

While the scientific implications of these calculations stretch from the depths of the ocean to the depths of an exoplanet, the philosophical implications reach even farther. From reducing carbon emissions to procuring clean water, many of the challenges we face depend, at their core, on the chemistry of well-understood compounds that sometimes behave in questioning ways.

Treating those chemicals as if they're still puzzles and working with variables like temperature and pressure to better understand their basic interactions – in short, identifying and pulling the puppets' strings – could provide some interesting answers.

Jordan Calmes[20]

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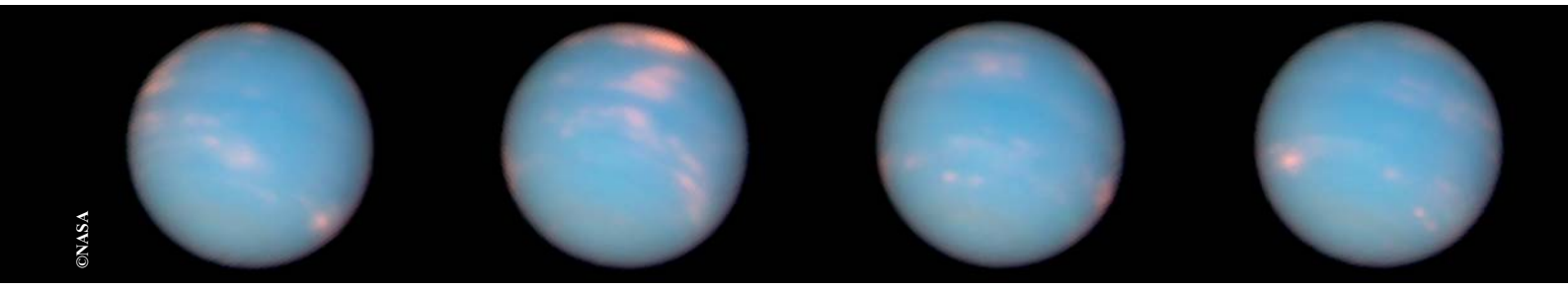
19. Quantum mechanics (or physics) describes how matter and energy interact at the atomic and subatomic levels. Statistical mechanics applies probability theory to studying the thermodynamics of systems composed of a large number of particles.

20. Intern at the ICTP from the Massachusetts Institute of Technology Graduate Programme in Science Writing in the USA



©NASA

Four images of Neptune, taken at four-hour intervals, showing one complete rotation of the planet. These images were taken by the Hubble Space Telescope in June this year. The high-altitude clouds in the northern and southern hemispheres are composed of methane ice crystals. The clouds are tinted pink because the images were taken using a near-infrared filter.

Diary

3–5 October
Astronomy
Capacity-building workshop for secondary school teachers. UNOOSA, UNESCO, with Bangladesh Astronomical Society. Enayetpur (Bangladesh): *s.gaines@unesco.org*

3–7 October
IPBES: towards full operationalization
UNESCO, UNEP, UNDP, FAO, etc. Nairobi (Kenya): *www.ipbes.net;* s.arico@unesco.org

12–14 October
Arab preparatory meeting for Rio+20
Regional S&T workshop in series. UNECSO Cairo, ICSU. Cairo (Egypt): *n.hassan@unesco.org*

17–20 October
International waters
6th GEF biennial conf. UNESCO-IHP main partner. Dubrovnik (Croatia): *h.treidel@unesco.org; http://iwlearn.net/abt_iwlearn/events/iwc6/index_html*

18 October
Law on transboundary aquifers
UN General Assembly discussion involving UNESCO-IHP to finalize Draft Articles. New York (USA): *a.aureli@unesco.org; r.stephan@unesco.org*

19–20 October
South–South co-operation on S&T to address climate change
Intl workshop. Results to appear in 2nd edition of Applicable Technology Manual on same topic. Co-organizers: China S&T Exchange Centre (CSTEC), UNESCO: Beijing (China): *lij@cstec.org.cn*

19–20 October
Towards a global observatory
Of policy instruments on STI. UNESCO Paris: *ga.lemarchand@unesco.org*

26–28 October
1st Intl environment forum for basin organizations
UNEP, with UNESCO-IHP contributing to Environmental Laws and Regulations theme for transboundary basins. UNESCO: Bangkok (Thailand): *a.aureli@unesco.org; www.unesco.org/water/water_events/Detailed/2264.shtml*

30 October – 1 November
Geotourism
3rd global conf. Convened by Oman's Ministry of Tourism. Supported by UNESCO. Oman : *b.boer@unesco.org*

10 November
World Science Day
for Peace and Development: *d.malpede@unesco.org*

15 November
Marie Curie: the opera
World premier, composed by Elżbieta Sikora, interpreted by Baltic Opera of Gdansk. Polish Del. to UNESCO. Intl Year of Chemistry. UNESCO Paris: *j.sozanska.pl@unesco-delegations.org; m.nalecz@unesco.org*

17–19 November
World Science Forum
On theme of The Changing Landscape of Science. UNESCO, Hungarian Academy of Sciences, ICSU. Budapest: *www.sciforum.hu*

18–20 November
Mobilizing the diaspora for Caribbean development through STI
Intl conf. Caribbean Science Foundation, with UNESCO, UWI, etc. Bridgetown (Barbados): *events@cadsti.org; http://cadsti.org/*

20–24 November
Production and utilization of microbial biomass
Advanced training workshop in microbiology. UNESCO, MIRCEN in CAIRO. Cairo: *n.hassan@unesco.org*

20–28 November
Aspiring geoparks in Africa and Arab world
1st intl conf to foster networking between members of Global Geoparks Network and aspiring geoparks. El Jadida (Morocco): *m.patzak@unesco.org; erramiezzoura@yahoo.fr; contact@aawg.org*

21–24 November
Managing coastal aquifers coping with climate change
Workshop. UNESCO-IHP, Caribbean Community Centre for Climate Change, Jamaica's Water Resources Agencies, Water and Sewerage Authority of Trinidad and Tobago. Port of Spain: *s.dangelo@unesco.org*

23–25 November
Towards stronger academia–industry partnerships in Arab Region.
Regional symposium. UNESCO Cairo, ISESCO. Cairo: *n.hassan@unesco.org*

27 November – 2 December
Understanding extreme geohazards
The science of the disaster risk management cycle. ESF conf. supported by UNESCO. Sant Feliu de Guixols (Spain): *s.gaines@unesco.org; www.esf.org*

28–30 November
Groundwater governance
A global framework for country action project. Steering committee meeting on regional consultation workshops to be developed under UNESCO-IHP: 1st in Uruguay in March 2012. Rome (Italy): *c.iskandar-abdalla@unesco.org*

30 November
UNESCO environmental awareness drive
To highlight importance of World Network of Biosphere Reserves and World Heritage Convention. Doha (Qatar): *b.boer@unesco.org*

2–4 December
Towards green industry in Arab region
Expert group meeting on energy management. UNESCO Cairo, ISESCO, Arab Academy of Science. Beirut: *n.hassan@unesco.org*

3–8 December
Frontiers of chemical sciences
Research and education in Middle East. 5th Malta Conf. in series. On energy, materials science, natural products, green chemistry, environment, etc. UNESCO Paris: *www.chemistry2011org; r.sigamoney@unesco.org*

5–8 December
Integrated aquifers management
A holistic approach. UNESCO-IHP, Itaipu-Parque Tecnologico workshop. Foz de Iguazu (Brazil): *s.dangelo@unesco.org*

5–9 December
Geo-InfoRmation in AFrica
2nd workshop. Organised by IUGS-CGI and UNESCO Nairobi. Southern and Eastern African Minerals Centre, Dar es Salaam (Tanzania): *www.cgi-iugs.org; sf.toteu@unesco.org*

7–9 December
Young scientists conference
10th in series. Cariscience. UNESCO co-sponsor with TWAS-ROLAC. Scarborough, Tobago: *harold.ramkissoon@sta.uwi.edu*

12 December
Extreme natural events
Joint meeting of UNESCO-AFPCN Special Group. UNESCO Paris (Room XI): *b.rouhban@unesco.org*

New **Releases**

World Network of Biosphere Reserves 2010
Sites for Sustainable Development
Produced by UNESCO-MAB to celebrate 40th anniversary, with funding from the Government of Spain. ISBN: 978-92-9089-166-6. Exists in English, French and Spanish, 600 pp.
Each page describes a different biosphere reserve belonging to the network, organized by region.Includes transboundary biosphere reserves. Download: *http://unesdoc.unesco.org/images/0020/002070/207049e.pdf*

For Life, for the Future
Biosphere Reserves and Climate Change: a Collection of Good Practice Case Studies
Lutz Möller (ed). Published by German National Commission for UNESCO, with support of Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, German Federal Agency for Nature Conservation and UNESCO-MAB. ISBN: 978-3-940785-27-5, English only, 80 pp.
A collection of 28 case studies based on a survey of biosphere reserves by the German National Commission for UNESCO. This publication was launched at the conference of the same name in Dresden, Germany, on 28 June – 1 July 2011. Download: *www.unesco.de/fileadmin/medien/Dokumente/Wissenschaft/Biosphere_reserves_climate_change_web_9MB.pdf*

Astrobiología: del Big Bang a las Civilizaciones
G. Lemarchand and G. Tancredi (eds). Produced by UNESCO Regional Bureau for Science in Latin America and the Caribbean. Special Topics in Basic and Engineering Sciences, no 1. Exists in Spanish with some abstracts in English, 348 pp.
Every year, UNESO organizes regional graduate schools in Latin America and the Caribbean. In 2009 (International Year of Astronomy), the theme was astrobiology. The proceedings cover, inter alia: The Galactic Habitable Zone; Exoplanets; The Relevance of Comets for the Origin and Development of Life; The Role played by Impacts in the History of the Solar System and; The Search for Life on Titan.
Download: *http://unesdoc.unesco.org/images/0019/001903/190398s.pdf*

Biosphere Reserves in the Mountains of the World
Excellence in the Clouds?
Produced by Austrian MAB Committee (ed). Austrian Academy of Sciences Press, English only, 120 pp. See also box on page 4. Download: *www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/OAW_BR_Mountains_Excellence_in_the_Clouds_2011.pdf*

Third Pole Environment
Policy brief by UNESCO-MAB, UNEP and Scientific Committee on Problems of the Environment. English only, 6 pp.
The Tibetan Plateau is known as the Third Pole for, along with the Arctic and Antarctic, it carries one of the largest ice masses on Earth. Melt water from this Third Pole ensures the permanent flow of Asia's main rivers. Download: *www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/sc_env_Third_Pole_EN.pdf*

Migration and Climate Change
Edited by Étienne Piguet, Antoine Pécoud and Paul de Guchteneire. Social Sciences Studies series, UNESCO Publishing /Cambridge University Press. ISBN: 978-92-3-104199-0, 24,00€, English only, 576 pp.
An introduction to one of the least understood consequences of climate change, with case studies. Discusses policy responses and normative issues from the point of view of human rights, international law and ethics.

Pacific MAB Discovery Kit
A Visit to the Island Biosphere Reserves in the Pacific
Alejandra Mejia-Restrepo. Hans Thulstrup, Tamara Logan and Emily Waterman (eds). Electronic handbook produced by UNESCO Apia office. English only.
Describes 24 island and coastal biosphere reserves in and around the Pacific basin. An educational kit designed for students and educators, it comes with an activity booklet and poster. For details, contact: *apia@unesco.org.* Access here: *www.unesco.org/mab/doc/coast_kit/index.html*

Monitoring Framework for Water
Briefing note prepared by World Water Assessment Programme and United Nations Statistics Division. Exists in English, 8 pp.
Outlines the System of Environmental-Economic Accounts for Water and the International Recommendations for Water Statistics. Download: *http://unesdoc.unesco.org/images/0021/002112/211296e.pdf*

Water and Climate Dialogue
Briefing note prepared by World Water Assessment Programme. Exists in English, 16 pp.
Focuses on why we need broader and out-of-the-box approaches to adapting to climate change. Download: *http://unesdoc.unesco.org/images/0021/002115/211591E.pdf*

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