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IN THIS ISSUE

EDITORIAL

A **triple** catastrophe

'My heart goes out to the people of Japan,' said UNESCO Director-General Irina Bokova hours after the country was struck by an earthquake and tsunami on 11 March. Estimated of magnitude 9.0 by the Japan Meteorological Agency (JMA), the earthquake was fairly shallow, just 24 km beneath the ocean floor, with an epicenter situated 130 km off the northeast coast of Japan. Thanks to the observance of strict building codes, not a single edifice collapsed in Tokyo, a conglomeration of 35 million people.

Within three minutes of the earthquake, JMA had sent out a warning. Unfortunately, the first wave arrived within 25 minutes, leaving very little time to alert people. The underwater earthquake generated a series of tsunami over 10 m high which flattened coastal villages and towns. Two weeks after the catastrophe, the provisional death toll has topped 10 000 with a further 16 000 reported missing.

The tsunami's progress across the Pacific was closely monitored by the Pacific Tsunami Warning System. This system was created by UNESCO's Intergovernmental Oceanographic Commission (IOC) in conjunction with Pacific Rim countries almost 50 years ago. The system counts 40 or so Deep-ocean Assessment and Reporting of Tsunami (DART) buoys dotted mainly around the Pacific Rim. Those close to Japan recorded a wave 1.08 m high on 11 March, confirming that a large tsunami was rapidly moving eastward.

Technical readiness for a tsunami is essential. Countries stretching from Venezuela to Canada and across the Caribbean islands have just participated in the first full-scale simulated tsunami alert exercise for the Caribbean and adjacent regions, on 23 March. The warning system was established in 2005 by the UNESCO–IOC in collaboration with the countries of the region.

It is also crucial to prepare coastal communities for the eventuality of a tsunami via education and contingency planning. UNESCO has just wound up a 15-month project which did just that in Chile, Colombia, Ecuador and Peru. You will find the details in this issue.

Of course, Japan suffered a third catastrophe this month. After the Fukushima nuclear power plant was swamped by the tsunami, it was left without power to drive the cooling system. This caused fuel rods in several reactors to overheat, setting off explosions on successive days that released radioactive particles into the air. More than 200 000 inhabitants living within a 30-km radius of the plant were evacuated. In mid-March, the situation was evaluated at level 6, just one level below the nuclear catastrophe of Chernobyl in Ukraine in 1986. As this issue goes to press, the situation at the plant remains highly volatile.

This earthquake was the biggest ever registered in Japan and the world's fourth-biggest on record. The second-biggest in the same area (8.3) dates back to 869 AD. More than ever, research is needed to ascertain where these large earthquakes and derived tsunamis are likely to occur. Palaeotsunami and geophysical research will improve our knowledge of these aspects and thus our preparedness for the next time disaster strikes.

Gretchen Kalonji
Assistant Director-General
for Natural Sciences

Wendy Watson-Wright
Assistant Director-General and
IOC Executive Secretary

The benefits of **biotech for South Asia**

©UNESCO/Pascal Maitre

Farm labourers in the Pakistani region of Mohenjodaro thrashing rice husks

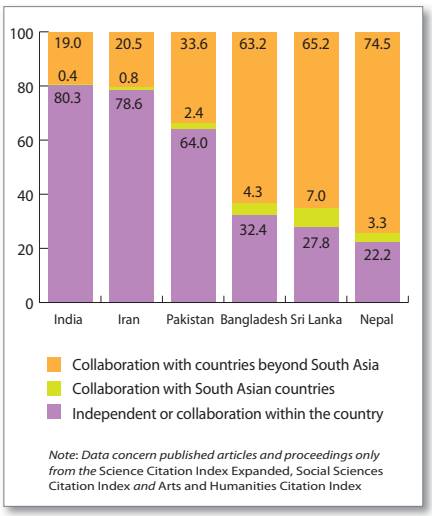
Once considered slow starters, South Asian economies have grown at an annual rate of about 5.5% on average over the past two decades. The current outlook for growth is even brighter, despite the global economic recession. As for the development targets set by South Asian countries, these are primarily based on investment in infrastructure to produce educated and skilled personnel. The other areas for investment are the core public services of agriculture, health and energy, which are becoming increasingly technology-driven.

Biotechnology is coming to be seen as the technology with the greatest potential for addressing problems arising from low productivity, overburdened health systems and costly, unsustainable energy supplies, together with the need for new materials for industrial and environmental applications. We examine some of the areas of biotechnology that have good potential for socio-economic development in South Asia. These exciting fields blend biology, chemistry, engineering, environmental sciences, informatics and physics, among others.

There will need to be much more regional co-operation than at present, if South Asia is to take advantage of these opportunities. Already, there are some encouraging signs, such as the founding of a Regional Centre for Biotechnology Education, Training and Research, under the auspices of UNESCO, and of the South Asia University.

Many governments are conscious today that biotechnology can provide valuable tools for meeting a number of development challenges. In agriculture for instance, the FAO estimated in its annual report for 2010 on *The State of Food and Agriculture* that, by 2050, the world would need to increase food production by 50% to avoid global food shortages. Biotechnology can address this issue via the use of crop genomics, biofertilizers and integrated pest management. Biotechnology can also be used to render plants resistant to droughts, floods and diseases, to fortify crops to combat human diseases such as vitamin A deficiency or anaemia caused by iron deficiency in undernourished populations, or to provide alternative sources of fuel (biofuels). Biotechnology has already revolutionized the health care system with new diagnostic tools, medicines and drug delivery systems.

Asia–Pacific biotech revenues grew by 25% in 2008, according to Ernst and Young's *Beyond Borders: Global Biotechnology Report* (2009). Several countries are investing heavily in the biotechnology sector, including China, Singapore, India, Indonesia, Malaysia, the Philippines and Thailand. In this, they are following on the heels of Japan and the Republic of Korea, according to the Organisation of Economic Co-operation for Development's *Bioeconomy 2030* report.



Source: *UNESCO Science Report 2010*

Scientific collaboration involving South Asian authors, 2007 (%)

However, despite this bright outlook, there are huge variations in the way countries are benefiting from biotechnology, particularly in South Asia. The Indian Department of Biotechnology reports that India has been investing heavily in the sector, generating revenues of over US$2 billion in 2006–2007 and around 3000 biotech-related patents over the period 1995–2004. Bangladesh, Pakistan and Sri Lanka, on the other hand, are still using first-generation technologies and, in Nepal, Bhutan and the Maldives, biotechnology is yet to be widely applied. In these countries, the focus has been mainly on tissue culture.

Scientists in South Asia have a tendency to look past each other and focus on collaboration with the USA or Europe, partly because this gets them more credit from their academic and government administrations. The *UNESCO Science Report 2010* estimates that 'only 3% of research articles are published in collaboration with scientists working in South Asia' (*see figure*). Notwithstanding the importance of international collaboration, there is a need for much greater regional co-operation. By envisioning areas of interest common to the region, the scope for scientific alliances can be widened and diversified. This is even more imperative in the wake of the

unfurling wave of multidisciplinary areas of biotechnology, which promise a paradigm shift in the way we solve critical problems in agriculture and medicine. Some of these areas are described below.

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One of this year's five l'Oréal–UNESCO laureates, Prof. Vivian Wing-Wah Yam develops light-emitting materials that can serve as chemosensors to detect glucose in the blood of diabetics or the presence of malignant cells (see also page 12).

Biomaterials and bioengineering for health

Biomaterials and bioengineering apply the principles of engineering to biological and clinical problems. Simultaneously, advances in engineering fields like nanotechnology are greatly increasing the sophistication with which biomaterials are designed and have allowed the fabrication of materials with increasingly complex functions. Biomaterials can regenerate tissues, for instance, to heal a wound.

The bioengineer relies on methodologies and techniques in more traditional engineering fields, which he or she then develops or adapts to suit the particular complexities associated with biological systems. Take the example of Infuse Bone Graft devices, a combination product that uses both traditional prosthetic components and a tissue-engineering approach to provide stability while spinal tissues are being regenerated. The applications of bioengineering vary from the design, development and operation of complex medical devices used in prevention, diagnosis and treatment like Infuse Bone Graft devices to the study of the way in which tissues behave in healthy and ailing patients, and the development of software products and theoretical models that enhance our understanding of complex biomedical issues. The obvious application is in manufacturing and delivering drugs more efficiently.

A growing percentage of the Asian population is being diagnosed with diabetes brought on by hereditary or environmental factors, according to WHO. In diabetics, the pancreas stops producing the hormone insulin, so patients have to control their blood glucose levels via the daily injection of insulin under the skin. However, these multiple daily injections cannot duplicate the body's natural pattern of insulin release. In addition, injecting insulin is painful and the chances of the puncture wound becoming infected are very high. The administration of medication through the mouth is the most common and most patient-friendly technique. This route, however, is not a possibility for insulin, as the synthetic hormone is inactivated by acids and the enzymes which break down proteins (proteases) in the gastrointestinal tract. Bioengineering has been able to provide a solution to this problem by developing a pH-sensitive oral insulin delivery capsule. New approaches to the fabrication of biomaterials, often incorporating physical as well as chemical fabrication techniques, have paved the way for new approaches to diagnostics too.

Bioengineering is not restricted to medical research. Disinfection of drinking water continues to be a challenging problem, particularly for a developing and over-populated region like Asia, where the majority of the population is rural without access to safe potable water. According to scientists from the National Environmental Engineering and Research Institute in India, a staggering 70% of the available water in India is polluted and sewage generated from 25 heavily polluting cities and towns in the country accounts for about 75% of pollution in rivers. The Yamuna River, into which 200 million litres of untreated muck is dumped every day by Delhi's sewerage system, has become one of the most polluted rivers in the world, according to the UNDP.

Chemical disinfection systems currently available on the market are based on silver, iodine and chlorine tablets. These are good on the whole but have certain shortcomings, such as the uncontrolled release of disinfectant which disturbs the biological system of the human body and can have toxic effects if released in excess. Moreover, the colour and odour of filtered water changes and, after certain cycles, solid material comes out along with the water due to the brittle nature of the matrix. The Indian Institute of Technology in Delhi has come up with a microporous non-brittle polymer which can kill microbes in a few minutes without releasing any toxic waste products.

Photo: S Rajib, UNESCO-IHE 50th anniversary water photo contest

Boy in front of the Taj Mahal. The city of Agra is situated 200 km south of New Delhi and counts a population of approximately 1.7 million. Some 80% of the city's sewage flows into the Yamuna River.

Crop genomics

Genetically modified (GM) crops were first grown commercially in the mid-1990s. While the majority continue to be grown in developed countries, an increasing number of developing countries are cultivating them. In 2008, the International Service for the Acquisition of Agri-biotech Applications estimated that farmers in 12 developing countries had planted biotech crops[1] the previous year and that, for the first time, these countries outnumbered their industrialized counterparts. Argentina led the movement for developing countries, with 47.2 million acres of land planted with GM crops of corn, soy and cotton (Bt cotton). Brazil came second with just over 37 million acres of GM cotton and soy. As for India, it grew 15.3 million acres of GM cotton in 2007, its only biotech crop. Almost all GM crops grown commercially are genetically modified for one or both of two main traits: herbicide tolerance (63% of GM crops planted in 2008) or insect resistance (15%). Some 22% contain both traits.

Asia will be facing a formidable challenge in the next 20–25 years: the world's highest absolute population growth, from 3.0 billion to 4.5 billion, according to recent reports by the FAO and UNDP. Climate change is also predicted to reduce grain yields throughout South Asia, placing the food security of more than a billion people at risk, especially as countries will have less water and land at their disposal with which to increase agricultural productivity in order to feed their growing population.

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Terraces in Bhutan where different rice varieties are grown

In the past couple of years, decent agriculture-based infrastructure for research and development (R&D) has emerged in both China and India, among other developing countries, according to FAO. However, it would seem that, given the ongoing agrarian crisis, there is a need for a detailed strategy in order to reap the benefits of biotechnology for the region. This is all the more important for smaller Asian countries such as Sri Lanka, Nepal, Cambodia, the Lao People's Democratic Republic and so on, which still face major challenges with regard to infrastructure and access to technology.

A good crop yield depends heavily on favourable soils and irrigation, which the poorest farmers typically lack. As the experiences of small-holder Bt-cotton farmers in South Africa have demonstrated, GM crop technology also needs to be supported by infrastructure and grassroots institutions if it is to benefit the poorest segment of the population. Stronger public–private linkages conducive to both international and local collaboration are also critical, not to mention awareness-building programmes.

The application of biotechnology to improving crops is not restricted to increasing yields. It also confers resilience to other environmental challenges such as droughts and floods. In a letter published in *Nature* on 20 August 2009, a team of Japanese researchers led by Dr Hatori identified two genes, SNORKEL1 and SNORKEL2, which allow deep-water varieties of rice to elongate their stems as water rises, helping the plant keep its leaves above water. The team's work will help to increase rice production in flood-prone areas. Thirteen years ago, the International Rice Research Institute in the Philippines discovered a gene, Sub 1A, that allowed an Indian variety of rice to survive submersion for more than two weeks. Sub1A is effective for short periods of flooding but SNORKEL1 and SNORKEL2 function in heavy, long-duration floods. This will be highly relevant in Asia, as about 30% of rice acreage concerns rain-fed paddies exposed to fluctuating water levels (*see also page 17*).

Systems biology for drug delivery

If it is hard to make something from nothing, it can be just as hard to make something from everything. But that, in essence, is what many pharmaceutical companies are trying to do as they seek new drug targets by integrating the massive sprawl of biological information now available, a new field of science that is termed 'systems biology'.

Systems biology is about gathering unprecedented amounts of data from cells then making sense of it via mathematical models. At its most sophisticated, it might involve the high-throughput collection of molecular data, such as DNA sequences, RNA molecules, proteins and substances produced by the body's metabolism (metabolites), as well as more descriptive data such as the patients' clinical diagnoses and response to drugs (a field called pharmogenomics). Computer programmes model these processes in our cells. These data are then assimilated into these models which must also accommodate the dimensions of time and space, as molecules change location and function every microsecond. It is not enough to mimic what is known about the cell; these models must also predict what is unknown so that scientists can test their hypotheses.

However, some people in industrial and academic circles remain hesitant about systems biology. No-one can be sure that it will really increase the number of potential drugs in the pipeline that make it through clinical testing. Still, it is a gamble that almost all companies seem willing to take, even if investment levels are sometimes small. In a report published in 2009 entitled *Diagnostics*, industry analysts at Price Waterhouse Coopers argued that the pharmaceutical industry

needed to rely much more on systems biology if it was to survive the current slump in drug discovery. They predicted that the approach would become more prevalent by 2020.

Systems biology may also be helpful in the area of traditional medicine. Pharmaceutical companies have become more interested in traditional Chinese and Ayurvedic medicines over the past decade. But their knowledge-mining approach has been characteristically Western: isolate the active ingredients and test them one at a time. This reductionist approach has led to the approval of such drugs as artemisinin for malaria, which is used to treat fever in traditional Chinese medicine, and arsenic trioxide, which has been carried over from Chinese medicine for the treatment of acute promyelocytic leukaemia. But identifying the active ingredients isn't easy. Most remedies in traditional Chinese medicine are compound formulae that contain as many as 50 species of herbs and thousands of chemicals therein. To tap into the deeper well of traditional Chinese treatments, researchers think they may need to look at how the mixtures of ingredients act in concert. Systems biology attempts to understand the function and behaviour of an organism by studying the interactions between its components. It is thus seen by some as a perfect match for traditional Chinese medicine. By measuring many genes, proteins and metabolites at the same time, systems biology may provide a measure of the entire body's response to a complex mixture of herbs.

Most developing countries in South Asia are still in the early stages of technological learning, where access to patented technologies is essential for industrial development. As yet, there are no general models that would enable countries to reflect these various balances in a single strategy. Agricultural biotech firms, for example, are exploring ways of sharing their patented technologies with developing countries under special institutional arrangements, including flexible licensing arrangements. Similar measures may be needed in the field of industrial and environmental biotechnology[2].

One such good institutional arrangement is the Open Source Drug Discovery initiative of India's Council of Scientific and Industrial Research. The aim is to make affordable medicines available to deserving populations by supporting open collaborative research across the entire spectrum of processes in drug discovery. The initiative is still at an early stage of development and its long-term success may depend on its ability to provide sufficient monetary and non-monetary incentives.

Immunization in India

© WHO/P Virot

Vaccine development

Immunization can be one of the most effective means of preventing and hence managing animal diseases. In general, vaccines offer considerable benefits at a comparatively low cost, a primary consideration for developing countries. In addition, the development of good vaccines for important infectious diseases can reduce the use of antibiotics. Of the countries that responded to a 2005 survey by the World Organisation of Animal Health, 7 out of 14 Asian countries indicated that they produced or used animal vaccines derived from biotechnology, including experimental use and commercial release.

Closely related to advances in vaccines are improved methods of vaccine and drug delivery. As underscored by WHO, thousands of children die each year from vaccine-preventable diseases because the logistics of vaccine delivery are prohibitively expensive. Refrigerated transportation and storage are a major expense for all vaccine programmes. The need to hire trained medical personnel to deliver vaccinations also adds to the cost. Long and complicated drug regimens are difficult for people to comply with, especially if they involve visits to medical facilities. Partial treatment can lead not only to death but also to the emergence of drug-resistant strains of the disease. As injection-free and controlled-release delivery systems could help to solve many of these problems, scientists are currently exploring a number of alternatives to needle-based delivery of drugs or vaccines.

Vaccines are also being used to improve fish health through conventional selection for disease resistance and through the use of molecular investigation of pathogens for characterisation and diagnosis. These techniques are being used to detect viral diseases in marine shrimp throughout the world and for bacterial

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Mountains in central Bhutan where medicinal plants can be found in abundance and (inset) agricultural researcher micropropagating medicinal plants at a UNESCO training workshop in Bhutan in June 2009

and fungal pathogens in fishes in many areas. This has implications for quarantine and trade in aquatic species, currently governed by the World Trade Organisation and the Office international des epizooties.

Biotechnology-based diagnostics are also important for analysing food. Many of the classic microbiological methods used in the past were culture-based, with micro-organisms being grown on agar plates and detected using biochemical finger-printing. These methods are often tedious, labour-intensive and slow. Genetic-based diagnostic and identification systems can greatly enhance the specificity, sensitivity and speed of microbial testing. Molecular typing methodologies are used in food testing to identify and monitor the presence of harmful bacteria in food (known as spoilage flora and micro-flora). Molecular typing methodologies commonly involve a Polymerase Chain Reaction, a technique which can amplify miniscule amounts of DNA for the purpose of effective and robust testing. The use of combinations of these technologies and other genetic tests allows scientists to describe and identify organisms at the genus, species, subspecies and even strain levels, thereby making it possible to pinpoint sources of food contamination[3].

©Shahaama Abdul Sattar, Maldives Research Center

Scientist from the Marine Research Center in the Maldives analysing the growth of microalgae in the laboratory

Bionanotechnology

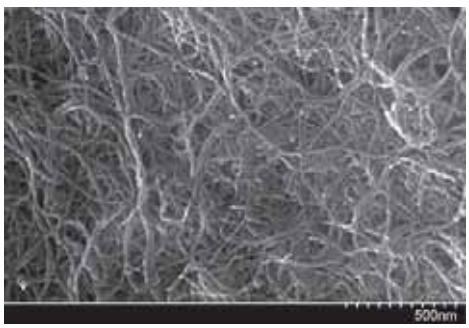
Bionanotechnology has the potential to revolutionize the agricultural and food industry with new tools for rapid plant disease detection and enhancing the ability of plants to absorb nutrients. Smart sensors and smart delivery systems will help the agricultural industry combat viruses and other crop pathogens.

Many emerging economies have ambitious R&D plans for nanotechnology, among them Brazil, China, India, Iran, Malaysia, Mexico, Singapore and South Africa. Yet while poor countries have an ongoing responsibility to strengthen health care systems, for example, and provide wider access to medicine, nanotechnology could, in the long run, save lives by making diagnosis and treatment far more effective and faster. Several developing countries in South Asia, South-east Asia and the Pacific are trying to follow suit.

In 2009, the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and the World Bank identified some core areas where nanotechnology could make a major contribution to fostering inclusive development and economic growth in the Asia–Pacific region. These areas include production of nanoparticles for safe drinking water, the use of carbon nanotubes in food processing and preservation, the development of cheap and effective diagnostic kits for a range of common diseases, innovative drug and vaccine delivery systems and greater conversion efficiencies in solar photovoltaic technologies by nanotubes and nanoparticles.

Bionanotechnology is regarded by many experts as a longer-term prospect: much basic science must first be investigated and many applications, especially in the medical field, will by necessity have to undergo strict testing and validation procedures. The field is moving very fast, however. If developing nations are to take advantage of the benefits that this technology has to offer, many serious financial, infrastructure, training and policy issues covering both technical and environmental aspects will have to be managed carefully.

There are also ethical issues. In its policy recommendations on *Nanotechnologies and Ethics* published in 2007, UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology explored a number of questions. For example, how do you ensure fair distribution of benefits arising from a technology developed largely by the private sector that also have important humanitarian implications? And would the lack of skills in developing nations when it comes to adopting and utilizing nanotechnology imply that manufacturing jobs will become obsolete as technologically advanced nations substitute traditional processes for nano-enabled ones?



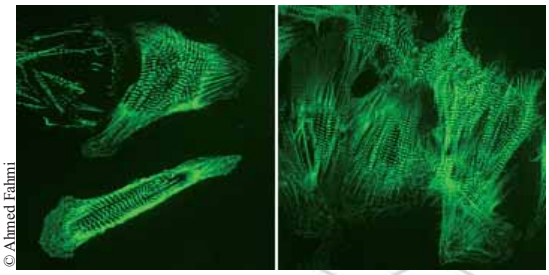
©V. Karunaratne/SLINTEC

Carbon nanotubes produced by Prof Veranja Karunaratne at the Sri Lanka Institute of Nanotechnology using Sri Lankan Vein graphite, a type of rock which can contain up to 99% carbon. Plants exposed to carbon nanotubes grow better than usual, making nanotubes a promising ingredient for agricultural fertilizers.

Biosafety and bioethics

Physical risk and uncertainty in the laboratory are technical issues. Policies and regulatory regimes intended to manage these risks will depend largely on scientific capacity, including human expertise and well-equipped laboratories. This capacity simply does not exist in many developing countries at present.

The Cartagena Protocol on Biosafety, the first international agreement specifically negotiated to deal with products of genetic engineering, applies the 'precautionary principle' to risk assessment of GM organisms. This principle holds that an absence or lack of scientific proof



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Heart muscles of a newborn laboratory rat highlighted by the injection of a green dye. This experiment performed at the Rayne Institute in London (UK) respected strict regulatory biosafety and bioethical protocols. On the left is a control image and, on the right, the same muscles after the addition of a chemical replica of a protein secreted naturally by the body, Interleukin 6. This protein stimulates the body's immune response to trauma, especially tissue damage leading to inflammation.

of risk should not be taken as conclusive evidence of the safety of any given organism and thus requires a risk/benefit analysis. This gives some degree of reassurance to developing countries that are as yet unable to undertake comprehensive risk assessments. However, in applying the precautionary principle, it must be argued that no technology is completely risk-free and that the precautionary principle could be open to misuse as a trade barrier and as a barrier against the further development of biotechnology. This suggests that there is a need to address concerns about the consistency of particular measures between the provisions of the Agreement on the Trade-related Aspects of Intellectual Property Rights and the provisions of the Convention on Biological Diversity.

The growing complexity of bioethical issues ranging from the manipulation of human genetic data to biopiracy, embryonic stem cell research, animal cloning and the genetic engineering of plants to produce vaccines and pharmaceutical products is inciting a growing number of countries in South Asia to set up national bioethics committees, according to UNESCO. These committees advise policy-makers on how to translate the universal norms articulated in international instruments into national legislation and regulations, in order to make a real impact on national science policy and practices in the biological sciences.

For example, pharmaceutical companies are increasingly conducting clinical trials in developing countries but many are using questionable practices. Conducting trials in global settings could save time and money. Target patient numbers could be met faster and speeding up drug development could earn companies an extra year of patent exclusivity. The countries themselves also stand to gain money and staff training for hospitals, medical schools and research bodies.

In particular, the number of trials carried out in China and India is growing but both countries have shortcomings when it comes to trial know-how and ethical oversight. A recent study by Normile revealed that only 207 out of 2 235 'randomised' trials reported in Chinese publications were appropriately randomised. And that, in India, most potential investigators lacked the appropriate skills to undertake these trials. Patients are frequently manipulated into participating in trials, with widespread illiteracy making it easy to sidestep informed-consent procedures, and sponsors frequently tempt would-be participants with massive payments and expensive medications. Applying bioethical norms on such issues in registries and journal policies can help keep up with the developing world's growing participation in clinical trials.

Regional co-operation a must

As far back as 1990, the heads of state or government of the South Asian Association for Regional Cooperation (SAARC) recognized the need to institutionalize and promote co-operation in biotechnology. However, regional co-operation in this field has been sparse and only translated into a formal commitment in June 2009 when the SAARC Working Group on Biotechnology initiated co-operation among member states in joint research and fellowship programmes, at a meeting in Colombo (Sri Lanka).

There is a dire need to develop regional co-operation in order to build proficient universities and research centres, provide ample funding for basic and applied research, forge strong international links and open up broad channels of communication. However, regional co-operation need not be a one-way traffic involving only donors and recipients. There is definitely scope for regional co-operation in joint research and the development and transfer of technology.

In the 1980s, UNIDO spearheaded the creation of the International Center for Genetic Engineering and Biotechnology (ICGEB) with components in Trieste (Italy), New Delhi (India) and, since 2007, in Cape Town (South Africa). Ever since, ICGEB has been building national capacity in industrial, agricultural, pharmaceutical, animal and human health biotechnology. It now has more than 30 affiliated centres around the world, some of which have become centres of excellence. Many of the above centres are located in developing countries and economies in transition. They highlight the importance of *local* research capabilities for the development of a *local* industrial base.

South Asia University: a first for the region

A quantum leap in regional co-operation came last June when the South Asia University began operating from a temporary campus at Jawaharlal Nehru University in New Delhi. Founded by SAARC, the university will initially admit 50 students in half a dozen master degree courses, one of which will be an MSc in Biotechnology. Admissions for the academic programmes will be processed in July and classes are expected to start in August. Students will hail mainly from the eight SAARC countries[4] and tuition fees for them will be heavily subsidized. Some students from non-SAARC countries may also be admitted on a full cost-recovery basis. Teachers will also be recruited predominantly from the eight SAARC countries.

Engineering for physicians and biology for engineers!

According to Narasimharao[5], very few institutions in India or the broader South Asian region provide interdisciplinary training or education, even though this is crucial for the success of any national biotechnology strategy. The very structure of academic departments in conventional universities – organized by discipline – is a barrier to this goal.

Moreover, institutions tend to overlook the fact that collaboration works best when it is intellectually productive for all disciplines involved. The initial urge may be for biologists to go to physicists or mathematicians for help in developing techniques or building models to answer purely biological questions, creating a one-way relationship. Alternatively, the allure of simple, elegant models may have some theorists working to ends that don't necessarily provide biological insight. But in the best examples of interdisciplinary work, insight and enlightenment are mutual. Biologists get a chance to answer key questions in their field while mathematicians and physicists develop and apply tools that better inform their understanding of the natural world.

Another shortcoming is the lack of recognition of the enormous diversity of specialists required for biotechnology. As a consequence, there is an acute shortage of many professions whose training tends to be of an interdisciplinary nature, such as physicians, engineers, clinical product development professionals and specialists in regulatory science and industrial quality assurance. This point was made by the UNESCO report published last year on *Engineering: Issues, Challenges and Opportunities for Development*.

This state of affairs incited the Indian government to set up a Regional Centre for Biotechnology Education, Training and Research, within the framework of UNESCO's International Basic Sciences Programme, via an agreement signed in July 2006. Interim state-of-the-art facilities have just been completed and three principal investigators have been recruited for the research component. Construction of the permanent facility in Faridabad located on the outskirts of Delhi should be completed within a few years. Although students from around the world may apply to attend the centre, Asian students are being given precedence.

A unique feature of training is the exposure to other disciplines. Future physicians enroll not only in medical sciences but also take courses in biomedical engineering, nanotechnology and bioentrepreneurship. During their medical training, they collaborate with biologists and engineers via networking through local hospitals and medical schools.

As world-class education and training goes hand in hand with a dynamic research environment, research at the centre will be at the interface of multiple disciplines and focused on technology development. It is planned to develop specialized domain-specific training and research programmes in 'new opportunity areas' such as cell and tissue engineering, nanobiotechnology and bioinformatics, a field which creates synergies between information technology and advanced biomaterials. An important focus of training will be regulation, product development, scale-up, manufacturing science and bioentrepreneurship.

It is hoped that this regional centre will provide a platform for fostering and implementing joint programmes both from a regional perspective to address South Asia's development challenges and from a wider perspective to ensure the development of products and services that can cater to global markets and industries.

Ahmed Fahmi[6]

Model of Regional Centre for Biotechnology Education, Training and Research (left) and Transnational Health Science Technology Institute (right), currently under construction in Faridabad. These centres will form part of a unique Biotech Science Cluster being set up by the Indian government.

For details of the regional centre: www.rcb.res.in

South Asia University: www.southasiauniversity.org

This article was inspired by a series of conferences on Asian Biotechnology and Development supported by UNESCO's Delhi's office since 2004.

A similar article by the same author is due to be published in Elsevier's Journal of Biotechnology *in May 2011.*

1. *Clive James (2008)* Global Status of Commercialized Biotech/GM Crops*: www.isaaa.org*
2. *See: Chaturvedi, S. and Ravi Srinivas, K (2011)* Contours of South–South Cooperation and Biotechnology in Asia: Strategising for Agricultural and Industrial Growth*. RIS Policy Brief. No. # 49*
3. *See J. Ruane and A. Sonnino (eds) (2006)* The Role of Biotechnology in Exploring and Protecting Agricultural Genetic Resources*. Background document, pp. 151-172. FAO, Rome.*
4. *Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka*
5. *B. P. Narasimharao (2009) Need for New Trends in Biotechnology Education and Training.* Asian Biotechnology and Development Review*, 11, 89–114.*
6. *Programme specialist, UNESCO Cluster Office in New Delhi for Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka : a.fahmi@unesco.org*

Chemistry year off to flying start

The International Year of Chemistry (IYC) was officially launched by UNESCO and the International Union for Pure and Applied Chemistry (IUPAC) at a conference on 27 and 28 January at UNESCO's Paris headquarters. During the Year, primary and secondary school pupils are being invited to take part in an attempt to break the record for the biggest scientific experiment ever conducted.

© EPCA/UNESCO/IUPAC

Still from the three-minute film Chemistry – All About You, *made by the European Petrochemical Association, UNESCO and IUPAC to show how the creativity of chemistry pervades our daily lives. The film was projected at the launch of the Year and is freely available to anyone wishing to screen it around the world.*

The Global Chemistry Experiment contributes to the Year's goal of deepening appreciation for chemistry. Entitled Water: a Chemical Solution, the project invites primary and secondary school pupils to carry out four experiments on water quality: they will test for both salinity and acidity, learning how to filter and distil water. On World Water Day on 22 March, the global experiment was officially launched by UNESCO with a 'big splash' in which 1000 schoolchildren from Cape Town (South Africa) tackled these four experiments.

Once their tests have been completed, children around the world will be able to enter the results onto an interactive map on a specially created website. The experiment could become the largest chemistry experiment ever undertaken. Rovani Sigamoney from UNESCO explains that 'these four experiments are easy to do in laboratories in most schools as no additional equipment is needed. However, for the many schools around the world that do not have a laboratory, the IYC Global Water Experiment kits have been developed.'

A second initiative, Visualizing and Understanding the Science of Climate Change, targets secondary school pupils and university students worldwide. Through nine interactive lessons accessible via a web platform, young people will gain insights into the scientific phenomena underlying climate change and be able to evaluate the human contribution to this phenomenon.

The conference which launched the Year was opened by the Director-General of UNESCO and Nicole Moreau, President of IUPAC. On 27 January, topics included the contribution of chemistry to modern life, the place of women in chemistry and the links between chemistry and sustainable development. The second day was devoted to the relationship between chemistry and a range of subjects that included health, energy, materials, nutrition and economics.

Speakers included Prof. Jean-Marie Lehn (France), Nobel laureate in chemistry in 1987; Prof. Ada Yonath (Israel), winner of the 2008 L'Oréal–UNESCO Award for Women in Science and Nobel laureate in chemistry in 2009, and Prof. Yuan Lee (Taiwan of China), Nobel laureate in chemistry in 1986.

Prof. Hélène Langevin-Joliot, Research Director at the French Centre national de recherche scientifique and granddaughter of Marie Sklodowska Curie, made a more personal speech. Retracing her grandmother's extraordinary life, she related how, after Pierre and Marie Curie discovered polonium and radium in 1898, the French Academy of Science transmitted only the names of Pierre Curie and Henri Bequerel to the Nobel Committee. Upon learning about this discrimination from Swedish mathematician Gösta Mittag-Leffler, Pierre 'energetically protested'. As a result, the 1903 Nobel Prize for Physics was shared by Henri Bequerel, Pierre and Marie Curie 'in recognition of the extraordinary services they have rendered by their joint research on the radiation phenomena discovered by Professor Henri Becquerel' [in 1896]. Five years after her beloved husband's accidental death, Marie Curie would be awarded the Nobel Prize for Chemistry in 1911 'for her discoveries and studies of the elements radium and polonium'.

The celebration of women's contribution to chemistry is one of the main goals of the International Year of Chemistry. At the launch, Mary Garson from the University of Queensland in Australia commented a short film portraying some of the 5000 women from 44 countries who had participated in the networking breakfasts on 18 January on the theme of Women sharing a Chemical Moment in Time.

For details: r.sigamoney@unesco.org; j.hasler@unesco.org; www.chemistry2011.org; www.explainingclimatechange.ca

Launch of *African Journal of Chemical Education*

The first issue of the *African Journal of Chemical Education* was published in January by the Federation of African Societies of Chemistry. The journal is the culmination of years of work on the part of editor Temechegn Engida from UNESCO's International Institute for Capacity-Building in Africa (IICBA) to improve chemistry teaching on the continent.

Founded in Ethiopia in February 2006 with UNESCO support, the Federation of African Societies of Chemistry today counts ten member countries, as well as the eight French-speaking West African countries which form a single chemical society.[7]

The online journal will appear in English twice a year, in January and July. That the journal should have been launched in the same month as the International Year of Chemistry was no coincidence. The Federation of African Societies of Chemistry and the Chemical Society of Ethiopia were driving forces behind the adoption of the Year, as it was they who were originally mandated by IUPAC to propose the Year to UNESCO's governing bodies in 2007. The rest is history.

The Federation is the first to admit that the main goals of the Year – namely increasing public appreciation for, and understanding of, chemistry in meeting world needs and encouraging an interest in chemistry among the young – pose a challenge to African chemical educators.

'We chemical educators on the continent have been complaining that chemistry has not been the first, not even the second or third option for many youngsters joining universities and colleges' writes Dr Engida in the editorial of the first issue of the *African Journal of Chemical Education*. 'We have also been arguing that many of our students do not have a proper understanding of chemistry, thereby hindering their ability to be creative citizens. Furthermore, the public at large has a distorted image of chemistry in which the subject is perceived negatively by being associated with explosives, toxics, etc.' He also laments the low proportion of female chemists and the 'very limited' visibility of African chemical societies in the international arena.

Engida argues that Africa will only be able to achieve the goals of the Year if African chemists and educators are able to provide contextualized, relevant and meaningful educational experiences to the young generation at primary, secondary, undergraduate and postgraduate levels of chemistry education. 'I personally feel that little has been done in this regard', he writes, 'and I even doubt that this can be appreciated by many of us in Africa.'

He calls for professionals in chemistry, chemical education, technology and education policy to work together to address such questions as how to develop and validate teaching strategies based on the use of local materials and how to maximize the use of these resources in schools and colleges, whether traditional teaching methods are adapted to 'our large classes and limited resources' and what Africa can learn from the experiences of developed nations.

The *African Journal of Chemical Education* has two Associate Editors, Sileshi Yitbarek from the Department of Chemistry at Kotebe College of Teacher Education in Ethiopia and Ahmed Mustefa from the Department of Chemistry at Addis Ababa University.

For details: t.engida@unesco.org; etemechegn@unesco-iicba.org; www.unesco-iicba.org ; read the journal: www.faschem.org

7. *Botswana, Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, South Africa, Tunisia, Uganda and the Société ouest africaine de chimie: Benin, Burkina Faso, Côte d'Ivoire, Guinea, Mali, Niger, Senegal and Togo*

Call for working group on **mining in biosphere reserves**

On 15 February, experts attending an international meeting at UNESCO headquarters in Paris recommended creating a working group to address mining and oil and gas extraction in biosphere reserves.

It was proposed that the working group be composed of members of the Man and the Biosphere (MAB) Advisory Committee, the Scientific Board of the International Geosciences Programme (IGCP) and invited experts. This would represent the first such collaboration between these groups.

At the meeting, more than 30 experts from government, industry, research institutions and civil society tackled the challenge of how to extract minerals sustainably from biosphere reserves. Biosphere reserves are more than just protected areas, in that they have a zoned structure comprised of nationally protected 'core' areas surrounded by 'buffer' and 'transition' zones open to controlled commercial and industrial activity. This zoning allows for planning at the landscape level to ensure equitable use of the area for both conservation and economic purposes like model mineral extraction techniques.

In most cases, mineral extraction in biosphere reserves has been viewed as a threat to biodiversity conservation. However, since biosphere reserves aim to operate as learning sites for sustainable development and current trajectories for development continue to rely heavily on mineral resources, biosphere reserves have sought to emulate best practices and forge public–private partnerships with companies. Growing demand for energy and precious metals has sent prices skyrocketing, putting pressure on biosphere reserves. 'There is a clear trend', said UNESCO programme specialist Sarah Gaines. 'What remains less clear is the best way for biosphere reserves to respond to this pressure.'

The meeting highlighted successful partnerships between the mining sector and biosphere reserves in Canada and Brazil and focused attention on established tools and sustainability frameworks for the mining industry. Artisanal, or subsistence, mining in Central Africa was also addressed.

Both secretaries of MAB and IGCP agree that the meeting heralded the start of a dialogue at UNESCO, the first question being: what are the key issues involved in mining in or near biosphere reserves? 'We were particularly keen to give biosphere managers an opportunity to describe the situation on the ground and engage with experts that have successfully tackled similar issues," said Aaron Welch, UNESCO Fulbright Fellow and co-ordinator of the meeting with Sarah Gaines.

The experts suggested that a joint working group involving MAB and IGCP could focus on:

- better communicating the purpose and structure of biosphere reserves to foster a broader understanding of how they could function as learning sites for sustainable Earth resource extraction;

- collecting and disseminating a body of case studies showing sustainable practices of Earth resource extraction and alerting extractive industries to existing guidelines and conservation tools;
- improving communication and the transparent flow of information between stakeholders to ameliorate the coordination of policy dialogue at all levels.

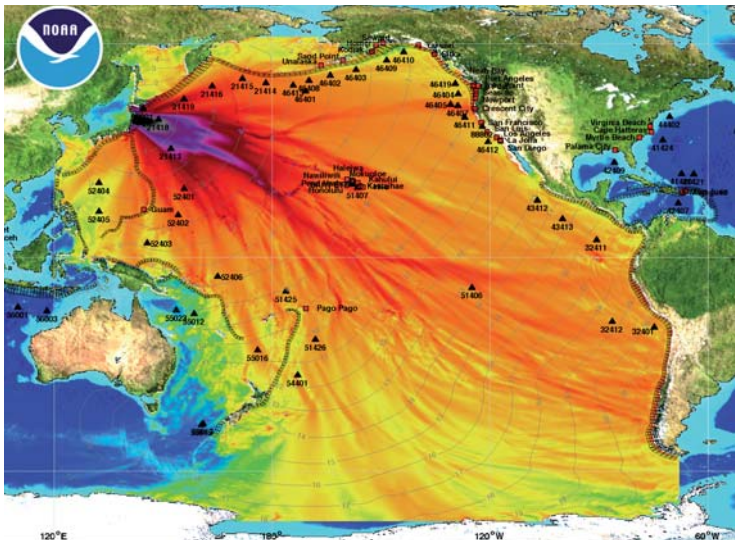
For details: s.gaines@unesco.org; a.welch@unesco.org

Six South American cities get wise to tsunamis

A 15-month UNESCO project to prepare coastal communities in Chile, Colombia, Ecuador and Peru for the eventuality of a tsunami via education and contingency planning wound up on 15 October.

Funded to the tune of US$779,000 within the Sixth Action Plan for Disaster Preparedness in South America sponsored by the European Commission Humanitarian Aid department (DIPECHO programme), the project was piloted by UNESCO's Intergovernmental Oceanographic Commission and the UNESCO Regional Bureau for Education in Latin America and the Caribbean in Santiago de Chile and implemented together with UNESCO's offices in Quito (Ecuador) and Lima (Peru).

The project targeted six cities along the South American Pacific coast which are particularly vulnerable to tsunamis: Penco, Tomé and Coronel in Chile's Bio Bio region, Tumaco in Colombia's Nariño region, Esmeraldas in Ecuador and El Callao in the Peruvian capital.



Map generated by the West Coast/Alaska Tsunami Warning Centre showing the initial estimate of the travel time, direction and wave height of the tsunami generated by the earthquake off Japan on 11 March

©UNESCO/Fernando Ulloa

Tsunami evacuation drill organized in 2010 by teachers at the Institución Educativa Heroínas Toledo, a secondary school in El Callao, Peru

Education specialists from the three UNESCO offices, the Ministries of Education and universities of the four participating countries and the Colombian Red Cross worked with primary and secondary school teachers and more than 10 000 pupils. In each country, educational materials on tsunamis were developed in line with the national curriculum and reflecting the national context. In Chile, the materials were even adapted for use in kindergartens. The schools from each participating country also seized this opportunity to test and review their school security plan via evacuation drills.

In parallel, the project ran an awareness-building campaign for parents' associations and community leaders. Key messages were conveyed via posters, pamphlets, radio spots and videos posted on the Internet and broadcast on television. In Ecuador, the campaign included door-to-door canvassing.

In order to improve contingency planning for tsunamis, specialists helped local authorities to update existing plans and improve the local tsunami early warning systems through the installation of sirens and signs indicating safe areas, hazard zones and evacuation routes. The efficacy of each contingency plan was then tested via desktop simulations and drills in the targeted communities.

One aim of the project was to establish or strengthen co-ordination mechanisms both at the national level and between countries as a step towards establishing a regional tsunami early warning system. Two regional meetings were organized in Quito in September 2009 and in Santiago de Chile in October 2010 to exchange information on the strengths and weaknesses of each country's national tsunami early warning system and explore opportunities for the regular exchange of information. UNESCO brought to the table its own diagnosis of the current situation and a set of recommendations for the regional early warning system.

For the past couple of years, the Permanent Commission of the South Pacific and its Co-ordinating Committee have been laying the foundations for a regional tsunami early warning system which would allow for the real-time exchange of seismological and oceanographic information between countries and institutions. By bringing on board the Ministries of Education, UNESCO was able to emphasize the importance of education for an "end-to-end" tsunami early warning system.

Countries bordering the Pacific Ocean are vulnerable to earthquakes and tsunamis. Most earthquakes occur in this part of the world, which is why it is

known as the Ring of Fire. The Pacific Ocean not only covers one-third of the Earth's surface but is also surrounded by a series of mountain chains, deep-ocean trenches and island arcs. On 27 February 2010, Chile was the victim of a destructive earthquake which generated a tsunami. Chile was also the theatre of the biggest earthquake ever recorded (9.5 magnitude) on 22 may 1960.

For details: a.hollander@unesco.org; b.aliaga@unesco.org ; watch a film on the project (in Spanish): www.youtube.com/user/UNESCOSantiago

Prize shows once more that **science needs women**

On 3 March, five laureates having made an exceptional contribution to either physics or chemistry were each awarded US$100,000 at UNESCO headquarters in Paris within the 13th edition of the L'Oréal–UNESCO Awards for Women in Science. The day before, 15 life scientists had each been awarded two-year fellowships worth up to US$40,000 within the same programme (*see map*).

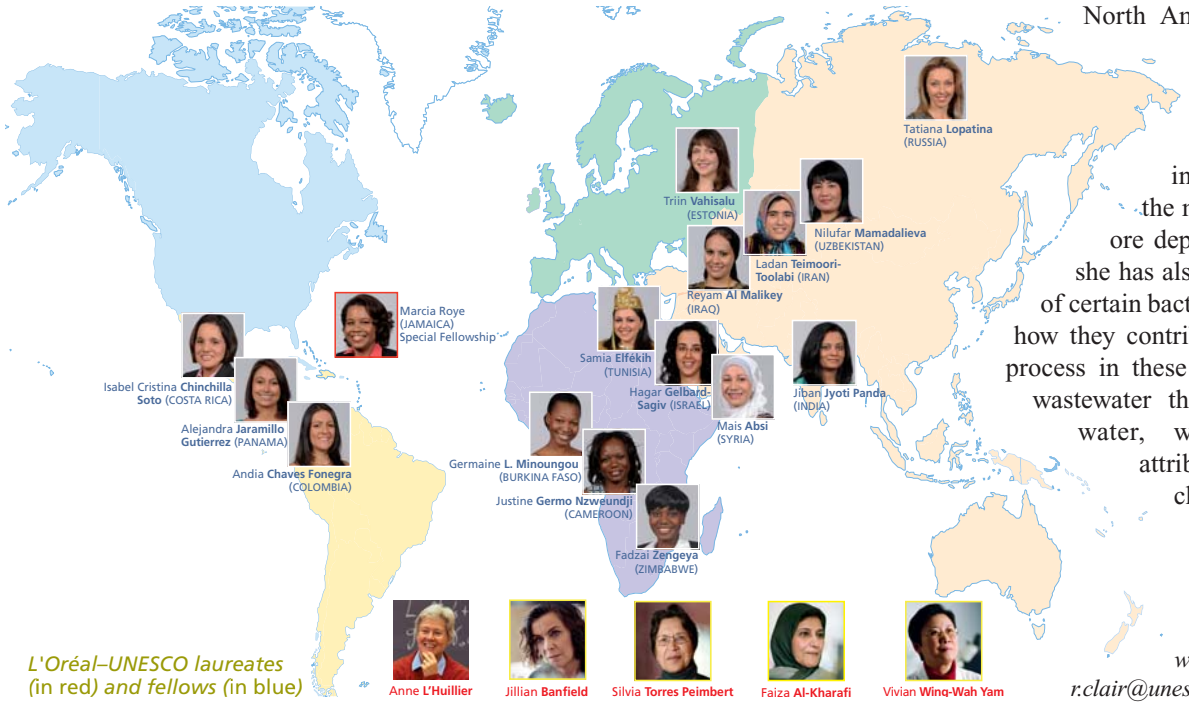
Prof. Faiza Al-Kharafi is the laureate for Africa and the Arab States. Professor of Chemistry at Kuwait University, she earns the reward for her work to inhibit corrosion, a big concern to mining, agriculture, the oil industry and water treatment. The cost of corrosion, which affects all machinery made from iron or steel when are exposed to oxygen in the air, is estimated at about 2% of world GDP. Every second, roughly 5 tonnes of steel are transformed into rust! Prof. Al-Kharafi has devoted her research to the study of two widely used metals in industry: copper and platinum.

Prof. Vivian Wing-Wah Yam is the laureate for Asia and the Pacific. Professor of Chemistry and Energy at the University of Hong Kong, China, she has been rewarded for her work on light-emitting (photoactive) materials and innovative ways of capturing solar energy. Lighting currently represents about 19% of global power. The development of materials for efficient white, organic light-emitting diodes will have a huge impact on efforts to develop a more efficient solid-state lighting system. Yet, biology is probably one of the most spectacular fields of application. By emitting light when exposed to oil or heavy metal ions, for example, these materials could be used to detect environmental hazards such as an oil spill or radioactive contamination (*on uses in health care, see photo, page 3*).

Prof. Anne L'Huillier is the laureate for Europe. Professor of Atomic Physics at Lund University in Sweden, she earns her reward for developing the fastest camera to record events in attoseconds: a billionth of a billionth of a second. This is what you need to capture the movement of an electron in an atom. Technologies based on ultra-fast laser pulses could allow us to observe the movement of electrons in atoms and molecules in real-time, enhancing our understanding of the structure of matter and its interaction with light.

Prof. Silvia Torres-Peimbert is the laureate for Latin America. Professor Emeritus at the Institute of Astronomy of Mexico City University (UNAM), she has been rewarded for her work on the chemical composition of nebulae, those regions of the universe with a high density of hydrogen and helium gas, dust and other gases. Specific nebulae called HII regions serve as birthplaces for new stars, while planetary nebulae are produced by the death of stars, which explode or run out of fuel. Her study of the Orion Nebula showed that it is chemically very similar to our own Sun.

Prof. Jillian Banfield is the laureate for North America. Professor at the University of California in the USA, she earns the reward for her work on how micro-organisms interact and survive in even the most unlikely places, like ore deposits. With her students, she has also sequenced the genome of certain bacteria and thereby revealed how they contribute to the acidification process in these mines, producing toxic wastewater that can pollute groundwater, which was previously attributed to a spontaneous chemical reaction.

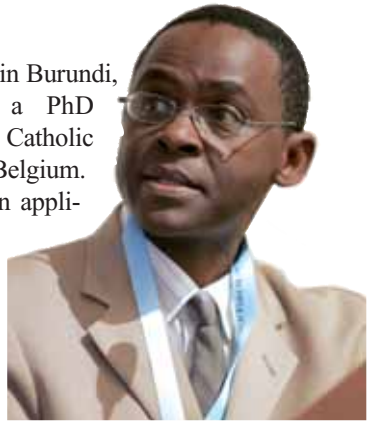


L'Oréal–UNESCO laureates (in red) and fellows (in blue)

For details: www.forwomeninscience.com; r.clair@unesco.org; j.hasler@unesco.org

Romain Murenzi to head TWAS

A key architect of Rwanda's plans for science-based sustainable development after years of civil war and genocide has been appointed Executive Director of the Academy of Sciences for the Developing World (TWAS). Romain Murenzi succeeds Mohamed Hassan, who is retiring.



Born in Rwanda and raised in Burundi, Romain Murenzi holds a PhD (1990) in physics from the Catholic University of Louvain in Belgium. His research has focused on applications of multidimensional continuous wavelet transforms to quantum mechanics and image and video processing.

After two years of post-doctoral research at the European Center for Advanced Training and Research in Scientific Computation in Toulouse (France), he worked first as a principal investigator then full investigator at the Clark Atlanta University Center for Theoretical Studies of Physical Systems in Georgia (USA).

In 2001, Rwanda's President Paul Kagame appointed Dr Murenzi Minister of Education, Science, Technology and Scientific Research then, in 2006, Minister of Science, Technology and Information and Communication Technologies. As minister, Dr Murenzi contributed to the expansion and modernization of Rwanda's education system and to building the country's scientific and technological capacity.

Over the past decade, Rwanda has overcome its war-torn past to become a model for science-based development in sub-Saharan Africa. Rwanda now spends 1.6% of its gross domestic product on science and technology, a level that is expected to rise to 3% over the next five years. Its national economy, moreover, grew at an annual rate of nearly 7% between 1998 and 2008. More than 95% of its 2.5 million school-age children are now enrolled in elementary school.

In 2009, Dr Murenzi left Rwanda for the American Association for the Advancement of Science in Washington, DC, where he was named Director of the Center for Science, Technology and Sustainable Development in 2010.

Romain Murenzi has served as Vice-president of TWAS for Africa. He is also a board member of the African Institute of Mathematical Sciences and the Dian Fossey Gorilla Fund International. He sits on the advisory board of Scientists Without Borders and on the scientific board of UNESCO's International Basic Sciences Programme.

TWAS operates under the administrative umbrella of UNESCO and receives core funding from the Italian government. The secretariat is located in Trieste (Italy) on the campus of UNESCO's Abdus Salam International Centre for Theoretical Physics. TWAS has regional offices in Brazil, China, Egypt, Kenya and India.

For details: www.twas.org

UNESCO helping Iraq to draw up science policy

UNESCO and the Iraqi government launched an initiative in December to help rebuild the country's intellectual infrastructure and begin the transition towards a knowledge-based economy via the development of a science, technology and innovation (STI) policy.

A joint effort between the Central Government, the Kurdish Regional Government and UNESCO, the scheme benefits from financial support from the Japanese government of about US$212,000.

Since the initiative was announced in December, the UNESCO Office for Iraq has been working closely with the government to set up a national task force. One of its first tasks will be to pilot a comprehensive assessment of research infrastructure across the country.

The task force will be comprised of national and international government experts, scientists, academics and entrepreneurs. They will be called upon to articulate policy priorities over a 12-month period within a consultation intended to foster a national dialogue on ways in which science, technology and innovation can spur economic growth and improve the quality of life in Iraq. The task force will examine mechanisms for encouraging technology transfer and private sector engagement, identifying the needs of researchers and innovators, channelling funding in line with regional and local priorities and so on. Once policy priorities have been identified, the programme will then draw up a comprehensive national STI policy.

Government priorities for research over the next four years have already been outlined in the Ministry of Planning's five-year plan. These fall into five broad categories: capacity-building, information technology, agriculture, environment and water resources, and renewable energy.

Once an engine of innovation in the Middle East, Iraq is sorely dependent on imported technology today, after years of isolation and conflict. There are modest signs of recovery, however. Iraqi scientists authored 55 scientific papers in 2000 but 184 in 2008, according to the *UNESCO Science Report 2010*, mostly in clinical medicine. The share of papers authored within international collaboration has also grown from 27% to 45%.

For details: www.unesco.org/en/iraq-office; c.walther@unesco.org

A science film festival for Cambodia's youth

A Science Film Festival in Phnom Penh has attracted 9 597 young viewers, more than half of them female (55%). Screened at various venues, including schools and universities, from 12 to 21 November, the 16 documentaries and 'docufictions' from Asia and Europe were selected to heighten awareness among young people of the wonders of the natural world and the threats facing biodiversity in Cambodia.

Much of Cambodia remains covered by forest and the country sports spectacular water systems such as the Mekong River and Tonle Sap Lake. Cambodia's forests are shrinking, however, and endemic species are disappearing under the pressures of recent economic and urban development.

Encouraged by the success of the first Khmer Science Film Festival in 2009, which attracted 5 500 youngsters, UNESCO decided to organize a second edition last year, in collaboration with the Ministry of Education, Youth and Sports and the Goethe Institute in Bangkok, Thailand.

The idea was to show that learning can be fun. *In Genes – What do they Look Like and What do they Say about Us?,* presenter Eric Mayer asks, 'If my parents did poorly at school, can I be a good pupil? Or do the genes of my parents hinder the way I learn?' A second film sees Lucie telling the story of how lighting and electricity were invented as she journeys into the past. Taking the viewer into a much more distant past is *Darwin (R)evolution*, as it deciphers Charles Darwin's theory on evolution by retracing *Homo sapiens*' distant origins.

Three of the films were taken from a new 26-part series called *I Got it!*, developed by broadcasters from seven Asian countries: Cambodia, Indonesia, Laos, Malaysia, the Philippines, Thailand and Vietnam. The three episodes screened during the film festival profiled silk worms, the water cycle and a Malaysian rainforest.

©Khmer Youth Social Development

Teenagers viewing a film projected in the street during the Khmer Science Film Festival

Dubbed into Khmer, the majority of films in the festival focused on ecology and the environment. In one docufiction, a young girl discovers the meaning of 'green fuel' after being sucked into the fuel tank of a car powered by sugarcane. *In Science Travellers*, explorer Stéphane Lévin takes a group of high-school pupils on a true-life adventure into the tropical wilderness of French Guiana to learn how climate change and human activities are affecting the rivers, forests and atmosphere. Meanwhile, *Eco-crimes* investigates a new source of revenue for organized crime, the highly lucrative trafficking in endangered animals, alive or dead, by international networks of poachers and criminal cartels. With the search for new and ever bigger reserves of natural resources pushing humankind to explore the vast deep-sea, another documentary asks the burning question: Who owns the Sea?

Funding permitting, UNESCO hopes to organize a third Khmer science film festival this year.

For details (in Cambodia): t.diez@unesco.org; www.goethe.de/sciencefilmfestival

ICTs for West African universities

UNESCO Director-General Irina Bokova signed an agreement on 11 February to launch a US$12 million project to boost information and communication technologies (ICTs) in West African universities.

The agreement was signed with Soumaïla Cissé, President of the Commission of the West African Economic and Monetary Union (UEMOA), which is providing the funds. The project will be implemented by UNESCO's cluster office in Bamako (Mali).

The project is part of a wide-ranging plan for co-operation initiated in 2006 by UNESCO and UEMOA. It aims to develop the use of ICTs to support an ongoing reform of higher education in the UEMOA member states: Benin, Burkina Faso, Cote d'Ivoire, Guinea Bissau, Niger, Mali, Senegal and Togo.

The three-year project will install both material and virtual ICT infrastructure. The campuses of eight universities, one in each UEMOA country, will be equipped with fibre optic equipment and at least 200 computers with a high-speed connection. In addition to a regional virtual library network to which universities will be linked, the project will set up a cyber institute giving professors online access to training courses. A central database for calculating students' course credits in all state universities will be established, in order to help harmonize academic standards and facilitate student mobility.

For details (in Bamako): j.shabani@unesco.org; www.unesco.org/new/en/unesco/themes/icts; www.uemoa.int

Moneef Zou'bi

'We were set for some dramatic events'

In recent months, a wave of pro-democracy protests has unfurled across the Arab world, toppling the autocratic regimes in Tunisia in January and Egypt in February and triggering armed conflict in the Libyan Arab Jamahiriya. In March, the movement incited Morocco, Oman and Yemen to announce constitutional reforms. Led by the region's youth, the calls across the region for better governance have also resonated in the scientific and academic communities.

If the timing and rapidity of regime change in Tunisia and Egypt took observers by surprise, Moneef Zou'bi believes conditions were ripe for 'dramatic events' to happen. Director-general of the Islamic World Academy of Sciences, he co-authored with former Jordanian prime minister Adnan Badran the chapter in the *UNESCO Science Report 2010* on the Arab States. In the report, the two scientists identified poor governance and high unemployment as being key threats to stability and development in a region where more than 30% of the population is under 15 years of age. Here, Dr Zou'bi discusses the implications of the pro-democracy movement for science in the region.

Are you surprised by the turn of events since December?

Knowing the Arab world as well as I do, I did think that we were set for some dramatic events, especially in the Arab countries of North Africa where, although the economies had been doing reasonably well, unemployment among youth was rampant and governance indicators reflected how bad things were. The actual picture turned out to be even worse and the level of frustration among youth was certainly higher than what we were led to believe.

How have Arab scientists reacted to the pro-democracy protests?

Scientists in the Arab world cannot *but* be pro-democracy and in favour of better governance and accountability. They feel it is a prerequisite for better, more equitable societies. This is why I think Arab scientists are in favour of reform at all levels.

The Arab scientific community is generally supportive of change. We have seen evidence of this in Egypt and Tunisia. For example, the new Egyptian prime minister Essam Sharaf, who was sworn in on 3 March, is a renowned Egyptian engineer who was the preferred choice for the post by the youth movement occupying Liberation (Tahrir) Square in Cairo.

Would you say that autocratic regimes had stifled science and innovation?

The majority of governments in the Arab world do not view science, technology and innovation (STI) as being an important means of achieving socio-economic development. Just 7 out of 22 Arab countries have a national academy of sciences or play host to a supranational academy, despite the role these institutions play as impartial advisory bodies.

Most Arab countries still have no national policies or strategies for science and technology. In others, this is a recent development: Jordan adopted its first policy in 1995 and Saudi Arabia as recently as 2003. All Arab countries nevertheless have sectoral policies, such as those for the priority areas of agriculture, water resources, energy and the environment.

Qatar plans to lift gross domestic expenditure on R&D (GERD) from 0.33% of GDP in 2006 to 2.8% by 2011, as we stated in the *UNESCO Science Report 2010*. Egypt itself had announced plans to raise its own ratio from 0.23% in 2007 to 1% of GDP by 2012. However, such targets will be difficult to achieve in the light of recent events.

If you go by the statistics, science was doing pretty well in Tunisia. It topped the region for spending on research and development (R&D) as a percentage of GDP in 2007 (1.02%), according to the report, a level of commitment that had risen from 0.46% in 2000. Tunisia was second only to Kuwait in the Arab world for publications per million population. However, the research environment was not conducive to innovation. Tunisian physicist Faouzia Charfi[8] is quoted in the 25 January edition of *Nature* as saying that 'universities and researchers had little freedom to develop their own strategies, or even to choose who they worked with' under former president Zine el-Abidine Ben Ali. The article reports scientists as saying that regime bureaucrats thwarted any attempts to build independent links with industry.

How had the rule of law and accountability evolved in recent years?

The problem is that they had not. In many Middle Eastern countries, there has not really been any improvement in governance indicators. The rule of law actually receded between 1998 and 2007 in Iraq, Lebanon, Morocco, Saudi Arabia, Syria and in the West Bank and Gaza, according to a 2008 study by Kaufmann *et al* cited in the *UNESCO Science Report 2010*.

In 2007, the top five countries for voice and accountability were Lebanon, Kuwait, Morocco, Qatar and Jordan, according to the same study. However, even for these countries, the scores were low by international standards. A further four countries had shown a marked improvement since 1998: Bahrain, Algeria, Djibouti and Iraq. Overall, 12 out of 18 Arab countries and territories registered a decline in voice and accountability between 1998 and 2007, including four of the top five countries for this indicator: Egypt, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Syria, Tunisia, United Arab Emirates, the West Bank and Gaza and Yemen.

What made you say in the report that 'governance in the majority of Arab countries is in a state of turmoil'?

It was very clear to me that Arab countries were suffering in terms of governance. Regimes were not really delivering. Moreover, those that were delivering were doing so in a haphazard way that did not have a positive impact on people at the grassroots level. Politically, there has not been a significant change in direction in the majority of Arab States for over 30 years. Generations of gifted decision-makers have not been given the chance to serve their countries. Talented people and brilliant scientists have had to carve out opportunities for themselves abroad.

Of course, regional conflicts played a role in regimes opting for governance continuity rather than governance ingenuity – but then events took everybody by surprise.

What do you mean by governance continuity?

This is how we put it in the *UNESCO Science Report 2010*: 'Arab regimes are torn between upholding national security – as they perceive it – and maintaining social order on the one hand, and generally adopting good governance practices, on the other; these practices include promoting democracy and the rule of law, promulgating accountability and combating corruption.'

'A key impediment to the region's economic development has been the lingering political conflicts in Iraq, Lebanon, the Palestinian Autonomous Territories and Sudan... Acts of terrorism in Algeria, Egypt, Jordan and Saudi Arabia have exacerbated the situation, causing many Arab countries to divert resources towards security, military and defence budgets at the expense of resources earmarked for development.'

According to the US Central Intelligence Agency, the world's top seven military spenders per capita all come from the Middle East: Iraq, Israel, Jordan, Oman, Qatar, Saudi Arabia and Yemen. Much of military expenditure in Arab countries goes on the purchase of expensive armaments from industrialized countries.

Are you optimistic about the chances for democracy in the region?

There are some signs of hope for democracy in the Middle East. Not necessarily Western-style multiparty democracy, as political parties in the region are weak and do not have workable agendas. However, until regional conflicts are resolved and the prominence of the region is appreciated for reasons other than its oil, democracy will not blossom in the Middle East.

How do you see the outlook for science in the region?

In the short term, science, technology and higher education will suffer, as Arab countries turn inwards to try to re-establish some sort of order. In the long term, however, we shall witness positive changes at all levels in the majority of Arab states.

What advice would you give to governments wishing to reform science governance?

We summed up our recommendations in the *UNESCO Science Report 2010* by saying that 'the stability and security of Arab countries cannot simply be a function of military expenditure and expenditure devoted to upholding law and order. Long-term security and prosperity for all countries in the region can only be achieved by assuring the triple helix of food, water and energy security, combined with sustainable and equitable socio-economic development in tolerant societies where accountability and rule of law prevail. Science and technology can achieve some of these goals, if not all.'

Equally important is for governments to use science to create national wealth and jobs for the masses of young people who are graduating from universities every year – estimated at about 100 million over the next decade. Currently, the bulk of research in the Arab world is carried out within the higher education system. Even in Egypt, universities conduct 65% of all research. Jordan has recently introduced two laws that could help to foster value-added industries and thus provide career opportunities for skilled graduates. The first law in 2005 transferred 1% of the net profit of public shareholding companies to a special R&D fund to finance research. The second compels public and private universities to allocate 5% of their budgets annually to R&D.

Countries share many common challenges, making it logical for governments to pool their resources. Over the past decade, two major research centres have been set up, the International Centre for Biosaline Agriculture in 1999, hosted by the United Arab Emirates, and the Regional Centre for Renewable Energy and Energy Efficiency in 2008, hosted by Egypt.

Governments need to consolidate these and other laudable initiatives to develop pan-Arab co-operation in priority fields for the region, including water, energy, health, agriculture, energy and biodiversity conservation. All five of these priorities figure in the draft Arab Science and Technology Plan of Action.

Could the unrest jeopardize the plan's adoption at the Arab summit in late March?

It certainly will, as the various events and meetings coming up of the Arab League, including the Arab summit, have now been postponed. Most Arab countries – whether or not they have witnessed regime change – will need some time to take stock of the dramatic events that have unfolded since the start of the year and institute reforms at all levels, including in STI, both at the national and regional levels.

Interview by Susan Schneegans[9]

8. *Faouzia Charfi was briefly Secretary of State for Higher Education in the transition government until she resigned on 1 March 'for personal reasons'. See: www.nature.com/news/2011/110125/full/469453a.html*
9. *Editor of* UNESCO Science Report 2010: *www.unesco.org/science*

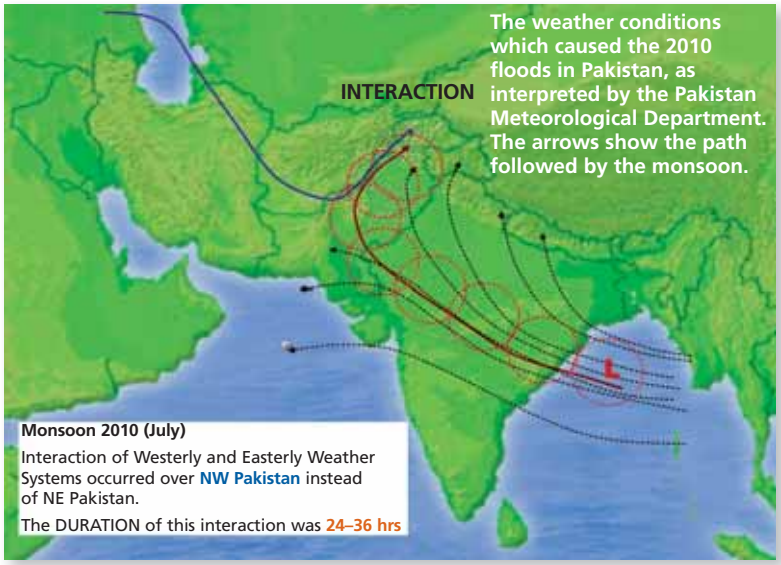
Coping with extremes in Pakistan

Eight months ago, the heaviest monsoon rains in 80 years battered Pakistan. Twenty million people were affected and nearly one million homes destroyed, together with four million hectares of crops. The floods obliterated livelihoods and washed away major infrastructure. Today, scientists are still analysing the weather conditions which caused the flooding, as we shall see below.

Homes surrounded by floodwaters on 11 August 2010

Although this flood was particularly devastating, events like this are becoming more frequent in Pakistan. Moreover, they tend to be coupled with simultaneous drought elsewhere in the country, exacerbating suffering. Since UNESCO's first expert mission travelled to Pakistan in August last year, the Organization has been helping Pakistan to develop an integrated strategy for flood and drought management, together with an overhaul of the country's water policy.

In Pakistan, floods are a normal consequence of the monsoon season from May to August. The Inter Tropical Convergence Zone brings moist air from the Bay of Bengal and the Arabian Sea into the sub-continent via the foothills of the Himalayas, where it reaches the rivers' catchment areas, causing normal monsoon rainfall. Easterly winds deflect the monsoon rains away from Pakistan, reducing the severity of flooding. Westerly winds, on the other hand, deflect the monsoon from the Bay of Bengal towards the north, causing sustained rainfall over the Himalayas like that responsible for last year's flooding in the Indus Basin.



Why last year's flooding was catastrophic is the subject of conflicting theories in the scientific community. Atmospheric scientist Olivia Romppainen Martius from the Institute for Atmospheric and Climate at the Swiss Federal Institute of Technology Zurich sees it as being a combination of the extraordinary high over Russia in mid-2010, coupled with an unusually strong monsoon. The missing link is the Northern Hemisphere jet stream, high-altitude winds which circle the globe from west to east in a meandering pattern known as the Rossby waves, transporting highs and lows.

The heat wave in western Russia in July and August 2010 fanned more than 300 forest fires that burned for weeks, blanketing the city of Moscow in a pall of smoke. Temperatures soared to 39°C in the Russian capital, setting a new record. According to *New Scientist*, the heat wave was the result of freak weather conditions. Instead of moving with the winds, the Rossby waves started moving against them in July and August 2010, thereby blocking the jet stream. The heat wave then fed itself, with the hot air rising into the atmosphere until it had gradually climbed to the top of the immobilized jet stream.

In an unfortunate coincidence, a second anomaly occurred. The stalled jet stream allowed an enormous amount of moisture to be dumped on northern India and Pakistan in 2010.

The question is: were the simultaneous heat wave in Russia and abnormal monsoon in Pakistan random phenomena or did other factors come into play? For instance, the authors of a 2008 study

Could la Niña be to blame?

We know that an abnormally strong monsoon was largely responsible for the flooding in Pakistan last year. This exceptional monsoon may itself be due in part to the presence of a La Niña phase. Could La Niña also be responsible for the recent megafloods in Australia, Sri Lanka, Brazil and Europe?

The La Niña phase is part of the El Niño Southern Oscillation, a massive cyclical pattern occurring once every 2–7 years which causes anomalies in air pressure and sea surface temperature which in turn feed into weather systems that cause floods and droughts. The El Niño Southern Oscillation consists of two phases: El Niño and La Niña. The El Niño phase is characterized by a slowing down of atmospheric and oceanic circulation patterns in the equatorial Pacific, causing higher sea surface temperatures in the eastern Pacific Ocean. Its counterpart, the La Niña phase, produces the opposite effect: an acceleration in circulation patterns and a drop in sea surface temperatures in the eastern Pacific.

Pakistan

In July last year, NASA recorded sea surface temperatures across the eastern Pacific Ocean that were much lower than usual and temperatures in the western Pacific Ocean that were warmer than usual: typical of La Niña. These conditions are associated with a stronger monsoon, as the presence of warmer, humid, buoyant air over the oceans may form more intense storms. La Niña was thus a factor in the abnormally strong monsoon which caused the Pakistani floods, according to NASA.

Australia

Similarly, it is thought that La Niña was largely responsible for flooding in the State of Queensland in January this year which submerged an area the size of France and Germany combined, a phenomenon compounded by the high ocean temperatures in the northeast Indian Ocean. La Niña caused the cold water in the eastern Pacific to reach towards the western Pacific, trapping high pressure along the coast of Australia. This high pressure then contributed to storm systems which were propagated westward by the strong east-to-west trade winds of La Niña.

Sri Lanka

These same east-to-west trade winds of La Niña intensified the monsoon in Sri Lanka. According to the NGO Oxfam, the flooding in Sri Lanka last January may have affected over 1 million people.

Brazil

Severe rainfall in January this year caused more than 500 deaths in Rio de Janeiro that were mainly associated with floods and mudslides. It is still unclear whether the effects of La Niña alone magnified the storm systems that led to the flooding in Rio de Janeiro, or whether La Niña was coupled with another long-term variation in the Earth's climate, the North Atlantic Oscillation (NAO, *see below*).

'Human settlements in the hilly part of Rio worsened the impact of the intense rainfall,' explains Zelmira May from UNESCO's Regional Bureau for Science in Latin America and the Caribbean. 'President Dilma Roussef referred to uncontrolled and accelerated growth of the city as being one of the main causes of the disaster, as it led to people settling in the most vulnerable parts of the city.'

Europe

The heavy rain that caused flash floods in the Czech Republic, Germany and Poland in the summer of 2010 has been linked by the US National Oceanic and Atmospheric Administration to the presence of a low NAO. This is a measure of the difference in pressure between the permanent high and low pressure systems over the Azores archipelago and Iceland in the Atlantic Ocean. A high NAO represents a large difference in pressure and is characterized by above-average rainfall over northern Europe and below-average rainfall over southern and central Europe. The low difference in pressure (a low NAO) in the summer of 2010 would herald greater than average rainfall over central Europe.

Amritaa Ganguly*

For details of UNESCO's work in Brazil: phi@unesco.org.uy; and, in Sri Lanka: b.neupane@unesco.org

**Mathematician from the Massachusetts Institute of Technology currently in UNESCO's Division of Water Sciences*

published in *Geophysical Research Letters* found that the jet streams in both the Northern and Southern Hemispheres had moved closer to the poles between 1979 and 2001 at an average rate of about 2 km per year. This phenomenon could affect major climate systems. The authors felt more research was required before this could be attributed to climate change.

The German Weather Service has concluded that the devastating flood in Pakistan was the result of a climate anomaly over the southern Pacific. It argues that the exceptionally strong monsoon in July was the handiwork of La Niña (*see box*). As they travel across the edge of the Himalayas, monsoon rains typically lose strength. In July 2010, strong winds enabled the rain to penetrate farther than usual into northwest Pakistan.

Water both abundant and in short supply

A capricious weather system was not the only factor responsible for the catastrophic flooding in 2010. Pakistan has a highly variable climate ranging from arid to humid with periodic surpluses brought on by the monsoon season.

Agriculture consumes up to 98% of freshwater. The Indus Basin Irrigation System in Pakistan is the largest in the world. With an average surface water supply of 123 000 cubic hectometres (hm^3) per year, it irrigates 13.5 million hectares, 9 million of which are irrigated all year round through an engineered system with a capacity of 7000 m^3 of water per second. Approximately 150 000 tube wells pump 24 500 hm^3 per year of groundwater to supplement crop needs.

Faced with rapid population growth, urbanization and climate change, Pakistan has become one of the most water-stressed countries in the world. The overall water availability has decreased from 1 299 m^3 per capita in 1996–1997 to 1 101 m^3 per capita in 2004–2005. Should this index drop to 1000 m^3 or less, Pakistan would become a country of water scarcity according to a common definition.

Surface water in the form of rivers, lakes or rainfall is inadequate to meet the requirements of irrigation. This shortfall is being compensated by the exploitation of groundwater and the use of storage dams constructed in the 1960s and 1970s. However, the live storage capacity of major dams in Pakistan has been decreasing due to sedimentation. For example, the capacity of the Mangla Dam (6.5 billion m^3) shrank by around 20% from 1967 to 2000 and the capacity of the Tarbela Dam (11.5 billion m^3) by over 40% between 1975 and 2000.

These problems are serious but not insurmountable. A more efficient use of water, fertilizer and other inputs could reduce overuse of water, mitigate the negative impact on the environment, lower production costs and balance irrigation with environmentally friendly water conservation technologies; raised bed technology and bed-furrow planting, for instance, have been shown to cut water use by 40–50% and increase yield by 10–25% compared to flood irrigation. One obstacle is the serious erosion of the

knowledge base in Pakistan of the complex water system in the Indus Basin, not to mention poor governance and a climate of mistrust and conflict stretching from the provincial authorities to the water course.

Pakistan is also feeling the impact of climate change, especially as concerns the magnitude and frequency of floods. Scientists generally agree that droughts and floods will become more common. There has been an increase in rainfall in the hot, dry parts of the country and a decrease in the cold, mountainous regions and coastal areas. As a result, average water flow has diminished in the Indus and Kabul Rivers, while a mixed trend has been observed in the Jhelum and Chenab Rivers. Recent flooding in the Kabul and Indus Rivers shows anomalies in the average flow pattern. Numerous scientific methods have been developed to tackle this challenge.

Accompanying Pakistan

In accompanying Pakistan in the reform of its water sector, UNESCO has dispatched numerous expert missions from headquarters, field offices and affiliated water centres with the support of UNESCO's Islamabad office. Participating in the reform process in Pakistan are, *inter alia*, the Ministry of Water and Agriculture, Ministry of the Environment, Federal Flood Commission, National Disaster Management Authority, Pakistan Meteorological Department and the Indus River System Authority. Likewise, there has been effective co-operation with United Nations agencies that include WMO, UNDP and UNESCAP. UNESCO's work is being piloted by the Assistant Director-General for Natural Sciences.

Flooding becoming more frequent

Flooding is definitely becoming more frequent in Pakistan. Since the 1970s, six catastrophic floods have swept across the country. Each time, they caused widespread human suffering, loss of life and colossal damage to private and public infrastructure. The 1992 flood, for instance, resulted in the loss of more than 1000 lives. About 13 000 villages grouping more than one million homes were destroyed when the floodgates were opened to release water from behind a storage reservoir (Mangla Dam). Over 2 million hectares of agricultural land were inundated, resulting in the loss of about 15% of both the country's cotton and rice crops and 10% of the sugarcane crop. The nation-wide damage was estimated at about US$2.2 billion.

The frequent recurrence of drought and flooding causes saline soils and water-logging, overexploitation and groundwater depletion. Tensions also build up over the water allocation between upstream and downstream users.

A mission for the Water Sector Task Force

UNESCO has formulated several projects responding to Pakistan's priorities that are currently awaiting donor approval. Moreover, it has become a key member of the Friends of Democratic Pakistan Water Sector Task Force set up in March last year, which is co-ordinated by the Asian Development Bank.

The key deliverable of the Water Sector Task Force will be a report proposing a comprehensive strategy for achieving water security by reconciling competing demands for water. The strategy will include an action and investment plan, and will be prepared in consultation with the Government of Pakistan.

Due for completion in December this year, the report will provide guidance on how to develop and manage the water sector based on the principles of resource sustainability, financial and economic efficiency and environmental improvement. It will also identify requisite policy and institutional reforms for the sector. Among the aspects covered by the strategy will be water service delivery, including aspects of surface and groundwater resource management, water storage, irrigation and drainage, domestic and industrial water use, wastewater management, hydropower generation, environmental issues like water-logging and salinity, wetlands management and climate change adaptation and mitigation.

An army helicopter provides emergency relief and rescue in the flood-hit areas of Nowshero Feroze

A potentially deadly duo: glacier lakes and landslides in northern Pakistan

In July and August last year, heavy rains fell across northern Pakistan before coalescing and running downstream, eventually overflowing the braided banks of the mighty Indus River and submerging the croplands and towns of one-fifth of Pakistan's territory. It is across this dynamic landscape that UNESCO proposes to focus the work of an interdisciplinary team of geologists, glaciologists, hydrologists and planners from national and international government agencies and universities to improve understanding of the interrelated natural processes at work and their impact downstream, in order to improve the country's preparedness for potential natural disasters.

The northern mountainous region of Pakistan is composed of the Gilgit Baltistan, Khyber Pakhtunkhwa and Pakistan-Administered Kashmir. A region of extreme beauty and heightened geological activity, it is home to part of the Himalayan–Karakorum–Hindukush mountain range, one of the tallest and most rapidly growing mountain ranges in the world. It was here that the devastating earthquake of 2005 struck.

The glaciers in this region are enormous reservoirs of freshwater which feed into Pakistan's rivers. Glacier-dammed lakes and devastating outburst floods have been common in the Karakoram Mountains over the past two centuries and have reshaped the landscape. Today, the increasing volumes of water in these lakes on account of the accelerated retreat of glaciers is one of the worst hazards related to climate change in Pakistan.

The region is traversed by the mythic Karakoram Highway, described by some as 'the Eighth Wonder of the Modern World', which follows one route of the historical Silk Road. The highway is subject to landslides, while at the same time triggering many landslides itself by undercutting the surrounding slopes.

The reason the region is vulnerable to landslide and river erosion lies in the great differences in elevation, the steep unvegetated slopes and fragile geological conditions, further destabilized by the 2005 earthquake. A major part of the snow and ice mass of the Himalaya–Karakoram–Hindukush region in Pakistan is concentrated in the watersheds of the Indus basin. As global temperatures continue to rise this century, so too should the mean temperature in Pakistan. At present, understanding of the mountainous headwater of the Indus River and especially of the prevailing snow and ice conditions is simply inadequate in Pakistan.

Although glaciers, mountains, lakes and rivers have traditionally been studied independently, the hazards associated with these landscape features and their processes tend to be monitored and studied around the world using the same set of tools, scientific perspectives and response planning. For this reason, disaster risk reduction in Pakistan should include studies of the northern region in an integrated approach blending analysis and capacity-building. UNESCO specialists have been working with experts in Pakistan since August 2010 to develop integrated proposals for interagency monitoring of this changing landscape.

Sarah Gaines* and Anil Mishra**

*Programme Specialist in Earth Sciences: s.gaines@unesco.org
** Programme Specialist in Hydrology: a.mishra@unesco.org

Landslides on the Karakoram Highway frequently block the road for hours or even days, as here in July 2001.

Dealing with uncertainty

UNESCO is leading the flood management component of the strategy. Its contribution to the report will include recommendations for better flood management in Pakistan, along with a specific investment plan. Again, it will be working in partnership with the Government of Pakistan.

The strategy UNESCO has been developing since September will not only help the country manage flooding but also measure the potential impact of land-use, population growth, climate change and other factors on water resources. The strategy covers four key areas:

- flood hazard forecasting and management;
- mapping and assessment of geohazards such as glacier melt and landslides (*see box*);
- mapping, development and protection of groundwater resources for safe use in emergency situations; and
- education.

The contours of the education component of this strategy were designed by a UNESCO workshop in Islamabad on 24–26 January for Pakistani and international experts on Education for Managing Hydrological Extremes and Related Geohazards. The workshop drew up an action plan which makes provisions for training politicians, policy-makers and high-level managers to deal with uncertainty.

The capacity of Pakistan's universities and specialized institutes to provide quality education and research will also be assessed and their curricula updated. Mid-level water managers and technicians will also receive training. In addition, modules on managing geohazards will be introduced into school curricula and programmes will be designed to raise awareness in the wider community.

Flood management may deal with uncertainty but there is at least one thing of which we can be certain. Next time disaster strikes, Pakistan will be better prepared.

Shahbaz Khan[10], Siegfried Demuth[11] and Toshihiro Sonoda[12]

10. *Senior Programme Specialist in Hydrology: s.kahn@unesco.org*
11. *Senior Programme Specialist in Hydrology : s.demuth@unesco.org*
12. *Programme Specialist in Hydrology: t.sonoda@unesco.org*

Rising to the challenge of rising waters

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Family in the flooded back garden

With a population exceeding 12 million, Jakarta is considered one of the world's most problematic megacities. Situated in a coastal lowland area crossed by 13 rivers and numerous streams, Indonesia's capital is frequently the theatre of flooding, especially during the rainy season from October to March. The floods of February 2002 were the worst in the city's history, killing at least 30 people and forcing 300 000 to flee their homes. Although high annual rainfall is to be expected at these latitudes, the severity and frequency of flooding is being amplified by rapid urbanization of the water catchment area and the use of the rivers for waste disposal.

Between July 2003 and October 2007, UNESCO's Regional Bureau for Science in Asia and the Pacific implemented a Community-based Flood Mitigation Project in one of Jakarta's most affected communities. The project was designed for areas where residents are legal occupants who either own or rent their homes and thus cannot be relocated. The pilot project involved a range of partners, including the government, the Foundation for Research and Industrial Affiliation of the Institute of Technology of Bandung and the Indonesian Red Cross. Taking a participatory approach, it combined education and training with low-cost mitigation measures.

In February 2002, floods swamped 24% of the greater Jakarta area, equivalent to about 650 km^2, paralyzing the city for days. One of the most severely affected areas was the sub-district of Kelurahan Bidara Cina in East Jakarta, with a population of approximately 44 000. Kelurahan Bidara Cina is divided into 16 neighbourhood units known as Rukun Warga.

Since the establishment of the community forum, I feel that we are more unified in helping the victims of floods. Before, had no practical experience in helping flood victims but now [thanks to] search and rescue training, I know how to do it.

Sofyan, a resident of Rukun Warga 6

On the recommendation of the mayor of East Jakarta, Rukun Warga 6 was chosen as the pilot site for the project. Located along the Ciliwung River, this neighbourhood of 3000 residents living in 757 households is flooded once or twice a year. Each time, residents are forced to evacuate to safe places in nearby office buildings, the Public Health Centre or to a street on higher ground. During evacuation, the Indonesian Red Cross and various governmental and non-governmental organizations offer free medical treatment and help the community to establish a public kitchen and shelters. In February 2002, the average height of flood waters ranged from 1.5 m to as much as 3 m!

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A resident tries to save his television from the floodwaters.

The community is the star player

Dealing with floods is like putting together the pieces of a puzzle. You need to analyse a range of environmental and socio-economic factors to understand the causes of flooding and thus to involve a wide range of collaborators. The first step in any disaster reduction programme should normally be to identify the specific problems a community faces and its perception of how these problems should be solved. This approach avoids top-down solutions being proposed by authorities, institutions or organizations external to the community that may not reflect local needs.

The Community-based Flood Mitigation Project was thus designed and developed on the basis of three simple but fundamental principles: community participation; non-structural mitigation measures and; a bottom-up approach. The spontaneous participation of the community in all phases of the project was important to ensure that mitigation measures proved effective.

What is flood mitigation?

Floods cause loss of life and property but victims are more likely to die from water-borne diseases than drowning, except in the case of flash floods and surges.

Flood mitigation consists of preventive measures to soften or eliminate the impact of flooding on both the community and the environment. Structural measures may take the form of attempts to raise street and floor levels or the construction of canals, dykes and sluices. Non-structural measures include the development of early warning systems and activities to increase community preparedness for floods. As knowledge, skills and local solidarity are key ingredients in non-structural flood mitigation, non-structural measures embrace public education and training courses for the community.

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Residents sometimes refuse to leave their homes then become trapped. A rescue team helps them evacuate.

In the project's first phase from July 2003 to January 2004, UNESCO and its partners assessed the community's vulnerability and its capacity to mitigate the impact of flooding. It was important for the community to participate in this assessment, not only to identify priority actions and target groups but also to increase the visibility and legitimacy of the measures proposed.

Learning more about floods

As the project was also designed to change residents' behaviour and thereby reduce their vulnerability to flooding, training courses were run for community representatives, who turned out to be willing students.

The courses covered such topics as community-based first aid, integrated waste management, flood mitigation, the institutional framework and strengthening the community's capacity to act. At the end of the first phase, a community forum was established. It consisted of 20 volunteers who participated in both the community assessment and the training courses. The forum's first responsibility was to propose activities to reduce the community's vulnerability.

The training was divided into two modules. During the first module, residents of Rukun Warga 6 were introduced to flood mitigation. Training focused on the following subjects: causes and consequences of floods, basic hydrological concepts and processes, interaction between water and urban waste, flood disaster and risk assessment, and institutional frameworks for flood management.

The second module lasted from May to August 2004, which corresponded to the project's implementation phase. This module gave participants the opportunity to

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take part in more practical activities, among them training in public awareness-building, waste management, leadership, search and rescue, fire drills, community-based first aid and post-flood management of epidemic diseases. One technique they learned was how to douse a fire by using wet sacks and simple fire extinguishers.

The implementation phase also included physical efforts to improve flood preparedness, such as the provision of clean water, the procurement of communications equipment such as walkie-talkies and megaphones, the rehabilitation of a storage site for this equipment and the rehabilitation of the local drainage system.

Waste not, want not

To complement the training courses, a waste collection system was established to promote recycling and composting. Here again, the project took a bottom-up approach. The community was responsible for developing proposals for waste management and for suggesting which techniques might allow the community to prepare better for floods. The community forum was also responsible for monitoring implementation and follow-up of measures to improve flood mitigation.

I used to dump waste into the river, even though I realized it was wrong. I don't have to do it anymore, since I only have to wait for the waste collectors to come and take it.

Juki, a resident of Rukun Warga 6

Most inhabitants of Rukun Warga 6 use Ciliwung River for waste disposal, despite the availability of a waste collection system based on handcarts. One reason is that many residents are reluctant to pay for their waste to be collected. The project set about this indifference tackling to the quality of their environment.

Help was on hand from an unexpected quarter. Having just undergone training themselves in waste management, the Banjarsari community in South Jakarta offered to provide the training in Rukun Warga 6, in close collaboration with UNESCO's Coastal Regions and Small Islands Unit.

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Waste dumped near the river

The project got under way in May 2004 with the distribution of 22 communal waste bins and 205 household bins to residents to encourage them to dump their waste in appropriate places. Once a day, three people came round to homes with a cart to collect the waste. Most residents got in the habit of using the bins and, after just two weeks, there was already a visible improvement in the condition of the river and riverbank.

To reduce waste and create jobs, a facilitator from Banjarsari taught the younger members of the community how to recycle paper and create photo-frames, small boxes and other merchandise out of secondhand materials, which they were then able to sell. At a later stage, it is planned to teach households how to create compost out of organic waste.

The closure of access to the Ciliwung River was also decided, in order to discourage residents from using the river for waste disposal. Two out of four accesses have already been closed thanks to the construction of new fences.

Still going strong

Seven years on, the community forum in Rukun Warga 6 is still going strong. The forum is in charge of pre- and post-disaster assistance and of co-ordination both with government authorities and within the community itself. It is also responsible for ensuring the perennity of the programme by maintaining existing activities and developing new ones.

The pilot project in Rukun Warga 6 was intended as a first step in establishing a permanent programme of flood mitigation involving other neighbourhoods in Jakarta. Each phase of the project was designed to be easily replicable on a larger scale, with the ultimate goal of improving flood control throughout the entire city. As of early 2011, the city of Jakarta had not yet taken steps to upscale the project to ensure wider outreach.

Giuseppe Arduino[13]

For details: g.arduino@unesco.org; www.unesco.org/jakarta

13. Programme Specialist in Hydrology and Earth Sciences in UNESCO's Regional Bureau for Science in Asia and the Pacific, based in Jakarta

International Year of CHEMISTRY 2011

Diary

28–31 March

Ocean climate and marine ecosystems in Western Pacific
8th UNESCO-IOC/WESTPAC intl scientific symposium to encourage interdisciplinary approach. Busan (Rep. Korea): *www.westpac.unescobkk.org*

29–31 March

Microscience experiments
Training run by UNESCO and Ethiopian Min. of Education, for curriculum developers, teacher trainers, etc. Addis Ababa: *a.makarigakis@unesco.org*

6–8 April

Energy management in cultural heritage
Intl conf. co-sponsored by UNESCO Venice and UNDP Croatia. Dubrovnik (Croatia): *www.unesco.org/en/venice; m.scalet@unesco.org*

12–15 April

STI policy review for Central Africa
Subregional workshop for the 10 countries of Economic Community of Central Africa plus Rwanda. UNESCO: Division for Science Policy, Institute for Statistics, Libreville office (Gabon): *m.bachiri@unesco.org, m.schaaper@uis.unesco.org, s.nair-bedouelle@unesco.org*

19 April

Natural risk preparedness for cultural heritage sites in Albania
Launch of project by One UN Albania and UNESCO Venice within Hyogo Framework for Action (2005-2015) to build capacity, for local managers and experts in seismology and cultural heritage. Tirana (Albania): *z.harasani@unesco.org; d.poletto@unesco.org*

24–28 April

Cash crop halophytes and biodiversity
UNESCO and EAD expert meeting. Abu Dhabi (UAE): *b.boer@unesco.org*

25–27 April

Promoting use of environmental education kits
1st subregional meeting to build capacity of government, local communities and schools. UNESCO Cairo and UAE NatCom. Dubai (UAE): *m.alaawah@unesco.org*

3–5 May

Best practices for adoption and implementation of renewable energy policies
Sessions organized by UNESCO Cairo within Middle East and North Africa Solar Conf. and Expo (MENASOL2011). Includes expert roundtable to draft Arab plan of action in renewable energy. UN ESCWA, CSP Today, Moroccan Ministry of Energy, Moroccan NatCom. Mazagan Hotel, El Gadida (Morocco): *n.hassan@unesco.org*

10 May

ICTP Ramanujan Prize
Prize for young mathematicians from developing countries to be awarded to Yuguang Shi from Beijing University. ICTP, Trieste (Italy): *ramadas@ictp.it*

16–20 May

Forum of World Summit on Information Society
ITU, UNESCO, UNCTAD and UNDP conveners. Includes UNESCO sessions on e-science and open access to scientific knowledge in Africa (19 May). Geneva (Switzerland): *m.yamanaka@unesco.org;* e-science: *s.nair-bedouelle@unesco.org*

20–25 May

Innovative technologies for more integrated water management
FRIEND Nile training workshop run by UNESCO Cairo on hydrological modeling, erosion and sediment transport modelling, eco-hydrology. Cairo (Egypt): *aa.zaki@unesco.org*

10–16 June

Ocean models
Training course run by UNESCO-IOC Regional Training and Research Center. Qingdao (China): *www.westpac.unescocobkk.org*

15–16 June

Towards a knowledge-based economy from the Gulf Sea to the Atlantic Ocean
Expert meeting for induction of an Arab STI Plan of Action for Sustainable Development. UNESCO Cairo and League of Arab States. Cairo (Egypt): *n.hassan@unesco.org; m.alaawah@unesco.org*

22 June

Sustainable socio-ecological systems
UNESCO conf. chaired by Elinor Ostrom (USA), first woman to receive Nobel Prize for Economics (2009), for her analysis of economic governance. UNESCO Paris: *m.bouamrane@unesco.org*

27–28 June

For life, for the future: biosphere reserves and climate change
Intl conf. of UNESCO-MAB, German govt, German NatCom. Will produce Dresden Declaration for submission to General Conference in late 2011. Dresden (Germany): *m.clusener-godt@unesco.org*

28 June – 1 July

MAB Intl Coordinating Council
23rd session organized by UNESCO-MAB to select new biosphere reserves and awardees. Dresden (Germany). *t.schaaf@unesco.org*

New **Releases**

Where the First Wave arrives in Minutes

Indonesian Lessons on Surviving Tsunamis near their Sources
Compiled by Eko Yulianto et al. Produced by Jakarta Tsunami Information Centre, UNESCO-IOC, UNESCO Regional Bureau for Science in Asia and the Pacific, based in Jakarta. Exists in English, 36 pp.
Explains why tsunamis strike Indonesia, including via maps. Describes warning signs of a tsunami and outlines evacuation strategies. Download: *www.ioc-tsunami.org/; for details; jtic.org*

Ocean Fertilization

A Scientific Summary for Policy-makers
By Doug Wallace et al. Produced by UNESCO-IOC, English only, 16 pp.
Defines ocean fertilization and places it in context. Explains why and how the ocean is fertilized, the intended and unintended consequences, analyses the efficiency of large-scale ocean fertilization for sequestering carbon, describes monitoring for verification and reversibility and outlines governance and policy issues.
Download: http://unesdoc.unesco.org/images/0019/001906/190674e.pdf

Sabkha Ecosystems

Volume III: Africa and Southern Europe
Öztürk, M.; Böer (UNESCO), B.; Barth, H.-J.; Breckle, S.-W.; Clüsener-Godt (UNESCO), M.; Khan, M.A. (eds). Foreword by W. Erdelen (UNESCO), Preface by HRH Prince Turki bin Nasser bin Abdulaziz al Saud. Springer Publishers, Tasks for Vegetation Science series. ISBN: 978-90-481-9672-2, €147.65, 148 pp.
Sabkha is a transliteration of the Arabic word for a salt flat. Sabkhas form along arid coastlines. This volume examines issues related to halophytes, salinity, water-logging etc in relation to agriculture and ecology. It targets graduate students and specialists. For background, contact (in Doha): *b.boer@unesco.org*

Advanced Simulation and Modelling for Urban Groundwater Management – UGROW

Dubravka Pokrajac and Ken Howard (eds). Urban Water series, UNESCO Publishing / Taylor & Francis, €38.00. Includes CD-ROM, English only, 252 pp.
Assessments and evaluations of urban water systems rarely consider the contribution groundwater makes to the urban water budget. Moreover, available decision-support tools for integrated urban water management often fail to include aquifer storage and the strong two-way interaction that commonly occurs between groundwater and surface water and other urban water system components.

Sandwatch

Adapting to climate change and educating for sustainable development
By Gillian Cambers and Paul Diamond. Revised and expanded edition published by Small Islands and Indigenous Knowledge Section. Exists in English, with French, Portuguese and Spanish editions to follow, 136 pp.
Activity booklet for schools.
Download: *http://unesdoc.unesco.org/images/0018/001894/189418e.pdf*

UNESCO in Action

Working Together for Haiti
Brochure published by Bureau of Field Coordination. Exists in English and French, 12 pp.
More than a year after the devastating earthquake of 12 January 2010, this brochure provides information about the different programmes and projects for Haiti in UNESCO's fields of competence: education, science, culture and communication. Appeals to bilateral and multilateral partners to support UNESCO's work. Download: *http://unesdoc.unesco.org/images/0019/001905/190539e.pdf*

World Heritage

No 59, UNESCO Publishing and Publishing for Development Ltd. ISSN: 1020-4202. Exists in English, French and Spanish, €7.50, 92 pp.
This issue takes a closer look at humanity's interaction with water over time, with a focus on sites such as the Beemster Polder (Netherlands), the Three Parallel Rivers of Yunnan Protected Areas (China), and Gough and Inaccessible Islands (UK). Background information and discounts for subscriptions at: *http://whc.unesco.org/en/review*

Acentos

Online newsletter of UNESCO Regional Bureau for Culture in Latin America and the Caribbean, based in Havava. Exists in Spanish. No. 1.
Stories include the launch of a commemorative stamp for the International Year of Chemistry and the presentation of the *UNESCO Science Report 2010* to the Cuban scientific community in Havana on 31 January. Download: *www.unesco.org.cu/acentos.php; i.viera@unesco.org.cu*

Report on the Current Status of Marine Non-Indigenous Species in the Western Pacific Region

Edited by Suchana Chavanich, Lik Tong Tan, Benjamin Vallejo Jr and Voranop Viyakarn. UNESCO-IOC Sub-Commission for the Western Pacific, English only, 64 pp.
Consolidates available information on the situation in China, Indonesia, Japan, Malaysia, Philippines, Republic of Korea, Singapore, Thailand and Viet Nam.
Download: *www.unescobkk.org/westpac/ioc-westpac*

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