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A system for managing the planet by 2015, p. 2

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# A World of **SCIENCE**

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## EDITORIAL

### The new **space race**

**F**or years, climate researchers have struggled with the fact that temperatures in the first 11 km of the atmosphere (the troposphere) have been rising far slower than models predict, given the speed at which the Earth's surface is heating. This apparent discrepancy has fuelled sceptics' arguments about global warming.

A new study published in the 6 May edition of *Nature* could silence the sceptics. According to this study, it is stratospheric cooling (above 11 km), a known effect of greenhouse gases, which accounts for the discrepancy. These findings result from statistical analyses of data collected from polar-orbiting satellites of the US National Oceanic and Atmospheric Administration.

Sceptics may scoff but the great majority of experts today concur that the climate is changing at an unprecedented rate and that this change is largely driven by human activities. We need to apply the Precautionary Principle and take immediate remedial action, since the longer it takes us to agree on a diagnosis of the planet's ills and the means of remedying these, the worse our environmental – and socio-economic – problems will become. In some cases, the damage will be irreparable. Biodiversity is shrinking daily, the victim of forest fires, land-clearing, pollution and other threats. According to Brazil's National Space Sciences Institute, 23,750 km<sup>2</sup> of Amazonian rainforest were cut down in the twelve months to August 2003. Of all the plant species we can't even put a name to yet, half of which are thought to grow in the Amazon, we can reasonably assume that some disappeared forever with that section of forest and with them the molecules for curing a whole range of existing and emerging human diseases.

Biodiversity loss, climate change and forest destruction are all interwoven problems. Since land, water and atmosphere are interlocking components of a single Earth system, our global Earth observing initiatives likewise need to be interlocking. Scientists are already working together on urgent questions for our future survival, such as how to increase agricultural productivity, attenuate the impact of earthquakes, or protect our children from atmospheric pollution. But for Earth observation to be comprehensive, sustained and perfectly co-ordinated, it needs political backing.

Now, it would seem, we have that political backing. In this issue, we look at a governmental initiative to put in place a Global Earth Observation System of Systems by 2015. Unlike the 'space race' before it, this new space race is fuelled not by Cold War politics but by a far more critical goal: the quest to understand the planet's life-support systems in order to protect them – and us.

W. Erdelen  
*Assistant Director-General for Natural Sciences*

# A system for managing the planet by 2015

**On 25 April 2004, the second Earth Observation Summit in Tokyo (Japan) moved a step closer to a global information system for 'managing the planet' with the adoption by Ministers of the *Framework* for a 10-year implementation plan. While not legally binding, the *Framework* represents a strong political commitment by 47 governments and the European Commission to putting in place comprehensive, co-ordinated and sustained observation of the Earth by 2015 within a Global Earth Observation System of Systems (GEOSS).**

On the face of it, this may seem like nothing new, since many international organizations and programmes are already working to sustain and improve co-ordination of Earth observation systems, such as within the Integrated Global Observing Strategy partnership. However, efforts have been hindered up to now by an ambivalent attitude on the part of governments. Even in the wealthiest countries, technical infrastructure has been eroding for want of a sustained commitment to Earth observation and space agencies have been feeling the pinch.

Times are changing. Governments are coming to appreciate the importance of Earth observation for planning sustainable development. This first became apparent at the World Summit on Sustainable Development in Johannesburg (South Africa) in 2002. The G8 meeting in France in June 2003 then went on to identify Earth observation as the highest scientific priority for the coming years. This in turn led to the first Earth Observation Summit in Washington (USA) the following month where 33 countries and the European Commission committed to preparing a 10-year implementation plan.

A technical Group on Earth Observations (GEO) was formed. Co-chaired by the USA, European Commission, Japan and South Africa, and joined by more than 21 international organizations including UNESCO and its Intergovernmental Oceanographic Commission (IOC), the GEO is to prepare the implementation plan. Now that the *Framework* has been approved, the next step will be for the GEO to translate this document into a detailed plan for presentation to the third Earth Observation Summit in February 2005.

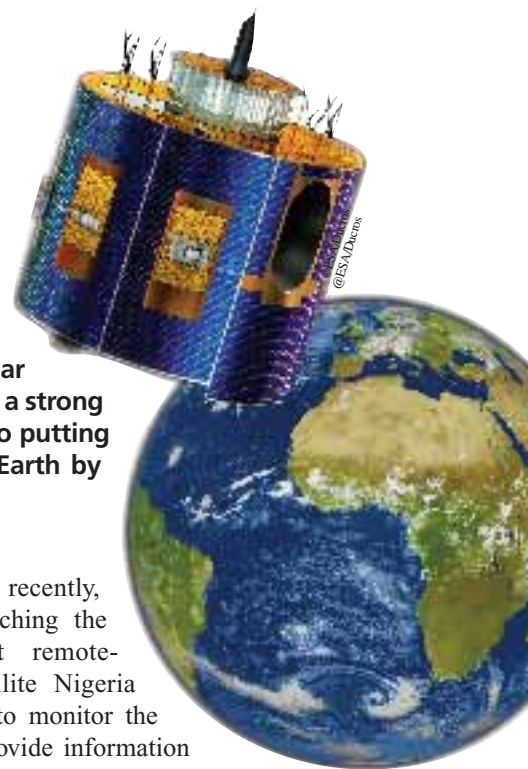
GEOSS will build on existing systems, including those of individual nations, the joint Global Monitoring for Environment and Security of the European Union and European Space Agency, and initiatives within the United Nations system.

Half of the 47 governments at last April's Summit represented developing countries. This is logical because countries of diverse financial means have invested in Earth observation satellites, from the USA, Japan and France to India, China, Vietnam, Argentina, Brazil, Algeria, South

Africa and, most recently, Nigeria. Since launching the Low Earth Orbit remote-sensing micro-satellite Nigeria Sat-1 last October to monitor the environment and provide information for infrastructure development, Nigeria has been welcomed into the fold of the Disaster Monitoring Constellation grouping Algeria, China, the UK and Vietnam. Natural hazards being unpredictable phenomena, membership of the constellation multiplies each country's chances of being overflowed by one of the five satellites at the 'right' moment and thereby of reducing reaction time.

It is also logical that countries which do not possess their own satellites should be part of GEOSS. For one thing, they are regularly overflowed and remotely sensed by satellites yet currently have only limited access to the data collected, a situation obviously unsatisfactory for them but also for developed countries which themselves have a stake in making Earth observation more inclusive. If we are to understand the natural processes involved in such long-term phenomena as climate variability, desertification or natural hazards and improve prediction, this will demand comprehensive, sustained global observation both by satellites and *in situ* (on land and at sea) over several centuries. We know from instrumental records dating back to 1861, for example, that the increase in surface temperatures in the Northern Hemisphere during the 20<sup>th</sup> century surpassed that of any other century for at least 1 000 years. But we are hampered in making a global assessment by the fact that insufficient records exist for the Southern Hemisphere.

'For GEOSS to achieve its objectives', Ambassador Ben Ngubane of South Africa told the April Summit, 'it is vital that membership include more representatives from developing countries [...] Integration of regional initiatives such as NEPAD into the development of GEOSS will be critical in this regard. It is ultimately essential for the GEO to interrogate and resolve issues such as the availability of Earth observation data to developing countries at minimum and affordable costs'.





## An information management system for our planet

Ben Ngubane was outlining South Africa's expectations of GEOSS on behalf of Phumzile Mlambo-Ngcuka, Minister of Arts, Culture, Science and Technology. 'Over the past 20 years', he noted, [...] 'we have made strides in establishing credible political structures to promote compliance with science-based global sustainable development criteria. This [...] is exemplified by the phenomenon of the 'ozone hole', where detection, an understanding of causality and an effective remedy mandated by international political structures were separated by little more than a decade<sup>1</sup>. What is missing then? To avoid our successes being limited to a series of *ad hoc* examples such as that of the ozone hole, we need what the business world calls an information management system, [...] founded on broad global benefit principles and monitored according to internationally accepted indicators amenable to reliable and affordable scientific measurement. Our vision for GEOSS is that it should be the information management system for our planet'.

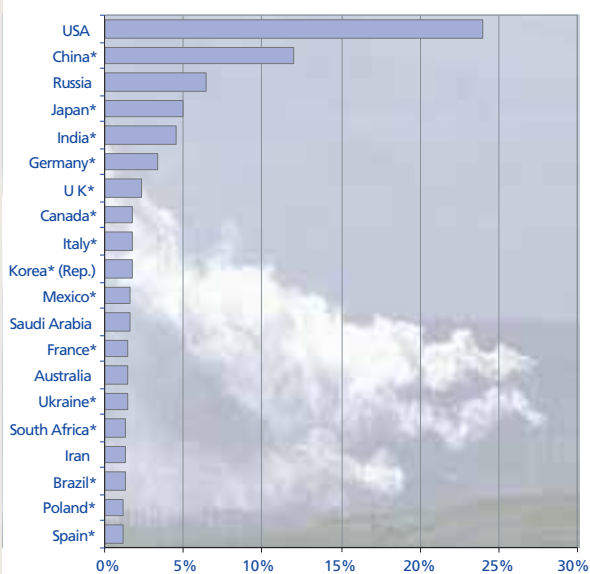
## The current status of the Kyoto Protocol

Negotiated by over 100 countries for more than a decade, the Kyoto Protocol of 1997 calls for the 38 largest industrial nations to reduce their emissions of greenhouse gases to 5.2% below 1990 levels by 2012.

As of April 2004, 122 countries responsible for 44.2% of the world's CO<sub>2</sub> emissions had ratified the Kyoto Protocol, the most recent additions being Israel (March 2004) and Ukraine (April 2004). Since the Protocol must be ratified by countries representing 55% of world CO<sub>2</sub> emissions before it can come into force, the Protocol's successful implementation will depend upon the ratification by one or more of the remaining Parties to the UN Framework Convention on Climate Change.

For details of the Kyoto Protocol: <http://unfccc.int>

The top 20 CO<sub>2</sub> emitters (2000)



\* has ratified or acceded to the Kyoto Protocol

## Furthering implementation of environmental treaty obligations

Besides improving understanding of dynamic Earth processes and enhancing prediction, the GEO has the stated ambition of furthering implementation of environmental treaty obligations. Examples in recent years are the Convention on Biological Diversity adopted at the Earth Summit in Rio in 1992, the Convention to Combat Desertification of 1994 or the Kyoto Protocol (see box).

As Eric Vindimian of the French Ministry of Ecology and Sustainable Development explains, 'the act of participating in the GEO does not imply a desire to ratify treaties. But the fact remains that the ambition of GEOSS is to develop tools which enable us to observe the planet and that these tools are designed to respond to the needs of the major users, in other words the governments; it is they who most need to know what state the planet is in, in order to sign and ratify international treaties. Even governments which have not ratified certain treaties are not averse to seeing GEOSS serve the implementation of international treaties. Obviously, the pressures on the environment are one parameter to observe and the manner in which the environment copes with these pressures is another'.

## The Integrated Global Observing Strategy

Since the end of the Cold War, space agencies have increasingly focused on environmental security by launching an expanding constellation of satellites equipped with optical, infrared and radar sensors to monitor the Earth. These satellites are often the only way to obtain suitable data to understand and predict both man-made and natural changes to the atmosphere, land and oceans.

However, satellites are an expensive business and global *in situ* observation hardly less so. In 2002, Tillman Mohr of the Committee on Earth Observation Satellites (CEOS) remarked that, 'there are several global initiatives to observe the climate or the oceans, for example, but no single agency or organization can afford to implement one of these systems alone.'

Cost-sharing was one consideration in the decision to launch the Integrated Global Observing Strategy (IGOS) six years ago. A second consideration was the growing realization that land, atmosphere and the oceans were not separate systems but interlocking parts of a single Earth system and that research programmes would only be effective if bridges were thrown between the different global initiatives.

IGOS is made up of 14 partners, including CEOS representing 23 space agencies, UNESCO, FAO, UNEP, WMO, the Global Terrestrial (GTOS), Ocean (GOOS) and Climate (GCOS) Observing Systems, ICSU, the World

1. Some 90% of ozone is found in the stratosphere (altitude of 11–30 km). At this height, ozone acts like a protective shield against UV radiation. The Montreal Protocol first reduced (1987) then banned (1992) chlorofluorocarbons in developed countries. The natural ozone production process should heal the ozone layer by 2050, although climate change could delay its recovery

Climate Research Programme and International Geosphere–Biosphere Programme.

The *Framework* for the implementation plan of GEOSS recognizes the contribution of IGOS as one of a number of groups which have developed ‘some important work and guidance for future action’ in the area of co-operation in land, water, climate, ice and ocean observation’.

Among the anticipated socio-economic benefits listed by the *Framework* are reducing loss of life and property from natural and human-induced disasters, understanding environmental factors affecting human health and well-being, improving management of energy resources, understanding, predicting, mitigating and adapting to climate variability and change, improving water resource management and the protection of terrestrial, coastal and marine ecosystems, and biodiversity conservation. These are the very objectives of IGOS.

**The IGOS ‘theme teams’**

Over the past four years, IGOS has identified several critical issues, including ocean currents and climate change, the state of the world’s water cycle, the global carbon cycle, atmospheric chemistry and geohazards such as volcanic eruptions and landslides. Scientists specializing in these areas have been working in committees to develop strategies in the form of reports, which begin by identifying the type and duration of satellite data which might fill the gaps in current knowledge.

So far, the IGOS partners have approved the strategies for five of the ‘theme teams’, as they are known. These concern the carbon cycle, water, the oceans, geohazards and the sub-theme on coral reefs. The strategies for atmospheric chemistry and coastal observations are still under preparation.

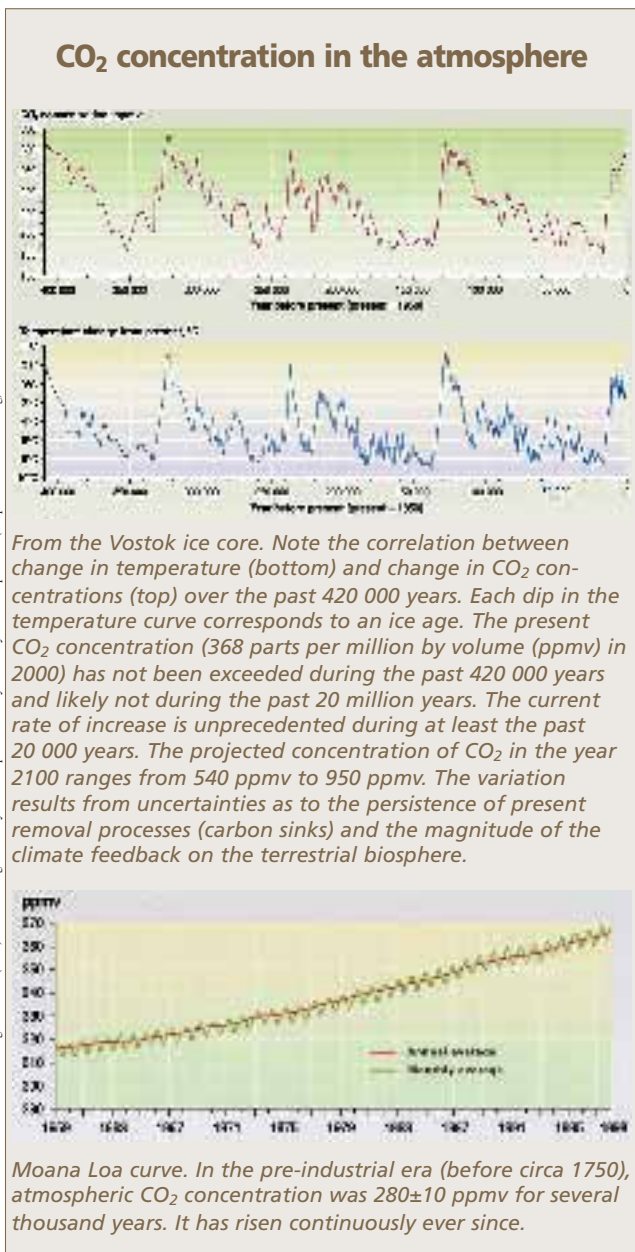
Two further themes have been proposed, those of land cover and the cryosphere. Derived from the Greek word *kruos* meaning frost or icy cold, the cryosphere is the portion of the Earth’s surface where water is found in a solid form, such as sea ice, freshwater ice, snow, glaciers and frozen ground (or permafrost). The land cover theme will focus on sustainable land use, natural ecosystems, soils, biodiversity and on monitoring changes in land cover.

**Life inside the greenhouse**

There are already fairly regular and accurate measurements of air-pollution levels for many capitals but air pollution goes unmonitored in most of the world’s cities, despite exponential growth in motor vehicle use in even the poorest countries. Air pollution being both a health issue and an environmental issue, we need a better grasp of the ways in which different chemicals affect the atmosphere. Satellites may very well provide a global monitoring system for this purpose.

Unlike stratospheric ozone which is beneficial, ground-level ozone (up to an altitude of 11 km) is the primary constituent of city smog. Ozone is created by sunlight acting on nitrogen oxides and volatile organic compounds emitted by motor vehicles and stationary sources. These emissions can be carried hundreds of kilometres and result in high ozone concentrations over great distances. An Airtrends summary in 1995 by the US Environmental Protection Agency cited scientific evidence that ‘exposure to ozone for six to seven hours, even at relatively low concentrations, significantly reduces lung function and induces respiratory inflammation in normal, healthy people during periods of moderate exercise. It can be accompanied by symptoms such as chest pain, coughing, nausea and pulmonary congestion.’ The report estimated that ‘ozone is responsible for approximately \$1–2 billion of agricultural crop yield loss in the USA each year [...] and damages forest ecosystems in California and the eastern USA’.

Two reports published as recently as May 2004 note growing damage to health as a result of atmospheric pollution. One published by the French Environmental Health Agency (*Agence française de sécurité sanitaire*



Source for both figures: IPCC (2001) Climate change 2001: Synthesis Report. Summary for Policymakers, September. (Graph from Climateark.org)



©UNESCO

*'Exposure to ozone for six to seven hours significantly reduces lung function and induces respiratory inflammation in normal, healthy people during periods of moderate exercise'*

*environnementale*) estimates that atmospheric pollution is responsible for 6,500–9,500 deaths every year (out of a French population of 60 million), or 3–5% of deaths in the population aged over 30. Another report published by the Harvard Medical School in the USA and cited by the medical journal *The Lancet*, entitled *Inside the greenhouse: the impacts of CO<sub>2</sub> and climate change on public health in the inner city*, lays part of the blame for more widespread childhood asthma at the door of fossil-fuel combustion. Inner-city children are described as being most at risk, since diesel particles are highly effective at depositing pollen in immune cells in the lungs, even as higher CO<sub>2</sub> levels are stimulating plants to produce more pollen earlier in the year. In the USA, childhood asthma rose by 160% between 1980 and 1994; in Europe, one child in seven is thought to suffer from the affliction today.

### **A decade of data just a drop in the bucket**

The approved ocean theme report was published in January 2001. The adoption of this ocean programme led to an agreement between two research space agencies, NASA (USA) and CNES (France), and two operational space agencies, NESOLS (USA) and EUMETSAT (Europe), to launch Jason-2 jointly in 2005. This satellite will follow in the footsteps of the Jason-1 and Topex/Poseidon, Franco-American satellites that revolutionized our understanding of oceanography.

Circling the Earth every 112 minutes, Topex/Poseidon (launched in 1992) was the first satellite capable of measuring the height of the ocean surface with a precision of a few centimetres; this permitted scientists to infer the dynamics of the underlying ocean and temperature of sea waves, as well as related wind speed. This kind of data ables scientists to observe the major ocean currents that regulate our climate by shifting heat around the world. Topex/Poseidon has also provided an efficient method of monitoring the variation in global mean sea level in relation to global climate change.

The Topex/Poseidon mission was so successful that the USA and France launched a follow-up, Jason-1, in 2001. The satellite has been sending the most precise measurements of sea surface ever recorded, with an accuracy of 1cm. Jason-1 should be operating for about ten years.

Even so, a decade of data is just a drop in the bucket in scientific terms. 'We now know that events like El Niño and the North Atlantic Oscillation, an atmospheric see-saw driving winter storms west to east across the ocean, don't simply occur on a year-to-year basis but follow decadal cycles,' says Colin Summerhayes of UNESCO's IOC. 'With longer-term data, weather forecasters might provide practical information for agricultural planning, especially in arid regions.'

### **Plugging the holes in our knowledge of the water cycle**

IGOS has produced a similar theme report on the world's water cycle. We take for granted the satellite images shown by weather forecasters on television, which have been around ever since a string of meteorological satellites followed the first US mission launched in 1960.

However, there are still gaping holes in scientists' understanding of the basic water cycle. Precipitation is notoriously difficult to evaluate; it has been estimated that only 1–4% of the globe's area is covered at any one time by rainfall. Moreover, the intensity of that rainfall can vary widely in a matter of minutes or even seconds. Scientists will soon have an unprecedented quantity and quality of water-related data thanks to a new generation of satellites: Terra and Aqua (USA) and Envisat (Europe).

IGOS is weaving a global network to collect, compare and synthesize the data of the various satellites with land-based observations. The aim is to finalize the system in time for what promises to be a technological milestone. In 2007, the USA and Japan will be launching a constellation of nine Global Precipitation Measurement satellites which will be able to measure the rainfall at any spot on the globe every three hours.

### **Satellites alone won't provide all the answers**

However, satellites alone cannot answer most of the critical questions facing scientists today. Satellites alone cannot measure the amount of CO<sub>2</sub> absorbed by forests or the rate of coastal erosion. This is why IGOS is also developing strategies to integrate land- and space-based data. Satellite images of coastal erosion can transform the studies of a marine biologist.



©D. Regier/UNESCO

*Rice paddies in Indonesia. Feeding the world's growing population will demand greater agricultural productivity, a goal better information on the water cycle will help us to achieve*

## The eruption of the century



Courtesy of US Geological Survey

*Mount Pinatubo wakes from 400 years of slumber*

After lying dormant for four centuries, Mount Pinatubo in the Philippines erupted so violently in June 1991 that it spewed columns of more than 10 km<sup>3</sup> of pyroclastic debris and ash to an altitude of 40 km and flung a giant umbrella cloud containing 17 megatons of sulphur dioxide into the stratosphere. Volcanic ash hung in the air for months, some of it being scattered by the wind as far as Russia and North America. The eruption caused average temperatures in the Northern Hemisphere to fall by up to 0.6°C. The eruption buried more than 400 km<sup>2</sup> of countryside under hot ash flows and blanketed 7,500 km<sup>2</sup> of the island of Luzon in ash. More than one million people were displaced and approximately 900 killed. Damage to property and infrastructure ran into hundreds of millions of dollars.



Courtesy of US Geological Survey

*The eruption blanketed the Philippine island of Luzon in ash and turned day into night*



Courtesy of US Geological Survey

*Children on the roof of their school in Bamban in October 1991*

Volcanic activity is monitored regularly around the world. Computer-based data acquisition and processing have made great strides but not to the point of replacing the traditional cylindrical drum recorders you will still see at volcano observatories, where they display record signals from seismometers that are strategically stationed around potentially active volcanoes.

At the same time, space agencies need information from the field to interpret the signals sent by satellites.

### Understanding the carbon cycle to predict climate change

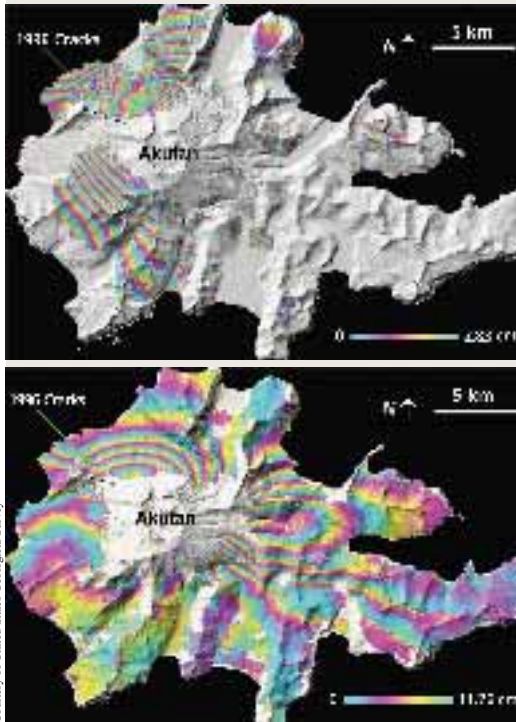
IGOS approved the strategy for a global observing system to study the impact of rising CO<sub>2</sub> emissions in early 2004. CO<sub>2</sub> is responsible for more atmospheric warming than all other greenhouse gases combined, including methane, nitrous oxide and halocarbons. Part of the problem stems from the fact that CO<sub>2</sub> concentrations in the atmosphere take centuries to stabilize even after the level of emissions itself stabilizes. Concentrations of methane, on the other hand, a gas produced primarily by agricultural activity, waste disposal, coal mining and natural gas, will stabilize only decades after the level of emissions itself stabilizes.

To predict how atmospheric CO<sub>2</sub> levels and climate may change in the future, we must understand where and how CO<sub>2</sub> moves between the land, oceans and atmosphere in what is known as the global carbon cycle.

Within this cycle, the oceans will ultimately absorb approximately 90% of the anthropogenic CO<sub>2</sub> emitted to the atmosphere. However, the rate of absorption by the ocean's surface waters and its transport into the deep ocean, where it is out of contact with the atmosphere for thousands of years, is much slower than the rate of CO<sub>2</sub> emissions to the atmosphere. This leads to a build-up of CO<sub>2</sub> in the atmosphere. At present, the oceans are absorbing about 30% of fossil fuel carbon but understanding how this process works, and may work in the future under a changed environment, is problematic. The ocean removes CO<sub>2</sub> from the atmosphere in two ways. Microscopic plants, known as phytoplankton, convert CO<sub>2</sub> to organic matter by photosynthesis; this carbon is then transported into the deep ocean when the plants die and sink in a process called the 'biological pump'. Another mechanism, the 'solubility pump', results from the fact that CO<sub>2</sub> from the atmosphere is soluble in seawater. When surface seawater is cooled in the high latitudes, it becomes very dense and sinks to the deep ocean, carrying this dissolved CO<sub>2</sub> with it. The net ocean uptake of anthropogenic CO<sub>2</sub> appears to be controlled over long time-scales by ocean physics, specifically the transport of these surface waters saturated with CO<sub>2</sub> to the deep ocean. However, in many regions and over shorter time-scales, the biological pump can have a stronger control on the distribution of CO<sub>2</sub> in the oceans.

Through measurements of carbon in surface and deep waters and an understanding of the physical circulation of the ocean, scientists can begin to understand where, how and how quickly the ocean is removing CO<sub>2</sub> from the atmosphere. These measurements are made through a combination of samples taken on board research vessels or specially equipped commercial vessels and by using scientific buoys. By studying satellite images of ocean colour, scientists can gauge phytoplankton levels globally and begin to understand the processes controlling the spatial and geographic variability of the growth patterns. It is essential to combine

## A satellite study



These two interferograms show Akutan Volcano on a remote island in the Aleutians in Alaska (USA). In 1996, an intense earthquake swarm shook the sparsely populated island. Fearing the dormant volcano might erupt (which it did not), scientists used two pairs of satellite images produced from radar of different wavelengths to measure changes in the volcano's topography.

The C-band interferogram (top) on the shorter wavelength was constructed on the basis of images taken by a sensor onboard the European Space Agency's ERS satellite; the L-band interferogram (bottom) stems from the Japanese J-ERS satellite.

To calculate an interferogram, you need a minimum of one pair of images of the same target taken at different times. Current satellites measure the same target about once a month. One image is then superimposed on the other to show where changes have occurred. The pairs of images used to produce the interferograms on the left reveal a deformation in the surface of the volcano caused by the intrusion of magma, which moved from under the volcano's summit to the east. This deformation has been 'captured' because one image was taken before the intrusion and the other afterwards (the colour fringes denote changes).

C-band may be more sensitive to smaller deformations than L-band but it is not suited to monitoring deformations that displace the target more than a few centimetres between two observations. The presence of vegetation and cloud variations alter the path followed by the wavelength. As most natural surfaces are not solid rock but include soils, rubble and so on (as in the case of this island), the longer L-band radar would appear to be much more useful than C-band for geohazards monitoring, even in the absence of vegetation.

No L-band missions are being flown at the moment, so observations like the one shown in the bottom picture are no longer possible. The Japanese Space Agency is, however, scheduled to send the (L-band) ALOS satellite into orbit. Several other satellites are flying with C-band interferometric capabilities: the Canadian RadarSat, the European ERS-2 and Envisat.

these observations to develop models on how the carbon absorbed and released by the ocean interacts with the atmosphere and land.

'Today, there are several models but the results they give can vary by as much as 50%', notes Philippe Ciais of the French Atomic Energy Commission, leader of the IGOS strategy for the carbon cycle. 'These models will probably improve. But if we don't improve our current observations, we won't have a reference point to measure the extent to which the carbon cycle has changed between now and the next decade.'

### Taking the measure of geohazards

The geohazards strategy was published in April 2004 by the three leaders of the theme team, the British Geological Survey, European Space Agency and UNESCO.

Every year, volcanic eruptions, earthquakes and landslides claim thousands of lives, injure thousands more, devastate peoples' homes and destroy livelihoods. The cost in terms of damaged infrastructure runs into the billions in any currency, a cost pushed higher still by insurance premiums. Geohazards affect rich and poor alike but have a disproportionate impact on the developing world. As the human population increases, more and more people are living in hazardous areas, causing this impact to grow at an unsustainable rate.

Citizens need to know a hazard's location, timing, extent, likely behaviour and duration. It is not yet possible to give firm answers to any of these questions. This is because of critical gaps in topographic data, hazard inventories and geoscience maps, insufficient coverage of local GPS and seismic networks, inadequate geohazards models and a lack of continuity in C-band – and especially L-Band – radar interferometry (see box).

The goal over the next decade is to fill these gaps by integrating disparate geohazards research into global operational systems. This should enable the geohazards community to improve mapping, monitoring, forecasting, mitigation and preparedness, and thereby provide the agencies involved in disaster management with critical information. The strategy will fill key gaps in long-term observations and bridge issues not covered by the disaster response system set up under the international Charter on Space and Major Disaster or the UN Action Team on Disaster Management.

### Into the political arena

Over the next decade, the IGOS partnership will bring us a more thorough understanding of how the planet's life-support systems function and interact. In so doing, IGOS will be fashioning the tools decision-makers will need to plan sustainable development.

The ten-year Earth observation summit process brings the work of IGOS into the political arena. These parallel processes hold the promise of a potent cocktail blending scientific rigour and political commitment. The summit next February should design the architecture of an Earth observation system which will revolutionize the way we manage the planet.

Susan Schneegans, Amy Otchet,  
Robert Missotten<sup>2</sup> and Maria Hood<sup>3</sup>

To read the theme reports: [www.igospartners.org](http://www.igospartners.org)

2. UNESCO Programme Specialist in geological sciences

3. UNESCO Programme Specialist in marine sciences

## Health and food security focus top women researchers

**Four of the five laureates of this year's L'Oréal/UNESCO Awards for Women in Science will be using the US\$100,000 they each took home on 11 March to alleviate widespread suffering from debilitating diseases and handicaps. The fifth will be helping to protect populations in Africa from the ravages of crop viruses, drought and other risks for food production.**

**Jennifer Thomson** of the University of Cape Town in South Africa will be pursuing the development of transgenic plants which are resistant to viral infections, drought and other risks. Over the past decade, Prof. Thomson's research team has developed an experimental variety of transgenic maize resistant to the Maize Streak Virus, a disease which has devastating effects on smallholder agriculture in parts of Africa where maize is the staple food and livestock forage crop. Recently, Prof. Thomson and her colleagues have been working on a project to engineer transgenic agricultural crops with a high tolerance to drought and other stresses, such as high salinity and heat.

**Christine Petit** of the Institut Pasteur in France has helped many families worldwide affected by hereditary deafness through her work on the genetic defects in hereditary deafness and other sensory disorders. Deafness is the most frequent sensory defect, affecting one child in 800 at birth and one in 500 before adulthood. Prof. Petit has demonstrated that, even though 100 different genes may cause congenital deafness, a single gene is responsible for about half of congenital forms. As a result, we now know that congenital deafness in developed countries is of genetic origin in 80% of cases, as opposed to of environmental origin, such as through infection or excessive noise.

**Lucia Mendonça Previato** of the Federal University of Rio de Janeiro in Brazil has done much to further the understanding, treatment and prevention of endemic Chagas disease, which is thought to affect 16–18 million people in Latin America. In its chronic form, Chagas disease causes fatal damage to the heart and digestive tract. The disease is transmitted to humans via a blood-sucking insect which acts as a vector for the parasite, *Trypanosoma cruzi*. Prof. Mendonça Previato's research group was the first to discover that the parasite scavenges a crucial molecule, sialic acid, that plays a key role in helping the parasite attach itself to its host. Sialic acid can also reduce the effectiveness of the host's immune response. Prof. Mendonça Previato hopes to develop a means of blocking the parasite before it disrupts the host cell and enters the human bloodstream. The enzyme



Above, Lucia Mendonça Previato  
Right, Jennifer Thomson



©Christa McConaghly

responsible for the transfer of the host's sialic acid to the parasite is a prime target for new drugs and improved vaccines for Chagas Disease.

**Nancy Ip** of the Hong Kong University of Science and Technology in China is a neuroscientist whose discoveries on the molecular control of growth, differentiation and the formation of synapses (the sites of communication between nerve cells or between nerve cells and target cells) in the nervous system have provided important insights into how receptor molecules affect the differentiation and maintenance of neurons during brain development. Her work may provide important clues for the treatment of neurodegenerative diseases, such as Parkinson's and Alzheimer's, and nerve-muscle disorders.

**Philippa Marrack** of the Howard Hughes Medical Institute in the USA has spent the past 35 years studying the family of cells that help the body fight off disease, T cells, and their effect on the immune system. In particular, she has investigated how T cells trigger auto-immune diseases such as rheumatoid arthritis and toxic shock syndrome. Her work on 'memory T cells', which survive after infection and become part of the 'armour' of cells that prevent reinfection by the same micro-organism, has also been crucial in understanding

how vaccines can be made to work more efficiently.

Within the same L'Oréal/UNESCO For Women in Science programme, 15 young women from five continents were awarded research fellowships worth US\$20,000 each. One of them, Blandina Lugendo, describes her work on page 13.

For details: [r.clair@unesco.org](mailto:r.clair@unesco.org); [www.forwomeninscience.com](http://www.forwomeninscience.com)

## Mountain climate change study gains ally in GLOCHAMORE

**A project using mountain biosphere reserves as study sites for monitoring global change has become part of the European Commission-funded Global Change in Mountain Regions (GLOCHAMORE) project. From 9 to 11 May, both projects teamed up for their second joint international workshop in Vienna (Austria).**

The workshop discussed indicators for measuring the cryosphere, terrestrial ecosystems, the past and present impact of global change on mountain waters and social monitoring. A peer-reviewed scientific article based on the Vienna workshop's findings will be submitted to the international journal *Mountain Research & Development* for publication in November.

UNESCO and the Swiss-based Mountain Research Initiative (MRI) joined forces in October 2002 to study global climate change in mountainous regions the world



over (see *A World of Science* 1(2)). The aim is to develop a global strategy for detecting and identifying indicators of global change which may be either bio-physical or socio-economic in nature.

The GLOCHAMORE project was launched last November. It represents a consortium of 14 organizations and institutes specializing in global change issues, among them UNESCO.

The first joint activity of the UNESCO project and GLOCHAMORE was an international 'kick-off' workshop at the Swiss Entlebuch Biosphere Reserve in November 2003 to identify sample mountain biosphere reserves as study sites. The list of potential sites may yet evolve.

The indicators chosen in Vienna will be used to measure global change in mountainous regions. Study sites will include the 30 biosphere reserves identified up to now, all of which are of sufficient altitude to comprise a nival zone offering permanent snow cover and an alpine zone. This is important because mountains harbour fragile ecosystems which are particularly sensitive to global climate change; one tell-tale sign of climate change in mountains is a shift in the altitude of the vegetation and snow lines.

Another criterion for the participation of mountain biosphere reserves in the study was an adequate level of research infrastructure and on-going research programmes. Social and economic features were also taken into consideration. As biosphere reserves contain both protected areas with natural or near-natural environments and non-protected areas which are used economically, they make ideal study sites for monitoring the impact of global climate change on different forms of land use.

The next thematic workshop will be organized by the MRI in L'Aquila (Italy) from 29 November to 1 December 2004. It will look at Scenarios of Global Change Impact in Mountain Biosphere Reserves. This will be followed by a workshop on Sustainable Development in Mountain Biosphere Reserves organized by Perth College and Jawaharlal Nehru University in India, in February 2005, and by another on Process Studies along Altitudinal Gradients, to be organized in July 2005 by the Potsdam Institute for Climate Impact Research (Germany). The four

thematic workshops will culminate in an Open Science Conference in late 2005.

*Read the Proceedings of the Entlebuch workshop:*  
[www.unesco.org/mab/publications/publications.htm](http://www.unesco.org/mab/publications/publications.htm);  
*for project details:* [www.unesco.org/mab/mountains/home.htm](http://www.unesco.org/mab/mountains/home.htm)

## Stemming brain drain with the Grid in Southeast Europe

**A joint UNESCO/Hewlett Packard project aims to help staunch brain drain by offering young scientists from Southeast Europe the means to work on joint research projects with fellow nationals living abroad. In February and March, the project delivered the latest Grid computing equipment to five universities in the region.**

The Grid is a service for sharing computer power and data storage capacity over the Internet, unlike the Web which is a service for sharing information over the Internet.

The state-of-the-art equipment was handed over to the Universities of Belgrade and of Montenegro (in Podgorica) in Serbia and Montenegro, to the Universities of Sarajevo and of Serb Sarajevo in Bosnia and Herzegovina and to the University of Split in Croatia. The equipment donated by Hewlett Packard will allow these universities to introduce new learning programmes. By working in close cooperation with the scientific diaspora, students will be able to tap into the expertise and knowledge of their fellow nationals abroad.

Piloting Solutions for Alleviating Brain Drain in Southeast Europe is the first in a series of initiatives planned by UNESCO and Hewlett Packard, who first sealed their partnership on 25 April 2003. The project is being implemented by UNESCO's Regional Bureau for Science in Europe (ROSTE), based in Venice (Italy).

'Two major and interrelated human resource problems are common to the countries in Southeast Europe', recalls Howard Moore, Director of ROSTE. 'The first is that their scientific communities are getting older; the second is that a decreasing number of young people are choosing scientific careers. Under the economic conditions prevailing in the region, careers in research have simply become "unattractive". This has led not only to external brain drain but also to a massive internal brain drain towards less prestigious but better paid professions.' The mass emigration of young, educated people in highly sought-after fields of expertise has been one of the most alarming phenomena the Southeastern European countries have had to face since the devastating war and break-up of the former Yugoslavia in the 1990s. This loss of talent has impoverished national capacities at a crucial time for reconstruction and development.

'The information technology (IT) architecture of this joint UNESCO/Hewlett Packard project is based on the very latest technology and design,' comments John Saw, Marketing Director and Philanthropy Manager at the International Sales Europe branch of Hewlett Packard. 'Grid computing is not



*Entlebuch, one of 30 mountain biosphere reserves on five continents selected for the climate change study*

©Gloria McConaughy

commonplace today; in fact, it is at the cutting edge of IT development. It has all the potential to convince some of the key local talented individuals that they no longer need to look further afield to gain access to the latest technology.'

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## New Chair takes science from the university to the village

**A UNESCO Chair for Women, Science and Development was inaugurated at the University of Ouagadougou (Burkina Faso) on 4 June. The Chair's ambitions can be summed up in the words of Mahatma Gandhi, 'When you educate a man, you educate an individual. When you educate a woman, you educate a family, a country'.**

The sub-regional Chair will provide village women with the scientific and technological know-how to improve their daily life and that of their families and to participate in their community's socio-economic development.

The strategy is to take the university to the village. It is the university which will be entrusted with the task of propagating a scientific and technological culture in rural zones, by training veritable African science communicators capable of adapting concepts and practices to local needs and knowledge.

Academics and students will be encouraged to meet village women, for whom they will put in place an interactive, informal science education programme constructed around recurrent themes. These include hygiene and health, water management, agriculture and food security, the use of simple technology and renewable energies. A research programme and a fourth-year diploma on the theme of Women, Water and Health are currently under preparation.

The Chairholder is Odile Nacoulma Ouedraogo, Professor of Biochemistry at the University of Ouagadougou. Several universities in the region will network with the Chair: Lomé (Togo), Bamako (Mali), Niamey (Niger) and Abidjan (Côte d'Ivoire).

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## Israeli-Palestinian Science Organization born

**The Israeli-Palestinian Science Organization (IPSO) was launched in Jerusalem on 21 and 22 April with the first meeting of IPSO's governing body, the International Scientific Council.**

IPSO will be enlisting the most qualified Israeli and Palestinian specialists to address issues faced by both

communities in health, environment, water, agriculture and irrigation, and the economic sphere. One aim will be to strengthen academic centres of excellence, particularly on the Palestinian side, since these centres are the most sustainable pillars of growth in a country with hardly any natural resources. The preservation of Jerusalem as a multicultural and multinational city, and its development, will be another area for co-operation.

A further aim will be improve science education of youngsters and children. A project is already under way to build a science centre at Al Quds University on the model of that at the Hebrew University of Jerusalem. UNESCO has been acting as mentor for this project, which was first launched a couple of years ago by Al-Quds University and the Andrea and Charles Bronfman Philanthropies (ACBP). Pending the end of the fund-raising campaign for the science centre, an exhibition is touring Israel and the Palestinian Territories to bring science to children without delay.

IPSO has made an initial call for research proposals. It will be managing the peer review of all incoming proposals, as well as grant allocation and fund-raising for this and other programmes. The US National Academies of Science, Rothschild Foundation and ACBP have provided IPSO with initial seed grants.

A non-political entity, IPSO is the brainchild of Prof. Sari Nusseibeh, President of Al Quds University in East Jerusalem, and Prof. Menahem Yaari of the Hebrew University of Jerusalem. In a joint letter to UNESCO's Director-General in March 2004, the men wrote that 'IPSO offers a critical opportunity to foster co-operation in an area that is of strategic importance to both societies. Hence, despite the continuing turmoil in our region, the preliminary response of many Israeli and Palestinian scholars and their institutions has been enthusiastic'.

Professors Nusseibeh and Yaari were panellists at a UNESCO roundtable on Science and Peace in November 2002 to mark World Science Day for Peace and Development. The roundtable was the first in a series of meetings which explored new ways of fostering Israeli-Palestinian academic and scientific co-operation.

Nobel Laureate Torsten N. Wiesel was a third panellist. An early convert to the cause, he sits on IPSO's International Scientific Council together with Professors Nusseibeh and Yaari, and eight other eminent scientists. A six-member Executive Committee made up of Israeli and Palestinian scholars and scientists oversees IPSO's ongoing operations.

The IPSO concept was first presented to the International Human Rights Network of Academies and Scholarly Societies in Ascona (Switzerland) in May 2003. A month later, IPSO was endorsed by the Palestinian and Israeli Academies of Science. Since then, over a dozen other Academies around the world have followed suit.

Temporary offices have been established at ACBP headquarters in West Jerusalem and at Al-Quds University. A joint office will be rented in Jerusalem as soon as possible.

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# Rashad Mandan Omar

## Priorities for redressing Iraq

On 2 June, Rashad Mandan Omar was appointed Minister of Science and Technology in the interim Government of Iraq, in anticipation of the handover of sovereignty by the US-led coalition forces on 30 June and elections in several months' time. A civil engineer originally from the northern town of Kirkuk, Dr Rashad worked in the Iraqi Ministry of Oil for 22 years then in Dubai before returning to Iraq in September 2003.

Here, Dr Rashad deplores the current state of infrastructure and outlines his priorities for research and development in the new Iraq.

**Iraq was one of the most scientifically and technically advanced countries of the Arab world in the 1970s and 1980s. How severely has science and technology infrastructure been affected by the Gulf wars of 1991 and 2003 and by the imposition of UN sanctions during the interim period?**

There was damage done to the science and technology system after Saddam Hussain assumed power in late 1979 – I shall elaborate on this on shortly – but the most serious damage was that done to infrastructure *following* the liberation war in 2003. The looting and ransacking of laboratories and other research facilities in the month following the entry into Baghdad of American and British forces and the collapse of the Saddam regime reduced science and technology infrastructure to a state of ruin. As a result of that looting and other damage, few laboratories and research facilities have much equipment now, some of them none at all. In many cases, even such small items as door-knobs have had to be replaced.

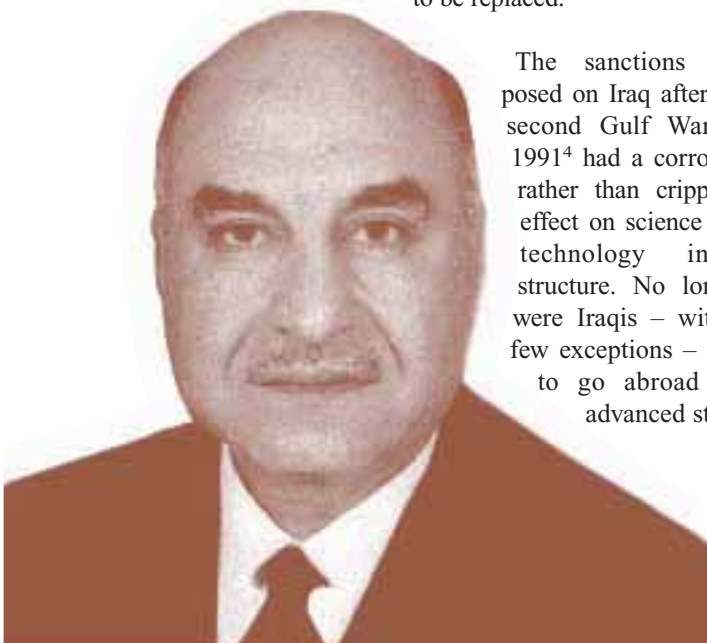
The sanctions imposed on Iraq after the second Gulf War in 1991<sup>4</sup> had a corrosive rather than crippling effect on science and technology infrastructure. No longer were Iraqis – with a few exceptions – able to go abroad for advanced study

and training; no longer were publications, supplies and equipment easy to obtain.

It should also be pointed out that the pathological suspicion of foreign contacts characteristic of Saddam's regime also had very harmful effects. The suspicion that fell on anyone – including scientists – with foreign contacts and the discouragement of association with anyone or any organization outside Iraq effectively cut Iraqi scientists off from the rest of the world. That isolation was extremely damaging, leaving Iraqi scientists unaware of most scientific developments throughout the world. The priorities accorded by the previous regime to research and development in areas related to weaponry also had damaging effects, both by shifting resources to areas of little benefit to the Iraqi people and by necessitating secrecy.

**Where do science and technology figure on the interim Iraqi government's list of priority areas for renewal and what will be its first major task?**

Although science and technology are critical to a wide range of urgent and high-priority needs in Iraq including security, health, water resources, environment, agriculture, communications, information technology and the economy, that does not mean that science and technology *as such* will be given priority in renewal. Nor does it mean that the Ministry of Science and Technology will be seen as having priority for addressing the country's needs. There are some areas, however, for which the Ministry of Science and Technology does have responsibility – such as dealing with sources of radiation in the country that pose serious risks, rebuilding the infrastructure for communications and information technology, problems of wastewater supply and water purity. These areas must be accorded priority and will be, I expect, by the new government.



Rashad Mandan Omar

The most urgent task for the new Iraqi government will be to guarantee security. The continuing violence and civil conflict which have marked the past year have made economic recovery difficult. Iraq has been seen as too unstable for much foreign investment and even some forms of foreign assistance. It has unfortunately been impossible for us to invite foreign experts, including scientific experts, and to hold meetings in Baghdad. The violence has also set back many of our efforts to reconnect Iraqi scientists and engineers with the rest of the world.

**In your view, what are the most urgent priorities for redressing research and development?**

The most urgent needs for research and development in Iraq are those linked to problems of security, health, pollution, water resources, housing, infrastructure for communications, information technology and economic recovery.

For the Ministry of Science and Technology, that means focusing our efforts on such areas as: safeguarding the pipelines, transmission lines and important facility locations; analytical techniques for detecting pollution and other environmental health hazards (air, water, soil); analysis and monitoring of the water supply, wastewater treatment and progress in desalination; petroleum extraction, additives, refining and transportation; agriculture, food production, food processing; communications and infrastructure; information technology; geographical information systems, global positioning systems and ground-penetrating radar systems; civil engineering for housing, public buildings and infrastructure.

**In which areas of research and development do you feel Iraq has the greatest potential in the medium-term and how will you build investment in these areas?**

Iraq has potential resources in four areas: a significant number of highly qualified and talented people; oil; land; and historical and religious sites. If we use the talents of our people well, we can build capabilities in a number of areas which will provide for the people of Iraq as well as generating exports.

We are endowed with the second-largest known reserves of oil in the world. I believe we can and should take advantage of this natural resource. I hope to see, in the medium-term if not sooner, many of our research and development efforts focus on a wide range of activities related to the petroleum industry and petroleum-based products, as well as agriculture. I believe that significant investment in this area will serve Iraq greatly in the long term.

**Do you have any plans to reformulate a science and technology policy for the new Iraq?**

The fundamental approach to science and technology in Iraq has already changed radically. Under the old regime, science and technology were used primarily for weaponry and to further the interests of the regime. We are now dedicated to using science and technology for the benefit of all Iraqis – and indeed all humanity. We have made significant changes to the structure of the science system here over the past year. But this is a period of transition and we are aware that we must now consider the best ways in which to make use of Iraq's scientific talent – which is considerable – for the benefit of the nation. Together with my colleagues in the Ministries of the Interior, Health, Environment, Oil, Agriculture, Industry and Minerals, Housing and Planning, and perhaps others, we will need to consider how resources are best allocated, what roles are best played by whom and, overall, how we can make the most of science and technology in Iraq. We do not, of course, have unlimited resources and must decide on priorities carefully, with due consideration of a number of factors, including the needs of Iraqi society, our own scientific strengths and weaknesses, and economic sustainability.

**What are your expectations of the international community?**

I am not sure we should talk of what we expect from the international community so much as what we hope for. We have been fortunate in having already received indications of interest from a number of countries about providing us with various kinds of assistance. Now that our long isolation from the international community has come to an end, we hope to participate actively in the work of a number of international organizations, particularly UNESCO, WHO, UNEP, ISO, WIPO and FAO, and to work closely with scientific institutions and organizations around the world.

I hope that the various organizations and institutions in which we participate and with which we work will, at least in our current period of transition, provide us with considerable assistance. But the real value of our relations with scientific institutions and organizations around the world will only be realized if our scientists and engineers take advantage of opportunities. Within my ministry, we will be making great efforts over the coming months to reconnect our scientists to organizations, institutions and their counterparts around the world and to show that we are strongly interested in working co-operatively in a wide range of fields.

Interview by Mustafa El-Tayeb

4. *The first Gulf War opposed Iraq and Iran from 1980 to 1988.*

# Saving a **survival kit** for the poor



I am a 34-year old PhD candidate in marine biology in a sandwich programme between the Catholic University of Nijmegen in the Netherlands and the University of Dar es Salaam.



My research aims to reveal the role that mangroves play in sustaining fish populations along the coast of Tanzania. Mangroves are salt-tolerant trees and shrubs that usually grow in the intertidal zones along tropical and sub-tropical coastlines. In many developing countries with a marginal economy like Tanzania, mangroves represent a vital resource for the daily subsistence of local coastal communities. They provide firewood, charcoal and building poles for household use. They are also an important source of protein in the form of fish and crustaceans. The cutting-back of mangroves is threatening the future usefulness of this ecosystem, since it threatens the survival of fish species and other organisms living in these areas.

The \$20,000 L'Oréal/UNESCO fellowship I was awarded in March of this year will enable me to collect data from the mangroves of Bagamoyo on mainland Tanzania to assess the impact of clear-felling on the functioning of these mangrove ecosystems.

I have been an assistant lecturer at the Faculty of Aquatic Sciences and Technology of the University of Dar es Salaam since 2000. I chose to study marine biology not only out of interest but also out of a desire to do something useful for the well-being of future generations. Coming from a coastal region as I do, I know only too well how much local coastal communities depend on the marine environment for their daily livelihood. I have also observed several activities along the coast which are threatening the future usefulness of the marine environment as a resource.

Mangroves are being felled for commercial purposes, such as for furniture-making or boat-building. Even the burning of coral for lime production is proving harmful, since it uses firewood taken from the mangroves. Coral-burning also destroys the reef from which the coral is extracted, of course. Entire mangrove areas are being cleared to make way for agriculture, especially rice paddies, salt pans and shrimp farms. Increasingly, though, mangroves are also being cleared for hotel construction. One 100 m stretch of coastline occupied by mangroves

covering a total area of 10 ha has been cleared by hotel developers, for example, to provide access to the beach at Nunge, Bagamoyo. But rest and relaxation are not the only draw for tourists; people interested in tracing some roots of the slave trade are flocking to Bagamoyo. Now that a new tarmac road connecting Bagamoyo to Dar es Salaam has been completed, this can only boost the tourist trade.

Fishing is one of the few activities that do not involve mangrove-clearing. Other exceptions are the gathering of honey and wax, or of mangrove leaves for use as animal fodder. Mangrove forests can also serve recreational purposes (eco-tourism), as they support a large variety of birds and some mammals, such as the endemic red *Colobus* monkey in Zanzibar.

Population growth is proving to be a big problem, especially in urban areas faced with an influx of rural migrants. Most people regard urban areas as providing better social services and greater chances of employment than their rural homelands. As the population grows, natural resources are being spread more thinly, resulting in overexploitation and environmental degradation.



Blandina collecting samples of fish from Chwaka Bay, Zanzibar, in October 2002



(Photo by YD Mgaya)



*Mangrove creek in Chwaka Bay. Mangrove prop roots are among the features that offer protection to young fishes*

© Martijn Dorenbosch

Declining yields of fish and the relentless shrinking of the area covered by mangroves along the Tanzanian coast are now evident. Data on the extent of harvesting of mangrove forests is scanty and inconsistent but there are telling signs that fish numbers have declined in shallow waters: local fishermen are complaining that fish catches are declining sharply, forcing them to venture into deep waters.

### **Assessing the effect of human disturbance on mangroves**

Mangroves are most often located along sheltered shores and can penetrate deeply into the estuaries of rivers. In the past, they were defined as wastelands and their removal was considered beneficial. However, their ecological importance has recently been recognized, spurring greater efforts to protect this ecosystem. In Tanzania, research is being conducted on the nursery function of mangroves and there are mangrove restoration projects. The government has also established a specific Mangrove Management project to promote sustainable use of mangrove ecosystems. A shortage of funds and working facilities, however, impedes policy implementation and follow-up.

The main focus of my research is to understand how mangrove ecosystems support fish communities and how human disturbance of these ecosystems may affect fish populations off the coast of Tanzania. This information is essential for the management of both fisheries and the coastal environment.

### **Nurseries for juvenile fish**

The importance of mangrove ecosystems as nurseries for juvenile fish, which will later grow to maturity on the reefs

and in the open sea, is now widely acknowledged. Many tropical fish species spend part of their life cycles in mangrove swamps or are dependent on food chains which can be traced back to these coastal forests. Numerous studies have documented the fish assemblages of such environments; however, the exact role that mangroves, as an ecosystem, play in sustaining the juvenile fish remains unknown. Greater insight is required into the resources used by different fish species at different stages of their life and the importance of these habitats for maintaining fish populations.

In order to understand the role mangroves play in sustaining fish populations along the coast of Tanzania, I shall be analysing stable isotopes of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) in samples taken from two mangrove areas, Chwaka Bay on the island of Zanzibar and Bagamoyo on mainland Tanzania. Stable isotope analyses are powerful tools for tracing energy flow in food webs and for the study of trophic positions of higher consumers. Using this method, it is possible to assess the importance of different primary producers, such as phytoplankton, micro- and



*Adult fish (sweet lips) over a coral reef off Bawi island, Zanzibar*

© Martijn Dorenbosch



© Marijn Dorenbosch

Unloading fish at the market in Zanzibar town

macro-algae, seagrasses and mangrove leaves, as the baseline source of energy for higher trophic levels. This is possible because different primary producers have different stable isotope carbon and nitrogen values. By analysing the stable carbon and nitrogen isotopes present in the tissue samples of fish and their food sources, I shall be able to demonstrate whether fish are dependent on organic matter or on other organisms present in the mangrove ecosystem for their food.

Stable isotope analysis requires technical equipment known as a Stable Isotope

Ratio Mass Spectrometer which is not available in Tanzania. I shall therefore be analysing my samples at the University of Nijmegen in the Netherlands.

I managed to collect data from Chwaka Bay on the island of Zanzibar on my Principal PhD scholarship, which was granted in June 2001 within the Dutch Government's Medewerker vor Hoger Onderwijs (MHO-ENVIRONS) Project via the Netherlands Organization for International Cooperation in Higher Education.

Now, the L'Oréal/UNESCO fellowship will enable me to collect data also from Bagamoyo. Both mangrove ecosystems are suffering from deforestation but Bagamoyo is the most severely affected. The mangroves of Bagamoyo cover an area of 5635 ha. In 1989, clear-cut areas and salt pans covered an estimated 29% of the total area. As neither domestic nor commercial mangrove-cutting has abated since, the current percentage can only be higher. Mangrove clear-felling alters the environment which in turn influences food webs and energy flows. It reduces the sanctuary value of the ecosystem, making it unsuitable both for small fish and for the crustaceans and other benthic animals they feed upon. By comparing these two mangrove ecosystems, I shall be able to assess the impact of mangrove clear felling on the functioning of mangrove ecosystems in sustaining fish communities.

Initial findings from Chwaka Bay indicate a wide diversity and an abundance of juvenile fish in the mangrove habitats and the bay as a whole. Furthermore, most small juveniles (< 5 cm) were found in mangrove habitats, whereas larger specimens of the same species (conspecifics) were found in seagrass areas in deeper waters. Although these results confirm my expectations, I am still analysing the stable isotope data to learn how mangrove food webs nourish these juveniles.

This information will contribute to a better understanding of how ecosystems work and could be used to back up management and conservation strategies to safeguard Tanzanian fisheries and protect the coastal environment.

## The necessary juggling of family and work

It is not always easy to juggle being a scientist and a mother of two small children aged four and one, a dual role which demands a lot of energy and organization. Fortunately, I can count on a strong support network. My husband and other family members take care of the children when I am on field work and, since it was not possible to bring my family with me to the Netherlands, they are again looking after the children at the moment. I have been away for four months now and shall not be returning to Tanzania for another two months. Next year, I plan to repeat the experience.



© Marijn Dorenbosch

Wading birds on a dugout canoe (mtumbwi in kiswahili) in Nungwi Bay, Zanzibar. Wading birds are also part of the food webs in shallow coastal habitats

Between now and December 2005, I shall be dividing my time between my host universities in the Netherlands and in Tanzania. Both are most useful to my research because of their strong knowledge base. Through them, I can easily access laboratory equipment and other facilities, as well as a broad range of literature, and benefit from expert supervision. I plan to publish my findings in international journals from early next year.

Blandina Lugendo

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Outrigger canoe (ngalawa in kiswahili) off Matemwe beach, Zanzibar. Traditional vessels limit fishing in the open sea. This leads to overexploitation of young fish in shallow waters

## A tale of **five cities**

One person in two lives in a city of fewer than 500,000 inhabitants, in most cases on the coast. It is in these cities that future population growth will be concentrated, a daunting prospect for many municipal authorities which find themselves ill-equipped to cope with the pressures exerted on coastal zones: marine pollution, saltwater intrusion into groundwater, coastal degradation, the decline of traditional fishing and handicrafts, a greedy tourist industry hungry for land and natural resources, overcrowding of historic quarters by destitute migrants, speculative real estate fuelled by the gentrification of city centres to draw tourists, not to mention a penury of training facilities and jobs.

Essaouira (Morocco), Mahdia (Tunisia), Omišalj (Croatia), Saida (Lebanon) and Jableh (Syria) all have a population of less than 500,000. In just a few years, the pressures on these coastal cities have been eased, thanks to an exchange of technical expertise, experience and skills with other cities and universities around the Mediterranean Basin within UNESCO's Small Historic Coastal Cities initiative.

In June 1996, a multidisciplinary team of experts met at UNESCO's invitation to mull over the disastrous effects of saltwater intrusion on the historic quarters of several Mediterranean cities. Along the seafront, saltwater was infiltrating groundwater and eroding the foundations of historic buildings, thereby exacerbating unhealthy living conditions in a quarter mostly inhabited by the city's poor and by newly arrived rural migrants.

The hydrologists, urban sociologists, historians, environmental economists, archaeologists, architects and urban planners seated around the table all concurred that the problem was cause for concern but found themselves struggling to communicate their concerns to one another. The urban planners were baffled by the hydrologists' scientific findings and the oceanographers were at a loss to understand the parameters of urban insalubrity. At this point, a Moroccan urban sociologist suggested tackling the challenge of integrated urban development by confining the scope of the study to a specific case, that of Essaouira, the ancient Mogador founded in the V<sup>th</sup> century B.C. by the Carthaginians.

### Essaouira: from obscurity to the World Heritage List

In 1996, Essaouira was not on the Moroccan tourist circuit. In the Tensift region, Agadir and Marrakech alone had been developed for tourism. Essaouira was in the grips of a



In Essaouira, the square in the Medina with its galleries and craft shops for tourists



©B. Collin/UNESCO

In the XV<sup>th</sup> century, Essaouira was still protected from the ocean by its ramparts and by the reefs in its northern bay. Today, saltwater is seeping under the ramparts and into the foundations of houses on the seafront. Unfit for habitation, the houses will eventually collapse. Expert studies conducted by UNESCO should make it possible to draw up a comprehensive project to protect the ramparts

serious economic recession at the time. Poorly connected to the national infrastructure, it nevertheless boasted a historic centre, the Medina, built in the XVIII<sup>th</sup> century by Sultan Sidi Mohammed Ben Abdallah according to a design by one of Vauban's<sup>5</sup> students, who had conceived Essaouira as a port town.

The survival of the Medina was in jeopardy. The Jewish quarter of Mellah was in a particularly piteous state. Deserted by its owners, the Jewish quarter was now inhabited by rural migrants. The historic centre was being literally undermined by the intrusion of saltwater mixed with toxic chemical waste; this had exacerbated insalubrity and was hastening the collapse of some dwellings. The poorest tenants rented from absentee owners who had ceased maintaining their property. The quarter's historic buildings, which included former foreign consulates, a Portuguese church, synagogues and the law courts, were crumbling. As for the besieged ramparts along the seafront, nothing was being done to maintain them.

5. French architect (1633-1707), military engineer famous for his fortifications





### A diagnosis of the Medina's ills

The First Adviser to the King of Morocco appealed to the international community for help. A workshop on the theme of Essaouira's development was established as an annual event. UN-Habitat sent a representative to the city to set up an *Agenda 21* unit. In early 1997, UNESCO stepped in. Its office in Rabat despatched a group of specialists to Essaouira to assess the Medina's problems. Their expertise spanned oceanography, coastal conservation, the restoration of historic buildings and socio-economic dynamics.

Their assessment was to serve as the working document for the first international seminar on the theme of Urban Development and Freshwater Resources: Small Historic Coastal Cities, in 1997. Organized by UNESCO through its offices in Rabat, Venice and Beirut, the seminar led to the establishment of a network of cities in both northern and southern Europe, the Middle East and the Maghreb.

Schools of architecture in France and Spain, and a number of other foreign universities, carried out architectural surveys of Essaouira and launched bilateral projects to rehabilitate historic buildings and homes in the Medina. The Faculty of Sociology of the University of Alghero in Italy produced feasibility studies on the city's potential for tourism. In parallel, the Moroccan authorities worked to resolve problems relating to accessibility, the development of tourism and the rehousing of people living in crumbling dwellings.



*Detail of the seafront façade of the Old City of Saida. After the Israeli bombardment in 1982, refugees moved into the Old City, constructing over Ottoman-epoch buildings*

### A perverse phenomenon takes hold of the Medina

It was the screening on French television in 1998 of a programme on the rehabilitation of the Medina which first catalysed foreign investment in the historic urban centre. Three years later, the city and its ramparts were placed on the World Heritage List. Suddenly, the local shops selling basic commodities were being edged out by a growing number of luxury guest houses, art galleries and craft shops. The price of even the most dilapidated houses in the Medina began to spiral. Within a short space of time, the perverse phenomenon of a 'gentrified' centre reserved for the lucky few had grown out of the tourism monoculture in the Medina.



*IV<sup>th</sup> century mosaic depicting fishermen from the ancient city of Utica in Tunisia*

The local economy recovered and unemployment fell. Big chains built hotels on Essaouira's beachfront and shopping centres sprouted, their backs resting against the Old City's ramparts. Yet, despite the economic boom, UNESCO experts meeting in Essaouira in December 2003 to assess the project were indignant to learn that nothing was being done to strengthen the northern ramparts protecting the historic centre from the ocean. Mayors and academics from the network cities of Mahdia, Omišalj, Saida, Jableh, La Rochelle (France) and Kotor (Montenegro) attended the meeting.

Since then, the new Mayoress and Governor of the Province have launched a series of consultations to regalanise the fund-raising campaign. The proceeds will be used to consolidate the northern ramparts and ensure regular maintenance of the wall.

### Universities and municipalities hand in hand

Essaouira was thus the first case study. During the 1997 UNESCO workshop on Essaouira, first Omišalj and Saida then Mahdia and Jableh asked to be considered as case studies themselves. The following are a few examples of the projects which grew out of this collaboration.



*Although it remains one of the locals' main activities in Mahdia, fishing is threatened by marine pollution and overfishing*



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*The Borj, a fort built at the end of the XVI<sup>th</sup> century to house the Ottoman military garrison. View of the tip of the Mahdia peninsula; drawing by Charles de Chassiron in 1849, courtesy of Mahdia's museum*



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*The Borj today showing erosion of the foundations of the ancient fortifications*

In Mahdia, ancient capital of the Tunisian Fatimids in the X<sup>th</sup> century, the schools of architecture of Tunis (Tunisia) and Nantes (France) set about rehabilitating a house in the Medina, following a UNESCO seminar in June 1999. Implemented with joint financial support from the department for decentralized co-operation of Nantes and UNESCO, the project included technical trials carried out by the

*ma'allemin*, masons specialized in traditional construction and materials in the Arab region, and a survey of residents on the social transformations in the Old City.

Acting on the recommendations of a UNESCO expert and with UNDP funding, the *Institut d'études des dunes* of the city of Montpellier (France) stabilized the dune border and training local specialists from the *Agence pour la Protection du Littoral* (Coastal Protection Agency).

The universities of Venice (Italy), Grembloux (Belgium) and Zagreb (Croatia) focused on Krk island (Omišalj), jointly producing a master plan for the development and urban planning of the island under the guidance of UNESCO's Venice Office. The latter also joined forces with the University of Venice to conceive a standard future-oriented urban planning methodology for small coastal cities on the Adriatic.

In Saida, the ancient Sidon, professors from the *Université Lumière* in Lyon (France) studied the erosion and rehabilitation of the city's northern beach with support from UNESCO's Beirut office and in tandem with experts from Saida. The *Université Libanaise* in Beirut (Lebanon) teamed

up with the *Université Aix-Marseille* (France) to conduct an urban assessment of the Old City in order to help the municipal authorities draw up a plan for its sustainable socio-economic development.

As for Jableh, a city dating back to ancient Phoenician, Greek and Byzantine times, Lattakia University and the University of Damascus in Syria are to conduct a future-oriented study on the development of urban tourism as a means of revitalizing its historic centre and coast. Acting on the recommendations of two UNESCO expert missions in 2002 and 2003, and in conjunction with the town and country planning course of the *Institut d'études politiques* in Paris, the universities will work on the project in tandem with the municipal authorities.

In addition to these projects involving co-operation between cities and universities, high-level experts from the Netherlands, Sweden, Denmark, Germany and Spain have carried out missions, at the invitation of UNESCO, on marine pollution and freshwater resources. These have been highly effective in raising awareness among the network's municipal authorities of the issues at stake.

The different initiatives have taught some valuable lessons, the successes and failures of early initiatives helping to finetune later ones. The cities which have supported these case studies deserve a word of thanks, in particular Venice and Taglio di Po (Italy) for Omišalj and La Rochelle and Nantes (France) for Essaouira, Mahdia and Saida. The city of Jableh, which only joined the network in 2002, is still looking for a fellow coastal city to support its own development efforts.



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*The reputation of Mahdia's traditional weavers extends far beyond Tunisia. Some of the World's leading designers call upon their craftsmanship*

### Global urbanization gravitates to the coast

The UN-Habitat *Global Report on Human Settlements* published in October 2003 noted that recent urban growth had been concentrated primarily in 19 megacities, home to 8% of the world population. Sixteen of these megacities lie on the coast.

Small cities may not have to cope with the phenomena of mass social exclusion or slums but they rarely dispose of adequate facilities and technical services. They also have



*View of the Mahdia peninsula*



Both photos courtesy of Municipality of Omišalj

*Aerial view of the historic centre of Omišalj. In coastal zones, urban expansion is exerting more and more pressure on land. The coastal environment and historic structures suffer the consequences*



*An archaeology workshop was organized by UNESCO's Venice office in co-operation with the universities and the City of Omišalj in this 5<sup>th</sup> century Roman basilica, which is being restored with assistance from the UNESCO World Heritage Centre*

trouble holding the attention of national authorities. Yet, small cities are the first destination rural and other migrants choose. If some will subsequently move on to bigger urban centres, most will decide to stay. The ability of small cities to integrate newcomers, both in terms of employment and housing, is a persuasive argument for staying put rather than trying one's luck in one of the regional capitals or megacities.

### Cities with a destiny

The political and economic influence of cities is destined to grow. Now that the three major organizations grouping cities and local authorities, the World Federation of United Cities, the International Union of Local Authorities and the World Association of Major Metropolises (Metropolis), have merged, since May 2004, the political and economic weight of the newly formed umbrella organization, United Cities and Local Governments, will be substantial. This new status is likely to be acknowledged at future sessions of the United Nations General Assembly.

In a speech from the Throne on 2 February 2004, the Government of Canada stressed that 'our communities, our towns, our cities are key to our social goals and our economic competitiveness. Large and small, rural and urban, Canada's communities are facing new challenges, often without sufficient resources or the tools they need'.

### An interdisciplinary approach to urban development

The Small Historic Coastal Cities initiative has drawn on the findings of research conducted within UNESCO's Management of Social Transformations (MOST) programme on

country-to-city migration in the Arab region. MOST also contributes to the research network on the role of medium-sized cities in the context of global urbanization. The initiative is an illustration, in the specific geographic context of coastal zones, of the important role played by small and medium-sized cities in absorbing rural migrant populations and in regulating national and interregional urban networks.

The initiative also reflects the priority accorded by UNESCO to the sustainable development of freshwater resources, within its International Hydrological Programme<sup>6</sup>, and that of coastal regions and small islands.

Inspired by the Istanbul Declaration on Human Settlements (Habitat II, 1996) and the ICOMOS<sup>7</sup> Charter for the Conservation of Historic Towns and Urban Areas (1987), the Small Historic Coastal Cities initiative strives above all to alert public policymakers to the socio-economic, environmental and cultural principles involved in an interdisciplinary and sustainable approach to the urban development of these small cities on the Mediterranean and Adriatic coasts.

Brigitte Colin<sup>8</sup>, Joe Kreidi<sup>9</sup>, Philippe Pypaert<sup>10</sup>  
and Alexei Suzyumov<sup>11</sup>

*For details: [www.unesco.org/most](http://www.unesco.org/most) or [www.unesco.org/csi](http://www.unesco.org/csi)*

6. [www.unesco.org/water/ihp/index.shtml](http://www.unesco.org/water/ihp/index.shtml)

7. International Council of Monuments and Sites: [www.icomos.org](http://www.icomos.org)

8. Programme Specialist for Architecture and Cities within MOST (Paris): [b.colin@unesco.org](mailto:b.colin@unesco.org)

9. Programme Specialist, UNESCO's Beyrouth office: [j.kreidi@unesco.org](mailto:j.kreidi@unesco.org)

10. Programme Specialist, UNESCO's Venice office: [p.pypaert@unesco.org](mailto:p.pypaert@unesco.org)

11. Programme Specialist, Coastal Regions and Small Islands Platform (Paris): [a.suzyumov@unesco.org](mailto:a.suzyumov@unesco.org)



## Diary

### 6–13 July

**Use of ICTs for reporting on the science of HIV/AIDS**  
SciDev.Net, UNESCO, Asian Institute of Technology workshop for science and health journalists in Cambodia, Indonesia, Laos, Malaysia, Philippines, Thailand, Vietnam. Participants to attend International AIDS Conference from 11 to 16 July to gain practical experience: [www.scidev.net](http://www.scidev.net) or [s.hughes@unesco.org](mailto:s.hughes@unesco.org)

### 27 July – 1 August

**Mountains in the Mist**  
Intl symposium on science for conserving and managing tropical montane cloud forests. Includes joint MAB/IHP session. Waimea, Hawaii (USA): [www.tropicalmontanecloudforest.com](http://www.tropicalmontanecloudforest.com)

### 29–30 July

**Forest, Water and People**  
National seminar organized by National Institute of Hydrology, Belgaum (India) for information dissemination and technology transfer to scientists, engineers, foresters, NGOs and social workers of UNESCO-NIH-KFD pilot research project on forest hydrology: [new.delhi@unesco.org](mailto:new.delhi@unesco.org)

### 20–28 August

**32nd International Geological Congress**  
Will include exhibits of UNESCO's work. Florence (Italy): [w.eder@unesco.org](mailto:w.eder@unesco.org); [y.berenguer@unesco.org](mailto:y.berenguer@unesco.org)

### 29 August – 1 September

**Good water governance for people and nature: what roles for law, science, institutions and finance?**  
AWRA-IWLRI intl conf. UNESCO's Hydrology for the Environment, Life and Policy (HELP) programme will contribute to the session. Dundee (UK): [www.dundee.ac.uk/](http://www.dundee.ac.uk/)

#### Small islands, big stakes

The review of the 1994 Barbados Programme of Action for the Sustainable Development of the Small Island Developing States, due to take place in Mauritius from 30 August to 3 September, has been postponed upon the request of the Government of Mauritius. The UN General Assembly has since fixed a new date from 10 to 14 January. The UNESCO-led youth forum, Youth Visioning for Island Living, has likewise been postponed, in order for it to coincide with the international meeting: [www.islandyouth.org](http://www.islandyouth.org); [c.green@unesco.org](mailto:c.green@unesco.org)

### 10–29 September

**Promoting and Preserving Congolese Heritage**  
Supporting conservation of the DRC World Heritage sites. Exhibition

for general public (10–26 September), intl donors conf. (16–17 September) preceded by experts' meetings (13–14 September), Congo Rhythm and Rumba fund-raising concert (23 September). UNESCO HQ: <http://whc.unesco.org>

### 14 September

**Great Apes Survival Project (GRASP).**  
People and Great Apes in the Congolese Heritage (see also above). Technical Session. UNESCO HQ: [www.unesco.org/mab/grasp.htm](http://www.unesco.org/mab/grasp.htm)

### 17–18 September

**Scales in Hydrology and Water Management**  
UNESCO/IAHS 7th Kovacs Colloquium, precedes the IHP Intergovernmental Council. UNESCO HQ: [www.unesco.org/water/ihp](http://www.unesco.org/water/ihp)

### 20–22 September

**Land Resources Management and Ecological Restoration in the Loess Plateau**  
Internat. ERSEC Conference. Yangling (China): [beijing@unesco.org](mailto:beijing@unesco.org)

### 25–28 September

**Sustainable Eco-tourism in Biosphere Reserves and Similarly Managed Areas**  
South and Central Asian MAB Network. Second expert meeting to share knowledge, best practices and experiences. Zibakernar (Iran): [new.delhi@unesco.org](mailto:new.delhi@unesco.org)

## New Releases

### The Changing Face of the Earth

By B. Vrielynck and Ph. Bouysse. Published by Commission for the Geological Map of the World/ UNESCO Publishing (16 euros), ISBN: 92-3-103900-8. Exists in English and French, 32 pp. Some 250 million years ago, all the continents were grouped into a single supercontinent known as Pangaea. Destined for a broad public, shows the nine most important stages in the break-up of this supercontinent, on the basis of recent scientific work. Includes CD-ROM with 11 maps.

### Mineral Atlas of the World (Europe map)

UNESCO Publishing and Commission for the Geological Map of the World (CGMW, Paris), English only, 40 euros, ISBN: 92-3-009980-5. For OS Microsoft Windows NT 4.0, Windows 2000 or Windows XP  
CD-ROM containing digital version of 1:10 000 000 scale International Metallogenic Map of Europe printed in 1997 by Norway Geological Survey (NGU) and CGMW. The ESRI data sets are accessible using included ArcReader software. This light version of a GIS software gives the user the possibility to zoom in and out with access to different layers. The base map data are obtained from Digital Map of the World from ESRI. Contains necessary data sets to reconstruct the printed version of the map using other GIS softwares compatible with ArcInfo coverage, shapefiles and dxf files. Gives geographical access to the Mineral Atlas database. An ESRI ArcMap document file (mxd-file) is included for ESRI ArcGIS software. For info: [Per.Ryghaug@ngu.no](mailto:Per.Ryghaug@ngu.no); [www.ngu.no](http://www.ngu.no)

### Solar detoxification

Eds J. Blanco Gálvez and S. Malato Rodriguez, Renewable Energies Series (English only), ISBN 92-3-103916-4, UNESCO Publishing, 24.80 euros, 188 pp.  
An innovative process of water treatment using solar technology, solar detoxification is ready for practical application after a decade of R&D. A compilation of present knowledge together with an in-depth explanation of the 'state of the art' engineering and applications. Describes the necessary conditions for, and limitations of, solar photocatalytic processes. Targets university students, post-grads, professionals and technicians.

### Glosario Fitoecológico de las Américas

Mexico, Central America and Caribbean islands: Spanish-speaking countries (Vol. 2) Edited by Otto Hubert and Ricardo Riina. UNESCO Publishing/ Corolab Humboldt Publishing (16.80 euros), ISBN: 92-3-303922-6. Exists in Spanish only, 474 pp.  
Contains 3,500 phyto-ecological terms, a reference work on the science of neotropical vegetation for botanists, ecologists, conservationists, biologists, etc.

### Tasks for Coastal Resources Assessments and Oil Spill Sensitivity Mapping in the Arab States of the Gulf

By A. Price, D. Gliddon, T. Zahran Al Abdessalaam and B. Boer  
Covers national status and needs, future options for UNESCO support, protection priority index maps, national coastal resource datasets, standards in data collection and processing, coastal habitat guide to promote environmental awareness. Request from Doha: [b.boer@unesco.org](mailto:b.boer@unesco.org)

## Governing Bodies

**At its April session, the Executive Board approved the Statutes of the International Basic Sciences Programme (IBSP) and its timetable for the coming year.**

The first task of the new Scientific Board, the members of which are to be appointed by August, will be to finalize the criteria and format for project proposals. This information is then to be circulated to Member States and interested partners in October. The project proposals are due to be evaluated by the Scientific Board in January, in order for those which are approved to be included in UNESCO's Programme and Budget for 2006–2007.

The Director-General will be reporting to the Executive Board on the development of the IBSP in October 2005.

The Board also considered the elaboration of a declaration on universal norms in bioethics to be a priority for UNESCO. It invited the Director-General to pursue consultations with all relevant UN and other multilateral organizations, including FAO, WHO, WIPO and WTO. The Director-General will be reporting on progress to the Board at its next session from 4 to 14 October.

The progress report the Director-General was due to make on the feasibility study for a regional centre for biotechnology and training in India has been rescheduled for the Board's next session.

For sales publications:  
[www.unesco.org/publishing](http://www.unesco.org/publishing)

UNESCO science portal:  
[www.unesco.org/science](http://www.unesco.org/science)