



United Nations Educational,
Scientific and Cultural Organization

Killer wave p. 2

A World of **SCIENCE**

Natural Sciences
Quarterly Newsletter

Vol. 3, No. 2
April–June 2005

IN THIS ISSUE

IN FOCUS

2 Killer wave

NEWS

9 Island agenda

9 UNESCO and NASA
strengthen ties

10 Five nano-giants celebrated

11 Scientific advisory body for
CBD mooted

12 Shipment for Iraqi universities

INTERVIEW

13 Four young scientists on why
their opinions should be
canvassed

HORIZONS

16 Controlling malaria, the vampire
of the technological age

20 The knowledge that saved the
sea gypsies

IN BRIEF

24 Diary

24 New releases

24 Governing bodies

EDITORIAL

The cost of playing the waiting game

Until 26 December, the World Conference on Disaster Reduction was just another rendez-vous on the United Nations calendar. On the first anniversary of the Bam tragedy, memories were fading of the 6.5 magnitude earthquake which had destroyed 80% of the ancient city in 12 seconds.

Then, 23 days before the Kobe conference got under way on 18 January, an underwater earthquake in the Indian Ocean generated the most destructive tsunami in living memory. Instantly, languishing plans for a tsunami early warning system for the Indian Ocean shot up the conference agenda. Within days, UNESCO could count on the support of numerous organizations and countries for the new warning system, the same one UNESCO had first proposed several years earlier. Given that the last ocean-wide tsunami in the Indian Ocean went back to 1883, the system had not been considered a priority; not, that is, until last December's earthquake and tsunami killed quarter of a million people in a single day.

The tsunami early warning system for the Indian Ocean should be in place by 2007. In this issue, we look at what the new system will entail and at progress thus far.

Meanwhile, in Bam, reconstruction is progressing slowly. The Iranian authorities have reiterated their intention to ensure that seismic building codes are observed. This should make the new structures as resilient to earthquakes as those of Fukuoka on the island of Kyushu (Japan), which suffered an earthquake of magnitude 7 as recently as 19 March. More than 26,000 people were killed in Bam; one person in Fukuoka. As Charles Richter, inventor of the scale of earthquake magnitude measurement, puts it, 'Earthquakes don't kill people, buildings do'.

We may not be able to predict natural hazards but we do know how to minimize loss of life and property, through building codes, zoning, early warning systems and other forms of disaster preparedness and prevention. Yet, so often, the temptation is to wait until disaster strikes to act. We are like the man with a hole in his roof who, when asked why he doesn't have it repaired, answers, 'when it's raining, the roof cannot be fixed; when it is not raining, there is no need to'.

Some may argue that prevention has a cost. They would be right. It does. The cost of instigating the Indian Ocean tsunami early warning system has been estimated at \$30–50 million. But that is a drop in the ocean compared to the bill for recovery from last December's megatsunami. And no amount of reconstruction will bring back the dead.

W. Erdelen

Assistant Director-General for Natural Sciences



Killer wave

In the days following the catastrophic tsunami of 26 December in the Indian Ocean, UNESCO launched a series of consultations with countries from the region for an early warning system similar to that which protects the earthquake-prone Pacific Rim. On 14 January, UNESCO proposed a system for the Indian Ocean that would cost \$30–50 million to build and could be operative by 2007. A project hub was set up by UNESCO at the Institute of Meteorological Research in Tsukuba (Japan). Governments meeting at UNESCO Headquarters from 3 to 8 March formed an intergovernmental

co-ordinating group for the Indian Ocean tsunami warning system within UNESCO's Intergovernmental Oceanographic Commission (IOC). All countries bordering the Indian Ocean were urged to establish a national tsunami warning centre or operational contact point capable of receiving and responding to an alert at any time. A second co-ordination meeting is due to take place from 14 to 16 April in Mauritius.

Since, to be truly effective, any early warning system must be global in scope, the tsunami warning system for the Indian Ocean is being developed within an International Early Warning Programme launched by the United Nations on 19 January to improve resilience worldwide to all types of natural hazards.

The 9.2-magnitude earthquake which caused the Indian Ocean tsunami was the fourth-largest in the world since 1900 and the largest since the 1964 earthquake at Prince William Sound in Alaska. Situated close to the Sumatra trench, it lifted the sea floor 6 m over a distance of 1000 km and a width of 130 km, displacing trillions of litres of water and inundating coastlines thousands of kilometres from the epicentre. It was the first ocean-wide tsunami to strike the Indian Ocean for 120 years and by far the world's most lethal in recorded history.

We may never know the exact number of victims but more than 270 000 are dead or missing, many of them children. A further 5 million people have been left without a livelihood or any basic services, an easy prey for deadly epidemics.

Three-quarters of the victims lived on the northern tip of the Indonesian island of Sumatra in the province of Aceh. Just 65 km from the epicentre of the underwater earthquake, Aceh was hit 31 minutes after the earthquake. The shock

waves from the earthquake itself were so violent that an estimated 20–40% of the victims from the coastal town of Banda Aceh were dead before the tsunami reached its shores.

Even had an early warning system been in place, the Aceh population could not have been alerted in time. But tremor and tidal gauges, rapid data transfer, alarm mechanisms and training in the danger zones would have provided ample time for thousands of people to flee to higher ground in the other countries hit by the tsunami over the next 12 hours. These countries included Sri Lanka (more than 30 000 fatalities), Thailand (*ca* 16 000), India (*ca* 10 000), Bangladesh, Malaysia, Myanmar and the Maldives and even the distant shores of Kenya, Somalia and Tanzania. In Kenya, where radio and television stations had warned the population three hours in advance of the oncoming tsunami after discovering news reports on satellite television, there was only one loss of life. In neighbouring Somalia where no word was received of the approaching tsunami, 300 lives were lost 8 hours after the earthquake.



Before and after satellite photos provided by Digitalglobe.com (dated 23 June and 28 December 2004) show the devastation to Banda Aceh's shoreline. Accurate geospatial information is indispensable during disaster response and recovery. In January, the Pacific Disaster Center in Maui (USA) launched the Indian Ocean Tsunami Geospatial Information Service to support emergency managers responding to the disaster in Asia. The service provides geospatial information that includes baseline Landsat imagery, SRTM-derived shaded relief images, LANDSCAN-derived population density, detailed coastlines, damage polygons and high-resolution imagery as it becomes available. The new service is part of the Center's Asia Pacific Natural Hazards Information Network: <http://laphin.pdc.org>



The Earth's surface is a mosaic of seven large and many small moving plates (left). Each about 80 km thick, these plates move a few centimetres a year on average in relation to one another. At the boundaries between plates, there are three types of movement: transform-fault, divergent and convergent (see diagram above courtesy of USGS). At convergent boundaries, plates move toward each other and collide. Where an oceanic plate collides with a continental plate, the oceanic plate tips down and slides beneath the continental plate, forming a deep ocean trench that is long and narrow. This type of movement

is called subduction and was responsible for the earthquake off the coast of Sumatra last December. When the India plate moved beneath (subducted) the overriding Burma plate, this caused an upward movement of the Earth's crust which displaced huge quantities of water, thereby generating a tsunami



A temporary refugee camp set up after the tsunami, at Ko Surin Park Headquarters in Thailand for the 'sea gypsies' of the Andaman Sea, with material provided by the international NGO Care. See how the sea gypsies fared on page 20

bunching of debt repayments once the suspension was lifted. World Bank president James Wolfensohn himself commented that debt write-offs would be a 'better idea' than just halting payments but that it was up to creditor nations to decide what course of action best suited them (*Financial Times*). Ultimately, only Sri Lanka, Indonesia and the Seychelles expressed interest in benefiting from the debt moratorium.

Aid must not be diverted from crises elsewhere

While praising the tsunami-related donations – pledges from governments and private parties totalled \$7 billion a fortnight after the disaster – Egeland also expressed the hope that donors would not divert aid away from crises in other parts of the world. A number of aid agencies and NGOs shared his concern, such as the spokesperson of the Canadian Council for International Cooperation, an umbrella organization working with several Canadian aid agencies. Recalling the 2002 meeting in Alberta (Canada) of G8 countries, Katia Gianneschi commented, 'When you look at the commitments to Africa in Kananaskis, it was supposed to be a priority but it has been side-swiped by commitments to Afghanistan and Iraq'.

A global response to a global disaster

Tsunamis were recorded as far away as South Africa, Australia, New Zealand, Antarctica and along the west and east coasts of South and North America. Damage was also reported in Madagascar and Mauritius. Among the dead in Thailand figured about 2500 foreigners, many of them tourists holidaying from as far away as Sweden. 'The tsunami was an unprecedented, global natural disaster,' Koffi Annan said at the World Conference on Disaster Reduction in Kobe (Japan) on 18 January. 'I think we are already seeing an unprecedented, global response'. He was referring to the wave of generosity around the world in the days following the disaster. Populations shocked by the tragedy plunged their hands deep into their pockets. Spontaneous donations poured into aid agencies and NGOs as they rushed teams into the affected countries.

At a donor's conference in Jakarta on 6 January, the United Nations requested \$977 million for its tsunami relief effort. The funds were earmarked for shelter, food, health, water and sanitation, economic recovery and infrastructure. A week later, one-third of this amount had been delivered, according to Jan Egeland, the world body's emergency relief co-ordinator.

On 7 January, the finance ministers of the world's seven most industrialized countries (G7) agreed to suspend debt repayments by tsunami-afflicted nations for one year, a move backed by the International Monetary Fund and World Bank. Financial analysts expressed doubts, however, as to the benefits of the moratorium, fearing it could undermine a country's credit worthiness and lead to an uncomfortable

The Director of the UN Millennium Project, Jeffrey Sachs, told Associated Press on 17 January that 'we have the world's eyes focused on the tsunami of the Indian Ocean but the world continues to overlook the silent tsunamis of deaths from malaria which take every month the number of people that died in the Asian tragedy'. One recommendation of the Millennium Project is for rich countries to double their aid to poor countries to an average of 0.5% of their national

Faisal in front of what was once the Nikoya FM Radio Station in Banda Aceh. The earthquake and tsunami killed four members of his family, including his father who owned the station



Tsunami Warning System in the Pacific



A Chilean DART buoy about to be anchored 150 km off the coast of Iquique in northern Chile, in water 4967 m deep

Located in Honolulu (USA), the International Tsunami Information Center was established in 1965 by UNESCO's IOC. Three years later, the IOC formed an International Co-ordination Group for the Tsunami Warning System in the Pacific that is today made up of 26* Member States. The group meets every two years to review activities and adopt the programme for the next biennium. The International Tsunami Information Center co-ordinates tsunami technology transfer among Member States interested in establishing regional and national tsunami warning systems, and acts as a clearing house for tsunami preparedness and mitigation activities.

The Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC) serves as the warning system's operational head quarters. It is run by the US National Oceanographic and Atmospheric Administration (NOAA).

The warning system disseminates tsunami information and warning messages to well over 100 points scattered across the Pacific. To detect and locate potentially tsunamigenic earthquakes, the system makes use of real-time seismic stations, coastal tide gauges deployed by more than 12 institutions from seven countries and sophisticated Deep-ocean Assessment and Reporting of Tsunamis (DART) buoys deployed in the Pacific Basin which are capable of detecting a centimetre's difference in ocean height. Without similar real-time sea-level stations in the Indian Ocean, the PTWC was unable to confirm that large waves had formed in this zone on 26 December.

On 14 January, NOAA announced plans to expand the US tsunami detection and warning capabilities as a contribution of the Global Earth Observation System of Systems (GEOSS). The plan commits \$37.5 million over the next two years to deploying 32 new DART buoys in the Pacific basin by mid-2007, bringing the total to 38.

Other countries participating in the system are operating national or regional warning centres. The Japan Meteorological Agency provides tsunami warnings to Japan and to the Republic of Korea and Russia for events occurring in the Sea of Japan or East Sea. The *Centre Polynésien de Prévention des Tsunamis* provides warnings in French Polynesia. The *Sistema Nacional de Alarma de Maremotos* does the same in Chile, as does the Russian Hydrometeorological Service. Australia, Colombia, Nicaragua, Peru and the Republic of Korea are also developing warning capabilities. Two additional DART buoys are deployed in the Pacific by Chile.

For details: <http://ioc.unesco.org/itsu/>

* Australia, Canada, Chile, China, Colombia, Cook Islands, Costa Rica, Democratic People's Republic of Korea, Ecuador, El Salvador, Fiji, France, Guatemala, Indonesia, Japan, Mexico, New Zealand, Nicaragua, Peru, Philippines, Rep. of Korea, Russian Federation, Samoa, Singapore, Thailand, USA

income, to change trade rules and target areas like slum upgrades and scientific research with their funding.

Could the wave of generosity following the Indian Ocean tsunami be more than a flash in the pan? For the first time, the G7 meeting in London on 5 February offered to relieve up to 37 mainly African countries of 'as much as 100%' of the debt they owe to international organizations such as the World Bank and International Monetary Fund. The ministers

diverged, however, on how to finance these policies. They now have until the next G7 summit in July to agree on a package for African debt relief.

Tsunamis move up Kobe agenda

That the conference on disaster reduction took place barely three weeks after the tragic Indian Ocean tsunami was a pure coincidence. The conference had long been planned as a forum for discussing disaster reduction in general. Kobe had been chosen as host in commemoration of the earthquake which had struck the city a decade earlier, on 17 January 1995. The biggest to hit Japan for 47 years, the earthquake had measured a magnitude of 7.2 and killed more than 6400 of Kobe's 1.5 million inhabitants. The city has since been totally rebuilt but a recent survey by the Kobe municipality has revealed that 48% of the population still feels its standard of living has dropped. The risk of a serious earthquake striking Tokyo in the next 30 years has been evaluated at 50%. Prior to 17 January 1995, the probability for Kobe had been evaluated at just 8%.

Japan is disaster-prone in more ways than one. The word 'tsunami' is, after all, of Japanese origin (*tsu* means 'port' and *nami* means 'wave'). Japan is highly vulnerable to tsunamis because its eastern and southern coasts face the vast expanse of the Pacific Ocean. With no land to stop it, a distant tsunami can sweep across thousands of kilometres of ocean to Japan's shores.

The Indian Ocean tragedy moved tsunamis up Kobe's conference agenda. At a special session, delegates pledged support for a regional tsunami early warning system in the Indian Ocean which would draw on the experience of the Pacific Ocean tsunami early warning system co-ordinated by UNESCO's IOC since 1968 (see box).

UNESCO argues for global warning system

UNESCO had been arguing the need for an early warning system for the Indian Ocean for several years. However, Member States had not seen the urgency at the time, given the rarity of tsunamis in the region, the lack of resources



School buildings in the Maldives devastated by the tsunami. A new Coalition on Education is set about improving the safety of school buildings in a disaster (see p.8)

in many countries, a long list of other priorities and the fact that about 85% of the world's tsunamis occur in the Pacific.

The head of ocean services at the IOC, Peter Pissierssens, explained why UNESCO favoured a global early warning system for ocean-related natural disasters over a system uniquely for the Indian Ocean. 'The odds are higher of the next major tsunami occurring outside the Indian Ocean, although of course we can never be sure', he said. 'Other unprotected regions are also at risk, such as the Caribbean, the Mediterranean and the South-West Pacific'.

Pissierssens stressed the importance of a co-ordinated effort to avoid countries and international organizations duplicating effort and investment. 'Generally speaking', he said, 'any early warning system for ocean-related natural disasters should be designed to detect multiple hazards that include fairly frequent events like tropical cyclones, storm surges, etc. There is the risk with an early warning system for a single hazard that this system may only need to be activated once in a decade or even once in a lifetime, making it harder to maintain a high level of preparation and vigilance.'

A number of countries bordering the Indian Ocean, including India, Indonesia, Thailand and China, announced their intention in Kobe of setting up national tsunami warning systems. Pissierssens cautioned that national systems might be adequate for local tsunamis but could not cope with massive tsunamis like the one last December.

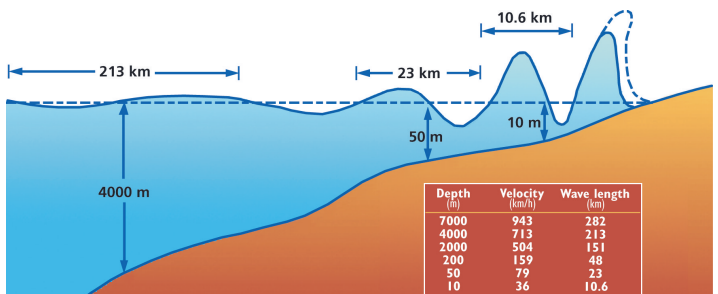
An interim system for the Indian Ocean

Pissierssens calculated that an interim tsunami early warning system for the Indian Ocean would be operational within six months, although the long-term system would not be ready until 2007. The interim system will utilize sensors already deployed in the Indian Ocean to monitor changes in sea level and earthquakes. This equipment will need updating and modernizing, as it has been designed to monitor longer term change, such as that caused by climate change, rather than sudden changes in sea level.

UNESCO Director-General Koïchiro Matsuura informed delegates to Kobe of a number of regional and international meetings being organized over the coming weeks to support the implementation of the Indian Ocean system. The first of these took place on 29 January at the seaside resort of Phuket, the centre of relief operations in Thailand, where 250 people had perished. In Phuket, Matsuura announced progress towards an interim system for the Indian Ocean in a speech delivered by IOC Executive-Secretary Patricio Bernal. He told ministers attending the regional meeting that, 'through a joint project with the United Nations International Strategy for Disaster Reduction (ISDR) [...], which has received financial support from Japan, the European Union and Sweden, we are planning the installa-

tion of six tsunami-enabled sea-level stations in the eastern Indian Ocean and the upgrading of 15 more in the whole basin'.

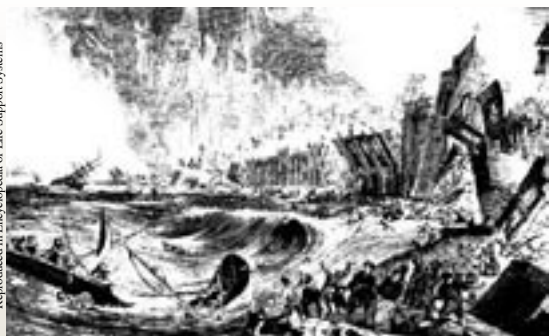
One proposal under consideration for the interim system would involve the Japanese Meteorological Agency and IOC Pacific Tsunami Warning Center providing national authorities in the Indian Ocean region with information and warnings arising from their own monitoring activities. UNESCO is also working with the Asian Disaster Preparedness Centre in Thailand and the Asian Disaster Reduction Centre in Japan to accelerate the translation and adaptation of public awareness-building materials developed for, and widely used, in the Pacific region.



In deep water, tsunami waves are low and long. They may even be imperceptible to people on boats. As they approach the shore, the waves lose speed, shorten in length and gain greatly in height. The fact that the water off Phuket was fairly shallow explains why the tsunamis took the same amount of time to hit both the Thai coastal resort and the more distant Sri Lankan shores. We know the height of the December tsunami thanks to four Earth-orbiting radar satellites, the data from which were analysed by scientists: two hours after the quake, the wave was 60 cm high. By 3 hours 15 minutes after the quake, it had dropped to around 40 cm high. By 8 hours 50 minutes after the quake, the wave had spread over most of the Indian Ocean and was quite small in most places (5–10 cm). The ability to make depth surveys from space may lead to better models for forecasting the hazardous effects of tsunamis

The Director-General stressed that a successful warning system required 'open, free and unrestricted exchange of data and information'. Other vital elements, he said, were the preparation of civil populations and the need to design early warning systems according to local conditions. 'For example, in Aceh, the rapid delivery of warning messages could well exploit the wide distribution of Islamic mosques with established loud-speaker systems. In other countries and local environments, alternative approaches may need to be employed, including local radio and traditional village communication structures.'

'Any early warning system', he recalled, 'goes far beyond the installation of seismic equipment to measure and pinpoint earthquakes. This equipment is already largely in place right around the globe. What is missing are the communication networks, public awareness and national disaster planning that are essential to alert populations quickly, to teach people what they can do to help themselves, to evacuate threatened areas rapidly and to look after the immediate needs of the wounded or displaced'.



Etching entitled Earthquake in Lisbon in 1755. The tsunami killed 60 000 Portuguese and even lashed Caribbean shores

Tsunamis are often mistakenly referred to as 'tidal waves'. They are in fact seismic sea waves of much greater force than the common sea wave. Some 95% of tsunamis are caused by submarine (underwater) earthquakes, followed by landslides (close to 5%) and other phenomena.

Submarine earthquakes

The epicentre of underwater earthquakes is located below the ocean floor in the Earth's crust. Many large submarine earthquakes are able to generate tsunami waves, as long as the earthquake results in an upward movement of a block of the Earth's crust (see diagram, p. 3)

Tsunamigenic earthquakes (i.e. tsunami-making) are characterized by high energy of a magnitude of over 7. None of the many aftershock earthquakes in Indonesia, Nicobar and the Andaman Islands in the days following the 9.2 magnitude earthquake of 26 December generated tsunamis, even though at least 27 of these were of a magnitude greater than 5.4. Sometimes, smaller earthquakes may trigger underwater landslides capable of generating tsunamis but these tsunamis generally only affect the area very near to the source (see Landslides below).

Today, scientists are unable to predict when the next large submarine earthquake will occur, what its size will be and whether a tsunami will be generated. Major earthquakes are a rare occurrence.

Landslides

Landslides may occur on the coast or under the sea. In the latter case, the long-term accumulation of sediments on the ocean floor causes these to become unstable. Any weak perturbation, such as a micro-earthquake, meteorological disturbance, tide, sustained rain- or snowfall, or the flooding of a river, then suffices to cause these sediments to collapse and slide into deeper waters. A connection has recently been made between submarine landslides and the tide. The majority of landslide tsunamis occur at extremely low tide. They tend to cause local or regional tsunamis but these are never ocean-wide.

Some landslides can cause extremely high tsunami waves that pose a real danger to the coastal population. These waves may be triggered by the caving in of the coast, by the breaking away of a marine glacier into the sea or by a snow avalanche. The large landslide in Lituya Bay (Alaska, USA) caused by an earthquake on 9 July 1958 contained a mixture of rock debris and ice blocks that generated a tsunami wave with trough-to-crest wave heights of about 60 m. Trees as high as 525 m above the entrance to Gilbert Inlet were washed out. Quite a number of tsunamis generated by landslides and/or landfalls have been observed on the shelf off the south-eastern Alaska coast, near the coast of Canada, as well as in Norway, France and Italy. A landslide induced by an earthquake may amplify the action of the tsunami wave. The 10 m-high tsunami of 17 July 1998 near Papua New Guinea proved more devastating than expected (2182 fatalities) because the 7.1-magnitude earthquake generated a submarine landslide which amplified the tsunami wave.

Volcanic eruptions

The explosions of volcanic islands and explosive eruptions of submarine volcanoes may give rise to great disturbances on the ocean surface. The explosion of Tire Island 3600 years ago is believed to have induced a des-

What causes tsunamis?

tructive tsunami that destroyed the mythical city of Atlantis. The explosion of the Greek Santorini Volcano and resulting tsunami destroyed the Crete-Mycenean civilization.

Of the 933 active burning volcanoes around the world, 195 are submarine. During a submarine volcanic eruption, gaseous products form a gas bubble in the water. This bubble contains hot volcanic fumes and steam at high pressure; it expands and rises to the water surface, thereby raising the sea level locally. The energy accumulated in the gas bubble changes into kinetic energy which gives rise to the tsunami wave. The gas bubble may take the form of a sphere (central volcano eruption) or of a cylinder (fissure eruption).

This photo of Krakatau was taken on 26 August 1883 on board a ship crossing the Sunda Strait between the islands of Java and Sumatra just hours before the volcano's main explosion. The eruption generated tsunami waves which rose to 40 m in the narrow Sunda Strait, which was barely 22 km wide in parts and only 200 m deep on average. The huge tsunami wiped out dozens of towns and villages, killing nearly 36 000 people. This was the last ocean-wide tsunami to occur in the Indian Ocean before 26 December 2004. Historically, submarine volcanic eruptions of this magnitude occur only once every 1000 years



An atmospheric disturbance

Meteotsunamis are caused by an abrupt change in atmospheric pressure, such as the passing of a cold front (squall), deep cyclone, typhoon, or hurricane. The typical length of low-frequency acoustic waves in the atmosphere is several kilometers and may sometimes reach 1000 km (as with the Krakatau explosion).

A cosmic body hitting the ocean

Around 70% of meteorites land in the ocean. Many geological structures in the shape of rings and circles discovered on all continents have been explained only in the last 30–40 years as craters created by the impact of a celestial body hitting the Earth. Such structures are called astroblema (the starry wound) and contain shock-metamorphosed rock. Over 150 similar crater-like objects with a size ranging from 1.2 km (Arizona crater, USA) to 100 km (Popiguy astroblema, East Siberia, Russia) have been found on the Earth. Estimations show that the fall of a meteorite into the ocean may lead to an intensive and long-term disturbance of the water surface that is capable of generating a tsunami wave.

Decomposition of a gas hydrate

Gas hydrates are a compound of natural gas (methane) and water found in the ocean. One volume of gas hydrate may contain up to 30 volumes of gas. Gas hydrates form what look like jagged solid crystals in stable conditions but a quick rise in temperature or drop in pressure, such as that caused by a micro-earthquake, volcanic eruption, an abrupt (relative) sea-level change, meteorite impact or nuclear explosion, may cause the gas hydrate deposit to decompose rapidly, releasing an immense volume of greenhouse gases in the process and thereby increasing the probability of a tsunami-inducing landslide.

Gas hydrate deposits have been found in the deep (outer)shelf areas of all the Earth's oceans, as well as under interior seas and lakes. In the polar regions, the gases in bottom sediments turn into gas hydrates from depths of 100–250 m; in the Tropics, this process begins at a depth of 400–700 m. Gas hydrate deposits occupy large areas: a strip off the Atlantic coast of the USA, for example, covers an area of 80 000 km².

Adapted from the Encyclopedia of Life Support Systems published in 2002 by EOLSS Publishers and UNESCO. Available online: www.eolss.net

Plans for a global early warning system

In Kobe on 19 January, the United Nations announced plans for a global early warning system to reduce the deadly toll of all types of natural hazards, be they droughts, wildfires, floods, typhoons, hurricanes, landslides, volcanic eruptions, earthquakes or tsunamis. The system will combine speedy data transmission with the training of populations at risk.

This multi-hazard International Early Warning Programme had first been proposed at the Second International Conference on Early Warning two years ago in Bonn (Germany). It rose to the top of the disaster relief agenda after 26 December.

The International Early Warning Programme brings together UNESCO, the World Meteorological Organization (WMO), the World Food Programme (WFP), the UN Environment Programme (UNEP), ISDR and other bodies such as the German Disaster Reduction Committee.

Effective early warning systems have been widely recognized as a worthwhile and necessary investment. Coupled with humanitarian aid and better preparedness, these have slashed the number of people dying from famine and saved 2 million lives over the past 20 years. In 2004, for example, millions of people in the Americas and Asia were evacuated when tropical storms struck, undoubtedly saving thousands of lives.

... and an International Flood initiative

Also launched in Kobe was the International Flood Initiative involving UNESCO, WMO, the United Nations University, ISDR and the International Association of Hydrological Sciences. The initiative will promote an integrated approach to flood management to maximize the long-term benefits of floods and minimize the hardship, loss of life and damage to goods and assets resulting from floods.

The Initiative will focus on improving early warning systems for weather and water events through risk assessment, hazard detection, awareness-raising and education about disaster prevention of communities at risk research. It will also advocate good governance and provide technical assistance. The headquarters for the new project will be based at a planned Centre for Water Hazard and Risk Management (ICHARM) to be hosted by the Public Works Research Institute in Tsukuba, Japan.

Technology alone won't suffice

Speakers in Kobe acknowledged that early warning systems alone were insufficient and needed to be complemented by hazard assessment, disaster management plans and education.

How did biosphere reserves and world heritage sites fare?

UNESCO's Man and the Biosphere Programme was grieved to learn of the death of 15 staff members of the Gunung Leuser Biosphere Reserve after the passage of the December tsunami. The staff were employed by the Nature Conservation Unit at Banda Aceh. This biosphere reserve and national park covers a vast area of tropical rain forest in northern Sumatra. It is home to many different ethnic groups and provides a haven for the Sumatran rhinoceros (*Dicerorhinus sumatrensis*), Sumatran tiger (*Panthera tigris*) and Asian elephant (*Elephas maximus*).

Several sites inscribed on UNESCO's World Heritage List were hit by the tsunami. Among the damaged cultural sites are the Old Town of Galle and its Fortifications in Sri Lanka and, in India, Mahabalipuram and the Sun Temple of Koranak. Natural sites damaged include the Ujung Kulon National Park and Tropical Rainforest of Sumatra, both in Indonesia. At Ranong Biosphere Reserve in Thailand, no damage to mangroves was reported.

UNESCO is studying the disaster's impact on the biosphere and examining ways in which man-made environmental damage, such as deforestation or the destruction of mangroves (see box p. 8) and coral reefs in the affected countries, may have aggravated the impact of the tsunami.

Since disasters can be particularly destructive in megacities, an open Alliance of Megacities was formed in Kobe to bring municipal authorities from megacities around the world together to develop city disaster management plans. Sixteen of the world's 19 megacities lie on the coast.

For Bernal, 'what is especially at stake is the issue of governance'. Recalling that 60% of the world population lives on the coast, he cautions that, 'rules must be made to cover the construction and development of coastal areas and afterwards there must be checks that these rules are being respected'. He gives an example. 'A methodology has been developed to produce computer models that chart flooding by tsunami waves. These charts are usually produced by the national tsunami warning centres of each country in the Pacific system. It is then up to the national authorities in charge of managing emergencies whether they use them or not'.

A tale recounted by a Japanese expert in Kobe illustrates the importance of education and public awareness. When the last tsunami struck the archipelago in March 2002, the expert said, the sophisticated sensors located far offshore worked perfectly. Alerted by these, Japanese meteorologists had been able to detect a tsunami heading towards the southern island of Ishigaki and give the alarm. Forewarned of the approaching tsunami and instructed to head to safety on higher ground, the islanders had ... gone down to the beach to watch. Fortunately, it was a micro-tsunami and no-one was hurt.



Destroyed tourist resort at Khao Lak in Phang Nga Province, Thailand. Homes and hotels constructed in places not traditionally inhabited were often the most exposed and the most extensively damaged

Nature's protection from nature's fury

In the days following the Indian Ocean tsunami, accounts poured in to Asian media testifying that populations living behind mangroves and coastal swamp forests had suffered less from the Indian Ocean tsunami than populations living directly on the shoreline.

'Dense mangrove forests growing along the coasts of tropical and sub-tropical countries can help reduce the devastating impact of tsunamis and coastal storms by absorbing some of the waves' energy', wrote V. P. Upadhyay et al. in *Current Science* on 30 December. 'When the tsunami struck India's southern state of Tamil Nadu on 26 December, for example, areas in Pichavaram and Muthupet with dense mangroves suffered fewer human casualties and less damage to property compared to areas without mangroves'.

Upon his return from visiting mangrove forests in Chennai on 8 January, Dr V Selvam, Project Director for Mangroves within the M S Swaminathan Research Foundation in India, told the *Deccan Herald* that, 'except the frontline trees, 99% of the trees are in good health'. The Chairman of the Foundation that bears his name added that 'our anticipatory research work to preserve mangrove ecosystems as the first line of defence against devastating tidal waves on the eastern coastline has proved very relevant today. The dense mangrove forests stood like a wall to save coastal communities living behind them.'

Despite the fact that mangroves have been shown to protect coastal areas not only from tsunamis but also from erosion, flooding, cyclones, typhoons and tidal waves – Swaminathan calls them 'bioshields' – many mangroves and swamp forests have been torn down in recent decades to make way for hotels and other construction. For marine scientist

Prof. J.H. Primavera from the Philippines, 'it is time we heeded nature's laws and replaced our stereotype of a romantic but vulnerable palm beach devoid of other vegetation with the lush forest greenbelt that our coastlines used to have'. Underscoring the breakwater effect of mangroves, she observes that 'a greenbelt of bungalow/pagatpat mangroves and talisay/bitoon beach forests will mitigate the impact of 15 m waves – nature's protection from nature's fury'.

UNESCO is currently drawing up a regional strategy for coastal fauna and flora restoration to build natural protection systems that will mitigate the force of possible future tsunamis. Entitled Post-Tsunami Actions for Conservation and Sustainable Resource Rehabilitation of Coastal Ecosystems, the programme will be implemented jointly by the Division of Ecological and Earth Sciences and UNESCO's Jakarta office.

This programme will complement the mangrove training courses run by UNESCO and the United Nations University over the past three years, the next of which is planned for 15–29 June in India.

Miguel Clüsener-Godt¹

On the mangrove training courses: www.inweh.unu.edu/inweh/Training/Mangroves.htm



©UNESCO/Elmas

Trawlers at Khuraburi port in Phang Nga Province (Thailand), the worst-hit of Thailand's six Andaman coastal provinces, in January. Much of the large fleet based here was spared the damage wreaked by the tsunami, thanks to the location of the port among an extensive and well-preserved mangrove ecosystem which buffered much of the coastline

The small island of Simeulue off the Sumatran coast, on the other hand, was the scene of an exemplary reaction by its 65 000 inhabitants, who possessed no sophisticated warning system. Tales of tsunamis had been passed down for generations, ever since a megathrust earthquake and its tsunami killed 1800 islanders in 1907. Simeulue lay just 44 km south of the epicentre of last December's earthquake. When people saw the tide suddenly withdraw, they gave the alert. All but seven islanders chose to run for the hills. All but seven were spared. A similar exploit was realized by the 'sea gypsies' of the Andaman Sea (see p. 20).

The geography lesson that saved 100 lives

There was also the widely reported tale of ten-year old Tilly Smith from the UK, who had been sitting on Mai Khao beach in Phuket on 26 December when the tide suddenly rushed out and boats began bobbing up and down on the horizon. Recalling a recent geography lesson at school on giant waves, Tilly had urged her mother to leave the beach, telling her, 'I think there is going to be a tsunami.' Tilly's parents had hastily alerted others and within seconds the beach was deserted. Mai Khao turned out to be one of the few beaches along the Thai coast where no one was reported killed or seriously injured.

Discussions on disaster preparedness in Kobe culminated in A Coalition on Education to be led by UNESCO which will incorporate disaster reduction education into school programmes and improve the safety of school buildings.

The coalition will bring together governments, UN agencies and specialized academic institutions.

10-year plan for disaster-prone countries

The Kobe conference wound up on 22 January with the adoption of an action plan by 168 national delegations. The *Hyogo Framework of Action to 2015* focuses on strengthening the capacity of disaster-prone countries to address risk and invest heavily in disaster preparedness. 'The critical ingredient is political commitment', Egeland noted. Isn't it always?

Susan Schneegans

Hyogo Framework for Action: www.unisdr.org/wcdr/;
on the early warning system for the Indian ocean:
<http://ioc.unesco.org/indotsunami/>;
on UNESCO's contribution to Kobe follow-up:
b.rouhban@unesco.org; www.unesco.org/disaster/

1. Programme specialist in the ecological sciences for coastal zones and islands (MAB): m.clusener-godt@unesco.org

Island agenda

The 10-year review of the UN Barbados Programme of Action for the sustainable development of Small Island Developing States (SIDS) wound up on 14 January. The two principal negotiated outputs are the *Mauritius Strategy* and *Mauritius Declaration*. Also of note is the agenda adopted by a UNESCO-facilitated side event for youth, which came up with no fewer than 43 project proposals.

Concerned that the vulnerability of SIDS will grow unless urgent steps are taken, the *Mauritius Declaration* reaffirms the world's commitment to supporting the efforts of SIDS to embrace sustainable development. The *Declaration* recognizes that the tragic Indian Ocean earthquake and tsunami and recent hurricane season in the Caribbean and the Pacific highlight the need to develop and strengthen effective disaster risk reduction, early warning systems and capacities for emergency relief and reconstruction. The text welcomes the proposal by the Special ASEAN Leaders Meeting on 6 January to establish a regional natural disaster early warning system for the Indian Ocean and Southeast Asia. Further, it commits to full implementation of the UN Framework Convention on Climate Change and to promoting international co-operation on climate change.

The *Declaration* recognizes that particular attention should be paid to building resilience in SIDS, including through technology transfer and design and human resource development. It further recognizes that international trade is important for building resilience and sustainable development and, therefore, calls upon international financial institutions to attend to the structural disadvantages and vulnerabilities of SIDS. The *Declaration* underscores that attention should be focused on the specific trade- and development-related needs of SIDS to enable them to integrate fully the multilateral trading system in accordance with the Doha mandate on small economies. The text goes on to address women, youth, conservation of marine biodiversity, the importance of cultural identity, HIV/AIDS, and commits to timely implementation of the *Mauritius Strategy*.

The *Strategy* states that the Barbados Programme remains the 'blueprint' for the sustainable development of SIDS and elaborates on a wide variety of actions under 20 broad headings: climate change and sea-level rise; natural and environmental disasters; management of wastes; coastal and marine resources; freshwater resources; land resources; energy resources; tourism resources; biodiversity resources; transport and communication; science and technology; graduation from least developed country status; globalization and trade liberalization; sustainable capacity development and education for sustainable development; sustainable production and consumption; national and regional enabling environments; health; knowledge management; culture; and implementation.

UNESCO's Coastal Regions and Small Islands (CSI) Platform served as Focal Point for housewide input to the



©Gillian Cumbers

Beach monitoring figures among the follow-up projects proposed by young islanders at the 'Youth Visioning for Island Living' side event in Mauritius in January. Shown here, young people from Palau learning scientific techniques for beach observation, as part of the UNESCO-facilitated 'Sandwatch' initiative

Mauritius process. It played a pivotal role in organizing one of five plenary panels, on the Role of Culture in the Sustainable Development of SIDS, and a high-profile side event for youth. The panel recognized culture as being an essential, pervasive dimension of sustainable island living and development.

Taking part in Youth Visioning for Island Living were 96 young people from 31 SIDS and six island territories. In a four-page *Declaration*, the young islanders commit to an ambitious programme around three themes: Life and love in islands: island lifestyles and cultures (17 projects); My island home: safeguarding island environments (15 projects); Money in my pocket: economic and employment opportunities (11 projects).

For details: <http://portal.unesco.org/islandsBplus10>

UNESCO and NASA strengthen ties

On 1 March, UNESCO's Director-General and Frederick D. Gregory, Deputy Administrator of the National Aeronautics and Space Administration (NASA), signed an agreement at NASA Headquarters in Washington D.C. (USA). Through this agreement, UNESCO will benefit from NASA's expertise in the earth sciences and space technology.

UNESCO's primary concern is to give Member States better access to the benefits of NASA's expertise, remote sensing data and results of scientific research. This co-operation should increase the efficiency and cost-effectiveness of conservation work in world heritage sites and the monitoring of biosphere reserves. It should also reinforce Member States' ability to mitigate the effects of natural hazards, a top priority in view of the recent tsunami disaster and the focus of several UNESCO programmes. Co-operation with NASA will broaden the scope of UNESCO's Space Education Programme and other activities aiming to stimulate interest in science.

This first comprehensive agreement between NASA and UNESCO expands a long-standing relationship between the two organizations.

UNESCO has had an interest in space programmes since the early 1960s when it began working with the International Astronautical Federation. Most recently, the Organization has worked with space agencies to develop the 10-year Implementation Plan for the Global Earth Observation System of Systems (GEOSS) adopted by 60 countries at the third Earth Observation Summit in Brussels in February this year.

UNESCO has been forging partnerships with other space agencies within its Open Initiative on the use of space technologies to support the World Heritage Convention and UNESCO's biosphere reserves. Initially launched with the European Space Agency in 2003, it currently includes the Argentinean and Canadian space agencies, and the Morocco Space Center. The Indian Space Agency and Chinese Academy of Sciences are preparing to join the Initiative, which embraces other space research institutions and universities. The new agreement between NASA and UNESCO brings an essential new partner on board.

For details: r.missotten@unesco.org; m.hernandez@unesco.org

Five nano-giants celebrated

On 3 March, five physicists from as many continents were presented with this year's L'Oréal-UNESCO For Women in Science award at UNESCO Headquarters. This year's awards, worth \$100,000 each, coincide with the International Year of Physics. The five laureates work in those most promising fields of physics: nanoscience and quantum physics.

Dominique Langevin is fascinated by soft matter and surfaces. She longs for a better understanding of the stability of foams. 'Why does a bubble burst?' Over the years, her work has found practical applications in a wide range of industrial sectors, from petroleum to laundry detergents, milk proteins, hair products, nuclear waste treatment and even in the construction of a foam module for the International Space Station.

By digging deeper into the secrets of soft matter, new developments will become possible: imagine being able to extract heavy petroleum trapped in underground rocks (an estimated 50% of global reserves), or using solid foams to build structures on planets that do not have the Earth's gravity, or even inventing smart 'vectors' for gene therapy.

For **Zohra Ben Lakhdar**, 'Light informs us about the state of matter throughout the Universe and even about the Universe's past'. Prof. Ben Lakhdar analyses bodies according to the spectrum of light they emit or absorb. At the interface between physics and chemistry, her research in atomic and molecular physics is an important starting point for potential applications in astrophysics, agriculture, medicine, pharmaceuticals and the chemical industry. She has

developed advanced theoretical and experimental spectroscopic methods of studying the influence of pollutants, such as methane and metals, on the quality of air, water and plants.

German physicist Joseph von Fraunhofer (1787–1826) was the first to demonstrate that the light emitted by a body was characteristic of the nature of that body and thus represented its 'signature'. By studying the spectrum of light, we can determine the composition of distant matter like the stars. Much later, Alfred Kastler (France, 1902–1984) would demonstrate that light falling on an atom in a particular state could be amplified by that atom through a chain reaction. This would give us the laser. The most common type of laser in the home is probably the CD or DVD player. The phenomenon of laser-type light amplification was later observed in nature, in interstellar space. One of Prof. Ben Lakhdar's most important accomplishments is to have calculated the conditions under which this laser effect would manifest itself in space matter. 'Manned space exploration has stopped', she says, 'whereas research into the atom is continuing at full speed. It is where our future knowledge of the Universe lies'.

Belita Koiller studies and controls crystals by shuttling between the macroscopic and microscopic worlds. By looking closely at a grain of salt, one can see cubes of different sizes. Other natural crystals, like quartz, display hexagonal shapes. It was mineralogists who first demonstrated that the macroscopic shape of a crystal reproduces the microscopic shape of atoms; the latter are positioned in each corner of a cube, hexagon or other structure. When these structures are piled on top of one another, they form a visible crystal. It was later discovered that atoms were composed of a positively charged nucleus surrounded by negatively charged electrons. Under certain conditions, some electrons are not drawn towards the nucleus but rather move around freely. In this case, the crystal is a conductor. When the electrons cannot move around freely, the material is an insulator. Prof. Koiller has studied a particular type of crystal, semi-conductors (particularly transistors). Semi-conductors are



'Why does a bubble burst?' Dominique Langevin is Director of Research at the Laboratory of Solid State Physics within the Centre national de recherche scientifique in France



'Light is the messenger of the Universe'. Zohra Ben Lakhdar is Professor of Physics at the University of Tunis, a founding member of the Tunisian Physics, Optical and Astronomy Societies and a member of the Islamic Academy of Sciences



We stand on the threshold of a new era, that of nanofabrication, where systems and devices will be built in the laboratory atom by atom. Belita Koiller is Professor of Physics at the Federal University of Rio de Janeiro in Brazil

crystals into which some impurities have been introduced to control the conductivity (a process known as ‘doping’).

Using statistical methods (macroscopic scale) and quantum theories (microscopic scale), Prof. Koiller has tried to link the organization of matter at the atomic level with the physical (i.e. electronic and optical) behaviour of matter. She has contributed to the modelling of a quantum computer ‘doped’ with silicon material that is able to calculate at extraordinary speeds, a feat which holds great promise for the future.

Fumiko Yonezawa establishes order in disordered systems. In a gas, the atoms are independent. In a liquid, the attraction between atoms is weak, so they are able to slide over one another. In a crystal, the atoms are immobile and bonded together in a regular lattice. In a glass, they are not free to move but are disordered as in a liquid that has been

instantly frozen. Glass is always unstable and, over time, transfers to the state of perfect crystal; on the windscreens of very old cars (before glass-making methods improved), you can see blue and white circular areas where the glass has crystallized. Fumiko Yonezawa has used computer simulation to understand how liquids become crystals or amorphous solids. ‘You take atoms, put them in a box, heat them up and see what happens’, she says with a smile. Prof. Yonezawa has been recompensed for her pioneering theory and computer simulations of liquid metals and amorphous semi-conductors.

Myriam Sarachik is an experimental physicist who has studied the magnetic and electronic properties of a wide spectrum of materials. She has strived to understand the transition from a metallic phase, where a metal conducts electricity, to an insulating phase, where it does not. As a young researcher, she discovered a paradoxical phenomenon which no-one could explain at the

time: her experiment contradicted the theory according to which resistivity (the capacity of metal to slow down the movement of electrons) diminished as the temperature dropped. Certain alloys containing magnetic impurities did indeed show greater resistivity at very low temperatures. Myriam Sarachik had just discovered a revolutionary phenomenon that would be subsequently theorized by the Japanese physicist Kondo.

She has also studied metal–insulator transitions in semi-conductors. Once again, she has shaken up the established wisdom by showing that electrons are free to move around

in two-dimensional layers, as in the three-dimensional world we live in. Prof. Sarachik ‘would ask the genie to guide me towards a definitive experiment that would settle whether what we are studying is a metal or not’.

In a natural extension of the L’Oréal–UNESCO Awards, the L’Oréal–UNESCO Fellowship programme encourages young women researchers in the life sciences to pursue their work by awarding them \$20,000 each. The 2005 list of 15 Fellows includes a strong showing from emerging countries such as Burkina Faso, the DPR of Korea and Jordan.

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

Scientific advisory body for CBD mooted

An international steering committee is to study models for the provision of independent scientific advice to the Convention on Biological Diversity (CBD). That there is a need for such advice, perhaps in the form of an independent scientific body, was acknowledged by a conference on biodiversity, science and governance held at UNESCO from 24 to 28 January under the joint patronage of UNESCO’s Director-General and French President Jacques Chirac.

Thirteen years after its adoption by 157² governments as a forum for policy development on biodiversity, many feel the CBD has not lived up to expectations. Although the Convention can boast of some success stories, its efficacy has been limited by its role as a negotiating forum. By contrast, the UN Framework Convention on Climate Change, which provides a forum for governments to negotiate climate change-related matters, can call upon independent scientific advice from the Intergovernmental Panel on Climate Change.

The *Paris Declaration on Biodiversity* adopted in January notes that, ‘in spite of protection efforts, the threats to biodiversity have clearly increased without a significant and effective response to them’. The World Conservation Union (IUCN) estimates that more than 7000 animal species and close to 60 000 plant species are today threatened with extinction. It will be no easy task to meet the Johannesburg (2002) target of curbing biodiversity loss significantly by 2010.

In Paris, more than 1500 researchers, political leaders and corporate managers from three score countries studied public and private approaches to stemming the alarming rate of extinction of living species and the destruction of their ecosystems. They looked at observation systems and at developing standards for measuring biodiversity.

Biodiversity provides ‘ecosystem goods’ (food, fuel, fibre, etc.) and ‘ecosystem services’ (soil fertility, renewal of oxygen in the air, maintenance of water quality, etc.).

2. *Of the signatories in 1992, only the USA had not ratified the CBD by 2005*

Parasitologist Andrew Dobson from Princeton University (USA) stressed in his presentation the key role biodiversity plays as a buffer against disease, particularly vector-transmitted diseases like malaria, as vectors tend to turn to humans when biodiversity is low.

Biodiversity also provides countless commercial products and services for economic sectors ranging from agriculture and fisheries to pharmaceutical bioprospecting and tourism.

'Biodiversity should not be considered an asset but pure capital', says Salvatore Arico. A Programme Officer for Biodiversity at UNESCO and member of the board driving the Millennium Ecosystem Assessment, Arico adds that 'everyone knows what happens when you spend your capital rather than investing it and drawing on the interest: your capital shrinks. Yet, that is what is happening today; we are drawing on nature's capital and, once it is gone, it will be gone forever'.

Perhaps the greatest achievement of the CBD has been to enable indigenous and local communities to defend a common position through an open-ended working committee on traditional knowledge. Since its inception in 1999, this committee has defended the rights of indigenous and local communities to share the benefits from plant genetic resources and from biodiversity in general. For example, with support from the International Treaty on Plant Genetic Resources for Food and Agriculture, the Convention has defended the farmers' right to keep, use, exchange and sell seed or propagating material. This right has been threatened in recent years by the emergence of what are known as genetic use restriction technologies. Perhaps the most famous of these was the 'terminator' technology designed by the multi-national Monsanto. Terminator technology was designed to switch off genetically a plant's ability to germinate a second time, thereby forcing farmers to buy fresh seed supplies every year. Even though Monsanto ultimately ceded to international pressure to withdraw the terminator technology, it remains illegal for farmers to re-use patented seed under existing patent laws in Canada, the USA and several other industrial countries.

The CBD has also managed to co-ordinate formerly disparate approaches to combating invasive species. Annual economic losses to introduced pests in crops, pastures and forests in the USA, UK, Australia, South Africa, India, and Brazil amount to nearly \$230 billion, or \$240 per capita. The development of guiding principles on how to prevent, miti-



Fish co-operative in Suriname. Between 1970 and 2003, overexploited fish stocks rose from 10% to 24% (2005 FAO report), particularly in the open sea where fishing has expanded rapidly over the past decade. To protect marine biodiversity and give stocks time to replenish themselves, the World Parks Congress in Durban in July 2003 recommended setting up a world network of protected marine areas covering 20–30% of the oceans by 2012 (a 40–60% increase).

gate and control the adverse effects of invasive species on ecosystems, species, genes and economies has not only fostered national quarantine policies and measures that are consistent with the three objectives of the CBD³ but also allowed adjacent countries, or trading partners, to develop a common approach to counteracting what is considered, after habitat fragmentation, the second main factor of biodiversity erosion and loss.

Another success of the CBD has been the drafting of intergovernmentally agreed principles on the 'ecosystem approach', a strategy guiding the development of sectoral policies consistent with the CBD's objectives. Directly concerned are such economic sectors as tourism, transportation, agriculture and energy.

It won't be known until after the consultative process is completed later this year what form any new advisory body may take. The assessment is being conducted by a multistakeholder steering committee composed of the G8, European Commission, FAO, IUCN, UNESCO-MAB, UNEP, World Bank, international programmes like Diversitas and international conventions.

For details: mab@unesco.org; CBD: www.biodiv.org

Shipment for Iraqi universities

Four containers of laboratory equipment, along with up-to-date reference works and student textbooks, arrived in Iraq in December as part of a consignment organized by UNESCO and the International Fund for Higher Education in Iraq within a programme financed by the latter.

Based on priorities identified by Iraqi education authorities, the shipment included \$4.6 million of equipment and materials for medical and related disciplines such as dentistry, pharmacy and nursing, as well as for engineering faculties. It also transported \$1 million in student textbooks and reference works for university libraries. The goods were delivered to a dozen universities and technical institutes in the capital, Basrah, Mosul and other regional centres.

This initial phase of the programme includes a package of 500 fellowships to enable Iraqi researchers and university teachers to spend three months in universities abroad updating their knowledge and teaching methods, and re-establishing contact with the academic community after years of isolation. It will be followed by a more comprehensive phase of academic co-operation with universities around the world. For background, see *A World of Science* 2(1), January 2004.

3. *The CBD's three objectives are: biodiversity conservation; the sustainable use of biodiversity and; the equitable sharing of the benefits arising from the utilization of biodiversity. The CBD definition of biodiversity encompasses diversity of ecosystems, species and genes*

'The opinions of young scientists should be canvassed'

The 'red city' of Marrakech and the hospitality of its people will long be etched in the memory of the young researchers from 87 countries who journeyed to the first conference of the World Academy of Young Scientists (WAYS) in December. They converged in Marrakech to discuss the rapidly changing work environment of young researchers, to elect a geographically representative board and to set up regional units and (inter)disciplinary departments to stimulate global co-operation in R&D. Placed under the high patronage of His Majesty Mohammed VI, the conference was organized jointly by UNESCO and the WAYS secretariat in Hungary, in collaboration with the Moroccan government, the Islamic Educational, Scientific and Cultural Organization (ISESCO) and the Academy of Sciences for the Developing World (TWAS).

WAYS is a permanent global network open to all scientists under the age of 40. Launched in 2003 as follow-up to the World Conference on Science (1999), WAYS functions under the aegis of UNESCO and today boasts more than 1000 individual members from close to 100 countries and all disciplines. In Marrakech on 13 December, 150 envoys formally adopted WAYS' constitution. We meet four of them here. Thirty-four year old Asha Pitadeniya from the University of Peradeniya in Sri Lanka is a Scientific Officer at the National Science Foundation and PhD candidate in environmental science and natural resource management with a focus on agriculture. Nineteen-year old Josephine McVitty is a second-year engineering student at the University of Auckland in New Zealand. Thirty-two year old Filomain Nguemo from Cameroon is a PhD candidate in cell and molecular biology at the University of Cologne in Germany. Last but not least, thirty-two year old Naoufal Raissouni is professor of physics and satellite remote sensing at the National School for Applied Sciences in Morocco.

What did you get out of the WAYS conference?

A.P. The forum provided an opportunity to meet many talented young researchers from different regions. I witnessed how aggressive and straightforward young scientists are in expressing their views and how concerned they are about such policy issues as employment opportunities and career development, funding and training requirements, science education and knowledge-sharing. However, science was not the only topic discussed; we also had time to learn about each others' countries, cultures, attitudes etc. and to form a new circle of friends from all over the world.

The conference gave me food for thought on some policy issues that restrict the development of S&T in any country. Although we came from countries with different economic, cultural, and social backgrounds and varying resource bases, most of the issues raised struck me as being somewhat similar. I think all of us agreed that scientists should be more involved in political decision-making. It was also emphasized that there should be a change in science teaching methods. The need for industry–research linkages was likewise stressed, as was the importance of the business sector in funding research and turning scientific knowledge into a new product, and the role of science communication in the global knowledge economy.

J. M. It was fascinating to meet young people from so many cultural backgrounds and with such varied expertise. I was struck by how useful dual expertise could be, such as that of Richárd Árpád Pantilimon, a Romanian studying both ecology and law, when it came to drafting the WAYS constitution. I was also impressed by the fact that, almost without exception, the students were at least bilingual, if not trilingual. The WAYS experience has confirmed my own choice to study a conjoint degree, in my case in arts and engineering. It has also sharpened my desire to study abroad for at least one semester and to pursue another language in addition to my French studies.

I was surprised to discover that some students from developing countries expected the WAYS conference to be dominated by wealthy countries. Their fears turned out to be unfounded because the constitution was subjected to a very democratic process. We stopped to discuss every clause of the draft text and voted on all amendments. One clause concerned the composition of the Board, which ended up being perfectly representative of the world's different regions. It was a painstaking but rewarding process.

The talks by students and experienced scientists were a real eye-opener, especially the one about the 'research trap' by Guntram Bauer⁴; he described the dilemma whereby students finish their doctorate only to discover they are

virtually unemployable outside the research fraternity and that their future career path is strewn with the hurdles of competing for research fellowships.

F.N. It was exciting to meet young people who share the common objective of contributing to scientific progress and a peaceful world. Since the conference, many of us have kept in touch. In listening to some of the eminent researchers speak, I was touched by the hopes they place in the younger generation.

N. R. When you meet under the same roof with 150 colleagues, when you eat the same food and share your ideas with all of them, it gives you a practical sense of collapsing barriers between cultures, between developed and developing countries.

Each envoy to the Morocco meeting is expected to create a network of young scientists once they get home. How do you plan to go about this?

A.P. WAYS highlighted the importance of having a network of young scientists in every country. In Sri Lanka, the Young Scientists Forum (YSF) fulfils this function. The YSF was inaugurated in 2000 by the National Science and Technology Commission, the government advisory body on S&T policy matters, as follow-up to the World Conference on Science. I am trying to persuade the YSF to interlink with WAYS to give it wider outreach.

J. M. The other representative of Australasia, Manoj Nair from the Marshall Islands, and I plan to work together. Our first step will be to approach universities to build up student membership of the network. Only then will we put together a programme of policy issues and begin lobbying politicians. As soon as I get home, I shall be reporting to the National Commission for UNESCO. It has strong ties to the media and will be able to set up interviews for me with

newspapers to give WAYS national exposure. They have already set up one interview, with the *Manawatu Standard* in my home town, before I left for Morocco.

F. N. Creating a national network of young scientists in Cameroon is a long process. Since 1999, we have been putting in place the Cameroonian young scientists assembly but have met with some difficulties that are not purely administrative. Many young scientists are not interested in belonging to an assembly of only a national dimension. The problem should be resolved once they hear that the assembly is to be a national branch of WAYS.

The first thing I did after Marrakech was to inform the Cameroonian Ministry of National Education, Higher Education and Scientific Research of my election as a WAYS officer. I am trying to persuade many young Cameroonian scientists, both within and beyond Cameroon's borders, to join WAYS, so that we can set up the national branch together.

N. R. Since being elected head of the Department of Engineering and Computer Sciences within WAYS last December, I have been contacting all the members of the department to encourage them to take responsibility for a specialized section. We are constructing a webpage⁵ to diffuse and share information on relevant issues.

Young researchers around the world are invited to join us. They are also invited to participate in a symposium I am organizing jointly with the Institute of Electrical and Electronic Engineers in the USA, an international NGO, and the University of Abdelmalek Essaadi in the United Arab Emirates, in my capacity as Vice-President of the Moroccan Association of Electrical, Electronics and Computer Engineers. The newly elected President of WAYS, Gaell Mainguy from France, sits on the scientific committee. This ICT meeting will be the first of its kind in Morocco⁶.



From left to right: Filomain Nguemo, Josephine McVitty, Asha Pitadeniya, Naoufal Raissouni

What policy issues would you most like to bring to the attention of your government?

A. P. In Sri Lanka, brain drain appears to be a major issue. We have experts in almost every field who are no less competent than those in developed countries; S&T policies should consider ways of recognizing, maintaining and nurturing these human resources as an essential component of development. Local conditions must induce scientists to remain in Sri Lanka and develop their potential to serve their own country. As emphasized in Marrakech, now is the time to revise our perception of science, to accept science as a ‘true profession’ and provide clear career development strategies for those interested in a research career.

One of the underlying issues in the Sri Lankan scientific research sector is the lack of co-ordination, both between scientists themselves and between research and industry. Building research–industry–university linkages is a must if we are to reap the benefits of research. Sri Lanka being a less developed country, our government cannot afford to spend much on research. Therefore, policies should encourage industry and the private sector to fund scientific research. This will pave the way for developing appropriate technologies and using local resources rather than importing them at great cost.

Even when the government is prepared to fund research, the results are often insignificant in terms of national development, as researchers tend to choose topics that will appeal to journals and thereby ensure their own advancement. It is now recognized that S&T policies should be directed towards demand-driven, multidisciplinary research and the commercialization of research output that could benefit the country. Any S&T policy should contribute to the UN Millennium Development Goals for combating poverty, hunger, disease and environmental degradation.

J. M. It is essential that the government make a serious effort to encourage effective communication of S&T, both within the scientific community and between scientists and decision-makers. It is equally essential that decision-makers be well-informed, to prevent misconceptions and ignorance. As, in a democracy, the general public participates in policy choices, the government should set up mechanisms that publicize expert scientific advice from a wide range of sources to educate society at large about environmental, health, safety and social issues. More investment should thus be channelled into using scientists as educators; science museums and interactive centres could be used to raise public awareness and increase the popularity of science among the younger generation.

We need to encourage more international collaboration, by promoting multinational and interdisciplinary networks for sharing knowledge and new technologies, especially

with developing countries, and by insisting on more funding for scientists to complete research abroad.

F. N. The entire African leadership should understand that there is not, and will not be, development without research and young people. The most important thing I would like to ask the Cameroon government is to combat brain drain; my government should do everything in its power to encourage young researchers to return home. You have to understand those who leave; there is no adequate research structure to accommodate them at home. Researchers need a stronger, more stable and more ethical career structure to support them early on their career. We will never manage to board the train of growth and development if brain drain is not stemmed.

I myself live in Germany. I regularly supply scientific journals and literature to friends, colleagues and several of my teachers in Cameroon because of the difficulties they encounter in accessing some important journals. I feel obliged to do this until our country catches up, especially in the area of ICTs like the Internet where development has been very slow.

The government needs to put mechanisms in place which permit young scientists to input into policy at the national and African levels. Their opinions should be canvassed. Cameroonian young scientists, for example, need funding and a more flexible research structure that makes room for them. It will take a concerted effort to increase the participation of young people from all ethnic and cultural backgrounds in policy- and decision-making. One of the most important things will be to remove the barriers between “old” and “young” research scientists, between universities and industry, between faculties and departments, between scientists and society. I am ready to make great sacrifices to contribute to the development of my country and am convinced that many other young Cameroonians feel the same way.

N. R. The Moroccan government clearly needs to reinforce the role scientific research plays in society, to invest more in science and to co-operate more intensely with other countries.

Interview by Diana Malpede⁷

For details: www.waysnet.org; d.malpede@unesco.org

4. Director of Fellowships within the Human Frontier Science Programme in Strasbourg, France. He spoke on The post-doctoral trap: a global challenge for science policy

5. web.ensat.ac.ma/decomsways

6. Co-operation for the Present Millennium: Systems, Services and Technologies, Tetuan (Morocco), 3–6 June 2005: web.ensat.ac.ma/ictis

7. Co-ordinator of WAYS at UNESCO

Controlling malaria, the vampire of the technological age



Anopheles gambiae (here) is the primary vector of malaria in Africa. One bite is enough

For decades, malaria had been under control in southern Iran. Then Afghan refugees began crossing the border in the 1980s and with them a stowaway by the name of *Anopheles*. Thus did malaria return to Qeshm Island. Up to this point, the disease had been confined to a triangular zone in southwest Iran encompassing the border provinces of Hormozgan, Baluchestan and Kerman. Although malaria was a persistent problem in this zone, eradication campaigns had always been thwarted by the cross-border traffic of refugees and nomadic tribes. The island of Qeshm, on the other hand, offered relative isolation from the mainland. It was here that, in the 1990s, a new biological weapon against malaria would be tested by Iranian scientist Nasrin Moazami. This is her story.

Malaria is a scourge. There are at least 300 million acute cases annually, resulting in more than 1 million deaths, 90% of them in Sub-Saharan Africa. ‘Malaria is the number one killer of children under five years old on the African continent,’ WHO Director-General Jong-Wook Lee recalled in 2003, adding that ‘the disease is overshadowed by daily reports focused on the HIV/AIDS plight [but] remains a titanic problem’. WHO estimates that more than 2.4 billion people are at risk, a situation aggravated by poverty, population displacement in time of war and the short-sighted use of new technologies in industry and agriculture.



introduce a potent cocktail of toxic chemicals into the human body.

To make matters worse, more than 50 species of *Anopheles* are now showing resistance to chemical pesticides. Initially, this resistance was limited to DDT, Malathion and Dieldrin. Coupled with concerns over environmental pollution and the mounting cost of new chemical insecticides, the growing resistance of mosquitoes to chemical pesticides makes these a less than attractive option for controlling malaria.

One option for eradicating mosquitoes is the use of chemical insecticides. For the past five decades, humans have been almost wholly dependent upon synthetic and organic insecticides. Agriculture has been revolutionized by the use of chemicals to protect crops.

The miracle of chemical technology has not, however, provided a viable solution when it comes to eradicating malaria.

In addition to their inefficacy, chemical pesticides can cause mutant strains of fauna and flora. Chemical pesticides also pollute water resources and

The other option is to use nature to control the mosquito. Malaria is a highly complex disease caused by four different pathogenic species of *Plasmodium* (a parasite), which is carried by 60 or more *Anopheles* species. *Anopheles* is the only mosquito which can transmit malaria and, even then, not all *Anopheles* species are vectors. Even among those which are vectors, only the female can transmit the disease. Depending on the species, *Anopheles* will deposit their larvae in pools, streams, coastal swamps, etc. Another characteristic of *Anopheles* is that it flies only after dusk.

For centuries, chloroquine was the preferred anti-malarial drug but, here again, the parasite has now developed resistance to the treatment. Some of the most severe epidemics of malaria in recent times have occurred in the highlands of Africa. The worst outbreak killed 25 000 people in Madagascar in 1988.



Nasrin Moazami (in sunglasses) with a group of schoolgirls who have travelled to Qeshm from Baluchestan in Pakistan to undergo a diagnostic test for malaria at the clinic in the background. Malaria causes flu-like symptoms such as fever, headaches and sweating. If the infection is not diagnosed (by a blood test) and treated, there is normally a sudden, drastic deterioration in health as the parasites multiply in the blood stream. Malaria is a cyclic illness which follows the life cycle of the parasites as they mature, reproduce and are once again released into the blood stream. Serious complications involving the kidneys and brain can develop, leading to delirium and coma, or even death. Cases have been reported of symptoms developing 12 months after the patient was bitten by a mosquito infected with the malaria parasite (Plasmodium), as the plasmodia may remain dormant in the liver for a long time

The profile of biological agent *B.t. M-H-14*

What was needed was a biological agent possessing the desirable properties of a chemical pesticide – to make it highly toxic to its target – and a long shelf life; the agent had to be safe to transport and lend itself to mass production, to make a minimal impact on the environment and be impervious to any attempts by potential malaria vectors and agricultural pests to develop resistance to it.

In 1986, I managed to isolate a bacterium from dead *Anopheles stephensis* larvae recovered from the Iranian province of Lorestan. *A. stephensis* is the major vector of malaria in the region and is resistant to chemical insecticides. I labelled the newfound bacterium *Bacillus thuringiensis M-H-14*.

Bacillus thuringiensis is a naturally occurring, soil-borne bacterium. It was discovered in 1901 in the province of Thuringia in Germany and was first used as a commercial insecticide to control agricultural pests in France (1938) then in the USA in the 1950s. These early products were replaced by more effective versions in the 1960s when strains of *B. thuringiensis* were discovered which proved lethal to moths and butterflies (*Lepidoptera*), small flies and mosquitoes (*Diptera*) and beetles (*Coleoptera*).

Testing of *B. thuringiensis M-H-14* revealed that different species of

Anopheles and the *Culex* mosquito were sensitive to this toxic bacterium, which killed only its target without causing any collateral damage. The toxin hones in on a receptor in the gut that only *Anopheles* possesses, making *B. thuringiensis M-H-14* completely innocuous to all other living species, including human beings. Within minutes of ingesting the toxin, the *Anopheles* larva stops feeding as its cells swell and burst, causing death.

Three years after my discovery, I was ready to produce the unique biolarvicide on a pilot scale, within a joint project with UNDP and UNESCO. Over a 15-month period, my research team at the Biotechnology Research Centre



The 3000-litre fermenter used to produce *B.t. M-H-14*. To form the toxin, the bacteria are cultivated in the fermenter with the culture media at a temperature of 30°C. It takes only 28 hours to form the toxin after inoculating the bacterium

Agent *B.t. M-H-14* arrives on Qeshm Island

The next step was to test *B.t. M-H-14* on the island of Qeshm in Hormozgan Province. The largest island in the Persian Gulf, Qeshm measures 1500 km² and is five times the size of Singapore. The temperature

fluctuates between 2–5°C in winter and 35–40°C in summer, with 60–80% humidity throughout the year. Although parts of the island are semi-arid, it also boasts mangrove swamps and a number of small dams dotted around the island to catch rainwater, which are ringed with vegetation. These are potential breeding grounds for mosquitoes.

Qeshm counts 60 residential villages and five towns, with a total population of 80 000. The inhabitants earn a living from fishing and shrimp-trapping, ship-building, date-growing, trade and folk art. The majority of Qeshm islanders are Sunnis, unlike their compatriots on the mainland who are mostly of the Shiite faith.

'You are a scientist, not a woman'

I had no trouble obtaining authorization from the local government to distribute the biolarvicide to different mosquito breeding sites around the island. But I also needed the support of the community to ensure that no potential mosquito breeding ground was neglected, including in the home.

Nasrin Moazami putting her case for the malaria trial to religious leaders in the Qeshm mosque



Wells used by villagers. *B.t. M-H-14* is environmentally safe, even in drinking water



©N. Moazami

Qeshm's development takes off

The special bond I formed with the Qeshm islanders during the malaria eradication trials led me to found the Persian Gulf Biotechnology Research Centre on the island in 1997. The centre develops plant propagation using the tissue culture of bananas, orchids and date palms to increase agricultural productivity. It also explores the qualities of coral for health applications. Coral is strikingly similar to bone, with a 98% degree of compatibility. This makes coral a potential substitute for bone transplants in patients, as there is no risk of rejection by the human body.



©N. Moazami

The sea offers endless possibilities for product development using biotechnology. Algae, for example, can be used as a bio-fertilizer for agriculture; it can be fermented to produce methane and methanol for use in cooking and to fuel cars. Like plants, algae can be marketed on the food, health and beauty markets.

The Persian Gulf Biotechnology Research Centre is also exploring the potential of *Aloe vera*. This plant can be marketed as a highly nutritious supplement or even in the form of a moisturizing cream. As it stimulates the body's immune system, it is also effective in healing intestinal diseases.

Shortly after the centre opened its doors, I proposed setting up a training school for female health-care workers on the premises. The project was designed to kill two birds with one stone: both health care on the island and employment opportunities for young unmarried women were sorely lacking on Qeshm at the time. It was not uncommon

for girls to be married off at the tender age of 12 or 13 for lack of other prospects. Girls were entitled to only three years of primary schooling, a restriction that did not apply to boys.

The local authorities were supportive of the scheme. Within a couple of years, thanks to the collaboration of the Ministry of Health and financial support from the UNDP, 25 girls were enrolled in the

health-care training school and first-aid clinics were sprouting in the villages.

The government went on to found secondary schools for both girls and boys and three universities which today offer courses in physics, chemistry, biology, environment and aquaculture. One of them also offers an MBA, in collaboration with Carlton University in Canada. The island is hoping to develop tourism. At the Persian Gulf Biotechnology Research Centre, students can enrol in Master's degrees in both environment and tourism, proposed in collaboration with the University of Wageningen in the Netherlands. Half of all tertiary students on Qeshm in 2004–2005 were women.

The government recently constructed a 50-bed hospital. Thanks to the generosity of hospital doctors working in Tehran, who give up a few weeks a year to operate 'on call' in Qeshm, the island's hospital benefits from some of the most skilled surgeons in the country. When 'bleeped' in an emergency, doctors in Tehran are able to reach the island rapidly, thanks to its modern international airport linking the island not only to the mainland but also to neighbouring Dubai.

I approached the religious leader Molana Khatib with a request to present the malaria trial to the religious leaders from the villages the next time they gathered in Qeshm mosque. Coming from a woman, such a request would normally have been turned down but Molana Khatib was so impressed with my arguments that he acquiesced. 'You are a scientist, not a woman', he reasoned.

From that day forward, sachets of *B.t. M-H-14* were distributed regularly through the mosque to all the families

on the island, who rallied to the project. Local people were trained to use the slow-releasing product in their ponds and reservoirs. With the community behind me, I was able to cover all of the island's exposed water points on a regular basis.

Field tests revealed that 1.7 kg of slow-releasing *B.t. M-H-14* applied per hectare killed 100% of larval mosquitoes within 24 hours. This killing ratio remained stable for a mean of 17 days. The results were encouraging, as compa-

One of many reservoirs of all shapes and sizes designed to trap rainwater. The reservoirs are deliberately situated away from inhabited areas to avoid contamination. Narrow channels carved in the rock transport water that is needed in greater quantities



©N. Moazami

A view of Laft City at dusk. Note the 'towers' in the middle of each building, a traditional means of ventilating the interior during the hot summer



©N. Moazami



(left) A dam on Qeshm Island. During tests on the island, the bio- larvicide remained toxic to surface-feeding mosquito larvae for a mean of 17 days, compared to a life of just 72 hours in situ for other commercial products. The bio- larvicide resisted temperatures of up to 60°C and was immune to the sun's ultraviolet radiation. It needed to be stored in dry places, however, as it was vulnerable to humidity (right) Women carrying drinking water from a rainwater reservoir to their village



©N. Moazzami

able products already on the market were only effective for 72 hours and had to be spread in much larger quantities.

Qeshm is declared malaria-free

Within four years, Qeshm was malaria-free. Parallel testing of *B.t. M-H-14* was conducted in the southern provinces of Iran and in Sudan against *Anopheles arabiensis*, where it proved equally conclusive. As predicted, however, cross-border traffic subsequently reinfested the Iranian provinces of Farse, Sistan-Baluchestan, Bushehr and Hormozgan.

Once its efficacy and innocuousness had been conclusively proven, I deposited *B.t. M-H-14* in the DSMZ Culture Collection in Germany, an international patent center of micro-organisms. The slow releasing *B.t. M-H-14* was patented at the European Patent Office in 2003.

IROST could now proceed with the next phase, the production of *B.t. M-H-14* on a commercial scale. Construction of a plant with an output of 1000 tonnes per year was entrusted to IROST's commercial partner, the Iranian Nature Biotechnology Company founded in 1999. The factory came on stream in November 2004 when *B.t. M-H-14* entered the market under the trading name of Bioflash. Bioflash is sold by the kilogram for the equivalent of \$25.

Safety in numbers

Six years after I founded the Biotechnology Research Centre in Tehran in 1982, it was incorporated by UNESCO in the international network of Microbial Resource Centres (see box).

In 1995, I organized a regional conference on combating malaria with scientists from Pakistan, Afghanistan and a number of African countries. This collaboration also involved the Iranian Ministry of Health, UNESCO and UNDP. The collaboration culminated in a meeting between Iran, Pakistan and Afghanistan in 2004, under the auspices of WHO, at which it was decided to conduct a controlled trial in an isolated village or town in each of Afghanistan and Pakistan. A tonne of Bioflash is due to depart for Afghanistan in early 2005.

Moreover, at its general conference in November 2004, the Islamic Development Bank in Tehran expressed interest in

buying large quantities of Bioflash from the Iranian Nature Biotechnology Company for free distribution to African countries plagued by malaria.

Given the ease with which malaria can be 'imported', Iran itself will only be able to eradicate malaria from the contaminated zone if its neighbours can do likewise. Each application of Bioflash may eliminate mosquitoes from a specific location within three weeks but mosquitoes are mobile; they are able to fly a distance of 5 km. Co-operation between regions and between countries will thus be the key any successful eradication campaign.

Nasrin Moazzami

For details: Nasrin_moazzami@hotmail.com
For background: www.who.int/mediacentre/factsheets/fs094/en/; www.malaria.org

The MIRCEN network

Microbial Resource Centres (MIRCEN) are existing academic or research institutes in both developed and developing countries which co-operate in microbiological and biotechnological research. Through their work, MIRCENs develop applications with a potential for paying economic and environmental dividends, such as in the form of biopesticides, bioprospecting for new bioactive substances, biodepollution technologies or inexpensive technologies for application in the field of agriculture. The use of bio-informatics in genetic data handling has become a key focus of some MIRCEN centres which also address the important issues of intellectual property rights, access and benefits-sharing.

Since 1975, UNESCO has built up the network, together with UNEP and UNDP, to the point where it now counts 34 centres worldwide. In Asia, there are centres on mainland China and in Hong Kong, India, Iran, Japan and Thailand. Participating centres are involved in the conservation, management and safe use of the microbial gene pool. The network provides essential expertise and infrastructure in the regions for training and developing research.

For details: www.unesco.org/science/bes/;
l.hoareau@unesco.org

The knowledge that saved the sea gypsies

When the water lapping the shores of Yan Chiak in Myanmar suddenly drew back on 26 December, the Moken recognized the signs. *La Boon* was about to strike. Dropping everything, the entire village headed for higher ground and safety. The Moken owe their survival to tales passed down by the elders of the seven waves which came to kill the Moken in their parents' day. As the story goes, those Moken who had anchored their boats close to the shore were crushed by the waves, whereas those who had made for higher ground were saved. *La Boon* is the Moken word for tsunami.



The Moken are 'sea gypsies', one of three groups who have roamed the waters straddling southern Thailand and Myanmar for centuries. They are all animists and culturally distinct from Thais and Burmese, speak their own languages and have their own set of traditions.

where they learned to dive and swim with skill. During low tide, the women scoured the reefs for sea urchins, crabs, mussels and sea cucumbers.

For years, the Moken led an isolated life until the Surin Islands were declared a national marine park in 1981. This would trigger a range of complex issues for the Moken that continue to entangle them today.



A Moken man playing traditional music on a *Kat-ting*

A limited livelihood

Located 55 km off the coast of Phang-Nga Province, Ko Surin is a cluster of five islands with beautiful coves and dense jungles. The channel between the two biggest islands, North and South Surin, used to be known for its beautiful coral reefs, which made for good snorkelling. An assessment of the damage caused to these reefs by the tsunami is currently being undertaken by UNESCO and other bodies.



UNESCO Bangkok office staff dug into their pockets to create a Moken Fund. The 45 000 baht (ca US\$1 000) donated by staff to the fund went to pay for this replacement boat for fishing cum transportation for the Moken in early January. The Moken lost about half of their boats to the tsunami. Many other organizations are providing emergency aid to the Moken in the form of money, clothes, food, etc.



Thanksgiving ceremony organized by the Urak Lawoi community on Rawai Beach two weeks after the tsunami to appease the souls of the dead. The Urak Lawoi community lives on the beaches of Rawai and Ko Sileh in Phuket

Today, some of the 200 Moken living on Yan Chiak island would like to move to the Surin Islands in Thailand to join their relatives. 'Living in Myanmar is very tough', one Moken explains. 'The Burmese soldiers force us to work without pay and, if we refuse, we are jailed for three or four days. The men are forced to carry heavy soil and sand for construction and the women are made to collect rocks'. The problem is that the Surin Islands are under Thai administration and the National Park Authority will not allow more Moken to move there.

While the other sea gypsy groups, the Moklen and the Urak Lawoi, have integrated Thai society and acquired a modern lifestyle on land, the Moken remain semi-nomadic. They live in boats out in the sea during the dry season, coming ashore only during the wet months. The total population amounts to approximately 3000; 200 live on Thailand's Surin Islands and the rest in Myanmar.

The Thai Moken settled on the islands decades ago. Here, they built bamboo huts suspended on stilts several feet above water. Men fished, sold their catch to the mainland and used their earnings to buy rice. Children grew up in the water,

To protect this unique ecosystem, the National Parks Department declared the islands and the surrounding seas a protected national marine park decades after the Moken settlement. Thailand's National Park Act forbids the occupation of land and the gathering and removal of flora and fauna within the protected zone.



Moken girls selling handicrafts made from Pandanus leaves

Others, like Dunung Klatalay, turn to handicrafts. 'I can earn at least 200 baht a day by selling these', he says. 'It's better than working at the national park where I am paid much less.'

Such alternatives, however, are only possible during the tourist months between November and April. What they earn during

Park officials accepted the Moken's presence, acknowledging the fact that they had been frequenting the islands for centuries. The Moken were allowed to remain but are forbidden to catch fish for commercial use. As long as they fished only for their families, using the chapam, a small wooden boat dug out of a tree trunk equipped with a paddle, fishlines, hooks and a spear, the ecological balance of the islands would not be harmed. However, this became a problem for the Moken, who needed cash to buy rice from the mainland.

By 1987, however, Ko Surin had become a popular tourist destination. The Moken resorted to the sale of decorative seashells as souvenirs, a trade which proved very profitable, with households earning as much as 3,000 baht a month (ca US\$75) during the tourist season. The flourishing trade continued until the park issued a ban in 1996.

Getting work on land is not an option for the Moken. Though they have been living on the Surin Islands for decades, they do not have Thai citizenship. Technically, they are stateless people. This means they cannot officially take up jobs in the park or on the mainland. As non-citizens, they are ineligible for monetary support from the government. This also denies them access to welfare services such as free education or health care.

The park had to devise other ways of caring for the Moken without handing out government money. After issuing the ban, park officials collected donations from tourists to help buy rice and necessities for them. Dr Narumon Arunotai from Chulalongkorn University's Social Research Institute, an anthropologist who has studied the tribe for years, subsequently reported that the donations were not sufficient to meet their needs. The practice was later discontinued.

Officials then established a "welfare shop," a convenience store cum restaurant selling snacks, bug spray and drinks to tourists and island residents during the high season. Part of the profits goes to pay the salaries of the 50 Moken contracted to work as boatmen, gardeners and rubbish collectors. According to Puttapoj Khunprasert, vice-superintendent of the national marine park, they could at least 'earn 100 baht a day, have three meals and take leftovers home.'

the tourist months is normally expended by season's end, so, during the monsoon season, the Moken have to return to subsistence fishing and clam harvesting. Stockpiling is frowned upon by a society that sets great store by sharing and solidarity.

There were also efforts to make use of traditional carving skills. During the fifth lunar month, the Moken erect a *lobong*, a tall, wooden totem representing an ancestor spirit. However, making souvenirs out of wood and grass proved a failure due to lack of demand and park restrictions on the harvesting of wood.

Tour operators were encouraged to hire the Moken as guides but that, too, proved difficult because the Moken are shy of outsiders.

From houseboat to speedboat

Tourism has increased contact between the Moken and the modern world but changed their lifestyle. They have developed a taste for packaged food. The money they earn in the park is used to buy rice and canned goods, departing from a once predominantly seafood and fish-based diet. Narumon observes that snacks, instant noodles and condensed milk are now favourites.

They have also become consumers, spending money on things such as cigarettes and beer. Four households now have TV sets. Others have stereos. Before, the Moken would sit on the beach under the stars and talk about legends and their past. Now they spend the evening watching Thai soap operas.



A Moken spearfishing on Ko Surin



©UNESCO/Elias



Before and after pictures of a Moken village originally built on the water. In the photo on the right, the Moken village is being reconstructed on Ko Surin. Note how the new location of the village is completely different. The houses have been pushed into the forest, favouring a poor breeze, zero visibility and poor sanitation

These same children are pupils of Surasawadee School, an *ad hoc* educational centre set up by the Fisheries Authority. This single-classroom school provides basic primary education in the Thai language, arithmetic and marine conservation. The inclusion of environmental issues in the curriculum is already commendable. It would be ideal if the curriculum also included classes in the Moken language.

‘Providing education to indigenous children is always complex. There is a risk that offering standardized formal education will alienate indigenous children from their own culture and affect the transmission of indigenous knowledge and cultural heritage from one generation to the other,’ says Sheldon Shaeffer, Director of UNESCO’s regional bureau for education in Bangkok. ‘Many strategies have been developed to address this. Gaining initial literacy in one’s mother tongue then moving to literacy in the national language is one such strategy. Most research shows that minority children in primary schools taught in their own language acquire knowledge skills faster,’ says Shaeffer. Another is the inclusion of ancestral stories in learning material – such as that about *La Boon*. In northern Thailand, minorities have established their own educational programmes using ancient tribal stories as content for reading materials. UNESCO and Chulalongkorn University have developed something similar for the Moken.

A working system to preserve indigenous heritage, however, is generally hard to develop, especially for small groups like the Moken. In Surasawadee School, the teacher herself is not Moken and no community member has ever been trained as a teacher.

More haste, less sustainability

‘The fact that the sea gypsies survived, while many others did not, points to certain lessons to be learned from traditional, indigenous knowledge,’ says Richard Engelhardt, UNESCO’s Regional Advisor for Culture in Asia and the Pacific. ‘Twenty years ago, beachfront construction was light and made of bamboo and thatch that, if it collapsed, would not kill the occupants. The use of such traditional construction “rules” should be part-and-parcel of village rehabilitation work’.

Unlike other Thai fishing villages affected by the tsunami, the sea gypsies prefer to remain in their traditional homes by the sea. On Ko Surin, where they also escaped without loss of life thanks to their knowledge of the sea, some 170 people had returned by mid-January to rebuild their homes from traditional bamboo and woven leaf.

Aid agencies have thrown themselves into the task of reconstruction. But Derek Elias of UNESCO’s Bangkok bureau observes with regret that, in the Surin Islands and elsewhere in Thailand, ‘a multitude of aid bodies are bringing in project money and “staking their claim” to certain areas for providing reconstruction assistance that often does not consider practical matters of sustainability’. Citing the example of a newly reconstructed Moken coastal village in Thailand’s Ko Surin National Park, he reports that, ‘new houses have been laid down into the forest too far from the water’s edge, lined up on a grid, built too low to the ground and too close together. The result is poor ventilation and sanitation, as well as obstructed views to the sea, even though clear visibility is essential both for monitoring sea conditions and for daily activities along the coast. Needless to say’, adds Elias, ‘the Moken would like to rebuild their village in the



©UNESCO/Elias

Moken family visiting from Mergui archipelago (Myanmar) on the traditional kabang, anchored at Ko Surin

traditionally sustainable manner at the earliest opportunity, if the park authorities will allow them to do so.'

UNESCO Bangkok developed a proposal last February to produce educational materials in health, disaster preparedness and tsunami education for different target groups, including schools, governments, municipalities and the private sector. Once finalized, these materials will be disseminated as an activity of the Decade of Education for Sustainable Development.

A problem has arisen from lack of consultation by local authorities. Another community saved from the tsunami⁸ by their knowledge of the sea, the Urak Lawoi, was unwilling to move from its village on Ko Sileh beach near Phuket, where only 10 houses had been destroyed and a further 200 damaged. The villagers cited the importance of remaining close to their boats and equipment and the loss of income from fishing if they moved inland. Yet, the Governor indicated in mid-January that 200 new houses would be allocated to the Urak Lawoi community, which was to be relocated to nearby degraded mangrove forest on public land some 300 m back from the sea.

Indigenous peoples part of protected lands

National park managers all over the world have generally considered the indigenous people living in their perimeter as separate entities they are not obliged to protect. In a new trend, however, governments are beginning to recognize that indigenous populations have an intimate relationship with these protected lands and that their heritage needs to be preserved as much as the landscape in which they are living.

One good example is Australia. The aptly named Department of Environment and Heritage currently manages three large national parks alongside resident Australian aborigines. This pioneering model began in 1978 with Kakadu National Park in the Northern Territory. Since then, two other parks have come under joint management: Uluru-Kata Tjuta (Ayer's Rock) National Park, which, at 80 km², is the country's largest, and Booderee National Park, a patch of coastal land along Jervis Bay in New South Wales measuring 6.4 km².

In 1995, Uluru-Kata Tjuta National Park and its management board won UNESCO's highest award, the Picasso Gold Medal. They were commended for distinctive landscape and heritage preservation and for lifting the bar on World Heritage site administration.

In Thailand, there is an apparent openness to such a paradigm. The Department of National Parks, in partnership with Danida, the Danish aid agency, has created a programme for



View of the temporary Moken camp at Ko Surin Park Headquarters

joint management of protected areas. This scheme consists of dialogue with all stakeholders, including indigenous villagers living within the national parks. Issues such as capacity-building for local people, livelihood concerns, land use and tenure will be a focus. According to Chatri Moonstan, environmental programme co-ordinator at the Danida office in Bangkok, the four-year pilot project will encompass 11 national parks and the western forest complex. Included are some parks with indigenous populations: Ob Luang National Park in Chiang Mai province, Doi Phu Ka National Park in Nan, Talay Bun in Satun and Hat Chao Mai in Trang, which is also home to sea gypsy communities.

Unfortunately, both the Surin Islands National Marine Park and the Moken are excluded from the project. Nonetheless, it is hoped that this programme will lead to a common policy that applies to all national parks.

Given the recent inclusion of the Andaman Islands in Thailand's tentative dossier for inscription on the List of World Heritage, now would seem the time for UNESCO to mobilize support for the inscription of Ko Surin as a mixed site of both natural and cultural heritage.

Soimart Rungmanee and Irwin Cruz

For details (in Bangkok⁹): d.elias@unesco-bkk.org; r.soimart@unesco-bkk.org

8. The Urak Lawoi term for tsunami is Uma Udo Bidi, Uma meaning wave, Udyo meaning seven and Bidi being the classification word

9. Derek Elias and Soimart Rungmanee are respectively Co-ordinator of the UN Decade of Education for Sustainable Development and Project Assistant for the Local and Indigenous Knowledge Systems (LINKS) project: www.unesco.org/links

DIARY

25 March – 25 September

Nature's Wisdom (World Expo)
UNESCO programmes are exhibited within UN Pavilion. Aichi Prefecture (Japan):
www.expo2005.or.jp/

27 March – 2 April

Optics Teaching
UNESCO/ICTP/SPIE/STO regional workshop for 30 participants, also 3rd meeting of UNESCO working group on Active Learning in Optics and Photonics: Training of Physics Trainers. University of Monastir (Tunisia):
m.alarcon@unesco.org

29–30 March

Physics Education
1st National Workshop. University of Diponegoro (Indonesia): Jakarta@unesco.org

14–16 April

Indian Ocean Tsunami Warning and Mitigation System (see p.2)
2nd Intl Co-ordination Meeting. Mauritius.

19–21 April

World Atlas of Mangroves (2nd edition)
Inter-agency workshop. Atlas joint initiative of FAO, ISME, ITTO, UNESCO-MAB, UNEP-WCMC, UNU-INWEH. UNU, Tokyo (Japan):
www.unesco.org/mab/mangroves

26 April – 26 June

Experiencing Mathematics
UNESCO-driven travelling exhibition at Haidian S&T Hall in Beijing (China):
beijing@unesco.org; www.mathex.org

30 April

Deadline
for biosphere reserve nominations (mab@unesco.org) and applications for MAB Young Scientists Award Scheme: mab.awards@unesco.org

22–23 May

Ensuring the Transmission of Traditional Knowledge and Practices on Biodiversity
Intl symposium within World Expo for experts and public. UNESCO (LINKS project), UNEP, National Museum of Ethnology. Aichi Prefectural University: www.unesco.org/links; d.nakashima@unesco.org

26–27 May

Basic Sciences
UNESCO/SIDA/SAREC workshop within IBSP for 30 participants on how to support basic sciences and show their impact in achieving Millennium Goals. Royal Swedish Academy of Sciences, Stockholm: www.unesco.org/science/bes

29 May – 2 June

Cultural and Biological Diversity
Role of Sacred Natural Sites and Cultural Landscapes – UNESCO Intl symposium within World Expo. UNU, Tokyo: www.unesco.org/mab/SNS/symposium.htm

15–29 June

Biodiversity in Mangrove Ecosystems
UNESCO/UNU training course on assessing, monitoring, conserving biodiversity. Annamalai University (India) (see p.8).

22–24 June

MAB Advisory Committee
Examines biosphere reserve nominations and/or extensions and selects beneficiaries of MAB Young Scientists Awards (see 30 April).

New Releases

Climate Change

By Guy Jacques and Hervé Le Treut. UNESCO-IOC Ocean Forum collection, UNESCO Publishing, 160 pp. ISBN 92-3-103938-5, €14.80, exists in English, French and Spanish. Combines science with a societal approach. Describes the changes occurring to our environment and follows the Sahara through 'geological time' to illustrate the notion of 'climate change'. Includes forecasts while acknowledging that some uncertainty remains.

Island Agenda 2004+

Coping with change and sustaining diversities in small islands
48-page booklet in English and French on UNESCO's concerns and activities. Distributed in Mauritius in January (see p.9). Download: <http://portal.unesco.org/islandsBplus10>; request a copy: islandsBplus10@unesco.org

Impacts and challenges of a large coastal industry

Alang-Sosiya Ship-breaking Yard, Gujarat, India
By Derek Elias. CSI Island Papers 17. UNESCO Bangkok and Delhi offices, 65 pp. Describes the socio-cultural, economic and environmental impact of the ship-building industry at one of the biggest ship-breaking yards in Asia. Examines avenues for improving working conditions and protecting the environment. A study conducted by Bhavnagar University (India) since 1999 with UNESCO support within CSI's efforts to develop, document and test wise coastal practices. Copy available at: unesco.org/csi/pub/papers3/alang.htm or ips@unesco.org; newdelhi@unesco.org;

Reef and rainforest

An environmental encyclopedia of Marovo Lagoon, Solomon Islands
By E. Hviding. Published by UNESCO LINKS project. Knowledges of Nature Series No. 1. ISBN: 92-990041-0-2, 4 maps and colour illustrations, 206 pp. Based on ecological knowledge of the Marovo peoples, catalogues and explains (in Marovo and English) more than 1200 indigenous terms for animals, plants and topographic features of the coastal and marine environment of this biodiversity-rich territory within the Solomon Islands (Pacific Melanesia). Scientists may search for species by their Latin name via indexes also providing cross-references to the Hoava and Vanunu languages. For distribution and use in local schools. Request a copy while stocks last: links@unesco.org

Ocean sciences bridging the millennia

A spectrum of historical accounts
UNESCO Publishing/China Ocean Press, Co-edited by joint panel: UNESCO-IOC and First Oceanography Institute of China. ISBN: 92-3-103936-9. English only, €45, 508 pp. – Compilation of papers on aspects of the history of oceanography and marine biology, with emphasis on Europe and China. Covers exploratory expeditions and emergence of new disciplines, such as quantitative plankton research in 19th century. Gives insights into early Chinese work, such as tidal observations dating back to 3rd century. For details: <http://ioc.unesco.org/icho/>

... for the young

Terra

By Bruno Faidutti. For children. Card game for 3–6 players produced by UNESCO, the 2004 Barcelona Forum and the NGO Holos. UNESCO Publishing / Days of Wonder 19.95 euros. Exists in English, French, Spanish, Catalan and German. ISBN: 92-3-010870-7. The world is in crisis. Ecological disasters, socio-economic difficulties and military-diplomatic challenges abound. Will you be able to help your fellow players save the planet by respecting sustainable development while balancing your natural desire to come out ahead?



Governing bodies

Proposals for the establishment of two new science centres under the auspices of UNESCO will be examined at the Executive Board's April session: the *Instituto de Matematica Pura e Aplicada* (IMPA) in Brazil; and the International Centre for Water Hazard and Risk Management in Tsukuba (Japan).

Moreover, the Director-General will be presenting a feasibility study for the establishment of a regional centre for biotechnology training and education in India, also under the auspices of UNESCO.

Under an item proposed by Venezuela, the Director-General will be reporting on the reactivation and strengthening of centres of excellence in biology, molecular biology and tropical ecology.

In addition, the Director-General will be presenting the Draft International Implementation Scheme for the UN Decade of Education for Sustainable Development and reporting on the drawing-up of a declaration on universal norms for bioethics.

For details: www.unesco.org/exboard/index.shtml

Corrigendum

During the 25–26 November meeting in Delft, the Water Co-operation Facility was not "launched" in the strict sense of the word, contrary to our report in the January 2005 issue of *A World of Science*. It was decided in Delft that the launch of the Facility will happen gradually in the course of a careful consultation process among institutions willing to join the alliance. In the meantime, the interdisciplinary global network of institutions involved in the initiative is continuing to provide expertise and foster co-operation around shared waters.