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Scientific and Cultural Organization

Taking the temperature
of mountains p. 16

A World of SCIENCE

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IN THIS ISSUE

EDITORIAL

We are all polar bears

On the first day of a UN conference in Montréal last December to begin preparing the post-Kyoto period after 2012, host country Canada described greenhouse gas emissions as being the greatest threat facing the world today. 'Let us set our sights on a more effective, more inclusive long-term approach to climate change', Canadian Environment Minister Stephane Dion urged delegates. With three of the world's four biggest CO_2 emitters not bound by the Kyoto Protocol – the USA because it never ratified, China and India because they are developing countries – the post-Kyoto period will indeed be critical.

James Hansen, a climate scientist with NASA's Goddard Institute for Space Studies, warned at an American Geophysical Union conference the same month that even perfect adherence to Kyoto by all countries would not prevent dramatic climate change as levels of greenhouse gases continue to rise. As for opting for 'business as usual', that scenario would lead to such dramatic climate change, he said, as to 'constitute a different planet'.

There is now a wide body of scientific evidence that human activity is changing the climate. The signs are perhaps most visible in the Arctic, where sea ice cover this past summer was the smallest ever measured. Scientists predict a mostly ice-free summer by 2080 if present trends continue unchecked. Without ice, polar bears will be unable to reach the seals that constitute their staple diet.

But polar bears are only the tip of the iceberg, as it were. Melting permafrost is also causing homes in Arctic regions to subside. In mountain regions around the world, supplies of usable freshwater are slowly but surely diminishing as glaciers retreat, a trend which is set to cause water shortages for tens of millions of Asians and Latin Americans dependent on this resource. As the Greenland and Arctic ice sheets melt, sea level could rise by up to 1 m by 2100, flooding low-lying areas worldwide. And what effect will the additional freshwater have on ocean circulation patterns? There are already signs that a section of the ocean conveyor belt transporting heat northward in the North Atlantic has slowed down. If the North Atlantic cools, so too will temperatures in Western Europe.

The Kyoto Protocol and its successor are an insurance policy against runaway climate change. In this issue, we look at UNESCO's contribution to research on climate change via the Global Ocean Observing System and the Global Change in Mountain Regions (GLOCHAMORE) project, against the backdrop of the Montréal conference.

The better our scientific understanding, the better equipped we shall be to cope with our changing climate.

W. Erdelen
Assistant Director-General for Natural Sciences

Watching the oceans for signs of climate change

© Jerzy Smykla

Summertime sea ice (here) may become a much rarer sight in the future

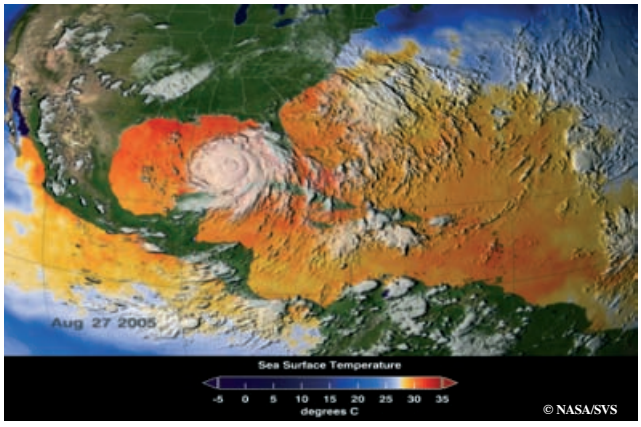
The International Year of Physics will also enter the record books as one of climate extremes. The year 2005 saw the most hurricanes ever in the Atlantic sector, including one with the lowest surface pressure ever recorded, which left thousands of dead in their wake in North and Central America. In the Arctic Ocean, northern summertime sea ice cover was a record low and rainfall in the Indian state of Maharashtra during the monsoon a record high. The Amazon forest, source of the world's strongest-flowing river, is experiencing its worst drought in recorded history. The five warmest years on record are now 1998, 2002, 2003, 2004 and 2005. All of these climate events have a link to the ocean.

It is scientifically impossible to link any one extreme event to global climate change but the ongoing trend confirms that global change is under way. The Intergovernmental Panel on Climate Change (IPCC), which is charged with assessing climate research, stated in 2001 that 'the balance of evidence' suggested a human influence on climate. Recent scientific studies, which will feed into the Panel's next report in 2007, reinforce this evidence, key pieces of which come from the oceans.

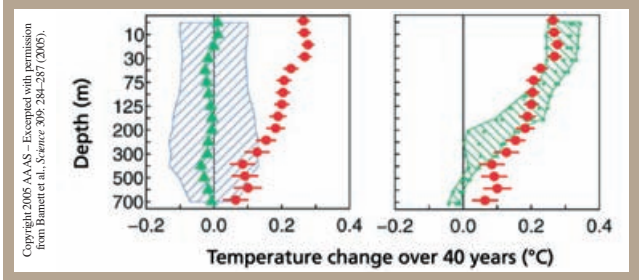
The oceans cover more than 70% of the globe. A major part of the climate system, they interact with the atmosphere and land. In the climate system, the oceans are unique for their high capacity to store heat: compared to air, seawater absorbs four times as much energy per kilogram in heating up one degree Celsius – and water is about 800 times denser than air at the surface. The heat energy contained in the top 3 m of the oceans is therefore equivalent to that contained in the entire atmosphere. This makes the oceans a key pathway for the transport of heat in the climate system.

Observations of the subsurface ocean have a fairly short history, beginning only in earnest after the Second World War and being concentrated in zones of high shipping traffic like the North Atlantic. But this history is now long enough to calculate trends in subsurface temperatures over vast expanses of ocean with a reasonable degree of scientific confidence.

The subsurface ocean is a good place to look for clear evidence of human-induced climate change. A change in the forcing of the climate system, such as that introduced by greenhouse gasses, forces the entire climate system to find a new balance, with a warmer Earth radiating more heat to space to compensate. The oceans are the major absorber of this extra heat. Since the subsurface oceans are less 'noisy' than the surface, which is affected by weather and the seasons, they have the clearest signals of long-term changes in the climate.



Warm ocean waters fuel hurricanes and the waters were unusually warm in the tropical Atlantic in 2005. Hurricane Katrina is shown here, on 27 August 2005, in a satellite cloud image super-imposed on a map of the sea surface temperature



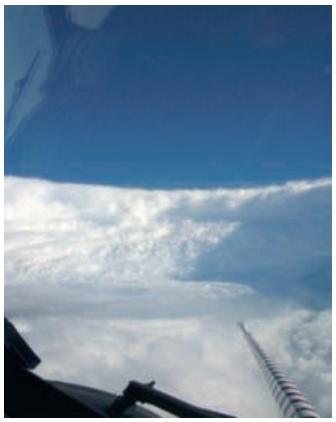
The panel on the left shows the average (green triangles) and range (blue hatching) of climate models reproducing natural climate variability over hundreds of years without inclusion of the human effect. The panel on the right shows the variability of a climate model run with the full history of human input of greenhouse gases (green hatching and dots); the red dots in each panel are averages over the North Atlantic of changes in ocean temperature over the past 40 years. The surface waters have warmed the most, by about 0.25°C. The panel on the right is a far better match to the observations than the panel on the left and excellent evidence of human influence on climate

Conclusive evidence from the oceans

In an article published in *Science* in July 2005, Tim Barnett and his colleagues showed that the observed patterns of ocean warming over the past 40 years could not be explained by natural variability but instead were a good match with the climate predictions incorporating the human effect on climate (see figure), findings which disagree with measurements taken elsewhere.

The study has helped to boost scientific confidence in the ability of modern land–ocean–atmosphere climate models to simulate climate change. In large part, the scientific debate over whether human activity has provoked climate change is over. Exactly how it will change remains a question.

Even if the human emissions of greenhouse gases were to stop today, the global climate would keep changing for decades to come, due to the level of greenhouse gases currently in the atmosphere and the thermal inertia of the climate system. The climate will stabilize again only when the Earth heats up enough or greenhouse gases get absorbed into other parts of the climate system. The oceans have absorbed about 50% of historical greenhouse gas production, with potentially dramatic effects on ocean ecosystems (see *A World of Science* Vol. 2, No. 4).



© NOAA

Too close for comfort. This view from the cockpit of the ring of thunderstorms surrounding the eye of Hurricane Katrina (known as an eyewall) was captured aboard a NOAA hurricane hunter aircraft a day before the powerful storm came crashing ashore. The heaviest rain and strongest winds are found in the eyewall, whose energy comes from heat from the ocean

Climate impacts driven from the ocean

Since the oceans are a major reservoir of heat in the climate system, prediction of short-term climate variations – those felt over days or months – is highly dependent on the interaction between the ocean and atmosphere. The climate records achieved this year are best understood using models that include the physics of ocean circulation. It is the extremes in rainfall and temperature which most affect humans, provoking floods, landslides, drought and shifts in the seasons which affect food production and tourism.

A record-breaking hurricane season

Unusually warm ocean conditions in the tropical Atlantic in 2005 contributed to the strength of hurricanes during the hurricane season, the most damaging season in recorded history. Hurricane Katrina last August devastated the US Gulf Coast (see images). Rainfall associated with Hurricane Stan in early October triggered severe flooding and landslides that killed up to 2000 people in Guatemala and other countries in Central America. Seven of the 14 hurricanes that formed were major and three were of the highest strength[1]. Meteorologists ran out of names for Atlantic hurricanes for the first time, resorting to the Greek alphabet and ending with Hurricane Epsilon.

© K. Niemi/US XCoast Guard Digital

The fierce winds and extreme low pressure of Hurricane Katrina forced enormous storm surges, flooding a territory half the size of France. They breached a number of the levees protecting the coastal city of New Orleans, built mostly below sea level. Over 1 million people had to be evacuated, like the children in this photo, and more than 1200 people lost their lives. It is estimated that reconstruction will cost the USA over US$100 billion.

The strong winds of a hurricane evaporate enormous quantities of water vapour from the ocean surface. Energy from the latent heat released when this vapour then condenses into raindrops is injected into the storm, further increasing its strength. The evaporation is strongest over ocean water with the greatest heat reserves. Climate change models incorporating hurricanes show an increase in the intensity of hurricanes – but not in their number – as the oceans warm. The debate is still ongoing as to whether the current warming of the tropical Atlantic is due to climate change or natural variability but global warming has already led to an increase in ocean temperatures.

A parched Amazon

While Central and North America flooded, the Amazon forest was experiencing its worst-ever recorded drought. Lakes and lagoons have dried up, river channels are no longer navigable, farming and fishing have been disrupted, the delicate tropical rain forests are burning, and stagnant water left

© Ana Cristina Vieira Folha

A dry mangrove swamp in Bragança, Brazil, in early 2005. The Amazon is experiencing severe drought, also due to the warm tropical Atlantic

1. *Category Five, with winds in excess of 249 km/hr*

The ocean conveyor belt

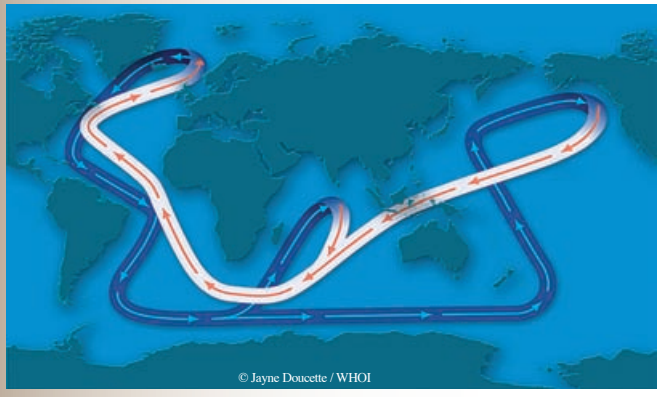
The average temperature between the equator and the poles differs because of the tilt of the Earth's surface relative to the sun. However, this difference is much weaker than one would expect. This is because the oceans and atmosphere carry heat to the poles, ensuring a more comfortable balance (for humans at least), by cooling temperatures at the equator and warming them at the poles.

The ocean transports about half of this heat via shallow and deep currents collectively known as the ocean conveyor belt (thermohaline circulation, see figure). One of the busiest ocean highways is the wind-driven Gulf Stream and North Atlantic Current, which warms Europe to its east. These surface currents transport tens of millions of cubic metres of warm tropical water northwards every second. Since mid-latitude weather systems generally move from west to east, New York in the USA is cooler than Naples in Italy, even though they are the same distance from the equator.

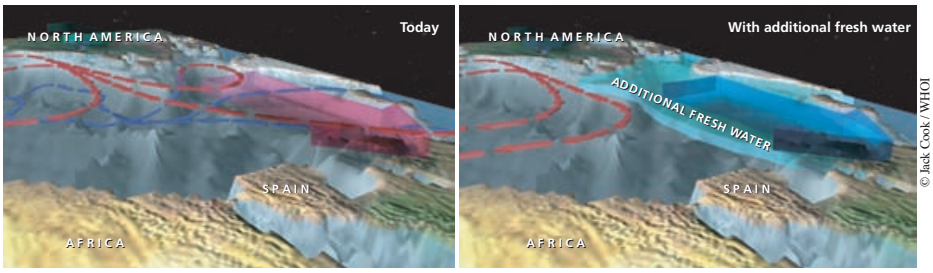
Evaporation to the atmosphere leaves behind saltier and cooler (and therefore denser) water. The waters below the upper layer everywhere in the world are filled with the densest cold and salty waters, formed mostly in the polar North Atlantic by extreme winter evaporation and heat loss; most of the sub-surface ocean is just a few degrees above freezing.

Carried in deep southward flows away from its source and, eventually, over thousands of years, spreading to the other oceans, the wind and tides bring this deep water back to the surface. There it is warmed by the sun and freshened by rain. Eventually, the water heads back to the poles again in the surface ocean to repeat the cycle.

Climate models with scenarios of human-induced change nearly all show that the ocean conveyor belt will slow down as the climate warms.



The path followed by the ocean conveyor belt



Left: the warm surface water of the North Atlantic flows northward (red lines), replacing the southbound flow of cold, deep water (blue lines). This transports heat northward, warming the winds blowing eastward over Europe (large red arrow). A large addition of freshwater from melting land ice (right) would prevent seawater from sinking in the North Atlantic. The northward oceanic heat transfer could then stop, making the winds blowing over Europe much cooler, despite global warming (large blue arrow)

in riverbeds is causing disease-carrying mosquitoes to proliferate. The same warming of the tropical Atlantic is thought to be to blame, as greater evaporation and rising air over the ocean has forced the air to descend over the Amazon, displacing the rains.

Monsoons driven by ocean heat

A similar balance of ocean and land evaporation drives the monsoon, a periodic wind which can be likened to a very strong sea breeze. The strongest of the monsoons occurs over the northern Indian Ocean, with the winds blowing from the southwest during one half of the year and from the northeast during the other half.

Tropical monsoon rainfall is driven by the difference in the heat capacity of the oceans and land. In summer under strong sunshine, the temperature on land rises much more quickly than the temperature at the sea surface. The warm air over land rises, drawing moist air from over the oceans inland and feeding strong rainfall. Both the amount of heat stored in the ocean and the difference in temperature between ocean and land affect the intensity of monsoons.

Melting ice and rising seas

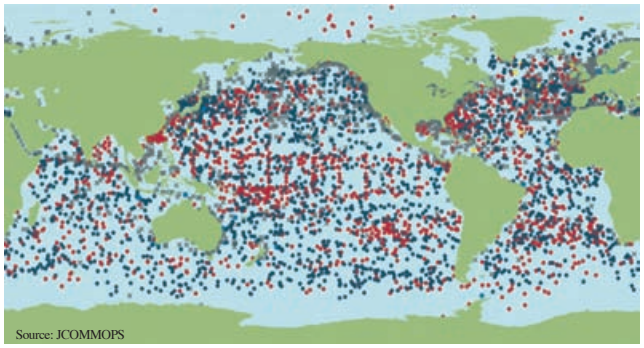
The oceans are of course central to sea-level rise caused both by the expansion of warming oceans and the melting of glaciers (see box, p. 16) and ice caps. The global average sea level has been increasing by about 2 mm per year. But the increase is not entirely uniform; as the climate changes, the average winds and ocean circulation have also changed, creating localized changes in sea level.

How will things change in the future? Will there be stronger hurricanes across the tropics? How likely is it that Europe will cool? Will disappearing sea ice finally open the fabled Northwest Passage to shipping? Will Tuvalu disappear beneath the waves? Will the mighty Amazon be reduced to a trickle? And could the climate change suddenly (see box)?

The World Climate Research Programme

The Intergovernmental Oceanographic Commission (IOC) of UNESCO, along with its partners the World Meteorological Organization (WMO) and the International Council for Science (ICSU), sponsors a World Climate Research Programme (WCRP) that tries to answer these questions. Its major goal is to determine both the limits of predictability of the climate system and the human influence on climate.

Published articles stemming from climate research within the WCRP make the main contribution to the body of knowledge periodically assessed by the IPCC.



Towards global coverage: in situ *platforms observing the ocean in October 2005, which produce data available in real time. These data come mainly from Argo floats (dark blue), ships of opportunity (light grey, light blue and yellow), fixed moorings and drifting buoys (red). The seasonally ice-covered oceans pose technical problems that are yet to be surmounted*

One continuing difficulty for scientists is how to separate human-induced climate change from natural climate variability. In fact, climate variability itself appears to be changing, with more extreme swings outside the realm of 'normal' weather. This in itself is an indication of climate change. The WCRP's Climate Variability and Predictability project is helping us to better predict and model the extremes in climate, on time scales ranging from days to months to years ahead.

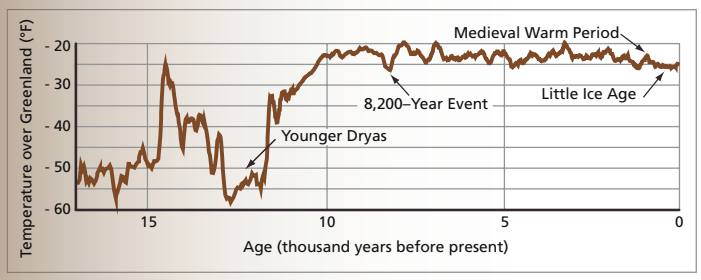
The aftermath of severe monsoon flooding in Mumbai, India, on 26 July 2005, when 1 m of rain fell in less than 24 hours, almost doubling the city's previous record. The resulting flooding and landslides took more than 1000 lives. The strength of the monsoon is dependent on the ocean heat content in the Indian Ocean, along with other factors like the phase of El Niño in the Pacific

Could the climate change suddenly?

Studies of past climate from fossils and ice cores show that the climate system has made sudden jumps in the past.

The most recent climate jump occurred at the end of the last ice age, about 12 000 years ago, as humans were settling the American continent and, elsewhere, first began to farm. The melting North American ice sheets suddenly released a large amount of fresh water into the North Atlantic. Fresh water is less dense than salt water, so the normal formation of deep water in the polar North Atlantic stopped abruptly (see *The ocean conveyor belt*). The consequence was the collapse of the thermohaline circulation, causing average temperatures in the North Atlantic region to plummet by 5°C in less than a decade.

Some scientists fear that the melting of the Greenland ice cap could lead to a similar freshening of the North Atlantic and a climate jump. A great exaggeration of that scenario was recently at the heart of a Hollywood disaster film. What then is the threshold for abrupt climate change? Our present-day climate models are not yet skilled enough to tell us. But the consequences of a sudden jump in climate to ecosystems and to human society would most likely be catastrophic.



Ice cores extracted from the 3km-thick Greenland ice sheet show several sudden shifts in climate in the past, within periods as short as a decade. Most dramatic was the Younger Dryas period, when average temperatures in the North Atlantic region dropped abruptly and remained cold for 1300 years before rapidly warming again[2]

There are already signs of a slowdown in part of the ocean conveyor. Only last month, scientists revealed that the deep southward flow of cool water in the North Atlantic, measured by five expeditions over five decades, had dropped by 30% between 1957 and 2004[3]. Should we put this down to a cycle of natural variability, or is this drop indicative of a longer-term change in the ocean conveyor? Only time – coupled with sustained observation – will tell.

2. *All the figures from the Woods Hole Oceanographic Institution are reproduced, with kind permission, from the brochure* Abrupt climate change: should we be worried?, *put together for the Davos Economic Forum in Switzerland in 2003: www.whoi.edu/institutes/occi/currenttopics/ct_abruptclimate.htm*

3. *These findings were published by Harry Bryden and colleagues in the 1 December 2005 issue of* Nature

Give and take: competing climate feedbacks

Scientists who grapple with trying to understand the complex climate system have found a simple way to describe the patterns of interaction that they observe: as feedbacks. Feedbacks can either reinforce the current state of the climate system or lead it to run away.

An example of a stabilizing feedback (called a negative feedback) is the interaction between solar radiation, the sea surface temperature and clouds in the tropics. The ocean warms from solar heating, warming and humidifying the atmosphere above. This air is less dense and rises, finally reaching a point where the water vapour in the air condenses into clouds. These clouds shield the ocean surface, which cools. In this way, the climate system creates a natural barrier to endless heating of the ocean. The opposite is also true: cooler oceans mean fewer clouds and more solar radiation reaching the surface. A negative feedback moves things towards an equilibrium.

Convective clouds in the tropics cast shadows over the warm ocean below

An example of a runaway feedback (called a positive feedback) is the interaction between solar radiation and ice in the polar regions. Ice is a very efficient reflector of sunlight, bouncing a significant fraction of its energy back into space. If the ice melts and is replaced by darker ocean or land surfaces, less sunlight is reflected, heating the surface. The heating will further melt ice. It is this which makes the polar regions particularly sensitive to climate change.

The balance of feedbacks, and whether a positive feedback can temporarily gain the upper hand over the stabilizing negative feedbacks, describes the evolution and natural variability of the climate.

The best-known interaction of climate feedbacks involving the ocean is El Niño, a temporary shift of the warmest waters in the tropical Pacific towards the east, with patterns of atmospheric uplift and rainfall following, bringing drought to Indonesia and Australia, excessive rainfall to Peru and Ecuador, and changed storm patterns over much of the globe.

Will El Niño change as the global climate changes? Many scientists believe it will or that it already has but predicting El Niños remains a difficult task.

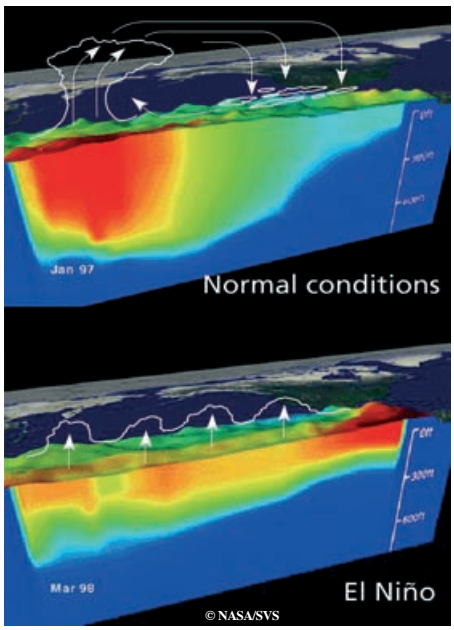
© ESA

Satellites provide global coverage of the oceans and are a key element of GOOS. This is an artist's impression of the European SMOS satellite, which will measure surface salinity from 2007 onwards

Observing the oceans to understand them

The IOC of UNESCO and its flagship programme, the Global Ocean Observing System (GOOS), make up the UN arm responsible for sustained global ocean observations. An IOC group of experts, the Ocean Observations Panel for Climate (OOPC), helps to define the standards and goals of the global climate component of GOOS and the tools for monitoring and evaluating the system.

Through a joint technical commission with the WMO for oceanography and marine meteorology (JCOMM), the IOC is also actively coordinating these global networks through an *in situ* (in the water) platform support centre (JCOMMOPS) located in Toulouse, France, which continually monitors the thousands of floats, ships and fixed moorings transmitting oceanographic data.



A slice of temperatures in the Pacific ocean, cut east–west at the equator and looking northwards, as visualized from the tropical array of fixed moorings in the Pacific. Normally, air rises over a pool of the warmest water in the western Pacific (top image), drawing the surface winds from the east that maintain this warm pool by piling up warm water. During an El Niño event (bottom image), something weakens the surface winds, which allows the warm water to slump eastward. The centres of rising air follow eastward, further weakening the surface wind and allowing the warm water to slump further, a positive feedback. The result is a change in the tropical Pacific on the ocean side and global changes in the atmospheric circulation

Satellites: scratching the surface

Ocean satellite missions have revolutionized oceanography; they are critical for global coverage of surface temperature, ocean eddies (the sea's weather systems), surface wind and ocean colour as an indicator of biological activity.

The oceans pose a serious impediment to satellite observations however. As the conductivity of salt water makes them almost impervious to electromagnetic radiation, only the skin of the ocean is visible from space. To observe the global oceans fully, measurements need to be taken in the oceans themselves, from different types of autonomous platforms and research ships.

An Argo profiling float being deployed from the Canadian coast guard ship John P. Tully in the Gulf of Alaska

Robotic sentinels of the deep

The most rapidly growing of these *in situ* networks is the Argo profiling float network. Argo floats are robotic, self-contained oceanographic measuring devices that park in the deep ocean, 2 km below the surface. Changing their buoyancy once every 10 days by shifting oil out to an external bladder, they rise to the surface. On the way up, they collect information on temperature and salinity (some also measure oxygen), which they then transmit by satellite at the surface.

By the end of 2005, the four-year old Argo project had seeded the oceans with more than 2000 floats, two-thirds of its way to its initial goal of 3000 floats, roughly one per every 100 000 km^2. When the batteries fail after about four years, the floats cannot rise to the surface. Most will eventually sink to the bottom. Argo floats are widely distributed in the world's oceans, thanks to the coordinated efforts of more than 20 participating countries. In some areas, the floats are now returning more information on the subsurface ocean in one year than can be found in the entire historical database before Argo.

A modern message in a bottle

Inspired by shipwreck survivors who sometimes cast messages sealed in a bottle to the waves, US scientist and statesman Benjamin Franklin used message-carrying bottles in the mid-1700s to compile an atlas of currents off the east coast of North America.

One of 70 fixed moorings in the tropical Pacific which monitor and forecast El Niño events within the global ocean observing system. The last El Niño event occurred in 2002–2003

In 1929, German scientists released a message that could be read without breaking the bottle in the South Indian Ocean. It was read and re-released a number of times. Caught up in the strong circumpolar current, it had travelled more than 25 000 km by 1935.

Today, a modern equivalent of these messages in a bottle – surface drifting buoys – ply the surface currents of the world, transmitting their electronic reports of surface temperature, currents and often barometric pressure. These buoys provide a ground truth for satellite estimates of the sea surface temperature and are the best witnesses of ocean surface currents, themselves driven by winds and ocean eddies. They also improve weather forecasts by reporting on the surface pressure.

The scientific goal set by OOPC for the surface drifting buoy network was to have one in every 300 000 km^2 box of ocean, or 1250 in total. That goal was reached in September 2005, when Global Drifter 1250 was launched at a special ceremony held in conjunction with the Second Session of JCOMM in Halifax, Canada. It is the first of the *in situ* global ocean observing networks to reach the goal it was designed for, a major milestone.

But scientists can't just declare victory and go home; the drifting buoy network needs constant replenishing as floats fail and drift out of regions of current divergence. Moreover, the planned global *in situ* ocean observation network of floats, profilers, moorings, sea level gauges and volunteer and research ships is currently only about 55% complete.

A message in a bottle: Global Drifter 1250, symbolically completing the first component of GOOS, is deployed in September 2005 in Canadian waters

A training course in ocean data management at the IOC's International Oceanographic Data and Information Exchange (IODE) programme office in Oostende, Belgium. These courses build countries' capacities to participate in, and benefit from, ocean observing systems

Scientists hitch a ride on the oceans

The M/V Skogafoss, a 100 m-long container freighter, sets sail monthly from the port of Reykjavik, in Iceland, carrying containers full of frozen fish to North America. It returns two weeks later, repeating this voyage year in and year out. It navigates the most northerly regular ship route in the North Atlantic, dodging icebergs flowing southward in the Labrador Current well into spring.

The Skogafoss is also a volunteer observing ship. It regularly launches radiosondes (atmospheric profilers) from an automated laboratory mounted on a rear deck. It has automatic systems recording surface meteorology and sea surface temperature, as well as atmosphere and ocean carbon measurements. Once every few hours, the officer on duty steps out onto one of the bridge wings, loads an expendable bathythermograph (XBT) into a launcher and pulls the trigger. The XBT drops into the ocean and measures a profile of temperature, sending back its data on an unspooling length of copper wire thinner than a human hair. These observations are a key part of the global system and are coordinated through JCOMM's Ship Observations Team. The captain and the shipping company provide their services for free, volunteering their time and space aboard the ship.

This is a real boon for scientists, as a modern research vessel is extremely expensive to run. Paying for fuel, maintenance, three round-the-clock shifts of officers, engineers and sailors adds up, to the tune of US$ 20 000–50 000 per day. These volunteer ships of opportunity are also a major deployer of Argo and surface drifting floats, filling holes in the observational network as they open up.

Global information for local decisions

The global component of GOOS was designed for climate monitoring, forecasting and research but it also helps to improve weather and marine prediction. Ocean data (now coming from nearly 70 countries) is managed and disseminated globally in a coordinated fashion and turned into ocean and climate models and other products. The IOC has also taken on a strong role in the coordination of global ocean natural hazard warnings, in particular as regards tsunamis. The observing platforms that feed into the warning systems are often the same: moored buoys and tide gauges are used in both the climate and tsunami observing systems. The IOC is working to maximize the synergies between the two systems.

Raw ocean data are of interest to scientists but may be incomprehensible to government officials and other decision-makers responsible for addressing climate change, managing fisheries or sailing safely. GOOS and the WCRP are working to develop ocean and climate models that can provide more targeted information for decision-making.

Long-term foresight in short supply

The global oceans that cover such a large portion of our Earth belong to all nations collectively – but very few people live on the oceans. Whereas nearly every country, rich or poor, has a national meteorological agency charged with observing and forecasting the atmosphere, very few have national oceanography agencies with a mandate to observe the oceans and even fewer a mandate to observe the global ocean.

The ocean observing network has been built on the sustained work of research oceanographers. But this poses its own problems; for example, subsurface current meters have been monitoring part of the thermohaline circulation in the Atlantic (see *The ocean conveyor belt*) for over a decade but a number will not be renewed because the national research agencies are keen to fund something new. There is no-one however to fill the gap once this monitoring ceases.

This lack of commitment by the world's governments to sustained observations of the oceans is shortsighted. In the face of slow political action to change mounting human production of greenhouse gases (see *Ups and downs in climate diplomacy*), it is clear that climate will continue to change and that this change may even accelerate.

Scientific observations and research are needed to help us understand how regional climate will change, to improve predictions about shorter-term changes in the local climate, to improve our poor understanding of how ocean chemistry and ecosystems may change and to equip governments and citizens of the world with better knowledge to help them in making decisions about the future.

Humans have generated an unprecedented perturbation in the Earth's climate. In facing the consequences, we need to be as informed as possible.

Albert Fischer[4]

For details: http://ioc.unesco.org/iocweb/climate-Change

4. UNESCO–IOC Programme Specialist and physical oceanographer

Ups and downs in climate diplomacy

After protracted negotiations, the 180 countries meeting in Montréal for the UN Conference on Climate Change decided on 10 December to open non-binding talks on further targets for reducing greenhouse gas emissions after the Kyoto Protocol expires in 2012. The Kyoto Protocol requires the 40 industrialized nations which ratified the treaty to reduce their greenhouse gas emissions to 5% below 1990 levels by 2012. It came into force in February 2005 after being ratified by the Russian Federation.

Critics of the Kyoto Protocol decry the lack of binding targets for developing countries. Yet, in Montréal, the developing countries offered to discuss just that. For the first time, they put forward a major legal mechanism for combating climate change by incorporating the fight against deforestation – responsible for 18% of greenhouse gases, according to a new study by the World Resources Institute. Some developing countries have already acted, like Gabon, where a new forest code imposes a 25-year rotation of tree-cutting to preserve the forests that cover 80% of the country.

It is true that the fastest growth rates in greenhouse gas emissions come from the fastest-growing economies of the developing world. But annual CO_2 emissions per capita remain much higher in the industrialized countries than in either China or India (see figure).

According to a report released by the UN Framework Convention on Climate Change (UNFCCC) last November, the developed countries as a whole reduced their greenhouse gas emissions by 5.9% between 1990 and 2003 – for the most part in the early 1990s, when countries in Eastern and Central Europe were undergoing transition to a market economy. With these countries now back on keel – and with the emissions of some countries having spiralled between 1990 and 2002 – the UNFCCC cannot exclude 'the possibility of emission growth by 2012'.

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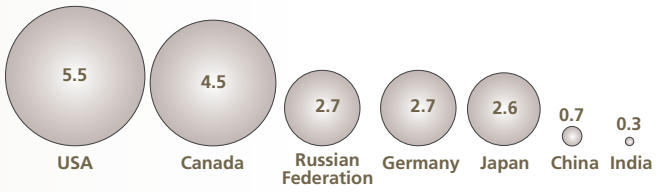
Delegates celebrate the closing of the UN Conference on Climate Change in Montréal, after an all-night negotiating session allowed for continuation of formal discussions on targets for the post-Kyoto period

Annual CO_2 emissions per capita, 2002
in metric tons of carbon



Source of both figures: http://cdiac.ornl.gov

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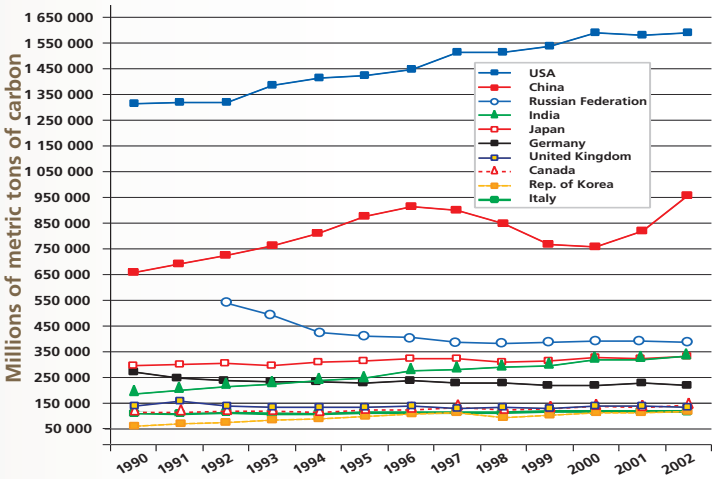
Protesters were less happy about the pace of negotiations in Montréal

Change in CO_2 emissions, 1990–2002
Top 10 emitters

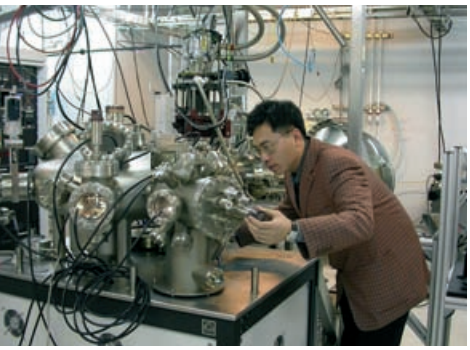


Science prizes awarded at Science Forum

On 10 November, seven UNESCO science prizes were awarded at the World Science Forum. The Forum was organized in Budapest by the Hungarian Academy of Sciences, UNESCO and the International Council for Science (ICSU) on the theme of Knowledge, Ethics and Responsibility.

Students and their teachers visiting the 'museum in a truck' created by Prof. Bertoletti, at Carazinho City, Rio Grande do Sul

The **Kalinga Prize for the Popularization of Science** was awarded to Jeter Jorge Bertoletti (Brazil). Professor at the Pontific Catholic University of Rio Grande do Sul (PUC–RS), Jeter Jorge Bertoletti is also founder and director of the university's science and technology museum, the biggest science museum in Latin America. In 2001, he launched the Itinerant Museum Project. This 'museum in a truck' proposes exhibitions, experiments and conferences to communities in Rio Grande do Sul.



Professor Dong-Lai Feng in his laboratory. His research covers superconductivity, strongly correlated systems, magnetism, nanoscience and the development of new techniques like laser photo-emission and resonant soft x-ray scattering

The **Javed Husain Prize for Young Scientists** was awarded to Professor Dong-Lai Feng (China), from the Fudan University in Shanghai. At just 33, he already leads the research group of complex quantum systems, which is part of the Shanghai Laboratory of Advanced Materials. He has made major contributions to current understanding of high temperature superconductivity. The prize is awarded to scientists under 35 years of age.

The **Carlos J. Finlay Prize for Microbiology** went to Professor Khatijah Binti Mohamad Yusoff (Malaysia) from the Universiti Putra Malaysia in Selangor, for her involvement in vaccine research and research on poultry virus and the Newcastle Disease Virus.

The **UNESCO Science Prize** was won this year by Professor Alexander Balankin (Mexico) from the National Polytechnic Institute, for his work on fractal mechanics and improving exploration techniques for the oil industry. A Mexican citizen born in Russia, he founded the National Interdisciplinary Research Group on 'Fractal mechanics' and the Escuela Superior de Ingeniería Mécánica y Eléctrica.

The **Great Man-made River International Water Prize** went to Dr Sayyed Ahang Kowsar (Iran), who has devoted his life to developing and implementing floodwater spreading and harvesting as a means of recharging aquifers and improving environmental quality.

The **Sultan Qaboos Prize for Environmental Preservation** was awarded jointly to the Great Barrier Reef Marine Park Authority of Australia and to Dr Ernesto Enkerlin-Hoelflich (Mexico). The Great Barrier Reef Marine Park is a UNESCO World Heritage site. Ernesto Enkerlin-Hoeflich is the President of the National Commission on Natural Protected Areas of Mexico. Under his leadership, five new Mexican sites have been added to UNESCO's World Network of Biosphere Reserves.

The **Institut Pasteur–UNESCO Medal** was presented to Professor Mireille Carmen Dosso (Côte d'Ivoire). As Director of the Institut Pasteur of Côte d'Ivoire, she has been active in research and prevention in the area of HIV-AIDS, as well as other tropical diseases like tuberculosis, malaria and poliomyelitis. The award is presented for outstanding and innovative contributions to health, fermentation, agriculture and food.

For details: y.nur@unesco.org

Telemedicine gives medical training new edge

On 7 September, UNESCO established a Chair in Telemedicine for interdisciplinary distance learning within its university twinning programme (UNITWIN). This brings the number of UNESCO chairs in medicine to 13.

The Chair is established on the international repute of the World Organization for Specialized Studies on Diseases of the Esophagus (OESO), a French NGO and world reference in its field. OESO promotes high-level electronic medical content developed by the OESO Foundation in the area of health in general and gastroenterology in particular[5].

The Chair will collaborate with the Health on the Net Foundation and operate alongside the distance learning activities of the University of Geneva (Switzerland). The University hosts a network in telemedicine (*Universanté*-RAFT) for French-speaking Africa and is the headquarters of the OESO Foundation. Hosted by the Department of Medical Informatics within the University of Geneva, a programme for medical training will be proposed by the universities behind the creation of the Chair, namely

5. *UNESCO endorsed the undertakings of OESO and the OESO Foundation in a Resolution approved by the General Conference in 1999*

Giving a lecture via Internet using fixed images. Here, an x-ray of the esophagus of an anonymous patient is shown. Filmed by a webcam, the speaker answers the questions put to him by students in the auditorium using a microphone or via e-mail. The centres connected to the lecture will subsequently adapt it to suit their own needs

those of : São Paulo (Brazil), Yaoundé (Cameroon), Abidjan (Ivory Coast), Helsinki (Finland), Paris VI (France), Sendai (Japan), Beirut (Lebanon), Rabat (Morocco) and Dakar (Senegal).

In 2006, these universities, and any others which may join them, will propose distance learning programmes in English and French via Internet. These programmes will be presented live or pre-recorded and will take two forms: lectures using either still or moving images and videoconferences between specialists invited to discuss an anonymous clinical case. The technology will be adapted to suit the technical capacity of each centre.

A wide spectrum of regularly renewed services will be proposed to all of UNESCO's Member States, from practical case studies to debates in basic sciences, traditional lectures and surgical demonstrations.

Professor Robert Giuli is a Member of the French National Academy of Surgery and Scientific Director of OESO. He is also the driving force behind the project. 'This UNESCO Chair is the culmination of an undertaking that goes back more than 20 years', he says, 'when OESO first invited specialists from the clinical and basic sciences who were all involved in the same part of the digestive tract to take part in collaborative studies and in innovative interdisciplinary congresses. Right from the start', he adds, 'OESO strived to disseminate and share knowledge, a central aspect of UNESCO's mission'.

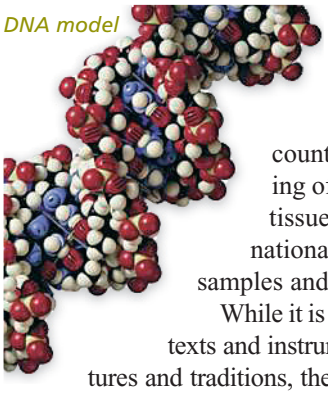
The OESO Knowledge Interactive Information System provides answers to 1420 specific questions on subjects related to esophagology. This evolving database can be accessed via the OESO Foundation website.

For details: www.oeso.org; www.oeso-foundation.org; robert.giuli@oeso.org

Declaration adopted on **Bioethics and Human Rights**

UNESCO's General Conference adopted the *Universal Declaration on Bioethics and Human Rights* on 19 October.

The *Declaration* meets a growing need for international ethical standards in medicine, life sciences and associated technologies, owing to the proliferation of practices that go beyond national borders, often without any regulatory framework: biomedical research projects and experiments carried out simultaneously in different countries; importing and exporting of embryos, stem cells, organs, tissue and cells; and the international transfer of tissue and DNA samples and genetic data.



DNA model

While it is still up to States to create legal texts and instruments appropriate to their cultures and traditions, the general framework proposed by the *Declaration* can help 'globalize' bioethics.

The first principle established by the *Declaration* is respect for human dignity and human rights, with an emphasis on the following two points: 'The interests and welfare of the individual should have priority over the sole interest of science or society' and 'If the application of the principles of this *Declaration* is to be limited, it should be by law, including laws in the interests of public safety, for the investigation, detection and prosecution of criminal offences, for the protection of public health or for the protection of the rights and freedoms of others. Any such law needs to be consistent with international human rights law.'

Among the other principles set forth, some are already well-established – informed consent, respect for privacy and confidentiality, non-discrimination and non-stigmatization – but the notion of social responsibility is new. It stresses that progress in science and technology should promote the well-being of individuals and of humanity, notably by improving access to quality health care and essential medicines, adequate nutrition and water. The principle of sharing benefits is also affirmed (different forms of sharing are proposed), as is the safeguarding of the environment, of the biosphere and biodiversity.

The *Declaration* also covers the application of these principles, calling for 'professionalism, honesty, integrity and transparency in decision-making' as well as the creation of independent, multidisciplinary and pluralist ethics committees. Referring to transnational practices, it specifies, 'When research is undertaken or otherwise pursued in one or more States – the host State(s) – and funded by a source in another State, such research should be the object of an appropriate level of ethical review in the host State(s) and the State in which the funder is located.'

UNESCO's International Bioethics Committee devoted an entire year to drafting the *Declaration*, in consultation with Member States and specialized organizations, and it took another year of governmental expert meetings to come up with the definitive version.

Three programmes will promote the *Declarations* developed by UNESCO in recent years: the Global Ethics Observatory, a collection of databases currently being put together; a programme which assists bioethical committees primarily by publishing practical guidelines; and a new ethics education programme.

Read the Declaration*: http://portal.unesco.org/shs.html*

Physicists commit to sustainable development

Hundreds of physicists from around the globe departed Durban on 2 November after putting together a plan to confront key challenges posed by sustainable development.

The most important international event on the calendar of the UN International Year of Physics, the World Conference on Physics and Sustainable Development in Durban, South Africa, from 31 October to 2 November, was a chance for the physics community in the developed world to focus on how it can work with colleagues in the developing world to bring their countries more benefits. 'The fact that the physicists from the developed world have also descended here is a clear indication of how serious the physics community is in terms of transferring skills to their not so fortunate counterparts,' remarked Dr Wiqar Hussain Shan from the Federal Urdu University in Islamabad, Pakistan.

It is common knowledge that many of the contributions made by physics to the world economy in areas such as electronics, materials and computer technology, or to health through x-rays, magnetic resonance imaging and nuclear medicine, have benefited people in the developed world more than those in the developing world. 'The conference is an attempt to redirect the attention and efforts of physicists towards the Millennium Development Goals', explained Edmund Zingu, President of the South African Institute of Physics, co-sponsor of the conference with UNESCO, its Abdus Salam International Centre for Theoretical Physics and the International Union of Pure and Applied Physics. Some 250 physicists from the developing countries and Eastern Europe were able to attend, thanks to funds made available by a slew of organizations.

The plan of action adopted in Durban is articulated around the four themes of the conference.

Under the umbrella of **physics education**, physicists pledge to make high-quality physics resources widely available in developing countries by setting up a website and establishing resource centres in Africa, Asia and Latin America. They will be developing instructional materials to complement secondary physics courses and help students understand the relation between physics and sustainable development. Model workshops will be run for teacher trainers in Asia, Latin America and Africa to exemplify the active learning technique as a means of improving secondary school teaching. The resulting resource material will be made available on-line. A multidisciplinary mobile science community will also be established to provide support to mobile science practitioners, via a website hosted by the Institute of Physics in the UK[6].

6. *www.mobilescience.info*

The second theme was **physics and economic development**. Physics makes a vital contribution to the economy, as Peter Melville of the aforementioned Institute of Physics recalled in Durban. In his own country, physics-based industries account for 43% of employment in manufacturing.

Among the projects put forward in Durban are a new Training Facility for Physicists in Economic Development to forge entrepreneurship and a network on physics and agriculture which will make materials available on-line. A joint research project on nanoscience and nanotechnology for economic development is also to be launched, with a focus on water, air and energy.

Under the umbrella of **energy and environment**, new battery technologies will be investigated, as will improved internal combustion technology for hybrid application, in an effort to enhance efficiency and reduce pollution in transportation. Teams will develop solar photovoltaic technologies, including new and environmentally-friendly materials and processes for the generation and storage of electricity. Moreover, to cover the basic energy needs (electricity, bio fuels, thermal) of small communities, an inexpensive multifunctional T-model biomass energy mini-plant will be developed on the basis of locally available biomass.

Last but by no means least, under **physics and health**, educational resources will be made available through the Physics and Engineering Resources for Healthcare Development (PERHD) website hosted by the Durban conference portal. Further projects include creating a network of training centres in the physics of radiation therapy, using shared resources from institutions around the world and providing guidelines to elaborate educational programmes in medical physics.

For details: http://www.wcpsd.org

First step towards **environmental institute**

UNESCO and Italy have taken the first step towards establishing an institute for environmental development, with the signing of a Memorandum of Understanding at UNESCO in Paris on 18 October.

The proposed institute would be located in Trieste (Italy) and offer an international programme for education, training and capacity-building in environmental development. Italy already hosts UNESCO's Abdus Salam International Centre for Theoretical Physics, within a tripartite agreement involving the Government of Italy, UNESCO and the IAEA.

The next phase of development for the environmental institute will be a feasibility study carried out jointly by the Italian authorities and UNESCO, in particular through the latter's Natural Sciences Sector. The study's findings will then be submitted to UNESCO's Executive Board during the next biennium before a final decision is made at the next General Conference in late 2007.

Sabrina Krief

Are humans just another Great Ape?

At 'one minute to midnight[7]' for the Great Apes, Sabrina Krief explains why the extinction of the Great Apes would also be a tragedy for humankind. Doctor in veterinary medicine and in ecology and the chemistry of natural substances, Sabrina Krief is Assistant Professor in the Unit of Eco-anthropology and Ethnobiology at the National Museum of Natural History in France.

Is size the only characteristic which differentiates monkeys from Great Apes?

No, the larger size and heavier weight of gorillas, chimpanzees, bonobos and orang-utans are not all that distinguishes them from other primates. Great Apes also have longer arms, a flat dorsoventral thorax, no tail and a highly developed brain. They can live up to 50 years – even longer in captivity – and the females give birth to a single baby every 5–7 years from the age of 13–14 years onwards.

Last September, researchers completed the sequencing of the genome of Clint, an adult male chimpanzee belonging to the sub-species *Pan troglodytes verus*. This sequencing confirms that there is just a 1.23% difference between the genomes of chimpanzees and humans[8]. This remarkable accomplishment may be a quantum leap in our knowledge of the species but it still doesn't enable us to answer that timeless question about our origins and originality: 'What makes us human?' We will only be truly able to compare the two species once we understand the function of genes and how they are expressed and regulated.

The anatomical and physiological resemblance of Great Apes to us can be explained by our close genetic likeness to them. Hence the importance of studying them in the wild to gain a better understanding of their behaviour in all its diversity. In the tropical zones inhabited by the Great Apes, observations of chimpanzee behaviour are shedding a new light on the frontier between humans and animals.

Don't we even speak of a 'chimpanzee culture'?

Each chimpanzee uses tools and/or demonstrates behaviour patterns particular to its community; these are learned socially and passed on from one generation to the next: this is what we mean by 'cultural' traits and what primatologists call the 'material culture' of chimpanzees.

These rich and varied cultural traditions are expressed in the way chimpanzees build their nests, process and eat food and maintain social ties, comfort and hygiene, etc. Chimpanzees in the Taï Forest in Ivory Coast and Bossou in Guinea, for example, use hammers and anvils made of stone or wood to crack open nuts. In Tanzania, chimpanzees 'fish' for termites with probes made from grass or bark in Mahale and use a two-handed technique known as ant-dipping to collect driver-ants in Gombe. Farther north, in Uganda, two chimpanzees engrossed in grooming one another often clasp one another's hand. In doing so, they discover one another's armpits, which they then proceed to groom as well. Chimpanzees also display some striking behaviour patterns in a social context, such as leaf-grooming accompanied by lip-smacking and close-up examination of a leaf, or leaf-clipping whereby chimpanzees clip dead leaves in their lips with tearing sounds. Depending on the community, this can be a signal for play or a means of attracting females' attention in courtship.

Chimpanzees thus have a complex system of communication. They hunt small mammals in a group and develop alliances within their community, which can include up to 150 individuals.

You can easily recognize the community to which a chimpanzee belongs from the cultural traits he or she displays. Studying the behaviour of chimpanzees also helps us make assertions about human evolution, thereby teaching us more about our own origins. We have learned so much about the behaviour of chimpanzees from comparing data accumulated over 151 years of observation of eight communities[9] that we can easily imagine this is only a fraction of what there is to know.

Just 50 years ago, we barely knew anything about the behaviour of chimpanzees in the wild. There is still a lot to learn about the Great Apes, on condition that we manage to preserve their habitat, of course.

Long-term field studies may have taught us a lot about the chimpanzee culture but what about the other Great Apes?

It's true that data on the other Great Apes are often more fragmented. Bonobos are endemic to the Democratic Republic of Congo (DRC). The difficult situation prevailing in the country has complicated field studies. Gorillas also live in zones where war and diseases like Ebola make observation problematic.

In the case of orang-utans, it is deforestation and forest fires which hamper the study of wild individuals. Nevertheless, findings show that orang-utans share some of the same cultural traits as chimpanzees but also some traits that have never been described for chimpanzees: orang-utans use leaves to make noise, shelter from the rain by taking cover under their nests and use leaves as gloves to handle prickly fruit.

Bonobos sometimes cover themselves with leaves in their nest. Their diet includes aquatic plants; whereas, in Lomako, bonobos will enter the water in a quadrupedal position, in Wamba and Lukuru, they will pull themselves up into a bipedal position before venturing into deeper waters.

It was in an 'aquatic' environment that wild gorillas were first observed using tools (observations published just a few weeks ago[10]). In trying to cross an expanse of water in the Nouabalé-Ndoki National Park (DRC) recently, a female lowland gorilla was seen to grab hold of a branch which she then used to test the depth of the water and to wade across the swamp before turning back. In a second instance, a female gorilla was observed in another group using a branch broken off a dead tree to steady herself while she used her other hand to gather aquatic plants. She then used the branch as a 'bridge' to cross the unstable, soaked ground of the swamp.

Whether we broaden our knowledge of the 'cultural' diversity of the Great Apes and manage to preserve this diversity will obviously depend on our capacity to lift the threats to their survival.

© Jean-Michel Krief

A chimpanzee from Kibale eating Trichilia *leaves, from which Sabrina Krief and collegues have extracted molecules that are effective* in vitro *against malaria-bearing parasites*

So humans are Great Apes too?

Yes, insofar as we share a lot of characteristics with them. No, insofar as we are the only Great Ape which inhabits the entire globe in great numbers and whose population is expanding constantly. It is our own behaviour which has accelerated the decline of our closest relatives; only we can prevent their extinction.

The Great Apes are in immediate danger?

It is estimated that there remain fewer than 400 000 Great Apes on the planet. Of the eastern gorillas, there are 700 mountain gorillas belonging to two separate populations and 3000–5000 eastern lowland gorillas. Of the western gorillas, just 200 of the Cross River population remain and 94 000 western lowland gorillas. The four sub-species of chimpanzee you find in 21 countries stretching from Senegal to Tanzania total 170 000–300 000, depending on the estimate, and there are just 15 000–50 000 bonobos living in the DRC. The forests of Borneo are home to 45 000–70 000 orang-utans but only 3 500 have survived in Sumatra[11].

Carrying out a census in these vast areas is difficult; the population density varies greatly and the rapid, alarming drop in numbers renders any figures obsolete very quickly: in some forests of Central Africa, Ebola, an emerging viral disease which afflicts humans, has also decimated the wild population of gorillas and chimpanzees by 50–90%.

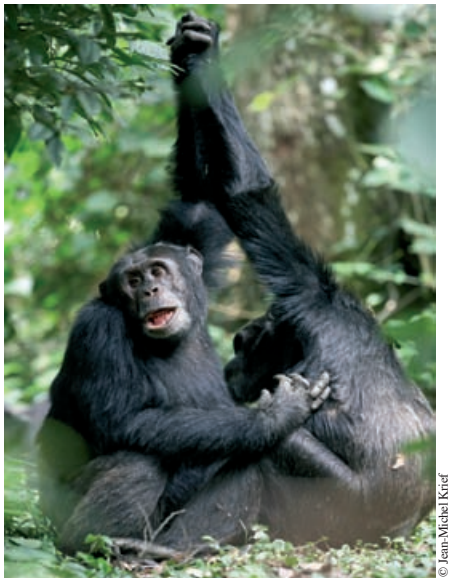
So Great Apes are also threatened by disease?

As I said, the Great Apes are very close to humans both physiologically and anatomically. This makes them vulnerable to certain human diseases, such as polio, anthrax and Ebola. The Great Apes are also carriers of certain pathogens akin to those carried by humans, such as the parasite responsible for malaria or viruses like the Simian Immunodeficiency Virus, very similar to HIV. This is why the Great Apes were the first to be chosen as laboratory 'guinea pigs' for experiments on human diseases and treatments for these.

It is this very similarity to humans, coupled with our growing understanding of the cognitive ability of Great Apes, that makes it completely inconceivable today for ethical reasons to use Great Apes in animal experiments.

Why single out the Great Apes when hundreds of other species are also on the brink of extinction?

If no Great Ape should ever again cross the threshold of a laboratory, they have an enormous amount to teach us in their natural environment. Some 30 years ago, R. Wrangham observed that chimpanzees used rough leaves to control sickness caused by intestinal parasites. Later, M. Huffman would demonstrate that the chemical properties of the bitter pith of *Vernonia amygdalina* restore chimpanzees to health.


© Jean-Michel Krief

Grooming with hand-clasp by two chimpanzees at Kibale, Uganda

Since the Great Apes are vulnerable to some of the same diseases we ourselves suffer from, chimpanzees should be able to guide us towards plants which would be useful for treating humans too.

Recently, we isolated molecules from plants eaten by the chimpanzees of Kibale in Uganda which are effective *in vitro* against tumoral cells and malaria-bearing parasites. These chimpanzees eat certain plants on rare occasions, in only a small quantity and following a particular ritual. These plants are nonetheless indispensable to their good health. This example underlines just how important the relationship is between plants and animals and the fragile balance that binds the two. Any break in this equilibrium can lead to the extinction of a population by making it more vulnerable to disease.

Some of the plants eaten by chimpanzees are also used by the local population as traditional medicines. Humans and Great Apes thus both need the forests to be preserved, in the interests of their health. Think of forests as a kind of open-air laboratory from which researchers can draw their knowledge of ecology and anthropology – but also the medicines of tomorrow.

The Great Apes are useful then both to local communities and to the West?

Humans draw many resources from the forest. By clearing forests at such a frenetic rate, we are also destroying our own future. According to a report by UNEP, less than 10% of the forest habitat of the Great Apes will be intact by 2030; the fate of the orang-utans is most worrying, with just 1% of their habitat to be spared.

The Great Apes Survival Project (GRASP)[12] is an international movement which strives to build awareness while coordinating initiatives in favour of the Great Apes. The aim is to improve the economic conditions of the local population by making conservation of the Great Apes' habitat an attractive option for the community.

In the field, concrete projects for conserving the Great Apes and their habitat are instigated in harmony with the local population, via: ecotourism; the use of ecological data on biodiversity to select parcels of forest land for exploitation; programmes for sustainable development in areas where humans and Great Apes share resources; law enforcement to thwart the illegal trade wild animals; anti-poaching measures allied with the development of alternatives to bush meat, etc.

These are major field projects. What can each of us do to play our part?

By avoiding multiple purchases of mobile phones, we can all help to limit the destruction of forests via the opening up of new coltan mines in areas inhabited by gorillas in the DRC. This is because coltan, a mineral resistant to heat, is used in the manufacture of mobile phones.

Moreover, by preferring local timber (chestnut, European cherry tree…) to exotic timber for furniture-making and construction, and by choosing exotic timber bearing the Forest Stewardship Council label – indicating that the timber comes from forests where wood-cutting has not generated any negative economic, social or environmental impact –, each of us can adopt consumer habits which help conserve tropical forests[13].

Everyone can also support field projects, such as those of NGOs associated with GRASP[14].

The growing public awareness of the human impact on the environment is a big step towards protecting the Great Apes.

Interview by Mambaele Mankoto[15]

To become a GRASP volunteer or donor: www.unesco.org/mab/grasp/Eng/E_support.htm

To receive print copies of the GRASP newsletter: grasp@unep.org

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7. *In the words of Klaus Töpfer, Executor Director of UNEP*
8. *Chimpanzee Sequencing and Analysis Consortium, USA,* Nature*, 437, 69–87*
9. *Whiten et al. (1999). Cultures in chimpanzees,* Nature*, 399: 682-685*
10. *Breuer et al. (2005)* PLOS Biol*, 3(11): e 385*
11. *UNEP and World Conservation Monitoring Centre (2005)* World Atlas of Great Apes and their Conservation*: www.unep.org/grasp/*
12. *GRASP is a consortium coordinated by UNEP and UNESCO. For the first time in September 2005, 16 range states affirmed their will to protect the great apes by signing the* Kinshasa Declaration *at an intergovernmental GRASP meeting in the DRC. See* A World of Science *3(1) and 3(4), January and October 2005*
13. *See, for example, the project: www.defipourlaterre.org*
14. *Such as the Jane Goodall Institute: www.janegoodall.fr/index.htm; Pole Pole Foundation (DRC): kahekwajohn@yahoo.fr; Berggorilla: www.berggorilla.org; Dian Fossey Gorilla Fund (in DRC): vitalkatembo@yahoo.com; Sumatran Orangutan Conservation Programme (Indonesia): www.sumatranorangutan.org*
15. *Secretary-General of GRASP and UNESCO Programme Specialist*

Taking the **temperature of mountains**


©D. Fagre

Future climate warming is expected to be especially marked in colder environments, such as mountains and northern climes. For the past two years, 350 scientists participating in the European Union-funded Global Change in Mountain Regions (GLOCHAMORE) project involving UNESCO and the Swiss-based Mountain Research Initiative have been developing a network of sites in selected mountain biosphere reserves to observe and study over time the signs of global change in nature and their impact on the people who inhabit these regions. The project was coordinated by the University of Vienna (Austria) and comprised 14 partners from eight European countries, plus India. By the time the project wound up last October, some 28 biosphere reserves around the world had been identified and the foundations had been laid for the long-term study of change in these alpine monitoring sites.

One-quarter of our globe's terrestrial surface is covered by mountain regions, which provide goods and services – such as the provision of clean freshwater – to more than half of humanity. Though rugged in appearance, mountains are actually highly susceptible to environmental degradation, as anyone knows who has seen the corrosive effects of strip-mining or clear-cut logging on mountain slopes. The main drivers of change in alpine environments are climate, land use and nitrogen deposits.


© T. Schaaf/UNESCO

In Issyk-Kul Biosphere Reserve in Kyrgyzstan

Climate change to create water shortages for millions dependent on glaciers

For millions of people in Asia and Latin America who rely on melting snow and glaciers for freshwater supplies, climate change will cause major shortages, says a research team led by Tim Barnett of the US-based Scripps Institute of Oceanography, in a paper published *in Nature* on 17 November.

In many parts of the world, glaciers are melting at an unprecedented rate. The area of Peru covered by glaciers has shrunk by 25% in the past 30 years. However, 'perhaps the most critical region in which vanishing glaciers will negatively affect water supply in the next few decades', say the authors, 'will be China and parts of Asia, including India, which together form the Himalaya–Hindu Kush region' populated by about 50–60% of the world's population.

The Himalaya–Hindu Kush region contains more ice than anywhere else on Earth, apart from the polar regions. The authors write that 'there is little doubt that the glaciers of the Himalaya-Hindu Kush region are melting and that the melting is accompanied by a long-term increase of near-surface air temperature'. After 25 years of study, the recently released *China Glacier Inventory* shows 'substantial melting of virtually all glaciers, with one of the most marked retreats in the last 13 years (750 m) of the glacier that acts as one of the major sources of the Yangtze River, the largest river in China,...' The authors add that the rate of melting seems to be accelerating.

'The hydrological cycle of the region is complicated by the Asian monsoon but there is little doubt that melting glaciers provide a key source of water for the region in the summer months: as much as 70% of the summer flow in the Ganges and 50–60% of the flow in other major rivers. In China, 23% of the population lives in the western regions, where glacial melt provides the principal dry season water source'.

The authors conclude that 'it appears that some areas of the most populated region on Earth are likely to "run out of water" during the dry season if the current warming and glacial melting trends continue for several more decades. This may be enough time for long-term planning to see just how the region can cope with this problem'.

Source: Nature *438, 303 (2005) and M. Shanahan for SciDev.net*

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In the Cordillera Blanca mountain range in Latin America, the area covered by glaciers has shrunk markedly over the past 30 years. Seen here is rapidly retreating Yanamarey Glacier in the Huascarán Biosphere Reserve in Peru

Scientists can reconstruct climate history from sediment layers and ice cores. These scientists are studying mountain snow pack to reconstruct climate history in Glacier National Park in the State of Montana in the USA

Mountain landscapes are among the most complex and fragile ecosystems on earth. Their mere verticality produces a huge range of habitats, whose composition varies dramatically with short changes in altitude. These differences can be obvious in the tropics or sub-tropics – such as the presence of palm trees at lower altitudes and glaciers at higher ones – or more subtle, such as the shifts in insect species as you move up a mountain slope.

Calculating and forecasting the effects of climate change on these environments encompasses a demanding range of scientific inquiry. This is why the scientists participating in the GLOCHAMORE project developed a research strategy encompassing such diverse areas as land-use changes, the cryosphere (permanent frozen landscapes, from the Greek word *cryo* meaning cold) and snow-covered areas, hydrological systems, grasslands and tundra areas, forests and aquatic ecosystems, wildlife, alien plant and animal species and natural hazards (floods, fires, landslides, etc), to name but a few.

One of the recommendations made by scientists participating in GLOCHAMORE is for 'early warning' mechanisms to be developed to detect invaders and their environmental impact. As annual temperatures rise over the long-term due to global warming, for example, non-native plant, insect and animal species may more easily invade new ecosystems where there is often no check on their behaviour. This lack of "checks and balances" can play havoc with a mountain ecosystem's structure and function. Hostile bugs might attack the plants and grasses that anchor a slope's thin layer of topsoil, for example. Remove the anchor and you get severe erosion and landslides, with their cascading effect on local communities.

A network of alpine observation posts

The GLOCHAMORE project set up a network of observation posts to monitor the effects of changes on the natural world but also on the people living in these colder climes. In the space of two years, the project has developed a plan for environmental and social monitoring in mountain regions that is helping to implement global change research strategies in selected UNESCO Biosphere Reserves (see table overleaf). There is no reason why the GLOCHAMORE research strategy could not be applied to other mountain biosphere reserves – there are over 150 in total – or to world heritage sites, such as Mount Kilimanjaro in the United Republic of Tanzania. Some alpine sites have even been accorded dual status, as in the case of Uvs Nuur Basin (Mongolia) and Mount Kenya, which are both biosphere reserves and world heritage sites. It so happens that the impact of climate change on world heritage sites will be the subject of a meeting taking place at UNESCO just two months from now, on 16 and 17 March.

Tell-tale signs of climate change

In a survey conducted in 2004 within the GLOCHAMORE project, managers of mountain Biosphere Reserves reported on their experiences of global warming. High on the list of concerns was the economic impact of the changing natural environment. In the Kosciuszko Biosphere Reserve in Australia, for example, where four ski resorts bring the area an estimated A$190 million annually, the winter season is becoming shorter. In Changbaishan Biosphere Reserve in China, lesser snow cover is responsible for a drop in the quantity of water available to farmers for agriculture. In Mount Kenya Biosphere Reserve, flash floods and other hydrological hazards are silting waterworks and canals used for irrigation. Local communities are also suffering from water shortages, as in the Kruger to Canyons Biosphere Reserve in South Africa.

The greatest impact of climate warming observed in nature can be seen in vegetation. The Changbaishan Biosphere Reserve reported that 'the alpine *Betula ermannii* birch tree has moved upwards towards the tundra ecosystem over the past 20 years. Results show that, for other species, such as the *Larix olgensis* and *Abies nephrolepis*, there is an apparent increase in their biomass with climate warming'. In other words, these two plant species are proliferating as a result of the increase in temperature, a phenomenon which will eventually create an ecological imbalance.

The following is a non-exhaustive list of impacts associated with climate change in mountain Biosphere Reserves. Many of the signs of climate change below are interlinked, reflecting the fact that a single impact of climate change can set off chain reactions with both physical and social dimensions:

- Greater solar ultraviolet radiation
- Melting of glaciers (see box on facing page)
- Thawing of permafrost soils causing greater weathering (the breakdown of rocks and minerals on, or just below, the surface, caused by changes in temperature or humidity, etc.)
- As a result of greater weathering, dryer soils, subsidence, siltation, landslides caused by erosion, etc.
- More frequent storms, floods, landslides and avalanches of greater intensity
- Changes in the distribution and numbers of plant and animal species
- A longer growing period for vegetation, with the vegetation lines moving up the mountain
- Less rainfall and snowfall (precipitation)
- Drying out of the forest area due to the drop in precipitation
- A greater fire hazard due to the drying out of the forest area
- Greater competition for more limited natural resources among the human populations living in the lowlands.

Sky Lake Meteorological Station at an altitude of 2600 m in Changbaishan Biosphere Reserve in China. Other research stations study hydrological factors and seismic and volcanic activity

Over the past two years, GLOCHAMORE has defined indicators to detect and analyse signals of change in these high-altitude regions and to analyse direct cause–effect relationships in individual ecosystems using carefully chosen markers. These indicators have been ranked in terms of ease of application.


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Crossing a river in Katunsky Biosphere Reserve in Altai, Russian Federation

Disturbing evidence of climate change

Glaciers, permafrost and alpine regions are all sensitive to changes in atmospheric temperature, so act as an indicator of global climate change. Warming during the 20th century has already had a pronounced effect on glacial and periglacial mountain belts. If this trend continues, experts predict smaller mountain glaciers could melt, areas of frozen ground (permafrost) could thaw and alpine regions could shrink.

Specifically, the network of selected biosphere reserves is observing cryospheric indicators, such as snow cover, glaciers, permafrost and solifluction (where freezing and thawing of the ground results in soil-surface slippage); high-mountain, freshwater ecosystems and watershed hydrology; and terrestrial ecosystems, especially mountain plant life and certain soil-dwelling animals. They have already uncovered disturbing evidence of climate change (see box on page 17).

Living laboratories for sustainable development

UNESCO's mountain biosphere reserves were chosen as monitoring sites for the GLOCHAMORE project both because they offer a major advantage for global comparisons and because the 'biosphere concept' is particularly well adapted to integrated research observing change in both the natural and socio-economic environments.

This is because the biosphere concept acknowledges that people and nature cohabit and that conservation practices have to incorporate this reality. The biosphere reserve concept adopts a zoning approach: strictly protected core areas are surrounded by buffer zones where conservation is emphasized but where people also live and work; and the whole is encircled by a transition area promoting sustainable development.

It was the Brundtland Report, *Our Common Future*, which proposed a definition of sustainable development in 1987 that is now generally recognized as the standard:

> *Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

The Brundtland report helped to trigger a wide range of initiatives by the United Nations, including the 'Earth Summits' in Rio (Brazil, 1992), which adopted *Agenda 21*, and in Johannesburg (South Africa, 2002), as well as the Framework Convention on Climate Change, to which the Kyoto Protocol was added in 1997 (see p. 9).

At the Earth Summit in Rio, the United Nations promoted UNESCO's wide network of biosphere reserves as 'living laboratories' for conservation efforts. The Rio Summit was the start of a growing awareness of the importance of mountains. A decade later, the United Nations would designate 2002 as the International Year of Mountains. UNESCO's main contribution to the Year would be the launch of the GLOCHAMORE project. Significantly, mountain-related research by the European Union has also gathered momentum in the past decade.

On the International Year of Mountains, see A World of Science *1(2), January 2003*

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People in the Sierra Nevada Biosphere Reserve in southern Spain live in close proximity to the mountain. The mountain serves as a source of revenue via tourism and recreational activities. A ski resort is situated in the buffer zone on the lower slopes

Ensuring the long-term viability of mountain monitoring

The choice of monitoring sites was not a random one. Sites were chosen in countries in such a way as to provide representative geographic coverage and different socio-economic backgrounds and cultures. Another criterion for selection was whether or not the site had the necessary infrastructure in place to partake in the project.

The studies undertaken at the chosen locations needed to integrate natural and societal factors, and therefore various scientific disciplines. 'Through monitoring, one can design a scheme to target indicators that are driven by human action and managers of mountain biosphere reserves can set threshold values, such as for sustainability for example, which can be met by management,' suggests the report of the project's first thematic meeting in Vienna in 2004. But a fully integrated study of the so-called 'nature–society system' entails finding common denominators and even coining a new language which practitioners of both the natural and social sciences can understand, the report concludes.

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Glacier National Park in the USA

The selected mountain biosphere reserves	*Altitudinal range (m.a.s.l.)*
Africa	
Tassili N'Ajjer (Algeria)	1 150 – 2 158
Mount Kenya	1 600 – 5 199
Oasis du Sud (Morocco)	680 – 4 071
Kruger to Canyons (South Africa)	200 – 2 050
Asia-Pacific	
Kosciuszko (Australia)	213 – 2 228
Changbaishan (China)	720 – 2 691
Issyk-Kul (Kyrgyzstan)	1 609 – 7 439
Nanda Devi (India)	1 800 – 7 817
Uvs Nuur Basin (Mongolia)	759 – 3 966
Katunskiy (Russian Federation)	765 – 4 506
Sikhote-Alin (Russian Federation)	0 – 1 600
Teberda (Russian Federation)	1 260 – 4 047
Europe	
Gossenköllersee (Austria)	2 413 – 2 828
Gurgler Kamm (Austria)	1 900 – 3 400
Berchtesgaden Alps (Germany)	471 – 2 713
Sierra Nevada (Spain)	400 – 3 482
Lake Torne (Sweden)	340 – 1 610
Entlebuch (Switzerland)	600 – 2 350
Swiss National Park	1 500 – 3 174
Latin America	
Araucarias (Chile)	800 – 3 124
Torres del Paine (Chile)	20 – 3 050
Cinturón Andino (Colombia)	1 700 – 5 750
Huascarán (Peru)	2 500 – 6 768
North America	
Mount Arrowsmith (Canada)	300 – 1 817
Glacier National Park (USA)	972 – 3 185
Niwot Ridge (USA)	2 866 – 3 780
Denali (USA)	122 – 6 194
Olympic (USA)	0 – 2 428

The *Perth Declaration* moves mountains

During its two years of activity, GLOCHAMORE organized no less than five specialized international workshops. In general, these scientific workshops focused on the drivers of global change and the impact of those changes on ecosystems, ecosystem goods and services, regional economies, health and institutional arrangements. The proceedings of these workshops are compiled in a series of publications.

Scientists examined the most pressing aspects of climate change observed in mountain landscapes, such as sustainable land use and natural resource management, the monitoring of human activity linked to environmental changes and modelling to project the future effects of global warming in mountains.

The project culminated in an Open Science Conference on Global Change in Mountain Regions in Perth (Scotland) from 2 to 6 October. This meeting built on successful gatherings in Vienna (Austria) and l'Aquila (Italy) in 2004, in Granada (Spain) and Samedan (Switzerland) in 2005 and the project's kick-off meeting at the Entlebuch Biosphere Reserve (Switzerland) in November 2003.

The Open Science Conference brought together 250 delegates from 47 countries to review the project's work and define the path ahead. At the conference, scientists issued a clarion call – the *Perth Declaration* – to governments, funding agencies and private sector to support further research into the effects of climate change on mountain ecosystems and the sustainable management of mountain environments and adjacent lowland communities.

Read the Perth Declaration*: www.unesco.org/mab/mountains/news.htm; and the Proceedings of the GLOCHAMORE meetings: www.unesco.org/mab/mountains/publications.htm*

Managers of mountain biosphere reserves will be crucial to the long-term viability of mountain monitoring. They will serve as the custodians of the information and data collected by the body of both national and visiting scientists who, themselves, will come and go over the coming decade. By definition, monitoring climate change is a long-term undertaking that calls for comprehensive and constant *in situ* observation. The involvement of other stakeholders, such as local communities, will also be crucial to maintaining a viable 'observation post' for climate change.

This article is the work of a wide group of contributors from the GLOCHAMORE Consortium.

Arsenic filter stalks silent killer **in Bangladesh**

Arsenic is a slow, silent killer. It is found in groundwater in countries worldwide but it is in Bangladesh that contamination has reached epidemic proportions. WHO estimates that as many as 57 million Bangladeshi – 44% of the population – are exposed to drinking water contaminated by arsenic.

At the UNESCO-IHE Institute for Water Education in Delft (Netherlands), more than 20 researchers from Argentina, Bangladesh, Gambia, Germany, Ghana, Peru, Sri Lanka and elsewhere have spent the past five years perfecting a low-cost family filter that has come through testing with shining colours. In a second phase due to begin in early 2006, up to 1000 family filters are to be distributed to a selected village in Bangladesh.

Groundwater is the main source of drinking water in many countries around the world. In rural areas of Bangladesh and India (West Bengal), the presence of arsenic in groundwater has endangered tens of millions of people, according to WHO. Information coming from nearby rural Nepal paints a similar picture.

The problem of arsenic poisoning is not limited to this part of Asia however (see map). In Europe for example, more than half a million people living in small towns and villages in northern Serbia drink water with high levels of arsenic that, in some cases, are more than 10 times above WHO's safety guidelines of 10 µg/l. In southern Hungary, drinking water in almost 400 settlements is contaminated.

The presence of arsenic in groundwater is well documented in each of the following countries: Argentina, Australia, Bolivia, Canada, Chile, China, Finland, Ghana, Japan, Mexico, Mongolia, Nepal, New Zealand, South Africa, Thailand and the USA. Many 'new' cases of contaminated groundwater are expected to be discovered in the near future.

A close-up view of natural arsenic, which can be found in minerals

A natural poison

Arsenic is a naturally occurring mineral found in water which has flowed through arsenic-rich rocks. It can also enter groundwater as the result of mining activity, the extraction of minerals from the ground, coal-burning and electricity production.

Arsenic in drinking water, usually in its inorganic form[16], is known as 'the silent, slow killer' because its presence is not revealed by taste, odour or colouring of the water.

16. Inorganic substances are of mineral origin, whereas organic substances are usually of animal or plant origin and contain carbon

Inspection of a family filter after one year of continuous operation. The used iron oxide-coated sand is a dark brown colour. Iron oxide is commonly known as rust

Some of the children from the Gafur family in Dhunshi. The early symptoms of arsenic poisoning can disappear by drinking good quality water that is arsenic-free

Groundwater contaminated by arsenic around the globe

As a rule, it takes more than 10 years for clear symptoms of arsenic poisoning to appear, for which there is no effective medical therapy or treatment. Recent studies on long-term human exposure to arsenic have shown that even very low amounts of arsenic in drinking water are associated with skin pigmentation changes, skin thickening known as hyperkeratosis, adverse neurological effects and skin, liver, lung, kidney and bladder cancers.

Arsenic-free drinking water the only cure

The disease symptoms caused by chronic ingestion of arsenic (over many years) are collectively known as arsenicosis. The only prevention is to provide arsenic-free drinking water. In order to minimize arsenic-related health risks, different regulatory agencies have set guidelines and regulations for arsenic concentration in drinking water. For instance, WHO and the European Commission recommend 10 µg/l, Bangladesh and India 50 µg/l.

UNESCO-IHE initiated its own research five years ago into an effective and affordable technology for arsenic removal from contaminated drinking water.

Installation of one of the family filters in the garden of the 10-member Gafur family, in Dhunshi

From the very beginning, it was clear to us that a 'point of use' system was the only feasible approach in the short term for rural areas of developing countries with no piped water supply systems. Since only 2–3% of water is used for cooking and drinking, the effective strategy would be to treat this amount of water using a simple system specifically developed for rural households.

After several years of intensive laboratory and field research, the team came up with a 'family filter' for arsenic removal. The filter recycles a by-product of groundwater treatment, iron oxide-coated sand.

A family filter based on sand

Water treatment plants in many countries around the world use natural sand for iron removal, which they then have to replace when the sand becomes coated with iron oxides after a few years. UNESCO-IHE research team discovered that iron oxide-coated sand acted as an excellent adsorbent of arsenic in water. The filter did not require any chemicals and operated under gravity, thus dispensing of the need for a power supply.

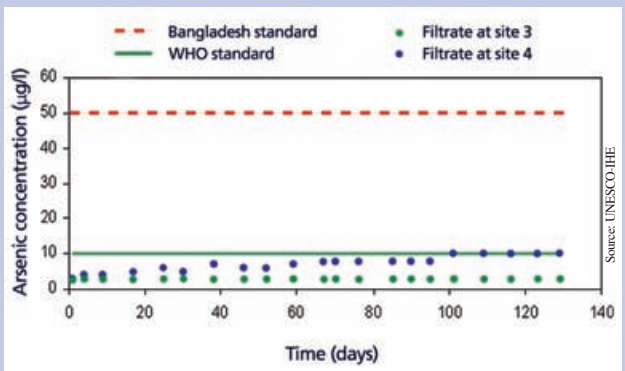
Moreover, as a waste product, the iron oxide-coated sand came free of charge, making the technology based on its use inexpensive.

The next step was for UNESCO-IHE to carry out field trials, together with its partners VITENS, the largest Dutch water supply company, Filtrix, a Dutch company specializing in household water treatment systems, the International Centre for Water Supply and Sanitation and the Christian Service Society, a Bangladeshi NGO.

Arsenic-free water for two years

The filter has come through these trials with flying colours (see diagram overleaf). Since February 2004, 14 family filters have been tested in parts of rural Bangladesh where groundwater is highly contaminated with arsenic levels of up to 500 µg/l (0.5 mg/l). As I write, 12 poor and middle-class families composed of between 5 and 22 members each are still benefiting from arsenic-

In the five-member Hassan household in Bhabanjpur (Raibarj), Mrs Hassan is pouring water into the family filter to remove any arsenic the water may contain. The filtered drinking or cooking water will be collected in the green container beneath the filter



Nearly two years after it was first installed in rural households in Bangladesh, the family filter has lost none of its efficacy. Above, the filter's performance over the first 130 days of trials in 2004.

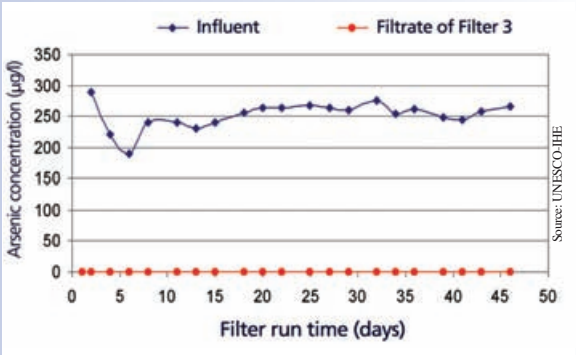
free water from filters first installed nearly two years ago. These families live in the Bangladeshi villages of Dhunshi, Someshpur, Babanipur, Charpara and Tilok.

Even though the family filters were made to operate at twice the capacity they were designed for throughout the first 12 months of the trial, there has been no need to replace the adsorbent (the iron oxide-coated sand) or carry out any maintenance more complex than regularly opening the drain valve at the bottom of the filter. If we extrapolate the results, this means that the family filter can, on average, provide a family in rural Bangladesh with arsenic-free water for drinking and cooking purposes for up to 24 months without replacement of the adsorbent. As for the arsenic-covered sand, tests conducted by the UNESCO-IHE have shown that it will leach (i.e. percolate) in a way that respects EU guidelines. The arsenic-covered sand can therefore be used safely for landfill, construction and other purposes.

'Big sister', an industrial-scale arsenic filter

In parallel, UNESCO-IHE has developed an innovative arsenic removal technology that is suitable for central-ized production of water for both drinking and industrial use. This technology is destined for water supply companies and is currently being tested by the Institute in Mako (Hungary), together with partners VITEN and SELOR. Testing in Chalastra (Greece) has been completed. Over a period of months, the pilot plants installed in these two towns have consistently produced arsenic-free water from groundwater with up to 300 µg/l of arsenic (see diagram). The cost of the technology is comparable to that of conventional groundwater treatment, with the added bonus of a lesser environmental impact. To add to the technology's economic appeal, UNESCO-IHE recently developed a very simple, inexpensive procedure for *in situ* regeneration of the adsorbent (iron oxide-coated sand).

Unlike the family filter, which UNESCO-IHE has decided not to patent, the arsenic removal technology being developed for water supply companies will be protected by a European patent, still pending as this article went to press. This will likely be the Institute's first patent in almost half a century of existence.



The effectiveness of the industrial-scale arsenic filter 45 days into trials in 2004, in Mako, Hungary. The 'influent' is groundwater from a well with an extremely high arsenic concentration.

In addition to arsenic removal, the family filter demonstrated a potential for effectively removing iron, even in cases where iron levels in the water were as high as 30 mg/l.

The next step

In the second phase of the project, starting in 2006, families in a selected village of Bangladesh will be provided with up to 1000 filters.

It is hoped that one of the 'by-products' of the family filter will be local income generation and, ultimately, economic development through the local manufacture of all components of the family filter.

As there are no large-scale groundwater treatment plants as yet in Bangladesh, the iron oxide-coated sand for the family filter is currently imported into Bangladesh from Europe. The UNESCO-IHE Institute for Water Education is involved in preliminary discussions with the Government of Bangladesh and funding partners for the construction of large-scale groundwater treatment plants in Bangladesh in the near future. Once these plants are built, iron oxide-coated sand will be available locally.

UNESCO-IHE is also developing a simple, cheap procedure for producing iron oxide-coated filter material. One of our family filters in rural Bangladesh is using this material with promising results. Assuming we attract enough funding to pursue this line of research, it should be possible to produce this effective, cheap arsenic adsorbent locally, thereby generating potential income opportunities for local vendors, who could provide a regular service replacing the used adsorbent.

It was the Christian Service Society we are working with which produced the 12 family filters for the trials out of their own workshop in the town of Kulna, on a non-commercial basis. The workshop usually produces furniture, so we were less than optimistic as to whether the carpenters would be able to turn their hand to producing filters in a short space of time. But they succeeded, producing all 12 filters within a month. We would like them to produce the filters for the next phase of the project in 2006 but this will only be possible if we can attract donor support to cover the costs.

UNESCO-IHE has not patented the family filter. This is a conscious decision. It is our hope that the absence of a patent will enable the technology to spread unfettered throughout the developing world.

Branislav Petrusevski[17]

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17. Member of the UNESCO-IHE research team working on arsenic removal, which also includes P. Kelderman, F. Kruis, J. Schippers, S. Sharma, Y. Slokkar and F. Wiegman

Governing **bodies**

Science tightens its belt

On 21 October, the General Conference adopted UNESCO's programme and budget for 2006–2007. The budget of US$56 million for UNESCO's natural sciences programme (inclusive of staff costs) represents a drop of US$2 million over the previous biennium, out of a zero nominal growth budget for UNESCO of US$610 million. Member States maintain 'freshwater and associated ecosystems' as the priority theme for natural sciences and increase its share in 2006–2007 from 45% to 50% of the total science budget (24% in 2002).

Two new Years

UNESCO's 191 Member States threw their support behind a UN International Year of Planet Earth in 2008, to show how Earth sciences contribute to sustainable development, and an International Year of Astronomy in 2009.

Five new centres

The General Conference approved the establishment of five centres under the auspices of UNESCO: (1) the Regional Centre for Biotechnology Training and Education in India; (2) the International Centre for Water Hazard and Risk Management (ICHARM) in Tsukuba, Japan; (3) the IHP–HELP Centre for Water Law, Policy and Science at the University of Dundee in the UK; (4) the Regional Water Centre for Arid and Semi-Arid Zones of Latin America and the Caribbean (CAZALAC) in La Serena, Chile; and (5) the European Regional Centre for Ecohydrology in Lodz in Poland.

The fate of three other centres is to be decided in April, the General Conference having delegated authority to UNESCO's 58-member Executive Board to authorize the establishment of a Regional Centre on Urban Water Management in Colombia and an International Centre for Biological Sciences (CICB) in Venezuela, as well as to grant regional institute status to the *Instituto de Matematica Pura e Aplicada* (IMPA) in Brazil.

Science ministers speak out

Ministers responsible for science from 50 countries issued a Communiqué on 14 October in which they stress that countries need to build capacity in the basic sciences 'as the platform for knowledge-based development'. The communiqué was issued at the conclusion of a two-day Ministerial Roundtable at UNESCO in Paris on the theme of The Basic Sciences: the Science Lever for Development.

The ministers stress that addressing poverty, environmental degradation, climate change, existing and emerging diseases, natural disasters and energy needs, etc., requires new knowledge provided by the basic sciences. 'Investment in research areas of the basic sciences should be driven by national and regional priorities', they state, adding that regional centres, networks of excellence and public–private partnerships all have an essential role to play. The ministers express concern over brain drain and reiterate the need to strive for gender parity.

They call upon UNESCO to place greater emphasis on promoting the basic sciences and science education, in particular through the International Basic Sciences Programme launched in 2004. They also ask UNESCO to strengthen the UNESCO Chairs and centres of excellence and to support the implementation of science and technology policies in developing countries. This effort must be combined, they say, with promoting equitable access for scientists and researchers to information and scientific literature, particularly in the developing countries, as well as reinforcing the ethical dimension of the practice of science.

Read the Communiqué: www.unesco.org/science/bes

Diary

10–12 January
Tsunami Warning System for Caribbean
Launch of Intl Coordination Group for warning system for tsunamis and other coastal hazards, involving 30 Caribbean and Central American countries, and USA. UNESCO-IOC, WMO, UN-ISDR, UNEP, Caricom, OAS, etc. : *http://ioc3.unesco.org/cartws/*

15 January
Deadline for Water and Film festival
(see 17 March) – Filmmakers are invited to submit: feature films, documentaries (52-mins max.), awareness-raising films (30 mins max.) and spots (2 mins max.): *salvador.aguirre@worldwaterforum4.org.mx*; *www.worldwaterforum4.org.mx/*

23–28 January
Moving the global oceans agenda forward
3rd Global conf. on Oceans, Coasts and Islands, one focus being implementation of *Mauritius Strategy* since January 2005. Co-sponsored by UNESCO-IOC, UNEP, NOAA, etc. UNESCO Paris: *www.globaloceans.org; http://ioc.unesco.org*

26 January – 1 February
Sustainable management of marginal drylands
4th intl workshop for UNESCO project. Organized by Pakistan Council of Research in Water Resources to review project implementation in 2005 and workplans for 2006, and train in data analysis. Islamabad, Pakistan: *www.unesco.org/mab/capacity/sumamad/home.htm*

22– 24 February
Engineering and technology for poverty reduction
Intl forum with focus on SADC countries, for senior policy-makers from public and private sectors. Co-organized by UNESCO, South African Institution of Civil Engineering, Ministry of S&T of Mozambique. Pretoria (South Africa): *t.marjoram@unesco.org*

27 February – 1 March
Conservation and sustainable development of Danube Delta
Intl conf. organized by Govt of Ukraine, with Govts of Moldova and Romania. Patronage: UNESCO, ICPDR, Ramsar Wetlands Convention, Council of Europe. Odessa (Ukraine): *j.robertson@unesco.org*

4–8 March
Mobility of engineers
WFEO World Congress on Engineering Education. Co-sponsored by UNESCO. Budapest (Hungary): *t.marjoram@unesco.org*

8 March
L'Oréal-UNESCO For Women in Science Awards
Award ceremony at UNESCO Paris, marks World Women's Day. Press kit available: *r.clair@unesco.org; www.forwomeninscience.org*

14–15 March
Bio-carbon sequestration and conservation to combat climate change
UNESCO-Pro Natura intl forum to promote rural development, energy solutions and biodiversity. UNESCO Paris: *p.dogse@unesco.org*

16–17 March
World heritage and climate change
Conf. to assess impact of climate change on sites. UNESCO Paris : *http://whc.unesco.org*

16–22 March
4th World Water Forum
UNESCO-IHP convening sessions on: conflict resolution, urban water, transboundary aquifers, etc. Mexico City: *www.worldwaterforum4.org.mx*

17–21 March
Water and Film festival
Satellite event of World Water Forum (see above)

22 March
Water: a shared responsibility
Launch of 2nd *World Water Development Report* by World Water Assessment Programme hosted by UNESCO, marks World Water Day. Mexico City (above): *www.unesco.org/water/wwap/index.shtml*

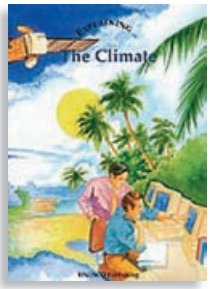
New **Releases**

Education Trends in Perspective – *Analysis of the World Education Indicators* (see p.12)
UNESCO Institute for Statistics/OECD, Montreal, Canada. UNESCO Publishing, 25.00 €. ISBN 92-9189-024-3. English only.
The fourth in a series analysing indicators on key education policy issues. This report focuses on trends between 1995 and 2003, identifying which countries have made progress and in which context. One of the report's main findings is that tertiary education has soared over the past eight years in 19 middle-income countries comprising over 50% of the world population. Download: *www.uis.unesco.org/TEMPLATE/pdf/wei/WEI2005.pdf*

UNESCO's response to HIV and AIDS
42-page booklet in English only.
Illustrates UNESCO's activities to help prevent the spread of the AIDS epidemic, with a focus on prevention via education of the young, of teachers and media professionals. UNESCO is also supporting research, as within UNESCO's Family First Africa project to develop a pediatric vaccine to prevent transmission of the HIV/AIDS from mother to child via breast-feeding (see *A World of Science*, 2(2), April 2004). Download: *http://unesdoc.unesco.org/images/0014/001414/141417e.pdf*

For the **young**

Introduction to Sandwatch
By Gillian Cambers and Fathimath Ghina. Coastal Regions and small island papers 19. 91 pp. English only.
For schools in island nations. Through a series of activities guided by their teachers, pupils learn how to observe and record problems facing their beach environments, such as erosion and accretion, beach debris, water quality and the risks to plants and animals. Sandwatch grew out of an environmental education workshop in Trinidad & Tobago in 1998. Originally a Caribbean activity, Sandwatch now extends to islands in the Indian and Pacific Oceans. Copies are being distributed through UNESCO's Associated Schools Project. Request a free copy while stocks last: *apia@unesco.org*; *dar-es-salaam@unesco.org*; *kingston@unesco.org*; or download: *www.unesco.org/csi/pub/papers3/sande.htm*

Explaining the climate


By Guy Jacques. UNESCO Publishing, 6.00 €. ISBN: 92-3-103990-3, 48 pp, Exists in English, French and Spanish.
This small-format book introduces climatology to younger readers keen to learn how the climate will affect their future. All topics are dealt with in an easily understandable, yet informative manner, from the effects of latitude to those of altitude, from the history of climates to the geography of great climatic regions, and from meteorologists' instruments to the Kyoto Protocol (see p.9).
The book offers a broad selection of clear explanatory diagrams, text boxes of easily memorized facts and a wide array of photographs.

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Cover photo: ©E.Kojekov – Yourtes in Issyk-Kul Biosphere Reserve, Kyrgyzstan. When winter comes, the nomads will resettle on the lower steppes.