Intergovernmental Oceanographic Commission

Annual Report

2004

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Photo by Andrea Rasetti

UNESCO

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Contents

Public Awareness

Policy

IOC Programme Sections

Ocean Sciences

Operational Observing Systems

Ocean Services

Regional Activities

Annexes

IOC Structure and Personnel

In Memoriam

Purpose and Role of the Intergovernmental Oceanographic Commission of UNESCO

The purpose of the Commission is to promote international cooperation and to coordinate programmes in research, services, and capacity building, in order to learn about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States.

The Commission will collaborate with international organizations concerned with the work of the Commission, and especially with those organizations of the United Nations system which are willing and prepared to contribute to the purpose and functions of the Commission and/or to seek advice and cooperation in the field of ocean and coastal area scientific research, related services, and capacity building.

FROM THE CHAIRMAN

This foreword is being written in March 2005, just two months after the disastrous Indian Ocean tsunami of 26 December 2004. A full account of the Intergovernmental Oceanographic Commission (IOC) of UNESCO's involvement in the international reactions to that event must await the Report for 2005. However, I want here to pay immediate tribute to the magnificent way in which Patricio Bernal and the Secretariat have responded to the call for IOC to provide a lead in setting up an extended warning system for potential future events. Member States have given us a great responsibility: we will undoubtedly justify that confidence.

During 2004 there have been other examples of growing popular and political awareness of the importance of the sea. In March I was invited as Chairman of IOC to chair a Group of Experts at the UN in New York, charged with developing proposals for a regular process of Global Marine Assessment. Governments are now considering the implementation of these proposals. In October I was invited to lead an Asia-Pacific Economic Cooperation (APEC) workshop in Chile on the contribution of marine activities to national economies: for many countries these are often substantial. One of the continuing roles of IOC is to promote international cooperation in the science and services that underpin these activities. We do this in many ways, notably through our targeted science programmes; through capacity building; through development of data exchange policies and procedures; and through leadership of the Global Ocean Observing System (GOOS). The involvement of GOOS as part of the emerging Global Earth Observation System of Systems has been another important theme in 2004.

In this Report you can read accounts of many impressive achievements by our Commission. Nevertheless there is no doubt that much more could be achieved if IOC were resourced at a level commensurate with its responsibilities. Our funding, which comes both through UNESCO and directly from Member States, is increasingly inadequate for the work we have been asked to do. Further development can only happen if new funding arrangements and enhanced Member State commitment to our programmes are forthcoming. A thorough review of the budget and resources of IOC will be an important issue at our Twenty-third Assembly in June 2005.

Dr David Pugh
IOC Chairman

FROM THE EXECUTIVE SECRETARY

Public services based on atmospheric and oceanic observing systems

Constraints imposed on ocean research by the use of vessels made it almost impossible to study the variability of oceanic processes, requiring repeated sampling in time. Even the so-called synoptic description of processes are always subject to some aliasing by the mere fact that those descriptions were not obtained by the simultaneous observation of the whole process, but by sampling with a single ship moving along a trajectory in space and time. As stated by Walter Munk (2000) in the introduction to the book *Satellites, Oceanography and Society* (Halpern, 2000), 'if I were to choose a single phrase to characterize the first century of modern oceanography, it would be a century of undersampling'.

The development of the Global Ocean Observing System (GOOS), i.e. the integrated operation of a series of observing systems covering the world's oceans, was the natural sequel of international oceanographic research efforts. One could say that GOOS is the continuation of ocean research by other means, or better, that the natural and logical next step in large-scale ocean research called for new ways of organizing research efforts. For science, GOOS addresses some fundamental limitations of oceanographic sampling.

The study of ocean variability and ocean predictability is essential for understanding the Earth's climate and climate change. Not all scientific understanding of oceanic processes requires repeated sampling in the time domain, but recognizing these limits has prompted the community to think 'outside the box' and propose solutions that can be collectively promoted and implemented through international cooperation.

The Intergovernmental Oceanographic Commission (IOC) of UNESCO presented the blueprint of GOOS at the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, in 1992. The Rio Summit subscribed to the recommendation made by the Second World Climate Conference (1990) to build a Global Climate Observing System (GCOS) and GOOS became the Ocean Component of GCOS. As such, GOOS is sponsored by the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP), the International Council of Science (ICSU), and the IOC, which acts as the lead agency for its development.

As part of their mandates, the individual observing systems initially integrated into GOOS have been under development by IOC in cooperation with WMO during the last three decades. The Global Sea Level Observing System (GLOSS) for sea level, the Integrated Global Ocean Services System (IGOSS) for the collection of data on the vertical structure of the upper layer of the ocean, and the Pacific Tsunami Warning System are examples of permanent ocean services developed by the IOC, integrating data from tide-gauges, vertical probes launched by commercial ships, fixed and drifting buoys, deep sea pressure sensors, bottom seismometers, and orbiting and stationary satellites.

The development of these new capabilities in oceanography have enabled the development of permanent ocean services, i.e. the continuous, routine delivery of information products containing forecast conditions for a given set of ocean properties. They are produced and distributed free of charge as public services for the use of a wide range of end-users. However, the information upon which these products are based is by no means restricted to public service applications.

In an unprecedented step forward in interagency cooperation, the thirteenth World Meteorological Congress (Geneva, Switzerland, 4–28 May 1999) and the Twentieth IOC Assembly (Paris, France, 29 June–8 July 1999) approved the fusion of several long standing independent technical committees belonging to both organizations into a single body: the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). The mandate of JCOMM is to supervise the technical teams of intergovernmental experts in charge of the operational systems for the climate component of the Global Ocean Observing System.

The implementation of GOOS, put simply, is coordinated by IOC and financed by the Member States of the IOC. The scientific community in oceanography has done a remarkable job in designing a light, cheap and distributed management for the new observation systems. However, moving an engineering system from prototype and research status to the operational domain implies significant changes and several challenges.

Examples of current public service operations supported by WMO and IOC through the JCOMM are:

The Global Maritime Distress and Safety System (GMDSS)

GMDSS is an integrated communications system using satellite and terrestrial radio communications to ensure that no matter where a ship is in distress, aid can be dispatched. Under the Surface Ocean–Lower Atmosphere Study (SOLAS) Convention, the GMDSS provides for the dissemination of warnings, weather and sea bulletins broadcast via Inmarsat-C SafetyNET by all national or maritime meteorological services appointed as issuing services. There are seventeen Metareas covering the world's oceans where information to all vessels at sea is available on a 24/7 basis.

The Marine Pollution Emergency Response Support System (MPERSS)

MPERSS's primary objective is to have a coordinated, global system in place for the provision of meteorological and oceanographic information for marine pollution emergency response operations outside waters under national jurisdiction. The areas covered have the same geographical distribution as those for the GMDSS.

The JCOMM Electronic Products Bulletin (J-EPB)

J-EPB provides information on real-time oceanography. Its continuing evolution is being implemented at the International Research Institute for Climate Prediction (IRI) at the Lamont-Doherty Earth Observatory (LDEO) of Columbia University, in response to the needs of the oceanographic and Earth science communities for real-time oceanography. The format of global analyses is standardized in such a way that monitoring products can be compared for decision-making. In addition, the different data sets are available online.

Wave, weather and climate services

The Wave Programme under WMO was established in 1984 to provide sea wave analysis and forecasting services. Codes for the real-time exchange and reporting of marine surface data, including directional wave spectra, have been developed. National focal points for the programme have been nominated. Now the programme is being extended to cover storm surges as well.

Sea ice services

Navigation in ice-frequented waters is a hazardous operation. For this reason, national sea ice information services have been established in many countries to provide support for such operations through the provision of both climatological and real-time ice analyses and forecasts. International coordination and cooperation in this activity is achieved principally through the JCOMM Expert Team on Sea Ice (ETSI) and through the Data Buoy Cooperation Panel (DBCP), including its action groups, the International Arctic Buoy Programme (IABP) and the International Programme for Antarctic Buoys (IPAB).

The first challenge is incremental funding. The funding of ocean research has allowed the deployment of most of the observing systems that we have today. However, the financing of the sustained collection of data streams to be transformed into permanent ocean services, on which other societal, public and private applications will depend, cannot rely exclusively on the funding for science.

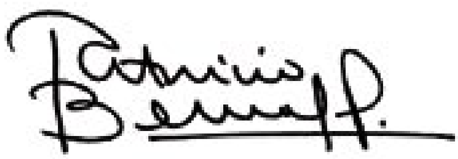
The second challenge is institutional building. Member States at the national level, and the IOC itself at the international level, need to decide on the institutional arrangements to support the development of operational oceanography. Effective use requires organizations capable of processing data, and modelling, generating and distributing information-products to end-users.

The third challenge is economic in nature. Global observations constitute a particular case of all the observations that can be collected. Their main feature is the very large scale at which they are collected. For *in situ* observations, moving from local to global networks, there is an upper spatial limit where private appropriation breaks down because the cost of extending the local network in space it is not compensated by the incremental benefit accrued; let's say in the precision of a given forecast.

Starting from the global observation, at each spatial and temporal scale there are specific properties of the ocean that are related to that scale and others that 'spill-over' to other scales. In theory, full forecasting capabilities would be available only if all scales are properly sampled. This is a huge technical requirement and challenge for the new engineering of global observing systems.

Today, organizations that are prepared to make immediate use of the increased data streams produced by GOOS and that can transform them immediately into useful ocean services only exist in very few countries in the south. However, these organizations do exist today in the developed world, both in the public and in the private sector. In the developing world, the challenge is even greater and relates to capacity building in the broadest sense possible, not only in science and technology, but also in policy design, management skills, economy; capacities, to quote Professor Nazli Choucri, both 'in the know-how and also fundamentally in the know-why'.

Our experience in IOC and in WMO is very encouraging and is based on international cooperation. Many of the difficulties can be overcome and the track record of these two UN organizations show that is possible to operate a global system that is inclusive to all nations of the world, providing public services to all its members. Clear, stable rules are required to enhance cooperation efforts among members of the system. There is a fundamental ethical, or at least equitable, issue at stake. We are speaking of protecting lives and the life-support system of our planet; we are all involved and everybody should have equitable access to the information and the derived benefits.

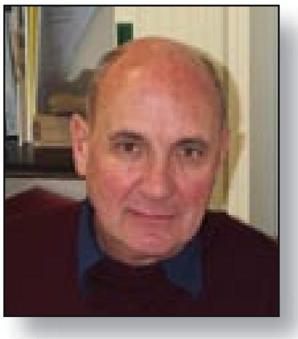


Dr Patricio A. Bernal
Assistant Director-General, UNESCO
Executive Secretary, IOC

Public Awareness

After the tsunami - children in Devanampattinam, India.

Our Changing Climate



Guy Jacques is a Marine Ecologist, with a particular interest in the carbon cycle in oceans. He was in charge of the Joint Global Ocean Flux Study Programme (JGOFS, France) and is Senior Research Director at France's National Centre for Scientific Research (CNRS). During the past decade he has written several books for students and general audiences on marine ecosystems, the water cycle, and the exchanges between the ocean and the atmosphere. In 1999 he co-authored *El Niño: Fact and Fiction*[1] with Bruno Voituriez, and his latest book, *Climate Change* [*Le changement climatique*][2], written with Hervé Le Treut, appears this year.

guy.jacques@wanadoo.fr

Hervé Le Treut is also a Senior Research Director at France's CNRS and a lecturer at the well-known École Polytechnique. He develops numerical models to help understand the climate system and evaluate the impact of the human-induced greenhouse effect. A participant in numerous international programmes studying climate and the water cycle, in 2001 he co-authored *The Greenhouse Effect: Are we changing the climate?*[3] with Jean-Marc Janvovici. He also directs the CNRS Laboratory of Dynamic Meteorology, which studies the mechanisms, evolution and forecasting of meteorological phenomena and the climate.

Examining data derived from models that simulate past and future climate scenarios, researchers agree that climate change is indeed already happening now and that the most likely cause is the burning of fossil fuels.

IOC is pleased to present a new title in the IOC Ocean Forum Series, *Le changement climatique*, which addresses the complexity of the interactions between the atmosphere and the ocean that regulate the climate, and discusses the scientific debate on climate. In the following article, authors Guy Jacques and Hervé Le Treut discuss the diverse consequences of climate change, and call for an international consensus to make the climate issue a central feature on world political agendas.

IOC's activities are concerned with determining the role of the oceans in climate change in order to lessen possible future impacts on society and the environment.

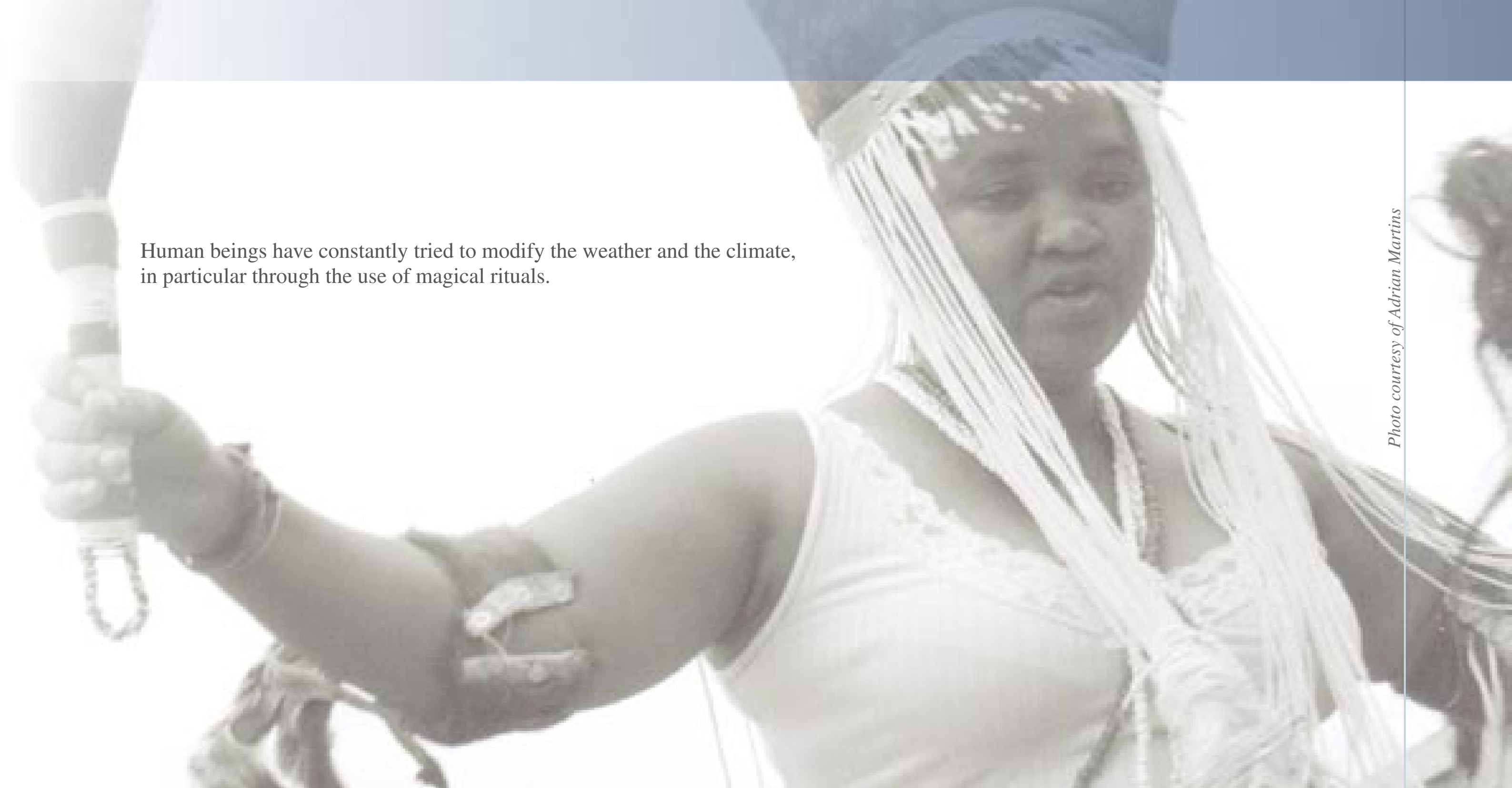
For more information:

http://ioc.unesco.org/iocweb/climatechange.php

For generations, human beings have been accumulating all types of possible information about their environment and doing their best to predict its evolution. They have also constantly tried to modify the weather and the climate, in particular through the use of magical rituals carried out by priests or shamans.

We are now facing a situation unprecedented in the history of Earth, when this impact of human activities on climate has become unexpectedly real: the human race, partly unconsciously, has begun to act as the sorcerer's apprentice. Improving the living conditions of a global population that has been rapidly increasing from two billion on the eve of the industrial revolution to six billion today, has been made possible through the massive use of fossil fuel energy (carbon, oil, gas), which is only renewable at geological time scales. The corresponding emission of long-lived gases into the atmosphere—principally carbon di-

1 Voituriez, B. and Jacques, G. 2000. *El Niño: Fact and Fiction*. UNESCO Publishing. (IOC Ocean Forum Series.) Available in English, French and Spanish.
2 Jacques, G. and Le Treut, H. 2004. *Climate Change* [*Le changement climatique*]. UNESCO Publishing. (IOC Ocean Forum Series.) ISBN 92-3-103938-5. Available in English and French.
3 Le Treut, H. and Jancovici, J.M. 2001. *L'effet de serre - Allons-nous changer le climat ?* [The Greenhouse Effect: Are we changing the climate?] Flammarion.



Human beings have constantly tried to modify the weather and the climate, in particular through the use of magical rituals.

Photo courtesy of Adrian Martins

oxide (CO_2)—is bringing a range of unexpected global modifications. Over the past few decades, the study of the climate system has therefore become a major focus of international research on environmental issues. Thousands of researchers from different disciplines are involved in this effort, using the most recent tools in scientific computation and Earth observation systems. Specific interest is paid to the study of past climate conditions, which constitute a necessary reference in evaluating future risks. This research is also unique because it may have a direct impact on shaping political decisions, with deep social and economic consequences. The Intergovernmental Panel on Climate Change (IPCC) diagnoses scientific information on climate change, its possible impact on natural or social systems, and the mitigation and adaptation measures that are possible.

Photo courtesy of Jason White

Devastating floods in Haiti in early 2004. In a warmer climate one may expect stronger atmospheric convection, modified and possibly increased occurrence of extreme events and storms.

To describe climatic change, it is first important to specify the time scales that come into play. The frequent confusion between widely different issues such as the rather immediate fear of flood episodes, concern over a more remote and irreversible modification of ocean currents as a consequence of the ongoing global warming, or anticipating a new ice age, reflects a confusion between daily, seasonal, decadal, or century-long fluctuations of the climate system. All these scales have received attention since the beginning of climate sciences, but organized, international efforts have been more unevenly distributed. Short-term fluctuations have been studied for more than a century. The motivation for setting up a weather prediction system came from the realization that dramatic hazards might have been predicted a few days in advance, such as the violent storm that sank forty-one French warships off the coast of Sebastopol on 14 November 1854 during the Crimean war. The astronomer Urbain Le Verrier (1811-1877) who was commissioned at that time to conduct an inquiry realized that the storm had already been active two days earlier in the Black Sea, northwest of the wreckage area. In 1879, an International Committee of Meteorology was created, from which the present World Meteorological Organization (WMO) originates. A century was necessary before the role of the ocean partner, which is key in understanding climate behaviour at pluri-annual time scales, was fully taken into account. The International Geophysical Year (IGY) 1957-1958 was the occasion for a systematic monitoring of the Pacific and Indian Oceans. The El Niño Southern Oscillation (ENSO) turned out to fully support researchers' efforts: its intensity during the IGY reached a level that had not been observed since 1941, demonstrating the large importance and extension of the process. The time lag between the systematic observation of the atmospheric and oceanic circulations is also reflected in the development of relevant international institutions. The International Oceanographic Commission (IOC)


Image courtesy of NASA

The reflection of a radar signal by snow or rain enables the Satellite Tropical Rainfall Measuring Mission to deliver a quantitative estimate of precipitation, which also charaterizes atmospheric circulation.

was created within UNESCO only fairly recently in 1960, more than eighty years after the corresponding meteorological organization. The observation of the ocean is still insufficient, and the Global Ocean Observing System (GOOS) has only just started.

Another important revolution came after the Second World War, when the first computers became available, and the first numerical models of the atmosphere were possible. The mathematician John von Neuman and the meteorologist Julius Charney together were able to analyse the circulation of the Northern Hemisphere numerically. The spectacular increase in computing power and the development of satellite-borne instrumentation has produced a regular increase in the quality of weather forecasts over the past several decades. These forecasts are now useful beyond five days. When trying to extend the simulations to longer ranges, one leaves the domain of meteorology and reaches that of climatology: the model builds its own climatology and behaves like a planet by itself. The objective in this case is no longer to study the dependence of simulated results on the initial state of the atmosphere, as in the case of weather forecasts, but the dependence of climate statistics on such forcing conditions as changes in radiation, ice cover, and albedo. Most parameters necessary to initialize and verify both the weather and climatic models are now available through satellite observations, which also constitute a continuous source of progress for the models.

This global increase in temperature, just like human body temperature, is revealing a change in the Earth's metabolism.

Although Svante Arrhenius, Nobel Prize winner in Chemistry in 1903, had already predicted during the first years of the twentieth century that the increase in anthropogenic emissions of greenhouse gases would bring about significant changes in the climate system, the concern for those risks only began to take a significant place in scientific literature during the 1970s. This concern is firmly grounded on a few undisputed facts: the chemical composition of the Earth has undergone a dramatic change since the beginning of the last century. The analysis of air bubbles trapped in ice cores, as retrieved for example in the Antarctic site of Vostok, shows that CO_2 levels during the last 100,000 years have been oscillating between 180 parts per million (ppm) during ice ages and 280 ppm during interglacial episodes. In comparison, the value of 300 ppm was reached in the 1950s, with a present level of about 380 ppm. This tendency is the most likely explanation for the recent increase in global temperatures of almost 1 °C compared with the pre-industrial level. This global increase in temperature, just like human body temperature, is revealing a change in the Earth's metabolism. The three warmest years since reliable statistics have been available were 1998 (+0.55 °C compared to the average value for 1961–1990), 2002 (+0.48 °C) and 2003 (+0.45 °C)[4]. By 2100 the predicted resulting increase in temperature ranges from about 2 °C to 6 °C, a change that would be of unprecedented amplitude since the last glacial maximum.

Inevitably the combination of scientific, economic, social and political factors leads to much debate and lobbying over the problem posed by the increasing greenhouse effect and its consequences. Communicating results is therefore a crucial task for scientists, particularly because ultimately citizens are the ones making decisions. The scientist must help them to develop independent thinking on the subject by providing them not only with the facts, but also with some intuition of what is sure or uncertain. In this context, each citizen is both an actor and a victim: because of the rapid mixing of the atmosphere and the long residence time of CO_2, a ton of greenhouse gas emitted in Europe, China or the USA has the same effects—even if these effects are not distributed evenly. This common responsibility might facilitate the solidarity and international cooperation implied by the Kyoto agreements. The publication of a series of books by UNESCO and the IOC (*El Niño: Fact and Fiction; The Changing Ocean*[5]; *Le changement climatique*) is a notable contribution to the diffusion of scientific knowledge

A drastic rather than progressive stabilization of greenhouse gas emissions is needed to avert significant climate change.

as well as a means to increase public awareness. The authors of such publications have a dual responsibility: to provide their readers with some knowledge of the ongoing scientific debates, without falling into the trap laid by some debaters who exhume already settled issues, or use facts that have proven to be wrong, to give the mistaken impression that 'experts still disagree'. Public voices have claimed that the ongoing global warming is due to the contamination of measurements caused by the 'urban heat island effect' (an effect which is, in fact, cautiously filtered out in all studies), and that the lack of greenhouse gases would cause the Earth's temperature to be warmer, reaching 160 °C and not cooler at –18 °C. Such declarations cannot be considered as a contribution to a healthy and necessary debate, but as disinformation. The same qualification also applies to papers showing pictures of the Eiffel Tower standing in a desert of sand dunes. In fact, the scientific community has reached a fairly broad consensus on many issues, taking the benefit of Earth observations, which are always more numerous, and using increasingly complex simulations of the climatic conditions to be expected during the coming century, simulations which are constrained by scientific laws. There is wide agreement on the fact that, contrary to the rapid variability revealed by Greenland ice cores during the ice ages, the changes in climate conditions that we have experienced over the past few decades constitute a very unexpected situation during interglacial conditions, and have no equivalent since at least the beginning of our civilizations 5,000 years ago. Some have tried to explain recent global tendencies exclusively as a response to a solar forcing: this corresponds to a general attitude that can be summarized by: 'blame any process, but not the greenhouse gases'. In fact, while we know that solar changes played a role earlier in time, and constitute a possible cause for the Little Ice Age, 1645–1715, the idea that recent global warming is causing the observed CO_2 increase is absolutely contradicted by isotopic measurements, which demonstrate that the additional CO_2 in the atmosphere is the result of fossil fuel burning. The media also expresses the hope that a new ice age might counteract the warming effect of the increasing

The idea that recent global warming is causing the observed CO_2 increase is absolutely contradicted by isotopic measurements, which demonstrate that the additional CO_2 in the atmosphere is the result of fossil fuel burning.

4 Global ocean-atmosphere models forced by greenhouse gas concentrations associated with the scenarios of the Second Report on Emission Scenarios (SRES) gathered by the Intergovernmental Panel on Climate Change (IPCC).

5 Voituriez, B. 2003. *The Changing Ocean: Its effects on climate and living resources*. UNESCO Publishing. (IOC Ocean Forum Series.) Available in English, French and Spanish.

Ice cores taken from the Antarctic ice cap enable scientists to analyse the air trapped in bubbles in the ice in order to establish a record of climate variations over the past 800,000 years.

© CNRS Photothèque – Laurent Augustin

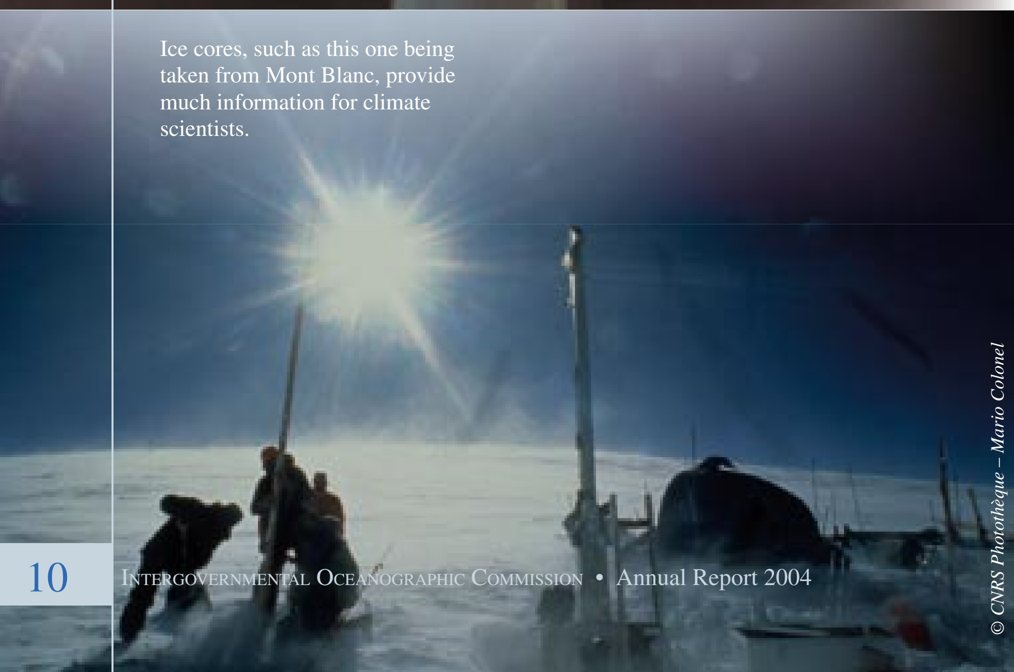
greenhouse effect: such claims are the result of a confusion between time scales.

Using numerical models to predict climate changes for future centuries requires an assessment of human activities that are subject to changes. Reducing greenhouse gas emissions is absolutely necessary to avoid a major climatic change. Stabilizing these emissions would not impede

A warmer ocean is more stable and has less capacity to absorb CO_2, which is not good news for our Earth.

some increase in global warming, whereas a more drastic stabilization of greenhouse gas concentration would still allow the climate to evolve for a few more decades, before it stabilizes again.

Are we nearing any solutions to this problem? Russia's ratification of the Kyoto Protocol (so that now more



Ice cores, such as this one being taken from Mont Blanc, provide much information for climate scientists.

© CNRS Photothèque – Mario Colonel

than 55 per cent of the countries representing more than 55 per cent of the CO_2 emissions are signatories) means the Protocol will enter into force on 16 February 2005. In 2005 'carbon' will be sold and exchanged in the main trade centres. This constitutes a necessary first step: current IPCC scenarios predict that global temperature might increase between approximately 2 °C and 6 °C in 2100. The lower range in this estimate corresponds to scenarios in which emissions are stabilized. It is important to realize that CO_2 is not the only gas in question. Methane emissions are also a concern, and so are Chlorofluorocarbons (CFCs), which in addition to their effect on ozone are also powerful greenhouse gases. The consequences would be very diverse: the Arctic sea ice would disappear in summer, and severe floods, or droughts might occur unexpectedly at various locations. An increase in sea level is already observed: a continuation, caused by ocean dilatation, or by the melting of mountain glaciers, for example in the Himalaya mountains, would threaten the very large populations living near rivers such as the Ganges in India, the Indus in Pakistan, or the Yang-tseu-kiang or the Huang-Ho in China.

A precise evaluation of these risks addresses the huge complexity of a climate system in which not only the ocean, the atmosphere, the criosphere or continental hydrology are coupled to each other, but also the biosphere. Scientific programmes such as the World Ocean Circulation Experiment (WOCE), a component of the World Climate Research Programme, which dealt with ocean circulation (1990–1998), or the Joint Global Ocean Flux Study (JGOFS) carried out under the umbrella of the Scientific Committee on Oceanic Research, evaluating the fluxes of carbon or other chemical species into the ocean from 1987 onwards, have shown that the ocean is responsible for a carbon sink of two Gigatons per year. The continental biosphere has a similar effect. Both effects are holding down the atmospheric increase in CO_2, but models show that this moderating effect might be diminished in a case of warming: a warmer ocean is more stable and has less capacity to absorb CO_2, which is not good news for our Earth. The complexity of interactions may also be internal to one component of the climate system: clouds, for example, are still among the largest sources of uncertainty within the climate system because they affect both solar and terrestrial radiations. We are therefore faced with a situation of global modification of the climate system, bringing a higher level of associated risks, at all time scales. The fact that these impacts cannot be described and predicted does not diminish the likelihood of their occurrence. In a warmer climate one may expect stronger atmospheric convection, modified and possibly increased occurrence of extreme events and storms, and intensification of ENSO, either in strength or in number of events. The share of the energy transport between the atmosphere and ocean may also be affected, because vertical motions are inhibited in a warmer ocean. The possibility of a cooler Europe, bordering an ocean where the Gulf Stream would no longer reach the Northern Atlantic is more than just a sheer fantasy.

Photo by Adrian Martins

An increase in sea level caused by the melting of mountain glaciers would threaten large populations living near rivers, such as the Ganges in India.

Photo by Andrea Rasetti

An Urgent Call to Mobilize: UNESCO and IOC Stand Ready

As 2004 drew to a close, several countries in the world were still assessing the damage that hurricanes, droughts, floods, volcanic eruptions, and other natural hazards had taken on them throughout the year. Then, at 0100 GMT on 26 December an 8.9 magnitude earthquake took place on the seafloor near Aceh in northern Indonesia generating a powerful wave resulting in the strongest tsunami the world has known in over forty years. It surged ashore without warning in Indonesia, Malaysia, Thailand, Myanmar, India, Sri Lanka, Maldives and even as far away as Somalia, leaving over 200,000 people dead, half a million injured, and millions more in need of basic services and at risk of epidemics. The Indian Ocean tsunami caused billions of dollars of material damage, and left countless families without livelihoods.

Photo courtesy of Hellmut Issels

The tsunami during the first seconds of its surge into Phuket, Thailand. As this photo clearly shows, a tsunami is a rapidly-rising tide and not a giant wall of water, which quickly and forcefully floods low-lying coastal areas.

Survivors recalled, "When the wave receded it had taken with it everything and in the very next moment there was an uneasy calm. Within a few minutes the wave had changed thousands of our lives forever."[1]

On 29 December, Koïchiro Matsuura, Director-General of UNESCO, convened the Task Force on the Prevention of Natural Disasters, in order to study UNESCO's response and its participation. 'We must work towards establishing risk-prevention policies, and towards extending warning systems available to the greatest number,' he urged. 'This is a domain in which we have the means and the experience to act effectively and quickly.'

In other parts of the world, notably Japan, the USA and Chile, among others, effective early warning systems, combined with better preparedness in the form of communication networks, and awareness-raising programmes that inform people about the actions they can take to save lives and limit damage, provide precious time for hundreds of thousands of people to escape to safety. In the Indian Ocean, however, where developing countries face many other urgent problems and lack adequate resources, such long-term planning has, until now, been a low priority.

1. Special thanks to humanitarian services volunteer, Dan Caldwell, in India for providing IOC with his moving descriptions and photographs.

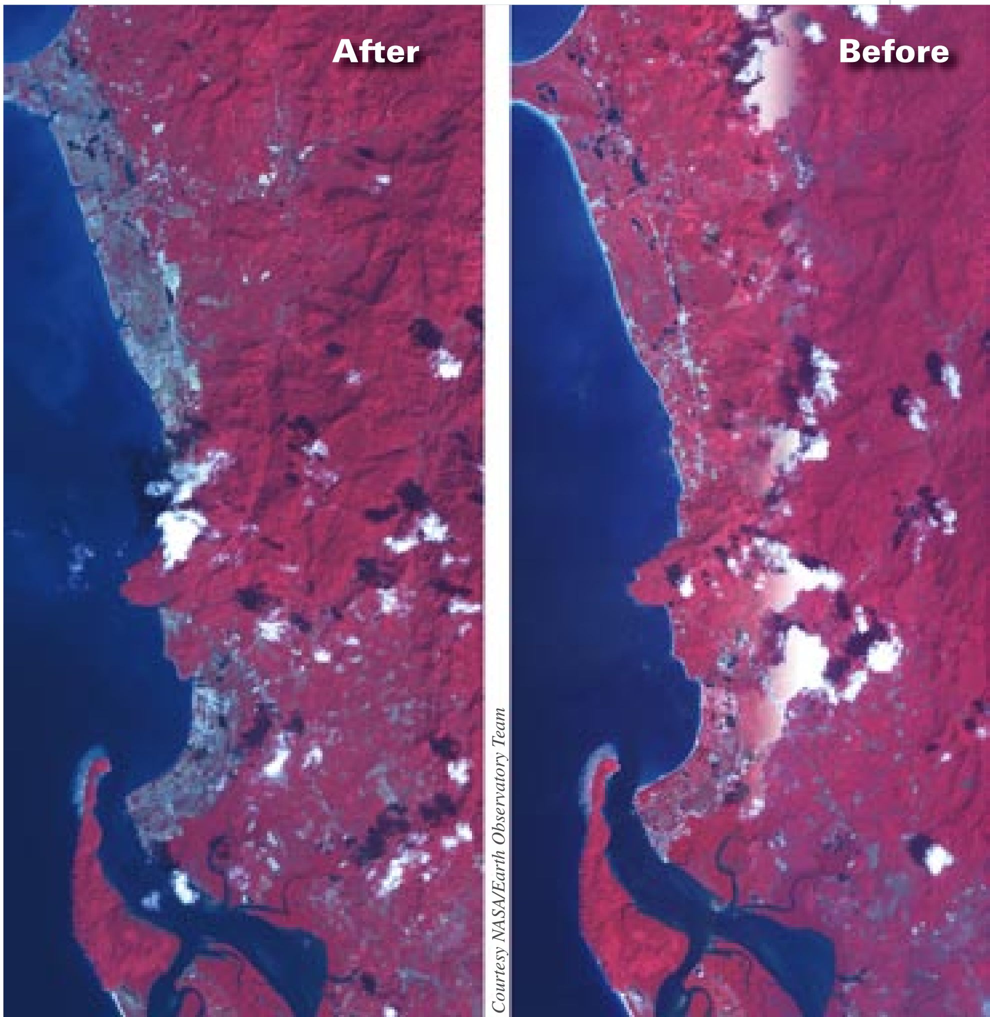
Nagappattinam, India. 'Boats were hurled a kilometre or more over sea barriers. Huge fishing boats were dropped like matchsticks along the seashore, crashing into one another and anything in their way. There were boats on rooftops and in backyards and piled on top of one another.'

Plans for a Global Tsunami Warning System

IOC's experience in the Pacific

The International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), operated by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, is currently the only tsunami warning system anywhere in the world. The IOC provides continuous support to the International Tsunami Information Center (ITIC) and the Tsunami Warning System in the Pacific (ITSU), which monitor, predict, and issue rapid warnings when tsunamis occur, as well as develop mitigation plans, store information, and maintain records on such events. The International Tsunami Warning System is one of the most successful international programmes ever undertaken involving twenty-six Member States with the direct responsibility of mitigating the effects of tsunamis, saving lives, and preserving property.

31 December 2004 **28 February 2003**



This pair of ASTER images contrasts before and after views of a portion of the western coastline of Thailand in the Phang-Nga province, about 50 kilometers north of the island of Phuket. In these images, vegetation is dark red, while bare earth is grey. On December 31, five days after the waves swept ashore, large sections of the shoreline are grey, stripped of vegetation or covered in mud and sand.

Lessons from the Pacific for the creation of the Indian Ocean tsunami warning system

In response to the Indian Ocean tsunami, the IOC/IGC, based on its mandate and experience with ICG/ITSU, will lead an effort to use the experience of the current existing tsunami warning system in the Pacific to create the Indian Ocean tsunami warning system. The existing system, which evolved from the system created by IOC in 1965, consists of a series of deep water measuring devices on the ocean floor, which pass wave movement data along to surface buoys, and, in turn, to a satellite. That information, and data from an extended network of tide gauges, will be collated at new Indian Ocean tsunami centres. The expertise acquired in the Pacific can be rapidly applied to the Indian Ocean for an implementation date of June 2006, through the concerted action of Member States of the IOC.

In a truly international effort of cooperation and collaboration, IOC of UNESCO is bringing together institutional partners, specialized agencies and donors who have offered support to discuss coordinating an Indian Ocean early warning system.

Worldwide expansion — a global early warning system

The possibility that the next catastrophic tsunami will occur outside the Indian Ocean basin exists and so, to ensure that appropriate warning systems are available in all regions of the world that are vulnerable to tsunamis, a major plan to develop and implement a global early warning system by June 2007 is underway. This decision is consistent with the other *in situ* Earth observing technology that is currently being used to build a Global Earth Observation System of Systems (GEOSS).

In a truly international effort of cooperation and collaboration, IOC of UNESCO is bringing together institutional partners, specialized agencies and donors who have offered support to discuss coordinating an Indian Ocean early warning system. Plans to determine exactly what will be required for a global alert system will subsequently be established. An assessment of the disaster's impact on the biosphere and ways in which man-made environmental damage, such as the destruction of coral reefs, may have aggravated the impact of the tsunami will be examined, as well as natural disaster prevention and mitigation, including public awareness campaigns and education initiatives. IOC's existing programmes already provide the framework for these activities.

To set these plans into action, two critical United Nations conferences will take place in early 2005:

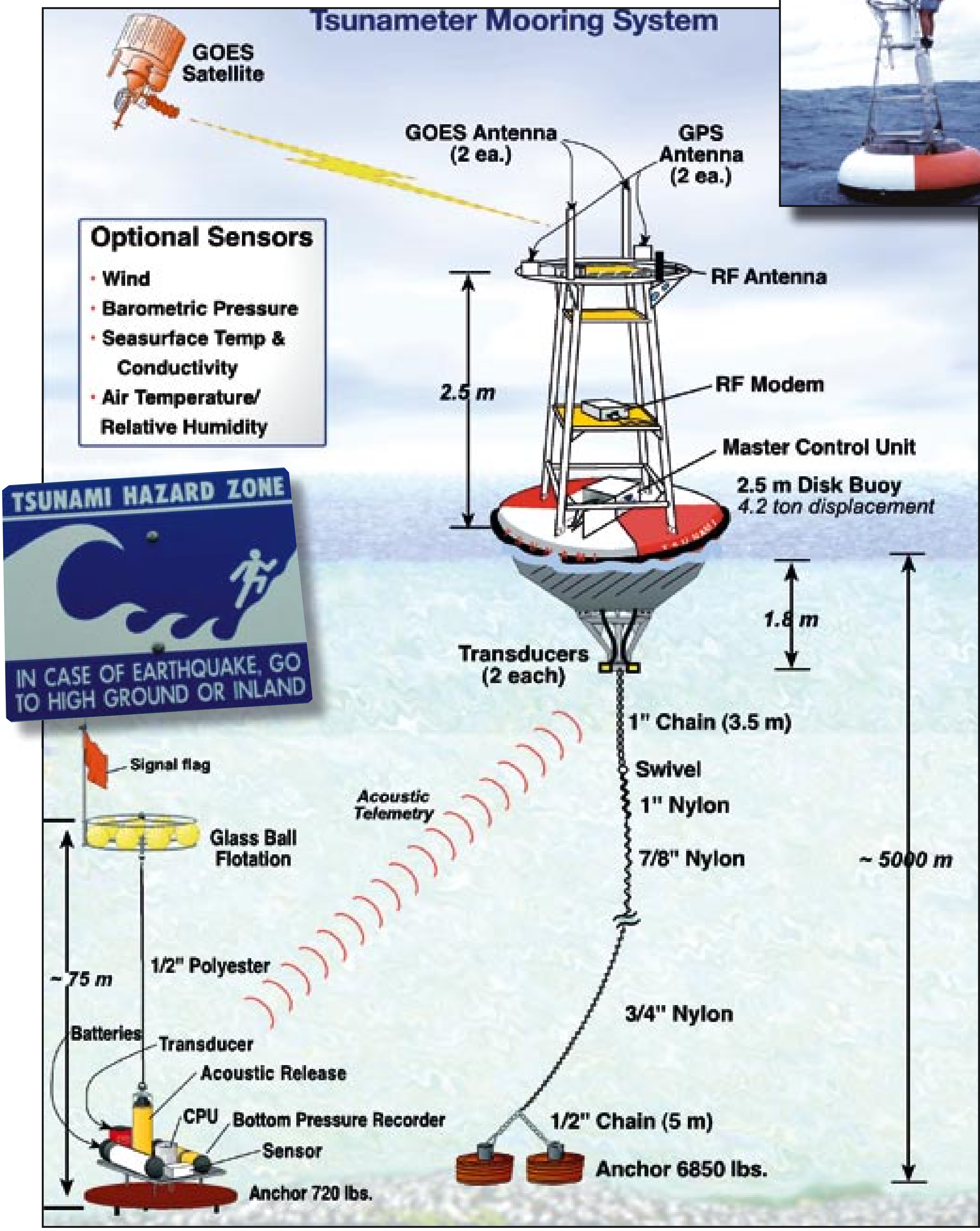
10–14 January 2005: the **Mauritius International Meeting** will address the multiple environmental, economic and social challenges facing the world's fifty-one Small Island Developing States (SIDS), which are extremely vulnerable to natural disasters.

18–22 January 2005: the **World Conference on Disaster Reduction**[2] in Kobe, Japan, will draw up a framework for action to create a global early warning system and to increase international cooperation to ensure that the world reduces risk and vulnerabilities to natural hazards.

Several of the affected countries have shown strong leadership in responding to

U.S. National Oceanic and Atmospheric Administration

Deploying a tsunami buoy as part of the International Tsunami Warning System.



Illustrations by U.S. National Oceanic and Atmospheric Administration

How the tsunami warning system operates: A series of deep water measuring devices on the ocean floor pass wave movement data along to surface buoys, and, in turn, to a satellite. Such information, and data from an extended network of tide gauges, will be collated at new Indian Ocean tsunami centres.

UNESCO will do everything in its power to help nations develop their disaster preparedness ... one of the many lessons we must learn from the Indian Ocean catastrophe is that tsunami can strike wherever there is a coastline.

UNESCO Director-General
Koïchiro Matsuura

the need to establish national and regional tsunami warning and mitigation systems. In addition, many Member States and organizations from outside the region have offered their expertise and assistance for the development of these systems. In view of these developments a consensus has developed in several fora to ask the UN to play a major coordinating role. In particular:

A special Association **of Southeast Asian Nations (ASEAN) leaders' meeting**[3] will be held in Jakarta, Indonesia, 6 January 2005.

The **Ministerial Meeting on Regional Cooperation on Tsunami Early Warning Arrangements**,[4] Phuket, Thailand, 29 January 2005.

In June 2005, the Thirty-eighth Session of the Executive Council of the Intergovernmental Oceanographic Commission of UNESCO will finalize plans for the creation of the first regional component of the global system, in the Indian Ocean, foreseen for June 2006.

2 At the time of this Annual Report's printing, the World Conference on Disaster Reduction had already taken place. A Common Statement of the "Special Session on the Indian Ocean Disaster: Risk Reduction for a Safer Future" was adopted at the conference, which 'recognizes the need to use the experience of the existing Pacific Ocean tsunami early warning systems, making use of the existing coordination mechanisms of the IOC and other relevant international and regional organizations'.

3 The special ASEAN leaders' meeting held in Jakarta on 6 January 2005 called for the 'establishment of a regional tsunami early warning system for the Indian Ocean and Southeast Asia region'.

4 The Ministerial Meeting on Regional Cooperation on Tsunami Early Warning Arrangements, Phuket, Thailand, 29 January 2005, decided 'to take immediate and practical steps to enhance early warning capabilities in the Indian Ocean and Southeast Asia and to cooperate towards the establishment of interim early warning arrangements and strengthening and upgrading of national systems, while moving towards a coordinated regional system.' The Ministerial Meeting agreed that a regional early warning system 'shall be developed within the UN's international strategy coordinated by the IOC of UNESCO'.

Further information about the International Tsunami Warning System is available at the IOC/ITSU website:

http://ioc.unesco.org/itsu/

'If we don't do this, we won't have anything to eat.' Despite feeling afraid of returning to the sea, desperate fishermen, unemployed since the tsunami, repair their nets.

Photos by Dan Caldwell

(Above) Blessing the sea: 'We watched as boats that had received repairs were pushed back into the ocean. Then we gathered together for a sacred and beautiful *Samudra Aarti* [ocean prayer ceremony.]'

Letter

by Dr David Pugh, IOC Chairman

to Dr Nasser H. Zaker,

Chairman, IOC Regional Committee for the Central Indian Ocean (IOCINDIO)

28 December 2004

Dear Dr Zaker

Please receive the deepest condolences from the IOC Member States, Secretariat and Officers for the suffering in the IOCINDIO Region. We have all watched in horror as the magnitude of the recent events has become increasingly apparent.

The absence of a tsunami warning system for the Indian Ocean has been widely queried after the event. I am sure this disaster will alert Member States of the IOC to set up urgently a system for the future. We must not forget that there are other oceans, notably the Atlantic, where tsunami, though rare, have been observed historically to precipitate disasters; and there are other ocean phenomena, including surges, for which there have been detailed proposals for warning systems. These proposals include one for the Bay of Bengal, most recently in the form of the MILAC plan discussed at the June 2004 IOC Executive Council.

Now could be the time to set up a GLOBAL warning system for ALL potential ocean disasters.

I hope that the Member State governments of the IOC, led by those Indian Ocean governments whose citizens have suffered so much in the past few days, will now make it an absolute priority to set up and maintain a warning system for ocean impacts. The IOC stands ready to provide the mechanisms for that cooperation.

Thank you also for the initiative you are taking in this.

David Pugh
Chairman,
Intergovernmental Oceanographic Commission of UNESCO

Roger Revelle (1909-1991) was a pioneer in oceanography and in global ocean science cooperation. His 1979 address on climate to the Eleventh IOC Assembly was a typical Revelle *tour de force*. As one of the first scientists to point to the role of the ocean in the climate system and in climate variability, he began 'I am about to describe what I believe to be the most important programme that has challenged the IOC in many years.'[1]

'His dream of equity in human relationships, based on equal access to education and knowledge ... was indeed reflected in every endeavour he undertook, including the rationale for an intergovernmental body for ocean research that resulted in the establishment of our Commission.'

Mr Federico Mayor, Director-General, UNESCO, paying tribute to Roger Revelle on the occasion of the Twenty-fifth Session of the IOC Executive Council, 1992

1. Extract courtesy of 'Roger Revelle and his Contribution to International Ocean Science' by the Honourable John A. Knauss, Revelle Memorial Lecturer, 1992.

Courtesy of UCSD Libraries/SIO: by Eugene LaFond

CELEBRATING

...one of the **founding fathers** of the IOC of UNESCO: The Roger Revelle Medal

Now an established tradition, every session of the Intergovernmental Oceanographic Commission's annual Executive Council opens with the hallmark Revelle Memorial Lecture. Named in honour of Roger Revelle, whose important contributions to the awareness of global change form the basis of many IOC initiatives today, the invited lecturer's research reflects much of the same pioneering spirit and aspirations as Revelle's, and by association, the ideals that originally led to the creation of the IOC forty-four years ago.

To formally honour Revelle's focal role in helping to create the IOC, Dr Patricio Bernal, IOC's Executive Secretary, announced the annual award of a 'Roger Revelle Medal' to all Revelle Memorial Lecturers, starting on the occasion of the Thirty-seventh Executive Council, 2004.

The Roger Revelle Medal recognizes outstanding contributions to the ocean sciences by inspired researchers who communicate their knowledge and global vision of the challenges facing our Planet in order to shape a better future for humankind.

Mrs Mary Ellen Revelle Paci, daughter of Roger Revelle, expressed her thanks to the IOC for this initiative and for offering her family the first IOC Roger Revelle Medal.

This year's lecturer and medal award recipient, Daniel M. Pauly, Professor and Director at the Fisheries Centre at the University of British Columbia, Canada, said, 'I am not only delighted, but deeply honoured to have received the Roger Revelle Medal. It commemorates the work of a scientific giant, and being associated with his name – never mind standing on his shoulder – is something I am quite proud of.'

Dr Pauly spoke on Upper Trophic Level Changes in Ocean-basin Ecosystems. His work is devoted to investigating the global impact of fisheries on marine ecosystems, and has led to software and scientific databases now used throughout the world, and to concepts structuring much research in marine biology. Dr Pauly has authored and co-authored numerous books, scientific articles, and reports. His latest book is titled *Darwin's Fishes: An Encyclopedia of Ichthyology, Ecology, and Evolution* (2004) and is available from Cambridge University Press.

Policy

UNESCO/Hammed Belmenouar

UNESCO Headquarters, Paris, France.

Mandate of the Intergovernmental Oceanographic Commission of UNESCO

At the Thirty-second General Conference of UNESCO, the Director-General was authorized to apply plans of action in order to:

I. Improve scientific knowledge and understanding of oceanic and coastal processes with a view to assisting Member States in the design and implementation of sustainable policies for the ocean and coastal zones, through the organization and coordination of major scientific programmes, responding to the mandate of the United Nations Law of the Sea (UNCLOS), Chapter 17 of Agenda 21/United Nations Conference on Environment and Development (UNCED), the Barbados Plan of Action for the Sustainable Development of Small Island Developing States, the Plan of Implementation of the World Summit on Sustainable Development (WSSD), the Global Conventions on Climate Change and Biodiversity, the relevant Millennium Development Goals (MDGs) and the regional conventions and programmes;

II. Organize the collection of ocean and coastal observations, the modelling and the production of forecasts needed for the management and sustainable development of the open and coastal ocean as well as the hinterland, particularly by implementing the Global Ocean Observing System (GOOS) and its related pilot projects and regional components, and by increasing the capacities and participation and full involvement of developing countries;

III. Continue the follow-up to the Pan-African Conference on Sustainable Integrated Coastal Management (PACSICOM) through the development and implementation of regional coastal management projects contributing to the operational phase of the African Process in the framework of the environment component of the New Partnership for Africa's Development (NEPAD);

IV. Answer the call to IOC contained in the Plan of Implementation of WSSD to support the development of permanent capacities in ocean sciences, services and observations by Member States of IOC, particularly through WSSD Type II partnerships on oceans where IOC is identified as a partner.

Global Results and Achievements in 2004

New knowledge is applied for the improvement of management, sustainable development, protection of the marine environment, and the decision-making processes of the Member States of IOC.

The Symposium on Quantative Ecosystem Indicators for Fisheries Management (Paris, France, 31 March–3 April 2004) was the culmination of work carried out by the IOC–Scientific Committee on Oceanic Research (SCOR) Joint Working Group 119 since 2001. The overall objective of this Joint Working Group was to develop a theory to evaluate changes (states and processes) in marine ecosystems, from environmental, ecological and fisheries perspectives. The Working Group defined generic indicators that can be used in marine environments, fisheries or for assemblages of exploited fish populations or marine ecosystems and it formulated these indicators in mathematical or statistical terms; it determined which values of an indicator are meaningful statistically and/or ecologically and when to apply these indicators to specific data sets or when using specific multispecies models (such as MSVPA, Ecopath, Ecosim, Ecospace, Osmose) in order to evaluate their usefulness. The outcomes of this meeting were presented at the Thirty-seventh IOC Executive Council and are being widely distributed through peer-reviewed publications.

SCOR and IOC convened an open symposium on 'The Ocean in a High CO_2 World', (Paris, France, 10–12 May 2004), which highlighted recent research findings that the ocean has taken up approximately fifty per cent of the fossil-fuel CO_2 released to the atmosphere since pre-industrial times, and that this increase in oceanic CO_2 is acidifying the oceans. The symposium addressed the biological and biogeochemical consequences of increasing atmospheric and oceanic CO_2 levels, and possible strategies for mitigating such increases. The symposium included plenary presentations, discussion sessions on research priorities, and a poster session. Papers from the symposium are being published in a special issue of the *Journal of Geophysical Research-Oceans* and research priorities will be published separately for the benefit of ocean scientists and research programme managers worldwide.

In the second half of 2004, the Panel followed up these activities with publication of the meeting report on 'International Research Priorities', which attracted the attention of the world's news media, including the *New York Times*, Cable News Network (CNN), the *Financial Times* of London, and the British Broadcasting Company (BBC). Scientific presentations from the symposium will be published in a special-issue of the peer-reviewed *Journal of Geophysical Research-Oceans* in early 2005.

On the other hand, at its Sixth Session held 18–19 September 2003, the High Level Commission on Programs (HLCP) approved the creation of an Ocean and Coastal Areas Network, building on the Subcommittee on Oceans and Coastal Areas (SOCA) and in line with a call from the Chief Executive Board (CEB) for a more dynamic arrangement which would enable non-UN actors to contribute to the achievement of the Johannesburg Plan of Implementation (JPOI) targets (Ref. CEB/2003/7). Following a request from the Secretariat of the CEB, IOC, together with former members of SOCA, contributed to the process that the HLCP lead for the definition of Terms of Reference and the establishment of the Ocean and Coastal Areas Network (UN-Oceans). During the Fifth Informal Consultative Process on the Law of the Sea (ICP V) (New York, USA 7–11 June 2004) UN-Oceans met twice and confirmed the Terms of Reference and the preliminary list of members.

International cooperation and coordination of programmes is promoted in research, services and capacity-building, in order to learn more about the nature and resources of the ocean and coastal areas.

The Earth Observation Summit (EOS), held in Washington, DC, 30 July–2 August 2003 was organized by the Government of United States of America to 'Promote the development of a comprehensive, coordinated, and sustained Earth observation system or systems among governments and the international community to understand and address global environmental and economic challenges.'

The *ad hoc* Group on Earth Observations (GEO) launched at EOS set in place the necessary follow-up machinery with a view to preparing a framework document in time for a Ministerial Conference on Earth observations held on 25 April 2004 in Tokyo, Japan and a complete Plan of Implementation in time for a further Ministerial Conference to be hosted by the European Union during the first quarter of 2005. IOC has been fully engaged in the process, co-chairing the International Cooperation Subgroup (ICSG) of GEO with representatives of Australia and the USA.

The GEO entrusted the ICSG with a task 'to develop for the 10-year Implementation Plan a long-term, international organizational strategy and coordination mechanism for a comprehensive, coordinated, and sustained Earth observation system of systems, building on existing mechanisms and structures' (quoted from ICSG *Terms of Reference*). It aims to establish international strategies, models, and organizational structures that could be used for effective long-term coordination of a comprehensive, coordinated Earth observation system or systems. Dr Patricio Bernal, Executive Secretary of IOC, is leading this activity as one of ICSG's co-chairs. After the considerable efforts of ICSG, the GEO agreed on the proposed principles of this process through the negotiation among the Members in GEO-3 (February 2004, Cape Town, South Africa), and adopted it as a part of Framework Document at the Second Earth Observation Summit held in Tokyo, Japan (EOS II, 25 April 2004).

MOVING FORWARD ON SUSTAINED EARTH OBSERVATIONS:

The Group on Earth Observations (GEO)

BORAM LEE, Programme Specialist in the GOOS Project Office, is IOC's representative serving on the GEO Secretariat. Working with subgroups and experts worldwide, Ms Lee is part of the team that developed the comprehensive report forming the basis of GEO's 10-Year Implementation Plan.

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Thirty-three countries plus the European Commission, and twenty-one multilateral organizations met at the Earth Observation Summit (EOS) on 31 July 2003, and adopted a Declaration that signifies political commitment to move towards the development of a comprehensive, coordinated, and sustained Earth observation system(s). Recognizing the need for timely, quality, long-term global information as a basis for sound decision-making, the Summit participants launched the intergovernmental *ad hoc* Group on Earth Observations (GEO) to develop a long-term plan and strategy for Earth Observation. The goal is to build upon existing systems to establish a comprehensive Global Earth Observation System of Systems (GEOSS) that will be as technologically interrelated as the planet it observes, predicts and protects. Such efforts have continued through the second Earth Observation Summit (EOS II, Tokyo, 25 April 2004) to launch a ministerial-guided successor to GEO for implementing the GEOSS 10-Year Implementation Plan from 2005 onwards.

Around the globe, Earth observing systems have already demonstrated their value in responding to various socio-economic needs, such as improving airline and maritime safety, forecasting the weather, monitoring water and air quality, and estimating crop yields. Governments and international organizations have made significant efforts in developing such systems to provide critical data. However, linking these data and expanding the information on Earth observations will add considerable power to existing systems and provide a quantum leap in our ability to predict and manage processes of the Earth system.

The Earth Observation Summit II, Tokyo, 25 April 2004.

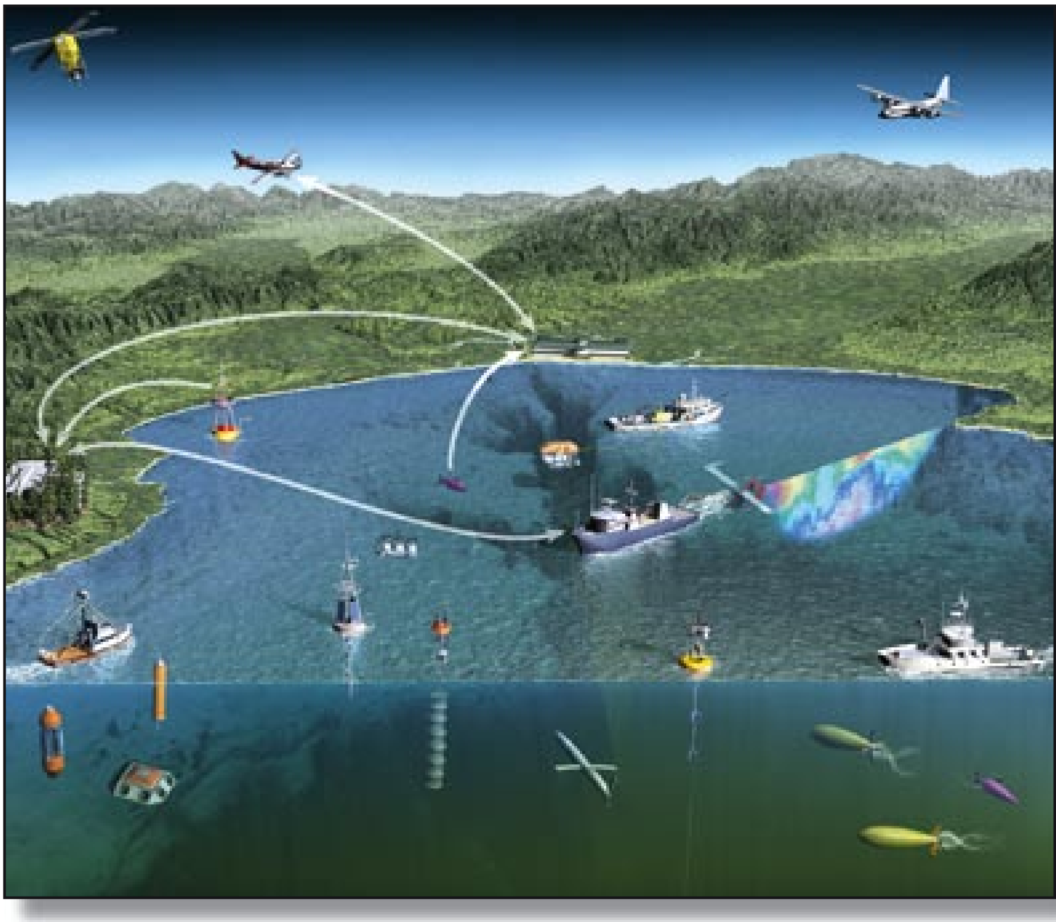

Illustration by David Fierstein © 2001 MBARI

The experiment shown here was conducted during August, 2000 by MBARI to assess the role of iron on phytoplankton blooms in Monterey Bay, CA. The 10-Year Implementation Plan for a Global Earth Observation System of Systems (GEOSS) entails the coordination of a wide range of space-based, air-based, land-based, and ocean-based environmental monitoring platforms, resources and networks – presently often operating independently.

The world is moving forward on sustainable Earth observation; the World Summit on Sustainable Development (WSSD) in 2002 and recent meetings of the G8 ministers have all noted the need for improved monitoring of environmental processes, which would provide better data to support decision-making with regard to sustainable development and the use of natural resources. It implies that producing information about our planet has become a worldwide priority.

The first Earth Observation Summit (EOS) was initiated and aimed at pressing industrial, political and societal questions. It affirmed in the first Declaration (July 2003, Washington, DC) the need to support the creation of a comprehensive, coordinated, and sustained Earth observing system of systems in order to monitor continuously the state of the Earth, to increase understanding of dynamic Earth processes, to enhance prediction of the Earth system, and to further implement environmental treaty obligations.

To further this goal, the Summit participants launched the intergovernmental *ad hoc* Group on Earth Observations (GEO) to develop a 10-Year Implementation Plan for a Global Earth Observation System of Systems (GEOSS). This plan entails the coordination of a wide range of space-based, air-based, land-based, and ocean-based environmental monitoring platforms, resources and networks – presently often operating independently. GEO is currently made up of fifty-one countries plus the European Commission, and twenty-nine participating international organizations.

A Framework Document that provides the overarching guidance for the GEOSS Plan was adopted on 25 April 2004 at the second Earth Observation Summit (EOS II) in Tokyo. It describes the principal benefits of Earth observations and the key components to be included in the 10-year Implementation Plan, as well as the needs and outcome of GEOSS. The adoption of this Framework Document, while not binding any member or organization to any financial commitment, serves as a strong indication of willingness to support substantively the 10-Year Implementation Plan for the creation of a Global Earth Observation System of Systems (GEOSS).

The GEOSS 10-Year Implementation Plan itself will be adopted at the third Earth Observation Summit (EOS III) in Brussels, Belgium in February 2005. It will require a long-term commitment by governments to ensure that planned future investments in Earth observation capabilities are developed and implemented in a manner that advances the success of the Plan. The *ad hoc* GEO will complete its mandate of developing such a plan by EOS III; responsibility for carrying out the work of the 10-Year Implementation Plan for GEOSS is then expected to pass on to an agreed successor mechanism – tentatively named as GEO – a new organization that will support the realization of a new organization.

The GEOSS

GEOSS will be a distributed system of systems, building step-by-step on current cooperation efforts between existing observing and processing systems within their mandates, while encouraging and accommodating new components. Participating members of GEO will determine the ways and means of their participation in GEOSS.

The resulting system – a comprehensive, coordinated and sustained GEOSS – will enable the collection and distribution of accurate and reliable Earth Observation data, information, products and services, delivering the benefits of these observations to both suppliers and consumers worldwide.

Benefits of GEOSS

Data derived from Earth observation sensors, instruments, and satellites are used to make important decisions in almost every area of life every day. Better data and improved analysis will help us to expand worldwide capacity and means to achieve sustainable development and will yield advances in many specific areas of socio-economic benefit.

These benefits will be realized by a broad range of user communities, including: (1) national, regional, and local decision-makers, (2) relevant international organizations responsible for the implementation of international conventions, (3) business, industry, and service sectors, (4) scientists and educators, and (5) the general public. Realizing the benefits of coordinated, comprehensive, and sustained Earth observations (i.e. the improvement of decision-making and prediction abilities) represents a fundamental step towards addressing the challenges articulated in the declarations of the 2002 World Summit on Sustainable Development and fulfilling the Millennium Development Goals agreed at the Millennium Summit in 2000.

The concept of GEOSS will be completed by full participation of developing country members, which will maximize their opportunities to derive real benefits in the above socio-economic areas. Such participation is supported as it enhances the capacity of the entire Earth observation community to address global sustainable development challenges.

GEOSS responding to socio-economic needs

The Framework Document aims to achieve advances in many specific areas of socio-economic benefit, including:

- **Reducing loss of life and property from natural and human-made disasters**: Better coordinated observation systems could save lives and preserve resources, as well as reduce the chance of hazards becoming disasters, by providing decision-makers with timely and accurate Earth observation data;
- **Understanding environmental factors affecting human health and well-being**: Earth observation data transformed into information, such as risk mapping of health threats, indicators of environmental quality, environment-related health and well-being statistics will increase public awareness, which in the long run will drive better policy development to improve quality of life;
- **Improving management of energy resources**: Energy is a key market driver that influences the life and economics of most countries. Challenges facing nations are related to exploration, production and transportation of energy, without damaging the environment. Earth Observation is a source of information that can potentially provide for optimization of energy resources and their distribution while minimizing environmental

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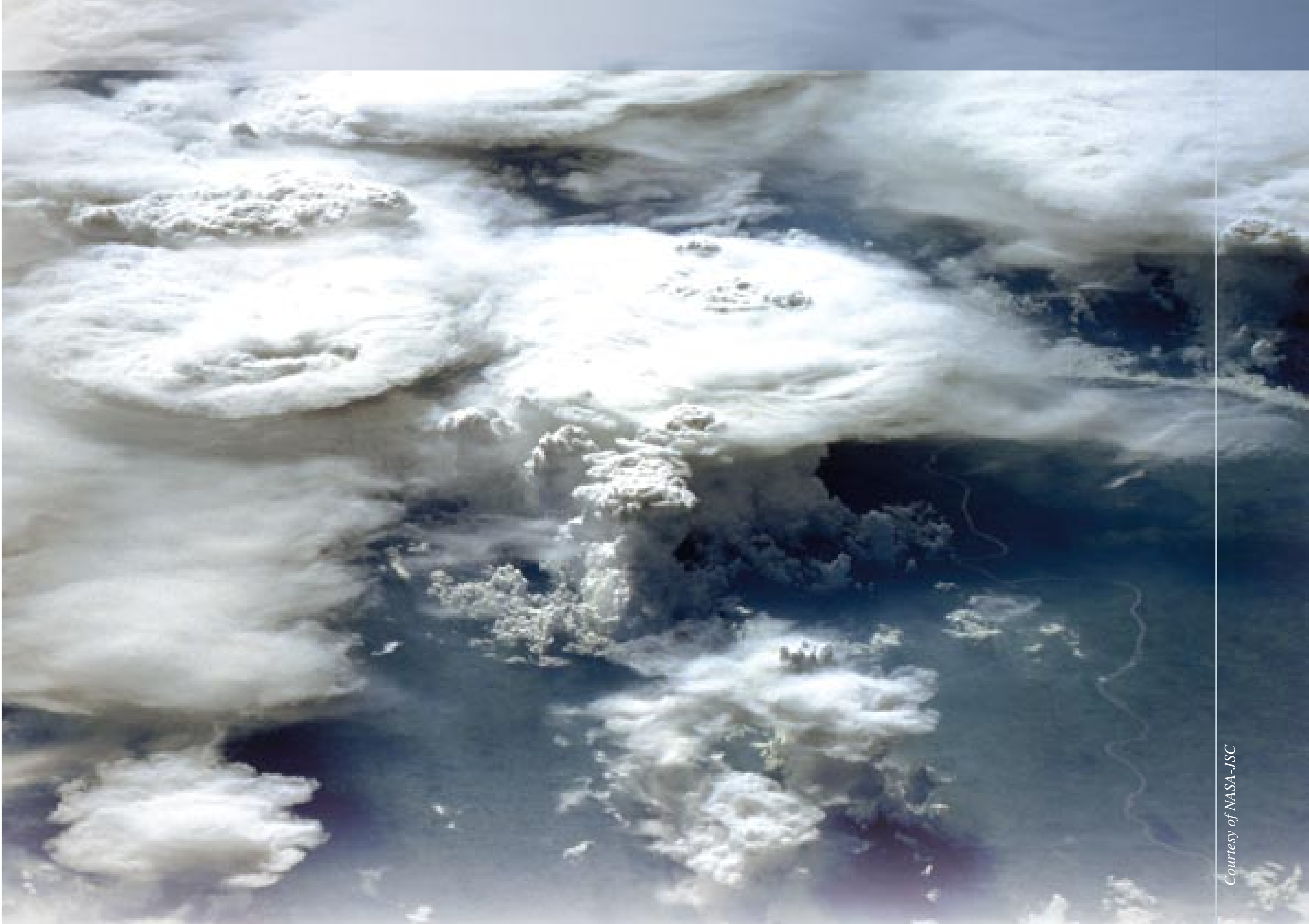
Better coordinated observation systems could save lives and preserve resources, as well as reduce the chance of hazards becoming disasters. The small village of Barois, Haiti was totally swept away by the floods and landslides during 2004. Only a couple of houses survived. This man lost all his animals and now survives by eating leaves.



Clouds from Space: This image over southern Brazil was taken from the space shuttle.

impact, as well as for direct influence on relevant policies;

- **Understanding, assessing, predicting, mitigating and adapting to climate variability and change**: Natural phenomena and human activities have altered and continue to alter the Earth's climate. The development and further improvement of monitoring and prediction capabilities is a necessary basis for mitigation and adaptation policies in support of sustainable development;
- **Improving water resource management through better understanding of the water cycle**: Comprehensive Earth observation can help monitoring, management and development of water resources, leading to improved economic production, protection of life and property, and reduction of human suffering;
- **Improving weather information, forecasting and warning**: There is an urgent need to monitor and predict weather in order to ensure human safety against extreme weather events, and to enhance capacity and readiness on a range of social and economic activities. Earth observations can support vastly improved weather forecasting and severe event warning schemes at global, regional and national levels, and also act as a cross-cutting issue for other GEOSS societal benefits;
- **Improving the management and protection of terrestrial, coastal and marine ecosystems**: Enhanced Earth observations, information, and decision support systems should provide assistance for land, coastal and marine management and policy-making to implement international environmental treaties;
- **Supporting sustainable agriculture and combating desertification**: Helping in the struggle to eradicate poverty and hunger, especially in food-insecure developing countries, is a critical issue. Integrated global Earth observation including terrestrial, meteorological, hydrological, and agricultural parameters will help sound decision-making process in this regard;

Data derived from Earth observation sensors, instruments, and satellites are used to make important decisions in almost every walk of life every day.

Combating desertification: Integrated global Earth observation including terrestrial, meteorological, hydrological, and agricultural parameters will help a sound decision-making process in this regard.

- **Understanding, monitoring and conserving biodiversity**: Various societal benefits derive from biodiversity that forms the Earth's rich heritage of life, which can be preserved from human activities with proper decision-making and education derived from Earth observation and relevant information.

The above list of issues details only a small part of the numerous areas; GEOSS will be a very powerful tool for both scientists and decision-makers across many far-reaching fields and sectors.

IOC's role in GEOSS

As the focal point of the UN for coordinating Ocean Science and the development of Ocean Services, IOC plays a key role in ocean observations and, as part of its mandate has been developing the Global Ocean Observing System (GOOS). In the process of developing the Framework Document and GEOSS 10-Year Implementation Plan, GOOS is recognized as an important work and guidance for future action of ocean monitoring, modelling and forecasting. The IOC is pursuing the establishment of an integrated, operational marine observation network through the IOC-WMO Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). This has also led to establishing the Integrated Global Observing Strategy Partnership (IGOS-P), aiming to provide a comprehensive framework to harmonize the common interests of the major space-based and *in-situ* systems for global observation of the Earth. These efforts fertilized the GEO initiative and following processes.

The IOC provides a considerable contribution to GEO, through technical advice on ocean observations, as well as support for the 10-Year Implementation Plan. In particular, IOC is deeply involved in incorporating GEO into existing implementation plans in oceanographic fields, and vice versa, in cooperation with related ocean communities and other Earth observation programmes. Ocean observations, accounting for approximately seventy per cent of the Earth's surface, will form a major component of GEOSS. Recognizing the demand, IOC will continue to

Tsunami buoy deployment: Ocean observations, accounting for approximately seventy per cent of the Earth's surface, will form a major component of GEOSS.

support GEO, either directly or indirectly, by enlarging the current scope of GOOS.

The IOC's role in GEO will be extended to include capacity building. In 2003 in Evian, France, the G8 countries, analysing the outcome of WSSD, adopted an Action Plan on Science and Technology for Sustainable Development, and proposed a strategy for global observations, as follows:

> 'To meet the objectives of the WSSD, developing countries and countries with economies in transition need to build and strengthen their capacity to assimilate and generate knowledge for sustainable development. We reaffirm our commitment made at the WSSD to assist them through international cooperation in enhancing their research capacities.'

Today, although there are only a few countries in the south where organizations are able to make immediate use of the increased data stream, the challenge of capacity building should be understood in its broadest sense possible; not only in science and technology, but in policy design, management skills and economy.

States. During last August's address at 'Oceans: Interaction between Man and Maritime Environments' Dr Patricio Bernal, IOC's Executive Secretary, explained, 'Many of the difficulties can be overcome and the track record of these UN organizations shows that it is possible to operate a global system that is inclusive

IOC is deeply involved in incorporating GEO into existing implementation plans in oceanographic fields

IOC has valuable experience to enhance GEO's capacity building, based on international cooperation, founded on a long history of activities in programmes such as Training, Education and Mutual Assistance (TEMA) and the Ocean Data and Information Networks (ODINAFRICA, ODINCARSA, and ODINCARIBE) that respond to the needs of Member

to all nations of the world, providing public services to all its members. What are required are clear, stable rules to enhance cooperation efforts among members of the system.' Such efforts will contribute towards making GEOSS a truly global network, and will ultimately provide societal benefits to every country in the world.

The Intergovernmental Oceanographic Commission of UNESCO's commitment to assisting

Small Island Developing States

The UN Millennium Development Goals call for the creation of global partnerships for development and urge assistance for Small Island Developing States (SIDS). In response, the 129 Member States of the IOC have expressed their willingness to work together in a collective effort with SIDS and other international organizations to develop the tools necessary to build marine science and observation capacity. These tools implement strategies that build resilience and capacity, and address the multiple environmental, economic and social challenges facing the world's fifty-one Small Island Developing States, including improved monitoring as a means of providing early warnings–critical for preventing hazards from becoming disasters.

The Mauritius International Meeting, 10–14 January 2005, will call to set up a system to help the world's most vulnerable low-lying States cope with natural disasters. Apart from the tsunami devastation in the Indian Ocean, Caribbean islands are still recovering from four major hurricanes and tropical storms that hit their region last year.

The Mauritius International Meeting is organized by the United Nations and its agencies, including UNESCO, to review the implementation of a programme of action for the sustainable development of Small Island Developing States (SIDS), agreed upon at a global conference in Barbados ten years ago. More than 2,000 delegates from 110 countries will be attending the conference in Mauritius along with United Nations partners, donor agencies, non-governmental organizations and civil society groups.

The integrated, sustained network that IOC can offer will help SIDS strengthen their regional and local institutions in marine sciences and services by providing technical assistance, partnerships and capacity building. IOC is poised to translate science and technology into action, and continue to develop the tools that will benefit Small Island Developing States in managing their large ocean domains effectively.

Photo courtesy of UNESCO/Yann Arthus-Bertrand/Earth from Above

IOC DECLARATION

to the International Meeting to Review the Implementation of the Programme of Action for the Sustainable Development of

SMALL ISLAND DEVELOPING STATES

Adopted by the IOC Executive Council, July 2004

The Intergovernmental Oceanographic Commission of UNESCO affirms its will to:

- Act as a focal point to encourage interactions in marine science and observations across relevant bodies of the UN system and other organizations;
- Further develop partnership in capacity building in marine science and services at regional and national levels, particularly with SIDS;
- Develop the Global Ocean Observing System (GOOS) as an operational system that could provide support to achieve the integrated management of marine and coastal resources of SIDS and also for better forecasts of the conditions of the oceans and seas;
- Promote the development and implementation of programmes on Integrated Coastal Area Management in SIDS countries;
- Promote the use of scientific knowledge for management decisions and policymaking and facilitate access to this knowledge through international cooperation in general, and South-South marine science cooperation in particular; and support ocean policy and governance programmes in all regions;
- Work to increase public awareness of the importance of the oceans and coasts for SIDS' sustainable development, including through the Global Forum on Oceans, Coasts and Islands.

'The world oceans and their adjacent seas, and the living and non-living resources they contain, are a necessary element for the survival of life as we now know it.'

IOC Declaration to the World Summit on Sustainable Development, Johannesburg 2002

The Member States of the Intergovernmental Oceanographic Commission invite the delegates and representatives at the International Meeting to Review the Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States to be held in Mauritius, in January 2005, to reaffirm:

1. The importance of the oceans and seas for sustainable development of SIDS;
2. The role of IOC as the competent marine science body of the UN; and
3. The need for governments and funding organizations to provide the resources necessary to implement marine science and observation capacity building in SIDS.

The Member States of the Intergovernmental Oceanographic Commission wish to reaffirm that they are also prepared to promote, improve and strengthen international cooperation in general, and South-South marine science cooperation in particular, as a way to increase the sharing of endogenous capacity in marine and coastal science and technology knowledge.

Promoting Integrated Marine and Coastal Management and Sustainable Development:

IOC and ICES

The Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Council for the Exploration of the Sea (ICES) signed a co-operation agreement on 28 September 2004 for both bodies to work together on programmes to study the North Atlantic Ocean and adjacent seas. In particular, the agreement sets specific plans for the implementation of the Global Ocean Observing System (GOOS), increased cooperation in the management of data and information including the development of marine information technology, and more studies on the increase in harmful algal blooms. It also provides for a common approach to specific themes such as education, training and technology transfer.

ICES and IOC also undertake to begin intensive efforts in working groups, workshops, symposia and conferences on themes of interest to both organizations. Mutual access to the relevant committees and expert groups and the expansion of networking between the main intergovernmental organizations active in the marine sciences are additional responsibilities taken on by ICES and IOC under the agreement.

ICES is the oldest and internationally most prestigious intergovernmental organization researching marine and fish resources. It was founded in 1902, has nineteen member countries and six affiliate countries. ICES designs, coordinates and promotes marine research and also provides scientific advice at the international level. At present 1,600 researchers work on eight Science Committees which, in addition to other research, study 135 fisheries including those of major commercial significance.

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer
ICES CIEM

ICES research vessels at the harbour in Copenhagen, Denmark. ICES designs, coordinates and promotes marine research and also provides scientific advice at the international level.

Photos courtesy of ICES.

Memorandum of Understanding

BETWEEN THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC) OF UNESCO AND THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA (ICES)

Recognizing that:

The Intergovernmental Oceanographic Commission of UNESCO, hereinafter referred to as IOC, is a specialized United Nations body with expertise in ocean science and services;

The purpose of the Commission is to promote international cooperation and to coordinate programmes in research, services, and capacity-building in order to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States;

In the effective implementation of its role the IOC relies on the network of the IOC Regional Subsidiary Bodies as mechanisms of implementation and strategic elements in identification of priority needs, formulation of, and agreement on regional cooperative programmes;

The IOC has significant responsibilities in the implementation of relevant parts of UNCLOS, the UNCED Agenda 21, the UNFCCC, and the Implementation Plan of WSSD.

Recognizing that:

The International Council for the Exploration of the Sea, hereinafter referred to as ICES, exists to (a) promote and encourage research and investigations for the study of the sea particularly related to the living resources thereof; (b) draw up programmes required for this purpose and to organize, in agreement with its Contracting Parties, such research and investigations as may appear necessary; (c) publish or otherwise disseminate the results of this work; and (d) provide scientific information and advice to Member Country governments and the regulatory commissions with which cooperative relationships have been established;

ICES is concerned with the Atlantic Ocean and its adjacent seas and primarily with the North Atlantic;

ICES seeks to establish and maintain working arrangements with other international organizations which have related objectives and cooperate, as far as possible, with them, in particular in the supply of scientific information requested;

The parties to this Memorandum of Understanding do hereby agree to work together in promoting integrated marine and coastal management and sustainable development as follows:

PART A

Objective

This Memorandum of Understanding is being entered into by the IOC and ICES to work together to, inter alia:

Prepare specific plans to intensify cooperation, to coordinate programmes, and to avoid unnecessary duplication in the study of the North Atlantic and its adjacent seas;

Develop a common approach to specific issues, for example, education, training and technology transfer for third parties, or joint workshops, symposia and conferences on key issues.

PART B

Roles and Responsibilities

IOC and ICES agree to the following, as appropriate and within available budgets:

Prepare specific plans for cooperation including the following actions in the study of the North Atlantic:

Intensify cooperation in the implementation of the Global Ocean Observing System (GOOS) including its Open Ocean and Coastal Modules;

Develop structured and increased cooperation in the field of data and information management, including development of marine information technologies;

Further develop studies on harmful algal blooms.

Develop a common approach to generic issues by:

Cooperating through working groups and task teams on education, training and technology transfer for third parties;

Organizing joint workshops, symposia, and conferences on key issues of interest to both organizations;

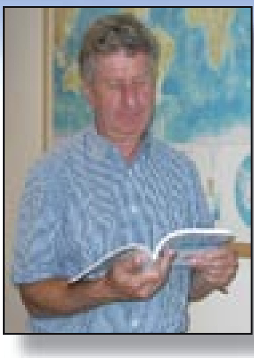
Facilitating mutual access to relevant Committees and Expert Groups and co-sponsor existing and new groups where appropriate;

Organizing joint policy discussions for officers of ICES and IOC on future developments of and key issues in marine science and on the consequent development of cooperation between the two organizations;

Intensifying and expanding networking between the main intergovernmental organizations active in marine science, in particular IOC, ICES, and PICES.

Include, as appropriate, the actions described above in the Programmes and/or Action Plans of the two organizations.

Regime Shifts, Marine Ecosystems and Indicators



DR ROGER HARRIS is a Marine Ecologist working at the Plymouth Marine Laboratory, UK. He has particular research interests in pelagic food-web dynamics. A past Chair of the Global Ocean Ecosystems Dynamics Programme (GLOBEC) Scientific Steering Committee and the International Council for the Exploration of the Sea (ICES) Working Group on Zooplankton Ecology, together with Dr John Steele he organized the IOC-sponsored workshop on Regime Shifts held in April 2003.

r.harris@pml.ac.uk

As a keynote speaker at the Thirty-seventh Session of the Executive Council last June, Dr Roger Harris came to Paris to brief the Commission on the latest advances in three research areas — marine ecosystems, regime shifts, and ecosystem indicators. In this article he examines regime shifts from a range of globally distributed marine ecosystems and discusses the ongoing IOC initiatives currently integrating research from several different international programmes aimed at understanding and managing long-term changes in marine ecosystems.

The Intergovernmental Oceanographic Commission (IOC) of UNESCO has recently supported research on marine ecosystems, regime shifts, and ecosystem indicators. Research on regime shifts in particular relates to ongoing IOC programmes and IOC might contribute further to our understanding of regime shifts in the future.

IOC together with the Scientific Committee on Oceanic Research (SCOR) and the International Geosphere-Biosphere Programme (IGBP) co-sponsors Global Ocean Ecosystem Dynamics (GLOBEC). This is a major international project with the aim: 'To advance our understanding of the structure and functioning of the global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change'. GLOBEC research has shown that the interconnections within ecosystems are complex. A challenge is to be able to identify key characteristics or indica-

Definitions

- **Ecosystem**: A system formed by the interaction of a community of organisms with their environment
- **Regime Shift**: A sudden shift in structure and functioning of a marine ecosystem, affecting one or several living components and resulting in an alternate steady, sustained ecosystem state
- **Indicator**: A variable, pointer or index. Its fluctuation reveals key elements of a system

Courtesy of NOAA

Pelagic communities in several parts of the world have repeatedly shifted between a sardine dominated and an anchovy dominated state … the fact that oscillations between the two states show a remarkable synchrony in different parts of the world suggests some external forcing.

tors enabling comparisons to be made spatially between ecosystems and temporally within a particular ecosystem.

Characteristics of regime shifts: examining the evidence

Ecosystems show considerable natural variability. This is illustrated by records of the fluctuations in abundance of Pacific sardines and anchovies reconstructed from fish scales deposited and preserved in anoxic sediments off the coast of California. The records over the past 1,700 years are characterized by abrupt recoveries and subsequent collapses and also the alternation of periods dominated by sardine and anchovy populations. These fluctuations occurred prior to any major influence by humans. More recently, fisheries records have been used to show that pelagic communities in several parts of the world have repeatedly shifted between a sardine dominated and an anchovy dominated state. Despite the dramatic nature of these shifts, the mechanisms responsible remain unclear. Fisheries may play a role, but the fact that oscillations between the two states show a remarkable synchrony in different parts of the world suggests some external forcing. Circulation-induced changes between a 'warm' and a 'cold' mode coincide with recent shifts. However, the relatively smooth changes in the physical environment do not explain the abrupt jumps between sardine and anchovy dominance.

The concept of 'regime shifts' to describe such changes is not new. It is implied in the early work of David Cushing (Cushing, 1982). However, the term did not gain widespread usage until more recently. In the development of the concept of regime shifts the plot in Figure 1 has achieved almost iconic status. Hare and Mantua (2000) analysed time series of large-scale climate and ecosystem change in the North Pacific. They assembled annual observations of 31 physical and 69 biological time series for 1965–1997 primarily for the North Pacific and Bering Sea regions. The biological data consisted of, for example, fish recruitment estimates, zooplankton biomass and regionally aggregated adult salmon catch. The physical records included hemispheric scale changes like those associated with the El Niño Southern Oscillation (ENSO) and also more local records such as annual discharge from major West Coast rivers.

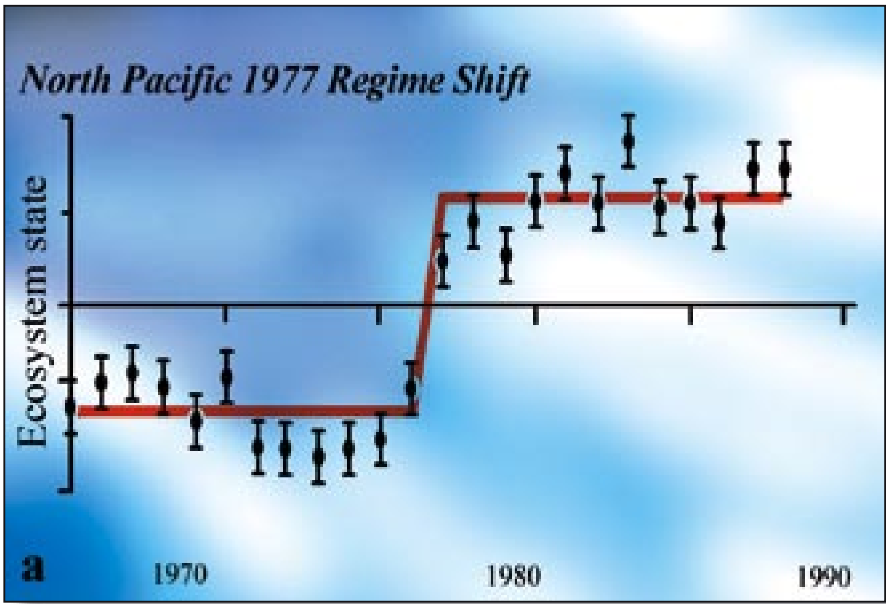


Fig.1. Change of state in the North Pacific Ecosystem as demonstrated by the combined effect of 100 biological and environmental variables (after Hare and Mantua, 2000).

Definitions of regime shifts

- 'A shift suggests an abrupt change in relation to the duration of a regime, from one characteristic behaviour to another' (Hare and Mantua, 2000)
- 'conspicuous jumps from one rather stable state to another' (Scheffer et al. 2001)
- 'a sudden shift in structure and functioning of a marine ecosystem, affecting several living components and resulting in an alternate steady state.' (Cury and Shannon, 2004)
- 'an abrupt change in a marine ecosystem and its abiotic environment from one stationary state to another.' (Wooster and Zhang, 2004)

The statistical approaches used have been discussed by others; however, following the signature 1976–77 regime shift in the North Pacific the term has been used commonly to describe such abrupt changes in the abundance of particular ecosystem components (often a commercially important fish species).

Subsequently, the term 'regime shift' has gained wider currency over the past ten years, leading to a variety of definitions of the concept (See box 'Definitions of regime shifts' at left.)

Such definitions together with increased research interest have led to the identification of suggested regime shifts in an increasing number of globally distributed marine ecosystems.

Reprinted with permission from *Nature* (http://www.nature.com/) Botsford L.W., Castilla J.C. and Petersen C.H., et al. 1997. The management of fisheries and marine ecosystems. *Nature*, Vol. 277, pp. 509-515.

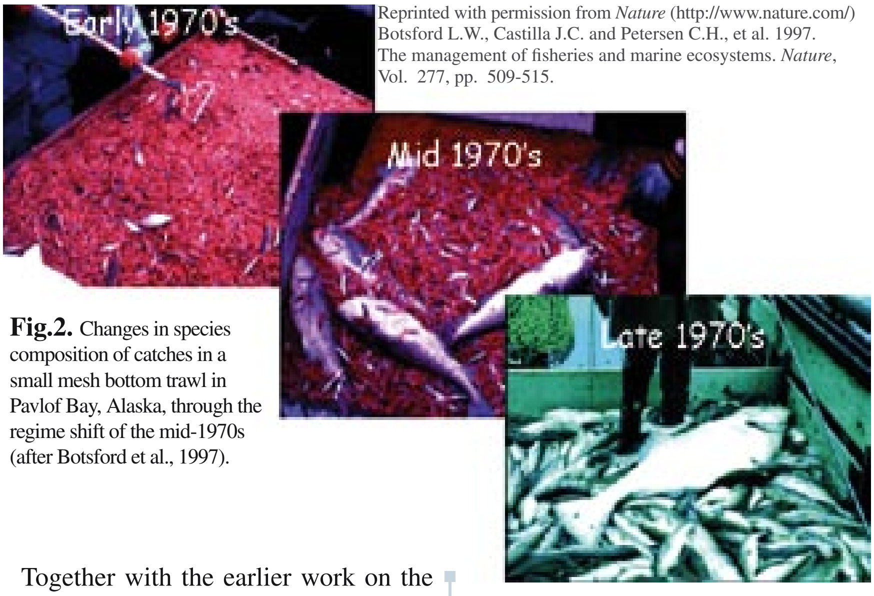


Fig.2. Changes in species composition of catches in a small mesh bottom trawl in Pavlof Bay, Alaska, through the regime shift of the mid-1970s (after Botsford et al., 1997).

Together with the earlier work on the alternation of anchovy and sardine populations, the North Pacific provides the most widely discussed examples of regime shifts. The consequences for bottom trawl catches during the 1970s off Alaska are dramatically illustrated in Figure 2. Despite profound implications for fisheries and other ecosystem components, the mechanism of such shifts is poorly understood. In view of the overriding importance of circulation for these ecosystems, it seems reasonable to expect changes in the oceanic circulation/weather pattern to be the primary drivers. However the shifts are sometimes reflected more consistently by the biological data than by the physical indices, suggesting that biotic feedbacks could be stabilizing a particular community state, while shifts to a different state are triggered by physical events.

Despite profound implications for fisheries and other ecosystem components, the mechanism of such shifts is poorly understood

Adjacent to the North Pacific, in the Bering Sea, alternation of warm and cold regimes together with the interplay between bottom up and top down control effects within the ecosystem has led to the so-called 'Oscillating Control Hypothesis' to explain the alternation of regimes within the Bering Sea fish populations. Similarly, in the Baltic Sea, the German GLOBEC programme has identified alternating regimes dominated by cod and sprat. A final example from research in the North Sea based on the results of the Continuous Plankton Recorder Survey has proposed a regime shift in the late 1980s evident at a number of trophic levels in the system.

Analysis of the characteristics of regime shifts indicates a number of common features. They are characteristically linked to large-scale regional climate forcing as indicated by links with the Pacific Decadal Oscillation or North Atlantic Oscillation, for example. There are some indications that they may be forced by fishing pressure. Characteristically the ecosystem effects have a spatial scale of 1,000 kilometres. The abrupt change between states within periods of five years and the persistence of a particular regime may last for decades.

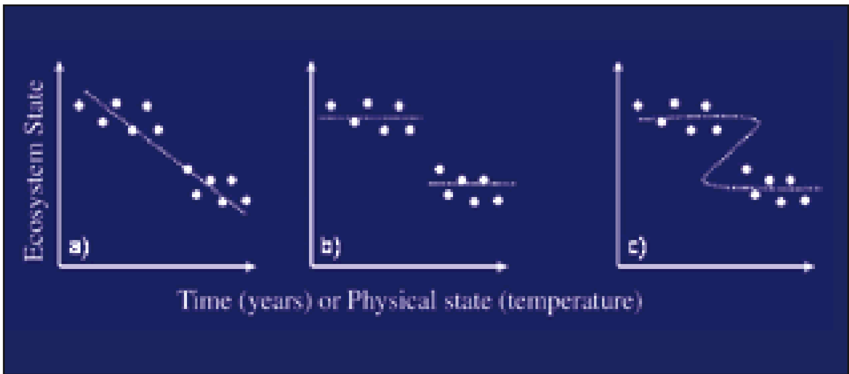


Fig.3. Different possible interpretations of a common data set: The dashed lines represent conceptual models of the data: (a) a linear evolution of declining overall abundance, (b) an abrupt but potentially reversible change in overall abundance, and (c) an abrupt change that is not directly reversible as the system exhibits non-functional response.

Reprinted from *Progress in Oceanography*, Vol. 60, deYoung et al, Detecting Regime Shifts in the Ocean: Data Considerations. pp. 143–164, Copyright 2004 with permission from Elsevier.

Many different types of change can take in ecosystem variables. The movement from one state to another can be linear and rather gradual, and may not represent any substantial change in ecosystem structure. The smooth and linear curve also suggests that the changes are reversible. The movement between states could also be rather abrupt in observation but still linear in that it is directly reversible, or could be fully non-linear, rather abrupt and non-reversible. There are, therefore, three possible interpretations of time series such as is illustrated in Figure 3. Figure 3 shows that although some dynamic systems respond smoothly to change in external conditions (panel a), others may change profoundly when conditions approach a critical level (panel b) or have more than one stable state over a range of conditions (panel c).

How are regime shifts relevant to the work of IOC? How does this research relate to ongoing IOC programmes? How might IOC contribute in the future?

Clearly, one very important aspect of the detection of regime shifts and associated changes in marine ecosystems is through sustained observation of the marine environment. Here the continued development of the Global Ocean Observing System (GOOS) will be important, particularly in relation to biological components of the system both in the coastal and open ocean. The long-term, basin-scale survey of the North Atlantic carried out by the Continuous Plankton Survey, itself supported by the IOC, is a good example of how sustained observation can be critical in advancing our understanding of long-term changes in marine ecosystems.

Understanding regime shifts is important for ecosystem management coming at a time when there is interest in developing an ecosystem-based approach. The Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem is the latest instrument emphasizing the need to manage whole ecosystems in the context of fisheries management. Much of the wording of the Reykjavik Declaration, with its emphasis on the structure and functioning of marine ecosystems, is almost identical to the goals of GLOBEC, the IOC co-sponsored programme mentioned earlier. As GLOBEC is showing, to study whole ecosystems both in terms of their structure and function is a major undertaking. A lot of work remains to be done to support the ecosystem-based approach.

There is increased international interest in managing marine living resources in a sustainable way, protecting rare or fragile ecosystems, habitats and species, and the conservation of biodiversity. Faced with the complexity of marine ecosystems there has been a desire to develop indicators which can be used to summarize ecosystem status particularly in relation to exploitation of marine resources. IOC has also had a major role in developing the indicator concept. It co-sponsored the SCOR Working Group 119 on 'Quantitative Ecosystem Indicators for Fisheries Management'. The work of Working Group 119 culminated in a major meeting held at IOC in Paris in early 2004. The strong participation and the variety and quality of presentations showed that this is a very active area of research.

In the previous year IOC also co-sponsored a Workshop held in Villefranche-sur-Mer in France with the title, 'Regime Shifts in the Ocean: Reconciling Observations and Theory'. This Workshop brought together the leading experts in the field under the leadership of John Steele. The proceedings have been published as a Special Issue of Progress in Oceanography (Figure 4) and provide an authoritative state of the art. The Villefranche Workshop was held in honour of Dr George Grice who himself contributed much to the work of IOC (Figure 5). George Grice, a member of the IOC Secretariat, passed away in 2001. The Special Issue is dedicated to his memory.

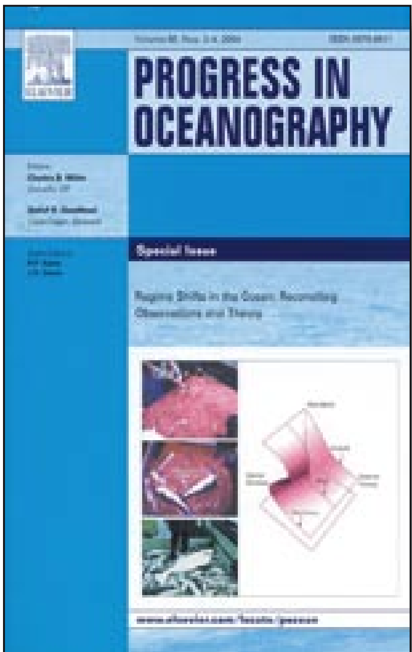


Fig.4. Outcome of the IOC co-sponsored Workshop held in Villefranche-sur-Mer in April 2003: Special Issue of *Progress in Oceanography*, Vol. 60, on 'Regime Shifts in the Ocean: Reconciling Observations and Theory' R.P. Harris and J.H. Steele (eds).

Fig.5. George Grice, member of the IOC Secretariat, who passed away in 2001. The Villefranche Special Issue is dedicated to his memory.

Some of the major outcomes of the Villefranche Workshop can be summarized as:

- Observations and modelling should be closely linked. Combining observations in the ocean with mathematical models with switches between equilibrium conditions has developed the concept of regime shifts.
- This has led to a revision of our view of how marine ecosystems respond to external forcing. Systems can naturally occupy alternative configurations as the exter-

nal world changes. A major future challenge is to understand how such systems respond to anthropogenic forcing (climate, fisheries, eutrophication).

- Evidence for bistable modes in marine ecosystems remains uncertain and mechanisms remain unclear. The evidence for bistable modes induced by overfishing is still circumstantial. However, there are potentially severe management implications of ecosystems with alternative stable states. A precautionary approach should take into account of regime shifts in marine ecosystems.

The conclusion from the Villefranche meeting was that there are exciting and pressing research challenges for the future if we are to understand regime shifts in marine ecosystems and their implications for human society.

When IOC was formed in 1960 it was with the recognition that such challenges could only be addressed by an international collaborative approach to put together a fully global picture:

> 'In order to properly interpret the full value of the oceans to mankind, they must be studied from many points of view. While pioneering research and new ideas usually come from individuals and small groups, many aspects of oceanic investigations present far too formidable a task to be undertaken by any one nation or even a few nations.'

The IOC projects GLOBEC and GOOS, together with specific activities such as Working Group 119 and the Villefranche Workshop, demonstrate how fruitful such an approach can be. These solid foundations will provide a strong basis for future research initiatives on regime shifts and marine ecosystems.

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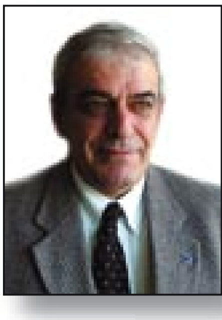
IOC Programme Sections

Photo by Andrea Rasetti



ocean science

Programmes Overview

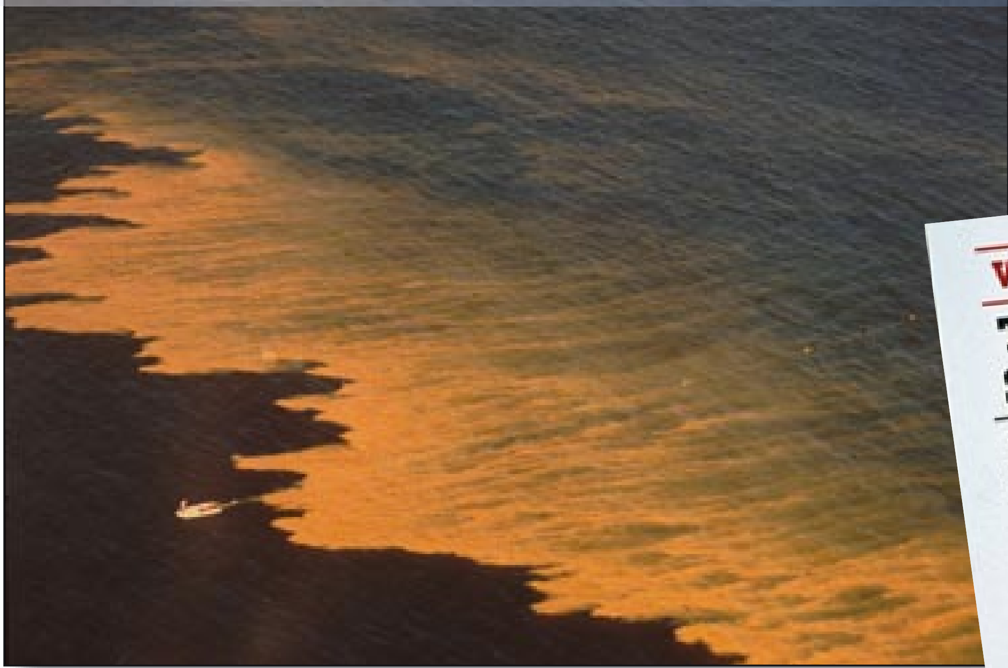
By Umit Unluata, Head of Section

Two major symposia marked the Ocean Science activities in 2004. The Symposium on 'Quantitative Ecosystem Indicators for Fisheries Management' held in April was the culmination of the work carried out by the IOC/Scientific Committee on Oceanic Research (SCOR) Joint Working Group 119 since 2001 (detailed further on in this overview). The International Ocean Carbon Coordination Project (IOCCP) Symposium held in May addressed the biological and biogeochemical consequences of increasing atmospheric and oceanic CO_2 levels, and possible strategies for mitigating atmospheric increases. Dr Maria Hood discusses the various aspects and results of this rather important Symposium in a separate article in this section. Following her article, Julian Barbière discusses the important Integrated Coastal Area Management (ICAM) Programme activity concerned with the development and implementation of socio-economic indicators for the management of coastal areas.

Some selected highlights of the Ocean Science Programmes' activities and results obtained include:

The Harmful Algal Blooms (HABs) Programme continued its activities in 2004 for the systematic enhancement of research and management capacity of harmful algae in Member States, including testing of innovative web-based learning tools. Individual training and study opportunities were provided to over fifty individuals in North Africa and South-east Asia and the Second Edition of *Manual on Harmful Marine Microalgae*, which provides guidelines on modern methods of sampling, identification, culturing, toxin analysis, monitoring and management of harmful marine microalgae, was published in 2004. The Programme collaborated with the International Atomic Energy Agency (IAEA) in efforts to develop and validate an alternative method to the Association of Official Analytical Chemists (AOAC) mouse bioassay for algal toxins. Cooperation was established and formalized with the North Pacific Marine Science Organization (PICES) in the effort to expand the coverage of the IOC–International Council for the Exploration of the Sea (ICES) database on harmful algal events, HAE-DAT. A joint expert consultation was established in 2004 with the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) to review the Codex Alimentarius Code of Practice for Marine Biotoxins. Based on the review the Codex Committee on Fish and Fisheries Products will revise the Code in early 2005. This will impact all national legislation on marine biotoxins and seafood safety.

Regarding IOC's work on Indicators as Assessment Tools, the IOC–SCOR Working Group Symposium on 'Quantitative Ecosystem Indicators for Fisheries Management', held at UNESCO in April 2004, was attended by 250 participants from forty-three countries. The Working Group was co-chaired by Dr Philippe Cury, France, and Dr Villy Christensen, Canada.



California *Noctiluca* Bloom
Photo courtesy of Peter Franks, Scripps Institution of Oceanography

Photo courtesy of NOAA

Fisheries are deeply embedded within ecosystems, which are now rightly viewed as an integrative level for fisheries management. The effects of fishing on marine ecosystems have been widely recognized, as has the need to move toward an ecosystem approach to fisheries (EAF). Such an evolution is being sought by society for all exploited natural resources. Fisheries are no exception.

To meet this new challenge, a new strategy is needed that will elaborate operational frameworks. This will require the development of quantitative indicators at the ecosystem level, and the definition of innovative reference points to provide bridges between scientific results, society's needs, and an effective EAF.

The overall objective of the Joint Working Group has been the establishment of the theoretical basis for evaluating changes in marine ecosystems (both states and processes) from environmental, ecological and fisheries perspectives. The tasks of the Working Group have been to define generic indicators that can be used in relation to the health of ocean ecosystems, fisheries or for an assemblage of exploited fish populations; to formulate these indicators in mathematical or statistical terms; to assess when values of an indicator are meaningful both statistically and/or ecologically; and to apply these indicators to specific data sets or using specific multispecies models (such as MSVPA, Ecopath, Ecosim, Ecospace, Osmose) in order to evaluate their usefulness.

The IOC–SCOR Symposium was planned to support scientific aspects of using indicators for an EAF, and aimed at reviewing existing indicators, as well as to develop new indicators reflecting the exploitation and state of marine ecosystems. The Symposium also aimed at evaluating the utility of indicators relative to specific objectives.

The papers presented at the Symposium will be published in a special volume of the ICES *Journal of Marine Science*.

Photo by Andrea Rasetti

Fishing is the most important activity along the coast of Mozambique, which is frequently ravaged by cyclones and flooding.

Several peer-reviewed journal articles emanating from the earlier work of the IOC–Global Ocean Ecosystems Dynamics Programme (GLOBEC) Study Group on the Use of Environmental Indices in Management of Pelagic Fish Populations were published in 2004. A common database (of upwelling indices, sea surface temperature and recruitment estimates linking environment and fisheries) has been developed.

The results of the workshop on Regime Shifts (in fish and other ocean ecosystems) were published in March 2004 in a special issue of the journal *Progress in Oceanography*. This is a major contribution by IOC to a scientific issue with serious implications in fisheries management.

The *ad hoc* group called 'Indicators for Health of Benthic Communities' developed a database on benthic communities and pollution levels in five different regions. The group's work on sedimentary pollution versus species richness has been published in *Marine Ecology Progress Series*.

The Global Environment Facility–World Bank (GEF–WB)

Coral Reef Targeted Research and Capacity Building project (US$23 million), which includes the IOC Group of Indicators for Coral Bleaching, was approved, with IOC and the University of Queensland, Australia being designated as the executing agencies.

Regarding assessments, the Department for International Development (DFID)/IOC Global Coral Reef Monitoring Network (GCRMN) South Asia activity came to an end with the publication of three monographs on reefs and livelihoods, which were publicized on the IOC website. A GCRMN report, *Status of Coral Reefs of the World: 2004* has been published and widely publicized to stakeholders. The Report indicates a myriad of problems concerning the reefs and suggests remedies.

Global NEWS (Global Nutrient Export from Watersheds) Group's work on the estimation of current and plausible future patterns of nutrient export to coastal ecosystems has begun. The group's work was successful in securing a GEF medium-size (US$230,000) project for training and raising public awareness. This project is a part of larger GEF Project (US$1 million), which also addresses an ecosystem approach to fisheries management, for which IOC is the executing agency.

An IOC–SCOR Working Group was formed in 2003 on the topic of developing basin and global scale models of marine ecosystems and involved the integration of research results from several different global programmes including GLOBEC, the Joint Global Ocean Flux Study (JGOFS) and the World Ocean Circulation Experiment (WOCE). The Group published its results in *Science* in June 2004, which was disseminated at the Thirty-seventh Executive Council.

In IOC Programmes, geosphere-biosphere coupling processes in relation to the protection of the marine environment of the high seas is addressed through the Training-through-Research Programme. In 2003–2004, this programme published nearly thirty papers in refereed journals (listed at IOC Reports and website) and in 2004 was successful in securing funds from the Belgian Government (US$250,000) and the EU project 'Hermes' (US$100,000).

In addition to its work on indicators, ICAM Programme's joint IOC/International Hydrological Programme (IHP)/IAEA Project on Submarine Groundwater Discharge (SGD) in the Coastal Zone published a Guide on SGD in 2004. More than twenty scientific papers have been published in various journals including: *Continental Shelf Research Journal; Biogeosciences; EOS; Biogeochemistry; Hydrological Processes; Journal of the Total Environment*; and the *Journal of Environmental Radioactivity*.

Bleached coral can often take on bright attractive colours due to the coral pigments that are left behind. In this photo, pink coral pigments dominate the otherwise white tissues.

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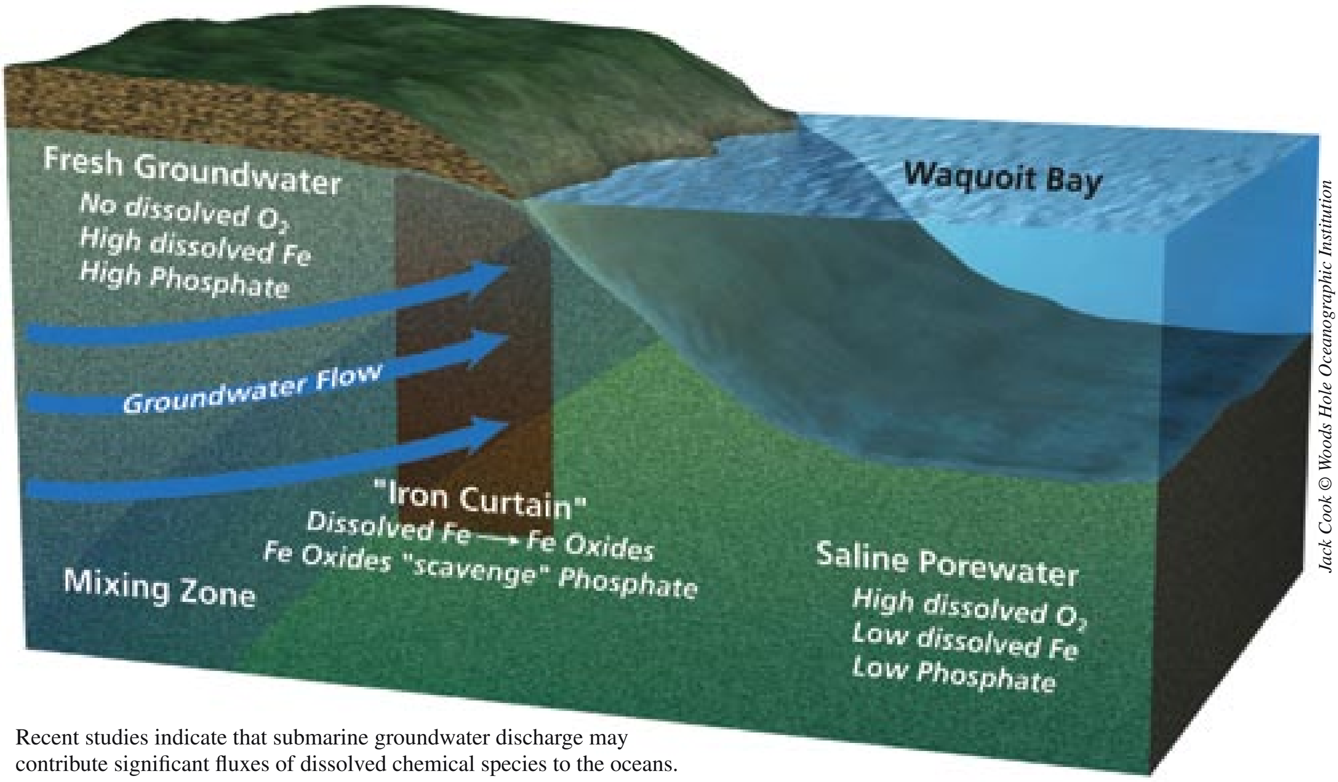

Recent studies indicate that submarine groundwater discharge may contribute significant fluxes of dissolved chemical species to the oceans.

As a follow-up to the Pan-African Conference on Sustainable Integrated Management (PACSICOM) and the African Process, IOC has led the development of a project proposal on climate change adaptation in coastal zones and shoreline change management through ICAM in West Africa. This project has been endorsed by the New Partnership for Africa's Development (NEPAD) Partnership Conference on Environment as a direct contribution to the NEPAD Environment Action Plan. The project has been accepted to pipeline entry as a PDF-B project and will be funded up to US$1 million. IOC will be the executing agency of this project, which is expected to start in March 2005.

In a drive to improve the delivery of useful ocean data products and services for the coastal management community at the national and regional level, ICAM has taken a major part in the development of the ODINAFRICA-III project, which was approved by the Government of Flanders (Belgium) in 2003. ICAM is organizing national consultations in the participating countries to identify stakeholder needs, as well as the development of targeted products, including training for the Coastal Geographic Information System (GIS), development of State of the Coast reports, vulnerability mapping activities, etc.

Selected Publication Highlights from IOC's Ocean Science Programmes

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IOC Ocean Carbon in the World's News Media:

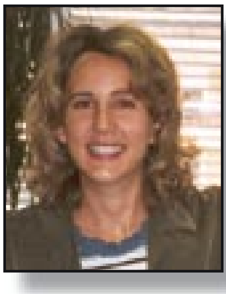
Carbon Dioxide Extends Its Harmful Reach to Oceans. *New York Times*, 20 July 2004;

Probe into Rising Ocean Acidity. BBC News, 17 August 2004;

Acid Test for the Marine Web of Life. *Financial Times*, 24 September 2004.

Deployment of a mooring array. This array was extended over 1,850 kilometres between Oman and India in the Indian Ocean to observe and assess sediment accumulation.

The Oceans in a High CO_2 World[1]



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The oceans provide us with a valuable service by absorbing half of the carbon dioxide (CO_2) emitted by the burning of fossil fuels, thereby reducing the impact of this greenhouse gas on climate. A symposium held by the Intergovernmental Oceanographic Commission (IOC) of UNESCO last May[2] has concluded, however, that we may soon pay a very high price for this service. When over one hundred of the world's leading ocean carbon scientists from different branches of marine biology and chemistry pieced together some of the best scientific information available, the results suggest that the acidity of the ocean is increasing – an effect that could seriously harm corals and other calcifying organisms, such as shellfish and some phytoplankton, the base of the marine food chain. These changes may also alter the ocean's ability to absorb fossil fuel CO_2 in ways that are not yet fully understood. The May meeting went on to fix urgent research priorities to investigate the possible consequences of an acidifying ocean on marine ecosystems, and to assess the safety of proposed geo-engineering strategies to mitigate the impact on climate by storing excess CO_2 in the deep ocean.

Oceans absorb millions of tonnes of fossil fuel carbon dioxide emissions from the atmosphere every day. The resulting rise in acidification of seawater, combined with globally warming temperatures, could have severe effects on marine ecosystems. The IOC is bringing together the world's leading experts from different branches of marine biology and chemistry to synthesize and assess our current understanding of these potential effects, and to evaluate the potential benefits and impacts of proposals to use the ocean to purposefully store excess atmospheric CO_2 in an attempt to stabilize atmospheric concentrations and diminish its future impact on climate.

For further information:
http://ioc.unesco.org/iocweb/co2panel/

The Good News – Missing Carbon Found

Of the fossil fuel CO_2 emitted globally, only half has accumulated in the atmosphere. The fate of the other half has prompted a decades-long search for the 'missing carbon sink'. The two possible sinks for this CO_2 are the terrestrial biosphere (e.g. via photosynthesis) and the ocean. The ocean represents the largest natural stockpile of carbon and has a dynamic interaction with the atmosphere over 70 per cent of the planet's surface. The only direct method for calculating the amount of CO_2 absorbed by the ocean is through direct measurements on a global scale. From 1990 to 1998, a multinational research programme called the 'World Ocean Circulation Experiment/ Joint Global Ocean Flux Study' amassed data from nearly 10,000 stations around the world's oceans from ninety-five separate expeditions and produced the first global survey of carbon distribution in the ocean.

Recent results from the global survey have resolved the mystery of the missing carbon sink: the data show that the oceans have taken up approximately 118 billion tons of the CO_2 emitted since 1800, roughly 48 per cent of the total; currently, some 20–25 million tons of CO_2 are being added to the oceans daily, calculates the study, published in *Science* in July[3].

1. Abridged from an article originally published in *A World of Science*. October–December 2004, Vol. 2, No. 4, pp. 2–5. Special thanks to Susan Schneegans and Yvonne Mehl for their assistance with images from the article
2. The Ocean in a High CO_2 World. International science symposium sponsored by the Scientific Committee on Oceanic Research (SCOR) and the IOC of UNESCO. Read the report of the symposium and the IOC Watching Brief at http://ioc.unesco.org/iocweb/co2panel/

Without the ocean sink, atmospheric CO_2 would be much higher and its climate impacts more severe[4]. But scientists are now faced with a new question, 'Will the oceans continue to take up almost half of the CO_2 emitted to the atmosphere, even in a warmer climate with changed ocean mixing patterns?' A second global survey and several international research programmes were launched in 2003 to address these questions.

The Bad News – New Pollutant Found

A second and perhaps more pressing question is, 'How are these higher levels of ocean CO_2 going to affect ocean ecosystems?' Today, there is growing concern that this natural service provided by the oceans may have a steep ecological cost – the acidification of the oceans.

As CO_2 dissolves in seawater, the pH of the water decreases, making it more acidic. Since the beginning of the industrial revolution, the pH has dropped globally by 0.12 pH units[5] . While these pH levels are not particularly alarming, the rate of change and the downward trend is cause for concern. To the best of our knowledge, the oceans have never experienced such a rapid acidification. By the end of this century, if concentrations in the atmosphere continue to rise exponentially, we may expect to see changes in pH that are 3 times greater and 100 times faster than those experienced during the transitions from glacial to interglacial periods. Such large changes in ocean pH have probably not been experienced on the planet for the past 21 million years.

3. Sabine et al. 2004. The Oceanic Sink for Anthropogenic CO_2. *Science*, Vol. 305, pp. 367-371.
4. The cost of avoiding CO_2 emissions is currently US$40–60 per ton of CO_2 (International Energy Agency Greenhouse Gas Research and Development Programme). By absorbing 118 billion tons of fossil fuel since the beginning of the industrial revolution, the ocean has provided a natural ecosystem service of the order of US$6 trillion.
5. The lower the pH, the more acidic the solution. Natural seawater has a range of 7.7–8.2 pH units.

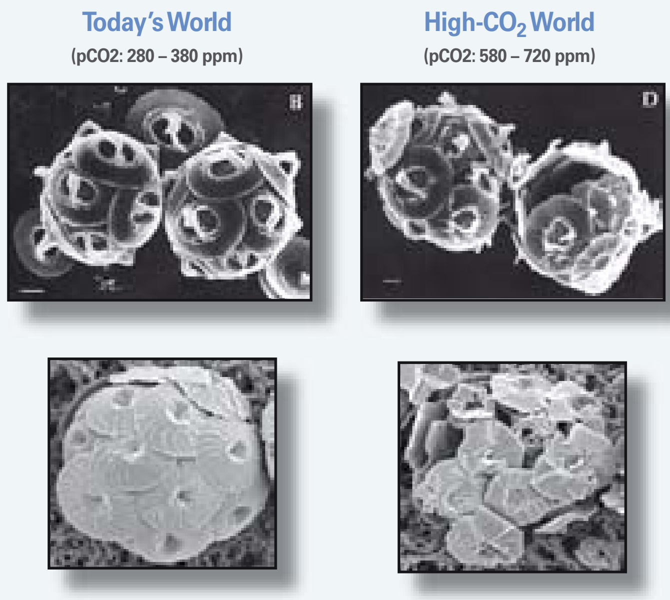

Figure 1. Scanning electron microscopy photographs of two calcifying phytoplankton under pCO_2 conditions of today (pCO2 from 280 – 380 parts per million) and under the High-CO_2 conditions expected by the end of this century. Experimental results show that increased CO_2 concentrations lead to malformations of calcium carbonate shells.

Photos courtesy of Professor Ulf Riebesell, Leibniz-Institut für Meereswissen-schaften, IFM-GEOMAR. Adapted and reprinted with permission of *Nature* (www.nature.com), Riebesell et al., "Reduced calcification of marine phytoplankton in response to increased atmospheric CO_2", 407, 364 to 367, 2000

Marine ecosystems under threat

Corals, calcareous phytoplankton, mussels, snails, sea urchins and other marine organisms use calcium carbonate ($CaCO_3$) in seawater to construct their shells or skeletons. As the pH decreases, such as when water is more acidic, it becomes more difficult for organisms to secrete $CaCO_3$ to form their skeletal material. It is this effect that has marine scientists concerned: since the oceans have never experienced such a rapid acidification, it is not clear how ocean chemistry will change or how ecosystems will adapt.

From experiments conducted to date, almost all calcifying organisms have shown decreased calcification in more acidic environments. This is true for

Photo courtesy of NOAA

Figure 2. Increasing CO_2 and sea temperatures can rapidly change coral reefs from healthy ecosystems (left) to virtual graveyards (right).
Photos courtesy of Dr Ove Hoegh-Guldberg, Centre for Marine Studies, University of Queensland, Australia

both the smallest single-celled organisms and for reef-building corals. Under such conditions, calcareous phytoplankton, which constitute part of the basis of the marine food chain, will form thinner skeletons and thus experience difficulties in growth and reproduction. This in turn may have profound effects on the marine food web, causing shifts in fish population size or geographic location.

Coral reefs face two challenges from increasing atmospheric CO_2. Firstly, higher CO_2 concentrations in the atmosphere are linked to warmer global temperatures, which in turn lead to warmer water temperatures. Corals are very sensitive to temperature change: a 1 ºC to 2 ºC change in local temperature above their normal summer maximum can lead to a phenomenon called 'bleaching', whereby the corals expel their vital algal symbionts (algae which live in symbiosis with the coral), leaving the coral tissues translucent. In 1998, a single bleaching event led to the loss of almost 20 per cent of the world's living coral. Corals can recover from these events but repeated episodes are likely to weaken the coral ecosystem, making them more susceptible to disease and causing a loss of biodiversity. The second challenge faced by corals is the increasing acidity of the water caused by increased CO_2 concentrations. Lowered calcification rates affect the reef's ability to grow its carbonate skeleton, leading to slower growth of the reef and a more fragile structural support, which makes the reef more susceptible to erosion. By the middle of this century, the estimated reduction in calcification rates may lead to a situation where we are losing more reef area to erosion than can be rebuilt through new calcification.

Higher marine life forms, such as invertebrates and even some fish, may be affected by lower pH environments through acidosis (an increase in carbonic acid in body fluids) leading to lowered resistance, metabolic depression, behavioural depression affecting physical activity and reproduction, and asphyxiation.

While these projections of our future oceans may seem like doomsday scenarios, we will probably never see dramatic, rapid changes. Instead, there will be slow, progressive shifts in the equilibrium conditions of marine ecosystems over many decades. Scientists at the UNESCO symposium established a set of urgent research priorities and will be watching for indications that these ecosystem changes are occurring.

Mitigating the impacts?

Many scientists believe that stabilizing atmospheric CO_2 concentration at 550 ppm (parts per million) may avoid the worst impacts on climate. Atmospheric concentration of CO_2 is currently ~380 ppm and, if no precautionary action is taken, is expected to reach 550 ppm by the middle of this century. Stabilization at 550 ppm will be a global challenge on an unprecedented scale. According to the Intergovernmental Panel on Climate Change (IPCC), the most authoritative source for scientific assessments of climate change, this may not be achieved through emissions reductions alone but rather through a carefully crafted portfolio of actions that also includes investments to develop low-cost, low-carbon or no-carbon energy sources, improvements in energy efficiency and carbon management options. These include storing carbon in the terrestrial biosphere (e.g. planting trees, limiting deforestation), or capturing the CO_2 emitted from an industrial source and storing it in geological formations or in the deep ocean. The IPCC is currently assessing these options for their feasibility, efficacy, and safety, and calling for more research wherever information is insufficient to make a sound policy decision.

Scientists participating in the UNESCO symposium were asked to examine the issue of the potential efficiency and ecological impacts of using the ocean to purposefully store atmospheric CO_2. Much relevant research has been conducted in the past decade but the potential effectiveness and risks of ocean carbon sequestration have not been thoroughly discussed or assessed.

Moreover, the science itself has become trapped in a tug of war between environmental groups and commercial entrepreneurs seeking financial compensation for artificially sequestering carbon in the ocean. Frustrated scientists have asked the IOC to provide a safe-haven for scientific discussions, free from the influences of outside interests.

Storage strategies and research requirements

Debate centres on two methods of using the ocean to store excess CO_2. One strategy is to artificially induce and enhance the growth of carbon-fixing plants in the surface ocean. When these organisms die, they sink to the deep ocean, carrying the carbon with them. In many regions of the ocean, phytoplankton growth is limited by lack of an essential micronutrient, iron. Over the past decade, eight small-scale experiments have shown that introducing iron to iron-poor regions can stimulate phytoplankton growth to 20–30 times the natural rate.

Frustrated scientists have asked the IOC to provide a safe-haven for scientific discussions, free from the influences of outside interests.

Symposium participants agreed that iron fertilization experiments have been, and will continue to be, important in understanding the links between marine ecosystems and the global carbon cycle. However, all available research indicates that iron fertilization would be a very inefficient method for sequestering atmospheric CO_2, both from the viewpoint of the limited amount of carbon that could be sequestered by this method and the likelihood that, even if iron limitations were eliminated, other nutrients and environmental factors would eventually limit growth.

Another method of ocean carbon sequestration is to capture CO_2 from industrial sources, compress it into a liquid and store it in natural reservoirs out of contact with the atmosphere, such as deep geological formations or the deep ocean. Many important questions remain about the efficiency and impacts of injecting liquid CO_2 into the deep ocean and experimental data are extremely limited. The efficiency of this method would depend on the location and depth of the injection, since the goal is to keep the injected CO_2 out of contact with the atmosphere for as long as possible, while minimizing environmental damage around the area of the injection. Reproducing the temperature, pressure, and the biological communities found in the deep ocean in a laboratory is extremely difficult. Carrying out small-scale experiments *in situ* in the deep ocean is also no simple matter, often requiring the use of deep-sea remotely operated vehicles or special instruments that must be lowered to great depths from a research vessel.

Moreover, several attempts to perform experiments *in situ* have been blocked by environmental groups over concerns that these experiments represent the first step towards industrial-scale dumping. This has been a very divisive issue within the scientific community itself, with many strongly opposed to ocean carbon sequestration, even to the extent of suggesting that the community should not pursue research on the subject.

Unfortunately, because of the ocean's large natural capacity to store CO_2, ocean carbon sequestration will continue to interest commercial companies, some of whom may attempt to promote this technique without regard for potential environmental impacts. Symposium participants agreed that, even in the face of strong ethical opposition, investigations into the technical and economic feasibility of implementing this mitigation strategy are likely to continue. The international scientific community must be ready to respond accurately and without bias to questions of potential environmental impacts, long-term efficiency or benefits of this technique, considering it in the balance of other options and the critical need to stabilize atmospheric CO_2 at a concentration that will avoid the majority of impacts on human life and welfare.

IOC - Keeping Watch

The ultimate objective of the United Nations Framework Convention on Climate Change is 'to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.' Whereas 'dangerous anthropogenic interference with climate' has been widely discussed, no such debate has taken place over acceptable oceanic CO_2 levels. As a result, there are no standards to apply to judge what oceanic CO_2 levels should be considered tolerable for marine life or how proposed carbon management strategies might moderate or exacerbate effects on ocean chemistry and biology. The IOC will maintain its Watching Brief on ocean carbon sequestration science and will continue to bring together the international and intergovernmental scientific community to develop unbiased policy-relevant scientific information for use by scientists, policy-makers and the general public.

International Project

on the Development and Application of Indicators for Integrated Coastal and Ocean Management

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ICAM assists IOC Member States in developing holistic management policies to address the economic, environmental and social pressures that converge in the world's coastal areas. In order to ensure the environmental health of coastal ecosystems while obtaining benefits from coastal development, a new IOC–Pilot Project has been developed to promote a more outcome-oriented approach to the selection and application of indicators. The project will measure the progress and effectiveness of the numerous longstanding ICAM efforts undertaken all over the world.

For further information:
http://ioc.unesco.org/icam

Rationale

Following the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil in 1992, Integrated Coastal Area Management (ICAM) has known an impressive growth in both developed and developing countries. In 1993, 75 countries, semi-sovereign states, and international organizations were engaged in 217 ICAM efforts at the national, subnational, and international levels. In 2002, 145 countries, semi-sovereign states, and international organizations had initiated 698 ICAM initiatives at the same levels. These efforts greatly differ in the type and scope, time span and financial resources committed, as well as in the actual level of implementation. Nevertheless, there is clear indication that nearly all coastal states and their respective subnational authorities, as well as international organizations, have undertaken ICAM initiatives that include coastal management programmes and projects, new legislation targeting coastal issues, and new institutions vested with authority over coastal zones.

Over thirty years of practical experience in ICAM and the formulation of a number of guidelines for ICAM by international organizations have allowed a series of good practices of broad application for ICAM to elaborate and establish itself as a model approach for the planning and management of coastal areas. Yet in spite of these advancements, the conditions of coastal areas are deteriorating all over the world: pollution from land-based sources still represents 75–80 per cent of total marine pollution, with 90 per cent of urban wastes and 70 per cent of industrial wastes discharged into the sea without treatment in developing countries; over-exploitation of fishery resources in the coastal zone and on the continental shelf does not come to a halt, with three-quarters of fish stocks in need of urgent management measures; and proper land use in coastal areas and use of environmental impact assessments are not yet routinely implemented with consequent continuing loss of coastal habitats and biodiversity to human uses.

The apparent failure of ICAM in many efforts worldwide in ensuring the environmental health of coastal ecosystems while obtaining benefits from coastal development makes the development and monitoring of appropriate indicators a necessity to track implementation of ICAM both in terms of process and outcomes. The international guidelines for ICAM and the scientific and technical literature recommend the use of indicators to appraise the effectiveness of the numerous and longstanding ICAM efforts undertaken all over the world at all geographical scales. With almost 700 ICAM initiatives recorded during the 1990s, it is impera-

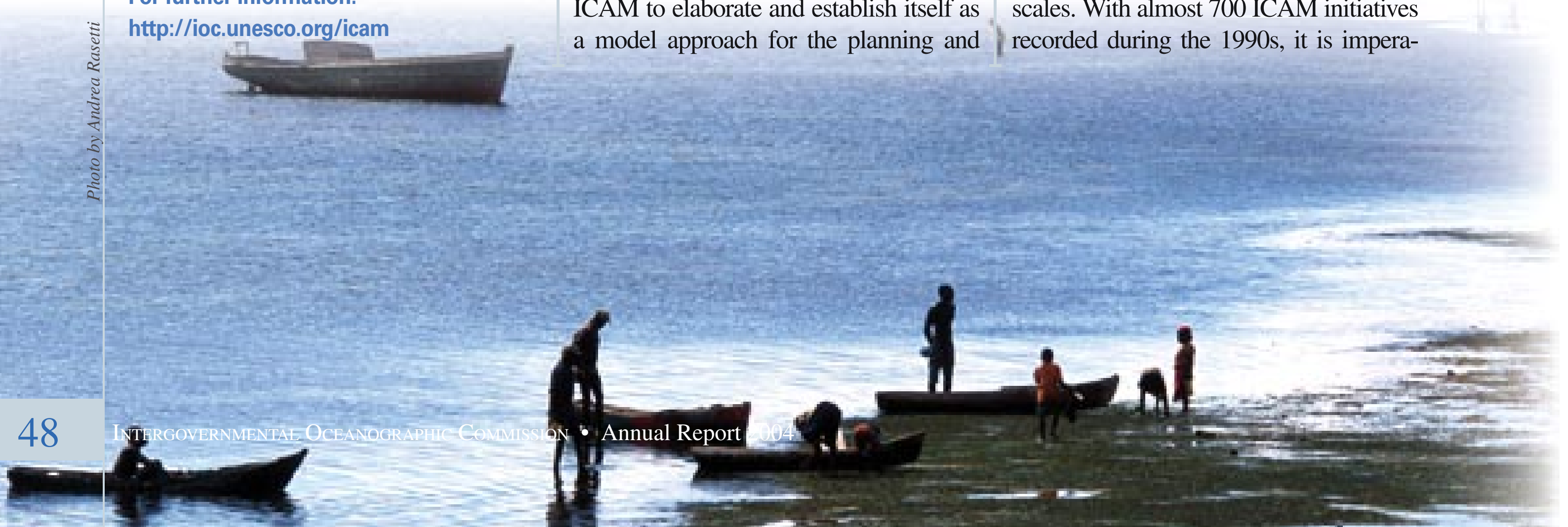


Photo by Andrea Rasetti

tive to develop and test measurements that can demonstrate 'success' in the recovery and sustained health of coastal resources as well as in the improvement of socioeconomic conditions of coastal communities.

The achievement of ICAM objectives will require the development and use of indicators to monitor and demonstrate progress and results on a comparable basis across countries, regions, and project portfolios. Whilst environmental indicators applicable to the coastal zone have typically been developed, examples of indicators that describe socioeconomic costs and benefits in coastal zones are rare, particularly at the national level.

While efforts have been made to monitor ICAM progress at the global, regional, national, and programme level, the use of governance performance indicators is still in its beginning stages. Difficulties are most apparent in tying ICAM efforts to on-the-ground outcomes and the attribution of effects to ICAM programmes remains an open issue.

In response to the above, a Pilot Programme was established in 2003 under the auspice of the Intergovernmental Oceanographic Commission (IOC) of UNESCO, and in collaboration with the Department of Fisheries and Oceans (Canada), the U.S. National Oceanic and Atmospheric Administration (NOAA), and the Center for Marine Policy (University of Delaware, USA) to promote the development and use of ICAM indicators. The IOC–Pilot Project intends to promote a more outcome-oriented approach to the selection and application of indicators to measure the progress and effectiveness of ICAM interventions.

Programme outputs

The main programme output will be the development of a **Handbook for Assessing and Reporting on the Progress and Outcomes of Integrated Coastal Area Management**, by an international group of leading experts in ICAM.

The Handbook will provide a tool for developing, selecting, and applying indicators to measure, evaluate, and report on the progress and outcomes of integrated coastal and ocean management initiatives. The Handbook is intended as a method and a series of guidelines that could assist different types of 'clients': coastal managers and decision-makers at the national and subnational levels in the design, implementation, and assessment of ICAM initiatives, practitioners and experts engaged in evaluation research, and donor agencies supporting coastal and marine management projects and programmes. The Handbook in preparation contains suggestions on how to prioritize ICAM issues, define measurable objectives for ICAM programmes and projects, and identify meaningful indicators to monitor the implementation and results of such programmes and projects.

The structure of the Handbook is built around three main types of indicators – environmental, socioeconomic, and governance performance – and includes an introduction to ICAM, suggestions on how to optimize relationships among these dimensions, and elements for further research on indicators. In order to validate and receive feedbacks from potential users, the Handbook will be tested in existing ICAM programmes and projects around the world. As a result, the Handbook should be used in conjunction with the companion collection of case studies, providing examples of development and application of indicators through validation and testing of the approach. The Handbook is expected to be published in 2005.

Other products

The Handbook intends to be useful to different kinds of users and is conceived as part of an IOC toolkit on ICAM indicators that includes:

(a) The *Reference Guide on the Use of Indicators for Integrated Coastal Management*, already published in 2003 as IOC Manual and Guide 45;

Photo by Andrea Rasetti

(b) A special issue of the Journal *Ocean & Coastal Management*, Volume 46, Issue 3-4 on The Role of Indicators in Integrated Coastal Management, in 2003;
(c) A Handbook companion volume of case studies in development and application of indicators for ICAM (to be prepared as the testing and refinement component of the exercise);
(d) A regularly updated website with results from the project, publications, a clearinghouse of projects, and links (www.globaloceans.org);
(e) A possible pilot decision-support tool in the form of the 'dashboard of sustainability' developed by the Joint Research Centre of the European Commission, derived from one of the case studies; and
(f) A training module to be delivered on site (e.g. through IOC regional offices) and online at the request of countries, to be developed in 2005.

The indicator project can be conceived as an open-ended initiative, susceptible to broad participation also through interfacing with global and regional observation and monitoring programmes and to initiatives of regional or more sectoral scope (e.g. marine protected areas, coastal tourism, or integrated coastal area and river basin management). In this regard, the opportunity to ensure wider dissemination of the products through different languages will be considered.

operational observing systems Overview

By Keith Alverson, Head of Section

> **'Today, in a time of concern over the possibility of potentially disastrous changes in climate, the Nation or Nations that establish a World Ocean Observing System (WOOS) would make a splendid contribution to the world ... It should be emphasized that technological development, process oriented research, monitoring and modelling are joint and necessarily coexisting and mutually supportive efforts. They all must be called upon to build WOOS. What a magnificent opportunity it can be for an enterprising Nation to present WOOS as a gift to an environmentally distracted world!'**
>
> ***Henry 'Hank' Stommel, U.S. Oceanographer, 1990***

The latter half of 2004 was an eventful period for operational oceanographers. Four major hurricanes made landfall in the southeastern USA, three of them crossing a single county in Florida, causing millions of dollars in damage (see figure 1). A massive tsunami wrought havoc and devastation in and around the Indian Ocean basin killing hundreds of thousands of people (see figure 2). These two 'events' are unrelated in their underlying physics, occurred on opposite sides of the globe, and were very different in their effects on individuals, societies and economies. One important aspect that they did have in common was that, though unavoidable, they were predictable. In the former case, predictions were widely available and response mechanisms had been planned ahead. Although substantial damage occurred, losses of lives and property were minimized. In the latter case, a useful prediction was not made and there were no alert or response mechanisms in place. Tragedy was the result.

Such events highlight the urgent need for an operational ocean hazard warning system.

Such events highlight the urgent need for an operational ocean hazard warning system. However, a stand-alone tsunami warning system in the Indian Ocean basin will not work. Although local tsunamis occur in the Indian basin, we have no idea when or where to expect the next large regional tsunami. It could be centuries away. A rapidly developed, single-basin, single-purpose tsunami warning system that goes unused for many years is likely to be rusting and falling apart by the time it is called to use. Thus, the warning system must be designed to serve multiple, more frequently occurring hazards, such as storm surges and cyclones. In addition, the best way to ensure that a tsunami warning system remains fully operational for decades to come is to embed it within an integrated observation system. Data used for tsunami warnings is of potential interest to an enormous array of users and stakeholders. It is these other users who will ensure the system is maintained operationally over the long term.

The best way to ensure that a tsunami warning system remains fully operational for decades to come is to embed it within an integrated observation system.

The plans and requirements for such an integrated observation and hazard warning system are already known and portions of it are already in place under the auspices of two of the main activities overseen in the Operational Observing Systems Section at IOC: the Global Ocean Observing System (GOOS), and the Joint WMO/IOC Commission for Oceanography and Marine Meteorology, (JCOMM). What is required now is a substantial effort to overcome three considerable hurdles: (1) Achieve operational status; (2) Facilitate full global implementation; and (3) Enable regional implementation.

Achieving Operational Status

In order to be useful in developing hazard warnings, relevant ocean observations must be operational. Those components of GOOS most relevant to marine hazards, such as sea surface temperature, sea level and sea floor pressure, need to be made available in real-time. This is not just a technical requirement, but also a difficult political issue. For example, some countries purposely limit public access to tide gauge data to monthly mean sea level values, years after the fact, while their high-frequency data (1–2 minute averages) are kept internal for reasons ranging from cost to national security. In addition, national centres running operationally twenty-four hours a day, seven days a week, are essential. With the exception of a few countries, oceanography

Fig 1. The tracks of Hurricanes Charley, Frances and Jeanne crossing central Florida in 2004. In the context of the past five years, the number of hurricanes in 2004 was not anomalous, but the number to make U.S. landfalls clearly was. Accurate predictions of the likely severity of a given hurricane season, the paths of individual storms, and the associated sea level surge at a given coast requires that upper ocean temperature and sea level data be available in real-time, all the time.

(Reproduced by permission of the American Geophysical Union, and Brian H. Bossak, U.S. Geological Survey. '"X" Marks the Spot: Florida is the 2004 Hurricane Bull's-Eye.' *EOS*, Vol. 85, No. 50, pp. 541-552, 14 December 2004.)

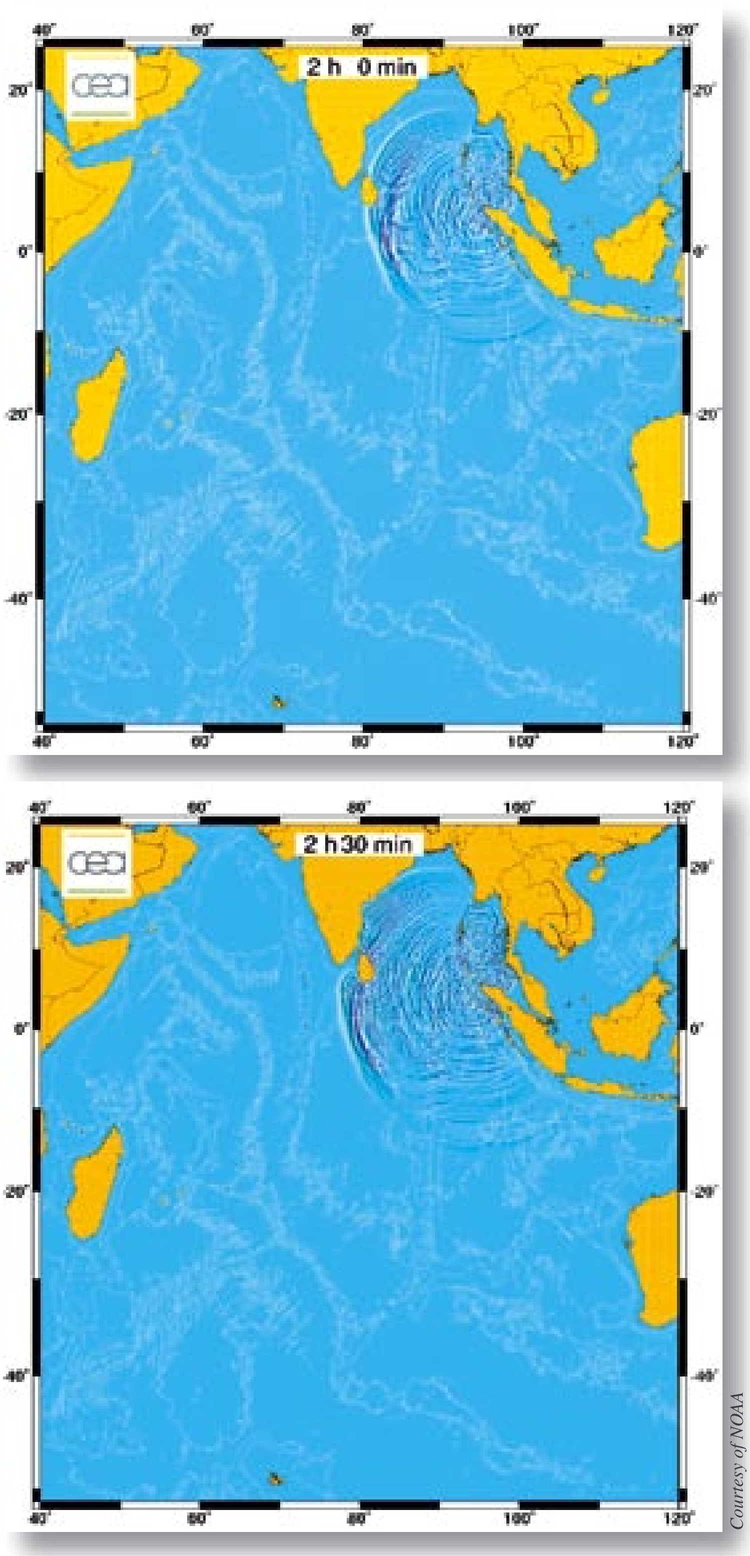


Fig 2. Time series showing the generation and propagation of a tsunami in the Indian Ocean on 26 December, 2004. In the context of the historical record, the tsunami itself was not anomalous, but changing demographics and lack of an operational warning system in the region meant a tragedy of unprecedented proportion. Accurate predictions of the generation, trajectory, and local run up of tsunamis requires accurate ocean bottom topography data and that bottom pressure and sea level data be available in real-time, all the time.

doesn't have the required institutional support at the national level to enable 24/7. Sometimes, though not always, this may occur through cooperation with national meteorological services, which already are operational, coordinated under the auspices of JCOMM. In other cases national navies may provide this service. In many cases new and creative solutions will be required.

Global Implementation

As of 2004 substantial progress towards global implementation of the open ocean portion of the GOOS has been made, with approximately fifty per cent of the *in situ* open ocean observing system for climate already in the water including buoys, moorings, floats, tide gauges and repeat ship of opportunity XBT hydrographic lines (see figure 3). However, current and projected future levels of national contributions to the network are clearly insufficient to finish the task. Full implementation of the observing system described in the plans of the Ocean Observations Panel for Climate (OOPC) will require substantial new commitments from Member States. The GCOS implementation plan, written with broad input and published in October 2004, estimated the yearly incremental cost of full implementation of the ocean observing network for climate (including satellite and *in situ* observations, dedicated analysis infrastructure, and targeted capacity-building) at US$200 million. Strong, independent, public calls for increased con-

Current levels of national contribution are clearly insufficient to finish implementation of the global component of GOOS.

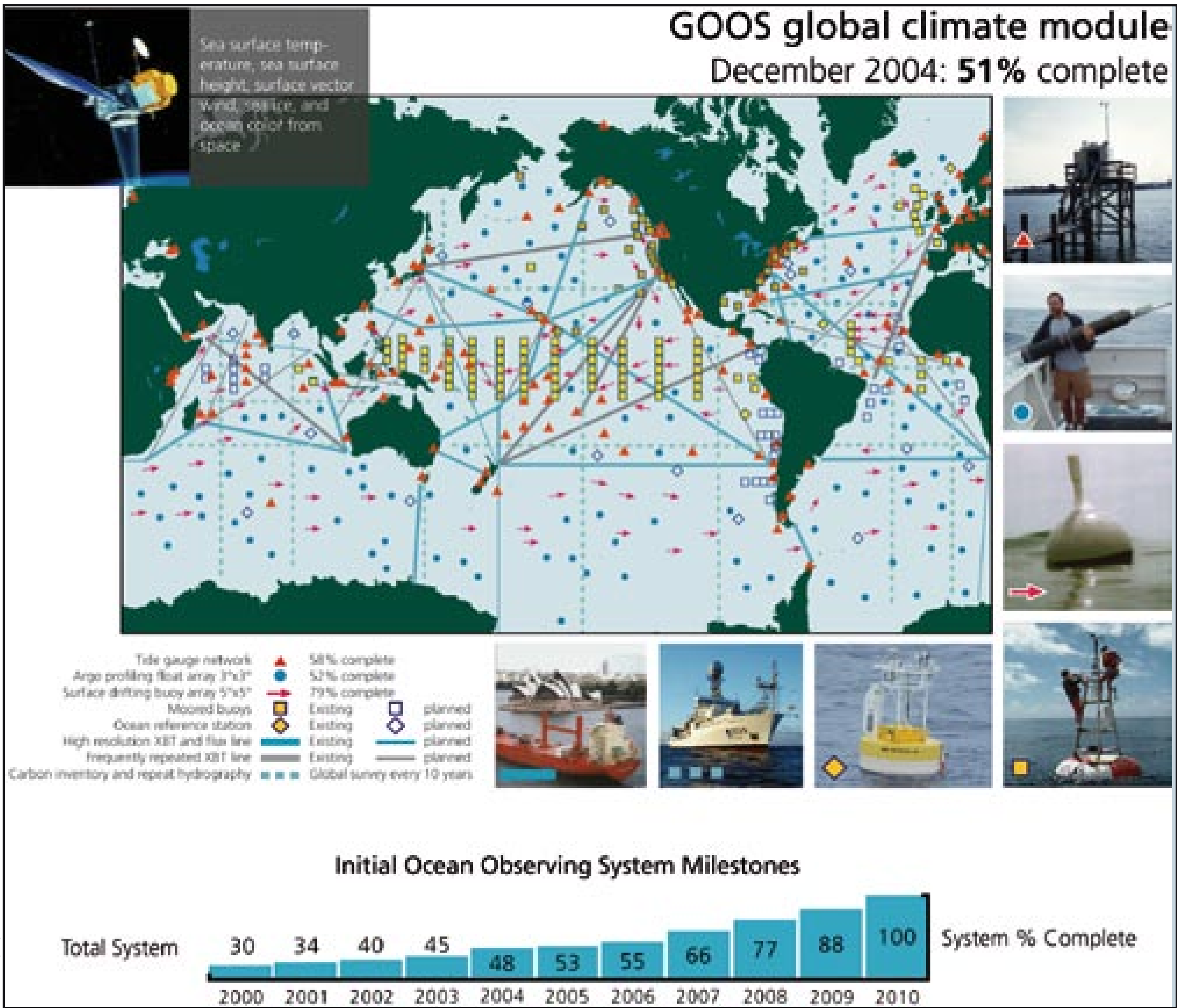
tributions to GOOS have been made (e.g. *Nature*, Editorial, 24 February 2005) and Member States are urged to heed them.

Although the technical backbone of the open ocean component of the observing system requires global co-operation, coastal observations (and hazard warnings in particular) are largely specific to regions or nations. This leads to the final challenge.

Regional Implementation

As expressed in the Coastal Ocean Observation Panel (COOP) Implementation Plan, finalized in 2004 and now in press, implementation of the coastal elements of GOOS is the primary remit of the GOOS regional alliances (see figure 4). Mechanisms for cooperation and coordination amongst the existing regional alliances are currently in development, as are initial efforts to form regional alliances covering one or both polar ocean regions, perhaps as an activity of the International Council for Science (ICSU)–World Meteorological Organization (WMO) International Polar Year in 2007–08.

Coastal observational needs are largely region specific. Thus a difficult challenge will be to ensure that regional observing systems, including hazard-warning aspects, are fully compatible with local cultural, social and economic conditions. As with so many things, successful implementation of coastal GOOS will require thinking globally and acting locally.



Courtesy of Mike Johnson, JCOMM OPS, NOAA/OCO

Fig 3. Status of the Global Observing System in December 2004. The global climate component of GOOS comprises a composite network of satellite and *in situ* measurements of surface and subsurface parameters. The *in situ* network was just over 50 per cent complete at the end of 2004, and will require substantial investment to reach its goal of 100 per cent completion by 2010.

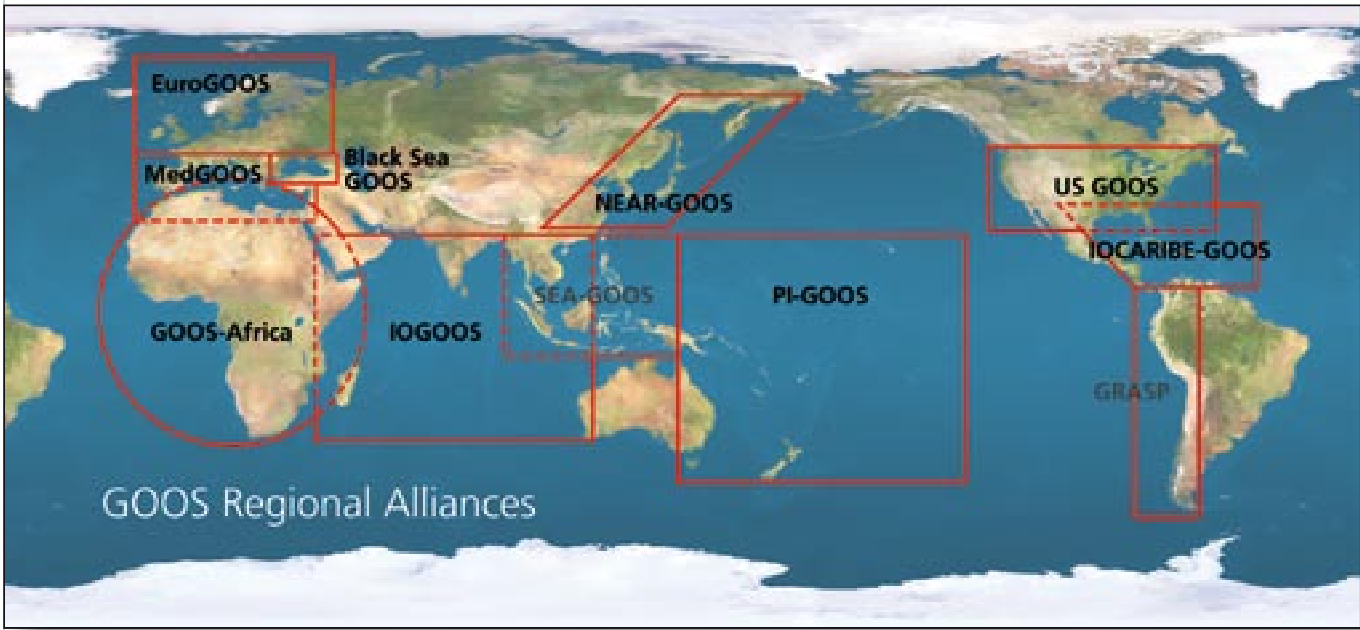


Fig 4. GOOS Regional Alliances as of December 2004.

Section News

After several years as Section Head, **Colin Summerhayes** departed in March to take up a position as Director of the Scientific Committee on Antarctic Research (SCAR) based in Cambridge, England. Much of the success of GOOS and JCOMM are owed to Colin's steady and efficient leadership in the secretariat. Colin continues to interact with IOC, including on issues related to the Southern Ocean and the International Polar Year.

Over a period of about four months, **Thorkild Aarup** held down the fort, continuing his work for the Coastal Ocean Observations Panel (COOP) and the Global Sea Level Observing System (GLOSS), while doing double duty as interim Head of Section, until, in August, **Keith Alverson** arrived to take up the helm. Keith came to the IOC following seven years, most recently as Director, of the Past Global Changes (IGBP-PAGES) Secretariat in Bern, Switzerland. Keith brings broad expertise in physical oceanography, paleoclimatology, and international research coordination to the IOC. Keith has a Bachelor of Engineering Sciences and East Asian Studies from Princeton University and a Ph.D. in Physical Oceanography from the M.I.T.–Woods Hole Oceanographic Institution. Having lived in the USA, Botswana, Germany, China, Canada, Switzerland and now France, he also brings wide ranging cross-cultural experience to the Secretariat.

In March **Albert Fischer** arrived, in a position joint with the Ocean Sciences Section, and supported by the USA (NOAA). Albert has a Ph.D. in Physical Oceanography, and was studying Indo-Pacific climate variability as a postdoc in Paris (LODYC) immediately before joining the IOC. He is working on the global module of GOOS and IOC Oceans and Climate programmes. The IOC gratefully acknowledges the USA (NOAA) for providing the funding to support Albert's post. In September, **Candyce Clark** arrived on secondment from the USA. Candyce is in charge of all JCOMM activities within the remit of the Operational Observing Systems Section and has been heavily engaged in preparations for the second meeting of the Joint Committee for Oceanography and Marine Meteorology (JCOMM) due to be held in Halifax, Canada in September 2005. The IOC gratefully acknowledges the USA (NOAA) for the secondment. In October, **Kazu Hashimoto**, who had been seconded to the Section from Japan for two years, departed to take up a position back in Japan at MEXT. Kazu successfully managed IOC's liaising with WESTPAC, NEARGOOS, SOPAC, and the East Asia region generally, tasks that will unfortunately not be continued. The IOC gratefully acknowledges Japan (MEXT) for the secondment. In December, **Alexandre Barault**, an informatics student at a local Parisian university, began an internship in the Section. Alexandre is programming a new website and associated databases for GOOS. The IOC gratefully acknowledges the USA (NOAA) for providing the funding to support this internship.

Meetings

In 2004 a number of meetings were organized and held with active participation of the Operational Observing Systems Section. Highlights include:

- The sixth meeting of the Coastal Ocean Observations Panel (COOP), 26–29 January, Wellington, New Zealand;
- The second Regional GOOS Forum, 7–9 February, Nadi, Fiji;
- The third meeting of the JCOMM Management Committee, 17–20 March, Geneva, Switzerland;
- The seventh meeting of the GOOS Scientific and Technical Committee (GSC), 26–29 April, Brest, France;
- The ninth meeting of the Ocean Observations Panel for Climate (OOPC) 7–10 June, Southampton, UK; and
- The seventh meeting of the COOP, 7–11 June, Tokyo, Japan.

Reports from these and all other meetings either coordinated by, or participated in by, the Operational Observing Systems Section are available on the GOOS website: (http://ioc.unesco.org/goos).

Links with Partner Programmes

The Operational Observing Systems Section continues to participate actively in joint activities with a number of partner organizations including:

- The terrestrial and climate observing system partners for GOOS (GTOS and GCOS, respectively);
- *In situ* and remote sensing Earth observing groups (e.g. Integrated Global Observing Strategy Partnership [IGOS-P] and the Committee on Earth Observation Satellites [CEOS]);
- Intergovernmental and international organizations (e.g. the World Meteorological Organization [WMO], the Scientific Committee on Oceanic Research [SCOR] and the International Council for Science [ICSU]);
- Global change research programmes (e.g. the World Climate Research Programme [WCRP], the International Geosphere-Biosphere Programme [IGBP] and the International Human Dimensions Programme on Global Environmental Change [IHDP]);
- Regional groups (e.g. the International Council for the Exploration of the Sea [ICES] and the North Pacific Marine Science Organization [PICES]);
- National agencies (e.g. the USA's National Oceanic and Atmospheric Administration [NOAA] and the UK's Natural Environment Research Council [NERC]); and
- The Global Earth Observing System of Systems (GEOSS).

Support to the Operational *In Situ* Observing Systems

JCOMM *In Situ* Observing Platform Support Centre (JCOMMOPS)

Marine observations from *in situ* observing systems along with other components are paramount for ensuring good quality ocean products, such as ocean modelling. Observing systems have to meet the requirements for ocean products and good coordination is therefore necessary internationally between all actors involved.

The JCOMM *In Situ* Observing Platform Support Centre (JCOMMOPS) was established in 2001 based upon coordination facilities provided by the Data Buoy Cooperation Panel (DBCP, i.e. drifting and moored buoys), the Ship of Opportunity Programme (SOOP, i.e. XBTs, TSGs), and the Argo profiling float programme. Synergy was therefore put in place between these three global marine observational programmes to assist at the international level those in charge of implementing the national components of these programmes.

The JCOMMOPS provides support to programme planning, implementation, and operations including information on:

(i) Observational data requirements;
(ii) Technology, instrumentation, and costs;
(iii) Operational status of observing networks (e.g. identification of data sparse area); and
(iv) Deployment opportunities (by ship and air).

It maintains information on relevant data requirements for observations in support of GOOS, GCOS, and the WWW as provided by the appropriate international scientific panels and JCOMM Expert Teams and Groups, and routinely provides information on the functional status of the observing systems. It also encourages platform operators to share the data and distribute them in real-time. For example, to that end it provides technical assistance regarding satellite data acquisition, automatic data processing and Global Telecommunication System (GTS) distribution of the data. JCOMMOPS also provides a mechanism for relaying quality information from data centres and users worldwide back to platform national operators.

The JCOMMOPS acts as a focal point for implementation and operation of relevant observing platforms. The Centre, located in Toulouse, France, is funded thanks to voluntary contributions from Member States, through the marine observing programme and panels such as the Data Buoy Cooperation Panel (DBCP) and Argo. More detailed information on JCOMMOPS and its products can be found at http://www.jcommops.org including monthly status maps for DBCP, Argo and SOOP.

The Global Sea Level Observing System (GLOSS)

DR THORKILD AARUP
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Sea level is such a fundamental parameter in the sciences of oceanography, geophysics, and climate change, that in the mid-1980s the IOC established the Global Sea Level Observing System (GLOSS). GLOSS was created to improve the quantity and quality of data provided to the Permanent Service for Mean Sea Level (PSMSL), and thereby data for input to studies of long-term sea level change by the Intergovernmental Panel on Climate Change (IPCC). It has also provided key data for international programmes, such as the World Ocean Circulation Experiment (WOCE) and the Climate Variability and Predictability Programme (CLIVAR).

Today GLOSS povides data both in delayed and real-time mode to a wide range of research programmes and practical applications and contributes to an understanding of sea level changes on timescales from hours (ocean tides, surges) to decades (climate change).

For more information:
http://www.pol.ac.uk/psmsl/programmes/gloss.info.html

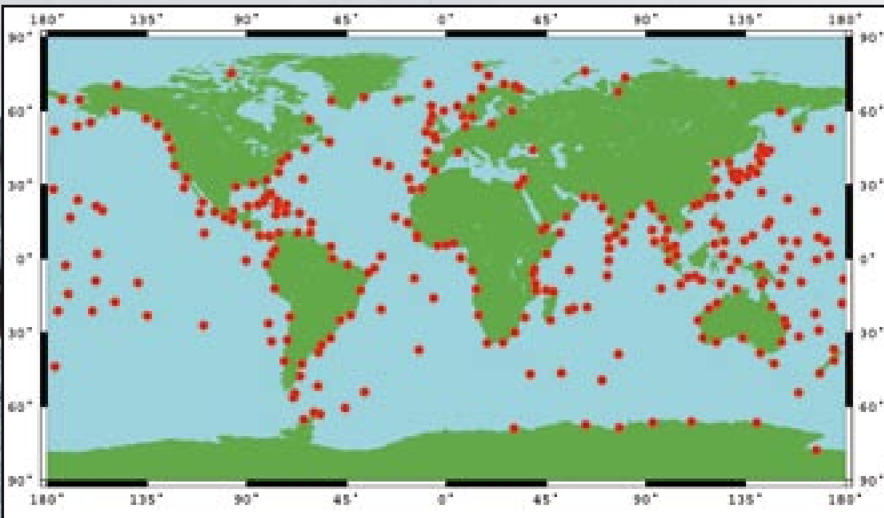
Courtesy of Brad Scott, Institute of Geological & Nuclear Sciences

Background

All countries with coastlines need information on sea level (or 'tidal') variations for a number of practical and scientific reasons. Practical applications include coastal engineering, in which sea level data are needed as instantaneous levels, as well as statistics of extreme levels over long periods. Short-term measurements, often with real-time data transmission, are needed for ship movements in harbours and ports, for issuing storm surge and tsunami warnings, and for the operation of sluices and barrages. Over a longer period, data are needed for tidal analysis and prediction, for control of siltation and erosion, for the protection of coral reefs, for inputs to models to estimate the paths of pollutants and to forecast water quality, and for the design of reclamation schemes and the construction of disposal sites. In addition, they have application to studies of upwelling and fisheries throughout tropical areas. Historically, many national datum levels for land surveys are based on measurements of mean sea level over some defined period. These levels are often used to define state and national boundaries, for example as specified in the United Nations Convention on the Law of the Sea. Low water levels are used as the datum for tidal predictions and for the datum level in hydrographic charts.

Many ask 'why measure sea level from tide gauges when we have satellite altimeters?' There are several reasons to continue to maintain a good tide gauge network:

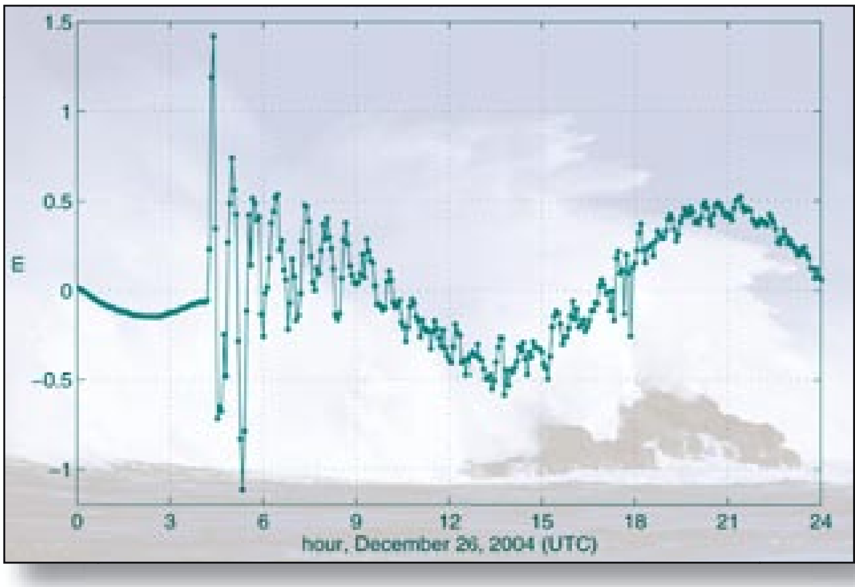
(i) Altimeters need to be calibrated;
(ii) Tide gauges provide continuity and are relatively inexpensive to operate – the altimeter record may have gaps in the future (or the satellite altimeter could malfunction or may not be replaced);
(iii) Long Mean Sea Level (MSL) records are needed for climate change studies (e.g. for the Intergovernmental Panel on Climate Change [IPCC]);



The GLOSS Core Network of Stations.

Courtesy of the Proudman Oceanographic Laboratory, UK

Courtesy of Mark Merrifield, University of Hawaii Sea Level Center



Sea level as observed at Male (Maldives) on 26 December 2004 showing the arrival of the first wave generated by the Indian Ocean Tsunami.

(iv) Long records of higher frequency climate change (e.g. changes in storm surge statistics) are needed;
(v) Higher frequency sampling in real-time is needed for storm and tsunami monitoring and warning.

In the mid-1980s, the Intergovernmental Oceanographic Commission (IOC) of UNESCO established the Global Sea Level Observing System (GLOSS). GLOSS was to improve the quantity and quality of sea level data provided to the data bank of the Permanent Service for Mean Sea Level (PSMSL) Liverpool, UK, and thereby, data for input to studies of long-term sea level change. It would also provide the key data needed for international research programmes, such as the World Ocean Circulation Experiment (WOCE) and later, the Climate Variability and Predictability Programme (CLIVAR), and the climate and coastal modules of the Global Ocean Observing System (GOOS).

Most researchers now accept that there is a threat to the coastal environment and infrastructure from sea level rise, and GLOSS is required to monitor such level changes

GLOSS has developed into an international coordination mechanism for global high quality sea level observation together with important elements for:

(i) Assisting in maintaining the GLOSS Core Network of tide gauges of 290 stations;
(ii) Training in sea level measurements and analysis;
(iii) Development of scientific and technical training material on various sea level aspects; and
(iv) Facilitation tide gauges and geodetic equipment (GPS) to developing countries.

Today GLOSS serves a multitude of users. Data from GLOSS-designated stations are used by scientific researchers in oceanography, geophysics, coastal engineering, and climate change. For example, most researchers now accept that there is a threat to the coastal environment and infrastructure from sea level rise, and GLOSS is required to monitor such level changes. GLOSS data are used extensively by the satellite altimetry community for calibration and joint analyses, and for the validation of operational numerical models. Some GLOSS station data are used in real-time by port offices to enable safe navigation or assimilated into storm surge models and many GLOSS stations in the Pacific currently provide data to the Pacific Tsunami Warning Center. Through recent participation in the Global Ocean Data Assimilation Experiment (GODAE) it is anticipated that the use of GLOSS real-time data for data assimilation will increase.

Additional background information on the GLOSS programme is available at http://unesdoc.unesco.org/images/0011/001126/112650eo.pdf

GLOSS Long-term Objectives

The GLOSS Implementation Plan (http://www.pol.ac.uk/psmsl/training/gloss.pub.html), established in 1997, outlines specific objectives for GLOSS that are reviewed and updated at regular meetings by the GLOSS Group of Experts (GE). These include:

- A fully operational global baseline network that would ensure adequate spatial coverage in traditionally data sparse regions (i.e. Southeast Asia, Africa, South America).
- A subset of stations for the purpose of ongoing calibration of satellite altimeter data (GLOSS-ALT).
- A subset of stations for monitoring ocean circulation via sea level changes (GLOSS-OC), especially

where altimetry is not ideal, including straits, high latitudes and western boundary current locations.
- The continuation of long sea level records for climate change monitoring purposes (e.g. within the scientific reviews of the IPCC). 'Long' might mean forty years or longer in Europe, North America, etc. but less in the southern hemisphere. This set of several hundred gauges was grouped within the GLOSS Long Term Trend (GLOSS-LTT) heading and was not a GLOSS Core Network subset.
- The installation of GPS receivers (and possibly other forms of geodetic monitoring such as DORIS and Absolute Gravity) at sites within most of the ALT and LTT sets, and ideally OC also, to enable vertical land movements in the gauge records to be removed.
- The delivery of Mean Sea Level data (MSL) from all GLOSS sites to the PSMSL by July in the calendar year following the data-year.
- The delivery of high frequency data (i.e. raw data, typically hourly values) to GLOSS Centres at the University of Hawaii Sea Level Center (UHSLC) and the British Oceanographic Data Centre (BODC). This activity, which began under the World Ocean Circulation Experiment (WOCE), has recently evolved into a real-time data system for a growing subset of stations.
- The promotion of historic data rescue projects.

GLOSS Status

The present status of the GLOSS implementation as measured in terms of data delivery from the GLOSS Core Network of stations (GCN) is reported annually by the PSMSL. An 'operational' station from a PSMSL viewpoint means that recent MSL monthly and annual values have been received and checked as far as possible, and have been included in the databank. (See http://www.pol.ac.uk/psmsl/gloss.status/status_oct2004.html).

A more elaborate status summary was provided in the GLOSS Adequacy Report from 2003 (http://unesdoc.unesco.org/images/0013/001302/130292e.pdf). Progress was measured primarily in terms of data return for the various GLOSS data streams. The numbers have changed slightly since 2003; however, the overall impressions given in the Adequacy Report are still valid and are summarized below:

- More than 55 Member States contribute data to GLOSS.
- About 60 per cent of the GCN is considered operational, with similar percentages for the various subnetworks (see the Adequacy Report for detailed assessments).
- Real-time (daily) data are available from approximately 76 GLOSS stations.
- Fast (monthly) data are available from approximately 114 GLOSS stations.
- There has been considerable growth in the number of GLOSS stations that are linked to GPS or DORIS (75 at the time of the Adequacy Report).
- Historic data rescue activities have increased data holdings (over three million additional hourly data points were added through initiatives from the National Oceanic and Atmospheric Administration alone).

Tide gauges, such as the one shown here, are essential for providing data that serve a multitude of users. More sea level data are now available, thanks to more gauges being installed where few existed previously, e.g. polar regions.
Courtesy of Peter Foden and Philip Woodworth, Proudman Oceanographic Laboratory

Highlights of GLOSS activities and events 2004

Highlights of GLOSS activities and events for 2004 are listed below:

- Dr Mark Merrifield was elected Chair of the GLOSS Group of Experts following the sudden death of Dr Christian Le Provost (see 'In Memoriam' in this Annual Report) who had been elected Chair in October 2003.
- Reports from the Eighth Session of the GLOSS Group of Experts (13 and 16–17 October 2003, Paris, France) and the associated technical workshop on New Technical Developments in Sea and Land Level Observing Systems (14–15 October 2003, Paris, France) were published and are available at http://ioc.unesco.org/goos/docs/GOOS_141_GLOSS-8.pdf and http://unesdoc.unesco.org/images/0013/001377/137705e.pdf
- In collaboration with the Department of Surveying and Mapping of Malaysia, GLOSS organized and sponsored a training course on sea level observation and analysis (9–20 February 2004 in Kuala Lumpur, Malaysia). The training course report is available at http://unesdoc.unesco.org/images/0013/001368/136865e.pdf
- The Norwegian Hydrographic Office GLOSS, in collaboration with the Hydrographic Department of the National Cartographic Center of Iran, sponsored a technical expert visit to Iran (7–14 March 2004) to provide advice on the national tide gauge network. The visit report is available at http://www.pol.ac.uk/psmsl/reports.gloss/general/Iran_IOC_GLOSS_Travel.pdf
- In collaboration with the Islamic Educational Scientific and Cultural Organization (ISESCO), the Regional Organization for Conservation of Environment of the Red Sea and Gulf of Aden (PERSGA), and the tide gauge agencies of Djibouti, Egypt, Saudi Arabia, Sudan and Yemen, GLOSS sponsored a technical expert visit to the Red Sea countries from 8–19 December 2004. Report available at: http://www.pol.ac.uk/psmsl/training/gloss.pub.html
- GLOSS sponsored the installation of a new pressure gauge in Takoradi, Ghana. (Takoradi has one of the longest time series of sea level observations in Africa). The gauge was donated by the National Institute of Oceanography (NIO) Goa, India, and the installation was carried out by two NIO scientists.
- Through the Proudman Oceanographic Laboratory, GLOSS has provided two new tide gauges to Mozambique, which will be installed in early 2005 by the South African Hydrographic Service (SAHS). GLOSS has also provided a gauge to Brazil, which will be installed at Cananeia in early 2005.
- Nigeria purchased with own funding a modern radar gauge to be installed at the GLOSS station in Lagos. GLOSS provided a grant for one Nigerian scientist to obtain training in installation and operation of the gauge.
- In late 2004 implementation of the Ocean Data and Information Network for Africa (ODINAFRICA III) project started, funded by the Government of Flanders (Belgium) through a grant to IOC. Work Package 2 under that project is titled 'The Coastal Observing System' and it will provide funds for tide gauge acquisition, installation and sea level training activities for Africa. It is expected that a total of between twelve and fifteen gauges can be established over the 2005–2008 time period with this funding. Many of the gauges will be installed at GLOSS Core Network stations in Africa. In 2004 GLOSS assisted the project managers with advice and coordination on the sea level aspects of the project.

The Future

GLOSS and sea level data from stations in the GLOSS Core Network serve many users. Much has been achieved in the life of GLOSS with limited resources. However, as pointed out in the GLOSS Adequacy Report, GLOSS needs investment in the order of US$3.5 million, especially in the developing countries, to close gaps in the GLOSS Core Network of stations, bring stations to deliver data in real-time and provide training. GLOSS will continue to explore funding opportunities to address this matter.

GLOSS will also explore opportunities under the International Polar Year 2007–08 programme to help Member States upgrade the Arctic and Antarctic tide gauge networks.

Many countries still hold considerable unanalysed sea level information from the past in the form of archived paper charts and tables. This information should, through a comprehensive data archaeology project, be digitized and entered into the sea level data banks. This will complement historical sea level data sets and provide a more complete description of past global and regional sea level trends.

The Coastal Module of the Global Ocean Observing System (GOOS)

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In order to rapidly detect and predict a broad range of coastal phenomena from changes in sea state, coastal flooding and sea level rise to increases in the risk of disease, habitat modification, harmful algal blooms and declines in fisheries, an integrated system of observations and analysis is needed to provide the data and information required. The Coastal Ocean Observations Panel (COOP), representing the coastal module of GOOS, sponsored by the IOC, WMO, UNEP, FAO, ICSU and IGBP, encompasses this vision and provides a framework for nations to make more cost-effective use of collective resources.

For more information:
http://ioc.unesco.org/goos/coop.htm

Background

Coastal nations worldwide are experiencing changes in their coastal marine and estuarine systems that jeopardize sustainable development, human health and safety, and the capacity of marine ecosystems to support products and services valued by society. Changes of concern include increases in the susceptibility of coastal populations to flooding, tsunamis, erosion and disease, habitat loss, declines in living resources, harmful algal blooms, and mass mortalities of marine mammals and birds. Such trends reflect the combined effects of both natural processes and human uses.

Because these changes, their causes and their effects often transcend national borders, numerous international treaties and conventions have been agreed to that require sustained, routine and reliable observations of oceanic, coastal, terrestrial and atmospheric systems on local, regional and global scales. Implementation of the coastal module of the Global Ocean Observing System (GOOS) will provide the required data and information on coastal marine and estuarine systems worldwide. As such, the coastal module of GOOS is an important contribution to the Integrated Global Observing Strategy (IGOS) and the Global Earth Observing System of Systems (GEOSS).

Implementation of the coastal module of the Global Ocean Observing System (GOOS) will provide the required data and information on coastal marine and estuarine systems worldwide.

GOOS is evolving as two interdependent modules, one for the global ocean and one for coastal marine and estuarine systems. The global module is primarily concerned with improving marine weather forecasts and marine services, predicting basin scale oscillations, and predicting decadal scale climate changes (e.g. global warming and sea level rise). Initial plans for this module have been completed by the Ocean Observation Panel for Climate (OOPC) and implementation has begun.

Photo by David E. Niles

Last April at least fifty people died in floods that caused extensive damage in Djibouti, Africa, located at the southern entrance of the Red Sea. The coastal module of GOOS is primarily concerned with establishing an observing system that, among other things, provides data and information required to mitigate and manage the effects of natural hazards.

Applications of data and information from the global module for mitigating and controlling the effects of natural hazards and climate change on ecosystems and socio-economic systems are most valuable in the coastal zone where human population density is highest and growing rapidly and ecosystem goods and services are most concentrated. Thus, the use of data and information from the global ocean module for these purposes depends to a significant extent on implementing the coastal module both regionally and globally.

The coastal module of GOOS is primarily concerned with establishing an observing system that provides data and information required to mitigate and manage the effects of natural hazards (e.g. tsunamis, tropical storms), climate change (e.g. sea level rise, warming) and human activities (e.g. land-use practices, extraction of natural resources, shipping) on coastal systems and their capacity to sustain goods and services of value to human society.

To this end, the coastal module of GOOS is intended to develop an integrated and holistic approach to addressing six goals for the public good:

- Improving the capacity to detect and predict the effects of global climate change on coastal ecosystems;
- Improving the safety and efficiency of marine operations;
- Controlling and mitigating the effects of natural hazards more effectively;
- Reducing public health risks;
- Protecting and restoring healthy ecosystems more effectively; and
- Restoring and sustaining living marine resources more effectively.

Routine, continuous provision of reliable data and information required to address these goals will make possible: rapid and repeated assessments of the condition of coastal marine and estuarine systems; timely predictions of the effects of extreme weather, climate change and human activities; and the development of ecosystem-based approaches to managing and mitigating the effects of human activities and natural variability on socio-economic systems that underpin the health and well-being of human populations.


Photo courtesy of NOAA

The goals addressed by the coastal module of GOOS include improving the safety and efficiency of marine operations.

Implementation of the coastal module is justified in terms of socio-economic benefits, environmental conservation, sustainable development, and national commitments articulated in international agreements and treaties.

Design and Implementation Planning for the Coastal Module of GOOS

Planning for the coastal module of GOOS started in the late 1990s initially through three design panels working in parallel and addressing observing requirements for various parts of the coastal module spanning from safe navigation, climate variability, water quality, marine pollution over to living marine resources:

- Coastal GOOS (C-GOOS) panel;
- The Health of the Oceans panel (HOTO); and
- The Living Marine Resources panel (LMR).

By 2000 the three panels had produced initial design plans for their respective observation focus areas:

C-GOOS
The Strategic Design Plan for Coastal Component of GOOS (GOOS Report No. 90) (http://ioc.unesco.org/iocweb/iocpub/iocpdf/i1146.pdf);

HOTO
Design Plan for HOTO (GOOS Report No. 99) (http://ioc.unesco.org/goos/docs/GOOS_099_HOTO_design_plan_3.pdf);

LMR
The Strategic Design Plan for the IOC-WMO-UNEP-ICSU-FAO LMR Panel of GOOS (GOOS Report No. 94) (http://ioc.unesco.org/iocweb/iocpub/iocpdf/i1150.pdf).

Following the completion of these plans the GOOS Steering Committee had decided that the planning efforts should be taken forward by one single panel – the Coastal Ocean Observations Panel (COOP).

The terms of references for COOP are to:

(i) Integrate and refine the design plans of the C-GOOS, HOTO and LMR panels consistent with GOOS Design Principles; and
(ii) Formulate an implementation plan that is coordinated with the OOPC plan for climate services, research and marine services with due emphasis on:

- Integrated observations, data and information management, data assimilation and modelling for the purposes of prediction and product development;
- Criteria and procedures for selecting observing system elements;
- Procedures for ongoing evaluation of system components, reliability of data streams, access to data, and applications;
- Capacity building; and
- National, regional, and global promotion of objectives and benefits of the observing system.

In 2003 COOP produced 'The Integrated Strategic Design Plan for the Coastal Ocean Observations Module of GOOS' (GOOS Report No. 125) (http://ioc.unesco.org/goos/docs/GOOS_125_COOP_Plan.pdf); (The plan is also available in Spanish thanks to Dr Rodrigo Ñũnez and SHOA [http://unesdoc.unesco.org/images/0013/001305/130523s.pdf] and in Russian thanks to Dr Vadim Sobolev, Head Department of Navigation and Oceanography of the Russian Federation [http://ioc.unesco.org/goos/docs/doclist.htm]).

The Integrated Design Plan for the Coastal Module of GOOS calls for establishing regional coastal ocean observing systems (RCOOSs) worldwide and, through this process, the development of a Global Coastal Network (GCN). The former has begun and coordinated development of these regional observing systems is needed to create a GCN that:

- Measures, manages and analyses common variables needed by all or most coastal nations and regions;
- Establishes sentinel and reference stations; and
- Implements internationally accepted standards and protocols for measurements, data telemetry, data management and modelling.

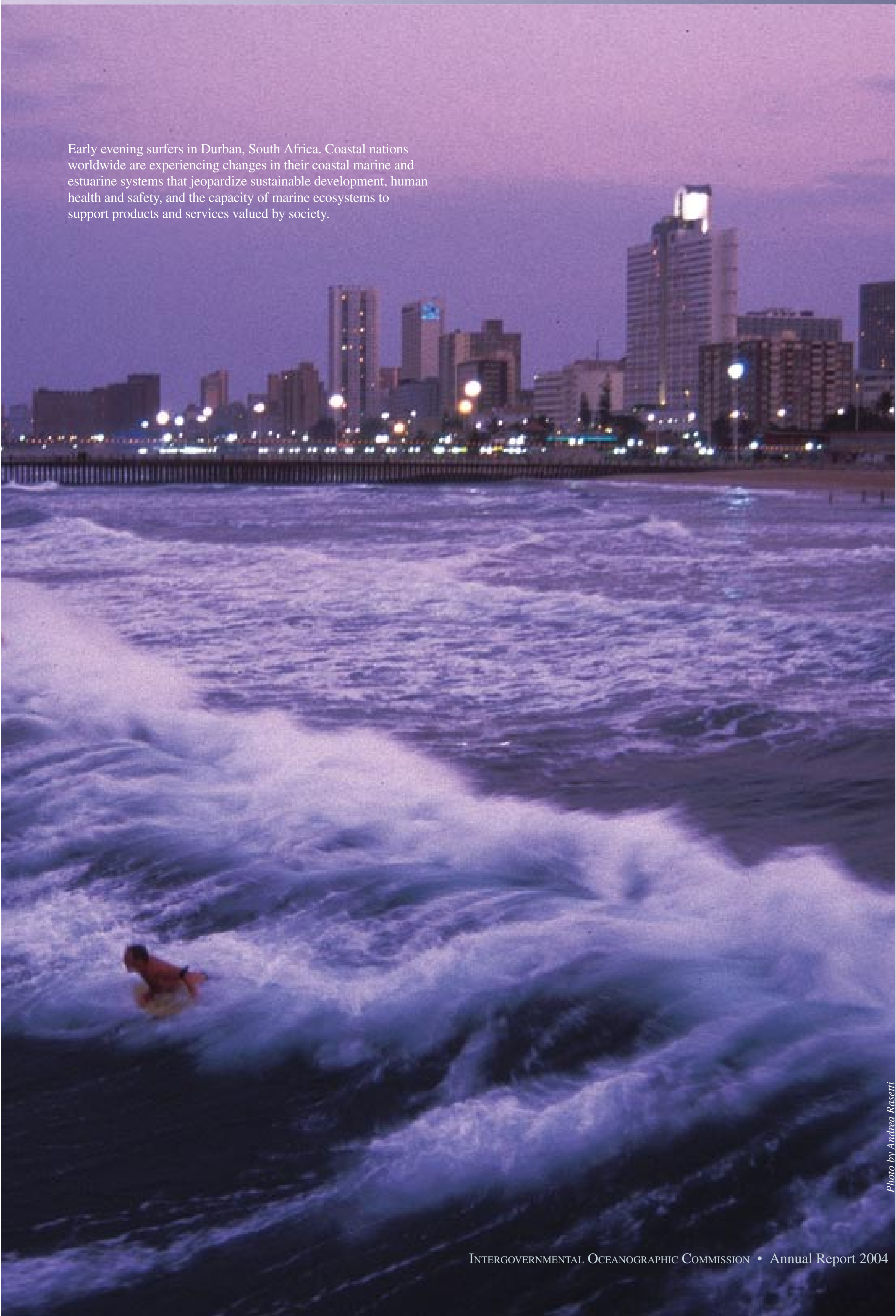
Daily life along the coast and estuaries of Mozambique. The coastal module of GOOS includes the development of an integrated and holistic approach to reducing public health risks.

Photos by Andrea Rasetti

The provisional common variables include geophysical variables (temperature, salinity, currents, waves, sea level, shoreline position, bathymetry, sediment grain size), chemical variables (dissolved inorganic nutrients, dissolved oxygen, sediment organic content), biological variables (faecal indicators, phytoplankton biomass, benthic biomass), and biophysical variables (optical properties).

Following the completion of the Integrated Design Plan, COOP has worked on formulating an Implementation Strategy for the coastal module of GOOS. In 2004 COOP held full panel meetings in Wellington, New Zealand (26–29 January) and in Tokyo, Japan (9–11 June) and a subcommittee meeting addressing socio-economic aspects was held in Halifax, Canada (15–16 April). The Implementation Strategy was completed in draft form, externally reviewed, revised in response to the reviews and finally externally edited during the fourth quarter of 2004. Following formal approval by the GOOS Steering Committee and the Intergovernmental Committee for GOOS the document will be available in printed form during the first half of 2005 (http://ioc.unesco.org/goos/docs/doclist.htm).

The Implementation Strategy proposes the actions needed to implement the Integrated Design Plan. The plan focuses on policies and procedures for establishing regional scale coastal ocean observing systems. It includes organizational and administrative proposals for governance and presents practical recommendations for phased development of the GCN through the establishment and networking of GOOS Regional Alliances (GRAs), National GOOS programmes, and existing global programmes. The Implementation Strategy is an 'organic' plan that is expected to be updated periodically and used to guide the formulation and implementation of action plans as GRAs mature, the diversity of user groups grows, and new technologies and understanding enable the evolution of a fully integrated and comprehensive system.



Early evening surfers in Durban, South Africa. Coastal nations worldwide are experiencing changes in their coastal marine and estuarine systems that jeopardize sustainable development, human health and safety, and the capacity of marine ecosystems to support products and services valued by society.

Photo by Andrea Rasetti

ocean Services Overview

By Peter Pissierssens, Head of Section

Decentralized networks of data centres providing access to a wide variety of users over the Internet are gradually replacing the traditional model of centralized data management. This model enables the development of a broad range of user communities having access to data, data products and information. The International Oceanographic Data and Information Exchange (IODE) Programme helps to narrow the 'digital divide' between developing and developed countries, through the creation of Ocean Data and Information Network (ODIN) projects to aid developing countries. Information provided will include certain specialized functions including seabed mapping and tsunami forecasting.

The IODE Programme develops applications of Information and Communication Technology (ICT) for data management and dissemination. It strengthens cooperation with ocean research and monitoring programmes to ensure that data and information needs of Member States are met through close collaboration with the programmes of other sections within the IOC, and especially with the Joint IOC/World Meteorological Organization Technical Commission for Oceanography and Marine Meteorology (JCOMM). The IODE Programme also increasingly plays an active role in guiding users to information through the

The IODE Programme develops applications of Information and Communication Technology (ICT) for data management and dissemination.
Courtesy of Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, U.S. Dept. of Commerce.

development and maintenance of specialized portals and clearing-house mechanisms, in close collaboration with the UN and other agencies. Advances in seabed mapping are being achieved through collaboration with international hydrographic agencies. Tsunami forecasting is being improved through cooperation between the scientific research community of the International Union of Geodesy and Geophysics (IUGG) and operational experts dealing with seismic and tidal observations, with the objective of disaster mitigation. Assistance to the establishment of national tsunami warning systems is critical in this regard.

Promoting full and open access to ocean data and information, and improved communication of ocean research findings to decision-makers and the public

During 2004 the IODE Secretariat and Officers participated in a number of meetings and conferences to promote IODE and to raise interest in the operational oceanography community for the capacities available from the IODE data centre network. Several cooperative links were thus established. In addition, the newly established IODE Group of Experts on Biological Data Management and Exchange Practices (GE-BICH) is involving several programmes, projects and organizations that have direct links with biological oceanography and taxonomy experts, thereby promoting IODE in those communities.

Strengthening capacity to collect, preserve, disseminate and use ocean data and information

Following the success of the pilot phase of OceanTeacher, implemented during the previous biennium, IODE successfully applied for donor funding for the operational phase of OceanTeacher, to be called ODIMeX. Accordingly, this activity is being funded from extra-budgetary sources during the biennium 2004–2005. The First Session of the ODIMeX Editors and Planning Meeting was held in Cape Town, South Africa, 19–23 April 2004. The meeting reviewed the project document, discussed the technical implementation of the distance learning application/content management system, nominated work package leaders and reviewed the table of contents of OceanTeacher. OceanTeacher is available online (http://www.oceanteacher.org).

Developing and disseminating global standards for the collection, management and exchange of ocean data and information

The Third Session of the International Council for the Exploration of the Sea (ICES)-IOC Study Group on the Development of Marine Data Exchange Systems using XML (SGXML) was held in Oostende, Belgium 6–7 May 2004. The Group decided to finalize and document its work by IODE-XVIII in April 2005. The objectives of the European Union Marine XML project for this period were to deliver on first tangible outputs of the project and establish a framework for the exploitation (continuation) of the standardization process post-project. A catalogue has been produced of the standards used by the marine community and these have been mapped onto an ontology to articulate their relationships. Work has begun to 'ring-fence' the scope and content of the test-bed demonstration. The Project Progress Meeting will be held 14–16 June 2004 in Oxford, UK, to summarize the project achievements.

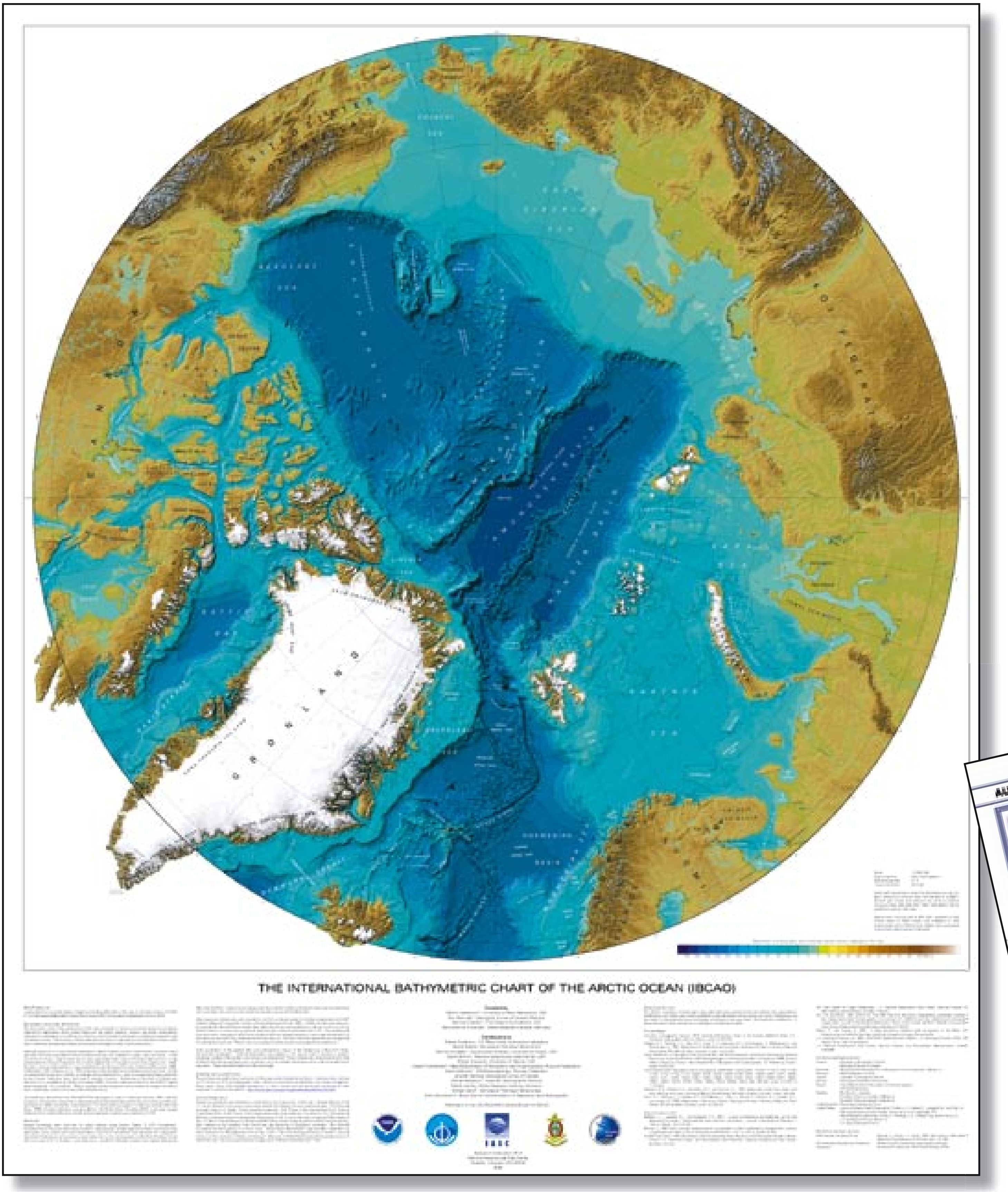
The project test-bed demonstrations are now being finished and will be presented at the final project meeting in January 2005 in Liverpool, UK. The work started within the project will be continued in the EU MOTIVE Project starting in February 2005. IOC/IODE is a participant in this project.

Furthermore, the Second Session of the IODE Group of Experts on Biological and Chemical Data Management and Exchange Practices was held at the Foresight Centre at the University of Liverpool, UK, 22–24 March 2004, hosted by the British Oceanographic Data Centre (BODC). The Session was attended, in addition to its regular members, by representatives from the Food and Agriculture Organization (FAO), the Global Biodiversity Information Facility (GBIF), ICES and the Integrated Taxonomic Information System (ITIS) as well as by the IODE Chair. The Group adopted a detailed work plan that focuses on:

(i) OceanTeacher modules on biological data management;
(ii) Raising awareness for the socio-economic importance of data management;
(iii) Closer collaboration with the Ocean Biogeographic Information System (OBIS), GBIF, ITIS, FAO;
(iv) Hosting of the UNESCO-IOC Register of Marine Organisms (URMO) website by the IODE Project Office;
(v) Collation of guidelines on data quality assurance and quality control for biological data;
(vi) Pilot projects related to test different systems of distributed querying based on XML (DiGIR and BioCASE) with XML schemas other than Darwin Core and ABCD (using metadata and distributed taxonomic name lists as data types); and
(vii) Implement survey, requesting information about systems, databases and inventories currently in use in various data centres.

Improving information on the topography of the World Ocean floor and its geological/geophysical parameters

The main results in the Ocean Mapping framework (2003–2004) are the publication of the *Geological Geophysical Atlas of the Pacific Ocean (GAPA)*, publication of a 3D updated version of the 'General Bathymetric Chart of the Oceans' on CD-ROM (GEBCO), and publication of the 2D



International Bathymetric Chart of the Arctic Ocean (IBCAO).
Courtesy of the British Oceanographic Data Centre

Edition of the International Bathymetric Chart of the Arctic Ocean (IBCAO). The digital version of the International Bathymetric Chart of the Caribbean Sea and Gulf of Mexico has been accomplished with Instituto Nacional de Estadística Geografía e Informática (INEGI). (All publications are currently available for users.) A contract was signed with Nippon Foundation for training activities in marine cartography, in accordance with which approximately US$2 million will be available for the next five years for postgraduate education.

In accordance with Resolution EC-XXXVII.5 the first meeting of the Editorial Board for the International Bathymetric Chart of the Southern Ocean was organized and took place at the end of July 2004 at the Alfred Wegener Institute for Polar and Marine Research, in Bremerhaven, Germany. The future structure of GEBCO and Ocean Mapping was discussed between Member States, IOC and the International Hydrographic Organization (IHO). Ocean Mapping continued its support to all existing regional bathymetric projects focused on compilation and classification of bathymetric data, in particular for the Caribbean Sea, and the Indian and Pacific Oceans. In accordance with the joint GEBCO/Nippon Foundation work plan, a group of seven students has started a one-year training course in bathymetry at the University of New Hampshire, USA.

Strengthening tsunami warning systems and mitigation procedures

The Tsunami Warning System in the Pacific (ITSU) Programme continued its support to the International Tsunami Information Center (ITIC), Honolulu, Hawaii. The Center produces the ITSU Newsletter, implements the ITSU Training Programme and coordinates the ITSU information dissemination programme (expert and general public level). Implementation of the ITSU-XIX work plan continued (details provided in previous report July-December 2003). Plans for the development of an Indian Ocean Tsunami Warning System, in response to December's tragic disaster, using knowledge from the ITSU Programme are discussed in detail in the Public Awareness section of this Annual Report.

Ocean Data and Information Network for Africa (ODINAFRICA) Phase III

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Sponsored by the IOC and the Government of Flanders (Belgium), the ODINAFRICA Project brings together marine institutions from twenty-five African Member States of the IOC in order to enable the development of relevant products and services contributing to the sustainable use and management of oceans and coastal areas in Africa. Designed to provide access to up-to-date oceanographic and data information and to build management capacity, ODINAFRICA fosters the full and active participation of developing countries in the Internet-based society.

For more information:
http://ioc.unesco.org/odinafrica/

The earlier phases of development of the Ocean Data and Information Network for Africa (ODINAFRICA) enabled Member States from Africa to get access to data available in other data centres, develop skills for manipulation of data and preparation of data and information products, and develop infrastructure for archival, analysis and dissemination of the data and information products.

The implementation of the current phase commenced with a meeting of the ODINAFRICA Project Steering Committee at the UNESCO Nairobi, Kenya Office. The phase will build on this foundation, with the goal of improving data flow into the national oceanographic data and information centres in the participating countries, developing data and information products required for integrated management of the coastal areas of Africa, and increasing the delivery of services to end-users. ODINAFRICA-III will be implemented by institutions from twenty-five Member States of the Intergovernmental Oceanographic Commission of UNESCO from Africa (Algeria, Angola, Benin, Cameroon, Comoros, Congo, Cote d'Ivoire, Egypt, Gabon, Ghana, Guinea, Kenya, Madagascar, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, Seychelles, South Africa, United Republic of Tanzania, Togo, and Tunisia), with support from the Commission. The Government of Flanders, Belgium will provide US$2.5 million to support the implementation of ODINAFRICA-III during the period August 2004–December 2007.

The following thematic work packages will be implemented to achieve the objectives of ODINAFRICA-III:

Coastal Ocean Observing System: focuses on upgrading and expanding the African network for *in situ* measurements and monitoring of ocean variables (e.g. sea level, temperature, salinity, currents, winds, etc.), provision of near real-time observations of ocean variables, and building adequate capacity for collection, analysis and management of sea-state variables.

More than twenty-eight sea level stations are currently operational along the African coastline. The majority of them are on the Indian Ocean coast. However few of these stations transmit the data collected to data centres in real-time. ODINAFRICA will install at least fifteen new stations, starting with Cape Bon (Tunisia), Casablanca (Morocco), Nouadhibou (Mauritania), Dakar (Senegal) and Takoradi (Ghana) in 2005.

Data and Information Management: focuses on further development and strengthening of National Oceanographic Data Centres (NODC) to manage data

Photo courtesy of Mireille Michiels

The objectives of Phase III ODINAFRICA enable Member States to address key issues such as the management of ecosystems and habitats, and the sustainable use of living resources.

Map (Africa 4045 Rev. 4 January 2004) courtesy of the UN Cartographic Section

streams from the coastal ocean observing network, upgrading infrastructures in the NODCs (including internet access and computer systems), and integrating biogeographic and hydrological data streams into NODC systems.

The five countries that have joined the network during the current phase (Algeria, Angola, Congo, Egypt and Namibia) will be provided with basic data management training as well as equipment and software to enable them to establish or strengthen their national oceanographic data and information centres. In addition, all the data centres will be provided with training and infrastructure for management of biodiversity data.

The products already developed such as directories of experts and institutions, library catalogues, and catalogue of publications from/about Africa, and catalogues of Africa marine data sets (MEDI-Africa) are being cleaned up and merged so that they can be availed on project websites by end of the first quarter of 2005.

Product development and end-user communication and information deliver: focuses on preparation of databases, and data and information products for the integrated management of coastal environments and resources and, in particular, enabling Member States to be able to address the key issues identified in the African Process: (i) Coastal erosion; (ii) Management of key ecosystems and habitats; (iii) Pollution; (iv) Sustainable use of living resources; and (v) Tourism.

Each of the participating countries will hold national consultations to identify key data, information and products required for the management of the coastal and marine environment and resources in the respective countries. On the basis of these, a set of core products to be prepared by each NODC will be selected. Skills and tools to facilitate their preparation and dissemination will be provided to the NODCs.

Regional Activities and Capacity Building

Photo by Andrea Rasetti

The Intergovernmental Oceanographic Commission of UNESCO

Subcommission for the Western Pacific (IOC/WESTPAC)

DR MIGUEL FORTES,
Head of IOC/WESTPAC

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Introduction

The responsibility of the IOC/WESTPAC Subcommission covers twenty countries in the Western Pacific region, encompassing an area roughly from the Andaman Sea part of Thailand to the Pacific coast of the USA, and from the southern tip of New Zealand to the northern part of the Bering Sea. While the region is the centre of marine generic wealth and diversity in the world, a significant portion of its coastal and ocean habitats is at high risk of being lost in the next decade; the current rates of loss of habitats are the highest in the world and are directly associated with the activities of more than half of the total world population, a large percentage of whom are poor and reside along the coasts. This region is extremely vulnerable as it is the most affected by natural disasters. Capacity building in ocean sciences and services is a policy objective common to all countries in the region.

The Western Pacific is a particularly vulnerable region, often challenged by natural disasters, and facing rapid decline of its coastal ecosystems. IOC's first programme within the region was in 1965 and since then a number of activities have been carried out. IOC/WESTPAC was formally established in 1989 to promote and coordinate programmes that demonstrate and enhance the value of marine scientific research and systematic observations of the ocean.

For more information
http://ioc.unesco.org/westpac

Activities in 2004

Largely in response to requests from its Member States, IOC/WESTPAC implements seven major programmes:

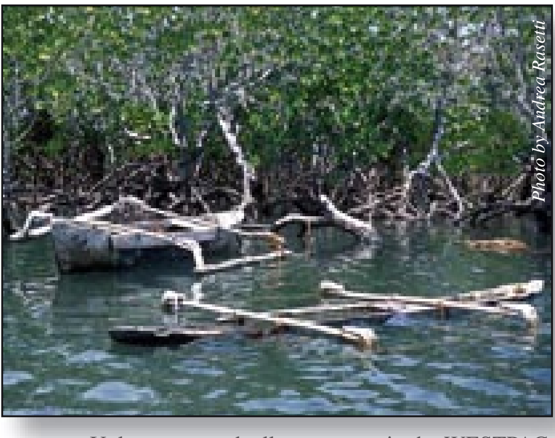
- Oceans and Climate
- Ocean Ecosystem Science
- Marine Environmental Protection
- Interdisciplinary Programmes
- Ocean Remote Sensing
- Global Ocean Observing System (GOOS)
- Ocean Services and General Activities.

In 2004, at least ten major projects or activities were implemented under these programmes. They ranged from project and coordination meetings, training courses and workshops, international symposia, publication of posters and a field guide, to the development of its own website (http://westpac.unescobkk.org). These initiatives were made possible with support from extrabudgetary sources whose contributions made up 72.3 per cent of the total expenditure, with the remaining 27.7 per cent coming from the regular programme budget.

Home page of WESTPAC's new website.

Disappearing natural habitats: reversing the decline

The region's coastal ecosystems are severely damaged: over 80 per cent of coral reefs face risks, mangroves have



Unless managed, all mangroves in the WESTPAC region will be lost by 2030.

lost 70 per cent of their cover in the last seventy years, and between 20 and 60 per cent of seagrass beds have been lost. Only 10 to 30 per cent of natural habitats remain in many countries of the region so that any further decrease could have serious consequences for biodiversity and people's lives. Unless managed, reefs will face collapse within twenty years, all mangroves will be lost by 2030, and seagrass beds will follow suit. As a result, total marine fish production in the region has fallen dramatically.

Over the past fifteen years the coastal zone has, nevertheless, improved in a few areas in the region. This advance has been helped along by the establishment of more Marine Protected Areas, and training courses, particularly in the extensive use of remote sensing in the region to obtain data on suspended sediments in the water column, topography, bathymetry, sea state, water colour, chlorophyll-a, sea surface temperature, fisheries, oil slicks, and submerged and emergent vegetation, including mangroves and seagrass. Consequently, many countries in the region are making great efforts to review their coastal and ocean management programmes in a thorough and competent way, with a view to changes in practice and policy at national and regional levels. Academic institutions, private and public agencies and international donors have substantially aided this effort. A more holistic and regional approach has been adopted through regional activities and agreements. With support from partners, IOC/WESTPAC helps substantially in this endeavour.

Highlights in 2004

The Strategic Plan for the North-east Asian Global Ocean Observing System (NEAR-GOOS, Intersessional Period, 2004) was adopted and put into operation, with the goal 'to develop a basic integrated ocean observing and operational forecasting system in the NEAR-GOOS area adhering to the GOOS principles, and building on the data management and exchange mechanism developed in the first phase through the inclusion of additional parameters, increased coverage in space and time, the generation of a generic suite of data products and adequate quality assurance/quality control procedures.'

Participants at a special session of the **Sixth WESTPAC International Scientific Symposium**, Hang Zhou, China, April 2004, agreed to establish the South East Asia Global Ocean Observing System (SEAGOOS) as a subsidiary body of IOC, working on the principle that 'an alliance of South East Asian countries and/or ocean and marine meteorological and related agencies is a suitable approach for collaboration and facilitating the development of solutions and their implementation to meet the economic, social and en-

Many countries in the region are making great efforts to review their coastal and ocean management programmes in a thorough and competent way, with a view to changes in practice and policy at national and regional levels

Dr Patricio Bernal, IOC's Executive Secretary, at the Sixth WESTPAC International Scientific Symposium.

vironmental needs of the region and its sustainable development.'

The Joint Regional Training Course/ Workshop 'Practical Methods in the Study of Marine Plant Biodiversity and Management in Asia-Pacific', The Philippines, 24–29 May 2004, sponsored by the United Nations Environment Programme–Global Environment Facility (UNEP–GEF), IOC/WESTPAC, the Japan Society for the Promotion of Science (JSPS), the UNESCO Man and Biosphere Programme (MAB), and the Philippine National Seagrass Committee (PNSC). The Workshop brought together major projects and programmes of at least five regional/ international organizations that deal with coastal and marine science conservation and management in the Western Pacific region, thus facilitating the much needed complementarity between regional/international agencies and institutions and local governments that are mandated to protect and sustainably manage the region's coasts.

One of the products of this joint initiative was the publication and distribution of the posters 'Seagrasses of East Asian Seas' and the 'Field Guide for the Identification of East Asian Seagrasses' to local, national and international institutions and individuals.

The Pacific Islands Regional Ocean Forum (PIROF), Fiji, February 2004. The participants, including the Pacific member countries and territories, development partners, non-State actors, private sector and civil societies adopted the Pacific Islands Regional Ocean Policy as a framework for integrated strategic action. The renewed commitment of IOC/WESTPAC as a partner to help Pacific Island Member States develop their ocean sciences and services was acknowledged, and the capacity building intervention by IOC recognized as an important means to achieve the goals of the policy.

The Sixth IOC/WESTPAC International Scientific Symposium: Challenges for Marine Science in the Western Pacific, Hang Zhou, China, 19–23 April 2004. The Symposium discussed the key challenges for marine science in the Western Pacific, promoting regional cooperation and interdisciplinary collaboration in marine scientific research with a special emphasis on ecosystem-based approaches to sustainable development and oceans management, and developing the regional infra-

Seagrass along the beach at Talibong, Thailand. In the WESTPAC region, between 20 and 60 per cent of seagrass beds have already been lost. Any further decrease could have serious consequences for biodiversity and people's lives.

Photos by Miguel Fortes

structure needed to support systematic ocean observations and data and information exchange (including coastal applications and biological studies). Attended by more than 150 participants, its success was evident from the significantly greater number of abstracts submitted during the Symposium (184, compared to 116 at the Fifth Symposium in Seoul, Korea). Furthermore, the application of more sophisticated state-of-the-art technologies, such as biomolecular genetic markers, new generation remote sensing and data and information management packages, were presented at this latest symposium.

Over 80 per cent of the region's reefs face risks and total marine fish production in the region has fallen dramatically. The beautiful Orange Spotted Filefish, shown here, is dependent on living coral for food and a place to live and is not expected to survive if the reefs collapse.

A Changing Ethic

There is now a growing movement to protect, understand, and sustainably use the seas and the ocean in the Western Pacific. It is becoming more and more accepted that the effectiveness of management actions to protect the ocean cannot be assessed without scientific knowledge and analysis. There are, however, significant obstacles that must be overcome before we can fully apply ocean science, and before IOC/WESTPAC becomes the ocean's effective steward in the region. The health of a science, which determines how effectively researchers can provide needed information to decision-makers, depends on the training of researchers, their status in society, and the facilities and funding available to them. While governments in the region have not been remiss either in this endeavour or in offering solutions to improve the generally bleak ocean situation, these efforts give short-term benefits and degrade the environment at society's cost. The overall results have aggravated the social and economic conditions of the greater portion of the region's population, turning ecological concerns into serious socio-economic issues. Today these issues bring about problems with far-reaching effects that go beyond socio-political boundaries. Undeniably, 'environmental security' along the coasts of the Western Pacific has recently become a serious concern. This is where IOC/WESTPAC and its partners play an important role. Indeed, its primary task is to help the region develop and nurture an ethic that views the seas as a resource in need of our stewardship and not simply a commodity.

The IOCWIO Project Office

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The IOCWIO Project Office was relocated from the Kenya Marine and Fisheries Research Institute in Mombasa, Kenya to the UNESCO Nairobi, Kenya office (United Nations office at Nairobi), which is also the UNESCO Regional Office for Science and Technology in Africa.

This move was necessitated by the need to improve the profile of the office and enable IOC's programmes in the region to work closely with and benefit from other relevant UNESCO Programmes. The IOCWIO Project Office will also be able to collaborate better with other UN bodies and programmes located in Nairobi, such as the United Nations Environment Programme (UNEP), the International Maritime Organization (IMO) and the World Meteorological Organization (WMO).

Dr Antonio Hoguane (Mozambique) and Dr Onésime Richard Ratomahenina (Madagascar) took over as Chair and Vice Chair of IOCWIO respectively, replacing Dr Rafamantanantsoa Jean Gervais (Madagascar) and Mr Ilidio Goenha (Mozambique).


NEPAD
COSMAR news
NIGER DELTA HIT BY FREQUENT OIL SPILLS
Coasts and Oceans: Hope for Africa
NEPAD
COSMAR news
WHALES ENDANGERED OFF SOMALIA
Coasts and Oceans: Hope for Africa

The African OceanPortal and its newsletter were redesigned to reflect the NEPAD/COSMAR focus.

The move to Nairobi enabled the IOCWIO Project Office to work closely with the recently established Secretariat for the Coastal and Marine sub-theme of NEPAD (COSMAR), which is located at the National Environment Management Agency in Nairobi, Kenya. IOCWIO and the New Partnership for Africa's

The IOC's Regional Committee for the Western Indian Ocean (IOCWIO) addresses the need for an effective, Africa-based coordination mechanism to assist in planning and implementing regional research, monitoring and management programmes. By focusing on the development and strengthening of capacity for observations and monitoring of the oceans and coastal areas, resulting data and information are able to be analysed and interpreted for the sustainable management of the marine environment and resources.

For more information:
http://ioc.unesco.org/iocinwio

Participants at the San Marco Space Station (Malindi, Kenya) during the remote sensing training course last September.

Development (NEPAD)/COSMAR initiated a comprehensive review and assessment of projects/programmes relating to the coastal and marine environment in Africa. This was carried out with a view to enabling the NEPAD/COSMAR Secretariat to advise and guide the implementation and development of new and existing projects and programmes. The report of the review will be presented to the NEPAD Environment Partnership Conference planned for the first quarter of 2005.

The development of the African OceanPortal was another focus for collaboration between IOC and NEPAD/COSMAR. The portal and its newsletter were redesigned to reflect the NEPAD/COSMAR focus. Two issues of the newsletter, now renamed ‘COSMAR News’, have been published and distributed.

The core institutions involved in the development and editing of the African OceanPortal were provided with support to enable them to improve internet access so that they could be more effective. The Institut Halieutique et des Sciences Marines (Madagascar) and the Nigerian Institute for Oceanography and Marine Research installed VSAT links, while the Kenya Marine and Fisheries Research Institute, and the Institute of Marine Sciences (Tanzania) upgraded their terminal equipment. Centre de Recherches Océanologiques (Cote d’Ivoire) and the Institut Mauritanien de Recherches Océanographiques et des Pêches (Mauritania) will be upgrading terminal equipment in 2005.

A training course on ‘Application of Satellite Altimetry’ was organized in collaboration with the Western Indian Ocean Marine Science Association (WIOMSA) and the Italian Space Agency and was held at the San Marco Research Centre (also known as Luigi Broglio Space Centre), Malindi, Kenya, 6–17 September 2005. The objective of the course was to give the participants (with some background knowledge of oceanography) a good grasp of the principles of altimetry and develop basic skills in its practical applications using both altimeter and *in situ* data collected from the Western Indian Ocean (WIO) region specially designed to demonstrate some interesting dynamical oceanography features. The limitations of altimetry and how they are overcome was also demonstrated by using altimetry in synergy with other satellite remote sensing techniques.

The ‘Application of Satellite Altimetry’ training course.

All photos by David Kirugara of Kenya Marine and Fisheries Research Institute

Capacity Building:
Towards an Implementation Plan

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Our ocean is being depleted of its resources and invaluable time continues to be lost whilst uneven capacities to address ocean issues exist around the world. Simply put, capacity to understand and protect ocean resources is being built slower than the destruction of those same resources. For the Capacity Building Section at the Intergovernmental Oceanographic Commission of UNESCO this means that besides standard deliverables and performance indicators, we additionally need to review the task of building capacity to search for fundamental and long-term solutions. An estimation of the real impacts that building capacity in communities has is needed in order improve future capacity building interventions and thereby help people lead safer lives, protect their livelihoods, and draw sustainable economic benefits from healthy oceans and coasts.

Examples of note to adopt and adapt

The Third World Academy of Sciences (TWAS) in its research report 'Building Scientific Capacity' promotes an uplifting principle for capacity building: 'respect, honour and support'. Living up to its own principle, TWAS has honoured and supported scientists and institutions, based purely on their scientific excellence, from scientifically lagging, least developed or heavily indebted poor countries raising hope that, economic status notwithstanding, excellence does exist in the most unexpected places and responds positively to recognition and support. Disappointingly however, only a tiny number of these cases deal with oceanography.

Capacity building for marine scientific research therefore must look for other ways of addressing this seemingly intractable issue. It is our belief that, in addition to 'respect honour and support', self-respect through self-help will be a key step in emerging from the cycle of dependency. How do we weave this into a strategy for capacity building and an implementation plan in a way that makes a major difference to the state of health of our oceans and coasts whilst recognizing that people are central to the process? We began by defining a vision that embodied this key step, and after much debate, reached agreement that:

> The vision of IOC capacity building is to establish networks of scientists, managers and other practitioners working within regional and similar cooperative mechanisms, to create demand-driven science, enhance protection of the marine environment and provide operational oceanographic services for the benefit of all humanity.

Put another way, IOC envisions a world where local scientists create products that have real benefits for their com-

Photo by Andrea Rasetti

IOC envisions a world where local scientists create products that have real benefits for their communities.

munities, real enough to attract supporting funds and of such excellence as to contribute to the larger global framework.

The process in developing principles and strategy for capacity building

With a vision statement to target, a strategy was drafted and presented to the IOC Executive Council in June 2004. This was followed by six months of dialogue with Member States to incorporate their comments and suggestions into the final draft strategy and vision statement. The result of all these inputs is a richer, more inclusive document profiting from the experiences and aspirations across the spectrum of IOC Member States.


Dr Venu Ittekkot, Chairman of the Consulting Group on Capacity Building.

In this process we were also fortunate to have the experience and wisdom of a group of scientists, science administrators, directors of scientific institutions, and scientific advisors to guide us. They form the Consultative Group on Capacity Building (CGCB), set up by the IOC Executive Secretary, to guide the Capacity Building Section as it developed its basic documents 'Principles and Strategy' and the 'Implementation Plan'. The final Draft Strategy for Capacity Building will be presented to the Assembly in June 2005. It is summarized as follows:

1. Capacity building interventions will follow the Principles of Capacity Building.
2. The Medium-Term Strategy of IOC, and its main operating themes, will be the framework within which IOC capacity building initiatives will be aligned and harmonized.
3. Ongoing regional projects, addressing key regional concerns, will be primary vehicles for capacity building interventions.
4. Regional project objectives will be facilitated through Capacity Building Pilot Programmes. Submission to funding agencies of pilot proposals, formulated by regional networks of scientists, will be facilitated by IOC regional entities in cooperation with the IOC secretariat. Importance will be paid to leadership programmes for heads of organizations and team-building programmes for scientists.
5. Capacity Building Pilot Programmes will address training needs in close partnership with the Global Ocean Observing System (GOOS), the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), the Coastal Ocean Observations Panel (COOP), the Committee on Earth Observation Satellites (CEOS) and other organizations and programmes on available operational products, remote sensing data and numerical model outputs. This will form the short-term component of the Pilot Programmes – the "know-how".
6. Education and research programmes will form the long-term components of the Capacity Building Pilot Programmes – the "know-why". In this way, products specific to regional needs can be created in future.
7. Regional networks of scientists and stakeholders participating in the Pilot Programmes will be facilitated to nucleate a Regional Resources Hub where they can continue working together and creating products specifically for regional communities.
8. In appreciation of differing capacities for marine scientific research between countries in a region, country-specific programmes will be carried out. These will pay special attention to building up institutional and legal frameworks, mutual assistance, and transfer of technology.
9. Partners and programmes whose capacity building strategies are in harmony with the IOC Principles of Capacity Building will be sought. In particular JCOMM, GOOS and COOP will form the core group for operational products.
10. Information and communication and awareness raising at different societal levels will be important activities in support of capacity building at the professional levels.
11. Funding resources are critical to capacity building efforts and several mechanisms will be evolved to ensure that interventions do not falter because of lack of resources.
12. Capacity building initiatives will be evaluated for effectiveness and efficiency and best practices continuously distilled from such analyses.

We strongly believe that with innovative and passionate leaders, supported by committed scientific teams addressing concerns of their regions, no problem can remain intractable

Keys to success in the strategic process

The underlying principle of sustainability is maintained through self-determined capacity building efforts. In this frame we target heads of research institutes/universities/industries as key players in combination with scientists, working in true teamwork. We strongly believe that with innovative and passionate leaders, supported by committed scientific teams addressing concerns of their regions, no problem can remain intractable. This principle of sustainability reflects in initiatives of 'know-how' as well as 'know-why'. 'Know-how' addresses quick returns on capacity building investments through training, whilst 'know-why' addresses the longer-term or 'sustainable' element of capacity building through education and research.

The internet and mobile telephony have opened new opportunities that capacity building must exploit. Capacity building must set the right elements in place, for sustainability to take.

The key funding approach prescribed is writing proposals for funding that are business-like in their approach by having clear, well-defined deliverables and associated performance indicators. Long-term committed sponsors are needed who understand that the capacity building process is not short. They must be willing to stay the course, without compromising on first-class deliverables measured against demanding performance indicators.

There are many other important elements in the strategy document. These address partners, their programmes, operational products, remote sensing, GIS, and modelling. Given the enormity of the capacity building task, executing entities will be as important as the philosophy of the strategy. In this process we see the GOOS Regional Alliances as key partners through which operational training can be effected. The marine operational community has much to offer, and partners and programmes such as GOOS, COOP, and JCOMM have greater resources and programmes to which the IOC capacity building efforts must contribute.

Best Practices and the Implementation Plan

The Executive Council also asked for a study on IOC Best Practices in Capacity Building. The Secretariat was further directed to develop an implementation plan as a follow-up to the strategy. The USA generously supported both these requests. As a result a Best Practices study was contracted to Groman Consulting International Ltd., and the document will be ready as an information document for the Twenty-third Assembly.

The Implementation Plan Workshop will be held in the first quarter of 2005. The Secretariat has drafted an 'Approach to the Implementation Plan' to assist regions format content on the different initiatives in their regions. This content will be used to prioritize interventions and align them within the Main Lines of Action of IOC. We expect to have attendance of all the Chairs of the IOC Regions present so that the plan is a true reflection of the concerns of the region. Sponsors of capacity building programmes, funding agencies, and Member States will be invited. The Workshop will be attended and coordinated by the CGCB.

Training, Education and Mutual Assistance (TEMA)

Regional Activities and Projects

The IOC Capacity Building Secretariat co-organized and provided funding for several regional capacity building events directly linked to the IOC's programme of work. Some highlights from 2004 include:

PORSEC 2004: 'Remote Sensing of Oceans, Coasts and the Atmosphere'. Regional capacity building events, such as this one held in Chile, are directly linked to the IOC's programme of work.

Capacity Building Intervention	Location	Sectional Activity	Date
Regional Training Course on 'Application of Satellite Altimetry to Oceanography'	Luigi Broglio Space Centre, Malindi, Kenya	IOCWIO, TEMA	Sept. 2004
Regional Workshop on 'El Niño Early Warning for Sustainable Development in Pacific Rim Countries and Islands'	San Cristobel, Galapagos Islands, Ecuador	IOCARIBE, TEMA	Sept. 2004
Second Symposium on 'Global Ocean Data Assimilation Experiment in Operation: Demonstrating Utility'	St. Petersburg, USA	TEMA	Nov. 2004
Regional Workshop on 'Remote Sensing Capacity Building Needs for Latin America and the Caribbean'	University of Concepción, Chile	IOCARIBE, TEMA	Nov. 2004
PORSEC 2004: 'Remote Sensing of Oceans, Coasts and the Atmosphere'	University of Concepción, Chile	IOCARIBE, TEMA, GOOS	Nov. 2004
Postgraduate course in Oceanography: 'Use of RS and GIS for Coastal Water Applications'	University of Concepción, Chile	IOCARIBE, TEMA	Oct.–Dec. 2004
Travel grants for twelve scientists from developing regions	Latin America, Eastern Europe, Africa, Middle East, Asia	TEMA	2004
Innovative coastal research grants for scientists from Chile and Senegal	Brest, France and Bilbao, Spain	TEMA	2004
IOC–SCOR–POGO Fellowships to seventeen scientists	Spain, Canada, Italy, Malaysia, UK, New Zealand, Mauritius	TEMA	2004
Travel grants to scientists to attend POGO Meeting in France	Brest, France	TEMA, POGO	Nov. 2004
Diffusion of ASFA–IAMSLIC information and database products to research institutes in developing countries	Africa	TEMA, IODE	2004
Two participants to the ICES–IOC Working Group on HAB Dynamics	Calvi, France	Ocean Sciences	Apr. 2004
FANSA Portal Itajai, Brazil	Itajai, Brazil	Ocean Sciences	June 2004
Fourteen individual internships at the IOC–VIGO HAB Centres	Copenhagen, Denmark and Vigo, Spain	Ocean Sciences	2004
IOC Training Course on HAB Identification for sixteen participants	Copenhagen, Denmark	Ocean Sciences	July 2004
IOC IAEA Training Course on HAB South East Africa for ten participants	Cape Town, South Africa	Ocean Sciences	June 2004
Ocean TTR 14 onboard R/V *Prof. Logachev* for thirteen participating research institutes	N. Atlantic/W. Mediterranean Cruises	Ocean Sciences	July–Sept. 2004
Twelfth Post TTR Cruise Meeting on 'North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes' attended by fifteen research students	Copenhagen, Denmark	Ocean Sciences	Jan. 2004
Oceanographic Training on the Beagle Earth Global Expedition 2003 (BEAGLE)	Australia and Southern Hemisphere	Ocean Sciences	2003–2004
NIPPON Foundation–GEBCO Training Project Postgraduate Certificate in Ocean Bathymetry	University of New Hampshire, USA	REGIONS	2004
BILKO Learning Project: Virtual Global Faculty for Remote Sensing	Developed at Southampton Oceanography Centre, UK	GOOS	Oct. 2004
Travel support to five participants from developing countries to attend the COSPAR Scientific Assembly	Paris, France	GOOS	July 2004
First Capacity Building Workshop for the GOOS Regional Alliances Network Development (GRAND)	Imperial College, University of London, UK	GOOS	Sept. 2004
UNESCO cross-cutting project 'Application of Remote Sensing for Integrated Management of Ecosystems and Water Resources in Africa' organized the Coastal Ocean Satellite Remote Sensing Session and Workshop in the framework of the Fifth Conference of the African Association of Remote Sensing of the Environment, and support for two participants	UNEP Nairobi, Kenya	UNESCO CCT and IOC–GOOS	Oct. 2004

Dissemination of data, information and GOOS products throughout the Pacific Island Region in cooperation with WMO and other agencies	South Pacific	GOOS	2004
Training Course for Editors of the African Ocean Portal (part of cross-cutting project on UNESCO Knowledge Portals); ten participants from Cote d'Ivoire, Ghana, Kenya, Madagascar, Senegal and Tanzania	Accra, Ghana	IODE	Nov. 2004
Planning Workshop for Ocean Data Management in Colombia (National Level); more than thirty-five participants	Cartagena, Colombia	IODE	June 2004
Ocean Data Management Training Workshop (National Level); more than fifteen participants with a regional ODINCARSA trainer	Caracas, Venezuela	IODE	Oct. 2004
Ocean Data Management Training Course (National Level); more than twenty participants	Valparaiso, Chile	IODE	Nov. 2004

Section News

In 2004, the IOC Secretariat strengthened its capacity building activities by creating a new Section. **Ehrlich Desa**, earlier with the National Institute of Oceanography at Goa, India (which was founded in response to the International Indian Ocean Expedition in which IOC played a coordinating role) joined the Secretariat in December 2003.

The emerging Capacity Building Section has to grow fast in both human and financial resources. It presently has only one other regular employee in **Sonia Guiraud** who ably administers, budgets, and carries out all the innumerable tasks that crop up in an intergovernmental organization. The Section was very fortunate to have the temporary services of **Peter Enone**, a Cameroonian student studying at the Free University of Brussels, and **Joannes Berque**, a recent doctorate from Scripps Institute of Oceanography. For the short periods that they are working in the Capacity Building Section they have brought some refreshing enthusiasm and the optimism necessary in these tasks.

Annexes

Photo by Andrea Rasetti

IOC Officers

IOC Officers at Major's Parlour, Winchester, UK, 23 January 2004.

Front row from left: Dr Patricio Bernal (Chile)[Executive Secretary];
Dr David Thomas Pugh (UK)[Chairman];

Standing from left: Dr Alexander V. Frolov (Russia); Prof. Su Jilan (China) [Past-Chairman]; Dr K. Radhakrishnan (India), Prof. Mário Ruivo (Portugal); C. de Navío Javier Armando Valladares (Argentina); Prof. Amor El Abed (Tunisia); [Vice-Chairmen]

The IOC Rules of Procedure indicate that the Officers of the Commission shall consist of the Chairperson and five Vice-Chairpersons. The five Vice-Chairpersons shall be nationals of Member States of different electoral groups (as listed in Appendix II of the Rules of Procedure.) The IOC Officers are elected every two years for a maximum of two terms.

IOC Member States

AFGHANISTAN	(11 March 1991)
ALBANIA	(26 January 1993)
* ALGERIA	(Jul. 1964/Nov.1965)
ANGOLA	(26 October 1982)
* ARGENTINA	(Before November 1961)
* AUSTRALIA	(Before November 1961)
AUSTRIA	(Oct. 1962/Jun. 1964)
AZERBAIJAN	527 January 1998)
BAHAMAS	(29 January 1979)
BANGLADESH	(29 October 1982)
BARBADOS	(18 December 1985)
* BELGIUM	(Before November 1961)
BELIZE	(22 September 1995)
BENIN	(23 October 1986)
* BRAZIL	(Before November 1961)
BULGARIA	(Oct. 1967/Dec. 1969)
CAMEROON	(Nov. 1971/Nov. 1973)
* CANADA	(Before November 1961)
CAPE VERDE	(20 August 1984)
* CHILE	(Before November 1961)
* CHINA	(Before November 1961)
COLOMBIA	(Oct. 1967/Dec. 1969)
COMOROS	(08 February 2000)
CONGO	(Nov. 1961/Sep. 1962)
* COSTA RICA	(28 February 1975)
COTE D'IVOIRE	(Before November 1961)
CROATIA	(24 December 1992)
* CUBA	(Before November 1961)
CYPRUS	(05 December 1977)
Democratic People's Republic of KOREA	(31 October 1978)
DENMARK	(Before November 1961)
DOMINICA	(21 September 1999)
DOMINICAN REP.	(Before November 1961)
* ECUADOR	(Before November 1961)
* EGYPT	(Oct. 1969/Nov. 1971)
EL SALVADOR	(16 February 1993)
ERITREA	(12 November 1993)
ESTONIA	(10 March 1992)
ETHIOPIA	(05 March 1976)
FIJI	(09 July 1974)
* FINLAND	(Before November 1961)
* FRANCE	(Before November 1961)
* GABON	(26 October 1977)
GAMBIA	(30 August 1985)
GEORGIA	(09 July 1993)

* GERMANY	(Before November 1961)
GHANA	(Before November 1961)
GREECE	(Oct. 1962/Jun. 1964)
GUATEMALA	(Dec. 1965/Oct. 1967)
GUINEA	(01 May 1982)
GUINEA-BISSAU	(26 January 1984)
GUYANA	(20 July 1977)
HAITI	(23 March 1976)
ICELAND	(Oct. 1962/Jun. 1964)
* INDIA	(Before November 1961)
* INDONESIA	(Oct. 1962/Jun. 1964)
* IRAN, Islamic Republic of	(03 June 1975)
IRAQ	(Oct. 1969/Nov. 1971)
IRELAND	(07 November 1978)
ISRAEL	(Before November 1961)
* ITALY	(Before November 1961)
* JAMAICA	(Oct. 1967/Dec. 1969)
* JAPAN	(Before November 1961)
JORDAN	(06 April 1975)
* KENYA	(Nov. 1971/Nov. 1973)
KUWAIT	(13 November 1974)
LEBANON	(Oct. 1962/Jun. 1964)
LIBYAN ARAB JAMAHIRIYA	(11 March 1974)
MADAGASCAR	(Dec. 1965/Oct. 1967)
* MALAYSIA	(Jul. 1964/Nov. 1965)
MALDIVES	(20 May 1987)
MALTA	(Oct. 1969/Nov. 1971)
MAURITANIA	(Before November 1961)
MAURITIUS	(Oct. 1969/Nov. 1971)
* MEXICO	(Before November 1961)
MONACO	(Before November 1961)
MOROCCO	(Before November 1961)
MOZAMBIQUE	(08 April 1981)
MYANMAR	(07 June 1988)
NAMIBIA	(25 April 2001)
NETHERLANDS	(Before November 1961)
NEW ZEALAND	(Nov. 1961/Sep. 1962)
NICARAGUA	(17 November 1977)
* NIGERIA	(Nov. 1971/Nov. 1973)
NORWAY	(Before November 1961)
OMAN	(16 November 1982)
PAKISTAN	(Before November 1961)
PANAMA	(Oct. 1967/Sep. 1969)
* PERU	(Dec. 1965/Oct. 1967)
* PHILIPPINES	(Oct. 62/Jun. 1964)

POLAND	(Before November 1961)
* PORTUGAL	(Oct. 1969/Nov. 1971)
QATAR	(20 July 1976)
* REPUBLIC OF KOREA	(Before November 1961)
ROMANIA	(Before November 1961)
* RUSSIAN FEDERATION	(Before Nov. 1961)
SAINT LUCIA	(14 September 1992)
SAMOA	(10 April 1978)
SAUDI ARABIA	(14 June 1978)
* SENEGAL	(Oct. 1967/Sep. 1969)
SEYCHELLES	(27 February 1979)
SIERRA LEONE	(19 April 1974)
SINGAPORE	(Dec. 1965/Oct. 1967)
SLOVENIA	(16 June 1994)
SOLOMON ISLANDS	(11 May 1982)
SOMALIA	(10 July 1974)
* SOUTH AFRICA	(Oct. 1967/Sep. 1969)
* SPAIN	(Before Nov.1961)
SRI LANKA	(Jun. 76/Jan. 1977)
SUDAN	(26 August 1974)
SURINAM	(21 January 1977)
SWEDEN	(Jul. 1964/Nov. 1965)
SWITZERLAND	(Before Nov. 1961)
SYRIAN ARAB REP.	(Oct.1969/Nov. 1971)
THAILAND	(Before Nov. 1961)
TOGO	(22 October 1975)
TONGA	(03 January 1974)
TRINIDAD & TOBAGO	(Oct. 1967/Sep. 1969)
* TUNISIA	(Before Nov. 1961)
* TURKEY	(Nov. 1961/Sep. 1962)
* UKRAINE	(Nov. 1961/Sep. 1962)
UNITED ARAB EMIRATES	(02 June 1976)
* UNITED KINGDOM OF GREAT BRITAIN & NORTHERN IRELAND	(Before Nov. 1961)
* UNITED REPUBLIC OF TANZANIA	(Oct. 1967/Sep. 1969)
* UNITED STATES OF AMERICA	(Before Nov. 1961)
URUGUAY	(Before Nov. 1961)
VENEZUELA	(Oct. 1962/Jun. 1964)
VIET NAM	(Before Nov. 1961)
YEMEN	(22 May 1960)

* Members of the Executive Council

IOC Structure

ASSEMBLY
EXECUTIVE COUNCIL
EXECUTIVE SECRETARY
SECRETARIAT

Ocean Sciences

- Oceans and Climate (WCRP, JGOFS, CLIVAR, El Niño, SCOR-IOC Advisory Panel on Ocean CO_2)
- Science for Ocean Ecosystems and Marine Environmental Protection (HAB, Indicators for Ecosystem Health, Nutrient Enrichment, LME, Biosphere-Geosphere Coupling)
- Marine Science for Integrated Coastal Area Management (COASTS, LOICZ-Basins, ICAM Indicators, Global Web-Service, Coastal Megacities, ICAM Methodological Manual)
- United Nations Convention on the Law of the Sea (IOC/ABE-LOS, ABLOS, Special Arbitration)

Operational Observing Systems

- Global Ocean Observing System (GOOS)
- GOOS Modules, Regional Bodies and Pilot Projects (OOPC, COOP, GODAE, Argo)
- Integrated Global Observing Strategy (IGOS)
- Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) (DBCP, SOOP, TIP, GLOSS)
- Global Climate Observing System (GCOS)
- Satellite Remote Sensing

Ocean Services

- International Oceanographic Data and Information Exchange (IODE) (GODAR, MIM, GTSPP, MEDI, ASFA, GETADE, GEBCDMEP, GEMIM, Ocean Teacher, OceanPortal, OceanExpert, MarineXML)
- IODE regional projects (ODINAFRICA, ODINCARSA, Regional Ocean Portals, MEDAR/MEDATLAS)
- IDNDR-Related Activities International Tsunami Warning System (ITSU)
- Ocean Mapping (GEBCO, GAPA, IBCM)
- Public Information (IOC website, newsletters, other publications, posters, brochures and leaflets, public events)

CAPACITY BUILDING

TEMA • POGO • FELLOWSHIPS • TTR

REGIONS

2 Regional Subcommissions, 4 Committees and 6 Programme/Project offices

- IOCARIBE
- WESTPAC
- IOCINDIO
- IOCWIO
- IOCEA
- Black Sea
- HAB Office, Copenhagen, Denmark
- HAB Office, Vigo, Spain
- DBCP/Argo Office, Toulouse, France
- GOOS Office, Perth, Australia
- GOOS Office, Rio de Janeiro, Brazil
- IOCWIO Project office, Nairobi, Kenya

Organization of Secretariat Staff

- Permanent Staff/Fixed-Term
- Temporary Posts
- ALDs
- Supernumerary
- **Consultants** *(unless otherwise specified)*

ADG/IOC
Executive Secretary
Patricio Bernal

OFFICE OF THE ADG

ASSISTANT OF THE ADG
- B. Aliaga

UNCLOS CONSULTANT
- A. Mateos

ADMINISTRATIVE ASSISTANT
- K. Yvinec

SECRETARIES
- R. Hervé-Smadja
- G. Bénière *(until Aug.)*
- S.Sermeno *(halftime, since Nov.)*

DOCUMENTALISTS
- P. Boned
- C. Pontes

HEAD OF SECTION TEMA/Regions
E. Desa

SECRETARIAT
- S. Guiraud
- S. Sermeno *(half-time)*

REGIONAL PROJECT OFFICES/SUBCOMMISSIONS

Professional Staff
- **M. Fortes,** *WESTPAC, Bangkok, Thailand*
- **C. Toro,** *IOCARIBE, Cartagena, Colombia*
- **W. Erb,** *Perth Office, Australia*
- **J. Trotte,** *Rio Office (part-time), Brazil*
- **M. Odido,** *IOCWIO Office, Nairobi, Kenya*

General Services Staff
- **W. Velez,** *IOCARIBE, Cartagena, Colombia*
- **N.Saransunth,** *(local post), WESTPAC, Bangkok, Thailand*

HEAD OF SECTION Ocean Sciences
U. Unluata

PROFESSIONALS
- J. Barbière
- M. Hood
- H. Enevoldsen *(Copenhagen)*
- O. Vestergaard *(until Dec.)*

SECRETARIAT
- C. Le Conan
- V. Bonnet

HEAD OF SECTION Operational Observing Systems, GOOS
C. Summerhayes
K. Alverson *(since Aug.)*

PROFESSIONALS
- T. Aarup
- B. Lee
- A. Fisher *(since March)*
- **C. Clark** *(NOAA Secondment)*
- **Y. Tréglos** *(WMO/Consultant since Mar.)*
- **J. Ahanhanzo**
- E. Charpentier *(Toulouse)*
- M. Bélbéoch *(Toulouse)*
- **K. Hashimoto** *(Associate Expert until Nov.)*

SECRETARIAT
- I. Gazagne
- H. H. Lam
- C. Whelan/ P. Coughlan

HEAD OF SECTION Ocean Services/IODE
P. Pissierssens

PROFESSIONALS
- **D. Travin**
- V. Vladymyrov
- **R.B. Gelfeld** *(NOAA Secondment)*
- B. Sims
- **J. Perce** *(part-time)*

SECRETARIAT
- F. Schiller-Ricotou
- A. Vannier

IOC Personnel

Headquarters personnel shown in the photo (left to right):
Front row: Dr K. Radhakrishnan (Vice-Chairman), Dr David T. Pugh (Chairman), Prof. Su Jilan (Past-Chairman), Dr Patricio Bernal (Executive Secretary), Prof. Mário Ruivo (Vice-Chairman), Christiane Le Conan, Cigié Pontes
Second row: Ole Vestergaard, Cesar Toro, Maria Hood, Peter Pissierssens, Thorkild Aarup
Third Row: Mika Odido, Patrice Boned, Jennifer Perce, Silvia Semeño, Françoise Ricotou, Dimitri Travin
Fourth Row: Gregory Reed (ex Staff), Sonia Guiraud, Julian Barbière, C. de Navío Javier Armando Valladares (Vice Chairman), Prof. Amor El Abed (Vice-Chairman), Benjamin Sims, Colin Summerhayes, Boram Lee, Umit Unluata, Justin Ahanhanzo, Bernardo Aliaga
Top Row: Adrien Vannier, Kasu Hashimoto

Personnel not shown in the above photo:
Keith Alverson, Graziela Bénière, Mathieu Belbéoch, Virginie Bonnet, Candyce Clark, Etienne Charpentier, Pamela Coughlan, Ehrlich Desa, Henrik Enevoldsen, William Erb, Albert Fischer, Miguel Fortes, Irène Gazagne, Bob Gelfeld, Ho Hien Lam, Aurora Mateos, Nachapa Saransunth, Yves Tréglos, Janice Trotte, Vladymyr Vladymyrov, Patricia Wills Velez, Ksenia Yvinec

In Memoriam

One of the world's notable tide modellers and leaders in GODAE

Photo courtesy of Bertrand Le Provost

Dr Christian Le Provost (1943-2004)

In 2004 the Intergovernmental Oceanographic Commission of UNESCO noted with sorrow the passing of our colleague and friend, Dr Christian Le Provost. He was a highly esteemed oceanographer and it was an honour to have worked with him. In particular, we express our debt to him for his dedication and contribution to the Global Sea Level Observing System (GLOSS) and the Global Ocean Data Assimilation Experiment (GODAE). Our condolences are with his family.

Patricio A. Bernal
Executive Secretary, IOC of UNESCO

The sudden death of Christian Le Provost came as a shock to all who knew Christian in the IOC community. Christian was a highly distinguished scientist and one of the world's leading tide modellers.

Dr Christian Le Provost died suddenly on 29 February 2004 while on vacation in Brittany, France.

Christian began his research career at France's National Centre for Scientific Research (CNRS) as a research engineer in 1967 and became Director of Research in 1984. In 1980 he created the research group 'Modélisation des Ecoulements Océaniques et des Marées' at Institut de Mécanique de Grenoble (IMG), a group which he directed until 1996. In 1997 Christian moved to Toulouse to become the Director of the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), a position which he held until 2003.

Christian Le Provost conducted pioneering research in ocean physics, remote sensing and ocean modelling, always acting at the forefront of these disciplines. He published more than eighty refereed publications. His early research was focused on both theoretical and experimental studies of non-linear tides in the coastal ocean. These results were applied to the English Channel in association with application of a physical model implanted on the 'rotating Grenoble platform'. This yielded remarkable insight in terms of characteristics of amplitude and phase of the tidal constituents for the area. With access to high speed computers Christian's work turned towards numerical tidal and ocean modelling, first on a regional scale and later on a global scale. His contributions to the understanding of ocean tides and the use of remote sensing in the numerical hydrodynamical modelling of this phenomenon are exceptional achievements, for which he received the Nansen Medal from the European Geophysical Society in 1999. He was also awarded the Grand Prix des Sciences de la Mer de l'Académie des Sciences de l'Institut de France in 1999 and the Prix Scientifique Emile Girardeau de L'Académie de Marine in 2000.

Christian maintained his zest for wanting to understand even more. Towards the end of his life he was focused on the phenomenon of internal tides and their impact on vertical mixing of water masses, which had long been unattainable for modelling. He recently wrote to a friend, 'this is the last big challenge for me to attain. I am five years away from retirement and that might be just enough to clear up this field that I truly believed was out of reach of study and modelling, even at the scale of a basin, before our discoveries with the Topex/Poseidon data and the proof of their importance upon the dissipation of tides and ocean circulation.'

Parallel to maintaining an active research career and for some years also being Director of the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales, Christian played a very active role in many international scientific projects and groups. He participated in the Intergovernmental Oceanographic Commission of UNESCO's Global Sea-Level Observing System (GLOSS) Group of Experts since the early 1990s, of which he was just elected Chair in October 2003. He was also a member of the Ocean Observations Panel for Climate (OOPC), the steering committee on the Global Data Assimilation Experiment (GODAE) and the associated French initiative for operational global ocean high resolution monitoring and forecasting – MERCATOR, co-president of the Science Working Team for Topex/Poseidon/Jason satellite missions and Chair of the Atlantic Task Team of EuroGOOS, to name a few.

Just before he died, Christian compiled and presented a major overview of the role of sea level data within coastal and deep ocean data assimilation at a meeting of sea level scientists at the Royal Society in London.

Christian's achievements measure high and he was one of the tall trees in the forest that now has fallen, along with Galileo, Descartes, Kepler, Newton, Euler, Bernoulli, Kant, Laplace, Airy, Lord Kelvin, Jeffreys and Munk.

To many of us Christian was a very good friend and he has left a big gap in the community and will be sadly missed.

Text courtesy of Bernard Barnier, Jean-Marc Molines, Jacques Verron, S. Debarbat and Philip Woodworth.

Background photo by Andrea Rasetti

Publications and Public Awareness

IOC Publications

Each year the IOC publishes numerous documents and other publications. These publications support its programme activities and communicate the scientific and organizational information resulting from the various conferences, meetings, training courses and other activities that have benefited from IOC's support. Many of these publications are available on the internet; certain titles are also available in print where the internet is not an option.

IOC TECHNICAL SERIES

Gupta, Harsh K. 2004. *Anton Bruun Memorial Lecture, 2003. Gas-Hydrates – A Potential Source of Energy from the Oceans*. (Technical Series, 65.) 28 pp. (English.)

Rayner, Ralph. 2004. *Anton Bruun Memorial Lecture, 2001. Operational Oceanography – A Perspective from the Private Sector*. (Technical Series, 58.) (English.)

Takahashi, Patrick. 2004. *Anton Bruun Memorial Lecture, 2003. Energy from the Sea: The Potential and Realities of Ocean Thermal Energy Conversion (OTEC)*. (Technical Series, 66.) 29 pp. (English.)

IOC MANUALS AND GUIDES

2004. Submarine Groundwater Discharge: Management Implications, Measurements and Effects. (Manuals and Guides, 44.) 35 pp. (English.)

IOC WORKSHOP REPORTS

Vanden Berghe, Edward et al. (eds). 2004. *Proceedings of the Colour of Ocean Data Symposium, Brussels, 25–27 November 2002*. Paris, UNESCO/IOC, Oostende, VLIZ. (Workshop Reports, 188.) 307 pp. ISSN 1377-0950. (English.)

2004. *First ODINCARSA Planning Workshop for Caribbean Islands, Christchurch, Barbados, 15–18 December 2003*. (Workshop Reports, 190.) (English, electronic copy only.)

2004. *North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes – International Conference and Twelfth Post-Cruise Meeting of the Training-Through-Research Programme, Copenhagen, Denmark, 29–31 January 2004*. (Workshop Reports, 191.) 49 pp. (English)

2004. *Workshop on New Technical Developments in Sea and Land Level Observing Systems, Paris, France, 14–16 October 2003*. (Workshop Reports, 193.) 211 pp. (English, electronic copy only.)

TRAINING COURSE REPORTS

2004. *ODINAFRICA II Training Course in Marine Data Management, Maputo, Mozambique, 11–22 August 2003*. (Training Course Reports, 73.) 16 pp. (English, electronic copy only.)

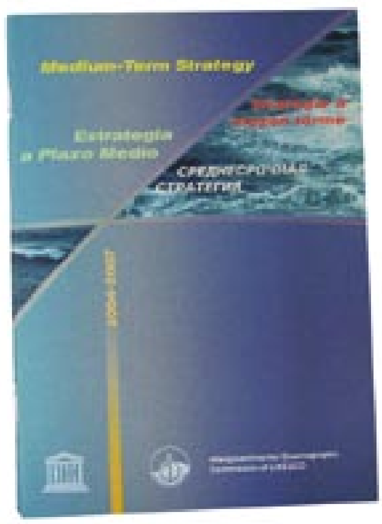
2004. *Final ODINAFRICA II Training Course in Marine Data Management, Brussels, Belgium, 1–5 September 2003*. (Training Course Reports, 74.) 68 pp. (English, electronic copy only.)

2004. *Second ODINCARSA Training Course in Marine Data Management, Cartagena, Colombia, 13–17 October 2003*. (Training Course Reports, 75.) (English, electronic copy only.)

2004. *IOC/JCOMM Training Course for the Global Sea Level Observing System (GLOSS) on Sea Level Observation and Analysis, Kuala Lumpur, Malaysia, 9–20 February 2004*. (Training Course Reports, 77.) 28 pp. (English, electronic copy only.)

INFORMATION DOCUMENTS

IOC/INF-1192. 2004. *Medium-Term Strategy/Stratégie à Moyen Terme/Estrategia a Plazo Medio 2004-2007*. 73 pp. (English, French, Spanish, Russian.)



IOC/INF-1193. 2004. prov. Guidelines. *Guidelines for the Structure and Responsibilities of the Subsidiary Bodies of the Commission, and for the Establishment of Decentralized Offices*. 22 pp. (English.)

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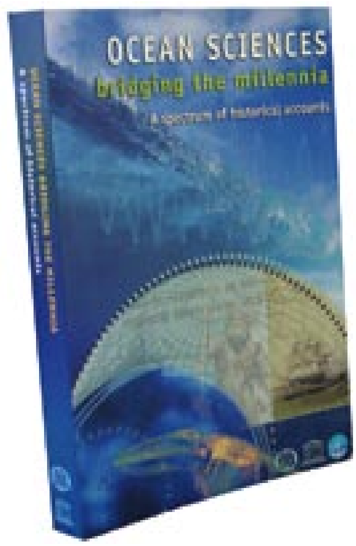

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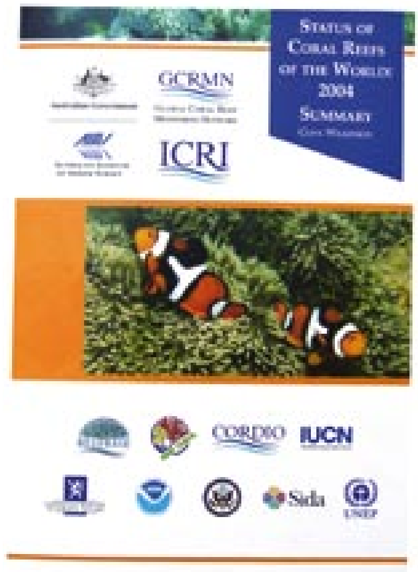

Further information is available at: http://ioc.unesco.org

Enquiries or requests for any of the above titles may be addressed to the IOC Documentalist:

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p.boned@unesco.org
Fax: +33 1 45 68 58 10

IOC Participation in 2004 Events

Event	Date	Venue	IOC Department
OceanPortal/HABSEA Regional Workshop Microscopy Course	5–11 January	Hue, Viet Nam	Ocean Sciences
IOCCP Workshop on Underway Sensors and Data Formats for Ocean Carbon	14–17 January	Tsukuba, Japan	Ocean Sciences
UN–Oceans Interagency Meeting	25–26 January	Paris, France	Ocean Sciences
Workshop on Integrated Coastal Area and River Basin Management (ICARM) in the South East Pacific, UNEP (PNUMA)	26–29 January	Lima, Peru	Ocean Sciences
Sixth Session of the Coastal Ocean Observations Panel	26–30 January.	Wellington, New Zealand	Operational Observing Systems
IOC/GLOSS Training Course	8–21 February	Kuala Lumpur, Malaysia	Operational Observing Systems
LOICZ AfriCat II Workshop on River Catchments and Coastal Impact	16–18 February	Mombasa, Kenya	Ocean Sciences
IGOS Coastal Theme Meeting	23–25 February	Paris, France	Operational Observing Systems
Regional Planning Meeting for a Project on Shoreline Protection through ICAM	3–5 March	Dakar, Senegal	Ocean Sciences
Steering Group Meeting for the Global Web Service on Oceans, Coasts and Islands	8 March	Washington, USA	Ocean Sciences
Working Group on Integrated Coastal Management (ICAM)	9–10 March	Washington, USA	Ocean Sciences
JCOMM Management Committee, Third Session (MAN-III)	17–21 March	Geneva, Switzerland	Operational Observing Systems
ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors	21–23 March	Cesenatico, Italy	Ocean Sciences
Joint FAO/IOC/WHO Expert Workshop on Biotoxins in Molluscan Bivalves	22–24 March	Dublin, Ireland	Ocean Sciences
Second Session of the IODE Group of Experts on Biological and Chemical Data Management and Exchange Practices	22–24 March	Liverpool, UK	Ocean Services
Large Marine Ecosystems Meeting	29–30 March	Paris, France	Ocean Sciences
SCOR–IOC International Symposium On Quantitative Ecosystem Indicators for Fisheries Management	31 March–3 April	Paris, France	Ocean Sciences
ICES–IOC Working Group on HAB Dynamics	5–8 April	Corsica, France	Ocean Sciences
ICAM–LAC Second Workshop	12–13 April	Recife, Brazil	Ocean Sciences
Eighth Session of IOC Subcommission for the Caribbean and Adjacent Regions (IOCARIBE-VIII)	14–17 April	Recife, Brazil	IOCARIBE
UN Atlas Editorial Meeting	15–16 April	Rome, Italy	Ocean Services
First ODIMEX Planning and Technical Meeting	19–23 April	Cape Town, South Africa	Ocean Services
Sixth IOC/WESTPAC International Scientific Symposium	19–23 April	Hanzhou, China	WESTPAC, Bangkok
GEOHAB Open Science Meeting on HABs in Fjords and Coastal Embayments	21–26 April	Valparaiso, Chile	Ocean Sciences
Seventh Session of the GOOS Steering Committee (GSC-VII)	26–30 April	IFREMER Brest, France	Operational Observing Systems
Fourth Open-Ended Informal Consultative Process on Oceans and the Law of the Sea	4–7 May	Lefkada, Greece	Secretariat

SG-MarineXML	6–7 May	Oostende, Belgium	Ocean Services
SCOR–IOC CO_2 Panel Joint Steering Committee Meeting with GCP/SOLAS/IMBER Ocean Carbon Research Groups	9 May	Paris, France	Ocean Sciences
Oceans in a High CO_2 World	10–12 May	Paris, France	Ocean Services
Workshop on Operational Metocean Products and Services (Ocean Ops 04)	10–15 May	Toulouse, France	Operational Observing Systems
Ocean Carbon Model Intercomparison Project Annual Meeting	13–14 May	Paris, France	Ocean Sciences
Marine Pollution Emergency Response Support System (MPERSS) Meeting and JCOMM Services Coordination Group, Second Session (SCG-II)	17–20 May	Toulouse, France	Operational Observing Systems
Global News Spring Workshop	24–27 May	Paris, France	Ocean Sciences
First Planning Meeting of the UNESCO Interdisciplinary Initiative on the Sustainable Development of the Caspian Sea	31 May–2 June	Yaroslavl, Russian Federation	Ocean Sciences
FANSA Portal Workshop	4–6 June	Itajai, Brazil	Ocean Sciences
Ninth Session of the Ocean Observations Panel for Climate	7–10 June	Southampton, England	Operational Observing Systems
IAEA–IOC Regional Training Course to Harmonize Approaches to HAB and Toxin Monitoring of Phytoplankton and Shellfish	7–11 June	Cape Town, South Africa	Ocean Sciences
Joint Meeting with IAEA–UNESCO on Submarine Groundwater Discharge	21–23 June	Monaco	Ocean Sciences
Thirty-seventh Session of Executive Council	23–29 June Paris, France	Secretariat	
ASFA Advisory Board	29 June–2 July	Mar del Plata, Argentina	Ocean Services
Integrated Coastal Area Management Indicators Steering Group	30 June 2004	Paris, France	Ocean Sciences
ODINAFRICA–III – ICAM Meeting	12–13 July	Nairobi, Kenya	Ocean Sciences
Global Carbon Project Fourth Steering Committee	12–15 July	Goa, India	Ocean Sciences
IOC Advanced Training Course on Harmful Marine Microalgae	19–30 July	Copenhagen Denmark	Ocean Sciences
GEMIM-VIII	2–3, 10 September	Hobart, Australia	Ocean Services
IOC/WIOMSA Regional Training Course on Applications of Satellite Altimetry to Oceanography	6–17 September	Malindi, Kenya	Ocean Services
Twentieth Anniversary of IFREMER	23 September	Paris, France	Secretariat
Meeting of IOC Benthic Indicator Study Group	6–9 October	Sardinia, Italy	Ocean Sciences
JCOMM Data Buoy Cooperation Panel, Twentieth Session (DBCP-XX)	18–22 October	Chennai, India	Operational Observing Systems
Argos Joint Tariff Agreement (JTA-XXIV)	25–27 October	Chennai, India	Operational Observing Systems
ODINAFRICA Project Management Committee Meeting	25–29 October	Accra, Ghana	Ocean Services
African Ocean Portal Editors Meeting	1–5 November	Lagos, Nigeria	Ocean Services

Funding for IOC Programmes

Introduction

This Annual Report describes a wide spectrum of activities that highlight the relevance of the Intergovernmental Oceanographic Commission (IOC) of UNESCO's programmes in 2004. Together with national and non-governmental initiatives, the implementation of IOC programmes and related staff costs during 2004 was financed through income from UNESCO as part of its regular programme allocation, as approved by the UNESCO General Conference, and from extra-budgetary resources, notably those provided by IOC Member States and partner organizations through their contributions to the Intergovernmental Oceanographic Commission of UNESCO Special Account and contributions for specific projects through the creation of UNESCO Funds-in-Trust. This Financial Report does not consider other contributions (either direct or in kind) provided by Member States in support of the Commission's programme execution, which do not enter the budgetary flow of IOC.

The Twenty-second Session of the IOC Assembly (24 June–2 July 2003) approved the programme and budget based upon anticipated resources, which for 2004-2005 were expected to amount to $12,055,900 (the regular budget allocation of $8,495,900 provided by UNESCO under the Real Growth $610M 32C/5 Scenario to finance direct programme costs [$4,743,900] and staff costs [$3,752,000–total approved net of lapse] and expected voluntary contributions from Member States and international organizations were estimated at $3,560,000[1]).

'The Approved Programme and Budget for UNESCO for 2004-2005' (Document 32 C/5) confirmed the funding for the Intergovernmental Oceanographic Commission at the level approved by the Assembly.

The allocation of $4,743,900 for direct programme costs represents an increase of forty-six per cent (representing $1,500,00 more) compared to the previous biennium. However, the Executive Council at its Thirty-seventh session (23–29 June 2004), while noting this increase with appreciation, expressed its concern that 'as a result of the increasing long-term responsibilities of the IOC in global ocean issues, the resources available to IOC will fall below the level needed to sustain the work of the Commission, and that extra-budgetary contributions, although substantial, cannot be expected to fill this gap.'

Table 1a. Summary of IOC Income in 2004 (in US$)

Type of Funding	Programme	Personnel	Total
Regular Programme Allocation (UNESCO) Budget (according to 32 C/5, before running costs)	2,371,950.00	1,876,000.00	4,247,950.00
Contributions to the IOC Special Account	2,866,263.67	390,769.40	3,257,033.07
Contributions to Specific Extrabudgetary Projects (including UNESCO Funds-in-Trust)	1,607,375.85	293,600.00	1,900,975.85
TOTAL	**6,845,589.52**	**2,560,369.40**	**9,405,958.92**

The total amount of resources available for programme implementation in 2004 was $6,845,589.52 of which $4,473,639.52 came from sources other than the UNESCO regular budget. The contribution from the regular budget towards programme implementation represents thirty-five per cent of the total available funding.

The most relevant fraction of the fixed cost of the operation of the IOC is personnel, representing twenty-seven percent of the total expenditure. the $2,560,369.4 was allotted for personnel to finance the total of 44 employees at Headquarters (34) and in the Field (10). Of these, 28 are professional staff and 16 provide administrative and secretariat assistance. Also, two secondments (C. Clark and R. Gelfeld) were provided by NOAA.

1. Funds already received or firmly committed.

Regular programme implementation

UNESCO's and therefore IOC's budget is implemented over a period of two years, based on the approved programme and budget for the biennium, in this case 2004 and 2005. The funds unspent on 2004 allotments are therefore carried over to 2005.

Table 1b. Budget Implementation Rate for the Biennium 2002–2003 (in US$)[2]

Activity Code	Title	Allocation* 2004-2005	Allotment 2004 (Year 1)	Total Expenses	Available on Allocation	Impl. Rate
Main Line of Action (MLA) 1 – OCEAN SCIENCE						
22151101 IOC	World Climate Research Programme	45,000.00	22,500.00	0	45,000.00	0%
22151102 IOC	Ocean Carbon Advisory Panel	85,000.00	42,500.00	36,196.95	48,803.05	85%
22151103 IOC	Ocean Observations Panel for Climate	124,000.00	62,000.00	55,051.33	68,948.67	89%
22151201 IOC	Harmful Algal Blooms	82,000.00	41,000.00	32,547.17	49,452.83	79%
22151202 IOC	Environmental Variability and Ecosystem Change	76,000.00	38,000.00	36,035.04	39,964.96	95%
22151203 IOC	Global Change and Large Ecosystems	83,300.00	41,650.00	30,111.73	53,188.27	72%
22151301 IOC	Interdisciplinary Coastal/Watershed Studies	60,000.00	30,000.00	18,522.59	41,477.41	62%
22151302 IOC	ICAM Methodologies, Information Products and Indicators	80,000.00	40,000.00	28,537.84	51,462.16	71%
22151303 IOC	Support to NEPAD Coastal Component	97,850.00	32,675.00	31,831.52	66,018.48	97%
22151304 IOC	ICAM Regional Project Development	56,000.00	26,000.00	11,576.06	44,423.94	45%
22151305 DAK	Shoreline Protection through ICAM: Dakar Planning	9,500.00	9,500.00	8,377.76	1,122.24	88%
22151306 NAI	NEPAD Coastal and Marine Unit (COSMAR)	23,000.00	23,000.00	16,262.00	6,738.00	71%
Subtotal MLA 1		**821,650.00**	**408,825.00**	**305,049.99**	**516,600.01**	**75%**
MLA 2 – GLOBAL OBSERVING SYSTEMS						
22152101 IOC	Overall GOOS Design and Policy	136,000.00	68,000.00	59,910.16	76,089.84	88%
22152102 IOC	Coastal GOOS Observations and Design	74,000.00	37,000.00	36,506.49	37,493.51	99%
22152103 IOC	Implementation of GOOS through JCOMM	420,000.00	120,000.00	98,170.85	321,829.15	82%
22152201 IOC	GOOS Regional Development	255,950.00	217,975.00	164,774.34	91,175.66	76%
22152202 IOC	Regional GOOS Offices Support	278,000.00	139,000.00	138,943.97	139,056.03	100%
Subtotal MLA 2		**1,163,950.00**	**581,975.00**	**498,305.81**	**665,644.19**	**86%**
MLA 3 – OCEAN SERVICES						
22153101 IOC	Further Development of the IODE System and Its Products	389,000,00	204,500.00	204,488.87	184,511.13	100%
22153201 IOC	Ocean Mapping Activities	141,500.00	82,750.00	81,149.24	60,350.76	98%
22153301 IOC	Strengthening of Responsive Warning Systems for Tsunamis	58,500.00	29,250.00	29,217.79	29,282.21	100%
Subtotal MLA 3		**589,000.00**	**316,500.00**	**314,855.90**	**274,144.10**	**99%**

2. Based on SAP records as of 3 January 2005. Authoritative figures are those contained in the financial statements prepared by the UNESCO Comptroller's Office.

MLA 4 – POLICY						
22154101 IOC	Governing Bodies Meetings	180,000.00	80,000.00	75,584.46	104,415.54	94%
22154102 IOC	Officers Meeting	35,000.00	35,000.00	34,999.60	0.40	100%
22154103 IOC	Subscriptions to SCOR and GESAMP	70,000.00	35,000.00	34,999.36	35,000.64	100%
22154104 IOC	Assistant to ADG/IOC	91,000.00	0	0	91,000.00	
22154201 IOC	ICP Meetings	8,000.00	4,000.00	3,999.47	4,000.53	100%
22154202 IOC	ABE-LOS Activities	114,000.00	57,000.00	56,999.59	57,000.41	100%
22154203 IOC	Global Marine Assessment and Forum of the Oceans	30,000.00	15,000.00	14,964.18	15,035.82	100%
22154301 IOC	Public Awareness on Ocean Issues	275,000.00	152,500.00	150,258.51	124,741.49	99%
Subtotal MLA 4		**803,000.00**	**378,500.00**	**371,805.17**	**431,194.83**	**98%**
MLA 5 – CAPACITY BULDING AND REGIONS						
22155101 IOC	TEMA General Grants Scheme	60,000.00	34,850.00	34,195.51	25,804.49	98%
22155102 IOC	TEMA POGO Scheme	60,000.00	30,000.00	30,000.00	30,000.00	100%
22155103 IOC	TEMA UNESCO IOC Chairs	24,000.00	9,000.00	8,999.82	15,000.18	100%
22155104 IOC	TEMA CB Activities General Pool	120,000.00	60,000.00	59,952.10	60,047.90	100%
22155105 IOC	TEMA Training-through-Research TTR Scheme	40,000.00	20,000.00	19,999.75	20,000.25	100%
22155201 IOC	WESTPAC Regional Subcommission	213,000.00	106,500.00	103,882.58	109,117.42	98%
22155202 IOC	IOCARIBE Regional Subcommission	170,000.00	80,000.00	76,833.92	93,166.08	96%
22155203 IOC	IOCEA Regional Committee	48,000.00	39,000.00	4,075.02	43,924.98	10%
22155204 IOC	IOCINDIO Regional Committee	39,955.00	29,955.00	10,000.00	29,955.00	33%
22155205 IOC	IOCWIO Regional Committee	50,000.00	0	0	50,000.00	
22155206 IOC	Black Sea, Volga-Caspian and Other Regions	83,000.00	41,500.00	41,374.32	41,625.68	100%
22155207 QUI	IOCARIBE- IODE ODINCARSA	14,000.00	14,000.00	14,000.00	0	100%
22155208 NAI	IOCWIO 2004 Project Office	36,045.00	36,045.00	36,009.30	35.70	100%
Subtotal MLA 5		**958,000.00**	**500,850.00**	**439,322.32**	**518,677.68**	**88%**
TOTAL IOC		**4,335,600.00**	**2,186,650.00**	**1,929,339.19**	**2,406,260.81**	**88%**

* Allocation of funds available after running costs deduction

II. Contributions to the IOC Special Account

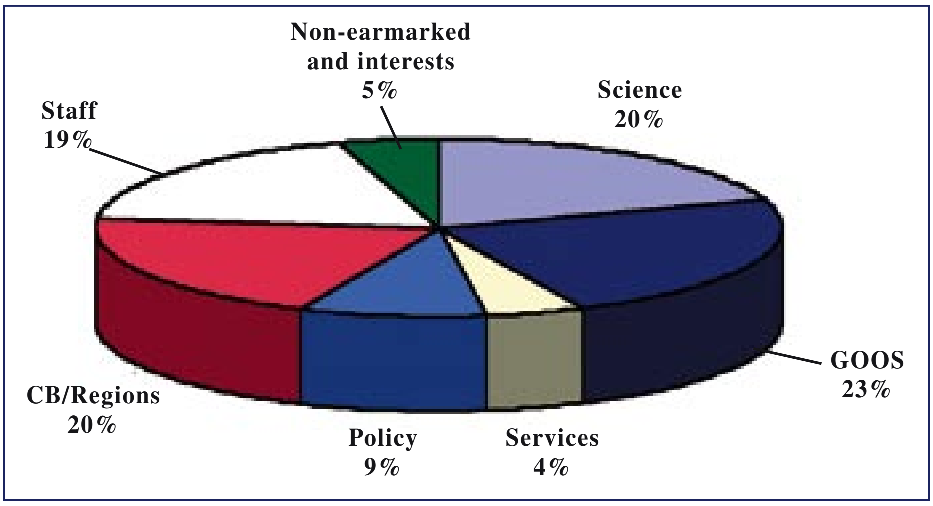
Table 2. 2004 Member States' Contributions to the IOC Special Account (in US$)

LIST OF CONTRIBUTIONS RECEIVED IN 2004		
Donor	**Amount**	**Purpose**
MLA 1 – SCIENCE		
Intern.Centre for Living Resources (Malaysia)	4,500.00	Coral Reefs Project (reimbursement)
USA (NOAA)	20,000.00	Global NEWS Project
USA (SD)	56,000.00	GEF/WB Coral Reefs Research and CB
France (CEA)	382.35	Ocean Carbon Project (reimbursement)
SCOR	8,838.00	Ocean Carbon Project
USA (NOAA)	7,000.00	ICAM
USA (NOAA)	15,000.00	ICAM Performance Indicators
USA (NOAA)	15,000.00	ICAM Performance Indicators
Spain	38,133.00	HAB Vigo Centre Activities
USA (SD)	24,000.00	HAB Training (including manuals)
Denmark (Danish Royal Ministry for Foreign Affairs)	165,563.35	HAB Centre (including staff component)
Subtotal	**421,416.70**	
MLA 2 – GOOS		
USA (NOAA)	120,000.00	Argo Profiling Float
USA (NOAA)	24,000.00	GOOS Steering Committee
WMO	19,273.42	GOOS Activities
USA (SD)	20,000.00	Communications
USA (SD)	30,000.00	Publications/Web
USA (SD)	50,000.00	XBT Workshop
ICSU	20,000.00	GOOS Activities
USA (NOAA)	60,000.00	GODAE
USA (NOAA)	20,000.00	GLOSS
ESA (Eurisy)	5,650.00	GLOSS
USA (SD)	40,000.00	GLOSS Global Core Network
FAO	12,000.00	COOP
USA (ONR)	10,000.00	COOP
UNEP	2,000.00	GOOS Programme Activities
UNEP	18,000.00	GOOS Programme Activities
UK (IACMST)	18,000.00	GOOS Programme Activities
UK (IACMST)	10,000.00	GLOSS
Italy (IMC)	4,039.42	MAMA Project
Subtotal	**482,962.84**	
MLA 3 – SERVICES		
Belgium (Government of Flanders)	12,353.54	IODE Activities
USA (NOAA)	15,000.00	Biodiversity Meeting Hamburg (November 2004)
Chile	3,000.00	ITSU
Korea (Republic of)	1,000.00	ITSU
Peru	2,760.00	ITSU

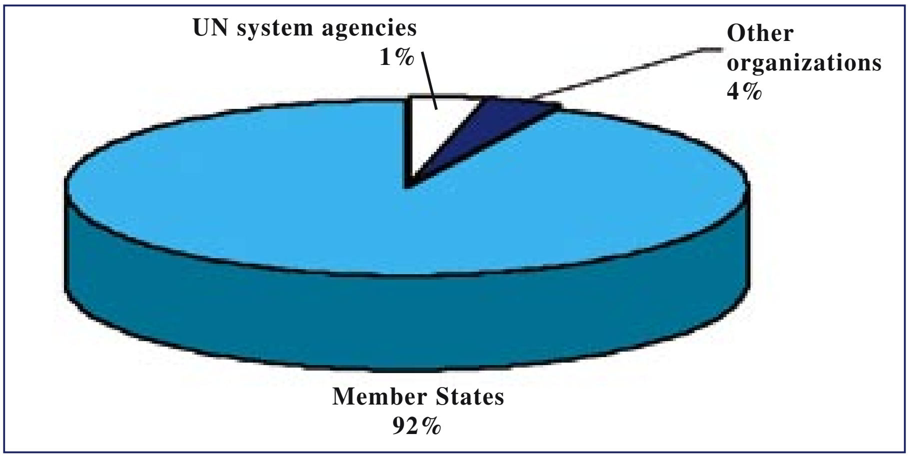
USA (SD)	40,000.00	ITSU
France (IFREMER)	7,615.48	EurOcean
WMO	11,656.00	
Subtotal	**93,385.02**	
MLA 4 -- POLICY		
Canada	21,703.34	Global Forum (reimbursement)
Canada	7,602.77	Global Forum (reimbursement)
IOI	2,500.00	Global Forum (reimbursement)
France (National Commission)	12,437.80	ABELOS
France (NU-OI)	54,151.65	UNCED Follow-Up
France (IFREMER)	19,083.90	Twenty Years of IFREMER/IOC Event
USA (SD)	30,000.00	Representation in GMA, UNOceans, GEO
USA (SD)	40,000.00	WCRP
Subtotal	**187,479.46**	
MLA 5 – CAPACITY BULDING AND REGIONS		
USA (NOAA)	25,000.00	Pacific Island GOOS Regional Alliance
USA (NOAA)	25,000.00	IOCARIBE-GOOS
USA (NOAA)	6,750.00	IOCARIBE-GOOS
USA (NOAA)	15,000.00	POGO
University of Malta	18,976.93	GRAND Project - IOCARIBE
Canada (CIDA)	58,785.11	IOCARIBE (ICAM)
Government of China	20,000.00	WESTPAC Regional Activities
USA (NOAA)	20,000.00	Rio-GOOS Office
USA (NOAA)	50,300.00	PIRATA
University of Malta	18,976.93	GRAND Project–RIO
USA (NOAA)	16,500.00	IOCARIBE Office
France (IFREMER)	3,078.83	GODAE Meeting Florida, USA
USA (SD)	70,000.00	CB Strategy (meetings)
USA (SD)	20,000.00	CB Guide for Best Practices
USA (SD)	40,000.00	IOCARIBE CB Pilot Phase
USA (NOAA)	12,500.00	GODAE Meeting Florida, USA
Subtotal	**420,867.80**	
STAFF		
France (IFREMER)	19,975.04	Argo Coordinator
United Kingdom (MetOffice)	37,548.00	Argo Coordinator
Canada (CIDA)	7,390.86	Argo Coordinator
Australia (CSIRO)	7,855.50	Argo Coordinator
USA (NOAA)	62,500.00	Albert Fischer
USA (NOAA)	12,500.00	Albert Fischer
USA (NOAA)	25,000.00	Albert Fischer
USA (SD)	10,000.00	Albert Fischer
USA (NOAA)	12,500.00	Maria Hood
USA (NOAA)	112,500.00	Maria Hood
USA (NOAA)	70,000.00	International Affairs ALD
World Bank	13,000.00	Coral Reefs Project Staff (reimbursement)
Subtotal	**390,769.40**	

NON-EARMARKED		
Canada	12,583.91	Programme Activities in General
Canada (DFO)	11,076.17	Programme Activities in General
USA (SD)	30,000.00	Programme Activities in General
Subtotal	**53,660.08**	
INTEREST		
	5,273.00	First Quarter
	13,688.00	Second Quarter
	9,128.00	Third Quarter
	15,401.00	Fourth Quarter
Subtotal	**43,490.00**	
TEMPORARY ALLOCATIONS/TRANSFERS		
Italy (Ministry of Foreign Affairs)	1,184,830.00	ADRICOSM (pending project creation)
Transfer to 193POL2001 to Cover Deficit	-21,828.23	
Subtotal	1,163,001.77	
TOTAL	3,257,033.07	

2004 Contributions Breakdown by Main Programme Axes



2004 Contributions Breakdown by Type of Donor



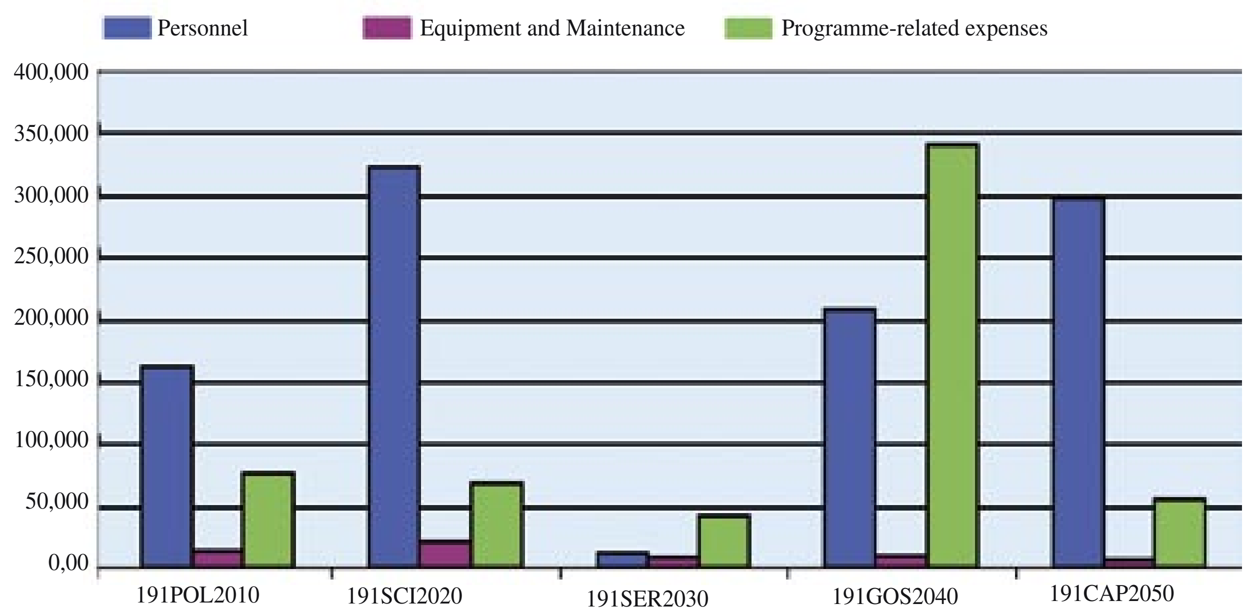
III. IOC Special Account - Expenditure

For the sake of clarity, it should be explained that voluntary contributions to the IOC Special Account are deposited into the IOC General Revenue Account (194IOC9090) from which funds are allotted to the five accounts established in accordance with the IOC programme structure. The expenditure is recorded on these operational subaccounts:

191POL2010 - General/Policy
191SCI2020 - Ocean Science
191SER2030 - Ocean Services
191GOS2040 - Global Ocean/Coastal Observing Systems
191CAP2050 - Capacity Building/ Regional Cooperation

Table 3. Expenditure on Operational Codes under the IOC Special Account (in US$)

Budget Lines	Type of Expenditure	191POL2010	191SCI2020	191SER2030	191GOS2040	191CAP2050
10	Other Personnel Cost	0	0	0	244.38	5,402.00
11.00	International Experts	40,828.42	273,091.31	0	174,217.23	172,541.03
11.50	Consultants	23,026.14	0	0	8,776.27	25,848.33
13	Administrative Support Personnel	73,276.70	13.49	0	0	29,825.13
16	Mission Costs	24,065.36	49,253.23	12,122.39	24,308.96	63,310.21
Subtotal 10	**Project Personnel**	**161,196.62**	**322,358.03**	**12,122.39**	**207,546.84**	**296,926.70**
20	Subcontracts	18,436.58	65,166.58	20,571.47	203,755.80	54,990.00
30	Training and Seminars/Meetings	57,532.27	2,846.69	21,754.77	136,360.64	10.13
40	Equipment and Maintenance	4,502.52	19,541.07	7,582.48	8,321.06	6,481.68
50	Miscellaneous (including sundry expenditure)	8,777.10	1,012.08	84.62	1,430.39	35.00
TOTAL		**250,445.09**	**410,924.45**	**62,115.73**	**557,414.73**	**358,443.51**

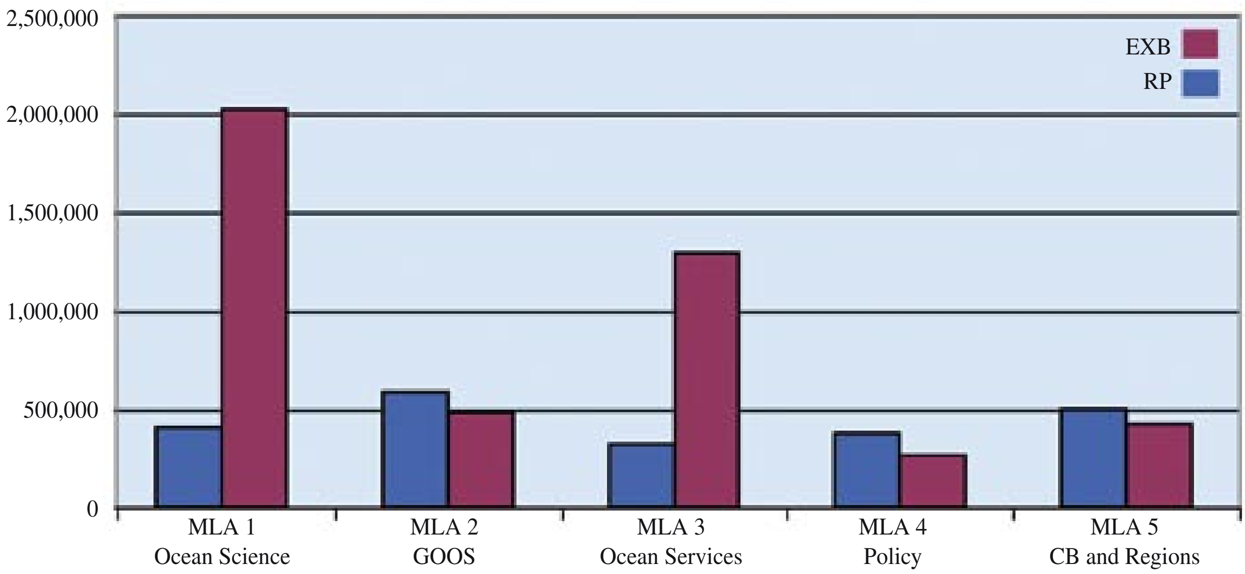


IV. Contributions for Specific Extrabudgetary Projects, including UNESCO Funds-in-Trust[3]

Table 4. 2004 Contributions for Specific Extrabudgetary Projects (in US$)

Project Code	Purpose	Donor	Amount
	MLA 1 - OCEAN SCIENCE		
193INT2000	IOC/UNEP/GEF Project on Large Marine Ecosystems	UNEP/GEF	400,000.00
213INT2002	Nutrient Transport to Coastal Ecosystems	UNEP	8,158.85
Subtotal			**408,158.85**
	MLA 2 – GOOS		
193GLO2001	DBCP	WMO	204,000.00
Subtotal			**204,000.00**
	MLA 3 - OCEAN SERVICES		
513INT2000	Sustainable Management of Marginal Drylands	Govt. of Flanders	307,750.00
513RAF2003	ODINAFRICA-III	Govt. of Flanders	512,877.00
513RAF2004	Development of an African Repository for Electronic Publications	Govt. of Flanders	69,140.00
513RAF2005	Geosphere-Biosphere Coupling Processes in the Ocean	Govt. of Flanders	108,750.00
513RAS2000	Biodiversity and Distribution of Megafaunal Assemblages in the Abyssal Nodule Province of the Eastern Equatorial Pacific	Govt. of Flanders	44,000.00
513GLO2002	ODIMEX	Govt. of Flanders	156,700.00
Subtotal			**1199,217.00**
	MLA 5 - CB AND REGIONS		
804GLO2044	Associate Expert	Japan	89,600.00
Subtotal			**89,600.00**
TOTAL			1,900,975.85

V. IOC Programme Funding in 2004 – Regular Programme (RP) versus Extrabudgetary[4] (EXB) Ratio by Main Programme Axes



3. The above table provides information on contributions credited to specific extrabudgetary projects in 2004 as recorded in SAP. Authoritative figures are those contained in the financial statements prepared by the UNESCO Comptroller's Office.
4. Including both contributions to the Special Account and to specific extrabudgetary projects, including UNESCO Funds-in-Trust.

UNESCO

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

STATEMENT OF INCOME AND EXPENDITURE AND CHANGES IN RESERVES AND FUND BALANCES
FOR THE PERIOD 1 JANUARY 2004 TO 31 DECEMBER 2004

(EXPRESSED IN US DOLLARS)

	Programme Activities	Earmarked Activities	Total at 31.12.2004
INCOME			
Voluntary Contributions - Schedule 1.3	3,235,371.30		3,235,371.30
Other income:			
Interest	43,490.00		43,490.00
Earmarked - Schedule 1.3		604,000.00	604,000.00
Transfers	(21,828.23)	21,828.23	-
TOTAL INCOME	3,257,033.07	625,828.23	3,882,861.30
Cash Disbursements Schedule 1.2	1,639,343.51	379,484.50	2,018,828.01
Increase (Decrease) in balance of undelivered orders	11,571.93	(45,904.25)	(34,332.32)
TOTAL EXPENDITURE	1,650,915.44	333,580.25	1,984,495.69
EXCESS (SHORTFALL) OF INCOME OVER EXPENDITURE	1,606,117.63	292,247.98	1,898,365.61
Reserves and fund balances, beginning of the period	1,080,159.95	61,312.18	1,141,472.13
Reserves and fund balances, end of the period	2,686,277.58	353,560.16	3,039,837.74

Schedule 1.2

UNESCO

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

SCHEDULE OF EXPENDITURE
FOR THE PERIOD 1 JANUARY 2004 TO 31 DECEMBER 2004

(EXPRESSED IN US DOLLARS)

	Disbursements	Undelivered Orders	Total Expenditure
A. Programme Activities			
Capacity Building/ Regional Cooperation			
11 - Experts & Consultants	198,389.36	8,700.00	207,089.36
13 - Adm. Support Personnel	29,825.13	12.00	29,837.13
16 - Mission Costs	63,310.21	4,192.00	67,502.21
10' - Other Personnel Cost	5,402.00	10,109.44	15,511.44
20 - Sub-Contracts	54,990.00	17,907.00	72,897.00
32 - Training & Seminars	10.13	13,275.22	13,285.35
40 - Equipment & Maintenance	6,481.68	-	6,481.68
50 - Sundry Expenditure	35.00	15.00	50.00
Sub-Total	358,443.51	54,210.66	412,654.17
Global Ocean/Coastal Observing Systems			
11 - Experts & Consultants	182,993.50	17,326.26	200,319.76
13 - Adm. Support Personnel	-	-	-
16 - Mission Costs	24,308.96	10,805.84	35,114.80
10' - Other Personnel Cost	244.38	1,051.00	1,295.38
20 - Sub-Contracts	203,755.80	13,550.00	217,305.80
32 - Training & Seminars	136,360.64	20,657.08	157,017.72
40 - Equipment & Maintenance	8,321.06	302.65	8,623.71
50 - Sundry Expenditure	1,430.39	-	1,430.39
Sub-Total	557,414.73	63,692.83	621,107.56
General Policy			
11 - Experts & Consultants	63,854.56	-	63,854.56
13 - Adm. Support Personnel	73,276.70	-	73,276.70
16 - Mission Costs	24,065.36	2,098.35	26,163.71
10' - Other Personnel Cost	-	-	-
20 - Sub-Contracts	18,436.58	603.21	19,039.79
31 - Individual Fellowships	-	-	-
32 - Training & Seminars	57,532.27	43.92	57,576.19
40 - Equipment & Maintenance	4,502.52	-	4,502.52
50 - Sundry Expenditure	8,777.10	-	8,777.10
Sub-Total	250,445.09	2,745.48	253,190.57
Ocean Science			
11 - Experts & Consultants	273,091.31	-	273,091.31
13 - Adm. Support Personnel	13.49	-	13.49
16 - Mission Costs	49,253.23	1,810.47	51,063.70
20 - Sub-Contracts	65,166.58	42,500.00	107,666.58
32 - Training & Seminars	2,846.69	375.12	3,221.81
40 - Equipment & Maintenance	19,541.07	101.63	19,642.70
50 - Sundry Expenditure	1,012.08	-	1,012.08
Sub-Total	410,924.45	44,787.22	455,711.67
Ocean Services			
11 - Experts & Consultants	-	-	-
13 - Adm. Support Personnel	-	-	-
16 - Mission Costs	12,122.39	-	12,122.39
20 - Sub-Contracts	20,571.47	9,934.67	30,506.14
31 - Individual Fellowships	-	-	-
32 - Training & Seminars	21,754.77	-	21,754.77
40 - Equipment & Maintenance	7,582.48	653.57	8,236.05
50 - Sundry Expenditure	84.62	-	84.62
Sub-Total	62,115.73	10,588.24	72,703.97
Total A.	1,639,343.51	176,024.43	1,815,367.94
B. Earmarked activities			
I.O.C. Science and Communication Centre on Harmful Agal Blooms	58,431.87	-	58,431.87
Charpentier Salary, Mission and Other Costs	167,745.78	-	167,745.78
Global Coral Reef Monitoring Network	36,964.76	-	36,964.76
Promoting Ecosystem-based Approaches to Fisheries Conservation and LMEs between UNEP and IOC	116,342.09	11,285.00	127,627.09
Total B.	379,484.50	11,285.00	390,769.50
TOTAL (A + B)	2,018,828.01	187,309.43	2,206,137.44

Schedule 1.3

UNESCO

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

SCHEDULE OF INCOME
FOR THE PERIOD 1 JANUARY 2004 TO 31 DECEMBER 2004

(EXPRESSED IN US DOLLARS)

A. Programme Activities (194IOC9090)

Funds received		
Belgium	12,353.54	
Canada	119,142.16	
China	20,000.00	
Denmark	165,563.35	
France	66,971.80	
Italy	1,184,830.00	
Korea Rep. of	1,000.00	
Peru	2,760.00	
United Kingdom	37,548.00	
U.S.A.	1,339,050.00	
FAO	12,000.00	
UNEP	20,000.00	
W.M.O	30,929.42	
World Bank	13,000.00	
CSIRO	7,855.50	
Eurisy 3	5,650.00	
IFREMER	49,753.25	
Instituto Espanol de Oceanografia	38,133.00	
Inter-Agency Committee on Marine Science & Techn.	28,000.00	
International Center for Living Aquatic Resources Management	4,500.00	
International Council of Scientific Unions	20,000.00	
International Ocean Institute, Malta	2,500.00	
International Marine Center	4,039.42	
SCOR	8,838.00	
Servicio Hidrografico y Oceanografico de la Armada de Chile	3,000.00	
University of Malta	37,953.86	3,235,371.30
Interest		43,490.00
Transfer to budget code 193POL2001		(21,828.23)
Total A.		**3,257,033.07**

B. Earmarked activities

Charpentier Salary, Mission and Other Costs (193GLO2001)	
W.M.O. contribution	204,000.00
Promoting Ecosystem-based Approaches to Fisheries Conservation and LMEs between UNEP and IOC (193INT2000)	
UNEP contribution	400,000.00
SC/942(BUI):Staff Costs (193POL2001)	
Transfer from 194IOC9090	21,828.23
Total B.	**625,828.23**
TOTAL (A + B)	**3,882,861.30**

UNESCO

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

STATEMENT OF ASSETS, LIABILITIES, RESERVES AND FUND BALANCES
AS AT 31 DECEMBER 2004

(EXPRESSED IN US DOLLARS)

	31.12.2004	31.12.2003
Assets:		
Cash and term deposits	3,227,147.17	1,363,113.88
Total Assets	**3,227,147.17**	**1,363,113.88**
Liabilities:		
Accrued Payables undelivered orders (see schedule 1.2)	187,309.43	221,641.75
Total liabilities	**187,309.43**	**221,641.75**
Reserves and fund balances:		
Earmarked activities	353,560.16	61,312.18
Operating reserves	2,686,277.58	1,080,159.95
Total reserves and fund balances	**3,039,837.74**	**1,141,472.13**
Total liabilities, reserves and fund balances	**3,227,147.17**	**1,363,113.88**

Annex

UNEP Trust Fund

193 INT 2000

Project No. GF/3010-04-06: Promoting Ecosystem-based Approaches to Fisheries Conservation and LMEs

Financial Status Report as at 31 December 2004

(Expressed in US dollars)

Income				
Funds received	May 2004			400,000.00

Deduct **Disbursements**	Approved Budget	Cash Disbursed	Unliquid. Obligations	
10 - Personnel	15,000.00	-	-	
20 - Sub-Contracts	580,000.00			
Sub-Contracts		116,327.09	10,800.00	
30- Training and seminars	320,000.00	-	-	
40 - Equipment and maintenance	50,000.00	-	-	
50 - Miscellaneous	30,000.00			
Sundry expenditure		15.00	485.00	
	995,000.00	116,342.09	11,285.00	
Total expenditure incurred				127,627.09
Funds Available as at 31 December 2004				**272,372.91**

Acronyms

ABE-LOS	Advisory Body of Experts on the Law of the Sea (IOC)
ACOPS	Advisory Committee on Protection of the Sea
AGU	American Geophysical Union
AOPC	Atmospheric Observation Panel for Climate
APEC	Asia-Pacific Economic Cooperation
Argo	GODAE global profiling float project (not an acronym)
BATHY	Bathythermograph Report, or code for reporting temperature profile observations
BBC	British Broadcasting Corporation
CARICOM	Caribbean Community
CD-ROM	compact disk – read only memory
CEOS	Committee on Earth Observation Satellites
CGCB	IOC Consultative Group on Capacity Building
CLIVAR	Climate Variability and Predictability Programme (WCRP)
CNES	Centre National d'Etudes Spatiales (French national space centre/agency)
CO_2	Carbon Dioxide
COOP	Coastal Ocean Observations Panel (GOOS)
COSMAR/NEPAD	Coastal and Marine Unit of the New Partnership for Africa's Development
CSD	Commission on Sustainable Development (UN)
DBCP	Data Buoy Cooperation Panel (WMO-IOC)
DNA	Designated National Agency (IODE)
EC	European Commission, also Executive Council (e.g. WMO or IOC)
ENSO	El Niño-Southern Oscillation (ocean/atmosphere interaction study)
EOS	AGU's weekly newspaper of geophysics, also NASA's Earth Observing System
EOS I	Earth Observation Summit, Washington, DC
EOS II	Earth Observation Summit, Tokyo, Japan
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
FUST	Flanders UNESCO Trust Fund
GCOS	Global Climate Observing System (WMO-ICSU-IOC-UNEP)
GCP	Global Carbon Project
GCRMN	Global Coral Reef Monitoring Network
GDA	GEBCO Digital Atlas (GEBCO Database)
GEBCO	General Bathymetric Chart of the Oceans
GEF	Global Environment Facility (World Bank-UNEP-UNDP)
GEO	The *Ad Hoc* Group on Earth Observations
GEOHAB	Global Ecology and Oceanography of HABs (IOC-SCOR)
GEOSS	Global Earth Observation System of Systems
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (IMO-FAO-UNESCO-WMO-WHOIAEA-UN-UNEP)
GLOBEC	Global Ocean Ecosystems Dynamics Programme (SCOR, IOC, IGBP/ICSU)
GLOSS	Global Sea Level Observing System
GODAE	Global Ocean Data Assimilation Experiment
GODAR	Global Oceanographic Data Archaeology and Rescue Project (IODE)

GOOS	Global Ocean Observing System (IOC-WMO-UNEP-ICSU)
GPO	GOOS Project Office
GSC	GOOS Steering Committee
HAB	Harmful Algal Bloom
HAE-DAT	Metadata database on Harmful Algal Events
HDNO	Head Department of Navigation and Oceanography (of the Ministry of Defence of the Russian Federation)
IABP	International Arctic Buoy Programme (DBCP)
IAEA	International Atomic Energy Agency
IAMSLIC	International Association of Aquatic and Marine Science Libraries and Information Centres
IBCAO	International Bathymetric Chart of the Arctic Ocean
IBCCA	International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
IBCEA	International Bathymetric Chart of the Central Eastern Atlantic
IBCM	International Bathymetric Chart of the Mediterranean
IBCSEP	International Bathymetric Chart of the South Eastern Pacific
IBCWIO	International Bathymetric Chart of the Western Indian Ocean
IBCWP	International Bathymetric Chart of Western Pacific
ICAM	Integrated Coastal Area Management (also name of IOC programme)
ICARM	Integrated Coastal Area and River Basin Management
ICES	International Council for the Exploration of the Sea
ICG/ITSU	International Coordination Group for the Tsunami Warning System in the Pacific (IOC)
ICM	Integrated Coastal Zone Management
ICSU	International Council for Science
ICT	Information and Communication Technology
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer (French Research Institute for the Exploitation of the Sea)
IGBP	International Geosphere-Biosphere Programme (ICSU) also known as Global Change Programme
IGO	Intergovernmental Organization
I-GOOS	Intergovernmental GOOS Committee (IOC-WMO-UNEP)
IGOS	Integrated Global Observing Strategy
IGOSS	Integrated Global Ocean Services System (IOC-WMO)
IHDP	International Human Dimensions Programme on Global Environmental Change (ISSC-ICSU)
IHO	International Hydrographic Organization
IHP	International Hydrological Programme (UNESCO)
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IOCARIBE	IOC Subcommission for the Caribbean and Adjacent Regions
IOCCP	International Ocean Carbon Coordination Project
IOCEA	IOC Regional Committee for the Central Eastern Atlantic
IOCWIO	IOC Regional Committee for the Cooperative Investigation in the North and Central Western Indian Ocean
IOCINDIO	IOC Regional Committee for the Central Indian Ocean
IODE	International Oceanographic Data and Information Exchange (IOC)
IOGOOS	Indian Ocean GOOS
IPCC	Intergovernmental Panel on Climate Change

ITIC	International Tsunami Information Center
IWG	Intergovernmental Working Group (on IOC Oceanographic Data Exchange Policy)
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology (WMO-IOC)
JGOFS	Joint Global Ocean Flux Study (IGBP)
LME	Large Marine Ecosystem
LOICZ	Land-Ocean Interaction in the Coastal Zone (IGBP)
MEDAR/ MEDATLAS	Mediterranean Data Archaeology and Rescue/Mediterranean (and Black Sea) Atlas
MedGLOSS	Mediterranean GLOSS
MedGOOS	Mediterranean GOOS project
MEDI	Marine Environmental Data Information Referral Catalogue
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSL	Mean Sea Level
NASA	National Aeronautics and Space Administration (USA)
NEAR-GOOS	North-East Asian Regional GOOS
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NODC	National Oceanographic Data Centre (IODE)
ODIMeX	Oceanographic Data and Information Management
ODIN	Ocean Data and Information Network
ODINAFRICA	Ocean Data and Information Network for Africa (IOC and Flanders)
ODINCARSA	Ocean Data and Information Network for the IOCARIBE and South America regions
ODINEA	Ocean Data and Information Network for Eastern Africa (IODE)
OOPC	Ocean Observations Panel for Climate (GCOS-GOOS-WCRP)
OOS	Operational Observing Systems (IOC programme section)
OS	Ocean Services (IOC programme section)
OSS	Ocean Sciences Section (IOC programme section)
PACSICOM	Pan-African Conference on Sustainable Integrated Coastal Management
PICES	North Pacific Marine Science Organization
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
POGO	Partnership for Observation of the Global Oceans
PR China	People's Republic of China
PSMSL	Permanent Service for Mean Sea Level
PTWC	Pacific Tsunami Warning Center
R/V	Research Vessel
SCOR	Scientific Committee on Oceanic Research (member of ICSU)
SEAGOOS	South East Asia Regional GOOS
SGD	Submarine Groundwater Discharges
SHOM	Service Hydrographique et Océanographique de la Marine (France)
SOLAS	Surface Ocean – Lower Atmosphere Study (WCRP)

SOOP	Ship-of-Opportunity Programme
TEMA	Training, Education and Mutual Assistance in the Marine Sciences (IOC cross-cutting provision/programme)
TMT	Transfer of Marine Technology
TSG	Thermosalinograph
TTR	Training-through-Research
UN	United Nations
UNCED	UN Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VLIZ	Flanders Marine Institute (Belgium)
VSAT	Very Small Aperture Terminal; earthbound station used in satellite communications of data, voice and video signals, excluding broadcast television
WAGOOS	Western Australia GOOS
WCRP	World Climate Research Programme (WMO-ICSU-IOC)
WESTPAC	IOC Subcommission for the Western Pacific
WHO	World Health Organization
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment (WCRP)
WSSD	World Summit on Sustainable Development (Johannesburg, 2002)
WWW	World Weather Watch (WMO)
www	World Wide Web
XBT	Expendable Bathythermograph

Intergovernmental Oceanographic Commission (IOC)

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