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A message from the Assistant Director-General and Executive Secretary of the Intergovernmental Oceanographic Commission (IOC) of UNESCO

The Intergovernmental Oceanographic Commission (IOC) is celebrating 50 years since the historic decision of the 1960 UNESCO General Conference to establish an organization that could coordinate among governments the necessary operational, logistical, and legal support necessary for conducting marine science on an international scale. Forty States joined as Members of the new Commission during its first year. Today IOC has 138 Member States and works as a body with functional autonomy within UNESCO.

In partnership with other UN agencies -- such as WMO, FAO, and UNEP -- as well as with hundreds of oceanographic and marine research laboratories, the IOC is playing a critical role in addressing the major challenges facing the world's ocean. Key programs include identifying and protecting marine biodiversity, monitoring the ocean's response to global climate change, and coordinating a global coastal hazards and tsunami early warning system.

The services that the IOC has offered over the last 50 years are to be commended. But during this 50th anniversary we are especially excited to look forward toward the future. Never has the IOC been so necessary as it is today. We are increasingly confronted with challenges of a global nature, requiring exactly the kind of intergovernmental platform that IOC offers.

The magnitude 9.0 earthquake of 26 December 2004 triggered a basin-wide Indian Ocean tsunami that killed more than 200,000 people in eleven countries -- over 30,000 of them in Sri Lanka, some 1600 kilometres away from the epicentre in Indonesia. Unlike in the Pacific Ocean, where IOC has been coordinating a tsunami warning centre since 1965, there was no early warning capacity for the Indian Ocean. As the UN-affiliated organization with responsibility for the oceans, the IOC was asked to coordinate a global effort to establish tsunami warning systems as part of an overall multi-hazard coastal disaster reduction strategy. After intense and delicate intergovernmental diplomacy involving 28 countries, an Indian Ocean tsunami warning system was set up in under 5 years and is now owned by the Member States. Similar systems are also nearing completion for the Caribbean, Mediterranean, and North Atlantic.

Much of what IOC does may not seem glamorous. It is often behind-the-scenes work such as meetings and consultations, agreements, and seminars. But at the grass-root level the main corpus of IOC are the scientists themselves, at sea and in laboratories around the globe. Through IOC researchers are able to form networks of cooperation and share ideas and resources that enable them to tackle challenges that are too big for any one research centre, one nation, or even one region. Indeed one of the founding mandates of IOC has been to coordinate global observations of the ocean. The physical, chemical and biological characteristics of the ocean are important vital signs of the planet's well-being. But to understand indications of change it is critical to monitor these vital signs frequently, with as fine detail as possible, and from marine locations around the world. Just in the last 10 years, for example, the IOC has helped countries launch more than 3,000 Argo floats, which take more than 100,000 salinity and temperature profiles each year – more than 20 times the annual hydrography profiles taken from research vessels. Last year, IOC helped to develop the "Assessment of Assessments" study – the first step in launching a Regular Process for assessing the state of the marine environment in order to have a more holistic and integrated picture of the ocean.

As a global organization the IOC relies on the continued support of its Member States, in terms of commitment and funding, to help improve the level of research, data exchange and dialogue on ocean-related issues. Credible and timely scientific information is essential to understanding the impacts of global change and to guide responses. With economies around the world still coping with recession, it would be ill-advised to think that oceanographic research is an expensive luxury.

This 50th anniversary of IOC should help remind Member States why continued and strengthened support of IOC is a vital investment for our future.

Wendy Watson-Wright

A Message to the Peoples and Nations of the World
On Behalf of the Ocean

(*On the occasion of a celebration for the fiftieth anniversary of the establishment of the Intergovernmental Oceanographic Commission/UNESCO, June 08, 2010*)

For generations the ocean has been regarded as massive, impenetrable and invulnerable. This is a false concept that can no longer be accepted with impunity. Relatively it is not massive, together with the land surface and atmosphere it forms only a thin skin between the thousands of kilometres of rock and magnum beneath and the infinity of space above. It is a planetary meniscus on which our present environment and our lives depend. Secondly it is no longer impenetrable; today a growing fraction of our mineral resources comes from beneath the sea floor. Our automated instruments are scattered in the ocean waters across the globe. Researchers are now reaching into the depths, and uncovering some of its secrets, although results suggest that these are merely harbingers of what is still unknown. Finally the ocean is not invulnerable. The wastes of our society, flowing from the land, and through the atmosphere, from agriculture, industry and a growing urban population can be seen in the fragile coastal waters and measured even in the centre of the water masses.

However, the context for this message to the world should not be one of doom. Thankfully our ocean is still vital; its life, beauty and power still amaze us. We can, and should, celebrate and recognize the importance of the ocean to the culture, economy and well-being of our society. But the ocean does deserve our attention. As a society we must collectively and unambiguously acknowledge the importance of the oceans to our existence on the planet. The ocean cleanses the air we breathe; it influences our weather, climate, and the water on which we depend. We must be aware of the changes we bring to the ocean and the consequences of our actions. For this we require information and the knowledge, insight and determination to use that information collectively and wisely.

We have a responsibility to our children, their children and their children's children. Our legacy must be a sustainable and healthy environment. It is a responsibility that transcends national, political and social differences. As one, we are the people of the Earth and we must act together to protect and perpetuate the environment on which we depend.

The attached call on behalf of the ocean is a plea to all for an adequate and responsive recognition of the importance of the ocean.

"...I must go down to the seas again/for the call of the running tide
Is a wild call and a clear call that may not be denied...."

John Masefield (1878 - 1967)

The Ocean Call

TO *the peoples of the world, we ask for recognition that the oceans and their resources are a necessary element of life on the planet. We also ask that you respect the ocean and understand that actions and activities even deep within continents can impact the marine environment. Governmental responses can be ponderous but ultimately they must reflect the will and priorities of their constituencies. The ocean deserves your support.*

TO *those who finance and undertake capacity building programs, we ask that increased priority be given to programs in coastal and ocean management, ocean sciences and ocean technologies in order to provide safe, healthy and sustainable environments and reduce poverty through the promotion of effective and efficient marine stewardship.*

TO *the scientists in all ocean disciplines, we ask that you continue your dedication to gather and interpret marine data, to inform the public and decision-makers of the results of your studies and to maintain a collegiate and multidisciplinary community.*

TO *the extensive framework of learned professionals and environmental lobbyists in academia, industry, politics and law and to all those who have achieved leading positions and authoritative voices in our society, we ask that you will use your position and influence to further the support and attention needed to sustain and preserve our ocean environment.*

TO *the media, whose role it is to inform our largely terrestrial society of the news and events of interest and importance, we ask that you recognise the ocean as an integral part of our environment and of our society. From tourism to trade, from energy to food, from high finance to indigenous fisheries and from megacities to mangrove habitats, there is a story with an ocean connection that needs telling.*

TO *governments, we ask that you address the present deficiencies in the support of the marine environment. Nationally, to ensure that ocean research is adequately funded, that the infrastructure to distribute ocean information is in place, that sustainable marine management practices are fostered and that terrestrial and atmospheric policies take account of potential impacts on the ocean. Internationally, we ask you to adopt as a premise that sustaining the global environment remains the ultimate priority and that national differences must be overcome in working collectively for the future.*

TO *the youth, we make the final and perhaps the most important request. We ask that you listen and learn, that you profit from the advances that we have achieved and avoid the mistakes that we have committed. You are the future. The ocean needs your enthusiasm, creativity and ability as scientists, managers, lawyers and politicians to champion its cause and to sustain its splendour and resources for generations to come.*

The Oceans in facts and figures

The oceans account for 96% (330 million square kilometres) of all the water on the surface of the Earth, the remainder being freshwater, in the form of rivers, lakes and ice.

An estimated 50-80% of all life on earth is found under the ocean surface and the oceans contain 99% of the living space on the planet. Less than 10% of that space has been explored by humans.

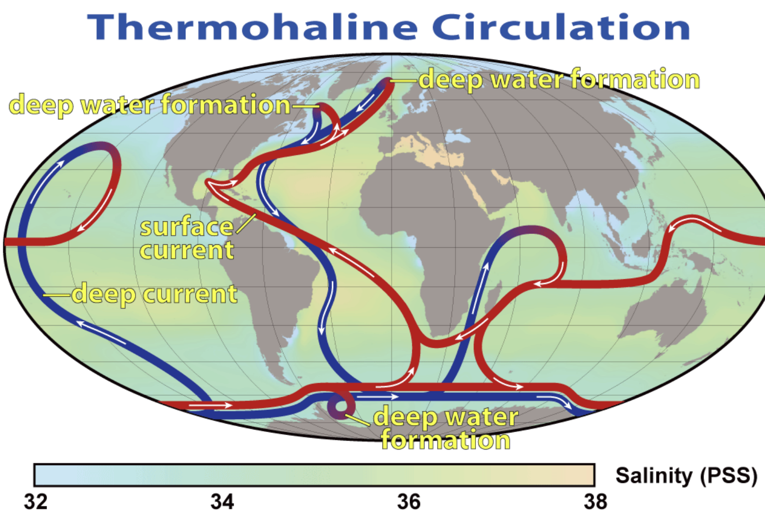
85% of the area and 90% of the volume of the oceans constitute the dark, cold environment we call the deep sea.

The average depth of the ocean is 3,795 m. The average height of the land is 840 m.

The largest of the Oceans is the **Pacific**, at 166,241,000 square kilometres. At its deepest, the Challenger Deep, it is 10,920 metres from surface to ocean floor. All of the land mass of the earth (continents and islands) would fit into the Pacific Ocean.

The **Atlantic** Ocean, which includes the Arctic, is 86,557,000 square kilometres and has a maximum depth of 8605 metres.

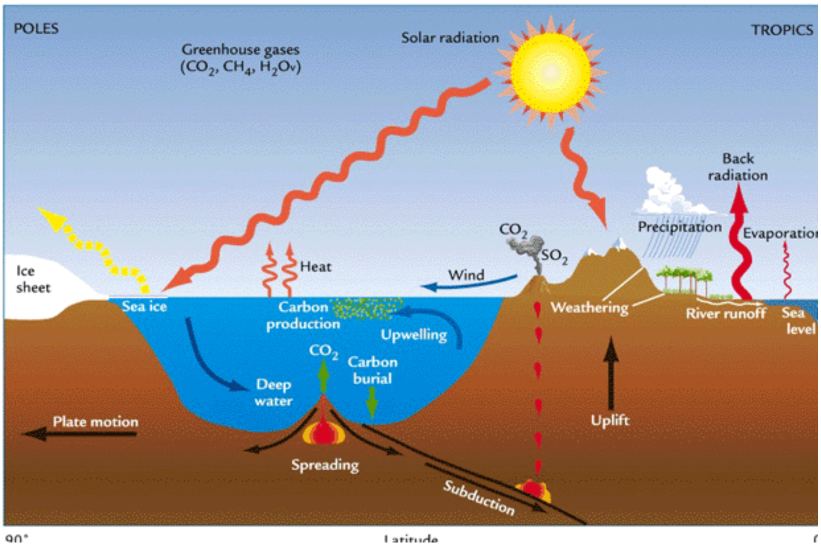
The **Indian** Ocean is 73,427,000 square kilometres and has a maximum depth of 7125 metres.



The oceans and the adjacent seas are not separate, but behave like a massive conveyor belt, with surface water warmed by the sun slowly being transported to higher latitudes and the poles. Deep below the surface, cold (2 degrees Centigrade) 'thermohaline' currents move slowly around the world. These deep currents move at only about 1mm/second, taking 1000 years to complete a cycle. In this way, though, North Atlantic water will end up in the Pacific and Indian Oceans, albeit 500 years later.

The oceans and their currents play a vital role in stabilizing global climate, in tandem with the atmosphere. Warm water from the tropics travels towards the poles and, when it meets the cold air, some will evaporate, forming fog and rain. The surface then becomes cooler, denser and more salty. This denser water sinks slowly and returns to the equator on the thermohaline currents.

Over the past 100 years the World has warmed by about 0.5˚ C and the rate of sea level rise has increased from roughly 1.5 mm/year to about 3.3 mm/year after 1990 and by 2100 it is likely that a rise of more than one meter is possible. A one-metre rise in sea level would mean the complete disappearance of the Maldives, while daily life in many other small islands would be seriously disrupted because of salt water intrusion.



From 1996 to 2006 there was a 75% increase in the destruction of the ice cap in Antarctica due to global warming, and some models predict no ice in the Arctic Sea in the second half of this century.

Roughly 430,000 square km of water evaporates from the ocean every year. Of this amount, around 110,000 square km fall as freshwater precipitation over land (the rest over the sea), replenishing surface and ground waters and eventually competing the cycle by returning to the sea.

The Amazon carries 15% of all the water returning to the world’s oceans

On average, seawater in the world's oceans has a salinity of about 3.5%. This means that every kilogram, or every litre, of seawater has approximately 35 grams (1.2 oz) of dissolved salts (mostly, but not entirely, the ions of sodium chloride: Na+, Cl−).

The most saline open sea is the Red Sea.

Ocean acidity has increased by 30% since the beginning of the Industrial Revolution and the rate of acidification will accelerate in coming decades. This rate of change is many times faster than anything previously experienced over the last 55 million years. Due to ocean acidification it is expected that, by 2100, 70% of cold-water corals may be exposed to corrosive waters, heavily damaged or destroyed.

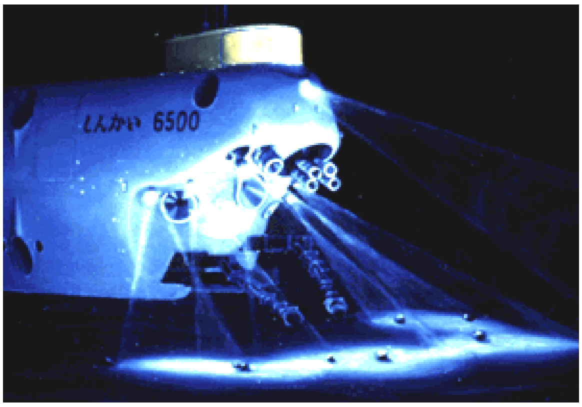
Since 1960 the intermediate-depth, low-oxygen layers of 300-700m (oxygen minimum zone) of the central and eastern tropical Atlantic and the equatorial Pacific Oceans has expanded and become more anoxic.

Out of 553 sites in over 107 countries in the UNESCO-MAB Network of Biosphere Reserves, more than 90 (in 40 countries) are marine reserves. Since the 1970s the number of Marine Protected Areas (MPAs) has grown steadily and a database currently stores information on over 6000 MPAs.

Of the 600 marine fish stocks monitored by the UN Food and Agriculture Organization (FAO):
3% are underexploited
20% are moderately exploited
52% are fully exploited
17% are overexploited
7% are depleted
1% are recovering from depletion
100 million sharks are caught every year for their fins.

Every year 90 million tons of fish are captured globally. Populations of large fish have declined by as much as 90% in the past century. Globally, by-catch (unwanted fish, because of size or species) amounts to 20 million tons, and accounts for approximately 25% of fish caught and discarded.

An estimated 80% of world biodiversity lives in the ocean. The deep ocean is still relatively unexplored. Marine biologists are still discovering new species living at depths mankind can only now reach. The largest census of marine life ever undertaken will report its finding in October 2010, providing access to over 20 million records. Scientists have catalogued 275,000 ocean creatures ranging in size from the largest of animals, the blue whale, to microscopic plankton.



Sketch of the Shinkai 6500, a Japanese vessel that is currently the world's deepest-diving manned research submarine. (Courtesy of Japan Marine Science & Technology Center.)

90% of the world’s fish is caught in oceans and adjacent seas.

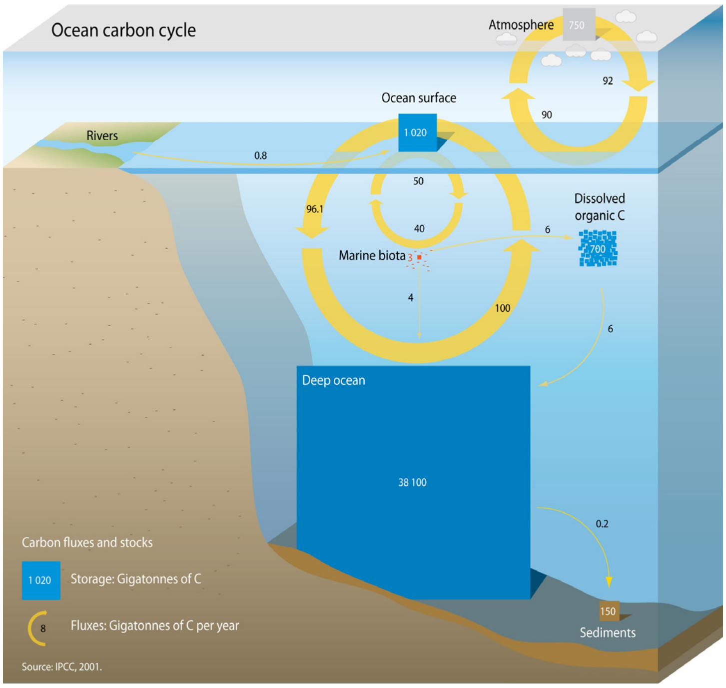
The salt water intake structures of the 13,600 desalinization plants across the world are responsible for the deaths of at least 3.4 billion fish and other marine organisms – involving a USD 212.5 million loss to anglers and commercial fishermen.

According to FAO an estimated 43.5 million people are directly involved, either full or part time, in capture fisheries and aquaculture. Most (86%) live in Asia. The world's motorized fishing fleet totals around 2.1 million vessels. The vast majority (90%) measure under 12 meters in length. Some 23,000 are large-tonnage "industrialized" vessels.

More than 3,500 large scale industrial vessels have the capacity to take 60% of all fish caught and represent 1% of all fishing boats.

Tourism in the Great Barrier Reef Marine Park (Australia) generates over $1b per annum in revenue.

The oceans have an enormous natural capacity to absorb and store carbon. The ocean contains an estimated 40,000 GtC (GtC = a billion tons of carbon). To put this in perspective, the atmosphere contains approximately 750 GtC and the land contains about 2200 GtC. This means that if we were to take all the atmospheric CO_2 and put it in the deep ocean, the concentration of CO_2 in the deep ocean would change by less than 2%.



Each year the ocean absorbs approximately 25% of all carbon dioxide (CO2) we emit. This hidden 'ocean service' has been estimated to represent an annual subsidy to the global economy of USD 60-400 billion per year.

By 2025 the UN estimates that three quarters of the world's population will be living within 100 km of its coasts. There are 3351 cities in the low elevation coastal zones around the world, including 15-18 mega cities, 64% of them in developing regions.

If both population and emission continue to grow at high rates, the number of people flooded per year will reach 21 million by 2030, 55 million by 2050 and 370 million by 2010. They will be forced to leave their homes due to climate change.

Currently, 90% of all world trade is seaborne and 60% of all transported oil moves by tankers on the high seas. CO_2 emissions from shipping are twice as high as that from airplanes and may rise by 75% in the next 15 years as seaborne trade expands.

Vessels release 10 billion tons of ballast water each year, releasing alien species in foreign waters.

A million items of marine litter enter the sea every day, accounting for 80% of the pollution of the ocean. 5 million items are thrown overboard or lost from ships. Over 46,000 pieces of plastic litter are floating on every square mile of ocean today.

705 of the world's beaches are eroded. With a 50 cm increase in sea level, over one-third of the beaches in the Caribbean will be lost.

“…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.” (UNESCO, 1960)

Fifty years of IOC in the service of society

Founded in 1960, the Intergovernmental Oceanographic Commission (IOC) has its Secretariat at UNESCO headquarters in Paris (France). IOC now focuses on four major themes:

Coordination of Oceanographic research programmes

IOC develops, promotes and facilitates international oceanographic research programmes to improve our understanding of critical global and regional ocean processes and their relationship to the sustainable development and stewardship of ocean resources.

Global Ocean Observing System and Data Management

IOC ensures the effective planning, establishment and co-ordination of an operational global ocean observing system. This provides the information needed for oceanic and atmospheric forecasting, for oceans and coastal zone management by coastal nations, and for global environmental change research as well as ensuring that data and information obtained through research, observation and monitoring are handled efficiently and made widely available.

Mitigation of Marine Natural Hazards

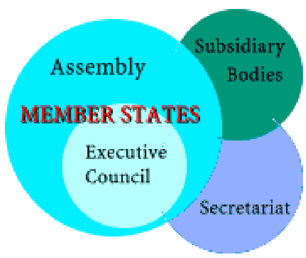
Following the December 2004 Indian Ocean Tsunami, IOC led the efforts to establish a global marine multi-hazards warning system to monitor and predict hazards and, when hazards occur, to issue rapid warnings and mitigation plans.

Support to Capacity Development

IOC provides international leadership for education and training programmes and the technical assistance that is essential for systematic observations of the global ocean and its coastal zone and related research, as well for the sustainable development of the countries involved.

Structure and organization of IOC

IOC currently has 137 Member States. Each Member State has one seat in the Assembly, which meets once every two years. The Assembly is the principal organ of the Commission and makes all decisions to accomplish the objectives of IOC. An Executive Council meets every year to provide guidance to the Secretariat for the implementation of activities, between meetings of the Assembly.



A maximum of 40 Member States sit on the Executive Council at any time. The Executive Council reports to the Assembly.

The activities coordinated by the Secretariat are implemented through technical and regional subsidiary bodies such as ICAM, GOOS, IODE, JCOMM and others (for more information see: http://ioc-unesco.org/)

IOC Timeline and Milestones

1955 UNESCO sets up an International Advisory Committee on Marine Sciences (IACOMS) The Special (later Scientific) Committee on Oceanic Research (SCOR) is established within the International Council of Scientific Unions (ICSU).

1956 First Session of IACOMS makes recommendations on future role of UNESCO in Marine Sciences.

1957 UNESCO co-sponsors (with SCOR[1]) the International Indian Ocean Expedition

1959 31 August-12 September: First International Oceanographic Conference in USA, organized by SCOR and the American Association for the Advancement of Science, with assistance of UNESCO and other organizations.

1960 11-16 July: Intergovernmental Conference on Oceanographic Research held in Copenhagen (Denmark). Recommends that an Intergovernmental Oceanographic Commission (IOC) is set up within UNESCO.

1960 UNESCO General Conference Resolution 2.31 adopts recommendation to establish IOC.

1961 19-27 October: First Intergovernmental Session of IOC at UNESCO headquarters, Paris (France); by the end of the meeting, 40 States had become Members of the Commission.

1961 Working group on oceanographic data exchange established. In 1987 this was renamed as the IOC Technical Committee on Data and Information Exchange (IODE).

1965 International co-ordination group for the tsunami warning system in the Pacific was established and International Tsunami Information Centre (ITIC) set up in Honolulu, USA.

1967 First IOC Regional programmes, offices and bodies were established for the Southern Ocean, Caribbean and Adjacent Regions. Followed later with the establishment of regional mechanisms for practically all regions of the World Ocean.

Fifth Session of the Assembly. Groups (later Committees) were established on IGOSS[2] and TEMA. From 1977 IGOSS became a joint IOC/WMO Committee.

1968 23rd Session of UNGA adopts Resolution 2476 on the long-term and expanded programme of world-wide exploration of the oceans and their resources of which the International Decade of Ocean Exploration (1971-1980) is an important element.

1969 UNESCO negotiates formal basis for IOC to cooperate with other UN Specialized Agencies with interest in matters related to ocean science. This leads to Inter-Secretariat Committee on Scientific Programmes Related to Oceanography.

[1] Scientific Committee on Oceanic Research
[2] Integrated Global Ocean Services System

1971 Establishment of GIPME (Global Investigation of Pollution in the Marine Environment) Programme.

1972 UN Conference on the Human Environment in Stockholm (Sweden) requests IOC to lead the investigation of pollution in the marine environment.

1973 Establishment of the IOC/IHO Committee for the new General Bathymetric Chart of the Ocean

1974 Third UN Convention on the Law of the Sea (UNCLOS) in Caracas (Venezuela) recognises IOC in articles of the draft Convention.

1976 Co-operative programme of El Niño research is launched as a joint IOC/WMO/CPPS programme

Approval of the report on the Future Role and Functions of IOC by the 11th Session of the Assembly

1979 IOC establishes a joint IOC/SCOR Committee on Climate Change and the Ocean (CCCO).

1982 Signing of UNCLOS to contribute to the establishment of a legal order facilitating international maritime communications, peaceful utilization of the seas and oceans, fair and rational exploitation of their resources, investigation and protection of the marine environment and conservation of the biological resources it contains.

1985 Establishment of GLOSS as a basis for an extension of existing sea-level networks at the 13th session of the Assembly.

1986 - 2002 Participation in the field phases and analysis and synthesis of the results of TOGA[3] and WOCE[4]

1987 24th General Conference of UNESCO confirms that the IOC is established as a body with functional autonomy within UNESCO. It requests the IOC to: assess and reduce scientific uncertainties on oceans and coastal areas; strengthen oceans services; foster capacity building in developing countries for marine science and observations; stimulate regional and international cooperation and commitments.

UNGA at its 44th session stated that " the protection of the oceans and all kinds of seas, including enclosed and semi-enclosed seas, and of coastal areas and the protection, national use and development of their living resources is a major concern in maintaining the quality of the global environment".

1987 Endorsement of the Harmful Algal Bloom Programme (HAB).

1989 15th session of the Assembly establishes a group of experts for GOOS.

1990 Second World Climate Conference in Geneva decided to create GOOS

1990 – 2000 Participation in the UN Decade on Natural Disaster Reduction (IDNDR)

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[3] Tropical Ocean and Global Atmosphere Programme

[4] World Ocean Circulation Experiment

1992 UN Conference on the Environment and Development (UNCED) in Rio de Janeiro (Brazil) drafts Agenda 21, in which Chapter 17 specifically deals with the oceans. It proposes the creation of an integrated and comprehensive global ocean observing and information system to provide the information needed for oceanic and atmospheric forecasting, for ocean and coastal zone management by coastal nations, and for global environmental change research.

Launch of the Global Ocean Ecosystem Dynamics project, as a core project of the IGBP[5], to advance our understanding on how global change will affect the abundance, diversity and productivity of marine populations.

Agreements are signed with WMO and ICSU to co-sponsor World Ocean Research Programme.

1994 UN Convention on the Law of the Sea (UNCLOS) enters into force.

UN Global Conference on the Sustainable Development of Small Island Developing States takes place in Barbados. The important role of IOC was stressed in providing scientific input and data for addressing such issues as sea level rise, natural environment disasters, management of marine resources, marine biodiversity, as well as development of marine science and technology and related human resources.

1995 The Washington Agreement recognizes the need to address pollution problems caused by the run-off of agricultural, industrial and human wastes into vulnerable coastal waters. IOC becomes a partner in the implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-Based activities.

1998 International Year of the Ocean: IOC organizes several international events, coordinates inputs to the Year objectives of Member States and international organizations, and contributes to the UN Pavilion and Pavilion of the Future at EXPO 1998 in Lisbon (Portugal).

1999 - 2000 Unique role of IOC as the competent intergovenrmental body with functional autonomy within UNESCO dealing with ocean science was strengthened in the new IOC statutes. UNESCO requested IOC to: assess and reduce scientific uncertainties on oceans and coastal areas; strengthen ocean services and the implementation of GOOS; facilitate capacity building in developing countries for marine sciences and observations; stimulate regional and international cooperation and commitments.

2001 UNESCO co-sponsors Global Conference on Oceans, Coasts and Small Islands at Paris headquarters to provide an assessment of oceans and coasts and to develop a strategy for addressing ocean- and coast-related issues at the coming World Summit in Johannesburg.

Launch of the **Census of Marine Life** – a ten year initiative (2001-2010) to assess and explain the diversity, distribution and abundance of marine life in the oceans. IOC supports the Ocean Bio-geographic Information System (OBIS) component of the Census.

2002 IOC presents ‘One Planet, One Ocean’ at World Summit on Sustainable Development (WSSD) in Johannesburg (South Africa), describing how its programme relates to the goals of sustainable development. The Summit identified several important actions and commitments that are crucial for the future work of IOC, one of which is participation in the global marine assessment.

[5] International Geosphere-Biosphere Programme

2003 Washington, USA. First Earth Observation Summit (EOS-10). 10-year Implementation Plan created for the development of a comprehensive, coordinated and sustained Global Earth Observation System of Systems (GEOSS) based on existing observing systems.

22nd session of the IOC Assembly adopts an oceanographic data exchange policy based on the principle of timely, free and unrestricted access to all data, associated meta-data and products generated under the auspices of the IOC programmes.

2004 26th December: Indian Ocean basin-wide tsunami causes an estimated 200,000 deaths

2005 January: World Conference on Disaster Reduction held in Kobe (Japan).
Establishment of a working group on Tsunamis and other Marine Hazards related to sea-level change warning and mitigation systems with the objective to review and provide guidance on establishing the framework mechanism for a comprehensive, sustained and integrated end-to-end global system covering tsunami and other hazards related to the sea.

2009 Publication of the 'Assessment of Assessments' report as the first step in implementing the regular process for keeping the state of world's oceans under continuous review.

2010 Fiftieth anniversary of IOC

Observing the Global Ocean

The oceans: source and guardian of life

The oceans are closely linked with atmospheric systems to maintain the planet's climate, and with it, the fine-tuned ecosystems upon which all life depends. Because of their tremendous heat capacity, the oceans are the memory of the climate system, controlling changing patterns of rainfall and storminess. The oceans have absorbed much of the human emissions of CO_2, reducing global warming - but this CO_2 is making the oceans more acid, harming organisms at the bottom of the food chain. Ocean fisheries provide more than 1 billion people with their main source of animal protein, and more than half of the human population lives within the coastal zone. Human impacts on the oceans, from a changing climate, to over-exploitation of fisheries, and to uncontrolled pollution, are putting stresses on the oceans. Will they continue to be able to serve our needs? To answer these questions, scientists need to monitor a range of ocean variables, including surface temperature, salinity, acidity, sea level and biodiversity. This is clearly beyond the capability of any one – or even a small group of – nations.

Need for global observations

For 15 years, UNESCO-IOC has been overseeing a **Global Ocean Observing System** (GOOS) to observe, model and analyse marine and ocean variables. The data the system yields are used to provide accurate descriptions of the present state of the oceans, including living resources; continuous forecasts of the future conditions of the sea for as far ahead as possible, and the basis for climate forecasts.

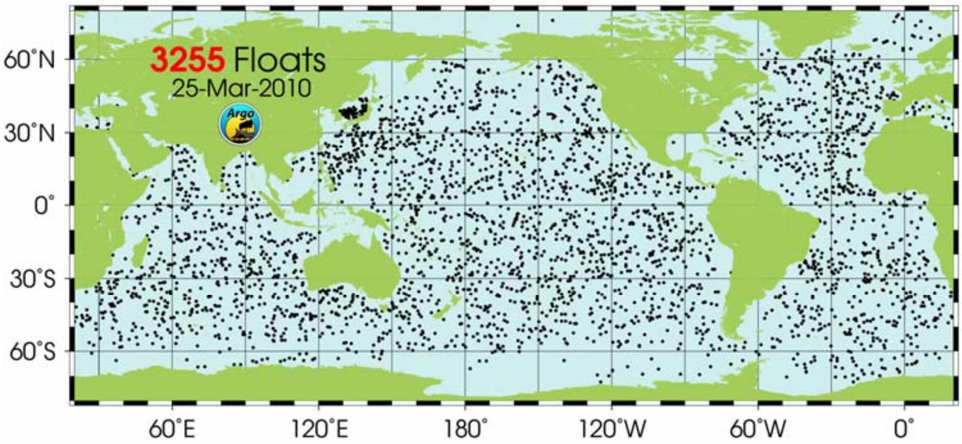
According to Keith Alverson, Director of GOOS at the IOC, and James Baker, former administrator of NOAA and consultant to IOC, writing in the journal *Science* in 2006, "…*the real requirement for integrated Earth system science is a systematic, sustained record of observations, starting from as early as we can get quantitative information and extending reliably into the future. In particular, the ocean is critically under-sampled both in space and time, and national and intergovernmental observational commitments are essential for progress.*"

A golden age for ocean observations

In some ways we are in a golden age for oceanography, with satellite monitoring of the surface temperature, winds, and sea surface height, and a growing array of in situ sensors measuring subsurface ocean properties.

For the first time in history, the upper half of the subsurface ocean is being systematically observed by the Argo network, an array of profiling floats that measure the temperature and salinity of the ocean, and – by their drift – the velocity. Meanwhile, networks of ship and mooring-based observations can measure other critical parameters, and most of these all share their data globally at no cost in real time. This is a great increase in the number of observations since the beginnings of GOOS, 15 years ago.

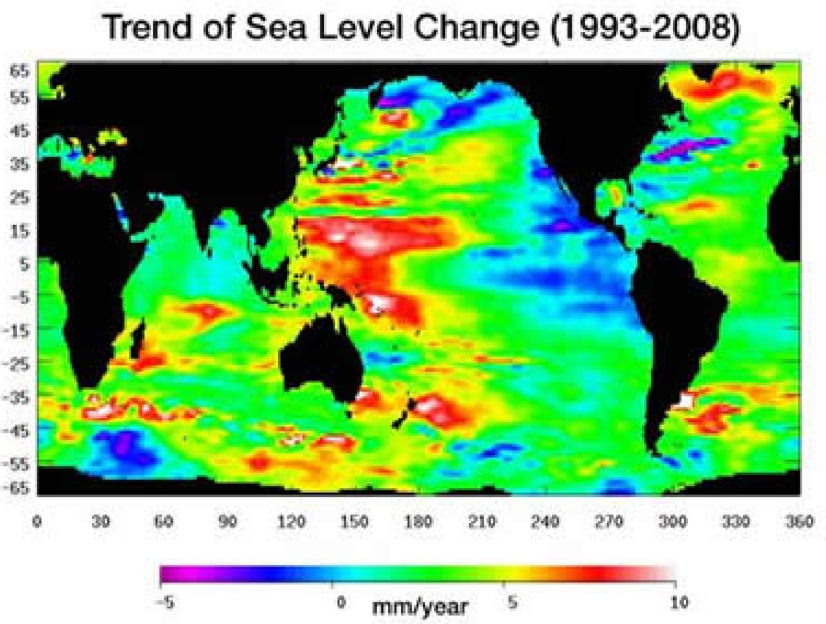
Challenges remain: the largest being that too many of these efforts rely on short-time-horizon research funding, and moorings, while floats have limited lifetimes and must be constantly replaced in order to maintain a full network of observations. Technological challenges also remain, with the ice-covered oceans being poorly observed, and with a need to integrate biological and chemical observations with the largely physical system now in place.



Argo is a global array of over 3200 free-drifting profiling floats that for the first time, allows continuous monitoring of the temperature, salinity, and velocity of the upper 2000 m of the ocean. All data are relayed and made publicly available within hours after collection. Until these buoys were deployed, ships of opportunity – where merchant mariners take measurements at 100-km intervals, for example – still provided the bulk of measurements, on a voluntary basis. Even now some areas, such as the Southern Ocean, are poorly represented. And Argo batteries need to be replaced every four years, so it is a challenge just to maintain the existing observation system.

Sea level rise

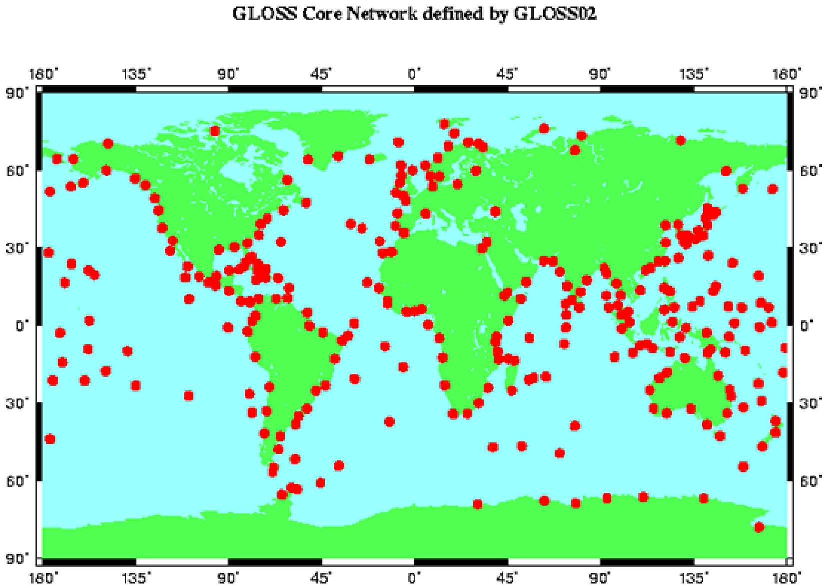
With about 200 million people living within coastal floodplains, and with two million square kilometers of land and one trillion dollars' worth of assets lying less than 1 metre above current sea level, sea level rise is one of the major socio-economic hazards associated with global warming. And with coastal development continuing and the population living in the coastal zone increasing rapidly, society is becoming more vulnerable to sea level rise and storm surges – as, for instance, Hurricane Katrina demonstrated in New Orleans (2005) and Cyclone Nargis demonstrated in Myanmar (2008).



"A major impact of global warming in coastal areas will be sea level rise," says Thorkild Aarup, a Programme specialist at IOC. "Rising sea levels will be felt most acutely through sea-level extreme events and a change in frequency of such events (storm surges and associated flooding, erosion and damage of coastal property and infrastructure). In other words the present day 'one in 100 years' flood could become a 'one in 10 years' risk at some locations before the end of the 21st century."

In 2007, the Intergovernmental Panel on Climate Change forecast a rise in global sea level of 18 cm to 59 cm by 2095. However, the IPCC acknowledged that there presently is insufficient knowledge about ice sheet dynamics in Greenland and Antarctic (discharge (calving) from glaciers, surface melting of ice caps and accumulation of snow at ice caps). In the light of this IPCC made an *ad hoc* additional allowance of 10-20 cm to account for ice sheet dynamics, but stated that a larger contribution cannot be excluded.

"Sea level rise is happening now and is beginning to have real impacts. It is an issue for here and now, for the twenty-first century and for the long term," said John Church, at his IOC Roger Revelle lecture in 2006.

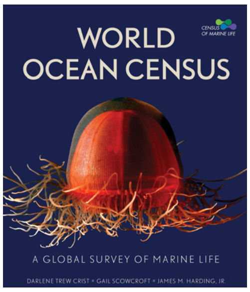


The Global Sea Level Observing System (GLOSS) is an international programme conducted under the auspices of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the World Meteorological Organisation (WMO) and IOC. The main component of GLOSS is a network of 290 sea level stations around the world monitoring global long-term sea level rise. This global array is currently operating at about 67% of the target number.

Protecting marine biodiversity

There is still much to be learned about the complex interactions between animals, plants and the physical environment. But we do know that biological diversity is essential if ecosystems are to continue to be resilient, both locally and globally. This resilience is particularly important when an ecosystem (like a coral reef) is recovering from stress, whether natural or man-made. Given how important ecosystem biodiversity is for human welfare, national and international policies need to make sure it stays high on the agenda, in order to safeguard the health of the oceans. The International Year of Biodiversity, 2010, is one effort to raise pubic awareness of this serious issue.

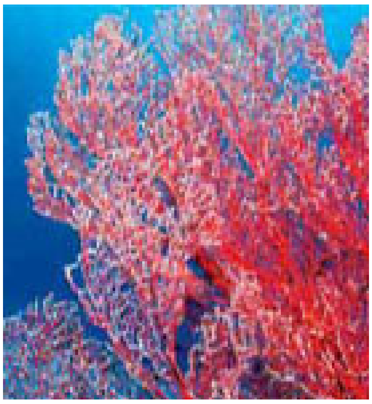
Discovering the diversity of marine life



According to an astonishing 10-year Census of Marine Life (www.coml.org/) due to be published later this year, there may be more and a greater variety of marine species in the sea than on land. And, until now, most of them have remained unknown, living in the dark, deep, open ocean. In October 2010, the Census will culminate by publishing an Internet database – the Ocean Biogeographic Information System (OBIS – www.iobis.org) – with over 16 million records, old and new. At the same time, the Encyclopaedia of Life (www.eol.org) will record photographs and details of some 250,000 marine species. The Census involved 2000 scientists from 82 countries and cost over $750m. UNESCO-IOC has been cooperating with Census researchers through a Memorandum of Understanding and the OBIS database will be an essential part of the IOC-IODE programme (International Oceanographic Data and Information Exchange).

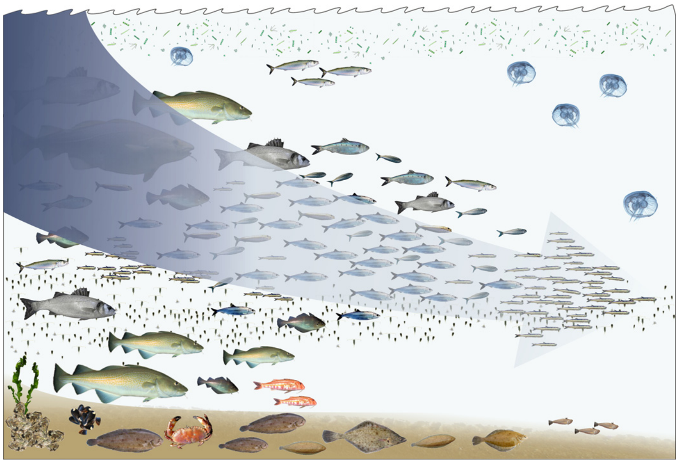
Marine species and ecosystems under threat

Yet, as we discover the full scale of the diversity of life in the oceans, we also know that human activities are threatening the sustainability not just of individual marine species, but of entire ecosystems. How will marine ecosystems react to a world that is 2°C warmer? Even a 1°C increase in temperature can kill the tiny, pigmented organisms that live in symbiosis with coral-building polyps. And their death ultimately kills the coral host that depends on them for nutrients synthesized by sunlight. Also, as the oceans absorb ever more excess atmospheric CO_2 produced by human activities, they are becoming more acidic (i.e. are lowering the pH), threatening a range of groups, including coral, mollusc, echinoderms and some species of zooplankton and phytoplankton. Most immediate impacts may be local, such as damage to coral reefs, but decisions have to be global, as collapsed ecosystems ultimately affect humanity as a whole. What can be done to reduce these impacts? What measures can be taken in the open seas, outside territorial waters? Are new legal measures, such as amendments to the UN Convention on the Law of the Sea (UNCLOS) needed?



Large marine species

Oceans are crucial to life on Earth; they support livelihoods and are vital to the world economy in several ways, including food as fish. Many large marine species are exploited for human consumption and have a high added value. We have reduced many of these large open ocean fish stocks to 10% during the last years and have driven some species to the brink of extinction. An estimated 52% of marine fish stocks are fully exploited, 19% overexploited and 9% depleted or recovering from depletion. Several species of large tuna, billfish and sharks, for example, could become extinct in the following years and the ecosystem will lose its top predators (the equivalent of lions, tigers and bears in terrestrial ecosystems).



Fishing down the food web

Ecological consequences of invasive species

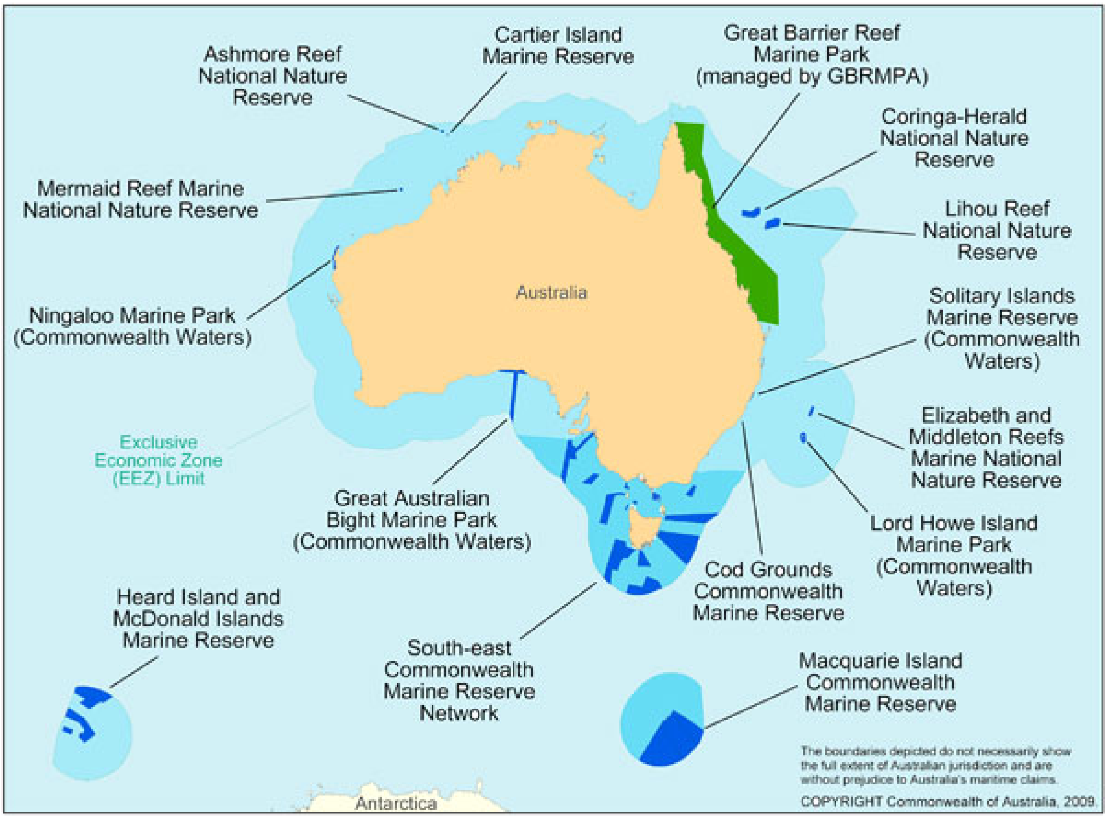
Thousands of marine animal species, plants and algae are introduced to 'new' areas from their native range. These non-native species are sometimes referred to as alien or invasive species. Many non-native marine species are introduced accidentally by the transport and discharge of ballast water, taken on board to stabilize a ship and its cargo and released later, for example at the end of the voyage, perhaps thousands of miles away. A single bulk cargo ship of 200,000 tons can carry up to 60,000 tons of ballast water. Once established in a new region, non-native species may displace native organisms by preying on them or out-competing them for resources such as for food, space or both.

Nearly $1 million per year for the past 20 years has been spent in California to remove the submersed, non-indigenous aquatic plant, hydrilla. In Florida, annual maintenance costs for hydrilla, a native of Asia, now exceed $14 million.
(http://www.globallastwaterindia.com/facts_faqs.htm)

Other invasive species creating significant problems include lionfish, ctenophores and red king crabs. We have already recorded many severe episodes of this serious ecological phenomenon, but only a few were properly monitored. We still need to evaluate the ways in which invasive species alter, stress and reduce the resilience of marine ecosystems. However, existing controls to limit the transfer of species are not fully implemented or respected at the moment. For example, control of ballast water and other vectors that transfer species from one region to another should be incorporated in monitoring programmes, as recommended by the International Maritime Organization's Ballast Water Convention.
(http://www.imo.org/Conventions/Mainframe.asp?topic_id=867).

Marine Protected Areas (MPAs)

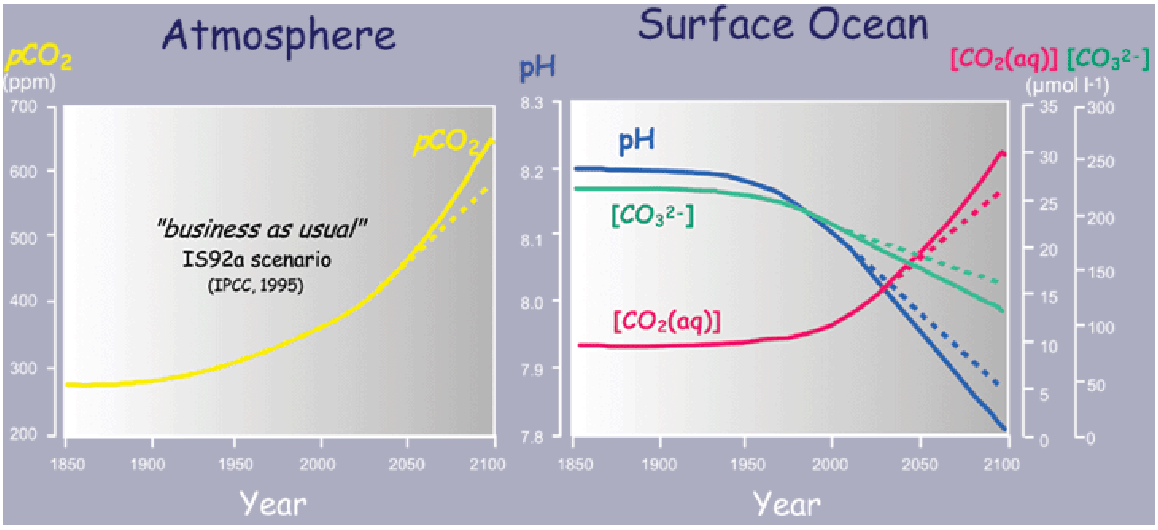
The designation of Marine Protected Areas (MPAs) is one measure that may protect the resilience of marine ecosystems, preserve biodiversity and ensure sustainable use of resources. But, although some progress has been made with MPAs in coastal (territorial) waters, there is a vast and largely unknown area of deep ocean and high seas, beyond the jurisdiction of coastal states, yet with abundant and rare biodiversity that needs international regulation and protection.



Ecosystem functioning

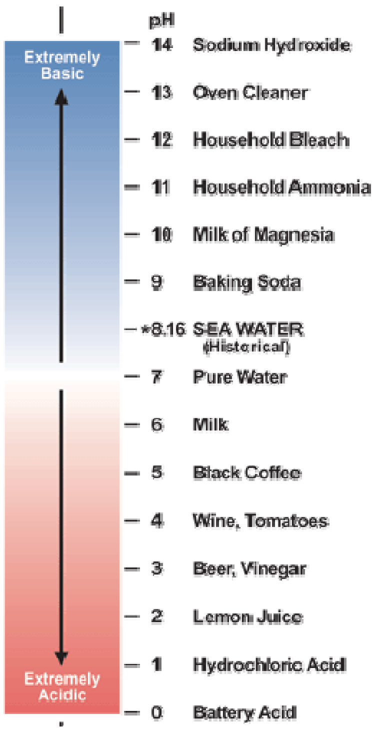
Ocean acidification

The ocean plays an essential role in the storage and exchange of CO_2 with the atmosphere, absorbing about 25% of excess atmospheric CO_2 due to human activities, and acting as a buffer to slow climate change. But the continual uptake of CO_2 and heat is changing the ocean in ways that could have dangerous consequences for marine ecology and biodiversity. Dissolved CO_2 makes the seawater more acidic (lowers the pH) which increases the solubility of calcium carbonate, the stuff of seashells and many invertebrate skeletons, decreasing the health and abundance of the microscopic animals at the base of the ocean's food web, and thus disrupting entire ecosystems.



Levels of pH have dropped at an unprecedented rate over the last 25 years and the trend is set to continue. Biological and chemical oceanographers are anxiously investigating the ramifications of this major shift in ocean chemistry to ocean ecosystems.

For the first time, the Intergovernmental Panel on Climate Change (IPCC) is including ocean acidification in its current (Fifth) assessment of climate change, due to be published in 2014. According to a report by the Secretariat of the Convention of Biological Diversity published at the end of last year, entitled *Scientific Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity,* "Ocean acidification is irreversible on timescales of at least tens of thousands of years, and substantial damage to ocean ecosystems can only be avoided by urgent and rapid reductions in global emissions of CO_2, and the recognition and integration of this critical issue in the global climate change debate."



UNESCO-IOC is a joint sponsor of the International Ocean Carbon Coordination Project, together with the Scientific Committee on Oceanographic Research (SCOR), coordinating observations and research, as well as developing policy and international agreements. http://unesdoc.unesco.org/images/0018/001873/187319e.pdf

Land-based marine pollution

Globally, sewage is the largest source of contamination by volume with discharges from developing countries on the rise as a result of rapid urbanization, population growth and a lack of planning and financing for sewerage systems and water treatment plants. According to the UN Environment Program (UNEP), the global economic impact of marine contamination, in terms of human disease and ill health, may be running at nearly US$13 billion. Meanwhile, sewage discharges, combined with run off of fertilizers from the land and emissions from cars, trucks and other vehicles, are enriching the oceans and seas with nitrogen nutrients. These, in turn can trigger invasions of harmful algal blooms (HABs). UNESCO-IOC has been running a Harmful Algal Bloom research and education programme since 1993. (http://www.ioc-unesco.org/hab/index.php?option=com_frontpage&Itemid=1)

Other pollution threats to the health of the oceans include oil spills, discharges of heavy metals, persistent organic pollutants (POPs) and litter. Meanwhile, sedimentation, as a result of coastal developments, agriculture and deforestation, has become a major global threat to coral reefs particularly in the Caribbean, Indian Ocean and South and Southeast Asia. See: http://www.unep.org/geo/press.htm

During the past 40 years, world production of plastic resins increased some 25-fold, while the proportion of material recovered (5%) stayed wconstant, so that plastics account for a growing segment of urban waste. Once discarded, plastics are weathered and eroded into very small fragments known as micro-plastics. Plastic pellets are already found on most beaches around the world and we still do no know impacts they will have on the marine environment or the marine food web.

Deoxygenation of the oceans

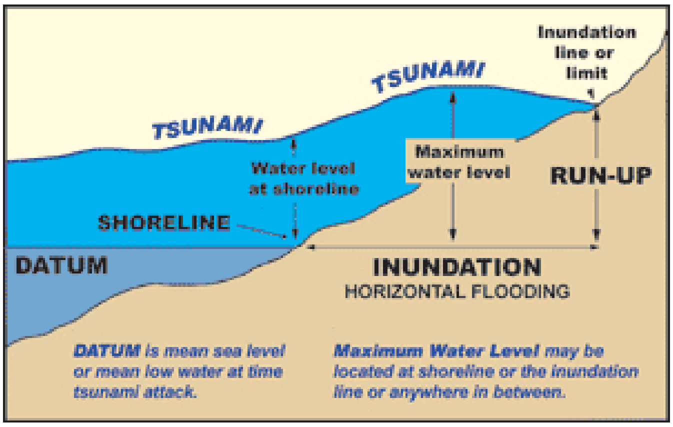
Dissolved oxygen is essential for the healthy functioning of marine ecosystems. But recent research is suggesting that, since 1960, the intermediate-depth, low-oxygen layers (about 300 – 700 m below the surface) of the central and eastern tropical Atlantic and the equatorial Pacific Oceans have expanded – so more of the ocean is low in oxygen. This low-oxygen zone has expanded in the past (and contracted again later), and led to reductions in biological diversity. Now, models are predicting a further decline in the concentration of oxygen that is dissolved in the oceans, as the climate continues to warm. Deoxygenation of the oceans is likely to have substantial effects on the structure and productivity of ocean ecosystems. More research is needed to investigate the causes and the consequences of this phenomenon.

Protecting people and property from tsunamis

http://www.ioc-tsunami.org/

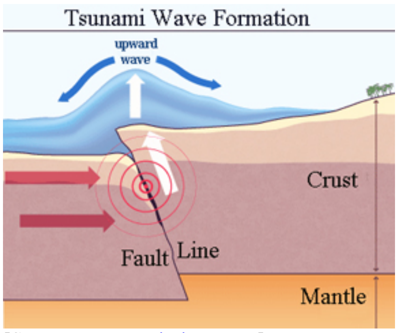
What is a tsunami?

Tsunami is a Japanese word meaning 'harbour (*tsu*) wave (*nami*)' and refers to the large and potentially destructive ocean wave created by the shock from an underwater earthquake (up to 100 km below the surface), a volcanic eruption or, sometimes, a landslide. After a trigger event, the wave radiates out in every direction from the centre of the shock (its *epicentre*), travelling in the deep ocean at as much as 1000 kilometres per hour (as fast as a jumbo jet). Tsunami waves are very long (often 100 km between crests) but are only a few tens of centimetres high where the ocean is deep. When a tsunami wave reaches the shallow waters of a coast, sometimes after many hours of travel, it slows down quickly and piles up, creating a wall of water. This wave strikes inland with tremendous force, creating loss of life and physical damage. Other waves then follow, about an hour apart or less. Tsunamis may sometimes be tens of metres high, but waves under two metres high can still cause massive destruction in low-lying areas.



Did you know?

- Tsunami waves are generated primarily by earthquakes occurring below the sea floor, but can also be caused by volcano eruptions and submarine or aerial landslides
- Although there are no records of large meteorites or asteroids reaching the earth, if they fall in the sea they can generate huge, disastrous tsunami waves.
- Tsunamis are a series of long-wavelength, long-period ocean waves. They are not surface waves. They come ashore for hours. The first wave may not be the largest.
- Tsunamis travel at jet airliner speeds in the deep ocean, but the waves are only centimetres high and cannot be felt aboard ships.
- They slow down and grow in height tremendously upon entering shallow water. Tsunamis can crest to 10-m high, strike with devastating force, and quickly flood all low-lying coastal areas.



[Source: www.sesimic.ca.gov]

- About 60% of tsunamis have their source in the Pacific, mostly along the fault lines around the Pacific coast ("rim of fire").
- During each of the past five centuries, there were three to four Pacific-wide tsunamis
- Japan experiences frequent earthquakes and tsunamis and has invested heavily in warning and protecting its citizens.
- The Indian Ocean tsunami of 26 December 2004 was the first known basin-wide destructive tsunami in the Indian Ocean.
- After an earthquake, move quickly inland and to higher ground. Rush to the hills before the first wave comes and do not return until the tsunami alert is over.
- At the coast, a tsunami may be tens of meters high. On July 9, 1958 a 520 metre wave was observed in Lituya Bay, Alaska (USA), triggered by a huge rock fall.

Tsunami facts and figures

Tsunamis are relatively common in the Pacific, which is surrounded by seismic areas. But they have been observed everywhere, from the North Atlantic to the shores of Antarctica.

Regional and local tsunamis causing 2,000 or more deaths

Year	Date	Source Location	Estimated Dead or Missing
365	21 July	Crete, Greece	5,700
887	2 August	Niigata, Japan	2,000
1341	31 October	Aomori Prefecture, Japan	2,600
1498	20 September	Enshunada Sea, Japan	31,000
1570	8 February	Central Chile	2,000
1586	18 January	Ise Bay, Japan	8,000
1605	3 February	Nankaido, Japan	5,000
1611	2 December	Sanriku, Japan	5,000
1674	17 February	Banda Sea, Indonesia	2,243
1687	20 October	Southern Peru	*5,000
1692	7 June	Puerto Real, Jamaica	2,000
1703	30 December	Boso Peninsula, Japan	*5,233
1707	28 October	Enshunada Sea, Japan	2,000
1707	28 October	Nankaido, Japan	30,000
1746	29 October	Central Peru	4,800
1751	20 May	Northeast of Honshu, Japan	2,100
1755	1 November	Lisbon, Portugal	*60,000
1771	24 April	Ryukyu Islands, Japan	13,486
1783	5 February	Straits of Messina, Italy	*30,000
1792	21 May	Kyushu Island, Japan**	4,300
1854	24 December	Nankaido, Japan	*3,000
1883	27 August	Krakatau, Indonesia**	36,000
1896	15 June	Sanriko, Japan	*27,122
1899	29 September	Banda Sea, Indonesia	*2,460
1923	1 September	Sagami Bay, Japan	2,144
1933	2 March	Sanriko, Japan	3,022
1941	26 June	Andaman Sea, India	5,000
1976	16 August	Moro Gulf, Philippines	4,456
1992	12 December	Flores Sea, Indonesia	*2,500
1998	17 July	Papua New Guinea	2,183
2004	26 December	Banda Aceh, Indonesia	*227,898

* May include earthquake casualties **Tsunami generated by volcanic eruption

Detection and early warning of a tsunami

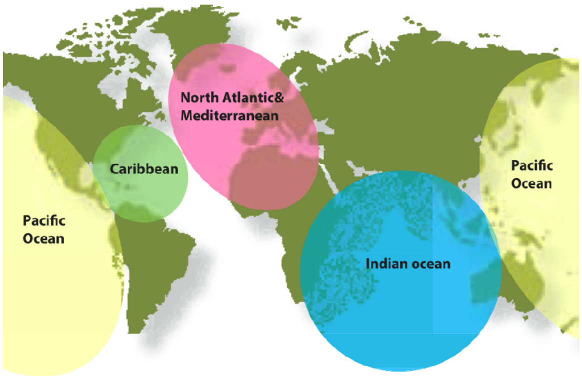
Most tsunamis are caused by earthquakes. Because it is impossible to predict when an earthquake will occur, it is also impossible to determine exactly **when** a tsunami will be generated. However, by looking at past tsunamis, we know **where** they are most likely to be generated. Tsunamis created by earthquakes have their source in seismically active areas.

In 1965, following devastating tsunamis generated from earthquakes in Chile (1960) and Alaska (1964), the newly-created IOC was requested to establish an International Tsunami Warning System in the Pacific, with the Pacific Tsunami Warning Centre (PTWC) and the International Tsunami Information Centre (ITIC) in Honolulu, Hawaii Islands (USA).

Since 1965 the IOC has continuously tried to extend cover for the Indian Ocean and the Caribbean region, similar to the Pacific Tsunami Warning System PTWS for the Pacific Ocean. But the dangers of a tsunami were ignored because they have been so rare in these areas.

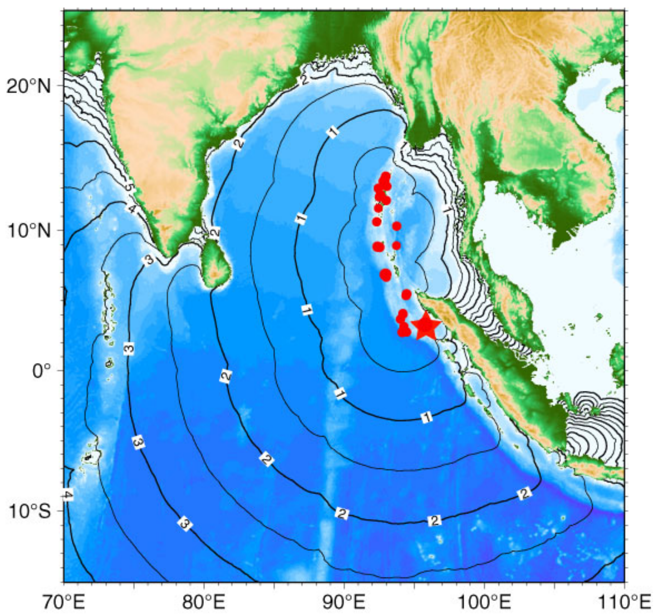
On 24 December, 2004 a massive (magnitude 9.1) earthquake off the coast of Banda Aceh, in Western Sumatra (Indonesia), generated a tsunami that caused over 230,000 deaths and billions of dollars of damage in 11 countries. Although Banda Aceh, itself, bore the brunt of the catastrophe, coasts and their populations in Sri Lanka, India and nine other Indian Ocean countries as far as 5000 km away, were also severely hit by the tsunami. It was the first basin-wide tsunami on record in the Indian Ocean. As there was no early warning system in the region, local people and tourists were neither warned, nor prepared to face the disaster. Following this catastrophe the IOC was mandated to establish a global warning system. It became imperative that a tsunami should never again create such avoidable loss of life.

In 2005, UNESCO-IOC was mandated to coordinate intergovernmental efforts to set up an **Indian Ocean Tsunami Warning System (IOTWS)**, building on over 40 years of experience gained with the Pacific Warning System. Five years later, after a tremendous effort involving 28 Member States, the system is planned to be operational by 2011. The Pacific Tsunami Warning Centre (PTWC) in Hawaii, USA and the Japanese Meteorological Agency (JMA) in Tokyo, Japan have, since April 2005, been providing an interim tsunami advisory service to the Indian Ocean. Similar tsunami warning systems are reaching completion for the **Mediterranean and the North East Atlantic (NEAMTWS)** and the **Caribbean (CARIBE-EWS)**, thus covering all the earthquake (and therefore tsunami) prone ocean basins in the world. PTWC provides an interim tsunami warning service to the Caribbean Sea. “We are now able to ensure global cover for tsunami and other sea-level related hazards” says Peter Koltermann, head of IOC’s Tsunami Unit.



Four regional systems for global early warning

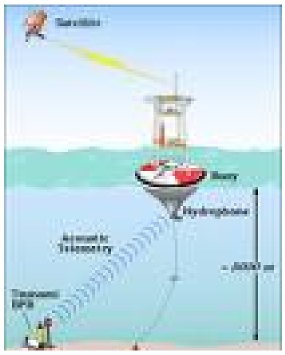
How does a tsunami early warning system work?



The first step is to detect and localise an event that is likely to cause a tsunami. In most cases this is an underwater earthquake of sufficient magnitude (usually greater than magnitude 7). Because at present it is impossible to predict when an earthquake will occur, it is also impossible to determine exactly **when** a tsunami will be generated. However, by looking at past tsunamis, we know **where** they are most likely to be generated. Tsunami travel paths and arrival times can be calculated quite precisely. Given the appropriate communications hardware, and institutional infrastructure, even the smallest village can, in theory, be notified that a tsunami is on the way so that they can take measures (e.g. evacuation to higher ground) to limit loss of life. These warnings are produced and send out by Tsunami Early Warning Centres to national disaster and emergency agencies. Making communities aware of the tsunami risk hazard and preparing to minimize the risk is the greatest challenge to save lives and livelihoods. Intense work by national and local authorities is required to establish and maintain this awareness.

Tide gauges – confirm or cancel a warning

Not every underwater earthquake generates a tsunami, so monitoring changes in the sea level is used to confirm the generation of tsunamis and predict their travel. Sea level data are needed at high time-resolution with fast transmission to the warning centres. The sea level data are also required to cancel tsunami warnings.



Deep sea moored Buoys – added certainty

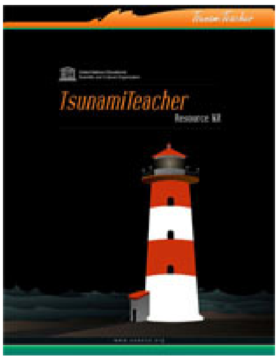
To provide even greater certainty that a tsunami has been generated, very sensitive 'DART' buoys (Deep ocean Assessment and Reporting of Tsunami) are deployed to measure sea level changes by observing deep sea pressure changes. Similar buoys are now being deployed in the Indian Ocean. Unlike tide gauges, they are expensive and need regular maintenance in remote areas of the ocean.

Communications

Once a tsunami warning has been issued, it has to get to those who are likely to be affected in time for them to take preventive action. Warnings are sent using several different means of communication on officially dedicated systems. In Japan – one of the most frequently struck countries – earthquake warnings are broadcast on television within 30 seconds of a tremor. Tsunami warnings follow very rapidly.
http://www.prh.noaa.gov/ptwc/messages/pacific/2010/pacific.2010.02.27.064454.txt

Awareness and preparedness

"The most difficult part of a successful tsunami warning system," says Bernardo Aliaga, Programme specialist at IOC, "is preparing and informing the public on what to do once a warning has been issued." This he says is the "first mile" of a successful warning system. While the technical aspects of early warning systems have developed rapidly in recent years, there is still much work to do with communities at risk. In much of Indonesia, the epicentre of an underwater earthquake can be so near to the coast that people have to be able to recognise and act on the signs immediately. Says Laura Kong, Director of the UNESCO IOC International Tsunami Information Centre, "They have to know that, if they're near a coast and the earth is shaking so violently that they can't stand up, there's a very good possibility that a wave might have been generated. It's time to head uphill as soon as you can."



In the light of the 2004 Indian Ocean tsunami, where tourists also lost their lives, hotels in many countries (e.g. Indonesia and Thailand) now give a tsunami information kit to guests, showing the evacuation route and meeting points. These hotels also have access to the tsunami warnings.

To help raise awareness and inform the public, UNESCO-IOC has published a *Tsunami Teacher* DVD for use by teachers, students, private enterprise, etc. It is so far available in Indonesian, French, and English language versions. Thai, Spanish and Urdu versions are been finalised.

Protecting our coasts

UNESCO-IOC is involved in a number of initiatives, particularly in Africa, focusing on developing measures that enable coastal communities to adapt to climate change. The IOC approach focuses on restoring natural coastal ecosystems that are threatened by the impacts of climate change (e.g. sea level rise, coastal erosion). These coastal ecosystems include mangroves, sea grasses, wetlands and sand dunes that have been depleted or destroyed, often through unsustainable development initiatives for housing, aquaculture, tourism, etc. Restoring these ecosystems brings several simultaneous benefits, including natural protection against sea level rise, storm surges and erosion, protected biodiversity – mangroves are spawning grounds for fish – and even absorption of atmospheric CO_2, as well as sustainable local livelihoods, such as fishing, or eco-tourism.

IOC also promotes risk and vulnerability assessments and works with local communities to integrate these into the planning cycle. In addition to the adaptation measures, IOC is involved in developing community zoning plans for coasts.

Coastal World Heritage Sites

IOC is also working with UNESCO World Heritage Centres and Marine Heritage Sites, developing a management approach to conservation and protection.

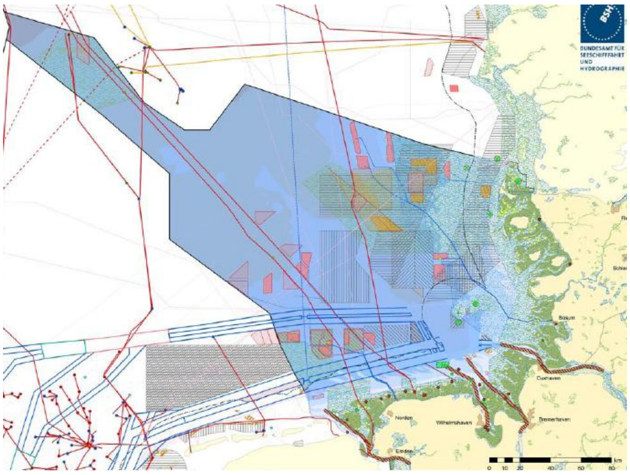
The recent creation of an in-house biodiversity liaison group, which assembles representatives of all parts of UNESCO with an interest and a mandate to conserve biodiversity, has set the foundation for more systematic cooperation between specialised UNESCO entities. For example, currently 74 Biosphere Reserves overlap with World Heritage sites and share similar challenges. Fortunately they can also share solutions towards better management of sites, promoting sustainable livelihoods and linking science to management.

Out of a total of over 800 World Heritage Sites, about 34 currently include marine areas. In addition, some 30 sites are limited to coastline. Meanwhile, UNESCO's Small Island Developing States (SIDS) Programme works closely with the Organization's World Heritage Marine programme and Sustainable Tourism Programme. It coordinates and develops World Heritage-related activities, both natural and cultural, on islands in the Caribbean, the Atlantic, Indian and Pacific Oceans

Marine spatial planning

Given the global trend for migration from rural areas to cities, and the overwhelming tendency for larger cities to be on the coast, it is going to be essential to plan development of marine and coastal spaces in a sustainable way, rather than try to stop it at all costs. A relatively new approach to planning, called **marine spatial planning** (MSP), takes whole maritime ecosystems, and provides tools to assess how the resources can be exploited sustainably – or not – alongside competing human demands on local resources, be they for recreation and tourism, offshore oil and gas exploitation, marine transportation, gravel mining, marine aquaculture, etc.

The marine spatial planning process usually results in a comprehensive plan or vision for a marine region. Marine spatial planning is one element for managing the use of the ocean or sea, while zoning plans and regulations are one of a set of management measures for implementing marine spatial planning. Zoning plans can then guide the granting or denial of individual permits for the use of marine space.



The purpose of this initiative, then, is to help countries operationalize ecosystem-based management by finding space for the conservation of biodiversity and sustainable economic development in marine environments.

The development and implementation of MSP involves a number of steps, including:

(1) Identifying need and establishing authority
(2) Obtaining financial support
(3) Organizing the process through pre-planning
(4) Organizing stakeholder participation
(5) Defining and analyzing existing conditions
(6) Defining and analyzing future conditions
(7) Preparing and approving the spatial management plan
(8) Implementing and enforcing the spatial management plan
(9) Monitoring and evaluating performance
(10) Adapting the marine spatial management process

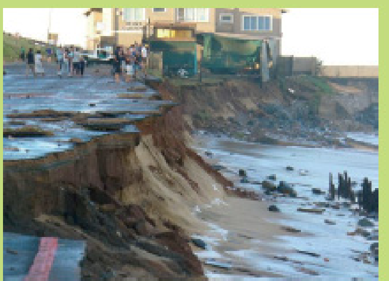
IOC's approach to Marine Spatial Planning has focused on:

Developing a step-by-step approach for implementing marine spatial planning;
Documenting marine spatial planning initiatives around the world;
Analyzing good practices of marine spatial planning;
Collecting references and literature on marine spatial planning;
Increasing understanding about marine spatial planning through publications;
Developing capacity and training for marine spatial planning.

http://www.unesco-ioc-marinesp.be/

Coastal hazards

An international group of experts, working under the auspices of the IOC, has compiled a series of guidelines to assist policy makers and managers to reduce the risks to coastal communities, their infrastructure and service-providing ecosystems, from a spectrum of coastal hazards. The group included specialists in the fields of sea-level related hazards, marine meteorology, vulnerability and risk in respect of natural hazards, early warning and preparedness, risk mitigation, and coastal zone management. Each step is described – including its purpose, its key considerations, the management challenges that it poses and its anticipated outputs.



Coastal erosion in Kwazulu-Natal, South Africa, March 2007

The hazards described make a distinction between **rapid-onset hazards** (e.g. tsunamis, storm surges, extreme wind-forced waves) and **cumulative, progressive or 'creeping' hazards** (e.g. long-term sea-level rise and coastal erosion).

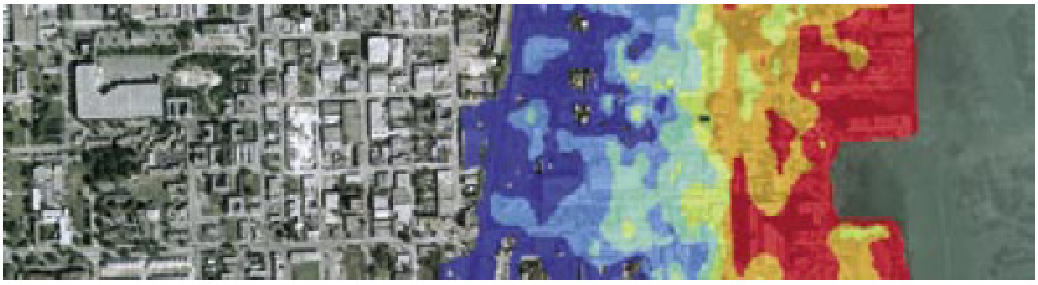


Fig. 4.6 *Inundation modelling of a storm surge impact.*
This model simulated a Category 5 hurricane generating a surge height of 7 m impacting Miami, U.S.A. The colour scale is based on modelled inundation depths: Blue = <1 m; Green = <2 m; Yellow = <3 m; Orange = <4 m; Red = >4 m. Atlantic Ocean to Right of image.
Source: Courtesy Ambiental Technical Solutions, Ltd. (www.ambiental.co.uk).

A key aspect of the guidelines approach is to assess the vulnerability of those exposed to a given hazard – the coastal community and their buildings, industrial and utilities infrastructure and the integrity of their local ecosystems. Vulnerability assessments also take account of deficiencies in preparedness at the institutional level.

The ultimate aim is to enhance public awareness of the risks and to improve the resilience of coastal communities in coping in emergency situations. The guidelines also describe options for structural and non-structural responses for the mitigation of the assessed risks using strategic management.

Whatever a coastal community's physical or developmental situation, there are ways of reducing risk in respect of these hazards which are sustainable and can be embedded in the culture of that community – this is one of the prime goals of the Guidelines.

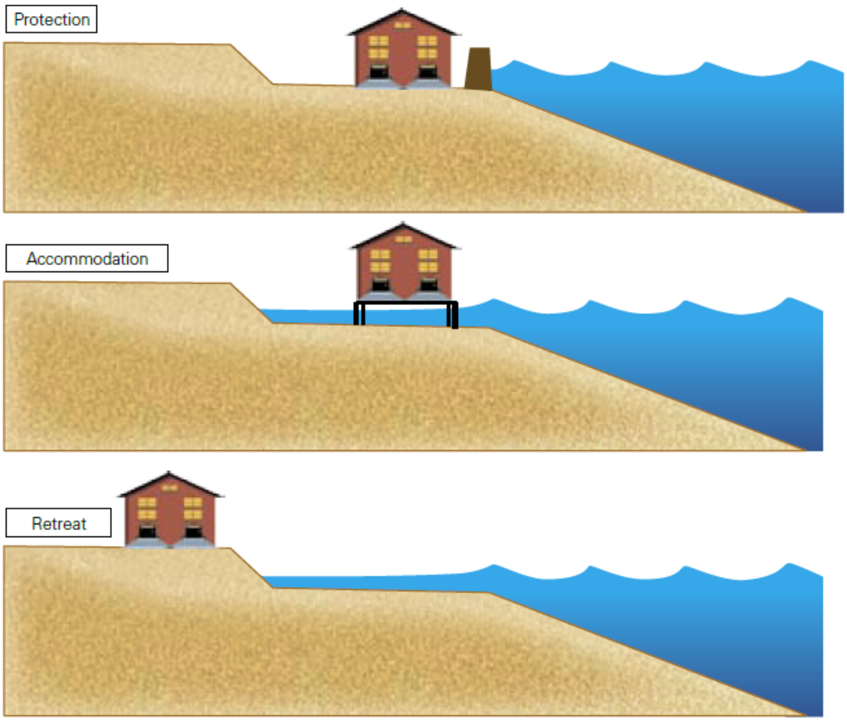
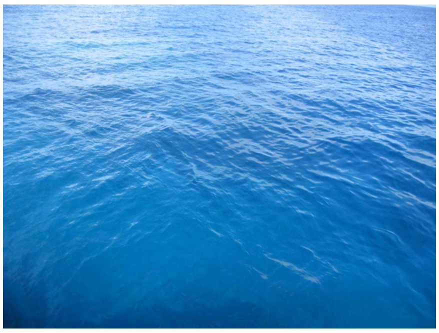


Fig. 8.1. *The three mitigation strategies: protection, accommodation and retreat.*
Source: Based on Bijlsma et al. 1996.

The need for a global and continuing review of the state of the ocean

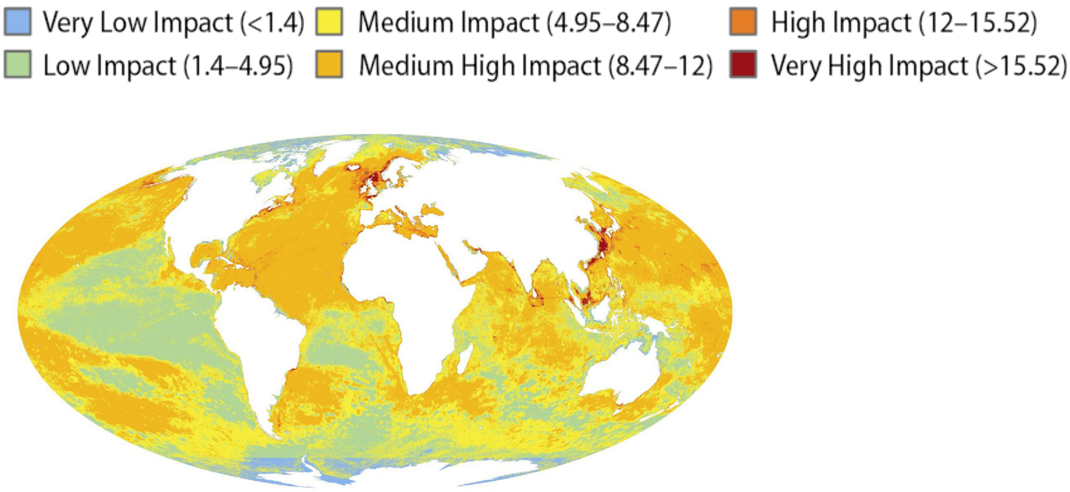
Who would run a business and not try to understand what happens to 70% of its assets? Yet the oceans cover seven-tenths of our planet, and we do not regularly assess what is happening to them as a whole.



Marine monitoring and research are the basic tools for understanding what is happening to the oceans, why it is happening, and how effective our responses have been. But to be useful for decision making, this knowledge has to be brought together, assessed and presented clearly.

Until recently, there had been no systematic effort to keep the state of the world's oceans under continuing review, or to assess the sustainability of how humans use and manage the oceans. Without baselines and reference points, it is impossible to put current knowledge into a historical context. And this means that it is difficult to detect long-term trends or to make accurate predictions. It is also important to integrate the various measurements that are being taken of different ocean variables, in order to build up a global picture and to make sure it is kept up to date. Without this information at hand, it is difficult to have a truly integrated and sustainable governance system for the oceans, as a sectoral approach to ocean management would be inefficient.

There are effectively no oceans space left that are not affected by human activities. With the effects of climate change and the increased encroachment of human activities in the open ocean, there is a need to understand how our oceans and resources are reacting to these pressures.



Halpern et al. 2008

Assessment of Assessments

This is why, at the World Summit on Sustainable Development, in Johannesburg in 2002, World leaders agreed to "establish by 2004 a *Regular Process under the United Nations for global reporting and assessment of the state of the marine environment, including socio-economic aspects*, both current and foreseeable, building on existing regional assessments."

The initial phase of this Regular Process, started in 2006, came to be known as the Assessment of Assessments and has been carried out under the joint leadership of UNESCO-IOC and the United Nations Environment Programme (UNEP). Using the results of the Assessment, the first cycle of the 'regular process' started in 2010 and is due to end in 2014.
http://www.ioc-unesco.org/index.php?option=com_content&task=view&id=159&Itemid=76

Main Findings

Under the Assessment of Assessments an Expert Group examined various existing marine assessments, looking at their scientific credibility, policy relevance and legitimacy, for example. This also helped identify best practices, as well as thematic, geographic or data gaps, scientific uncertainties, and needs for further research and capacity-building, particularly in the developing world.

The main findings of this assessment of assessments revealed that:

•Living marine resources and water quality assessments are the strongest, with good international networks, though they still vary around the globe.

•Assessment capability for fisheries and water quality is substantial but data collection funding is often insufficient.

•Habitat status and trend assessments are increasing but less well developed globally

•Social and economic assessments for marine activities and coastal communities are lacking in many areas

•Integrated assessments are rare; most analyses are on a sectoral basis.

•Lack of integration as well as social and economic analyses hinders understanding of overall conditions in the marine environment and the analysis of policy alternatives

•While the use of reference points is common for fisheries and water quality, more effort is needed for other aspects

•There are major gaps in global data, including social and economic data. Coverage for many types of data is limited, availability may be restricted and interoperability of data sets may be limited as well.

The main recommendation of the Group of Experts is that, despite some of the identified gaps in our knowledge, there are sufficient data and information to produce and package a global integrated assessment on oceans for use by national and international decision-makers. The cycle and structure that would be set up to conduct this major assessment would come directly under the responsibility of the UN General Assembly. The Regular Process would link to other global environmental assessment such as the International Panel on Climate Change (IPCC), the Global Environment Outlook (GEO), the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), etc.

The Regular Process will also need to be accompanied by a major effort in capacity building in order to make sure that developing countries have the human and institutional capacity to participate in the Assessment and to benefit from its results, by building sustainable marine and coastal policies.

The UN General Assembly will (hopefully) decide in 2010 to establish the Regular Process and define the institutional arrangements that will need to be in place in order to deliver the first truly integrated assessment report by 2014-2015.

The full Assessment of Assessments report, including a Summary for Decision-Makers, is available on the Regular Process website – http://www.unga-regular-process.org