United Nations
Educational, Scientific and
Cultural Organization

Intergovernmental
Oceanographic
Commission





FIVE YEARS AFTER

the tsunami in the Indian Ocean

From strategy to implementation

Advancements in global early warning systems
for tsunamis and other ocean hazards 2004-2009

Acronyms

AWI	Alfred Wegener Institute for Polar and Marine Research (Germany)
BMBF	German Federal Ministry of Education and Research
CARIBE-EWS	Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CSIR	Council of Scientific and Industrial Research
CTBTO	Comprehensive Nuclear Test Ban Treaty Organization
CTIC	Caribbean Tsunami Information Centre
CTWC	Caribbean Tsunami Warning Centre
FDSN	International Federation of Digital Seismograph Networks
GEOSS	Global Earth Observation System of Systems
GMDSS	Global Marine Distress and Safety System
GLOSS	Global Sea Level Observing System
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System
IAS	Interim Advisory Service
IASPEI	International Association of Seismology and Physics of the Earth's Interior
ICG	Intergovernmental Coordination Group
INCOIS	Indian National Centre for Ocean Information Services
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
ITIC	International Tsunami Information Centre
ITP	International Tsunami Programme
ITWS	Interim Tsunami Warning System
IUGG	International Union of Geodesy and Geophysics
JMA	Japan Meteorological Agency
JTIC	Jakarta Tsunami Information Centre
NEAMTWS	Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas
NOAA/NWS	U.S. National Oceanic and Atmospheric Administration/National Weather Service
NTWC	National Tsunami Warning Centres
OPECST	Parliament Office for the Evaluation of Scientific and Technological Choices (France)
PRSN	Puerto Rico Seismic Network
PTWC	Pacific Tsunami Warning Center
PTWS	Pacific Tsunami Warning and Mitigation System
RTWP	Regional Tsunami Watch Providers
SOP	Standard Operating Procedure
TOWS-WG	Working Group on Tsunamis and Other Hazards Related to Sea Level Warning and Mitigation Systems
TSU	Tsunami Coordination Unit (IOC)
TWFP	Tsunami Warning Focal Points
TWS	Tsunami Warning System
UHSLC	University of Hawaii Sea Level Center
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISDR	United Nations International Strategy for Disaster Reduction
USGC	United States Geological Survey
WG	Working Group
WMO	World Meteorological Organization

Useful Web Resources

http://www.ioc-unesco.org

Find out more about UNESCO/IOC and its involvement in numerous other global programmes.

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

UNESCO/IOC global tsunami website: a one-stop resource for all tsunami related information, including regional tsunami warning systems, meeting and event schedules, capacity-building activities, a quarterly Tsunami Newsletter, and more!

http://ioc3.unesco.org/itic/

More resources, information and downloadable materials from the International Tsunami Information Centre.

http://ioc.unesco.org/TsunamiTeacher

Free information kit providing reliable and verified tsunami warning, response and mitigation information and tailored training modules.

FIVE YEARS AFTER

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(IOC/BRO/2009/4)

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UNESCO/IOC: building on more than forty years of tsunami experience

MR KOÏCHIRO MATSUURA
Director-General of UNESCO

IN THE DAYS THAT FOLLOWED the Indian Ocean tsunami in December 2004, UNESCO's long-standing association with tsunami-related actions became more widely known, particularly through its Intergovernmental Oceanographic Commission (IOC), which had established and operated the tsunami warning system in the Pacific Ocean since 1965. The unspoken question, however, was why, if a tsunami warning system existed in the Pacific Ocean, a similar system did not exist in the Indian Ocean?

The risk of tsunamis exists in varying degrees in all oceans and coastal seas. Given the knowledge and technology available, it is unacceptable that at the dawn of the twenty-first century, humanity still has not been able to utilize this knowledge and technology to protect the people of the Earth and to mitigate the effects of natural disasters.

In a historic meeting in July 2005, the IOC General Assembly approved the creation of three tsunami warning and mitigation systems in the Indian Ocean, the Caribbean Sea, and the Mediterranean Sea and North Eastern Atlantic. Effectively, when added to the existing Pacific Ocean system and when fully operational, these new systems will provide global coverage to protect coastal populations from tsunami hazards.

'these new systems will provide global coverage to protect coastal populations'

UNESCO through its IOC is leading this initiative as part of the ongoing effort to complete building the Global Ocean Observing System (GOOS). Although the earliest signals that give warning about the possibility of an impending strong and distant tsunami draw upon the monitoring of seismic activity, the observational backbone of the tsunami warning system consists of measurements of sea level already being made under the auspices of GOOS. A key decision was made early on not to develop a new capability to measure sea level but rather to harness the system that already exists for tsunami warning. This strategic approach is essential, since the long-term sustainability of the warning systems depends on the multiple uses of detection networks.

At the core of the warning systems are the National Tsunami Warning Centres, designed to respond to the most frequent types of events occurring in their regions and fully interlinked with national emergency authorities, so that long-term preparedness plans can be implemented and timely warnings can be issued by responsible agencies.

Last but not least, UNESCO also has a fundamental role in supporting the valuable cross-fertilization of education and emergency management. After all, what can even a flawlessly executed warning hope to achieve if the people who are at risk along the coasts do not know how to respond? Without a doubt, an informed, knowledgeable community is a prepared, safer one too.

United Nations General Assembly resolutions mandating UNESCO/IOC in disaster prevention

United Nations

General Assembly

Resolutions adopted by the General Assembly

calling for UNESCO/IOC and governments to participate in strengthening emergency relief, rehabilitation, reconstruction and prevention in the aftermath of the Indian Ocean tsunami disaster

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61/132.

Sixty-first Session
Agenda item 69 (a)
1 March 2007

The General Assembly,

[…] Stressing the need to develop and implement risk reduction strategies and to integrate them, where appropriate, into national development plans […] so as to enhance the resilience of populations in disasters and reduce the risks to them, their livelihoods, the social and economic infrastructure and environmental resources, and stressing also the need for Governments to develop and implement effective national plans for hazard warning systems with a disaster risk reduction approach.

Emphasizing that disaster reduction, including reducing vulnerability to natural disasters, is an important element that contributes to the achievement of sustainable development.

Welcoming the role of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization in the establishment and implementation of the Indian Ocean Tsunami Warning and Mitigation System, given the importance of strengthening regional and subregional cooperation and coordination, which is essential for effective early warning system arrangements for tsunamis. […]

[…] Encourages international agencies and Governments to enhance and accelerate their support for the development, implementation and maintenance of the Indian Ocean Tsunami Warning and Mitigation System, under the Intergovernmental Oceanographic Commission, as the appropriate vehicle for the rapid and timely exchange of alerts and related information required to deliver effective tsunami warnings at the national level.

62/91.

Sixty-second Session
Agenda item 71 (a)
8 February 2008

The General Assembly,

[…] Emphasizing the role of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization in coordinating the establishment of the Indian Ocean Tsunami Warning and Mitigation System, given the importance of strengthening regional and subregional cooperation and coordination, which is essential for effective early warning system arrangements for tsunamis.

MR PATRICIO BERNAL
Executive Secretary of IOC

...However the lingering, often not formulated question was, if a Tsunami Warning System existed in the Pacific Ocean, how was it possible that a similar system did not exist in the Indian Ocean and elsewhere. To me the hardest lesson from the Indian Ocean Tsunami is that we were dealing with a major collective institutional failure. Failure in communicating science to governments, in bringing science to bear on everyday life, failure to coordinate the relevant institutions, failure to educate the public on the risks that natural disasters bring.

How could the ocean leave such a trail of suffering and destruction? The tsunami put in evidence our distorted vision of nature, built by our lifestyles, determined by our lifespan and by the short latency of our collective memory. We build our cities and occupy the coasts as if risks do not exist, regardless of the intrinsic instability of the coasts, measured in a time-scale of centuries and millennia.

[…] *Urges* Governments of the affected countries to identify their unmet needs in terms of financial and technical assistance in order to foster the ongoing efforts to enhance national capacity and create a reliable tsunami early warning system in the region in concert with the activities of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization.

[…] *Welcomes* the establishment of Tsunami Warning Focal Points capable of receiving and disseminating tsunami advisories around the clock, and encourages the continuation of the efforts of the Intergovernmental Oceanographic Commission supported by Member States, United Nations agencies and donors, including for developing national action plans for all countries participating in the Indian Ocean tsunami early warning system.

63/137.

Sixty-third Session
Agenda item 65 (a)
3 March 2009

The General Assembly,

[…] *Emphasizing* also the role of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization in coordinating the establishment of the Indian Ocean Tsunami Warning and Mitigation System, given the importance of strengthening regional and subregional cooperation and coordination, which is essential for effective early warning system arrangements for tsunamis,

[…] *Urges* Governments of the affected countries to identify their unmet needs in terms of financial and technical assistance in order to foster the ongoing efforts to enhance national capacity and create a reliable tsunami early warning system in the region in concert with the activities of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization;

[…] *Acknowledges* that relevant activities in evaluating and strengthening the tsunami early warning systems have focused principally on establishing the system's governance structure, its technical implementation, increasing public awareness and preparedness, including training, and technical advice;

Welcomes the operationalization of Tsunami Warning Focal Points capable of receiving and disseminating tsunami advisories around the clock, and encourages the continuation of the efforts of the Intergovernmental Oceanographic Commission supported by Member States, United Nations agencies and donors, including for developing national action plans for all countries participating in the Indian Ocean tsunami early warning system.

Consolidating global coverage and international commitments

PETER KOLTERMANN
Head of Tsunami Unit, UNESCO/IOC

Before the tsunami in 2004, there was no system in the Indian Ocean to warn its coastal populations that danger was imminent. Now, five years after and following intensive efforts by twenty-eight governments around the Indian Ocean and a huge international effort coordinated by UNESCO/IOC, a regional end-to-end tsunami and multi-hazard warning system is firmly in place; an interim cover has been provided by Japan and the United States of America since 2005. The Indian Ocean Tsunami Warning and Mitigation System (IOTWS) will start full operational service in 2010. In the Pacific, the Samoa tsunami on 29 September 2009 came unannounced yet again. However, this time it found the islands well prepared, although the fact that there were any casualties at all remains deplorable.

UNESCO/IOC was chosen by the nations of the United Nations General Assembly to lead the coordination effort as a result of more than forty years' experience in coordinating the Pacific Tsunami Warning System. Having built on this strong foundation, we have now established three new systems for the Indian Ocean; the Caribbean; and the North Eastern Atlantic, the Mediterranean and connected seas. Each system is well advanced; some are even about to operate independently.

The goal of UNESCO/IOC where disaster reduction is concerned is to be present before ocean and coastal related disasters strike: more specifically, to provide global coverage against the threat of tsunamis and other ocean hazards. Towards this end, the design of the warning system is based on three mutually dependent components: the assessment of tsunami hazards; detection/warning systems; and the adoption of preparedness measures.

Through intensive regional diplomacy, so far we have engaged the governments of twenty-eight Member States in the Indian Ocean region to participate at the highest level. Why, especially during an economic crisis, are Member States dedicating their time and resources to developing tsunami warning systems? The answer is quite simple: the cost of not acting is far greater than the investment needed to protect people and assets from the impact of natural disasters. Furthermore, leaders know they must demonstrate they are fully committed to protecting the coastal populations and economies of their own countries.

Commissioning early warning systems depends heavily on how they will be supported and sustained during the coming years. While national governments have primary responsibility for defining and implementing national preparedness procedures, UNESCO/IOC will be available to support the development of educational and communication plans that are both scientifically based and culturally adapted. The governance model of our regional Intergovernmental Coordination Groups has provided important insights into establishing systems responsibly within nationally owned end-to-end systems.

Our ability to monitor the Earth, identify risks, threats and hazards has improved tremendously during recent years. Best efforts alone, however, will not be sufficient for this task. Global scientific coordination is still very much required if we are ever to answer the persistent questions 'why now?' and 'how?'. Concerning one question in particular there is no doubt whatsoever: humanity needs to do everything it can to prevent another disaster of the magnitude of the 2004 Indian Ocean tsunami.

Establishing basin-wide tsunami warning systems

Background

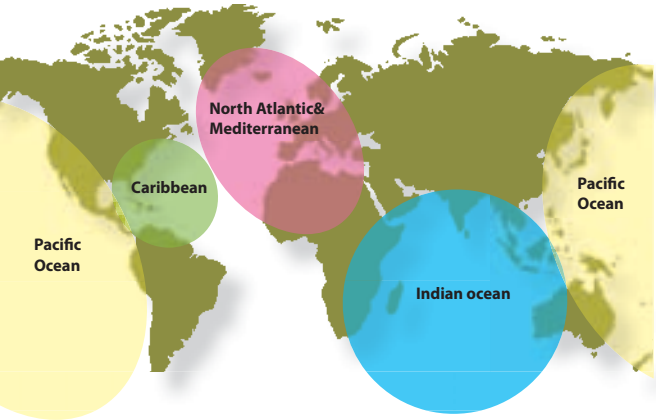
In 1965, the Intergovernmental Oceanographic Commission (IOC) of UNESCO established a Tsunami Warning System (TWS) in the Pacific Ocean where about sixty per cent of all tsunamis take place. This system has been operating successfully and effectively now for more than forty years, ensuring that people living on the ocean's rim and on its islands receive prompt forecasts and warnings of impending tsunamis.

An early warning system in the Indian Ocean would have saved many thousands of lives, but none was in place at the time. As a result, the 2004 tsunami killed over 230,000 people, displaced more than one million people and left a trail of destruction around the coasts of the Indian Ocean. Although the tsunami took over two hours to cross the Bay of Bengal, more than 50,000 people in East Africa, India, the Maldives and Sri Lanka also lost their lives.

UNESCO/IOC took the lead in coordinating activities for the immediate establishment of a Tsunami Warning System (TWS) in the Indian Ocean. The response included setting up an interim system with tsunami advisory information provided through the Pacific Tsunami Warning Center (PTWC) in Hawaii and the Japan Meteorological Agency (JMA).

Setting up global protection

Since 2004, there has been much activity by governments, international agencies and civil society organizations to create national and regional early warning systems; now 24 early detection buoys have been placed in the Indian Ocean, and 168 governments have resolved to reduce multi-hazard risks.[1] Along the coastlines of affected countries, governments have installed signs for evacuation routes, siren towers and local early warning centres, signaling an important shift in attitudes towards preparedness.



Four regional systems for global early warning

Four regional systems for global early warning

The Twenty-third Session of the Intergovernmental Oceanographic Commission's General Assembly in June 2005 confirmed the immediate action and response to the 2004 tsunami and adopted resolutions to create three regional Intergovernmental Coordination Groups (ICGs) for **the Indian Ocean, the North Eastern Atlantic and Mediterranean**, and **the Caribbean** in order to establish basin-wide TWS. Together with the existing system in the **Pacific Ocean** and other relevant United Nations agencies, these regional systems contribute to the work of a global coordination group on tsunami and other sea level related hazard warning systems.

NOAA ship servicing a DART tsunami warning buoy. *(Courtesy of NOAA Pacific Environmental Laboratory.)*

What is a Tsunami Warning System (TWS)?

A TWS issues timely and clear warnings for its area of operation and exchanges these data and information with other national and international centres. Identifying and mitigating the hazards posed by local and distant tsunamis involves a fully integrated end-to-end warning system comprising three key components: hazard detection and forecasting; threat evaluation and alert dissemination; and community preparedness and response.

Each TWS is owned and operated by Member States and continuously collects, distributes and interprets all available seismic and sea level data relating to the existence and propagation of a tsunami. Sustained activities in tsunami hazard risk assessment, tsunami warning training, emergency response, and preparedness form part of the complementary mitigation activities that extend a TWS into an end-to-end system.

What is the Tsunami Unit (TSU)?

The tsunami-dedicated team at the IOC works within the TSU to coordinate the four systems and establish common procedures and guidelines. Based at UNESCO/IOC Headquarters in Paris, France, the TSU includes the Secretariats for each Intergovernmental Coordination Group (ICG) of each TWS, the International Tsunami Information Center (ITIC), and technical and professional staff.

What is an Intergovernmental Coordination Group (ICG)?

An ICG is an IOC subsidiary body that reports to the IOC Assembly or Executive Council. ICGs represent their governments by commenting on ICG agenda items, announcing initiatives, making and supporting recommendations, and committing to actions that improve and enhance the effectiveness of their regions' TWS. ICG activities are Member State driven according to the needs of the region and integrate the advice of experts contributing to working groups and other tertiary bodies.

1. *The Tsunami Legacy: Innovation, Breakthroughs and Change*. Source: Tsunami Global Lessons Learned Project. Available online at (http://www.reliefweb.int/rw/rwb.nsf/db900SID/MUMA-7RF7PQ?OpenDocument).

Global coordination of tsunami and other sea-level related hazard warning systems

Mangrove rehabilitation, Malaysia.
(© FRIM-JPSM/NRE National Task Force Committee of Planting Mangroves and Other Suitable Species Operation in Shoreline of Malaysia.)

The risk of tsunamis is quite variable for different coastlines. From a broader perspective, however, risks such as storm surges or rising sea levels that result in coastal inundation threaten nearly every coastline all over the globe to some degree. Warning time scales are different for various phenomena but a tsunami is certainly the most challenging because it demands a warning lead time measured usually only in minutes.

Regardless which phenomena actually cause coastal flooding, the network of instruments monitoring changes in sea level is the same; therefore the forces driving coastal inundation hazards are of little interest. By contrast, what is extremely important for risk reduction is preparedness at national level combined with coastal zone planning and/or constructional countermeasures. Consequently, there is significant synergy in a multi-hazard approach towards monitoring and warning systems for sea level related hazards.

Based on this fact, following the Indian Ocean tsunami tragedy in December 2004, UNESCO/IOC established Intergovernmental Coordination Groups (ICGs) with a mandate not only to coordinate the regional tsunami warning systems but also, by collaborating with relevant agencies, to outline a global framework that ensures the inclusion of other related marine hazards.

There are four ocean regions in the world coordinated by ICGs: these are the Pacific Ocean (ICG/PTWS); the Indian Ocean (ICG/IOTWS); the Caribbean Sea and adjacent regions (ICG/CARIBE-EWS); and the North Eastern Atlantic, Mediterranean and Connected Seas (ICG/NEAMTWS).

This global framework has led to the establishment of the Working Group on Tsunamis and Other Hazards Related to Sea Level Warning and Mitigation Systems (TOWS-WG). Its primary task is to advise the IOC Governing Bodies on the coordinated development and implementation activities of warning and mitigation systems for tsunamis and other ocean-related hazards that are particularly related to sea level.

In this way, the Working Group not only harmonizes global procedures and standards for instrument networks, data exchange and communication of tsunami watch messages, but also maximizes coordination with other relevant UN partners throughout both the upstream (detection) and downstream (mitigation) part of a complete end-to-end warning system.

The Tsunami Warning and Mitigation System in the Pacific (PTWS)

The Intergovernmental Coordination Group for the Pacific Tsunami Warning System (ICG/PTWS) recommends and coordinates programmes most beneficial to the twenty-six UNESCO/IOC Member States throughout the Pacific region whose coastal areas are threatened by tsunamis. When it was created in 1965, the PTWS was the world's only operational tsunami warning system and it remains one of the IOC's most successful longest-running programmes. Following the offer of the United States of America to expand its tsunami warning centre, UNESCO/IOC's Pacific Tsunami Warning Center (PTWC) today is operated in Hawaii by the U.S. National Oceanic and Atmospheric Administration/National Weather Service (NOAA/NWS).

The IOC also established the International Tsunami Information Center (ITIC) in Hawaii. Hosted by the USA, the ITIC's mandate is to: (1) monitor and recommend improvements in the warning system; (2) provide information about the activities of the warning system; (3) assist in the establishment of national tsunami warning systems in the Pacific region; (4) gather and distribute knowledge on tsunamis and foster tsunami research and its application; (5) help make available all records pertaining to tsunamis; and (6) assist with and develop procedures for post-tsunami surveys. In addition, the ITIC is routinely involved in public education efforts such as: answering inquiries from students and concerned individuals; providing information to the news media, producers of television and film documentaries and book writers; giving public lectures; and assisting organizations with programmes that educate the public about tsunamis. ITIC has also developed a website (http://ioc3.unesco.org/itic) that contains a wide variety of tsunami-related information.

The five general areas for work that programmes in the Pacific address overall are: (1) Preparation of tsunami-related educational material; (2) Collection and compilation of historical tsunami data, and development of better techniques for using historical data, seismic data, and modelling to provide warnings and predict runups; (3) Establishment of better communications channels for transmitting real-time data and disseminating warnings; (4) Development of improved seismic and water level data collection and processing equipment and techniques, establishment of new data collection stations where needed, and provision of training in the installation and maintenance of equipment and stations; and (5) Improvement of existing tsunami warning centres and establishment of new centres, where needed, along with appropriate technology transfer, training and documentation.

Although a significant amount of progress has been made in recent years, continued efforts to improve all aspects of the warning system are still needed to meet stakeholder requirements to effectively mitigate the hazard posed by local and distant tsunamis in all parts of the Pacific Basin. An unprecedented number of locally destructive tsunamis occurring within the last few years have heightened the need for more risk assessment, capacity-building, disaster prevention education and other activities to achieve further and sufficient tsunami preparedness and sustainability of operational systems.

The Indian Ocean Tsunami Warning and Mitigation System (IOTWS)

The Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) was established in July 2005 with a membership of twenty-eight IOC Member States from around the Indian Ocean rim. The ICG/IOTWS is guided by six working groups made up of experts who provide advice on the major components of an end-to-end warning system, such as hazard detection and forecasting; threat evaluation and alert dissemination; and community preparedness and response.

Since the Indian Ocean tsunami of December 2004, considerable progress has been made towards the installation of vital earthquake and tsunami detection core networks. By March 2009, seventy-three operational seismic stations had been installed and over sixty coastal sea level stations were operating with data available on the WMO Global Telecommunication System (GTS). A total of about twenty deep ocean tsunameters had also been installed by Australia, Germany, India, Indonesia, Malaysia, and the United States of America (in association with Indonesia and Thailand).

The development of the IOTWS must be considered within a risk management framework and the ICG has conducted a number of studies to address this requirement. An Indian Ocean tsunami hazard map has been developed and published under the technical leadership of GeoScience Australia. The need for a standardized methodology for tsunami risk assessment has also been recognized: the ICG has developed risk assessment guidelines for the Indian Ocean published by UNESCO as IOC Manuals and Guides 52: *Tsunami risk assessment and mitigation for the Indian Ocean. Knowing your tsunami risk – and what to do about it*.

Since 2006, a key activity of the ICG has focused on capacity-building in numerical tsunami inundation modelling. The ICG's goal is to train at least two people from each Member State; so far over seventy-five people from over twenty countries have been trained in the theory and application of inundation models.

The National Tsunami Warning Centres (NTWC) form the core of the IOTWS. As of 2009, the ICG/IOTWS had twenty-six designated Tsunami Warning Focal Points (TWFP). In 2007, the ICG decided to establish a network of interoperable Regional Tsunami Watch Providers (RTWP) to replace the Interim Advisory Service (IAS) providers of the Japan Meteorology Agency (JMA) and the Pacific Tsunami Warning Center (PTWC). An RTWP Implementation Plan was adopted by the ICG in 2008 (published as IOC Technical Series No. 81) that not only describes three levels of advisory services but also maps out a staged transition from the IAS to the RTWP by 2011. By early 2009, Australia, India and Indonesia had commenced RTWP Service Level 1 operations and will progress towards Service Level 2 during 2009 and 2010.

Since the 2004 tsunami, many countries have implemented community awareness programmes and conducted evacuation drills. At the regional level, the ICG has promoted and supported meetings and workshops to bring emergency response, disaster management and development planners together to develop and share best practice information and to promote capacity-building in community resilience and emergency management.

Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS)

The Intergovernmental Coordination Group for the North Eastern Atlantic, Mediterranean and Connected Seas Tsunami Warning System (ICG/NEAMTWS) was created in June 2005 to establish a tsunami warning system for this region using existing national experiences and resources by launching the following two-phase process:

- Implementation of an initial or interim tsunami warning system (ITWS) by 2007;
- Establishment of a full operational system by 2011.

The ICG/NEAMTWS consists of a chair and two vice chairs, a secretariat (provided by the IOC) and four working groups. These working groups address essential thematic issues for the tsunami warning system in the region, namely hazard and risk assessment including numerical modelling (WG1); a seismic monitoring network (WG2), a sea level monitoring network with coastal and offshore stations (WG3); and advisory, mitigation and public awareness (WG4).

The ICG/NEAMTWS has met five times since 2005 (about once per year) in different European countries (France, Germany, Greece, Italy and Portugal). The working groups have organized additional intersessional meetings to monitor the progress of their work and activities.

In 2007 a Task Team on NEAMTWS architecture was created with the specific purpose of discussing the basic architecture of the tsunami warning system and the relationships between the national and regional tsunami centres.

Progress made since the creation of the ICG/NEAMTWS in terms of increasing coverage and performance by means of national and international programmes has ensured that the seismic monitoring system today is adequate to support an ITWS in the region. Initial drawbacks in the state of the sea level monitoring network are slowly being eliminated to establish a core network of real-time tsunami stations for the ITWS, as defined in the ICG's implementation plan.

The ICG has addressed the problem of the architecture of the tsunami warning system, stating that it must be a system of systems, namely that at the top level there is a Regional Tsunami Watch Centre (RTWC) and below, at the second level, National Tsunami Warning Centres (NTWCs).

The functions and requirements of all these centres have been discussed and defined within the Task Team of the ICG, although there do remain several crucial unresolved organizational questions as to the number and locations of RTWCs to build throughout the Euromediterranean region. The ICG continues to stimulate Member States towards operational decisions in this regard and is encouraging momentum for the construction of NTWCs, which are equally essential for the tsunami warning system in the region.

The Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (CARIBE-EWS)

Since 2006 the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS) has met four times (ICG I: 2006 in Barbados; ICG II: 2007 in Venezuela; ICG III: 2008 in Panama; ICG IV: 2009 in Martinique).

ICG/CARIBE-EWS has four working groups (WG1: Monitoring and Detection Systems, Warning Guidance; WG2: Hazard Assessment; WG3: Warning, Dissemination and Communication; WG4: Preparedness, Readiness and Resilience). It has twenty-three designated Tsunami Warning Focal Points (TWFPs).

The Pacific Tsunami Warning Center (PTWC) provides an interim tsunami warning service for the Caribbean. This duty should be assumed by the proposed Caribbean Tsunami Warning Centre (CTWC).

There is already a DART buoy in the region and significant improvement has been achieved in terms of sea level monitoring coverage. The United States of America, with support of the University of Hawaii Sea Level Center (UHSLC) and the Puerto Rico Seismic Network (PRSN), plans to install eleven additional sea level stations in the region during 2009 and 2010.

In the Caribbean and adjacent regions there are over 110 seismic stations with real-time seismic data exchange capabilities. These stations are operated by local, regional and global seismic networks. Earthworm and SeisComP are used for the real-time exchange of seismic data. Seismic data exchange for tsunami warning purposes is progressing well in the region.

Significant progress has been made towards the establishment of a Caribbean Tsunami Warning Centre (CTWC) by 2010. The USA has adopted a phased planning approach towards developing a Caribbean Tsunami Warning System including the establishment of a Regional Tsunami Warning Center at the University of Puerto Rico Mayagüez Campus.

Significant progress has also been made towards the establishment of the Caribbean Tsunami Information Centre (CTIC) in Barbados by 2009 with funding provided through the United Nations Development Programme (UNDP).

The Puerto Rico Seismic Network (PRSN), located at the University of Puerto Rico, Mayagüez Campus, has now become operational on a 24/7 basis and is providing earthquake and tsunami information and warning for Puerto Rico and the Virgin Islands as well as post-earthquake information for the Caribbean and Adjacent Regions (http://redsismica.uprm.edu/).

Getting the message out

Post-event Assessment of the Indian Ocean Tsunami Warning and Mitigation System (IOTWS): 12 September 2007

ON 12 SEPTEMBER 2007, a tsunami was generated by a magnitude 8.4 earthquake southwest of Bengkulu, Sumatra. The first tsunami wave (a leading depression wave, i.e. sea level initially receded) was recorded at around 11:54, forty-four minutes after the earthquake. An Indian Ocean-wide watch bulletin was issued by the Pacific Tsunami Warning Center (PTWC) and the Japan Meteorological Agency (JMA) for the first time since the interim advisory service began in March 2005.

This event, occurring as it did when many components of the IOTWS had been installed and the interim tsunami advisory service had been operational for just over two years, presented an ideal opportunity to evaluate the performance of the IOTWS. The analysis highlighted both the strengths and weaknesses of the system, identified areas requiring further attention, and provided a benchmark of the system's status. It served as a test of the IOTWS and it functioned well.

11:10 Earthquake occurs
Following the earthquake, PTWC and JMA issued bulletins at the following times:

11:24 PTWC Bulletin No. 1	Mwp=7.9: Indian Ocean-wide tsunami watch
11:36 JMA Bulletin No. 1	Mwp=7.9: Indian Ocean-wide tsunami watch
11:53 PTWC Bulletin No. 2	Upgraded Mwp=8.2: Indian Ocean-wide tsunami watch
12:08 JMA Bulletin No. 2	Upgraded Mwp=8.2: Indian Ocean-wide tsunami watch
12:30 PTWC Bulletin No. 3	0.35m at Padang (12:21)
12:51 JMA Bulletin No. 3	0.5m at Padang (11:55)
13:21 PTWC Bulletin No. 4	0.56m at Padang (13:06), 0.11m at Cocos Island (12:36)
13:35 JMA Bulletin No. 4	0.6m at Padang (11:55), 0.1m at Cocos (12:28)
14:25 JMA Bulletin No. 5	1.0m at Padang (11:55), 0.1m at Cocos (12:28)
14:40 PTWC Bulletin No. 5	0.98m at Padang (13:48), 0.11m at Cocos (12:36), 0.02m DART 23401 (14:21)
15:05 PTWC Bulletin No. 5	FINAL BULLETIN; 0.09m at Sibolga (14:34), 0.98m at Padang (13:48), 0.11m at Cocos (12:36), 0.02m DART 23:401 (14:21)

SENATOR ROLAND COURTEAU
OPECST, France

Evaluating and preventing the tsunami risk

UNESCO/IOC's role in coordinating early warning systems

On 22 May 1960, a teletsunami devastated Chile and several Pacific islands. A few months later, the United Nations Educational, Scientific and Cultural Organization (UNESCO) set up the Intergovernmental Oceanographic Commission (IOC), charged with developing global cooperation in oceanic research. Since its creation, the IOC has established as its mission the prevention of ocean-related risks, including tsunamis.

The tsunami of 28 March 1964 which originated off the coast of Alaska accelerated the setting up of a tsunami warning system for the Pacific: as early as 1965, an international coordination group for the tsunami warning system in the Pacific (known as ICG/Pacific) was created.

The IOC accepted the offer of the United States to expand the services of its national tsunami warning centre in Hawaii, which has since been used as the operational warning centre for all Pacific States.

The realization that all basins are vulnerable

Statistically speaking, the Indian Ocean is considered the safest ocean basin with regard to tsunamis, since it accounted for only four per cent of tsunamis generated during the twentieth century. However, the tsunami of 26 December 2004 claimed more victims than all other (known) tsunamis combined since ancient times.

Even if the risk is rare, the public no longer accepts being unprotected when a warning system that saves human lives could be set up. Under the aegis of the United Nations, it was therefore decided in 2005 to create a tsunami warning system for the Indian Ocean, the Caribbean and the Mediterranean/North Eastern Atlantic zone.

In addition, it served as a reminder that certain regions that had not been struck by a tsunami in human memory had nevertheless been completely devastated in the distant past, with the volcanic eruption on Santorini, Greece, being a good example.

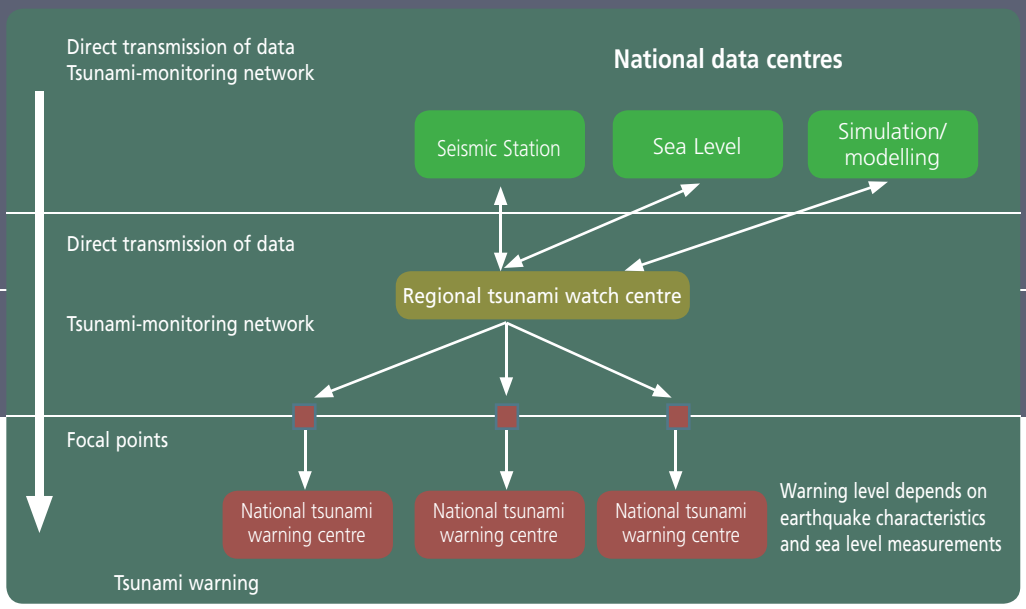
Shedding light on the shortcomings of the tsunami-risk prevention system

The Indian Ocean tsunami above all revealed enormous shortcomings with regard to mitigating the tsunami risk.

First of all, the images showing tourists playing in those areas where the sea had withdrawn revealed the public's complete ignorance of this phenomenon and its manifestations.

Secondly, scientists were surprised by the violence of the earthquake that had generated the tsunami and it became clear that, outside the Pacific zone, the tsunami phenomenon was not well understood due to insufficient research in this domain. For example, few catalogues of past tsunamis per basin had been published and the potential sources of tsunamis had not been systematically recorded and even less frequently analyzed in order to establish tsunami-exposure maps.

The structure of the tsunami warning system



Finally, many observed that if a warning system had been in place, thousands of human lives could have been saved.

The international community, therefore, under the aegis of UNESCO, decided to complete the existing tsunami warning system and extend it to all zones.

The desire for an effective tsunami warning and mitigation system that covers all basins

The international community estimated that setting up an effective warning system for the Indian Ocean, the Caribbean and the Mediterranean required, on the one hand, the creation of Intergovernmental Coordination Groups (ICGs) for each basin (following the example of the ICG/Pacific) and, on the other hand, increased scientific research to better understand tsunamis in these regions.

The structure of the tsunami warning system

Each country is responsible for collecting and processing the national data from its seismic stations and tide gauges. Each country must also ensure that this data is accessible in real-time to all members of the warning system. In addition, the countries must carry out the necessary computer simulations to better understand this hazard, to identify the exposure zones, and to establish tsunami and inundation maps.

The data thus collected are transmitted in real-time either directly or by the countries to one or several regional tsunami watch centres. These centres are responsible for analyzing the earthquake data (localization of the earthquake and estimation of its depth, magnitude, date and origin time) in order to determine if a tsunami risk indeed exists. If the answer is yes, the regional centres send a warning message indicating the hour of arrival and the concerned zones to the Focal Points of the Member States. The regional centres will also use the data relative to the sea level to confirm the presence of a tsunami and either refine their forecasts or cancel the warning.

Focal Points and National Contacts for the IOC's warning system

- **The ICG Tsunami Warning Focal Points**
  The Focal Point is the person to contact, reachable 24/7 and chosen by the ICG-member government to receive and rapidly send tsunami information. The IOC advises countries to choose one or several bodies, rather than persons. The Focal Point receives the bulletins and warnings issued by the regional warning centres and then passes them on to the relevant emergency services (usually the civil protection services).

- **The ICG Tsunami National Contacts**
  The ICG Tsunami National Contact is the person designated by the ICG-Member State to act as its representative in the coordination of international tsunami warning and prevention activities. This person is a key player in the national warning system programme. He or she may be the Tsunami Warning Focal Point, someone belonging to the country's national disaster management organization, a member of a technical or scientific body, or a representative of some other tsunami warning-related organization.

Finally, the Focal Points are responsible for transmitting the regional centres' warning bulletin(s) to the national authorities, so that the latter may take the necessary measures: implementation of the specialized tsunami emergency plan, which mobilizes all parties liable to be involved in preventing the tsunami and in crisis management after the tsunami; warning and evacuating the beaches and coasts.

The three ICGs have established an action plan and created specialized work groups that are meant to meet with one another on a regular basis. For example, the ICG/CARIBE-EWS has created the following four groups:
- Tsunami hazard assessment;
- Monitoring and detection system (this group is divided into two subgroups specialized in seismology and sea level monitoring);
- Warning and communication;
- Emergency and training.

Depending on the region, a yearly or half-yearly meeting is organized, to record the progress made by the Member States and workgroups, and to define the group's future actions.

Other initiatives of the international community should strengthen the effectiveness of the tsunami warning and prevention systems.

These systems should rely, in the midterm, on the sharing of terrestrial observation means: the Third Earth Observation Summit, held in February 2005, agreed to a ten-year implementation plan for a Global Earth Observation System of Systems (GEOSS). Furthermore, the policy of increasing public awareness and education with regard to the tsunami risk has authority to be carried out within the framework of the United Nations International Strategy for Disaster Reduction (ISDR).

Finally, the rapid and reliable transmission of tsunami warning system data demands close cooperation with the World Meteorological Organization (WMO). This United Nations body specialized in meteorology manages the Global Telecommunication System (GTS) whose objective is to rapidly collect, exchange and transmit meteorological observation data. The GTS is used to transmit tide gauge data and warning messages.

Extracts reproduced with permission from the Parliament Office for the Evaluation of Scientific and Technological Choices (OPECST) Report No. 117 (2007-2008). Evaluating and preventing the tsunami risk for France's metropolitan and overseas coasts by M. Roland Courteau, Senator. A full version of the Report is available online at (http://www.senat.fr/opecst/english_report_tsunami/english_report_tsunami0.html).

Protecting people and economics from the threat of tsunamis and other ocean-related hazards

PROFESSOR HARSH GUPTA
National Geophysical Research Institute [1]

THE RARITY OF A TSUNAMI EVENT does not deny the potential devastation that accompanies its arrival. On the contrary, the scarcity of such events makes it even more difficult to develop effective warning systems. The most complex risk management challenges, in fact, are often posed by very rare events that prove extremely deadly when they strike. Remaining vigilant over long periods of time is not easy to do – regardless of the size of the threat.

Nevertheless, the basic elements of an effective tsunami detection and warning system are well known among scientists who have studied these devastating events. The key to success is to put in place mechanisms that are capable of detecting a tsunami in real-time and then conveying that information quickly to both public officials and the public at large. This overall strategy requires ocean bottom sensors like those, for example, that have been successfully deployed by a consortium of Pacific Rim countries to spot the more frequently occurring tsunamis that take place in that region. It means calculating the travel time from potential sea-bottom tsunami locations to populous coastal areas. It means preparing inundation maps based on modelling and careful assessments of historical documents. And it requires devising effective communication schemes that convey the information as swiftly as possible to those most at risk and then providing evacuation plans to help ensure their safety.

Although tsunamis are very rare in the Bay of Bengal and the Arabian Sea, storm surges occur almost every year. These two bodies of water account for only about three per cent of global ocean area; however, about twenty per cent of global storms occur here. A system designed to take care of tsunamis only would likely become ineffective due their rare occurrence; hence the warning system is designed to monitor both tsunamis and storm surges.

‘the warning system is designed to monitor both tsunamis and storm surges’

India has succeeded in setting up a state of art tsunami and storm surge warning system. The system has been functioning uninterruptedly since August 2007. It became operational within the stipulated time of thirty months (from April 2005 to the end of August 2007) and within the estimated direct cost of about US$30 million. It performed satisfactorily during the 12 September 2007 tsunamigenic earthquake of M8.4. This has been possible due to appropriately comprehending the situation, developing a suitable approach, total support from the Government of India and its Department of Science and Technology, Space, the Council of Scientific and Industrial Research (CSIR) and Academia. India shall be sharing advisories with all concerned.

India is not the only nation in Southeast Asia to build a detection and early warning system to safeguard citizens against the potential deadly impact of tsunamis and storm surges. Other regions of the world have also taken note of the Indian Ocean mega-tsunami to improve their own warning and detection systems. The goal is to reduce the average time that it takes to inform the public of the occurrence of a tsunami or storm surge from forty minutes to ten minutes. Thirty minutes may not seem like much. But this saving in time could ultimately save thousands of lives. And as the events of 26 December 2004 tell us in dark and deadly ways, time does indeed matter.

1. Council of Scientific and Industrial Research, Hyderabad, India

Technical support, capacity-building, regional diplomacy:

How UNESCO/IOC supports regions to protect coastal populations

1. Producing tsunami warning or advisory information at the Pacific Tsunami Warning Center and the Japan Meteorological Agency and disseminating it to national tsunami warning focal points. In April 2005, UNESCO/IOC put an interim early warning system in place. Significant progress has now been made towards establishing a network of Regional Tsunami Watch Providers (RTWPs) in the Indian Ocean that will take over from the Interim Advisory Service by 2011. (India commenced the transition process in June 2008, followed by Australia in August 2008 and Indonesia in January 2009.)

2. Upgrading and installing real-time reporting sea level gauges for tsunami detection. During 2006-2007, fifteen sea level gauges were deployed throughout the Indian Ocean reporting in real-time to the Pacific Tsunami Warning Center, thereby facilitating the production of interim advisory information for the Indian Ocean. Since then there has been considerable progress in the installation of vital earthquake and tsunami detection equipment. Over fifty out of a projected total of seventy-five core seismic stations have been installed; the remainder to be installed progressively up to 2010. Progress has also been made in the installation and upgrade of coastal sea level measurement gauges in the Indian Ocean. Over sixty core network gauges are now in operation, compared to just eleven before the 2004 tsunami. Deep ocean tsunami detection equipment has also been deployed. (Australia, India, Indonesia together with Germany, Malaysia, Thailand and the United States of America have, between them, deployed nineteen out of a projected total of thirty-two tsunameter systems in the Indian Ocean.)

3. Incorporating tsunami bulletins into the Global Marine Distress and Safety System (GMDSS). Marine forecasts now include tsunami warnings as they are issued by the Pacific Tsunami Warning Center (PTWC). Passenger vessels and cargo ships over 300 gross tons on international voyages are fitted with GMDSS satellite and radio communications equipment to send and receive alerts issued through Inmarsat-C SafetyNET.

4. Incorporating seismic data from the Federation of Digital Seismograph Networks (FDSN) and the Preparatory Commission for the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO Preparatory Commission) into the tsunami warning systems. The CTBTO, FDSN and UNESCO/IOC agreed to share highly reliable and high quality seismic monitoring data to facilitate the detecting capabilities and operation of tsunami warning centres.

5. Developing agreed participation and governance mechanisms for tsunami warning systems. To support the ICG/IOTWS, a Secretariat was established in the UNESCO/IOC Perth Office, Australia in June 2005, funded by Australia. It is staffed by two professionals and secondees from Indian Ocean Member States.

Photo: © Laura Kong, ITIC

Evacuation platform at Aonae port, Hokkaido, Japan.

The ICG/NEAMTWS Secretariat was opened at the UN Campus in Bonn, Germany, in January 2009 with initial funding provided by the German Federal Ministry of Education and Research (BMBF) and the UNISDR.

The Caribbean will soon be launching a Caribbean Tsunami Information Centre (CTIC) hosted by the Government of Barbados and funded through a collaborative approach with Italy and the UNDP.

6. Supporting the establishment of National Warning Centres. Most countries in the Indian Ocean region (26 out of 28) have established National Tsunami Warning Centres (NTWCs) with communications links to the Interim Advisory Service providers, the Pacific Tsunami Warning Center (PTWC) and the Japan Meteorological Agency (JMA).

7. Training in tsunami warning and emergency response. During 2005-2008, UNESCO/IOC and its partners offered training to national experts in:

- Interpretation of tsunami advisory information provided by PTWC/JMA;
- Tsunami travel time calculation;
- National tsunami warning response coordination (end-to-end approach);
- Operation and maintenance of sea level gauges and seismic stations used for tsunami warning;
- Tsunami warning communication (reaching the population);
- Developing national Standard Operation Procedures (SOPs);
- Preparedness: 'informing the population' actions; and
- Risk assessment: preparing inundation maps.

In order to ensure the long-term re-usability of the training initiatives, a comprehensive training system, 'TsunamiTeacher', was developed and translated into French, Indonesian and Thai (additional language translations are in preparation). Under a partnership led by UNESCO/IOC, ITIC and USGS, about 300 participants from more than 20 Indian Ocean countries were trained through more than 15 one-week courses during 2005-2008. The UNESCO/IOC project 'Strengthening Tsunami Warning and Emergency Responses' has also provided training and workshops on the development of Standard Operating Procedures (SOPs) for countries around the Indian Ocean and Southeast Asia.

Long-term planning:

Developing permanent, sustained, operational tsunami warning systems

1. Supporting National Tsunami Warning Centres (NTWCs); including assurance of long-term support arrangements at national level. Setting up NTWCs operational 24/7 within existing disaster management systems whenever possible (such as meteorological services, naval facilities, etc.) ensures the maintenance of national tsunami warning and mitigation systems. A survey of Member States' responses to the 12 September 2007 tsunami event in the Indian Ocean yielded extremely positive feedback and confirmed that NTWCs had indeed received watch bulletins from PTWC/JMA:

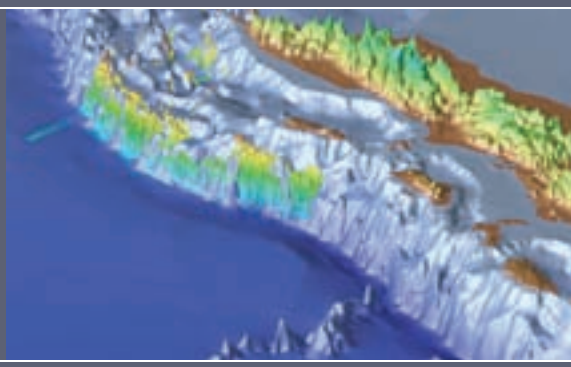
- 15 NTWCs received watch bulletins via the GTS;
- 12 NTWCs undertook their own earthquake analysis;
- 19 Member States took some action after receiving the PTWC/JMA bulletin;
- 13 Member States monitored sea level;
- 8 Member States used numerical models in their analysis (Indonesia located the earthquake hypocentre and issued a warning within just five minutes of the event).

The survey indicates that, despite some gaps and weaknesses that still exist, significant progress has been made in the development and implementation of the IOTWS.

2. Strengthening regional cooperation. A Regional Tsunami Watch Providers (RTWP) Implementation Plan was developed, received and approved by the ICG/IOTWS.

3. Coordinating mechanisms to ensure tsunami buoy deep sea mooring deployments benefit from maintenance and ship time associated with tsunami warning system activities (developed through bilateral agreements).

4. Providing materials and expertise to strengthen the capacity of participating countries to use bathymetric data for accurate risk mapping in coastal zones. In the COAST MAP IO project, UNESCO/IOC provided training to more than 120 specialists from the Indian Ocean region in developing high resolution near-shore ocean bathymetry data sets, their retrieval and using relevant computer models. Hardware and software for inundation map construction was supplied to twelve countries in the region. Many scientists in Indian Ocean countries are now using these tools to develop their own national scenarios.



3D bathymetric map of the northern part of Sumatra (coastal zones in brown). Dataset: GEBCO (General Bathymetric Chart of the Oceans), supplemented by high resolved data obtained by R/V *Scott*. The dataset is employed in the wave propagation model TsunAWI. (Sven Harig, Alfred Wegener Institute for Polar and Marine Research.)

5. Improving tsunami warning science and technology, including the development of a historical tsunami database (important for risk assessment), tsunami risk assessment guidelines and preparing a tsunami hazard map for the Indian Ocean.

6. Preparing tsunami inundation maps for accurate risk-mapping in coastal zones. The historical tsunami database was re-structured and updated to provide solid information on location, size and origin of observed tsunamis. Training courses in using GIS, topographic measurement systems and processing tools strengthen the national capacity in numerical tsunami inundation). Risk Assessment Guidelines have been prepared and agreed upon, and a Tsunami Hazards Map for the Indian Ocean has been published in cooperation with Australia.

7. Further development of relevant training tools. Through the Jakarta Tsunami Information Center (JTIC) an extensive effort has been carried out in developing materials for capacity-building, including TsunamiTeacher (in its Bahasa translation), a tsunami glossary, information leaflets and posters. TsunamiTeacher is used by the JTIC to support its community preparedness programme in Indonesia.

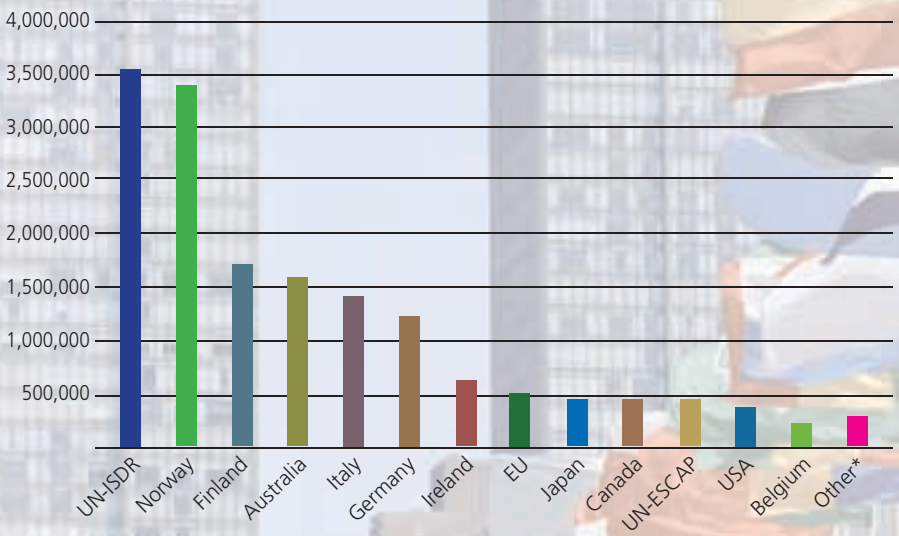
8. Enhancing the sustainability of the sea level network in the Indian Ocean. Real-time sea level observations are an essential part of a tsunami warning system. However, sustaining the sea level station network can be a challenging task, especially in countries with a lack of expertise in the sea level field. Trained sea level gauge operators and technicians are clearly needed to assure proper functioning and periodic maintenance of the equipment. The UNESCO/IOC IOTWS fellowship programme in Sea Level Science and Applications, funded through a contribution from the Government of Norway, was launched in 2007. The programme provided thirty engineers and scientists with on-the-job training lasting between one to three months at a sea level institution in the Global Sea Level Observing System (GLOSS) network.

9. Cooperating with the IUGG/IASPEI Tsunami Commission ensures close interaction in all aspects of tsunami science that can improve operational warning systems**.**

Five years of international cooperation and political will

CONTRIBUTIONS TO THE UNESCO/IOC TSUNAMI PROGRAMME			
	Special Account	Funds-in-Trust	Total
2005			
	2,331,642	4,564,044	6,895,686
2006			
	143,229	2,147,223	2,290,452
2007			
	1,181,609	1,410,783	2,592,392
2008			
	685,182	2,622,438	3,307,620
2009 (provisional as of 01 October 2009)			
	383,412	752,022	1,135,433
		GRAND TOTAL	**16,434,721**

Table detailing annual contributions (in US$) to the UNESCO/IOC Tsunami Programme. Support has been steady since 2006.



Graph showing contributions (in US$) to the UNESCO/IOC Tsunami Programme considered globally for 2005–2009.

(*) Refers to the sum of contributions less than $100,000.

This graph only reflects the funding provided directly to the IOC Tsunami Unit. There have, however, been many other indirect contributions to the programme: disaster managers and staff of national agencies in affected countries have participated in Tsunami Unit related activities; scientists have shared their expertise during workshops and training courses; and many countries have hosted Intergovernmental Coordination Group (ICG) meetings and workshops.

UN Photo/Yutaka Nagata

Lessons that open minds, lessons that save lives

UN Photo/Paulo Filgueiras

Disaster risk is rising in an alarming way, threatening development gains, economic stability and global security while creating disproportionate impacts on developing countries and poor rural and urban areas. While we cannot prevent natural phenomena such as earthquakes and cyclones, we can limit their consequences. Pre-emptive risk reduction is the key. Sound response mechanisms after the event, however effective, are never enough.

Disasters caused by natural hazards are taking a heavy toll on communities everywhere. I have seen that firsthand with Cyclone Nargis in Myanmar and the Sichuan earthquake in China, as well as in Haiti and West Africa […] Tropical Cyclone Jade in Madagascar […] and severe floods and landslides in Colombia, Peru and, again, Indonesia. Yet humanity is not the helpless victim of nature. Our capacity to cope with natural disasters is much greater than we realize.

We cannot prevent such events, but we can diminish their potential for disaster. Doing so requires foresight and advanced planning, not just emergency relief…Experience has shown that good building designs, proper land-use planning, public education, community preparedness and effective early warning systems can reduce the impact of severe weather events.

UN Secretary-General Ban Ki-Moon
Tsunami Lessons Learned Event
April 2009, New York, USA.

UN Photo/Paulo Filgueiras

'Following an earthquake which occurred off the coast of Indonesia, I had the information on my table within fifteen minutes, enabling us to evaluate and take a decision to evacuate the coastal area,' says **Mahinda Samarasinghe, Minister of Disaster Management and Human Rights**, who championed the establishment of the disaster management process in Sri Lanka. 'Within forty-five minutes, the authorities were able to get the people out of coastal areas using the systems put in place after the tsunami.'[1]

The Tsunami Legacy: Innovation, Breakthroughs and Change Available online at (http://www.ifrc.org/Docs/pubs/Updates/the-tsunami-legacy.pdf) Tsunami Global Lessons Learned Project.



Emergency preparedness drills: in the wake of a tsunami, communities must be ready to respond.
(Photos courtesy of Rendy Maulana.)

UN Photo/Joao Araujo Pinto

'The Indian Ocean Tsunami was probably the loudest wake up call in recent history about the need to strengthen early warning capabilities and to reduce risk and vulnerability globally,' **Margareta Wahlstrom, UN Assistant Secretary-General for Humanitarian Affairs** told the opening session of [a workshop on mitigation, preparedness and development for Tsunami Early Warning Systems in the Indian Ocean region]. She called on participants 'not to rest until every coastal community in the Indian Ocean region, both in Africa and Asia has ready access to early warnings of tsunami.'

The fact that the Pacific region has just been hit by a devastating tsunami at the very time these words are being written is a solemn reminder that natural hazards challenge all of us.

Nevertheless, our experiences since the 2004 Indian Ocean tsunami have been beneficial in our struggle for disaster risk reduction. The Hyogo Framework for Action, drawn up in January 2005 and involving UNESCO/IOC as a key actor, was a milestone in urging nations to strengthen their disaster preparedness.

Since then, despite some setbacks along the way, the prospects are promising. There is a strong international commitment towards establishing adequate early warning systems (in line with the Pacific Tsunami Warning System already operating since 1965) in all regions of the world. Similarly, we have learned that the climate is changing, settlement patterns are shifting and the nature of crises is becoming more complex. This in its way has enhanced a stronger focus on urban planning and good governance, food and health security, gender perspectives with an emphasis on the specific needs of the most vulnerable and - last but not least - an increasing understanding of the vital relationship between short-time emergency and long-term development policies.

Our main challenge now is to include disaster risk reduction initiatives within recovery and reconstruction activities and, more generally, within development strategies. Disaster management should never be viewed merely as an annex to development; it is intrinsic to poverty alleviation and therefore basic to development itself. Furthermore, disaster risk reduction is not primarily about establishing hardware and technicalities. Building awareness, information and education are also imperative and this is part of the reason the Government of Norway has strongly supported UNESCO/IOC`s leadership in coordinating the promotion of early warning.

Although different parts of the world are in the midst of humanitarian crises, it is encouraging that many countries, based on the experiences of the past five years, have still managed to build local communities that will now, should Nature challenge them, be more resilient to disasters. Experiences such as these should be our guidelines as we strive for even greater achievements in this area.

Bjørn Johannessen
Senior Adviser in the Norwegian Ministry
of Foreign Affairs, 2004-2008,
and current Norwegian Ambassador to Malawi.

Intergovernmental Oceanographic Commission (IOC)

United Nations Educational, Scientific and Cultural Organization (UNESCO)
1, rue Miollis,
75732 Paris Cedex 15,
France
Tel: +33 1 45 68 39 83
Fax: +33 1 45 68 58 12

http://www.ioc-unesco.org/
http://www.ioc-tsunami.org/
http://ioc3.unesco.org/itic/

The Intergovernmental Oceanographic Commission (IOC) of UNESCO promotes international cooperation and coordinates 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.