Intergovernmental Oceanographic Commission

Workshop Report No. 196

International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework

UNESCO Headquarters, France,
3–8 March 2005

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Abstract:

The International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework was held at UNESCO Headquarters between 3 and 8 March 2005. The Meeting was attended by nearly 300 participants from 21 countries in the Indian Ocean region, 25 other IOC Member States, 24 organizations, and 16 observers. The Meeting ensured that Indian Ocean Member States are fully informed, at the technical level, on tsunami warning and mitigation programmes at the national, regional and global levels. The Meeting adopted a communiqué that provides guidance to all partners regarding the required actions that will lead towards the establishment of an Indian Ocean Tsunami Warning and Mitigation System. The Meeting also recommended the establishment of an "Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) and drafted Terms of Reference for the Group.

* The communiqué of the workshop and the mandate of the intergovernmental coordination group for the tsunami warning and mitigation system for the Indian ocean (ICG/IOTWS) are given in French in Annexes IV and V of this report.

(SC-2005/WS/17)

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ANNEXES

1. OPENING

1.1. OPENING ADDRESS BY MR KOICHIRO MATSUURA, DIRECTOR-GENERAL OF UNESCO

The Director-General, Mr Koïchiro Matsuura opened, at UNESCO Headquarters, the "International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework". He explained that this was the first meeting in a series that will lead to establishing the technical and 'legal' framework for the establishment of the Indian Ocean System. UNESCO received a clear mandate from the international community to coordinate the establishment of the System during the course of several international and regional meetings, including the World Conference on Disaster Reduction (Kobe, Japan, 18–22 January 2005), and the Phuket Ministerial Meeting on Regional Cooperation on Tsunami Early Warning Arrangements (Phuket, Thailand, 28 and 29 January 2005).

In his opening address, Mr Matsuura indicated the outcomes that he hoped would emerge from the meeting. In particular, he mentioned the need to reach agreement on the basic design of the observation networks that will constitute the Indian Ocean System, including the designation by governments of the national agencies that will act as National Tsunami Warning Centres. He also indicated the need to identify the mechanism for the coordination of the required research for the assessment of the tsunami hazard, as well as to address the organizational aspects and governance mechanism(s) that will enable the joint operation of the detection/warning system, based on international cooperation with the aforementioned observation networks.

Mr Matsuura went on to situate the Indian Ocean System in the global context that lies at the core of UNESCO's strategy for a tsunami warning system. He informed the audience that the Indian Ocean System is just "*the first step in building a Global Tsunami Warning System that will be fully embedded in the IOC global, operational ocean observing system that is regularly used for other related hazards, such as storm surges and cyclones*". He also outlined the merits of this system being linked to the soon-to-be-established Global Earth Observation System of Systems (GEOSS) that will aim at integrating space-based and 'in situ' observations covering the land, the ocean, the atmosphere and ecosystems. A group of nations have committed themselves to building GEOSS in the next ten years, following appeals to that effect at the World Summit on Sustainable Development (Johannesburg, 2002).

The full speech is available in Annex III

1.2. MESSAGE FROM ISDR (MR. SALVANO BRICEÑO, DIRECTOR, INTER-AGENCY SECRETARIAT FOR THE INTERNATIONAL STRATEGY FOR DISASTER REDUCTION (UN/ISDR)

Mr Briceño welcomed the initiative of UNESCO and the Intergovernmental Oceanographic Commission in organizing and hosting the meeting, noting the many calls for action by regional and international leaders following the tsunami disaster to develop a regional early warning system, including through a UN General Assembly resolution (A/RES/59/279). He said that the topic had been high on the agenda of the World Conference on Disaster Reduction (WCDR) in Kobe-Hyogo, in January, where there were strong calls for concrete action on disaster risk reduction in the region and for efforts to increase resilience to future hazards. He emphasized the common challenge faced, to ensure that we respond to the needs of the countries and build understanding, solidarity and commitment to improve early warning systems and to reduce disaster risk, with integrated systems covering not only tsunamis but also other hazards such as cyclones and floods. The International Strategy for

Disaster Reduction (ISDR) framework, comprising relevant UN agencies, regional organizations and civil society partners, has been requested to play a facilitation role, through the ISDR Platform for the Promotion of Early Warning (PPEW), alongside the Intergovernmental Oceanographic Commission of UNESCO, in the development of early warning capabilities in the region. He said that the Paris meeting was an important step towards a consolidated plan for a tsunami warning system for the Indian Ocean as part of broader efforts to increase resilience under the framework of the International Strategy for Disaster Reduction.

The full speech is available in Annex III

2. ADMINISTRATIVE ARRANGEMENTS

2.1. INTRODUCTION OF THE MEETING

Dr Patricio Bernal, Assistant Director-General of UNESCO and Executive Secretary IOC welcomed the participants to the Meeting. He informed the participants of the objectives of the Meeting:

- Indian Ocean Member States fully informed, at the technical level, on tsunami warning and mitigation programmes at the national, regional and global levels;
- Draft Design Plan for a Tsunami Warning and Mitigation System for the Indian Ocean that includes considerations for the international, regional and national levels;
- Draft work plan and timetable for the establishment of a Tsunami Warning and Mitigation System for the Indian Ocean, including the regional and national requirements;
- Scoping exercise completed to move in the direction of establishing a global tsunami warning system.

2.2. DOCUMENTATION AND PRACTICAL ARRANGEMENTS

Dr Patricio Bernal introduced the documentation for the Meeting including the Provisional Annotated Agenda and Provisional Timetable. The Agenda of the Meeting is available in Annex I. The List of Participants is available in Annex II.

3. TECHNICAL ASPECTS OF TSUNAMIS AND TSUNAMI WARNING SYSTEMS

3.1. BRIEF INTRODUCTION OF THE SESSION

Dr Jan Sopaheluwakan, in his capacity of Chair of this Session recalled that the 26 December 2004 tsunami was a wakeup call for the countries in the region. In Aceh, Indonesia, the damage caused was estimated at US$ 4.5 billion which is equal to the annual GDP of Aceh. He expressed his gratefulness to the many countries and organizations that provided humanitarian assistance. He stated that while each government in the region is now doing its best to rebuild, the tsunami has united the region against future disasters. It is necessary to identify how the tsunami happened, how to assess hazards, how to empower the people with appropriate awareness and governments need assistance to reduce impact. He expressed his hope that the meeting would provide technical information on tsunamis, detection technology, the limitations of warning systems and how to use inundation information in planning.

He then invited the speakers to make their presentations. All presentations are available from the web site through URL http://ioc.unesco.org/INDOTSUNAMI/paris_presentations.htm. Each presentation was followed by a brief opportunity for questions and comments. These are not covered in this summary report of the Meeting.

3.2. SCIENTIFIC INTRODUCTION ON TSUNAMIS

This presentation by Dr Viacheslav Gusiakov (Head, Tsunami Laboratory, Institute of Computational Mathematics, and Mathematical Geophysics, Siberian Division, Russian Academy of Sciences) provided scientific background information on tsunamis: what is a tsunami, how is it caused, how does it travel, what are the limits of our knowledge today.

3.3. DETECTING AND MONITORING TSUNAMIS

In his presentation Dr Kenji Satake (Active Fault Research Centre, GSJ/AIST — National Institute of Advanced Industrial Science and Technology, Japan) outlined the current technology available to detect the generation, occurrence and propagation of tsunamis (seismology, sea level monitoring,…), decision making related to warning, and communication of warnings. It will include information on alternate technologies for local tsunamis and real-time crust deformation. It also addressed what are the limitations of warning systems (e.g. warning times.)

3.3.1. Emerging technologies

In his presentation, Dr François Schindelé explained that the emerging technologies on tsunami monitoring and detection are useful for different purposes.

- A better estimation of the magnitude of the earthquake: The TREMORS system computes the seismic moment through the mantle magnitude. This magnitude is computed with very long period seismic surface waves - 50 s to 300s. This system already equips the PTWC centre, the SHOA centre and other national warning centres. After the 26 December event, the period of waves was increased to 450 s , to take into account very long sources such as the Sumatra (Magnitude > 9.3);
- The second method is the use of geodetic data to detect large crustal deformation (more than 1cm/s). High frequency GPS real-time stations are implemented on the coast of Japan. The 2003 M=8.0 Tokachi-Oki earthquake deformation was recorded by some GPS stations. The advantage is that GPS is never saturated and measures the displacement in wide frequencies and dynamic ranges. Very large earthquakes like the Sumatra 2004 event generated locally deformations of more than 10 cm/s;
- The GPS stations can also detect tsunamis of several centimetres just before the arrival, due to the variation of the ionosphere due to the propagation of the tsunami;
- Coastal and oceanic ionospheric stations can also detect a tsunami during his propagation;
- The other objective is to detect the size and location of the rupture zone. This information, not available in real time by current records, can be provided by arrays of stations: seismic arrays, infrasound arrays and hydro-acoustic arrays. Specific processing is needed and must be automated;
- Submarine landslides can be detected by hydro-acoustic stations and arrays;
- Tsunamis of more than 10 cm of amplitude are detectable by space borne radar altimetry. The current constellation of monostatic altimeters cannot meet the coverage requirement for a warning system;

- Remote sensing can also detect a tsunami: the leading waves and the inundation zones are clearly visible on satellite images. Currently they are not available in real time, less than 12 h.

3.4. PREDICTING THE DAMAGE: TSUNAMI RISK ASSESSMENT
3.5.

In his presentation Prof Fumihiko Imamura (Professor of Tsunami Engineering Disaster Control Research Center, Graduate school of Eng., TOHOKU University , Japan) covered today's methods in predicting the propagation, runup and inundation of tsunamis. It also addressed how runup and inundation information can be used for zoning and coastal planning. In terms of "Tsunami Wave System Generation" he explained how a seafloor disturbance, such as motion along a fault, pushes up the overlying water. The wave then propagates across the deep ocean at jetliner speeds. Shoaling and refraction may amplify the wav. As the wave moves into shallower water, increased energy density increases both the wave height and the currents. Finally we see the occurrence of runup on land and run-down. To reduce damage and casualties, disaster measures; at the public, mutual and individual level are essential.

4. ORGANIZATIONAL AND PRACTICAL ARRANGEMENTS FOR A REGIONAL TSUNAMI WARNING AND MITIGATION SYSTEM

4.1. BRIEF INTRODUCTION OF THE SESSION

In his introductory words, Dr François Schindelé (Chair ICG/ITSU) explained that this session was dedicated to organizational arrangements for a tsunami warning and mitigation system. He stated that the presentations would give an overview of the requirements in establishing national and regional tsunami warning centres, the operations, services and products and the challenge of long term sustainability.

The responsibility of a national tsunami warning centre is to provide to the national authorities information about the occurrence of large earthquakes and tsunami at the national and local level. The responsibility of a regional tsunami warning centre is to provide to the national warning centres or contact points of Member states the information about the occurrence of large earthquakes that can produce ocean-wide tsunamis. These warning centres use the data received from numerous institutions and countries.

The last speaker presented the role of the International Tsunami Information centre: information dissemination, trainings and day-to-day coordination with ITSU officers.

All presentations are available from the web site through URL http://ioc.unesco.org/INDOTSUNAMI/paris_presentations.htm

4.2. ESTABLISHMENT AND OPERATION OF A NATIONAL TSUNAMI WARNING CENTRE

4.2.1. Chile

In his presentation entitled "The national tsunami warning system in Chile", Capt. Roberto Garnham (Director, Hydrographic and Oceanographic Service of the Chilean Navy, Chile) recalled that Chile had been hit by a tsunami in 1960. The earthquake had a magnitude of 9.5 and the tsunami caused 2000 casualties in Chile, 61 in Hawaii and even some in Japan. In view of the relatively small population in the stricken area, this was a high death toll. In response to the disaster, Chile established its national tsunami warning system in 1966. It has now been in operation on a 24/7 basis for over 40 years under the responsibility of the

Chilean Navy. The system is composed of three elements: (i) prevention; (ii) monitoring; and (iii) mitigation of effects. In addition there are two types of responses: for a local or distant tsunami.

In the case of a distant tsunami there is time to react. The system is then fed with data by the PTWC in Hawaii, the Alaska warning centre, the seismological service of the Mediterranean, the USGS, the Ecuadorian oceanographic institute, the Hydrographic Directorate of Peru, the DART buoy system (Chile has deployed one DART buoy. A total of 3 are planned), and the Chilean national tide gauge network which extends along the coastline of Chile. The Chilean operational sea level gauge network is connected to the PTWC. The entire coastline is covered, including the Antarctic area. Each station provides hourly data. To share costs the stations are used for weather, scientific research and tsunami warning. The data received from these many sources allow making a well-informed decision and issuance of a tsunami warning as required.

The case of a local tsunami is more problematic: experience in the past four decades has shown that the first system to fail will be the communication system. The biggest problem is therefore informing the population. Chile has three networks: (i) normal internet and telephone communication system; (ii) independent Navy network; and (iii) independent network of the Ministry of the Interior. In addition there are Police and Fire brigade/Civil Protection networks. Obviously the authority responsible for issuing a tsunami warning must have reliable telecommunication systems. For local seismic events Chile works mostly through inundation maps and public education. Chile has produced 28 inundation maps since 1997. These maps also indicate the most dangerous zones so officials can warn the population effectively. Public education includes educational videos for children so the population is educated from the youngest age.

4.2.2. Japan

In his presentation, Mr Tomoo Inoue (Senior Scientific Officer, Planning Division, Japan Meteorological Agency: “The tsunami warning system in Japan”) gave a brief overview of the tsunami warning system in Japan. He showed that tsunami warnings are disseminated from JMA, via satellite and dedicated telephone lines to local government, police and fire brigade, TV broadcasters and radio broadcasters. Residents in risk areas are also warned through loudspeakers. He then showed a map displaying earthquakes that generated tsunamis in the Indian Ocean in the past, most of which were small in height. Finally he showed that since the start of tsunami warning in Japan in the early 1950s, the elapsed time to issue a tsunami warning in Japan has been reduced from over 20 minutes to less than 5 minutes.

4.3. ESTABLISHMENT AND OPERATION OF A REGIONAL TSUNAMI WARNING CENTRE

Dr Charles McCreery (Director, Pacific Tsunami Warning Centre, Honolulu) gave a presentation on the establishment and operation of a Regional Tsunami Warning Centre. He pointed out the advantages of a having such a Centre located in the region rather than as being one function of a more distant global Centre. He also explained the importance of national Centres and of having at least one or more of them take on regional responsibilities. Considerations for the design of national and regional Centre capabilities was given including priorities based on an assessment of tsunami risk, requirements for seismic and sea level instrumentation, and methods for rapid warning dissemination. Typical warning products were described based on what is used in the Pacific. Lastly there was a discussion of methods to ensure reliability and long-term sustainability, including taking a multi-hazard approach, and functioning in coordination with the Global Earth Observation System of Systems.

This presentation gave an overview of the requirements in establishing a regional tsunami warning centre, its operations, its services and products, and the challenges for its long term sustainability. It will also address the interaction between national and regional centres as well as between different regional centres.

4.4. DAY-TO-DAY COORDINATION, INFORMATION DISSEMINATION AND TRAINING: THE ROLE OF THE INTERNATIONAL TSUNAMI INFORMATION CENTRE (ITIC)

Dr Laura Kong (ITIC Director) presented information on the mission of the ITIC, its role in the implementation of the global tsunami warning system, and the day-to-day activities it carries out as part of the IOC Tsunami Programme Secretariat.

The ITIC has been in operation since 1965 and has been hosted since its inception by the USA. Its activities include monitoring and recommending improvements to the existing Tsunami Warning System in the Pacific, assisting in the establishment of new regional and national tsunami warning systems and the implementation of comprehensive mitigation programmes to reduce tsunami risk, facilitating technology transfer through expert missions and the conduct of its Hawaii-based training programme in tsunamis and tsunami warning systems, developing and creating educational and awareness materials in local contexts and acting as a clearinghouse for the distribution of these materials globally in multiple languages, gathering and documenting information on tsunami events and working with the World Data Center for Solid Earth Geophysics to archive and quality control these data, and encouraging the conduct of research that can improve the detection and analysis of tsunamis thereby reducing damage and saving lives.

Through its programmes, the ITIC works directly with the International Tsunami Coordination Groups in the Pacific and the Indian Ocean and interested stakeholders in the Caribbean, Atlantic, and Mediterranean to increase awareness and facilitate the coordination required to implement regional tsunami warning centres.

At the same time, the ITIC is very active internationally in the delivery of safety preparedness materials and in working with governments and other non-government partners to effect community level engagement and empowerment that is essential for an effective response to tsunami warnings, and perhaps more importantly, the immediate response to a local tsunami which can arrive in minutes and for which no official tsunami warning will be available.

5. TSUNAMI AWARENESS AND PREPAREDNESS

5.1. BRIEF INTRODUCTION OF THE SESSION

In his introduction, Mr Reid Basher (Coordinator, Platform for the Promotion of Early Warning, ISDR) explained that this Session would focus on the following issues:

- Putting warnings to work, linking the scientific capacities to social institutions and communities at risk
- Integrating into an all-hazards approach
- Linking into complete effort on risk reduction
- Dealing with the complexity, of multiple organizations, sectors, levels of government, and individual vulnerability and capacities

All presentations are available from the web site through URL http://ioc.unesco.org/INDOTSUNAMI/paris_presentations.htm

5.2. NATIONAL PREPAREDNESS PLANS – EXISTING CAPACITIES, ADDITIONAL NEEDS

5.2.1. Meteorological and Geophysical Agency (BMG), Indonesia

In his presentation, Mr Masturyono (Indonesian Centre of Meteorology and Geophysics (BMG)) defined the tasks of the Meteorological and Geophysical Agency of Indonesia (BMG) as to provide accurate, prompt and qualified services for protection of citizen lives and properties from natural disaster. It accomplishes this through (i) policy formulation for standard operational procedures in the fields of meteorology, climatology and geophysics; and (ii) implementation of meteorological, climatological and geophysical observation, data processing-analysis, and information services in the ocean and in the atmosphere. BMG is the authority to announce severe weather warnings and alerts.

He proceeded by identifying the Indonesian national agencies that are involved in tsunami early warning and mitigation: (i) the technical aspects of tsunami early warning are assured by the Meteorological and Geophysical Agency (BMG), the Agency for survey and mapping coordination, and the agency for assessment and application of technology; (ii) assessment and capacity building is assured by the Ministry of Research and Technology; and (iii) mitigation and governance (national effort on shelter preparation) is the responsibility of the national planning agency’s department of communication, department of public work, department of education, department of health, department of defence and Kem. Kesra & Bulog.

Mr Masturyono then provided information on the existing system (that was established in 1996). He explained that the current seismic network is composed of 30 non-real-time seismometers, 28 real-time seismometers, 5 accelerographs, 20 JISNET (Japan-Indonesia Seismic Network) stations, 2 CTBTO stations and 2 ERI (Earthquake Research Institute) stations. The non real-time stations are mostly analog and they produce estimates of epicentre and magnitude. Data are sent daily or on request. The real-time stations produce information on the epicentre, depth and magnitude. With regard to tide gauges he explained that 54 permanent stations are operated by the National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL), and 10 permanent stations are operated by PT Pelindo I-IV (port infrastructure and management). In addition, TREMORS (Tsunami Risk Evaluation through seismic Moment from a Real-time System) has been installed at the Tretes geophysical station, which is located in East Java.

In terms of future plans Mr Masturyono explained that Indonesia wishes to expand the seismic network to 160 stations, spaced at 100 km distance.

Indonesia is establishing several bilateral agreements: (i) China-Indonesia: agreements were signed on 28 February 2005 for the establishment of the Indonesia-China Digital Seismograph Network (ICDSN); (ii) Japan-Indonesia: 11 March 2005: discussions on DAPHNE (upgrading of JISNET); (iii) Germany-Indonesia: 14 march 2005: agreement to be signed on tsunami early warning system development (including seismograph, accelerograph, DART buoys, GPS, tide gauge, processing facilities, telecommunications, instructional training for operators); and (iv) The Netherlands-Indonesia: training was held between 31 January and 1 February by Delft Hydraulics tsunami simulation software.

Mr Masturyono concluded by stating that the basic infrastructure for a tsunami warning and mitigation system exists in Indonesia. However, improvements are required in terms of the density of the observation network, automatic data acquisition and processing, training to operate the system, and capacity building in general.

5.2.2. Tsunami Preparedness in Coastal Washington State

In his presentation Mr David Johnston (Institute of Geological & Nuclear Sciences, Lower Hutt, New Zealand) reported on warning systems research. This involves determining the factors that enhance public response to warning systems. It requires (i) reviewing training amongst response agencies; (ii) gap analysis of existing and proposed training (for both warning and evacuation); (iii) on-site analysis of operating conditions and environments; and (iv) surveying of communities to determine understanding of warning systems and attitudes towards risk.

Since the mid 1990s the State of Washington, in association with the U.S. National Tsunami Mitigation Program has undertaken a wide range of mitigation activities. Warning and evacuation signs have been erected in prominent position, maps and public displays have been put in place illustrating the tsunami inundation zone. A study was undertaken to assess the influence of these activities on tsunami hazard preparedness. The study involved 211 residents and 97 visitors.

The conclusions of the study are:

- The hazard education program to date has been successful in terms of promoting awareness of and access to information about tsunami hazard.;
- Despite success in disseminating hazard information, levels of preparedness were recorded at low to moderate levels;
- The findings emphasised both the importance of:
    - Accommodating pre-existing beliefs and interpretive processes,
    - The need for additional strategies to augment existing programs with initiatives that manage these beliefs and perceptions in ways that facilitate preparedness;
- The data furnished by these analyses also provides baseline data against which subsequent intervention activities can be assessed;
- Major challenges for risk communication are:
    - Ensuring that the information provided is meaningful to recipients;
    - Motivating risk acceptance,
    - The adoption and maintenance of risk reduction behaviour.
- There is a need to promote these during periods of quiescence
- Attention must be directed to developing better ways of measuring levels of preparedness and the effectiveness of interventions
- All activities must be linked to broader all-hazards risk management and community empowerment initiatives.

5.3. COMMUNITY BASED EARLY WARNING SYSTEMS — THE CHALLENGE OF SUSTAINABILITY

5.3.1. Perspectives on what constitutes effective community-based disaster risk management and early warning systems and how to ensure ownership and sustainability and what is required to further develop these

In his presentation Mr Marc Gordon (DIPECHO South East Asia, Directorate General for Humanitarian Aid - ECHO, European Commission, Bangkok) started by emphasizing the futility of engaging in disaster reduction strategies that do not fully consider the irreplaceable role that the community must play. Any early warning mechanism must be people-centred. He then elaborated on a number of particular issues:

- Perspectives on risk: the practical realities of implementing early warning systems, particularly at community level, often manifest themselves in ways that confound project designers and programme managers alike, despite unprecedented efforts for fully participatory project development. Many of the most successful examples of community-based disaster risk management have been with project strategies that have identified "the need to move out of the disaster risk reduction mindset and into one of sustainable development with a disaster risk reduction dimension";

- Information transmission, Exchange and Dissemination:
    - A major problem is the challenge of communication between a largely educated, literate project workforce and a little educated, often illiterate beneficiary population.
    - If no clear government commitment exists to reinforce national disaster management structures and systems (with real inter-ministerial resource mobilisation and decision-making capabilities at all levels), then information transmission will depend heavily or totally on civil society, mass organizations and the community. The mass media have a crucial role in assuring wide and effective warning dissemination and awareness raising. Education and training for the media is required;
    - The mass media have a crucial role in assuring wide and effective warning dissemination and awareness raising. Education and training for the media is required;
    - Message content must be as simple as possible for end users (e.g. sounds, graphic symbols). Message delivery systems must be cost effective, replicable and simple for system operators;
    - Regarding the issue of "false warning" the credibility of the message is crucial for initial project acceptance and consequent community ownership.

- Appropriateness:
    - It is essential to merge technical knowledge with indigenous knowledge in a socio-culturally appropriate manner. Gender issues need to be considered.
    - Simulations, post project evaluations and continued follow-up are essential to identify flaws and successes.

- Comprehensive stakeholder participation
    - An early warning system is dependent upon the sustained investment of all stakeholders at multiple levels before, during and after completion of the project cycle. An early warning system should not be attempted unless there is genuine grass roots demand for the system;
    - An early warning system should have relevance from the perspective of the end-user: it may address pressing concerns of the community and individual households (rooted in risk to livelihoods rather than thereat to life). This is particularly the case for communities vulnerable to low magnitude or low frequency hazards, and which require specific strategic dispensation;
    - Perceived usefulness and effectiveness of a system is indispensable for project acceptance. Acceptance is essential for sustained end-user and system operator ownership.

- Operation and maintenance
  - Low cost and technical assistance designs must be used that reflect the degree of sustained budgetary commitment that can realistically be expected from national and sub-national budgets;
  - The components of a system that require maintenance by the community or nominated individuals must have a general relevance to the lives of the community members;
  - The system must be "calibrated: over time for all communities at risk.

- Education
  - Facilitating awareness of, and timely decision-making for, appropriate risk reducing measures is a great challenge. It requires both community and household awareness, achieved through comprehensive education related to the nature of hazards, vulnerability, existing capacities and appropriate actions. This requires time and sustained investment, which are often lacking. Incorporating disaster reduction management in school curricula has provided moderately successful in seeking heightened awareness and behavioural adjustment. "Captive audiences" who can mobilize and disseminate through family and the broader community are good vehicles for widened understanding.

5.3.2. Community based early warning systems : the challenge of sustainability

Ms Amy Mintz (Senior Officer, Disaster Preparedness & Response Policy & Relations Division International Federation of Red Cross & Red Crescent Societies) stressed that early warning system or tsunami alert systems alone have limitations in their life-saving capabilities, if not combined with "people centred" networks. She used Bangladesh, where the annual monsoon and cyclone season devastates large parts of the country and population, as an example. Following the 1970 cyclone season which took half a million lives, the cyclone preparedness programme (CPP) had been developed by the Bangladesh Red Crescent Society with the support of the Government. The CPP can now alert 8 million people in at-risk coastal areas. The warning system relies on a radio network that links Dhaka with 143 radio stations. Alerts are then relayed to 33,000 village-based volunteers, who pass on the warning by megaphone to their village communities. This process has now taken a multi-hazard approach, and is augmented with year round awareness raising and education activities such as regular drills to ensure that the system works. As a result, the 2004 floodings, one of the worst in decades, affected 36 million people but only 747 lives were lost. Early warning is not a dormant system only activated when the hazard occurs: early warning is part of a continuous process of activities that strengthen the resilience of communities at risk, while developing a culture of readiness. People-centred systems are therefore of core importance. The message is that with only early warning systems, without clear understanding of the process following the warning message, people will not know how to prepare, how to act and how to help others.

Ms Mintz then defined what constitutes effective community based early warning systems and how to ensure ownership and sustainability:

1. Partnership with all stakeholders to ensure that the process is developed with joint efforts and without gap;
2. Participatory process to ensure that needs are covered and that the information (with local understandable language) flow is in place;
3. Support of local community to ensure that preparedness mechanisms are set accordingly, with a trusted and a legitimated multi-hazard approach;
4. Support of all relevant Ministries and other agencies;

5. Effective programming around the rhetoric: people need to see and appreciate the existence of programmes in essential areas (e.g. water and sanitation, housing standards,…). They also need to see that programmes accommodate the needs of the most vulnerable.

She then pointed out the strengths of the Red Cross and Red Crescent Movement (RCRC) to support early warning and disaster preparedness: (i) with their work at community level, the RCRC National Societies have long been recognized as indispensable partners in galvanizing and mobilizing local support for community-based disaster preparedness and response; (ii) the RCRC has a pre-existing trained volunteer network (at both national and local levels) to support community risk mapping, monitoring and dissemination, with people who understand culture, language and where to locate people; (iii) the RCRC has easy leverage points to integrate early warning safety support into other programmes at local level to ensure coverage and sustainability; (iv) the RCRC national societies can play a complementary role to Governments, scientific community, donors and other partners in disseminating information and education to raise the public's awareness of the risks they face and empower them with ways to minimize those risks before a disaster, and disseminating early warning safety information during disasters by mobilizing volunteers and community members; and (v) the International Federation of the Red Cross and red Crescent Societies, using their global network, bring in solidarity, outreach and access to the UN system through their status as an international organization to build support for activities at national level.

She concluded by stating that building local resilience through, for instance, small-scale disaster mitigation projects as well as through effective preparedness for disaster response must be a central element of any early warning system. The tsunami disaster has clearly shown that such measures can save lives and resources.

5.4. AWARENESS BUILDING AND PUBLIC INFORMATION

In his presentation: Mr Akihiro Teranishi (Senior Researcher of Asian Disaster Reduction Centre (ADRC)) , explained that our society is vulnerable to disasters due to, among other things, "risk perception gaps", i.e. a disparity between the actual risk and what is perceived as risk by people. Lack of proper recognition of tsunami risk is one of the major factors aggravating huge human losses. According to our field survey in affected countries, few people are aware of the tsunami risk and most of the local people including government officials did not even know the term "tsunami". Therefore, it is vital to plug this gap in order to lessen the impact of tsunami disaster.

With regard to raising public awareness and education, reference was made to broadcasting of TV or radio programs, compilation and distribution of videos, posters, pamphlets and booklets, and education at schools. It is crucial to spread tsunami disaster reduction knowledge to the inhabitants through all means possible.

There is one example that ADRC achieved in cooperation with the Papua New Guinea government: developing tsunami reduction pamphlets based on the experience with the Aitape tsunami in 1998. As one of the effects of this tsunami pamphlet, when the tsunami hit PNG in November 2000, residents in the vicinity evacuated to higher ground immediately and no one was killed by the tsunami this time.

In the planning of materials for disseminating knowledge on disaster reduction and increasing public awareness, we have to take into consideration the diversity of each country. Owing to the different situation of each country, needs on the dissemination of disaster reduction knowledge and enhancement of disaster reduction awareness also differ by country.

From this point of view, we must identify the needs of each country and implement the appropriate measures.

In this respect, ADRC is now carrying out an interview survey in Sri Lanka. The survey consists of approximately 20 questionnaires addressed to the general public, school children and government officials to identify the current situation and characteristics of the community's capacity and to propose the strategy for dissemination of tsunami knowledge and raising public awareness.

Disaster reduction training is also essential to improve disaster reduction measures and disaster countermeasures and reduce damage caused by natural disasters. In addition we aim at making trainees themselves understand the current situation, problems, tasks and solutions of disaster reduction measures and disaster countermeasures, in their own countries and surrounding regions, through the exchange of experience and expertise between participating countries.

ADRC organize and conduct various seminars and trainings for developing human resources through learning about disaster reduction measures and disaster countermeasures using Japan's disaster reduction system as a model case. The "Mission on Policy Dialogue for High Level Administrative Policy Maker on Establishing a Tsunami Early Warning System in the Indian Ocean" held in Japan on 24-26 February 2005 was one of these seminars and trainings conducted by ADRC responding to the World Conference on Disaster Reduction. In addition, due to the importance and urgency of capacity building for the Indian Ocean countries, ADRC organized the "Regional Seminar on Tsunami Early Warning System" on 6-19 March 2005.

In summary, concrete projects should be implemented appropriately and effectively to improve raising public awareness and capacity building within a global framework.

5.5. INSTITUTIONAL CAPACITIES FOR MOVING FORWARD

In his presentation, Mr Michael Ernst (Regional Disaster Reduction and Transition Recovery Advisor UNDP/Bureau of Crisis Prevention and Recovery, Bangkok, Thailand) explained that in the wake of the tsunami, there will be many activities in all of the countries of Asia to increase disaster management capacities and enhance early warning system effectiveness. UNDP in collaboration with many organizations via the UN Resident Coordinator system will be focusing on national and sub-national capacity building efforts for early warning system development and for improved disaster management, in general, as part of broad disaster risk reduction efforts.

One of many partnerships UNDP is currently exploring is one with the IFRC, where the IFRC would support community-based early warning and preparedness efforts, while UNDP would cooperate with support to the local and national government agencies that interface with the vulnerable communities.

To facilitate UN system-wide support to early warning system development, a number of UN agency representatives based in Bangkok initiated the development of a brief mapping of potential UN roles as part of a holistic, multi-hazard and multi-stakeholder approach to support early warning system development within the existing global framework. The mapping exercise aims to provide a framework for coordination and collaboration among the full range of UN agencies in support of the broader international community's efforts at the international, regional and sub-regional, national and sub-national, and local levels. Briefly, within the UN system, ISDR provides the international platform via the Platform for the Promotion of Early Warning Systems (with UNESCO/IOC providing the coordination platform for tsunami specific efforts); UNESCAP provides a regional platform, while the UN Resident Coordinator System provides a national platform.

Within the mapping, early warning is recognized as part of a comprehensive disaster reduction approach that builds on existing development and disaster mitigation programmes and will be included in tsunami recovery and reconstruction programming. This UN mapping exercise is a work in progress and it will be further refined in the coming weeks based on the outcome from this meeting and other UN system inputs.

One important area of collaboration that the mapping should facilitate is the closer cooperation among the UN technical agencies and the development agencies working at the local level. Technical information can help guide local-level preparedness, and local information and experience can help guide research and technology development, as well.

6. REVIEW OF EXISTING CONTRIBUTIONS TOWARDS THE DEVELOPMENT OF THE TSUNAMI WARNING AND MITIGATION SYSTEM FOR THE INDIAN OCEAN REGION

6.1. BRIEF INTRODUCTION OF THE SESSION

This Session was introduced by Dr David Pugh, Chairperson of the Intergovernmental Oceanographic Commission of UNESCO (IOC). He invited representatives of Member states and Organization to make brief presentations on the current status or of planned activities related to tsunami warning and mitigation.

Presentations under Agenda Item 6.2 and 6.3 are available in PDF format from the web site page http://ioc.unesco.org/INDOTSUNAMI/paris_presentations.htm and are not reported on individually.

6.2. PRESENTATIONS OF CONTRIBUTIONS

Member States (Indian Ocean)

- ***Australia**: “Australian statement" by Mr Robert Owen-Jones (Decision-maker on Policy, Director for the Environment, Department of Foreign Affairs and Trade;*

- ***France**: “France statement” by Dr François Gérard (Président du Comité National pour la COI, Météo France) ;*

- ***India**: “Early Warning System for Tsunami and Storm Surges: The Indian Initiative" by Dr. Harsh. K. Gupta (Secretary, Department of Ocean Development, Government of India);*

- ***Indonesia**: “The establishment of the Indonesian Tsunami Early Warning System: A dual approach towards a regional tsunami early warning system” by Mr Jan Sopaheluwakan (Deputy Chairman for Earth Sciences, Indonesian Institute of Sciences);*

- ***Kenya:** “Development of a Tsunami Early Warning System for Kenya: Experiences, Limitations And Opportunities” by Mr Ali Mafimbo, Meteorologist, Kenya Meteorological Department;*

- ***South Africa**: "Can an earthquake in the Indian Ocean create a tsunami along the South African coast?" by Dr Andrzej Kijko (Pr.Sci.Nat, Manager Seismology, Council for Geoscience);*

- ***Sri Lanka**: "Hydraulic impact of the Tsunami, which affected Sri Lanka, explaining how the near shore transformations contributed to the devastation" by Mr Prasad Kariyawasam and Prof. Samantha Hettiarachi;*

- ***Thailand: "**Thailand country report" by Ms Chirapa Chitraswang (Principal Advisor for Communications, Ministry of Information & Communication Technology);*

Member States (other)

- ***Finland**: "Statement by Finland" by Dr Tapani Stipa (Scientist, Docent, Finnish Institute of Marine Research);*

- ***Germany**: "The Tsunami Early-Warning-System in Indonesia: concept and status quo" by Dr. Joern Lauterjung (GeoForschungsZentrum Potsdam), Mr Reinhard Junker (Assistant Secretary, Federal Ministry of Education and Research, Germany);*

- ***Japan**: Interim Arrangement for Tsunami Warning in the Indian Ocean" (JMA) by Mr Mashiro Yamamoto (JMA);*

- ***Japan:** "Science and Technology for Tsunami Research: Sea Bottom Observatory and Aftermath Survey" by Dr Kazuhiro Kitazawa, (Special Advisor for the Director, Planning Dept., Japan Agency for Marine-Earth Science & Technology (JAMSTEC));*

- ***New Zealand**: "Integrating warning systems: New Zealand in the context of the Southwest Pacific and Southern Oceans" by Mr John Norton (Director, Ministry of Civil Defence and Emergency Management);*

- ***Italy:** "Coastal Risk Analysis of Tsunamis and Environmental Remediation (CRATER)" by Mr Marco GONELLA (Ministère de l'Environnement Italien (MATT));*

Organizations

- ***ADPC (Asian Disaster Preparedness Center):** "Establishing regional end-to-end tsunami early warning system for Indian Ocean and Southeast Asia" by Dr Suvit Yodmani (Executive Director ADPC);*

- ***CTBTO (Comprehensive Nuclear-Test-Ban Treaty Organization)**: "Potential contribution of the CTBTO Preparatory Commission to a tsunami alert service" by Dr Lassina Zerbo (Director of the International Data Centre (IDC) of the Provisional Technical Secretariat of the CTBTO Preparatory Commission);*

- ***GEO:** "GEO Communique in support to Tsunami and Multi-Hazard Warning Systems " by Mr Guy Duchossois, (ESA Consultant, European Space Agency, Directorate of Earth Observations);*

- ***GLOSS**: "GLOSS Global Sealevel Observing System " by Dr Bernard Kilonsky, (University of Hawaii Sea Level Center, Department of Oceanography, University of Hawaii, USA);*

- ***IMO (International Maritime Organization)**: "IMO Response to the Indian Ocean Tsunami Disaster" by Mr Vladimir Lebedev (Senior Technical Officer, Maritime Safety Division);*

- ***IRIS (Incorporated Research Institutions for Seismology)**: "The Global Seismographic Network and recording of the earthquake of December 26, 2004", by Dr David W. Simpson (President IRIS Consortium);*

- ***ITU (International Telecommunications Union)**: "ITU Work on Emergency Warning System", by Mr. Richard Hill (ITU Telecommunication Standardization Bureau);*

- ***UN/ESCAP:** "Towards an Effective Regional Early Warning System in Asia: Experiences of UNESCAP" by Mr Ti-Lehuu (Economic Affairs Officer, Water Resources Section, Environment and Sustainable Development Division);*

- ***WMO** (World Meteorological Organization): " World Meteorological Organization and NMHSs Contributions to Tsunami Early Warning System " by Ms Maryam Golnaraghi (Chief-Disaster Prevention and Mitigation Programme, World Meteorological Organization);*

- ***IOC** (Intergovernmental Oceanographic Commission of UNESCO (IOC)): "IOC contribution to the Indian Ocean Tsunami Warning System" by Dr Patricio Bernal (Executive Secretary IOC);*

- ***ISDR** (International Strategy for Disaster Reduction): "UN concerted approach in support of Indian Ocean tsunami early warning system" by Mr Reid Basher (PPEW Coordinator, ISDR Secretariat).*

7. DEVELOPMENT OF THE DESIGN PLAN, WORK PLAN AND TIMETABLE

7.1. ESTABLISHMENT OF DRAFTING GROUPS

Dr. Patricio Bernal introduced this agenda item, referring to Document IOC/IOTWS-I-Information document 1 entitled "Terms of Reference for drafting groups: general rules for the establishment of drafting groups". This document provided recommendations for the membership, method of work, expected outcome and detailed goals for each drafting group.

The objectives of the three groups are summarized as follows:

Group 1: Technical aspects of an IOTWS

This group will:

1. Identify and recommend the immediately available technologies to be used for the geophysical and oceanographic monitoring networks of the IOTWS.
2. Identify and recommend the methodologies for tsunami hazard assessment at the local, national and regional levels.
3. Identify and recommend the technologies to be used for warning delivery at the regional, national and local levels.
4. Define the draft design plan including technical details like:
    - The localization of instruments (seismographs, sea-level sensors, pressure sensor buoys, etc.)

- Upgrading of existing networks to real time transmission (identify stations and frequency of sampling/transmission),
- The required communication links, and identification of available communication networks
- Linkages between global and regional systems.

Group 2: Organizational aspects of an IOTWS

This group will:

1. Define the requirements for national agencies implementing Tsunami Warning Systems in each country, with particular focus on incremental training needs and staff reinforcement.
2. Propose the architecture of the system, including the number and character (functionality) of sub regional components, such as National Coordinating or Tsunami Technical Review Committees.
3. Outline the procedures for information exchange between the International System and the National Agencies.
4. Identify the next steps required to establish the IOTWS and to initiate its operation.

Group 3: Awareness and preparedness actions for an IOTWS

This group will:

1. Propose a strategy to fast- track the transfer of IOC's ITIC tsunami preparedness experiences and existing products (brochures, textbooks, teacher's handbooks, stickers, signs) to all the countries surrounding the Indian Ocean basin.
2. Identify a limited number of training centers in the Indian Ocean rim capable of providing support to National Agencies in charge of disaster relief and emergency procedures dealing with tsunami hazard, among others.
3. Outline regional and national plans to sensitize local populations about tsunami risk.

7.2. MEETING OF DRAFTING GROUPS

The grafting groups met on Saturday 5 March. They started by electing a Chair and then proceeded with their deliberations. Each Chair was requested to prepare a summary report of the deliberations.

The Chairs of the drafting groups were:

- group 1 (Technical aspects of an IOTWS): Dr Neville Smith (Australia)
- group 2 (Organizational aspects of an IOTWS): Dr. Harsh K. Gupta (India)
- group 3 (Awareness and preparedness actions for an IOTWS): Mr Prasad Kariyawasam (Sri Lanka)

7.3. REPORTS BY THE DRAFTING GROUPS AND DISCUSSIONS

The reports shown below are the composite result of the reports drafted and agreed upon by the drafting groups, and the plenary discussions that took place on Monday 7 March 2005. Individual interventions by country or organization representatives are not reflected.

7.3.1. Report of drafting group 1: Technical aspects of an Indian Ocean tsunami warning system

7.3.1.1. <u>The technological basis: measurements and telecommunication</u>

- <u>Seismic and Geophysical Measurements</u>

Existing international, regional and national seismic networks in the region need to be considered as essential components of a tsunami warning system. These networks need to be evaluated, upgraded, expanded to fill in the data gaps and strengthened to address all requirements for monitoring and for the IOTWS.

- International seismic observing system (Federation of Digital Seismic Network);
- The meeting recognizes and welcomes the important contributions of CTBTO;
- National networks (several countries);
- AfricaArray is a collaborative project between Penn State University and some African national agencies.

Action:
- Needs for upgrades must be identified and prioritized. Broadband seismic sensors are recommended to correctly measure large earthquakes. The critical need is availability of real-time data transmission). Suitable experts (international and national) must be identified to carry out this task;
- Data must be made available in real-time to all national warning centres and centres designated for processing and analysis;

- **Ocean**

Indian Ocean GOOS (IOGOOS) is active in the coordination of deep-sea observation networks for a variety of purposes and in operational oceanography for the region and opportunities for cooperation and sharing of infrastructure and logistics should be explored.

In the western Indian Ocean, ODIN-Africa and GOOS-Africa have contributed to new observations.

Coastal and Island Tide Gauge Network

- International - GLOSS presently has 14 near-real-time high-frequency sampling gauges suitable for tsunami early warning. Their distribution is shown in Figure 1. These gauges are currently transmitting data every hour through the Geostationary satellites that are immediately retransmitted over the WMO Global Telecommunication System to PTWC and JMA;

- There are 41 other GLOSS stations in the Indian Ocean operated (not in real-time) by other national agencies (See Figure 1 on next page for details).

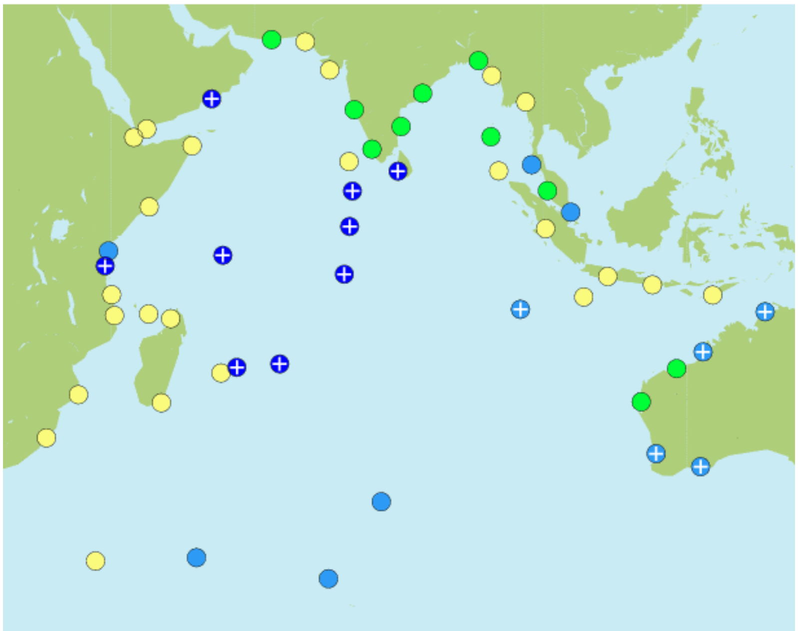

Figure 1: 9 Figure 1: GLOSS sites in the Indian Ocean categorized according to latest data submission to the international GLOSS data archiving centers. There are 9 sites that provide hourly mean data in real-time (dark blue), 11 additional sites provide fast delivery of hourly mean data (light blue), 10 additional sites have provided hourly mean data later than 1999, 2 additional sites have provided hourly mean data before 1999, 15 additional sites provided monthly mean data later than 1999, and 8 additional sites provided monthly mean data before 1999.White crosses indicate immediate re-transmission to PTWC and GMS via WMO GTS. Additional details about data submission from individual stations can be found at http://ilikai.soest.hawaii.edu/uhslc/IOTSAT.html

Action

- There is a need for evaluation and improvement of this network. Improvements will include (i) adding gauges, in the eastern and north eastern areas of the Indian Ocean as well as in the mid- and western Indian Ocean; (ii) ensuring that all gauges transmit data in real-time with at least 2 minute data sampling rate and less than 15 minute data transmission rate;
- Data must be made available in real-time to all national warning centres and centres designated for processing and analysis.

Deep Ocean Network

- There are national ocean buoy networks in the Indian Ocean operated by India, Malaysia, Indonesia, Thailand, Australia and Japan. These are multi purpose oceanographic buoys collecting meteorological and standard oceanographic parameter. Some are coastal and some are deep ocean buoys. These are transmitting every hour, and have two-way communication capabilities for intelligence training of the system. Some could be equipped with bottom-pressure sensors to measure tsunami heights in the open ocean;
- It has been demonstrated that bottom-pressure sensors installed in buoy and/or cable system arrays offshore (100-200 km from the coast) could detect tsunami waves in advance of their arrival at the coast.

Action

- These systems must be reviewed and evaluated with respect to their potential for contributing to a tsunami early warning system and, as necessary, upgraded to address the needs for tsunami monitoring and tsunami early warning;
- There is need for the establishment of deep ocean buoys specifically designed for tsunami monitoring;
- Cable-based systems should also be assessed;
- It was noted that these measurements are important for slumping events and other events that are not seen in seismic measurements;
- Data must be made available in real-time to all national warning centres and centres designated for processing and analysis.

- **Other Observations in the Coastal Zone**

- Bathymetric data are essential for pre-tsunami mitigation planning. Knowledge of the near-shore seafloor depth allows wave height predictions, storm surge calculation and facilitates response strategies, e.g. fleet re-deployments;
- Coastal bathymetry, sea floor configuration, topography and land mapping are essential and must be carried out and be made available in high resolution format for all at-risk national coastal regions.

- **Telecommunication**

- The following systems are identified:
    - Use of geostationary communication satellites operating in the Indian Ocean region;
    - Use of the Global Telecommunication System (GTS) of WMO, which is currently operational, for the Pacific Tsunami Warning System (PTWS) for collection of sea-level observations and distribution of bulletins and warnings should be upgraded within 6 months and be made fully operational to address the needs of the Indian Ocean region in the interim and longer-term;
    - Use of satellite systems should be fully explored and a consolidated plan for telecommunication needs should be developed for use by the space agencies for coordination of their activities in this area (see above comments on new technologies). It was noted that data-collection systems of geostationary meteorological satellites were integrated within the WMO GTS to ensure distribution of collected data;
    - The use of IP-based networks should be explored, including the possibilities of, for example, VPN, to complement and enhance the GTS;
    - The use of *ad hoc* mobile telecommunications systems such as TETRA could significantly improve warning/alert communications between authorities as well as rescue operations;
    - All-media all-hazard citizen alert systems should be explored to identify which GSM cell broadcasting systems could help reaching a large number of exposed citizens in the shortest amount of time;
- There is a need for broadband facilities for the real-time distribution of seismic data. Available telecommunication systems that meet these requirements should be identified and utilized;
- There is a need to distribute other data such as sea level data, analysis and warning messages. Appropriate telecommunication systems need to be identified and utilized for this purpose;
- Reliable systems should be put in place to address all needs for data collection and distribution.

7.3.1.2. The technological basis: analysis, processing and hazard/risk assessment

- **Risk Management Framework**

The development of a tsunami early warning system for the Indian Ocean needs to be put into a risk management framework. This framework will ensure that the warning system that is ultimately implemented is appropriate for the level of risk. The guiding principles of a tsunami risk management framework are to:

- Apply at national and regional (and global) levels;
- Identify and assess the hazard and risk;
- Optimize the development of an early warning system;
- Identify and inform a range of mitigation options (e.g., land-use planning, education, and building codes);
- Capture tsunami risk relative to other hazards (e.g., tropical cyclone); and
- Identify and differentiate between long-term and short-term priorities for tsunami research and development of a warning system.

The risk assessment process should focus on the following issues in the near term:

- The use of available data and models;
- Regional hazard/vulnerability assessment in order to identify areas of highest risk;
- Development of credible "worst" case scenarios for planning purposes;
- Protection of coastal areas especially of small island developing states against adverse effects of tsunamis;
- Evaluation of most probable sources of tsunamis;
- Consideration of mechanisms other than earthquakes, especially in the western Indian Ocean;
- Capture lessons learned from the 26 December 2004 tsunami;
- Establishment of a distributed, uniform and consistent database for hazard, vulnerability and impact modelling and assessment; and
- Establishment of guidelines for data collection (including post disaster).

Action

It is recommended that a working group be formed to review hazard/risk management frameworks in the region and to draft strategic and implementation plans to improve them.

- **Tsunami simulation and analysis**

A tsunami warning system needs to be complemented by robust models and scenarios of potential tsunami events that can be used in the formation and dissemination of warnings. The initial focus should be on:

- Developing a suite of credible (scientifically-defensible) worst case scenarios;
- Creating a modelling library of potential (simulated) tsunami events;
- Implementing a scenario-based library modelled after the PTWC into a warning system;
- Preparing simulations and impact maps on a first-cut, regional basis by **June 2006**.

In the longer term, the accuracy of warnings can be improved by

- Incorporation of real-time observations of earthquake (and volcanoes) and sea-level data;
- Extension of warning information to include physical impact, and socio-economic loss potential;

- Include non-earthquake sources of tsunami, especially volcanoes and submarine landslides.

- **Analysis and processing of geophysical data (real time)**

All data, as well as the results of the real-time analysis, need to be made available to all analysis/warning centres in real time. Data analysis needs to focus on improving:

- Real-time access to seismic, positioning, sea-level and ocean-bottom data;
- The identification of tsunamigenic potential of an earthquake, especially surface displacement;
- The rapid verification of tsunami waves from sea-level and ocean-bottom sensors.

7.3.1.3. The technological basis: warning dissemination and communications

There are different ‘relations’ that describe the dissemination of tsunami bulletins and warnings:

- Authority to Authority
  - International/Regional Centres to National Centre;
  - Within Nation - from national to local authority.
- Authority to Public
  - Local authority disseminate to community.

We should take advantage of existing and evolving systems. These may include (i) WMO GTS consisting of leased lines, IP networks, satellite communications, and the next generation of the Future WMO Information System (FWIS); (ii) the international SafetyNET System/IMO/IHO/WMO (reference is also made to COMSAR/Circ.36 of 18 February 2005); (iii) RANET; (iv) leased lines, satellite communications, VPN internet, direct broadcasts; and (v) mobile methods such as SMS, cell broadcasts and dedicated TETRA-like networks for authorities..

The following conclusions are drawn:

- Redundancy is a prime requirement to ensure that communication links remain operational after earthquakes, floods etc;
- We should make best use of existing dissemination and communications infrastructure to minimize overall cost;
- There is a need to identify best practices in different countries that could be applicable;
- There is a need for an inventory of existing standards and protocols;
- There is a need to identify requirements on delivering emergency and distress messages and information to end users for incorporation in existing and future communication systems such as mobile, IP –based technology etc.;
- There is a need to communicate such requirements to telecommunication standards development organizations such as ITU.

7.3.1.4. Elements of the design of the indian ocean tsunami warning and mitigation system

- **General strategy**

- Immediate, free and open distribution of raw data from the observing systems in real-time must be acknowledged as a founding principle for all national, regional and global tsunami warning systems. Without such, both the timeliness and effectiveness of the system may be severely compromised and the risk may be greater than would otherwise be the case;

- Any network planning should start with identifying and mapping the tsunami prone areas, including in the Makran region of the western Indian Ocean. This should be based upon a historical study of earthquake and tsunami occurrences;
- Many of the standards that underlie the systems for open data collection and exchange can be adopted (or adapted) from already established international systems;
- A sustained and reliable Indian Ocean measurement network will require responsible national and international actions and cooperation, including sustained investment and commitments;
- There is need to develop the networks within a consistent integrated framework for system of systems;
- In terms of the technological implementation, the tsunami warning system as a whole should build on and be a part of a multi-purpose system. It should address several hazards where possible, and be able to deliver many types of routine operational products including warnings both to authorities as well as the public. The sustainability of the observing system including cost effectiveness and efficiency are also enhanced with such an approach;
- National and international agencies need to invest in a coordinated centralization approach to build an integrated tool for earthquake and tsunami surveillance and scientific research;
- Robustness and durability of the instruments and the system as a whole to the impacts of the earthquakes needs to be addressed.

- **Measurement Design**

Seismic, geophysics, and geodetic requirements and commitments

- The group acknowledges the standards for seismic data collection and distribution developed and established by FDSN should be considered as basis for establishment of standards for seismic data collection and distribution;
- It is important to characterize as soon as possible the “tsunami generating potential” of an earthquake.

Priorities:
- Immediate need to establish systems dissemination of data real-time;
- On the basis of the analysis of the region, ensure that the region is covered for detection of potential tsunami generating earthquakes;
    - Upgrade instrumentations as needed.
- Application of the real-time high gain positioning network, for IOTWS purposes;
- Densification of the network.

Ocean

Tidal Gauges
- The Group acknowledges the need for a new standard to enhance the value of new tidal stations to operate in real-time, and with the possibility of a mode that triggers high-sampling rates under certain circumstances. The Group recognizes the existing standards of GLOSS, PTWS and ITIC, and the need for robust communication channels such as the WMO GTS system.

Problems
- Lack of *in situ* instruments for detection and verification of a major tsunami compromises the ability for cancellation of a warning in a timely manner with consideration for short warning lead-times.

Priorities

- Upgrading of all tide gauges to meet measurement and telecommunication requirements and standards. There is immediate need for specific gauges (at-least 10 sites) to become fully operational. All other gauges must be fully operational in medium term;
- A more comprehensive network of tide gauges to be designed and implemented with consideration for at-risk areas to complement the existing system (an immediate action).

Deep Ocean Network

- Data collection and distribution standards must be developed for the deep ocean instrumentation (i.e., buoy and cable systems);
- Based on requirements for the IOTWS, the distribution network of deep ocean sensors (e.g., mooring, cable-based systems) must be designed and established and integrated with the complementary tide gauge network to rapidly detect tsunami. Other new technologies should be considered as they are proven;
- Real-time telecommunication of data and reliability of communication between instruments on the ocean floor and surface needs to be enhanced.

Other Observation in the Coastal Zones

- Coastal bathymetry, sea floor configuration and land mapping is an essential element of the system;
- Each nation should carry out surveys with immediacy for their own coastal region with assistance from expert organizations (i.e., IOC-IHO) if needed.

Telecommunications

Needs are:

- Broadband communications;
- Remote access;
- Reliable, backup, multiple networks;
- Systems that are independent of local power and communication grids;
- Systems that have been demonstrated in the international domain, avoiding proprietary systems to encourage interoperability.

Priorities:

- In the immediate future, WMO GTS should be upgraded where needed, especially as regards developing and less-developed countries and made fully operational within the 6 months time frame in the Indian Ocean. There is need for participation and input of the seismic and tsunami experts who participated in the Jakarta meeting held by WMO on March 14-18, 2005, and implementation of the developed action plan to achieve this goal in the 6 month time frame;
- Expansion of the already-in-use satellite facilities;
- Within six months and beyond, ensure that the space-system use for data collection and dissemination is fully utilized in the region. Development of a requirement plan and coordinated mechanism for the use of satellite systems operated by different countries in the region to maximize utilization of capabilities for data collection and dissemination is strongly recommended (also see action in 2.1.4). The group recommends that a coordinated system be operational with in the region in the medium to longer term timeline;
- Other means including IP-based system and use of mobile network should be expanded.

Network monitoring and system maintenance

As the tsunami early warning system will be based upon various data sources, in-situ ocean and land stations, and networks, it is emphasised that the network of stations for tsunami early warning should be constantly monitored to guarantee its reliability and effectiveness. This encompasses checking (i) operational status of stations; (ii) data quality; (iii) operational status of communication links; and (iv) whether data are properly disseminated. We could build on existing WMO-IOC experience, such as JCOMM, (as well as IMO experience) which provides this facility for the ocean and maritime community.

- Free and open access to data is essential. Without fully respecting this principle the system cannot operate;
- Data must be quality controlled, and archived for post-event assessment and research;
- Systems should be qualified and certified.

- <u>Analysis and processing centres</u>

Hazard and risk modelling

Hazard and risk modelling development should have the following elements:
- Develop maps of extreme / maximum run-up and impact;
- Develop maps of probabilities of different run-ups and impacts;
- Focus initially on earthquake and volcanic source in the subduction zones in the east Indian Ocean;
- Focus initially on identifying regions of higher hazard (headlands, bays, etc.), which can be done without detailed bathymetry or topography data; and
- Develop models to capture impact as well as uncertainty and variability in hazard and risk to communities.

Tsunami analysis and simulation

Tsunami analysis and simulation can be divided into two components:

1) a base, regional scale model of the Indian Ocean Basin, to be developed as a matter of priority; and
2) A detailed model, incorporating near-shore run-up and inundation, which will evolve as data and models improve.

- The base model:
    - Can be developed using consensus hydrodynamic models such as IOC's TIME, which are valid for deep water to approximately 200 m depth;
    - Should focus initially on earthquake sources;
    - Is limited by lack of detailed bathymetric data and tsunami source information (earthquake, landslide, volcano);
    - Needs detailed seismic and bottom surveys in these zones, to help determine the possible source displacement; and
    - Will need to be expanded to incorporate collateral damage from earthquake, volcano and landslide.
- The detailed model:
    - Can be developed using existing wave run-up and inundation models (e.g., ADCIRC);
    - Will enable tsunami impact to be captured as part of the warning process;
    - Needs to be interfaced with the base model at the regional and national level;

  - Requires better bathymetry (<200 m depth) and topography data to be acquired at the local level;
  - Requires training, expert assistance and guidelines to implement at national or local centres; and
  - Can be improved by developing new models specifically for tsunami use: {finite element with irregular triangular grids; or finite difference; or fractal (latest technology)}

Recommend for immediate action: working group to decide in the short-term which models to use and to build the model library and training tools.

Analysis and processing of geophysical data

The analysis and processing of geophysical data in warning centres can be divided into categories for detection, warning and dissemination. It must be noted that the warning system capability in terms of robustness, false alarm rates and reaction times can be reduced with better investment in the observational framework. A guiding principle for the development of warning systems is: the better the national systems are, the better the entire system will be.

- Detection - need continuous real-time analysis of geophysical and sea level data that:
  - Is robust and automatic;
  - Can be verified;
  - Can be assimilated into a warning system, using a continuous updating of analysis as data becomes available;
  - Incorporates standards for analytical methods that are maintained across the national and regional centres;
  - Provides improved detection and localization of earthquake magnitude and location estimate;
  - Provides improved estimates of source displacements, such as from positioning data;
  - Provides tsunami wave data to 1 cm or better, and with a 2-minute or better sampling rate.
- Warning system
  - Needs to be linked between centres for common message;
  - Needs to adhere to hierarchical rules for regional/national/local centres so that one authoritative warning is issued, to avoid public confusion;
  - Will have to adapt to type of event - i.e., local tsunami will have local centre precedence, mid-ocean ridge generated tsunami will have regional centre precedence;
  - Must recognize that issuing of warnings ultimately rely on national centres;
  - Must recognize that implementation of warnings rely on local centres;
- Warning criteria and standards need to be established recognizing:
  - PTWC protocols (4: advisory, watch, warning...);
  - Warning times in Indian Ocean are shorter than the norm in the Pacific;
  - Diversity of social and cultural situations in Indian Ocean: population density, perception of risk, acceptance of false warnings differ;
  - Distribution of infrastructure;
  - Dichotomy of need, noting that Indonesia has different requirements from rest of basin, since the risk is largely of local tsunamis.
  - Capability for National/regional centres must include experts in seismology, oceanography, data management and processing, hazard analysis; and
  - 24/7 capabilities to a high degree of reliability (i.e., 99.9%).

- Dissemination
  - Messages must be clear and consistent, unambiguous, simple, and practiced (consistent)
  - Information must be sensitive to cultural setting, social patterns, perceptions of risk
  - Is the clear responsibility of national centres
  - Must be effective by:
    - Broadcasting quickly, and broadly, using multiple paths;
    - Using existing mechanisms where possible - radio, television, emergency broadcast systems, SMS, beach sirens;
    - Adhering to common rules to cancel an alert ("all-clear")
    - Engaging in periodic testing and verification, drills (emergency management), and public education

7.3.1.5. Warning system elements

There is an urgent need to identify interim contact information from each country to receive bulletins:

- should be operational with 24/7 capabilities;
- should be part of an established national mitigation system or civil defence, rescue coordination centre, etc.;
- Need to take into consideration limitations of use of communication methods (fax, email, etc.).

It was noted that the WMO GTS has the potential to provide for the international distribution of interim tsunami advisories and information in the immediate future, through National Meteorological and Hydrological Services (NMHSs). The WMO meeting (14-18 March, Jakarta) would develop the required operational arrangements.

It is important to have regional grouping and coordination to effectively issue warnings for regional or teletsunamis.

- Different arrangements at national, regional and basin wide scale will be necessary to deal with local, regional and teletsunamis;
- Urge where possible to achieve efficiencies by use of common standards and systems – balance between related needs to maintain sufficient redundancy and avoid unnecessary duplication;
- Focus on the currently known high risk areas in the Indian Ocean, will require different capability requirements and different response timelines in many Indian Ocean countries (eastern and western);
- The multi-hazard framework covering risks similar to tsunamis (e.g., storm surges, cyclones, coastal flooding) that are more frequent, contributes to the sustainability and effectiveness of tsunami warning distribution systems;
- Need to address need for authentication of bulletins and related messages;
- Note that legal responsibility for issuing warnings (that may lead to evacuation) is issued by national centres (unless other arrangements are agreed upon by countries).

7.3.1.6. Database and distribution capabilities

An effective data and information system for the IOTWS needs to be developed. Free access to data will concern not only seismic and sea level data but also bathymetric/topography data and data important to risk assessment.

Modern data management approaches should allow local, national, and other relevant processing and warning centres to access the pool of Indian Ocean data through the virtual selection of data customized to their individual needs. These centres may connect through an "information bus" through which warnings, analysis, processing tools, assessment and research can be exchanged.

The Group noted the importance of historical databases and tsunami scenario databases (based on simulations). Availability and access to palaeo data is also important, as are databases for hazard/risk assessment, including population, built environment and other data needed for emergency management.

- Where possible interoperability should be an aim, especially if the centres are part of a multi-hazard natural disaster warning system ;
    - Need to investigate the issue of data archival for sea level and seismic data: what data are archived, and where?
- Need to inventory current seismic stations and availability rules and modalities of practicalities for access;
- Need to inventory SL stations and availability rules and modalities of practicalities for access;
- Need to inventory data collecting stations.

7.3.1.7. New technologies and needed r&d

Time did not permit extensive drafting on this aspect. The Group recognizes that there are many emerging technologies that should be consider in the overall strategy, to ensure the evolution of the system relative to best practice. There are also many important research and development issues, many of which are referred to in the preceding sections...

- Utilization of New Technologies

Space Technology

It is highly recommended to utilize space technologies for monitoring and observation of seismic activity and tsunamis as well as to exploit their critical function for data collection and dissemination.

- Use of a single Global Navigation Satellite System (GNSS), or a combination of, in real-time mode and high gain sampling (>= 1 Hz) along major subduction zones for early detection of mega earthquakes complement the seismic networks. The contribution of the International GPS Service will be highly appreciated;
- AFREF, a proposal of IAG and ICSU supported by UNOOSA, aims to use new GNSS space technology to unify African geodetic reference frames;
- It is recommended to take a coordinated approach for defining the requirements for use of space technology for these applications, and ensure effective coordination of the space systems to meet these requirements effectively, efficiently and in a timely manner. In this context, the meeting noted the existence of the International Charter for Space and Major Disasters, which groups a number of the major space agencies, and has already been activated some 60 times since its establishment in November 2000. The meeting strongly urged the Charter partners to expand both the membership and activities in order to urgently address the identified issues and requirements for tsunami preparedness, detection, warning and response.

Radar Systems

There is some potential to integrate tsunami requirements with the use of radar technologies from the coastline out to 200 kilometres into the ocean for detection and measurements of incoming tsunamis to particular coastal areas. In this regard reference was made also to RANET (an international collaboration to make weather, climate, and related information more accessible to remote and resource poor populations- see http://www.ranetproject.net/

- **Technology Transfer**

The Drafting Group also briefly considered the requirement for information and technology transfer, from developed nations (including from beyond the region) to developing and less-developed Indian Ocean nations desiring enhanced technical capabilities.

Education and training and capacity building related to technology is critical. Several countries in the Southeast Asian region of the Indian Ocean require assistance in developing scientific and technological capability in the science of tsunami and associated warnings. Issues include methods for making data and products available to national centres, and consolidation and cooperation at sub-regional and/or regional levels. One example would be to make seismic data available to developing countries.

A specific case relates to small island developing states and their high usage of the coastal environment, particularly for tourism. They particularly require access to technologies for hazard/risk assessment and mitigation measures.

7.3.1.8. The strategy for building and maintaining a system

Time constraints prevented a full discussion of the overall strategy for building and maintaining a System for the Indian Ocean. Important considerations are:

- Interoperability within the region;
- Adoption of uniform standards, protocols and performance measures;
- Testing and validation agreements;
- Links to sister warning systems and to external providers of capability;
- The technical role and responsibility within a global system; and
- Consideration of investment.

It was noted that many of the discrete operational activities discussed above are in fact implemented as integrated end-to-end systems.

Many nations of the eastern Indian Ocean region face dual threats, from the Pacific, Southwest Pacific and Southeast Asian marginal seas.

Based on the technical consideration of section 2 and 3, some conclusions were drawn relative to the overall architecture.

- National capabilities provide the foundation of the system:
    - Operation of national measurement networks;
    - Contributions to regional networks, as appropriate;
    - Operational 24/7 centres;
    - Early warning arrangements;
    - …
    - Local tsunami warning capabilities.

- Next level of aggregation of responsibility and implementation takes advantage of the ability of some national operations to also meet the needs of neighbouring nations:
    - Grouped national requirements, served by a national centre: sub-regional;
        - Mutual assistance in IOC parlance;
    - Providing data capabilities and information needs for a sub-region;
    - Issuing warnings to specified and agreed national contact points;
    - Shared and aggregated pool of expertise, for all elements of the warning system;
    - Shared responsibility for capacity building and training needs;
    - …

- The next level of aggregation in a technical sense is at the “basin” level. At this level the role includes:
    - Interaction;
    - Interoperability;
    - Advocating participation and shared ownership;
    - Ensuring agreements for the exchange of data and information;
    - Cooperation.

Clearly there is also a further level for the global system. These observations are based purely on technical grounds, as we seek efficiency and effectiveness, and aim for desired levels of redundancy and system robustness. It is also important that the strategy be developed within a system-of-systems context, to optimise the efficiency of the system and to ensure consistency with the multi-hazard approach. In this regard, the Global Ocean Observing System (GOOS) and the regional alliance Indian Ocean GOOS (IOGOOS) in particular, offer opportunities for synergy, sharing of resources and integration with other basin and coastal observing systems.

The preceding sections provide a broad outline of the overall strategy and some detail on the needed actions. An urgent task is to continue the dialogue among experts with the aim of providing a clear roadmap for implementation. It should contain (a) agreement on measures for establishing an interim warning system for the region; (b) a set of actions that can be undertaken in the near-term (2005/6) to establish an IOTWS; and (c) longer-term actions (2005-2008) required to implement a comprehensive, robust and durable IOTWS.

Toward this goal, the Group agreed that several *ad hoc* teams could be formed subsequent to this meeting to further elaborate and define the actions suggested in this Report. The aim would be to have a timeline of actions agreed at the next technical meeting of the IOTWS (April).

7.3.2. Report of drafting group 2: Organizational aspects of an Indian Ocean tsunami warning system

7.3.2.1. <u>Report by the chairman of drafting group 2</u>

<u>PREAMBLE</u>

The recent Indian Ocean Tsunami (December 26, 2004), considered to be one of the strongest in the world, resulted in devastations amounting to national calamities in several parts of the Indian Ocean. This has been a call to action for the entire global community. This has been the deadliest tsunami of all time by an order of magnitude.

This calls for developing a Tsunami Warning System in the Indian Ocean immediately with the purpose of enhancing all aspects of tsunami disaster mitigation in the

Indian Ocean including hazard assessment, detection and warnings, preparedness, and research through international cooperation and coordination of activities.

Unlike the Pacific Rim countries which are affected frequently by Tsunamis due to high seismic activity in the circum-pacific belt, the Indian Ocean rim countries are likely to be affected by tsunamis generated by more limited sources which are already identified. It may be mentioned that during the 20th century, there were about 900 tsunamis affecting the Pacific, there were only 6 for the Indian Ocean. However, it is realized that in spite of infrequent occurrence of tsunamis in the Indian Ocean, they could occur any time and could be very devastating as was the case with the December 26, 2004. There is also the very real possibility of the occurrence of local tsunamis generated by landslides or underwater sediment slumps. These many occur anywhere in the region. Therefore, it becomes very important that to be effective, the System for the Indian Ocean must be durable, reliable. It is also noted that there is a high level of false alarms issued in the Pacific. For the Indian Ocean scenario where there are very huge population densities and operations in the coastal areas false alarms cause inordinate inconvenience and destruction of normal life apart from loss in confidence on the warning system. It is therefore very important to improve the science of tsunami forecasting, taking into consideration the valuable information available within the body waves of earthquakes during the first few minutes of the occurrence of the earthquake.

The special ASEAN leaders' meeting in Jakarta on 6 January 2005, the UN Conference on Small Island Developing States held at Port Louis on 14 January, 2005, the UNGA Resolution 59/279 in New York on 19 January 2005), the Common Statement of the Special session on Indian Ocean disaster adopted at WCDR in Kobe on 22 January 2005), the Ministerial Declaration in Phuket on 29 January, 2005, and the GEO Communiqué at Brussels on 16 February, 2005 and meetings in India and China addressed the imminent need to set up a tsunami warning system for the Indian Ocean and provided directions for the future course of action.

REPORT

The drafting group recommends the formation of an Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning System (ICG/IOTWS) to govern the system as a subsidiary body of the IOC Assembly and comprised of interested IOC Member States from the Indian Ocean region. All other Member States of IOC as well as the relevant international/regional organizations (and non-governmental organizations) are welcome to participate in accordance with the IOC Rules of procedure. The Group will function in accordance with the established Rules of Procedures of IOC.

IOC is requested to act as the Secretariat to the Intergovernmental Coordination Group. The functions of the Secretariat to ICG/IOTWS should be to: (a) support meetings of the Group; (b) facilitate the liaison among the various national contact points and National Tsunami Warning Centres; (c) maintain a current list of operational national contact points and facilities and make it available on request to all Member States; (d) liaise as appropriate with other international and regional organizations on matters relevant to IOTWS; (e) liaise as appropriate with the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), with the Pacific Tsunami Warning Center (PTWC) and with other Tsunami Warning Centres to facilitate best practices in tsunami warning; (f) initiate and support training activities and enhance and enrich tsunami warning in the Indian Ocean; and (g) develop and maintain a list of action plans for implementation in the region and make these easily available, to avoid duplication and to promote synergies and cooperation. The IOC, working together as appropriate with other regional and international organizations, is also requested to ensure that the efforts to establish an IOTWS are appropriately integrated into countries' efforts to implement the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, coordinated by the UN Inter-agency Task Force for Disaster Reduction (IATF/DR).

IOTWS should consist of an integrated network of National Systems and Capacities, and all associated assets shall be owned and operated by the Member States hosting or otherwise taking responsibilities for them.

It is recognized that the Member States have the responsibility to have control over issuing of warnings within their respective territories.

It is recognized that the Member States have the responsibility to ensure the effective community awareness of the risks posed by tsunami so that their populations are prepared for and know how to act in the event of a tsunami warning.

To facilitate durability, it is recommended that the tsunami warning system utilize or build on, where possible, existing organizations and institutions, including national platforms and mechanisms for disaster risk reduction and management, applying a multi-hazard approach where appropriate.

It is recognized that special assistance needs to be given to developing countries, with priority given to the least developed countries and special attention to SIDS, for setting up national systems.

Recognizing the need for members to have access to real-time observation data, in particular for the purpose of providing local tsunami warnings, there should be an arrangement for free and unrestricted broadcast of these data in addition to processed information, to all interested parties.

Each Member State is urged to quickly identify or establish a National Tsunami Warning Centre or operational contact point in the relevant responsible agency, along with a response plan, to be able to receive and react to warnings on 24x7 basis and further rapidly disseminate warning information when appropriate within its territory. These national Centres/contact points should be designated by their governments to ensure the issuance of warnings both within their territories and coastal waters.

[National Tsunami Warning Centre – A Centre operated by a Member State with responsibility for and capabilities to generate tsunami warnings for that Member State. The Centre may also act as the Operational Contact Point for warnings generated by other Tsunami Warning Centres].

[Operational Contact Point – The office designated by a Member State to receive and act on tsunami warning products from other Tsunami Warning Centres. This office may not necessarily be a tsunami warning centre but it must be capable of responding immediately on a 24x7 basis with pre-planned actions that, when appropriate, lead to the dissemination of warnings to coastal areas at risk].

Also, the minimal national requirements include the mechanism for dissemination, preparedness for tsunamis including evacuation maps, awareness and education programs, including the preparation and distribution of educational materials, to facilitate an effective response to the natural warning signs of a tsunami including a local tsunami, and an effective response to the receipt of the warning.

Other capabilities beyond the above minimal requirements for a national tsunami warning system include vulnerability maps, operation of seismic, sea level, and other data collection networks in support of national tsunami warning, and a capability to generate local or regional tsunami warnings.

Appropriate training on operational aspects of tsunami warning for personnel of National Tsunami Warning Centres or contact points should be provided.

Australia, India, Indonesia, Malaysia and Thailand have stated their intentions and plans to establish systems and capacities to detect potential tsunamigenic events, detect and measure tsunami, and issue appropriate warnings to forecast their impacts. The products and services that these centres are looking to provide to other Member States includes information and warnings relevant to the tsunamigenic events.

Australia and Thailand are expected to invest in similar systems and capacities to detect and analyze tsunamigenic events to provide timely warnings of tsunami in the Indian Ocean. Australia and Thailand will elaborate on their planned contributions in due course.

India has already designed a system for real time monitoring of tsunamigenic events, establishing a comprehensive real time network of observation systems to detect and monitor movement of tsunamis. A tsunami warning centre operating on a 24x7 basis with necessary capabilities for modelling to generate tsunami warnings and advisories involving inundation scenarios is also being set up. This system also addresses the requirements of storm surges. India has reported that the project has the necessary approval and funding support from the Government of India. The implementation of the project started in February 2005. The key elements of the system will be in place by March 2006 and the whole system will be operational by September 2007. The Government has assigned a high priority for this project, which is being monitored at the highest level. The products from the system will be made available by India to all Member States and organizations, on request, in real time. India is also willing to assist the Member States in the technical training on the different components of the system including vulnerability and inundation mapping.

Indonesia has developed an elaborate plan of upgrading and revitalizing their observation system of seismic stations, ocean level monitoring, tide gauge data, GPS measurements, improvement of environmental buoys into DART-like data buoys, long term research to make more useful and implementable warnings and processing the data using the latest techniques. They are also addressing capacity building, techniques of disseminating information and public awareness. Indonesia is also planning to set up a Warning Centre and collaborate internationally with its products. They have indicated their interest in sharing their knowledge at regional and international levels. The programme will be implemented in two stages: interim stage (2005-07) and post interim stage (2007 onwards)

Member States outside the region are encouraged to provide technical and other kinds of assistance in order to promote regional and international cooperation, if requested by the countries in the region.

Other Centres may be established to act as dissemination points for the relay of information and for technical support and training, as for example, the one proposed by France for the Southwest Indian Ocean.

The IOC Data Exchange Policy adopted by the Assembly in June 2003 shall be the guiding policy for IOTWS. However, it does not include reference to seismic and other geophysical measurements in the definition of “data”.

In addition to the steps taken, or to be taken, by countries of the Indian Ocean for interim tsunami warning, the PTWC and the Japan Meteorological Agency (JMA) have agreed to provide interim tsunami advisory information to the Indian Ocean based on existing facilities until adequate warning capabilities are established within the region. Member States are requested to provide the IOC their official 24x7 contact information (prime and alternate) for receiving this information by April 1, 2005. A form for submitting this information will be attached to the invitation for the 2nd Coordination meeting (see below).

We note that Indian Ocean Member States shall present a resolution at the IOC Assembly in June 2005 regarding the possibility of establishing a tsunami warning system for the Indian Ocean. The Group also noted that a 2nd Coordination Meeting for the IOTWS is planned in April (see Communiqué).

7.3.3. Report of drafting group 3: Awareness and preparedness actions for an Indian ocean tsunami warning system

INTRODUCTION

The United Nations has been committed for over 10 years to promote policies to reduce loss of lives and property from natural and man-made disasters. These efforts have continued from the International Decade for Natural Disaster Reduction, through the succeeding International Strategy for Disaster Reduction (ISDR) and the establishment of the UN Task Force on Disaster Reduction.

An effective Indian Ocean Tsunami Early Warning System (IOTEWS) awareness programme can be supported by UN efforts in its natural disaster reduction programmes as awareness and preparedness, together with channels of warning delivery, are common to all natural hazards mitigation programmes. Like many other UN initiatives, IOTEWS will be people centred and will promote broader community participation. IOTEWS will also be based on a multi-hazard approach that will integrate a tsunami warning and mitigation system with other coastal-based natural hazards for efficacy and usefulness to the public.

An effective awareness and preparedness programme for an IOTEWS will require focus and action in the following broad areas:

- ✓ Risk and vulnerability assessments and applications;
- ✓ Awareness and education;
- ✓ Preparedness and emergency response capacities.

These issues were discussed recently in Kobe, Hyogo, Japan at the United Nations World Conference on Disaster Reduction (18-22 January 2005) leading to the Hyogo Framework for Action 2005-2015. This report will build on the commitments of the Hyogo Framework with the additional requirements of an IOTEWS.

The impact of tsunamis and other hazards can be substantially reduced through institutional and legislative frameworks as well as community participation. This requires that people are well informed and motivated towards safety measures and actions that require:

1. Collection, compilation and dissemination of relevant knowledge and information on - hazards and vulnerabilities; existing capacities for awareness raising; educational resources (globally, regionally, nationally, locally); and lessons learnt from past disasters;
2. Clear and easily understood structures of responsibilities at local, national and regional levels;
3. Policies and practices to reduce disaster impact and risk with reference to land use zoning, construction activities, leasing, purchasing & sale of land, forestry and farming;
4. Community-wide understanding of their risks; knowledge, behaviour and practices required for safety actions; community engagement in risk assessment and risk management; and
5. Information that is easily understood by all levels of societies and all communities.

In addition, countries need to identify one disaster management national focal point for increasing tsunami/multi-hazard public awareness. The focal point of each country, together with other relevant agencies, should plan and implement the actions detailed in the following sections. Finally, the measures detailed below can only be implemented and be effective through strong and ongoing commitments of legislative, financial, and other relevant institutional support of national governments, and the support of the international community.

ASSESSMENT OF RISKS AND APPLICATIONS TO REDUCE RISK

Hazards in Indian Ocean regions

The Indian Ocean region is prone to several natural hazards; the most frequent ones being storm surges, cyclones, coastal and river flooding, landslides, earthquakes, volcanic eruptions, and tsunamis. The environmental consequences related to the recent tsunami have been pollution of groundwater and salination of agricultural fields, industrial accidents and spills, waste deposits, degradation of coral reefs and other near-shore habitats and ecosystems, fishing and other food cycles, coastline changes and beaches. Whilst countries of the region can adapt the best practices on marine-related hazards from other ocean regions, they also need to take into consideration the special characteristics of the Indian Ocean. Countries also need to identify the risks to their coastal zones, the important components of which are:

1. Hazard identification: typically carried out by scientific organizations.
2. Vulnerability (*): including the consideration of the built environment and the social/demographics characteristics of populations.
3. Risk: integration of hazard and vulnerability.

(*) The ISDR defines vulnerability as the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

Addressing risk reduction

The first requirements in assessing risks are coastal zone digital bathymetry and topography map information (from -200m to +50m) on:

1. Distribution of population, social-economic/land-use activities, critical/lifeline infrastructure (public services such as power, communication, hospitals, water, and other services)
2. Land-use map of the built environment
3. Data on physical oceanographic parameters.

It is also important to carry out the following:

1. Post-tsunami Survey Mapping – available quickly, including observations of run-up, inundation with height of water, and structural/non-structural damage, scouring, erosion, and other environmental damage
2. Numerical simulation modelling for the prediction of tsunami impacts

The products from such information are:

1. Hazard risk maps & other data layer maps, including built environment, and population distributions
2. Inundation maps – inundation and run-up, including calculations such as predicted currents
3. Evacuation maps, which include safe areas and shelters, how to get there, and where to go, based on scientific products.

An important tool for effective display of risk information is a GIS system. Hazard risk maps provide inputs to decision makers to promote sustainable development, either for future planning or in response to recent disaster impacts.

The methods of reducing risk are through:

1. Land-use planning based on risk assessments, such as the establishment of buffer zones or setback lines for the built environment.
2. Strengthening of lifelines and other public structures through the review and update of engineering codes of practices to withstand tsunami impacts in the coastal zone
3. *Structural interventions*: Construction of engineering interventions such as tsunami breakwaters, tsunami dykes/embankments or sea walls and secure water supply. [Appropriate strengthening of existing protection works also may need to be undertaken.]
4. *Non-structural interventions*: Protection, rehabilitation, conservation and improvement of coastal ecosystems, which serve as preventive interventions. These include valuable and unique coastal ecosystems, including coral reefs, sea grass beds and mangroves, and creation of forest belts, which have both social and economic value to communities as well as tsunami mitigation value.
5. Design and construction, where appropriate, of multi-purpose coastal structures and elevated shelters to mitigate local tsunami impacts.
6. Recognizing traditional means of response, strengthening and promoting these where applicable. This recognizes and respects the indigenous knowledge base and harnesses community-based local knowledge and systems to reduce tsunami impact.
7. Reviewing risk-sharing mechanisms, such as insurance policies which provide a coping mechanism for communities to recover from tsunami disasters

Involvement of organizations

Whilst national institution must provide the framework or guidance for risk assessment, community-based disaster management planning is also an important part of the process, involving the following:

1. Active community participation at all stages of the mapping process, including planning, and definition of hazards to be included.
2. Community participation and inputs in elaborating tsunami evacuation maps.

Numerical modelling and national risk assessments can be carried out collaboratively with international expertise. However, the need for capacity building, institutional strengthening, and technology transfer is critical for building sustainable technology capacity. The process must be nationally-owned and maintained, and be continuously monitored and revised when necessary. The importance of strengthening the community’s capacities to cope with hazards is of paramount importance and strongly emphasized.

AWARENESS AND EDUCATION – USING INNOVATION AND LOCAL KNOWLEDGE TO BUILD A CULTURE OF SAFETY

Awareness, education and public outreach are essential elements in any natural hazard risk management and mitigation programme, and involve informing decision makers as much as the public at risk. These activities can, and should, be undertaken immediately, in advance of the implementation of a full tsunami or other hazard detection, assessment and warning service.

The World Conference on Disaster Reduction identified key issues and actions for awareness and education within the Hyogo Framework for Action under four main headings.

This part of the report on *Awareness and Preparedness Actions for an Indian Ocean Tsunami Warning System* is structured under 4 closely similar headings:

1. Information management and exchange;
2. Education and training;
3. Linkages with social aspects – media, social sciences, community coping & resilience;
4. Public Awareness of Safety Preparedness Measures.

In addition a number of other actions specific to hazards such as need to be considered:

- Ensuring that all awareness and dissemination material is culturally sensitive, in local languages, with standard joint safety messaging for education, training, and warnings, taking into account all different educational and literacy levels, etc. ;
- Promoting the use of all existing communication technologies and formal and informal educational methods for ensuring access to all communities to mitigate and cope with disasters;
- Putting in place on-site programmes to facilitate study, learning experiences and lessons related to hazard risk reduction activities;
- Promoting community-based training initiatives, (in particular the role of volunteers, and other community based and civil society organizations as appropriate), to enhance local capacities to mitigate and cope with disasters;
- Learning from the experiences of others in the region as well as relevant regional and global emergency management programmes, each country should identify and assess the risk conditions along their coasts, and plan and implement a system for dissemination of warnings to the communities, including the use of media and existing community structures;
- Empowering local communities through recognition of their contributions, promoting stewardship and enhancing their involvement in risk assessment and management;
- Promoting the engagement of the media to understand the scope and limitations of the warning process and to implement practices to support this process. Such a media would stimulate a culture of disaster resilience and strong community involvement in sustained public education campaigns and public consultations at all levels of society;
- Developing promotional outreach materials using innovation and culturally-based on local knowledge, the experience of international organizations and programmes and others in the region who have relevant experience;
- Using existing outreach campaigns for awareness and promotional efforts;
- Developing a participatory approach of local communities in the preparation of safety measures and plans;
- Ensuring public awareness of national warning responsibilities, processes, procedures and terminology;
- Involving community leaders and volunteers in informing the public of warning and safety actions;
- Integrating these activities on marine risks with awareness and education of other natural hazard risks;
- Noting that many countries have economies that are largely based on tourism, promoting awareness (among tourism operators and managers, tourists and other transient populations), of the nature of and risks from tsunamis and other natural hazards, as well as of details of the warning process and response mechanisms;
- Considering that national Tsunami Warning Systems will be the backbone of the Indian Ocean System, and noting the high technical competence that this entails, countries should also ensure that Capacity-Building and technology transfer are given priority within the overall system.

Responsibilities, actions and process

Under coordination of a national focal point agency, Ministries of Education and other relevant institutions from each country should be involved directly in the development of educational materials related to multi-risk natural hazards, including tsunamis. National government planning should include focal points selected from all sectors, to ensure that information and outreach material reaches individuals in all sectors of society. Some of the steps in this process are:

- Collect and assess existing knowledge and awareness systems material from international organizations and programmes, as well as national and regional sources to:
  - ✓ support consortiums with the country focal points to leverage knowledge sharing, consistency, resources and relevance;
  - ✓ provide existing products (brochures, handbooks) as potential models for national focal points;
  - ✓ support training on tsunami and other natural hazard awareness programs for the affected counties in the Indian Ocean.
- Communication of the role of National Emergency Management Agencies in establishing clearly defined disaster-warning procedures, chains of command and responsible agencies, for trustworthy warnings;
- Institutions dealing with urban planning and development and responsible to enforce safe building codes and regulations, should make the public aware of the building laws, procedures, codes and best practices;
- Collaborate internationally to develop a comprehensive training and awareness program that includes training of trainers and of trainees and educational materials in local languages, and recognising cultural specificities;
- Developing innovative community empowering methodologies, drawing on other initiatives in health, environmental management, and social education programs.

PREPAREDNESS AND EMERGENCY RESPONSE CAPACITIES

Preparedness as the critical element in saving lives

1. Clarify roles and responsibilities of institutions for different functions through appropriate legislations. There must be a legally empowered designated national disaster management focal point/organisation (NDMO), and an established line of authority with clear protocols and procedures, reliable alert notifications, provision of safe infrastructure for public evacuation, and appropriate relief provisions for impacted populations. The NDMO must be capable of receiving and acting on a 24x7 basis;
2. Tsunami information must be understood at all levels. Tsunami information must reach local communities by various means including broadcasting;
3. Tsunami Warning Centres issue warnings based on scientific information, but do not provide instructions to the public for action. This is the responsibility of NDMO. The NDMO must be able to interpret the warning information to provide clear, simple, and concise instructions to first responders and the affected public. Recipients of warning information include policy and decision-makers, emergency management and emergency responders, media, and the affected public;
4. The public needs to be informed on how best they can respond to warnings. Safe places need to be identified, prior to disaster, so that they can evacuate to safe sites as soon as a warning is given. Where such places are not available nearby, tsunami/multi-hazard shelters need to be built to save lives. Preparedness and awareness should be tailored for local needs;
5. Preparedness and emergency response involves both pre- and post-disaster activities which should ensure the effective response during a real event. Activities include

rehearsals, drills, scenario impact and response analysis, updating of response plans using best-available risk assessment knowledge;

6. Education plays a critical role in the preparation of communities, and is especially effective when implemented in elementary schools;
7. Specific policies and plans for safe routes, shelters and evacuation must be implemented and practiced.

Increasing Effectiveness

1. National disaster management capacities for tsunami response and preparedness will be strengthened by:
   - Assessing existing capacities for a multi-hazard risk response and mitigation;
   - Developing and/or updating legislation on coastal zone management and land use planning, and for enabling an efficient emergency response.

2. Mitigation programs will benefit from partnerships between government institutions, the private sector, and civil society organizations. These include improvements in structural engineering and the strengthening of building codes, and community public awareness programs (awareness months, museums, and risk understanding);

3. A desirable mechanism for efficient emergency response could be the establishment of a National Emergency Disaster Fund, with pre-determined expenditure protocols for the carrying out of response plans and priorities.

7.4. CONCLUSIONS AND OUTCOMES

7.4.1. Communiqué

In order to summarize the discussions held throughout the Meeting during the information sessions (agenda items 3,4,5), and particularly during the session of the drafting groups and the plenary discussions thereafter, the Meeting decided to adopt a communiqué as included below. This document is intended to provide guidance to all partners regarding the required actions that will lead towards the establishment of a Tsunami Warning and Mitigation System for the Indian Ocean (IOTWS).

The Meeting adopted the following “Communiqué of the International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a global framework held in Paris on 3-8 March 2005”:

“We, the participants at the International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a global framework held in Paris on 3-8 March 2005:

1. Recognising that the recent Indian Ocean tsunami of 26 December 2004, considered to be one of the strongest in the world, resulted in devastations amounting to national calamities in the Indian Ocean. This has been the deadliest tsunami of all time by an order of magnitude, and has led to a call for action for the entire global community;

2. Recalling the direction and guidance provided by the Special ASEAN Leaders’ meeting in Jakarta on 6 January 2005, the UN Conference on Small Island Developing States held at Port Louis on 14 January 2005, the UNGA Resolution 59/279 in New York on 19 January 2005, the Common Statement of the Special Session on Indian Ocean Disaster and the Hyogo Framework for Action 2005-2015 both adopted at the World Conference on Disaster Reduction in Kobe on 22 January 2005, the Ministerial Declaration in Phuket on 29 January 2005, the GEO

Communiqué in Brussels on 16 February 2005, and the technical meetings held in Indian and China;

3. Recognising the need to develop a tsunami warning and mitigation system in the Indian Ocean with the purpose of enhancing all aspects of tsunami disaster mitigation, including hazard assessment, detection and warnings, preparedness, and research through international cooperation and coordination of activities;

4. Noting that, despite the infrequent occurrence of tsunamis in the Indian Ocean, tsunamis could occur at anytime and can be very devastating as was the case on 26 December 2004. Therefore, to be effective, a tsunami warning and mitigation system for the Indian Ocean must be durable;

5. Noting it is important to improve the science of issuing tsunami warnings to reduce false alarms given the inordinate inconvenience and disruptions to normal life caused by false alarms, especially given the high population densities and intensive operations in coastal areas in the Indian Ocean, and also to continuously improve forecasting;

6. Recognising that the impact of tsunamis can be substantially reduced through institutional and legislative frameworks as well as community participation, and that this requires that tsunami warnings must reach local communities by various means and be understood at all levels, so that people are well informed and motivated towards safety measures and actions;

7. Recognising that national tsunami disaster mitigation programmes will benefit from partnerships between governmental institutions, the private sector and civil society organizations;

8. Recommend that the IOC Assembly establish, in accordance with its rules of procedures, an Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), which will govern the system. Such a group will be composed of interested IOC Member States from the Indian Ocean region. All the other Members of the IOC, as well as relevant concerned international and regional organizations, will be welcome to participate as observers;

9. Recommend that the IOC Secretariat act as the secretariat to the Intergovernmental Coordination Group for the IOTWS;

10. Agree that the IOTWS should consist of a coordinated network of national systems and capacities, and that all associated assets should be owned and operated by the Member States hosting or otherwise taking responsibilities for them;

11. Agree that the Member States should have the responsibility to have control over the issuance of warning within their respective territories;

12. Agree that the Member States build public awareness through education and capacity building to ensure effective community awareness of the risks posed by tsunami, so that their population is prepared for, and knows how to act in the event of a tsunami warning;

13. Recommend that, to facilitate durability, the IOTWS should utilise or build on, where possible, existing organisations and institutions and complement existing warning frameworks, including within a multi-hazard approach where appropriate;

14. Recommend that each Member State in the Indian Ocean quickly identify and establish a National Tsunami Warning Centre or operational contact point in the relevant responsible agency, along with a response plan, to be able to receive and react to warnings on a 24x7 basis and further rapidly disseminate warning information;

15. Recommend that each Member State in the Indian Ocean identify a disaster management national focal point for increasing public awareness of tsunami, within a multi-hazard approach as appropriate;

16. Recommend that all Member States make every endeavour to share seismic, sea-level and other data relevant to tsunamigenic events at or near real-time with interested Member States;

17. Recommend that all Member States make every endeavour to share national assessments and warnings of tsunamigenic events and tsunamis with interested Member States in a timely manner;

18. Welcome the various intentions and plans of Member States in the Indian Ocean to establish effective and durable national systems for tsunami early warning;

19. Welcome the intentions and plans of Australia, India, Indonesia, Malaysia and Thailand to establish systems and capacities to detect potential tsunamigenic events, detect and measure tsunami, and issue appropriate warning to forecast their impacts and to provide such information and warnings to other interested Member States;

20. Welcome that other centres may be established to act as dissemination points for the relay of information and for technical support and training, such as the one proposed by France for the South West Indian Ocean;

21. Recommend that efforts to establish an IOTWS be appropriately consistent with efforts to implement the International Strategy for Disaster Reduction (ISDR) and the Hyogo Framework for Action;

22. Welcome the many generous offers of financial, technical and other kinds of assistance made by key countries across the globe to help establish an IOTWS;

23. Encourage all Member States to provide financial, technical and other kinds of assistance in order to promote national capacity and cooperation as well as preparedness, mitigation and prevention, if so requested by the Member States in the Indian Ocean;

24. Welcome that, in addition to the steps taken, or to be taken, by countries of the Indian Ocean, the UNESCO/IOC and ISDR for interim tsunami warning, the Pacific Tsunami Warning Center and the Japan Meteorological Agency have agreed to provide, if requested, reliable interim tsunami advisory information to authorized contacts in the Indian Ocean states. Member States are requested to provide to UNESCO/IOC their official 24x7 contact information (prime and alternate) for receiving this information by 1 April 2005;

25. Welcome also the attention and intention to address tsunami disaster mitigation in other oceans and seas, such as South-East Asia and the South China Sea, within the global framework;

26. Note the need to develop mechanisms for effective coordination of tsunami warning systems for all at-risk regions on a global basis;

27. Appreciate the financial contribution made by Japan through the UN Flash Appeal to help make the first meeting possible;

28. Agree to consider, *inter alia*, at the Second International Coordination Meeting for the Development of an IOTWS the following issues: (a) keep under constant scrutiny the status of the system and how it satisfies the needs(b) the coordination of donor activities and other tsunami related activities;

29. Recommend that the IOC Secretariat enter into consultation with Member States with the view to addressing the feasibility of constituting ad hoc technical working groups on: (a) measurement systems, including data management, standards and interoperability; (b) risk management, including assessment and modelling; and (c) warning systems, including dissemination and communications. The IOC Secretariat will report to the April meeting on the progress of this recommendation.

30. Welcome and accept the generous offer of the Republic of Mauritius to host the second International Coordination Meeting for the Development of an Indian Ocean Tsunami Warning and Mitigation System at high level to be held at Port Louis on 14-16 April 2005"

7.4.2. Draft Terms of Reference of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS)

Regarding the recommended establishment of an "Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), which will govern the system" (see 7.4.1, para 8 above), the Meeting decided to formulate draft Terms of Reference for the ICG/IOTWS. These will be included as an annex to a Resolution on the establishment of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), that will be prepared for, and submitted to the Twenty Third Session of the IOC Assembly (21-30 June 2005).

The Meeting agreed on the following draft Terms of Reference for the Intergovernmental Coordination Group for the Tsunami Warning and Mitigation System for the Indian Ocean (ICG/IOTWS):

"Will be established as a subsidiary body of the IOC and will report to, and seek guidance from, the IOC Assembly. A resolution will be prepared for adoption by 23 rd Session of the IOC Assembly (June 2005).

Objectives

1. To coordinate the activities of the IOTWS;
2. To organize and facilitate as appropriate the exchange of seismic, sea level and other data at or near real-time and information required for the interoperability of the IOTWS;
3. To promote the sharing of experience and expertise related to tsunami warning and mitigation for the Indian Ocean basin;
4. To promote tsunami research;
5. To promote the establishment and further development of national tsunami warning and mitigation capacities in accordance with standard protocols and methods;
6. To develop, adopt and monitor implementation of work plans of the IOTWS, and to identify required resources;
7. To promote implementation of relevant capacity building;

8. To liaise and coordinate with other tsunami warning systems;
9. To liaise with other relevant organizations, programmes and projects;
10. To promote the implementation of the IOTWS within a multi-hazard framework;
11. To keep under constant scrutiny the status of the system and how it satisfies the needs.

The IOC Secretariat shall provide the secretariat for the ICG/IOTWS. It shall:

1. Support meetings of the ICG;
2. Facilitate the liaison among the various national contact points and national tsunami warning centres;
3. Maintain a current list of operational national contact points and facilities and make it available on request to all Member States;
4. Organize the liaison between ICG/IOTWS and the ICG/ITSU, with the PTWC and with other tsunami warning centres to facilitate best practices in tsunami warning;
5. Initiate and support training activities and enhance and enrich tsunami warning in the Indian Ocean.

Membership

- Member States of the IOC within and bordering the Indian Ocean
- Observers from other IOC Member States
- Invited observers from other organizations (including NGOs), programmes and projects in accordance with the IOC rules and procedures. "

8. THE INDIAN OCEAN SYSTEM WITHIN A GLOBAL FRAMEWORK

Presentations under Agenda Item 6.2 and 6.3 are available in PDF format from the web site page http://ioc.unesco.org/INDOTSUNAMI/paris_presentations.htm and are not reported on individually.

8.1. BRIEF INTRODUCTION OF THE SESSION

In his introductory words Dr Bernal referred to the requests expressed during this meeting, to include the Southeast Asia region in the IOTWS initiative, as well as to pay attention to the Southwest Pacific. He recalled that Portugal had been hit by a severe tsunami 250 years ago which clearly reminds us that a tsunami can occur in all regions.

8.2. THE ROLE OF GOOS IN A GLOBAL EARLY WARNING SYSTEM

*(Speaker: **Mr. Keith Alverson**, Head of Section, Operational Observing System Section, IOC)*

In his presentation Mr. Keith Alverson emphasized that a two pronged approach to development of an Indian Ocean Tsunami Warning System is required. The system must be both (1) installed rapidly in the Indian Ocean and (2) provide global coverage and be sustained over the long term. Protecting local populations in the Indian Ocean region against the possibility of another tsunami in the near future clearly mandates that an operational system for that region be put in place with alacrity. However, putting in place a system without accounting for the equally plausible scenario that no large tsunami occurs in the Indian Ocean for centuries, or that the next large tsunami occurs in some other unprotected area, would be an enormous mistake. Just as people living in coastal regions of the Indian Ocean today must be protected against the eventuality of a similar event occurring in the near future, future generations must be protected against the eventuality that the next event may occur centuries from now. We must avoid developing a rapidly installed system that is no longer working when it is called upon for use. In order to put in place a system with global reach that can be sustained over the long term requires that it serve multiple, more regularly occurring but equally devastating hazards such as storm surges. In addition, the most cost effective and efficient way to provide data for ocean hazard warnings is to integrate the system within broader efforts to observe the ocean. It is by entraining the resources and interest of a much wider community of interested, regular users of ocean data, that we can best ensure the long term sustainability of the technical backbone of a tsunami warning system.

8.3. POSSIBLE CONTRIBUTIONS OF THE GLOBAL FEDERATION OF SEISMIC NETWORKS, THE PRIMARY LAND-BASED SEGMENT OF THE FUTURE GLOBAL MONITORING SYSTEM

*(Speaker: **Dr. Domenico Giardini**, Global Federation of Seismic Networks (GSN))*

In his presentation, Dr Giardini explained that many efforts are currently underway in different countries to address the issue of tsunami warning in the aftermath of the magnitude 9 Sumatra earthquake and the devastating tsunami that followed. As this event illustrated, the consequences of earthquakes do not stop at national boundaries. This is a unique opportunity to rise above the traditional fragmentation due to national or state boundaries and achieve seamless, standardized, coordinated and sustained data access. National and international agencies need to invest in coordinated centralization, to build an integrated tool for earthquake and tsunami surveillance and scientific research.

There are two complementary components to the development of an effective global warning system for large, earthquake-generated tsunamis, that will help avoiding a repeat of the recent tragedy: 1) enhancement of the global monitoring and quantification of earthquakes in real time, and, 2) coordination of information distribution from the earthquake and tsunami data processing centres to the local governments, and from the local governments to the local populations. We address here only the first component, noting that the second one is equally crucial when the saving of lives is at stake.

Accurate and rapid seismological information is a key component of an effective global tsunami warning system, which cannot be provided without strong coordination among international infrastructure efforts. At the national scale, efforts should be directed toward improving the distribution of state-of-the-art strong motion and broadband sensors, both on land and on the sea-floor, and the collection of data in real time, sustained over decadal time frames. At the international scale, the national efforts must commit to the free exchange of well characterized waveform data in real time, according to standardized protocols, and to contributing these data to globally coordinated state-of-the-art processing and analysis systems. The information should be progressively updated, merged with other data as the tsunami progresses, and distributed back to national and local governments and populations. The seismological efforts established nationally or through bi-lateral or multilateral agreements should build upon the already existing framework and standards established by the global Federation of Digital Seismographic Networks and should include a component of coordination with other national and international efforts underway to improve global tsunami warning capabilities.

8.4. DEVELOPMENT OF A TSUNAMI WARNING AND MITIGATION SYSTEM FOR THE CARIBBEAN (AND CENTRAL WEST ATLANTIC) REGION

*(Speaker: **Dr. George Maul**, Professor and Department Head, Marine and Environmental Systems, Florida Institute of Technology)*

Dr Maul explained that, according to Bryant (1991), approximately 25% of Earth’s tsunami events occur in the North Atlantic basin, which includes the Caribbean and

Mediterranean Seas. The tsunami risk to the Caribbean and Central West Atlantic Region is fourfold: locally generated by earthquakes, subaerial or submarine landslides, subaerial or submarine volcanoes, and teletsunami from sources such as that which generated the 1755 Lisbon event (Mader, 2004). Fatalities in the region during the last century and a half include at least 400 in 1853 in Venezuela, 23 in the USVI in 1867, 75 in Panama in 1882, 500 in Jamaica in 1907, 91 in Puerto Rico in 1918, 28 in eastern Canada in 1929, 1790 in the Dominican Republic in 1946, 75 in Puerto Rico in a separate event in 1946, and 2 in Costa Rica in 1991. The conservative total (O'Loughlin and Lander, 2003) is more than 2,500 persons in about 150 years.

In 2003, after 10 years of development (Maul, 2003), the IOC Executive Council approved a tsunami warning system for the Intra-Americas Sea (Caribbean Sea, Gulf of Mexico, Guyana, Bahamas, and the Straits of Florida region). The four elements of the project proposal are: Education, Warning, Management, and Research (http://www.fit.edu/~gmaul). Education is the first order of importance, and is illustrated by the materials published in the popular press (*e.g.* Watlington and Lincoln, 2001) as well as by the IOCARIBE Secretariat and Florida Institute of Technology. Warnings involve three interconnected subsystems: seismic, sea-level, and communications. Numerous management issues need to be fully explored, but perhaps the most stressing is the issue of coastal population growth (Duedall and Maul, 2005). Research issues include development of the next generation of DART (Deep-ocean Assessment and Reporting of Tsunami) buoys, reducing false warnings by neural networks, and mapping of potential sources of tsunamis.

The current state of affairs with the Intra-Americas Sea Tsunami Warning System (IAS TWS) is that no funding has been yet committed. An update of the requirements in the IOC-approved project proposal of 2003 is that approximately $3,515,000 is needed to modernize the seismic and sea-level subsystems, and a continuing expense of $2,200,000 per year. In this sense, the IAS TWS proposal needs to change from being a "project" to being a "program". In order to maintain readiness, the IAS TWS must be integrated into IOCARIBE-GOOS, the regional component of the Global Ocean Observing System. Accordingly, the investments in tsunami warning must have other applications of public benefit, such as monitoring for climate change, for hurricane storm surge, for rogue waves and similar maritime hazards, and for safety of life at sea (tides, currents, waves, and winds).

In Puerto Rico, personnel from the Puerto Rico Seismic Network, the University of Puerto Rico, the Puerto Rico Emergency Management Agency, and the National Weather Service, are putting together the elements of a local warning system. With little funding and much inventiveness, the protocols between the seismic, sea-level, and communications subsystems have been developed, and signage is being placed in sites where tsunami waves have caused death and destruction in the past. Funding for a 24-hour-a-day system has, up top this point, eluded the project.

In summary, there have been more than 2,500 tsunami deaths in the Caribbean and Central West Atlantic Region since 1853, and the Atlantic coastal population is expected to grow by another 40,000,000 persons by the year 2025. Most of this population growth will be in the Caribbean and Central America. The IOC-approved Intra-America Sea Tsunami Warning System budget needs to increase about 40% over that required in 2003, largely due to placing DART buoys at strategic sites, repairing existing infrastructure, upgrading sea-level and seismic subsystems, developing warning protocols, and most importantly – educating the public.

During the plenary discussions it was emphasized that many countries in the Caribbean region are developing countries that will need substantial capacity building efforts to enable their full benefit from a tsunami warning and mitigation system.

It was also noted that there exists a geographic gap between the planned system for the Indian Ocean and that for the Caribbean as the Atlantic and Southern Ocean regions are not receiving any attention

8.5. DEVELOPMENT OF A TSUNAMI WARNING AND MITIGATION SYSTEM FOR THE MEDITERRANEAN (AND NORTH EAST ATLANTIC) REGION

*(Speakers**: Dr. Rémy Bossu**, European Mediterranean Seismological Centre (EMSC) Secretary General; and **Prof. Frédéric Briand,** Director-General of the International Science Commission for the Mediterranean (CIESM)*

In his presentation Dr. Bossu explained that, up to the disaster in the Indian Ocean last December, tsunami risk has not been identified as a priority in Europe. This is illustrated by the limited European – Commission (EC) projects devoted to this topic in the recent years. This short text aims at presenting the conclusions of two meetings recently held on possible tsunami alert systems in Europe, the Nice meeting named “*Colloque International pour un Réseau d’Alerte Tsunami en Méditerranée Occidentale*” and the expert meeting organised by the EC in Brussels.

There are different sources of tsunami hazard in the Mediterranean, earthquakes, submarine landslides, volcano’s slope instability and combined sources. Tsunami hazard related to earthquakes is much smaller in the Mediterranean than in the Pacific. It is significantly higher in Eastern Mediterranean than in Western Mediterranean. Earthquake can be very close to coasts (e.g., North Africa, Messina Strait, Crete…), and then these segments can be affected by tsunami very rapidly (less than 10 minutes) after the earthquake. Submarine landslides can also generate tsunamis and they are a significant component of the tsunami hazard in Europe. They generally have local effects, but again their associated warning time is small. One of the key challenges related to submarine landslides is that that today there is no operational techniques to detect and characterise them, especially as they can occur along many of the margins. This is the main difference with volcano’s slope instability for which the potential sources are well identified and can be instrumented.

Although seismic data will play a key role in any tsunami warning system for the Mediterranean, the other potential sources make the integration of other type of data very likely. In order to cope with the short warning times, a system will have to heavily rely on automatic data processing. The closeness of some potential sources to the coasts advocates for the implementation of automatic local systems, in addition to national and/or transnational systems. The EMSC, which is in charge of the operational alert system for potentially damaging earthquakes, has been proposed to operate a transnational tsunami warning system. This system could benefit from the Virtual Earthquake Broadband Seismic Network (ORFEUS).

Today, the tsunami risk in Europe is clearly identified. Nevertheless, if scientists have presented what could be a tsunami warning system in the Mediterranean, no funding has been identified yet.

In his presentation, Dr Frédéric Briand, Director General of CIESM, first emphasized that the Mediterranean Sea was historically prone to tsunamis due to its position in a seismically active region. Historical records provided evidence of a frequency of at least 30 significant tsunami events per century, most of them located in the Ionian/ Aegean Sea area, with a second focus around the Italian peninsula and Sicily. The main sources were volcanic explosions and collapses (Aegean Sea, Tyrrhenian Sea), sea-floor rupture induced by large earthquakes (Ionian Sea, Aegean Sea, Sea of Marmara, Alboran Sea) and submarine landslides (particularly along western Mediteranean shores). These unstabilities are recorded, in one way or another, on the sea-bottom, hence the interest of integrating concrete inputs from marine scientists in a composite warning system.

Dr Briand highlighted that, given the limited reaction time available for civil protection, a Tsunami Alert System in the Mediterranean Sea -- incorporating land- and sea bottom seismographs -- would be significantly strengthened by contributions which several scientific units of CIESM were prepared to make, specifically:

- by adapting and geographically extending the MedGLOSS network of digital tide gauges stations (operated jointly between CIESM and IOC): with 42 stations in operation, 15 of which operating in quasi real time mode, the others requiring a relatively modest financial input for upgrading the data communication, this system should be densified in north African countries, and rely on faster links with stations operated by national agencies in France, Greece, Italy and Turkey;
- by using CIESM/Ifremer high-resolution multi-beam and acoustic maps of the sea bottom to locate the likely submarine sources of Mediterranean tsunamis : areas of seafloor rupture, submarine slopes covered by massive unconsolidated sediment;
- by developing hydrodynamic models of tsunami wave propagation towards specific target areas;
- by drawing vulnerability maps of most threatened coastal areas, as a function of tsunami directivity and coastal orientation.

During the plenary discussions it was stressed that, especially in the Mediterranean, the tsunami hazard is mostly local as the sources of earthquakes are close to the coasts. A Mediterranean tsunami early warning system will therefore need to be able to react in a very short time (i.e. 2-3 minutes).

Prof. Mohammed S. Sheya, Vice-Chairperson of the Executive Board of UNESCO called on the meeting to extend the present initiative to include the East Atlantic Ocean (West, Central and Southern Africa zones). He invited the international community to initiate an African led effort towards the development of Early Warning Systems taking advantage of existing successful programmes, notably the ODINAFRICA, GOOS Africa, the LMEs, and GCOS that provide basic environmental data and information needed. He stated that further Tsunami follow-up actions should fully integrate the oceans on the African coasts in the process of developing Early Warning Systems in partnership with the United Nations Agencies and the African Union. He urged the Executive Secretary IOC to take the necessary measures to include IOC African regional seas in the future Agenda of meetings of this kind and plan of implementation of the Global Early Warning System.

8.6. DEVELOPMENT OF A TSUNAMI WARNING AND MITIGATION SYSTEM FOR THE SOUTHWEST PACIFIC REGION

*(Speaker**: Dr. Laura Kong**, Director ITIC, Honolulu, Hawaii, USA)*

The ITIC Director reported on the ongoing ICG/ITSU activities in support of a southwest Pacific Regional Tsunami Warning System. The recognition by Member States was first noted through discussion at ITSU X (1985), ITSU XI (1987), and ITSU XIII (1991), and recognized as a gap in coverage in the TWSP Master Plan (1999). During ITSU XVI (1997), the need was again discussed and clearly acknowledged because of the region's high seismic hazard and destructive regional and local tsunami history, especially in the 1990's when fives tsunamis caused more than 3500 fatalities in Indonesia and Papua New Guinea, and small, locally destructive tsunamis were also registered in Vanuatu and the Solomon Islands. At ITSU XIX, an intersessional working group was formed to take further action. Representatives from Indonesia, Australia, Fiji, New Zealand, Japan, Papua New Guinea, ITIC, and PTWC comprise the working group. Its Terms of Reference included focused on tsunami warning services, particularly the evaluation of the capabilities of countries to provide services, and the ascertaining of the requirements within each country to provide such services.

To obtain the information, the ITIC and the South Pacific Applied Geoscience Commission (SOPAC) Community Risk Programme organized and convened the South Pacific Tsunami Awareness Workshop (SPTAW), July 1-3, 2004 at the Forum Secretariat in Suva, Fiji Islands. Funding was provided by SOPAC, UNESCO/IOC-ICG/ITSU, and the RANET Project. The SPTAW brought together National Disaster Managers and Technical Experts from agencies responsible for earthquake and tsunami monitoring and emergency response from American Samoa, Cook Islands, Fiji Islands, Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu. The first two days were used to conduct the ITP-International training programme in tsunami risk reduction. Topics included warning guidance, hazard and risk assessment, and education, preparedness and land-use mitigation, and were presented by an international team of experts. To facilitate a better assessment on the level of awareness and understanding of the tsunami hazard, a User Questionnaire was distributed prior to the workshop. Country responses identified as foremost of the many issues at stake, the inadequacies of their national response systems, communication systems and education and awareness programmes to the tsunami hazard. The SPTAW produced a Work Programme which was endorsed as high priority at the SOPAC STAR meeting and Governing Council in September 2004. Three key priorities were the establishment of a Tsunami Working Group-South Pacific (TWG-SP), the establishment of a Regional Tsunami Warning Service starting first with the conduct a Feasibility Study within the next two years, and the development of Effective and Timely Tsunami Response through emergency preparedness, national response plans, and capacity building. Improvement of the regional tsunami event database was also identified as a key to better understanding the tsunami hazard. Presently, the ITDB Project led by Dr. V. Gusiakov has obtained limited funding to continue to improve the database in the southwest Pacific, and Australia and New Zealand are working together to develop the feasibility study pilot project. The TWS-SP is chaired by Papua New Guinea and plans to meet in late April 2005 in Fiji to evaluate progress and coordinate activities in the next year.

During the discussions it was pointed out that the Southwest pacific region is currently not covered by any system. The meeting was informed that Australia is giving attention to this matter and will work closely with France and New Zealand to establish a warning system for this area.

8.7. THE ITSU SYSTEM IN THE PACIFIC REGION (DISCUSSIONS ON UPGRADING REQUIREMENTS)

*(Speaker: **Dr. Eddie Bernard**, Director, Pacific Marine Environmental Laboratory (PMEL), Seattle, USA)*

In his presentation Dr Bernard stated that President Bush is acting to improve tsunami protection for the United States and the world. He is doing this by: (i) adding deep-sea buoys and other sensors to enhance tsunami detection along the U.S. coast (Pacific, Atlantic, Caribbean, and the Gulf of Mexico); (ii) working internationally to build a global warning system, including in the Indian Ocean (iii) improving seismic sensor data and infrastructure for better earthquake detection and warning, including in the Caribbean; (iv) expanding research on tsunami forecasting; and (v) improving response capacity with enhanced emergency warning systems, community response plans, and public education. In terms of improving U.S. protection from tsunamis, the Administration will commit $37.5 million over the next two years to expand U.S. tsunami detection and monitoring capabilities. The National Oceanic and Atmospheric Administration (NOAA) will deploy 32 new advanced-technology Deep-ocean Assessment and Reporting of Tsunami (DART) buoys for a fully operational enhanced tsunami warning system by mid-2007. The United States Geological Survey (USGS) will enhance its seismic monitoring and information delivery from the Global Seismic Network, a partnership with the National Science Foundation. These measures will provide the United States with nearly 100% detection capability for a U.S. coastal tsunami, allowing response within minutes. Expanded monitoring capabilities throughout the entire

Pacific, Atlantic, and Caribbean basins will provide tsunami warning for regions bordering half of the world's oceans.

In terms of providing improved protection around the world, the United States will work to build a global tsunami warning system, with coverage that includes the Indian Ocean, through international bodies, including the Global Earth Observation System of Systems (GEOSS), the international effort to develop a comprehensive, sustained, and integrated Earth observation system:

- GEOSS includes 54 participating nations, including India, Indonesia and Thailand.
- The GEOSS plan focuses around nine societal benefit areas, including "Reduce loss of life and property from disasters" and "Protect and monitor our ocean resources."
- The G-8 called for establishing a global observation system in June 2003 and President Bush's Administration launched the GEOSS process by hosting first Earth Observation Summit in 2003.
- For more information on GEOSS, visit http://earthobservation.org

8.8. DRAFT DESIGN OF A GLOBAL TSUNAMI WARNING SYSTEM

*(Speaker: **Dr. François. Schindelé**, Chair ICG/ITSU)*

In his presentation Dr François Schindelé stated that, considering the scientific facts that every Ocean and sea basin can be impacted by a tsunami and that the next tsunamis can occur anywhere and at anytime, there is a need to design a Global Tsunami warning and Mitigation System.

The International Co-ordination Group for the Tsunami Warning System in the Pacific is responsible of coordination of the tsunami warning and mitigation programs in that basin. The Intergovernmental Co-ordination Group for the Indian Ocean Tsunami Warning System will be responsible for the Indian Ocean basin.

The Operational Warning System must be organized at the scale of and Ocean basin or a sea basin. It should be based on National Tsunami Warning Centers connected together. Regional Tsunami Warning Centers such as the Pacific Tsunami warning Center can also be implemented. The responsibility of that Regional Center is to warn the National centers and the Member States when a trans- Pacific tsunami is generated.

Operational Warning Systems must also be implemented in the other basins: Atlantic Ocean, Mediterranean and Marmara Sea, the Intra-Americas Sea, the South east-Asian seas, and the South West Pacific.

Hazard assessment and preparedness are managed by the International Tsunami Information Center (ITIC). All information about tsunamis are available in that centre: Library, Newsletters, brochures, global tsunami data base, etc. Several Regional Information Centers must be implemented, participating in the activities of each Group. Training courses are core activities. The domains can be very different, fro; hazard and risk assessment, warning guidance, warning center operational procedure, numerical modeling, preparedness and educational. These activities can be separated between the different Regional Information Centers

9. CLOSURE OF THE MEETING

Dr Patricio Bernal was presented with a Special Issue of "Natural Hazards" on "Developing Tsunami-Resilient Communities: The National Tsunami Hazard Mitigation Programme", edited by E.N. Bernard (by Ms. Petra Van Steenberg, Springer).

The Meeting was closed on Tuesday 9 March at 20h15. Dr Bernal thanked the speakers and other participants for their valuable contributions to the Meeting. He further informed the participants that the final report of the meeting will be prepared by the Secretariat and be circulated through the Indotsunami web site (*http://ioc.unesco.org/indotsunami*) during the week of 21-25 March 2005.

ANNEX I

AGENDA

1. OPENING

1.1 Opening Address by Mr Koichiro Matsuura, Director-General of UNESCO
1.2 Message from ISDR (Mr. Salvano Briceño, Director of the Inter-Agency Secretariat of the ISDR)

2. ADMINISTRATIVE ARRANGEMENTS

2.1 Introduction of the Meeting (Mr. Patricio Bernal, Executive Secretary IOC)
2.2 Documentation and Practical arrangements

3. TECHNICAL ASPECTS OF TSUNAMIS AND TSUNAMI WARNING SYSTEMS

3.1 Brief introduction of the Session
3.2 Scientific introduction on tsunamis
3.3 Detecting and monitoring tsunamis
3.4 Predicting the damage: tsunami risk assessment

4. ORGANIZATIONAL AND PRACTICAL ARRANGEMENTS FOR A REGIONAL TSUNAMI WARNING AND MITIGATION SYSTEM

4.1 Brief introduction of the Session
4.2 Establishment and operation of a national tsunami warning centre
4.3 Establishment and operation of a regional tsunami warning centre
4.4 Day-to-day coordination, information dissemination and training: the role of the International Tsunami Information Centre (ITIC)

5. TSUNAMI AWARENESS AND PREPAREDNESS

5.1 Brief introduction of the session
5.2 National preparedness plans – existing capacities, additional needs
5.3 Community based early warning systems – the challenge of sustainability
5.4 Awareness building and public information
5.5 Institutional capacities for moving forward

6. REVIEW OF EXISTING CONTRIBUTIONS TOWARDS THE DEVELOPMENT OF THE TSUNAMI WARNING AND MITIGATION SYSTEM FOR THE INDIAN OCEAN REGION

6.1 Brief introduction of the Session
6.2 Presentations of contributions

7. DEVELOPMENT OF THE DESIGN PLAN, WORK PLAN AND TIMETABLE

7.1 Establishment of drafting groups
7.2 Meeting of drafting groups
7.3 Report by the drafting groups
7.4 Conclusions and outcomes

8. THE INDIAN OCEAN SYSTEM WITHIN A GLOBAL FRAMEWORK

8.1 Brief introduction of the Session
8.2 The role of GOOS in a global early warning system
8.3 Possible contributions of the Global Federation of Seismic Networks, the primary land-based segment of the future global monitoring system
8.4 Development of a Tsunami Warning and Mitigation System for the Caribbean (and Central West Atlantic) Region
8.5 Development of a Tsunami Warning and Mitigation System for the Mediterranean (and North East Atlantic) Region
8.6 Development of a Tsunami Warning and Mitigation System for the Southwest Pacific Region
8.7 The ITSU system in the Pacific Region (Discussions on upgrading requirements)
8.8 Draft Design of a Global Tsunami Warning System

9. CLOSURE OF THE MEETING

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ANNEX III

SPEECHES

Address by Mr Koïchiro Matsuura
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on the occasion of the opening of the International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework
UNESCO, 3 March 2005

Excellencies,

Distinguished Participants,

Ladies and Gentlemen,

It is a great pleasure to welcome you here for this international coordination meeting for the development of a tsunami warning and mitigation system for the Indian Ocean within a global framework. I am delighted to see you here for this important meeting.

The recent Indian Ocean tsunami has tragically demonstrated that there is an urgent need for improved ocean observing systems and for enhancing the capacity of all nations to make optimum use of the information these systems generate.

The international community was shocked by the magnitude of the disaster and has shown an unprecedented and generous level of response to the tragedy.

Allow me now to provide some background and orientation so that we can have a shared understanding of the present situation and the most desirable way forward. The United Nations has been engaged for fifteen years in a process of creating awareness and promoting the development of policies to diminish the loss of life and property from natural and man-made disasters - first through the International Decade for Natural Disaster Reduction and then through the International Strategy for Disaster Reduction that followed and the establishment of the UN Disaster Task Force, in which UNESCO and IOC participate. This process of awareness-raising and policy development culminated in the World Conference on Disaster Reduction held in Kobe, Japan, in January 2005.

The Kobe Conference adopted the “Hyogo Framework for Action 2005-2015”, a document that commits governments and the international community to achieving a set of concrete goals, among them the commitment to halve the loss of life caused by disasters, to make all schools and hospitals disaster-proof, and to establish national natural disaster platforms in each country.

The Hyogo Declaration states that “ […] we are far from powerless to prepare for and mitigate the impact of disasters. We can and must alleviate the suffering from hazards by reducing the vulnerability of societies. We can and must further build the resilience of nations and communities to disasters through people-centered early warning systems, risks assessments, education and other proactive, integrated, multi-hazard, and multi-sectoral approaches and activities in the context of the disaster reduction cycle, which consists of prevention, preparedness, and emergency response, as well as recovery and rehabilitation.”

However, in the face of the Indian Ocean tsunami disaster and because today we have the knowledge and technology to avert such a human catastrophe, one cannot avoid feeling part of a major collective failure - failure to effectively communicate between science and government; failure to communicate with and prepare society; failure to build or renovate the necessary institutions; and failure to bring all these assets into play for the benefit of humankind.

The UN agencies have responded to this particular urgent need by agreeing to undertake the immediate creation of an Early Warning System for the Indian Ocean, building upon the experience of the International Coordination Group for the Tsunami Warning System in the Pacific – ITSU - of UNESCO/IOC. The robust, comprehensive mitigation approach used by ITSU is based on three mutually dependent components: first, the assessment of tsunami hazards; second, the detection/warning system; and third, the adoption of preparedness measures.

We are here in this technical meeting to start work on this task - to agree on the basic design of the observation networks; to identify those that need upgrading and to add new components; and to secure the communication links for the existing and new instruments. But we also need to look at the assessment of the tsunami hazard in the region, an aspect that is connected to the design of the networks but that also supports key activities in regard to preparedness.

The assessment of the tsunami hazard also requires important levels of research, and we need also to coordinate those efforts to get the best results and to avoid wasteful duplication of effort and investment. The bottom of the ocean needs to be re-surveyed. We need accurate bathymetric and topographic charts of the coastlines in order to successfully run the numerical models that forecast flooding in the case of a tsunami, thereby enabling the design of evacuation plans and the identification of safe locations.

Finally, the meeting needs to address the organizational aspects and the governance mechanism(s) that will enable the joint operation of the detection/warning system, based by necessity on international cooperation with the national system of emergency preparedness that is part of the governmental and societal structures of each country.

Ladies and Gentlemen,

Allow me now to make some points and clarifications that might help your deliberations on this subject, drawing upon our experience of designing and operating the Pacific Ocean system.

The tsunami warning system is composed essentially of an internationally run detection/alert system and the nationally run warning systems. IOC provides a governance structure to link the international component and the national components. Tsunamis, especially distant tsunamis, propagate through the high seas traveling at up to 800 km/h, where they can be detected thanks to the networks of instruments. These networks, operated by national agencies from the Member States of IOC, are coordinated by IOC under the principles of international cooperation and the open, free and unrestricted exchange of data and information. Accordingly, data and information are available to the operational centers where they are processed and information is distributed to participating countries according to pre-established protocols.

The high seas are an “international space” lacking a clear authority with jurisdictional responsibilities. However, tsunamis affect countries where the national authorities have responsibilities to warn and protect populations and property under their jurisdiction. It is incumbent only upon national authorities to issue warnings in the territory under their jurisdiction. These relationships define clear responsibilities.

Accordingly, one key element of the tsunami warning system is the designation by governments of a National Agency, with operational capabilities (24 hours a day, 7 days a week), to act as the National Tsunami Warning Centre. Its functions are to liaise with the international warning/detection system on the one side, and with the national competent authorities dealing with civil defense and emergency relief, on the other.

The system also requires a governance mechanism that enables and facilitates the articulation between the international detection/warning system and the national warning system, handled by national governments. In the case of the Pacific Ocean, this governance mechanism was established through the adoption of an IOC Resolution by the IOC Assembly (129 member states) specifying the duties and obligations of the participant members. As with other services run internationally, for example in meteorology, it would be wise that the governance text adopted establishes that those national officers who are responsible at the national operational agency/center should be the same as those who represent their nations at the international level. In the case of the Pacific Ocean, the International Coordination Group of ITSU meets every year and reports on its activities to the IOC governing bodies.

The existence of sub-regional centers in the Pacific Ocean is based on a strong technical requirement of the detection system. The detection system, based on the best science and technology of today, enables the detection of “distant tsunamis” and therefore the issue of a secure warning to distant places. However, a distant tsunami also generates a “local tsunami” for which there is no proven tool to confirm the presence of a tsunami in a short time-lapse between its generation and the moment it touches the adjacent coast. For local tsunamis, the time to issue a warning is very short indeed and the protection of the population depends almost exclusively on preparedness. This also provides a fundamental reason why local authorities (authorities from the land closest to the tsunami generating point) must take full responsibility in issuing a warning to their populations (or ordering evacuations or other actions).

In the Pacific, there are five sub-regional centers with the responsibility to issue this warning in the sub-regions under their jurisdiction. The establishment of a sub-regional center requires approval by all the countries participating in the system and, in particular, the elevation of a National Tsunami Center to the status of a sub-regional center must have the consent of the countries over which the Center will have jurisdiction to issue the warnings. It should be noted that, as far as the entire Pacific basin is concerned, it is only the Hawaii center that can truly be called “regional”. It never issues warnings to individual countries but passes on warnings to the sub-regional centers, which alone have the authority to transmit the information to the countries within their jurisdictions.

In this context, and given the number of initiatives that have been put forward by different nations, the design of the Indian Ocean system could benefit from a more “network-centric” approach and will certainly require the establishment of more than one sub-regional center in the system and the designation of one as the regional center.

Ladies and Gentlemen,

UNESCO’s IOC has proposed a strategy to make this regional effort the first step in building a Global Tsunami Warning System. Tsunami risk exists in all ocean basins to different degrees. This proposal is consistent with the long-term goal of IOC to establish a Global Ocean Observing System, that can underpin a variety of ocean services world-wide.

In the Master Plan of the Pacific Tsunami Warning System, presented to the tenth IOC Assembly and published in 1999 in four languages, one finds a sober assessment of the achievements and limitations of the system: "The present system of warning centers has gaps in its coverage. Southeast Asia, the southwest Pacific, and Central and South America have no regional tsunami warning centers. Yet these areas are extremely vulnerable … In addition, although PTWC provides warning for distant tsunamis crossing the Pacific Ocean, there are no corresponding centers to warn against tsunamis crossing most of the Pacific's marginal seas." In hindsight, concentrating on a single use warning system for the Pacific basin is a strategy that has shown limitations. Let us not repeat the same mistake today.

The sensible way to proceed is to develop a tsunami warning system fully embedded in the global, operational ocean observing system that is regularly used for other related hazards, such as storm surges and cyclones. Storm surges associated with tropical cyclones can hit coastal areas well ahead of the landfall of the actual storm, with nearly the same rapidity as tsunamis, but they occur much more frequently. For unprepared and unwarned populations, they can be equally deadly. In 1970 and again in 1990, for example, 6 to 7 meter high storm surges associated with large cyclones struck Bangladesh and resulted in about half a million deaths.

The GLOSS tide gauge network can provide vital information for model validation and data assimilation in high-resolution models employed for storm surge prediction. The same high-resolution coastal bottom topography data needed for tsunami run-up and inundation maps is also required for storm surge impact modeling.

Responding to an appeal from the World Summit on Sustainable Development in Johannesburg (2002), a group of nations have committed themselves to build, in ten years, a Global Earth Observation Systems of Systems (GEOSS). This metasystem is aimed at integrating space-based (i.e. satellites) and "in situ" observations covering the land, the ocean, the atmosphere and ecosystems. A major driving force behind GEOSS is the need to provide early warning of natural disasters such as tsunamis as well as earthquakes, floods and storm surges. The value added of GEOSS is that, through its comprehensive and integrated architecture, the limitations of single systems can be overcome and the benefits of multipurpose usage can be maximized. It therefore makes every sense to develop a global tsunami warning system as part of the GEOSS architecture. Far from promoting a huge, single, centralized system, the goal is to integrate the existing efforts in an architecture that allows for the many specialized environmental, meteorological and oceanographic services to be run by the corresponding responsible agencies on a 24 hours a day, 7days a week regime, but benefiting from a strong synergy and a continuous upgrading of their components. The Indian Ocean tsunami warning system will be an early example of a coordinated and sustained effort in the family of systems foreseen in GEOSS.

There is a strong indication that the participating countries in GEOSS wish to make a global disaster warning system one of its priority objectives. The synergies between existing and new systems will make possible a multi-hazard approach that should improve the cost-effectiveness and long-term sustainability of the overall system. A number of early warning systems are already operating in the United Nations for areas such as drought, pests, floods, landslides, health and weather.

In response to the Indian Ocean tsunami, GEOSS adopted a declaration supporting the coordination efforts that UNESCO and IOC are leading on behalf of the UN system. GEOSS now has a unique opportunity to prove the validity of the concepts underpinning its design.

I sincerely hope that you will be able to agree upon a common plan and timetable to implement the tsunami warning system of the Indian Ocean. The deployment of such a tsunami warning system by June 2006 is realistic under the condition of using the existing networks of instrumentation and communication links, working on their immediate upgrading and establishing the national warning centers as a first priority. Together with the World Meteorological Organization, we intend to contribute to this immediate goal.

The implementation of preparedness plans based on up-to-date tsunami hazard assessments will take more time and the incremental improvement of the system should be planned in close association with the development of a global system, which should be in place by June 2007.

Excellencies,

Ladies and Gentlemen,

We are honoured by the requests made to UNESCO and its Intergovernmental Oceanographic Commission to provide the needed leadership in coordinating the establishment of a tsunami early warning system in the Indian Ocean. I feel that your positive response to our invitation to come to this meeting provides us with a very good concrete first step in this direction.

Thank you.

Opening Statement by Sálvano Briceño, Director, Inter-agency secretariat of the International Strategy for Disaster Reduction (UN/ISDR)

Director-General, colleagues, distinguished participants,

It is only two months ago that coastal communities and tourists from around the world were hit by the tsunami in the Indian Ocean. In this short time frame, a great deal of solidarity from within the affected countries and internationally has been demonstrated by providing relief to the survivors and support to those mourning their lost ones.

The United Nations through the Office for the Coordination for Humanitarian Affairs (OCHA) has played an essential role in the coordination of the relief efforts and we now face the challenges of ensuring the transition into recovery and rehabilitation, with a sustainable risk reduction approach.

These two months have also allowed for substantive reflection on the lessons learnt from the disaster and in particular what measures are needed to avoid events like this occurring again.

Immediately following the disaster, the need for a tsunami early warning system for the Indian Ocean was identified. Such a system has now been requested by the affected countries at meetings in Jakarta, Delhi, Beijing, Phuket and in the UN General Assembly resolution A/RES/59/279 on Strengthening Emergency Relief, Rehabilitation, Reconstruction and Prevention in the Aftermath of the Indian Ocean Tsunami Disaster
.

The topic was also high on the agenda of the World Conference on Disaster Reduction in Kobe-Hyogo (WCDR, 18-22 January 2005) where a Common Statement was made by Governments.

Importantly, the recognition that an early warning system could have saved many lives if it had been in place prior to 26 December was amplified by strong calls for development of strategies for disaster risk reduction in the region as an essential element of broader efforts to increase resilience to future hazards.

Breaking new grounds, commitments were made and resources provided, as part of humanitarian efforts following a disaster to ensure that disaster risk reduction is recognized as an integral part of the longer-term recovery efforts and sustainable development.

A core component of this endeavor is the fact that regional tsunami early warning systems must be tailored to the specific circumstances and the individual requirements of the countries of the Indian Ocean. Those countries must be the ones to determine the shape and nature of the regional system building on and linking national capacities.

This, of course, also applies to the development of similar capacities in other regions at risk, such as the Caribbean, Mediterranean, Pacific, etc., which should also be at the core of our concerns during the coming days, weeks and months.

We also need to ensure that the relevant elements of an effective early warning system are integrated, cohesive, and can be utilized to cover not only tsunamis but also other hazards such as cyclones and floods.

The successful support of a regional early warning system as well as the national and local implementation of disaster risk reduction goes beyond the mandate of any one institution. The International Strategy for Disaster Reduction (ISDR) provides an appropriate framework to address the wider risk reduction perspective. The ISDR comprises relevant UN agencies, regional organizations and civil society partners.

Governments at Kobe and other recent meetings have requested that the ISDR framework and mechanisms be utilized to facilitate this process, with the first task being to support the efforts of the Intergovernmental Oceanographic Commission of UNESCO in coordinating the set-up of regional tsunami early warning systems.

We are also developing, with partners, a matrix of roles and functions to address the numerous tasks ahead of us. This distribution of tasks should be fully complementary to the functions identified to support the implementation of the Hyogo Framework for Action in the Indian Ocean and other regions.

We now have a common challenge, to ensure that we respond to the needs of the countries and build understanding, solidarity and commitment to improve early warning systems and to reduce disaster risk.

This gathering in Paris is an important step towards a consolidated plan for a tsunami warning system for the Indian Ocean as part of broader efforts of strengthening capacities for tsunamis in other regions and to increase resilience under the framework of the International Strategy for Disaster Reduction.

As you will be aware, the Secretary-General has appointed President Bill Clinton as his Special Representative, in order to sustain the political will of the international community to support medium- and long-term rehabilitation, reconstruction and risk reduction efforts following the 26 December tsunami. I can share with you that during initial consultations this week in New York, the Special Representative's office stressed the importance of this area of work and expressed his interest in supporting these activities as part of his mandate.

Let me finish by reiterating that the ISDR secretariat looks forward to continuing our joint efforts with all of you, and would like to thank UNESCO in particular for their warm hospitality today, as well as the strong spirit of partnership shown throughout this challenging endeavor.

I will unfortunately not be able to stay for the rest of the meeting, due to other commitments, but my colleague Reid Basher the head of the Platform for the Promotion of Early Warning (PPEW) and several other colleagues will be here during all the meeting.

Thank you for your attention and I wish for a very productive meeting.

ANNEX IV

REUNION INTERNATIONALE DE COORDINATION POUR LA MISE EN PLACE D'UN SYSTEME D'ALERTE AUX TSUNAMIS ET D'ATTENUATION DE LEURS EFFETS DANS L'OCEAN INDIEN A L'INTERIEUR D'UN CADRE MONDIAL

Siège de l'Unesco, Paris, 3–8 mars 2005

COMMUNIQUÉ

Nous, participants à la Réunion internationale de coordination pour la mise en place d'un système d'alerte aux tsunamis et d'atténuation de leurs effets dans l'océan Indien à l'intérieur d'un cadre mondial, tenue à l'UNESCO, Paris, du 3 au 8 mars 2005 :

Conscients du fait que le récent tsunami du 26 décembre 2004 dans l'océan Indien, l'un des plus violents du monde, a provoqué des dommages comparables à des calamités nationales dans l'océan Indien. Ce fut le plus meurtrier de tous les temps, d'une magnitude inégalée, qui a suscité une réaction de solidarité de l'ensemble de la communauté mondiale ;

Nous référant à l'orientation donnée et aux conseils prodigués par la réunion spéciale des responsables de l'ASEAN à Djakarta, le 6 janvier 2005, à la Conférence des Nations unies sur les petits États insulaires en développement réunie à Port-Louis le 14 janvier 2005, à la résolution 59/279 de l'Assemblée générale des Nations unies tenue à New York le 19 janvier 2005, à la *Déclaration commune de la session spéciale sur le cataclysme de l'océan Indien* et au *Cadre d'action de Hyogo pour 2005–2015*, adoptés tous deux le 22 janvier 2005 par la Conférence mondiale de Kôbe sur la prévention des catastrophes, à la *Déclaration ministérielle* de Phuket du 29 janvier 2005, au communiqué du Groupe *ad hoc* sur l'observation de la Terre (GEO) de Bruxelles, en date du 16 février 2005, et aux réunions techniques tenues en Inde et en Chine ;

Conscients de la nécessité de mettre en place dans l'océan Indien un système d'alerte aux tsunamis et d'atténuation de leurs effets afin de tirer le meilleur parti — grâce à la coopération internationale et à la coordination des activités — de tous les procédés permettant de réduire les conséquences des catastrophes, comme l'évaluation des risques, la détection et l'alerte, la prévention et enfin la recherche ;

Notant que si les tsunamis ne sont pas fréquents dans l'océan Indien, il peut toutefois s'en produire à tout instant et qu'ils peuvent être très destructeurs, comme ce fut le cas le 26 décembre 2004. C'est pourquoi, pour être efficace, un système d'alerte aux tsunamis et d'atténuation de leurs effets dans l'océan Indien doit être durable ;

Notant qu'il est indispensable de faire progresser les connaissances concernant l'émission d'avis d'alerte aux tsunamis afin d'éviter les fausses alarmes, étant donné la gêne considérable et l'interruption des activités courantes qu'ils provoquent, compte tenu notamment de la forte densité de la population et de l'intensité des activités dans les zones côtières de l'océan Indien, tout en poursuivant les recherches pour améliorer la prévision ;

Conscients du fait que l'impact des tsunamis peut être très sensiblement atténué par des dispositifs institutionnels et réglementaires ainsi que par la participation des communautés, ce qui suppose que les alertes aux tsunamis parviennent jusqu'aux communautés locales par de multiples canaux et soient compris par tous, afin que la population soit parfaitement informée et motivée pour respecter les consignes et les conduites sécuritaires ;

Conscients de ce que les programmes d'atténuation des tsunamis auront tout à gagner à des partenariats entre autorités nationales, secteur privé et société civile ;

Recommandons que l'Assemblée de la COI établisse, conformément à son règlement intérieur, un Groupe intergouvernemental de coordination du Système d'alerte aux tsunamis et d'atténuation de leurs effets dans l'océan Indien (GIC/SATOI), qui gèrera le système. Ce Groupe sera composé des États membres intéressés de la COI dans la région de l'océan Indien. Tous les autres membres de la COI, ainsi que les organisations internationales et régionales concernées sont les bienvenus pour y participer en tant qu'observateurs ;

Recommandons que le Secrétariat de la COI serve de secrétariat au Groupe intergouvernemental de coordination du SATOI ;

Estimons que le SATOI devrait constituer un réseau coordonné de systèmes et de capacités nationales et que tous les atouts en jeu devraient être possédés et mis en œuvre par les États membres qui les abritent ou qui en prennent la responsabilité d'une manière ou d'une autre ;

Convenons que les États membres devraient être maîtres de la décision d'émettre ou non des alertes à l'intérieur de leurs territoires respectifs ;

Convenons que les États membres devraient sensibiliser le public en lui dispensant une éducation appropriée et en renforçant ses capacités afin qu'il soit correctement préparé et connaisse la conduite à tenir en cas d'alerte aux tsunamis ;

Recommandons , afin de favoriser sa permanence, que le SATOI utilise les organisations et les institutions existantes ou s'appuie sur elles et qu'il complète les dispositifs existants d'alerte, si nécessaire, dans l'optique de risques multiples ;

Recommandons que chaque État membre de l'océan Indien choisisse rapidement et crée un Centre national d'alerte aux tsunamis ou nomme un point de contact opérationnel dans l'agence compétente responsable, en même temps que son plan d'organisation afin d'être en mesure de recevoir 24 h sur 24 et 7 jours sur 7 les bulletins d'alerte et d'y réagir en diffusant rapidement ses bulletins d'alerte ;

Recommandons que chaque État membre de l'océan Indien nomme un point focal national de gestion des catastrophes naturelles chargé de renforcer l'éducation du public au sujet des tsunamis, dans une optique de risques multiples, selon les circonstances ;

Recommandons que tous les États membres fassent tout ce qui est en leur pouvoir pour mettre à la disposition de tous leurs homologues qui le désireraient, en temps réel ou quasi-réel, les données sismiques, de niveau de la mer et autres données liées aux événements « tsunamigènique » ;

Recommandons que tous les États membres fassent tout ce qui est en leur pouvoir afin de mettre aussi rapidement que possible à la disposition de leurs homologues qui le désireraient les évaluations nationales et les bulletins de tsunamis ou d'événements « tsunamigéniques » ;

Nous félicitons des diverses annonces et projets des États membres de l'océan Indien en vue de mettre en place des systèmes nationaux permanents d'alerte rapide aux tsunamis ;

Nous félicitons des intentions et des projets de l'Australie, de l'Inde, de l'Indonésie, de la Malaisie et de la Thaïlande de mettre en place des systèmes et des capacités pour déceler des événements potentiellement annonciateurs de tsunamis, détecter et mesurer les tsunamis et émettre des alertes appropriées, assorties de prévisions sur leur impact et fournir ces informations et ces alertes aux États membres intéressés ;

Nous félicitons de ce que d'autres centres puissent se créer pour servir de relais à la diffusion de l'information, de support technique et de formation, à l'exemple de celui proposé par la France pour le sud-ouest de l'océan Indien ;

Recommandons que les efforts pour mettre en place le SATOI soient soigneusement intégrés dans les efforts de mise en œuvre de la Stratégie internationale d'atténuation des effets des catastrophes (ISDR) et du cadre du plan d'action d'Hyogo ;

Exprimons notre gratitude quant aux offres généreuses, tant financières que techniques et aux autres types d'assistance faites par de nombreux pays à travers le monde dont la contribution est déterminante à la mise en place du SATOI ;

Invitons tous les États membres à fournir une assistance financière, technique ou autre, afin de promouvoir les capacités nationales et la coopération, ainsi que la préparation, l'atténuation des effets et la prévention des tsunamis, si des États membres de l'océan Indien en faisaient la demande;

Exprimons notre reconnaissance du fait que — indépendamment des mesures déjà prises ou sur le point de l'être par des pays de l'océan Indien — l'UNESCO/COI et l'ISDR pour le système provisoire d'alerte aux tsunamis, le Centre d'alerte aux tsunamis du Pacifique et l'Agence japonaise de météorologie sont convenus de fournir aux points de contact officiels dans l'océan Indien des informations fiables, à titre consultatif et provisoire si cela leur est demandé. Les États membres sont priés de faire connaître à l'UNESCO/COI, avant le 1 er avril 2005 les coordonnées de leurs contacts (le chef et son suppléant) désignés officiellement pour recevoir ces informations, joignables de jour et de nuit, 7 jours sur 7 ;

Nous félicitons également de la sollicitude et de l'intention généreuse de répondre à l'atténuation des cataclysmes dans d'autres océans et d'autres mers, comme celles de l'Asie du Sud-Est et la mer de Chine du Sud, dans le cadre du projet mondial ;

Notons la nécessité de mettre en place des mécanismes de coordination efficace des systèmes d'alerte aux tsunamis pour toutes les régions à risques, dans une optique mondiale ;

Remercions le Japon de la contribution qu'il a faite en réponse à l'Appel-éclair des Nations unies pour permettre la tenue de cette première réunion ;

Décidons d'étudier, entre autres, lors de la deuxième Réunion internationale de coordination pour la mise en place d'un SATOI, les questions suivantes : (a) l'analyse en continu de l'état du système et sa performance ; (b) la coordination des activités des donateurs et autres activités en rapport avec les tsunamis ;

Recommandons que le Secrétariat de la COI entame des consultations avec les États membres sur la faisabilité de mettre en place des groupes de travail provisoires spécialisés sur : (a) les systèmes de mesure, y compris la gestion des données, leurs normes et leur compatibilité d'ensemble ; (b) la gestion des risques, y compris leur évaluation et leur modélisation ; et (c) les systèmes d'alerte, y compris les moyens de diffusion et de communication. Le Secrétariat de la COI présentera à la réunion d'avril un rapport sur l'état d'avancement de la mise en œuvre de cette recommandation ;

Remercions la République de Maurice de l’offre généreuse, que nous acceptons, d’accueillir la deuxième Réunion internationale de coordination pour la mise en place d’un système d’alerte aux tsunamis et d’atténuation de leurs effets dans l’océan Indien, qui se tiendra entre hauts responsables à Port-Louis, du 14 au 16 avril 2005.

ANNEX V

MANDAT DU GROUPE INTERGOUVERNEMENTAL DE COORDINATION DU SYSTÈME D'ALERTE AUX TSUNAMIS ET D'ATTÉNUATION DE LEURS EFFETS DANS L'OCÉAN INDIEN (GIC/SATOI)

Ce Groupe sera créé à titre d'organe subsidiaire de la COI : il soumettra des rapports à l'Assemblée de la COI et lui demandera de guider son action. Une résolution sera rédigée à ce sujet pour adoption éventuelle par l'Assemblée de la COI en sa 23 ème session (juin 2005).

Mandat

1. Coordonner les activités du SATOI ;
2. Organiser et faciliter, selon les besoins, les échanges de données sismiques, de niveau de la mer et autres données, en temps réel ou quasi-réel, ainsi que les informations nécessaires pour assurer la compatibilité des composantes opérationnelles du SATOI ;
3. Faciliter la mise en commun des expériences et du savoir-faire acquis en matière d'alerte aux tsunamis et d'atténuation de leurs effets pour le bassin de l'océan Indien ;
4. Promouvoir la recherche sur les tsunamis ;
5. Promouvoir la mise en place et le développement ultérieur des capacités nationales dédiées à l'alerte aux tsunamis et leur atténuation, conformément aux protocoles et méthodes en vigueur ;
6. Établir des programmes de travail pour le SATOI, les adopter et veiller à leur exécution ; évaluer les ressources nécessaires à leur affecter ;
7. Promouvoir la mise en œuvre du renforcement des compétences et des équipements ;
8. Assurer la liaison et la coordination avec les autres systèmes d'alerte aux tsunamis ;
9. Assurer la liaison avec d'autres organisations, programmes et projets de même nature ;
10. Faciliter la mise en œuvre du SATOI dans un cadre élargi à tous les types de catastrophes naturelles (dimension multirisque) ;
11. Surveiller constamment l'état du système et observer dans quelle mesure il satisfait aux besoins.

Le Secrétariat de la COI pourvoira aux besoins du Secrétariat du GIC/SATOI. Il s'engagera à :

1. Apporter son soutien aux réunions du GIC ;
2. Faciliter les liaisons entre les divers points de contact nationaux et les centres nationaux d'alerte aux tsunamis ;
3. Tenir à jour une liste des points de contact et des services opérationnels nationaux et la communiquer à tout État membre qui en ferait la demande ;
4. Organiser la relation entre le GIC/SATOI, le GIC/ITSU, le PTWC et les autres centres d'alerte aux tsunamis afin que les meilleures pratiques en matière d'alerte soient mises à la disposition de tous ;
5. Organiser et soutenir des actions de formation ; améliorer et perfectionner l'alerte aux tsunamis dans l'océan Indien.

Composition

- . États membres de la COI de l'océan Indien et de son pourtour ;
- . Observateurs représentant d'autres États membres de la COI ;
- . Observateurs représentant d'autres organisations (y compris des ONG), et d'autres programmes et projets, invités dans le respect des dispositions du règlement intérieur de la COI.

ANNEX VI

LIST OF ACRONYMS

ADCIRC	ADvanced CIRCulation Model
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Centre
AFREF	Association pour la Réflexion et l'Echange sur la Formation
ASEAN	Association of Southeast Asian Nations
BMG	Meteorological & Geophysical Agency of Indonesia
CIESM	International Science Commission for the Mediterranean
CPP	Cyclone Preparedness Programme
CRATER	Coastal Risk Analysis of Tsunamis & Environmental Remediation
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DART	Deep Ocean Assessment & Reporting of Tsunamis
DIPECHO	Directorate General (European Commission) for Humanitarian Aid
ERI	Earthquake Research Institute
ESA	European Space Agency
FDSN	Federation of Digital Broad-band Seismograph Networks
GDP	Gross Domestic Product
GEOSS	Global Earth Observation System of Systems
GLOSS	Global sea level Observing System
GMS	Geostationary Meteorological Satellite (Japan)
GNSS	Global Navigation Satellite System
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GTS	Global Telecommunication System
IATF/DR	Inter-agency Task Force for Disaster Reduction
ICDSN	Indonesia-China Digital Seismograph Network
ICG/IOTWS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning & Mitigation System
IDC	International Data Centre
IFRC	International Federation of Red Cross & Red Crescent Societies
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IOGOOS	Indian Ocean GOOS

IOTEWS	Indian Ocean Tsunami Early Warning System
IOTWS	Indian Ocean Tsunami Warning System
IRIS	Incorporated Research Institutions for Seismology
ISDR	International Strategy for Disaster Reduction
ITIC	International Tsunami Information Center (USA)
ITU	International Telecommunications Union
JAMSTEC	Japan Marine Science & Technology Center
JISNET	Japan-Indonesia Seismic Network
JMA	Japan Meteorological Agency
LME	Large Marine Ecosystems
NDMO	National Disaster Management focal point/Organization
NGO	Non-Governmental Organizations
ODINAFRICA	Ocean Data Information Network for Africa
PMEL	Pacific Marine Environmental Laboratory
PPEW	Platform for the Promotion of Early Warning
PTWC	Pacific Tsunami Warning System
RCRC	Red Cross & Red Crescent Movement
TREMORS	Tsunami Risk Evaluation through seismic Moment from a Real-time System
UN	United Nations
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic & Social Commission for Asia & the Pacific
UNESCO	United Nations Educational, Scientific & Cultural Organization
UNGA	United Nations General Assembly
UNOOSA	United Nations Office for Outer Space Affairs
USGS	United Sates Geological Survey
VPN	Virtual Private Network
WCDR	World Conference on Disaster Reduction
WMO	World Meteorological Organization

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No.	Title	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand, 24-29 September 1973 UNDP (CCOP),	E (out of stock)
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (UNESCO Technical Paper in Marine Sciences, No. 20).	E (out of stock) S (out of stock)
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean; Monte Carlo, 9-14 September 1974.	E,F E (out of stock)
4	Report of the Workshop on the Phenomenon known as 'El Niño'; Guayaquil, Ecuador, 4-12 December 1974.	E (out of stock) S (out of stock)
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources; Kingston, Jamaica, 17-22 February 1975	E (out of stock) S
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Suva, Fiji, 1-6 September 1975.	E
7	Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/ EAC; Nairobi, Kenya, 25 March-2 April 1976.	E, F,S, R
8	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters; Penang, 7-13 April 1976	E (out of stock)
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience; Mauritius 9-13 August 1976.	E, F, S, R
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring; Monaco, 14-18 June 1976	E, F E (out of stock) R
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976.	E, S (out of stock)
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976	E (out of stock), S
12	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects; Fort-de-France, Martinique, 28 November-2 December 1977.	E, F, S
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area; Port of Spain, Trinidad, 16-18 January 1978.	E, S
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas; Abidjan, Côte d'Ivoire, 2-9 May 1978	E, F
15	CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific; Santiago de Chile, 6-10 November 1978.	E (out of stock)
16	Workshop on the Western Pacific, Tokyo, 19-20 February 1979.	E, F, R
17	Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS); Moscow, 9-11 April 1979.	E
17 suppl.	Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOSS Data Processing and Services System; Moscow, 2-6 April 1979.	E
18	IOC/UNESCO Workshop on Syllabus for Training Marine Technicians; Miami, U.S.A., 22-26 May 1978 (UNESCO reports in marine sciences, No. 4 published by the Division of Marine Sciences, UNESCO).	E (out of stock), F, S (out of tock), R
19	IOC Workshop on Marine Science Syllabus for Secondary Schools; Llantwit Major, Wales, U.K., 5-9 June 1978 (UNESCO reports in marine sciences, No. 5, published by the Division of Marine Sciences, UNESCO).	E (out of stock), S, R, Ar
20	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources; Bandung, Indonesia, 17-21 October 1978	E
21	Second IDOE Symposium on Turbulence in the Ocean; Liège, Belgium, 7-18 May 1979.	E, F, S, R
22	Third IOC/WMO Workshop on Marine Pollution Monitoring; New Delhi, 11-15 February 1980.	E, F, S, R
23	WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific; Tokyo, 27-31 March 1980.	E, R
24	WESTPAC Workshop on Coastal Transport of Pollutants; Tokyo, Japan, 27-31 March 1980.	E (out of stock)
25	Workshop on the Inter-calibration of Sampling Procedures of the IOC/ WMO UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters; Bermuda, 11-26 January 1980.	E (Superseded by IOC Technical Series No.22)
26	IOC Workshop on Coastal Area Management in the Caribbean Region; Mexico City, 24 September- 5 October 1979.	E, S
27	CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Nouméa, New Caledonia, 9-15 October 1980.	E
28	FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes. Lima, 20 April-5 May 1980.	E
29	WESTPAC Workshop on Marine Biological Methodology; Tokyo, 9-14 February 1981.	E
30	International Workshop on Marine Pollution in the South-West Atlantic; Montevideo, 10-14 November 1980.	E (out of stock) S
31	Third International Workshop on Marine Geoscience; Heidelberg, 19-24 July 1982.	E, F, S
32	UNU/IOC/UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E, F, S
32 Suppl.	Papers submitted to the UNU/IOC/ UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the Context of the New Ocean Regime; Paris, France, 27 September-1 October 1982.	E
33	Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR); Halifax, 26-30 September 1963.	E
34	IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa); Tenerife, 12-17 December 1963.	E, F, S
35	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific; Suva, Fiji, 3-7 October 1983.	E
36	IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, Portugal, 28 May-2 June 1984.	E
36 Suppl.	Papers submitted to the IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, 28 May-2 June 1984	E
37	IOC/UNESCO Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs; Colombo, 8-13 July 1985.	E
38	IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region; Basrah, Iraq, 8-12 January 1984.	E
39	CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific; Suva, Fiji, 24-29 September 1985.	E
40	IOC Workshop on the Technical Aspects of Tsunami Analysis, Prediction and Communications; Sidney, B.C., Canada, 29-31 July 1985.	E
40 Suppl.	First International Tsunami Workshop on Tsunami Analysis, Prediction and Communications, Submitted Papers; Sidney, B.C., Canada, 29 July-1 August 1985.	E
41	First Workshop of Participants in the Joint FAO/IOC/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2); Dakar, Senegal, 28 October-1 November 1985.	E
43	IOC Workshop on the Results of MEDALPEX and Future Oceanographic Programmes in the Western Mediterranean; Venice, Italy, 23-25 October 1985.	E
44	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E (out of stock) S
44 Suppl.	IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, Submitted Papers; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986.	E
45	IOCARIBE Workshop on Physical Oceanography and Climate; Cartagena, Colombia, 19-22 August 1986.	E
46	Reunión de Trabajo para Desarrollo del Programa "Ciencia Oceánica en Relación a los Recursos No Vivos en la Región del Atlántico Sud-occidental"; Porto Alegre, Brasil, 7-11 de abril de 1986.	S
47	IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence; Townsville, 1-6 December 1966	E
48	IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on 'Ocean Science in Relation to Non-Living Resources (OSNLR)'; Havana, Cuba, 4-7 December 1986.	E, S
49	AGU-IOC-WMO-CPPS Chapman Conference: An International Symposium on 'El Niño'; Guayaquil, Ecuador, 27-31 October 1986.	E
50	CCALR-IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR); Paris, France, 2-6 June 1987.	E
51	CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations; Lae, Papua-New Guinea, 1-8 October 1987.	E
52	SCOR-IOC-UNESCO Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere; Paris, France, 6-10 May 1985.	E
53	IOC Workshop on the Biological Effects of Pollutants; Oslo, 11-29 August 1986.	E
54	Workshop on Sea-Level Measurements in Hostile Conditions; Bidston, UK, 28-31 March 1988.	E
55	IBCCA Workshop on Data Sources and Compilation, Boulder, Colorado, 18-19 July 1988.	E
56	IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Cleveland, Australia, 24-30 July 1988.	E
57	IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms; Takamatsu, Japan, 16-17 November 1987.	E
58	International Workshop on the Technical Aspects of the Tsunami Warning System; Novosibirsk, USSR, 4-5 August 1989.	E
58 Suppl.	Second International Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness,	E

No.	Title	Languages
	Observation and Instrumentation. Submitted Papers; Novosibirsk, USSR, 4-5 August 1989.	
59	IOC-UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring Research, Control and Abatement in the Wider Caribbean; San José, Costa Rica, 24-30 August 1989.	E, F, S
60	IOC Workshop to Define IOCARIBE-TRODERP proposals; Caracas, Venezuela, 12-16 September 1989.	E
61	Second IOC Workshop on the Biological Effects of Pollutants; Bermuda, 10 September-2 October 1988.	E
62	Second Workshop of Participants in the Joint FAO-IOC-WHO-IAEA-UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region; Accra, Ghana, 13-17 June 1988.	E
63	IOC/WESTPAC Workshop on Co-operative Study of the Continental Shelf Circulation in the Western Pacific; Bangkok, Thailand, 31 October-3 November 1989.	E
64	Second IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Phuket, Thailand, 25-31 September 1989.	E
65	Second IOC Workshop on Sardine/Anchovy Recruitment Project (SARP) in the Southwest Atlantic; Montevideo, Uruguay, 21-23 August 1989.	E
66	IOC ad hoc Expert Consultation on Sardine/ Anchovy Recruitment Programme; La Jolla, California, U.S.A., 1989	E
67	Interdisciplinary Seminar on Research Problems in the IOCARIBE Region; Caracas, Venezuela, 28 November-1 December 1989.	E (out of stock)
68	International Workshop on Marine Acoustics; Beijing, China, 26-30 March 1990.	E
69	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Leningrad, USSR, 28-31 May 1990.	E
69 Suppl.	IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Submitted Papers; Leningrad, USSR, 28-31 May 1990.	E
70	IOC-SAREC-UNEP-FAO-IAEA-WHO Workshop on Regional Aspects of Marine Pollution; Mauritius, 29 October - 9 November 1990.	E
71	IOC-FAO Workshop on the Identification of Penaeid Prawn Larvae and Postlarvae; Cleveland, Australia, 23-28 September 1990.	E
72	IOC/WESTPAC Scientific Steering Group Meeting on Co-Operative Study of the Continental Shelf Circulation in the Western Pacific; Kuala Lumpur; Malaysia, 9-11 October 1990.	E
73	Expert Consultation for the IOC Programme on Coastal Ocean Advanced Science and Technology Study; Liège, Belgium, 11-13 May 1991.	E
74	IOC-UNEP Review Meeting on Oceanographic Processes of Transport and Distribution of Pollutants in the Sea; Zagreb, Yugoslavia, 15-18 May 1989.	E
75	IOC-SCOR Workshop on Global Ocean Ecosystem Dynamics; Solomons, Maryland, U.S.A., 29 April-2 May 1991.	E
76	IOC/WESTPAC Scientific Symposium on Marine Science and Management of Marine Areas of the Western Pacific; Penang, Malaysia, 2-6 December 1991.	E
77	IOC-SAREC-KMFRI Regional Workshop on Causes and Consequences of Sea-Level Changes on the Western Indian Ocean Coasts and Islands; Mombasa, Kenya, 24-28 June 1991.	E
78	IOC-CEC-ICES-WMO-ICSU Ocean Climate Data Workshop Goddard Space Flight Center; Greenbelt, Maryland, U.S.A., 18-21 February 1992.	E
79	IOC/WESTPAC Workshop on River Inputs of Nutrients to the Marine Environment in the WESTPAC Region; Penang, Malaysia, 26-29 November 1991.	E
80	IOC-SCOR Workshop on Programme Development for Harmful Algae Blooms; Newport, U.S.A. 2-3 November 1991.	E
81	Joint IAPSO-IOC Workshop on Sea Level Measurements and Quality Control; Paris, France, 12-13 October 1992.	E
82	BORDOMER 92: International Convention on Rational Use of Coastal Zones. A Preparatory	E
83	IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 12-13 October 1992.	E
84	Workshop on Atlantic Ocean Climate Variability; Moscow, Russian Federation, 13-17 July 1992	E
85	IOC Workshop on Coastal Oceanography in Relation to Integrated Coastal Zone Management; Kona, Hawaii, 1-5 June 1992.	E
86	International Workshop on the Black Sea; Varna, Bulgaria, 30 September – 4 October 1991	E
87	Taller de trabajo sobre efectos biológicos del fenómeno «El Niño» en ecosistemas costeros del Pacífico Sudeste; Santa Cruz, Galápagos, Ecuador, 5-14 de octubre de 1989.	S only (summary in E, F, S)
88	IOC-CEC-ICSU-ICES Regional Workshop for Member States of Eastern and Northern Europe (GODAR Project); Obninsk, Russia, 17-20 May 1993.	E
89	IOC-ICSEM Workshop on Ocean Sciences in Non-Living Resources; Perpignan, France, 15-20 October 1990.	E
90	IOC Seminar on Integrated Coastal Management; New Orleans, U.S.A., 17-18 July 1993.	E
91	Hydroblack'91 CTD Intercalibration Workshop; Woods Hole, U.S.A., 1-10 December 1991.	E
92	Réunion de travail IOCEA-OSNLR sur le Projet « Budgets sédimentaires le long de la côte occidentale d'Afrique » Abidjan, côte d'Ivoire, 26-28 juin 1991.	E
93	IOC-UNEP Workshop on Impacts of Sea-Level Rise due to Global Warming. Dhaka, Bangladesh, 16-19 November 1992.	E
94	BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Field of Eutrophication in Semi-enclosed Seas and Harmful Algal Blooms, Bremerhaven, Germany, 29 September-3 October 1992.	E
95	SAREC-IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 23-25 November 1993.	E
96	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Zanzibar, United Republic of Tanzania, 17-21 January 1994.	E
96 Suppl.	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers 1. Coastal Erosion; Zanzibar, United Republic of Tanzania 17-21 January 1994.	E
96 Suppl	IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Submitted Papers 2. Sea Level; Zanzibar, United Republic of Tanzania 17-21 January 1994.	E
97	IOC Workshop on Small Island Oceanography in Relation to Sustainable Economic Development and Coastal Area Management of Small Island Development States; Fort-de-France, Martinique, 8-10 November, 1993.	E
98	CoMSBlack '92A Physical and Chemical Intercalibration Workshop; Erdemli, Turkey, 15-29 January 1993.	E
99	IOC-SAREC Field Study Exercise on Nutrients in Tropical Marine Waters; Mombasa, Kenya, 5-15 April 1994.	E
100	IOC-SOA-NOAA Regional Workshop for Member States of the Western Pacific - GODAR-II (Global Oceanographic Data Archeology and Rescue Project); Tianjin, China, 8-11 March 1994.	E
101	IOC Regional Science Planning Workshop on Harmful Algal Blooms; Montevideo, Uruguay, 15-17 June 1994.	E
102	First IOC Workshop on Coastal Ocean Advanced Science and Technology Study (COASTS);	E
	Liège, Belgium, 5-9 May 1994.	
103	IOC Workshop on GIS Applications in the Coastal Zone Management of Small Island Developing States; Barbados, 20-22 April 1994.	E
104	Workshop on Integrated Coastal Management; Dartmouth, Canada, 19-20 September 1994.	E
105	BORDOMER 95: Conference on Coastal Change; Bordeaux, France, 6-10 February 1995.	E
105 Suppl.	Conference on Coastal Change: Proceedings; Bordeaux, France, 6-10 February 1995	E
106	IOC/WESTPAC Workshop on the Paleographic Map; Bali, Indonesia, 20-21 October 1994.	E
107	IOC-ICSU-NIO-NOAA Regional Workshop for Member States of the Indian Ocean - GODAR-III; Dona Paula, Goa, India, 6-9 December 1994.	E
108	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Paris, France, 9-12 May 1995.	E
108 Suppl.	UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Submitted Papers; Paris, France, 9-12 May 1995.	E
109	First IOC-UNEP CEPPOL Symposium; San José, Costa Rica, 14-15 April 1993.	E
110	IOC-ICSU-CEC regional Workshop for Member States of the Mediterranean - GODAR-IV (Global Oceanographic Data Archeology and Rescue Project) Foundation for International Studies, University of Malta, Valletta, Malta, 25-28 April 1995.	E
111	Chapman Conference on the Circulation of the Intra-Americas Sea; La Parguera, Puerto Rico, 22-26 January 1995.	E
112	IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM) Workshop; Miami, U.S.A., 7-8 December 1993.	E
113	IOC Regional Workshop on Marine Debris and Waste Management in the Gulf of Guinea; Lagos, Nigeria, 14-16 December 1994.	E
114	International Workshop on Integrated Coastal Zone Management (ICZM) Karachi, Pakistan; 10-14 October 1994.	E
115	IOC/GLOSS-IAPSO Workshop on Sea Level Variability and Southern Ocean Dynamics; Bordeaux, France, 31 January 1995	E
116	IOC/WESTPAC International Scientific Symposium on Sustainability of Marine Environment: Review of the WESTPAC Programme, with Particular Reference to ICAM, Bali, Indonesia, 22-26 November 1994.	E
117	Joint IOC-CIDA-Sida (SAREC) Workshop on the Benefits of Improved Relationships between International Development Agencies, the IOC and other Multilateral Inter-governmental Organizations in the Delivery of Ocean, Marine Affairs and Fisheries Programmes; Sidney B.C., Canada, 26-28 September 1995.	E
118	IOC-UNEP-NOAA-Sea Grant Fourth Caribbean Marine Debris Workshop; La Romana, Santo Domingo, 21-24 August 1995.	E
119	IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995.	E
120	International Training Workshop on Integrated Coastal Management; Tampa, Florida, U.S.A., 15-17 July 1995.	E
121	Atelier régional IOC-CERESCOR sur la gestion intégrée des zones littorales (ICAM), Conakry, Guinée, 18–22 décembre 1995	F
122	IOC-EU-BSH-NOAA-(WDC-A) International Workshop on Oceanographic Biological and Chemical Data Management, Hamburg, Germany, 20-23 May 1996	E
123	Second IOC Regional Science Planning Workshop on Harmful Algal Blooms in South America; Mar del Plata, Argentina, 30 October–1 November 1995.	E, S
124	GLOBEC-IOC-SAHFOS-MBA Workshop on the Analysis of Time Series with Particular Reference to the Continuous Plankton Recorder Survey; Plymouth, U.K.,4-7 May 1993.	E
125	Atelier sous-régional de la COI sur les ressources marines vivantes du Golfe de Guinée ; Cotonou, Bénin, 1-4 juillet 1996.	E

No.	Title	Languages
126	IOC-UNEP-PERSGA-ACOPS-IUCN Workshop on Oceanographic Input to Integrated Coastal Zone Management in the Red Sea and Gulf of Aden. Jeddah, Saudi Arabia, 8 October 1995.	E
127	IOC Regional Workshop for Member States of the Caribbean and South America GODAR-V (Global Oceanographic Data Archeology and Rescue Project); Cartagena de Indias, Colombia, 8-11 October 1996.	E
128	Atelier IOC-Banque Mondiale-Sida/SAREC-ONE sur la Gestion Intégrée des Zones Côtières ; Nosy Bé, Madagascar, 14-18 octobre 1996.	E
129	Gas and Fluids in Marine Sediments, Amsterdam, the Netherlands; 27-29 January 1997.	E
130	Atelier régional de la COI sur l'océanographie côtière et la gestion de la zone côtière ;Moroni, RFI des Comores, 16-19 décembre 1996.	E
131	GOOS Coastal Module Planning Workshop; Miami, USA, 24-28 February 1997	E
132	Third IOC-FANSA Workshop; Punta-Arenas, Chile, 28-30 July 1997	S/E
133	Joint IOC-CIESM Training Workshop on Sea-level Observations and Analysis for the Countries of the Mediterranean and Black Seas; Birkenhead, U.K., 16-27 June 1997.	E
134	IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum); Shanghai, China, 27-29 May 1997.	E
135	Regional Workshop on Integrated Coastal Zone Management; Chabahar, Iran; February 1996.	E
136	IOC Regional Workshop for Member States of Western Africa (GODAR-VI); Accra, Ghana, 22-25 April 1997.	E
137	GOOS Planning Workshop for Living Marine Resources, Dartmouth, USA; 1-5 March 1996.	E
138	Gestión de Sistemas Oceanográficos del Pacífico Oriental; Concepción, Chile, 9-16 de abril de 1996.	S
139	Sistemas Oceanográficos del Atlántico Sudoccidental, Taller, TEMA;Furg, Rio Grande, Brasil, 3-11 de noviembre de 1997	S
140	IOC Workshop on GOOS Capacity Building for the Mediterranean Region; Valletta, Malta, 26-29 November 1997.	E
141	IOC/WESTPAC Workshop on Co-operative Study in the Gulf of Thailand: A Science Plan; Bangkok, Thailand, 25-28 February 1997.	E
142	Pelagic Biogeography ICoPB II. Proceedings of the 2nd International Conference. Final Report of SCOR/IOC Working Group 93; Noordwijkerhout, The Netherlands, 9-14 July 1995.	E
143	Geosphere-biosphere coupling: Carbonate Mud Mounds and Cold Water Reefs; Gent, Belgium, 7–11 February 1998.	E
144	IOC-SOPAC Workshop Report on Pacific Regional Global Ocean Observing Systems; Suva, Fiji, 13-17 February 1998.	E
145	IOC-Black Sea Regional Committee Workshop: 'Black Sea Fluxes' Istanbul, Turkey, 10-12 June 1997.	E
146	Living Marine Resources Panel Meeting, Paris, France, 23-25 March 1998.	E
147	IOC-SOA International Training Workshop on the Intregration of Marine Sciences into the Process of Integrated Coastal Management, Dalian, China, 19-24 May 1997.	E
148	IOC/WESTPAC International Scientific Symposium – Role of Ocean Sciences for Sustainable Development Okinawa, Japan, 2-7 February 1998.	E
149	Workshops on Marine Debris & Waste Management in the Gulf of Guinea, 1995-97.	E
150	First IOCARIBE-ANCA Workshop Havana, Cuba, 29 June-1 July 1998.	E
151	Taller Pluridisciplinario TEMA sobre Redes del Gran Caribe en Gestión Integrada de Áreas Costeras Cartagena de Indias, Colombia, 7-12 de septiembre de 1998.	S
152	Workshop on Data for Sustainable Integrated Coastal Management (SICOM) Maputo, Mozambique, 18-22 July 1998	E
153	IOC/WESTPAC-Sida (SAREC) Workshop on Atmospheric Inputs of Pollutants to the Marine Environment Qingdao, China, 24-26 June 1998	E
154	IOC-Sida-Flanders-SFRI Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA project) Capetown, South Africa, 30 November-11 December 1998.	E
155	Science of the Mediterranean Sea and its applications UNESCO, Paris 29-31 July 1997	E
156	IOC-LUC-KMFRI Workshop on RECOSCIX-WIO in the Year 2000 and Beyond, Mombasa, Kenya, 12-16 April 1999	E
157	'98 IOC-KMI International Workshop on Integrated Coastal Management (ICM), Seoul, Republic of Korea 16-18 April 1998	E
158	The IOCARIBE Users and the Global Ocean Observing System (GOOS) Capacity Building Workshop, San José, Costa Rica, 22-24 April 1999	E
159	Oceanic Fronts and Related Phenomena (Konstantin Fedorov Memorial Symposium) – Proceedings, Pushkin, Russian Federation, 18-22 May 1998	E
160	Under preparation	
161	Under preparation	
162	Workshop report on the Transports and Linkages of the Intra-americas Sea (IAS), Cozumel, Mexico, 1-5 November 1997	E
163	Under preparation	
164	IOC-Sida-Flanders-MCM Third Workshop on Ocean Data Management in the IOCINCWIO Region (ODINEA Project), Cape Town, South Africa, 29 November – 11 December 1999	E
165	An African Conference on Sustainable Integrated Management; Proceedings of the Workshops. An Integrated Approach, (PACSICOM), Maputo, Mozambique, 18 –25 July 1998	E, F
166	IOC-SOA International Workshop on Coastal Megacities: Challenges of Growing Urbanization of the World's Coastal Areas; Hangzhou, P.R. China, 27 –30 September 1999	E
167	IOC-Flanders First ODINAFRICA-II Planning Workshop, Dakar, Senegal, 2-4 May 2000	E
168	Geological Processes on European Continental Margins; International Conference and Eight Post-cruise Meeting of the Training-Through-Research Programme, Granada, Spain, 31 January – 3 February 2000	E
169	International Conference on the International Oceanographic Data & Information Exchange in the Western Pacific (IODE-WESTPAC) 1999, ICIWP '99, Langkawi, Malaysia, 1-4 November 1999	***under preparation***
170	IOCARIBE-GODAR-I Cartagenas, Colombia, February 2000	***under preparation***
171	Ocean Circulation Science derived from the Atlantic, Indian and Arctic Sea Level Networks, Toulouse, France, 10-11 May 1999	E
172	(*Under preparation*)	
173	The Benefits of the Implementation of the GOOS in the Mediterranean Region, Rabat, Morocco, 1-3 November 1999	E, F
174	IOC-SOPAC Regional Workshop on Coastal Global Ocean Observing System (GOOS) for the Pacific Region, Apia, Samoa, 16-17 August 2000	E
175	Geological Processes on Deep-water European Margins, Moscow-Mozhenka, 28 Jan.-2 Feb. 2001	E
176	MedGLOSS Workshop and Coordination Meeting for the Pilot Monitoring Network System of Systematic Sea Level Measurements in the Mediterranean and Black Seas, Haifa, Israel, 15-17 May 2000	E
177	*(Under preparation)*	
178	*(Under preparation)*	
179	*(Under preparation)*	
180	Abstracts of Presentations at Workshops during the 7th session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, USA, 23-27 April 2001	E
181	*(Under preparation)*	
182	*(Under preparation)*	
183	Geosphere/Biosphere/Hydrosphere Coupling Process, Fluid Escape Structures and Tectonics at Continental Margins and Ocean Ridges, International Conference & Tenth Post-cruise Meeting of the Training-through-Research Programme, Aveiro, Portugal, 30 January-2 February 2002	E
184	*(Under preparation)*	
185	*(Under preparation)*	
186	*(Under preparation)*	
186	*(Under preparation)*	
187	Geological and Biological Processes at deep-sea European Margins and Oceanic Basins, Bologna, Italy, 2–6 February 2003	E
188	Proceedings of 'The Ocean Colour Data' Symposium, Brussels, Belgium, 25-27 November 2002	E
189	Workshop for the Formulation of a Draft Project on Integrated Coastal Management (ICM) in Latin America and the Caribbean (LAC), Cartagena, Colombia, 23–25 October 2003 Taller de Formulación de un Anteproyecto de Manejo Costero Integrado (MCI) en América Latina y el Caribe (ALC), Cartagena, Colombia, 23–25 de Octubre de 2003	E F ***(electronic copy only)***
190	First ODINCARSA Planning Workshop for Caribbean Islands, Christchurch, Barbados, 15–18 December 2003	E ***(electronic copy only)***
191	North Atlantic and Labrador Sea Margin Architecture and Sedimentary Processes — International Conference and Twelfth Post-cruise Meeting of the Training-through-research Programme, Copenhagen, Denmark, 29–31 January 2004	E
192	Regional Workshop on Coral Reefs Monitoring and Management in the ROPME Sea Area, Iran I.R., 14–17 December 2003	E ***(under preparation)***
193	Workshop on New Technical Developments in Sea and Land Level Observing Systems, Paris, France, 14–16 October 2003	E ***(electronic copy only***
194	IOC/ROPME Planning Meeting for the Ocean Data and Information Network for the Central Indian Ocean Region	***(under preparation***
195	Workshop on Indicators of Stress in the Marine Benthos, Torregrande-Oristano, Italy, 8–9 October 2004	***(under preparation***
196	International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework, Paris, France, 3–8 March 2005	E