

**Second International Coordination Meeting for the Development of
a Tsunami Warning and Mitigation System for the Indian Ocean**
International Conference Centre, Grand-Baie, Mauritius, 14-16 April
2005



Progress and further requirements for the development of a Tsunami Warning and Mitigation System for the Indian Ocean

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1

Introduction

The Indian Ocean tsunami was triggered by 9.0-magnitude earthquake near Sumatra in Indonesia. While the earthquake is estimated to have killed at least 80,000 people, more than 200,000 are estimated to have died from the tsunami with the main cause of death being trauma and drowning from the flux of seawater, water-born debris, and waves pouring into coastal areas without warning. The death toll is believed to be over 300,000 people. No warning systems for tsunamis were in place and all of the affected countries were unprepared.

The Pacific Ocean has had a regional tsunami warning system in place since 1965. This comprises seismological and oceanic observation networks, regional analysis and advisory centres, and national tsunami warning centres, linked under cooperative arrangements, and coupled to national activities in risk assessment, preparedness and warning dissemination. The Tsunami Warning System for the Pacific (PTWS) was established by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and is guided by the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), which is composed of national experts from 26 countries in the Pacific region. It is a subsidiary body of the IOC and reports to the IOC Assembly composed of 130 states. These bodies have also endeavored to stimulate interest and capacity development in tsunami warning systems in other at-risk areas of the world. The IOC also set up in 1965 the International Tsunami Information Centre to support ITSU in carrying out its comprehensive tsunami mitigation programme. The ITIC, as an implementing center for tsunami mitigation activities, works closely with the Pacific Tsunami Warning Center, the Pacific's international tsunami warning operations center, to facilitate improvement and enhancement in its operations, and directly with ITSU Member States to assist in the establishment of national and regional tsunami warning systems and in the development of national tsunami mitigation programmes.

Tsunami early warning systems are set within the wider framework of disaster reduction and management and early warning systems generally. The International Strategy for Disaster Reduction (ISDR), mandated by a series of UN General Assembly resolutions, provides the overall intergovernmental policy environment for integrating the many elements of activity required to effectively reduce and manage disaster risks. In particular, the Hyogo Framework for Action 2005-2015, negotiated by governments at the World Conference on Disaster Reduction, Kobe, Hyogo, Japan, 18-22 January 2005 sets out specific directions and priorities for action by governments and organizations over the next decade.

Substantial knowledge and expertise in natural disaster management and mitigation is available to deal with the risks of tsunamis in the Pacific region. In particular, invaluable experience and knowledge has been accumulated on how to assess tsunami risk at the national and local level, how to promote awareness and preparedness, and how to build national and regional tsunami warning systems. These require strong and sustained commitment by the national governments, collaborating in a regional framework for sharing data and by jointly bearing the cost for the regional elements of the network. The need for regional collaboration is a result of the nature of tsunamis: local tsunamis can be handled by national warning centres; but regional or ocean-wide tsunamis travel at 800 km/h across the ocean and require observational data from multiple countries in a region.

Coordinated and concerted activities by the UN are now underway to support the rapid development of early warning capacities in the Indian Ocean region, particularly under the UN Flash Appeal project "Evaluation and Strengthening of Early Warning Systems in Countries Affected by the 26 December 2004 Tsunami in South East and South Asia", (TSU-REG-05/CS06-REGION), which is coordinated by the ISDR secretariat's Platform for the Promotion of Early Warning (PPEW) in close cooperation with UNESCO-IOC.

The purpose of the current document is to elaborate on progress on the above collaborative process and to identify further necessary activities and funding requirements, in particular to support UNESCO-IOC efforts to build the substantive elements of an effective and sustainable Indian Ocean Tsunami Warning System for the (IOTWS).

2

Tsunami early warning systems as part of broader disaster risk reduction strategies

It is recognized that an effective early warning system requires a number of elements such as a prior knowledge of the risks faced by communities; technical monitoring and warning service for these risks; dissemination of understandable warnings to those at risk, as well as education, public awareness and preparedness to act.

Frequently, hazard monitoring and forecasting is carried out by specialized scientific agencies at both the international and national levels. These include meteorological organizations and similar institutions involved in the monitoring and research of specific hazards. Depending on each country and region, these may be public sector, universities, regional organizations, and others.

The responsibility for transforming those warnings into disaster risk reduction activities, however, normally lies with organizations responsible for disaster management at the national level. In most countries, specialized government agencies, organizations such as the national Red Crescent or Red Cross Societies or UN agencies play a significant role.

These responsibilities include hazard and vulnerability mapping, the development of disaster preparedness strategies, and communicating warnings. These agencies also often have a political responsibility for ensuring that warnings are issued and acted upon.

With the establishment of the International Strategy for Disaster Reduction (ISDR) countries were requested to establish national and multisectoral platforms for natural disaster reduction with a view to provide more resourced, effective and integrated efforts of risk reduction amongst national and local stakeholders.

Such structures, can contribute considerably to the development of organizational structures, information flows and decision-making protocols, capable of integrating the different elements of an early warning system, at both local and national levels.

A table presenting sources of information on current disaster risk management capacities from affected and threatened countries in the region is attached as Annex 3.

These principles, along with the need to adopt multi-hazard approach are driving factors behind the elaboration of the tsunami early warning system for the Indian Ocean and the support provided to countries by the United Nations.

Action: Development of National Platforms for Disaster Risk Reduction as required

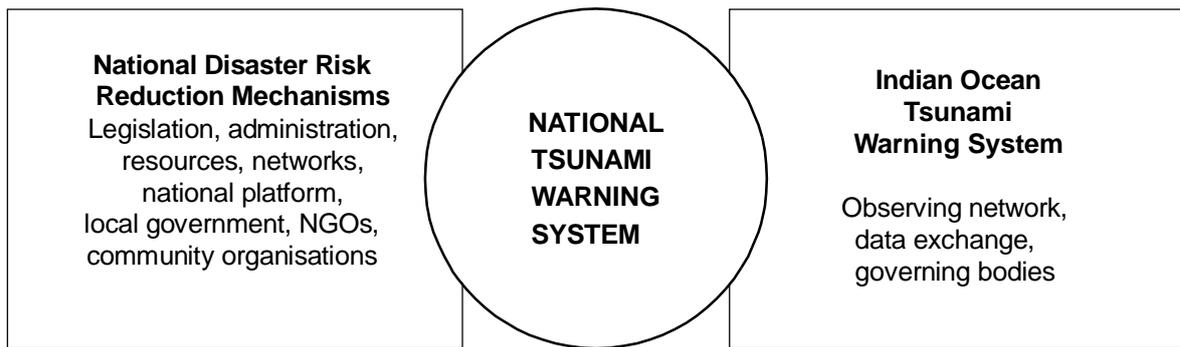


Fig 1: national linkages map

2.1. National Tsunami warning mitigation coordination committees proposed mechanisms

While it is the prerogative of Member States to identify the format of national mechanisms for tsunami warning, in order to facilitate the integration of the various sectors and actors required at the national level it is proposed to establish **National Tsunami Warning and Mitigation Coordination Committees**.

The membership of such committees, during the development phase, could include the following type of representatives:

- (i) Members of National Disaster Reduction Platform;
- (ii) Interim tsunami national contact point(s);
- (iii) Representatives of relevant national organizations/institutions (e.g. port authority, meteorological service, seismological service, ocean research institutions, universities, other organizations/institutions relevant to national tsunami warning and mitigation system not included in (i),)
- (iv) Relevant international experts (tsunami, seismology, sea level, oceanography,);
- (v) Civil society representatives including Red Cross and Red Crescent representatives and representatives of the media
- (vi) Members of UN country teams;
- (vii) Representatives of interested donor countries/agencies.

It is proposed that these Committees, during the development phase, will have the following objectives:

- (i) Review National Disaster Reduction Platform and how the National Tsunami Warning System can "plug in" to it;
- (ii) Prepare a national tsunami communication plan;
- (iii) Identify/assess infrastructure requirements for the full deployment of the National Tsunami Warning Centre, taking into consideration (i) and (ii), and taking into consideration the need to compatibility with other Centres in the region;
- (iv) Identify/assess human resource and related training requirements for the operation of the National Tsunami Warning Centre, taking into consideration (i) and (ii);

- (v) Prepare, as required, full project proposals/documents for funding by interested donor(s);
- (vi) Coordinate closely with IOC and ISDR to ensure that available funding (e.g. from OCHA Flash Appeal) will contribute to fulfilling the requirements identified under (iii) and (iv) and to avoid duplication with (v);
- (vii) Report their findings to the First Session of the Intergovernmental Coordination Group for the Tsunami Warning and Mitigation System in the Indian Ocean (ICG/IOTWS);
- (viii) Prepare the terms of reference of a national tsunami warning, assessment and mitigation programme.

We note that the National Tsunami Warning and Mitigation Coordination Committees will be a body under national authority. International experts will cooperate in an advisory capacity only.

It is recommended that these Committees be established as soon as possible and that experts be identified to assist with the national assessments as detailed above.

The cost of organizing initial meetings of the Committees and participation of relevant international experts are covered as part of Activity 3 (see Annex 2) of project TSU-REG-05/CS06-REGION.

3

Scope of the current project

The current project “Evaluation and Strengthening of Early Warning Systems in Countries Affected by the 26 December 2004 Tsunami in South East and South Asia.”, (TSU-REG-05/CS06-REGION), aims to address immediate matters concerning the implementation of a tsunami early warning system for the Indian Ocean, and to facilitate a UN-wide coordinated process toward this end. It identified a range of UN and regional entities that would need to be involved, including specialized technical organizations (particularly UNESCO-IOC) along with development and disaster risk reduction organisations. Donors have pledged about US\$11,000,000 in support to the project.

3.1. Project structure

The project is now structured around **five components, each focusing on a coherent area of results**. The two phases of work described in the original proposal, concerning warning system development and preparedness activities, will be pursued in parallel. The five components are as follows.

3.1.1. Core system¹ implementation

Obtain regional consensus on the nature of a tsunami early warning system, design its core elements, particularly the observing system, national tsunami warning centres, and permanent regional coordination mechanisms, and commence initial strengthening and implementation steps, including relevant training and other capacity building.

3.1.2. Integrated risk management

Integrate the tsunami early warning system into national disaster risk management and reduction mechanisms, seeking synergies with other hazard early warning systems and strengthening national capacities for disaster risk management and risk reduction as required.

3.1.3. Public awareness and education

Develop and disseminate publications on tsunami, early warning and risk reduction, tailored to local languages and cultures, targeting key intermediaries such as public officials, teachers, and community leaders, and develop and promote mass media materials and campaigns.

3.1.4. Community level learning

Implement community-level pilot activities to test and demonstrate good practices, including hazard and vulnerability assessment, organisational strengthening, warning system operation, capacity building, evacuation planning, and the design and construction of shelters and other works.

¹ The expression core system is used here to describe the observing system, national tsunami warning centres and permanent regional coordination mechanisms, including training of personnel and operational capacities, necessary to routinely generate accurate and timely warnings and communicate them to appropriate authorities.

3.1.5. Project coordination

Establish the mutual understandings, agreements, information resources, networks, support capacities and decision-making mechanisms needed to ensure the effective implementation of the project and its early warning system objectives.

3.2. Project implementation

A project plan has been elaborated that sets out the details of the project activities that will be carried out under each component, and the partners involved.

The work of the project will be undertaken through partnerships among a variety of UN and other organizations as listed in the original proposal (TSU-REG-05/CS06-REGION), although not restricted to these organisations. At least half of the funds received will be committed to other organisations to support work plans, as set out in written agreements. Much of the responsibility for the design of the work plans will lie with these other organisations, making use of their specialist knowledge and capacities.

A Memorandum of Agreement has been finalized between ISDR and UNESCO-IOC and an agreement is underway with WMO to support the upgrading of the meteorological communications systems in the region used to transfer tsunami data and warnings. Discussions are underway with other organisations concerned with disaster preparedness and disaster reduction in the region, including UNDP, OCHA, UNESCAP, ADRC, ADPC, UNU, UNV and UNEP. A number of work elements and agreements are under consideration and the work plans will be made available in due course.

It should be noted that the different donors each have specific requirements, according to national law or administrative procedure, which must be met. In some cases specific project proposals are being developed in order to allow the release of funds. Nevertheless, the project will be operated as a single project, with all project donations pooled in a single sub-account of the Trust Fund for Disaster Reduction, and will be reported on as a single integrated project.

3.3. Progress on project implementation

A number of activities have been carried out relevant to all five components of the project proposal by UNESCO-IOC and the ISDR secretariat (For a list of activities see Annex 2).

In addition, many partners² are actively supporting countries in the immediate phase of the establishment of the tsunami early warning systems. In order to facilitate these activities and identify eventual gaps and needs a group of agencies are developing a matrix of activities/roles and resources of partners for the evaluation and strengthening of early warning systems in countries affected by the 26 December 2004 tsunami. An initial version of this matrix will be presented at the Mauritius meeting.

Component 3.1.1 of the project – the core warning system implementation is a task that is both major and urgent, and therefore this is an immediate priority for action under the project. UNESCO-IOC is moving quickly on the first steps to establish the necessary basis of technical information and institutional consensus. Likewise, the countries of the region are mobilizing technical capacities and resources to establish national tsunami warning systems and to engage in the international and regional dialogue and negotiations toward a regional early warning system. Several donors have expressed their willingness to support countries in the substantial investment needed to build a fully fledged system, including the provision of specialized instrumentation and training.

² Partners include: UNDP, OCHA, WMO, UNEP, IFRC, UNESCO-IOC, UNU, ADRC, ADPC, DIPECHO, ISDR secretariat.

The agreement between ISDR and UNESCO-IOC covers the disbursement of **US\$ 3,525,000** for an initial suite of activities that UNESCO-IOC drafted in a project document dated 3 February 2005 (as described in Annex 2 of this Document) and included in project TSU-REG-05/CS06-REGION. These predominantly concern matters of core system implementation. The activities funded by the project include, among other things, the major coordination meetings organised by UNESCO-IOC in Paris, 3-8 March and in Grand-Baie, Mauritius, 14-16 April, national coordination and training meetings, and the partial upgrading of the Indian Ocean sea level gauge network.

It was made clear in the Flash Appeal proposal that the project would undertake only the preparatory steps and that the development of a fully fledged tsunami early warning system would require further planning and substantial resources. The discussions and efforts since early January have now set in place a better basis for elaborating what is required. In particular, UNESCO-IOC has defined a further set of immediate tasks on the core system implementation that require additional support over the next 6-21 months, as described in Section 4.

The future requirements for other activities concerned with preparedness and in-country partnerships with risk reduction and risk management sectors will be elaborated later in 2005 following experience with the relevant activities in partnership development, assessments, dialogues and other activities that remain to be undertaken.

4

Immediate additional needs for Core system implementation: Project TSU – REG-05/CSS10 – region

Requirements will (i) include short-term requirements that will focus on the strengthening of the interim system and the establishment of national capabilities; and (ii) requirements that assist in migrating from the interim system to the permanent operational system. These requirements will be fine tuned further on the basis of the Meetings of the proposed National Tsunami Warning and Mitigation Coordination Committees.

The list of activities that follows (4.1 to 4.10) has been included in a project proposal submitted to UN/OCHA within the framework of the Mid-Term Review of the Tsunami Flash Appeal. The requested budget amounts to US\$ 12,000,000. The Project has been given the code TSU – REG-05/CSS10 – REGION.

4.1. Support of the interim system

An interim system has been put in place (as part of project TSU-REG-05/CS06-REGION mentioned above) to generate Indian Ocean tsunami advisory information at the Pacific Tsunami Warning Center, Hawaii and the Japan Meteorological Agency, Tokyo and to disseminate it to national focal points in Indian Ocean countries. The advisory information is initially based on seismic data only, which brings a high risk of false warning. It will progressively make use of real-time sea level data being developed elsewhere in the project which will considerably improve the quality and reliability of tsunami advisory information.

- Funding is requested for the continued support and management of this interim system by the IOC secretariat.

4.2. Provision and management of sea level gauges in tsunamigenic areas in the eastern Indian Ocean

Work urgently carried out over the period April-June 2005 (as part of TSU-REG-05/CS06-REGION) will result in fifteen tide gauges in the Indian Ocean reporting in real time to the Pacific Tsunami warning center, but the resulting sea level observing network is still insufficiently dense to provide reliable and timely data for the entire Indian Ocean basin.

- Funding is required for upgrading, procurement and installation of new gauges, for mobile service and technical teams, and the continued interim management of the sea level data reporting system in the Indian Ocean by the IOC's secretariat for the Global Sea Level Observing System (GLOSS). The data will support the interim advisory system and subsequent permanent system.

4.3. Utilizing the global marine distress and safety system (GMDSS) to deliver tsunami bulletins to ships in ports or at sea

The GMDSS provides marine weather information that is broadcast via Inmarsat-C SafetyNET by all National Meteorological Services (NMS) appointed as Issuing Services within the framework of the WMO Marine Broadcast System. All passenger vessels and all cargo ships of over 300 gross tons on international voyages are fitted with applicable satellite and radio communications GMDSS equipment, for sending and receiving alerts. This real time communication system can be used to deliver tsunami bulletins directly to ships in port or at sea and is of particular importance for passenger/cruise ships and cargo vessels and tankers carrying hazardous materials.

- Funding is requested to develop appropriate tsunami warning information for ships, both at harbor and at sea, and implement the broadcasting of this information on the GMDSS;

4.4. Incorporate seismic data from the Federation of Digital Broad-Band Seismograph Networks (FDSN) and the preparatory commission for the comprehensive nuclear-test-ban treaty organization (CTBTO preparatory commission) into the IOTWS

The Federation of Digital Broad-Band Seismograph Networks (FDSN) provides real-time seismic data from more than 150 stations around the world. An initial agreement between the CTBTO and UNESCO/IOC tsunami warning centers was achieved during the initial phase of the UN CAP Flash appeal.

- Funding is requested to (i) carry out technical testing of the inclusion of additional seismic data for tsunami warnings; (ii) further development and formalization of cooperation between IOC and FDSN and IOC and CTBTO; and (iii) improvement, procurement and installation of stations as needed;

4.5. Support of governance mechanisms for an Indian ocean tsunami warning system

An agreement among member states to set up an IOC Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) subsidiary to the IOC Assembly was achieved during project TSU-REG-05/CS06-REGION. This activity may also include scientific and technical conferences to enable the sharing of expertise and experience.

- Funding is requested to cover the activities of this Group and its secretariat;

4.6. Support for the establishment and operational support of national tsunami warning centers

Country assessments completed during the project TSU-REG-05/CS06-REGION will provide detailed terms of reference for each National Tsunami warning Centre to be established. This activity will assist national government with the practical implementation of the establishment of the Centres through the provision, installation, upgrading or repair of equipment and related materials. In addition, financial support will be provided to assist these new Centres through an initial start-up period.

- Funding is requested for the procurement, installation, upgrading or repair of required equipments and related materials to establish National Tsunami Warning Centres, as well as for their operational support.

4.7. Fast-track training related to tsunami warning

This activity will focus on providing fast-track training to national experts as relevant to steps 1 to 6 above. It is also a follow-up to the initial set of three training courses implemented during project TSU-REG-05/CS06-REGION. In particular this activity will cover fast-track training in: (i) interpretation of tsunami advisory information provided by PTWC/JMA; (ii) tsunami travel time calculation; (iii) national tsunami warning response coordination (end-to-end approach); (iv) operation and maintenance of sea level gauges and seismic stations used for tsunami warning; (v) tsunami warning communication (reaching the population); (vi) preparedness: fast-track “inform the population” actions; (vii) risk assessment: introduction to preparation of inundation maps (tsunami inundation risk needs to be taken into consideration prior to reconstruction of destroyed dwellings). In order to ensure the long-term re-usability of the training initiatives, a comprehensive training system will be developed, similar to IOC’s OceanTeacher system (TsunamiTeacher). This may also include support for internships and travel grants. In this regard extensive use will be made of the long-term experience and expertise of the International Tsunami Information Center (ITIC) in Honolulu, Hawaii that has training as a core element of its mandate;

- Funding is requested to implement a number of regional training courses, as well as to develop the accompanying computer-assistance training tool Tsunamiteacher.

4.8. Development of high resolution near shore bathymetry

Near shore bathymetry data are needed in every site where tsunami hazard and risk assessment must be performed. The speed and, in consequence, the amplitude of the tsunami phenomena is directly related to the variation of the bathymetry. In consequence, near shore bathymetry with enough accuracy (cells of 10 - 15 m) is absolutely necessary to compute tsunami run-up and inundation maps

- Funding is requested to identify and obtain high resolution near shore bathymetry data.

4.9. Initial development of a basic and applied scientific research effort to improving tsunami warning science and technology

The capability to correctly assess tsunami occurrence, magnitude and impact depends to a large extent on the scientific knowledge underpinning the operational activities. Continued scientific research as well technological development is required to improve our capabilities. In addition a historical tsunami database for the Indian Ocean needs to be developed (as has been done for the Pacific region), as an important element in risk assessment).

- Funding is requested to strengthen scientific research and technological development efforts focusing on tsunami warning capability in the Indian Ocean.

4.10. Preparation of tsunami inundation maps

To assess tsunami hazard and risk for various coastal areas, taking into consideration population and reconstruction, focusing on highest risk and highest population areas, tsunami inundation maps have to be developed at the national level for the most essential coastal areas (e.g. high population areas). This activity will be strengthened also through activity 9 above.

- Funding is requested to support partial funding to develop national tsunami inundation maps.

4.11. Timeline for proposed immediate additional needs

The below figure shows the timeline for implementation of the activities outlined in 4.1 to 4.10 above. It is noted that some activities will need to be supported beyond December 2006.

	2005								2006			beyond
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
1: Interim system	■	■	■	■	■	■	■	■	■	■	■	■
2: Sea level gauges				■	■	■	■	■				
3:GMDSS					■	■	■	■	■	■	■	■
4: FDSN/ CTBTO data					■	■	■	■	■	■	■	
5: Governance system			■	■	■	■	■	■	■	■	■	
6: NTWC support	■	■	■	■	■	■	■	■	■	■	■	
7: Fast-track training					■	■	■	■	■	■	■	■
8: Bathymetry						■	■	■	■	■	■	
9: Science and Technology							■	■	■	■	■	■
10: Inundation maps								■	■	■	■	■

4.12. Costing table

	Total cost in US\$
1: Interim system	300,000
2: Sea level gauges	3,000,000
3:GMDSS	450,000
4: FDSN/ CTBTO data	700,000
5: Governance system	380,000
6: NTWC support	3,000,000
7: Fast-track training	1,000,000
8: Bathymetry	400,000
9: Science and Technology	180,000
10: Inundation maps	1,350,000
Coordination support costs	1,240,000
	12,000,000

5

Further requirements as formulated by countries and organizations

In order to make a preliminary assessment of requirements as identified by countries in the Indian Ocean region, IOC requested countries, as well as a few organizations and programmes to submit relevant proposals. These are collated as Annex 1. We note that only summaries are provided and the proposals should be considered as preliminary proposal briefs Fully detailed proposals will be prepared after extensive consultations and national assessment exercises that could be planned to coincide with meetings of the National Tsunami Warning and Mitigation Coordination Committees (see 2.1)

The following proposals have been received: (see Tables, next pages)

INDIAN OCEAN TSUNAMI
TSUNAMI WARNING AND MITIGATION SYSTEM

Countries in the Indian Ocean region			
Country/ Organization	Title	Cost US\$	Amount requested
Bangladesh	Bangladesh National Comprehensive Tsunami and Cyclone Early Warning System for Bay of Bengal	Not specified	Not specified
France	French National Center within the IOTWS	16,900	0
India	Early Warning System for Mitigation of Tsunami and Storm Surges in Indian Ocean	30,000,000	0
Indonesia	Establishment of Tsunami Early Warning System in Indonesia	59,800,000	Not specified
Kenya	Establishment Of An Operational Multi-Hazard Early Warning System For Kenya	2,103,000	2,103,000
Madagascar	Système d'alerte aux Marées et Inondations Extraordinaires A Madagascar (Samiem) (to be reduced by \$ 25,000/year obtained through ODINAFRICA)	1,358,000	1,358,000
Malaysia	Malaysian National Tsunami Early Warning System (except for technical expertise)	5,000,000	0
Mauritius	National Tsunami warning System in Mauritius under a multi-hazard framework	Not specified	Not specified
Oman	Multi-hazard early warning system in Oman	Not specified	Not specified
Seychelles	Establishment of a Seychelles Early warning and mitigation system based on a multi-hazard approach	2,640,000	2,640,000
Singapore	Enhancement of seismic sensors and tidal gauges network	400,000	400,000
Sri Lanka	Establishment of a 24-hour operational Natural Disaster Early Warning System for Sri Lanka, including capacity building	Not specified	Not specified
Tanzania	Tsunami Warning and Mitigation System for Tanzania	1,050,000	1,050,000
Subtotals		102,367,900	7,551,000

INDIAN OCEAN TSUNAMI
TSUNAMI WARNING AND MITIGATION SYSTEM

Others			
Country/ Organization	Title	Cost US\$	Amount requested
Flanders (Belgium)	Data management and other training related to tsunami warning	1,000,000	350,000
Russia (Tsunami Laboratory, Computational Mathematics and Mathematical Geophysics (TL/ICMMG), Novosibirsk)	Integrated Tsunami Database for the Indian Ocean (ITDB/IND)	60,000	45,000
IOC (IOC WIO/ODINAFRICA project Office, Kenya)	Establishment of a Western Indian Ocean and Red Sea regional tsunami warning and mitigation system for tsunamis and other marine related hazards	7,713,000	7,213,000
IOC (IOC Regional Office, Perth, Australia)	Sustained Mooring Array for Indian Ocean Tsunami	8,500,000	4,000,000
IOC (Ocean mapping)	Building Capacity to generate Coastal Bathymetry: A critical element in protecting lives and livelihoods in areas prone to ocean-based extreme events	810,000	800,000
UNESCO (Natural Sciences Sector)	Community Based Earthquake and Tsunami Warning, Awareness and Recovery Programme, and Its Implication to Disaster Preparedness	678,000	650,000
WMO	Enhancement of multi-hazard national warning alert and response mechanisms	4,500,000	4,500,000
WMO	Use and strengthening of the WMO's Global Telecommunication System (GTS) for exchange and distribution of Tsunami Warning System alerts and related information	1,400,000	1,000,000
WMO	Increased utilization of space-based capabilities in the IO region for multi-hazard EWS including Tsunamis	300,000	300,000
Subtotals		24,961,000	18,858,000
Grand Totals		127,328,900	26,409,000

Annex 1 National and Regional Preliminary Proposals

NATIONAL

- Bangladesh
- France
- India
- Indonesia
- Kenya
- Madagascar
- Malaysia
- Mauritius
- Oman
- Seychelles
- Singapore
- Sri Lanka
- United Republic of Tanzania

REGIONAL

- IO-GOOS
 - Tsunami Laboratory, Russian Federation
 - UNESCO/IOC – Warning and Mitigation
 - UNESCP/IOC – Coastal Bathymetry
 - VLIZ/Belgium
 - UNESCO/SC – Earthquake and Tsunami Warning
 - WMO – Global Telecommunication System
 - WMO – Multi-hazard EWS
 - WMO/IOC – National Warning Alert
-

This chapter presents a compilation of summaries of national and regional initiatives towards the coordinated development of an Indian Ocean Tsunami Warning and Mitigation System. These documents were prepared by countries and organisations using a format provided by the IOC.

Some of these summaries reflect the fact that leading countries are already engaged in the process of establishing National Tsunami Warning Systems. Some other summaries can be utilized as starting points towards the development of fully detailed project proposals for submission to donors.

Countries may want to invite relevant international and other organizations as well as interested donors to assist with technical guidance and expertise for further developing their proposals. Some countries have already asked for technical assistance. UNESCO/IOC and ISDR will undertake technical missions with relevant national and international partners with the goal of producing a comprehensive proposal at the country level. These missions will include national coordination meetings, expert missions and preliminary training, as foreseen in the projects submitted by UNESCO/IOC and ISDR through the OCHA Flash Appeal.

It is worth to note that some of the components of the national proposals may be funded under the UNESCO/IOC Flash Appeal Project, notably those related to the establishment of core capacities at the national level for the tsunami Warning Centre, including provision of equipments.

BANGLADESH

Bangladesh National Comprehensive Tsunami and Cyclone Early Warning System for Bay of Bengal

Implementing Organization:

Directorate of Relief and Rehabilitation, Ministry of Food and Disaster Management

Contact Person:

Md. Mahfuzur Rahman, Director General
Directorate of Relief and Rehabilitation, Ministry of Food and Disaster Management, Mahakhali, Dhaka
Phone: 880-2-8813639, Fax: 880-2-9860130, E-mail: dgdr@agnionline.com

Beneficiaries:

- a. 20 Million people living in coastal areas of Bay of Bengal
 - b. 15 Urban Clusters, including Chittagong Port City, Khulna Port City and Barisal Town
 - c. International Sea Ports of Chittagong and Chalna
 - d. Industries along the Chittagong, Sitakunda, Mirsharai and Khulna coastal zone
 - e. Sundarban (Mangrove Forest) World Heritage, Agriculture Land and Fisheries
-

Partners:

- | | |
|--|--|
| 1. Disaster Management Bureau | 8. Chittagong Port Authority |
| 2. Prime Ministers Office | 9. Khulna Port Authority |
| 3. Geological Survey of Bangladesh | 10. Bangladesh Armed Forces Div. |
| 4. Water Development Board | 11. Bangladesh Navy |
| 5. Bangladesh Inland Water
Transportation Authority | 12. National Oceanographic Institute |
| 6. Bangladesh meteorology Dept. | 13. Bangladesh Red Crescent |
| 7. Department of Shipping | 14. Geology Dept. Dhaka University |
| | 15. Bangladesh University for and technology |
-

Aim:

Comprehensive Tsunami and Cyclone Early Warning System for Bangladesh (Bay of Bengal) to support IOTWS. Integrated observational network for Seismic and Tsunami monitoring, assessment of the tsunami hazard, development of national data system and tsunami simulation/prediction systems, arrangements and standards for warning dissemination and communication, risk management, installation of telecommunication to support the observational and warning components.

Support pledged:

- A) No support pledged for development of tsunami warning system
 - B) Well-developed Cyclone Prepared Programme (CPP) exists in Bangladesh. The cyclone warning system will be linked to the proposed Tsunami Early warning system (TEWS).
-

Financial Support Already Obtained:

INDIAN OCEAN TSUNAMI
NATIONAL PRELIMINARY PROPOSALS

Different NGOs and Donor Agencies acting into the maintenance and awareness development programmes for cyclone, tidal bore and coastal surges. Bangladesh successfully reduced the loss of lives and properties. Flood forecasting & Warning system also exist in the country, it would be modernized and linked with TEWS.

Financial Support Already Obtained:

NA

Support sought:

- a. Short Period Seismometer-2 Nos., Broadband Seismometer 1 No., Hydro-acoustic Station-3 Nos. Sea height Buoys-3 Nos., Tide gauges-25 Nos., Automated Processing System, Telemetric Communication System, GIS based data integration system, maintenance and operation cost. Installation cost. Accessories for development of link with the existing cyclone and flood warning system.

Financial Support Being Sought:

US\$ 9,000,000

- b. Research, training and capacity building, periodic updating/replacement of equipment and tools for durability of the system. Coordination with consistent global satellite monitoring network and Global Warning System.

Financial Support Being Sought:

US\$ 4,000,000

Total:

US\$ 13,000,000

Overview

Andaman-Sumatra earthquake of 26 December 2004 has forced us to re-evaluate the seismogenic hazard maps and develop observation, monitoring and warning system. It is massive tsunami causing death of about 300,000 people and destruction of huge livelihood. The earthquake caused unprecedented changes in the seafloor configuration, coastal livelihood and created panic among the people living in the earthquake and tsunami vulnerable zones. A cooperative and integrated observational network a comprehensive assessment of the tsunami hazard, development of national data analysis and tsunami simulation/prediction systems, installation and standards for warning dissemination communication, development of risk management framework, appropriate telecommunication capabilities to support the observation and warning components. The proposed project comprises seismic and geophysical instruments, coastal tidal gauge, and cooperative deep ocean pressure measurement to detect tsunami related changes in the sea, bathymetry, seafloor and coastal mapping for modeling and mitigation studies, hazards and risk assessment. Implementation will reduce multi-hazard risk and ensure sustainable development.

FRANCE

French National Center within the IOTWS

Implementing Organization:

Météo-France, RSMC La Réunion

Contact Person:

The director of Météo-France RSMC La Réunion Island
Phone: +262 262 92 11 01, Fax: +262 262 92 11 47, Email: dirred@meteo.fr

Beneficiaries:

People living in coastal areas of Réunion Island and Mayotte, with extension to countries in the South-West Indian ocean

Partners:

- La Réunion French authorities and agencies
- Commission de l'Océan Indien

Aim:

Set up an operational 24 hour tsunami warning & mitigation centre, hosted by the Météo-France La Réunion Island, and providing support at Regional level (South-west Indian Ocean).

Overall Budget:

13 000,000€ (immediate actions taken)

To be confirmed for the short and longer term actions

Support pledged:

Financial Support Already Obtained: NA

Support sought:

Financial Support Being Sought: NA

Overview

Météo-France in La Réunion has been designated to host the French national tsunami warning centre and act as the focal point within the IOTWS.

- This centre will benefit from the experience gained from operation of the Regional Specialized Meteorological Centre (RSMC) for cyclones in La Réunion, in charge of tropical cyclone warning 24 hour-7 day for the South-West Indian Ocean, to the benefit of 14 countries;
- Météo-France in La Réunion has an high speed link to the WMO Global Telecommunication System (GTS) and strong capacity of data collection and information management;
- The centre can rely on expertise of the other French agencies in La Réunion, Mayotte and French Austral territories. This namely encompasses those in charge of seismic and volcanic

- monitoring (IPGP, CEA), sea level monitoring (SHOM, DDE, CNRS), risk assessment and education (BRGM) as well as oceanic studies (IFREMER, IPEV, IRD);
- The centre will be part of the already existing risk management framework set up and coordinated by the French authorities in La Réunion (Préfet, Zone de Défense civile), and benefit from previous experience in natural hazard warnings and advisories to local authorities and neighbouring countries.
 - The Centre will be developed further in multi-hazard perspective with focus on sea-level related risks.

INDIA

Early Warning System for Mitigation of Tsunami and Storm Surges in Indian Ocean

Implementing Organization:

Department of Ocean Development (DOD), Government of India

Contact Person:

Secretary, DOD, Phone: +91-11-24360874, Email: dodsec@dod.delhi.nic.in

Beneficiaries:

- (a) People living in coastal areas of India and
- (b) the countries surrounding the Indian Ocean Basin

Partners:

1. Department of Space
2. Department of Science and Technology
3. Council of Scientific and Industrial Research
4. Academia

Aim:

- (a) Realize operational National Early Warning System for Tsunami and Storm Surges,
- (b) Set up National Early Warning Centre at Indian National Centre for Ocean Information Services (INCOIS) Hyderabad and operate on a 24x7 basis to generate and issue 'warning' and 'watch' advisories, and
- (c) Institute a mechanism to sustain the System

Overall Budget:

US\$ 30.000.000

Support pledged:

Not applicable

Full funding by Government of India

Support sought:

Not applicable

Financial Support Being Sought: NA

Overview

The Indian Ocean rim countries are likely to be affected by tsunamis generated in the two known tsunamigenic zones (viz. Java-Sumatra-Andaman-Myanmar belt and the North Arabian Sea). While the occurrence of tsunamis has been infrequent (about 6 events reported in the 20th century) in the Indian Ocean, it may be noted that they could occur any time and could be very devastating. Recognizing this imminent need, India is developing Tsunami Early Warning System on high priority, covering these two tsunamigenic zones. India could also provide warnings to the countries in the region through an appropriate mechanism (such as IOGOOS). The coastal population being the victims of cyclonic storm surges and tsunami, it has considered prudent and cost-effective to address them together.

INDONESIA

Establishment of Tsunami Early Warning System in Indonesia

Implementing Organization:

Meteorological and Geophysical Agency of Indonesia

Contact Person:

Prime:

Ir. Sri Woro B. Harijono, M.Sc., Deputy for Data & Information System
Meteorology & Geophysical Agency, Jl. Angkasa No. 2, Kemayoran, Jakarta 10220
Phone: 62-21 424 63 21, Fax: 62-21 424 67 03, Mobile: +62-816-1980225
E-mail: sriworo@bmg.go.id, Website: www.bmg.go.id

Alternate:

Dr. P.J. Prih Harjadi, Director Center for Geophysical Data & Information System
Meteorology & Geophysical Agency, Jl. Angkasa No. 2, Kemayoran, Jakarta 10220
Phone: 62-21 424 63 21, Fax: 62-21 424 67 03, Mobile: +62-811-109636
E-mail: prih@bmg.go.id, Website: www.bmg.go.id

Beneficiaries:

- Local Government
 - People and tourists living in coastal areas
 - Industries, hotels, restaurants and other business in coastal areas
-

Partners:

National Partners

- Ministry of Research and Technology
- National Coordinating Agency for Mapping and Survey
- National Agency for Assessment and Application Technology
- Indonesian Institute for Sciences
- National Coordinating Board for Disaster and Refugee
- Management
- Institute Technology Bandung
- Etc.

Foreign Partners

- Comprehensive Nuclear Test ban Treaty Organization (CTBTO)
 - National Research Institute of Earthquake and Disaster
 - Prevention (NIED), Japan
 - China Earthquake Administration (CEA)
 - Ministry of Education and Research of Germany
 - Japan Meteorological Agency (JMA)
 - World Meteorological Organization (WMO)
 - Delf Hydraulic and KNMI of the Netherland
-

Aim:

- To establish one National and ten Indonesian Regional Earthquake Information and Tsunami Warning Center
- Install and upgrade 160 seismic station, 500 accelerometer, DART system, GPS buoys, network of GPS and network of Tide Gauges
- Set up automatic integration system
- Set up automatic data acquisition, phase picking and processing
- Set up Data base system
- Set Up telecommunications system for data collection and warning dissemination

Overall Budget:

US\$ 59,800,000

Support pledged:

- China thru CEA will provide ten seismograph broadband and accelerometers, processing facilities, training, expertise, maintenance for limited time. The Intention of Cooperation is already signed in early March
- Germany thru Ministry of Federal Education and Research will support on the first phase: up to 25 seismograph and accelerometers, 10 GPS, 10 GPS-buoys, 20 DART, capacity building. Joint Declaration has been signed on mid of March
- Japan thru NIED will support up to 44 seismometer, at which 20 has been operated and others will be soon
- The Netherlands, thru Delf Hydraulic has support software for tsunami simulation. Cooperation has been signed in February 2005

Financial Support Already Obtained: NA

Support sought:

In kind support requested are the rest of the equipment and facilities proposed that are not yet covered by donors countries Japan, Germany, China, Netherlands. The list of countries/organizations expected to become donors are:

- Japan
- USA
- France
- Australia
- Unesco
- Etc.

Financial Support Being Sought: NA

Overview

Indonesia is located in very seismic active region, this can be referred to the historical record from 1900 up to 2004 that 212 earthquakes with magnitude greater and equal 7.0 RS had occurred at which 183 located in the sea and 153 were shallow. According to Gusiakov data base, there were 86 tsunami generated. On the ASEAN regional basis, earthquake with magnitude greater than 6.0 on Richter Scale 46 % located in Indonesia. With regards to Indian Ocean, most of major earthquake take place in Indonesia along more than 4000 km long of subduction zone which begins from north Sumatra to east of Timor island.

The distance of the earthquakes source to shore lines varies from few tenth of kilometers to around 300 km, this will correspond to few minutes to 30 minutes of arrival of tsunami waves. In this regards, the tsunami warning should be disseminated much earlier which will need earthquake location and magnitude and depth should be found before 5 minutes. In order to locate the earthquake source in less than 5 minutes MGA proposes to set up 10 Indonesian Regional Centers and one National Center. When one of the Indonesian regional Center issue the warning for local tsunami, National Center will verify and decide to transmit the warning to national level and regional scale event global scale.

The system will base on earthquake monitoring system and strongly supported by DART, tide gauges, GPS at which the data will be collected and processed at the respective Center.

KENYA

Establishment of an Operational Multi-Hazard Early Warning System for Kenya

Implementing Organization:

Kenya Meteorological Department (KMD)

Contact Person:

Dr. Joseph Mukabana, Director / KMD

Phone: 254-20-567880, Fax: 254 20 57 6955, mukabana@meteo.go.ke

Beneficiaries:

- The resident Kenyans along the coastal zones
 - The tourists and visitors at the Kenyan sandy beaches
 - The Hotel industry and tour operators at the coastal zone
 - Artisanal and commercial fishermen in Kenya
 - Scientific community
 - Decision makers
-

Partners:

Kenya Marine & Fisheries Research Institute (KMFRI)
IGAD Climate Prediction and Application Center (ICPAC)
IOC/UNESCO
WMO Sub-regional office

Aim:

To establish an operational multi-hazard warning system for Kenya hosted at KMD. The project aims at contributing to the sustainable use and protection of the marine environment through establishment of early warning systems and mitigation for improved long-term planning and management of impacts of tsunamis and other hazards (e.g., storm surges, coastal flooding, tropical cyclones, etc).

Overall Budget:

US\$ 2,103,000

Support pledged:

- Provision of office facilities to host the Multi-hazard early warning system secretariat
 - Provision of scientists for the operation of the system
 - Availability of two sea-level gauges at Mombasa and Lamu as part of the system. University of Hawaii Sea Level Center has pledged to upgrade both Mombasa and Lamu gauges to real-time observing stations
 - Availability of the global Telecommunication System for links with other regional countries hosted at KMD
 - 15 Drifting Buoys available to Kenya Meteorological Department to be deployed along the Kenya Coast donated by NOAA.
 - Open and free access of data generated by the system
-

Financial Support Already Obtained: None

Support sought:

Financial Support Being Sought: US\$ 2,103,000

- Three (3) anchored oceanographic buoys with meteorological, sea-level and bottom pressure sensors: to be deployed offshore in the Indian Ocean
 - 3 tide gauges at Shimoni, Malindi and Kiunga
 - 8 seismic meters (land based as well as ocean bottom based)
 - Capacity building for installation and maintenance of above equipment as well as for analysis and interpretation of data generated by the warning system
 - Establishment of a modeling center at KMD
 - Improvement of GTS telecommunication network in Kenya to ensure rapid transmission and timely exchange of data
 - Improve the Meteosat Second Generation telecommunication missions to relay the data and information from these platforms to chosen KMD ground station
 - VSAT links to marine institutions for broadcasts of warnings
 - Networking the Early Warning Center to special institutions along the coast (GoK, NGO, Hotels)
 - Provision of broadcasts through RANET Radio stations using the most appropriate language
 - Provision of Posters showing escape routes during warning
 - Education Campaign posters
 - Sustained awareness campaigns etc.
 - Establishment of all-media all-hazard citizen alert systems with most appropriate GSM cell broadcasting systems to reach a large number of exposed citizens in the shortest amount of time
-

Overview

The recent Indian Ocean Tsunami resulted in devastations amounting to national calamities in several countries surrounding the Indian Ocean. Kenya is among the affected countries in the region. Kenya supports the establishment of multi-hazard warning system on a national level while cooperating with other countries for setting up a regional system for the Indian Ocean.

The project aims at contributing to the sustainable use and protection of the marine environment through establishment of early warning systems and improved long-term planning and management of impacts of tsunamis and other hazards (e.g. storm surges, coastal flooding, tropical cyclones, etc). This will be achieved through improved ocean monitoring and predictions, based on enhancement of coastal and offshore observing systems. It will also focus on capacity building at technical and scientific levels through training on equipment installation and maintenance as well as on data analysis and interpretation with emphasis of numerical modeling and forecasting. The project also focuses on the establishment of all-media all-hazard citizen alert systems with most appropriate GSM cell broadcasting systems to reach a large number of exposed citizens in the shortest amount of time as part of awareness and preparedness. The system will form part of IOTWS. There will be open and free access of data generated from the system to all countries in the region.

MADAGASCAR

Système d'alerte aux marées et inondations extraordinaires à Madagascar (SAMIEM)

Implementing Organization:

Ministère de l'Éducation Nationale et de la Recherche Scientifique (MENRS)

Contact Person

Ratomahenina Onésime Richard J.

c/o: Ministère de l'Éducation Nationale et de la Recherche Scientifique (MENRS)

Direction de la Recherche (DR)

BP 4163, Antananarivo (101), Madagascar, Phone: [+261 20] 33 12 419 23, Fax: [+261 20] 20 631 65

Email1: richardrato@hotmail.com Email2: lalarazafi@mineseb.gov.mg

Beneficiaries:

- Population des zones côtières et
 - Secteurs potentiels à caractère social et socio-économiques:
 - Pêche,
 - Tourisme,
 - Transports Maritimes et fluviaux
-

Partners:

- Direction de la Recherche
 - IH.SM,
 - CNRO
 - Direction Générale de la Météorologie
 - Direction des Exploitations Météorologiques
 - Institut National de Géographie et d'Hydrographie
-

Aim:

Développer un système intégré scientifique et technique de prévision, d'alerte, face aux risques multiples des marées et des inondations extraordinaires, pour produire des éléments pertinents d'aide à la décision à usages nationaux et internationaux, en vue de réduire leurs effets.

Overall Budget:

US\$ 1, 358 000^(*)

^(*) excluant la composante: "Financial Support Already Obtained"

Support pledged:

Financial Support Already Obtained: US\$ 25,000 per year

(valeurs accessibles via IOCWIO/UNESCO Project Office, Nairobi, Kenya)

- Contribution nationale en cours (Direction Générale de la Météorologie)
 - Personnel scientifique et technique,
 - Système d'Observation Synoptique,
 - Météorologie opérationnelle: modélisation des hauteurs des vagues
 - Contribution prévue dans le cadre de ODINAFRICA
 - Installation de marégraphes et
 - Formation en maintenance et traitements des données marégraphiques
-

Support sought:

Financial Support Being Sought: US\$ 1 358 000

- Recyclage et/ou formation en matière d'acquisition jusqu'à la restitution des données et des informations scientifiques et techniques:
 - Océanographie (physique et opérationnelle),
 - Météorologie (dynamique et opérationnelle),
 - Télécommunication (transmission des données environnementales, systèmes de réseaux de communication,...)
 - Acquisition et/ou réactualisation des données:
 - Bathymétriques et topographiques côtières détaillées,
 - Courbes de niveau des zones terrestres côtières.
 - Acquisition de système informatique de lecture/ traitements (ordinateurs, logiciels,...) et de restitutions cartographiques (imprimante grand format)
 - Recyclage et/ou formation en matière de modélisation numérique (inondations dues aux cyclones/ondes de tempête/marées extraordinaires)
 - Réhabilitation (Nosy-Be et Fort Dauphin)/installation (Tamatave et Sambava)/Maintenance de quatre stations d'observation du niveau de la mer (marégraphes) et installation de systèmes associés de transmission et de télétransmission des données
 - Recyclage et/ou formation en matière d'Information, d'Education et de Communication (IEC):
 - Acquisition d'un véhicule (4x4) de campagnes de sensibilisation
 - Production de documents IEC (Brochures, affiches, vidéo,...) bilingues
 - Matériels de communication du Comité d'Alerte aux marées et inondations extraordinaires (CAMIE):
 - un ordinateur, emails, deux téléphones, un fax
 - un véhicule (4x4) de coordination/liaison
-

Overview

Plus de 38% de la population de Madagascar constituent sa communauté côtière. L'économie de l'île est tributaire de l'exploitation de la mer : secteurs Pêche, Tourisme et Transports maritimes et fluviaux.

Sur les façades maritimes, les effets des risques naturels multiples pourraient être : les inondations induites par les cyclones tropicaux, par les ondes de tempête, et celles éventuellement engendrées par les marées extraordinaires dont les résidus des ondes de tsunamis. A cette série s'ajouteraient, les menaces de déversement d'hydrocarbures.

Pour pouvoir prendre des mesures pertinentes de réduction de leurs impacts, il faudrait disposer de réseaux thématiques d'observation (niveau national et régional). En amont desquels, les processus de "sensibilisation-prévision-alerte" constituent un élément de pérennisation.

Dans cette perspective, Madagascar devrait renforcer ses potentialités scientifiques et techniques, à travers les grands programmes régionaux tels que le GOOSAFRICA, IO-GOOS, WIOMAP, et des accords bilatéraux/multilatéraux ciblant les domaines de l'océanographie physique et opérationnelle, de la météorologie maritime et de la télécommunication.

MALAYSIA

Malaysian National Tsunami Early Warning System

Implementing Organization:

Ministry of Science, Technology and Innovation
Malaysian Meteorological Service

Contact Person:

Mr. Chow Kok-Kee
Phone: 603-79678046, Email: chow@kjc.gov.my

Beneficiaries:

Public and disaster relief agencies

Partners:

- 1) Ministry of Science, Technology and Innovation
- 2) Malaysian Meteorological Service
- 3) National Oceanography Directorate
- 4) National Space Agency
- 5) Malaysian Centre For Remote Sensing
- 6) National Security Division

Aim:

To establish a national tsunami warning system centred at the Malaysian Meteorological Service which is tasked to provide timely and accurate information and early warning on earthquakes and tsunamis to the public and disaster relief agencies.

Overall Budget:

US\$ 5 000,000

Support pledged:

Malaysian Government has allocated US\$ 5 000,000 for the implementation of the National Tsunami Early Warning System.

Financial Support Already Obtained: US\$ 5 000,000

Support sought:**Financial Support Being Sought: International centers and donor countries**

Malaysia is seeking technical assistance from Japan Meteorological Agency, Pacific Tsunami Warning Centre (PTWC) and other donor countries for the implementation of the national tsunami warning system. These include technical advices on network design, risk assessment and capacity building for seismologists, geologists, coastal hydrologists as well as best practice in dissemination of warning and public awareness.

1. Overview

The proposed national tsunami early warning system shall include the upgrading of present seismic monitoring network, tidal stations in selected sites along the country shorelines for sea levels measurement. The possible need for installation of deep sea pressure sensors will be investigated. Technical assistance will be sought from current existing centers such as Japan Meteorological Agency, PTWC and others to guide in the setting up of the tsunami warning system. The tsunami warning system will be integrated with existing national early warning system for other hazards such as storm surges and tropical cyclones.

The national tsunami warning center will be coordinated and eventually linked up with the Indian Ocean Tsunami Warning Centre, other international centers and national centers. Seismic data, water-level measurement data and other information in real time will be made available for sharing with other centers.

MAURITIUS

National Tsunami Warning System in Mauritius under a Multi-Hazard Framework

Implementing Organization:

- (1) Ministry of Environment and NDU (Coordination)
 - (2) Meteorological Services (Technical)
 - (3) Mauritius Oceanography Institute (Technical)
-

Contact Person:

- (1) Mrs D Lan Ng, Director, dirdoe@mail.gov.mu
Alternate: Mr P Kallee, Deputy Director, pkallee@mail.gov.mu
 - (2) Mr Sok Appadu, Director, meteo@intnet.mu
 - (3) Dr M. Bhikajee, Director, bhikajee@moi.intnet.mu
-

Beneficiaries:

- Public Sector
 - Fishing Community
 - Student's School Community
 - Tourist/ Hotels
 - Private Sector/ Industrial Community
 - Coastal Residents
 - Scientific Community
 - Port Users/ Harbour/ Shipping Companies
-

Partners:

- Police Force
 - National Coast Guards
 - Mauritius Ports Authority
 - Local Authorities
 - Meteorological Services
 - Mauritius Oceanography Institute
 - Ministry of Fisheries
 - Media (TV, Radio, Press)
 - AHRIM
 - Private Sector
 - Beach Authority
-

Aim:

Set up an operational 24 hour Tsunami warning system hosted within the national meteorological agency of country under a multi-hazard framework

Overall Budget:

NA

Support pledged:

Local

- Ministry of Environment – Promotion and protection of environment
- National Environment Fund – Emergency fund
- Funding from Government (Ministry of Finance and Economic Development)
- Prime Minister's Relief Fund

Government is committed to provide all support – provision will be made for the setting up of the National Center Personnel: existing staff

Financial Support Already Obtained: NA

Support sought:

- Financial/Technical support for purchase, installation and commissioning of equipment
- Logistical Support for networking with other centers.
- Short attachment to different Centres such as Pacific Tsunami Warning Centre, JMA...

Financial Support Being Sought: NA

Overview

The small size of the island, high population density, fragile ecosystems (coral reefs and coastal zone), inadequate infrastructure and natural resources, climate variability, are the numerous factors which affect our social and economic development.

The meteorological office has noted that during the past decades, there is a marked increase in the number of violent cyclones which influence our country and also that there is a decrease by 10 % in the annual rainfall during the last 50 years.

In Mauritius there is already an advance warning system for cyclones. The Met Office is equipped with sophisticated apparatus to follow the movement of cyclones and accurately predict when it will hit the island and what its force is. The population is warned well in advance and is knowledgeable in terms of precautions that need to be taken during a cyclone.

Moreover there is a natural disaster committee under the Prime Ministers Office which deals with cyclones, floods, landslide and drought. The Committee is composed of several ministries, parastatal and private sector.

After the 26th December 2004, Mauritius realized that it is vulnerable to tsunamis and therefore there is a proposal to include tsunami as one of the natural disasters that shall be considered by the Natural Disaster Committee.

OMAN

Multi-hazard early warning system in Oman

Implementing Organization:

Directorate General of Civil Aviation and Meteorology
& The Earthquake Monitoring Center

Contact Person:

Mr. Ahmed Al-Harthy, Acting Director of Meteorology
Email: a.alharthy@met.gov.om

Beneficiaries:

For example: Omani Citizen along the coast and people living in coastal areas of countries surrounding the Indian Ocean Basin

Partners:

Directorate General of Civil Aviation and Meteorology
Earthquake Monitoring Center Ministry of Regional Municipality,
Water Resources and Environment Department of Civil Defense

Aim:

The main aim of this proposal is to set up an operational 24 hour tsunami warning system as well as other natural and man-made hazards hosted within Directorate General of Civil Aviation and Meteorology of Oman

Overall Budget:

The budget is still not known yet?

US\$ NA

Support pledged:

The sultanate of Oman is committed to establishing a Tsunami warning system along the coastal areas of the country. Oman will finance it own TEWS.

Financial Support Already Obtained: It is not yet finalized

Support sought:

Oman will seek the support of the IOC and countries participating in the Pacific Tsunami Warning System in the planning and training of the local scientist on such a system

Financial Support Being Sought: None

Overview

The December 26 tsunami disaster is one of the largest natural disasters ever to hit South and Southeast Asia. Oman southern coast was slightly affected by the Tsunami wave which caused minor damage to fishing boats and inundating shore areas in Salalah region. Oman coast extends from Yemen in the south to strait of Homuz in the northwest approximately 1700 km of shore line on waters that are part of the Indian Ocean.

In response to December 26, 2004 disaster, Oman has called for a coastal monitoring and response system to be established. Since Tsunamis are rare events, to be sustainable, such a system will serve as a multi-hazard warning system for the coastal region of Oman. This system will be an integral part of the Indian Ocean Tsunami Warning System (IOTWS). The Omani monitoring network will enhance the IOTWS system by providing additional coverage of the region and give them information that will help in designing the over all Indian Ocean network. The real-time data can be sent to the monitoring facility designated by the UN for immediate analysis. Therefore, the seismic data which is forwarded will allow prediction of tsunami and local processing of other oceanographic, meteorological and coastal environments parameters. This data will be of benefit to coastal industries using seawater, and other Omani government institutions.

SEYCHELLES

Establishment of a Seychelles Early warning and mitigation system based on a multi-hazard approach

Implementing Organization:

Submitted by National Meteorological Service of Seychelles

Contact Person:

Wills Agricole, Director National Meteorological Services
Phone: +248 384066/68, Fax +248 384078, Mobile +248 714419, Email: w.agricole@pps.gov.sc

Beneficiaries:

The ultimate goal is to save lives and property within the Seychelles and also contributing to the Global Initiative towards mitigating natural disasters

Partners:

National agencies in the IOC/UNESCO/JICA/UNDP/World Bank/EU

Aim:

Develop and establish a 24 hour Early Warning System in Seychelles based on a multi-hazard approach which mainly geared towards the improvement of atmospheric and oceanic observing networks, particularly in the planning of network of observations, acquisition of modern meteorological equipment and a comprehensive capacity building programme, that will enable all our partners and member from the public to respond promptly and take appropriate action to mitigate potential loss of life and damages to the environment and property

Overall Budget:

US\$ 2,640,000

Support pledged:

Seychelles Government will provide support personnel and resources during installation and maintenance of all equipment

Financial Support Already Obtained: US\$ 20,000

Support sought:

5 Sea-level Infrastructure Modernization (tide - gauges); 1 Seismic Infrastructure Modernization; 1 deep ocean station; 1 Doppler weather radar for better detection and forecasting of meso and micro-scales weather phenomenas; strengthening and enhancement of the observational networks of systematic observation, to meet the needs in the meteorological, oceanographic and hydrological observations of Seychelles; Establish a Disaster Information System; Dissemination of Warning – Communications Infrastructure Modernization; To promote community and residents' awareness and education to improve disaster-preparedness; Capacity Building and Institutional Strengthening of warning centre operation and a new National Meteorological and Early Warning Centre

Financial Support Being Sought: US\$ 2,640,000

Overview

The tragedy of the tsunami event of 26th December 2004 and the torrential rain of 28th and 29th December 2004 had not only threatens the security and sustainable development of Seychelles, but is also a reminder that natural hazards know no borders and that we must always be vigilant and prepared for such natural disasters. The global impact of the tsunami tragedy underlines that addressing threats from natural disasters are a common responsibility and Seychelles National Meteorological Service should take the leading role in combating similar disaster in future and the need for such efforts to be sustained. Hence the main reason to set up an Early Warning System based on multi-hazard approach.

The enormous data gaps which existed for the proper monitoring of the Oceanic and Atmospheric parameters, leading to untimely warning during the occurrence of natural disaster has to be addressed. Therefore as part of the Global Initiative towards mitigating natural disasters, National Meteorological Service urgently need to establish an Early Warning System in Seychelles based on a multi-hazard approach which mainly geared towards the improvement of their atmospheric and oceanic observing networks, particularly in the planning of network of observations, acquisition of modern meteorological equipment and a comprehensive capacity building programme. This proposal is for a 3-year programme to develop an early warning system based on multi-hazard approach with the ultimate goal to save lives and property. It is based on an end-to-end principle- from data collection to the provision of services and issuing warnings. It includes efforts in developing data collection sites, communication arrangements, development of the warning centre, distribution of information, and raising the level of multi-hazard education and awareness.

Attentions are then drawn to the following main items of concern to enhance the existing national warning system based on a multi-hazard approach

SINGAPORE

Enhancement of seismic sensors and tidal gauges network

Implementing Organization:

National Environment Agency, Singapore

Contact Person:

Woon Shih Lai, Director General Meteorological Services, National Environment Agency
DID: (65) 6545 7190, Email: Woon_Shih_Lai @nea.gov.sg

Beneficiaries:

Singapore residents

Partners:

Nil

Aim:

To enhance Singapore's seismic and tsunami surveillance capability for the purpose of setting up an operational 24 hour earthquake and tsunami monitoring and warning system within Singapore, and contribute to regional surveillance efforts

Overall Budget:

US\$ 400,000

Support pledged:

Nil

Financial Support Already Obtained: NA

Support sought:

Nil

Financial Support Being Sought: NA

1. Overview

This projects seeks to enhance the existing seismic monitoring system and tidal gauges in Singapore to enable the system to provide operational real-time seismic and tidal wave data for timely detection of earthquakes and tsunamis. The system will follow international (Global Seismographic Network, or GSN) standards to facilitate data sharing with regional countries, and to form part of the integrated network of monitoring stations in contribution to the Indian Ocean Tsunami Warning System.

2. Workplan

Singapore currently has a network of five seismic sensors and a network of 12 tidal gauges. Only one seismic sensor follows GSN standard, and many of the tidal gauges do not provide real-time data update. The project will add an additional GSN-standard sensor to the seismic network, and enhance the tidal gauge network to provide real-time data at selected points.

The enhancement is estimated to cost US\$ 400,000 to implement, including purchase and installation of additional seismometers, upgrading of tidal gauges and installation of communication links. It is also expected to incur an annual recurrent cost of US\$ 80,000 for subsequent maintenance:

SRI LANKA

Establishment of a 24-hour operational Natural Disaster Early Warning System for Sri Lanka, including capacity building

Implementing Organization:

Department of Meteorology, Sri Lanka

Contact Person:

Director General of Meteorology
Phone: 94-11-2694104, Fax: 94-11-2698311, Email: meteo@slt.lk

Beneficiaries:

People living in coastal areas of Sri Lanka and in other countries in the Indian Ocean Basin

Partners:

National agencies:

Departments of Meteorology, Coast Conservation, Irrigation and Geological Survey and Mines Bureau, National Aquatic Resources Agency, Sri Lanka Navy, National Building Research Organization and National Science Foundation

International organizations:

IOC/UNESCO, World Meteorological Organization, IHO, CTBTO, ISDR, UNDP

Aim:

Establishment of a 24-hour operational Natural Disaster Early Warning System for Sri Lanka including an operational centre catering for collection and analysis of real-time data, information dissemination, public awareness, research and development needs.

Overall Budget:

NA

Support pledged:

Financial Support Already Obtained: NA

Support sought:

Financial Support Being Sought: NA

- To establish an interim mechanism for monitoring, issuance and dissemination of early warnings
 - Establishment of the operational center (National Disaster Management Center – NADIMAC)
 - Needs assessment for the National early warning system in Sri Lanka
 - Develop capacities (infrastructure, technologies and human resources) for generation, reception, monitoring and storing data and issuance of early warnings, dissemination of warnings
 - Develop capacity of the centre to establish local, regional and global networks
 - Develop capacities for creating public awareness and research and development
-

Overview

The project is aimed at developing a National System for Disaster Early Warning. The Sri Lankan Government hopes to build this early warning system as a part of the wider scope catering for a National Disaster Management Centre, where the early warning look after a specific field and an operational centre for,

- collection and analysis of real-time data
- information dissemination
- public awareness
- research and development.

The government wishes to have the active involvement of non governmental, international and regional donors in implementing the associated projects in order to have a better coordination and end result. The Government of Sri Lanka depends on countries with advanced technologies to render whatever support possible to establish the Early Warning System.

As the national centre, this early warning mechanism is expected to integrate with the Regional Tsunami Warning System, thus making it a receiver of warnings as well as a provider of warnings to the general public, after detailed analysis.

UNITED REPUBLIC OF

TANZANIA

Tsunami Warning and Mitigation System for Tanzania

Implementing Organization:

Tanzania Meteorological Agency
P.O. Box 3056, Dar es Salaam, Tanzania, Website: www.meteo.go.tz

Contact Person:

Dr. M. S. Mhita
Phone: +255 22 2460706, met@meteo.go.tz

Beneficiaries:

Coastal and island communities of Tanzania (including tourists & visitors) with an ultimate goal to save life and property

Partners:

- Disaster Management Department (Prime Minister's Office)
- Ministry of Water, Construction, Energy and Lands (Zanzibar)
- University of Dar es Salaam (Institute of Marine Sciences)
- Tanzania Harbours Authority
- Tanzania Fisheries Research Institute
- International Organizations
(IOC, GLOSS, GOOS, JMA, PTWC, UHSLC, PSMSL, FDSN, CTBTO, ITIC, WMO)

Aim:

Set up an operational 24-hour tsunami warning and mitigation system hosted within the Tanzania Meteorological Agency

Overall Budget:

US\$ 1,050,000

Support pledged:

The Tanzania Meteorological Agency will avail part of her current facilities and staff for the Project. The Institute of Marine Sciences in Zanzibar will also provide oceanographic data through GOOS-AFRICA, NODC and ODINAFRICA Projects

Financial Support Already Obtained: US\$ NA

Support sought:

Upgrading and expansion of the current sea level and communications networks,
Development of a seismic and geodetic network and Capacity building

Financial Support Being Sought: US\$ 1,050,000

Overview

This proposal is for a three-year programme to develop a system that will be based on an end-to-end principle – from data collection to the provision of services and issuing of warnings. It will be designed based on existing infrastructure and resources, and will consist of four major components:

- (a) Data observation network – seismic and sea level
- (b) Data transmission and receiving system for evaluation and sharing
- (c) Data processing system for acquiring, archiving and evaluation
- (d) Dissemination of warnings to target communities.

The system will be integrated into the existing national disaster management system, and will also contribute to the IOTWS. Close links with international organizations such as IOC, GLOSS, GOOS, PSMSL, WMO, FDSN, ITIC, CTBTO, JMA, PTWC etc is also envisaged.

IO-GOOS

Sustained Mooring Array for Indian Ocean Tsunami

Implementing Organization:

IOGOOS with support from: CMAR, PMEL, IOC Perth Regional Office

Contact Person:

Gary Meyers, Chair, Indian Ocean Panel

Beneficiaries:

People in the Indian Ocean Rim exposed to tsunami

Partners:

NOAA, JAMSTEC, NIO, INCOIS, NIOT, CSIRO, BoM

Aim:

- To design, test and build a mooring-instrumentation package for tsunami warning, at existing weather mooring sites.
 - To deploy an array of 3 multi-hazard moorings with bottom pressure gauges spanning the Indian Ocean region
 - To establish real time communication to hazard warning centers
-

Overall Budget:

This is a **pre-proposal**.

Design, test and build moorings: US\$ 2.5 million
Deploy array: US\$ 1 million
Communications: US\$ 5 million

Support pledged:**Financial Support: US\$??? to be provided with the final proposal**

9 mooring sites for weather and upper ocean monitoring are presently occupied. Resources are provided by JAMSTEC (3 sites), NIO (3 sites) and NOAA (3 sites). 3 additional sites will be added in 2005 depending on available resources.

Support sought:**Financial Support Being Sought: \$4 million**

The IOP is aware that several nations including Australia, India, Thailand and Indonesia are planning to build and operate warning systems in the Indian Ocean region. This proposal is based on cooperation with some or all of these nations. Collaboration would be necessary to avoid duplication and to capitalize on the synergy. Shared use of shiptime and technical personnel is anticipated. Communication facilities would be shared to the extent possible. In addition, support from nations supporting IOP development activities would be sought wherein commitments have already been made to support the climate system deployment.

Overview

Nations on the Indian Ocean Rim are exposed to tsunamis generated by earthquakes in the Indonesian Archipelago and the Mid-Indian Ocean Ridge system. After an earthquake occurs, tsunamis are predicted using a hydrodynamic model and assumed movement of the sea floor. Bottom pressure measurements can confirm the existence of the tsunami and its amplitude and thus avoid false alarms. The CLIVAR/GOOS Indian Ocean Panel is establishing an array of moorings in the latitude band of the earthquake zones, for the purpose of weather and climate prediction. This proposal is concerned with design, testing and implementation of an instrument package and mooring array that will detect tsunamis using bottom pressure sensors at the weather/climate sites. The highest cost for any open ocean mooring array is the cost of ship time. The dual purpose mooring sites will in particular be cost effective in ship time.

TSUNAMI LABORATORY
RUSSIAN FEDERATION

**Integrated Tsunami Database for
the Indian Ocean (ITDB/IND)**

Implementing Organization:

Tsunami Laboratory, Institute of Computational Mathematics and Mathematical Geophysics (TL/ICMMG), Novosibirsk, Russia

Contact Person:

Dr.V.K.Gusiakov
Phone: +7(3832)307070, Fax: +7(3832)308783, Email: gvk@sscc.ru

Beneficiaries:

All agencies and institutions involved in the IO TWS planning, development and operation

Partners:

ITIC, Honolulu, USA
NGDC/NOAA, Boulder, USA.

Aim:

To develop a comprehensive historical tsunami database for the Indian ocean provided with an interactive graphic shell and built-in analyzing and modeling tools

Overall Budget:

US\$ 60,000

Support pledged:

PDM and WinITDB graphic shells for the database compilation, maintenance and handling.
Initial tsunami catalog for the Eastern Indian Ocean compiled within the HTDB/PAC Project.

Financial Support Already Obtained: US\$ 15,000

Support sought:

Historical data on earthquake and tsunami occurrence available in national and institutional archives, mareograph records, data on bathymetry and tectonics

Financial Support Being Sought: US\$ 45,000

Overview

Historical data are of primary importance for delineating of tsunami-prone areas, understanding of tsunami generation mechanism, selection of warning criteria and estimation of the long-term tsunami risk for coastal areas. A wealth of data exists, but they are scattered in numerous regional and local sources, are not properly organized and are not widely known. Their compilation, parameterization and converting into the computerized database, provided with a specialized graphic shell for easy data retrieval, visualization and handling will make them readily available for all participants of the Indian Ocean Tsunami Programme.

UNESCO/IOC

Establishment of a Western Indian Ocean and Red Sea regional tsunami warning and mitigation system for tsunamis and other marine related hazards

Implementing Organization:

Intergovernmental Oceanographic Commission of UNESCO

Contact Person

Mika Odido, UNESCO Nairobi Office
Phone: [254] 20 673830, Email: m.odido@unesco.org

Beneficiaries:

for example: people living in coastal areas of the Western Indian Ocean

Partners:

National agencies in the IOC Member states in the region, NEPAD/COSMAR secretariat, ICPAC/IMTR, RCMRD

Aim:

Develop 24 hour early warning system for tsunamis and other marine related hazards, that will enable member states from the region to respond promptly and take appropriate action to mitigate potential loss of life and damages to the environment and property.

Overall Budget:

US\$ 7,713,000

Support pledged:

6 sea level stations will be upgraded by UHSLC; 7 Sea level station acquired through ODINAFRICA (5) and GLOSS (2) will be installed with assistance from SAHC; POL/PSMSL will assist in training on installation and maintenance of tide gauges; National institutions will provide personnel and resources for maintenance of coastal equipment.

Financial Support Already Obtained:

US\$ 500,000

From ODINAFRICA to installation of some of the tide gauges and training maintenance and sea level data analysis

Support sought:

Financial Support Being Sought: US\$ 7,213,000

Procurement and installation of 7 additional tide gauges, 20 coastal observation stations, and 10 deep ocean stations; Establishment/strengthening of national and regional analysis, processing and warning centers; Mapping of coastal bathymetry and topography; Development and implementation of awareness and preparedness programmes.

Overview

The inhabitants of the Western Indian Ocean region coastal areas are heavily dependent on goods and services provided by the ocean and coasts. The diverse ecosystems in the region, comprising coral reefs, seagrass beds, mangroves and beaches, make the area attractive for tourism. The damages to property and loss of life that resulted from the Indian Ocean tsunami of December 2004 demonstrated the dangers that the coastal communities are exposed to, and the need to find ways of getting early warning of potential hazards and mitigating their impacts. Other marine related hazards that pose a danger to the coastal areas of the Western Indian ocean include flooding caused by severe weather systems such as cyclones, and storm surges, as well as oil spills from ships plying the waters of the WIO. The planned system will address these hazards by strengthening the capacity of countries from the region to forecast, prepare for, and respond to them. This project will also contribute towards the realization of the objectives of ODINAFRICA, GOOS Africa, WIOMAP and IOGOOS in the region.

UNESCO/IOC

Building Capacity to generate Coastal Bathymetry: A critical element in protecting lives and livelihoods in areas prone to ocean-based extreme events

Implementing Organization:

Intergovernmental Oceanographic Commission UNESCO

Contact Person:

Mr Dmitri Travin(IOC)

Phone: 331-45-68-40-44, fax: 331-45-68-58-12, Email: d.travin@unesco.org

Beneficiaries:

People living in coastal areas of countries surrounding the Indian Ocean Basin

Partners:

National Hydrographic services of the countries of the Indian Ocean region such as Bangladesh, India, Indonesia, Mauritius, Madagascar, Malaysia, Pakistan Seychelles Sri Lanka. Germany, France, India, United Kingdom, USA, International Hydrographic Organization(IHO), UNEP, WMO, IMO, world Agency of Planetary Monitoring and Earthquake Risk Reduction(WAPMERR).

Aim:

- Determination of tsunami height and wavelength
Decisions concerning zonation and equitable use of coastal spaces
- no build areas and buffer zones around vulnerable coastal lines
 - construction setback lines
 - identification and protection of natural barriers
-

Overall Budget:

US\$ 810,000

Support pledged:

- India – confirmed its desire to provide 'in Region' surveying assistance, including cartographic/surveying training.
- Norway -Norway's offer to replace tidal stations.
- UK – offered a range of assistance: survey support, chart production (for rapid promulgation of new information to mariners), cartographic/surveying training, coastal zone management and equipment. Requests for equipment should be passed through UK embassies in country.
- USA – offered survey assistance whilst its naval presence was in the region, fly away survey teams, equipment loans and survey training.

Financial Support Already Obtained: US\$ 10,000**Support sought:**

Not yet decided

Financial Support Being Sought: US\$ 800,000

Overview

tsunami warning needs prediction of wave height and length. Both are influenced by Ocean bottom relief the more a tsunami approaches the coast. Nearshore topography is elucidated by high precision bathymetric surveying. To be able to survey, countries threatened by tsunamis need capacity building for mapping and data handling. IOC with its Ocean Mapping Programme has the mandate to initiate and promote coastal mapping. IOC works in close co-operation and partnership with UNEP and IHO in enhancing locally available expertise providing tools and training for disaster management and preparedness, and assist national agencies in exploiting data for targeted maps

- An Implementation plan is set up with 3 phases:
- Information gathering/project definition,
- surveys/database construction;
- development in coastal zone model/predictions.

As result, countries will establish coastal sensitivity maps indicating vulnerability to wavw action and flooding, management plans for enhancing the resilience of human populations and coastal ecosystems, and coastal engineering models

VLIZ/BELGIUM

Data management and other training related to tsunami warning

Implementing Organization:

Flanders Marine Institute (VLIZ), Oostende, Belgium

Contact Person:

Jan Mees, director VLIZ
Phone: +32 (0) 59 34 21 30, jan.mees@vliz.be

Beneficiaries:

students, data managers, decision makers and other professionals of countries surrounding the Indian Ocean Basin

Partners:

IOC Project Office for IODE

Aim:

To organize training for students and experts on oceanographic data management, with special attention for the development and exploitation of early warning systems for tsunamis and other ocean related hazards.

Overall Budget:

US\$ 1,000,000

Support pledged:

Administrative, technical and IT support staff of VLIZ will be provided on an as-needed basis.

Financial Support Already Obtained: US\$ 650,000

Support sought:

Additional funds to organize more training events in the IOC Project Office for IODE are welcomed.

Financial Support Being Sought: US\$ 350,000

Overview

Flanders marine institute (VLIZ,) jointly with the IOC Project Office for IODE is going to organize a set of Tsunami Warning System related trainings directed to the oceanographic data management; GIS usage in marine and coastal issues, use of GIS for the coastal zone management and planning adapted for prediction and reconstruction tasks; development the interaction/mutual understanding between ocean numerical modelers and ocean data managers to implement national services for warnings of wind waves, storm surges, tsunamis, and potential application services such as oil spill simulations.

UNESCO/SC

Community Based Earthquake and Tsunami Warning, Awareness and Recovery Programme, and Its Implication to Disaster Preparedness

Implementing Organization:
UNESCO Natural Sciences Sector

Contact Person:
Badaoui Rouhban, UNESCO Natural Science Sector
1 rue Miollis, 75732 Paris Cedex 15, France
Phone: +33145684120, Fax: +33145685820, Email: b.rouhban@unesco.org

Beneficiaries:

- Direct: People, communities in the four affected countries
- Indirect: Local and national governments, and other disaster prone countries

Partners:

- Kyoto University (Graduate School of Global Environmental Studies), Kyoto, Japan and
- National Museum of Ethnology
(Graduate University for Advanced Studies, School of Cultural and Social Studies), Osaka, Japan

Aim:

- To implement pilot community based recovery programs in four affected countries (India, Indonesia, Sri Lanka, and Thailand),
- To learn from each other's lessons and practices, and
- To formulate future framework of community based learning programs

Overall Budget: **US\$ 678,000**

Support pledged: **Financial Support Already Obtained: US\$ 28,000**
UNESCO Natural Science Sector and Kyoto University jointly organized a thematic session on Education for Sustainable Development in the World Conference On Disaster Reduction in January 2005. The focal person in the Kyoto University has been involved in a multi-country, multi-hazard project on community recovery in 7 Asian countries, including Indonesia, and published a set of guidelines. Moreover, the National Museum of Ethnology has been conducting surveys on local culture and community interventions in this region for several years. Also both these institutions have extensive network. All these expertise, network, and human resources will be used as in-kind contribution

Support sought: **Financial Support Being Sought: US\$ 650,000**
The support sought will be mainly used for implementing four pilot programs in the affected countries, to document these programs, analyze it, and develop useful learning tools for use in other parts of the affected countries, as well as future disaster prone countries. Part of the support will be used to hire consultants, and support the consultant's travel to the affected countries, conducting workshops, and develop publication materials

Overview

The key factor of the Earthquake Disaster Preparedness and Tsunami Warning System is its implementation in the community level. The tsunami warning system needs to be used for other disasters, and should be linked to other development activities to make it useful and effective in long term. To do so, the project proposes four pilot community based recovery programs in four affected countries (India, Indonesia, Thailand and Sri Lanka), where the disaster preparedness and warning systems will be linked to local development and recovery process, so that its sustainability is ensured. The infrastructure of the warning system will be used for the local development needs, and other hazards like storm surge, cyclone, which are more common in the areas. While implementing the pilot projects, experience sharing will be facilitated among the countries, and past experiences from the relevant countries like Japan, Papua New Guinea (PNG) will be used to enhance the effectiveness of the community based warning system.

WMO's GTS

Use and strengthening of the WMO's Global Telecommunication System (GTS) for exchange and distribution of Tsunami Warning System alerts and related information

Implementing Organization:

World Meteorological Organization (WMO)

Contact Person:

Dr Maryam Golnaraghi, Chief of Disaster Prevention and Mitigation Programme
Phone: +41 22 730 8006, Email: mgolnaraghi@wmo.int

Beneficiaries:

Governments and their NMHSs, in particular from developing and less-developed countries in the IO region

Partners:

UNESCO-IOC, ISDR, EUMETSAT, JMA, CMA, NOAA/NWS, MeteoFrance,
National Meteorological and Hydrological Services (NMHSs) of States on the Indian Ocean Rim

Aim:

Upgrade the GTS where needed, in particular for NMHSs of developing and less-developed countries, to support the exchange and distribution of Tsunami Warning System alerts and related information within multi-hazard alert and response mechanisms, during the interim phase as well as long term

Overall Budget:

US\$ 1.400,000

Support pledged:**Financial Support Already Obtained: US\$ 400,000**

(pledged through the Flash Appeal Proposal Administered by ISDR)

The WMO's Global Telecommunication System (GTS) is already operational and interconnects all NMHSs. Operational arrangements were developed and being implemented to support interim Tsunami Watch. WMO has advanced the funding for the initial phase for the operational arrangements, including a Workshop and Expert Meeting (Jakarta, 14-18 March 2005).

The \$ 400,000 pledged by ISDR would cover the initial phase, roving experts visits to relevant countries and technical specifications for national GTS upgrade projects

Support sought:**Financial Support Being Sought: US\$1.000,000**

Funding planning and implementation coordination meetings, national GTS upgrade projects (equipment and installation), technology transfer, support for implementation and deployment and related capacity building are required to enable all countries of the Indian Ocean Rim to fully participate and take benefit from the GTS as part of multi-hazard alert and response mechanisms. The following countries were particularly identified as requiring upgrade/strengthening of equipment facilities and training: Bangladesh, Maldives, Myanmar, Sri Lanka and Yemen; Comoros, Djibouti, Kenya, Madagascar, Seychelles, Somalia and Tanzania

Overview

Critical to the success of the Tsunami EWS is availability of reliable telecommunication mechanisms. This need can be achieved through the WMO's Global Telecommunication System (GTS), which includes its satellite-based telecommunications sub-systems and the data-collection and data-distribution components of meteorological satellites, and interconnects all National Meteorological and Hydrological Services (NMHSs). The GTS already provides for the exchange of warnings related to cyclones and severe weather, including in the Indian Ocean region, and supports the Pacific Tsunami Warning System in the Pacific basin. The GTS has the potential to support the exchange of Tsunami Warnings and related information. In the short-term, WMO is ensuring that the GTS support the Tsunami Warning System in the Indian Ocean, in particular for the interim arrangements. To this effect, the WMO Workshop and Expert Meeting (Jakarta, 14-18 March 2005) confirmed the full feasibility and agreed on operational arrangements that were being implemented, in particular for the interim Tsunami Watch. Further steps were consolidated and funding is required for necessary upgrades for strengthening the GTS where needed, in particular for NMHSs of developing and less-developed countries. In the longer-term, WMO proposes to expand the use of the GTS for tsunami early warning applications to other at-risk regions, including the Mediterranean Sea, Atlantic Ocean and the Caribbean Sea.

WMO-EWS

Increased utilization of space-based capabilities in the IO region for multi-hazard EWS including Tsunamis

Implementing Organization:

World Meteorological Organization (WMO)

Contact Person:

Dr Maryam Golnaraghi, Chief of Disaster Prevention and Mitigation Programme
Phone: +41 22 730 8006, Email: mgolnaraghi@wmo.int

Beneficiaries:

governments and inhabitants of the coastal areas of countries surrounding the Indian Ocean Basin

Partners:

Space-agencies NESDIS, CMA, ROSHYDROMET, IMD, JMA, EUMETSAT, ESA, NASA, JAXA and CNES, UNESCO-IOC

Aim:

- To develop consolidated plan for space component of a multi-hazard including tsunami alert system based national and regional requirements for increased utilization of space-based data, products and services;
- To increase national and regional utilization of space-based capabilities through awareness workshops

Overall Budget:

US\$ 300,000

Support pledged:

Space agencies already provide satellite missions with associated data, products and services costing more than US\$ 4.000,000 per day for operations and a capital investment of more the US\$ 8.000,000. Space agencies have committed to coordination through the WMO's space-based GOS

Financial Support Already Obtained: NA

Support sought:

Participation by Indian Ocean Rim countries including relevant National Meteorological and Hydrological Services, multidisciplinary hazard experts and national organizations involved with seismic and tsunami hazards, as well as other disaster risk management authorities and agencies

Financial Support Being Sought: US\$ 300,000

Overview

WMO is uniquely qualified as the sole intergovernmental organization responsible for the coordination of the complete global set of environmental satellites. All environmental space agencies have committed to work with WMO to coordinate the space-based Global Observing System for providing critical input to the observation, data collection and sharing related to EWS for meteorological hazards. The recent Asian-Pacific Tsunami highlighted the dramatic need development early warning systems. The proposed project is a necessary step to develop rapidly a consolidated plan for a coordinated space system amongst the few space agencies covering this region. The plan will identify specific required observing capabilities presently available from existing satellite system but not yet utilized in alert mechanisms, required data collection needs as well as contribution to dissemination systems made possible through environmental satellite systems. The improved satellite system capabilities will directly support all National Meteorological Services and other regional and national agencies. A consolidated report of needs will be developed through five regional workshops with participation by Indian Ocean Rim countries and space agencies to identify local, regional and global requirements as well as to increase awareness of existing and planned improvements through enhanced satellite system utilization. WMO will also ensure that these requirements are incorporated in the implementation plan for the Global Earth Observing System of Systems (GEOS).

WMO/IOC

Enhancement of multi-hazard national warning alert and response mechanisms

Implementing Organization:

World Meteorological Organization (WMO) with support from UNESCO-IOC

Contact Person:

Dr Maryam Golnaraghi, Chief of Disaster Prevention and Mitigation Programme
Phone: +41 22 730 8006, Email: mgolnaraghi@wmo.int

Beneficiaries:

Governments, through enhancement of their overall national alert mechanisms and People in the Indian Ocean Rim exposed to tsunami and other related hydro-meteorological hazards

Partners:

National Meteorological Services (NMSs), UNESCO-IOC, ISDR, Media, National and Regional Disaster Management authorities

Aim:

Ensure availability of operational 24-hour multi-hazard warning alert capabilities of the national meteorological Service, to provide multi-hazard warnings, including tsunami to authorities, media and the public, in all countries in the Indian Ocean Rim. Raise public awareness and enhance community preparedness through educational and community outreach programmes of NMSs

Overall Budget:

US\$ 4.500,000

Short-term (2005):

1) Expert Assessments of the NMSs multi-hazard including tsunami, alert capabilities, public awareness programmes

2) Evaluation of countries requirements for alert mechanisms: **US\$ 500,000**

Medium to longer-term (2006-2007):

Build strong sustainable multi-hazard (including tsunami) alert mechanisms and public education programmes delivered through NMHSs

Initial proposal: US\$ 4.000,000

Support pledged:

Financial Support Already Obtained: US\$????

Support sought:

Financial Support Being Sought: US\$ 4.500,000

In most countries, early warning mechanisms are a direct part of the NMSs infrastructure and thus are a natural conduit for all natural hazard warnings including tsunami warnings. Partnerships among NMSs with organizations at national to local levels such as regional and national tsunami centers (if not the NMSs), disaster management agencies, media, educational institutions are critical for reaching this goal. Support and participation of these organizations would be sought wherein commitments have been made. Other support will be sought through regional and international organizations involved in disaster reduction activities in the region

Overview

WMO for over 50 years, has been working with NMSs of its Members to enhance and develop public meteorological services including national warning capabilities. In most countries, early warning mechanisms are part of the NMSs infrastructure and can be utilized for all hazards such as tsunami warnings. NMSs use various mechanisms, from traditional approaches (sirens, flags and beacons) to more advanced technologies (Internet, public television and radio) to disseminate around-the-clock warnings to authorities and the public. Expert assessments of the NMSs national to local multi-hazard alert capabilities, public awareness programmes, related needs and gaps will be completed along with an evaluation of the countries requirements for alert and response mechanisms. Based on this information concrete projects will be developed to help build sustainable capacity for multi-hazard warning capabilities of NMSs and their public outreach and educational programmes.

**Annex 2 Status of Ongoing
Projects:
Proposals Submitted
to OCHA by ISDR**

TSUNAMI WARNING AND MITIGATION SYSTEM
ANNEX 2

ISDR, together with UNESCO/IOC submitted a proposal (TSU-REG-05/CS06-REGION) for US\$ 11M. As on 26 March a total of US\$ 5.4M has been received for the project. Another US\$ 5.7M has been pledged. Note that the implementation of activities under the Appeal funding should be completed by September 2005.

Referring to the System Development Components (see 3. above) the following funding was requested and obtained:

Component	Primary Actors	Amount requested
Coordination	ISDR-PPEW; UNESCO/IOC	1,500,000
Early Warning System implementation (technical)	UNESCO/IOC; WMO	4,000,000
Integrated Risk management	UNDP; ISDR; OCHA; UNEP; ADRC; ADPC	2,500,000
Public Awareness and education	ADPC; ADRC; UNDP; ISDR	2,000,000
Community Level learning	IFRC; ADPC; UNDP; OCHA; ISDR	1,000,000
Totals		11,000,000

List of Activities

IMPLEMENTED

ISDR Activity 1: Activity 3
The Scoping Meeting on the Development of Tsunami Early Warning Systems, particularly in the Indian Ocean.

On 22 January 2005 (Kobe, Japan), It was intended to share information on the process to develop more effective tsunami early warning systems globally and in particular for the countries affected by the tsunami of 26 December 2004. The technical meeting of national representatives and UN organizations was organized by UNESCO/IOC and UN/ISDR http://ioc.unesco.org/indotsunami/documents/IOTWS_scopingmtg.pdf.

ISDR Activity 2
Training Seminar – Mission on Policy Dialogue for High Level Administrative Policy Makers on Establishing a Tsunami Early Warning System in the Indian Ocean.

Tokyo, Japan, 22-24 February 2005.

IOC Activity 1:
International coordination meeting for the development of a Tsunami Warning and Mitigation system in the Indian Ocean within a global framework

This is the Coordination Meeting that was held at UNESCO, Paris,, 3-8 March 2004

IOC Activity 2:
Regional coordination and planning meeting for the deployment of an Indian Ocean Tsunami Warning System

This is the Second Coordination Meeting, held in Grand Baie, Mauritius, 14-16 April 2005

PLANNED

IOC Activity 3:
National coordination meetings and expert advisory missions

All participating countries will need to establish national tsunami warning centres as well as national coordinating committees that ensure the end-to-end chain from earthquake observation to population evacuation. In this regard it is essential for all countries to assess available resources and avoid building new facilities or organizations that duplicate existing ones. The Project will provide support to facilitate the organization and meetings of the national committees, as well as to organize expert missions to assist with assessment of existing resources and identification of requirement, as required.

Expected output:

- Formal arrangements made at the national level to ensure end-to-end chain between earthquake (that generates tsunami) observation and population evacuation with all relevant national stakeholders
- National focal points for regional tsunami warning system identified

IOC Activity 4:

Distribution of pamphlets to promote awareness and preparedness

To issue a warning without having prepared and exercised how the population should respond to the warning is useless. The IOC/ITSU Programme already prepared a number of school textbooks to teach children from pre-school to secondary school about tsunamis and how to respond to them. The Asian Disaster Reduction Center (Japan) has extensive experience in preparing easy-to-understand pamphlets related to disaster warning. ADRC will design, translate, print and distribute 200,000 pamphlets to the 7 countries that were affected most by the 26 December 2004 tsunami.

IOC Activity 5:

Support for national awareness and preparedness activities

National awareness and preparedness against the tsunami hazard is one of the cornerstones of a national and regional tsunami warning and mitigation system. Each country will need to implement an extensive work plan working through emergency managers, local authorities, national broadcasting companies, schools, relevant NGOs etc to promote tsunami awareness and preparedness. The project will provide start-up support to each country to implement a wide range of activities.

IOC Activity 6:

Establishment of core of operational GLOSS sea-level gauges in the Indian Ocean region

The establishment of the 6 eastern Indian Ocean real-time GLOSS sites in conjunction with the upgrade of the existing central and western Indian Ocean real-time GLOSS sites will enable PTWC to provide basic basin-wide tsunami monitoring and warning to the Indian Ocean nations. The existing real-time GLOSS stations and the new established interim GLOSS stations will supply PTWC with high frequency, 1-4 minute sampling, sea level data transmitted via the European Space Agency's Meteosat and the Japanese Meteorological Agency's GMS satellites. The sea level data messages will be forwarded immediately to the PTWC and the Japanese National Center using WMO's GTS facilities (note that ensuring that GTS can accommodate this data stream is a separate activity implemented by WMO). The sea level messages will be suitable to confirm the existence of a major tsunami or to cancel a tsunami watch or warning by confirming a major tsunami does not exist.

These interim sea level station will remain in place until appropriate national agencies have established their own stations at the GLOSS sites and are routinely forwarding data via the GTS suitable for tsunami monitoring and warning to PTWC or another appropriate duly designated international tsunami warning center. Additionally, UNESCO's IOC will upgrade the 15 existing real-time GLOSS sea level stations increasing their capability to monitor tsunami for warning purposes.

**IOC Activity 7:
Provision of tsunami bulletin service**

PTWC and JMA will provide an intermediate bulletin service for the Indian Ocean service and will disseminate the bulletins to all national focal points.

**IOC Activity 8:
Training Courses on the establishment of a national tsunami assessment, mitigation and warning system**

Courses will be organized to provide training in each of the core areas of the regional system:

1. **Hazard Assessment** (historical and paleo-tsunami studies, field surveys, numerical modelling, vulnerability studies: result in hazard, risk, inundation, and evacuation maps)
2. **Hazard Mitigation** (education and communication of safety and preparedness information in culturally-appropriate ways taking into consideration gender issues: results are brochures, books, videos, community meetings, public service messages on TV/radio, pre-disaster planning, table-top disaster response exercises, TsunamiReady and tsunami-resilient communities)
3. **Warning Guidance** (measurement, scientific evaluation, numerical modelling, threat assessment, warning message transmission: results in real-time data, early detection, wave forecasts, warning dissemination, even to the most isolated communities)

PROVISIONAL TIMELINE IOC ACTIVITIES

Note: this timeline has been revised on 1 April 2005 based upon available funding at this time.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1: Coordination meeting 1												
2: Coordination meeting 2												
3: Natl. Assessments												
4: Awareness pamphlets												
5: Support national awareness												
6: Core sea level gauges												
7: Startup interim system												
8: Training courses 1st cycle												

implemented
 planned provided funds are available

COSTING TABLE IOC ACTIVITIES

	Total cost in US\$
1: Coordination meeting 1	249,000
2: Coordination meeting 2	299,000
3: Natl. Assessments	447,000
4: Awareness pamphlets	188,000
5: Support national awareness	579,000
6: Core sea level gauges	556,000
7: Startup interim system	797,000
8: Training courses 1st cycle	410,000
	3,525,000

**Annex 3 Sources of information
on current disaster risk
management capacities
from affected and
threatened countries
in the region**

It is recognized that an effective early warning system requires a number of elements such as a prior knowledge of the risks faced by communities; technical monitoring and warning service for these risks; dissemination of understandable warnings to those at risk, as well as education, public awareness and preparedness to act.

Therefore tsunami early warning systems have to be part of boarder disaster risk reduction strategies, as recommended by the Governments during the World Conference on Disaster Reduction (WCDR) in Kobe in January 2005.

It is usually the responsibility of Governments, through their national disaster risk management organizations to disseminate to the communities at risks the useful knowledge they need to reduce their vulnerability to natural hazards in general and to tsunamis in particular.

The present document provide sources of information of existing national capacities for disaster risk management in countries affected by the 26 December Tsunami or threatened by Tsunamis around the Indian Ocean. This input comes from the following sources of information:

1. The Yokohama review report:

The information provided by countries served as one of the main inputs for the “Review of the Yokohama Strategy and Plan of Action for a Safer World”. The original national reports submitted by countries are available in the UN/ISDR website under country information: <http://www.unisdr.org/eng/country-inform/introduction.htm>

The preparation of the national information provided an opportunity to bring together stakeholders from governments, academic and other sectors dealing with disaster risk reduction. In many cases consultations were held with institutions specializing in disaster management including environmental planning and education departments, meteorological services, NGOs and other key domains.

The guidelines provided a reporting structure based on the components and priority areas specified in the ISDR/UNDP “Framework for disaster risk reduction for guidance and monitoring”. The following themes serve as a core set of principles to understand, guide and monitor current status of disaster risk reduction and therefore provide a common basis for consolidated observations:

- Political Commitment and Institutional Aspects;
- Risk Identification;
- Knowledge Management;
- Risk Management Applications and Instruments;
- Preparedness and Contingency Planning;

National authorities and platforms on disaster reduction were therefore invited to provide information to identify needs and develop future policy recommendations for consideration.

2. ADPC's Report "Overview of Early Warning Systems in selected Countries of Southeast Asia,

by Lolita Garcia, July 2002. <http://www.adpc.net/pdr-sea/publications/OEWS.pdf>

This report attempts to raise awareness of the early warning systems in the respective countries and to provide a basis for further enhancing institutional mechanisms, technical capacities and community response options for reducing vulnerability to extreme climate events. The study has the following objectives:

- Review the international initiatives on early warning system;
- Conduct a rapid appraisal of existing early warning system for hydro-meteorological hazards;
- Undertake short case studies to assess community-level vulnerability and response to for hydro-meteorological hazards;

3. ADRC's national report from member state

http://www.adrc.or.jp/country_report.php

The information is being regularly updated and additional sources of information will be included based on feedback from partners and will be made available on ISDR/PPEW and IOC of UNESCO website.

South Asia

India

National Disaster Management, Ministry of Home Affairs.

<http://www.ndmindia.nic.in>

(YR) <http://www.unisdr.org/eng/country-inform/reports/India-report.pdf>

(ADRC) http://www.adrc.or.jp/countryreport/IND/INDeng02/India_CR.htm

Sri Lanka

National Disaster Management Centre, Ministry of Social Services and Housing Development.

<http://www.lk.undp.org/ndmc>

(YR) <http://www.unisdr.org/eng/country-inform/reports/Sri-Lanka-report.pdf>

(ADRC) <http://www.adrc.or.jp/countryreport/LKA/2003/index.html>

Maldives

Ministry of Home Affairs, Housing and Environment and National Council for Protection and Preservation of the Environment

Pakistan

The Federal Flood Commission, Ministry of Water and Power, Flood Forecasting Division

(YR) <http://www.unisdr.org/eng/country-inform/reports/Pakistan-report.pdf>

Bangladesh

Ministry of Disaster Management and Relief, Government of the People's Republic of Bangladesh

(YR) <http://www.unisdr.org/eng/country-inform/reports/Bangladesh-report.pdf>

(ADRC) <http://www.adrc.or.jp/countryreport/BGD/2003/index.html>

Southeast Asia

Indonesia

National Natural Disaster Management Coordinating Board (Bakornas PB),
Ministry of People's Welfare and Poverty Alleviation
(YR) <http://www.unisdr.org/eng/country-inform/reports/Indonesia-report.pdf>
(ADPC) <http://www.adpc.net/pdr-sea/publications/OEWS.pdf> p. 31
(ADRC) <http://www.adrc.or.jp/countryreport/IDN/2004/index.html>

Malaysia

Central Disaster Management and Relief Committee, Inter-Ministerial Committee
(ADRC) <http://www.adrc.or.jp/countryreport/MYS/2003/index.html>

Myanmar

Central Committee for Disaster Prevention and Relief, Ministry of Home and Religious Affairs
(ADRC) http://www.adrc.or.jp/countryreport/MMR/2002/CR_MMR2002.htm

Thailand

National Civil Defense Committee, Ministry of Interior
(YR) <http://www.unisdr.org/eng/country-inform/reports/Thailand-report.pdf>
(ADRC) <http://www.adrc.or.jp/countryreport/THA/2004/index.html>

Singapore

(ADRC) <http://www.adrc.or.jp/countryreport/SGP/2003/index.html>

Philippines

National Disaster Coordinating Committee (NDCC), Department of National Defense
(YR) <http://www.unisdr.org/eng/country-inform/reports/Philippines-report.pdf>
(ADPC) <http://www.adpc.net/pdr-sea/publications/OEWS.pdf> p. 43
(ADRC) <http://www.adrc.or.jp/countryreport/PHL/PHLeng99/Philippines99.htm>

Vietnam

Department of Dike Management, Flood and Storm Control, Ministry of Agriculture and Rural Development
(YR) <http://www.unisdr.org/eng/country-inform/reports/Vietnam-report.pdf>
(ADPC) <http://www.adpc.net/pdr-sea/publications/OEWS.pdf> p. 51
(ADRC) <http://www.adrc.or.jp/countryreport/VNM/VNMeng99/Vietnam99.htm>

Africa and other Indian ocean countries

Somalia

(YR) <http://www.unisdr.org/eng/country-inform/reports/Somalia-report.pdf>

Kenya

National Disaster Operations Centre.

(YR) <http://www.unisdr.org/eng/country-inform/reports/kenya-report.pdf>

Madagascar

Conseil National de Secours, Ministry of Interior and Administrative reform

(YR) <http://www.unisdr.org/eng/country-inform/reports/Vietnam-report.pdf>

Seychelles

Mauritius

Meteorological Services

(YR) <http://www.unisdr.org/eng/country-inform/reports/Mauritius-report.pdf>

Tanzania

Yemen

Environmental Emergency Unit, Ministry of Water and Environment

(YR) <http://www.unisdr.org/eng/country-inform/reports/Yemen-report.pdf>

Oman

(YR) <http://www.unisdr.org/eng/country-inform/reports/Oman-report.pdf>
