Assessment of Capacity Building Requirements for an Effective and Durable Tsunami Warning and Mitigation System in the Indian Ocean

Consolidated Report for Countries Affected by the 26 December 2004 Tsunami

IOC/INF-1219

UNESCO

Assessment of Capacity Building Requirements for an Effective and Durable Tsunami Warning and Mitigation System in the Indian Ocean

Consolidated Report for Countries Affected by the 26 December 2004 Tsunami

IOC/INF-1219 UNESCO 2005

IOC/INF-1219
Paris, 29 November 2005
English only

The Consolidated Report was based on the results of Expert Missions funded through the UN/OCHA project "Evaluation and Strengthening of Early Warning Systems in Countries Affected by the 26 December 2004 Tsunami in South East and South Asia, "submitted by UNESCO-IOC and UN-ISDR (TSU-REG-05/CS06-REGION), with additional support by the United States Agency for International Development (USAID).

The Consolidated Report was prepared by the UNESCO-IOC, UN-ISDR/PPEW, and WMO, with assistance from IRG-Tetra Tech JV under the U.S. Indian Ocean Tsunami Warning System Program; USAID Contract Task Order EPP-I-02-04-00024-00. The views expressed in this Report do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

For bibliographic purpose, this document should be cited as follows:

> UNESCO-IOC; UN-ISDR/PPEW; WMO. *Assessment of Capacity Building Requirements for an Effective and Durable Tsunami Warning and Mitigation System in the Indian Ocean: Consolidated Report for 16 Countries Affected by the 26 December 2004 Tsunami.* Paris, UNESCO 2005. UNESCO-IOC Information document No. 1219

Published by the United Nations Educational, Scientific and Cultural Organization
7 Place de Fontenoy, 75 352 Paris 07 SP, France

(SC-2005/WS/62)

Executive Summary

The December 26, 2004 Indian Ocean tsunami has tragically demonstrated that there is an urgent need for early warning systems that provide timely, understandable warnings which motivate ordinary citizens to quickly move out of harm's way. The objective of the Indian Ocean Tsunami Warning and Mitigation System (IOTWS) is to effectively mitigate the hazard posed by local and distant tsunamis in all parts of the Indian Ocean. To achieve this objective, an end-to-end tsunami warning system is needed that establishes national and regional tsunami warning systems and promotes preparedness and risk reduction against tsunami hazards within a multi-hazard approach.

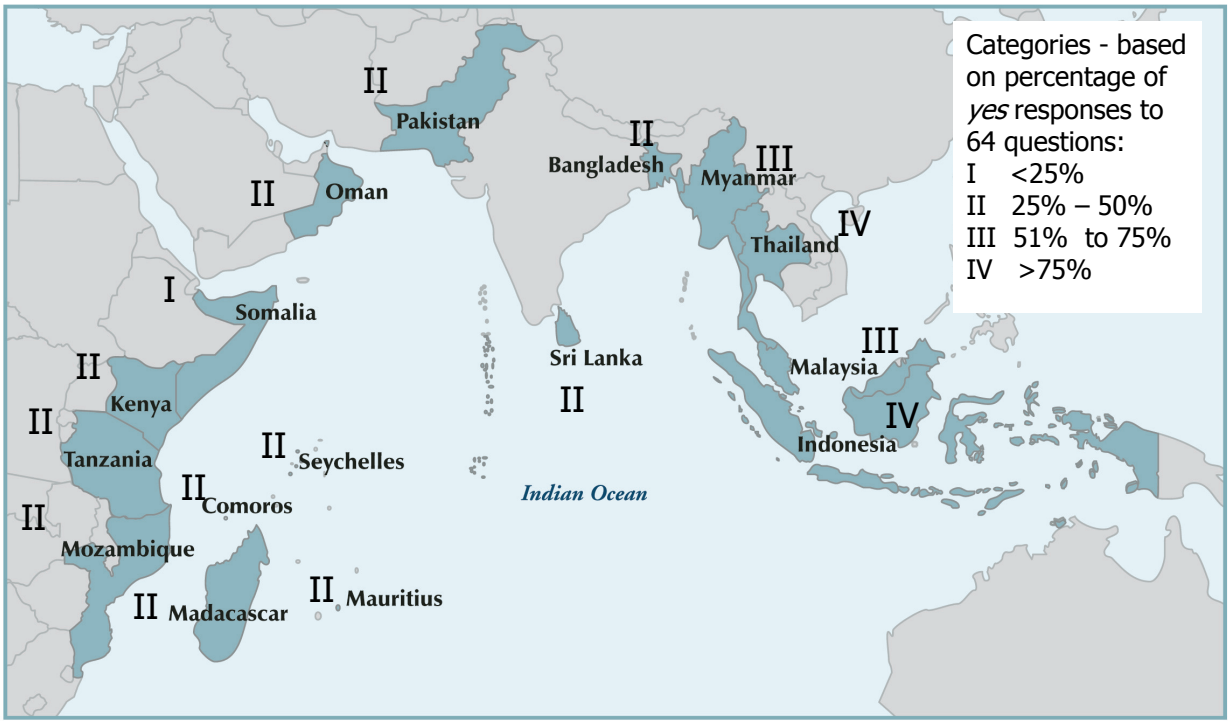
Over the last year, substantial progress has been made toward the development of the IOTWS by individual country efforts and through intergovernmental coordination meetings organized under the umbrella of the United Nations Educational, Scientific, and Cultural Organization Intergovernmental Oceanographic Commission (UNESCO-IOC). Between May and September 2005, national assessments of 16 countries in the Indian Ocean were conducted to identify capacity building needs and support requirements for developing an IOTWS. National assessments were conducted by international expert teams working together with experts from each participating country. Three-day missions were conducted to each country to meet with national experts from government agencies and non-governmental organizations involved in tsunami or natural disaster management to complete a questionnaire covering all aspects of tsunami warning and mitigation system. Mission teams were composed of international experts from the UNESCO-IOC, United Nations International Strategy for Disaster Reduction/Platform for the Promotion of Early Warning (UN-ISDR/PPEW), World Meteorological Organization (WMO), and the Asian Disaster Reduction Center (ADRC) and subject matter experts from Australia, China, France, Finland, and the United States of America (USA). Country teams that participated in the mission discussions included national experts from academic institutions, government agencies, and nongovernmental organizations from each participating country.

A regional overview of tsunami warning and mitigation capacity is provided in Figure ES-1. The questionnaire was used as a basis for tabulating the percentage of *yes* responses to a subset of 64 questions from the questionnaire in the national assessment. These 64 questions are shown in Table ES-1 along with the *yes*, *no*, or in some cases, *partial-yes* responses (where activities had been initiated or partially accomplished) by country.

The percentage of *yes* responses varied from country to country but generally fell into four categories (Figure ES-1). Most of the countries were assigned to Category II based on the percentage of *yes* responses. Myanmar and Malaysia were assigned to Category III. Indonesia and Thailand fell in the highest Category IV with > 75% yes responses to 64 questions.

Overall, most countries have established or strengthened their disaster management laws, national platforms, and national and local coordination mechanisms to guide all-hazard disaster risk reduction and to establish clearer responsibilities for end-to-end early warning system (Table ES-1; Questions 2, 3, 4, and 5). Not all have specifically addressed the tsunami coordination aspect.

Figure ES-1. Regional Overview of Tsunami Warning and Mitigation Capacity



All participating countries receive international tsunami warnings from the Pacific Tsunami Warning Center (PTWC) and the Japan Meteorological Agency (JMA) except Somalia, and most countries receive these warnings at facilities with back-up systems for receiving warning messages that operate 24 hours a day, 7 days a week (Questions 17, 19, and 20). Few countries operate a national tsunami warning centre or have the capacity to receive or provide real-time seismic or sea level data (Table ES-1; Questions 22, 24, 28, 30, 31, 32, 37, 38, and 39).

Few participating countries have developed tsunami emergency and evacuation plans and signage or tested response procedures for tsunamis or earthquakes (Questions 50, 59, 60 and 61). Much of the information and data needed to develop these plans, such as post-event surveys, inundation modeling, and tsunami hazard and vulnerability assessment, has yet to be collected (Table ES-1; Questions 65, 68, 69, 71, 73, and 77).

Many participating countries have assessed local government capacity for disaster preparedness and emergency response but not community preparedness (Questions 84 and 86). Community education and outreach programmes are being developed but are largely not in place in most participating countries (Table ES-1; Questions 87, 88, 101, 105, and 110).

Few countries are implementing structural mitigation measures, such as revision of building codes or non-structural mitigation measures, such as improving coastal vegetative buffers, to reduce tsunami impacts (Table ES-1; Questions 115 and 116).

Overall, most countries have made progress developing policies, assessing technological needs, and establishing coordination mechanisms at a national level for tsunami warning and mitigation. Local planning and preparedness activities are being carried out first in selected target areas, or cities and towns, rather than as comprehensive national programmes.

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
2	Legal framework in place for disaster warning formulation, dissemination, and response	○	○	◉	●	○	●	○	●	●	●	●	○	○	●	●	●
3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●	●	●	●	●	●	●	●	●	●	●	●	--	●	●	●
4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●	○	●	○	◉	●	●	○	○	●	●	●	--	●	○	●
5	Disaster coordination mechanisms at the community level established	●	●	●	●	●	●	●	○	○	●	○	●	--	●	●	●
13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○	●	●	○	●	●	●	○	●	●	○	○	--	○	◉	●
14	Regional partnerships exists for assessing and responding afterward to earthquake and/or tsunami disasters	○	●	●	●	○	○	○	○	●	●	○	●	--	○	●	●
15	Active research ongoing in seismology or tsunamis	●	●	●	○	●	◉	○	●	●	●	●	●	--	○	●	●
16	Government-sponsored research organization exists that can provide products or services to strengthen your tsunami warning and mitigation system	●	○	●	◉	○	●	○	○	◉	●	○	◉	--	◉	●	●
17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●
19	Back-up or alternative method exists for receiving the warning messages?	●	○	●	●	●	●	●	●	○	●	●	●	--	●	●	●

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●	●	●	●	●	●	●	●	●	●	●	●	--	●	●	●
22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○	○	●	○	○	●	◉	◉	○	○	○	○	○	◉	○	●
24	Warning center staffed 24-hours-a-day, 7-days-a -week	○	○	●	○	○	●	◉	◉	○	○	○	○	--	●	○	●
28	Seismographic stations or seismograph networks operated monitor regional seismicity	●	●	●	○	●	●	○	●	●	●	●	●	○	●	●	●
30	Real-time seismic data received	●	●	●	○	●	●	○	○	○	●	○	○	○	◉	○	○
31	Real time seismic data provided	○	○	●	○	○	●	○	○	○	●	○	○	○	○	◉	○
32	Seismographic stations or seismograph networks monitor local seismicity	●	●	●	●	●	●	○	○	●	●	●	○	○	●	●	●
37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○	○	●	●	●	●	●	●	○	●	○	●	○	●	●	●
38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○	○	●	◉	○	○	●	●	○	●	○	●	○	●	○	○
39	Sea level data sampling frequently sufficient to resolve short-wavelength tsunami	○	○	●	○	○	○	●	○	○	○	○	○	○	●	○	○
42	International agencies providing assistance to strengthen your tsunami monitoring, evaluation, warning capabilities	○	○	●	●	●	○	◉	○	●	○	○	●	○	●	○	●
44	Agency receiving tsunami warning designated by law	●	●	●	○	●	●	○	●	◉	○	●	○	○	○	○	●
45	Designated agency receiving tsunami warning issues public evacuations	○	●	○	●	●	●	○	○	●	○	●	○	--	○	○	●

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●	○	◉	○	●	●	◉	●	●	○	●	◉	--	◉	●	●
50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist indicating evacuation routes to safety or higher ground	○	○	◉	○	○	○	○	○	●	○	○	○	--	◉	○	●
51	Marine warnings issued according to guidance or instructions for marine vessels, harbors and ports	○	○	●	●	●	●	○	○	●	○	○	●	--	●	○	●
53	Procedures or criteria exist for determining when it is safe for responders or the public to return	○	●	○	●	●	●	○	●	●	○	○	○	--	●	○	●
54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●	○	◉	--	●	○	●	--	◉		●	●	--	--	--	◉
55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●	●	●	--	●	●	●	--	●		●	●	--	--	--	●
59	Response procedures for regional- or locally-generated tsunami in place	○	○	○	○	○	●	○	○	●	○	○	○	--	○	○	●
60	Response procedures for earthquakes in place	○	●	◉	○	○	●	○	○	●	○	●	○	--	○	○	●
61	Response procedures have been tested or exercised	○	○	◉	○	○	○	○	○	◉	○	○	◉	--	◉	○	●
63	Critical infrastructure and lifeline support facilities for disaster response identified	○	●	○	◉	●	○	◉	○	◉	●	○	○	--	○	○	●
65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○	○	●	○	○	●	○	○	●	◉	○	●	●	●	○	●

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
67	International agencies providing assistance to strengthen your tsunami warning response	○	○	●	○	○	○	○	○	●	○	○	●	--	○	○	●
68	Tsunami hazard evaluation conducted prior to December 26, 2004	●	○	●	○	○	●	○	○	●	○	●	○	--	●	○	●
69	Historical record of past earthquakes and tsunamis documented	◉	◉	●	◉	◉	◉	○	○	◉	○	◉	○	--	○	●	◉
71	Tsunami vulnerability assessment conducted	●	○	●	○	○	○	◉	○	○	○	○	○	--	○	○	●
73	Numerical modeling studies conducted to calculate inundation from tsunamis	○	○	●	○	●	○	○	○	○	○	○	○	--	◉	○	●
77	Accurate bathymetry and topography data exist for the coastlines	●	○	○	○	○	○	●	○	○	◉	●	◉	--	○	○	○
78	Geographical information systems used as a decision support tool during emergency response	○	○	●	○	●	●	○	●	○	○	○	◉	--	○	○	●
80	International agencies providing assistance to evaluate tsunami hazard and risk assessments, and/or conduct numerical modeling	○	○	●	○	○	○	◉	○	●	○	○	●	--	○	○	●
82	Post-tsunami impact assessments been conducted	○	○	●	○	○	●	●	○	●	○	●	●	●	●	○	●
84	Local government disaster preparedness and emergency response assessed	●	○	◉	●	●	●	●	●	●	○	●	○	--	○	○	●
86	Community and ordinary citizen disaster preparedness and emergency response assessed	◉	○	○	○	○	○	●	○	○	○	◉	◉	--	◉	○	●
87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○	○	●	◉	◉	○	◉	○	◉	◉	○	◉	--	◉	◉	●

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●	○	●	◉	◉	○	◉	●	◉	●	○	◉	--	○	○	●
92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●	●	●	○	●	○	○	●	●	○	●	●	--	○	○	●
93	Tsunami mitigation and emergency response decisions based on knowledge of the known local risks and the potential impacts of tsunami on the specific community	◉	○	●	○	●	○	○	○	●	○	○	◉	--	○	○	●
94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○	○	○	○	○	○	○	○	○	○	○	○	--	○	○	●
95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●	●	●	○	●	○	○	●	●	○	○	●	◉	○	○	●
98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●	●	●	○	●	○	○	●	●	○	◉	●	--	○	○	●
101	Tsunami education and public outreach programme currently in place	○	○	◉	--	○	○	◉	--	--	--	○	○	--	--	○	○
103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	●	--	○		○	○	○	--	--	--	--	●	--	--	--	●
105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--	○	◉	--	○	○	○	--	--	--	◉	○	--	--	○	●

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
106	Training programmes for the media on other hazards and their vulnerability current exist	●	●	●	--	●	○	●	--	--	--	○	○	--	--	●	●
110	Earthquake and tsunami hazards and preparedness is incorporated into educational curricula for school children	○	○	○	○	◉	○	○	○	●	○	○	◉	--	○	◉	●
113	Tsunami memorials, museums, interpretative signage or other public reminders of past tsunami impacts exist	○	○	○	○	○	○	○	○	●	○	○	○	--	○	○	○
115	Structural mitigation measures established to reduce tsunami impact	●	○	●	○	○	○	○	○	○	○	○	○	--	○	○	○
116	Non-structural mitigation measures established to reduce tsunami impact	●	○	●	○	○	●	◉	○	○	○	○	○	--	○	●	●
117	Tsunami evacuation maps, evacuation routes, and evacuation signage have been developed for some areas	○	○	◉	○	○	◉	○	○	◉	○	○	○	--	○	○	●
121	International agencies are providing assistance in developing materials or the deployment of information to the relevant institutions and/or the public	●	○	●	○	○	○	○	○	○	○	○	●	--	○	○	●
123	International agencies are providing assistance in developing structural and non-structural tsunami mitigation measures at local levels	●	○	●	○	○	○	○	○	●	○	○	●	--	○	○	●
125	Awareness and response to March 2005 tsunami warning improved	○	○	●	●	○	●	○	○	●	●	●	●	--	●	●	●
127	Internationally tsunami advisory message from the PTWC or JMA received for March 2005 event	●	○	●	●	○	●	●	●	●	●	●	●	--	●	○	○
129	National monitoring systems in place that detected and evaluated the earthquake	●	◉	●	○	●	●	○	○	●	●	●	○	--	◉	○	●

Table ES-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
131	National tsunami response plan in place and exercised for March 2005 event	○	○	○	●	○	○	○	○	○	○	○	○	--	●	○	●
134	Establishment of the Tsunami Early Warning capabilities, including the response within your national boundary, within a multi-hazard framework are addressed	●	●	◉	--		●	●	--	--	--	●	●	--	--	--	●

Notes:

○ = No	BAN = Bangladesh	MAD = Madagascar	MYA = Myanmar	SOM = Somalia
◉ = Partial Yes	COM = Comoros	MAL = Malaysia	OMA = Oman	SRI = Sri Lanka
● = Yes	IND = Indonesia	MAU = Mauritius	PAK = Pakistan	TAN = Tanzania
-- = Not Available	KEN = Kenya	MOZ = Mozambique	SEY = Seychelles	THA = Thailand

Support requirements to build regional capacity in tsunami warning and mitigation systems were identified by national experts in each country together with international experts as part of the national assessment. Common support requirements are summarized on Table ES-2. The most commonly identified support requirements identified by most countries in the region include:

- Assistance to harmonize existing practices and protocols in data collection, monitoring, evaluation, and warning communication to achieve international standards and interoperability of tsunami early warning systems in the region
- Assistance to establish real-time regional and local seismic and sea level networks with real-time data acquisition, display, and analysis to support the monitoring and detection of tsunami hazards
- Equipment upgrade and capacity building in Global Telecommunication System (GTS) to upgrade communications lines and capacities to National Meteorological Services responsible for the receipt and issuance of tsunami warnings and enable them to disseminate warnings more effectively to the designated stakeholder and authorities.
- Training and software for numerical modeling to support the development of inundation maps and for evaluation of tsunami hazards and vulnerability
- Educational modules on multi-hazards and their impacts including tsunami targeted at various stakeholders (trainers of risk managers, schools) including school curriculum on the tsunami and other hazards early warning system process
- Regional training activities on overall multi-hazards early warning system process to strengthen linkages between key organizations, including media, technical agencies, and risk managers
- Need for equipment upgrades and capacity building related to utilization of satellite information for multi-hazard early warning systems including tsunami

Other common support requirements identified by three to five countries in the region include:

- Upgrade dissemination mechanisms for marine warnings
- Assistance to strengthen GIS capabilities and applications to disaster management to aid in planning and preparedness, event emergency response, and post-disaster recovery to aid in planning and preparedness, event emergency response, and pots-disaster recovery
- Electronic versions of existing materials on tsunamis and other disasters that can be adapted, translated and disseminated

The national assessment missions provided an opportunity to define the components and implementation actions of tsunami early warning and mitigation systems and to identify related capacity building opportunities. Table ES-2 provides a summary of the types of guidance documents and capacity building activities that could catalyze national actions.

Table ES-2. Support Requirements for Building Tsunami Warning and Mitigation System Capacity in the Indian Ocean Region

Support Requirement	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
Authority and Coordination																
Assistance to harmonize existing practices and protocols in data collection, evaluation and communication to achieve international standards for tsunami monitoring and the dissemination of warnings	●	●	●	●	●		●	●	●	●	●	●		●	●	●
Tsunami Warning and Monitoring																
Training in operational aspects of tsunami warning center			●		●			●								
Assistance to establish real-time regional and local seismic data acquisition, display and analysis	●		●					●	●	●	●	●		●	●	
Assistance to establish real-time regional and local sea level data acquisition, display, and analysis	●		●	●	●	●	●	●	●	●	●	●	●	●	●	
Training, equipment, and installation of GLOSS sea level gauges					●	●				●			●		●	
Training, equipment, and installation of TREMOR system												●		●	●	
Upgrade/develop environmental satellite systems and related applications and technical expertise		●					●				●				●	●
GIS system support and applications									●			●				
Equipment upgrade and capacity building assistance for upgrading Global Telecommunication System (GTS)	●	●	●	●			●		●		●	●	●	●	●	
Long-term GTS sustainability assistance	●			●					●		●			●	●	
Provide technical expertise and upgrade environmental satellite systems and related applications		●	●				●				●				●	●

Table ES-2. Support Requirements for Building Tsunami Warning and Mitigation System Capacity in the Indian Ocean Region

Support Requirement	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
Tsunami Response and Emergency Preparedness																
Assistance to assess disaster management system and critical infrastructure		●					●				●					
Guidelines on conducting post-event surveys							●									
Upgrade dissemination mechanisms for marine warnings and assistance to integrate marine warning procedures for tsunamis					●	●					●				●	●
Assistance to develop tsunami response plans, exercises and drills to test preparedness			●					●					●			
Assistance to develop robust tsunami warnings dissemination mechanisms from national to local levels	●	●	●	●	●		●	●		●	●	●	●	●	●	
Tsunami Hazard and Risk																
Training and software for numerical modeling to develop inundation maps and evaluate tsunami hazards and vulnerability	●	●	●	●	●	●	●	●	●		●	●		●	●	●
Assistance to strengthen GIS capabilities and applications in disaster management		●	●						●		●					●
Guidelines on bathymetric and topographic requirements and other data inputs for tsunami inundation mapping			●				●		●							●
Tsunami and Other Hazards Public Awareness and Preparedness and Community Level Activities																
Educational modules and school curriculum for public outreach and education on tsunami early warning system process	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Regional training activities on early warning system process to strengthen linkages between key organizations including media, technical agencies, and risk managers	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Table ES-2. Support Requirements for Building Tsunami Warning and Mitigation System Capacity in the Indian Ocean Region

Support Requirement	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
Electronic versions of materials on tsunami and other disasters including brochures, videos, posters, and textbooks for adaptation, translation and dissemination		●		●	●			●		●			●	●	●	
Assistance on development of tsunami evacuation routes, maps, and signage for communities, tourists, and other stakeholder groups		●		●	●									●		

CONTENTS

FIGURES

TABLES

1.0 Introduction

The 26 December 2004 Indian Ocean earthquake and tsunami tragically demonstrated the urgent need for early warning systems that provide timely, understandable warnings which motivate ordinary citizens to quickly move out of harm's way. As part of the process for developing an effective and durable tsunami warning system in the Indian Ocean, national assessments of tsunami and other natural disaster management systems were conducted in countries in the region by international expert teams together with national experts from June to September 2005.

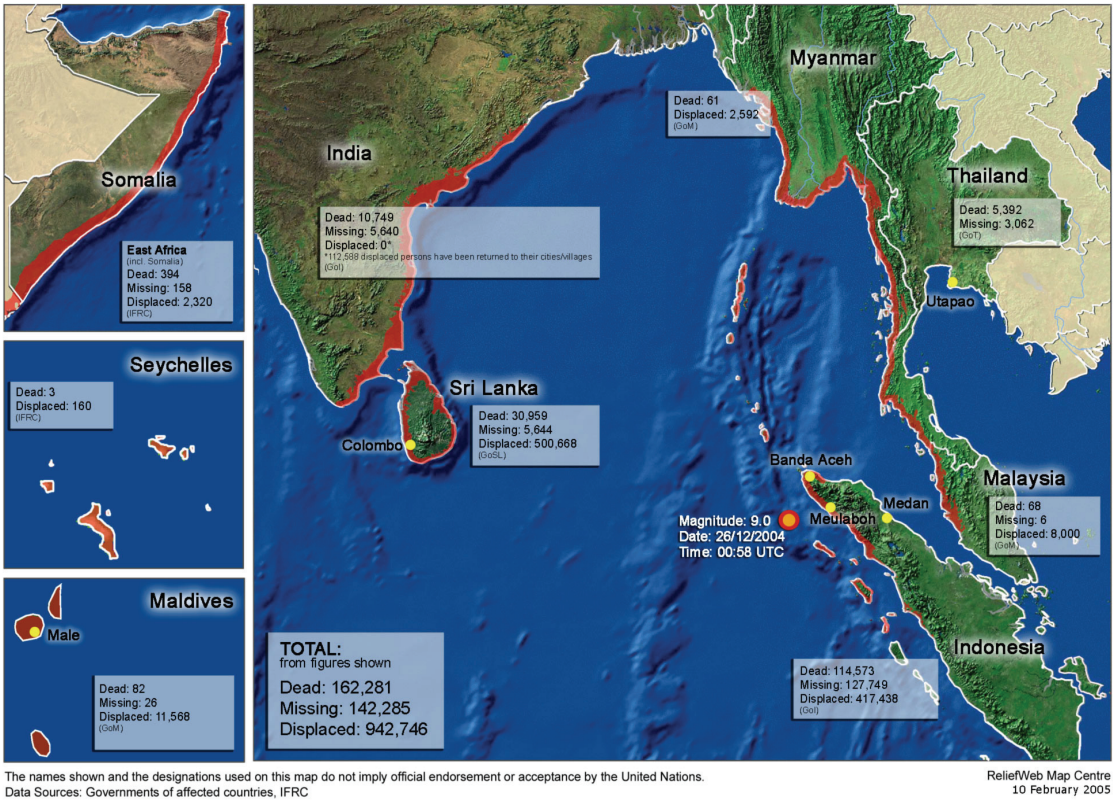
This document provides an overview of the assessment results and capacity building requirements for the development of a tsunami warning and mitigation system in 16 countries in the Indian Ocean. Background information on the earthquake and tsunami event, components of an end-to-end tsunami warning and mitigation system, and the status of efforts to establish the system is summarized in Section 1. Section 2 describes the assessment methodology and consolidation process. Section 3 provides summaries of the assessment results for each country. Section 4 provides a regional overview of capacity building requirements and opportunities. Annex A provides a list of acronyms and abbreviations and Annex B is the assessment questionnaire.

1.1 Indian Ocean Earthquake and Tsunami Event of 26 December 2004

An estimated 250,000 people lost their lives, and more than million people were displaced by the earthquake and ensuing tsunami, making it the worst tsunami catastrophe in history. The Mw9.3 26 December 2004 great earthquake off the west coast of northern Sumatra, Indonesia was the fourth largest earthquake since 1900, and the largest since the 1964 Mw9.2 Prince William Sound, Alaska earthquake. The tsunami affected coastal populations most drastically 10 countries - Indonesia, Sri Lanka, India, Thailand, Malaysia, Myanmar, the Maldives, the Seychelles, Somalia, and Tanzania (Figure 1-1).

Tsunami waves with runups of over 30 m were measured in nearby Banda Aceh, Sumatra with the first waves receding about 15 minutes after the earthquake. In Sri Lanka, tsunami wave runups of up to 15 m inundated the coast about two hours later, and wave runups of 4 to 9 m arrived more than seven hours later on the northeastern shores of Somalia (Figure 1-2). Waves and wave-carried debris left once-thriving communities in rubble, mud, and sediment, destroying livelihoods, economies, and the environment. Vegetation was stripped or died from the influx of salt water, local coastlines were eroded by wave action that permanently changed morphologies and so altered local sea-land fluxes, and coral reefs in areas dependent on tourism have been killed by the waves which physically broke the reefs apart and deposited sediments that choked the living reefs. Space satellite imaging of the wave arrivals and aerial photographs of the impact showed the widespread devastation that the tsunami caused across the Indian Ocean.

Figure 1-1. Population Affected by the December 26, 2004 Earthquake and Tsunami



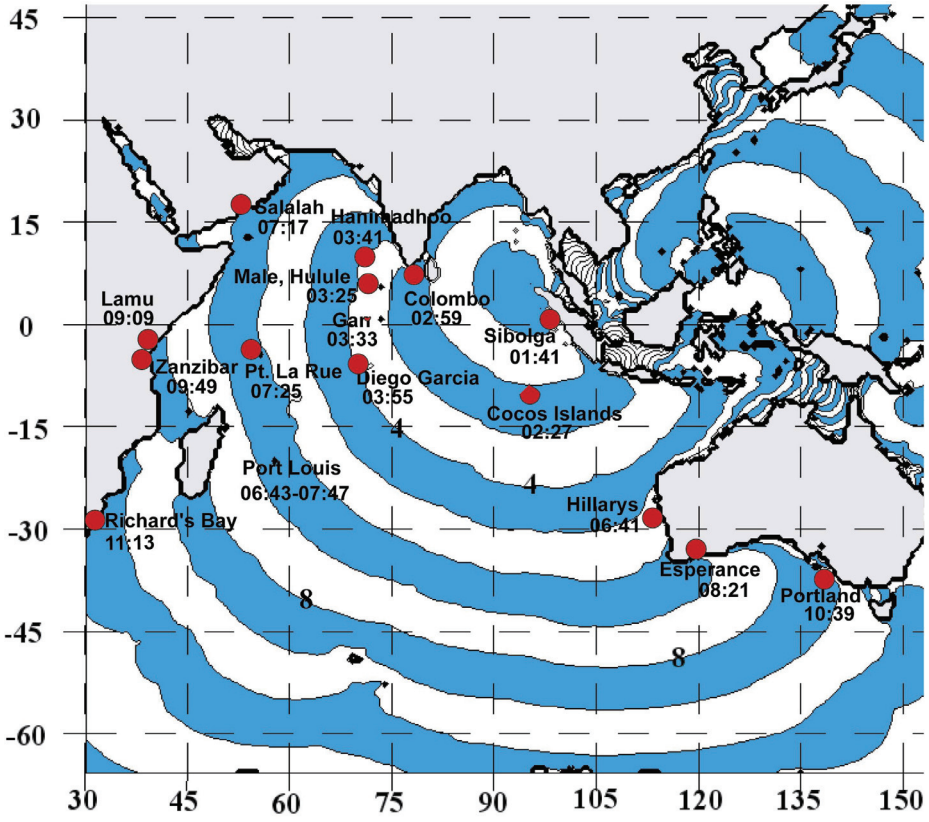
The coasts of Sumatra, and north through the Nicobar and Andaman Islands, have a documented history of great earthquakes occurring in 1833, 1861, and 1907. The 26 December 2004 earthquake, however, offered unprecedented opportunity for physical and social scientists and engineers to collect information on the impact of the tsunami. These data, including runup and inundation, deformation, scour, building and structural impact, wave arrival descriptions, and social impact, are helping to build our understanding on how to better mitigate against the impacts of tsunami on life and property.

The basin and global tsunami wave measurements from coastal sea level gauges and the satellite profiles, although not available in real-time to be used for tsunami warnings before wave arrival, have provided opportunities to ground-truth calculated propagation and inundation models of the affected coastlines (Figure 1-2 and 1-3). When combined with seismically-derived models for the tsunami source, these are providing very detailed depictions of the tsunami wave from its generation and immediate impact, its propagation as an edge wave along the coast of Sumatra, propagation into the Andaman Sea and the shallow waters towards Thailand and Malaysia, diffraction around Sri Lanka and reflections off the southern coast of India, reduced impacts to small islands which the long-wavelength tsunami passed over, directivity in the tsunami wave energy caused by the tsunami source as influenced by the sea floor bathymetry, and amplification of the tsunami wave signals due to shallow water morphology and the shape of the attacked coastlines.

Coastal sea level records across the Indian Ocean showed the variation in the character of the tsunami arrival. At locations to the east of the earthquake, the tsunami was first observed as a draw-down of sea level as the wave receded seaward, whereas the first tsunami wave was an

advancing which inundated the coastlines to the west (Figure 1-3). Additionally, the first wave was not always the largest wave, and the waves continued for hours afterward at periods of tens of minutes to 3 to 4 hours in the Pacific.

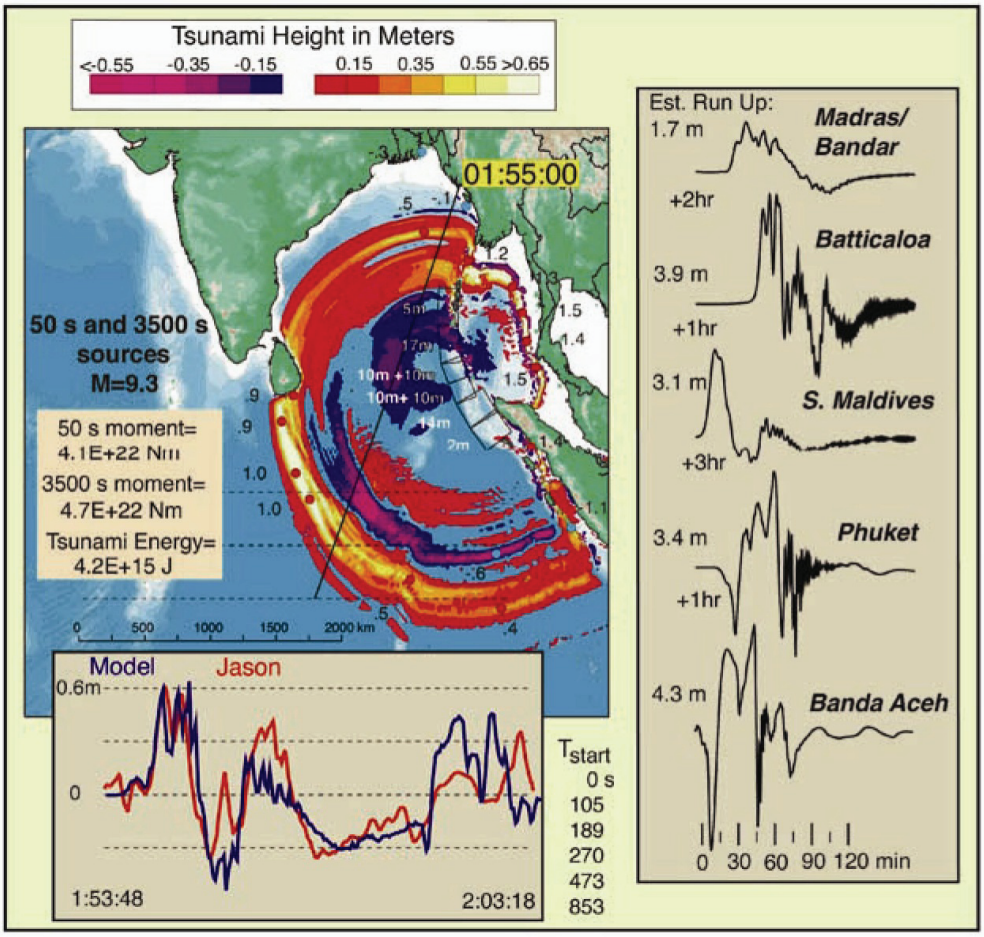
Figure 1-2. Tsunami Calculated Travel Times and Observed Arrival Times



Notes: Tsunami calculated travel times and observed arrival times for stations in the Indian Ocean. Tsunami travel times to Indian Ocean sea level gauge stations in hours:minutes. The blue-and-white contour bands show predicted travel times in hours as computed by the WC/ATWC model. Figure 5 from Merrifield et al., 2005.

The earthquake was felt at Banda Aceh, Meulaboh and Medan, Sumatra and in parts of Bangladesh, India, Malaysia, Maldives, Myanmar, Singapore, Sri Lanka, and Thailand. Aftershock earthquake distributions and fault rupture models using long-period body and surface waves suggest that the 26 December 2004 earthquake faulting occurred over a 200 km wide zone that extended 1300 km northward from the initial rupture (Figure 1-4). This earthquake was the first great earthquake to be fully captured by the modern high-quality, digital Global Seismic Network (GSN) and the Federation of Digital Broad-Band Seismograph Networks (FDSN). Begun by the seismological community in the 1980s, the 138-station GSN instrumentation is capable of measuring and recording with high fidelity all seismic vibrations from high-frequency, strong ground motions near an earthquake to the slowest global Earth oscillations excited by great earthquakes. GSN and FDSN data available continuously and in real time are the critical information used by tsunami warning centers such as the PTWC and JMA to monitor and rapidly evaluate the tsunamigenic potential of earthquakes.

Figure 1-3. Tsunami Wave Heights and Sea Level Modelling of Satellite Altimetry



Notes: (Left) Tsunami model at a time of 1 hour 55 min after earthquake initiation, computed for a composite slip model with fast slip (50-s rise time) in the southern portion of the rupture and slow slip (3500-s rise time) in the north. The northward propagating rupture velocity is about 2 km/s for the first 745 km, then slows to 750 m/s. The amplitude of fast and slow slip on the six fault segments are indicated by white numbers and outlined numbers, respectively. Red colors in the map indicate positive ocean wave height, blue colors negative. The numbers along the wavefront give wave amplitudes in meters. Diagonal line is the track of the Jason satellite that passed over the region at about this time (10 min of actual transit time along the profile). The predicted (blue) and observed (red) tsunami wave are shown in the inset. The tsunami generated by the fast component of slip alone cannot explain the trough in the central Bay of Bengal. (Right) Tsunami waveforms and estimated runup heights for five locations around the Bay of Bengal. The first arrivals show water draw-down toward the east and inundation toward the west. Principal wave period is about 30 min. Figure 7 from Lay et al., 2005.

Figure 1-4. Location of Epicenter (yellow star) and Aftershocks of 26 December 2004 (USGS National Earthquake Information Center)

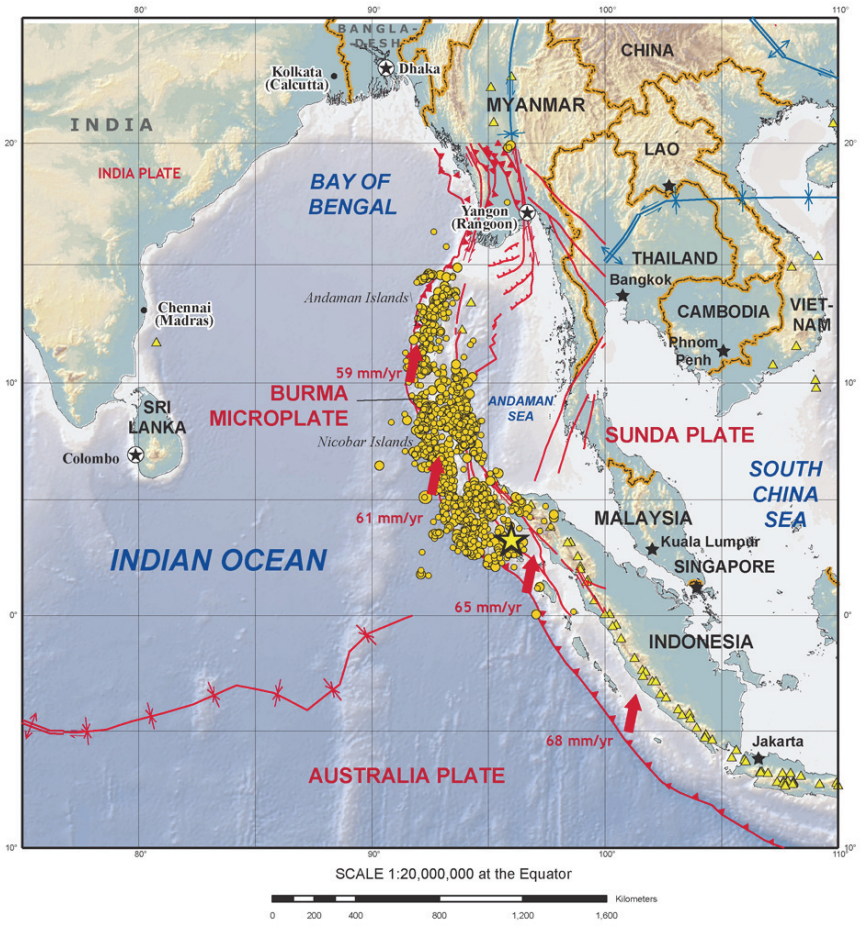
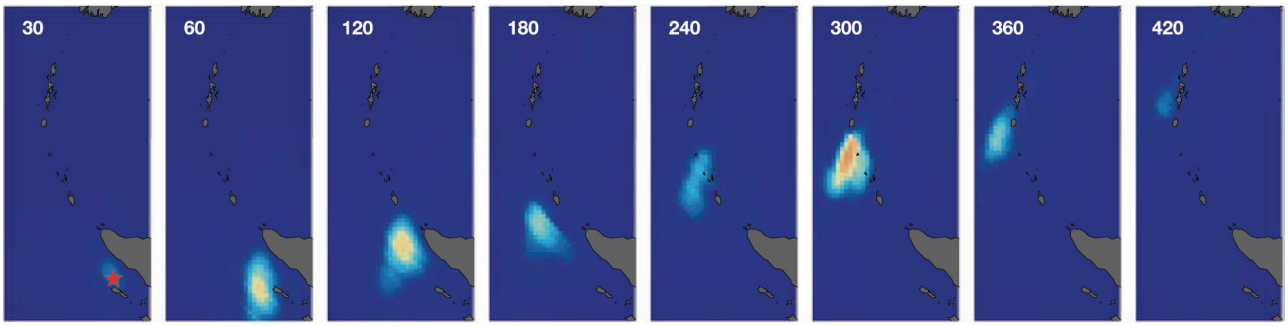


Figure 1-5. Earthquake Rupture Along the West Coast of Sumatra, Indonesia



Note: Maps show the distribution of seismic energy radiation at 30-s intervals for the first minute, and at 1-min intervals thereafte (seconds after the event in upper lef)r, following the earthquake initiation. The images show the northward migration of the rupture during the 8-min-long event. The epicentre is indicated by the red star in the first panel. The spacing for the source grid used to stack seismograms is 0.28 in both latitude and longitude, meaning that the energy values used were assigned into blocks 0.28 degrees (about 30 km). The highest energy values are shown in red, followed by orange, yellow, light blue and dark blue as the lowest resolvable energy. Figure 2 from Ishii et al., 2005

The unprecedented GSN and FDSN recordings of the great Sumatra-Andaman earthquake of December 26, 2004 provided the basis for rapid quantification of the faulting process. Additionally, direct imaging of the earthquake rupture in time and space, obtained using the first-arriving compressional wave energy recorded by a dense network of stations in Japan, showed that the rupture started in the south off Banda Aceh and over the next eight minutes ripped continuously northward into the Nicobar and Andaman Islands in a series of faulting episodes each with decreasing strength over a 1,200 km region (Figure 1-5, Ishii *et al.*, 2005).

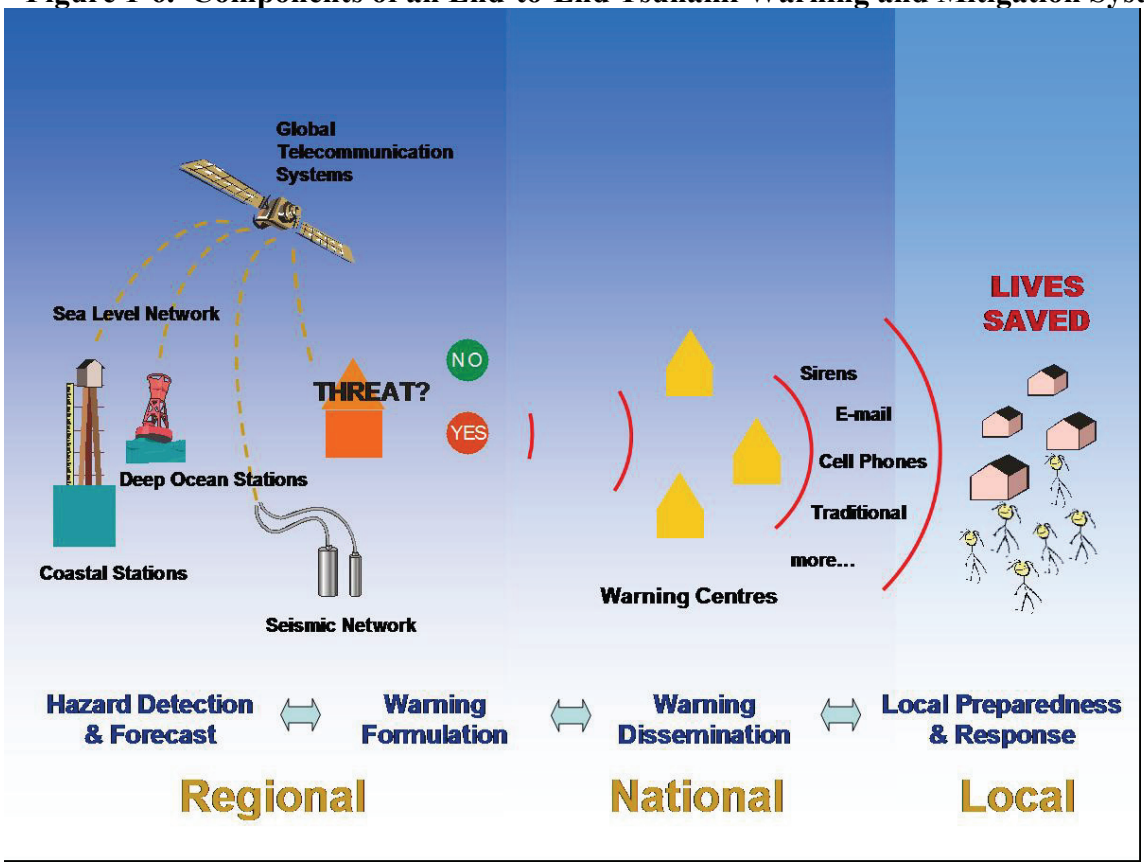
On 28 March 2004, another great Mw8.7earthquake occurred to the south near Nias Island in the region where the 1861 and 1907 events had occurred. Luckily this event did not cause widespread tsunami damage because the much smaller rupture (several hundred kilometers southward), complexity in the tectonic structure and its location landward of offshore islands, and its energy directivity more to the southwest and away from Sri Lanka, India, and other countries to the east. The earthquake did provide a second reminder to the already-anxious populations of south Asia that large earthquakes, and thus tsunamis, can occur at any time without notice.

1.2 Components of an End-to-End Tsunami Warning and Mitigation System

The objective of the Indian Ocean Tsunami Warning and Mitigation System (IOTWS) is to effectively mitigate the hazard posed by local and distant tsunamis in all parts of the Indian Ocean. Comprehensive tsunami mitigation requires progress in three mutually dependent components: first, the assessment of tsunami hazards; second, a detection and warning system; and third, the adoption of preparedness measures. To achieve this objective, an end-to-end tsunami warning system (Figure 1-6) is needed that establishes national and regional warning systems for local, regional, and ocean-wide tsunamis, and promotes preparedness and risk reduction against tsunami hazards within a multi-hazard approach.

Substantial knowledge and expertise in natural disaster management and mitigation is available to deal with the risks of tsunamis in the Indian 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 kilometers per hour cross the ocean and require observational data from multiple countries in a region.

Figure 1-6. Components of an End-to-End Tsunami Warning and Mitigation System



1.3 International Collaboration for the Development of an Indian Ocean Tsunami Warning and Mitigation System

The United Nations has been engaged for fifteen years in a process of creating awareness and promoting the development of policies to diminish the loss of life and property from natural and man-made disasters - first through the International Decade for Natural Disaster Reduction and then through the International Strategy for Disaster Reduction that followed, and the establishment by the UN-ISDR of the Inter-Agency Task Force on Disaster Reduction, in which both the WMO and UNESCO-IOC participate. This process of awareness-raising and policy development culminated in the World Conference on Disaster Reduction held in Kobe, Japan, in January 2005.

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

The Hyogo Declaration states that " […] we are far from powerless to prepare for and mitigate the impact of disasters. We can and must alleviate the suffering from hazards by reducing the vulnerability of societies. We can and must further build the resilience of nations and communities to disasters through people-centered early warning systems, risks assessments, education and other proactive, integrated, multi-hazard, and multi-sectoral

approaches and activities in the context of the disaster reduction cycle, which consists of prevention, preparedness, and emergency response, as well as recovery and rehabilitation."

Following the devastating tsunami disaster on 26 December 2004, the international community has made concerted efforts to address the humanitarian, recovery and development needs of the countries and population affected. Recognizing the urgency to mobilize efforts and resources towards establishing an early warning system for the Indian Ocean region, the United Nations International Strategy for Disaster Reduction (UN-ISDR) in coordination with several agencies developed the tsunami early warning initiative Evaluation and Strengthening of Early Warning Systems in countries affected by the 26 December 2004 Tsunami, coordinated by the UN-ISDR/PPEW under the UN Tsunami Flash Appeal with contributions totaling US$11 million received from the European Commission, and the Governments of Finland, Germany, Japan, Norway, and Sweden. Activities are implemented in partnership with several United Nations agencies including UNESCO-IOC, the United Nations University- Institute for Environment and Human Security (UNU-EHS), the World Meteorological Organization (WMO), the UN Economic & Social Commission for Asia and the Pacific (UNESCAP), the UN Environment Programme (UNEP), and the UN Development Programme (UNDP).

Partnership agreements have been established with other organizations to carry out specific activities aimed at enhancing public awareness and education, developing better informed national preparedness and mitigation policies, and strengthening the communication and information flow channels in the region. Partner organizations include the ADRC, ADPC, the Asia-Pacific Broadcasting Union (ABU), the Center for Research on the Epidemiology of Disasters (CRED), the Disaster Mitigation Institute in India, and the University of Geneva.

Substantial progress has been made toward the establishment of a tsunami warning and mitigation system for the Indian Ocean region. In addition to the national assessments summarized in this report, selected other accomplishments include:

- The Hyogo Framework for Action 2005 to 2015, negotiated by governments at the World Conference on Disaster Reduction, Kobe, Hyogo, Japan, January 18 to 22, 2005 sets out specific directions and priorities for action by governments and organizations over the next decade.

- Agreement has been reached on the general design and management of a regional early warning system for the Indian Ocean. This major achievement was the result of a series of international intergovernmental meetings organized by UNESCO-IOC, which generated necessary consensus and regional agreement on building a distributed, interconnected tsunami warning system.

- A simple interim early warning system has been set up involving the exchange of data and warning advisory information to national tsunami focal points centres from Japan and Hawaii tsunami centers. The system was partly effective when a 2nd major earthquake occurred on 28 March 2005.

- National experts from 26 Indian Ocean countries have enhanced their knowledge and capacity to identify requirements for national tsunami warning and mitigation systems, through participation in two study tours to Japan and Hawaii organized by UN-ISDR and UNESCO-IOC in order to observe existing Pacific Ocean tsunami early warning systems.

The knowledge gained is already being put into practice by participants, for example in organizing national tsunami early warning centres and providing public information products.

- The Global Telecommunication System (GTS) – coordinated by WMO, is being reviewed and strengthened to support the exchange and distribution of Indian Ocean Tsunami Warning System alerts and related information, including for the interim Tsunami Watch arrangements. This will have the added long-term advantage of providing the basis for an all-hazards information exchange system for the future.

- Two media-targeted regional workshops were jointly organized by ABU and UN-ISDR bringing broadcasters together with technical experts from the tsunami and weather warning fields. The workshops improved dialogue and understanding in respect to warning dissemination and public education. Each broadcaster prepared some video material for discussion at the workshop. The broadcasters, UNESCO-IOC and WMO were enthusiastic about the results and are planning further workshops at national levels.

- To address and better coordinate the public awareness and education components of tsunami early warning system in Asia, UN-ISDR/PPEW coordinated a 2-day workshop in Bangkok involving participants from UN agencies, IFRC, national institutes, broadcasting agencies, and NGOs. Participants shared experiences and devised plans to implement public awareness campaigns and identified synergies for further coordination.

- With focus on community-based approaches, UNDP country offices in India and Sri Lanka will pilot activities targeting the institutionalization of early warning systems within Disaster Management centres and teams and the strengthening of dissemination mechanisms of early warnings to communities. This work represents a natural step of enhancement of established UNDP disaster management efforts in these countries.

- Field studies and research are carried out by CRED in Tamil Nadu to assess the epidemiological factors in deaths and casualties, while UNU-EHS has conducted field studies of disaster risk management in Galle, Sri Lanka, and have provided advice to government officials based on results of the studies.

- A regional consultative meeting on early warning for the east coast of Africa was organized by UN-ISDR/PPEW Africa office in Nairobi in order to inform participants from the region on tsunami matters, to share best practices and lessons learned on early warning, and to identify early warning gaps needs and in the east coast of Africa.

- An initiative documenting lessons-learned has begun under the coordination of UN-ISDR/PPEW. Reports from numerous organizations and actors have been compiled for review and summary to disseminate the information.

- A regional UN-ISDR/PPEW team has been established in Bangkok to support multi-partner activities in Asia, which are targeted at national disaster risk reduction efforts and Hyogo Framework implementation. The team is actively supporting early warning activities through network building, information provision, and advocacy.

- UN-ISDR/PPEW has established a web-based information system that contains information and documents on the activities and initiatives supported by the tsunami early warning project http://www.unUN-ISDR-earlywarning.org/tewis

1.4 Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System

Through a number of high-profile meetings in 2005[1], the UNESCO-IOC has been widely recognized as the appropriate UN intergovernmental body to facilitate the development of both interim and permanent tsunami warning systems for the Indian Ocean. This was in recognition for its work in the Pacific since 1965 in coordinating one of the most successful international scientific programmes that has a direct humanitarian aim of mitigating the effects of tsunami to save lives and property.

Formed in response to the 1960 M9.5 Chile earthquake that caused ocean-wide deaths in Hawaii and Japan, the International Coordination Group for the Tsunami Warning System in the Pacific (ITSU, now ICG/PTWS (Pacific Tsunami Warning and Mitigation System) and its central implementing organizations, the UNESCO-IOC International Tsunami Information Centre (ITIC) and the US National Oceanic and Atmospheric Administration (NOAA) Pacific Tsunami Warning Center (PTWC), have accumulated invaluable experience and knowledge on how to assess tsunami risk at the national and local level, how to promote awareness and preparedness amongst the population, and how to build national and regional tsunami warning systems in the Pacific region (ITSU Master Plan, 1999).

In the aftermath of the 26 December 2004 tsunami, the PTWS Member States shared their experience and expertise widely to help increase awareness on tsunami hazards and how to effectively prepare and warn against local and distant tsunami threats.

To start the development process of the IOTWS, the UNESCO-IOC convened the *International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a Global Framework* at UNESCO Headquarters, 3-8 March 2005. Attended by nearly 300 participants from 21 Indian Ocean region countries, 25 other UNESCO-IOC Member States, 24 organizations and 16 observers, the meeting ensured that Indian Ocean Member States were fully informed, at the technical level, on tsunami warning and mitigation programmes at the national, regional and global levels. It was further stressed that the regional system should be a coordinated network of national systems; that warnings should be the responsibility of each participating country; and that effective operation of the regional system will require sharing of relevant observational data. The Meeting also recommended the establishment of an "Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS)".

[1] *UNESCO/UNESCO-IOC had been requested to lead the process of establishing an Indian Ocean Tsunami Warning and Mitigation System on several occasions, such as the Special ASEAN Leaders' Meeting (Jakarta, 6 January 2005), the UN Conference on Small Island Developing States (Port Louis, 14 January 2005), the UN General Assembly (New York, 19 January 2005) by Resolution 59/279, the Common Statement of the Special Session on Indian Ocean Disaster and the Hyogo Framework for Action 2005-2015, both adopted at the World Conference on Disaster Reduction (Kobe, 22 January 2005), the Ministerial Declaration in Phuket (29 January 2005), the GEO Communiqué (Brussels, 16 February 2005), and several technical meetings held in China, India and Indonesia.*

The *Second International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean* (Grand Baie, Mauritius, 14-16 April 2005), attended by nearly 192 participants from 24 countries in the Indian Ocean region, approved the work plan prepared by the UNESCO-IOC Secretariat.. Several donors pledged financial support, amounting to approximately US$ 5 million, including Belgium, Germany, Italy and Norway. Several others, including Australia, France, Japan, Germany, the United States of America, as well as the European Commission, also indicated their continuing support and their willingness to provide more financial aid as the plans for the system became more clearly defined.

At the 23rd Session of the UNESCO-IOC General Assembly, Intergovernmental Coordination Groups for the Indian Ocean (ICG/IOTWS), the Caribbean Sea and adjacent regions, and the Northeastern Atlantic, the Mediterranean and its connected seas (ICG/NEAMTWS) were established, demonstrating the high-level commitment by governments to initiate comprehensive tsunami risk reduction programmes. A fourth UNESCO-IOC Intersessional Ad-Hoc Working Group was also established to discuss a global framework for the establishment of an early warning system for all coastal marine hazards. The ICGs provide a governance mechanism for the coordination and implementation of tsunami mitigation activities in each region.

The first session of the ICG/IOTWS met in Perth, Australia 3-5 August 2005 to discuss the technical implementation of the tsunami warning and mitigation system. Intersessional Working Groups were established to provide a means for the further discussion on the preferred way forward for the real-time monitoring of large earthquakes, the monitoring of sea levels both along the coast and in the deep ocean for tsunami confirmation, the identification and quantification of the hazard through modeling, prediction and scenario development, and the establishment of a system of interoperable operational centres.

The second session of the ICG/IOTWS will meet 14-16 December 2005 in Hyderabad, India to report on the activities of the Intersessional Technical Working Groups, but importantly to also discuss and endorse the capacity-building needs and requirements of nations. This Consolidated Report and the individual National Assessment Reports document the baseline activities as of the third quarter of 2005, and identify activities for national and regional urgent action.

2.0 Methodology

In preparation for the *Second International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean* held in Grand Baie, Mauritius from April 14 to 16, 2005, Indian Ocean Member States were invited to prepare project proposals for the development of national tsunami warning and mitigation systems. Summaries of these proposals were distributed at the meeting and were included in Document IOTWS-II/5. Based on a review of these proposals, it was concluded that it was difficult for countries to clearly identify needs and produce comprehensive information based on available resources.

During the *Second International Coordination Meeting*, the Mauritius Declaration was adopted inviting the countries of the Indian Ocean to complete an assessment of their requirements and capacity needs by May 2005 with the support of UNESCO-IOC, where appropriate, for an effective and durable national tsunami warning and mitigation system to be followed by the development of appropriate national strategic plans (Mauritius Declaration, paragraph 14). In response to this declaration, the UNESCO-IOC, in collaboration with WMO and UN-ISDR/PPEW offered to undertake national assessment missions.

During and after the Mauritius meeting, sixteen Member States requested an assessment mission (Figure 2-1). These countries are Bangladesh, Comoros, Indonesia, Kenya, Madagascar, Malaysia, Mauritius, Myanmar, Mozambique, Oman, Pakistan, Seychelles, Somalia, Sri Lanka, Tanzania and Thailand. All assessments were completed between July and September 2005. The overall objectives of the national assessment missions were to:

- Inform national stakeholders of the requirements for the establishment and operation of a tsunami warning and mitigation system
- Assess existing organizational, infrastructure, and human resources for tsunami detection, warning and mitigation
- Identify capacity building needs and priorities

Additionally, Iran, South Africa, and Yemen made later requests for assessment missions. The UNESCO-IOC will coordinate visits to these countries in 2006, as well as to the Maldives which had requested postponement in August 2005.

National assessments were conducted by international expert teams working together with experts from each participating country. Three-day missions were conducted to each country to meet with national experts from government agencies and non-governmental organizations involved in tsunami or natural disaster management. A questionnaire, consisting of 136 questions covering eight topics on tsunami mitigation was completed by the team of international and national experts in each country. The eight topics are listed below with the complete questionnaire provided as Annex B.

Questionnaire Topics

Section 1: Contact Information
Section 2: Authority and Coordination
Section 3: Tsunami Warnings and Tsunami Monitoring
Section 4: Tsunami Warning Response and Emergency Preparedness
Section 5: Tsunami Hazard and Risks
Section 6: Tsunami Public Awareness and Preparedness and Community Level Activities
Section 7: Tsunami Response to 28 March 2005 M8.5 Earthquake off Sumatra, Indonesia
Section 8: Overall Enhancement of National Capabilities to Mitigate the Impact of Hazards

Figure 2-1. Countries Participating in National Assessments

The questionnaire was composed of primary questions and secondary questions (Table 2-1). Secondary questions were designed to provide additional information in support of the primary questions. Eighty-six of the questions were designed to provide *yes* or *no* responses to questions with the remaining questions generally requesting detailed information about human resource, infrastructure, or technological capacity.

Table 2-1. Questionnaire Profile

Question Type	Primary	Secondary	Total
All Questions	80	59	136
Yes/No	67	19	86
Descriptions (who, what, where, when)	13	37	50

The questionnaire was sent to each country several weeks prior to the visit of the mission team and it was requested to return the filled questionnaire to the UNESCO-IOC Secretariat. This was achieved in some but not all cases. The national assessment mission consisted of the following elements:

- Pre-mission information gathering
- 3-day expert mission
- Preparation of full report
- Assistance (as required) in developing capacity building strategy for national tsunami warning system for submission to national government and (as required) donors

During the first day of each mission, international experts made presentations on various requirements, including organization, infrastructural, and human resources, needed for the establishment and operation of a tsunami warning and mitigation system. These presentations were followed by presentations by national experts on the existing capacities for tsunami mitigation and the management of other natural disasters, as well as initiatives and future plans. The second and third days of each mission were focused on completing the country assessment interview through joint discussions on each question.

Generic 3-Day Expert Mission

Day 1

- Introduction of the experts and national committee members
- Introduction by UNESCO-IOC on objectives of the assessment mission
- Individual presentations by experts
- Presentations by national coordination committee on status of tsunami warning system arrangements as well as on national disaster management arrangements
- Field visit organized as necessary to visit national agencies, facilities and resources

Day 2

- Joint discussions on questionnaire (WMO, UN-ISDR and UNESCO-IOC)
- Preparation of recommendations for national actions and required support by experts

Day 3

- Discussion of recommendations
- Other business

Mission teams were composed of international experts from the UNESCO-IOC, UN-ISDR/PPEW, WMO, UNESCAP, and the Asian Disaster Reduction Center (ADRC) and subject matter experts from around the world. Country teams that participated in the mission discussions included national experts from academic institutions, government agencies, and nongovernmental organizations from each participating country. It was agreed between the core partner organizations (UNESCO-IOC, UN-ISDR/PPEW, WMO) and additional partners (ADRC, IFRC) that UNESCO-IOC would provide the team leader for the missions and would also be responsible for the organization of the missions and preparation of the assessment reports. Two meetings were conducted in Paris, France to agree on the mission schedules and on the terms of reference for the assessment mission. One meeting was held in Paris after the completion of the 16 missions to discuss the results and coordinate the compilation of the Consolidated Report.

International Expert Team

Mr. Bernardo Aliaga, UNESCO-IOC Team Leader, France
Mr. Eisa H. Al-Majed, WMO, Doha, Qatar
Mr. Masaru Arakida, ADRC, Japan
Dr. Chris Hartnady, Umvoto Africa (Pty) Ltd, South Africa
Dr. Laura Kong, UNESCO-IOC ITIC, USA
Mrs. Haleh Kootval, WMO, Switzerland
Dr. Tetsushi Kurita, ADRC, Japan
Dr. Feng-Min Kan, UN-ISDR, Switzerland (formerly in Kenya)
Mr. David McKinnie, NOAA, USA
Dr. Walter Mooney, USGS, USA
Ms. Akiko Nakamura, ADRC, Japan
Dr. Yuichi Ono, UN-ISDR/PPEW, Germany
Mr. Praveen Pardeshi, UN-ISDR, Switzerland
Mr. Peter Pissierssens, UNESCO-IOC Team Leader, France
Ms. Noro Rakotondrandria, UN-ISDR, Kenya
Mr. Grahame Reader, Bureau of Meteorology, Australia
Ms. Cristel Rose, UN-ISDR, Thailand
Mr. Henri Savina, Météo France
Dr. François Schindelé, former ICG/ITSU Chair, Département Analyse, Surveillance Environnement, France
Mr. Bengt Tammelin, Finish Meteorological Institute, Finland
Mr. Akihiro Teranishi, ADRC, Japan
Mr. Le-Huu Ti, UNESCAP, Thailand
Mr. Brian Yanagi, UNESCO-IOC ITIC, USA
Mr. Masahiro Yamamoto, UNESCO-IOC (formerly with JMA), France
Mr. Kai-Hing Yeung, Hong Kong Observatory, China
Mr. Laurent Zerbib, Météo France

National assessment reports included information from both international and national experts; the jointly completed country assessment questionnaire, and in some cases, national proposals. These reports were reviewed and information and data extracted and summarized in tables found in Section 3 of this report. In addition, responses to primary, *yes/no* questions were tabulated and analyzed. Summary tables were sent to each country to review for accuracy and to provide any updates and comments received were incorporated in each table.

The WMO conducted Global Telecommunication System (GTS) expert missions to Sri Lanka, Bangladesh, Maldives, Myanmar, Pakistan, Djibouti, Kenya and Tanzania for on-site assessment of national GTS components upgrades that are required to fully meet the operational requirements for an efficient IOTWS and multi-hazard EWS. Detailed survey and project information already available from WMO Programmes (e.g. Tropical Cyclone Programme) were used for assessing needs for Comoros, Madagascar, Mauritius and Seychelles. A GTS upgrade coordination meeting was held in Geneva in October 2005 to review and consolidate the results of these assessments into a consistent "GTS Upgrade and Implementation Plan" for the Indian Ocean rim. The meeting was participated by a team of telecommunication experts. The outcome of the meeting is included in the respective National Assessment Summaries for each country.

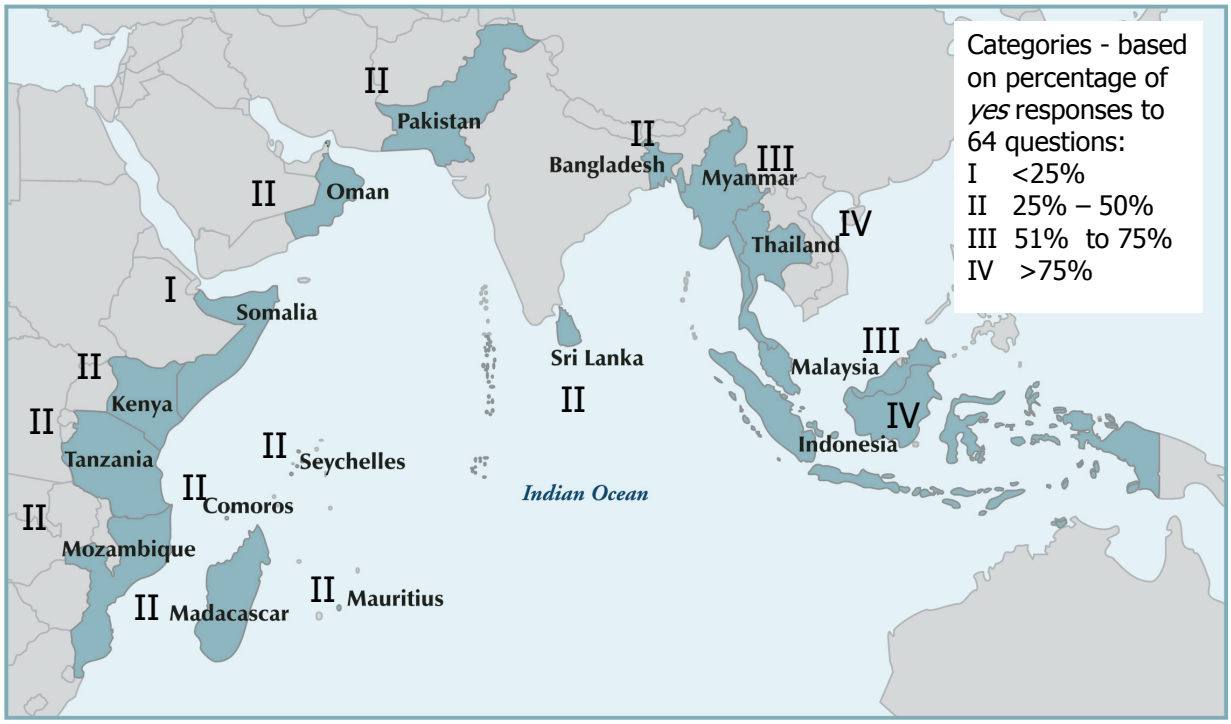
3.0 Summary of National Assessments

In the aftermath of the December 26, 2004 tsunami, countries throughout the Indian Ocean region have intensified their efforts to develop an effective tsunami warning and mitigation systems. Countries that had not previously experienced a tsunami are beginning to develop monitoring capability and community preparedness plans. Other countries with historical records of tsunami inundation are enhancing existing systems for real-time monitoring and warning formulation. Activities are occurring at national and regional scales. Overall, there is a strong desire to integrate tsunami warning and mitigation systems with ongoing disaster risk reduction initiatives and programme in order to ensure the sustainability of the tsunami warning system. This section provides a regional overview and national assessment summaries of 16 countries in the Indian Ocean region.

A regional overview of tsunami warning and mitigation capacity is provided in Figure 3-1. The questionnaire was used as a basis for tabulating the percentage of *yes* responses to a subset of 64 questions from the questionnaire in the national assessment. These 64 questions are shown in Table 3-1 along with the *yes*, *no*, or in some cases, *partial-yes* responses (where activities had been initiated or partially accomplished) by country.

The percentage of *yes* responses varied from country to country but generally fell into four categories (Figure 3-1). Most of the countries were assigned to Category II based on the percentage of *yes* responses. Myanmar and Malaysia were assigned to Category III. Indonesia and Thailand fell in the highest Category IV with > 75% yes responses to 64 questions.

Figure 3-1. Regional Overview of Tsunami Warning and Mitigation Capacity



Overall, most countries have established or strengthened their disaster management laws, national platforms, and national and local coordination mechanisms to guide all-hazard disaster risk reduction and to establish clearer responsibilities for end-to-end early warning system (Table 3-1; Questions 2, 3, 4, and 5). Not all have specifically addressed the tsunami coordination aspect.

All participating countries receive international tsunami warnings from the Pacific Tsunami Warning Center (PTWC) and the Japan Meteorological Agency (JMA) except Somalia, and most countries receive these warnings at facilities with back-up systems for receiving warning messages that operate 24 hours a day, 7 days a week (Questions 17, 19, and 20). Few countries operate a national tsunami warning centre or have the capacity to receive or provide real-time seismic or sea level data (Table 3-1; Questions 22, 24, 28, 30, 31, 32, 37, 38, and 39).

Few participating countries have developed tsunami emergency and evacuation plans and signage or tested response procedures for tsunamis or earthquakes (Questions 50, 59, 60 and 61). Much of the information and data needed to develop these plans, such as post-event surveys, inundation modeling, and tsunami hazard and vulnerability assessment, has yet to be collected (Table 3-1; Questions 65, 68, 69, 71, 73, and 77).

Many participating countries have assessed local government capacity for disaster preparedness and emergency response but not community preparedness (Questions 84 and 86). Community education and outreach programmes are being developed but are largely not in place in most participating countries (Table 3-1; Questions 87, 88, 101, 105, and 110).

Few countries are implementing structural mitigation measures, such as revision of building codes or non-structural mitigation measures, such as improving coastal vegetative buffers, to reduce tsunami impacts (Table 3-1; Questions 115 and 116).

Overall, most countries have made progress developing policies, assessing technological needs, and establishing coordination mechanisms at a national level for tsunami warning and mitigation. Local planning and preparedness activities are being carried out first in selected target areas, or cities and towns, rather than as comprehensive national programmes.

Table 3-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
2	Legal framework in place for disaster warning formulation, dissemination, and response	○	○	◉	●	○	●	○	●	●	●	●	○	○	●	●	●
3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●	●	●	●	●	●	●	●	●	●	●	●	--	●	●	●
4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●	○	●	○	◉	●	●	○	○	●	●	●	--	●	○	●
5	Disaster coordination mechanisms at the community level established	●	●	●	●	●	●	●	○	○	●	○	●	--	●	●	●
13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○	●	●	○	●	●	●	○	●	●	○	○	--	○	◉	●
14	Regional partnerships exists for assessing and responding afterward to earthquake and/or tsunami disasters	○	●	●	●	○	○	○	○	●	●	○	●	--	○	●	●
15	Active research ongoing in seismology or tsunamis	●	●	●	○	●	◉	○	●	●	●	●	●	--	○	●	●
16	Government-sponsored research organization exists that can provide products or services to strengthen your tsunami warning and mitigation system	●	○	●	◉	○	●	○	○	◉	●	○	◉	--	◉	●	●
17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●
19	Back-up or alternative method exists for receiving the warning messages?	●	○	●	●	●	●	●	●	○	●	●	●	--	●	●	●
20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●	●	●	●	●	●	●	●	●	●	●	●	--	●	●	●

Table 3-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○	○	●	○	○	●	◉	◉	○	○	○	○	○	◉	○	●
24	Warning center staffed 24-hours-a-day, 7-days-a -week	○	○	●	○	○	●	◉	◉	○	○	○	○	--	●	○	●
28	Seismographic stations or seismograph networks operated monitor regional seismicity	●	●	●	○	●	●	○	●	●	●	●	●	○	●	●	●
30	Real-time seismic data received	●	●	●	○	●	●	○	○	○	●	○	○	○	◉	○	○
31	Real time seismic data provided	○	○	●	○	○	●	○	○	○	●	○	○	○	○	◉	○
32	Seismographic stations or seismograph networks monitor local seismicity	●	●	●	●	●	●	○	○	●	●	●	○	○	●	●	●
37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○	○	●	●	●	●	●	●	○	●	○	●	○	●	●	●
38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○	○	●	◉	○	○	●	●	○	●	○	●	○	●	○	○
39	Sea level data sampling frequently sufficient to resolve short-wavelength tsunami	○	○	●	○	○	○	●	○	○	○	○	○	○	●	○	○
42	International agencies providing assistance to strengthen your tsunami monitoring, evaluation, warning capabilities	○	○	●	●	●	○	◉	○	●	○	○	●	○	●	○	●
44	Agency receiving tsunami warning designated by law	●	●	●	○	●	●	○	●	◉	○	●	○	○	○	○	●
45	Designated agency receiving tsunami warning issues public evacuations	○	●	○	●	●	●	○	○	●	○	●	○	--	○	○	●
47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●	○	◉	○	●	●	◉	●	●	○	●	◉	--	◉	●	●

Table 3-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist indicating evacuation routes to safety or higher ground	○	○	◉	○	○	○	○	○	●	○	○	○	--	◉	○	●
51	Marine warnings issued according to guidance or instructions for marine vessels, harbors and ports	○	○	●	●	●	●	○	○	●	○	○	●	--	●	○	●
53	Procedures or criteria exist for determining when it is safe for responders or the public to return	○	●	○	●	●	●	○	●	●	○	○	○	--	●	○	●
54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●	○	◉	--	●	○	●	--	◉		●	●	--	--	--	◉
55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●	●	●	--	●	●	●	--	●		●	●	--	--	--	●
59	Response procedures for regional- or locally-generated tsunami in place	○	○	○	○	○	●	○	○	●	○	○	○	--	○	○	●
60	Response procedures for earthquakes in place	○	●	◉	○	○	●	○	○	●	○	●	○	--	○	○	●
61	Response procedures have been tested or exercised	○	○	◉	○	○	○	○	○	◉	○	○	◉	--	◉	○	●
63	Critical infrastructure and lifeline support facilities for disaster response identified	○	●	○	◉	●	○	◉	○	◉	●	○	○	--	○	○	●
65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○	○	●	○	○	●	○	○	●	◉	○	●	●	●	○	●
67	International agencies providing assistance to strengthen your tsunami warning response	○	○	●	○	○	○	○	○	●	○	○	●	--	○	○	●
68	Tsunami hazard evaluation conducted prior to December 26, 2004	●	○	●	○	○	●	○	○	●	○	●	○	--	●	○	●
69	Historical record of past earthquakes and tsunamis documented	◉	◉	●	◉	◉	◉	○	○	◉	○	◉	○	--	○	●	◉

Table 3-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
71	Tsunami vulnerability assessment conducted	●	○	●	○	○	○	◉	○	○	○	○	○	--	○	○	●
73	Numerical modeling studies conducted to calculate inundation from tsunamis	○	○	●	○	●	○	○	○	○	○	○	○	--	◉	○	●
77	Accurate bathymetry and topography data exist for the coastlines	●	○	○	○	○	○	●	○	○	◉	●	◉	--	○	○	○
78	Geographical information systems used as a decision support tool during emergency response	○	○	●	○	●	●	○	●	○	○	○	◉	--	○	○	●
80	International agencies providing assistance to evaluate tsunami hazard and risk assessments, and/or conduct numerical modeling	○	○	●	○	○	○	◉	○	●	○	○	●	--	○	○	●
82	Post-tsunami impact assessments been conducted	○	○	●	○	○	●	●	○	●	○	●	●	●	●	○	●
84	Local government disaster preparedness and emergency response assessed	●	○	◉	●	●	●	●	●	●	○	●	○	--	○	○	●
86	Community and ordinary citizen disaster preparedness and emergency response assessed	◉	○	○	○	○	○	●	○	○	○	◉	◉	--	◉	○	●
87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○	○	●	◉	◉	○	◉	○	◉	◉	○	◉	--	◉	◉	●
88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●	○	●	◉	◉	○	◉	●	◉	●	○	◉	--	○	○	●
92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●	●	●	○	●	○	○	●	●	○	●	●	--	○	○	●
93	Tsunami mitigation and emergency response decisions based on knowledge of the known local risks and the potential impacts of tsunami on the specific community	◉	○	●	○	●	○	○	○	●	○	○	◉	--	○	○	●

Table 3-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○	○	○	○	○	○	○	○	○	○	○	○	--	○	○	●
95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●	●	●	○	●	○	○	●	●	○	○	●	◉	○	○	●
98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●	●	●	○	●	○	○	●	●	○	◉	●	--	○	○	●
101	Tsunami education and public outreach programme currently in place	○	○	◉	--	○	○	◉	--	--	--	○	○	--	--	○	○
103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	●	--	○		○	○	○	--	--	--	--	●	--	--	--	●
105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--	○	◉	--	○	○	○	--	--	--	◉	○	--	--	○	●
106	Training programmes for the media on other hazards and their vulnerability current exist	●	●	●	--	●	○	●	--	--	--	○	○	--	--	●	●
110	Earthquake and tsunami hazards and preparedness is incorporated into educational curricula for school children	○	○	○	○	◉	○	○	○	●	○	○	◉	--	○	◉	●
113	Tsunami memorials, museums, interpretative signage or other public reminders of past tsunami impacts exist	○	○	○	○	○	○	○	○	●	○	○	○	--	○	○	○
115	Structural mitigation measures established to reduce tsunami impact	●	○	●	○	○	○	○	○	○	○	○	○	--	○	○	○
116	Non-structural mitigation measures established to reduce tsunami impact	●	○	●	○	○	●	◉	○	○	○	○	○	--	○	●	●

Table 3-1. Overview of Tsunami Warning and Mitigation Capacity in the Indian Ocean Region

Question No.	Question	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
117	Tsunami evacuation maps, evacuation routes, and evacuation signage have been developed for some areas	○	○	◉	○	○	◉	○	○	◉	○	○	○	--	○	○	●
121	International agencies are providing assistance in developing materials or the deployment of information to the relevant institutions and/or the public	●	○	●	○	○	○	○	○	○	○	○	●	--	○	○	●
123	International agencies are providing assistance in developing structural and non-structural tsunami mitigation measures at local levels	●	○	●	○	○	○	○	○	●	○	○	●	--	○	○	●
125	Awareness and response to March 2005 tsunami warning improved	○	○	●	●	○	●	○	○	●	●	●	●	--	●	●	●
127	Internationally tsunami advisory message from the PTWC or JMA received for March 2005 event	●	○	●	●	○	●	●	●	●	●	●	●	--	●	○	○
129	National monitoring systems in place that detected and evaluated the earthquake	●	◉	●	○	●	●	○	○	●	●	●	○	--	◉	○	●
131	National tsunami response plan in place and exercised for March 2005 event	○	○	○	●	○	○	○	○	○	○	○	○	--	●	○	●
134	Establishment of the Tsunami Early Warning capabilities, including the response within your national boundary, within a multi-hazard framework are addressed	●	●	◉	--		●	●	--	--	--	●	●	--	--	--	●

Notes:

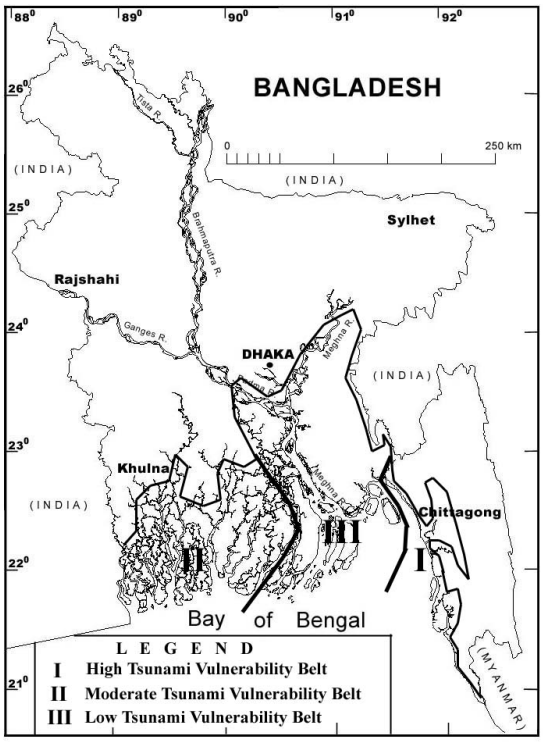
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

BAN = Bangladesh
COM = Comoros
IND = Indonesia
KEN = Kenya
MAD = Madagascar
MAL = Malaysia
MAU = Mauritius
MOZ = Mozambique
MYA = Myanmar
OMA = Oman
PAK = Pakistan
SEY = Seychelles
SOM = Somalia
SRI = Sri Lanka
TAN = Tanzania
THA = Thailand

3.1 Bangladesh

Source: http://www.cia.gov/cia/publications/factbook

With a coastline stretching more than 580 km along the Bay of Bengal, Bangladesh[2] is vulnerable to a tsunami generated within the region. Bangladesh has a total area of 144,000 sq km and a population of 144,319,628 with 13 population centers located within 8 km of the coastline.[3] Natural disasters include droughts, cyclones, and routine flooding from summer monsoons. Currently there is no record of a modern tsunami prior to December 26, 2004 reaching the coast of Bangladesh, but there is some evidence of paleo-tsunami deposits along the coastline. Due to the close proximity of the continental shelf and the interface of the Indian and Myanmar tectonic plates that are seismically active, the threat of a tsunami, especially a local one with very little warning lead time is very real. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in August 2005.[4]



Assessment results are summarized in Table 3-2 with responses to specific questions provided in Table 3-3. Bangladesh currently plans to integrate a tsunami warning center and system within its current emergency alert system that is used for cyclones and floods to create a multi-hazard warning center. The Bangladesh Ministry of Food and Disaster Management has established a Disaster Management Information Center under the Comprehensive Disaster Management Program. Plans to upgrade its current seismic network and install sea level monitoring stations are underway. The Bangladesh Meteorological Department currently receives tsunami warnings from the JMA and PTWC and disseminates the information to other government agencies. Three Tsunami Vulnerability Coastal Belts have been recently identified with the Chittagong-Teknaf coastline identified as most

[2] http://www.cia.gov/cia/publications/factbook/geos/bg.html#Intro
[3] www.world-gazetteer.com; population centers with greater than 10,000 people
[4] UNESCO-IOC et al., 2005a

vulnerable. Several structural mitigation measures have been taken in the form of evacuation shelters, stricter building codes and platform structures. Assessments of existing disaster management systems and local government disaster preparedness and emergency response capacity have been conducted. Bangladesh supports a multi-hazard approach and is working to integrate the threat from tsunamis into its current disaster management programmes. Existing warning dissemination mechanisms based on their cyclone warning system, including siren loudspeakers, temple bells, and bicycles at the community level, can be adapted for tsunami warnings.

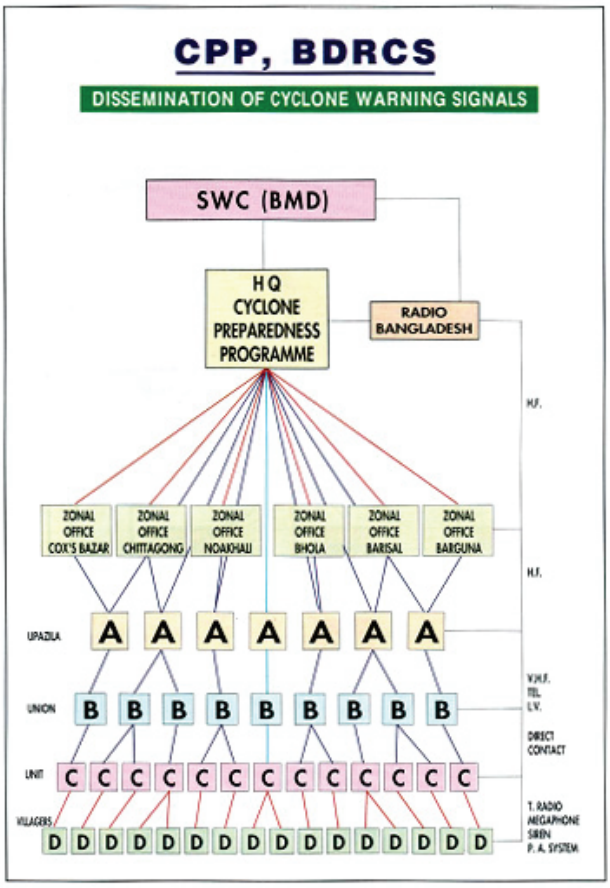


Table 3-2. Bangladesh: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Standing Order on Disaster (SOD) describes roles and responsibilities; disaster management act has been drafted and in the process of government approval ***National Coordinating Bodies:*** National Disaster Management Council and Inter-ministerial Disaster Management Committee are coordinating bodies for tsunamis and other natural disasters. The Ministry of Food and Disaster Management (MFDM) serves as national platform for disaster management and guides disaster risk reduction through the inter-ministerial disaster management coordination committee and advocacy advisory committee ***Local Coordinating Bodies:*** 5 community-level coordination mechanisms exist: District Disaster Management Committee, Upazila Disaster Management Committee (subdistrict), Union Disaster Management Committee (Union level, for rural areas); City Corporation Disaster Management Committee and Pourashava Disaster Management Committee (for urban areas) ***National Organizations:*** • Bangladesh Meteorological Department (BMD) responsible for warning formulation • Ministry of Food and Disaster Management (MoFDM) responsible for warning dissemination has established Disaster Management Information Center (DMIC) under the Comprehensive Disaster Management Program (CDMP) • Disaster Management Bureau (DMB) • Directorate of Relief and Rehabilitation (DRR) • Geological Survey of Bangladesh • National Oceanographic Institute • Bangladesh Maritime Institute • Bangladesh University of Engineering and Technology (BUET) • Bangladesh Navy • Bangladesh Coast Guard ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Regional coordination with neighboring countries for rescue and rehabilitation activities for earthquake activities in Turkey, India, Thailand, and Sri Lanka (most medical assistance) but not for early warning, assessment or mitigation. ***Research:*** Capacity for research in seismology with the BMD, Geological Survey of Bangladesh, University of Dhaka, and BUET		• Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Enhance capacity in tsunami-related research • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:***	• Establish national tsunami warning center for locally generated tsunami	• Assistance with planning and international collaboration of the seismic and sea level

Table 3-2. Bangladesh: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
• DMIC planned as multi-hazard warning center with comprehensive communication system • International tsunami warnings from JMA and PTWC received by BMD through WMO Global Telecommunication Link; fax and email serve as back systems; BMD operates 24/7; however, capacity limited. • BMD sends original tsunami message to MoFDM, DMB, DRR, and other relevant stakeholders such as the Bangladesh Red Crescent ***Seismic Network:*** One seismic monitoring station established in 1954, upgraded twice, partially operational available for real-time regional and local seismic monitoring; ongoing efforts for the establishment of 4 new seismic monitoring stations; BUET monitors local seismicity using several seismic stations for academic purposes ***Environmental Satellite System Use:*** Bangladesh Space Research and Remote Sensing Organization (SRARRSO) utilizes a number of environmental satellites including LANDSAT, SPOT, IKONOS, and ENVISAT ***Sea Level Network:*** No sea level stations current in operation; however, plans to install ***Global Telecommunications System:*** • GTS for reception of IO-TWS warnings and information, and exchange of related data: • Existing message switch at NMC Dhaka is more than 6 years old with equipment becoming unreliable. The system is duplicated but one is not running • Connected to RTH New Delhi via a low speed (2.4 kbps) analogue leased line using an old protocol (X.25) • Connected to Internet via a slow speed dial up connection with no security or firewall • GTS Satellite receiving system is inoperable.	• Enhance capacity to operate 24/7 • Establish four new seismic monitoring stations with modern equipment, and networking • Install seal level stations • Upgrade of GTS link to RTH New Delhi from 2.4kbps to 64 kbps expected late 2005. • Reception and handling of seismic data by BMD; • Tidal gauge data from Bangladesh Inland Water Transport Authority (BIWTA). • Establish Internet link with RTH New Delhi • Upgrade of national data communications to 64 kbps TCP/IP between Dhaka and Chittagong, Bogra, Sylhet, Barisal and Khulna.	network • Need for specialized software for Oceansat data analysis • Implementation of a new message switching system with specifications compliant with WMO recommendations and guidelines, including WAN & LAN connectivity and WMO standard TCP/IP security guidelines • ICT training and capacity building • Selected spare parts for GTS key critical systems • Recurrent costs for hardware and software maintenance for GTS for a period of 5 years • Long term GTS sustainability plan
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • BMD and DMIC under the CDMP program designated by law as agencies for receiving and acting upon tsunami advisory message • MoFDM issues public evacuation advisories • Marine warnings for weather and sea conditions issued by BMD for mariners to port authorities through fax, telephone and by local Meteorological offices • No system to issue tsunami warnings to mariners and coastal zone users • Assessment of existing disaster management system and identified capacity building needs completed	• Upgrade GTS Link and BMD's communication capacity • Establish a tsunami response and preparedness plan by utilizing and adapting the existing Cyclone Preparedness Program • Have 24/7 operational capacities in the response agency	• Technical and non-technical supports for the establishment of tsunami preparedness and response

Table 3-2. Bangladesh: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Response Procedures: • No tsunami emergency plans, evacuation plans, signage have not been developed • Critical infrastructure and lifeline support facilities have not been inventoried		
Tsunami Hazard and Risks • Historical records of past earthquake events prior to December 26, 2004 exists but not for tsunamis • Tsunami vulnerability studies have identified three Tsunami Vulnerability Coastal Belts based on seismic sources and presence of islets and shoals • No numerical modeling has been carried out • GIS not currently used as decision support tool during emergency response	• Conduct numerical modeling to develop inundation maps • Introduce GIS at local levels as decision-making tools (CDMP)	• Technical training on inundation modeling
Tsunami Public and Community Awareness and Preparedness • Assessment available of local government preparedness and emergency response for cyclone and flood but not tsunami hazard or earthquake • Education and public outreach programmes on other hazards but not for tsunamis • Community-based organizations (schools, religious organizations) are being utilized to ensure information on disaster preparedness and emergency response reaches ordinary citizens • Structural tsunami mitigation measures have been developed including multipurpose evacuation shelthers, embankment, building codes for earthquakes, and platform structures such as bridges, culverts, roads, and buildings • Non-structural tsunami mitigation measures have been developed including land use policy, integrated coastal zone management policy and plan, and coastal forestry • Emergency plans, evacuation plans, signage has not been developed • No procedures currently set up to disseminate a tsunami warning at local level; however, plans to establish DMIC at district level to disseminate warnings through multi-channel communication to people at risk	• Multi-hazard structural measures such as planting mangroves trees and re-identifying cyclone shelters	• Educational modules and regional training activities on public outreach and education for early warning system process • Expertise, assistance and advice from international and regional partners on the Plan of Action for Tsunami Risk Reduction • Assist with implementation of national actions as identified by country
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework • Multi-hazard approach strongly supported	• Establishment of the DMIC under the MoFDM as the multi-hazard warning center	• Multi-hazard approach to be used in the development of early warning systems • Assist with implementation of national actions as identified by country

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-3. Bangladesh: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	◉
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	●
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-3. Bangladesh: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	●
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	●
	116	Non-structural mitigation measures established to reduce tsunami impact	●
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	○
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	●
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-3. Bangladesh: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.2 Comoros

The island nation of Comoros consists of four major islands with a total coastline length of 340 km.[5] Comoros has a total area of 2,170 sq. km and a population of 671,247 with 7 population centers located within 8 km of the coastline.[6] Volcanic eruptions are common in Comoros with Mt. Karthala erupting in April 2005. Due to the seismic activity associated with volcanic eruptions, locally-generated tsunamis are possible. The country already has a Volcano Emergency Plan and the Weather Emergency Plan for cyclones. Integrating a tsunami warning system into a multi-hazard warning system and center would be best for a country like Comoros. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in July 2005.[7]

Source: http://www.cia.gov/cia/publications/factbook/geos/cn.html

Assessment results are summarized in Table 3-4 with responses to specific questions provided in Table 3-5. In 2003, the National Directorate for Civil Defense was formed to provide the general framework for civil security. The National Coordination Committee within the National Directorate provides disaster management and aid. At the island level, coordination committees are being formed to deal with local issues. The Volcanic Observatory of National Scientific Research Center monitors regional and local seismicity. Sea level monitoring stations need to be installed around the islands at locations must vulnerable. Currently warnings from JMA and PTWC are received by Ministry of Defense and the Meteorological Service. Tsunami vulnerability studies need to be conducted on all islands to plan for future inundation maps and evacuations zones and routes. Comoros has a Volcano Emergency Plan in place, which can be adopted easily to incorporate tsunamis. The incorporation of community-based organizations into current disaster preparedness and early warning system is already taking place, so education of tsunami risks and evacuation plans need to be added. Both structural and non-structural mitigation measures need to be implemented to reduce the impact of a tsunami on Comoros' shores.

[5] http://www.cia.gov/cia/publications/factbook/geos/cn.html#Intro
[6] www.world-gazetteer.com; population centers with greater than 10,000 people
[7] UNESCO-IOC et al, 2005b

Table 3-4. Comoros: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** None at this time; National Plan for Emergency and Response not decreed by law or legislation yet but draft has been submitted to national assembly. ***National Coordinating Bodies:*** No national tsunami coordination committee ***Local Coordinating Bodies:*** Coordination mechanisms do exists at the island level for disaster management ***National Organizations:*** • National Directorate for Civil Defense (DNPC) • National Directorate for Civil Aviation and Meteorology • Karthala Volcanological Observatory ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Regional cooperation does exists for non-tsunami events ***Research:*** Karthala Observatory studies and analyses local and regional seismic events	• Ratify National Plan as law • Complement the law with a tsunami plan • Form a tsunami coordination committee with clearly defined roles, responsibilities and authority of member agencies • Develop a specific tsunami plan and integrate into a national disaster mitigation plan • Develop an action plan for science and coordination of disaster management • Promote and expand regional cooperation and sharing of experience in assessing and responding to earthquakes and tsunami disasters • Initiate scientific research using 26 December 2004 and 28 March 2005 events as a platform for a national warning system	• Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • Currently no national tsunami warning center; however, intention to establish • International tsunami warnings from JMA/PTWC received by fax to Ministry of Defense; by email for multiple focal points, by SMT to the airport Meteorological Service. Latter two operate 24/7. • Confirmation that a tsunami has occurred is reported by the National Directorate for Civil Defense and National Development Army ***Seismic Network:*** Regional and local seismicity monitored in real-time as part of the Volcanological Observatory of National Scientific Research Centre (CNDRS); however data is only viewable within the Centre ***Environmental Satellite System Use:*** Two satellite data reception systems (RETIM-Africa and METEOSAT) exist. ***Sea Level Network:*** No sea level stations at this time ***Global Telecommunications System*** • NMC System: TRANSMET message switching system and SYNERGIE visualization workstation • GTS link: via Internet to La Reunion • GTS satellite-based components: RETIM-Africa receiving system • EUMETCAST receiving system	• Provide specific focal point contact information to PTWC & JMA and set up system to manage any incoming warnings • Establish national tsunami warning center integrated within national tsunami warning center within a national multi-risk center • Establish alarm and paging system to notify staff of tsunami warnings • Install a seismic station equipped with a broad-band sensor; data handled by single-station system such as TREMORs for independent monitoring of earthquake location and magnitude • Define priority areas for installation of stations, taking into consideration monitoring and maintenance • Install sea level measuring stations that collect data every 1-2 minutes and sent every 15 minutes to regional and global tsunami warning centers • Maintenance of current GTS system	• Tsunami warnings to be received from PTWC and JMA using SMS messages • Assist with implementation of national actions as identified by country • Develop technical expertise and upgrade environmental satellite systems and related applications • Training for capacity building for GTS • More cost-effective Internet connection, e.g. via VSAT (current costs are high)

Table 3-4. Comoros: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • Directorate of Civil Defense has the authority to issue public evacuations for other natural hazards • No specific plans to deal with incoming tsunami warnings at this time • Assessment of existing disaster management system and capacity building needs detailed in national plan • Marine warnings and forecasts issued for storms but not for tsunamis and not in a standardized format • No mechanisms for disseminating marine warnings to mariners at sea ***Response Procedures:*** • Local tsunami emergency plans, evacuation plans, signage has not been developed • Critical infrastructure and lifeline support facilities have been inventoried on a national level	• Include tsunami warnings in public evacuation authority of the Directorate of Civil Defense • Assess existing disaster management system and identify training and capacity building needs regarding tsunamis • Establish tsunami response procedure • Develop dissemination mechanisms for marine warnings • Review and assess the Karthala eruption (April 2005) event in terms of dissemination, evacuation in terms of future warning systems • Prepare inventory of hospital, ports and marine facilities, land transportation, energy utilities, telecommunications and other critical infrastructure with respect to tsunamis • Conduct scientific surveys to assess earthquake/tsunami damage and post-tsunami run-up and inundation	• Assistance to carry out an assessment of the existing disaster management system and identify the requirements of individuals and institutions for training and capacity-building with regard to tsunamis • Training in inundation modeling required • Assistance with implementation of national actions as identified by country
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004. There are records for earthquakes • No hazard or vulnerability studies conducted prior to December 26, 2004 • No numerical modeling studies have been carried out • GIS not currently used as decision support tool during emergency response • No post-tsunami surveys have been conducted by national and international agencies or experts	• Develop complete database on history of tsunamis in the Comoros • Conduct vulnerability studies of coastal communities to tsunamis • Post-tsunami study of 26 December 2004 event and 1945 Makran tsunami need to done • Use GIS for any emergency response plan • Digital modeling studies to develop inundation maps • Compile accurate bathymetric and topographic data • Use GIS to develop emergency response plans for tsunamis and other risks • Conduct studies to characterize the impacts of the 26 December 2004 tsunami including geophysical, oceanographic, and disaster management	• Training and software for inundation modeling to evaluate tsunami hazard and vulnerability studies and modeling • Assistance in strengthening GIS capabilities • Financial assistance for post-tsunami studies of 26 December 2004 tsunami • Assist with implementation of national actions as identified by country
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system established for tsunamis • No systematic educational programmes on tsunamis for general public or communities but plan to include along with other hazards (July 2005)	• Establish education and awareness campaigns and programmes for the public on tsunamis • Incorporate tsunami preparedness and risks in school curriculum and awareness raising materials • Create and implement evacuation maps and	• UNESCO-IOC to provide electronic versions of existing teaching, informational, and outreach materials on tsunamis and other disasters including: brochures, video, and posters for translation into local languages • Assist with implementation of outreach

Table 3-4. Comoros: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
• Community-based organizations (schools, religious organizations) serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented	routes for tsunamis • Translate existing teaching and outreach materials on tsunamis • Encourage community participation in disaster management • Develop tsunami evacuation routes and maps • Study public reaction to 28 March 2005 tsunami alert to try to understand the reactions of different people depending on their location and the available information	activities (materials, train-the-trainer courses) • Assist with development of tsunami evacuation routes and maps • Assist with implementation of national actions as identified by country • Educational modules and regional training activities on public outreach and education for the early warning system process
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework • Multi-hazard approach strongly supported	• Integrate tsunamis in national early warning plan	• Multi-hazard approach to be used in the development of early warning systems • Assist with implementation of national actions as identified by country

Status: *based on responses in national assessment questionnaire provided by the country*
National actions: *actions for implementation by the country based on recommendations of the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-5. Comoros: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	○
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	○
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	●
	84	Local government disaster preparedness and emergency response assessed	○
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	○
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	○
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-5. Comoros: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	○
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	○
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	●
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-5. Comoros: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	○
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	●
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes

3.3 Indonesia

Source: http://www.cia.gov/cia/publications/factbook/geos/id.html

Of Indonesia's 54,716 km of coastline about 6,349 km faces the Indian Ocean.[8] Indonesia suffered some of the greatest damage and highest number of casualties during the December 26, 2004 earthquake and tsunami event with 131,029 confirmed deaths, mainly in the northern province of Aceh on the island of Sumatra.[9] Indonesia has a population of 241,973,879 with over 137 population centers located within 8 km of coastline fronting the Indian Ocean.[10] Its diverse population of 300 ethnic groups, speaking 583 languages and dialects[11] spans tsunami threatened coastal areas along the Indian Ocean, Pacific Ocean, Celebes Sea, and Banda Sea. Due to large amount of seismic activity in the region and short travel time, local tsunamis pose a significant threat providing little time to issue warnings at the local level. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in September 2005.[12]

An overall summary of the assessment results are provided in Table 3-6 with responses to specific questions provided in Table 3-7. Indonesia has a tremendous challenge ahead to build an effective end-to-end system that will reach all of its peoples but has made great progress over the last year with substantial international donor support combined with high-priority national commitment.

The government currently has a National Coordinating Agency for Disaster Response, along with its counterparts on the provincial, district, and municipal levels. The Indonesian Meteorology and Geophysics Agency will host a national tsunami warning center with 10 sub-national centers located regionally and has the responsibility of issuing warnings. Currently there are 60 permanent sea level stations operating around the islands with many being upgraded to the Global Sea Level Observing System (GLOSS). Germany is providing assistance to enable real-time data transmission. Numeric modeling to calculate

[8] http://www.cia.gov/cia/publications/factbook/geos/id.html#Intro
[9] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[10] www.world-gazetteer.com; population centers with greater than 10,000 people
[11] http://www.asianinfo.org/asianinfo/indonesia/about_indonesia.htm
[12] UNESCO-IOC et al., 2005c

inundation zones is on-going, along with using geographical information system (GIS) as a decision support tool. Structural mitigation measures such as tougher building codes and building homes higher to withstand flooding are being implemented. Non-structural mitigation including mangrove rehabilitation is also underway.

SATKORLAK and Red Cross volunteers attending to the "wounded" on the beach during the Padang simulation exercise

Pilot programmes involving community-based emergency response education and awareness in Padang and Aceh are on-going. Evacuation plans and signage had been developed for Padang and to a lesser degree in Aceh.

Table 3-6. Indonesia: National Assessment Summary, September 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Law on "national disaster management" still under discussion between House of Representative and government ***National Coordinating Bodies:*** Informal group not yet formalized as a National Tsunami Warning and Mitigation Coordination Committee with the Vice President as Chairman. Members include Ministers of Health, Social Affairs, Public Works, Finance, Home Affairs, Transportation, Police, Armed Forces and Impacted Governors ***Local Coordinating Bodies:*** Local level disaster management represented by Satkorlak on the Provincial level and Satlak at Distrci/County level ***National Organizations:*** • National Coordinating Agency for Disaster Response (BAKORNAS); public awareness, preparedness, rapid response • Provincial coordinating unit for disaster management (SATORLAK); public awareness, preparedness, rapid response • District/Municipal unit for disaster management (SATLAK); rapid response • Meteorology & Geophysics Agency (BMG); warning guidance and dissemination, earthquake monitoring ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Regional cooperation through ASEAN for earthquakes and monitoring tsunamis in real-time ***Research:*** Research expertise in Tsunami Modeling, Decision Support Systems for early warning, Micro-zonation, Spatial Planning, Evacuation Mapping, Up-grading buoys and tide gauges, Seismotectonic, Seismic Tomography, Earthquake Engineering, and Instrumentation Development	• Finalize Disaster Management law and decrees with clear responsibilities for end-to-end early warning system • Establish multi-stakeholder National Tsunami Warning and Mitigation Coordination Committee with legal responsibilities for end-to-end tsunami early warning system • Develop standard operating procedures for different disasters and update using recent experiences • Better define roles of governmental and nongovernmental agencies and organizations involved in disaster preparedness and response including tsunami hazard, in particular standby arrangements with Indonesian Red Cross for community preparedness and last mile warning dissemination • Increase capacity and designating responsibilities for preparedness and early warning dissemination at the district and sub-district levels	• Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • BMG will host national tsunami warning centre with 10 sub-national centers regionally. • International tsunami warnings received by telephone, SMS, fax, GTS and email at National Seismological Centre of the BMG operated 24/7.	• Develop a comprehensive national strategy and implementation plan that integrates all requirements of an end-to-end system including instrumentation requirements, communications infrastructure, and contingency planning • Develop operational warning dissemination directive to include specifics on when, how and who should be	• Assistance in developing comprehensive national strategy for tsunami warnings and monitoring, including the deployment of monitoring networks of instruments, and the access and use of these data as delivered in real- or near real-time through different satellite systems (regional and global).

Table 3-6. Indonesia: National Assessment Summary, September 2005

Status	National Actions	Support Requirements
• Confirmation that a tsunami has occurred is reported by designated contacts ***Seismic Network:*** Regional seismicity monitored in real-time as part of the GSN. Data will be available for international use. ***Environmental Satellite System Use:*** Extensive use of environmental satellites including LANDSAT, SPOT, NOAA operated by LAPAN (National Space Agency) and other government agencies ***Sea Level Network:*** • 60 permanent sea level station currently operating around Indonesia • Nine stations will be under GLOSS programme after upgrades in 2205 and 2006 • One station currently near real-time mode and transmitting GTS and sharing data with PTWC/JMA • Germany will conduct site surveys for deep ocean pressure sensors for DART in late 2005, and install an Tsunami Early Warning Monitoring System (Center, plus seismic, coastal sea level and DART instrumentation, and associated numerical modeling) ***Global Telecommunications Systems*** • Connected via GTS to RTH Melbourne and NMC Singapore via TCP/IP Frame Relay dedicated links • ISCS satellite receiving system • No external Internet connection	contacted for various warnings received all on a national, sub-national , and local levels • Make high quality real-time data available to other warning centers • Implement moment magnitude methodologies for determining earthquake magnitude • Upgrade seismic and sea-level stations in coordination with the IOTWS Working Group activities • Develop strategy to acquire and use data from environmental satellites in tsunami warning and response • Provide national sea level network data in real or near-real time by VSAT or through the WMO GTS to the NETWC • Indonesian government has committed to upgrading communication systems at BMG Headquarters, 5 existing Regional Centers as well as developing 5 new Regional Centers over the period 2005 to 2007. This includes upgrading the MSS. Commitment is of the order of: o 2005 $830K USD o 2006 500K USD o 2007 700K USD • Upgrade of national data communications to 128 kbps links to Ciputat, Yogyakarta and Denpasar and 128 kbps VSAT links to Medan, Makassar, Jayapura, Padang, Kupang, Ambon and Manado	• Provide for technology transfer of seismic and sea level evaluation methods effective for operational tsunami warning centers through training and other technical assistance on a regional or national level. This would include seismic and sea level instrumentation and network development, data transmission and archiving, data reduction and analysis methodologies for monitoring, detection, and evaluation for tsunamigenic potential. New data and technologies should also be considered for operational use by warning centers, including GPS, hydroacoustic, satellite altimetry and photographic imagery, and other geophysical, oceanographic, and remote sensing data. • Provide assistance for training of staff of Tsunami Warning Agencies to maintain and operate newly established Tsunami warning system. Consider training visits by national staff to existing warning centers in Japan, USA (Hawaii, Alaska), and France to observe procedures and evaluation in actual practice. • ICT training and capacity building are needed to support maintenance and operations of MSS and to enable local updating of changes to meet existing and future GTS requirements (6 people from Headquarters and 10 people from the Regional Centres) • Upgrade of GTS TCP/IP links between NMC Jakarta and RTH Melbourne and NMC Singapore • Assist with implementation of national actions as identified by country
<u>Tsunami Warning Response and Emergency Preparedness</u> ***Warning Dissemination:*** • Currently Interim Tsunami Warning Center under the BMG sends information to Satkorlak and Satlak levels. Both have the authority to issue evacuation orders on provincial and district levels.	• Conduct comprehensive assessment of capacity needs of all stakeholders including NGOs in disaster management • Enhance national capacity on disaster management particularly at the level of local Government identified through the above mentioned capacity assessments. • Develop multi-hazard disaster management response plans at national and provincial government levels.	• Provide examples of tsunami exercises and drills which test and prepare national and local response systems. • Provide guidelines on reliable and robust methods of dissemination, including technical considerations and examples of technologies and current costings of working systems (sirens,

Table 3-6. Indonesia: National Assessment Summary, September 2005

Status	National Actions	Support Requirements
• Decision to evacuate based on tsunami advisory based on rapid assessment of information, activate all corresponding agencies by standard operating procedure and check & re-check warning received from BMG. • No guidance or instructions for issuing marine warnings for tsunamis to mariners • Marine warnings issued for weather and sea conditions through shipping bulletins to Port Authority; however, dissemination limited without use of INMARSAT • Warning information disseminated by: TV and radio stations for public; by SMS or fax to government leaders. Currently no sirens • A partial capacity assessment has been done. Comprehensive assessment of all relevant sectors has not been attempted. • Marine warnings issued for storm surges but not specifically for tsunamis ***Response Procedures:*** • Currently local tsunami emergency plans, evacuation plans, signage developed for pilot project sites in Padang only. • Critical infrastructures under the Indonesian Earthquake-resistant building codes • Post disaster surveys are carried out to identify and assess damage and run-up/inundation carried out by MGA, LIPI, BMG and Bakosurtanal (land surveys) and BPPT (sea-surveys)	including all stakeholder group response plans • Ensure proper understanding for messages received in terms of Tsunami Information Bulletins, Tsunami Watches and Tsunami Warnings along the entire dissemination chain • Continue to develop 24/7 capacity throughout the country to sound sirens along coastal areas, announce emergency information to the media, and communicate with the public • Develop comprehensive tsunami response plan for national, provincial, and district levels integrating earthquake and tsunami response procedures, and including standard operating procedures covering all relevant agencies into one plan • Encourage local jurisdictions to implement mandatory evacuation regulations • Consider use of SafetyNET service of INMARSAT satellite communication to enhance marine warning dissemination to mariners • Develop procedures for issuing tsunami mariner safety message including SOLAS vessels and guidance for artisanal fishermen and other small craft lacking on-board communication • Implement 2-3 drills/exercises per year at district and municipal levels • Undertake a study to determine how much time is minimally required to ensure a complete evacuation out of the inundation zone to a safe zone for the most vulnerable (or highly-populated) community, considering high-risk groups. This is critical for designing an effective tsunami warning system. • Overlay GIS database on critical infrastructures with tsunami inundation and evacuation maps • Compile and forward list of reporting contacts to PTWC and JMA • Consider a national plan for immediate and efficient collection of run-up and inundation data after an event	mass media (visual and audio), traditional methods). • Provide and facilitate twinning (institution-institution cooperation and expertise exchange) and assistance to Universities to provide higher University education in the requested disciplines. • Provide guidelines for enhancing long term capacity building through national and international educational opportunities (degree programs in disaster risk management and technical mitigation (engineering, coastal zone management, geophysics and oceanography). • Provide post-tsunami science survey guidelines (UNESCO-IOC manual and Hawaii post-tsunami observation plans) which can be immediately implemented after an event. • Assist with implementation of national actions as identified by country
Tsunami Hazard and Risks • Good historical records of past earthquakes or tsunami events prior to December 26, 2004	• Establish exchange programmes for sharing experience in building historical records of earthquakes and tsunamis and GIS with other countries in the region	• Provide guidelines for improving the quality and validity of tsunami historical records through the use of local historical records (written and oral).

Table 3-6. Indonesia: National Assessment Summary, September 2005

Status	National Actions	Support Requirements
• Hazard or vulnerability studies conducted prior to December 26, 2004 • Numerical modeling done for 10 locations around the country • GIS is currently used as decision support tool during emergency response • Post-tsunami surveys have been conducted by national and international agencies and experts	• Update topographic and bathymetric information for modeling	• Facilitate the regional sharing by Indonesia of its experiences in the building of tsunami historical databases and the use of GIS in tsunami mitigation. • Provide guidelines on the bathymetric and topographic requirements, and other input requirements for tsunami inundation mapping. • Assist with implementation of national actions as identified by country
Tsunami Public and Community Awareness and Preparedness • Pilot programmes in Aceh and Padang are underway to formally organized community response system established for tsunamis • Educational and outreach programmes for tsunamis planned and will be integrated with other hazards in the future • Educational and outreach programmes for other hazards already developed with standard operating procedures • Community-based organizations (schools, religious organizations) serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have been developed and in the process of being implemented • Emergency plans, evacuation plans, signage developed for Padang and to a lesser degree in Banda Aceh	• Replicate pilot programmes on community preparedness conducted in Banda Aceh and Padang by national and local government with local and international NGOs in other areas of the country • Conduct community risk assessments integrating scientific and traditional knowledge with activity community participation • Institute a "National Disaster Preparedness Day" to reinforce education and training • Enhance media training programmes through routine press conferences, interviews, and special reports • Include disaster preparedness to school curriculum • Develop public outreach programmes on all aspects of tsunami warning and mitigation system • Utilize ToT (Training of Trainers) to build capacity, with special emphasis on coordination with local authorities.	• Regional training activities to strengthen linkages of key organizations involved in the early warning process including media, technical agencies, and risk managers • Technical support and sharing of expertise by other countries in establishing tsunami memorials and museums • Provide and facilitate the development of appropriate and consistent educational curricula and public outreach in tsunami science, preparedness, and emergency response information. Provide examples in formats which are easily customized. • Assist with implementation of national actions as identified by country
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are not currently being integrated within a multi-hazard framework	• Fully integrate all warnings for other hazards into a multi-hazard framework	

Status: *based on responses in national assessment questionnaire provided by the country*
National actions: *actions for implementation by the country based on recommendations of the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-7. Indonesia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	◉
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	◉
	61	Response procedures have been tested or exercised	◉
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	◉
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	●
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	◉
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	○
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	◉
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-7. Indonesia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	●
	71	Tsunami vulnerability assessment conducted	●
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	●
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	●
	116	Non-structural mitigation measures established to reduce tsunami impact	●
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	◉
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	●
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	●
	31	Real time seismic data provided	●
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	●
	39	Sea level data sampling sufficient to measure short period tsunami	●
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-7. Indonesia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	◉
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	◉
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes

3.4 Kenya

Located on the Horn of Africa, Kenya has 536 km of coastline that runs along the Indian Ocean.[13] Kenya has a total land area of 582,650 sq. km and population of 33,829,590 with 14 population centers located within 8 km from the coast.[14] The December 26, 2004 event generated waves that struck coast lead to one drowning death near Mombasa and caused minor damage.[15] The Great Rift Valley runs through Kenya making the country seismically and volcanically active. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in June 2005.[16]

Source: http://www.cia.gov/cia/publications/factbook

Assessment results are summarized in Table 3-8 with responses to specific questions provided in Table 3-9. After the devastating effects of El Niño rains on Kenya in 1998, the government established the National Disaster Operations Center (NOC) to deal with all types of natural hazards on a national level. Currently the Kenya Meteorological Department receives all tsunami warnings from JMA and PTWC and the NOC disseminates the messages. The local seismic network at the University of Nairobi is currently not operational, but two permanent GLOSS sea level stations have been established. Coastal sensitivity mapping is on-going in order to support the future use of GIS as a decision support tool. Community level education and public participation programmes currently in place for other natural hazards will be utilized for tsunami awareness and preparedness.

Tide gauge in Mombasa

Existing local government programmes for other natural hazards can be used to integrate and disseminate education about tsunamis and the threat they pose. Developing evacuation plans, routes and procedures still need to be completed on both a local and national scale. With the establishment of the NOC, the government of Kenya already has plans and procedures in place and needs to incorporate tsunamis as known natural hazards that can affect their coastline.

[13] http://www.cia.gov/cia/publications/factbook/geos/ke.html#Intro
[14] www.world-gazetteer.com; population centers with greater than 10,000 people
[15] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[16] UNESCO-IOC et al., 2005d

Table 3-8. Kenya: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Environmental Management Coordination Act (EMCA) of 1999 covers all natural disasters ***National Coordinating Bodies:*** No Committee but mechanism exists through National Disaster Operations Center (NOC) under the Office of the President, Special Programmes ***Local Coordinating Bodies:*** NOC does go to the community level. President, Provincial Commissioner, District Commissioner, District Officer, Chief, Sub-chief and Village Headman. ***National Organizations:*** • Kenya Meteorological Department (KMD) • National Disaster Operations Center (NOC) • Kenya Marine and Fisheries Research Institute (KMFRI) • Kenya Port Authority (KPA) • Department of Mines & Geology (MGD) • Department of Defense (DOD) • Department of Remote Sensing and Resource Survey (DRSS) ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** No cooperative mechanisms for early warning, assessment or mitigation for tsunamis. Cooperation does exists for other disasters and search and rescue ***Research:*** Minimal research in seismology at University of Nairobi; KMFRI, Institute for Meteorological Training Research (IMTR) and DRSS are also conducting research	• Define role of governmental and non-governmental agencies and organizations identified to participate in the implementation of the tsunami early warning and mitigation system • Planned national tsunami warning and mitigation committee should include all relevant stakeholders	• Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • International tsunami warnings received by fax and back-up email at KMD operated 24/7 • Confirmation that a tsunami has occurred is reported by the KPA, Kenya Navy and Provincial Commissioner ***Seismic Network:*** No regional seismicity is monitored. There is a local seismic network operated by University of Nairobi, but currently non-operational. ***Environmental Satellite System Use:*** Receiving data on cloud systems, forest fires, flooding, temperatures from the Meteosat Second Generation satellites ***Sea Level Network:*** Two permanent GLOSS sea level stations	• Establish national tsunami warning center taking into consideration proposed terms of reference • Sea level data of 26 December 2004 tsunami and 28 March 2005 event need to be reported and processed • Provide list of seismic stations with full characteristics to UNESCO-IOC • Implement 3-component broad-band seismic station close to Nairobi • Provide seismic data to FDSN • Implement automatic seismic processing software (TREMORS) with automatic alerting • Consider common observing platforms for tsunami.	• Investigation of why advisory tsunami warnings not received by Kenyan Meterological Department through the GTS (WMO) • Assistance to expand and upgrade sea level network to provide real-time data along entire coast (UNESCO-IOC) • Implementation at RTH Nairobi of a new message switching system with specifications compliant with WMO recommendations and guidelines, including WAN & LAN connectivity and WMO standard TCP/IP security guidelines (Provided by joint project France-Kenya) • Implement in coastal provincial center

Table 3-8. Kenya: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
established at Mombasa and Lamu. Only Lamu station is near real time. Sampling rate at Lamu is sufficient for real time, but data transmissions frequency is at 1 hr intervals ***Global Telecommunications System*** • Existing message switch at RTH Nairobi is more than 12 years old with equipment becoming unreliable • Kenya is devolving marine functions to Mombassa which is connected via VSAT 64 kbps TCP/IP • Connected to RTH Offenbach, Toulouse via 64 kbps leased line via TCP/IP • Connected to RTH Cairo via slow (9.6 kbps) analogue leased line using old protocol • EUMETCAST receiving system • VSAT network	climate and ocean observations • Kenya Met. Department upgrading the message switch at RTH Nairobi as a matter of priority • VSAT network recently installed to be further extended	Mombassa of a message switching system, RETIM-Africa receiving system and Visualization workstation (Synergie or equivalent) (To be provided by France) • Implement in coastal provincial centers Malindi and Lamu of RETIM-Africa receiving system and Visualization workstation (Synergie or equivalent) • ICT training and capacity building • Selected spare parts for GTS key critical systems • Recurrent costs for hardware and software maintenance of GTS for a period of 5 years; • Long term GTS sustainability plan • Assist with implementation of national actions as identified by country
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • NOC under executive authority of the President issues public evacuation advisories • Decision to evaluate based on tsunami advisory received from PTWC or JMA indicating possibility of a tsunami • Warning information disseminated through NOC structure; no warning sirens. • Kenya National Meteorological and Hydrographical Service (NMHS) does not have any mechanism at the moment to warn mariners. • Assessment of existing disaster management system have been identified ***Response Procedures:*** • No local tsunami emergency plans, evacuation plans, signage have been developed • Critical infrastructure and lifeline support facilities have been inventoried	• Identify agency that will receive and act upon tsunami advisory messages sent by national TWC • Assess existing disaster management system and identify training and capacity building needs regarding tsunamis • GMDSS search and rescue facility being established by IMO along coast of Kenya will enable the Meteorological service to issue warnings to mariners when operational. • Develop detailed procedures for responding to local/regional as well as distant tsunamis including procedures for informing the public, emergency response authorities, and evacuation procedures • Conduct response procedure drills as part of public awareness/education programme related to tsunamis • Complete surveys of affected areas to assess earthquake damage and post-tsunami run-up and inundation, and make data available	• Assist with implementation of national actions as identified by country
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004. Historical record of previous earthquakes not based on seismological data • No hazard or vulnerability studies conducted prior to December 26, 2004	• Implement post-tsunami field survey of 2004 tsunami • Undertake detailed study of the 1945 tsunami • Conduct tsunami vulnerability study using coastal population density, coastal development, and infrastructure using GIS • Improve high resolution bathymetry and topography	• Assistance and training to develop national capacity in numeric modeling • Assist with implementation of national actions as identified by country

Table 3-8. Kenya: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
• No numerical modeling has been done • GIS not currently used as decision support tool during emergency response however, various data layers are available at KMFRI. Coastal sensitivity mapping is now on-going. • No post-tsunami surveys have been conducted	• Implement numerical modeling studies to calculate inundation from tsunamis	
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system established for tsunamis, current local structure can be implemented for tsunamis • No systematic educational programmes on tsunamis for general public or communities. Presentations to schools, mass media, and community activities are planned. • Community-based organizations (schools, religious organizations) need to be involved to serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented; however integrated coastal zone management guidelines are being developed including coastal setbacks and maintenance of mangroves and coral reefs as bioshields • Emergency plans, evacuation plans, signage have not been developed	• Include awareness on tsunami hazard in school curriculum • Address need to increase awareness of tourists for tsunami • Invite the Red cross to play a role in the early warning preparedness and community outreach and education to people at the local level	• Electronic versions of existing teaching, informational, and outreach materials on tsunamis and other disasters including: brochures, video, and posters for translation (UNESCO-IOC) • Training in the development of evacuation maps, routes, and signage • Assist with identifying sustainable communication means • Assist with estimating cost of maintenance of monitoring systems • Share concrete examples of operational TWSs • Request for technical training • Assist with implementation of national actions as identified by country
Enhancement of Disaster Mitigation Capabilities • Better warnings, increased database, greater awareness and preparedness will benefit preparedness and response to all other hazards like droughts, floods		• Assistance in all areas of risk assessment, inundation modeling, warning and preparedness, and evacuation procedures as well as awareness programmes • Assistance, guidance, and on-going contact with national and regional partners through more seminars and workshops

Status: *based on responses in national assessment questionnaire provided by the country*
National actions: *actions for implementation by the country based on recommendations of the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-9. Kenya: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	○
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	○
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	◉
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	◉
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	○
	101	Tsunami education and public outreach programme currently in place	--
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	--

Table 3-9. Kenya: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	○
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	○
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	○
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	◉
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-9. Kenya: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

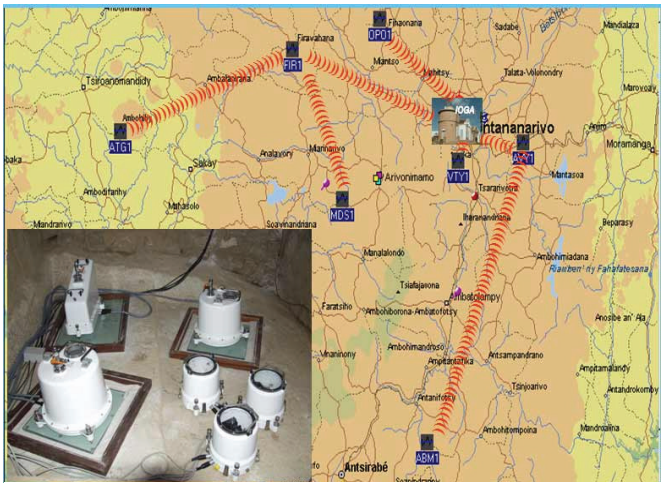
Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.5 Madagascar

Source: http://www.cia.gov/cia/publications/factbook

The world's fourth largest island, Madagascar has about 4,828 km of coastline.[17] Madagascar has a total land area of 587,040 sq. km and population of 18,040,341 with 132 population centers living within 8 km of the coast.[18] No casualties were reported as a result of the December 26, 2004 tsunami; however low-lying coastal districts were flooded and waves 1.6 to 10 meters in height swept through the towns of Manakara, Sambava, and Vohemar, leaving over 1,000 people homeless.[19] Tsunamis are a new phenomenon for Madagascar; however, a national risk and disaster management strategy exists that can serve as a national platform. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in July 2005.[20]

Assessment results are summarized in Table 3-10 with responses to specific questions provided in Table 3-11. Madagascar's National Emergency Council is established under national decree for other disasters. Currently, there is no national tsunami warning center however; international tsunami warnings are received by the Antananarivo Geophysical Institute and Observatory (IOGA). The IOGA monitors regional and local seismic monitoring in real-time. Warning dissemination is accomplished by sirens, local radio stations and other mechanisms. Response procedures for tsunamis have yet to be established. Simulation studies are being conducted to describe ocean wave propagation. Emergency management extends down to the commune level; however, tsunami specific educational or public outreach activities have yet to be developed. Disaster preparedness activities include assessments of existing disaster management systems, critical infrastructure, and local government preparedness. Coordination mechanisms are established at the community level and being established at the national level.



Seismic Network in Madagascar

[17] http://www.cia.gov/cia/publications/factbook/geos/ma.html#Intro
[18] www.world-gazetteer.com; population centers with greater than 10,000 people
[19] http://en.wikipedia.org/wiki/Countries_affected_by_the_2004_Indian_Ocean_earthquake
[20] UNESCO-IOC et al., 2005e

Table 3-10. Madagascar: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** No legal framework for tsunami. National Emergency Council (CNS) set up for other disasters ***National Coordinating Bodies:*** CNS and a newly formed ad hoc committee comprised of local organizations and government bodies ***Local Coordinating Bodies:*** Regional Emergency Committee (CRS), Local Emergency Committee (CLS) and Commune Emergency Committee (CCS) exist ***National Organizations:*** All members of ad hoc committee • Antananarivo Geophysical Institute & Observatory (IOGA); Geophysics detection and monitoring • National Centre for Oceanographic Research (CNRO); Tides and wave observation networks • National Institute of Cartography & Hydrography (FTM); Bathymetry and GIS • Meteorology Office (DGM); Receiving and dissemination of warnings • National Emergency Council (CNS) • National Commission for UNESCO ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Cooperation with South Africa with reports and evaluations of regional seismic events ***Research:*** Seismology research regularly conducted at local university level	• Adapt legal framework to include tsunamis for National Emergency Council • Integrate tsunami risks with other risks covered by the national risk and disaster management strategy • Formalize ad hoc committee as a tsunami warning and mitigation coordination committee	• Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Assistance in organizing a seismology and TREMORs course for local universities • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • Currently, no national tsunami warning center • International tsunami warnings received by email or fax at IOGA and by GTS, fax & email at DGM which is operated 24/7 • Confirmation that a tsunami has occurred is available from several local observation points ***Seismic Network:*** Regional and local seismicity monitored in real-time by IOGA. Real time data is available through batch processing via internet. ***Environmental Satellite Systems Use:*** Receives photographs (visual, infrared, Indian Ocean) and meteorological data and products from METEOSAT at the Meteorology Office. ***Sea Level Network:*** • Two coastal stations used for conventional sea-level monitoring	• Establish tsunami warning center with monitoring capability and analysis including real-time regional and local seismic and sea level data acquisition, display and analysis • Modernize computer system using TREMORs as well as alerting of on-duty seismologist • Ensure that new seismic stations are equipped with broadband sensors for data processing through TREMORS • Consider establishing new seismic station in north-east of Madagascar • Establish sea-level stations with 1-2 minute data acquisition that is sent every 15 minutes to tsunami warning centers in Pacific and Indian Ocean • Priority for new sea level stations: NE Madagascar	• Training in operational aspects of a tsunami warning center • Tide gauges and training of technical staff to monitor, process, and interpret data and maintain equipment • Make available real-time sea level station data by GTS (WMO) • Assist with implementation of national actions as identified by country • Implement in coastal provincial center Tamatave of a message switching system, RETIM-Africa receiving system and Visualization workstation (Synergie or equivalent) (To be provided by France)

Table 3-10. Madagascar: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
using WMO SYNOP code. • Two tide-gauge stations (mechanical float-operated drum-and-cylinder gauges) have been non-operational since 2000 ***Global Telecommunications System*** • NMC System: TRANSMET message switching system and SYNERGIE visualization workstation • GTS link: 9.6 kbps to La Reunion and 19.2 kbps to Dakar • GTS satellite-based components: RETIM-Africa receiving system • EUMETCAST receiving system	• Maintenance of current GTS system	
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • National Emergency Council has the authority to issues public evacuation advisories • Warning information disseminated by: sirens, church bells, local radio stations and single side band radio • Tsunami marine warnings not issued • Marine warnings for weather and sea conditions issued in daily reports and using TRANSMET; however limited dissemination to mariners ***Response Procedures:*** • No local tsunami emergency plans, evacuation plans, signage have been developed • Critical infrastructure and lifeline support facilities inventory updated annually by CNS • No post disaster surveys have been carried out	• Update existing resources plan with resource needs for tsunamis • Evacuation and response plans need to be drawn at regional and local levels • Update cyclone procedure manual with tsunami section • Carry out tsunami drills • National Emergency Council and Metereology Office to contact APMF (port, maritime, and river agency) to ensure that it takes account of tsunami hazards in reports sent through TRANSMET	• Assist with implementation of national actions as identified by country • Upgrade dissemination mechanisms for marine warnings
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004 • Historical records of past seismic activity is available from IOGA • No hazard or vulnerability studies conducted prior to December 26, 2004 • Simulation studies currently being conducted for the east coast by IOGA based on ocean wave propagation • GIS is currently used by CNS for cyclone and flooding hazards. FTM does have demographic layers available • No post-tsunami surveys have been conducted by national and international agencies and experts	• Conduct tsunami hazard and vulnerability studies for coastal communities • Undertake post-tsunami study of 26 December 2004 tsunami • Undertake study of historical tsunamis • Implement digital simulations and numerical modeling studies to draw inundation maps • Initiate a vulnerability study for communities, especially on the east coast of Madagascar (population, density, infrastructure, etc.), in cooperation with a GIS specialist. • Update and collect bathymetry and topographic data for coastline	• Training and modeling software for tsunami hazard and vulnerability studies and modeling • Assist with implementation of national actions as identified by country

Table 3-10. Madagascar: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
	• Conduct tsunami impact surveys including run-up and inundation and among fishermen	
Tsunami Public and Community Awareness and Preparedness • Currently emergency management does extend down to the commune level • No formally organized community response system established for tsunamis • No educational or public outreach programmes on tsunamis and other natural hazards but planned for development • Community-based organizations (schools, religious organizations) serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Currently, no emergency plans, evacuation plans, signage have been developed	• Ensure population understands tsunami warning system and evacuation plan • Add disaster preparedness and procedures to primary school curriculum • Organize tsunami training for the media • Assess current risk at community level with active participation of local community • Organize outreach programmes, public awareness briefings, and informational materials and related train-the-trainer activities • Prepare evacuation maps, routes, and signage for areas affected by 26 December tsunami and other recognized risk areas	• Provide electronic version of tsunami-related materials (UNESCO-IOC) • Teaching modules and training courses for key organizations involved in the early warning process • Training in developing evacuation maps and routes • Assist with implementation of national actions as identified by country • Educational modules and regional training activities on public outreach and education for the early warning system process
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities not being developed within a multi-hazard framework; but development of the tsunami system will improve warning system for other hazards and provide outreach to authorities		• Encourage use of multi-hazard approach in the development of early warning systems

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-11. Madagascar: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	◉
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	●
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	◉
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	○
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	○
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-11. Madagascar: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	●
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	○
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	●
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-11. Madagascar: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes

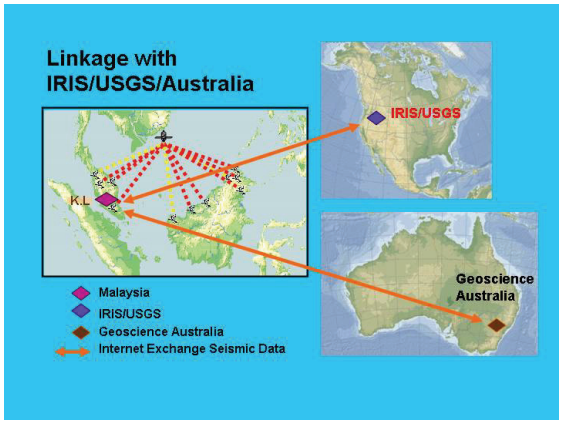
3.6 Malaysia

Malaysia's coastline stretches over 4,675 km with about 1,700 km along the Straits of Malacca.[21] The December 26, 2004 tsunami was the first documented in the country. A total of 68 persons were killed and much property was destroyed along the northwest coastal areas of Penang, Kedah, Perlis and other areas as a result of the tsunami.[22] Despite its close proximity to the epicenter, Malaysia escaped the severe damage that struck other countries located farther from the epicenter. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in August 2005.[23]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-12 with responses to specific questions provided in Table 3-13. Malaysia has existing laws and national and local coordinating councils that cover all disasters. The Malaysia Tsunami Warning Center has been established at the Malaysian Meteorological Department (MMD) in 2005. Malaysia maintains extensive capacity for monitoring includes real time monitoring of seismicity and sea level, satellite imagery, and fully operation global telecommunications system. The Malaysia TWC monitors regional seismicity using a real-time and automated data acquisition and earthquake monitoring system that provide SMS-based alerts within 10 to 20 minutes of an event.


Sand-filled Geotextile tubes placed in front of eroding mangrove shoreline



Response procedures for tsunamis and earthquakes have been established. Disaster coordination mechanisms are in place at national and community levels. Malaysia is implementing a number of non-structural mitigation measures including mangrove rehabilitation. Disaster warning, dissemination, and response mechanisms are largely in place.

[21] http://www.cia.gov/cia/publications/factbook/geos/my.html
[22] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[23] UNESCO-IOC et al., 2005f

Table 3-12. Malaysia: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Laws or administrative rules for other hazards, nothing tsunami specific ***National Coordinating Bodies:*** National Disaster Management Committee headed by Deputy Prime Minister for all disasters ***Local Coordinating Bodies:*** State and District level mechanisms do exists ***National Organizations:*** • Malaysian Meteorological Department (MMD); Issuing earthquake and tsunami warning information, maintains own network of tidal gauges • National Security Division; coordinating all agencies for evacuation • Department of Irrigation and Drainage (DID); coastal engineering and erosion control, mapping and modeling • Malaysian Center for Remote Sensing (MACRES); mapping satellite images and tsunami modelling • Department of Survey and Mapping (DSMM); maintains own network of tidal gauges and datum establishment • Hydrographic Directorate, Royal Malaysian Navy; bathymetric data, maintains own network of tidal gauges • Department of Minerals and Geoscience (DMG); geological survey, marine surveys • National Oceanography Directorate (NOD), MOSTI, as lead contact point with UNESCO-IOC as well as national focal point for marine science R&D in Malaysia ***Strategic Alliance Group:*** Sea to space programme formed under Ministry of Science, Technology and Innovation (MOSTI) to synergy and galvanize technical expertise in the following agencies: Malaysian Meteorological Department (MMD) National Oceanography Directorate (NOD) Malaysian Center for Remote Sensing (MACRES) National Space Agency (ANGKASA) Astronautic Technology (M) Sdn Bhd (ATSB) ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Cooperation through ASEAN, specifically Technical Taskforce for Establishment of Monitoring Network for the Tsunami Early Warning System for data exchange, standardization of information, and training ***Research:*** Local universities express much interested in conducting research. Recently funded: Universiti Teknologi Malaysia (UTM) to study tsunami propagation and affects in the Straits of Malacca	• Participate in and contribute to working groups of the ICG/IOTWS • Invite local government institutions and community and nong-governmental organizations to participate in development of a National Response Plan for Tsunamis	• Assistance in developing effective tsunami preparedness and awareness programmes
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:***	• Install 2 new seismic stations and upgrade of 2 existing seismic stations to broadband by end of	• Provide software for decoding currently non-standard sea level data

Table 3-12. Malaysia: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
• Malaysian Tsunami Warning Center established at the MMD • International tsunami warnings from JMA and PTWC received by GTS and fax, and dedicated phone line to JMA and PTWC at MMD, operated 24/7 • Fully operational ground satellite receiving station capable of utilizing satellite technology for monitoring hazards, data collection, and exchange • Confirmation that a tsunami has occurred is reported by the MMD ***Seismic Network:*** Malaysian Seismic Network monitors local and regional seismicity in real-time and is able to provide the waveform data in real-time to IRIS, USGS and Australian Geoscience Department; Fully automated seismic data acquisition and earthquake location programmes use both national, regional and GSN Stations. ***Environmental Satellite System Use*:** Established satellite imagery capabilities through the Malaysian Center for Remote Sensing (MACRES) and extensive domestic use of environmental satellite systems including IKONOS and Quickbird satellite imagery ***Sea Level Network:*** • 39 sea level stations operate along the coastline. One real-time GLOSS station will be upgraded in 2005. Six stations are planned for near real-time transmission through MMD VSAT system and will be available through ***Global Telecommunications System*** • GTS fully operational • Recent upgrade of GTS circuits to Bangkok, Singapore and (via Internet) Melbourne and Tokyo	2005 resulting in total of 7 broadband stations with real-time data transmission to the Malaysian National Tsunami Early Warning Center • Upgrade of 7 seismic stations with real-time data transmission to the Malaysian National Tsunami Early Warning Center planned for completion by the end of 2005 • Upgrade of existing sea level stations and the installation of additional sea level stations including DART-like buoys in shallow waters in planned • Use up-to-date analysis methodology for calculation of seismic moment as Mwp (based on P-wave) or Mm (mantle magnitude) • Increase technical capacity through further training of existing and new staff of the MMD • Hire specialized professional and technical staff with working knowledge in seismology, geophysics, oceanography, and tsunami modeling • Hire computer specialists to maintain the archiving, computing, and dissemination infrastructure • Improve hazard response time by implementing automated processes • Make data available in real or near-real time to disaster management and other relevant agencies in order to effectively contribute to early warning and immediate deployment of emergency resources to affected areas • Prepare written tsunami emergency response plans at national and as appropriate state and district levels with checklists for action and logging warning information developed as SOPs • Conduct drills to evaluate notification systems and protocols for delivering warning	formats that are provided by various sources (including PTWC) • Provide software code for calculation of Mwp and Mm magnitude (PTWC)
<u>Tsunami Warning Response and Emergency Preparedness</u> ***Warning Dissemination:*** • Tsunami Warning Center within the Malaysian Meteorological Department will disseminate to National Security Division who issues public evacuation advisories • Decision to evacuate based on information analyzed by MMD and alerts received from JMA and PTWC	• Develop comprehensive tsunami response and preparedness plan utilizing and adapting existing plans for other national disasters such as floods, involving national government, state and district administrations, and incorporating standard operating procedures and protocols • Determine time requirements to ensure complete	• Provide information on best practices used in marine warning dissemination from other countries

Table 3-12. Malaysia: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
• No marine warnings for tsunami events; however, MMD will issue a termination of warning that no tsunami wave generated • Marine warnings issued for weather and sea conditions by the Royal Malaysian Navy and other government entities; however dissemination mechanisms to mariners are limited • Warning information disseminated by: telephone, fax and direct broadcast to TV and radio stations; sirens installed at vulnerable locations; • Assessment of existing disaster management system and capacity building has been done ***Response Procedures:*** • Local tsunami emergency plans, evacuation plans, signage are being developed • Critical infrastructure and lifeline support facilities have been inventoried and mitigation studies are underway • Post disaster surveys have been carried out to identify and assess damage and run-up/inundation by DID and MACRES	evacuation of inundation zones to safe zones for the most vulnerable (or highly populated) community • Include evacuation guidelines as part of the public education programme • Develop procedures and coordination mechanisms with TV, radio, and other broadcast media (SMS) to ensure that tsunami warnings and associated guidelines are available to the public as quickly as possible • Develop and upgrade marine warning system and integrate tsunami marine warnings for mariners • Identify appropriate mechanisms for alerting mariners and coastal zone users • Encourage use of GMDSS to disseminate marine warnings to SOLAS vessels • Consider whether SafetyNET service of INMARSAT satellite communication can be used to disseminate marine warnings to national agencies • Conduct specific information, communication, and training for mariners • Conduct regular surveys to check community knowledge of emergency response procedures	
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004 • Good historical records for past earthquakes are available • No hazard or vulnerability studies conducted prior to December 26, 2004 • No numerical modeling has been carried out yet. • GIS is currently used as decision support tool during emergency response, but not for tsunamis yet • Post-tsunami surveys have been conducted by national and international agencies and experts	• Produce inundation maps for tsunami-prone-risk areas • Conduct comprehensive studies to document historical tsunamis including geological and paleotsunami studies with international collaboration	• Training and technical assistance in inundation modeling to build capacity to produce hazard and vulnerability maps
Tsunami Public and Community Awareness and Preparedness • Standard Operations Procedures based on National Command 20 document has been issued clearly defining functions and responsibilities of each relevant agency in emergency situations. Disaster management organization based on 3 levels namely; national, state and local. Need to organize preparedness assessment at local level. • No education or outreach programmes on tsunamis or other natural hazards; however basic awareness-raising activities have been carried out to increase awareness of early warning systems at all levels	• Engage local communities in decision-making process in order to improve the efficiency of the response and to ensure sustainability of the actions • Develop educational and outreach programmes on tsunamis in the multi-hazard framework to increase preparedness and build awareness of stakeholders in early warning systems • Enhance use of media in community awareness and preparedness	• Education and training modules for stakeholders and general public on tsunamis and other natural hazards • Provide advice on how to implement an effective multi-hazard preparedness programmes • Organize workshops and seminars by UN agencies and regional organizations

Table 3-12. Malaysia: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
• Website on earthquakes and tsunamis have been developed by the Malaysian Meteorological Department • Currently community-based organizations (schools, religious organizations) do not serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures are currently being assessed by DID and shore line restrictions and setbacks have been in place since 1997. Replanting of mangroves for a natural barrier has started • Emergency plans, evacuation plans, signage development will occur when hazard mapping is completed	• Collaborate with non-government organizations that are actively involved in disaster reduction and management, including the Red Crescent Society	
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework including tropical storms, strong wind and high seas		

Status: *based on responses in national assessment questionnaire provided by the country*
National actions: *actions for implementation by the country based on recommendations of the visiting expert teams*
Support Requirements: *activities or assistance for implementation by donors identified by the visiting expert teams*

Table 3-13. Malaysia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	○
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	○
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	○
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	○
	106	Training programmes for the media on other hazards and their vulnerability current exist	○

Table 3-13. Malaysia: Preparedness, Assessment, and Warning Capacity

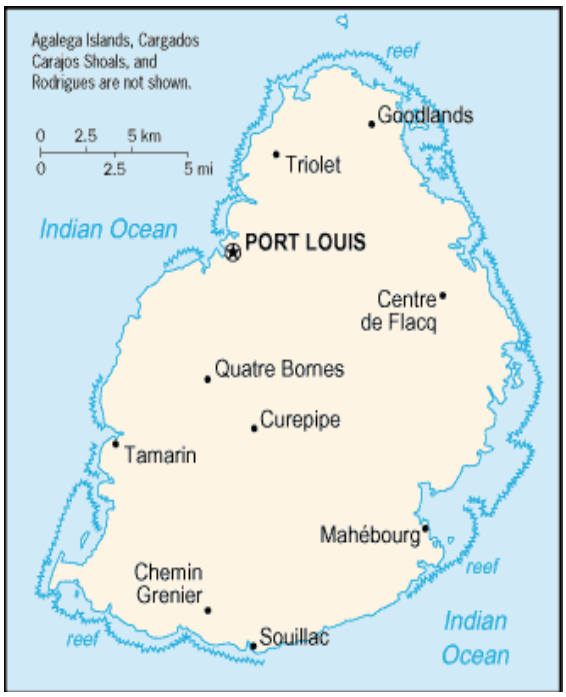
	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	◉
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	○
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	●
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	●
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	●
	31	Real time seismic data provided	●
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-13. Malaysia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	○
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	●
	60	Response procedures for earthquakes in place	●
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

Notes:
○ = No
◉ = Partial Yes
● = Yes

3.7 Mauritius



Source: http://www.cia.gov/cia/publications/factbook

The island nation of Mauritius has a total land area of 2,040 sq km, population of 1,230,602, and 177 km of coastline.[24] On December 26, 2004, Mauritius was struck by the tsunami wave submerging a village in the north of the island.[25] The Government of Mauritius has had a long history of dealing comprehensively with natural disasters such as floods and cyclones. This experience has facilitated the preparations of Mauritius to deal with the challenge posed by tsunamis. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in August 2005.[26]

An overall summary of the assessment results are provided in Table 3-14 with responses to specific questions provided in Table 3-15. The national tsunami warning center is located at the Meteorological Service which has recently been given the technical lead and the responsibility for issuing warnings under administrative order of the Government of Mauritius. The Mauritius Institute of Oceanography is providing technical leadership for sea level data observations and tsunami numerical modeling. A national tsunami warning and mitigation coordination committee has been established and community level coordination mechanisms exist, however, response procedures have yet to be developed for tsunamis. No seismic stations exist in Mauritius; however, the Meteorological Service is willing to operate them if installed. Two GLOSS coastal sea level gauges, upgraded in April 2005, provide data on a real-time basis.

Tide Gauge in Port Louis

Warning dissemination mechanisms, including TV and radio, are already established in Mauritius because of its experience in alerting for tropical cyclones. The addition of sirens is being considered. Critical infrastructure and lifeline support facilities need to be inventoried. Community-based organizations are not currently engaged in the early warning system.

[24] http://www.cia.gov/cia/publications/factbook/geos/mp.html
[25] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[26] UNESCO-IOC et al., 2005g

Table 3-14. Mauritius: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** No legal framework exists; Mauritius Meteorological Services mandated under administrative rules to prepare issue and disseminate warnings for all natural disasters, including tsunamis ***National Coordinating Bodies:*** The Central Cyclone and other Natural Disasters Committee (CCNDC) under the Prime Minister. Includes Meteorological Services, Mauritius Oceanography Institute, Ministries of Environment, Housing & Land and Police Force ***Local Coordinating Bodies:*** On the local level a Cyclone and Natural Disasters Committee chaired by Chief Commissioner does exists on Rodrigues Island ***National Organizations:*** • Prime Ministers Office: CCNDC, evacuation strategy, damage assessment and rehabilitation strategy • Meteorological Services; Alert protocol. Receipt of alerts, warning dissemination, evaluate real-time data • Mauritius Oceanography Institute (MOI): Production of risk maps, tsunami • Ministry of Environment; education preparedness and risk reduction/mitigation • NGOs' Support, public awareness ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Seismic data consultation with Observatorie Volcanologique de Piton de la Fournaise, Reunion France. Possible cooperation with Comoros in future ***Research:*** Future research is planned through MOI and University of Mauritius with support of Mauritius Research Council (MRC)		• Provide assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Pursue regional cooperation of sharing seismic and sea level data with other countries
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • National tsunami warning center located at the Meteorological Service (Met Service) • International tsunami warnings from JMA and PTWC received by GTS, fax and email at Met Service operated 24/7. Staff notified by alarm system • Confirmation that a tsunami has occurred is reported by Port Authority, Coast Guard and other marine facilities	• Upgrade all sea level stations to transmit real-time data and install additional stations on east coast of main island and other few remote islands • Upgrade data analysis and warning procedures in coordination with ICG/IOTWS • Install new seismic station • Implement UNESCO-IOC sea level data sharing policy especially between Indian Ocean islands • Upgrade and enhancement of satellite facilities for data	• Request for 2 additional sea level stations at Agalega and St Brandon (outside of lagoon). • Training on tsunami evaluation procedures • Need for access to environmental RTD satellite data and real time data from altimeters • Training for capacity building on GTS • Request of 4 seismic stations to be installed at Mauritius, Rodrigues, Agalega and St. Brandon

Table 3-14. Mauritius: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Seismic Network: No seismic stations at this time. Met Services is willing to operate if installed. ***Environmental Satellite System Use:*** Satellites systems used include EUMETSAT, GMS, NOAA, and FY2 mostly for meteorological parameters ***Sea Level Network:*** • Coastal tide gauges at Port Louis and Port Mathurin (Rodrigues) are operated by Met Services on a real-time basis. Both gauges transmit every 15 minutes to PTWC, UH and JMA. MOI operates one pressure tide gauge at St Brawdon, but not in real time ***Global Telecommunications System:*** • NMC System: TRANSMET message switching system and SYNERGIE visualization workstation • GTS link: 9.6 kbps to La Reunion • GTS satellite-based components: RETIM-Africa receiving system • EUMETCAST receiving system	access, interpretation, processing and equipment including capacity building in training and forecasting tools and to interpret satellite products • Additional audio alarm will be required in order to make sure the staff is alerted. Furthermore automatic relay system to mobile phone and other devices will be required in order to shorten the delivering time to stake holders. Similar software shall be developed under the international coordination • Investigate possible use of INMARSAT satellite system: special attention should be given to materials compatible with the GMDSS, to be able to receive also the Maritime Safety Information provided to SOLAS vessels. • Investigate use of SafetyNET service of INMARSAT: coordination with the METAREA Issuing Service(s) • Maintenance of current GTS system	
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • Interim Tsunami Warning Center under Meteorology Services receives warning. Prime Minister Office as Chair of CCNDC will issue any evacuation order • Decision to evacuate based on tsunami advisory received from PTWC or JMA, sea level gauges readings and media reports from other countries of possible destruction • Warnings issued to mariners for tropical cyclones; protocols for tsunamis have not been established • Warning information disseminated by: TV and radio stations similar to cyclone warnings or other hazards. Use of sirens are being considered • Assessment of existing disaster management system and capacity building of Met Services and MOI have been assessed. Other government agencies not completed yet. ***Response Procedures:*** • Local tsunami emergency plans, evacuation plans, signage development are being assessed • Critical infrastructure and lifeline support facilities have	• Develop one comprehensive Tsunami Response Plan involving national, regional and local governments including outlying islands and including Standard Operating Procedures and Protocols • Install emergency plans, evacuation plans and routes and signage • Conduct a study to determine the minimal time required for a warning message to reach the population and to ensure a complete evacuation out of the inundation zone to a safe zone for the most vulnerable (or highly-populated) community • Prepare specific procedure in coordination with Mauritius Radio Station or other additional broadcast agency to issue tsunami warnings and associated guidelines available as quick as possible, with an appropriate broadcast frequency and to ensure the widest reception for non-SOLAS vessels • Need to establish and test or exercise procedures to improve the response through better planning and preparedness • Carry out post-event data surveys to assess damage and collect tsunami run-up/inundation data	• Assistance needed for identified critical infrastructure and lifeline support and make plans to ensure minimal government services after a destructive tsunami, or other natural disaster • Need assistance on the list of parameters to be monitored for post-event data surveys • Regional coordination should be organized, especially with the other Issuing Service for METAREA VIII(S), La Reunion, to ensure consistency, completion and to limit redundancy in tsunami warning/information dissemination within the GMDSS (NAVTEX & SafetyNET broadcasts • Advice on development of the disaster risk management plans for tsunami

Table 3-14. Mauritius: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
not been inventoried	• Specific information, communication and training should also be planned for skippers, boat operators • Conduct regular surveys to check community knowledge of response procedures • Specific procedure for ports should be prepared. Special attention should also be given to the provision of appropriate guidelines to mariners at sea, both for SOLAS & non-SOLAS vessels	
Tsunami Hazard and Risks • No historical records of past earthquakes or tsunami events prior to December 26, 2004 • Coastal zone vulnerability study has been undertaken by MOI. • No numerical modeling has been carried out yet. MOI is commissioned to do this. • GIS not currently used as decision support tool during emergency response • Post disaster surveys are carried out to identify and assess damage for non-tsunami disasters like cyclones. • A post-tsunami survey has been conducted by the Beach Authority post 26 December 2004 event for the main island.	• Prepare tsunami inundation maps building on existing environmental vulnerability studies and post-tsunami impact assessments to further focus work in public awareness and preparedness • Develop and institutionalize research programmes on tsunami hazards including focal tsunami generation, bathymetric, and geophysical investigations	• Training on inundation modeling for the development of tsunami inundation maps • Assist in updating (higher resolution and especially near-shore) of bathymetric and topographic maps
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system established for tsunamis • Systematic educational programmes on tsunamis for general public or communities are now under development by Ministry of Environment and NDU in collaboration with Meteorological Services. • Community-based organizations (schools, religious organizations) do not serve as early warning mechanisms for disasters • Structural tsunami mitigation measures have not been developed or implemented. Land-use policies restriction are in place related to cyclone and storm-surge hazards for non-structural mitigation measures • Emergency plans, evacuation plans, signage are being developed	• Develop public education programmes on appropriate and effective tsunami response • Conduct local risk assessments with special attention to small, outer-island communities (e.g., Agalega and St. Brandon Rocks) • Broaden tsunami awareness and preparedness into a multi-hazard framework • Consider establishing an annual tsunami-awareness/resilience day	• Support for tsunami public awareness campaign • Training on the development of tsunami evacuation maps, evacuation routes, and evacuation signage • National and regional seminars and workshops for interaction between stakeholders • Regional training should be organized (short, week-long courses), with practical orientation. Should be undertaken on a rotating basis among the Commission de l'Ocean Indien (COI) nations, coupled with site visits, and with university links (e.g., the "University of the Mascarene"concept). • Assistance for conducting outreach programmes • Commission de l'Océan Indien (COI) group of nations should develop professional, in-service training and postgraduate education initiatives related to a comprehensive hazard assessment and risk management (CHARM) paradigm

Table 3-14. Mauritius: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
		• Collaboration mechanisms for regional tertiary institutions and state research organizations, within a wider "University of the Mascarene" framework, through inter-regional cooperation between COI, Caribbean Community (CARICOM) and Pacific Island Forum (PIF) states, following the Mauritius Strategy for the sustainable development of small island developing states (SIDS).
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework	• Expand systems for tsunami to other hazards including flooding and landslide	• Multi-hazard approach to sustain awareness and optimize use of available resources on tsunami and other natural hazards

Status: *based on responses in national assessment questionnaire provided by the country, August 2005*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-15. Mauritius: Preparedness, Assessment, and Warning Capacity

	Question No.	Selected Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	◉
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	◉
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	●
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	◉
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	○
	101	Tsunami education and public outreach programme currently in place	◉
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	○
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	○
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-15. Mauritius: Preparedness, Assessment, and Warning Capacity

	Question No.	Selected Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	○
	69	Historical record of past earthquakes and tsunamis documented	○
	71	Tsunami vulnerability assessment conducted	◉
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	○
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	◉
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	○
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	◉
	28	Seismographic stations or networks to monitor regional seismicity	○
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	○
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	●
	39	Sea level data sampling sufficient to measure short period tsunami	●
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-15. Mauritius: Preparedness, Assessment, and Warning Capacity

	Question No.	Selected Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

Notes:
○ = No
◉ = Partial Yes
● = Yes

3.8 Mozambique

Source: http://www.cia.gov/cia/publications/factbook

Mozambique's coastline stretches over 2, 470 km along the west side of the Indian Ocean.[27] With a population of 801,590, Mozambique has 37 population centers within 8 km of the coastline fronting the Indian Ocean.[28] Very limited information is available from historical tsunami events occurring in 1762 and 1883. No casualties or reports of damage occurred in Mozambique as a result of the December 26, 2004 tsunami. The Government of Mozambique has experience in dealing comprehensively with natural disasters, including floods, droughts, and cyclones. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in July 2005.[29]

An overall summary of the assessment results are provided in Table 3-16 with responses to specific questions provided in Table 3-17. The National Institute of Meteorology, declared the focal point for issuing tsunami warnings, has recognized capabilities for forecasting and issuing warnings for other national disasters but no experience in seismology or tsunamis. The DNG operates the sparse and not real time seismic monitoring network which is in need of upgrading. Sea level monitoring stations under the National Institute of Hydrography and Navigation (INAHINA) are being upgraded. Mozambique has a fully operational GTS.

The existing disaster management system has been assessed. Tsunami emergency plans, evacuation routes, and signage have been developed; however, tsunami vulnerability assessments and numerical modeling have not been conducted to develop inundation maps. Present capacity to undertake this is limited. Structural and non-structural mitigation measures have not been addressed. Community preparedness for tsunami threats need to involve local stakeholders, communities as well as international and non-governmental organizations, to identify vulnerable communities and establish disaster coordination mechanisms. Mozambique's high level of illiteracy, especially in rural areas, needs to be considered in implementing an alert system.

[27] http://www.cia.gov/cia/publications/factbook/geos/mz.html
[28] www.world-gazetteer.com; population centers with greater than 10,000 people
[29] UNESCO-IOC et al., 2005h

Table 3-16. Mozambique: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Resolution 38/99 created the National Institute of Disaster Management (INGC), Resolution 30/89 created the National Institute of Meteorology (INAM). ***National Coordinating Bodies:*** The INGC establishes contingency plans based information from INAM. ***Local Coordinating Bodies:*** Some local committees for emergencies do exists, more communication and coordination are needed ***National Organizations:*** • National Institute of Meteorology (INAM); issue and dissemination of early warning • National Institute of Disaster Management (INGC); prevention, preparedness, relief assistance of disasters • National Directorate of Geology (DNG); Geophysics studies and observations of geological events • National Institute of Hydrology (DNA) • National Institute of Hydrography and Navigation (INAHINA); observation and monitoring of oceanic processes (tides, waves, surges, currents) • Eduardo Mondlane University (UEM); UNESCO chair of Marine Sciences and Oceanography • Maritime Safety Authority (SAFMAR) • National Red Cross Society ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Limited cooperative with Council for Geoscience of South Africa ***Research:*** Research expertise in hydrodynamic models and storm surge modeling available	• Formally designate INAM to be responsible for tsunami warnings • Enable better communication and coordination at the national and local levels. INGC, INAM, and INAHINA are lead agencies for tsunami mitigation. • Establish national tsunami coordination committee to develop and review periodically tsunami response plan. Members of committee are agencies and individuals that will implement and be held accountable for required actions. Can be done under Technical Disaster Management Committee chaired by INGC • Establish when needed ad-hoc groups of experts led by appropriate agency of national tsunami coordination committee to develop response plans. Example: for marine warnings, SAFMAR leads group for procedure for dissemination and preparedness for ports and non-SOLAS vessels. • Engage UN Disaster Management Team to assist in developing tsunami responses within all-hazards framework	• Provide assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • INAM serves as national tsunami warning center • International tsunami warnings received by GTS, fax and email at INAM operated 24/7. The INGC receives messages by fax and email as a backup. • Confirmation that a tsunami has occurred is reported by the INAM with SAFMAR as well ***Seismic Network:*** Limited 4-station seismic network that needs upgrading. All data is currently sent to South Africa for analysis	• Establish and strengthen national analysis, processing and warning center • Develop capacity of INAM/DNG for seismic data processing for monitoring local and sub-regional seismicity • Modernize and augment existing seismic network for digital recording and real-time transmission. • Modernize and augment existing sea level data network for tsunami monitoring (15-minute transmission frequency of 1-minute sampled data).	• Training in operational aspects of a tsunami warning center • Teaching modules and training courses for key organizations involved in the early warning process • Technical assistance for developing capacity to monitoring local and regional seismicity in real time, including network upgrades, station maintenance, data processing, and data analysis

Table 3-16. Mozambique: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
Sea Level Network: Five coastal stations with 2 new digital ones installed in April 2005. Data currently relayed at 2-3 hour intervals. Will be upgraded soon. ***Global Telecommunications System:*** GTS fully operational	• Develop capacity of INAHINA for display and manipulation of sea level time series to confirm tsunami • Collect coastal bathymetry and topography where needed	• Technical assistance for upgrading sea level networks for tsunami monitoring and evaluation of sea level data for tsunamis.
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • Interim Tsunami Warning Center under the INAM receives the warning and will pass it to INGC and Cabinet. Any evacuations are issued by the INGC • No formal criteria established to evacuate based on tsunami advisory received from PTWC or JMA indicating possibility of a tsunami • Warning information disseminated by: television via emergency broadcast along with central and local authorities • Assessment of existing disaster management system and capacity building needs have been assessed ***Response Procedures:*** • Local tsunami emergency plans, evacuation plans, signage have not been developed • Critical infrastructure and lifeline support facilities have not been inventoried • Post disaster surveys are carried out to identify and assess damage and run-up/inundation carried out and reported to INGC for non-tsunami disasters	• Develop Response Plan including: Standard Operating Procedures and Protocols; actions taken (including definition of criteria if needed); organizations and individuals involved and their roles and responsibilities; means by which they will be contacted, including phone numbers and other essential emergency contact information, timeline and urgency assigned to action, and means by which ordinary citizens alerted to evacuate. • Model tsunami plans, procedures or protocols after other natural hazards response plans if available. • Exercise periodically telecommunication systems to check operational contacts, procedures and protocols and build preparedness for response to actual emergency. • Strengthen communication system to reach local authorities and people in risk areas • Inventory critical infrastructure and lifeline support facilities	• Provide examples of tsunami response plans used by other countries with mature tsunami warning systems • Assist with implementation of national actions as identified by country
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004. Records of past earthquakes are poor. • No hazard or vulnerability studies conducted prior to December 26, 2004 • Preliminary numerical modeling has not been carried out • GIS is currently used as decision support tool during emergency response with regards to cyclones and flooding. Multiple databases and layers are available. • Post-tsunami surveys have not been conducted by any national and international agencies and experts	• Generate coastal inundation and vulnerability maps • Develop capacity to produce inundation maps • Better understand historical seismicity of Mozambique channel to determine tsunami- generating potential	• Assist in building capacity. Training and modeling software for tsunami hazard and vulnerability studies and modeling • Assist with implementation of national actions as identified by country
Tsunami Public and Community Awareness and Preparedness • INGC does operate local level operations • No systematic educational programmes on tsunamis for	• Develop and implement awareness and education programmes • Engage non-government, people-centered, community-based organizations, such as the Red Cross Society to	• Provide examples of awareness and education programmes and materials used by other countries with mature tsunami warning and mitigation systems

Table 3-16. Mozambique: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
general public or communities, will incorporate programme used for flooding and cyclones • Community-based organizations (schools, religious organizations) serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Emergency plans, evacuation plans, signage have not been developed	assist in tsunami warnings and in education, preparedness and awareness, modelling after involvement in floods and tropical cyclones • INGC to initiate discussions with Education to include disaster preparedness in school curricula. INAM and other national agencies to produce specific materials if requested.	• Provide electronic versions of tsunami-related materials (UNESCO-IOC) • Assist with implementation of national actions as identified by country
Enhancement of Disaster Mitigation Capabilities • Use of comprehensive approach to management of natural disasters including floods, droughts, and cyclones		

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-17. Mozambique: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	○
	5	Disaster coordination mechanisms at the community level established	○
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	--
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	--

Table 3-17. Mozambique: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	○
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	◉
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	○
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	●
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-17. Mozambique: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.9 Myanmar

Myanmar coastline stretches 1,930 km along the Bay of Bengal and Andaman Sea.[30] The total land area of Myanmar is 678,500 sq km and population is 42,909464, with 53 population centers within 8 km of the coast.[31] The most common natural disasters in Myanmar include floods, storms, earthquakes and landslides. Tsunamis are a new hazard to coastal communities. In 1762, a local tsunami generated near the Rakhine coast killed several people. In 1883, distant tsunamis occurred but no reports of loss of life. The December 26, 2004 tsunami event resulted in 61 casualties and 2,592 people homeless.[32] This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in 2005.[33]

An overall summary of the assessment results are provided in Table 3-18 with responses to specific questions provided in Table 3-19. The Department of Meteorology and Hydrology is designated to issue tsunami warnings. The Department of Relief and Resettlement is designated to disseminate the public action message to the public and to ensure it reaches the local levels. A national Committee of Disaster Management is established, however, local level coordination mechanisms have yet to be established.

Source:
http://www.cia.gov/cia/publications/factbook

Computer Receiving Tsunami Information

Seismic monitoring capacity is limited with four analog stations. An 8-station high-quality national seismic network with real-time data transmission is planned in order to monitor local seismicity. No sea level monitoring stations are currently operated. Asian Disaster Preparedness Center (ADPC), based in Thailand, plans to upgrade seismic and sea level stations throughout the region and share data in real-time. Two new GLOSS stations are planned for November 2005 with near real-time transmission.

[30] http://www.cia.gov/cia/publications/factbook/geos/bm.html
[31] www.world-gazetteer.com; population centers with greater than 10,000 people
[32] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[33] UNESCO-IOC et al., 2005i

Table 3-18. Myanmar: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Government entrusted Department of Meteorology & Hydrology (DMH) for warnings. New constitution will endorse this. ***National Coordinating Bodies:*** National Committee of Natural Disaster Management (NCNDM). Prime Minister is chairman. ***Local Coordinating Bodies:*** Local level coordination is being considered ***National Organizations:*** • Department of Meteorology & Hydrology (DMH); monitoring & issue of warnings for natural disasters • Department of General Administration • Department of Relief and Resettlement • Department of Information & Public Relation; evacuation of victims, resettlement • Department of Myanmar Radio and Television; disseminating information; broadcasting warnings • Department of Health; medical care • Department of Education; natural disaster education • Myanmar Post and Telecommunications; communicating messages, communication at disaster sites • Myanmar Red Cross Society; assistance and disaster relief • Myanmar Engineering Society; technical studies on earthquake and tsunamis and preparation of hazards maps • Myanmar Geo-science Society ***International Standards:*** Protocols meet international standards ***Regional Cooperation:*** • Close coordination with ASEAN committee on Disaster Management (ACDM), ADRC & Asian Disaster Preparedness Center (ADPC) • ADPC, based in Thailand, plans to upgrade seismic and sea level stations throughout the region and share data in real-time ***Research:*** Seismic research in Myanmar, Micro-zonation of earthquakes in Yangon and Mandalay. Data collection of Indian Ocean tsunamis. Ministry of Energy and private companies have some cooperation in research	• Establish the National Committee on Natural Disaster Management (NCNDM) and National Tsunami Warning and Mitigation Coordination Committee • Setting up of coordination mechanism at community level • Establishment of National Tsunami Warning Center	• Provide assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • Intention to operate a national tsunami warning center to monitor and warn for regionally or locally generated tsunamis with realt-time monitoring network with 8 broadband s • DMH receives international tsunami warnings from PTWS & JMA by fax, GTS and email; DMH operated 24/7 by 12 persons on shifts, 2 to 3 at a time	• Develop Automatic Alert System, if tsunami information is delivered, to inform the staff on duty immediately. A verification protocol for tsunami alerts should be in place as soon as possible • Upgrade national seismic network in close cooperation with ICG/IOTWS • Install sea level stations and implement	• Provide assistance to establish real-time regional and local seismic and sea level data acquisition, display and analysis as an extension of DMH • Assistance for the installation of GIS facilities • Assistance with upgrading of instruments • Assistance in improvement of communication systems (data transmission) • Assistance for equipment and manpower related

Table 3-18. Myanmar: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
• Confirmation that a tsunami has occurred is reported by the DMH at local offices ***Seismic Network:*** Four analog seismic stations installed, not telemetered; not available in real-time. ***Environmental Satellite System Use:*** Cloud images received from GOES ***Sea Level Network:*** No sea level stations or network operated in Myanmar ***Global Telecommunications System:*** • Limited capability with no message switching system, manual operation • GTS connection to RTH New Delhi and RTH Bangkok via very low speed 50 baud • PCVSAT receiver recently provided by CMA to allow reception of GTS data; No capacity to transmit data • GOES-9 satellite reception for WEFAX low resolution cloud imagery	real-time communication network including seismic data • Upgrade national network with PCs and PSTN use. • Support to upgraded GTS link	to use of space technology • Improved GTS link to RTH New Delhi and RTH Bangkok via 64 kbps TCP/IP • Implementation of a new message switching system with specifications compliant with WMO recommendations and guidelines, including WAN & LAN connectivity and WMO standard TCP/IP security guidelines • ICT training and capacity building • Selected spare parts for GTS key critical systems • Recurrent costs for hardware and software maintenance of GTS for a period of 5 years; • Long term GTS sustainability plan
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • DMH has authority to issue warnings and evacuation for tsunamis. • Decision to evacuate based on magnitude greater than 7.0 for submarine earthquake • Warning information disseminated by: telephone to TV and radio stations; by handheld loud speakers at community level. • Assessment of existing disaster management system and capacity building training is on-going • DMH issues marine warnings for weather and sea conditions for mariners to Port Authority, Navy, and port Wireless (Yangon Radio) which passes messages to ships in Myanmar waters by hoisting signal and through radio; no NAVTEX access to INMARSAT SafetyNet ***Response Procedures:*** • Tsunami emergency plans, evacuation plans, signage developed • Critical infrastructure and lifeline support facilities have been inventoried and stockpile of relief supplies collected	• Develop a detailed plan to transmit tsunami warning including use of amateur radio • Conduct tsunami drills including evacuation and evaluate results • Designate a model village to facilitate the process of establishment of early warning response system • Designate safe places such as higher ground or tsunami shelter • Train community leaders to educate the public on tsunami awareness	
Tsunami Hazard and Risks • Good historical records of past earthquake events are available • Very limited information from 1762 & 1883 tsunami events are available • No hazard or vulnerability studies conducted prior to December 26, 2004. In 2005, study with DMH, Geological Society and Japan has occurred • No numerical modeling is currently happening. Future work to be done by Yangon Technical University. • GIS not currently used as decision support tool during emergency	• Undertake high-resolution bathymetric and topographic surveys for developing charts and maps • Encourage international cooperation in numerical tsunami modeling • Conduct tsunami vulnerability studies and prepare inundation maps • Conduct post tsunami field surveys and finalize analysis of 26 December 2004	• Provide training and modeling software for tsunami hazard and vulnerability studies and modeling • Assistance to attain nearshore bathymetric information • Capacity building in GIS applications for disaster management and to develop tsunami inundation maps

Table 3-18. Myanmar: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
response • Post-tsunami surveys have been conducted by national and international agencies and experts • Post disaster (December 2004) survey with Geological Survey of Japan done in 2005. • Department of General Administration with DMH & military also conducts post-disaster surveys	tsunami event • Review building codes for earthquakes for tsunami mitigation • Consider non-structural tsunami mitigation measures as appropriate • Use GIS applications in disaster management	
Tsunami Public and Community Awareness and Preparedness • Local authorities have system for alerts in disaster prone areas • Public education has been done. Need systematic educational programmes on tsunamis for general public or communities • Community-based organizations (schools, religious organizations) need to utilized better for education and dissemination of warnings • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Emergency plans, evacuation plans, signage developed in Pyinsalu Island	• Need for outreach programme • Training for tsunami early warning for local government officials in the coastal area is needed • Community-level education seminars or workshops need to be organized • training-the-trainer activities are required • Training for the media, especially for the radio announcers on tsunami information dissemination, as well as public education on tsunami, is required	• Training programmes and train-the-trainor for government and NGOs in public and community awareness and preparedness
Enhancement of Disaster Mitigation Capabilities • Technical expertise and extensive experience in handling warnings for natural disasters other than tsunamis	• Integrate tsunamis hazards through a multi-hazard approach	

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-19. Myanmar: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	○
	5	Disaster coordination mechanisms at the community level established	○
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	●
	61	Response procedures have been tested or exercised	◉
	63	Critical infrastructure and lifeline support facilities for disaster response identified	◉
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	◉
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	--
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	--

Table 3-19. Myanmar: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	○
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	◉
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-19. Myanmar: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	●
	60	Response procedures for earthquakes in place	●
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.10 Oman

Oman's 4,675 km of coastline extends along the Gulf of Oman and Arabian Sea.[34] Oman has a total land area of 329,750 sq km and population of 23,953,136, with 35 population centers located within 8 km of the coast.[35] Natural hazards include sand storms from summer winds and periodic droughts. The December 26, 2004 tsunami wave event struck the coast but no casualties were reported.[36] This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in June 2005.[37]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-20 with responses to specific questions provided in Table 3-21. The Department of Meteorology receives international tsunami warning advisories along with the Earthquake Monitoring Center. National and local coordination mechanisms have been established under the National Committee for Civil Defense. Oman operates and extensive seismic network. As sea level monitoring stations are part of the GLOSS network reporting date in near real time. Oman maintains a fully operational GTS. Existing warning dissemination mechanisms include TV, radio, internet, SMS, telephone, and fax.

Critical infrastructure and lifeline support facilities have been assessed; however, capacity building needs of individuals and institutions in disaster management systems have not been identified. Evacuation plans and routes, and response procedures for tsunamis have yet to be developed; however, international collaboration for numerical modeling is planned to develop inundation maps. Additional systems put in place for tsunamis would benefit response to other natural disasters including floods and landslides.


Meteorological Monitoring

[34] http://www.cia.gov/cia/publications/factbook/geos/mu.html
[35] www.world-gazetteer.com; population centers with greater than 10,000 people
[36] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[37] UNESCO-IOC et al., 2005j

Table 3-20. Oman: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Royal decree refers to weather-based natural hazards in general. ***National Coordinating Bodies:*** National platform for guiding disaster reduction exists under National committee for Civil Defense (NCCD) ***Local Coordinating Bodies:*** Local organizations established under NCCD ***National Organizations:*** • Ministry of Foreign Affairs • National Committee for Civil Defense (NCCD) • Meteorological Service • Earthquake Monitoring Center (EMC) • Hydrographic Survey Unit of Royal Navy of Oman ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Participates in interim system with JMA and PTWC, and sea level changes through GLOSS ***Research:*** Currently does research relating to crust thickness, three component seismic data and microseismicity evaluation in oil fields EMC at Sultan Qaboos University was recently established for earthquakes and associated hazards. Marine Science and Fisheries Center deals with physical oceanography.	• Consider updating decree to encompass all natural disasters including tsunamis if necessary • Proceed with establishment of National Tsunami Coordination Committee • Reconfirm UNESCO-IOC action address for Oman • Identify roles and responsibilities of the NCCD and planned National Tsunami Warning Center (NTWC) with regard to tsunami warning and mitigation	• Provide assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** International tsunami warnings received by GTS, fax and email at Meteorological Service on a 24/7 basis. ***Seismic Network:*** National seismic network located throughout the country. Data is available in real-time at EMC. ***Environmental Satellite System Use:*** Existing capacity for meteorological satellite systems including orbiting satellites, METEOSAT, and FY2 ***Sea Level Network:*** • One permanent GLOSS sea level stations established at Salalah. • Four additional seal level stations are either not working or not connected to GLOSS network. Real time data is available and transmitted at 1 hour frequency	• Establish a National Tsunami Warning Center • Establish tsunami warning alarm infrastructures • Make seismic data available to other users in the Indian Ocean region • Ensure operational status of 5 sea level stations linked to GLOSS network with data transmission through GTS	• Provide assistance to establish tsunami warning center with real-time regional and local seismic and sea level data acquisition, display and analysis • Provide assistance to establish a tsunami warning alarm system infrastructures • Assistance required to make data available in real-time or near real-time to users outside EMC • Provide assistance to repair and upgrade 5 sea level stations and link them to the GLOSS network

Table 3-20. Oman: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Global Telecommunications System: • GTS fully operational		
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • No formal arrangements exists for any current warnings received • No tsunami marine warnings issued to mariners • Marine forecasts and warnings prepared for weather and sea conditions and disseminated through NAVTEX, fax, radio, SMS • Other hazards warning information disseminated by: TV, radio, internet, SMS, WAP, telephone, fax and answering machine ***Response Procedures:*** • No evacuation plan and procedures currently exists • Critical infrastructure and lifeline support facilities have been inventoried for other disasters. • No post disaster surveys have been carried out to identify and assess damage and run-up/inundation. The EMC will be collaboration with Northwestern University to do this.	• Decide on the agency that will act on tsunami warning messages generated by the tsunami warning center • Assess existing disaster management system in terms of tsunami response to a warning received from the tsunami warning center (PTWC & JMA until local center is establish) • Establish detailed procedures to respond to international tsunami advisory messages, local and regional tsunami warnings, and local earthquakes • Integrate tsunami marine warnings into existing marine warning system • Prepare inventory of hospital, ports and marine facilities, land transportation, energy utilities, telecommunications and other critical infrastructure and coordinate with existing National Disaster Management Plan of the NCCD • Make available results of planned tsunami run-up/inundation study to the Indian Ocean countries through the UNESCO-IOC	
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004 • Earthquake data from previous four years is available and limited data prior • No hazard or vulnerability studies conducted prior to December 26, 2004 • Numerical modeling for inundation zones is now planed in cooperation with Northwestern University, US • GIS not currently used as decision support tool during emergency response however, Sultan Qaboos University has remote sensing, but not as a decision support tool. • No post-tsunami surveys have been conducted	• Collect historical inundation and run-up data from historical events for the development of evacuation maps for coastal communities • Conduct tsunami vulnerability study to identify vulnerable areas within the country • Build local expertise in numerical modeling related to tsunami inundation • Prepare 5-year plan for high-resolution bathymetric and topographic data acquisition • Build national capacity for GIS as a decision support tool • Conduct post-tsunami survey for 26 December 2004 evacuation	
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system	• Engage all layers of government in tsunami awareness and preparedness • Expand school curriculum at all education levels to include	• Educational modules and regional training activities on public outreach and education for the early warning system process

Table 3-20. Oman: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
established for tsunamis • No systematic educational or outreach programmes on tsunamis or other hazards for general public or communities. Looking into adding to school curriculum • Community-based organizations (schools, religious organizations) currently are not involved in serving as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented • No emergency plans, evacuation plans, signage have been developed	tsunami hazards • Assess local government disaster preparedness and emergency response as relevant to tsunami such as existence of local emergency operations centers, alert systems, and incident command processes • Develop comprehensive, multiple stakeholder community-wide and long-term community awareness and preparedness strategy and curriculum • Prepare evacuation maps, routes and signage • Consider establishment of tsunami memorials, museums, interpretative signage or other public reminders to ensure awareness of tsunami risks across generations	• Provide electronic copies of tsunami-related educational materials and other publications for translation into Arabic for printing and distribution (UNESCO-IOC)
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework • Multi-hazard approach strongly supported		• Multi-hazard approach to be used in the development of early warning systems

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-21. Oman: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	○
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	●
	84	Local government disaster preparedness and emergency response assessed	○
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	○
	101	Tsunami education and public outreach programme currently in place	--
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	--

Table 3-21. Oman: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	○
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	○
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	●
	31	Real time seismic data provided	●
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	●
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-21. Oman: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	◉
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.11 Pakistan

Pakistan's coastline extends about 1,040 km along the Arabian Sea.[38] With a total land area of 803,940 sq km and population of 162,419,946, Pakistan has 11 population centers within 8 km of the coastline.[39] Pakistan was not impacted by the December 26, 2004 tsunami event; however, tsunamis are not a new phenomenon. The last tsunami that occurred in Pakistan was November 27, 1945. The tsunami was generated along an active subduction zone off the Makran coast of Pakistan in a zone that marks the boundary between the Arabian plate sliding beneath the Iranian micro-plate. More than 4,000 people were killed by the 1945 earthquake and tsunami along the Makran coast.[40] In this respect, the Makran source area represents the second major tsunami source region in the Indian Ocean. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in June 2005.[41]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-22 with responses to specific questions provided in Table 3-23. The Pakistan Meteorological Department has been designated the national focal agency for international tsunami watch information. Seismic and sea level monitoring capability is limited and needs upgrading. The government has approved funding of the PMD's high-priority request to upgrade the seismic network to enable real-time monitoring and evaluation of local seismicity. The 1945 tsunami off the Makran coast was well documented and can be used as input to tsunami vulnerability studies and numerical modeling. Warning dissemination mechanisms used for other natural disasters include media and loud speakers at mosques; however, local emergency response plans and tsunami evacuation routes need to be developed. Community response mechanisms have not been established for tsunamis. Educational and public outreach programmes are planned.

Seismic Monitoring Center

[38] http://www.cia.gov/cia/publications/factbook/print/pk.html
[39] www.world-gazetteer.com; population centers with greater than 10,000 people
[40] http://www.iiees.ac.ir/bank/Tsunami/bank_Tsunami_Makran.html#5
[41] UNESCO-IOC et al., 2005k

Table 3-22. Pakistan: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Administrative order by government, Pakistan Meteorological Department (PMD) is focal agency for tsunamis; Federal Flood Commission (FFC) has served as national platform for flood risks reduction; however other natural disasters not currently covered ***National Coordinating Bodies:*** A national coordination committee formed headed by Minister for Science and Technology; ***Local Coordinating Bodies:*** No local level coordination at this time ***National Organizations:*** • Pakistan Meteorological Department (PMD); establish, maintain seismic monitoring equipment, issue alerts, warnings, advisories • Emergency Relief Cell (ERC); mitigation and relief of disasters • National Institute of Oceanography (NIO); research • Hydrographic Department of Pakistan Navy (HDPN) • Geological Survey of Pakistan (GSP); research • Civil Defense Organization • Red Crescent Society ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** No formal cooperative mechanisms for early warning, assessment or mitigation ***Research:*** Research capacity in seismology and geophysics, limited expertise in tsunami research	• Develop a comprehensive system for dealing with all types of disasters • Establish national tsunami warning center	• Provide assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • PMD intends to operate a national tsunami warning center and is designated as the national focal agency for receiving tsunami watch information from JMA • International tsunami warnings intended to be received from JMA using GTS but currently not operational • PMD maintains operations 24/7 with internet as a back-up system • Confirmation that a tsunami has occurred has not been determined yet ***Seismic Network:*** Regional seismicity monitored by PMD. Data	• Upgrade seismic network including real-time data transmission • Use VSAT for data collection of sea level stations • Use an automatic alert mechanism to draw the attention of message addressees to incoming tsunami warnings from PTWC and/or JMA. A software module should be implemented for monitoring the incoming GTS data stream for tsunami warnings and raising an alert. In the short-term, PMD has proposed that message addressees should also be alerted by mobile SMS at least before the software module for monitoring the GTS is implemented. • Upgrade to 64 kbps of link to RTH Tehran is planned	• PMD requested to receive International tsunami warnings issued from PTWC and JMA by GTS/WMO, email and fax • Technical expert to help design and implement the enhanced seismic network, including site selection and specification of equipment (UNESCO-IOC) • Assistance to update or replace its GTS message switching software to ensure maintainability as well as proper handling of such messages and data (WMO) • Technical assistance for the design and

Table 3-22. Pakistan: National Assessment Summary, June 2005

Status	National Actions	Support Requirements

is not in real-time.
Environmental Satellite System Use: Limited capability; receiving meteorological cloud images received from orbiting meteorological satellites
Sea Level Network:
• Intermittent sea level data for Gwadar and Karachi for the past is available; sea level stations are not operational
Global Telecommunications System:
• Limited capability with no message switching system.
• Connected to:
  ○ RTH New Delhi via 64 kbps leased lines;
  ○ RTH Tehran via 50 baud link;
  ○ No connection to RTH Tashkent.
• Internet via low speed dialup (40 kbps) not reliable
• GTS satellite based components out of operation.
	• Upgrade of seismic network approved by Government
	• Improved Internet link between Karachi and RTH New Delhi and RTH Tehran for exchange of data
		implementation of multi-sensor arrays fro tsunami warnings including network of sea level stations, moored buoys and pressure sensors (UNESCO-IOC)
		• Develop technical expertise and upgrade environmental satellite systems and related applications
		• Reception of IO-Tsunami Watch messages issued by JMA and PTWC via New Delhi;
		• Automatic dissemination of these messages to a number of national agencies including: 5 or 6 important disaster reduction centers; PTV (Government TV station) and other electronic media
		• Radio station
		• Implementation of a message switching system with specifications compliant with WMO recommendations and guidelines, including WAN & LAN connectivity and WMO standard TCP/IP security guidelines
		• ICT training and capacity building
		• Selected spare parts for GTS key critical systems
		• Recurrent costs for hardware and software maintenance of GTS for a period of 5 years
		• Long term GTS sustainability plan

<u>Tsunami Warning Response and Emergency Preparedness</u> ***Warning Dissemination:*** • ERC and Provincial Relief Commissioners (PRC) will be future designated agencies for warning dissemination • Decision to evacuate still to be decided • No tsunami marine warnings issued to mariners • Marine warnings issued for weather and sea conditions and disseminated to mariners through INMARSAT • Warning information disseminated by: media, loud speakers at mosques and armed forces	• Conduct tsunami risk assessment research to identify vulnerable areas from tsunami. At the same time, safe places with evacuation routes need to be designated. • Educate coastal residence to evacuate whenever they feel a large earth tremor • Develop the Comprehensive Disaster Response Plan including tsunami warning dissemination, evacuation routes, and drills • Adapt the existing disaster warning and mitigating system for tsunami	• Prepare inventory of hospital, ports and marine facilities, land transportation, energy utilities, telecommunications and other critical infrastructure • Integrate tsunami marine warning mechanism into existing system

Table 3-22. Pakistan: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
• Assessment of existing disaster management system and capacity building has been done recommendations are being implemented ***Response Procedures:*** • Local tsunami emergency plans, evacuation plans, signage have not been developed yet • Critical infrastructure and lifeline support facilities have not been inventoried with reference to tsunamis		
Tsunami Hazard and Risks • 1945 Great Offshore Makran Coast earthquake and subsequent tsunami is well documented • PMD has good records of other previous earthquakes • No hazard or vulnerability studies conducted prior to December 26, 2004 • No numerical modeling has been carried out. Future plans are being assessed • GIS not currently used as decision support tool during emergency response • Post-tsunami surveys have been conducted by interviewing general public in effected areas • Post disaster surveys are carried out to identify and assess damage for earthquakes		• Provide training and modeling software for tsunami hazard and vulnerability studies and modeling • Capacity building for GIS applications in disaster management and to develop tsunami inundation maps is needed
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system established for tsunamis • No systematic educational or public outreach programmes on tsunamis for general public or communities; but planned • Educational and outreach programmes exist for other hazards • Community-based organizations (schools, religious organizations) are planned to be integrated into local and regional warning and mitigation systems • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Emergency plans, evacuation plans, signage have not been developed	• Implement both structural countermeasures and non-structural countermeasure, including but no limited to making a concrete evacuation plan for each community for timely response • Develop community-level education and preparedness programmes for tsunamis Integrate disaster reduction in the school curriculum • Develop educational materials for schools that give knowledge on natural disasters including tsunami, earthquake, cyclone and flash flood is needed • Designate model village to facilitate community-level tsunami educational preparedness programmes • Develop better communications means such as amateur radio network and sirens, designation of safe places or tsunami shelters, as part of model village programme	• Educational modules and regional training activities on public outreach and education for the early warning system process
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed	• Establishment of tsunami early warning system, Phase I (upgrade of seismological network) and Phase II (establish	• Multi-hazard approach to be used in the development of early warning systems

Table 3-22. Pakistan: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
within a multi-hazard framework building on expertise of PMD in forecasting and issuing warnings for national disaster other than tsunamis • Multi-hazard approach strongly supported	separate networks of tide gauges and bathymetric pressure sensors).	• Assistance for establishing the tsunami early warning system in Pakistan

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-23. Pakistan: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	○
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	◉
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	○
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	○
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	◉
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	◉
	106	Training programmes for the media on other hazards and their vulnerability current exist	○

Table 3-23. Pakistan: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-23. Pakistan: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	●
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.12 Seychelles

The Seychelles are an archipelagic nation with a total land area of 455 sq km and population of 81,188[42]. The archipelago is composed of 41 granitic and 75 coralline islands with about 490 km of coastline. The December 26, 2004 tsunami event resulted in 3 casualties, seven missing people, and the destruction of a major bridge in capital, Victoria. It was followed by torrential rains on December 28 and 29.[43] While the Seychelles lie outside most disaster zones, the frequency and intensity of storms and other hazards has been increasing. As a result, even before the recent tsunami, the government was in the process of developing a national plan to cover all natural hazards. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in July 2005.[44]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-24 with responses to specific questions provided in Table 3-25. The National Risk and Disaster Management Secretariat, established by the President in October 2004 is the focal point for disaster coordination in the Seychelles. In the aftermath of the tsunami, the National Disaster Committee has met regularly to develop a tsunami preparedness and response plan. Active working groups involving a broad spectrum of stakeholders including the media are helping to provide input to the national plan for tsunamis. At the local level, all districts have some basic disaster response systems in place but need upgrading and improvement. Some seismic monitoring capability exists but not in real-time. The Seychelles Petroleum Company assists in the operation and maintenance of the MANY real-time broad band seismic station of the GSN and some capacity exists for seismic research and monitoring through the SPC and international collaborative efforts. One GLOSS station operated by the NMS will be upgraded in order to sample sea levels frequently enough to resolve short-wavelengths.

National Meteorological Service

Community-based organizations serve as early warning mechanisms for disasters and formally organized community response mechanisms or evacuation plans for tsunamis are in the process of being developed. GIS database systems exist

[42] http://www.cia.gov/cia/publications/factbook/print/se.html
[43] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[44] UNESCO-IOC et al., 2005l

which are planned to be used to support decision-making. Post-tsunami surveys have been conducted and could serve as input to numerical modeling studies to develop inundation maps. Design of the National Alert and Response system must take into account the vastness over which the islands are distributed. Nonetheless, basic communications services exist between the main island of Mahe and the other districts.

Table 3-24. Seychelles: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** No laws designate responsibilities. National Meteorological Services (NMS) by default is designated to provide forecast, issue advisory and warnings as appropriate ***National Coordinating Bodies:*** National Disaster Secretariat (NDS) created in 2004. National Disaster Committee for all hazards also has been established. ***Local Coordinating Bodies:*** District level disaster management in place. Coordination between districts and islands not very good. ***National Organizations:*** • National Disaster Secretariat • National Meteorological Services • Ministry of Environment and Natural Resources • Ministry of Local Government, Sports and Culture • Ministry of Land Use and Habitat • Seychelles People Defence Force • Seychelles Coast Guard • Seychelles Broad Casting Corporation • Seychelles National Oil Company • Red Cross ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** A few projects are being considered within a regional context with La Reunion Island. Project being considered with the Indian Ocean Commission framework on safeguarding of communities from risks. ***Research:*** Semi-active tsunami and seismology research is done by National Meteorological Services and Seychelles Petroleum Company respectively. Imperial College London, University of Hawaii SLC also are conducting research.	• Finalize legal framework for early warning system • Streamline decision making capabilities in an emergency situation of the National Disaster Committee • Develop interim protocols for night-time evacuations warnings • Disaster platform will be launched in early November 2005 • It is recommended to establish a center for multi-hazard early warning system	• Provide assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Develop guidelines for land use planning taking into natural disasters
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** International tsunami warnings received by GTS, email and fax at National Meteorological Services (NMS) operated 24/7 ***Seismic Network:*** Regional seismicity monitored. Data transmitted to University of California, San Diego. Real-time data not available locally. ***Environmental Satellite System Use:*** Two satellite data reception systems (RETIM-Africa and METEOSAT) exist. ***Sea Level Network:*** • One permanent GLOSS sea level stations established but not specifically designed for detecting tsunami signal at short-	• Enhance technical expertise and upgrade environmental satellite systems and related applications • Maintenance of current GTS system	• Provide assistance to establish tsunami monitoring capability and analysis including real-time regional and local seismic and sea level data acquisition, display and analysis • Training for capacity building in GTS • Upgrade current GLOSS station to provide real-time data • Install one-station tsunami monitoring system such as TREMORs for independent monitoring of earthquake location and magnitude at current seismic station MSEY

Table 3-24. Seychelles: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
wavelengths • Tide gauge using float type mechanism located at Airport maintained by UHSLC and NMS. ***Global Telecommunications System:*** • NMC System: TRANSMET message switching system and SYNERGIE visualization workstation • GTS link: via Internet to La Reunion • GTS satellite-based components: RETIM-Africa receiving system • EUMETCAST receiving system		• Four additional Tide gauges are required for installation within Seychelles' EEZ to monitor tsunami emanating from different geographical sources
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • NMS dissiminates advisories and warning and recommends action to be taken according to established guidelines to the Media, National Disaster secreatariate, Disater committee etc. • The Disaster secretariate coordinates and manages the hazard (tsunami) response. • Advisories and warnings are issued based on information received from regional earthquake- tsunami warnuing centers and local assessment of the location, depth , magnitude and predicted tsunami height • Decision to evacuation based on confirmation of abnormal sea level report and data observation of inundation/run-up from upstream station such as Indoneasia, India, Sri Lanka, Maldives(earthquake, landlside or asteroid) located east), Somali (earthquake, landlside, asteroid) located north). • President officially declares evacuation order • No tsunami marine warnings issued • Marine warnings for weather and sea conditions prepared and disseminated through radio and HF broadcast • Warning information disseminated by: TV special reports and word of mouth ***Response Procedures:*** • Procedures still being developed, no drills done yet • Critical infrastructure and lifeline support facilities have not been inventoried • Several post tsunami scientific surveys have been carried out in coordination by Ministry of Foreign Affairs	• Develop procedures for the dissemination of tsunami warnings to mariners and port authorities • Enhance dissemination mechanism for marine warnings • Develop one comprehensive plan to be disseminated down to the district and local levels. • Assess safety and preparedness of religious buildings for shelters • Conduct test on amount of time to disseminate warning messages down to the local level. • Prepare inventory of hospital, ports and marine facilities, land transportation, energy utilities, telecommunications and other critical infrastructure	• Provide assistance to establish operational and technical terms of reference (TOR) for organization and institutions.(e.g. clearly define TOR for early Warning Centers, Disaster Secretariat, Media, local government, Red Cross etc) to set up a tsunami alarm infrastructure for the public
Tsunami Hazard and Risks • No historical records of past earthquakes	• Collect historical inundation and run-up data from 1954 Makran event for the development of evacuation maps for coastal communities	• Provide training and modeling software for tsunami hazard and vulnerability studies and modeling

Table 3-24. Seychelles: National Assessment Summary, July 2005

Status	National Actions	Support Requirements
• Few records of tsunami events prior to December 26, 2004 • No hazard or vulnerability studies conducted prior to December 26, 2004 • After the 26th Dec 2004 tsunami , there are emerging hazard and vulnerability studies • No numerical modeling studies have been done to calculate inundation zones. • GIS not currently used as decision support tool during emergency response but for post disaster recovery. The Ministry of Land Use only has access to GIS data. • Post-tsunami surveys have been conducted by national and international agencies and experts	• Produce high-resolution bathymetric and topographic maps to improve modeling and prediction capacity • Use GIS to do vulnerable studies of the coastal population • Incorporate GIS into disaster management	• Training required to develop capacity in numeric modeling. • Assistance required for bathymetric and topographic surveys
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system established for tsunamis • No systematic educational programmes on tsunamis for general public or communities but planned and will include multi-hazards; Outreach to schools is starting. • Community-based organizations (Red Cross) serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Emergency plans, evacuation plans, signage has not been completed	• Develop comprehensive, multiple stakeholder community wide and long-term community awareness and preparedness strategy and curriculum • Prepare evacuation maps, routes and signage	• Educational modules and regional training activities on public outreach and education for the early warning system process
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework • Multi-hazard approach strongly supported		• Multi-hazard approach to be used in the development of early warning systems • Enhance national capacity on disaster management • Assistance to carry out community risk assessment

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-25. Seychelles: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	◉
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	◉
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	○
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	◉
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	◉
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	●
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	○
	106	Training programmes for the media on other hazards and their vulnerability current exist	○

Table 3-25. Seychelles: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	○
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	○
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	○
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	◉
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-25. Seychelles: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	●
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

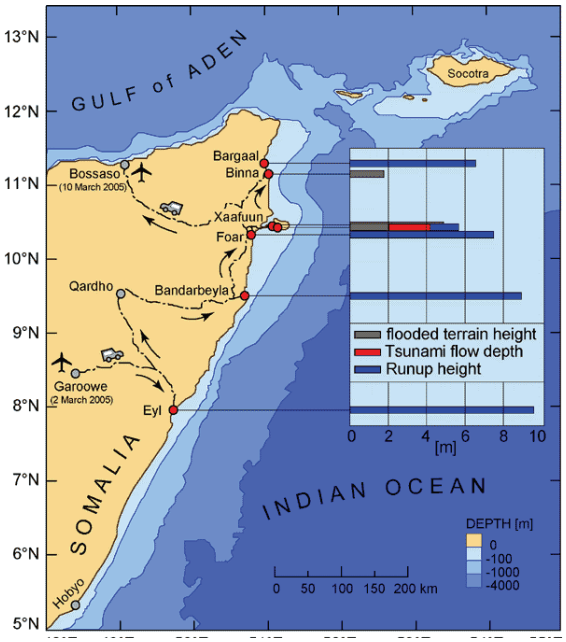
Notes:
○ = No
◉ = Partial Yes
● = Yes

3.13 Somalia

Somalia has a coastline length of about 3,025 km.[45] With total land area is 627,337 sq km and population of 8,591,629, Somalia has 28 population centers within 8 km of the coast.[46] Somalia's natural hazards include recurring droughts, frequent dust storms, and flooding during the rainy season. The December 26, 2004 tsunami event resulted in 176 casualties, 136 missing persons, and more than 50,000 displaced persons.[47] Villages and coastal communities in Somalia were swept away and destroyed. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in June 2005.[48]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-26 with responses to specific questions provided in Table 3-27. The questionnaire was not completed during the assessment and many responses are missing. At the time of the assessment, Somalia's transitional federal government was based in Nairobi, Kenya; however, has since relocated to the capital of Somalia, Mogadishu. As no governmental mechanisms or facilities existed at the national level at this time, the assessment focused on short-term possibilities towards the development of a long-term plan to address tsunamis and other natural hazards. In the absence of seismic or seal level observation networks, it was recommended that Somalia operate in a "passive mode" to receive warnings from other centers and act upon them when received. At the provincial level; however, disaster response mechanisms can be implemented as community-based government structures appear to be intact and strong. Some technical capacity in hydrology exists that can be used to begin to address the development of tsunami mitigation activities.



Post-Tsunami Field Survey of Somalia Coast (2005) http://UNESCO-IOC.unesco.org/IOsurveys/somalia/somalia.htm

[45] http://www.cia.gov/cia/publications/factbook/print/so.html
[46] www.world-gazetteer.com; population centers with greater than 10,000 people
[47] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[48] UNESCO-IOC et al., 2005m

Table 3-26. Somalia: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Transitional federal government still being established ***National Coordinating Bodies:*** None reported ***Local Coordinating Bodies:*** Several regional (local) governments are functioning ***National Organizations:*** No national organizations identified ***International Standards:*** No protocol described ***Regional Cooperation:*** No regional coordination activities reported ***Research:*** No research activities reported	• Identify focal point for receiving interim tsunami advisory information using UNESCO-IOC standard form • Establish a National Tsunami Coordination Committee • Develop tsunami warning and mitigation system at the Somalia regional level where regional and district level administration are operations	
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** None ***Seismic Network:*** No seismic observation network ***Sea Level Network:*** No sea level observation network ***Global Telecommunications System:*** No GTS implementation	• Establish a national tsunami warning center • Establish tsunami warning and mitigation systems on a local/regional level first, then replicate to federal level as government becomes more established • Establish mechanism to receive warnings from other centers • Contact Oman and Kenya to obtain waring information for regional and local tsunami events • Install two GLOSS sea level gauges (Mogadishu and Hafoun)	• Inform JMA and PTWC of information for national focal point for receipt of tsunami warnings (UNESCO-IOC) • Training, equipment, and installation of GLOSS sea level gauges (UNESCO-IOC) • Comprehensive GTS systems for the National Meteorological Service to be assessed
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • All local villages have two-way radios that can be used by appointed national authority to disseminate warnings to coastal villages ***Response Procedures:*** • Critical infrastructure and lifeline support facilities have not been inventoried	• Use Mosques and local police to disseminate tsunami warnings • Identify institutional contact for UN-ISDR	• Send experts to assist in the development of tsunami response procedures (UNESCO-IOC)
Tsunami Hazard and Risks • Post-tsunami surveys have been conducted by international agencies and experts in March 2005		• Conduct a combined post tsunami field survey/hazard assessment building on post-tsunami survey conducted in March 2005 (UNESCO-IOC)
Tsunami Public and Community Awareness and Preparedness • No activities conducted related to tsunami public awareness and preparedness	• Translate UNESCO-IOC brochures into Somali language and add tsunami information to school curriculum	• Provide electronic versions of related tsunami brochures and textbooks for translation (UNESCO-IOC)
Enhancement of Disaster Mitigation Capabilities • Transitional federal government relocated to the country in June and now operates from Jowhar 90 km north of Mogadishu – the	• Send delegates at appropriate technical level to UNESCO-IOC/IOTWS meetings	• Substantial assistance required to build oceanographic capacity to support multi-hazard approach

Table 3-26. Somalia: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Capital • Lack of oceanographic and meteorological capacity for multi-hazard approach • Illegal fishing conducted by other countries is an underlying risk factor for disaster mitigation		• Training and infrastructure support required to establish meteorological stations

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-27. Somalia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	--
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	--
	5	Disaster coordination mechanisms at the community level established	--
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	--
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	--
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	--
	61	Response procedures have been tested or exercised	--
	63	Critical infrastructure and lifeline support facilities for disaster response identified	--
	84	Local government disaster preparedness and emergency response assessed	--
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	--
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	--
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	--
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	--
	101	Tsunami education and public outreach programme currently in place	--
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	--

Table 3-27. Somalia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	--
	69	Historical record of past earthquakes and tsunamis documented	--
	71	Tsunami vulnerability assessment conducted	--
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	--
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	--
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	--
	115	Structural mitigation measures established to reduce tsunami impact	--
	116	Non-structural mitigation meas\ures established to reduce tsunami impact	--
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	○
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	○
	19	Back-up or alternative method exists for receiving the warning messages	--
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	--
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	○
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	○
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	○
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	--

Table 3-27. Somalia: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	--
	53	Procedures or criteria exist for determining when it is safe for the public to return	--
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	--
	60	Response procedures for earthquakes in place	--
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	◉

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.14 Sri Lanka

Sri Lanka's coastline stretches over 1,500 km.[49] With a total land area of 64,740 sq km and a population of 20,064,776, Sri Lanka has 36 population centers within 8 km of the coast.[50] Occasional cylones and tornados are the most common natural hazards in Sri Lanka. The only recorded tsunami occurrence prior to December 26, 2004 was after the 1883 Krakatau volcanic eruption and tsunami. The 2004 tsunami event resulted in 31,229 confirmed casualties, 4,093 missing persons, and over one and a half million people homeless.[51] The south and east coasts were the worst affected. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in 2005.[52]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-28 with responses to specific questions provided in Table 3-29. The Disaster Management Bill approved by Parliament in May 2005, outlines a new national disaster management framework for Sri Lanka, coordinated through the National Council for Disaster Management. Organizational structures have been defined and significant progress has been reported.

In addition to national coordination mechanisms, Sri Lanka has operational district level disaster management committees. Sri Lanka operates a seismic network; however, currently, real-time seismic data are only viewable. The Geological Survey and Mines Bureau (GSMB) helps maintain the PALK station that provides real-time seismic data as part of the GSN. Plans are to upgrade its modest network with better sensor and real-time monitoring of local seismicity, including microseismicity that might be a precursor to dam breaches. One GLOSS station located in Columbo was upgraded in January 2005 to provide real-time data adequate for tsunami monitoring and several more stations are planned under the National Aquatic Resources, Research and Development Agency (NARA). The tsunami warning focal point for the receipt and dissemination of warnings is the Department of Meteorology.

[49] http://www.cia.gov/cia/publications/factbook/print/ce.html
[50] www.world-gazetteer.com; population centers with greater than 10,000 people
[51] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[52] UNESCO-IOC et al., 2005n

Tsunami vulnerability studies have not been conducted. Historical inundation data, from the 1883 tsunami event, together with numerical modeling to develop inundation maps are needed to focus local response planning. A number of collaborative research initiatives exist between international scientists and the University of Moratuwa.

Local tsunami emergency plans, evacuation routes, and signage have been developed and tested successfully in model tsunami-prepared villages of Balapitiya and Perilya with plans for similar efforts in Galle reported in November 2005.

Table 3-28. Sri Lanka: National Assessment Summary, May 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Disaster Management Bill No. 13 of 2005 ***National Coordinating Bodies:*** National Early Warning Centre of the Disaster Management Council ***Local Coordinating Bodies:*** District level disaster management committees operational under the chairmanship of each District Secretary ***National Organizations:*** • Department of Meteorology: Reception and issuance of early warnings • Geological Survey and Mines Bureau: Seismological monitoring • National Aquatic Resources, Research and Development Agency: Oceanography • Sri Lanka Navy: Decision-making support, coordination, & information dissemination • National Science Foundation: Research and public awareness ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** No cooperative mechanisms for early warning, assessment or mitigation ***Research:*** Research expertise in tsunami physics and engineering and seismology limited; National Science Foundation promoting research and developing in disaster mitigation and management through the Committee on Science and Technology Initiatives for Disaster Mitigation and Management	• Assess technical capacities of relevant institutions for early warning system • Improvement of technical capacity of such institutions for early warning • Assist relevant institutions create awareness at all levels with the government and public down to the community levels	• Build capacity of relevant institutions in vulnerability analyses and development of inundation maps through the use of numerical modeling. • Assistance to relevant institutions in creating public awareness at all levels through community workshops, posters, and leaflets • Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • National Tsunami Early Warning Centre is operational at the Department of Meteorology which is responsible for receiving warnings from JMA and PTWC • International tsunami warnings received by fax and email at the Department of Meteorology operated 24/7 • Confirmation that a tsunami has occurred is reported by the Department of Meteorology and GSMB ***Seismic Network:*** Regional seismicity monitored in real-time as joint research project of the GSMB and UCSD; however data are only viewable; GSMB not equipped for real time data	• Establish a permanent National Tsunami Warning Center • Provide for redundancy in incoming and outgoing telecommunication channels through increased capacity of commercial network or installation of dedicated emergency communications networks • Study need for installation of cabled ocean bottom pressure sensors on Sri Lanka continental shelf (width = 20 nm) due to high anticipated cost • Establish a national seismic network capable of monitoring levels of local seismicity • Provide seismic data to the FDSN in a standardized format and in real-time if possible	• Provide assistance to establish tsunami monitoring capability including real-time regional and local seismic and sea level data acquisition, display and analysis • Conduct feasibility study on improving tsunami warning time through installation of ocean bottom pressure sensors on continental shelf (20 nm width) or seal level stations on eastern coast closest to Sumatra • Provide capability for warning center to receive local sea level data streams in real-time and continuously

Table 3-28. Sri Lanka: National Assessment Summary, May 2005

Status	National Actions	Support Requirements
recording and analysis ***Sea Level Network:*** • Real-time seal level transmission capability to resolve short-wavelength tsunami to PTWC/JMA but not locally at NARA or to early warning center in Colombo • One permanent GLOSS sea level stations established at Colombo (western coast) in 2004 with assistance from University of Hawaii Sea Level Center (UHSLC) and upgraded in 2005 to increase transmission frequency and sampling adequate for tsunami monitoring with two more stations to be established at Krinda (southern coast) and Trincomalee (eastern coast) by the end of 2005 with assistance from the Federal Maritime & Hydrographic Agency, Germany (FMHA) and the UHSLC ***Global Telecommunications System:*** • Limited capability with no message switching system. • GTS connection to RTH New Delhi at very low speed (50 baud link) • Internet link via 64 kbps leased line not available for operational data • Current GTS satellite based components out of operation	• Install a TREMOR system using the PALK station to enable it as a single station dedicated to tsunami warning system • Expand and enhance the national sea level network through the installation of additional real time sea level stations to monitor tsunami wave progress around the island • Establish a government-academic partnership to maintain and run the sea level network • Acquire all GLOSS sea level network data available via the GTS and implement an automatic data acquisition, reduction, and display system at the national warning center which can view and measure any tsunami wave heights or other sea levels • Establish eyewitness observers of the wave's arrival and impact to supplement instrumentally-based early warning system • INSAT/DMDD provided by IMD and likely to be upgraded late 2005 • Improve GTS link to RTH New Delhi via 64 kbps leased link • Upgrade to 64 kbps link between NMC Colombo and International airport	• Assistance to install a TREMOR system • Implementation of a message switching system with specifications compliant with WMO recommendations and guidelines, including WAN & LAN connectivity and WMO standard TCP/IP security guidelines • ICT training and capacity building • Selected spare parts for GTS key critical systems • Recurrent costs for hardware and software GTS maintenance for a period of 5 years • Long term GTS sustainability plan;
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • National Early Warning Centre in consultation with members of its technical committee and the Disaster Management Centre issues public evacuation advisories • Decision to evaluate based on tsunami advisory received from PTWC or JMA indicating possibility of a tsunami • Warning information disseminated by: telephone to TV and radio stations; by HF radio through the policy communication system; by telephone and fax to District Secretaries; and through the military telecommunication network activated through the Joint Operations Headquarters • Marine warning system in place through Sri Lanka Navy under International Sea Port and Security Code for major harbors; fishery harbors covered by Ministry of Fisheries • Assessment of existing disaster management system and capacity building needs detailed in national proposal	• Empower the DMC or its equivalent to coordinate all disaster risk reduction activities with other organizations • Expand the financial and human resource capacity of the DMC for all aspects of disaster risk reduction and preparedness • Develop disaster risk management plans that include designation of high risk areas, evacuation routes, communication and information dissemination system and involve central and local governments and municipalities • Provide for redundancy in receiving warning from PTWC/JMA (e.g. satellite broadcast, upgrading 50 bps line) and disseminating warnings by adding other communication methods (VHF radio) • Upgrade land-line between Delhi and colomo for time receipt of tsunami warning messages from PTWC and JMA • Request implementation of satellite GTS broadcasts of warning message from Indians Ocean countries • Consider joining the Global Maritime Distress and Safety System (GMDSS) for access to IMO's integrated	• Provide assistance in *TsunamiReady* program as guidance for specifying model village standards

Table 3-28. Sri Lanka: National Assessment Summary, May 2005

Status	National Actions	Support Requirements
Response Procedures: • Local tsunami emergency plans, evacuation plans, signage developed and tested successfully in one model village. A similar programme is presently in progress at Galle city. • Critical infrastructure and lifeline support facilities have not been inventoried • Post disaster surveys are carried out to identify and assess damage and run-up/inundation carried out by Ministry of Social Services (for non-tsunami disasters) and by research institutes, universities, and various professional bodies (after tsunamis)	communications system and provision of Maritime Safety Information on a global basis at sea • Use real-time sea level data to monitor and decide when tsunami threat is over and it is safe for responders or public to return in conjunction with information received by PTWC and JMA • Develop detailed comprehensive tsunami response procedures for local, regional, and distant tsunamis • Conduct study to determine minimal time required to ensure complete evacuation of inundation zones to safe zones • Develop guidelines and criteria to permit police or other first responders to judge whether it is safe for citizens to return to their homes • Expand and institutionalize the Tsunami Ready Model Village as a national programme in partnership with civil society organizations such as the national and local Red Cross and using the U.S. *TsunamiReady* program as guidance for specifying model village standards • Prepare inventory of hospital, ports and marine facilities, land transportation, energy utilities, telecommunications and other critical infrastructure • Avoid building future critical infrastructure in tsunami evacuation zones	
Tsunami Hazard and Risks • No historical records of past earthquakes or tsunami events prior to December 26, 2004 • No hazard or vulnerability studies conducted prior to December 26, 2004 • Preliminary deepwater numerical modeling carried out by international researchers up to 10 m contour depts. Based on December 26, 2004 tsunami seismic source • GIS not currently used as decision support tool during emergency response however, National Disaster Management Center of the Ministry of Social Services planning to develop GIS-based system • Post-tsunami surveys have been conducted by national and international agencies and experts	• Collect historical inundation and run-up data from Krakatoa event for the development of evacuation maps for coastal communities • Compile national standardized database of all post-tsunami field surveys • Document historical local seismicity • Conduct tsunami vulnerability study • Implement numerical models to calculate expected tsunami arrival times, tsunami wave inundation, and wave height	• Provide training and modeling software for tsunami hazard and vulnerability studies • Facilitate cooperative study on numerical simulation studies and planning for emergency response (ITIC)
Tsunami Public and Community Awareness and Preparedness • No formally organized community response system	• Institutionalize the Tsunami-prepared model village programme working with the Red Cross/Red Crescent societies as a partner and modifying criteria and concepts	• Awareness, education, and preparedness materials in electronic formats for duplication, translation, and distribution (UNESCO-IOC,

Table 3-28. Sri Lanka: National Assessment Summary, May 2005

Status	National Actions	Support Requirements
established for tsunamis • No systematic educational programmes on tsunamis for general public or communities • Community-based organizations (schools, religious organizations) serve as early warning mechanisms for disasters • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Emergency plans, evacuation plans, signage developed and tested successfully in only one model village	from the U.S. *TsunamiReady* Program • Assess safety and preparedness of religious buildings for shelter and use of loudspeakers and bells for relaying warnings to the population • Incorporate tsunami hazard and general disaster preparedness in school curriculum at all levels • Use existing tsunami awareness museums as models for developing displays and other types of exhibits • Map new areas of flooding resulting from the Indian Ocean tsunami and consider non-structural mitigation measures such as sea walls, vegetative barriers, and relocation of roads or facilities	ITIC) • Tsunami textbooks in electronic format for translation into Sinhala and Tamil (UNESCO-IOC) • Examples of activities targeting tourists and tourism industry (UNESCO-IOC) • Information on tsunami evacuation guidance for coastal communications, including recent engineering studies and guidance on vertical evacuation (UNESCO-IOC) • Information on tsunami evacuation guidance from marine vessels and other recreational or fishing boats (UNESCO-IOC) • Educational materials for promoting disaster reduction awareness translated material in Sinahala and Tamil (UNESCO-IOC) • Examples of tsunami emergency response plans and preparedness activities for medication and use by NDMC (UNESCO-IOC)
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework established by the recent passage of the Disaster Management Act	•	• Assistance in the development of tsunami warning and mitigation system in core system implementation, integrated risk management, public awareness and education, community-level approaches, and coordination (UN-ISDR, UNESCO-IOC, WMO, UNDP, OCHA, UNEP, UNESCAP, UNU, UNV, ITU, IFRC, ADRC, ADPC, and DIPECHO)

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-29. Sri Lanka: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	○
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	◉
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	◉
	61	Response procedures have been tested or exercised	◉
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	○
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	◉
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	○
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	○
	101	Tsunami education and public outreach programme currently in place	--
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	--
	106	Training programmes for the media on other hazards and their vulnerability current exist	--

Table 3-29. Sri Lanka: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	○
	69	Historical record of past earthquakes and tsunamis documented	○
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	◉
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	○
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	○
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	◉
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	◉
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	●
	39	Sea level data sampling sufficient to measure short period tsunami	●
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-29. Sri Lanka: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.15 Tanzania

Source: http://www.cia.gov/cia/publications/factbook

Tanzania has a coastline that stretches over 1,400 km of the Indian Ocean.[53]. With a total land area of 886,037 sq km and a population of 36,766,356, Tanzania has 34 population centers within 8 km of the coast.[54] Earthquakes, flooding, and drought are natural hazards experienced by Tanzania. Tanzania is seismically active and earthquakes recorded occur along the East African Rift system ranging up to a magnitude of 7.2 on the Richter scale have been recorded. Earthquakes have caused considerable damages and casualties in some cases. The December 26, 2004 tsunami event resulted in 10 casualties and an unknown number of missing persons.[55] An oil pipeline was damaged by an oil tanker that ran aground in Dar es Salaam harbor. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in June 2005.[56]

An overall summary of the assessment results are provided in Table 3-30 with responses to specific questions provided in Table 3-31. The Disaster Management Department, established in 2000, is responsible for coordination, preparedness, and response to disasters. The Tanzania Meteorological Agency is mandated to provide science-based warnings for natural disasters. National coordination for disasters is achieved through the Tanzania Disaster Relief Coordination Committee and coordination mechanisms also occur at the local level. Regional and local seismicity is monitored as part of the East and Southern Africa Regional Seismology Working Group; however, data are not available in real-time. Tanzania's sea level network consists of two operational stations that are part of the GLOSS network but need to be upgraded to adequately monitor tsunami events. Historical records of past tsunami events do not exist. Community level preparedness is limited and emergency plans, evacuation plans, or response procedures have yet to be developed.

[53] http://www.cia.gov/cia/publications/factbook/print/tz.html
[54] www.world-gazetteer.com; population centers with greater than 10,000 people
[55] http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake
[56] UNESCO-IOC et al., 2005o

Table 3-30. Tanzania: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Act No. 6 of 1978 gives Tanzania Meteorological Agency (TMA) mandate to provide science-based warnings for natural disasters. Act No. 9 of 1990 gives power to Disaster Management Department to have "safe livelihood with minimum disaster interruptions to social and economic development issues". ***National Coordinating Bodies:*** Tanzania Disaster Relief Coordination Committee (TANDREC) is responsible for all disasters including tsunamis ***Local Coordinating Bodies:*** Similar coordination does exists on the village level ***National Organizations:*** • Disaster Management Department (DMD); coordination • TMA; monitoring and dissemination of information • Academic Research Institutions; relevant scientific research, monitoring • Local Government; dissemination of warnings to public, implementation of evacuation plans • Media; communication of warnings ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** No cooperative mechanisms for early warning, assessment or mitigation ***Research:*** Government sponsored seismic research is on-going		• Assistance to harmonize existing standards and protocols in data collection, evaluation and warning communication to achieve international standards • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • International tsunami warnings received by fax and email at TMA operated 24/7; GTS is not functional (see below) • No local confirmation that a tsunami has occurred has been coordinated ***Seismic Network:*** Regional and local seismicity monitored as part of the East and Southern Africa Regional Seismology Working Group; however, data not available in real-time. Should be available in 2 years. ***Environmental Satellite System Use:*** Tanzania Meteorological Agency has a METEOSAT Second Generation satellite receiver used for reception and use of various data and products ***Sea Level Network:*** • Tanzania sea level network consists of two stations at	• Establish National Tsunami Warning Center with specific operational requirements • implement a 3 component broad-band seismic station close to Dar es Salaam (less than 50 km) and send the data to the national tsunami warning center (radio-modem); • implement automatic seismic processing software (single station like TREMORS system) with automatic alerting • Conduct post-tsunami field survey of region affected by 26 December 2004 event • Establish direct operational link between Tanzania Meteorological Agency and the Disaster Management Department • Install 8 VSAT systems to collect and provide	• Investigate why advisory information not received by the Tanzania Meterological Agency through GTS (WMO) • Provide assistance to establish tsunami monitoring capability and analysis including real-time regional and local seismic and sea level data acquisition, display and analysis • Install one-station tsunami monitoring system and seismic station with broad-band such as TREMORs for independent monitoring of earthquake location and magnitude • Provide capability for interim warning center to receive local sea level data streams in real-time and continuously and be connected to GLOSS network

Table 3-30. Tanzania: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Zanzibar and Dar es Salaam Zanzibar station as a satellite transmitting station. Not known if it transmits in real-time. Dar es Salaam is a mechanical float gauge. • Four other stations are non-operational. ***Event Monitoring and Surveys:*** • No post disaster surveys have been carried out to identify and assess damage and run-up/inundation ***Global Telecommunications System:*** • Existing message switch at NMC Dar Es Salaam is old with equipment becoming unreliable • Software version is old and not supported • Connection to RTH Nairobi via medium speed (9.6 kbps) link which is unreliable and prone to failure • A number of issues related to equipment failure and software licenses due to move of systems from the Airport; satellite access to GTS data is limited • Internet connection is slow (32 kbits/s) and limited • EUMETCAST receiving system	meteorological data. Recommended stations include Pemba, Tanga, Kilwa or Mutwara. • Upgrade connection between NMC and airport.	• Upgrade environmental satellite system for Polar Orbiting satellites • Assistance in developing hazard monitoring applications using environmental satellite data • Assist with implementation of national actions as identified by country • Replacement of GTS link between Dar-Es-Salaam and Nairobi by a 64 kbps VSAT link. • Implementation at NMC of a new message switching system with specifications compliant with WMO recommendations and guidelines, including WAN & LAN connectivity and WMO standard TCP/IP security guidelines (To be provided by France) • ICT training and capacity building • Selected spare parts for GTS key critical systems • Long term GTS sustainability plan • RETIM-Africa receiving system or equivalent (To be provided by France) • Visualization workstation (Synergie or equivalent) (To be provided by France) • Recurrent costs for hardware and software for GTS maintenance for a period of 5 years; • Implement in coastal provincial centers Zanzibar and Pemba of RETIM-Africa receiving system and Visualization workstation (Synergie or equivalent).
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • No procedures currently set up to disseminate a tsunami warning • Marine forecasts and warnings prepared; however, no specific mechanism for disseminating marine warnings except public media • Assessment of existing disaster management system and capacity building needs was done some years ago ***Response Procedures:*** • Local tsunami emergency plans, evacuation plans, signage have not been developed	• Designate an agency for receiving and acting upon tsunami advisory messages received from the interim national tsunami warning center • Update assessment of existing disaster management system and incorporate capacity building needs for tsunami warning and mitigation system within a multi-hazard framework • Develop detailed procedures for responding to both distant and local tsunamis • Develop access to INMARSAT • Conduct more studies to assess local tsunami hazards	• Assistance to enhance dissemination mechanisms for marine warnings • Assist with implementation of national actions as identified by country

Table 3-30. Tanzania: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
• Critical infrastructure and lifeline support facilities have not been inventoried	• Implement response procedure drills as part of public awareness/education • Prepare inventory of hospital, ports and marine facilities, land transportation, energy utilities, telecommunications and other critical infrastructure • Identify local reporting contacts that can receive tsunami warnings from PTWC and JMA • Conduct post-tsunami field surveys in areas affected by 26 December 2004 tsunami	
Tsunami Hazard and Risks • No historical records of past tsunami events prior to December 26, 2004 • Historical records of past earthquake events prior to December 26, 2004 exists • No tsunami hazard or vulnerability studies conducted prior or post to December 26, 2004 event • No numerical modeling has been carried out • GIS not currently used as decision support tool during emergency response	• Undertake tsunami vulnerability studies using GIS • Improve high resolution bathymetric and topographic maps • Conduct numerical modeling studies to calculate inundation from tsunamis	• Provide training and modeling software for tsunami hazard and vulnerability studies and modeling • Assist with implementation of national actions as identified by country
Tsunami Public and Community Awareness and Preparedness • No assessment available of local government preparedness and emergency response • Plans for public outreach and education on tsunamis and other hazards for general public or communities • Community-based organizations (schools, religious organizations) are not being utilized by local governments • Structural and non-structural tsunami mitigation measures have not been developed or implemented • Emergency plans, evacuation plans, signage has not been developed	• Develop capacities at sub-national levels to enhance community participation in disaster risk reduction and mitigation activities • Develop capacities of nongovernmental and community based organizations to play a role in the receipt and delivery of multi-hazard early warnings and community preparedness • Include all natural hazards and their preparedness and response in all national educational curriculum • Develop comprehensive plan of action to promote disaster awareness and preparedness at the community level with the national tsunami warning and mitigation system as a core element • Organize recurrent public events to commemorate past natural disaster and promote awareness and preparedness • Implement non-structural tsunami mitigation measures including mangrove replanting and adjustment of land use policies based on tsunami hazard inundation maps • Prepare evacuation plans, maps, routes and signage	• UNESCO-IOC: provide electronic (multi-layered) versions of existing teaching, informational, and outreach materials on tsunamis and other disasters including: brochures, video, and posters for translation • Educational modules and regional training activities on public outreach and education for the early warning system process • Assist with implementation of national actions as identified by country

Table 3-30. Tanzania: National Assessment Summary, June 2005

Status	National Actions	Support Requirements
Enhancement of Disaster Mitigation Capabilities • Tsunami warning system capabilities are being developed within a multi-hazard framework • Multi-hazard approach strongly supported		• Multi-hazard approach to be used in the development of early warning systems • Assist with implementation of national actions as identified by country

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donors identified by the visiting expert teams*

Table 3-31. Tanzania: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	○
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	◉
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	○
	61	Response procedures have been tested or exercised	○
	63	Critical infrastructure and lifeline support facilities for disaster response identified	○
	84	Local government disaster preparedness and emergency response assessed	○
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	○
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	◉
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	○
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	○
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	--
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	○
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-31. Tanzania: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	●
	71	Tsunami vulnerability assessment conducted	○
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	○
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	○
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	○
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	●
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	○
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	○
	31	Real time seismic data provided	◉
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	○
	45	Designated agency receiving tsunami warning issues public evacuations	○

Table 3-31. Tanzania: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	○
	53	Procedures or criteria exist for determining when it is safe for the public to return	○
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	--
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	--
	59	Response procedures for regional- or locally-generated tsunami in place	○
	60	Response procedures for earthquakes in place	○
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	○
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	○

Notes:
○ = No
◉ = Partial Yes
● = Yes
-- = Not Available

3.16 Thailand

Thailand's 3,219 km of coastline borders the Andaman Sea on the west and Gulf of Thailand on the east.[57] The December 26, 2004 tsunami approached the Andaman coast of Thailand at Phuket, Pang-nga, Krabi, Trang, Satoon, and Ranong causing 5,396 casualties of Thais and foreign tourists. As an immediate response to this tragedy, Thailand formed the Committee on Study of the Disaster Early Warning System on 11 January 2005. This section provides a summary of the tsunami warning and mitigation system assessment conducted by expert teams in August 2005.[58]

Source: http://www.cia.gov/cia/publications/factbook

An overall summary of the assessment results are provided in Table 3-32 with responses to specific questions provided in Table 3-33. Thailand is rapidly enhancing its capacity in all aspects of an end-to-end tsunami early warning system. The National Disaster Warning Center (NDWC) was officially established on May 30, 2005 following the Order issued by the Office of the Prime Minister, No. 16.B.E. 2548, appointing a committee to study the disaster early warning center in January 2005. The NDWC receives international tsunami advisory information and is responsible for disseminating the public safety action.

The Meteorological Department (TMD) is providing information on seismicity directly to NDWC where NDWC will analyze information and provide early warning as determined by their standard operating procedures. Close collaboration exists between TMD and NDWC. At a later date, seismic center and earthquake stations will be separated from TMD and become a technical body of the Mineral Resources Department under the Ministry of Natural Resources and Environment (MONRE) called the Office of Earthquake under MONRE and linked to NDWC. Asian Disaster Preparedness Center (ADPC), based in Thailand, plans to upgrade seismic and sea level stations throughout the region and share data in real time. In September 2005, NDWC signed a Memorandum of Understanding (MOU) with ADPC clarifying roles for seismic and sea level monitoring of regional and local seismicity.

[57] http://www.cia.gov/cia/publications/factbook/print/th.html
[58] UNESCO-IOC et al., 2005p

The NDWC has developed written standard operating procedures which describe the action criteria, agency responsibilities, contact information, and emergency response actions that will be taken when a tsunami alarm occurs. Warning dissemination mechanisms include TV, radio, and sirens. Tsunami hazards and risks have been evaluated including post-tsunami surveys and inundation modeling for six coastal provinces. Community-level education and outreach programmes have been established to include natural hazards and now will integrate tsunamis.

Tsunami evacuation maps and signage have been produced and installed in Phuket, Phang Nga, and Karabi. In Phuket, sirens have been installed atop tall towers to give the public assurance that tsunami alerts will be widely broadcast and tsunami evacuation drills have been carried out. Structural and non-structural mitigation measures have been limited to relocation of some communities and businesses.

Table 3-32. Thailand: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Authority and Coordination ***Legal Authority:*** Legal authority under Order of the Office of Prime Minister No. 16/2548 (2005); Order of the Committee on Study of the Disaster Early Warning System No. 4/B.E. 2548 (2005); Civil Disaster Prevention Acts .E. 2522 (1979), and National Plan for Civil Disaster Prevention B.E. 2548 (2005) ***National Coordinating Bodies:*** Committee on the Study of the Disaster Early Warning System and Sub-Committee on the National Disaster Warning Center Administration ***Local Coordinating Bodies:*** Local coordination at the Department of Provincial Administration, Ministry of Interior ***National Organizations:*** National Disaster Warning Center (NDWC) Department of Mineral Resources Hydrographic Department of the Royal Thai Navy Meteorological Department (TMD) Department of Disaster Prevention and Mitigation ***International Standards:*** Protocols do not meet international standards ***Regional Cooperation:*** Regional cooperation with JMA and PTWC to receive tsunami watch information; coordination with Indonesia, Malaysia, and Sri Lanka Asian Disaster Preparedness Center (ADPC), based in Thailand, plans to upgrade seismic and sea level stations throughout the region and share data in real-time NDWC and ADPC roles clarified in September 2005 Memorandum of Understanding (MOU) ***Research:*** Research expertise in inland earthquakes and tectonic movement; earthquake database, simulation, modeling, and impacts; mapping tsunami inundation areas and impacts on coral reef and other coastal areas	• Need for the appointment of a longer-term leadership structure (technical and administrative) • Preparation of a detailed written description of the present and future roles and responsibilities of the NDWC. In addition, there is a need for a clear description of the linkages with all relevant national organizations	• Assistance to harmonize existing standards and protocols in data collection, evaluation, and warning communication with those utilized by the global system to ensure interoperability • Assist with implementation of national actions as identified by country
Tsunami Warnings and Monitoring ***National Tsunami Warning Center:*** • NDWC established • Tsunami warnings received from PTWC and JMA by GTS, fax and email, and from the TMD • NDWC receives earthquake and sea level information from national organizations with TMD responsible for seismic evaluations ***Seismic Network:*** Regional seismicity monitored by not in real-time; local seismicity monitored in 16 provinces in near real-time	• Upgrade and enhance seismic and sea-level stations in coordination with the activities of WG-I and II (Seismic network and Sea-Level network, respectively) of the ICG/IOTWS • Develop clear roles and responsibilities of NDWC and the relevant contributing national and international organizations, including the ADPC. Thailand's warning system should take advantage of existing experience, expertise, and infrastructure whenever possible to avoid unnecessary duplication of primary services	• Develop technical expertise and upgrade environmental satellite systems and related applications • Assist with implementation of national actions as identified by country

Table 3-32. Thailand: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
Environmental Satellite System Use: Meteorological satellite data used for weather applications ***Sea Level Network:*** • 4 tide gauges currently operated in near-real time by the Hydrographic Department of the Royal Thai Navy ***Global Telecommunications System:*** GTS fully operational to the TMD, but not connected to the NDWC	• Connect NDWC to the GTS • Amend notification systems to the public and protocols for delivering warning based on the results of drills. The protocols should have clear lines of command to avoid confusion and the waste of time in critical situations • Implement new upgraded message switching system at RTH Bangkok (2006); • Further upgrade of GTS links to Singapore, New Delhi (2005-2006), Beijing, Jeddah; • Implement GTS links to Myanmar and Cambodia when countries are ready.	
Tsunami Warning Response and Emergency Preparedness ***Warning Dissemination:*** • Standard Operating Procedures (SOP) exist with criteria for action, agencies involved, actions taken, and contact information • Department of Disaster Prevention and Mitigation, Department of Provincial Administration are designated to receive and act on tsunami advisory message from the NDWC Both have the authority to issue evacuation orders • Decision to evacuate based on monitoring undersea earthquakes with magnitude greater than 7.0 on the Richter scale and monitoring sea level • Marine warnings are prepared for weather and sea conditions with limited distribution, but not for tsunamis • Warning information disseminated by: TV, radio, and sirens • Disaster management system assessment has been done. ***Response Procedures:*** • Emergency plans, tsunami evacuation plans, and signage developed • Critical infrastructure and lifeline support facilities has been identified through Department of Provincial Administration • Local drills have been carried out	• Continue to evaluate and improve upon the SOP based on the results of drills. Protocols should have clear lines of command to avoid confusion and waste of time during critical situations	• Upgrade dissemination mechanisms for marine warnings especially for users at sea for tsunamis • Assist with implementation of national actions as identified by country
Tsunami Hazard and Risks • Good historical records of past earthquakes but not for tsunami events prior to December 26, 2004 • Hazard or vulnerability studies conducted prior to December 26, 2004 • Numerical modeling done for 6 coastal provinces • GIS is currently used as decision support tool during emergency response	• Undertake tsunami inundation modeling • Collect bathymetric and topographic data	• Technical assistance is needed for: digital elevation maps, bathymetric cartography, GIS training, numerical modeling of inundation, and the production of hazards and vulnerability maps. • Technical assistance is requested for geological studies of previous tsunamis

Table 3-32. Thailand: National Assessment Summary, August 2005

Status	National Actions	Support Requirements
response • Post-tsunami surveys have been conducted by national experts on coral reefs, non-structural mitigation measures, health of coastal communities		• Training and technical assistance for post tsunami surveys and documentation of structural and non-structural damages from tsunamis and earthquakes • Assist with implementation of national actions as identified by country
Tsunami Public and Community Awareness and Preparedness • Community-level awareness and preparedness programmes have been established for natural hazards • Community-based organizations (schools, religious organizations) serve as early warning mechanisms for disasters • No tsunami-related education and public outreach programme but planned for future along with other hazards • Provincial Administration is looking at structural mitigation in impact areas • Non-structural tsunami mitigation measures include relocation of communities and local entrepreneurs • Tsunami evacuation maps, evacuation routes, and signage have been developed and installed in Phuket, Phang Nga, and Karabi	• Identify a central body to coordinate the activities of all organizations that play a role in disaster reduction, in agreement with the Hyogo Framework of Action • Evaluate the outcomes of tsunami drills (i.e. evacuation of more vulnerable populations, time required for evacuation, etc.). • Conduct evacuation drills regularly at schools, hospitals and other public facilities. • Reproduce public awareness materials for tsunami (prepared by Ministry of Natural Resources) for wider dissemination. • Investment is required for building a tsunami memorial /museum in Phang Nga • Consider developing a plan for structural and non-structural mitigation measures such as conservation/plantation of mangroves, construction of sea walls and evacuation shelters/mounds should be considered • Develop a tsunami education and public outreach programme	• Educational modules and regional training activities on public outreach and education for the early warning system process • Development of educational modules and materials and conducting training activities to strengthen linkages with key organizations involved in the early warning process • Assist with implementation of national actions as identified by country
Enhancement of Disaster Mitigation Capabilities Tsunami warning system capabilities are being developed within a multi-hazard framework Multi-hazard approach strongly supported		• Multi-hazard approach to be used in the development of early warning systems • Assist with implementation of national actions as identified by country

Status: *based on responses in national assessment questionnaire provided by the country*
National Actions: *actions for implementation by the country recommended by the visiting expert teams*
Support Requirements: *assistance needed from donor identified by the visiting expert teams*

Table 3-33. Thailand: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Preparedness (Coordination, Planning, Training, Exercises, Education, and Outreach)	3	National Platform or other mechanism in place for guiding disaster risk reduction in general	●
	4	National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism established	●
	5	Disaster coordination mechanisms at the community level established	●
	13	Cooperation exists with neighboring country to evaluate earthquakes and monitor tsunamis in real-time, or for tsunami warning services, or other mitigation activities	●
	47	Existing disaster management system assessed to identify requirements of individuals and institutions for training and capacity building	●
	50	Tsunami emergency plans, tsunami evacuation plans and/or signage exist showing evacuation routes to safety or higher ground	●
	61	Response procedures have been tested or exercised	●
	63	Critical infrastructure and lifeline support facilities for disaster response identified	●
	84	Local government disaster preparedness and emergency response assessed	●
	86	Community and ordinary citizen disaster preparedness and emergency response assessed	●
	87	Public is aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis	●
	88	Community-level education and preparedness programmes for national hazards or tsunamis exist	●
	98	Non-government or community-based organizations play a role in the early warning preparedness and community outreach and education to people at the local level	●
	101	Tsunami education and public outreach programme currently in place	○
	103	Other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, are covered in the programme plan	●
	105	Training programmes for the media on tsunami hazards, mitigation, warning, and preparedness currently exist	●
	106	Training programmes for the media on other hazards and their vulnerability current exist	●

Table 3-33. Thailand: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
Assessment (Hazard Identification, Risk Assessment, Mitigation Implementation, and Effectiveness)	15	Active research ongoing in seismology or tsunamis	●
	69	Historical record of past earthquakes and tsunamis documented	◉
	71	Tsunami vulnerability assessment conducted	●
	73	Numerical modeling studies conducted to calculate inundation from tsunamis	●
	92	Local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities	●
	94	Local risk assessments conducted to incorporate traditional/community knowledge of multi-hazard response	●
	115	Structural mitigation measures established to reduce tsunami impact	○
	116	Non-structural mitigation measures established to reduce tsunami impact	●
Warning (Detection, Evaluation, Dissemination, and Emergency Action)	2	Legal framework in place for disaster warning formulation, dissemination, and response	●
	17	International tsunami warnings received for teletsunamis from the Pacific Tsunami Warning Center and / or from the Japan Meteorological Agency	●
	19	Back-up or alternative method exists for receiving the warning messages	●
	20	Agency receiving warnings staffed 24-hours-a-day, 7-days-a-week service	●
	22	National or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunami currently in operation	●
	28	Seismographic stations or networks to monitor regional seismicity	●
	30	Real-time seismic data received	○
	31	Real time seismic data provided	○
	32	Seismographic stations or networks to monitor local seismicity	●
	37	Sea level stations (coastal or deep-ocean instruments) monitor sea level.	●
	38	Sea level data available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS	○
	39	Sea level data sampling sufficient to measure short period tsunami	○
	44	Agency receiving tsunami warning designated by law	●
	45	Designated agency receiving tsunami warning issues public evacuations	●

Table 3-33. Thailand: Preparedness, Assessment, and Warning Capacity

	Question No.	Related Questions	Status
	51	Marine warnings issued for marine vessels, harbors and ports	●
	53	Procedures or criteria exist for determining when it is safe for the public to return	●
	54	National Meteorological and Hydrographical Service (NMHS) has a mechanism for warning mariners	◉
	55	NMHS issue marine forecasts and warnings to mariners and coastal zone users in their region	●
	59	Response procedures for regional- or locally-generated tsunami in place	●
	60	Response procedures for earthquakes in place	●
	65	Post-event data surveys to assess damage and collect tsunami run-up/inundation data conducted	●
	95	Non-government, people-centered, community-based organizations play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level	●

Notes:
○ = No
◉ = Partial Yes
● = Yes

4.0 Regional Capacity Building Needs and Status

Support requirements to build regional capacity in tsunami warning and mitigation systems were identified by national experts in each country together with international experts as part of the national assessment. Specific support requirements for each country were summarized in Section 3.0. This section provides an overview of common support requirements for countries in the Indian Ocean region.

Common support requirements are summarized on Table 4-1. The most commonly identified support requirements identified by most countries in the region include:

- Assistance to harmonize existing practices and protocols in data collection, monitoring, evaluation, and warning communication to achieve international standards and interoperability of tsunami early warning systems in the region
- Assistance to establish real-time regional and local seismic and sea level networks with real-time data acquisition, display, and analysis to support the monitoring and detection of tsunami hazards
- Equipment upgrade and capacity building in Global Telecommunication System (GTS) to upgrade communications lines and capacities to National Meteorological Services responsible for the receipt and issuance of tsunami warnings and enable them to disseminate warnings more effectively to the designated stakeholder and authorities.
- Training and software for numerical modeling to support the development of inundation maps and for evaluation of tsunami hazards and vulnerability
- Educational modules on multi-hazards and their impacts including tsunami targeted at various stakeholders (trainers of risk managers, schools) including school curriculum on the tsunami and other hazards early warning system process
- Regional training activities on overall multi-hazards early warning system process to strengthen linkages between key organizations, including media, technical agencies, and risk managers
- Need for equipment upgrades and capacity building related to utilization of satellite information for multi-hazard early warning systems including tsunami

Other common support requirements identified by three to five countries in the region include:

- Upgrade dissemination mechanisms for marine warnings
- Assistance to strengthen GIS capabilities and applications to disaster management to aid in planning and preparedness, event emergency response, and post-disaster recovery to aid in planning and preparedness, event emergency response, and pots-disaster recovery
- Electronic versions of existing materials on tsunamis and other disasters that can be adapted, translated and disseminated

The national assessment missions provided an opportunity to define the components and implementation actions of tsunami early warning and mitigation systems and to identify related capacity building opportunities. Table 4-2 provides a summary of the types of guidance documents and capacity building activities that could catalyze national actions.

Table 4-1. Support Requirements for Building Tsunami Warning and Mitigation System Capacity in the Indian Ocean Region

Support Requirement	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
Authority and Coordination																
Assistance to harmonize existing practices and protocols in data collection, evaluation and communication to achieve international standards for tsunami monitoring and the dissemination of warnings	●	●	●	●	●		●	●	●	●	●	●		●	●	●
Tsunami Warning and Monitoring																
Training in operational aspects of tsunami warning center			●		●			●								
Assistance to establish real-time regional and local seismic data acquisition, display and analysis	●		●					●	●	●	●	●		●	●	
Assistance to establish real-time regional and local sea level data acquisition, display, and analysis	●		●	●	●	●	●	●	●	●	●	●	●	●	●	
Training, equipment, and installation of GLOSS sea level gauges					●	●				●			●		●	
Training, equipment, and installation of TREMOR system												●		●	●	
Upgrade/develop environmental satellite systems and related applications and technical expertise		●					●				●				●	●
GIS system support and applications									●			●				
Equipment upgrade and capacity building assistance for upgrading Global Telecommunication System (GTS)	●	●	●	●			●		●		●	●	●	●	●	
Long-term GTS sustainability assistance	●			●					●		●			●	●	
Provide technical expertise and upgrade environmental satellite systems and related applications		●	●				●				●				●	●

Table 4-1. Support Requirements for Building Tsunami Warning and Mitigation System Capacity in the Indian Ocean Region

Support Requirement	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
Tsunami Response and Emergency Preparedness																
Assistance to assess disaster management system and critical infrastructure		●					●				●					
Guidelines on conducting post-event surveys							●									
Upgrade dissemination mechanisms for marine warnings and assistance to integrate marine warning procedures for tsunamis					●	●					●				●	●
Assistance to develop tsunami response plans, exercises and drills to test preparedness			●					●					●			
Assistance to develop robust tsunami warnings dissemination mechanisms from national to local levels	●	●	●	●	●		●	●		●	●	●	●	●	●	
Tsunami Hazard and Risk																
Training and software for numerical modeling to develop inundation maps and evaluate tsunami hazards and vulnerability	●	●	●	●	●	●	●	●	●		●	●		●	●	●
Assistance to strengthen GIS capabilities and applications in disaster management		●	●						●		●					●
Guidelines on bathymetric and topographic requirements and other data inputs for tsunami inundation mapping			●				●		●							●
Tsunami and Other Hazards Public Awareness and Preparedness and Community Level Activities																
Educational modules and school curriculum for public outreach and education on tsunami early warning system process	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Regional training activities on early warning system process to strengthen linkages between key organizations including media, technical agencies, and risk managers	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Table 4-1. Support Requirements for Building Tsunami Warning and Mitigation System Capacity in the Indian Ocean Region

Support Requirement	BAN	COM	IND	KEN	MAD	MAL	MAU	MOZ	MYA	OMA	PAK	SEY	SOM	SRI	TAN	THA
Electronic versions of materials on tsunami and other disasters including brochures, videos, posters, and textbooks for adaptation, translation and dissemination		●		●	●			●		●			●	●	●	
Assistance on development of tsunami evacuation routes, maps, and signage for communities, tourists, and other stakeholder groups		●		●	●									●		

Table 4-2. Regional Guidance Documents and Capacity-Building Activities for the Implementation of Tsunami Early Warning and Mitigation Systems

Topic	System Components -Tasks	Guidance Documents/Capacity-Building Activities
Authority and Coordination Legal Authority National Coordinating Bodies Local Coordinating Bodies National Organizations International Standards Overall Capacity Building	• Establish Disaster Management law and decrees with clear responsibilities for end-to-end early warning system • Establish multi-stakeholder National Tsunami Warning and Mitigation Coordination Committee with legal responsibilities for end-to-end tsunami early warning system • Develop a comprehensive national strategy and implementation plan for a tsunami warning and mitigation system that integrates all requirements of an end-to-end system including instrumentation requirements, communications infrastructure, emergency response and contingency planning, risk assessments, and preparedness, awareness, and education • Enhance capacity on disaster risk management at the local government • Develop multi-hazard disaster risk management and response plans where possible	• Provide handbook on guidelines for building a tsunami warning and mitigation system for a local and distant tsunami hazards. Handbook considers what is involved, what must be considered, desired outcomes, what is required and how quickly, prioritization, funding, human resources, and examples of minimum and maximum systems and communities. • Provide examples of working systems, including organizational structures, laws and decrees, roles and responsibilities of government and as appropriate, non-government agencies, standard operating procedures and internal/public messaging products for tsunami emergencies • Provide international assistance to work with National or Local Coordination Committees to develop sustainable comprehensive tsunami mitigation strategy and implementation plan within an all-hazards framework • Provide international assistance for conduct of detailed assessments for all aspects of tsunami warning and mitigation system. • Provide guidelines for enhancing long term capacity building through national and international educational opportunities (degree programs in disaster risk management and technical mitigation, engineering, coastal zone management, geophysics and oceanography). • Provide international assistance to work with National or Local Coordination Committees to develop a sustainable comprehensive tsunami mitigation strategy and implementation plan within an all-hazards framework • Provide international assistance for conduct of detailed assessments for all aspects of tsunami warning and mitigations system • Provide and facilitate twinning (institution-institution cooperation and expertise exchange) and assistance to Universities to provide higher University education in the requested disciplines. • Provide regional or customized national training workshops to fully inform nations on the tsunami phenomena, the tsunami warning system, and tsunami risk and preparedness. Target audience at government decision makers, TWC and DMO staff, UN and other

Table 4-2. Regional Guidance Documents and Capacity-Building Activities for the Implementation of Tsunami Early Warning and Mitigation Systems

Topic	System Components -Tasks	Guidance Documents/Capacity-Building Activities
		resource agencies, hazard risk scientists, and other tsunami professionals involved in the provision of tsunami warning services or the implementation of tsunami mitigation programmes. The workshop will also provide the tools, curriculum, and training modules to enable a train-the-trainer programme for the transfer of tsunami knowledge.
Tsunami Warnings and Monitoring Tsunami Warning Centre Seismic Network Sea Level Network Other Data Networks Satellite System Utilization Event Monitoring & Analysis	• Establish a National Tsunami Warning Centre (TWC). The TWC will either receive warnings from international sources, or issue their own warnings by monitor earthquakes and sea levels, or both. The TWC issues warnings to the National Emergency Response Agency who then issues the public safety message that advises the public on what actions to take. • If needed, establish Local Tsunami Warning Centres if there is a significant tsunami hazard which requires dense monitoring networks and very rapid warning issuance. • Continuously monitor regional and local seismicity for large submarine earthquakes that have the potential to generate tsunamis • Monitor sea levels using coastal sea level gauges and/or deep-ocean tsunami detection instruments (DART systems) to confirm tsunami generation, especially after the occurrence of large earthquakes • Monitor other geophysical, remote sensing , and other oceanographic data streams for tsunami detection • Provide tsunami wave forecasts when needed to estimate potential impacts along coasts	• Provide a handbook, or examples of operations manuals of existing TWC, on activities of warning centres, including the types of data collected, analyses undertaken, and the tsunami alarm event procedures, the infrastructure requirements for data and warning communication, and the human resource requirements. • Provide international assistance for the establishment of National of Local Tsunami Warning Centres, including required instrumentation, communications reliability and redundancy, data evaluation methods, and message content, costs, and human resources required for an operational TWC. • Provide guidelines on standards and protocols in data collection, evaluation and warning communication method and message content to achieve international standards for interoperability • Provide international assistance in developing a national strategy for tsunami warnings and monitoring, including the deployment of monitoring networks, and the access / use of the real or near real-time data delivered through satellite systems (regional and global), the internet, and other dedicated lines of communication. New data and technologies to be considered for operational use by tsunami warning centers include GPS, hydroacoustic, satellite altimetry and photographic imagery, and other geophysical, oceanographic, and remote sensing data. • Provide for technology transfer of operational seismic and sea level monitoring and evaluation methods for tsunami warning centers. This would include seismic and sea level instrumentation and network development (siting, installation), data transmission and archiving, data reduction and analysis methodologies for monitoring, detection, and evaluation for tsunamigenic potential. • Facilitate the deployment of deep-ocean tsunami detection instruments in critical locations for regional tsunami monitoring and the transfer of technology to support the operational use of the deep-ocean data for tsunami wave forecasting for coastal

Table 4-2. Regional Guidance Documents and Capacity-Building Activities for the Implementation of Tsunami Early Warning and Mitigation Systems

Topic	System Components -Tasks	Guidance Documents/Capacity-Building Activities
		impact. • Provide international assistance for the establishment of National of Local Tsunami Warning Centres, including required instrumentation, communications reliability and redundancy, data evaluation methods, and message content, costs, and human resources that are the necessary responsibilities of the TWC. • Provide assistance for training of staff of newly established Tsunami Warning Centres. Consider training visits by national staff to existing warning centers in Japan, USA (Hawaii, Alaska), and France to observe procedures and evaluation in actual practice, or visits by existing warning centre staff to countries.
Tsunami Warning Response and Emergency Preparedness Emergency Operations Centre Warning Dissemination Emergency Response Procedures	• Establish a National Emergency Operations Centre (EOC) through the National Disaster Management Organization (DMO). Upon receiving tsunami warnings from the TWC, the EOC immediately issues the public safety message that advises the public on what actions to take. • Develop Tsunami Response Plans at all levels - national, sub-national, and local levels. The Tsunami Response Plan. includes Standard Operating Procedures and Protocols for emergency response, including actions taken (including definition of criteria for action), organizations and individuals involved and their roles and responsibilities, means by which they will be contacted, including phone numbers and other essential emergency contact information, timeline and urgency assigned to action, and means by which both ordinary citizens and special needs populations (physically/mentally handicapped, elderly, others) will be alerted in a timely manner. • The NDMO should ensure or oversee the following tasks: 1) identify high risk areas in collaboration with hazard risk scientists; 2) identify evacuation places and routes; 3) establish reliable and redundant communication and information dissemination systems, and establish good coordination with mass media if they are used for information dissemination; 4) establish protocols for response regarding traffic regulation, evacuation to safe shelters, warning cancellation, “all-clear”;	• Provide a handbook, or examples of operations manuals of existing EOC, on the activities of emergency operations centres and its DMO. These would include Tsunami Response Plans and Procedures, data and communications infrastructures used, as well as Preparedness Programmes and Activities targeted at both stakeholders and the Public. • Provide international assistance to the DMO or relevant agency for the establishment of National of Local Emergency Operations Centres, including the development of the Tsunami Response Plan, alert notification system, message content, evacuation, sheltering, and safe return considerations, outreach programmes, costs, and human resources required for an operational EOC. Specifically: • Provide guidelines on reliable and robust methods of dissemination, including technical considerations and examples of technologies and current costs of working systems (sirens, mass media (visual and audio), traditional methods), and special technologies to notify special needs populations • Provide assistance for the determination and development of tsunami evacuation zones, maps, and routes through the consideration of historical data, numerical modeling, the built environment and engineering guidelines, and public risk tolerance in a process that builds community ownership in the disaster preparedness • Provide examples of tsunami exercises and drills which test and prepare national and local response systems. Consider

Table 4-2. Regional Guidance Documents and Capacity-Building Activities for the Implementation of Tsunami Early Warning and Mitigation Systems

Topic	System Components -Tasks	Guidance Documents/Capacity-Building Activities
	5) contingency plans for lifelines and critical facilities loss of service, business, government, and school closures, and other interruptions; 6) conduct regular drills and exercises at national to local levels to build stakeholder response familiarity prior to a real event; 7) develop education and public awareness programmes, especially to ensure proper understanding for messages received in terms of Tsunami Information Bulletins, Tsunami Watches and Tsunami Warnings along the entire dissemination chain. • Issue tsunami mariner safety message for both SOLAS commercial vessels and artisanal fishermen and other small craft lacking on-board communication • Develop national plan for immediate and efficient collection of run-up and inundation, engineering, eyewitness reports of tsunami arrival, and other perishable tsunami impact data after an event	the conduct of a regional tsunami exercise which is initiated internationally to national focal points followed by local responses including evacuation to test end-to-end system. • Provide examples of localization of warnings according to cultures and customs, and guidelines for the development and communication of effective warnings. Effective communication requirements for warnings should consider all hazards. • Provide guidance on the issuance of marine warnings, and facilitate through cooperation with the relevant international authorities the issuance of tsunami warnings to mariners • Provide post-tsunami science survey guidelines (UNESCO-IOC manual and Hawaii post-tsunami observation plans) which can be immediately implemented after an event. Provide samples of survey forms for tsunami science, engineering and structural impacts, eyewitness accounts, and social science-based perceptions on hazard and hazard response.
Tsunami Hazard and Risks	• Develop and improve the earthquake and tsunami historical database to document the tsunami hazard • Collect adequate topographic and bathymetric information, and other critical infrastructure databases necessary for tsunami inundation numerical modeling and risk evaluation • Conduct tsunami inundation numerical modeling to determine areas of tsunami impact using worst case tsunami source scenarios. • Conduct tsunami risk evaluation to identify vulnerable coastlines • Develop GIS systems as decision support tools which can simultaneously display hazards, inundation and evacuation maps, critical infrastructure and lifelines, and other data layers valuable for disaster preparation, response, and recovery.	• Provide guidelines for improving the quality and validity of tsunami historical records through the use of local historical records (written and oral). Provide tools and formats for building a global historical database. • Provide training, where appropriate, on the use of tsunami deposits for extending the tsunami historical record for estimating the recurrence intervals of damaging tsunamis. • Provide guidelines on the bathymetric and topographic requirements, and other input requirements for tsunami inundation mapping. • Provide training and technical assistance on the conduct of tsunami numerical modeling for the calculation of wave height forecasting and inundation distances • Provide training and technical assistance on the conduct of tsunami risk assessments • Provide assistance for the construction of community-based tsunami evacuation maps (see previous section)
Tsunami Public and Community Awareness and	• Establish pilot community preparedness programmes and activities through cooperation by national and local	• Provide and facilitate the development of appropriate and consistent educational curricula and public outreach in tsunami

Table 4-2. Regional Guidance Documents and Capacity-Building Activities for the Implementation of Tsunami Early Warning and Mitigation Systems

Topic	System Components -Tasks	Guidance Documents/Capacity-Building Activities
Preparedness, and Education Coastal Zone Management and Land Use Planning Education	governments and involving local and international NGOs. Replicate pilot implementation nationally based on these experiences. • Incorporate traditional knowledge into disaster preparedness • Designate a "National Disaster Preparedness Day" or "Tsunami Awareness Week or Month" to reinforce education and training • Enhance media training programs through routine press conferences, interviews, and special reports • Develop sound policies on the uses of coastal areas, and especially those in tsunami inundation zones, including the siting of lifeline or other critical facilities in areas vulnerable to tsunamis and other natural hazards • Strengthen the built environment to better withstand earthquake shaking and tsunami flooding through the adoption of modern seismic building codes and development of engineering guidance on building structures to withstand tsunami flooding. • Consider the planting of coastal vegetative barriers or the construction of other man-made structures (sea wall, sea gate) to reduce the impact from tsunamis • Include tsunami preparedness as part of all-hazards disaster preparedness in required school curricula	science, preparedness, and emergency response information. Provide examples in formats which are easily customized. Where needed, provide the necessary information (performance measures required for learning or similar) to enable the educational modules to become part of the required curriculum starting in primary and extending through secondary school education. • Develop training activities to strengthen linkages of key organizations involved in the early warning process including media, technical agencies, and risk managers • Facilitate the sharing of expertise by other countries in establishing tsunami awareness events, tsunami memorials and museums. Provide examples of such activities. • Provide examples of coastal zone management policies which guide development in and activities which can occur in tsunami inundation zones.

5.0 References

Web sites

AsiaInfo, http://www.asianinfo.org/asianinfo/indonesia/about_indonesia.htm; accessed November 23, 2005

Countries affected by the 2004 Indian Ocean earthquake; http://en.wikipeida.org/wiki/Countries_affected _by_the_2004_Indian_Ocean_earthquake; accessed October 24, 2005

Earthquake Engineering Research Institute, Sumatra-Anadamana Islands Earthquake Virtual Clearinghouse, http://www.eeri.org/lfe/clearinghouse/sumatra_tsunami/observ1.php, 2005

UNESCO-IOC. Indian Ocean Tsunami Post-Tsunami Field Survey Site, http://UNESCO-IOC.unesco.org/iosurveys/Thailand/asce/thailand.htm, 2005

Population centers within 8 km of the coast as ESRI data layer based on www.world-gazetteer.com; accessed October 24, 2005

The December 26, 2004 Earthquake Tsunami Disaster of Indian Ocean, Japan Research Group on The December 26, 2004 Earthquake Tsunami Disaster of Indian Ocean, http://www.drs.dpri.kyoto-u.ac.jp/sumatra/index-e.html, 2005.

Tsunami Occurrence in the Makran Region, http://www.iiees.ac.ir/bank/Tsunami/bank_Tsunami_Makran.html#5; accessed October 31, 2005

West Coast / Alaska Tsunami Warning Center Indian Ocean Tsunami of 26 December, 2004, http://wcatwc.arh.noaa.gov/IndianOSite/IndianO12-26-04.htm, 2005.

World Factbook; http://www.cia.gov accessed October 30, 2005

Journal Articles

Ishii, M., P. Shearer, H. Houston, J. Vidale, 2005, Extent, duration and speed of the 2004 Sumatra–Andaman earthquake imaged by the Hi-Net array, Nature, 435, 933-936.

Kawata, Y. (editor), Report for Grant-in-Aid for Special Purpose Research, No. 16800055, Kyoto Univ. (in press).

Lay, T., H. Kanamori, C. J. Ammon, M. Nettles, S. N. Ward, R. C. Aster, S. L. Beck, S.L. Bilek, M. R. Brudzinski, R. Butler, H. R. DeShon, G. Ekström, K. Satake and S.Sipkin, 2005, The great Sumatra-Andaman earthquake of 26 December 2004, Science, 308, 1127-1133.

Merrifield, M. A., Y. L. Firing, T. Aarup, W. Agricole, G. Brundrit, D. Chang-seng, R. Farre, B. Kilonsky, W. Knight, L. Kong, C. Magori, P. Manurung, C. McCreery, W. Mitchell, S.

Pillay, F. Schindele, F. Shillington, L. Testut, E. M. S. Wijeratne, P. Caldwell, J. Jardin, S. Nakahara, F.-Y. Porter, N. Turetsky, accepted 31 March 2005, Geophys. Res. Lett., doi:10.1029/2005GL022610

Stein, S., and E. A. Okal. 2005. Speed and size of the Sumatra earthquake. Nature, 434, 581-582.

Titov, V., A. B. Rabinovich, H. O. Mofjeld, R. E. Thomson, and F. I. Gonzalez. 2005. The global reach of the 26 December 2004 Sumatra tsunami, Science, 309, 2047-2048.

UNESCO-IOC Publications

UNESCO-IOC. ITSU Master Plan, UNESCO-IOC, UNESCO-IOC/INF-1124, Second edition, 1999, (English, French, Spanish, Russian), http://UNESCO-IOC3.unesco.org/itic/categories.php?category_no=64

United Nations Educational, Scientific, and Cultural Organization Intergovernmental Oceanographic Commission (UNESCO-IOC); United Nations International Strategy for Disaster Reduction / Platform for the Promotion of Early Warning (UN-ISDR/PPEW), World Meteorological Organization (WMO). 2005a. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Bangladesh, 22–24 August 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 12.

_____. 2005b. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Comoros, 8-10 July 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 13.

_____. 2005c. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Indonesia, 28 August – 02 September 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 14.

_____.2005d. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Kenya, 13 – 14 June 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 15.

_____. 2005e. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Madagascar. 5 – 7 July 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 16.

_____. 2005f. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Malaysia. 25 – 26 August 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 17.

_____. 2005g. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System,*

Mauritius. 15-17 August 2005. Paris, UNESCO 2005. UNESCO-IOC Mission Report No 18.

_____. 2005h. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Mozambique. 4 – 7 July 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 19.

_____. 2005i. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Myanmar. 10 – 12 June 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 20.

_____. 2005j. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Oman. 7 – 9 June 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 21.

_____. 2005k. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Pakistan. 13 – 15 June 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 22.

_____. 2005l. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Seychelles. 13 – 15 July 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 23.

_____. 2005m. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Somalia. 12 June 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 24.

_____. 2005n. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Sri Lanka. 19 – 21 May 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 25.

_____. 2005o. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Tanzania. 16 – 17 June 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 26.

_____. 2005p. *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System, Thailand. 18 – 20 August 2005.* Paris, UNESCO 2005. UNESCO-IOC Mission Report No 27.

ANNEX A

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

24/7	24 hours a day, 7 days a week
ACDM	ASEAN Committee on Disaster Management
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Center (Japan)
ANGKASA	National Space Agency (Malaysia)
ASEAN	Association of South East Asian Nations
ATWC	West Coast / Alaska Tsunami Warning Center (USA)
BAKORNAS	National Coordinating Agency for Disaster Response and Displaced People (Indonesia)
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BMG	Badan Meteorologi & Geofisika/Meteorology and Geophysics Agency (Indonesia)
BPPT	Badan Pengkajian dan Penerapan Teknologi (Indonesia)
BPR	Bottom Pressure Recorder
BUET	Bangladesh University of Engineering and Technology
CAP	Common Alerting Protocol
CCNDC	The Central Cyclone and other Natural Disasters Committee (Mauritius)
CCS	Commune Emergency Committee (Madagascar)
CDMP	Comprehensive Disaster Management Program (Bangladesh)
CLS	Local Emergency Committee (Madagascar)
CNRO	National Centre for Oceanographic Research (Madagascar)
CNS	National Emergency Council (Madagascar)
CRS	Regional Emergency Committee (Madagascar)
DART	Deep-ocean Assessment & Reporting of Tsunamis
DID	Department of Irrigation and Drainage (Malaysia)
DGM	Meteorology Department (Madagascar)
DMB	Disaster Management Bureau
DMG	Department of Minerals and Geoscience (Malaysia)
DMH	Department of Meteorology & Hydrology (Myanmar)
DMIC	Disaster Management Information Center (Bangladesh)
DMO	Disaster Management Organisation
DNA	National Institute of Hydrology (Mozambique)
DNG	National Directorate of Geology (Mozambique)
DNPC	Directorate for Civil Defense (Comoros)
DRR	Directorate of Relief and Rehabilitation (Bangladesh)
DRSS	Department of Remote Sensing and Resource Survey (Kenya)
DSMM	Department of Survey and Mapping (Malaysia)
EMC	Earthquake Monitoring Center (Oman)
ERC	Emergency Relief Cell (Pakistan)
EUMETCAST	EUMETSAT satellite-based data-distribution system
EUMETSAT	Intergovernmental organisation operating European Meteosat satellites
FDSN	Federation of Digital Broad-Band Seismic Networks
FFC	Federal Flood Commission (Pakistan)
FMHA	Federal Maritime & Hydrographic Agency (Germany)
FTM	The National Institute of Geodesy and Cartography (Madagascar)

GEOSS	Global Earth Observing System of Systems
GIS	Geographic Information System
GLOSS	Global Sea Level Observing System (UNESCO-IOC)
GMDSS	Global Maritime Distress and Safety System
GMS	Geostationary Meteorological Satellite (Japan)
GOES	Geostationary Operational Environmental Satellite (USA)
GOOS	Global Ocean Observing System
GSMB	Geological Survey and Mines Bureau (Sri Lanka)
GSN	Global Seismic Network (IRIS)
GSP	Geological Survey of Pakistan (Pakistan)
GTS	Global Telecommunications System (WMO)
HDPN	Hydrographic Department of Pakistan Navy (Pakistan)
ICG	Intergovernmental Coordination Group
ICG/PTWS	ICG for the Pacific Tsunami Warning and Mitigation System
ICS	Incident Command System
IKONOS	Private imaging spacecraft
IMTR	Institute for Meteorological Training Research (Kenya)
INAHINA	National Institute of Hydrography and Navigation (Mozambique)
INAM	National Institute of Meteorology (Mozambique)
INGC	National Institute of Disaster Management (Mozambique)
INMARSAT	International Maritime Satellite Organization
UNESCO-IOC	Intergovernmental Oceanographic Commission
IOGA	Antananarivo Geophysical Institute & Observatory (Madagascar)
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
IRIS	Incorporated Research Institutions for Seismology (USA)
UN-ISDR/PPEW	United Nations-International Strategy for Disaster Reduction/Platform for the Promotion of Early Warning
ITSU	ICG for the Tsunami Warning System in the Pacific (ICG/ITSU); renamed in October 2005 to ICG/Pacific Tsunami Warning and Mitigation System (ICG/PTWS)
ITIC	International Tsunami Information Centre (UNESCO-IOC)
JMA	Japan Meteorological Agency
km	Kilometers
KMD	Kenya Meteorological Department
KMFRI	Kenya Marine and Fisheries Research Institute
KPA	Kenya Port Authority
LANDSAT	Landsat, NASA satellite collecting remotely sensed images of the land surface and coastal regions, originally Earth Resources Technology Satellite
LAPAN	Lembaga Penerbangandan Antariksa Nasional (Indonesia)
LIPI	Lembaga Ilmu Pengetahuan Indonesia/Indonesian Institute of Sciences (Indonesia)
MACRES	Malaysian Center for Remote Sensing
MGD	Department of Mines & Geology (Kenya)
MMD	Malaysian Meteorological Department
MoFDM	The Ministry of Food and Disaster Management (Bangladesh)
MSS	Message Switching System for the GTS
NARA	National Aquatic Resources, Research and Development Agency (Sri Lanka)
NASA	National Aeronautics and Space Administration (USA)

NCCD	National Committee for Civil Defense (Oman)
NCNDM	National Committee on Natural Disaster Management (Myanmar)
NDWC	National Disaster Warning Center (Thailand)
NETWC	National Earthquake and Tsunami Warning Center (Indonesia)
NIO	National Institute of Oceanography (Pakistan)
NMC	National Meteorological Centre (WMO Member countries)
NMHS	National Meteorological and Hydrographical Service (WMO Member countries)
NMS	National Meteorological Service (WMO Member countries)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOC	National Disaster Operations Center (Kenya)
NOD	National Oceanography Directorate (Malaysia)
NTHMP	National Tsunami Hazard Mitigation Program (USA)
NWLON	National Water Level Observation Network
OCHA	UN Office for the Coordination of Humanitarian Affairs
PMD	Pakistan Meteorological Department (Pakistan)
PTWC	Pacific Tsunami Warning Center (USA)
PTWS	Pacific Tsunami Warning and Mitigation System
RETIM	« Réseau de Transmission d'Information Météorologique par satellite » Satellite-based meteorological data distribution system (GTS, operated by France)
RTH	Regional Telecommunication Hub of the GTS
SAFMAR	Maritime Safety Authority (Mozambique)
SMS	Short Message Service
SOD	Standing Order on Disaster (Bangladesh)
SOLAS	International Convention for the Safety of Life at Sea
sq km	square kilometers
SRARRSO	Space Research and Remote Sensing Organization (Bangladesh)
TIME	Tsunami Inundation Modeling Exchange
ToT	Training of Trainers
TREMORS	Tsunami Risk Evaluation through Moment from a Real-Time system
TWS	Tsunami Warning and Mitigation System
TWSP	Tsunami Warning System in the Pacific
UCSD	University of California at San Diego (USA)
UEM	Eduardo Mondlane University (Mozambique)
UHSLC	University of Hawaii Sea Level Center
UN	United Nations
UNESCAP	United Nations Economic & Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USAID	United States Agency for International Development
USG	United States Government
USGS	United States Geological Survey
UTM	Universiti Teknologi Malaysia
VSAT	Very Small Aperture Terminal (an earthbound station used in satellite communications of data)
WMO	World Meteorological Organization

ANNEX B

COUNTRY ASSESSMENT QUESTIONNAIRE

SECTION 1: CONTACT INFORMATION (NAME, ADDRESS, PHONE, FAX, E-MAIL)

Question 1: *Please identify or confirm the national points-of-contact who we can work with for tsunami mitigation activities in your country. Mitigation activities include tsunami warning and emergency response and preparedness, and education and outreach. Typical agencies involved in these activities are the national emergency response agency, meteorological services, and universities or other technical agencies operating seismic and/or sea level networks or conducting numerical modeling or other engineering studies.*

SECTION 2: AUTHORITY AND COORDINATION

*Scope**:** Please outline your country's situation regarding authority and coordination. Below are some questions that should be considered in providing a description.*

2A: LEGAL FRAMEWORK

Question 2: *Does your country have laws which designate specific government agencies to provide science-based warnings to specific government agencies, disseminate public warnings instructing the public to take or prepare to take actions, and to provide appropriate emergency response after a destructive tsunami to the affected communities? Please briefly describe these, listing the laws or administrative rules or similar legislation, the agencies designated, and their roles and responsibilities.*

2B: NATIONAL PLATFORM FOR DISASTER REDUCTION

Question 3: *Does your country have a National Platform or other mechanism for guiding disaster risk reduction in general?*

Question 4: *With respect to tsunamis, for example, has your country established a National Tsunami Warning and Mitigation Coordination Committee or some other coordination mechanism?*

Question 5: *Does your country have similar coordination mechanisms at the community level?*

Question 6: *Who (types of persons and agencies) are members of this Committee?*

Question 7: *What authority does this Committee have (decision-making, policy-making, advisory (if yes, to whom), independent reporting to one agency, etc.)?*

2C: NATIONAL ORGANIZATIONS

Question 8: *What are the important organizations, both government and non-government, for the implementation of a tsunami early warning and mitigation system?*

Question 9: *What roles will they play? Please specifically include the roles, responsibilities and authorities of the National Meteorological Service and the National Disaster Management Organization, or their equivalent monitoring, warning evaluation, and warning dissemination agencies. These, in fact, may be the same as those that comprise your Coordination Committee above.*

2D: PRIORITIES

Question 10: *What are your priorities for implementation of an effective tsunami warning and mitigation system? For example, by topic and sub-topic (assessment, warning, emergency response/preparedness/awareness, public/government or technical capacity-building, etc), by level (national, province, community, individual), by urgency (urgent, short-term, long-term, and time frame for action).*

Question 11: *What major activities are currently taking place to address these priorities?*

2E: INTERNATIONAL STANDARDS ASSISTANCE

Question 12: *Do you require assistance to harmonize existing standards and protocols in data collection, evaluation, and warning communication with those utilized by the global system to ensure interoperability?*

2F: REGIONAL COOPERATION – EARLY WARNING

Question 13: *Does your country currently cooperate with any neighboring country when evaluating earthquakes and monitoring tsunamis in real time, or for tsunami warning services, or other*

2G: REGIONAL COOPERATION – ASSESSMENT AND MITIGATION

Question 14: *Does your country participate in any regional partnerships for assessing and responding afterward to earthquake and/or tsunami disasters? If yes, please describe.*

2H: RESEARCH EXPERTISE

Question 15: *Does your country have active researchers in seismology or tsunamis? If yes, please describe recent activities.*

Question 16: *Does your government have a government-sponsored research organization that can provide products or services to strengthen your tsunami warning and mitigation system?*

SECTION 3: TSUNAMI WARNINGS AND TSUNAMI MONITORING

Scope: Please outline your country's situation regarding tsunami warnings and tsunami monitoring. Below are some questions that should be considered in providing a description.

3A: RECEPTION OF WARNINGS FROM INTERIM SYSTEM

Question 17: *Does your country currently receive international tsunami warnings for teletsunamis from the Pacific Tsunami Warning Centre and/or from the Japan Meteorological Agency?*

Question 18: *If yes, by what method and who receives it?*

Question 19: *Is there a back-up, or alternative method, for receiving the warning messages?*

Question 20: *Does this agency provide 24-hours-a-day, 7-days-a-week services?*

Question 21: *If your country does not currently receive international tsunami warnings for teletsunamis from the Pacific Tsunami Warning Centre and/or from the Japan Meteorological Agency then would your country like to receive these and by what method? Available methods include e-mail, fax, EMWIN, GTS (Global Telecommunications System with WMO headers), AFTN/NADIN.*

3B: NATIONAL TSUNAMI WARNING CENTRE

Question 22: *Does your country operate, or intend to operate, a national or regional tsunami warning center to monitor and warn of regionally- or locally-generated tsunamis?*

Question 23: *If yes, please provide information on the system (data networks, evaluation methods, and message dissemination processes).*

Question 24: *Does the warning center have staff that are always present in the operations center 24-hours-a-day, 7-days-a-week, or are staff on an on-call basis through automated processes which notify the on-duty staff through a phone message or pager?*

3C: TSUNAMI WARNING ALARM INFRASTRUCTURES

Question 25: *Does your country use alarms and other types of paging systems to notify staff of tsunami alarm events?*

Question 26: *Are these dedicated notification systems, or do they use commercial services?*

Question 27: *If so, who is notified, and does this include both warning centre staff and emergency response officials?*

3D: SEISMIC NETWORK

Question 28: *Does your country operate any seismographic stations or seismograph networks to monitor regional seismicity?*

Question 29: *If yes, please describe the system or institution, including location, instrumentation and telecommunications and analysis.*

Question 30: *Are the data available in real-time in your center?*

Question 31: *Can you provide these data in real time and how?*

Question 32: *Does your country operate any seismographic stations or seismograph networks to monitor local seismicity?*

3E: UTILIZATION OF SATELLITE SYSTEMS FOR MONITORING, DATA COLLECTION AND DISSEMINATION (WMO)

Question 33: *Is your country aware of the satellite capabilities offered through different countries in the region?*

Question 34: *What is the current capacity (equipment to receive, technical ability to access and interpret, etc) of your country in utilizing satellites for hazard monitoring, data collection and exchange?*

Question 35: *Please describe through which satellite systems you are receiving data? What kind of data and how*?

Question 36: *What are the major obstacles faced by your country with respect to the use of satellites for hazard monitoring, data collection and exchange? If they are not used, please specify why (lack of technical expertise, lack of funds, lack of equipment, or other reasons).*

3F: SEA LEVEL NETWORK

Question 37: *Does your country operate any sea level stations (coastal or deep-ocean instruments) to monitor sea level?*

Question 38: *Are these stations available real-time to the central monitoring site, or available in near real-time to the PTWC/JMA for use in the IOTWS?*

Question 39: *Do these stations sample sea levels frequently enough and transmit their data frequently enough to resolve short-wavelength tsunami (e.g. do they sample at 1 min or less intervals, and transmit their data every 15 minutes or less to a central site or by satellite)?*

Question 40: *If yes, please describe the system or institution, including location, instrumentation and telecommunications and analysis.*

Question 41: *If other digital data are available in your center, can you provide these data to the PTWC/JMA?*

3G: INTERNATIONAL COORDINATION

Question 42: *Are there international agencies, besides the UNESCO-IOC of UNESCO, or through bilateral or other assistance, any countries, universities or other technical institutions that you are coordinating, working with, or who are providing services to strengthen your tsunami monitoring, evaluation, warning capabilities?*

SECTION 4: TSUNAMI WARNING RESPONSE AND EMERGENCY PREPAREDNESS

Scope: Please describe your country's situation regarding tsunami warning response and emergency preparedness. Below are some questions that should be considered in providing a description.

4A: WARNING DISSEMINATION AGENCY

Question 43: *Who is the designated agency for receiving and acting upon the tsunami advisory message from the tsunami warning center?*

Question 44: *Does this agency have authority by law?*

Question 45: *Does this agency issue public evacuations?*

Question 46: *If not, who are the responsible agencies?*

4B: CAPACITY-BUILDING ASSESSMENT

Question 47: *Have you assessed your existing disaster management system and identified the requirements of individuals and institutions for training and capacity-building?*

4C: TSUNAMI RESPONSE PROCEDURE (DISTANT OR REGIONAL TSUNAMIS)

Scope: After receiving an international tsunami advisory message (distant tsunami), what are the procedures for responding? Response procedures should typically answer the following questions:

Question 48: *What criteria are used by the designated emergency authority to determine whether an evacuation should be issued, i.e. how is the science-based tsunami warning message translated into public guidance?*

Question 49: *How is that information disseminated to the public? Are there sirens, or other emergency broadcast methods for immediately broadcasting warning messages? Are these all-hazard, specific to a certain hazard, or tsunami-specific? If an early warning notification system exists to alert communities, please briefly describe.*

Question 50: *Are there tsunami emergency plans, tsunami evacuation plans and/or signage indicating evacuation routes to safety or higher ground?*

Question 51: *Are there marine warnings, and is there guidance or instructions for marine vessels, harbours and ports?*

Question 52: *When an evacuation is issued, is the public required by law to evacuate or is it an evacuation advisory only?*

Question 53: *Are there procedures or criteria for when it is safe for responders or the public to return?*

4D: ISSUANCE OF WARNINGS FOR MARINE SAFETY

Question 54: *Does the National Meteorological and Hydrographical Service (NMHS) have a mechanism for warning mariners (e.g. communication system NAVTEX, access to INMARSAT Safety-Net)? Please specify current capabilities.*

Question 55: *Do the NMHSs issue marine forecasts and warnings (e.g. storm and gale warnings, weather bulletins, etc.) to the mariners and coastal zone users in their region, and how? (e.g. GMDSS fax, facsimile and radio, or other)*

Question 56: *How are the contents of the warnings for mariners formulated? Are these developed within the NMHS or in collaboartinon with other agencies? Please describe.*

Question 57: *Are these warnings effective and timely? What are the weaknesses associated with the current marine warning systems that you utilize in your organization?*

Question 58: *In light of the short time window for tsunami warnings what are the strengths and weaknesses of the current warning mechanisms you utilize for issuance of warnings to mariners and coastal zone users? Do you need assistance in formulation of the warnings, enhancement of your communication mechanisms, or other subjects (please specify) to address specific requirements for tsunami warnings?*

4E: DISSEMINATION PROCEDURE (LOCAL TSUNAMIS)

Question 59: *For the case of a regionally or locally generated tsunami, do you have procedures for responding?*

4F: DISSEMINATION PROCEDURE (EARTHQUAKES)

Question 60: *Does your country have response procedures for earthquakes? If so, do these include tsunamis?*

4G: RESPONSE PROCEDURE DRILLS/EXERCISES

Question 61: *Are your procedures tested or exercised to improve the response through better planning and preparedness?*

Question 62: *If yes, please describe how this is done, who is involved, and whether it is done regularly.*

4H: CONSIDERATION OF CRITICAL INFRASTRUCTURE

Question 63: *Have you identified critical infrastructure and lifeline support facilities (hospitals, ports and marine facilities, land transportation, energy utilities, telecommunications, etc.) and made plans to ensure minimal government services after a destructive tsunami, or other natural disaster?*

4I: OTHER LOCAL CONTACTS

Question 64: *Please provide local reporting contacts that the PTWC/JMA can contact during a tsunami alarm to confirm that a tsunami has occurred. Eyewitness observations or other local information are especially important for monitoring the destructiveness of the tsunami as it propagates across the Indian Ocean.*

4J: POST-TSUNAMI SCIENCE SURVEYS

Question 65: *After a damaging earthquake and/or tsunami, does your country carry out post-event data surveys to assess damage and collect tsunami run-up/inundation data?*

Question 66: *If yes, what organization(s) usually carry out this task?*

4K: INTERNATIONAL COORDINATION

Question 67: *Are there international agencies, besides the UNESCO-IOC of UNESCO, or through bilateral or other assistance, any countries or other institutions that you are coordinating, working with, or who are providing services to strengthen your tsunami warning response? If yes, please indicate who and describe the assistance.*

SECTION 5: TSUNAMI HAZARDS AND RISKS

Scope: Please describe your country's situation regarding tsunami hazards and risks, including tsunami numerical modelling. Below are some questions that should be considered in providing a description.

5A: TSUNAMI HAZARD STUDIES

Question 68: *Have studies been done to document the tsunami hazard in your country or region (either before or after 26 December 2004)?*

Question 69: *Do you have a good historical record of past earthquakes and tsunamis?*

Question 70: *If yes, please provide references to those studies.*

5B: TSUNAMI VULNERABILITY STUDIES

Question 71: *Have studies been done to identify vulnerabilities and then to document the tsunami risk in your country or region?*

Question 72: *If yes, please provide references to those studies, and generally describe your tsunami risks.*

5C: NUMERICAL MODELLING STUDIES

Question 73: *Have numerical modelling studies been done to calculate inundation from tsunamis in your country?*

Question 74: *If yes, please provide references to those studies and indicate where the studies were conducted.*

Question 75: *If no inundation modelling has been done, does your country plan to do this in the future?*

Question 76: *Is technical training required to build this capacity?*

Question 77: *Does accurate bathymetry and topography data exist for the coastlines (30 m grid resolution or better), or does data need to be collected first?*

5D: GIS USE

Question 78: *Are geographic information systems (GIS) used as a decision support tool during emergency response?*

Question 79: *If yes, are building inventory, critical infrastructure, demographics, emergency response and evacuation, bathymetry and topography, tsunami, earthquake or other hazard or risk data layers available?*

5E: INTERNATIONAL COOPERATION

Question 80: *Are there international agencies, or through bilateral or other assistance, any countries, universities, or other technical institutions that you are coordinating, cooperating with, or who are providing services for conducting tsunami hazard and risk assessments, and/or numerical modelling?*

Question 81: *If yes, please indicate who and describe the assistance.*

5F: POST-TSUNAMI SURVEYS

Question 82: *Have post-tsunami impact assessments been conducted in your country?*

Question 83: *If yes, what types of data were collected? For example, structural and non-structural physical damage, run-up and inundation, geological, geophysical, and oceanographic tsunami signatures, emergency response, public perceptions of hazard and response.*

SECTION 6: TSUNAMI PUBLIC AWARENESS AND PREPAREDNESS, AND COMMUNITY-LEVEL ACTIVITIES

Scope: Please describe your country's situation regarding tsunami public awareness and preparedness. Below are some questions that should be considered in providing a description.

6A: ASSESSMENT OF LOCAL-GOVERNMENT PREPAREDNESS AND EMERGENCY RESPONSE

Question 84: *Have you assessed your local government disaster preparedness and emergency response? For example, are there local emergency operations centres, alert systems, incident command processes for response?*

Question 85: *How have you ensured, or will you ensure, that the information given to ordinary citizens during a warning is understood and then acted upon in an appropriate and timely manner (for example, by meetings, mass media, schools, drills, community activities, etc)?*

6B: ASSESSMENT OF COMMUNITY PREPAREDNESS AND EMERGENCY RESPONSE

Question 86: *Have you assessed your community and ordinary citizen disaster preparedness and emergency response? Is there public awareness of tsunami hazard and risk?*

Question 87: *Is the public aware of what a tsunami is, and how to respond to both locally-generated and distant tsunamis*

Question 88: *Are there any community-level education and preparedness programmes for national hazards or tsunamis?*

Question 89: *If yes, please describe how the awareness and preparedness was achieved (for example, through brochures, education, meetings, etc.).*

Question 90: *What types of outreach have been conducted and who conducts them?*

Question 91: *What is planned for the future to increase or sustain the awareness and preparedness?*

6C: COMMUNITY PARTICIPATION

Question 92: *Do local authorities engage in community-level, citizen-based, stakeholder participation in developing and deciding risk avoidance and mitigation activities?*

Question 93: *Is community-based, risk-based decision-making used? In other words, at the community level, are tsunami mitigation and emergency response decisions based on knowledge of the known local risks and the potential impacts of tsunami on the specific community?*

Question 94: *Informed people at the community level may be the ones best suited to make decisions for their own communities on the risk level they are willing to tolerate or retain, and the risk level they want to transfer to someone else. Have local risk assessments been carried out, or are they necessary?*

6D: PEOPLE-CENTERED EARLY WARNING MECHANISMS

Question 95: *Do non-government, people-centred, community-based organizations, such as the local Red Cross/Red Crescent Society, play a role in the receipt and delivery of tsunami or multi-hazard early warnings to people at the local level?*

Question 96: *If yes, please describe their role and activities.*

Question 97: *If no, is there an interest in involving these organizations as an early warning mechanism that carries messages from national authorities to communities and into households? Please specify which organizations.*

6E: PEOPLE-CENTERED PREPAREDNESS MECHANISMS

Question 98: *Do non-government, people-centred, community-based organizations, such as the local Red Cross/Red Crescent Society, play a role in the early warning preparedness and community outreach and education to people at the local level?*

Question 99: *If yes, please describe their role and activities.*

Question 100: *If no, is there an interest in involving these organizations as a preparedness mechanism to reach communities and households? Please specify which organizations.*

6F: EDUCATIONAL MODULES OF THE TSUNAMI NATIONAL FOCAL POINTS

Question 101: *As the designated national tsunami focal point, do you have a tsunami education and public outreach programme currently in place or planned for the future? If yes, please describe and provide implementation time line if planned.*

Question 102: *How does the plan address the different stakeholders (e.g., risk managers, media, and schools)?*

Question 103: *Are other natural hazards, such as tropical cyclones, storm surges, earthquakes, and volcanoes, covered in this programme plan?*

Question 104: *How are educational materials distributed?*

Question 105: *Do you have training programmes for the media on tsunami hazards, mitigation, warning, and preparedness? If yes, please describe?*

Question 106: *Do you have training programmes for the media on other hazards and their vulnerability? If yes, please describe.*

Question 107: *Would availability of educational modules and training sessions customized to your particular culture/infrastructure be helpful to your organization and to raising public awareness in your country?*

Question 108: *Through what mechanisms do you interact with your major stakeholders? Would you benefit from assistance/guidance/on-going contact with your national and regional partners through seminars and workshops?*

Question 109: *Would you benefit from on-going regional training activities strengthening the linkages of key organizations involved in the Early Warning Process (technical agencies, Media, Risk Managers, etc.)?*

6G: EDUCATIONAL CURRICULUM

Question 110: *Are earthquake and tsunami hazards and preparedness part of the educational curricula taught to school children? If yes, please describe.*

6H: OTHER OUTREACH PROGRAMMES

Question 111: *Are there other funded programmes which have provided outreach, or is there a need for such programmes?*

Question 112: *If yes, what types of outreach are needed? For example, public awareness briefings, technical training or education, informational material (printed brochures, video, computer, etc), materials targeted for children, decision-makers, general public or targeted segments of the populations, indigenous populations.*

6I: TSUNAMI MEMORIALS AND MUSEUMS

Question 113: *Are there any tsunami memorials, museums, interpretative signage or other public reminders of past tsunami impacts to your country?*

Question 114: *Do you have plans to establish such reminders? If yes, please describe.*

6J: STRUCTURAL MITIGATION EFFORTS

Question 115: *Has your country implemented any structural mitigation to reduce tsunami impact? Examples might be sea walls, tsunami evacuation shelters or other man-made high platforms, building codes for earthquake-resistant, flood-prone, or typhoon-resistant structures, or vertical evacuation guidance? If yes please describe.*

6K: NON-STRUCTURAL MITIGATION INCLUDING LAND USE

Question 116: *Has your country implemented any non-structural mitigation, such as land-use policies regarding the location and building of structures or public utilities in potentially hazardous coastal areas, vegetative sea barriers, or the retaining or rebuilding of key features of the natural landscape or ecosystem that can serve to buffer the effects of future national disasters? If yes, please describe.*

6L: EVACUATION ISSUES

Question 117: *Have tsunami evacuation maps, evacuation routes, and evacuation signage been developed for any part of your country?*

Question 118: *If yes, please indicate where and how they were assembled.*

Question 119: *If no, does your country plan to do this in the future*

Question 120: *Is training required to build this capacity?*

6M: INTERNATIONAL COOPERATION FOR AWARENESS

Question 121: *Are there international agencies, or through bi-lateral or other assistance, any countries, universities, or other technical institutions that are you coordinating, cooperating with, or who are assisting in the development of materials or the deployment of information to the relevant institutions and/or the public?*

Question 122: *If yes, please indicate who and describe the assistance.*

6N: INTERNATIONAL COOPERATION FOR STRUCTURAL AND NON-STRUCTURAL MITIGATION

Question 123: *Are there international agencies, or through bi-lateral or other assistance, any countries, universities or other technical or humanitarian assistance institutions that are you coordinating, working with, or who are providing services to strengthen your structural and non-structural tsunami mitigation activities at the local levels?*

Question 124: *If yes, please indicate who and describe the assistance.*

SECTION 7: TSUNAMI RESPONSE TO 28 MARCH 2005 M8.5 EARTHQUAKE OFF SUMATRA, INDONESIA

Scope: Please describe your country's response to this earthquake which did not generate a destructive basin-wide tsunami.

7A: PREPAREDNESS

Question 125: *Was your country more aware and your public better prepared to respond appropriately? Please describe how you ascertained this.*

Question 126: *Did they respond appropriately?*

7B: ADVISORY

Question 127: *Did your country receive an internationally tsunami advisory message from the PTWC or JMA?*

Question 128: *How timely was this?*

7C: MONITORING SYSTEMS

Question 129: *Did your country have national monitoring systems in place that detected and evaluated the earthquake?*

Question 130: *How timely was this?*

7D: NATIONAL RESPONSE PLAN

Question 131: *Did your country have a national tsunami response plan in place, and was it exercised?*

Question 132: *How did it perform?*

Question 133: *What went well and what are areas still needing coordination and improvement?*

SECTION 8: OVERALL ENHANCEMENT OF YOUR NATIONAL CAPABILITIES TO MITIGATE THE IMPACT OF HAZARDS (WMO)

Question 134: *Is your country addressing the establishment of the Tsunami Early Warning capabilities including response within your national boundary, with a multi-hazard framework? If (yes) please explain.*

Question 135: *In the absence of a tsunami, how can you benefit from with the capacities and linkages being developed in your country, to better respond to other hazards?(e.g. improved dissemination, coordination and response to all hazards affecting your country)*

Question 136: *We would especially appreciate if you could comment further on critical areas where the international community can provide additional specialized technical or capacity building assistance.*