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Agenda Item 6.2

IOTWS Medium Term Strategy

> The ICG through Recommendation ICG/IOTWS-VII.1 instructed the Steering Group to prepare a draft Medium Term Strategy (MTS) for consideration by ICG/IOTWS-VIII. This document has been prepared by Mr Rick Bailey on behalf of and with the support of the ICG/IOTWS Steering Group. The ICG is requested to consider, comment on and adopt the draft Medium Term Strategy as presented or with amendments.

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Draft IOTWS Medium Term Strategy 2011-2015

I.   Introduction

1.1.   Purpose of the document

The IOTWS Medium Term Strategy (MTS) describes the basic directions towards continuously improving the Indian Ocean Tsunami Warning & Mitigation System to meet stakeholder requirements during the period 2011-2015. It focuses on describing general, common but essential, strategic objectives to ensure an effective and efficient, tsunami warning and mitigation system that is interoperable wherever possible with the other ocean basins and seas. The IOTWS working group structure supports implementation of the IOTWS MTS. Details of the activities and tasks to accomplish the strategic objectives are defined in the IOTWS Implementation Plan.

1.2.   Vision

> *An interoperable tsunami warning and mitigation system based on coordinated Member State contributions, which uses best practices and operational technologies to provide timely and effective advice to National Tsunami Warning Centres (NTWCs). Indian Ocean communities at risk are aware of the tsunami threat and able to assess and reduce risk, prepared and ready to act to save lives, protect property and infrastructure.*

1.3   Context

The devastating Indian Ocean Tsunami of 26 December 2004 (IOT 2004) demonstrated the risk to Indian Ocean countries of the tsunami threat. More than 230,000 people around the Indian Ocean lost their lives and more than one million people were left homeless.

Indian Ocean nations are threatened by and must be prepared for distant and local tsunami threats. Prior to 2005 there was no coordinated regional tsunami warning and mitigation system. The risk was considered too low. However, following the IOT 2004 an Interim Advisory Service (IAS) was quickly and gratefully established by the Pacific Tsunami Warning Centre (PTWC) in Hawaii and the Japan Meteorological Agency (JMA) in Japan. The role of the IAS was to provide advice to inform NTWC decisions. Tsunami warnings are the sovereign responsibilities of Members States to be provided by their designated NTWCs.

A new awareness of local and regional threats following the IOT 2004 demanded that Member States commit to address these threats through improved and expanded NTWC capacities and through formal regional collaboration. Accordingly, and with support of the United Nations, an Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning & Mitigation System (ICG/IOTWS) was established in 2005 under UNESCO's Intergovernmental Oceanographic Commission (IOC). The result has been the development of an interoperable network of national and regional tsunami monitoring, warning and advisory systems. This has been supported by development and exchange of guidelines and best practices in the risk assessment and reduction, including greater community awareness and preparedness.

A major outcome from the ICG/IOTWS has been the development of a Regional Tsunami Watch Provider (RTWP) Service for the entire Indian Ocean to replace the IAS in 2011. Initially the RTWP Service will be provided by Australia, India and Indonesia. The new service will provide more detailed tsunami threat information for NTWCs to make their decisions and enable the PTWC and JMA to again concentrate primarily on the Pacific Ocean.

This MTS provides the framework for Member States to take responsibility and ownership for their National systems. It will enable Member States to engage in the international coordination and collaboration process through the ICG/IOTWS to support an integrated "system-of-systems" providing tsunami threat information for all Indian Ocean nations.

1.4 Global Ocean-related Hazards Warning and Mitigation System

The Indian Ocean Tsunami Warning and Mitigation System (IOTWS) is an important part of a global framework of ocean basin tsunami warning and mitigation systems governed by Intergovernmental Coordination Groups (ICGs) of the Intergovernmental Oceanographic Commission (IOC). The IOTWS is also part of the Global Ocean-related Hazard Warning and Mitigation System (GOHWMS) and should reflect the key GOHWMS principles of:

- Identifying warning and mitigation system requirements unique to Indian Ocean basin
- Capitalizing, to the extent practicable, on existing international groups with relevant responsibilities such as JCOMM, including GLOSS and DBCP
- Harmonising structure, standards, and practices among ICGs
- Cooperating with other international systems and organizations such as WMO, UNDP and ISDR
- Collaborate on research and development across ICGs

The GOHWMS is guided by the IOC Working Group on Tsunami and Other Hazards Related to Sea Level Warning & Mitigation Systems (TOWS-WG).

1.5 Strategic Pillars

Considering the important role the GOHWMS plays and the unique requirements of the Indian Ocean basin, the Indian Ocean Tsunami Warning and Mitigation System Medium Term Strategy is comprised of three Pillars supported by three foundational elements. The three Pillars are:

- Risk Assessment and Reduction: *hazard and risk identification and risk reduction*
- Detection, Warning and Dissemination: *rapid detection and warning dissemination down to the last mile*
- Awareness and Response: *public education, emergency planning and response*

The supporting foundational elements are:

- Interoperability: free, open and functional exchange of tsunami information
- Research: enhanced understanding and improved technologies and techniques
- Capacity Building: training and technology transfer
- Funding and Sustainability: resources to sustain an effective IOTWS
- Outreach: knowledge of system utilities, capabilities and limitations

1.6 Document Structure

Section II provides an analysis of the Current State of the IOTWS. Section III describes the three Pillars. Section IV reviews the Foundational Elements, and Section V discusses Implementation.

II.   Analysis of the Current State of the IOTWS

The current state of the IOTWS can be summarised as follows:

1.   Whilst there has been significant progress through development of guidelines and delivery of numerous capacity building workshops, detailed risk assessment and reduction is still incomplete for many areas. As experienced globally, most countries still lack high-resolution bathymetry and topography data required to complete detailed inundation studies to underpin further development of emergency response and evacuation plans.

2   Whilst there has been a considerable expansion in the amount of seismic and sea level data to detect tsunami threat, there are still gaps and the data is not always made available to the warning centres in a timely manner. Exchanging observational data between neighbouring Member States (sometimes even within a single Member State) and across the region remains an area requiring urgent improvement.

3   Indian Ocean-wide services provided by the IAS operated by PTWC and JMA have been robustly operated with high reliability. The IAS is being provided by the US and Japan whilst Indian Ocean Member States develop their own regional capability to replace the IAS.

4   Many NTWCs have been making ceaseless efforts to develop and improve their national services and ability to provide regional services, by introducing new technologies and providing resources to maintain operational systems. The IOTWS in many areas is leading the world in the capabilities being developed for more threat based tsunami warnings. However, maintaining 24/7, robust and sustained national and regional systems remain great challenges, especially as donor funding is reduced following the hiatus immediately after the IOT 2004.

5   A positive tendency is that Member States' awareness of the urgent necessity for preparing countermeasures against tsunami threats has been increasing, especially after the IOT 2004 disaster. Still, there is a need for more risk assessment, capacity building, disaster prevention education and other activities to achieve further and sufficient tsunami preparedness and sustainability of operational systems.

6   Whilst there are now semi-regular, internationally coordinated exercises for the IOTWS, there is minimal routine monitoring and detailed evaluation of overall system performance to underpin continuous improvement and ensure messages are delivered in a timely and accurate manner down to the "last mile".

7   Whilst awareness and preparedness is improving around the region, considerable effort is required to ensure all communities at risk are aware of the threat and able to respond in a timely manner to natural and official warnings safely. The need for even more focus on community education to enable response to local tsunamis has been highlighted by events such as tsunami impact on Mentawai Islands, Indonesia in October 2010

8   The media are a key element for disseminating tsunami threat information and warnings to the public. Multiple and sometimes conflicting information, from official and unofficial sources, can lead to misinformation being communicated to the public. Further effort is required to educate the media and the public that the authoritative sources for tsunami warnings are the NTWCs in any particular country. The media and public also need to be educated on the limitations of the warning systems and the importance of awareness of natural warning signs (e.g. earthquake near coast) in responding to local tsunamis.

9   Member States are the main contributors to the IOTWS. The budget for the ICG/IOTWS provided by the governing body, UNESCO/IOC, and donated by Australia is not able to support all critical ICG/IOTWS activities. Operational implementation of the IOTWS activities is highly dependent on

national regular budgets. NTWC and RTWP Services are not included in the IOTWS budget, nor are extra budgetary contributions offered by concerned organizations such as UNISDR, UNESCAP, UNDP and aid or technical agencies such AusAID for targeted outcomes.

III   Strategic Pillars

3.1   Introduction

To formulate the IOTWS Medium Term Strategy MTS we should consider the present situation described in section II and develop realistic strategic objectives that are achievable in 5 years. The driving question is "What can be done even with the present limited resources to at least make the populations at risk safer?" The response to this question makes it possible to prioritize the activities for improving the various components of the entire IOTWS. These priorities may also be considered by aid and technical cooperation agencies as guidance for their support to the IOTWS.

3.2   Meeting Strategic Objectives

The following sections describe the strategic objectives to be accomplished and the contents of each pillar, as well as offering suggested priority actions. The ICG/IOTWS and Member States will need to support the activities addressing these strategic objectives as much as possible. It is therefore important to encourage Member States initiative as the main stakeholders and actors in these activities.

3.2.1. Pillar 1: Risk Assessment and Reduction

Evaluation of tsunami risk consists of hazard assessment (specifying potential tsunami sources and waves height along the coast) and risk assessment (estimating likely tsunami effects to the coasts and estimating damages to life and property). The objective is to determine where the dangerous locations are along a coast and how strongly a tsunami could affect those areas.

Risk and hazard assessment needs to be conducted by each Member State who knows best the natural and social conditions of its coastal area more than any other countries. The assessments must utilise the recent and historical data and scenarios completed for Indian Ocean-wide and local tsunamis.

Risk assessment is an essential starting point for developing efficient tsunami preparedness activities at the national level to enable disaster risk reduction — activities that reduce community exposure to tsunami and other ocean-related threats. It is also fundamental to the other pillars.

Strategic Objectives

- Continue to apply and develop the guidelines for tsunami risk assessment developed by the ICG/IOTWS for the Indian Ocean
- Member States should continue to specify and detail risk levels and vulnerable areas on their own coast due to the tsunami phenomenon.
- Member States should develop risk reduction strategies through appropriate agencies and organizations into national and local disaster management policies, to reduce, where possible, community exposure to threats from tsunamis and other ocean-related hazards.

Activities

- Utilise and further develop the tsunami hazard map for the Indian Ocean based on recent and historical data and/or numerical simulation to underpin risk assessments.
- Upgrade Tsunami Risk Assessment Guidelines to reflect latest developments
- Risk assessments and guidelines should be expanded to include potential damage to marine infrastructure and loss of life related to the majority of tsunamis that generate dangerous ocean currents and rips, but not necessarily land inundation.
- Prepare a collection of state of the art Case Studies on Risk Assessment and Management from the Indian Ocean, as well other ocean basins.

- Where information is available, undertake detailed risk assessments using inundation modelling for tsunami scenarios utilized in national warnings and regional tsunami threat information.
- Where detailed information isn't available and although not ideal, simple and rough estimation (e.g. using altitude data of coastal topography and estimated onshore and run-up wave heights) can serve temporarily as inundation criteria until more accurate mapping develops in the future, including through paleo-tsunami research.
- Prepare a guideline on Coastal Hazard Mitigation focusing on physical interventions.

Suggested Mechanisms:

— Since the work for the above steps includes technical and research capabilities, capacities and skills, it needs support from or cooperation with research communities. To make it relevant and timely a compromise solution should be sought in terms of accuracy in the short term, because it would take long time and large budgets to pursue it due to its continuous improvement.

— Continued collaboration and interaction with other related international programmes, such as IOC Coastal Area Management (ICAM) Programme

— In the long term, Member States should have available experts who can deal with various technical matters. Such human resources development is essential for the sustainability of the system. It requires ongoing training courses, overseas or national opportunities for graduate or postgraduate education and scientific and technical networking.

3.2.2 Pillar 2: Detection, Warning and Dissemination

An effective tsunami warning system involves the rapid detection and quantification of the earthquake source, forecasting and verification of wave propagation and the likely threatened areas, development and dissemination of information about the threat to the "last mile" to enable communities to respond.

— **Detection** involves the implementation and development of seismic and sea level observing systems that enable rapid assessment and verification of the threat.

— **Warning** involves the rapid analysis of local earthquakes capable of generating local tsunamis, forecasting of wave propagation and potential impacts for regional and ocean wide tsunamis, and conveying that information in interoperable message formats.

— **Dissemination** involves the timely and accurate distribution of threat and warning information from and between warning centres, and from NTWCs to the community.

Tsunami threat and warning information for the Indian Ocean should be harmonised with other ocean basins as far as possible, taking into account the recommendations of the TOWS-WG, whilst recognising any specific requirements for the Indian Ocean.

The Indian Ocean has major tsunami sources in basically two regions (related to Indonesian and Makran trenches) with warnings developed on national local and ocean-wide scales.

The following are descriptions of strategic developments for warning systems of each scale.

3.2.2.1 *National Tsunami Warnings*

National tsunami warning systems are a critical component in the end-to-end system for both local and distant tsunamis, due to the inalienable, sovereign national responsibility for informing communities at risk and urge or order immediate evacuation.

Strategic Objectives

- Develop and maintain NTWC capability or function by each Member States, including ability to develop national inundation modelling given availability of high-resolution bathymetry and coastal topography data.
- Develop emergency response mechanisms on 24/7 basis among concerned organizations.
- Base national tsunami warnings on globally harmonized threat levels, with land inundation threshold for tsunami wave amplitude determined in consultation with emergency management authorities and taking into account local topography and vulnerability.

Activities

- Establish or reinforce capabilities to analyze seismic and sea level data, interpret RTWP threat information, evaluate tsunami effects, and issue national tsunami warnings through improved communication networks.
- Build optimized Standard Operating Procedures (SOPs) for all steps; from receiving and interpreting RTWP threat information, issuing warnings through to evacuation. Master the procedure by continuous improvement practices including full-scale evacuation exercises and drills down to and including the "last mile".
- Utilise new and available technologies and develop arrangements for the transmission and receipts of tsunami threat information from RTWPs, and the dissemination of warnings and public safety actions within countries by NTWCs.
- Monitor and routinely evaluate performance of monitoring and warning systems against agreed Key Performance Indicators

Suggested Mechanisms:

— Capacity building workshops, including RTWP training for NTWCs
— Work with national and international research groups to further enhance and refine tsunami warning capability
— Harmonise national tsunami warnings with other countries by implementing recommendations of the TOWS-WG
— Make national contact information available for NTWCs and RTWPs, with quarterly review of the information to ensure accuracy and currency
— Implement evaluation systems to monitor system performance
— Undertake routine national exercises to test and improve system performance as required.
— Rigorous and timely post-event evaluations and implementation of "lessons learnt"
— Develop national tsunami warning service within multi-hazard frameworks to benefit from synergies, as well as maximize utility and return from investment
— While the precise production and definition of a tsunami warning requires specific capabilities, the delivery of warnings to the population is usually provided through and/or in conjunction with other mechanisms by mandated agencies (e.g. Emergency Services/Civil Defence, Department of Interior, Cabinet, Hydrometeorological and Weather Services). Early involvement of these bodies in the national tasks of the IOTWS may help save time and money.

> **Note:** For local tsunamis, which occur at the coast of a particular country near the earthquake source, there is usually a very short time until the tsunami arrives. Therefore, local or national warning system should also develop community awareness beforehand and initiate emergency

action on their own, without necessarily waiting for information from RTWPs or the NTWC. For distant tsunamis, local and national systems securely receive timely information from RTWPs and NTWCs, evaluate the effect on domestic coast and decide to issue national warnings accordingly.

3.2.2.2 Regional Tsunami Threat Information

Ocean-wide and/or regional tsunami warning systems deal with tsunamis capable of propagating over a vast area of the Indian Ocean, affecting a number of countries. These systems use regional and global observational networks of seismic and sea level data. It requires prompt and reliable communication means to deliver threat information determined by Regional Tsunami Watch Providers (RTWPs) to countries around the Indian Ocean. This tsunami threat information has the role of triggering the national warning procedure in each MS for ocean-wide tsunamis.

Where possible, ocean-wide and/or regional tsunami warning systems assist nations susceptible to local tsunami threat. However, due to practical limitations of the technical warning systems and the rapid arrival of local tsunamis, national public education on the natural signs of tsunamis for communities close to earthquake sources is essential to facilitate the required early response.

Strategic Objectives

- At least maintain the present level of operational services provided by the IAS.
- Provide more detailed threat information to NTWCs through RTWPs.
- Continue to develop and maintain the RTWP service as state-of-the-art to improve accuracy and level of detail in regional tsunami threat information available to NTWCs

Activities

- Implement best practice state-of-the-art threat information systems harmonized with similar systems in the other ocean basins.
- Where possible provide users with more detailed threat information to guide response, such as tsunami wave amplitude estimations (offshore and at beach), and improved tsunami arrival time estimation accuracy (initial time wave amplitude above agreed threat threshold; time of maximum wave amplitude; time wave amplitude below agreed threat threshold).
- Improve the accuracy and timeliness of earthquake source information (location, depth,, magnitude, rupture direction).to enhance accuracy and timeliness of tsunami threat information.
- Keep the Tsunami Warning Focal Point (TWFP) list up to date and as complete and reliable as possible to ensure tsunami threat information reaches and can be utilised by national authorities to warn communities.
- Monitor and routinely evaluate performance of monitoring and warning systems against agreed Key Performance Indicators

Suggested Mechanisms:

— Implement the RTWP Service as agreed under RTWP Implementation Plan
— Work with national and international research groups to further enhance and refine tsunami threat information
— Harmonise regional tsunami threat information system with systems developed in other ocean basins by implementing recommendations of the TOWS-WG
— Make TWFP information available for NTWCs and RTWPs, with quarterly review of the information to ensure accuracy and currency
— Implement evaluation systems to monitor system performance
— Undertake routine ocean-wide exercises to test and improve system performance as required.
— Rigorous and timely post-event evaluations and implementation of "lessons learnt"
— Develop RTWP Service within multi-hazard frameworks to benefit from synergies, as well as maximize utility and return from investment

Note: What is most important for tsunami warning systems of any scale is to guarantee stability, reliability and sustainability in the end-to-end operation, from receiving/delivering warning at centers down to the population evacuation. The system should always be ready (24/7) for the occurrence of this relatively rare natural phenomenon. In other words, the primary aim for a warning system should be to maintain the system as a whole and keep the necessary reliability after its construction, or to develop such system as to be easy to maintain and to assure reliability.

From this standpoint, state-of-the-art technologies should be carefully assessed before bringing these into operational systems. It is essential to evaluate the newest, promising technologies from the viewpoints of not only effectiveness or attractive prospects but also operational reliability and robustness, when considering introduction into the warning system.

3.2.2.3 Regional Earthquake and Tsunami Detection

Detection involves the implementation and development of seismic and sea level observing systems that enable rapid assessment and verification of the threat to enhance the accuracy and timeliness of threat information.

Strategic Objectives

- Enhance and maintain seismic and sea level monitoring capability to meet identified tsunami warning requirements
- Development of cost efficient sea level observing technologies to maximize the return from resources and underpin sustainability of the system.

Activities

Maintain, build (or improve) observational networks for seismic and sea level data and online communication system(s) to rapidly collect these data and to meet identified tsunami warning requirements.
Improve timeliness and accuracy of earthquake location and size by making available all present and future seismic data collected by national and internationally coordinated networks.
Develop national capability with access to interoperable neighbouring seismic information for detecting local tsunami threat.
Coordinate and share information on the development of analysis techniques.
Provide timely access for tsunami warning centres to all currently available and suitable sea level station data in agreed standard format (CREX) to enable timely verification of tsunami generation. Priority should be given to stations within 1-hour travel time from known sources.
Monitor and routinely evaluate performance of monitoring systems against agreed Key Performance Indicators

Suggested Mechanisms:

— Improvement of seismic and sea level observation networks requires considerable funding and human resources, so that it may be difficult for many countries to achieve this strategic objective.
  o Address improvements by better focusing on hazard assessment and building on efficient use of existing support mechanisms and international networks (such as but not limited to CTBTO, FDSN and IRIS for seismic monitoring and GLOSS and DBCP for sea level monitoring).
  o Close coordination with neighbouring and other countries in the region to optimize and maximize regional coverage of monitoring systems.
  o Where possible install multi-purpose sea level monitoring stations to maximize use and return from investment, optimized against cost and utility.
  o Demonstrate value of observing systems to warning system accuracy and timeliness

3.2.3 **Pillar 3: Awareness and Response**

It is essential that the communities that are vulnerable to the effects of tsunami are knowledgeable with their underlying risks, its effects to livelihood, and how to respond when it happens through simple cost-effective and cultural sensitive awareness programmes, and whenever possible, mainstreamed to gender and livelihood issues. Such programmes would include developing participatory evacuation planning, and disseminating information through the media, workshops/seminars, awareness materials, Internet, signage and billboards. If not already in existence, tsunami related curriculum programmes should be developed to build that inherent capability in the young adults and children.

Due to the nature of tsunamis, Member States must be able to respond; however this will require putting in place systems and processes to enable cost effective response coordination. These systems and processes would include response management structures, evacuation plans and maps, communication systems to enable such amongst emergency services, emergency operation centers, shelters and other basic necessities to support evacuees/victims, medical, search and rescue infrastructures.

Member States should also plan and conduct exercises on regular basis to test early warning systems and evacuation planning and emergency response planning at all levels.

To ensure that Government officials, NGOs, private sector and community representatives are able to provide the required response, sustainable capacity building programmes should be developed and delivered.

Strategic Objectives

- Strengthen public awareness of tsunami and associated hazards and the ability to prepare and respond;

Activities

- Sharing of community-based Best Practices
- Develop basic template of Standard Operating Procedures on Warning Dissemination and Emergency Response from NTWCs to DMOs and DMOs to communities at risk.
- Develop guidelines and conduct regular exercises to test early warning systems and evacuation mechanisms;
- Develop and deliver suitable and sustainable capacity building programmes to facilitate effective and efficient response and coordination;
- Stock-take of national status of Awareness and Response to guide priorities for capacity building
- Develop education programmes for the global and national media to assist community awareness, preparedness and response.
- Develop general framework of disaster education and tsunami-related curriculum programmes for all levels of education to build an inherent capability and raise the interest of young people in the disaster management field providing a source of career development and support to the Member States in the future to plan, respond to and recover from tsunamis;

Suggested Mechanisms:

— More training at DMO to the community level,
— Develop better understanding of the role of the national and regional tsunami warning systems.
— Build on existing good practices, recognizing the existing effective SOPs already developed and evaluated.
— Build collaboration mechanism with the media.
— Close collaboration with ISDR, ECHO, UN Regional Organizations and other relevant donors including use of CBDRR/CBDRM Platforms to allow mainstreaming of tsunami preparedness into the disaster risk reduction framework at national, regional and global level.
— Introduce and mainstream awareness and response programmes into Member States development strategies and sector plans to facilitate acquiring of resources to enable implementation of required response infrastructures/mechanisms;
— Encourage effective linkages between the respective SOPs within countries.
— Encourage Member States to review and revise plans based on their exercises.
— Develop minimum compentencies and conduct competence-based trainings to responsible officials of government and awareness raising programmes for the public. Make use of various training and educational programmes offered by various organizations.
— Establish Indian Ocean Tsunami Information Centre
  ▪ Develop materials in collaboration with TICs from other ocean basins to support capacity building and improve public awareness
  ▪ Exchange and translate existing good educational materials into local languages and delivering these materials to the people is one of the best ways for disaster prevention education;
— Investigate what materials and supporting system exist by questioning the offering organizations and Member States, and what materials are still needed
— Full scale evacuation exercises and drills should be considered as reliable preparedness tools and be part of end-to-end system evaluation, to test both warning systems and evacuation plans. It also helps to strengthen awareness of both local governments and population.

IV. Foundational Elements

4.1 Interoperability

Taken together, the GOHWMS and IOTWS MTS require three kinds of interoperability:

First, National Tsunami Warning and Mitigation Systems must be interoperable among IOTWS Member States and with the RTWP to ensure full and open access to tsunami-relevant observational data, analysis, advisory and warning information, operational techniques and technologies, and best practices. More effective National Tsunami Warning and Mitigation Systems will result.

Second, the IOTWS must be interoperable with other ocean-related hazards warning and mitigation systems to use and share data, analyses, and awareness and preparedness, and other common elements of such systems. Synergies will result that will increase the effectiveness of National Tsunami Warning and Mitigation Systems, regional warning centre operations, and drive down the costs of operating and maintaining ocean-related hazard and mitigation systems.

Third, the IOTWS must be interoperable with the TWSs from other ocean basins in the context of the GOHWMS framework. Again, improvements in effectiveness and efficiency will result—for Member States both individually and collectively.

For enhancing such interoperability, IOC created the TOWS-WG to coordinate and harmonize activities of the ICGs and of relevant organizations dealing with other ocean-related hazards. The ICG/IOTWS should share its experiences and knowledge within TOWS-WG and learn from experiences and new developments in other regions.

4.2 Research

Each of the three pillars requires on-going research and development to advance all elements of the IOTWS. Investigations of the tsunami phenomena, including tsunami caused by landslides, volcanoes, and other sources and new developments, whether in tsunami detection, tsunameter technology or innovative GPS applications, advanced threat-based forecast systems, developments in operations and communications technologies, or innovative approaches to community preparedness need to be monitored, evaluated, and publicized to Member States. Such advances are critical supports to the three central pillars of the IOTWS MTS.

There are many new research programmes and technologies being conducted and developed. Since these are leading edge activities, many of them provide interesting and relevant results in theory, but they need to be validated in experimental stage in order to be put into practical use. Therefore we have to pre-assess new research results or technologies from various viewpoints such as relevance, effectiveness, efficiency, robustness, ease of maintenance easiness and sustainability before officially introducing them into operational systems.

IOTWS needs to utilize and promote closer cooperation with relevant research communities. IOTWS also should take the role of requesting research communities to conduct or develop research or technology necessary for improving tsunami warning and mitigation system and contribute to solving problems discovered or highlighted through our actual system operations or various other activities.

4.3 Capacity Building

An effective tsunami warning and mitigation system requires ongoing capacity building and training to support all three strategic pillars. Capacity building activities must be carried out continuously and forever in the three strategic pillars. Each country must be able to understand its risk and know ways in which they can mitigate the hazard, provide warning guidance to its populations in a timely manner, and be able

to carry out awareness and preparedness activities to sustain knowledge and ability-to-respond across generations.

The building of national human resource capacities that can develop, guide and lead these activities in each country is essential. Substantial experience, knowledge, and best practices have been accumulated over the years by Member States prone to tsunamis. This should be shared widely through trainings and workshops. Training courses and national, cross-sector and inter-regional workshops are excellent ways in which to build these skill sets and at the same time, to improve the networking between countries during a real event.

As these skills are developed over time, trainings should be regularly conducted, and also be continually refreshed as new methods, technologies, and practices are identified. An example of regular training already provided by the ICG/IOTWS is the ComMIT Training Workshops delivering national capability in inundation modelling.

4.4   *Funding and System Sustainability*

Like any system, a robust, effective IOTWS requires substantial investment to be viable, maintain existing systems, and evolve to meet new needs and incorporate new technologies. There is a need for continuing Member State commitment to invest in National Tsunami Warning and Mitigation Systems and to contribute—in whatever way possible—to the operation of the IOTWS. In addition, there is a need engage donor agencies and organizations to support all elements of the end-to-end tsunami warning and mitigation system in the Indian Ocean.

Implementing this Medium Term Strategy will require additional investments from within and outside the IOTWS Member States. A strategy to support funding and sustainability, overseen by the ICG/IOTWS Steering Group, is needed to realize these investments. This involves:

- Monitoring and evaluating system efficiencies and effectiveness
- Undertaking gap analyses
- Identifying resource requirements
- Demonstrating value and impact of existing systems and proposed enhancements
- Allocating priorities
- Developing costed plans and proposals
- Identifying and consulting relevant funding sources and aid agencies

4.5   *Outreach*

An Outreach Strategy needs to be developed and managed by the ICG/IOTWS Steering Group. It is essential that this Outreach Strategy conveys the utility, capability, new developments and limitations of the IOTWS to key stakeholders – the pubic, media, government authorities, NGOs, industry groups, related international programmes (e.g. WMO, JCOMM, UNDP). This needs to be accomplished through:

- Maintenance of a dedicated, up-to-date web site for the IOTWS
- User Guides for National and Regional tsunami warning and threat information systems
- Coordinated RTWP and NTWC threat information and tsunami warnings
- Service Change Notifications
- Up-to-date displays of System Performance and Evaluations
- Development and provision of educational tools and support for translation into different countries and cultures
- Global and National media training, including greater involvement in Indian Ocean Wave Exercises
- Presentations at international and national meetings, conferences, and workshops of partner programs and related disciplines

V. Implementation

The IOTWS Steering Group will help coordinate and monitor overall MTS implementation through and on behalf of the ICG/IOTWS.