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US INDIAN OCEAN TSUNAMI WARNING SYSTEM (IOTWS) PROGRAM

PROCEEDINGS: WORKSHOP ON THE TRANSITION OF THE US IOTWS PROGRAM TO INDIAN OCEAN PARTNERS

DECEMBER 6-7, 2007 (BANGKOK, THAILAND)

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CONTENTS

ACRONYMS

ADPC	Asian Disaster Preparedness Center
AIT	Asian Institute of Technology
BAKORNAS	National Disaster Management Coordinating Board of Indonesia
BPPT	Agency for Assessment and Application of Technology, Indonesia
BMG	Meteorological and Geophysical Agency, Indonesia
CCR	Coastal Community Resilience
CONOPS	Concept of Operations
DART	Deep-ocean Assessment and Reporting of Tsunamis
GTS	Global Telecommunication Systems
ICG	Intergovernmental Coordination Group
ICS	Incident Command System
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning and Mitigation System (or Indian Ocean Tsunami Warning System, as used for the US program title)
ICG/IOTWS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System
ITTI	International Tsunami Training Institute
NGO	non-governmental organizations
NOAA	National Oceanic and Atmospheric Administration
PTWC	Pacific Tsunami Warning Center
RANET	RAdio and InterNET for the Communication of Hydro-Meteorological and Climate Related Information
RTWC	Regional Tsunami Warning Center
SOP	Standard Operating Procedure
TARNS	Tsunami Alert Rapid Notification System
TEWS	tsunami early warning system
UNDP	United Nations Development Program
UNESCAP	United Nations Economic and Social Commission for Asia Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNISDR	United Nations International Strategy for Disaster Reduction
USAID/RDMA	United States Agency for International Development/Regional Development Mission for Asia
USFS	United States Forest Service
USGS	United States Geological Survey
USTDA	United States Trade and Development Agency
WG	Working Group
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

The US Agency for International Development (USAID) launched the US Indian Ocean Tsunami Warning System (IOTWS) Program as part of the large international response to the December 2004 tsunami disaster coordinated by the United Nations. Through this two-year, $16.6 million effort, scientists and experts from the United States have been sharing their technical expertise, providing guidance, and helping to build early warning system capacity within the Indian Ocean region as a contribution to the international Indian Ocean Tsunami Warning and Mitigation System,[1] so that governments and communities will be able to detect and prepare for tsunamis and related coastal hazards. US Government (USG) program partners include USAID, the National Oceanic and Atmospheric Administration (NOAA), US Geological Survey (USGS), US Forest Service (USFS), and US Trade and Development Agency (USTDA).

As the US program prepares for close-out in March 2008, the Program team conducted a Transition Workshop in Bangkok on December 6-7, 2007 to address three objectives: discuss key US program accomplishments and overall progress of the international IOTWS effort; ensure continued support for US program contributions; and identify future priorities and resource needs for the international effort supporting the IOTWS. The USG and the Intergovernmental Oceanographic Commission (IOC) of United Nations Education, Scientific and Cultural Organization (UNESCO) co-sponsored this workshop to help continue momentum of US and international efforts. The workshop brought together government representatives from the five focus countries as well as international, regional, and country-level partners to engage in the transition process.

Governments in the region have demonstrated impressive progress since the 2004 tsunami, and United Nations partners, country counterparts, and others reaffirmed their commitment to sustaining key initiatives and tools. To best understand overall progress in the region, the Intergovernmental Oceanographic Commission (IOC) and national government representatives presented country experiences from the tsunami event of September 12, 2007 following an 8.4 magnitude earthquake near Sumatra, Indonesia. According to a recent assessment of national efforts conducted by the IOC Secretariat of the Intergovernmental Coordination Group for the IOTWS (ICG/IOTWS), installation of or upgrades to seismic and sea-level monitoring stations, including those implemented under the US IOTWS Program, have enhanced hazard detection, disaster management institutions and coordination systems are stronger, warnings are more effectively disseminated, and communities are becoming more prepared to respond. In addition to receiving information from the Pacific Tsunami Warning Center (PTWC), in several cases the countries formulated their own warnings based on receipt of available seismic and oceanographic data. However, much more work needs to be done before the international IOTWS is fully developed.

Building on this progress, the ICG/IOTWS expects that one or more Regional Tsunami Watch Providers will become operational in 2008 or 2009, potentially meaning that the region will no longer rely solely on tsunami notifications from PTWC.

US-funded activities have been implemented in close coordination with international, regional, national, and local counterparts, and most have been incorporated into the ICG/IOTWS Implementation Plan. Progress has been achieved in all aspects of the end-to-end regional tsunami warning system, from oceanographic and seismic hazard detection to local community resilience. Participants agreed that the sustainability of the system depends on continued efforts to build and maintain these new capacities.

[1] The "Indian Ocean Tsunami Warning and Mitigation System" is the official IOC term for the regional system, which includes 28 Member States.

An important aspect of sustainability is for regional partners to adopt training modules and materials developed under the US IOTWS Program into their future capacity building and training programs. Key regional partners include the Asian Institute of Technology (AIT), which is jointly implementing a new International Tsunami Training Institute (ITTI) with the University of Washington and NOAA, and the Asian Disaster Preparedness Center (ADPC), which has secured funding for new training activities in tsunami rapid alert systems, incident command systems, tsunami warning concept of operations (CONOPS), and Coastal Community Resilience (CCR). US IOTWS Program products such as CONOPS and CCR policy and program frameworks may also be further incorporated into ICG/IOTWS and ICG Working Group plans.

The USG will continue technical support for the IOTWS in selected areas following Program close-out. NOAA and USGS plan to remain engaged with a number of government agencies and other partners in the region through new and ongoing partnership agreements focused on technology transfer, research and development, and capacity building. NOAA's PTWC will continue to provide interim tsunami notification services to the Indian Ocean until a Regional Tsunami Watch Provider is established. USAID is similarly exploring possible continuation of CCR-related efforts through new programs in disaster management and climate adaptation.

It is important to recognize the US IOTWS Program sought to address the most strategic, immediate needs in developing a functional IOTWS. Ongoing needs will continue to be addressed by long-term domestic programs, as well as through other donor efforts, such as Germany's €45 million five-year program with Indonesia. However, additional technology transfer and capacity building are required to ensure the IOTWS becomes fully operational. Tsunamis are the most difficult of all the natural hazards to prepare for, detect, analyze, and warn against, and the process of building a robust, reliable warning system is an undertaking of many years. Countries other than those most affected by the 2004 tsunami have received little or no tsunami reconstruction funding, and continue to require assistance in developing tsunami/multi-hazard warning capabilities. With the help of activities such as the IOC Secretariat's assessment of the member states' response to the September 12, 2007 tsunami, the ICG/IOTWS plans to identify additional needs region-wide for "upstream" tsunami detection, communications, and warning center capacity as well as "downstream" warning dissemination and preparedness.

Many of the "upstream" warning components established to date have provided an important foundation for national systems. Having these in place is helping local authorities and disaster managers better focus "downstream" efforts by adopting more appropriate standard operating procedures, local response systems, and awareness-building programs. Still, just as disaster risk management and preparedness remain significant challenges in general, the "downstream" aspects of the IOTWS will require continued support over the near and long term. Ideally, efforts to address downstream IOTWS needs should be integrated with broader disaster risk management initiatives.

Important gaps remain that require on-going technology transfer and capacity and institution-building. The ICG/IOTWS and other workshop participants identified several critical needs for additional donor investment in the IOTWS, including:

- Timely access to observational data, analyses, and other information products for tsunami warning purposes;
- Region-wide standard operating procedures (SOPs) for warning formulation and dissemination and additional assistance with developing functional and appropriate national standard operating procedures;
- Continued support for coastal community resilience (with a multi-hazards focus);
- Capacity and institution building at all levels to institutionalize the end-to-end tsunami warning and mitigation system nationally and across the region.

Ongoing funding, technical, and coordination needs identified at this transition workshop will be considered at the Fifth ICG/IOTWS meeting in April 2008 in Kuala Lumpur, Malaysia. The IOC and its partners, including the USG, need to explore possible options for long-term technical and

financial support mechanisms for the IOTWS. The development of any such mechanisms will likely require sustained diplomatic and technical engagement among several agencies of the United Nations, national government counterparts, and donors.

1. BACKGROUND AND OBJECTIVES

1.1 US SUPPORT FOR THE INDIAN OCEAN TSUNAMI WARNING AND MITIGATION SYSTEM

The US Agency for International Development (USAID) launched the US Indian Ocean Tsunami Warning System (IOTWS) Program in response to the December 2004 tsunami disaster. Through this two-year, $16.6 million effort, scientists and experts from the United States are sharing their technical expertise, providing guidance, and helping to build early warning system capacity within the Indian Ocean region so that governments and communities will be able to detect and prepare for tsunamis and related coastal hazards. The Program serves as the US Government's (USG) direct contribution to the ongoing international efforts to develop the regional IOTWS under the auspices of the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Intergovernmental Oceanographic Commission (IOC).

The US IOTWS Program promotes the development of an end-to-end integrated warning system, working primarily in the countries most affected by the tsunami—Indonesia, Sri Lanka, Thailand, India, and the Maldives. The US program involves several partner agencies with specialized expertise and access to technical resources for the region. In addition to USAID, these agencies include the National Oceanic and Atmospheric Administration (NOAA), US Geological Survey (USGS), US Department of Agriculture/Forest Service (USFS), and US Trade and Development Agency (USTDA). USAID's Regional Development Mission for Asia (RDMA) in Bangkok manages the program with the coordination support of a contractor, IRG-Tetra Tech Joint Venture, which serves as the Program Integrator (PI). The PI includes a consortium of technical organizations including the Asian Disaster Preparedness Center (ADPC) and the University of Rhode Island's Coastal Resource Center. USAID oversees and coordinates the efforts from the participating USG agencies and identify opportunities for complementary activities that can lead to the integration of individual activities to achieve a larger shared impact while maximizing the impact of limited resources.

The US IOTWS Program commenced in August 2005 to provide technical assistance to the region through an integrated, "end-to-end" approach—addressing all stages of early warning from initial hazard detection and warning to community-level response. US expertise is helping countries make decisions concerning strategic technology deployment at regional and national levels and is supporting extensive training and capacity building to augment detection, prediction, warning, and communication systems. The US IOTWS Program is organized into several inter-related program areas that address regional, national, and local levels of tsunami warning system development, as well as cross-cutting support activities, including:

- **Regional:** Technical support to the international IOTWS and regional hazard detection, observation, and forecasting systems
- **National:** National warning center capacity and warning communications
- **Local:** Local preparedness, mitigation, and resilience
- **Cross-cutting:** Regional exchanges, training, and information resources; overarching program coordination, administrative support, and outreach; and a Small Grants Program.

1.2 TRANSITION WORKSHOP

On December 6-7, 2007, the USG and UNESCO/IOC co-sponsored a forum to review progress and discuss strategies for sustaining activities with partners. The Governments of Indonesia, Sri Lanka, Thailand, Maldives, and India joined United Nations and US Government officials, as well as other disaster experts and business representatives, in Bangkok, Thailand to define priorities for future development and sustainability of the regional Indian Ocean Tsunami Warning and Mitigation System (IOTWS).

The objectives of the meeting were as follows:

- To present and evaluate overall progress of the international IOTWS effort achieved to date;
- To highlight the US government's commitment to the IOTWS and accomplishments in cooperation with program partners;
- To provide a forum for program partners to present and announce their commitment to sustaining key activities initiated with support from the US IOTWS Program in coordination with UNESCO/IOC Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), and to describe how they will do so;
- To provide these partners with an opportunity to promote the tools and systems developed with support from the US IOTWS Program to other potential partners in the region, and describe lessons learned and facilitate further linkages between partners; and
- To identify future priorities and resource needs for the international effort through the ICG/IOTWS.

2. SESSION SUMMARIES

2.1 WELCOME AND SETTING THE STAGE

Welcome and US Government Support for ICG/IOTWS

Richard Whelden, Deputy Mission Director, USAID/RDMA

Mr. Whelden welcomed participants and emphasized the importance of taking stock of progress achieved so far. He said discussions during the regional forum would help identify priorities for the continued development of the regional tsunami warning system. The workshop would highlight US contributions, as well as what the US Government has been able to learn from the program. Specifically, the regional nature of the program has provided best practices for USAID's management of regional programs. It has also strengthened partnerships within the US Government and with Indian Ocean countries and the United Nations. He urged partners to continue the work and partnerships that were developed under the US IOTWS Program.

Welcome by UNESCO/IOC

Peter Koltermann, Head, Tsunami Coordination Unit, UNESCO/IOC

Dr. Koltermann remarked that the achievements in the IOTWS should be shared with other regional tsunami warning systems that are now being established. In contrast to the Pacific Tsunami Warning System, the IOTWS has reached its current level over only two or three years, and it is also more decentralized. He emphasized that nations have a heavy burden to carry. The system is working, but the biggest challenge is to ensure that each of the 28 countries works in synchronization with the others. The IOC focuses on setting standards and guidelines, and on encouraging its member states to uphold their responsibilities. He expressed appreciation for the US Government's contributions, along with the efforts of many other countries, for helping to build the warning capacity of member states. He closed by saying that although the everyday activities of building capacity are not the most attention-grabbing, they are vital to ensuring the safety of all people in the Indian Ocean. The IOC would forward recommendations to its members for sustaining the progress achieved on the IOTWS.

US Contribution to the IOTWS: Lessons Learned and Tools for Sustainability

Orestes Anastasia, US IOTWS Program Manager, USAID/RDMA

Mr. Anastasia gave an overview of the program, its approach, and the progress achieved in each of the key areas of work. He also discussed the lessons learned over the past two years as follows:

- Program Scope, Timeframe, and Design: The end-to-end design is an important unifying vision. A short-term program timeframe encouraged quick results but at a cost to sustainability and coordination. Nonetheless, a comprehensive work plan with a "rolling design" provided structure with flexibility, and lessons learned from similar past programs contributed to the program's success.
- Program Management and Organization: The US IOTWS Program is an effective model for large-scale, complex USG disaster programming. For large regional programs, in-country presence is very important to maintain momentum and ensure effective coordination.
- Program Coordination and Outreach: Regular communication is essential with donors, partners, and stakeholders. In addition, donor countries must recognize the burdens that assistance programs place on its partners.
- Program Impact and Sustainability: Sustainability strategies need to be incorporated and implemented from the beginning of the program. Government buy-in, ownership, and

institutionalization of activities are key to long-term success. He noted that the approaches to sustainability include developing institutional mechanisms, maintaining and developing key partnerships, and increasing diplomatic outreach.

Overview of ICG/IOTWS and Status Report

Tony Elliott, Head, ICG/IOTWS Secretariat

Mr. Elliott's opened with an overview of the history and current role of the ICG/IOTWS. He also provided an implementation update and brief review of the performance of the IOTWS, based on an IOC Secretariat-led assessment following the earthquake and tsunami event on September 12, 2007. He finished with a summary of US IOTWS Program contributions to the regional system. From the regional point of view, the Pacific Tsunami Warning Center (PTWC) and Japan Meteorological Agency (JMA) warnings are currently the backbone of the detection capacity. Downstream, the Coastal Community Resilience (CCR) tool is being adopted by more and more countries, which strengthens local preparedness. He urged continued support from the U.S., particularly in the ICG/IOTWS working groups and other meetings, and in collaboration with other donors to leverage the efforts of each.

2.2 DETECTION AND FORECASTING

ICG/IOTWS Status: Seismic and Sea Level Monitoring, Risk Assessment, and Modeling

Jane Cunneen, ICG/IOTWS Secretariat, and David McKinnie, NOAA

Dr. Cunneen presented an overview of the seismic and sea-level monitoring network. The region aims to deploy a core network of 70 seismic stations, which have been identified as critical for detection and communications. Of these, 48 in are place. For sea-level monitoring, there are at least 40 coastal sea-level stations and 10 deep-ocean tsunameters planned for the Indian Ocean. Several risk assessment case studies have utilized different approaches in different countries based on needs and other variables. Although the variations in approach pose challenges, the results from the case studies are very important for developing guidelines and methodologies. Inundation modeling courses have helped strengthen technical skills in the region. Mr. McKinnie noted that the IOC provided an important structure within which the US IOTWS Program could be implemented. Furthermore, lessons and best practices could be shared throughout the ICG/IOTWS as a way to scale up efforts.

US IOTWS Program Contributions on Detection and Forecasting

Curt Barrett, NOAA, and Walter D. Mooney, USGS

Mr. Barrett described how NOAA provided support for the deployment of deep-ocean tsunameters and upgraded tide gauges. An internet-based interface, developed in collaboration with the Australian Bureau of Meteorology, for inundation modeling allows a community of scientists to share and analyze results. In addition to detection capacity, it is also important to ensure that information from tsunameters and tide gauges flows to where it is needed. To address this, NOAA worked with partners to upgrade GTS communications links in Sri Lanka and the Maldives. Dr. Mooney described USGS's work on the installation and upgrade of seismic and GPS stations. They also developed standards and protocols for issuing warnings, as well as seismic hazard maps for Southeast Asia.

Challenges for sustainability include continuing the operations and maintenance of valuable equipment that has been installed or upgraded in the region. Of the capacity that has been built through the US IOTWS Program, Mr. Barrett believes the biggest sustainability challenge lies with deep-ocean tsunameters. He and Mr. Mooney outlined sustainability strategies such as continuing technical support to partners, working with the IOC and regional partners (e.g. ADPC), continuing training, and continuing support to ICG/IOTWS working groups.

Partner Presentation: Overview of the Royal Thai Government Tsunami Warning System and Plans for the Thai DART Array Development and Operations and Maintenance

Smith Dharmasaroja, Chairman of the Committee on National Disaster Warning Administration, Thailand

Dr. Dharmasaroja described the Deep-ocean Assessment and Reporting of Tsunamis (DART) tsunameter that was jointly launched by Thailand and the US on December 1, 2006. He thanked the US organizations that provided support to enhance Thailand's detection capabilities, also noting that Thailand plans to buy two more tsunameters for installation in the Andaman Sea. He presented table outlining budget allocations by the Royal Thai Government for the tsunameter program, which includes a total of 213 million baht for purchase, deployment, and maintenance in 2008. He requested assistance from the IOC for support to maintain this capacity since it provides benefits for the entire region.

Partner Presentation: Indonesia–US Cooperation on Tsunami Buoy Development

Ridwan Djamaluddin, Head, Technology Center for Marine Survey, BPPT, Indonesia

Dr. Ridwan Djamaluddin presented an overview of DART activities with the US IOTWS Program, including the deployment on September 19, 2007, key training events, and participation in the International Tsunami Training Institute (ITTI) in July 2007. He also discussed Indonesia's Tsunami Buoy Program, or InaBuoy, which includes 13 buoys that are operated and maintained with international partners. In 2008, Indonesia plans to deploy 20 more buoys. He stated that their experience with the Krakatau buoy provided an important learning process, during which they built, deployed, maintained, recovered, and redeployed the buoy. He expressed appreciation to the US IOTWS program for supporting Indonesia's capacity development through technology transfer in this critical area.

Priorities for cooperation include improving real-time data available for analysis and processing. They request technical guidance on mooring line materials and design. Mr. Djamaluddin expressed his appreciation for the support of their tsunami detection network and indicated that Indonesia would not have achieved its successes to date without US technology transfer support. He looked forward to collaboration to continue expanding the network.

Partner Presentation: Risk Assessment and Design of Countermeasures for Tsunami Hazard: Case Study for the District and the Port City of Galle

S.S.L. Hettiarachchi and S.P. Samarawickrama, University of Moratuwa, Sri Lanka
N. Wijeratne, University of Ruhuna, Sri Lanka

Professor Hettiarachchi provided an overview of the project to develop a risk assessment case study for Galle, which was funded and implemented under the US IOTWS Small Grants Program. Through the project, the team undertook field investigations to understand impacts from the 2004 tsunami and develop a platform for mitigation options. The project also investigated the use of bio-shields for mitigation and conducted numerical modeling of tsunami wave propagation. Some mitigation methods for improving coastal community resilience included the conservation of coral reefs and sand bars, developing sand dunes, and using coastal vegetation to protect against tsunamis.

DISCUSSION: Detection and Forecasting

Key points from the discussion on detection and forecasting are summarized below:

- ***Funding for operations and maintenance.*** A critical issue is long-term operational costs for the IOTWS. The IOC is not a funding body and it is important that all countries in the region, which will all benefit from the regional warning system, are strongly encouraged to contribute to the operation and maintenance of detection equipment, communications systems, and other necessary elements. Similarly, a wide variety of industries benefit from the warning system, such as tourism or fisheries. Engaging the private sector could help lessen the burden on governments.

- ***Density of Indian Ocean DART buoy array compared to the Pacific.*** The optimization of the location of the buoy array has been made by mathematical modeling. In the Pacific, tsunamis are usually generated at great distances from the coasts. However, in Indonesia, the fault line is very close. So warning times may be very short, but they are still vital and it is important to have both the detection equipment and trained staff to operate these observation systems.
- ***Exchanging data within the region.*** A representative from India informed participants that the country has recently established a full-fledged tsunami warning system, including six buoys deployed and functioning, including two in the Arabian Sea. He stated that there is a need to set up a mechanism for sharing data internationally with partners, and that the ICG/IOTWS can provide a forum for those linkages.

2.3 WARNING DISSEMINATION

ICG/IOTWS Status: Warning Dissemination

Jane Cunneen, ICG/IOTWS Secretariat, and David McKinnie, NOAA

Dr. Cunneen presented an overview of warning and dissemination in the region. Twenty-six of 28 countries have established at least fundamental national tsunami warning centers (NTWCs), and 21 have confirmed that they receive warning information from PTWC. ICG/IOTWS Working Group (WG) 5 formed a task group to develop guidelines on the concept of operations, standard operating procedures, and performance indicators for regional tsunami watch provider and NTWCs, such as, for example, elapsed times for tsunami warnings, evacuations, or cancellations. Mr. McKinnie suggested that the CONOPS framework is an important vehicle for identifying and standardizing regional tsunami watch provider services.

US IOTWS Program Contributions on Warning Dissemination

David McKinnie, NOAA, and Stan Goosby, Pacific Disaster Center

Mr. McKinnie opened by describing CONOPS as a set of practices and principles to establish a multi-hazard warning center. State-of-the-art knowledge and experiences on the hardware, software, and human resource requirements to provide accurate analyses, forecasts, and warnings have been compiled into the *Tsunami Warning Center Reference Guide*, which was distributed to all participants on CD. He emphasized that the US IOTWS Program drew on the expertise of those at NOAA and numerous regional partners to develop the resource guide.

Mr. Goosby described the CONOPS developed with Thailand under a grant from USTDA. This activity focused on data integration, analysis, and tools for Thailand's National Disaster Warning Center (NDWC). Mr. McKinnie and Mr. Goosby also briefly discussed the Tsunami Alert Rapid Notification System (TARNS), a framework for delivering warning information from national to local levels in Thailand. As part of TARNS and the efforts of other international organizations, approximately 25,000 people participated in the Andaman Wave tsunami evacuation drill in July 2007. The US Program initiated similar tsunami early warning system activities in Indonesia. To help warning centers reach remote locations in Sri Lanka and Indonesia, NOAA also introduced Radio and Internet for the Communication of Hydro-Meteorological and Climate Related Information (RANET) technologies, which uses satellite broadcasts with internet applications, FM radio, HF radio, and SMS.

Challenges for sustainability include the need to further develop institutions, rationalizing approaches across sectors and partners, and ensuring sub-national support for approaches and tools. In addition, the newly built capacity requires continuous training and periodic drills. Coverage of communications systems should be expanded. For example, while 200 RANET units have been distributed, many more are needed. Strategies to address these challenges include maintaining partners and ensuring that resources, such as the CONOPS guide, are incorporated into regional

activities such as ITTI. Many of the resources and tools can be used to address multiple hazards in addition to tsunamis.

Partner Presentation: International Tsunami Training Institute (ITTI)

Amrit Bart, Asian Institute of Technology

Dr. Bart stated that ITTI was an opportunity for sustaining the US IOTWS Program achievements in building capacity. He believes ITTI has brought professionals together from a range of disciplines to create a community of individuals interested in learning and working towards tsunami resilience. The first course was held at the University of Washington in July-August 2007, with field visits and trainers who are the best in their field. Faculty from the Asian Institute of Technology (AIT) participated in that course and are now preparing to "bring it home" for the first course in Asia, which is scheduled for March 10-26, 2008. The three core modules cover assessment, warning, and preparedness. Organizers aim to build on the original course by strengthening the final module on CCR, drawing on a mix of Asian and US experts as resource persons, and visiting areas in Thailand that were affected by the tsunami, including Khao Lak, Baan Nam Khem, Koh Prathong, and Ranong.

Dr. Bart discussed how AIT's graduate programs can be used as a sustainability strategy for US IOTWS Program achievements. It has an extensive network of partnerships and has established Memoranda of Understanding with international institutes of higher learning such as the University of Washington. ITTI also strongly complements AIT's Disaster Preparedness, Mitigation, and Management Program.

DISCUSSION: Warning Dissemination

Key points from the discussion on warning dissemination include:

- ***Financial sustainability.*** Regional partners such as the United Nations Economic and Social Commission for Asia Pacific (UNESCAP) and the Asian Disaster Preparedness Center (ADPC) are instrumental in seeking and identifying funding opportunities and ensuring that the priorities are addressed in programs. The ITTI program fits well with AIT's graduate program framework so sustainability will be achievable. Future courses could be conducted in Indonesia, and the Caribbean region has also expressed interest. Participants noted that if the course is offered to a broader range of students, and if people are willing to pay for the course, then it will be more sustainable. AIT is opening the course beyond the five US IOTWS Program countries, and will consider holding the course in other countries in the future.
- ***Addressing evacuation protocols in the CONOPS guide.*** Because local needs and circumstances are so specific in communities, the *Tsunami Warning Center Reference Guide* did not include evacuation. Further discussion on this topic could come through the CCR initiative and application of tools in another guidebook developed under the US IOTWS Program titled *How Resilient is Your Coastal Community?*
- ***Intellectual property of materials in the ITTI course.*** Materials developed for ITTI under the US IOTWS Program will be in the public domain.

2.4 MITIGATION, RESPONSE, AND RESILIENCE

ICG/IOTWS Status: Mitigation, Preparedness, and Response

Jane Cunneen, ICG/IOTWS Secretariat, and David McKinnie, NOAA

Dr. Cunneen remarked on the need for inclusion of "downstream" activities into the ICG process. The new Working Group 6 was established to focus on such "downstream" issues at the third sessional meeting of the ICG/IOTWS in August 2006. The ICG/IOTWS aims to develop an action plan based on identified national needs and capacities on mitigation, preparedness, and response. A

workshop to assess the level of community resilience of member states and review case studies will be conducted in Seychelles in February 2008. Based on discussions there, a proposal will be developed to address the identified gaps in community resilience. Mr. McKinnie noted that CCR helped to integrate ideas into a single conceptual framework, resulting in an integrated approach that has been tested locally with partners.

Mitigation, Response, and Resilience: US IOTWS Program Contributions

Deanne Shulman, USFS, and Kitty Courtney, Program Integrator

Dr. Courtney provided an overview of the CCR framework, which was designed to address key downstream issues: How can communities better plan and prepare for hazard events like tsunamis? At the same time, how can communities deal with economic, environmental, and population changes? In answer to these challenges, the US IOTWS Program attempted to develop an integrated approach, and then worked with partners from across the region to test and apply it in Indian Ocean communities. The CCR initiative involved intensive five-day training courses and fieldwork in Indonesia, Maldives, Sri Lanka, and Thailand. CCR teams conducted assessments in over 30 communities. Over the course of two years, capacity gaps were identified and addressed in all eight resilience areas: Governance; Society & Economy; Coastal Resource Management; Land Use & Structural Design; Risk Knowledge; Warning & Evacuation; Emergency Response; and Disaster Recovery.

Challenges for sustainability of CCR include how to incorporate it into all sectors and ensure that assessment results are used to inform policies, plans, and programs at the national, sub-national, and local levels. There is also a need for a mechanism to ensure that the CCR tools and framework are continually improved as more and more practitioners gain experience in applying the tools on the ground. Sustainability strategies include incorporating it into the ongoing activities of partners such as ADPC and others, since CCR tools support integrated solutions in a variety of circumstances beyond disaster management.

Ms. Shulman described achievements in the Incident Command System (ICS), which is a multi-hazard disaster response system that helps ensure accurate information, strict accountability, planning, cost effective operations, and logistical support for any incident. The program has been implemented extensively in Sri Lanka where a cadre of "master trainers" underwent a series of courses on ICS.

Challenges for sustainability of ICS include transferring theoretical understanding towards practical applications. In addition, new trainers and operational staff will need continued capacity building at the national to district to local levels. As with other program activities, partnerships and integration into ongoing activities is a key sustainability strategy.

Partner Presentation: Incorporation of ICS and CCR into National Programs, Sri Lanka

Lalani Imbulana, Director, Preparedness Planning, Disaster Management Centre, Sri Lanka

Ms. Imbulana presented on ICS and CCR implementation in Sri Lanka. Following the 2004 tsunami, decision-makers realized that the country needed a professional approach to disaster response to ensure efficiency and accountability. Under the US IOTWS Program and with technical support from the US Forest Service, Sri Lanka's Disaster Management Center and other relevant agencies embarked on an ICS training program to establish and strengthen the disaster management response structures. Sustainability strategies for ICS include obtaining Cabinet approval to institutionalize ICS, disseminating training and the district and local levels, and incorporating ICS in disaster management policies and plans. To promote this, ICS documentation should be adapted and standardized for the Sri Lankan context.

CCR assisted in identifying gaps in resilience in communities in seven districts. Challenges included providing sufficient in-depth training for local practitioners. Sri Lanka currently lacks a group of experts in CCR to disseminate knowledge and ensure sustainability. Ms. Imbulana reviewed the top priorities for CCR as follows: 1) Need to interact with other agencies, such as the Red Cross, to

gain exposure and experience in a wide range of risk assessment tools; 2) Nurture a CCR expert group in Sri Lanka; 3) Conduct at least one or two more intense training programs; and 4) Make available more copies of the CCR guidebook, preferably in Sri Lanka's national languages, for practitioners.

Partner Presentation: School Education Program in Padang City
Patra Rina Dewi, Executive Director, KOMUNITAS SIAGA TSUNAMI (KOGAMI), Indonesia

Ms. Dewi presented on the school education project implemented by KOGAMI under the US IOTWS Small Grants Program. The three main objectives of the project were to increase knowledge of disasters, develop school hazard maps, and conduct local disaster simulations based on the hazard maps. The project was successfully implemented in 30 elementary schools, 21 junior high schools, and 10 senior high schools. A total of approximately 17,700 students and 900 school staff members underwent training on disaster preparedness and proper evacuation.

Challenges for sustainability are to continue improving the local early warning system so that people trust the messages and instructions; to continue training community members on appropriate responses to a warning, including the remaining 199 schools in the "red zone"; and to ensure that there are safe evacuation shelters, especially in areas where the population is very dense and the only choice may be a vertical shelter. Sustainability strategies include continuing training and drills in all 60 schools. The Education Department and KOGAMI will collaborate to design a curriculum and will replicate it in other districts. KOGAMI will continue working with the government and international organizations to develop Standard Operating Procedures (SOPs) and contribute to disaster preparedness planning.

DISCUSSION: Mitigation, Response, and Resilience

Key points from the discussion on mitigation, response, and resilience include:

- ***Value of integrating disaster preparedness with other resilience elements.*** The CCR framework was established with the understanding that if a community cannot govern itself, it will not be successful in promoting coastal community resilience. There is a clear need to address socio-economic problems as part of a building disaster readiness. Practitioners must take on these challenges in culturally and economically appropriate ways while working with communities.
- ***Drawing on IOC assessments in developing the CCR framework.*** Following the tsunami, the IOC conducted assessments, which included examining countries' capacities for disaster recovery. Members of the US IOTWS Program team were involved in those assessments and described how those activities helped shaped the CCR benchmarks. The CCR tool could now be used to assess countries' progress against the baseline information from the IOC assessments.

2.5 REGIONAL PARTNERS' ROLES IN SUSTAINING ACTIVITIES

UNESCAP Tsunami Regional Trust Fund Overview
Charles Davies, UNESCAP

Mr. Davies provided an update of the $12.5 million Tsunami Regional Trust Fund established in 2005 and managed by UNESCAP. He also discussed the key eligibility criteria, the fund's governance structure and review process, progress, and the upcoming fourth round of funding. Implementation of the fund began with a mapping study of needs in the region, and to date $4.25 million has been approved for six projects. Applications for the fourth round opened in December 2007 and further information is available at www.unescap.org/pmd/tsunami_index.asp.

DISCUSSION: UNESCAP Tsunami Regional Trust Fund Overview

- ***Fund approval process.*** A participant questioned why the approval process seems to be proceeding slowly. UNESCAP answered that a wide variety of factors determine the schedule, for example the funds can be used for a variety of activities. The advantage of not programming all of the money very quickly is that lessons from previous projects can be applied to later ones. In addition, the fund targets regional activities and there are currently a limited number of appropriate organizations. IOC commented that the review process was very rigorous and transparent. The grants that have been awarded fit with IOC priorities in the implementation plan.

  UNESCAP stated that it has mainly acted as an administrator for the fund. In choosing which priorities to address, UNESCAP has coordinated with a number of agencies such as the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), United Nations International Strategy for Disaster Reduction (UNISDR), United Nations Development Program (UNDP), World Meteorological Organization (WMO), and IOC, bringing together a number of technical experts. This group reviews the gaps and proposals, and works together to ensure that approved projects will address those gaps. The one requirement is that projects should be regional. Beyond that, the fund aims to take a balanced approach across activities.

- ***Applications.*** The application includes standard questions about the technical design and management arrangements of the project. UNESCAP encourages anyone with questions to contact them for additional information.

  Of a total of 36 proposals, 23 were received in the first round, nine were received in the second round, and four were received in the third round. UNESCAP is exploring how to address the decreasing number of proposals received. It may put more efforts towards reaching out to new organizations.

- ***Countries eligible.*** Countries eligible for the fund must be UNESCAP member states, which include approximately 60 countries in Asia. Not all of the Indian Ocean countries are eligible. For example, in a case where a project is implemented through ICG/IOTWS WG6, one option would be to fund only those countries that are UNESCAP members, and it would depend on the type of activities proposed. The activity could entail developing a model template or a model SOP, which could be used by any country. However, if the activity involves training in specific countries, then UNESCAP advises proposing the training only for UNESCAP countries.

- ***Activities eligible.*** In general, the fund is targeted for tsunami early warning through a multi-hazard approach. Regarding CCR, some funding has been approved for ADPC to implement CCR activities.

- ***Monitoring and evaluation (M&E).*** UNESCAP has developed an M&E framework that incorporates general monitoring of projects, and next year there will be a comprehensive evaluation of the overall fund. Regarding individual grants, some have monitoring components while others do not. Any grant awarded one million dollars or more is required to have an M&E component. Participants recommend a streamlined, yet rigorous M&E framework.

ADPC's Role in the Implementation and Sustainability of US IOTWS Program Activities

A.R. Subbiah, Director, Climate Risk Management, ADPC

Mr. Subbiah presented on the involvement of the Asian Disaster Preparedness Center (ADPC) in the implementation of the US IOTWS Program, and the organization's current and planned activities to sustain the progress achieved under the US IOTWS Program. ADPC has been the Program's main regional partner; in that role, it has provided technical expertise for capacity building on hazard

detection, warning dissemination, mitigation, and local preparedness and response. It has already established MOUs with government agencies in partner countries, in addition to countries beyond those involved in the US IOTWS Program, to continue these activities. Funding has been secured from the United Nations and other bilateral donors. ADPC plans to continue activities on CONOPS, TARNS, ICS, and CCR, and is seeking partnerships with various international organizations.

2.6 PROGRESS ACHIEVED: SEPTEMBER 12, 2007 TSUNAMI

Regional Overview of Progress Achieved

Tony Elliott, Head ICG/IOTWS Secretariat

Mr. Elliott gave an overview of findings from an assessment the ICG/IOTWS Secretariat conducted following the earthquake and tsunami event on September 12, 2007 to assess progress and performance of the regional tsunami warning system. The Secretariat conducted a survey of Indian Ocean countries and compiled the results from the 21 countries that responded. The survey asked about countries' experiences receiving interim advisory information, responses to warnings, actions taken following the earthquake, and monitoring and modeling. The assessment included a comparison of tsunami travel times with warning and cancellation times. From the results, it is clear that significant improvements have been achieved, even in comparison to just one year ago. However, there is still much work to be done before the international IOTWS is fully developed. The report will be available in the first quarter of 2008.

DISCUSSION: Regional Overview of Progress Achieved

- ***"Earthquake detected".*** "Earthquake detected" refers to the time at which a national warning center reported that they were aware a major earthquake had occurred. Many countries mentioned that information from the PTWC alerted them, in addition to the CISN website and USGS website.
- ***Official vs. voluntary evacuation.*** It is difficult to definitively classify an evacuation as official or voluntary. For example, in India there was not an official national warning, but one state government issued a warning.
- ***Assessment results.*** Participants commented that the assessment results and methodology should be carefully reviewed by the expert Working Groups of the ICG/IOTWS and ICG itself. It should be emphasized that the assessment shows that countries' efforts are achieving progress, but there is still room for improvement. The IOTWS community can take these responses and interpret them to identify remaining gaps.
- ***USGS information.*** The ICG/IOTWS Secretariat thanked USGS and other organizations for their information and graphics.

Progress Achieved: Indonesia

Fauzi, Head, Earthquake Engineering and Tsunami Division, BMG, and Vidiarina, Senior Adviser, German Indonesia Tsunami Early Warning System (GITEWS), Indonesia

Dr. Fauzi and Ms. Vidiarina described Indonesia's experience on September 12, 2007, explaining the timeline of actions the Indonesian government undertook once the earthquake struck. The alarms were triggered less than two minutes after the earthquake, and a warning was sent approximately two minutes later. This message reached the general public by radio, television, SMS, and other local communication networks. In some areas, RANET units were also able to provide information. The presentation also covered lessons learned from the September 12 tsunami event regarding the remaining challenges. At the institutional level, SOPs have not yet been developed so agencies and individuals respond without clear directions or defined roles. Warning messages can also be more clearly communicated. At the community level, awareness should be raised on the appropriate

responses to a warning. For example, only 25% of people evacuated, and in many cases they did not evacuate until 30 minutes after the earthquake. Priorities in addressing these challenges include the following:

- Ensure the sustainability of InaTEWS and establish SOPs to improve decision-making and communication structures;
- Train disaster management agencies and other relevant organizations on their roles and responsibilities during an emergency;
- Establish better communication links between the national and local levels, for example Padang needs more channels to receive BMG warning messages;
- Provide additional early warning dissemination devices to relay information to the communities at risk;
- Increase the robustness and accuracy of tsunami warning forecasting by improving tsunami database simulations and the observation network; and
- Enhance preparedness and understanding of risk through hazard mapping at the community level and evacuation planning, especially in dense areas.

DISCUSSION: Progress Achieved: Indonesia

- ***Reaching the last kilometer through RANET.*** One hundred fifty RANET units have been distributed in Indonesia through the US IOTWS Program, of which 136 are installed by the end of 2007. Noting that RANET does not cover eastern Indonesia, an Indonesian representative suggests that the eastern region receive support for communications to the last kilometer.

  In one case, the RANET unit was turned off, so it did not receive the warning message. Unlike a mobile phone system, incoming messages are not stored on the network for retrieval when the unit is turned on again.
- ***Asian Conference on Disaster Reductions in 2008.*** This conference will be held in November 2008 and one of the main themes will be public–private partnerships. These partnerships present an opportunity for the maintenance and sustainability of the warning system.
- ***Low rate of evacuation.*** Many local people did not understand the information from BMG and other government agencies. For example, the instructions on where to evacuate were confusing. In addition, September 12 was the first day of Ramadan and some people chose to pray in the mosque instead of evacuating.
- ***Development of SOPs.*** In light of the great importance in ensuring smooth evacuations, particularly for an earthquake- and tsunami-prone country like Indonesia, a participant expressed surprise that SOPs have still not been developed three years after the 2004 tsunami. Indonesian representatives replied that local governments have the mandate to develop SOPs. So while national agencies have provided workshops and guidelines, local agencies are working to ensure that SOPs are appropriate and accepted in their specific circumstances.

  Local governments also want to ensure that their SOPs are in line with any national disaster management policies, which have not yet been developed. The Disaster Management Law was finalized in 2007, which includes local regulations.

  The SOP should include evacuation as well as how people's property will be protected. This complexity is another factor contributing to the slow development of SOPs.

  The national InaTEWS coordinator (RISTEK) is working closely with its sister agencies to facilitate local SOP development.
- ***Safe evacuation in Padang.*** Most "safe areas" in Padang are located quite far away from the town, which is densely populated. It would be very difficult to safely and quickly evacuate

hundreds of thousands of people. Padang's local government will require support to address this issue. They may need to explore options for vertical evacuation.

Progress Achieved: Maldives

Fathmath Fairooza, Geological Officer, and Ali Wafir, Deputy Director, Department of Meteorology, Maldives
Anwar Ali, Deputy Director, Ministry of Planning and National Development, Maldives

Representatives from the Maldives presented on progress achieved in the warning system. Maldives plans to complete its seismic network by the end of January 2008 and to complete a multi-hazard EWS by mid-2009. Risk assessments and gaps have already been identified. On September 12, the National Tsunami Warning Center (NTWC) issued a warning, based on information from PTWC and JMA, by phone, fax, SMS, radio, and TV. However, the mobile phone network was overloaded so there were some communication problems in distributing the tsunami information. The heavy coverage of the event by international media caused unnecessary panic among many people. Key priorities in improving tsunami early warning in Maldives are as follows:

- Conduct more awareness programs and mock drills in schools and local communities;
- Improve coordination between stakeholders; and
- Continue establishment of a multi-hazard EWS and emergency communications plan in collaboration with the Telecommunications Authority of Maldives, the National Disaster Management Center, the Maldives Meteorological Department, and other relevant organizations.

Progress Achieved: Thailand

Tavida Kamolvej, Disaster Management and International Affairs Advisor, NDWC, Thailand

Dr. Kamolvej presented Thailand's warning experiences on September 12, 2007 and provided an overview of progress and remaining priorities for the national system. Main achievements include the revision of SOPs and strengthening the decision support system. There has also been significant capacity building for various disaster management agencies and increasing community awareness. The warning infrastructure now includes an interoperable system in the country with 144 warning towers. On September 12, NDWC analyzed the earthquake information received and determined that a public alarm was not needed. They used the national communications network to send out a confirmation of "no tsunami threat". The top three priorities for further improvements to the system include:

- Enhance technical and human capacity related to the tsunami and earthquake warning system and nationwide full-scale exercises and evacuations;
- Improve multi-hazard capability and database management;
- Collaborate with institutions and build a network of disaster experts and practitioners domestically, regionally, and globally; and
- Define institutional roles and responsibilities, and build capacity for early warning dissemination and research.

DISCUSSION: Progress Achieved: Thailand

- ***Contributions and involvement of various organizations.*** Although the presentation emphasized NDWC's activities, other Thai Government agencies as well as international, national, and local organizations have made significant contributions to Thailand's tsunami warning system.
- ***Decision to evacuate.*** In Thailand's SOP, an earthquake of magnitude 7.8 or higher calls for an evacuation. However, when the warning center received additional information and conducted further analysis, officials realized that the earthquake was further south than initially believed and did not pose a tsunami threat.

Progress Achieved: India

Vinay Sehgal, Professor and Head, and Biswanath Dash, Assistant Professor, National Institute of Disaster Management, India

Dr. Vinay described India's experience on September 12, explaining that, based on an initial analysis, the first bulletin was issued 25 minutes after the earthquake with an alert issued for the Andaman and Nicobar Islands only. The alert was withdrawn in a fourth bulletin approximately four and a half hours after the earthquake. He also described the communication pathways to the local level and how capacity has improved since 2004. The top priorities for India's tsunami warning system include the following:

- Strengthen last mile connectivity by improving the real-time communication network from the district to communities, including standardizing warning content, channels, format, and language;
- Build capacity by adapting ICS for a multi-hazard, multi-level response system and train administrators, officials, academicians, and practitioners;
- Improve community preparedness with tsunami shelters, hazard maps, increased awareness, and drills;
- Mitigate coastal tsunami risks with bio-shields, dunes, infrastructure design guidelines, and sea walls;
- Implement coastal zone management guidelines; and
- Establish strong linkages with regional and other international agencies.

DISCUSSION: Progress Achieved: India

- ***Determining risk after the earthquake.*** Immediately after the earthquake, India's analysis showed that the southeast and southwest coasts would likely be affected by a small tsunami of 20 cm and the Andaman and Nicobar Islands would be affected by a negligible run-up. This was determined by modelling since deep-ocean observation (buoy) information was not yet available.
- ***Sharing data.*** India used international data in its modelling and is now discussing internally the best way to share its data internationally. The Government of India wants to be sure that the Indian system is providing reliable data, and expects that in time it will be linked with the regional system. Participants suggested that India could provide information at the next ICG/IOTWS meeting on how it will share data and how the system became operational.
- ***Evacuation.*** Although people received information from the television, the action to evacuate was initiated only once district officials determined the need.
- ***Cost of the system.*** Roughly $50 million has been spent in establishing India's tsunami warning system, and the running costs have not yet been fully calculated.

Progress Achieved: Sri Lanka

Lalani Imbulana, Director, Preparedness Planning, Disaster Management Centre, Sri Lanka
P.M.J. Banda, Director, Meteorology, Meteorology Department, Sri Lanka

Ms. Imbulana and Mr. Banda provided an overview of the communication network from national to local levels for tsunami warnings, as well as how the network and disaster management institutions have improved since 2004. On September 12, the government issued a tsunami warning advising people in the eastern and southern regions of the coast to evacuate. The warning was later cancelled and people were advised that it was safe to return. The government plans to provide bicycles, motorbikes, and 2,500 sirens and loudspeakers in 2008 to communities in vulnerable areas to improve warning dissemination. The priorities for continued improvement in Sri Lanka's tsunami warning system include the following:

- Develop human resources for seismology and ocean-based data analysis;
- Establish reliable and efficient dissemination system for the last mile;
- Develop SOPs for emergency operation centers at the national and district levels; and
- Conduct mock drills at the district, division, and community levels.

2.7 ADDRESSING PRIORITIES

Addressing Priorities
Rick Bailey, Vice Chair, ICG/IOTWS

Mr. Bailey briefly reviewed the governance structure of the ICG/IOTWS and the current status of the regional warning system. He recommended that the issues discussed during this forum be raised again at the next ICG/IOTWS meeting in Malaysia. He identified the key priorities for maintaining the momentum in progress of the last three years as follows:

- Gather more seismic and sea-level information to improve accuracy of analyses;
- Strengthen Regional Tsunami Watch Providers (RTWPs) and transition the interim tsunami bulletin service;
- Continue building capacity on effective warning messages, risk and hazard assessments, public and media awareness, and preparedness;
- Promote greater coordination between institutions and facilitate related activities;
- Improve performance measures and monitoring; and
- Integrate tsunami warnings with multi-hazard warnings.

Panel Discussion
Fauzi, ICG/IOTWS WG1; Sam Hettiarachchi, ICG/IOTWS WG3; Michel Vielle, ICG/IOTWS WG6; Rick Bailey, Vice Chair, ICG/IOTWS; Tony Elliott, Head, ICG/IOTWS Secretariat; Peter Koltermann, Head of Tsunami Coordination Unit, UNESCO/IOC; Patrick Kratt, ISDR

Representatives of ICG/IOTWS working groups, UNISDR, and other panel members discussed the status of activities, contributions under the implementation plan, and key challenges and priorities.

Working Group 1: Seismic measurements, data collection, and exchange. One of the most important issues is to identify potential earthquakes with a magnitude 6.0 or greater and their precise locations. The core stations required to reach this goal and develop a network for the Indian Ocean have been identified. The main technological gaps in those countries have also been identified. Equally important is the need to share real-time data between Indian Ocean countries. USGS and others have the experience to operate and maintain the system, so assistance from those organizations is requested. Indonesia now operates 73 stations. Although capacity is not the same across all countries in the region, WG1 reports progress in the development of seismic networks.

Many countries are at the stage of establishing seismic stations, so sharing data is not yet the main concern for them. However, those countries with well-established networks are encouraged to share their information and data. Participation in all of the working group meetings varies. Travel is often lengthy and expensive, so they request support for participants with limited funds. For example, in the most recent WG1 meeting, there were representatives from only five countries.

Working Group 2: Sea-level data collection and exchange, including deep-ocean tsunami detection instruments. Sea-level stations established before 2004 had the primary purpose of measuring the climate. WG2 aims to determine the optimal design and network for providing

tsunami warnings. Another aim is to develop standards on real-time data access, data sharing, and interoperability.

Working Group 3: Risk assessment. WG3 operates in a multi-hazard risk framework, which has three components: hazard, vulnerability, and capacity. All three sub-working groups are collaborating and have identified gaps in assessing tsunami risk. WG3 is developing guidelines for risk assessment for the Indian Ocean region and is working with Geoscience Australia to develop a tsunami hazard map. UNDP is a key partner for WG3 activities.

Working Group 4: Modeling, forecasting, and scenario development. WG4's main aims are to develop the tools and models for deep ocean propagation and to provide training. The greatest limitation so far is adequate bathymetric and topographic data. COAST MAP IO is a UNESCO IOC project to increase capacity of member states to collect this data. The WG has developed guidelines for model standards, as there are so many different modelling programs being used by Indian Ocean countries. Training in the use of the ComMIT interface (based on the MOST model) has been conducted for a total of 47 people from approximately 16 countries, with a goal of training at least two people from each member state. The next training session will take place in Seychelles in January 2008.

Working Group 5: The establishment of a system of interoperable advisory and warning centers. One of the main issues in establishing a truly end-to-end regional tsunami warning system is interoperability. Priorities for WG5 are to develop a network of interoperable RTWPs and NTWCs, identify approaches for testing the system, and to get an accurate assessment of what the regional system is currently delivering.

Working Group 6: Mitigation, preparedness, and response. WG6 was the last group created and its focus—and therefore its progress—is less tangible than the other WGs. It has faced greater coordination challenges since the relevant organizations for mitigation, preparedness, and response are more varied, and the vast majority of those organizations will not be aware of WG activities. At the intergovernmental level, the WG can only recommend steps to take and provide information to its member states for action at the local levels. WG6 conducted an assessment and developed an action plan with 18 priorities, but there have been several barriers to progress. The priorities include improving warning dissemination at the last mile, developing SOPs at the local level, identifying socially and culturally appropriate public awareness methods, and obtaining government commitment for activities.

United Nations International Strategy for Disaster Reduction (UNISDR). UNISDR has worked with donors to take the outcomes achieved "upstream" and ensure that they are sustained at the national and community levels. The program on Building Resilience to Tsunamis in the Indian Ocean works to strengthen disaster risk reduction capacity of government and communities. Partners for the program include UNDP, UNEP, and ADPC. UNISDR is involved with the ICG/IOTWS process and focuses its support to WG6. It aims to establish a regional platform for disaster risk reduction, drawing on its experiences with the global platform. UNISDR looks forward to further discussion on sustainability and the lessons from the US IOTWS Program, particularly regarding multi-hazards.

DISCUSSION: Addressing Priorities

- ***Promoting Engagement in the IOC ICG/IOTWS Process***. The IOC's ICG/IOTWS process is critical to an effective "system of systems" for tsunami warning and mitigation. Active participation by member states is required if the process is to serve the need of the countries in the region. One hurdle has been maintaining consistency of participation in ICG working groups and meetings as well as lack of clarity about points of contact for engaging the member states. Countries need to be encouraged to participate consistently.

  In addition, participating in the ICG working groups is costly for any member state since there are six working groups, each meeting at different times. Participants suggested that

working group meetings could be held simultaneously and other steps taken to ease the burden on member states. Least developed countries will continue to need financial support to continue to participate in the ICG process.

Participants noted that WG 6 presents a particular challenge. It serves a very important role, yet the scope of the terms of reference, the very large number of organizations involved in disaster risk reduction and coastal community resilience, and that implementation of WG6 activities is inherently local present obstacles. Many WG 6 participants are new to the ICG process and it is a challenge to indentify a single point of contact for WG6 participation. Recognizing the unique aspects of WG6, participants suggest exploring funding options to support these very important WG6 activities. IOC may consider conducting a gap analysis focused on local needs and funding opportunities.

- ***IOC Investments in the ICG/IOTWS.*** The IOC's budget is $2.8 million for two years to cover all activities in tsunami warning systems around the world. IOC representatives noted these financial constraints and the need for increased funding to all for improved support to the region.
- ***Strategies for ongoing investments in sustainability.*** Most major IOTWs donor programs are phasing out after intensive effort. But critical needs for system development, capacity building, and regional partnerships remain to ensure viable and sustained national and regional tsunami warning systems. For example, Indonesian representatives requested continued knowledge transfer from the US on tsunami warning. In addition to building capacity on technical communications and warning dissemination, it is also important to effectively communicate the continued need for developing tsunami warning system capabilities and create political will among decision makers. This would help ensure funding and sustainability for the system.

  Participants noted that holding the US IOTWS Program transition workshop earlier would have been useful. Partners would then have been able to begin identifying and implementing sustainability strategies earlier. That would help minimize breaks in activities. To help promote sustainability, the workshop proceeding should be presented at the next ICG/IOTWS meeting in Malaysia (April 2008)
- ***Ongoing technical support and training.*** As countries continue to develop SOPs and the elements required for their development, including inundation maps, contingency plans, evacuation planning, and other issues, there is an ongoing need for cooperation between US technical agencies and their counterparts in the Indian Ocean. In addition to assisting with system development, this cooperation would help incorporate international standards with local needs and established protocols. Participants noted the value of outside review and consultation for SOPs and other aspects of the end-to-end tsunami warning and mitigation system.
- ***Strengthening regional partnerships and professional support networks.*** An effective IOTWS requires the sharing of information and experiences among Indian Ocean neighbors. Organizations such as the IOC and institutions like the International Tsunami Training Institute can help promote exchanges among professionals involved in operating and maintaining National Tsunami Warning Centers, but other mechanisms are needed as well.
- ***Partnerships for improving data collection, data sharing, and data quality.*** Free and open access to data is critical to an effective IOTWS. Some national policies on the sharing of real time information could hamper effective operation of the IOTWS in the event of a tsunami; there is a need to address this issue in appropriate international forums. There is also a need to promote data collection—making the seismic, coastal sea level, and deep ocean sea level networks more robust—improve real time data sharing, and encourage more collection of bathymetric and topographic information for risk analysis, hazard mapping, and inundation models. In many countries there is insufficient data to run precise models. The quality of data collected should be improved and presented in a usable way.

And there is an ongoing need for increased human resource capacity in data analysis, GIS, and other analytical disciplines.

- ***Adapting information for local/community use.*** In many countries developing risk maps, evacuation zones, and other risk and preparedness tasks are the responsibility of local governments. Inundation maps, hazard maps, and the numerical models often used to prepare the present complex information that should be carefully adapted for training and awareness events and materials in local communities. National officials sometimes assume people will get their messages and understand them, but repeated testing should occur in communities to gather feedback on how the message is interpreted. Multi-hazard warning systems will reduce confusion and leverage resources. It is important to work with the media in crafting messages and sharing information to avoid panic. Another advantage of establishing reliable warning communication is so the public looks to the government for information, reducing the impact of rumors in an emergency. Ongoing efforts to tailor technical information for local requirements and to increase local technical capacity are required.

Next Steps for IOC and Development of the IOTWS

Tony Elliott, Head, ICG/IOTWS Secretariat

Mr. Elliott said he believes the core network of detection equipment is 70% complete and is optimistic of reaching implementation targets by the 2010 deadline. From the workshop discussions, he notes that there has been significant progress in the upstream elements of the system, but there is a need to put more effort toward the community level. Sustaining the operation of the hardware that has been installed to date is clearly very important. Another issue requiring attention is establishing mechanisms to share the data that is generated by all of the detection equipment. Finally, capacity building across the board will continue to be critical to the sustainability of the IOTWS. He concluded by thanking the US IOTWS Program for organizing the workshop and bringing everyone together. He assures participants that the results of the workshop will be forwarded to the next ICG/IOTWS meeting and urged the US to continue its involvement in the ICG/IOTWS.

2.8 SUMMARY OF WORKSHOP OUTCOMES AND CONCLUSIONS

Workshop Outcomes and Conclusions

Orestes Anastasia, US IOTWS Program Manager, USAID/RDMA

Mr. Anastasia reviewed the objectives of the workshop and summarized outcomes of the discussions. He concluded that there has been much progress in developing the IOTWS, particularly regarding warning times and dissemination. Key challenges include continued coordination and resources, access to data and data sharing, hazard assessments, rapid alert systems, SOPs, coastal preparedness and education, and community resilience. He discussed an internal mapping exercise the US IOTWS Program is undertaking to ensure the transition of activities to partners. Partnership agreements are being finalized or re-confirmed regarding equipment, tools, and future collaboration. The transition plan includes sharing the results of this workshop and continuing engagement with the ICG/IOTWS (see *full summary of conclusions on page 20*).

2.9 CLOSING REMARKS AND PRESENTATION OF CERTIFICATES OF APPRECIATION

James Entwistle, Deputy Chief of Mission, US Embassy, Bangkok

Mr. Entwistle delivered closing remarks, saying the partnerships in developing the US IOTWS provide a model for collaboration. The efforts have resulted in tangible improvements to communities' safety all around the Indian Ocean. He emphasized that the US Government will continue to be active and support activities related to detection and forecasting, warning dissemination, and community resilience. He closed by recognizing the contributions of several partners in the US IOTWS Program, who will continue to improve the regional warning system. He presented certificates of appreciation to the following organizations in the region:

Indonesia

- Meteorological and Geophysical Agency (BMG)
- Agency for Assessment and Application of Technology (BPPT)
- National Disaster Management Coordinating Board of Indonesia (BAKORNAS)
- Department of Marine Affairs and Fisheries (DKP)
- State Ministry of Research and Technology (RISTEK)
- KOGAMI Foundation

Thailand

- National Disaster Warning Center (NDWC)
- Thai Meteorological Department (TMD)
- Department of Disaster Prevention and Mitigation (DDPM)
- Chulalongkorn University

Sri Lanka

- Disaster Management Centre (DMC)
- Meteorological Department
- University of Moratuwa

Maldives

- Department of Meteorology
- Ministry of Planning and National Development

India

- National Institute of Disaster Management (NIDM)

Regional

- Asian Institute of Technology

3. CONCLUSIONS

3.1 US IOTWS PROGRAM ACHIEVEMENTS

Governments in the region have demonstrated impressive progress since the 2004 tsunami, and United Nations partners, country counterparts, and others reaffirmed their commitment to sustaining key initiatives and tools. US-funded activities have been implemented in close coordination with international, regional, national, and local counterparts, and most have been incorporated into the IOC's ICG/IOTWS Implementation Plan. US IOTWS Program achievements include:

- Support to the ICG/IOTWS and its technical working groups;
- Official tsunami notifications to the region from NOAA's Pacific Tsunami Warning Center for two tsunami and 17 non-tsunami events;
- Optimal design of the tsunameter array for the Indian Ocean and deployment of two DART tsunameter stations;
- Upgrade/installation of six coastal sea-level observation stations and four seismic stations;
- Capacity building on earthquake detection, hazard mapping, and warning processes;
- Development of ComMIT, a new, low-cost approach to tsunami inundation modeling, and training and support for 45 scientists to develop inundation maps;
- GTS upgrades and trainings in Sri Lanka and the Maldives in partnership with the World Meteorological Organization;
- Establishing CONOPS policy, frameworks, and a reference guide for adoption in the region;
- National warning center operations, emergency communications, and/or rapid alert systems in four countries, including training;
- RANET technology communication alert systems installed in Indonesia for notifying local authorities of tsunami bulletins;
- ICS capacity building in Sri Lanka and Indonesia;
- Support for disaster and tsunami warning policy and institutional frameworks in four countries;
- CCR tools and frameworks, including community-level disaster preparedness training for nearly 20,000 people in five countries;
- ITTI, which provides professionals with formal training in the end-to-end tsunami warning and mitigation system; and
- Additional support from USG agencies to the region to leverage the US IOTWS Program.

3.2 SUSTAINABILITY OF US PROGRAM CONTRIBUTIONS, AND ADDRESSING LONG-TERM IOTWS PRIORITIES

Sustainability of US Program Contributions

The US IOTWS Program and its partners have invested in several key sustainability mechanisms and approaches to ensure the long-term value added of Program contributions are carried forward into the long term. Most major IOTWS donor programs are phasing out after intensive effort and encouraging progress. But critical needs remain for national and regional system development, capacity building, and regional partnerships. In addition to building capacity on technical aspects,

creating political will among decision makers and ongoing leadership will be needed for continued investments in IOTWS development and sustainability.

An important aspect of sustainability is for regional partners to adopt training modules and materials developed under the US IOTWS Program into their future capacity building and training programs. Key regional partners include AIT, which is jointly implementing ITTI with the University of Washington and NOAA. Another key partner is ADPC, which has already secured funding for new training activities in tsunami rapid alert systems, ICS, tsunami warning concept of operations, and coastal community resilience. US IOTWS Program products such as the CONOPS and CCR policy and program frameworks may also be further incorporated into ICG/IOTWS Working Group plans.

Ongoing needs will continue to be addressed by long-term domestic programs in Australia, Indonesia, India, Thailand, Malaysia, Sri Lanka, the Maldives, and elsewhere, as well as through other donor efforts, such as Germany's €45 million five-year program with Indonesia. Through its assessment of the member states' response to the September 12, 2007 tsunami, the ICG/IOTWS plans to identify ongoing needs for the entire region on both "upstream" tsunami detection, communications, and warning center capacity and "downstream" warning dissemination and preparedness.

Building on the progress of the last three years, the ICG/IOTWS expects that one or more Regional Tsunami Watch Providers will become operational by 2008 or 2009. In spite of these encouraging achievements, the IOTWS is far from a fully operational system. Tsunamis are the most difficult of all the natural hazards to prepare for, detect, analyze, and warn against. The challenge of building a robust, reliable tsunami warning and mitigation system in a region where no nation had the ability to issue a national warning before December 26, 2004 is an undertaking of many years. Important gaps remain that require on-going technology transfer and capacity and institution building.

Workshop participants identified critical needs for additional donor investment in the IOTWS that remain, as summarized below.

Regional and Cross-Cutting Needs

- ***Continuing technical support and training.*** Partners emphasized the need for continued technical assistance and capacity building in all areas. ITTI provides a unique opportunity for training on all components of the end-to-end tsunami warning system, but it needs continued support to reach true sustainability. Participants noted the value of outside review and consultation for SOPs and other aspects of the end-to-end warning and mitigation system, and cooperation between USG technical agencies and country partners helps to incorporate international standards with local needs and established protocols.
- ***Maintaining equipment and systems.*** Countries have made significant investments in the installation and upgrading of tsunami warning equipment and technical capacities. Continued operations and maintenance of these systems is crucial to ensuring effective tsunami warning services. Models and mechanisms to enable multi-national contributions for the maintenance of equipment and systems providing a regional benefit (but that are currently supported by an individual country, e.g., DART stations) should be identified.
- ***Strengthening regional partnerships and professional support networks.*** An effective IOTWS requires the sharing of information and experiences among Indian Ocean neighbors. For example, a regional assessment of the IOTWS achievements and gaps will provide valuable direction for ongoing and planned activities to support sustainability. Organizations such as the IOC and institutions like the ITTI can help promote exchanges among professionals, but other mechanisms are needed as well. While programs may need to focus on a sub-set of Indian Ocean countries, networks should encourage the participation of all countries across the region. In addition, more effectively engaging the private sector is one avenue to better promote sustainability.

- ***Promoting engagement in the ICG/IOTWS process***. The ICG/IOTWS process is critical to an effective "system of systems" for tsunami warning and mitigation. Continued engagement of the US Government in the ICG/IOTWS Working Group process is critical to the future of the IOTWS. Similarly, consistent and active participation by member states is required if the process is to serve the need of the countries in the region. Holding working group meetings simultaneously is one step that would help ease the burden on member states.

Detection and Forecasting

- ***Improving data collection, data sharing, and data quality.*** Free and open access to data is critical to an effective IOTWS. The appropriate international forums should address national data-sharing policies that could hamper the effective operation of the IOTWS in the event of a tsunami. There is a need to promote data collection and more robust seismic, coastal sea level, and deep-ocean sea level networks. In addition, more bathymetric and topographic information for risk analysis, hazard mapping, and inundation models is needed.
- ***Bolstering national- and local-level modeling.*** In many countries there is insufficient data to use standard hazard risk assessment tools or to develop tsunami forecast and inundation models. More data is needed and the quality of the data collected should be improved and presented in a usable way. There is a need to encourage broader access to existing geospatial data through government policies that support the appropriate use of these data for disaster risk reduction. There is also an ongoing need for increased human resource capacity in data analysis, GIS, and other analytical disciplines.

Warning Dissemination

- ***Strengthening local tsunami early warning systems.*** Programs to promoted effective communication of national warnings to provincial governments and local communities should continue. Countries should test versatile, multi-hazard communications mechanisms, such as RANET, in a wide range of areas to increase the utility of the system. Simulations and mock drills should be promoted as a way to test early warning systems and identify gaps, which enables further improvement.
- ***Adapting information for local/community use.*** Hazard maps and numerical models used to present complex information should be carefully adapted for training, awareness events, and materials in local communities. National officials may assume locals will receive and understand their warning messages, but repeated testing in communities is needed to gather feedback on how warning messages are interpreted. It is also important to work with the media in crafting messages and sharing information to avoid panic.

Mitigation, Response, and Resilience

- ***Testing and further implementation of the CCR tools.*** Mitigation activities, response systems, and public safety solutions at the community level are needed. National and regional partners conducted assessments of community resilience in three countries using the CCR tools and benchmarks; the findings and recommendations of those assessments should be taken forward.
- ***Increasing efforts for tsunami and multi-hazard resilience.*** Many of the "upstream" warning components established to date have provided an important foundation for national systems. However, just as disaster risk management and preparedness remain significant challenges in general, the "downstream" aspects of the IOTWS require increased support to adopt appropriate SOPs, local response systems, and awareness-building programs. Efforts to address downstream needs should be integrated with broader disaster risk management initiatives. Priorities for the "last mile" (last kilometer) assistance include increasing education, mitigation efforts, identification of safe areas, and development of local decision making procedures.

To contribute to addressing these gaps, US Government partners will outline possible options for future collaboration with the IOC to support long-term needs. Technical agencies, such as NOAA and USGS, also plan to remain engaged with a number of partners in the region through new and ongoing partnership agreements focused on technology transfer, research and development, and capacity building. Further details on these plans are presented in Annex 3 and Annex 4. Member States and international partners may address the ongoing funding, technical, and coordination needs identified during this transition workshop at the Fifth ICG/IOTWS meeting in April 2008.

ANNEXES

A1. WORKSHOP AGENDA

Workshop on the Transition of
US Indian Ocean Tsunami Warning System (IOTWS) Program to Indian Ocean Partners

December 6-7, 2007 – Bangkok, Thailand

Objectives

- To present and evaluate progress achieved in Indian Ocean tsunami warning capacity;
- To highlight the US government's commitment and contributions achieved in cooperation with program partners for tsunami warning;
- To provide a forum for program partners to present and announce their commitment to continue implementing key activities initiated with support from the US IOTWS Program in coordination with UNESCO/IOC Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), and to describe how they will do so;
- To provide these partners with an opportunity to promote the tools and systems developed with support from the US IOTWS Program to other potential partners in the region, and describe lessons learned and facilitate further linkages between partners; and
- To identify continuing priorities for the development of the IOTWS under UNESCO/IOC.

AGENDA

Thursday, December 6, 2007

DAY 1	TOPIC	SPEAKER
9:00-9:10	**Welcome, Introductions, Summary of US Government Support for ICG/IOTWS**	Mr. Richard Whelden, USAID/RDMA Acting Mission Director
9:10-9:20	**Welcome, UNESCO Intergovernmental Oceanographic Commission (IOC)**	Dr. Peter Koltermann, Head, UNESCO/IOC Tsunami Coordination Unit
9:20-10:00	**Setting the Stage: Workshop Objectives and US IOTWS Program Contributions** Lesson Learned and Tools for Sustainability	Mr. Orestes Anastasia, US IOTWS Program Manager, USAID/RDMA
10:00-10:30	**Putting it in Context: Overview of ICG/IOTWS and Status Update by ICG/IOTWS Secretariat**	Mr. Tony Elliott, Head, UNESCO/IOC - ICG/IOTWS Secretariat
10:30-10:45	Break	
	DETECTION AND FORECASTING *Seismic and Sea-Level Monitoring, Hazard Risk Assessment, Modeling*	
10:45-11:30	**ICG/IOTWS Status**	Dr. Jane Cunneen, UNESCO/IOC - ICG/IOTWS Secretariat Mr. David McKinnie, NOAA
	US IOTWS Program Contributions • Progress achieved: DART tsunameters, sea-level stations, seismic monitoring, GTS, ComMIT • Challenges for sustainability and strategies to	Mr. Curt Barrett, NOAA

	address these challenges • Key partners engaged to promote sustainability	Dr. Walter Mooney, USGS
	Discussion	
11:30-12:15	**Partner Presentations** • Incorporation of Program tools and activities • Strategy to promote sustainability	
	DART Program with Government of Thailand *DART Program with Government of Indonesia* *Small Grants Program —Sri Lanka* **Discussion**	Dr. Smith Dharmasaroja, NDWC Dr. Ridwan Djamaluddin, BPPT Dr. Sam Hettiarachchi, University of Moratuwa
12:15-1:15	Lunch	
	WARNING DISSEMINATION *Warning Centers*	
1:15-2:00	**ICG/IOTWS Status**	Dr. Jane Cunneen, UNESCO/IOC - ICG/IOTWS Secretariat Mr. David McKinnie, NOAA
	US IOTWS Program Contributions • Progress achieved: CONOPS, TARNS, warning center capacity, RANET • Challenges for sustainability and strategies to address these challenges • Key partners engaged to promote sustainability	Mr. David McKinnie, NOAA
	Discussion	
2:00-2:30	**Partner Presentations** • Incorporation of Program tools and activities • Strategy to promote sustainability	
	International Tsunami Training Institute and the Asian Institute of Technology	Dr. Amrit Bart, AIT
	Discussion	
2:30-3:00	Break	
	MITIGATION, RESPONSE, AND RESILIENCE	
3:00-3:45	**ICG/IOTWS Status**	Dr. Jane Cunneen, UNESCO/IOC - ICG/IOTWS Secretariat Mr. David McKinnie, NOAA
	US IOTWS Program Contributions • Progress achieved: coastal community resilience, ICS • Challenges for sustainability and strategies to address these challenges • Key partners engaged to promote sustainability	Ms. Deanne Shulman, USFS Dr. Kitty Courtney, PI
	Discussion	
3:45-4:35	**Partner Presentations** • Incorporation of Program tools and activities • Strategy to promote sustainability	
	Incorporation of ICS and CCR into Sri Lanka's national programs *KOGAMI disaster preparedness training program (Padang)*	Ms. Lalani Imbulana, DMC Ms. Patra Dewi, KOGAMI
	Discussion	
4:35-4:45	***UPDATE ON UNESCAP TSUNAMI TRUST FUND***	Mr. Charles Davies, UNESCAP
4:45-5:30	***ADPC's ROLE TO IMPLEMENT US IOTWS PROGRAM ACTIVITIES***	Mr. A. Subbiah, ADPC
5:30-7:00	Reception	

Friday, December 7, 2007		
DAY 2	**TOPIC**	**SPEAKER**
9:00-9:30	**Progress Achieved: 12 September 2007 Tsunami Event** Description of the sequence of events from detection of the earthquake through transmission of warning to cancellation of warning	Mr. Tony Elliott, ICG/IOTWS Secretariat
9:30-10:30	**Country Perspectives: Indonesia, Thailand** • Account of how each country received and responded to the tsunami warning on September 12 from a national and local level • Assessment of progress achieved in national capacity for warning and response • Description of any inputs from the US program and other international efforts that improved the response as compared to December 2004 • Identification of top 3 priorities towards continued improvement in tsunami detection, hazard assessment, warning, preparedness and response	Indonesia (Dr. Fauzi and Ms. Vidi Henny Dwi) Thailand (Dr. Tavida Kamolvej and Mr. Passkorn Kunthasap)
10:30-11:00	Break	
11:00-12:30	**Country Perspectives continued: Maldives, India, Sri Lanka**	Maldives (Mr. Anwar Ali, Ms. Fathmath Fairooza) India (Mr. Biswanath Dash, Dr. Vinay Kumar Sehgal) Sri Lanka (Ms. Lalani Imbulana, Mr. P.M. Jayatilaka Banda)
12:30-1:30	Lunch	

1:30-3:30	**Addressing Priorities: Panel Discussion (UNESCO/IOC, ICG/IOTWS, ISDR, UNESCAP, USG agencies)**
	• Introduction of ICG Working Group function and governance under UNESCO/IOC
	• Brief remarks by ICG/IOTWS
	  o Purpose of working groups
	  o Status of activities and products under implementation plan
	  o Key challenges and priorities
	• Introduction of additional panelists
	  o Open discussion
		Mr. Rick Bailey, ICG/IOTWS Chair
		Mr. Tony Elliott, UNESCO/IOC
		Dr. Peter Koltermann, UNESCO/IOC
		Dr. Fauzi, ICG/IOTWS WG 1
		Dr. Sam Hettiarachchi, ICG/ICG WG 3
		Mr. Michel Vielle, ICG/IOTWS WG 6
		Mr. Patrick Kratt, ISDR
		USG representatives

3:30-3:45	Break	
3:45-4:00	**Next Steps for UNESCO/IOC and the Development of the ICG/IOTWS** • Next steps towards the development of the regional system. • Identification of key challenges and priorities	Mr. Tony Elliott, ICG/IOTWS Secretariat
4:00-4:15	**Summary of Workshop Outcomes and Conclusions**	Mr. Orestes Anastasia, USAID/RDMA
4:15-5:00	**Closing Remarks** **Presentation of Certificates of Appreciation to Country Counterparts**	Mr. James Entwistle, Deputy Chief of Mission, US Embassy/Thailand

A2. LIST OF PARTICIPANTS

US IOTWS Program Transition Workshop

United Nations Conference Centre, Bangkok, Thailand
December 6-7, 2007

Ahmed, Atiq Kainan
Social Scientist
Asian Disaster Preparedness Center
PO Box 4, Klong Luang
Pathumthani 12120
Thailand
Tel: +66 2 516 5900 to 10 Ext. 331
Fax: +66 2 524 5360
Email: atiqka@adpc.net

Ali, Anwar
Deputy Director
Ministry of Planning and National Development
4th Floor, Ghaazee Building, Ameeru Ahmed Magu
Male 20125
Republic of Maldives
Tel: +96 0 334 8383
Fax: +96 0 332 7351
Email: anwar.ali@planning.gov.mv

Anastasia, Orestes
US IOTWS Program Manager
Regional Development Mission for Asia
U.S. Agency for International Development
GPF Witthayu Tower A, 10th Floor
93/1 Wireless Road
Bangkok 10330
Thailand
Tel: +66 2 263 7468
Fax: +66 2 263 7497
Email: oanastasia@usaid.gov

Bailey, Richard John
Vice-Chair, Intergovernmental Coordination Group, IOTWS
Australian Bureau of Meteorology
700 Collins St., Docklands
Melbourne 7008
Australia
Tel: +61 3 9669 4103
Fax: +61 3 9669 4803
Email: r.bailwy@bom.gov.au

Balmadier, Richard
Catholic Relief Services
Jl Wijaya I, No. 35,
Jakarta
Indonesia
Email: rbalmadier@id.seapro.crs.org

Banda, Porakara Mudiyanselaga Jayatilaka
Director of Meteorology
Department of Meteorology
Bauddhaloka Mawatha
Colombo 7
Sri Lanka
Tel: +94 11 269 2756
Fax: +94 11 269 8311
Email: jayatilakamet@hotmail.com

Barlee, Amnat
Director
Relief and Community Health Bureau
The Thai Red Cross Society
Henry Dunant Rd.,
Bangkok 10330
Thailand
Tel: +66 2 251 7853
Fax: +66 2 252 7976
Email: abarlee@yahoo.com

Barrett, Curtis B.
Manager
NOAA International Tsunami Project Team
U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Weather Service
1325 East West Highway
Room 11152, Silver Spring,
MD 20910
USA
Tel: +1 301 713 1784 Ext. 136
Fax: +1 301 587 4524
Email: curt.barrett@noaa.gov

Bart, Amrit
Associate Professor, AIT and
Chief of Party, USAID Post-Tsunami Sustainable Coastal Livelihood Program
Asian Institute of Technology
KM. 42 Paholyothin Highway, Klong Luang
Pathumthani 12120
Thailand
Tel: +66 2 524 5471
Fax: +66 2 524 6200
Email: bart@ait.ac.th

Barton, Robert
Regional Advisor
Office of Foreign Disaster Assistance (OFDA)
U.S. Agency for International Development
GPF Witthayu Tower A, 10th Floor
93/1 Wireless Road
Bangkok 10330
Thailand
Tel: +66 2 263 7459
Fax: +66 2 263 7499
Email: rbarton@usaid.gov

Boonsongsrikul, Lukhana
Fisheries Biologist
Fisheries Foreign Affairs Division
Department of Fisheries
Paholyothin Rd., Chatuchak
Bangkok 10900
Thailand
Tel: +66 2 579 7939
Fax: +66 2 579 7939

Boonyamalik, Napas
Disaster Prevention and Mitigation Official
Research and International Cooperation Bureau
Department of Disaster Prevention and Mitigation,
Ministry of Interior
3/12 U-Thong Nok, Dusit
Bangkok 10300
Thailand
Tel: +66 2 243 2206
Fax: +66 2 243 2199
Email: plusaport@hotmail.com, plusaport@yahoo.com

Bowman, Winston
Regional Environmental Director
Regional Development Mission for Asia
U.S. Agency for International Development
GPF Witthayu Tower A, 10th Floor
93/1 Wireless Road
Bangkok 10330
Thailand
Tel: +66 2 263 7469
Fax: +66 2 263 7499
Email: wbowman@usaid.gov

Chantra, Thanikun
Program Assistant, Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathorn Road, Bangrak
Bangkok 10500
Thailand
Tel: +66 2 637 8517 Ext. 24
Fax: +66 2 637 8520
Email: thanikun@iotws.org

Chongpaibul, Chatchalapa
Training Coordination Specialist, Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathorn Road, Bangrak
Bangkok 10500
Thailand
Tel: +66 2 637 8517 Ext. 13
Fax: +66 2 637 8520
Email: chatchalapa@iotws.org

Chotiyaputta, Cherdchinda
Marine and Coastal Resources Management Specialist
Department of Marine and Coastal Resources
92 Phaholyothin 7, Sam Sen Nai, Phayathai
Bangkok 10400
Thailand
Tel: +66 2 298 2659
Fax: +66 2 298 2659
Email: cherdchc@dmcr.go.th, cherdchc@yahoo.com

Clark, Douglas J.
Corporate Vice President
Environment and Natural Resources Division
International Resources Group (IRG)
1211 Connecticut Ave, NW, Suite 700
Washington,
DC 20036
USA
Tel: 1 202 289 0100
Fax: 1 202 289 7601
Email: dclark@irgltd.com

Collier, Peter
Chief of Party, Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathorn Road, Bangrak,
Bangkok 10500
Thailand
Tel: +66 2 637 8517 Ext. 20
Fax: +66 2 637 8520
Email: PCollier@iotws.org

Courtney, Catherine
Program Integrator
US Indian Ocean Tsunami Warning System Program
Tetra Tech EM Inc.
707 Richards St. Suite 300
Honolulu,
HI 96813
USA
Tel: +1 808 441 6612
Fax: +1 808 839 1689
Email: kitty.courtney@ttemi.com

Cunneen, Jane
ICG/IOTWS Secretariat
UNESCO IOC Perth Regional Programme Office
P.O. Box 1370, West Perth
1100 Hay Street
WA 6872
Australia
Tel: +618 9321 9976
Fax: +618 9226 0599
Email: j.cunneen@unesco.org

Dash, Biswanath
Assistant Professor
National Institute of Disaster Management
I.P. Estate, Ring Road
New Delhi 110002
India
Tel: +91 11 2370 2432
Fax: +91 11 2370 2442
Email: dashvishy@yahoo.com

Davies, Charles
Programme Management Officer
UNESCAP – Programme Management Division
Rajdamneon Nok Avenue
Bangkok 10200
Thailand
Tel: +66 2 288 1948
Fax: +66 2 288 3035
Email: davies@un.org

Dewi, Patra Rina
Executive director
Komunitas Siaga Tsunami (KOGAMI)
Jl. Bt. Pasaman No.2 Komp. GOR. A. Salim
Padang 25114
Indonesia
Tel: +62 815 3534 3037
Email: patrarinadewi@gmail.com, patra@kogami.or.id

Dharmasaroja, Smith
National Disaster Warning Center
Tambon Bangkrasor, Amphur Muang
Nonthaburi 11000
Thailand
Tel: +66 2 589 2497 Ext. 24
Fax: +66 2 589 2497 Ext. 22
Email: smith_dh@hotmail.com

Djamaluddin, Ridwan
Director
Marine Survey Technology
Agency for Technology Assessment and Application (BPPT)
Jl. Genderal Gatot Subroto No.10
Jakarta 12710
Indonesia
Email: ridwan@webmail.bppt.go.id

Duangkeo, Siriluksana
Chief of Research and Development Sub-Bureau,
Research and International Cooperation Bureau
Department of Disaster Prevention and Mitigation,
Ministry of Interior
3/12 U-Thong Nok, Dusit
Bangkok 10300
Thailand
Tel: +66 2 243 2206
Fax: +66 2 243 2199
Email: siriluk_d@hotmail.com, siriluk_o@yahoo.com

Dwi, Vidiarina Henny
GTZ/GI-TEWS
German-Indonesia Tsunami Early Warning System
Senior Adviser - Capacity Building
GTZ International Services
Deutsche Bank Building, 10th floor
Jl. Imam Bonjol No. 80
Jakarta 10310
Indonesia
Tel: +62 21 3983 1517
Fax: +62 21 3983 1591
Email: Henny.Vidiarina@gtz.de

Haitook, Theerachai
Program Specialist
AARM/ SERD
Asian Institute of Technology
P.O. Box 4 Klong Luang
Pathumthani 12120
Thailand
Email: theerachai@ait.ac.th

Elliott, Tony
Head of ICG/IOTWS Secretariat
UNESCO IOC Perth Regional Programme Office
PO Box 1370, West Perth
WA 6872
Australia
Tel: +61 8 9226 0191
Fax: +61 8 9226 0599
Email: t.elliott@unesco.org

Entwistle, James
Deputy Chief of Mission
United States Embassy, Thailand
Wireless Road
Bangkok 10330
Thailand

Fairooza, Fathmath
Geological Officer
National Tsunami Warning Center
Department of Meteorology
Male 20125
Republic of Maldives
Tel: +96 0 331 0806
Fax: +96 0 331 5509
Email: fathmath.fairooza@gmail.com

Fakhruddin, S.H.M.
Technical Specialist
Asian Disaster Preparedness Center
PO Box 4, Klong Luang
Pathumthani 12120
Thailand
Tel: +66 2 516 5900 to 10
Fax: +66 2 524 5360
Email: fakhruddin@adpc.net

Dr. Fauzi
Head of Seismic Engineering and Tsunami
Badan Meteorologi dan Geofisika
Jl. Angkasa I no. 2, Kemayoran,
Jakarta Pusat 10720
Indonesia
Tel: +62 81 682 1106
Fax:+ 62 21 654 6316
Email: fauzi@bmg.go.id, fauzi_bmg@yahoo.com

Fernando, Indira
Sri Lanka Program Coordinator
US IOTWS Program
Colombo
Sri Lanka
Tel: +94 77 368 0425
Email: indira6lk@yahoo.com

Goosby, Stanley
Chief Scientist
Pacific Disaster Center
1305 N. Holopone St. Suite 2
Kihei,
HI 96755
USA
Tel: +1 808 891 0525
Fax: +1 808 891 0526
Email: sgoosby@pdc.org

Hettiarachchi, Sam
Professor of Civil Engineering
Chairman WG3/ Risk Assessment ICG/IOTWS
University of Moratuwa, Sri Lanka
Department of Civil Engineering,
University of Moratuwa
Katubedda
Moratuwa,
Sri Lanka
Email: sslh@civil.mrt.ac.lk

Imbulana, Patikiri Arachchige Indra Lalani
Director (Preparedness Planning)
Disaster Management Centre
2-222, B M I C H, Baudhaloka Mawatha
Colombo 07
Sri Lanka
Tel: +94 77 395 7898
Fax: +94 11 267 0079
Email: Lalani.Imbulana@gmail.com

Ismayanti, Maya
Head of International Cooperation Division
Centre of Analysis for International Cooperation and Institution
Ministry of Marine Affairs and Fisheries,
Indonesia
Tel: +62 21 350 9070 Ext. 7607
Fax: +62 21 386 4293
Email: mayafishid@yahoo.com

Jankaew, Kruawan
Faculty of Science
Chulalongkorn University
Phyathai Road, Pathumwan
Bangkok 10500
Thailand
Tel : +66 2 218 5442
Email: kjankaew@yahoo.co.uk

Kahandawa, K.M. Suranga Sooriya Kumara
National Programme Coordinator
United Nations Development Programme
Program Management Unit
Disaster Management Center BMICH
Colombo 07
Sri Lanka
Tel: +94 77 331 3416, +94 33 226 9772
Fax: +94 11 267 0025
Email: skahandawa@yahoo.co.uk

Kamolvej, Tavida
School of Political Science
Thammasat University
2 Prajan Road, Pranakorn
Bangkok 10200
Thailand
Tel: +66 2 613 2314
Fax: +66 2 224 1406
Email: Tavida@polsci.tu.ac.th, Tavida_k@yahoo.com

Khovadhana, Kriengkrai
Meteorological Department
4353 Sukhumvit Road, Bangna
Bangkok 10260
Thailand
Tel: +66 2 398 9888
Fax: +66 2 399 0968
Email: kriengkrai@metnet.tmd.go.th

Koltermann, Peter
Head, Tsunami Coordination Unit
Intergovernmental Oceanographic Commission
UNESCO
1, rue Miollis
75732 Paris cedex
France
Tel: +33 1 4568 4015
Fax: +33 2 4568 5810
Email: p.koltermann@unesco.org

Kratt, Patrick
UN ISDR
Rajdamneon Nok Avenue
Bangkok 10200
Thailand
Email: kratt@un.org

Kunthasap, Passkorn
Geologist, Environmental Geology Division
Department of Mineral Resources (DMR)
75/10 Rama 6 Rd., Ratchathewi,
Bangkok 10400
Thailand
Email: passkornk@hotmail.com

Lertcharoenchok, Yindee
UN OCHA
Rajdamneon Nok Avenue
Bangkok 10200
Thailand
Email: lertcharoenchok@un.org

MacPherson, Charlie
Program Integrator
US Indian Ocean Tsunami Warning System Program
10306 Eaton Place, Suite 340, Fairfax,
Virginia 22030-2201
USA
Tel: +1 703 385 6000
Fax: +1 703 385 6007
Email: charlie.macpherson@tetratech.com

Mattich, Nives
Senior Monitoring & Evaluation Specialist
Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathorn Road, Bangrak,
Bangkok 10500
Thailand
Tel : +66 2 637 8517 Ext. 12
Fax: +66 2 637 8520
Email: NMattich@iotws.org

McKinnie, David
Coordinator/Technical Manager
NOAA IOTWS Program
7600 Sand Point Way NE B.1,
Seattle,
Washington 98115
USA
Tel: +1 206 526 6950
Email: david.mckinnie@noaa.gov

Moeller, Dale
American Signal
4801 W.Woolworth Avenue
Milkakke,
WI 53218
USA
Email: dmoeller@americansignal.com

Mooney, Walter
Research Geophysicist
U.S. Geological Survey
345 Middlefield Road, Menlo Park,
California 94025
USA
Tel: +1 650 329 4764
Email: mooney@usgs.gov

Narasimhan, Ramraj
Disaster Management Specialist
Asian Disaster Preparedness Center (ADPC)
PO Box 4, Klong Luang,
Pathumthani 12120
Thailand
Tel: +66 2 516 5900 to 10 Ext. 329
Fax: +66 2 524 5360
Email: ramrajn@adpc.net

Oppusunggu, Yusak
Program Specialist
Office of Basic Human Services
USAID/Indonesia
Jl. Medan Merdeka Selatan 3-5
Jakarta 10110
Indonesia
Tel: +62 21 3435 9416
Fax: +62 21 380 6694
Email: yoppusunggu@usaid.gov

Paenghom, Aurasa
Raydant International Co.,Ltd.
99/178-180 Tesaban Song
Ladyao, Jatujak
Bangkok
Thailand
Tel: +66 2 589 7011
Email: aurasa@raydant.com

Pariatmono, Ir.
Assistant to Deputy Minister for Analysis of Science and Technology Needs
The State Ministry of Research and Technology
BPPT Building II, 6th Floor
Jl. M.H. Thamrin No.8
Jakarta 10340
Indonesia
Tel: +62 21 316 9169
Fax: +62 21 314 8192 / 310 1952
Email: pariatmono@ristek.go.id

Pattarakavin, Paravee
Information Management Specialist, Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathorn Road, Bangrak
Bangkok 10500
Thailand
Tel: +66 2 637 8517 Ext. 18
Fax: +66 2 637 8520
Email: paravee@iotws.org

Perera, Gamage Don Susil Manodara
Executive Director - DM
Sri Lanka Red Cross Society
No.307, T B Mawatha
Colombo 10
Sri Lanka
Tel: +94 77 360 0971
Fax: +94 11 563 3068
Email: susilp@redcross.lk

Pinta, Arun
Department of Disaster Prevention and Mitigation
U-Thong Nok Road, Dusit
Bangkok 10300
Thailand

Potisat, Somsak
National Disaster Warning Center
Tambon Bangkrasor, Amphur Muang
Nonthaburi 11000
Thailand
Tel: +66 2 589 2497 Ext. 24
Fax: +66 2 589 2497 Ext. 22

Prachuab, Sumalee
Director Seismological Bureau
Meteorological Department
4353 Sukhumvit Road, Bangna
Bangkok 10260
Thailand
Tel: +66 2 399 0965
Fax: +66 2 399 0968
Email: sumalee_tmd@yahoo.com

Purwana, Ibnu
Head, Center for Observation Network System
Meteorological and Geophysical Agency (BMG)
Jl. Angkasa 1 / No. 2
Jakarta 10720
Indonesia
Tel: +62 21 424 1169
Fax: +62 21 424 6703
Email: ibnu@bmg.go.id

Puttawibul, Wansaree
Administrative Assistant, Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathorn Road, Bangrak,
Bangkok 10500
Thailand
Tel: +66 2 637 8517 Ext. 19
Fax: +66 2 637 8520
Email: wansaree@iotws.org

Raksakulthai, Vivian
Senior Technical Advisor, Program Integrator
US Indian Ocean Tsunami Warning System Program
Chartered Square Building, 28th Floor, Unit 2802
152 North Sathon Road, Bangrak,
Bangkok 10500
Thailand
Tel: +66 2 637 8517 Ext. 17
Fax: +66 2 637 8520
Email: vivian@iotws.org

Rasiah, Ivan Prem Kumar
Project Management Specialist
USAID/Sri Lanka
44, Galle Road
Colombo 3
Sri Lanka
Tel: +94 11 249 8000
Fax: +94 11 247 2850 to 60
Email: irasiah@usaid.gov

Roller, Christopher
Sales Manager
American Signal Corporation
4801 W. Woolworth Avenue,
Milkakke,
WI 53218
USA
Tel: +1 414 358 8000
Fax: +1 414 358 8008
Email: croller@americansignal.com

Rottman, Michael
Special Coordinator on TEWS
UNESCO Office Jakarta
Jl. Galuh (II) No. 5, Kebayoran Baru
Jakarta 12110
Indonesia
Tel: +62 21 739 9818 Ext. 870
Fax: +62 21 7279 6489
Email: m.rottmann@unesco.org

Rubinoff, Pam
University of Rhode Island
Coastal Resources Center/ RI Sea Grant
Narragansett,
RI 02882
USA
Tel: +1 401 874 6135
Email: rubi@crc.uri.edu

Russell, Ryan
Regional Emergency Advisor
Catholic Relief Services
Jl Wijaya I, No. 35
Jakarta
Indonesia
Tel: +62 81 1177 9234
Email: rrussell@seapro.crs.org

Sabprung, Pimkarn
Pacific Disaster Center
National Disaster Warning Center
Tambon Bangkrasor, Amphur Muang
Nonthaburi 11000
Thailand
Tel: +66 81 564 8228
Email: psabprung@pdc.org

Sehgal, Vinay Kumar
Professor & Head
Division of Hydro-Meteorological Disasters & IT
National Institute of Disaster Management
Ministry of Home Affairs, Government of India
5-B, I.P. Estate, IIPA Campus, Ring Road
New Delhi 110002
India
Tel: +91 11 2372 4308
Fax: +91 11 2370 2442, 2370 2446
Email: vinay.sehgal@nidm.net, vksehgal@gmail.com

Shulman, Deanne
Disaster Mitigation Programs
Office of International Programs
USDA Forest Service
USA
Tel: +1 760 376 6263
Fax: +1 760 376 3142
Email: dshulman@fs.fed.us

Siripong, Absornsuda
Associate Professor
Chulalongkorn University, Marine Science Department
Phya Thai Road, Khet Pathumwan
Bangkok 10330
Thailand
Tel: +66 2 218 5405
Fax: +66 2 255 0780
Email: sabsorns@chula.ac.th

Soekarno, Dyah Hesti Brata Chandra Sastrawati
Project Manager & Liaison
BGR - GITEWS (German Federal Institute for Geosciences and Natural Resources for project: German-Indonesian Tsunami Early Warning System)
Ministry of Research and Technology
BPPT Building I, 17th Floor
Jl.M.H. Thamrin No.8
Jakarta 10340
Indonesia
Tel: +62 21 316 8735
Fax: +62 21 3190 4070
Email: soekarno_cha@yahoo.com

Sondita, Fedi
Ministry of Marine Affairs and Fisheries and
Department of Fisheries Resources Utilization
Faculty of Fisheries and Marine Sciences
Bogor Agricultural University Kampus IPB Darmaga
BOGOR 16680
Indonesia
Tel: +62 251 421 730, +62 81 111 3806
Fax: +62 251 421 732
Email: fsondita@indo.net.id

Spahn, Harald
GTZ/GI-TEWS
Team leader
GTZ-IS
Jl. Imam Bonjol 80
Jakarta
Indonesia
Tel: +62 81 2103 5175
Fax: +62 21 3983 1591
Email: harald.spahn@gtz.de

Srisawaskraisorn, Saengroaj
Regional Program Development Specialist
Regional Development Mission for Asia
U.S. Agency for International Development
GPF Witthayu Tower A, 10th Floor
93/1 Wireless Road,
Bangkok 10330
Thailand
Email: ssrisawas@usaid.gov

Sriswasdi, Rachaneekorn
Deputy Regional Manager
U.S. Trade and Development Agency (USTDA)
Asia Regional Office
GPF Witthayu Tower A, Suite 302
93/1 Wireless Road,
Bangkok 10330
Thailand
Tel: +66 2 205 5278
Fax: 66 2 255 4366
Email: rsriswas@mail.doc.gov

Stapke, Volker
Project Coordinator
BGR - GITEWS (German Federal Institute for Geosciences and Natural Resources for project: German- Indonesian Tsunami Early Warning System)
Ministry of Research and Technology
BPPT Building I, 17th Floor
Jl.M.H. Thamrin No.8
Jakarta 10340 Indonesia
Tel: +62 21 316 8735
Fax: +62 21 3190 4070
Email: volker.stapke@bgr.de

Strobel, David Andrew
Senior Field Representative
American Red Cross
170/71 Ocean Tower I, 22nd Floor,
Ratchadapisek Road, Sukhumvit 16,Klong Toey
Bangkok 10110
Thailand
Tel: +66 2 661 8201
Fax: +66 2 259 1910
Email: drew.strobel@ifrc.org

Subbiah, Ajunapermal
Team Leader, Climate Risk Management
Asian Disaster Preparedness Center
PO Box 4, Klong Luang,
Pathumthani 12120
Thailand
Tel: +66 2 516 5900 to 10 Ext. 405
Fax: +66 2 524 5360
Email: subbiah@adpc.net

Ti, Le Huu
Economic Affairs Officer
Sustainable Development and Water Resources Section
UNESCAP
Rajdamneon Nok Avenue
Bangkok 10200
Thailand
Tel: +66 2 288 1450
Fax: +66 2 288 1059
Email: ti.unescap@un.org

Thumkosit, Jintana
Assistant Head of Relief Division,
Relief and Community Health Bureau
Thai Red Cross Society
1871 Henry Dunant Rd.
Bangkok 10330
Thailand
Tel: +66 2 251 7853
Fax: +66 2 252 7976
Email: Tumkosit_j@hotmail.com

Tucker, Brian E.
GeoHazards International
200 Town and Country Village
Palo Alto,
California 94301
USA
Tel: +1 650 614 9050
Fax: +1 650 614 9051
Email: tucker@geohaz.org

Tunsuwandee, Narumol
Planning and Policy Analyst Level 3,
Research and International Cooperation Bureau
Department of Disaster Prevention and Mitigation,
Ministry of Interior
3/12 U-Thong Nok, Dusit
Bangkok 10300
Thailand
Tel: +66 2 243 2206
Fax: +66 2 243 2199
Email: narumolja@hotmail.com

Vielle, Michel
Director General
Department of Risk and Disaster Management
MS Complex, Second floor, Room 2, Victoria
Mahe
Seychelles
Tel: +248 322 979
Fax: +248 324 039
Email: m.vielle@statehouse.gov.sc

Virapat, Cherdsak
Senior Fishery Scientist/Manager
Department of Fisheries (DOF)
Kaset Klang, Bangkhen
Bangkok 10900
Thailand
Tel: +66 84 973 8978
E-mail: cvirapat@hotmail.com

Wafir, **Ali**
Deputy Director, Department of Meteorology
Orchid Magu,
Male 20125
Republic of Maldives
Tel: +960 689 8095
Fax: +960 760 8007
Email: wafir@meteorology.gov.mv

Walters, Greg
U.S. Trade and Development Agency (USTDA)
Asia Regional Office
GPF Witthayu Tower A, Suite 302
93/1 Wireless Road,
Bangkok 10330
Thailand

Warnitchai, Pennung
Associate Professor, Structural Engineering
School of Engineering and Technology
Asian Institute of Technology
KM. 42 Paholyothin Highway, Klong Luang,
Pathumthani 12120
Thailand
Tel: +66 2 524 5530
Fax: +66 2 524 6059
Email: pennung@ait.ac.th

Wechbuntung, Burin
Thai Meteorological Department
4353 Sukhumvit Road, Bangna
Bangkok 10260
Thailand
Tel: +66 2 399 0965
Fax: +66 2 399 0968

Whelden, Richard
Deputy Mission Director
Regional Development Mission for Asia
U.S. Agency for International Development
GPF Witthayu Tower A, 10th Floor
93/1 Wireless Road
Bangkok 10330
Thailand
Tel: +66 2 263 7400
Fax: +66 2 263 7499
Email: rwhelden@usaid.gov

A3. US IOTWS PROGRAM SUSTAINABILITY MATRIX

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
1. Support to IOC and ICG/IOTWS Working Groups (WGs)	NOAA; USGS; USAID	Regional	National Assessments; IOTWS Conceptual Design; Participation in Working Groups	None	Continue	Not applicable; USG engagement to be continued	ICG/IOTWS Secretariat, ICG/IOTWS WGs	Continued participation of **NOAA** and **USGS** in future IOC ICG/IOTWS Working Group meetings
2. PTWC Interim Notifications	NOAA	Regional	Real-time tsunami advisory bulletins	Continued issuance of real-time tsunami advisory bulletins to IOTWS region by Pacific Tsunami Warning Center (PTWC) and Japan Meteorological Administration (JMA)	Continue	2010, or until a permanent RTWP is established	future Regional Tsunami Watch Provider (RTWP) TBD; ICG/IOTWS Secretariat; IOC International Tsunami Information Center (ITIC); ICG/IOWTS WG5	Continued cooperation and coordination between **NOAA-PTWC**, JMA, and future RTWPs
I. Seismic Measurements, Data Collection, and Exchange								
3. Seismic Station Equipment installation/upgrades	USGS	Indonesia	Seismic equipment and instruments	Continuing through USGS Caltech contract; Caltech to provide assistance and funding for maintenance	Continue	Not applicable; Caltech engagement to be continued	Badan Meteorolgi & Geofisika (BMG), Indonesia; Institute Teknologi Bandug (ITB)	Maintenance and utilization of equipment to conduct seismic hazard detection and tsunami analysis work by **Caltech**, BMG and ITB
4. Seismology and Tsunami Hazard trainings	USGS	Regional	Seismicity, Tsunami, Paleo-earthquake and Paleo-tsunami training materials	Transfer of International Tsunami Training Institute (ITT) training materials to AIT	Transfer	March 2008	Asian Institute of Technology (AIT)	Potential additional trainings as need and funding available from USGS
II. Sea Level Data Collection and Exchange, Including Deep-Ocean Tsunami Detection Instruments								
5. Deep Ocean Assessment and Reporting of Tsunamis (DART) tsunameter, Thailand	NOAA	Thailand	DART buoy system	Ensure NDWC has maintenance contract in place; Technical consultation	Transfer	January 2008	National Disaster Warning Center (NDWC), Thailand; Thai Meteorological Department	Government of Thailand to provide maintenance to ensure continuous tsunameter real-time operation
6. Deep Ocean Assessment and Reporting of	NOAA	Indonesia	DART buoy system	Support through agreement and additional funding mechanism	Transfer	January 2008	Indonesia Agency for the Assessment and Application of	Government of Indonesia to provide maintenance to ensure continuous tsunameter real-

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
Tsunamis (DART) tsunameter, Indonesia							Technology (BBPT)	time operation
7. Sea Level Station upgrades	NOAA	Sri Lanka, Indonesia, Maldives	Sea level station design package documents and installation of stations at: Gan, Maldives; Hanimaadh, Maldives; Colombo, Sri Lanka; Sibolga, Indonesia; Cilacap, Indonesia; Prigi, Indonesia	Transfer of maintenance responsibility to UHCSLC and Governments of Sri Lanka, Indonesia and Maldives	Transfer	September 2007 (completed)	UN Sea Level Center, University of Hawaii (UHCSLC); NARA Sri Lanka; Department of Meteorology, Maldives; Bakourtanal, Indonesia	Maintenance by UHCSLC and Governments of Sri Lanka, Indonesia and Maldives to ensure continued transmission of data with funding from multiple regional and global partners; UHCSLC to work with countries to maintain sites and communications and further develop their capabilities
III. Risk Assessment								
8. Hazard Analysis Tool	NOAA	Region; Sri Lanka	Hazard Assessment Tool Template based on ArcIMS software and training materials	Limited technical assistance to ADPC with the development of similar tools utilizing the IOTWS Hazard Assessment Tool Template	Continued	Not applicable; NOAA engagement to be continued	Sri Lanka Disaster Management Center (DMC); EMSO Sri Lanka; Asian Disaster Preparedness Center (ADPC); Asian Institute of Technology (AIT)	Continuing limited assistance through **NOAA**. Sri Lanka DMC to maintain Sri Lanka Hazard Assessment tool and incorporate new GIS datasets as become available; ADPC incorporating training materials into Regional Expansion Strategy
9. Multi-hazard risk assessment, data sharing, and warning communication	USGS	Indonesia, Thailand	CAP, EIDS, seismic hazard maps	Materials provided to AIT/ITTI for incorporation into training curriculum. Support provided on "as needed" basis	Transfer	September 2007 (completed)	Badan Meteorolgi & Geofisika (BMG), Indonesia; Institut Teknologi Bandug (ITB); Chulalongkorn University, Thailand; Asian Institute of Technology (AIT)	Continuing through **USGS** and AIT/ITTI; Maintenance and utilization of CAP and EIDS software as well as hazard maps by all USGS, ITB, Chulalongkorn University and AIT/ITTI
IV. Modeling, Forecasting and Scenario Development								
10. ComMIT - Community Model	NOAA	Regional, Australia, Thailand, Indonesia	ComMIT training materials	Limited technical support in region, further general development of ComMIT	Continued	Not applicable; NOAA engagement to be continued	ICG/IOTWS WG4	TBD - Continuing through **NOAA**

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
V. Establishment of a system of Interoperable Advisory and Warning Centers								
11. Warning Center Concept of Operations (CONOPS)	NOAA	Region, Sri Lanka, Indonesia, Thailand	CONOPS - Concept of Operations; TWCG - Tsunami Warning Center Guide	NOAA to continue monitoring and updating of TWCG; Public product made available on US IOTWS Program website; Printing and distribution of guide	Transfer	March 2008	ICG/IOTWS Secretariat; ICG/IOTWS WG5; University of Oregon Natural Hazard Reduction Center; Pacific Disaster Center (PDC); Asian Disaster Preparedness Center (ADPC)	Continuing through **NOAA**, ICG/IOTWS, ADPC and AIT/ITTI; IOC to monitor TWCG and report to NOAA for need to upgrade; Training on CONOPS through ADPC and AIT/ITTI
12. Tsunami Alert Rapid Notification System (TARNS) Early Warning System (EWS)	USFS; NOAA; USAID	Thailand Indonesia	TARNS workshop materials TARNS/ EWS materials	Transferred to ADPC, Governments of Thailand and Indonesia	Transfer Continue TBD	August 2007 (completed) TBD: USFS, NOAA engagement to continue pending funds availability	Thai National Disaster Warning Center (NDWC); Badan Meteorolgi & Geofisika (BMG), Indonesia; Ministry of Research and Technology, (RISTEK), Indonesia; CARE Indonesia, Asian Disaster Preparedness Center (ADPC)	Continued **USG** engagement with partners if funding can be identified; Governments of Thailand and Indonesia to implement EWS - Early Warning System; ADPC institutionalizing technical materials from TARNS and developed activity plan within existing budget; CARE partnering with ADPC to promote EWS in Indonesia
13. RANET	NOAA	Sri Lanka; Indonesia	Worldspace receivers, computers, and GSM modems; training materials	Continued through NOAA and Governments of Indonesia and Sri Lanka	Transfer/ Continue	September 2007 (completed)	NOAA/NWS/IA; Badan Meteorolgi & Geofisika (BMG), Indonesia; Sri Lanka Disaster Management Center (DMC); Sri Lanka Department of Meteorology	**NOAA** to maintain broadcast operations on WorldSpace satellite for duration of satellites life (approx. 8years); Government counterparts to manage deployment, utilization, tracking and deployment of RANET equipment; Continued training by NOAA
14. National Disaster Warning Systems Integration and Capacity Development	USTDA	Thailand	Recommendation report for organizational structure and technology for tsunami preparedness and warning	Completed; distribution of report	Transfer	February 2007 (completed)	Thai National Disaster Warning Center (NDWC); Pacific Disaster Center (PDC), East-West Center	Implementation of a decision support system to improve NDWC's tsunami early warning capability; Funding proposal has been forwarded to USTDA for next phase

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
15. National Disaster Management plan and Technology Strategy	USTDA	Indonesia	Designed decision making system; hardware and software for pilot decision making platform; study of communications/ emergency notification and impact assessments	Completed; distribution of study and assessments	Transfer	December 2007	Badan Meteorolgi & Geofisika (BMG), Indonesia; Techno-Sciences	Implementation of technical recommendations and utilization and maintenance of equipment by BMG
16. National Emergency Communications Strategy	USTDA	Indonesia	Assessment of requirements, comparison with international best practices, gap analysis	Completed; distribution of Assessment	Transfer	December 2007	Badan Meteorolgi & Geofisika (BMG), Indonesia; Techno-Sciences	Implementation of technical recommendations and utilization and maintenance of equipment by BMG
17. National Disaster Management Policy and Institutional Strengthening	USAID	Regional	National Disaster Management Policy and Institutional Strengthening Assessments	Completed; transferred to ADPC	Transfer	October 2007 (completed)	Asian Disaster Preparedness Center (ADPC); Governments of Thailand, Indonesia, and Sri Lanka	Modification and updates as needed by each country facilitated by ADPC
VI. Mitigation, Preparedness and Response								
18. International Tsunami Training Institute (ITTI)	NOAA; USAID	Regional	ITTI archive, course curriculum and materials	Support to AIT for implementation of second ITTI course in March 2008	Transfer	March 2008	Asian Institute of Technology (AIT); University of Washington, Seattle (UoW)	Continued support to AIT by **NOAA** until ITTI fully institutionalized through TBD funding; Incorporation of ITTI curriculum into AIT and UoW course offerings
19. Coastal Community Resilience (CCR)	NOAA; USAID (PI)	Regional	CCR Guide	Distribution of CCR guide to CCR partners; NOAA to collect feedback on CCR guide as it is being used in field; Continued advocacy to strengthen CCR programming regionally	Transfer	March 2008	Asian Disaster Preparedness Center (ADPC), ICG/IOTWS WG6; IUCN-Mangroves for the Future; Asian Institute of Technology; The Nature Conservancy, USAID Indonesia; Department of Marine Affairs and Fisheries, Indonesia; Disaster Management Center (DMC) Sri Lanka;	Continued through **ADPC** and partner agencies through UNESCAP funding; Partner organizations to incorporate CCR guide into program operations; Continued trainings through URI activities

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
							Coastal Conservation Department (CCD), Sri Lanka; University of Rhode Island (URI)	
20. Incident Command System (ICS)	USFS; USAID	Sri Lanka Indonesia	Course curriculum and reference materials		Transfer Continue TBD	July 2007 TBD: USFS, engagement to continue pending funds availability	Disaster Management Center; USAID/Sri Lanka; American Red Cross, Sri Lanka; UNDP; Sri Lanka Institute of Development Administration (SLIDA); Government of Indonesia	Continued **USG** engagement with partners if funding can be identified; DMC and SLIDA adapting and using curriculum in training courses; ICS in process of being written into National Policy and legislated; ARC and UNDP providing ICS trainings as part of their programming. Government of Indonesia exploring training options
21. Knowledge-Sharing Information Systems	USAID (PI)	Regional	Program website	Complete website and upload all products completed under program	Transfer	September 2007 (completed)	Asian Disaster Preparedness Center (ADPC)	ADPC will host and maintain site, and provide updates and information of follow on activities
22. GRANT: Strengthening Capacity on Multi-hazard Risk Assessment in Tsunami-affected Countries (SCRATCH)	USAID (PI)	Regional	Training manual; Case studies	None	Transfer	September 2007 (completed)	Asian Institute of Technology (AIT) Geoinformatics Center	Maintenance of materials on AIT Geoinformatics Center web portal
23. GRANT: Assessment of Local Institutions on the National Policies and Measures towards Disaster Preparedness and Mitigation	USAID (PI)	India, Sri Lanka	Inventory of disaster management and mitigation resources; Recommendations for policy; Disaster preparedness of manual	None	Transfer	September 2007 (completed)	Asian Institute of Technology (AIT)	Continued use of materials through AIT courses and programs
24. GRANT: Tsunami Response Program, Community Based Disaster Management (CBDM)	USAID (PI)	India	Training materials; Village Disaster Management Plans for 52 villages.	None	Transfer	September 2007 (completed)	Sustainable Environment & Ecological Development Society (SEEDS)	Training materials and knowledge maintained in SEEDS Citizen Resource Center being developed in Port Blair

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
25. GRANT: Revising, Expansion, and Multi-stakeholder Endorsement of IDEP's CBDM kit	USAID (PI)	Indonesia	Community Based Disaster Management kit	None	Transfer	September 2007 (completed)	IDEP Foundation	Funding sought by IDEP for translation and printing of kit into Indonesian
26. GRANT: Rehabilitation of Fisheries and Aquaculture in Tsunami-affected Coastal Communities in Aceh Province	USAID (PI)	Indonesia	Technical research studies and reports: Community Action Plans in Aceh Jaya	None	Transfer	September 2007 (completed)	World Fish (ICLARM)	Continued monitoring and evaluation in project area by World Fish; Replication of work to Aceh Barat and use of lessons learned in FoN-funded project
27. GRANT: Outreach and Public Dialog on Decentralization in Legal Reform for Disaster Management	USAID (PI)	Indonesia	Case Study; Guidebook for creating legal reform in DM at provincial and district level	None	Transfer	September 2007 (completed)	Indonesian Society for Disaster Management (MBPI); Ministry of Home Affairs (MoHA)	Use of materials in ongoing MBPI work; Launch of "The Guidebook of Legal Reform" by MoHA
28. GRANT: School Education Road Show in Padang, Indonesia	USAID (PI)	Indonesia	Educational materials	None	Transfer (continue if funding is identified)	September 2007 (completed)	Komunitas Siaga Tsumai KOGAMI	Trainings of schools in Padang Indonesia not covered by initial grant to KOGAMI; Continued use of training materials and experience gained from Grant in other KOGAMI activities; **USAID/Indonesia** and **USAID/RDMA** to facilitate identification of funding for additional activities
29. GRANT: Community Institutional Strengthening in Coastal Hazard Analysis & Mitigation, Disaster Response, and Disaster Recovery	USAID (PI)	Sri Lanka	Training materials	None	Transfer	September 2007 (completed)	Sewlanka Foundation	Sewelanka exploring funding with DMC for follow on work in grant and additional communities.
30. GRANT: Development of Tsunami Hazard Zoning Maps for	USAID (PI)	Sri Lanka	Tsunami hazard maps for five coastal cities; Training materials	None	Transfer	September 2007 (completed)	University of Peredeniya; Disaster Management Center (DMC)	Inclusion of training materials into University of Perideniya Master's program in Disaster Management; Use of hazard

Activity	USG Agency Lead	Countries	Handover product(s)	Action Required Prior to Handover	Action	Handover Date/Status	Handover Partners/Recipients	Partner & USG Follow-on Activities after Handover
the Coastal Belt of Sri Lanka								maps by DMC
31. GRANT: Risk Assessment and Design of Countermeasures for Tsunami Hazard: Case Study for the Port City of Galle	USAID (PI)	Sri Lanka	Numeric and physical tsunami impact models. Socio-economic surveys; Risk assessment study	None	Transfer	September 2007 (completed)	University of Moratuwa (UoM), Coastal Conservation Department (CCD) and Disaster Management Center (DMC)	Research will be published by University of Moratuwa; Research will be expanded and utilized by UoM, CCD, and DMC
32. GRANT: Capacity Building of Coastal Communities on Coastal Mitigation	USAID (PI)	Thailand	Coastal mitigation plan and training materials	None	Transfer	September 2007 (completed)	Asian Institute of Technology (AIT)	Training materials will be utilized by AIT in its course curriculum for coastal management
33. GRANT: Last Mile Communications Inventory	USAID (PI)	Thailand	Report	None	Transfer	September 2007 (completed)	D-TRAC	None
34. GRANT: Building Community Capacity and Technical Assistance to Effectively Respond to Warnings of Tsunamis and Other Hazards	USAID (PI)	Thailand	Education materials	Distribution of education materials; Ongoing monitoring and evaluation of education materials	Transfer	September 2007 (completed)	East Tennessee State University (ETSU); Save Andaman Network (SAN)	Distribution of education materials; Ongoing monitoring and evaluation of education materials by ETSU and SAN
35. GRANT: Coastal Community Resilience and Coral Reef Management in Tay Muang District, Phang Nga	USAID (PI)	Thailand	Baseline biodiversity and socio-economic reports; Coastal resources maps; Nature education curriculum. Educational materials	Materials provided to local community and National Park Advisory Committee	Transfer	September 2007 (completed)	World Wildlife Fund (WWF)	Continued engagement and monitoring in target communities by WWF
36. GRANT: Earthquake & Tsunami Education for Phang Nga	USAID (PI)	Thailand	Training materials	Training materials made available on Chulalongkorn University site	Transfer	September 2007 (completed)	Chulalongkorn University	Training materials maintained on Chulalongkorn University site

A4. TERMS OF REFERENCE FOR ICG/IOTWS WORKING GROUPS

Working Group 1: Seismic measurements, data collection, and exchange

- Identify the core seismic stations in Indian Ocean region
- Establish the core seismic network in Indian Ocean region
- Make seismic data of core seismic station available to member state countries in real time for tsunami warning purposes
- Establish the communication link to the members to update the status of development of seismic stations and new available technology

Working Group 2: Sea-level data collection and exchange, including deep-sea tsunami detection instruments

- Examine various user requirements (i.e. a multi-hazard approach) for the IOTWS sea-level gauge network
- Examine the current and future requirements for the IOTWS, taking account of information obtained from the IOC National Assessment on the Sea Level Network
- Investigate the technical issues of bandwidth and satellite coverage
- Investigate the issues with interoperability between existing (and future)sea-level stations, such as the lack of meta data
- Address the issue of the sustainability of the system
- Form a DART operators group to investigate various issues relating to the IOTWS deep-ocean tsunami detection instruments network

Working Group 3: Risk Assessment

The development of a tsunami early warning system for the Indian Ocean needs to be put into a risk management framework that can be applied at global, regional, national and local levels. The goal is to reduce vulnerability and strengthen coping capacities of communities with regard to tsunami risk as outlined below:

- Develop guidelines for tsunami risk assessment as part of a multi-hazard risk management framework
- Provide guidance to emergency response managers on the preparation of risk assessment products
- Facilitate the application and use of model outputs for tsunami hazard and risk assessment.
- Facilitate data sharing, including access to and development of databases, incorporating exposure, tsunami hazard and vulnerability.
- Facilitate capacity building, including knowledge transfer, in the form of workshops, training programs and case studies for risk assessment in all Indian Ocean countries.
- Facilitate and promote the process of developing cost-effective and practical mitigation options and measures.
- Liaise with other modelling committees (including other ICG/IOTWS working groups) and organisations or professional groups that are developing models and data for their implementation.

Working Group 4: Modelling, Forecasting, and Scenario Development

- Develop standards for operation and application of models
- Facilitate the development: source, deep water propagation, inundation and forecast models
- Develop bench mark tests for model verification and validation
- Facilitate the development of a web-based community model
- Development of credible case scenarios for model application for the entire Indian Ocean including all possible sources (Sundra Arc, Makran region etc).
- Facilitate capacity building and knowledge transfer in the form of web-based tools and training programs
- Liaise with other working groups, especially WG3 - Tsunami hazard detection, characterisation and risk assessment for model requirements and effective model usage and application

Working Group 5: The establishment of a system of interoperable operational centers

- To progress the establishment of a coordinated regional warning system for the entire Indian Ocean basin, through the establishment of a network of National Inter-operable Warning Centres
- Advise on the modalities of operation, methods and standards for development and issuance of warnings, and requirements in terms of coordination and operating within a multi-hazard approach
- In consultation with the IOC Secretariat, examine the IOC/WMO Assessment process results still underway, and develop guidelines for the distribution of tsunami warnings by National Tsunami Warning Centres (NTWCs) to emergency centres in their country, the media and the public. These Guidelines will be included in the IOTWS master plan being developed by the IOC tsunami technical unit
- Provide further detailed elaboration of the roles of RTWPs (including responsibility for advisories) and NTWCs.

Working Group 6: Mitigation, Preparedness and Response

- Promotion and enhancement of the institutionalisation of tsunami early warning systems, their implementation and maintenance
- Mainstreaming of tsunami warning and mitigation system into development policy, plans, practice and legislation
- Integration of national tsunami programs and experts into the defined national platforms for disaster risk reduction and national disaster management processes
- Development and adaptation of tsunami-related guidelines, manuals and tools for downstream activities i.e. public information, education, training, communication processes, evacuation planning and drills, standard operating procedures and emergency management
- Coordination at regional and sub-regional levels on the above matters