# Annex I

**Terms of Reference/Work Plan and Budget**

**Multi-donor Voluntary Trust Fund on Tsunami Early Warning Arrangements in the Indian Ocean and Southeast Asia**

## A. Overview

<table>
<thead>
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<th>Organization</th>
<th>Asian Disaster Preparedness Center (ADPC)</th>
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</table>
| 2. | List of supporting organizational documents (attached to the original Grant Proposal submitted by ADPC to the Tsunami Regional Trust Fund on 15 April 2007) | Organizational charter  
Registration certificate  
2006 Audited financial statement |
| 3. | Focal point at organization and relevant contact information | Dr. Bhichit Rattakul, Executive Director a.i.  
Tel. 02-516-5900 ext 101, E-mail: bhichit@adpc.net |
| 4. | Project title | End-to-end early warning of tsunamis and other natural hazards for disaster preparedness and mitigation in the Indian Ocean and Southeast Asia: Phase 2 |
| 5. | Beneficiary countries | Bangladesh, Cambodia, Lao PDR, Maldives, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam |
| 6. | Target group / specific locations | Regional facility of the 11-country multi-hazard early warning system in the Indian Ocean and Southeast Asia at the Asian Disaster Preparedness Center, Pathumthani, Thailand |
| 8. | Total budget (US$) and breakdown of funds | UN Regional Tsunami Trust Fund: US$ 1,211,766  
Counterpart contribution (Danida): US$ 580,000 |

## Executive Summary

This project supports activities under the ADPC programme on *End-to-end early warning of tsunamis and other natural hazards for disaster preparedness and mitigation in the Indian Ocean and Southeast Asia*, developed by Bangladesh, Cambodia, China, Lao PDR, Maldives, Myanmar, Philippines, Sri Lanka, Thailand and Vietnam. The proposed project aims at enhancing tsunami warnings with the use of pre-computed simulations. Expected outcomes of the project are:

a) Database of pre-computed tsunami simulations that is integrated into the warning system for the Indian Ocean and Southeast Asia;  
Interactive procedure for tsunami forecasting and graphical presentation for tsunami watch.
B. Needs assessment

The key elements of an end-to-end early warning system, as defined by the Intergovernmental Oceanographic Commission (IOC), the global body overseeing tsunami early warning, are: a) hazard detection and forecast, consisting of a regional and national hazard detection network of instrumentation and communication mechanisms to continuously monitor and detect tsunamigenic events, and tsunami modeling, forecasting and scenario development; b) threat evaluation and alert formulation at regional and national levels; c) alert dissemination at national and local levels; and d) local preparedness and response.

Numerical modeling is essential in warning, particularly in predicting tsunami arrival time and heights. It is also necessary for emergency response planning, as well as for preparedness and mitigation, as worst case scenarios are simulated for predicting tsunami inundation and become the basis for these actions.

Seismic parameters, used as indirect measurements of tsunami generation, are utilized as the basis for the initial tsunami warning decision. Warnings based solely on seismic parameters are not very reliable (refer to Annex 3a of the original Grants Proposal: case study of the 28 March 2005 tsunamigenic earthquake in Sumatra, Indonesia). Warning reliability is improved using sea level data from the nearest coastal tide gauge station, which are used to confirm the generation of a tsunami. This method also has the following constraints: a) time lag of tide gauge data receipt, which impacts on rapid warning dissemination for evacuation purposes; and b) tide gauge data interpretation because of the complex tsunami transformations induced by interaction with continental shelf, coastline and harbor features as the tsunami travels from source to the tide gauge station site (refer to Annex 3b of the Grants Proposal). Warning reliability is further improved using tsunami numerical modeling, in addition to seismic and tide gauge data, as demonstrated by the 7.5 magnitude tsunamigenic earthquake in the Rat Islands in the Pacific on 17 November 2003 (refer to Annex 3c of the Grants Proposal).

Numerical modeling may be done in real-time, using earthquake information provided by broadband seismometers during an event and fed to high-performance (super) computers for the prediction of arrival time and tsunami heights; or during non-emergency times, using several earthquake scenarios, fed to personal computers (PC) to generate tsunami travel time, heights and coastal inundation, and archived for later retrieval when an earthquake of the same magnitude occurs. The latter approach is more economical as it requires only a PC with at least 512 Mb RAM and a Pentium processor. It does not “race with time”, since it is undertaken during non-emergency times, and it is an activity that would keep tsunami watch standers occupied and sharp, as the next tsunami threat may come in the region decades or more hence.

Among the target and/or beneficiary countries, only the Philippines is capable and experienced in numerical modeling. Capabilities also exist with Thailand, the Maldives and Vietnam. In the Indian Ocean region, only 3 of 16 countries surveyed by IOC have modeling capacities: Thailand (with the Asian Institute of Technology, refer to Annex 4a of the Grants Proposal: IOC rational capacity assessment), Malaysia (with the National Hydraulic Research Institute and Universiti Teknologi Malaysia, refer to Annex 4b of the Grants Proposal), and Indonesia (with Institut Teknologi Bandung (ITB), Agency for the Assessment and
Application of Technology (BPPT) and the Meteorological and Geophysical Agency (BMG), refer to Annex 4c of the Grants Proposal).

The ADPC-facilitated system, supported by the Asian Institute of Technology (AIT), should undertake tsunami modeling for the participating countries for the following reasons:

- ADPC was entrusted with the responsibility by 11 participating countries (Bangladesh, Cambodia, China, Lao PDR, Maldives, Mauritius, Myanmar, Philippines, Sri Lanka, Thailand and Vietnam) to act as their regional tsunami watch provider (RTWP) (refer to Annex 5 of the Grants Proposal: Resolution of participating countries in the July 2006 meeting), and numerical modeling capability is an IOC requirement for a RTWP.
- Capacity exists at AIT, which is ably supported by its partners, Tohoku University and Tokyo University.
- The Philippines, through the Philippine Institute of Volcanology and Seismology (PHIVOLCS), and China, through the China Earthquake Administration, provide technical and practical guidance.
- Bilateral cooperation agreements with participating countries facilitate access to data and information (e.g. bathymetry and topography) required to run inundation models.
- Economy of scale, since the limited fund from the UN Regional Tsunami Trust Fund cannot support individual countries in the region in tsunami modeling.
- Capacity building of scientists in participating countries through a secondment scheme.
- A regional facility at ADPC that is “owned by the participating countries” can provide need-based training of scientists and practitioners of these countries.
- A national center’s capacity to take on this regional role is only a by-product of the national system (i.e. national systems are developed with the main aim of protecting their own territories).

C. Problem analysis and project design process

Two expert consultations were undertaken in February and April 2005 to seek guidance on establishing a regional tsunami early warning system in response to the Royal Thai Government’s request in January 2005 and the request by six other countries in the March 2005 Bangkok meeting of early warning focal points for ADPC to play that regional role (refer to Annex 6 of the Grant Proposal: Meeting declaration). The first expert consultation identified numerical modeling as one of the key tasks of the regional facility for tsunami warning (refer to Annex 7 of the Grant Proposal: Preliminary technical system design). The second expert consultation detailed the requirement for numerical modeling in tsunami prediction (Annex 8 of the Grant Proposal). Expert participants at these meetings came from international, regional, and national institutions as follows:

Seismic experts:
- Center for Hazards and Risk Research, Lamont-Doherty Earth Observatory, Columbia University
- Global Seismic Network, USA
- Swedish Defense Research Agency (FOI)
- World Agency of Planetary Monitoring and Earthquake Risk Reduction
- Malaysian Meteorological Service
- Geological Survey and Mines Bureau, Sri Lanka
• Thai Meteorological Department
• Department of Mineral Resources, Ministry of Natural Resource and Environment, Thailand
• Asian Institute of Technology
• Institut Teknologi Bandung, Indonesia

Oceanic system experts:
• University of Hawaii Sea Level Center
• State Oceanic Administration of China
• Royal Thai Navy
• Rangsit University, Thailand

Telecommunication experts:
• Ministry of Information and Communication Technology, Thailand
• National Electronics and Computer Technology Center, Thailand
• Geo-Informatics and Space Technology Development Agency, Thailand
• Vietnam Hydro-meteorological Service

Operational tsunami warning centers:
• Philippine Institute of Volcanology and Seismology (PHIVOLCS)
• Pacific Tsunami Warning Center

The first expert consultation also looked at the convergence of tsunami warning and warning for other natural hazards (refer to Table 5, Annex 6 of the Grant Proposal) to analyze how tsunami warning may be integrated into existing warning systems. The expert consultation in July 2006 provided further guidance and developed a work plan (refer to Annex 9 of the Grant Proposal). Participants at this consultation came from the following regional and national institutions:

• Bangladesh Meteorological Department
• Department of Meteorology, Cambodia
• China Meteorological Administration
• Department of Meteorology and Hydrology, Lao PDR
• Department of Meteorology, Maldives
• Department of Meteorology and Hydrology, Myanmar
• Philippine Atmospheric, Geophysical and Astronomical Services Administration
• Department of Meteorology, Sri Lanka
• Thai Meteorological Department
• National Hydro-Meteorological Services, Vietnam
• Center for Atmospheric Science, India Institute of Technology Delhi

Technical details in this proposal were provided by PHIVOLCS, Center for Atmospheric Science, India Institute of Technology, and an ADPC consultant on climatology (from the Department of Atmospheric Sciences, National Taiwan University of Taiwan, Province of China). Technical review was provided by the Department of Meteorology and Hydrology, Myanmar, as Chair of the Regional Steering Committee of the ADPC-facilitated early warning system, Department of Meteorology, Sri Lanka and Thai Meteorological Department as Vice Chairs of the Regional Steering Committee, and the Pacific Tsunami Warning Center.
D. Target group

The proposed tsunami modeling capacity targets the regional facility of the 11-country multi-hazard early warning system in the Indian Ocean and Southeast Asia at the Asian Disaster Preparedness Center. Support towards establishment of the regional facility was approved under the first round of funding from the UN Regional Tsunami Trust Fund (UN-RTTF). Activities of the regional facility being supported by UN-RTTF are: establishing a network of real-time broadband seismic stations; a network of near real-time GLOSS multi-purpose sea level stations; data receiving, processing and evaluation center; tsunami watch preparation and dissemination to participating countries; and local preparedness. Tsunami modeling will be added to these capacities to enable ADPC to meet the requirements of IOC for a regional tsunami watch provider.

E. Project strategy

ADPC will source expertise from two streams: a) technical support (through a numerical modeling expert and a coastal scientist) from the School of Civil Engineering of the Asian Institute of Technology (AIT), with access to their technical partners in tsunami modeling, which include Tohoku University and Tokyo University in Japan, on the development of appropriate numerical modeling methods; and b) practical experience by an international expert who will be engaged for technology transfer and skill diffusion during the project, in addition to ensuring that data sources, communication and processing are properly integrated. ADPC will also closely coordinate with other institutions that have undertaken simulations for sources in the Indian Ocean and South China Sea, such as Bureau of Meteorology, Australia, Earthquake Information Center of the Association of Southeast Asian Nations (ASEAN), the Coordinating Committee for Geoscience Programmes in East and Southeast Asia, for synergy and information sharing.

ADPC is currently finalizing a Partnership Agreement with AIT to establish the regional facility for multi-hazard warning, operate a regional multi-hazard warning system, and undertake collaborative research (refer to Annex 10 of the Grant Proposal). Building on its strengths in science and technology, AIT will take a lead role in scientific and technical research and provide scientific and technical support in the operation of the regional early warning system. As host to the regional center facility, AIT will provide on-campus accommodation, to be rented by ADPC, to the regional center’s staff involved in 24/7 operation. ADPC, in line with its existing mandate, will continue to facilitate regional partnerships and agreements, mobilize resources, and operate the regional system. This partnership will enable both parties to assist regional capacity development, facilitate scientific and technical exchanges, and conduct further research.

F. Results framework

i. Capacities developed in target group

The activities proposed under the present project will enhance tsunami warnings disseminated as advisories to National Tsunami Warning Centers (NTWCs) with the use of pre-computed tsunami simulations, along with seismic and sea level data.

Indicator: Interactive procedure to rapidly and accurately forecast tsunami generation, propagation and inundation, using seismic, sea level and deep-ocean data and
pre-computed tsunami simulations database is developed, tested, validated, and integrated into the regional facility operations.

The IOC architecture for the Indian Ocean Tsunami Warning and Mitigation System (IOTWS) consists of Regional Tsunami Watch Providers (RTWPs) and NTWCs. ADPC has established collaborative arrangements with NTWCs in the form of memoranda of understanding (refer to Annex 11 of the Grant Proposal). Key areas of cooperation include the provision of tsunami and multi-hazard warning information and strengthening of national capacities in early warning.

The proposed project will build the capacity of the regional facility at ADPC to perform the functions of an IOC-accredited RTWP, with participating countries benefiting from its products and services. Annex 2 of the Grant Proposal details the minimum IOC capability requirements of a RTWP as: a) operating as a multi-hazard/multi-purpose center on 24/7 basis; b) with contingency plans, secure infrastructure and uninterruptible power supply for continuous operation; c) has capacity to back-up another regional tsunami watch provider; d) has capacity to collect seismic and oceanographic data in real-time, analyze and interpret the information, and ability to undertake numerical modeling; and e) has a communications infrastructure capable of effective dissemination of all information to all recipients. The IOC Intergovernmental Coordination Group for IOTWS (ICG/IOTWS) Working Group 5 is in the process of defining RTWP services and performance indicators. ADPC, being a member of this working group, would ensure that IOC standards and requirements are met by the regional facility.

The fourth session of the ICG/IOTWS held from 28 February - 2 March 2007 in Mombasa, Kenya acknowledged that “ADPC has moved into a gap left by the original planning of the IOTWS. Whatever system is put in place by ADPC, the ICG/IOTWS needs to ensure that it integrates with other aspects of the system.” (refer to Annex 13 of the Grant Proposal: Report of the ICG/IOTWS 4th Session, p.55). The meeting established a task team, consisting of representatives of potential RTWPs (Australia, India, Indonesia, Iran, Malaysia, and Thailand/ADPC), representatives of interim watch providers (PTWC and Japan Meteorological Agency (JMA)), and invited experts as required to develop capability guidelines for a RTWP, identify RTWPs, consult with national tsunami focal points to determine appropriate requirements for products and services from Watch Providers, exchange information on methodologies, and complete an implementation plan, including a transition strategy for the interim service, for integration into the IOTWS Implementation Plan (refer to Annex 13 of the Grant Proposal).

ii. Project activities

Expected Outcome 1: Database of pre-computed tsunami simulations developed at the ADPC-facilitated REWC for the Indian Ocean and South China Sea and integrated into the warning system for the region:

1.1 Review current and emerging seismological techniques for rapid estimation of earthquake parameters. Current seismological techniques have difficulty determining the magnitude of very large earthquakes, such as the case of the Sumatra earthquake of 26 December 2004. Emerging techniques, such as those based on broadband body waves, use of Global Positioning System (GPS), and use of very long-period displacement seismograms will be
investigated. Reliable and effective techniques will then be identified and adopted for integration into regional facility operations.

**Indicator:** Reliability of each seismological parameter rapid estimation technique is determined.

1.2 Evaluate available tsunami generation, propagation and inundation models; select and acquire models that are most appropriate for the region, e.g., through comparing performance against the actual propagation of historical tsunamis. Tsunami generation and propagation models (MOST and TSUN) are freely available; contingency budget would allow purchase of inundation models, if necessary.

**Indicator:** Numerical models appropriate for the region identified from an inventory of available models.

1.3 Train technical staff on open-source tsunami numerical models. Training can be opened for participation of member countries.

**Indicator:** At least 3 technical staff, as well as participants from interested participating countries, are trained in the use of Method of Splitting Tsunamis (MOST) and TSUN 1 and 2, numerical models for tsunami generation, propagation and inundation.

1.4 Acquire software required for preparing topographic, bathymetric, and hazard maps. These include mathematical software for preparing bathymetric and topographic grid, surfer for nesting grids, and GIS software for preparing tsunami hazard maps.

**Indicator:** At least three mapping tool software acquired.

1.5 Develop a database of information on potential tsunamigenic seismic sources in the region, including the Manila, Sulu, Cotabato, Sunda and Makran subduction zones, and factors (e.g., depth, orientation, near shore parameters) affecting the likelihood of tsunami generation and the characteristics of tsunamis generated.

**Indicator:** At least 5 tsunamigenic seismic sources identified, characterized and archived in a database.

1.6 Select, in collaboration with national partners, at least 30 key coastal sites in the region for computing tsunami inundation. Selection criteria include coastal population density and development, history of tsunami events, and availability of adequate bathymetry and topographical data.

**Indicator:** 30 coastal sites selected for tsunami inundation modeling.

1.7 Identify data requirements and sources, and acquire necessary data and information (see Activity 1.6) for conducting the simulations.

**Indicator:** Data requirements and sources listed.

1.8 Develop a comprehensive database of pre-computed tsunami simulations for various possible scenarios in the region.
Indicator: Database, containing at least 30 scenarios, is developed.

1.9 Generate tsunami risk maps.

Indicator: Tsunami risk maps for at least 10 selected coastal sites prepared.

Expected Outcome 2: Interactive procedures between ADPC REWC and National Meteorological Services (NMSs) for tsunami forecasting and graphical presentation of tsunami watch are developed, tested and integrated into national and regional tsunami warning systems:

2.1 Develop an interactive procedure to rapidly and accurately forecast tsunami impacts using four data streams: seismic, sea level, deep-ocean, and pre-computed tsunami simulations, and test and validate the procedure to confirm its reliability, accuracy and timeliness.

Indicator: Tsunami forecasting procedure developed, tested, validated, and accepted by IOC.

2.2 Develop an easy-to-understand graphical format for presenting tsunami warning information and forecast products to NTWCs.

Indicator: Graphical format available for use.

2.3 Integrate the procedure and graphical presentation of tsunami watch into the regional facility operation.

Indicator: User-friendly tsunami watch information tested with receiving countries.

2.4 Provide on-the-job training to scientists seconded by participating countries.

Indicator: At least one scientist is trained from each of the following countries: Bangladesh, Maldives, Myanmar, Sri Lanka and Vietnam.

2.5 Document process, experiences and lessons learned, and periodically report progress to Regional Steering Committee, UN Regional Tsunami Trust Fund Advisory Council, IOC, national, regional and international forums as opportunity arises, and the general public through ADPC website and quarterly newsletter.

Indicator: Periodic reports to above-identified receivers.

iii. Expected project impact: Improved early warning system performance with the use of pre-computed tsunami simulations.

Indicator: Increased accuracy of tsunami forecast with the use of pre-computed tsunami simulations compared to the use of seismic and sea level data only.
G. Organizational capacity

ADPC has two decades of experience in disaster management, facilitating regional cooperation, and building capacities of disaster management institutions at all government levels, disaster management practitioners, and communities (refer to Annex 14 of the Grant Proposal: ADPC Capacity). It has implemented projects that involved development of forecast systems, in particular the delivery of new-generation weather forecasts and forecast application in various climate- and weather-sensitive sectors (Extreme Climate Events Program, 1998-2003; Climate Forecast Applications in Bangladesh, 2000-2003; Flood Forecast Technology for Disaster Preparedness in Bangladesh, 2006-2009; Climate Forecast Applications for Disaster Mitigation in Indonesia and the Philippines, 2003-2008). Annex 15 of the Grant Proposal provides the curricula vitae of its key technical staff that would be involved in implementing this proposed project.

More importantly, ADPC could enrich its expertise, drawing from countries in the region and from its alumni base of over 6,000 in various parts of the world. For example, in the preparation of this project proposal, the Government of the Philippines offered decades of 24/7 earthquake and tsunami warning experience to ADPC through PHIVOLCS on secondment basis.

To meet the new demands of an operational RTWP, ADPC plans, in addition to the staffing identified in the first proposal, to acquire the necessary technical capacity as follows:

Staff in addition to those under the first phase to complete the minimum number required for 24/7 operation:
Two tsunami watch standers (1 seismologist, 1 oceanographer)
Warning Coordination Scientist
Coastal Scientist
International experts for the required training of regional facility personnel in tsunami modeling and application
NTWC scientists from participating countries on secondment

This would bring the total RTWP staffing to:

Technical staff:
Senior Scientific Officer, who is also a seismologist/ geophysicist (1)
Seismologists/ geophysicist (2)
Oceanographers (2)
Warning Coordination Scientist (1)
Coastal Scientist (1)
Electronic Technician (1)
ICT Officer (1)
International experts / seconded seismologists, geophysicists and oceanographers (2)

Field Staff:
Field Coordinator (seismic surveys and station installations)

Support staff:
Administrative Assistant (1)
Operational partnerships from project implementation in countries in the region exist between ADPC and the United States Geological Survey’s Albuquerque Seismological Laboratory (USGS/ASL), University of Hawaii Sea Level Center, Pacific Tsunami Warning Center, and the Asian Institute of Technology. This enables ADPC to mobilize expertise from within and into the region, required in the development of the end-to-end multi-hazard early warning system for tsunamis and other natural hazards. Also, ADPC’s memberships in IOC’s ICG/IOTWS Working Group 5 on System for Interoperable Advisory and Warning Centers, UNISDR Inter-Agency Task Force on Disaster Reduction, and the ProVention Consortium facilitates coordination with UN and international organizations for project implementation, and in tabling concerns of the region in these forums.

ADPC capacity to implement the project being proposed is supported by the institutional mechanism established to guide the implementation of the regional EWS programme. The July 2006 Bangkok meeting constituted a Regional Technical Steering Committee of heads of early warning national focal points and selected international experts to provide policy and technical advice to the Center. This committee is chaired by Myanmar Department of Meteorology and Hydrology, with Sri Lanka Department of Meteorology and Thailand Meteorological Department as Vice-Chairs. National Steering Committees were agreed to be established in the participating countries consisting of national early warning stakeholders, with the head of the early warning national focal point as Chair, to guide implementation of in-country activities. Steering committees of early warning stakeholders at sub-national and local levels will be set-up for project implementation.

H. Contribution to regional coordination and/or cooperation towards the establishment and functioning of a regional early warning system for tsunamis and other hazards in the Indian Ocean and Southeast Asia region

ADPC coordinates with the IOC through the ICG/IOTWS Working Group 5 on System for Interoperable Advisory and Warning Centers. This Working Group is responsible for setting the standards, minimum requirements and modalities of operation of RTWPs, and takes stock of the progress towards establishing a coordinated regional warning system in the Indian Ocean basin. ADPC is also a member of the Working Group 5 task team, responsible for developing RTWP guidelines and determining appropriate requirements for RTWP products and services. ADPC’s involvement in these groups would ensure that ADPC coordinates with and is integrated into the IOC process of establishing the IOTWS, and would meet IOC standards and requirements of a RTWP.

The fourth session of the ICG/IOTWS in Mombasa recognized Thailand/ADPC as one of the six potential RTWPs, along with Australia, India, Indonesia, Iran, and Malaysia. ADPC regularly reports its activities and provides action plan updates to the ICG/IOTWS.

The regional facility will allow 6-month to 1-year on-the-job training of seconded scientists from participating countries. This will complement the training provided by IOC, USGS, the US National Oceanic and Atmospheric Administration (NOAA) and other technical institutions, by providing an environment for practical application of technical skills acquired.

Coordination with other RTWPs at operational level will be carried out through the Warning Coordination Scientist of the regional facility, who is also tasked to provide updates on current development and activities of the regional facility (refer to Annex 16 of the Grant Proposal).
National Steering Committees, which are an integral part of the project’s implementation arrangements, will also ensure that activities are integrated into national systems within a multi-hazard framework.

I. Knowledge management strategy

Section F, Activity 2.5, includes the documentation of processes, experiences, lessons learned, and research outcomes, including periodic progress reports, for sharing with the Regional Steering Committee, the UN Regional Tsunami Trust Fund Advisory Council, IOC and ICG/IOTWS working groups, relevant publications and journals, national, regional and international forums, and the general public (through the ADPC website and quarterly newsletter). Under the bilateral agreements with participating countries, countries are to share the contributions of the ADPC-facilitated system in appropriate external forums. Methodologies for collecting information would include taking note of first-hand experience, informal interview, seeking feedback from partners, and collecting newspaper clips.

J. Sustainability

The proposed project will adopt and continue to take the sustainability measures of the Phase 1 project, in addition to:

- Integrate three services – tsunami watch provision, technical assistance in enhancing disaster risk management capabilities, and training facility for NTWC scientists adds value to the ADPC-facilitated system. Countries intending to become RTWPs have not yet integrated these services.
- Secondment arrangement with participating countries reduces manpower costs and enhances technical training exchanges between institutions.
- Through the outcomes of this project, demonstrate to participating countries the benefits to be derived from the regional facility and for them to appreciate the need for this facility.
- Advocate for participating countries to financially contribute towards the annual operating costs of the regional facility. With more countries participating in the system, the potential contribution for each would be reduced. In the western Indian Ocean, in addition to Mauritius, Somalia, Kenya, Tanzania, Mozambique, Comoros, Madagascar and Seychelles have expressed interest to participate in this regional cooperation on tsunami warning.
- Seek donor assistance to fill any gap in financial resources since most countries participating in the system are countries in need.

Already, ADPC has mobilized resources through two projects, which are currently being implemented, in recognition of these three integrated services:

- Flood Forecast Technology for Disaster Preparedness in Bangladesh, supported by United States Agency for International Development (USAID) Bangladesh through CARE Bangladesh, October 2007 – June 2009. The project generates flash flood and river discharge forecast products for Bangladesh, using rainfall forecast model outputs from the ADPC Multi-hazard Center, and their pilot application in select communities (refer to Annex 18 of the Grant Proposal).
• Establishment of an Early Warning and Disaster Management System in Seychelles, supported by UNDP Seychelles, October 2007 - February 2008. The project provides technical services to the Department of Risk and Disaster Management of Seychelles to develop and test an immediate early warning system, and develop an early warning capacity-building action plan for the medium to long-term.

A project proposal, submitted to the American Red Cross, is now being considered for funding (January 2008 - December 2009), targeting Sri Lanka, Myanmar, Philippines and Indonesia. The project aims to integrate field-based organizations, including the National Red Cross Societies, in the institutional system for end-to-end early warning of tsunamis and other natural hazards at all levels (national through community levels), and capacity building of these organizations in forecast/hazard warning translation into potential impacts and response options to improve community response to warnings.

K. Partnerships

As elaborated in Section G, the July 2006 meeting of early warning national focal points (refer to Annex 26: institutional arrangement) established the institutional arrangement for project implementation as follows:

Regional Technical Steering Committee of heads of early warning national focal points of participating countries, which are often national meteorological services, and select international experts to provide policy and technical advice to the ADPC-facilitated system. Dr. Charles McCreery, Director, PTWC; Mr. Geoff Crane, Warning Specialist, Bureau of Meteorology, Australia; Dr. Renato Solidum, Director, PHIVOLCS; and Dr. Pennung Warnitchai, Associate Professor, School of Civil Engineering, Asian Institute of Technology. National Steering Committees consisting of national early warning stakeholders in the participating countries, with the head of the early warning national focal point as Chair, to guide implementation of in-country activities. Local Steering Committees of early warning stakeholders for project implementation.

Other operational partners include:
USGS/ASL Global Seismic Network (GSN) for global data sharing and archive.
University of Hawaii Sea Level Center for establishment and maintenance of sea level stations, global data archive, and training.
Asian Institute of Technology for tsunami numerical modeling and host of the regional facility.
Pacific Tsunami Warning Center for tsunami warning operations.

L. Expected counterpart contributions (in-kind and cash)

For this proposed project, the expected counterpart contribution would be:

• Computing facility for real-time tsunami modeling research (Danida-funded): US$ 580,000

M. Reporting
ADPC shall submit to ESCAP biannual progress reports, together with cumulative financial reports, on 31 May and 30 November within the duration of the project, following a progress reporting template provided by ESCAP.

ADPC will also provide a terminal report within one month of the agreed project end date and copies of all evaluations and audits carried out under the project.