



From Knowledge to Action: Learning to go the Last Mile

A participatory assessment of the conditions for strengthening the technology–community linkages of tsunami early warning systems in the Indian Ocean

Frank Thomalla, Rasmus Klocker Larsen, Fareedali Kanji,
Sopon Naruchaikusol, Chanyuth Tapa, Bruce Ravesloot
and Atiq Kainan Ahmed

From knowledge to action: Learning to go the last mile

A participatory assessment of the conditions for strengthening the technology–community linkages of tsunami early warning systems in the Indian Ocean

Frank Thomalla,^{1,2} Rasmus Klocker Larsen,¹ Fareedali Kanji,³
Sopon Naruchaikusol,² Chanyuth Tapa,⁴ Bruce Raveslout⁴ and
Atiq Kainan Ahmed³

(1) Stockholm Environment Institute

(2) Department of Environment and Geography, Macquarie University, Sydney, Australia

(3) Asian Disaster Preparedness Center, Bangkok, Thailand

(4) Raks Thai Foundation (CARE Thailand), Bangkok, Thailand

Stockholm Environment Institute
Kräfftriket 2B
SE 106 91 Stockholm
Sweden

Tel: +46 8 674 7070
Fax: +46 8 674 7020
Web: www.sei-international.org

Head of Communications: Robert Watt
Publications Manager: Erik Willis
Layout: Richard Clay

Cover Photo: © Frank Thomalla

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes, without special permission from the copyright holder(s) provided acknowledgement of the source is made. No use of this publication may be made for resale or other commercial purpose, without the written permission of the copyright holder(s).

The study presented in this report has been made possible through financial support provided by the Swedish International Development Cooperation Agency (Sida). However, Sida was not involved in the design of the study and does not necessarily support the views expressed in the report.

Copyright © December 2009
by Stockholm Environment Institute



CONTENTS

List of tables	iv
List of figures	iv
List of boxes	iv
List of acronyms and abbreviations	v
Foreword	ix
Executive summary	xi
1 Introduction	1
1.1 SEI's Strategy to support the Sustainable Recovery and Resilience Building in the Tsunami Affected Region (SEI's Tsunami Programme)	1
1.2 Project aim: Early warning and community preparedness: strengthening the technology–community interface	1
2 Approach and methodology	3
2.1 Participatory assessment of last mile implementation	3
2.2 Literature review	4
2.3 Disaster preparedness and early warning in Krabi Province: A detailed case study	4
2.4 Regional sharing of lessons learned	6
3 Review findings	8
3.1 International efforts to promote early warning through strengthened policy and institutional structures	8
3.2 The Indian Ocean Tsunami Warning System (IOTWS): Concept, Development and Coordination	10
3.3 EWS development in Thailand	19
3.4 EWS development in Sri Lanka	28
3.5 EWS development in Indonesia	35
4 Findings from participatory assessment	45
4.1 Synthesis of insights from participatory stakeholder assessments in Thailand, Sri Lanka and Indonesia	45
5 Conclusions and recommendations	54
6 Project outcomes and outputs	56
7 Project publications	57
7.1 Reports	57
7.2 Policy briefs	57
7.3 Scientific articles	57
7.4 Press releases and news items	57
7.5 Conference papers and presentations	58
7.6 Book chapters	58
7.7 Other articles	58
7.8 Databases	58
8 Literature cited	59
Appendix 1: List of online databases and websites reviewed	68

LIST OF TABLES

Table 1: The SEI Tsunami programme	5
Table 2: Participating agencies, organisations and communities in selected case studies in Sri Lanka, Thailand and Indonesia	9
Table 3: ICG/IOTWS member states	17
Table 4: Event intensity, vulnerability, coping capacity and risk of Thailand to different hazards	24
Table 5: Number of villages in the six Andaman provinces located in tsunami hazard area	25
Table 6: Notable natural disaster events in Sri Lanka and their humanitarian and financial effects since 1957	34
Table 7: Roles and responsibilities for early warning of various hazards lie with various designated departments and agencies	37
Table 8: Resilience elements and desired outcomes	47
Table 9: Summary of evidence organised according to selected resilience elements from the CCR framework and the three dimensions of EWS policy/guidance	48

LIST OF FIGURES

Figure 1: Dialogical tool used in the participatory assessment	8
Figure 2: Screenshot of the homepage of the Online Dialogue of Early Warning	11
Figure 3: Key elements of people-centred early warning systems	15
Figure 4: Components of an end-to-end TEWS as developed for IOTWS	15
Figure 5: The four regions of the IOC-ICG overall regional coordination of TWS	18
Figure 6: Legal structure of DRM in Thailand	25
Figure 7: NDWC warning process	31
Figure 8: Three seismic awareness zones of Thailand tsunami preparedness	31
Figure 9: People affected by different disasters in Sri Lanka from 1974-2004	34
Figure 10: Organisation of the NCDM in Sri Lanka	36
Figure 11: Organisational structure of the Disaster Management Centre	37
Figure 12: Organisational structure of a typical District Disaster Management Coordination Unit, example of Hambantota	38
Figure 13: Occurrence of different disasters in Indonesia	40
Figure 14: Mortality from different disasters in Indonesia	40
Figure 15: Organisational structure of BNPB	42
Figure 16: Organisational structure of Ina-TEWS	44
Figure 17: The role of normative, cognitive and procedural dimensions of EWS policy and guidance, exemplified by the CCR framework	49

LIST OF BOXES

Box 1: The Coastal Community Resilience (CCR) Initiative	20
Box 2: The Indian Ocean Wave Exercise of 14 October 2009	22
Box 3: One Tambon One Search and Rescue Team (OTOS)	27
Box 4: Safer Communities Through Disaster Risk Reduction (SC-DRR) in Development	42
Box 5: Kommunitas Siaga Tsunami (Tsunami Prepared Communities) (KOGAMI)	45

LIST OF ACRONYMS AND ABBREVIATIONS

ADRC	Asian Disaster Reduction Center
ADPC	Asian Disaster Preparedness Center
ARC	American Red Cross
BAKORNAS PB	Badan Koordinasi Nasional Penanggulangan Bencana (Indonesian National Coordination Board for Disaster Management)
BAKOSURTANAL	National Mapping and Survey Coordinating Board (Indonesia)
BAPPEDA	Provincial Development Planning Agency (Indonesia)
BAPPENAS	National Development Planning Agency (Indonesia)
BGR	German Federal Institute for Geosciences and Natural Resources
BMG	Badan Meteorologi dan Geofisika (Indonesian Meteorological and Geophysical Agency)
BMKG	Indonesian Agency of Meteorology, Climatology and Geophysics
BNPB	Badan Nasional Penanggulangan Bencana (Indonesian National Disaster Management Agency)
BPBD	Indonesian National Disaster Management Agency – provincial level
BPPT	Badan Pengkajian dan Penerapan Teknologi (Indonesian Agency for the Assessment and Application of Technology)
BRR	Badan Rehabilitasi dan Rekonstruksi NAD dan Nias (Indonesian Agency for the Rehabilitation and Reconstruction of Aceh Province and Nias)
CBDRM	Community-Based Disaster Risk Management
CBDRR	Community-Based Disaster Risk Reduction
CBO	Community-Based Organisation
CCD	Coastal Conservation Department (Sri Lanka)
CCR	Coastal Community Resilience
CPRU	Crisis Prevention and Recovery Unit
CSO	Civil Society Organisation
DART	Deep Ocean Assessment and Reporting of Tsunami
DDMCU	District Disaster Management Coordinating Units (Sri Lanka)
DDPM	Department of Disaster Prevention and Mitigation (Thailand)
DEPDAGRI	Departmen Dalam Negeri (Indonesian Ministry of Home Affairs)
DKKV	German Committee for Disaster Reduction
DoM	Department of Meteorology (Sri Lanka)
DMAct	Disaster Management Act (Sri Lanka)
DMC	Disaster Management Centre (Sri Lanka)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision Support System
DTRAC	Disaster Tracking Recovery Assistance Centre (Thailand)
EGAT	Electricity Generating Authority of Thailand
EMS	Emergency Medical Service (Thailand)
EOC	Emergency Operations Center (Sri Lanka)
ESDM	Energi dan Sumber Daya Mineral (Indonesian Ministry of Energy and Mineral Resources)
EWS	Early Warning System
GIS	Geographic Information System
GI-TEWS	German-Indonesian Tsunami Early Warning System
GOI	Government of Indonesia
GP/DRR	Global Platform for Disaster Risk Reduction
GPS	Global Positioning System
GRC	German Red Cross
GTS	Global Telecommunication System
GTZ/IS	GTZ International Services (Deutsche Gesellschaft für Technische Zusammenarbeit)
HDRTN	Hydrographic Department of the Royal Thai Navy
HFA	Hyogo Framework for Action 2005 – 2015
IAS	Interim Tsunami Advisory System
IATF/DR	Inter-Agency Task Force on Disaster Reduction
ICG	Intergovernmental Coordination Group
ICG/IOTWS	Intergovernmental Coordination Group Indian Ocean Tsunami Warning System

ICT	Information and Communication Technology
ICTW	International Conference on Tsunami Warning
IDNDR	International Decade for Natural Disaster Reduction
IDRN	India Disaster Resource Network
IEWP	International Early Warning Programme
IFRC	International Federation of Red Cross and Red Crescent Societies
Ina-TEWS	Indonesian Tsunami Early Warning System
INGO	International Non-Government Organisation
IOC	Intergovernmental Oceanographic Commission
IOTWS	Indian Ocean Tsunami Warning System
IRC	Irish Red Cross
ITB	Bandung Institute of Technology, Indonesia
ITIC	International Tsunami Information Centre
IUCN	The World Conservation Union
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JTIC	Jakarta Tsunami Information Centre (Indonesia)
KLH	Kementerian Negara Lingkungan Hidup (Indonesian Ministry of Environment)
KOGAMI	Kommunitas Siaga Tsunami (Tsunami Prepared Communities)
KOMINFO	Indonesian Ministry of Communication and Information
LIPI	Lembaga Ilmu Pengetahuan Indonesia (Indonesian National Institute of Sciences)
MOA	Memorandum of Agreement
MoDM	Ministry of Disaster Management
NBRO	National Building Research Organisation
NCDC	National Civil Defense Committee
NCDM	National Council for Disaster Management
NDWC	National Disaster Warning Centre (Thailand)
NGO	Non-Government Organisation
NOAA	National Oceanic and Atmospheric Administration (United States)
NTWC	National Tsunami Warning Centre
OCHA	Office for the Coordination of Humanitarian Affairs (United Nations)
OTOS	One Tambon One Search and Rescue Team
PAO	Provincial Administration Organisation (Krabi)
PDMO	Provincial Disaster Prevention and Mitigation Office (Thailand)
PIRBA	Information Centre for Research on Natural Disasters (Indonesia)
PMI	Indonesian Red Cross Society
PPEW	Platform for the Promotion of Early Warning
PPP	Public Private Partnership
PTWC	Pacific Tsunami Warning Center
PUSDALOPS	Provincial Emergency Operations Centre (Indonesia)
RIMES	Regional Integrated Multi-Hazard Early Warning System
RISTEK	State Ministry of Research and Technology (Indonesia)
Raks Thai	Raks Thai Foundation (Thailand)
RTG	Royal Thai Government
RTWP	Regional Tsunami Watch Providers
SAN	Save the Andaman Network (Thailand)
SATKORLAK PBP	Indonesian Implementing Coordination Unit for Disaster Management (provincial level)
SATLAK PBP	Indonesian Implementing Unit for Disaster Management (district level)
SDC	Sea Defence Consultants (Indonesia)
SDF	Sustainable Development Fund
SEI	Stockholm Environment Institute
SLRCS	Sri Lanka Red Cross Society
SOP	Standard Operating Procedure
TAO	Tambon Administrative Organisation (Thailand)
TARNS	Tsunami Alert Rapid Notification System
TAT	Tourism Authority of Thailand
TDMRC	Tsunami and Disaster Mitigation Research Center (Indonesia)
TEWS	Tsunami Early Warning System

TICA	Thailand International Development Cooperation Agency
TMD	Thai Meteorological Department
UN/ISDR	United Nations International Strategy for Disaster Reduction
UNDP	United Nations Development Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organisation
UNESCO/IOC	United Nations Educational, Scientific, and Cultural Organisation Intergovernmental Oceanographic Commission
US-IOTWS	United States Indian Ocean Tsunami Warning System Programme
USAID	United States Agency for International Development
VHF	Very High Frequency
WCDR	World Conference on Disaster Reduction
WG	Working Group
WMO	World Meteorological Organisation
WSSD	World Summit on Sustainable Development

ACKNOWLEDGEMENTS

This report was produced for sub-project 2 ‘Early Warning and Community Preparedness: Strengthening the Technology – Community Interface’ undertaken by Stockholm Environment Institute (SEI) and its regional partners as part of SEI’s Programme ‘Sustainable Recovery and Resilience Building in the Tsunami Affected Region’. The programme was undertaken between 2005 and 2009 under SEI’s Risk, Livelihoods & Vulnerability Programme with financial support from the Swedish International Development Cooperation Agency (Sida). The project was a collaboration between multiple partners in the Indian Ocean Region. The main collaborating partners were SEI, Macquarie University, Sydney, the Asian Disaster Preparedness Center (ADPC) and the Raks Thai Foundation (Raks Thai). The UNDP Regional Centre for Asia and the Pacific provided valuable feedback and advice in the planning stages of the project. Mrs. Lalani Imbulana, Director of the Preparedness Planning Division at the Disaster Management Centre (DMC), Sri Lanka, and Ms. Vidiarina Henny, Senior Advisor for Capacity Building for the German Indonesian Tsunami

Early Warning System (GITEWS) at GTZ Indonesia, kindly reviewed the summaries of early warning system (EWS) development within their respective countries. We would like to thank all EWS stakeholders in the Indian Ocean region who have communicated with us throughout the last two years and provided valuable perspectives and insights from their efforts. For a full list of agencies and organisations that contributed to this project please see Appendix 1. Ms. Boontawee Teamvan is thanked for compiling a comprehensive database of almost 450 scientific and ‘grey’ literature documents relating to the EWS development in the Indian Ocean region. Ms. Elnora De La Rosa and Ms. Dusita Krawanchid at SEI, and Ms. Christine Metusela at Macquarie University, Sydney, provided support in the final writing and editing stages of the report. Matthew Chadwick reviewed the final report and Delia Paul coordinated all input towards finalising and producing the report.

FOREWORD

The 2004 Indian Ocean Tsunami was one of the worst disasters in recorded history, triggering an unprecedented worldwide humanitarian response. More than US\$7 billion in humanitarian aid was donated to support the relief and recovery processes in the affected countries.

These funds have enabled a large number of initiatives supporting capacity building for disaster risk reduction in general, and for early warning in particular. The Indian Ocean Tsunami Warning System (IOTWS) is being developed under the leadership of the United Nations Education Scientific and Cultural Organisation Intergovernmental Oceanographic Commission (UNESCO/IOC), and member countries of the IOTWS are establishing national early warning systems.

The importance of strengthening disaster preparedness and early warning systems was demonstrated once again by the recent disasters in Asia. In just one September week this year, Typhoon Ketsana struck the Philippines, Vietnam, Cambodia, Laos and China, while an earthquake measuring 8.0 occurred south of the Samoan archipelago, resulting in a tsunami with a wave height of up to 2.5m in American Samoa. The next day, 30 September, an earthquake 7.6 in magnitude devastated the Indonesian city of Padang. In total, these events killed at least 1,200 people.

Had it not been for the considerable progress made by some of these countries to strengthen institutions and policies for disaster risk reduction and early warning, many more lives are likely to have been lost. However, these events have also exposed some of the continuing challenges in making early warning systems effective.

In Samoa, the earthquake that triggered the tsunami occurred so close to the south coast of Upolu that whilst warning messages were issued, insufficient time existed for low-lying exposed communities to fully evacuate, some people reporting that they had had less than seven minutes to get to safety. The physical magnitude of the event was greater than that planned for.

In Padang, due to limited local dissemination channels and reported few immediately tuning in to the radio, it took some time for information to reach the majority of the people. Even then many people were unsure of what to do. Those who evacuated found themselves

in massive traffic jams along the few routes out of the affected area.

The experience from these recent events shows that building early warning systems is a complex process, both technically and socially. There are many different actors and the region is diverse. Also, the warning situations in different countries and communities can be very different due to differences in the geography, the nature of the built environment, social characteristics and previous experience of tsunamis.

While the 2004 Indian Ocean tsunami has had a dramatic effect on disaster risk reduction and early warning efforts in the region and around the world, important challenges remain, which this report highlights. There are several key challenges at the local level. One is a lack of human and financial capacities of local government authorities in decentralised political systems. Another is that even in some of the communities devastated by the 2004 tsunami, disaster risk reduction is not a priority because other issues, such as poverty reduction, livelihoods, natural resource management and community development are perceived as more important. We also encountered a lack of political will among some local leaders to engage in community-based disaster risk reduction activities.

Despite all the efforts, not enough is currently being done in many cases to truly address the underlying reasons of the vulnerabilities of individuals and communities to tsunamis and other shocks and surprises. Some of these relate to the broader political ecology that keeps people in poverty and socially marginalised, and addressing these will require considerable social change. Quite often it is not even well understood who is vulnerable to hazards and why, because an effort to undertake a proper assessment of social vulnerabilities and capacities is rarely made. There are many preconceived and outdated ideas on who is most vulnerable: for example, in the aftermath of the 2004 tsunami, governments and humanitarian organisations were quick to compensate people engaged in traditional livelihoods such as fishermen, craftsmen and farmers, whereas small tourism entrepreneurs and traders received little or no support.

Another shortcoming of international support for early warning system development in the Indian Ocean region is the overwhelming emphasis on technocratic approaches. Technology alone cannot be the answer.

Most people will probably agree with this statement, but despite this, there is comparably little attention paid to the human aspects of early warning system development. Important questions remain as to how people perceive hazard vulnerabilities and their causes, how early warning systems can best be developed to create joint ownership and trust between stakeholders, how early warning systems can best address other priorities, and what motivates and enables communities to engage in collective action.

To be effective and sustainable, approaches to disaster risk reduction and early warning have to radically change. We must depart from the current approach, which is largely scientifically motivated and expert driven and hence highly prescriptive, to an approach in which the end-users of early warning systems shape the design of the system according to their priorities and needs.

Little attention has been given to how culture influences responses to natural hazards, and yet these beliefs influence choices about livelihoods, priorities and values. The tsunami experience shows that communities that possessed traditional knowledge of the natural signs of an impending hazard took better precautionary action and suffered considerably fewer

casualties. A recent study in Padang also revealed that socio-economic household characteristics strongly influence evacuation behaviour.

Many of the post-tsunami initiatives are winding down. Not all vulnerable communities have benefitted from these initiatives as efforts concentrated on areas that were severely affected by the tsunami, particularly those where traditional and subsistence livelihoods dominate. Much of what has been learned from the disaster has been categorised as relating only to tsunamis, when in fact there are profound lessons for us in adapting to the impacts of socio-economic and environmental change, including climate change.

The institutions and processes for integrated disaster risk reduction and climate adaptation are only in the initial stages of development and require sustained support. In our changing world, this ought to become a priority.

Dr Frank Thomalla

*Macquarie University
Sydney, December 2009*

EXECUTIVE SUMMARY

Following the 2004 tsunami, the development of the Indian Ocean Tsunami Warning System (IOTWS) was initiated at the World Conference for Disaster Reduction in 2005 under the leadership of the United Nations Education Scientific and Cultural Organisation Intergovernmental Oceanographic Commission (UNESCO/IOC). In 2005, the Hyogo Framework for Action (HFA), adopted in Kobe, stresses that disaster risk reduction (DRR) must be ‘underpinned by a more pro-active approach to informing, motivating and involving people in all aspects of disaster risk reduction in their own local communities’. Thus a core message from this Kobe Conference was that ‘to be effective early warning systems must be embedded in, understandable by, and relevant to the communities which they serve’ (Moench, 2005). The HFA emphasises the urgency of promoting community participation in DRR, policies, networking, and strategic management of volunteer resources, roles and responsibilities, thus calling for multi-stakeholder partnerships as a crucial mechanism (UN/ISDR, 2005).

Initial consultations with stakeholders in 2008 emphasised that a large number of organisations were engaged in early warning system (EWS) development and community-based disaster risk management (CBDRM) in the region, and that considerable knowledge regarding community linkages of EWS existed. However, stakeholders voiced concerns that the technological aspects of EWS development had been receiving considerably more attention than had the human aspects such as hazard awareness, disaster preparedness, reconciling priorities in the context of multiple agendas, and motivation and support for CBDRM activities linked with early warning efforts. Even though the importance of addressing community linkages in EWS is strongly emphasised in current guidance, practitioners face considerable challenges in applying these insights in their operational contexts.

Based on these observations, the Stockholm Environment Institute (SEI), together with Macquarie University, Sydney, the Asian Disaster Preparedness Center (ADPC), and the Raks Thai Foundation (Raks Thai) (CARE Thailand), conducted a multi-stakeholder participatory assessment to provide a platform for EWS stakeholders, and so to create an improved understanding of the challenges and enabling conditions for different practitioners to implement recommendations and guidance.

The specific objectives of this project were to:

- investigate progress made in EWS in the Indian Ocean in the wake of the 2004 tsunami;
- develop an understanding of what constitutes an effective EWS;
- investigate requirements for and recommendations on community linkages and community empowerment within the chain of an EWS;
- explore existing experience of EWS in Indonesia, Thailand and Sri Lanka;
- review lessons learned for effective EWS in the region, or elsewhere, for transfer of knowledge and learning between Indonesia, Thailand and Sri Lanka; and,
- conduct a south-to-south set of learning activities for Indonesian, Thai and Sri Lankan partners to develop the community end of EWS.

The approach and methodology included: a participatory multi-stakeholder assessment of experiences of last mile implementation; a review of the available literature on efforts to promote disaster risk reduction (DRR) and early warning by strengthening institutions and policies at international, regional, national and sub-national levels; a review of the establishment of the IOTWS; a detailed case study of community disaster preparedness and early warning in Krabi province, Thailand; an Online Dialogue on Early Warning; and contributions to meetings, workshops, conferences and initiatives aimed at identifying lessons learned throughout the Indian Ocean region and sharing these experiences amongst IOTWS member countries and globally.

The background review of the development of the IOTWS indicates that although there has been significant investment in two of the three inter-related stages of the early warning process, namely evaluation/forecasting (the scientific and technical dimension) and warning/dissemination (the institutional and political dimension), little attention has been paid to the response (the human dimensions of risk perception and decision making).

Summary of evidence organised according to selected resilience elements from the CCR framework and the three dimensions of EWS policy and guidance.

Resilience element	Normative challenges (associated with desirable nature and level of resilience; benchmarking)	Cognitive challenges (associated with ways to rate current level of resilience against the desired and create plans for action)	Procedural challenges (means and instruments to implement actions to improve the resilience towards the benchmark)
Governance: Leadership, legal framework, and institutions provide enabling conditions for resilience through community involvement with government	EWS development can have a bearing on and can be affected by socio-economic factors and projections of social change in society and communities	Sectoral fragmentation of sub-national DRM planning undermines integrating frameworks and collective actions Lack of mechanisms for facilitating exchange of diverging stakeholder perspectives lead to duplication of efforts and lack of integration	Methodological polarisation between top-down government approach to provide early warning technology and bottom-up NGO approach that focuses on community-based disaster preparedness Sub-national platforms for dialogue between government, NGOs and village level organisations play a crucial role in formalising innovation and implementing policies and guidance Lack of mechanism for the feeding back of CBDRM lessons learned to the formulation of policy and guidance
Risk Knowledge: Leadership and community members are aware of hazards and risk information is utilised when making decisions.	The norms of stakeholder participation in generating risk knowledge are contested Low trust in EWS providers undermines the confidence in risk knowledge	The prevailing political economy of knowledge in EWS development disqualifies competencies of many stakeholders CBDRM guidance/policy promotes knowledge prescriptive and expert based approaches	Risk knowledge for CBDRM is approached as a matter of public education and awareness programmes EWS introduce artefacts as systems of symbols that have to be internalised and/or constructed by users In practice, norms of stakeholder participation conflicts with the knowledge prescriptive education programme
Warning and Evacuation: Community is capable of receiving notifications and alerts of coastal hazards, warning at-risk populations, and individuals acting on the alert.	De facto priorities of national and sub-national decision makers conflict with stated goals of the regional EWS	Decentralisation implies additional roles and responsibilities for provincial and district government authorities with limited or no additional financial and human resources Tsunami EWS dominates and multi-hazard approach is rarely integrated	Despite considerable international funds for the development of national EWS in the short term there is a lack of sub-national funds available Reliance on volunteerism and concerns over the long-term sustainability of newly created government institutions, such as research facilities and operational emergency centres.

Insights of the multi-stakeholder participatory assessment are discussed by an analysis of those elements of resilience relating to governance, risk knowledge, and warning and evacuation based on the Coastal Community Resilience (CCR) framework. In addition, we distinguish between the cognitive, normative and procedural dimensions of EWS. This approach acknowledges that early warning and DRR address ‘over-determined’ problems, i.e. problems characterised by multiple legitimate perspectives on what constitutes the actual causes of a given risk. In

order to support practitioners in navigating conflicts of interest and reconciling these diverging interests, policies must build a ‘space of meaning’ with theories for action (cognitive), social change (normative) and instruments for implementation (procedural). The normative dimension is defined here as the identification of the resilience benchmark, through an implicit theory of social change, to represent the desirable level and nature of resilience for each element. The cognitive dimension is the definition of ways to rate current levels of resilience against that desired, and to create

plans for action. The procedural dimension is the proposal and application of the means and instruments to move from the current level of resilience towards that desired. The purpose of this approach is to illustrate the current challenges in building community resilience that constrain the joint construction of EWS policy/guidance by the stakeholders involved. The following table summarises the evidence organised according to the selected resilience elements and the three dimensions of EWS policy/guidance.

The findings of this report indicate that Thailand, Indonesia and Sri Lanka, along with other countries in the region, have made significant progress in strengthening institutions and policies for disaster risk reduction and early warning at all levels of governance and that there is an increasing awareness amongst policymakers and practitioners of the importance of ‘last mile’ approaches to enable and support community-based disaster preparedness and people-centred early warning.

However, the insights obtained from this project also indicate that recent calls to develop participatory and people-centred EWS as promoted by the Hyogo Framework for Action 2005 - 2015 (HFA) have not been sufficiently translated into action in the implementation of national policies and strategies for early warning. Policy and guidance still places significantly more emphasis on the procedural compared to the normative and cognitive dimensions of EWS. In addition, those practitioners who are engaged in early warning and DRR operate in contexts shaped by multiple stakeholder agendas, and face considerable challenges in learning how to negotiate diverse needs and priorities. Furthermore, few platforms currently exist to enable stakeholders to coordinate and reconcile agendas, negotiate joint targets, share knowledge and reflect critically on lessons learned, and to improve the integration of early warning with other priorities.

Our recommendations are therefore to:

1) Ensure that policy and guidance is relevant in different sub-national contexts

In many current policies, guidance documents and recommendations for EWS implementation, community linkages are frequently too generic and therefore not directly applicable in many national and/or sub-national contexts. Also, many guidelines for early warning do not take into account CBDRM and few documents are targeted at field staff. To be useful, such guidance must be linked more closely to implementation processes. Hence the translation and implementation of national policy into sub-national initiatives must aim to build

shared and mutual understanding, and trust among the many actors in the EWS. Both government and civil society CBDRM initiatives are hindered by the lack of capacity building material in national languages. This prevents access to essential information and experience at the local government and community practitioner levels where English-language skills are limited. But translation is only a first step. The resources must also be shaped and reviewed by national and sub-national stakeholders and adapted into appropriate training material and tools.

2) Support practitioners in navigating and reconciling multiple needs and priorities

Many practitioners tend to operate in contexts shaped by multiple stakeholder agendas and must learn to navigate diverse needs and priorities. This is particularly true for decision makers at provincial, district and village levels, whose political will, motivation and agency is crucial in supporting EWS development at the local level. Recent warning exercises and evacuation drills indicate that many people prioritise other needs relating to their livelihoods and their social and economic wellbeing. Policy and guidance must therefore support practitioners in reconciling these needs and priorities by ensuring co-benefits for communities. This can be achieved by framing proposed initiatives in ways that are relevant in addressing local priorities, for example by linking DRR and EWS initiatives with natural resource management, livelihoods improvement and wider development concerns. It should also address the challenges associated with the conflicts of interest amongst government officials at district levels in the decentralised management of DRM resource allocation.

3) Acknowledge and consider cognitive and normative differences amongst stakeholders

Although the participation of communities and other stakeholders of EWS is generally perceived as important little attention is paid to the degree and nature of this involvement. The sectoral and fragmented character of sub-national DRR planning is an obstacle to the ability of societies to build an understanding of current and evolving vulnerabilities to different hazards, and to develop agreed targets for resilience building. EWS development is often scientifically motivated and the cognitive dimension is the domain of researchers and ‘experts’, thus a prescriptive approach to risk knowledge dominates. This can exclude other legitimate perspectives.

4) Improve platforms for knowledge sharing and collective negotiation of policy targets

Platforms for knowledge sharing need to be improved to enable stakeholders to negotiate collectively and agree on joint targets, to improve the integration of early warning with other priorities such as livelihoods improvement, natural resource management, and community development, and to provide opportunities for critical reflection on ‘on-the-ground’ experiences. Enabling practitioners to help shape policy and guidance is crucial if the underlying systemic causes of hazard vulnerability are to be addressed, irrespective of short-term political agendas. Improved platforms for knowledge sharing would also increase the transparency, accountability and relevance of DRR and EWS initiatives by forcing donor organisations to look beyond their own organisational priorities and to address national and sub-national issues of ownership, trust, roles and responsibilities.

The work presented in this report was conducted for the project: ‘Early Warning and Community Preparedness: Strengthening the Technology – Community Interface’ as part of SEI’s Programme of ‘Sustainable Recovery and Resilience Building in the Tsunami Affected Region’. The programme was undertaken between 2005 and 2009 under SEI’s Risk, Livelihoods & Vulnerability Programme with financial support from the Swedish International Development Cooperation Agency (Sida).

1 INTRODUCTION

1.1 SEI'S STRATEGY TO SUPPORT THE SUSTAINABLE RECOVERY AND RESILIENCE BUILDING IN THE TSUNAMI AFFECTED REGION (SEI'S TSUNAMI PROGRAMME)

Focusing on Thailand, Sri Lanka and Indonesia, the overall objective of this programme is to support the region's recovery from the tsunami by generating knowledge and building capacity with key regional partners in the areas of vulnerability assessment, sustainable livelihoods, and resilience building. The programme consists of five integrated projects that aim to build long term resilience to coastal hazards among vulnerable communities through knowledge generation (field and desk studies, assessments, policy and institutional analyses); synthesis of research and studies; identification of lessons learned; facilitation of policy dialogues; and applied interventions.

For more information about SEI's Tsunami Programme, please visit: <http://sei-international.org>

1.2 PROJECT AIM: EARLY WARNING AND COMMUNITY PREPAREDNESS: STRENGTHENING THE TECHNOLOGY–COMMUNITY INTERFACE

The overall aim of this project was to explore the links between technology and communities in the development of national EWS in the Indian Ocean region. The project departed from the recognised challenges associated with implementing policy/guidance for EWS on the 'last mile', and explored how community resilience could be supported more effectively through EWS development.

After the 2004 tsunami, at the 2005 World Conference on Disaster Reduction (WCDR) (UN/ISDR, 2005) the Intergovernmental Oceanographic Commission (IOC) of the United Nations Education Scientific and Cultural Organisation (UNESCO) received a mandate from the international community to coordinate the establishment of the Indian Ocean Tsunami Warning System (IOTWS). This coincided with the adoption of the Hyogo Framework for Action 2005 - 2015 (HFA) which is based on the insights of a review of global

Table 1: The SEI Tsunami programme

Tsunami vulnerability assessment: for immediate and longer-term sustainable recovery
This project aims to produce a synthesis of a regional vulnerability analysis, and assessments of the local vulnerability and capacity in order to inform the longer term recovery and reconstruction of the region, to help target assistance programmes, and to ensure that new vulnerabilities to future shocks and stresses are not created as a result of the reconstruction process.
Early warning and community preparedness: strengthening the technology–community interface
This project aims to ensure that the establishment of an Indian Ocean EWS addresses the link between technology and communities, by promoting community preparedness and resilience, across a range of hazards.
Public administration, coastal zone disaster preparedness and vulnerability
Through the process of identifying key lessons from disaster responses, this project aims to facilitate a dialogue on better institutional structures, policies, and management plans for dealing with disasters in general, and, more specifically, for managing resources in coastal areas.
Sustaining coastal communities – aiding livelihood recovery
This project aims to support the sustainable recovery of those in key coastal industries, such as the informal tourism sector, through an integrated study of the factors underlying their vulnerability and inhibiting their recovery.
Sustainable water and sanitation for household/community systems
This project aims to support the water and sanitation needs of remote and poor communities affected by the tsunami through a focus on sustainable water supply, well rehabilitation, the promotion of improved rainwater harvesting techniques, and ecological sanitation.

progress made in disaster risk reduction (DRR) under the Yokohama Strategy between 1994 and 2004. The HFA recognises early warning as an effective tool to reduce vulnerabilities, and to improve preparedness for and response to natural hazards.

In hazard EWS the term ‘last mile’ or ‘last kilometre’ is frequently used to describe the dissemination of a warning of an impending hazard to the largest number of people at risk in the shortest possible time. The development and implementation of effective systems and procedures for the delivery of credible warnings is typically seen as a considerable challenge – so much so that some actors refer to the ‘last 99 miles’ (e.g. Hollister, pers. comm., 2008). The term ‘last mile’ has been criticised by some researchers (e.g. Richardson and Paisley, 1998; Twigg, 2003; Lassa, 2008; Kelman, 2009) because it refers to an approach in which the delivery of warnings to the people at risk is the last step in a top-down approach to EWS development. In their view, EWS should be developed using a bottom-up approach that prioritises the needs of the communities/users and engages them more actively in the development of the system. In this approach the interface of the community with the EWS is seen as the ‘first mile’. Others regard this distinction as semantics. Some actors refer to integrated end-to-end EWS that address all stages of early warning, from hazard detection and warning to community-level response (US-IOTWS, 2007a).

Notwithstanding the diversity of definitions, the notion of the ‘last mile’ has become increasingly popular in the Indian Ocean during the development of tsunami EWS (Vidiarina, pers comm., 2008). As a notion it is understood and interpreted differently by different actors (Jegillos, pers. comm., 2008). For example, in Sri Lanka LIRNEAsia regards the ‘last mile’ as the challenge for rural communities to access media and addresses this by supplementing traditional media channels for warning dissemination with additional technologies (LIRNE Asia, 2008). The United States Indian Ocean Tsunami Warning System (US-IOTWS) distinguishes between ‘upstream’ and ‘downstream’ components of the EWS and identifies education, mitigation efforts, identification of safe areas, and development of local decision-making procedures as priorities for ‘last mile’ assistance (US-IOTWS, 2007a). Singh Bedi (2006) understands the ‘last mile’ as the capacity of the community to take action in response to a received warning and therefore supports the development of the capacities of local institutions. It is thus not relevant to seek a comprehensive definition of the ‘first mile/last mile’. Rather, the diversity in interpretations hints at the complexities associated

with the links between technology and communities in the development of national EWS in the Indian Ocean region and the current challenges associated with improving this link.

Consultations undertaken in 2008 by SEI and partners with regional stakeholders including the United Nations International Strategy for Disaster Reduction (UN/ISDR), the United Nations Development Programme (UNDP) Regional Centre for Asia and the Pacific, and the Asian Disaster Preparedness Center (ADPC) indicated that despite the actions taken so far, there is amongst policy makers as well as practitioners at international and regional levels a widespread sense of a lack of implementation on the ‘last mile’ and the mainstreaming of DRR as promoted under the HFA.

Accordingly, the objectives of this project were to:

- investigate progress made in EWS in the Indian Ocean in the wake of the 2004 tsunami;
- develop an understanding of what constitutes an effective EWS;
- investigate requirements for and recommendations on community linkages and community empowerment within the chain of an EWS;
- explore existing experience of EWS in Indonesia, Thailand and Sri Lanka;
- review lessons learned for effective EWS in the region, or elsewhere, for transfer of knowledge and learning between Indonesia, Thailand and Sri Lanka; and
- conduct a south-to-south set of learning activities for Indonesia, Thailand and Sri Lanka partners to develop the community end of EWS.

2 APPROACH AND METHODOLOGY

While the end users of early warnings have been subject to a great deal of research, very few systemic enquiries have been conducted into the divergent experiences and understanding of actors in the entire warning chain. Here, we start with the premise that early warning and DRR address ‘over-determined’ problems, i.e. problems that are characterised by multiple legitimate perspectives on what constitutes the actual causes of a given risk (Powell and Jiggins, 2003). Because ‘outsiders’ and ‘insiders’ measure and describe risk in very different ways (Twigg, 2003; Salter, 1996) in over-determined problem situations, the distinction between risk perception and actual risk loses its justification (Beck, 1992). Just as people in a warning situation do not always respond rationally to warnings (e.g. Buchanan-Smith and Davies, 1995; Thomalla and Schmuck, 2004), EWS implementation is not a rational and logical process. Rather, it consists of a wide range of social and organisational processes that employ technological means to reduce risks and losses (Hamza, 2006). Warning channels can be described as chaotic patchworks of communication (Andersen, 2007) that require multiple iterative coordinative actions between agencies, officials and citizens (De Marchi, 2007; Rego, 2001).

The challenge of implementation suggests that existing policy and guidance for early warning cannot fulfil its role if it is treated as a knowledge prescriptive instrument. Instead, it has to be understood as a process that builds principles for action for ‘communities of practice’, creating a ‘space of meaning’ with theories for action, social change and instruments for implementation (SLIM, 2004). Because each operational context is unique, stakeholders who aim to implement a policy or a recommendation have to learn their way into this implementation, often with a considerable need for innovation. This places implementation of recommended actions in a ‘community of practice’, a group of stakeholders who are interacting regularly in a certain manner and with a certain set of values, assumptions and actions (Wenger, 1998).

2.1 PARTICIPATORY ASSESSMENT OF LAST MILE IMPLEMENTATION

In 2008, a participatory assessment was conducted with the objective to provide a platform for stakeholders to participate in the joint creation of an improved understanding of the challenges and enabling conditions for the different actors to implement

recommendations and guidance to strengthen technology community linkages of EWS (the ‘last mile’). The assessment was initiated through a series of planning meetings with key regional stakeholders. In these meetings, the project team identified the point of departure for the assessment, and developed an improved understanding of ‘last mile’ issues. Through these discussions it became clear that substantial work to address ‘last mile’ implementation challenges had already been conducted by a range of organisations, and that a participatory assessment approach would be best suited to ensure that this project added value to existing efforts. In June 2008, stakeholders from the region were invited to participate in the assessment through email communication. Between July and December 2008, SEI, in collaboration with ADPC and Raks Thai Foundation (Raks Thai) undertook a series of stakeholder consultations in Thailand, Sri Lanka and Indonesia to elicit experiences of the different actors actively engaged in early warning and community-based disaster risk reduction (CBDRR) activities in developing national EWS and strengthening linkages with community-based initiatives. Consultations were held with government agencies involved in disaster management, coastal resource management, and community development at different administrative levels, and with international and national non-government organisations (NGOs), community-based organisations (CBOs), and communities at risk from tsunamis and other coastal hazards (table 2) in order to elicit factors at the national, provincial and district levels that contribute to or limit the effective implementation of early warning. The assessment process was designed to give participants the opportunity to provide input and feedback throughout the project, particularly on the problem statement, the proposed research approach, and the discussion and evaluation of the emerging insights. The following questions guided this process:

- What is the state of understanding of EWS-community linkages (‘last mile’)?
- Why are identified issues for the ‘last mile’ not being addressed?
- Which conditions enable/hinder stakeholders to implement recommendations in practice?
- Which learning process are organisations going through to be able to implement policy and practice recommendations?

To understand how organisations seek to implement policy in their specific operational context, the consultations were guided by an adapted methodology of investigating innovation histories (Douthwaite and Ashby, 2005). Policy was defined here according to Hay (2002) as the outcome of political action, which in turn is a process of power relations between stakeholders. Innovation histories enable people who have been involved in a learning process to record and reflect on how this learning took place. In addition, an adapted, simplified version of the policy life cycle of Parsons (1995, cf. Lindahl, 2008) was used as a dialogical tool in discussions with stakeholders to explore the guidance and policy related to the ‘last mile’ (figure 1).

The four steps of policy/guidance, implementation, outcomes, and reflection – and the connections between them – were posed as hypotheses and explored with participants in workshops and focus groups. Participants were asked to critique the current situation and to explore scenarios for improving it.

Case studies for detailed analysis were identified and selected based on the following criteria:

- The selected localities had a high exposure to coastal hazards;
- There was a dominant sense amongst decision makers of the urgency in establishing an EWS;
- The actors and initiatives placed a significant emphasis on issues relating to early warning and disaster preparedness;
- The selected cases in conjunction addressed multiple hazards;
- The selected cases represented operations at different scales and/or different organisational entry points for the project team;

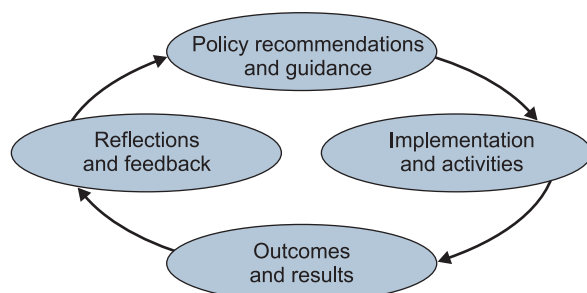


Figure 1: Dialogical tool used in the participatory assessment

- The selected cases exhibited different levels of both hazard awareness and previous disaster preparedness experiences.

2.2 LITERATURE REVIEW

An analysis of almost 500 scientific and ‘grey literature’ documents, and of more than 30 web repositories was conducted in order to review international, regional, national and community-based activities relating to EWS development and community disaster preparedness in the Indian Ocean region. The aims of the review were to 1) achieve an understanding of international knowledge and experience of the design and implementation of EWS, 2) to review the state of the art and progress made in establishing the IOTWS, and 3) to identify key elements for effective warning dissemination and community responses. The review incorporated the wider elements of effective disaster risk management (DRM), such as livelihood vulnerability, cultural and political aspects, as well as institutional, technological, and logistical issues. The literature review was conducted in parallel with the participatory stakeholder assessment and the online dialogue to substantiate the insights arising from these processes, and to position them in the overall policy and institutional context for EWS and DRR. Appendix 1 shows the scientific online databases and websites searched for relevant documents and information. References to particular documents (‘grey reports’) made by stakeholders in the consultations were also included in the review. Only English language literature was considered. Due to the large amount of information available, documents referenced but not available online for download were excluded.

2.3 DISASTER PREPAREDNESS AND EARLY WARNING IN KRABI PROVINCE: A DETAILED CASE STUDY

Between April and July 2009, SEI and Raks Thai jointly conducted a small pilot project in the tourism community of Phi Phi Island, Krabi Province, Thailand, to verify and substantiate the findings from the SEI-Raks Thai stakeholder consultations undertaken in July 2008 (Thomalla *et al.*, 2008) and to raise awareness of the importance of integrating community-based disaster preparedness and early warning at the local level through a set of community level activities. The work built directly on the development of the Disaster Emergency Prevention and Mitigation Plan for Phi Phi Island that had been initiated in 2008. The objectives of this project were to review the institutional and

Table 2: Participating agencies, organisations and communities in the selected case studies in Sri Lanka, Thailand and Indonesia

Sri Lanka	
Disaster Management Centre (DMC), Ministry of Disaster Management and Human Rights	
Ministry of Fisheries and Aquatic Resources	
Coastal Conservation Department (CCD)	
Department of Meteorology (DoM)	
Sri Lanka Red Cross Society (SLRCS)	
UNDP Disaster Management Programme	
The World Conservation Union, Sri Lanka Country Office (IUCN)	
Practical Action	
LIRNEasia	
Sewalanka Foundation	
Mawella village of Hambantota District	
Krabi Province, Thailand	
Department of Disaster Prevention and Mitigation (DDPM)	
Krabi Provincial Administration Division of Public Works	
Krabi Provincial Administration Organisation (PAO)	
Raks Thai Foundation (Raks Thai)	
Thai Red Cross	
Save the Andaman Network (SAN)	
Monitoring, Control and Surveillance (MCS) fisheries network	
Emergency Medical Service (EMS)	
One Tambon One Search and Rescue Team (OTOS)	
CBDRM committee, village Ban Klong Prasong	
CBDRM committee, village Ban ThaKlong	
CBDRM committee, village Ban Thalane	
Rescue Team for marine accident management, Koh Punyee	
CBDRM committee, village Ban Nam Khem	
Indonesia	
Padang	
Provincial Emergency Operations Centre (PUSDA-LOPS)	
Komunitas Siaga Tsunami (KOGAMI)	
Centre for Disaster Studies, Andalas University	
Provincial Development Planning Agency, Padang (BAPPEDA)	
Municipal Government	
Banda Aceh	
International Federation of Red Cross and Red Crescent Societies (IFRC)	
German Red Cross (GRC)	
American Red Cross (ARC)	
Irish Red Cross (IRC)	
GTZ Aceh Rehabilitation and Reconstruction Programme	
Agency for the Rehabilitation and Reconstruction of Aceh Province and Nias (BRR)	
Sea Defence Consultants (SDC)	
Tsunami and Disaster Mitigation Research Centre (TDMRC)	
Jakarta	
UNDP Crisis Prevention and Recovery Unit (CPRU)	
Indonesian Red Cross (Palang Merah Indonesia – PMI), Aceh Darussalam Chapter	
Indonesian National Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia - LIPI)	
GTZ International Services (GTZ/IS)	
Badan Nasional Penanggulangan Bencana (BNPB)	
Badan Meteorologi dan Geofisika (BMG), ASEAN Earthquake Information Centre, Earthquake Engineering and Tsunami Division	
State Ministry of Research and Technology (RISTEK), Information Centre for Research on Natural Disasters (PIRBA)	
UNESCO Indonesia, Jakarta Tsunami Information Centre (JTIC)	
German Federal Institute for Geosciences and Natural Resources (BGR)	
United Nations Development Programme (UNDP)	
German-Indonesian Tsunami Early Warning System (GI-TEWS)	

policy framework for DRM and EWS development in Thailand; to examine the division of roles and responsibilities between government agencies and NGOs involved in EWS development at all levels; to identify progress made in building capacity to increase disaster preparedness; to summarise insights on how stakeholder interactions on early warning and disaster preparedness at the provincial and district levels can be improved; to identify gaps and entry points for interventions to increase community disaster preparedness in collaboration with multiple stakeholders including the Tambon (Sub-district) Administrative Organisation (TAO), the relevant government agencies and tourism entrepreneurs, and to share good practices and lessons learned on linking community-based disaster preparedness initiatives and early warning. Insights from this work were integrated into the synthesis of the participatory stakeholder assessments in Thailand, Sri Lanka and Indonesia in Section 4.1. A detailed summary on DRR and EWS development in Thailand is provided by Thomalla *et al.* (2009b).

2.4 REGIONAL SHARING OF LESSONS LEARNED

Online Dialogue on Early Warning

Between 13 May and 30 June 2009, SEI in cooperation with ADPC, Macquarie University and Raks Thai hosted an online dialogue on ‘Strengthening the last mile of tsunami Early Warning Systems in the Indian Ocean.’ The purpose of this dialogue was to share insights from SEI’s stakeholder consultations in Thailand, Sri Lanka and Indonesia with a wider audience, and to provide an easily accessible platform that enabled a wide range of actors engaged in DRR in the region and globally, to jointly explore recent lessons learned in strengthening disaster preparedness and developing tsunami EWS in the countries affected by the 2004 tsunami.

Participants were invited either through targeted personal email invitations or alerted through postings on various disaster preparedness websites, including PreventionWeb, CabNet., ISDR and RedR. The discussions were moderated by staff of the host organisations and structured according to the key elements of people-centred EWS as defined by the UN/ISDR Platform for the Promotion of Early Warning (PPEW): risk knowledge; monitoring and warning services; dissemination and communications; and response capability. The dialogue drew a response of 154 registrations from 41 countries. More than half of the registered participants represented countries affected by the 2004 tsunami. A wide range of organisations

was also represented, with the majority of participants being affiliated with NGOs, research and educational organisations, and government authorities.

The forum was successful in bringing together people from across the region, and in enabling interaction between policymakers, practitioners, researchers and community groups. Additional insights derived from this initiative were integrated in the analysis of the participatory stakeholder assessment presented in Section 3.8. A full summary report is available in Paul *et al.* (2009).

Regional lessons learned workshop

Building on the insights of the participatory stakeholder assessment, the online dialogue and the literature review, SEI consulted with regional and national partners in Indonesia, Thailand and Sri Lanka to identify ways in which the experiences and lessons learned on the EWS-community interface from the region and internationally could be shared amongst stakeholders in the region and the international community. The intention was that SEI would assist regional partner organisations in organising and hosting a regional lessons learned workshop for key stakeholders from Indonesia, Thailand and Sri Lanka, as well as from other countries affected by the tsunami.

SEI, the UNDP Regional Centre for Asia and the Pacific and the Indonesian National Institute of Sciences (LIPI) provided the opportunity to share insights from the stakeholder consultations and the Online Dialogue on Early Warning during a set of workshops held in Jakarta, Indonesia, between 11 and 14 August 2009. These meetings included the ICG/IOTWS Working Group 6 Inter-session Meeting and Scoping Workshop and the Regional Task Team and Regional Standard Operating Procedures (SOP) Workshop. Both of these meetings were held in preparation for the Indian Ocean Tsunami Wave Exercise to be conducted in October 2009.

Sign In

Home Discussion Topics Resources Sign In Register

There's only a few days left to contribute to the discussion. After June 30 you will no longer be able to post messages on the forum.

Counter Hits
02572

Please click [here](#) to evaluate this forum.

Online Dialogue on Early Warning: Linking communities and technology in the Indian Ocean region

The 2004 tsunami showed that many villages and coastal communities did not receive sufficient warning of this major disaster. Since then, governments and humanitarian organisations have worked hard to improve 'early warning' systems in the Indian Ocean region.

This online dialogue is part of that effort. Here we will:

- Share Insights obtained from stakeholder consultations held in 2008 in the Indian Ocean countries
- Involve more people and organisations from the Indian Ocean region and globally
- Use our collective experience to support the development of better systems for early warning

The stakeholder consultations and this online dialogue are part of the project 'Early Warning and Community Preparedness: Strengthening the Technology-Community Interface' undertaken by the Stockholm Environment Institute, the Asian Disaster Preparedness Centre, Macquarie University and the Raks Thai Foundation.

How you can contribute

From **13 May to 30 June 2009**, you are invited to join this online dialogue in our E-forum [here](#). Share your insights, experiences, examples and stories about the development of tsunami early warning systems from your community and country. You can participate in the E-forum by reading people's comments and writing your own comments [here](#).

E-forum facilitators:

- **Atiq Kisan Ahmed**
Asian Disaster Preparedness Center, Bangkok, Thailand
- **Frank Thomalla**
Macquarie University, Sydney, Australia
- **Delia Paul**
Stockholm Environment Institute
- **Bruce Ravesloot**
Raks Thai Foundation (CARE), Bangkok, Thailand

Please report any technical or other problems to the website administrator Fareedali Kanji (Khem) at [odew@adpc.net]

"This Online Dialogue has been made possible through the SEI programme on Sustainable Recovery and Resilience Building in the Tsunami Affected Region funded by the Swedish International Development Cooperation Agency (Sida)."

Join a discussion here





Risk knowledge Monitoring and warning services Dissemination and communication Response capability

Some 'ground rules' for engagement

What we would like you to do
You can read all messages without registering. In order to contribute your own messages to the online dialogue, please register your name, organization and email address.

What we promise to do
As facilitators, we will monitor the discussions to ensure a civil debate, organize supporting documentation, summarise the different points of views expressed, and synthesise the key points.

Home Discussion Topics Resources Sign In Register

Copyright © 2009 ADPC

Figure 2: Screenshot of the homepage of the Online Dialogue of Early Warning

3 REVIEW FINDINGS

3.1 INTERNATIONAL EFFORTS TO PROMOTE EARLY WARNING THROUGH STRENGTHENED POLICY AND INSTITUTIONAL STRUCTURES

The high frequency and severe impacts of coastal hazards induced by a combination of climate related stresses, global environmental change, and socio-economic factors contributing to inequality and poverty in coastal societies, have put the development of EWS as a central theme in international governance. Over the past two decades, early warning has been increasingly institutionalised in international policy and institutional structures. Here, we highlight the key international milestones that have provided important reference points for the development of the IOTWS.

The International Decade for Natural Disaster Reduction (IDNDR) (1990-2000) recognised early warning as a critical element of disaster reduction (Resolution A/RES/44/236) and undertook specific activities to support early warning development. In 1991, the IDNDR's Scientific and Technical Committee declared early warning as a programme target. All countries were encouraged to ensure that the ready access to global, regional, national and local warning systems would become part of their national development targets and were to be attained by all countries by 2000, and that part of their plans to achieve sustainable development would include ready access to global, regional, national and local warning systems and broad dissemination of warnings.

In 1995, the Secretary General Report A/50/526 provided a review on the early warning capacities of the United Nations system with regard to natural disasters. It stated that early warning is a universally pursued and self-evident objective in determining disaster reduction strategies. The IDNDR requested further examination of new scientific and experimental concepts for accurate and timely short-term forecasting in order to give recommendations on the applicability and development of effective EWS in the context of international cooperation. Several expert working groups were established to study different aspects of early warning: (i) geological hazards, (ii) hydro-meteorological hazards including drought, (iii) fire and other environmental hazards,

(iv) technological hazards, (v) earth observation, and (vi) national and local capabilities pertinent to the effective use of early warning.

The Guiding Principles for Effective Early Warning were published in 1997 (IDNDR, 1997). The result of this multi-sectoral review was presented in the Secretary General Report A/52/561 on improved effectiveness of EWS with regard to natural and similar disasters. The report contained important elements on the further development of disaster reduction strategies, including EWS.

In 1998, the International Conference on Early Warning Systems for Natural Disaster Reduction (EWC'98) in Potsdam, Germany confirmed early warning as a core component of national and international prevention strategies for the 21st century. It identified accomplishments and experiences best suited to improve organisational relationships and practical effectiveness for early warning, and major strengths and weaknesses in early warning capacities around the world. It stressed that effective early warning depends upon a multi-sectoral and interdisciplinary collaboration among all concerned actors, and that although based on science and technology, early warning must be tailored to serve people's needs, their environments, and their resources. The Declaration of the Potsdam Early Warning Conference was used as a basis for early warning activities.

In 1999, the WMO/UNESCO Sub-Forum on Science and Technology in support of natural disaster reduction reviewed the contributions of science and technology to the disaster reduction process, including the operation of integrated EWS. The Sub-Forum recognised the advances made during the previous decade and made recommendations for future actions. In the same year, the IDNDR Programme Forum, Geneva, Switzerland adopted the strategy 'A Safer World in the 21st Century: Risk and Disaster Reduction' and the 'Geneva Mandate on Disaster Reduction'. The latter includes community participation and increase of partnership activities, improvement of early warning capacities and establishment of EWS as integrated processes, with particular attention to emerging hazards such as climate change. It also called for regional and international approaches, collaborative and organisational arrangements, and for links with the Agenda 21 implementation process for enhanced

synergy with environmental and sustainable development issues. At its fifty-fourth session, the UN General Assembly recognised the importance of early warning as an essential element in the culture of prevention, and encouraged renewed efforts at all levels in this field. In particular, the member states reaffirmed ‘the need for strengthening an international framework for the improvements of EWS and disaster preparedness by developing an effective international mechanism for early warning, including the transfer of technology related to early warning to developing countries, which ensures that vulnerable people receive appropriate and timely information, as well as expanding and improving existing systems, in particular those under the auspices of the United Nations, as an integral part of the International Strategy for Disaster Reduction and within its framework for action.’

When the UN/ISDR was established in 2000, it included the strengthening of disaster reduction capacities through early warning in its mandate. In 2001, the UN/ISDR Inter-Agency Task Force Working Group 2 on Early Warning was established to support the early warning activities of Inter-Agency Task Force members, the UN/ISDR Secretariat and other relevant partners, to facilitate a more coordinated approach to improving early warning and to contribute to the overall implementation of the UN/ISDR. The UN General Assembly resolution on the implementation of ISDR (A/56/68) confirmed the importance of early warning to reduce vulnerability. It identified early warning as a priority area for action and reaffirmed the need to strengthen the international framework for the improvement of EWS. The assembly endorsed the recommendations of the Secretary General with regard to the 10-year review of the Yokohama conference process.

In 2002, an Expert Meeting on Early Warning and Sustainable Development was held in Bonn, Germany, under the auspices of the German Committee for Disaster Reduction (DKKV), within the framework of the UN/ISDR. The World Summit on Sustainable Development (WSSD), Johannesburg, South Africa emphasised the significance of early warning for disaster reduction in the ‘Plan of Implementation of the World Summit on Sustainable Development’.

In 2003, the Inter-Agency Task Force on Disaster Reduction (IATF/DR) Working Group 2 on Early Warning was established to support the early warning activities of Inter-Agency Task Force members, the UN/ISDR Secretariat and other relevant partners, with a view to facilitate a more

coordinated approach to improving early warning; thereby, contributing to the overall implementation of the ISDR. Linking to the efforts of Working Group 2, the Second International Conference on Early Warning (EWC II) in 2003 hosted by the UN/ISDR, the DKKV and the Federal Foreign Office, emphasised the need for integrating early warning into relevant public policy. In response to the call for establishing a suitable framework for advancing early warning as an essential risk management tool, the International Early Warning Programme (IEWP) was proposed. This was intended to reduce the impact of disasters through an effective, worldwide ‘people-centred’ EWS based on the cooperation of partner organisations. EWC II saw the publication of the report ‘Effective Early Warning to Reduce Disasters: The Need for More Coherent International Action’. In the same year, the ISDR Asia Partnership (IAP) for Disaster Risk Reduction was established as an informal multi-stakeholder forum to facilitate the coordinated and coherent implementation of DRR and the HFA in the Asian region. It was originally composed of four UN bodies (UNDP Regional Centre Bangkok, UNESCAP, UNOCHA Regional Office for Asia and Pacific, ISDR Secretariat for Asia and Pacific) and two regional organisations (the Asian Disaster Reduction Center (ADRC) and ADPC). Also in 2003, the Government of India and UNDP jointly launched a DRM programme, which amongst other objectives aimed to foster multi-hazard preparedness response and mitigation plans for 169 hazard prone districts in India. As part of this programme, the India Disaster Resource Network (IDRN) was initiated to provide a database of available resources (Stephen, 2007).

In 2004, the Platform for the Promotion of Early Warning (PPEW) was established with support from the Government of Germany to facilitate the implementation of the proposed IEWP, to sustain the dialogue and cooperation on early warning, to collect and disseminate information on best practices, and to mobilise resources to strengthen partnerships and capacities at all levels. PPEW also aimed to help the development of early warning and preparedness systems by advocating for better EWS, especially in development assistance policy and programs, and by developing new ways to improve EWS.

3.2 THE INDIAN OCEAN TSUNAMI WARNING SYSTEM (IOTWS): CONCEPT, DEVELOPMENT AND COORDINATION

Operational definition of an Early Warning System (EWS)

Before we enter into a description of the IOTWS, we briefly review the central principles of an EWS and introduce the major concepts that have guided the international and regional EWS development. Two definitions with respect to EWS in general (but also useful for tsunami EWS) are discussed below. From these definitions the central characteristics of an integrated EWS can be understood in an operational way.

According to Mileti and Sorensen (1990), the three crucial aspects of any EWS are: a) getting information about an impending emergency, b) communicating that information to those who need it, and c) facilitating good decisions and timely response of the people in danger. Effective EWS are those which are integrated in nature but are comprised of several well-defined separate sub-systems in a systematic manner. An integrated system is composed of three subsystems:

- **Detection:** that includes monitoring and detection of hazards, data assessment and analysis, prediction of hazard behaviour, and informing of emergency management officials.
- **Management:** that includes interpretation of scientific hazard information, the decision to warn, the method and content of warning, the channel of warning, and the monitoring of response for feedback and warning revision.
- **Public Response:** that includes the interpretation and confirmation of emergency warning information, response to the warning, and the dissemination of warning to others.

Integration requires that sound relationships among these subsystems be developed and maintained (Mileti and Sorensen, 1990).

According to the Platform for the Promotion of Early Warning (PPEW),

‘the objective of people-centred early warning systems is to empower individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment’ (UN/ISDR PPEW, 2006, p. 2).

The PPEW distinguishes between the following four cross-cutting key elements of ‘people-centred’ EWS and suggests that a complete and effective early warning system comprises these four inter-related elements, spanning knowledge of hazards and vulnerabilities through to preparedness and capacity to respond (UN/ISDR PPEW, 2006). The elements and their respective aims can be described as follows:

- **Risk knowledge:** The aim of this element is to establish a systematic, standardised process to collect, assess and share data, maps and trends on hazards and vulnerabilities. This includes the establishment of organisational arrangements, the identification of hazards, the assessment of risks, and the accessible storage of information.
- **Monitoring and warning service:** The aim of this element is to establish an effective hazard monitoring and warning service with a sound scientific and technological basis. This includes the establishment of institutional mechanisms, the development of monitoring systems, and the establishment of forecasting and warning systems.
- **Dissemination and communication:** The aim of this element is to develop communication and dissemination systems to ensure people and communities are warned in advance of impending natural hazard events and facilitate national and regional coordination and information exchange. This includes that organisational and decision-making processes are institutionalised, effective communication systems and equipment are installed, and warning messages are recognised and understood.
- **Response capability:** The aim of this element is to strengthen the ability of communities to respond to natural disasters through enhanced education of natural hazard risks, community participation and disaster preparedness. This includes that warnings are respected, the establishment of disaster preparedness and response plans, the strengthening of community response capacity, and the enhancement of public awareness and education.

These elements can be seen as integral building blocks of an EWS with a clear set of activities that interact with the next element through effective communication channels (figure 3).

Definition of the Tsunami Early Warning System (TEWS) in the Indian Ocean

The Intergovernmental Oceanographic Commission (IOC), the global body overseeing TEWS, also distinguishes four key elements: a) hazard detection and forecasting, consisting of a regional and national hazard detection network of instrumentation and communication mechanisms to continuously monitor

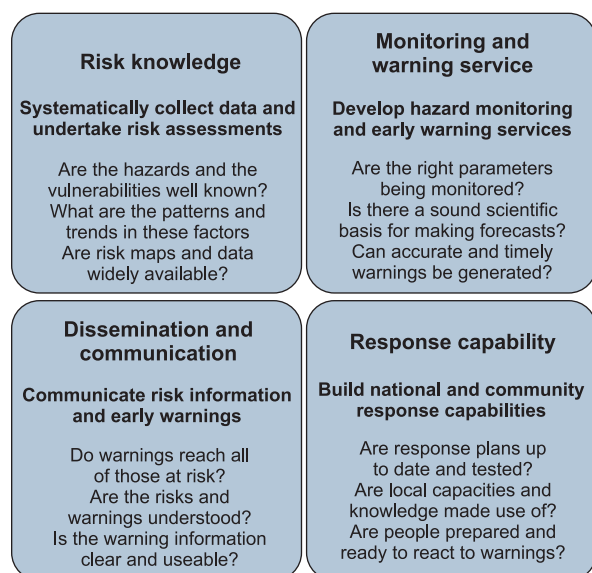


Figure 3: Key elements of people-centred early warning systems (UN/ISDR PPEW, 2006)

and detect tsunami events, and tsunami modelling, 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. Figure 4 shows a typical “end-to-end” system.

The primary purpose of the TEWS is to identify and mitigate the hazards posed by local and distant tsunamis and to provide an integrated end-to-end warning system comprising the four key components described earlier. The success of a TEWS often depends on the continuum of these activities associated with an ‘end-to-end’ approach. An ‘end-to-end’ TWS begins with the rapid detection of a tsunami wave and ends with a well-prepared community that is capable of responding appropriately to a warning. TEWS are thereby comprised of regional, national and local stakeholders and can be operational only in an ‘end-to-end’ condition.

The TEWS is expected to be gradually owned and operated by the Member States (at the national level, with inputs from the regional level), which collect, distribute and interpret the continuously available seismic and sea level data for the existence and propagation of a tsunami. It is often thought of as a coordinated network of systems, designed according to well-defined operational standards that are uniformly implemented across the broad range of activities of the TEWS.

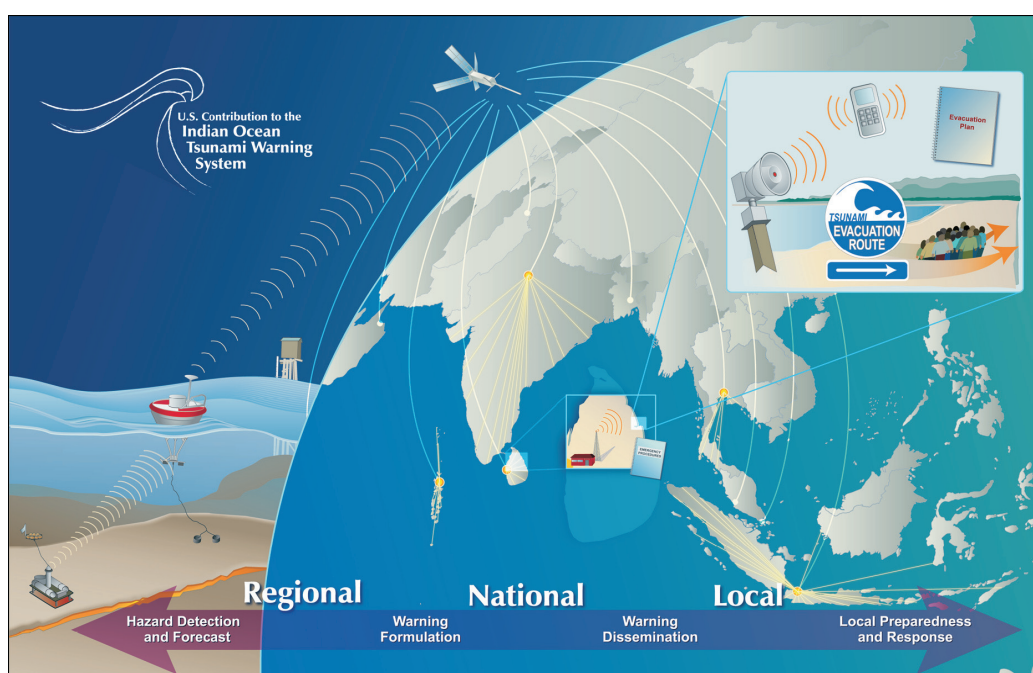


Figure 4: Components of an end-to-end TEWS as developed for IOTWS (Source: USAID, 2007)

Development of the IOTWS

In this section we present a review of the chronology of main events and developments in the establishment of the IOTWS. The review draws on events and outcomes from developments outside the region if they have a clear bearing on the IOTWS. Whilst this review is not exhaustive, it aims to illustrate the investments and advances in the establishment of EWS institutions and policies in the Indian Ocean, drawing on the international structures discussed in Section 3.1. The review indicates that there is an increasing awareness of the importance of the ‘last mile’, or community-based preparedness. However, the developments recounted in the literature portray a stronger emphasis on the evaluation/forecasting and warning/dissemination, and less attention to the response (i.e. the human dimensions of risk perception and decision-making).

2004

The 2004 tsunami caused widespread damage and loss of life. At the time of the tsunami, no tsunami EWS existed in the Indian Ocean, and the tremendous scale of this disaster provided the impetus for international, regional and national actors to initiate the establishment of an end-to-end warning system and to strengthen mitigation efforts to reduce vulnerability to future tsunami events. Drawing on the international developments recounted in section 4.2, the ISDR Secretary-General called for ‘global early warning systems that addressed all natural hazards and with no country left out’ (UN/ISDR, 2005). In the aftermath of the tsunami, countries throughout the Indian Ocean region intensified their efforts to develop effective tsunami warning and mitigation systems. Countries that had never previously experienced a tsunami began to develop local monitoring capability and community preparedness plans. Other countries with historical records of tsunami inundation started to enhance existing systems for real-time monitoring and warning formulation at a regional scale (IOC, 2005). Most countries have established or strengthened their disaster management laws, national platforms, and national and local coordination mechanisms to guide DRR and to establish clearer responsibilities for end-to-end EWS (IOC, 2005).

2005

The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) Flash Appeal 2005 for Indian Ocean Earthquake – Tsunami included dedicated funds for EWS development in affected countries through a ‘rapid boosting of the capacities for action and planning by public authorities’; and ‘linking the available technical capacities on tsunami with humanitarian and emergency management capacities’.

UNESCO/IOC received a mandate from the international community to coordinate the establishment of the IOTWS at the World Conference on Disaster Reduction (WCDR) in Kobe, Japan, in January 2005, at the Phuket Ministerial Meeting on Regional Cooperation on Tsunami Early Warning Arrangements in Thailand in January 2005, and at the twenty-third Session of the IOC Assembly in June 2005 (www.ioc-tsunami.org) (UN/ISDR, 2005).

The WCDR recognised early warning as an effective tool to reduce vulnerabilities and to improve preparedness and response to natural hazards. The conference included a special thematic session on people-centred EWS. The Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA) adopted at the WCDR is based on the insights of a review of global progress made in DRR under the Yokohama Strategy between 1994 and 2004. The HFA highlights early warning as one of the major elements of DRR that could both save lives and help protect livelihoods and national development gains. It recognises early warning as an effective tool to reduce vulnerabilities and to improve preparedness and response to natural hazards (UN/ISDR, 2005). The HFA stresses that DRR must be ‘underpinned by a more pro-active approach to informing, motivating and involving people in all aspects of disaster risk reduction in their own local communities’ (p. 2). A core message from the WCDR was thus that ‘to be effective early warning systems must be embedded in, understandable by, and relevant to the communities which they serve’ (Moench, 2005). The HFA thus emphasises the urgency of promoting community participation in DRR, policies, networking, and strategic management of volunteer resources, roles and responsibilities, calling for multi-stakeholder and tri-sector (PPP) partnerships as a crucial mechanism (UN/ISDR, 2005).

The WCDR also saw the launch of the IEWP and the formation of the Intergovernmental Coordination Group (ICG) formed under the auspices of the IOC to serve as the regional body to plan and coordinate the design and implementation of the IOTWS, and to strengthen and share knowledge relevant to each thematic issue. The ICG initially established four Working Groups (WG) at the First Session of the ICG/IOTWS (UNESCO/IOC, 2005a) tasked with developing the technical plans for the warning system: WG 1) Seismic Measurements, Data Collection, and Exchange; WG 2) Sea Level Data Collection and Exchange, including deep-ocean tsunami detection instruments; WG 3) Tsunami Hazard Identification and Characterisation, including modelling, prediction and scenario development; and

WG 4) The Establishment of a System of Interoperable Advisory and Warning Centres (UNESCO/ICG, 2005). The report of the ICG/IOTWS-I meeting indicates that discussions focused on questions of technology transfer. Two additional WGs, WG 5) Risk Assessment, and WG 6) Mitigation, Preparedness and Response, were established at the Second and Third Sessions of the ICG/IOTWS, respectively (UNESCO/IOC, 2005b; 2006). With the participation of the Member Countries, the National Tsunami Warning Centres (NTWCs) and Regional Tsunami Watch Providers (RTWPs), and other partners, the WGs are tasked to establish a sustainable Tsunami Early Warning System for the Indian Ocean region.

In March 2005, the UN General Assembly adopted the resolution on Natural Disasters and Vulnerability (A/RES/59/233) and the resolution on International Cooperation on Humanitarian Assistance in the Field of Natural Disasters, from Relief to Development (A/RES/59/212). For the Second International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean in Grand Baie, Mauritius, in April of the same year, Indian Ocean Member States were invited to prepare project proposals for the development of national tsunami warning and mitigation systems. Through the adoption of the Mauritius Declaration countries of the Indian Ocean region were invited to complete an assessment of their requirements and capacity needs for an effective and durable national tsunami warning and mitigation system, and the development of appropriate national strategic plans.

In April 2005, UNESCO established an Interim Tsunami Advisory System (IAS) under the aegis of the IOC, in cooperation with the Pacific Tsunami Warning Center (PTWC) in the USA and the Japan Meteorological Agency (JMA).

Under this arrangement almost all participating countries of the IOTWS now receive international tsunami warnings through the IAS of PTWC and JMA, and most countries receive these warnings at those NTWCs with back-up systems for receiving warning messages and that operate 24/7. Southeast Asian countries were originally excluded from the UNESCO/IOC deliberations on the establishment of the regional end-to-end TEWS (Bildan, 2006) but the geographical scope was later enlarged. It is envisaged by the IOC that the responsibility of the IAS will eventually be taken over by the growing number of RTWPs located in the Indian Ocean Region. A number of RTWPs are in the process of developing their operational capacity to act independently.

At the national level, each member country is responsible for issuing warnings to its own citizens through its NTWC. These warnings are based either on the NTWC's own analysis of the situation, on the advisory messages received from PTWC and JMA (and other possible sources), or on a combination of both. By mid 2009, almost all countries in the Indian Ocean region had established NTWCs (with differing levels of capacity) with links to the interim service providers, PTWC and JMA. In many cases, the NTWCs are situated in or have close links with the national

Table 3: ICG/IOTWS member states (UNESCAP, 2009)

Australia	Myanmar
Bangladesh	Oman
Comoros	Pakistan
Djibouti	Seychelles
France	Singapore
India	Somalia
Indonesia	South Africa
Iran	Sri Lanka
Kenya	Tanzania
Madagascar	Thailand
Malaysia	Timor-Leste
Maldives	United Arab Emirates
Mauritius	United Kingdom
Mozambique	Yemen

meteorological office, and therefore have access to the World Meteorological Organisation's (WMO) Global Telecommunications System (GTS). Both PTWC and JMA conduct regular tests with the NTWCs of the member countries using GTS, fax and email services.

In May 2005, the United Nations Secretary-General requested a global survey of EWS with a view to advancing the development of a global EWS for all natural hazards (UN/ISDR, 2006). The report concluded that while some warning systems are well advanced, there are numerous gaps and shortcomings, especially in developing countries and in terms of effectively reaching and serving the needs of those at risk. The report recommended the establishment of a globally comprehensive EWS, rooted in existing EWS and capacities. It also recommended a set of specific actions toward building national people-centred EWS, filling in the main gaps in global early warning capacities, strengthening the scientific and data foundations for early warning, and developing the institutional foundations for a global EWS.

Between May and September 2005, national assessments of 16 countries in the Indian Ocean were conducted to identify capacity building needs and support requirements for developing an IOTWS (www.ioc-tsunami.org). Mission teams were composed of international experts from the UNESCO/IOC, the UN/ISDR/PPEW, WMO, and ADRC, and experts from Australia, China, France, Finland, and the United States of America (USA). Country teams that participated in the mission discussions included national experts from academic institutions, government agencies, and NGOs from each participating country. The assessments investigated the legal state of affairs and national institutional structures but did not address issues relating to the last mile (IOC *et al.*, 2005).

The evolution of the IOTWS has been based on the historic experiences of the TEWS first established in the Pacific Ocean region in 1965, and which has been operating for more than four decades. In June 2005, the IOC General Assembly XXIII in Paris confirmed immediate action and response to the 2004 tsunami and adopted resolutions to create three other regional ICGs to establish basin-wide TEWS for the Indian Ocean, the North-East Atlantic and the Mediterranean, as well as the Caribbean (figure 5).

In July 2005, the G8 Gleneagles Summit in Scotland saw the formulation of a 'G8 Response to the Indian Ocean Disaster, and Future Action on Disaster Risk Reduction' to support international efforts to improve global early warning capacity. In August 2005, as part of the international response to the tsunami, the United States Agency for International Development (USAID) launched the (US-IOTWS) Programme (US-IOTWS, 2008). This two year programme aimed to provide technical assistance to the region through an integrated 'end-to-end' approach that addressed all aspects of EWS development from hazard detection and warning to community-level response (US-IOTWS, 2008, p. 1). The programme included regional, national and local, as well as cross-cutting activities encompassing all 28 Indian Ocean countries but focused in particular on Indonesia, Sri Lanka, India, Thailand, and the Maldives. During the development of the IOTWS the importance of a Tsunami Response Plan that included drills, education programmes targeted at communities at risk, search and rescue plans, and evacuation procedures, was recognised. Bernard (2005) highlights the educational materials produced by UNESCO and the road signs and other equipment produced by USAID.

In 2005, a Multi-Donor Voluntary Trust Fund on Tsunami Early Warning Arrangements in the Indian



Figure 5: The four regions of the IOC-ICG overall regional coordination of TEWS

Ocean and Southeast Asia was established by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) through resources from the Governments of Thailand, Sweden, Turkey and Nepal. The fund aims to build tsunami early warning capabilities in the region within the framework of the IOTWS by building institutional, technical, system-wide and other types of capacity for the development of early warning systems for tsunamis in a multi-hazard context (UNESCAP, 2007).

2006

In March 2006, the Third International Conference on Early Warning (EWC III) held in Bonn, Germany, was an initiative of the German Government to respond to the devastating effects of the 2004 tsunami and in the recognition that many lives could have been saved if an effective EWS had been in place in the Indian Ocean (UN/ISDR, 2006). The conference emphasised the need to strengthen the IEWP and the PPEW as part of the UN/ISDR system, and to develop concrete measures and project ideas to implement the HFA. A key outcome was the establishment of the Indian Ocean Consortium (IO Consortium), a consortium of seven international organisations under the coordination of UNISDR intended to facilitate and help Indian Ocean Member States to develop the national components of the IOTWS by fostering coordination mechanisms amongst governments, supporting implementation of national plans for tsunami warning, and creating linkages between regional efforts (IOC, 2008). The IO Consortium was agreed on by eight international partners - UNESCO/IOC, UNDP, WMO, UNEP, IFRC, OCHA, the World Bank, and the UN Special Envoy for Tsunami Recovery, former US President William Jefferson Clinton. The IO Consortium is coordinated by the UN/ISDR and supports the coherent implementation of the HFA (UNISDR, 2005). More specifically, the IO Consortium aims to support the establishment of national coordination mechanisms among governments and the UN/ISDR system; partners in tsunami EWS; implementation of national action plans on tsunami early warning; and linking ongoing regional tsunami early warning activities (IOC, 2008). Key documents from EWC III are the reports entitled *Early Warning – From Concept to Action* (UN/ISDR-PPEW, 2006), *Developing Early Warning Systems: A Checklist* (UN/ISDR-PPEW, 2006), *Global Survey of Early Warning Systems* (UN/ISDR, 2006) and *Compendium of Early Warning Projects* (UN/ISDR-PPEW, 2006). Under the IOC, UNDP was charged with the task of supporting national governments to facilitate multi-stakeholder processes for inclusive preparedness plans and implementation.

In May 2006, at the Symposium on Multi-Hazard Early Warning Systems for Integrated Disaster Risk Management at WMO Headquarters in Geneva, Switzerland, a consultation process was undertaken with governments, UN agencies, research organisations and a small number of international NGOs under the guidance of the IATF/DR to establish indicators with which to measure progress in DRR through the implementation of the HFA (UN/ISDR, 2008). The discussion focused on what constitutes meaningful progress at the policy and global/national level.

In July 2006, the Third Session of the ICG/IOTWS in Bali, Indonesia saw the endorsement of the IOTWS Implementation Plan (IOC Technical Series - 71, UNESCO: 2006). This plan noted that regional and national capacity in hazard detection is required to maintain a complex network of instrumentation and communications mechanisms to continuously monitor and detect tsunami events, and model and forecast tsunami wave inundation. Tsunami threats must be evaluated, and alerts formulated and disseminated in an understandable manner to regional and national levels and to the public at risk. Well planned and practiced response mechanisms must be in place with the resources necessary to respond in a crisis situation. Finally, the plan emphasised the planning of structural and non-structural mitigation measures and their incorporation into a multi-hazard framework as part of routine development activities.

The UN/ISDR recognised the challenges in the implementation of rapid and effective dissemination of warning, stating that ‘what needs to be done to address the shortcomings is not a mystery, but has been already laid out in general terms in a succession of documents and meetings over the last decade’ (UN/ISDR, 2006a, p. vi). The ICG/IOTWS Secretariat noted that ‘for all the progress and improvement at the detection end of the system, the hard reality is that much remains to be done to ensure dissemination of effective warnings and improve the preparedness of communities to respond to such warnings’ (Elliot, 2006, p. 5). The UN/ISDR (2006b) also reported in 2006 that 20 of the 28 countries participating in the IOTWS lacked response plans for early warning. In 2007, the UN/ISDR (2007a) reported that 25 of the 28 IOTWS countries had established official focal points for disseminating tsunami early warning information.

2007

In February 2007, the Fourth Session of the ICG/IOTWS was held in Mombasa, Kenya and in March the IEWP held the Advisory Group Meeting’s first session in Bonn, Germany. This meeting saw the launch of the

IEWP Strategic Plan 2007 - 2009 (IEWP, 2007). At the first meeting of the Global Platform for Disaster Risk Reduction (GP/DRR) in Geneva, Switzerland, in June 2007, the platform declared its intention to strengthen the ISDR system.

The Global Network of NGOs for Disaster Risk Reduction, through the UN Special Unit for South-South Cooperation (SU-SSC) and in collaboration with the UN/ISDR, published a compilation of good practices in the region (UN/ISDR, 2007a). Cases from different NGO projects in the region's countries showed how community-based organisations (Bangladesh) disseminate early warning messages, and local networks in city governance can contribute to EWS (Philippines). In Indonesia knowledge integration between science and indigenous communities was described as good practice in the development of a warning system for food shortage.

As part of a wider programme on Coastal Community Resilience (CCR), USAID published a guide for evaluating coastal community resilience to tsunamis and other hazards in October 2007 (US-IOTWS, 2007d) (see Box 1).

In December 2007, the US Government and UNESCO/IOC co-sponsored a forum in Bangkok, Thailand, to review progress and define priorities for future development and sustainability of the IOTWS with national and regional partners at a transition workshop (US-IOTWS, 2007e). Participants included the Governments of Indonesia, Sri Lanka, Thailand, Maldives, and India, UN and US Government officials, other disaster experts and business representatives. The proceedings of this workshop (US-IOTWS, 2007e) indicated that the effectiveness of hazard detection and warning dissemination as well as community preparedness had improved significantly but that there were still considerable gaps in the implementation of the US-IOTWS. Additional technology transfer and capacity building was needed to make the system fully operational. Also, it highlighted that the 'downstream' aspects of the system required continued support and that continuing capacity building was needed in accessing warning data, developing SOPs for warning dissemination, strengthening community resilience, and building institutions at all levels.

After the transition of the IOTWS programme, ADPC took over the CCR Programme and expanded it to

Box 1: The Coastal Community Resilience (CCR) Initiative

The CCR initiative has been developed to enhance capacity building and to demonstrate how resilience can be strengthened in coastal communities in the region. The initiative contributes towards the implementation of the Hyogo Framework of Action (HFA) and incorporates the 'end to end' early warning system development frameworks at the community level. The framework and program evolves through various layers of local, national, regional and international partners with an active facilitation from the ADPC. Through a coordinated approach the CCR initiative outlines an action-orientated process for facilitating resilience building by:

- creating minimum standards for communities to adopt in order to become more resilient to tsunamis and other coastal hazards;
- increasing public awareness, understanding, and preparedness for tsunamis and other coastal hazards; and
- promoting community development and sustainable livelihoods for increased resilience to unexpected conditions and challenges.

The CCR initiative promotes pilot activities at local, national and regional levels for strengthening resilience of coastal communities in an operational way in countries of the Indian Ocean and other Asian and Pacific countries. The CCR framework was developed under the USAID supported US-IOTWS program. After the transition of the US-IOTWS program in December 2008, an implementation phase has gradually been developed through the collaboration between the Regional Tsunami Trust Fund and ADPC in the Maldives, Myanmar and Sri Lanka. Earlier CCR related activities were carried out with local-national partners in India, Indonesia and Thailand. The adoption of CCR by various regional and national actors including NOAA, USAID, UNESCO-ICG IOTWS, ADPC, RIMES and other national disaster management centres, meteorological departments, and NGOs, is an ongoing process. There are also plans for a number of future initiatives and programs that will build on CCR.

For more details, go to www.adpc.net/v2007/Programs/EWS/CCR/CCR.asp

include a number of other countries in the Indian Ocean Region.

2008

Milestones in 2008 include the report entitled *Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and the Implementation of the Hyogo Framework for Action* (UN/ISDR, 2008) in January, the Fifth Session of the ICG/IOTWS in Kuala Lumpur, Malaysia, in April (ICG/IOTWS, 2008), and in November, the official launch of the German-Indonesian Tsunami Early Warning System (GI-TEWS) in Jakarta and the International Conference on Tsunami Warning (ICTW): Towards Safer Coastal Communities in Bali, Indonesia. The ICTW was organised by the Ministry of Research and Technology (RISTEK) and focused mainly on the technical aspects of EWS development. According to the organisers, 10 papers were presented on seismic monitoring, 10 papers on sea level monitoring, 30 papers on database, modelling and simulation and 10 papers on crustal deformation monitoring. Much less emphasis was placed on the human dimensions of early warning: 10 papers on information, communication and warning dissemination and 42 papers on community preparedness and mitigation. However, of the 42 papers presented in the latter category, only 9 focused on non-technical aspects, such as risk and vulnerability assessment (Post *et al.*, 2008; Birkmann *et al.*, 2008), early warning and preparedness (Spahn, 2008; Thomalla *et al.*, 2008) evacuation planning (Ismail *et al.*, 2008), institutional capacity building (Brunken, 2008; Stapke, 2008), and community disaster preparedness (Hidayati, 2008; Anuratpanich *et al.*, 2008).

At the regional level, ADPC's EWS Programme aims to implement and operate EWS and, with other capable organisations, assists in facilitating resource mobilisation, capacity building and tool development, and in advocating the integration of coastal zone management and disaster management (ADPC, 2007). ADPC hosts regular training courses, including the Regional Training Course on End-to-End Early Warning Systems, with the purpose of building the capacity amongst professionals to manage all aspects of people-centred EWS. The 'Enhancing Community Resilience to Natural Disasters in Southeast Asia' project aims to deliver a range of outputs with relevance for local response capacity, focusing on Vietnam and Cambodia. ADPC also facilitates the Regional Integrated Multi-Hazard Early Warning System (RIMES), a regional cooperation on early warning by 25 IOTWS Member States including Bangladesh, Bhutan, Cambodia, China, Comoros, India, Lao PDR, Maldives, Mauritius, Mongolia, Myanmar, Nepal, Philippines, Sri Lanka,

Thailand, Vietnam and Yemen. East Timor, Kenya, Madagascar, Mozambique, Pakistan, Seychelles, Somalia, and Tanzania are in the process of joining this regional cooperation. As an international, inter-governmental, non-profit organisation, RIMES has the mandate to provide regional early warning services within the framework of UNESCO/IOC and WMO to the build capacity of its Member Countries in providing early warnings of tsunamis and other natural hazards.

2009

At the Sixth Session of the ICG/IOTWS held in Hyderabad, India, in April 2009, the intersessional report from WG 6 (Mitigation, Preparedness and Response) reflected constraints in keeping track of accomplishments and monitoring progress in the response capacity in member countries and announced that additional tsunami warning drills were planned for 2009 (IOC-ICG/IOTWS, 2009).

The 2009 Global Assessment Report (GAR) on DRR (UN/ISDR, 2009) provides evidence to demonstrate how, where and why disaster risk is increasing globally and presents key findings from a global analysis of disaster risk patterns and trends, including where high mortality and economic loss is concentrated. The review of progress in implementing the HFA (Chapter 5) noted that whilst 'good progress is...made in the identification, assessment and monitoring of disaster risks and in the enhancement of early warning systems...little progress is being made in the use of knowledge, innovation and education and in particular in the mainstreaming of disaster risk reduction into economic, social, urban, rural, environmental and infrastructure planning' (p. 117). The recommendations include, amongst others, to develop emergency and response plans and education and awareness programs at the community level. It concludes that the lack of progress in this response capacity undermines the progress made in the information provision and monitoring.

A review of the funding priorities for TEWS in the Indian Ocean and Southeast Asia of the UNESCAP Tsunami Regional Trust Fund (UNESCAP, 2009) stresses the importance of providing long-term funding to continue to strengthen governance and institutional arrangements, and to adopt a multi-hazard focus in order to ensure ongoing maintenance and functioning of the network in the face of an expected increase in the frequency and severity of natural hazards under climate change.

In August 2009, a series of workshops including the ICG/IOTWS WG 6 Inter-sessional Meeting and Scoping Workshop, the Regional Task Team and

Regional Standard Operating Procedures (SOP) Workshop, and a media workshop were held in Jakarta, Indonesia, in preparation for the Indian Ocean Wave Exercise conducted in October 2009 (see Box 2). UNDP launched a review of the institutional and legislative systems for early warning and DRR in Indonesia (UNDP, 2009). WG 6 is currently working on a Compilation of Good Practices in Tsunami Early Warning Dissemination as part of its efforts to support the IOTWS. The Compilation will be published in June

2010 and will be the outcome of the collaborative effort of members of the IOTWS, and particularly members of WG 6. The document will place community preparedness as a central part of the EWS and will present different tsunami warning situations, good practices and tools to enhance last mile communication and community preparedness throughout the Indian Ocean and worldwide, in order to share experiences and lessons learned amongst member states.

Box 2: The Indian Ocean Wave Exercise of 14 October 2009

The Indian Ocean Wave Exercise (IOWAVE) on 14 October 2009 was arranged by the ICG/IOTWS and marked World Disaster Reduction Day. The initiative tested the warning systems and overall preparedness of nations in the region by simulating the magnitude 9.1 earthquake that triggered the 2004 tsunami. The IOWAVE09 was an important exercise for the region because it provided an opportunity for Indian Ocean nations to 'test their operational lines of communications, review their tsunami warning and emergency response standard operating procedures, and to promote emergency preparedness' (IOC/UNESCO, 2009). According to the IOC, post evaluation will focus on 'the adequacy of plans, policies, procedures, assessment capabilities, communication, resources and inter-agency/inter-jurisdictional relationships that support effective tsunami warning and decision-making at all levels of government' (IOC/UNESCO, 2009). The mock tsunami evacuation drill was held simultaneously in 18 nations including Australia, Bangladesh, India, Indonesia, Kenya, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Myanmar, Oman, Pakistan, Seychelles, Singapore, Sri Lanka, Tanzania and East

Timor (Johnson and Shankar, 2009). Mock bulletins were issued by the JMA and the PTWC as the simulated tsunami spread across the Indian Ocean, taking approximately 12 hours to travel from Indonesia to the coast of South Africa. The exercise involved different areas going on different levels of alert. Dummy warnings by telegram, fax and email were sent to participating countries (Davis, 2009).

For participating countries, such as Indonesia and Sri Lanka that took the exercise down to the community level, the importance of carrying out mock evacuations can be clearly seen in both the positive and negative responses of the local people as well as in the opportunity to test the capabilities of the warning systems right down to the local level. In media reports of the event, national government officials generally declared the exercise a success but there are still improvements to be worked on. Reports of warning sirens not working, confusion among officials, and safe areas being located in inappropriate places, all need to be looked into. There were also reports of people panicking or refusing to participate in the emergency drills because the exercise revived traumatic memories of the events of the 2004 tsu-

nami. Such psychological trauma prevented many people from comprehending the importance of such an exercise and this needs to be addressed. In other nations, such as Thailand and India, despite the devastation of the 2004 tsunami, the drill was limited to 'table-top exercises for government agencies' (Herman, 2009). Thus, in these countries the IO-Wave09 would have lost some of its impact on local communities due to the lack of community involvement. In their review of local perspectives of progress towards the implementation of the HFA in 48 countries in Africa, Asia and the Americas, the Global Network of Civil Society Organisations for Disaster Reduction (2009) found that community participation in the decision-making process was one of the lowest scoring indicators and concluded that the emphasis must shift from international and national policy making to policy execution at local levels. According to Marcus Oxley, the chairman of the Global Network, 'Local people need to build response capacities that fit their context, and feed these upwards into national policy-making. Information needs to go from the bottom up, rather than top down' (AlertNet.org, 2009).

3.3 EWS DEVELOPMENT IN THAILAND

The impacts of the 2004 tsunami on Thailand

The impacts of the 2004 tsunami were most severe on the Andaman Coast devastating the provinces of Phang-Nga, Krabi, Phuket, Trang, Satun, and Ranong. Severely affected areas included Khao Lak and Phi Phi Islands (ASCE, 2005). The tsunami left Thailand with over 8,300 Thais and foreign tourists dead or missing, and with over 9,500 houses, as well as other buildings, roads, bridges and physical infrastructure, damaged or destroyed (Steering Committee of the Tsunami Global Lessons Learned Project, 2009). Phang-Nga Province was the hardest hit, with the devastated area covering six districts, 19 tambons and 69 villages with 19,509 people affected. In Krabi Province, 15,812 people were affected in five districts, 22 tambons and 112 villages (DDPM, 2008a). Because the tsunami struck some of Thailand's prime tourist areas, a large number of foreign tourists were among the dead and injured. In Krabi Province, the Phi Phi Islands were the most damaged, particularly the main tourist areas of Ton Sai Bay and Loh Dalum Bay (The Office of Krabi Provincial Governor, 2007). When the tsunami struck there were 8,000 - 10,000 people, including tourists, on the Phi Phi Islands. At least 750 people were killed and a further 1,300 people missing, leaving 104 orphans (Pongponrat et.al, 2009; Sirichanna, 2006; Mureau, 2005).

The tsunami adversely affected about 20 percent of coral reefs and damaged approximately 10 percent of sea grass beds. However, less than one percent of mangrove forests were damaged; considerably less than in other countries. Seawater intrusion affected about 30,000 hectares of land including the vegetation cover (Srinivas, undated). There was significant contamination of well water in Phang-Nga Province with 187 out of 530 wells unsafe to drink from due to coliform bacterial contamination (UNEP, 2005a). Four sea turtle conservation projects were significantly affected with the breeding/conservation centre at Tap Lamu Naval Base (Phang-Nga Province) losing around 2,000 turtles (UNEP, 2005a).

Total damage was assessed at around USD 508 million, while losses were estimated at USD 1,690 million; equivalent to a total of USD 2,198 million or around 1.4 percent of GDP. The impact on the provinces affected was severe, and was assessed to be equivalent to half of the combined gross provincial product (GPP) (Nidhiprabha, 2007). In Phuket, damages and losses equalled 90 percent of GPP, with 70 percent in Krabi and Phang-Nga (Nidhiprabha, 2007). Loss of livelihood was particularly severe in fishing (with

30,000 people affected) and tourism industries (with 120,000 people affected) (UN Thailand, 2008). In Phang-Nga, the fishing industry losses amounted to USD 22,830,462, while the total fishing industry losses for the six provinces was USD 43,873,447, including the loss of 7,500 fishing boats (DDPM, 2008a; UN Thailand, 2008). Over 50 percent of all tourism industry losses occurred in Phuket (ADPC, 2005). The new upscale resort area of Khao Lak (Phang-Nga) was completely devastated by waves higher than 10 metres high (Edwards and Wang, 2005). Livestock losses amounted to USD 341,515 and agriculture losses to USD 61,466 (UN Thailand, 2008).

Hazard profile

As Thailand has no experience of any catastrophic natural disasters such as volcanic eruptions or earthquakes, the Department of Disaster Prevention and Mitigation (Research and International Cooperation Bureau, 2006) consider it to be a non-disaster prone country. Notwithstanding this classification, Thailand does experience occasional large-scale natural disasters particularly those related to water hazards such as riverine floods, urban inundation, tropical storms and droughts (Research and International Cooperation Bureau, 2006; Jacquelyn, 2006).

Geographically, Thailand is divided into four regions; the North, the Central or the Chao Phraya River Basin, the Northeast and the South or the Southern Peninsula. The northern terrain is mountainous and prone to water-related hazards such as flash floods, landslides and debris flow. Although the north eastern region is arid it frequently experiences flash floods and inundations during the rainy season, as well as severe droughts and cold spells during the summer and cool season. The central region, the vast fertile land that is often referred to as the country's 'Rice Bowl' frequently experiences riverine floods and urban inundation during the rainy season. The southern region is hilly along the west coast with a low-lying coastal plain along the east coast. In this part of Thailand flash floods, mudslides, tropical storms and forest fires occur occasionally (Jacquelyn, 2006).6).

The Research and International Cooperation Bureau (2006) ranks floods, accidents and explosives as high level risks; tropical cyclones, droughts, fires, landslides, earthquakes, social unrest, and agricultural pests and diseases as moderate risks; and human epidemics as low level risks. According to the Tsunami Prevention and Mitigation Plan (2008 – 2012), 509 villages in the six Andaman provinces are located within tsunami hazard areas (DDPM, 2008b).

Institutional Arrangements and Policies for DRM and Early Warning

The institutional and policy framework for DRM in Thailand involves a wide range of institutions at the national, provincial and local levels (IRC and Tetra Tech, 2007). The 1979 Civil Defence Act and the 2002 Civil Defence Plan form the legal basis of the DRM framework, which categorises disasters as: natural and man-made disasters, disasters resulting from air raids during wartime, and disasters resulting from sabotage or terrorist attacks. Prior to the 2004 tsunami, the Department of Disaster Prevention and Mitigation (DDPM) and the Ministry of the Interior coordinated to enforce the provisions in the Disaster and Fire Disaster Prevention Act, which gave guidance to those DRM activities related to man-made and natural hazards.

The National Civil Defence Committee (NCDC) formed under the 1979 Civil Defence Act is Thailand's strategic policy-making body for all activities relevant to civil defence and DRM (figure 6). It is chaired by the Minister of the Interior (Jacquelyn, 2006; Research and International Cooperation Bureau, 2006; DDPM, 2009a) and is composed of 17 representatives from various ministries including the Ministry of Health, the Ministry of Transportation, the Ministry of Information and Communication Technology, the Ministry of Agriculture and Cooperatives, and the Ministry of Natural Resource and Environment (IRC and Tetra Tech, 2007; DDPM, 2009a). It performs all DRM functions at the national level, including the formulation of the Civil Defence Master Plan, the

evaluation of implementation, and the organisation of annual or periodic training.

Under the 2002 Bureaucrat Reform Act, the NCDC, which previously came under the Civil Defence Division of the Department of Provincial Administration, became part of the DDPM at the Ministry of the Interior, and the DDPM replaced the former Civil Defence Division of the Department of Provincial Administration (Research and International Cooperation Bureau, 2006). DDPM staff were seconded from five government agencies including the Department of Rapid Rural Development; the Civil Defence Division; the Department of Provincial Administration; the National Safety Council of Thailand, the Office of the Permanent Secretary of the Prime Minister; the Department of Public Welfare; and the Department of Community Development (DDPM, 2009a).

In 2005, the National Civil Defence Plan replaced the previous plan of 2002 and now serves as the master plan for all agencies concerned with DRM, and provides guidelines for the formulation of operational plans. Community-based disaster risk management (CBDRM) was introduced through the 9th National Economic and Social Development Plan (2002 – 2006), which places a high priority on enabling participatory processes between the government, the private sector, and the communities. The plan is complemented by 10 Disaster Prevention and Mitigation sub-plans that include hazards relating to floods, accidents, explosives, tropical cyclones, droughts, fires, landslides, earthquakes, social unrest,

Table 4: Event intensity, vulnerability, coping capacity and risk of Thailand to different hazards

(Source: Research and International Cooperation Bureau, 2006)

Type of Hazard	Intensity Level	Vulnerability Level	Managing Competency Level	Risk Level
Flood	High	Moderate	Moderate	High
Tropical Cyclone	High	High	Moderate	Moderate
Earthquake	Low	Low	Poor	Moderate
Land slide	Moderate	Low	Poor	Moderate
Drought	High	Moderate	Moderate	Moderate
Fire	High	Moderate	Moderate	Moderate
Explosives	High	Moderate	Poor	High
Accident	High	Moderate	Poor	High
Human Epidemics	Low	Low	Moderate	Low
Agricultural Pests and Diseases	Moderate	Low	Poor	Moderate
Social Unrest	Low	Low	Poor	Moderate
Influx of Refugee	Moderate	Low	Moderate	Moderate

agricultural pests and diseases, and human epidemics (Singbun et. al., 2008).

The Disaster Prevention and Mitigation (DPM) Act of 2007 is the most important planning instrument aimed at strengthening DRM efforts in Thailand. Implementation of the DPM Act is through the National Civil Defence Plan of 2005 and the Tsunami Disaster Prevention and Mitigation Plan of 2007. These plans were established by the institutions responsible for disaster prevention and mitigation under the Ministry of the Interior, and the National Civil Defence Committee under the Office of the Prime Minister's Secretary in charge of pandemic diseases and natural disasters. The 2007 DPM Act gives the authority for DRM to the DDPM and the Civil Defence Committee at the national and provincial levels. This is an important change as the DDPM had previously functioned only in an advisory role to the provincial governments (Singbun et. al., 2008). Now, the newly established DDPM and NDWC have DRM as their sole responsibility, while various long-standing departments and technical agencies still have roles in the different phases of the disaster management cycle (IRC and Tetra Tech, 2007). The 2007 DPM Act also provides the legal guidelines for the operations of the DDPM and outlines the structure, policies and resources needed for DRM. DDPM plays a vital role in formulating policy and allocating different responsibilities to the provincial, district and sub-district levels, while the provincial governors are responsible for implementing DRM in their respective provinces.

Eighteen Regional Disaster Prevention and Mitigation Centres have been established to provide technical assistance and to collaborate closely with provincial governors on DRM issues, particularly large scale disasters. These regional centres have to mobilise their own resources including personnel, equipment and relief efforts to support the provincial governors and the provincial DDPM offices (Research and International Cooperation Bureau, 2006; DDPM, 2009a). The regional centres oversee provincial, district, and sub-district level Civil Defence Committees under the command of the Provincial Governor, the District Deputy and the Tambon Head, respectively. These institutions and mechanisms are directly responsible for carrying out relief operations during and after a disaster, and for supporting disaster preparedness activities.

At the provincial level, the primary organisation for DRM is the Provincial Disaster Prevention and Mitigation Office (PDPMO) under the Provincial

Governor's Office. The PDPMO's activities include the development of a Provincial Disaster Prevention and Mitigation Plan, the allocation of roles and responsibilities at each level; the organisation of drills, the testing of tools, the provision of training to local administrative organisations and the undertaking of evaluations. The provincial plans all specify CBDRM as an important activity to develop and support. The PDPMOs are composed of representatives from government agencies, private sectors, and Civil Society Organisations (CSOs). The Department of Local Administration instructs local government agencies to develop local disaster preparedness policy and action plans in collaboration with these stakeholders. The plans aim to integrate infrastructure and communication systems development, and capacity building for volunteer rescue and recovery operations, and must be linked to the Community Development Plan and the Provincial Disaster Prevention and Mitigation Plan. The PDPMOs have to mobilise all resources including personnel, equipment and relief efforts to support the provincial governors and the DDPM provincial offices (Research and International Cooperation Bureau, 2006; DDPM, 2009a). They also oversee provincial, district, and sub-district level Civil Defence Committees under the command of the Provincial Governor, the District Deputy and the Tambon Head, respectively. These institutions and mechanisms are directly responsible for carrying out disaster relief activities during and after emergencies, and taking precautionary measures before the occurrence of disaster.

District level authorities do not play a significant role in the DRM process in Thailand, where the main responsibility is allocated to the sub-district level, the Tambon Administration Organisations (TAO). The 2007 DPM Act and the National Disaster Plan specify that TAOs are the primary organisations responsible for both relief and community disaster prevention. While oversight and technical support is located at the provincial level, the majority of DDPM DRM funding is allocated to TAOs, along with the decision-making authority on how to utilise these funds in accordance with Thailand's decentralised government structure.

The National Tsunami Prevention and Mitigation Strategy (2008 - 2012) was created under the 10th National Economic and Social Development Plan (2007 – 2011) and the National Civil Defence Plan of 2005 frameworks and provides the policy framework for DRM in Thailand. This Strategy reflects a proactive approach, focusing on knowledge transfer, enhancing community understanding, early warning, safety area preparation, evacuation, and CBDRM. Ten tsunami

prevention and mitigation principles are used as a framework for government agencies. These principles emphasise the importance of disaster prevention and multi-stakeholder participation, an integrated management approach, the creation of a management system that supports CBDRM, as well as efficiency and accuracy of early warning and communication, the strengthening of human resource capacities and skills, the encouragement of the volunteer system, the enhancement of networks, and the importance of lessons learned (DDPM, 2008b).

Six Disaster Prevention and Mitigation Academies (DPMA) have been established to conduct training in DRM for managers, practitioners, local government officers, and other actors located in the northern, central and southern regions in Thailand with the aim to enhance the understanding of DRM and to build the DRM capacities. The Ministry of Public Health and provincial hospitals are required to establish emergency rescue centres (Narenthorn Centre) to provide training to communities and village health volunteers to evacuate and rescue people to hospitals in compliance with a good system and standard.

The National Disaster Warning Centre (NDWC) and the DDPM have prepared two plans for community evacuation in tsunami-affected areas: the Master Plan (2005) and the Tsunami Prevention and Mitigation Master Plan (2007). The NDWC is also currently preparing additional plans that address other natural and man-made hazards.

The Ministry of the Interior has instructed the DDPM to train at least two percent of the population, or around 1.2 million volunteers, in disaster preparedness. This is implemented through the establishment of search and rescue teams, known as 'One Tambon One Search and Rescue Team' (OTOS) (see Box 3). Local government executives are required to attend a 5-day training course in disaster prevention and mitigation,

and civilian volunteers to train for disaster prevention, CBDRM, and OTOS.

Various pilot CBDRM projects along the Andaman Coast were initiated in collaboration with the Japan International Cooperation Agency (JICA), the Friend in Need (of "Pa") Volunteer Foundation, the Thai Red Cross, Raks Thai and CARE, and GTZ/IS in Phuket Province, Bangnieng and Taplamu, and Krabi, Ranong and Phang Nga Provinces (Singbun et al., 2008), but these were not often coordinated.

Our focused assessment in Krabi Province indicates that DRM activities started in early 2005 through the formation of the Coordination Committee which aims to support tsunami-affected people and consists of a number of government agencies. NGOs, people networks and volunteer groups have also been undertaking activities to support the recovery of affected people and communities. Many of these actors have been working independently; many others have been cooperating with government agencies to support CBDRM or CBDRR in more than 20 communities. Various actors including government agencies at different levels, NGOs, international organisations and entrepreneurs with Corporate Social Responsibility (CSR) programmes have been working with coastal communities since 2007.

In the last three years, the NDWC has conducted a number of pilot projects aimed at preparing communities through school mechanisms by developing evacuation plans and practicing evacuation drills. In Krabi Province, these tasks have now been transferred to the Krabi Provincial Disaster Prevention and Mitigation Office, which collaborates with local government agencies along the Andaman Coast to increase disaster preparedness of coastal communities. The Krabi provincial government agencies include the Disaster Prevention and Mitigation Office, the Public Health Office, and several other organisations that have

Box 3: One Tambon One Search and Rescue Team (OTOS)

DDPM has incorporated various government agencies such as the Department of Local Administration, the Health Insurance Office, the Office of Health Promotion and Support Fund, and the Thai Red Cross, to achieve the following OTOS objectives: 1) to ensure the safety of life, and rapid and efficient search and rescue operations; 2) to establish efficient search and rescue teams in every province, district and tambon (sub-district) in the country; 3) to enhance the capacity and efficiency of search and rescue teams through technical training and drills; 4) to build up the self-confidence of search and rescue teams; and 5) to provide first aid treatment and rapid transfer to the appropriate medical establishment (Ratananakin, 2007).

the mandate and resources to implement early warning, rescue and recovery. These agencies have established a number of services aimed at helping tourists during natural disasters and marine accidents, including the Krabi Marine Rescue Unit, the Koh Lanta District of the 3rd Region Royal Navy, and the Tourist Rescue Centre of the Krabi Provincial Administration Organisation (PAO). Even though the activities of the different agencies are not yet formally integrated, they do cooperate. According to the 2007 Disaster Prevention and Mitigation Act, it is expected that the Disaster Prevention and Mitigation Office will coordinate the work of all related agencies in the future.

NGOs and CSOs have played an important role in the aftermath of the tsunami by strengthening community capacity in planning and implementing CBDRM and supporting cooperation among different sectors. NGOs have been involved in response and relief operations, and in preparedness activities (IRC and Tetra Tech, 2007). As part of the longer-term sustainable recovery and resilience building efforts, a number of international organisations, NGOs, CSOs, private sector actors, and government agencies, including World Vision, World Concern, Raks Thai, PDA, Sustainable Development Fund (SDF), Save the Andaman Network (SAN), Asia Foundation, the Thai Red Cross Society, the American Red Cross, IFRC and UNDP, have been engaged in building resilience in affected areas through disaster preparedness and CBDRM activities, the establishment of revolving (savings) funds, the promotion of alternative livelihoods, support for skills improvement, and help with legal issues such as proof of nationality and land ownership.

Community leaders, community groups and community members have been encouraged by the Royal Thai Government (RTG) to join in the participatory process in cooperation with government agencies, NGOs, and private and public sector community networks to build information systems and to develop community preparedness plans for tsunamis and other natural hazards, as well as marine accidents.

In December 2004, SAN was established as a collaborative network between NGOs and local CBOs. The six core members of SAN are the Community Development Project (south), the Federation of Southern Fishermen, the Southern NGOs-Coordinating Committee on Rural Development (the southern NGOs-CORD), the Community Organisations Development Institute (CODI), the Health Public Life Project (south), and the Friends of the Andaman Group. Forty four other NGO partners have been working with SAN in supporting the recovery of local communities in the

six tsunami-affected provinces in the south of Thailand (Save Andaman Network, 2005).

The Mirror Foundation, the Tsunami Volunteer Centre, and other NGOs that have experience in organising volunteer programmes and undertaking DRM activities in Thailand, are currently working on the establishment of a Disaster Volunteer Centre to coordinate volunteer activities in response to all potential hazards. The lessons learned from the tsunami indicate that volunteers are crucial in preparing for and responding to disasters. It is envisaged that the planned Centre will enhance the efficiency of volunteer work (Thai NGOs Team, 2009) and help to fulfil DRM work with other NGOs, civil society, and government agencies in providing relief and recovery efforts in affected communities.

In Krabi Province, the Thai Red Cross Society, SDF, SAN, ActionAid and Raks Thai cooperate with technical organisations to arrange training for practitioners. For example, the Marine Rescue Unit (Koh Lanta District) has provided VHF radio communication and marine rescue skills training, and the Narenthorn Centre (EMS), provincial and district hospitals and health centres have provided standard first aid and evacuation training. This training has highlighted the importance of CBDRM. After receiving the training, practitioners are delegated to established CBDRM project pilot areas where they work closely with the communities and, with the cooperation of local government agencies and other NGOs, arrange training for community volunteers.

Establishment of an EWS for Thailand

Prior to the tsunami, the Thai Meteorological Department (TMD) was responsible for providing farmers and fishermen countrywide with weather forecasts and warnings for rain and floods, cold and dry weather events, storms and monsoons. The Mineral Resources Department had the mandate for earthquake warning.

In 2005, the RTG first established a Committee for the Development of an EWS and then, a few months later, the NDWC. This centre was later transferred from the Secretariat of the Prime Minister to the Ministry of Information and Communication Technology (ICT) with the task of improving the disaster prevention and mitigation system. The NDWC building was renovated, new equipment installed, and a national and international communication system was established. The newly refurbished NDWC officially commenced operation on 30 May 2005. Its main responsibility is to detect earthquakes and to analyse seismic data to determine the possibility of tsunami generation

before issuing notification messages to the public, the appropriate authorities and emergency services to evacuate people to safe places (Research and International Cooperation Bureau, 2006).

In November 2006, the Thailand International Development Cooperation Agency (TICA), the NDWC and the National Oceanic and Atmospheric Administration (NOAA) of the United States of America signed a series of agreements, including a Memorandum of Agreement (MOA) for a Technical Cooperation in Effective Tsunami System Analysis and Early Warning, a General Cooperation in Meteorology, Oceanography and Hydrology and for the Deployment of the Tsunami Detection System in the Indian Ocean, and a Deep Ocean Assessment and Reporting of Tsunami DART II buoys in the Indian Ocean. The MOA will remain in force for five years from 2006 – 2011 (NDWC, 2006).

In November 2006, the US Ministry of Commerce donated a DART II buoy to the TMD on behalf of the NDWC and in December of the same year, the NDWC in collaboration with the NOAA and the Southeast Asian Fisheries and Development Center (SEAFDEC) successfully deployed the first DART buoy in the Indian Ocean. In its first phase, the DART Buoy Operation system will be carried out through the National Data Buoy Center of the NOAA in Maryland, USA by disseminating information through GTS of the WMO to the TMD before sending information to the NDWC. The NOAA will provide capacity building for the NDWC and relevant government agencies in operating the DART System until it can operate independently.

According to the Director of the Division of Early Warning and Public Relations of the NDWC (Group Captain Sarun Tappasut, pers. Comm., 2009), the information from the buoy has changed the SOP of the NDWC, which previously had relied only on earthquake information, to also include DART buoy information. This helps to reduce the time necessary to analyse whether a tsunami has been generated and to respond to the tsunami situation in an effective and timely manner. From the date of deployment in December 2006 to the present time, the buoy has been working continually. The system has gone into tsunami mode five times, for example, as a result of the 8.5 magnitude earthquake in Southern Sumatra, Indonesia, on 12 September 2007. The buoy data can also be provided to other agencies within Thailand and other Indian Ocean countries through the website of the NOAA's National Data Buoy Center.

Ten government agencies are responsible for the development of the Thai EWS: the TMD; the Department of Mineral Resources; The Department of National Parks, Wildlife and Plant Conservation; the Department for Pollution Control; the Hydrographic Department of the Royal Thai Navy (HDRTN); the DDPM, the Department of Fisheries; the Royal Irrigation Department; the Department of Maritime Transport and Commerce; and the Electricity Generating Authority of Thailand (EGAT). Regional partners include the Pacific Disaster Centre (PDC), PTWC, JMA, the United States Geological Survey (USGS), the NOAA, the European - Mediterranean and Seismological Centre (EMSC), the Indonesian Meteorological and Geological Agency (IMGA), the Malaysian Meteorological Service (KJC), and GTS of the WMO.

Supported by USAID, Thailand, together with Cambodia, China, Lao PDR, Myanmar, Philippines, and Vietnam agreed to cooperate in an end-to-end multi-hazard EWS arrangement in the Indian Ocean region under the guidance and leadership of the UNESCO/IOC and the WMO (Luwin, 2008). The NDWC and the DDPM aim to enhance capacity and cooperation in Thailand on early warning and disaster management with other countries in the Indian and Pacific Oceans. The RTG, particularly the DDPM, has been supporting institutional capacity building for DRM and early warning through technical cooperation with ADPC, and training and study visits to Japan.

The Thai EWS is being developed in three phases: In the 1st phase 76 warning towers were installed in the six tsunami-affected provinces. During the 2nd phase, which will end in 2009, the system is being expanded to other vulnerable areas along the Gulf of Thailand and in other provinces. In the 3rd phase another 144 warning towers will be installed in other parts of Thailand, particularly in mountain areas that are vulnerable to other natural hazards such as flash floods and landslides.

Starting with EWS development for earthquake and tsunami hazards in 2005, the NDWC's activities expanded to other hazards such floods, storms, landslides, chemical and toxic spills, and forest fires during 2006 – 2008. Then, the NDWC began to focus on drought, pollution, multi-hazard preparedness and awareness rising in 2007 to 2010. Most recently, through activities planned between 2007 and 2011, the NDWC has started to target the establishment of a joint DRM network with other countries in the Indian and Pacific Oceans (Tappasut, 2009).

In addition to the establishment of the NDWC and the installation of warning towers, the analogue observation equipment at the HDRTN and the TMD have also been upgraded in phases. Additional seismic stations are being established and communication links between the technical agencies and the NDWC are being improved (IRC and Tetra Tech, 2007). The NDWC controls the operation of the tsunami warning towers while the provincial governor is the official in charge of the decision to transmit warning signals to the towers (Tsunami Aid Watch, 2007). The Department of Water Resources in the Ministry of Natural Resources and Environment cooperates with the TMD to develop flash flood and sudden land slide warning systems in communities located on slopes and along waterways, especially in the northern and southern regions of Thailand.

Characteristics of the EWS

The EWS information network is linked to the ten government agencies mentioned above. Data on the intensity of seismic and wave activities are received and transmitted via the EWS established by the NDWC (Tourism Authority of Thailand, 2007). The NDWC receives information from these government agencies, as well as the DART buoys and other international agencies, and verifies and analyses the data. Since its deployment in the Indian Ocean, the DART II system has been working properly and has been sending wave data regularly. Initially, the data was sent to the National Data Buoy Center in the USA and then transferred to the NDWC via the internet. Now the data is transferred directly to the NDWC through GTS (Tatong et.al, 2008).

After receiving the seismic information from the DART buoys and/or the national and international agencies, the NDWC undertakes an analysis of whether a tsunami might be generated and which areas are likely to be affected by the potential tsunami using a tsunami model on their mainframe computer. The model considers the magnitude of the earthquake and the bathymetry of the near-shore area to generate information for decision-making. After receiving the seismic information, the NDWC assesses which of the three seismic awareness zones is likely to be affected (figure 7). The hazard information is disseminated through the Government Information Network (GIN) which comprises the intranet¹ (OpenCARE), the warning towers, telephone

network channels e.g. SMS (5,000 messages/time), auto-fax (sending out 150 fax/time), call centre (1860), radio (280 stations) and television (TV5). If an alarm is sounded through the warning towers, the messages are broadcast in five different languages including Thai, English, German, Chinese and Japanese.

Short messages are also sent to community leaders, volunteers, health facilities and schools in remote areas where radio and television is inaccessible. In some areas, shortwave radio communication normally used for official purposes in government departments and local government offices as well as for informal users like fishermen and volunteer networks is also sometimes used as a supplementary device for warning and rescue missions in areas at risk or affected by earthquakes and tsunamis. Such initiatives are largely community driven and not properly coordinated.

When the NDWC was first established, the decision to issue a tsunami warning was entirely based on earthquake information. Existing data indicate that a tsunami can only be generated by earthquakes that have a magnitude higher than 6.5. It was assumed that the magnitude of the tsunami is directly related to the magnitude of the earthquake. However, the near-shore bathymetry is also a key factor affecting the magnitude and hence potential impacts of the tsunami. Therefore, three different SOPs were developed to account for the potential differences in the tsunami impact levels based on these considerations. For example, an earthquake in Zone 1 (indicated in figure 8 by the red box) represents a high tsunami potential for the six coastal Andaman provinces. This earthquake zone covers the seismically active Burma Micro-Plate in the Andaman Sea and the Sunda Micro-Plate in the Indian Ocean.

Remaining Challenges and Future Sustainability of the Thai EWS

As the TAOs are the government authorities directly overseeing village affairs, DDPM policy stipulates that TAOs are also responsible for supporting CBDRM processes. This is also specified in the plans prepared at the provincial level. However, the funding that DDPM allocates for local DRM processes is incorporated in the annual budget for TAOs without clear guidance on how much should be spent on DRM or modalities for spending. As a result, DRM activities, including support to CBDRM as proposed under the provincial plans, receive very little priority amidst the many social

1 The intranet NDWC Open exchange for Corroborative Activities in Response to Emergency: (OpenCARE) is one of several information dissemination channels of the NDWC. OpenCARE has four different groups of target

audiences: the general public, the disaster management agencies, the DDPM and related government agencies, and the NDWC operating staff (Singbun et.al, 2008).

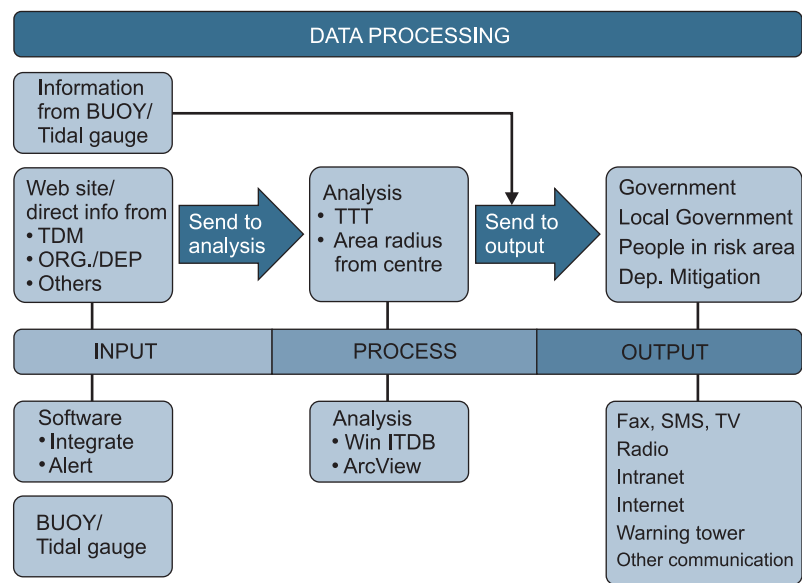


Figure 7: NDWC warning process (Source: Tappasut, 2009)

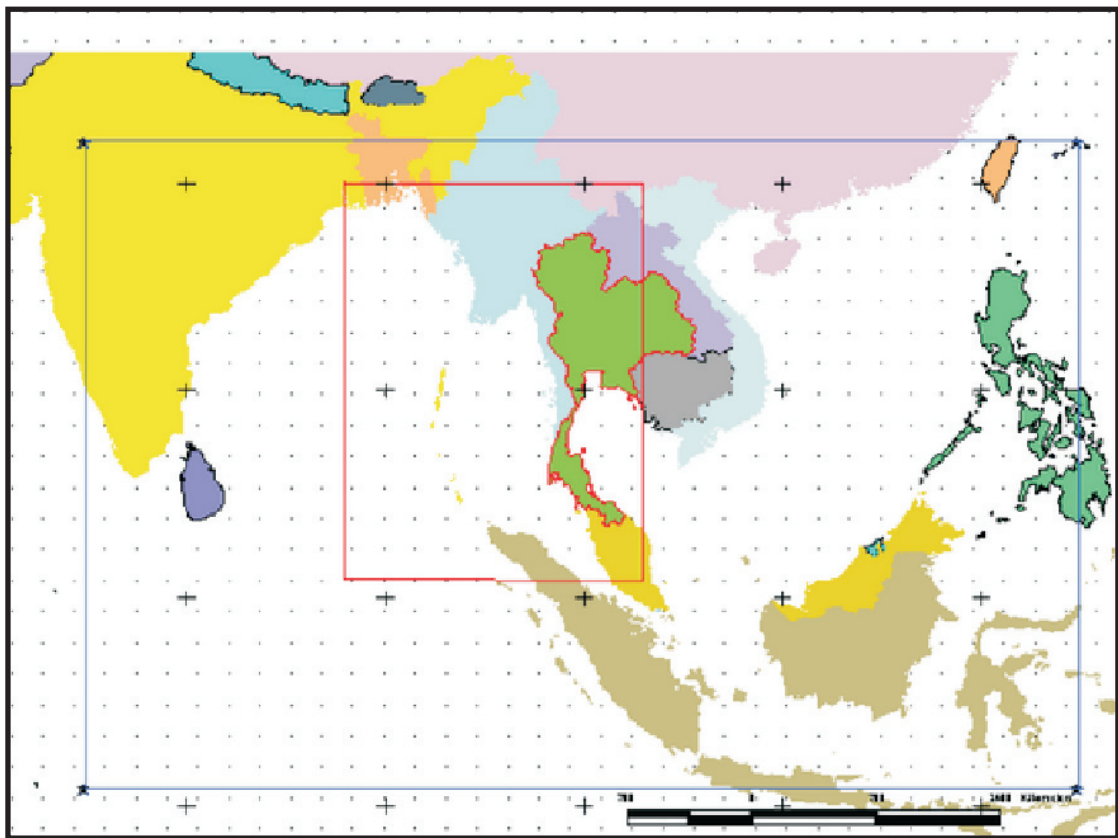


Figure 8: Seismic awareness zones of Thailand tsunami preparedness (Source: Tappasut, 2009)

and economic programmes under the TAOs' purview. Moreover, the decentralised government structure leaves provincial authorities with little leverage over TAOs to encourage a greater response in line with the provincial plan. A situation has now developed wherein DRM is largely decentralised with resources allocated at sub-district level without comprehensive guidance (both from policy and practice) on how to effectively allocate such resources.

Participants at the 2007 National Conference on Community Disaster Risk Management (NCDRM)² highlighted the TAOs' responsibility to initiate planning, develop mechanisms for coordination and monitoring, and undertake resource mobilisation for CBDRM processes in villages under their purview. While several TAO representatives expressed their willingness to support CBDRM better, there was general consensus that the TAO support to communities was not in line with this responsibility, mainly due to the TAO's lack of capacity and CBDRM experience.

A total of 103 warning towers have been installed in the six Andaman provinces, 79 by the NDWC and 24 by local administrative organisations in Krabi (20) and Ranong (4). In addition, the NDWC has also installed a total of 48 warning towers 17 of which are in the northern provinces and the other 31 in other provinces along the Gulf of Thailand. These are intended not only for tsunamis but also for other hazards such as flash floods and landslides. The NDWC plans to install another 144 towers in other parts of Thailand (Tappasut, 2009).

In 2009, the RTG instructed the NDWC and the Ministry of Information and Communication Technology to install two new DART II buoys in the Andaman Sea to detect earthquakes in the Burma Micro-Plate and the Sunda Micro-Plate. From these sources, a tsunami would take only 15 minutes to reach

Thailand's coast. With the new buoys, the NDWC will be able to alert communities in these vulnerable areas five minutes before the arrival of the tsunami. The RTG also allocated funds to maintain the existing buoys, and to improve or upgrade the 144 warning towers by enhancing the towers' capacity for two-way communication (Sirisukwattananon, 2009).

The NDWC plans to develop a more accurate tsunami model and to apply GIS to EWS and DRM activities. This includes the development of a seismic operating system; the development of EWS for other water related hazards; the development of a model for EWS equipment, and the development of a model to simulate different early warning situations. The NDWC also plans to develop a disaster command and control system for crisis situations, and to use satellite images for early warning (Tappatsut, 2009).

The NDWC, DDPM, the Tourism Authority of Thailand (TAT), and the Government Department of Public Relations aim to conduct a tsunami warning and evacuation drill in the six tsunami affected areas once a year. The first drill was undertaken in selected areas in 2005. In 2006 one drill was conducted in each affected district, and in 2008, the drills covered all tsunami-affected areas for the first time. The National Tsunami Drill on 21 August 2009 showed that a number of technical and non-technical problems still need to be overcome. For example, in Ban Thoong-La-ong, one of 15 coastal communities in which Raks Thai has been engaged in CBDRM projects, the main problems related to the communication of the warning, particularly the areal coverage of the loudspeakers and the reporting and feedback to the administration and coordinating centre (Tepa, pers. comm., 2009).

3.4 EWS DEVELOPMENT IN SRI LANKA

The impacts of the 2004 tsunami on Sri Lanka

The impact of the 2004 tsunami on Sri Lanka was most severe on the eastern and northern coastal areas and somewhat less severe in the south. The districts most affected were those of Gampaha, Colombo, Kalutara, Galle, Matara, Hambantota, Ampara, Batticaloa, Trincomalee, Mullaitivu, Killinochchi and Jaffna (FAO, 2005). Approximately 30,970 people were killed, 23,175 were injured and 4,695 are missing. Approximately 27,000 of the dead were fishermen and nearly two-thirds of these occurred in the districts of Mullaitivu, Ampara and Hutambantot (FAO, 2005). The tsunami surge completely destroyed approximately 99,480 homes and partially damaged about 44,290.

2 The 2007 NCDRM was hosted by Raks Thai, and co-organised by Raks Thai, the Department of Disaster Prevention and Mitigation, the Ministry of the Interior; the Royal Thai Government's Coastal Habitats and Resources Management (CHARM) Project, the International Organisation for Migration (IOM), the World Conservation Union (IUCN), the Office of Population and Technical Assistance (OPTA), the Save Andaman Network, Save the Children, the Sustainable Development Foundation, the Thai Red Cross, the United Nations Children's Fund (UNICEF), the United Nations World Food Programme (WFP) and the World Wide Fund for Nature (WWF).

Fifty eight percent of the half a million people displaced were from Ampara, Galle and Batticalao (FAO, 2005). Many children suffered greatly, with 1,200 losing one parent and 1,000 losing both (Yamada *et al.*, 2006).

Overall, the tsunami affected two-thirds of the coastline of Sri Lanka, over 1,000 km in total. The damage to reefs was most severe where coral mining had been rampant in the past (UNEP, 2005b). Agricultural land was affected by the incursion of large amounts of salt water and marine sediment to fields and wells. Approximately 2,175 hectares of rice paddies and 1,708 hectares of other crops were destroyed (Stoffs, 2005). Out of the 12 fishery harbours, 10 suffered considerable damage, with extensive loss of essential infrastructure such as ice plants, cold rooms, workshops, slipways and marine structures (FAO, undated).

Preliminary estimates of total direct losses were approximately USD 1 billion (4.5 percent of GDP). The destruction of private assets in the affected districts was substantial (USD 700 million). The fishing and tourism industries suffered losses of USD 97 million and USD 250 million respectively through lost infrastructure and equipment, while the housing sector sustained damages close to USD 340 million (ADB, JBIC and World Bank, 2005). Many of the village industries located along the southern and eastern coastlines were destroyed, causing disruptions to livelihood activities (ADB, JBIC and World Bank, 2005). The unemployment rate in provinces affected rose from approximately 9.2 percent before the tsunami to over 20 percent afterwards with over 400,000 workers losing their jobs (Fabrycky *et al.*, 2005). Approximately two-thirds of the nation's fishing boats were wrecked, destroying many jobs (UNEP, 2005b). The damage to the tourism industry resulted in an estimated 14,000 job losses (ADB, JBIC and World Bank, 2005). About 50 percent of 105 large and medium scale hotels in the affected areas were partially damaged and eight hotels were completely destroyed (Jayasuriya *et al.*, 2005). Two hundred and forty schools were either destroyed or sustained serious damage along with a total of 92 health facilities such as local clinics, hospitals and drug stores, causing disruptions to the delivery of health services and patient care. At least 12,000 wells were damaged mainly by salt water intrusion and approximately 50,000 were abandoned (Jayasuriya *et al.*, 2005, ADB, JBIC and World Bank, 2005).

Hazard profile

Sri Lanka is commonly affected by natural hazards such as cyclones, floods, droughts, wind storms, wildfires, landslides, earthquakes, tsunamis, coastal erosion, lightning strikes, insect infestations and health

epidemics. More than 50 percent of communities in the country are threatened by at least one of these hazards. In addition, the country is also affected by man-made hazards such as deforestation, mining, pollution, road accidents, famine, and civil and political conflicts (ADRC, 2006; DMC, 2005). Floods and droughts tend to affect the largest number of people with more than 10 million having been affected by floods and 6 million by droughts over the last three decades. Floods and wind storms cause the greatest amount of loss and damage (CRED, 2009; IOTWS, 2007; GFDRR, 2009).

Historically, tsunami hazards have not been a threat to Sri Lanka. The only recorded tsunami prior to 2004 was in 1883 resulting from the Krakatoa volcanic eruption, but this caused only limited damage (ADRC, 2006; GFDRR, 2009; Hettiarachchi *et al.*, 2006; IOC, ISDR, WMO, USAID, 2005). The severity of landslides has increased over the past two decades due to high intensity rain, geological changes and human activity. The frequency and magnitude of cyclones and risk from earthquakes is also expected to increase (GFDRR, 2009).

Natural and human-made disasters in Sri Lanka have increased in the past two decades and are expected to further increase due to changing demographics, development patterns and climate change. There is some scientific evidence that Sri Lanka may experience increasing seismic activity as a result of the fracturing of the tectonic plate extending from Australia to India. The potential of seismic activity is also increasing in the entire region and this may result in more tsunamis affecting Sri Lanka in the future (UNDP, 2007).

Institutional Arrangements and Policies for DRM and Early Warning

The policy frameworks and arrangements for DRM and EWS in Sri Lanka have changed significantly since the 2004 tsunami with the setting up of new institutional platforms. Previously, there was no legal framework for DRM and few coordination mechanisms existed.

One of the major developments in DRM policy and institutional arrangements was the creation of the Disaster Management Act (DMA) in May 2005. While this Act builds on the 1993 Action Plan for Disaster Management, its formulation was largely motivated by the political climate existing in response to the 2004 Indian Ocean Tsunami. The National Council for Disaster Management (NCDM) and the Disaster Management Centre (DMC) were also established at the same time. The DMA accords DRR a higher level of priority, and provides the legal foundation for

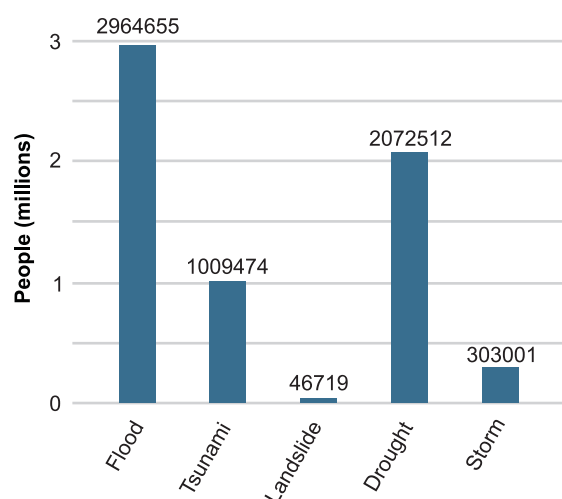


Figure 9: People affected by different disasters in Sri Lanka from 1974 - 2004

(Source: DMC, 2005)

a range of DRR activities, including early warning. However, the main portion of the DMACT focuses on preparedness for response and response mechanisms. Specific references to early warning are limited to implications under mitigation and preparedness. Thus, early warning, EWS and the preventive effects of such systems are not specifically referred to in the DMACT.

A comprehensive Disaster Management Policy, a National Disaster Management Plan and a National Emergency Operations Plan have been developed to support the DMACT, but they have yet to receive ministerial approval. The National Disaster Management Policy (drafted in April, 2006, but yet to be approved by the national council and national parliament) is intended to strengthen support to the provinces and local administrations, and to provide the institutional framework for EWS development in the country.

Table 6: Notable natural disaster events in Sri Lanka and their humanitarian and financial effects since 1957 (adapted from CRED, 2009; IOTWS, 2007; and GFDRR, 2009)

Date	Location	Disaster	Effects
1969	Northern, Eastern, Southern, and Central Provinces	Flood	62 killed 1,000,000 affected USD 8,500,000 worth of damage
1978	East Coast and Northern Province	windstorm, cyclone, flood	750 killed 5,000 injured 1,002,000 affected USD 100,000,000 worth of damage
1982-1983	All of Sri Lanka	flood, drought	57 killed 4,930,000 affected >USD 1,000,000 worth of damage
1987	Northern, and North-eastern Regions	Drought	2,200,000 affected
1989	All of Sri Lanka	flood, drought	325 killed 1,000 injured 200,000 homeless 1,106,000 affected >USD 35,000,000 worth of damage
2001	Hambantota, Kurunegala, Puttalam, Ratnapura, Moneragala, Badulla, and Ampara Districts	Drought	1,000,000 affected
2002	All of Sri Lanka	flood, drought	1,057,000 affected
2004	All of Sri Lanka	flood, tsunami	35,405 killed 23,176 injured 480,000 homeless 716,130 affected USD 1,316,500,000 worth of damage

The execution of the National Disaster Management Plan (drafted in 2007) is overseen by the NCDM, the Ministry of Disaster Management (MoDM) and the DMC. Specifically, Chapter Seven of the National Disaster Management Plan sets out responsibilities for the Early Warning Division of the DMC. These include the coordination of early warning information from the institutions responsible for monitoring and disseminating warning messages, as well as the building of awareness on early warning among the various government agencies and the public. The draft plan also lists the technical institutions responsible for forecasting and warning of each hazard. The institutional roles and responsibilities are shown in figure 10.

The 10-year Road Map for a Safer Sri Lanka identifies the priority activities to be implemented by various government agencies, and coordinates the efforts of government and non-governmental actors (Hettiarachchi, 2008; IOTWS, 2007). This Road Map is the manifestation of the Hyogo Framework at the national level in Sri Lanka and the United Nations is committed to support its implementation (Hettiarachchi, 2008; IOTWS, 2007). The Road Map contains 109 strategic projects within seven thematic areas: Policy, Institutional Mandates and Institutional Development, Hazard, Vulnerability and Risk Assessment, Multi-hazard Early Warning System, Preparedness and Response Plans, Mitigation and Integration of DRR into Development Planning, CBDRM, and Public Awareness, Education and Training (DMC, 2006).

These developments have led to the institutionalisation of the NCDM, which is chaired by H.E. the President and vice-chaired by the Hon. Prime Minister. The Leader of the Opposition, Ministers, Provincial Council Chief Ministers and five members of the Opposition are also members of the Council. The Council is required to meet every three months in an effort to gather inter-ministerial oversight and support for the DMC. However, to date the Council has met very infrequently, and thus its role has been considerably diluted (ADRC, 2006; DMC, 2005; IOTWS, 2007; UNDP, 2007). The NCDM monitors the implementation of both the National Disaster Management Plan and the National Emergency Operation Planning. It assigns responsibilities to the DMC and directs its activities. The NCDM was created to oversee all aspects of DRR, advising the Cabinet of Ministers on potential and actual disasters and recommending the allocation of funds. It was also intended to promote local and community self-reliance as well as liaison with those conducting research on hazards.

The DMC was established in July 2005 to implement the directives of the NCDM and functions under the Ministry of Disaster Management and Human Rights (MoDMHR). The DMC Early Warning Dissemination Unit disseminates early warning messages issued by the technical agencies responsible for different hazards to vulnerable communities. Another notable initiative of the DMC was the establishment of the National Emergency Operations Centre (EOC), which carries out emergency operations during a disaster through coordination with the armed forces, police and other actors at national and sub-national levels. The DMC Training and Public Awareness Unit conducts different programmes to enhance the capacities of vulnerable communities on last mile activities by conducting drills and providing training in search and rescue, and first aid skills.

Establishment of an EWS for Sri Lanka

Dedicated units in the relevant agencies have the sole authority to issue warnings and to disseminate them to the public through the media and the DMC. Efforts are made to use the existing communication channels within the government's administrative setup, in addition to the three major channels of communication already being used for mass dissemination: the popular media, such as television, newspapers, radio, etc; the police wireless communication system; and the military communication channels of the Joint Operation Command (ADRC, 2006; DMC, 2005; Hettiarachchi, 2008; WCDR, 2005). In recent months, the DMC Early Warning Unit has established several new early warning dissemination mechanisms such as multi-hazard early warning towers, the Disaster Emergency Warning Network (DEWN), and Radio Communication Systems to provide information to vulnerable communities within a short time period.

In recent years, there has been an increasing focus on improving the coordination between government agencies at the district and division levels, and between government agencies and NGOs at the community level. There is also commitment to support CBDRM activities and to enhance community resilience for DRM and early warnings in collaboration with NGOs, CBOs, the Sri Lanka Red Cross (SLRCS) and other local actors. The DMC, together with NGOs and International non-governmental organisations (INGOs), has established Grama Niladari (GN) level committees, undertaken community risk assessments, prepared community hazard maps, conducted drills, and implemented the Coastal Community Resilience (CCR) Programme (see Box 1).

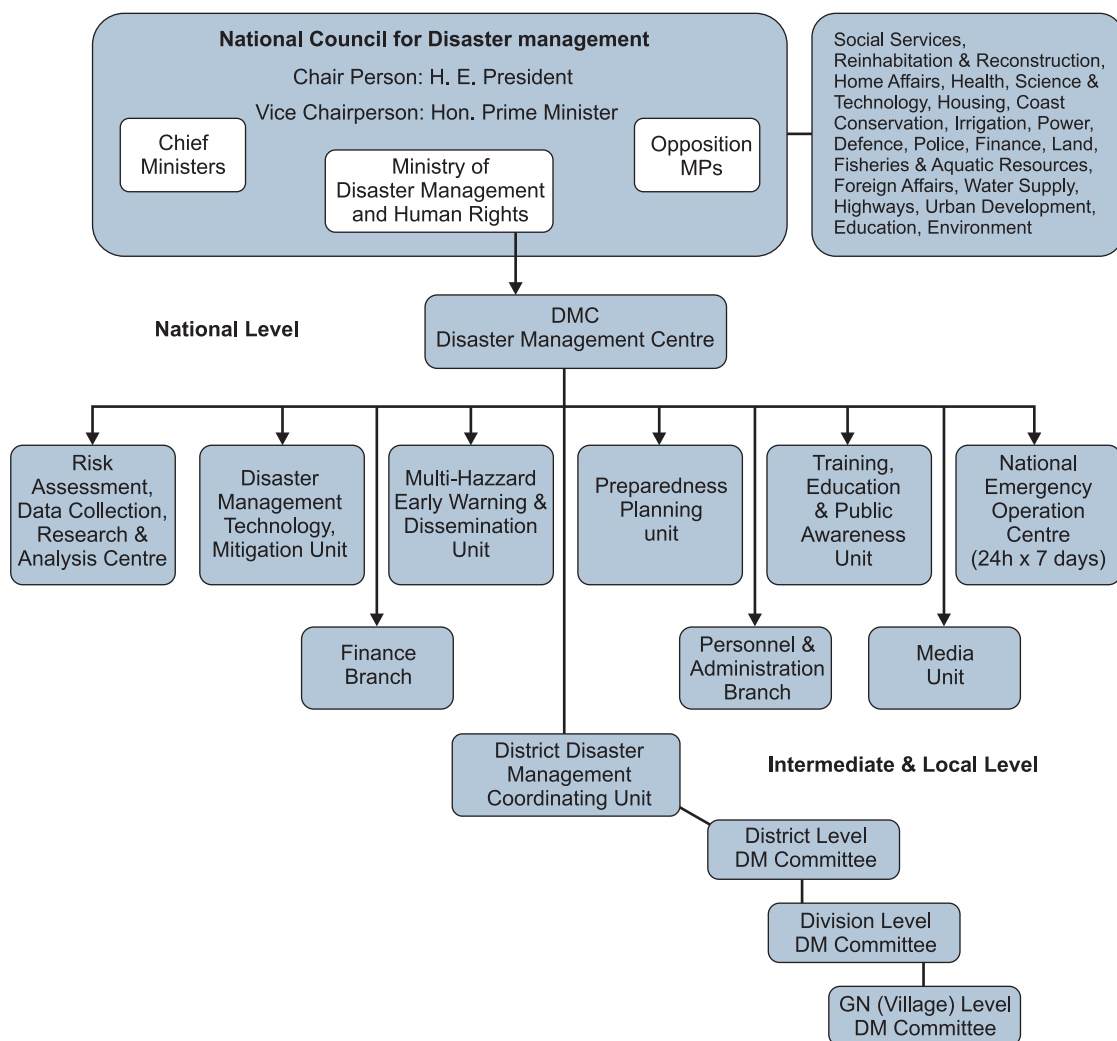


Figure 10: Organisation of the NCDM in Sri Lanka (Hettiarachchi, 2008 and ADRC, 2006)

Under these new arrangements, each District Secretary is required to conduct a meeting with all INGOs/NGOs engaged in DRM activities in order to review and to coordinate their programmes. However, to-date, this has only occurred in a few districts but the DMC is instructing the other districts to follow the same procedures. In some districts, some NGOs conduct CBDRM activities without informing the DMC district units, but it is expected that these are in the process of establishing a coordinated framework in the future. At the national level, all ministries and INGOs/NGOs are members of the National Disaster Management Coordination Committee that coordinates the DRM activities of all members.

The role of the DMC at the sub-national level is to facilitate the coordination of geographical areas for undertaking programmes, to support the linkages between CBDRM teams and NGOs with the division

and district officials and plans, and to establish and administer the small grants and applied research grants programmes. In addition, community resilience initiatives are developed with the coordination of the District Disaster Management Coordinating Units (DDMCU) attached to each District Secretariat. The initiatives focus on participatory hazard mapping to identify routes and areas for evacuation, and evacuation drills (GoSL, 2008; 2007; Hettiarachchi, 2008). International support for building capacity on CCR has been provided by the US-IOTWS, ADPC and UNESCAP. The DDMCU and the EOCs are IOTWS also being strengthened to build the capacity to mobilise ground level agencies in the respective districts, sub-districts, villages, and local community organisations. The CBDRM activities conducted by NGOs in collaboration with government line agencies are currently expanding and are expected to play a

Table 7: Roles and responsibilities for early warning for various hazards lie with various designated departments and agencies

(ADRC, 2006; Goyder *et al.*, 2009; Hettiarchchi, 2008; US-IOTWS, 2007b; WCDR, 2005; UNDP, 2007)

Government agency	Roles and responsibilities
Department of Meteorology (DoM)	responsible for weather-related natural hazards
Irrigation Department	flood forecasting, monitoring, warning and control
National Building Research Organisation (NBRO)	lead agency for landslide risk identification and mitigation, as well as public awareness
Geological Survey and Mines Bureau (GSMB)	responsible for seismology
National Aquatic Resources Research and Development Agency (NARRDA)	monitors ocean wave activities
Urban Development Authority (UDA)	promotes sustainable urban development through the formulation of urban land use policy
National Physical Planning Department (NPPD)	integrates information on natural disaster prone areas and disaster mitigation aspects into the planning process
Ministry of Fisheries and Aquatic Resources (MoFAR)	operates a warning dissemination system in all fishing harbours
Coastal Conservation Department (CCD)	develops the National Coastal Management Plan and regulates and oversees all development activities in the coastal zone
Human Disaster Management Unit (HDMU)	implements preparedness measures for man-made disasters
National Science Foundation (NSF), under the Ministry of Science and Technology (MoST)	coordinates research and public awareness on hazards through its Committee for Science and Technology Initiatives for Disaster Mitigation and Management

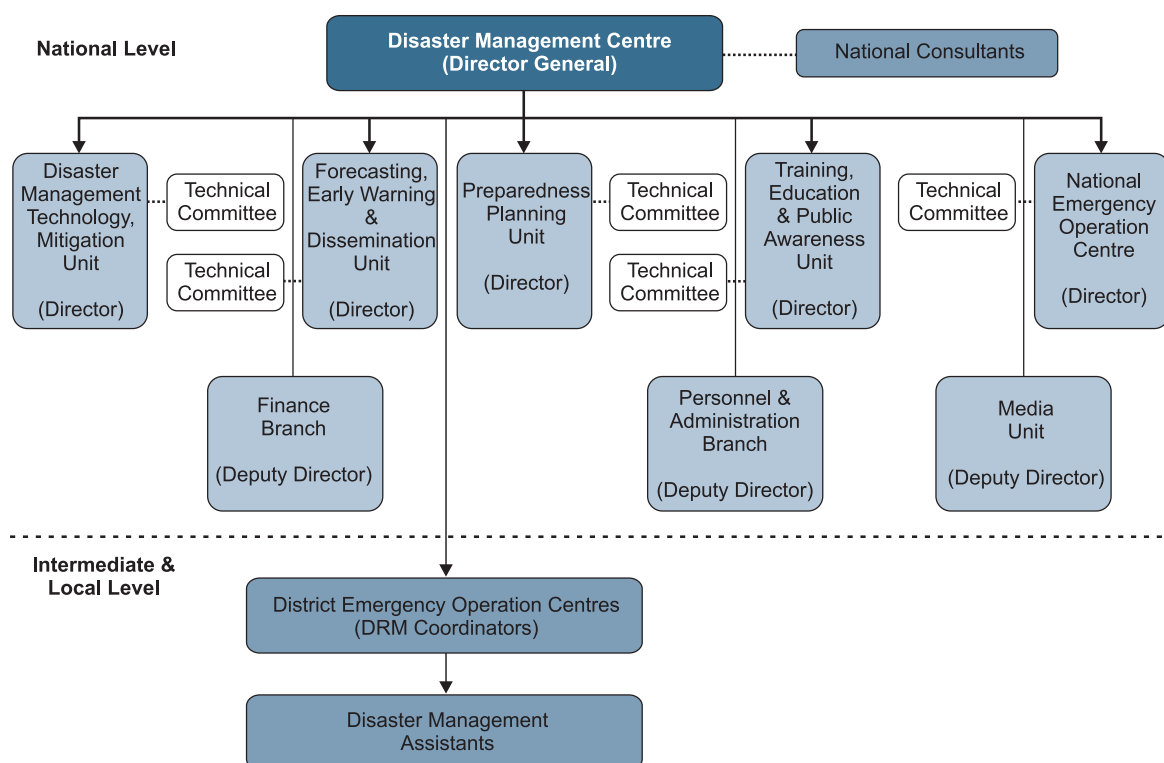


Figure 11: Organisational structure of the Disaster Management Centre

(Goyder *et al.*, 2009; UNDP, 2007)

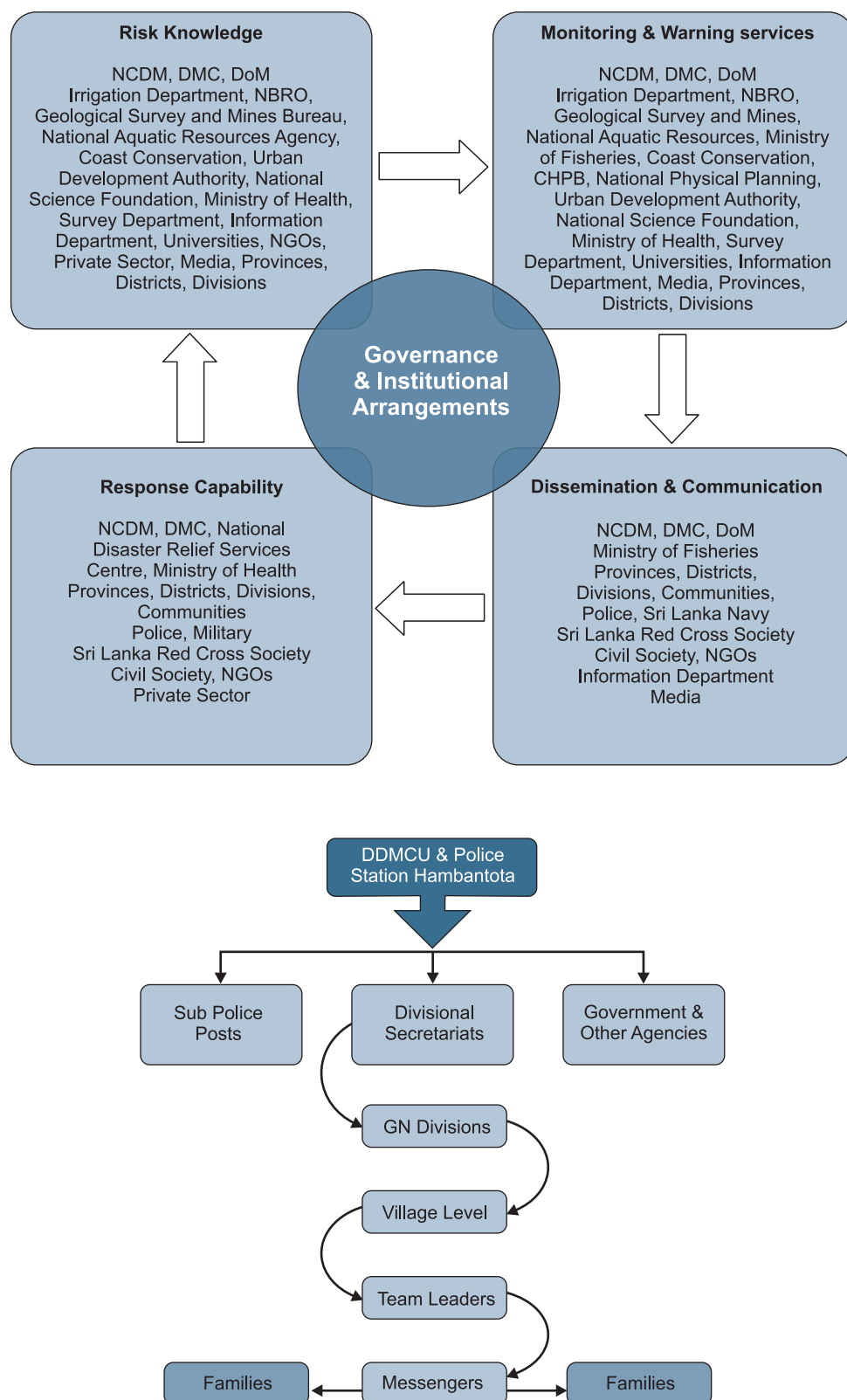


Figure 12: Organisational structure of a typical District Disaster Management Coordination Unit, example of Hambantota (Hettiarchchi, 2008)

key role in supporting the district-level DDMCUs in future.

3.5 EWS DEVELOPMENT IN INDONESIA

Impacts of the 2004 tsunami on Indonesia

The 2004 earthquake and the subsequent tsunami caused the most devastation in the densely populated provinces of Aceh and North Sumatra. Cities and heavily populated areas such as Meulaboh and the district capital of Calang experienced significant devastation but so too did villages such as Gleebruk and towns such as Leupung and Teunom that were completely destroyed (Samek *et al.*, 2004). Significantly affected sub-districts included Arongan Lambalek, Bubon, Johan Pahlawan, Kaway XVI, Mereubo and Samatiga in Aceh Barat and Darul Makmur and Kuala in Nagan Raya. Thirty-six villages in four sub-districts of Aceh Barat were completely destroyed. In Nagan Raya, the Kuala sub-district was the most heavily affected with more than 8,000 people displaced (UNEP, 2005c).

Indonesia suffered greater devastation than any other nation, accounting for 80 percent of all deaths and 47 percent of all those internally displaced. The official figures (as of February 2005) stand at 164,891 deaths, 114,897 people missing and 412,438 people displaced, although the human cost will probably never be fully known (UNEP, 2005c).

In terms of environmental impacts, UNEP calculated the total damage to environmental assets as USD 155 million and total losses equalling USD 515 million. An estimated 100,000 hectares of coral reefs in the affected area were damaged with a calculated net loss of USD 332.4 million (USD 1,599/ha). Approximately 48,925 hectares of coastal forests (excluding mangroves) were affected by the tsunami with a net loss exceeding USD 21.9 million and the damage to mangrove forests resulted in a further net loss of USD 2.5 million (UNEP, 2005c).

The Indonesian economy was also devastated with approximately 40 percent of private-sector losses occurring in the housing industry. An estimated 25 percent of the labour force became unemployed, raising the total unemployment rate to over 30 percent in the disaster area (Schepere, 2006). According to reports from IOC, ISDR, WMO, USAID (2005) and ADRC (2006) there was a total cost of USD 4,451,600 in losses and damage - nearly 97 percent of Aceh's Gross Domestic Product (GDP), however the impact on lives, families and communities cannot be counted in dollar terms.

Aquaculture was a significant industry that was severely affected. According to FAO (2005) approximately 47 percent of ponds were severely damaged or lost, and at least 40,000 people directly employed in aquaculture in Aceh were directly affected. The region, although not heavily industrialised, suffered heavy damage to 14 public port facilities in Aceh and North Sumatra. Three key industrial sites were damaged: the Pertamina oil depot in Kreung Raya Bay/Banda Aceh; the Pertamina oil depot in Meulaboh; and the Semen Andalas Indonesia cement factory in Banda Aceh (UNEP, 2005c).

Hazard profile

Located in the middle of the Australian, Eurasian, Pacific and Philippine Sea tectonic plates, Indonesia is a seismically and volcanically active area. Due to its location along one of the world's most active tectonic fault zones (the so-called 'ring of fire'), Indonesia experiences frequent submarine earthquakes and island volcanic eruptions, and is highly vulnerable to tsunamis.

The country's proximity to the source of powerful earthquakes also provides the particular challenge of locally generated tsunamis that due to their short travel distance are capable of reaching the coast within a few minutes (ADRC, 2006; BNPB, 2005; IOC, ISDR, WMO, USAID, 2005). In addition, the country's archipelagic structure and the remoteness of some of the inhabited islands create tremendous challenges for the rapid dissemination of early warnings and evacuation (US-IOTWS, 2007c). Due to its high vulnerability to multiple natural as well as man-made hazards, Indonesians and development workers often refer to Indonesia as the 'supermarket bencana' (supermarket of disasters).

The magnitude 8.6 Sumatra earthquake in March 2005 killed more than 900 people and displaced more than 100,000, and the magnitude 6.3 Java earthquake in May 2006 killed almost 6,000 people, injured almost 40,000 and destroyed or damaged more than 600,000 houses (ADRC, 2006).

In addition to earthquakes and tsunamis, Indonesia is also affected by floods, cyclones, storm surges, tornados, landslides, droughts, wildfires, wind storms and health epidemics, and man-made disasters such as fires, pollution, environmental degradation, social and political unrest, failures of technology and transportation, and acts of terrorism which can have both national and international implications. Over 50 percent of the population is vulnerable to two or more of these hazards which places the country twelfth on a list of countries with high mortality risks from multiple

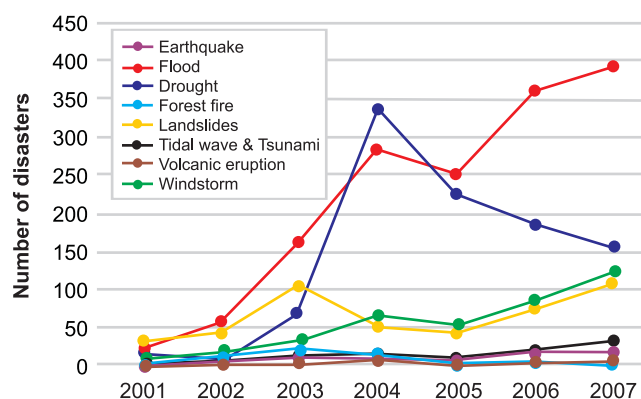


Figure 13: Occurrence of different disasters in Indonesia (GFDRR, 2009)

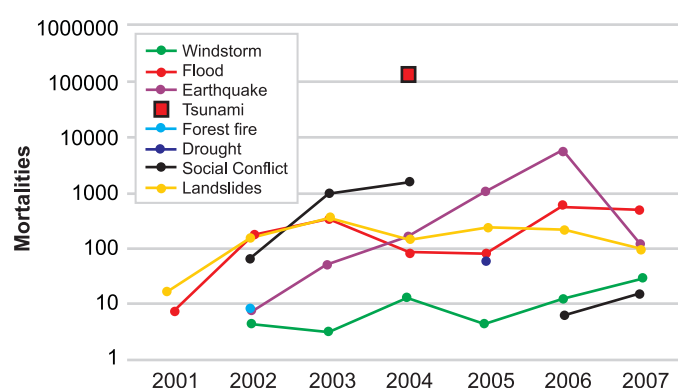


Figure 14: Mortality from different disasters in Indonesia

hazards (ADRC, 2006; BNPB, 2005; GFDRR, 2009). Of the 4,000 disasters that occurred in Indonesia over the period between 2001 and 2007, 37 percent were floods and 27 percent were droughts (GFDRR, 2009).

Institutional Arrangements and Policies for DRM and EW

In response to disasters, the Government of Indonesia (GOI) has issued a series of Presidential Decrees for DRM: The 1961 Presidential Decree created the Bakornas PBA (the National Coordinating Board for Natural Disaster Management) to coordinate natural disaster management exclusively. Presidential Decree No. 28 (1979) included two revisions: the Bakornas PBA became the Bakornas PB with the inclusion of man-made and environmental disasters, and industrial accidents, while DRM was extended to include prevention, mitigation, rehabilitation measures and disaster relief. In the Presidential Decrees Nos. 3 and 111 (2001), the Bakornas PB was further revised to become the Bakornas PBP in which the definition of disasters was expanded to include complex emergencies

and internally displaced persons (IDPs). The latest decrees basically state that the facilitator and main actor responsible for DRM and IDPs is a non-structural co-ordination body formed by the central government. The names and tasks of this coordinating body differ at the different levels of governance: Bakornas PBP for the national, Satkorlak PBP for the provincial, Satlak PBP for the municipal (district), Satgas PBP for the Kecamatan (sub-district), and Satlinmas for the Kelurahan (village) level.

In 2005, the GOI issued Presidential Regulation No. 83 renaming the Bakornas PBP as Bakornas PB which was to address the need for restructuring the duties, functions, membership and organisational structure of the National Coordinating Agency for DRM and IDP Management covering preventive, preparedness, emergency response and recovery measures. BAKORNAS PB is chaired by the Vice President of the Republic of Indonesia and vice-chaired by the Coordinating Minister for People's Welfare and Minister of Home Affairs. and comprises ten other

members including the Ministers of Finance; Energy and Mineral Resources; Transportation; Public Works; Health; Social Affairs; Communication and Information (KOMINFO); the Commander of the Armed Forces; the Chief of the National Police; and the Chairperson of the Indonesian Red Cross. An Executive Officer of Bakornas PB acts as the Secretary. This non-structural co-ordination body is composed mainly of government institutions, which are responsible for ensuring the safety and preparedness of the citizens and for coordinating the work of the different actors involved in DRM, and has the right to utilise a budget and the obligation to report on activities. However, due to its ad hoc and coordinating nature, the organisation does not have the authority to issue laws, and the secretariat cannot formulate a National Disaster Management Plan. For these reasons Bakornas PB is oriented more towards disaster-response rather than disaster prevention.

In the absence of a National Disaster Management Plan, a series of laws that include a DRM element have been issued by several ministries. These include Act No. 11 (1974) on Water Resource Management (currently under revision), Act No. 23 (1992) on Health, Act No. 23 (1997) on Environmental Management, and Act No. 41 (1999) on Forestry. Some important issues for DRM, such as guidelines for hazard mapping, are still missing. However, these policies were established before the recent political decentralisation and are hence outdated since the institutions responsible for implementing them have not yet been delineated under the new decentralised governance system.

The 2004 tsunami and more recent disasters have increased hazard awareness in Indonesia, highlighted the urgent need for improved disaster management legislation, and provided the impetus for the GOI and the House of Representatives, along with NGOs, private institutions, and civil society in a process of public consultations and comparative studies, to establish Indonesia's integrated Disaster Management Law No. 24 of April 2007 (DM Law 2007). The Law provides the legal framework for establishing a strong institutional policy framework for disaster management, giving institutions at all levels a clear mandate and sufficient power to coordinate disaster management activities. The DM Law No. 24/2007 was followed by several other laws and regulations including the Presidential Regulation/Peraturan Presiden (Perpres) No 8/2008 on BNPB, the Governmental Regulation /Peraturan Pemerintah (PP) No 21/2008 on DM arrangements, Law No 22/2008 on financing, No 23/2008 on participation of international institutions and INGOs, the Regulations from the Ministry of Home Affairs (Permendagri): No 38/2008 on support mechanisms from international

agencies, No 03/2008 on cooperation mechanisms between local government and international agencies, No 46/2008 on the organisational and administrative guidelines of BPDB (Disaster Management Agency at sub-national level), and the Regulation from the Chair of BNPB No. 3/2008 on the establishment guidelines of the Regional Agencies for Disaster Management (BPBD). The planning documents in Indonesia, as stipulated by the National Development Planning Agency (Bappenas) are comprised of the National Long-term Development Plan (Rencana Pembangunan Jangka Panjang Nasional/RPJPN) 2005-2025, the National Mid-Term Development Plan (Rencana Pembangunan Jangka Menengah Nasional/RPJM) 2004 - 2009, as well the National Yearly Development Plan (Rencana Kerja Pemerintah/RKP). There are no specific mentions of DRM in the RPJPN 2005-2025 and RPJM 2004 - 2009.

After the 2004 tsunami, the national government started to include DRR specifically in these planning documents. The RKP for 2007 mentions DRR as a priority for disaster mitigation and management. The National Action Plan for Disaster Risk Reduction (RAN PRB) launched in January 2007 is a significant milestone in planning and budgeting for DRR because Bappenas included DRR as one of the nine development priorities and incorporated this in the Mid-Term Development Plan (Rencana Pembangunan Jangka Menengah/RPJM) for 2008. In the RKP for 2008, DRR is mentioned as a priority for Disaster Management, Disaster Risk Reduction, and Improvement of Contagious Disease Eradication. EWS was specifically mentioned as a priority focusing on the development of institutional and human resource capacity in disaster mitigation and EWS. In the RKP for 2009, DRR and CCA are mentioned as priorities 'in the acceleration of economic development through fortification of economic resilience supported by agriculture development, focusing on strengthening capacity in global climate change mitigation and adaptation'.

According to Law No 25/2004 on National Development Planning Systems (SPPN), local governments are obliged to develop their planning and development programmes in alignment with the national priorities. Local governments translated RPJM and RKP into their Mid-Term Regional Development Planning (Rencana Pembangunan Jangka Menengah Daerah/RPJMD) as well as into their Regional Budget Expenditure Plan (Anggaran Pembangunan dan Belanja Daerah/APBD).

The DM Law 2007 comprises policy formulation, coordination of implementation and provision of

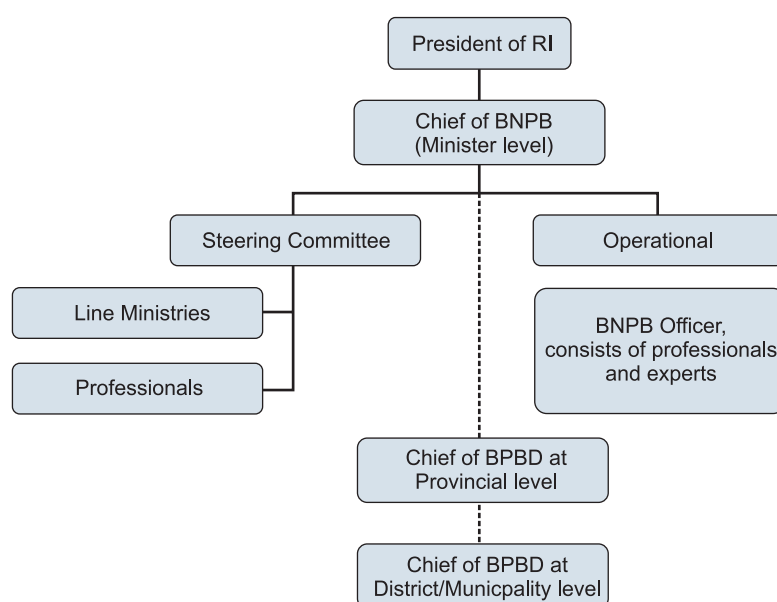


Figure 15: Organisational structure of BNPB

guidelines and directives for disaster preparedness and emergency response for all hazards. The law has brought about a strong political commitment and motivation across all sectors of the government and society to develop a comprehensive DRR approach (US-IOTWS, 2007c; UNDP, 2009). Bringing together all relevant sectors, the Law also reflects a shift from response-oriented mechanisms to a more pro-active

and preventive approach (US-IOTWS, 2007c). Basic principles addressed in this legislation include public participation, public-private partnership, international collaboration, multi-hazards approach, continuous monitoring, national and local dimensions, financial and industrial dimensions, incentive system, and education (ADRC, 2006; BNPB, 2005; GFDRR, 2009; US-IOTWS, 2007c).

Box 4: Safer Communities through Disaster Risk Reduction (SC-DRR) in Development

Launched in 2007, the SC-DRR project aims to mainstream DRR into development processes. 'The ultimate aim of this project is to ensure that, over the long term, development takes place in a way that disaster risks are considered and accounted for so that over time, a culture of safety becomes the norm in Indonesia leading to sustainable development and poverty reduction in Indonesia' (<http://www.sc-drr.org>). The project is supported by UNDP, co-financed by DFID and AusAID and implemented by BAPPENAS in close partnership with BNPB and MoHA (Kementrian Dalam Negeri). Seven SC-DRR initial priority locations include the provinces of West Sumatera, Central Java, Bengkulu, DI Yogyakarta, East Nusa Tenggara, DKI Jakarta, and the city of Palu (BAPPENAS *et al.*, 2007; UNDP and BAPPENAS, 2008; see also <http://www.sc-drr.org>).

Under the 2007 DM, Standard Operating Procedures (SOPs) are to be developed for different disasters using recent experiences. The roles of government agencies, NGOs, international organisations and community service organisations are to be better defined and utilised for community preparedness and last mile warning dissemination. And provisions for increasing capacity and designating responsibilities for preparedness and early warning dissemination and implementation of SOPs regarding response to early warning at the district and sub-district levels are to be made (GFDRR, 2009; US-IOTWS, 2007c). The legislation is also expected to address future needs by accommodating issues stipulated in the Yokohama Strategy Plan of Action, such as increasing the roles and responsibilities for DRR of local governments and the communities, and increasing local capacities to anticipate, respond to and recover from natural hazards (BNPB, 2005).

Parallel to the creation of the DM Law 2007, the National Action Plan for Disaster Reduction 2006 - 2009, supported by UNDP, was developed in a multi-stakeholder process to address the priorities of the Hyogo Framework for

Action (HFA) 2005 - 2015 (UN/ISDR, 2005). The plan addresses EWS and EWS capacity development among the five key priorities (UNDP, 2009). The five key priority areas for DRR (BNPB, 2006): are 1) to ensure that DRR is a national and a local priority with a strong institutional basis for implementation; 2) to identify, assess and monitor disaster risks and enhance early warning; 3) to improve the use of knowledge, innovation and education to build a culture of safety and resilience at all levels; 4) to reduce underlying risk factors; and 5) to strengthen disaster preparedness for effective response at all levels. It considers the institutional, legal, societal and technical requirements for an end-to-end multi-hazards EWS (UNDP, 2009) and attempts to integrate all relevant government institutions, international agencies, and NGOs working in the field of disaster management (US-IOTWS, 2007c). The National Plan is expected to be complemented by local level action plans. Respecting basic human rights, the action plan recognises the right to a dignified life and livelihood, and the responsibility of the government to ensure protection from disasters. It also aims to reduce disaster risk factors arising from unsustainable development practices that are likely to be exacerbated by climate change. The plan highlights the accountability of the GOI to communities at risk and/or affected by disasters, the importance of sensitivity to gender issues, participatory processes, and equity and justice perspectives (BNPB, 2006). To ensure the accountability of DRR on development policy, measurable achievement indicators have been developed as part of the action plan and CSOs are involved in the monitoring through control mechanisms at all levels, from national to village level. The 28 indicators include aspects of disaster resilience, geography, and DRR policy and implementation (BNPB, 2006).

The DM Law 2007 automatically superseded the ad-hoc function of BAKORNAS PB that had functioned since 1961 and transforming it into a permanent National Agency for DRM. The BNPB structure is defined under the Presidential Regulation/Peraturan Presiden (Perpres) No 8/2008 on BNPB (figure 15).

The National Disaster Management Agency (BNPB) comprises a DM advisory element that focuses on policy-making, monitoring and evaluation, and a DM operational element that oversees the day-to-day operational functioning of DM activities. Membership of the DM advisory element consists of ten relevant government officials representing the Coordinating Ministry For People's Welfare; the Ministry of the Interior; the Ministry of Social Affairs; the Ministry of Public Works; the Ministry of Health; the Ministry of Finance; the Ministry of Transportation, the Ministry of Energy and Mineral Resources (ESDM); the Ministry of the Police

and Armed Forces; and nine professional community members. The structure of the DM operational element consists of professionals and specialists, i.e. the Main Secretary, the Deputy for Prevention and Preparedness; the Deputy for Emergency Response, the Deputy for Rehabilitation and Reconstruction, the Deputy for Logistics and Equipment; the Main Inspectorate; and the Technical Operational Unit. BPBD at the provincial and district levels have the same structure as does BNPB at the national level.

In an effort to increase people's awareness of natural hazards and to strengthen DRR efforts, the Tsunami and Disaster Mitigation Research Centre (TDMRC) was established in 2006 at Syiah Kuala University in Banda Aceh. The priorities of the TDMRC are to encourage national and international research on disasters in Indonesia; to develop DRR materials; to conduct training for teachers and develop school curricula; to support local government in designing and implementing DRR strategies and activities; and to develop the Aceh Region as an international disaster laboratory for researchers to conduct disaster research (TDMRC, 2008). The GOI has also supported the establishment of centres for disaster management study in other universities, such as the University of Gadjah Mada (UGM) in Yogyakarta, the Bandung Institute of Technology (ITB) and the Sepuluh November Institute of Technology (ITS).

In November 2008, a National Platform for DRR was established to expand the cooperation among the various sectors involved in disaster management (BNPB, 2006; US-IOTWS, 2007c). The National Platform consists of stakeholders from government, the private sector, academia, national NGOs, the media, and international organisations. To-date, six out of 33 provinces have established provincial disaster management agencies (BPBD) (GFDRR, 2009). In those provinces that have not yet created a BPBD, the responsibility for DRR planning lies with the institutions that have functions relevant for DRM.

Establishment of an EWS for Indonesia

The devastating impacts of the 2004 Tsunami on Banda Aceh indicated the tremendous scale of a tsunami disaster on Indonesia. Before this event, it had not been realised that a tsunami was capable of causing such large-scale devastation and far-reaching impacts.

In 2003, the Badan Meteorologi dan Geofisika (Meteorology and Geophysics Agency. BMG) invited local governments to discuss the potential impacts of tsunamis. The International Tsunami Information Centre (ITIC), together with Dutch and Japanese experts were part of the discussions. The outcome of this meeting

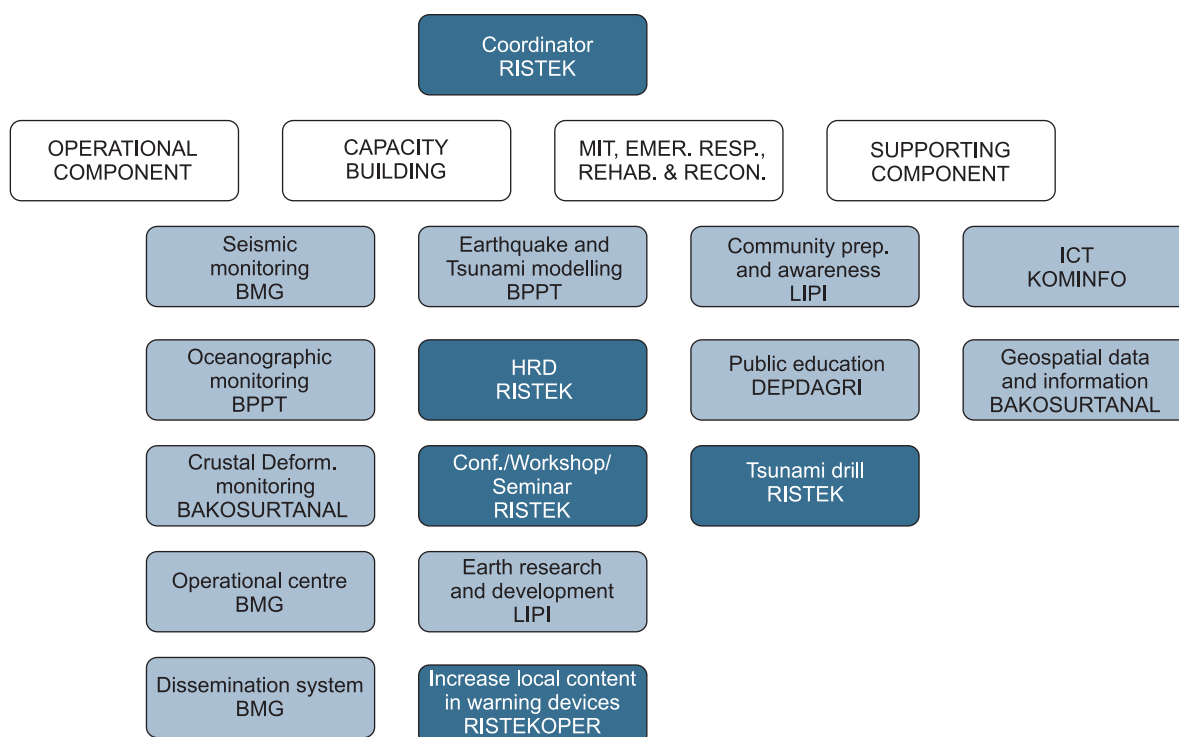


Figure 16: Organisational structure of Ina-TEWS

was a set of recommendations to develop an EWS for Indonesia (BMG). In 2004, arrangements were made to start setting up an EWS but the commitment from local governments was limited. Only after the 2004 tsunami, were people more motivated and bought into the idea of a national EWS Meteorology, Climatology and Geophysics Agency (BMKG). The HFA was taken as the policy basis for establishing the system and this represents an important paradigm shift from disaster response to preparedness and prevention (BMG, Andalas Uni). Prior to the new law, disaster management was generally ad-hoc, sectoral and uncoordinated (Andalas Uni, PMI Padang).

In January 2005, a Tsunami Aid Summit was held in Jakarta. This special ASEAN leaders' meeting issued a declaration on action to strengthen emergency relief, rehabilitation, reconstruction and prevention in the aftermath of earthquake and tsunami disasters. The Governments of Germany, China, the USA and Japan committed to co-finance the system. The GOI and a team of international, regional and national stakeholders, decided to establish the Indonesian Tsunami Early Warning System (Ina-TEWS). Activities started in late 2005 with a 4 - 5 year budget for the development of an EWS (BMG). Because of the threat of locally generated tsunamis, a key aim was to develop an EWS able to

provide the information needed to make the decision to evacuate within five minutes of the earthquake (BMG).

In 2006, the Decree of the Coordinating Minister For People's Welfare of the Republic of Indonesia in the capacity of the Executive Director for National Coordinating Agency For Disaster Management (Bakornas PB) Number: 21/Kep/Menko/Kesra/Ix/2006 formally appointed a government institution as the focal point for early warning and established a tsunami EWS development team.

With the State Ministry of Research and Technology (RISTEK) as coordinator, Ina-TEWS is being developed as a collaborative effort between 20 different government institutions (UNDP, 2009) (figure 16). Ina-TEWS is a comprehensive system encompassing a technologically intensive mechanism for data collection and a set of activities that cover mitigation, preparedness, dissemination and response, and capacity building in accordance with the SOPs for Tsunami Warning and Response. The concept of Ina-TEWS is described in the 'Grand Scenario' which consists of earthquake and oceanographic monitoring, tsunami modelling, crustal deformation monitoring, information and communication technology, community preparedness and capacity building (JTIC, 2009).

For earthquakes and tsunamis, the Meteorology, Climatology and Geophysics Agency (BMKG), formerly the Meteorology and Geophysics Agency (BMG) hosts a national Tsunami Warning Centre and ten sub-national warning centres throughout the country. BMG in cooperation with donor countries has so far installed 148 of the planned 160 seismic sensors, 49 of 60 Global Positioning Systems (GPS), 57 of 80 tide gauges, and 11 of 23 DART-OBU buoys (Report from BMKG during the 5th coordination meeting of June 2009).

The German Government supports the implementation of a tsunami EWS in Indonesia through the GITEWS project with financing from the German Ministry of Education and Research (BMBF). GITEWS was established in 2005 through a joint declaration on the cooperation concerning the realisation of a tsunami EWS between RISTEK and BMBF.

The German contribution to the earthquake and tsunami detection system for Indonesia supports a network of seismological stations and marine measurement units. The warning concept, developed under the guidance of the Geophysical Research Centre Potsdam (GFZ) and in cooperation with national and international partners, aims to significantly reduce warning time by using real-time data transfer, predetermined flooding scenarios in coastal regions and direct warning reports (GTZ IS, 2008).

Box 5: Komunitas Siaga Tsunami (Tsunami Prepared Communities)

KOGAMI is an Indonesian NGO established in July 2005 with the objective to reduce the loss of life resulting from earthquakes and tsunamis, and to improve the planning and response. KOGAMI's role is to facilitate the supply of community needs; to act as a catalyst for the government to produce and implement policy and regulation; and as a mediator to integrate community needs and government planning. KOGAMI's activities are aimed particularly at schools, the construction sector, and the public transport sector to improve decision-making during an emergency. Activities include the design and development of SOPs for emergency response in collaboration with the responsible government authorities, the design and development of local action plans; capacity building of government authorities; and capacity building in communities through school education programmes, CBDRM and evacuation drills (Dewi, 2008).

Ina-TEWS consists of earthquake and sea-level monitoring, and the utilisation of a tsunami simulation database (Sukamdo and Warsono, 2008). The different components of the system come together in the Early Warning and Mitigation System (EWMS). EWMS supports an end-to-end chain of preparedness and response activities from the continuous tracking of multiple sensor data events to the dissemination of tsunami warnings, as well as the mapping of a post-disaster situation. Here the data from the sensor systems are received and analysed based on simulations and hazard and risk maps of the coastlines; assessments can be made of whether a tsunami has been generated, where and when it is expected to make landfall and at what height. This information is delivered to governmental institutions, local disaster management entities, action forces and the media in order to warn at-risk areas and initiate evacuation measures (GITEWS, 2009).

In addition to the technical components of the EWS, GTZ IS undertakes capacity building in the area of disaster management for decision makers, experts and the general public at risk. Capacity building activities include training and research, institutional development and community preparedness in three pilot areas: Padang, Jawa, and Bali. GTZ IS also undertakes baseline studies, identifies best practices, and documents lessons learned (GTZ IS, 2008). Awareness raising activities are undertaken in collaboration with LIPI, UNESCO, KOGAMI (see Box 5), the Indonesian Red Cross (PMI), and DREAM-UPN.

The different components of the TEWS are integrated in the National Tsunami Warning Centre (NTWC). A Decision Support System (DSS) is currently being developed at the national level. The DSS is used by the officer on duty to analyse the earthquake information and observations recorded by buoys, tide gauges and the GPS. If these data indicate that a tsunami has been generated, predetermined scenario simulations will be used to estimate the geographical location, timing, and magnitude of the tsunami and to issue a timely warning to the people in danger (GITEWS, 2009; BMKG, 2008). The system requires information input from three agencies: BMKG (seismic), Badan Pengkajian dan Penerapan Teknologi (BPPT) (tide), and Badan Koordinasi Survey dan Pemetaan Nasional (Bakosurtanal) (crustal deformation) (Wisnu, pers. comm., 2008). BMG received a prototype of the DSS developed by GITEWS in 2008 and are currently testing the system. GTZ IS (Hoppe, pers. comm., 2008) expects that the system will be fully functional by mid 2009 and that the system will be able to provide differentiated warnings.

In November 2008, Ina-TEWS was officially inaugurated by the President in Jakarta, and in the same month, RISTEK hosted the International Conference on Tsunami Warning: Towards Safer Coastal Communities in Bali. The system is expected to be fully operational by 2010 (UNDP, 2009). BMKG has announced its intention to serve as Regional Watch Provider for the coordinated regional warning system for the Indian Ocean Region (UNDP, 2009).

Remaining Challenges and Future Sustainability of the Indonesian EWS

The complex institutional structure for EWS has been described as both a strength and a weakness (e.g., US-IOTWS (2007c). According to US-IOTWS (2007c), meaningful coordination of EWS is a challenge because the disaster management activities of the different institutions are funded by different ministries independent of BAKORNAS PB.

A major challenge for the GOI has been the transition from a centralised government system to a decentralised community-based system, and the resulting consequences for DRR. Many of the sub-national government authorities are not familiar with the concept of DRR and are of the opinion that DRR is the responsibility of the central government. The GOI is striving to design institutions for DRR that are compatible with changes in government systems, as well as the vastness of the country, the variety of hazards, and the challenges in accessing disaster stricken areas (BNPB, 2005).

According to UNDP (2009), Indonesia has made considerable progress in encouraging the participation of NGOs and CBOs in DRR and EWS. However, the challenge has been to coordinate the activities of the various government and civil society actors. A considerable number of international, national and local NGOs are engaged in preparedness, response and recovery activities (table 2). Several disaster management platforms exist that aim to coordinate the activities of the different actors but there is a need to further strengthen the role of civil society (UNDP, 2009) and to establish regulations to govern and standardise their activities (BNPB, 2005).

The implications of the new Disaster Management Law for the implementation at the sub-national levels are still unclear to some stakeholders. Responsibilities and institutional arrangements for an end-to-end EWS, in particular, a clear delineation of the role of BMKG with respect to the generation of scientifically based warnings, and its interface with BNPB, LIPI, universities and local government institutions, in relation to their responsibilities for dissemination and preparedness, remains unclear

(e.g. ARC, TDMRC, US-IOTWS, 2007c). Also, the same level of detail as that for other hazards has not been determined. This gap results in overlaps in EWS coverage and confusion over roles and responsibilities (UNDP, 2009). More work is needed to build consensus and to ensure that new regulations are disseminated and implemented by the respective institutions, and observed by the public (GFDRR, 2009).

While at the national level the policy framework and institutional structure for disaster management are now in place, few provinces and district governments have to date developed disaster management bodies and plans. West Sumatra was the first province to prepare a plan; completing 5-year plan in November 2008 (RPB, 2008). This plan lays out the roles and responsibilities of all actors for the effective coordination of activities. A disaster management body will be established in 2009. The local law for disaster management in Padang city was ratified in 2008, and a local action plan for disaster management for 2005 - 2015 is in place (KOGAMI). In Banda Aceh a draft disaster management plan (Provincial Government of NAD and UNDP, 2008) has been developed but the new disaster management law has not yet been implemented.

According to GTZ-IS (Spahn, pers. comm., 2009), there is currently a gap in the warning chain because the National Tsunami Warning Centre (NTWC) does not have the mandate to make the decision to evacuate. This mandate lies with local authorities (governor, head of district/mayor), but they do not have the capacity to establish and maintain 24/7 emergency operation centres (PUSDALOPS) because of the lack of motivated and skilled staff, and of financial resources. While the political decision of who has the authority to make the decision to evacuate is unresolved, lives remain at risk.

LIPI and UNESCO focus on community preparedness and education. They have conducted five national drills and several local drills since 2005. These drills have highlighted important challenges in decision-making and evacuation procedures. The report also indicates that scientific studies provide different findings, and that it is unclear which information should be used.

Standard Operating Procedures (SOPs) for the reduction of tsunami hazards are crucially important and an inherent part of the development of a tsunami EWS at the national, regional and local levels. Throughout 2006 and 2007, BNPB and several international organisations held a series of four workshops in collaboration with other national agencies responsible for disaster management activities in Indonesia for Capacity Building for Development of Local SOPs for Tsunami Warning and

Response. The participants carried out some exercises on developing SOP drafts that could be used as the base for establishing actual SOPs. These SOPs consider the dynamic nature of tsunamis and the cultures of the vulnerable communities vulnerable in order to build tsunami-prepared communities. In addition efficiency is stressed in that no overlapping roles and responsibilities occur (JTIC, 2009). In order to raise hazard awareness and preparedness, simulation exercises, training on capacity building and contingency planning for all levels have been conducted. Local government agencies have been encouraged to provide contingency budgets to deal with unpredictable disasters.

In terms of risk knowledge, few systematic risk assessments have been conducted and there is a lack of data, such as hazard maps, crucial for the DSS. Currently only seismic data are available, the other components of the DSS (tide gauges, GPS, buoys) are not yet functional. Because of the lack of this information it is currently very difficult to make informed decisions on EW and evacuation.

Table 8: Resilience elements and desired outcomes (US-IOTWS, 2007d)

A	Governance: Leadership, legal framework, and institutions provide enabling conditions for resilience through community involvement with government.
B	Society and Economy: Communities are engaged in diverse and environmentally sustainable livelihoods resistant to hazards.
C	Coastal Resource Management: Active management of coastal resources sustains environmental services and livelihoods and reduces risks from coastal hazards.
D	Land Use and Structural Design: Effective land use and structural design that complement environmental, economic, and community goals and reduce risks from hazards.
E	Risk Knowledge: Leadership and community members are aware of hazards and risk information is utilized when making decisions.
F	Warning and Evacuation: Community is capable of receiving notifications and alerts of coastal hazards, warning at-risk populations, and individuals acting on the alert.
G	Emergency Response: Mechanisms and networks are established and maintained to respond quickly to coastal disasters and address emergency needs at the community level.
H	Disaster Recovery: Plans are in place prior to hazard events that accelerate disaster recovery, engage communities in the recovery process, and minimize negative environmental, social, and economic impacts.

Table 9: Summary of evidence organised according to selected resilience elements from the CCR framework and the three dimensions of EWS policy/guidance

Resilience element	Normative challenges (associated with desirable nature and level of resilience; benchmarking)	Cognitive challenges (associated with ways to rate current level of resilience against the desired and create plans for action)	Procedural challenges (means and instruments to implement actions to improve the resilience towards the benchmark)
Governance: Leadership, legal framework, and institutions provide enabling conditions for resilience through community involvement with government	EWS development can have bearing on and can be affected by socio-economic factors and trajectories of social change in society and communities	Sectoral fragmentation of sub-national DRM planning undermines integrating frameworks and collective actions Lack of mechanisms for facilitating exchange of diverging stakeholder perspectives lead to duplication of efforts and lack of integration	Methodological polarisation between top-down government approach to provide early warning technology and bottom-up NGO approach that focuses on community-based disaster preparedness Sub-national platforms for dialogue between government, NGOs and village level organisations play a crucial role in formalising innovation and implementing policies and guidance Lack of mechanism for feeding back CBDRM lessons learned to the formulation of policy and guidance
Risk Knowledge: Leadership and community members are aware of hazards and risk information is utilised when making decisions.	The norms of stakeholder participation in generating risk knowledge are contested Low trust in EWS providers undermines the confidence in risk knowledge	The prevailing political economy of knowledge in EWS development disqualifies competencies of many stakeholders CBDRM guidance/policy promotes knowledge prescriptive and expert based approaches	Risk knowledge for CBDRM is approached as a matter of public education and awareness programmes EWS introduce artefacts as systems of symbols that have to be internalised and/or constructed by users In practice, norms of stakeholder participation conflicts with the knowledge prescriptive education programme
Warning and Evacuation: Community is capable of receiving notifications and alerts of coastal hazards, warning at-risk populations, and individuals acting on the alert.	De facto priorities of national and sub-national decision makers conflict with stated goals of the regional EWS	Decentralisation implies additional roles and responsibilities for provincial and district government authorities with limited or no additional financial and human resources Tsunami EWS dominates and multi-hazard approach is rarely integrated	Despite considerable international funds for the development of national EWS in the short term there is a lack of sub-national funds available Reliance on volunteerism and concerns over the long-term sustainability of newly created government institutions, such as research facilities and operational emergency centres.

4 FINDINGS FROM PARTICIPATORY ASSESSMENT

The above review of the development of the IOTWS and national EWS in Thailand, Sri Lanka and Indonesia indicates that there has been significant investment in two of the three interrelated stages of the early warning process, namely evaluation/forecasting (the scientific and technical dimension) and warning/dissemination (the institutional and political dimension), whereas little attention has been paid to the response (the human dimensions of risk perception and decision-making) (Smith, 2005; see also Hamza, 2006). As described in the introduction, the point of departure for this project was the widespread sense of a lack of implementation on the ‘last mile’ and the mainstreaming of DRR as promoted under the HFA amongst policy makers and practitioners at international and regional levels. In the following section we highlight some of the issues contributing to this ‘lack of implementation’, as viewed through the eyes of practitioners involved in early warning initiatives at national and sub-national levels.

4.1 SYNTHESIS OF INSIGHTS FROM PARTICIPATORY STAKEHOLDER ASSESSMENTS IN THAILAND, SRI LANKA AND INDONESIA

The CCR framework was applied to synthesise the participatory assessment insights (US-IOTWS, 2007d). The framework comprises eight elements essential for CCR (table 8). These elements of resilience incorporate long-term planning and implementation such as society and economy, coastal management, land use and structural design. Hazard event-oriented resilience elements focus on contingency planning and preparedness for warning and evacuation, emergency response, and disaster recovery. Governance as a resilience element provides the enabling framework for resilience in all other elements. Risk knowledge is a cross-cutting requirement within each resilience element (US-IOTWS, 2007d).

Each resilience element is assessed with reference to a benchmark representing the desired conditions against which the resilience status of a coastal community is evaluated (table 8) (US-IOTWS, 2007d, p. 3-4). The resilience of the community is evaluated by using selected rating systems to rank the assessment results against these benchmarks, to position the current situation of the community, and to suggest plans and means for action.

When investigating policy and guidance for EWS development as a process in which knowledge is jointly constructed by the stakeholders involved, three dimensions can be discerned: the cognitive, normative and the procedural (SLIM, 2004). These are expressed in the language of the CCR framework as follows (figure 17):

- Normative dimension: The identification of the resilience benchmark, through an implicit theory of social change, to represent the desirable level and nature of resilience for each element.
- Cognitive dimension: The definition of ways to rate current levels of resilience against the desired and to create plans for action.
- Procedural dimension: The proposal and application of means and instruments to move from the current level of resilience towards that desired.

In this section, we discuss the evidence from the stakeholder consultations, substantiated by secondary data, in terms of the normative, cognitive and procedural challenges associated with EWS implementation. Three selected CCR elements and benchmarks are used as points of departure for this discussion. Each section below therefore starts with a discussion of the normative challenges associated with the often very

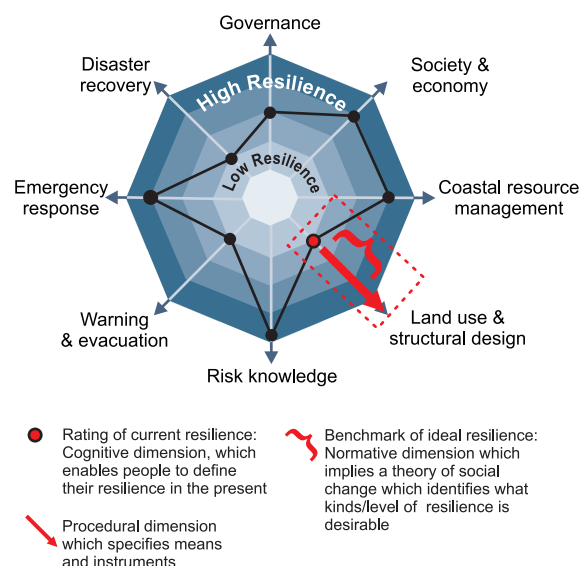


Figure 17: The role of normative, cognitive and procedural dimensions of EWS policy and guidance, exemplified by the CCR framework (adapted from US-IOTWS, 2007d)

diverse views on what, for each stakeholder, comprise desirable qualities of resilience. The purpose is to illustrate the current challenges in building community resilience that constrain the joint construction of EWS policy/guidance by the stakeholders involved.

Governance

Normative: Trajectories of social change

Disasters can affect everyone and are in the HFA assumed to be ‘everybody’s business’, uniting stakeholders irrespective of the fact that they may have other diverging interests. However, EWS plans and actions can have bearing on, and be affected by longer trajectories of social change in society and communities. Moreover, the EWS implementation after the 2004 tsunami takes place in a contested legal environment. In Banda Aceh, Indonesia, the peace process and the tremendous scale of reconstruction which shapes the understanding of EWS, has also led to a decimation of government capacity arising from losses caused by the tsunami as well as those caused by the conflict. In Sri Lanka, the coastal buffer zone policy has led to conflict and increasing disparities between social groups. Communities that had already been disadvantaged by this policy were later expected to participate in EWS development (Ingram *et al.*, 2006). In Banda Aceh, a similarly motivated coastal zone policy, the so-called ‘blue zone’, was left unenforced due to resistance from fishing communities and the absence of alternative livelihood support initiatives. High disaster impacts in Asia are frequently attributed to ineffective measures to counter increasing vulnerabilities due to population growth, poorly planned urbanisation and other socio-economic factors. For instance, in Krabi, private investors increasingly purchase land for development and form alliances with influential people in villages and Tambon, which in many cases push the poorer inhabitants to more exposed areas. Labelling disasters as ‘natural’ can be perceived as placing the causes outside the realm of society or those responsible for warning systems and addressing vulnerabilities. For this reason, initiatives such as the regional Duryog Nivaran network have emerged that promote an alternative perspective which emphasises solutions that change the relationships and structures in society.

Due to the potential power associated with EWS, i.e. in mobilising large numbers of citizens, the sharing of information is subject to political battles at various levels of government and across national borders. In Padang, Indonesia, both the provincial and the district government have the responsibility for disaster management and thus development workers experience tension between the authorities due to the ambiguity in

their respective mandates. In Sri Lanka, government staff described similar challenges of power-sharing between government departments. In Krabi Province, provincial government officials raised the concern that surveys organised by the DDPM after the 7 July 2008 Drill were sent directly to the national government and were not shared with the provincial departments. As argued by Moench (2005) the legitimacy of authority can be a dilemma when agencies fight for seizing mandates. Some therefore argue that current policies relating to EWS support existing power structures but increase social vulnerability when DRM is not integrated into wider development policies (e.g. Heijmans and Victoria, 2001). Indeed, traditional rhetoric in policy mainstreaming promotes a rather mechanistic conception of ‘up-scaling of good practices’. This ignores the fact that negotiation of what constitutes good practice can be a vehicle for addressing normative aspects of EWS.

Cognitive: Sectoral fragmentation and duplication of efforts

There is a continuing cognitive challenge in integrating CBDRM with sectoral policies, and in developing SOPs at sub-national levels (USAID, 2007). Linking coastal management and disaster preparedness requires the development of new mental models and shared theoretical frameworks for action with new roles and responsibilities, e.g. to ensure that resettlement does not occur in areas highly exposed to hazards or in areas important for food production. In many cases, CBDRM practitioners have to frame and repackage EWS in innovative ways to address other priorities such as livelihoods improvement and overall development planning, particularly when working with large numbers of partners. In Krabi Province, this comprises alignment with the restoration and expansion of mangrove ecosystems to increase food security and reduce hazard impacts. In Sri Lanka, there is the ambition of using the 2010 revision of the national coastal zone management plan to enable DRM activities to build on existing management structures and staff resources at the lowest levels of government through integrated coastal zone management (ICZM) and Special Area Management (SAM) planning.

A lack of appreciation of the divergences in what actors consider desirable benchmarks of institutional coordination and leadership results in duplication of efforts and lack of capacities and progress. However, parallel efforts can also be a manifestation of attempts to complement or improve existing initiatives. One example is the Hazinfo project (Evaluating Last Mile Hazard Information Dissemination) led by LIRNE

Asia in Sri Lanka (LIRNE Asia, 2008). Some even claim that what might be perceived as duplication of efforts can also reflect a distribution of labour amongst government and non-governmental actors (Shaw, 2006). Several NGOs in Sri Lanka perceived their DRM and EWS projects as contributions to government technical instalments, with what the NGOs could do best, namely participatory expertise employed in the communities. Evidence does suggest that EWS tend to evolve in a piecemeal fashion (Davis *et al.*, undated), and that they often ride on the back of political and financial windows of opportunity, aligned with past and ongoing initiatives by various stakeholders. For instance, in Sri Lanka, the DMACT had been in the pipeline even before the 2004 tsunami, but was only officially launched in 2005. Similarly, in Indonesia, the BMG described how it had attempted to convene support for developing a national EWS in 2003, but only after the 2004 tsunami did local government express full commitment. Instead of single administrative units and monolithic decision making, complementary redundancy, which is manifest in several of the region's countries (Rego, 2001), has proven beneficial in many cases (Bueno *et al.*, undated; Kea *et al.*, 2005). As a result, some practitioners question the value of overly homogenised SOPs and instead highlight the importance of 'linking' mechanisms (Kulphaichitra, 2007)

Procedural: Polarised approaches and a lack of feedback from practice

Normative divergence and cognitive fragmentation can also trigger polarisations at the procedural level. This is manifest most strongly in the tension between what is frequently described as a 'top-down government approach' to provide early warning technology ('hardware') and a 'bottom-up NGO approach' that focuses on community-based disaster preparedness ('software'). This reflects an ongoing debate on the role, control and ownership between state and non-state actors, nested within ongoing decentralisation and governance reforms. In many cases, the private sector also plays an important role, e.g. in the provision of risk data and the dissemination of warnings through the mass media. Some NGOs were seen as being 'over-participatory', focusing too strongly on engagement with community organisations which lack legal status, and failing to collaborate with the appropriate government agencies (see also Lukitasari, 2006). In turn, governments are faced with the considerable challenge of integrating the diverse activities with the EWS developed by different NGOs. Many government agencies suffer from a high turnover of project staff and attribute this to the attraction of the more lucrative posts in foreign NGOs that remain active in the country

after contributing to the post-tsunami recovery efforts. A competitive environment and a need to maximise spheres of influence can be further exacerbated when the media promote images of conflicts between state and non-state actors through sensational reporting (Rakshit, 2007). Furthermore, in the aftermath of the tsunami, competition for donor support has undermined the previously well-functioning relationships between many NGOs in Krabi Province. In Indonesia, concerns were expressed on how tendencies to allocate donor funding to high-status programmes can create disconnections with the needs of the ultimate clients of the EWS. Standard assessment approaches have been criticised, because they may fail to measure the initial level of preparedness of the targeted community and thus might create a false sense of preparedness (JTIC, 2009).

Sub-national platforms for dialogue between government, NGOs and CBOs play a crucial role in enabling stakeholders to build operational relationships with communities of practice with other normative and cognitive standpoints. Organisations often invest considerable efforts in building relationships with multiple actors at all levels (see also Bueno *et al.*, 2007). In Indonesia, more than 16 organisations are jointly responsible for the national EWS (Ina-TEWS), and in Padang, the NGO network, Palanta Siaga Bencana (Disaster Preparedness Network) consists of 20 NGOs. In Krabi Province (Thailand) a network was established between Raks Thai, SAN, SDF, the DDPM, and the Thai Red Cross. Many organisations prefer, if resources are available, to draw on support from such platforms to develop their own guidelines, manuals and strategies, which implement policy goals in context. In Krabi, this included the adaptation of the DDPM guidelines into an improved manual for local stakeholders. When joint reflection upon experience can be linked to joint activities this can be a major mechanism for improving CBDRM activities and sharing recommendations. In Sri Lanka, collaborative projects between the World Conservation Union (IUCN) and the CCD have led to important lessons for coastal zone management policy that most likely will be integrated into the next national coastal zone management plan in 2010. In Krabi, experiences exist of how NGOs and provincial governments can secure funds from the Ministry of the Interior upon the sharing of success stories for up-scaling and replication. However, the timing of such sharing is important and can lead NGO project managers to delay communication with provincial and national governments until, as expressed by one project coordinator, a 'substantial package' is ready to present to government. Naturally, the legitimacy of such

partnerships and transparency of funding windows is crucial.

Despite the growth of sub-national stakeholder networks, there are few adaptive mechanisms that enable feedback of lessons learned for CBDRM from practice to policy. Large numbers of national and international workshops and conferences have been held – in Sri Lanka, common references were made to more than six national workshops on EWS, hosted by the Disaster Management Centre and international partners. Yet, concern was shared that these events focus unduly on high level policy goals, concepts and/or theories. NGOs were concerned that government executives rarely stay on after their own presentations to learn from the ensuing discussions or commit to representing their institutions in stakeholder meetings. Important implementation lessons thus tend to be communicated only to staff working at lower government levels and who rarely have the mandate or the power to respond to the needs and so to induce positive change within their organisations. Another challenge is the disconnection between national and sub-national stakeholders and expatriate staff, many of whom due to the short duration of their posting have limited knowledge of the local situation (see also ALNAP, 2003). This may be further aggravated by the dependency of governments on external consultants due to a lack of the internal capacities to conduct risk assessments. In general, provincial government officials highlighted the fact that they rarely found international and national meetings conducive to sharing actual concerns and critique of the national EWS and international initiatives. These concerns motivate criticisms such as that of one government executive who stated that ‘decisions are made in air-conditioned rooms’ and that ‘the form and procedures in dialogues connected to EWS development could benefit from more critical scrutiny by practitioners’. Both government and civil society CBDRM initiatives are hindered by the lack of capacity building material in national languages. This prevents access to essential information and experience at the local government and community practitioner levels where English-language skills are limited. But translation is only a first step. The resources must also be shaped and reviewed by national and sub-national stakeholders, and adapted into appropriate training material and tools.

Risk Knowledge

Normative: Contested mechanisms for stakeholder participation and distrust in EWS and providers of risk information

The challenges associated with developing effective DRM has in recent years led to an increasing emphasis on participatory planning in humanitarian work with mainstreaming of community participation into international DRR policy and humanitarian standards (ALNAP, 2003; de Ville de Goyet and Moriniere, 2006). The Indonesian Disaster Management Law No 24 of 2007 provides the legal basis for the participation of government, NGOs, the private sector, and communities. Many assessments, however, find that there is a long way to go. The World Bank concluded in a self-assessment that participation of stakeholders and communities in DRM planning continues to be rare (IEG, 2006).

This is partly due to the fact that goals of community participation reflect norms regarding what constitutes ‘good governance’ and these may not be shared by decision makers (see also Tingsanchali, 2005). Many actors in the region remain unconvinced of the value of participatory methods, and some development professionals are of the opinion that a military approach to early warning is more efficient than a participatory approach. One representative of a Sri Lankan NGO observed that ‘there is a huge gap between the military man and the community, and this undermines the efficacy of the EWS’. In addition, many DRR professionals find it difficult to give up their integrity as ‘experts’ when the norms of ‘people-centred’ early warning have not yet been translated into institutional changes in research, agency and government organisations. The promotion of prescriptive knowledge regarding what constitutes organised national SOPs can contribute to the positive sentiments towards military leaderships, when, as in Indonesia, expatriate development workers experience that ‘Indonesian culture is not conducive to establish standardised procedures’.

The use of risk information and the sharing of knowledge depend to a large degree on trust in the credibility of the information provider as well as the many actors in the ‘trust chain’ of an EWS. This highlights the importance of shared ownership in the EWS and the cultural and governance context in which it is embedded. This is critical as EWS development in the three countries exposes problems of trust between community-based organisations such as DRM Committees and village leaders, and the higher levels of government. In Krabi Province, many villagers consider the sirens of warning towers unreliable, and voice concerns over the positioning and aerial coverage of some towers, and the lack of communication equipment to warn fishermen at sea. Incidents of accidental triggering of the sirens and false alarms have led to panic evacuations resulting

in car accidents and lawsuits against the government. Although there is daily testing of the system by sending a signal to the towers via satellite, with repairmen being dispatched within 24 hours to repair any faulty towers (USAID and DTRAC, 2007), the RTG have not made any plans for the regular inspection and maintenance of the towers. Building and maintenance contractors are perceived as not accountable, and there is a lack of information about the maintenance schedule. Consequently, public trust in the system remains low, and citizens and tourists rely on their traditional knowledge and experiences to observe changes in the sea-level (see also Tsunami Aid Watch, 2007; Calgaro et al., 2009; Thomalla et al., 2009b; Pongponrat et al., 2009). It was mentioned that one suggestion to check if the warning towers are working by transmitting audible sounds, e.g. by playing the Thai National Anthem, was not supported by the NDWC because of the costs involved. In July 2009, the DDPM Office in Krabi Province received USD 0.57 million from the Office of the Prime Minister to solve the signal connection problem of 20 dysfunctional warning towers under the budget of the provincial governor. On Phi Phi Island, the existing two towers are incompatible because one was established by the NDWC and the other by the provincial governor, each using different technologies.

In Sri Lanka, NGO staff noted that whilst the government claims to be able to issue official warnings within 40 minutes of an earthquake, recent drills indicate a timeframe of 80 minutes. Some end-users, who find themselves excluded from EWS planning processes, disregard official warnings and rely instead on self-maintained EWS. Guided by traditional knowledge on how to interpret hydro-meteorological changes, they take their own initiatives to warn and evacuate using media such as TV, walkie-talkies and alternative speaker systems (for Krabi see also TAW, 2007). In some cases this requires exceptions from regulatory prohibitions of the use of such technologies by civilians. In some villages the lack of trust in the government is linked to a general suspicion of government agencies because of rumours/evidence of fraud and corruption in post-tsunami compensation payments for lost and damaged items such as boats and fishing gear. The lack of trust between EWS stakeholders is further exacerbated where resource conflicts have created factions amongst local user groups.

These issues are easily forgotten in the negotiation between international donor organisations and national and sub-national decision makers regarding ownership, roles and responsibilities between regional governments, international donor agencies,

and UN agencies. ‘Turf wars’ between international development agencies providing humanitarian and technical assistance, and mismatches between the priorities of aid and development donors and recipients further aggravate such challenges. In fact, the UN/ISDR Platform for the Promotion of Early Warning was launched partly to stimulate donors to adapt to national government opposition to the EWS values promoted by donors (PPEW, 2006).

Cognitive: A prescriptive political economy of knowledge

Policy and guidance widely recognise that EWS require a well-functioning communication system between the organisations comprising the warning chain. Three sets of actors are typically discerned: originators, intermediaries and disseminators or recipients of warning messages (Davis, *et al.*, 1998). The ICG/IOTWS Concept of Operations states that in end-to-end early warning ‘information must flow from one end (detection) to the other (community response) without interruption or ambiguity’ (Elliot, 2006, p. 5). Here the ‘last mile’ is placed in the operational context of the recipients, where effective communication depends on the transfer of information from the national warning centre to the communities. This view of communication is rooted in a certain communication model, which Lackoff and Johnsson (1980) have termed the ‘conduit’ metaphor, i.e. the assumption that communication comprises the ‘conduit’, or transfer, of packages of information between two or more stakeholders.

When the EWS is designed by the same actors tasked with its management in the warning situation, this communication model is often extrapolated from the warning situation to the development situation, notwithstanding the fact that these two situations are quite different. This maintains the distinction between the ‘people with information’ and the ‘people at risk’ (US-IOTWS, 2007e) in the planning and development of EWS, and creates a dominating political economy of knowledge that disqualifies the competencies of many stakeholders. The separation of categories of ‘risk management’ from ‘community participation’ in many DRR and DRM planning models disconnects stakeholder involvement from knowledge generation. This can lead to assumptions of a direct relationship between technical and scientific knowledge, and the capacity to implement EWS policy, which ignores the knowledge of practitioners and communities (see e.g. AIT, 2005). The approach used in the ICG national assessments (international expert teams deploying questionnaire surveys with yes and no answers to predefined categories of questions) can

also disadvantage other stakeholders in entering the process (e.g. IOC and UN/ISDR, 2005). The role of gender is particularly important as women often have less opportunity to participate in disaster risk reduction and preparedness activities, and the realities of women are therefore inadequately represented in the prevailing risk knowledge. Such knowledge is particularly crucial in the many cases when EWS rely predominantly on the adaptation of existing low-tech community alert systems and social networks with neighbouring communities.

In managing risks from coastal hazards, there is a danger of ignoring the risks associated with assumptions about who has the valid knowledge to define these risks. Here, it may be valuable to recall the risk that ‘hazards’ and ‘vulnerability’ are notions evoked in a larger discursive framework employed by experts (us) to make scientific statements about populations (them) that imply a ‘moral obligation’ to save the vulnerable populations through the cure of improved knowledge (Bankoff, 2001). In both Krabi Province and Indonesia, examples were provided where specific initiatives are being taken to integrate indigenous knowledge and practices into disaster risk management planning. However, this can be problematic if the validity of claims comes to depend only on judgements of what comprises ‘intergenerational wisdom’, or ‘indigenouness’, particularly if such judgements are made only by outsiders, e.g. government officials or development workers. Thomalla *et al* (2006) argue that a multi-community dialogue and learning process should be part of integrating disaster risk reduction, climate change adaptation, environmental management and poverty reduction. Such approaches enable communities to take part in designing frameworks for disaster risk reduction that are appropriate to their situation. Going beyond a local scale, this argument could be widened to include disaster risk reduction practitioners in general.

Procedural: Education and awareness raising

Education and awareness raising is a core element of most EWS frameworks (e.g. Perera, undated; CTEC, 2007). A core objective of the HFA is education for disaster preparedness and mitigation. This has been linked to UNESCO’s Education for Sustainable Development (ESD) initiatives and the IFRC is charged with the task of implementing awareness raising and education for national capacities under the ISDR-IOC (IOC *et al.*, 2005). UN/ISDR states that a unanimous view has emerged amongst humanitarian agencies ‘that a better education and awareness of local communities on natural hazards could have contributed to reduce

and mitigate the tragic human losses caused by these events’ (UN/ISDR, 2007b, p. 11). The UN/ISDR global survey provided similar general conclusions in terms of the gaps worldwide (UN/ISDR, 2006a).

However, a logical consequence of prescriptive approaches to risk knowledge is to emphasise a one-way ‘teaching model’ in public education and awareness programmes. One of the most common problem statements we heard from government and NGO representatives across the three case studies was that of a ‘lack of awareness’ amongst communities. It must be recalled that EWS development introduces artefacts as systems of symbols which have to be internalised and/or constructed by users if they are to be meaningful. This includes the interpretation of warning data into categories relevant for the users and choices of locally relevant technologies. The prescription of what is considered relevant risk knowledge means that warning artefacts such as signposts and risk maps may in some cases not be relevant in that particular locality and/or for those particular end-users. In Krabi Province, evacuation routes identified by the national government are based on topographic maps without visual on-site inspection of the characteristics of the villages and their surrounding areas. Because of a lack of consultation with communities, suitable buildings that could be used as shelters, such as temples and schools, were not considered. Not trusting in the safety of a designated evacuation site, the inhabitants of one village evacuated to the neighbouring village during recent drills. In another location, villagers explained that a sign pointing to a safe site had been erected, but that the shelter had never been constructed due to a lack of funds. Another concern was that the signs were only in English. One Village Rescue Team set up additional signs in Thai advising people to evacuate to the local school and mosque. Similarly, the DMACT in Sri Lanka was criticised by a number of NGOs for lacking appreciation of how local factors such as population density and religion can affect the effectiveness of SOPs. In Indonesia, the mechanisms to implement the national policy in shared systems of artefacts are undermined by the absence of DRM bodies and response plans in many provinces and districts. This also constrains the adaptation of Common Alerting Protocols (CAPs), which have been adapted from international partners such as the US-IOTWS.

Because EWS development is a complex and evolving process, the stated goals of an organisation’s principles of participatory planning and implementation may differ somewhat from the daily practice of its field personnel (see also ALNAP, 2003). Examples were made in

Indonesia of how concepts such as ‘participation’ and ‘socialisation’, can be variously interpreted in practice, often as information sharing and awareness raising with stakeholders rather than the creation of joint ownership. Further, capacity building is frequently considered to comprise developing the capacity to implement guidelines handed down in the decision making hierarchy, and not the capacity to engage in decision making per se. This reflects, as observed by one stakeholder, that the discourse of participation also draws on a ‘technical language’ which is not necessarily shared by local decision makers.

Indeed, stakeholder participation often departs from the availability of human resources. For example, in Cuddalore in Tamil Nadu, India, DRM trainers are recruited from government agencies in the district and trained by TOT personnel from a number of institutes in the area (David, undated). De Ville de Goyet and Moriniere (2006) argue that the degree of participation in the design phase of humanitarian action needs to be carefully thought through to match project resources and time lines with the specific needs. Very few documents aimed at EWS development, however, entail critical attention to the degree and nature of stakeholder involvement in the project cycle. In a DRM project cycle used by some organisations in Krabi Province, the evaluation phase is placed immediately before project closure and basic participatory monitoring, and evaluating principles are not incorporated. Where tools for participation and stakeholder involvement are outlined in guidebooks and manuals, processes for participation are rarely considered in the context of early warning. Rather, they are included as more or less direct import from standard textbooks on public participation. While the HFA recognises that indicators for quantifying and measuring progress for DRR must be meaningful and credible to a range of stakeholders, it provides no guidance as to how stakeholder participation might take place in order to develop and agree on context specific indicators (UN/ISDR, 2008).

Warning and Evacuation

Normative: Reconciling EWS and DRM with other priorities

As highlighted in the background reviews, in many countries in the Indian Ocean region, national level disaster preparedness planning has been considerably improved following the 2004 tsunami through new policy frameworks and a restructuring of the roles and responsibilities of different government agencies for DRM and early warning (see also Tsunami Global Lessons Learned Project Steering Committee, 2009). In Sri Lanka, the DMAct changed the legal environment

for DRM, and a restructuring of the government is currently ongoing with more power being transferred to the DMC. But despite the increased importance given to disaster preparedness at the national level, decision makers at provincial, district and village levels have to reconcile the new demands for disaster preparedness placed on them with a range of other interests and priorities. The value sets, willingness and priorities of local administrators therefore to a large degree determine to what extent EWS and DRM policies and strategies are implemented. This is particularly true in decentralised governance systems such as those in Indonesia, where ultimate fiscal and managerial responsibilities lie with the city and district governments.

Despite the need for a cross-sector warning system DRM is frequently, within the public administration, and approached as a separate sector rather than a cross-sectoral activity. There are different perceptions of the role of DRM in relation to other sectors. For example, in Krabi Province, where fisheries and tourism are the two most important economic sectors the provincial government sees the demonstration of DRM activities as important to instil confidence in the tourism sector. In Indonesia, there is the opposite perception; some local government authorities resist the implementation of disaster preparedness activities driven by the national government within their districts because of concerns of the negative image this might shed on tourism destinations. Similarly, in the communities, the value of CBDRM as a tool for community empowerment depends on the interest of local stakeholders to engage in risk reduction activities. In Krabi Province, this varies markedly between, for instance, inhabitants of Ban Nam Khem village which was severely affected by the 2004 tsunami, and those in villages affected to a lesser degree or not at all. In Krabi’s Ban Tha Klong community, the village DRM Committee found a way to develop EWS for sea-based transport that directly improves the safety and effectiveness of income generation through fishery and trade. Sixty of the 84 households depend directly on fishery, and most of the other households are indirectly dependent on fishing through family relationships.

Additional motivations for NGOs and CBOs to undertake CBDRM activities include concerns over the risks faced by communities, a lack of trust in national efforts to develop EWS and to enhance disaster preparedness, and potential co-benefits for natural resource management and livelihoods improvement. However, the integration of DRM in sectoral policies remains a challenge, because the links with coastal

zone management, natural resource management, and livelihoods are currently not well understood by decision makers in sub-national government agencies. Few integrated approaches exist to integrate DRM into community level development planning processes for food security, livelihoods, housing and infrastructure. This lack of coordination contributes to the prevalence of autonomous actions by various organisations and government agencies.

Cognitive: Taking a multi-hazard perspective

There seems to be a consensus amongst policy makers, practitioners and researchers that EWS should address multiple hazards because such systems enable the integration of hazard information sharing in the context of broader societal development by linking preparedness and response to different kinds of hazards, including hydro-meteorological hazards, as well as, for instance, biological and food security hazards (see also Minamiguchi, 2005). The Hyogo Declaration stresses the importance of ‘integrated, multi-hazard, and multi-sectoral approaches’ to build disaster resilience (UN/ISDR, 2005, p. 2) while the G8 Response to the Indian Ocean Disaster pledged that ‘early warning systems should cover as many hazards as possible, not just tsunamis’ (G8, 2005). Recognising that many communities face numerous hazards, the Third International Conference on Early Warning (EWC III, 2006) included a session on multi-hazard approaches highlighting the benefits of multi-hazard EWS as: 1) ‘a multi-hazard system will be triggered more often and hence, processes and links will remain better exercised’, and 2) ‘synergies in the generation of data and knowledge serve multiple purposes and target groups and result in more favourable cost-benefit ratios’.

However, there is little evidence in the countries investigated that the national EWS currently being developed consider any hazards other than tsunamis. The US-IOTWS which includes Thailand and Sri Lanka aimed to apply a multi-hazard approach that simultaneously addressed tsunamis as well as other coastal hazards such as cyclones, sea swells, floods, and earthquakes (US-IOTWS, 2008). However, in the transition workshop the continued support for CCR activities with a multi-hazard focus was identified as a major gap (US-IOTWS, 2008). Ina-TEWS, currently being developed through GI-TEWS, focuses on tsunamis, earthquakes and volcanic hazards (GFZ, undated). Some representatives from government agencies informed us that they aim to build a multi-hazard system in the longer-term but other stakeholders voiced doubt as to whether this will be accomplished.

Because of the diversity of needs and priorities at the local level, it is important to frame proposed interventions for early warning and DRM in contexts that are relevant in addressing local priorities and building partnerships between different actors. Addressing multiple priorities within an integrated framework will also improve the coordination between different actors. This is particularly so when EWS development as a political and social activity has to be bought into by government representatives as well as community leaders. The Thai Red Cross and the Raks Thai Foundation both learned that DRM activities must be planned with local decision makers such as the village headman to ensure response plans and EWS activities are properly sanctioned to get a buy-in from villagers.

While there is considerable potential for integrating DRM in the environmental domain, there are to date few efforts to integrate DRM into development planning processes in order to reduce disaster risks in the recovery process and to improve livelihoods. In Sri Lanka, the IUCN Lanka highlighted the potential to integrate DRM objectives when performing Environmental Impact Assessments. Some actors have started to link DRM with natural resource management. This provides an incentive for communities to engage in DRM and ensures local ownership (see also Sudmeier-Rieux *et al.*, 2006).

Procedural: Creating sustainable mechanisms for DRM funding

Despite the provision of considerable international funds for the development of national EWS in the region, there are many concerns regarding the distribution of these funds for early warning and disaster preparedness activities. In decentralised government structures, national and provincial authorities tend to have little leverage over district and municipal authorities to guide the investment of allocated resources and encourage a greater response in line with the objectives of DRM planning. However, whilst many authorities and non-government actors experience a shortage of funds at sub-national levels, concerns exist that the strict rules governing the use of the significant volume of donations from the international community have led to a large proportion remaining unspent. Some organisations lack the capacity to absorb the large amount of funding they received through donations. Also, some donors are not aware of the budgeting procedures in local government agencies (see also Lukitasari, 2006; ADPC, 2006) and some local government officials are reluctant to provide funds dedicated for CBDRM (Managbanag, 2006).

As a consequence of the lack of resources at the local level, staff capacity and operational capacity for EWS are low and CBDRM relies heavily on volunteerism. The SLRCS for example has 100,000 trained volunteers, many of these are pupils recruited in schools. In some villages in Krabi Province, only those who have acted as volunteers are eligible for village elections. However, despite incentives such as health care, skills training, eligibility for village elections, and improved social status, and the dedication of volunteers, many stakeholders voiced concerns about the longer-term sustainability of disaster preparedness efforts that rely to a large extent on volunteerism because even volunteers require basic financial support for operational logistics such as transport, food, and compensation for the loss of income. In all three countries, the lack of funds to pay, or at least compensate volunteers for their time, is a cause of low staff retention rates. The high turnover of volunteers and the need to continuously recruit and train new people throughout project implementation puts a considerable strain on an organisation's capacities. Frustration over the lack of resources also relates to the inability of committees and volunteers to act and to induce positive change in their communities. Because many of the volunteers have full-time occupations and no compensation is provided for their time, they may not participate in important meetings. This is similar to the Philippines, where limited local level funds for the implementation of national disaster preparedness policies means that village Disaster Coordinating Councils/Committees (DCCs) are essentially 'shell' organisations that are not functional in emergency response (Heijmans and Victoria, 2001).

Other concerns relate to the long-term sustainability of newly created government institutions, such as research facilities and operational emergency centres. Many of these new institutions have been initiated with financial and logistical support from the international community and are still very much at the beginning of a long-term process to build capacity.

Clearly, improved financing mechanisms are important in making disaster risk reduction more effective (e.g. Southasiadisasters.net, 2005). Indeed, innovative ways of addressing DRM financing have recently emerged in the form of micro-credit arrangements. In Krabi Province, the establishment of Revolving Loan Funds provide a major entry point for the Raks Thai Foundation into EWS and DRM projects with community groups. In Sri Lanka, many community groups that are engaged in NGO and government programmes were originally formed to administer economic activities such as micro-credit schemes

or loan funds. In Vietnam, Development Workshop France (DWF) provides short-term affordable loans to reduce household vulnerability by strengthening house construction (Chantry, 2006). In Sri Lanka, LIRNE Asia and Sarvodaya developed a new funding model to ensure the retention of staff. In the IOTWS such community-based micro-financing mechanisms have not received much attention and many of the NGOs supporting such activities play only a minor role in EWS development.

5 CONCLUSIONS AND RECOMMENDATIONS

This report reviews the progress made in strengthening the institutions and policies guiding DRR and EWS development at the international and regional levels, and the progress made in implementing guidance and policies for reducing the vulnerability of coastal communities to tsunamis at the national and sub-national levels focussing on Thailand, Sri Lanka and Indonesia. Since the 2004 tsunami, all three countries, as well as other countries in the region, have made considerable progress in creating an enabling environment for promoting early warning approaches and in facilitating improved governance at national and sub-national levels. The review also indicates that there is an increasing awareness amongst decision makers and practitioners of the importance of addressing the ‘last mile’, which is understood here as the interface between the national EWS and communities at risk. ‘Last mile’ approaches therefore aim to empower vulnerable communities through community-based or community-driven initiatives as part of ‘people-centred’ approaches to EWS development. However, many of the institutional and policy changes are yet to be translated into action or are currently facing considerable implementation challenges.

In the multi-stakeholder participatory assessment, including the detailed case study from Krabi Province in Thailand, we examined why, despite the tremendous efforts to improve tsunami disaster preparedness, the current policy and institutional environment in many cases fails to provide the conditions necessary to implement the ‘last mile’ effectively and to mainstream DRR as promoted under the HFA. The insights gained in this project suggest the main reason is that the critical perspective on the ‘last mile’ espoused in the HFA and other EWS policy and deliberations is not translated into action in the policy implementation process. We identify six areas that relate to governance, risk knowledge, and warning and evacuation that must be addressed in order to strengthen capacities to implement policies aimed at strengthening the community-technology interface of EWS:

1) Policy and guidance needs to be more relevant to different sub-national contexts

Many of the advances have taken place at the national scale. However, in many of the current policies, guidance documents and recommendations for implementing EWS the community linkages are frequently too generic and therefore not directly applicable in many national and/or sub-national

contexts. Also, many guidelines for early warning do not take into account CBDRM and few documents are targeted at field staff. To be useful, such guidance must be linked more closely to implementation processes. For instance, the normative nature of the goal of ‘stakeholder and community participation’ is problematic when it conflicts with existing governance structures, and is perceived as an externally imposed demand. Issues of trust between community-based organisations such as DRM Committees and village leaders, and the higher levels of government also need to be considered in EWS development. Hence the translation and implementation of national policy into sub-national initiatives must aim to build shared and mutual understanding, and trust among the many actors in the EWS. Both government and civil society CBDRM initiatives are hindered by the lack of capacity building material in national languages. This prevents access to essential information and experience at the local government and community practitioner levels where English language skills are limited. Furthermore, it is important to note that translation is only a first step. The resources must be shaped and reviewed by national and sub-national stakeholders, and adapted into appropriate training material and tools (including for those for the most vulnerable).

2) Practitioners must be better supported to navigate and reconcile multiple needs and priorities

Many practitioners, both government and NGO actors, tend to operate in contexts shaped by multiple stakeholder agendas and have to learn to navigate the diverse needs and priorities. This is particularly true for decision makers at provincial, district and village levels, whose political will, motivation and agency is crucial in supporting EWS development at the local level. Recent warning exercises and evacuation drills indicate that many people prioritise other needs relating to their livelihoods and their social and economic wellbeing. Policy and guidance must therefore support practitioners in reconciling these needs and priorities by ensuring co-benefits for communities. This can be achieved by framing proposed initiatives in ways that are relevant in addressing local priorities, for example by linking DRR and EWS initiatives with natural resource management, livelihoods improvement and wider development concerns. It should also address the challenges associated with the conflicts of interests amongst government officials at district levels in the decentralised management of DRM resource allocation.

EWS development is a political and social process, and partnerships and networks between different actors are important mechanisms to enable participation and joint ownership.

3) Cognitive and normative differences amongst stakeholders need to be acknowledged and considered

Policy recommendations and guidance tend to focus predominantly on the procedural dimension of EWS development. Little attention is paid to addressing the cognitive and normative challenges in positioning EWS in the wider trajectories of social change in societies and communities at risk. The participation of communities and other stakeholders of EWS is generally perceived as important but little attention is paid to the degree and nature of this involvement. The sectoral and fragmented character of sub-national DRR planning is an obstacle to the ability of societies to build an understanding of current and evolving vulnerabilities to different hazards, and to develop agreed targets for resilience building. Because EWS development is often scientifically motivated and the cognitive dimension is the domain of researchers and ‘experts’, a prescriptive approach to risk knowledge dominates. Assumptions of who has valid knowledge has led to a dominating political economy of knowledge in which the distinction between the ‘people with information’ and the ‘people at risk’ excludes practitioners and communities at risk from defining and negotiating the normative and cognitive dimensions of vulnerability and resilience.

4) Platforms for knowledge sharing and collective negotiation of targets need to be improved

Platforms for knowledge sharing need to be improved to enable stakeholders to negotiate collectively and agree on joint targets, to improve the integration of early warning with other priorities such as livelihoods improvement, natural resource management, and community development, and to provide opportunities for critical reflection on ‘on-the-ground’ experiences. Such mechanisms would require that local actors, such as district and municipal government representatives, community leaders and NGO field staff become more actively involved in developing policy and guidance. Currently, although the lessons learned at the local level might be considered in local government policy and procedures they are rarely integrated into national level policy. Yet, enabling practitioners to help shape policy and guidance is crucial if the underlying systemic causes of hazard vulnerability are to be addressed, irrespective of short-term political agendas. This could consider the

need for sustainable funding mechanisms which are focused on relevant budgeting procedures, thus making stakeholder participation relevant by connecting it to a real influence on budgeting decisions. This would require improving the transparency, accountability and relevance of DRR and EWS with international donor organisations looking beyond internal priorities and competition with other agencies and responding to the national and sub-national issues of ownership, trust, roles and responsibilities.

6 PROJECT OUTCOMES AND OUTPUTS

Links to policy and capacity building processes

Institutional learning within the Raks Thai Foundation (Raks Thai)

The participatory stakeholder assessment in Thailand, which was co-organised by Raks Thai in July 2008, made a significant contribution to Raks Thai's momentum and programmatic vision in the field of DRR and the overall strengthening of community resilience. The field report (Thomalla and Larsen, 2008) was translated into Thai, and the concrete and forthright findings informed the overall internal reflection process undertaken by Raks Thai in 2009 to review its complex post-tsunami programme in the affected provinces. The report also served as important background information for the external end-of-project evaluation undertaken in 2008. The report findings (and the participation in the Online Dialogue for Early Warning) have also been used to inform the design of multiple projects submitted to public and private donors, and to guide broader programme development in Southern Thailand. Most recently, a successful proposal to the UNESCAP Multi-donor Voluntary Trust Fund on Tsunami Early Warning Arrangements in the Indian Ocean and Southeast Asia on 'Strengthening Community-based Disaster Risk Management in Thailand' was based on the study findings for the situational analysis in the Thailand component of the project.

Joint SEI/Raks Thai Workshops on Policy and Institutional Framework for DRM and EWS in Krabi province, Thailand

Between March and July 2009, SEI and Raks Thai held a series of joint workshops in Krabi Province to review the policy and institutional framework for DRM and EWS in the province, to increase disaster awareness and preparedness amongst the participating stakeholders, and to identify the lessons learned on CBDRM and EWS development. Participants included DRR zone committees, community members, local government agencies and representatives from the Phi Phi Island tourism sector. A number of outreach and communication materials on disaster preparedness and early warning targeted at tourism stakeholders and tourists in Phi Phi Island were produced. These include two evacuation maps that provide information on evacuation routes for tourists and on the location of high buildings, safety areas and emergency boxes for both local people and tourists in Moo Village 7 on

Phi Phi Island. A summary report of these workshops is provided by Naruchaikusol (2009).

Collaboration with ICG/IOTWS Working Group 6 on Mitigation, Preparedness and Response

On 11 August 2009, in the session allocated to potential donors and supporting institutions and agencies, at the ICG/IOTWS Working Group 6 Intersessional Meeting and Scoping Workshop in Jakarta, Indonesia, SEI and ADPC presented project insights. The presentation focused on the motivation, rationale and methods of the overall project, and SEI's plans for future work focusing on building resilience to natural hazards and climate change in coastal communities.

Contributions to Regional Task Team and Regional Standard Operating Procedures (SOP) Workshop

At the SOP workshop held in Jakarta on 12 and 13 August in preparation for the Indian Ocean Tsunami Wave Exercise to be conducted in October 2009, SEI and ADPC shared key lessons learned and insights from the stakeholder consultations and online dialogue during discussions on warning chain and emergency response preparedness.

Contributions to a Compilation of Good Practices in Tsunami Early Warning Dissemination

SEI and ADPC are providing scientific support to Working Group 6 of the ICG/IOTWS in compiling a document of good practices in tsunami warning dissemination as part of its efforts to support the development of the IOTWS. The Compilation will be published in June 2010 and will be the outcome of the collaborative effort of members of the IOTWS, and particularly of the members of WG 6. The document will place community preparedness as a central part of the EWS and, in order to share experiences and lessons learned amongst member states, will present different tsunami warning situations, good practices and tools to enhance last mile communication and community preparedness throughout the Indian Ocean and worldwide. The document refers to the work of other Working Groups, including the development of the IOTWS and updates on the NTWC as well as on the RTWP (WG 5), and the assessment of risks (WG 3). The effort is coordinated by the country representative of Pakistan and supported by LIPI and UNESCO Indonesia.

7 PROJECT PUBLICATIONS

7.1 REPORTS

Thomalla, F., Larsen, R.K., Kanji, F., Naruchaikusol, S., Tapa, C., Ravesloot, B. and Ahmed, A.K. (2009a) *From Knowledge to Action: Learning to Go the Last Mile. A Participatory Assessment of the Conditions for Strengthening the Technology – community Linkages of Tsunami Early Warning Systems in the Indian Ocean*, Project Report, Stockholm Environment Institute, Macquarie University, Asian Disaster Preparedness Centre, and Raks Thai Foundation, December 2009.

Paul, D., Larsen, R.K., Thomalla, F., Kanji, F., Ahmed, A.K. and Ravesloot, B. (2009) *Linking Communities and Technology in the Indian Ocean Region: Summary of the Online Dialogue on Early Warning*. Project Report, Stockholm Environment Institute, Macquarie University, Asian Disaster Preparedness Centre, and Raks Thai Foundation, December 2009.

Thomalla, F., Metusela, C., Naruchaikusol, S., and Tapa, C. (2009b) *Post-tsunami Disaster Risk Reduction and Tsunami Early Warning Systems in Thailand with a case study on Krabi Province*. Research Report, Stockholm Environment Institute, Macquarie University, Asian Disaster Preparedness Centre, and Raks Thai Foundation, December 2009.

Naruchaikusol S., Tapa, C. and Chairuk, S. (2009) *Summary of Workshop on Community Based Disaster Risk Management and Linkages to the Early Warning System in Krabi Province*, Krabi Provincial City-Hall, Thailand, 9 July 2009 (unpublished), 12pp.

Thomalla, F. and Larsen, R.K. (2008) *EWS Stakeholder Consultations in Sri Lanka and Thailand*, 22-30 July 2008, Stockholm Environment Institute (unpublished), 23pp (in English and Thai).

Thomalla, F. (2008) *Indonesian Tsunami Early Warning System (Ina-TEWS) Stakeholder Consultations*, 11-27 November 2008, Indonesia, Stockholm Environment Institute (unpublished), 30pp

7.2 POLICY BRIEFS

Thomalla, F., Chadwick, M., Shaw, S. and Miller, F. (2008) *Cyclone Nargis: What are the Lessons from the 2004 Tsunami for Myanmar's Recovery?* Policy Brief, Stockholm Environment Institute, Bangkok, 29 May 2008, 5pp.

7.3 SCIENTIFIC ARTICLES

Thomalla, F. and Larsen, R. K. (2009) Resilience in the Context of Tsunami Early Warning Systems and Community Disaster Preparedness in the Indian Ocean Region. *Environmental Hazards* Special Issue on Coastal Hazards (accepted).

Thomalla, F., Larsen, R.K., Ahmed, A.K., Ravesloot, B. and Tapa, C. (2009) *From Knowledge to Action: Learning to Go the Last Mile: Participatory Assessment of the Enabling Conditions for Implementing Community Based Early Warning in the Indian Ocean*. *Natural Hazards* (accepted, with major revisions).

7.4 PRESS RELEASES AND NEWS ITEMS

Thomalla, F. (2008) *Addressing Coastal Issues in Southeast Asia*, SEI Open House, Bangkok, Thailand, 5 September 2008.

Thomalla, F. and Larsen, R.K. (2008) *Indian Ocean Early Warning System: SEI investigates challenges and opportunities in implementing community based early warning in Sri Lanka and Thailand*, SEI Website News Item, Stockholm Environment Institute, Bangkok, 21 August 2008.

Thomalla, F. (2008) *Myanmar: The Lessons From Recent Disasters Must Not Be Forgotten*, Press Release, Stockholm Environment Institute, Bangkok, 29 May 2008.

Larsen, R.K. and Thomalla, F. (2008) *SEI Researchers Call for Improved Tsunami Recovery*, SEI Website News Item, Stockholm Environment Institute, Bangkok, March 2008.

7.5 CONFERENCE PAPERS AND PRESENTATIONS

Thomalla, F., Larsen, R.K., Calgaro, E., Ahmed, A.K. and Raffles, I. (2009) *Building Resilience to Coastal Hazards: Lessons from Post-tsunami Efforts in the Indian Ocean*, session at the 4th Annual International Workshop & Expo on Sumatra Tsunami Disaster & Recovery 2009. Tsunami and Disaster Mitigation Research Center (TDMRC), Syiah Kuala University, Banda Aceh, Indonesia, 23-25 November 2009.

Larsen, R.K., Calgaro, E.L. and Thomalla, F. (2009) *Addressing Underlying Vulnerabilities in Disaster Recovery and Preparedness: Stakeholder Agency in Shaping of the Governance of Resilience Building in Thailand's Tourism-dependent Coastal Communities*, Paper presented in the session: Meeting Challenges of Climate Change at the Local Government Level through ICM at the East Asian Seas Congress, Manila, the Philippines, 23-27 November 2009.

Thomalla, F. and Larsen, R.K. (2009) *Building Resilience to Coastal Hazards and Climate Change: Lessons from Post-tsunami Efforts in the Indian Ocean*, Presentation at 'Balancing Choices and Effects in a Dynamic World', Institute of Australian Geographers (IAG) Conference, James Cook University, Cairns, Australia, 28 September – 1 October 2009.

Thomalla, F. and Larsen, R.K. (2008) *From Knowledge to Action: Learning to Go the Last Mile: Participatory Assessment of the Enabling Conditions for Implementing Community Based Early Warning in the Indian Ocean*, International Conference on Tsunami Warning, Towards Safer Coastal Communities, Bali Indonesia, 12-14 November 2008.

7.6 BOOK CHAPTERS

Larsen, R.K., Thomalla, F. and Miller, F. (2009) *Learning to Build Resilient Coastal Communities: Post-tsunami Recovery in Sri Lanka and Indonesia*, In: C.T. Hoanh, B. Szuster, S.P. Kam, A. Noble, and A.M. Ismail (eds.) *Tropical Deltas and Coastal Zones Community, Environment and Food Production at the Land-Water Interface*. UK: CABI Publishing (In press).

7.7 OTHER ARTICLES

Thomalla, F., Larsen, R.K., Ahmed, A.K., Ravessloot, B. and Tepa, C. (2009) *Strengthening the Technology-Community Interface of Tsunami Early Warning Systems in the Indian Ocean*, ISDR Informs Asia Pacific Issue 4, May 2009.

Thomalla, F. (2008) Myanmar Cyclone: The Lessons from Recent Disasters must not be Forgotten. *Sustainable Development Update* Issue 3, Volume 8, July 2008.

Hamza, M. (2006) *The Human Dimension of Early Warning: Why Technology Alone is Not the Answer*, Stockholm Environment Institute, February 2006 (unpublished).

7.8 DATABASES

An Endnote library containing close to 450 documents relating to early warning system development in the Indian Ocean region was established as part of this project. This database was made available to the project partners and the Prevention Consortium Secretariat of the International Federation of Red Cross & Red Crescent Societies (IFRC) at the Prevention Consortium Forum 2009 'Risk and Governance: Bridging National Enabling Environments and Local Action' in Istanbul, Turkey, 13-15 May 2009.

8 LITERATURE CITED

- ADB, JBIC and World Bank. (2005) *Sri Lanka 2005 Post-Tsunami Recovery Program Preliminary Damage and Needs Assessment*.
- ADPC. (2005) *Thailand - Post Rapid Assessment Report: Dec 26th 2004 Tsunami* (available at: <http://www.adpc.net>).
- ADPC. (2006) The Fourth Disaster Management Practitioners' Workshop for South-East Asia. Learning from Community-Based Practices: Strengthening Policy and Partnerships. Proceedings. Asian Disaster Risk Preparedness Center, Bangkok, Thailand.
- ADPC. (2007) *Early Warning Systems*, Available at: <http://www.adpc.net/v2007/Programs/EWS> (accessed on 11 September 2009).
- ADRC (2006) *ADRC Country Report: Sri Lanka*. ADRC: Kobe, Japan.
- ADRC (2006) *ADRC Country Report: Indonesia*. ADRC: Kobe, Japan.
- AIT (2005) *Scientific Forum on Tsunami, its Impact and Recovery*. A Regional Symposium, (Asian Institute of Technology), 6-7 June 2005, p. 33.
- AlertNet.org. (2009) *Make communities the starting point in tsunami risk reduction - experts* (accessed on 14 October 2009 at: http://www.alertnet.org/db/an_art/55076/2009/09/14-170250-1.htm).
- ALNAP (2003) *Participation by Crisis-Affected Populations in Humanitarian Action*. A Handbook for Practitioners, Action Learning Network for Accountability and Performance in Humanitarian Action, Overseas Development Institute, London.
- Andersen, P.S. (2007) Last-mile Hazard Information Dissemination: Challenges and Opportunities for Sri Lanka, *Asian Disaster Management News* 13 (1), 7-8.
- Anuratpanich, K., Kamolvej, T., Virapat, C. and Kaewkrajang, V. (2008) *Adaptive Learning in Disaster Management for Community Awareness and Resilience*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Bankoff, G. (2001) Rendering the World Unsafe: 'Vulnerability' as Western Discourse, *Disasters* 25 (1), 19-35.
- BAPPENAS and BAKORNAS PB with UNDP and DFID. 2007. *Safer Communities through Disaster Risk Reduction in Development* (SC-DRR) Indonesia. A project to promote risk reduction as a component of development for the benefit of poor communities at risk from natural disasters. 21 June 2007.
- Beck, U. (1992) *Risk Society: Towards a New Modernity*, London: Sage.
- Bernard, E. (2005) *Concept for a Regional Tsunami Warning System for the Indian Ocean*, National Oceanic and Atmospheric Administration. Draft. 30 July 2005. [link]
- Bildan, L. (2006) Eleven-country Cooperation in Establishing a Regional Multi-Hazard Early Warning System in the Indian Ocean and Southeast Asia, *Asian Disaster Management News*, 12 (4), 1-3.
- Birkmann, J., Setiadi, N.J. and Gebert, N. (2008) *Socio-economic Vulnerability Assessment at the Local Level in Context of Tsunami Early Warning and Evacuation Planning in the City of Padang, West Sumatra*. International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- BMKG (2008) *Ina-TEWS, Indonesian Tsunami Early Warning system, Concept and Implementation*, Agency of Meteorology, Climatology and Geophysics. Jakarta, Indonesia, 11 November 2008.
- BNPB (2005) National Information Prepared for World Conference on Disaster Reduction (WCDR 2005): WCDR: Geneva, Switzerland.
- BNPB (2006) *National Action Plan for Disaster Reduction 2006-2009*, Perum Percetakan Negara RI: Indonesia.

- Brunken, F. (2008) *Sustainable Capacity Building Towards Safer Coastal Communities*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Buchanan-Smith, M. and Davies, S. (1995) *Famine Early Warning and Response – The Missing Link*, Intermediate Technology, London.
- Bueno, P.B., Phillips, M.J., Padiyar, A. and Kongkeo, H. (2007) *Wave of Change: Coping with Catastrophe*, in McLaughlin, K.D. editor, *Mitigating Impacts of Natural Hazards on Fishery Ecosystems*, Sep 4-6 2007, San Francisco, American Fishery Society, Bethesda, Maryland, (in press).
- Calgaro, E. and Lloyd, K. (2008) Sun, Sea, Sand and Tsunami: Examining Disaster Vulnerability in the Tourism Community of Khao Lak, Thailand. *Singapore Journal of Tropical Geography* 29, 288-306.
- Chantry, G. (2006) *Microfinance and Disaster Preparedness: How to Finance Disaster Prevention at Household Level? An Innovative Approach in Vietnam*, in: ADPC (Asian Disaster Risk Preparedness Center) (ed.): *Proceedings of the Fourth Disaster Management Practitioners' Workshop for South-East Asia. Learning from Community-Based Practices: Strengthening Policy and Partnerships*, 23-24.
- CRED. (2009) EM-DAT: *Emergency Events Database*, USAID: Washington, DC, USA.
- CTEC. (2007) *Upgrading a Community-based Public Address System and its Use for Awareness Raising through Child/youth Study Groups (COMPASS)*, Community Tsunami Early-warning Centre, ProVenton Research & Action Grants Proposal.
- Davis, E. (2009) *Indian Ocean Tsunami Drill Unfolds Across Region*, International Herald Tribune (Global Edition of the New York Times) (accessed at: <http://www.nytimes.com/reuters/2009/10/14/world/international-uk-tsunami-drill.html> on 14 October 2009).
- David, S. (undated) *A Report on Activities Carried out by the GOI-UNDP's Programme in Cuddalore District since Inception*, draft report.
- Davis, I., Sanderson, D., Parker, D., and Stack, J. (1998) *The Dissemination of Warning*, 5 pp. Published for the UK National Coordination Committee for the IDNDR by Thomas Telford Publishing, London.
- DDPM (2008a) *Earthquake/Tsunami Victims Relief Efforts*, Department of Disaster Prevention and Mitigation, Ministry of the Interior, Thailand (available at http://www.un.or.th/pdf/ddpm_tsunami.pdf).
- DDPM (2008b) *Tsunami Prevention and Mitigation Master Plan (5 years)*, Department of Disaster Prevention and Mitigation, Ministry of Interior.
- DDPM (2009a) Internal DDPM agencies. Department of Disaster Prevention and Mitigation, Ministry of the interior Available at: http://www.disaster.go.th/dpm/index.php?option=com_wrapper&Itemid=292, (accessed 23 July 2009).
- DDPM (2009b) Draft Integrated Ministries Disaster Prevention and Mitigation Action Plan for Disaster Risk Management. Department of Disaster Prevention and Mitigation, Ministry of the Interior. Available at: http://www.disaster.go.th/dpm/index.php?option=com_docman&task=cat_view&gid=203&Itemid=221 (accessed 7 October 2009)
- De Marchi, B. (2007) *Not just a matter of knowledge*, The Katrina debacle, Environmental Hazards.
- de Ville de Goyet, C. and Morinière, L.C. (2006) *The Role of Needs Assessment in the Tsunami Response*, Tsunami Evaluation Coalition, London.
- Dewi, P.R. (2008) *Community Preparedness in Padang City, Indonesia*, KOGAMI. 24 August 2008. Powerpoint Presentation.
- DMC (2006) *Towards a Safer Sri Lanka: Road Map for Disaster Risk Management*, Ministry of Disaster Management: Colombo, Sri Lanka.
- Douthwaite, B. and Ashby, J. (2005) *Innovation Histories: A Method for Learning from Experience*, ILAC Brief 5, IPGRI, Rome, available at www.cgiar-ilac.org/downloads/Briefs/Brief5Proof2.pdf
- Edwards, C. and Wang, Y. (2005) *December 26, 2004 Tsunami Impacts on Coastal Thailand*. American Association of Civil Engineers (ASCE)

- Elliot, T. (2006) The Indian Ocean Tsunami Warning and Mitigation System: Progress and Challenges, *Disaster Management News*, 12 (4), 4-5.
- Fabrycky, D., Inderfurth, K. and Cohen, S. (2005). *The 2004 Indian Ocean Tsunami*, The Sigur Center Asia Papers, June, 2005.
- FAO (2005) *Mission Report - Assessment of Forestry-Related Requirements for Rehabilitation and Reconstruction of Tsunami-Affected Areas of Sri Lanka*.
- FAO (undated) *Assessment of the tsunami damages to fisheries and aquaculture in affected countries in Asia and Africa and immediate and long-term FAO plans for rehabilitation measures* (available at: <http://www.fao.org/tsunami/doc/Tsunami-fish-DGbrief11.pdf>).
- G8 (2005) *Response to the Indian Ocean Disaster, and Future Action on Disaster Risk Reduction*, G8 Summit, Gleneagles, Scotland, 6-8 July 2005, available at: www.unisdr.org/eng/media-room/press-release/2005/PostG8_Gleneagles_Tsunami.pdf
- GFDRR (2009) *Disaster Risk Management Programs for Priority Countries*, The World Bank: Washington, DC, USA.
- GFZ (undated) Factsheet: *Project Management, German Indonesian Tsunami Early Warning System*, German Research Centre for Geosciences, RISTEK and the German Federal Ministry of Education and Research.
- GITEWS (2009) *German Indonesian Tsunami Early Warning System*, German Research Centre for Geosciences: Germany.
- Global Network of Civil Society Organisations for Disaster Reduction. (2009) *"Clouds but Little Rain..." Views from the Frontline*. A local perspective of progress toward implementation of the Hyogo Framework for Action, June 2009.
- GoSL (Government of Sri Lanka) (2008) National ICG/IOTWS Report submitted by Sri Lanka. 4pp.
- Goyder, H., Perera, R. and Pribadi, K. (2009) *External Evaluation of the UNISDR – Coordinated Tsunami Early Warning Systems Initiative*. UNISDR: Geneva, Switzerland.
- GTZ IS. (undated) *The German Indonesian Tsunami Early-Warning System* (GITEWS). Flyer.
- GTZ IS. (2008) Project Summary Report 2006 – 2008. GITEWS WP 6300. *Capacity Building in Local Communities*. Working Document No. 19 Project – Report. August 2008, German-Indonesian Cooperation for Tsunami Early Warning System (GITEWS), Capacity Building in Local Communities. GTZ-International Services, Jakarta, Indonesia.
- Hamza, M. (2006) *The Human Dimension of Early Warning – Why Technology Alone is Not the Answer*, Sustainable Recovery and Resilience Building in the Tsunami Affected Region, Stockholm Environment Institute (SEI), February 2006, (unpublished).
- Hay, C. (2002) *Political Analysis: A Critical Introduction*, Palgrave, Houndmills, and New York.
- Heijmans, A. and Victoria, L. (2001) *Citizenry-Based and Development-Oriented Disaster Response. Experiences and Practices in Disaster Management of the Citizens' Disaster Response Network in the Philippines*. Center for Disaster Preparedness.
- Herman, S. (2009) *Indian Ocean Tsunami Warning System Tested for First Time*. Voice of America (accessed at: <http://www.voanews.com/english/2009-10-14-voa9.cfm> on 14 October 2009).
- Hettiarachchi, S. (2008) *Completed, Current & Future Activities for Disaster Management*. Ministry of Disaster Management: Colombo, Sri Lanka
- Hettiarachchi, S. and Samarawickrama, S. (2006) The tsunami hazard in Sri Lanka: a strategic approach for the protection of lives, ecosystems and infrastructure. *J Natn Sci Foundation Sri Lanka*, 34(1), pp 7-14.
- Hidayati, D. (2008). *Community Preparedness in Anticipating Earthquake and Tsunami: Lessons Learned from Some High Risk Areas in Indonesia*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Hollister, D. (2008) *UNDP Crisis Prevention and Recovery Unit*, Jakarta, Indonesia, 24 November 2008.

- Hoppe, M. (2008). *GITEWS Capacity Building*, German Technical Cooperation – International Services, Jakarta, Indonesia, 26 November 2008.
- ICG/IOTWS. (2008). Fifth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-V) Kuala Lumpur, 8-10 April 2008. IOC-ICG/IOTWS-V/5.4. [link]
- IEG World Bank Independent Evaluation group (IEG). (2006) *Hazards of Nature, Risks to Development. An IEG Evaluation of World Bank Assistance to Natural Disasters*, World Bank, Washington D.C.
- IEWP (2007) International Early Warning Programme (IEWP) Strategic Plan 2007-2009. Bonn, Germany, March 2007
- Ingram, J. C., Franco, G., Rumbaitis-del Rio, C., Khazai, B. (2006) Post-disaster Recovery Dilemmas: Challenges in Balancing Short-term and Long-term Needs for Vulnerability Reduction, *Environmental Science and Policy* 9, 607-613.
- IOC (Indian Ocean Consortium - A Multi-Agency Initiative). (2006) *Tsunami Teacher. An Information and Resource Toolkit. Building Global Capacity to Respond to and Mitigate Tsunamis*. IOC Manual and Guides, 47. [link]
- IOC and UN/ISDR. (2005) *Assessment of Capacity Building Requirements for an Effective and Durable National Tsunami Warning and Mitigation System in the Indian Ocean* Consolidated Report for 16 Countries Affected by the 26 December 2004 Tsunami November 8, 2005. Draft version.
- IOC-ICG/IOTWS (2009) Sixth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-VI) Hyderabad, 7-9 April 2009. IOC-ICG/IOTWS-V/16.
- IOC, ISDR, WMO and USAID. (2005) *Assessment of Capacity Building Requirements for an Effective and Durable National Tsunami Warning and Mitigation System in the Indian Ocean: Consolidated Report for 16 Countries Affected by the 26 December 2004 Tsunami*, UN/OCHA: New York, USA.
- IOC (2005) *Expert Missions to Indian Ocean Countries to Assess Requirements and Capacity for an Effective and Durable National Tsunami Warning and Mitigation System*, UNESCO: Paris, France.
- IOC (2008) *Strengthening National Capacities for Tsunami Early Warning and Response Systems in the Indian Ocean*, Progress Report as of 25 March 2008, Indian Ocean Consortium.
- IOC/UNESCO (2009) *Exercise Indian Ocean Wave 2009: An Indian Ocean-wide Tsunami Warning and Communication Exercise*, Prepared by the IOWave Task Team for the ICG/IOTWS (available at: http://ioc3.unesco.org/itic/files/IOWave09_Exercise_Manual.pdf).
- IRC and Tetra Tech (2007) *Review of Policies and Institutional Capacity for Early Warning and Disaster Management in Thailand*, U.S. Indian Ocean Tsunami Warning System (IOTWS) Programme, USAID: Asia.
- Ismail, F.A., Hakam, A. Nur, O.F. and Adji, B.M. (2008) *Study on Tsunami Evacuation Route in Padang City - West Sumatra*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Jacquelyn P. (2006) *Comprehensive Disaster Risk Management Framework*, Natural Disaster Risk Management Programme, World Bank Institute Distance Learning. Available at: <http://info.worldbank.org/etools/docs/library/238675/C1percent20ECPpercent20Pinat.pdf> (accessed 2 July 2009).
- Jayasuriya, S., Steele, P., and Weerakoon, D. (2005) *Post-Tsunami Recovery: Issues and challenges in Sri Lanka, 2005*.
- Jegillos, S. (2008) *UNDP Regional Center for Asia and the Pacific, Bangkok, Thailand*, pers. comm., June 2008.
- Johnson, E. and Shankar, J. (2009) *Indian Ocean Nations Test Warning System for Tsunamis (Update1)*. Bloomberg.com (accessed at: <http://www.bloomberg.com/apps/news?pid=20601087&sid=aGzHZASwhtnY> on 14 October 2009).
- JTIC (2009) Jakarta Tsunami Information Center, UNESCO: Jakarta, Indonesia.

- JTIC. (2008) http://www.jtic.org/en/jtic/index.php?option=com_content&task=view&id=446&Itemid=143. Accessed June 2009.
- Kea, K., Heang, S.S., Prak, S. and Brun, J.-M. (2005) *Assessment of Local Authorities and Communities Practices and Information Needs to Face Disasters*, Report from Surveys in Ba Phnom and Peam Ro districts, Prey Veng Province, Cambodia.
- Kelman, I. (2009) Don't Forget the People, *Weather and Society Watch* 3 (2), pp. 7,14.
- Kulphaichitra, P. (2007) OpenCARE, Making Order out of Chaos, *Asian Disaster Management News* 13 (1), 14-15.
- Lackoff, G. and Johnsson, M. (1980) *Metaphors We Live By*, University of Chicago Press.
- Larsen, R.K., Miller, F. and Thomalla, F. (2008) *Vulnerability in the Context of Post 2004 Indian Ocean Tsunami Recovery: Lessons for Building More Resilient Coastal Communities. A Synthesis of Documented Factors Contributing to Tsunami Related Vulnerabilities in Sri Lanka and Indonesia*. SEI Risk, Livelihoods & Vulnerability Programme Research Report, Stockholm Environment Institute, Stockholm, Sweden, September 2008, 44pp.
- Lassa, J.A. (2008) *When Heaven (hardly) Meets the Earth: Towards Convergency in Tsunami Early Warning Systems*. Paper presented at the ISSM Conference (13-15 May 2008), Delft, the Netherlands.
- Lindahl, K.B. (2008) *Frame Analysis, Place Perceptions and the Politics of Natural Resource Management: Exploring a Forest Policy Controversy in Sweden*, Doctoral Thesis 2008:60, Swedish University of Agricultural Sciences (SLU).
- LIRNE Asia (2008) *Regional Dissemination of Findings from the Last-Mile Hazard Information Dissemination Pilot Project*, HazInfo Supplemental Report.
- Lukitasari, C. (2006) *Strengthening Local Government System to Support Community Initiatives*. In: ADPC (Asian Disaster Risk Preparedness Center) (ed.): Proceedings of the Fourth Disaster Management Practitioners' Workshop for South-East Asia. Learning from Community-Based Practices: Strengthening Policy and Partnerships, 48-51.
- Luwin, T. (2008) *Towards Sustaining the Indian Ocean and Southeast Asia Multi-Hazard Early Warning System*, Presented in the Regional Steering Committee Meeting 24 – 25 January 2008, Bangkok, Thailand.
- Managbanag, E. (2006) *The Contribution of the Philippine National Red Cross in Capacity Building for Disaster Management in Vulnerable Communities in Partnership with the Local Government Units in the Philippines*, In: ADPC (Asian Disaster Risk Preparedness Center) (ed.): Proceedings of the Fourth Disaster Management Practitioners' Workshop for South-East Asia, Learning from Community-Based Practices: Strengthening Policy and Partnerships, 45-47.
- Mileti, D.S. and J.H. Sorensen (1990) *Communication of Emergency Public Warnings: A Social Science Perspective and State-of-the-Art Assessment*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA.
- Minamiguchi, N. (2005) *The Application of Geospatial and Disaster Information for Food Insecurity and Agricultural Drought Monitoring and Assessment by the FAO GIEWS and Asia FIVIMS*, paper presented at the Workshop on Reducing Food Insecurity Associated with Natural Disasters in Asia and the Pacific Bangkok, Thailand, 27-28 January 2005.
- Moench, M. (2005) Kobe Report Draft. Report of Session 2,7, Thematic Cluster 2, People Centred Early Warning Systems, pp. 3.
- Mureau, C. (2005) *Back to Koh Phi Phi. Surviving after Tsunami*. Published on behalf of Foundation Help Koh Phi Phi Thailand, Van Ierland Uitgeverij, The Netherlands.
- NDWC (2006) Progressive Report on the Deployment of the DART II Buoy in the Indian Ocean between 1 – 5 December 2006, National Disaster Warning Centre of Thailand, 59 pp.
- NDWC, UNESCO/IOC, US Geological Survey, USAID. (2006) Thailand Training Programme in Seismology and Tsunami Warnings, pp.16. [link]

- Nidhiprabha, B. (2007) *Adjustment and Recovery in Thailand Two Years after the Tsunami*, Tokyo: Asian Development Bank Institute, available at: <http://www.adbi.org/discussion-paper/discussion-paper/2007/08/022344.thailand.tsunami.adjustment.recovery/> (accessed 12 December 2007).
- Parsons, W. (1995) *Public Policy: An Introduction to the Theory and Practice of Policy Analysis*, Edward Elgar, Cheltenham.
- Pelling, M. and Holloway, A. (2006) *Legislation for mainstreaming disaster risk reduction*, Tearfund.
- Perera, S. (undated) *Disaster Management Programme*, Sri Lanka Red Cross Society (SLRCS), Power Point Presentation.
- Pongponrat, K., Calgaro, E. and Naruchaikusol, S. (2009) *Promoting Sustainable Recovery and Resilience Building in Tsunami Affected Tourism Destination Communities: Vulnerability Assessment of Phi Phi Don, Thailand*. Bangkok: Stockholm Environment Institute, Asia (forthcoming).
- Post, J., Muck, M., Zosseder, K., Wegscheider, S., Steinmetz, T., Riedlinger, T., Strunz, G., Mehl, H., Dech, S., Birkmann, J., Gebert, N., Anwar H.Z., and Harjono, H., (2008) *Tsunami Risk Assessment for Local Communities in Indonesia to provide Information for Early Warning and Disaster Management*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Powell, N. and Jiggins, J. (2003) *Learning from participatory land management*, in: Becker, H. A. and F. Vancley (eds.): *The International Handbook of Social Impact Assessment. Conceptual and Methodological Advances*, 44-55.
- PPEW. (2006) *Platform for the Promotion of Early Warning*, www.unisdr.org/ppew/ppew-index.htm
- Rakshit, R. (2007) Bridging the Gap, *Asian Disaster Management News* 13 (1), 22-23.
- Ratananakin, S. (2007) *Thailand Report on Progress Towards Implement the Hygo Framework for Action*, Department of Disaster Prevention and Mitigation, Ministry of Interior. Available: http://www.adrc.asia/acdr2007astana/Presentations/Country_Presentations/Thailand/HFA_Thailand.pdf (accessed 20 August 2009).
- Rego, A.J. (2001) *National Disaster Management Information Systems & Networks: An Asian Overview*, Paper presented at Global Disaster Information Network (GDIN), available at: <http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN009640.pdf>.
- Research and International Cooperation Bureau. (2006) *Thailand Country Report*. Department of Disaster Prevention and Mitigation, Ministry of Interior.
- Richardson, D. and Paisley, L. (Eds). (1998) *The First Mile of Connectivity*, Rome: Food and Agriculture Organization (FAO). Available at <http://www.fao.org/sd/cddirect/cdpub/SDREpub.htm>.
- RISTEK and UNDP. (2007) *National Workshop Report for Tsunami Early Warning Systems in Indonesia*, September 2007.
- RPB (2008) *Disaster Management Plan (PRB) West Sumatra Province 2008-2012*. November 2008. Padang, Indonesia.
- Salter, J. (1996) Towards a Better Disaster Management Methodology, *Australian Journal of Emergency Management* 10 (4), Summer 1995 – 1996, 8-16.
- Samek, J, Skole, D. and Chomentowski, W. (2004) *Assessment of the December 26, 2004, Tsunami in Aceh Province Indonesia*, Centre for Global Change and Earth Observations.
- Save Andaman Network (2005) *Introduction to Save Andaman Network: Presentation*, The Coalition Network for Andaman Coastal Community Support.
- Schepere, E. (2006) *Impact of the Tsunami Response on Local and National Capacities: Indonesia Country Report*.
- Shaw, R. (2006) Critical Issues of Community Based Flood Mitigation: Examples from Bangladesh and Vietnam, *Journal of Science & Culture* 72 (1-2)

- Singbun P., Opasapakornkit, S., Sirisuk, D., Jongkaijak, M., Suksai, S., To-Rang, S., Nunual, P., Panitdee, C., Sucharitkul, K., Kaichak, P., Pratepwanich, P., Sott, J., and Tavisai, A. (2008) *Lessons Learned from Thailand's Tsunami Experiences for Future Preparedness: 60 case studies of Good Practice for Thailand Disaster Management (2004 – 2007)*, Tsunami Knowledge Decode Project, 3 Years after Tsunami Conference, Bangkok, 17 December 2007.
- Singh Bedi, G. (2006) Strengthening Multi-Hazard Early Warning Systems – The Last Mile, *Asian Disaster Management News* 12 (4): 7-8.
- Sirisukwattananon, P. (2009) *Ministry of Information and Communication Technology allocated THB280 million to install EWS*, IT-Innovation News, Bangkok Business News. Available at: <http://www.bangkokbiznews.com> (accessed 23 August 2009).
- SLIM (2004) *The Role of Conducive Policies in Fostering Social Learning for Integrated Management of Water*, Policy Briefing, EU 5th Framework Programme Research Project, Social Learning for the Integrated Management and Sustainable Use of Water at Catchment Scale.
- Smith, D.E. (2005) Tsunami: A Research Perspective, *Geology Today*, 21 (2), 64-68.
- Southasiadisasters.net (2005) *Disaster Risk Mitigation: Potential of Micro Finance for Tsunami Recovery*, Special Issue 7.
- Spahn, H. (2009). German Technical Cooperation – International Services, Jakarta, Indonesia, 13 August 2009.
- Spahn, H. (2008) *Local Tsunamis: Challenges for Preparedness and Early Warning*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Srinivas, H. (undated) *The Indian Ocean Tsunami and its Environmental Impacts*, GDRC special feature on 'Environmental management and disaster risk reduction', Global Development Research Centre, Kobe, Japan (available at: <http://www.gdrc.org/uem/disasters/disenvi/tsunami.html>).
- Stabke, V. (2008) *Development of a Sustainable Organization Structure for the Tsunami Early Warning System in Indonesia*, International Conference on Tsunami Warning, Towards Safer Coastal Communities, Bali Indonesia, 12-14 November 2008.
- Stephen, I. (2007) Disaster Resource Network, *Asian Disaster Management News*, 13 (1), 7-8.
- Stoffs, H. (2005) *Tsunami's Effects on Agriculture: Waves of Devastation* (available at: <http://academic.evergreen.edu/g/grossmaz/STOFFSH>).
- Sudmeier-Rieux, K., Masundire, H., Rizvi, A. and Rietbergen, S. (eds) (2006) *Ecosystems, Livelihoods and Disasters: An Integrated Approach to Disaster Risk Management*, The World Conservation Union-IUCN, Gland, Switzerland.
- Sukamdo, P. and Warsono, S.Y. (2008) *The Development of Tsunami Early Warning Systems in Indonesia*. International Conference on Tsunami Warning, Towards Safer Coastal Communities, Bali Indonesia, 12-14 November 2008.
- Tappasut S. (2009) *Disaster Situation in Thailand and Implication to GIS for Disaster Management*, Presentation for Integration of Geo-Informatics for Disaster Management. 20 – 24 July 2009.
- Tatong T., Worakanok, W. Kunthasap, P. and Ratanakongviput, C. (2008) *The First Dart and Its Operating System for Tsunami Detection in the Indian Ocean*. International Conference on Tsunami Warning (ICTW), November 12-14, 2008. Bali, Indonesia.
- TAW. (2007) *The Tsunami Early Warning System in Thailand: A Resource Book with a Synopsis of Comments by Tsunami Impacted Communities 30 Months after the Disaster*, Edited by Tsunami Aid Watch, a Programme of the Heinrich Boell Foundation, Southeast Asia Regional Office.
- TDMRC. (2008) *TDMRC at a Glance* (Information CD). Tsunami & Disaster Mitigation Research Center. Syiah Kuala University, Banda Aceh, Indonesia.
- TEC. (2006) *Impact of the Tsunami Response on Local and National Capacities: Indonesia Country Report* (Aceh and Nias). Tsunami Evaluation Coalition, April 2006.
- Tepa, C. (2009) *Raks Thai Foundation*, Bangkok, Thailand, 19 October 2009.

- The Office of Disaster Prevention and Mitigation, Krabi Province. (2007) *Community Disaster Prevention Plan 2007*, Community Disaster Prevention Division.
- The Office of Krabi Provincial Governor. (2007) *Summary of Damage and Tsunami Relief in Krabi Province*, Available at: http://203.151.46.10/anda/krabi/tsunami/tsunami_h_4.htm (accessed 19 August 2009).
- Thomalla, F., Larsen, K. R., Ahmed, K. A., Ravessloot, B., and Tepa, C. (2008) *From Knowledge to Action: Learning to Go the Last Mile, Participatory assessment of the enabling conditions for implementing community based early warning in the indian ocean*, International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12 – 14, 2008.
- Thomalla, F. and Schmuck, H. (2004) We All Knew that a Cyclone was Coming, Disaster Preparedness and the Cyclone of 1999 in Orissa, India, *Disasters*, 28 (4), 255–269.
- Thomalla, F., Downing, T.E., Spanger-Siegfried, E., Han, G. and Rockström, J. (2006) Reducing Hazard Vulnerability: Towards a Common Approach Between Disaster Risk Reduction and Climate Adaptation, *Disasters*, 30 (1), 39–48.
- Tingsanchali, T. (2005) *Development of Water-Related Disaster Management in Thailand*, In (ed.) AIT (Asian Institute of Technology): Scientific Forum on Tsunami, its Impact and Recovery. A Regional Symposium. 6–7 June 2005 at AIT p. 33.
- Tourism Authority of Thailand. (2007) *Installation of an Early Warning System & Tsunami Evacuation Drills in Patong Beach in Phuket Completed*, News Room: Crisis Communication Centre Update. Available at: <http://www.tatnews.org/common/print.asp?id=2501> (accessed 13 November 2007).
- Tsunami Aid Watch. (2007) *The Tsunami Early Warning System in Thailand: A Resource Book with a Synopsis of Comment by Tsunami Impacted Communities 30 months after the Disaster*, Edited by Tsunami Aid Watch, a Programme of the Heinrich Boell Foundation, Southeast Asia Regional Office.
- Tsunami Global Lessons Learned Project Steering Committee. (2009) *The Tsunami Legacy: Innovation, Breakthroughs and Change*.
- Twigg, J. (2003) *The Human Factor in Early Warnings: Risk Perception and Appropriate Communications*, In: Zschau, J. and Koppers, A.N. (eds) *Early Warning Systems for Natural Disaster Reduction*. Springer.
- UN Thailand. (2008) (available at: <http://www.un.or.th/tsunamithailand2004anditsimpact.html>).
- UN/ISDR. (2005) *The Hyogo Framework for Action 2005 - 2015: Building the Resilience of Nations and Communities to Disasters*, United Nations International Strategy for Disaster Reduction.
- UN/ISDR (2006a) *Global Survey of Early Warning Systems. An Assessment of Capacities, Gaps and Opportunities Toward Building a Comprehensive Global Early Warning System For All Natural Hazards*, a report prepared at the request of the Secretary-General of the United Nations, United Nations International Strategy for Disaster Reduction.
- UN/ISDR (2006b) EWC III: Third International Conference on Early Warning, From Concept to Action. International Strategy for Disaster Reduction, 27 - 29 March 2006, Bonn, Germany.
- UN/ISDR (2007a) *Disaster Reduction in Asia Pacific*, Issue 3, United Nations International Strategy for Disaster Reduction.
- UN/ISDR (2007b) *Building Disaster Resilient Communities: Good Practices and Lessons Learned*, A Publication of the “Global Network of NGOs” for Disaster Risk Reduction, International Strategy for Disaster Reduction.
- UN/ISDR (2008) *Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and Implementation of the Hyogo Framework for Action*, United Nations International Strategy for Disaster Reduction, Geneva, Switzerland.
- UN/ISDR (2009) *Global Assessment Report on Disaster Risk Reduction: Risk and Poverty in a Changing Climate*. United Nations, Geneva, Switzerland, ISBN 978-92-1-132028-2.
- UNDP and National Development Planning Agency (BAPPENAS), Government of Indonesia. (2008) *Safer Communities Through Disaster Risk Reduction (SC-DRR) in Development*.

- UNDP (2007) *Regional Programme on Capacity Building for Sustainable Recovery and Risk Reduction in Tsunami Affected Countries*. UNDP: Bangkok, Thailand.
- UNDP (2009) *Institutional and Legislative Systems for Early Warning and Disaster Risk Reduction: Indonesia*. UNDP Regional Programme on Capacity Building for Sustainable Recovery and Risk Reduction, Bangkok, Thailand.
- UNEP. (2005a) National Rapid Environmental Assessment–Thailand (available at: http://new.unep.org/tsunami/reports/TSUNAMI_THAILAND_LAYOUT.pdf).
- UNEP. (2005b). *After the Tsunami: National Rapid Environmental Assessment – Sri Lanka*, (available at: http://new.unep.org/tsunami/reports/TSUNAMI_SRILANKA_LAYOUT.pdf).
- UNEP (2005c) *National Rapid Environmental Assessment – Indonesia* (available at: http://www.unep.org/tsunami/reports/TSUNAMI_INDONESIA_LAYOUT.pdf).
- UNESCAP (2007) *ESCAP Technical Cooperation. Multi-Donor Voluntary Trust Fund on Tsunami Early Warning Arrangements in the Indian Ocean and South-East Asia*, 5 pp. [link]
- UNESCAP (2009) *Tsunami Early Warning Systems in the Indian Ocean and Southeast Asia. Report on Regional Unmet Needs*, United Nations Economic and Social Commission for Asia and the Pacific. Tsunami Regional Trust Fund, New York, USA.
- UNESCAP (2009) *Tsunami Early Warning Systems in the Indian Ocean and Southeast Asia*. Report on Regional Unmet Needs.
- United Nations Development Programme Regional Centre, Bangkok (2007) *UNDP Support to Institutional and Legislative Systems for Early Warning and Disaster Risk Reduction*. Sri Lanka Report. [link]
- US-IOTWS (2007a) Tsunami Warning Center Reference Guide supported by the United States Agency for International Development and partners, Bangkok, Thailand. 311 p.[link].
- US-IOTWS (2007b) *Review of Policies and Institutional Capacity for Early Warning and Disaster Management in Sri Lanka*, USAID: Washington, DC, USA.
- US-IOTWS (2007c) *Review of Policies and Institutional Capacity for Early Warning and Disaster Management in Indonesia*, January 2007.
- US-IOTWS (2007d) *How Resilient is Your Coastal Community? A Guide for Evaluating Coastal Community Resilience to Tsunamis and Other Coastal Hazards*. U.S. Indian Ocean Tsunami Warning System Program supported by the United States Agency for International Development and partners, Bangkok, Thailand. 144 p. [link].
- US-IOTWS (2007e) Proceedings: Workshop on the Transition of the US/IOTWS Program to Indian Ocean Partners, 6-7 December 2007, Bangkok, Thailand, U.S. Indian Ocean Tsunami Warning System Program.
- USAID and DTRAC (2007) *Last Mile Warning Communications Inventory: An On-The- Ground Assessment of Thailand's Tsunami Early Warning System*. Submitted to US Indian Ocean Tsunami Warning System Program, United State Agency for International Development.
- USAID (2007) *Review of Policies and Institutional Capacity for Early Warning and Disaster Management in Sri Lanka*, U.S. Indian Ocean Tsunami Warning System (US-IOTWS) Program, US-IOTWS Program Document No. 12-IOTWS-06.
- Vidiarina, H.D. (2008) GTZ International Services, Jakarta, Indonesia, pers comm., 18 November 2008.
- WCDR. (2005) *National Disasters in Sri Lanka*, UNISDR: Geneva, Switzerland.
- Wenger, E. (1998) *Communities of Practice: Learning, Meaning, and Identity*, Cambridge University Press.
- Wisnu, B. (2008) Director of Disaster Risk Reduction, Badan Nasional Penanggulangan Bencana (BNPB), 25 November 2008.
- Yamada, S., Gunatilake, R., Roytman, T., Gunatilake, S., Fernando, T., and Fernando, L. (2006) The Sri Lanka Tsunami Experience. *Disaster Management and Response*, 4 (2): 38-48.

APPENDIX 1: LIST OF ONLINE DATABASES AND WEBSITES REVIEWED

http://ccb.colorado.edu/book_headsup.php
<http://ccb.colorado.edu/galapagos>
<http://ccb.colorado.edu/warning>
<http://findinghighergroundfilm.com>
<http://kogami.multiply.com>
<http://lirneasia.net/2007/09/the-role-of-telecom-operators-and-broadcasters-in-a-national-public-warning-system/>
<http://scholar.google.com>
<http://www.achr.net>
<http://www.acts.or.ke>
<http://www.adpc.net/ews>
<http://www.adpc.net/v2007/IKM/ONLINEpercent20DOCUMENTS/Default-DOCUMENTS.asp>
<http://www.adpc.net/v2007/Programs/CBDRM/Default.asp>
<http://www.adrc.or.jp>
<http://www.adrrn.net>
<http://www.amandaripley.com/book>
<http://www.benfieldhrc.org>
<http://www.blackwell-synergy.com>
<http://www.boell-southeastasia.org>
<http://www.c2taw.org>
<http://www.cegisbd.com>
<http://www.doaj.org>
<http://www.dmc.gov>
<http://www.duryognivaran.org/duryog>
<http://www.eldis.org>
<http://www.emeraldinsight.com>
<http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/CDdirect/CDre0026.htm>
<http://www.firstmilesolutions.com>
http://www.fragileecologies.com/may15_06.html
<http://www.fritzinstitute.org>
<http://www.gitews.org>
<http://www.gdnonline.org>
<http://www.google.com> 'last mile' and 'EWS' – pdf first 40 hits
http://www.greensl.net/action_dmip.htm
<http://www.ifrc.org>
<http://www.ilankelman.org/articles1/gobags1.pdf>
<http://www.ilankelman.org/articles1/kelman2006warning.pdf>
<http://www.informaworld.com>
<http://www.informaworld.com/smpp/content~content=a906252186~db=all~order=page>
<http://www.interscience.wiley.com>
<http://www.ioc-tsunami.org>
<http://www.ioc-unesco.org>
<http://www.iotws.org>
<http://www.isted.com/programmes/island/anglais/homepage.htm>
<http://www.iucn.org>

<http://www.jstor.org>
<http://www.jtic.org>
<http://www.kogami.multiply.com>
<http://www.nature.com>
<http://www.ngoforum.org>
<http://www.oasis-open.org/committees/download.php/14759/emergency-CAPv1.1.pdf>
<http://www.palangmerah.org/publikasi.asp?stat=eng>
<http://www.piango.net>
<http://www.preventionweb.net>
<http://www.preventionweb.net/english/multimedia/v.php?id=1402&tid=34>
<http://www.proventionconsortium.org>
<http://www.regionalcentrebangkok.undp.or.th>
<http://www.regionalcentrebangkok.undp.or.th/practices/cpr/rpcb>
<http://www.reliefweb.int>
<http://www.riskred.org>
<http://www.riskred.org/schools.html>
<http://www.sc-drr.org>
<http://www.science.com>
<http://www.sciencedirect.com>
<http://www.sei.se>
<http://www.southsouthnorth.org>
<http://www.springerlink.com>
<http://www.thejakartapost.com/news/2008/11/27/warning-system-about-people.html>
<http://www.tilz.tearfund.org>
<http://www.tsunami-evaluation.org>
<http://www.tveap.org/disastercomm>
<http://www.unescap.org>
<http://www.unesco.or.id>
<http://www.unisdr.org>
<http://www.unisdr.org/asiapacific/ap-informs/ap-informs.htm>
<http://www.unisdr.org/asiapacific/asiapacific-index.htm>
<http://www.unisdr.org/ppew>
<http://www.unisdr.unbonn.org>
<http://www.unisdr.unbonn.org/ewpp>
http://www.zef.de/module/register/media/2efd_GITEWS-Lassa-2009.pdf
http://www.zef.de/module/register/media/407b_Governance-of-sustainability-of-EWS.pdf
http://www.zef.de/module/register/media/d614_Lassa-Tsunami-Early-Warning-System.pdf
<http://www.worldbank.org>

SEI - Africa
Institute of Resource Assessment
University of Dar es Salaam
P.O. Box 35097, Dar es Salaam
Tanzania
Tel: +255-(0)766079061

SEI - Asia
15th Floor, Witthayakit Building
254 Chulalongkorn University
Chulalongkorn Soi 64
Phyathai Road, Pathumwan
Bangkok 10330
Thailand
Tel+(66) 22514415

SEI - Oxford
Suite 193
266 Banbury Road,
Oxford, OX2 7DL
UK
Tel+44 1865 426316

SEI - Stockholm
Kräfteriket 2B
SE -106 91 Stockholm
Sweden
Tel+46 8 674 7070

SEI - Tallinn
Lai 34, Box 160
EE-10502, Tallinn
Estonia
Tel+372 6 276 100

SEI - U.S.
11 Curtis Avenue
Somerville, MA 02144
USA
Tel+1 617 627-3786

SEI - York
University of York
Heslington
York YO10 5DD
UK
Tel+44 1904 43 2897

The Stockholm Environment Institute

SEI is an independent, international research institute. It has been engaged in environment and development issues at local, national, regional and global policy levels for more than a quarter of a century. SEI supports decision making for sustainable development by bridging science and policy.

sei-international.org

