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Disaster Risk Preparedness

The Role of Risk Governance, Multi-Institutional Arrangements and Polycentric Frameworks for a Resilient Tsunami Early Warning System in Indonesia

by Denis Chang Seng

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Denis Chang Seng

About the author

Denis Chang Seng is currently working with the United Nations University Institute for Environment and Human Security (UNU-EHS) in the scope of a collaborative project with the German Committee for Disaster Reduction (DKKV) focusing on adaptive Disaster Risk Reduction (DRR) in the light of climate change. Earlier he provided expertise knowledge to DKKV and the United Nations International Strategy for Disaster Reduction (UN/ISDR) towards a report on "Emerging Challenges for Early Warning Systems" in the context of climate change and urbanization.

Denis Chang Seng is a specialist in the areas of climate science, climate change adaptation (CCA), institutions and governance of disaster risk preparedness and early warning systems (EWSs).

He completed his doctoral degree from the department of Geography, Mathematics and Natural Science Faculty at Bonn University, Germany in July 2010 as part of the German-Indonesian Tsunami Early Warning System (GITEWS) project as a PhD researcher at UNU-EHS.

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This dissertation was conducted within the framework of the GITEWS project. *www.gitews.de*

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Foreword

EWSs are a major tool of DRR and CCA to extreme events. EWSs encompass technical measures, such as hazard detection tools and technical installations for warning communication; however, these systems also need to address the so-called "Last Mile". That means EWSs have to deal with people at risk, their level of preparedness and different response capacities.

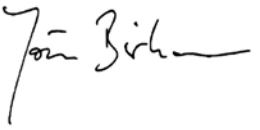
In the broader context of the GITEWS project, Denis Chang Seng deals in his dissertation with the key issue on how to improve the resilience of coastal communities exposed to tsunami through EWS governance. In this regard he examines systems of governance, their architecture and actor-agent perspectives, concentrating on the development of a Tsunami Early Warning System (TEWS) in Indonesia. He compares the development of TEWS at the local level using case studies in West Sumatra and Bali. A key part of his dissertation focuses on the question on how selected attributes of governance and institutions function and how these influence early warning and preparedness processes. Furthermore, he also examines on how to enhance the capacity of different institutional arrangements to promote preparedness and resilience, especially in the light of early warning.

Institutional arrangements and governance are viewed as critical cross-cutting themes in DRR, yet there is a lack of systematic approaches and sound methodologies to address the role of multi-level and cross-scale governance and institutions in the context of disaster risk preparedness and EWSs. Based on these findings, Denis Chang Seng develops an integrated Early Warning System Governance (EWSG) framework and applies it to the context of tsunami risk in Indonesia.

He underscores that polycentric and multi-layered institutions and structures are important to build national resilience and to improve the performance of disaster risk preparedness, however, he argues that for the tsunami risks these concepts need to be modified.

Overall, the work of Denis Chang Seng is an important contribution to the further enhancement of the discourse around EWSs, risk governance and DRR. The dissertation contributes to an improved knowledge about the role and importance of multi-level governance and institutional vulnerability in disaster risk preparedness, particularly in the context of early warning and the so-called "Last Mile".

Finally, the work can also inform CCA strategies, particularly in the context of an expected increase in extreme events. Dr Chang Seng´s research underlines that the development of preparedness and warning strategies have to take into account the broader context of governance and institutional arrangements.



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Abstract

This study examines, discusses and provides insights into tsunami risk resilience through an analysis of systems of governance, their architecture, and actor-agent perspectives, concentrating on the development of a TEWS in Indonesia.

The key problem is that so far little attention has been paid to the cross-cutting issues of governance and institutions involved in such an EWS. There is also no integrated and comprehensive framework to enquire into and analyse the role of multi-level and cross-scale governance and institutions in the context of EWSs. Institutional analyses have focused on investigating the governance of natural resources and applications in new institutional economics and internal relations. In addition, current efforts are focused on building tsunami resilience based on either the four phase EWS model or the disaster management cycle only, and do not pay adequate attention to socio-ecological resilience attributes, such as adapting and fitting systems according to ecological challenges. The main argument of this study is that an effective and sustainable EWS depends on multi-level governance, institutional arrangements and frameworks that draw on attributes of resilience capacities of managing the uncertain tsunami hazard risk and its interaction with social-ecological systems.

Therefore, a comprehensive integrated framework is developed and employed to structure inquiry, and analyse governance and institutions in the context of the TEWS. The study employs a system-architecture-actor-oriented approach based on institutional analyses. It is mainly based on qualitative methodologies and data collected in Jakarta, Bali and Padang, Indonesia during the development of the TEWS in Indonesia.

The key findings of this research highlight the underlying conditions that caused the coping capacity to be severely exceeded in the 26 December 2004 tsunami disaster in Indonesia. It argues and outlines the hindering and driving factors for institutional change in disaster risk management (DRM) and points out the challenges in implementing and sustaining an effective TEWS based on prevailing systems of governance in Indonesia. On the other hand, it shows the emerging TEWS-related architecture in terms of the new TEWS design, supporting multi-institutional arrangements, frameworks and structures.

The actors' interaction with the TEWS architecture from the national to the local level underlines the highly debated and negotiated issues and improving good governance attributes centred on the creation of hazard-risk maps for further evacuation, spatial planning and development and preparedness versus response financing. The study outlines the key contrast in rooting TEWS in Padang and Bali based on demographic differences.

ESG (2009) defines agency as the capacity to act in the face of earth system transformation or to produce effects that ultimately shape natural processes. This study also identifies and shows how agency for effective governance was exercised beyond the state in relation to the TEWS in Indonesia. The study explores the issues of TEWS effectiveness to this end and identifies the main unsatisfactory outcome and proposes multi-level incentive mechanisms beyond systems of governance and

state agency to motivate change at operational and policy level to sustain an effective TEWS in Indonesia.

The findings suggest that the developing polycentric and multi-layered institutions and structures synchronized according to the decentralized political-administrative system are ideal governance architectures for improved performance and for building national resilience to local and transboundary multi-hazard risks and disaster in Indonesia. However, it is argued that such a polycentric multilayered architecture and top-down technocratic TEWS is not completely adequate for dealing with local field earthquake generated tsunami risks due to problems of fit, adaptability, institutional diversity and norms in Indonesia. Tensions constantly emerge and are contested about the actual primary mode of TEWS governance. Hence, a theoretical basis of an effective and sustainable TEWS process and framework is proposed, drawing on the theoretical concepts, observations, experiences and empirical findings in Indonesia. It is a mixture model of the EWS process consisting of the local people-centred-adaptive approach and the national technocratic system approach to address the challenging issues of tsunami resilience in Indonesia. Other specific recommendations are also put forward to help improve the TEWS in Indonesia.

Key limitations of the research such as deeper analysis of internal institutional capacities, and institutional performances are also highlighted.

To conclude, the role of risk governance, multi-institutional arrangements and polycentric frameworks in the context of the TEWS has strengthened the tsunami resilience capacities of Indonesia; however, the future of the Indonesia Tsunami Early Warning System (InaTEWS) should rest on both system and people-centred approaches to build effective and sustained resilience to uncertain tsunami risks.

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1. Introduction

1.1 What is this study about?

This study examines and discusses how multi-level and cross–scale governance, institutional arrangement and frameworks, and the configuration of actors and communities interact together to develop resilience capacities to achieve an effective and sustained tsunami early warning system (TEWS) in Indonesia. It emphasizes and compares the development of TEWS at the level of Padang, a large coastal city in West Sumatra and Bali.

The Indian Ocean tsunami of 26 December 2004 killed more than 230,000 people, displacing more than one million people, and left a trail of destruction around the coasts of the Indian Ocean (IOC-UNESCO 2009). According to official statistics[i], in Indonesia alone more than 128,728 people were killed, 179,312 houses were destroyed, 500,970 people were displaced, with total economic losses of US$4270 million. Since then, there has been unprecedented interest in developing an early warning system (EWS) to cater to the needs of all countries. On this note, in a special session of the Hyogo, Kobe World Conference on 18–22nd January 2005, the Indian Ocean countries including Indonesia agreed to design and establish respective national and an Indian Ocean Tsunami Early Warning System (IOTEWS) based on national and regional cooperation. The current effort has its roots going back to the United Nations International Decade for Natural Disaster Reduction (1990–99).

1.2 The importance of early warning systems

EWSs are a major element of disaster reduction. They should empower societies and communities to prepare for and confront the power and the uncertainties of both natural and climate change-driven hazards. They bring safety, human security and peace of mind. An EWS provides resilience to natural hazards and protects economic assets and development gains (IEWP 2006). The importance of an effective EWS was re-emphasized in the third Early Warning Conference (EWC III) in Bonn in March 2006.

An effective and sustainable EWS needs to have not only a strong scientific and technical basis, but also a strong focus on the people exposed to risk, with a systems approach that incorporates all of the relevant factors in that risk, whether arising from natural hazards or social vulnerabilities, and from short-term or long-term processes (Basher 2006).

To be effective, EWSs should be people-centred and must integrate and span four elements: (i) a knowledge of the risks faced, (ii) a technical monitoring and warning service, (iii) the dissemination of meaningful warnings to those at risk and (iv) response capabilities. The other critical cross-cutting issues are governance and multi-institutional arrangements covering legislative, policy frameworks, institutional capacities and government funding that support the implementation and maintenance of effective EWSs. Best practice EWSs must have strong interlinkages between all the elements, and the major players concerned with the dif-

ferent elements should be familiar with all the other components and what other parties need from them (IEWP 2006). A weakness or failure in any one part of the chain or link could cause the whole system to fail.

1.3 Problem definition and research challenges

There are at least two levels of problems, challenges and gaps to outline. On the one hand, the problem and challenge is that globally many societies have not adapted their frameworks of development to the natural surrounding environment (Villagrán et al. 2006). Therefore, globally many countries and millions of people are not protected by an effective EWS, thus risking devastation, death and destitution (IEWP 2006). A United Nations (UN 2006) report on a global survey of EWSs stipulates that if an effective EWS had been in place in the Indian Ocean on 26 December 2004, thousands of lives would have been saved.

In addition, a United Nations Development Programme (UNDP 2004) report on "Reducing disaster risk: a challenge for development" highlighted that the critical cross-cutting issue of governance remains a key unresolved challenging problem and there is the need to further strengthen institutional and legislative systems for disaster risk management (DRM). However, though there have been extensive efforts in relation to the design and establishment of the EWS for tsunamis from all segments and chains down to the vulnerable coastal cities, there are still enormous gaps, weaknesses, problems and challenges to be resolved. Some of the specific problems in Indonesia range from the lack of an agreed inter-institutional operational tsunami warning chain from national level to the local level, to the lack of tsunami risk knowledge, preparedness, credibility and trust in the TEWS (Villagrán 2006; Pribadi 2006; Siahaan 2006).

Earlier understanding and use of EWSs were largely technical and scientific and less attention was placed on an end-to-end warning system. Lassa (2008) points out that what has often been termed as an EWS hardly uses a systems approach but rather a cyclical and chain type. Consequently, it is underlined that there is little experience and evidence of systematic successful testing and implementation of such a framework, particularly in the case of developing countries. Therefore, the design, implementation, and operation of such a system are the major challenges (Villagrán and Hinsberger 2007). More often, what has been observed is that existing EWSs, which may be sustainable, are rarely effective in terms of saving lives and reducing damage cost (i.e. Hurricane Katrina, the Chilean earthquake-generated tsunami, etc.). The above problems, gaps and challenges can be viewed as the consequence of pervasive, difficult, dynamic cross-scale and cross-level interactions in a multilevel world (Cash et al. 2006).

On the other hand, governance and institutional analysis (i.e. Institutional Analysis Development (IAD) framework) have heavily focused on investigating the governance of natural resources (i.e. Ostrom 1990; Oakerson 1992), new institutional economics (i.e. North 1990) and applications in internal relations (i.e. Gordenker and Weiss 1995). However, there is a lack of an integrated and comprehensive framework to enquire into and analyse the role of multi-level and cross-scale governance and institutions in the context of effective and sustainable EWSs.

It is also clear that even within TEWS studies (i.e. Keating 2006; Rodriguez et al. 2004; Seibold 2003; Michaelis 1984; Quarantelli and Taylor 1977; Weller 1970) research has mainly focused on the early warning elements with little attention paid to the cross-cutting issues of governance and institutions of these elements. In a recent international conference[ii] on tsunamis in Bali there were a total of 78 scientific papers covering issues from seismic monitoring, tsunami modelling to community preparedness; however only one conference paper discussed the cross-cutting issues related to governance and institutions.

In the context of development projects, the emerging reports on TEWS simply outline and list the institutions and institutional arrangements in Indonesia (UNESCAP 2009; BNPB 2009; BGR 2009, 2010). It is clear that such reports do not pay attention to the complex interactions between the actors, the community at risk, or the architecture in a multi-level and cross-scale context and do not analyse agency in TEWS.

In addition, current efforts have not addressed the development of TEWS with a resilience-based approach, considering the issues of self-organization, threshold, uncertainty, diversity, learning, adapting and fitting systems according to ecological challenges (i.e. Lebel et al. 2006; Gunderson 1999; Berkes and Folke 1998; Peterson 2000; Holling 1986; Walters 1986, etc.). Overall, the role of cross-cutting issues of governance and institutions in the context of TEWS remains largely under-researched.

1.4 Research aims and contributions

The main aims of the research are to examine and understand the cross-cutting issues of governance and institutional architectures and frameworks which support the very foundation for an effective TEWS as part of the resilience capacities in Indonesia, and more specifically in Padang and Bali provinces. The second part of the research objective is to outline a framework of the TEWS process that links all elements, ranging from institutions to the people at risk.

This study offers a more integrated and comprehensive framework for enquiring, analysing and measuring the role of multi-level and cross-scale governance and institutions for EWSs. The main argument is that an effective and sustainable EWS is founded on good governance and institutional arrangements, and attributes of ecosystem management.

The study attempts to provide social science-based knowledge of EWSs with a view to improving the existing operational TEWS as part of disaster preparedness and in the development of more effective governance, institutional arrangements, policies and planning to reduce tsunami vulnerability throughout Indonesia.

1.5 Main research question

The central question addressed in this research is how certain attributes of governance and institutions function and how they should function in society to enhance the capacity to manage resilience in the case of uncertain tsunami risks.

1.6 Research sub-questions

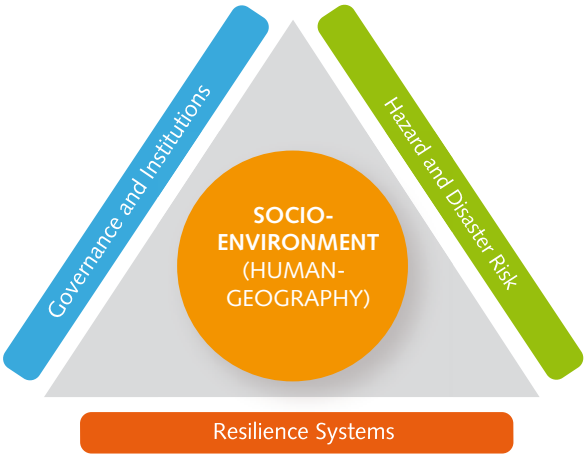
In order to fully address the objective of this research, the study also employs a number of sub-questions as follows:

1. What were the prevailing tsunami warning capacities before December 2004 and how were the capacities exceeded?
2. What were the hindering factors and driving forces for institutional change?
3. What are the environmental consequences of a lack of TEWS governance?
4. What are the prevailing systems of governance and capacities to implement and support TEWS in Indonesia?
5. What are the governance, institutional arrangements and structures to support TEWS in Indonesia and how is the performance of institutions affected by being embedded in larger architectures?
6. Who are the actors-agents of TEWS governance and how are they exercising governance/agency?
7. Are there any impacts of institutional change and what is the TEWS performance to this end?
8. What are the most challenging problems and what are the incentive mechanisms to effect changes at different levels?

The research is mainly based on qualitative methodologies; however quantitative analyses are also employed. An integrated framework is employed to structure inquiry and analyse governance and institutions in the context of TEWS. The field research was carried out in Jakarta, Bali and Padang in Indonesia in two phases from October to November 2008 and January to mid-March 2009. The time of the field research and writing coincided with the intermediate and final stages of the German Indonesian Tsunami Early Warning System (GITEWS) project and also when the technical tsunami early warning centre (TEWC) in Jakarta was officially launched in Indonesia in November 2008.

This PhD research forms part of a PhD programme within the GITEWS project and is coordinated by UNU-EHS. It is underlined that the study is a socio-geographical analysis of the socio-environment and institution relation at a time when Indonesia desires to build its resilience capacities to cope with hazards and disasters including tsunami. The study rests on three main academic research fields that are all prominent in human geography as indicated in figure 1.

Figure 1: Main research areas relevant to the study



Source: Author.

The first field of study is a large diverse body of research on understanding institutions for improved governance. Institutions have focused on a wide range of ways to investigate the governance of natural resources and the particular challenges this entails (Ostrom 1990; Oakerson 1992; Keohane and Ostrom 1995; De Groot et al. 2002; Hagedorn 2002) and on governance issues in the context of development management and sustainability (i.e. Fischer et al. 2007). It is also related to New Institutional Economics (e.g., North 1990) and is increasingly used in Internal Relations (Gordenker and Weiss 1995). It is part of the social sciences, which studies how institutions – i.e. structures and mechanisms of social order and cooperation governing the behaviour of two or more individuals – behave and function according to both empirical rules (informal rules-in-use and norms) and also theoretical rules (formal rules and law). This field deals with how individuals and groups construct institutions, how institutions function in practice, and the effects of institutions on society.

On the other hand, governance attributes have been of interest and widely employed in different settings (Leeuwis 2000; Roling 2002; Dryzek 1999; Backstrand 2003; Mc Ginnis 1999; Cash 2000; Young 1994; Berkes 2002; Agrawal and Ribot 1999; Cash et al. 2003; Low and Gleeson 1998, etc.). Of major interest is the use of governance in understanding regional socio-ecological systems and capacities to manage resilience (i.e. Lebel et al. 2006).

The second field of study consists of three other research areas, namely hazard, disaster and risk research. In the case of the hazard research area, studies cover a wide spectrum of topics, including geological hazards (i.e. earthquake, volcanic eruptions, floods, tsunamis), hydro-meteorological (i.e. tropical cyclones to

droughts), technological hazards (i.e. industrial accidents) and biological (i.e. epidemic diseases). The natural hazards are of interest to this study. The natural hazard research area (see White 1974; Fischhoff et al. 1978; Kreps 1991; Quarantelli 1991; Godschalk 1998; Pearce 2000, 2003; Cardona 2003; Rodriguez et al. 2004; Wisner 2004; Keating 2006; Basher 2006; Chang Seng and Jury 2010a, b, etc.) is a relatively well-studied area of great interest in the field of human geography.

Disaster research deals with conducting field and survey research on group, organizational and community preparation for, in response to and recovery from natural and technological disasters and other community-wide crises. The purpose behind this field of research is to attempt to advance and communicate knowledge on mitigation techniques and procedures and disaster preparedness, response and recovery. Work in the disaster research field attempts to provide social science knowledge on disasters and information that can and has been applied to develop more effective policies, programmes, and planning to reduce disaster impacts (see Quarantelli 1984; Kreps and Gary 1984; UN/ISDR, etc.). It is clear that disaster research is a relatively new addition to the social sciences field and is expanding as an area of interest following the 11 September 2001 terrorist attacks, the South Indian Ocean tsunami and hurricane Katrina.

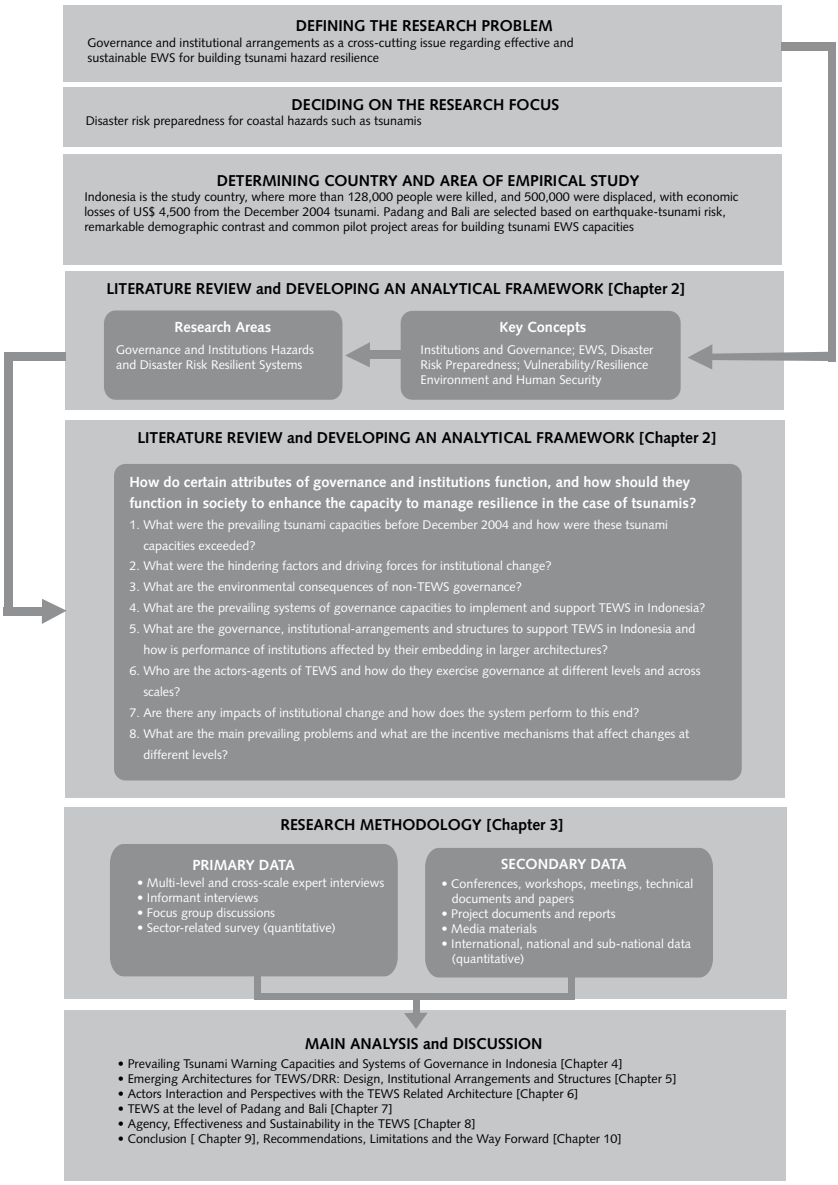
The risk research area is also attracting great interest in human geography because natural hazards are not isolated events but complex features that are connected with the social and environmental system. Risk research (see Renn 1992; Smith 2004; IRG 2009a, b) is related not only to hazards but also to vulnerability, which is also an area of increasing interest (see Cutter 1996; Bohle 2001; Wisner et al. 2004; Birkmann 2004, 2005).

The third area of study in this PhD is resilience systems, which have been a focus of interest in geography, environment, hazard research, sociology and economics. A very diverse body of research has developed, focusing on assessing people's exposure to environmental and socio-economic risks and their mechanisms for coping and adapting to these (see Chambers 1989; Watts and Bohle 1993; Blaikie et al. 1994; Ostrom 1999; Carpenter et al. 2001; Holling 2001; Adger et al. 2005; Brooks et al. 2005; Gunderson 1999; Berkes and Folke 1998; Berkes 1999; Peterson 2000; Ostrom 2005; Holling 1986; Walters 1986; Berkes 1999; Young 2002; Brauch 2005; Lebel et al. 2006).

1.7 Structure of the research process

Figure 2 gives an overview of the research process, capturing the main research structure and progressive steps from first defining the research problem, to data analysis and presentation. The diagram is very useful for quickly assessing the material presented in the study. The study consists of nine chapters following the first chapter. Chapter 2 focuses on the discussion of the key research concepts and frameworks. It presents the conceptual framework used to study TEWS governance and institutions. Chapter 3 centres on the research methodology. Chapter 4 starts the analysis and discussion, focusing on tsunami capacities before the 2004 disaster and explores systems of governance in Indonesia to implement and sustain such efforts. Chapter 5 outlines the emerging architectures for TEWS/DRR

Figure 2: Schematic overview of the research process



Source: Author.

in terms of the new TEWS design that supports multi-institutional arrangements and structures. Chapter 6 analyses and discusses the actors' interaction with the architecture in Indonesia, while chapter 7 examines and compares the interactions of the actors and the community at risk in developing the TEWS architecture and resilience capacities at the local level in Padang and Bali. Chapter 8 analyses agents and agency as fundamental issues in governance in relation to TEWS. The study also explores the issues of TEWS effectiveness to this end, mainly from the media perspective. It describes the major problems and proposes incentive structures to motivate change from an actor's perspective to improve and sustain an effective TEWS. The author outlines a theoretical basis for an improved TEWS based on theoretical concepts, field observations and the findings of this research study. Chapter 9 concludes the research study while chapter 10 provides recommendations and highlights key limitations of the research study and the way forward.

2. Key research concepts and theoretical frameworks

In this chapter the key research concepts and theoretical frameworks are discussed in order to address the research questions. The underlying theoretical concepts are based on institutional analysis to study governance in the context of the TEWS. Key subjects discussed range from institutions, mainstream and emerging views on institutional theory, key concepts of the IAD framework (Ostrom 1990) and the extended IAD Framework (Fischer et al. 2007). In addition, governance is also explored from a slightly different angle by focusing on the attributes for ecosystem management (Lebel et al. 2006) and also on emerging concepts of governance of the new Earth System Governance (ESG) project (ESG 2009).

The second part of this chapter is devoted to understanding the concepts and frameworks in the area of hazards and disaster risk, including hazard EWSs. The third part of this chapter focuses on discussions on resilient systems for ecosystem management. The chapter also highlights the issues of the environment and human security which form the central goal of the study. An integrated and comprehensive framework is developed for enquiring, analysing and measuring the role of multi-level and cross-scale governance and institutions for an EWS.

2.1 Institutions and institutional analysis

It is first important to understand the general notions and importance of institutions and institutional analysis. The term "institution" includes more than agencies and organizations, and extends to laws, legislation and management behaviours. These are the arrangements or 'rules of the game' which affect the management strategies of resource users. They shape the behaviour of local community members and include common understandings about how issues and problems should be addressed and solved. Institutions are dynamic and they respond to changes in local actors, as well as to external power or environmental conditions, but the process of change can often be difficult. Institutions form the 'framework' upon which organizations are based.

The benefits of institutional analysis include assessing the existing situation to discern which organization(s) could deliver services or interventions most effectively and efficiently by analysing the (potential) institutional and organizational set-up, and by assessing which institutions and institutional linkages, as well as organizational factors are critical to successful service delivery. This also includes the analysis of the policymaking and coordination processes. Institutional analysis can help to propose a design for the most appropriate institutional set-up to ensure that the institutional and organizational arrangements required will be available in the given country. It can also be used to develop measures to help strengthen the institutional capacities for the organizations and actors involved in order to ensure an appropriate institutional set-up for programme performance. By understanding institutions and drawing upon the selection of management arrangements that they represent, development practitioners and local people can work together to develop the most effective, sustainable institutional arrangements for the community-based management of resources and services.

2.2 Mainstream and emerging views on institutional theory

In this section, the main ongoing discourses on institution theory are discussed. Firstly, traditional theories view institutions as the rules of the game (Ostrom 1990), or the regulations or conventions imposing constraints on human behaviour to facilitate collective action (e.g., North 1990). They are rather functionalist and managerial in style and are grounded on the Common Pool Property (CPR) theory, which in turn is based on game theory. They are centred on collective action dilemmas and institutions which are designed or crafted to produce collective action. Mainstream institutional applications have focused on local situations of natural resource management which are subject to boundaries and to relative socio-economic homogeneity among users (Ostrom 1990; Wade 1998).

On the other hand the New Institutional Economics (e.g., North 1990) views institutions as representing formal rules and conventions, including informal codes of behaviour, or norms in the context of transaction costs with effort of moving towards efficiency, but ignores history, socio-culture and political economy.

Recent institutions based on CPR have paid more attention to differences in people's capabilities (Keohane and Ostrom 1995); which now extends to include people's assets, preferences and knowledge, but lacks the socio-cultural dimensions and information as well as power asymmetries. Others view institutions as more processual and dynamic. They are more than just rules or regulations but are what people do or how people behave, endowing actors as agentive roles (Cleaver 1998).

In contrast, Internal Relations (IR) explains governance and the complex interlocking of global challenges and local realities as the "Global Commons". In that context, global governance has focused and centred on a single type of formal organization (Young 1994; Gordenker and Weiss 1995; Haas et al. 1993). New IR thinking on governance is evolving to include plurality and a complex institutional mix of institutions at multiple levels consisting of state, private and public that are all involved in these networks of environmental governance to deal with problems

outside the scope of one actor (Gordenker and Weiss 1995). The network of governance operates both horizontally and vertically, drawing on the participation and cooperation of actors at national and local levels. However, the approach still draws on collective action and continues to make sharp formal distinctions between vertical institutions.

Of particular contrast to mainstream institutionalists, Mehta et al. (1999) argue that institutions emerge to embrace, moderate or exacerbate uncertainty, and they are embedded in social relations, being symbolic and interlinked with knowledge and power that span temporal and spatial scales which are not self-evident in terms of formality and informality, rather than institutions that work to mitigate uncertainty as in the case of mainstream theories.

Therefore, based on the different discourse on institutions, several analytical frameworks have been put forth to organize information about the interaction between institutions and the environment. Nevertheless, a methodology for institutional analysis should provide a systematic way to answer questions about architecture that includes: what are the laws and controls; what are the incentives; who has control and what roles do they take; and what is the management culture?

2.3 Institutional Analysis and Development framework

One particularly useful framework, which has structured inquiry across a broad array of policy and disciplines, is the IAD framework developed by Elinor Ostrom and other scholars in political theory and policy analysis at Indiana University. Institutional analysis offers a wide range of ways to investigate the governance of natural resources and its particular challenges (Ostrom 1990; Oakerson 1992; De Groot et al. 2002; Hagedorn 2002; Campbell and Sayer 2003), and governance issues in the context of development management and sustainability (Fischer et al. 2007). Its roots lie in the fields of classical political economy, neoclassic microeconomic theory, institutional economics, public choice theory and non-cooperative game theory. IAD presents a general language describing how institutions (rules), physical and material conditions, and the attributes of community affect the structure of action arenas, the incentives that individuals face, and the resulting outcome (Ostrom 2005). In this context, the decision environment-action arena, the actors, rational choice and collective choice theories, the action situation, exogenous influence in the action arena and institutional development of the IAD framework are discussed.

Ostrom defines the action arena as "social spaces where individuals interact, exchange services, goods, solve problems, dominate one another, or fight" (1999: 42). Ebenhöh (2005) explains the action arena as the decision environment of the actors. The action arena exists in and ranges from households, village communities, local, regional, national and international levels to firms and markets (Ostrom 2005). It is characterized by interacting individuals with decision-making abilities who affect activities and outcomes in the arena. Satisfactory and positive outcomes encourage actors to maintain the present state of interactions while negative, unsatisfactory results are likely to challenge actors to change their strategy

and tactics to confront the problem. The following elaborates on the characteristics of an actor in the action arena.

An actor is any person, social group or institution that has an interest or stake in a development activity, project or programme, such as use of ocean resources (i.e. fisheries) or providing services and products (i.e. early warning information). Actors have the potential to influence a specific state of affairs or a process by act, intervention or by refraining from intervening or participation (Giddens 1984). This definition includes intended beneficiaries and intermediaries, winners and losers, and those involved or excluded from decision-making processes. However, actors' behaviour has been theoretically debated around the rational choice theory and the new institutionalism debate on collective decision theory or Collective Action "Prisoner's Dilemma".

In this context, the rational choice theory for understanding and modelling social, economic behaviour is a central theoretical paradigm in microeconomics and political science, and is sometimes used in sociology and philosophy. It hinges on the analysis of the choices made by rational actors under conditions of interdependence. Rational choices are diverse, but all assume individuals choose the best action according to stable preference functions and the constraints facing them (Immergut 1998).

On the other hand, collective actions imply that actors make the best choices collectively. However, the 'Prisoner's Dilemma', with the precondition that all actors possess complete information, illustrates the benefits and limitations of collective action in decision situations because in reality not all actors have all the information necessary to enable them to make the best decision. Under such circumstances, it is individually beneficial not to cooperate with each other even though collaboration by all actors would entail acceptable benefits. In that way, actors consider that they need to defect due to vagueness about other actors' actions.

Nonetheless, it is important to note that both theoretical debates have weaknesses in terms of explaining fundamental social attributes such as trust, altruism and the prevailing and binding issues of norms and obligations. The divergence of actors' motives is of importance and is not necessarily based on *rationality or collective choice* or action as discussed above. In that sense, the IAD framework is focused on the actors' goal of achieving utility rather than achieving power, convenience and reputation. Therefore, actors in the IAD are considered to be constrained by their environment which is composed of social, institutional, historical, religious, ideological, as well as psychological factors (GTZ 2004: 9) rather than acting in absolute full rationality.

In the action arena, a typical action situation could be an exchange of products by buyers and sellers or politicians negotiating an agreement with fishermen on access rights. In this case, for example the action situation is centred around the diverse stakeholders from the hazard scientist, warning centres, disaster emergency managers, civil societies and the community at risk agreeing or disagreeing on who will issue warnings, contrasted to who will decide what actions will take place (i.e. evacuation orders). Ostrom (2005) describes the action situation when two

or more actors have to come up with potential actions' leading to a certain goal or outcome. Each individual actor has a set of potential decisions and actions to take which are influenced or determined by the positions of the other actors within a specific period of time. In that context, actors' control over their actions is an important issue because their decisions and actions may depend on the agreement of other actors. For that reason, actors can be divided into primary and secondary actors: primary actors are those who are ultimately affected, i.e. who expect to benefit from or be adversely affected by the intervention, or who may have defined mandates of responsibility (i.e. early warning centres for issuing warnings) while secondary actors have some intermediate role.

At this point it is clear that the action arena is influenced by a variety of exogenous variables which the IAD framework groups into three clusters which are interrelated and impact on each other. These are the attributes of the natural resource/service, attributes of the community and institutions. Attributes of the natural resource or service are often characterized by excluding 'outsiders' from resources or services. These affect the behaviour of actors within the action arena (Ostrom et al. 1994). On the other hand, the attributes of the community comprise "generally accepted norms of behaviour, the level of common understanding about action arenas, the extent to which the preferences are homogeneous, and distribution of resources among members" (Ostrom et al. 1994). The third group of exogenous variables which influences the action arena are institutions, the 'rules of the game' consisting of three worlds of action where every institutional arrangement is shaped by the three layers of hierarchy institutions consisting of operational, collective choice and constitutional types (Kiser and Ostrom 1982). Each level is arranged to independently serve different functions, but nevertheless, higher levels affect lower ones by dictating their boundaries of actions. Operational institutions regulate activities which occur on a day-to-day basis. Accordingly, the operational level includes the rules and regulations that define actors' right and actions. Collective choice institutions regulate how decisions are made to establish operational rules. Finally, constitutional institutions provide political and legal arrangements which 'officially' shape the rules and laws by which actors operate.

2.4 Institutional change and development process

2.4.1 Institutions and path dependence

Institutional change is often found in history not only because of what can be learned from it, but because present time and future are linked to the past by the continuity of institutions. In this context, history determines the setting up, performance, as well as future development of institutions, and consequently provides stimuli or limitations for institutional change. Every institutional development is path-dependent and each change becomes the foundation for the next (Ostrom 1990). Once a particular path is chosen, the challenges of switching become more difficult (Pierson 2004). As path dependence limits actors' bargaining flexibility, it may encourage relatively weak actors to decide whether institutional change will take place or not. In extreme cases, this might result in institutional deadlock (Levi 1990).

2.4.2 Information, origin and institutional change

Shepsle (1989) underlines lack of information as a main factor influencing institutional change. Not all important parameters are known to each actor and institutions can be established with extremely incomplete information. This complicates coordination between actors and aggravates difficulties appraising unmeant outcomes of institutional change (Poteete and Ostrom 2002).The information incompleteness may prompt actors and the community to work for the establishment of new institutions (Wegerich 2001). Thus, information has to be regarded as one essential driving force or constraint for institutional change.

On the other hand, the origin of institutions significantly influences their stability and potential for change. Studies have found that institutions that evolve without planning and instinctively within a group of executing individuals are likely to be more inertial and need more effort and time to change than institutions that are designed knowingly and planned from 'outside' (Jütting 2003).

An interesting issue is that although institutions and governance constituting the formal rules change overnight as the result of political and judicial decisions, informal constraints embodied in customs, tradition and codes of conduct are much more impervious to deliberate policies and are characterized by the individual or collective choice, intentionally or unintentionally, not to adhere to the rules or the formal results.

2.4.3 Power and institutional change

Power is an important factor impacting on institutional change because power can be exerted directly by humans in order to suppress or achieve institutional change. In traditional rural societies, power is characterized by patriarchal and clan systems. On the other hand, in the so-called modern societies, expertise and professionalism act as the main legitimization factors (Marcus 1983). Elite power holders position themselves within different institutions and dominate decisions at the collective choice level. Elites dominate the institutional order (Marcus 1983). Elites interact with other elites across institutional boundaries, and develop systems which are not necessarily serviceable for the institutions or that may not correlate with recognized institutional hierarchies (Wegerich 2001). Institutional change can be supported or resisted depending on "if these changes do not change their position or enhance their status" (Wegerich 2001: 20). In that case, inequity in power encourages power holders to resist changes; hence, fewer institutional changes occur (Das Gupta 2001).

In regard to institutional change, it is important to underline that it is more difficult and expensive to change higher level institutions, while it is relatively easy to change the rules and regulations on the operational than on the collective choice level, or even the constitutional one (Ostrom 1990; Ostrom 1999; Vasenda 2001).

2.5 The extended Institutional Analysis and Development framework

The IAD frameworks of Ostrom et al. (1994) have some key weaknesses. The critical issue that has motivated the required changes to the IAD framework is that al-

though it consists of an analysis of incentives of the prevailing *status quo* situation to encourage ways to shape and modify these incentives, these do not explicitly account for dynamic aspects such as institutional change which is highly relevant in the study area. Most important in this research is that the multiple stakeholder interactions (Paavola 2006) and the interplay between different rule systems (Young 2002; Kim 2004) are not necessarily accounted for in the IAD framework. Consequently, in the case of multiple actors on multiple levels they are limited in application (Edwards and Steins 1998). Fischer et al. (2007) point out that the solution of Ostrom et al. (1999) to governance cannot simply be scaled up because it is related and influenced by other levels and areas of governance. This addresses the question of how international agreements (i.e. Hyogo Framework for Action (HFA) 2005–2015) and national action plans can be translated and streamlined into strategies responding to the local reality, which are very important issues to address in this study. On these matters, very recently Fischer et al. (2007) proposed a comprehensive extended analytical IAD framework to analyse sustainable governance of natural resources and institutional changes which was founded on earlier work by Oakerson (1992), Thompson (1992), Thompson and Freudenberger (1997) and Ostrom (1999). It focuses on the identification of incentives that motivate the way environmental goods and services are used. In addition, it provides an elaborate tool to analyse and categorise related cooperation measures. It focuses on the goods and services provided by the natural resources rather than on the resource itself. The authors suggest ways to modify institutional incentives for more effective governance. This aspect gains considerable importance in development cooperation practice where the implementation of incentives is crucial. Therefore, according to Fischer et al. (2007), the IAD framework needs a more elaborate second part that serves to describe the change activities that are also viewed as beneficial in the context of this research. It consists of two parts. The extended framework incorporates components from institutional analysis (Williamson 1996; Wittmer and Birner 2004), policy sciences (Rohe 1977) and targets incentive changes initiated by development co-operation agencies.

The framework may be structured in steps according to the analytical process, and supports the description and analysis of incentives that motivate resource use patterns at a given point in time and planning of corresponding incentive measures to guide resource use, or a retrospective analysis of past interventions. The analytical process consists of the situation analysis which tackles the analysis of the motives of the actual resource users' behaviour, termed the 'situation analysis'. The process of analysing the natural resource management (NRM) problem requires first of all a separate identification of the actual situation in question. Secondly, reasons in terms of motives or incentives for the ongoing problems have to be identified. The difference with Ostrom's IAD work is in terms of the accountability for these often complex circumstances that it involves a multitude of actors and their interaction at a single time, rather than focusing on the local community of resource users. Thus, an approach to examining institutional arrangements between the multitude of actors in natural resource management (Huppert and Urban 1998; Huppert et al. 2001) is added to the first part of the framework. This becomes an essential, strong and relevant element of DRR as it involves multi-level and cross-scale actors. Thompson and Freudenberger (1997) suggest the need to

distinguish between three kinds of incentives related to (1) the characteristics of the goods and services in question, (2) characteristics of the community, and (3) characteristics of the actual rules in the respective community. Hence, the second part, the analysis of change activities, represents the major innovation of the extended IAD framework.

2.6 Suitability of the extended Institutional Analysis Development framework

The extended framework analysis process is found to be suitable for this particular research because it is an open framework, it considers multiple actors and multiple level interactions (i.e. cross-scale and cross level), it is an elaborate tool to analyse incentive mechanisms for more effective governance, it is flexible in addressing different cross level issues (i.e. process, constitutional organization and operation level) and it specially includes opportunities to set goals of development to induce incentive change. However, the extended IAD framework by Fischer et al. (2007) and the wide range of literature and applications of the IAD framework have developed and focused on the issues of incentives for natural resource management and governance rather than on actors providing services to the community with the aim of saving lives and reducing damage costs. Therefore, the characteristics and incentives of a service can be in sharp contrast to natural resource use. The second issue is that in this study the community are not gaining direct benefits in terms of wealth but receive information for human security and to minimize damage. It is important to differentiate between the institutional actors (i.e. EWC, disaster management agency) who are producing a service and the community at risk who receive the information and participate in the process. Thirdly, the extended framework focuses on the normative goals of development for sustainable development and the reduction of poverty. In this research, sustainable development is also part of the ultimate goal but is achieved through environment and human security and resilience building to hazards and disaster risks.

2.7 Governance

2.7.1 The governance attributes for ecosystem management

It is highlighted that the IAD framework has been widely used to study natural resource governance and does not implicitly and adequately address the specific attributes of "good" governance. Therefore, the study also considers the attributes of "good'' governance as described in the framework of Lebel et al. (2006).

This includes participation, deliberation, negotiations, mediation, polycentric multi-layered organization and architecture, transparency and accountability, equity and justice. These are further discussed below.

2.7.1.1 Participation

Communities are becoming increasingly frustrated at being excluded from participation and the decision-making process with reference to risk and disaster management (Rubin 1991). Multi-stakeholder participation is a mechanism for coping with plural values and interests (IRGC 2005). Rechkemmer (2005) argued

that with the advance in globalization, new agreements will be developed which hinge on multi-stakeholder participation. The Integrated Risk Governance Council (IRGC)(2005) framework for risk governance has broadened the concept of risk assessment by adding the parallel activity of concern assessment, which considers individual, organizational and societal perceptions of and concerns about the consequences of risk. Furthermore, it addresses the issue of inclusive governance by providing guidance, which is based on the assumption that all stakeholders have something to contribute to the process of risk governance and that their inclusion improves the final decisions rather than impedes the decision-making process or compromises the quality of scientific input. In that sense IRGC has recommended that stakeholder involvement is a function dominant characteristic of a risk. For instance, a simple risk may require little consultation while highly *complex* and *uncertain* risks (i.e. tsunami) may benefit from wider dialogue amongst, respectively, a broader base of people with expert knowledge, or all directly affected stakeholders. The involvement of stakeholders is both to ensure that the risk handling process is inclusive and responsive to those affected by it and to maximise the effectiveness and acceptability of the decisions that are made (IRGC 2005). Public participation often broadens the range of interests and issues that need to be considered, because different stakeholders assign different values to different ecosystem services and risks.

2.7.1.2 Deliberation and negotiation

Deliberation is discussion and consideration of all sides of an issue. It is characterized by a process of open communication, discussion and reflection among actors who have different political viewpoints and understandings (Leeuwis 2000; Roling 2002). Schusler et al. (2003) argue that deliberation offers the opportunity to learn about the views and motivations of others even when their positions remain fixed. This argument is supported by Backstrand (2003) who suggests that such a process helps both citizens and scientists to understand each other better. Dryzek (1999) argues that deliberation is a form of democracy.

Negotiation is often viewed as a dialogue intended to resolve disputes, to produce an agreement upon courses of action, to bargain for individual or collective advantage or to craft outcomes to satisfy various interests. It is the primary method of alternative dispute resolution. One interesting development dating back to the 1970s is the win-win or mutual gains bargaining approach adopted from the Economic Game Theory. The mutual gains approach in negotiation has been effectively applied in environmental settings.

2.7.1.3 Polycentric multi-layered institutions

Polycentric institutions, by definition, have multiple centres or authorities (Lebel et al. 2006). Such organizations' structures have been argued (Imperial 1999; McGinnis 1999; Cash 2000) to enhance contribute opportunities for understanding and for servicing needs in spatially heterogeneous contexts. Polycentric systems are often multilayered, but do not necessarily have neat hierarchical structures. Multilayered institutional arrangements are important for handling scale-dependent government challenges as well as cross-scale interactions (Young 1994; Berkes

2002; Lebel 2005). Multilayered governance facilitates vertical interplay among institutions (Berkes 2002; Young 2002; Lebel 2005). However, the conventional criticism of polycentric and multilayered arrangements is that there is inefficient overlapping of coordination and administrative responsibilities.

2.7.1.4 Transparency and accountability

Transparency often implies openness, communication and accountability. One may be transparent, but not see oneself as accountable. In that sense, authorities are obliged to provide information and explain decisions and actions or inactions and whether they can be sanctioned when those answers are unsatisfactory (Agrawal and Ribot 1999). The lack of these elements may often lead to corruption. Corruption is the abuse of entrusted power for private gain. Ribot (2002) argues that top-down accountability is often weak, while Cash et al. (2003) point out that horizontal accountability between actors is stronger. Mechanisms that support accountability are transparency, independent monitoring, polycentricism, separation of powers, legal recourse, budget control and a free media (Ribot 2002). Accountability is an important element in EWSs. For instance, authorities who fail to give legitimate reasons for why a warning was inaccurate or untimely will rapidly erode people's trust and credibility in the EWS.

2.7.1.5 Equity and injustice

Equity in the context of the research implies that every individual at risk receives early warning information and knows how to respond to the threat or risks and in the distribution of benefits and involuntary risks. Injustice is the result of repressive social control and of structural inequalities of power and actual realities (Swyngedouw and Heynen 2003; Barry 2005).

2.7.2 The new Earth System Governance conceptual framework

Humans now influence all biological and physical systems of the planet (ESG 2009). On this basis the Earth System Science Partnership has declared an 'urgent need' to develop 'strategies for Earth System management'. However, what such strategies might be, how they could be developed, and how effective, efficient and equitable such strategies would be, remain unspecified.

Apparently, the institutions, organizations and mechanisms by which humans currently govern their relationship with the natural environment and global biochemical systems are not only insufficient – they are also poorly understood (ESG 2009), and this is the rationale for the ESG research programme developed under the auspices of the International Human Dimensions Programme on Global Environmental Change (IHDP). In this context, the ESG is defined as the interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating and adapting to global and local environmental change. It is understood that the notion of governance in ESG refers to forms of steering that are less hierarchical than traditional governmental policymaking, rather decentralized, open to self-organization, and inclusive of non-state actors that range from industry and non-governmental organizations

to scientists, indigenous communities, city governments and international organizations. The ESG project framework advances a science plan that is organized first around five analytical problems ranging from architecture, agents, adaptiveness, accountability, allocation and access.

The architecture of ESG includes questions relating to the emergence, design and effectiveness of governance systems, as well as to the overall integration of global, regional, national and local governance.

Understanding effective ESG requires the understanding of the agents that drive ESG and that need to be involved. The research gap here concerns especially the influence, roles and responsibilities of actors apart from national governments, such as business and non-profit organizations, and the ways in which authority is granted to these agents and how it is exercised.

ESG must respond to the inherent uncertainties in human and natural systems. It must combine stability, to ensure long-term governance solutions, with flexibility to react quickly to new findings and developments. In other words, we must understand and further develop the adaptiveness of ESG.

Accountability in ESG entails more regulatory competence, and the more authority is conferred upon larger institutions and systems of governance – especially at the global level -, the more we will be confronted with questions of how to ensure the accountability and legitimacy of governance. Simply put, we are faced with the need to understand the democratic quality of ESG.

Allocation and access as the fifth analytical problem addresses any political activity related to the distribution of material and immaterial values. It is, in essence, a conflict about the access to goods and about their allocation – it is about justice, fairness and equity. The novel character of earth system transformation and of the new governance solutions that are being developed puts questions of allocation and access, debated for millennia, in a new light. This might require new answers to old questions.

2.8 Disasters and risks, hazard early warning systems

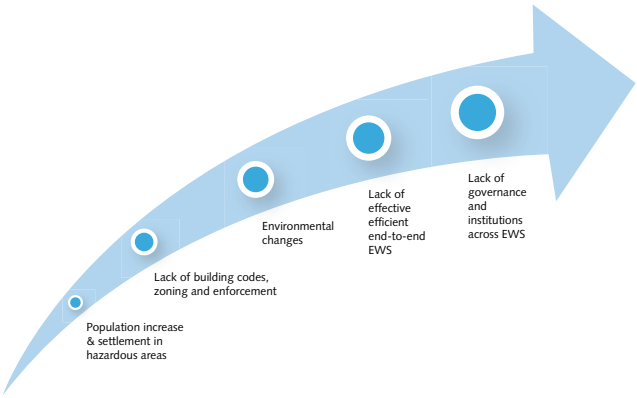
2.8.1 The increase in disasters and risks and their underlying causes

The incidence of global societal calamities is growing (ProventionConsortium 2004: 3, MunichRe). Consequently, the cost of disaster recovery far exceeds the cost of sustainable hazard management. Basher (2006) compares the most recent decade 1995–2004 with the previous decade 1985–1994 using the Centre for Research on the Epidemiology of Disasters (CRED) data to show that the number of people affected has increased 1.5 times, economic damage has increased 1.8 times and the total number of deaths increased 2.0 times. The latter figure is heavily influenced by the 26 December 2004 tsunami. This largely undermines the claimed great achievements of science and technology during the 20th century which have supposedly improved warning and forecasting systems (WMO 2005). This strongly suggests that there are certain critical problems within the early warning process which are being not addressed. Shah (2006) begins by asking questions, such

as "why is this happening?", "are information or programmes reaching the right people?" He suggests that we are maybe reaching the people and doing the right actions, but the question is whether we are reaching the people who represent the 'last mile' of the pathway to effective mitigation.

The causes of disasters and the increase in risks can be related to the fact that people are simply becoming more vulnerable as populations increase, and they are living in risky areas. There are also recurrent themes such as rural poverty that characterize how development shapes risk worldwide (Prevention Consortium 2004). Brauch (2005) underlines that the impacts of hazards also differ for people at different levels of preparedness, resilience, and with varying capacities to recover (Brauch 2005). UNU-EHS points out that globally many societies have not adapted their frameworks of development to the natural surrounding environment (Villagrán et al. 2006). Thus, globally many countries and millions of people are not protected by effective EWSs, thus they risk devastation, death and destitution (IEWP 2006). A United Nations (2006) report on a global survey of EWSs stipulates that if an effective EWS had been in place in the Indian Ocean on 26 December 2004, thousands of lives would have been saved. However, others argue that an extraordinary amount of money is spent on developing science and technology but that this has not been very successful in reducing deaths and injuries and property damage (Rodriguez et al. 2004). This is partly because the technical EW is the well-recognized part of the EWS, while failures typically occur in the communication and preparedness element, as happened during Hurricane Katrina in New Orleans in August 2005 (Basher 2006). Rodriguez et al. (2004) argue that effective warning is only part of the equation. There is a general consensus that a state of the art warning system has to link directly with the community. Figure 3 illustrates the increase in disaster and risk with time as well as the causes.

Figure 3: The causes of the increase in disasters and risks



Source: Author.

2.8.2 Disaster risks: Hazard, vulnerability, exposure and coping capacities

In a methodological review, Villagrán (2006c) concludes that a disaster is preceded by at least two predispositions: the possibility that the triggering event will take place, usually called a hazard in this potential state; and a pre-existing vulnerability, the pre-disposition of people, processes, infrastructure, services, organizations or systems to be affected, damaged or destroyed by an event. Villagrán summarizes some important mathematical expressions in terms of hazards, vulnerability, coping capacity, exposure and susceptibility. In this study, the UN/ISDR definition is employed based on global scientific consensus. In this case, risk is the multiple combination of hazard, vulnerability and coping capacity. UN/ISDR expresses risk in the context of probability of harmful consequences, or expected losses (i.e. deaths, injuries, property, livelihoods, economic activity disrupted or environmental damage) resulting from crossovers between natural or human-induced hazards and vulnerable conditions (UN/ISDR 2004).

Vulnerability is a complex term and is understood in diverse ways. In a review process related to the study of vulnerability to environmental change and the challenges for current vulnerability research in integrating with the domains of resilience and adaptation, Adger (2006) finds that the antecedent traditions include theories of vulnerability such as entitlement failure and theories of hazard. In another review process on vulnerability, Birkmann (2006) identifies at least six different schools of thought on the subject by analysing the different conceptual and analytical frameworks.

Present formulations of vulnerability to environmental change are viewed as a characteristic of social-ecological systems linked to resilience. In the context of global environmental change and, more specifically, climate change, vulnerability is most often described in terms of three primary attributes: 1) the exposure of a particular population, place or system to a threat, or suite of threats associated with global environmental change, 2) the sensitivity of the population, place or system to the threat(s) and 3) the capacities of the population, place or system to resist impacts, cope with losses and/or regain functions when exposed to global environmental change. Exposure and sensitivity increase vulnerability, while capacity acts to decrease it. While the inter-relationship and relative importance of these three attributes is ambiguous and openly debated, together these three attributes capture both the internal and external dimensions of vulnerability.

Hence, the double structure of the vulnerability model is a remarkable concept of vulnerability characterised by an external and an internal side (Bohle 2001). The external side involves the exposure to risks and shocks (i.e. tsunami hazard) while the internal side includes coping capacities (i.e. EWS, Governance and Institutional Arrangement), and resistance to and recovery from the impact of the hazard. The model views vulnerability as the exposure to shocks and stressors and the ability to cope with the shocks. On the other hand, another famous vulnerability concept is the Wisner et al. (2004) "Pressure and Release" (PAR) model which views vulnerability as the intersection of two major forces: those processes generating vulnerability, and on the other hand, the natural hazard event. It relates to the root causes and dynamic pressures that determine vulnerability and unsafe conditions.

A recent concept of vulnerability is the so-called BBC model (Bogardi and Birkmann 2004; Cardona 1999), which links vulnerability assessment to the concept of sustainable development by focusing on exposed and susceptible elements, and on the coping capacities at the same time, and is a process operating at different levels spanning socio, economic and environmental spheres. UNDP (2004) defines exposure as "Elements at risk, an inventory of those people or artefacts that are exposed to a hazard." In an uninhabited area the human exposure to a hazard is zero. The UN/ISDR (2004) definition of coping capacity adopted in this research is

> *"the means by which people or organisations use available resources and abilities to face adverse consequences that could lead to a disaster. It involves managing resources, both in normal times as well as in crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards."*

Interestingly, Füssel (2007) presents a generally applicable conceptual framework of vulnerability that combines a categorization of vulnerable situations and a terminology of vulnerability concepts based on the distinction of four fundamental groups of vulnerability factors. It provides the much-needed conceptual clarity and facilitates bridging the various approaches to researching vulnerability to climate change.

2.8.3 Definition of resilience

In this PhD research resilience is defined and understood as:

> *"The capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures"*
>
> (UN/ISDR 2004).

2.8.4 Disaster risk management and consensus for disaster risk reduction

Scanlon (1982) claims that historically, disaster management planning in North America has been viewed from a para-military perspective; that is, it has been conducted for, not with, the community (Laughy 1991). It dates back to the cold war and preparing for military attacks in bomb shelters. Kreps (1991) found that whether or not a community has effective emergency management depends to a large extent on the credibility given to it by local government officials. In that sense, Rubin (1991) observes that community members are becoming increasingly frustrated at being excluded from the decision–making process in community planning, but also at being excluded from disaster management (DM). Public participation has increased along the Pacific coast from California to Canada and involves the push to develop neighbourhood emergency programmes such as the Home Emergency Response Organization System (HEROS) in Coquitlam, British Columbia.

To be effective and efficient, sustainable DRR requires a paradigm shift throughout the DRR process. It requires a focus not only on the hazards but also on the notion of vulnerability and how to build resilience capacities. Secondly, there should be a shift from a reactive to a proactive approach which would move towards mitigation rather than response and recovery. Thirdly, the process requires a multidisciplinary approach which recognizes all the stakeholders and community and strives to create partnership (i.e. Keating 2006; Rodriguez et al. 2004; Seibold 2003; Michaelis 1984; Quarantelli and Taylor 1977; Weller 1970). The fourth requirement is working, relating and communicating *with* rather than to the community. There needs to be a comprehensive global framework, strategy and mechanism to meet such desired goals. The Yokohama Strategy and Hyogo Framework for Action (HFA) represent such a vision.

Globally, there is increasing consensus for DRR. In recent years key international players such as UN/ISDR and the International Early Warning Programme (IEWP) have been promoting national systems for comprehensive and sustainable disaster and risk management with a view to transforming concepts into action, thus changing the prevalent culture of reaction to a culture of prevention (Annan 1999). The Yokohama Strategy of the World Conference on Disaster Reduction held between 18–22 January 2005, in Kobe, Hyogo, Japan conveyed and resolved to pursue the following expected outcome for the years 2005–2015: "The substantial reduction of disaster losses, lives and in the social, economic and environmental assets of communities and countries".

It is worth pointing out at this point that the HFA identified five priority areas for action. This research also falls under priorities 3 and 5 which are on *public commitment and institutional frameworks, including organizational, policy, legislation and community action* in the context of *EWSs, including forecasting, dissemination of warnings, preparedness measures and reaction capacities.* Overall, there is little experience and evidence of systematic successful testing and implementation of such a framework. It also appears that there is relatively little research in this area. Very recently, some project documents have emerged on the issue; however most if not all view and analyse the system in isolation rather than considering the dynamic interaction between architectures (i.e. institutions, norms and structures), actors and agents in the action arena.

2.8.5 Natural hazard early warning systems

Basher (2006) claims that the most common view of EWSs is a linear top-down warning chain that is expert-driven and hazard-focused from observation through warning generation and transmission to users. He suggests that an effective and sustainable EWS needs to have not only a strong scientific and technical basis, but also a strong focus on the people exposed to risk, with a systems approach that incorporates all of the relevant factors in that risk, whether arising from the natural hazards or social vulnerabilities or from short-term or long-term processes. Basher suggests that an integrated EWS should include linkages and interactions, feedback from the population at risk through their organizations, the actors, i.e. political administrators, the district and community actors, the research commu-

nity and links to international communities. The risk manager and citizens are most concerned with the integrated risks faced and how to mitigate and prepare for them. This implies that an approach that addresses all relevant hazards in an integrated fashion, and not as separate unconnected systems, is more appropriate to the management of natural risks. However, Basher clearly underlines that the multi-hazard approach should not encourage generalities and control of warning systems. It must be tailored for each hazard, and the issue is how to create a coordinated "system of systems".

In addition, when designing devices and systems such as TEWS, we understand and know from the very start that these devices will not stand alone, but rather are used by people and subject to cost. The architecture or design should start with the fundamental issue, which is the people. It should start by analysing situations in the ways that they are meaningful to the people involved (Agre 2000). In that sense, the effectiveness of an institutionalized EWS can only be achieved by close cooperation between agencies running the system and the vulnerable people. EWSs need to be adapted to different conditions. The complex structure of large cities for example requires different arrangements than a rural environment. In order to reach the last mile, an integrated approach to early warning has to be based on the needs, priorities, capacities and cultures of those people at risk. People at risk must be partners in the system, not controlled by it.

Experience has shown that an effective EWS must be both technically systematic and people-centred (EWC III). Being people-centred means including actors and the risk community, identifying the risks through social interactions, exploring mapping, planning and responses, generating public information, and using the media, perception surveys, monuments, publications, organising annual events, exercise, drills and simulations. Such activities require the coordinated participation of different organizations. They should be based on community engagement, empowerment and the sense of ownership. In this context, it is important to understand human heterogeneity, the community size at risk, behaviours of individuals and groups, current practices, system unification, intrinsic human interactions and persistence in the existing institutional order. These issues influence the individual, community members' motivation to cooperate, participate and communicate with each other, obey rules and use and manage local affairs in a 'positive' way. Such initiatives are the conditions for a sustainable, scaled up and, most importantly, adaptable and resilient system. To have a sustainable EWS requires annual and long-term strategies.

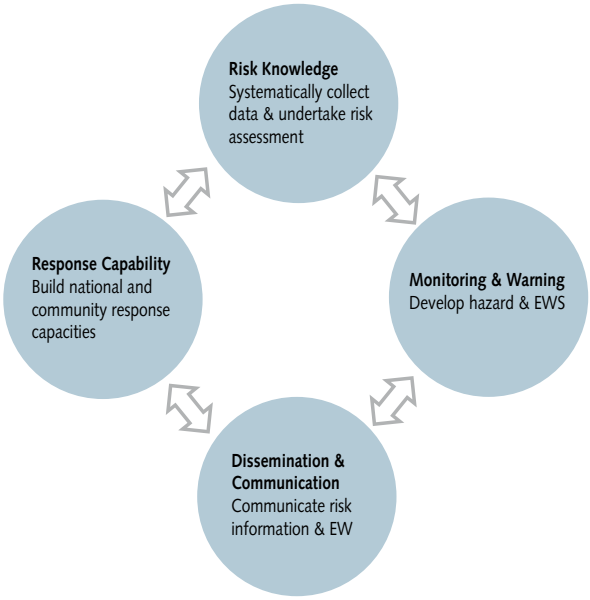
The other important issue to consider when designing an EWS is the need for different risk management strategies. These include strategies of how to deal with routine, mundane risks, complex and sophisticated risks, highly uncertain risks, highly ambiguous risks and imminent dangers and crises. The IRGC (2005) proposes the following for characterization and their implications for risk management. To be more specific, IRGC underlines the coping strategies to deal with complex, uncertain and ambiguous risks. For highly complex risks, there is a need for risk–informed and plural knowledge strategies with stakeholder participation through mainly epistemological or theory of knowledge discourse. On the other

hand, highly uncertain risks require a precautionary and resilience building approach including making compromises between too much and too little precaution with a reflective discourse approach. This strategy should be of great relevance in the case of developing a defence system against tsunami. Ambiguous risks require plural value input social groups in terms of reflective discourse. EWSs not only need to continue to innovate and adapt in the context of technologies, but must also continuously review their aims during performance and renegotiate the multiple organizational and community relationships of the system. A prerequisite for an effective EWS is the recognition of its benefits by the general public, policymakers and the private sector. A cost benefit analysis for example will help to foster the necessary political engagement and the will to promote the objectives.

2.8.6 The effective early warning system framework

UN/ISDR also claims that for an EWS to be effective, it must be people-centred and should integrate and span four elements as defined by the ISDR model: (i) a knowledge of the risks faced, (ii) a technical monitoring and warning service, (iii) the dissemination of meaningful warnings to those at risk and (iv) responses which depend on public awareness and preparedness (see Figure 4). While this set of four elements appears to have a logical sequence, in fact each element has a direct two-way linkage and interaction with each of the other elements.

Figure 4: The four elements for an effective Early Warning System framework



Source: Author. Adapted from IEWP (2006).

In order to sustain the four elements, it is necessary to have strong political commitment and durable institutional capacities, which in turn depend on public awareness and an appreciation of the benefits of an effective EWS (Basher 2006). A weakness or failure in any part of the chain or link could cause the whole system to fail.

The major failures of EWSs over recent times have been failures largely of governance and institutions rather than science. The governance and multi-institutional arrangements range from legislative, policy frameworks, institutional capacities and government funding that supports the implementation and maintenance of effective EWSs. The cross-cutting issues also include the UN/ISDR-EWC III (2006) multi-hazard approach, involvement of the local communities, and consideration of gender perspectives and cultural diversity. Institutions are required to capture and sustain political commitment, to capitalise on and apply existing scientific knowledge, to assess risks and manage investment in systems, to globalize and systematize EWSs and to guide and resource scientific research (Basher 2006).

The UNDP report (2004) highlighted that the critical cross-cutting issue of governance remains a key unresolved and challenging problem, and there is the need to further strengthen institutional and legislative systems for DRM. On this note, it was highlighted that governance areas ranging from political commitment, policy priority, legal and regulatory frameworks, institutional frameworks and structures, multi-stakeholder participation, capacities for disaster reduction and financial resources are increasingly recognized to be key areas for the success of the sustained risk reduction.

In addition, the United Nations Survey requested by Annan (2005) on a global EWS for all natural hazards confirmed that there is inadequate political commitment and responsibility, a poor legal framework, poor links between DRR and sustainable development and insufficient investment in EWS capacities. Moreover, there is insufficient coordination among actors, a lack of a participatory approach, with over-reliance on centralized government direction, and limited engagement of civil society, NGOs and the private sector, as well as inadequate identification and sharing of methodologies and good practices.

2.8.7 The modified effective early warning system framework

The UN/ISDR model for effective EWS has one major weakness: It lacks the differentiation of the communication process between and within actors during both non-hazard events and during impeding disaster events. Apparently, the model shows communication as active only between the monitoring, warning and response processes (see Figure 4.) Therefore, it is necessary to differentiate between the two communication processes and to show that communication is a central element across all the components of an EWS. In other words, communication between actors is viewed as a central and important mechanism which should remain active at all times throughout the process to improve learning, information exchange and coordination (Thompson 1967; Galbraith 1977; IRG 2005). In this context the UN/ISDR EWS in modified as shown in Figure 5. The modified model of the ISDR effective EWS is adopted in this research.

Figure 5: Modified model of the effective Early Warning System

Source: Author.

2.9 The ecosystem resilience capacities framework

In this PhD research, it is suggested that an effective and sustainable TEWS should also satisfy the attributes of resilience rather than simply address the elements of the TEWS. The ecosystem resilience capacities include considering attributes of resilience such as self-organization, learning and adapting, scale, uncertainties, fit, thresholds, knowledge and diversity. These are further elaborated below:

A system can maintain and renovate its identity if it has the capacity for self-organization. Although most systems are linked to and impacted by other systems, self-organizing systems are able to buffer the impacts of other systems and do not need to be continually invested in, subsidized or replenished from outside to persist (Ostrom 1999; Carpenter et al. 2001; Holling 2001). Management systems can get better over time with an increased ability to learn and adapt (Adger et al. 2005; Brooks et al. 2005; Folke et al. 2005).

The capacity to cope with non-linearities or other forms of surprise and uncertainty requires openness to learning, an acceptance of the inevitability of change, and the ability to treat interventions as experiments or adaptive management (Gunderson 1999; Adger 2000; Pahl-Wostl and Hare 2004; Adger and Vincent 2005). The ability to detect hard-to-reverse thresholds in a timely matter is important because it could allow societies to take measures to prevent ecosystems from crossing thresholds and ending up in another undesirable basin of attraction

(Holling 1978; Carpenter et al. 2001; Scheffer and Carpenter 2003). It is crucial to have abilities to engage effectively at multiple scales to deal with regional systems because they are invariably subject to powerful external influences, including changes in regulations, investments, and the environment (Berkes 2002; Young 2002).

The ability to improve knowledge about ecological processes in institutions should improve the fit between rules and ecosystems even as they go through dynamic cycles (Holling 1986; Walters 1986; Berkes 1999; Gunderson 2000; Young 2002; Folke et al. 2003). Following a major crisis the capacity to build and maintain social and ecological diversity provides the opportunity for renewal and reorganization (Peterson 2000; Ostrom 2005). Our capacity to successfully combine or integrate understanding gained from different sources and forms of knowledge, including tacit and formal knowledge, increases the likelihood that the key thresholds and components of diversity will be acknowledged (Berkes and Folke 1998; Berkes 1999).

2.10 Environment and human security

2.10.1 Environment: Global governance and sustainable development

Finally, the ultimate goal of developing an effective TEWS and resilience capacities is geared towards environment and human security. However, it is important to highlight the concept and discourse on environment and human security in the context of this study. Environmental phenomena can be categorized into three levels: local, regional and global. By definition, global problems are of international concern; nevertheless, local problems can evolve into global problems (Rechkemmer 2005). It was in 1968 that the United Nations General Assembly for the first time engaged in international environmental issues with the resolution GA 23/198. A breakthrough for global environmental governance came in the eighties following the release of the so-called Brundtland World Commission on Environment and Development (WCED 1987) report "Our Common Future". It instantly became the foundation and blueprint for sustainable development; its definition a paradigm: "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987: 8). The notion of global environmental governance, which is highly relevant to this research, is characterized by national governance through governmental regulation, and international governance through collective action facilitated by international organizations that foster partnership arrangements due to the complexity of managing human relations. It consists of elements ranging from public-private partnerships, multi-stakeholder processes, and global public policy networks (Ivanova 2003). It is clear that cooperation mechanism such as multilateral cooperation between actors, which characterizes global environmental governance, was driven by the incentive of achieving sustainable development.

The threats and challenges of global environmental governance emerged due to a collapse of multi-lateral cooperation after the 1990s linked with the unilateral actions of the classic restoration of power politics based on the national interest

which undermined the principles of collective action and global governance. However, in response to this deadlock, new initiatives and the approach of selective multilateralism emerged, led by European Union member countries (Messner et al. 2003). Thus, a change in international politics has emerged where willing states are forming new alliances of political forerunners creating a new form of "multilateralism at different speeds" (Messner et al. 2003: 247). Hamm (2002) and Rechkemmer (2005) foresee an advance in globalization, new avenues and strategies for joint implementation or informal agreements which may be between states or in the form of voluntary networks and partnerships.

The report "In Larger Freedom": Towards Development, Security, and Human Right for All (UNGAA/59/2005) by the then United Nations Secretary-General Kofi Annan identifies environmental governance as particularly relevant. In this context, a bold new vision of collective security for all was identifying and clustered into six threats. The report perceives global environmental change and environmental degradation as a new challenge and a major threat to collective human security, exemplified by natural catastrophes, such as the recent tsunami in the Indian Ocean, requiring global environmental governance. The most important call of Annan (2005) is to establish a worldwide EWS for all natural hazards, building on existing national and regional capacity. Finally, a new paradigm shift for environmental governance is emerging. Rechkemmer (2005) urges us to pay attention to human security and to methodically add to the model concept of sustainable development, bringing about a triangular understanding of the inter-relatedness of environmental change, development and human security.

2.10.2 Human security: State and people-centred security

In this section, the human security dimension is discussed from a number of research fields, including development studies, international relations, strategic studies and human rights. It is an emerging paradigm for understanding global vulnerabilities whose proponents challenge the traditional notion of national security by arguing that the proper referent for security should be rather the individual than the state. Human security emerged after the cold war as a challenge to ideas of traditional or state security, based on the argument that the proper referent for security should be the individual rather than the state. Traditional security or state security is about a state's ability to defend itself against external threats, and in this context the United Nations High Level Panel recognized "human security" in the context of the "state" as the cause and the key actor in dealing primarily with military and societal threats, but also pointed out that "to be secure is to feel free from threats, anxiety, or danger". Wolfers (1962) argues that there are two sides to the security concept, where "Security, in an objective sense, measures the absence of threats to acquired values, in an objective sense, the absence of fear that such values will be attacked". However, fairly recently in 2003, Moller criticized this definition for its inability to explain whose and which values might be threatened and from who and how? However, a remarkable contribution and critique to the above state-centred security paradigm was highlighted by Mack (2004) to explain situations where the state is actually the threat to the individual.

One of the greatest achievements in human security is the publication of the Human Development Report by UNDP in 1994 with its argument that ensuring "freedom from want" and "freedom from fear" for all persons is the best path to tackle the problem of global insecurity. The Human Development Report's definition of human security argues that the scope of global security should be expanded to include *threats in seven areas from* economic, food, health, environmental, personal, and political and community security. Wolfrum (1994: 50) indicates that the United Nations charter on the "nation-centred concept of "international security" and the concept of "negative" peace indicate that peace is more than just the absence of war. Two years later, Waever (1997) notes that the scope of "securitisation" has changed, notably from a "national" to a "human–centred" security concept within the United Nations system and the academic security community. Nevertheless, the human security concept used by UNDP (1994) stirred globally, contrasting and deepening views and debate that has not abated.

Annan (2001) informs us that human security can no longer be understood in purely military terms, but encompasses economic development, social justice, environmental protection, democratization, disarmament, respect for human rights and the rule of law. He further suggests three building blocks of human security which include: freedom from want, freedom for fear and the freedom of future generations to inherit a healthy environment-these are the interrelated building blocks of human and therefore national security.

Human security can be considered a condition whereby individuals and communities have the options necessary to end, mitigate or adapt to threats to their human, social and environmental rights, and where they have the capacity and freedom to exercise these options (GECHS 1999).

The Sen-Ogata Commission's 2003 report "Human Security Now" raised the visibility of human security. Freedoms emphasize "both the *processes* that allow freedom of actions and decisions and the actual *opportunities* that people have, given their personal and social circumstances" (Sen 1999: 17). Human security thus implies both protection from threats and empowerment to respond to those threats in a positive manner. Gasper argues it "includes normative claims that what matters is the content of individuals' lives, including a reasonable degree of stability" (2005: 228). It encompasses issues related to human development, human rights and environmental sustainability (Gasper 2005).

2.10.3 Human security: Freedom from hazard impact

Brauch (2003) and Bogardi (2004) suggested focusing the human security discourse on the environmental dimension, especially on interactions between individuals or humankind as the cause and victim of factors of global environmental change, both in anthropogenic and natural variability. Finally, in 2005, Bogardi and Brauch claimed that human security could rest on three pillars (freedom from want, freedom from hazard impact and freedom from fear) reflecting the corresponding issues of sustainable development.

The Commission on Human Security report (CHS 2003) proposes a new people-centred security framework that requires two general, mutually reinforcing strategies which offer protection so that individuals are shielded from dangers and are empowered to become full participants in decision-making. Aiming towards a learning society by creation of knowledge is a key approach to reducing vulnerability and enhancing resilience.

2.11 Synthesis, integrated conceptual framework and analytical steps

To investigate a problem and propose possible explanations, it is important to distinguish among three conceptual levels; frameworks, theories and models. Overall, a framework organizes an enquiry by specifying the general sets of variables of interest. It specifies classes of variables and their relationships to each other such that there is a coherent structure to the enquiry (Schlager 1999). The advantage of a framework is that it allows the use or integration of several theories that would otherwise be examined in isolation from each other (Kootz 2003).

2.11.1 The integrated framework

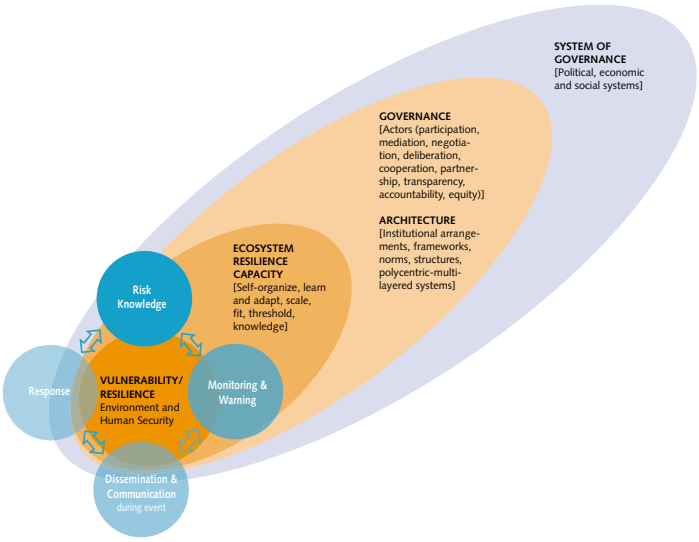
An "Integrated Governance-Institution-EWS-Resilience Framework" is developed (see Figure 6) to address the central question of this research: how do certain attributes of good governance such as participation, deliberation, equity, multilayeredness, polycentricism, accountability, transparency and institutional arrangements (i.e. rules and regulations), configurations of actors and social processes function, or how should they function to enhance and shape the capacity to manage resilience in Indonesia.

Firstly, the integrated framework consists of the systems of governance (i.e. political, economic and social) required to support the TEWS. Secondly, the core of the analyses focuses on the governance framework which consists of architectures (i.e. institutional frameworks, arrangement, norms, structures, polycentric-multilayered systems and actors-agents (i.e. their participation and networks, mediation, negotiation, deliberation, cooperation, partnership, transparency, accountability, equity and legitimacy). The underlying theories and concepts are grounded on earlier institutional work by Fischer et al. (2007), emerging institutional theorists (Mehta et al. 1999), and mainstream institutions (Ostrom 1990; North 1990; Keohane and Ostrom 1995, etc.). Thirdly, the framework addresses the issues of ecosystem resilience capacities to manage ecological challenges (Lebel et al. 2005). Fourthly, these frameworks operate on the EWS framework with the central goal of tsunami vulnerability reduction or alternatively tsunami resilience to safeguard the environment and human security.

The integrated framework captures multi-level and cross-scale interactions. It considers both mainstream institution theory (Ostrom 1990; North 1990; Keohane and Ostrom 1995; Gordenker and Weiss 1995; Wade 1998; Cleaver 1998) and emerging views such as Mehta et al. (1999). It addresses the notion of formal and informal institutions. Therefore, on the one hand, institutions could serve as the rational, collective choice (e.g., Ostrom 1990) and be geared towards utility maximization, economic and operational efficiency for deliberate ends (e.g.,

North 1990) in the upstream technical component of the EWS. On the other hand, the framework simultaneously seeks to capture the idea that in the downstream-culture component of the EWS it is possible to cater for flexible-informal processes which can be blurred and often overlapping to respond to dynamic environmental uncertainties (Mehta et al. 1999). It recognizes that institutions designed with the community should be flexible and contingent and should have ad-hoc and non-robust approaches making use of public institutions characterized by social relations and networks. This requires not only an inclusionary, participatory decision-making process, but the creation of space for institutional learning that reflects and makes use of plurality of perspectives. This approach is particularly relevant when addressing the issue of people-centred warning system as institutions should be embedded in social interactions and social practices and everyday life for sustainability. Thus, it includes plurality and the complex institutional mix of institutions at multiple levels – state, private and public – involved in these networks of environmental governance to deal with problems outside the scope of one actor. Therefore, in this research, governance is understood as the body of rules, enforcement mechanisms and the corresponding interactive process that coordinates and brings into line the activities of the involved persons with regard to a concerted outcome (Huppert et al. 2003: 8). The concerted outcome in this case is resilience to the uncertain tsunami risks in the context of Indonesia.

Figure 6: The Integrated Governance-Institutions-Early Warning System-Resilience framework

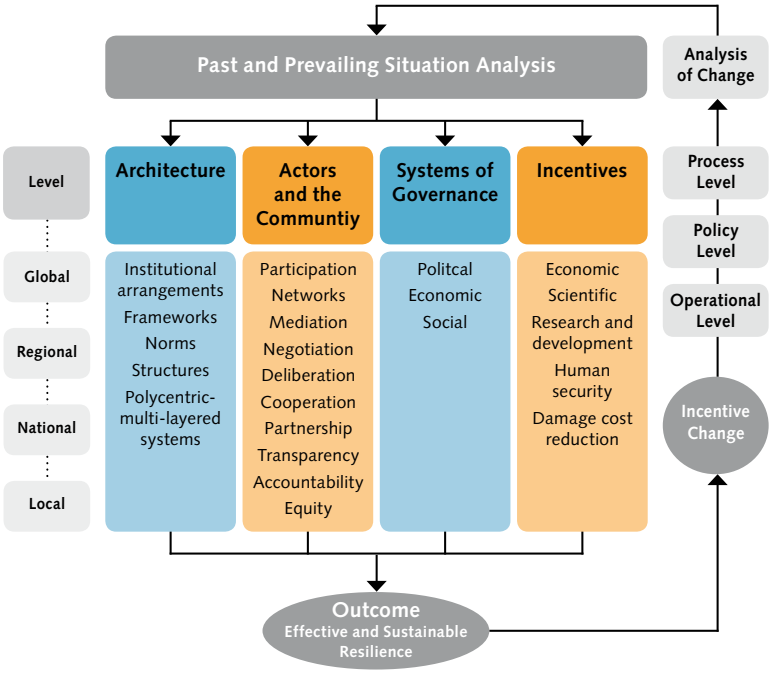


Source: Author.

2.11.2 The institutional analysis analytical steps

In order to show the dynamic process, the framework is reconfigured to capture the analytical steps based on the modified extended IAD framework analysis process of Fischer et al. (2007) as indicated in figure 7. The reconceptualized analytical process describes the past and prevailing situation analysis which consists of the architecture, actors-agents and the community at risk, the system of governance and the prevailing associated incentives in the arena. To analyse the complex interactions, the framework considers the issues of cross level and cross-scale interactions consisting of the multitude of actors from state to non-state actors, technical to non-technical actors and their interaction spanning different levels vertically (i.e. international, national and local levels). The goals include effectiveness and sustainability in tsunami resilience viewed from the TEWS standpoint for environment and human security. For instance, if the outcome is not satisfactory, then actors and the community need to aim for an improved outcome. The second part of the analysis process consists of the incentive change activities as described by Fischer et al. (2007) that can be applied to the constitutional, organizational and operational levels, and it examines their impacts on the prevailing situation in part 1.

Figure 7: The institutional analysis analytical steps



Source: Author, based on the modified extended IAD Framework of Fischer et al. (2007).

3. Research methodology

This chapter discusses and provides a detailed account of the selection procedures for the research country and areas, describes the methodological steps undertaken for data collection and presents analysis and interpretation. It also includes the process of selecting the empirical methods and tools employed during different phases of the research study. The difficulties and challenges encountered during field research are also presented.

3.1 Selection of research country, area and sites (arenas of action)

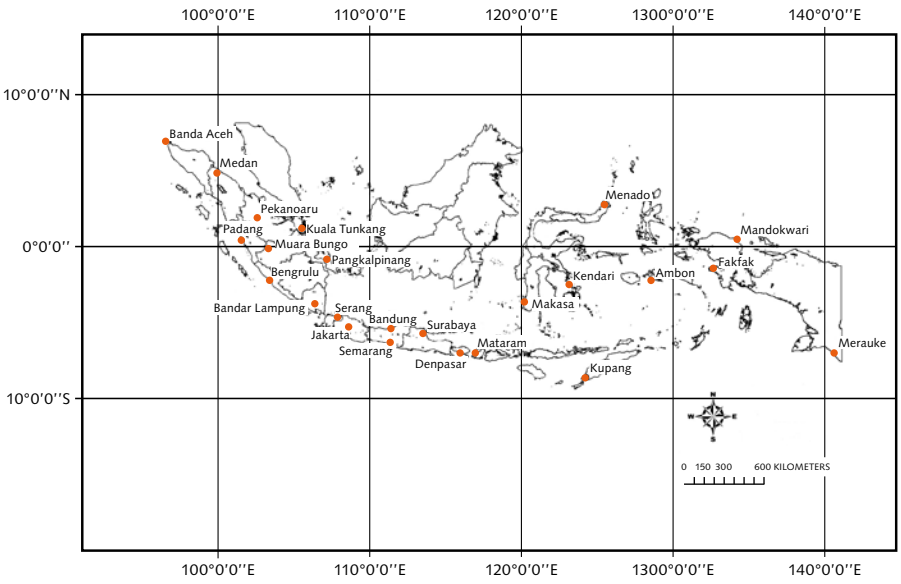
The question is why Indonesia and Padang coastal city and Bali were chosen as specific research sites for this study. Indonesia is one of the largest archipelagos in the world, composed of 18,000 islands with a population of over 200 million, and it is vulnerable to natural disasters. Indonesia's location on the edges of three tectonic plates makes it the site of 130 active volcanoes and it has frequent earthquakes and tsunamis. The Indonesian earth segment, the coastal and marine waters, and the atmospheric conditions are quite dynamic and potentially prone to all sorts of natural disasters, including tsunamis.

In December 2004, the Aceh tsunami killed more than 128,728 people and displaced 500,000[iii] people in Indonesia alone because there was no TEWS in place in Indonesia. Following the calamity, Indonesia and the other Indian Ocean countries agreed to develop their own national TEWSs to build national resilience to tsunami hazards and disasters. Based on a bilateral agreement, Indonesia and Germany spearheaded a project named GITEWS. This PhD research forms part of the capacity-building of experts of the GITEWS project in Indonesia and the Indian Ocean region.

Secondly, Indonesia has experienced many tsunamis in the past (see Chapter 4). A recent study by UNOCHA (2009) based on a tsunami inundation deterministic scenario[iv] and population exposure results shows that Indonesia is exposed to the highest wave run-up ranging from 5 to 20 metres over most parts of the coast facing the Indian Ocean with an exposed population of 1.5 million people. Therefore, it was natural to select Indonesia as the country for this research.

Initially, three research areas were envisaged to be covered in the study. However, during the first field trip it was quickly realized and decided that only two research areas would be manageable considering that the two research areas are located about one hour flight time from Jakarta, the capital of Indonesia. Hence, Padang and South Bali (see Figure 8) were finally selected as the research areas based on three criteria which are further elaborated below:

Figure 8: Study areas in Indonesia



Source: UNU-EHS and DLR.

3.1.1 Geography, socio-economic and demographic characteristics in Padang and Bali

Firstly, the two communities Padang and Bali profoundly contrast in terms of their socio-economic activities, religious and cultural dimensions. Therefore, it would be desirable to understand how these existing underlying conditions influence and determine how actors and communities develop capacities to manage tsunami resilience. This is further elaborated below:

Padang is the capital and the largest city of West Sumatra, Indonesia. It is located on the western coast of Sumatra (see Figures 9 and 10) with an area of 694.96 km^2 and a population of over 750,000 people.

Figure 9: Map of Padang city, West Sumatra, Indonesia

Source: UNU-EHS and DLR.

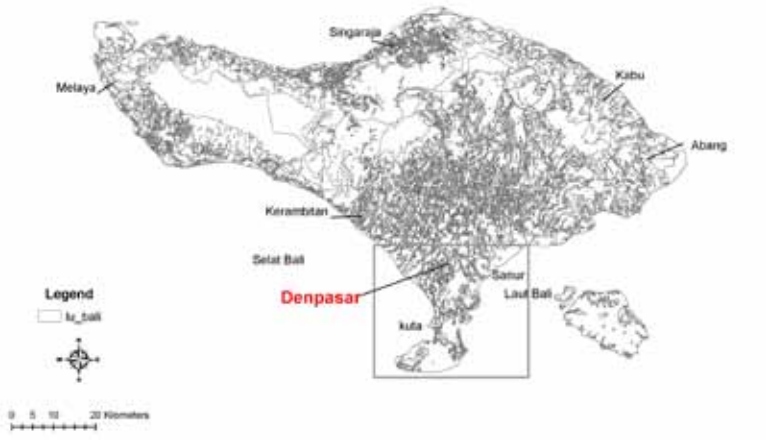
Padang has 11 sub-districts (kecamatan) and its transportation system includes the newly-opened Minangkabau International Airport in Ketaping, Padang. Padang's Teluk Bayur harbour is the largest and busiest harbour on the west coast of Sumatra. Andalas University is the main campus, located about 12 km from the centre of Padang, and it is the oldest university in Indonesia outside Java. Since the 16th century Padang has been a trade centre. During the 16th and 17th centuries pepper was cultivated and traded with India, Portugal, the United Kingdom and the Netherlands. In 1663 the city came under the authority of the Dutch. Later, the city came under British authority twice, the first time from 1781 to 1784 during the Fourth Anglo-Dutch War, and again from 1795 to 1819 during the Napoleonic Wars. Afterwards the city was transferred back to the Netherlands. Until approxi-

mately 1780 the most important trade product was gold, originating from the gold mines in the region. When the mines were exhausted, the emphasis shifted to other products such as coffee, salt and textiles. At the time of independence, the city had around 50,000 inhabitants. Coffee was still important, but copra was also a major item produced by farmers in its hinterland. The population growth has been partly a result of growth in the area of the city, but is mainly a result of the migration to major cities seen in so many developing nations. In 1950 there was also development of the Ombilin coal field, with Padang as its outlet. This is an indication of the colonization of Indonesia having been economic as well as political. Padang is not a popular tourist destination but it is a common transit point for travelling to other islands, and for tourists visiting the West Sumatran highlands.

According to local social indicators, the life expectancy is 68.2 years in Padang while the literacy rate is 96 per cent and there is 8.0 years of schooling (see Table 1). The relatively high educational indicators are influenced by the fact that Padang established an education system very early, for example Andalas University. The overall Human Development Index (HDI) is 70 per cent, while the infant mortality rate and the crime rate are 48 per cent and 7203 respectively. The Gross Regional Product in West Sumatra including Padang is 17.5 Million Indonesian Rupiah per year.

In contrast, Bali (see Figures 8 and 10) is an Indonesian island located at the westernmost end of the Lesser Sunda Islands, lying between Java to the west and Lombok to the east. It is one of the country's 33 provinces, with the provincial capital at Denpasar towards the south of the island. Bali had a population of 3.15 million in 2005.

Figure 10: Map of Bali



Source: UNU-EHS and DLR.

Historically, about 2000 B.C., the Austronesian people migrated from Taiwan through Maritime Southeast Asia to Bali. Therefore, the Balinese people are culturally and linguistically closely related to the peoples of the Indonesian archipelago, the Philippines and Oceania. When the empire of the Hindi Majapahit Empire (1293-1520 A.D.) on eastern Java declined in 1343, there was an exodus of intellectuals, artists, priests and musicians from Java to Bali in the 15th century.

In 1597, the first European, a Dutch explorer, made contact with Bali. The Europeans used the strategies of distrustful Balinese realms against each other and the Dutch began to take political and economic control over Bali. In the late 1890s, struggles between Balinese kingdoms in the island's south were exploited by the Dutch to increase their control. Following the conflict and wars, the Dutch governors were able to exercise administrative control over the island, but local control over religion and culture generally remained intact. During World War II, Imperial Japan occupied Bali, but the Dutch promptly returned to Indonesia to reinstate power, including over Bali, following Japan's surrender in August 1945. However, following further fighting, the Dutch wiped out the last traces of Balinese military resistance. In 1946, the Dutch constituted Bali as one of the 13 administrative districts of the newly proclaimed State of East Indonesia, a rival state to the Republic of Indonesia, which was proclaimed and headed by Sukarno and Hatta. Bali was included in the "Republic of the United States of Indonesia" when the Netherlands recognized Indonesian independence on 29 December 1949. After 1965/66, Bali emerged in a modern form, and the resulting large growth in tourism has led to a dramatic increase in Balinese standards of living and significant foreign exchange earned for the country. Tourism is now the largest single industry, and as a result, Bali is one of Indonesia's wealthiest regions. About 80 per cent of Bali's economy depend on tourism. Previously, the Balinese economy was agriculture-based.

About 93 per cent of Bali's population adheres to Balinese Hinduism, formed as a combination of existing local beliefs and Hindu influences from mainland Southeast Asia and South Asia. Minority religions include Islam (4.79 %), Christianity (1.38 %) and Buddhism (0.64 %). When Islam triumphed over Hinduism in Java (16th century), Bali became a refuge for many Hindus. Balinese Hinduism is an amalgam in which gods and demigods are worshipped together with Buddhist heroes, the spirits of ancestors, indigenous agricultural deities and sacred places. It pervades nearly every aspect of traditional life. There are an estimated 20,000 temples and shrines, and this is why Bali is known as the "Island of the Gods". Balinese and Indonesian are the most widely spoken languages in Bali, and the vast majority of Balinese people are bilingual or trilingual. Balinese culture was strongly influenced by Indian and Chinese, and particularly Hindu culture, in a process beginning around the 1st century A.D. Bali is renowned for its diverse and sophisticated art forms and boasts one of the most diverse and innovative performing arts cultures in the world.

Basic socio-economic indicators show that the average annual population growth in the year 2000 was 1.31 per cent compared to Padang at 0.63 per cent in 2000. Social indicators such as life expectancy are slightly higher by 3.1 per cent in Bali with an age of 70.4 compared to Padang at 68.2 years of age. However,

Bali has a slightly lower literacy rate and fewer years of schooling of 86.2 per cent (–9.8 %) and 7.4 years (–8.1%) compared to Padang with 8.0 years of schooling. Therefore, the overall HDI is slightly lower in Bali at 69.1 per cent (-2.0 %) compared to Padang with an HDI of 71.2 per cent in the year 2005. Infant mortality and the crime rate are lower in Bali by 17 per cent and 22 per cent respectively compared to Padang. In terms of economic indicators, the GDP is higher by 41 per cent for the whole of West Sumatra-Padang compared to Bali. However, in terms of tourism-related activities, Bali receives a total of 15,045 tourists per day while Padang receives only 1,272. Hence, tourism is 91.5 per cent higher in Bali than in Padang. Table 1 summarizes the key socio-economic and demographic characteristics of West Sumatra (Padang) and Bali in Indonesia.

Table 1: Local geography-socio-economic indicators of West Sumatra (Padang) and Bali

Dimension	Socio-Economic Indicators	West Sumatra (i.e. Padang)	Bali
Geography	Area (km^2)	694.96	5,632.86
	Population – 2000	750,000	3151162
	Population Density (Pop/km^2)	1,090	630.4
Socio	Religion (%)	98 Muslim majoriy	93.2 Hinduism majoriy
	Average Annual Pop Growth Rate (%) 1990–2000	0.63	1.31
	Live Expectancy – 2005 (%)	68.2	70.4
	Literacy Rate (%) – 2005	96	86.2
	Mean Years of Schooling – 2005	8	7.4
	HDI (%) – 2005	71.2[9][a]	69.1 [15]
	Ranking in Indonesia – 2005	9	15
	Infant Mortality Rate – 1999[b] (%)	48	31
	Under Five Mortality Rate (%) – 1999	62.2	38.06
	Crime – 2005	7203	5902
	DIPLOMA i/ii (%) – 2005	25.136	23.984
	University (%) – 2005	73.021	72.241
	Quantity of Cleanded Water Distribution to Customers 2006	40,280.00	78580
Economic	GRDP at Current Market Prices, 2007 (Million Rp)	59,799,045.30	42,336424
	Total Foreign Guests per day – 2008	220	11,759

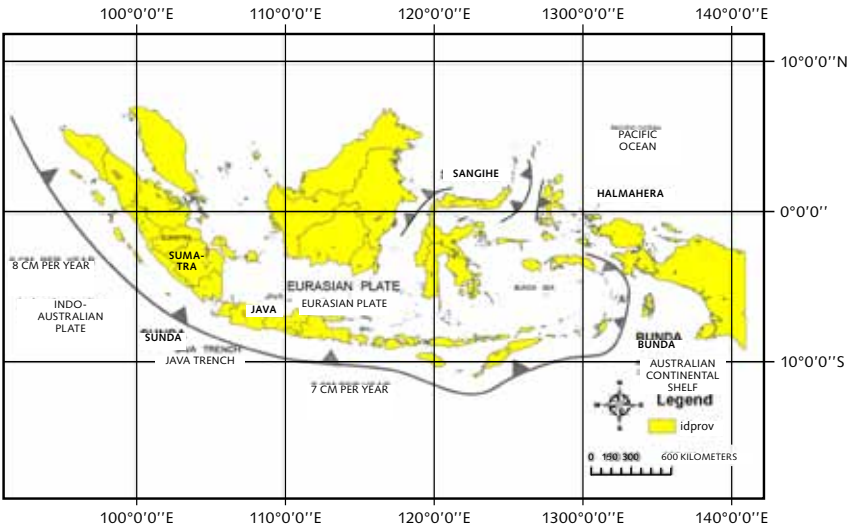
[a] Rank in Indonesia
[b] No recent updated data

Source: Statistics Indonesia of the Republic Indonesia, Badan Pusat.[v]

3.1.2 Tsunami risk in Padang and Bali

Padang is a large coastal city sitting 40 km above the most earthquake-prone stretch of the interface between the Indo-Australian and Eurasian plates (see Figure 11).

Figure 11: Geological setting around Indonesia



Source: Author. After Gertisser and Keller 2003.

According to Hamzah, Puspito and Imamuru (2000), destructive earthquakes and tsunamis originate from the seismic region of the Western Sunda Arc, the Eastern Sunda Arc, the Banda Arc and the Makassar Strait (see Table 2). The seismic zones of the Western and Eastern Sunda Arcs are potential earthquake-tsunami sources for Padang while the Eastern Arc, the Banda Arc, and the Makassar Strait affect Bali. The number in brackets indicates tsunami-related statistics. There have been about 117 disastrous earthquakes and 26 tsunamis in the zones of the Western and Eastern Sunda Arcs relevant to Padang with a total of 39,621 fatalities killed from tsunami.

Table 2: Destructive earthquakes and tsunami activity around Indonesia

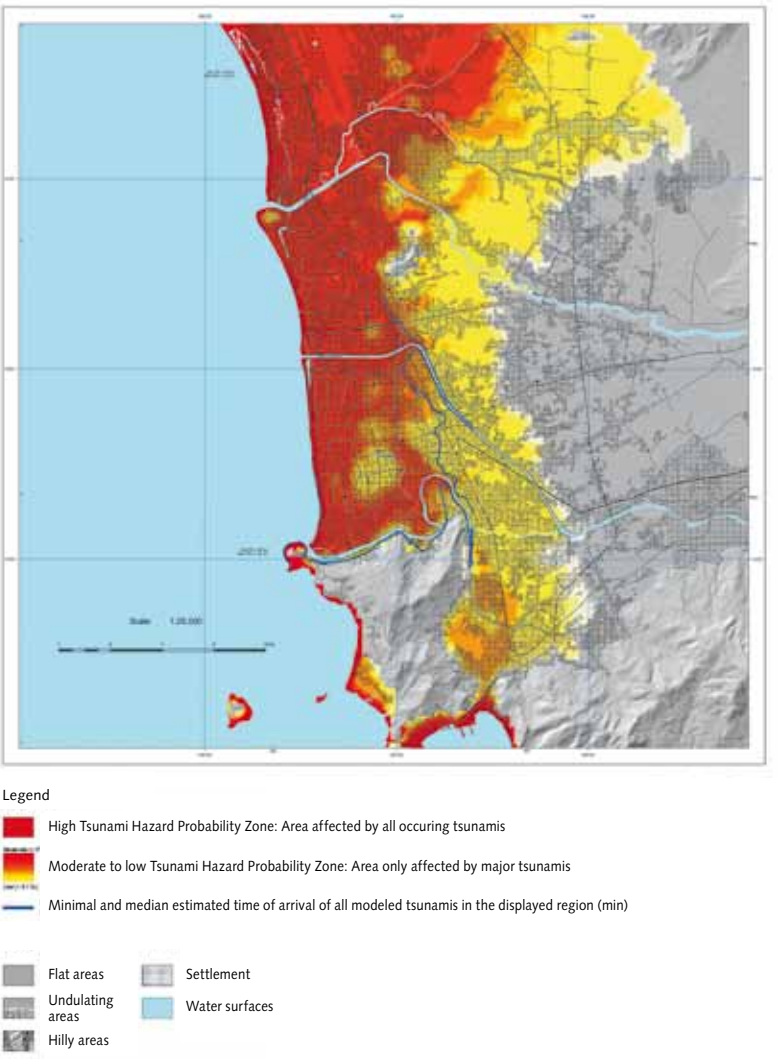
Region	Number of disastrous Earthquakes and Tsunamis	Percentage of Occurrences	Number of Fatalities	Percentage of Fatalities
Western Sunda Arch	35 [16]	19.1 [15.3]	716 [36,360]	6.7 [67.7]
Eastern Sunda Arch	82 [10]	44.8 [9.5]	2502 [3261]	24.9 [6.0]
Banda Arc	20 [35]	10.9 [32.3]	285 [5,570]	2.7 [10.3]
Makassar Strait	10 [9]	5.5 [8.6]	2 [1,023]	0.0 [1.9]
Others	183 [105]	100	54,147	100

Source: Derived from Hamzah et al. (2000).

In 1797, Padang was inundated by a tsunami with an estimated flow depth of 5–10 metres, following an earthquake estimated to be 8.5–8.7 moment magnitude, which occurred off the coast (see Table 3). The shaking caused considerable damage and the deaths of two people. In 1833, another tsunami inundated Padang with an estimated flow depth of 3–4 metres as a result of an earthquake, estimated to be 8.6–8.9 moment magnitude which occurred off Bengkulu. The shaking and tsunami caused considerable damage in Padang.

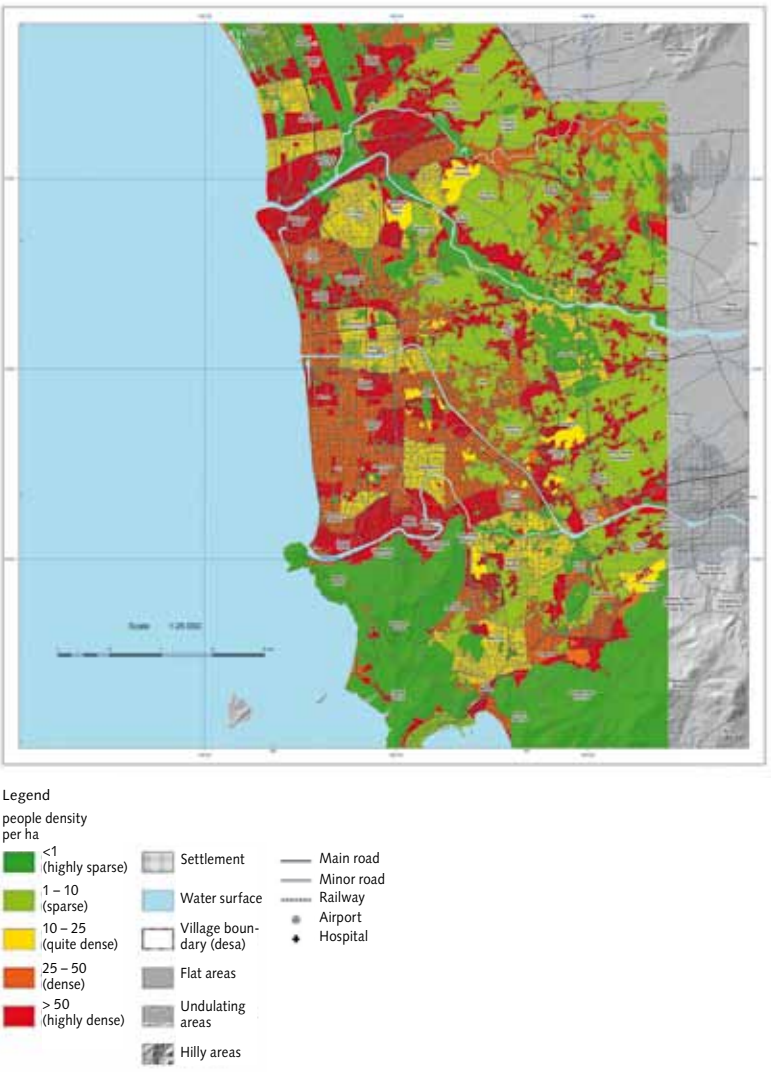
This interface has not experienced the stress relief of an earthquake for over 200 years. According to New Scientist (02/10/2009), Mc Closkey's analysis of historical coral growth rings, shows no sign of seafloor uplift. GPS measurements of the rate of plate motion suggest that there have been around 13 metres of movement in this area over the same period. *"A shallow earthquake at the plate interface off Padang is long, long overdue"*, says McCloskey. Konca et al. (2008) have shown that the earthquakes of March 2005 with moment magnitude of 8.6 Mw occurred at the site of a similar event in 1861, and large earthquakes also occurred in the Mentawi area in 1797 (Mw 8.8), 1833 (Mw 9.0); in September 2007 two mega earthquakes of 8.4 and 7.9 Mw occurrence represented only a fraction of the rupture in 1833. The interface consisted of distinct asperities within a patch of the mega-thrust that had remained locked in the inter-seismic period. In other words, the moment released in 2007 amounts to only a fraction of both that released in 1833 and the deficit of moment that had accumulated as a result of inter-seismic strain since 1833. It can be concluded that the potential for a large mega thrust event in the Mentawi area remains large. Therefore, Padang is a large city with a high risk of being impacted by an earthquake-generated tsunami. Figures 12 and 13 show the latest tsunami hazard probability scenario of daytime population exposure to tsunami hazards. The whole coast of Padang is characterized by high to moderate tsunami hazard probability and population exposure to tsunami.

Figure 12: Tsunami hazard map for Padang



Source: DLR in the framework of the GITEWS project 2009.

Figure 13: Tsunami hazard exposure: daytime population



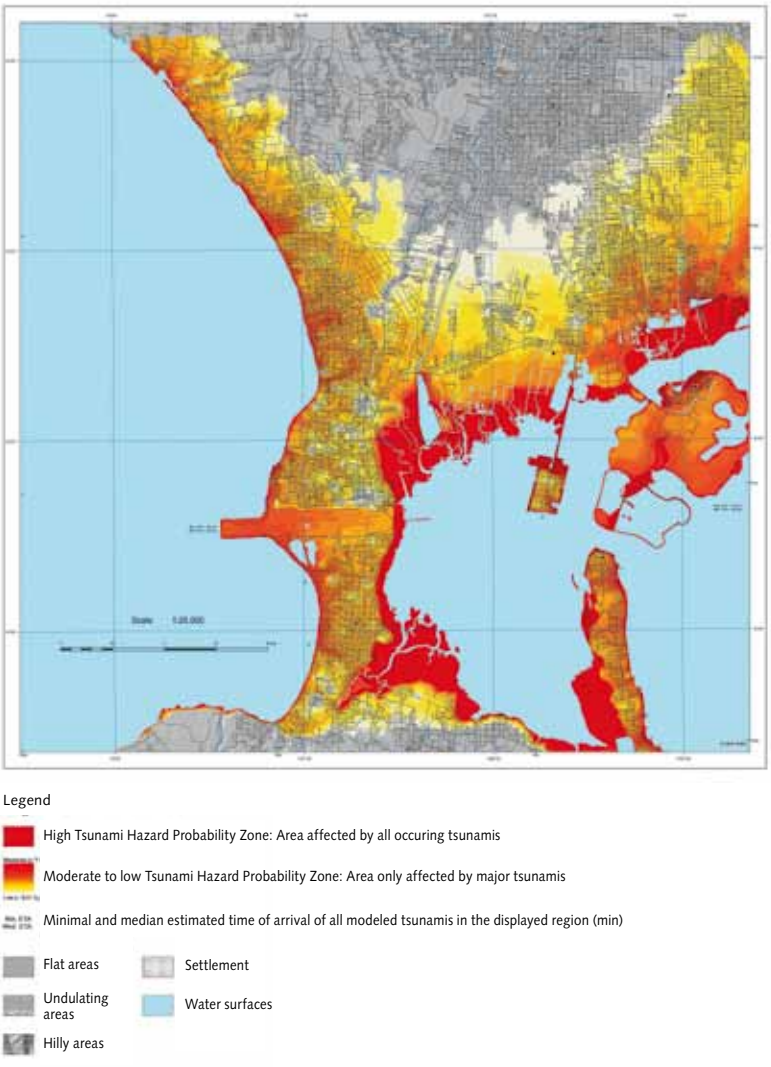
Source: DLR in the framework of the GITEWS project 2009.

On the other hand, the very same fault line, which caused the 26 December 2004 tsunami, where the Eurasia plate pushed over the Australia plate, runs just south of Bali and causes some worry about the extra tension created between the plates just off south Sumatra, Java and Bali by the December 2004 disaster. Therefore, the major tectonic feature in the region is the Sunda Arc, which extends approximately 5,600 km between Andaman Island in the northwest and the Banda Arc in the east. The island arc results from convergence and subduction of the Indo-Australian plate beneath Southeast Asia. The direction of plate convergence between Southeast Asia and the Indo-Australia plates is assumed to be about north-south and the overall rate of convergence is probably about 7.7 cm per year.

According to further calculations based on Hamzah et al. (2000) data, there have been about 112 disastrous earthquakes and 54 tsunamis in the zones relevant to Bali with a total of 9,854 fatalities representing 18.2 per cent killed from tsunamis. The deadliest event in Bali was in the year 1816 with 10,253 fatalities. There is almost an equal number of earthquakes in the north. There are more tsunamis generated in the southern zones, but the tsunamis to the north are more disastrous. Table 3 summarizes the earthquakes and tsunamis generated and the level of impacts in Bali and Padang respectively, compiled from different sources. The events and statistics have been cross checked, but do not necessarily show all the events and disasters.

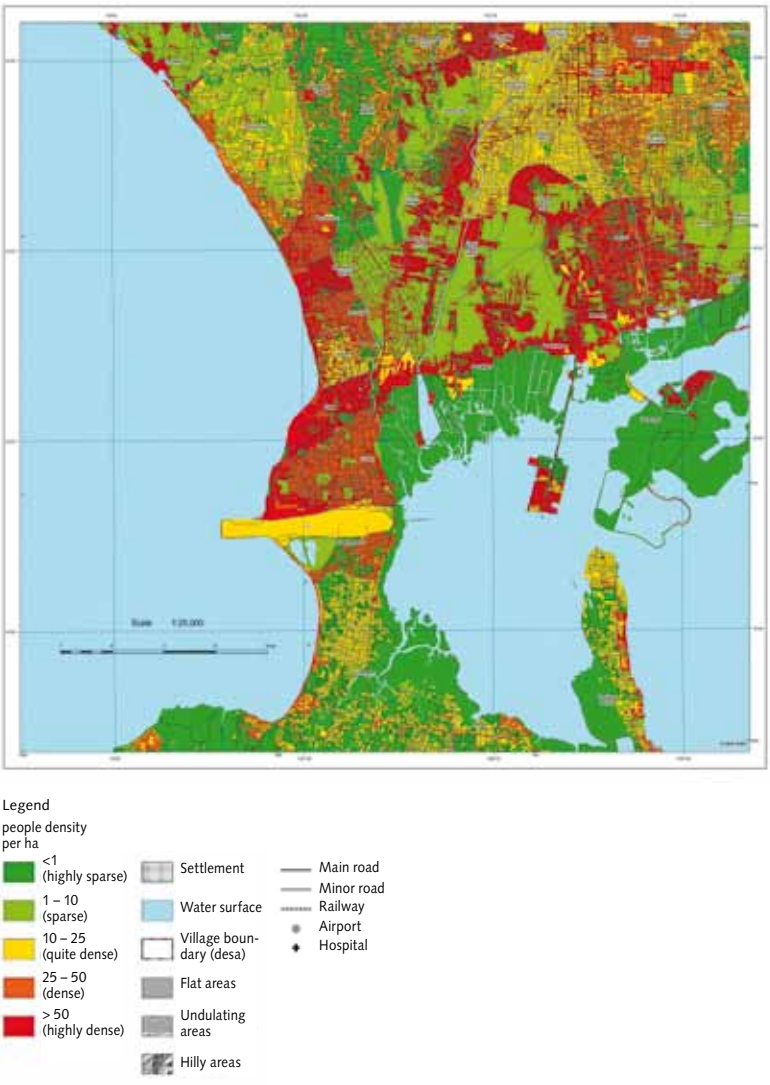
The City of Denpasar, the capital of Bali Province, is considered one of the most densely populated cities in this province. The recent tsunami hazard probability scenario and daytime population exposure to tsunamis for the southern coast of Bali are shown in figures 14 and 15 respectively. There is a moderate to high tsunami risk potential for most of Kuta, South Bali. The maximum risk is located east of South Kuta and along the Sanur coast. Interestingly, the daytime exposure is highest to the west of Kuta and inland of the Sanur area. Clearly, both areas have high earthquake-tsunami risk probability. Overall, as mentioned by the Bali Hotel Association (BAH) Tsunami Alert Coordinator[vi] "*Bali is one of the world's international tourism icons, and needs to be prepared for possible tsunami disasters*".

Figure 14: Tsunami hazard map of South Bali, Guta



Source: DLR in the framework of the GITEWS project (2009.)

Figure 15: Exposure map of daytime population in South Bali, Guta



Source: DLR in the framework of the GITEWS project (2009).

Table 3: Statistics of earthquakes, tsunamis, and level of impacts in Bali and Padang

Areas	Year	Earthquake Magnitude (Mw)	Flow Depth (m)	Death Toll	Level of Damage
Bali	1816*	–	–	10,253	–
	1840***	–	–	–	–
	1859*	6.0	–	–	Some damage
	1862*	7.0	_	_	_
	1867***	–	–	5	–
	1875***	–	–	7	–
	1896*	7.0	–	250	–
	1917*	–	–	1500	–
	1950*	7.0	–	–	–
	1976*	–	–	6000	75 % of buildings in the area damaged
	1979*	–	–	24	–
Padang	1797**	8.7–8.9	5–10	2	Several houses washed away
	1833**	8.9–9.1	3–4	Numerous but unknown	Considerable damage
	1861*	–	–	725	–
	1935**	7.7	–	11	–
	2000**	7.9	–	–	–
	2005**	8.6	–	–	–
	2007**	7.9	–	–	–
	2009	7.2	–	1100	–

Source: Hamzah et al.(2000); **Konca et al. (2008);***NewComb and McCann (1987).*

3.1.3 Pilot areas of the German Indonesian Tsunami Early Warning System Project

The rational for selecting these two locations was that they are also GITEWS pilot project areas. The pilot areas will be used to show lessons learned and best practices developed for the development of a national TEWS in Indonesia. It should be pointed out that the author also spent a significant amount of time in Jakarta, the capital of Indonesia. This was because the TEWC with all the other key international and national institutional actors such as UNDP, UNESCO, the coordinator of the TEWS (State Ministry of Research and Technology (RISTEK)), the National Disaster Management Agency (BNPB), etc. are actually located in Jakarta.

3.2 Field research methods

The empirical data on which the main analyses are based was collected during three stages of field work. The first field trip took place in Jakarta, Indonesia over a period of six weeks from mid-October to the end of November 2008. The primary objective of the first mission was to start the process of establishing a network of actors to be interviewed. Secondly, the in-depth and informant interviews were initiated in Jakarta with the international and national actors. Thirdly, because the research permit was still in the process of approval, it was necessary to start engaging in the collection of data by participating in meetings, workshops and conferences both in Jakarta and Bali. These included observing the International Conference of Tsunami Early Warning: Resilience coastal Communities, 12–14 November 2008, Nusa Dua Bali and participating in the IOC-UNESCO-IOTEWS International conference in working group six on preparedness.

When returning to UNU-EHS, the research questions were re-examined and fine-tuned based on the first field trip experience. It was also necessary to reduce the number of questions as the interviewees said the interview was very long, sometimes exceeding three hours. In Jakarta, the researcher was briefly based at BGR/InWent[vii]. This provided the opportunity to meet different actors and strengthen the network while sharing useful and practical field trip advice.

The second phase of the field trip was very intense. It started in early January 2009, even though it was rainy season with frequent flooding in Jakarta. The plan was to avoid planning a second field trip that would coincide with the national parliamentary and presidential election scheduled for the second quarter of the year. Usually the political campaign in Indonesia starts early and actors' interest and priorities would probably shift during these times. It was also necessary to exercise basic safety and security procedures and avoid being in the field during these periods. The second field trip ended close to mid-March of 2009. It consisted of three field visits. In the first two to three weeks, the in-depth informant interviews and the process of observing meetings and workshops continued in Jakarta with actors at international and national level. This was followed by a second field trip to Bali, where the author stayed in Sanur to conduct the interviews and focus group discussions (FGD). While operating from Sanur, the author also travelled to Nusa Dua where most tourism activities are concentrated. In addition, the author also participated in another German Technical Cooperation (GTZ-IS) workshop with the objective of reviewing the progress of TEWS capacity-building at the community level and planning for the next steps. After completing the primary data collection in Bali, the author returned to Jakarta to organize the final field trip to Padang.

The last field trip was more challenging because the awareness and perception of the higher earthquake-tsunami risks in Padang contrasted with the many poor buildings and inadequate infrastructure. There were few options for hotel accommodation in Padang. On this note, the researcher stayed at the Ambacang hotel. Several months later, on 31 September 2009, Padang was hit by an undersea earthquake of 7.6 moment magnitude which razed a large part of the city to the ground killing more than 1100 people, with as many as 5000 people left homeless. The five-storey Ambacang hotel collapsed like a pancake. At least 80 people were

missing at the Hotel (Reuters 02/10/2009). One man was later rescued. Currently, no official figures for the victims killed in the hotel have been officially published. At that time, the researcher followed the earthquake disaster news with grief from Germany. The event highlights the risks many hazard-disaster–risk researchers constantly face on a daily basis.

The third field trip in April 2010 was very brief and included informant interviews to fill the identified gaps, observations of the latest developments, participation in and feedback from workshops and conferences in Padang, Aceh and Jakarta, Indonesia.

3.2.1 Expert in-depth interviews on multiple levels

As a foreigner in Indonesia with limited resources and logistical support, it was important to be highly efficient in the data collection process. The approach adopted was "*no entry without a strategy*". As a first step it was necessary to develop a theoretical framework and broad research questions before heading for Indonesia. The main questions developed were based on the synthesized governance-institutions-EWS-resilience theoretical framework. The in-depth actor interview was the principle method of data collection at international, national and sub-national levels.

The expert qualitative interview was selected as the key method for collecting primary data at multiple levels and cross-scales in Indonesia. Today, the expert interview is considered a standard method of qualitative approach in divergent fields of the political and social sciences, such as international relations, science and technology studies, organizational research, gender studies etc. It is frequently applied in empirical research (Bogner et al. 2010). Therefore, the method seems suitable compared to other methods for this kind of study. Normally, experts are responsible for the development, implementation or control of solutions/strategies/policies and may have privileged access to information about groups of persons or decision processes (Meuser and Nagel 1991). In other words, they have direct or indirect decision powers, technical knowledge in the field such as details on operations, rules, process knowledge and explanatory knowledge. On the other hand, the drawbacks of the expert interview are that the knowledge obtained is not always neutral, and there is also the issue of experts and counter experts. The method has rather high effects of interaction and is not rigorously standardized. Other weaknesses are the dangers of anecdotal and illustrative information. This weakness was noticed for some key high profile people who wanted move off the subject to explain actual experiences or events. Furthermore, clearly this interview method is not inter-subjectively repeatable.

Initially, the in-depth interview consisted of 60 questions; however these were reduced to 40 questions following the feedback and experience of the first field trip. The interview questions were designed with a first level giving the interviewee a chance to answer either *yes*, *no* or *unsure*. The second level of interview consisted of the open-ended unstructured questions of *what, when, how, why, who*, etc. In addition, for some questions there was a scale to rank the priority of the issue to be addressed. For example, if the interviewee said there was no multi-hazard

framework it was important to capture if it was a low, medium or high priority to establish one etc. The questions were initially examined by a social science PhD student with sufficient years of field work experience. The questions were further circulated among one or two close friends to have their input and comments on the overall presentation and clarity of the questions.

The selection of the interviewees depended on a combination of factors such as the degree of involvement in the TEWS or DM in Indonesia. Secondly, it was important to select different actors in the chain from international level to local level and those with similar, deviant views. For example, groups not in favour of a technical TEWS contrasted with groups or individuals favouring social aspects of TEWS and typical critics of the TEWS based on different aspects or field impacting issues. However, the experts selected were not necessarily the top experts but a mixture, as the study interviewed actors at multiple levels and scales such that the likelihood of any expert lacking knowledge on the issue of interest was minimized while some lower actors selected were committed and probably had much more detailed knowledge and more time available This ensured that the sample was as diverse as possible, representing the entire range of the actors involved.

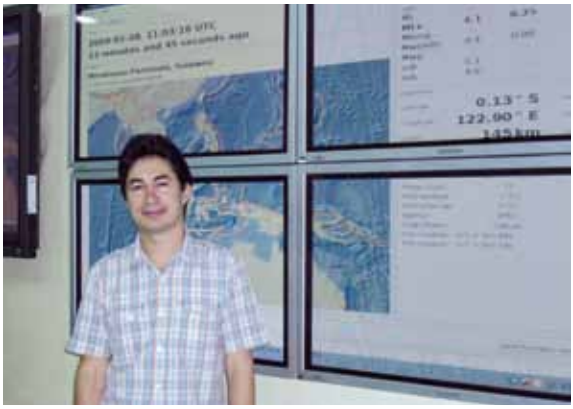
The actors selected were identified through a variety of methods but initially with specialized conference/workshop and meeting reviews and then gradually shifting to the snowballing method. Very few actors were selected based on literature review in Indonesia. Most interviewees selected were either initially contacted by electronic mail and by phone to organize the interview. This ensured that interviewees were willing to openly corporate. The goal and scope of the interview was introduced and briefly discussed with each actor interviewed. It was firmly established that the research was purely academic with potential recommendations for further improvements of the system, but it was made clear that there were no direct benefits. The interviewers were free to indicate if they would remain anonymous, such that their names would not be passed to third parties when writing up the research. In reality, very few actors actually decided to remain anonymous. On the other hand, some actors have been critical on some issues and there can be consequences either within their own organization or between actors of different organisations. Therefore, a decision was made to standardize the process of reporting the interviewee's statements. Hence, the names of the interviewee's are not listed; however, their respective organizations are indicated.

The author did not record the interviews because it was clearly outlined that the interview would take two to three hours or more and there was adequate time to write down the responses on paper. This was an advantage to the author because it prompted listening and understanding and the chance to interact and stimulate discussions with a view to going deeper into the different issues. Depending on a recording instrument would not have provided the same alertness and immediate grasp of the answers.

The sample size of the survey depended on the overall number of actors in the action arena. The sample size was moderate in relation to the total number of potential actors involved in TEWS and DM. The sample size consisted of 25 institutional actors. The advantage of this moderate-sized group of interviewees is

that detailed and qualitative data can be drawn to address the research questions. It was also fairly easy to follow up with certain interviewees, especially non-state actors while in Germany when writing up the research. The in-depth interview focused on generating information on a range of issues from risk knowledge, to response, governance and institutional aspects of the TEWS and DM in Indonesia. It is also highlighted that a so-called strength, weakness, opportunity, threat (SWOT) analysis was carried out during the in-depth interviews.

Figure 16: Researcher at the National Tsunami Early Warning Centre, Jakarta



Source: Author (2009).

Figure 17: Meeting with the local government authorities (right) in Kuta, Bali

Source: Author (2009).

3.2.2 Key informant interviews

Some actors were carefully selected as key informants. These were the main practitioners in the TEWS and DM process. They were familiar with the details of all elements of the TEWS and DM. At the national level the key resource persons were the actors carrying out capacity-building in the pilot areas – policymakers, chairpersons and those facilitating institutional development nationally. At the local levels, key informants were the actors leading the implementation of activities within the community. Key informant interviews were mainly carried out on the telephone and by electronic mail and consisted of several questions and sometimes further clarifications on ongoing and changing activities in the field.

3.2.3 Focus group discussions

FGDs are an important form of qualitative methodology to collect data from a group of individuals and to discuss and comment on issues based on personal experience on the topic of the research. They can be used to explore a range of opinions and views on a topic of interest. They complemented the main in-depth interview by providing information based on the interaction through discursive short debates between different actors on the different issues raised. A typical criticism of a FDG is that the researcher has less control over a group and this causes more trouble than it is intended to solve with contributors aiming to please rather than offering their own opinions (Rushkoff 2005).

FGDs were conducted only at the local level in Padang and Bali, involving three to six actors mainly from the local national disaster management agency, and the Emergency Operations Centre (EOC). It was a suitable method to discuss issues at ground level, for example in capturing the actual implementation and status of TEWSsDM at the local level, and difficulties and challenges encountered derived from different angles of the people's perspectives on different issues. In addition, it proved particularly useful when there were limitations in language communications. Other participants would help in the translation and communication of the discussion. In one instance, the head of the local DM agency requested further help from his daughter, a student from Andalas University, with the translation and communication during the discussions. In the end, it was an exciting experience and was very fruitful.

3.2.4 Interviews with some deliberately selected coastal inhabitants

This research focuses on inter-institutional actors from the international level to the local level (i.e. districts). Therefore, it was not possible to conduct a comprehensive community survey to address various issues such as the community participation, cooperation and trust in the TEWS to capture the effectiveness and the legitimacy of the TEWS. Therefore, considering the limitations, interviewers with some deliberately selected coastal inhabitants were carried out along the coast of Bali and Padang to try and capture the issues of community preparedness in terms of their risk concern, risk knowledge, questions on living with the risk, risk zoning and its enforcement. The number of questions was rather small, targeting the local fishermen, restaurant owners and coastal tourism-related shop owners, etc. Recent literature on the subject will be used to triangulate on the issue.

3.2.5 Electronic mail survey for the tourism-related sector

Tourism-related activities most often take place along the coast. These activities attract not only tourists but a diverse range of business such as restaurants, souvenir shops, boat charters, fishing, etc. These structures and activities are widely exposed to tsunami hazard and automatically fall in the tsunami high risk areas. The main economy of Bali is based on tourism activities. Therefore, a quantitative survey was designed to capture the status of the "last mile" part of the end-to-end TEWS along the coast. The selection process was simply based on the position of the establishment in the known tsunami hazard risk zone and whether the establishment had an active electronic mail system on their official website.

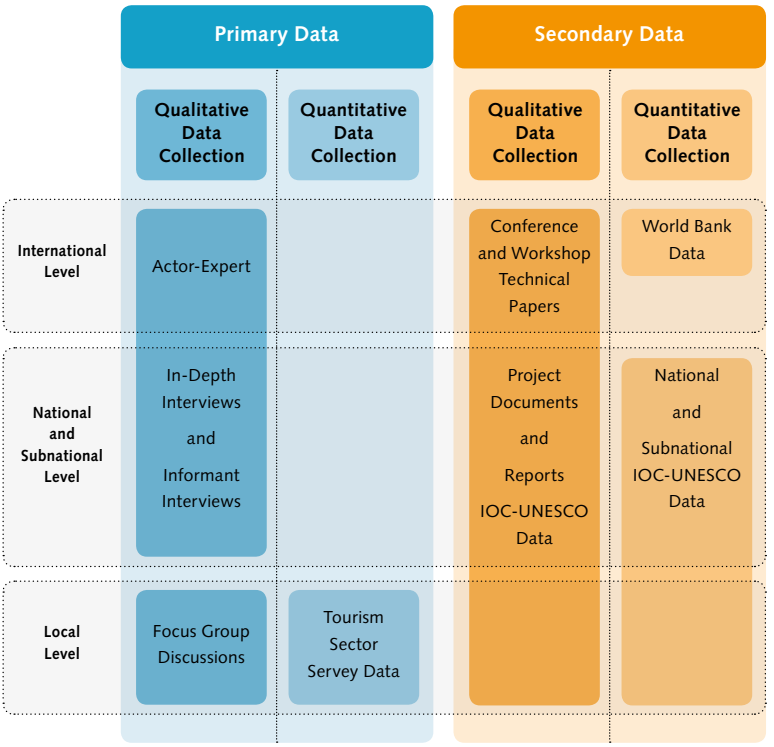
The survey consisted of 25 closed questions focused on tsunami perception and institutional preparedness covering issues of risk knowledge, education and awareness activities, tourist concern for tsunami risk, tsunami information delivered to the establishment from the authorities, accuracy, and whether information was timely and clear enough to make informed decisions. The most important questions focused on whether the establishment had a tsunami receiving information system and had evacuation plans and procedures in place coordinated with the local authorities, and what would be their interest in arranging these if there were none. Other questions related to private-public partnership in this national effort. The survey form was sent to 50 hotel tourism-related establishments between the months of July and September 2009. The hotel-related establishments were free to indicate whether their establishment wanted to remain anonymous. It was clearly indicated that the establishment name would not be passed to any other third party for any other purposes and the survey was only for academic research. Unfortunately, the feedback was fairly disappointing with only 16 establishments returning the questionnaire; nevertheless very useful and important information could be derived from the exercise. In Padang, tourism activities are very low. Therefore, a similar sector survey was planned for the industrial sector. However, following the major earthquake this survey was cancelled.

3.2.6 Secondary data collection

Secondary data were collected from various sources such as conference proceedings, papers, project and research documents and reports. Data were also extracted from variousinternational (i.e. World Bank) and government databases (i.e. Ministry of Finance, BMKG, Statistical Bureau and the National Disaster Management Agency (BNPB)) etc. Furthermore, it was also decided to collect and employ media material for the study.

Figure 18 shows the overall structure of the data collected, consisting of primary, secondary, qualitative and quantitative data for the research.

Figure 18: Overview of various data collected and their sources



Source: Author.

3.3 Difficulties and challenges encountered during field research

3.3.1 Access to the research areas

The procedure to obtain a research permit in Indonesia was very long, consisting of a number of administrative steps involving different organizations at various levels and places all over Jakarta. The initial problem was aggravated by the challenge to find a local research partner in Indonesia relevant to the study which would also satisfy the authorities in Indonesia. The research permit process was very time-consuming which almost derailed the whole study in Indonesia.

3.3.2 Funding difficulties

The research funds were only released by the project donors on an annual basis and covered a maximum of only six weeks per year. This implied that field trips could not be extended beyond two months for each field trip per year. The other challenge was that the research funds were limited and it was not possible to employ translators or research assistants.

3.3.3 Difficulty in maintaining good rapport with the state actors

The TEWS and DM process is a fluid and dynamically evolving matter. Many issues on institutional architecture, such as local regulations and Standard Operation Procedures (SOPs) were still being addressed while in the field. Therefore, the researcher maintained communication with different actors throughout the study period; however, feedback was poor from national state actors once back in Germany but was excellent with non-state actors.

On the other hand, one problem which emerged in the later part of the study was that on 31 September 2009, Padang was hit by a major earthquake that killed many people and caused widespread damage. Much of the city was in a crisis-like situation. The local DM authorities, local emergency operations and partners' priorities changed from preparedness to response and recovery following the earthquake. This disrupted normal life for many people, hence communication with partners deteriorated. It was rather difficult to contact the informants and have timely feedback as their priorities had changed, but the rapport from the local level gradually improved after some time.

3.4 Data analysis techniques and tools

3.4.3.1 Qualitative data analysis

A category system is first developed according to the researcher's existing theoretical knowledge, concepts and research questions which are not empirically tested but have a heuristic function, background knowledge for a specific research situation, and empirically verified social theories (Kelle and Kluge 1999). However, more categories and codes emerge during actual data analysis.

The data analysis process is based on the qualitative data analysis process as described by Powell and Renner (2003). It consists of five steps. After examining the data collected, the second step of the analysis focused on how all actors responded to each question within each topic (risk knowledge as part of the TEWS, participation as part of governance, legal arrangement as part of architecture, etc.).

All the data from each question was organized together by paying close attention to the actors' operational level (i.e. international, national, province, district, etc.). As the analysis progressed further, a combination of techniques by either time period or event (specific earthquake-tsunami event) or by case (i.e. such as non-government organizations (NGOS)) was required. The third step of the analysis involved categorizing the information. This involved identifying or grouping themes or patterns and organising them in coherent categories. As the categoriza-

tion progressed, new themes were identified and were treated as sub-categories. The fourth step included identifying patterns, connections and relationships between categories and importance. The last part of the analysis involved pulling together all the analysis for final interpretation of the data and proposing new concepts and ideas (i.e. Chapter 9). Since the data collected was relatively small, the software used to analyse and categorize the data was Microsoft Access.

3.4.3.2 Quantitative data analysis

Apart from the primary data collected, secondary quantitative data were also collected from the World Bank. World Governance Indicators (WGIs) based on several hundreds of individual variables measuring perceptions of governance, drawn from 35 separate data sources constructed by 33 different organizations from around the world, were also used in the research. Simple analysis was carried out using either SYSTAT (Statistical Analysis Software) or Microsoft Excel software.

3.5 The researcher's role

According to Lee-Treweek and Linkogle (2000), the process of collecting data in empirical social science risks four key categories of danger, namely physical, emotional, professional and ethnical. In regard to the fieldwork conditions concerned, the latter issue is found to be of particular relevance, basically due to the development-oriented project approach, the focus on qualitative research techniques. Each empirical social science development research in (and on) other cultures raises ethical problems. Hence, ethical concerns have to be considered fundamental when conducting intercultural development research in any region of the world.

It is also unavoidable that the researchers incorporate their own "personal potential" into research (Seiffert 2003: 257). However, subjectivity of a researcher is not viewed as an alarming variable which impairs research results; rather, it is part of the research process. Therefore, the researcher in that case exercise diligence to reduce such risks in collecting and in the interpretation of the data collected.

4. Tsunami warning capacities before 2004 and governance in Indonesia

This chapter examines a number of questions, namely: (1) What were the prevailing tsunami capacities before the December 2004 tsunami and how were these capacities exceeded? How and why were the existing coping capacities severely exceeded? Understanding the existing and entry conditions prior to a major disaster is important (IRG 2009a) because the resilience and vulnerability of socio-ecological systems surface during these critical times and analysing them closely determines to a considerable extent how well the socio-ecological system in question will be able to deal with shocks in future. In order to answer these questions, a review and a detailed analysis of the IOC-UNESCO report document for Indonesia is revisited. The questionnaire was initially completed by diverse institutional actors involved in the different components of the TEWS through electronic communication. The questionnaire[viii] was finalized through a stakeholder workshop in Indo-

nesia from 29 August until 2 September 2005. The other questions addressed are (2) What were the hindering factors and driving forces for institutional change?, (3) What are the environmental consequences of lack of TEWS governance and (4) What are the prevailing macro level systems of governance to support the TEWS in Indonesia?

To capture and analyse tsunami EWS capacities, the ISDR effective EWS framework and the attributes of the resilience framework (Lebel et al. 2006) are employed by revisiting the IOC-UNESCO (2005) tsunami survey questionnaire in Indonesia. The third step analyses the consequences of non-operational TEWS in Indonesia in terms of impacts, while the last section analyses the macro level systems of governance using the World Bank's Knowledge Assessment Methodology (KAM) database (2008) and other sources.

4.1 Early warning capacities perspective

4.1.1 Risk knowledge

ISDR outlines risk knowledge as the systematic collection of data and the undertaking of risk assessment. Risk assessment and maps are common forms of risk knowledge creation. The risk assessment and knowledge creation process has three steps: (i) identifying the nature, location, intensity and probability of a threat (hazard assessment); (ii) determining the existence and degree of vulnerability and exposure to those threats (e.g., the physical and socio-economic spheres) and (iii) identifying the coping capacities and resources available to address or manage threats. Risk knowledge allows decision makers and the community to understand their exposure to various hazards and their social, economic, environmental and physical vulnerabilities. The question is what was known in terms of risk knowledge before the tsunami disaster.

The majority of the destructive tsunamis (90 %) in the Indonesian region have been caused by earthquakes (Hamzah et al. 2000). Few of them were actually caused by volcanic eruptions and landslides that occurred in the sea. On the one hand, a rather unique and interesting trans-oceanic tsunami occurred in 1883, killing more than 36,000 coastal inhabitants following the violent eruption of the Krakatau volcano. Indonesians have a relatively good historical record of past earthquakes and tsunamis. Therefore, tsunami sources and history were fairly well known by Indonesian scientists before the recent major tsunami disaster.

On the other hand, tsunami characteristics were not adequately studied by the local scientists in Indonesia before 2004. Nevertheless, although there was a lack of accurate and high resolution bathymetry and topography data for the coastlines, some numerical modelling studies have been carried out to calculate tsunami inundation along certain selected coasts in Indonesia. Tsunami modelling was initiated as part of the collaboration in modelling the 1992 Flores tsunami. The Indonesian scientists have successfully modelled several tsunamis that occurred before and after the 1992 Flores tsunami. Clearly, the Indonesian scientists had scientific capabilities in tsunami hazard identification and modelling.

Vulnerability and risk assessment for tsunami hazard were scarce in Indonesia. The ones that existed include the study of Flores, which was hit by the 1992 tsunami, and that in Banyuwangi in 1994. The survey suggests that in reality the risk assessments were more hazard-specific assessments with limited focus on vulnerability.

The communities in Indonesia were largely unfamiliar with tsunami hazards and risk knowledge, although there is an interesting traditional tsunami story from Simeulue Island (UNESCO et al. 2005). Therefore, the existing tsunami hazard-risk knowledge was poorly communicated to the communities at risk but had circled around academic circles at universities, workshops and conferences only.

4.1.2 Monitoring and warning of tsunami hazards

The core responsibilities of BMG (now the Meteorology, Climatology and Geophysics Agency (BMKG)) are to assess, formulate and facilitate a national policy and coordinated activity in the field of meteorology, geophysics, climatology and air quality. BMG consisted of three divisions under the Deputy for Data and Information System, namely (1) the Division of Earthquakes (2) the Division of Engineering Seismology and Tsunamis and (3) the Division of Geophysics. BMKG had an operational seismograph network to monitor local and regional seismicity and evaluate earthquakes using conventional methods. The only near real-time seismological equipment in Indonesia capable of providing an early warning was on the island of Java, installed in 1996, but it had no telephone line following office relocation in 2000. In addition, the National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) operated a network of 60 permanent sea level stations under the Global Sea-Level Observing system (GLOSS) programme in cooperation with the National Oceanic and Atmospheric Administration (NOAA). However, the sea level stations were not in real-time mode, only transmitting by Global Telecommunication System (GTS) every 15 minutes to the central monitoring site. BAKOSURTANAL carries out data processing and analysis based on the GLOSS standard; however during that time there was no capability at BMKG or BAKOSURTANAL to download GTS transmitted data, and decode and display them in real-time. Furthermore, BMKG did not have tsunami operational warning levels and basic criteria to determine whether a tsunami warning should be issued or not.

4.1.3 Dissemination and communication

The dissemination and communication phase is to ensure the community at risk are warned in advance to explicitly and implicitly promote appropriate protective behaviour (Rodriguez et al. 2004) and this measures the efficiency and effectiveness of the EWS. Dissemination and communications systems are critical to ensure that people and the communities are warned in a timely manner of the impending risk. As indicated above, Indonesia and all the Indian Ocean island countries were not institutionally linked in real time with the existing tsunami warning centres such as the Pacific Tsunami Warning Centre (PTWC) and the Japan Meteorological Agency (JMA). Hence, it is well known that failure of regional dissemination and communication was the key reason that Indonesia and all the Indian Ocean countries were not alerted in a timely manner.

On the other hand, in Indonesia, the survey indicated that internal communications between key BMKG staff were activated during extreme events using unregistered commercial cell phones. However, there were no internal dedicated notification systems or back-up systems such as through radio links. For external communication to other authorities there were no dedicated and reserved telephone lines for dissemination and communication. BMKG issues marine forecasts and warnings (e.g., storm and gale warnings, weather bulletins, etc.) to the Port Authority of the Department of Transportation, and Directorate General for Sea Transportation, and also broadcasts through the radio system of the Department of Fisheries to mariners and coastal zone users in their region using the International Maritime Organization (IMO) standard. Weather information is routinely dispatched to newspapers on a daily basis. In the context of tsunamis, there was no proper language format for tsunami warnings or guidelines on how to issue a warning to the general public. There were no coastal sirens for alerting people about incoming tsunamis anywhere in Indonesia.

4.1.4 Emergency response capability

The survey also indicated that there was no designated agency for receiving and acting upon any local or international advisory message from any tsunami warning centre. However, BAKORNAS at the national level was involved, but was not legalized by law in providing information and actions to be implemented down at provincial level by the Provincial Natural Disaster Management Coordination Board (SATLORLAK) and at district level by the District Natural Disaster Management Coordination Board (SATLAK) in the case of a disaster. Inter-institutional roles and responsibilities were absent and there were no criteria to be used by the existing emergency authority (i.e. SATLORLAK and SATLAK) to determine whether an evacuation should take place or not.

In addition, actors indicated that no critical infrastructure or lifelines were identified to support minimal government services after a destructive tsunami or other natural disaster. It is also clear that drills, simulations and exercises were not part of the Indonesian culture to prepare for disasters. Media-related interactions in sharing knowledge of tsunami hazards; mitigation and preparedness were rather ad-hoc and limited to tsunami disaster reporting only. According to the survey, awareness through tsunami memorials, museums, interpretative signs or other public reminders of past tsunami impacts had never been realized.

It is important to highlight at this point that Symonds (2005) pointed out that in the few countries in which contacts were established to alert to the possibility of a wide scale tsunami on 26 December 2004; the actual response was disorganized and lethargic. The few who were aware of the dangers were hampered by lack of preparation, bureaucracy and inadequate infrastructure. Others either did not know how to interpret the warning signs, or were indifferent to them.

4.1.5 Governance and institutional arrangements

The 1945 constitution of the Republic of Indonesia forms the basis of providing public welfare to the people of Indonesia. On the other hand, the national coordinated arrangements for natural disasters emerged back in 1966 by the establishment of an Advisory Board for Natural DM. Its activities were focused on emergency relief for disaster victims (see figure for the evolution of institutional change in Chapter 5). In 1979, a decree transformed the Advisory Board for DM to the National Natural DM Coordinating Board known as BAKORNAS PB. It was directly responsible to the President and chaired by the Coordinating Minister for the People's Welfare. The 1979 Decree also included the establishment of a similar arrangement at the provincial (SATKORLAK) as well as district levels (SATLAK). A Presidential Decree No. 43/1990 was issued as an amendment to the previous decree (28/1979) to improve and facilitate integrated sectors related to disasters, including back-up from the armed forces. The organization was called BAKORNAS PB. On 2 September 1999, Presidential Decree No. 106/1999 was issued as an amendment to the previous Presidential Decree No. 43/1990, which had not included the management of human-induced disasters or social unrest. In order to facilitate this additional scope, BAKORNAS PB became BAKORNAS PBP and the number of members of the BAKORNAS PBP was extended to 13 ministers and related governors. As the coordinating body, it is important to underline that BAKORNAS did not have direct implementation or policymaking functions.

The Disaster Management and Coordination by Presidential Decree No. 111/2001 was intriguingly chaired by the army commander at the respective level. He reported directly to the governor or the district/county head or the mayor. The actors and agencies of the committee are composed of representatives of the relevant sectors, such as police, public works, health service, social welfare, civil defence, local logistics service, the water supply company, the electricity company, the telecommunication company, etc. The authority of the committee in terms of decision-making, policymaking and advice were on the shoulders of BAKORNAS, who had the decision-making and policymaking authority with three main tasks: (1) policy formulation (2) coordination and (3) providing guidelines and directives to SATKORLAK and SATLAK to implement the decisions of BAKORNAS at provincial and local levels. However, the survey clearly shows that there were no legitimate laws, local regulations, standard operating procedures or a legitimate warning chain in Indonesia for managing hazard risks prior to the December 2004 tsunami disaster.

4.2 Capacities from a socio-ecological resilience perspective

The TEWS should not only be designed according to the four main elements, but must also satisfy the attributes of socio-ecological resilience capacities (Lebel et al. 2006). Therefore, the attributes of resilience from the socio-ecological perspective (i.e. knowledge, uncertainty, threshold, scale, self-organization, fit, learn and adapt) are also examined and discussed.

Very often individuals or groups of people including scientists are ridiculed for their knowledge and for warning about 'uncertain' risks at global, national and local levels. This is captured by a statement made to the media by a leading tsunami researcher Vasily Titov in the US following the tsunami disaster, "*Tsunami is always on the agenda (…) Only two weeks ago it would have sounded crazy. But it sounds very reasonable now*" (New York Times 31/12/2004). In October 2003, Australian-based seismologist Dr Phil Cummins requested the International Coordination Group for the TWS in the Pacific to extend its reach to the Indian Ocean. However, he was 'rebuffed' in a meeting in New Zealand with a rapid declaration that such an expansion would mean redefining the group's terms of reference (ToR) and instead the group voted to establish a "sessional working group" to study the problem (*New York Times 31/12/2004*). Furthermore, at the national level and sub-national levels, Samith Dhamasaroj, then Director General of the Thailand Meteorological Department, was branded "crazy" and sidelined and banned in some provinces from entering their territories by senior officials as they claimed he was damaging their image with foreign tourists for suggesting an EWS (The Internationalist 2005)." Interestingly, the outcome also highlights the issue and question of how to achieve successful risk communication governance under knowledge uncertainty as outlined by the Integrated Risk Governance Framework (2005).

On the other hand, theoretical academic knowledge and understanding did not clearly capture the issues of knowledge uncertainties and critical thresholds of ecological systems. For example, the famous Ruff and Kanamori earthquake models (1980) indicated that the Sumatra subduction zone's maximum earthquakes were predicted to be of around 8.3 moment magnitude based on the age of the subducting plate in millions of years and the convergence rate in centimetres/year. This theoretical earthquake threshold was surprisingly exceeded on 26 December 2004.

Furthermore, even estimating earthquake size in real time is also an uncertain science. For instance, even the initial earthquake size of December 2004 was estimated at only 8.0 moment magnitude. Consequently three minutes later a message was sent to other observatories in the Pacific notifying all countries that the quake posed no threat of a tsunami to the Pacific. An hour later, the centre revised its initial estimate of the size of the tremor from 8.0 to 8.5, and issued a second alert, warning of a possible tsunami in the Indian Ocean. It took several days to estimate accurately the real size of the earthquake at 9.2 moment magnitude. The estimation depends on a number of parameters ranging from the density of the network seismographs and the details of the earthquake size estimation. This clearly suggests the operational limitations and uncertainties which need to be addressed in developing a TEWS.

On the other hand, scale as an attribute of resilience is understood as the ability to engage effectively at multiple scales and is crucial for regional systems because they are invariably subject to powerful external influences, including changes in regulations, investments and the environment (Berkes 2002; Young 2002). There was little exchange and effective interaction between Indonesia and the countries

involved in the Pacific tsunami warning system. This partly explains why TEWS proposals for the Indian Ocean were simply shelved or stalled for lack of funds and due to technicalities (*New York Times 31/12/2004*). In Indonesia, institutional actors were not actively engaged and collaborating vertically and horizontally on the issues of tsunami risk and disasters.

A TEWS has existed in the Pacific Ocean since the late 1940s. The NOAA Pacific Tsunami Warning Centre (PTWC) was established in 1949, following the 1946 Aleutian Island earthquake and a tsunami that resulted in 165 casualties in Hawaii and Alaska. In 1964 another earthquake generated a tsunami killing hundreds of people in Alaska. Soon after, the TEWS was substantially upgraded. Therefore, the Pacific countries have self-organized, learned and adapted their developments to their surrounding environmental tsunami risks. In contrast, the Indonesian people did not self-organize, learn and adapt from their many past tsunami experiences (see Tables 2 and 3). This implies that the existing system did not get better at pursuing a particular set of management objectives over time and at tackling new challenges.

On the other hand, the traditional knowledge about tsunamis among certain islanders was not replicated and shared in Indonesia. The capacity to translate traditional experiences (i.e. knowledge domain diversity) of the islanders into formal knowledge to fit and adapt into formal institutions (i.e. disaster management structures, schools) and the wider society about the ecological processes has been neglected.

The question is how to build such resilience capacities against the uncertain tsunami risks in Indonesia. Symonds (2005) argued that the Pacific region enjoys the presence of the superpowers such as the United States and Japan which have huge resources and social-political economic order to deal with the tsunami risk, which is in great contrast to the Indian-Asia region where the same social and economic and political order condemns billions of people to wretched daily poverty. It is indeed highlighted that Section 4.2 explores the governance system that will implement and support the TEWS in terms of socio-technological, economic and political dimensions in comparison with that of Japan and the United States, two countries with decades of operational tsunami warning systems.

4.3 The hindering and driving forces for institutional change

4.3.1 The Hyogo Framework for Action (2005–2015)

According to UNDP (2009), discussions on legal reform in DM were well underway in 2003 between UNDP, the United Nations Office for the Coordination of Human Affairs (OCHA), BAKORNAS PB and the Indonesian Society of Disaster Management (MPBI). However, at this time, UNDP was dealing with conflict-affected areas in Indonesia. UNDP clearly points out that *"Political will was not yet conducive … and interest in resolving national security in the form of regional conflict and acts of terrorism"*.

However, in early 2005, the Indonesian Association of Southeast Nations (ASEAN) foreign minister 'initially' signed the HFA in 2005. The HFA is the global governance framework for DRR. It is reported that donors such as UNDP subsequently realigned their programmatic priorities and contributed substantial funds specifically for DRR within their portfolios parallel to this process (UNDP 2009). UNDP initially provided support from 2005–2009 to the legal reform process through its Emergency Response and Transitional Recovery (ERTR) programme. This allowed the drafting of the DM law and familiarization workshops for parliamentary committee members and a deliberation process. However, the question is what motivated actors and the people of Indonesia to officially sign the HFA and subsequently institutionalize changes in DM?

4.3.2 An extreme shock

Extreme catastrophes provide opportunities for change, and create long-term resilience (Birkmann et al., 2009). The 26th December 2004 tsunami was a catastrophe in terms of lives lost and coastal damage in Indonesia, thus clearly qualifying as an extreme shock.

To understand the impact of the tsunami disaster a statement of UN/ISDR is revisited:

> *"… ten Southeast Asian countries, including Indonesia, have finally completed the HFA agreement after five years of negotiations since it was initially signed by the ASEAN foreign minister in 2005, just a few months after the tsunami struck the Indian Ocean into a binding agreement … Political will is decisive to reduce disaster risks …".*

The statement suggests that the HFA was only officially signed just a few months after the tsunami disaster because at that time there was political commitment.

In addition, the Indonesian DRR platform also outlines that "*the initial idea to form a DRR platform (PRB Planas) in Indonesia emerged after 2006, because many people realized that as a nation living in disaster-prone areas, Indonesia needs a vehicle to integrate the knowledge of government and disaster management stakeholders …*"

It is also clear that "*domestically, Indonesia's impetus for legal reform for DM and DRR was drawn from the coalescence of actor's perceptions in the post-tsunami emergency response and subsequent rehabilitation and reconstruction phase*" (UNDP 2009).

Furthermore, in a report on evaluation and strengthening of EWSs in countries affected by the 26 December 2004 Tsunami, UN/ISDR (2006a) underlines that "*the strategy aims to capitalise on achievements to date and ensure the continuation of collective inter-agency efforts and enhanced linkages and partnerships … the future strategy identifies specific outcomes, building on the ongoing tsunami early warning initiative, and addressing the needs and gaps identified in the national needs-assessment reports, as well as areas that require further enhancement on a long-term basis*."

In this context, it is argued that the extreme shock had a significant influence and impact on the actor's perceptions and decision-making process. It helped a decisive and swift final agreement to be reached on the HFA. This consequently allowed donors to change project priorities and shift funds for DRR, hence providing new incentives for actors in order to speed up the DM reforms not only in Indonesia but also in India, Sri Lanka, etc.

4.4 Consequences of the lack of governance in disaster risk preparedness

The grand scenario (RISTEK 2005) reports on the destructive tsunamis caused by tsunamigenic earthquakes while Tables 2 and 3 lists the number of fatalities and the level of destruction from the earthquake-tsunami. A recent record from BAKORNAS PB for the period of 2003-2005 shows that the geological tsunami-related disasters comprise only 6.4 per cent of the total; however, they are high impact disasters causing tremendous loss and fatalities. The official statistics in Indonesia show that more than 128,728 people were killed, 179,312 houses destroyed, 500,970 people were displaced, with total, economic losses of US$4,270 million from the December 2004 tsunami only. This highlights the consequences of lack of governance in disaster risk preparedness characterized by persistent failures in minimizing damage costs and safeguarding human security, with far-reaching impacts on sustainable development.

4.5 Systems of governance perspective in Indonesia

Symonds (2005) argued that the Pacific region enjoys the presence of superpowers such as the United States and Japan. According to Symonds, these two countries have great resources and the social-political economic order to deal with the tsunami risk which is in great contrast to the Indian-Asia region where the social and economic and political order condemns billions of people to wretched daily poverty. Hence, this section examines this argument which is also a central question in this study about the systems of governance that will implement and sustain TEWS in Indonesia. In order to investigate the political, socio-technological and economic dimensions of governance in Indonesia, macro level data from the World Bank KAM (2008) database[ix] and other sources are employed to analyse the three dimensions of governance systems (i.e. political, economic and socio-technological). WGIs of the World Bank KAM (2008) database provide a useful tool to assess governance challenges and monitor reforms and understand the causes and consequences of good governance.

4.5.1 Political governance system in Indonesia

4.5.1.1 Decentralization

It is very important to grasp the merits and notion of decentralization as part of the political governance system and how it is being implemented in Indonesia, along with the existing challenges. Firstly, decentralization supporters point out that the decentralization process will result in greater efficiency and equity and responsiveness centred on local people's participation in local decisions on programmes, projects, investment and management and ultimately more socially and

environmentally sustainable development (Blair 1998; Manor 1999; Oates 1972; Tiebout 1956; Webster 1992). Decentralization increase government decisions making the process closer to the citizens (Fox and Aranda 1996). Decentralization is fundamentally a strategy of governance to facilitate transfer of power closer to the people (Ribot el al. 2006) and is therefore closely linked with democratic mechanisms and processes (Smoke 1999) such that aspirations of people are met. Decentralization enhances the ability to solve regional and local problems while central government will have more time and energy to deal with globalization and promote the interests of the country. However, case studies reveal that most decentralisation reforms suggest that the institutional arrangements to meet such a desired outcome are rarely observed (Agrawal 2001; Agrawal and Ribot 1999; Larson and Ferroukhi 2003; Ribot 2002; 2003; Ribot and Larson 2005). Ribot et al. (2006) underline that most decentralization is either flawed in the concept or faces strong resistance from diverse actors, mainly from state central actors and agencies which make policy and implementation choices that serve to preserve their own interests and powers.

The notion and goals of decentralization are the political acts whereby the central government formally transfers powers to actors and institutions at lower levels in a political–administrative and territorial hierarchy (Mawhood 1983; Smith 1985); such that local actors can exercise a certain degree of autonomy (Booth 1998; Smoke 1993). Decentralization is therefore characterized by a significant transfer of power and downward accountability of local authorities is central to it (Agrawal and Ribot 1999; Ribot 1995, 1996). Any power-related strategies used by the central government to undermine, obstruct or weaken the ability to transfer power, resources and local capacities are viewed as authoritarian-centralized behaviours.

However, prior to the late 1990s, under President Suharto's leadership, Indonesia ensured highly central domination in a single or unitary state. The main focus was on developing and maintaining a sub-national administration and government which could be controlled by central agencies. Devas (1997) points out that the Indonesian governance was not only highly centralized but also highly complex. In 1974, the government introduced a policy of gradual decentralization with Law No. 5; however, in reality it was viewed mainly for further maintenance of control and could be termed as devolution in which political power was not decentralized (Rohdewohld 1995; Devas 1997). Such governance was instrumental and supported national development for three long decades. The sub-national territorial divisions of Indonesia are the province, the district and the sub district. The central control was under the responsibility of the Ministry of Home Affairs, a national ministry with a local agenda (Morfit 1986). Accountability was upward and was obscured from the public view. At the sub-national level, the heads of regions were simultaneously heads of central state agencies and were appointed and responsible to the President rather than elected by sub-national assemblies. The assemblies of the provinces and districts operated more as a deliberative decision-making body of popularly elected representatives. Members were not accountable to the electorate.

However, the once rigid and highly centralized system ultimately proved itself unable to cope and respond to the financial and economic crises that swept across Southeast Asia in 1997 (Mera 2004). In 1998, the real GDP contracted by 13.7 per cent. This resulted in widespread and uncontrollable social unrest, with anti-government demonstrations by students. Nationwide rejection of the regime emerged. Suharto's unitary authoritarian rule came to an end when students were killed in the social violence in Jakarta. Rasyid claims that the failure of the government was mainly caused by the lack of time to observe, learn and understand the global financial and economic crises as the central government was wasting time dealing with provincial and local problems.

His vice-president, B. J. Habibi, succeeded Suharto and quickly endorsed the policy of decentralization by passing two laws which would have the most profound effect on governance in Indonesia. They were approved by parliament to empower provincial and local governments. These are Law No. 22 on Regional Autonomy and a supporting Law No. 25 on the financial balance between central and regional government. In principle, the Law No. 22/1999 on Regional Autonomy allows all authorities to be decentralized, except security and defence, foreign affairs, fiscal and monetary, justice and religious affairs. The exception added to this law is found in Article No. 7, Law No. 22/1999, which states that the central government is also responsible for policies to organize national planning and development, allocate financial subsidies to the regions, strengthen the national system of economic institutions and public administration, promote human resource development, control the exploitation of natural resources and determine the use of high technology and national standardization. On the other hand, Article No. 11 of Law No. 22/1999 ensures that municipalities and regencies are obliged to execute authority in the fields of public works, public health, education and culture, agriculture, transportation, trade, and industry, investment, environment, land administration and labour affairs. Only Aceh and Papua are exempted from the two laws, and are given status through special autonomy. Furthermore, decentralization has been regulated through Law No. 32/2004.

These two laws fundamentally reversed three decades of centralism and authoritarianism and had the potential to transform the country completely (Turner 2001).The decentralization was notable for its scale and speed and was known as the "Big Bang". Another reason for the sudden "Big Bang" seems to be linked with the desire of resource-rich provinces such Aceh to break away from the control of Jakarta, and such a strategy was decisive in keeping all regions of the country united (Mera 2004).

The implications of the decentralization in Indonesia include the dissolution of the hierarchical relationship between the province and the districts, implying they are autonomous regions with a wide range of functions and can communicate directly with the central government and responsible sub districts (Turner 2001). In this context the local assemblies are locally elected with more legislative powers and an expanded role. Heads of regions are now elected and accountable to the local assemblies and the local citizens rather than the central agency or President as in the past, with the responsibility to foster democratic governance and encour-

age participation and partnership with the civil society. The head of the district government ceases to report to the governor of the province and is elected by and responsible to the locally elected assembly. Provincial governments, i.e. governors, continue to report to the central government. The district government absorbs most of the de-concentrated central government functions. The autonomous regions can structure their organizations according to their own preferences. In order to deal with the consequences of Law No. 22, Law No. 25/1999 abolishes two leading transfers from central government for paying public servants and routine expenditures and the funds for development projects are replaced by a General Allocation Fund which is at least 25per cent of domestic revenue, where 90 per cent is budgeted for the districts and 10 per cent to provinces according to a formula. A special allocation fund may be used to fund special initiatives in the region and loans.

It was feared the bold decentralization initiatives would fail on a number of critical issues due to the brevity of the two laws, rapidity of implementing them and the context into which they were introduced. The problems most feared included (1) revenue-expenditure imbalance since new sources of revenue were given to local governments, (2) insufficient local government capacity to deliver services, (3) unwillingness of central civil servants to work for local governments, (4) accountability of elected local officials, (5) central leadership in fiscal relations and (6) the lack of implementing regulations. However, nothing dramatically catastrophic happened (Mera 2004) but there were various forms of misunderstanding and uncertainty about the powers in the light of the long history of centralized government, conflicting interpretations of the law, conflicts in natural resource management, etc.

These two laws leading to decentralization have had enormous implications and consequences in the way disaster and risk management have evolved in Indonesia, especially in the context of how new laws, legislation and policies of DRR are developed, enacted, implemented and enforced and how actors and institutions at various levels come together to deal with hazards, risks and disasters. At the same time the most important concern is how the decentralisation policies affect and determine the institutional arrangements and hierarchy structure of the DRR and the TEWS chain process. On the other hand there are specific indicators that define the political dimension, and these include accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and corruption. These political governance indicators are therefore explored.

4.5.1.2 The voice of accountability[x]

Since 1999, Indonesia has had a multi-party system. 27 new political parties were registered at the department of Law and Human Rights in the 2009 election[xi]. Local assemblies are locally elected with more legislative powers and an expanded role while heads of region are now elected and accountable to the local assemblies and the local citizens rather than to the central agency or President as in the past. The emergence of civil associations in Indonesia on a national scale (Faud 2002) is believed to be an important ingredient for a healthy, democratic and sustainable society. The voice of accountability has improved greatly in recent years, as

evidenced by the smooth passage of the 2004 and 2009 elections (Jakarta Post 29/08/2009).

One of the most promising aspects of Indonesia in the post-Suharto era is the birth of hundreds of new print and broadcast media throughout the country during the past five years. The passing into law of Press Law No. 40/1999 represented a positive move away from the formerly restrictive legislation governing the Indonesian media. However, legal cases recently brought against media professionals highlight continuing flaws in the Indonesian legal system and indicate disturbing attempts to restrict fundamental rights to freedom of expression[xii] and opinion and the public's right to access to information (Amnesty International 2003). Media-Press Freedom can be viewed as 'partly free', rated as 4.14 out of 10 compared to Japan and United States at 8.14 and 9.14 respectively according to World Bank KAM data (2008). Media–press freedom is very important because it provides the opportunity to cover various angles of view and is a tool for pressing for transparency and accountability. Media impacts on risk perception and policy and communication between risk assessment and risk management. However, despite the apparent success, World Bank KAM (2008) data shows Indonesia is ranked with a voice of accountability of 4.29 compared to Japan and the United States with 7.57 and 8.29 respectively. In this context, the voice of accountability is just below the average level in Indonesia.

4.5.1.3 Political stability and absence of violence[xiii]

In the post-Suharto era, the stability of Indonesia's political and civil institutions has been strengthened. This has resulted from the devolution of political power to local governments, implementation of a well-managed system of fiscal decentralization and a deepening of democracy within an ethnically and religiously heterogeneous state. Indonesia's politics have become much more stable in recent years. The public are satisfied with elections and they perceive them as fair, as indicated in a recent exit poll survey of 92 per cent from the Indonesia Survey Institute (LSI) in 2009. The overwhelming satisfaction rate is imperative to give legitimacy to the ruling government for the next five years and this suggests that "the threat of political instability going forward is minimal" (Jakarta Post 29/08/2009).

However, conflicts such as the terror threat of the early 2000s continue to exist from separatist and sectarian groups (Business Monitor International 2009). The latest terrorist attack on 17 July 2009 on Jakarta hotels after four years of quietness was a shock, but did not exclude in the overall risk estimation in Indonesia (Moody's Investors Service 2009). The latest actions do not reflect widespread political instability since the political and security responses to several large scale incidents of terrorism, from earlier this decade, have eroded[xiv] the lethal terror network, but the risk of sporadic incidents, as is evident, has not been fully eliminated. It is found that political stability in Indonesia is rated fairly low at 1.57 compared to Japan at 9.21 and the United States at slightly above the average at 6.36. Further, questioning of the very poor political stability is examined. One social scientist from Indonesia argues:

> *"In many terms, the Indonesian politics is highly volatile especially when it comes to human rights and issues of separatism and independence. There are political struggles going on in Papua, Aceh, Central Sulawesi, West Kalimantan, and many other places like Maluku province"* (Interview 29, 23 May 2010).

Violent conflicts continue unabated. Very recently, the military killed one pro-independence leader of West Papua[xv]. Indonesia has made attempts to reform the army. However, Army General Djoko Santoso warned that *"the greatest threats to Indonesia's security are domestic issues and maintaining unity"* (Reuters 24/01/2008). Hence, this explains the low ranking of political stability in Indonesia by the World Bank in 2008.

Political stability should be viewed as an important element here because it is a social practice where human needs and securities are constantly contested and fought over (Bohle 2007) and it has strong links to the other elements of good governance such as participation, mediation, negotiation, etc. In these struggles, the relationship between any victims or acts of agency in the context of tsunami resilience building could become a central issue.

4.5.1.4 Government effectiveness[xvi]

The World Bank rated Indonesia's government effectiveness at 3.79, compared to Japan and the United States with 8.66 and 9 respectively. McLeod argues that a return to sustained, rapid economic growth will require an overhaul of Indonesia's bureaucracy and judiciary, along with the legislatures, the military and the state-owned enterprises. To reform the civil service it will be necessary to undertake a radical overhaul of its personnel management practices and salary structures, so as to provide strong incentives for officials to work in the public interest. Government effectiveness is a very important issue which will be elaborated on further in this research.

4.5.1.5 Regulatory quality

In the context of regulatory quality[xxvii], the McKeever Institute of Economy and Policy Analysis (2006) argues that the Government of Indonesia can say all it wants to attract new businesses, but the bottom line is that people will always be reluctant to do business in Indonesia knowing that they must deal with a highly corrupt government system. These conditions are based on laws and regulations that are often vague and require substantial interpretation by implementing offices, leading to business uncertainty for all (McKeever Institute of Economy and Policy Analysis 2006; Embassy of the United States, Jakarta 2003). Extensive red tape makes it very time-consuming to set up a business in Indonesia. According to WGIs, the time taken to start a business is 105 days in Indonesia compared to six days in the United States. The issue of regulatory quality is important when considering developing partnership programmes and cooperation with the various partners, such as the private sector and international actors.

4.5.1.6 Rule of law

Since 1998, the Indonesian constitutional order has undergone an almost complete transformation characterized by four constitutional amendments which have laid solid foundations for the rule of law, including a human rights catalogue, judicial and constitutional review of legislation and independence of the judiciary. However, enforcement of the law is vaguely tarnished by corruption. The judiciary is still notorious for corruption, and human rights violations are common. In short, there is no 'living' rule of law culture[xviii]. This is reflected closely in the low rating of the WGIs of 2.07 in the rule of law. However, according to the University of Indonesia, the rule of law situation differs widely from one district to the other and there is in particular a lack of knowledge of the way in which actors at regional and local levels use the legal avenues opened up to them by the recent reforms.

4.5.1.7 Corruption

Corruption[xix] in Indonesia deserves very close attention because it is the indicator with the lowest governance rating of 1.79 out of 10 in Indonesia (World Bank KAM 2008), having diverse negative impacts on all levels of governance. It also affects development assistance by causing severe social and economic costs and lack of confidence in the government. According to a report from World Bank on fighting corruption in Indonesia, "Enhancing Accountability for Development" (2003), Indonesia suffers from a very poor international reputation regarding corruption, ranking near the bottom alongside the most corrupt countries in the world. It is also perceived as doing worse over time in controlling corruption. The new openness of a democratic Indonesia may have overly influenced current corruption perception; however the corruption originates from colonial times and became institutionalized under the New Order of President Suharto which now continues to flourish by exploiting the many new opportunities in the fluid environment of Indonesia's simultaneous political and economic transition (World Bank East Asia Poverty Reduction and Economic Management Unit 2003). New laws and a more vigilant parliament are beginning to strengthen the hands of those politicians who wish to control corruption in the ministries and agencies of government. Nevertheless, the efforts have dissipated because of poor reflective credibility on corruption among the political parties. Indonesia's strongly party-orientated political system means that accountability is to party bosses rather than to constituents, and the high cost of campaign finance now drives the corruption beast (World Bank East Asia Poverty Reduction and Economic Management Unit 2003). Meanwhile, even the World Bank questioned corruption in Indonesia in the context of "Development Assistance: Part of the Problem or Part of the Solution?" Fortunately, the World Bank has revisited its own strategy for development assistance to Indonesia by improving project design to empower those fighting corruption in Indonesia. Clearly, corruption may reduce development assistance for an EWS and DRR and have deeper consequences on various services such as institutional enforcement of rules, as will be shown later.

4.5.2 Economic governance system in Indonesia

There is a general consensus (Kahn 2005; Raschky 2008) that economic development mitigates the effects and impacts of natural disasters, especially in reducing death. If economic development is exclusively planned and has a collective social purpose with due consideration of widespread security of livelihoods and environmental enhancement then the result can be a reduction in disaster risk (Wisner et al. 2004). The investment climate indicator covers institutional rules such as the risk of expropriation or contract laws. The main reason to include this indicator (Raschky 2008) stems from the idea that property rights are key determinants for an efficient allocation of resources, which is also important to natural hazard management. Globally, much work is now devoted to a societal risk-transfer mechanism through disaster insurance and relief to reduce financial losses. In regions without institutionalized insurance regimes, risk transfer against natural hazards depends on the individuals and politicians and on where government disaster assistance can lead to the problem of "charity[xx] hazard" management (Raschky 2008).

4.5.2.1 Gross Domestic Product growth

The GDP is a good indicator of a country's overall economic development. Indonesia has the largest economy in Southeast Asia, and is one of the emerging market economies[xxi] of the world. Its normalized GDP growth between 2002 and 2006 was 5.76 per cent, outperforming the United States and Japan with their GDP growth of 2.45 per cent and 0.86 per cent, respectively (World Bank KAM 2008). Indonesia is rich in a variety of commodities, ranging from agricultural products to metals and natural gas. Indonesia's per capita GDP is US$ 2,000. In addition, private consumption as a percentage of GDP in Indonesia is around 65 per cent, which is bigger than in India (around 60 %). It is important to highlight that Business Monitor International (2009) forecasts Indonesia's per capita GDP rising to around US$6,200 by 2018.

4.5.2.2 Composite risk rating, local competition and external debt

On the other hand, the composite risk rating from September 2006 until August 2007, based on an overall index of 22 components of political, financial and economic risks, shows that Indonesia's composite risk rating is moderate[xxii] at 69.76, while the intensity of local competition in Indonesia is remarkably high in comparison to the United States and Japan (World Bank KAM 2008). On the other hand, Indonesia is rated as a good debtor nation, always finding a way to service its debt (McKeever Institute of Economy and Policy Analysis 2006). The government debts totalled USD 61.04 billion up until December 2005. The country's total external debt has been steadily decreasing since 2002 from about 65.7 per cent of GDP to a projected 41.6 per cent by the end of 2006.

4.5.3 Social and technological governance system in Indonesia

4.5.3.1 Public health and education

Public health and safety is also of concern due to the increasing number of factories with poor environmental policies (McKeever Institute of Economy and Policy Analysis 2006). There has been a rise in tuberculosis, with at least half a million new cases of tuberculosis per year in Indonesia. Indonesia's HIV/AIDS crisis is threatening to become a full-blown epidemic, while malaria affects up to 20 per cent of Indonesians. More than 100 million people lack adequate sanitation, and more than 40 million people do not have access to safe drinking water sources (UNICEF 2006). The level of infant mortality has been cut in half from 60 per 1000 in 1990 to about 30 per 1000 in 2004. On the other hand, the prolonged economic crisis in Indonesia plus the limited availability of funds caused the Indonesian Government not to implement its nine-year compulsory education programme for elementary and junior high school children. This has resulted in a decreasing number of students of school age actually attending school, and even fewer making it to college. In 1998–1999 the percentage of school age children (13–19) not in school rose from 33 to 38 per cent. The adult male literacy rate is reported to be 92 per cent and for females it is 83 per cent.

It is widely established that poverty is related to vulnerability; however, the concept of vulnerability has a broader remit that also embraces cultural and social components (Chambers 1989). Other social factors of exposure such as living in a nation with a higher level of educational attainment and openness for trade are less vulnerable to disaster (Skidmore and Toya 2007).

4.5.3.2 Income level

Officially, the income level for government jobs is low. The McKeever Institute of Economy and Policy Analysis suggests this is part of the reason many people turn to corruption. Additionally, any small increase in wages has been offset by the high inflation in recent years. Salary is an important incentive to the actors of the TEWS because it determines how actors of various specializations change jobs or migrate between institutions which could have critical impacts on the efficiency and sustainability of the TEWS. Actors commented that their salaries had not increased despite new responsibilities. In addition, some actors pointed out that the state actors are very 'volatile' in job positions; however it was found that the brain drain is surprisingly quite low.

According to the World Food Programme[xxiii] (WFP), out of a population of over 245 million people, 52 per cent live on less than US$2 per day with an estimated 35 million poor people who live on less than US$0.65 per day. The number of the 'near poor' in Indonesia is estimated to be 115 million. Approximately 28 per cent of children under the age of five are malnourished. Despite steady progress being made on the United Nations Millennium Development Goals, Indonesia is still designated as a low-income, food-deficit country. Overall, Indonesia falls slightly below the poverty line in terms of the poverty index[xxiv] with a normalized value of 4.31 out of 10 (World Bank KAM 2008) while the HDI is low at a normalized value of 3.62 compared to the high HDI of the United States and Japan ranked above 9.0

(World Bank KAM 2008). Indonesia was ranked 107 out of 177 countries in the UNDP's 2007/2008 HDI.

4.5.3.3 Transportation and communication system

The road network and traffic are important indicators of how fast the community at risk can be evacuated in case of emergency and also how rapidly the emergency authorities can attend to the impacted population facing a crisis. Only 57 per cent of the roads[xxv] are paved in Indonesia, while traffic jams have emerged as a key problem in the big cities of Indonesia. In an earthquake in 2005, the Tsunami Alert Community Foundation (KOKAMI), a local NGO, reported a traffic jam even three hours after a warning and evacuation guidance was issued in Padang city.

In a country survey[xxvi], Britannica Almanac in 2003 claims that most parts of the country have reasonable access to a variety of media and communication systems. Radio broadcast stations and radio sets were numerous in Indonesia in the early 1990s. There were some 530 medium-wave, around 140 short-wave, and 28 Frequency Modulated (FM) privately owned stations and some 26 million radio receivers. Recent World Bank KAM data from 2008 indicates that 360 out of 1000 people have telephones, while 290 have mobile telephones, and Indonesians are buying new cellular phones at a growing annual rate of 11 per cent[xxvii]. The number of computers and internet users is very low at 10 and 70 per 1000 people respectively. The percentage of households with a TV is reasonably high at 65.4 per cent. The electronic communication system is rated at 2.78 compared to electronic communication governance of 6.7 and 9.04 in Japan and the United States. The communication system of governance is a key element which needs to be improved in the context of end-to-end EWS.

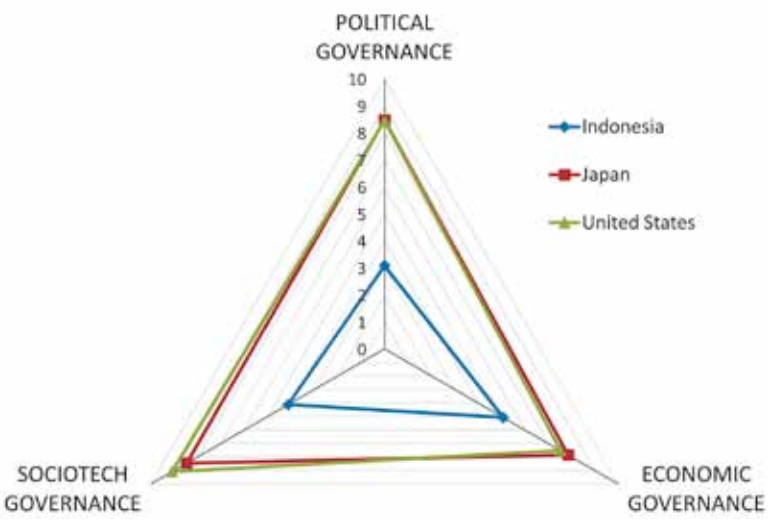
4.5.3.4 Innovation systems

The number of scientific and technical journal articles[xxviii]/millions of people plus University-Company Research Collaboration should help in boosting the country's innovativeness. Currently, Indonesia is rated fairly low in both areas compared to the United States and Japan (World Bank KAM 2008). This partly explains why Indonesia relies heavily on imported technology and expertise from other countries to build its own TEWS.

By considering a composite (see Figure 19) of the World Bank KAM (2008) indicators across the three governance dimensions (i.e. political, economic and socio-technological) it is found that economic governance (i.e. GDP growth, composite risk, external debt, etc.) is the strongest governance dimension in Indonesia while slightly below average in the socio-technological governance system (i.e. poverty index, HDI, health and innovation systems). The political governance dimension (i.e. voice and accountability, political stability, control of corruption, regulatory quality, rule of law, government effectiveness and press freedom) is the weakest governance system in Indonesia. However**,** the important issue to note is that Indonesia is moving up in all the key indicators of political governance (i.e. political stability, voice and accountability, control of corruption and government effectiveness, rule of law, etc.) and in fact now outperforms other countries in the region on

voice and accountability. Indonesia's ranking shows that the fight against corruption, terrorism and poverty is a long-term effort. Overall, there is a relatively wide governance gap between Indonesia compared to the United States and Japan, who have managed to run TEWSs for decades. It is clear that the economic dimension is the most promising; however, for maximum positive impacts on the effectiveness and sustainability of the TEWS, all three governance systems need to be addressed collectively.

Figure 19: Systems of governance between Indonesia, the United States and Japan



Source: Author.

4.6 Summary

It has been established that the existing coping capacities of Indonesia were severely exceeded on 26 December 2004 due to a combination of factors ranging from lack of attention to issues such as knowledge, uncertainty, critical thresholds and the element of surprise. Consequently, different scales of governance also failed. The Indonesian people generally did not reorganize, learn and adapt from many of their past tsunami experiences. Experience and traditional knowledge were exclusive and not replicated informally or formally to fit into the national institutions. Risk knowledge was limited to only hazard assessment, and communicated only among academics and practitioners in the rooms of universities, workshops and conferences. Observation and warning methods were too slow to fit and match the ecological challenge. There were no operational warning alerts while risk communication and dissemination systems and standard formats were lacking both externally and internally. Disaster preparedness organizational activities and efforts were rather ad-hoc, fragmented and uncoordinated while cooperation across levels

and scales was lacking. Clearly, there were no institutional and governance frameworks to deal with tsunami risks and disasters and consequently the community at risk were totally unprepared even if it could have been alerted in a timely fashion.

The main factors which have inhibited institutional progress in EWS/DRR in Indonesia include the issues of national security and social conflict, the challenges of implementing the decentralization policies and the subsequent lack of political commitment, funding and resources. It is argued that the extreme shock and scale of the tsunami disaster provided the impetus and opportunity for the actors to negotiate for the final settlement of the HFA providing the key driving incentive mechanism towards the enactment of the DM law including an EWS. The usual path dependency characterized by persistent failures was no longer accepted as a way to live with the risk.

There is a relatively wide governance gap between Indonesia compared to the United States and Japan which have had operational TEWSs for decades. This underlines the challenge Indonesia has to face to support and sustain such an effective TEWS. It is clear that the economic dimension is the most promising system of governance; however, for maximum positive impacts, all three governance systems need to be addressed collectively. The exiting decentralization system will strongly determine and shape the architecture of the early warning chain and DRR in Indonesia.

5. Emerging architectures for the tsunami early warning after 2004 in Indonesia

In this chapter the emerging designs and architectures supporting the TEWS in Indonesia after the 2004 tsunami disaster are examined and discussed. In order to address the issues above, this chapter raises questions relating to (1) what is the emerging TEWS design strategy and what are main weaknesses?, (2) what are the key multi-level institutional-governance arrangements, frameworks and structures to support TEWS in Indonesia and (3) how is performance of institutions affected by their embedding in larger architectures?

5.1 The Grand Scenario and the German concept of the Tsunami Early Warning System

In 2005, following the IOC-UNESCO survey visit and recommendations, RISTEK with the participation of various Indonesian Institutions (i.e. the Institute of Technology Bandung (ITB), BAKOSURTANAL, BMKG and the Agency for Assessment and Application of Technology (BPPT)) spearheaded the design concept of the Indonesian Tsunami Warning System known as the Grand Scenario (RISTEK 2005). Ideally, the Grand Scenario would consist of three main components: (1) the monitoring of earthquakes through a seismic network, (2) oceanographic monitoring system through a network of buoys of different types to detect abrupt changes in pressure at the ocean bottom or changes in the level of the surface and (3) database and tsunami modelling. The Indonesian Grand Scenario considers dissemination of information as a supporting component of the TEWS. In addition,

the Indonesian Grand Scenario mentions risk knowledge in the broader context of preparedness, but is rather limited in details.

On the other hand, GITEWS is one of the major projects to implement part of the concept of the Indonesian Grand Scenario, especially in adopting the novel technology from Germany for the monitoring and forecasting component of the TEWS. The conception integrates terrestrial observation networks of seismology and geodesy with marine measuring processes and satellite observation. It is pointed out that the GITEWS project concept did not explicitly address risk knowledge and communication, or communication and dissemination and response as central elements of the TEWS. Nevertheless, substantial project activities have focused on tsunami modelling, and risk map preparation and capacity-building programme for preparedness spearheaded by GTZ-IS at the local level. In the following section, the GITEWS concept is elaborated.

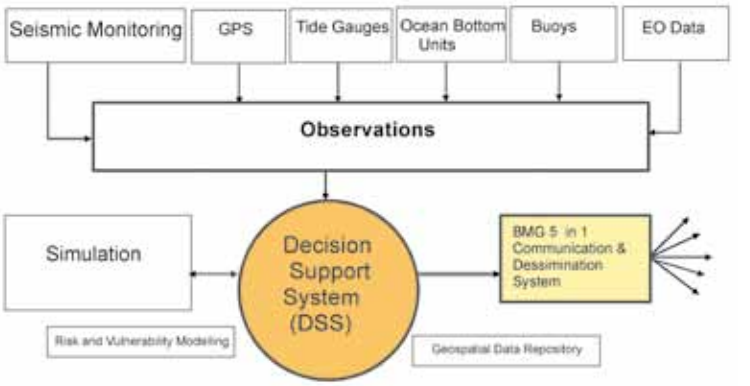
5.1.1 The new monitoring and warning system

5.1.1.1 Tsunami observation and operational procedures

A two-step procedure will be used to forecast tsunamis due to the speed of travel of seismic waves and the challenge of detecting any sea level deformation to confirm any tsunami generated. In the first step process, in the event of an earthquake in the region, a network of seismic in-situ instruments will record and send fast seismic wave data to a central station at BMKG[xxix] in Jakarta.

The seismic processing is carried out via a new processing and forecasting procedure in an automatic fashion using a novel expert Decision Support System (DSS) as illustrated in figure 20. It is developed by the German Aerospace Agency (DLR) to compute key seismic parameters of the earthquake such as epicentre, location, magnitude, depth and focal mechanism via an integrated new software programme called SeisComP3 developed by scientists at the GFZ in Germany. In addition, the expert DSS, which is at the heart of the technical warning system, will be used at the time of an earthquake to match and compare the signature and consequence of the real earthquake with the database of hypothetical earthquakes of different sources and its simulation scenarios to decide whether to issue a warning or not, and to assess inundation and impact areas. In addition, new software known as "TsunAWI" has been developed at the Alfred-Wegener Institute for Polar and Marine Research in Germany. It depicts the wave propagation and tsunami inundation in a novel and rapid way based on an unstructured triangular finite element method, which allows for a very flexible discretization and which does not need a nested model like other mainstream models (Chaeroni et al. 2008). A multitude of scenarios covers the possible tsunami events, so that in the case of an emergency a pre-computed scenario approximates the actual situation.

Figure 20: Tsunami Early Warning System Decision Support System (DSS)



Source: DLR in the framework of the GITEWS project (2008). Reproduced by author.

A match can be made within seconds while the ever improving data availability during a tsunami event continuously stabilizes and completes the picture of actual prevailing conditions. A rapid overview is gained and a visual display of the situation is shown on several monitors, together with recommendations for action. The DSS is geared for application in a crisis situation to enable fast and reliable decisions to be made under high time pressure and stress conditions. Extensive databases hold, in addition to general geo-data, advanced processed risk information and hazard maps. If a close match is identified, according to the Grand Scenario an initial warning is issued within five minutes.

5.1.1.2 The tsunami operational warning alert levels

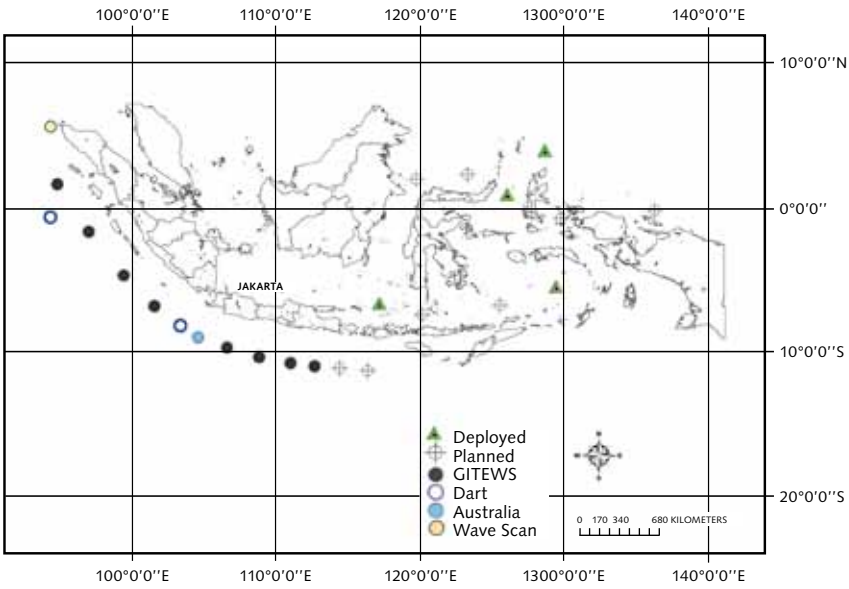
Within the tsunami operational warning procedures, a warning segment system of the coastline defined according to administrational boundaries is used as the smallest warning unit for which tsunami threat information is aggregated and for which warning products may be available. The current definition of warning segments for the coastline of Indonesia along the Indian Ocean covers 125 warning segments for Sumatra, Java and Bali.

Warning segments can be set to specific states of warning levels in connection with the dissemination of warning products (e.g., warning messages). The warning levels depend on the expected or confirmed tsunami threat. Which warning level is assigned during the decision proposal generation process depends mainly on the height of the wave at the coastline. The tsunami warning computed on the DSS has three grading levels consisting of: (1) advisory for tsunami in the range 0-0.5 metre, (2) warning for likely tsunami in the range 0.5 -3.0 metres, (3) major warning for likely tsunami greater than 3.0 metres.

Therefore, the warning centre issues tsunami information based on the predicted tsunami height at the coast in under 10 minutes (T^{xxx}<10 min). The second

step of the warning procedure takes several more minutes and involves measuring and processing the ocean parameters from several deep sea buoys positioned along the coastline (see Figure 21). It is the responsibility of BPPT to determine if a tsunami has been generated or not, and communicate the information to BMKG.

Figure 21: Network of Tsunami metres



Source: BMKG (2009). Reproduced by author.

If a tsunami passes the underwater pressure gauge the data are sent to buoys at the surface and passed on from there to the central warning centre. At this point, for a period between 10-30 minutes, (10<T<30 min) a second message would theoretically be disseminated and communicated to confirm or cancel the first message. If a tsunami has been confirmed, citizens should execute partial or full evacuation depending on whether it is a warning or a major warning. Once the offshore waves are measured by the tide gauges[xxxi] located near the island before they reach the mainland, a third tsunami message will be disseminated and communicated within a period of 30–60 minutes (30<T<60 min) after the occurrence of the earthquake. A fourth, all clear message from BMKG will be disseminated and communicated within a period of 1–10 hours (1.0<T<10.0 hours).

If a tsunami is detected by a buoy, in line with the Grand Scenario, it is foreseen that international warnings will be dispatched to the neighbouring countries and a confirmation of a warning will be sent to the coastal communities at risk and areas to be impacted within ten minutes of earthquake generation (RISTEK 2005). Information on potential impacts of the tsunami is also assessed using the expert DSS.

After much effort, the monitoring and forecasting part of the TEWS, which was spearheaded by GITEWS, was inaugurated on 11 November 2008, less than four years after the catastrophe of 2004 in which approximately a quarter of a million people lost their lives. The system was officially handed over to the BMKG by the President of Indonesia, Susilo Bambang Yudhoyono, in the Indonesian capital, Jakarta.

5.1.2 National dissemination and communication systems

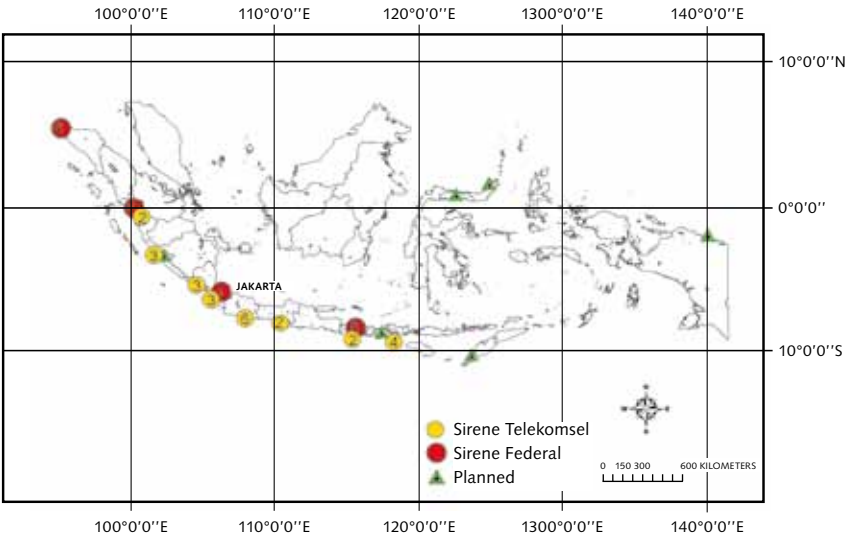
According to the Grand Scenario, Information and Communication Technology (ICT) comprises two main bases: (1) upstream data communication (UDC) and (2) downstream[xxxii] information communication (DIC). UDC has five main components: an equipment sensor, data submission, a regional centre, a national centre and media transmission. The equipment used for data acquisition may be located in the sea or on the land.

By focusing our attention on DIC, the process includes the management of information among regional centres, national centres and government and authoritative officials in the local and national levels. Observed data transmitted to the national centre will be conveyed to the president, ministers, police stations, local government officials, mosques, churches, temples, army stations, post offices, cellular operators, TV stations and radio stations.

Currently, the warning message consists of information on location, depth, size of earthquake and information on whether a potential tsunami has been generated or not. According to BMKG, through standard operating procedures, the tsunami information is to be disseminated through various communication and dissemination systems such as terrestrial line radio link, Global System for Mobile Communications (GSM), terrestrial line satellite and fibre optic and wireless local area network (WLAN) to the interface institutions such as police headquarters (POLRI), governors, the Ministry of Home Affairs DEPDAGRI, BAKORNAS, TV stations, radio stations and harbour authorities. The interface institutions will disseminate information further downwards to the community through a series of standard operating procedures. The community can receive information through sirens, radio, TV, SMS, FM Radio Data System (FMRDS), electronic mail, speakers, police sirens, etc. It is noted that BMKG will also issue tsunami information such as warnings directly to the community through the different media outlets.

There are currently a total of 140 radio internet (RANET) stations that can receive tsunami information in Indonesia. There are a total of 44 tsunami sirens (see Figure 22) of which 19 are government owned while the rest belongs to a private company (i.e. Sanken/Milano-Telekomsel). This implies that non-state actors have contributed significantly to establishing the siren network along the tsunami-prone coast.

Figure 22: National network of coastal sirens in Indonesia



Source: BMKG (2009). Reproduced by author.

The major weakness identified at this point is that both the Indonesian Grand Scenario and the GITEWS project treat dissemination of information as a supporting component of the TEWS. As indicated in the effective EWS framework, dissemination and communication (see Figure 5) is a key element of the EWS. The implications of such an approach will be further explored in the following chapters.

5.1.3 Response strategies

In the Grand Scenario, the response strategies are captured in terms of the nine major components involved in disaster preparedness. The Grand Scenario points out of a plan, response mechanisms, public education and training, rehearsals, etc.; however, no details are provided for each component. The Grand Scenario itself recognizes that these components provide a basis upon which a national disaster preparedness strategy can be developed.

5.2 The institutional legal system in Indonesia

At this point, it is necessary to first introduce the history and institutional legal system in Indonesia before examining the DM and TEWS-related architecture. Before the Dutch colonization in the sixteenth century, indigenous kingdoms ruled the archipelago independently with their own traditional laws, known as adat. Foreign influences from India, China and Arabia have not only affected the culture, but also impacted on the customary adat laws. The Dutch presence and subsequent occupation of Indonesia for 350 years has left a legacy of Dutch colonial law, largely

in the Indonesian civil code. Following independence in 1945, Indonesia began to form its own modern Indonesian laws based on the precepts of existing laws. As a result, these three components (adat, Dutch-Roman law and modern Indonesia law) still co-exist in current Indonesian laws.

Indonesian legislation takes different forms. According to Tabalujan (2002), the official hierarchy order of Indonesian legislation (from top to bottom) is enumerated under Law No. 10, Year 2004 on the Formulation of Laws and Regulations. The 1945 Constitution (Undang-Undang Dasar 1945 or UUD'45) is the highest in the order, followed by the Law (Undang-Undang or UU) and Government Regulation in Lieu of Law (Undang-Undang), Government Regulation (PP); Presidential Regulation (Perpres) and at lower level are the Regional Regulation (Perda). In practice, the formal legal system also includes Presidential Instruction (Inpres), Ministerial Decree (Kepmen) and Circulation Letters (Surat Edaran), which sometimes conflict with each other.

The 1945 Constitution emerged after the end of the Japanese control during World War II. It is the highest legal authority in Indonesia, and executive, legislative and judicial branches of government must refer to it. It was abrogated by the Federal Constitution of 1949 and the Provisional Constitution of 1950, but restored after President Sukarno's decree on 5 July 1959. During the 32 years of Suharto's administration, the constitution remained unchanged, but the People's Consultative Assembly passed a law in 1985 requiring a national referendum for constitution amendments. In 1998, after Suharto's fall, the People's Consultative Assembly amended the constitution four times in 1999, 2000, 2001 and 2002. The significant amendments included direct presidential election by the people (third amendment) and changing the presidential office term from being unlimited to only two years (first amendment). The fourth amendment gave more power and control to the People's Representative Council over the executive branch, and the Regional Representatives Council was established, regional government was recognized, and an expanded section on civil rights was introduced. Currently, the constitution consists of 16 sections and 36 articles.

On the other hand, Undang-Undang is simply the laws that can only be established by the People's Representative Council (DPR). The executive branch (the President) can propose a bill (Indonesian: Rancangan Undang-Undang or RUU) to the DPR. A small task group is created by the DPR to discuss the bill as part of the process to turn the bill into law. Once an agreement is reached, the President should endorse a bill into law. If the President does not endorse the bill that has received joint agreement the bill is automatically enacted as law in thirty days and can be promulgated as such. When an agreement cannot be reached to enact a bill into law, the bill cannot be proposed again during the current term of the legislative members.

5.3 Multi-level architecture for disaster management in Indonesia

5.3.1 The national mechanisms for multi-sector participation

The global governance framework for DRR is the HFA. It was adopted by the member states of the United Nations in January 2005 in Kobe, Hyogo, Japan. Its overarching goal is to build resilience of nations and communities to disasters by achieving a substantive reduction of disaster losses by 2015. The HFA offers five areas of priority for action – guiding principles and practical means for achieving disaster resilience for vulnerable communities in the context of sustainable development. These are: (1) ensure that DRR is a national and a local priority with a strong institutional basis for implementation, (2) identify, assess and monitor disaster risks and enhance early warning, (3) use knowledge, innovation and education to build a culture of safety and resilience at all levels, (4) reduce the underlying risk factors and (5) strengthen disaster preparedness for effective response at all levels.

The United Nations General Assembly has called for the implementation of HFA and reconfirmed the multi-stakeholder participation system of the ISDR and the Global Platform for DRR to support and promote it. Many regional bodies have formulated strategies of regional scale for DRR in line with the HFA. More than 100 governments have designated official focal points for the follow-up and the implementation of the HFA (March 2007). Some have taken action to mobilize political commitment and establish centres to promote regional cooperation in DRR.

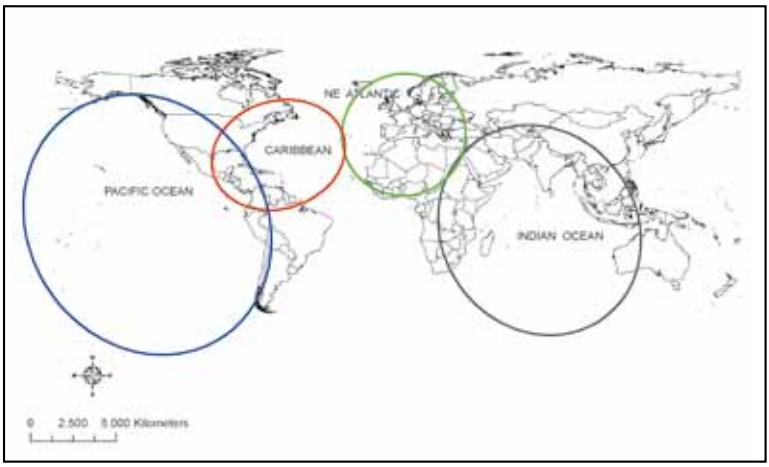
In this context, the Indonesian-ASEAN foreign minister initially signed the HFA in 2005. However, it was only recently that all the countries in the region, including Indonesia, agreed to the leading framework in DRR that will enhance regional cooperation and nations' capacities. It will also increase the technical cooperation among member states and establish an ASEAN Coordinating Centre for Humanitarian Assistance on DM.

The establishment of the DRR platform in Indonesia (PRB Planas) was initiated in 2006. The DRR platform[xxxiii] in Indonesia was declared official in November of 2008 to operate as a national mechanism for multiple stakeholders, acting as an advocate of DRR at different levels. The platform for DRR is currently being familiarized in Indonesia through public exposure. It is clear that the HFA is a non-binding international legal agreement while DRR platforms can be viewed as a mechanism to support the HFA goals.

5.3.2 Regional architecture for Tsunami Early Warning System coordination

The IOC General Assembly XXIII in Paris, 21-30 June 2005, confirmed the immediate action and response to the 2004 tsunami and adopted resolutions to create three[xxxiv] new regional Intergovernmental Coordination Groups (ICGs) for the Indian Ocean, the North-East Atlantic and Mediterranean as well as the Caribbean to establish a basin-wide TWS (see Figure 23).

Figure 23: Global-regional governance of tsunami



Source: Author. After IOC-UNESCO (2009).

Together with the existing system for the Pacific and other relevant United Nations bodies they will also contribute to the work of a global coordination group on tsunamis and other sea level-related hazard warning systems (TOWS). The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) received a mandate from the international community to coordinate the establishment of the system during the course of several international and regional meetings, including the World Conference on Disaster Reduction (Kobe, Japan, 18–22 January 2005). According to UNESCO, the IOC Assembly, during its twenty-third session (21–30 June 2005), formally established the ICG/IOTWS through Resolution IOC-XXIII-12.

ICG/IOTWS is a primary subsidiary body of the IOC, which was created and governed by the governing body comprising 28 member states from countries bordering the Indian Ocean. Thus, the IOC provides secretariat support to the ICG/IOTWS. Membership of the ICG/IOTWS is open to member states bordering the Indian Ocean, other interested IOC member states as observers and invited NGOs and other organizations. The system is fully owned by Indian Ocean countries and based on international and multilateral cooperation. It facilitates open and free data exchange and is transparent and accountable to all the countries. The IOTWS function is based on joint operation of international networks of observation connected with the national tsunami warning centres.

5.3.3 The disaster management law and regulations in Indonesia

As indicated in chapter 4, the DM Law No. 24 was enacted in 2007 in Indonesia. According to UNDP (2009), as early as 2005 it was reported that the DM law was

ranked priority 55 of 234 pieces of legislation for the parliament. Later in 2005, the DM law which also covers early warning was elevated rapidly to the seven top national priorities. It was introduced to the Indonesian House of Representatives by the legislature where it was approved and enacted on 27 April 2008 with an unusually smooth passage and only limited opposition.

The DM law No. 24/2007 provides a comprehensive basis on the rules of the game in disaster management in Indonesia. The key highlight of the law is that it provides protection as part of the people's basic rights, and designates the government to be the duty bearer. It expresses the State's constitutional duty to render protection from disaster risks. It provides for DM to be an integrated part of development and governance. This is to be accomplished through reducing risks, mostly when there is no disaster, while at all times the system is charged to be better prepared to respond to and recover from the impacts of disasters. In addition, the law makes provision for the establishment of DM agencies at different levels to be equipped with a robust mandate, authority and resources. When a state of emergency is declared, these agencies are to be provided with special access to wide-ranging special powers including mobilization of response assets, influencing customs, immigration and quarantine and, when necessary, exerting "command" over sectors and locales.

To this end several regulations have been enacted to support the DM law No. 24/2007. The deliberations which followed on the enactment of the DM law 24/2007 in working groups consisting of the United Nations Children's Fund (UNICEF), OCHA and the International Federation of the Red Cross and Red Crescent Societies (IFRC) were encapsulated in Government Regulation (PP) 21/2008 on International Cooperation in Disaster Management. The other derivatives of law are two additional PPs and two Perpres. These are PP 23/2008, which deals with the organization of disaster management for pre-disaster, emergency response and post-disaster, while PP 22/2008 deals with funds and assistance management. Perpres 8/2008 stipulates the creation of the National DM Agency. Other regulations include the Ministry of Home Affairs Regulation No. 46/2008.

5.3.4 Early warning and risk reduction institutional arrangements

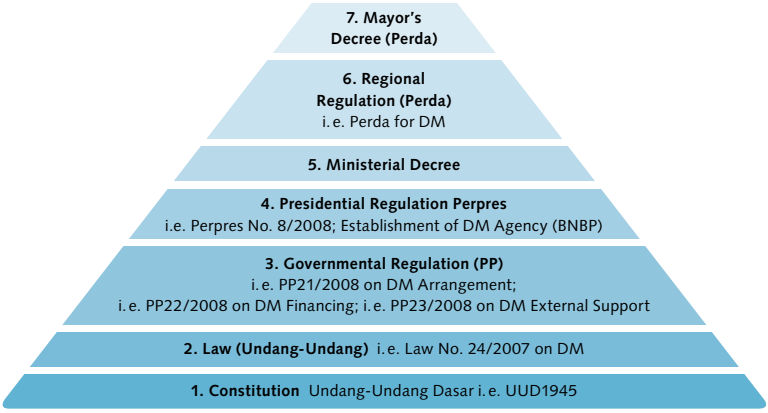
It is underlined that in the context of the InaTEWS, the Indonesian actors had previously in 2006 provided a legal framework for InaTEWS development through decree SK: 21/KEP/MENKO/KESRA/IX/2006 enabling progress in the TEWS development even in the absence of the DM law which was enacted in 2007. Of major importance to this research is article 46 of Law No. 24/2007 which stipulates that early warning shall aim to take quick and appropriate DRR actions to prepare emergency response actions, and which refers to observation of disaster signs, analysis of results from disaster sign observation, decision-making by the authorities, dissemination of disaster warning information and community actions. This implies that early warning should be integrated into the Indonesian DM system. These legal instruments highlight the government's intended commitment and prioritization towards DM.

Another very important legal instrument of the DM law and one that is closely linked to the EWS concerns the planning and management of human settlements which incorporate DRR including enforcement of building codes. According to the DM law No. 24/2007, article 32 paragraph 1, the government may determine that the disaster-prone areas shall come under prohibition for settlement, and/or revoke, in part or completely, anybody's propriety right in accordance with legislation, although they will have the right to compensation. BNPB is the legitimate authority to prepare and stipulate disaster risk analysis requirements according to Article 41(1) and carry out monitoring and evaluation (i.e. Article 41(3)). The implementation and enforcement of spatial structures is underlined in Article 35 (f) and aims to reduce disaster risk including the applications of the regulations of the spatial structure, safety standards and the imposition of sanctions on violators. Separate legal arrangements also exist specifically for spatial planning and will need to be addressed later in the study. In the penal provisions, Article 75 of the DM law details the penalties for negligence in failing to carry out disaster risk analysis in the event of a disaster later on.

5.3.5 Hierarchy and evolution of institutional arrangements

It is noteworthy to understand the hierarchy of the DM in the context of the legal system in Indonesia. Figure 24 shows the hierarchy structure of the institutional arrangements related to DM from the 1945 constitution of Indonesia which represents the highest legal system of the land, DM law, supporting regulations and Decrees. It is pointed out that the Government Regulation is of higher order compared to Presidential Regulations or Decrees. On the other hand, figure 25 maps out the key institutional changes related to DM since the 1945 constitution of Indonesia up to 2009. In appears that there is a decadal pattern of institutional reform related to DM in Indonesia prior to 2005. It is observed that from 1999–2004, institutional development in DM was lacking, overshadowed by the "big bang" decentralization challenges in Indonesia; however there have been constant legal arrangements to support DRR since 2005.

Figure 24: The hierarchy order of the disaster management legal system in Indonesia



Source: Author.

Figure 25: Evolution of institutional changes related to disaster risk reduction in Indonesia

Goal		Emergency Relief	Coordiation of Desaster Response		Manage Induced Disasters and Social Unrest			Disaster Risk Reduction / Disaster Management *Paradigm Shift from Response towards Preparedness*		
Structual Change		Advisory Board	NAT DM Coord. Board BAKORNAS PBA	NAT DM Coord. Board BAKORNAS PB	NAT DM Coord. Board BAKORNAS PBP	INATEWS Dev. HFA initially signed	DRR Action Plan 2006–2009		**Steering Committe** (Formulate Policies, Monitoring and Evaluation) **Executive Board** (Coordiante Command and Execute)	Multi-Sector Participation
									Creation of Multi-Level DM Agencies and EOCs	Nat. DRR Platform
Legal Basis	Constitution		Decree No. 28 / 1979	Decree No. 43 / 1990	Pres. Decree No. 106 / 1999	Min. Decree No. 21 / 2005	Pres. Decree No. 19 / 2006	DM Law No. 24 / 2007	Pres.Decree No. 8 / 2008 Gov. Decree No. 21 / 2008 - NGO No. 22 / 2008 - Funding No. 23 / 2008 - Operation	
Year	**1945**	**1966**	**1979**	**1990**	**1999**	**2005**	**2006**	**2007**	**2008**	**2009**

INATEWS: Indonesian Tsunami Early Warning System; **Dev.:** Development; **Nat.:** National;
HFA: Hyago Framework for Action 2005–2015; **Pres.:** Presidential; **Min.:** Ministerial; **Coord.:** Coordination

Source: Author.

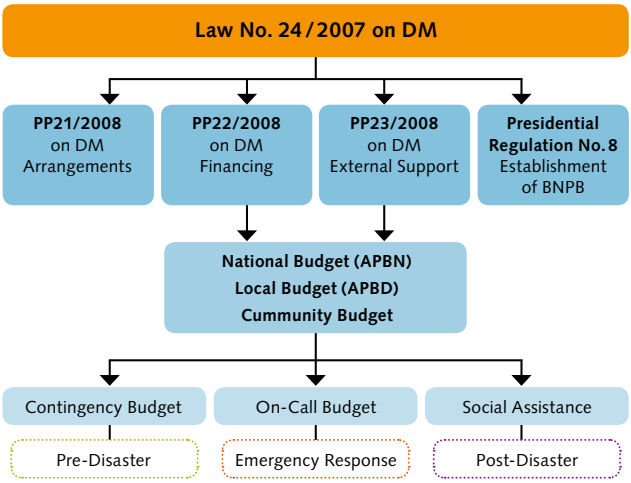
5.3.6 Institutional financial arrangements and frameworks for disaster management

Adequate financial arrangements are a key indicator of the government's priorities and political commitment. According to the transportation minister, the installation of a nationwide TEWS will cost about Rp1.3 trillion, equivalent to US$142 million (Antara 20.07.2007). The international partners have committed tremendous financial support through multilateral and bilateral loans/grants to support not only the development of the TEWS (i.e. US$ 60 million from Germany, US$ 16.6 million from the United States and other significant contributions from the French and Japanese governments) but also major financial contributions were offered for the development of the legal reform and DRR. These funded activities included consultancy in drafting the law, workshops and deliberations between the years of 2005 to 2007. Furthermore, UNDP (2009) reports that their ongoing funding partners; the Australian Agency for International Development (AusAID) and the Department for International Development (DFID) are providing US$ 18 million towards the development and enactment of the subordinate ancillary regulations and to develop safer communities to strengthen DRR to achieve the HFA as part of a five-year programme. Other substantial amounts include the US$ 42 million and another US$ 5 million from AusAID for disaster reduction activities and projects. The highest financial budget was contributed by 15 donors and managed by the World Bank following the December 2004 tsunami disaster, and these funds were especially for reconstruction and recovery. A comparison of financial expenditure between international actors and that of the Indonesian government reveals a wide gap in disaster-related financing.

Following the enactment of the DM law No. 24/2007, there are two Government Regulations that define institutional financing of DM in Indonesia. These are the Government Regulation PP 22/2008 on DM Financing and PP23/2008 on DM External Supports in Indonesia (see Figure 26). Therefore, the former regulation legitimizes national financing while the latter deals with international support, either through multilateral and bilateral loans/grants.

In addition, the current arrangement for DM financing defines where funds come from, i.e. the national budget (APBN), local budget (APBD), and the community budget. These in principle define the financial flow mechanisms and how to get access to them. Furthermore, the financial arrangement is characterized by three categories of funding known as (1) the contingency budget, (2) the on-call budget and (3) the social assistance fund covering the DM cycle consisting of the pre-disaster, emergency response and post disaster stages as shown in figure 26.

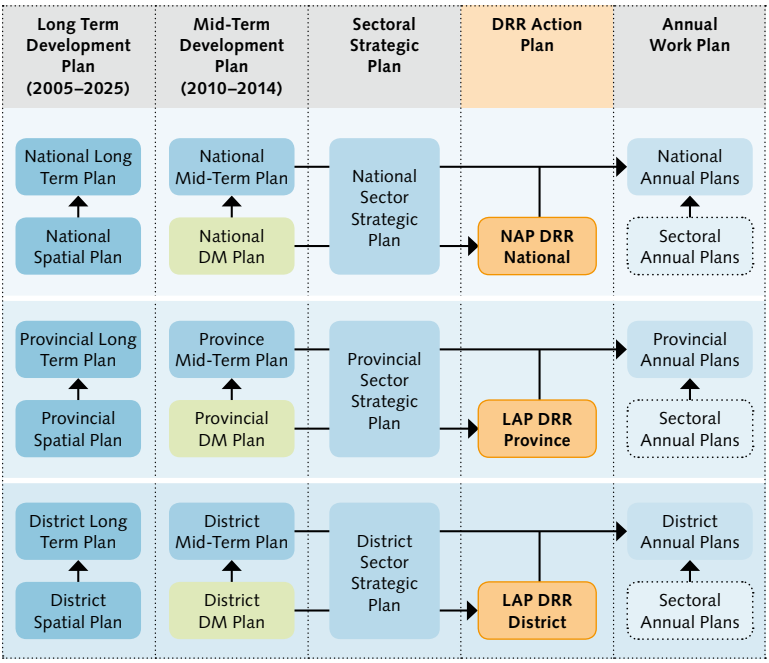
Figure 26: Institutional arrangement for disaster management financing in Indonesia



Source: Author.

In the past, DM financing was not integrated in the National Development Plans (NDP). Currently efforts are underway to integrate the DM Plan into the National Action Plan for DRR financing. According to the framework, DM planning and coordination has to be addressed in the multi-level context from national, province and district level with respect to different development plans classified as the long-term development plan, the mid-term development plan, the sectoral strategic plan, the DRR action plan and finally into annual government work plans as shown in figure 27.

Figure 27: Framework for disaster management planning in Indonesia



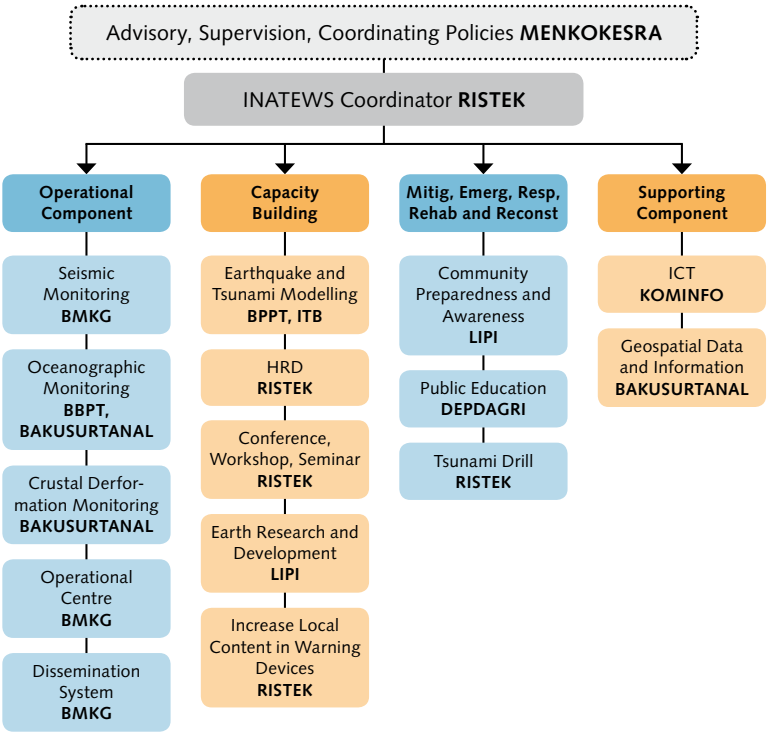
Source: Azis (2009). Reproduced by author.

5.3.7 Institutional architectures and coordination mechanisms

5.3.7.1 Policy and coordination through an ad interim body

Following the formulation of the Tsunami Grand Scenario, the government quickly passed Decree SK: 21/KEP/MENKO/KESRA/IX/2006 to enable and shape the process of establishing InaTEWS in the absence of the DM law. Decree SK 21 also appointed RISTEK as the coordinator of the InaTEWS with eight national state government tsunami focal point organizations as indicated in figure 28.

Figure 28: InaTEWS organizational chart

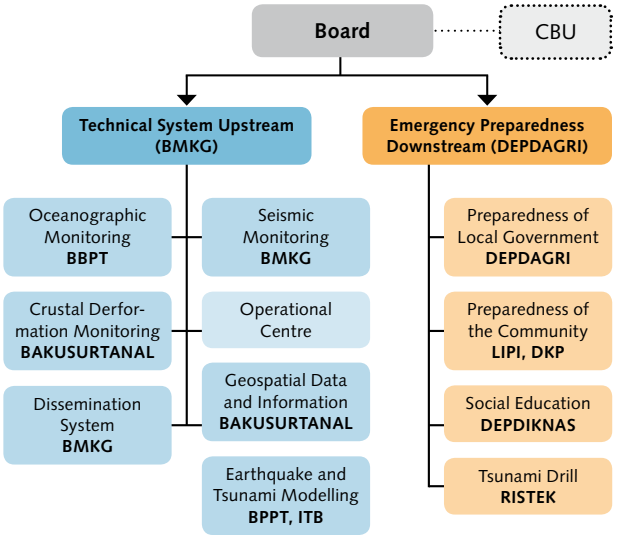


Source: RISTEK (2006). Reproduced by author.

The above figure shows the tsunami focal points with their operational components (up-stream) involving BMKG for seismic monitoring, dissemination and as an operational centre, and using BAKOSURTANAL for oceanographic monitoring and crustal deformation monitoring. The downstream component representing preparedness and mitigation aspects of the system such as capacity-building includes an organization such as BPPT with tasks for earthquake and tsunami modelling. LIPI was appointed for research and development, while response and rehabilitation included LIPI, DEPDAGRI and RISTEK for community preparedness, public education and tsunami drill respectively. The supporting focal organizations, for example for information and technology and geospatial data and information, are KOMINFO and BAKOSURTANAL respectively. However, the organisational chart functionality was identified as having a number of working weakness (BGR 2009) relating working flow and decision-making processes. Therefore, the organizational chart was revised by BGR after a consultative process which included interviews and questions and two national institution building roundtables in June and August 2008 to reflect the current situation until the end of 2008. The revised interim organization

structure actors made an effort to clearly distinguish the organizational functions and responsibilities between the upstream technical component and the downstream emergency preparedness (see Figure 29). It is noted that BGR was unclear about who is responsible for the operational centre. However, BMKG is regarded as the operational centre for tsunami warnings.

Figure 29: Revised InaTEWS organizational chart



Source: BGR (2008). Reproduced by author.

In the revised organizational structure, BMKG is suggested to spearhead the technical upstream component while DEPDAGRI leads the emergency preparedness. The newly created capacity-building unit (CBU) (see dotted link to the board in Figure 29), which includes 20 InaTEWS stakeholder organizations, is integrated in the process according to Decree SK MENRISTEK No. 68/M/Kp/V2008. However, three main weaknesses are identified in this revised InaTEWS organizational chart. Firstly, it is considered that the revised InaTEWS organizational structure still does not actually show working flows as was intended. Secondly, the use of the term 'emergency preparedness' is not clear, as it does not differentiate between preparedness and response, as well as the responsible institutions. Therefore, it does not show the institutions responsible for risk knowledge – a very important element of the EWS. The main weakness of the two organisation structures is the persistent lack of recognition of dissemination and communication as a core element of the EWS. Nevertheless, a very recent informant interview with BGR suggests that the organizational structure has been legitimatized by a decree. The Coordinating Ministry for People´s Welfare (KESRA) assisted by RISTEK are mandated to lead the downstream culture part of the TEWS. RISTEK is a national institution with

technical expertise mandated with formulating policies and coordinating research, Science and Technology. It is pointed out that RISTEK does not sound like the right institution to be assisting KESRA in the downstream-culture component of the TEWS as they have a small budget. Furthermore, according to the SWOT analysis, RISTEK contribution would be most crucial in the technical component of the TEWS, especially in science and technology (i.e. dissemination and communication). It is recalled that Table 1 in the Appendix provides a profile on each of these key institutions with respect to the InaTEWS.

5.3.7.2 Formal permanent bodies: The new multi-level disaster management agencies

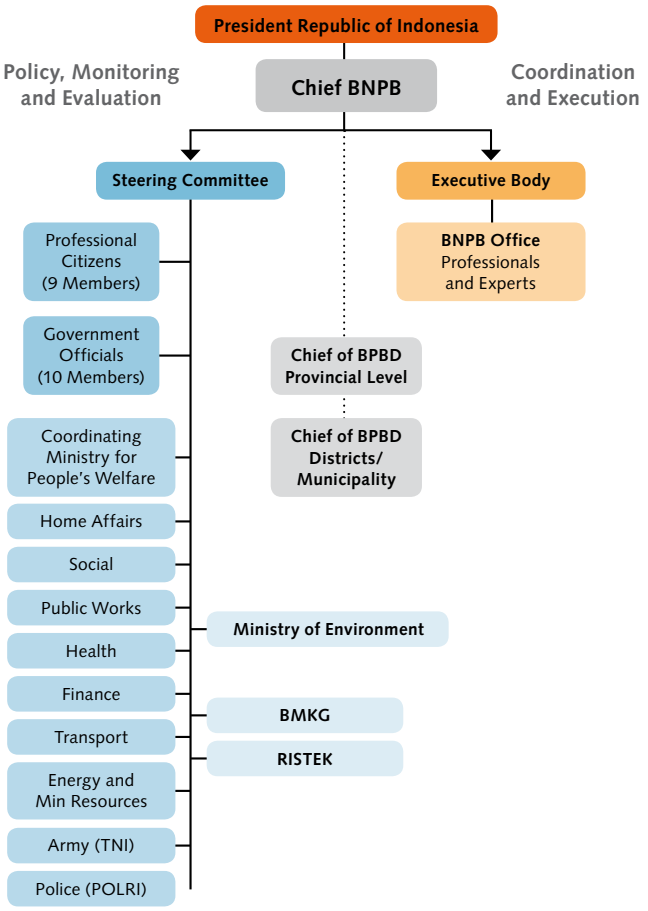
Perpres 8/2008, following the DM law No. 24, gives notice of the creation of the National DM Agency now known as BNPB in Indonesia. In addition, in line with article 18 of the DM law and article 55 of the President Regulation 08/2008, in order to carry out the tasks of DM in a province as well as a city, it is necessary to establish the DM Regional Agency referred as BPBD, stipulated by a Regional Regulation. This implies that at all levels there will be a steering committee and an executive body as shown in figure 30. The regional DM agencies (BPBD) have to be established within a year, which was the end of the year of 2009. This implies that all local governments were responsible for finalizing the local DM regulation (i.e. Perda) by the end of 2008. Furthermore, DM agencies must consist of a steering committee and an executive board as further stipulated in the Presidential Regulation 08/2008 of article 5.

5.3.7.3 The steering committee: Policy, monitoring and evaluation

According to article 19 of the Presidential Regulation, the steering committee shall have the functions of formulating policy on national DM and monitoring and evaluation of DM. The role of the steering committee is of utmost importance because it is the forum through which stakeholders shape the whole legal, political and operational process on improving InaTEWS and DRR in Indonesia.

The major change in membership to reflect a people-centred EWS is outlined in article 11. The new 19-person membership structure does not only consist of the government officials from KESRA to the Indonesian Army (TNI) and POLRI as in the old BAKORNAS structure, but also includes diverse institutions such as the department of social affairs, health, etc., and nine professional community members are also included who can be a mixture of experts and community leaders as shown in figure 30.

Figure 30: Draft organizational chart of the BNPB steering committee and executive body



Source: Author. Update based on BNPB (2008).

It is highlighted that the membership participation of the nine professional community leaders was indeed an outcome of intense debate and mediation between the Executive and Legislature which had been divided on the representation and composition of the steering committee. The Executive were trapped in their old paradigm structure of the bureaucratic members of the BAKORNAS PB, while the legislative body was determined to change the domination of bureaucrats in the steering committee with a new image reflecting the paradigm shift in DRR to involve academics, experts and other individuals outside the government. The legislature wanted to demonstrate the elimination of the old structure and replace

it with a new one so that the international community would have more confidence in the system in Indonesia. The head of respective government institutions nominates their members to the head of BNPB while the head of BNPB nominates members for appointment by the President (Article 55 (1)), but all are subject to a test demonstrating they are fit and proper by the House of Representatives of the Republic of Indonesia in accordance with the provisions of legislation (Article 55(2)). The selection mechanism and criteria for members of the steering committee emanating from the professional community is said[35] to be defined by a regulation from the head of BNPD. According to BNPB,

> *"the assessment of the prospective members of the steering element includes three aspects, namely communication skills, depth of insight, managerial experience and education"* (Interview 1, 16 February 2009).

On the other hand, the composition of the official government membership has also been challenged. For instance, BGR (2009) identified that the steering committee of the new Disaster Management Agency (BNPB) lacks the membership of key InaTEWS stakeholders such as RISTEK, the Ministry of the Environment and the official presence of BMKG as the TEWC. BGR argues that BMG is not a ministry but forms part of the parent Transport Ministry and it not clear who is responsible for tsunami early warning in the steering committee. The role of BMKG in the steering committee is without any doubt not to be neglected. The Ministry of Environment is viewed as a critical partner in natural disaster reduction and environment security.

5.3.7.4 The executive body: Coordination, command and execution

On the other hand, the executive body consisting of professional and expert staff is mandated in article 15 of paragraph (2) of the DM law for coordinating, commanding and executing functions in DM.

The local DM agency BPBD[xxxvi] will comprise a provincial level agency presided over by an official who ranks second to the governor or equivalent, and a regency/city level agency presided over by an official whose rank is second to regent/major or equivalent. All will be established in coordination with the National BNPB and also have steering and executive bodies. The heads of the DM Office employed by BPBD at the province and local level will function below the governor and mayor respectively, with some autonomy in their responsibilities in DM planning, prevention and mitigation. Figure 30 also shows BNPB at national level under the authority of the President, while BPBD at provincial and local level falls under the overall authority of the governor and mayor respectively. BNPB shall hold coordination meetings[xxxvii] with the provincial, Regency/City at least twice a year and the steering committee at all levels shall hold meetings regularly or any time according to the need[xxxviii]. In addition, the national BNPB may invite regional government institutions, business and international institutions to the session[xxxix]. However, according to a recent informant interview, BGR has indicated that KESRA will supervise and monitor BNPB in their progress (e.g., InaTEWS coordination meetings).

This clearly indicates a polycentric and multi-layered architecture which matches closely the decentralization system in Indonesia and would offer favourable conditions for multi-level work procedures and a coordination mechanism. This being the case, the polycentric-multi-layered architectures would help in building resilience and coping capacities to hazards and disasters at all levels. However, the polycentric-multi-layered architectures indeed represent the real challenges for full implementation across Indonesia and will be discussed in greater detail in the forthcoming chapters.

5.3.7.5 The local government operational body: The multi-level emergency operation centres

The fact that DM law stipulates under article 46 paragraph 2 of (d) that early warning includes dissemination of disaster warnings implies that BMKG is the responsible institution for tsunami warning only while local government is mandated to issue guidance and evacuation orders to the communities at risk. This leads to a number of institutional and organizational implications apart from the impacts on the people's reaction and response behaviours (see Chapter 8).

In order to fulfil their responsibility, local governments would have to establish 24/7 tsunami warning services (i.e. Emergency Operations Centres (EOCs)) in order to be able to provide guidance to the community at risk. Ideally, the EOCs will be separate from BNPB working structures and facilities but would be the operational arm at national, provincial and local level on a 24/7 basis. EOC will receive tsunami information from BMKG or interface institutions for local decision-making through local established Standard Operation Procedures (SOPs) and guidelines.

The EOCs at provincial and local level will have an Incident Commander and Emergency Officer who is expected to press the alarm (i.e. siren) button to effect a response (i.e. evacuation). However, it is not very clear if the Incident Commander will have the mandate and responsibility to make critical decisions without political approval of the situation and if equivalent actions to be taken by the governor or mayor. A recent informant interview with BGR suggested that inter-institutional procedures for evacuation are now secured by SOP. This implies the mayor is pre-authorized to order an evacuation. BGR also states:

> *"In a round table discussion policymakers for disaster management discussed and clarified the institutional coordination for the warning chain by considering experiences and perspectives from other areas. A key output of this meeting was that the participants agreed on the need for holistic and integrated SOPs for Tsunami Early Warning, which should be implemented by provincial and municipal/district governments. It was agreed that all municipalities and districts that are able to implement the tsunami early warning services on a 24/7 basis are authorized to call for evacuation. For cities and districts that are not yet able to implement TEWSs, the authority to call for an evacuation lies with the provincial government"*
>
> (Interview 2, 25 January 2010).

RISTEK published a "guideline on tsunami drill implementation for city and Regency" in 2008 which also addresses issues on guidelines on EOC establishment and operations with the support of GITEWS partners. The guideline was distributed to all 33 provinces by DEPGADRI and must be implemented by PEMDA. Temporary EOCs have been established in Jakarta, Bali and Padang. A new EOC is under construction in Bali.

The establishment of local 24/7 EOCs for tsunami warning services requires trained personnel and significant resources on a sustainable basis. The establishment of the EOC is being financed by the French Red Cross while the maintenance plus staffing are expected to come from PEMDA.

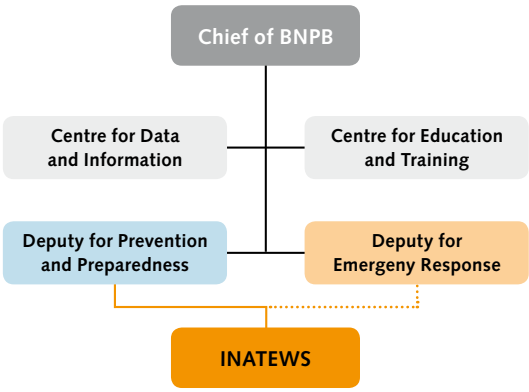
5.3.8 Institutionalizing the Tsunami Early Warning System within a larger architecture

As stipulated by article 46 of Law 24/2007, the EWS needs to be integrated or embedded into the Indonesian DM system as shown in figure 31. This implies the EWS is indeed regulated by the law (UU) which is higher than the ministerial level regulation, as was previously the case in 2005 through the ministerial decree SK21/2006.

Recent developments for institutionalizing InaTEWS with BNPB prevention and preparedness structure followed a consultation process between BGR and BNPB (Deputy for Prevention and Preparedness) and Indonesian partners in October 2008. It is expected that the upstream part of the InaTEWS (i.e. the EWC) and warnings will flow and link to BNPB under the Deputy for Prevention and Preparedness Directorate as part of the executive body or operations. However, the INATEWS (i.e. the EWC) should link simultaneously to both prevention and preparedness and emergency response directorates as indicated by the dashed line in Figure 31, as there would be a very rapid shift in responsibility from preparedness to response in the case of tsunami hazard and disasters.

The directorates under the Deputy for Prevention and Preparedness are DRR with two further sub-directorates in Prevention and Mitigation (not shown). The other Deputy directorates of BNPB include the Deputy of Emergency Management, Rehabilitation and Reconstruction, Logistics and Equipment and the Technical Operation Unit.

Figure 31: InaTEWS embedded within BNPB



Source: Author.

5.3.9 The emerging national institutional tsunami early warning chain in Indonesia

A TEW chain from the national level down to the local level at the coast is the key element of an effective EWS. Table 5 shows the end-to-end institutions involved in InaTEWS. The shading indicates the institution's involvement in the process. However, at this point there is still no final agreed national tsunami warning chain or early warning process in Indonesia. Nevertheless, much progress has been achieved at different levels. Figure 32 maps out the TEW chain from the author's observations and findings. For example, it is now clear that BMKG's institutional role is to monitor earthquake data and issue tsunami warnings shortly after an earthquake. BMKG is also responsible for the technical upstream component of InaTEWS. This also implies that BMKG is the legitimate agency for receiving and acting upon any international advisory message from any tsunami warning centre (i.e. PTWC, JMA).

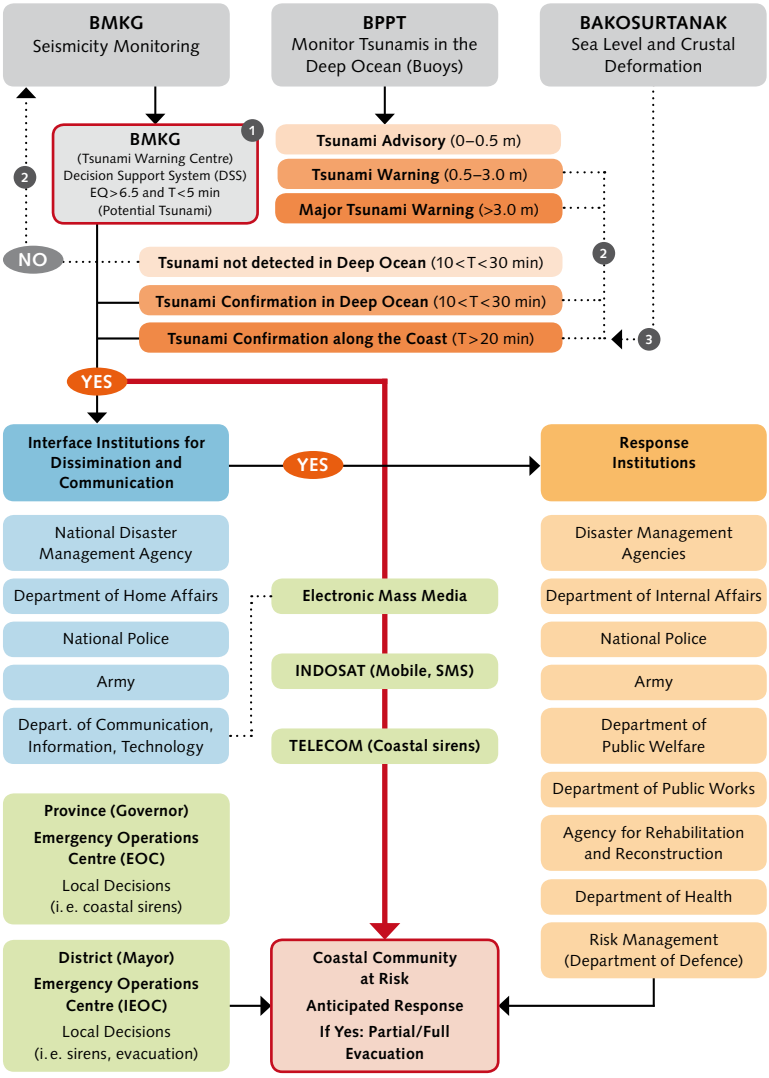
In the event of a significant earthquake with a moment magnitude greater than a critical threshold (i.e. 6.5 Mw), an alarm would be triggered in BMKG. Once the seismic data is processed and matched with the best tsunami prediction in the database, considering the operational warning alert levels (i.e. tsunami advisory 0-0.5 m, tsunami warning 0.5–3.0 m, etc.), BMKG should disseminate the tsunami information (i.e. a potential tsunami) through the DSS to the interface institutions and directly to the community through electronic institutions such as the media (TV, radio), INDOSAT (Mobil text) and TELECOMSEL. The key interface institutions consist of the DM agency, department of home affairs, national police, army, department of information, communication and technology, provincial government, city and district (i.e. Padang and Bali), Port Radio, Provider GSM/CDMA. The interface institutions will communicate and disseminate the potential tsunami information to the sub-national government and the response institutions.

The sub-national (i.e. province and district) government operational arm in DM is the EOC. However, the legitimate functioning of the EOCs is in the process of final agreement by actors. The inter-level operations depend on specific local arrangement between province and district. Province and districts with EOCs may make own local decisions. It is the responsibility and mandate of the local governments, i.e. province, district or city to interpret the potential tsunami information through SOPs and make final decisions on whether to sound the siren and call for public evacuation because of the impeding tsunami hazard. Chapter 7 describes further specific local arrangements between sub-national levels in the case of Padang and Bali.

On the other hand, the potential tsunami information will reach the response institutions through the interface institutions. The institutions involved in the emergency response, mitigation and rehabilitation include the DM agencies (provincial, districts), department of internal affairs, department of public welfare, department of public works, agency for rehabilitation and reconstruction, department of health, police and the army. According to the revised organizational structure of InaTEWS, DEPDAGRI is the response leader.

Following the first potential tsunami message, BPPT is mandated to provide BMKG with GPS buoy data to confirm or deny if a tsunami has been generated in the deep ocean within a period of less than 10–20 minutes after the earthquake event. If a tsunami has been generated (i.e. *yes*), a second tsunami message in the form of a confirmation is disseminated and communicated again downstream to confirm partial or full evacuation with the response institutions. If no tsunami is detected, in the deep ocean, (i.e. *no*), ideally the whole process is cancelled, while BMKG, BPPT and BAKOSUTANAL continue with the monitoring process. BAKOSUTANAL is mandated to monitor and provide sea level data and GPS crustal deformation to BMKG to confirm if, for example, a tsunami has been observed along the coast from the tide gauges. The institutional agreement between the three monitoring organizations is based on the Memorandum of Understanding (MoU) agreement founded on the legal framework of the Ministerial Decree SK 21/2006.

Figure 32: Emerging national institutional tsunami warning process in Indonesia



Source: Author.

5.3.10 Sector institutional interplay and interactions

The DM legal framework is not the only institutional arrangement to govern environmental risks such as tsunamis in Indonesia. In Indonesia there are a number of sector-specific legislations such as the spatial planning Act No. 24/1992, law No. 23/1997 on the Environment Management law No. 23/1997 and the coastal and small Island Management Law No. 27/2007. For instance, the spatial planning regulation addresses spatial planning and development in all conservation and protected areas which may also be at risk to natural hazards while Law No. 23 / 1997 on Environment Management governs the development activities in terms of license issuance, preventive regulation development or prohibition to any parties who engage in activities in relation to the environment. Furthermore, the relatively new Coastal and Small Island Management Law No. 27/2007 is a very strong sector-specific law for integrated coastal zone management including mitigation of coastal hazards such as tsunamis. To reduce the impact of coastal disasters in Indonesia, the Ministry of Marine Affairs and Fisheries (MoMAF) is also proactive in minimizing the impact of coastal disasters on coastal communities and on aquaculture activities. The MoMAF is emphasizing the implementation of Integrated Coastal Zone Management (ICZM) with the objective of achieving balance between natural resources, human utilization and disaster mitigation aspects to enhance coastal socio-ecology resilience. A healthy coastal ecosystem condition helps in the sustainability of exploitation activities by humans while ecological conditions due to the exploitation by humans will decline in the absence of a disaster mitigation concept in coastal areas. In this respect, MoMAF has reformulated the building code for earthquake and tsunamis to include the existing traditional design with some modern building techniques.

However, an exploration of the issue and interplay between sector institutional arrangements in environmental governance and development also points to situations of conflict and lack of governance effectiveness between different institutions; between the overarching norms and principles that govern these interactions. For instance, in Bali, development in the restricted areas is an ongoing challenge, a battle between rapid tourism-related developments that often infringe on protection and conservation areas. The main problem is that developers do not wait for permit approval or have none, while others build in the restricted zones which are either conservation areas or violate local zoning rules such as the 100-metre no-build zone from the high water mark. These illegal and rapid developments are likely to generate new risks. The enforcement problems are due to overlapping institutional mandates and lack of cooperation among actors, and long bureaucratic procedures leading to bribes and corruption. These experiences provide useful insights into the challenges and implications of tsunami risk zoning and enforcement.

5.4 Summary

The Grand Scenario strategy was ambitious while the GTEWS project with partners has spearheaded a novel tsunami observation and forecasting system in Indonesia. However, in the case of the GITEWS project, inadequate attention was paid to risk

knowledge, dissemination and communication and response as key elements of an effective EWS because it was not explicitly designed to address that.

There have been substantial multi-level institutional-governance arrangements and structures to support a TEWS in Indonesia. The DM law No. 24/2007 and auxiliary regulations and decrees provide a comprehensive basis for the rules of the game in DM supporting the paradigm shift from disaster response to preparedness and mitigation in Indonesia. Article 46 of the DM law governs the EWS and stipulates its integration as part of the Indonesian DM system. Supporting legal instruments are the risk reduction institutional frameworks concerning prohibition of settlement in disaster-prone areas, the implementation and enforcement of spatial structure and the imposition of sanctions on violators. A separate interim institutional ministerial decree SK 21/2005 has provided the momentum and coordination mechanism for developing InaTEWS despite many practical weaknesses. A revised institutional structure proposed BMKG leading the technical upstream component while DEPDAGRI would lead the emergency preparedness. However, the latest development legitimatized by a decree suggests KESRA assisted by RISTEK should be mandated to lead the downstream culture-preparedness of the TEWS. However, questions arise of whether an institution such as RISTEK is fit for this responsibility.

The three important auxiliary Government Regulations, namely PP 21/2008, PP 22/2008 and PP 23/2008, have been enacted to regulate the international cooperation in DM, the organizations of DM, and funds and assistance management respectively. The Presidential Regulation 8/2008 is in the process of transforming the old BAKORNAS PBP into the National DM Agency. The two DM financial institutional arrangements define where funds come from and further categories of funding covering the DM cycle.

The major architectural change is the creation of permanent new multi-level DM agencies for policy, monitoring and evaluation. A major development reflecting the paradigm shift towards preparedness is the new steering committee composed of membership participation from diverse institutions, the professional community and the state institutional actors; an outcome achieved through intense debate and mediation. Currently, there is a lack of direct participation of key state stakeholders in the steering committee.

The fact that the DM law stipulates that early warning includes dissemination of disaster warning implies the local government is mandated to make their own local decisions of what to do. Thus, local governments are establishing 24/7 EOCs as a separate but operational arm of the BNPB in order to provide guidance to the community at risk. However, institutional mandates and clear SOPs at multiple-levels are still under development. It is agreed that areas with EOCs have the legitimate authority to make local decisions. Hence, a formal institutional TEWS chain is gradually emerging in Indonesia.

In general, the institutional change has remarkably progressed from an emergency relief, armed forces type of leadership and participation towards multi-stakeholder participation through the steering committee and DRR platform. The

multi-level-polycentric architectures, frameworks and structures consisting of the HFA, the IOC-UNESCO regional governance framework and multi-level-polycentric architectures and structures are ideal to cope and build resilience for local and transboundary risks such as tsunami hazards and disasters in Indonesia. However, it is becoming very clear that the full implementation of such architectures represents the central challenge in Indonesia.

The interplay between institutional architectures (i.e. DM law and the Coastal and Small Island Management Law) and actors are very important to finally build national resilience to tsunami hazards and disasters in Indonesia.

6. Actors' interaction and perspectives

Understanding effective governance requires understanding the actors-agents that drive and shape the outcome. The main questions asked include who are the actors of TEWS governance in Indonesia? What are their roles, interest, agendas and incentives? What are these strategies, tactics and coping capacities? Are there any potential conflicts, trust and cohesion among the diverse actors? How are the actors participating and exercising agency to shape the outcome? What are the diverse views of the actors on the TEWS-related architecture and frameworks?

6.1 Actors' participation, networks, roles and responsibilities

6.1.1 Actors at the international level

As indicated in chapter 5, the leading global actor in the TEWS is IOC-UNESCO, consisting of ICG/IOTWS. IOC-UNESCO is mandated by the international community to coordinate the establishment of IOTEWS in the Indian Ocean.

On the other hand, at the national level, the development of IOTEWS has been supported by several foreign countries and international agencies such as Germany, the USA, Japan, China, France, etc. Germany spearheads the largest group of external scientists and researchers and is the largest financial contributor in developing GITEWS. The German Federal Ministry of Education and Research (BMBF) funds the GITEWS project. The official institutional partners[xxxx] of the German project include the German Research Centre for Geosciences Potsdam (GFZ), Consortium Leader, the Alfred Wegener Institute for Polar and Marine Research (AWI), Bremerhaven, the Federal Institute for Geosciences and Natural Resources (BGR), Hannover, the German Aerospace Centre (DLR), Oberpfaffenhofen, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, GKSS Forschungszentrum, Geesthacht, Konsortium Deutsche Meeresforschung (KDM), Berlin and Leibniz Institute of Marine Sciences (IFM-GEOMAR), Kiel.

All these organizations are leading centres of excellence in Germany in their respective fields. They are all technical scientific actors, with the exception of GTZ. For instance, AWI is Germany´s leading institute for polar and marine research with the responsibility of developing a modern tsunami modelling component. DLR is Germany's national research centre for aeronautics and space, with the responsibility of providing the DSS. On the other hand, GTZ is a federal-owned organization.

It is an international cooperation enterprise for sustainable development. It offers sustainable solutions for political, economic, ecological and social development in a globalized world and promotes complex reforms and change processes, often under difficult conditions. Their goal is to improve the living conditions of people. The GTZ core competence is in capacity development.

Apart from the German partners involved in the GITEWS project, the United Nations bodies include UNDP, OCHA and IOC-UNESCO. Their specific roles and responsibilities include facilitation and coordination throughout the process. UNU-EHS contributes particularly in the "last mile" component of the TEWS, focusing on vulnerability assessment and capacity development in terms of doctoral programmes in Germany.

6.1.2 Actors at the national and sub-national level

There is a wide range of actors involved in the TEWS and it is not possible to detail each player's roles and responsibilities. Therefore, for simplicity, Table 1 in the Appendix list summarizes the InaTEWS main national institutional actors, their corporate responsibilities, executive and operational functions and specific mandate.

The key national institutions and actors are concentrated mostly in Jakarta. The eight official partners of GITEWS include *RISTEK, BMG, BAKOSURTANAL, BPPT, the National Institute for Aeronautics and Space (LAPAN),* the *Department of Communication and Information Technology of the Republic of Indonesia,* the *National Board for Civil Protection (BAPPENAS)* and the Technical University Bandung (ITB). It is noted that GITEWS official partners[xxxxi] are indicated in italics. On the other hand, other actors involved are the Secretariat of National Board for Disaster Management (BAKORNAS PBP), the Ministry of Home Affairs and Fisheries*, the National Planning Agency (BAKORNAS PB)*, the Ministry of Home Affairs (MoHA) and the House of Representatives (DPR).

At the sub-national levels the state actors include the army, local police (POLDA), BPBD, EOCs, provincial governors and the district mayors. Other partners involved include the academic institutions, universities such as LIPI, ITB and the Anadalas University in Padang.

Important civil societies and associations involved in TEWS development include KOKAMI, MPBI, the Indonesian Red Cross (PMI) and IDEP. KOKAMI is a student-based NGO headed by an executive director in Padang consisting of around 12 students with affiliations and links with faculty members of the Andalas University of Padang. Their special interest and agenda is in community preparedness. MPBI (a community disaster preparedness organization) is based in Jakarta and was founded one year before the tsunami disaster. It is an association of professionals in the area of DM having an interest in DM legal arrangements and with wide-reaching impacts on the development of a more appropriate DM strategy for Indonesia. For example, MPBI was the key actor at the forefront in strengthening the civil society and wider public support for the DRR legal reform in Indonesia (UNDP 2009). On the other hand, PMI is an important actor with over 850,000 volunteers and members participating in disaster preparedness and response all

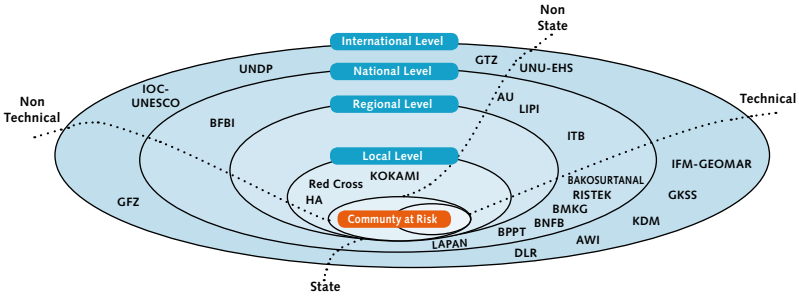
over the archipelago. It represents a huge resource for civil society in Indonesia. IDEP is an Indonesian non-profit foundation that was formally established in Bali in 1999, at the height of Indonesia's economic crisis. IDEP's objective was to respond to urgent needs for sustainable food production and resource management, while conveying the importance of environmental education for sustainable living. IDEP has good links with MPBI and PMI, although not officially listed [xxxxii] yet.

Major public-private actors include the Bali Tourism Board and the Bali Hotel Association (BHA). At the local level in Bali, religious, cultural and traditional village leaders are also participating and influencing the outcome. Finally, the communities at risk are also participating in the TEWS and preparedness. There are slightly more than 125 provincial communities at risk of tsunami hazard in Indonesia.

6.1.3 Actors' participation dynamics

Most of the external researchers are highly scientific-technical actors participating mainly in the upstream component of the TEWS (see Figure 33). Most of the state actors with technical and policy backgrounds situate themselves at the national level of the tsunami EWS development. At the sub-national levels, the state actors tend to have a broad range of backgrounds. They also include the local political and decision makers such as governors, mayors, etc. Ideally, the DM authorities operate at all levels with various domains of knowledge and expertise. On the other hand, the civil societies and NGOs such as KOKAMI and PMI pay more attention to preparedness, carrying out education, awareness and sensitization at the local level within the community. Some actors tend to be more flexible in their participation, operating at multiple levels, such as LIPI, MPBI and GTZ-IS.

Figure 33: Key institutional actors' participation in the Tsunami Early Warning System



Source: Author.

The sheer number of actors participating in the whole process reveals a high degree of multi-stakeholder participation differentiated by various domains of knowledge and backgrounds operating vertically and horizontally at different levels and scales throughout the process. Highly scientific and technical actors tend to situate themselves at the national level with priorities in the technical EWS, while other actors

of various domains of knowledge and expertise tend to operate at multiple levels with much focus and interest in community-related activities. Hence, it is clear that there exists a hierarchical participation dynamics related to authority in technical knowledge and expertise that contrasts with the authority of hierarchy and discipline. Consequently, the participation structure creates a fluid and dynamic action arena shaping the actions and outcomes at all levels. For example, the high interest in developing a sophisticated technological approach is driven by the national technical actors (i.e. BMKG, BPPT, RISTEK and German partners, etc.), while the civil societies such as KOKAMI at the local level advocates for people-centred EWS through strong education and preparedness.

Collective participation is more successful among the national actors compared to the sub-national level actors. This is not to say that actors are simply unwilling to participate collectively at these lower levels but rather there are far greater challenges, and this will be addressed progressively in this study. This is captured by the statement made by several actors. For instance UNESCO said:

> *"… if there is a lack of collective participation it is perhaps due to specific technicalities and internal issues involved.… and there are so many players operating in a vast country especially in the downstream culture part of the EWS"*
>
> (Interview 3, 27 October 2008).

6.1.4 Actors' participation through capacity-building

Almost all actors in Indonesia engaged in the TEWS/DM have participated in different capacity-building initiatives. The Indonesian Tsunami Grand Scenario strategic plan, the GITEWS project and other capacity-building initiatives have recognized the need to support the local community, local decision-makers, and local disaster risk management organizations, as well as executive agencies and scientific institutions for TEWS sustainability, as well as the establishment of the requisite technological bases to implement the end-to-end system throughout Indonesia. The German cooperation contribution also includes training of scientists and staff on how to operate the various components of the TEWS. In addition, there are three work packages of the GITEWS project targeting capacity-building at various levels focusing on (1) building individual organization capacities, (2) executive agencies' capacities and (3) inter-institutional and organizational capacities in the fields of preparedness and early warning respectively. There has also been some exchange of visiting scientists between Indonesia and Germany.

The unique component of the GITEWS project differentiating it from other initiatives in Indonesia, the Indian Ocean and Southeast Asia is the PhD programme consisting of nine active experts around the Indian Ocean rim. The high level academic training[xliii] programme is coordinated by UNU-EHS in Germany, involving various organizations that will become the future generation of scientists in charge of operating and improving the system.

It is difficult to measure the impact and success of the actors' participation in various capacity-building programmes in Indonesia. However, a GTZ-IS project evaluation during its first phase (2006–2008) at the community level in the three

pilot areas suggested a wide range of achievements in the fields of knowledge and awareness, hazard and risks, warning services and reaction with regard to the end-to-end Indonesian TEWS. The project's intervention suggests an impact at national and local levels. At the national level the project contributed significantly to the discussion on issues related to the warning chain, reaction schemes and decision-making (on evacuation), addressing questions like standard reaction schemes, SOPs for local warning services and the delegation of decision-making from the local regent or mayor to local warning centres (in the context of very short warning times). A total of at least 28 separate capacity-building-related activities have been developed by the German project, while 15 activities were reported for the United States contribution in the period of 2005–2009. A comparison of the clustered activities according to the TEWS shows that the GITEWS concept is well spread over the TEWS elements while the United States IOTWS is less intense on the warning and dissemination but more focused on reaction, response and public outreach. Both programmes apparently focus relatively equally on the response and public outreach.

In this context, most actors indicated that capacity-building has increased in all institutions covering all domains of knowledge and expertise. However, capacity-building has also been heavily criticized by many. The main argument raised is that the percentage contribution for capacity-building is marginal compared to the amount spent on the technical TEWS. It is reported that the GITEWS budget for capacity-building is about 5% of the close to US$60 million project. On this note, InWent pointed out that:

> *"Capacity-building needs to be improved for sustainability. We are working with a tight budget and there is a lack of integration in the Indonesian planning cycle, and the problem is that the people involved change quickly"*
>
> (Interview 4, 28 October 2008).

Similar arguments are emphasized by MPBI who said:

> *"… there is a lack of permanent training facilities and integration in the Indonesian planning cycle … we do not have a comprehensive capacity building sustainability plan; however we have plans to develop a training centre related to disaster''*
>
> (Interview 5, 3 November 2008).

6.1.5 Actors' cooperation – multilateral and bilateral

The current effort to establish the Indonesian TEWS was initiated through several international meetings following the tsunami disaster, including the Tsunami Summit held in Jakarta on 6 January 2005. This was followed by the World Conference on Disaster Risk Reduction held in Kobe, Japan in January 2005, the IOC meeting held in Paris in March 2005 and the IOC Meeting held in Mauritius in April 2005. During the special sessions of the Hyogo, Kobe world conference, the Indian Ocean countries agreed, based on national and regional cooperation, to design and establish IOTEWS. Furthermore, to great surprise, it was during the world conference that Germany announced it would contribute US$ 60 million over the next

five years of 2005-2009 to assist Indonesia in establishing a TEWS, now known as the GITEWS project, as discussed in chapter 4.

In 2005, the United States Agency for International Development (USAID) spearheaded the United States IOTWS programme with a direct contribution of $16.6 for two years to the international IOTEWS effort led by IOC. The project initiative helped United States scientists and experts share technical expertise, provided guidance, and helped build a multi-hazard warning system capacity within the Indian Ocean region. The American experts have worked through strategic collaboration and partnership with the international community, host country governments and private sector and NGO partners and at the community levels. Overall, working through the IOC and the ICG/IOTWS, the United States IOTWS programme provided substantial input into shaping the overall design of the IOTEWS and links with InaTEWS.

On the other hand, Japan is cooperating and assisting in strengthening the InaTEWS centre while the Republic of China has also installed seismometers. The Government of France has worked in partnership with PMI and the French Red Cross to reinforce the capacities of Indonesia in coping with disasters focusing on a community awareness project on disaster preparedness and risk reduction using a participatory approach. The French Red Cross is also funding the establishment of the EOCs in 10 provinces in Indonesia.

6.1.6 Actors' agenda

All actors have a specific interest and agenda in the TEWS in Indonesia. According to the in-depth interview, there are three main agendas of interest set by the actors. For international actors the agenda is primarily driven by the desire to innovate, carry out research and development and by human security issues. In contrast, all national actors including civil societies in Indonesia have priority agendas on human security, reducing damage from disasters and institutional and capacity development. The third group, mainly private actors, are simply driven by the incentive to protect and sustain existing and expected future economic gains.

6.1.7 Actors' priorities: Institutional change, words and real budget allocation

The actor's priorities in the TEWS/DM have constantly been argued by actors at all levels. In-depth interviews suggest that most actors perceived that DM and early warning became national priorities following the tsunami disaster, and this is exemplified in the new DM law and supporting regulations. For example, UNESCO highlighted:

> *"The government has the TEWS as a priority because they have legally allowed national actors to collaborate with international actors through Government Regulation, PP 23/2008 and their commitment in the tsunami drills"*
>
> (Interview 3, 27 October 2008).

Furthermore, according to the state actors, the President's speeches and the recent inauguration of the TEWS in November 2008 demonstrate clearly the government's priorities are the TEWS and DM in Indonesia. For instance, BNPB said:

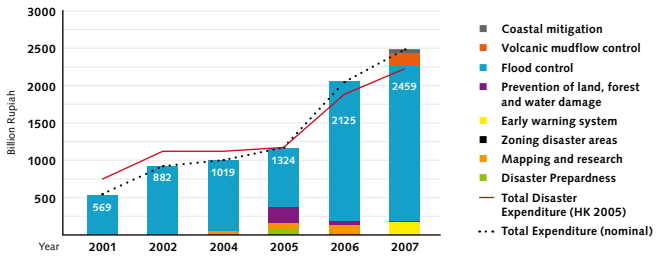
> *"The President in a recent monthly meeting requested the local government to prepare an evacuation route as it was a pending matter. We have consequently dispatched letters to all local governments for implementation"*
>
> (Interview 1, 16 February 2009).

On the other hand, some actors commented that the rather early launch of the TEWS by the President and the government was simply a politically opportunistic strategy[xliv] since the TEWS is not really complete yet.

6.1.7.1 Priorities in terms of real financial commitment

An important indicator of the government's real engagement with its priorities is not only measured in terms of the institutional financial arrangements developed but also by how much is actually budgeted and equitably distributed among actors at all levels to implement activities. The financial expenses allocated by the Indonesian Government as indicated in figure 34 show that the government national budget spending[xlv] on DRM quadrupled from US$0.06 million (569 million Rupiah) to US$ 0.25 million (2459 million Rupiah) between 2001 and 2007 in response to two major disasters in Aceh (2004) and Java (2006). The total national expenditure on prevention and preparedness slightly increased after 2004. However, the total amount, including for early warning, is less than US$26,315.00 (250 million Indonesia Rupiah) representing 10 per cent of the expenditure. Most of the funds have been allocated to response to floods (i.e. flood controls).

Figure 34: Disaster expenditure in Indonesia



Source: Azis (2009).

In comparing the programme proposal of the National Action Plan-Disaster Risk Reduction (NAP-DRR 2006–2009) and the government budget allocation for 2007–2009, BAPPENAS pointed out that the government has already allocated enough funds, even exceeding the programme proposal for the five key programmes on the National Action Plan for DRR (NAP-DRR 2006–2009). In total the government has allocated six times more compared to the proposed budget allocation. Indonesian DRR financing has reached 2.1 per cent of the total national budget. However, it is underlined that the post-disaster expenditure is an overwhelming US$1094.73 million (10.4 trillion rupiah) compared to US$ 258.94

million (2.46 trillion rupiah) spent on DRR. What is interesting is that spending for post disaster is more than four times the spending devoted to DRR.

6.1.7.2 Declining sector budget – far from expected budget allocation

According to BAPPENAS, more detailed sectoral budget analysis indicates that the amount allocated in the last three years from 2007 to 2009 actually decreased with the budget for 2009 back to one third of the spending in 2007. BNPB proposed US$ 16.11 million (153 billion Rupiah) for the year 2009 but initially received only US$ 6.28 million (Rp59.7 billion Rupiah). A hearing of BNPB with the House of Representatives Commission was heard. In the end BNPB was further approved US$5.15 (Rp49.0 billion Rupiah). This amounts to a total of US$ 11.44 million (108.7 billion Rupiah), and represents a deficit of US$ 4.66 million (44.3 billion Rupiah). It is underlined that the council members argued that the budget was not appropriate to the real needs of DM, noting that the largest portion of the budget of US$ 10.32 million (98 billion Rupiah) went to emergency response. This statistically represents 90 per cent of the disaster budget for emergency response. The BNPB national budget for DM for the year 2010 is US$ 18.1 million (172.062 billion Rupiah) which is a relative increase compared to the year 2009. The House of Representatives Commission VII approved the Work Plan Budget Ministry/Agency. However, BNPB complained that:

> *"The budget is far from the expected … the budget should be adjusted to the real priority needs in DM including those pre-disaster, during, and post-disaster"*
> (Interview 1, 16 February 2009).

In this context the Commission VII BNPB plans to immediately apply to the Ministry of Finance to narrow down the gap in the budget. This shows that expenses for DM have increased; however sector-specific funding has recently decreased, probably because the approved budget is consistently lower than the proposed budget for DM financing. In addition, most of the spending was for response and recovery rather than for preparedness.

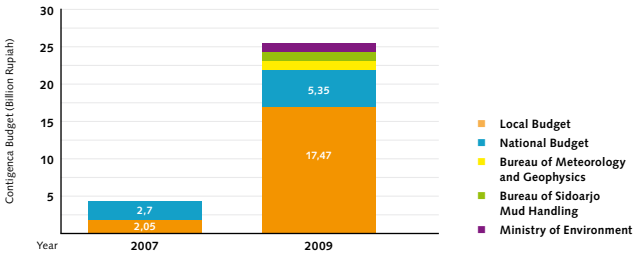
6.1.7.3 Shift in contingency budget from central to local government?

The contingency budget of the local and national government clearly shows that there has been an increase from US$ 0.52 million (5 Billion Rupiah) to US$ 2.63 million (25 Billion Rupiah) from 2007 to 2009 as shown in figure 35. In 2007, the local and the national contingency budgets were of relatively equal amounts. In 2009, the local contingency budget went up by 8.5 times from USS 0.22 million to US$ 1.83 million (2.05 to 17.47 billion Rupia) while the national budget only doubled. This is an important financial arrangement indicator of increasing distribution of financial resources to the local government to help cope with and manage the hazards locally. However, the DM agency BNPB is not satisfied with the financial arrangements. This is exemplified by the statement made by BNPB:

> *"… this has not been balanced with decentralization or delegation of authority and resources, which actually is very much needed by local authorities to perform functions well … much of the existing resources are still concentrated at the National Level"*
> (Interview 1, 16 February 2009).

It is also observed that the planned contingency budget (i.e. for pre-disaster preparedness) is consistently slightly lower than the approved DRR contingency budget. There was a gradual convergence between proposed and actual allocated budgets in the years 2006, 2007 and 2008.

Figure 35: Contingency budget of local and national government



Source: Azis (2009).

6.1.7.4 Unjust allocation of funds

Further analysis shows that almost all the districts and provinces had an increase in their contingency budgets for DM; however the allocation per district and province varied significantly. For instance, Java Barat, Java Tengen, Katim, Sulteng, Bali and Papua received more than three per cent increase in the local contingency budget[xlvi] (APBD) for the year 2009 compared to 2007, while Maku reported a decrease of about one per cent in 2009 compared to 2007.

An informant interview on the differential contingency budget allocation reveals key institutional weaknesses in the national DRR financing. The Co-Chairman of the Parliament Budget Committee of the Republic of Indonesia said:

> *"… up to now, the contingency budget has more or less depended on the political judgement of the government and the budget committee of the DPR (i.e. House of Representatives). The government has the power to propose which districts it prefers to allocate; this could depend on the amount requested from the local government, but in many cases not all the requesting proposals from local government are accepted … it could also depend on the budget committee's judgement, mostly because a mayor from a certain district can strongly defend and win the arguments over the debate in the committee session"* (Interview 6, 15 October 2009).

In a separate discussion, BNPB mentioned that:

> *"Financial resources for DRR also depend on the local government's financial capacity … for instance in Jakarta the local government is rich and can afford to allocate adequate funds for preparedness if they are committed, compared to some less rich cities, and it is for that reason that some local governments can only ask central government for recovery funds rather than for preparedness"*
>
> (Interview 1, 16 February 2009).

Therefore, although all the districts and provinces had an increase in their contingency budget for DM, the allocation per district and province vary significantly. This suggests the ongoing multi-level institutional financial weaknesses and challenges in Indonesia despite the DM regulations on DM financing (i.e. PP 22/2008). The contingency budget financing depends on the political judgement of the government of the day and the abilities of local leaders to propose and defend their proposed budget at the budget committee rather than on a clear institutional set-up and mechanisms. Therefore, provinces and districts with lower abilities in proposing and defending proposed budgets can be left behind in DRR, and this reveals unjust prevailing conditions in budget allocation. BNPB also stated that:

> *"There is inconsistency in the framework and lack of an integrated mechanism to allocate resources for every region"* (Interview 1, 16 February 2009).

6.1.7.5 Perplexing multi-level bureaucratic mechanisms and delayed funds

Another issue raised by BNPB is the absence of a mechanism for technical implementation for rapid resource mobilization. There are problems with emergency funds or on-call funds. It is argued that:

> *"… fund distribution was slow due to perplexing bureaucratic mechanisms from the national level to the provincial level and regional level. It took months after the emergency response was over until the on-call funds arrived at the disaster–affected regions"* (Interview 1, 16 February 2009).

Moreover, detailed mechanisms, standard frameworks and criteria need to be developed to effectively support the institutional financing for DRR. The major advantage of well defined criteria is that they will save time in debating such budget allocating issues and potential inequitable, unjust and very slow distribution of funds for DM between districts and provinces.

6.1.7.6 Securing disaster management budgeting

The critical elements identified by actors are that budgeting for DM planning is a very complex issue, particularly as there was no DM plan, which is an essential document needed as the basis for budgeting. However, actors indicated that very recently BAPPENAS has successfully completed a DM plan and a National Action Plan for DRR (NAP-DRR 2010-2014)[xlvii] to be integrated into the National Development Plan (NDP) as well as a mid-term Government Plan. This will ensure that DRR is included in the Government Annual Plans and that DM budgeting becomes the priority for the next development programme in Indonesia.

6.1.7.7 Distribution of funds across the Tsunami Early Warning System

The other issue that actors have complained about is the fact that most funding was heavily focused on the technical development of the technical TEWS and much less was allocated for the downstream culture component. UNESCO and RISTEK point out that as the technical upstream warning system is being established, funds are reducing but there is a shift in allocation from upstream to the downstream culture component of the EWS. In reality, it is obvious that both financial resources and priorities are reducing and gradually shifting. This is very well captured by the statements made by RISTEK who said that:

> *"TEWS is no longer a government priority in DM because the upstream component is close to completion and there is a parallel shift in interest to climate change issues and adaptation which are also attracting potential external funds. In addition, we have even covered the financial gap and pledged DRR-related budget for LIPI for the year 2009.... it is now becoming difficult to get new funding and quite difficult to push the TEWS as a sustained national priority"*
>
> (Interview 7, 24, 25 and 26 October).

6.1.8 Actors' conflicts and coping strategies

In the action arena, it is not surprising to uncover that there are instances of both synergy and conflict between different actors; between the overarching norms and principles that govern these interactions, and between norms and principles that run through distinct institutions. In the following sections, discussions focus on the relatively mild conflicts which emerged between key international actors, between actors in the observation and risk knowledge production, and over financial resources, and how actors managed those conflicts. It is underlined that conflict is an integral part of social life (Galtung 2003) and when constructively managed, can be even considered a dynamic force of social development (Dahrendorf 1992). Violence is what has to be prevented (Bohle 2007).

At the international level, following the tsunami disaster, international actors such the United States and Japan with many years of experience in operational TEWS were confronted by the fact that Germany was interested and would spearhead TEWS in Indonesia. Germany was formally recognized as an inexperienced actor in the TEWS compared to the traditional experienced actors such as the United States and Japan who have decades of operational TEWS. An article highlighted "*The job of detecting the next wave in time now falls to the Germans, a move that brought them little more than widespread derision at first*" (Der Spiegel 11/06/2008). According to Der Spiegel[xlviii], "*… experts in Japan and the United States claimed that the German tsunami neophytes had too little experience with monster waves…the Germans faced malicious criticism when early measuring buoys were torn from their moorings and ended up adrift off the coast*".

On the other hand, a reasonable criticism was also put across by prominent international experts concerning the development of a new TEWS in terms of the time needed to develop a new technology and fine-tune it. It was reported that " *the director of the Tsunami Research Centre at the University of Southern California is also frustrated that India, Indonesia and Germany are wasting time develop-*

ing their own buoys and pressure sensors, which will require time to fine-tune, when effective technology already exists" (Der Spiegel 11/06/2008). However, it is reported that the so-called criticisms and concern have grown silent since then. *"The design of the system seems sound,"* says Vasily Titow, a tsunami researcher in the United States, while Costas Synolakis of the University of Southern California has almost paternal words of praise for the Germans, saying: *"While I was one of the early critics, I have to admit that German scientists have made incredible strides towards developing the system"* (Der Spiegel 11/06/2008).

On the other hand, there is a general perception that there is some duplication and conflicts among actors in the seismic observation which involves different countries such as Germany, Japan and China. In addition, duplication and conflict have emerged in the risk knowledge component of the TEWS. GTZ-IS points out:

> *"Hazard and tsunami risk maps were being prepared by different actors and there were conflicting results. In the end, the key decisions were delayed until a convergence and standardized result was agreed by all"* (Interview 8, 29 January 2009).

Furthermore, it is not surprising to find that the underlying causes leading to conflicts between actors are related to the distribution of donor funding, particularly at the local levels. The two key issues outlined are how funds are distributed between different stakeholders to carry out activities and resulting potential conflicts from duplication in activities.

However, conflicts have often been well managed by actors at different levels. According to BMKG, the German early warning system technology was carefully designed to allow some synergy and integration for seismic and tsunami monitoring such that potential conflicts in common interest areas were minimized. The DSS can accept data signal input from different sensors from different countries, individually process the signal and display the analysis results simultaneously for comparison. The InaTEWS design architecture minimizes conflicts of interest by employing a seismic integration system as indicated in chapter 3. However, the system integration is also acknowledged by BMKG as a challenge in terms of training experts for each individual seismic system, and also the problem of maintaining different components from different countries. Therefore, while the seismic system integration has literally galvanised the immediate risk of conflicts and serves as an important backup system, the long-term sustainability of the separate imported technologies is the challenge.

On the other hand, at the sub-national levels, decision makers and policymakers requested actors to collaborate and avoid conflicting results in risk mapping. In other cases, civil societies are often exercising the win-win or mutual gains bargaining strategy as an alternative approach to dispute resolution. This is reflected closely in the response of MPBI who stated:

> *"… although there are certain duplications which result in potential conflicts they are actually minimized by first carrying out an initial assessment of the situation and if necessary, cooperating and working with other actors"*
>
> (Interview 5, 3 November 2008).

6.1.9 Actors' transparency, social cohesion and trust

It is important to understand if actors are satisfied with the level of transparency, social cohesion and trust in building the TEWS in Indonesia. The international actors including GTZ-IS, InWent, UNESCO and local actor KOKAMI perceived that there was a lack of transparency, mainly linked with financial resources and information sharing. In contrast, most state actors thought there was a reasonably high degree of transparency among actors in the context of the TEWS. The issue of lack of transparency is exemplified by GTZ-IS who argued:

> "Indonesia received different financial resources from different donors, but how much has been received is not clear among all the stakeholders"
>
> (Interview 8, 29 January 2009).

Interestingly many actors have realized that being well informed is strategically important and there is sufficient competition in the action arena even in the TEWS. KOKAMI argued:

> *"… Sharing of information is not really transparent between NGOs because of the potential competition among so many local actors here in Indonesia"*
>
> (Interview 9, 3 March 2009).

Surprisingly, it is interesting to find that cohesion and trust among the actors was perceived as high. This agrees well with the UNDP report which underlined that the fast pace of the legal reform in Indonesia and the formation of the National Platform for DRR was based on the strong collegial bond and high trust between actors, which attracted additional actors to the cause (UNDP 2009). The mechanisms described by actors of encouraging social cohesion and trust worked through regular contacts such as meetings at the national level, music, sports and tsunami drills in the local community. Many actors stated that the best time of social harmony and trust building was actually during and following tsunami drills in the local communities where new things were discovered collectively. However, it was also found that social cohesion and trust were not institutionally based but rather personal. KOKAMI points out:

> "Social cohesion and trust is strongly personal rather than institutional… I can easily contact and discuss issues with certain officials of different organizations ''
>
> (Interview 9, 3 March 2009).

6.2 Actors' perspectives of the Tsunami Early Warning System architecture

In this section, the actors´ perspectives of the TEWS architecture are examined and described. Actors were questioned on the issues of the difficulties, challenges and implications of implementing the new architecture. Furthermore actors were specifically questioned on formal and informal rules and whether there were conflicts between informal and formal rules ranging from risk knowledge to response phases of the early warning process. Other questions related to their perceptions of roles and responsibilities and if these were clear and working. Furthermore, actors were asked if the rules were appropriate, who was disregarding rules, if rules were enforced and whether there were capacities for enforcement and monitoring.

Lastly, actors were questioned on the perceptions of modifying the rules (i.e. institutional change) where they were identified as not working.

6.2.1 Challenges in implementing the polycentric multi-level architectures

6.2.1.1 Local regulations to transform the local disaster management agencies

Firstly, the completion of DM local regulation (i.e. Perda) according to the DM law 24/2007 which would transform the previously coordinating and implementing unit of SATKORLAK and SATLAK in the provinces and regencies/cities respectively to BPBD is still an ongoing challenge. The actual reality on the ground shows that only a few provinces and districts have completed the Perda DM local regulation to allow the transformation to take place. The head of BNPB outlined:

> *"In our department, we have members of the BARKONAS team in the central government, a lot of personnel that are experts in their own particular fields including the ones developing the network with universities to create applicable technologies … The regional governments have been unresponsive and unwilling to accept these experts to look into such matters in helping them to formulate their local regulations and other issues. This rejection has been looked into, but we are still not sure why it happened. I have requested the regional governments to take these experts as consultants. It will benefit their areas, because we do hope that all development in the country will be based on disaster risks"*
>
> (Interview 1, 16 February 2009).

6.2.1.2 Few provincial and district disaster management agencies and emergency operation centres

Secondly, actors pointed out that in reality, so far only the National DM Agency has been established at national level while only six out of 33 provinces have established DM agencies. At lower levels, only six out of 450 districts and municipalities have DM officers (BPBD). UNESCO comments:

> *"The disaster management law mentions a National Disaster Management Centre which can, if necessary, be a local centre; however, local disaster centres have not been established yet"* (Interview 3, 27 October 2008).

Thirdly, actors indicated that only Aceh has a complete EOC at the provincial level, which proved to be successful during the Aceh tsunami drill of 2008; however the emergency system at lower levels was reported to be ineffective (BGR 2008). In this context, actors such as GTZ-IS (2009) have questioned "*whether smaller and economically weaker districts have the financial and human resources to implement and operate this kind of service*". GTZ-IS also points out that "*even in the pilot areas it wasn't possible yet to establish these services in a reliable way*". It is also unclear who will provide the financial support to set up all the early warning structures at provincial and local levels.

6.2.2 Implications of embedding the InaTEWS system in a larger architecture

The most important implications of embedding the InaTEWS within BNPB and using the EOCs as part of the operational arm of BNPB is that it is an important step towards effective governance of hazards through a multi-hazard approach (i.e. tsunamis, floods, volcanoes, landslides, etc.) by optimizing existing resources to effectively respond to local ecological challenges. The concentration of responsibilities offers a great chance to back up and empower levels below the national level which depends on the support from the top.

However, the key negative implications to be cautious about in embedding the InaTEWS structure in the BNPB structure are bureaucracy and ineffective governance resulting from the creation of a larger structure, noting that Indonesia already suffers from bureaucracy and corruption. For instance BGR points out:

> *"There is a concentration of mandates, and BNPB is emerging as a rather complex super organization with challenging tasks and responsibilities, considering BNPB will have to deal with multi-hazards, not only tsunami"*
>
> (Interview 2, 3 March 2009).

Similarly, apart from the questions of how to support and maintain financially the multi-level EOCs, there is a real danger that such architecture may be ineffective if not properly resourced. This is exemplified by the argument made by GTZ-IS:

> *"Such a centralized local 24/7 service might represent a deadly bottleneck in the warning chain if it fails to take a decision and to communicate guidance messages on time"* (Interview 8, 29.01.2009).

Similar concerns actually surfaced in a recent and final GITEWS capacity-building workshop hosted by InWent in Jakarta from 21 until 22 April 2010[xlix]. The agenda of the workshop was to examine the achievements and the way forward for sustainable capacity-building in the InaTEWS and beyond as the project has formally ended. Interestingly, the deliberations of the workshop indicated that the legitimate actor, i.e. the DM agency BNPB, was unwilling to take responsibility and leadership in future capacity-building. It is pointed out that capacity-building for disaster preparedness and response is a mandate of BNPB through the DM law No. 24/2007. BNPB argued that their hands were already full with many responsibilities. From an institutional perspective it is difficult to enforce rules and have a successful outcome if actors do not agree. Hence, actors who wish to lead capacity-building until BNPB is capable of taking that role do not have the official institutional mandate and resources to do so. It is pointed out that RISTEK no longer has the legitimacy to accept the responsibility as the Ministerial Decree SK 21/2006 mandating such responsibility has expired. It appears there is no continuity and immediate leadership in capacity-building which is an essential element for sustainability of the INATEWS and DM in Indonesia. Nevertheless, actors have agreed to have more consultations to address the problem. The outcome clearly demonstrates the implications of embedding InaTEWS into a larger structure with increasing responsibilities for all hazards and disasters.

6.2.3 Formal and informal institutional arrangements and potential conflicts

It is important to note that all actors were aware of the official rules such as decree 21 and the DM law No. 24/2007 and the ongoing process of implementation at different levels across Indonesia. The main issues raised are discussed further.

6.2.3.1 Local reaction and response behaviours

It was remarkable to observe the diversity of discussions among actors in relation to informal rules, yet these converged on the local reaction and response behaviours distinguished by scientific and non-scientific approaches and their potential advantages and disadvantages created. For example, UNESCO comments:

> *"In some areas, informal rules are part of the traditional knowledge such as the 'Smong story' in Simelue Island, Aceh, underlying the importance of traditional informal knowledge as an important institutional norm"*
>
> (Interview 3, 27 October 2008).

Lassa (2008) reported that only seven people died from the 26 December 2004 tsunami on the island because the community ran to high ground following the earthquake and draw down of the tide. The possible reason for the low number of deaths is the Smong story which was documented by UNISDR in the context of 'The Power of Knowledge'. The local leader of the Simelue district reports that *"in 1907 a smong (i.e. tsunami) happened here in Simuelue, and so our grandmothers always gave us the following advice: if an earthquake comes, we must go and look at the beach: if the sea is at low tide the smong or tsunami will be coming and we must look for higher ground*". Based on knowledge developing in the Simeulue community, the earthquake and tsunami was known as the *Smong of 07, an* Acehnese term for tsunami, meaning 'air bah dari laut' (i.e. big flood from the sea) (Lassa 2008).

Most people thought that the Smong was found only in the Simelue islands. However, it was also found on mainland South and Southeast Aceh. Lassa (2008) suggests that the Smong has been paternalistically shared amongst the locals through generations, exclusively in the Simelue islands and points out that the fundamental weakness of the traditional knowledge EWS is that it is rarely replicated in neighbouring districts and he suggests that it works best only where a formal EWS is absent (Gregg et al. 2007).

On the other hand, the disadvantages due to conflicts between formal and informal approaches were outlined by many actors in diverse contexts. For example, UNESCO said that:

> *"A volcanic threat was identified in west Java but the local leader ignored the threat, and the local community listens to their local leader. Fortunately nothing happened, but in the process the authorities were undermined"*
>
> (Interview 3, 27 October 2008).

In contrast, MPBI points out the mix of advantages and disadvantages of informal institutions. It is argued that:

"Some local leaders could be a problem in DRR. In the Merapi mountains the local leader told the people to stay despite the danger of the volcano. In that case an earthquake happened and many people died, but on the other hand, in a different situation, the local leader asked the people to leave and many people left and as a result only one person died. In the end, the local leader was right and became an advertising model" (Interview 5, 3 November 2008).

6.2.3.2 Mysticism and superstitious norms

The most concerning issue raised among diverse actors with reference to hazards and disasters affecting the community was linked with religious beliefs where people often think disasters are God's way. In a Saturday sermon at Jakarta's largest mosque following tremors felt in Jakarta on Monday, 19 July 2007, President Susilo Bambang Yudhoyono of Indonesia was quoted as saying "*Earthquakes are part of God's creation to maintain the balance in the universe... It is, therefore, up to us Indonesians, as a nation, to manage wisely both this God-given wealth as its disasters*" KOMPAS (21/07/2007). KOMPAS reported that President Yudhoyono has been busy giving lectures to all levels of society, from evacuees of the most recent earthquake and tsunami in the south of Java to leaders in Jakarta, on geological realities in Indonesia. KOMPAS argues "*the President is fully aware that, faced with continuous huge disasters during the past year, many if not most Indonesians will prefer to believe in mysticism if not in superstitious explanations, rather than seek scientific and rational clarifications*".

This explanation is consistent with the findings of Lavigne et al. (2008) who found that 97 per cent of those surveyed around the Merapi Mountains thought the eruptions were a reproach from the supernatural world and they did not see death as a negative event. It was rather a regenerative process that should be accepted with human humility. Both environment and risk are based on social constructs, suggesting that individuals and groups with different world views will have different risk views (Wildavsky 1979). On the other hand, Douglas (1992) concurred from a more anthropological perspective, indicating different societies fear different sorts of threats which correlate with differences in social structure.

6.2.4 Functionality of institutional arrangements

6.2.4.1 Coordination

It is generally perceived that coordination has improved and become more efficient both upstream and downstream of InaTEWS. Actors reported that the mechanisms that have helped improve coordination include the institutional formal appointment of RISTEK as the interim coordinator of the InaTEWS through the Ministerial Decree 21/2005, regular monthly meetings, reporting, sharing and information exchange through mailing, workshops and conferences. In addition, RISTEK has prepared tsunami guidelines to help in better coordination.

Defining roles and responsibilities at different levels among organizations and actors is an important element of improving the linkages and coordination for an effective TEWS. The actors' responses on the issue reveal that multi-level roles and responsibilities are still lacking but are working better in the upstream technical

component of the TEWS. Actors suggested that more time is required to properly define roles and responsibilities down to the local level. These problems are highlighted by RISTEK who said:

> *"According to the Ministerial Decree No. 21 on paper, responsibilities are defined but there are still some overlaps and they are not always clear and working, especially in the downstream component … for instance, each time there is a tsunami drill the procedures are different (…) in the last drill in December 2008 there was no Emergency Operations Centre for Gorontalo, an island located to the north. According to the rules and procedures, there needs to be an EOC for drill simulation. To solve the immediate problem, a temporary EOC was quickly established by the local authorities just for the drill''* (Interview 7, 15 January 2009).

In addition, RISTEK underlines:

> *"Preparedness for the drill fell under the responsibility of the Indonesian navy and the concept was totally inappropriate. It seems there is little scope for much improvement … I also think disasters should be managed at city level. The tsunami drill exercises were supposed to allow local authorities to prepare, but in reality the local people have no authority because the organizations who were supposed to be responsible for the tsunami drill are very problematic and there are often completely new faces''* (Interview 7, 15 January 2009).

The second problem of coordination is linked with the authority of RISTEK as the coordinator of the InaTEWS according to Decree 21/2006. RISTEK is part of a ministry that is small relative to other government ministries, with inadequate authority and power across scales in Indonesia. Some actors have criticized RISTEK for lacking leadership and authority in implementing activities. However, another RISTEK official clearly and strongly states:

> *"We are the coordinator of InaTEWS by mandate of the Decree; however, we are not an implementer of activities in the TEWS and DM"*
> (Interview 10, 18 February 2009).

Thirdly, coordination has been affected in some cases due to lack of timely reporting and information sharing among actors at the local level. What NGOs are doing on certain remote islands is sometimes unreported and uncertain. However, the other dimension of the problem is that there is a lack of structures to support communication throughout Indonesia at different levels. This is supported by UNESCO who clearly pointed out:

> *"Indonesia is a big country and most of the national actors including the coordinating institution RISTEK are all located in Jakarta, therefore coordination is not easy"*
> (Interview 3, 27 October 2008).

This suggests that coordination can be improved with multiple information and communication centres rather than having them concentrated at a single point in Jakarta. The EOCs or local DM Agencies are in a favourable position to support communication and coordination at the local levels within the community. This issue is further discussed in chapter 7.

6.2.5 Monitoring and enforcement of the institutional arrangements

6.2.5.1 A new concept

Clearly, institutional monitoring and enforcement either in the TEWS and DM is a new concept for the Indonesian authorities and the community. Therefore, it is not surprising to find that all actors indicated that it is rather too early to comment on the institutional monitoring and enforcement as the DM law and regulations has just been enacted. BNPB argues that:

> *"Enforcement of the institutional arrangements including the disaster management law is rather new and is an ongoing process. However, it terms of the TEWS it is sometimes difficult to identify the mistake. When the Disaster Management Agencies and Emergency Operations Centres are fully established it is envisaged we will have the time and capacity for institutional monitoring and enforcement"*
> (Interview 1, 16 February 2009).

Although the institutional arrangements in DM and early warning are new, there are already some efforts towards the monitoring of procedures. For example, drills and table top evaluation have provided some opportunities to monitor operational rules but lack proper feedback and legitimate enforcement as no-one is punished for mistakes.

6.2.5.2 Investing in disaster risk reduction, administration of funds and accountability

An interesting problem which has emerged relating to the monitoring and enforcement of the rules of the game in DM and early warning is that local authorities are simply not spending or investing in DRR because of worries about penalties. For example, the BNPB head states:

> *"There are many regional governments reluctant to use their budgets because they are afraid of being audited…Now the coordination has to be segmented. There has to be some sort of cost setting, some kind of sharing, and the disaster-struck regency can take on some of those responsibilities, at least in cases where they can contribute"*
> (Interview 1, 16 February 2009).

By revisiting DM law No. 24/2007, it is found that chapter XI, Penal Provisions, Article 78 states that "*anybody who deliberately misuses disaster aid management as referred to Article 65, shall be punished by life imprisonment or imprisonment of at least 4 years or at most 20 years and a fine of at least six billion rupiah or at most twelve billion rupiah"*. This partly explains why local authorities are unwilling to spend the DM budget despite the Government Regulation No. 22/2008 concerning Disaster Aid Financing and Management, Chapter III Articles 10 to 23 clearly detail how, who, where and when in regard to using the funds. It is would be interesting to find if the local authorities need familiarization with the legal regulations or are simply evading legal risks associated with DM spending.

Another major problem related to the issue of financial expenditure monitoring and the chance for enforcing rules relates to the lack of timely feedback and clear financial expenditure data from both the international communities and the central

government. The existing database does not have specific data on DRR but rather sectoral and departmental spending. The data available are based on estimation and it is difficult to assess whether the spending meets actual needs. Of greater interest is that there is a lot of spending but no tracking is currently possible at the sub-national governments. The problems of proper documentation and expenditure tracing raise the questions of efficiency and possible corruption.

6.2.5.3 Dynamic pressures and root causes

Currently, BNPB is overwhelmed and confronted with the challenge of how to deal with existing settlements in the high risk areas. RISTEK pointed out that this goal is very difficult and challenging in developing countries. This is exemplified by the argument raised by RISTEK:

> *"… the floods in Jakarta are perceived by the poor people as normal events and people do not really view them as disasters, particularly if you have a non-permanent house, because poverty is the real disaster…many times the government has destroyed the slums but people still return. People complain that within one year a flood occurs only in two weeks and they are not afraid of disasters because poverty is their disaster.enforcement of risk zones is very challenging and it is not easy to make people move''* (Interview 10, 18 February 2009).

The other challenge is that reducing the underlying risk is not only a complex issue of extreme poverty, but also a problem associated with illegal development in restricted areas. For instance in Bali, development in restricted areas is an ongoing challenge, a battle between rapid tourism-related developments often infringing on protection and conservation areas. The main problem is that developers do not wait for permit approval or have none while others build in the restricted zones which are either conservation areas or which violate local zoning rules such as the 100-metre no-build zone from the high water mark. These illegal and rapid developments are likely to generate new risks. The enforcement problems are due to overlapping institutional mandates and lack of cooperation among actors, and long bureaucratic procedures leading to bribes and corruption. The emerging solutions identified are a cross-sector approach and public accountability as observed in 2006 and again in 2009 when there were a large number of complaints from the general public and groups. BNPB argues:

> *"Institutions have started to enforce policies on building codes, zoning, and building construction permits and there is a growing awareness of the need for earthquake-proof buildings and an effort to certify the quality of buildings"* *(Interview 1, 16 February 2009).*

These accounts highlight the relationship between the EWS, poverty and development.

6.2.5.4 Infrastructure security

Maintaining the InaTEWS security is also an important issue raised at different levels by the actors. Following the tsunami disaster in December 2004, diverse actors cooperated to develop a TEWS. Part of the system is highly technical, requir-

ing networks of complex and expensive instruments, from ocean sensors to sirens located along the coast as explained earlier. However, it is evident that no one really thought about securing the instruments and the infrastructure, which required additional logistical resources and financial arrangements. UNESCO reports:

> *"In Aceh[l] angry villagers stoned and damaged a tsunami warning siren after it accidentally went off, triggering panic in the region''* (Interview 3, 27 October 2008).

In addition, RISTEK argues:

> *"Vandalism of buoys is a real challenge and there is a lack of knowledge and awareness in the local community, particularly among the local fishermen"*
> (Interview 10, 18 February 2009).

Recently it was found that the towers of the recovered buoys, equipped with GPS, meteorological sensors and solar panels had been used by fishing boats as moorings, preventing data from being transmitted to the tsunami warning centre (GTZ-IS 2009). In early 2009, the CBU[li], consisting of 20 stakeholder organizations of InaTEWS, also debated[lii] the issue of vandalism as it threatens the operations of InaTEWS. Actors agreed that there is a need for further education, awareness, sensitization and more frequent coast guard patrols. However, the law and order enforcement actors (i.e. police) pointed out that security and enforcement would require additional resources and financial arrangements. The same concern was also raised at the international level, where IOC also urged member states to note the impact of vandalism to Deep Ocean and other monitoring stations on the tsunami detection capacity of IOTWS (ICG/IOTWS-VI/3s 2009). In this context, the EWS should also include additional financial arrangements and resources to secure the safety of such expensive technological devices.

6.2.5.5 Capacities for institutional monitoring and enforcement

Indonesia has witnessed remarkable institutional change to manage hazards and disasters. However, monitoring and enforcement of the rules of DM is greatly lacking and this is linked to available human resources and capacities. BNPB clearly pointed out that there is a lack of training and leadership in institutional monitoring and enforcement. It was suggested that further training is needed to support the monitoring and enforcement of rules, and this should be an important component of a future capacity-building programme. Meanwhile, key actors indicated their interest in this area when rules are finalized. For instance, GTZ-IS pointed out:

> *"Once the SOPs are developed we will be monitoring the implementation of the institutional arrangements"* (Interview 8, 29 January 2009).

6.2.5.6 Institutional development/change process

It is underlined that Indonesia has just experienced a major institutional change in terms of new laws, regulations and policies, etc. However, not all actors are satisfied with the institutional arrangements for DM. There is a general consensus that the law, regulations and actions of the government pay less attention to preparedness and mitigation compared to response. Nevertheless, currently actors are not

remarkably motivated to change existing process level institutional arrangements (i.e. DM law). Most actors suggested that more time is needed to observe and experience the strengths and weaknesses of the DM-related rules before engaging in further institutional change. It is pointed out that lower hierarchy institutional arrangements such as regulations, SOPs and guidelines will dominate the arena for the next few years. These include the need to formulate new higher order institutional arrangements to create a culture of disaster preparedness starting at school level, new policies to help regulate multi-hazard governance and presidential regulation through a participatory approach to tackle the issues of disaster status and thus allow funds and resources to flow as rapidly as possible and improve response.

6.3 Actors' interactions with the Tsunami Early Warning System architecture

In this section, focus is on the general interactions of the actors with the different elements of the TEWS in Indonesia, from risk knowledge, monitoring and forecasting, to response. Chapter 7 will focus on the elements of the TEWS at the level of Padang and Bali.

6.3.1 Emerging national approach in risk knowledge and communication

6.3.1.1 New historical tsunami events discovered and characterized

Risk knowledge creation has progressed very well in Indonesia on different levels. On the one hand, typical hazard assessment continues to be of key interest for some actors. For example, approximately 26 new tele-tsunamis[liii] have been discovered (Macquarie University 2006). In terms of frequency of tsunamis, Puspito and Gunawan (2005) have shown that historical records indicate that a total of 163 tsunamis caused by earthquakes occurred in the region for a period from the year 1801 to 2006 (RISTEK 2005). There are records of around 135 such events over the last 400 years. Diposaptono (2008) shows that from 1960-2007 there have been 22 significant tsunamis.

The essential characteristics of tsunami hazard knowledge have also improved. For example, Puspito and Gunawan (2005) shows that tsunamigenic earthquake magnitude varies from 5.6 to 9.0 with focal depths of earthquakes ranging from 10 to 130 km in the Sumatra region. The findings also suggest that most of the tsunamis in the Sumatra region were generated by moderate to great earthquakes with 84 per cent of tsunamis in the Sumatra region generated by earthquakes with a moment magnitude greater than 6.0, while about 32 per cent were generated by moderate earthquakes of a moment magnitude between 6.1 to 7.0, and about 30 per cent were generated by large earthquakes with a moment magnitude between 7.1 to 8.0. Great earthquakes of moment magnitude greater than 8.0 contributed to 22 per cent of the tsunamis generated.

6.3.1.2 Vulnerability analysis and multidisciplinary approach

In addition, the emerging trend shows that risk knowledge has progressed beyond simple hazard assessment, with more focus on vulnerability and risk assessment. Risk knowledge creation ranges from a regional to local scale in geographical resolution. For instance, at regional level, a recent study based on a tsunami inundation

deterministic scenario[liv] and population exposure shows Indonesia is exposed to the highest wave run-up ranging from 5-20 m over most parts of the coast facing the Indian Ocean with an exposed population of 1.5 million people (OCHA 2009). In some cases, vulnerability has been analysed over the components of the early warning chain using criteria of potential vulnerability indicators derived through literature analysis as well as consultation with the local actors (Birkmann et al. 2009). In addition dynamic vulnerability in terms of detailed population distribution for day and night time exposure to tsunamis along the southwest coast of Sumatra, Java, and Bali has also been addressed (Rokhis et al. 2008).

Another interesting development which has emerged is the combined use of remote sensing, GIS, satellite imagery, tsunami modelling, relevant geo-databases and socio data (Rokhis et al. 2008; Riedlinger et al. 2008; Konca et al. 2008). For example in a study, integrative remote sensing and GIS approaches based on VHR Satellite Image (i.e. Quickbird) were employed to study building vulnerability in urban areas for the city of Cilacap. Results suggest Cilachap is highly vulnerable to tsunami hazard due to its poor buildings. Konca et al. (2008) show that tsunami hazard potential covers 11.2 km^2 of Cilachap for the worst-case scenario and there are 12 villages affected by tsunami. Villages at highest risk are identified and recommended as priority villages for preparedness. More complex work on risk has been carried out by international actors from DLR and partners and integrated in the database of the InaTEWS for decision support and DM for the entire coastal area of Sumatra, Java and Bali.

6.3.1.3 Tools, standard methodologies and capacities for risk analysis

Despite these achievements, it is clear that risk assessment has focused mainly on high hazard impact areas only. In certain regions and districts there is a lack of tools, standardized methodologies and capacities to carry out risk analysis and assessments. Therefore, there is insufficient interest to conduct risk assessment in most areas. BNPB states:

> *"The core problem identified is the lack of awareness of the importance of disaster risk analysis while multi-risk assessment is poor due to lack of tools and their use especially at the local levels. A broad range of methods and techniques are being employed and there is lack of standardization"* (Interview 1, 16 February 2009).

It is reported that a team consisting of experts from various institutions commissioned by the BNPB and RISTEK are currently preparing to formulate guidelines and standards for multi-risk assessment. Formal agreements on hazard data have been produced by different sectoral ministries such as (BNPB), PIRBA (Ministry of Research and Technology/Menristek) and LAPAN. The Ministry of Home Affairs, mandated with regulation No. 46/2008, has asked districts/city government to collect and report on occurrences of hazards in their areas. Several regions meet the requirements. There is an effort between various governmental organizations and NGOs to develop a disaster information system to reach out to other actors and the community; however, the existing information system is not user-friendly and is difficult to access, and there should be increased data sharing among actors. Currently, much of the data collected are being under-utilized at all levels.

6.3.1.4 Institutional authority and multi-sector participation

UN/ISDR advocates that DRR should start at school. In this respect, a presidential decree was issued to the Ministry of National Education and Ministry of Home Affairs to integrate DRR in school curricula; however actors reported that although there has been some formal and informal implementation, the decree has not been implemented because the policy implementation instrument has not been devised at the national level. In other words it requires a higher order legal framework to effectively integrate DRR education in school curricula. On the other hand, a national disaster day is generally observed in Indonesia, but multi-sector participation is described as very low. The business sector remains largely uninvolved in risk knowledge.

6.3.2 The national tsunami warning centre

6.3.2.1 Observation and monitoring

The Grand Scenario strategic plan and the GITEWS design concept were very ambitious despite their weaknesses as discussed in chapter 4. However, the actual ground realities suggest key ongoing challenges, for example in the monitoring and forecasting component of the TEWS. In the area of seismic observation the actors have so far completed only about 20 per cent of the entire plan, even though it has been operational since November 2008. The entire Indonesian system needs 160 seismographs and 500 units of accelerographs (i.e. to measure the speed of waves), as well as other supportive equipment. Recently, at the ICG/IOTEWS International Conference, BNPB reported major progress in installing a total of 158 seismographs but only 112 accelerographs. Only a small percentage of these seismographs are actually capable of going online with the BMKG.

A greater challenge has affected the ocean component of the TEWS. An in-depth interview with BMKG in January 2009 revealed that only two buoys have been installed in the deep ocean. There were problems in mooring the buoys, therefore they had to be recovered for repair. Deeper questioning on the issue also revealed that during the retrieve and repair there were no replacements for back-up. This is a critical operational weakness should a significant earthquake occur. Later in April 2009, a further eight GPS-buoys were deployed along the Indian Ocean coastline off Sumatra and Java by a German research vessel. The ocean monitoring planned to have 25 Dart buoys and currently there are close to 20, but it is reported that very few are online or fully operational. In the case of sea level monitoring, only about half of the total expected 80 tide gauge stations have been installed. Similarly, in the context of GPS observation of the earth deformation only half of the targets of 50 stations have so far been accomplished.

What is also revealing is that although there are formal agreements in terms of MoU between institutions for observing respective parameters and sending the data to BMKG as the mandated tsunami warning centre, there have been some problems with data sharing between the institutional actors, at least in the period of late 2008. There is a general sense of confusion among actors. Actors indicated that it is not clear what is going on in the upstream technical part of the TEWS. Apparently, there is either a lack of transparency on the ongoing technical chal-

lenges faced by the respective institutions or there is a lack of clear communication and understanding on what the problems between the actors are, given that the explanations may be technical in nature.

6.3.2.2 Technical capabilities and false tsunami alerts

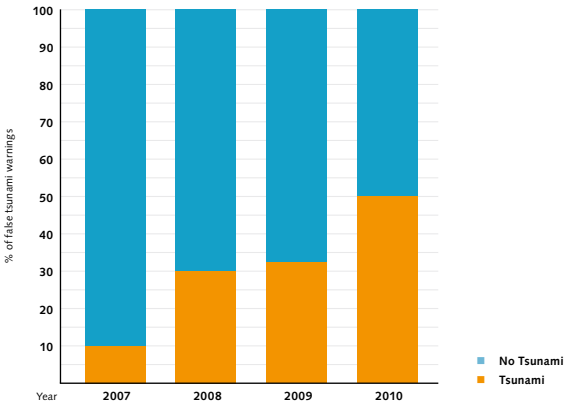
In terms of warning accuracy, BMKG acknowledges that there are many false alarms. BMKG explains that the main reason for the relatively high number of false alerts is that there is a lack of compromise between the present technical capabilities and political goals which demand a warning to be issued within five minutes. Firstly, it is argued that the seismic network is not dense enough, especially to the east of Indonesia. Secondly, the earthquake moment magnitude threshold to issue potential tsunami messages is too low at 6.6 Mw. BMKG said:

> *"… there is a need to reach a technical-socio-political balance to minimize false alerts"* (Interview 11, 19 February 2009).

In other words, this statement can be interpreted as showing the need to engage less in politics and more in science to reduce false alerts.

However, such balance has political and social consequences. To partly address the problem rather than increase the time taken to evaluate the earthquake event, BMKG states that they are in the process of elevating the threshold level for potential tsunami warnings to 7.0 Mw with the objective of minimizing the rate of false alarms. Figure 36 shows the gradual improvement in the tsunami warnings characterised by fewer false tsunami alerts. However, what has to be realized is that by elevating the threshold to 7.0 moment magnitude, there will be a compromise between achieving higher levels of accuracy compared to a complete miss. It is recalled that 32 per cent of tsunamis are generated by moderate earthquakes of moment magnitudes between 6.1–7.0 (Puspito and Gunawan 2005).

Figure 36: Percentage of false tsunami warnings from InaTEWS 2007–2010



Source: BMKG (2010).

6.3.2.3 Uptaking imported technology and human resources

The TEWC is now a highly technical institution with diverse and sophisticated novel technologies, mostly imported from Germany, Japan and China, etc. Actors have been trained to operate and run the system. However, more specialized dedicated human resources are required to operate such complex systems. Actors are very concerned about the 'jack of all trades and master of none' mentality developing because technicians and IT personnel are always on the move in the different sections of the organization. It is argued that it is difficult to specialize. On this note, to exemplify the concern, BMKG said:

> *"Due to the complexity of the tsunami observation and forecasting system it is vital to have separate dedicated staff to specialize in the areas of information and technology, and engineering in the TEWS"* (Interview 11, 19 February 2009).

6.3.3 Dissemination and communication

Chapters 7 and 8 will provide further details on the actual status of the dissemination and communication part of the InaTEWS. In general in Indonesia, this component still faces the most challenges, primarily because there is a lack of a dedicated system to reach the community, and the existing one is characterized by breakdowns and systems failures. In addition, the dissemination and communication system depends on the institutional warning change which is still under development or only emerging in some areas. The communication of information is usually late and at times authorities are confused whether to inform the public or not.

6.3.4 The emerging national approach to response

6.3.4.1 Sectoral fragmentation and coordination difficulties

There is a wide scope of activities and actors involved in this phase. The attention here is on the issues of disaster preparedness for an effective response at all levels. There are several national to village level personnel and volunteers tasked with response and they include PMI, the Rapid Response Team (TRC), and others. International organizations that are mandated include OCHA, UNICEF, the World Food Programme (WFP) and the United Nations Population Fund (UNFPA). However, currently, there are poor coordination mechanisms due to sectoral fragmentation causing overlapping and duplication. BNPB said:

> *"The absence of integration and harmonization of inter-institutional rules resulted in lack of coordination and confusion, particularly in budget use"*
> *(Interview 1, 16 February 2009).*

An institutional arrangement for financial reserves is in place to support response and recovery when required. Emergency/buffer stocks have been prepared by the government for Disaster Emergency response at all levels (tents, rice medical supplies, etc.) and the available contingency budget can be increased when needed. Under Government Regulation No. 23/2008, donor organizations can also provide contingency funds.

6.3.4.2 Disaster preparedness and contingency plans

To this end, GTZ-IS has produced two case studies for evacuation planning (one with DLR), a manual for tsunami drill (Bantul), documentation of the drill in Bantul, evacuation plans at sub-village level and provision of evacuation signs. RISTEK produced a guideline[lv] on tsunami drill implementation for cities and regencies with the support of BGR/GITEWS in 2008. This document has been distributed at different levels. In addition, a reaction scheme to tsunami warnings has been developed by GTZ-IS and partners.

On the other hand, disaster preparedness and contingency plans in case of emergency are poorly developed across Indonesia. National scale contingency plans, simulation and tsunami drills have not been realized yet. Simulations and tsunami drills are not comprehensive, performed at sectoral level or in certain regions. Tsunami drills were carried out in West Sumatra (Padang) on 26 December 2005, in Bali on 26 December 2006, in Banten on 26 December 2007, in Aceh on 2 November 2008, in Yogyakarta on 24 December 2008, in Gorontalo on 26 December 2008 and in North Sulawesi on 27 December 2009.

BNPB highlighted that:

> *"Disaster preparedness and contingency plans for emergency response situations were implemented in no more that 10% of Indonesia at different levels and those places that have preparedness and contingency plans will need to update and test these plans regularly"* (Interview 1, 16 February 2009).

According to BNPB, the poor achievement in contingency planning is related to the low levels of awareness at the regional, societal and sectoral levels on the importance of disaster preparedness and contingency plans. In addition, progress has been hampered as actors failed to achieve collective agreement. It is also argued that the lack of risk assessment, and poor availability of risk and zoning maps has crippled progress throughout Indonesia. Therefore, BNPB highlighted that:

> *"Arranging an integrated contingency plan should be one of the priorities delegated to the steering committee of BNPB, and also to build a system of comprehensive institutional capacity development that is supported by the commitment of local authorities to ensure its implementation and allocation of sufficient resource"* (Interview 1, 16 February 2009).

However, very recently a regional tsunami drill known as the "Indian Ocean Wave Exercise 2009" was organized and coordinated by ICG-IOTEWS with member countries has contributed to the increased Indonesian capacity in response at the regional to local level.

6.4 Summary

This chapter has shown that the actors' participation is rather complex, characterized by a high degree of multi-stakeholder participation at various levels and across scales. Collective decisions are sometimes compromised due to the large action arena and technical complexities involved. Actors' interest, incentives and agenda

range from research and development, human security and minimizing damage costs to maintaining development and economic gains. The participation dynamics of actors showcase the hierarchical power structure of actors based on domains of authority in knowledge and expertise, as well as and those of authority of hierarchy and discipline. Such a multi-stakeholder participation structure has a profound impact on the final outcome in the action decision arena. International participation is grounded on a mixture of multilateral and bilateral cooperation with Indonesia. The emerging new bilateral partnership between Indonesia and Germany is trying to follow on from the traditional TEWS forerunners such as the United States and Japan, at least in the technical component of the TEWS. The mixture of multi and bilateral environmental governance adopted by Indonesia is ideal to rapidly build national resilience to tsunami hazards and risks. Consequently, such a strategy initially invited mild rivalry and 'silent' conflicts at the international level as new global actors for TEWS emerged. However, in some cases actors have collaborated and applied win-win strategies to resolve potential conflicts.

The government bureaucrats are satisfied with the prevailing decree of transparency while the international and non-government actors demand more transparency in the process. The process of producing the tsunami service is characterized by sound competition, exclusion strategies and rivalry, where being more informed brings key advantages. Even so, a high level of individual cohesion and trust prevails among actors.

TEWS became a national priority after the December 2004 calamity; however there are mixed signals about whether the TEWS is still a government priority. Actors are generally well informed about institutional development and the major institutional arrangement challenges in the downstream component compared to the upstream component of the TEWS.

On the other hand, the government's national budget spending on DM has increased significantly. Indonesia's DRR financing has reached 2.1 per cent of the total national budget. However, in reality most spending is for post disaster rather than for preparedness which represents only 0.17 per cent per annum. In addition, the sector-specific funding has also recently decreased while the approved budget is consistently lower than the proposed budget for DM financing. Actors are also not satisfied with the budget available at the local level to manage disaster risk activities; however very recently the local contingency budget has increased compared to the national budget, signifying an important step towards coping and managing hazards at the local level. Intriguingly, the budget allocation at the sub-national level is spatially variable, suggesting an unjust allocation of resources. In addition, the on call-budget mobilization has been very slow due to multi-level bureaucratic procedures. These are fundamental institutional weaknesses in the financial arrangement that must be addressed. The key milestone achieved is the integration of the DM Plan and National Action Plan for DRR (NAP-DRR 2010-2014) into the National Development Plan (NDP) to ensure that DRR is included in the Government Annual Plans and DM budgeting in Indonesia.

There are many challenges in implementing the polycentric-multi-layered architectures and structures. Few provinces and districts have actually completed

the DM local regulation Perda to allow the transformation to take place, and less than 20 per cent of the provinces have yet established provincial level disaster management agencies, and less than 2 per cent of the districts and municipalities have DM officers (BPBD). Furthermore, the EOCs are few in number at provincial level and fairly ineffective at lower levels. The key obstacles include multi-level commitment, bureaucracy, a large number of actors with different agendas, financial resources, and specialised human capacities. Institutionalizing and embedding InaTEWS within the BNPB as a larger architecture is a key step towards a multi-hazard approach, improved institutional coordination and performance. However, the danger is the creation of a large superstructure vulnerable to bureaucracy and poor performance.

Formal and informal institutional arrangements among actors have centred on the local reaction and response behaviours distinguished by scientific and non-scientific approaches and their potential advantages (i.e. paternalistically shared amongst the locals through generations), and disadvantages encompassing being exclusive, non–replicable, frequently undermining local authorities and frequently characterized by mysticism and superstitious norms based on social constructs of environmental risks. In contrast, to this the functionality of institutional arrangement in terms of multi-level roles and responsibilities through SOPs at all levels is still not very clear despite an overall improvement in coordination, mainly through the appointment of an interim coordinator through Decree 21/2005. It is found that rules are more functional in the upstream technical component of the TEWS while institutional arrangements at the local level are often urgently developed to carry out activities such as drills, and this raises the question of their legitimacy given that the origin of institutions significantly influences their stability and potential for change.

Institutional monitoring and enforcement in the TEWS is a new concept among actors in Indonesia. Sporadic, ad-hoc drills and table top evaluation have provided some opportunities to monitor operational rules but lack proper feedback. Actors pay close attention to the financial arrangements, but surprisingly, actors at sub-national level are unwilling to spend on DRR, perhaps to avoid legal risks associated with DM spending. The greater concern is that financial details and reporting among actors is lacking, raising further questions about good governance. The lesson of environmental conservation and spatial planning underlines the challenge of institutional enforcement versus extreme poverty and the need for development. In the latter case, enforcement lessons have shown that overlapping institutional mandates, lack of cooperation among actors and long bureaucratic procedures, bribes and corruption undermine any efforts at institutional enforcement.

There is a general consensus that even the new institutional frameworks have not addressed adequately the paradigm shift from response to preparedness. However, more time is needed for weaknesses to be identified to motivate institutional changes at the higher level.

In the context of the TEWS elements, it is found that national risk knowledge has improved significantly in terms of new hazard assessments and more attention to vulnerability. New approaches and methodologies are emerging for risk assess-

ment and creation of risk knowledge. However, risk assessment has focused mainly on high hazard impact areas and there is a lack of risk assessment capacities, tools and standardised methodologies at local level. Risk communication has improved nationally but is insufficient and requires more multi-sector participation beyond the state and civil societies.

In terms of the National TWC (NTWC), despite being operational since November 2008, actors have highlighted the key weaknesses and gaps centring on the density of the seismic network and tsunami observation in the deep sea. Consequently, there are many false tsunami alerts and there is a need to have a compromise between actual technical capabilities and political-social goals. The strategy of elevating the threshold magnitude for issuing potential tsunami alerts on one hand would increase the chance of reducing false alerts at the expense of a likely miss of tsunamis generated from moderate earthquakes below the new elevated threshold.

In the response phase, the major gap is the lack of national disaster preparedness and contingency plans. Drills are not well developed and implemented across Indonesia despite some efforts to prepare ad-hoc drills in some province-districts, including the involvement in the Indian Ocean tsunami drill in late 2009. The reason for the poor achievement in contingency planning is related to difficulties in reaching collective agreement due to the large number of stakeholders involved, low levels of awareness in the regional, societal and sectoral level on the importance of such plans, and in some cases the lack of risk assessment to kick start the process.

7. The Tsunami Early Warning System at the level of Padang and Bali, Indonesia

This chapter focuses on the provincial and district level in the large coastal city of Padang and south Bali. It examines and compares the architecture and the actors' interactions in the two locations at the sub-national levels. The other central question focuses on prevailing problems, gaps and challenges in implementing such a desired TEWS at the local level. Analysis is primarily based on in-depth interviews with actors at different levels, FGDs in the study areas and workshop and conference deliberations triangulated with other secondary data sources. A few coastal inhabitants were also interviewed.

7.1 Actors' participation and cooperation at the level of Padang and Bali

7.1.1 Government participation and cooperation

Padang local government was the first city in Indonesia in November 2006 to agree on partnership cooperation with GTZ-IS in the context of building a comprehensive TEWS. The leadership of the mayor of Padang City was founded on the collective vision raised by KOKAMI that Padang would be the first city to have an end-to-end TEWS in Indonesia. The efforts of the local mayor were recognized in 2007 when the mayor received the BMKG award presented by the President of Indonesia. In

order to implement a TEWS in Padang, the actors took the initiative of developing a joint synchronized annual work plan to support the process of implementing a TEW in Padang. The concept is also synchronized with the local strategy for disaster preparedness (Padang Strategic Plan for Disaster Preparedness).

In comparison, unlike Padang, Bali lacked initial initiatives and leadership in tsunami preparedness and TEWS. Actors reported that initially there was some resistance among certain actors in Bali, who feared that such tsunami preparedness activities would have negative impacts on the tourism sector. Therefore, cooperation between GTZ-IS had to be initiated through a visit to government agencies. A plan for a pilot project was submitted to the city development agency (BAPPEDA) in Denpasar, the Bali Tourism Board and the local government of Bali. A couple of months later, the Governor of Bali and Deputy Bupati of Badung agreed to negotiate on the proposal. Meanwhile, informal participation in the form of capacity-building from Balinese institutions was initiated. A joint agreement on capacity-building for the TEWS and preparedness was agreed and signed in May 2007 between the Province Government of Bali and GTZ-IS during the opening ceremony of the TEWS Assessment and Planning in Bali workshop, attended by a total of 90 actors representing provincial public institutions. Working groups were organized equipped with an agreed action plan for the development of a TEW in cooperation with Bali province and Badung District. The cooperation commitment was formalized by signing a cooperation agreement with the Vice Bupati of Badung in March 2007.

7.1.2 Civil societies and private sector participation and cooperation

As indicated earlier, the key civil society participating in Padang is KOKAMI. The next chapter will examine in detail the role of KOKAMI in tsunami governance in Padang. Collective participation includes stakeholders participating in SOPs development through working groups and mid-term planning.

On the other hand, unlike Padang, NGO participation in Bali had to be encouraged through basic orientation seminars organized by the Centre of Environmental Education (PPLH) with support from GTZ-IS in August 2007. These awareness and basic knowledge training sessions in Bali targeted teachers, NGO workers and a women's group. An ex-member of PMI in Bali said:

> "We *have initially carried out village disaster preparedness and socialization regarding TEW dissemination in three villages and with the people living close to the sirens installed by BMKG in cooperation with IDEP, SATLAK and SATKORLAK (…) We have also distributed educational materials to the community and are facilitating the development of SOP"* (Interview 12, 9 February 2009).

Interestingly, a framework for a private sector partnership with the tourism sector was discussed with the representatives from the Bali Tourism Board, BHA and others. Cooperation agreements on tsunami preparedness and capacity development were formalized between the Bali tourism sector and GTZ-IS. Key activities involving the hotel establishments include the distributing of tsunami information to tourists and locals at their own cost. One issue to keep in mind was highlighted by UNESCO who said:

> *"Hotels might not like to continue distributing tsunami information because of the extra cost to them, especially in the case for lower star hotel establishments"*
>
> (Interview 3, 27 October 2008).

This suggests that smaller hotel establishments need support to carry out activities to promote awareness of tsunami risk and preparedness.

In a very recent press release in September 2009, BHA indicated the collective participation and cooperation between nine hotels by signing a MoU with the local village as an institutional mechanism marking the successful preparation of Kelurahan Tanjung Benoa hotels in becoming tsunami-ready[lvi]. This provides the legitimacy for the hotels and village people to cooperate in Tanjung Benoa to jointly prepare for tsunamis, for example by providing local village people access to the hotels in the case of an anticipated tsunami. This achievement has been supported by multi-sectoral actors such as PMI, the German Joint Committee, GTZ-IS-GITEWS and the Indonesian Tourism and Culture Ministry.

7.1.3 Community participation and cooperation

Community participation described by all actors includes involvement of the public in workshops, evacuation planning, developing evacuation routes, posting sign boards and participating in tsunami preparedness drills. The community is also involved in the strategic planning. Actors perceived that the participation and cooperation of the community has improved but there is a need to improve the participation of the local people at the national level.

Further examination of the local participation dynamics reveals that some actors are not employing the local participatory methods and are paying close attention to gender issues when interacting with the local people. For instance, UNESCO outlines that:

> *"The gatherings are dominantly attended by males and there is gender inequality in participation. In addition, participation of the community and local leaders should not be through formal conferences and workshops but rather it should be through informal social processes, such as FGDs and social gatherings"*
>
> (Interview 3, 27 October 2008).

This suggests that the methods and techniques to encourage participation need to fit the existing institutional social order. In-depth interviews with actors involved in the community such as KOKAMI, MPBI and GTZ-IS indicated that participatory approaches and socialization techniques are used to interact with the communities. A review of the capacity-building component of the GITEWS project underlined the use of simple visual aids for local authorities and outreach communities (GTZ-IS 2009).

A people-centred EWS also depends on whether policymakers and decision makers listen to the community directly or through their local representatives. Actors generally perceived that some decision makers are listening to the community through different negotiation channels but often through NGO's advocacy.

KOKAMI states:

> *"Most often it is the community of Padang who decides on the evacuation route and conditions for its participation. For instance the community asked the authorities for a bridge to be built to facilitate the evacuation drill. However, building evacuation roads and bridges is costly and the administrative procedures are long, and the community is still waiting"* (Interview 9, 3 March 2009).

In contrast, in Bali, participation and the decision-making process is a complex mesh between the local government and religious and cultural structures. This is highlighted by the statement by the GTZ-IS local representative:

> *"We have working groups here and we meet regularly with the head of villages. However, the likely outcome is unpredictable because in Bali, Kuta there are various decision structures"* (Interview 12, 9 February 2009).

7.1.4 Transparency and accountability

Actors who are collaborating with international actors indicated that there is an improvement in transparency and accountability within the TEWS process because of the established procedures of constant evaluation, monitoring and reporting at all levels. This suggests that within the project, concept transparency and accountability are well addressed. However, beyond the project concept, transparency and accountability are perceived as not very clear.

7.2 Tsunami Early Warning System-related architecture at the level of Padang and Bali

7.2.1 Financial arrangements

The important issue to highlight at this level is that according to the contingency budget for the province, Padang had an increase from about 0.6 to 2.0 per cent of their local budget, while the Bali local budget increased from about 0.4 to 3.0 per cent from 2007 to 2009, respectively. Actors in Bali and Padang indicate that the fixed running costs are now guaranteed while other financial arrangements for establishing EWS and DM architectures are lacking. Some actors stated that in their opinion the government has not provided adequate and consistent financial resources to implement the planned activities and this seems to make them doubt if the TEWS is still a government priority.

7.2.2 Local institutional arrangements regarding tsunami early warning

In Padang, the earliest exposure to institutional development in the context of work flows, SOP development and evacuation planning was supported by a UNU-EHS expert at the Padang Working Group in November 2006. Participatory workshops were organized in West Sumatra Province and Kota Padang early in the process in order to have a clear idea of the local situation in terms of actors, roles and responsibilities for the development of a legal framework. The implications of a lack of clear roles and responsibilities were highlighted by the GTZ-IS local advisor in Padang who stated that:

> *"A dramatic and threatening incident occurred here in Padang when there was a disagreement between provincial leaders and the City in Padang following an earthquake in March 2007. The provincial level announced that no evacuation was needed but the mayor of Padang requested the community to evacuate."*
>
> (Interview 13, 27 February 2009).

In 2008, Padang city became the first city in Indonesia to have a local law (Perda) to regulate DM. The local regulation development and institutionalization involved the Law Division, Social Welfare and Disaster Management Agency of Government of Padang and KOGAMI. This positive outcome was the result of clear leadership, cooperation, negotiation and deliberation between all institutional actors. Furthermore, local actors indicated that they were pressing to have a Governor's Decree to guarantee the necessary legal and administrative framework for the DM system in Padang. Currently, a mayoral regulation on TEW is going through the legislative process. The legislative process should cover aspects such as the capacity of the regional DM agency and the EOCs to function efficiently. However, policymakers and stakeholders involved in drafting the regulation on TEW earlier decided to postpone final approval of the regulation decree until the system at the national level has been finalized and the references clearly defined. A draft version of the TEW SOPs was presented to the Padang municipal policymaking board during the inauguration of the new DM agency (BNPB).

In Bali, the local actors reported that the first workshop for local SOP development was carried out in Sanur in October 2006. In addition, Balinese actors reported how they exchanged experiences on SOP and participated in related workshops in Padang and Jakarta with support from GTZ-IS. At the same time, an inter-institutional working group for tsunami preparedness and early warning was established.

On the other hand, in Bali, the GTZ-IS local advisor stated that:

> *"A provincial regulation has been drafted by the Bali working group based on the concept document developed by the TEWS working group and GTZ-IS. The legislative concept document, updated tsunami hazard map, and related technical documents were handed over to the governor in June 2009. The governor has expressed his support for the draft provincial regulation and has urged actors to continue with the initiative"* (Interview 12, 9 February 2009).

To this end, TEW and DM architectures in Bali include governor decrees 29/2009, 30/2009 and 31/2009 that concern the establishment of the EOC (PUSDALOPS) and the DM Agency (BPBD) at the provincial level and tsunami warning procedures in Bali respectively. The Governor Decree 31/2009 addresses the newly developed SOPs, which delegate decision-making to the EOC and recognize the tsunami hazard map developed with the support of the GITEWS project as the official map for southern Bali.

7.2.3 Religious and cultural norms

It is absolutely critical to understand the religious and cultural dimensions of religion and cultural norms in order to root the TEWS and DM into the society. For example, in Bali, it is important to pay attention to the views of the Balinese culture regarding earthquakes and their meaning. Earthquakes for the Balinese are not simply disasters; there is a hidden meaning or a prophecy for every earthquake based on the sacred *Palelindon* (treatise on earthquakes) manuscript. Interestingly, the cultural view reflecting "disaster prevention and mitigation" lies in another manuscript called "Lontar Pacaruan Linuh", or "treatise on appeasing the earthquake", which gives details of offerings and ceremonies to offset the negative effect of the earthquake, so the bad prophecy will not be materialized.

In this context, it is not surprising to find that local people in Bali tend to follow strongly their religious and cultural norms. The GTZ-IS local advisor in Bali said:

> *"The Balinese community in general has strong traditions and culture, and these constitute assets of the people's capacity that need to be empowered and optimized … in addition, if I have a difficult choice to make on certain issues, I would rather follow instructions and decisions from the community traditional leaders than from the state"* (Interview 12, 9 February 2009).

It is clear that the Balinese religions and culture are strongly interconnected and cannot be undermined, but should be empowered and integrated in the EWS and DRR. The challenging question is how. To partly solve the problem, the Province of Bali, in cooperation with GTZ-IS, held a seminar resourced from competent experts on Hindu Religion and Balinese Custom and Cultural Perspectives on the TEWS in Denpasar in September 2007. The seminar was attended by more than 50 actors from diverse institutions including the media, universities and traditional village leaders. Important messages from the Balinese perspective included living in harmony with the environment, proper technical interpretation in the general teaching and the integration of early warning into the Balinese customs and cultural perspectives.

On the issue of integration and fit of the TEWS, some cultural village leaders expressed their expectation that the BMKG TEWS would be linked with the existing local community system using the 'kulkul or kentongan'. This was also the interest of the head of the province's Regional Community Protection Agency who wanted to develop a community-based DM system in which citizens were trained to identify and be responsive to signs of disasters. Thus, the administration is considering incorporating the 'kulkul or kentongan' Balinese traditional alarm system in the disaster mitigation regulations. This clearly suggests it is a more challenging task to root the TEWS in the Balinese society compared to Padang; however, if successful it has potential advantages of being effective and sustainable.

7.2.4 Formal sub-national institutional structures

7.2.4.1 Sub-national disaster management agencies

In the past, at sub-national level both former local disaster response authorities SATKORLAK (city) and SATLAK (district) existed in the same city because Padang is the capital of the city, hosting both the provincial and municipal governments. The institutions and agencies operating in Padang in the past under SATKORLAK include the armed forces, the police department at the provincial level, search and rescue, the BMKG regional office, Red Cross Sumatra, Education Services, the telecommunication agency, the electric company and the health department. In August 2009, the government of Padang represented by the Deputy Mayor inaugurated the new Padang Disaster Management Office (BPBD). In Bali, the influence of DM authorities was very much absent. According to the provincial EOC,

> *"Bali did not host local DM authorities (SATKORLAK, SATLAK) and the local BMKG in the past. We are now trying to build these structures with French Red Cross assistance and finding more competent people to run the office"*
>
> (Interview 28, 9 February 2009).

It is highlighted that even in early 2009; the establishment of BPBD in Badung district was still pending. Figure 37 shows the multi-level structure consisting of the steering committee and executive committee of national DM (BNPB), and the sub-national DM agency (BPBD). It also shows links with the President of the Republic of Indonesia, the political administrative levels consisting of the governor at provincial level and the mayor at district/municipality level, the respective EOCs and links to the community.

Figure 37: The multi-level architectures, structures and links to the community

Source: Author.

7.2.4.2 Sub-national emergency operation centre

The local government (PEMKO) in Padang initially operationalized a temporary 24/7 EOC (PUSDALOP) for TEW purposes located at the Padang Fire Brigade with some technical support from GTZ-IS. Recently, during the inauguration of the BNPB in August 2009, the new EOC was also launched in Padang. Very recently BGR stated that:

> *"Each Emergency Operation Centre finally decides and is backed-up legally by BNPB/BPBD, and KESRA (Coordinating Minister for People's Welfare) supervises effective coordination between BNPB and sectors/ministries"*
>
> (Interview 2, 25 January 2010).

One advantage of the local EOC was demonstrated when strong winds generated extremely high waves impacting on several settlements near the northern beach of Padang. The EOC coordinated the efforts of the fire brigade, police, navy and KOKAMI to evacuate and shelter 500 people.

The government of Badung District (Bali) in cooperation with GTZ-IS also initially operationalized a temporary 24/7 unit for TEW. A new provincial EOC was also under construction during the field research. The EOC was inaugurated in August 2009 in Denpasar, and recently institutionalized with Governor Decree 29/2009. Furthermore, the new Governor Decree 31/2009 addresses the operations of the newly constructed EOC, which delegate decision-making to the EOC. The establishment of EOC at district level, particularly in Bali, is not being adequately addressed yet. Figure 38 shows the temporary and new EOC under construction in Bali.

Figure 38: Temporary (left) and new Emergency Operation Centre (right) under construction in Bali

Source: Author.

7.2.5 Emerging institutional coordination

As stated in the previous chapter, the new DM agencies and EOC at multiple levels are the ideal polycentric architectures for improved institutional coordination for the TEWS and DRR in Indonesia. From the actors' perspective, it is perceived that

coordination has improved at different levels down to the local level. For example, KOKAMI in Padang stated that:

> *"We have observed an increase in coordination and facilitation from the national government rather than directly executing activities and programs at the local level as in the past"* (Interview 9, 3 March 2009).

On the other hand, another mechanism which has contributed towards improved coordination is meetings to discuss the division of roles and responsibilities regarding TEW between the government levels. However, not all actors are satisfied with the level of coordination. For instance, the Environmental Education Centre (PPLH) Director has criticized the Bali administration and related institutions for lacking coordination and aggressiveness in their preparation for natural disasters.

7.2.6 The emerging institutional tsunami warning chain at sub-national level

Chapter 6 provided details of the national tsunami warning process in Indonesia. As indicated before, there is also no final consensus of a tsunami warning chain at sub-national level between the province and districts. Nevertheless, in Padang and Bali, actors have agreed that once tsunami information is received from BMKG or interface institutions the provincial and district governments, through their respective EOCs, have the legitimate authority to decide as per SOP on operating sirens and evacuation. This implies the SOPs at district level describe the delegation of authority from the mayor to the EOC to call for evacuation of communities. The development of an SOP follows the division of responsibility (decentralization architecture) between province and the district level. However, actors have not yet fully agreed on the inter-level institutional arrangement between the provinces and the districts. Other issues to be addressed include how the warning will be delivered to the districts and to whom, and what procedures will be followed at the district level when warnings or guidance are received from the provincial EOC. In chapter 9, the author proposes a concept model for TEW.

7.3 Risk knowledge at the level of Padang and Bali

Some actors have complained about the long delay in producing the risk maps in Bali and Padang. The long delay is partly because of the lack of accurate and detailed data to produce reliable formal standard risk maps for better decision-making. This is further discussed below:

7.3.1 Hazard and risk mapping: A highly negotiated and contested issue

The tsunami hazard-risk mapping process in the study areas highlighted some important governance elements between actors that should be considered. An official tsunami hazard, vulnerability and risk map was desired by all the actors due to the fact that there were several unofficial maps in circulation in Pandang. The existing zoned tsunami hazard map had been very useful. This was based on simple inundation up to ten metres high, and was developed earlier by KOGAMI in cooperation and partnership with UNESCO. However, the tsunami hazard map needs to be updated to correctly define the risk zones for evacuation, spatial planning and development.

The tsunami hazard and risk mapping process started with base studies to find available information on tsunami hazards conducted by actors of a working group. As indicated in the previous chapter, there was no convergence and agreement between actors on tsunami inundation modelling. Since 2007, there have been discussions and debates on tsunami hazards and vulnerability in Padang, initiated in the "International Symposium on Disaster in Indonesia, Problem and Solution", the seminar "Scientist Meets Politics-Padang Consultative Group" and the "International Symposium in Hazard Map". The output of the Symposium was known as "the 1st Padang Consensus" in 2008. In the first Padang Consensus, international actors from Japan, the United States, Germany and other local actors agreed on standard guidelines such as a the worst case scenario[lvii], non-uniform land surface roughness for preparing an official tsunami hazard and risk map for further use in evacuation, spatial planning and development in Padang city. Consequently, two workshops were organized on 12 and13[lviii] April 2010 to follow-up on the discussions of the Padang Consensus with the objectives of presenting the available tsunami high-resolution hazard modelling and assessment from various research groups, especially considering the agreed scenarios and data stemming from the Padang Consensus I of August 2008.

At this point the Japanese and the United States actors were not participating in the final showdown. Nevertheless, the deliberations were characterized by lengthy mediation and debates, especially between two actors from Germany, DLR representing the GITEWS project and actors from the Franzius Institute of Hannover representing the "Last Mile" project. Interestingly, the "Last Mile" Project actors claimed:

> *"We have apparently met almost all the guidelines of the first Padang consensus which includes tsunami modelling using the agreed single worst case scenario and employing highest land topography resolution, and uniform land roughness. The only criteria we have all not been able to satisfy is model validation because this simulated event has not actually occurred in Padang before"*
>
> (Interview 14, 14 April 2010).

On the other hand, DLR said:

> *"We have employed the most conservative approach based on the probabilistic prediction scenario, uniform land roughness and slightly lower resolution land topography data. As a consequence, our result shows a greater degree of tsunami inundation compared to the Last Mile Project actors from the Franzius Institute"*
>
> *(Interview 15, 21 April 2010).*

However, the debate shifted to seek answers on whether the map to be selected should represent the worst or least tsunami inundation. The selection of any of the inundation and risk maps has enormous implications for evacuation, spatial planning and development in Padang. However, the final challenge is who will finally decide? The provincial and city planning agency and other local actors were confronted and were unable to make a final decision. The local actors recommended that the scientific actors resolve and settle the contentious issues. Finally, the two contending parties agreed that the hazard-risk mapping carried out by the Franzius

Institute, representing the "Last Mile" project simulating least inundation be accepted and recommended as the final hazard–risk map for Padang city.

In the case of Bali, tsunami hazard-risk mapping was initiated by having a TEWS assessment and planning workshop held early in April 2007. For evacuation planning, the village of Kuta in Badung district was selected as a pilot study area for the mapping process because of its representative structure for tourist coastal areas. Actors exchanged knowledge, provided spatial and statistical data and developed a cooperation mechanism and a joint working plan. Similar to Padang, national experts, representatives from district governments, GTZ-IS and GITEWS partners developed a general approach for tsunami hazard mapping that can be applied at district level. The GTZ-IS local advisor stated:

> *"We have agreed on a reference scenario and criteria for tsunami hazard zoning in order to develop a zoned tsunami hazard map as a planning tool in Bali"*
> (Interview 12, 9 February 2009).

Actors considered the facts that Bali had experienced several strong earthquakes of moment magnitude greater than 6.0 in historical times including the years of 1976, 1979, 1984 and 2004, and there are four sources for tsunami. On this basis, actors agreed and recommended a multi-scenario approach. Further debate focused on the exclusion of highly unlikely scenarios. Finally, the multi-scenario hazard map and documentation process was completed in April 2008 through multi-institutional cooperation and collective deliberations and negotiations with the involvement of actors from the Balinese Government, Indonesian scientific institutions and partners from the GITEWS project. The process of developing hazard risk maps in Bali was characterized by less competition, debate and contested issues because the "Last Mile" project does not include Bali. Both documents were presented and handed over to the Balinese authorities. Figures 14 and 15 in chapter 3 showcase the DLR-GITEWS tsunami hazard and daytime population exposure maps for Bali.

However, for equitable opportunities in risk knowledge, the risk mapping should include the entire coastline of Bali, not only the southern coast where the tourism activities are located. The coastal residence of Sanur for instance, a few kilometres further northeast, is not covered in the present risk map. Sanur is a coastal stretch of beach of Denpasar city in south east Bali, and it has grown into a little town in its own right. It is observed that there are various elements at risk in Sanur ranging from traditional fishing, coastal tourism, school and family recreational activities along the coast (see Figure 39).

7.3.1.1 Risk communication: Education, awareness and socialization

Overall, Bali and Padang have been subjected to fairly similar education and awareness strategies on tsunami risk and disasters, but they vary in intensity. These include outreach activities such as educational tsunami posters, comics in English and Bahasa, short training videos and modules for the training of facilitators, and training materials for the contribution of school curricula. These products have involved collaboration and cooperation between a number of actors such as GTZ-IS,

IOC-UNESCO, LIPI and the Red Cross with the support of UNISDR, the Indonesian Ministry of Home Affairs, BMKG and BNPB.

To highlight the efforts made in Padang, various national exhibitions along Taman Budaya beach were organized by LIPI and PEMKO. The exhibitions were officially opened by the Governor of West Sumatra Province and this attracted thousands of local visitors from all over the Province. Meanwhile in Bali, the initial efforts include the distribution of posters to schools and public health centres as well as the Balinese Tourism Associations (GTZ-IS 2009).

In order to efficiently communicate risk knowledge to a wider audience and to enhance community participation, a group of actors from various institutions participated in a training course. The course prepared actors for a tsunami awareness campaign to be carried out in the villages along the coast of Badung district and simultaneously implement a socialization campaign which is managed by Badung district authorities. The GTZ-IS local advisor reported that in Bali:

> *"An outreach campaign to spread basic knowledge on tsunami hazard and TEW in villages along the southern coast of Bali was implemented by involving target groups and representatives from the traditional structures (Desa Adat), youth organizations, women's organizations and other important organizations in the villages. Usually around 30 to 40 people attended the meetings, which involved socialization activities including performance"* (Interview 12, 9 February 2009).

Training was also provided to the primary school teachers and employees operating the Ritz Carlton security office to help set up the BHA TEW Service with the assistance of the local government (BUDPAR). However, much more needs to be done, and this is reflected in the statement made by the BHA's Tsunami Alert Coordinator, who was reported as saying *"The people of the Tanjung Benoa villages lack knowledge and awareness to overcome tsunami disasters which have become a very high risk for them. The local residences do not have a proper evacuation site, because almost no building in the villages is a safe place to avoid the tsunami, except for the hotels"* (Antara 17/09/2009).

The latest workshop in Padang from 12 until 14 April 2010 was another major attempt to communicate the formal risk knowledge created for the responsible institutions at the local level for endorsement, implementation and further socialization within the community at risk. Earlier, the GTZ-IS local advisor highlighted that:

> *"The real challenge is to familiarize government agencies, the development sector and community with these products through education and socialization activities, and to streamline the risk knowledge into local planning and development"* (Interview 13, 27 February 2009).

Figure 39: Vulnerable elements along Sanur beach, Bali, Indonesia

Source: Author (2009).

7.3.2 Communities risk concern

The local actors who interact directly with the community perceived that the public concerns for tsunami risk are high mainly in the risk areas only. For example thousands of people attended the national exhibition on tsunamis over just a few days even though they had to pay a small fee. MPBI commented that:

> *"Recent events and information have increased the people's concern, but some communities in high risk areas even with no information are concerned and rely on local wisdom. The communities are concerned about the high technology and how to understand at the local level, and they raise questions of what to do"*
>
> (Interview 5, 3 November 2008).

On the other hand, one 41-year-old man who has been a fisherman in a nearby village in Padang for 25 years with his home close to the beach believes there is no way of escaping fate:

> *"We don't care about this tsunami issue. The most important thing is to go fishing and get some money, so we can stay alive. We submit our fate to God. Our destiny has been written. If we die because of a tsunami, there's nothing else we can do. We are not afraid…it feels normal. Just take a look around, everybody here has his home near the beach. If a tsunami hits this place, I will just submit my fate to God. Big earthquakes rarely occur here, that's why I'm not too worried about this. But of course we have to be on the alert. When we hear the sirens, we will run to higher ground"*
>
> (Interview 16, 4 March 2009).

The fisherman's account shows elements of concern, and indicates actions to follow in the event of a tsunami warning; however, the fisherman is not willing to relocate as this could impact and disrupt his usual livelihood. In other words, the message is that the fisherman is ready to accept or tolerate a certain amount of risk

so that he can continue to earn his living and thus cope with the daily struggles (see Figure 40).

Figure 40: Vulnerable elements along Padang coast

Source: Author.

7.3.3 Risk perceptions and understanding of the communities

All actors interviewed perceived that correct risk understanding and perceptions are still lacking, but the situation is spatially diverse depending on the communities who have been exposed to education, awareness and actual experiences. Most actors generally perceived that the Padang community has good perceptions of tsunami risk and people are interested in doing things. The GTZ-IS local advisor in Padang city explained that:

> *"Padang community was not only exposed to education and awareness but we have actually experienced some earthquakes and tsunamis and we find people evacuating themselves".*

According to RISTEK, the interim coordinator of the InaTEWS, there are three reasons explaining the current low level of risk awareness of tsunamis in Bali, Padang and throughout Indonesia:

> *"Firstly local governments have been requested to come up with risk maps, but capacities are lacking and most communities are still learning by doing. Secondly, the authorities are still working on official risk maps as the country is big and official risk maps have not been published in the media yet. Thirdly, of critical concern is that risk maps have not actually been distributed and circulated to the community at risk as was observed in Bantul in the case of the last drill"*
>
> (Interview 7, 15 January 2009).

However, one major element, which constantly affects all the education and awareness carried out by all the actors such as KOKAMI based on the scientific risk

approach, is linked with the old religious superstitious traditions. In the devastated city of Padang, following a major earthquake killing more than 1000 people, an Islamic watch website[lix] indicated *"… a commonly heard refrain has been that the quake is a test, or a punishment, ordained by God"*. Furthermore, according to one interview, a local person was quoted as saying *"I think the quake happened because many of the youths in Padang commit sins, especially during Ramadan"*. These perceptions are not new but are indeed very old views of hazards globally as being a part of the problem of evil, or more particularly, part of the problem of "natural evil" (Miller 2001) and lack of understanding of scripture and testimonies attributed solely to God's purposeful action.

7.4 Dissemination and communication at the level of Padang and Bali

7.4.1 Formal institutions and systems for dissemination and communication

Some of the formal interface institutions involved in disseminating and communicating tsunami information include the DM agencies, the department of home affairs, the national police, the army, the department of information, communication and technology, and the provincial government and district.

7.4.1.1 The Frequency Modulation Radio Data System

In both study areas, more than 30 selected public and private institutions have the capability to further disseminate tsunami information to the community from BMKG via FMRDS technology. This technology works on the same principle as traffic warnings via car radio in Germany. If a warning is sent out, this is conveyed automatically, independently of whether the early warning receiver is switched on or off or is adjusted to another radio station. Bali was the first location in Indonesia to test the FMRDS technology as part of the end-to-end EWS. The main test was performed during the Bali Drill on 26 December 2006. 37 FMRDS receivers were distributed to the institutions and tested between December 2006 and January 2007. The private sector is particularly interested in this tool, but there have been some obstacles concerning property rights for the institutional integration of FMRDS in the TEWS.

7.4.1.2 The locally developed communication system

The development of the TEWS thus far has witnessed few innovation efforts in terms of the development of local technologies. However, among the few which have emerged is a system called the 'RABAB' communication system. It is a simple and cheap, with a 24/7 standby function and battery back-up, and provides wide area coverage for local tsunami information dissemination. It was installed in January 2008 by the Padang Working Group. The GTZ-IS local advisor indicated that

> *"the RABAB communication system provides the flexibility to local authorities (mayor, police and army) to send out information (audio voice and sound) by a normal FM Radio without the necessity to be physically at the emergency command centre"* (Interview 17, 3 March 2009).

7.4.1.3 The radio and internet community-based communication tool

In addition, the "RAdio and InterNET" system known as RANET contributed to the live tsunami drill by sending information into Indonesia's TEWS so that local operators could sound an alarm. The RANET system is a useful community-based communications programme designed to reach the "last mile". The BHA has implemented its own RANET warning dissemination service covering many four and five-star rated hotels on Bali's southern shoreline.

However, the RANET system is emerging as a disappointment for BHA. The actors are now learning that the system will be phased out. The BHA coordinator said:

> *"We are quite disappointed at this news because this information should have been communicated to us earlier as we have already invested a lot of money in this RANET system"* (Interview 18, 6 January 2009).

Further questioning of BMKG and RISTEK revealed that the producers of the RANET system, the NOAA in the United States, are actually ending their programme on RANET due to financial difficulties. This experience has raised an issue between private-non-government actors and the government institutions, because it is perceived that with more information such an investment could have been avoided.

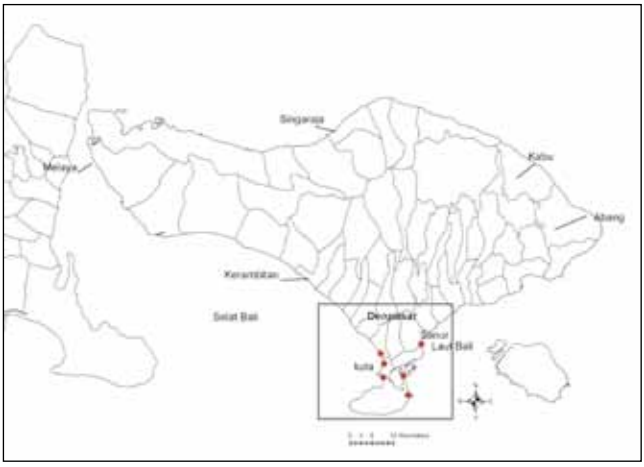
7.4.1.4 Coastal sirens

On the other hand, in the immediate areas along the coast where people have to be evacuated in an event of a tsunami, a network of nine sirens has been strategically placed in the city near the coastline by the local government of Padang based on a proposal from the Padang communication group (see Figure 41). These sirens can be triggered from BMKG in Jakarta and local EOCs in Padang. The sirens were successfully tested in December 2007 in the West Sumatra Tsunami Drill. The sirens have an operating range of just under 1000 metres. In a survey[lx] conducted by UNU-EHS (2008) in Padang city, it was found that sirens contribute to around 25 per cent of the information received by the public.

Figure 41: Siren network in Padang, Indonesia

Source: Setiadi and Birkmann (2010).

Figure 42: Siren network in Bali, Indonesia



Source: Author.

Currently, Bali has six sirens placed along the coast in the southern area of the island, installed by BMKG, as mapped in Figure 42. Personal observation indicated that in Sanur for example, the siren was tucked away in the less inhabited and visited areas of the coast. The siren could have been strategically placed at the centre where most local people are operating tourism-related activities reaching from restaurants to boat excursions and where most local families spend time on the beach. The visibility of the siren will serve as a constant reminder of the tsunami risk. On the other hand, in Padang the sirens were positioned a few kilometres away from the coast in the heart of the urban areas. Tsunami information such as sign boards and evacuation routes could not be found anywhere in the immediate area, but one to two kilometres away from the coast. Tsunami information needs to be displayed clearly along the coast, not only along and around the main streets.

However, the problem about sirens is that in reality many local people question the sirens. For example KOKAMI states:

> *"Some people do not understand the need for sirens, how they work, the meaning of the sound, and they do not know the exact procedures for evacuation"*
>
> (Interview 9, 3 March 2009).

This suggests that the community is not familiar with these strange new devices along the coast. The other problem is that currently there is no formal agreement on siren operation, including the way the alert is sounded.

7.4.1.5 Personal media system

The private media system plays a critical role in informing the public. Elements of the system include radio, TV (i.e. direct systems), mobile phones and landline telephones (i.e. indirect systems). Radio as a direct official communication and dissemination system is a very effective medium to reach out to the public (UNU-EHS 2008). It has a dissemination rate of 60 per cent compared to TV, landline phone and SMS at 25, 10 and 5 per cent, respectively. Hence, mobile SMS is the least effective and reliable system for communication and dissemination during a crisis situation. However, it is pointed out that the survey was carried out during the daytime and it is not surprising to find that most people would receive tsunami information on the radio. During the evening and night people may prefer to watch TV rather than listen to the radio, and this needs to be captured in new surveys. On the other hand, it is clear that the number of households with a TV is reasonably high in Indonesia at 65.4 per cent (see section 4.2.3.4 of Chapter 4) compared to radio sets at 26 million in a population of 200 million. Hence, different media systems have a different effectiveness according to the time of the warning.

In addition, some actors question whether radio is actually an effective and reliable system in the case of alerting the community quickly in the case of a local tsunami. Nevertheless, the strategy to adopt is to use a multiple-mode communication and dissemination system with consistent and clear tsunami information to the public.

7.4.2 Informal institutions and systems for dissemination and communication

7.4.2.1 Connecting the TEWS with mosques and speakers in Padang

In Padang, a communications task force was formed in 2007 to implement new ideas of a dissemination and communication system to support the TEWS. This included drafting the necessary SOPs to advance the development of the new mosque speaker triggering mechanism. In a very recent informant interview, GTZ-IS stated:

> *"KOGAMI supported by GTZ-IS is running a pilot dissemination network in Padang that will connect 30 mosques and five other locations directly with the local EOC (PUSDALOPS) of the City of Padang. If the system functions, this would imply that the people in the surroundings will be able to receive warnings and guidance from the government of the city"* (Interview 19, 2 February 2010).

Such an endeavour is viewed as very important and would be meaningful to the people involved in terms of installing devices (i.e. speakers in mosques) that fit with the current practices in a given existing institutional order[lxi]. The potential effectiveness of public-mosque-trained people in delivering indirect tsunami information and guidance to the public is estimated at 25 per cent.

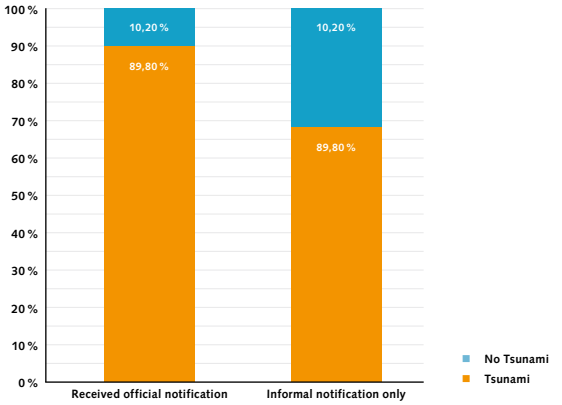
7.4.2.2 Linking the TEWS to the "Kulkul" system in Bali

In contrast, in Bali the "Kulkul" system would ideally replace modern sirens in areas where such technology is not available or appropriate. The "Kulkul" system has traditionally been used in Balinese villages to call the community members for public gatherings or to inform them of threats. Each banjar (traditional neighbourhood association) has a tower housing several kulkul, which are wooden bells with different pitches. The bells can be struck differently to convey different announcements. A bell struck in a fast, uninterrupted rhythm indicates danger. When alerted of danger, citizens rush to the village tower to be given instructions. Each traditional village (Desa Pekraman) is usually made up of four to eight banjar. Currently there are over 1,400 traditional villages across Bali. Unfortunately, it is unknown what concrete steps have been taken to link the kulkul system to the TEWS.

7.4.3 Information gap and clarity between official and unofficial notification

In Padang, actors need to address the existing tsunami information gaps as highlighted earlier. On the other hand, according to the UNU-EHS survey in 2008, it is clear that the ability to understand tsunami warnings in Padang decreases by 20 per cent for informal notification compared to access from official warning as shown in figure 43. This highlights the effectiveness of official and informal communication and dissemination systems in the case of Padang city.

Figure 43: Ability to understand formal and informal tsunami information



Source: Birkmann et al. (2008).

7.5 Response capabilities at the level of Padang and Bali

7.5.1 Formal institutions involved in response

In both study areas, formal institutions involved in response include the different DM Agencies (BNPB), the fire brigade, the police, the armed forces, Search and Rescue (SAR), PMI, KOKAMI (Padang), the media, the national water and electricity company, food and water departments (Ministry of Public Welfare; Department of Social), Telkom, health and sanitary departments (Department of Health), the Indonesian Culture and Tourism Minister (Bali), the Department of Internal Affairs, the Department Public Works and the Agency for Rehabilitation and Reconstruction.

In addition, in Padang a trained community response team is also an important element of the people-centred TEWS architecture for distributing tsunami information indirectly to the public. The community response team contributes about 25 per cent of the information distributed to the public in Padang.

7.5.2 Evacuation planning and preparedness

In terms of tsunami response capabilities, the actors and the community at risk carried out tsunami drills in Padang city in West Sumatra one year after the tsunami in December 2004. In addition, community-based disaster preparedness has been conducted by PMI in Padang in three pilot villages. In February 2009, a pilot tsunami drill was conducted. The authorities received tsunami information from BMKG which was disseminated to the community using two-way communication radios in each pilot village. For efficient community response, the representatives from a community and partners have also agreed on a reaction scheme while SOPs are being developed by GITEWS and partners of the TEW.

In 2006, Bali was the first location in Indonesia to attempt the full end-to-end TEWS drill. It is reported that about 15,000 people including foreign tourists participated in a national tsunami drill conducted on Bali's Sindi Beach. However, the most critical issue is that there is no agreed plan on when and how often to carry out simulations and drills in these communities in Indonesia.

The actors have deliberated extensively on the issue of evacuation planning. For instance, in Bali, the evacuation map will be based on the recently developed tsunami hazard map for southern Bali. A dialogue with actors from the Kuta community was held in June to discuss the ideas of the working group and to collect further input and ideas. In several meetings actors agreed on the establishment of two zones for evacuation and basic ideas of evacuation planning and they proposed conveying the outcome to all managers of the association. However, so far there are no formal agreed disaster preparedness plans and contingency plans in place in any administrative levels in Padang or Bali because official risk maps have only just been completed. Thus, evacuation and spatial planning as part of the contingency planning and preparedness are expected to dominate the action arena in both Bali and Padang.

Meanwhile, evacuation buildings are also planned. In this context, the Indonesian Culture and Tourism Minister is reported as saying *"This will accelerate the ministry's programme to provide a safe and secure feeling for holidaymakers... escape buildings for other coastal areas would be built in stages depending on the availability of the ministry's budget while welcoming local administrations who wanted to build their own facilities with their own budget."* The buildings are planned to be built on or near Bali's beaches. However, strong local critics have emerged of the Indonesian Culture and Tourism Ministry related to the issue of shelter and evacuation in Nusa Dua, Bali. One restaurant owner interviewed in the periphery of Nusa Dua complained that:

> *"Firstly, the proposed tsunami shelters would only cater for tourists in the area as locals are unlawfully prohibited access to Nusa Dua's beaches. Secondly, why the need to build tsunami-safe shelters when the hotels can cater for such needs?"*
> (Interview 20, 12 February 2009).

The restaurant owner raises an important issue of equity and access rights of the village community when evacuating after a tsunami warning. Ideally, tsunami evacuation shelters would help protect people who would have no time to escape to the hotels. This is clearly shown in the evacuation time map (see Figure 44). It is underlined that for a tsunami warning, the tsunami arrival time is 20 minutes, with an expected wave height of three metres at the coast. In the case of a major tsunami warning the people's immediate response capability will vary from more than 120, 90–120, 60–90, 30–60 and 30 minutes of evacuation time to reach the closest evacuation target point depending on the position from the coast to the higher ground. Areas indicated in green can be evacuated in 20 minutes. The potential large number of casualties is found to be concentrated on the east and west side of Kuta, indicated by the dark grey portion of the circle. These are the priority areas for planning and building tsunami evacuation buildings.

On the other hand, in Padang KOKAMI argues that:

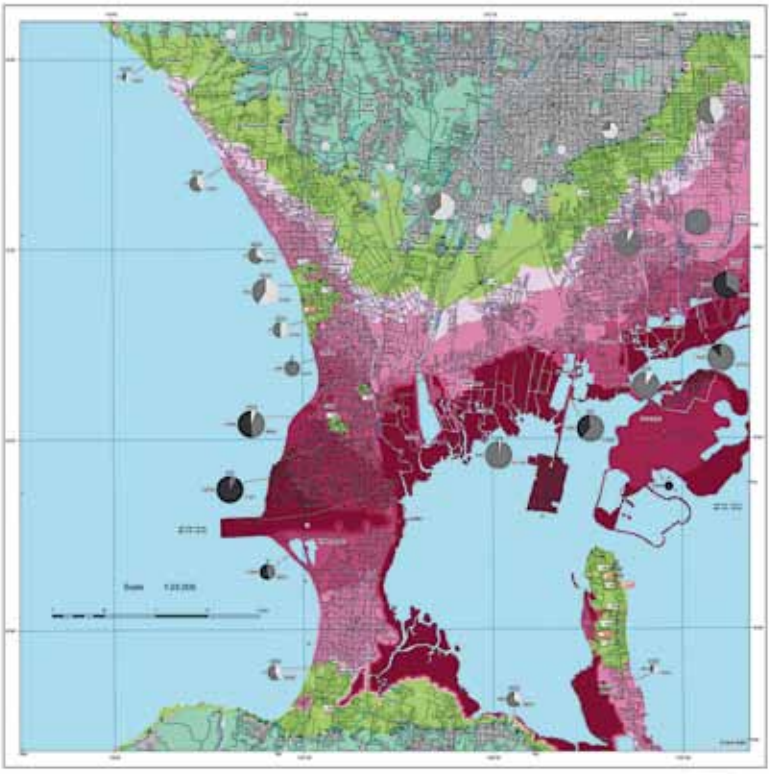
> *"In certain areas it is very difficult for the people to evacuate because there is lack of infrastructure for earthquakes, like bridges or roads for evacuation. Even if all the people in Padang knew how to evacuate we predict that 60,000 people could not survive because of the infrastructure problem … We have identified a military area as a potential evacuation zone, but our requests to the government have been consistently rejected"* (Interview 9, 3 March 2009).

Similarly, McCloskey, a seismologist at the Environmental Sciences Research Institute at the University of Ulster in Coleraine, Northern Ireland, argued **"***if the people of Padang are well prepared, then most should survive if they can reach the 10 metres contour... however, over 100,000 people – a seventh of the city's population – are blocked from running directly to higher ground by the barbed wire-laced, 10-metre-high walls of a huge military airport. Padang needs to build a tunnel under that airport, because if they don't these poor people will have to run parallel to the coast for several hundred metres while the tsunami is coming at them. So far, no steps have been taken to build such an exit route*" (New Scientist 10/09/2009).

The evacuation time map of Padang (see Figure 45) shows the coastal communities would need at least 60 minutes to complete the evacuation; however, the tsunami would strike the coast in about 20 minutes. The important difference compared to Bali is that in Padang the entire stretch of the coast is characterized by a likely higher potential number of casualties indicated in the dark grey portion of the circle. These are the areas to plan and build additional tsunami vertical evacuation buildings as indicated by the red-orange areas.

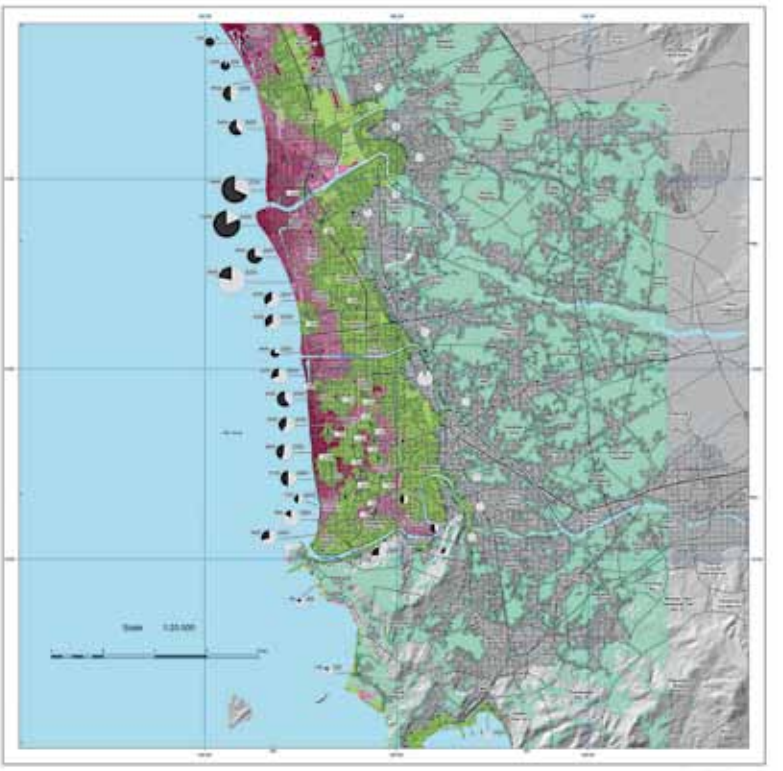
An effective response by the community depends on the environment, for example the presence of obstacles such as traffic jams. Personnel observations indicate the potential traffic problems in the event of an evacuation in Padang. KOKAMI reported a traffic jam some three hours after a tsunami warning was issued in Padang in 2005. A recent study shows there are few roads which can facilitate full evacuation while other roads that lie in the dense population area cannot satisfy the evacuation requirements in Padang. It is predicted that within the next 10 years due to increased urbanization and population growth, Padang's existing tsunami evacuation routes will probably fail to save all the people (Febrin 2008). In contrast, Bali roads and traffic are in better condition[lxii]; however, detailed studies and evaluation would be necessary to derive a better assessment under a crisis situation.

Figure 44: Tsunami evacuation time map in Bali



Source: DLR in the framework of the GITEWS project (2009).

Figure 45: Tsunami evacuation time map in Padang



Legend

- 0–15 min. evacuation time
- 15–30 min. evacuation time
- 30–45 min. evacuation time
- 45–60 min. evacuation time
- > 60 min. evacuation time
- Temporary shelter area
- Evacuable area – evacuation possible due to the available capacity of evacuation buildings and the available evacuation time (ETA)
- Flat area
- Undulating areas
- Hilly areas
- Settlement
- Water surface
- Village boundary (desa)

Source: DLR in the framework of the GITEWS project (2009).

7.5.2.1 Vertical evacuation

It is clear that in both cases a large portion of the coastal communities in the case of a near field tsunami would have difficulty escaping to higher ground. The challenge therefore is to address how to carry out evacuation vertically. However, there is a lack of vertical evacuation facilities and a clear institutional arrangement for vertical evacuation in both locations, particularly in Padang. However, there are some emerging initiatives and efforts to embrace. For example, the Padang provincial government provided 1.7 hectares of land with support from public works for building four twin apartment blocks in July 2009 in Purus Village to accommodate 3,200 people for the dual purpose of accommodation and for vertical evacuation in the event of a tsunami. The Padang government is committed to securing national and international cooperation and support to provide vertical evacuation in all tsunami-prone areas of Padang. Another fisherman along the Padang coast interviewed on the matter said that:

> *"Building vertical evacuation buildings for the people would be wiser than building the expensive sea walls in Padang"* (Interview 21, 4 March 2009).

Interestingly, in Bali, this challenge was partly achieved when an MoU was agreed between the nine hotels and the villages in 2009. This implies 'labelled tsunami-ready hotels' have formally agreed on a joint evacuation space, an evacuation trigger, evacuation procedures and codes of conduct allowing the villages at risk to get to the hotels in case of an official tsunami alarm. However, tsunami drills between the villagers and tourists need to be practiced and scheduled in regular exercises. In addition, the cooperation needs to be scaled up throughout Bali to include more hotel establishments and villages at risk rather than confined only to the nine high class hotels in Tanjung Benoa. GTZ-IS (2009) views this initiative as a long-term solution if promoted and implemented on a larger scale in the southern part of Bali. However, UNESCO warned:

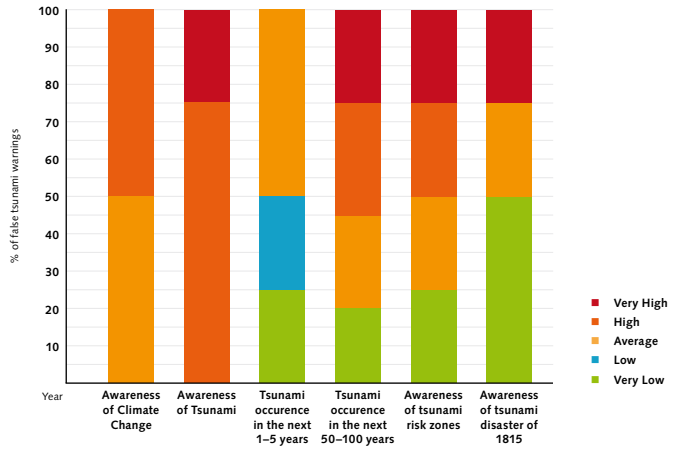
> *"It is unknown how hotels would react and respond if there is any demand for all hotels to provide space for vertical evacuation" (Interview 3, 27 October 2008).*

Therefore, to minimize potential conflicts erupting in an already fragile environment between tourism-related activities and tsunami preparedness, this issue is best solved through intensive negotiation and consultations with the hotelier actors.

7.5.3 Institutional tsunami preparedness in the tourism-related establishment in Bali

The tourism-related establishment survey in south Bali shows firstly that tsunami awareness is higher than the awareness of climate change in Bali (see Figure 46). Interestingly half of the establishments have a low to very low perception that a tsunami will occur in the next one to five years. The perception that a tsunami will probably occur in Bali in the next 50-100 years is slightly higher. However, 75 per cent of the establishment were not aware of the tsunami disaster of 1815 which killed 10,250 people in Bali. Only half of the establishments had high to very high awareness of the tsunami risk areas in Bali.

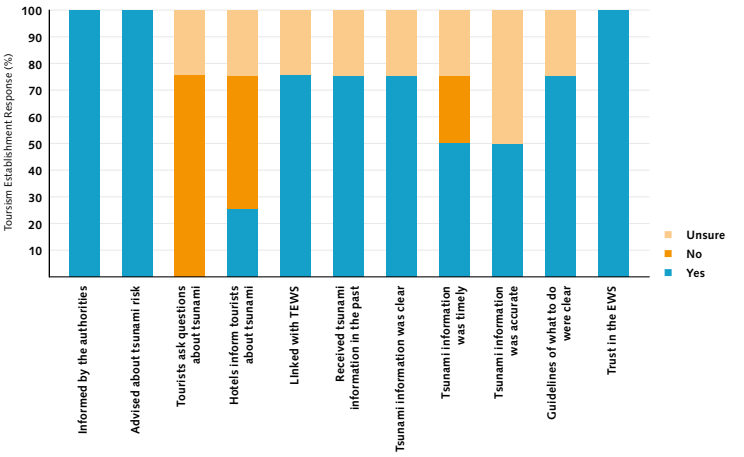
Figure 46: Tsunami risk knowledge in Bali for tourism-related establishments



Source: Author.

The survey also suggests all the tourism-related establishments have been informed and been advised by the authorities about tsunami risk. However, tourists generally do not ask questions about tsunami risks and only 25 per cent of the establishments surveyed communicate tsunami risks to the tourists, as shown in figure 47. 75 per cent of the establishments are linked with the TEWS and have received tsunami information in the past. Surprisingly, 75 per cent of the hotel establishments reported that the tsunami information and what to do was clear; however, only 50 per cent of the establishments pointed out that the tsunami information was timely and accurate. Encouragingly, all establishments indicated they had trust in the TEWS.

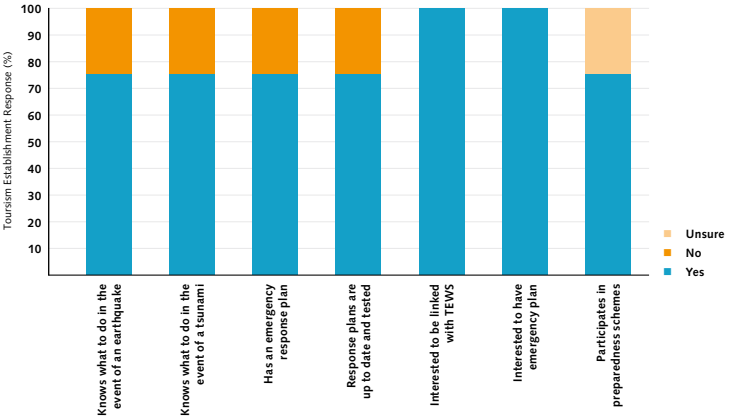
Figure 47: Tsunami warning information in Bali for tourism-related establishments



Source: Author.

Interestingly, 75 per cent of the establishments indicated that they knew what to do in the event of an earthquake or tsunami event and had emergency response plans. Moreover, all establishments indicated an interest in being linked with TEWS and had emergency plans as illustrated in figure 48. However, only 75 per cent of the tourism establishments were participating in community tsunami preparedness schemes.

Figure 48: Institutional tsunami response in Bali for tourism-related establishments



Source: Author.

7.6 Summary

Overall, this chapter has shown that initially political commitment, leadership and participation as indicators of good governance were higher in Padang compared to Bali. This was driven by the strong leadership of the mayor and local NGO (i.e. KOKAMI). In Bali, there is an emerging cooperation following initial resistance, but this is characterized by a higher degree of negotiation and deliberation among actors. The emerging multi-stakeholder partnership with the tourism sector and the traditional and cultural structures is far more complex in Bali than in Padang, but it may ultimately be the critical element which defines TEWS sustainability in Bali. The communities are also participating, but community leadership in the TEWS is lacking.

Padang became the first city in Indonesia to have a local institutional DM regulation, while in Bali the regulation is still in progress. The TEWS and DM architectures in Padang include a new DM Agency and EOC at provincial level, while Bali received a new EOC at the provincial level only. Key local regulations on TEW and DM in Bali include the governor's decrees 29/2009, 30/2009 and 31/2009 concerning the establishment of the EOC, the DM Agency (BPBD) at the provincial level and tsunami warning procedures in Bali respectively. Governor´s decree 31/2009 addresses the newly developed SOPs, which delegate decision-making to the EOC and recognize the tsunami hazard map, developed with the support of the GITEWS project, as the official map for southern Bali. Therefore, each EOC makes the final decision and is backed-up legally by BNPB/BPBD and KESRA.

Inter-institutional coordination has improved both in Padang and Bali. Key mechanisms that have improved coordination include the establishment of multi-level DM architectures and SOPs with the government acting as facilitators rather than implementers at local level. However, the development of multi-level work flows and SOPs have presented the central challenge. Therefore, a final consensus on a tsunami warning chain is gradually surfacing. Actors have agreed through the governor´s decree that once tsunami information is received from BMKG or interface institutions, the provincial and district governments through their respective EOCs have the legitimate authority to make decisions as per SOPs.

Risk knowledge creation is a highly contested issue, especially in Padang; however, the process has been characterized by multi-institutional cooperation, collective participation, intense debate and negotiations among diverse actors. For equitable risk knowledge, risk mapping should extend to the whole coastline of Bali. There has been a significant increase in disaster preparedness education and awareness in Padang and Bali. However, most actors perceived that good perceptions of tsunami risk are higher in Padang because the community have been subjected to a more intense education programme carried out by KOKAMI while at the same time having experienced some real earthquake tsunami events. Risk concerns are relatively high in the high risk areas but people do also tolerate a certain level of risk because of their usual livelihood conditions. Risk communication in Bali has been quite effective by training trainers, target groups and traditional structures to effectively transfer risk knowledge to the community. The religious-social construct may strongly negatively affect the communities' good risk percep-

tions of tsunami hazards and disasters. The emerging new risk knowledge needs to be communicated and socialized at multi-levels.

There are a number of formal and informal institutions involved and being equipped with different communication tools to further disseminate tsunami information downstream to the community. A key obstacle to unlock in the future is the legal arrangements to allow the integration of FMRDS in the TEWS. FMRDS has enormous opportunities for improving the effectiveness of the TEWS in Indonesia. The effort or idea of installing speakers in mosques in Padang and temples in Bali with Kulkul is viewed as an important step to fit meaningful practices into a given existing institutional order, but it lacks formal recognition and legitimacy for effectiveness and sustainability. The development of a local warning dissemination service among hotels in Bali is an interesting partnership development, but the effort needs to be scaled up nationally for equitable benefits. The combined use of formal-informal institutions, tools and trained agents contributes significantly towards a people-centred EWS and to improving the gaps and reducing social vulnerability in information access. The effectiveness of various media systems varies with time, hence a multi-mode dissemination and communication system is always required.

Due to the delay in producing the tsunami risk maps, institutional preparedness (i.e. evacuation planning, contingency planning, etc.) have not progressed significantly in Padang and Bali, but would be the next priority area to address. Both Padang and Bali have carried out TEWS drills; however the drills are ad-hoc and need to be institutionalized into scheduled inter-annual events. Evacuation routes and vertical evacuation have been developed on a small scale through joint collaboration between the actors and the community. Padang needs innovative partnership to build vertical evacuation buildings quickly. A small village in Nusa Dua Peninsula has formally institutionalized procedures for timely tsunami vertical evacuation in cooperation with neighbouring hotels; however, the concept needs to be developed and scaled up in Bali. The tourism-related establishment survey in Bali indicated fairly good institutional preparedness for tsunamis; however, tsunami risk knowledge and its communication to tourists are lacking.

8. Agency, effectiveness and sustainability

In the first part of this chapter, the central questions are (1) who are the agents of TEWS governance and how do they govern?, (2) what makes them agents?, (3) what is their power base?, (4) by what means do actors become authoritative?, (5) is it delegation of authority based on relational behaviour or an approach based on social interactions?, (6) what are the conditions for emerging agents at different levels? and (7) does the source of authority differ across policy domains?

The second part briefly explores for any signs of impacts of DM spending in terms of improvement of human security. The third part of the chapter explores the performance of InaTEWS to this end, mainly from the media's perspective. The fourth part of the chapter presents the main prevailing unsatisfactory outcome and emphasizes the major incentive mechanisms identified by the actors to effect

change at different levels. The last part of this chapter provides the author's own perspective of a TEWS model for Indonesia based on key theoretical concepts, empirical observations and the findings of this research study.

8.1 Agents and agency in relation to the Tsunami Early Warning System

Before identifying the agents related to TEWS governance, it is necessary to have a better understanding of the concept of agency, of how agents differ from actors, and what constitutes an agency (ESG 2009). Agency is understood in this study as the capacity to act in the face of earth system transformation or to produce effects that ultimately shape natural processes (ESG 2009) or processes between human and physical systems. It considers agency in a multilevel context where actors have stepped in to fill the gap where the national government has not been able to effectively respond on its own. This implies that the study focuses on agents and agency from the non-government individuals or organizations and also applies the concept only in the case of national actors (i.e. excluding international actors).

8.1.1 Agent and agency: Indonesian Society for Disaster Management

The Indonesian Society for Disaster Management (MPBI) was established in March 2003 as a professional network for individuals working in the field of DM. The organizational structure consists of a governing body of seven presidents with a range of backgrounds from hazards specialists to practitioners of law and legislation. It also consists of a secretary general, vice secretary, treasurer and secretary to run the organization on a daily basis. The member assembly is the highest authority. MPBI has a very extensive network of partners at various levels and scales including OXFAM, OCHA, UNDP, AusAID, USAID, etc.

MPBI's mission is to support comprehensive DM to achieve safety and protection from disasters and to create welfare for society in Indonesia. It is committed to the HFA and has focused on areas ranging from the preparation of the DM Bill (enacted on 26April 2007 to the Law No. 24/2007 on Disaster Relief), encouraging development regulations derived from Law No. 24/2007 at both the national and regional levels to carrying out multi-level disaster training.

MPBI and other partners were apparently driven by the incentive that the DM reform process was overshadowed by the emergency responses to national security in the form of regional conflict and acts of terrorism while persistent failures continued in managing disasters. As early as 2005, it was reported that the DM law was ranked priority 55 of 234 pieces of legislation for the parliament (UNDP 2009). MPBI and partners wanted to spearhead and fill the existing gap on the issues of DM legal reform in Indonesia because the local state government had been unable to respond effectively on its own. This was an opportunity to exercise agency beyond the state.

According to UNDP Indonesia (2009); MPBI was already collaborating with UNDP, OCHA and BAKORNAS PB on a DM legal reform in 2003. This effort materialized in 2005 when MPBI formulated an initial strategy for legal reform with partners. It was the road map for the DM reform process. In 2005 the DM law was

included in the list of priority legislative reforms. While UNDP organized meetings with the Legislative Agency within the House of Representatives (Baleg) and provided funding to draft sections of the DM law, MPBI started to assemble the civil society organizations, to organize workshops and build mass public support for the DM law with the support of UNDP and OCHA. As the political commitment gained momentum for DM reform, MPBI worked to strengthen capacity within, and beyond, the government as the parliament drafted Indonesia's Disaster Management Bill with the keen participation and commitment from the government, particularly BAKORNAS. In addition, MPBI helped stakeholders at the local level to gain a deeper understanding of the scope of this proposed new law. New actors joined the cause based on the level of trust among actors. MPBI also earned the trust of new actors, creating a strong well-coordinated network and collaboration which extended to both the executive and legislative branches of the government and within the DM community, partners and within the government of Indonesia. In the end, MPBI led the DM process while other partners such as UNDP gave coordination and technical assistance.

MPBI has certainly influenced and shaped the final outcome of the DM legal reform process. Three very important events took place consecutively. These were (1) the launch of the National Action Plan for Disaster Risk Reduction (NAP DRR), (2) the passage of the Disaster Management Bill by the House of Representatives and (3) the DM platform which emerged from the DM law process. MPBI is also facilitating the process by which local policymakers and stakeholders can draft their own legal reforms and action plan documents to suit the needs of their communities. It has successfully created two key tools that have increased awareness throughout the network of civil society and government institutions, and it has aided local governments in reforming their DM laws to suit their community needs. Other outcomes include workshops in the four highly disaster-prone provinces of West Sumatra, Bali, East Java, and West Nusa Tenggara. MPBI said that "we will continue to support local governments in the formation of local disaster management laws".

It is quite clear that MPBI has emerged as an *agent* in driving and shaping governance and institutional change in DM at multiple levels and scales in Indonesia. It has exercized *agency* and filled the gap which the official state government was unable to effectively attend to due to lack of policy and priorities in national security threats from social conflicts and acts of terrorism. MPBI have clearly gone beyond simply DM reform lobbying and advising national governments in the creation and implementation of rules. They have substantially participated at various levels and scales. They have proposed new legal standards in DM and have developed very extensive partners at all levels and disciplines. Consequently, there is a reconfiguration of authority in the DM sphere. They possess the ability to prescribe behaviour and have obtained the trust and consent of the governed and are capable of influencing the final outcome. MPBI has emerged as an authoritative and legitimate agent through a mix of knowledge base, consent and trust from the state, international and national partners and from the broad-based community. The other underlying conditions which have helped MPBI emerge as an *agent* are the need to exercise flexibility, patience and coordination among a diverse array

of partners. The agency of MPBI is believed to resonate across multiple levels and spatial scales in the area of DM in Indonesia, although presently its authority is rather limited across policy domains.

8.1.2 Agents and agency in preparedness: Tsunami Alert Community Foundation

The idea of the Tsunami Alert Community Foundation (KOKAMI) as an NGO surfaced when a San Francisco-based NGO called the SurfZone Relief Operation (SRO) wanted to set up an educational programme for disaster preparedness. SRO was already providing aid distribution with the support of some locals to the tsunami victims of 26December 2004 to the island of Simeuleu. On 4 July 2005 a formal meeting was held at a cafe, attended by several individuals concerned about the threat of earthquake and tsunamis in West Sumatra. The SRO decided to volunteer to form a NGO named the Tsunami Alert Community Foundaion (KOKAMI). KOKAMI was officially established on 21 September 2005. KOKAMI is led by an executive Director, P. Rina Dewi. Its organizational structure includes an advisory board, supervisory board, an administrative director and a programme director. There are around 12 permanent staff members and 200 facilitators, who are all local volunteers. KOKAMI currently operates in a small building in Padang, with apparently limited infrastructure and resources.

Its official vision is based on a culture of building disaster preparedness. KOKAMI's current working arena is Padang because the city has the largest population of people at risk of a major tsunami. Out of Padang's 750,000 residents, 400,000 live or work along the coast. According to Patra Rina Dewi, the current Executive Director of KOGAMI, although Padang and the rest of West Sumatra were not affected by the Aceh Tsunami, the people of Padang were greatly traumatized from the news of the tsunami calamity. Patra said *"...they were scared because there was no information about when they had to run or what action they should take."* Apparently, the other main reason driving the actors of SRO and KOKAMI to initiate change was linked to the discovery that the city of Padang has one of the highest risks of tsunami threat in the world in March 2005. This came from the National Geographic magazine brought by actors from SRO, San Francisco. KOKAMI realized it was not only necessary to provide assistance to tsunami survivors on Simeulue but also to address evacuation planning for the city of Padang.

Therefore, on 27 July 2005, KOGAMI had a 'serious meeting' with the mayor of Padang as there were no preparedness plans for the community in the coastal area and there was a lack of government and community capacities to respond to the threat. KOGAMI urged the mayor of Padang to pay serious attention to building community preparedness in Padang. In other words, the state could not exercise an agency successfully at the local level in the area of city preparedness for tsunami hazard and risks. This clearly implies that KOKAMI wanted to lead and fill the existing gap on the issues of community preparedness in Padang where the local state government had been unable to effectively respond on its own. This was an opportunity to exercise agency beyond the state. In the end, a mutual civil society-public partnership and cooperation was founded based on the common vision that Padang would be the first city to have an end-to-end TEWS in Indonesia.

Intriguingly, KOKAMI had no knowledge and background of hazard EWSs, hazard preparedness or disasters. At this point, it is clear that the KOKAMI power base was certainly neither knowledge nor hierarchy-based. Despite these limitations, KOKAMI submitted a community preparedness plan to the mayor of Padang which was given green light. The community preparedness plan became more urgent when soon after, on 10 April 2005, Padang was struck by an earthquake measuring 6.8 moment magnitude.

Interestingly, KOKAMI also successfully captured the interest and response of the President of the Republic of Indonesia, Susilo Bambang Yudhoyono, while he was visiting the city of Padang on 13April 2005 following the West Sumatra earthquake and the eruption of mount Talang in Solok district. The President Susilo Bambang Yudhoyono ordered that activities and plans of SRO and the emerging KOKAMI should continue as they were very beneficial for the community.

To implement the plan to make preparedness education a priority, KOKAMI initially adopted a range of community strategies ranging from socialization, door to door canvassing, meeting with community leaders, distribution of leaflets and outreach to schools and mosques. Initially, KOGAMI had been rejected by the community and some elements of the government because they were not ready to hear the word 'tsunami' as it threatened business opportunities in Padang. However, according to KOKAMI, the reception was very good based on the increasing demand for earthquake and tsunami education from schools and public groups.

KOKAMI worked with the people with support from the Mercy Corps. The activities were guided through further cooperation with faculty members of the Andalas University of Padang and members of the Californian NGO and members of different institutions. UNESCO has also supported KOKAMI in different settings. The government and the West Sumatra town of Padang were finally able to officially support KOKAMI activities by allocating budget funds almost three years later in 2008 following the enactment of the DM Law No. 24/2007 and the regulations on disaster funds. The engagement was then marked by a cooperation agreement in the form of an MoU between the Government of Padang and KOKAMI. In a short period of time KOKAMI official strategic partners have expanded to include international bodies such as UNESCO, ISDR, UNDP, Mercy Corps, SRO, GTZ and USAID. Its network with the national NGOs includes MPBI and IDEP, while universities range from Andalas University, the University of Washington and Waseda University. State partners are the Government of West Sumatra Province, the Municipality of Padang, the Marine and Fisheries department and LIPI.

KOKAMI has initiated and implemented a range of activities in cooperation with the local government and partners such as UNESCO since the beginning, and has also contributed significantly in developing policies regarding preparedness in Padang. They have set up a number of programmes, including disaster mitigation and surveys and assessments which focused on identification of eight main sectors at risk in the coastal areas of the city, preliminary identification of hazards, an evacuation plan for the city including mapped evacuation routes and safe areas based on simple observations. Other activities include educational programmes for school students, educational material development and capacity-building. Since

2005, a total of 61 schools have received training starting from first grade on how to deal with natural disasters. In January 2009, a trial programme to integrate disaster preparation into the curriculum began in 12 Padang schools. Education workshops are also held in villages to ensure a system is in place and that everyone has the necessary knowledge of disaster planning and evacuation strategies. Preventive-measure groups have also been established in each mapped risk zone. These groups focus on disaster and emergency preparation for at least three days in the red zones as it is expected that national assistance will arrive only after 24 hours and local resources will have to be able to shelter casualties for that amount of time. As early as 11 June 2005, Padang exercised the first tsunami evacuation simulation in Indonesia. An estimated number of 3,000 people were involved in the simulation.

Furthermore, KOKAMI facilitated responsible agencies for disaster response to design a standard operating procedure for DM. KOGAMI is also closely collaborating with the mayor to establish a decree and cooperating with BNPB to make this legalized SOP a model for other cities in Indonesia.

Another challenge KOKAMI had to constantly overcome was the prevailing religious beliefs and the local mind-set that locals have:

> *"Some locals argue that if Allah thinks we're meant to die, we shall die...We need to break down this perception because we need to do our best first, and then leave it to God"* (Interview 9, 3 March 2009).

KOKAMI also faced potential conflicts with some partners on the issue of technical TEWS versus community preparedness. KOKAMI initially argued that "*the only usefulness they assign to the system (i.e. TEW) is in supplying proper information regarding when families can return to their houses in coastal areas once a tsunami has passed*" (Villagrán 2006b). This critical view on the limited use of the TEWS has also been commented on at the highest levels of the Parliament of Indonesia. It is believed that such a TEWS will only benefit the countries of the Indian Ocean and not Indonesia because of the challenge of locally generated tsunamis (Villagran 2006b). Therefore, Villagrán recommended that IOC-UNESCO and the institutions involved should design an awareness campaign to counteract such a belief.

However, when KOKAMI was questioned again during an interview with the author in Padang on the issue, the response actually revealed that KOKAMI was very knowledgeable despite being uninformed on the different sources and mechanisms of tsunami generation such as the difference between near and far field tsunamis, slow earthquakes and landslide-generated tsunamis. Nevertheless, KOKAMI actually clarified and stated:

> *"We want to educate the community first until the TEWS is fully effective ... only then can one depend on the technical TEWS, but not the reverse as is the case now"* (Interview 9, 3 March 2009).

In other words: KOKAMI believes that the TEWS starts with the fundamental issue of people. Gradually, the efforts of KOGAMI have been recognized by different institutions such as SATLAK, SATKORLAK now BNPB, LIPI, GTZ-IS and the govern-

ment as a committed partner in local disaster preparedness activities in Padang. However, such recognition had to be earned. KOKAMI said

> *"Initially the government did not recognize and support us; however the government has found advantages in supporting NGOs such as KOKAMI"*
>
> (Interview 9, 3 March 2009).

Furthermore, on 6 May 2008, the City Hall of San Francisco in the United States recognized the Founder and Director of KOGAMI, Patra Rina Dewi, for organizing the volunteer response in assisting victims of the 2004 Indian Ocean Tsunami, for her innovative solutions and continued dedication to preparing West Sumatra and other earthquake and Tsunami-endangered regions, for her international leadership in community preparedness and disaster mitigation and for her ongoing relationship with San Francisco and Californian agencies.

Finally, all indications show that KOKAMI has emerged as an *agent* in community disaster preparedness in Indonesia. They have also gone beyond lobbying and advising national governments in the creation and implementation of rules. They have substantially participated in and /or proposed new approaches and rules. They have negotiated their own standards and have developed quite extensive partners in a short period of time. As a result there is a reconfiguration of authority, particularly at the local level. They possess the ability to prescribe behaviour, obtain consent of the governed, and are capable of influencing and shaping outcomes. KOKAMI has emerged as an authoritative and legitimate agent through consent from the local government, community and partners, both formally or informally. The agency of KOKAMI is believed to resonate strongest at the sub-national levels in Padang and other provinces in the area of community preparedness for disaster, but presently their authority is decaying rapidly across policy domains.

8.2 Measuring the effectiveness of the Tsunami Early Warning System in Indonesia

A geologist and Chairman of the Exploration Think Tank Indonesia (ETTI) stated, *"the effectiveness of the high-tech installations has yet to be tested though … a billion rupiah have been spent over there just to show the people and the world we are doing something. But in terms of scientific things it is ridiculous … without building inherent awareness in the social community, all that technology is just garbage, just nothing…Perhaps it should have been spent on other things that are very important: campaigning, going into the grassroots, building social awareness rather than introducing high tech that many scientists are skeptical about"* (Asia Calling 13/06/2007).

The challenging and daunting question is therefore how to test or measure the effectiveness of the TEWS, which is in dynamic evolution, as exemplified by the InaTEWS. This will help in managing and improving the system. It is pointed out that earlier chapters have also identified weak points, gaps and constraints in the process of implementing the new TEWS. However, the system's effectiveness is most often valued in terms of the final outcome during actual events, as indicated in the IAD framework.

In order to evaluate the effectiveness of the TEWS, analysis is carried out across all the TEWS elements during an event, paying close attention to the existing notions and descriptions of EWS effectiveness discussed in chapter 2. The rationale of how the events are selected is based on (1) the characteristics of the earthquake and risk to the respective communities, (2) how the actors and the community at risk reacted and responded to the risk and (3) the level of impact in terms of lives lost and damage reported. As the system is evolving, it is necessary to measure the effectiveness as a function of time after the December 2004 tsunami calamity. The information is primarily based on the media perspective, key informant interviews and observations. These materials were compared, verified by mean of triangulation, and collated into a larger narrative on TEWS effectiveness or performance. The following provides an analysis of the selected tsunami hazard risk and disasters classified into earlier and recent earthquake-tsunami shocks after the 26 December 2004 tsunami. The earlier shocks are those occurring between the period of 2005-2007 and the recent shocks are those occurring after the year 2007 (see Table 4).

8.2.1 Earlier earthquake-tsunami shocks

8.2.1.1 The 28 March 2005 earthquake: Sumatra

A few months after the December 2004 earthquake, while Indonesia was still in disaster shock, a second deadly tsunami disaster struck on 28 March 2005, killing at least 1,000 people following an earthquake with a moment magnitude of 8.7 which hit the coast of Sumatra. In this second experience, the Indonesian authorities took more than 30 minutes to manually process and locate the earthquake off Sumatra. In this second experience, Indonesia clearly had not made any progress in the TEWS.

8.2.1.2 The 17 July 2006 earthquake: South coast of Java

Some 17 months later, on 17 July 2006, a major earthquake of moment magnitude 7.7 occurred on the south coast of Java generating a three-metres-high tsunami with a run-up of 182 m along a 177 km stretch that caused extensive damage, destroying houses, restaurants, cars and hotels on the south coast, taking the lives of at least 668 people and leaving at least 65 missing including three foreigners (WHO 2006).

This time, the development of the TEWS started to come into question. Analysis of the operations shows that a tsunami bulletin was actually issued by the PTWC in Hawaii 12 minutes after the earthquake alerting Indonesia (Java) and Australia (Christmas Island) to a possible local tsunami affecting coasts within a 100 km radius from the quake epicentre. The alert was sent 24 minutes before the estimated tsunami impact time. The State Minister for RISTEK confirmed that Indonesian officials had received bulletins from both the PWTC in Hawaii and JMA 20 minutes before the first tsunami wave struck (Guardian 18/07/2006). Two and a half hours later, a second bulletin from the PTWC confirmed the occurrence of a local tsunami.

In terms of local observation and forecast, BMKG still could not quickly and accurately estimate the size of the earthquake. RISTEK acknowledged there were

no operational devices to detect tsunamis since they had been damaged and decommissioned and one was awaiting repair (MSNBC 18/07/2006). The surprising and most concerning issue within the process of dissemination and communication of the tsunami risk is underlined by the statement made by the state minister for RISTEK who said "*the government did not publicise the bulletins because they did not want to cause unnecessary alarm*" (CNN 19/07/2006). The other interesting fact is that the minister also commented on the likely consequences if it was actually a false tsunami warning.

The event revealed elements of inter-intuitional process in communication and dissemination among actors since the minister also said "*warnings were issued seven minutes before the incident via 400 text messages to the government representatives, district heads and mayors*" (Jakarta Post 20/07/2006). On the other hand, this account is clear evidence that the tsunami information ended up circulating among actors but never actually reached the coastal community at risk.

Furthermore, at the local level the dissemination and communication system also faced a major problem. BMKG said that "*telecommunication lines to the affected areas were cut by the quake, causing the few available lines from Jakarta to be jammed by worried relatives, and therefore no available phone line was free for BMKG to warn the authorities in charge*" (BBC 19/06/2006). It was also revealed that the- southern Java area had no system to warn the people of the coming waves.

In this case, it is clear that the system lacked the observational and forecasting capacity, rapid backup systems, clear protocols and mechanism for tsunami warning, or a formal institutional arrangement to ensure warnings were actually communicated to reach the people at risk rather than circulating among government bureaucrats. Proper dedicated dissemination and communication systems should be used rather than depending on the public system. Overall, the TEWS largely failed to alert the communities at risk.

However, the emerging and interesting issue is that the Indonesian authorities such as RISTEK or BMKG faced increasing tensions of accountability, despite the lack of DM laws and legislation during that time, from not only the free press media, but also from the political legislative system and the community. For instance, the parliament called the minister for explanations. In his defence, the minister explained that "*he was misquoted…his ministry is not the appointed authorized agency to issue warnings to the public. This duty is entrusted to the Meteorological and Geophysics Office" (Ministry of Tourism and Culture 2006).*

On the other hand, some villagers in the community complained that "*there was little or no warning ahead of the tsunami*" while a Java resident, whose village of Batukaras was one of those affected, said *"…why did a warning not reach Java's affected communities in time*? (BBC 19/06/2006). The undesired, negative outcome and emerging accountability pressed the government and all actors to intensify their efforts to deliver the so-called TEWS which had been promised earlier.

8.2.1.3 The 12 September 2007 earthquake: Bengulu

8.2.1.3.1 Rapid earthquake monitoring, dissemination and communication

It is noted that GITEWS was well in progress and this time the monitoring, warning and dissemination of the 12 September 2007 event set a record with alarms being triggered less than two minutes after the earthquake and a warning was sent approximately two minutes later. It was the first estimate of where and how powerful the earthquake was from the established system in BMKG. The message was also received by the public from diverse media outlets such as radio, TV, SMS and in some areas by RANET (UNESCAP 2009). Indonesia was able to issue a national warning to local authorities within 10 minutes of the earthquake, comparable to the speed of issuing tsunami warnings in the USA and Japan. In this event, the InaTEWS system was effective in terms of earthquake detection, estimation, dissemination and communication of earthquake-tsunami information to the interface institutions through the various systems downstream to the community at risk. However, the outcome of the event also revealed important gaps and weaknesses as discussed below.

8.2.1.3.2 Over-reactions, false tsunami warnings and non-functioning sirens

Authorities in the Indian Ocean issued a series of tsunami alerts after a powerful quake hit Indonesia's Sumatra Island. However, in reality, only a few localized and non-fatal tsunamis were generated (Reuters 14/09/2007). This implies the tsunami warning forecast was timely but not accurate. Reuters questioned if authorities had over-reacted. However, seismologist Mike Turnbull of Australia's Central Queensland University argued that "*It would have been irresponsible not to issue the warnings.*" An official at RISTEK said "*a warning, even if it was false, was better than none, but…at the moment the system is not fully reliable, and that is why there are many false warnings*". Nevertheless, an effective warning system is judged not only in terms of being timely in detecting earthquakes, but more in terms of its ability to indicate, for example, if a tsunami has been generated such that informed decisions and action can be taken. False warnings rapidly degrade people's trust in the EWSs.

On the other hand, the village chief of Padang Bakung in Bengulu province reported that "*We have a siren, but it doesn't work because of power failures after the quake*"(Reuters 14/09/2007). This account by the chief of the village highlights again the flaws in the dissemination and communication system without proper back-up systems.

8.2.1.3.3 Reaction and response behaviours

The reaction and response behaviours of the event have raised questions even in Padang city. Some actors during the interview highlighted that people do not interpret well the tsunami warning from BMKG which consists of only technical words such as earthquake intensity, location, depth and the word 'potentsi' tsunami.

In addition, a UNU-EHS survey (2008) reported that only 22 per cent of the respondents in Padang city during the Bengulu earthquake actually evacuated on

ground shaking while the rest stayed on the alert despite receiving rapid tsunami warning information, but no guidance of what to do was issued by BMKG (GTZ-IS 2007). They did not perceive the messages as a call to take action and evacuate. GTZ-IS (2007) rightly suggested that a warning without clear guidance does not trigger consistent reaction because it leads to a high level of uncertainty for people who must decide whether to evacuate or not.

8.2.1.3.4 Warning process: not a simple stimulus response

GTZ-IS apparently views the reaction behaviour from a simple stimulus-response model (Mileti and Beck 1975). However, in reality, warning involves far more than just a linear transmission of the message. In a review of the warning process and evacuation behaviour, it was found that warning behaviour involves selective perception, collective multiple perceptions and social interactions including other independent observations to socially confirm the warning message before accepting or rejecting a warning which may evoke an appropriate response (Quarantelli 1990). Hence, reaction behaviour is not simple stimulus-response behaviour. Believability depends on the confirmation process (i.e. there was no confirmation from BMKG), the proximity of the threat (i.e. not indicated in the warning) and the perception of danger as real (i.e. *'potentsi'* tsunami probably does not indicate if danger is real).

On the other hand, the village chief in Bengulu reported that "*villagers fled after seeing the water pull back*" while one businessman from the Padang coast interviewed said

> *''Whenever there are rumours of tsunami, I close up my shop and run. But it's just rumours, causing trouble, causing traffic. Next time I'm going to wait and see if the water goes out before I run."* (Interview 22, 2 March 2009).

This adds more evidence that people most often carry out personal observation of the precursor environment, to confirm that the threat behind that warning process is not based on a simple stimulus-response.

8.2.1.3.5 The mosque as safe haven

As indicated earlier, Padang is perceived as a model for an end-to-end TEWS in Indonesia. However, the low community response provokes further questions. An in-depth interview with the local NGO KOKAMI in Padang revealed an interesting issue that should not be ignored when rooting an EWS in society. KOKAMI said:

> *"The poor responses of the community at risk were probably due to the coincidence of the earthquake and the tsunami warning with the first day of Ramadan … Most of the local people remained in the mosques as they were praying"*
> *(Interview 9, 3 March 2009).*

This account and observation probably suggests that people perceive that in mosque they are safe and there is no need to evacuate as indicated in a national presentation by Diposaptono in 2008 where he highlighted "*Nothing remains except for mosque … a safe haven*". The author also gave explanations of the flow dynamics around the concrete pillars which do not have a blocking effect which

could weaken and collapse the building. However, not all mosques are built on concrete pillars and have satisfied tsunami engineering building codes. Therefore, the message that a mosque is a safe haven should be treated with caution.

8.2.1.3.6 Ambiguity in warning and understanding of the tsunami warning scheme

The fact that people did not view the BMKG warning as information about an imminent threat requiring immediate reaction provokes further questions. Firstly, it is likely that the word 'potentsi' tsunami although scientifically correct (GTZ-IS 2008) may actually be ambiguous to the ordinary citizen.

On the other hand, the fact that 21 per cent of the people interviewed (UNU-EHS 2008) stayed on the alert suggests there is a lack of knowledge of the tsunami hazard threat in terms of its speed of impact. Furthermore, there is a likely possibility that the people did not understand the tsunami warning scheme, or perhaps the authorities educated the public about the warning levels to be used, but in reality, during that event the authorities did not follow the warning procedures as the confirmation step was not carried out.

8.2.2 Recent earthquake-tsunami shocks

8.2.2.1 January and February 2009 earthquakes: North coast of West Papua and Sulawesi Island

Another major earthquake of 7.6 moment magnitude struck near the north coast of West Papua, Indonesia, killing at least two people and injuring 35, and damaging dozens of houses, with four buildings collapsing. A tsunami warning was initially issued but lifted within an hour of the quake (BMKG; CNN 04/01/2009). Fairly similar procedures were carried out in the case of the February Sulawesi earthquake. In both cases, the process of issuing the warning and cancellation within an hour suggest improving operational capabilities at national level despite more initial false tsunami alerts. The main problem identified is the inability to confirm if a tsunami has been generated or not.

8.2.2.2 The 11 August 2009 earthquake: Andaman islands

On 11 August 2009, a large earthquake of moment magnitude 7.6 occurred in the Andaman Islands prompting PTWC to issue a tsunami alert for coastal regions of Indonesia, Burma, Thailand, India and Bangladesh. The PTWC cancelled the alert two hours after the massive earthquake (IOC 11/08/2009). On the other hand, BMKG was completely silent on the earthquake event[63]. There were no real-time observations and reporting of the earthquake event at BMKG, even though Indonesia was among the countries on the alert list from PTWC. It is unknown if institutions were internally informed, but there was no news on the event locally, except breaking news reported in the international media such as CNN and the BBC. Local experts related to the system at BMKG were immediately contacted to explain the silence of BMKG. The local expert explained:

> *"The earthquake occurrence is outside the jurisdiction of Indonesia … The InaTEWS system can only give a tsunami warning if the epicentre is in the Indonesian region even though the system could 'detect' the earthquake source … there are plans to enlarge the seismic observation system beyond the Indonesian region"*
> (Interview 23, 11 August 2009).

This suggests very clearly that BMKG currently has limited capabilities for monitoring earthquakes just outside its territory despite being in operation since November 2008. BMKG needs to establish clear procedures to deal with the present observational gaps. The immediate solution is to make use of the JMA and PTWC tsunami information while expanding the observational capacity beyond its territorial boundaries. The other serious concern identified is that the authorities continue to have a dilemma regarding communicating risk information to the community.

8.2.2.3 The 2 September 2009 earthquake: Java, Bali and Sumatra

At least 39 people in five cities and regencies in West Java died while 57 residents of two villages in southern Cianjur Regency houses were buried under landslides from the cliffs following the big earthquake. In addition, 1200 houses experienced minor damage while 976 houses collapsed following an earthquake of moment magnitude 7.3 on 2 September 2009 some 142 kilometres southwest of Tasikmalaya District, West Java (KOMPAS 03/09/2009).

The key weakness identified was that the three tsunami-detection buoys[lxiv] failed, and the Regional DM Agency in Cilacap had no idea why. The Head of the Sub Division for Disaster Mitigation in Cilacap admitted that "*there is no expert who can operate them; hence we do not know why the equipment was not functioning …*" In addition, it was reported that even the two radio transmission units that serve to inform of the tsunami threat in the BPBD Office in Cilacap had no-one to operate and had been tested only a couple of times (Regional KOMPAS 03/09/2009). The challenging reality is that training to operate the tsunami detection equipment was not addressed despite requests from the donors (i.e. GITEWS) due to other priorities (Regional KOMPAS 03/09/2009). The tsunami sirens in Cilacap also did not function because residents reported that the equipment had been stolen, while the earthquake shocks cut off the electricity (KOMPAS 03.09.2009). In another area, 400 km northwest of Cilacap, at Pelabuhan ratu, Sukabumi, a siren alarm went on for about 10 seconds but then stopped (Antara 2009). KOMPAS, the local newspaper, concluded that "*the local people should read the water; should it recede, they should go to higher ground, leave the sophisticated and expensive technology unused*". This report of KOMPAS requests people to observe the sea level change. This is a not an appropriate recommendation from KOMPAS. This highlights the need to engage effectively with the media. On the other hand, such frustration exemplifies the discontent and unsatisfactory outcome of the effectiveness of the expensive technological TEWS. This outcome clearly points to the issue of the challenge of local communities uptaking of new imported technology and the lack of effective local governance at the local level.

8.2.2.4 The 30 September earthquake: Padang

On 30 September 2009 a large earthquake killed 1,100 people and caused many buildings to collapse, with widespread damage. The quake was estimated at a moment magnitude of 6.8 at 14 minutes after the event by the PTWC and JMA (IOC 2009). On the other hand, BMKG estimated the earthquake moment magnitude at 7.6 some 4 minutes after the event (BMKG 2009). Later it was revised to 7.9 Mw. All the tsunami warning centres were accurate in terms of not issuing a tsunami alert; however, the question is what could have been the consequences of the earlier underestimation of the earthquake?

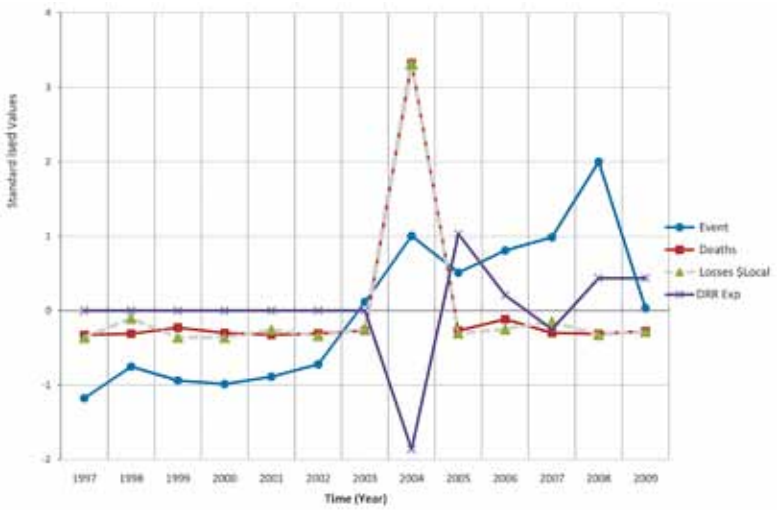
According to the GTZ-IS local advisor in Padang, after the earthquake, power was cut and cellular networks including GSM were also down. This implies that mobile text messages could not be communicated to the public during the first hour. Fortunately, there was back-up power at the EOC. The landline telephone system was still operating and able to provide an internet connection to receive earthquake information from BMKG. The information from BMKG had reached Padang authorities about five minutes after the earthquake but was only available to the public about 20 to 25 minutes later, when the mayor received information and announced it (GTZ-IS 2009). The EOC used FM, very high frequency (VHF) radio networks to tell communities and agencies that there was no tsunami threat and inform the people to stop evacuating. Other communication equipment such as sirens was not used as there was no tsunami threat.

Interestingly, it was also found that there was no communication between the mayor and the EOC, and they acted independently. The mayor could not receive information from BMKG via text message. This implies there was no effective coordination between the institutional actors, and the tsunami information was too late. Despite the announcement by the EOC and the mayor that there was no tsunami threat, people continued to evacuate. It is not clear why they did so; however, the tsunami risk communication from the mayor to the community was surely not timely. Confirmation of tsunami or no tsunami should ideally happen 10-30 minutes after the earthquake. However, there are unclear local reports that indicate that the earthquake damage also triggered one siren to go on accidentally for some time and it is unclear if people continued to evacuate because of that. This suggests that in a crisis situation, the formal institutional warning chain process from national level to the local level in Padang did not materialize. Nevertheless, people in Padang started self-evacuation after the strong tremors, which led to a major traffic jam. This event highlights again the local reactions and response of the community irrespective of the national TEWS. There were coordinated arrangements to dispatch disaster teams to Padang, although it took several hours to reach the remote areas. The earthquake badly damaged the EOC. There was a chance that the whole building could have collapsed and this would imply that even the first line of defence would have failed. It is not clear whether the newly built EOC was designed according to strict building codes for a high seismic area. Table 7 highlights the positive (+), negative (-) and important outcomes across all the TEWS elements.

8.3 Cost benefit of investing in disaster management in Indonesia

To date, there has been a lack of cost benefit analysis to show the impacts of investing in DRR including the TEWS. Surely, this question merits detailed research on its own. However, it is important to explore the impacts of DRR financing. In order to gain some insight into this rather intriguing question only the contingency budget expenses are analysed. To facilitate plotting of all the relevant parameters (i.e. disaster events, deaths, losses and the DRR expenditure) the data are standardized to allow plotting on the same scale as shown in figure 49. It is found that in 2004, the contingency budget was at its lowest. Interestingly, it is observed that after 2004[lxv] even though the number of reported disaster events increased[lxvi], the total number of deaths and losses did not increase. This signals that the DRR financing which increased after 2005 is probably already having a positive impact in reducing the severity of more disaster events in Indonesia.

Figure 49: Impact of investing in disaster risk reduction in Indonesia



Source: Author.

Table 4: Measuring the effectiveness of InaTEWS events in Indonesia

Earthquake magnitude location and time	Monitoring and Forecasting	Dissemination and Communication	Response	False / Accurate	Timely	Fatalities	Level of Damage
8.7 Mw – Sumatra 28-03-2005	⊖ Slow					1000	–
7.7 Mw – South Coast of Java 17-07-2006	⊖ No back up ocean instrument in place	⊖ Perceptions of unnecessary public alarms ⊖ Failure in institutional warning chain ⊖ Communication and dissemination break down				668	Extensive
8.0 Mw – Bengulu 12-09-2007	⊕ Rapid observation and forecasting	⊕ Timely communication between institutions ⊖ Sirens not functioning	⊖ Low response, people stayed on alert ⊕ Lack of understanding of warning scheme and warning	⊖ False alert		–	–
7.6 Mw – Sulawesi Island 11-02-2009	⊕ Rapid observation and forecasting	⊕ Timely communication between institutions		⊖ False alert	⊕ Alert cancelled	(2)	Buildings damaged
7.6 Mw – Andermann Island 11-07-2009	⊖ No real time reporting ⊖ Limitations in seismic observation area			⊖ False alert from PTWC/JMA		–	–
7.3 Mw – Java, Bali, Sumatra 02-09-2009	⊖ Ocean sensors not functioning ⊖ No expert ⊖ Equipment not functioning and stolen	⊖ Sirens not functioning				(39)	1200 homes damaged and 976 collapsed
7.3 Mw – West Java 02-09-2009	⊕ Rapid observation and forecasting	⊖ Lack of a dedicated mobile phone system and malfunctioning internet connection ⊕ Timely communication ⊕ Advisory guidance issued by speakers and mosques (No siren was used) ⊕ All clear communicated one hour later via public media ⊖ Other districts at risk did not react	⊖ Many did not evacuate and asked for information from institutions ⊖ Many did not hear warnings due to noise distortion from the speakers		⊕ Advisory cancelled		–
7.9 Mw – Padang 30-09 2009	⊕ Rapid observation and forecasting ⊖ Initially BNKG under measuring the earthquake at 7.6 Mw	⊖ Risk communication was untimely ⊕ Telephone and internet connection working to receive information from BMKG ⊖ Power, cellular networks, and GSM failure ⊖ Failure in text messaging initially ⊕ Back up power at EOC ⊕ VHF radio networks and FM radio functions	⊕ People started self-evacuation after the strong tremors ⊖ Traffic jam ⊖ People not listening to EOC and mayor (people continued to evacuate) ⊕ Regional coordination arrangements	⊕ Accurate alert	⊖ Tsunami guidelines rather late	(1100)	Wide-spread damage and collapsed buildings
7.7 Mw – Aceh – Sinabang area 07-04-2010	⊕ Rapid observation and forecasting	⊕ Sirens went on in many areas including on the island of Simeulue	⊕ Local residents immediately fled to high ground	⊕ Accurate alert		several people affected	

Source: Author. NB: Numbers in the brackets represent earthquake victims, Mw: Moment magnitude.

8.4 Actors' perspective of the main problems and the incentive change

It is highlighted that the interviewees had a chance to identify, list and discuss the main problems and what they thought would be the best way to achieve a good outcome through new incentives which could target and impact at all levels to ensure the effectiveness and sustainability of InaTEWS. The main problems identified and incentives proposed are further discussed below.

8.4.1 Multi-hazard approach framework

The rationale for developing a multi-hazard-risk approach is grounded on three issues including the relatively high mortality risk from multiple hazards (since Indonesia ranks 12th among countries in terms of mortality risks from multiple hazards), infrequency of tsunamis and the high cost of maintaining such an expensive system. The actors' perception of the multi-hazard approach is explored. It is also found that there are key challenges and opportunities when considering a multi-hazard approach.

8.4.1.1 Challenges in implementing a multi-hazard approach

On the one hand, all the actors interviewed indicated that the multi-hazard-risk approach is not yet being addressed in Indonesia. BNPB acknowledges that the application is still not fully implemented across policy and practice, but the concept has been partially acknowledged in the formulating strategy and use in the National Action Plan for DRR 2010-2014.

A key problem in implementing a multi-hazard approach is institutional and organizational challenges. The hazard EWS in Indonesia is fragmented and dispersed and more time is needed to develop an integrated framework for the separate hazard EWSs. For example, flood warnings are carried out by public works while the volcano EWS is under the responsibility of the Centre for Volcanology and Geologic Hazard Mitigation and the Ministry of Energy and Mineral Resources (PVMBG), while BMKG is the legitimate institution providing various services from weather or climate to tsunami information. The other problem identified is that within the same organization, services are produced under different departments and there are challenges to bringing together the different products and services. The BMKG director for earthquakes said:

> *"The Weather Centre tried to upload their system on the DSS for the weather-related information, but we had problems"* (Interview 24, 19 January 2009).

The third issue is the geographical occurrence of hazards and disasters. BMKG pointed out:

> *"The immediate problem with the multi-hazard approach is that each respective hazard is spatially specific in occurrence and the problem is how to organize such a national effort for a large country consisting of diverse organizations located in different areas of the country to deal with such spatial challenges"*
> (Interview 24, 19 January 2009).

The fourth challenge is the lack of leadership and adequate resources to implement a multi-hazard framework approach in Indonesia. For instance BNPB argues:

> *"RISTEK, the present coordinator of the TEWS, is inexperienced in the technical process for implementing a multi-hazard approach; however, once the newly created BNPB settles in the local areas it will be in a better position to influence DM towards the multi-hazard approach. In addition, the real problem is to have adequate resources and budget … if there is an adequate budget then we can think more widely about all hazards"* (Interview 1, 16 January 2009).

BNPB is already facing tough challenges and is struggling to cope with existing challenges of integrating the TEWS within BNPB as part of the fundamental process towards a multi-hazard approach and in implementing structures at all levels nationwide. According to a very recent informant interview with BGR, the challenge is for BNPB to build up a qualified and competent work force from the current 111 to 400 staff.

8.4.1.2 Opportunities in implementing a multi-hazard approach

On the other hand, despite the challenges, actors have ranked the issue of the multi-hazard approach as a high priority in Indonesia. Actors point out that InaTEWS development has served for the first time as a collective effort and inspiration in Indonesia. RISTEK highlighted:

> *"The development of the TEWS is a good model because it is attributed to emotional involvement of the people following the December 2004 disaster. It demonstrated for the first time that cooperation among actors is the only way to cope with such extreme challenges; other disasters do not have this model. TEWS success should be inspiring in the development of a multi-hazard framework*
> (Interview 7, 15 January 2009).

This argument strongly suggests that the unique experience of the different actors in terms of their collective participation, cooperation, mediation and negotiation are the key elements offering wide opportunities to implement a multi-hazard approach in Indonesia.

8.4.2 Strengthening and seeking new innovative partnership and cooperation

The actors identified partnership as a key prevailing problem and then pointed out that IOC-UNESCO should offer a policy for maintenance. It is highlighted that BGR (2009) also concludes that TEWS sustainability is through the maintenance of the existing partners for the TEWS in Indonesia.

However, what is even more important is to seek for new innovative and creative partnerships to go beyond what has already been achieved. For instance, after years of failures in developing weather networks over Africa, the World Meteorological Organization (WMO) developed an innovative initiative and partnership with Ericson and the Earth Institute at Columbia University to bridge the ground-level weather observation gap by installing automatic weather observations stations throughout Africa (Global Humanitarian Forum 2009). Such a partnership

would, for example, be particularly encouraged in the manufacturing of the automatic radio alert system for mass notifications. RISTEK said:

> *"Indonesia rejected the proposal from Germany for importing these automatic radio alert systems … our engineers can manufacture them"*
>
> (Interview 7, 15 January 2009).

However to this end it appears nothing has been achieved. Therefore, innovative and creative partnerships would serve as a new incentive to help create an effective and sustainable TEWS.

Fresh endeavours to help fine-tune prevailing weaknesses and sustain the TEWS and DRR initiatives include new bilateral cooperation on challenging issues such as the new cooperation between Indonesia and Australia which extends to 2013 for setting up facilities for DRR in Jakarta, and to strengthen disaster response capacity in Indonesia. Bill Farmer from AusAID, Australia said *"This aid is not just aid but also partnership"* (Indonesian Platform for Disaster Risk Reduction 09/03/2009). Bilateral cooperation would help to scale–up financing initiatives to create adequate incentives and momentum to help address the core issues of the EWS and DRR.

8.4.2.1 Strengthening multilateral partnerships, cooperation and coordination: Regional governance and coordination

One of the most important incentive mechanisms for InaTEWS sustainability is linking InaTEWS with the IOTEWS as indicated in Figure 54. At the regional level, ICG/IOTWS also expects countries to build on the current progress and expects one or more regional tsunami watch providers to play a similar function to PTWC. The PTWC in Hawaii and the JMA in Tokyo currently provide tsunami alerts to the region, but by 2011 at the latest the regional tsunami watch providers, which provisionally include Australia, India, Indonesia, Malaysia and a regional centre in Bangkok, are set to take over this function. This means that the Indian Ocean region will no longer rely solely on official tsunami notifications from PTWC or JMA.

According to the Grand Scenario, the Indonesian TEWS in the future will strengthen to function as a regional tsunami warning system or tsunami watch provider for the Indian Ocean. Therefore, Indonesia needs to continue to pursue strongly its goal of becoming a tsunami information provider[lxvii] for the region under the regional coordination and governance framework of IOC-UNESCO to help sustain its own TEWS, for example in terms of funding, expertise, quality, security and evaluation as pointed out at a recent conference in Potsdam, Germany (BMKG 2009).

8.4.3 Capacity-building for a knowledge base and innovative society

It is vital to address capacity-building challenges in order to guarantee the sustainability of the TEWS in the future. Capacity-building should become a priority in future rather than being marginalized, and there is a need to change donors' and capacity builders' approaches on practicing capacity-building (Briinkerhoff and Morgan 2010).

Of greater concern is to urgently address the issues of likely discontinuity in capacity-building that threatens the InaTEWS sustainability due to lack of legitimate leadership beyond the GITEWS project. Actors should recommend a new temporary institutional arrangement or an extension of the existing one so that interested organizations such as RISTEK can have the mandate and resources to continue until the mandated[lxviii] organization BNPB is able to handle their own responsibilities. With adequate emphasis on capacity-building, universities can increase the scope for higher level academic education while broadening DRR education through the school curriculum. Equipped with such knowledge, society would be challenged to become more innovative, and thus better able to adapt to imported technologies and new challenges.

8.4.4 Sharing and exchange of local experiences

The local traditional knowledge of the story of "Smong" in the Simelue islands taught us two main lessons. On the one hand, it demonstrated the paternalistically shared knowledge of tsunami amongst the locals through generations, exclusively in the Simelue islands, and on the other hand it showed the fundamental weakness that such knowledge was hardly replicated in neighbouring districts. Therefore, the lesson learned was that a new strategy of sharing and exchange of local experiences should be encouraged and facilitated between provinces and regions to ensure knowledge is replicated and inclusive for all risk communities in Indonesia. Sharing and exchanging of information, tools, methodologies, base line studies, experience, lessons learned and best practices to new areas from the three pilot project areas of Bali, Padang and Java is of crucial importance within the process of building national resilience to uncertain tsunami risks. Actors reported that there is some interest in sharing and exchanging experience between provinces. For example, Cilacap province approached the project implementers and pilot areas to discuss how to develop their own TEWS programme. However, currently the effort for sharing and exchanging experience lacks national momentum.

8.4.5 Gender perspectives

There is little acknowledgement of the issue of gender perspective in the TEWS and DM policy or practice. In general they have received little attention because of poor understanding of gender vulnerabilities and risks to disasters (UN/ISDR 2007a). In Indonesia, BNPB reports that there has been little effort in engaging with relevant sectors such as the Ministry for Women's Empowerment. Therefore, it is vital that gender is also addressed effectively, and this can be achieved by formulating clear policies to mainstream gender perspectives on the issues to create new incentives.

Links can be established with international bodies and social networks can be built to encourage cooperation. Building resilience to tsunamis provides good opportunities for women to play public roles with the support of their families and communities. It is an opportunity to increase participation by having men and women working on the same issues such as awareness-raising and capacity-building. Women's participation can be important in building safe communities and

households and equal access to information (UN/ISDR 2007a). In a nutshell, women can contribute and provide new incentives for tsunami community resilience.

8.4.6 Disaster risk reduction and climate change adaptation

According to the United Nations Framework Convention on Climate Change (UNFCCC)[lxix], adaptation to climate change is vital in order to reduce the impacts of climate change that are happening now, and to increase resilience to future impacts. The Bali Action Plan identifies adaptation as one of the five key building blocks required for a strengthened future response to climate change. Developing countries require international assistance to support adaptation and this includes funding, technology transfer and capacity-building.

8.4.6.1 Tsunami resilience and climate change adaptation: Potential threat or opportunity?

The SWOT[lxx] analysis revealed some actors' perception that climate change mitigation and adaptation activities are potential threats to the sustainability of the TEWS. The explanation is that there is an increasing shift in interest to climate change mitigation and adaptation. Actors reported that donors and actors are already shifting their interest from tsunamis to climate change. In 2009, BMG changed its name to BMKG to become the legitimate focal point institution dealing with climate change in Indonesia. Deeper questioning revealed that the actors' shift in interest is driven by the better financial mechanism, economic incentives and opportunities in climate change mitigation and adaptation compared to tsunami resilience building. Initially, this appeared to be turning into a dilemma in terms of sustaining tsunami resilience. It is also often argued that there are no links between tsunami and CCA.

It is pointed out that tsunami hazards and disasters and climate change are part of the greater discourse on hazard origin, causes and need for a hazard classification scheme and the implications of management of these areas. Pearce (2000) argues that it is important to classify the causes of hazards because a lack of communication between various scientists leads to potential duplication in research if gaps are unaddressed. The second most important reason is that the type of hazard affects the choice of mitigation strategy (Godschalk et al. 1998) and failure to accurately classify types of hazards may lead to the misapplication of mitigation strategies.

On the other hand, a number of researchers (Kreps 1991; Quarantelli 1991) have earlier questioned the need to separate the causes of hazards from one another. Jovanovic (1988) believes that human-induced and natural hazards are interrelated because humans can influence natural events and conversely, natural events can change and modify human activities. However, the argument is that CCA is differentiated from DRR since the former involves preparing for and adapting to the known and unknown effects and impacts of climate change while DRR involves strengthening efforts to reducing existing vulnerability and risk with the objective of promoting resilience, safeguarding human security and sustainable development. In other words, there are many overlaps between DRR and CCA in terms of reducing the community's vulnerabilities. A challenging question is,

what if CCA fails? DRR is a highly promising tool to maintain this balance and to promote more resilience and adaptive capacities, particularly regarding extreme events linked to climate change. The main concern pointed out is that the humanitarian community is the first one to be confronted with the consequences of the failure in adaptation (Birkmann et al. 2009). Despite the challenges in linking DRR and CCA, the way forward is to fundamentally recognise that tsunami hazards and preparedness is part of DRR. This being true, tsunami hazard and resilience building can be linked to CCA as long as one no longer views the link in the context of hazard classification, but rather in terms of impacts and coastal communities' vulnerabilities and coping and response capacities. Specific details on how to bridge the gap are provided by (Birkmann, Tetzlaff and Zentel 2009). Therefore, by considering the links between DRR and CCA, tsunami resilience capacities can be sustained. It is rather a window of opportunity, a potential incentive rather than an absolute threat.

8.4.7 Mainstreaming disaster risk reduction into sustainable development

The prevailing unsatisfactory outcome especially in the "last mile" concept of the TEWS should in principle be largely addressed through the HFA considering that recently all the countries in the region have agreed to the leading framework in DRR that will enhance regional cooperation and nations' capacities. The ASEAN Agreement for Disaster Management and Emergency Response will intensify the collaboration between nations in DRR. It will also increase the technical cooperation among member states and establish an ASEAN Coordinating Centre for Humanitarian Assistance on DM. The integration of DRR in planning and sustainable development is central in the ISDR polices and should be at the heart of all country's development initiatives and activities.

However, in Indonesia most actors perceived that DRR is not yet linked to sustainable development. Deeper questioning established a strong relationship between the past failures in harmonizing disaster-related budget planning with national planning. GTZ-IS argued:

> *"There are weak links between DRR and sustainable development because the national planning cycle in Indonesia is every ten years while local planning is every five years"* (Interview 8, 29 January 2009).

However, as indicated earlier, very recently in 2009, BAPPENAS swiftly took actions to include the DM Plan and National Action Plan for DRR (NAP-DRR 2010-2014)[lxxi] in the NDP. With adequate funding and resources, the DRR initiative can be linked with sustainable development.

Despite the current weaknesses, mainstreaming of DRR into development has started. For example the Spatial Planning Law No. 26/2008 has accommodated DRR assessment in planning and land use. However, the challenge of mainstreaming DRR into development, for example in environmentally-related policies and plans, lacks stakeholder participation and policies are too broad to be implemented. This suggests that actors need to have a clear plan and prioritize activities to create the incentive from a DRR perspective.

8.4.8 Coastal city planning and governance

The earthquake–tsunami experiences clearly pointed to the need to address the EWS and evacuation with caution based on the communities' reaction-response behaviours. Evidence has clearly indicated that whether people exercise a local approach (i.e. evacuate themselves when the ground shakes) or a national approach from a TEWC, evacuation has so far been characterized by some chaotic behaviour and traffic jams. This clearly suggests far deeper problems other than the TEWS. These problems will continue, no matter what TEWS design is used. In this respect, a separate but integrated scaled-up effort should be placed not only on evacuation, but on how the city is designed, planned and governed. To achieve such goals among other initiatives requires enhancing the support from sector specific legislation such as the spatial planning Act No. 24/1992, Law No. 23/1997 on the Environment Management, Law No. 23/1997 and the Coastal and Small Island Management Law No. 27/2007.

Of particular interest is the relatively new Coastal and Small Island Management Law No. 27/2007. It is a very strong sector-specific law for integrated coastal zone management including mitigation of coastal hazards such as tsunamis. To reduce the impact of coastal disasters in Indonesia, the MoMAF is also proactive in minimizing the impact of coastal disasters on coastal communities and on aquaculture activities. The ICZM objective is to achieve a balance between the natural resources, human utilization and disaster mitigation aspects to enhance coastal socio-ecology resilience. A healthy coastal ecosystem condition helps in the sustainability of exploitation activities by humans while ecological conditions due to exploitation by humans will decline in the absence of a disaster mitigation concept in the coastal area. In this respect, MoMAF has reformulated the building code for earthquakes and tsunamis to include the existing traditional design with some modern building techniques.

In a key informant interview, MoMAF pointed out:

> *"An integrated hazard mitigation plan is a key element in very developed coastal areas. The programme has been implemented in 15 provinces in Indonesia and now we are replicating it in other provinces … so far, we have built 200 earthquake and tsunami 'friendly' houses in several coastal districts/cities that are at risk of earthquake and tsunami. It is hoped that these designs and concepts will create new interest in traditional adaptable architecture and so will be replicated by local builders"* (Interview 25, 3 November 2008).

The statement clearly shows that MoMAF is spearheading an approach based on "living with the risk" by employing adaptable infrastructures for coastal hazards that are part of the geophysical reality of Indonesia. This is viewed as a new incentive for the many coastal people. It provides an option for local actors to reduce their vulnerability to coastal hazards, empowering the community in terms of their economic livelihood, social cohesiveness, community awareness and access to capital and markets, while increasing the coastal environment capacity to provide its services for livelihood sustainability.

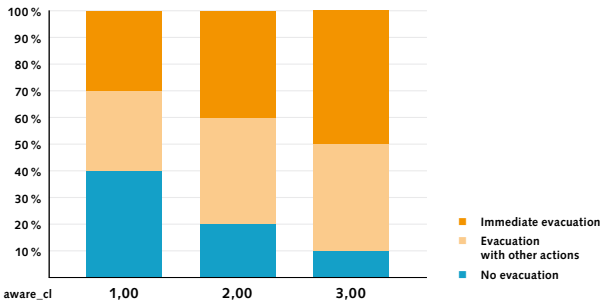
8.5 A theoretical basis for an effective and sustainable Tsunami Early Warning System

It should be stressed that the polycentric and multi-layered institutions synchronized according to the decentralized political-administrative system are ideal governance architectures for general DRR. However, the architecture is not completely suitable for dealing with local field earthquake-generated tsunamis. There is sufficient evidence to suggest that the current TEWS which relies on a technocratic approach and follows a multi-level linear warning chain process with polycentric governance architecture would be partially or completely ineffective in dealing with first the earthquake, and the near field tsunamis as revealed in the case studies.

For instance in one case, a warning simply was circulated among officials and not quickly communicated to the people at risk. Even BMKG acknowledged that *"… we were compounded by the speed at which Monday's tsunami struck"*. In the last major earthquake experience in Padang, the EOC received information from BMKG five minutes after the earthquake. Assuming all the procedures were carried out successfully, the bottom line is that it would simply be impossible to evacuate all the people at risk in the remaining 15-20 minutes if people waited for and depended on BMKG information in Jakarta. The bitter reality is that official earthquake-tsunami information was largely absent in the first 30 minutes after the earthquake (GTZ-IS 2010). This really highlights the fact that even the highly technological TEWS will not be enough to save lives.

In addition, it is important to pay attention to and observe how the society immediately responds to the immediate threats. Empirical evidence suggests that people most often carry out personal observation of the precursor environment to confirm the threat and ensure that the warning process is not based on a simple stimulus-response. This was exemplified when some villagers fled after seeing the water pull back on 12 September 2007, after an 8.4 moment magnitude earthquake in Bengulu. This also happened during the 30 September 6.8 moment magnitude earthquake in Padang city when people went to the coast to observe the sea level and started self-evacuation after feeling the strong tremors and continued to do so even when the mayor later gave no communication of tsunami risk. It is highlighted that 51 per cent of the 200 respondents interviewed evacuated in the first hour (GTZ-IS 2010) and in the first five to ten minutes almost 70 per cent of the respondents had evacuated before receiving an official warning. This conveys a very strong message regarding the role of the local approach compared to the national TEWS approach which must not be ignored. It is not clear what the underlying reasons for the self-evacuation were, however they seem to have been a combination of factors including the elements of panic, uncertainty and fear from the strong earthquake, unofficial warning (i.e. word of mouth) during that time or perhaps the result of the previous education and awareness (see Figure 50 on how intended evacuation increases with increasing awareness).

Figure 50: Correlation between intended evacuation behaviour and awareness index



Source: Birkmann et al. (2008).

According to the survey, GTZ-IS suggested that the people actually trusted the mayor and the government to provide them with accurate information directly after an earthquake; however the actual reaction-response behaviour suggests otherwise. It is also recalled that earlier, 26 per cent of 1000 respondents interviewed in 2008 indicated lack of trust in the TEWS. The experience conveys a rather clear message about how to design a TEWS, irrespective of the actual reasons for evacuation. It clearly shows an emerging micro-level, people-centred local approach independent of the national technical EWS.

GITEWS developed a novel rapid approach for monitoring and forecasting tsunamis, but the required time to evacuate in the event of a tsunami is simply not enough even if the dissemination and communication across the warning chain to the people is timely and effective. Hence, from a resilience point of view there is a problem of the fit and adaptability of the existing TEWS to the ecological challenge, and there is a need to rethink the real challenge of the problem to achieve a better outcome.

8.5.1 The local tsunami early warning model: Adaptive-people-centred approach

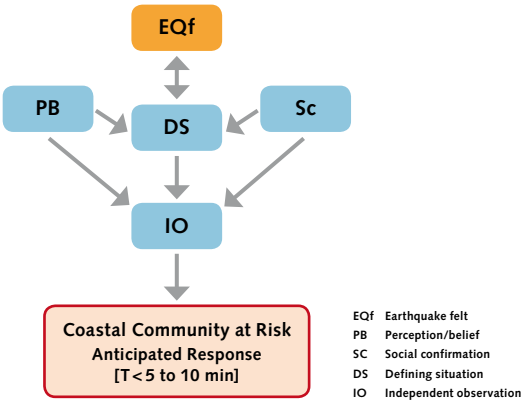
The local TEW approach involves people at risk starting some kind of anticipated response once a significant earthquake (i.e. a near field earthquake) is felt, and no one should wait for an official warning. A people-centred EWS empowers human agents who are "threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment" (Wiltshire and Amlang 2006: 1). In this context, different components of the local TEWS approach are explained which consist of a combination of (1) social micro level reaction and response, (2) the response of the EOC to earthquakes felt of certain threshold duration and (3) the use of religious-cultural based structures and norms. The concept is that the TEWS starts not only with observation and monitoring from instruments but also from the correct reaction-response of the people.

The emerging reaction behaviour pattern observed is that as soon as an earthquake is felt (EQf), most people according to their perception and belief (PB) socially and interactively through their networks socially confirm (SC) the threat in order to come to a decision (DS). In addition, there are independent observations (IO)[lxxii] of the precursor environment before carrying out an anticipated response. The reaction-response model (Quarantelli 1990) is therefore systematized and applied at the micro-local level (see Figure 51). It represents step 1 as shown in the dotted circle in figure 60. The social-reaction response would most probably continue for some time and would need a local legitimate authority to lead the process.

It is highlighted that LIPI argues:

> *"We should increase awareness and preparedness so that even before BMKG issues warning information people are already prepared"* (Interview 26, 15 April 2010).

Figure 51: Socio micro-level reaction response model



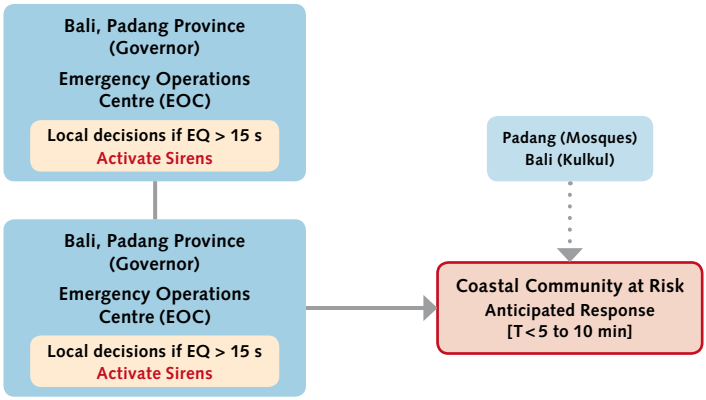
Source: Author.

In the case that a significant earthquake is felt for long enough, say a time exceeding 15 seconds (EQf>15s), the EOC should independently decide to sound the alarms as shown in figure 52 because at this stage BMKG will still be collecting the seismic data and it is simply unwise to wait for another 5-10 minutes just to receive earthquake parameters and an uncertain probability of whether a tsunami has been generated. This represents step 2 as shown in the dotted circle in figure 53. This process has actually been observed during real events. Interestingly, GTZ-IS (2010) also recommends that actors provide Padang's EOC with the authority and mandate for decision-making and direct dissemination of public guidance.

Furthermore, the commitment to link the mosque and Kulkul systems in Padang and Bali is also part of the local approach because these are socially accepted religious and cultural devices that need to be fully empowered, and this is repre-

sented as step 3 (see Figure 53). Local leaders and citizens should view such an arrangement as their own system rather than be controlled by it. It is easy for local people to trust those socially and spatially nearest to them. The trained agents to help in response can also be considered part of this step.

Figure 52: Response of Emergency Operation Centre and other local structures for long duration earthquakes



Source: Author.

The local approach has many advantages; however, it is also prone to false alarms as was observed in the 10 April 2005 event and others. Of greater concern is that the local approach may totally fail in the case of far field tsunamis, slow earthquakes or even in cases of volcanic eruptions and landslide-generated tsunamis. In the case of far field tsunamis, the epicentre of the earthquake is far off in the ocean and one may not feel the earthquake on the mainland. On the other hand, slow earthquakes are known as "deceptive mild quakes". They are caused by a "slow-slip" motion between oceanic plates. Hence, the coastal people may barely feel the seismic waves from this relatively gradual movement (Kanamori and Masayuki 1993). This occurred on Nicaragua's Pacific coast in September 1992 when 45 minutes later a tsunami of about 10 metres in height crashed onto a 300 km-long stretch of the coastline. In the third case, less than 10 per cent of volcanic eruptions and landslides may generate tsunamis (Hamzah et al. 2000). The common issue is that in all the three cases, the local approach based on feeling the earthquake would most probably fail. Therefore, it is important to integrate the local approach with the national approach to improve the effectiveness of the TEWS. On this note, the new chairperson of working group three of the Indian Ocean TEWS from LIPI stated:

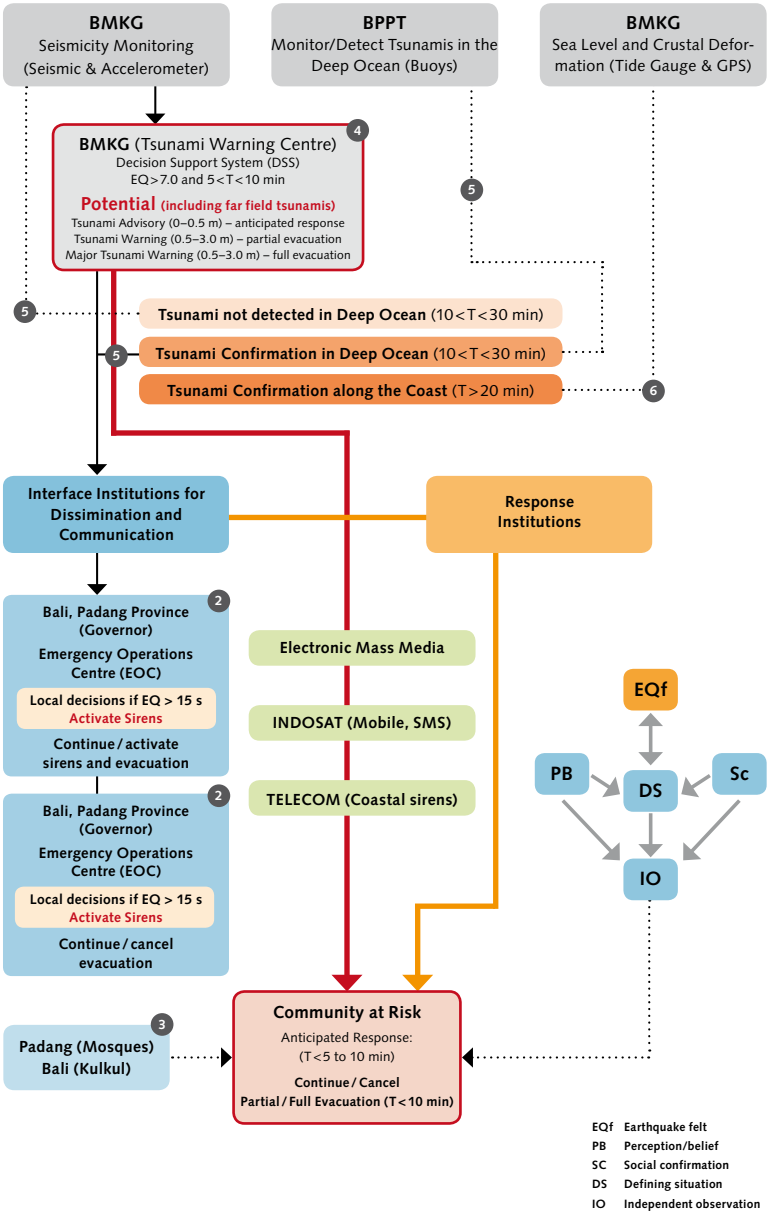
> *"… we simply cannot avoid the technology"* (Interview 2, 16 April 2010).

This strongly suggests that in contrast to some actors' thinking, an effective EWS cannot totally escape some elements of a technocratic approach, but should be embraced.

8.5.2 Integration of the local approach into the national early warning system

Naturally, as the event progresses, earthquake and tsunami information is expected to flow from InaTEWS in a period 5<T<10 minutes through the interface institutions or directly to the EOC or public via the mass media. Hence, at this stage the EWS will change from the local to the national approach. This represents step 4 of the process. However, even at this point, the mandated authorities can only provide certain observed earthquake information and the probabilistic occurrence of a tsunami based on a close match from simulated scenarios. It is very unlikely BMKG could confirm tsunami generation or not at this point for most significant earthquake occurrences. Ideally, only after a period of 10<T<30 minutes would the authorities be in a position to confirm if a tsunami had been generated or not, and this would represent step 5 of the tsunami warning process. At this point, once the information was more certain, the authorities could continue or cancel the evacuation process. Therefore, the earlier InaTEWS process (see Figure 32) is modified as shown in figure 53.

Figure 53: Integrated local adaptive people-centred and national TEWS approach



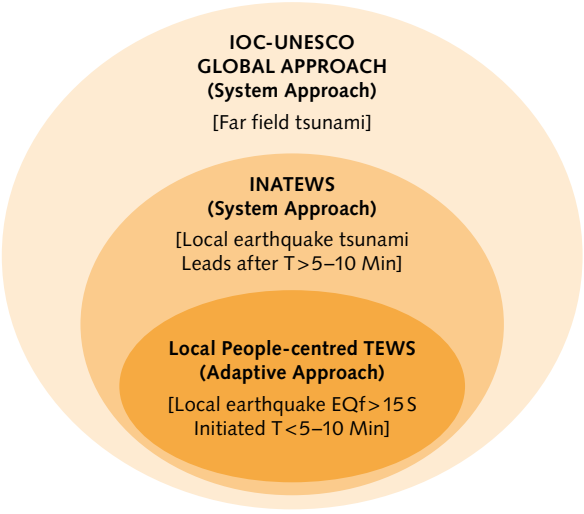
Source: Author.

8.5.2.1 Far field tsunamis

As indicated earlier, although Indonesia was on the list of countries on tsunami watch by the PTWC following the July earthquake off Indonesia's territory in 2009 and during the Chilean earthquake, there were no reports of an institutional response or official communication of the risk to the community. This is not to suggest that internal institutions were not preparing and coordinating among themselves. In that sense, it is argued that the TEWC does not pay enough attention to far field tsunamis.

To address far field tsunami risks, the InaTEWS needs to be embedded in the regional-global IOC-UNESCO TEWS coordination framework as shown in figure 54. In this context, the institutional arrangement and operational TEWS alert system needs to include the tsunami watch phase as part of the existing tsunami information system. In addition, the institutional preparedness will need to address the tsunami risk as a function of distance and time from expected landfall impact. For example, in Hawaii, sirens are sounded more frequently as the risk increases. Overall, the operational tsunami alert level needs to also show clearly what the corresponding decisions and actions are likely to be, as shown in figure 55.

Figure 54: Mix model of the tsunami early warning system



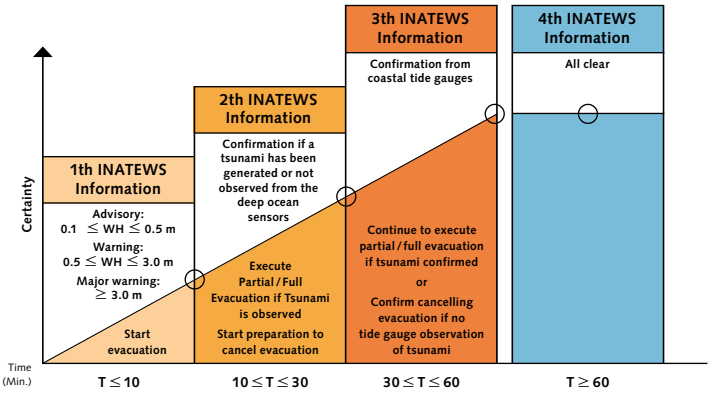
Source: Author.

It is argued that the integration of the local approach with the formal TEWS will transform the technocratic-top-down-single-TEWS into the people-centred TEWS by defining characteristics of a mixed-composite of EWS models. Such an arrangement between a formal and informal arrangement has the advantage of being flexible, adaptable and fitting the socio-ecological challenge. Evidently, the whole

system would require and depend on a disaster preparedness subculture, and this is what KOKAMI had in mind since the beginning and is highlighted as follows:

> *"There are no informal rules because local wisdom, which is considered as informal rules, is employed in our daily practices, but among the community and actors there are some perceptions of conflict"* (Interview 9, 3 March 2009).

Figure 55: The InaTEWS alert system and proposed actions



Source: Author.

8.6 Summary

This chapter has shown that there are two non-state actors who have emerged as agents and have exercised agency beyond the state where and when the state government was unable to effectively respond to TEWS-related governance. On the one hand, MPBI has emerged as an *agent* in driving and shaping governance and institutional change in DM on multiple levels and scales in Indonesia while on the other hand, KOKAMI has emerged as an *agent* in exercising agency in community disaster preparedness in Padang city in Indonesia. The underlying conditions of their authority and legitimacy include a mix of knowledge base, consent and trust from the state, and an extensive network of partners at international, national and local level including support from the broad-based community. Additional conditions include exercising flexibility, patience and coordination among a diverse array of partners.

On the other hand, actual significant events are used to measure the effectiveness of the TEWS. The immediate events in the earlier period of 2005-2007 revealed that the TEWS in Indonesia continued to face major problems, from very slow monitoring and forecasting to tsunami information being circulated among institutional actors and failing to reach the community at risk. Government authorities are still confronted with a risk communication dilemma. On the other hand, authoritative actors have become increasingly more accountable from the

free press media, political system and the community. The role of the media in influencing risk perception is not to be ignored and needs to be exploited.

Recently, the TEWS has emerged as an effective technical system in rapidly monitoring and issuing warnings. However, seismic observational and operational capabilities are also limited outside Indonesian territory; thus BMKG needs to clearly establish operational procedures to deal with the present regional observational gaps. There are signs of improving institutional capabilities in terms of issuing the tsunami warnings and cancellations, despite continued false tsunami alerts. In addition, the InaTEWS needs a reliable partner to spearhead a dedicated rapid dissemination and communication system.

Evidence suggests some promising local approaches independent of the national technical TEWS, but tsunami warnings without clear guidance do not trigger consistent reactions. The TEWS is currently overwhelmed with issues ranging from simple potential ambiguity in warning information, likely false risk perceptions within the community to lack of understanding of the operational tsunami warning scheme.

At the local level the ground realities are even more challenging in terms of poor local governance compounded by delays and a lack of financial resources. The difficulty of learning and adapting to the sophisticated TEWS underlines the challenge and dangers of importing new technology without fundamentally understanding the culture, perception and the dynamics of the local people.

The experiences have pointed to the dangers of synchronizing the formal institutional linear warning chain with the polycentric-multilayered architectures of governance and relying on a technocratic approach. The mode of tsunami governance between local and national technocratic approaches is a constant issue of debate and tension. Therefore, a theoretical integrated TEWS framework is put forward based on theoretical concepts, findings and observations to help address the existing problems of fit and adaptability of the TEWS to the ecological challenge. The TEWS operational tsunami alert system needs to be modified to include far field tsunami risk, the tsunami watch phase and what actions to carry out.

Furthermore, the existing outcome in terms of the TEWS is clearly unsatisfactory. New incentive mechanisms are proposed to change the existing outcome to address issues of effectiveness and sustainability. In this context, the multi-hazard-risk approach is one of the key incentive mechanisms to help sustain the TEWS. In reality, actors perceived that the multi-hazard approach is largely unaddressed in Indonesia because of poor organization, time and space factors regarding hazard occurrence, technical complexity and funding challenges. Nevertheless, most actors perceived the multi-hazard approach to be of top priority and the window of opportunity for the multi-hazard approach lies in the unique experience in developing the TEWS.

New innovative and creative partnerships are also required to initiate proper economic–driven incentives, particularly in the dissemination and communication part of the TEWS. Enhanced bilateral and multilateral cooperation can help sustain

partnerships for developing and maintaining the system in Indonesia. A strong link between InaTEWS and IOTEWS needs to be pursued for policy maintenance, regional governance, coordination, and cooperation.

The practice of marginalizing capacity-building in projects requires a rethinking process to ensure human capacity-building becomes central for the InaTEWS sustainability. National resilience to tsunami hazard risks depends on the ability to share and exchange the local experiences and lessons learned and ensure that best practices are replicated and inclusive for all tsunami risk communities. The role of gender in tsunami resilience has been overlooked and it is becoming clear that women can contribute and provide new incentives for tsunami community resilience.

Climate change mitigation and adaptation is perceived as a threat to the sustainability of the TEWS because of shifting interest and funding towards climate change issues. However, this should be viewed as a window of opportunity as long as tsunami resilience building and climate change risks are no longer viewed from a hazard classification perspective but rather in terms of overlaps between DRR and CCA.

The HFA serves as a driving incentive mechanism to further enhance regional cooperation and build disaster risk resilient communities, including tsunamis. In this respect, there are weak links between DRR and sustainable development in Indonesia. However, the integration of DRR planning into the national budgeting and planning will help to bridge the gap.

Coastal planning and governance has emerged as a key issue to be addressed as the TEWS is only part of the solution. Among other initiatives, the integrated use of the sector-specific legislations such as the Small Island Management Law No. 27/2007 will help to fill the existing gaps and serve as a key institutional incentive for better risk and disaster governance, assuming actors collaborate across scales and levels.

9. Conclusion

In order to conclude the research on the role of risk governance, multi-institutional arrangements and polycentric frameworks for a resilient TEWS in Indonesia, this section summarizes and puts key ideas and findings into perspective.

9.1 Earlier tsunami early warning capacities, hindering and driving forces for change

In this study it was found that the coping capacities in Indonesia were severely exceeded on 26 December 2004, not only because there was no EWS for tsunamis but also due to a range of underlying causes linked with poor attention and recognition of resilience capacities from a socio-ecological perspective. These causes included critical threshold, knowledge uncertainties, the element of surprise, ability to re-organize, learn and adapt, scale, and institutional fit to match the ecological challenge. The existing institutional arrangements and frameworks were designed

for disaster emergency and recovery only. Consequently, all elements of governance of tsunami hazard risk and disasters failed.

The hindering factors for institutional change towards disaster and risk preparedness include the issues of national security, social conflict, and the challenges of implementing the decentralization policies in Indonesia. Consequently, the outcome of lack of TEWS governance was characterized by persistent disasters and this explains why the coping capacities were severely exceeded in the December 2004 tsunami.

It is argued that the extreme shock of the tsunami disaster coupled with the HFA (2005–2015) momentum for DRR provided the driving incentives and opportunity to initiate and implement major institutional changes towards disaster risk preparedness in Indonesia. To spearhead the TEWS, a Grand Scenario strategy was developed while the GITEWS project with other partners would help partly implement the new ambitious plan. However, the Grand Scenario lacked multi-stakeholder participation from the beginning, and consequently inherited and propagated key institutional weaknesses across the process of building resilience to tsunami hazard and risks.

9.2 Governance and the Tsunami Early Warning System in Indonesia

It was found that although the economic system of governance is promising, Indonesia will face tough challenges to implement and sustain an effective TEWS based on the prevailing political-social governance system, in comparison with Japan and the United States which have decades of operational TEWS backed with a very strong governance system.

9.3 Tsunami Early Warning System-related architecture in Indonesia

The study established that there has been substantial and remarkable institutional change to support DRR and TEWS governance in Indonesia. The major institutional legal arrangement is the DM law No. 24/2007. It provides a comprehensive basis for the rules of the game in DM supporting the paradigm shift from disaster response to preparedness and mitigation in Indonesia. Other supporting government regulations are PP 21/2008, PP 22/2008 and PP 23/2008 to regulate the international cooperation in DM, the organizations of DM and funds and assistance management respectively. The DM law governs the EWS and its integration as part of the Indonesian DM system. An interim institutional ministerial decree, Sk 21/2005 provided the momentum and coordination mechanism for developing the InaTEWS despite key institutional weaknesses such as a lack of institutional attention on risk knowledge, communication and dissemination. The Presidential Regulation 8/2008 legitimized the establishment of the multiple-level DM agency. A major change is the new steering committee of the BNPB legitimising the participation of diverse institutions and the professional community apart from the state actors; an outcome achieved through good governance.

Institutionalizing and embedding the InaTEWS within the BNPB as a larger architecture is a key step towards a multi-hazard approach and improved institutional coordination and performance. However, the integration is also prone to poor ef-

fective governance performance if proper attention is not paid to the bureaucratic norms in Indonesia. The global-regional governance framework for tsunami hazard and risks under IOC-UNESCO coordination and the development of multi-level architectures and structures synchronized with the existing decentralization are ideal polycentric-multilayered architectures for optimum performance to reduce vulnerability and build resilience to local and transboundary risks such as tsunamis in Indonesia. However, there are many challenges in implementing the polycentric multi-layered architectures and structures throughout Indonesia. Few provinces and districts have actually completed the DM local regulation to allow the transformation to take place. Less than 20 per cent of the provinces have yet established the local DM agencies and less than two per cent of the districts and municipalities have DM officers (BPBD). Furthermore, the EOCs are few in number at provincial level and are fairly ineffective at lower levels. The key obstacles include multi-level commitment, government bureaucracy and a large number of actors with different agendas, financial resources and specialized human capacities. Consequently, institutional mandates and clear SOPs are also still under development. A national formal institutional TEWS chain is gradually emerging. BMKG is the mandated NTWC linked directly to the community and the interface institutions for further dissemination and communication and for response. The multi-level EOCs are to be mandated through the local government to make local decisions on what to do in the event of a significant earthquake and anticipated tsunami.

Institutional monitoring and enforcement in the TEWS/DM is a new concept among actors in Indonesia. Currently, the operational rules are more functional in the upstream technical component of the TEWS. Interestingly, institutional arrangements and their monitoring at the local level are not well planned and organized and their legitimacy is in question given that the origin of institutions significantly influences their stability and potential for change. Detailed financial tracing is virtually non-existent and raises further questions on good governance. The institutional enforcement in spatial planning in Bali has provided useful insights associated with the future potential challenges of institutional monitoring and enforcement versus dynamic pressures (i.e. extreme poverty and the urge for development) and their root causes (i.e. lack of government effectiveness, bureaucracy and corruption). Overall, there is a general consensus that even the new institutional arrangements and frameworks and their implementation have not addressed adequately the paradigm shift from disaster response to preparedness. However, more weaknesses need to be identified with time to motivate major institutional changes at the highest level in Indonesia.

9.4 Actors and the Tsunami Early Warning System architecture in Indonesia

Actor participation in Indonesia is rather complex and is characterized by a high degree of multi-stakeholder participation at various levels and across scales. The agenda of actors includes research and development, human security, minimizing damage costs, maintaining development and economic gains. The participation dynamics of actors showcase the hierarchical power structure of actors based on domains of authority in knowledge and expertise, and in hierarchy and discipline.

Such a multi-stakeholder participation structure has a profound impact on the final outcome in the TEWS action decision arena.

The mixture of multilateral (IOC-UNESCO-IOTEWS) and bilateral (i.e. GITEWS) environmental governance adopted by Indonesia is ideal for rapidly building national resilience to tsunami hazards and risks. Such a governance approach also invites potential rivalry and conflicts as new TEWS actors emerge (i.e. Germany). However, through collaboration and mutual-win strategies, conflicts have been resolved. Throughout the large action arena, transparency is not always satisfactory, especially when observed from non-state actors. Nevertheless, there is a high level of individual cohesion and trust among actors, which is sometimes affected by cultural barriers and how financial resources are distributed.

It should be pointed out that the TEWS became a national priority after the December 2004 calamity; however, currently there are mixed signals about whether TEWS/DM is still a government priority. In this context, an important indicator of political commitment is the actual DM financing which is an issue that is continually contested and negotiated. On the one hand, the government national budget spending on DM has increased significantly to reach 2.1 per cent of the total national budget[lxxiii]. Interestingly, the key milestone achieved is the integration of the DM Plan and National Action Plan for DRR (NAP-DRR 2010-2014) into the NDP to ensure that DRR is included in the Government Annual Plans and DM budgeting in Indonesia. Very recently the local contingency budget has increased, signifying an important step towards achieving effective decentralization to help cope and manage the hazards locally. On the other hand, the budget allocation at sub-national level is spatially variable and there are opportunities for unjust allocation of funds and resources, pointing to critical institutional weaknesses in the DM financing mechanisms. In addition, the on-call budget mobilization is very slow due to perplexing bureaucratic procedures. The most concerning issue calling into question the so-called paradigm shift towards preparedness is that in reality most spending is for post disaster rather than for preparedness. Only 0.17 per cent of the national budget is budgeted for preparedness.

The study has shown that there are at least two non-state actors who have emerged as agents and have exercised agency beyond the state where and when the state government was unable to effectively respond. On the one hand, MPBI has emerged as an agent in driving and shaping governance and institutional change in DM at multiple levels and scales in Indonesia. On the other hand, KOKAMI has emerged as an agent in exercising agency in community disaster preparedness in Indonesia. The underlying conditions of their authority and legitimacy include a mix of knowledge base, consent and trust from the state, and an extensive network at multiple levels and across scales including support from the broad-based community. Additional conditions include exercising flexibility, patience and effective coordination among a diverse array of partners.

In the context of the TEWS perspective at national level, it was found that national risk knowledge has improved significantly in the region and within Indonesia in terms of new hazard assessments and some attention to vulnerability at different geographical scales in Indonesia. New approaches and methodologies

are emerging for risk analysis assessment in a move towards better creation of risk knowledge. However, risk assessment has focused mainly on high hazard impact areas only and there is a lack of risk assessment capacities, tools and standardized methodologies at local level. To communicate and create a culture of risk preparedness in schools requires a higher order institutional arrangement. Risk communication has improved nationally but is insufficient and requires more multi-sector participation beyond the state and civil societies.

In terms of the observation and forecasting element of the TEWS, despite being officially operational since November 2008, there are key weaknesses and gaps centred on the density of the seismic network[lxxiv] and tsunami observation in the deep sea. Consequently, there are many false tsunami alerts because there is a lack of compromise between actual technical capabilities and socio-political goals. The alternative strategy of elevating the threshold magnitude for issuing potential tsunami alerts would increase the chance of reducing false tsunami alerts at the expense of a likely miss of tsunamis generated from moderate earthquakes below the new elevated threshold.

In the response phase of the TEWS, the major gap is the lack of disaster preparedness and contingency plans nationally. Drills are not well developed and implemented across Indonesia, despite some efforts to prepare for ad-hoc drills in some province-districts, and through Indonesia's active participation in the Indian Ocean tsunami drill in late 2009. The reason for the poor achievement nationally in contingency planning is on the one hand related to difficulties in reaching collective agreement on hazard and risk maps due to the large number of stakeholders involved, and on the other hand low levels of interest in the importance of such plans to kick start the process.

9.5 The Tsunami Early Warning System at the level of Padang and Bali

Overall, fairly similar architectures are being developed and implemented in both locations in terms of local regulations, and there has been a Governor Decree to legitimize the establishment and functions of the local BNPB and EOC. However, the development of inter-institutional arrangements has presented the central challenge and progress has been relatively slow. An emerging tsunami warning chain from national level to the local level in both locations is gradually emerging in both provinces. The Governor Decree mandates that once tsunami information is received from BMKG or interface institutions, the provincial and district governments through their respective EOCs have the legitimate authority to make decisions of what to do as per SOPs. In terms of response preparedness, both Padang and Bali have carried out TEWS drills; however the drills are ad-hoc and need to be institutionalized into scheduled inter-annual events.

Interestingly, in Bali, the tourism-related establishment survey indicated fairly good institutional preparedness for tsunamis in terms of links with TEWC, emergency response plans and satisfactory tsunami information from the TEWC. However, historical tsunami disaster events are lacking and are poorly communicated to the tourist. The key contrasts between the development of tsunami resilience in Padang and Bali are as follows:

- Political commitment, leadership and participation as indicators of good governance are perceived to be higher in Padang compared to Bali because of strong commitment and leadership from the mayor and the local NGO (i.e. KOKAMI), while Bali initially resisted tsunami preparedness fearing negative impacts on the tourism sector
- Consequently, Padang has made more progress in institutional disaster preparedness than Bali
- Padang tsunami disaster risk preparedness is also perceived to be higher because of more intense education, an awareness programme and actual experiences of earthquake-tsunami events
- The emergence of the civil society KOKAMI as an agency in Padang has contributed significantly to institutional local tsunami preparedness
- The preparation of tsunami hazard and risk maps for further evacuation, spatial planning and development in Padang has been a highly contested area characterized by a high level of debate, negotiation, institutional cooperation and collective participation because a larger number of competing actors are involved compared to Bali
- The effort of installing speakers in mosques in Padang and temples in Bali with "Kulkul" is viewed as an important step to fit meaningful practices into a given existing institutional order, but lacks legitimacy
- The process of rooting tsunami preparedness in Bali society is characterized by a higher degree of negotiation and deliberation compared to Padang
- The emerging multi-stakeholder partnership with the tourism sector and the traditional and cultural structures is far more complex in Bali than in Padang; nevertheless, it may ultimately be the critical element and model defining TEWS sustainability in Indonesia
- Development of a local warning dissemination service among hotels in Bali and formal institutionalized procedures for timely tsunami vertical evacuation between village and neighbouring hotels
- Padang is more lacking in infrastructure for evacuation compared to Bali.

9.6 An effective and sustainable Tsunami Early Warning System

Measuring the effectiveness of the TEWS is a challenging task requiring a rigorous target group and household surveys. Nevertheless, the major earthquake and significant tsunami experiences, examined and analysed from the media's perspective, suggest that the InaTEWS system has progressed mainly in terms of being fairly effective in seismic observation. However, considerable work needs to be done across all elements for it to become a reliable, effective TEWS. The parallel challenge is to also address coastal planning and governance.

Despite the major effort and significant improvement in the TEWS elements including institutional arrangements and emerging good governance attributes, the outcome is generally not yet satisfactory. It is recalled that Indonesia has a weak system of governance and would probably face tough challenges to implement and sustain an effective TEWS. However, by embarking and focusing on a series of incentive mechanisms, the current challenges can be overcome. The incentive structures range from a multi-hazard-risk approach, new innovative and creative partnerships especially with the private sector, gender issues in the TEWS to increase participation and collaboration, enhanced bilateral and multilateral cooperation, integration of InaTEWS with IOTEWS, unified and scaled up capacity-building, sharing and exchange of local experiences, learning lessons and ensuring that best practices are replicated and inclusive, tapping into the opportunities which exist between DRR and CCA and making optimum use of the HFA.

An important finding is that this study points to the dangers of synchronizing the formal single institutional linear top-down warning chain for tsunamis with the polycentric-multilayered architectures. Ironically, tensions arise and there is constant debate about the actual mode of TEWS governance and on whether to use a national technocratic approach or a local approach, or a scientific and non-scientific approach, and about the potential advantages (i.e. paternalistically shared amongst the locals through generations) and disadvantages (i.e. exclusive, non–replicable, frequently undermining local authorities and frequently characterized by mysticism and superstitious norms) of these approaches.

Hence, a theoretical basis of a TEWS framework is proposed based on theoretical concepts, observations and empirical findings in Indonesia. It is a mixture model of the EWS process consisting of the local people-centred approach (i.e. adaptive self-organized social systems) and the national technocratic approach (system-oriented for robustness and system stability) to address both local and far field tsunamis and the issues of effectiveness and sustainability in tsunami resilience in Indonesia.

This study generally supports the argument that "unless experts and scientists address the incentive structures of selected governance indicators of the TEWS as in Japan's or the USA's TEWS infrastructure, the sustainability may seem mission impossible" (Lassa 2008). However, the sustainability of the TEWS cannot simply be measured in terms of macro level incentives of governance which cannot be changed overnight and are rather pervasive, but rather through a multi-level incentive approach operating at different temporal and spatial scales and to be able to recognize the role of agents and agency beyond state for sustainability. A participatory approach in this study is also recognized as a potentially effective method for the implementation of an effective EWS (Sagala and Okada 2007).

The study finds that there has been substantial effort and advancement in building resilience to tsunamis in Indonesia, and there are signs of positive benefits in investing in disaster risk preparedness.

The role of risk governance, multi-institutional arrangements and polycentric frameworks in the context of the TEWS has strengthened the resilience capacities

of Indonesia; however, the future of InaTEWS should rest on both system and people-centred approaches and a broader coastal city planning and governance strategy to build effective and sustained resilience to the uncertain tsunami risks.

10. Recommendations, limitations and the way forward

In this final chapter, key recommendations are put forward to help improve TEWS governance in Indonesia. The chapter ends with a discussion of the key limitations and potential areas for future research related to the TEWS.

The systems of governance and incentives structures should be a constant issue addressed by the broader actors and the Indonesian community as they cannot be changed in the short term. Meanwhile, the most plausible governance is to encourage multi-level incentive structures and mechanisms, which include the multi-hazard approach, enhanced bilateral and multilateral cooperation, innovative partnerships, capacity-building, sharing and exchange of local experiences, mainstream gender perspectives in DRR and linking DRR with CCA. A policy of integration of the InaTEWS within a larger architecture (i.e. IOTEWS) for coordination with coastal zone city planning and governance is the key recommendation which will help address the issues of effectiveness and sustainability of the TEWS in Indonesia. These recommendations are expected to impact at different levels (i.e. policy and operational) to bring a better outcome. Other specific recommendations of this research study are as follows:

10.1 Specific recommendations

10.1.1 Risk knowledge

Develop, implement and promote:

1) Institutional leadership in hazard risk knowledge and communication

2) Higher order institutional arrangements and polices to integrate DRR in school curricula

3) A separate policy strategy for education and awareness is required for Negative Outcome Expectancy (NOE) such as those based on negative perceptions of religious and cultural constructs, limited use of the TEWS in the case of local tsunamis and ongoing fears of potential negative impacts of hazard preparedness on economic activities (i.e. tourism)

4) Promote the importance of risk assessment and disaster preparedness plans in society and across sectors

5) Tsunami risk knowledge communication in the tourism sector (i.e. leaflets)

6) A medium to long-term integrated socio-political and economic strategy is required to address the root causes (i.e. ineffective governance) and the dynamic pressures such as poverty and aggressive development to build a comprehensive and sustainable tsunami resilience culture.

10.1.2 Technical monitoring and forecasting system

1) Operational TEWS alerts need to be revised to address tsunami probability accordingly. i.e. employ a tsunami watch for far field tsunamis and address the issues of tsunami information if correctly interpreted by the general public

2) Realistic expectations of actual TEWS capabilities need to be communicated to the public to improve transparency and accountability

3) A major public education and awareness programme is required with high focus on tsunami warning procedures (i.e. levels of tsunami information and what to do).

10.1.3 Dissemination and communication

1) For an effective EWS, good telecommunication infrastructures are very important because the Indonesian ICT infrastructure is mainly concentrated in the big cities, therefore a significant policy is needed to fill the information gap

2) A major institutional leadership and innovative partnership is also needed to encourage dedicated systems of dissemination and communication from the authorities to the communities at risk

3) The design and operation of the siren network needs to be reviewed, including its standards of operation for both local and far field tsunamis.

10.1.4 Response

1) The existing reaction scheme needs to consider response as a complex stimulus-response consisting of social reactions and social confirmation of the warning rather than a simple linear response

2) Local government needs to develop, adapt and implement existing guidelines and make clear institutional arrangements for responses at different levels in Indonesia

3) Develop proper feedback and mechanisms for institutional monitoring

4) The local warning dissemination network among hotels and sectors needs to be scaled up while the institutional arrangements for evacuation between hotels and villages need to be exercised regularly as scheduled events (i.e. similar to IOTEWS drills executed in 2009 and the second and more elaborated one already planned for 2011).

10.1.5 Cross-cutting issues

1) It is recommended that the earthquake-tsunami information chain should not be synchronized with the decentralization and polycentric-multilayered architectures, but rather consideration should be given to addressing

the real ecological challenge based on a mixed model of a system-people-centred approach

2) The development of multi-level BNPB into a larger superstructure with complex functions requires close attention to avoid potentially rapidly creeping multi-level bureaucracy

3) Develop clear institutional mechanisms (i.e. based on disaster risk index) for effective and equitable DM financing allocation at sub-national level

4) Develop a proper financing mechanism and database at all levels and phases of DM to improve reporting, tracking and auditing of budget use

5) Social familiarization of the institutional arrangements with the local government to empower them to make effective and optimum use of available funds and resources to avoid legal risks and penalties

6) DM financing data and statistics should be regularly published to improve transparency and accountability.

10.2 Key limitations and areas for further research

10.2.1 Evaluation of internal institutional capacities

Very often, actors claim that their organization is best suited for certain projects or key responsibilities. Elite actors rarely declare their weaknesses, particularly regarding people and resource management, management systems and practices which actually determine effectiveness and level of performance. The question is how to evaluate such claims or capacities. Therefore, at the beginning of this research, an open system model was selected and modified to evaluate and assess strategic, environmental and organizational problems viewed from several levels of analysis on the internal issues of respective organizations. The analysis ideally covers the external environment, financial resource systems, roles and strategy, people and resource management, management systems and practices, organization structure, output and performance. However, the internal evaluation of respective organizations and agencies would require embedding and studying each respective major stakeholder along the early warning chain for a sufficient amount of time, which was not possible in this research. Therefore, only certain elements of the open system model were considered. In future, such a comprehensive open system model should be used on key stakeholders to investigate the internal institutional capacities and ascertain which institution would be best suited for key responsibilities, and determine key strengths and weaknesses for these institutions' own further capacity-building.

10.2.2 Analysis of the monitoring and enforcement of institutional rules

It was not possible to capture in detail the monitoring and enforcement of the rules in a different context since the DM law and regulations are relatively new, SOPs and the institutional warning chain are still being considered, and tsunami risk zoning, evacuation procedures and planning are still under development. Therefore,

such analysis of the constraints of the rules on human activities would be highly relevant in future studies.

10.2.3 Structural equation analysis: System and people-centred approach

It would be interesting to explore how structural equation analysis can be applied to further understand the interaction between the local people-centred and the national system approaches in the context of the TEWS. Such approaches have been applied to understand risk perception and volcanic hazard mitigation (Paton et al. 2008) and system analysis of social resilience against volcanic risk in Indonesia and Japan (Sagala 2009).

10.2.4 Analysis of the effectiveness of the Tsunami Early Warning System

The study has analysed the effectiveness of the TEWS measured from the actual outcome of significant events, viewed mainly from the actors' and media perspective. However, it would be interesting to analyse and measure the TEWS effectiveness from the public point of view on a regular basis with more detailed indicators of effectiveness or performance. In order to assess the performance it is important to have input and feedback (Basher 2006) from the "end user community" to the technical or scientific community that generates warnings.

10.2.5 Evaluating the impacts of the incentive change mechanism process

The modified IAD framework has allowed past and prevailing incentives and problems to be analysed and assessed. It has also provided the opportunity to identify major existing problems and key incentive mechanisms to change the prevailing outcome. However, the impacts of these new incentives at different levels cannot be analysed and interpreted. Future research would need to focus on how such incentives are being implemented and what their impacts are.

Endnotes

i http://dibi.bnpb.go.id/

ii International Conference on Tsunami Warning (ICTW) Bali, Indonesia, November 12–14, 2008

iii http://www.irw.org/tsunami/

iv No probabilities are associated with the scenarios, which is important for effective risk assessment.

v http://www.bps.go.id/eng/aboutus.php?tabel=1&daftar=1&id_subyek=07

vi http://web3.bernama.com/ssig/news/fullnews.php?news_id=78134&news_cat=wh

vii Responsible for institutional development and inter-institutional capacity building for the INATEWS respectively.

viii The document consists of 137 questions and answers from diverse institutional actors in Indonesia.

ix http://info.worldbank.org/etools/kam2/KAM_page3.asp?default=1

x Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as enjoy freedom of expression, freedom of association, and a free media. Ten represents the highest voice of accountability while one is the lowest on the scale.

xi http://www.indonesiamatters.com/723/new-political-parties/.

xii Amnesty International believes that these cases represent the most serious threat to press freedom in Indonesia for almost a decade, and is urging the Indonesian government to take the steps necessary to uphold fundamental rights and avert backsliding into a more restrictive environment.

xiii It is understood as capturing perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

xiv Terrorists targeted the President of Indonesia due to the government's decision on the execution of three Bali bombers http://news.xinhuanet.com/english/2009-08/08/content_11848477.htm

xv http://www.etan.org/issues/wpapua/2010/10012wpap.htm

xvi Captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

xvii Captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

xviii http://www.knaw.nl/indonesia/pdf/Rule_of_Law.pdf

ix Captures the perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

xx Depending on foreign aid.

xxi http://en.wikipedia.org/wiki/Indonesia

xxii Composite Risk Rating: Very high risks (00.0 to 49.9), high risk (50.0 to 59.9), moderate risk (60.0 to 69.9), low risk (70.0 to 79.9), and very low risk (80.0 to 100).

xxiii http://www.wfp.org/countries/indonesia

xxiv The Poverty Index measures deprivation in three essential dimensions of human longevity, literacy and decent standard of living (% of the population without sustainable access to improved water resources and children underweight for age. NB: The poverty index is different in developed countries, where it accounts for social exclusions such as unemployment, etc.

xxv Source: World Development Indicators database, April 2009.

xxvi http://www.country-data.com/

xxvii McKeever Institute of Economy and Policy Analysis, 2006.

xxviii There are many local publications.

xxix Change of name from BMG to BMKG. The new responsibility is in climatology.

xxx T: Time period.

xxxi A new feature (not available in the US and Japanese TEWS) of the TEWS is that all tide gauges have been equipped with GPS receivers – to detect and determine the vertical and horizontal displacement immediately, including the mechanism of the earthquake ground displacement and possible tsunami to be expected.

xxxii Communication and dissemination system to the public.

xxxiii During the field survey, I attended a DRR platform meeting where the debate and discussions were focused on developing mission and vision statements for the DRR platform in Indonesia.

xxxiv In addition to the TEWS in the Pacific Ocean.

xxxv Article 58 of the Presidential Regulation No. 8/2008.

xxxvi Article 19 of the Disaster Management Law.

xxxvii Article 64 of the Presidential Regulation No. 08/2008.

xxxviii Article 41 (1) of the Presidential Regulation No. 08/2008.

xxxix Article 41 (2) of the Presidential Regulation No. 08/2008.

xi http://www.gitews.org/index.php?id=13&L=1

xli http://www.gitews.org/index.php?id=13&L=1

xlii http://www.idepfoundation.org/idep_partners.html

xliii This PhD research forms part of this academic training.

xliv Fresh elections were scheduled in early and mid 2009.

xlv Data from BAPPENAS.

xlvi Budget allocation ratio is accumulation of contingency budget region (Provinsi and Kabupaten/Kota) to total APBD.

xlvii Expected to be endorsed by the President.

xlviii http://www.spiegel.de/international/world/0,1518,588919,00.html

xlix Participated in the GITEWS Capacity-Building Unit final workshop.

l The region hardest hit by the 2004 killer waves.

li As per Decree SK MENRISTEK No. 68/M/Kp/V2008.

lii Personnel attendance of the meeting.

liii Tele-tsunamis travel thousands of kilometres from source before reaching land

liv No probabilities are associated with the scenarios which are important for effective risk assessment.

lv The Guideline elaborates on the need for testing the tsunami EWS, establishment of an organizing committee, disaster scenario formulation, planning, preparation and implementation, documentation, dissemination, monitoring and evaluation and expected output.

lvi The Segara Hotel, Benoa Rose Residence, Benoa Palm, Ramada Benoa Hotel, Rasa Sayang Hotel, the Bali Khama Hotel, Puri Panca Setia Hotel, Club Bali Mirage, Grand Bali Mirage Hotel.

lvii Moment magnitude of 9.3 and slip 20 metres.

lviii Presented end of project on social vulnerability of the "Last-Mile" project for UNU-EHS on behalf of PD Dr Birkmann and Setiadi, and participated in the workshop.

lix http://islamizationwatch.blogspot.com/2009/10/indonesians-blame-earthquake-on-unlucky.html

lx Part of the "Last-Mile" project – only for Padang city.

lxi Muslin dominance in religion.

lxii Own observation for south Bali which is also the highest tsunami risk area.

lxiii The BMKG website did not indicate the occurrence of the earthquake near real time.

lxiv Installed around the coast of Cilacap regency.

lxv The number of deaths and losses were exceptional mainly due to the tsunami.

lxvi Reporting of disaster events has also apparently increased compared to the earlier period, and this could be a biased interpretation of the initial trend.

lxvii RISTEK, Indonesia under the framework of IOC-UNESCO and IOTEWS coordinated the Indian Ocean Tsunami drill on 14 October 2009.

lxviii By DM law No. 24/2007.

lxix http://unfccc.int/adaptation/items/4159.php

lxx Strength, Weakness, Opportunity and Threat.

lxxi Expected to be endorsed by the President.

lxxii Earthquake felt intensity. Sea level observation by ordinary citizens is not recommended.

lxiii Thailand declared at the second session of the Global Platform for DRR held in Geneva, 16-19 June 2009 that their national budget for DRR had increased to 5.1 per cent of their national budget, twice more than Indonesia.

lxiv Especially to the east of Indonesia which is not covered by GITEWS.

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Abbreviations and acronyms

APBD	Local Budget
APBN	National Budget
CBU	Capacity Building Unit
CCA	Climate Change Adaptation
CPR	Common Pool Property
DIC	Downstream Information Communication
DM	Disaster Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision Support System
ERTR	Emergency Response and Transitional Recovery
ESG	Earth System Governance
EWS	Early Warning System
EWSG	Early Warning System Governance
EWC III	Third Early Warning Conference 2006
FGD	Focus Group Discussion
FM	Frequency Modulation
FMRDS	Frequency Modulation Radio Data System
GDP	Gross Domestic Product
GECHS	Global Environmental Change and Human Security
GIS	Geographical Information System
GLOSS	Global Sea-Level Observing System
GSM	Global System for Mobile Communications
GTS	Global Telecommunication System
HDI	Human Development Index
HFA	Hyogo Framework of Action
IAD	Institutional Analysis Development
ICT	Information and Communication Technology

ICTW	International Conference On Tsunami Warning
ICZM	Integrated Coastal Zone Management
IEWP	International Early Warning Programme
Inpres	Instruksi Presiden – Presidential Instruction
IOTEWS	Indian Ocean Tsunami Early Warning System
IR	Internal Relations
IRG	Integrated Risk Governance
IRGC	Integrated Risk Governance Council
ISDR	International Strategy for Disaster Risk Reduction
KAM	Knowledge Assessment Methodology
KEPMEN	Keputusan Menteri – Ministerial Decree
LAP	Local Action Plan
MoU	Memorandum of Understanding
NDP	National Development Plan
NGO	Non-governmental organization
NOE	Negative Outcome Expectancy
NRM	Natural Resource Management
PAR	Pressure and Release
Perda	Regional Regulation
Perpres	Presidential Regulation
PP	Government Regulation
PTWC	Pacific Tsunami Warning Centre
RANET	Radio Internet
RAN-PRB	National Action Plan for Disaster Risk Reduction
RAPI	Indonesian Citizen–Band Radio Association
RUU	Rancangan Undang-Undang
SAR	Search and Rescue
SOP	Standard Operation Procedure
SWOT	Strength, Weakness, Opportunity and Threat

TEW	Tsunami Early Warning
TEWC	Tsunami Early Warning Centre
TEWS	Tsunami Early Warning System
ToR	Term of Reference
UDC	Upstream Data Communication
UU	Undang-Undang (Law)
UUD' 45	Undang-Undang Dasar 1945 (Constitution 1945)
VHF	Very High Frequency
WGI	World Governance Indicator
WLAN	Wireless Local Area Network

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Appendix

Table 1: List of state organizations, showing corporate responsibility, executive and operational capacities and InaTEWS-related mandates and tasks

Organization	Corporate Responsibility	Executive / Operational	InaTEWS Mandate and Key Tasks
KESRA	Coordinate the planning and formulation of policies, synchronize implementation of policies related to people's welfare and poverty, alleviate and coordinate cross-sector activities and international cooperation related to civil protection and natural DM	Deputy for Social Vulnerability; Assistant Deputy for Technological & Environmental Disasters; Assistant Deputy for Natural Disaster Issues	Formulate policies, synchronize the implementation of policies in the field of environmental and technological disasters, prevention of disasters and DM; Coordinate the legal aspects of the INATEWS development team and related instiutions in the development of INATEWS
RISTEK	Formulate policies and coordinate on research, science and technology	Deputy for Utilization & Dissemination of Science Technology; Assistant Deputy for Science & Technology Promotion & Marketing; Assistant Deputy for Analysis of Science and Technology Needs; Community Needs Studies; Academic Research & Development	Coordinator of INATEWS stakeholder technical and operational acitvities, focal point for capacity building, organizes local content events, conferences, workshops, seminars and tsunami simulations, training of trainers, drills; Adapt the sophisticated INATEWS technology to Indonesian culture
DEPDAGRI	Formulate and implement policies, standards, norms and guidelines, criteria and procedures for DM; Coordinate the activities of DM with provincial and city governments	Director General; Director of DM	Provide and implement relevant policies, regulations, guidelines, SOPs; Coordinate public education and support BMKG in dissemination system; Coordination of local governments; Support RISTEK in coordination of INATEWS, tsunami drills etc; Support BAKOSURTANAL and LIPI
DEPLU	Foreign affairs formulation and implementation of related policies and politics	Head of Sub directorate of Technical Cooperation for International Organisations under Directorate of Technical Cooperation; Division Head for America under Sub directorate of Technical Cooperation for International Organisations	Assist RISTEK in international stakeholder coordination; Support LIPI on research and development of geosciences and support MoHA on public education
BNPB	Formulate, monitor and evaluate national policy on DM; Coordinate and implement DM; Provide guidelines and guidance to the initiatives of DM; Determine standards and needs; Inform communities about DM and related activities	Head of BNPB; Deputy for Prevention and Preparedness; Director of Preparedness; Director of Community Empowerment	Provide policies, planning, coordination and implementation of activities related to national multi-hazard DM; Dissminate EW to public through EOC

Organization	Corporate Responsibility	Executive / Operational	InaTEWS Mandate and Key Tasks
BAPPENAS	Formulate policies and coordinate the implementation of policies in the field of national development planning	Director of Industry, Science, Technology and State Enterprises; Head of Industrial Organisation and Competition; Head of Science and Technology Development	Support RISTEK in coordination; Support LIPI in research and MoHA in public education; Planning, monitoring the INATEWS budget and stakeholder development plans
BMKG	Assess, formulate and facilitate a national policy and coordinate activity in the field of Meteorology, Geophysics, Climatology and Air Quality	Executive Head of BMKG; Deputy for Data and Information System; Centre for Geophysics Data Information System	Responsible for seismic monitoring, tsunami operational warning centre and dissemination of warnings
BPPT	Formulate national policy on assessment and application of technology	Deputy for Natural Resource Technology Development; Head od Marine Technology Survey	Responsible for the deployment and operation of buoys; Operate research vessels for installation and maintenance, relocation of buoys; Oceanographic monitoring and tsunami modelling
BAKO SURTANAL	Assess and formulate national policy in the field of surveying and mapping; Develop infrastructure of national spatial data	Executive Deputy Infrastructure, Spatial Data; Operational Head Division Gravity and Tide	Focal point for crustal deformation monitoring and geospatioal data and information; Install and operate tide gauges and GPS networks
KOMINFO	Formulate and implement national policies in the field of communication and informatics covering post, telecommunications, broadcasting, information & communication technology, multimedia services and dissemination of information	Director of Communication Facility & Dissemination of Information; Director of Institutionalised Government Communication; Director of Communication Technology Facilities	Focal point for Information and Communication Technology; Disseminate warning information by mass media and telecommunication; Public information and media campaigning on TEWS
LAPAN	Carry out government tasks on research, development, aeorspace applications; Carry out secretariat function	Head of Remote Sensing Application and Technology Development Centre; Head of Division Remote Sensing Data	Provide Geospatial, remote sensing data to INATEWS operational stakeholders
KLH	Formulate policies and coordinate in the field of environment and impact analysis	Assistant Deputy for Environment Data and Information Affairs; Head of Division Information	Provide RISTEK and INATEWS with relevant environmental information and planning
DKP	Formulate policies and coordinate in the field of marine affairs and fisheries	Head of Research Centre for Marine Affairs and Fisheries; Head of Sub directorate for coastal; Disaster Mitigation and Pollution under Director General of Coastal Marine and Small Islands; Head of technical Services Division under BRKP	Assist INATEWS stakeholders in all relevant aspects of marine and coastal affairs

Organization	Corporate Responsibility	Executive / Operational	InaTEWS Mandate and Key Tasks
ESDM	Provide policies, information and services on geological disasters, geosciences	Head of Geology Agency; Head of Vocanology and Geological Disaster Mitigation Centre (PVMB)	Support INATEWS stakeholders in the field of geological DM; Formulate and support implementation of polices and services for geological disaster mitigation including tsunami
LIPI	Assessment and formulation on national policy of science research; The implementation of basic science research, inter & multidiscipline research; Monitoring & evaluation of sicence and technology progress	Deputy of Geosciences; Researcher, Supervisor of Compress Program	Focal point for Research & Development of Geosciences and Community Awareness and Preparedness
ITB	Conduct Research & Development of identifying hazards and the magnitude of both natural and man-made hazards; Conduct multi-hazard vulnerability assessment; Organise and conduct research	Rector ITB; Head of Mitigation Centre; Risk and DM, Public Education	Prepare tsunami database; Develop human resources needed to sustain INATEWS
DEPDIKNAS	Formulate policies and coordinate in the field of national education	Head of Curriculum Centre; Researcher	Assist DRPDAGRI and INATEWS stakeholders related to public education, awareness, and preparedness
DEPBUDPAR	Formulate and implement technical policies and standardisation in the field of tourism destination development	Director General of Tourism Desintaiton Development; Head of Sub directorate of Tourism Prouct Facilitation	Assist INATEWS stakeholders in issues related to tourism awareness and preparedness
POLRI	Protect and give service to people in the field of security, safety and peace; Give guidance through preemptive and preventive actions to increase people's awareness and law-abiding citizenship	Deputy of POLRI for Operation; Head of Sub-Division of Data & Statistics	Network communication from headquarters to the regional police (POLDA) as well as resort police used to communicate warnigs to areas prone to tsunamis
TNI	Provide security	Assistant operational of TNI; Commodore; Head of Sub-Division for DM	Provide security in the INATEWS infrastructure; Provide emergency response, public awareness and preparedness

Disaster Risk Preparedness

The Role of Risk Governance, Multi-Institutional Arrangements and Polycentric Frameworks for a Resilient Tsunami Early Warning System in Indonesia

by Denis Chang Seng

The ability and capacity to cope with and build resilience to various risk and disasters inherently depends on Early Warning Systems, which are a major tool of disaster risk preparedness and reduction. They should empower societies and communities to prepare for and confront the power and the uncertainties of both natural and climate change-driven hazards.

This PhD dissertation examines, discusses and provides insights into tsunami risk resilience through an analysis of systems of governance, ecosystem resilience, architecture, and actor-agent perspectives, concentrating on the development of a Tsunami Early Warning System in Indonesia. It emphasizes and compares the development of the Tsunami Early Warning System at the level of Padang, a large coastal city in West Sumatra and Bali. The study employs a new comprehensive integrated Early Warning System Governance framework based on institutional analyses. Institutional research offers a wide range of ways to investigate governance describing how institutions (rules), physical and material conditions, and the attributes of actors and the community affect the structure of action arenas, the incentives that individuals face, and the resulting outcome. It is mainly based on qualitative methodologies. The central question addressed in this research is how certain attributes of governance and institutions do function and how they should function to enhance the society's capacity to manage the uncertain tsunami risks.

The research was conducted within the scope of the German Indonesian Tsunami Early Warning System (GITEWS) project as part of the global initiative to establish a Tsunami Early Warning and Mitigation System in the Indian Ocean.

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