This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603839

ASTARTE

Assessment, Strategy And Risk Reduction for Tsunamis in Europe

Grant Agreement no: 603839
Organisation name of lead contractor: IPMA
Coordinator: Maria Ana Baptista

Deliverable 9.27

Report on institutional plans, operative response capacities and needs for crisis management and capacity building

Due date of deliverable:	M24
Actual submission date to PC:	M30
Start date of the project:	01/11/2013
Duration:	36 months

Work Package:	9 "Building Tsunami Resilient Societies"
Lead beneficiary of this deliverable:	METU
Author(s):	**Leading Authors:** Nilay Dogulu (METU) **Contributors:** Georgios Marios Karagiannis (TUC), Costas E. Synolakis (TUC), Ahmet Cevdet Yalciner (METU), Ocal Necmioglu (KOERI), Ceren Ozer (KOERI)
Version:	V1.0

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)	
Dissemination Level	
PU Public	X
PP Restricted to other programme participants (including the Commission Services)	
RE Restricted to a group specified by the consortium (including the Commission Services)	
CO Confidential, only for members of the consortium (including the Commission Services)	

Table of Contents

EXECUTIVE SUMMARY

Crisis management and emergency planning are essential prerequisites for effective and efficient disaster risk reduction, response and recovery. Establishing disaster risk management strategies based on comprehensive and integrative crisis management and emergency planning approaches can prove very valuable in building a culture of preparedness and resilient communities such that the impacts and consequences of these disasters are minimized. This report presents an overview of institutional plans and operative response capacities for crisis management and capacity building, while building upon the fundamental concepts in crisis management. One particular aim of this work is to identify needs and gaps in crisis management with emphasis on tsunami disasters.

DOCUMENT INFORMATION

Project Number	FP7 - 603839	**Acronym**	ASTARTE
Full Title	Assessment, STrategy And Risk Reduction for Tsunamis in Europe		
Project URL	http://www.astarte-project.eu/		
Document URL	http://www.astarte-project.eu/index.php/deliverables.html		
EU Project Officer	Denis Peter		

Deliverable	**Number**	D9.27	**Title**	Report on institutional plans, operative response capacities and needs for crisis management and capacity building
Work Package	**Number**	WP9	**Title**	Building Tsunami Resilient Societies

Date of Delivery	**Contractual**	M24	**Actual**	M28
Status	Version 1.0 (V1.0)		☐ final	
Nature	☐ prototype ☑ report ☐ dissemination			
Dissemination level	☑ public ☐ consortium			

Authors (Partner)	METU			
Responsible Author	**Name**	NilayDogulu	**E-mail**	ndogulu@metu.edu.tr
	Partner	METU	**Phone**	+90 312 210 54 39

Abstract (for dissemination)	Crisis management and emergency planning are essential requisite for effective and efficient disaster risk reduction, response and recovery. Establishing disaster risk management strategies based on comprehensive and integrative crisis management and emergency planning approaches can prove very valuable in building a culture of preparedness and resilient communities such that consequences of these disasters are minimized. This report presents an overview of institutional plans and operative response capacities for crisis management and capacity building while building upon the fundamental concepts in crisis management. One particular aim of this work is to identify needs and gaps in crisis management with emphasis on tsunami disasters.
Keywords	Tsunami, crisis management, capacity building, preparedness.

Version Log			
Issue Date	**Rev. No.**	**Author**	**Change**
30.08.2015	V0.0	N. Dogulu	Writing of the first draft
30.09.2015	V0.1	N. Dogulu, Ahmet C. Yalciner	Review of the document
15.12.2015	V0.1	N. Dogulu	Chapter 2 write-up
28.01.2016	V0.3	N. Dogulu	Chapter 5 write-up, Review of the document
14.02.2016	V0.4	Georgios Marios Karagiannis, Costas E. Synolakis	Chapter 3 is inserted.
20.02.2016	V0.5	Georgios Marios Karagiannis, Costas E. Synolakis	Chapter 4 is inserted.
21.02.2016	V1.0	N. Dogulu, Ahmet C. Yalciner	Review of the document

LIST OF FIGURES AND/OR LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

-

DEFINITIONS

-

CHAPTER 1 INTRODUCTION

Natural hazards (earthquakes, volcanic eruptions, landslides, tsunamis, floods, and droughts) are catastrophic events which pose a significant threat to the lives and livelihoods in many parts of the world. Whenever they occur, emergency plans are activated to address the consequences of these widespread and severe events which usually cause extensive damage to resources in the disaster area, and sometimes they transcend national boundaries. Consequently, natural disasters can be considered as crisis events.

Crisis management and emergency planning are essential prerequisites for effective and efficient disaster risk reduction, response and recovery. Establishing disaster risk management strategies based on comprehensive and integrative crisis management and emergency planning approaches can be quite valuable in building a culture of preparedness and resilient communities, thus reducing the impacts and consequences of disasters.

This report presents an overview of institutional plans and operative response capacities for crisis management and capacity building, while building upon the fundamental concepts in crisis management. One particular aim of this work is to identify needs and gaps in crisis management with emphasis on tsunami disasters. Chapter 1 introduces the basic definitions and concepts related to crisis management and emergency planning. Chapter 2 reviews the literature of tsunami crisis management and summarizes various aspects involved in crisis management, i.e. early warning systems, response, relief and recovery, funding of humanitarian aid and response, logistics, (post-disaster) waste management, (post-disaster) resettlement and reconstruction, media and communication, and assessment of post-disaster activities. This main focus of this chapter is on the needs for crisis management and capacity building. In Chapter 3 the incident planning process is described, and critical points in command, control, coordination, decision-making and the common operational picture are highlighted. Furthermore, the need for a common operational picture in disaster response, and advances in the common operational picture are discussed. Tsunami disaster response capabilities in Greece and Turkey are presented as case studies, in Chapter 4 and Chapter 5, respectively.

Next, in relation to their relevance for the discussion in this report the subjects “crisis and crisis management”, “emergency planning and management”, “disaster response and recovery” and “capacity building” are briefly summarized so as to provide background and context to readers.

1.1. Crisis and crisis management

A crisis is ‘an unstable condition involving an impending abrupt or significant change that requires urgent attention and action to protect life, assets, property, or the environment’ (ASIS International, 2009). A crisis event can be described by the following elements: (i) a threat to the organization, (ii) the element of surprise, and (iii) a short decision time (Seeger et al., 1998). There are various types of crises, natural and technological crises being the most common :

> *Natural crises, typically natural disasters, are such environmental phenomena as earthquakes, volcanic eruptions, tornadoes and hurricanes, floods, landslides, tsunamis, storms, and droughts that threaten life,*

> *property, and the environment itself. (e.g. 2004 Indian Ocean earthquake and tsunami) ("Crisis management", 2015, para. 12)*
>
> *Technological crises are caused by human application of science and technology. Technological accidents inevitably occur when technology becomes complex and coupled and something goes wrong in the system as a whole (Technological breakdowns). (e.g. Chernobyl disaster, Exxon Valdez oil spill, Heartbleed security bug) ("Crisis management", 2015, paragraph. 13).*

Crisis management can be defined as 'the process by which an organization deals with a major event that threatens to harm the organization, its stakeholders, or the general public' ("Crisis management", 2015, paragraph 1). Crandall et al. (2014) defines crisis management as 'the stage at which the organization is encountering some type of crisis that has occurred', where the fundamental aim of tailored efforts is to address the crisis and resume operations at the earliest possible time.

Crisis management originated from strategic planning for contingencies in case of unexpected events (Niininen, 2013). The related research has rapidly evolved following the increasing number of environmental (e.g. the Chernobyl accident and the Sandoz chemical spill, both in 1986) and natural (e.g., Hurricane Katrina in 2005 and 2004 Indian Ocean earthquake and tsunami) disasters. It is important to distinguish between a crisis and a disaster. Figure 1.1 shows how crises and disasters differ in terms of causative factors. According to Faulkner (2001), while crises are caused by self-inflicted situations (i.e. induced by the actions or inactions of management organizations), disasters are events caused by sudden and uncontrollable catastrophic changes, such as natural phenomena or external human actions. This report addresses natural disasters, particularly tsunamis, as crises and discusses crisis management and capacity building.

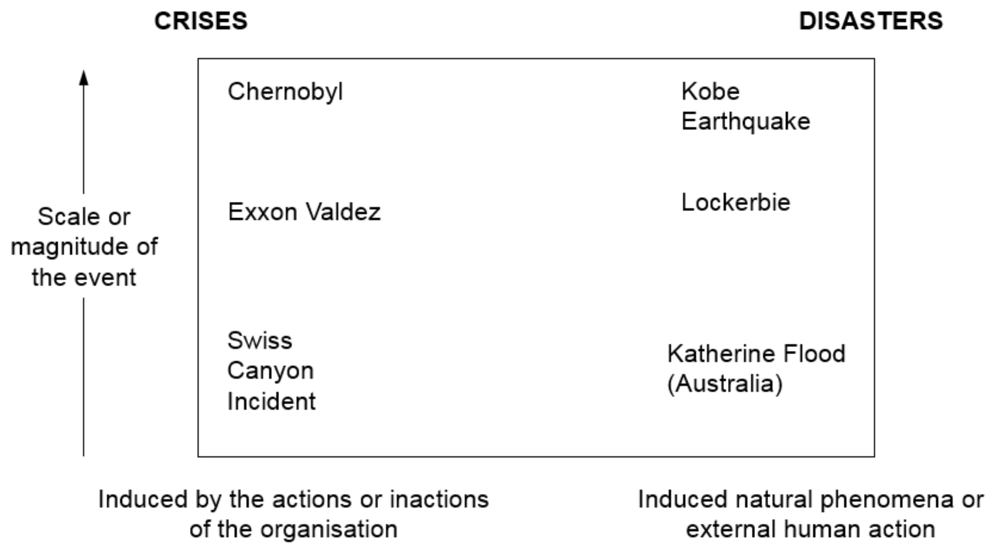


Fig. 1.1. Crises and disasters (Adapted from Faulkner, 2001).

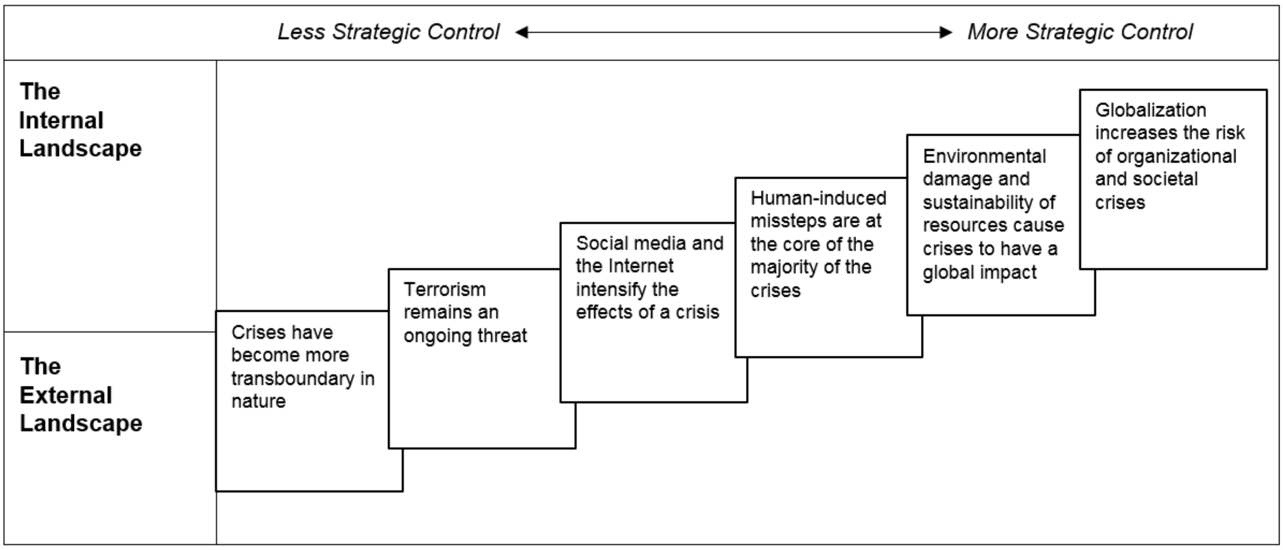


Fig. 1.2. Trends in the crisis management landscape (Adapted from Crandall et al., 2014).

Crandall et al. (2014) identifies six trends in today's crisis management (Figure 1.2): (i) crises have become more "transboundary" in nature, (ii) terrorism remains an ongoing threat, (iii) social media and the Internet intensify the effects of a crisis, (iv) human-induced missteps are at the core of the majority of the crises, (v) environmental damage and sustainability of resources cause crises to have global impact, and (vi) globalization increases the risk of organizational and societal crises. It is important to note that the effectiveness of strategic-level crisis response measures is reduced as the origin of the crisis moves from the internal environment of the organization towards its external landscape. For example, while policy makers, engineers and emergency managers can effectively shield critical infrastructures and key resources from internal system failures, little can they do against a "determined and intelligent opponent" when dealing with acts of terrorism.

Crisis management essentially involves preparedness as well as mitigation responses and recovery activities (ASIS International, 2009), and is aimed at ensuring 'a rapid and adequate response to the crisis' while 'maintaining clear lines of reporting and communication in the event of crisis' ("Crisis management", 2015, para. 4). It should be emphasized that crisis management is a holistic and continuous process for various activities including crisis prevention, assessment, handling, and termination before, during, and after the crisis event. In fact, crisis management consists of four principal "dimensions: (Boin et al., 2006):

- ✓ *Crisis prevention*: the timely recognition and early warning of emerging threat patterns, and the ability to intervene effectively to nip crises in the bud.
- ✓ *Crisis preparation*: the capacity to prepare for the unknown, to put plans in place and update those plans based on practice and discussion
- ✓ *Crisis coping*: the response stage of crisis management, requiring critical decisions and getting them implemented
- ✓ *Crisis aftermath*: learning lessons from crises, maintaining accountability, and restoring legitimacy to weakened government institutions.

Such holistic and continuous management process are of great value for building resilience for crises and disasters.

Crises and crisis management have attracted studies by social scientists and other researchers globally. For example, there have been efforts to develop frameworks for crisis management (see, e.g. Myers, 1993; Fink, 1996; Coombs, 2006). However, among various proposed frameworks, here we present only a recently developed framework by Crandall et al. (2014) so as to provide a general overview (see Figure 1.3). This framework is particularly useful for organizations and distinguishes between four phases, namely, landscape survey, strategic planning, crisis management, and organizational learning.

	Landscape Survey	*Strategic Planning*	*Crisis Management*	*Organizational Learning*
The Internal Landscape	What crisis threats exist INSIDE of your organization?	How can your organization plan for potential crisis events?	How should you manage your INTERNAL stakeholders during a crisis	What can your organization learn from this crisis?
The External Landscape	What crisis threats exist OUTSIDE of your organization?	What planning has been done outside of your organization to help prepare for potential crisis events?	How should you manage your EXTERNAL stakeholders during a crisis?	What learning is taking place outside of your organization in relation to the type of crisis you just experienced?

Fig. 1.3. A framework of crisis management (Adapted from Crandall et al. 2014).

Crisis management research focuses on other aspects as well. Major research areas in crisis management, as identified by Hart and Sundelius (2013) are given in Table 1.1. Each has particular emphasis and implications for advancing the practice of crisis management. However, it needs to be highlighted that they are all complementary and integrative in crisis management, and essentially within the context of disaster risk management.

Unfortunately unsolved issues still remain in studies of crisis management and international social science research regarding their effective implementation. 't Hart and Sundelius (2013) identified eight priority areas for strengthening crisis management in Europe: (a) analysis, (b) prevention, (c) preparedness, (d) sense-making, (e) steering and synthesizing, (f) meaning-making, (g) managing adaptation, and (h) training for enhanced skills. Gourlay (2004) points out the necessity for the European Union to adopt a broad range of instruments and capabilities for conflict prevention, crisis management and post-conflict reconstruction. It is clear, that for the practice of crisis management to advance effectively, e.g. adoption of a management practice which is capable of securing the interests of involved key stakeholders, it is crucial that social scientists and researchers work in collaboration with public authorities, government regulators as well as the industry.

Table 1.1. Major research subjects in crises and crisis management (Adapted from 't Hart and Sundelius, 2013).

	Technical-Managerial: the study of risk and crisis 'management'	*Strategic-political: the study of risk and crisis 'politics'*
Pre-crisis phase	Mitigation, preparedness, early warning as professional activity clusters and determinants of systematic resilience	Strategic interests and controversies about risk perception, risk acceptability and risk regulation
Crisis phase	Dynamics of individual, group and network information processing decision making, coordination, communication under conditions of threat, uncertainty and urgency	Role of political, economic and bureaucratic self-interests and power relations in shaping crisis response operations
Post-crisis phase	Organization and delivery of long-term support and recovery programs, lessons-drawing	Contested legitimacy of status quo through media and official investigations and debates, resulting in opportunities for advocates of change, reform and renewal

Crises should be seen as opportunities. Regardless of the characteristics of each crisis event, it is by means of these experiences that the organizations can learn from the identified gaps and mistakes in their present crisis management and emergency planning strategies. Such learning can be very influential in capacity building for crisis management and emergency planning, which are vital in disaster risk management, thereby increasing resilience against natural disasters, including tsunamis.

The disaster management literature is centred around three different successive stages of planning activities (Perry, 2007; Figure 1.4): preparedness, response, aftermath. While *preparedness* refers to awareness, preparatory activity and action to mitigate the full impact of a possible disaster *response* includes mainly activities aimed at saving of lives as well as emergency relief activities. However, aftermath stages focus on recovery and development and resilience activities (Perry, 2007). In principle, crisis management incorporates the *response* and *aftermath*. Hence, crisis management is essentially considered as a fundamental aspect of the disaster management cycle. A comprehensive and efficient crisis management can likely prevent excessive loss of life and reduce the disaster impacts.

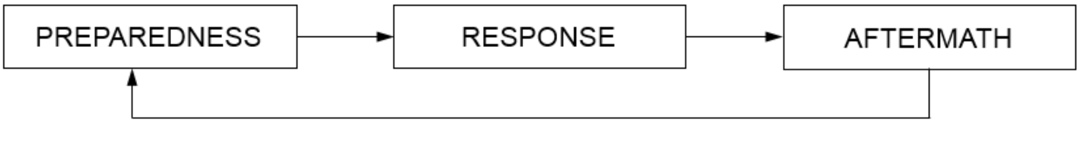


Fig. 1.4. Disaster management planning continuum (Adapted from Perry, 2007).

1.2. Emergency planning and management

(*This section is based mainly on Alexander, 2014*)

Emergency events pose impending risks to societies and have great potential to reveal societies' vulnerabilities, thus are potentially crisis situations.

Emergency planning and management are essential themes of disaster response and recovery. The ultimate objective of emergency management is to achieve satisfactory levels of public preparedness against future disasters for minimizing loss of life and property. In the context of crisis management, emergency planning has evolved as a complementary discipline to emergency management for enabling effective response to disasters. While the world's awareness on the necessity of emergency planning and management for disasters (i.e. at many scales and diverse sectors and jurisdictions) is gradually increasing there is still room for further efforts to focus on identifying common objectives, content and methodology for emergency plans.

The generation of a valid emergency response plans is the first step in emergency response planning. Such a plan should include (i) warning notification protocols and systems; (ii) evaluation and mapping of evacuation routes, with signage to designated assembly points; (iii) consideration of evacuation timing; and (iv) staff training and evacuation plan exercising (Garside et al., 2009). Followed by the implementation (and dissemination), the plan should be integrated and maintained in the long-term.

Emergency planning is an integrative and continuous process that combines several layers of plans, namely, a permanent emergency plan; strategic, tactical and operational emergency plans, business continuity plan; and recovery and reconstruction plans (Figure 1.5).

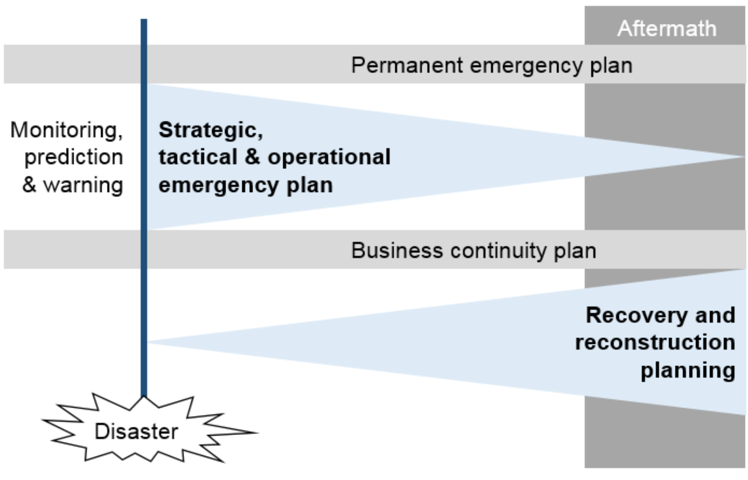


Fig. 1.5. Time phases and salience of different kinds of planning (Adapted from Alexander, 2014).

Collaboration and cooperation between the authorities and agencies responsible for crisis management is of fundamental necessity for achieving good outcomes. Integration of emergency plans is the key to efficient emergency management. In an emergency plan there are a variety of responsibilities and tasks that needs to be handled at different levels and by different authorities. Therefore it is crucial that such integration extend between levels of government, jurisdictions and services, i.e. municipalities, intermediate levels of public administration (countries, provinces, regions, etc.), national governments and some international bodies. Figure 1.6 shows the relations and connections between different emergency plans, where the core plan is that of the municipality. However, ensuring compatibility of these plans still remains a challenge and requires further mutual collaboration among the levels involved. Integration of emergency plans should also address and incorporate stakeholders' concerns and needs. All of these highlight the importance of communication in creation and development of emergency plans.

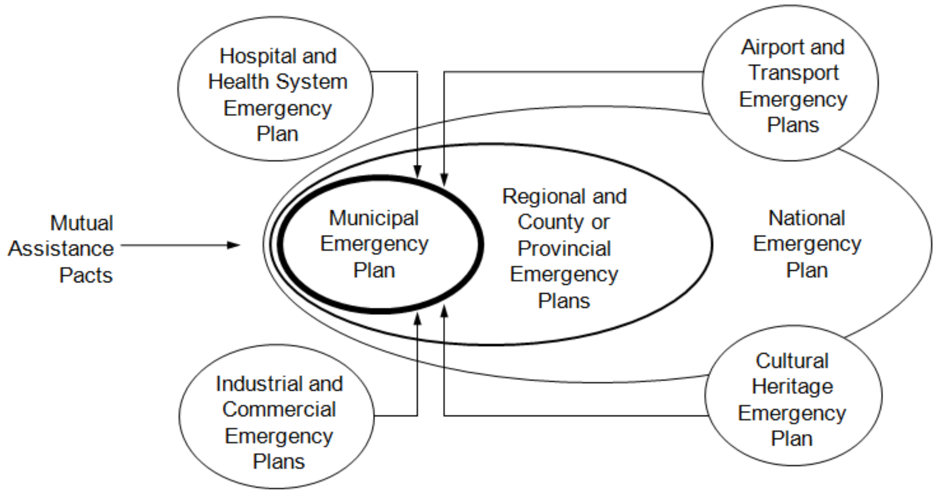


Fig. 1.6. A nested hierarchy of emergency plans centred around the municipal level (Adapted from Alexander, 2014).

Within the overall emergency planning process, summarized in Figure 1.7, communication plays a vital role. For example before a disaster (early) warning, readiness and mobilisation activities rely heavily on multiple information from various sources. During a disaster event communication is essential for achieving coordinated emergency action. Communication is also needed for effective recovery following a disaster. It should be noted that lack of success in communicating or acting on important information inevitably leads to the failure of emergency plans and responses. Moreover, enabling conditions for multi-lateral communication is the basis of efficient and sound disaster response and recovery as a means to enhance robust and meaningful integration of emergency plans between levels.

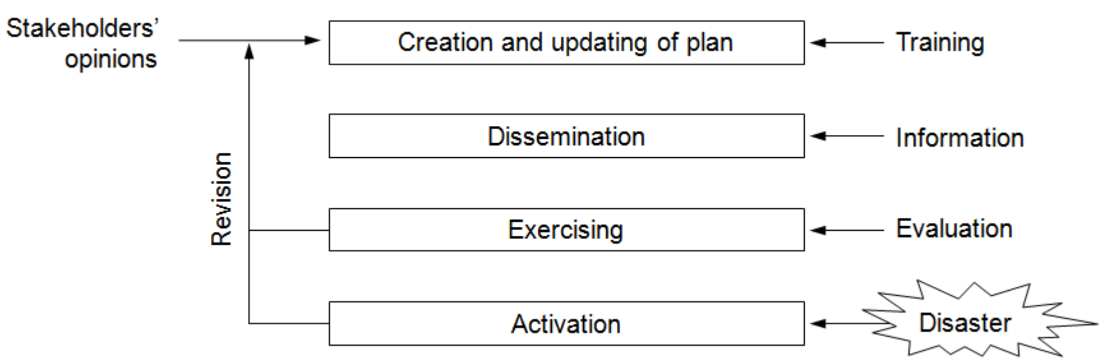


Fig. 1.7. An overview of the emergency planning process as a whole, with feedback loops (Adapted from Alexander, 2014).

Adoption of a community-based approach in emergency response planning is another key factor which will definitely prove beneficial.

1.3. Disaster response and recovery

(*This section is based mainly on Kapucu and Özerdem, 2013 – Chapter 4: Disaster Response and Recovery*)

Disaster response and recovery are of primary concern for emergency and crisis management. The overall aim of disaster response and recovery plans and/or activities is to address the consequences of disasters, during and following the events, and they are usually carried out by governments, agencies and disaster management professionals. From an operational perspective, there remain challenges associated with effective and efficient disaster response and recovery, although there have been continuing substantial improvements in the management of disaster response and recovery operations, particularly in the recent years. In the next paragraphs, the terms disaster response and recovery are explained further.

Disaster response is actuated when there is an impending disaster event (e.g. as confirmed by early warning system) and encompasses the time of disaster, as well as the time immediately following the event. Accordingly, disaster response process intersects with two phases of emergency management cycle, mitigation and preparation. The response activities include appropriate mitigation efforts, as well as actions to protect the public. The latter set of activities is necessary to minimize potential (emergency) risks to people and environment. Among the examples of protective actions are early warning and evacuation along with other self-preparedness activities. Activities ensuring immediate disaster needs such as rescue and search, initial medical care, and shelter are example to other protective activities aimed at providing emergency assistance to disaster victims. On the other hand, mitigation efforts focus greatly on reducing the direct impact of the disaster event (e.g. removal of flood debris from channels) as well as further damage associated with the disaster (e.g. earthquake-induced fires).

Perry (2007) emphasized the key disaster response requirements as (i) preparedness activity in vulnerable region, (ii) involvement of the local people, (iii) coordinated, locally inclusive needs assessments, (iv) collaborative information sharing between participating parties, and (v) logistical expertise and efficiency. An effective disaster response system should be capable of efficiently overcoming the challenges associated with (i) citizen behavioural response to disasters, (ii) resource and people convergence, (iii) role abandonment by emergency workers, (iv) disaster declarations, and (v) communications.

It is important that the organizations responsible for disaster response adopt both flexibility and discipline in their emergency strategies. In this regard, the level of institutional rigidity has been a major concern for organizations. An organizational typology suggested by Harrald (2006) is given in Figure 1.8. Based on the attributes agility and discipline this typology recommends balanced/adaptive organizations (i.e. well-structured organizations with creative culture) as they are capable of properly functioning in case of a disaster situation given their ability to overcome uncertainties creatively in operational context.

Disaster response is followed by disaster recovery, a process mainly aimed at bringing systems effected (by the disaster) to their normal state, as much as possible. Unlike disaster response activities, disaster recovery efforts extend beyond the emergency time soon after the disaster event. Disaster recovery encompasses activities of planning to resource acquisition. Examples to disaster recovery activities are housing reconstruction/shelter, economic, environmental, debris management, infrastructure and financial resources. One can distinguish between two types of recovery activities, short-term and long-term. The main distinction is that short-term recovery activities are those immediate (i.e. within two weeks) activities performed to maintain critical human systems at the minimum required standards for their optimum operation.

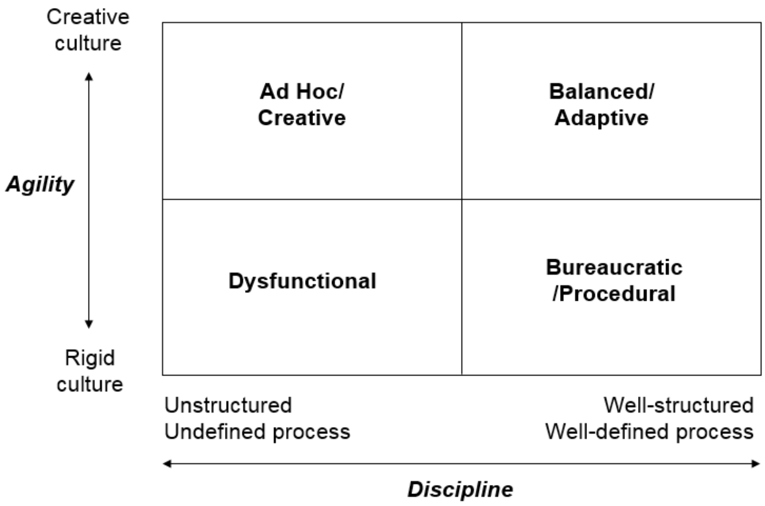


Fig. 1.8. An organizational typology for response organizations (Adapted from Harrald, 2006).

Figure 1.9 illustrates the time line of phases occurring soon after a disaster. Here the term (emergency) relief is used to describe the phase in which necessary assistance or intervention is facilitated to meet the life preservation and basic needs of affected people. Some of the relief efforts may last for longer than the recovery phase, e.g. healthcare support such as psychological treatments. Rehabilitation refers to a set of decisions actions taken following a disaster for the purpose of restoring/improving the pre-disaster state in the disaster hit area. It is important that these decisions be tailored to decrease latent vulnerabilities and facilitate actions to reduce disaster risk. Reconstruction concerns building of damaged living conditions of affected communities in consideration of long-term economic, environmental and social sustainability (Boano, 2014). As shown in Figure 1.9, disaster recovery management can be considered to cover relief, rehabilitation and reconstruction.

Disaster recovery can be considered as a process that is heavily defined by the nature and the severity of damage to the built environment. Hence, high levels of communities' resilience to disasters, as determined by the soundness of economic infrastructure, sufficiency of social and human capital, and having enough knowledge and experience, they all of course help ensuring a quicker and less costly recovery (Perry, 2007). It should be noted that each disaster will lead to different consequences and at different levels (e.g. societal, financial, and organizational). All these factors have a huge influence on the extent, scope and success of recovery. Besides these, disaster recovery is a process that needs to be determined by the communities' and the governments' expectations. Consequently, involvement of citizens and community representatives within the process of decision making for recovery planning gains wider importance.

Effective disaster response and recovery is often challenging due several reasons, lack of communication and collaboration within the planning and management processes being the most important ones. The past experiences showed that many times that lack of coordination and cooperation among stakeholders between the authorities, parties and stakeholders hinders effectiveness of the response actions.

Some of the operational challenges to disaster response can be listed as: (i) destructive citizen behaviour (ii) emergency personnel role abandonment, (iii) incomplete and limited information, (iv) unanticipated resources shortfalls. Local governments need to make sure that their disaster response and recovery plans address efficient strategies for capable management of disruptions arising from these challenges.

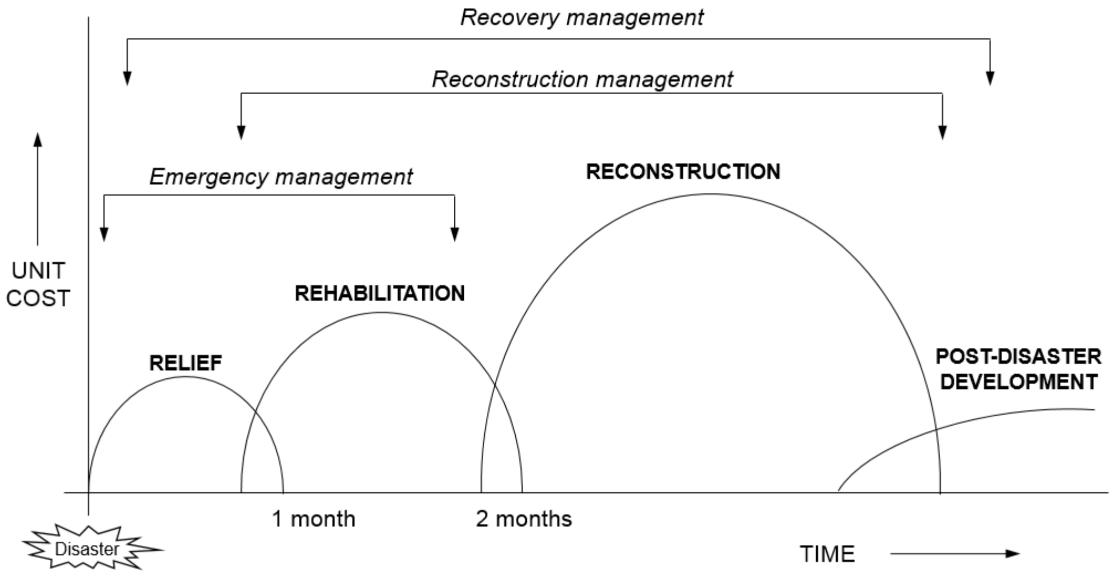


Fig. 1.9. An organizational typology for response organizations (Adapted from Alexander, 2000; Boano, 2014).

A comprehensive overview of the incident planning process, and critical points in command, control, coordination, decision-making and the common operational picture is provided in Chapter 3 where the need for a common operational picture in disaster response, and advances in the common operational picture are discussed as well.

1.4. Capacity building

Capacity building is the development of "capabilities, resources and personnel that facilitate the development of policies and procedures that proactively manage response and recovery so as to lessen the financial and emotional hardships that disasters leave in their wake" (Kapucu and Özerdem, 2013). One fundamental issue that underlies efforts for capacity building for crisis management is the availability of funding. The required funding for disaster response and recovery should be secured by policies formulated so as to enhance disaster preparedness in vulnerable communities. Another issue is joint collaboration of public authorities and of the stakeholders involved in crisis management as well as researchers. 't Hart and Sundelius (2013) mentions various activities where such collaboration is carried out to upgrade EU-level contingency planning and crisis preparedness. These are (i) first-hand observations and in-depth evaluations of major crisis management operations, (ii) assistance in risk assessment and crisis planning, and (iii) extensive training and exercise programs. The reader is referred to Boin et al. (2006) for a discussion on the crisis management capacity in the European Union, where the strengths and weaknesses of the EU's organizational capacity to manage crises are described.

Allen (2006) emphasizes the value of community involvement for local capacity building, and identifies four factors which can contribute to disaster preparedness, response and recovery: (i) technical information dissemination and training, (ii) raising awareness of risk and vulnerability, (iii) accessing local knowledge, (iv) mobilizing local people.

Lessons from past experiences should guide any efforts for capacity building.

CHAPTER 2 TSUNAMI CRISIS MANAGEMENT

In this chapter, various aspects of tsunami crisis management are discussed with special emphasis on the needs for crisis management and capacity building using both the academic and the grey literature.

A disaster management cycle with special reference to tsunamis is provided in Figure 2.1. In this figure, the components "response", "short term relief", "post-disaster assessment and mitigation", and "relief and recovery" are central to the scope of tsunami crisis management. While "response" puts special emphasis on measures like early warning and evacuation, "short term relief" includes measures complementing "response" activities, e.g. provision of evacuation centres and temporary housing, basic health services, and food. "Post-disaster assessment and mitigation" on the other hand is another major component crucial for reducing the potential tsunami risk in the future. Lastly, "relief and recovery" is aimed at helping people to recover from the tsunami disaster and continue their routine life. The role of local government, national government, international bodies, private sector, media, and scientific community as well as communities is all equally important for a successful tsunami crisis management.

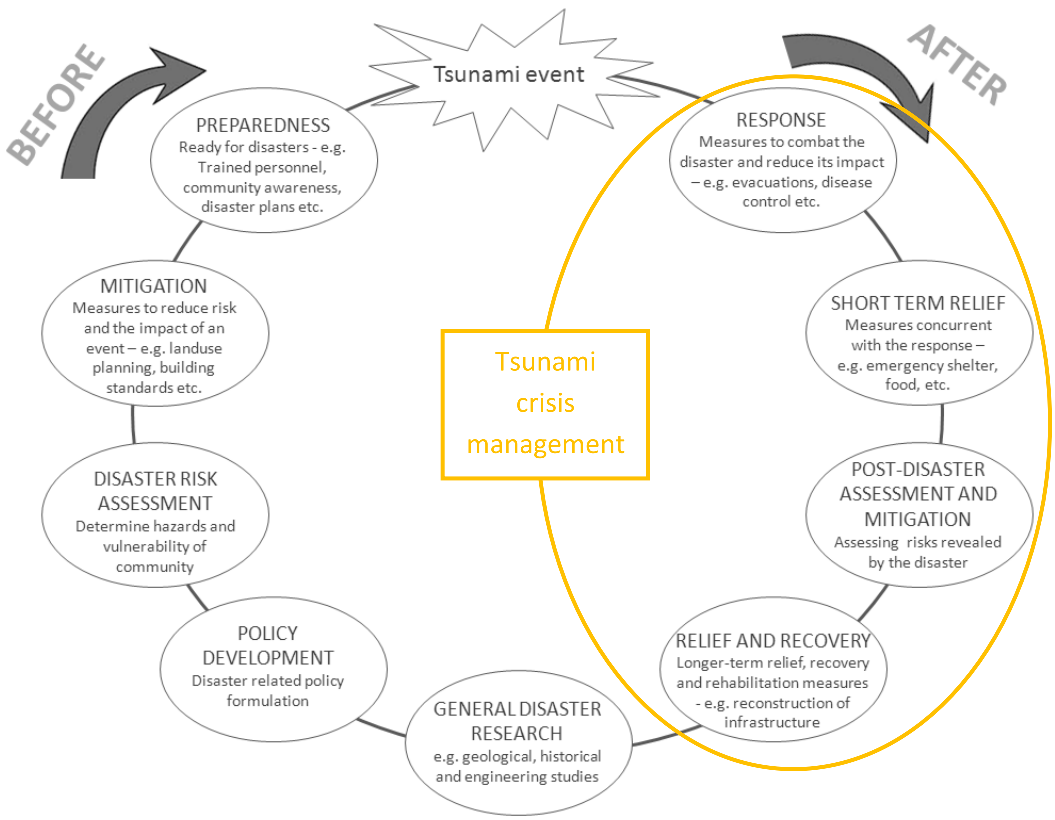


Fig. 2.1. Key elements of the disaster management cycle (with special reference to tsunami) (Adapted from Bird and Dominey-Howes, 2008).

The discussions that follow seek to address the issues: Early warning systems; Response, relief and recovery; Humanitarian aid and response; Logistics; Post-disaster waste management; Post-disaster resettlement and reconstruction; Coastal zone management; Media and communication; Employment recovery and business continuity; Assessment of post-disaster activities

2.1. Early warning systems

In case of a tsunami, the outcome of an efficiently designed early warning system can prove valuable to the community in that people can evacuate the region or at least go to higher elevations (i.e. vertical evacuation) to avoid the destruction of tsunami waves to their lives.

IOC/UNESCO is responsible for addressing the needs and the management of regional Intergovernmental Coordination Groups (ICGs) developed for tsunami warning systems in the Pacific Ocean, in the Indian Ocean, in the Caribbean Sea, and in the North-East Atlantic, Mediterranean and connected seas region – which are:

- The Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS)
- The Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS)
- The Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS)
- The Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS)

As part of ICG/NEAMTWS, a Tsunami Information Centre for the NEAM region – called NEAMTIC – was also established with the aim of increasing awareness and preparedness of the general public, which is an essential requirement for such tsunami warning systems to be successful and effective. NEAMTIC provides information on warning systems, risks and good practices in respect of tsunamis and other sea-level related hazards for civil protection agencies, disaster management, decision makers, schools, industries in the coastal zone and the general public. TsunamiReady program by the U.S. National Oceanic and Atmospheric Administration (NOAA) is "*a voluntary community recognition program aimed at promoting tsunami hazard preparedness as an active collaboration among federal, state/territorial and local emergency management agencies, community leaders and the public"* and helps "communities (i.e. a local government entity, an Indian tribal government or a facility that has the authority and ability to implement the TsunamiReady Guidelines) minimize the risk posed by tsunamis through better risk assessment, planning, education and warning communications" (http://www.tsunamiready.noaa.gov/).

Post et al. (2009) proposes a methodological framework for assessing human immediate response capability (in terms of time) related to tsunami threats in Indonesia at a sub-national scale. They identify the estimated time of arrival of a tsunami, the time at which technical or natural warning signs can be received by the population, the reaction time of the population, and the evacuation time as the key factors determining human response. Quantification of the evacuation time considers *human extrinsic (land cover, topography, population density) and intrinsic factors (age, gender distribution) by assigning different evacuation speeds properties and evacuation speed reductions*. The results are obtained for the coastal areas of Sumatra, Java and Bali and give indication for hotspots of weak response capabilities and estimation of evacuation times. As such, the findings of the study provide prioritization strategies for early warning, evacuation and contingency planning as well as for awareness and preparedness particularly in terms of local level tsunami response.

2.2. Response, relief and recovery

In this part the three phases of emergency, which are response, relief, and recovery, are discussed in view of the needs for tsunami crisis management and capacity building.

Learning from past tsunami disaster experiences and analysis of best practices plays a key role in guiding and improving future efforts response, relief and recovery both operationally and functionally. Such learning strategy actually proves valuable in investigation of reasons behind possible failures as well as identification of effectiveness factors (Khasalamwa, 2009; Ching, 2011; Athukorala, 2012).

Perry (2007) summarizes the disaster response deficiencies in the 2004 Indian Ocean Tsunami (Table 2.1). The interview findings confirm the well-recognized needs of effective disaster management: (i) more proactive governments and local communities, and (ii) more collaboration among all parties, but including also the local people – which are all issues that have been extensively addressed in the recent relevant literature. Athukorala (2012) recommends building up institutional mechanisms supported by disaster policies and programs as an implicit part of national development strategies.

Table 2.1. Shortfalls in effective tsunami response in the 2004 Indonesian tsunamis (Adapted from Perry, 2007).

Disaster response requirements	*Identified response shortfalls*
Preparedness activity in vulnerable region	The lack of community knowledge of tsunamis, lack of local government disaster planning, early warning systems, education programs and emergency protocols and drills
Involvement of local people	Clear cultural differences, local bureaucracy, poverty and local vulnerabilities, aid agency paternalism, frustrations of dependency relationship
Coordinated needs assessments and relief provision	Early delays in international effort. Aid agency competition rather than coordination, lack of early knowledge of local needs
Collaborative information sharing between parties	Lack of aid agency information and collaboration in the early response days. Degrees of mistrust and misunderstanding between the government and the aid agencies
Logistical expertise	Lack of skilled logisticians on the ground in the early days. This was particularly a problem at the airports
Fostering trust and hope	In isolated instances, ascertaining a lack of the fostering of hope and trust by the relief providers in the affected communities
The bigger picture	A lack of aid-agency awareness of/or involvement in the local government's longer-term planning and initiatives to address safe relocation, community survival and infrastructure requirements. An overall lack of general understanding by the international donor cohort of the overall socio-economic plight and long-term resilience requirements of the most-affected countries

The report by IOC/UNESCO (2008) – where the focus is mainly on early warnings and evacuation strategies – summarizes the lessons learned from Indonesian tsunamis in 2004 and 2006 (Aceh and Pangandaran, respectively) based on the experiences of eyewitnesses. Referring to the experiences from the Great East Japan Earthquake of 2011, the knowledge notes by IBRD/World Bank (2012) provides a tremendous source of information on emergency response and recovery planning (Clusters 3 and 4) in the form of recommendations. Within aspects of emergency response, the highlighted issues are: ▪ mobilization and coordination of expert teams ▪ nongovernmental organizations, non-profit organizations, and volunteers ▪ emergency communication ▪ logistic chain management for emergency supplies ▪ supporting and empowering municipal functions and staff ▪ evacuation centre management ▪ ensuring protection in response and equity in recovery.

In terms of recovery planning, the points of necessity are identified as: infrastructure rehabilitation; reconstruction policy and planning; transitional shelter; debris management; livelihood and job creation. In the long-term relief practices for tsunami crisis management, provision of psychological support to disaster victims is as well important, and it requires a special emphasis. However, this practice is often neglected especially in developing countries.

A tsunami emergency response plan for a coastal community in Malaysia is developed founded on a community-based disaster preparedness approach by Said, Mahmud and Abas (2011). The work, using the 2004 Indian Ocean Tsunami as a case study, proves the viability of a community-based approach (where the local community is taken as the primary focus of attention in disaster risk reduction) to tsunami mitigation and preparedness. It is stated that community-based approach to disaster preparedness can enhance community preparedness to tsunami and should be adopted in countries which do not have a tsunami emergency response plan yet. In this respect this study highlights the importance of building local disaster response capacity for tsunami preparedness, i.e. through utilization of local resources, in engagement with of local capacities, and inclusion of local communities. Similarly, Gupta and Sharma (2006) points out to the importance of local capacities in accelerating the recovery process and making the whole process more efficient. Furthermore, evidenced by their findings from the 2004 Indian Ocean Tsunami, they identify good governance and social capital as the key features of rightful recovery process as well as proper capacity building in underdeveloped and most vulnerable communities. Analysing the impact of the 2004 Indian Ocean Tsunami response on local and national capacities for relief and recovery, Scheper et al. (2006) summarizes examples of capacities in different phases of disaster response as shown in Table 2.2.

Table 2.2. Capacities in different phases of disaster response (Adapted from Scheper et al., 2006).

Phase	*Examples of relevant capacities*
Rescue and relief	• Search and rescue, determination of death, burial of bodies • Damage and loss assessment, distinguishing between needs • Restoring basic access • Immediate relief materials • Providing information to affected people about search and rescue • National coordination
Recovery	• Restoring infrastructure and services • Conducting participatory assessments • Delivering support for livelihoods, transitional shelter, etc. • Providing information to affected people on the recovery process • Formulating recovery policy • Developing policies to address the interface between conflict and disaster

- Communities to take collective and equitable decisions
- Ability to influence and hold accountable

A joint evaluation study by the Tsunami Evaluation Coalition (TEC) (Telford et al., 2006) on the international response to the Indian Ocean tsunami reveals important lessons and identifies key recommendations – which are centered around strengthening international disaster response capacity and quality, and international funding for disaster response:

- ✓ *The international humanitarian community needs a fundamental reorientation from supplying aid to supporting and facilitating communities' own relief and recovery priorities.*
- ✓ *All actors should strive to increase their disaster response capacities and to improve the linkages and coherence between themselves and other actors in the international disaster response system, including those from the affected countries themselves.*
- ✓ *The international relief system should establish an accreditation and certification system to distinguish agencies that work to a professional standard in a particular sector.*
- ✓ *All actors need to make the current funding system impartial and more efficient, flexible, transparent and better aligned with principles of good donorship.*

The quality of disaster response (and recovery) to disasters can be improved. Whybark (2015) argues, based on the recent disasters around the world, that there is a decrease in response quality, and discusses opportunities for co-creation of improved quality disaster responses and recovery. In his paper three major reasons behind such decrease are identified as (i) limited global logistics capacity, (ii) difficult inter-agency and/or international collaboration, and (iii) increased reliance on non-governmental organizations to provide the response. Borrell et al. (2008) presents an approach for enhancing emergency response capability through supporting individual and organisational learning (e.g. planning processes for transferring the information and knowledge obtained from the evaluation of emergencies to the entire organisation) from previous emergency response evaluations. The approach was verified on several case studies, including the 2004 Indian Ocean Tsunami.

In the Tsunami Evaluation Coalition (TEC) report by Scheper et al. (2006) three recommendations for improving tsunami response practice are given as:

- *Engagement with local and national capacities.* "This includes the ability to recognise and identify local capacities and the need to include local communities in planning and decision-making through participation and consultation, and commitment to devolve decision-making as far as possible".
- *Attention to social inequalities, exclusion and hierarchies.* "Capacity should be defined in relation to not only skills and training, but also the empowerment of poorer and marginalised groups. The capacity of a community to resist disaster is particularly sensitive to this. It includes not simply identification of such groups but ensuring that particularly their voices are heard in decision-making".
- *Contribution to an enabling environment and context.* "Marginalised groups should improve their position in relation to communities, and communities in relation to district and national authorities. The basis for this process is empowerment through the strategic management of information, and strengthening downward accountability. Advocacy is also an important element but should be based on enhanced local capacities rather than external interventions".

Recognizing the essence of effective response in integrated and comprehensive tsunami disaster management and planning, Perry (2007) presents a model of natural disaster planning which builds upon the tsunami disaster response requirements (see Table 2.1). It considers disaster response as its essential process within the context of disaster planning-continuum and can be seen in Figure 2.2. The model (i) highlights "the focal importance of the local-nation governance and leadership in disaster preparedness activities, (ii) depicts the widespread local and international consultation and collaboration that is required for complete planning thoroughness, (iii) highlights the requisite interrelatedness of disciplines, governments, communities, nations, support organizations and experts, in planning to cope with widespread devastation and associated loss of life and injury, (iv) presents a representation of the types of players required for a thorough, widely informed planning and committed implementation (Perry, 2007).

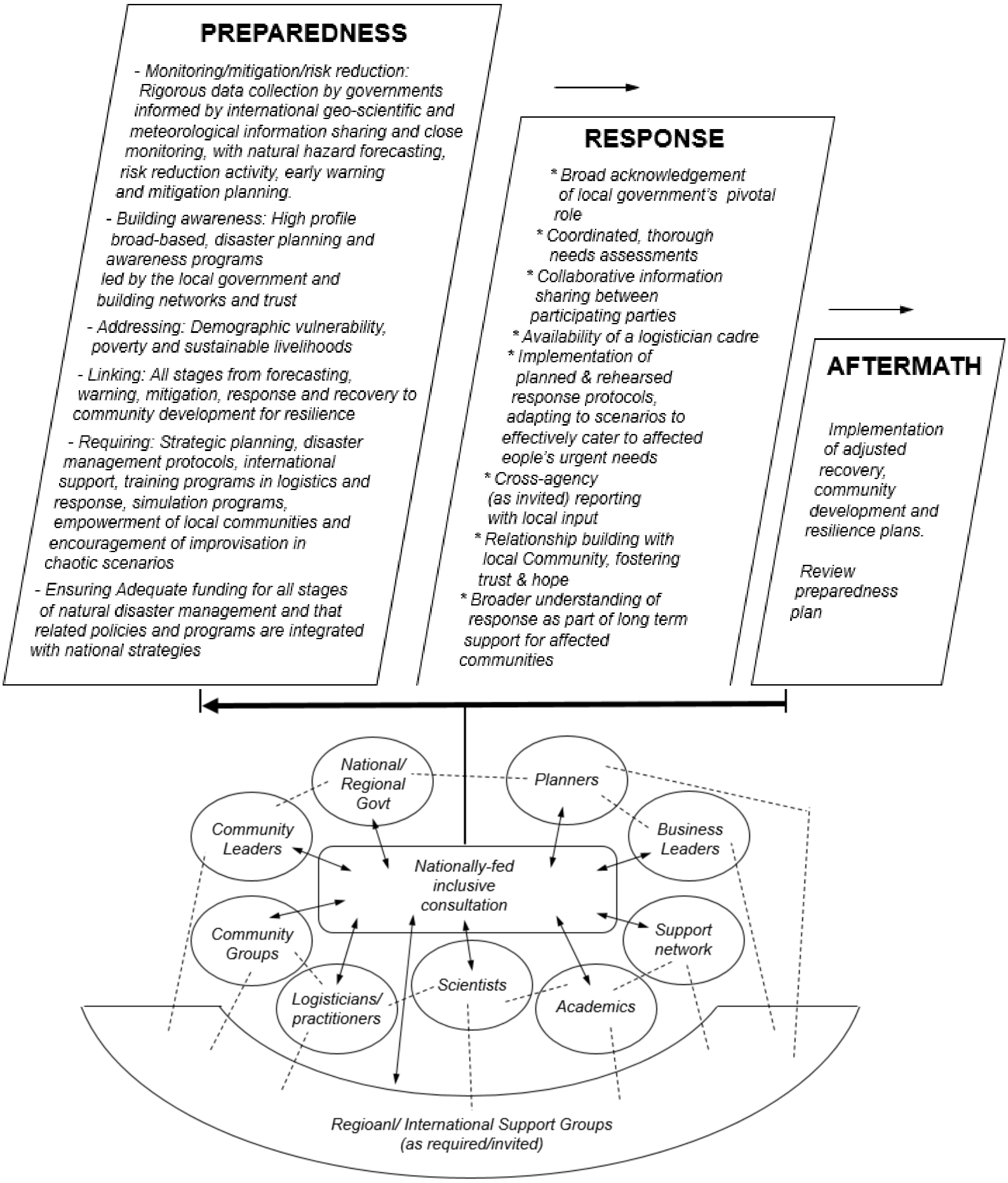


Fig. 2.2. Effective response as part of holistic, inclusive natural disaster management planning (Adapted from Perry, 2007).

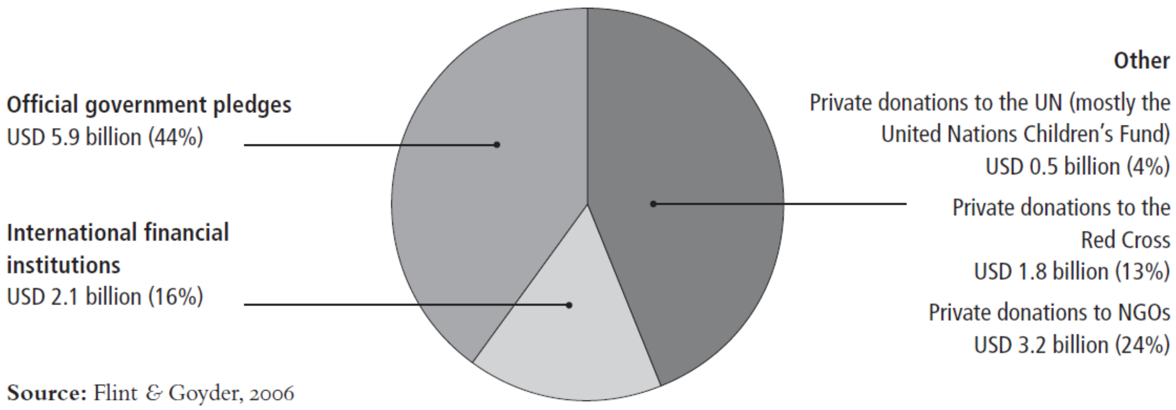
2.3. Funding of humanitarian aid and response

Humanitarian aid is the material and logistic assistance to people in need. It is usually short-term help until the long-term help by government and other institutions replaces it. Among the people in need belong homeless, refugees, victims of natural disasters, wars and famines. The primary purpose of humanitarian aid is to save lives, reduce suffering and respect to human dignity. Humanitarian aid is material or logistical assistance provided for humanitarian purposes, typically in response to humanitarian crises including natural disasters and man-made disaster. The primary objective of humanitarian aid is to save lives, alleviate suffering, and maintain human dignity. It may therefore be distinguished from development aid, *which seeks to address the underlying socioeconomic factors which may have led to a crisis or emergency* ("Humanitarian aid", 2015, para. 1). United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) has an online platform to support humanitarian operation globally which serves to connect responders and disseminate operational information (https://www.humanitarianresponse.info/).

There has been a huge growth in international humanitarian response since 1989 with respect to volume, number of organisations and systems for information and communication (Walker and Maxwell, 2009; as cited in Hilhorst, 2013). Such growth, together with disaster risk reduction measures, undeniably helped effectively decrease fatalities. The fundamental aspect of humanitarian aid and response to disasters concerns funding of such efforts. The TEC report by Engelhardt et al. (2006) further evaluates the flow of funding for humanitarian aid at different levels following the 2004 Indian Ocean Tsunami with a focus on the principles of good humanitarian donorship. Figure 2.3 shows proportions of different sources of funding the humanitarian aid and response to the 2004 Indian Ocean Tsunami by the international community (Telford and Cosgrave, 2007; Flint and Goyder, 2006). While such distribution was not found to be unsatisfactory – overall it was a well-funded humanitarian emergency, Flint and Goyder (2006) discussed that the accountability and transparency of the funding could have been better with more emphasis on financial tracking and reporting. Furthermore, Telford and Cosgrave (2007) highlighted the need for speedy and flexible funding which is based on the actual needs of tsunami hit communities. Above all it is important that the funding schemes are managed in consideration of the affected communities' national capacities, institutional mechanisms as well as various cultural, social and environmental characteristics (Perry, 2007).

The OXFAM Research Report (December, 2014) investigates the reasons behind unequal and nonrapid funding by the international community for certain emergencies during the 2004 Indian Ocean Tsunami. Based on the funding challenges identified (e.g. insufficient funding and funding inequalities) the report concluded that there is an imperative need to increase international funding and work to alleviate the consequences of future emergencies while fostering impartial, needs-based funding.

Figure 2.4 depicts very well the dynamics of international humanitarian funding. Understanding the external (i.e. level and type of fund raising, level of media coverage, level humanitarian need, and level of international pressure) as well as the internal factors (i.e. private vs. government donations) within this framework will certainly help to achieve more adequate and equal funding opportunities for a disaster emergency.



Source: Flint & Goyder, 2006

Fig. 2.3. Funding sources for the response to the tsunami of December 2004 (Adapted from Telford and Cosgrave, 2007).

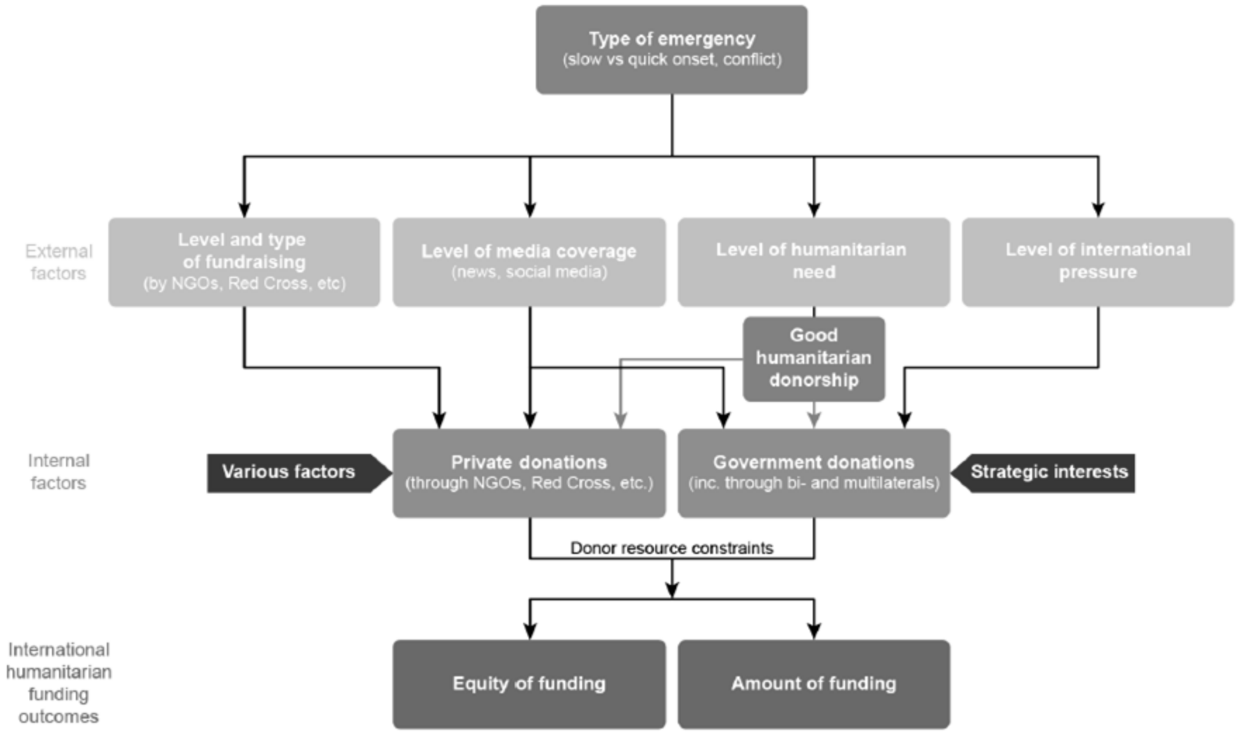


Fig. 2.4. Factors influencing humanitarian funding (OXFAM Research Report, 2014)

The practice of humanitarian aid requires rather more attention. Challenged also by the dynamics of humanitarian funding (see Figure 2.4) the practice of humanitarian aid needs to be shaped in accordance with the nature of humanitarian actors, the interaction of different kinds of politics involved, and the prevailing humanitarian partnerships as opposed to dictated solely by the theoretical principles and policies (Fernando and Hilhorst, 2006; Hilhorst and Jansen, 2013; Brandstrom et al., 2008)

2.4. Logistics

Logistics is the most vital aspect of any disaster relief effort determining the success of relief operations and it constitutes around 80% of the total costs in disaster relief (Van Wassenhove 2006). Emergency logistics is often the largest and most complex element of relief operations (UNDP, 1993; as cited in Pettit and Beresford, 2009). The effectiveness of the emergency aid response depends on logistic speed and efficiency (Pettit et al., 2011; as cited in Cozzolino, 2012). The 2004 Indian Ocean Tsunami clearly highlighted the critical role of logistics in humanitarian relief operations (Christopher and Tatham, 2011), and consequently, resulted in increased interest in disaster logistics by researchers and practitioners (Kovács and Spens, 2007).

The peculiar characteristics of humanitarian logistics can be summarized as given in Table 2.3. While majority of these characteristics are valid for different types of emergency situations including disaster relief, the logistics operations needed might differ. Kovács and Spens (2007) affirms that humanitarian logistics, despite having some distinct features, can benefit from the basic principles of business logistics. Pettit and Beresford (2009) brings a humanitarian aid context to the discussion of critical success factors which are widely used in commercial supply chains, thereby contributing to the understanding of the nature of supply chain management for humanitarian aid in crisis conditions. Holguín-Veras et al. (2012) identifies the research gaps of necessity to be dealt with for improving the efficiency humanitarian logistics. They conclude that the field of humanitarian logistics broad enough that it cannot be precisely characterized by a single definition of operational conditions. While some humanitarian logistic efforts are aimed at the long-term disaster recovery and humanitarian assistance where the main focus is operational efficiency, post-disaster humanitarian logistic operations are primarily realized (often in a chaotic operational environment) as part of disaster response and short-term recovery activities.

Table 2.3. Characteristics of humanitarian logistics (Kovács and Spens, 2007).

	Humanitarian logistics
The main objective	Alleviating the suffering of vulnerable people
Actor structure	Stakeholder focus with no clear links to each other, dominance of NGOs and governmental actors
3-phase setup	Preparation, immediate response, reconstruction
Basic features	Variability in supplies and suppliers, large-scale activities, irregular demand, and unusual constraints in large-scale emergencies
Supply chain philosophy	Supplies are “pushed” to the disaster location in the immediate response phase. Pull philosophy applied in reconstruction phase
Transportation and infrastructure	Infrastructure destabilized and lack of possibilities to assure quality of food and medical supplies
Time effects	Time delays may result in loss of lives
Bounded knowledge actions	The nature of most disasters demands an immediate response, hence supply chains need to be designed and deployed at once even though the knowledge of the situation is very limited
Supplier structure	Choice limited, sometimes even unwanted suppliers
Control aspects	Lack of control over operations due to emergency situation

Natural disasters bring many logistical challenges which can negatively affect disaster response and recovery activities. Among these challenges are destruction of physical infrastructure such as roads, bridges and airports, remoteness of the area and limited transport capacity, and disruption of power and telecommunication lines (Thomas and Kopczak, 2005; Perry, 2007). Lack of logistical expertise, e.g. lack of skilled logisticians to procure and transport supplies, has further potential to hamper effective response efforts (Perry, 2007). In the 2004 Indian Ocean Tsunami the major logistics challenges were caused by the sheer quantity and associated chaos of donated relief supplies in addition to the shortage of logistics expertise and lack of warehousing capacity, moving equipment and suitable transport (Perry, 2007). Therefore coordination of logistical activity is essential and requires more attention for preventing duplication and waste of resources due to unnecessary competition between agencies (Perry, 2007). In order to eliminate delays in distributing relief Thomas and Kopczak (2005) suggests that logisticians are included in the planning and decision-making process. Perry (2007) underlines the obligation for aid agencies to recognize increased logistical capacity building (e.g. training of more logisticians locally in vulnerable regions).

Kovács and Spens (2007) presents a framework for helping practitioners to plan and conduct humanitarian logistics operations (Figure 2.5). In this framework the perspectives of different actors involved in providing humanitarian aid on disaster relief operations were brought together (Kovács and Spens, 2007).

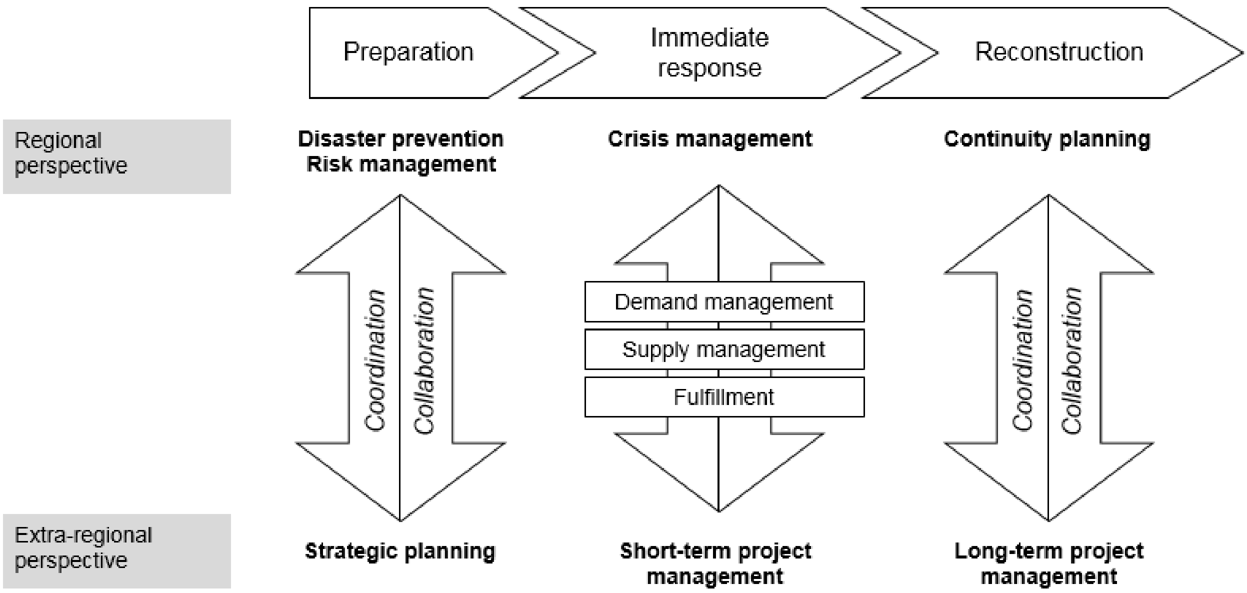


Fig. 2.5. Disaster relief logistics framework by Kovács and Spens (2007).

Unfortunately the literature on humanitarian logistics for tsunami response and recovery is limited. The readers are advised to refer to the Chapter 16: Management of Logistics Chain for Emergency Supplies in the book by Ranghieri and Ishiwatari (2014) for an overview of logistics as part of the emergency response to the Great East Japan Earthquake.

2.5. Post-disaster waste management

Great volumes of debris and waste can be generated by disasters of high severity and substantial nature. The type of built environment affected by the disaster (e.g. coastal/inland, urban/rural) as well as the disaster type are influential determining factors of waste types. Disaster wastes can differ in their composition and manageability (e.g. recyclability, handling procedures required). Some examples of disaster wastes are “vegetative debris or greenwaste, sediment/soil and rock, household hazardous waste (refrigerant, oils, pesticides, etc.), construction and demolition debris from damaged buildings and infrastructure (such as roads, pipe networks and other services), industrial and toxic chemicals (including fuel products), putrescible wastes (such as rotting food), vehicles and vessels, recyclables (plastics, metals, etc.), electronic and white goods, waste from disaster-disturbed pre-disaster disposal sites, human and animal corpses" (Brown et al., 2011). Typical debris streams for tsunamis include vegetative, construction and demolition, personal property/ household items, hazardous waste, household hazardous waste, white goods; soil, mud and sand, vehicles, and vessels, putrescent (FEMA, 2007). Disaster debris and waste remain the most critical environmental problem faced by the countries (Srinivas and Nakagawa, 2008). Debris removal is the principal step to initiate suitable conditions for rehabilitation and reconstruction in the aftermath of disasters. Debris removal is also important in that it creates (temporary) employment opportunities to communities affected by the disaster.

In the 2004 Indian Ocean Tsunami around 10 million cubic metres of waste was generated in Indonesia alone (Bjerregaard, 2009). The total cost of disaster waste management in Sri Lanka (0.5 mill tonnes of waste) and Thailand (0.8 mill tonnes of waste) was estimated to be approximately US$5–6 million and US$ 2.8 million), respectively (Basnayake et al., 2006). Following the Great East Japan Earthquake of 2011 there was some 20 million tonnes of disaster waste in Japan (Chapter 23: Debris Management - Ranghieri and Ishiwatari, 2014). Figure 2.6 shows examples and stages of disaster waste removal. The report by UNDP (2012) on debris clearance and demolition after the 2004 Indian Ocean Tsunami identifies four challenges: (i) bringing together all stakeholders for a consensus and effective action plan (ii) ensuring workers' health and safety (iii) halting of work when human remains were found on the site (iv) heavy equipment contract payment conditions. Karunasena et al. (2011), based on a pilot study concerning post-disaster waste management in Sri Lanka, reported the predominating capacity gaps in post-disaster waste management as (i) unavailability of a centralized body, poor implementation of rules and regulations; and (ii) lack of skills and confidence, inadequate funds, lack of communication and coordination. More specifically, Karunasena et al. (2012) and Karunasena et al. (2015)lists the major challenges in post-disaster construction and demolition waste management in Sri Lanka as lack of a sound legal framework, finance and technology constraints, community unawareness, a lack of human resources and physical assets and the inadequate capacities of responsible authorities.

United Nations Development Programme (UNDP) carried out a project for the management of debris and municipal solid waste during the recovery and rehabilitation of Aceh Province and Nias Island following the 2004 Indian Ocean Tsunami. Started in March 2005, the Tsunami Recovery Waste Management Project (TRWMP) had three phases during its seven-year lifetime: recovery, rehabilitation, and reconstruction. The short-term aim of the project was debris and rubble clearance and its corresponding improvement to public health protection, physical recovery and the creation of immediate temporary employment (http://www.id.undp.org/content/indonesia/en/home/operations/projects/crisis_prevention_and_recovery/tsunami-recovery-waste-management-project--trwmp-.html).

Fig. 2.6. Top: Massive clean-up operation with the participation of communities in the worst hit zones of Banda Aceh (UNDP, 2012). Bottom: Cleanup progress in Wakabayashi-ward in Sendai, Japan following the March 11, 2011 tsunami. The photos were taken on 16 March 2011, 2 June 2011, and 3 September 2011, respectively (AP/Kyodo News)

The management of disaster waste is essential to avoid any environmental and public health, which forms a crucial step in achieving successful recovery process. In line with the disaster management cycle disaster waste management can be addressed in three phases (Kuramoto, 1995; Baycan and Petersen, 2002; JEU, 2010; as cited in Brown et al., 2011):

- Emergency response*: Debris management to facilitate preservation of life, provision of emergency services, removing immediate public health and safety hazards (e.g. unstable buildings).*
- Recovery*: Debris management as part of restoring lifeline restoration and building demolition.*
- Rebuild*: Debris management of wastes generated from and used in re-construction.*

The key aspects of disaster waste management, as identified by Brown et al. (2011), are: (i) planning, (ii) waste (e.g. waste composition, quantities, and management phases), (iii) waste treatment options, (iv) environment, (v) economics, (vi) social considerations, (vii) organisational aspects, (viii) legal frameworks, and (ix) funding. All these aspects should be considered in the practice of disaster waste management, particularly within capacity building efforts (Karunasena et al., 2011; Karunasena and Amaratunga, 2015). Brown et al. (2011) emphasize that the literature needs to start focusing on the institutional (organisational, legal and financial) frameworks for disaster waste management, and should address disaster waste management plans/guidelines through integrated case studies. Future research efforts are recommended to address evaluation of existing legislation, organisational structures and funding mechanisms for disaster waste management programmes as well as their social impact (Brown et al., 2011).

Sustainability of post-disaster waste management is a fundamental issue that should not be ignored by the relevant authorities and agencies responsible for policy development. Accordingly, capacity building becomes an imperative objective within post-disaster waste management planning and practice. To guide involved actors in sustainable post-disaster waste management Karunasena et al. (2010) proposes a framework for capacity building where it is characterised as a dynamic and a continuous process that can be influenced by the external environment. The framework considers two levels: human resource and organisational, contributing institutional and legal development.

Karunasena and Amaratunga (2015) identifies seven areas for evaluating existing capacities, capacity gaps and factors affecting capacity building in post-disaster construction and demolition waste management: skills and confidence building, organisational implementation, continuity and sustainability, investment in infrastructure, research and development, communication and coordination and linkages and collaboration (Table 2.4). The analysis conducted for Sri Lanka based on these seven areas, presented in Table 2.4, clearly implies gaps in legal powers, finance, management, technology, physical assets and human resources – majority of which concerns the functional activities of national entities in post-disaster waste management (Karunasena and Amaratunga, 2015).

a

2.6. Post-disaster resettlement and reconstruction

Post-disaster resettlement is fundamental to developing tsunami-resilient communities in that appropriate resettlement policies can greatly help reducing tsunami damage hence increase resilience to future tsunamis (Danar and Pushpalal, 2014). Post-disaster settlement and reconstruction plays a key role in continued, local capacity building (Leon et al., 2009). In the aftermath of a tsunami providing transitional settlement and shelter becomes one of the urgent responses as part of a tsunami crisis management plan. Post-disaster shelter encompasses both infrastructure and non-infrastructure elements. Post-disaster settlement directly concerns planning of infrastructure developments and maintenance (e.g. public health, energy supply, water, and waste management) for post-disaster settlement (Leon et al., 2009). As Leon et al. (2009) explained:

> *“By building and maintaining capacity for post-disaster infrastructure and maintenance, the transitional settlement and shelter process should produce permanent communities and housing that have significantly reduced vulnerabilities. That is a necessary, even if not sufficient, component for stopping disasters from occurring in the first place and for bypassing the need for the transition.”*

The process of resettlement, which mainly involves relocation of people from low to higher ground, is often challenging due to various inevitable controversies that may arise. The success of resettlement process depends crucially on consideration of different social cultural, economic and policy contexts (Danar and

Table 2.4. Capacity gaps and the factors which influence post disaster construction and demolition waste management (Karunasena and Amaratunga, 2015).

	Influencing factors	
Capacity gaps	*External*	*Internal*
Skills and confidence building Fewer opportunities for personal development – training/workshops Unavailability of formal	• Repetition/duplication of programmes and committees • Lack of capacities of participants • Lower number of participants	• Lack of in-house trainers Inadequate resources – human and physical • Lack of awareness among national level officers Inappropriate assignment of ministerial functions

procedures for the preparation, conducting, monitoring and evaluation of training and awareness programmes Unavailability of strategies to retain valuable human resources	with high female representation • Language barriers • Non-functioning of important and necessary committees	• Traditional bureaucratic red tape • Unavailability of pension schemes/life insurance policies for staff
Organisational implementation Unavailability of provision for disaster waste management in existing policies Unavailability of single point responsibility at national level for post disaster waste management Inefficiency and ineffectiveness of prevailing peace time solid waste management practices, policies and responsible authorities Non-revision of existing waste management systems/ procedures	• Unenforceability of prevailing rules and regulations • Scarcity of land • Deviation at administrative and local government structures • Unavailability of a uniform system to manage solid waste • Non-functioning of important and necessary committees • Unavailability of historical data on disaster waste generated • Lack of political support	• Inadequate resources – physical and human • Unavailability of responsible persons/committees on waste management • Unavailability of a supportive system to fill vacancies in government sector. • Insufficient cadre positions • Unavailability of pre-planned scheme for disaster waste management • Inadequacy of existing spot fining system
Linkages and collaborations Unavailability of formal procedures to establish linkages and collaborations Availability of projects with complete proposals without implementation Reduced active participation of NGOs and INGOs	• Lack of capacities of working groups • Lesser commitment from responsible parties • Language barriers • Bad impressions of NGOs and INGOs	• Lack of funds • Lack of transparency and accountability in linkages • Lack of collaboration
Continuity and sustainability Less consideration of incorporation of sustainable concepts into disaster waste management practices	• Culture of people • Public attitude of environmental values • Unavailability of avenues to convert waste into	• Lack of motivation among employees on waste management • Inadequate funds

Pushpalal, 2014). Table 2.5 lists the factors which were influential on the resettlement process in three locations following the 2004 Indian Ocean Tsunami and the 2011 Great East Japan Earthquake and Tsunami. According to this table people's customs and belief, emotional place attachment, community culture and tsunami awareness, population and occupation before tsunami, proximity to relocated area, and community participation in the decision making process are all factors affecting the outcome of resettlement process in tsunami-affected regions. The latter emphasizes the importance of residents' participatory planning towards achieving tsunami-resilient communities, and helps reaching consensus about resettlement issues. It needs to be mentioned that efforts to post-disaster reconstruction for settlements and shelters are usually put by the tsunami-affected people, highlighting the significance of local community participation (Pardasani, 2006) and response (Leon et al., 2009). Overall, these factors that determine social cultural, economic and policy context of the tsunami-affected regions should be addressed within the planning process of relevant policies prior to their implementation (Danar and Pushpalal, 2014).

The decision making process for post-disaster resettlement and reconstruction presents certain challenges. Hayles (2010) explores those key challenges that non-governmental organisations (NGOs) are confronted in their decision making processes. The study points out to the need of knowledge management activities to be more focused "to guarantee that lessons learned previously are implemented elsewhere; critical in hazard mitigation and meeting the challenges of increased vulnerability due to climate change". In this respect identification and analysis of lessons learned is essential. Kennedy et al. (2008) examines the theory and practice of 'build back better' with respect to settlement and shelter implementation in post-tsunami Aceh and Sri Lanka based on four areas: (i) safety, security, and livelihoods; (ii) how post-disaster settlement and shelter could have an improved connection with permanent housing and communities; (iii) fairness and equity; and (iv) connecting relief and development by tackling root causes of vulnerability. Based on the findings of their study Kennedy et al. (2008) proposes following recommendations:

Community involvement: Community involvement does not exactly refer to community control. Accordingly, the three pillars of community involvement should be: (i) communication of planned settlement and shelter process which needs to be shaped by not only short-term but also long-term needs of tsunami-affected communities, (ii) efficient exchange of accurate and realistic information (especially on the available resources and the time plan necessary to deliver transitional and permanent settlement and shelter) to avoid unrealistic expectations which might result in frustration and tension, and (iii) adequate representation of ages, genders, and ethnicities from the communities (e.g. people who will live in the settlements and shelters and from others who will be affected by reconstruction) in decision making for settlement and shelter.

Collaboration: Transitional settlement and shelter process has links to other sectors such as water, sanitation, and public health. Concurrent planning with these sectors is therefore crucial.

Long-term planning: Integration of relief and development efforts by means of long-term planning and disaster risk reduction strategies is essential.

Leon et al. (2009) evaluates post-disaster (including tsunamis) settlement and shelter in 23 case studies from Africa, Asia, and Latin America to exemplify capacity buildings lessons. The evaluation is based on a framework that consists of four parts similar to that of Kennedy et al. (2008): (i) safety, security, and livelihoods; (ii) the question "Transition to what?" with the aim of understanding better how to connect

Table 2.5. The factors influenced on resettlement (Danar and Pushpalal, 2014).

	Banda Aceh, Indonesia	*Minamisanrikui, Japan*	*Natori, Japan*
Agree with relocation	Majority of disaster-affected people disagree to the resettlement	Majority of disaster-affected people agree to the resettlement	Still chaotic, conflict between those residents who want to return and those who against
Belief	Belief (Islam value) influenced the resettlement process	Belief did not influence the resettlement process	Belief did not influence the resettlement process
Psychological aspect	Generally, psychological and emotional bond was not the important factors that affect resettlement.	Psychological and emotional bond is not the dominant factors that affect resettlement.	Emotional bonds with housing, neighbours, communities, and the surrounding area are the dominant factors in resettlement.
Community culture and tsunami awareness	Low tsunami disaster awareness. Due to the first tsunami disaster, preparedness and awareness of communities still very low.	High tsunami disaster awareness. Preparedness for future tsunami has strongly built through the past tsunami experience.	High tsunami disaster awareness. Preparedness for future tsunami has strongly built through the past tsunami experience.
Population and occupation before tsunami	Employees in the fishing industry is 2,012 out of 239,146 Population (0,09%).	Employees in the fishing industry is 1,434 out of 17,687 Population (0,08%).	Employees in the fishing industry is 41 out of 73,193 Population (0,0006%).
Proximity to relocated area	Approximately 4 – 15 Km	Approximately 1-2 Km	Approximately 1-2 Km
Participation in decision making	In the beginning, there was no participation; but finally it is accommodated.	People participation is considered even though the decision made by Government.	People participation is considered even though the decision made by Government.

post-disaster programmes to permanent communities and housing; (iii) fairness and equity; and (iv) connecting relief and development, which also explores root causes of vulnerability. The analysis of main lessons indicates six particular activities that should be underlined for capacity building in transitional settlement and shelter. These are site selection, good governance, participatory and consultative processes, land ownership, logistics, and monitoring and evaluation.

Environmental considerations are of high importance in post-disaster resettlement and reconstruction efforts in the context of achieving tsunami resilient communities (Kennedy et al., 2008; Shaw, 2006). Kennedy et al. (2008) calls for adopting environmental considerations in the design and construction of settlement and shelter facilities for reducing long term impacts on ecosystems and livelihoods. Shaw (2006) emphasizes incorporation of environmental issues in the long-term planning for the reconstruction process. Implementation of integrated coastal zone management concepts within the recovery of tsunami-affected areas is also important (Wong, 2009). Furthermore, post-tsunami rehabilitation and reconstruction programmes provide an opportunity for actions towards improved ICZM (Sonak et al., 2008). A model for integrated coastal zone management of tsunami affected regions is given in Figure 2.7.

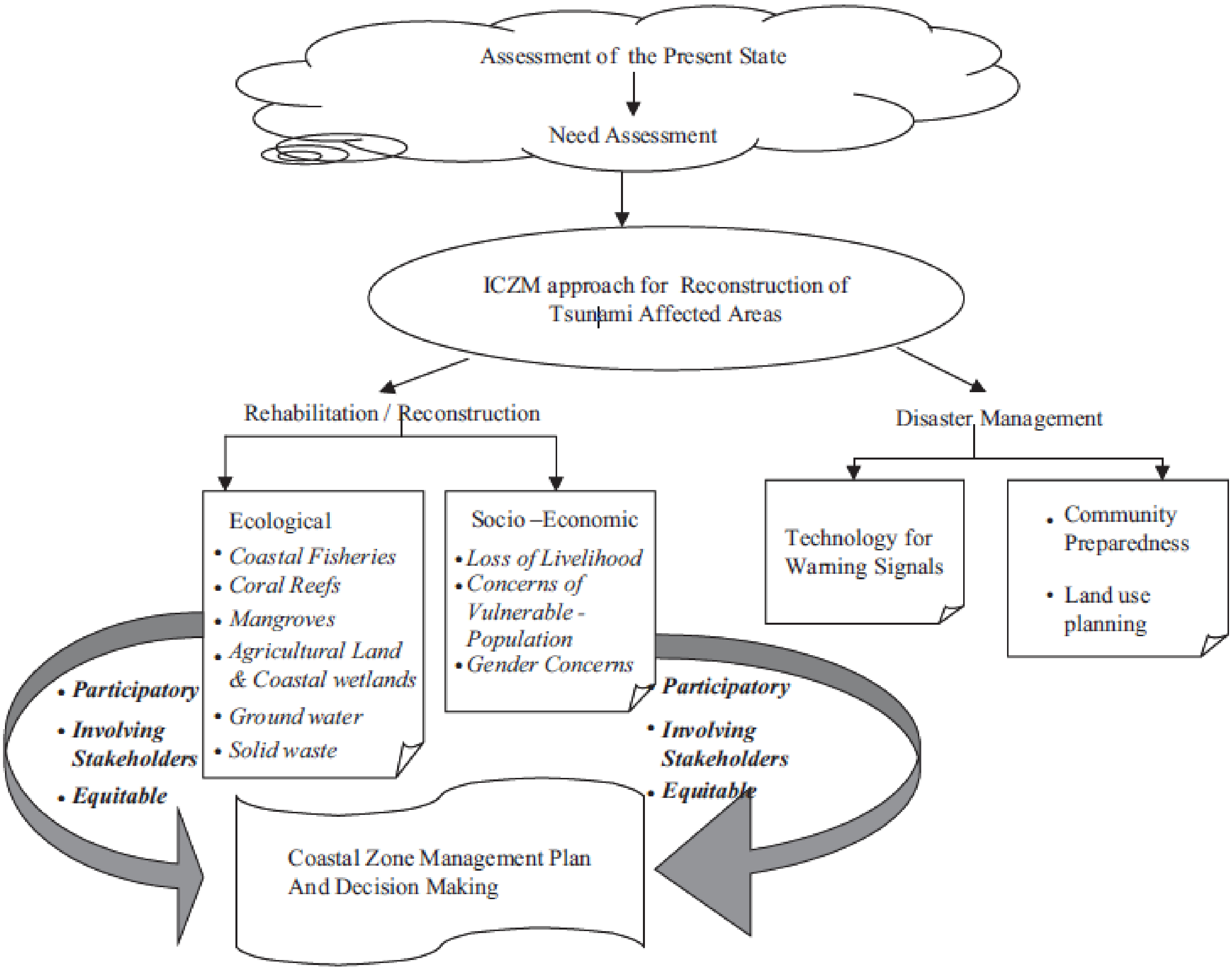


Fig. 2.7. Model for integrated coastal zone management of tsunami affected regions (Adapted from Sonak et al., 2008).

2.7. Media and communication

Crisis and risk communication is a vital component of tsunami crisis management. There are different forms of crisis and risk communication, e.g. (early) warnings, risk messages, evacuation notifications (Reynolds et al., 2005). It is important that crisis and risk communication be distinguished. Table 2.6 presents an overview of peculiar features of crisis and risk communication. Today, crisis and risk communication are commonly referred to as crisis and emergency risk communication which is a practice that incorporates principles of effective risk communication and crisis communication throughout the evolution of a risk factor into a crisis event and on through the clean-up and recovery phase. (Reynolds, 2002). A model consisting of five stages to describe the process of crisis and emergency risk communication (by Reynolds, 2005) is considered here and is explained in detail next. Based on the assumption that crises will progress in largely predictable and systematic ways: from risk, to eruption, to clean-up and recovery on into evaluation, this comprehensive model encompasses risk and warning messages and crisis communication activities:

Table 2.6. Distinguishing features of risk and crisis communication (Reynolds et al., 2005).

Risk communication	*Crisis communication*
▪ Messages regarding known probabilities of negative consequences and how they may be reduced; addressing technical understandings (hazards) and cultural beliefs (outrage)	▪ Messages regarding current state or conditions regarding a specific event; magnitude, immediacy duration and control=remediation; cause, blame, consequences
▪ Principally persuasive, i.e., advertising and public education campaigns centered	▪ Principally informative, i.e., news disseminated through media or broadcast through warning system
▪ Frequent/ routine	▪ Infrequent=nonroutine
▪ Sender=message centered	▪ Receiver=situation
▪ Based on what is currently ▪ known, i.e., scientific projections	▪ Based on what is known and ▪ what is not known
▪ Long-term (precrisis) Message ▪ preparation, i.e., campaign	▪ Short-term (crisis) Less preparation, ▪ i.e., responsive
▪ Technical expert, scientist	▪ Authority figures=emergency manager, ▪ technical experts
▪ Personal scope	▪ Personal, community, or regional scope
▪ Mediated; commercials, ads ▪ brochures, pamphlets	▪ Mediated; press conferences, press releases, ▪ speeches, websites
▪ Controlled and structured	▪ Spontaneous and reactive

- *[Stage I] Precrisis (Risk Messages; Warnings; Preparations): Communication and education campaigns targeted to both the public and the response community to facilitate:*
  - *Monitoring and recognition of emerging risks*
  - *General public understanding of risk*
  - *Public preparation for the possibility of an adverse event*
  - *Changes in behaviour to reduce the likelihood of harm (self-efficacy)*
  - *Specific warning messages regarding some eminent threat*
  - *Alliances and cooperation with agencies, organizations, and groups*
  - *Development of consensual recommendations by experts and first responders*
  - *Message development and testing for subsequent stages*
- *[Stage II] Initial Event (Uncertainty Reduction; Self-efficacy; Reassurance): Rapid communication to the general public and to affected groups seeking to establish:*
  - *Empathy, reassurance, and reduction in emotional turmoil*
  - *Designated crisis=agency spokespersons and formal channels and methods of communication*
  - *General and broad-based understanding of the crisis circumstances, consequences, and anticipated outcomes based on available information*
  - *Reduction of crisis-related uncertainty*
  - *Specific understanding of emergency management and medical community responses*
  - *Understanding of self-efficacy and personal response activities (how=where to get more information)*
- *[Stage III] Maintenance (Ongoing Uncertainty Reduction; Self-efficacy; Reassurance): Communication to the general public and to affected groups seeking to facilitate:*
  - *More accurate public understandings of ongoing risks*
  - *Understanding of background factors and issues*
  - *Broad-based support and cooperation with response and recovery efforts*

  - *Feedback from affected publics and correction of any misunderstandings/rumours*
  - *Ongoing explanation and reiteration of self-efficacy and personal response activities (how/where to get more information) begun in Stage II.*
  - *Informed decision making by the public based on understanding of risks=benefits*
- *[Stage IV] Resolution (Updates Regarding Resolution; Discussions about Cause and New Risks/New Understandings of Risk): Public communication and campaigns directed toward the general public and affected groups seeking to:*
  - *Inform and persuade about ongoing clean-up, remediation, recovery, and rebuilding efforts*
  - *Facilitate broad-based, honest, and open discussion and resolution of issues regarding cause, blame, responsibility, and adequacy of response.*
  - *Improve/create public understanding of new risks and new understandings of risk as well as new risk avoidance behaviours and response procedures*
  - *Promote the activities and capabilities of agencies and organizations to reinforce positive corporate identity and image*
- *[Stage V] Evaluation (Discussions of Adequacy of Response; Consensus About Lessons and New Understandings of Risks): Communication directed toward agencies and the response community to:*
  - *Evaluate and assess responses, including communication effectiveness*
  - *Document, formalize, and communicate lessons learned*
  - *Determine specific actions to improve crisis communication and crisis response capability*
  - *Create linkages to precrisis activities (Stage I)*

In recent years social media has gained paramount importance in emergencies and disasters with its critical role in empowering disaster relief efforts (Gao et al., 2011; Lindsay, 2011; White, 2011). Various sources of information in the form of texts, photos and videos can be easily made available via social media channels like Twitter, Flickr, Facebook, and blogs, and Youtube during disasters and emergencies. The report by Lindsay (2011) elaborates on the use of social media by emergency management officials and agencies for emergency and disaster situations while also pointing out to potential implications (e.g. inaccurate information, quality of information, malicious use of social media during disasters, privacy issues) in addition to potential benefits. The book by White (2011) is a useful reference source for those who are interested in building social media to help manage emergencies.

Information systems and technologies now have wider recognition in crisis response and management. Leidner et al. (2009) investigates the role of information technologies in Singapore’s response to the SARS and Asian Tsunami disasters and develops a framework to guide organizations/ governments in acting upon existing resources (assets and capabilities) and, in the process, enhance its pool of existing resources (Figure 2.8).

Nitsmer (2013) discusses the role of media in Thailand for tsunami disaster prevention.

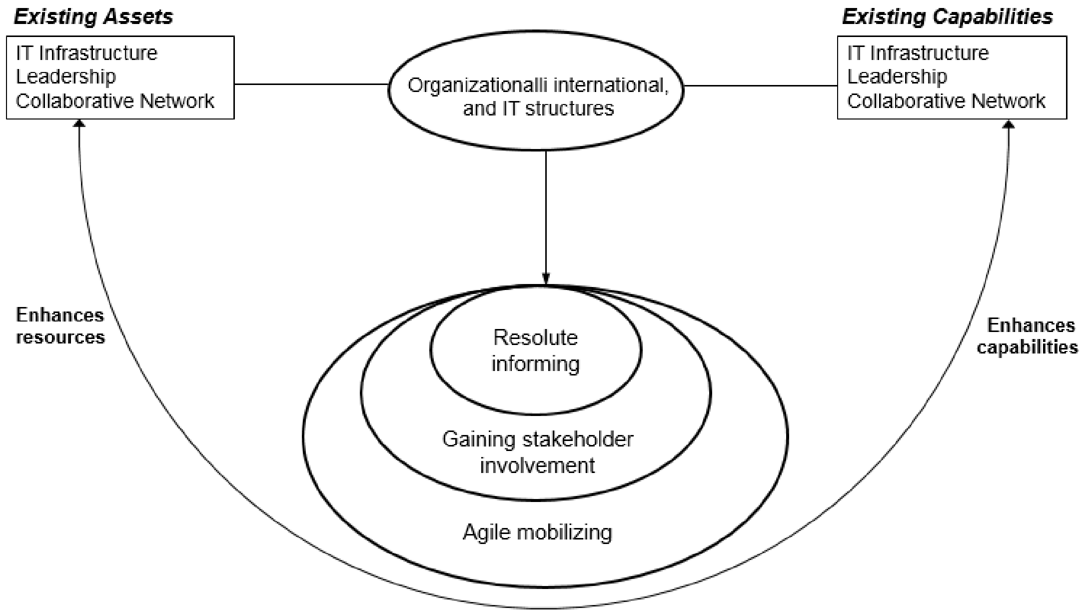


Fig. 2.8. Crisis response resource deployment framework (Adapted from Leidner et al., 2009).

2.8. Assessment of post-disaster activities

The role of learning from past experiences of tsunami disaster is of great importance for improving tsunami crisis management for a future tsunami from both functional and operational aspects. In point of fact, each tsunami disaster is an opportunity for communities, and authorities responsible for emergency/response activities to identify their incompetence regarding tsunami crisis management. Accordingly, they can enhance their ability to cope with tsunamis. This requires a detailed assessment of post-disaster activities. Conducting post-disaster surveys is a worthy way of gaining such information for improving both the functional and operational aspects of existing system of tsunami crisis management in general. A post-disaster research can utilise various methodological techniques such as video interviewing and questionnaire surveys.

- A post-tsunami survey field guide is provided by the International Tsunami Survey Team (ITST) of IOC/UNESCO (Dominey-Howes et al., 2012) which covers principles, protocols, and a set of best practices and templates for post-tsunami surveys.
- Bird, Chagué-Goff and Gero (2011) reviews three post-tsunami disaster case studies: the 2004 Indian Ocean tsunami (using primarily video interviews), the 2006 Java tsunami (using primarily video interviews), and the 2009 South Pacific tsunami (using primarily questionnaire interviews). By investigating survivors' behaviour before, during and after the tsunami disasters through the data generated from these interviews, they analyse the complexities affecting public response on which they base their recommendations for facilitating improved community-based disaster risk reduction strategies (e.g. tsunami education programmes) in Australia.
- Sahal and Morin (2012) presents the results from the post-tsunami survey conducted in La Re'union Island following the October 2010 earthquake and tsunami in Indonesia. The findings from the survey provide indicate that the event management by the local authorities was not successful due to their lack of action – pointing especially to the weaknesses of the local early warning system and protocols.

CHAPTER 3 INCIDENT PLANNING FOR AND OPERATIONAL RESPONSE TO TSUNAMIS

3.1. Introduction

Disasters create overwhelming demands to affected communities and pose unique response problems. Effective disaster response is not only a function of the magnitude of the hazard and its effects, but also of complexity. Early disaster response research highlighted that disasters cannot be adequately managed merely by mobilizing more resources, and that scaling up procedures for responding to daily routine emergencies may be inadequate for major incidents (Auf der Heide, 1989). Furthermore, disasters are notorious for extending across multiple jurisdictions, both geographical and functional, and the modern disaster response operational environment is fraught with a multitude of agencies with different mandates (Salmon et al., 2011). The complexity and unpredictability of interactions between various actors contribute to the "fog" and "friction" of what constitutes a crisis, similar to the fog and friction of war discussed by Carl von Clausewitz (Howard & Paret, 2008).

Therefore, although situational awareness is an absolute necessity in disaster response, it is impossible to achieve without effective coordination and communication. The importance of situational awareness in high uncertainty environments has been well-known to military leaders since early war history. While on campaign, Roman Emperor and stoic philosopher Marcus Aurelius wrote that "everything we hear is an opinion, not a fact. Everything we see is a perspective, not the truth" (Stephens, 2012).

In addition to the uncertainty inherent in disaster response operations, the sheer number of organizations involved in the field and the existence of multiple decision-making centers makes coordination and communication an arduous task. In 2005, the challenges during the response to Hurricane Katrina were partly attributed to the existence of three separate operational commands and the involvement of more than 500 organizations. Poor coordination and lack of situational awareness were two of the major issues of concern during the entire response. Some of the coordination and communication problems subsided when United States Coast Guard Rear Admiral Thad Allen was appointed as both Principal Federal Official and Federal Coordinating Officer (Moynihan, 2009). He subsequently described the situation as "a weapon of mass destruction without a criminal dimension", thus highlighting the need for framing the issue from the outset (Lagadec, 2015).

This dire need for coordination between the myriad of responding organizations and for situational awareness can be addressed almost exclusively through joint planning. Multi-agency coordination systems facilitate collaborative planning and assist all involved jurisdictions and responding agencies to achieve situational awareness (Kapucu et al., 2010). They need to be established before the disaster and regularly maintained through training and exercising. Emergency operations centers (EOCs) are a major component of multi-agency coordination systems (Karagiannis et al., 2014). They are critical decision-making hubs and provide a link between the strategic level and the resources in the field (McEntire, 2006).

Here, we focus on the common operational picture in disaster response. Although the term "common operational picture" was originally coined by the military (U.S. Department of Defense, 2015; Mittu & Segaria, 2000), it has been increasingly used by emergency management practitioners to denote a single identical display of relevant operational information, such as disaster affected areas; position and status of critical infrastructure and critical buildings; position and types of own resources etc., shared by more than one agencies or jurisdictions. Modern communications technology and a common operational picture (shared electronically) allow collaboration between multiple decision-making centers from distant locations, increase information sharing and improve decision-makers' visualization of the situation. Furthermore, the common operational picture allows planning staff to take advantage of tactical units' input and knowledge of the situation and develop better courses of action faster (US Army, 2010).

The notion of a common operational picture is well-known among experienced practitioners (Huder, 2012). However, although several technical solutions have been developed to build and share a common operational picture, its actual operational use remains a matter of debate in professional cycles (Alexander, 2002). Similarly, most academic discussions of the common operational picture focus on the technological component rather on the operational aspects thereof (Topper & Lagadec, 2013; Warren Milles et al., 2008; Wolbers & Boersma, 2013).

This chapter endeavours to contribute to the discussion on the operational component of the common operational picture by identifying the capabilities of the technological component and how they are put to the test in the field. This chapter is structured in six parts. First, we present an overview of the incident planning process. Then, we discuss how the common operational picture can improve collaborative incident planning in the time-constrained post-disaster environment. Next, we establish a typology of the capabilities of common operational picture solutions and identify major software categories, based on their utility for incident planning. We subsequently discuss an example that can help illustrate incident planning and the common operational picture in a real disaster. Finally, we outline potential developments towards more integrated common operational picture solutions and we summarize our findings.

3.2. Incident planning process

Incident planning includes analysis and synthesis. The former involves the organization of critical information such as the nature and extent of the incident or disaster, its effects, the affected area and its characteristics, the time of the incident, and the available resources. The identification of the needs generated by the disaster marks the transition between analysis and synthesis. An appropriate course of action is then proposed and a corresponding plan of action developed for a determined operational period. The latter may or may not be in writing, depending on the complexity of the situation and the incident tempo. In either case, the process is circular, with a new operational planning process beginning as each developed plan of action is approved and executed. Incident planning is usually implemented by an Incident Management Team (Bhandari, Owen and Trist 2015) operating from an Incident Command Post, an Emergency Operations Center or similar location.

The following sections illustrate a conceptual model of the incident planning process, based on several guidebooks (Federal Emergency Management Agency, 2012; Ständige Konferenz für Katastrophenvorsorge und Katastrophenschutz, 2000; Pandélé, 1998; Interagency Standing Committee, 2014; International Federation of Red Cross and Red Crescent Societies, 2008; US Army, 2014; North Atlantic Treaty Organization, 2010; United Nations Office for the Coordination of Humanitarian Affairs, 2013). The model outlines the sequence of activities and the output of each activity. For presentational purposes, the incident planning process is described in four phases, situation analysis, incident assessment, course of action development and analysis, and incident action plan development (Figure 3.1).

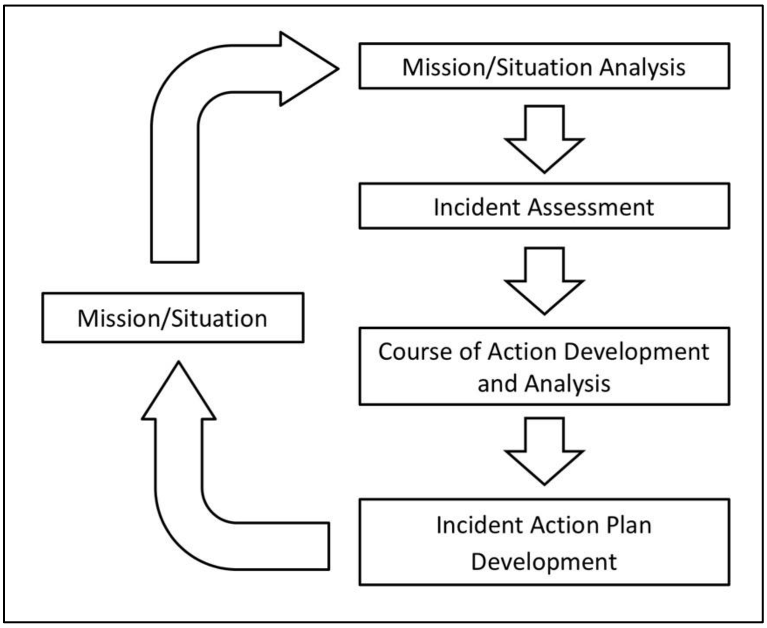


Fig. 3.1. Incident planning outline (Karagiannis & Synolakis, in press).

3.2.1 Situation/mission analysis

Incident planning starts with an analysis of the situation and/or mission, which aims at developing and maintaining a level of situational awareness to support the process. This phase includes activities directed at collecting critical and accurate information, in an organized fashion, about the incident or the mission. No disaster or emergency is exactly the same, and the information to be gathered differs every time. However, all planning approaches commonly use checklists to help command staff evaluate the most critical aspects of the situation. Although there are as many checklists as incident planning approaches, the information requirements generally include "standard" items that incident managers need to make timely and informed decisions (Table 3.1).

Despite the progress in communications technology, information in the early stages of a disaster is most limited, and data is piecemeal at best. Therefore, incident planners are encouraged to analyze the hazard in combination with information on the area of operations to build running estimates of the situation. These running estimates are assumptions about the impact of the hazard on the community, the population, critical facilities and infrastructure, as well as associated and secondary hazards. Prior information gathered during emergency planning and included in emergency operations plans may prove very useful at this stage. Incident managers maintain running estimates to consolidate their understanding of the situation in the absence of further information. However, assumptions should be recorded and incident planners should actively seek information to confirm or disprove their running estimates. As new information arrives, assumptions become facts or are invalidated.

Table 3.1. Critical elements of information considered by incident action planning approaches used in disaster response (Karagiannis & Synolakis, 2016).

Item	Description
	Area of operations
Terrain	Access, topography, water masses, vegetation, populated areas, roads, railway lines etc.
Population	Number of people affected and status and position of special populations (e.g. tourists and the elderly), media, responders.
Weather	Present situation and forecast
Incident date and time	Self-explanatory
	Essential elements of information
Incident type and location	Incident type, hazard characteristics, affected area(s), imminent or expected hazard occurrences.
Lifesaving needs	Warning, evacuation, search and rescue, emergency medical care, firefighting.
Status of critical infrastructure	Transportation, power, communications, food, water and fuel supplies
Status of critical facilities	Police and fire stations, medical providers, water and sewage treatment facilities, and media outlets
Imminent hazards and/or threats	Examples may include the potential for explosion, hazardous materials release, dam or levee failure, or collapse of critical structures.
Potential for cascading events	Examples may include secondary hazards or "domino" effects.
Actions already taken	Actions taken by first responders

In addition, it is emphasized that information collection is a continuous process which should stretch throughout the incident. Nevertheless, the ultimate goal of the analysis of the situation or mission is to provide the necessary information and intelligence for the identification of disaster-generated needs.

3.2.2 Incident assessment

Incident assessment is the second part of the process. It incorporates an analysis of the incident, the development of one or more incident objectives and the assessment of resources that can be used to achieve them. First, the information collected during the situation/mission analysis phase is used to determine the needs generated by the disaster, which incident managers then translate into incident objectives, and in turn converge on the tasks to achieve them. Next, they establish the resources required to accomplish each them. This analysis is then used to identify critical facts, develop assumptions and determine constraints for the remainder of the planning process.

Needs assessment

The assessment of disaster needs is the first part of the incident assessment and the intermediate step that links the analysis of the situation with the identification of the resources required to respond to the emergency. Disaster needs are determined from the information gathered during the analysis of the situation. Although experience and technical knowledge are necessary, guidance can be found in handbooks. For example, 15 liters of water per person per day are required in most humanitarian settings (Davis & Lambert, 2002). The identification of needs provides insight about required resources.

Resource evaluation

Resources are analyzed to determine the extent to which they can cover the needs generated by the disaster and if they can support the objectives and tasks required to accomplish them. The need for experience and specific technical knowledge for determining resource needs and evaluating resources is emphasized, although guidance is provided in technical publications and relevant curricula. Examples include disaster shelter (American Red Cross, 2007), food provision (American Red Cross, 2006), water supply (Davis & Lambert, 2002), search and rescue (National Fire Academy, 2006), Emergency Operations Center management (McEntire, 2006) and others. Incident planning guidelines require planners to estimate the required resources to cover the demands generated by the disaster, then to assess what is available (including on hand, en route and ordered) and take action to acquire what is required but unavailable. They also emphasize the need to evaluate the capabilities of resources, including training and equipment. The analysis of resources and the assessment of needs helps develop incident objectives.

Determining objectives

Objectives are generally understood as statements of the expected outcome of disaster response operations. Experience is a critical requirement in determining objectives, and textbooks and manuals offer general guidelines rather than checklists. While there is no limitation as to the number of objectives to be developed, most incident command guidebooks suggest that a limited number of well-designed objectives is preferred. Once objectives have been established, one or more courses of action are developed to accomplish them. Here, a course of action is defined as an option that will accomplish or contribute to the accomplishment of a mission or task, and from which a detailed plan is developed. Some planning approaches suggest the development of course of action criteria, i.e. factors to be used later to measure the relative effectiveness and efficiency of alternative courses of action, during this phase. Other guidelines suggest that critical facts, assumptions and constraints be explicitly identified, before courses of action are developed and analysed.

3.2.3 Course of action development and analysis

The third component of the process includes the development, analysis and comparison of alternative courses of action, or broad concepts of actions aimed at addressing the needs generated by the disaster. The notion of a course of action is embedded in all planning processes, however, designations differ.

Course of action development

Incident planning guidelines support different approaches in developing courses of action. Some suggest that one course of action should be developed (although it is expected to include multiple objectives), which arguably reflects the intuitive decision-making concept. Others suggest that a single course of action (yet again with multiple objectives) should be selected out of several alternatives, thereby implying rational decision-making. A few recommend that the best course of action is selected out of at least two alternatives, except when planning in a time-constrained environment, when the number of alternative courses developed should be reduced to save time (Figure 3.2).

When it comes to course of action development, the guidance provided in incident planning handbooks and training curricula varies. Some guidelines are arguably more explicit and planners are advised to present courses of action using statements and sketches to describe the general task organization, tasks, location, time and purpose for each participating agency. Others take a similar approach, with courses of action described on a matrix organized based on the tasks to be accomplished. For each task, planners determine the organization the task is assigned to, the location and time of the action, as well as the available and required resources. Provided that more time to plan is available, a project planning approach can be employed for greater detail.

Course of action analysis

Courses of action are analysed with a view to developing an incident action plan. There is a marked disparity in course of action analysis among the incident planning which we reviewed. Some include an elaborate course of action analysis, with war-gaming its main tool. It is a disciplined process used to visualize the flow of the operation being planned and anticipate critical events and decision points. These guidebooks provide a lot of information about war-gaming techniques and how to use them. When multiple courses of action are developed, the analysis is the tool with which courses of action are compared to select the best alternative. On the other hand, when a single course of action is developed, the analysis serves to modify the course of action based on the war-game results. However, most disaster-oriented incident action planning approaches hardly include any guidance on course of action analysis.

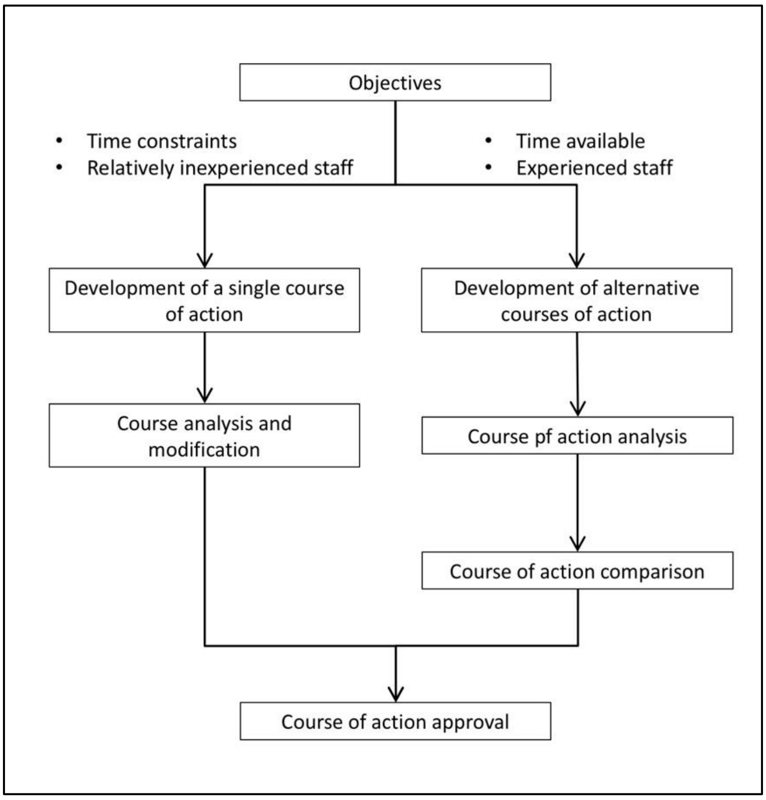


Fig. 3.2. Single vs. multiple course of action development processes (Karagiannis & Synolakis, 2016)

3.2.4 Incident action plan development

Course of action approval

The incident planning cyclical process ends with the selection of a course of action, then used to draft the incident action plan. Regardless of whether one or more courses of action have been developed and analysed, the final call is made by a senior official with decision-making authority. Depending on the regulatory framework, this may be an elected official, an incident commander or members of a unified command. The decision-maker is traditionally presented with the course(s) of action that were developed, the analysis and the results of the course of action comparison, where applicable. If only one course of action is presented, he or she is expected to approve, modify or entirely disapprove it.

Draft and issue an incident action plan

Once a decision has been made, command staff disseminates this information to the organizations involved in a response. Although the exact form and designation of the information varies with each incident planning approach, the structure and content of the incident action plan is essentially the same and includes:

- an overview of the situation;
- a statement of the mission, in terms of the expected outcome;
- a description of the way the final outcome is to be achieved (often called concept of operations);

- an outline of the organization (i.e. the structure and specific assignments) that will be used to implement the concept of operations;
- logistics support; and
- command, control, coordination, communication and information.

The volume of the order or incident action plan varies with the complexity of the incident, which is a function of the hazard, the vulnerability of the affected area, socioeconomic issues, political support, the number of responding agencies, the number of available resources, the time period covered by the planning, and others. Little guidance is generally given as to whether the order or incident action plan shall be written or oral. This decision is typically left to the Incident Commander or person responsible for the overall management of the incident. Similarly, while incident action plans are expected to address all the issues above, the decision as to the exact content of a written incident action plan is again typically left to the Incident Commander, for short. As the incident action plan is disseminated to and implemented by its intended recipients, the focus of the command staff shifts from planning to monitoring and to situation awareness, marking the beginning of a new planning cycle.

3.3. Collaborative incident planning and the common operational picture

3.3.1 Common operational picture: collaborative incident planning in a time-constrained environment

Collaborative incident planning improves coordination in the post-disaster time-constrained environment by allowing decision-makers to jointly explore capabilities and develop better courses of action faster. Modern information and communication systems and a common operational picture can facilitate joint planning by providing planners and decision-makers with a single identical display of the necessary information. Information requirements may be different during each phase of the incident action planning process, as illustrated in the following paragraphs.

Situation analysis

Situational awareness is one of major challenges in disaster response. For example, the U.S. National Response Plan, developed by the Department of Homeland Security, points out that disaster response activities may have to begin without a complete assessment of critical needs. In addition, the response to Hurricane Katrina is a well-documented example of the failure to establish situational awareness (Harrald, 2006). Information about the effects of a dis-aster and the operational environment comes from various sources. A common operational picture can streamline this process by providing a centralized platform for all responding organizations to input information on the effects of the disaster, based on geographical and/or functional jurisdiction. In addition, modern information and communications technologies (ICT) help planning staff take into consideration first-hand accounts of the situation from field units. The added value of the common operational picture originates from the combination of information provided by various sources. For example, a local Department of Health Services may provide information about the number of available beds in local hospitals, while the Fire Department may advise the estimated number of injured victims in the affected area. It only through the combination of both pieces of information that decision-makers can get an accurate picture of the status of health services in the affected area.

Incident assessment

In the aftermath of a disaster, numerous agencies assess critical response needs, usually based on their functional or geographical jurisdiction. The lack of coordination between agencies at this stage leads to gaps in the provision of critical services and limited efficiency and effectiveness as some needs are identified and addressed by more than one organizations, while others may go unnoticed in the early stages. Furthermore, the lack of situational aware-ness may lead to agencies setting conflicting objectives or planning to address the same objectives therefore wasting precious resources. A common operational picture expedites the identification of needs and helps identify synergies between the myriad of responding organizations by providing a centralized platform linking decision-making centers in distant locations. In addition, it allows organizations to plan joint operations, ultimately sharing resources and maximizing effectiveness.

Incident planning

Once common objectives have been decided upon, organizations can use a common operational picture to jointly develop and war-game one or more courses of action. Here, a single identical display of teams, equipment, facilities, affected areas and critical infrastructure helps planners from distant locations to visualize the area of operations, identify elements or capabilities to achieve objectives and analyze courses of action faster.

Incident action plan development

At the incident action plan development stage, the common operational picture allows emergency operations centers at distant locations to share a jointly developed incident action plan. As incident planning goes from situation analysis to the development of the incident action plan, the common operational picture transforms from a planning to a communication tool.

A common operational picture can therefore increase the efficiency all four phases of the incident planning process. Given the wide range and diversity of the agencies and organizations involved in disaster response, a combination of planning, training and modern information and communications systems is required to maintain a common operational picture throughout the incident planning process.

3.3.2 Common operational picture and emergency planning

The implementation of a common operational picture requires by definition modern information and communications technology (ICT). Consequently, the common operational picture encompasses both a technological and an operational component. The technological component includes the ICT technology assets and systems that connect distant emergency operations centers and decision-making focal points. The operational component is comprised of the non-technological activities that build and maintain the emergency response system, such as collaborative emergency planning, joint training and disaster exercises.

Several parts of both components can be developed before a disaster strikes. Although technically not a part of the incident planning process, emergency planning can greatly enhance situation analysis and incident assessment. Several elements of these two phases can actually be addressed before a disaster occurs. For example, information about the area of operation, populated areas, critical infra-structure assets and resources (both existing and available through mutual aid agreements) can be gathered while the emergency operations plan is developed and displayed on maps.

A lot of information can be displayed on maps created during the preparedness stage. Maps are highly useful in incident planning because they help decision-makers visualize the area of operations and provide a common reference system for planning and communication (Alexander, 2002). In addition, emergency planning typically includes the development of disaster scenarios as the baseline for planning. Although disasters never happen according to plan, emergency planning is fundamentally an educational activity (FEMA, 2010). In this sense, the purpose of developing disaster scenarios is not to foresee every possible development of the situation. Scenarios are rather intended to help disaster planners estimate post-disaster needs, determine response objectives, identify the resources necessary to achieve them and establish an appropriate organization before the disaster strikes.

Besides its more or less tangible result, which is the development of appropriate emergency operations plans, disaster preparedness also helps build trust and willingness to share information among the various stakeholders, central to coordination on the volatile and dynamic post-disaster environment (Janssen et al., 2010). In other words, emergency planning builds a network of people and stakeholders that forges the concept of coordination into effective disaster response. However, the high uncertainty and fast operational tempo of emergencies need to be counter-balanced by efficient technical information management and communications capabilities. The advent of modern information and communications technology has increased real-time information sharing capabilities and has spawned several solutions to facilitate joint and parallel planning in the aftermath of a disaster.

3.4. Common Operational Picture capabilities and solutions

Several ICT-based solutions have been developed experimentally or have been commercialized to support decision-making and joint planning in emergencies by establishing the technological component of common operational picture capabilities. Despite the vast array of software available, most available solutions encompass similar or comparable functions.

Our approach has been based on the use of the incident planning process to investigate how software solutions reduce uncertainties during disaster response. First, we reviewed available information on common operational picture solutions available commercially or through research projects, such as user's guides, technical documents and advertising documentation. In addition, we observed how these applications are employed during several disaster exercises. Then, we used the incident planning process as a guide for identifying the capabilities of applications. Specifically, we war-gamed a number of all disaster scenarios to highlight the information needs of emergency managers during each phase of the incident planning process and matched these needs to the functions of available applications to develop a typology of the available capabilities. Finally, the known common operational picture solutions were assigned to categories according to the nature of services they provide.

This section discusses common operational picture software capabilities and categories. The first part establishes a typology of the key functions of common operational picture software, while the second presents the major categories of software solutions.

3.4.1 A typology of COP software functions and capabilities

As the locus of incident planning changes from analysing the situation to identifying one or more courses of action and then building an incident action plan, the common operational picture needs to accommodate different types of information. During situation analysis, emergency managers need both static (e.g. topographic features of the area of operations) and dynamic (e.g. disaster effects) information. Yet, in either case, information is mostly descriptive of the situation and the level of certainty is relatively high. During the incident assessment and incident planning stages, information management becomes more dynamic as the agent- and response-generated demands accumulate, the status of available and on-call resources changes and emergency managers develop one or more courses of action to address set objectives. The level of certainty also decreases at this stage, as emergency managers need to make several assumptions about the future situation.

Given the wide range of information types that needs to be included in a common operational picture and the multi-disciplinary nature of disaster management, the capabilities of existing solutions naturally span across a wide range of science and engineering disciplines. Although not all software incorporate all capabilities, most of the ones commercially available today or developed through research have one or more of the functions described in the following paragraphs.

Hazard modelling

Hazard modelling capabilities include numerical models of the hazard-generating natural process that yield the consequences of the hazard. In-puts include specific data on the hazard-generating process, while outputs include quantifiable parameters of the effects of the hazard. For example, tsunami hazard models require input on the dislocation of the ocean floor and the bathymetry and topography of the undersea and onshore environment, while they yield tsunami arrival times and run-up (Synolakis & Bernard, 2006).

Hazard mapping

Hazard maps are used to represent critical characteristics of one or more hazards over a given territory (Alexander, 2002). For example, a flood hazard map could depict the inundated area for the 100-year flood, while an industrial accident hazard map could highlight the affected areas for various accident scenarios. Maps are especially useful for hazards that can be spatially defined, e.g. technological accidents, landslides and floods (Karagiannis, 2012). The advent of Geographical Information Systems (GIS) has streamlined hazard mapping capabilities and enabled hazard modeling software to project hazard affected areas as a shape file on a GIS base map.

Vulnerability and risk mapping

Vulnerability maps illustrate the spatial distribution of elements at risk (Alexander, 2002). They are generally used in conjunction with hazard maps. While hazard maps delineate the area that will likely be affected from a hazard of a given intensity level, vulnerability maps are part of the base map. Once the hazard map is overlaid on the base map, elements at risk are identified either visually or through appropriate database queries. Risk maps combine hazard and vulnerability maps. They illustrate the level of risk from the combination of the probability of occurrence and severity of single or multiple hazard scenarios. Although risk maps are often developed together with hazard and vulnerability maps, they reflect a combined probabilistic and deterministic approach and, therefore, they are predominantly used to support decision-making regarding prevention measures. Yet, incident planning essentially requires a deterministic estimation of the effects of the hazard, hence the utility of risk mapping in disaster response is somewhat limited.

Incident assessment

Incident assessment capabilities include interfaces that al-low users to log information about the effects of hazards, the needs generated by the disaster, and activities performed by responding organizations. These logs can present information in a variety of formats, including chronological, geographical or incident-based. Chronological formats present information about incidents in the order that they occurred or the information was logged into the system, essentially building a "timeline" of the emergency. Geographical formats display incident information based on geographical clusters, which may or may not coincide with administrative boundaries. Incident-based formats describe incidents in groups according to major events. In all cases, modern incident assessment functions can be linked to resource management capabilities and enable users to assign tasks to specific resources and monitor, either manually or automatically, the status of completion of these tasks.

Two-way communications

Two-way communications capabilities integrate horizontal and vertical operational communications using diverse communications technologies. The use of several communications systems reduces dependency on any one asset and lowers the risk of communications breakdown in the aftermath of disasters. The capabilities of two-way communications systems have steadily increased over the years, and modern systems can provide for digital and/or encrypted communications, and can be linked via GPS systems with resource management functions to help track individual resources in real time.

Resource management

In their earliest form, these functions were essentially databases of individual resources (people, teams, equipment, facilities, vehicles), built to store basic information, such as resource name, function, technical capabilities, contact details and location. Later versions allowed the user to group individual resources to create task forces (i.e. combination of different resources with a specific mission) or strike teams (i.e. a set number of resources of the same type). An improvement over these functions was the capability of manually inputting resource status and assigning resources to specific tasks, thus linking resource management with incident assessment. Modern versions use GPS locators to track resources in real time.

Automated response checklists

Automated response checklists are used to en-sure consistency and completeness in carrying out critical tasks. Two types are generally used. The first includes digitized versions of checklists included in standard operating procedures, field operations guides or even emergency operations plans. They are essentially an electronic version of resources that already exist on paper. The second checklist type is more dynamic, as it allows the user to log the completion of each task included in the checklist. More advanced versions of these systems include the time that each task was accomplished in the incident log and generate alerts when certain tasks have not been completed on a set timeframe.

Alert notifications

This capability sends automated or semi-automated messages to selected respondents, including emergency operations center staff, specialized units or elected officials. These messages are used to activate emergency response arrangements, staff emergency operations centers, issue warning orders for key resources and transmit critical information to elected officials. Pagers were among the earliest versions of this capability, but have rapidly been replaced by automated text messages and other solutions. Notwithstanding information security concerns, some disaster management organizations are also considering social media as surrogate alert notification applications (Karagiannis & Synolakis, 2015).

Social media monitoring

In the aftermath of disasters, the public turns to social media for up-to-date and unfiltered information on the hazard event and to check the whereabouts of family and friends. Crowdsourcing applications have been used to develop online maps of incidents after major disasters, such as the 2011 earthquake in Haiti and the 2010 Deepwater Horizon oil spill. Social media monitoring capabilities are used sporadically by emergency operations centers to enhance situational awareness by complementing the information received through official channels. However, the use of social media as an active crisis communications tool remains controversial (Lindsay, 2011; Karagiannis & Synolakis, 2014).

Multi-channel communication

Multi-channel communication capabilities are predominantly used to disseminate crisis information to the public, for example broadcasting warnings, news and situation updates. They encompass a diversity of communications media, including television and radio ads, pre-recorded telephone messages, text messages, pagers, e-mail and social media, with a view to reaching as wide an audience as possible.

Despite the diversity of capabilities of common operational picture solutions, the type of information that needs to be shared and the nature of the activities performed during each stage of the incident planning process are different. Therefore, not every function is required for every stage of the process. Table 3.2 illustrates which capabilities are mostly required during each stage of the incident planning process.

3.4.2 Common Operational Picture software categories

Several software solutions have been developed by research institutions or have been commercialized by software companies to support decision-making and incident planning in emergencies. Each solution encompasses one or more of the functions delineated above. The following paragraphs describe the capabilities of the most common software solutions.

Table 3.2. Common operational picture software capabilities required to support the incident planning process at various stages).

Function/capability	Situation/mission analysis	Incident assessment	Incident planning	Incident action plan development
Hazard modelling	X			
Hazard mapping	X			
Vulnerability and risk mapping	X	X		
Incident assessment		X		
Two-way communications	X	X		
Resource management		X	X	
Automated response checklists	X			X
Alert notifications		X		X
Monitoring social media	X	X		
Multi-channel communication				X

Hazard modelling software

Hazard modelling software includes computer codes that run hazard-specific models. They provide running estimates of hazard intensity and help identify the areas that are likely to be affected should a hazard occur. Their use is essentially based on computing time and required input of an appropriate likely event and its magnitude or duration. Software solutions with long computing times or requiring excessive or difficult-to-obtain data are predominantly used to identify assumptions for the development of emergency operations plans. Examples include a number of codes using computational fluid dynamics to simulate hazardous materials releases. On the other hand, software that requires little computing time and easily obtainable input data is more effective during disaster response. Areal Location Of Hazardous Atmospheres (ALOHA), a hazardous materials release modelling software developed by the U.S. Environmental Protection Agency and the U.S. National Oceanic and Atmospheric Administration (Available at http://www2.epa.gov/cameo/aloha-software) is one example. In other cases, part of the required input data can be collected and set up in advance, therefore sharply reducing computing times. Examples include the FARSITE wildland fire growth simulation software (Available via http://www.firelab.org/project/farsite) and the Method Of Splitting Tsunami (MOST – Available via the National Oceanic & Atmospheric Administration's Pacific Marine Environment Laboratory at http://nctr.pmel.noaa.gov/model.html) (Titov & Synolakis, 1998). The former uses spatial information on fuel, weather and topography to simulate the spread of wildland fires, while the latter uses spatial bathymetric, topographic and seismic data to simulate tsunami generation, propagation and run-up. In either case, the GIS baseline map can be developed in advance to speed the simulation process and help provide almost real-time results. In addition to computing time, operator training is also an important issue regarding the use of hazard modelling software. The models run by software codes are hazard-specific and require expert knowledge on the natural phenomena simulated and the inner workings of the model. Yet, emergency operations center staffers have typically only generalist-level knowledge on a number of hazards. One solution is to train emergency managers and EOC staff members to use the software, provide that they software interface is simple enough and that non-specialist personnel can be trained in a reasonable timeframe. For example, the duration of a standard ALOHA user training course is about 2 days (EPA & NOAA, 1999).

If the model is too complicated to teach over a short timeframe, technical experts can be assigned to the emergency operations center to support decision-makers by running simulations to help assess the effects of the hazard or war-game courses of action (Karagiannis & Synolakis, 2014). Finally, modern information and communications technology allows experts to support decision-making without being physically present at the emergency operations center. For example, several Tsunami Watch Centers are using software such as MOST to run tsunami simulations with a view to providing early warning to civil defence agencies (Kanoglu et al., in press). In this case, the experts run the simulation from their office or facility and send the results to the authorities having jurisdiction. The advantage of this solution is that scientists work from their own facility, where they can more easily get support from peers, access documentation or use more powerful and faster computers.

Hazard, vulnerability and risk maps

Hazard, vulnerability and risk maps are disaster prevention and hazard mitigation tools. They are developed before a disaster strikes and are primarily intended to support disaster risk assessments and the establishment of risk management priorities (Karagiannis, 2012). Modern GIS maps can provide a wide range of geospatially referenced information, including the extent of the hazard-affected area and the elements at risk, such as critical buildings and infrastructure in the hazard zone.

In addition to disaster prevention, hazard and vulnerability maps are also useful in disaster response, as they provide estimations about the impact of selected hazards under a number of pre-designated, high-risk scenarios. Although disasters do not follow risk assessment scenarios, hazard and vulnerability maps can support incident planning assumptions about the impact of hazards (Billa et al., 2006; Bouamrane et al., 2012). They are particularly useful during the early stages of a disaster, when information is scarce and uncertainty about the situation is at its' highest. By providing information about risk assessment scenarios, hazard and vulnerability maps help emergency managers develop better courses of action faster.

Emergency Operations Center (EOC) software

Emergency Operations Center software solutions typically incorporate several in-formation management capabilities. At their simplest form, EOC solutions include incident assessment and resource management options. A mapping interface may be provided to indicate the location of incidents and position of resources. One example is the Sahana Eden software, an open-source platform designed for disaster response (Available at http://sahanafoundation.org/products/eden). Sahana Eden is highly configurable and easy to modify to fit different situations. It is being used by the City of New York Office of Emergency Management, by the International Federation of Red Cross and Red Crescent Societies and other agencies around the world (Sahana Software Foundation, 2015).

In addition, a number of software solutions are available commercially. Some agencies, especially in Europe, use custom-made software, designed to meet their needs. Several solutions have also been developed by academic institutions of re-search purposes (for example Assilzadeh & Gao, 2010). These software solutions usually incorporate additional functions, such as two-way communications, auto-mated response checklists and alert notifications.

EOC software typically seeks to address the coordination aspect of emergency management, and support the situation analysis and incident assessment phases of incident planning. These applications operate in stand-alone or network mode. The stand-alone configuration only allows one user to input information, which is usually enough for simple incidents with minor communication needs. In this case, a single user needs to centralize information from a few responding agencies. However, disasters and emergencies involve by nature many organizations and cross jurisdictional and geographical boundaries. As multiple decision-making centers are involved, it is both ineffective and impractical to centralize information management to a single data entry point. In addition, resources are assigned to the emergency, but remain under the control of their parent organizations. In these situations, EOC software in network configuration allows multiple users from various decision-making centers to contribute information on the hazard-affected area, the demands and constraints generated by the emergency, as well as the status and capabilities of resources. In turn, this single identical display can be used by all responding organizations as a reference for joint planning from distant locations. In other words, by establishing and maintaining a common operational picture, organizations can develop better courses of action faster, and improve decision-making.

Crisis communication software

Crisis communication applications generally focus on sharing information through multiple channels, such as text messages, social media, e-mails and mobile telephone applications. They were primarily developed for business continuity and were initially intended to provide private companies with multi-channel communications capabilities to support two-way messaging with employees, clients and other stakeholders during a crisis. Nowadays, these first-generation crisis communication tools have been readily replaced by various instant messaging, chat rooms and other social media applications, for example Facebook, Twitter and Google+, as several businesses use social media as a primary crisis communication tool (Karagiannis & Synolakis, 2015; Lindsay, 2011).

Later versions of crisis communication applications can be operated on handheld devices, such as smartphones and tablet PCs. They have expanded capabilities, including social media monitoring and automated alert notifications. Automated alert notifications are essentially an expansion of the original capabilities of crisis communication software, oftentimes combined with the capability of sending messages to multiple recipients. On the other hand, social media monitoring aims not at sending, but at gathering information to support corporate crisis response.

Integrated software

Integrated software is an augmented version of common operational picture applications, including multiple capabilities, such as cartography, alert notifications, automated response checklists, resource management, incident assessment and two-way communications. Cartography is usually provided in a GIS-based format. Although several applications provide users the option of using web mapping services as an alternative, GIS formats are usually preferred because of configurability and the risk of security breaches. In addition to baseline cartography and the possibility of mapping events and resources, some integrated applications either include or can be linked with hazard modelling software, thereby allowing the user to make on-the-spot projections of the hazard affected area and hazard impact.

These solutions are arguably the most comprehensive member of the common operational picture software family. They provide the widest range of capabilities, but with three caveats. First, given the wide range of capabilities they provide, user training is highly recommended by most commercial providers of integrated software. Second, the acquisition budget also needs to include the cost for one or more workstations, communications infrastructure (e.g. high-speed internet ac-cess), and potentially additional space in the EOC. Third, they mark the transition to an ICT-based operations management paradigm, which usually comes with strategic-level changes in emergency plans, but also required a mature multi-agency coordination system to operate.

3.5. Disaster response in practice or The Perfect Disaster: Incident planning after the Fukushima Dai-Ichi Nuclear Power Plant incident.

The objective of this chapter has been to discuss incident planning. Here, we briefly analyse the response to the Fukushima Dai-Ichi accident as an example which can illustrate the incident planning process. The Fukushima Daiichi nuclear power plant (NPP) accident began on March 11, 2011, when a 14m tsunami, triggered by the Mw~9 Tohoku earthquake, struck the NPP. The tsunami inundated and disabled the emergency diesel generators powering cooling systems, which led to explosions, meltdowns and the release of radioactive material (Tokyo Electric Power Company, 2012). The response to this disaster illustrates some of the points we have made here. This total station blackout resulting in a meltdown had not been considered as a possibility and was unlikely planned for (Synolakis, & Kanoglu, 2015). In what follows, we discuss the response to the accident, which helps illustrate the incident planning process in a real situation.

First and foremost, local tsunami emergency plans and hazard studies for the NPP had not considered the eventuality of this triple disaster (Synolakis & Kanoglu, 2015). The Fukushima prefecture had planned their evacuation based on a 5m tsunami, while tsunami scenarios for the NPP were limited to a 5.7m tsunami. Not planning for natural hazards is a common pathology of industrial emergency plans, which often leads to failures of the emergency response system when disaster strikes (Karagiannis, 2010). In this case, lack of planning meant that the system had been designed for a less complex event with considerably less fog and friction.

Second, situational awareness was a critical parameter in planning the response. Radiation dose measurements are typically used to guide protective action planning. Yet, in this case, there were no reliable dose measurements. This lack of information is ubiquitous in every disaster response (in an analogy to military operations, one could speak of the “fog” of disaster response). Therefore, the loss of cooling to Unit 1, the elevation of pressure and an explosion on Unit 2 were used as proxies to estimate potential disaster effects in lieu of direct dose measurements (International Atomic Energy Agency, 2011).

Third, this information revealed the need to restore cooling to the affected units and to protect the population around the nuclear power plant from an impending release of radioactive material. However, as the situation changed and new information became available, the area around the plant where people would likely be affected got progressively larger (International Atomic Energy Agency, 2011). In other words, incident objectives had to be modified as the situation changed.

Fourth, the typical protective action dilemma is whether to shelter-in-place or evacuate. This means that Japanese emergency managers likely had to develop and analyse two alternative courses of action, although probably both of them would have included some combination of iodine tablet distribution and public information. It is unclear whether Japanese emergency managers war-gamed either course of action. However, a box war-game would likely reveal that the sheltering-in-place was logistically simpler and generated considerably less response-related demands, but at the same time would potentially expose the population to dangerous levels of radioactivity. On the other hand, an avenue-in-depth war-game would have probably pointed out that this solution involved considerable response-generated demands (notification, transportation, debris removal, traffic management, shelter activation and operation). Planners also needed to consider the attrition of disaster response resources due to the earthquake and the tsunami, the increased demand for disaster shelter due to the triple disaster, and the fact that debris clearance had to be delayed for mass fatality management (as the debris from a tsunami often includes dead bodies). Again, in an analogy to military operations, this could amount to the "friction" of disaster response. Interestingly, Japanese emergency managers did not systematically opt for one or the other course of action, rather they chose to evacuate or shelter-in-place depending on the situation.

3.6. Discussion: the way forward

Common operational picture software applications provide a wide range of capabilities to emergency managers and help streamline the incident planning process. As the technological component of the common operational picture is essentially based on information and communications technology, new capabilities will undoubtedly be developed and existing ones will keep improving. However, common operational picture software cannot substitute for prior network building, planning, interpersonal relations and trust, all of which are key requirements for coordination in disaster response.

3.6.1 Operational vs. technological component

The importance of information and communications technology (ICT) lies in facilitating coordination rather than the information it processes. Therefore, prior planning and network-building are required to forge the coordination mechanism that is needed in the volatile post-disaster environment. In the absence of prior planning, common operational picture technical solutions cannot be implemented, because people are not familiar with the concept of working together. For example, the command, control, communications and integration (C4I) system designed to coordinate Athens' security during the 2004 Olympic Games is often referred to as a crucial failure. Although the Greek government invested in 100 new command centers, it was the central software, intended to centralize information from all sensors, that failed to work (Samatas, 2007). In addition, a series of administrative deficiencies, arguably indicative of an immature public administration and homeland security system, also contributed to the failure. In another case, a relatively straightforward EOC application was used to augment a local multi-agency coordination system during a disaster exercise. However, the lack of prior planning and training made it difficult for emergency managers and decision-makers to use the software (Karagiannis et al., 2014).

Both cases point to the need for emergency response systems to focus on the operational component of the common operational picture. Poorly prepared organizations often regard the technological component of the common operational picture as the panacea to all their problems. However, early research has highlighted that it is the network built long before a disaster that carries the weight of coordination and decision-making in the aftermath. Technological solutions can improve and augment the network, but cannot create it from the outset. In addition, technological solutions rely on communications systems that may not be available in the early phases of disaster response. Many organizations that have successfully employed common operations picture solutions frequently train their key staff to operate without the software by switching to a non-ICT system in regular intervals. Therefore, disaster preparedness, including planning, training and exercising, should take precedence over high-tech solutions.

The above is not to belittle the role of the technological component. Common operational picture applications have proven their worth during disaster response. The only limitation is that that any information management software is as good as the system it helps coordinate. A common operational picture solution cannot create a disaster response system, but it can augment and improve an existing one.

3.6.2 Limitations and further research

The goal of this chapter has been to identify the capabilities and categories of common operational picture solutions and correlate them with the incident planning process, in an effort to bridge the gap between the technological and operational components of the common operational picture. However, the framework we have presented is somewhat abstract. A comprehensive and detailed treatment of the common operational picture would go well beyond the scope of a single chapter. So, although we have attempted to identify the major capabilities that information and communications technologies contribute to the incident planning process, future research is still needed to specify further how a common operational picture can streamline the incident planning process and identify future research goals.

As the capabilities of ICT systems improve at a fast pace, common operational picture software will become more affordable and information management more dynamic. For example, current resource management capabilities either allow users to input information on the status and position of resources manually, or at best can track resources using GPS locators. Future systems may be able to use sensors to monitor additional information on assets, for example the level of water and foam concentrate remaining in the tank of a fire engine, therefore improving decision-makers' visualization of the situation in the field. As more information becomes available in emergency operations centers, common operational picture applications will likely become more useful in the development and analysis of courses of action, by involving disciplines such as operations research and systems engineering.

Operations research has often been used to aid decision-making regarding complex aspects of emergency response, such as disaster relief supply chain optimization (Nagurney & Nagurney, 2015) and evacuation flow modelling (Vogiatzis et al., 2015). However, current capabilities generally remain at the emergency planning level and have yet to be expanded to incident planning. As sensor-based automated information collection and management improves, future research could develop capabilities for building mathematical models of courses of action in real-time, therefore speeding course of action analysis.

In addition to operations research, functional modelling has been used to model emergency plans with a view to analysing their performance. Functional models provide the platform for the assessment of the risk of failure of the functions of an emergency plan. As the capability of building mathematical models of functions and activities of emergency plans becomes available, further research could use systems modelling approaches to identify potential critical points in courses of action before they occur, and streamline course of action analysis and decision-making (Karagiannis et al., 2013).

3.7. Conclusion

The goal of this chapter has been to identify the capabilities and categories of common operational picture solutions and correlate them with the incident planning process, in an effort to bridge the gap between the technological and operational components of the common operational picture. We have used the incident planning process as a guide to identify the information requirements of emergency managers during disaster response operations. This chapter establishes a typology of the current capabilities and identifies the major categories of existing software. Several of these capabilities can be developed before a disaster strikes. However, the technological component is but one half of the common operational picture. These solutions cannot create a disaster response system, but they can augment and improve an existing one. Therefore, the operational component of the common operational picture, that encompasses the activities that build and maintain the emergency response system, should be given priority before major investments in information and communications technologies are considered. Finally, as the capabilities of ICT systems improve at a fast pace, common operational picture software will become more affordable, information management will become more dynamic and common operational picture applications will likely become more useful in the development and analysis of courses of action.

CHAPTER 4 TSUNAMI DISASTER RESPONSE CAPABILITIES IN GREECE

4.1. Introduction

Disaster response includes all the actions taken when a hazard is imminent or after it has occurred, to save lives, protect property and the environment. It includes activities such as fire fighting, search and rescue, first aid and medical care, provision of shelter and food, and restoration of critical services (Lindell et al., 2007). Early disaster research highlighted that emergencies require organizations to develop new goals and objectives, to make internal structural changes, and to coordinate and share resources with other organizations (Auf Der Heide, 1989). Moreover, the demands created by disasters often call for the establishment of new structures or new organizations altogether. As it is virtually impossible to make all these changes in the immediate aftermath of a disaster, communities need to prepare to respond before an emergency occurs.

Disaster preparedness shapes a jurisdiction's response capabilities. Emergency planning is perhaps the most critical disaster preparedness activity, as it builds the community's disaster response system. An emergency operations plan assigns responsibility to organizations and individuals, establishes an organizational structure, describes the activities to be performed and identifies resources. Emergency planning invariably depends on the hazards that face a community, region or country. Therefore, any analysis of disaster response capabilities needs to consider the level of disaster risk facing the community in question.

Here, we review tsunami disaster response capabilities in Greece. This nation is vulnerable to tsunamis, due to the length of its coastline, its islands and its geographical proximity to the Hellenic Arc, an active subduction zone. Our analysis is structured in four parts. First, we present Greece's tsunami hazard profile, with a view to setting the framework for the subsequent analysis of tsunami disaster response capabilities. Then, we outline emergency planning, early warning and disaster exercises. Finally, we discuss recommendations and future research thrusts.

4.2. Greece's tsunami hazard profile

A hazard profile aims at capturing the unique characteristics of each hazard in the way it can impact a specific community. It describes the location and boundaries of hazardous areas, the potential magnitude of the hazard, the likelihood of occurrence of tsunamis and their specific characteristics (Brower and Bohl, 2000; FEMA, 2001). Here, we present Greece's tsunami hazard profile. We discuss the geophysical characteristics of the Eastern Mediterranean, then we outline previous occurrences of major tsunamis. Next, we discuss the probability of future occurrences and, finally, we describe Greece's exposure to tsunamis.

Tsunamis in the Mediterranean are mostly earthquake-generated. The Hellenic Arc is concave to the northeast and extends from the island of Rhodes eastwards to the Ionian Islands northwards (Papadopoulos et al., 2004). Papazachos (1990) identifies two high-seismicity zones in the Hellenic Arc. The convex side of the arc (Ionian Islands and south of Peloponnese, Crete and Rhodes) has the highest shallow seismicity. The concave side of the Hellenic Arc towards the Aegean Sea is part of a Benioff zone with high seismicity (Mw 7.0 to 8.0 considered).

Given its high seismicity, Greece has experienced several major tsunamis throughout its history, some of which have produced widespread damage. Several catalogues outline historical tsunami occurrences in Greece (Galanopoulos, 1960) and the Mediterranean (Maramai, 2014; Papadopoulos et al., 2014; Ambraseys and Synolakis, 2010). Camilleri (2006) argues that about 20% of historical tsunamis in the Mediterranean have caused significant damage.

One of the most notable events in Greece and the Eastern Mediterranean is the tsunami that resulted from the earthquake of July 21, 365 AD. The Mw~8.4 earthquake occurred near Crete and uplifted the island by up to 10m. Besides its substantial direct impact, the earthquake also produced a tsunami that propagated throughout most of the Mediterranean. However, the Aegean Sea was probably affected to a lesser extent (Shaw et al. 2008), with the exception of Crete, where a recent simulation estimated the maximum wave height at 8.9m locally (Alexandrakis et al., 2010). Another devastating tsunami ensued from the earthquake of August 8, 1303 in Southeastern Crete. The shake occurred at approximately 05:30 in the morning and caused extensive damage. According to a comprehensive survey by Guidoboni and Comastri (1997), Arabic, Greek and Latin historical references of that era report that Heraklion (Crete's largest city, then called Candia) and the western part of the island suffered the most damage. The islands' entire building stock was affected, with widespread total collapses of houses, churches and administrative buildings. In addition, the earthquake produced heavy damage in Peloponnese, Alexandria, Cairo and Damascus, while it was felt as far as Istanbul and Tunis. The tsunami that followed destroyed more buildings and added to the death toll. The twin disaster had significant economic consequences and also caused a population revolt against the Venetian rule in Crete.

More recently, evidence of another large earthquake was discovered in Rhodes (Howell et al., 2015). Radiocarbon dating of uplifted shorelines on the eastern and northwestern coast of the island was found to be indicative of a Mw ≥ 7.7 earthquake between 2000BC and 200BC. The effects of the ensuing tsunami are difficult to estimate, mainly due to the shallow offshore bathymetry and its effects on the dissipation of the tsunami energy. However, hydrodynamic simulation using MOST (Titov and Synolakis, 1995; 1998) points to significant damage potential in Rhodes and Southwestern Turkey, and perhaps as far as Cyprus and the Nile Delta.

One important feature of tsunamis in the Mediterranean is that they are predominantly near-field events with limited travel times to shore. For example, the simulation of the 365 AD tsunami by Flouri et al. (2010) showed that the first elevation waves take between 5 and 37 minutes after the earthquake to arrive at various locations in Crete. In other words, tsunamis in the Mediterranean are rapid-onset events with little time for early warning.

Despite the abundance of data provided by several catalogues, the probability of occurrence of tsunamis cannot be determined from historical data alone. Historically, about 10% of all world tsunamis have been reported to have occurred in the Mediterranean region (IFRC, 2009). However, this is possibly an overestimation given that, other than Japan, the region has the most extensive historic written records worldwide. Major tsunamis in the Mediterranean are thought to have a recurrence interval of the order of 10-2 per year (Flouri et al., 2012), which arguably makes them a rare occurrence. Yet, sedimentologic evidence or geologic field evidence is required to estimate the return period for a given event (Ambraseys and Synolakis, 2010). For example, Shaw et al. (2008) estimate the return period of earthquake-generated tsunamis of the magnitude of the one of 365 AD at 800 years.

Notwithstanding the rarity of major tsunamis in the region, Greece's exposure to the hazard stems from its geographical configuration. The Greek territory includes over 6,000 islands, of which 227 are inhabited. Overall, the total length of Greece's coastline is approximately 8,500 miles, or half the length of the coastline of Africa. Greece's coastline is disproportionately long compared to its size and population. Although Greece only has less than 1.5% of Europe's population (UN, 2015) and less than 1.3% of its surface area, it has about one third of its coastline. Although Greek census does not indicate the number of people living in coastal areas, about 15% of the Greek population lives in the Aegean and Ionian Islands and Crete (Hellenic Statistical Authority, 2015). Accounting for continental Greece, we can assume that well over 50% of the Greek population lives within 1.5km off the coastline. In addition, a major part of the Greek population is concentrated in urban and suburban centers, which adds to the vulnerability. Finally, the exposure landscape is further burdened by substantial numbers of seasonal visitors who may have little knowledge of local hazards. In 2014 alone, the Hellenic Statistical Authority (2015) counted over 22 million international arrivals in Greece, mostly from Europe and Asia.

4.3. Emergency planning

Two characteristics of Mediterranean tsunamis need to be taken into account in the discussion about disaster preparedness in Greece. First, tsunamis in the Mediterranean are predominantly earthquake-generated and, second, they are essentially near-field events. These characteristics have two important implications for emergency planning and disaster response. One, tsunamis are likely to strike right after earthquakes, therefore the damage from the combined hazards is likely to be heavier than what would be produced from either hazard alone. And two, warning time about tsunamis may be minimal and early warning may be compromised by the communications blackout that may occur after major earthquakes. Emergency managers need to consider these two issues when developing tsunami annexes in emergency operations plans.

Emergency planning aims at establishing an effective system for timely and well-targeted disaster response. "Xenokrates" is the code name for Greece's "General Civil Protection Plan". It is essentially not a plan itself, rather a meta-plan, a framework for the development of emergency operations plans throughout all levels of government. In addition, Greek civil protection regulations have required since 2003 that a different plan be drafted for each hazard at each level of government. This requirement is in contrast to the well-known emergency management practice of building a single, multi-hazard plan per jurisdiction, with hazard-specific and functional annexes, as required (FEMA 1996; 2003). We note that emergency managers have been cautioned against creating a different plan for each hazard since the 1980's (Auf Der Heide, 1989), as this has been proven to lead to duplication of effort and confusion.

Even so, the 2003 legislation would require a National Earthquake Emergency Operations Plan and eventually a separate National Tsunami Emergency Operations Plan. Yet, neither exists to date. Some local and regional civil protection (i.e. emergency management) agencies have developed earthquake emergency operations plans, as these are perhaps the most prominent hazard in Greece. However, our survey of local and regional emergency managers in coastal areas around the country (including in Crete and Rhodes) revealed no tsunami emergency plans or tsunami-specific annexes in existing earthquake emergency operations plans. In other words, tsunami emergency planning is practically non-existent.

4.4. Early warning

Because tsunamis in the Mediterranean are near-field events with little travel time to shore, early warning is critical. However, as simulations have demonstrated that the first elevation wave may arrive to the coast in as little as five minutes after the earthquake, early warning is simply impossible. In these cases, public education can be literally lifesaving and citizens need to learn to recognize tsunami warning signs and what to do when a tsunami is imminent. A few cases from the 2004 Indian Ocean tsunami have demonstrated that citizen awareness can actually save lives (Bernard and Synolakis, 2006; IFRC, 2009; Kanoglu et al., 2015).

The Greek National Tsunami Warning Center (NTWC) was established in 2010 to provide tsunami early warning services to the community. It is a Member of UNESCO's Tsunami Program for North-eastern Atlantic, the Mediterranean and Connected Seas (NEAM) region. Several exercises have been organized by the NEAM Tsunami Warning System, with the Greek NWTC actively participating as a Candidate Tsunami Service Provider. Using newly installed tide gauges and an extended database of tsunami scenarios, the NWTC is claimed to have improved warning times considerably (Melis and Charalampakis, 2014).

4.5. Disaster exercises

Disaster exercises are the principal method of assessment of emergency plans, as they put disaster response systems to the test under realistic conditions (Karagiannis et al., 2013). The Greek Civil Protection designed and conducted the first tsunami exercise program in the European Union Civil Protection Mechanism in 2011, which also considered the attrition of response capabilities by the earthquake generating the tsunami (Karagiannis et al., 2014). The program, designated EU Poseidon 2011, was co-funded by the European Commission. It included a table top exercise, a command post exercise and a full-scale exercise, all of which were conducted in Crete.

The exercise scenario was based on the event of 365 AD to satisfy the key requirement of the disaster overwhelming the capacities of the affected country, as the earthquake and subsequent tsunami occurred in very close proximity to the modern-day cities of Chania and Heraklion (Shaw et al., 2008) and would likely produce widespread damage. A detailed description of the earthquake and tsunami was developed to provide key information to emergency responders, including tsunami arrival times and maximum wave heights in Heraklion and Chania, tsunami inundation maps and earthquake ground shaking maps (Alexandrakis et al., 2010; Flouri et al., 2010).

These exercises had several important outcomes for Greek emergency management. First, they allowed inferential testing of the adequacy of the disaster response organization, including emergency operations plans and information management procedures (Figure 4.1). For example, the full-scale exercise revealed that it takes approximately 8 minutes for the tsunami warning to be issued from the National Tsunami

Warning Center in Athens and to be transmitted to the Crete Crisis Management Center through the National Civil Protection Operations Center. However, the Crisis Management Center took an additional 20 minutes to reach a decision whether to issue a tsunami warning using an experimental internet-based text message service (Karagiannis et al., 2014). Overall, the tsunami warning dissemination time is disproportionately long compared with near-shore tsunami events arrival timeframes (Titov and Synolakis, 1998; Shaw et al., 2008; Flouri et al., 2010). The exercise helped identify several alternatives to improve warning times in tsunamis, including an appropriate delegation of authority and the increase of public education.

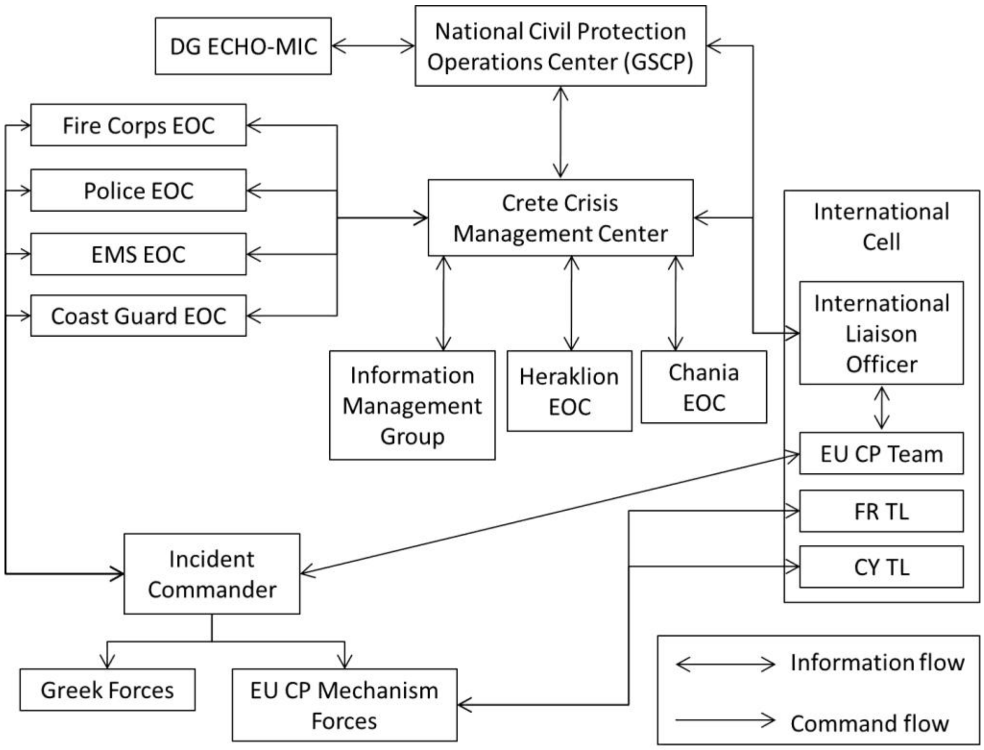


Fig. 4.1. EU POSEIDON 2011 Full Scale Exercise information flow chart (DG ECHO: Directorate-General for Humanitarian Aid and Civil Protection, GSCP: General Secretariat for Civil Protection, EOC: Emergency Operations Center, EMS: Emergency Medical Service, EU CP: European Union Civil Protection, TL: Team Leader, FR: France, CY: Cyprus).

Second, the exercises were a comprehensive test of personnel training, including incident management and urban search and rescue skills. Third, the full-scale exercise was extensively publicized in the local and national media. More than 70 articles appeared in local and national media within a 10-day period before and after the exercise. The exercises also provided an opportunity for a hands-on check of communications systems and equipment. Finally, they helped assess the viability of the emergency response network relative to a tsunami. For example, the Crisis Management Center was physically located in a public administration building inside the tsunami inundation zone. However, the jurisdiction Emergency Operations Plan did not include any arrangements for a backup site, should the primary location become inoperable. The exercises provided an opportunity emergency operations plan to be revised to include a secondary Crisis Management Center location.

4.6. Recommendations and future research

Our analysis clearly indicates that tsunamis are a textbook case of a low-probability, high-impact hazard for Greece. We argue that Greece needs to upgrade its tsunami emergency response capabilities. This may involve addressing some underlying pathologies of the public sector and particularly emergency management (e.g. the requirement for different emergency plans for each hazard). However, Greece's protracted sovereign debt crisis has maintained public interest away from disaster risk reduction and provides no incentive to policy-makers in that direction.

Despite its grave impact on Greece, the financial crisis also provides an opportunity to study the impact of the downturn on disaster risk management. Theoretically, economic crises increase vulnerability to all hazards. In addition, public spending is development-driven and has a high elasticity of demand, and a recession typically changes priorities. Emergency management is a labor-intensive public good and a reduction in spending should in principle prompt a decrease in reliability of emergency services. But to what extent is this hypothesis true? Furthermore, which hazard mitigation and disaster preparedness decisions are likely to be influenced, and how?

One additional future research thrust is related to risk perception. Although the effect of disaster exercises on emergency management systems has been emphasized in official documentation, textbooks and the research literature, little is known about how exercises affect the risk perception of citizens and their propensity to take protective action. In future research endeavours, we will conduct a survey of households in Crete to measure statistics of the action that residents have taken to reduce their exposure to tsunamis following the 2011 Poseidon Exercise. In particular, we will measure hazard awareness, perceived risk and knowledge about what to do to mitigate, prepare for and respond to tsunamis.

CHAPTER 5 TSUNAMI DISASTER RESPONSE CAPABILITIES IN TURKEY

Turkey, as a country with a history of devastating earthquakes and with a coastline of 8333 km, has been affected by more than 100 tsunamis during the observation period over 3500 years. A possible tsunami today affecting the coastal areas of Turkey may cause considerable damage, especially considering the densely populated coastal areas, infrastructure and harbours. Coastal cities cover less than 5% of the total surface area of Turkey, but they have over 30 million inhabitants and are growing rapidly. Continued urbanization and tourist development will further increase exposure to tsunami hazard. Currently, the consequences of a possible tsunami are ignored in coastal management, and although strengthening of coastal management mechanisms is required for a number of reasons, tsunami hazard should be considered an important long-term issue. The determination of inundation limits for a range of credible tsunami scenarios at the coastal areas is of high importance in order to assess vulnerability and develop, coastal protection, land-use planning and evacuation plans.

5.1. National tsunami warning center: KOERI

Kandilli Observatory and Earthquake Research Institute (KOERI), established in 1868 as the Imperial Observatory, has a long tradition of earth observation and science and is a unique organization in Turkey encompassing earthquake observation, research, education and application services within a single, integrated body. KOERI's Regional Earthquake and Tsunami Monitoring Center (RETMC, Figure 5.1, Figure 5.2) is a 24/7 operational center operating 128 Broadband (BB) and 88 Strong Motion sensors at the national level and utilizing seismic data from global and various regional networks. Sea-level data from 7 tide-gauges operated by General Command of Mapping (GCM) is integrated in the system in real-time. Real-time data transmission from selected primary and auxiliary stations from the International Monitoring System is in place based on an agreement concluded with the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) in 2011. Duty officers of the RETMC perform internal tests of the Tsunami Warning System on a daily basis based on pre-determined set of scenarios.

KOERI's Regional Earthquake and Tsunami Monitoring Center (RETMC) has officially declared Interim Candidate Tsunami Service Provider Status and provides services to the Eastern Mediterranean, Aegean and Black Seas since 1 July 2012.

As a result of a collaborative agreement with the European Commission - Joint Research Centre (EC- JRC), several Tsunami Scenario Databases (MOD1, MOD2 and MOD2-TR) are available for RETMC for operational use. In cooperation with the Turkish State Meteorological Service, KOERI has its own GTS system and is connected to the GTS via its own satellite hub for message dissemination.

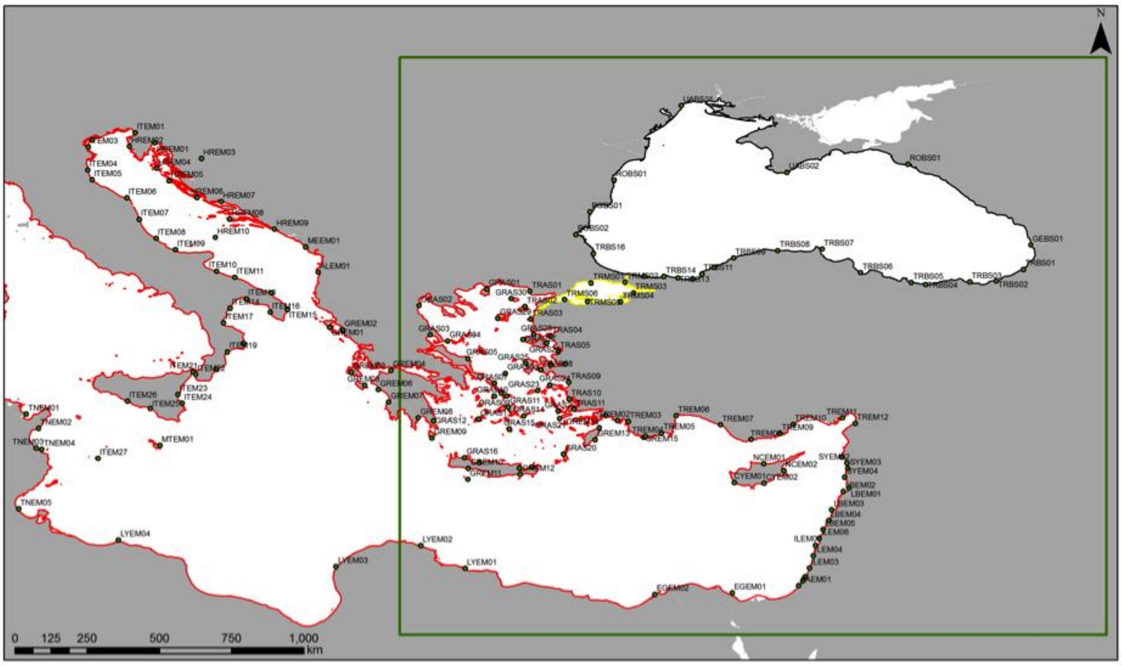


Fig. 5.1. KOERI- Regional Earthquake and Tsunami Monitoring Center Service Area. Earthquake monitoring area is shown in green rectangle as the area monitored by KOERI to assess the tsunamigenic potential of an earthquake. whereas disseminated messages include Tsunami Forecast Points as indicated on the map.

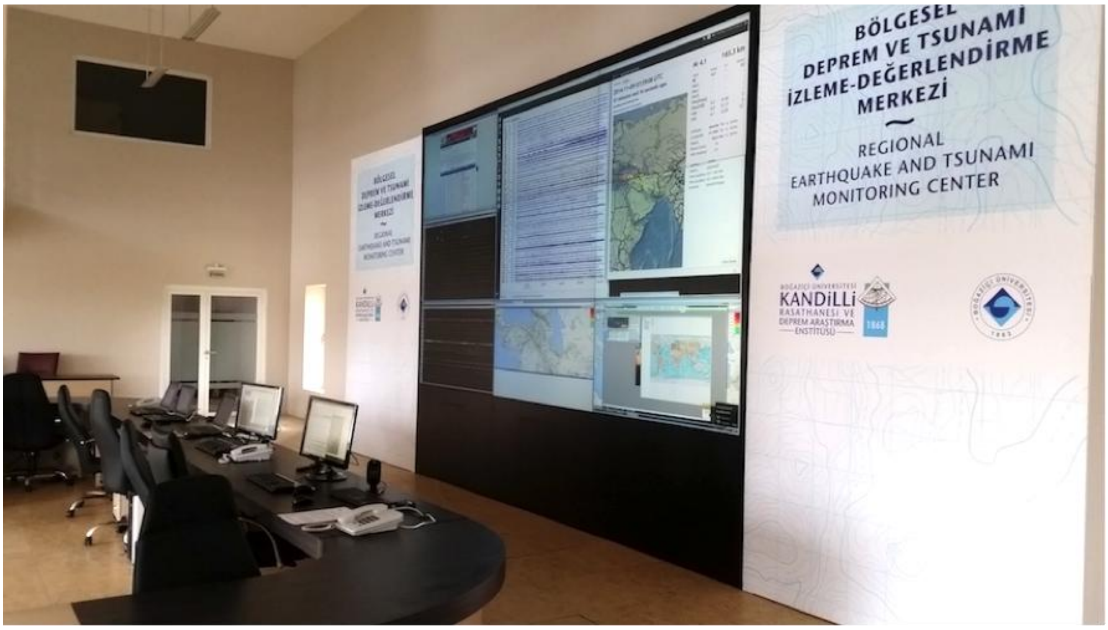
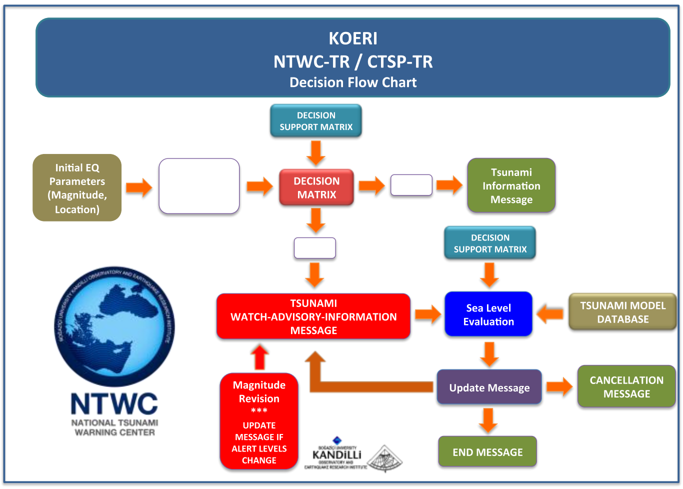


Fig. 5.2. Operations Room of KOERI's Regional Earthquake and Tsunami Monitoring Center (RETMC).



CTSP-TR (KOERI)

Decision Matrix for the Eastern Mediterranean, Aegean and Black Seas

Depth (km)	Epicentre Location	Earthquake Magnitude	Tsunami Potential	Type of Tsunami Message		
				Local	Regional	Basin-wide
				< 100 km	≥100 - ≤400	> 400
< 100	Offshore or close to the coast (≤ 40 km inland)	5.5 ≤ Mw < 6.0	Low tsunami potential	Information	Information	Information
		6.0 ≤ Mw < 6.5	Tsunami potential	Advisory	Information	Information
	Offshore or close to the coast (≤ 100 km inland)	6.5 ≤ Mw < 7.0	Potential for a destructive tsunami	Watch	Advisory	Information
		7.0 ≤ Mw < 7.5	Potential for a destructive tsunami	Watch	Watch	Advisory
		Mw ≥ 7.5	Potential for a destructive tsunami	Watch	Watch	Watch
≥ 100	offshore or inland (≤ 100 km)	Mw ≥ 5.5	Low tsunami potential	Information	Information	Information

NEAMTWS Decision Support Matrix

Alert Level	Advisory	Watch
Wave Amplitude	0.2-0.5 m	> 0.5 m
Run-up	< 1m	> 1 m
Impact	Current, bore, damage in water; possible minor inundation in beaches	Watch impact + inundation of the low-lying coastal land

Other messages used in the operational context, such as (Regular) Communication Test and Tsunami Exercise Messages are not shown here.

Fig. 5.3. KOERI NTWC/CTSP-TR Decision Flow Chart (left) and Decision Matrix (right).

KOERI performs monthly Communication Test Exercises with the Turkish Civil Protection Authority (AFAD) and other CTSPs and participates in NEAMTWS Communication Test Exercises. KOERI is providing guidance and assistance to a working group established within the AFAD on issues such as Communication and Tsunami Exercises, National Procedures and National Tsunami Response Plan. KOERI has also participated in NEAMTIC (North-Eastern Atlantic and Mediterranean Tsunami Information Centre) Project.

Further improvement of the Tsunami Warning System at the NTWC-TR was accomplished through KOERI's participation in the FP-7 Project TRIDEC focusing on new technologies for real-time intelligent earth information management to be used in Tsunami Early Warning Systems. In cooperation with Turkish State Meteorological Service (TSMS), KOERI has its own GTS system now and connected to GTS via its own satellite hub. The system has been successfully utilized during the First Enlarged Communication Test Exercise (NEAMTWS/ECTE1), where KOERI acted as the message provider.

5.2. National disaster and emergency organization: AFAD

The Disaster and Emergency Management Presidency of Turkey (Turkish: Afet ve Acil Durum Yönetimi Başkanlığı, AFAD) is the sole responsible organization in case of a disaster and emergency. The AFAD was established in 2009 to take necessary measures for effective emergency management and civil protection nationwide in Turkey. The presidency conducts pre-incident work, such as preparedness, mitigation and risk management, during-incident work such as response, and post-incident work such as recovery and reconstruction. AFAD reports to the Turkish Prime Ministry. Amongst the Governmental, NGO and private institutions, the presidency provides coordination, formulates policies and implements policies. (https://en.wikipedia.org/wiki/Disaster_and_Emergency_Management_Presidency)

On behalf of the Prime Minister of Turkey, Deputy Prime Minister oversees the activities of the Disaster and Emergency Management Authority, an institution working to prevent disasters and minimize disaster-related damages, plan and coordinate post-disaster response, and promote cooperation among various government agencies. In this regard, the Disaster and Emergency Management Authority introduced a novel disaster management model which prioritizes Turkey's transition from crisis management to risk management – which came to be known as the Integrated Disaster Management System. AFAD currently has 81 provincial branches across Turkey in addition to 11 search and rescue units. Notwithstanding its position as the sole authority on disasters and emergencies, AFAD cooperates with a range of government institutions and non-governmental organizations depending on the nature and severity of individual cases (Source: https://www.afad.gov.tr/en/IcerikDetay.aspx?ID=1).

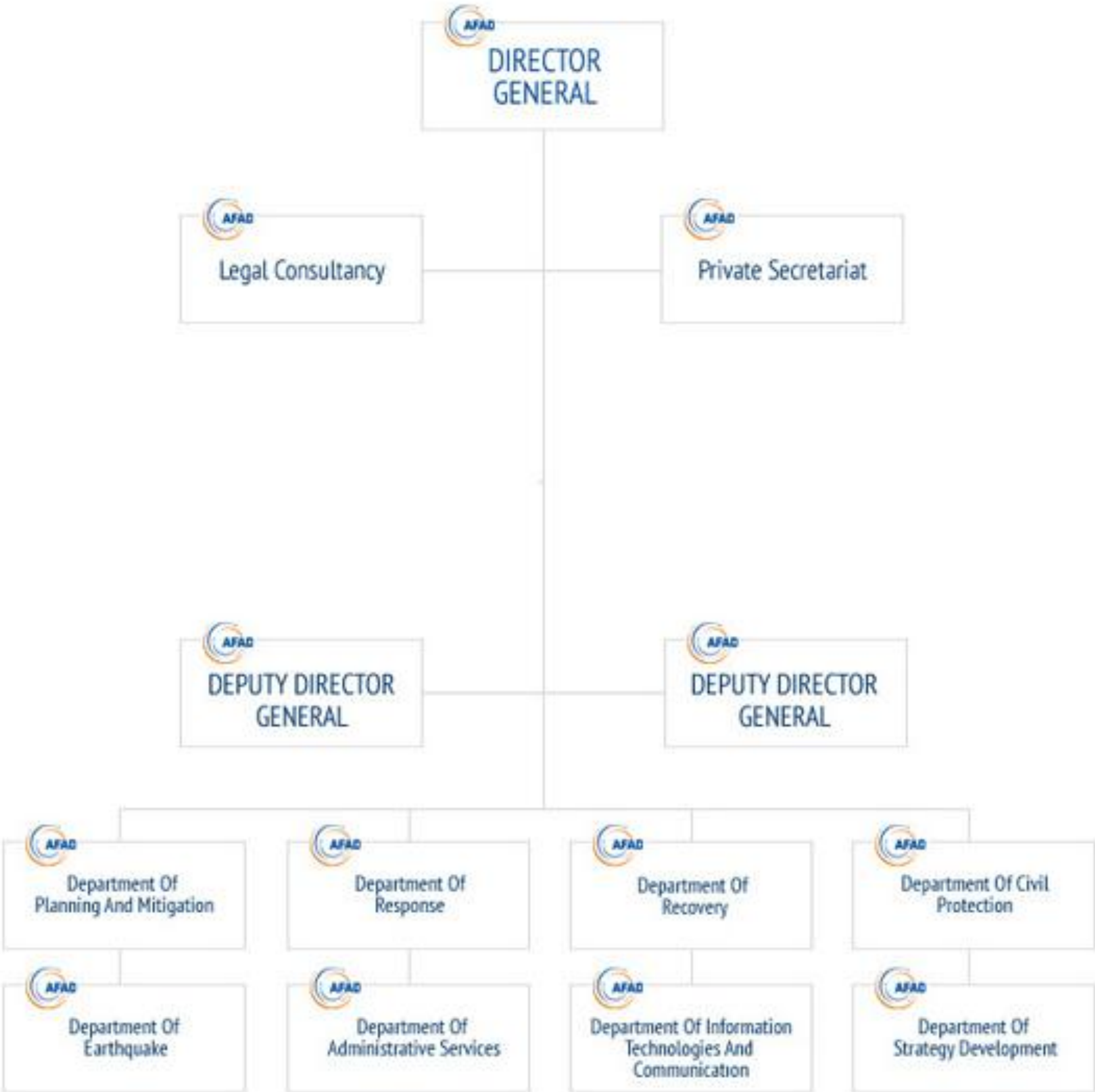


Fig. 5.4. AFAD Organization chart (Source: https://www.afad.gov.tr/en/IcerikDetay.aspx?ID=6).

5.3. ICG/NEAMTWS Communication Test and Tsunami Exercises

The Candidate Tsunami Watch Providers (CTSP), National Tsunami Warning Centres (NTWC) and Tsunami Warning Focal Points (TWFP) must keep a high level of readiness so as to be able to act efficiently and effectively to provide watch (CTSP) and warnings (NTWC/TWFP) for the public's safety during fast-onset and rapidly-evolving natural disasters like the tsunamis. To maintain this high state of operational readiness, and especially for infrequent events such as tsunamis, tsunami watch/warning centres and emergency agencies must regularly practice their response procedures to ensure that vital communication links work seamlessly, and that agencies and response personnel know the roles that they will need to play during an actual event. Initial Communication Test Exercises were planned, conducted and evaluated by the ICG/NEAMTWS Task Team on Communication Test Exercises (TT-CTE) in June and September 2010. The communication links used were limited to e-mail and fax. Despite the small-scale and limitations, these two first Communication Test Exercises provided the required capacity building that opened the way to the first Enlarged Communication Test.

The 1st NEAMTWS Enlarged Communication Test Exercise (ECTE1) in 2011

KOERI was the Message Provider at the 1st NEAMTWS Enlarged Communication Test Exercise (ECTE1) in 2011 with the involvement of all the Tsunami Warning Focal Points (TWFP) with 139 end-users in 31 countries of the NEAM region and

NEAMWave12

KOERI has also successfully participated in NEAMWave12, the first Tsunami Exercise in NEAM region, as a Candidate Tsunami Watch Provider with a scenario based on Mw=8.4 worst-case interpretation of the 8 August 1303 Crete and Dodecanese Islands earthquake resulting in destructive inundation in the Eastern Mediterranean. 12 messages were disseminated within a 3-hour time-frame to the relevant end-users in total, where four dedicated messages were sent to the NEAMTWS Member States via e-mail, fax and GTS targeting the subscribers of the KOERI Scenario in terms of scenario affected areas. Besides the NEAMTWS messages, KOERI has also sent messages in Turkish to the Disaster and Emergency Management Presidency of Turkey (AFAD). AFAD and other selected internal end-users were also provided with the messages produced by the TRIDEC Natural Crisis Management System, currently being developed within the same titled EC-FP7 Project, where end-users were also provided with hazard maps. In addition, KOERI has also monitored IPMA (Instituto Português do Mar e da Atmosfera, Portugal) Scenario through the unique system-to-system communication capabilities of TRIDEC. The final evaluation of the exercise indicates that the messages were disseminated successfully and both KOERI and AFAD benefited from the exercise considerably, where the NEAMTWS Tsunami Warning Chain System has been tested to a full scale for the first time.

NEAMWave14

NEAMWave 14, as the second Tsunami Exercise in NEAM, was held on 28-30 October 2014. And involved the simulation of the assessment of a tsunami, based on an earthquake-driven scenario followed by alert message dissemination by Candidate Tsunami Service Providers-CTSP (Phase A) and continued with the simulation of the Tsunami Warning Focal Points/National Tsunami Warning Centres (TWFP/NTWC) and Civil Protection Authorities (CPA) actions (Phase B), as soon as the message produced in Phase A has been received. During NEAMWave14, KOERI acted as the Message Provider for a Black Sea Scenario, where Black

Sea was covered for the first time in a NEAMTWS Tsunami Exercise. The schedule of events list followed by KOERI included the dissemination of 5 messages to the recipients from the countries of Bulgaria, Belgium, Cape Verde, Croatia, Cyprus, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Ireland, Israel, Italy, Lebanon, Malta, Monaco, Netherlands, Poland, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Syria, Turkey, Ukraine and United Kingdom. In addition to the NEAMTWS messages, KOERI has disseminated 5 Turkish alert messages to the Disaster and Emergency Management Presidency of Turkey (AFAD) as the authorized CPA in Turkey, where the first message included enhanced products such as Tsunami Travel Map, Tsunami Forecast Point Alert Level Map and Distance Based Tsunami Alert Maps. In NEAMWave14, KOERI also disseminated tsunami exercise message via SMS to the subscribed recipients.

Fig. 5.5. UNESCO NEAMWave14 Tsunami Exercise, 28 October 2014, (view from AFAD headquarter Emergency Management Center in Ankara)

REFERENCES

CHAPTER 1 & 2

- Alexander, D. E. (2000). *Confronting Catastrophe: New Perspectives on Natural Disasters*, Harpenden: Terra Publishing/New York: Oxford University Press.

- Alexander, D. (2014). “Emergency and disaster planning” In: *Disaster Management-International lesions in risk reduction, response and recovery*, Edited by Alejandro Lopez-CARESİ, Maureen Fordham, Ben Wisner, Ilan Kelman and JC Gaillard.

- Allen, K. M. (2006). Community-based disaster preparedness and climate adaptation: local capacity-building in the Philippines. *Disasters*, *30*(1), 81-101.

- ASIS International. (2009). Organizational Resilience: Security, Preparedness, and Continuity Management Systems-Requirements with Guidance for Use, ASIS SPC.1-2009, American National Standard. Available at: https://www.ndsu.edu/fileadmin/emgt/ASIS_SPC.1-2009_Item_No._1842.pdf

- Athukorala, P. C. (2012). *Disaster, Generosity and Recovery: Indian Ocean Tsunami*. The Australian National University, Arndt-Corden Department of Economics. Available at: https://crawford.anu.edu.au/acde/publications/publish/papers/wp2012/wp_econ_2012_04.pdf

- Basnayake, B. F. A., Chiemchaisri, C., & Visvanathan, C. (2006). Wastelands-clearing up after the tsunami in Sri Lanka and Thailand. *Waste Management World*, (R), 31.

- Bjerregaard, M. (2009). MSB/UNDP Debris Management Guidelines. Disaster Waste Recovery. Available at: https://www.sheltercluster.org/sites/default/files/docs/Debris%20Management%20Guidelines%202010.pdf

- Bird, D. K., Chagué-Goff, C., & Gero, A. (2011). Human response to extreme events: A review of three post-tsunami disaster case studies. Australian Geographer, 42(3), 225-239.

- Brown, C., Milke, M., & Seville, E. (2011). Disaster waste management: A review article. *Waste Management*, *31*(6), 1085-1098.

- Bird, D., & Dominey-Howes, D. (2008). Testing the use of a ‘questionnaire survey instrument’ to investigate public perceptions of tsunami hazard and risk in Sydney, Australia. *Natural Hazards, 45*(1), 99-122.

- Boano, C. (2014). “Post-disaster recovery planning: Introductory notes on its challenges and potentials” In: *Disaster Management-International lesions in risk reduction, response and recovery*, Edited by Alejandro Lopez-CARESİ, Maureen Fordham, Ben Wisner, Ilan Kelman and JC Gaillard.

- Boin, A., Ekengren, M., Rhinard, M. (2006). Functional Security and Crisis Management Capacity in the European Union, Chapter 1 - Crisis Management in Europe: What Role for the European Union? Downloadable at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.138.2159&rep=rep1&type=pdf

- Borell, J., & Eriksson, K. (2008). Improving emergency response capability: an approach for strengthening learning from emergency response evaluations. *International Journal of Emergency Management*, *5*(3-4), 324-337.

- Brandstrom, A., Kuipers, S., & Daleus, P. (2008). "The politics of tsunami responses: comparing patterns of blame management in Scandanavia" In: *Governing After Crisis – The Politics of Investigation, Accountability and Learning*, Edited by Arjen Boin, Allan McConnell, Paul 'T Hart.

- Burnett, J. J. (1999). A strategic approach to managing crises. *Public relations review*, *24*(4), 475-488.

- Ching, E. (2011). Best Practices and Lessons Learned: The Humanitarian Response in Post-Tsunami Sri Lanka. Case-Specific Briefing Paper, Josef Korbel School of International Studies. Available at: http://www.du.edu/korbel/crric/media/documents/erinching.pdf

- Christopher, M., & Tatham, P. (2011). Introduction. In M. Christopher & P. Tatham (Eds.), Humanitarian logistics. Meeting the challenge of preparing for and responding to disasters (pp. 1–14). London: Kogan Page.

- Coombs, W. T. (2006). *Code red in the boardroom: Crisis management as organizational DNA*. Greenwood Publishing Group.

- Cozzolino, A. (2012). Humanitarian logistics and supply chain management. In *Humanitarian Logistics - Cross-Sector Cooperation in Disaster Relief Management* (pp. 5-16). Springer Berlin Heidelberg.

- Crandall, W. R., Parnell, J. A., & Spillan, J. E. (2014). Crisis Management in the New Strategy Landscape (2nd Edition). Sage Publications, Thousand Oaks, CA.

- Crisis management. (2015, October 5). In Wikipedia, The Free Encyclopedia. Retrieved 09:15, October 6, 2015, from https://en.wikipedia.org/w/index.php?title=Crisis_management&oldid=684238073

- Danar, O. R., & Pushpalal, D. (2014). Building Community Resilience: Conceptual Framework and its Application in Post Tsunami Resettlement. *Procedia Economics and Finance*, *18*, 489-496.

- Davis, I. (1978). *Shelter After Disaster*, Headington: Oxford Polytechnic Press.

- Dominey-Howes, D., Dengler, L., Dunbar, P., Kong, L., Fritz, H., Imamura, F., McAdoo, B., Satake, K., Yalciner, A., Yamamoto, M., Yulianto, E., Koshimura, S., and Borrero, J. (2012). International Tsunami Survey Team (ITST) Post-Tsunami Survey Field Guide. 2nd Edition. UNESCO-IOC, Paris.

- Engelhardt, A., Hidalgo, S., & Sole, R. (2006). The International Community's Funding of the Tsunami Emergency and Relief: Government Funding Synthesis. London: Tsunami Evaluation Coalition. Downloadable at: http://daraint.org/wp-content/uploads/2011/04/tec_government_funding_synthesis.pdf

- Faulkner, B. (2001). Towards a framework for tourism disaster management. *Tourism Management*, *22*(2), 135-147.

- Fernando, U., & Hilhorst, D. (2006). Everyday practices of humanitarian aid: tsunami response in Sri Lanka. *Development in Practice*, *16*(03-04), 292-302.

- FEMA (2007). Debris Management Guide. Public Assistance. Available at: https://www.fema.gov/pdf/government/grant/pa/demagde.pdf

- Fink, S. (1996). Crisis management: Planning for Inevitable, New York, American Management Association.

- Flint, M., & Goyder, H. (2006). Funding the tsunami response, a Synthesis of Initial Findings. London: Tsunami Evaluation Coalition. (Special version only published in Swedish International

Development Cooperation Agency (SIDA)'s publication data base and can be downloaded from: http://www.sida.se/publications)

- Gao, H., Barbier, G., Goolsby, R., & Zeng, D. (2011). *Harnessing the crowdsourcing power of social media for disaster relief*. Arizona State Univ Tempe.

- Garside, R., Johnston, D., Saunders, W., & Leonard, G. (2009). Planning for tsunami evacuations: the case of the Marine Education Centre, Wellington, New Zealand. *Australian Journal of Emergency Management, 24*(3), 28.

- Gourlay, C. (2004). European Union procedures and resources for crisis management. *International Peacekeeping*, *11*(3), 404-421.

- Gupta, M., & Sharma, A. (2006). Compounded loss: the post tsunami recovery experience of Indian island communities. *Disaster Prevention and Management: An International Journal*, *15*(1), 67-78.
- Harrald, J. R. (2006). Agility and discipline: critical success factors for disaster response. *The annals of the American Academy of political and Social Science*, *604*(1), 256-272.

- Hayles, C. S. (2010). An examination of decision making in post disaster housing reconstruction. *International Journal of Disaster Resilience in the Built Environment*, *1*(1), 103-122.

- Hilhorst, D. (2013). "Disaster, conflict and society – Everyday politics of crisis response" In: *Disaster, Conflict and Society in Crises – Everyday politics of crisis response*, Edited by Dorothea Hilhorst.

- Hilhorst, D., & Jansen, B.J. (2013). "Humanitarian space as arena – A perspective on the everyday politics of aid" In: *Disaster, Conflict and Society in Crises – Everyday politics of crisis response*, Edited by Dorothea Hilhorst.

- Humanitarian aid. (2015, December 22). In Wikipedia, The Free Encyclopedia. Retrieved 15:35, December 25, 2015, from https://en.wikipedia.org/wiki/Humanitarian_aid

- https://www.humanitarianresponse.info/

- Leidner, D. E., Pan, G., & Pan, S. L. (2009). The role of IT in crisis response: Lessons from the SARS and

- IBRD/World Bank (2012). *The Great East Japan Earthquake: Learning From Megadisasters*. Knowledge Notes, Executive Summary, Washington, DC. Available at: http://wbi.worldbank.org/wbi/megadisasters

- Intergovernmental Oceanographic Commission of UNESCO (2008). Surviving a Tsunami – Lessons to Learn from Aceh and Pangandaran Tsunamis. IOC Brochure 2009-1, 32 pp. (English) (IOC/BRO/2009/1) Available at: http://unesdoc.unesco.org/images/0018/001831/183133e.pdf

- Kapucu, N., & Özerdem, A. (2013). Chapter 4 – Disaster Response and Recovery. In: *Managing emergencies and crises*. Jones & Bartlett Publishers.

- Karunasena, G., Amaratunga, D., & Haigh, R. (2010). Capacity building towards sustainability: context of post disaster waste management. *International Research Conference on Sustainability in Built Environment*, Colombo, 18-19 June.

- Karunasena, G., & Amaratunga, D. (2015). Capacity gaps in post disaster construction & demolition waste management. *Engineering, Construction and Architectural Management*, *22*(4), 446-466.

- Kennedy, J., Ashmore, J., Babister, E., & Kelman, I. (2008). The meaning of 'build back better': evidence from post-tsunami Aceh and Sri Lanka. *Journal of Contingencies and Crisis Management*, *16*(1), 24-36.

- Khasalamwa, S. (2009). Is 'build back better' a response to vulnerability? Analysis of the post-tsunami humanitarian interventions in Sri Lanka. *Norsk Geografisk Tidsskrift-Norwegian Journal of Geography*, *63*(1), 73-88.

- Kovács, G., & Spens, K. M. (2007). Humanitarian logistics in disaster relief operations. *International Journal of Physical Distribution & Logistics Management*, *37*(2), 99-114.

- *Kyle Farmbry (2013) Optimism interrogated: The Earthquakes and Tsunamis of 1775 and 2004. In: Crisis, Disaster, and Risk – Institutional Response and Emergence. ME Sharpe*.
- Asian Tsunami disasters. *The Journal of Strategic Information Systems*, *18*(2), 80-99.

- Leon, E., Kelman, I., Kennedy, J., & Ashmore, J. (2009). Capacity building lessons from a decade of transitional settlement and shelter. *International Journal of Strategic Property Management*, *13*(3), 247-265.

- Lindsay, B. R. (2011). Social media and disasters: Current uses, future options, and policy considerations.

- Myers, K. N. (1993). *Total Contingency Planning for Diasters: Managing Risk... Minimizing Loss... Ensuring Business Continuity*. John Wiley & Sons, Inc..

- Niininen, O. (2013). *Five Star Crisis Management--Examples of Best Practice from the Hotel Industry*. INTECH Open Access Publisher.

- OXFAM Research Reports (December, 2014). The Indian Ocean Tsunami, 10 Years On - Lessons from the response and ongoing humanitarian funding challenges. Downloadable at: https://www.oxfam.org/sites/www.oxfam.org/files/file_attachments/the_indian_ocean_tsunami_10_years_on_-_lessons_from_the_response_and_ongoing_humanitarian_funding_challenges.pdf

- Pardasani, M. (2006). Tsunami reconstruction and redevelopment in the Maldives: A case study of community participation and social action. *Disaster Prevention and Management: An International Journal*, *15*(1), 79-91.

- Perry, M. (2007). Natural disaster management planning: A study of logistics managers responding to the tsunami. *International Journal of Physical Distribution & Logistics Management*, *37*(5), 409-433.

- Pettit, S., & Beresford, A. (2009). Critical success factors in the context of humanitarian aid supply chains. *International Journal of Physical Distribution & Logistics Management*, *39*(6), 450-468.

- Pettit, S., Beresford, A., Whiting, M., & Banomyong R. (2011). The 2004 Thailand tsunami reviewed: Lesson learned. In M. Christopher & P. Tatham (Eds.) Humanitarian logistics. Meeting the challenge of preparing for and responding to disasters (pp. 103–119). London: Kogan Page.

- Post, J., Wegscheider, S., Mueck, M., Zosseder, K., Kiefl, R., Steinmetz, T., &Strunz, G. (2009). Assessment of human immediate response capability related to tsunami threats in Indonesia at a subnational scale. *Natural Hazards & Earth System Sciences, 9(*4).

- Ranghieri, F., & Ishiwatari, M. (2014). Chapter 23: Debris Management. *Learning from Megadisasters: Lessons from the Great East Japan Earthquake*. Washington, DC: World Bank. © World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/18864

- Ranghieri, F., & Ishiwatari, M. (2014). Chapter 16: Management of Logistics Chain for Emergency Supplies. *Learning from Megadisasters: Lessons from the Great East Japan Earthquake*. Washington, DC: World Bank. © World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/18864

- Reynolds, B. (2002). Crisis and emergency risk communication. Atlanta, GA: Centers for Disease Control and Prevention.

- Reynolds, B., & W. Seeger, M. A. T. T. H. E. W. (2005). Crisis and emergency risk communication as an integrative model. *Journal of Health Communication*, *10*(1), 43-55.

- Sahal, A., & Morin, J. (2012). Effects of the October 25, 2010, Mentawai tsunami in La Réunion Island (France): observations and crisis management. Natural Hazards, 62(3), 1125-1136.

- Said, A. M., Mahmud, A. R., & Abas, F. (2011). Community preparedness for tsunami disaster: a case study. *Disaster Prevention and Management, 20*(3), 266-280.

- Sapriel, C. (2003). Effective crisis management: Tools and best practice for the new millennium. *Journal of Communication Management*, *7*(4), 348-355.

- Scheper, B., Parakrama, A. & Patel, S. (2006). *Impact of the tsunami response on local and national capacities*. London: Tsunami Evaluation Coalition. Downloadable at: https://docs.unocha.org/sites/dms/documents/tec_capacities_report.pdf
- Shaw, R. (2006). Indian Ocean tsunami and aftermath: need for environment-disaster synergy in the reconstruction process. *Disaster Prevention and Management: An International Journal*, *15*(1), 5-20.

- Seeger, M. W., Sellnow, T. L., & Ulmer, R. R. (1998). Communication, organization and crisis. *Communication Yearbook, 21*, 231–275.

- Sonak, S., Pangam, P., & Giriyan, A. (2008). Green reconstruction of the tsunami-affected areas in India using the integrated coastal zone management concept. *Journal of Environmental Management*, *89*(1), 14-23.

- Srinivas, H., & Nakagawa, Y. (2008). Environmental implications for disaster preparedness: lessons learnt from the Indian Ocean Tsunami. *Journal of Environmental Management*, *89*(1), 4-13.

- Telford, J., Cosgrave, J. & Houghton, R. (2006). *Joint Evaluation of the international response to the Indian Ocean tsunami: Synthesis Report*. London: Tsunami Evaluation Coalition. Downloadable at: http://www.undp.org/content/dam/india/docs/joint_evaluation_of_the_international_response_to_the_indian_ocean_tsunami.pdf

- Telford, J., & Cosgrave, J. (2007). The international humanitarian system and the 2004 Indian Ocean earthquake and tsunamis. *Disasters*, *31*(1), 1-28.

- t'Hart, P., & Sundelius, B. (2013). Crisis management revisited: A new agenda for research, training and capacity building within Europe. *Cooperation and Conflict*, 48(3): 444-461.

- Thomas, A. and Kopczak, L. (2005), From Logistics to Supply Chain Management: The Path Forward in the Humanitarian Sector, Fritz Institute, San Francisco, CA, pp. 1-15.

- UNDP. (2012). Tsunami Recovery Waste Management Programme, Best Practice Series 2012 - Debris Clearance & Demolition. Available at: http://www.id.undp.org/content/dam/indonesia/2015/doc/trwmp/Debris%20Clearance%20and%20Demolition%20-%20Best%20Practice%20Book.pdf

- UNDP (1993), Logistics, 1st ed., United Nations Development Programme, Geneva.

- Walker, P., & Maxwell, D. (2009). *Shaping the Humanitarian World*. London/New York: Routledge.

- Whybark, D. C. (2015). Co-creation of improved quality in disaster response and recovery. *International Journal of Quality Innovation*, *1*(1), 1-10.

- Van Wassenhove, L. N. (2006). Humanitarian aid logistics: supply chain management in high gear†. *Journal of the Operational Research Society*,*57*(5), 475-489.

- Wong, P. P. (2009). Rethinking post-tsunami integrated coastal management for Asia-Pacific. *Ocean & Coastal Management*, *52*(7), 405-410.

- White, C. M. (2011). *Social media, crisis communication, and emergency management: Leveraging Web 2.0 technologies*. CRC press.

CHAPTER 3

- Ahmadun, F.R., Shalu, I.M. & Aini, M.S., 2003. Review of an incident at a petrochemical plant. *Disaster Prevention and Management*, 12: 85-90.

- Alexander, D. E., 2002. *Principles of emergency planning and management*. Hertfordshire, UK: Terra Publishing.

- American Red Cross. 2006. *Disaster Kitchen Supervision – Participant's Workbook*. Washington, DC: American Red Cross.

- American Red Cross. 2007. *Shelter Operations Management Toolkit*. Washington, DC: American Red Cross.

- Assilzadeh, H. & Gao, Y., 2010. Designation of an interactive oil spill management system. *Disaster Prevention and Management*, 19(2): 233-242.

- Auf der Heide, E. 1989. *Disaster Response: Principles of Preparation and Coordination*. St. Louis: Mosby.

- Bhandari, R.B., Owen, C. & Trist, C., 2015. Incident Management Approaches above the Incident Management Team Level in Australia. *Journal of Homeland Security and Emergency Management*, 12(1): 101-119.

- Billa, L., Shattri, M., Mahmud, A.R. & Ghazali, A.H., 2006. Comprehensive planning and the role of SDSS in flood disaster management in Malaysia. *Disaster Prevention and Management*, 15(2): 233-240.

- Bouamrane, K., Hamdadou, D., Yachba, K. & Guenachi, K., 2012. Towards a decision support system, application: itinerary road modification for road transport of hazardous materials. *International Journal of Decision Sciences, Risk and Management*, 4(3/4): 175-196.

- Davis, J. & Lambert, R. 2002. *Engineering in Emergencies – A practical guide for relief workers – Second Edition*. Rugby, United Kingdom: Practical Action Publishing.

- Federal Emergency Management Agency, 2012. *Incident Action Planning Guide*. Washington, DC: FEMA.

- Federal Emergency Management Agency, 2010. *Developing and Maintaining Emergency Operations Plans: Comprehensive Preparedness Guide (CPG) 101, Version 2.0*. Washington, DC: FEMA.

- Harrald, J.R., 2006. Agility and Discipline: Critical Success Factors for Disaster Response. *The Annals of the American Academy of Political and Social Science*, 604(1): 256-272.

- Howard, M. & Paret, P. 2008. *Carl von Clausewitz – On War*. Oxford: Oxford University Press.

- Huder, R.C., 2012. *Disaster Operations and Decision Making*. Hoboken, NJ: Wiley.

- Interagency Standing Committee. 2014. *Strategic Response Plan Guidance*. Geneva: Interagency Standing Committee. https://www.humanitarianresponse.info/en/programme-cycle/space/strategic-response-planning-guidance-templates, accessed February 19, 2016.

- International Atomic Energy Agency, 2011. *IAEA International fact-finding expert mission of the Fukushima Dai-ichi NPP accident following the Great East Japan earthquake and tsunami*. http://www-pub.iaea.org/MTCD/meetings/PDFplus/2011/cn200/documentation/cn200_Final-Fukushima-Mission_Report.pdf, accessed May 8, 2015.

- International Federation of Red Cross and Red Crescent Societies. 2012. *Guidance on the Emergency Plan of Action (for National Societies) including accessing DREF and emergency appeal as funding mechanisms*. Geneva: International Federation of Red Cross and Red Crescent Societies.

- Janssen, M., Lee, J.K., Bharosa, N. & Cresswell, A., 2010. Advances in multi-agency disaster management: Key elements in disaster research. *Information Systems Frontiers*, 12(1): 1-7.

- Kanoglu, U., Titov, V.V., Bernard, E. & Synolakis, C.E., 2015. Tsunamis: bridging science, engineering and society. *Philosophical Transactions of the Royal Society A*, 373: 20140369.

- Kapucu, N., Arslan, T. & Demiroz, F., 2010. Collaborative emergency management and national emergency management network. *Disaster Prevention and Management*, 19(2):452-468.

- Karagiannis, G.M. & Synolakis, C.E., in press. Collaborative incident planning and the common operational picture. In: Pardalos, P., Nagurney, A. & Kotsireas, I. (eds.), *Dynamics of Disasters*. Berlin: Springer.

- Karagiannis, G.M. & Synolakis, C.E., 2016. *Twenty critical points in incident planning*. Working paper.

- Karagiannis, G.M. & Synolakis, C.E., 2015. Using Social Media to manage Disaster Volunteers in Greece. *2015 International Crisis and Risk Communication Conference*, Orlando, Florida, USA.

- Karagiannis, G.M. & Synolakis, C.E., 2014. Using risk analysis and hazard numerical simulation models to support the design, conduct and evaluation of disaster exercises. *5th International Disaster and Risk Conference*, Davos, Switzerland, ISBN: 978-3-033-04701-3.

- Karagiannis, G.M., Saini, K.S. & Synolakis, C.E., 2014. Lessons from the first European Union tsunami simulation exercise. *Proceedings of The International Emergency Management Society USA Conference*, Hattiesburg, Mississippi, USA, ISBN: 9789490297107.

- Karagiannis, G.M., Piatyszek, E. & Flaus, J.M., 2013. Model-driven and risk-based performance analysis of industrial emergency plans. *Journal of Contingencies and Crisis Management*, 21(2): 96-114.

- Karagiannis, G.M., 2012. *Model Local/Regional Disaster Prevention Policy Plan*. Athens, Greece: General Secretariat for Civil Protection, 67pp.
- Karagiannis, G. M., Piatyszek, E. & Flaus, J. M., 2010. Industrial emergency planning modeling: A first step toward a robustness analysis tool. *Journal of Hazardous Materials*, 181: 324-334.

- Lagadec, P., 2015. Framing the issue – Hurricane Katrina: A weapon of mass destruction without criminal dimension. Available at http://www.patricklagadec.net/fr/, accessed July 15, 2015.

- Lindsay, B.R., 2011. *Social Media and Disasters: Current Uses, Future Options, and Policy Considerations*. Washington, DC: Congressional Research Service.

- McEntire, D.A., 2006. *Disaster Response and Recovery: Strategies and Tactics for Resilience*. Hoboken, NJ: Wiley.

- Mittu, R. & Segaria, F. 2000. *Common Operational Picture (COP) and Common Tactical Picture (CTP) Management via a Consistent Networked Information Stream (CNIS)*. Washington, DC: Naval Research Laboratory.

- Moynihan, D.P., 2009. The Network Governance of Crisis Response: Case Studies of Incident Command Systems. Journal of Public Administration Research & Theory, 19: 895-915.

- Nagurney, A. & Nagurney, L., 2015. A Mean-Variance Disaster Relief Supply Chain Network Model for Risk Reduction with Stochastic Link Costs, Time Targets, and Demand Uncertainty. Paper presented at the *2nd International Conference on Dynamics of Disasters*, 29 June – 2 July 2015, Kalamata, Greece.

- National Fire Academy. 2006. Incident Command System for Structural Collapse Incidents Student Manual 3rd Edition. Washington, D.C.: National Fire Academy, U.S. Department of Homeland Security.

- North Atlantic Treaty Organization. 2010. *Allied Command Operations Comprehensive Operations Planning Guide*. Mons, Belgium: North Atlantic Treaty Organization, Supreme Headquarters Allied Powers Europe.

- North Atlantic Treaty Organization. 2012. *SOTG Decision-Making Process Handbook – Study Draft*. Available at: http://www.istc-sof.org/documents/sotgdecisionmaking.pdf, accessed January 28, 2015.

- Pandélé, P. 1998. *Gestion opérationnelle et commandement – La méthode de Raisonnement Tactique d'état-major niveau 1 (CODIS et PC de site en phases 2 et 3)*. Nainville-les-Roches, France: Ecole Nationale Supérieure des Officiers de Sapeurs-Pompiers [in French].

- Sahana Software Foundation, 2015. http://sahanafoundation.org/about-us/deployments/, accessed August 7, 2015.

- Salmon, P., Stanton, N., Jenkins, D. & Walker, G., 2011. Coordination during multi-agency emergency response: issues and solutions. *Disaster Prevention and Management*, 20(2): 140-158.

- Samatas, M., 2007. Security and Surveillance in the Athens 2004 Olympics: Some Lessons From a troubled Story. *International Criminal Justice Review*, 17(3): 220-238.

- Ständige Konferenz für Katastrophenvorsorge und Katastrophenschutz. 2000. *Führung und Leitung im Einsatz – DV 100*. Köln, Germany: Ständige Konferenz für Katastrophenvorsorge und Katastrophenschutz. [in German]

- Stephens, W.O., 2012. *Marcus Aurelius: A Guide for the Perplexed*. London: Continuum.

- Synolakis, C.E. & Kanoglu, U., 2015. The Fukushima accident was preventable. *Philosophical Transactions of the Royal Society A*, 373: 20140379.

- Synolakis, C.E. & Bernard, E.N., 2006. Tsunami Science Before and after Boxing Day 2004. *Philosophical Transactions of the Royal Society A*, 364(1845): 2231-2265.

- Titov, V.V. & Synolakis, C.E., 1998. Numerical modeling of tidal wave runup. *Journal of Waterway, Port & Coastal Engineering*, 124(4): 157-171.

- Tokyo Electric Power Company. 2012. *Fukushima Nuclear Accident Analysis Report*. Available at: http://www.tepco.co.jp/en/press/corp-com/release/betu12_e/images/120620e0104.pdf, accessed 08 May 2015.

- Topper, B. & Lagadec, P., 2013. Fractal Crises – A New Path for Crisis Theory and Management. *Journal of Contingencies and Crisis Management*, 21(1): 4-16.

- United Nations Office for the Coordination of Humanitarian Affairs. 2013. *United Nations Field Assessment and Coordination Field Handbook – 6th Edition*. Geneva: United Nations Office for the Coordination of Humanitarian Affairs.

- U.S. Army. 2014. *Commander and Staff Organization and Operations – FM 6-0*. Washington, D.C.: Headquarters, Department of the Army.

- U.S. Army, 2010. *The Operations Process – FM5-0*. Washington, DC: Department of the Army.

- U.S. Department of Defense, 2015. *Dictionary of Military and Associated Terms – Joint Publication 1-02*. Available at DTIC. http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf, accessed February25, 2015.

- U.S. Environmental Protection Agency, National Oceanic & Atmospheric Administration, 1999. *Areal Location Of Hazardous Atmospheres (ALOHA) Instructor Manual*. Washington, DC: EPA & Seattle, WA: NOAA.
- Vogiatzis, C., Walteros, J.L. & Pardalos, P.M., 2012. Evacuation Through Clustering Techniques. In: Goldengorin, B., Kalyagin, V.A., Pardalos, P.A. (eds). *Models, Algorithms, and Technologies for Network Analysis*. Springer Proceedings in Mathematics & Statistics, vol. 32. Heidelberg: Springer.
- Warren, Mills J., Curtis, A., Pine, J.C., Kennedy, B., Jones, F., Ramani, R. & Bausch, D., 2008. The clearinghouse concept: a model for geospatial data centralization and dissemination in a disaster. *Disasters* 32(3): 467–479.
- Wolbers, J. & Boersma, K., 2013. The Common Operational Picture as Collective Sensemaking. *Journal of Contingencies and Crisis Management*, 21(4): 186-199.

CHAPTER 4

- Alexandrakis, G., Flouri, E. Kalligeris, N., Kampanis, N. & Synolakis, C.E., 2010. *Poseidon Project – Disaster Scenario description (Deliverable B.5d)*. Foundation for Research and Technology Hellas, Heraklion, Greece. http://www.crete-region.gr/el (accessed October 29, 2015)
- Ambraseys, N. & Synolakis, C.E., 2010. Tsunami Catalogs for the Eastern Mediterranean, Revisited. *Journal of Earthquake Engineering*, 14(3): 309-330.
- Auf Der Heide, E., 1989. *Disaster Response – Principles of Preparation and Coordination*. St. Louis: Mosby.
- Bernard, E.N., Mofjeld, H.O., Titov, V.V., Synolakis, C.E. & Gonzalez, F.I., 2006. Tsunami: scientific frontiers, mitigation, forecasting and policy implications. *Philosophical Transactions of the Royal Society A*, 364: 1989-2007.
- Brower, D.J. and Bohl, C.C., 2000. *Principles and practice of hazard mitigation*. Emmitsburg, MD: Federal Emergency Management Agency/Emergency Management Institute, http://training.fema.gov/emiweb/edu/HMPrinciple.asp (accessed October 27, 2015).
- Camilleri, D.H., 2006. Tsunami construction risks in the Mediterranean – outlining Malta's scenario. Disaster Prevention and Management, 15(1): 146-162.
- Federal Emergency Management Agency, 1996. *Guide for All-Hazard Emergency Operations Planning, State and Local Guide (SLG) 101*. Washington, D.C.: FEMA.
- Federal Emergency Management Agency, 2001. *State and Local Mitigation Planning how-to guide, Volume II: Understanding Your Risks: identifying hazards and estimating losses*. Washington, D.C.: FEMA, http://www.fema.gov/library/viewRecord.do?id=1880 (accessed October 27, 2015)
- Federal Emergency Management Agency, 2010. *Developing and Maintaining Emergency Operations Plans, Comprehensive Preparedness Guide (CPG) 101. Version 2.0*. Washington, D.C.: FEMA.

- Flouri, E.T., Mitsoudis, D.A., Chrysoulakis, N., Diamantakis, M. & Synolakis, C. E., 2012. Tsunami risk and vulnerability analysis for the city of Rhodes. *Proceedings of the 22nd International Offshore and Polar Engineering Conference,* Rhodes, Greece.

- Galanopoulos, A.G., 1960. Tsunamis observed on the coasts of Greece from Antiquity to present time. Annals of Geophysics, 13: 369-386.

- Guidoboni, E. & Comastri, A., 1997. The large earthquake of 8 August 1303 in Crete: seismic scenario and tsunami in the Mediterranean area. *Journal of Seismology*, 1(1): 55-72.

- Hellenic Statistical Authority, 2015. *Greece in figures*. Athens, Greece: Hellenic Statistical Authority. http://www.statistics.gr/documents/20181/301069/GreeceInFigures_2015Q3_EN.pdf (accessed October 31, 2015)

- Howell, A., Jackson, J., England, P., Higham, T. & Synolakis, C.E., 2015. Late Holocene uplift of Rhodes, Greece: evidence for a large tsunamigenic earthquake and the implications for the tectonics of the eastern Hellenic Trench System. Geophysical Journal International, 203(1): 459-474.

- International Federation of Red Cross and Red Crescent Societies, 2009. *World Disasters Report 2009: Focus on early warning, early action*. Geneva: IFRC.

- Kanoglu, U., Titov, V., Bernard, E. & Synolakis, C.E., 2015. Tsunamis: bridging science, engineering and society. *Philosophical Transactions of the Royal Society A*, 373: 20140369.

- Karagiannis, G.M., Piatyszek, E. & Flaus J.M., 2013. Model-driven and risk-based performance analysis of industrial emergency plans. *Journal of Contingencies and Crisis Management*, 21(2): 96-114.

- Karagiannis, G.M., Saini, K.S. & Synolakis, C.E., 2014. Lessons from the first European Union tsunami simulation exercise. *Proceedings of The International Emergency Management Society USA Conference*, Hattiesburg, Mississippi, USA.

- Maramai, A., Brizuela, B. & Graziani, L., 2014. The Euro-Mediterranean Tsunami Catalogue. *Annals of Geophysics*, 57(4): S0435, doi: 10.4401/ag-6437.

- Melis, N. & Charalampakis M., 2014. The Hellenic National Tsunami Warning Centre (HL-NTWC): Recent updates and future developments. *Geophysical Research Abstracts*, 16, EGU2014-10035.

- Mitsoudis, D.A., Flouri, E.T., Chrysoulakis, N., Kamarianakis, Y., Okal, E.A. and Synolakis, C.E., 2012. Tsunami hazard in the southeast Aegean Sea. *Coastal Engineering*, 60: 136-148.

- Papadopoulos, G.A., Gracia, E., Urgeles, R., Sallares, V., De Martini, P.M., Pantosti, D., Gonzalez, M., Yalciner, A.C., Mascle, J., Sakellariou, D., Salamon, A., Tinti, S., Karastathis, V., Fokaefs, A., Camerlenghi, A., Novikova, T. and Papageorgiou, A., 2014. .Historical and pre-historical tsunamis in the Mediterranean and its connected seas: Geological signatures, generation mechanisms and coastal impacts. *Marine Geology*, 354: 81-109.

- Shaw, B., Ambraseys, N.N., England, P.C., Floyd, M.A., Gorman, G,J., Higham, T.F.G., Jackson, J.A., Nocquet, J.-M., Pain, C.C. and Piggott, M.D., 2008. Eastern Mediterranean tectonics and tsunami hazard inferred from the AD 365 earthquake. *Nature Geoscience*, 1(4): 268-276.

- Titov, V.V. & Synolakis, C.E., 1995. Modeling of breaking and nonbreaking long-wave evolution and runup using VTCS-2. *Journal of Waterway, Port, Coastal & Ocean Engineering*, 121(6): 308-316.

- Titov, V.V. & Synolakis, C.E., 1998. Numerical modeling of tidal wave runup. *Journal of Waterway, Port, Coastal & Ocean Engineering*, 124(4): 157-171.

- United Nations, 2015. *World Population Prospects – The 2015 Revision: Key Findings and Advance Tables*. New York: United Nations. http://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf (accessed October 31, 2015).