# Lessons learned from Asian tsunami disaster: sharing knowledge

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## Abstract

Creating an organised common platform to capture, organise and share the knowledge on disaster management strategies is considered vital to enhance the effectiveness of future disaster management efforts. Hence, ensuring the availability and accessibility of accurate and reliable disaster risk information when required entails an efficient system for knowledge sharing. This paper highlights the importance of knowledge and good practice sharing in disaster management strategies, and discusses key lessons learned from 2004 Asian tsunami, particularly relating to the Sri Lankan context. Good practices and lessons learned are discussed on five different themes: social, technical, legal, operational and environmental. Further, the ISLAND website is introduced and developed as part of a research aimed at increasing the effectiveness of disaster management by facilitating the sharing of appropriate knowledge and good practices.

**Keywords:** Disaster management, Knowledge sharing, Lessons learned, Good practices.

## 1. Background

Disasters, both natural and man-made, have been occurring with increasing frequency and effect in recent decades in many countries around the world. According to the World Disaster Report 2005 [1], the number of reported disasters has increased steadily over the past century and risen sharply during the past decade. This reflects the high value of the infrastructure and assets at risk. Disasters bring about the loss of lives, property, employment and damage to the physical infrastructure and the environment. The Asia-Pacific region has experienced the greatest loss of life in absolute terms and in proportion to the population, due to earthquakes, tsunami, floods and tropical cyclones. The Asian tsunami that struck on the morning of December 26, 2004 is

widely acknowledged as the largest, most devastating natural catastrophe in the Asian region. This left behind widespread destruction, killing over 250,000 people, damaging natural ecosystems and coastal infrastructure [2]. As such, there is a conscious effort for disaster management at national, provincial and sub-provincial level.

Effective lesson learning should reduce the risk of future disasters through well-informed mitigation and preparedness planning. Ensuring the availability and accessibility of accurate and reliable disaster risk information when required entails an efficient system for knowledge sharing. Despite its importance, knowledge appears fragmented, although there are undoubtedly many successful practices and lessons to be learned from 2004 Asian tsunami [3]. The UK Higher Education Disaster Relief Project Report 2007 [4] highlighted a lack of mechanisms at national level in the UK to link the expertise, skills and knowledge that resides in UK Higher Education with the practitioners in the humanitarian agencies. A lack of prior knowledge and proper point of reference have made most of the recovery plans guessing games, eventually failing without adding appropriate values to the recovery attempts [5]. In view of addressing the perceived need to share knowledge relating to disaster management strategies, the School of the Built Environment, at the University of Salford, undertook the research project '*ISLAND*' (Inspiring Sri-Lankan reNewal and Development), partly funded by the RICS Education Trust.

The paper aims to share good practices and lessons learned from 2004 Asian tsunami, while highlighting the importance of knowledge sharing in current disaster management strategies. It identifies appropriate good practices relating to several themes, based on case materials collated as part of ISLAND project. Accordingly, the paper is broadly divided into three sections. Initially, an overview on disaster management process and the need to share knowledge relating disaster management strategies are discussed. Secondly the paper introduces ISLAND project, where aims, objectives and methodology are presented. Finally, it provides an analysis on good practices and lessons learned from Asian tsunami disaster.

## 2. Disaster management process

Disaster management efforts aim to reduce, or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims, and achieve a rapid and effective recovery [6]. As shown in Figure 1, the process of disaster management is commonly visualised as a two-phase cycle, with a post-disaster recovery informing pre-disaster risk reduction and vice versa. As Warfield [6] states, the disaster management cycle illustrates the ongoing process by which governments, businesses and civil society plan for and reduce the impact of disasters, react during and immediately following one and take steps to recover after it has occurred.

The significance of this concept is in its ability to promote the holistic approach to disaster management as well as to demonstrate the relationship of disasters and development. Recovery and reconstruction are commonly identified within the post-disaster phase, that is the period that immediately follows after the occurrence of the event. However, the terminology of disaster relief and recovery, rehabilitation and reconstruction is used without precise and commonly agreed definitions, although in practice, a distinction is drawn between the emergency relief

phase and the subsequent non-emergency recovery [5]. Once a disaster has taken place, the first concern is effective 'recovery' – helping all those affected to recover from the immediate effects of the disaster. 'Reconstruction' involves helping to restore the basic infrastructure and services that the people need so that they can return to the pattern of life which they had before the disaster [7]. The importance of the 'transitional phase', linking immediate recovery and long-term reconstruction, is also stressed by a number of publications [2, 5]. With the recovery of social institutions, the economy and the main infrastructure, transition to the longer-term recovery and reconstruction process can be implemented.

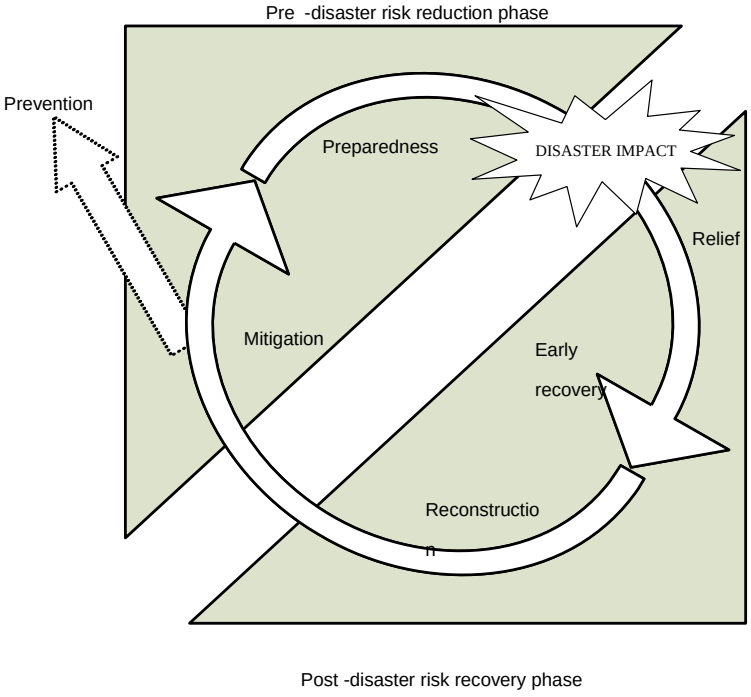


*Figure 1: Disaster management cycle (adopted from RICS [5])*

The pre-disaster phase of the disaster management cycle includes both mitigation and preparedness. As RICS [5] defines, disaster mitigation refers to any structural and non-structural measures undertaken to limit the adverse impacts of natural hazards, environmental degradation and technological hazards. 'Mitigation' measures may eliminate or reduce the probability of disaster occurrence, or reduce the effects of unavoidable disasters. As Warfield [6] describes, these measures can include building codes; vulnerability analyses updates; zoning and land use management; building use regulations and safety codes; preventive health care; and public education. In the ideal case, mitigation eliminates the risk of future disasters by effective sharing of lessons learned through 'preparedness' planning. Hence, the attention to disaster mitigation and risk reduction, which comprises the development portion, is equally important as disaster recovery and reconstruction, and rehabilitation. Greater attention to pre-disaster planning and preparedness, and sharing the lessons from previous disasters, could considerably reduce the risk associated with such events. Thereby, the mitigation phase, and indeed the whole disaster management cycle, includes the shaping of public policies and plans that either modify the

causes or mitigate their effects on people, property, and infrastructure. Appropriate actions at all points in the cycle lead to greater preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next iteration of the cycle [6].

Natural events however only become potential hazards when they threaten people or property [7]. As Warfield [6] states, natural hazards themselves do not necessarily lead to disasters. Natural hazards like earthquakes, however intense, inevitable or unpredictable, translate to disasters only to the extent that the population is unprepared to respond, unable to cope, and consequently, severely affected. An earthquake will cause little damage if it takes place in an empty desert. It may also cause little damage if it takes place where people can afford to be well protected. Hence, a natural event only causes serious damage when it affects an area where the people are at risk and poorly protected. Disasters occur when these two factors are brought together (as shown in Figure 2):

- People living in unsafe conditions
- A natural hazard such as a flood, tsunami, hurricane, earthquake.


*Figure 2: Components of a disaster*

Thereby, the threat from natural hazards can only be minimised through the elimination of unsafe conditions, as much as possible, in terms people, property and infrastructure. The role of the pre-disaster risk reduction phase, also referred as development portion, is considered to be vital in bringing unsafe conditions to a controlled safe environment, through mitigation and preparedness.

# 3. The need to share knowledge

There is a conscious effort for disaster management at national, provincial and sub-provincial level. Despite this, knowledge appears fragmented, although there are undoubtedly many successful practices and lessons to be learned [3]. Hence, there is a perceived gap in information coordination and sharing particularly relating to disaster mitigation. A lack of prior knowledge and proper point of reference have made most of the recovery plans guessing games, eventually failing without adding appropriate values to the recovery attempts [5]. The lack of effective information and knowledge sharing, and dissemination on disaster mitigation measures can thereby be identified as one of the reasons behind the unsatisfactory performance levels of current disaster management practices.

Knowledge can be differentiated between explicit, tacit and implicit forms of knowledge. Tacit knowledge represents knowledge based on the experience of individuals, expressed in human actions in the form of evaluation, attitudes, points of view, commitments and motivation [8]. Explicit knowledge, in contrast, is codifiable knowledge inherent in non-human storehouses including organisational manuals, documents and databases. In an organisational context, knowledge management is about applying the collective knowledge of the entire workforce to achieve specific organisational goals and facilitates the process, by which knowledge is created, shared and utilised [9]. However, within the disaster management context, knowledge management is about getting the right knowledge, in the right place, at the right time [3]. As a strategic approach to achieve disaster management objectives, knowledge management will play a valuable role in leveraging existing knowledge and converting new knowledge into action through the knowledge management cycle. In essence, knowledge organisation and human knowledge conversion processes can bring a comprehensive foundation to the common operating picture, interoperability, intelligence, training and acquisition [2]. In the light of this, it can be perceived that valuable knowledge on disaster management is present at three different levels: institutional, group and individual, in the forms of both tacit and explicit knowledge.

Thousands of organisations and institutions have been supporting the efforts on disaster management over last few decades. The linkages among all agencies working on disaster management need to be strengthened in order to derive the regional best practices and coping mechanisms [5]. In order to enhance the information sharing and management of the knowledge generated in institutions, it is essential to knit these organisations and institutions, and moreover groups and people working within them [2] more closely together. There are many gaps that could be bridged by the appropriate use of professional skills, but access to these by the local organisations on the front line of the recovery effort is highly constrained through lack of recognition of their existence. Therefore, recognition needs to be given for the institutions and organisations operating not only at international and national level, but also at the local level. In addition, this local knowledge can reside among the groups operating within different communities; hence, it can be extended to the existence of these formal and informal groups involved with the disaster management process.

The knowledge and experiences of disaster practitioners remain mainly in the individual domain. Due to its large geography, the experiences, approaches and adopted modalities for disaster management is not codified and remains with individuals as a tacit knowledge [3]. Acknowledging the need for a disaster knowledge-networking platform to facilitate interaction and have simultaneous dialogue with all related expertise dealing with disaster management, a knowledge management initiative was envisaged as a tool to store, retrieve, disseminate and manage information related to disaster management.

# 4. ISLAND project

*ISLAND* (Inspiring Sri-Lankan reNewal and Development) is aimed at increasing the effectiveness of the current disaster management strategies by sharing appropriate knowledge

and good practices about post-tsunami programmes, particularly in the Sri Lankan context. To this effect, the research was built around following objectives:

- To create an infrastructure for developing, sharing and disseminating knowledge about disaster management for land, property and construction.
- To develop a knowledgebase on post-tsunami recovery efforts, including but not limited to, disaster mitigation strategies.
- To develop case materials on post-tsunami responses.

Although the initial research focused on tsunami mitigation strategies and Sri Lanka in particular, the infrastructure developed during the project is scalable to permit growth in the knowledgebase to address other aspects of disaster management.

## 4.1 Methodology

The research was carried out according to three Work Packages (WPs). Details of WP specific objectives and description are provided within the WP outline.

Work Package 1: Develop knowledgebase infrastructure

*Aim*: WP1 aimed to develop the infrastructure for capturing, sharing and disseminating knowledge about disaster management in land, property and construction. Going beyond the scope of mere information management, it integrated knowledge extraction and dissemination techniques within this WP. The objective of this initiative is to ease and speed-up the decision making process within disaster management exercises. Specifically, mechanisms were developed to extract and disseminate explicit knowledge from materials gathered in WP2. This provided the necessary scalability for the knowledge dissemination exercise within the proposed project, be it internal to an organisation or accessible worldwide, as the database can be hosted centrally. A dynamic web portal was created as the front end of this database, providing the search and update facilities, to ensure enhanced user friendliness and self expansion of the proposed knowledgebase.

Work Package 2: Populate knowledgebase

*Aim*: WP2 aimed to populate the knowledgebase with a range of land, property and construction information related to tsunami mitigation strategies. Accordingly case materials focusing on good practices and lessons learned from the 2004 Asian tsunami disaster, particularly Sri Lankan post-tsunami context, were collated and analysed. The portal user interface developed in WP1 provided the capability to upload case study information to the backend database. In addition, professional bodies and relevant research groups were identified and invited to contribute materials to the knowledgebase. This included: disaster recovery strategies, their effectiveness, drawbacks and current good practices; the level of community involvement; details on the allocation of funding to recovery and reconstruction programmes in the region;

details on short term relief and its benefits; plans for long term developments including the consultation process between the government and the local community, knowledge on planning and building settlements that respond to community needs while providing a more secure environment; and finally, information on reporting frameworks.

Work Package 3: Disseminate research and identify future research directions

*Aim*: WP3 aimed to disseminate the research outputs and identifying future research directions. The web portal forms the focal point for the research's dissemination strategy. However, the project will also use and integrate with other appropriate dissemination mechanisms. A range of academic publications and prestigious International Conferences on relevant themes were targeted as a means of promoting the portal and disseminating the case material to a wider audience.

## 5. ISLAND website

As part of WP 1, the ISLAND web portal and knowledgebase was developed to capture, process, and disseminate the lessons learned from the Indian Ocean tsunami in the form of policy advice and good practices to guide future post-disaster interventions. Hence, the web portal provides an organised common platform to capture, organise and share the knowledge on disaster management strategies and create a versatile interface among users from government, professional bodies, research groups, funding bodies and local communities.


*Figure 3: ISLAND website - Home page*

The knowledgebase was created to address several themes of disaster management based on published case materials collected on Asian tsunami disaster 2004, particularly cases from the

Sri Lankan context. Case materials are organised into types of disaster, phase, country, source, research methodology followed, level, scope and access to the study is stored in a MySQL database using a PHP-Database interface. With the usage of SQL query, simple and advance searchers are provided to retrieve and view data. Also a key word search function is provided in the same manner to search the relevant keywords in the description provided of the materials.

The web site provides an introduction to the ISLAND project and project output together with the publications of the project. The web portal acts as the public interface to share and disseminate the lessons learned and good practices in disaster management. Further, the portal provides tools to capture, acquire and organise knowledge, through which the knowledge database will be kept up to date and live with disaster management strategies.

# 6. Good practices and lessons learned

As part of WP2, an analysis of good practices and lessons learned from the Asian tsunami disaster was carried out based on case material collated, particularly from Sri Lanka. Good practices and lessons learned, relating to different phases of disaster management cycle, are summarised into several themes that emerged from case material: social, technical, operational, legal, and environmental.

## 6.1 Social Issues

The importance of community participation within reconstruction process, public awareness and education, and job creation programmes like Cash for Work (CFW) are emphasised in most of the case material collated. Within the last decade, growing recognition of the necessity of community participation for sustainable disaster reduction was translated into actions to realise community based disaster management. Major benefits of the community based risk assessment, mitigation planning and implementation processes underscored include [10]; building confidence, pride in being able to make a difference, and enhanced capabilities to pursue disaster preparedness, mitigation as well as bigger development responsibilities at the local level. Additionally, individual and community ownership, commitment and concerted actions in disaster mitigation, including resource mobilisation produce a wide range of appropriate and innovative mitigation solutions, which can be cost-effective and sustainable.

As Doocy et al. [11] state, job creation programmes have been used to provide aid to less well-off citizens and can be considered as antecedents to CFW, which are an increasingly common element of humanitarian assistance in food-insecure settings, disaster-affected areas and post-conflict environments. The tsunami of 26 December 2004 caused massive devastation and hundreds of thousands of people were no longer able to participate in their routine employment activities. Considering the benefits of harnessing idle labour in the immediate post-disaster period, cash for work programmes can be recognised as a logical response that provide a structured mechanism to engage people in low-skilled constructive activities while injecting cash into the economy and promoting decision-making at the community and individual level.

Experiences in implementing large-scale CFW programmes [10, 11] in the Asian post-tsunami phase have led to the following set of recommendations:

- Communities need to be informed of benefits and limitations of CFW.
- It is helpful to identify potential community coordinators as well as be aware of what other agencies are doing.
- Adequate attention should be paid early on to procurement, warehousing and the delivery of supplies and equipment in order to expedite CFW activities.
- Cash for planning is seen as a good way of working; aids participation in the planning process and promotes informed choice.
- CFW implementers either limit the need for technical expertise by providing simple project design or ensure the availability of skilled labour needed to complete CFW activities.
- Train local staff to lead these programmes and for community leadership
- Consider work groups with no more than 25 workers and a ratio of no more than four work groups to one supervisor (overall maximum ratio of 100 workers: 4 group leaders: 1 area supervisor) to ensure quality and efficient work.
- There is a need for synergy in communication/coordination between organisers and the community.

Public awareness and education are essential to protect people and property from disasters. A lack of awareness has been identified as a major reason behind the huge loss of lives and property from the 2004 Asian tsunami. Indeed, the term “Tsunami” was heard by most of the ordinary Sri Lankans only after this devastation. As Briceno [12] states, in Thailand more than 1,800 people were saved because a tribal chief recognised that there was something wrong and decided to evacuate his people up to the hills. A 10-year-old girl from England saved 100 tourists on a beach in Phuket, Thailand after alerting her mother of the imminent tidal wave and prompting a speedy evacuation to safety. The girl recognised the signs after learning about tsunamis in her geography class. Knowing what to do and when to do it is the key to saving lives. The media also have a social responsibility to promote prevention. Journalists need to be sensitised and maintain an ongoing focus on prevention aspects of disasters [12]. These disasters are happening on an almost daily basis around the world. Not to be overlooked is the media’s role essentially in early warning systems. The Asian tsunami disaster could be a trigger for the media to play a more active role in improving lines of regional and global awareness, and communication using new media technologies.

## 6.2 Technical know-how

The tsunami affected two-thirds of the coastline of Sri Lanka, and it also resulted in the destruction of nearly 100,000 houses and infrastructure such as roads, bridges etc [2]. Depending on the wave height, various types of structures were affected. Waves of up to 2m in height caused 1–2m high boundary walls to collapse. As wave heights increased, single-storey masonry structures were significantly damaged and were completely swept off their foundations at wave heights of around 4m. Buildings of two storeys and higher, especially those with

concrete frames, had their infill masonry walls that were perpendicular to the waves knocked down by waves of up to 4m, but waves of even 5m did not cause the complete collapse of such buildings [13]. Partial collapse occurred, however, if foundations were undermined by waves of 3–5m in height.

According to Dias et al. [13], there are two common threads that run through the structural failures. The first is that structures have to be tied down in addition to being held up. The latter is obviously the focus of everyday attention, since gravity loads will assert themselves almost immediately otherwise. However, when natural disasters such as cyclones and tsunamis occur they have the effect of trying to lift up or push aside structures. Such actions can be resisted only by having a continuous chain of tying down from roof to foundation, and also by having sufficient gravity load to resist the overall upward or lateral forces. The second thread is that soil scouring has to be accounted for, or anticipated [13]. This can be done by improving the soil properties, especially soil that has been backfilled; deepening foundations, whether in buildings or bridges; and also by providing sufficient structural redundancy to prevent catastrophic collapse even if some foundations fail. The strategic use of natural features such as sand dunes and provision of vegetation barriers are also ways of mitigating potential tsunami damage [14]. In Sri Lanka, newly published national guidelines for reconstruction emphasise the importance of tying down structures against upward and lateral loads as well as the need to anticipate and reduce soil scour around foundations, especially of backfilled earth.

However, it was not only buildings that were destroyed due to the tsunami tidal waves, civil engineering structures like roads and bridges were also damaged. An investigation [15] on infrastructural damage in Sri Lanka due to the tsunami revealed the following:

- Damage to roads induced by the tsunami included erosion of embankments, erosion of abutment backfills and collapse of bridges following the loss of stability of the abutments.
- Erosion of embankments tended to have occurred at locations where the land was relatively low, presumably because the back flow of the tsunami concentrated on those parts of the land.
- No bridge girders were washed away by the direct impact force of the tsunami. However, it is too optimistic to conclude that bridges are always safe against the impact force of a tsunami.
- Existence of detour and quick restoration weakened the socio-economical impact of the damage.

## 6.3 Operational issues

Coordination is often a scarce resource in disasters, yet remains the key operational principle for effective response. It is important in order to avoid duplication of effort that resources are directed to those most severely affected by the disaster. Good coordination can also facilitate the learning of lessons. The importance of effective coordination of disaster management work at international, regional, national, organisational, group and individual level is overwhelmingly highlighted within the case material. Reducing risk depends on communication and information

exchange between the scientific community and politicians. The Asian tsunami disaster showed that in the absence of an open dialogue, valuable information and research from technical sectors is redundant. As Senanayake [16] argued, there was a striking absence of expertise and professionals, from the region in the post tsunami operation in Sri Lanka, despite the stated aim to develop regional disaster response capacity in the Asia Pacific Region by a number of agencies. Hence, it is necessary to strengthen the link between scientific institutions and national and local authorities that need to react to avoid human, economic and social losses from disasters.

International, regional and national organisations should work better together and be better coordinated. Coordination is an essential element of disaster prevention, mitigation, preparedness and response for the entire UN system, governments and non-governmental organisations. Efforts need to be made to promote complementary services and avoid duplication [12]. A number of reports [2, 12, 16] emphasised the primary role of national authorities in coordinating and directing national and international assistance. Existing inter-agency coordination arrangements should be further strengthened, particularly concerning the sharing of information and knowledge in the early phases of the disaster response. Mechanisms should be devised to ensure the participation of smaller organisations and institutions with less international experience to the coordination process. Further, governments need to demonstrate their political will and commitment to disaster risk reduction through concrete measures e.g. reserve national budget line for disaster reduction, and strategic donor funds to support and build capacity for disaster risk management.

## 6.4 Legal concerns

Coastal zones and small islands are often densely populated areas that increase the risk to and vulnerability of people. Nearly 3 billion people, or almost half the world population live in coastal zones, which in many cases are prone to hazards including tropical cyclones, floods, storms and tsunamis [12]. Often coastal populations are dependent on the sea for their livelihoods (e.g. fishing villages) and do not have the choice to live elsewhere. Small island countries such as the Nicobar and Andaman islands are barely a few metres above sea level, which means that evacuation to higher land is almost impossible. Governments and local authorities need to take human habitats into consideration in long-term development planning, ensuring that risks are minimised.

Beyond preparing for evacuation and emergency response, communities can reduce their tsunami risk by modifying their land use planning and development approval practices. Although planning for tsunamis will not be a top priority for most coastal communities, relatively small efforts to plan for this hazard can significantly increase community safety. The US National Tsunami Hazard Mitigation Program's publication 'Designing for Tsunamis' stresses the importance of understanding site planning. Through zoning, creation of open spaces and not allowing new development in potential tsunami areas, safer land use will be better able to protect people and buildings. Specific site planning strategies to reduce tsunami risk can include [14]:

- Avoiding inundation areas: site buildings or infrastructures away from hazard areas or locate on a high point.
- Slowing water: forests, ditches, slopes, or burns can slow down waves and filter out debris. The success of this method depends on correctly estimating the force of the tsunami.
- Steering: water can be steered to strategically placed angled walls, ditches and paved roads. Theoretically, porous dikes can reduce the impact of violent waves.
- Blocking: walls, hardened terraces, burns and parking structures can be built to block waves.

Several reports [12, 17, 18] emphasise the necessity for a national and institutional level legislative framework governing disaster management efforts. From the institutional point of view, the law should bring about a reform of the entire national institutional arrangement for disaster management, provide for the allocation of resources for preparedness and emergency response at all levels of governance, and create a permanent liaison mechanism with the international humanitarian community. Decentralisation of decision-making authority should feature prominently in the new set up. Administratively, such law should promote the development of detailed contingency plans at local level. Such plans should include [18]:

- Risk analysis, zoning and mapping,
- Comprehensive air, sea and road transportation arrangements (including stand-by agreements with the national air carrier and shipping companies),
- The pre-positioning of relief supplies and – notably - of fuel, and
- Backup emergency communications arrangements, notably assigning an institutional role to amateur radio communications.

Further, drafting of a National Disaster Management Bill is recommended, which should:

- Deal with the creation of policies/provisions/regulations at sectoral level to enable special conditions applicable for emergency response,
- Formulate operating policies for the mobilisation of military assets in disaster management and emergency response,
- Regulate the role of NGOs in the national setup for disaster response, and
- Specify provisions for the request and reception of international assistance.

## 6.5 Environmental concerns

The tsunami reduced some coastal communities to piles of bricks, tin and wood mixed with car and boat parts, construction materials, ocean mud and dead bodies. While the December 2004 tsunami killed more than 250,000 people in 12 countries and left millions of homes and businesses in ruin, officials were most worried about the killer wave's environmental aftermath. In many cases, the tsunami worsened pre-existing environmental management problems on the inhabited islands. The Joint United Nations Environment Programme (UNEP)/United Nations Office for the Coordination of Humanitarian Affairs (OCHA) Environment Unit (Joint Unit),

integrated in the Emergency Services Branch of the OCHA, is the principal United Nations mechanism mandated to assist countries facing environmental emergencies.

As Casey et al. [19] argue, a common best practice approach to debris removal should be developed to minimise negative environmental impact. Related guidance material should be translated into local languages and effectively disseminated. Re-mapping affected areas before redevelopment begins can ensure the identification of hazardous areas created by tsunami-induced changes, such as mass graves and locations vulnerable to flooding. Remapping is therefore an important tool to help ensure that tsunami victims do not face new dangers when they resettle, and can also reassure affected populations of the safety of the locations where they rebuild. In this regard, local expertise and capacities in recycling, composting and environmental management can play a key part in clearing efforts. However, as Calvi-Parisetti and Pasche [20] argued, immediately following the tsunami, the inclusion of environmental issues into disaster management efforts at the national level was limited. Another revelation that has emerged from several studies is the fact that many operational agencies of the United Nations system have very little awareness of the potential environmental threats in the aftermath of disasters.

In Sri Lanka, the key environmental findings from the Rapid Environmental Assessment (REA) carried out on 2004 tsunami disaster included the following [19]:

- While there is damage to the natural and built environment in affected coastal areas, there are no major life-threatening environmental emergencies as a result of the tsunami.
- Specific coordination needs to enhance environmental risk mitigation efforts.
- Remapping needs to ensure effective reconstruction efforts.
- Areas of acute environmental concern requiring immediate attention include management of tsunami waste and debris, and sanitation and sewage issues in settlements.

Calvi-Parisetti and Pasche [20] prescribes the process to be followed when assessing environmental impacts after a tsunami disaster. Assessments carried out in the first 48-72 hours after a major disaster should aim at identifying major secondary risks through a relatively simple checklist that should become a standard feature of the overall emergency assessments. If such risks are identified, specialised expertise should be quickly mobilised for further assessments and quick response. The initial environmental assessment should also look at those issues that are not immediately life threatening but may become so at a later stage if not dealt with immediately. Once the most acute phase of the response is over, the environmental consequences of the disaster on the livelihood of the affected population should be assessed and programmes designed to address them. Finally, the environmental consequences of the disaster on ecosystems and habitats should be assessed in order that they may be addressed through programmes in the reconstruction/rehabilitation phase.

# 7. Conclusion

Information and knowledge play an extremely important role in effective disaster reduction and response. Good communication and exchange of critical disaster management information and knowledge could enhance coordination and integration of stakeholders' actions in disaster mitigation and response. This paper highlighted the importance of knowledge and good practice sharing in disaster management strategies, and discussed the principal lessons learned from the 2004 Asian tsunami disaster, particularly relating to the Sri Lankan context. Several good practices and lessons learned, from 2004 Asian tsunami disaster, are explored relating to five different themes: social, technical, legal, operational and environmental. The ISLAND website introduced an organised common platform to capture, organise and share knowledge on disaster management strategies. However, the UK Higher Education Disaster Relief Project Report [4] highlighted the lack of mechanisms at national level in the UK to link the expertise, skills and knowledge that resides in UK higher education with practitioners in the humanitarian agencies. Neither is there a comprehensive overview of the expertise which exists and who is willing to offer it. Therefore, ISLAND could be extended to create mini-hubs of academic (and non-academic) expertise in order to act as the mechanism by which needs for expertise in a range of areas could be identified by the humanitarian agencies. Further, case material relating to different phases and types of disasters could be collated and populated using the available infrastructure of the ISLAND website.

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