UNDP

Crisis Prevention and Recovery

RISK ASSESSMENT AND DESIGN OF COUNTERMEASURES FOR TSUNAMI HAZARD

Case Study of the Port City of Galle

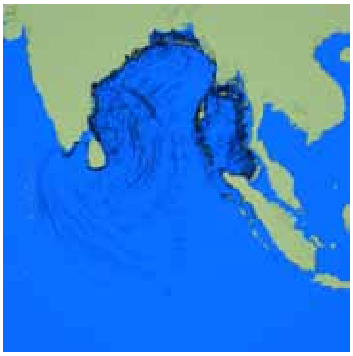
The model has the flexibility to change the resolution of the mesh according to the area of importance. A major capability of the model is that it can simulate the process of wetting and drying as water enters and leaves an area, and is therefore suitable for simulating water flow onto a beach or dry land and around structures such as buildings. High-resolution nearshore bathymetric data obtained for the new Galle Port Development (2007) and high-resolution topographic data obtained after the 2004 tsunami were used for study (LIDA Surveys, 2005).

Broad-scale deepwater propagation modelling was carried out for a number of source scenarios selected from the Sunda/Java Trench. The results of four selected scenarios are presented here. A fault length of 500 km, a width of 150 km, a dip angle of 8°, a slip angle of 110° and a displacement of 40 m was used for the study. **Table 1** gives the source details and the maximum and minimum wave amplitudes from the propagation modelling. **Figure 5** provides snapshots of tsunami propagation for these four scenarios 180 minutes after the earthquake. **Figure 6** illustrates the distribution of computed maximum tsunami heights over the Indian Ocean.

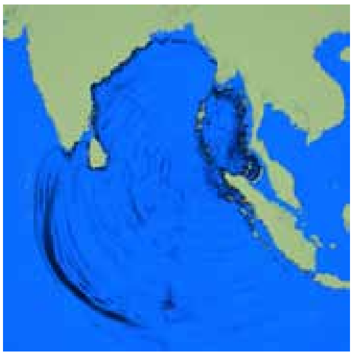
Table 1: Source details and the maximum and minimum wave amplitudes from the propagation modeling

	Longitude	Latitude	Strike angle	Max. amplitude (m)	Min. amplitude (m)
Scenario 1	92.00′ E	8.52′ N	350′	2.015	-1.501
Scenario 2	94.26′ E	3.09′ N	329′	3.477	-2.391
Scenario 3	97.01′ E	2.07′ N	329′	1.419	-1.33
Scenario 4	97.60′ E	-0.60′ N	329′	2.608	-2.081

Figure 5: Snapshots of tsunami propagation in four scenarios 180 minutes after the earthquake



(a) Scenario 1



(b) Scenario 2

(c) Scenario 3

(d) Scenario 4

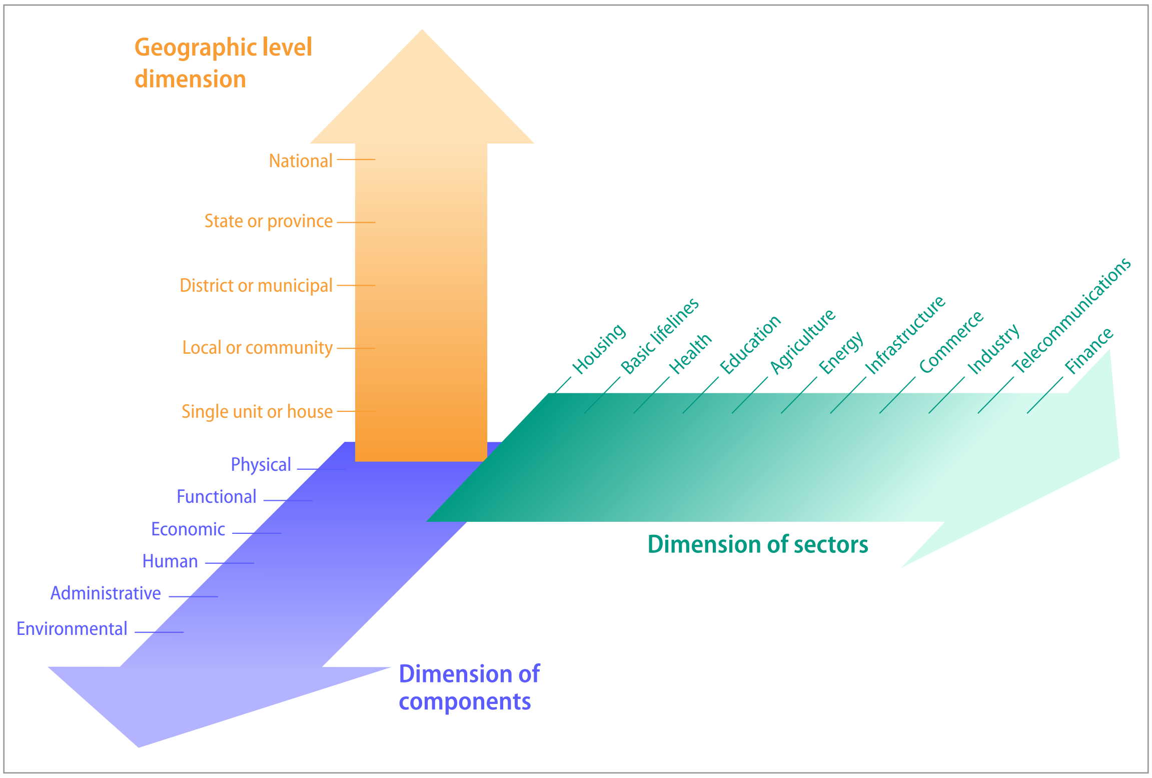
4 Vulnerability

4.1 From a single dimension of susceptibility to a three-dimensional sector approach

The assessment of vulnerability remains a complex area, in view of the widely varying parameters associated with a detailed analysis, and also due to the difficulties in defining and quantifying certain parameters. The basic components of vulnerability can be broadly classified as human, physical, socioeconomic, environmental, functional and administrative. This approach is primarily a one-dimensional approach. Reviews of recent post-tsunami vulnerability studies indicate that the greater focus has been on potential loss of life and damage to houses and dwellings. Only a few studies have considered other aspects in detail.

Villagran de Leon proposed a framework to break down vulnerability assessment into components by analysing how disasters can impact the different sectors of society (Villagran de Leon, 2008). The sector approach identifies dimensions of vulnerability in three areas, namely dimensions of susceptibility, sectors and scale. In effect, the dimensions of sectors and scale are added to the existing dimension of susceptibility. Typical sectors identified are housing, communications, education, health, energy, government, industry, commerce, finance, transportation, public infrastructure, environment, tourism etc. **Figure 9** illustrates this concept. The

Figure 9: The three-dimensional sector approach showing dimensions of vulnerability



6 Managing risk classification and planning risk management

6.1 Classification of risk management measures

There are many measures that could be adopted for risk management in coastal zone management when planning for a tsunami and other coastal hazards that accompany high waves and high inundation. These include early warning systems, regulatory interventions in the form of extending existing setback defence lines, and physical interventions such as the protection of structures and utilizing the full potential of coastal ecosystems. These should be supplemented with public awareness of disaster preparedness and efficient evacuation procedures incorporating planned evacuation routes.

Measures for risk management can be broadly classified into three categories, namely, those that mitigate the impact of the hazard, those that mitigate exposure and vulnerability to the hazard, and those that promote successful evacuation.

6.1.1 Measures that mitigate the impact of tsunami hazard

1. The implementation of artificial measures for protection, including tsunami breakwaters, dikes and revetments
2. The effective use of natural coastal ecosystems including coral reefs, sand dunes and coastal vegetation (mangrove forests)
3. Hybrid systems of artificial and/or natural systems

6.1.2 Measures that mitigate exposure and vulnerability to the tsunami hazard

1. Land-use planning
2. Regulatory interventions such as setback of defence lines
3. Hazard-resilient buildings and infrastructure

6.1.3 Measures that promote successful evacuation from tsunami hazard

1. Early warning systems (local and regional)
2. Public warning systems
3. Evacuation routes and structures
4. Community education, including community maps and other measures for community preparedness

Hazard, vulnerability and risk maps play a vital role in risk management. In view of the benefits of risk management measures, it is important to upgrade these maps regularly. These maps can be used for the production of disaster preparedness or management maps.

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United Nations Development Programme
Asia Pacific Regional Centre
United Nations Service Building
Rajdamnern Nok Avenue
Bangkok 10200 Thailand
http://regionalcentrebangkok.undp.or.th

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