Rebuilding Infrastructure – Rebuilding Hope

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ABSTRACT

Disaster reduction on the coasts of the Indian Ocean

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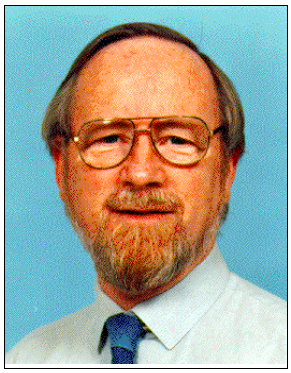

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Summary

The great Indian Ocean Earthquake of 26th December 2004 with the devastating tsunamis as triggered a massive and generous humanitarian response in disaster relief. There is need for a corresponding effort in disaster reduction in the face of future cataclysmic events. The disaster risks of the Indian Ocean are reviewed, leading to a proposal for a *Guide to disaster reduction on the coasts of the Indian Ocean*

Keywords: Risk assessment, earthquakes, tsunamis, tropical cyclones, storm surge, disaster reduction

1. Introduction

Engineers have used their skills for disaster relief after the great tsunami of 26th December 2004 through groups such as EwF (Engineers without frontiers) and REDR (Registered engineers for disaster relief). Are these shattered communities with or without engineers rebuilding only to be flattened by the next disaster? Are those coastal communities unscathed this time preparing for when their turn comes? How many realise that tropical cyclones, floods, earthquakes and other cataclysmic events kill far more and destroy far more livelihoods than tsunamis?

This paper addresses the issues involved in effecting a reduction of disasters in the face of natural cataclysmic events, with particular emphasis on coastal communities of the Indian Ocean, where the need for action in this regard is as great as anywhere in the world. To address this problem requires (1) a quantified risk assessment by magnitude and return period of all cataclysmic events by region within the Indian Ocean basin, (2) a determination of the effect of those events with respect to depth, velocity and inland penetration of inundation, ground acceleration, etc, as affected by local topology, (3) determination of the effect of such inundation, etc., on buildings and infrastructure, (4) implementation of an affordable disaster reduction strategy depending on the importance of the structure or facility and the risk of loss of life, and (5) implementation of the disaster reduction strategy at the local community level.

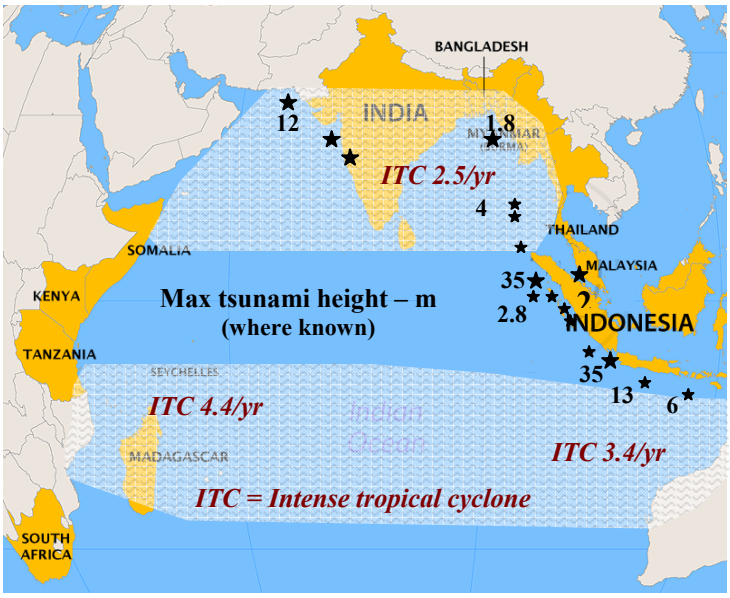

Figure 1 – The Indian Ocean basin showing approximately 20 tsunami events in 280 years and frequency of intense tropical cyclones.

2. Risk assessment

Figure 1 depicts two of the hazards which threaten the coasts of the Indian Ocean. An average of 10 intense tropical cyclones each

year can wreak havoc if the come near or cross the coastline, since they can cause storm surges (up to 7 m reported in the Bay of Bengal) coupled with wave action, wind and floods. In the last 50 years they have produced far more deaths and loss of livelihood than all the tsunamis of the last 280 years, including the most recent. All but one (Krakatoa) of these tsunami events was the result of an earthquake.

Taking into account all causes of inundation it is possible to arrive at the magnitude of storm surge or tsunami with a 50 year return period, 500 year return period and 1000+ year return period. In structural engineering terms the 50 year return period corresponds to the serviceability limit state for design, while the 500 years refers to the ultimate limit state. These are applied to individual structures. However, when whole communities are at risk one needs to consider 1000+ years, dubbed the "disaster" limit state. The concept is used by civil engineers who might design a dam to safely pass the "maximum possible flood" with a nominal 100,000 year return period.

3. Impact on infrastructure

Tsunami run-up or inundation and storm surge depend very much on topography of the sea bed leading up to the coast, the configuration of the coastline, the topography inland from the high water mark and the presence of obstructions to flow – reefs, mangroves, forestation, buildings, etc. Using coastal position, defined by latitude and longitude, with local topography derived where possible from geophysical databases and supplemented by local knowledge it is possible to determine whether buildings or infrastructure

Using the acceptance criteria of "no deaths or injuries, and no damage" for the serviceability limit state, and "no deaths, limited injuries, some damage but the structure still standing" for the ultimate limit state, "minimised loss of life with critical infrastructure such as hospitals, schools, places of worship, water supply, etc., still functioning" for the disaster limit state it is possible identify which aspects of dwellings and community infrastructure are at unacceptable risk.

4. Determination of disaster reduction strategy

Disaster reduction strategies to reduce risk to acceptable levels can include raising habitable floor levels of buildings, strengthening buildings for earthquakes and wave forces, building levees around important buildings and infrastructure, or simply relocating villages and towns on higher ground. Unfortunately, many communities are too poor to implement such solutions.

Relocation can be impracticable in populous areas, or in the absence of higher ground, or because of loss of livelihood such as fishing. Then it becomes necessary to develop warning systems of impending inundation which communities recognise and act upon. Low lying areas will need refuges raised above "probable maximum" storm surge or tsunami and appropriate community education simply to save lives. Buildings with upper floors of sufficient elevation can be designated emergency refuges.

Nature's early warning signs need to be recognised as the first signal for evacuation in case scientifically determined warnings do not reach the ears of those who need to hear them. Banda Aceh was subjected to four minutes of a very strong motion earthquake, which did enormous damage. It should have warned the residents to expect a tsunami within fifteen minutes. Under the best of circumstances it would take seismologists perhaps ten minutes to generate a warning – simply not enough time. More distant parts would have the drawdown of the sea in the harbour as a warning of perhaps 15 minutes. Storm surges rise more slowly so that evacuation becomes possible. But obviously chances of survival are improved by having effective communication of early warnings to those at risk.

5. Implementation

The production of a *Guide*, difficult as it might be, is relatively easy compared with having it used effectively where it is needed. The implementation will require recognition of the risks of living on the coast at the regional government and local community level, the realisation that these risks can be reduced in an affordable way, and the knowledge of how to do it. At government level the political will to face something which might happen in the future is weak. At village level the community leaders must somehow become aware of the possibilities. It would seem that the best option is to introduce disaster awareness and the commitment to disaster reduction is through community school curricula and the development of teams to inform community leaders and regional governments. Without the support of aid groups such as the UN International Strategy for Disaster Relief this is unlikely.