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Assessing Vulnerability Before, During and After a Natural Disaster in Fragile Regions

Case Study of the 2004 Indian Ocean Tsunami in Sri Lanka and Indonesia

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Abstract

Current approaches of measuring vulnerability to natural hazards generally use a rather static perspective that focuses on a single point in time—often before a hazardous event occurs. In contrast, the paper argues that vulnerability assessment should also take into account the changing dynamics during and after a disaster. This paper provides a comparative analysis of the situation in Sri Lanka and Indonesia within the context of the 2004 Indian Ocean tsunami. The author presents concepts for measuring revealed vulnerabilities and methods of assessing the recovery process, and highlights the differing ways in which the tsunami affected the ongoing civil conflicts in both regions.

Keywords: vulnerability, dynamics, transition, natural hazards, fragile regions, Sri Lanka, Indonesia, coastal regions, tsunami

JEL classification: Q54, I39

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Acronyms

ADPC	Asian Disaster Preparedness Center
BPPT	Indonesian Research and Applied Technology Agency
CRED	Centre for Research on the Epidemiology of Disasters
DFID	Department for International Development of the UK
GAM	Free Aceh Movement
IDPs	internally displaced persons
IFRC	International Federation of the Red Cross and Red Crescent Societies
LTTE	Liberation Tigers for Tamil Eelam
OECD	Organization for Economic Cooperation and Development
UNDP	United Nations Development Programme
UNDSS	United Nations Department of Safety and Security
UNU-EHS	Institute for Environment and Human Security of the United Nations University

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1 Introduction

Most countries and regions have developed national or regional hazard maps for natural hazards such as floods, landslides or storm surges, and focus on a specific scenario or hazard type, its occurrence and its potential spatial distribution. However, disasters triggered by natural hazards are not solely influenced by the magnitude and frequency of the event (wave height, drought intensity, etc.). Instead, they are also heavily defined by the vulnerability of the affected society and its natural environment (see, e.g., Bohle 2001). Research and concepts on assessing vulnerability to natural hazards encompass a variety of different approaches, implying different worldviews and pre-analytic visions (for more details, see Birkmann 2006).

The author follows the understanding that vulnerability to natural hazards consists of at least three major components: exposure, susceptibility and coping capacity, and spans over different thematic dimensions such as social, economic, institutional or environmental vulnerabilities (Birkmann 2006). It is particularly important to acknowledge that the different components of vulnerability (exposure, susceptibility, coping) are strongly interlinked. While wealthier people, for example, can generally overcome economic losses resulting from a natural hazard more easily than poor households, it is also evident that in natural disasters the degree of exposure to the hazard plays a crucial role. If the exposure of a certain group or household to a hazard such as tsunami, flood, or earthquake is very high, people suffer substantial harm regardless of whether they are poor or wealthy.

However, the vulnerabilities revealed in Indonesia and Sri Lanka after the Indian Ocean tsunami show interesting patterns, which are discussed in depth in this paper. Also, those who survived the direct tsunami impact showed very different coping capacities and recovery potentials. Therefore, measuring and assessing vulnerability to natural hazard should not be limited to one phase only, rather it is important to measure and assess vulnerability *before*, *during* and *after* the disaster. Current approaches of vulnerability and risk assessment often imply a relatively static picture for a specific point in time. Changes and dynamics generated, for example, through disaster aid and recovery processes are often not captured sufficiently. Furthermore, it is still quite difficult to promote vulnerability and risk assessment for low-frequency hazards, since people prioritize their daily risks and frequent hazards (see Cannon 2006). Thus less attention is given to low-frequency but extreme natural events. Lastly, it is interesting to compare the revealed vulnerabilities and the recovery processes in two fragile regions which prior to the tsunami disaster had been subjected to violent conflicts within the last decades—east and north Sri Lanka and the region of Banda Aceh in Indonesia (for the definition of fragile states, see DFID 2005a).

2 Frameworks and conceptual background

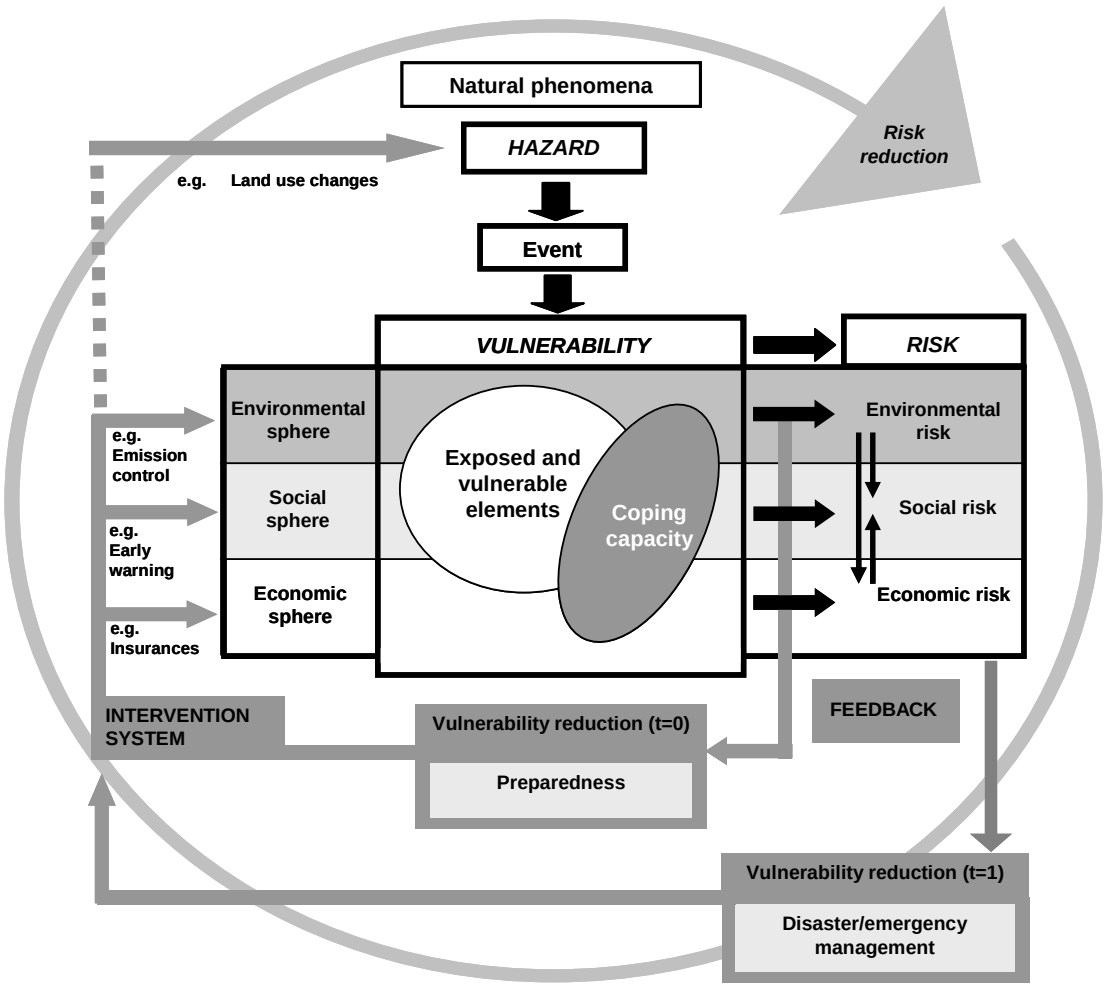
The UNU-Institute for Environment and Human Security (UNU-EHS) conceptualized vulnerability as encompassing exposure, susceptibility and coping capacity. Moreover, it is important not to limit the analysis of vulnerability to one dimension, such as economic vulnerability. Instead, it is crucial to link vulnerability reduction and sustainable development by integrating social, economic and the often-overlooked environmental dimension into the vulnerability assessment framework (see BBC framework, Figure 1).

2.1 The BBC conceptual framework

The term 'BBC' is linked to conceptual work done by Bogardi and Birkmann (2004) and Cardona (1999, 2001), which served as a basis for this approach. The framework is based on three objectives: (i) how to link vulnerability, human security and sustainable development (Bogardi and Birkmann 2004; see also Birkmann 2006: 34); (ii) the need for an integrated approach to disaster-risk assessment (Cardona 1999, 2001; Carreño, Cardona and Barbat 2004, 2005a, 2005b); and (iii) from the broader debate on developing causal frameworks for measuring environmental degradation in the context of sustainable development (e.g., OECD 1992: 6; Zieschnak et al. 1993: 144).

The BBC framework understands vulnerability as a dynamic process that goes beyond the estimation of damage and the probability of loss: it promotes a problem-solving perspective by simultaneously analysing probable losses and weaknesses of the various exposed affected elements (e.g., social groups) and their coping capacities as well as potential intervention measures (feedback-loop system) within all three key spheres of sustainable development (social, economic and environmental) (Birkmann 2006).

Figure 1
The BBC conceptual framework



Source: Birkmann (2006: 34), based on Bogardi and Birkmann (2004); Cardona (1999, 2001).

The BBC framework—as a meta-framework—outlines two potential ways of reducing disaster risk and vulnerability: first, through preventive measures and, second, through disaster management. Preventive measures are generally introduced before an event strikes society; these could range from raising awareness, moving people out of hazardous zones, or improving the resilience of households or environmental services to the impact of hazards (actions in t=0). However, we have to recognize that public media as well as political responses often focus solely on disaster management as a way of improving disaster preparedness. Although disaster-management capacities are important for limiting the impact of catastrophes and managing crises, the BBC conceptual framework emphasizes the essential role of anticipating risk and taking action before hazardous events can cause a disaster (t=0) (see Figure 1). The improvement of disaster- and emergency-response capacity (t=1) is necessary. However, it is only one part of the response and often occurs at the end of the chain (Birkmann 2006). Furthermore, we have to acknowledge that the promotion of disaster resilience is particularly difficult for low-frequency and extreme natural events because everyday risks, such as unemployment or the lack of income-earning opportunities, can supersede the awareness and scope of risks resulting from natural hazards. A major challenge is also the selection of appropriate mitigation and preparedness measures against these low-frequency but extreme events in the context of fragile livelihoods (see e.g., Birkmann and Fernando 2008). In addition, it is important to examine the role and effect of other threats: in the particular case of Indonesia (Banda Aceh) and Sri Lanka (northeast Sri Lanka), it is the influence of the military conflict on the vulnerabilities and recovery processes after the tsunami.

3 Sri Lanka and Indonesia

3.1 Sri Lanka

Sri Lanka is located off the southern tip of the Indian subcontinent, with a population in 2004 of nearly 20 million people. Sri Lanka encompasses an ethnic majority of Singhalese, comprising over 80 per cent of the population; a Tamil minority of 9.4 per cent, a Muslim minority of 8.1 per cent, and smaller percentages of other minorities (e.g., Malays, Burgher, Moors, Vedda). Various natural hazards also characterize the country. Floods, landslides, droughts, tropical cyclones, storm surges and tsunamis are common, indicating the vulnerability of local communities in the country to natural hazards (GoSL 2005). Although floods and droughts are the most frequent hazards in different parts of the country, the highest number of fatalities within the last decade was caused by the tsunami, a low-frequency but an extreme natural hazard (see Figure 3). With more than 30,000 deaths and half a million people displaced, Sri Lanka ranked second among the worst hit countries affected by the Indian Ocean tsunami in December 2004.

3.2 Indonesia

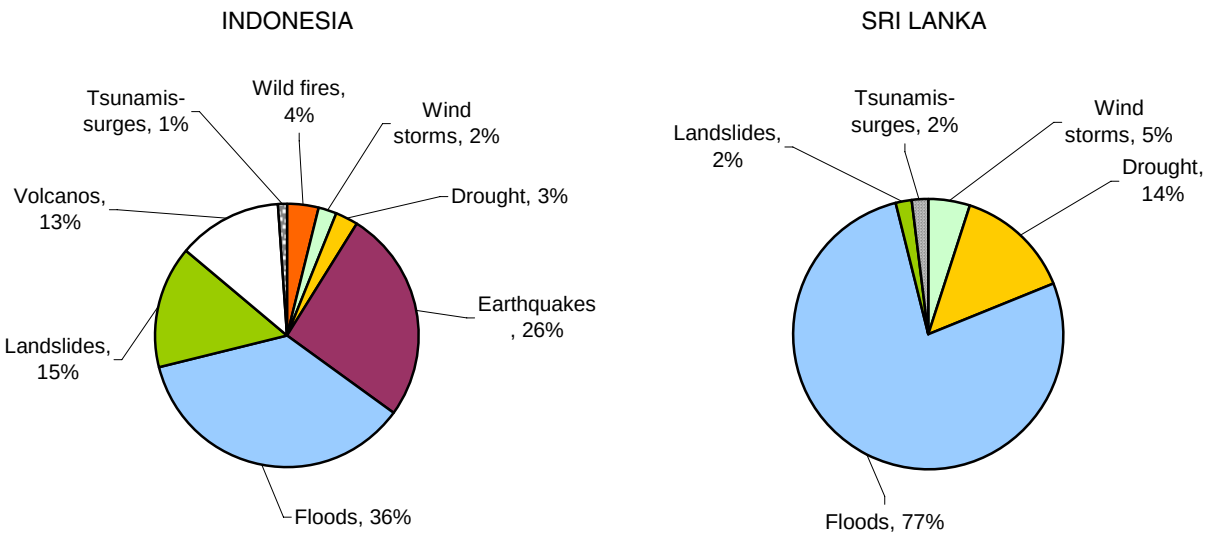
With about 17,500 islands, Indonesia is the world's largest archipelagic state. It is the fourth most populated country, with over 200 million inhabitants (UNDP 2004a). Indonesia consists of around 300 distinct ethnic groups and 742 different languages and dialects, spread across the numerous islands. Javanese, who comprise 42 per cent of the population, are the largest and mainly politically dominant ethnic group (Cribb 2000).

With 86 per cent of its population Muslim (BPS 2001), Indonesia is the country with the highest number of Muslims worldwide. Other religious groups are Christian (11 per cent), Hindu (2 per cent) and Buddhist (1 per cent). Sectarian tensions and separatism have undermined political stability in some regions, particularly on the island of Sumatra, which was hit the hardest by the Indian Ocean tsunami. Overall, Indonesia was the country most severely affected by the tsunami: some 110,000-130,000 people were killed; 12,000-37,000 remain missing and about 500,000-700,000 people were displaced (BAPPENAS 2005; BRR 2005: 14; ADPC 2006). Eight hundred kilometres of coastline in Aceh were swept clean (BRR 2005). Even before the tsunami, a third of the population of Aceh and Nias lived in poverty.

In contrast to Sri Lanka, where floods are the dominant type of hazard, Indonesia faces a variety of natural frequently-occurring hazards such as floods, earthquakes, landslides, volcanic eruptions, and wind storms (Figure 2). The country is also plagued by low-frequency but extreme natural hazards such as tsunamis and storm surges (EM-DAT 2007). If one compares the exposure of these two countries to natural hazards (Figure 2), it can be noted that Indonesia is exposed to a higher number of seismic hazards, while in Sri Lanka they are mostly of a meteorological/atmospheric nature. This is understandable, considering that Indonesia covers a wider and more varying area geographical area and is located in a tectonically more active region.

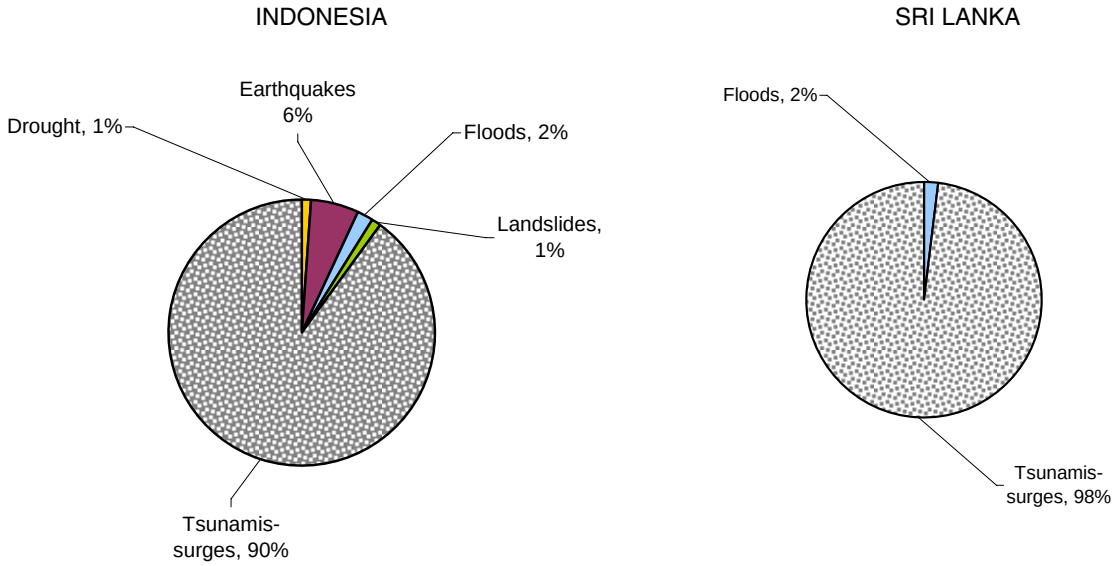
For both countries, the most severe natural hazard with respect to fatalities since the 1980s was the Sumatra tsunami of December 2004. Figure 3 shows that the tsunami accounted for more than 90 per cent of all deaths from natural hazards (the tsunami falls under the category wave/surge). Next, earthquakes and frequent floods show relatively higher impact compared to other disasters.

Figure 2
Occurrence of natural disasters by type, 1980-2007



Source: EM-DAT.

Figure 3
Fatalities caused by natural hazards, 1980-2007



Source: EM-DAT.

3.3 Sri Lanka and Indonesia before the tsunami

A comparison of the level of development in the two nations before the tsunami shows that Sri Lanka had built a sound reputation with high social indicators. Particularly, life expectancy at birth, infant mortality and literacy rates show much better values in Sri Lanka than in Indonesia (see Table 1). The social development indicators available for Aceh (the worst affected region in Indonesia) underline these differences.

Overall, the general socioeconomic development at national level shows that Sri Lanka performs better than Indonesia. However, subnational patterns might imply significant differences within the countries themselves. Both countries, and especially the most severely affected regions, were characterized by violent conflicts. In Sri Lanka, the conflict between the Liberation Tigers for Tamil Eelam (LTTE) and the government has eroded the political, social and legal rights of many Sri Lankans, particularly those living in the eastern and northern provinces. Similarly, the island of Sumatra, and the region of Banda Aceh in particular, had also suffered for 30 years from hostilities between the Free Aceh Movement (GAM) and the government.

Table 1
Selected development indicators of the pre-tsunami period, Sri Lanka and Indonesia

	Sri Lanka 2003	Indonesia 2003	Aceh (in Indonesia) 2002
Life expectancy at birth (years)	74	68	67.7
Infant mortality at birth, per thousand	15.4	41.4	36.1
Literacy rate (in %)	89.0	81.9	95.8
GDP per capita (in US$)	950	970	
Human development index	0.751	0.697	0.66

Source: UNDP (2002, 2004b); ADPC (2006).

4 Vulnerabilities exposed by the tsunami

4.1 Sri Lanka

Major research on vulnerability assessments with respect to tsunamis was started after the 2004 incident.[1] Although a predictive vulnerability assessment would have been more desirable (prediction function), analysis of the vulnerabilities revealed after a disaster can also provide important insights with respect to the most fragile groups, economic sectors and geographic areas. This can help disaster management and recovery aid to identify priorities better and to target the groups and areas that are most vulnerable (see, e.g., Birkmann and Fernando 2008). UNU-EHS has conducted vulnerability assessments at the local level in Sri Lanka jointly with local partner universities, with the aim of comparing the vulnerabilities observed in two cities, Galle and Batticaloa. Galle is located on the southern coast of Sri Lanka and Batticaloa is located on the east coast of the country (for more details see Birkmann and Fernando 2008; Birkmann, Fernando and Hettige 2006). The analysis of about thousand households showed significant differences in vulnerability in terms of gender and age. Also the spatial distribution of the damage indicated major differences in devastation between the first 100-200 and 200-400 metres from the shore line, although tsunami waves often extended further inland.

Gender

In both cities the household surveys showed that the number of females reported dead or missing is significantly higher than for males. In Batticaloa, females accounted for 56 per cent of the dead or missing, males 44 per cent. The situation in Galle was even more striking: 65 per cent of the casualties or missing were female, 35 per cent male. The reasons are manifold. Some of the affected people interviewed in Batticaloa reported that they climbed onto roof-tops, while their wives or daughters had less time to do so within the short interval once the devastating wave was noticed (oral reports from Batticaloa in 2005). In addition, other studies indicated that female household members were more at risk because of their traditional role of working around the house and the fact that they often did not know how to swim (see e.g., Guha-Sapir et al. 2006; Oxfam 2005).

Age

An analysis of the relative number of casualties (dead or missing) compared to the total number indicated that the groups suffering the most in Batticaloa were elderly and young people (Figure 4). Similar patterns were also observed in Galle. A comparison of our household survey findings with official census data was difficult, since official post-tsunami census differentiates only between the age groups of younger people and those above 30 years. Thus it was not possible to analyse the revealed vulnerability of elderly with the published statistics (see GoSL 2005).

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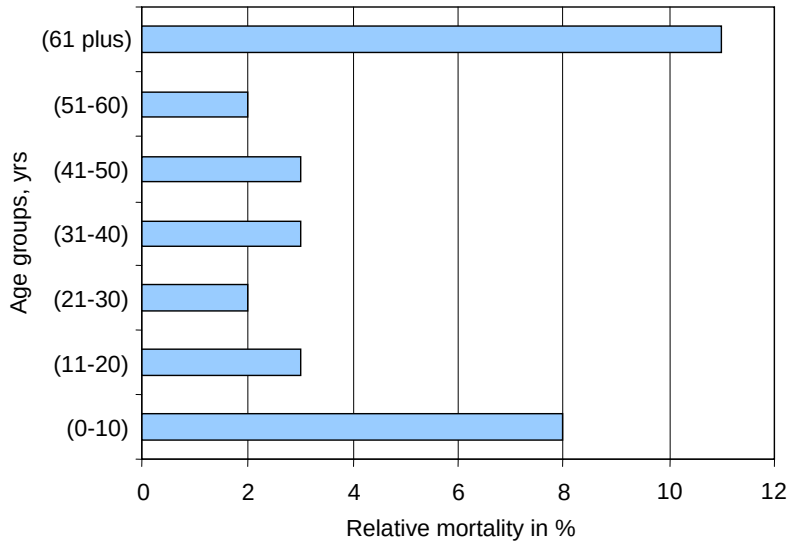
1 The author is not aware of a single study for Sri Lanka that had focused on the vulnerability of coastal communities to tsunami prior to the occurrence of the Indian Ocean tragedy.

Figure 4
Revealed vulnerabilities of different age groups in Batticaloa to tsunami



Source: Computed by author based on Birkmann et al. (2007).

Exposure and physical damage patterns

The damage patterns on housing revealed, on the one hand, that construction material affected the likelihood of buildings collapsing from the impact of tsunami waves. On the other hand, it is interesting to note from our household survey that even though the tsunami advanced much further inland than just the first 100 metres, there were significant differences in the level of damages to houses located within the first 100-200 metres of the sea and those in the following zones (200-400 metres). In this regard we assumed that the varying levels of damage to actual physical structures were not defined by the 100-metre line, but instead by the vertical elevation differences of the coastal area. However, a comparison of the low-damage houses (suffering no or only minor damage) with the severely damaged sector (partial/total destruction; cannot be used) in selected locations of Galle indicated that there was significantly more devastation inside the 100 metre zone than in the subsequent zones. For example within the 100 metre zone, only 20 per cent of the devastated houses were considered low-damage, while in the zone beyond the first 100 metre of coast, 40 per cent of the affected houses were low-damage. In contrast, of the severely damaged houses in Galle, 47 per cent were within the 100 metre zone, compared to 29 per cent for those located beyond the first zone. Clearly, the 100 metre line from the sea made a difference in Galle in damage impact. However, the damage pattern was quite different in Batticaloa. Here, 70 per cent of the severely damaged houses were located within the first 100 metres, while in the 100-400 metre zone, 56 per cent of the houses were classified similarly. Both within and beyond the buffer zones, only 10 per cent of the houses survived with minor damage. The spatial impact patterns in these cities highlighted major differences and underlined the need to take specific local conditions into account when establishing buffer zones.

4.2 Indonesia

Based on national reports and NGO surveys undertaken in the aftermath of the Indian Ocean tsunami in Indonesia and, in particular, in the northern part of the island of Sumatra, the following observations can be made:

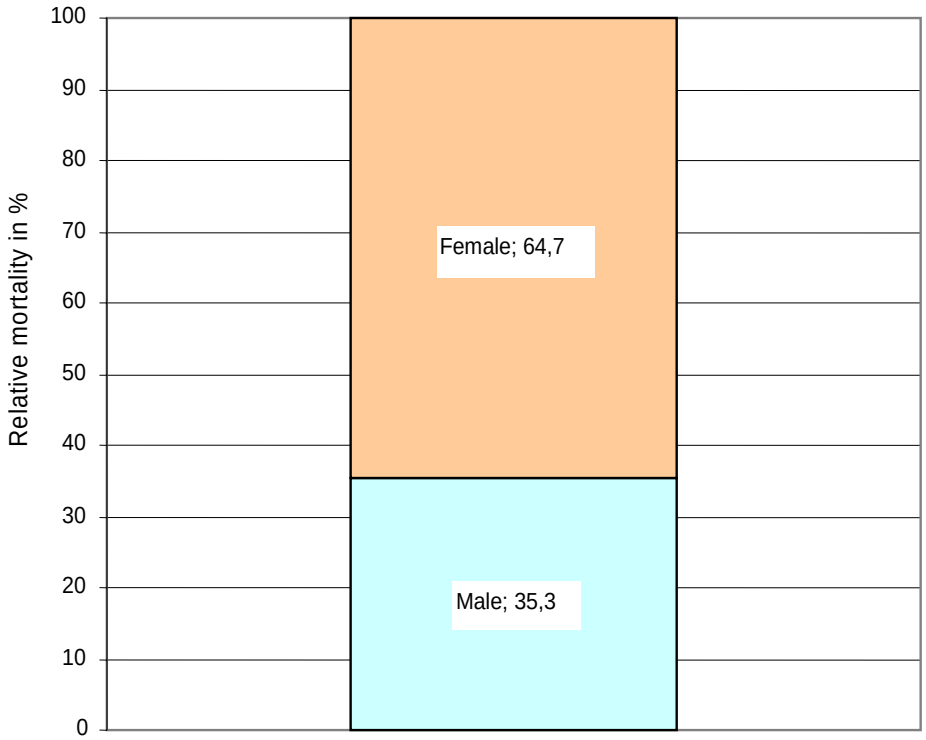
Gender

The considerable gender gap between the vulnerability of females and males with regard to the probability of being killed by the tsunami has also been observed in other studies of tsunami-affected areas, for example, the Aceh province in Indonesia (Oxfam 2005; Rofi, Doocy and Robinson 2006). In the North Aceh district, the proportion of female victims (78 per cent) is more than three times that of male victims (22 per cent). In addition, the survivor percentage observed in Aceh Besar district is much smaller for females than for males (28 per cent and 72 per cent, respectively) (Oxfam 2005).

Age

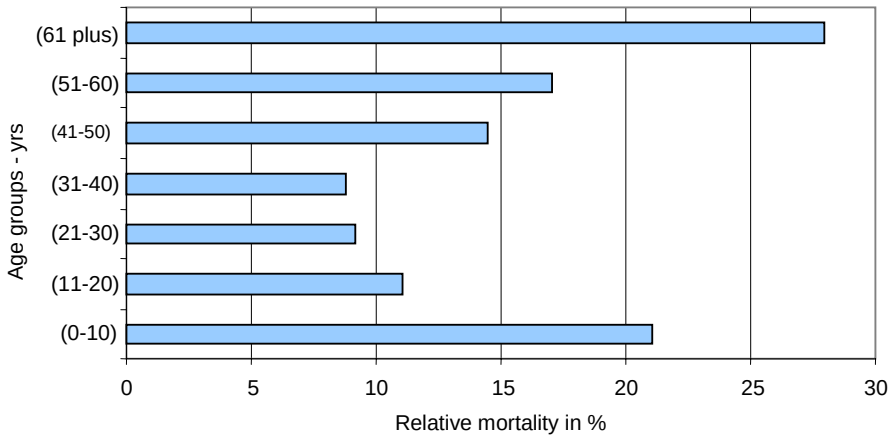
Similar to the situation in Galle, the number of casualties according to age group shows that especially the elderly and young were most vulnerable. Thus the pattern observed in Sri Lanka is also noted in Indonesia. Although the general assumption that the young and elderly population sectors are *per se* more vulnerable to natural hazards is true with respect to the tsunami, different patterns have emerged in other disasters, as, for example, with Hurricane Katrina (see Birkmann and Fernando 2008).

Figure 5
Relative mortality by gender, Aceh (Indonesia)



Source: Own computation based on data from Rofi, Doocy and Robinson (2006).

Figure 6
Relative mortality by age groups, Aceh (Indonesia)



Source: Own computation based on data from Rofi, Doocy and Robinson (2006).

Exposure and physical damage

The western tip of Sumatra was hit hardest in terms of loss of life and physical damage because of its proximity to the epicentre of the earthquake. The earthquake damaged buildings in Aceh and caused tremors in neighbouring cities and provinces, including Bukit Tinggi, Paya Kumbuh and Parapat. It has been estimated that the subsequent tsunami waves reached a height of 10-15 metres when they hit Sumatra's coast before sweeping several kilometres inland (Guy Carpenter and Company 2005)

Overall, an estimated 14 per cent of the approximately 820,000 building units (around 114,000 units) in the affected districts were completely destroyed, and 19 per cent (or 155,000 units) suffered, on average, 50 per cent damages. Devastation extended inland from the coast as far as 3.2 to 6.4 kilometres. Kota Banda Aceh, Aceh Jaya, Aceh Besar, Kota Sabang and Aceh Jaya bore the brunt of the disaster, with damages to over 80 per cent of their housing stock (BAPPENAS 2005).

Table 2
Classification of coastal zone devastated areas

		Devastated area from the coastline	
Coastline type	Damage level	Zone I—Severe zone (damage rate = 88%)	Zone II—Dangerous zone (damage rate = 78%)
Muddy coast Tidal coast Meander belt	Severe	0–3.0 km for flat coastal terrain* 0–1.5 km for gently sloping terrain**	2.0–5.0 km for flat coastal terrain 1.0–2.0 km for gently sloping terrain
Alluvial plain	High		
Sandy beach	Moderate		
Rocky beach Hilly beach	Low	Areas at 0–10 m above sea level	Area within 0–10

Note: * Flat terrain = slope 0-3%, total amplitude of relief less than 3 metres;
** Gently sloping = slope 0-5%, total amplitude of relief less than 5 metres.

Source: Shofiyati et al. 2005 (Data source Kristijono et al. 2005).

As a result of its field observations, the Indonesian Research and Applied Technology Agency (BPPT) suggested a classification scheme for coastal zone damage areas (Table 2). Based on coastline typology, there are two types of zones: Zone I, *severe zone*, where damages are caused by the direct impact of wave energy, and Zone II, *dangerous zone*, where devastation is caused by inundation or floods and debris deposit. The results also showed that the average damage rate to buildings in Zone I in both rural and urban areas is 88 per cent and 78 per cent in Zone II (Shofiyati et al. 2005).

5 Recovery and vulnerability in the post-tsunami process

5.1 Review of Sri Lanka

The task of measuring and assessing the sustainability of the recovery process, including the mitigation or potential generation of vulnerability during the reconstruction phase, is a major challenge. Particularly after mega-disasters, such as the Indian Ocean tsunami, international aid and external intervention can alter or reduce the vulnerability of certain groups or even create new ones for others. Monitoring vulnerability and the recovery progress is still underdeveloped, in comparison to most standardized needs-assessments after major disasters. This also means that measuring recovery and vulnerability in the reconstruction phase is still underdeveloped and under-researched. A first approach in this direction was undertaken in the aftermath of the December 2004 tsunami, for example, by the International Federation of the Red Cross and Red Crescent Societies (IFRC). IFRC developed a set of indicators, known as TRIAMS, to measure sustainable recovery (see the IFRC website), but this approach needs to be improved since it still has the tendency to primarily monitor the reconstruction of physical and social infrastructure.

Interestingly, in the tsunami-affected countries (Indonesia, Sri Lanka, India, Maldives and Thailand), the sectors most severely hit in terms of absolute economic damage and losses were not the fisheries, but tourism and housing sectors. The total cost of the housing-sector devastation is estimated at US$2,196 million, of which US$2,120 million represents home replacement value and US$76 million constitutes losses (see ADPC 2006: 18, 27).

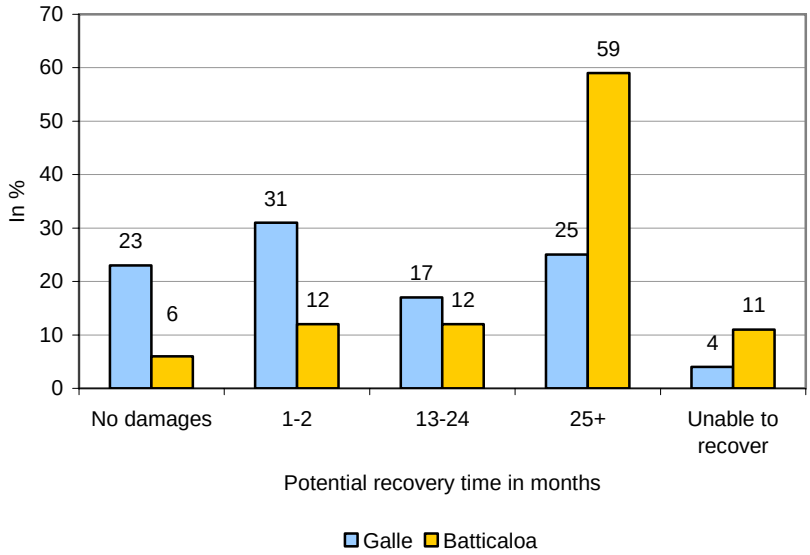
Within the framework of the local vulnerability survey conducted after the tsunami in the two selected cities in Sri Lanka, UNU-EHS used an index to measure the recovery potential of the different households and communities for rebuilding the houses damaged by the tsunami. The equation for this index was based on the human security index proposed by Plate (2006: 246-8), which, however, was modified in order to make it applicable to the post-tsunami situation and availability of data on the local level. The equation (see Figure 7) constitutes reconstruction costs linked to actual damage to the

Figure 7
Equation used to measure the recovery potential of different households

$$\frac{Damage\ category\ of\ the\ house(HH_{x1}, .., HH_{x5})}{\sum_{HH\ members} HH\ Members\ income\ per\ month - minimum\ subsistance\ level}$$

Source: Birkmann, Fernando and Hettige (2006).

Figure 8
Unusual difficulties in recovering: Galle and Batticaloa in comparison



Source: Birkmann (based on data from Birkmann et al. 2006).

house, which was determined by its exposure to risk and the type of construction material of the house. Moreover, available income was calculated and used as a potential asset and resource for the reconstruction process. For each of the five levels of damage, a specific reconstruction cost was estimated, based on governmental figures and the support received by various households (see details in Birkmann and Fernando 2008).

Although individual reconstruction and replacement costs differ among households and locations, the objective of the index was to outline major deviations between families and communities. Figure 8 shows the potential recovery times of households in Galle and Batticaloa (based on the questionnaire survey) in overcoming actual housing damage.

Interestingly, there are significant differences in the recovery potential of the households in Batticaloa in eastern Sri Lanka and Galle in the south. A comparison of the severely affected households which needed more than two years to recover or those unable to recover at all, indicates that in Galle around 30 per cent of the households fall into this category, while the corresponding figure for Batticaloa is 70 per cent, an observation which underscores the city's vulnerability and greater need during the recovery process.

Land ownership

Another major problem within the recovery process in both countries was the availability and accessibility of land. In addition to the financial resources needed for rebuilding damaged property, ownership and legal titles to land were essential in order to receive reconstruction aid. Squatters in highly exposed coastal areas of Sri Lanka were faced with the reality that they were unable to rebuild their house in the original place because the land was not legally theirs. Furthermore, during the first phase of the recovery process, the reconstruction of heavily and/or totally destroyed houses within

100 metres from the sea was prohibited, making it particularly difficult for many people, especially squatters, to recover to the pre-tsunami situation. Interestingly, during the second reconstruction phase, some squatters also received plots of land, if they had lived in the tsunami risk zone.

Interventions: relocation, housing, livelihoods

Among the tools introduced in Sri Lanka and Indonesia to reduce tsunami-risks were the so-called 'buffer zone' measure, 'relocation/resettlement' scheme for people exposed to risk, and the establishment of an 'early warning system', which also included evacuation plans. It is no surprise that the establishment and amendment of the buffer zones in particular, and the relocation issue are still being controversially discussed. Even though the buffer zone is generally considered an important instrument in preventing people from settling too close to the sea, the injustice generated by the handling of the matter (the lack of transparency and lack of reliability resulting from frequently amended rules) created tension and frustration, particularly for people still living within the 100 metre limit, or those being relocated. However, damage patterns in Galle and Batticaloa clearly indicated a strong correlation between risk exposure and damage. Thus, the proposed ban on construction within the immediate proximity of the sea should be taken into consideration in future development plans. However, various exemptions for hotels, for example, have undermined the logic and effectiveness of the buffer zone. Relocation, on the one hand, created the opportunity for some squatter households to overcome chronic poverty, through the acquisition of their own land-title. On the other hand, our surveys also found that relocation areas at times were located in the hinterland, offering in some cases solely new houses but without the appropriate essential physical and social infrastructure.

5.2 Indonesia

In Indonesia also, most recovery programmes focused heavily on housing, health and restoring agrarian livelihoods. About 500,000 people were displaced from their homes by the tsunami in Aceh and the island of Nias. While most have been able to return home or find alternative housing, in Aceh as of December 2005 some 190,000 people and a further 13,500 families in Nias remain homeless (BRR 2005: 19).

Other major natural disasters have occurred in the tsunami-affected regions of Indonesia. These include floods at the end of 2006 in north Sumatra and Aceh, causing 80 fatalities and displacing at least 100,000 people (BBC News Indonesia, 25 December 2006). A strong earthquake in Padang, West Sumatra (6.3 on the Richter scale) caused about 70 fatalities with hundreds injured (BBC News Indonesia, 6 March 2007). These events clearly show that Indonesia's coastal communities are exposed to various hazards, highlighting the major challenge of finding areas that are relatively safe in terms of hazard exposure. Large areas are no longer suitable for housing because these were flooded when the tectonic plate shift within the December 2004 tsunami compressed much of the coastal shelf by as much as 1.5 metres (BRR 2005: 15).

Table 3
Changes to vulnerability through resettlement

Positive effects	Negative effects	Not clear/open question
Reduction in exposure to tsunami and coastal hazards	New exposure to other natural hazards, such as floods	How to cope with new natural hazards?
Improvement in housing quality; standard often better than before	Lack of physical and social infrastructure at relocation site	When and whether physical and social infrastructure will be provided?
New housing often provided and external support received	External aid and support are a disincentive to developing one's own capacities to overcome the disaster	
Some households escape chronic poverty, through the receipt of an own plot of land (this is particularly relevant for squatters)	Confrontation and tension between new settlers and old village communities	Is there actual success or failure in lifting people from chronic poverty?
Relocation can offer new opportunities for better integration into the local community, e.g., for squatters and marginalized people	Lack of livelihood security because of lack of access to markets or the income-generating activities (jobs) as well as due to the lack of social infrastructure (schools and hospitals)	
New livelihood and income earning opportunities can be generated	Separation of households	Sustainability of income earning activities?

Source: Compiled by author.

6 The context of recovery in fragile regions: violent conflicts

Both Sri Lanka and Indonesia are perceived as fragile or even as failed states, in particular due to the presence of civil conflict. Fragile or failed states are defined as states where the government cannot or will not provide core functions—including service delivery, justice, and security—to the majority of its people (see DFID 2005b). Within the current discourse on fragile and failed states, one can distinguish three dimensions of state failure: authority, service delivery and legitimacy failures. This implies that fragile states are those which are at risk of, or are currently, failing, with respect to authority, comprehensive service delivery and legitimacy (Brown and Stewart 2007: 5). Although the military conflict in Sri Lanka and the earlier conflict in the Aceh region of Indonesia affected only small geographical areas, this state authority failure had (and in case of Sri Lanka still continues to have) major consequences for the whole country (see Mayer and Salih 2006).

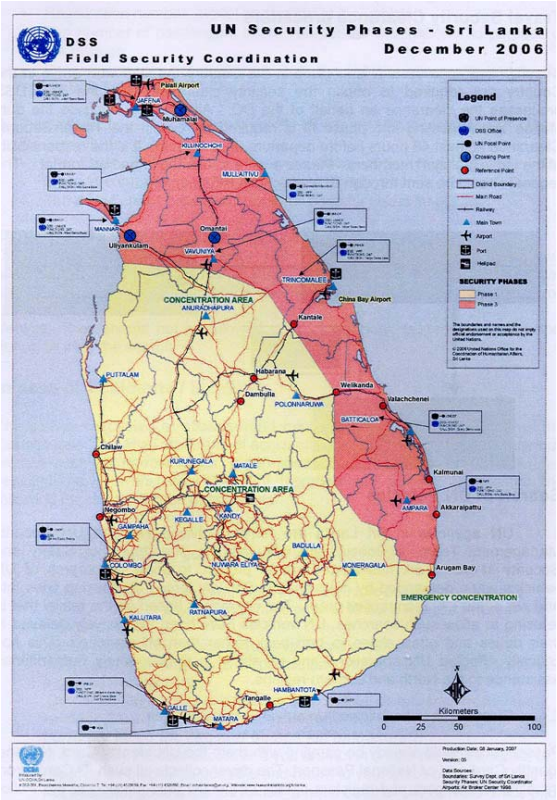
Sri Lanka has been scarred by violent hostilities for over three decades.[2] The conflict amounting to separatist struggle between the LTTE and the government has been going on since the early 1980s, and is seen mainly as an ethnic war. However, high youth unemployment was also a major driving force (see Mayer and Salih 2006). Currently,

2 For more detailed information see, for example, Bohle (2004).

many of the northern and eastern provinces, which were hit the hardest by December 2004 tsunami, are under LTTE control with some exceptions mainly along the coastal belt. The ceasefire agreement signed in 2002 did not last, and conflict intensified after the tsunami and during the recovery process. On the one hand, the split of the LTTE in two groups and the highly charged discussions regarding the aid-distribution mechanisms (so-called joint mechanism) on the other hand, contributed to the deterioration in relations (Mayer and Salih 2006). The number of fatalities increased in 2006 to a total of 2,657 (UN 2007: 11), with nearly half of the deaths occurring in the northern provinces of Jaffna and Killinochchi. Overall, the conflict has eroded the political, social and legal rights of all Sri Lankans. It has also generated economic losses and insecurity in various parts of the country, particularly in the north and east. As a result, the recovery process has been undermined and in some areas even reversed, due to the withdrawal of investors and NGOs supporting the reconstruction.

Moreover, it is reported that since the tsunami many of the internally displaced persons (IDPs) have not yet been able to return home or to relocation sites in eastern or northern Sri Lanka. In addition, the ongoing conflict generates new IDPs who have to turn to refugee camps. This means that the displacement of large populations created by Indian Ocean tsunami in December 2004 has been compounded by additional people displaced by the hostilities between the government and the LTTE. Overall, the tsunami, and particularly the handling of the tsunami relief, generated new threats to Sri Lanka's fragile ceasefire agreement, first by prioritizing tsunami-affected communities over other

Figure 9
Conflict zone, Sri Lanka



Source: UNDP (2007).

neighbourhoods which were unaffected by the disaster, but were nevertheless very poor and affected by the civil conflict. Second, and even more important, through the adoption of more a centralized mode of governance in both the government's and the LTTE's handling of rehabilitation efforts. This is counter to the policy of strengthening local and regional capacities, which is perceived to be an important element of the proposed political solution to ethnic conflict (Mayer and Salih 2006). The intensification of violent conflict in Sri Lanka undermined and even reversed the tsunami recovery process in the east and north parts of the country. While relocated households in the south still lack the appropriate social and physical infrastructure even today, the situation in the east and north has worsened to the point where the development of new housing is almost impossible and access to social and physical infrastructure has deteriorated.

Indonesia

Contrary to Sri Lanka, the devastating tsunami and the international attention focused on the province of Aceh in the direct aftermath contributed to the current peace process. It was formally established with the signing of the peace agreement in Helsinki between the government of Indonesia and the Free Aceh Movement on 15 August 2005, ending 30 years of conflict during which almost 15,000 people had died. While the tsunami and the subsequent recovery aid generated a situation in Sri Lanka that led to increased mistrust and intensified hostilities, in Indonesia it gave Aceh the chance for peace. In Aceh the reconstruction efforts were seen as an opportunity to strengthen peace by bringing entire communities together to plan for their future (BRR 2005: 14-5). Even though the current status of living conditions are far from normal—about 67,500 people are still living in tents and hundreds of thousands more still depend on food aid and emergency employment schemes—the overall trend is positive and progress visible. Differences in the recovery process in Indonesia and Sri Lanka are outlined in Figures 10 and 11.

Figure 10
Outline of the reconstruction and recovery process, Indonesia and southern Sri Lanka

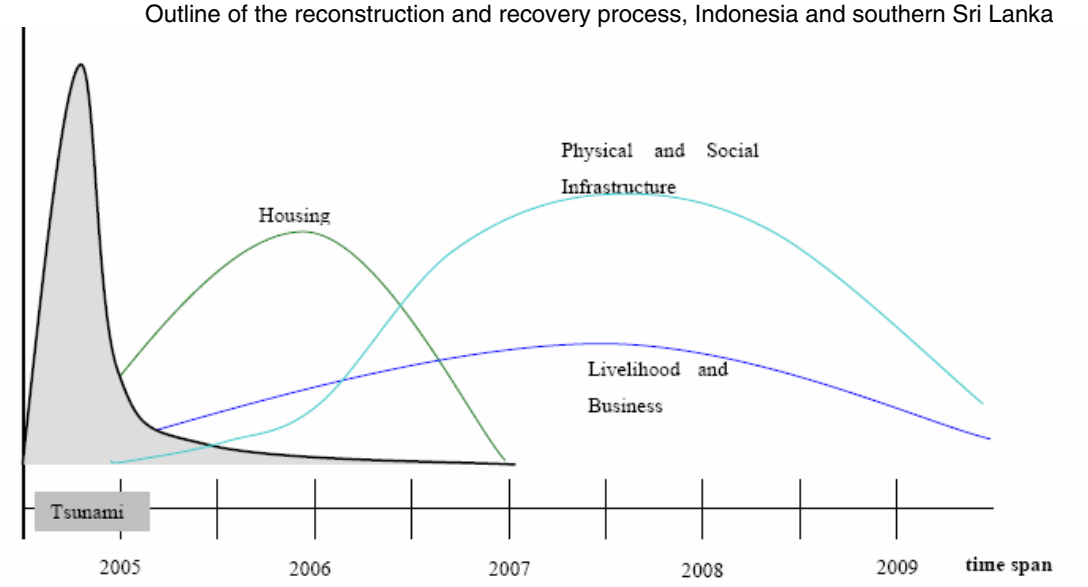
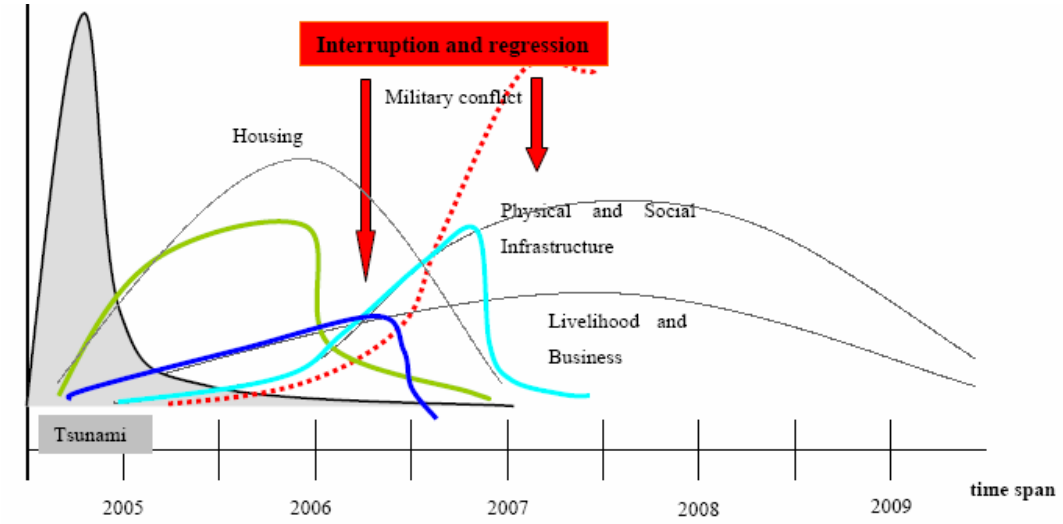


Figure 11
Outline of the reconstruction and recovery process in eastern and northern Sri Lanka



Source: Figures 10 and 11 computed by the author.

7 Preliminary conclusions

One of the most important questions the study raises is whether the dynamics of and changes in vulnerability can be captured with a single approach, or whether vulnerability needs to be assessed differently during the various phases: *before*, *during* and *after* a disaster has occurred.

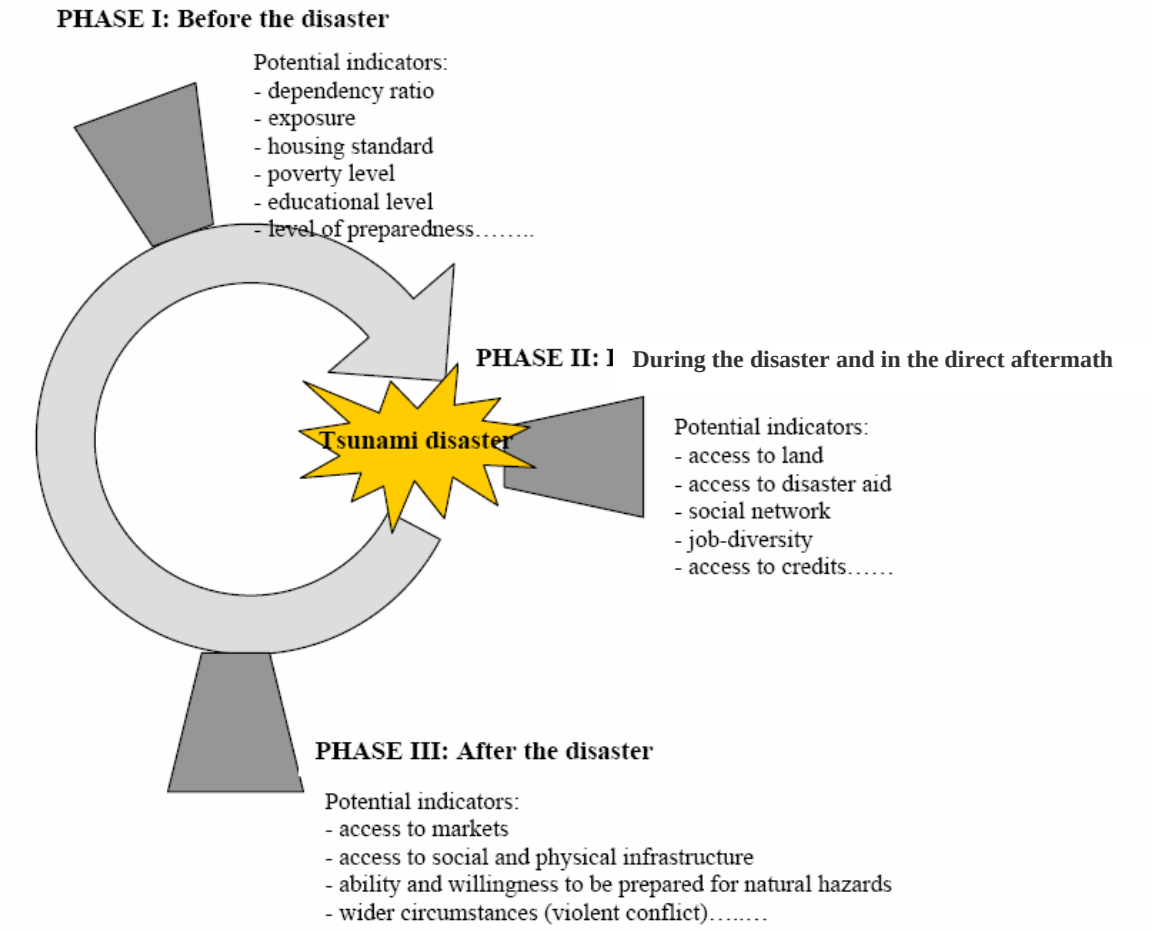
The findings of the field research as well as the review of the post-tsunami studies and reports show that it is crucial to assess vulnerability differently within the various phases in order to be able to capture some of the dynamic changes that constitute the vulnerability of people, local economies and environmental services. For example, in the first phase—before a disaster has occurred—a vulnerability assessment of the population exposed to a risk often has to be based on general indicators, such as dependency ratio, exposure, housing standard, income/poverty, the level of preparedness, etc.

Contrary to this general assessment, analysis in the direct aftermath of a disaster allows one to focus on the observed vulnerabilities and the actual impacts caused by the event. This assessment can be seen as a tool to be implemented in the second phase (Figure 12). In the immediate aftermath, other assets and skills are critical for coping and sustainable recovery. In the case of the 2004 tsunami, for example, assets such as access to land, access to loans or aid and social networks, as well as job-diversity of households, played a crucial role in Sri Lanka and Indonesia. This means that, based on actual patterns of coping and recovery, the assessment of the revealed vulnerability can be more precise.

In addition, in the third phase, a vulnerability assessment should examine the medium- and long-term risk of different groups, sectors and environmental services. In the case studies presented here, access to physical, social and educational infrastructure was a major problem, compounding the vulnerability of people in the medium and long run when they lack appropriate health care and schooling. However, the ability and the

willingness to prepare for potential natural hazards in the future is another major aspect that needs be taken into account during third-phase vulnerability assessment. Overall, the author recommends that a more in-depth examination should be conducted to develop more dynamic and phase-specific vulnerability assessments that can provide in-depth information on how vulnerabilities change and manifest themselves *before*, *during* and *after* a disaster.

Figure 12
Dynamic vulnerability assessment: Before, during and after the disaster



Source: Prepared by author.

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