SUMMARY UNU-EHS VULNERABILITY STUDY
Measuring Revealed Vulnerability in Sri Lanka at the Local Level

by
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ABSTRACT
The UNU-EHS study deals with the development and testing of different methodologies to identify and measure the pre-existing and emergent vulnerability (revealed vulnerability) of coastal communities in Sri Lanka to tsunami and coastal hazards. The study noted that females were more vulnerable to the tsunami then males. Single-story buildings were more vulnerable then multi-story buildings, particularly in the first 100 meters from the sea. Additionally, the study reveals a better recovery potential of households in Galle then in Batticaloa. While for example around 25 percent of the household captured within the survey in Galle need more than 2 years to replace their housing damage, the same category counts for Batticaloa nearly 60 percent. Thus the households in Batticaloa face higher difficulties than in Galle in terms of bouncing back to normal conditions. This might also be a result of the devastating conflict in the region for the past 20 years. This summary is based on research undertaken within the joint project of UNU-EHS, the University of Colombo, University of Ruhuna, Eastern University and the German Space Agency and the Center for Development Research (ZEF), with financial support from UN/ISDR-PPEW.

BACKGROUND
The devastating tsunami in the Indian Ocean on December 26, 2004 hit the hardest Sri Lanka and Indonesia. In Sri Lanka alone the tsunami affected more than 546,509 people or 3 percent of the total population: about 40,000 people were killed or missing (Department for Census and Statistics). Although the vulnerability of the coastal communities in Sri Lanka was highly visible in the tsunami catastrophe, future reconstruction, relocation and urban renewal are medium and long-term tasks, which should promote development of more disaster resilient communities in coastal areas. Thus, the identification and understanding of different vulnerability patterns, coping capacities and intervention tools need to be promoted in order to be able to facilitate the reconstruction process with appropriate information to ensure sustainable development.

STRUCTURE AND METHODOLOGY
The vulnerability assessment approach that was developed and tested aimed to explore various characteristics of vulnerability of different social groups, basic infrastructure services and economic sectors to tsunami and coastal hazards. As a theoretical framework and definition of vulnerability, the approach is based on the BBC-conceptual framework (Birkmann 2006), which stresses the fact that vulnerability is defined through exposed and susceptible elements on the one hand, and coping capacities of the affected entities (e.g. social groups) on the other. Moreover, it is also important to address the potential intervention tools that could help to reduce vulnerability within the social, economic and environmental sphere. Overall, the study encompassed four main techniques to identify and measure vulnerability, focussing on different data sources and different characteristics of vulnerability.

The first methodology aimed at estimating the overall exposure of the settlement area as well as examining some physical characteristics of vulnerability of different city areas (GN divisions) by looking at the structure and quality of the built environment using remote sensing.

Overview of the 4 techniques used to assess vulnerability
1) Assessment of the built environment with remote sensing: estimation of vulnerability of different urban areas;
2) Critical infrastructures and sectors vulnerability: ground survey of the exposure and susceptibility of basic infrastructure services and their facilities, e.g. hospitals and schools;
3) Vulnerability of different social groups – questionnaire based: interviews with households in selected locations to identify and assess the different vulnerabilities of various social groups to tsunami risk;
4) Vulnerability of social groups and local communities. census data based assessment of vulnerability using general indicators;

We think that the type of the settlement and housing unit allow a classification of urban areas with regard to their socio-economic status. That means, we assume that a higher or lower vulnerability of the community can be associated with the conditions of the built environment that different groups are living in. However, this methodology has proved to be more complicated than expected, particularly because the city of Galle encompasses very diverse housing types in nearly all locations.

The second methodology explores the exposure and susceptibility of different critical infrastructures and sectors, such as education (e.g. schools), the health system (hospitals), and finance/banking (banks). In the first phase of the research the main focus was on the degree of exposure of different units of critical infrastructures and sectors, although we intend to expand the focus also to other criteria later.

The third methodology requires the most attention and included questionnaire-based interviews to explore the various vulnerabilities of different social groups in selected locations prone to tsunami and coastal hazards in Galle and Batticaloa. Besides the analysis of the revealed vulnerability, the in-depth questionnaire survey also allows a better understanding of current vulnerability after the tsunami.

The fourth methodology focuses on general indicators available in the census and local statistics to estimate the vulnerability of different social groups and economic sectors of coastal communities to tsunami. This technique also intends to use some of the data examined in the other methodologies mentioned in order to combine it with census data, which is available for most parts of the country and its coastal areas.

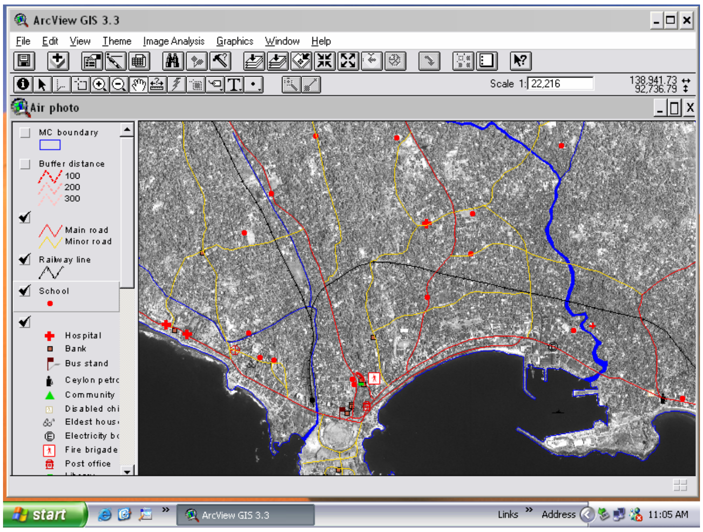
The use of various methodologies provides a more comprehensive picture regarding the multi-faceted vulnerability of coastal communities to tsunami and coastal hazards. The rationale behind this approach is that ideally the weaknesses of one method are offset by the strengths of the others. It was decided to focus on the city of Galle as the major study area and to conduct similar research in the city of Batticaloa.

SELECTED RESULTS

Critical infrastructure and sector vulnerability

Since the exposure to the sea was a major factor which determined the likelihood of damage and destruction, the analysis of the vulnerability of critical infrastructure was based in a first phase on the assessment of exposure. The GIS analysis and the ground survey, aimed at identifying the degree of exposure of different critical infrastructures, such as schools, banks etc. assessing, for example, the number of schools in the 100 meter zone (from the sea), compared to the total number of schools in the Galle municipality was used as a first estimation of vulnerability. Thus, as a first definition to measure the exposure of different critical infrastructure in the high risk zone, the governmental 100 meter zone (proposed buffer zone) was used as a classification. It means that if a high concentration of facilities of a specific critical infrastructure, such as hospitals, is located within the 100 meter zone, this infrastructure or service is more vulnerable to tsunami than those whose major facilities are located further inland. In order to capture information regarding the hinterland, the research takes into account the 200 meter zone and the 300 meter distance and more from the sea (see Figure).

Figure: Spatial exposure of different critical infrastructures



Source: Authors, based on satellite photo IKONOS

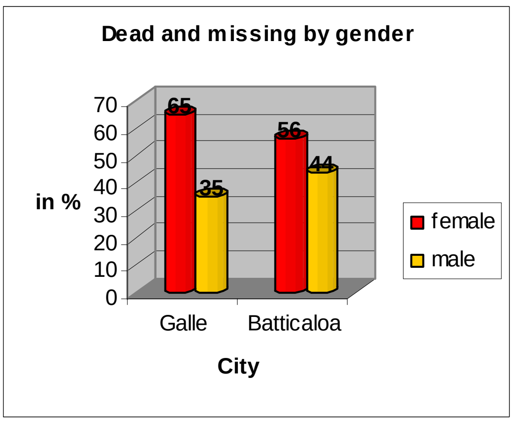
Our analysis shows that 50 percent of the hospitals, approximately 20 percent of the banks, but also 13 percent of the schools (4 schools) are located in the "high risk zone" (100 meter zone) in Galle municipality. Thus, particularly the health infrastructures, and also the banking and schooling sector are especially vulnerable due to their high degree of exposure in the high risk zone compared to other infrastructures/sectors. On the other hand the distance from the sea is only one indicator that allows a first estimation of vulnerability regarding exposure.

It is intended also to use an elevation map to assess the exposure of different critical infrastructures and sectors in the high risk zone.

Vulnerability assessment of different social groups using questionnaires

The questionnaire-based identification of vulnerability and most vulnerable groups was executed in six GN divisions (Grama Niladari divisions; smallest statistical unit in Sri Lanka) all located close to the sea. A sample of 502 households in Galle and a similar sample of 532 households in Batticaloa were conducted by applying the stratified random sampling method to administer the interview schedule. The household survey showed for Galle and Batticaloa that people within the 100 meter zone from the sea were facing higher degrees of damage than others located within the 200 and 300 meter zone. A higher proportion of deaths were particularly reported from the households in Galle that were situated within the 100 meter zone compared to outer areas. The likelihood of being killed during the tsunami was twice as high in the 100 meter zone as outside of it. In contrast the study for Batticaloa revealed that major destruction and loss of life was also observed beyond the 100 meter zone from the sea.

Figure: Dead and missing by gender



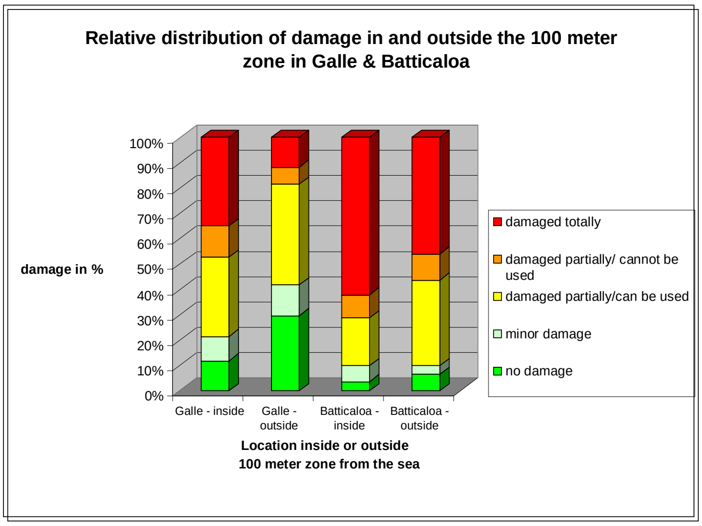
Source: authors

The analysis of the distribution of the dead and missing according to age and gender shows that in both cities (Galle and Batticaloa) the number of females reported as dead and missing is significantly higher than for males (see Figure). Hence, the indicator "dead and missing by gender" shows that gender played an important role in terms of the likelihood of being killed in the tsunami.

The reasons are manifold: some of the affected people interviewed in Batticaloa (Navalady and Dutchbar) reported that they climbed on to the roof, while their wives or daughters were less able to do so within the short timeframe once they noticed the devastating wave was coming (oral reports from Batticaloa in 2005). Additionally, - according to a study from Banda Ache - female household members were more exposed due to their traditional role of carrying out activities around the house (Oxfam 2005).

Furthermore, the physical damage patterns in Galle and Batticaloa show significant differences regarding the 100 meter zone from the sea and outside.

Fig.: Relative distribution of damage inside & outside the 100 meter zone



Source: authors

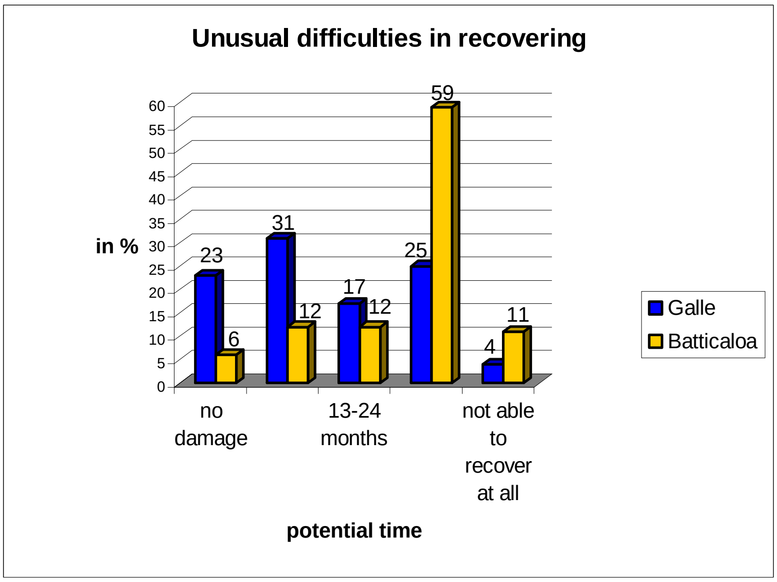
The comparison of the low-damage segment (no damage and minor damage) with the number of severely damaged houses (damaged totally and damaged partially and cannot be used) in Galle shows that there is significantly more and more intensive damage inside the 100 meter zone than outside.

Thus, regarding the degree of damage, a clear difference can be observed in Galle between the 100 meter zone and the area further inland. Interestingly, the results in Batticaloa are different. Inside the 100 meter zone the number of severely damaged houses amount to 70%, while outside the 100 meter zone the houses which were ‘totally damaged’ and ‘damaged so that they cannot be used’ also amount to 56 percent. Therefore, in contrast to Galle, the spatial impact and damage patterns in Batticaloa do not show major differences between the area inside the 100 meter zone and outside it.

For measuring the vulnerability of different social groups we also calculated the potential time the different households would need to recover. This recovery index is based on the reconstruction costs of the house according to the respective damage category and the free available income of the household (aggregated income of all household members minus the minimum subsistence level). The analysis shows major differences in the recovery potential of households in Galle and Batticalao (see Figure).

The figure shows significant differences between the recovery potentials of the households in Batticaloa and Galle. Especially if one compares the number of households which faced no damage and those which need more than two years to recover plus the households which are not able to recover at all, it becomes evident that around 30 percent of the households captured in Galle either need more than two years or are not able to recover at all. By contrast, the same categories account for 70 percent in Batticaloa. This means around 70 percent of the households in Batticaloa are unable to recover by themselves in an appropriate time period. Although the households in Galle also faced major destruction of their houses (nearly same wave hight), the situation is evidently more problematic in the city of Batticaloa.

Figure: Unusual difficulties in recovering: Galle and Batticaloa

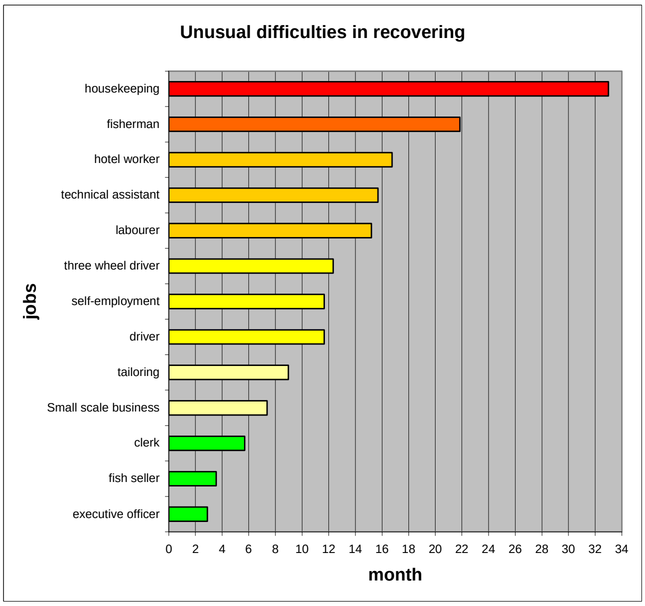


Source: Birkmann

Moreover, one can also analyze the unusual difficulties of different households to recover using the occupation of the head of household as the classification criterion. Our hypothesis was that there are differences in terms of the potential recovery time of those households working primarily in fishing compared to households in which the household head works, for example, as a clerk or is in business.

The analysis for Galle shows, for example, that the households engaged in housekeeping – i.e. which earn their income through being employed in domestic work (full or part-time), such as washing clothes, cooking, cleaning and gardening – are one of the most vulnerable groups regarding their difficulties to replace and repair actual housing damage.

Figure: Unusual difficulties in recovering – Galle



Source: Birkmann

These households need more than 32 months (2.6 years) to repair or replace their actual housing losses (average/median). By contrast, the households where the head of the household is a clerk, an executive officer or fish seller are able to repair or replace their actual housing damage within half a year or even less than that. These differences are based on various factors, including the different exposure, the income level, the household composition and the job diversification of the household.

Another important indicator to estimate coping capacities and differences in the potential recovery time of households to replace their housing damage is land ownership. The analysis of this aspect shows, for Galle, that households which live on ‘owned land’ need around 7 months, while the average squatter needs about 44 months to repair their actual housing damage (median). Furthermore, the indicator ‘land ownership’ encompasses two important components. On the one hand, it reveals that squatter households constitute the most vulnerable group in terms of their household income and actual damage (land title as an indirect indicator); on the other hand, ‘land ownership’ itself can serve as a surrogate indicator to classify vulnerable households, since the access to land plays a major role in terms of being able to move to another location and to receive financial support from the government for reconstruction.

OPEN QUESTIONS AND LIMITATIONS

This summary outlined different approaches and indicators used to measure vulnerability of coastal communities in Sri Lanka to tsunami and coastal hazards. The analysis of exposure regarding critical infrastructures and sectors allowed a first estimation which infrastructures and sectors are highly exposed. However, the actual or the specific "exposure" might also be influenced by the road systems, the built infrastructure, small rivers and canals. Therefore, the critical infrastructure analysis regarding the high risk zone based either on the 100 meter zone defined by the government or on an elevation model needs to be seen as a first overview; it would require more in-depths studies for application to specific emergency plans. The analysis of the vulnerability of various social groups has provided interesting insights into the vulnerability of different professional groups and groups classified according to their land ownership. One can conclude that although income related vulnerability measures – for example the ability to replace experienced economic and property damage are often appealing and of high interest to decision makers, income data at a fine resolution is often difficult to grasp.

CONCLUSIONS & RECOMMENDATIONS

The intention to combine different methodologies and data sources seems to be an important step forward in overcoming the specific limitations of a single methodology. The estimation and assessment of vulnerability will be a key issue also for the future, especially with regard to the reconstruction process and the implementation of an early warning system. Since the buffer zone is reduced to 50 meters, allowing the proliferation of settlements and other structures close to the sea, it will be important to know more about the specific vulnerabilities of different social groups or critical infrastructure and sector facilities in order to being prepared for emergency situations and future coastal hazards. The in-depth analysis for example revealed that the 100 meter "buffer" zone might be appropriate as one tool to reduce vulnerability in Galle, but in contrast, this instrument is inappropriate for Batticaloa, since the heavily devastated areas goes far beyond the 100 meter from the sea. Regarding the time and costs of the different methodologies used within the study, the analysis of available census data is often processed within one or two month, while the development, testing and implementation of a household questionnaire survey takes at least 4-6 months. The remote sensing analysis allows estimating the impact of disaster on physical structures nearly all over the world. However, although the satellite is able to provide actual information for nearly any part of the world, the methodology is costly, since one satellite image with high resolution required to assess the structure of a single building could cost around USD 5.000 to USD 10.000. This means a combination of different methods is needed.

Moreover, it has to explored how to integrate this information in development and emergency preparedness plans in order to ensure that vulnerability assessment effectively supports practical activities towards disaster resilient communities. The identification of the most vulnerable social groups indicates that women, small children and elderly people (above 61 years) have to be targeted first and be prioritised in evacuation planning and emergency situations. An in-depth study revealed that also underlying vulnerabilities have to be taken into account within the sustainable reconstruction such as the problem of access to land for squatters which are on of the most vulnerable and highly exposed groups, particularly in Galle. The assessment of the vulnerability of critical infrastructure shows that the health and schooling sector should be seen as a priority area for fostering increasing preparedness and mitigation since a large amount of facilities of these sectors are located in the high risk zone. Lastly, the results of the measurement of the potential recovery time point out that the households in Batticaloa face more difficulties in recovering from negative impacts; therefore, this indicator allows to set priorities when planning external disaster aid and reconstruction efforts. Finally, transforming vulnerability assessment to a continuous monitoring system will become increasingly important.