Developing a Framework for a Social Vulnerability and Consequence-Based Post-Disaster Behavior Analysis Methodology

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ABSTRACT

The proposed study is expected to focus on the less investigated areas by the previous seismic risk analyses in Turkey. Most of the existing loss assessment methodologies focus on structural damage, infrastructural damage, economic impact, and casualties. However, affected population estimates and development of plans for the immediate needs and recovery requirements of the surviving population are also of equal importance. The proposed framework in this aspect will be utilizing previous social vulnerability and seismic loss assessment studies to develop an analysis methodology for affected population and social response analyses. The methodology is expected to help response planners and decision makers in determining the needs for the surviving population in the recovery process.

Keywords

Social vulnerability, social resiliency, affected population, seismic loss assessment.

INTRODUCTION

Concepts like risk and vulnerability are perceived differently by different study groups and have variations on their definitions according to the focus of research and the point of view of the researchers. Within the scope of the proposed study, the concept which will be focused on is social vulnerability.

Most of the existing loss assessment methodologies focus on structural damage, infrastructural damage, economic impact, and casualties. However, it is the surviving population that will take part in response and recovery actions and it is important to know the capabilities, capacities, abilities to recover, organizational structure and specific needs of the surviving communities. With the proposed study, a framework for a parametric social vulnerability and consequence-based social response analysis methodology with a focus on the surviving population is aimed to be developed.

BACKGROUND

Social vulnerability analyses can be defined as determination of a certain society's control or non-control situation over various parameters such as gender, age, education, etc. It can also be suggested that pre-disaster behavior of a society is the best predictor of the post-disaster dynamics of that society. With the assumptions above, Pelanda (1981) aimed to analyze social vulnerability based on a single pre-determined parameter which would have the highest influence on social vulnerability. The study also suggested that a certain amount of indeterminacy within the society is required for maximizing the adaptation of social systems to post-disaster conditions. Socials systems which are too rigid and predictable or too unpredictable are both classified as highly vulnerable. Pelanda's (1981) definition for social vulnerability is: "A threshold, beyond which the average capability of the disaster area social units for maintaining a sense of cultural coherence and predictability collapses."

The general neglecting of social factors over physical and economic factors in vulnerability analysis resulted in a framework proposed by Uitto (1998). The proposed framework was focusing on the social geography of vulnerability in megacities. One of the biggest challenges in social vulnerability considerations are the highly complex and temporary nature of most post-disaster situations (Wisner, 2001). Another key point of view emphasized in the study was the mistake of treating vulnerable populations as special need groups. An alternative approach is recommended as to see everyone as having certain capabilities of self-protection and

group action. With this approach, Wisner (2001) redefined risk as the factor of hazard and vulnerability, minus the capabilities of the socially vulnerable groups.

The relative ignorance on social vulnerabilities is caused by the difficulty in classification and quantification. In an attempt to overcome this challenge, Cutter et al. (2003) prepared a comprehensive list of social and environmental indicators and index to quantify social vulnerability (SoVI) for a zoning study to determine vulnerabilities of counties in the United States. Later, validation of the SoVI methodology was made (Cutter & Emrich, 2006) on affected regions from Hurricane Katrina. In a SoVI aspect, among the affected regions, New Orleans turned out to have the highest SoVI score based on pre-disaster metrics. Predictably so, the less affected regions in Alabama and Mississippi had low vulnerability scores.

Given that hazard, exposure, preparedness, prevention, and response are all mappable measures, when overlaid, one can obtain the resulting vulnerability map of the study region. Weichselgartner (2001) followed an approach to identify the main contributors to vulnerabilities of certain regions for focusing on to reduce vulnerability. An alternative approach for quantification of social vulnerability may be via risk perception questionnaires containing questions for assessment of certain vulnerability indicators such as: age, income, gender, employment, residence type, household type, tenure type, health insurance, house insurance, car ownership, and disabilities (Dwyer et al., 2004).

Several studies state poverty as the dominant factor on social vulnerability. High poverty is considered in correlation with high vulnerability and weak recovery and adaptation capabilities following disasters (Cannon et al., 2003; Morrow, 1999). It is suggested that development works to reduce poverty should also be instrumental in reducing disaster vulnerability both physically and socially. Another approach with a parallel point of view suggests the computation of social vulnerability as a composed index including poverty and demographic vulnerability parameters (Armaş, 2008).

The following definition of social vulnerability coincides with the perception of it in the proposed research: Potential for loss derived from the interaction of society with biophysical conditions which in turn affect the resilience of the environment to respond to the hazard or disaster as well as influencing the adaptation of society to such changing conditions (Weichselgartner, 2001). In a complimentary approach to the vision in the proposed study, social vulnerability is alternatively defined as a human induced situation resulting from public policy and resource distribution, and it's the root cause of the majority of disaster impacts (Chakraborty et al., 2005). Quoting Chakraborty et al. (2005): "Previous research demonstrates that marginalized groups invariably suffer most in disasters. Higher level of vulnerability is correlated with higher levels of poverty, with the politically disenfranchised, and with those excluded from the mainstream of society."

The changing social dynamics of Turkey in both economic and political aspects have placed once marginalized and politically disenfranchised population closer to the mainstream of society. However, this social movement has not changed the general stature of this population completely. Although significant improvements are witnessed, majority of the mentioned part of the society are preserving their customs, including education, health care, awareness/consciousness to possible hazards, etc. Moreover, spatial and temporal alterations in social vulnerability necessitate different mitigation, response, and recovery schemes for different regions instead of one-size-fits-all approaches (Cutter & Emerich, 2004). Thus, it is important to tailor a social vulnerability model for the preparation of accurate and extensive plans. Instead of a direct adoption of an existing methodology, this situation necessitates a localized approach via adaptation of existing methodologies.

PREVIOUS WORK

HAZTURK – A Seismic Loss Analysis Tool for Turkey

In order to aid preparedness, mitigation, response, and recovery planning studies in Turkey, Karaman (2008) used a loss assessment methodology using a consequence-based risk management framework. The methodology was presented in a software environment which can realize all possible earthquake scenarios for the region of interest, determining structural, infrastructural and socio-economic losses and offer reinforcements to mitigate the consequences. The methodology provides analyses for building damage, building economic loss, repair cost, retrofit cost, fiscal impact, and decision-support.

Seismic Performance Analysis of Interdependent Lifeline Networks

In a complementary context to the structural loss assessment research by Karaman (2008), infrastructural seismic loss and post-seismic performance of interdependent lifeline networks were assessed in the study (Ünen,

2011). The study uses a methodology developed by the Mid-America Earthquake Center in the University of Illinois at Urbana-Champaign (Duenas-Osorio, 2005; Kim, 2007). The methodology was improved during the study with the addition of liquefaction-induced buried pipeline damage, a natural gas network model, and a heterogeneous dependency approach in addition to the homogeneous approach of the methodology. For the methodology, potable water, electric power, and natural gas networks of the region of interest are topologically modeled. The methodology provides buried pipeline damage, network facility damage, and an interdependent network analyses to assess the post-seismic serviceability of topologically modeled interacting lifeline network systems.

PROPOSED FRAMEWORK

The framework will include affected population analyses based on the available physical and socio-economic impact assessment methodologies mentioned in the previous section. Affected population analysis methodology will require the determination of social vulnerability against the impact agents. Help from social studies will be sought for the development of post-disaster response and recovery models.

General structure of the proposed framework is presented in Figure 1. The backbone of the framework is formed by two previous doctoral studies (highlighted in green) mentioned in the previous section. The process starts with the assessment of physical damage to buildings and infrastructure systems against the selected earthquake scenario. Based on the physical damage, the existing methodologies also assess lifeline serviceability, building economic loss, building repair cost, and casualties.

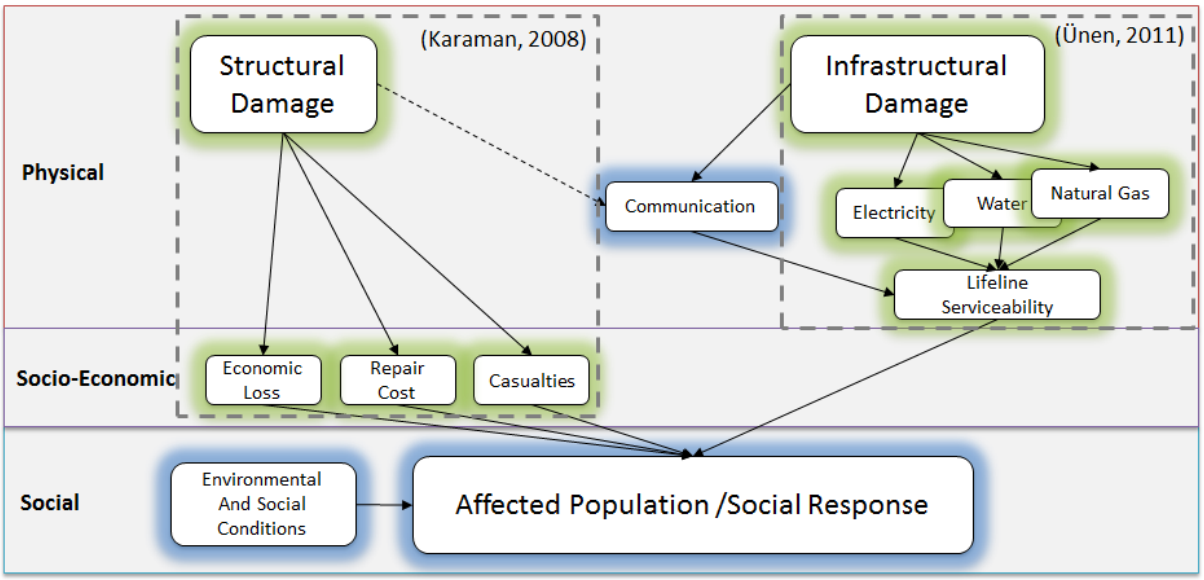

Figure 1. Schematic illustration of the proposed framework

The physical and economical loss, casualty, and lifeline serviceability assessment results are associated with the census information for affected population estimation. Possible situations regarding building damage, lifeline serviceability, and financial situation will be defined as decision parameters for the social response model which will utilize fuzzy algorithms for decision making processes. Decision parameters will be defined for different age, gender, education, residency, financial categories. The input data for the development of decision parameters will be gathered from questionnaires and past social studies. The assessment results are expected to give tendencies of various demographic categories to stay, relocate temporarily, or relocate permanently.

Several tasks have to be completed for the development of the framework. The yet incomplete portions of the proposed framework are highlighted in blue in Figure 1. These include:

- Improvement of physical loss assessment methodologies to include serviceability analyses of communication systems. Different approaches may be needed to assess the post-disaster performances of wired and mobile communication networks.
- Development of a social vulnerability model for affected population analysis and response planning based on the physical and socio-economical loss assessment results. The parameters which influence social vulnerability must be determined and correlated with physical damage. For this process, results

from sociological studies, reports on past events, and field studies containing questionnaires/interviews on risk perception can be utilized. The SoVI framework (Cutter et al., 2003) provides a comprehensive list of parameter influencing social vulnerability and can be instrumental on the determination process.

- Development of a methodology to calculate the post disaster needs based on the surviving population profile for resource and evacuation planning purposes. One example can be the effects of water shortages in different parts of the society: people with lower life quality and inadequate access to health-care services may become more vulnerable to the loss of water. This situation necessitates prioritization in resource planning studies and needs to be considered among the parameters of the affected population analysis.
- Development of a preliminary post-disaster behavior model based on the surviving population profile to predict social behavior such as immigration, relocation, immobility, struggle etc. Given the high complexity of social systems, this task is seen as a long term goal of the study and achievement of a simpler model is expected in the short term rather than a comprehensive simulation model.

CONCLUSION

Portrayal of both physical and social post-earthquake situations in the simulations would provide more comprehensive assessment results for researchers. Specific needs of the surviving population need to be effectively met to ensure recovery of the societies back to the pre-disaster conditions or better in the long term.

Social resiliency should also be ensured in societies along with structural and infrastructural resiliency in order to reduce the impacts of future disasters. Reduction of social vulnerability by increasing life quality and raising awareness is indeed a key aspect in disaster mitigation. The methodology that will be developed as a result of the proposed framework is expected to be utilized in mitigation studies aiming to minimize earthquake loss by increasing the overall resiliency of the societies. In pre-disaster analyses, the framework would identify the vulnerabilities in the society which need to be reduced. In post-disaster analyses, the framework would be utilized to determine region-specific needs of a society according to surviving population.

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