Elaboration of Data Layers for Global Earthquake Models: Case Study Pakistan

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DEDICATION

To my loving parents

ABSTRACT

Earthquakes are amongst the worst natural disasters that could cause vast devastation, lots of casualties and enormous economic loss. Earthquake risk assessment is a technique usually adopted by engineers and decision-makers to mitigate the undesirable results of such disasters. The goal of a seismic risk assessment is the estimation of the consequences of seismic events upon a geographical area (a city, a region, a state or a nation) in a certain period of time. The results provided by an earthquake risk analysis can be regarded as helpful guidelines in respect to all the phases of the risk management: during normal periods, during crisis periods, as well as in the recovery and post-emergency periods.

The aim of this Ph.D. thesis is the elaboration of data layers for earthquake risk assessment. Several field surveys have been conducted to define typical building types in the study area, i.e., Pakistan, and to assess vulnerability of the building stock. Special surveys after the damaging 2005 Kashmir and 2008 Baluchistan earthquakes helped to identify the typical failure mechanisms of different construction types and the factors contributed to their failure. Reconstruction after the 2005 Kashmir earthquake is also observed and key statistics have been collected to compare the risk level before and after the reconstruction. Building and population statistics from the 1998 national census of Pakistan have been used to quantify the social and structural vulnerability and its distribution across the country.

An empirical approach based on European Macroseismic Scale – 1998 and developed at Bauhaus University Weimar, Germany, is used to assess the vulnerability of building stock at different levels of study, i.e., micro (Muzaffarabad City), meso (Northern Pakistan) and macro (whole Pakistan). The empirical method describes the seismic hazard in terms of macroseismic intensities and structural vulnerability in terms of vulnerability classes which is dependent upon building type, quality of materials, workmanship, level of earthquake resistant design etc.

A comprehensive literature review of the published casualty models has been conducted to identify the key contributing parameters and limitations of those published models. An estimation of casualties during the 2005 Kashmir earthquake is carried out using the casually rates from the published models. Later, a new vulnerability-based casualty model (VBCM) is developed and applied to the 2005 Kashmir earthquake.

Several damage scenarios have been developed in different parts of the study area to estimate the level of damage and loss in the selected scenarios which can be used by the decision makers to begin to draft mitigation policies and programs.

There has been a significant development in the recent years at the global level in this field of research. The two major initiatives are the USGS Prompt Assessment of Global Earthquakes for Response (PAGER) program and Global Earthquake Model (GEM). For the case of Pakistan, PAGER utilizes the published data of the present study to estimate building damage and risk in Pakistan. GEM is still in the initial stages, however, the methodology and goals of both PAGER and GEM are similar in nature to the present study. Therefore, it can be attributed that the work done is in conjunction with the recent demands and developments.

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