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Earthquake vulnerability assessment using GIS and high resolution satellite imagery

E. Nolte (1), F. Wenzel (2), B. Khazai (3)

(1, 2, 3) Institute of Geophysics, University of Karlsruhe, Germany

(1) Eike.Nolte@gpi.uni-karlsruhe.de

The Island of Java (Indonesia) was hit by a major earthquake on 27^{th} of May 2006.

According to the USGS the epicentre was located south of Yogyakarta City. The widespread damage and high number of casualties revealed the necessity of vulnerability assessment within this region. An area of 40 km^2 within the district of Bantul was chosen as the study area for an earthquake vulnerability assessment approach using GIS and remote sensing technology.

A vulnerability model was developed using the ArcGIS Modelbuilder (ESRI). This numeric assessment approach was based on expert knowledge and iterative adjustment of indices. According to their influence on the damage indices were assigned to the input parameters (so called layers). For example, the subsurface of the study area mainly consists of unconsolidated, volcanic sediments. Since the major damage has occurred in areas with such underground conditions, this lithological unit was assigned the highest index. The weighted parameters were divided into five thematic groups: environment, geology, topography and climate. These groups were assigned indices according to their importance among each other.

The next step in assessing the vulnerability was to calculate the susceptibility. Therefore each layer was multiplied with its index and afterwards all layers were summed up. The resulting values range from 0 (low) to 1 (high). In order to calculate the vulnerability different elements of risk were considered: landuse types, infrastructure and population density. The resulting vulnerability map clearly shows the major influence

of the subsurface on the vulnerability.

This modelling methodology will be complimented using a computing with words approach (Miles & Keefer 2007), including fuzzy logic tools implemented in ArcGIS. This model will consist of different rule blocks: “Indicator” rule blocks, which handle the weighting of the hazard descriptors, e.g. topology, geology using fuzzy logic and “Intensifier” rule blocks, which handle the interaction of potential hazard indicators and elements at risk. The use of natural language for the purpose of characterizing uncertainty is an advantage of this approach compared to the numeric approach illustrated above. The direct comparison of both approaches allows for identifying the critical points of the modelling methodology.

Both approaches illustrated above are based on input variables such as infrastructures and landuse types. A major problem is the actuality of the input data. In order to obtain up-to-date input data an object based classification approach is used to classify high resolution Quickbird images using the software Definies Developer 7. Input data such as trees, grass land and street network will be classified. Using pre- and post-disaster images allows for detecting changes and thus, damaged areas. In turn these areas will be used to validate the vulnerability models, assuming that the highest damaged area should be assigned the highest vulnerability.