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Tsunami damages assessment: vulnerability functions on buildings based on field and earth observation survey.

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The assessment of damages caused by tsunami scenarios on coastal buildings requires using vulnerability matrixes or functions to carry out a relation between the magnitude of the phenomena and the damage expected. These functions represent the probability for a building belonging to a class of vulnerability to suffer from a mean damage level.

The physical vulnerability of buildings depends on two parameters: the solicitation level applied by the tsunami on buildings and their resistance capacity. According to the authors after post-tsunami observations (Reese et al. 2007; Ruangrassamee et al. 2006; Leone et al. 2006; Peiris 2006), the level of damage is clearly linked to the water elevation of the inundated areas and the type of observed buildings. Very few works propose relations based on velocity or hydrodynamic pressure of the waves.

An approach developed for the estimation of the building vulnerability consists in deriving empirical damage functions starting from field observations. As part of the SCHEMA European Project on the vulnerability assessment for tsunami hazards in the Atlantic and Mediterranean area, vulnerability functions have been elaborated for different classes of buildings in order to produce vulnerability maps for exposed areas with emphasis on extraction of building characteristics using remote sensing data. The damage detection has been carried out by field data collected after the 24 December 2006 tsunami event on the southwest area of Banda Aceh (Sumatra, Thailand) completed by photo-interpretation of satellite images to get representative functions with large population of samples. The building classes consist in several categories depending mainly on the type of construction material (timber/bamboo, traditional brick, reinforced concrete . . .), the type of structure (beam, pillars, etc) and the number of storeys. The level of damage has been also classified in five categories, from D0 (no damage) to D5 (total destruction). Vulnerability functions have been established then for four classes of buildings. For some classes of buildings (the strongest, engineered, in reinforces concrete) there is not enough field observations to build damage functions.

Resulting matrixes allow the cartographic representation of expected damage according to inundation depths and types of buildings. As expected, they show that the damage levels relative to the water elevation are linked to the resistance capacity of each building class considered in this study. But divergence exists between the shape of the expected curves and the curves obtained. Indeed, secondary factors affecting the buildings are responsible of the damage level increase before or during the tsunami: prior impact of the earthquake occurred before the tsunami and of impact of debris and floating objects during the wave passing. Other characteristics such as foundation types, type of surrounding soils, proximity to shore lines, cannot be easily extracted unless detailed site and building studies. For some of them it is simply impossible. Some of the factors can however be mapped as local additional vulnerability criteria but cannot be integrated to damage functions.

Furthermore the dispersion between the distribution of field observations and interpreted data underlines the limits of the interpretation of satellite image for the damage detection in this type of study. These difficulties raise the importance of carrying out post-tsunami field observations to feed the knowledge of phenomena in the aim of more efficient risk assessment. The final target is to develop generic rules and tools to apply the damages functions to European coastal zones and produce damages scenario which could be exploited either by civil protection for their relief actions after a disaster or by coastal zone planners to adapt land use of exposed coast or at least to take in consideration tsunami hazard for the development of coastal zones.