Probabilistic seismic risk assessment of buildings in Thailand based on proper orthogonal decomposition

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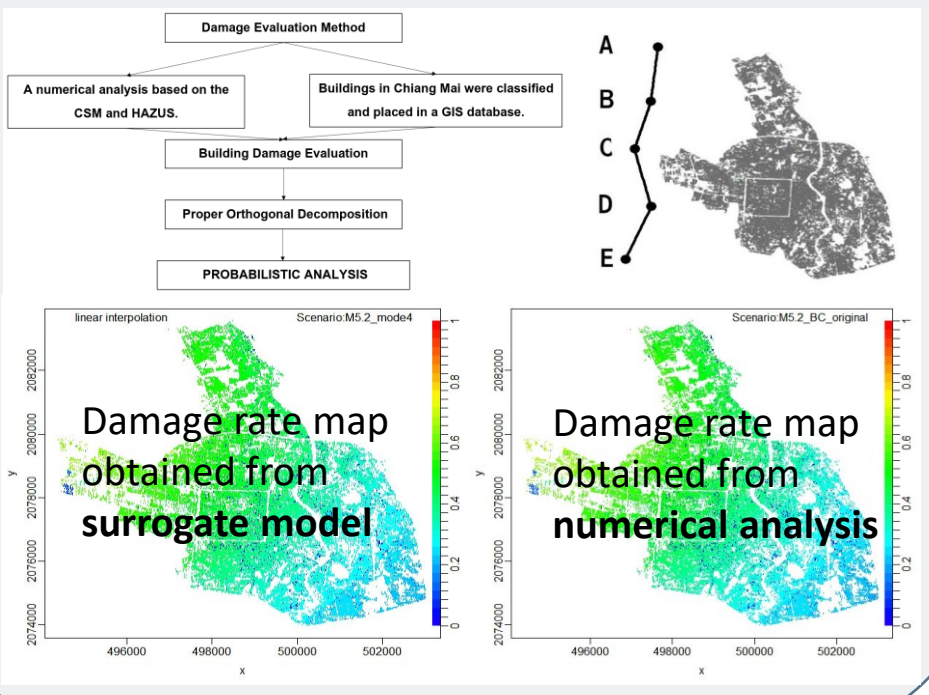
Background & Objective

Chiang Mai is the largest province in Northern Thailand. During the last decade, Chiang Mai has rapidly developed with increasing population and infrastructures. The number of the earthquake has been increasing and the 2006 Mae Rim earthquakes with a magnitude 4.6 have triggered awareness of local people in Chiang Mai. The epicenter of both events was not located in a populated area. However, this is a warning that the Chiang Mai municipality should be considered as a seismic risk area in which there are few secondary faults near urban areas. In this study, Proper Orthogonal Decomposition (POD) is used to simulate the spatial distribution of building damage rates in parts of Chiang Mai city. A POD-based surrogate model was obtained from the results of a series of numerical simulations, and probabilistic analysis was performed using the surrogate model.

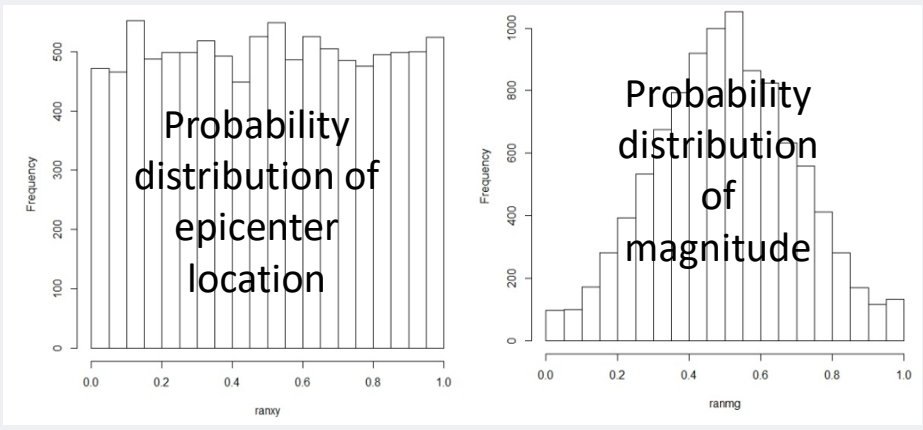
Methodology

A numerical analysis based on the Capacity Spectrum Method and HAZUS methodology is employed to evaluate the seismic damage of buildings. POD is applied to the numerical analysis results of the building damage rate in parts of Chiang Mai to obtain eigenmodes representing data features. Surrogate models are represented by linear combinations of the eigenmodes. Monte Carlo Simulations were then performed using information about surrogate models and parameter variations (magnitude and epicenter), and probabilistic destruction results can be obtained.

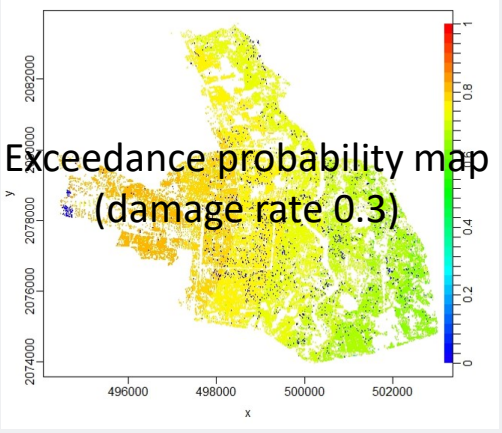


Probabilistic Analysis

The normal distribution and the uniform distribution were employed for the distribution function of the magnitude and epicenter.



By setting a threshold for the damage rate, the probability of exceeding can be calculated for each building, and the risk assessment can be performed as a spatial distribution of excess probability. As the distance from the epicenter increases, the possibility of damage tends to decrease.



Conclusion

The proposed framework provides an efficient probabilistic risk approach based on numerical simulations. This method can calculate the destruction rate of a building at any magnitude and epicenter with the same accuracy as numerical analysis. According to the results obtained by this research, it can be concluded that this is an effective seismic probability risk analysis method based on numerical simulation, and has high potential for disaster risk assessment.