Earthquake Damage Prediction in Different Earthquake Parameter and Liquefaction Effect for Banda Aceh City, Indonesia

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The city of Banda Aceh is particularly vulnerable to earthquakes due to its geography and location. A study of possible earthquake scenarios, and their effects on people and buildings, can provide precious insights to city officials and support disaster mitigation and preparedness plans.

New housing in Ule Lheu, Banda Aceh, Indonesia, part of a World Bank reconstruction effort following the 2004 Asian tsunami. Photo: Abbie Trayler-Smith / Panos Pictures / Department for International Development (DFID)

Objectives

The study aimed at predicting the effects of an earthquake in the city of Banda Aceh, estimating casualties, injuries and damage ratio as well as distribution according to earthquake intensity and time of the day.

Approach

Tectonic and geological datasets were collected and processed with GIS software to generate intensity maps for different earthquake scenarios. Geo-electrical data was acquired and analyzed to determine groundwater levels, which affect soil liquefaction. An inventory of over 62,000 buildings was carried out, dividing the buildings in four categories with different fragility rates. The datasets were combined and analyzed to estimate the percentage of damages and injuries based on predicted building occupancy.

Results Overview

The study developed four models – three earthquakes generated from the Aceh segment of the Great Sumatran Fault (M_w 7, M_w 6.5, and M_w 6) and one from the Seulimuem segment (M_w 6.5). The analysis produced a map of building damages for each scenario. The study showed that the strongest earthquake from the Aceh segment would damage 47-75% of the town's buildings and injure 5 to 26% of the population in almost all of the town's sub districts during day time, and 22% of the population during night time (over 57,700 people).

Conclusion

The study produced maps showing the vulnerability of Banda Aceh subdistricts to earthquakes, and an estimate of damages and injuries that different intensity earthquakes would cause. The findings were presented to local government and non-governmental organizations' representatives during a seminar in September 2017.

City officials confirmed that the study provides key knowledge that can support preparedness plans, including targeted building restoration and the development of earthquake simulation programs.

The journey continues...

Ibnu Rusydy is furthering knowledge in earthquake vulnerability in Indonesia. He presented his findings at the 7th International Symposium on Earth-Hazard and Disaster Mitigation in West Java, Indonesia in November 2017 and published a paper focusing on Banda Aceh's Kuta Alam subdistrict (AIP Conference Proceedings, July 2018). He has also published two papers on the research he undertook during his fellowship exchange with the University of the Philippines, estimating building vulnerability and human loss at the University's Los Baños campus in different earthquake scenarios (Philippines Journal of Science, June 2018 and IOP Conference Series, 2017).

Ibnu Rusydy works at Syiah Kuala University, Indonesia as a researcher at the Tsunami and Disaster Mitigation Research Center and as a lecturer at the Geological Engineering Department. He holds a Bachelor's degree in Geophysics from Syiah Kuala University and a Master's degree (MSc) in Engineering Geology from the National University of Malaysia (Universiti Kebangsaan Malaysia – UKM). In the past five years he has published more than 20 scientific papers and created a website to disseminate disaster knowledge.