SOUTH AFRICA

Mitigation of Earthquake Risk in Sub-Saharan Africa

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Sub-Saharan Africa is largely a stable intra-plate region characterized by a relatively low level of seismic activity, with earthquakes randomly distributed in space and time. The only parts that do not display the characteristics of an intra-plate region are the East African Rift System and the Cameroon Volcanic Line, where earthquakes are associated with active fault zones and volcanic activity, respectively. The results of a recent USAID-funded project to gain knowledge and build capacity to mitigate seismic risk in regions affected by the East African Rift System are presented.

Damaging earthquakes with M>6 occur almost annually in the East African Rift. Five M>7 earthquakes have occurred in eastern Africa since 1900, the largest known event being the 13 December 1910 Ms7.4 Rukwa (Tanzania) event that badly cracked all European-style houses in towns on the eastern shore of Lake Tanganyika. In the 21st century there have been several events that have caused loss of life. For example, on 3 February 2008 an Mw5.9 earthquake struck the Lac Kivu region of the DRC and Rwanda. While these events caused relatively small losses, the populations has increased enormously over the last century and urbanized. Building methods have changed from wattle and daub or timber with grass roofs, which have a large inherent resistance to earthquake shaking, to European-style unreinforced masonry constructions, which are far more vulnerable to shaking. The occurrence of similar events close to a town would likely cause serious human and economic losses. Hence Africans cannot be complacent: a damaging earthquake could occur anywhere in Africa, although the frequency is greatest in tectonically active regions such as North Africa and the East African Rift System.

The most recent probabilistic seismic hazard assessment (PSHA) covering Africa was published by the Global Seismic Hazard Assessment Program

(GSHAP) based on a catalogue that extended to 1996. We sought to extend the GSHAP catalogue and improve the PSHA map using Gobal Earthquake Model (GEM) tools and products and data from temporary deployments of seismic networks

Probabilistic Seismic Hazard Assessment (PSHA) computations were performed using the OpenQuake-engine (Ver. 2.0). The investigation area consists of a mesh of 79,109 sites spaced at approximately 10 km. For each site of the mesh, free rock conditions were assumed, with a fixed 30-metre averaged shear-wave velocity (Vs30) reference of 600 m/s. Target ground motion intensity for calculation were 5% damped response spectral acceleration (in g), estimated for probabilities of exceeding (PoE) of 10% and 2% within an investigation time of 50 years. This corresponds to return periods of about 475 and 2,475 years, respectively. Spectral acceleration was computed at PGA and for the response spectral periods of 0.05, 0.1, 0.2, 0.5, 1 and 2 s.

The SSA-PSHA model is generally consistent with the previous regional model from the GSHAP project, but with some noticeable differences. For example, the biggest difference is found in the south Sudan cluster (Juba region), where a difference in acceleration of about 0.08 g is observed. This is likely due to the differences in the strategies used to model area sources. The major issue affecting the SSA model is the shortage of strong-motion recordings within a sufficient distance to be used for selection and validation of existing ground motion prediction models. Improvements are also possible in the design of the logic tree structure. For example, M_{max} is the only source model parameter whose epistemic uncertainty was taken into account; uncertainties in b-value and occurrence rates were neglected.

The mitigation of earthquake risk in Africa requires coordinated action on several fronts. Firstly, seismic hazard assessments should be improved by maintaining and expanding seismic monitoring networks and mapping active faults. Secondly, building codes should be formulated and enforced, and vulnerable buildings and infrastructure reinforced to prevent serious damage in a minor quake or collapse when exposed to severe shaking. Thirdly, emergency first responders and disaster management agencies should be equipped and trained to act effectively during an earthquake and to deal with the aftermath.