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Surface topography effects on seismic ground motion and correlation with earthquake-induced landslide: An example of the JiuJiu peaks in 1999 Chi-Chi Taiwan earthquake

Chun-Te Chen, Shiann-Jong Lee, and Yu-Chang Chan
Institute of Earth Sciences, Academia Sinica, Nangang,Taipei, Taiwan (pokayoke69@gmail.com)

The topography effect has been thriving investigated based on numerical modeling. It impacts the seismic ground shaking, usually amplifying the amplitude of shaking at top hills or ridges and de-amplifying at valleys. However, the correlation between the earthquake-induced landslide and the topographic amplification is relatively unexplored. To investigate the amplification of seismic response on the surface topography and the role in the Chi-Chi earthquake-induced landslide in the JiuJiu peaks area, we perform a 3D ground motion simulation in the JiuJiu peaks area of Taiwan based on the spectral element method. The Lidar-derived 20m resolution Digital Elevation Model (DEM) data was applied to build a mesh model with realistic terrain relief. To this end, in a steep topography area like the JiuJiu peaks, the designed thin buffer layers are applied to dampen the mesh distortion. The three doubling mesh layers near the surface accommodate a more excellent mesh model. Our results show the higher amplification of PGA on the tops and ridges of JiuJiu peaks than surrounding mountains, while the de-amplification mostly occurs near the valley and hillside. The relief topography could have a ±50% variation in PGA amplification for compression wave, and have much more variety in PGA amplification for shear wave, which could be in the range between -50% and +100%. We also demonstrate that the high percentages of the landslide distribution right after the large earthquake are located in the topographic amplified zone. The source frequency content interacts with the topographic feature, in general, small-scale topography amplifies the higher-frequency seismic waves. It is worthy of further investigating the interaction between the realistic topography and the velocity structure on how to impact the seismic response in the different frequency bands. We suggest that the topographic seismic amplification should be taking into account in seismic hazard assessment and landslide evaluation.