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Site effects on Gros Morne Hill, Port-au-Prince, Haïti

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After the M = 7.0 Haiti earthquake in 2010, many teams completed seismic risk studies in Port-au-Prince to better understand why this not extraordinarily strong event had induced one of the most severe earthquake disasters in history (at least in the Western World). Most highlighted the low construction quality as the main cause for the disaster, but some also pointed to possible soil and topographic amplification effects, especially in the lower and central parts of Port-au-Prince (e.g., close to the harbor). Therefore, we completed a detailed site effect study for Gros-Morne hill located in the district of Pétion-Ville, southeast of Port-au-Prince by using near surface geophysical methods. The horizontal to vertical spectral ratio technique was applied to ambient vibrations and earthquake data, and multichannel analysis of surface waves and P-wave refraction tomography calculation were applied to seismic data. Standard spectral ratios were computed for the S-wave windows of the earthquake data recorded by a small temporary seismic network. Electrical resistivity tomography profiles were also performed in order to image the structure of the subsurface and detect the presence of water.

Different site effect components are represented for the entire survey area; we present maps of shear wave velocity variations, of changing fundamental resonance frequencies, and of related estimates of soft soil/rock thickness, of peak spectral amplitudes and of ambient ground motion polarization. Results have also been compiled within a 3D surface-subsurface model of the hill that helps visualize the geological characteristics of the area, which are relevant for site effect analyses. From the 3D geomodel we extracted one 2D geological section along the short-axis of the hill, crossing it near the location of the Hotel Montana on top of the hill, which had been destroyed during the earthquake and has now been rebuilt. This cross-section was used for dynamic numerical modelling of seismic ground motion and for related site amplification calculation. The numerical results are compared with the site amplification characteristics that had been estimated from the ambient vibration measurements and the earthquake recordings. Related results only partly confirm the strong seismic amplification effects highlighted by previous papers for this hill site, which had been explained by the effects of the local topographic and soil characteristics.