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Modelling Sediment Thickness for Site-Effect Characterisation using H/V Spectral Ratio Analysis and Electrical Resistivity Tomography

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The H/V Spectral Ratio (HVSR) analysis of ambient seismic noise has been widely used to estimate the fundamental site resonance frequency in the context of site-effect characterisation. In regions of unknown subsurface structure, in which there is a significant acoustic impedance contrast between sediments and the underlying bedrock, HVSR can be a very powerful tool to map bedrock morphology and sediment thickness. Calibrating the power-law relationship between the variation in fundamental frequency and sediment thickness around these unknown sites is crucial for sediment thickness mapping. This empirical relationship can be easily calculated by conducting HVSR analysis of ambient noise measurements above boreholes with known bedrock depth. Additional local H/V measurements above near-surface geophysical profiles, for instance created by Electrical Resistivity Tomography (ERT), allow training and improving the power-law relationship for sites with a shallow bedrock depth. As the compaction of sediments influences the Vs, one has however to take into account that this empirical relationship can only be applied in relative small areas with a similar local geology.

Between 2008 and 2010, a seismic swarm (M_{Lmax} = 3.2) occurred in a hilly area, 20 km SE of Brussels (Belgium). 60 of the 300 recorded events were felt/heard by the local residents and were reported in the corresponding '*Did You Feel It'* internet inquiries held by Royal Observatory of Belgium. Several low-magnitude events show a distinct macroseismic intensity variation that can be explained by the geological site effect, i.e. the local sediment thickness, affecting the human perception of these earthquake-induced ground motions. In this presentation, we apply the above described methodology and discuss the results of a geophysical survey including ERT-profiling, ambient noise recording, HVSR analysis in Geopsy and DEM-modelling to characterise the local site effects. The resulting sediment thickness model (between 0 m and 80 m) allows us to demonstrate that the highest macroseismic intensities are reported by respondents living on eroded valley flanks above shallow bedrock, whereas lower macroseismic intensities are reported on hill sites where respondents live on a thicker sedimentary pile.

This site-effect characterisation shows that the lower macroseismic intensities of felt events on hill tops can only be explained by the absorption of high frequency seismic energy radiated by the local source if a considerable thickness of the local sediment column is present.