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Continuous H/V spectral ratio analysis of ambient noise: a necessity to understand microzonation results obtained by mobile stations

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Estimating the resonance frequency (f_0) and amplification factor of unconsolidated sediments by H/V spectral ratio (HVSR) analysis of seismic ambient noise has been widely used since Nakamura's proposal in 1989. To measure f_0 properly, Nakamura suggested to perform microzonation surveys at night when the artificial microtremor is small and does not fully disrupt the ambient seismic noise. As nightly fieldwork is not always a reasonable demand, we propose an alternative workflow of Nakamura's technique to improve the quality of HVSR results obtained by ambient noise measurements of mobile stations during the day. This new workflow includes the automated H/V calculation of continuous seismic data of a stationary or permanent station installed near the microzonation site for as long as the survey lasts in order to control the error in the HVSR analysis obtained by the mobile stations.

In this presentation, we apply this workflow on one year of seismic data at two different case studies; i.e. a rural site with a shallow bedrock depth of 30 m and an urban site (Brussels, capital of Belgium, bedrock depth of 110 m) where human activity is continuous 24h/day. By means of an automated python script, the fundamental peak frequency and the H/V amplitude are automatically picked from H/V spectra that are calculated from 50% overlapping, 30 minute windows during the whole year. Afterwards, the f_0 and amplitude picks are averaged per hour/per day for the whole year. In both case studies, the H/V amplitude and the fundamental frequencies range considerable, up to $\sim$15% difference between the daily and nightly measurements. As bedrock depth is known from boreholes at both sites, we concluded that the nightly picked f_0 is the true one. Our results thus suggest that changes in the determined f_0 and H/V amplitude are dominantly caused by the human behaviour which is stored in the ambient seismic noise (e.g. later onset of traffic in a weekend, quiet Sundays, differences between daily/nightly activity,...). Consequently, performing a continuous HVSR analysis next to your microzonation site allows you to characterise the deviation of the measured f_0 to the true f_0 during the period of investigation (in our case during the whole year)! As mobile stations are affected by the same variation stored in the ambient noise, then a correction factor can be applied on the calculated f_0 of individual measurements during the microzonation survey and a proper Vs can be estimated.

Based on these results we recommend that microzonation with mobile stations should always be accompanied by a stationary seismic station to characterise the ambient noise and to control the error.