

Statistical investigation of site effects with emphasis on sedimentary basins, using earthquake and ambient noise recordings

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During the last two decades, three empirical methods for assessing site effects have been widely used: the Standard Spectral Ratio (SSR), the Horizontal-to-Vertical Spectral Ratio from earthquake recordings (HVSER) and the Horizontal-to-Vertical Spectral Ratio from ambient noise recordings (HVN). The SSR is considered the reference empirical method to detect amplification as a function of frequency, while the HVSER and the HVN realistically indicate fundamental frequency but, for the majority of the worldwide examined sites, they cannot give reliable amplification curves as a function of frequency. Given the fact that HVSER and especially HVN can be easily obtained, it is challenging to search for any correlation with SSR amplification functions.

We used recordings from 168 sites worldwide, for which all three types of spectral ratios were homogeneously processed (Haghshenas et al., *Bull. Earthquake Eng.* 2008). On this data set we applied standard multivariate statistical analyses, namely, factor analysis and canonical correlation, to investigate and quantify -where it is possible- any correlation between spectral ratios for a certain number of the examined frequency bins. Results show that the correlation between HVN and HVSER is very good. Moreover, their correlation with broad band SSR can be statistically quantified and receive a satisfactory physical explanation.

In addition, we looked for the correlation of SSR, HVSER and HVN collected in sedimentary basins (a subset of the previous database) with geometrical and geophysical parameters. These attempts were constrained by the limited amount of reliable in-situ data. Among many, we select 5 parameters: Vs30, Hb, Vs_average/Hb, Hb/W_valley, Hb/W_edge (where Hb is the bedrock's depth below the station; Vs_average is the average Vs from surface to bedrock; W_valley is 2D-width of the valley; W_edge is the distance from the closest valley's edge). The analysis assesses that larger are the first 4 parameters, larger is the low-frequency amplification in HVSER and HVN, and lower the high-frequency contribution.

Although additional data would improve our statistical investigation and better establish quantitative correlation between spectral ratios and geophysical or/and geometrical characteristics of sedimentary basins, our results clearly show that statistical correlation between SSR and HVN-HVSER is present and modulated in specific frequency domains.

This study has been performed in the framework of the ToK ITSAK-GR EC project (2006-2010).