The Stability of H/V Spectral Ratios from Noise Measurements in Armutlu Peninsula (Turkey)

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Abstract. The horizontal to vertical spectral ratio (H/V) method has been successfully using in order to estimate the fundamental resonance frequency of the sedimentary cover, its thickness and amplification factor since at least 3 decades. There are numerous studies have been carried out on the stability of the H/V spectral ratios. Almost all studies showed that fundamental frequency is stable even measurements are repeated at different times. From this point of view, the results will show us an approach whether the stations are suitable for accurate estimate of earthquake studies and engineering purposes or not. Also we want to see if any effects of the amplification factor changing on the seismograms for Armutlu Seismic Network (ARNET) even though seismic stations are established far away from cultural noise and located on hard rock sites. It has been selected one hour recorded data of all stations during the most stationary times. The amplification and resonant frequency variations of H/V ratio were calculated to investigate temporal stability in time. There is a total harmony in fundamental frequencies values and H/V spectral ratio values in time-lagged periods. Some stations shows secondary minor peaks in high frequency band due to a shallow formation effect or cultural noises around. In the east side of the area ILYS station shows amplitude peak in lower fundamental frequency band from expected. This could compose a high amplification in lower frequencies and so that yield less reliable results in local earthquakes studies. By the experimental results from ambient noise analysis, it could be worked up for relocation of one station.

1.Introduction

The Armutlu Peninsula which is located in the eastern Marmara region of Turkey has known with active seismic activity. The area has been faced with moderate to large earthquakes in several times in their history. Knowing active fault zones and microearthquake activity is crucial for seismic hazard analysis. Also, knowing correct magnitude information is also very important to evaluate probabilistic seismic hazard studies and magnitude information is obtained by amplitude of seismic waves. So, amplification factor in different frequencies become important. Parolai et al., (2004) observed that the amplification factor could vary and recommended repeated measurements before using the results for engineering purposes.

From this point of view, we want to analysis find to see the stability of H/V spectral ratios and also want to see if any effects of the amplification factor changing on the seismograms for the ARNET seismic network which includes 28 3-C stations (Tunç et al., 2011) operated by Kocaeli Univesity and Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ, even though seismic stations are established far away from cultural noise

and located on hard rock sites. In case of any unstability in the amplification factor, it is likely to affect the seismic records in different frequencies.

Ambient noise recordings within the different time period of 2015's and in the past years, one our recorded stationary data were watched over to select in midnigt. The region shows lots of micro seismic events therefore the micro seismic events were eliminated when it was detected. The collected data yields us to investigate temporal stability of the peak in H/V curves and the fundamental frequency.

2. Method and Stability of H/V Peaks

The H/V ratio technique (Nogoshi and Igarashi,1970, 1971; Nakamura, 1989) has been widely studied. These studies reveals that when a significant impedance contrast between the sediments and the bedrock exists, the peak in H/V ratio can be used for estimating the fundamental resonance frequency of a site (S.Parolai et all,2004).
Data were recorded at stations using CMG-40T sensors (flat velocity response between 0,03 and 50 Hz) and another sensor types. Figure 1 shows the map of study area and stations.

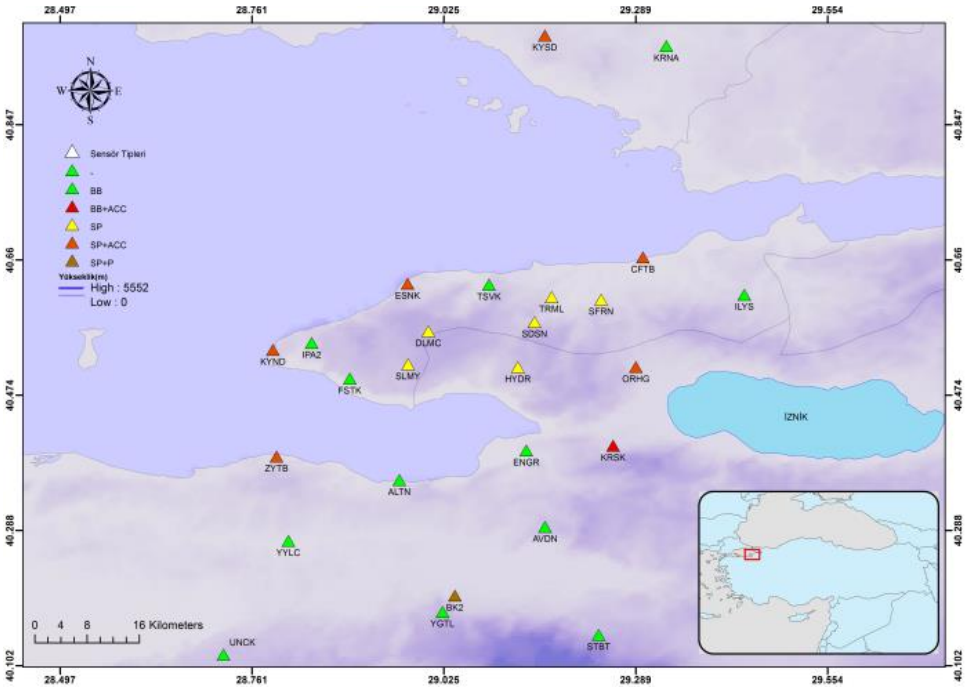

Figure 1. Map of study area and the location of investigated stations

At per station the signals were recorded with sample rate of 0,01 s for one hour.). Data processing for each station follows as; ambient noise recordings were divided into 25 s length window. Each component was filtered with butterworth bandpass filter (0.1-20 Hz) with the order of two. In some stations filtering process was carried out between the frequency of 1 and 20 Hz because of scattering to low frequencies of amplitudes due to station's conditions. The fourier spectrum were then smoothed using Konno&Ohmachi function with the constant number of 40.In order to figure out the stability of the peak in H/V curve, the parameters and its standard deviation has been calculated every other month around midnight.

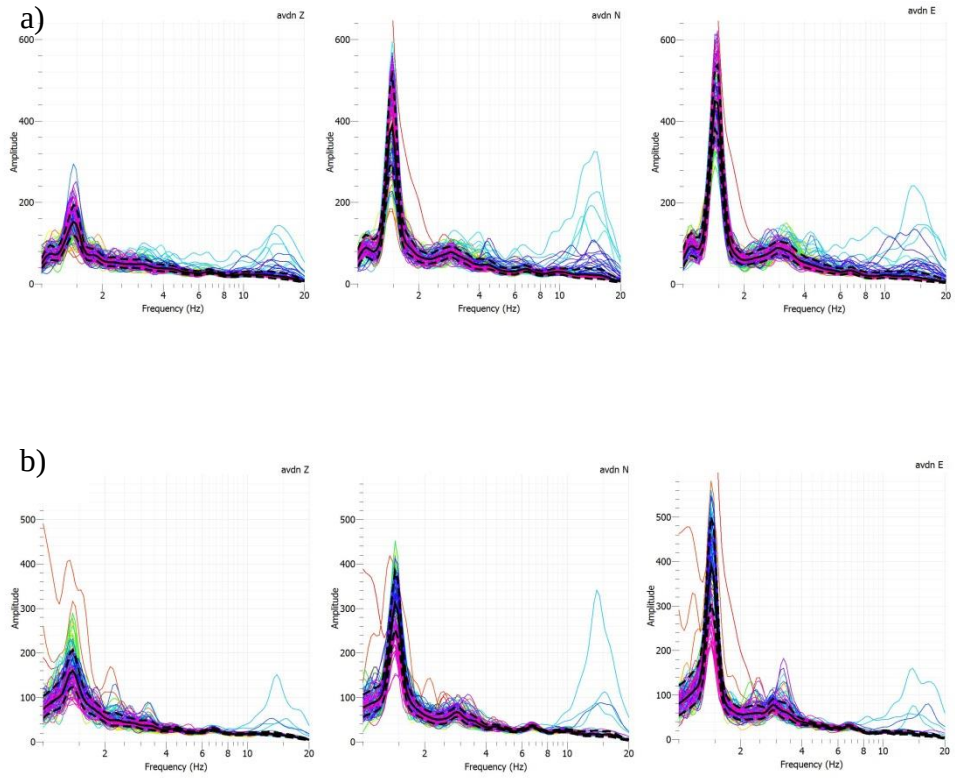

Figure 2. Amplitude spectrum of each component in AVDN station with the time lag of a full month (a: in September 2015, b: in October 2015)

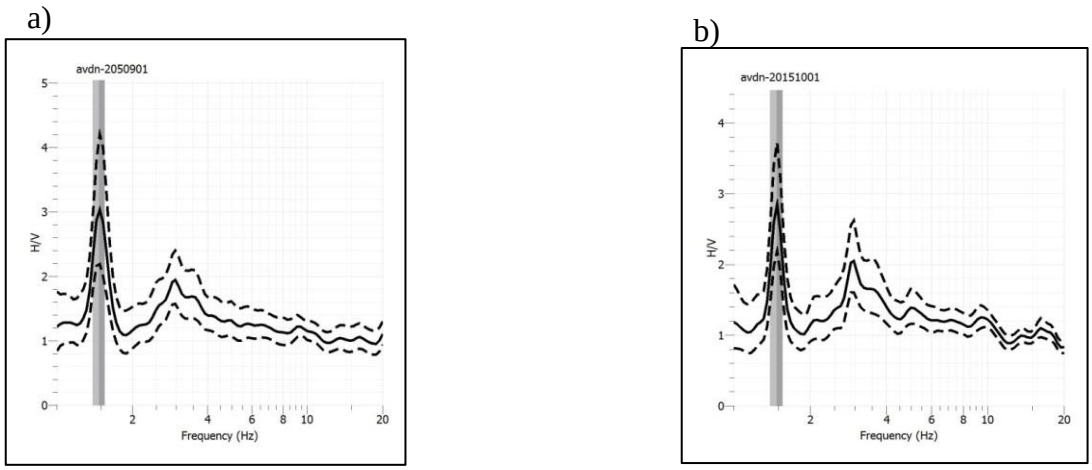

Figure 3. H/V ratio of AVDN station with the time lag of a full month (a): in September 2015, b): in October 2015)

3. Discussion and Conclusion

The notable number of ambient noise recording was analyzed in the study area. The data set gives an opportunity to investigate the stability of frequency and amplitude of peaks in the H/V spectral ratio. In all stations the frequency of the peaks is clear, reliable and stable although there has been estimated in different times (Figure 2 and 3) Observed level of amplitude in the peak of H/V ratio is fairly close together so that it could be useful when compared with different methods for engineering purposes. Generally, there is a good compatibility in the shape of H/V curves. Some significant properties also were detected in some stations. One station shows peak in low frequency range (under 1 Hz). Other four stations show clear peaks in high frequency (above 1 Hz). The station (ILYS) which shows lower fundamental resonant frequency could be relocated and transfer to a more isolated and a bedrock place.

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