Seismic noise analysis of broadband stations of the Italian Seismic Network by Power Spectral Density

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The Italian Seismic Network (IV) consists of more than 500 stations located throughout the Italian territory.

The detection capability of the network is constrained by its location performance that is affected by the seismic noise levels variations depending on the characteristics of the dominant source. Discriminating the noise level in each station may allow to improve in its performance, in order to reduce noisy stations to detect even the smaller energetic seismic events sometimes hidden by high noise values. The main goal of this research has been to establish the characteristics (frequency content) and origin of seismic noise background at these sites and secondly to assess the effects of performance of the network.

For this purpose we have estimated the Power Spectral Density (PSD) of seismic noise selecting only a subset of 233 stations equipped with broadband velocimeters (with minimum period of 40 seconds and with a high sensitivity until to 120s) and operating at least three consecutive years of available data (2015-2017).

The variations of seismic background noise have been investigated using also the relative Probability Density Function (PDF). The data processing of signals carried out with the robust method proposed by McNamara and Buland, (2004). In this study, the analysis was limited in the frequency band from 0.025 to 30 Hz, in accordance with the seismic sensors bandwidth. Four different frequency bands have been identified: 0.025-0.12, 0.12-1.2, 1.2-10 and 10-30 Hz. Each of these has been associated to a main type of source, in agreement with the literature.

A preliminary data analysis has been carried out to understand the statistical properties of the noise power, in the four class identified, both in space and frequency domains. Extracting the PDFs all stations, it was produced a representative seismic noise model that it could be considered as a new reference noise for Italian territory. Histograms have been computed for each band, both for vertical and horizontal components and its ratio. In addition, a spatial-statistical analysis was performed showing a good correlation of noise level with some weather conditions and anthropogenic source. Several clustering techniques were applied to the data to identified group of stations with similar PSD level, attributable to the same noise source.
Furthermore, a correlation between the noise found at the different stations and spatial data (maps of rainfall, winds, coastlines, etc...) was carried out for a better characterization of the type of source.