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Analysis of seismic noise cross-correlation in urban area: the test site of Benevento city (Southern Italy)

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The city of Benevento is located in the Sannio region (Southern Italy), one of the italian areas with highest seismic hazard. It has been struck by several destructive historical earthquakes, the strongest of which occurred in 1456, 1688, 1805 with associated MCS intensity (Is) up to X–XI. Recently a moderate magnitude 6.1 earthquake occurred on 1962, and at present the region is interested by low energy swarms and sparse events (M<3.7). For its high seismic potential and historical heritage, this area has been the subject of several studies addressed to define the shallow geological structure and local site effects. In the last decade the use of passive methods based on ambient noise analysis has become appealing in reconstructing the properties of the propagation medium by ambient noise measurements, without the use of localized natural or artificial sources. Hence, passive methods can be used as a cheap alternative to active methods even in regions characterized by a low seismicity rate.

We installed a temporary seismic network in the urban area of Benevento in order to study the subsoil properties of the city using the seismic noise continuously acquired by stations. We used sixteen seismic stations (Quanterra Q330 and Nanometrics Centaur as digitizers connected to Le3d-5s and Trillium Compact 120s velocimeters, respectively) recording ambient noise for about 1 month. Inter-stations Green's functions were reconstructed by the cross-correlation of continuous ambient noise data recorded from the sixteen seismic stations deployed in the city. The aim of cross-correlation analysis is to extract surface waves from Green's functions (GFs) for investigating the dispersive response of the structure. In this regard, we used the beamforming analysis to test the hypothesis of isotropy distribution of noise sources, which is necessary for the cross-correlation theorem. Particle motion analysis confirmed the presence of surface Rayleigh waves in the GFs. We analyzed the temporal stability of the cross-correlated signals and the results show that 12 days of continuous measurements are sufficient to stabilize the surface waves signal extracted from the GFs. The phase velocity dispersion curves are computed for the 120 stations pairs through the use of a far-field representation of the surface wave GFs and an image transformation technique. The used strategy provides robust phase velocity dispersion curves that vary approximately from 1.4 km/s at 0.7 Hz to 0.6 km/s at 5 Hz. Six different couples, with stations pairs on the same geological unit, were selected for a inversion of phase velocity dispersion aimed to a construction of 1D shear wave velocity (Vs) profiles (up to a maximum depth of about 500 m).