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Developments in ambient noise analysis for the characterization of dynamic response of slopes to seismic shaking

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In the last few decades, we have witnessed a growing awareness of the role of site dynamic response to seismic shaking in slope failures during earthquakes. Considering the time and costs involved in acquiring accelerometer data on landslide prone slopes, the analysis of ambient noise offers a profitable investigative alternative. Standard procedures of ambient noise analysis, according to the technique known as HVNR or Nakamura's method, were originally devised to interpret data under simple site conditions similar to 1D layering (flat horizontal layering infinitely extended). In such cases, conditions of site amplification, characterized by a strong impedance contrast between a soft surface layer and a stiff bedrock, result in a single pronounced isotropic maximum of spectral ratios between horizontal and vertical component of ambient noise. However, previous studies have shown that the dynamic response of slopes affected by landslides is rather complex, being characterized by multiple resonance peaks with directional variability, thus, the use of standard techniques can encounter difficulties in providing reliable information. A new approach of data analysis has recently been proposed to exploit the potential of information content of Rayleigh waves present in ambient noise, with regard to the identification of frequency and orientation of directional resonance. By exploiting ground motion ellipticity this approach can also provide information on vertical distribution of S-wave velocity, which controls site amplification factors. The method, based on the identification of Rayleigh wave packets from instantaneous polarization properties of ambient noise, was first tested using synthetic signals in order to optimize the data processing system. Then the improved processing scheme is adopted to re-process and re-interpret the ambient noise data acquired on landslide prone slopes around Caramanico Terme (central Italy), at sites monitored also with accelerometer stations. The comparison of ambient noise analysis results with the outcomes of accelerometer monitoring reveals potential and limits of the new method for the investigations on slope dynamic response.