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Spatial and temporal variability of seismic noise records on landslide-prone slopes

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The assessment of the influence of slope dynamic response on earthquake landslide triggering is hampered by the scarcity of accelerometric data acquired on slopes prone to seismic failures. Previous studies showed that the spectral analysis of 3-component recordings of seismic noise can represent a promising tool for the characterisation of slope dynamic response. In this case the main method of analysis is based on the calculation of horizontal-to-vertical spectral ratios of noise recordings (HVNR). However, this method was originally designed to investigate properties of litostratigraphic amplification of sites with simple setting as approximated by 1D layering; thus its application to hillslope sites affected by 2D-3D and anisotropic amplification effects requires further tests to verify which properties of seismic response can be reliably obtained. For a fruitful interpretation of seismic noise recordings the main problems that needs to be addressed are i) the extension of analysis to frequencies below 1 Hz and ii) the temporal consistency and spatial resolution of noise recordings.
The extension of analysis from microtremor frequencies (>1 Hz), mainly of anthropic origin, to microseismic frequencies (< 1Hz) of natural origin is desirable, in that lower frequencies can be more relevant for triggering of large landslides. However the reliability of the results of low frequency noise analysis strongly depends on the adequate response of portable instruments at such frequencies and on the influence of changing environmental conditions. Regarding the problem of spatial-temporal variability of noise signal, we stress that directional properties of site response can be masked by polarisation properties of transient noise sources and that the spatial scale of geological and morphological features causing directivity is still unclear. Thus, the repeatability of noise analysis results, as well as their spatial resolution and representativeness need to be verified through comparisons of noise recordings suitably arranged in space and time.
With this motivation a series of tests of seismic noise recordings and analyses are in progress on landslide-prone slopes at Caramanico Terme, in central Italy, where the results of noise analysis can be compared with those derived from a long term accelerometric monitoring. In particular repeated noise recordings are carried out both at the same site and at different sites using simultaneously seismic sensors having different frequency response.
The first results indicate that directional properties of site response appear to characterise landslide prone slopes also at frequencies lower than 1 Hz, even though in this case ad hoc methods of analysis need to be used to reveal such effects. Furthermore, the tests of seismic noise recordings conducted at different times and with different sensors show that ground motion anisotropy due to site response directivity can be discriminated from that related to noise source polarisation by few repetitions of noise data acquisitions of proper duration.