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Characterisation of slope directional resonance by analysing ambient noise instantaneous polarisation

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Several studies have shown that the dynamic response of landslide prone slopes to seismic shaking can play an important role in failure triggering during earthquakes. It was also demonstrated that slope seismic response is often characterised by directional resonance phenomena. Directivity can be revealed by the analysis of ambient noise recordings according to a technique known as HVNR method based on the analysis of azimuthal variation of spectral ratios between the spectral amplitude of horizontal H and vertical V component of noise recording. Directional resonance is then revealed by the presence of a preferential polarisation of H/V ratio peaks, whose frequencies correspond to resonance frequencies and whose amplitudes depend on the impedance contrast between surface material and bedrock. H/V ratio amplitudes can potentially provide information also on amplification factors. However, the relation is not straightforward depending on the nature of the waves contributing to the ambient noise. Thus, it is desirable to distinguish different kinds of noise wave packets, possibly isolating the contribution of Rayleigh waves, which appear to better reflect site response properties. To identify Rayleigh wave packets in noise recording a new approach was tested, based on a technique of analysis of instantaneous polarisation. The results are promising for the investigation of site response directional properties, particularly in the case of complex site conditions, where resonance can be characterised by multiple anisotropic peaks. In our preliminary tests of noise recordings carried out at a site located on a slope affected by landslides, only a small fraction of data samples (in the order of 1 %) were identified as Rayleigh type waves: this was likely due the fact that the noise recording was dominated by an overlapping of signals with different kinds of polarisation. Thus, it was possible to recognise Rayleigh polarisation only when the energy of this kind of wave was prevalent. However, from a relatively short noise recording (in the order of 30-45 minutes) one can obtain a high number (in the order of thousands) of estimates of H/V amplitude and azimuth, providing a robust statistics to recognise ground vibration properties reflecting site response. The tests on sites where directional resonance properties had been verified through the analysis of seismic event recordings, showed that more coherent observations can be obtained for H/V ratios and directivity estimates by selecting Rayleigh type data samples, rather than analysing the entire data set or SH-type wave packets.This offers the possibility of reducing the uncertainties in data interpretation related to the influence of the nature of the noise wavefield.