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Soil depth mapping using seismic surface waves for the assessment of soil vulnerability to erosion.

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The purposes of the multidisciplinary DIGISOIL project are the integration and improvement of in situ and proximal technologies for the assessment of soil properties and soil degradation indicators. Foreseen developments concern sensor technologies, data processing and their integration to applications of (digital) soil mapping (DSM). Among available techniques, the seismic one is, in this study, particularly tested for characterising soil vulnerability to erosion.
The spectral analysis of surface waves (SASW) method is an in situ seismic technique used for evaluation of the stiffnesses (G) and associated depth in layered systems. The method is based on the propagation of mechanically induced Rayleigh waves. By striking the ground surface with a hammer, seismic waves are generated, including surface Rayleigh waves. During their propagation, they are recorded by seismic receivers (geophone sensors) regularly spaced along a profile to produce a seismogram. The particularity of Rayleigh waves lies in the dependence of their velocity with frequency, a phenomenon called dispersion. A profile of Rayleigh wave velocity versus frequency, i.e., the dispersion curve, is calculated from each recorded seismogram before to be inverted to obtain the vertical profile of shear waves velocity. Then, the soil stiffness can easily be calculated from the shear velocity if the material density is estimated, and the soil stiffness as a function of depth can be obtained. This last information can be a good indicator to identify the soil bedrock limit.
From a geometrical point of view, a SASW system adapted to soil characterisation is proposed in the DIGISOIL project. This system was tested for the digital mapping of the depth of loamy material in a catchment of the European loess belt. Parametric penetrometric studies are also conducted for the purpose of verifying the accuracy of the procedure and evaluating its limitations. The depth to bedrock determined by this procedure can then be combined with the soil erosion susceptibility to produce a risk map. This methodology will help to target conservation measures to the most threatened areas, i.e., areas that show a reduced soil depth associated with a high soil erosion susceptibility.