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Towards electrical resistivity soundings in eco-engineering: A non-invasive and fast method to model the near-subsurface characteristics on stabilized alpine slopes.

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The observation and monitoring of the aboveground plant development is a common practice in eco-engineering to estimate the plant's influence on the stabilization process. In contrast to this aboveground "sphere", the near subsurface is invisible and therefore difficult to address. To get an impression of the near subsurface and to model slope stability, (soil)samples are taken or a soil profile is dug and root traits (e.g., tensile strength) are determined. Other parameters as rooting depth, root length density, root clustering or the type of root in general are also of interest. However, soil samples or soil profiles only provide limited point-by-point data, alter parts of the study site, and are often time-consuming and expensive. The development of plants results a complex spatial and temporal distribution of the root network along a slope. This network causes shear strength variations and hydrological heterogeneities in the near subsurface within short distances. In contrast to the common point data, geophysical methods provide minimally-invasive, spatial and, via a time-lapse approach (monitoring), also temporal information of the near subsurface conditions. Hence, by measuring physical properties of the near subsurface, the root system, i.e. root distribution and rooting depth can be modeled. Furthermore, if a correlation between root traits and the measured physical properties is determined, the corresponding root trait can be estimated.

To test this approach we applied electrical resistivity tomography (ERT) in a subalpine catchment in the Prättigau valley/Eastern Swiss Alps. Different ERT-soundings were conducted using varying electrode spacings (5cm, 25cm, 50cm and 100cm), electrode arrays (Wenner and Wenner-Schlummberger) and locations (eco-engineered slopes, stabilized two, three and 17 years ago; two forest stands of different stand densities). Furthermore, we took soil samples along the electrical profiles, and dug out several soil profiles to evaluate our resulting near subsurface models and to determine soil physical properties (grain size, bulk density, aggregate stability) and root traits (root density). The results show, that modelling the near subsurface with ERT is possible, due to differences in the soil moisture content and its distribution. It is possible to estimate the rooting depth and the direction of root growth. ERT is a valuable method to model root spread belowground and provides a high potential in this field of application.