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Minimalistic models of the vertical distribution of roots under stochastic hydrological forcing

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The assessment of the vertical root profile can be useful for multiple purposes: the partition of water fluxes between evaporation and transpiration, the evaluation of root soil reinforcement for bioengineering applications, the influence of roots on biogeochemical and microbial processes in the soil, etc. In water-controlled ecosystems the shape of the root profile is mainly determined by the soil moisture availability at different depths. The long term soil water balance in the root zone can be assessed by modeling the stochastic incoming and outgoing water fluxes, influenced by the stochastic rainfall pulses and/or by the water table fluctuations.
Through an ecohydrological analysis one obtains that in water-controlled ecosystems the vertical root distribution is a decreasing function with depth, whose parameters depend on pedologic and climatic factors. The model can be extended to suitably account for the influence of the water table fluctuations, when the water table is shallow enough to exert an influence on root development, in which case the vertical root distribution tends to assume a non-monotonic form. In order to evaluate the validity of the ecohydrological estimation of the root profile we have tested it on a case study in the north of Tuscany (Italy). We have analyzed data from 17 landslide-prone sites: in each of these sites we have assessed the pedologic and climatic descriptors necessary to apply the model, and we have measured the mean rooting depth. The results show a quite good matching between observed and modeled mean root depths.
The merit of this minimalistic approach to the modeling of the vertical root distribution relies on the fact that it allows a quantitative estimation of the main features of the vertical root distribution without resorting to time- and money-demanding measuring surveys.