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Integrated use of soil physical and water isotope methods for ecohydrological characterization of desertified areas

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Measures for monitoring desertification and soil degradation require a thorough understanding of soil physical properties and of the water balance in order to guide restoration efforts (Costantini et al. 2009). It is hypothesized that long term restoration success on degraded land depends on a series of interacting factors such as exposition, soil type, soil hydrology including lateral flow on hill-slope catenae. Recently, new soil water isotope measurement techniques have been developed (Garvelmann et al. 2012) that provide much faster and reliable stable water isotope profiles in soils. This technique yield information on groundwater recharge, soil water balance and on the origin of water available for plants, which in combination with conservative chemical tracers (chloride) can be validated. A multidisciplinary study including ecologists, soil physicists and hydrologists of the COST Action Desert Restoration Hub was carried out on four semi-arid sites in Portugal. A comparative characterization of soil physical parameters, soil water isotope and chloride profiles was performed in order to estimate pedoclimate, soil aridity, soil water balance and groundwater recharge. In combination with soil physical data a comprehensive and cross-validated characterization of pedoclimate and soil aridity was obtained. These indicators were then integrated and related to plant cover. The long-term rainfall of the four sites ranges from 512 to 638 mm, whereas air temperature is from 15.8 to 17.0°C. The De Martonne index of aridity spans from 19.3 to 24.6, pointing to semiarid to moderately arid climatic conditions. The long-term average number of days when the first 0.50 m of soil is dry ranges from 110 to 134, while the mean annual soil temperature at 0.50 m spans from 15.8 and 19.1°C. The studied profiles show different hydrological characteristics, in particular, the estimated hydraulic conductivity ranges from 0.1-1 to 10-100 μm/s. Three out of four profiles show a marked decrease in water permeability at 0.04, 0.20, or 0.40 m depth. Soil isotope profiles indicated that percolation beneath the root zone and groundwater recharge ranges from 21.7 mm/y to 29.7 mm/y. The recharge rate was positively related to mean annual rainfall and soil organic matter, and interestingly, increased with aridity and desertification. The difference between mean annual rainfall and percolation was positively related to plant cover and in inverse proportion to the aridity index. Our results highlight the importance of combining different methods of site characterization by soil physics, soil water isotopes and soil water chemistry (chloride) with vegetation data, providing a more specific analysis of ecohydrological conditions and their relation to ecosystem functioning and recovery potential. The field protocol applied can provide relevant information for guiding restoration strategies.

Costantini, E. A. C., Urbano, F., Aramini, G., Barbetti, R., Bellino, F., Bocci, M., & Tascone, F. (2009). Rationale and methods for compiling an atlas of desertification in Italy. Land Degradation & Development, 20(3), 261-276.

Garvelmann, J., Külls, C., & Weiler, M. (2012). A porewater-based stable isotope approach for the investigation of subsurface hydrological processes. Hydrology and Earth System Sciences, 16(2), 631–640.