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Vegetation effects on event water dynamics - Insights from in-situ stable isotope observations and dye patterns

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The predicted changes of climate and land-use could have drastic effects on the water balance of ecosystems, particularly under frequent drought and subsequent rewetting conditions. Yet, inference of these effects and related consequences for the structure and functioning of ecosystems, groundwater recharge, leaching of nutrients and pollutants, drinking water availability, and the water cycle is currently impeded by gaps in our understanding of the manifold interactions between vegetation and soil water dynamics. While plants require water and nutrients, they also exert, for instance, important below-ground controls on the distribution and movement of water and chemicals in the rooted soil horizons via uptake and redistribution of water, modification of soil hydraulic properties, and formation of conduits for rapid preferential water flow. This work aims to contribute to fill existing gaps by assessing the effects of different plant types and their rooting systems on the soil water dynamics. Therefore, we conducted artificial drought and subsequent rewetting experiments using isotopically and dye (Brilliant Blue FCF) labeled water on plots of various surface cover (bare soil, grass, beech, oak, vine) established on relatively homogeneous luvisol on loess in southwestern Germany. Detailed insight into the short-term dynamics of event water infiltration and root uptake during the field experiments was facilitated by the application of novel techniques for high-frequency in-situ monitoring of stable isotope signatures in pore and transpiration water using commercial laser-based spectrometers, augmenting conventional observations of soil physicochemical states (soil water content, matric potential, electrical conductivity). The temporal point information is complemented by dye staining profiles, providing a detailed picture of spatial infiltration patterns, and by root density observations. The results of the experiments allow for a comprehensive spatiotemporal characterization of the effects of differing vegetation cover and rooting systems on infiltration, preferential flow path characteristics, and water storage in the rooted soil horizons. This will contribute to an improved ability to estimate environmental change impacts on the fate of water, nutrients, and pollutants in this critical zone and associated feedbacks within the soil-vegetation-atmosphere system.