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Dynamic H-2 irrigation pulse labelling reveals rapid infiltration and mixing of precipitation in the soil and species-specific water uptake depths of trees in a temperate forest

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Understanding the movement of water in terrestrial ecosystems and determining the soil depths from which mature trees take up water has become an important research priority. Here, we test the suitability of a dynamic H-2 pulse-labelling experiment for assessing (1) the fate of a simulated precipitation event as it moves through the ecohydrological system and (2) the water uptake depths of different tree species in a mature temperate forest. We applied H-2-labelled water as a single pulse to the top soil using a sprinkler system and then allowed it to infiltrate into deeper soil layers by washing it through the soil column with a sequence of non-H-2-labelled irrigation pulses. We then followed this H-2-enriched irrigation pulse over a period of 81 days in different depths of the soil and in the xylem of four tree species (*Fagus sylvatica*, *Quercus petraea*, *Picea abies* and *Pinus sylvestris*). Our experiment shows infiltration and mixing of the irrigation pulse in the soil occurs within a few days. Furthermore, we found that tree species differed significantly in their use of shallow (-10- to -30-cm soil depth) and deep (-80-cm soil depth) soil water. We also found immediate uptake of infiltrating mobile soil water by trees, which questions the recently established two-water-worlds hypothesis. Our study demonstrated that a dynamic H-2-labelled irrigation pulse is a useful approach to (1) assess how water from a precipitation event infiltrates into a forest ecosystem and (2) assess the water uptake depths of different temperate tree species.

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