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Root water uptake and its pathways across the root: quantification at the cellular scale

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The pathways of water across root tissues and their relative contribution to plant water uptake remain debated. This is mainly due to technical challenges in measuring water flux non-invasively at the cellular scale under realistic conditions. We developed a new method to quantify water fluxes inside roots growing in soils. The method combines spatiotemporal quantification of deuterated water distribution imaged by rapid neutron tomography with an inverse simulation of water transport across root tissues. Using this non-invasive technique, we estimated for the first time the in-situ radial water fluxes [m s^{-1}] in apoplastic and cell-to-cell pathways. The water flux in the apoplast of twelve days-old lupins (Lupinus albus L. cv. Feodora) was seventeen times faster than in the cell-to-cell pathway. Hence, the overall contribution of the apoplast in water flow [m^3 s^{-1}] across the cortex is, despite its small volume of 5%, as large as 57±8 % (Mean ± SD for n=3) of the total water flow. This method is suitable to non-invasively measure the response of cellular scale root hydraulics and water fluxes to varying soil and climate conditions.