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# Interactions between soil and xylem water: an isotope-based global analysis

Anam Amin (1), Daniele Penna (2), Giulia Zuecco (1), Luitgard Schwendenmann (3), Josie Geris (4), and Marco Borga (1)

(1) Land, Environment, Agriculture and Forestry, University of Padova, Padova, Italy (anam.amin@phd.unipd.it), (2) Department of Agricultural, Food and Forestry Systems, University of Florence, Florence, Italy, (3) School of Environment, University of Auckland, Auckland, New Zealand, (4) Northern Rivers Institute, School of Geosciences, University of Aberdeen, Aberdeen, Scotland

Investigating the ecohydrological interactions at the soil-plant interface in diverse climatic and physiographic settings is essential to gain a better understanding of the mechanisms associated with the partitioning of water fluxes in vegetated environments. In this study, we analysed the isotopic composition ($^{2}$H and $^{18}$O) of soil and xylem water across 72 study sites extracted from 58 scientific papers published between 1990 and 2017. We compared the xylem water against their potential soil water sources and investigated the controls of climate, vegetation type, soil depth and soil texture. As such, the global dataset was analysed distinguishing data based on Köppen classification of climate zones (i.e., tropical, arid, temperate and cold), gymnosperms and angiosperms, shallow (0-50 cm depth) and deep (50-300 cm depth) soil water, and sand/clay percentage.

Our results have shown climate specific overlap of the isotopic composition of xylem water and soil water across the world. The isotopic composition of soil and xylem water was correlated with the mean annual temperature of the respective study sites. This indicates a strong climatic control on the isotopic composition of soil and xylem water, which mainly varied as a function of temperature, elevation and latitude. Arid and temperate climate zones showed larger deviations of both soil water and xylem water samples from the Local Meteoric Water Line and the Global Meteoric Water Line with soil water typically more deviated than xylem water. A marked evaporation signal was observed in the soil water collected from the shallow soil as compared to the deeper soils and there exists higher degree of intersection between the isotopic signature of shallow soil water and xylem water across the climate zones. With exception of the arid zone, the deviation of angiosperms and gymnosperms isotopic signal from the Global Meteoric Water Line was comparable in all climates however, the isotopic compositions of these two plant groups varied among the different climate zones. In the arid zone, the largest intersection between deep soil water and xylem water suggests that in water-scarce environments plants likely have a temporally-limited access to shallow soil water and depend more on water stored in deeper layers. In addition, we observed a large consistency of heavy isotope enrichment of soil and xylem water with an increase in soil clay content and a depletion in heavy isotopes with an increase in sand content.

In conclusion, we observed that at the global scale 1) xylem water seems to have the same origin as shallow soil water, 2) plants more likely adapt to extract water available at greater depths in the arid climate, 3) climate is the factor that mainly controls the isotopic composition of both soil and xylem water.

Keywords: stable isotopes; soil water; xylem water; climate zones; global scale.