Hydrologic regulation of plant rooting depth : breakthrough or observational conundrum?

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LETTER

Hydrologic regulation of plant rooting depth: Breakthrough or observational conundrum?

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In PNAS, Fan et al. (1) propose that landscape-scale hydrologic convergence along topography is the main driver of rooting depth. Fan et al. (1) base their assessment on a compilation of published reports and the development of an inverse modeling applied at the global scale.

One of the central hypotheses of Fan et al. (1) is that the water table depth (WTD) both determines—as a readily available water supply—and restricts—due to lack of oxygen below the water table—rooting depth, as indicated by the alignment of points with 1:1 line in their figure 3F. However, some points in their figure 3F correspond to roots growing more than 10 m deeper than the WTD. Their figure S6 also shows that *Picea* and *Eucalyptus* roots grow below the WTD. Supporting information provided by Fan et al. (1) reveals that observer-expectancy bias (2) hampers the informative value of their dataset: "most excavations [were] terminated at arbitrary depths"; "the deepest roots were discovered accidentally"; and rooting profiles were "likely under-sampled." While stated, it is unclear how these strong limitations have been accounted for by Fan et al. (1).

Root growth within the water table exists in both temperate and tropical plant species and plant adaptations to waterlogged conditions are well documented (3, 4): hypertrophy of lenticels; development of aerenchyma and intercellular spaces; deposition of suberin in cell walls. Furthermore, the saturated zone is not necessarily oxygen depleted: high concentrations of dissolved oxygen in shallow water tables flowing through sandy material have been reported (5). Fan et al. (1) never consider how dissolved oxygen and nutritive solutes transported by lateral groundwater flows can shape an environment conducive to root growth within the water table, as previously evidenced (6, 7).

Fan et al. (1) also hypothesize that plants preferentially take up water from the most readily available sources. Not only does this hypothesis contradict a putative absence of rooting at depths that exceed the WTD but it also overlooks the fact that trees do not always use the most readily available water (6). Root growth in saturated layers is often offset by enhanced access to nutrients (7, 8), and nutrient uptake rates at depth can be higher than that observed near the surface (9). Fine roots can also grow deep in fractured bedrock, where, under predominantly saturated conditions, they contribute to mineral alteration through respiration-induced acidification of the soil solution (10).

In conclusion, the analysis and modeling effort of Fan et al. (1) represent an original contribution that sheds new light on the determinants of plant rooting depths. However, we advocate that there is a pressing need to resolve the observational conundrum that we identify in this Letter and that new data on plant rooting depth, free of observer-expectancy effects, are still required to significantly improve our understanding and predictive capacity of the role of plants with regard to global hydrogeochemical cycles.

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Author contributions: A.P. and G.L. wrote the paper.

The authors declare no conflict of interest.

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Published online February 27, 2018.

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