frontiers | Frontiers in Forests and Global Change

TYPE Editorial
PUBLISHED 03 September 2025
DOI 10.3389/ffgc.2025.1688809

OPEN ACCESS

EDITED AND REVIEWED BY
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RECEIVED 19 August 2025
ACCEPTED 21 August 2025
PUBLISHED 03 September 2025

CITATION
Van Stan JT, Dymond SF, Klamerus-Iwan A and Rosell JA (2025) Editorial: Community series in bark-water interactions, volume II. *Front. For. Glob. Change* 8:1688809.
doi: 10.3389/ffgc.2025.1688809

Editorial: Community series in bark-water interactions, volume II

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KEYWORDS

ecohydrology, surface tension, xylem-phloem exchange, wood debris, bark conductance

Editorial on the Research Topic
Community series in bark-water interactions, volume II

Natural science has overlooked the "bark side" of the water cycle. Spanning millions of square kilometers, this complex surface is a major component of forest hydrology (Van Stan et al., 2021), but models of water, vegetation, and landscapes often treat it as an afterthought or give it a borrowed identity. For instance, bark's ability to intercept rainwater is often (enough) reduced to that of a leaf or "a soggy piece of blotting paper" (Van Stan and Simmons, 2025). Vegetation models currently lack bark-specific vapor conductance pathways, utilizing "stem desiccation through residual water loss from leaves, not bark" (Wolfe, 2020). Bark–xylem water exchange may also influence isotopic signals used to trace plant water sources—an unmodeled pathway with profound implications for ecohydrological inference (Nehemy et al., 2021; Treydte et al., 2021). Even bark hydrologic traits are shaped by legacy assumptions, e.g., hydrophobicity is typically tested with deionized water (see discussions in Tonello et al., 2021; Ossola and Farmer, 2024), as if precipitation were purified by the canopy rather than enriched by it. The result is trait values that assume clean droplets fall on clean bark (Noren et al.). And when trees become woody debris, entering streams, models often render it as static blockage, ignoring bark's role in shaping sediment texture, routing organic matter, and altering channel dynamics. This second volume in the Bark–Water Interactions Community Series presents new work that reveals bark's overlooked potential to transform forest–water modeling routines, from vapor exchange (Ávila-Lovera and Winter) and isotope tracing (Vega Grau et al.) to sediment dynamics (Słowik-Opoka et al.) and surface tension physics (Noren et al.).

Noren et al. delivered the first field observations showing that rainwater exiting tree canopies can have lower liquid–vapor surface tension (γ_{lv}) than the rain that entered. Their work is connected to bark water storage capacity, a key variable in hydrologic and plant physiology models. As rainwater becomes enriched with canopy-derived solutes (e.g., dissolved organic carbon concentrations up to $\sim$100 mg L^{-1}) (Stubbins et al., 2020), its γ_{lv} may drop by 12–18 mN m^{-1} via Gibbs isotherm. This chemical shift has direct physical consequences—based on Young's equation, it can increase a droplet's contact angle on bark, potentially increasing water storage by 10–20% before drainage occurs. This creates a testable hypothesis (γ_{lv} as a driving variable in hydrologic models' canopy storage states) that suggests changes in rainwater chemistry can influence drainage dynamics, surface evaporation, and microbial habitats.

Ávila-Lovera and Winter investigate bark conductance to water vapor (g_{bark}) across Neotropical tree species and its implications for drought stress, finding it varies widely among species. Notably, even "low" g_{bark} values (~5–20 mmol m^{-2} s^{-1}) can represent a persistent drain on a tree's stored water. In practical terms, during drought this seemingly minor flux could equal the entire amount of water a stem recharges overnight. Compounded over several rainless days, this steady desiccation can theoretically lower midday stem water potential by an additional 0.1–0.2 MPa, pushing a tree closer to its hydraulic failure threshold. By showing that g_{bark} varies predictably with relative bark thickness and temperature, the authors provide a clear path to incorporate this process into drought mortality models that may improve forecasts of when and why trees succumb to water deficit.

Vega Grau et al. show that water held in bark in tropical forest species can differ from outer-xylem water by ±4–10‰ δ^2H during a morning transpiration surge, before equilibrating by midday. Alternatively, these isotope values may converge during other times of day, with similarity between xylem and bark interpreted as radial exchange between the two pools. Transient offsets in isotope ratios between xylem and bark suggest times at which there is and is not exchange, providing insights into a model of within-tree flows that counters classical perspectives. From the perspective of using plant-water isotope data to infer depth of water uptake, artifacts from co-extracting bark and xylem waters (e.g., +8‰) could lead to misattribution of uptake depths if there are small differences between shallow and deep soil water δ^2H. Thus, by accounting for bark's influence, we may get a clearer picture of what is happening below ground.

Even after death, bark and its associated wood continue to shape the water cycle. In a Carpathian mountain stream, Słowik-Opoka et al. found that accumulations of woody debris acted like natural sieves, trapping finer gravel and sand. Where debris piled up, mean grain size was about 8 mm in diameter; downstream, after the debris barrier, it averaged closer to 2 mm. These debris patches held modest amounts of organic matter (around 5–9% by weight) depending on forest age. Thus, hypothetically during high-flow events, partial dam failures could release some of the stored sediment and organic material, creating brief pulses of turbidity and carbon export. Although commonly treated as fixed roughness, woody debris dynamically filters and then flushes sediments and nutrients.

Together, these studies invite ecohydrologists to explore the "bark side" of the water cycle (from treetops to streambeds) and to recognize bark as hydrologically active infrastructure embedded in every forest stem. Bark emerges as a multifaceted regulator, depending on setting and conditions: it could release rainwater with altered surface physics, "bleed" vapor during drought, skew the isotopic fingerprints used to infer plant water sources, and (via woody debris) moderate the routing of sediment and carbon in forest streams. Each process examined in this volume carries open questions: How dynamically does canopy chemistry modify interception storage? To what extent does bark transpiration tip trees from survival to mortality during drought? When should we deconvolve bark-water mixing from root uptake in isotope models? And, how often do woody debris jams switch from buffers to sudden sources of turbidity and nutrients? Addressing these uncertainties will require dedicated measurement, process-based representation, and integration into models. As global changes intensify drought stress and alter precipitation patterns, bringing the "bark side" of the water cycle into mainstream hydrological science will close a long-standing, likely massive and thus critical gap in our understanding of how forests store, release, and transform water across scales.

Author contributions

JV: Conceptualization, Project administration, Writing – original draft, Writing – review & editing. SD: Conceptualization, Writing – original draft, Writing – review & editing. AK-I: Conceptualization, Writing – original draft, Writing – review & editing. JR: Conceptualization, Writing – original draft, Writing – review & editing.

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References

Nehemy, M. F., Benettin, P., Asadollahi, M., Pratt, D., Rinaldo, A., and McDonnell, J. J. (2021). Tree water deficit and dynamic source water partitioning. *Hydrol Process* 35:e14004. doi: 10.1002/hyp.14004

Ossola, R., and Farmer, D. (2024). The chemical landscape of leaf surfaces and its interaction with the atmosphere. *Chem. Rev.* 124, 5764–5794. doi: 10.1021/acs.chemrev.3c00763

Stubbins, A., Guillemette, F., and Van Stan, J. T. (2020). "Throughfall and stemflow: the crowning headwaters of the aquatic carbon cycle," in *Precipitation Partitioning by Vegetation: A Global Synthesis*, eds J. T. Van Stan, E. D. Gutmann, and J. Friesen (Cham: Springer Nature), 121–132. doi: 10.1007/978-3-030-29702-2_8

Tonello, K. C., Campos, S. D., de Menezes, A. J., Bramorski, J., Mathias, S. L., and Lima, M. T. (2021). How is bark absorbability and wettability related to stemflow yield? observations from isolated trees in the brazilian cerrado. *Front. Forests Glob. Change* 4:650665. doi: 10.3389/ffgc.2021.650665

Treydte, K., Lehmann, M. M., Wyczesany, T., and Pfautsch, S. (2021). Radial and axial water movement in adult trees recorded by stable isotope tracing. *Tree Physiol.* 41, 2248–2261. doi: 10.1093/treephys/tpab080

Van Stan, J. T., Dymond, S. F., and Klamerus-Iwan, A. (2021). Bark-water interactions across ecosystem states and fluxes. *Front. Forests Glob. Change* 4:660662. doi: 10.3389/ffgc.2021.660662

Van Stan, J. T., and Simmons, J. (2025). Water models as geographical chimera: precipitation interception routines as an example of "patchwork empiricism." *Water Altern.* 18, 200–220.

Wolfe, B. T. (2020). Bark water vapour conductance is associated with drought performance in tropical trees. *Biol. Lett.* 16:20200263. doi: 10.1098/rsbl.2020.0263