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Stand-Scale Metrics for Expressing Stemflow Commensurate with its Ecohydrological Importance

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Precipitation that has been intercepted by tree canopies and subsequently routed to the boles of trees is termed stemflow. Stemflow, because of its concentrated nature at the base of trees and the resultant depth equivalent inputs to near-stem soils, has been shown to contribute to overland flow and erosion, preferential and subsurface flow, perched water table development and groundwater recharge, and has been linked to by-pass flow promoting storm runoff in certain streams. Although the quantitative importance of stemflow has been captured at the tree-scale using the funneling ratio –a metric that compares the volume of stemflow generated by a tree to the volume of precipitation that would have fallen on an open area equivalent to the basal area of the tree-, representative expressions of the volumetric importance of stemflow at the stand-scale have been seldom used. As such, two metrics for expressing stemflow at the stand-scale are advocated for: the stand-scale funneling ratio and the stand-scale infiltration funneling ratio. The stand-scale funneling ratio is akin to the original funneling ratio, however, the stemflow volume from all trees within a stand is compared to the volume of water that would have fallen as rain in the open over an area equivalent to the basal area of that stand, while the stand-scale infiltration funneling ratio utilizes the total infiltration area of the stand in place of the stand basal area. Two case studies, one from a juvenile lodgepole pine stand in British Columbia, Canada, and one from a lowland tropical deciduous forest in Kratie, Cambodia, are used to illustrate the quantitative importance of stemflow using these two metrics even though stemflow is a relatively small percentage of rainfall in both forests. The stand-scale funneling ratio is also derived for eighteen mature forests from around the globe using the results from recent studies (January 2017 – June 2018, inclusive) and, when coupled with the stand-scale funneling ratios reported for 16 mature forests in the stemflow review paper of Levia and Germer (2015), it is shown that stemflow only needs to be as little as 0.5% of rainfall for stand-scale funneling ratios to exceed unity. As such, near-stem soils in mature forest environments typically receive inputs from stemflow that far exceed what they would have received from throughfall or precipitation alone. Typical values of the stand-scale infiltration funneling ratio that should be expected in mature forests given typical stemflow flow rates, stand basal areas, and surface soil saturated hydraulic conductivities in these environments is also discussed. The case for future studies to report these stand-scale funneling metrics is made so that this water input is expressed in a way that is commensurate with its ecohydrological importance and so that the role of stemflow in plant-soil interactions may be better conceptualized, permitting advances in critical zone science.