EGU2020-8813
https://doi.org/10.5194/egusphere-egu2020-8813
EGU General Assembly 2020

Stemflow infiltration areas into forest soils around American beech trees

Pilar Llorens[1], Jérôme Latron[1], Darryl E. Carlyle-Moses[2], Kerstin Näthe[3], Jeff L. Chang[4], Kazuki Nanko[5], Shin'ichi Iida[5], and Delphis F. Levia[4]

[1]Institute of Environmental Assessment and Water Research (CSIC), Barcelona, Spain (pilar.llorens@idaea.csic.es)
[2]Thompson Rivers University, Kamloops, Canada
[3]Friedrich Schiller University Jena, Jena, Germany
[4]University of Delaware, Newark, DE, USA
[5]Forestry and Forest Products Research Institute, Tsukuba, Japan

Despite the fact that stemflow is often a small percentage of precipitation, it is a concentrated flux of water, solutes, and particulates to near-trunk soils. As a consequence, per unit area, near-trunk soils receive water and nutrient inputs that largely exceed those received by soils in the distal zone via throughfall. This funnelling effect of trees can contribute to preferential flow and groundwater recharge and can have important biogeochemical implications. However, to evaluate the importance of this flux for near-trunk soils is necessary to quantify the magnitude of the stemflow infiltration area.

This study presents a stemflow simulation experiment with the objective of determining the stemflow infiltration area in near-trunk soils. The experiment was conducted at the Fair Hill Natural Resources Management area in northeastern Maryland (USA). We selected four American beech (Fagus grandifolia Ehrh.) trees with a DBH of ~29 cm, growing in a loam soil. Each tree was equipped with a collar, built with a tube with small holes, and installed around the tree. This tube was connected with a hose to a 36.5 L container positioned ~ 1 m above the collar. The hose had two stopcocks to regulate the water rate. Before starting the simulations, litterfall was removed.

A total of thirteen simulations were run with differing simulated stemflow rates (from 30 to 290 L/h) and differing initial soil moisture conditions (mean soil moisture from 25 to 43 m^3m^{-3}). Soil moisture was measured around the trees before each simulation with a TDR device. To further increase soil moisture between simulations, 40 L of water were carefully applied circumferentially around the trunk, at a maximum distance of 35 cm. Each simulation was performed with different colour dye tracer to enable accurate measurements of the stemflow infiltration area. After each simulation, the infiltration area was measured using a mesh grid of known area. At the end of the last simulations soil samples were taken around each tree.

The results show that in all cases the infiltration area is < 0.1 m^2, with a mean value of about 0.03 m^2. Likewise, there is a tendency to decrease the area of infiltration by increasing soil moisture. This trend seems to be modified for saturated conditions or when the stemflow rate is extreme.

These small stemflow infiltration areas are explained by both the high infiltration rates of near-trunk soils in forests and the macroporosity produced by living or decaying roots. Moreover, these trees have slight buttressing that increase the perimeter of contact between the stem and the soil (with respect to the basal perimeter (calculated at breast height)), thus further promoting infiltration. Results suggest the importance of measuring the infiltration areas for different species and soil conditions to better evaluate the relevance of stemflow.