Geophysical Research Abstracts
Vol. 16, EGU2014-16583, 2014
EGU General Assembly 2014

The influence of stemflow from an European Beech Tree (Fagus Sylvatica L.) on soil solution and seepage fluxes

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European Beech (Fagus sylcatica L.) is particularly prone to produce large amounts of stemflow even during comparatively small precipitation events. This may lead to preferential flow and solute transport to greater depths next to the stem at lower precipitation heights than would be expected without considering water redistribution by the canopy.

In this study we investigated the influence of beech stemflow on soil solution and seepage fluxes, based on observed quality of all precipitation components as well as soil water. For estimation of transport, the soil water flow was modeled.

We measured concentrations of Na+, K+, Mg2+, Ca2+, NH4+-N, NO_3–N, Dissolved Organic Nitrogen (DON) and Dissolved Organic Carbon (DOC) in throughfall, stemflow and soil solution at depths of 10 cm and 30 cm and stem distances of 10 cm, 40 cm and 100 cm during autumn 2012 and spring and summer 2013. Throughfall and stemflow were sampled at 38 precipitation events during summer and autumn 2012 and summer 2013 from 192 (throughfall) and 16 (stemflow) collectors, respectively. Soil solutions were collected on 10 events during autumn 2012 and spring and summer 2013. Element fluxes were calculated from the chemical and hydrological measurements and model results.

Water flow through the soil was calculated using the model VS2DTI and was based on Richard′s equation and the model of van Genuchten and Mualem for predicting unsaturated hydraulic conductivity. The model also accounted for evapotranspiration, which was estimated using the Penman-Monteith equation with meteorological data from a nearby weather station. Longterm time series of throughfall and stemflow were estimated based on the observed relations and using rainfall data from the same weather station. Since the actual stemflow infiltration area was unknown, two scenarios with assumed infiltration areas of 1 m^2 and 2.76 m^2 were calculated.

All concentrations and fluxes were within the range of published results. However, stemflow fluxes could not be estimated reliably due to missing information on the actual infiltration area. Our data suggest that the influence of stemflow on soil solution seems to reach to at least up to 40 cm stem distance but not as far as 100 cm distance from the stem. We observed lower element concentrations in soil solution next to the stem, which may be a result of the locally increased water input, therefore diluting element concentrations.
Element seepage fluxes calculated from modeled water fluxes were lower than measured fluxes, due to an overestimation of transpiration by the model. With the given setup the model did not indicate a significant importance of stemflow on water or element seepage fluxes.

Further development should include enhancing the model to account for preferential flow patterns, recalculating of evapotranspiration and consideration of its spatial distribution and integrating in situ measured soil properties.