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Investigating the interrelations between throughfall, meteorological variables and vegetation structure in a developing hydrological catchment

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In landscapes with heterogeneous vegetation structure, interception and throughfall patterns produce spatio-temporal variability of soil moisture. This variability is important for eco-hydrological processes, in particular on small spatial scales up to the catchment scale. Throughfall depends on vegetation structure, whereas vegetation development is presumably co-determined by the spatio-temporal distribution of throughfall itself. In addition to vegetation structure, meteorological factors like wind speed and rainfall intensity also have an impact on throughfall.

The objective of this study is to quantify the influence of vegetation structure and meteorological variables on spatial (and in the long run the temporal) variability of throughfall. For that purpose, we developed an approach combining field methods, image analysis and multivariate statistics. The 6-ha constructed catchment ‚Hühnerwasser' (aka Chicken Creek, southern Brandenburg, Germany) offers ideal conditions for the investigation of eco-hydrological feedback processes. After more than 10 years of development, vegetation structure on the catchment is spatially heterogeneous and evolves through natural succession. Furthermore, complementary meteorological data are available on-site.

Throughfall was measured using 50 tipping-bucket rain gauges, which are aligned along two transects in 0.5 and 1 m heights, covering the dominating vegetation types on the catchment (e.g., robinia, sallow thorn, reed, reedgrass, herbs). The spatial distribution of vegetation structures around each measurement site was recorded with hemispheric photographs, which were subsequently analyzed using image processing techniques. Two weather stations provide reference values for precipitation and relevant meteorological variables for wind speed and direction, air humidity, temperature and irradiation.

The amount and distribution of precipitation measured in scarcely vegetated areas of the catchment widely correspond with values from the reference weather stations. Under dense vegetation, very heterogeneous values were recorded, which can be explained by i) canopy interception, and ii) fetching effects. The results of this study can serve as basis for interception models and may also contribute to complex eco-hydrological models.