Geophysical Research Abstracts
Vol. 18, EGU2016-4729-1, 2016
EGU General Assembly 2016

A methodology for investigating interdependencies between measured throughfall, meteorological variables and canopy structure on a small catchment.

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In evolving initial landscapes, vegetation development depends on a variety of feedback effects. One of the less understood feedback loops is the interaction between throughfall and plant canopy development. The amount of throughfall is governed by the characteristics of the vegetation canopy, whereas vegetation pattern evolution may in turn depend on the spatio-temporal distribution of throughfall. Meteorological factors that may influence throughfall, while at the same time interacting with the canopy, are e.g. wind speed, wind direction and rainfall intensity. Our objective is to investigate how throughfall, vegetation canopy and meteorological variables interact in an exemplary eco-hydrological system in its initial development phase, in which the canopy is very heterogeneous and rapidly changing. For that purpose, we developed a methodological approach combining field methods, raster image analysis and multivariate statistics.

The research area for this study is the Hühnerwasser ('Chicken Creek') catchment in Lower Lusatia, Brandenburg, Germany, where after eight years of succession, the spatial distribution of plant species is highly heterogeneous, leading to increasingly differentiated throughfall patterns. The constructed 6-ha catchment offers ideal conditions for our study due to the rapidly changing vegetation structure and the availability of complementary monitoring data.

Throughfall data were obtained by 50 tipping bucket rain gauges arranged in two transects and connected via a wireless sensor network that cover the predominant vegetation types on the catchment (locust copses, dense sallow thorn bushes and reeds, base herbaceous and medium-rise small-reed vegetation, and open areas covered by moss and lichens). The spatial configuration of the vegetation canopy for each measurement site was described via digital image analysis of hemispheric photographs of the canopy using the ArcGIS Spatial Analyst, GapLight and ImageJ software. Meteorological data from two on-site weather stations (wind direction, wind speed, air temperature, air humidity, insolation, soil temperature, precipitation) were provided by the 'Research Platform Chicken Creek' (https://www.tu-cottbus.de/projekte/en/oekosysteme/startseite.html). Data were combined and multivariate statistical analysis (PCA, cluster analysis, regression trees) were conducted using the R-software to i) obtain statistical indices describing the relevant characteristics of the data and ii) to identify the determining factors for throughfall intensity.

The methodology is currently tested and results will be presented. Preliminary evaluation of the image analysis approach showed only marginal, systematic deviation of results for the different software tools applied, which makes the developed workflow a viable tool for canopy characterization. Results from this study will have a broad spectrum of possible applications, for instance the development / calibration of rainfall interception models, the incorporation into eco-hydrological models, or to test the fault tolerance of wireless rainfall sensor networks.