Geophysical Research Abstracts
Vol. 20, EGU2018-16471, 2018
EGU General Assembly 2018

Observing and predicting streamflow intermittency across a mesoscale catchment

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Surface streamflow connectivity is a substantial part of research under the umbrella of hydrological connectivity. The connectivity of surface streamflow is dynamic in space and time. Dependent on the temporal dynamics of surface runoff streams can be classified into ephemeral, intermittent and perennial streams. Ephemeral streams are only active during precipitation events whereas intermittent streams only flow continuously for certain times of the year when the water table intersects the surface at the channel. Perennial streams define the part of the stream network which maintain streamflow for most of the year. Based on the degree of intermittency, in our case the probability of surface runoff at a location and hence the probability of connectivity of streamflow, we will delineate the shrinking and extending stream network using a spatial modelling approach. In order to understand the spatial predictors that drive streamflow intermittency, we measured the presence or absence of streamflow at various locations in the Attert catchment. The catchment covers three very different geologies - Luxembourg sandstone, Keuper marls and Devonian slate shale - on an area of 240 km^2. Similar climatic conditions allow for a direct comparison of the streamflow intermittency between the different geological regions. We measure presence and absence of flow by integrating various measurement approaches, such as time-lapse imagery, water level sensors and EC sensors. Our data set provides streamflow intermittency information at 181 locations in the catchment. Generalized linear models (GLM) describe the degree of intermittency at each “gauging station” over the entire year as well as for the winter and summer seasons. All spatial predictors like soil functional parameters, land use, presence of roads, topographical properties and relative geological permeability were derived for each grid cell along the flow path as the mean or proportion of each predictor within the upslope area of that grid cell (DEM with 15m spatial resolution). We identified the upslope catchment area, the saturated hydraulic conductivity of the soil and the permeability of the geological parent material as the most important predictors in the Attert catchment. The final model was then applied to the entire catchment, thus providing maps of the degree of intermittency of streamflow, which can then be used to calculate other stream network or scaling parameters based on the streamflow length under a certain degree of streamflow intermittency. Our approach allows predictions of streamflow intermittency for a large, heterogeneous catchment including perennial, intermittent and ephemeral streams.