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Event-scale investigations of natural and anthropogenic controls on river recession behaviour and trends

Patrick Bogaart (1), Ype van der Velde (2), Stefan Dekker (1), Steve Lyon (3), and Martin Wassen (1)

(1) Copernicus Institute for Sustainable Development, Environmental Sciences Group, Utrecht University, Utrecht, Netherlands (p.w.bogaart@uu.nl), (2) Soil Geography and Landscape Group, Department of Environmental Sciences, Wageningen University, Wageningen, Netherlands, (3) Physical Geography and Quaternary Geology, Stockholm University, Stockholm, Sweden

In this paper we investigate how river basin storage-discharge relationships are related to landscape and climate characteristics in Sweden, and how humans might have changed these storage-discharge relationships during the last 50 years.

One of the key questions in understanding the dynamics behind ‘fresh water’ as a planetary boundary is how terrestrial precipitation is divided between evapotranspiration, storage in biomass, soil and subsurface, and river runoff, and how this division is affected by climate change and human actions. Answering these questions means facing the complexity and multitude of interactions between soil, vegetation, atmosphere and humans in which clear cause-effect relations are rare.

These relationships can be studied on the various time scales, for example the annual time scale, using the Budyko framework, or on the event time scale, allowing for a physical based approach.

Here, we use the Brutsaert-Nieber (1977) approach to streamflow recession analysis to summarize the event-scale dynamic behaviour of streams and catchments while allowing, through the use of the Boussinesq equation and/or similar storage-discharge relations, a physically-based interpretation in terms of catchment variables such as effective hydraulic conductivity and drainage density.

We hypothesize that natural and anthropogenic (both direct and indirect) causes influence the catchment hydrological behaviour by means of these physical parameters.

To test this hypothesis, we analysed 50–100 year of daily discharge time series for > 100 catchments in Sweden. For each catchment, the event-scale hydrological behaviour is captured with the Brutsaert-Nieber (BN) approach. By using maps of climate, land use and catchment physiography, we explained the spatial variability in BN parameters in terms of natural and anthropogenic environmental controls. We found that the BN coefficient varied most strongly with the amount of open water, catchment area, precipitation rate, topograhic relief and fractions wetlands and agriculture. The BN was best explained by open water, temperature and soil types.

Changes in Brutsaert-Nieber parameters were analyzed by using multiyear sub time intervals. We found that the BN coefficient and exponent consistently decreased respectively increased. This was explained mainly by changes in low-flow conditions.