Geophysical Research Abstracts
Vol. 21, EGU2019-438, 2019
EGU General Assembly 2019

Assessing the effects of riparian restoration and beaver re-colonisation on stream flow quantity and quality in an agricultural catchment.

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Characterising stream water quality and the catchment water balance are effective tools for establishing the response of catchments to changing land management practices. Here we examine the influence of constructed riparian wetlands designed to retain nutrients and alleviate agricultural impacts on water quality. This corresponded to a change to more ecological approaches toward farming and reduced nutrient inputs. Soon after this restoration, re-colonisation by beavers (Castor fiber) greatly extended the wetland areas along the river network. We used long-term (∼30 year) water quality and stream discharge data in a 70 km2 rural mixed land use catchment in northern Germany. Weekly samples at 5 nested locations along the river network showed spatio-temporal changes in water quality parameters over the 30 year period, whilst long-term hydrological changes were assessed using groundwater levels and discharge monitoring.

Water balance estimates indicate high proportions of evapotranspiration loss (75% of total precipitation) and relatively low groundwater leakance (6% of total precipitation) prior to restoration. Increasing groundwater levels from 2000-2017 and the relatively linear-relationship of the catchment storage to discharge, have resulted in a gradual increase of loss by groundwater leakance (11% of total precipitation) while stream discharge has lost a summer diurnal signal.
Long-term changes in stream chemistry occurred at almost all sampling sites. Wetland restoration, aided by increasing beaver populations, resulted in longer transit times and increased long-term DOC concentrations downstream, whilst moderating stream temperatures. Declining electrical conductivity, SO4, Ca+ are consistent with long-term catchment flushing of acidic, atmospheric deposition derived from high industrial air pollution prior to 1990, which may have been be enhanced by S reduction in the wetlands. However, there has not yet been a significant decline in N and P concentrations, reflecting long-term fertilizer use and the resulting reservoirs of nutrients in the catchment soils, groundwater and stream sediments.

These long-term trends in stream chemistry and hydrology due to stream restoration and changes in agricultural management practices yield invaluable insights into ecohydrological catchment functioning and evidence base for future planning in relation to long-term climatic changes.