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Towards a coupled hydro-ecological catchment modeling approach Pt.2: water quality model

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Fine sediments are a key constraint for the functions of a river. On the one hand they impact the light and heat regime and, consequently, the primary production. On the other hand they control the hydraulic connectivity of the hyporheic zone, determining residence time and oxygen availability and, hence, bio-geochemical reactions and habitat suitability. In turn, fine sediment delivery to and its fate in the aquatic system is a matter of catchment hydrology and erodability as well as transport capacity and load, respectively.
This study aims to assess the influence of fine sediments on the aquatic system and the responses thereupon. The holistic modeling of fine sediment dynamics at catchment scale is challenging because of a lack of available information (input data), knowledge gaps in mathematical descriptions and the large range of spatiotemporal resolutions. In order to face these problems we approach to link distributed overland transport to in stream processes. Study site is the Kharaa river in northern Mongolia that shows a gradual degradation from pristine headwaters to disturbed lower reaches impacted by agricultural practices. Besides effects of climate change and population growth there are several pressures enhancing soil erosion from land surface or bank structures: deforestation and wildfires at headwater hill slopes, intensive grazing at floodplains, diminishing of riparian vegetation from downstream the mid reaches on and irrigated agriculture on vast stretches. Former investigations revealed deficits in benthic communities developed within the middle region and an increase in fine sediment colonisers.
The part presented here concerns the water quality modeling using a compartmentalisation approach that describes the water column and sediment compartment at the same time. This is done according to the compendium described within the River Water Quality Model No.1 (RWQM1) and implemented through the AQUASIM Program for Identification and Simulation of Aquatic Systems which includes simplified submodels for sediment transport and oxygen balance.
Water quality and hydraulic parameters of water column and hyporheic zone are in focus for a distinct intensive monitoring program at three different reaches along the main river course. This concept of measures contains 24 hour physicochemical measurements as well as recording of water constituents in surface and pore water (extracted via interstitial probes). Further techniques include the analysis of subsurface temperature records and freeze coring for studies on hyporheic flow as well as the examination of biomass of benthic and pelagic phytoplankton for the estimation of production and respiration parameters. Macroinvertebrates and meiofauna communities are investigated at the same time to facilitate the calibration of an ecological submodel.
We expect to see effects by colmation of the upper sediment layer in dependency of space (reach) and time (hydrology). This blocking of interstices causes changes in the benthic community composition as well as it seals the lower sediment layers where oxygen depletion and anaerobic biogeochemical processes like denitrification or the mobilization of phoshorus are able to evolve.