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Hydrological and geochemical consequences of river regulation – hyporheic perspective

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River-aquifer interfaces, essential for ecosystem functioning in terms of nutrient exchange and biological habitat, appear greatly threatened worldwide. Although river regulation is a vast pressure on river-aquifer interaction, influencing entire watersheds, knowledge about hyporheic exchange in regulated rivers is rather limited. In this study, we combine two decades of research on hydrological and geochemical impacts of hydropower regulation on river water and hyporheic zone in two large boreal rivers, unregulated Kalix River and regulated Lule River. Altered river discharge, with reduced spring peaks, daily summer fluctuations and elevated winter base flow severely modified Lule River water geochemistry and thus the transport of solutes to the Bothnian Bay (Baltic Sea). Further, these river modifications changed the river-aquifer exchange on both daily and seasonal scale, which resulted in deteriorated hyporheic conditions with reduced riverbed hydraulic conductivity (formation of a clogging layer) reflected in a declined hyporheic flux. Altered hydrological regime of the hyporheic zone created quasi-stagnant conditions beneath the river-aquifer interface and promoted the formation of geochemically suboxic environment. Taken that hyporheic water is a mixture of river water and groundwater, mixing models for the regulated site demonstrate a considerable addition of Fe, Mn, Al, NH4 and removal of dissolved oxygen and nitrate, which suggests the hyporheic zone in the Lule River to be a source of solutes. This contradicts the observations from the hyporheic zone in the unregulated river, with opposite behaviour functioning as a barrier. These results suggest that the hyporheic zone function is dependent on the river discharge and the state of the river-aquifer connectivity. Improved knowledge about the latter on a watershed scale will substantially increase our understanding about the status and potential pressures of riverine ecosystems and assist management and decision makers.