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Spatial hydrological flow processes, water quality, sediment and vegetation community distributions in a natural floodplain fen – implication for the Flood Pulse Concept

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We studied spatial patterns in inundation water quality, sediment and vegetation distribution in a floodplain fen in Poland to map interacting peatland hydrological processes. Using PCA and K-means cluster analysis, we identified four water types, related to river water inundation, discharge of clean and polluted groundwater, and precipitation and snowmelt dilution. Spatially, these hydrochemical water types are related to known water sources in the floodplain and occupy distinctive zones. River water is found along the river, clean and polluted groundwater at the valley margins and groundwater diluted with precipitation and snowmelt water in the central part of the floodplain. This implies that, despite the floodplain being completely inundated, nutrient input from river flooding occurs only in a relatively narrow zone next to the river. Our findings question the relevance of the edge of inundation, as presented in the Flood Pulse Concept, as delineating the zone of input and turnover of nutrients.
Secondly, we studied rich-fen and freshwater vegetation community distributions in relation to the presented inundation water quality types. We successfully determined inundation water quality preference for 14 out of 17 studied rich-fen and freshwater communities in the floodplain. Spatial patterns in preference show vegetation with attributed river water preference to occur close to the river channel, with increasing distance to the river followed by communities with no preference, diluted groundwater preference in the central part, and clean and polluted groundwater preference at the valley margins.
In inundation water, nutrients are known to be transported mainly as attached to sediment, besides in dissolved state. This means that in the zone where sediment deposition occurs, nutrient input can be a relevant contribution to the nutrient input of the floodplain. We found a significant decrease in sediment-attached nutrient deposition with distance from the river. Sediment-attached nutrients correlated better to aboveground standing biomass than dissolved nutrients. These findings further reduce the spatial zone where significant nutrient input is influenced by transport from the river, compared to the zone influenced by dissolved nutrients.
Our findings indicate the need for a revision of the Flood Pulse Concept for temperate river with multiple water sources, as peatland hydrological processes significantly influence spatial floodplain vegetation distribution.