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Water flow and solute transport in floating fen root mats

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Floating fens are valuable wetlands, found in North-Western Europe, that are formed by floating root mats when old turf ponds are colonized by plants. These terrestrialization ecosystems are known for their biodiversity and the presence of rare plant species, and the root mats reveal different vegetation zones at a small scale. The vegetation zones are a result of strong gradients in abiotic conditions, including groundwater dynamics, nutrients and pH.

To prevent irreversible drought effects such as land subsidence and mineralization of peat, water management involves import of water from elsewhere to maintain constant surface water levels. Imported water may have elevated levels of salinity during dry summers, and salt exposure may threaten the vegetation. To assess the risk of exposure of the rare plant species to salinity, the hydrology of such root mats must be understood.

Physical properties of root mats have scarcely been investigated. We have measured soil characteristics, hydraulic conductivity, vertical root mat movement and groundwater dynamics in a floating root mat in the nature reserve Nieuwkoopse Plassen, in the Netherlands. The root mat mostly consists of roots and organic material, in which the soil has a high saturated water content, and strongly varies in its stage of decomposition. We have found a distinct negative correlation between degree of decomposition and hydraulic conductivity, similar to observations for bogs in the literature.

Our results show that the relatively young, thin edge of the root mat that colonizes the surface water has a high hydraulic conductivity and floats in the surface water, resulting in very small groundwater fluctuations within the root mat. The older part of the root mat, that is connected to the deeper peat layers is hydrologically more isolated and the material has a lower conductivity. Here, the groundwater fluctuates strongly with atmospheric forcing. The zones of hydraulic properties and vegetation, appear to be very similar and likely functionally related.

Our experimental field data were used for modelling water flow and solute transport in floating fens, using HYDRUS 2D. Fluctuations of surface water and root mat, as well as geometry and unsaturated zone parameters can have a major influence on groundwater fluctuations and the exchange between rain and surface water and the water in the root mats. In combination with the duration of salt pulses in surface water, and sensitivity of fen plants to salinity (Stofberg et al. 2014, submitted), risks for rare plants can be anticipated.