Determination of governing processes that drive groundwater flow between a coastal peatland and the Baltic Sea

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ABSTRACT

Coastal peatlands are characterized by intense interactions between land and sea, comprising both a submarine discharge of fresh groundwater and inundations of the peatland with seawater. Nutrients and salts can influence the biogeochemical processes both in the shallow marine sediments and in the peatland. The determination of flow direction and quantity of groundwater flow are therefore elementary. Anthropogenic interferences like extensive drainage and flood protection measures are common in (coastal) peatlands and have a strong influence on the groundwater flow regime. The objective of this study is to identify the governing processes that cause the exchange of fresh and brackish water across the shoreline on different time scales in a previously drained, but recently rewetted, coastal peatland located in Northeastern Germany.

For this purpose, a 3D numerical groundwater flow model is set up to simulate density driven flow, changing seawater level (e.g. storms) and landside hydraulic gradients. Permanent water level and electrical conductivity readings, groundwater age dating, meteorological data and hydraulic conductivities from slug tests and grain size analysis are the base for the calibration of the numerical model. The groundwater flow model will support and test the following observations and assumptions:

The lateral groundwater flow appears through 3-10 m thick basin sands below a 1-3 m thick peat layer. Long-term drainage decreased the hydraulic conductivity of the peat, while the ditches constitute potential flow paths between ground- and surface water, which affects salt transport during and after inundations. The ditches are still active when a certain water level is exceeded, hence they influence the groundwater flow regime and the resulting hydraulic gradient. The hydraulic gradient further depends on dry or wet periods, stormy winters with periodically higher sea levels and the interaction of these states. As a result of lower sea levels after the ice age, the peat layer extends into today's Baltic coast and depending on its hydraulic conductivity influences mixing processes of fresh- and seawater and hence biogeochemical reactions.

A legacy effect of past inundations is observed in electrical conductivity readings both in the peat and the aquifer. Electrical conductivity measurements in different depths close to the beach show a heterogeneous distribution and indicate complex mixing processes at the interface due to geology and dune dike width.

It is assumed that the fresh-seawater interface is in a transient state as a result of long-term drainage of the peatland (landwards hydraulic gradient) in the past and will change as a result to recent rewetting of the peatland (seawards hydraulic gradient).