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Development of a high resolution modeling tool for prediction of waterflows through complex mires: Example of the Mukhrino bog complex in West Siberian middle Taiga Zone

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Water flow through peat bogs differ substantially from mineral soil landscapes. Permeability of the peatlayers decrease dramatically with depth within the permanently watersaturated peat layers (Catotelm), whereas the 10-60 cm thick superficial layer (Acrotelm) has a very high conductivity. Water flows predominantly in this acrotelm layer where an open structure of stems of mosses and few plants hardly limit water flow. By omitting this superficial flow infrastructures in many places block the waterflow. Moreover, the different bog types within a complex bog have different hydrological conductivities. Without considering the typical water-flow of bogs the construction of roads and platforms for oil and gas production threatens downhill mire ecosystems by partly drainage.

The objective of our study was to develop a modeling tool which can be used to predict quantitatively spatially distributed water-flow of a bog complex. A part of the extensive bog complex "Mukhrino bog complex" located at the left bank of Irtysh river near the West Siberian town Khanty-Mansiysk' was chosen as modeling area. Water discharge from this bog catchment occurs by "waterfalls" at the East margin where a scarp with ca. 8 m elevation difference has been developed by backward erosion into the bog by the Mukhrino river. From field observations it was proven that no discharge of groundwater occurred at the margin of the bog catchment area.

We used PCRaster-MODFLOW as modeling environment. The model area size was 3.8 km^2, cell size 5 m and the model included 3 Acrotelm layers and 3 Catotelm layers. Thickness of Acrotelm and Catotelm have been measured by coring in transects. Input data of rain, snow have been recorded in the study area. Evapotranspiration was measured with small lysimeters and crop factors for different land unit types (open water, raised bog, patterned bog, poor fens) were elaborated by water balance modeling (1-D). Land unit types have been mapped by supervised classification of a satellite image (QuickBird). For modeling open water type was split into shallow lakes and deep "primary" lakes.

From the model output of water level heads and flows in three dimensions it was concluded that 95% occurs by superficial flow through the Catotelm layers. Water flow through the Catotelm occurs bit was of minor importance.

With the modeling tool a virtual dam was created through the modeling area and the accumulated water-flow across this dam calculated. The tool proved to be suitable for calculation of optimization of permeability of road constructions through mires avoiding damaging the high valuable bog ecosystems.