Hydrogeology of a young moraine area in NE Germany: Subsurface structures and groundwater modeling

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Investigating subsurface structures and properties of young moraine areas is a challenging task due to the heterogeneity of the subsurface combined with limited possibilities of outcrop characterization. To overcome this challenge we suggest a multi-method approach that merges a variety of geophysical, hydrochemical and hydrogeological monitoring data with iterative hypothesis-based modeling of groundwater dynamics.

The focus area of this study is the region of Lake Fürstenseer See, which is located in a young moraine area in the terminal moraine and outwash plain area of the last glacial maximum (Pomeranian) in Mecklenburg-Vorpommern, north-eastern Germany. A number of buried subglacial valleys from the Weichselian cross the area in a mainly NNE – SSW direction BÖRNER (2015).

Currently, no detailed knowledge about subsurface structures and groundwater dynamics is available for the lake Fürstenseer See region. However, as we are looking at a purely groundwater controlled lake system (no natural surface inflows or outflows), this information is essential for a better understanding of the ongoing processes of groundwater-lake interactions. The assumed main control on groundwater flow paths of the uppermost aquifer in this region is the depth and the “topography” of the first aquiclude. Additionally, the buried valleys and the terminal moraine are likely to influence the groundwater flow.

In order to obtain more detailed information on the subsurface structures and characteristics geophysical methods are used. Electric resistivity tomography (ERT) surveys along different transects of up to 1000 m length are performed to detect the boundary between aquifer and aquiclude or the lateral extent of the buried valleys. The measured specific electrical resistances provide the chance to infer information on the valley filling.

The groundwater flow model Visual MODFLOW Pro was parameterized based on average hydraulic properties determined from core samples taken during observation well drilling. In a first hypothesis the depth of the aquiclude was assumed to be uniform over the entire region. Data from a nearby climate station was used as input, while well water level dynamics in 23 observation wells and lake water level dynamics were used for validation. In a second iteration, the depth of the aquiclude which was identified at 20 of the wells was interpolated over the area. The resulting groundwater flow paths and dynamics were re-evaluated.

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In a final step, data from the ERT investigations along several transects throughout the area as well as the information on the buried valleys by BÖRNER (2015) were also included in the interpolation of the depth of the aquiclude. While groundwater dynamics can be evaluated directly by comparison with the observed dynamics at the observation wells, groundwater flow paths are evaluated based on hydrochemical data from the observation wells and the observed spatial patterns of groundwater inflow into the lake.

Reference:

BÖRNER, A. (2015): Geologische Entwicklung des Gebietes um den Großen Fürstenseer See. – In: Kaiser, K., Kobel, J., Küster, M., Schwabe, M. (eds.): Neue Beiträge zum Naturraum und zur Landschaftsgeschichte im Teilgebiet Serrahn des Müritz-Nationalparks (Mecklenburg). Forschung und Monitoring, 4; Berlin (Geozon Science Media). in print.