Modelling Hydrological Consequences on Groundwater Dependent Habitats

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Modelling hydrological consequences on groundwater dependent habitats

Introduction
A well field is planned 1 km north of a Danish river valley which is covered by a NATURA 2000 habitat area. Fens and springs in the area depend on stable groundwater flows and the well field potentially threatens the integrity of the habitats.

Hydrological modelling is potentially a very useful tool for studying how different abstraction scenarios affect the hydrology in the habitats. However, it is necessary to describe groundwater vadose zone and surface water flows on a small scale to capture the important flow processes. This is on the edge of how far we can go with distributed modelling today and requires a large amount of input, calibration and validation data.

In the presented work a solid data foundation for hydrological modelling was provided by intensively monitoring the natural hydrological conditions during a 3-year period and subsequently performing pumping tests and monitoring effects of pumping from the groundwater aquifer.

Hydrological modelling is shown to be a very useful tool for supporting decisions regarding groundwater abstraction in catchments that contain groundwater dependent nature.

Nested hydrological models
The model is a 3D distributed model describing saturated flow, unsaturated flow as well as surface runoff. A regional groundwater model is used to provide the boundary conditions for submodel 1 with a resolution of 25 X 25 meter and a detailed model for the fen area of 5 X 5 meter resolution.

The nested modelling approach is used to achieve a sufficient resolution and yet a manageable computational demand in the models.

Small scale hydrolgy in fens
The rich fen area is located in a small depression in the terrain as illustrated in figure 2. Surface runoff in the fen ensures that flooding does not occur and the drainage ditches transport the water to the river. The model result is highly sensitive towards the detailed topography and the level of ditches and spring overflows in the area. The 5 X 5 meter horizontal resolution is required to resolve these small scale structures in the numerical model.

Model validation

The hydrological effect of groundwater abstraction on groundwater dependent habitats has been quantified by combining integrated numerical models at different scales. The model depends on a large amount of input data and observations used in calibration of parameters. The results can to some extent be validated and confirmed by measurements in the natural springs during pumping tests. In the fen areas no significant effect of pumping was modelled.

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