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Reliability of groundwater supply from a coastal aquifer in the context of climate and socio-economic changes

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Especially coastal areas are vulnerable in case of sea level rise and changing climate conditions. Therefore, the NAWAK study (design of sustainable adaptation strategies for infrastructures in water management under the conditions of climatic and demographic change) started in 2013. It is designed to assess impairments of groundwater availability for a coastal lowland aquifer system in North-West Germany (> 1.000 km^2) in the context of climate and socio-economic changes. The research results are focused on the quantification of the groundwater availability for past and future scenarios. Impacts from both climatic and socio-economic changes on the water availability and water balance are assessed by means of hydrologic, hydrogeological and geophysical models and methods, which where developed and adapted by project partners.

For the model area there are three fields of work to create the conditions for a density dependent calculation of changings in salt-freshwater budget with the numerical model d^3f++ (distributed density-driven Flow). The first is the description of initial conditions in three dimensions, especially for the salt-freshwater boundary. That description is based on airborne electromagnetic data of the underground and a complex processing to identify the differences between salt and freshwater, without anthropogenic and geologic influences. A validation is possible by comparison with groundwater measurements and an online monitoring of specific conductivity. The second is the calculation and measurement of flow conditions to derive the boundary conditions and the groundwater recharge. The groundwater recharge was calculated by using the hydrologic model PANTA RHEI. It is a conceptual model with partly physic-based modules, especially for the soil water processes. The model was calibrated and validated by discharge measurements and groundwater levels.

The third step is a detailed information about the spatial discretization and the reconstruction of the geologic body. The interpolation of point information's from boreholes and geologic sections was calculated with the geologic modelling software SubsurfaceViewerMX. For implementation in the groundwater model, the layers were combined to hydrogeological similar units.

With this sophisticated models it is possible to model the density-dependent complex groundwater systems at large spatial scales as well as contaminant transport.

The modeling analysis is focused on water-budget components (groundwater recharge, submarine groundwater discharge, surface-groundwater interaction and water supply), salt- water intrusion and sea level rise under different climate and water-use scenarios. With our models we offer the capability to evaluate possible coastal aquifer management strategies of real-world applications.