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Hydrogeophysical investigations on the North Sea island Föhr using airborne and ground-based transient electromagnetics

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Most climate change scenarios predict a sea level rise in the North Sea region in the decimeter-meter range due to changes in the seasonal distribution of rainfall. Aim of the EU Interreg project CLIWAT is the investigation of the potential impact on groundwater systems in selected project areas. Project partners are earth science research institutes, geological services and water works from Belgium, Denmark, Germany, and the Netherlands.

The North Sea island Föhr is one of the seven pilot areas of CLIWAT. For subsequent simulations of possible scenarios detailed geological and hydrogeological models are necessary. Föhr is glacially overprinted and consists of sand, till, and clay. The island can be geologically divided into the areas of a higher-lying Geest core with a freshwater lens and an extended plain Marsh area where the groundwater is substantially salty. For hydrogeological issues, the horizontal and vertical extent of the freshwater lens, as well as the distinction of aquifers and aquitards are of particular interest. For the water supply of the island in the area of the water works a dense drilling pattern exists.

In order to determine the overall electrical resistivity structure, in particular to evaluate the extent of the freshwater lens, LIAG commissioned SkyTEM Aps. to perform comprehensive airborne transient electromagnetic measurements. Along the flight lines the electrical resistivity distribution of the subsurface to around 200 m depth was determined. Freshwater saturated sand layers are characterized by relatively high resistivities, glacial till, clay, and in particular areas with saltwater by low to very low resistivities. The interpolation between the flight lines (250 m spacing) results in a three-dimensional image of the subsurface which reveals a larger extent of the freshwater lens than previously expected. At selected locations ground-based TEM measurements were conducted by BGR and TU Berlin to verify the SkyTEM results. The comparison of SkyTEM with TEM and the lithological logs was satisfactory. In the Marsh area a glacial thrust structure was detected. Seismic reflection data reveal the complexity of the structures.

These and other geophysical results will be linked with existing borehole information and integrated into a geological model.