Motivation & objectives

The water supply of islands is in many cases restricted to a freshwater lens and intrusion of seawater is a major constraint on groundwater utilisation. In order to study the impact of water extraction and climate change on the freshwater lens of a barrier island, numerical simulations were done (Sulzbacher et al., 2012). The groundwater model of the island was designed and calibrated by using information from boreholes, direct push measurements, pumping tests as well as geological investigations including airborne-EM, seismics, geoelectrics, NMR and GPR.

The main task of the GPR investigation was to map the shape of the groundwater table in a large central area of the island where the coverage by observation wells was poor. Furthermore, the architecture and stratigraphy of the aquifer was investigated and hydraulic properties of the sediments were deduced.

Velocity analyses & hydraulic properties

CMP radar section on top of a dune (a), semblance velocity analysis (b) and deduced velocity model (c). The different wave types are: direct air wave (AW), critically refracted waves (CRW), ground wave (GW) and reflected waves (RW).

VRP radar section in a monitoring well on top of a dune (a). Inversion of VRP data: picked travel times (b) and inverted velocity-depth model (c). The blue line shows the groundwater level in the well.

Groundwater table & aquifer architecture

Migrated GPR section across a dune area in the central island with lithology from hand drillings. The close up view (inset, 280–290 m) shows details of the reflectors.

- Highly-permeable aeolian sands can be distinguished from less-permeable marine sediments.
- The strong reflection below the GWT is caused by a silt loam layer. A detailed analysis shows some gaps. They are interpreted as erosion channels causing leakage in the aquitard. This is in good accordance with results of pumping tests.

Groundwater table (contours) based on observation wells (diamonds) and GPR (thick lines). The influence of considering additional GPR data is demonstrated in the insets (background greyscale shows interpolation errors, light to dark: increasing errors).
- Freshwater lens appears larger when using additional information from GPR investigation compared to information from observation wells only.
- Groundwater table is found up to 3.5 m above sea level in the centre area of the island, which is covered by dunes, and is low in the marshland and towards the sea.
- Groundwater table shows local depression in the area of the water extraction wells.

Reference


http://www.liag-hannover.de