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Subsurface characterization of a fresh water lens barrier island using geological, geophysical, geochemical and hydrological data - case study Borkum, Germany.

Mohammad Azizur Rahman (1), Helga Wiederhold (1), Susanne Stadler (2), Paul Koeniger (2), Sebastian Winter (3), and Bernhard Siemon (2)

(1) Leibniz Institute for Applied Geophysics , Geoelectrics and Electromagnetics, Germany (mohammadazizur.rahman@liag-hannover.de), (2) Federal Institute for Geosciences and Natural Resources, Hannover, Germany, (3) HSW Nordwest, Leer, Germany (sebastian.winter@hsw-nordwest.de)

Climatic variability, sea level rise and storm events often make the limited fresh groundwater reserves in barrier islands vulnerable to pollution. The dynamics of fresh water lenses below such islands largely depends on the interplay of groundwater abstraction, recharge, salt water intrusion and the hydrogeochemical character of the subsurface. Therefore, efficient withdrawal and management of fresh groundwater resources at these islands requires a comprehensive understanding of hydrological, hydrogeological and hydrochemical characteristics of the subsurface and associated flow and transport processes. This study investigates the groundwater catchment of the barrier island of Borkum, Germany, in an integrated way taking the above mentioned disciplines into consideration. The investigations were performed within the scope of the CLIWAT project, financed by the European Union in 2008-2012. During the project period several field campaigns were performed conducting pump tests, borehole drilling, direct push tests, geophysical investigations, groundwater and sediment sampling, flow measurements etc. In this study, we have analyzed 41 direct push tests in order to characterize the groundwater catchment area using resistivity (R0), electrical conductivity (EC), and groundwater hydrochemistry. The data gathered during the direct push tests have been used to analyze: (i) horizontal and vertical (up to 30m depth from the surface) distribution of freshwater and saltwater using the chloride contents in groundwater together with EC and R0 and (ii) the relations between petro-physical properties, hydraulic conductivity (estimated from pump test data) and resistivity. This relation could be used to convert available high resolution helicopter-borne electromagnetic (HEM) data into representative hydraulic conductivity data of the aquifer and salinity distribution in the subsurface. In addition groundwater quality in the aquifer was investigated. This study shows the advantage of combining interdisciplinary information for an improved characterization of the groundwater dynamics of barrier island aquifers. This study is part of the EU Interreg project TOPSOIL.