COMBINING GEOPHYSICAL METHODS TO INVESTIGATE THE SALT/ FRESHWATER INTERFACE AT THE VICINITY OF WATER EXTRACTION FACILITIES

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Freshwater reserves in coastal areas are vulnerable, due to the proximity of seawater. Two complementary processes play a role in the complex interface between freshwater aquifers and seawater: saltwater intrusion (SI) and submarine groundwater discharge (SGD). The former threatens coastal aquifers with salinization. And the latter – a combination of recirculated seawater and groundwater flowing out to coastal waters – is of ecological importance, since it creates a gateway of nutrients and possibly contaminants to near-shore coastal environments. Therefore, quantitative and qualitative assessment of the equilibrium between SGD and SI is important.

This interface is investigated in front of the city of De Panne and 'De Westhoek' nature reserve, which lies to the West. The Belgian coastline contains a long, semi-continuous dune belt, which is widest at 'De Westhoek'. Rainwater infiltrates in the dunes, forming a large freshwater lens, and partly flows towards the North Sea as SGD. A groundwater extraction site of the Intercommunale Waterleidingsmaatschappij van Veurne-Ambacht (IWVA) is located at 'De Westhoek', which has nowadays extraction rates of around 250,000 m^3/year.

A geophysical survey was performed in order to delineate salt and freshwater from the near-shore environment up to the dunes. The semi-diurnal tides and an intertidal zone of 300 to 450 m make it difficult to investigate the beach. Therefore, frequency domain electromagnetics (FDEM) and electrical resistivity tomography (ERT) are chosen. They are highly sensitive to the salinity and relatively quick and easy-to-use tools, which can be used in the intertidal zone. The methods are combined with marine continuous resistivity profiling (CRP), to extend the investigations seaward; and provide us a 3D image of the salt and freshwater distribution, from which we can deduce the zones where SGD occurs.

ERT data on land show the presence of a freshwater lens under the dunes with a fresh-/brackish tongue arising from it. On the beach, this tongue is overlain by a thick saltwater lens, which becomes thinner towards the sea. At the limit of the city of De Panne, we find the zone of groundwater discharge on the lower beach, close to the low water line. FDEM mapping reveals a lateral, northward shift of this zone when we move away from the city limit. As the discharge disappears underneath the sea water level at the border, it can only be detected by marine CRP. This is due the fact that the extraction site is located close to the city limit, decreasing the amount of SGD and displacing the discharge zone towards the beach.

The results show that a combination of ERT, CRP, and FDEM can be used to investigate the salt and freshwater interface in the intertidal zone. The presented methodology can easily be used at other locations along the Belgian coast, as well as in similar conditions around the world.

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