Using multiple geophysical methods for the assessment of submarine groundwater discharge in the Western Belgian coastal area

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Submarine groundwater discharge (SGD) is a mix of fresh groundwater discharging from the land and recharging seawater. SGD has the potential of influencing shallow coastal environments, since it constitutes a gateway for nutrients and pollutants in marine ecosystems. In Belgium, the shoreline is delineated by a semi-continuous dune belt, which varies in thickness. Freshwater recharges in the dunes during rainfall, leading to the development of a freshwater lens. Part of it flows towards the North Sea as submarine fresh groundwater discharge (SFGD). Although the existence of SFGD in the western part of the coast is known for decades, it has never been thoroughly characterized and quantified. *De Westhoek* nature reserve was chosen as a study site given its wide dune belt and low anthropogenic influence.

To delineate SGD, a combination of several geophysical methods are used for characterizing the salt / freshwater interface. Electromagnetic (EM) and electrical resistivity tomography (ERT) methods were chosen for their sensitivity to salinity variations. EM mapping was done on the beach at low tide with the CMD-MiniExplorer and the DUALEM-421s. Both devices have multiple investigation depth ranges up to 4m. Land ERT (Abem Terrameter LS) was performed on the beach and in the dunes. Finally, marine ERT (IRIS Instruments Syscal Pro Deep Marine) profiles were collected at sea during high tide with logistical support from the Flanders Marine Institute (VLIZ).

The combination of techniques provides a lateral and vertical distribution of salinity from the dune to the sea. 1 km from the French-Belgian border, we identify a large discharge zone located approximately at the low water line. This discharge zone can be followed laterally; it shifts seaward towards the French-Belgian border where it is located below the low water line. Our study is the first successful combination of EM, land and marine ERT to detect freshwater discharge in the intertidal and near-shore zone. Further field campaigns are planned to identify other areas of SFGD along the coast and to characterize SGD further (geochemistry, quantity…).

Keywords: Submarine groundwater discharge; Geophysics; ERT; EM