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The value of stable Isotope (18O) and electrical conductivity (EC) as tracers for submarine Groundwater exfiltration and density-driven flow infiltration into the aquifer.

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Saltwater intrusion (SWI) into a freshwater aquifer is a dynamic process due to e.g. natural changes in sea levels (tides) and recharge. Coastal lagoons, on the other hand, are often controlled water bodies where the water level and salinity are managed by the operation of a sluice connecting the lagoon to the ocean.
This study describes the seasonal dynamics of the saltwater/freshwater interface and submarine groundwater discharge (SGD) patterns at a coastal lagoon on the West coast of Denmark. Here the salinity of the lagoon is high in the summer period, where recharge is low (favoring SWI) and vice versa in the winter time. SGD was measured over four seasons in 2012 along two transects. 18O and electrical conductivity (EC) were measured at the same time to a depth of 3.5 m with a sample interval of 0.25 m. In September 2014 a transect with 12 piezometers (screening depth between 1.5 and 15 m below surface) and one profile well (with measurements every 1 m down to 15 m) was established across the saltwater/freshwater interface at one of the transects. 18O and EC were measured and each piezometer was equipped with a CTD-diver measuring pressure head, temperature, and EC in the period switching from summer to winter conditions.
Although 18O and EC is relatively well correlated (correlation coefficient of 0.8) the use of both tracers are recommend for this type of environment. Salinity (or EC) in the lagoon changes seasonally, whereas 18O in both lagoon water and groundwater is relatively stable within each end- member, suggesting that 18O is the tracer to prefer. However, on the other hand EC is an easy and in-expensive (continuous) measurement allowing a much better resolution in both space and time. The combination of both tracers can improve the explanation of the origin of water with more certainty.
Both tracers show a seasonal interplay between freshwater discharge into the lagoon and a density- driven recycling with opposing flow into the aquifer. 18O and EC results indicate freshwater dominated profiles during spring, but lagoon water influenced profiles during summer. Yet, seepage meter measurements cannot confirm this trend and only show exfiltration conditions of different pattern across seasons.
A transgressing/regressing interface could be observed with the 3 months data from 2014 with continuous measurements of EC serving as further evidence for the 2012 observed seasonal discharge dynamics.