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Dense distributed temperature sensing to infer local seepage fluxes in coastal areas

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In many deltas, land surfaces are largely below sea level, and consequently suffering from saline groundwater seepage. This phenomenon affects the fresh water supply for, for example, agriculture and drinking water production. In many of those deltas, sea level rise and land subsidence enhance these problems.

Depending on the geology, the seepage fluxes can occur both distributed and locally. Local seepage occurs through ancient channels that were filled with higher-conductive material at later times, but also works its way up via small vents through the soil. The latter is called boil seepage and usually is the most saline of the mentioned seepage types. Boils commonly appear in ditches and canals, since the pressure gradient is most of the time larger compared to the surrounding area. Although boils appear only as local point inflows, their high discharge and consequent salt flux can make them contribute for over 70% of the salt flux into lowland water systems (de Louw et al., 2010).

Seepage measurement methods include the application of so-called seepage meters and tracers like temperature. Conventional methods using temperature differences between groundwater and surface water require drilling temperature sensors into the soil. Because the locations of boils are sensitive to disturbances of the soil, we measure the seepage flux by measuring a 3D temperature profile in the surface water above the boil instead. The seepage flux is inferred from a numerical surface water model that includes salt and temperature transport.

Laboratory and field results show the onset of stratification because of the denser groundwater. In the winter situation, the temperature of the groundwater is relatively high, and double diffusive processes may play a role, mainly because there is negligible lateral flow most of the time, when the downstream pumping station is not active. Therefore, a model is set up that is well able to represent these double diffusive processes.

References

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