M. Graham, D.J. MacAllister, V. Vinogradov, A.A. Ijioma, M.D. Jackson, A.P. Butler (2017) Predicting seawater intrusion in coastal groundwater boreholes using self-potential data, *AGU Fall Meeting Conference Abstracts, New Orleans 11-15 Dec 2017*

Many coastal groundwater abstraction wells are under threat from seawater intrusion: this is exacerbated in summer by low water tables and increased abstraction. Existing hydrochemistry or geophysical techniques often fail to predict the timing of intrusion events. We investigate whether the presence and transport of seawater can influence self-potentials (SPs) measured within groundwater boreholes, with the aim of using SP monitoring to provide early warning of saline intrusion.

SP data collection: SP data were collected from a coastal groundwater borehole and an inland borehole (> 60 km from the coast) in the Seaford Chalk of southern England. The SP gradient in the inland borehole was approximately 0.05 mV/m, while that in the coastal borehole varied from 0.16-0.26 mV/m throughout the monitoring period. Spectral analysis showed that semi-diurnal fluctuations in the SP gradient were several orders of magnitude higher at the coast than inland, indicating a strong influence from oceanic tides. A characteristic decrease in the gradient, or precursor, was observed in the coastal borehole several days prior to seawater intrusion.

Modelling results: Hydrodynamic transport and geoelectric modelling suggest that observed pressure changes (associated with the streaming potential) are insufficient to explain either the magnitude of the coastal SP gradient or the semi-diurnal SP fluctuations. By contrast, a model of the exclusion-diffusion potential closely matches these observations and produces a precursor similar to that observed in the field. Sensitivity analysis suggests that both a sharp saline front and spatial variations in the exclusion efficiency arising from aquifer heterogeneities are necessary to explain the SP gradient observed in the coastal borehole. The presence of the precursor in the model depends also on the presence and depth of fractures near the base of the borehole.

Conclusions: Our results indicate that SP monitoring, combined with hydrodynamic transport and geoelectric modelling, holds considerable promise as an early warning device for seawater intrusion. We now aim to refine our understanding of the technique by applying it to a range of aquifer types.

https://doi.org/10.1002/2016JB013376