Classes of seawater intrusion: An extension to consider the effects of offshore aquifers

Adrian D. Werner[1], Andrew C. Knight[1], Leanne K. Morgan[2], Jason A. Thomann[1], Cristina C. Solórzano-Rivas[1], and Marc Walther[3,4]
[1]College of Science and Engineering, and National Centre for Groundwater Research and Training, Flinders University, Adelaide, SA, Australia
[2]Waterways Centre for Freshwater Management, University of Canterbury and Lincoln University, Christchurch, New Zealand
[3]Helmholtz-Centre for Environmental Research GmbH – UFZ Leipzig, Department of Environmental Informatics, Leipzig, Germany
[4]Technische Universität Dresden, Professorship of Contaminant Hydrology, Dresden, Germany

ABSTRACT

Previous efforts to develop classification systems for seawater intrusion (SWI) neglect the role of offshore aquifers in the response of coastal aquifers to pumping and other pressures (e.g., Werner, 2017). Given recent evidence for the widespread occurrence of offshore freshwater (Post, 2013; Knight et al., 2018), the inventory of conceptual models of SWI need to be extended so that the losses of offshore fresh groundwater can be considered in addition to onshore freshwater declines. We adopt a recently developed analytical solution for the steady-state location of the freshwater-seawater interface in aquifers with semi-confined offshore extensions (i.e., Werner and Robinson, 2018), to add to the existing classes of SWI that are based on aquifers that are entirely onshore. The results show that offshore aquifers experience a muted rate of SWI relative to SWI in onshore aquifers. Furthermore, the movement of the tip of the interface (the point at which the freshwater-seawater interface meets the top of the offshore aquifer) is an additional variable of interest that has been largely neglected in onshore SWI cases, which typically consider only the toe (where the interface meets the base of the aquifer). The responsiveness of the tip and toe differ, depending on the stress-change applied to the offshore aquifer. We conclude that aquifers in which the seawater intrusion is a considerable distance offshore may present as plausible options for the long-term provision of freshwater, given the slower rates of response to onshore pumping stresses under these situations.

REFERENCES

Knight, A.C., Werner, A.D., Morgan, L.K. 2018. The onshore influence of offshore fresh groundwater. Journal of Hydrology, In press.

Post, V.E.A., Groen, J., Kooi, H., Person, M., Ge, S., Edmunds, W.M. 2013. Offshore fresh groundwater reserves as a global phenomenon. Nature 504: 71–78.

Werner, A.D. 2017. On the classification of seawater intrusion. Journal of Hydrology 551: 619-631.

Werner, A.D., Robinson, N.I. 2018. Revisiting analytical solutions for steady interface flow in subsea aquifers: Aquitard salinity effects. Advances in Water Resources, In press.

Contact Information: Adrian D. Werner, Flinders University/NCGRT, GPO Box 2100, Adelaide SA, 5001, Australia, Phone: 618-8201-2710, Email: adrian.werner@flinders.edu.au