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An assessment of seawater intrusion overshoot using physical and numerical modelling

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A number of recent numerical modelling studies of transient sea-level rise (SLR) and seawater intrusion (SWI) in flux-controlled systems have reported an overshoot phenomenon, whereby the freshwater-saltwater interface temporarily extends further inland than the final steady-state position. There are significant implications for coastal aquifer management arising from the overshoot, because it implies that the post-SLR steady-state interface position may not be the worst case, as is generally assumed. In this study, physical sand-tank modelling of SLR-SWI in a flux-controlled unconfined aquifer setting was carried out to confirm whether SWI overshoot is a physical process and not a nuance of numerical simulation. Images of the physical SLR experiments show, for the first time, that an overshoot occurs under controlled laboratory conditions. A sea-level drop (SLD) experiment was also carried out, and overshoot was again observed, whereby the interface was temporarily closer to the coast than the final steady-state position. Overshoot for a retreating interface has not been reported previously. Numerical modelling of the physical SLR and SLD experiments produced a reasonable match to the physical modelling results. This substantiates the overshoot observed in the physical modelling. The extent of the overshoot under SLR and SLD was significant relative to the change in steady-state interface position in both the physical experiments and numerical modelling, albeit the laboratory setting involved high groundwater flow gradients and large sea-level changes.