Saltwater upconing zone of influence

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ABSTRACT

In this study, we define and characterize the saltwater upconing zone of influence (SUZI), which is the extent of impact in terms of saltwater rise attributed to pumping. While the zone of influence of a pumping well can be clearly defined in terms of hydraulics (e.g. drawdown), the zone of influence in terms of upconing has received considerably less attention. In coastal areas where a threat of saltwater intrusion and upconing exists, characterization of the salinity zone of influence of a pumping well would provide an improved basis for coastal aquifer management decision-making, e.g. relating to the salinity implications of pumping well operations. Both radial and three-dimensional numerical modelling of saltwater upconing at the field scale were undertaken. The extent of impact in terms of saltwater rise was found to be dependent on the relative magnitudes of the pumping rate and the lateral flow. The three-dimensional coastal setting simulations revealed an asymmetrical shape of the lateral extent of the SUZI, i.e. the SUZI is largest in the direction parallel to the coast. This occurs because the specified head boundary condition at the ocean limits the drawdown near the coast. Also, the inland extent of seawater in the aquifer further limits the propagation of the SUZI perpendicular to the coast, thereby compressing the SUZI in this direction. The steady-state simulations were also compared to the predictions by the Ghyben-Herzberg approximation, including in cases where sloping interfaces occur and where solute dispersion is significant. This provided a reasonable first-order insight into the nature of the magnitude of the SUZI. Observations from this study offer an insight into the formation and extent of the SUZI below pumping bores. Furthermore, the extent of saltwater upconing impact was found to be highly influenced by the lateral flow, implying that lateral flow should be considered in the saltwater upconing studies. Further simulations are needed to explore the effects of multiple-bore pumping as well as transient effects due to intermittent pumping.

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