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Freshwater-Saline water Interactions in Unconfined Coastal Aquifers

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This research addresses the dynamic nature of fresh groundwater flow and saline transport in unconfined coastal aquifers. The discussion was made based on the field observation in a nourished sandy beach and related theoretical investigations.

Taniyagi Beach, a constructed beach on Toban coast that faces the Harima Sound was selected as the field observation site. The beach extends in front of sea cliff of Pleistocene soil which fringes a terraced landform. With this kind of geological settings, the beach is very vulnerable to coastal erosion by wave actions (Woodroffe, 2003).

The field measurements made include those of tidal levels, of groundwater-level fluctuations on a cross-shore array of observation wells, of groundwater electric conductivities (ECs), and of a range of beach hydrological parameters such as the precipitation, air temperature, wind speed, soil moisture and soil suction (Azuma et al., 2002).

Analytical sharp-interface solutions are used to predict the location of interface between fresh groundwater and saline water in the unconfined aquifer under study by incorporating the Q/k value. The sharp-interface approach to estimating the configuration of saline water-freshwater interface is proved to be applicable to the situation when the net groundwater head inland is positive in value. This methodology, in combination with the tidal response method for determining the aquifer constant C, permitted an estimate of the fresh groundwater discharge to the sea on Taniyagi Beach namely, Q=1.45 m^2/ day per running meter of the beach.

The performance of groundwater ECs continuously measured over a prolonged period of time clearly indicates the extents of maximum seawater intrusion and of minimum seawater intrusion. The states of maximum seawater intrusion occur at each stage of high tides, irrespectively of the magnitude of the peak tidal levels, in a sequence of flood and neap tides. By contrast, the states of minimum seawater intrusion occur at the stage of low tides during the flood tides. These results suggest that once the body of fresh groundwater has been formed in a coastal setting, it can withstand subsequent, continued exposures to tidal actions as long as the hydrological conditions in the hinterland are maintained.

References

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