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Effect of Sea Level Rise on Groundwater Resources: A Case Study of Southwest Coastal Rhode Island

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This study evaluates the effect of sea level rise, induced by the global warming, and the effect of pumping, on the groundwater resources of the coastal aquifer of the Quonochontaug Neck Area, in southwest Rhode Island, USA. A three dimensional groundwater model was built for the year 1999, using Visual MODFLOW software. The simulation was run in steady state, with the freshwater and saltwater bodies treated as immiscible fluids, and thus diffusion and dispersion were not taken into account. The interface between the freshwater and the denser saltwater was simulated as a sharp interface, using the Ghyben-Herzberg approximation. The movement of the interface under different future scenarios was evaluated, and the possibility of saltwater intrusion into the public water supply wells of the area was assessed.

The basic groundwater model of the area was build and calibrated to available observation data from monitoring wells for the year 1999. A sensitivity analysis was performed to examine the model's behavior. Future scenarios for the years 2020, 2050 and 2100 were simulated for different sea level rise rates and various pumping rates. The sea level rise rates varied from a local minimum, observed in the nearby Newport tidal gage, to the global maximum predicted by the Intergovernmental Panel on Climate Change (IPCC), while the pumping rates ranged from the current rate to maximum increased rate projected for the year 2100.

The model concluded that the groundwater table responds to the sea level rise by increasing its head, and that the depth to the interface between the freshwater and the saltwater decreases. Increased pumping rates exacerbate those observations. Under some combined scenarios of sea level rise and pumping, the water supply wells can be threatened by the possibility of saltwater intrusion and contamination. Some adaptation strategies and suggestions were formulated as part of the conclusions of this study, and the limitations of the simulation were also evaluated.