Impact of Submarine Groundwater Discharge (SGD) on Coastal Water Quality

Freshwater and saltwater regions, in an unconfined aquifer, are separated by a mixing zone also referred to as saltwater-freshwater interface or saltwater wedge. Most of the freshwater flow occurs above the interface while a majority of the saltwater flows in recirculation cells below the interface. The total water (freshwater and saltwater) flowing out to the ocean or coastal discharge is called submarine groundwater discharge (SGD). Although various factors such as tidal forcing, wave action, and seasonal oscillations in groundwater flux affect SGD, its major components are the regional freshwater flow and the re-circulating saltwater flow. SGD is an important phenomenon that controls the overall nutrient budgets of coastal water. Currently, there is considerable controversy in the estimated values of these freshwater and saltwater fluxes and the associated water budgets. For example, in a classic field study, Moore (Nature, 1996) discovered very high rates (much higher than the estimated regional freshwater flux) of SGD in a coastal aquifer. Younger (Nature, 1996) argued that only 4% of the SGD estimated by Moore is from the land (fresh groundwater) and the rest of the water is of marine origin (caused by re-circulation).

The objective of this work is to study the relationship between saltwater recirculation, movement of saltwater-freshwater interface due to seasonal oscillations and SGD via numerical modeling. Previously, we have conducted physical studies of saltwater intrusion phenomenon in porous media flow tanks. Our experimental setup allowed us to quantify the freshwater flux through the system as well as visualize tracer movement within the saltwater wedge. In the current work we have numerically simulated the re-circulation patterns of saltwater and the discharge patterns of freshwater under various boundary conditions in a hypothetical unconfined aquifer system. The widely used and validated variable-density code SEAWAT was used to perform the numerical modeling. This presentation will include analysis of the results obtained from numerical experiments and aid in defining freshwater and saltwater residence times in an unconfined aquifer and a discussion on the effect of SGD on water quality issues in coastal zones.

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