The impact of climate conditions and pumping strategies on the groundwater system in the Mekong Delta, Vietnam

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Abstract

The Vietnamese Mekong Delta (VMD) is one of the largest economic centers in southern Vietnam, home to approximately 18 million inhabitants. Groundwater is the crucial water source for domestic, agricultural, and industrial uses in the VMD. For decades, groundwater levels have been depleting rapidly due to over-extraction and climate change, negatively impacting human lives and infrastructures. Therefore, it is necessary to understand the hydrological mechanisms and forecast future groundwater levels as well as groundwater salinity in the VMD, supporting groundwater resource management. This study adopted USGS-SEAWAT, which is the coupled version of MODFLOW and MT3D, to simulate groundwater flow and solute transport in a variable-density condition. The model was developed using stratigraphic columns obtained from borehole drilling, groundwater extraction, sea level, river stages, and precipitation. The groundwater flow and salinity model was calibrated by modifying the boundary conditions, initial values, and material properties such as hydraulic conductivity, storativity, and dispersion coefficient. The calibrated model shows a good performance in simulated groundwater flow (RMSE < 1 m, NSE > 0.95) and an acceptable performance in reproducing groundwater salinity (RMSE < 3 g/l, NSE > 0.85). After that, by applying a reasonable scenario, the model was utilized to forecast groundwater levels and salinity of 7 aquifers in the future. The prediction results show groundwater level will continue to drop due to over-extraction, particularly in deep aquifers. In contrast, groundwater salinity slightly increases in deep aquifers, whereas it rises sharply in shallow aquifers. This study succeeded in hindcasting as well as forecasting groundwater levels and salinity in the future, which might support decision-makers in developing an appropriate groundwater management strategy.

Keywords: Vietnamese Mekong Delta, forecast, groundwater level, groundwater salinity.