Estimation of Groundwater Storage Changes in Transboundary Cambodia-Mekong River Delta Aquifer using GRACE Satellite

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Globally, agricultural, domestic, and industrial sectors have become increasingly reliant on groundwater use to meet the water demands. Excessive groundwater is being consumed along with surface water to fulfill the increasing water demand for agricultural purposes in the transboundary Cambodia-Mekong River Delta (CMD) aquifer, which has an area of approximately 180,000 km^2 and covers two countries: Cambodia and Vietnam. This study aims to analyze the spatio-temporal trend in groundwater storage changes in the CMD over a 15-year period from 2002-2017 using satellite estimates. Groundwater storage anomalies (GWSA) were obtained by subtracting soil moisture storage and lake water storage from the terrestrial water storage obtained by the Gravity Recovery and Climate Experiment (GRACE). In this study, the viability of remote sensing data to accurately estimate GWSA was evaluated through the water balance approach. A non-parametric ranked Mann-Kendall trend test and Sen's slope were used for trend analysis. The correlation between GRACE and observed groundwater storage anomalies was found to be high (>0.8). Long-term change in groundwater storage showed a declining trend of 0.68 cm/year in the entire CMD aquifer. The maximum decline was observed in the Vietnam part, however, less decline was seen in northern-western parts of Cambodia. In 15 years, the total loss in groundwater volume was 18.28 km^3. However, significant negative trends were observed in the months from September to December with the highest declining trend for the month of October with a rate of 1.17 cm/year and a total volume loss of around 36 km^3. If the recent trend persists in the upcoming years, it might have consequences for the domestic and agricultural sectors in the aquifer. Control mechanisms in terms of groundwater abstraction through some effective laws and policies are needed in reducing the depletion rate. However, the two countries within the transboundary aquifer have differences in terms of laws and policies, levels of understanding of the groundwater system, complex hydrogeology, type of aquifers present, sectoral usage of groundwater, and management priorities. This study thus shows the potentiality of GRACE in capturing groundwater storage change in a data-scarce area and on a regional scale which will be a basis for the formulation of sustainable groundwater management strategies and policies to reduce groundwater stress in the transboundary aquifer.

Keywords: Transboundary aquifer, groundwater monitoring, remote sensing