

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 km² 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 the Gravity Recovery and Climate Experiment (GRACE). The GRACE is a state-of-the-art remote sensing tool, that has made it possible in monitoring groundwater storage changes, in areas with a lack of observed monitoring stations. Firstly, GWSA obtained from GRACE was compared with data obtained from observed groundwater stations in both point and grid scales. Non-parametric ranked Mann-Kendall trend test at a confidence interval of 95% was used in the study to estimate the trend in the dataset. Sen's slope was used to see the magnitude and direction of the trend. The trend was seen on an annual, seasonal, and monthly scale in the aquifer and country boundary. The correlation between GRACE and observed groundwater storage anomalies was found to be high (>0.8). A comparison of the GRACE satellite and observed data from point to point (centroid) scale showed a poor correlation in comparison to the grid-to-grid (interpolation of observed data) scale. The discrepancies might be because ground-based observations from monitoring wells capture changes in water level for certain levels in certain aquifers, while GRACE captures comprehensive changes in storage for all aquifers. 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 km³. 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 km³. Therefore, this study 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 groundwater management strategies and policies to reduce groundwater stress in the region.

Keywords: Transboundary aquifer, groundwater monitoring, remote sensing