Estimating Terrestrial Water Storage and Groundwater Storage Change using GRACE Time-Variable and GLDAS-LSM Derived Data : A Case Study in Thailand

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This study integrates time-variable Gravity Recovery and Climate Experiment (GRACE) gravimetric measurements and Global Land Data Assimilation System (GLDAS) land surface models (LSM) in order to understand the inter-annual and long term variations of surface water and groundwater storage changes (GWSC) at the regional-scale in Thailand, based on the water balance equation and hydrologic parameters. From averaged GRACE and GWSC data, the results showed that over almost one-decade period, the entire Thailand region experienced surface water storage loss of 125 mm/year. The seasonalized groundwater variation analysis gave a net gain in groundwater storage of 189 mm/year that is considered equal to groundwater recharge gain of 96,980 mcm/year. The observed results are consistent and comparable to the averaged groundwater recharge of 103,000 mcm/year or safe yield of 3,200 mcm/year as estimated by the Department of Groundwater Resources (DGR) Thailand. Through cross-plotting and analysis with *in situ* measurements from rainfall and streamflow discharge, the total water storage change (TWSC) and GWSC in the basin were consistent and closely correlated in variation trends. The inter-annual standard deviation of groundwater elevation change was determined as ± 3.67 mm/year, which is equivalent to 80% degree of confidence in the obtained results. The results in this study show that GRACE gravity-variable solutions and GLDAS-LSM provide reliable data sets suitable for the study of small to larger area total water storage and groundwater storage variation, especially in areas with scarce and sparsely available in situ data. Results strongly indicate that spatial variations in groundwater recharge of Thailand are predominantly controlled by the climate (e.g., rainfall and evapotranspiration) and pumping rates at the regional-scale of the study area.

Keywords: GRACE, Satellite Gravity, GLDAS-LSM, Groundwater Storage, Hydrological Balance, Safe Yield, Terrestrial Water Storage.