

POSTER

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Comparison of seasonal total water storage variations from GRACE with groundwater levels, stream flow and soil moisture in Southern Laos

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Abstract

The Gravity Recovery and Climate Experiment (GRACE) gravity satellite program was launched jointly by the National Aeronautics and Space Administration (NASA) of the United States and the German Aerospace Centre (DLR) in March 2002 to measure changes in the earth's gravity field (Tapley et al. 2004). The movement of mass in surface water, soil water and ground water causes these changes. GRACE measurements are processed mathematically to extract estimates of total water storage (TWS) expressed as equivalent water height (EWH) with a spatial resolution of about 200,000 km². In 2013, a new website for GRACE was developed by The Australian National University (ANU) using the spherical harmonic fields of the French Groupe de Recherche en Géodesie Spatiale (GRGS). This website provides a Data Visualisation Tool (DVT) by which users can estimate the EWH in a user specified region (polygon) or point with a spatial resolution of about 62,500 km². GRACE data has been widely utilised to determine the variations of groundwater storage in many countries. However, this has not yet been implemented in Laos. Therefore, the main objective of this study is to investigate the feasibility of applying GRACE satellite data to estimate total groundwater storage in Southern Laos by comparing time series data of GRACE-derived TWS with groundwater levels, streamflow observations and soil moisture. A basin scale of about 25,000 km² was utilised to investigate the GRACE-derived total water storage correlation with in situ groundwater levels and measured streamflow in southern Laos, one of the main target areas for agricultural development. The total groundwater availability in this area is currently not yet known exactly. This study presents the first direct comparison of total water storage derived from GRACE satellite mission with in situ hydrological monitoring. Monthly time series of soil moisture derived from the Global Land Data Assimilation System (GLDAS) and TWS drawn from GRACE between November 1, 2011 and April 30, 2013 are compared with groundwater levels from a piezometer network in Sukhuma district and Mekong River flow at Pakse hydro-meteorological station in Champasak Province, Southern Laos. Moreover, seasonal soil moisture maps derived from GLDAS are also compared with surface soil, land use and vegetation cover maps. The results illustrate that the GRACE-derived TWS agrees with the on-site groundwater table and streamflow measurements. In addition, comparison between soil moisture derived from GLDAS and measured groundwater table elevation in Sukhuma district and flow at Pakse station demonstrates similar seasonal fluctuations. The comparison between seasonal soil moisture maps and surface soil and vegetation maps shows that the highest volumes of soil moisture are usually found in Shrub land areas underlain by sandy loam soils. These preliminary results could be useful for estimating total groundwater storage variations and availability from GRACE data for Sukhuma district and Southern Laos in the future.

Keywords: GRACE, GLDAS, Seasonal variations, Total Water Storage, Soil moisture, Groundwater levels, Southern Laos