Downscaling WGHM-Based Groundwater Storage Data Using Regression Method: A Regional Study over Qazvin Plain, Iran

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Climate change, urbanization, and growing population have led to the rapid increase in the use of groundwater. Therefore, monitoring the groundwater (GW) changes is essential for water management and decision-makers. Due to frequent lack of reliable and sufficient in-situ information, remote sensing and hydrological models can be counted as the alternative sources for assessing GW storage changes on a regional and global scale. Here, we test such an approach for Qazvin Plain in Iran, one of the regions that recently have been facing severe drought conditions. The main purpose of this study is to downscale GW storage anomaly (GWSA) of the WaterGAP Global Hydrology Model (WGHM) from a coarse (0.5-degree) to a finer spatial resolution (0.1-degree) using fine spatial resolution auxiliary datasets (0.1-degree) such as the evaporation, surface and subsurface runoff, snow depth, volumetric soil water, and soil temperature from the ERA5-Land model and precipitation from integrated multi-satellite retrievals for global precipitation measurement (IMERG). Different regression models were tested for the GWSA downscaling. Moreover, since different water budget components such as precipitation or storage are known to have temporal lead or lag relative to each other, the approach also includes a time shift factor among the components. The most suitable regression model with the highest skill score during the validation test was selected and applied to predict the 0.1-degree GWSA. The downscaled results showed a high agreement with the in-situ groundwater levels for Qazvin Plain in both interannual and monthly scales, with a correlation coefficient of 0.99 and 0.65, respectively. Moreover, the downscaled product clearly proves that the developed downscaling technique is able to learn from high-resolution auxiliary data to capture GWSA features at higher spatial resolution. The major benefit of this method is in utilizing only the auxiliary data that are available with global coverage and free of cost, and that this method does not need in-situ GW records for training. Therefore, the proposed downscaling technique can potentially be applied to a global scale, other geographical regions, or aquifers.

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