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Determination of groundwater abstractions by means of GRACE data and Artificial Neural Networks

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The EU Water Framework Directive requires for each groundwater body the determination of annual average rates of abstraction from all points providing more than 10m3 per day as well as groundwater level monitoring, so as to ensure that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction. In order to acquire such information in situ observation networks are necessary. However, there are cases, e.g. Greece where WFD monitoring programme has not yet become operational due to bureaucratic, socioeconomic and often political constraints. The present study aims at determining groundwater use at the aquifer scale by using Gravity Recovery and Climate Experiment (GRACE) satellite data coupled with readily available meteorological data. Traditionally, GRACE data have been used at the global and regional scale due to their coarse resolution and the difficulties in disaggregating the various Total Water Storage (TWS) components. Previous works have evaluated the subsurface anomalies (ΔGW), using supplementary data sets and hydrologic modeling results in order to disaggregate GRACE TWS anomalies into their various components. Recent works however, have shown that changes in groundwater storage are dominating the GRACE Total Water Storage (TWS) changes, therefore it was though reasonable to use changes in Grace derived TWS in order to quantify abstractions from a groundwater body. Statistical downscaling was performed using an Artificial Neural Network in the form a Multilayer Perceptron model, in conjunction with local meteorological data. An ensemble of 100 ANNs provided a means of quantifying uncertainty and improving generalization. The methodology was applied in Rhodope area (NE Greece) and proved to be an efficient way of downscaling GRACE data in order to estimate the monthly quantity of water extracted from a certain aquifer. Although our methodology does not aim at estimating abstractions at single points, it manages to capture the total monthly abstracted quantities from a groundwater body The developed herein approach offers a handy advantage to water managers who will be able to acquire information on groundwater uses without having to adhere to in situ costly observations.