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Estimation of Irrigation Water Using Satellite Soil Moisture Data in a Semi-Arid Area

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Irrigated agriculture is the principal consumer of fresh water resources. Most countries don't have precise measurement of water consumption for irrigation. In this study we proposed an innovative approach that allows to estimate irrigation water amount from satellite soil moisture data. We exploit the SM2RAIN algorithm (Brocca et al. 2014), that was originally developed for estimating rainfall from the soil moisture observations to quantify the irrigation. The satellite soil moisture observations obtained from the Advanced Microwave Scanning Radiometer 2 (AMSR2) sensor and the Soil Moisture Active Passive (SMAP) mission are used as the main input to the simulation model. As study area, one of the main agricultural plain of Iran, is selected, where actual observations of the temporal evolution of irrigation are available.

The results reveal that the proposed approach can well capture the irrigation pattern, consistent with observed irrigation data (surface allocated water). In particular, in rainless periods the simulated amount of irrigation water shows a good agreement with in situ. Although both of satellite soil moisture observations (AMSR2 and SMAP) can reflect the irrigation signal, the simulations carried out by SMAP data underestimate the irrigation compared to in situ data that can be associated from the large number of missing value in the time series of soil moisture for this region. The AMSR2 simulations slightly overestimate in situ irrigation data. However, since the model estimates total irrigation (i.e. surface + ground water), simulation employed by AMSR2 soil moisture might have the ability to determine the ground water depletion by subtracting the allocated amount from surface resources. Therefore, the overestimation can be due to the extra resources for irrigation which is not included in observed irrigation data like ground water resources.

The quality, spatial and temporal resolution of satellite soil moisture retrievals and precipitation data have a significant impact on the simulation accuracy. Low spatial resolution of soil moisture products makes it difficult to capture the irrigation water of small irrigated area. Unreliable rainfall data can also lead to the over/underestimation of irrigation water in non-irrigated time periods. The method is also applied to less irrigated areas obtaining significantly lower irrigation rates, although they are not completely zero due to the noise in soil moisture retrievals. The effect of noise in the irrigated pixel is lower and a clear weekly signal can be seen in its soil moisture fluctuation.

References:

Brocca, L. et al., 2014. Soil as a natural rain gauge: Estimating global rainfall from satellite soil moisture data. Journal of Geophysical Research: Atmospheres, 119(9), pp.5128–5141.