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Study of the hydrological functionning of the irrigated crops in the southern mediterranean basin

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In southern Mediterranean region water consumption has significantly increased over the last decades, while available water resources are becoming increasingly scarce. In Morocco, irrigation is highly water demanding: it is estimated that 83% of available resources is dedicated to agriculture with efficiency lower than 50% (Plan Bleu, 2009). In the semiarid region of Tensift Al-Haouz (center of Morocco), typical of southern Mediterranean basin, crop irrigation is inevitable for growth and development. In this situation, and to preserve water resources, the rational management of water irrigation is necessary. This objective is one of the priorities of the research program SudMed (Chehbouni et al., 2008) and the Joint Mixed Laboratory TREMA (Khabba et al. 2013), installed in Marrakech since 2002 and 2011, respectively.
In these two programs, the scientific approach adopted, to monitor water transfers in soil-plant-atmosphere system, is based on the synergistic use of the mathematical modeling, the satellite observations and in situ data.
Thus, during the decade 2002-2012, 17 experiments on dominant crops in the region (wheat, olive, orange, sugar beet, apricot) were performed. In these experiments, the different terms of water and heat balances exchanged between land surface and atmosphere are controlled with different devices. Results showed that the water losses by evaporation can reach 28% of water inputs for the flooding irrigation site and are obviously lower (about 18-20 % on average) for the drip irrigation sites. Concerning the deep percolation, results are surprising: water losses for the drip irrigation are in the range 29-41% of water input, whereas theses losses are between 26 and 31% for flooding irrigation.
Concerning the modeling component, several models ranging from the most simple (FAO-56) to the most complex (i.e. SVAT: Soil Vegetation Atmosphere Transfer) were implemented to estimate the spatio-temporal variability of ET. The results showed that the physically based SVATs such as ISBA provide good estimates of surface fluxes over all sites once a proper calibration is carried out. However, they required several input parameters that are not routinely available at the appropriate spatial scale. For operational purposes, simpler approaches such as the FAO-56 and the TSEB models showed a good estimate of ET at field scale.
Also, the FAO-56 approach was adapted to use a satellite-based vegetation index. It was calibrated and validated on the Haouz plain, for the main crops (wheat, olive and citrus). Its implementation was validated using a Landsat TM image time series and also using low resolution images. The results showed that despite the simplicity of the model, spatial estimates of ET were reasonable. This model was converted in software for Satellite Monitoring of Irrigation. However, the FAO-56 method combined with solar remote sensing data alone was not sufficient to accurately estimate water consumption, especially when soil evaporation and stress under full vegetation cover conditions occurred.
In this regard, we directly assimilated snapshot evaporation data that could be obtained through the resolution of a simple energy budget forced by TIR observations. These preliminary results showed a clear improvement of the seasonal ET estimates.