Combining Remote Sensing and Hydrological Models to Estimate Regional Evapotranspiration

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Introduction

Insufficient water is the greatest limitation to crop production in the arid regions, because of the scanty and erratic precipitation. As water resources become scarce, the determination of crop water requirements is an important component in irrigation and agricultural water research, management and development (Yang et al., 2002). A thorough knowledge of all terms of the water balance is essential to understanding how the system functions hydrologically and how productivity and sustainability can be improved. Evapotranspiration (ET) from crops, native vegetation, forest, weeds, bare soils and open water surfaces forms a major component of the water balance in rural areas (Droogers and Bastiaanssen, 2002).

Data related to ET at regional scale are very limited. Field techniques provide answers, but are limited to the local environments in which the instruments are installed. ET has, therefore, to be calculated using some physical-mathematical procedures, i.e., simulation models or remote sensing algorithm (Black et al., 1989).

In this study, a comparison between ET determined from SEBAL (the surface energy balance algorithm for land) and SWAP$^{(+)}$ (soil-water-atmosphere-plant model) will be made. This methodology diminishes the need of field data and combines the strong points of remotely sensed techniques and hydrological models. It also provides all the terms of annual water balance for irrigation seasons in the study area to support irrigation performance analyses.

Materials and Methods

Two available Landsat Thematic Mapper images will be acquired at the start of the irrigation season and at the end of the season. An unsupervised classification will be applied on every

pixel to differentiate the crops grown in the area using all reflectance bands of Thematic Mapper except for the thermal infrared band, which reflects the soil water conditions more than the type of crop. The development stages of the crops will be estimated through the Leaf Area Index (LAI). LAIs can be calculated from spectral radiance measurements in the red and infrared part of the spectrum (Turner et al., 1999). Thematic Mapper bands 3 and 4 will be used to obtain the Soil Adjusted Vegetation Index and an empirical relationship will be applied to arrive at the LAI (Droogers and Bastiaanssen, 2002; Moran, 1994).

The hydrological analyses will be performed using the SWAP model. For this study, only the water transport, irrigation practices and crop growth modules will be used. Potential ET will be partitioned into potential soil evaporation and crop transpiration using LAI. Actual crop transpiration and soil evaporation will be obtained as a function of the available soil water in the top soil or root zone for, respectively, soil evaporation and crop transpiration.

Finally, irrigation can be prescribed at fixed times, scheduled according to different criteria or by using a combination of both.

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(+) http://www.alterra.nl/models/swap/index.htm