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Crop Water Stress Detection from Remote Sensing using the SSEBI-2 Algorithm: A Case Study in Morocco

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Accurate estimations of actual evapotranspiration (ET_a) give insight in water consumption, crop water stress, and production levels of crops. For planning and management of water resources, water managers and specifically irrigation engineers need to have temporal and spatial values of ET_a for various land uses.

The use of remote sensing is a powerful tool to estimate ET_a for large areas. A simplified method is provided by the SSEBI algorithm, developed to estimate surface fluxes from remote sensing images. SSEBI provides accurate ET_a values, and has the advantage that limited field data are required (Roerink *et al.*, 2000). Previously, SSEBI was applied to separate remote sensing images, representing individual days within a growing season. A method for temporal integration of the images into a time series of daily ET_a maps was lacking. The current paper describes a new, easy to use procedure that applies such a temporal integration: the SSEBI-2 algorithm. SSEBI-2 derives daily actual and potential ET maps from remote sensing. The approach allows a quick temporal and spatial assessment of seasonal water consumption for large river basins or irrigation systems, with a minimum amount of input data required.

The SSEBI-2 algorithm is applied to the Oum Er Rbia Basin in Morocco, which includes the Tadla irrigation perimeter, one of the most productive irrigation areas in Morocco. A total of 26 low resolution MODIS images of 2006 were used to derive evaporative fraction maps. These maps are subsequently integrated in equal intervals

(days, decades, months), after which the net radiation flux is calculated on the basis of standard meteo data, combined with remote sensing input. Finally actual and potential ET on a daily basis were derived for the Tadla irrigation scheme. For validation, surface flux measurements are used.

A comparison of actual and potential ET reveals the occurrence of crop water stress at specific moments in the irrigation season of 2006 in Tadla. This information can be used to improve irrigation strategies or to propose alternative cropping calendars. In addition, the use of SSEBI-2 showed that the Tadla irrigated area consumes a large fraction of water within the whole river basin. This leaves little room for agricultural perimeters located downstream in the basin.

Promising results have been obtained, which demonstrate the usefulness of SSEBI-2 to derive constant time series of evapotranspiration to assess water consumption for irrigation perimeters and for alternative land uses at basin scale. The results are understandable and reproducible by non-remote sensing experts.

The use of MODIS appears highly suitable for the calculation of ET time series. This is due to its: (i) high temporal resolution, (ii) standard atmospheric correction, and (iii) standard geometrical correction. An additional advantage is the easy access of MODIS images (free of charge through internet) which provides the opportunity for routine processing of images. This is promising for operational crop monitoring applications that require processing at a near-real-time basis.

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References

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