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Assessing actual evapotranspiration in irrigation districts using Landsat TM images and SEBAL model: Potential uses for irrigation monitoring

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Satellite imagery allows the observation of large land stretches and the acquisition of worthwhile information that can be used efficaciously in agro-hydrologic systems. On the other hand, remotely sensed data coupled with energy balance models represent reliable tools to estimate actual evapotranspiration (ET).
Objective of the research was to propose a methodology to estimate ET by using Landsat TM images and surface energy balance, thus allowing the monitoring of current irrigation practices and/or possible vegetation stress.
The proposed methodology was applied in an irrigation district managed by “Consorzio di Bonifica Agrigento 3”, Castelvetrano, Sicily (Italy), in which water is distributed by a pressurized distribution network operating on-turn. Satellite information retrieved by a set of Landsat TM images allowed to implement the surface energy balance model (SEBAL) in order to map the spatial distribution of instantaneous ET over two main crops (olives and grapevines), during irrigation seasons (from May to September) 2009 and 2010. These instantaneous values were then up-scaled to daily values based on the hypothesis of self-preservation of evaporative fraction. Finally, daily acquisitions were used to derive ET within longer time intervals, by assuming the by assuming proportionality to temporal dynamics of the reference evapotranspiration (ET0) computed using standard ground meteo-data.
With reference to the acquisition days, the comparison between SEBAL outputs and maximum daily crop evapotranspiration (ETc) estimated with the FAO 56 approach, showed notable stress levels for both the investigated crops, except for the images acquired in May, when significant rainfall occurred in both years. Moreover, measurements of eddy covariance fluxes collected by a tower located in the district within an olive orchard, evidenced the general reliability of daily ET retrieved by the model and consequently the validity of the self-preservation hypothesis applied to upscale instantaneous ET. Even if the applied methodology can be considered a valuable tool to monitor irrigation practices, the availability of cloud-free satellite images, as well as the temporal frequency of sensing, are critical issues for the proposed applications.