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Soil moisture modeling by means of Landsat-5 TM data over a Mediterranean mountain catchment

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Soil moisture has important implications on the hydrological cycle and its monitoring is relevant for the assessment of environmental stress that affects forest and agricultural ecosystems. Nowadays, radiometric measurements provided by Remote Sensing are the technologies used to model soil moisture at regional scales in a feasible way.

In this study we present a preliminary estimation of the daily soil moisture, for the period 2002-2009, using a set of 30 Landsat images (22 Landsat-5 TM and 8 Landsat-7 ETM+), for several locations in the Vallcebre research catchments (42º 12'N, 1º 49'E). This area is located in the NE of the Iberian Peninsula at 1100m a.s.l., and is characterized by a sub-Mediterranean climate with marked water deficit in summer. Mean annual temperature is 9.1ºC and mean annual precipitation is 862 $\pm$ 206 mm, with a mean of 90 rainy days per year. Mean annual reference evapotranspiration is 823 $\pm$ 26 mm.

Landsat-7 ETM+ and Landsat-5 TM images have been corrected by means of conventional techniques based on first order polynomials taking into account the effect of land surface relief using a Digital Elevation Model, obtaining an RMSE less than 30 m. Radiometric correction of Landsat non-thermal bands has been done following the methodology proposed by Pons and Solé (1994), which allows to reduce the number of undesired artifacts that are due to the effects of the atmosphere or to the differential illumination which is, in turn, due to the time of the day, the location in the Earth and the relief (zones being more illuminated than others, shadows, etc). Atmospheric correction of Landsat thermal band has been carried out by means of a single-channel algorithm improvement developed by Cristóbal et al. (2009) and the land surface emissivity computed by means of the methodology proposed by Sobrino and Raissouni (2000).

Soil water content has been modeled through a multiple regression analysis between soil moisture data and several vegetation indexes – NDVI, EVI, Greenness – and wetness indexes – NDWI, Wetness and the land surface temperature. In order to select the variables before performing the multiple regression analysis a model's predictors have been computed on the basis of Mallows' Cp.

Models have been validated through surface soil moisture measurements obtained in 10 TDR profiles covering a wide range of soil moisture conditions in different topographic locations and over different types of vegetation: grassland, Scots pines (Pinus sylvestris) and Pubescent oaks (Quercus humilis).

Preliminary results show a good agreement between soil moisture multiple regression models obtained using remote sensing data and field soil moisture data.

Keywords: Soil moisture, Landsat-5 TM, multiple regression analysis, Mediterranean region.