ON THE ESTIMATE OF THE LEAF AREA INDEX BY REMOTE SENSING IN THE MULARGIA BASIN, SARDEGNA

Nicola Montaldo¹, Matteo Detto¹, Marco Mancini¹, Guido D’Urso², Mario Minacapilli³, and Maria A. Dessena⁴

1. Dipartimento di Ingegneria Idraulica, Ambientale, Infrastrutture viarie, e del Rilevamento, Politecnico di Milano, Italy
2. DIAAT, Università di Napoli Federico II, Italy
3. ITAF, Università di Palermo, Italy
4. Ente Autonomo del Flumendosa, Cagliari, Italy

Key-words: LAI, Mediterranean ecosystem, remote sensing

Objective of the study
The assimilation of remote sensing data in hydrologic models allows improving surface water and energy balance predictions. In typical small and medium Mediterranean basins remote sensing observations need to be at high spatial resolution (< 100 m). At these spatial resolutions the monitoring of the soil water balance main term, the soil moisture, is difficult, while other eco-hydrologic terms, such as leaf area index (LAI), can be monitored successfully using passive sensors.

The objective of this study is to develop models for deriving LAI from visible and infrared spectral channels of remote sensing images for the Mulargia basin case study, and to test the models for different remote sensors and spatial resolutions.

Materials and Methods
From April 2003 to May 2004, the performance of recent satellite sensors (Aster mounted on Terra, Quickbird and ETM+ on Landsat 7) for estimating LAI are tested for the Mulargia river basin (area of about 65 km²), located in center-east Sardegna (Italy). It is a typical Mediterranean heterogeneous ecosystem mainly covered by grass, trees and dense shrubs. In particular, we estimated LAI and albedo from visible and near infrared spectral channels of Quickbird (2.8 m spatial resolution), ETM+ Landsat 7 (30 m), and Aster-Terra (15-30 m) images comparing several vegetation indexes (SAVI, NDVI, WDVI). In particular, we acquired two Quickbird images: one in August 2003 and one in May 2004. The two images allow to depict the contrasting land covers of the Summer and the Spring, respectively, which, are key seasons in the water resources planning and management of this Mediterranean water-limited ecosystem.

During the same period, extensive field campaigns were carried out over the basin. LAI estimates were performed using the Li-Cor LAI 2000 instrument, and emission spectra were estimated by a spectra radiometer (FieldSpec UV/NIR).

Results
The comparison of the vegetation indexes demonstrated that the LAI estimates derived from SAVI are the most accurate, because this index estimates well LAI also in low vegetated areas, which were predominant in the basin during the extremely dry Summer 2003. Moreover, the results highlight the importance of the field measurements of LAI, because the use of literature models for the derivation of LAI from vegetation indexes didn’t provide satisfactory results. The use of the ASTER image, although the lower resolution, allowed to estimate maps of LAI similar to those derived from Quickbird images, if appropriate field
measurements are made, so that the ASTER images seem a good compromise between accuracy and parsimony.
Finally, a sensitivity analysis of the LAI map of the basin to the spatial resolution demonstrated that high spatial resolutions (< 30 m) are important in this typical Mediterranean basin, in particular for hydrologic applications.