IMPACT OF SATELLITE-BASED SOIL MOISTURE INDEX ON HYDROLOGICAL SIMULATION FOR FLOODS PREDICTION

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This work is part of the OPERA Project. The general aim of the OPERA project is to test the benefit obtainable from the use of satellite observations within the existing Italian Civil Protection Operational Warning System against Floods. One of the main functionalities developed by the project regards soil moisture monitoring at catchment scale. At this stage of the project two different methods of soil moisture retrieval have been used to compare the effects on hydrologic modeling for flood forecast (Figure 1 and Figure 2).

The first method relies on well established techniques based on the apparent thermal inertia (Mitra and Majumdar (2004), Verstraeten et al.(2006)). A Soil Moisture Standardized Index (SMSI) has been derived from the MSG LST half-hourly product (LAND-SAF). SMSI maps have been produced over Italy from 2005 to present for all days where daily min and max LST estimates are available.

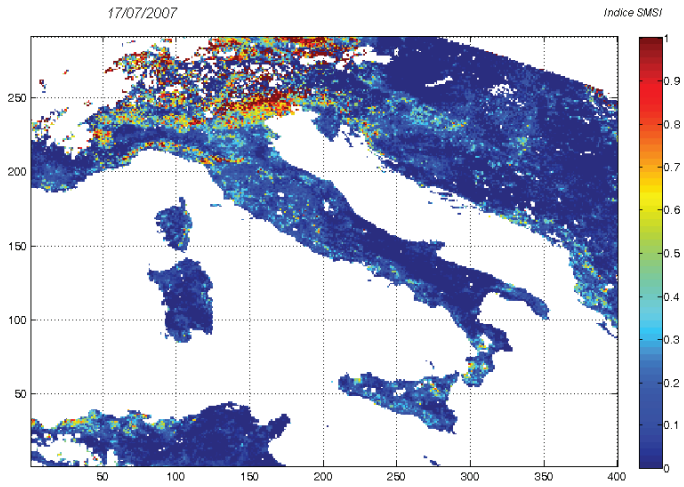

Figure 1 Examples of Soil Moisture Standardizez Index based on thermal inertia

The second method uses an approach based on sequences of LST estimates (NIR channels) coupled with a simplified SVAT model through a variational data assimilation technique, named ACHAB (Boni

et al., 2001a; Boni et al., 2001b; Caparrini et al., 2002; Caparrini et al., 2004a; Caparrini et al., 2004b) The data assimilation scheme provides a useful framework that allows us to combine measurements and models to produce an optimal and dynamically consistent estimate of the evolving state of the system. The assimilation scheme can take advantage of the synergy of multisensor-multi-platform observations in order to obtain estimations of soil moisture, surface fluxes, flux partitioning, and surface characteristics. Similarly to SMSI, Soil Moisture Index maps have been produced over Italy from 2005 to present.

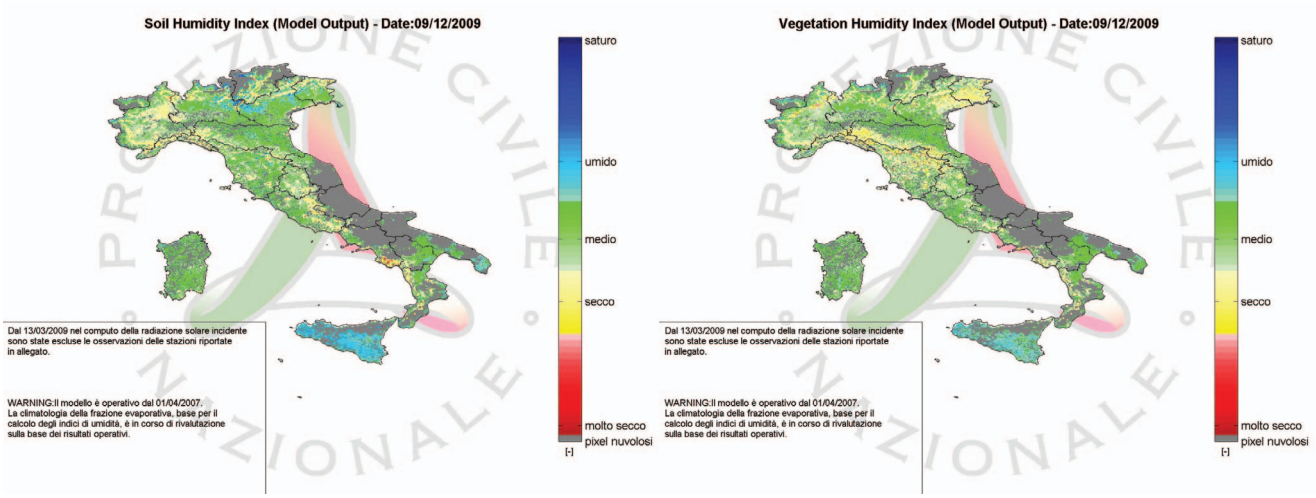

Figure 2 Examples of soil moisture estimates using ACHAB variational technique. In this case a separated index can be derived for bare soil and vegetation.

Three operational implementations of hydrological models (MIKE-NAM, DRiFt, MOBIDIC) at three different Civil Protection centers in Italy have been chosen as case studies in order to explore the possible benefits of using such indexes in the modeling process targeted to flood prediction. The three case studies show differences in terms of hydrological modeling complexity (from event to continuous models, from lumped to fully distributed) and in terms of local morphology. Means of linking quantitatively the soil moisture indexes retrieved from satellites to the models state variables have been drawn and a discussion of operational benefits and drawbacks of using such indexes with reference to historical case studies is provided.

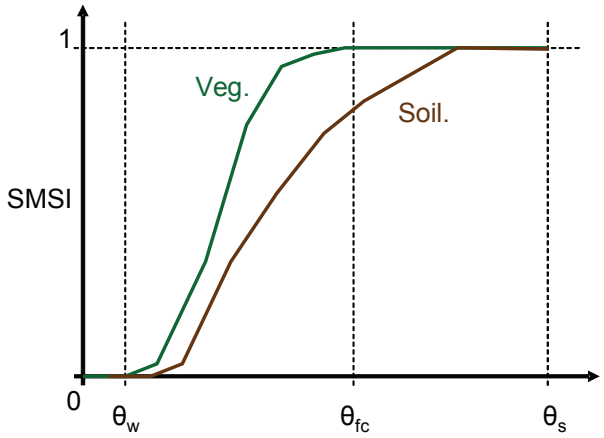

Figure 3 graphical representation of SMSI dependence on soil moisture in case of bare soil and vegetated pixels

The way of linking the Soil moisture indexes and the model state variables strongly depends on the nature of the index and on the schematization implemented in the hydrological model considered (3). Models proved to be substantially sensitive to soil moisture updates in all cases.

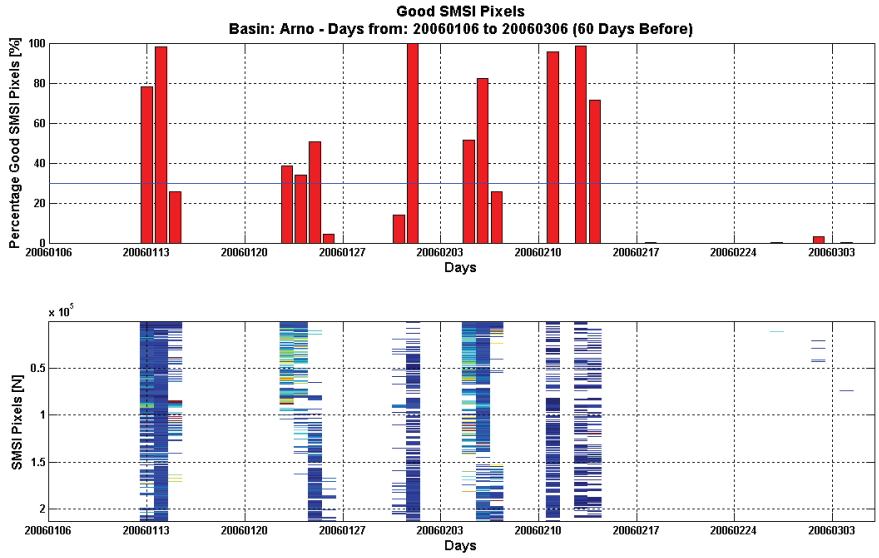

Figure 4 Good pixel estimates (SMSI) 60 days before a flood event: Arno basin

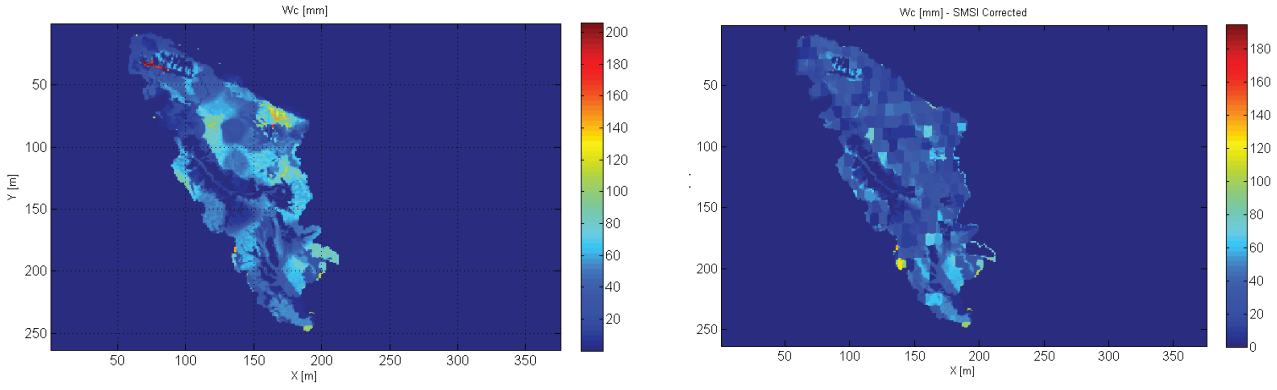

Figure 5 Soil moisture update at catchment scale: Arno catchment, MOBIDIC model.

The operational framework of this work required an analysis regarding the reliability of the soil moisture retrieval. The cloud cover often hampers the usability of the satellite soil moisture estimate (Figure 4). On the other hand the impact of soil moisture updates extends way back in the past, so that the hydrologic modeling capable of continuous soil moisture accounting are the ones that most benefit from such updates.

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