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Studying the relationship between superficial soil water content and observed Land surface Temperature with AHS data and modeling techniques within the SEN2FLEX experiment

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Algorithms for quantitative estimation of canopy biophysical variables from remote observation enable continuous crop status monitoring. Mediated by root apparatus, a link exist between crop water content and soil water availability. Previous research has evidenced the existence of a robust relationship between the water status of vegetated surfaces, their canopy development and the corresponding surface temperature. Although it is very difficult to determine with accuracy the soil water content of vegetated surfaces from surface temperature, this latter can be taken –under given circumstances– as a proxy of soil water status. This information, together with other observations in the solar range needed to determine land surface parameters, can be of great usefulness for the validation of hydrological distributed models, and possibly for a definition of data assimilation schemes. So doing, it is possible to increase the reliability of distributed hydrological numerical models, widely used as operative tools in a large number of applications dealing with water management problems.

The objective of the analysis presented here is to test a semi-empirical methodology to retrieve soil water content in the upper part of the root zone by means of thermal and optical airborne observations. The ESA SEN2FLEX (SENtinel-2 and FLuorescence EXperiment) experiment in Barrax (Spain) has represented an excellent opportunity to develop the proposed approach, thanks to the availability of multi-temporal high resolution optical images in the VIS, NIR and TIR ranges on a variety of surfaces with very different moisture conditions. A first step has been devoted to explore the relations between Land Surface Temperature and the Normalized Difference Vegetation Index (NDVI), derived from the AHS (Airborne Hyperspectral Scanner) thermal infrared and optical data, and ground measured soil water content and soil temperature. At the same time, soil water flow and soil temperature dynamics have been simulated by using the HYDRUS-1D code. The model has been supplied with soil parameters retrieved from laboratory analysis, along with crop characteristics gathered from imaging data analysis. A proper definition of upper and bottom boundary conditions has allowed a satisfactory forecast of root zone water availability for principal crops. Results of simulations are close to field observations, and explain the role of soil type and soil use. Using least square algorithm, simple line-fitting techniques has allowed the modelling of the relation between LST retrievals and soil water content in-situ measurements. Finally an estimation of distributed superficial water content has been made by applying the calibrated relation to thermal derived LST images.

Within all the limitation of the empiricism, this study has shown that high resolution TIR observations can be used as an indicator of soil water content in the upper soil layer. With the help of ad-hoc local calibration, this approach is useful to derive maps of the instantaneous soil water content. This information, even at a coarse level of accuracy, may results of great usefulness in the validation of distributed hydrological models, in the context of water management applications at local and regional scales.