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Operation monitoring of irrigation in the Campania Region (Italy) for the compliance of EU Water Directive by using Sentinel-2 data and OPTRAM model: the DIANA Project.

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Submitted Abstract

The actual extent of irrigated areas and the corresponding irrigation amounts are difficult to assess in most of the countries of the World. In EU regions, statistical data acquired by means of periodical surveys, i.e. Eurostat, are meant to give a picture at the national scale, but they are rather imprecise at regional and local scales, which are the most relevant for the management of water resources in hydrographic basins. The lack of accurate and up-to-date data is hampering the full implementation of the Water Framework Directive (WFD) and its compliance especially in Mediterranean regions. This has been highlighted in Communications from the EU Commission to the European Parliament (see for example the Com.673/2012), which have led to the imposition of additional conditionalities for the utilization of EU funds by Member States in the agricultural sector. For example, the Italian Ministry of Agriculture has adopted specific actions (Decree 31/07/2015) for monitoring irrigation areas and volumes on a regular basis to improve the compliance to the Water Directive. To this end, information provided by Sentinel-2 satellites are representing the most suitable technical basis for developing tools for final users and stakeholders.

The DIANA project (H2020 Grant agreement No 730109; http://diana-h2020.eu/en/) is focused on the development of Earth Observation tools for quantifying on a regular basis the irrigated areas and the irrigation abstractions and delivering these data to stakeholders in a simple and intuitive way by means of the most advanced Information Technologies.

The procedure developed in DIANA for discriminating irrigated and non irrigated crops is based on their different seasonal development or phenology assuming that in arid and semi-arid environment (like the Mediterranean Region), high trends of vegetation growth are only compatible with irrigation. To this end, dense time series of Sentinel-2 data have been processed for monitoring the seasonal pattern of changes in leaf area index (LAI) and Vegetation Indices such as NDVI (Normalized Differential Vegetation Index) and NDWI (Normalized Differential Water Index). This methodology benefits from improved spectral and temporal resolution of Sentinel 2A and 2B; in addition, SWIR bands provide very significant information for better identifying irrigated areas.

The case-study is the Sannio Alifano Irrigation and Land Reclamation Consortium located in Campania region (Southern Italy) during the irrigation season 2018, using dense time series of Sentinel-2A/B images and other ancillary data (ground truths, irrigation scheduling and agrometerological data).

From an operational point of view, the procedure consists of the following stages:

- Preliminary processing, consisting of atmospheric correction of S2 data, cloud masking and gap filling procedures;

- Production of multi-time series of vegetation index NDVI;

- Masking of areas out of interest, typically urban, mountain and wetlands such as rivers, lakes and water basins;

- Unsupervised classification (clustering) applied to time series of NDVI index maps: 70 clusters are generated and the corresponding temporal NDVI index pattern are generated, in fig.1 there are typical examples of irrigated (left) and non irrigated (right) pattern.

- Labelling of vegetative areas, identification of classes of vegetation categories that, given the water deficit conditions, show NDVI pattern compatible only with irrigation;

- Supervised classification: this is done using such training pixels of irrigated areas identified via the multi-time classification of NDVI index combined with on field inspection and ground-truth data; this phase is aimed at improving the accuracy of the unsupervised classification step;

- Mapping of irrigated areas along with possible integration with other GIS data (such as maps of parcel holding irrigation water rights).

Different machine learning supervised classification algorithms have been tested in order to analyse the impact in term of overall accuracy by introducing additional information, such the soil moisture index, derived on SWIR bands with the algorithm OPTRAM [1].

The quantification of irrigation abstraction has been carried out by applying the Penman-Monteith equation, with appropriate values of the canopy parameters namely the canopy resistance, crop height and surface albedo [2]. The canopy resistance is calculated from the Leaf Area Index, also derived from S2 data, and a stomatal resistance which takes into account the soil and canopy water status from soil moisture index of OPTRAM. From a comparative analysis it has been proven that the estimations of water volumes from Sentinel-2 are close to the data provided by in-situ metering devices of the Sannio Alifano consortium; furthermore, S2-based monitoring has an operating cost which is one or two orders of magnitude smaller than field installations.

The procedure is now currently used in the Campania region for updating every year the actual consistency of irrigated areas and the corresponding water volumes, in line with the conditionalities for the EU Water Directive compliance.

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