Definition of EO indicators for Irrigation Performance Monitoring

Executive Summary

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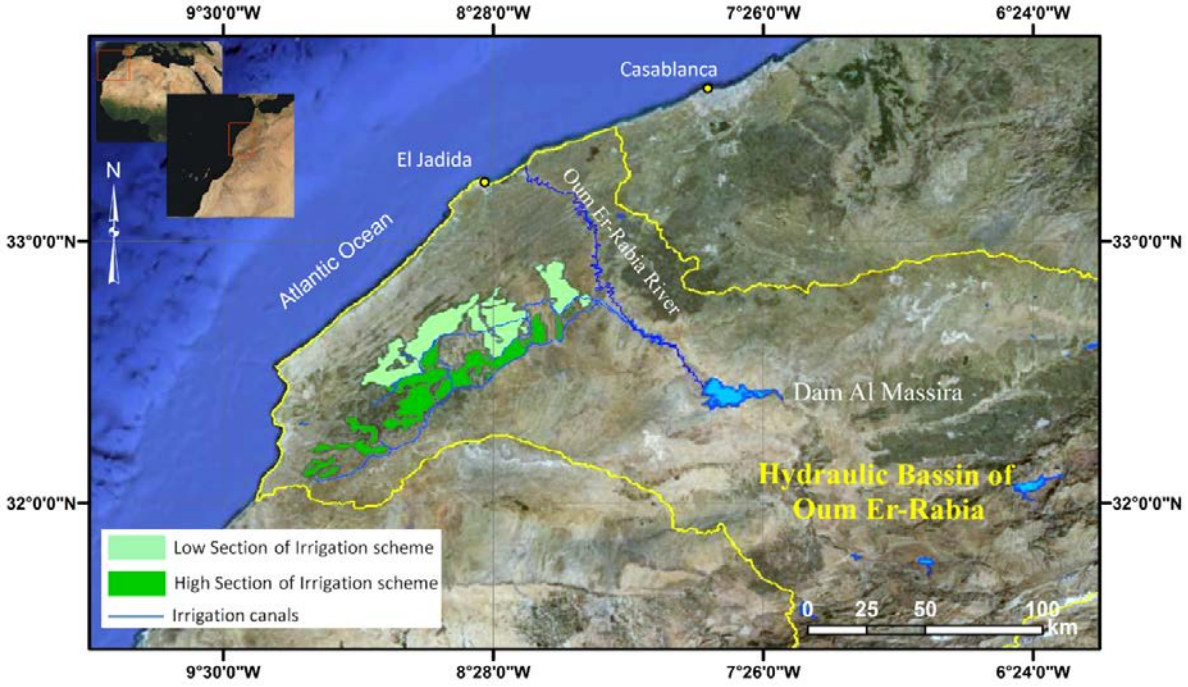
Picture:

Please put here a picture, image (format A5, resolution: 300DPI) representative of the study.



Motivation:

The study combined hydrologic models with multi-spectral remote sensing informationto assess the consistency of the water allocation with the actual irrigated area and crop water requirements (CWR) by refining algorithms for Irrigation Performance Indicators (IPI's). It evaluated thefrequency and continuity of monitoring CWR using medium / high spatial resolution satellite data.

Methodology:

Two approaches have been compared: A first one, called the vegetation index approach, based on the correlation between the Near Difference Vegetation Index (NDVI) and the value of crop coefficient. A second one, called the analytical approach (D'Urso et al., 1995), based on the direct application of Penman-Monteith equation by using reflectance-based estimates of canopy variables such as Leaf area Index (LAI), expressing the amount of foliage in m² per unit soil surface, the albedo (r), defined as fraction of solar radiation reflected by the surface, and crop height (hc). The two different techniques were evaluated in the entire Doukkala irrigation scheme. We have evaluated two indicators of irrigation performance: **IP2** to describe adequacy of water allocation in comparison with crop water requirements and **IP3** to describe the marginal benefit of applying irrigation water by means of the actual crop evaporation with and without irrigation.

Results:

Please list here a brief description of the most significant results obtained during the study (max:4items).

• In this study we have demonstrated the potential of using satellite remote sensing as a practical tool for crop water requirement (CWR) estimation for improved understanding of water use in major irrigation schemes such as the Doukkala. Repetitive multispectral and high resolution imaging (RapidEye (REIS), Landsat 5 (TM), Landsat 8 (OLI), SPOT4 (HRVIR1), and SPOT2 (HRV1)) of this agricultural area was used to provide a precise and quantitative evaluation of the crop water needs during different irrigation periods during the growing season of 2012/2013 and 2000/2001. The assessment of temporal evolution of ET_c estimates using K_c-NDVI and analytical approach shows that the two methods gives rather similar mean value throughout the year. The analytical approach captures more spatial variability than K_c-NDVI.

•The satellite-based estimates of ET_c were validated with success using ground-based measurements of h_c and fractional cover (f_c) of the dominant crops in the Doukkala irrigation scheme (Wheat, Maize, sugar beet and forage) with R^2=0.75 and RMSE=0.79 versus R^2=0.73 and RMSE=0.89 for the K_c-NDVI respectively the analytical approach.

•The appraisal of irrigation performance (IP2) in terms of adequacy between CWR and water allocation at both the district and CGR level documented a significant mismatch of requirements and allocations. Taking rainfall into account, the difference between requirements and water supply becomes acceptable in winter, but the irrigation water deficit increases in summer (90-145 $mm.m^{-1}$). The mismatch in both winter and summer becomes even lower when the Net Irrigation Water Requirement (NIWR) is taken as a reference, especially when considering that the conveyance and operational water losses are re-used by farmers.
In general, both spatially and temporally, the adequacy of water allocation to requirements could be improved by judicious management of irrigation, i,e by reducing the water excess in some CGR/date and use it in others in deficit.

• Four data set are combined (Land use, soil hydrological properties, irrigation water volumes and meteorological data) for IP3 monitoring. Crops are identified and mapped using multitemporal satellites images. Soil water retention and unsaturated capillary conductivity are estimated from grain size distribution, and combined with soil map. We have calculated relative transpiration and IP3 for an alfalfa crop grown on a clay soil, and 3 irrigation strategies: Irrigation water was applied when daily relative transpiration reached the tresholds (< 1) 0.4, 0.8.and 0.95. the Irrigation amount is equal to actual soil water deficit. Irrigation is most effective when targeting a moderate reduction in relative transpiration Ta/Tp= 0.8. Whith this strategie, irrigation amount is reduced by 20%, while actual transpiration is reduced by only 3%. The modelling using SWAP were spatialized for all crops and soil type in Sidi Bennour district, and for four differents pamping station (Birlaabid, Sidi smail extension, Sidi Smail gravitaire and Cuvette Sidi Smail). Low IP3 values in winter indicates that NIWR are met by precipitation with a minor contribution of irrigation.

Effectiveness of irrigation is highest in late spring at the time of maximum crop development.

Publications:

• Labbassi, K., Akdim, N. Alfieri, S.M., Menenti, M., Multisource EO Data for the optimal agricultural drainage water management in semi-arid area of Doukkala(Western MOROCCO): Potential of Sentinel-2 Type Observation, Sentinel 2 for science workshop, Frascati, 20-22 May 2014.

•AKDIM.N., ALFIERI, S., LABBASSI, K., MENENTI, Constructing Time Series of Crop Evapotranspiration by combining multiple Imaging Spectral Radiometers: a preview of the use of Sentinel2 data, Sentinel 2 for science workshop, Frascati , 20-22 May 2014.

• MENENTI, M., AKDIM.N., ALFIERI, S., LABBASSI, K., De Lorenzi F., Bonfante A., Basile A., Evaluation of the spatial variability of soil water content at the spatial resolution of SMAP data products : case studies in Italy and Morocco, EGU international conference, Vienna, 27 April-2May 2014.

•LABBASSI, K., AKDIM.N., ALFIERI, S.,, MENENTI, M., Observation and Modelling of Soil Water Content Towards Improved Performance Indicators of Large Irrigation Schemes, EGU international conference, Vienna, Vienna, 27 April-2May 2014.

•AKDIM.N., ALFIERI, S., LABBASSI, K., MENENTI, Monitoring of Irrigation schemes by Remote Sensing : phenology Vs retrieval of Biophysical variables, 3rd International Conference on the Use of Space Technology for water management jointly by the United Nations, Rabat-Morocco, 1-4 April 2014.

•AKDIM.N., ALFIERI, S., HABIB.A, LABBASSI, K., MENENTI, Definition of EO indicators for irrigation performance monitoring (Doukkala-Morocco), Alcantara final meeting, ESTEC in Noordwijk, 20 February 2014.

•AKDIM.N., ALFIERI, S., HABIB.A, LABBASSI, K., MENENTI, M., EO data for the exploration and support the optimal management of water in the Doukkala region (western Morocco). Tiger workshop, Tunis, 2013.

•AKDIM, N., ALFIERI, S., LABBASSI, K., MENENTI, M., Irrigation Performance using Hydrological Modeling and Remote Sensing: Case of Semi-arid Region of Doukkala, Morocco. Living Planet Symposium, Edinburgh, Kingdom United, 9-13 September 2013.

•AKDIM, N., ALFIERI, S., HABIB, A., CHOUKRI, A., MENENTI, M., LABBASSI, K., Definition of EO indicators for irrigation performance monitoring (Morocco)-(Ref: 12-A13). ALCANTARA Symposium, Faculty of Geo-Information sciences and earth observation (ITC), Twente, Netherlands, 23-24 June 2013.

•ALFIERI, S., AKDIM, N., MENENTI, M., LABBASSI, K., Assessing the effectiveness of irrigation using the SWAP model and remote sensing. ALCANTARA Symposium, Faculty of Geo-Information sciences and earth observation (ITC), Twente, Netherlands, 23-24 June 2013.

•AKDIM, N., LABBASSI, K., MENENTI, M., Definition of EO indicators for irrigation performance monitoring: Case of Semi-arid Region of Doukkala – Morocco. ALCANTARA meeting, Frascati, Italy, 3-4 October 2012.

•AKDIM, N., LABBASSI, K., HABIB, A., MENENTI, M., GANA, L., ER-RAKI, S., EO Data to support the optimal management of irrigation water in western morocco: case of semi-arid region of Doukkala. 9th International Conference of the African Association of Remote Sensing and the Environment (AARSE), El Jadida, Maroc, from October, 29 to November 2nd, 2012.

Highlights:

Please put here a more extended description of one particularly relevant result obtained or any further/ on going work (max: 80words).

The Pixel-wise CWR data provide a reference for better precision in quasi-real time scheduling of Irrigation water depth. The primary users of this information are farmers and the operators of the tertiary canals. The pixel wise CWR data will present useful information for precise irrigation scheduling, when the spatial variability of CWR in the plot scale is higher than RMSE. The CWR data aggregated by CGR and district provide a reference to adjust water allocation. The primary user of this information is the water management body in our case ORMVAD.