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A Simple approach to optimise water irrigation and cereal yield in the southern Mediterranean areas

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Population growth and the associated increase in demand for food have led to an urgent need for efficient agricultural production monitoring systems. Furthermore, southern Mediterranean, water shortage is likely to be one of the main pressing problems, resulting from combined effects of alterations in the hydrological cycle, anticipated under climate change, and of the increase in water demands, especially for agriculture.
The objective of this study is to develop a simple and spatial approach, based on remote sensing data, to optimize water irrigation and cereal production (dry matter DM and grain yield GY) in the semi-arid areas. The proposed method is based on the three efficiencies model of Monteith (1972). It consists of converting of solar radiation to the DM by the climate (Cc), interception (Ci) and conversion (Cconv) efficiencies. The proposed method combines the maximum of both Ci and Cconv (noted Cimax and Cconvmax) into a single parameter denoted Cmax, calculated as a function of cumulated growing degree day (CGDD). Also, the stress coefficient Ks, which affects the conversion of the absorbed solar radiation to the biomass, was derived from the surface temperature or the FAO-56 water balance at the root zone. In addition, the expression of Ks has been improved to optimize water irrigation amount and cereal production. It has been shown that the value 0.7 of Ks is considered as a suitable threshold for triggering irrigation in semi-arid areas. Otherwise, the developed method proposes a variable Harvest Index coefficient (HI) for partitioning the dry matter developed, between straw and grain. Since the ear apparition, the evolution of HI is derived from CGDD whereas, the final harvest Index (HI0) is estimated from the maximal value of Normalized Difference Vegetation Index (NDVI).).
The developed model has been calibrated and validated on both semi-arid regions (Haouz in Morocco and Kairouan in Tunisia). The obtained results showed a good agreement between observed and estimated DM and GY values. Average values of R2 and RMSE are about 0.98 and 0.35 t/ha for DM and 0.98 and 0.19 t/ha for GY, respectively.