Geophysical Research Abstracts
Vol. 21, EGU2019-14209, 2019
EGU General Assembly 2019

Validation of Normalized Difference Infrared Index (NDII) to estimate soil moisture in traditional olive cultivation systems, Tunisia

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Olive trees are one of the most cultivated plants in the south-eastern Tunisia, characterized by semi-arid to arid climate. In that area, olive trees are grown under rainfed conditions or in areas upstream traditional water harvesting techniques, called jesr (plural: jessour). Under conditions of water scarcity, having information on soil moisture could be fundamental, since crop productivity is mainly determined by soil water availability. There are direct (gravimetric) and indirect (TDR, FDR, tensiometers, neutron probe…) methods to estimate the soil moisture, but most of those are based on punctual sampling and demand an intensive field work, thus the use of satellite images can be an effective alternative to estimate the soil moisture on these areas. Sriwongsitanon et al. (2016) have shown on their work that the Normalized Difference Infrared Index (NDII) values are strongly correlated with modelled soil moisture in the root zone. The aim of this research is to validate the use of the NDII to estimate the soil moisture in olive tree orchards situated in Tunisia. Time series of NDII values were compared with measured soil water contents, collected at a non-regular time interval between 2009 and 2017, by using the novel Google Earth Engine platform. Soil moisture data was collected on tree olive orchards: Jessour sites Techine and Adbach and rainfed site Dar Dhaoui. The measurements on Jessour Adbach and Techine were made using a soil moisture probe, based on Time Domain Reflectometry (TDR). The moisture was measured every 15 centimeters from 0 to 120 cm. Access tubes remained installed on the field during the whole experiment, thus all the readings were collected on the same spot. On Dar Dhaoui, the gravimetric method was used, where five soil layers were evaluated from 0 to 100 cm. Though the measurements were not made exactly on the same spot but all the soil samples were taken on the same region. We tested the correlation between NDII (8-days composites) and soil moisture at each available depth, by using the ‘Landsat 7 Collection 1 Tier 1 8-Day NDWI Composite’, using a linear interpolation on the NDII data to find an estimated value on the days we had the soil moisture data. Once the correlation was tested, the data available was used to build equations that allows the estimation of soil moisture using the NDII, for each site. Results show that the soil moisture of the first layer had the best correlation with the NDII for all the tree sites evaluated. The coefficient of determination values (R2) for Dar Dhaoui, Jesr Adbach and Jesr Techine sites, were respectively 0.67, 0.63 and 0.62. Our analysis represents a confirmation of previous validation of NDII as a proxy of soil moisture, but based only on modelled values of soil moisture. The results allow us to conclude that Landsat 7 NDII values are correlated with the soil moisture for the three study areas. It is possible to infer the soil moisture variations for other points on the study area using NDII values.