Remote sensing of tillage areas and period in order to elaborate an initial cultural calendar in case of semi-arid region

Zeineb Kassouk (1,2), Hayfa Zayani (1,2), Bernard Mougenot (2,3), Raja Mabrouki (1,2), Zohra Lili Chabaane (1,2)

(1) INAT, Carthage University, National agronomic Institute of Tunisia, Rural engineering, Tunis, Tunisia (kassouk.zeineb@gmail.com), (2) LMI Naila LMI NAILA « Gestion des ressources en eau dans les milieux ruraux tunisiens », (3) Centre d'Etudes 3- CESBIO (IRD/CNRS/PS/CNES),18 av. Edouard Belin, bpi 2801, 31401 Toulouse cedex 9, France

Observation and assessment of agricultural practices such as tillage is a crucial topic for agronomic planning and management of cropping systems and for mitigating the effects induced by climate change and extreme events. The objective of this study is to present a new application of optical remote sensing for mapping soil tillage and initial cultural calendar for crops in semi-arid region.

Our approach is based on the potential of spectral indices derived from high spatial (10 m) and temporal (5 days) resolution Sentinel 2 data for the detection of tillage and to categorize that intensity in agricultural fields over Merguellil plain, one of the most important extensive agricultural region in Center of Tunisia, semi-arid region. We selected 115 images from 141 available images acquired between 03/06/2017 and 30/07/2018 considering low cloud cover acquisitions.

The Normalized Difference Vegetation Index (NDVI) was used to discriminate between vegetation, crop residues and soil. Second, seven spectral indices (Saturation Index (IS); Hue index (IF); Color Index (IC); Redness Index (IR); Gloss Index (IB); Normalized Difference Tillage Index (NDTI) and Soil Tillage Index (STI)) have been tested over different time step datasets, to distinguish their value for identifying tillage intensity. Principal components analysis (PCA) based on correlation statistics between temporal profiles of the spectral indices shows that IB is the best index for the detection of tillage. Validation of results in relation to 229 plots ground truth related to land use and agricultural practices shows that the combination of the NDVI and the IB indices provide very good separating power between deep, shallow ploughing and harrowing areas.

The application of the decision tree method with IB index thresholding and the change detection algorithm over six-month time series allowed mapping seven tillage period on the Merguellil plain, with an overall accuracy of 92.3% and a 0.68 Kappa coefficient.

The spatial and temporal analysis (crossing) of tillage and seasonal land use maps identify of tillage areas and timing for two main cultures (seasonal crops and cereals) and the elaboration of an initial cultural calendar. We identify two tillage timing for cereals, five timing for winter vegetables and three tillage timing for summer vegetables.

This information could be useful in regional decision support systems to refine crop calendars and to improve prediction of crop water needs over large areas.