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Object-oriented classification using quasi-synchronous multispectral images (optical and radar) over agricultural surface

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In the context of climate change (with consequences on temperature and precipitation patterns), persons involved in agricultural management have the imperative to combine: sufficient productivity (as a response of the increment of the necessary foods) and durability of the resources (in order to restrain waste of water, fertilizer or environmental damages). To this end, a detailed knowledge of land use will improve the management of food and water, while preserving the ecosystems. Among the wide range of available monitoring tools, numerous studies demonstrated the interest of satellite images for agricultural mapping. Recently, the launch of several radar and optical sensors offer new perspectives for the multi-wavelength crop monitoring (Terrasar-X, Radarsat-2, Sentinel-1, Landsat-8...) allowing surface survey whatever the cloud conditions. Previous studies have demonstrated the interest of using multi-temporal approaches for crop classification, requiring several images for suitable classification results. Unfortunately, these approaches are limited (due to the satellite orbit cycle) and require waiting several days, week or month before offering an accurate land use map.

The objective of this study is to compare the accuracy of object-oriented classification (random forest algorithm combined with vector layer coming from segmentation) to map winter crop (barley, rapeseed, grasslands and wheat) and soil states (bare soils with different surface roughness) using quasi-synchronous images. Satellite data are composed of multi-frequency and multi-polarization (HH, VV, HV and VH) images acquired near the 14th of April, 2010, over a studied area (90km^2) located close to Toulouse in France. This is a region of alluvial plains and hills, which are mostly mixed farming and governed by a temperate climate. Remote sensing images are provided by Formosat-2 (04/18), Radarsat-2 (C-band, 04/15), Terrasar-X (X-band, 04/14) and ALOS (L-band, 04/14). Ground data are collected over 214 plots during the MCM'10 experiment conducted by the CESBIO laboratory in 2010.

Classifications performances have been evaluated considering two cases: using only one frequency in optical or microwave domain, or using a combination of several frequencies (mixed between optical and microwave).
For the first case, best results were obtained using optical wavelength with mean overall accuracy (OA) of 84%, followed by Terrasar-X (HH) and Radarsat-2 (HV or HV) which respectively offer overall accuracies of 77% and 73%. Concerning the vegetation, wheat was well classified whatever the wavelength used (OA > 93%). Barley was more complicated to classified and could be mingled with wheat or grassland. Best results were obtained using of green, red, blue, X-band or L-band wavelength offering an OA superior to 45%. Radar images were clearly well adapted to identify rapeseed (OA > 83%), especially at C (VV, HH and HV) and X-band (HH). The accuracy of grassland classification never exceeded 79% and results were stable between frequencies (excepted at L-band: 51%). The three soil roughness states were quite well classified whatever the wavelength and performances decreased with the increase of soil roughness.
The combine use of multi-frequencies increased performances of the classification. Overall accuracy reached respectively 83% and 96% for C-band full polarization and for Formosat-2 multispectral approaches.