Analysing Cover Crop Presence in Piedmont Rice Paddy Area through Satellite Images

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Introduction

Italy is the major European rice producer. Nowadays, conventional cultivation is the main rice agricultural system. However, organic rice is becoming more important, with several farms converting to organic cultivation. Some techniques mostly used in organic agriculture, such as introduction of cover crops in the crop rotation, are enlarging their surface in conventional agriculture, as well.
Remote Sensing (RS) techniques are promising tools for understanding the relationship between canopy optical properties and crop biophysical parameters, then enabling crop status assessment (Stroppiana et al, 2018), as well as crop identification. Moreover, multi-temporal data acquired during the growing season can provide information about the adopted agronomic practices. This study used Sentinel-2 images to determine temporal patterns of NDVI values with the aim of i) evaluating the ability of temporal variation of NDVI to describe presence of cover crops in the crop rotation; ii) evaluate the consequences of the cover crops introduction on the rice management.

Materials and Methods

The study was conducted in Piedmont, NW Italy. Regione Piemonte administration provided a database, including all the cadastral particles enrolled in the Rural Development Programme (RDP). For each cadastral particles the area, the cultivated crop, and the management type (i.e. conventional, organic, or conversion) were specified for each growing season from 2013 to 2018. Based on information of the regional Land Registry, the cadastral particles were georeferenced, using QGis open-source software.
Sentinel-2 images from March to November 2018 were downloaded from the Copernicus open-access website (https://scihub.copernicus.eu). If available, Level-2A images, already atmospheric corrected, were selected. Otherwise, Level -1C images were processed using ESA's SNAP software. Only images showing a cloud cover lower than 40% were retained. Afterward, the Normalized Difference Vegetation Index (NDVI) was calculated for all images at 10x10 m full resolution, using the formula: (NIR-RED/NIR+ RED), where NIR represent the near infrared band reflectance and R the red band reflectance. In Sentinel-2 data, NIR is represented by band 8 and RED is represented by band 4. Next, mean NDVI for each cadastral particle was computed, using QGis. The final database consisted in several records with cadastral information, crop, management and soil type, and NDVI. Analysis of variance not assuming homoscedasticity was carried in order to discover differences in NDVI among crop management. Statistical analyses were performed using R Software version 3.6.0.

Results

Figure 1 represents the land use map created for the study area. Rice monoculture is the prevalent agricultural system, covering 64% of the area.
The temporal patterns of NDVI values during the 2018 growing season is shown in Figure 2. The differences among the management types appear evident. From March to May, NDVI values decreased progressively for organic, conversion, and conventional management type. The same trend is highlighted in October and November. Indeed, in organic rice and in conversion farms, winter cover crops are inserted between two subsequent rice crops. Starting from mid-May, NDVI values resulted higher in conventional management than in organic or conversion, suggesting that planting date is earlier in conventional management. In August, NDVI reached the highest values, with no differences among the

management types. After the peak, NDVI values resulted lower for conventional management than for organic or conversion rice.

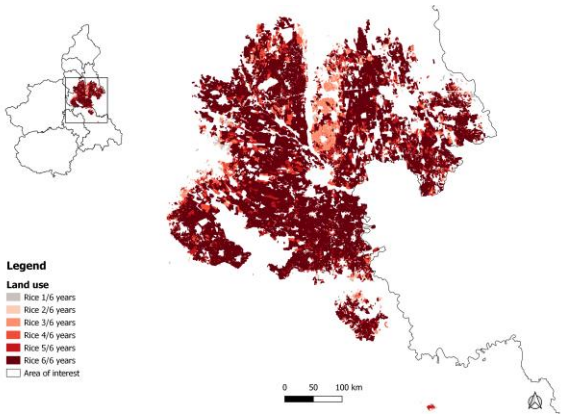

Fig.1 Land use map in the study area

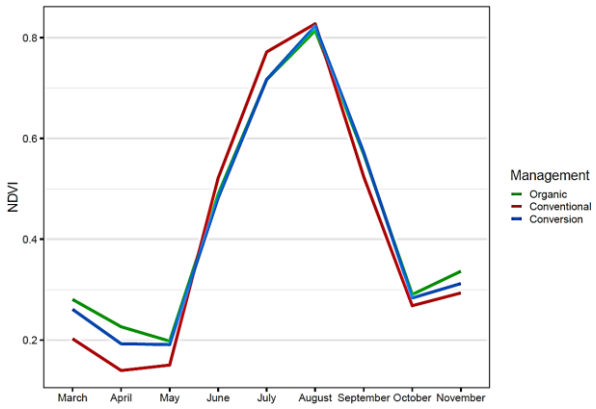

Fig. 2 Temporal pattern of NDVI recorded in 2018

The analysis of temporal patterns in NDVI values allowed linking crops spectral response to the management practices adopted in the field, highlighting differences among the management types adopted in rice cultivation. Higher values of NDVI during intercropping season revealed that remote sensing data are promising in assessing the presence of cover crops. Moreover, the late sowing of the rice after cover cropping seems to be evident as well, according to the most used agricultural practices adopted in organic farming.
Although differences appear evident, thresholds that allow identifying presence of cover crops are still undefined, due to variability of NDVI data related to soil types.

Conclusions

Temporal patterns in NDVI values seem promising in linking crops spectral response to the management practices. However, large variability associated to pedological conditions require further efforts to define specific thresholds to discriminate between cover crop presence.

Acknowledgments

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References

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