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Soil tillage ground data for validating tillage change maps identified by remote sensed data

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Introduction

Conventional tillage involves approximately 66% of the arable land in Europe [https://ec.europa.eu/eurostat]. This practice influences negatively soil water moisture, nitrogen and phosphorus fluxes, and it also increases surface runoff and soil erosion (Foley et al., 2011). For these reasons, the Common Agricultural Policy (CAP) promotes the conservation agriculture (CA) that can prevent and mitigate soil degradation processes (Rinaldi et al., 2022). It is, however, also important to set up appropriate methods to periodically assess the level of adoption of CA at global scale. The availability of Copernicus Sentinel data (S-1 and S-2), systematically acquired over large areas at high spatial and temporal resolution, can enable cost effective tools to monitor tillage/no-tillage practices, which can occur sparsely in space and in time. An assessment of the accuracy of the methodology employed to identify tillage changes is therefore necessary to get reliable products. The objective of this study is to present the last data set collected in an Italian cal/val test site and some examples of tillage change maps at high resolution (e.g. ~100m).

Materials and Methods

The Apulian Tavoliere agricultural test site represents an opportunity for large scale calibration and validation of earth observation derived products. A large historical data base about land use, plant and soil parameters is available. The detection of tilled fields, the accuracy improvement of the spatial and temporal resolution of Surface Soil Moisture (and irrigated fields) represent innovative and useful services in semi-arid environments (Mattia et al., 2022). For this purpose, over the past years, weather, land use, soil moisture, plant biomass and tillage data have been collected at Apulian Tavoliere (Italy, Rinaldi et al., 2020). The collected information were geo-referenced and compiled into a database. The remote sensed images employed for this study are Sentinel-1 (radar IW- GRD products) and Sentinel-2 (optical MSI-L2A products) time series, acquired every 6 and 5 days, respectively. In particular for the tillage change identification, the last ground data set of ground observations have been collected in the framework of the ASI-SARAGRI project.

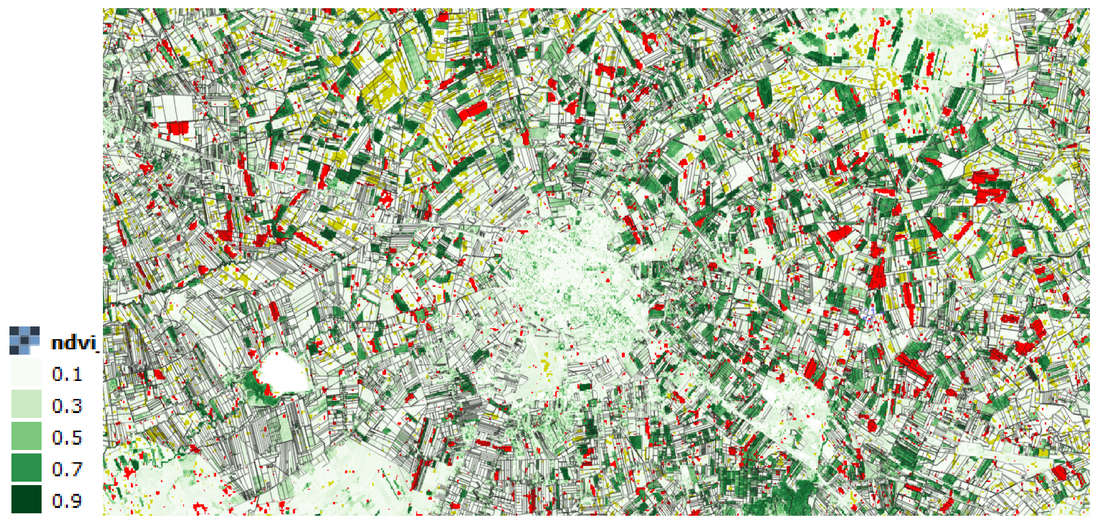

Fig. 1. Map (Apulian Tavoliere, Italy) of temporal changes (between 28 June - 4 July, 2021) of VH polarization S-1 data superimposed on a NDVI S-2 image. Rolled fields are in yellow, plowed fields are in red.

The main periods when tillage operations were observed with on the-road surveys have been from July to October. The following roughness classes, referred to ridges height or clump size, were used: 1 = less than 3 cm; 2 = from 3 to 10 cm; 3 = greater than 10 cm.

Results

As an example in Fig. 1 a map of tillage changes taking place between 28 June - 4 July, 2021 is shown. The map identifies a number of areas (red spots) of various dimensions, which are predicted as ploughed fields, after durum wheat harvest. These maps have been assessed comparing with ground truth data derived from local surveys. Preliminary results on historical data show that an overall The tillage change maps have been obtained by a double-scale change detection method applied over bare fields to time series of S-1 VH backscatter and S-2 NDVI, this last computed from the NIR (B8) and Red (B4) bands. The VH polarization of S-1 SAR data is particularly sensitive to surface roughness changes due to, for instance, ploughing, harrowing, etc. (Mattia et al., 2011); while S-2 NDVI are suitable to identify bare or scarcely vegetated soils, which are exposed to tillage operations. The two spatial scales are used to separate the contrast between the changes occurring at field scale (due to e.g. tillage changes) and those obtained at medium scale (due to e.g. precipitation) (Satalino et al., 2018). Accuracy of 82% over the Apulian Tavoliere site has been achieved. Anyway, additional accuracy assessment by using new data is in progress.

Conclusions

The study demonstrated the ability of SAR and optical sensors to monitor tillage at the farm scale, 100m resolution; future research is directed toward validating the NDVI threshold and backscatter variations to be used to monitor changes in soil roughness. This application, from the perspective of the CAP, which requires the adoption of practices related to conservation agriculture, may be useful in identifying tilled fields.

Literature

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