SENSAGRI tillage change proof-of-concept

The **SENSAGRI tillage change** product is a proof-of-concept service derived from Sentinel-1 (S1) and Sentinel-2 (S2) data over agricultural areas. It consists of binary maps of surface roughness changes related to tillage practices. The strategy adopted to derive the product consists of two steps. First, the S2 NDVI is used to identify bare or sparsely vegetated soils over which tillage practices are usually carried out [Satalino et al., 2018]. In presence of cloud cover, the ratio of VH/VV is utilized as a proxy of NDVI [Veloso et al., 2017; Palmisano et al., 2019]. In a second step, a **temporal change detection of S1-VH backscatter at two scales** – namely, the “field” (i.e., $\sim 0.1\ km$) and the “small-scale precipitation field” (i.e., $\sim 5.0\ km$) - has been implemented in order to discriminate changes due to surface roughness from those due to soil moisture. The rationale is that surface roughness varies at the “field” scale and unevenly in space, whereas soil moisture adjusts rather uniformly at a larger scale due to rainfall events. Therefore, the changes in VH, observed at the “field” scale only, are classified as due to roughness changes, whereas those occurring both at the “field” and “precipitation field” scale are discarded as likely due to precipitation.

The **algorithm has been validated** by using observations of various types of tillage practices, such as ploughing and rolling, gathered over the Apulian Tavoliere site (Italy) and Castile and León (Spain), in 2017 and 2018. The classification results indicate an Overall Accuracy that ranges from 68% (Castile and León) to 82% (Apulian Tavoliere). Similar figures have been obtained for the correspondent Producer’s Accuracy (PA) for the class tilled. A common result for the two sites is that PA_{tilled} is lower compared to $PA_{not\ tilled}$, whereas the User’s Accuracy for the class tilled is quite high (more than 90%). The reason for the lower accuracy obtained over Castile and León is that a fairly long period of intense precipitations was observed over the region, in particular in 2018. This is a confounding aspect because its effects on soil moisture (i.e., the abrupt increase and then the slower dry-down) can mask the tillage changes for a significant long period, then causing a decrease of the classification accuracy.

The classified product is a binary pixel wise map (i.e., 1 byte integer raster images) containing a flag class (i.e. tilled/not tilled), which refers to the identification of tillage changes occurred between two consecutive S1 passes (i.e. 6 days). The maps have a geographic lat/lon projection, WGS84 datum and a spatial pixel size of 0.0004°. These metadata are stored in an ENVI header file (.hdr).

One example of tillage change map, obtained over the Apulian Tavoliere on July 01, 2017, is shown in Figure 1. The map includes all changes identified from June 25 to July 01. The inset shows the S1 frame (in grey) and the mosaic of the NDVI covering the area. In the inset, the red square shows the location of the zoom. In the tillage map, the dark yellow and red colours represent negative and positive VH changes, respectively. Greenish colours code NDVI levels. The parcel borders are over-imposed. It is worth noting that tillage changes are identified always within parcels with NDVI lower than 0.3. In addition, they are fairly sparse in space and cluster in fields of different size.

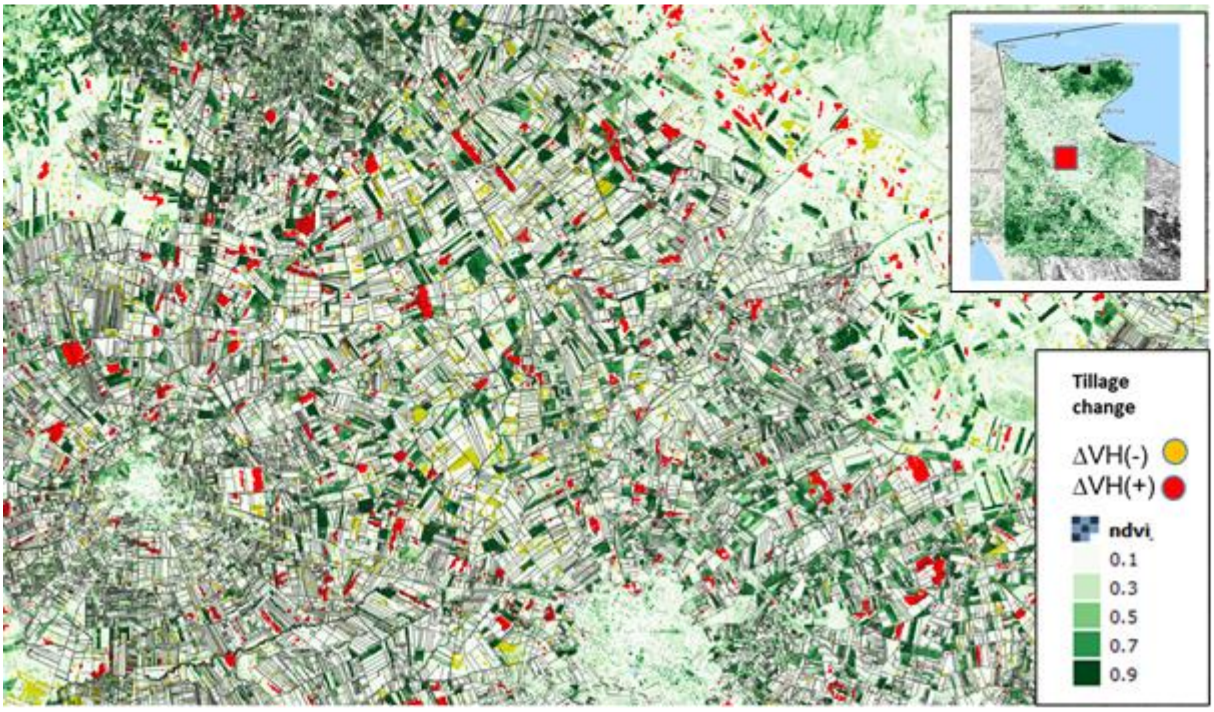

Figure 1. Tillage change map between June 25 and July 01, 2017 over Apulian Tavoliere area, over imposed to a mosaic of S2 NDVI on June 27, 2017. The dark yellow and red colours identify negative and positive changes, respectively. Greenish colours represent NDVI ranges. The boundaries of the parcels are also over-imposed.

References

SENSAGRI deliverable D6.13: Proof-of-concept of tillage change product v.3.
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