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Irrigation mapping using statistics of Sentinel-1 time series

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Irrigated agriculture is of great importance for global food security. Water resources management in agriculture is crucial for crop fields planning. Spatially-explicit irrigated area information is needed for different crops and different crop growing seasons [Ambika et al., 2016]. Remote sensing is a useful tool for mapping irrigated areas to better support water resources and agricultural development [Cai et al., 2017]. Optical remote sensing data is most widely used for irrigation mapping, however, it is limited by the weather conditions. The advantage of Sentinel-1 SAR missions opens the path to irrigation mapping under any kind of weather conditions with its high spatial and temporal resolutions. Radar remote sensing measurements of soil are very sensitive to the water content in the surface layer due to the pronounced increase in the soil dielectric constant with increasing water content [Baghdadi et al., 2016]. Sentinel missions also proved can be used to retrieve soil moisture under dense vegetation cover [Gao et al., 2017]. By analyzing the parameters derived from the SAR backscatter time series, the difference of irrigated and nonirrigated fields is revealed, thus can be separated by setting thresholds of the parameter vector.

In our study, four parameters are introduced including the mean value and the signal variance, which are the basic math statistics, auto-coherence related parameter (signal correlation length) and fractal related parameter (fractal dimension) derived from Sentinel-1 data over the period from June 2015 until September 2017. The study is performed using VV polarization over an agricultural site in Urgell, Catalunya (Spain). By combining all the parameters and setting thresholds to different fields type, the irrigated and nonirrigated fields are separated. In this methodology, the Sentinel-2 optical data is used for fields segmentation. Then the pre-processed radar data are averaged to segmented fields. For each field, the temporally related parameters are analyzed accordingly, and fields are classified as irrigated or nonirrigated or other types (forest and urban area) areas. The final results are compared with the supervised classification from Sentinel-2 multi-band data. The overall accuracy is 77%.

The methodology can be used in any areas of the Earth when SAR data is available. It is unrestricted by the weather condition and the location of the fields. The result demonstrates the potential of Sentinel-1 data for the irrigation mapping at fields scale.