Mapping irrigated permanent grasslands using Sentinel-2 data based on temporal patterns of leaf area index (LAI)

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Context

With climate change, drought events are more frequent with associated water restrictions particularly in the mediteranean regions. Irrigated Permanent Grasslands (IPG) in the Crau region (South-East France) offers high economic values (with a specific label COP), plays a crucial role in the recharge of the ground water table via flooding irrgation from March to October.

Their irrigation is related to the flow of the Durance River which risk to be greatly decreased by the future climatic forcasts. For the water managers at territory scale, it is very important to have accurate estimation of irrigated surfaces each year to prevent the needs

Thanks to the Corpernicus program with the Sentinel images acquired at high spatial and temporal resolutions, it is now possible to better characterize various crops based on phenology and monitor their agricultural practices.

Objectives

To evaluate the potentials of Sentinel-2 data to map Irrigated Permanent Grasslands (IPG) fields by requiring less or no ground truth data and easily reproducible each year (annually).

Approach

The method was based on the analysis of temporal profiles of leaf area index (LAI) computed at pixel scale and also capturing of agronomic traits (detecting mowing events). Aggregation was then performed at field scale to obtain map of irrigated plots at regional scale. Calibration was done on 29 fields and Validation of the algorithm was done using ground observations of 780 fields of both IPG (362) and not an irrigated permanent grasslands (NIG) with 418.

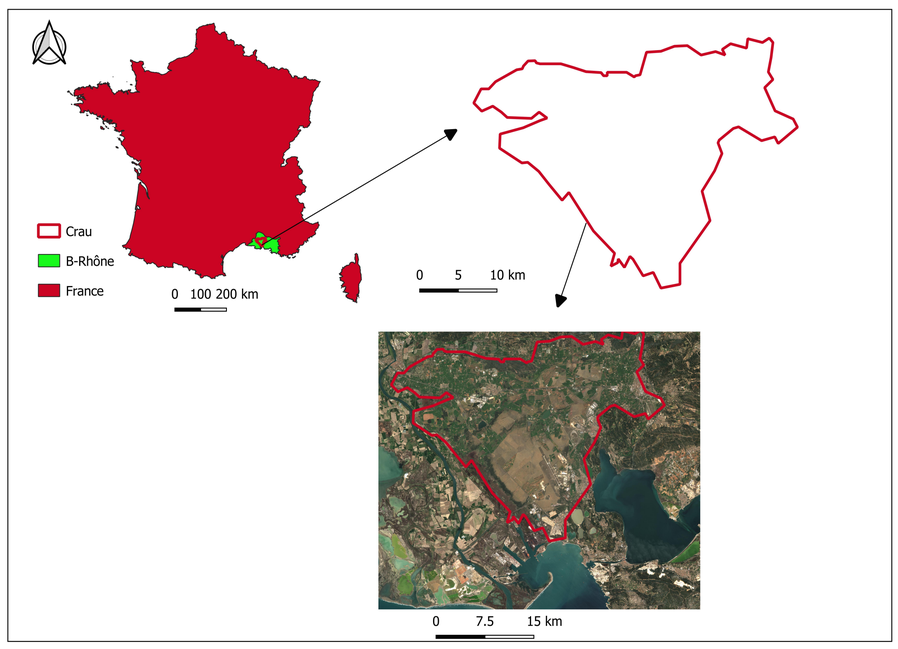
Data used

Sentinel-2 data (Tile 31TFJ) were downloaded from THEIA[1] platform (at level 2 corrected from atmospheric effects) for five years (2016-2020), then BVNet model (Weiss et al., 2002) was used to derived the biophysical variables i.e leaf area index (LAI) from the reflectances in green, red and near-infrared. For each pixel, we consider the annual temporal profile of the LAI.

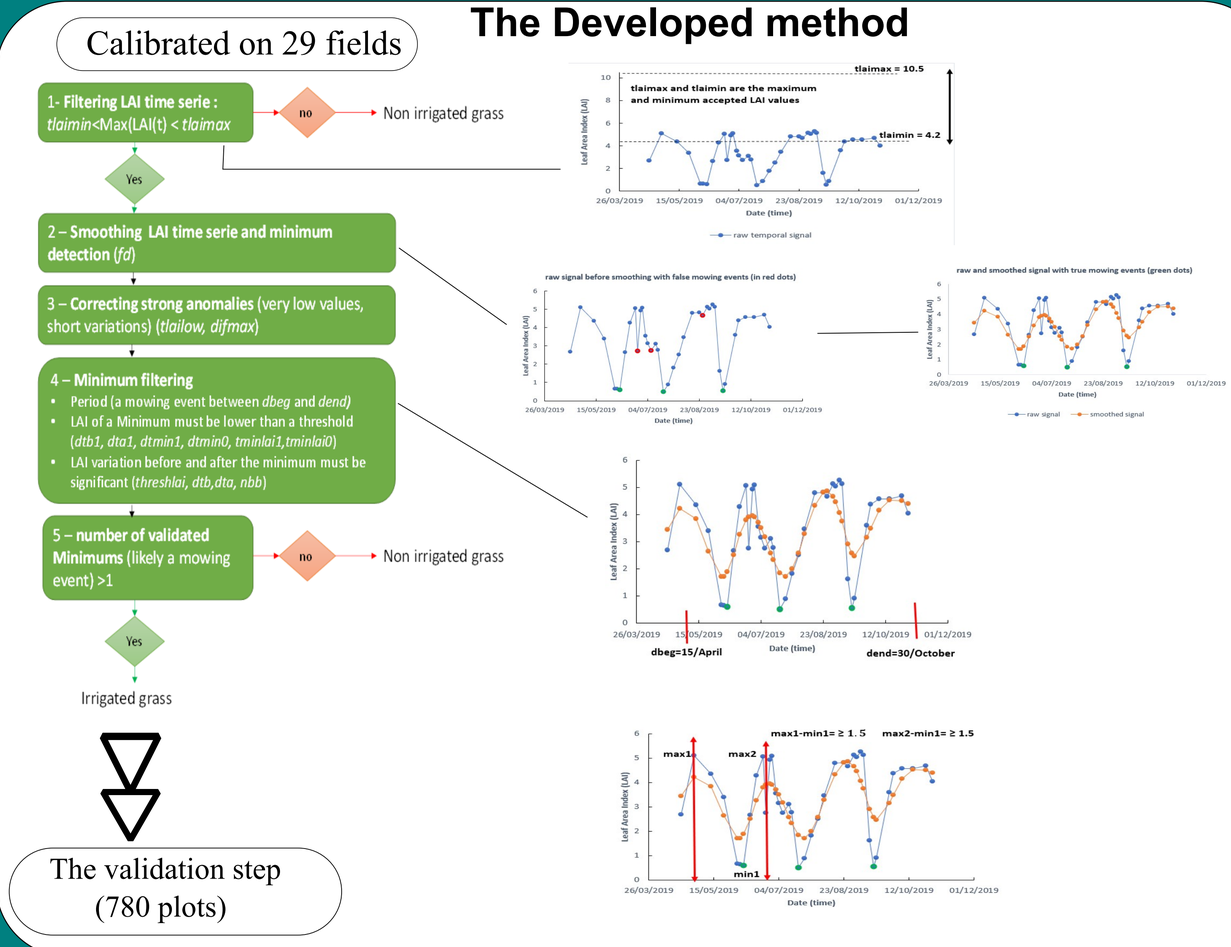
We also used field shapefiles from RPG[2], ground observations, THEIA landuse map for three years (2016-2018) and two years (2016-2017) classification using support vector machine (SVM) as to compare our results.

Study site

The Crau region (Fig. 1) is located near Rhone delta in South-East France with a surface area of 540 to 600 km^2 having IPG as the dominant.



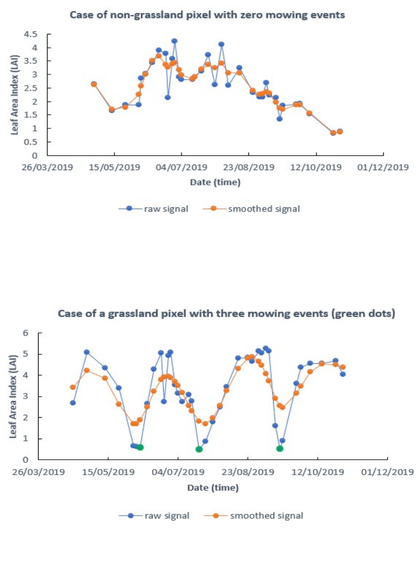
The Developed method

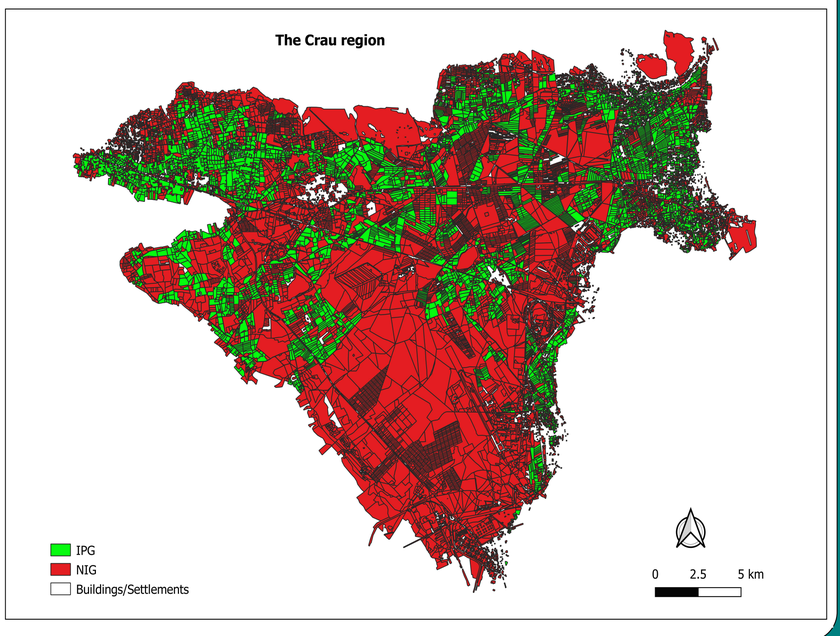


Comparisons with other classification methods

Methods	statistics	2016	2017	2018	2019	2020
Developed method	Overall accuracy (OA) Kappa (K)	96.69% 0.94	98.01% 0.96	98.67% 0.97	97.74% 0.96	96.15% 0.94
THEIA OSO classification	Overall accuracy (OA) Kappa (K)	96.42% 0.92	95.2% 0.93	97.75% 0.96		
Supervised classification	Overall accuracy (OA) Kappa (K)	91.25% 0.84	93.51% 0.88			

Spatial distributions of irrigated permanent grasslands (IPG) and non irrigated grasslands (NIG) in Crau region





Conclusion

Our method was based on the analysis of temporal profiles of LAI and showed good performances compared to other classification methods. It allowed us to make automatic delineations of IPG fields which present at least two (2) mowing events per year. The validated method can run without the need of ground truth information after calibration with few plots (29).

Acknowledgments

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