Mapping black Locust stands with Sentinel-2 and Venμs time series images

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MAPPING BLACK LOCUST STANDS WITH SENTINEL-2 AND VENμS TIME SERIES IMAGES

A test in Médoc, France

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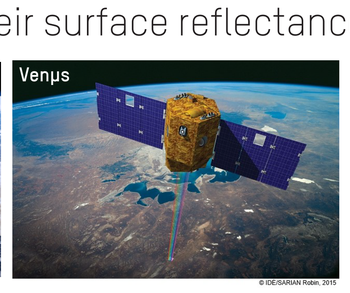
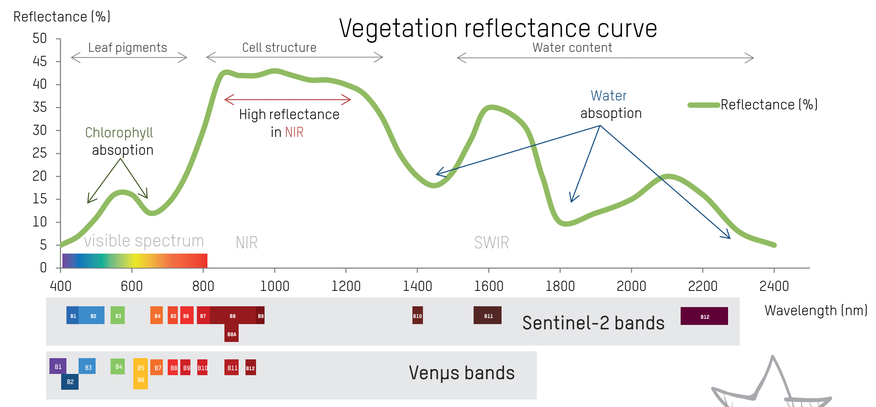
WHY SATELLITE DATA?

In France, *Robinia* sp. has been included in the latest version of the NFI large-scale forest mapping (*BD Forêt V2*). Considering the shortness of the list of broadleaved species , this addition provides an invaluable asset for management and geographical analysis. Due to a production process based on the interpretation of aerial photos, the **space-time coverage is yet uneven**. With a minimum mapping unit of 0,5 ha (and a width of 20 m), it may underestimate the **diffuse spatial dynamics** of pioneer tree species.

WHY NOW?

The recent earth observation satellites Sentinel-2 (launched in jun. 2015 & mar. 2017) and Venμs (aug. 2017) have been hailed as game changers for the monitoring of vegetation: a high revisit rate (5 days) and a multispectral high resolution camera allows discriminating forest stands by the analysis of the **spatial time-series** (SITS) of their surface reflectance [1].

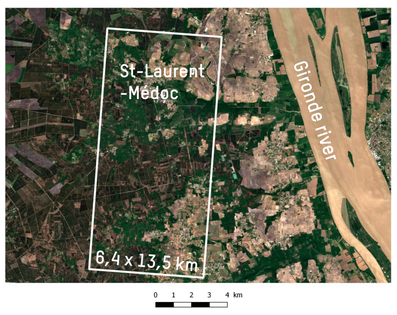




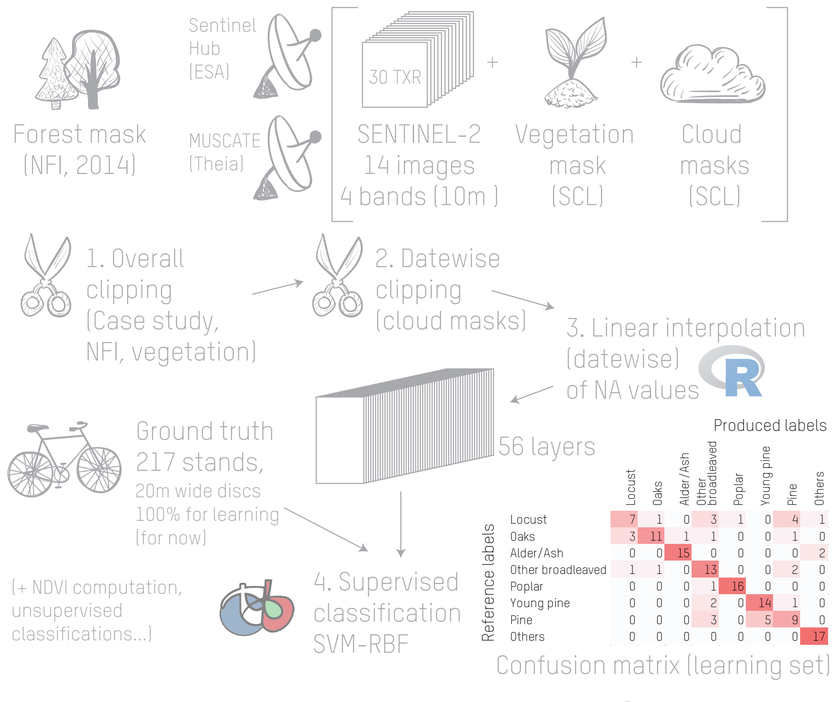
IS ROBINIA SP. A GOOD CANDIDATE FOR THIS?

Black Locust is able to expand in urban fringes and peripheries, cropland-vineyards interfaces, along linear infrastructure... It has also a **specific phenological pattern** (peak in chlorophyllous activity in summer, flowering in May [2]).

LOCATION



METHODS



Produced labels

Reference labels	Locust	Oaks	Alder/Ash	Other broadleaved	Poplar	Young pine	Pine	Others
Locust	7	1	0	3	1	0	4	1
Oaks	3	11	1	1	0	0	1	0
Alder/Ash	0	0	15	0	0	0	0	2
Other broadleaved	1	1	0	13	0	0	2	0
Poplar	0	0	0	1	16	0	0	0
Young pine	0	0	0	2	0	14	1	0
Pine	0	0	0	3	0	5	9	0
Others	0	0	0	0	0	0	0	17

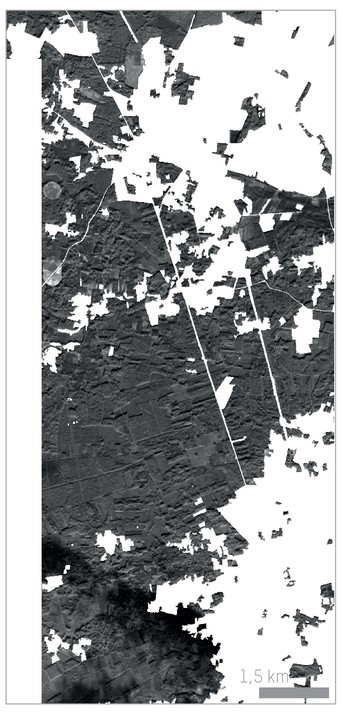
Confusion matrix (learning set)

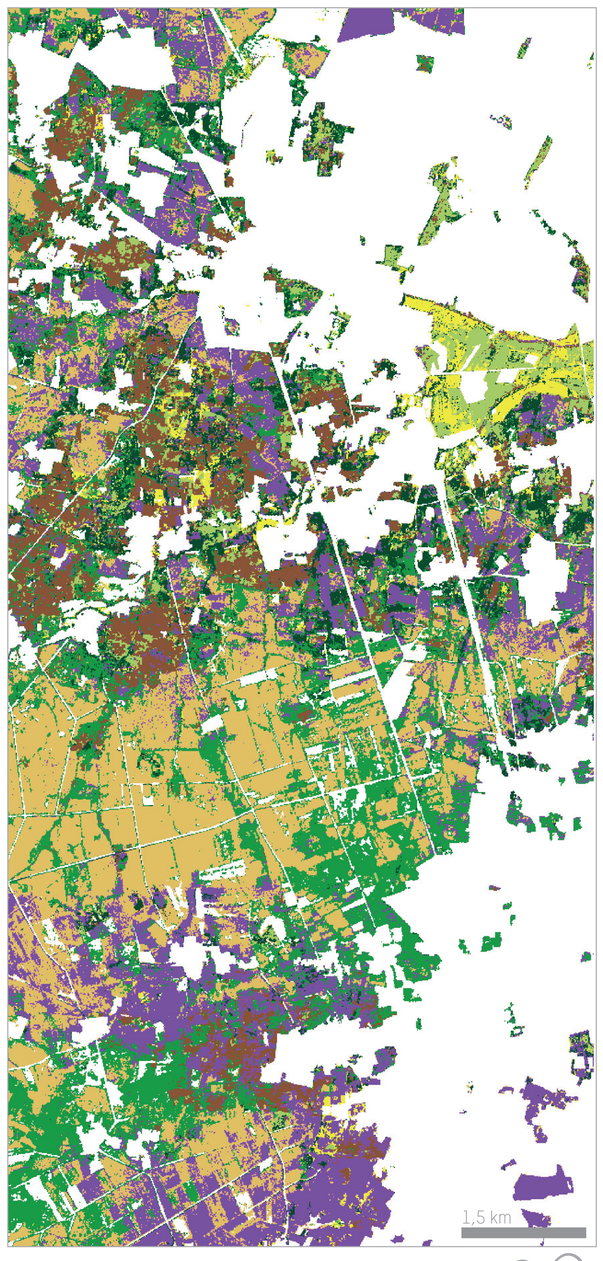
TENTATIVE RESULTS

As proposed by Karasiak *& al.* [1], a machine-learning method delivers a relevant supervised classification: the **Support Vector Machine** algorithm of the Orfeo ToolBox (with a Radial Basis Function kernel). It discerns most *Robinia* forests from their neighbouring Pine & Oak-dominated stands. It does also a good job on other broadleaved (*e.g.* Poplar *Vs*. Alder/Ash).

NFI map (*BD Forêt v. 2*), orthophoto (jul. 2014)

Composite of the 56 Sentinel-2 10m bands (mar. nov. 2017)

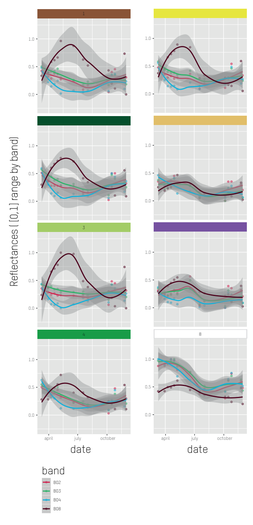




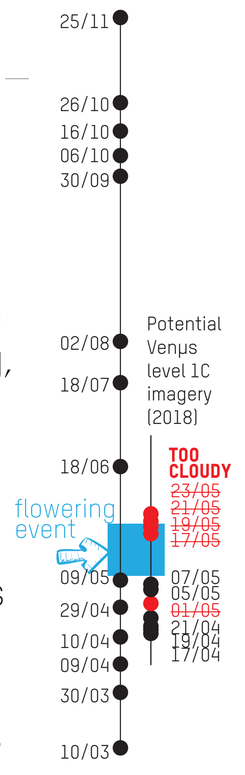
Classification map - SVM-RBF 8 classes

- Black Locust
- Deciduous Oaks
- Alder/Ash
- Other broadleaved species (Chestnut, Maple, Aspen...)
- Poplar
- Young maritime Pine plantation
- Maritime Pine
- Others (bare soil, artificial,pasture...)

Reflectance curves in the 4 bands for the 8 SVM-RBF classes



Selected Sentinel-2 imagery (2017)



MAY THE NFI MAPS OVER-ESTIMATE ROBINIA STANDS?

Part of the discrepancies between the classification and the NFI map can be attributed to time (a 4 year gap) and scale (with a marked improvement on edges and small woodlands). But Robinia forests are here actually **far from monocultures**: along with young coppices, it is also very present in mixed stands under *Q. robur* & *P. pinaster*. More originally, it was also found under high concurrence by Aspen (*Populus tremula*) and Alder Buckthorn (*Frangula alnus*).

MASKING THE CLOUDS OUT, AN ESSENTIAL TASK WITH 'SITS' DATA

Clouds are the main concern of remote sensers, but the need is even more pressing with time-series. The use of mask clouds (with level 2A data), followed by a linear interpolation was here instrumental. But frontier effects (& differences between ESA & Muscate algorithms) leave out **spatial artefacts**, to which some algorithms are highly sensitive (*e.g.* K-means unsupervised classifications). Seamless monthly composites provided by Theia (Level 3A) might be a trade-off to consider.

IT'S ALL WELL AND GOOD, BUT WHERE IS THE NICE FLOWERING!?

Robinia's flowering event is **short**: typically 10 days around the 15/05 in SW France. In case of a **cloudy spring**, whatever the merits of the observation platform, assuming a favourable window is a risky gamble: no image over Médoc in 2017 **and** 2018 ! The biological trait of black Locust that is the most evident for the neighbouring dwellers is thus the one that would remain elusive from the above.

THE NEXT STEPS

Densifying the set of ground truth points for proper cross-validation & area comparison (NFI). Testing Sentinel-2 3A & Venμs 2A over a season once images are available. Replicating the model on neighbouring regions.

REFERENCES

[1] Karasiak, Sheeren, Dejoux, Willm, & Monteil (2018) Monitoring and understanding the green-leaf phenology of tree species with Sentinel-2, *Sentinel-2 Theia Workshop*, Toulouse,
[2] Somodi, Čarni, Ribeiro & Podobnikar T (2012) Recognition of the invasive species *Robinia pseudacacia* from combined remote sensing and GIS sources. *Biological Conservation* 150(1):59-67.

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