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Assessment of dense Sentinel-2 and Sentinel-1 time series to map natural vegetation in a West African savannah protected area

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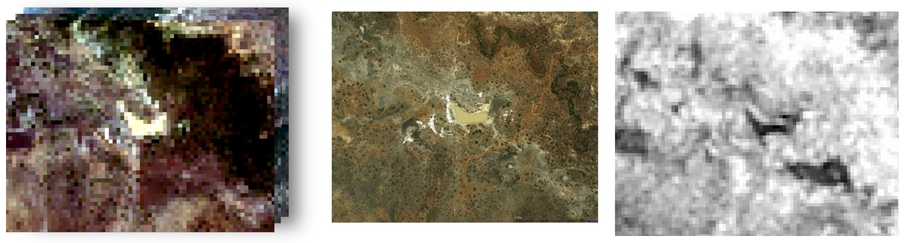
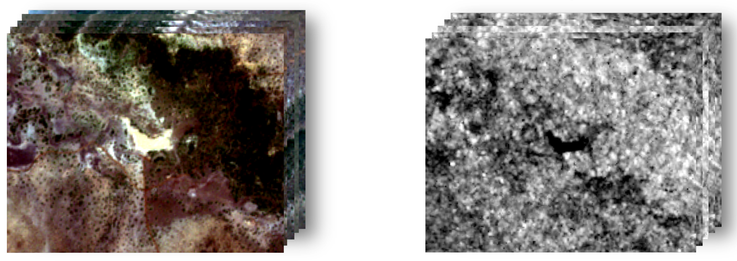
Introduction

Before...



Now...



Little is known about the potential of combining fusion of optical and radar images and time series analysis for natural vegetation mapping and biodiversity monitoring [1].

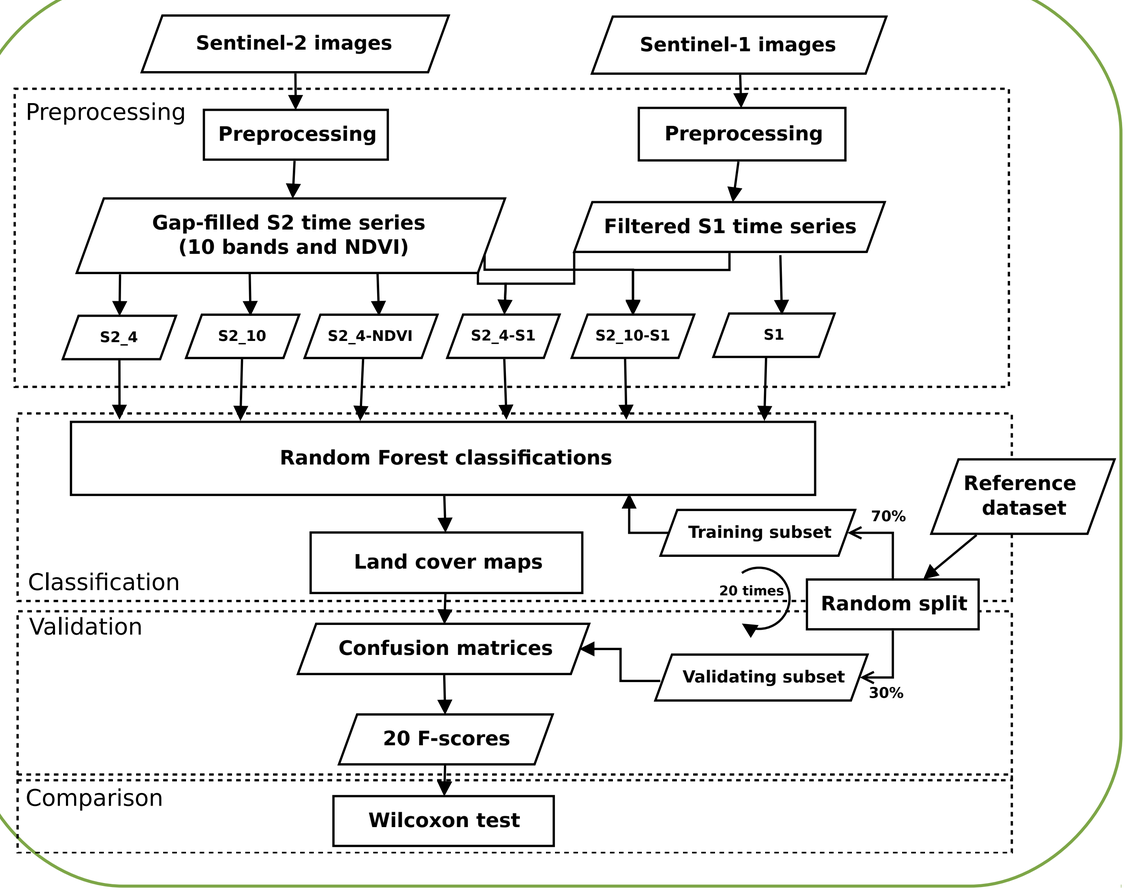
Objective

Analyse the complementarity between dense radar (Sentinel-1) and optical (Sentinel-2) time series for natural vegetation mapping over a Sahelian savannah protected area.

Hypothesis

H1: Classification based on fusion performs better than based on optical or radar data alone.
H2: Dense optical time series (> 30 images per year) significantly enhance classification outcomes compared with multitemporal analyses (5-6 images per year).

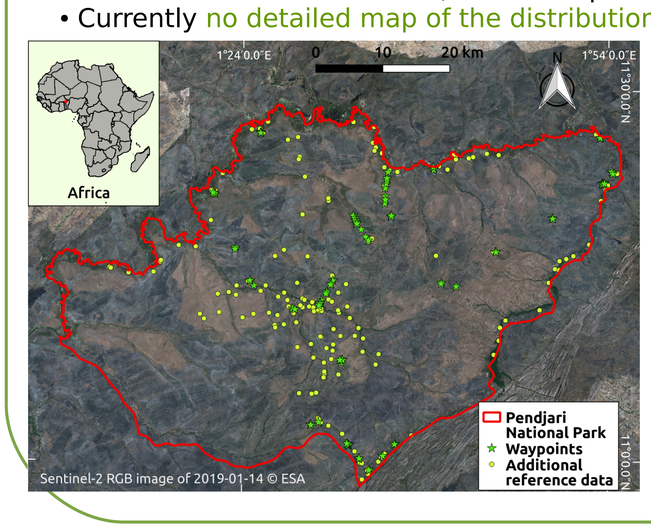
Method



Study area and field data

Pendjari National Park (Benin)

- Largest remaining preserved savannah ecosystem in West Africa (2,800 km²);
- Key biodiversity hotspot (elephants, endangered West African lions and cheetahs) threatened by anthropogenic pressure and climate change [2];
- Sudanese-Guinean climate (av. annual precipitation: 1,100 nm);
- Currently no detailed map of the distribution of natural habitats.



A field survey was conducted in January 2019 to collect reference data, categorized into 9 classes:

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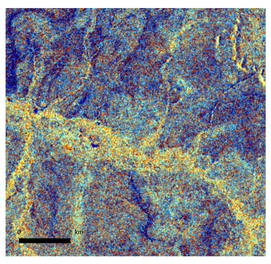
Land cover classes
Grass savannah
Shrub savannah
Tree savannah
Woodland savannah
Forest
Water bodies
Temporary wetlands
Bare ground & built up
Rocks vegetation

Remote sensing data

Sentinel-1 time series

Backscattering coefficient σ^0 in polarizations VH, VV, VH/VV (10mx10m)

Color composition of one acquisition *(18-10-2018)*

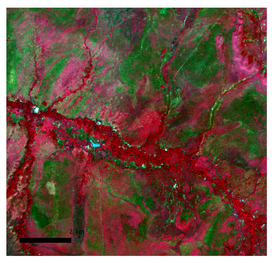


Time series associated to the same pixel *(grass savannah)*

31 dates

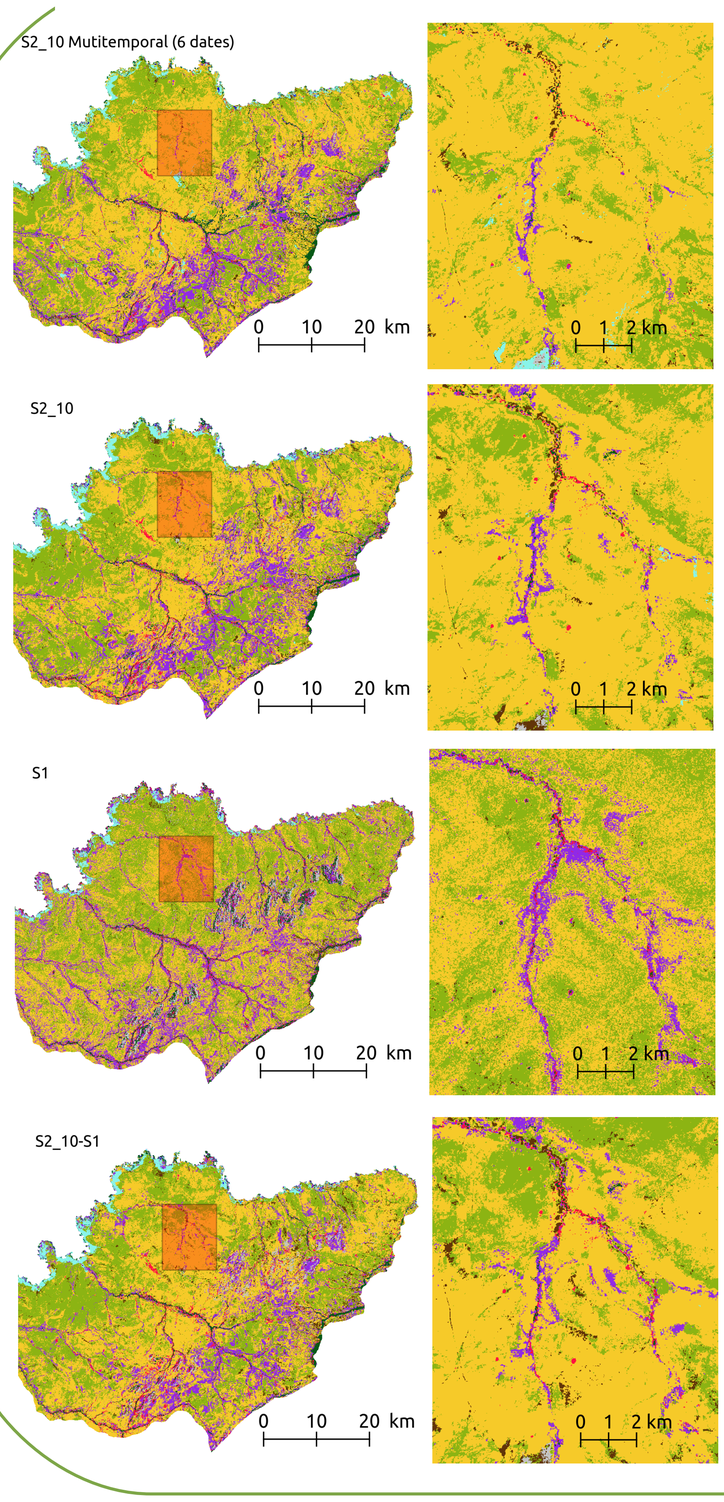
Sentinel-2 time series

Reflectance in bands B1, B2, B3, B4, B8, B5, B6, B8A, B11, B12 and NDVI (10mx10m)



43 dates

Results



Conclusions

- H1 ✓ Combination of Sentinel-2 and Sentinel-1 time series performs better on average than Sentinel-1 and Sentinel-1 time series alone to classify savannah vegetation, but not significantly better than Sentinel-2 alone.

Fusion optical + radar time series

Our results show the potential of dense optical and radar time series for reliable monitoring of changes in savannah habitat, providing important data to inform the management of protected areas.

Outlooks:

- Classifying area covered by different Sentinel-1 orbits and improving fusion method.
- Accounting for the order of the temporal variables during the classification.

- H2 ✓ Using dense Sentinel-2 time series significantly improves savannah classification compared to using a few (6) images per year.

Dense optical time series

References

[1] C. Kuenzer, M. Ottinger, M. Wegmann, H. Guo, C. Wang, J. Zhang, S. Dech, and M. Wikelski. (2014) Earth observation satellite sensors for biodiversity monitoring: potentials and bottlenecks, *International Journal of Remote Sensing*, vol. 35, no. 18, pp. 6599–6647.

[2] O. Amahowe, L. Houessou, S. Ashanti, S. and A. Tehou (2013) Transboundary protected areas management: experiences from W-Arly-Pendjari parks in West Africa. *PARKS*. 19. 95-105.