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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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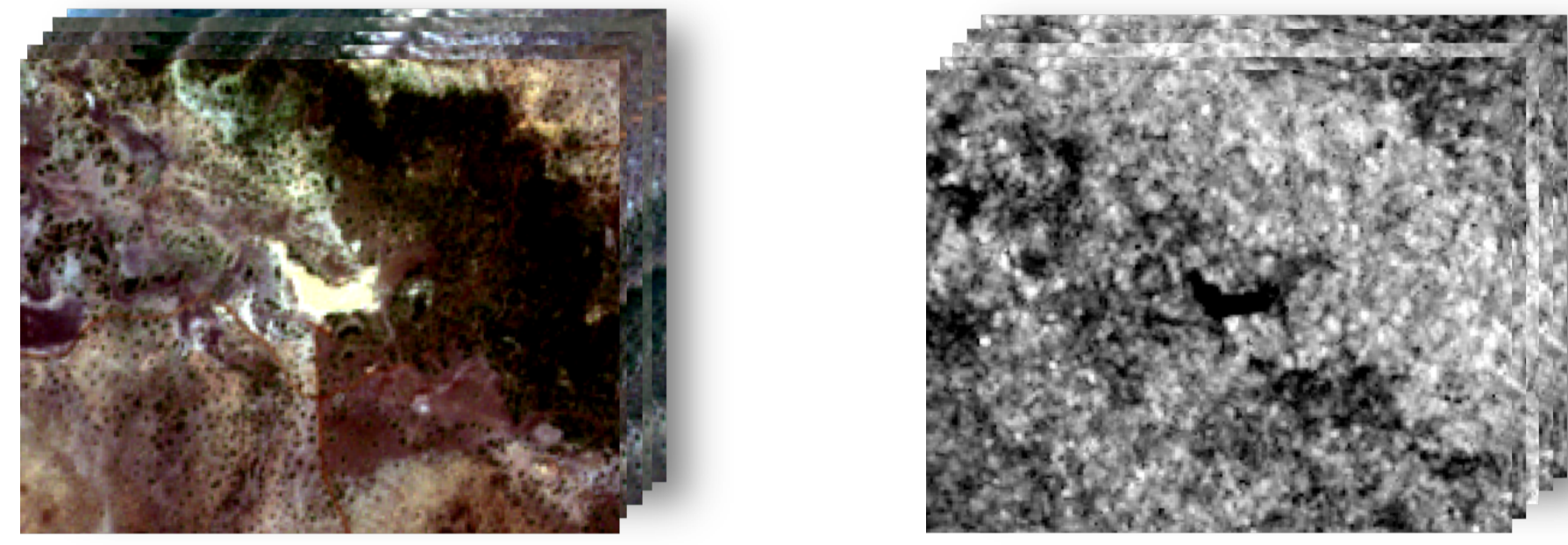


## Introduction

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].

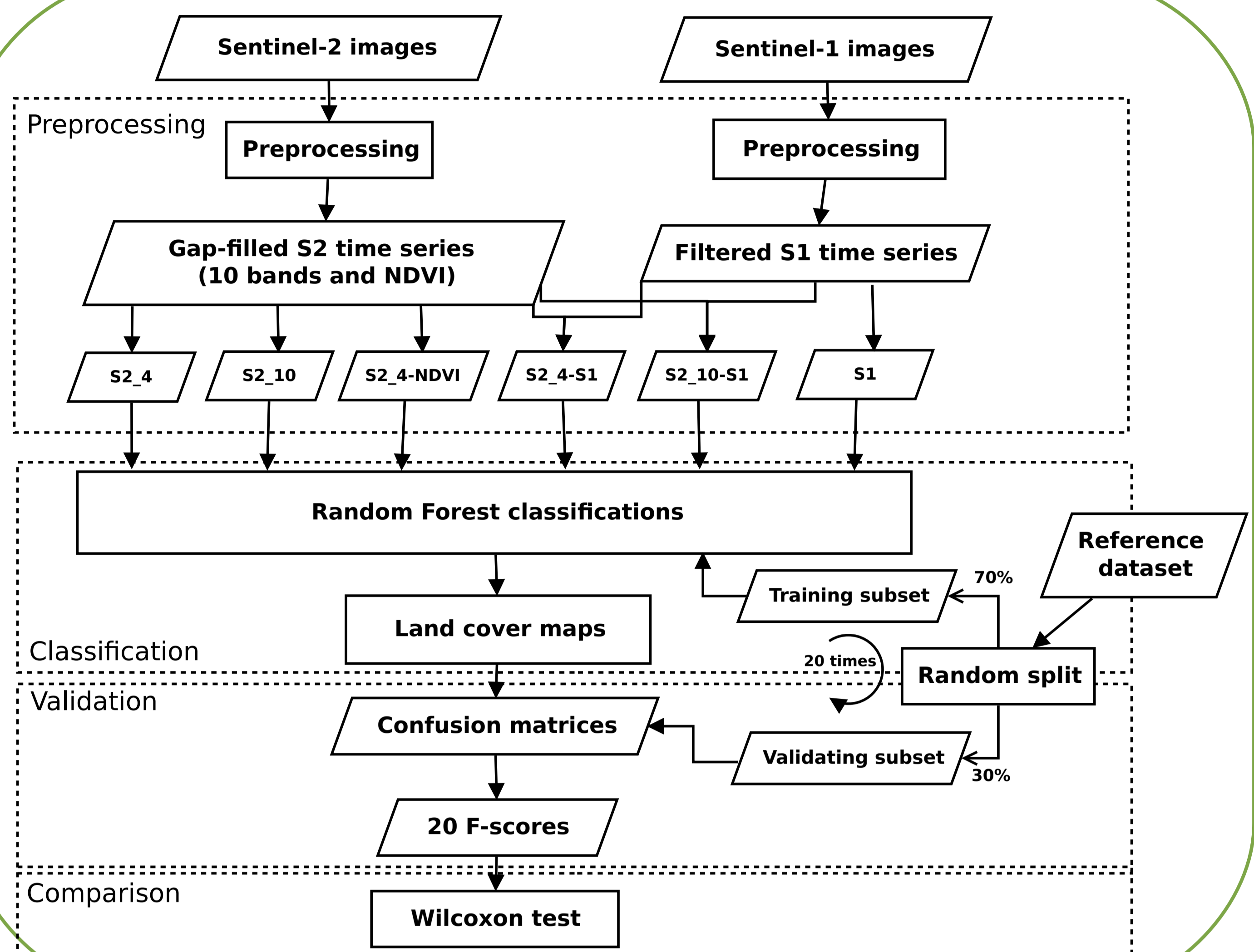
### Objective

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).

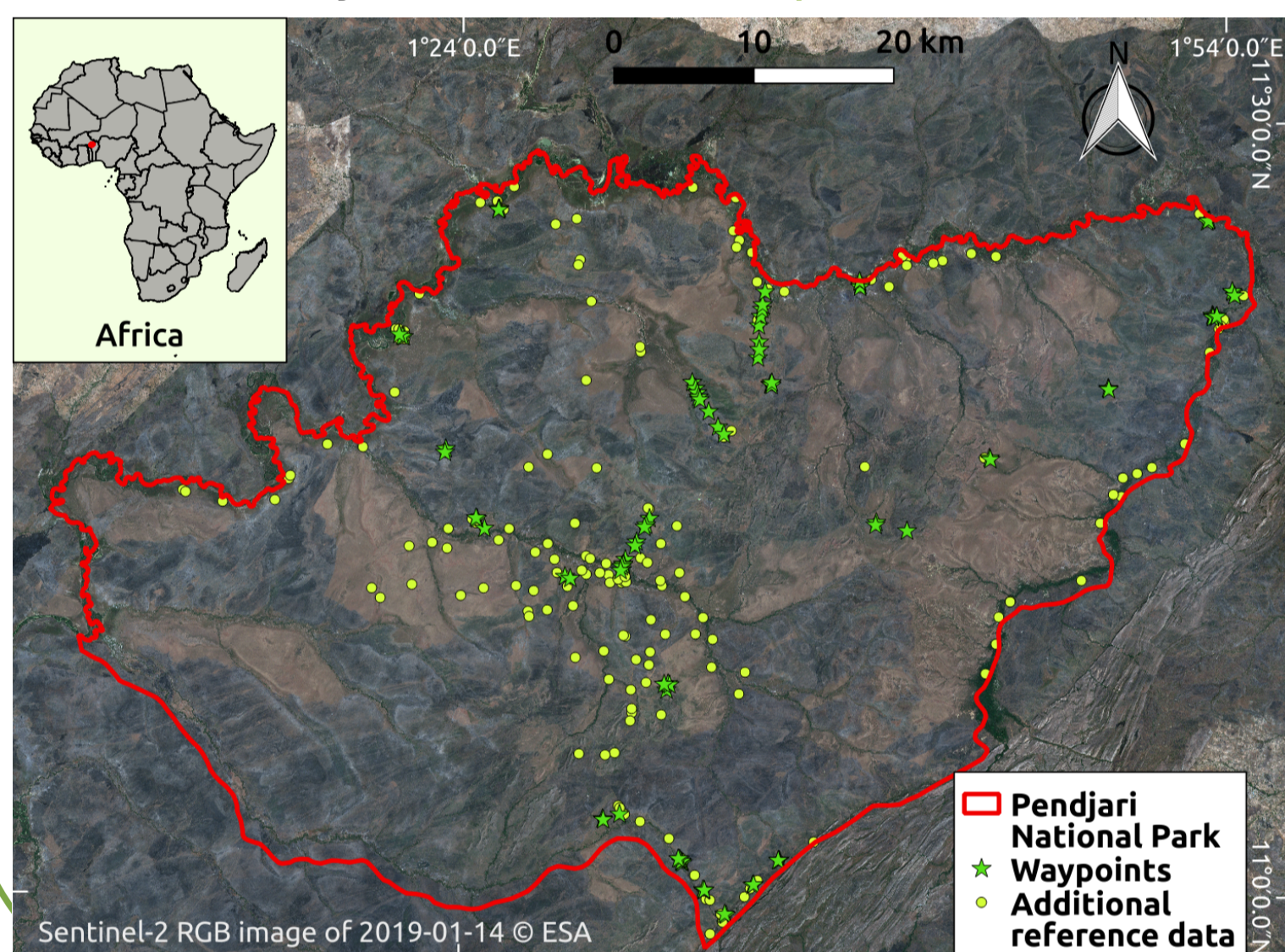
## Method



## Study area and field data

### Pendjari National Park (Benin)

- Largest remaining preserved savannah ecosystem in West Africa (2,800 km<sup>2</sup>);
- 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 mm);
- 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:

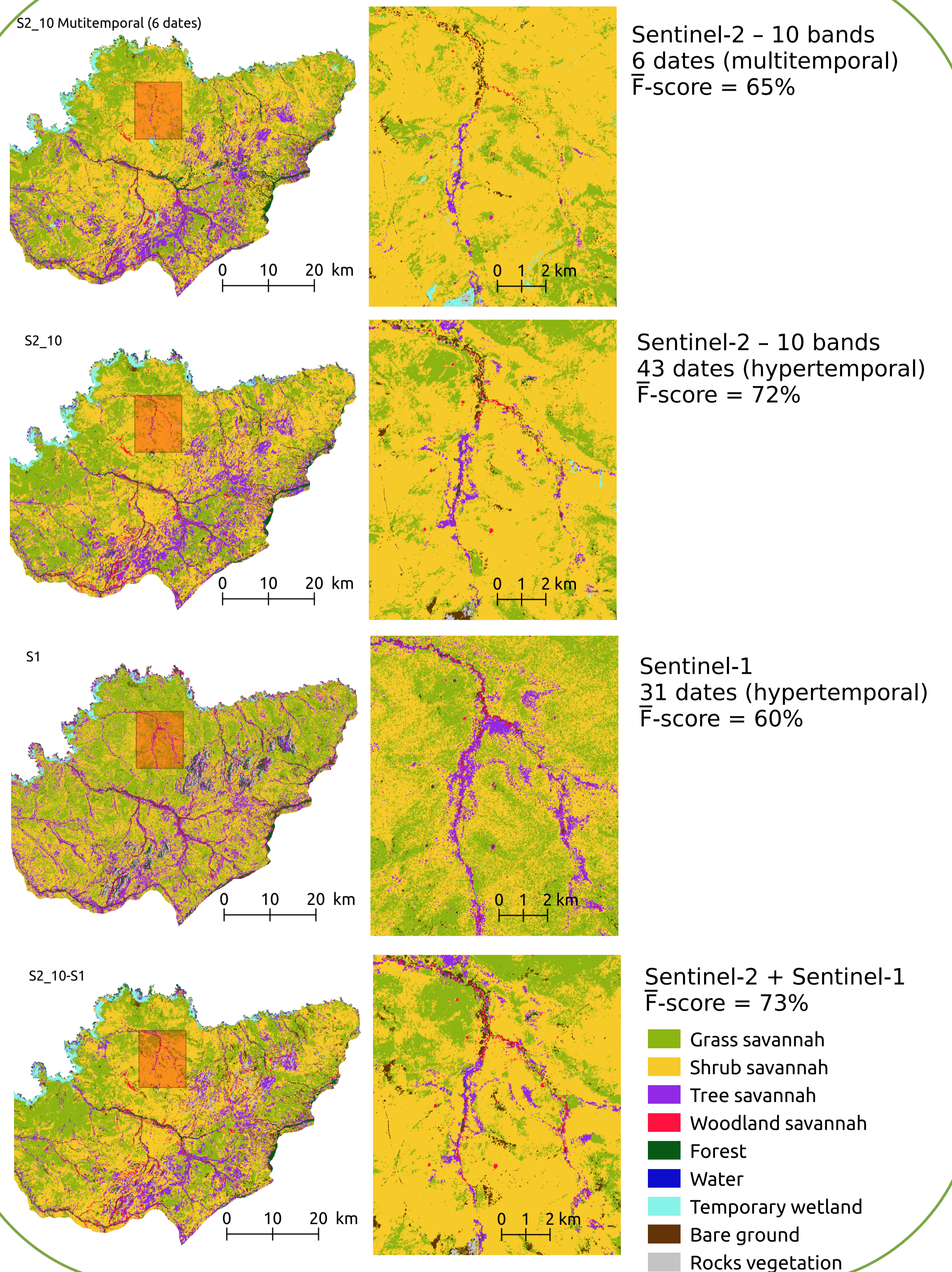
#### Land cover classes

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



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## Results

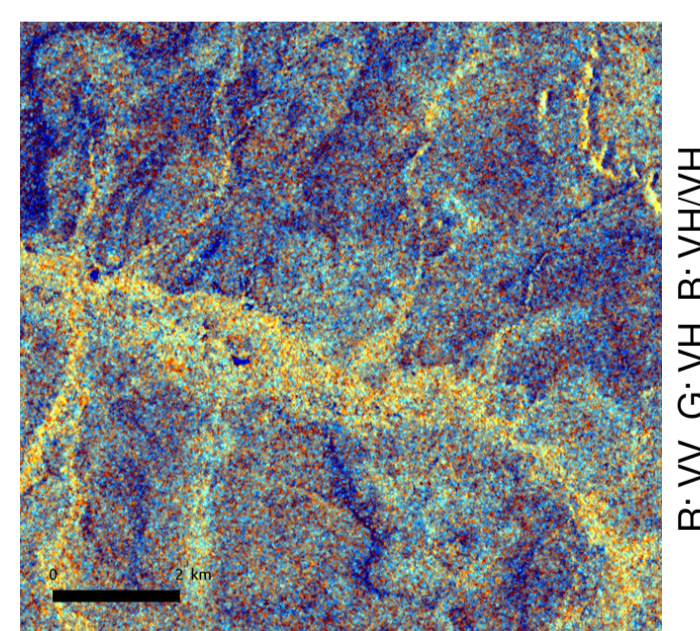


## Remote sensing data

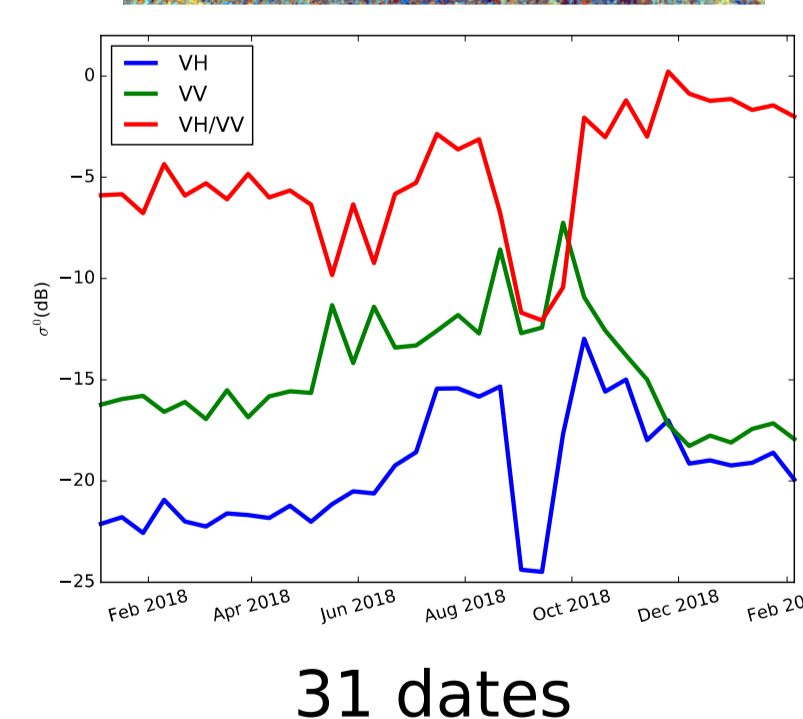
### Sentinel-1 time series

Backscattering coefficient  $\sigma^0$  in polarizations VH, VV, VH/VV (10m x 10m)

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

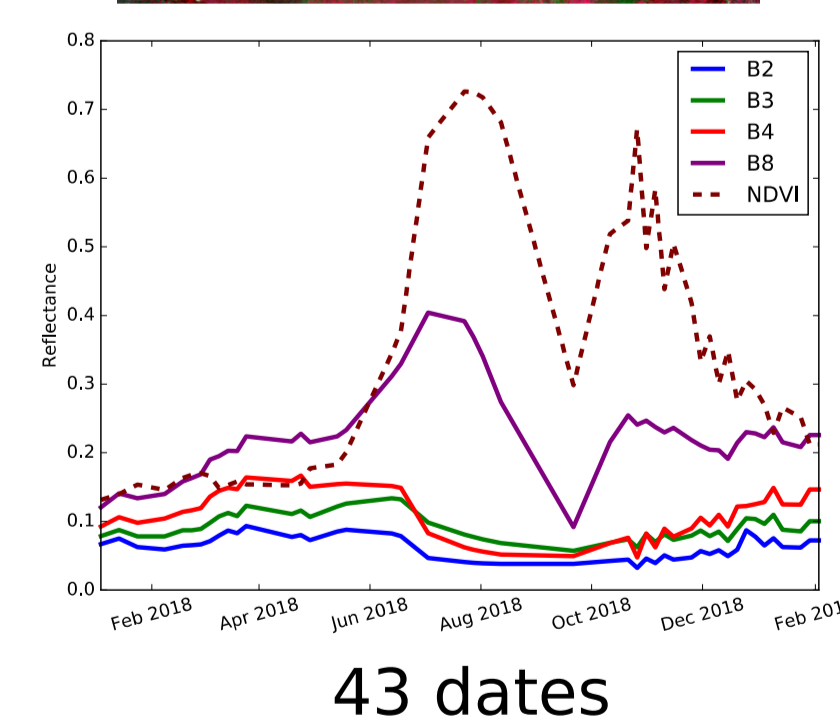
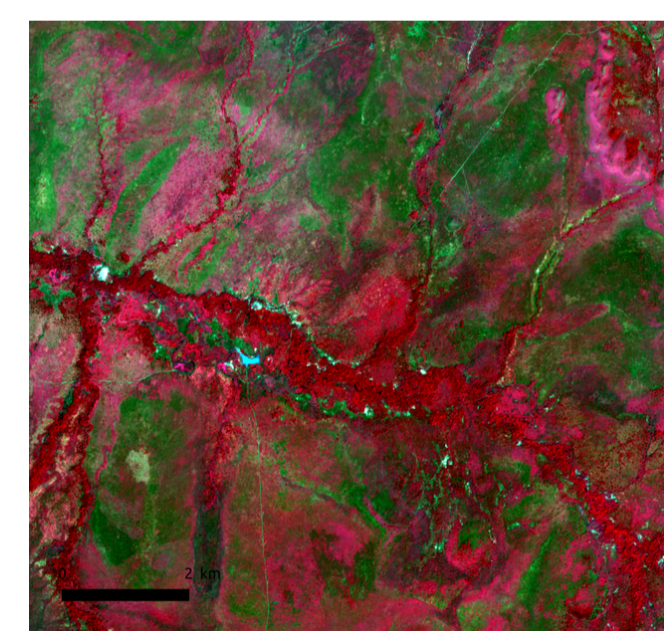


Time series associated to the same pixel (grass savannah)



### Sentinel-2 time series

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



## 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.