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# IMPROVING THE ASSESSMENT OF BLUE CARBON STOCK OF MANGROVES USING REMOTE SENSING ALONG THE AMAZON COAST



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Espace DEV  
OBSERVATION SPATIALE, MODÈLES  
& SCIENCE IMPLIQUÉE



i-Sea



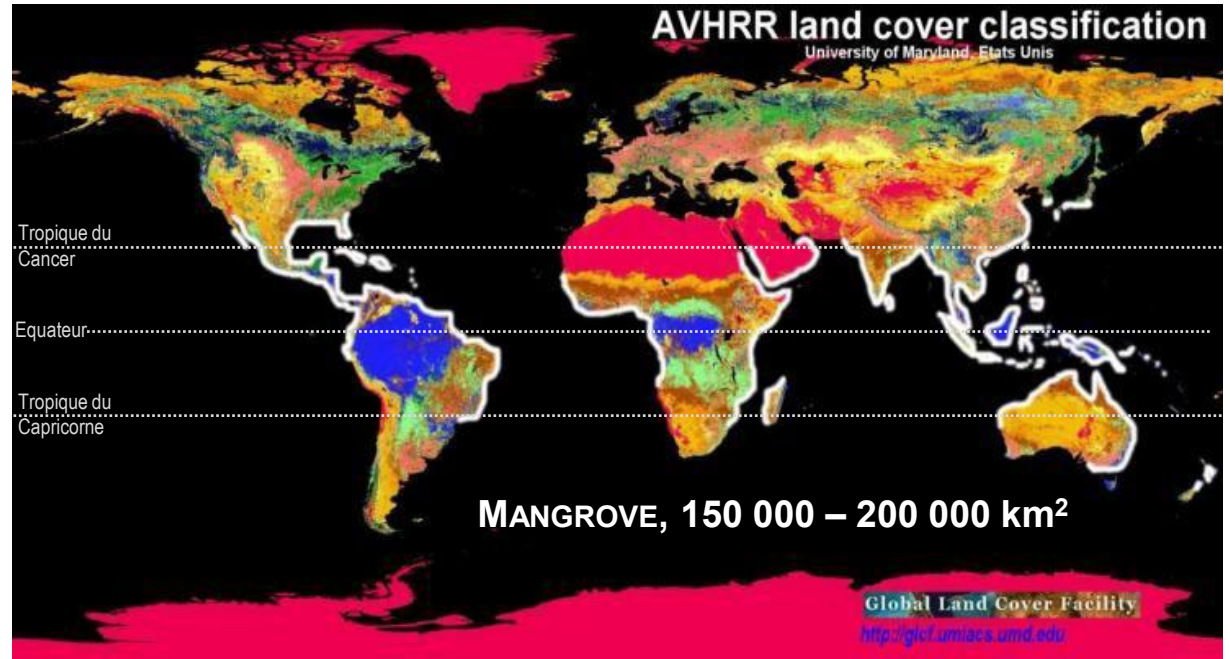
ESA Coastal  
Blue Carbon  
PROJECT

# Mangrove forest

➤  $\frac{3}{4}$  of all coastal intertropical areas

➤ Intertidal zone: ecosystem between ocean and land

➤ Blue Carbon ecosystem





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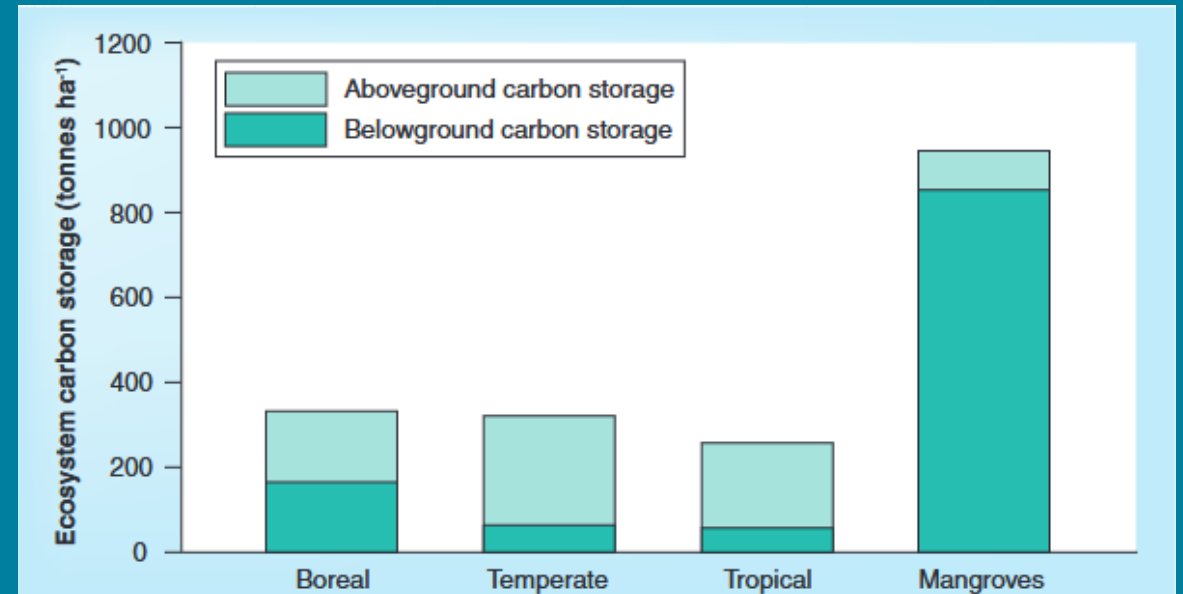
➤ Intertidal zone: ecosystem between ocean and land

➤ Blue Carbon ecosystem

**Blue Carbon:** carbon stored by coastal marine ecosystems, mainly MANGROVES, salt marshes and seagrass



**High carbon sequestration capacity**

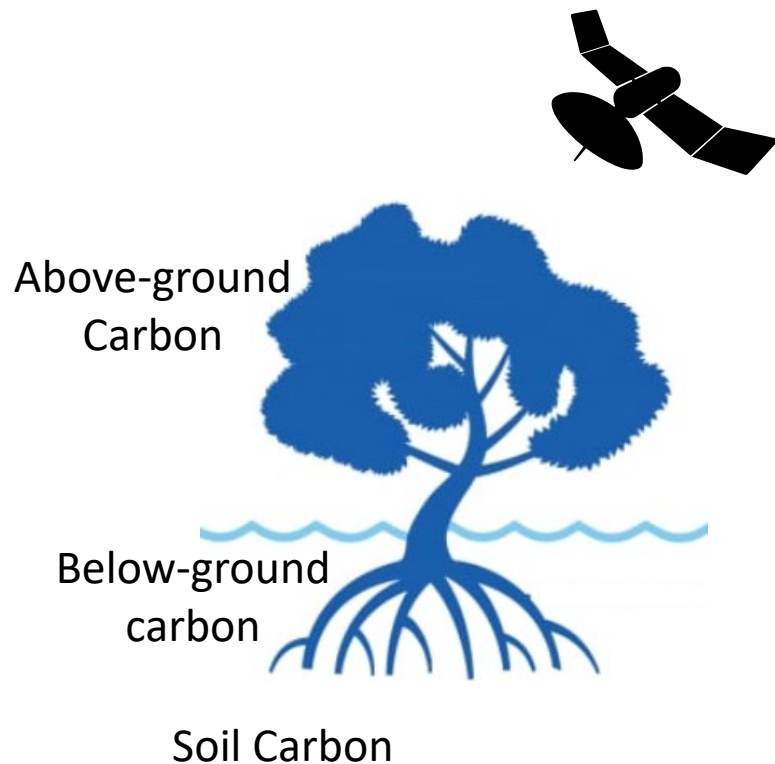


Differences in whole-ecosystem carbon stocks among boreal, temperate and tropical terrestrial forests, and mangrove forests, from Alongi 2014.

# Mangrove above-ground Carbon

Mangrove Carbon = soil + below-ground + above-ground (AG)

AG-Biomass (AGB) from REMOTE SENSING → CARBON from AGB



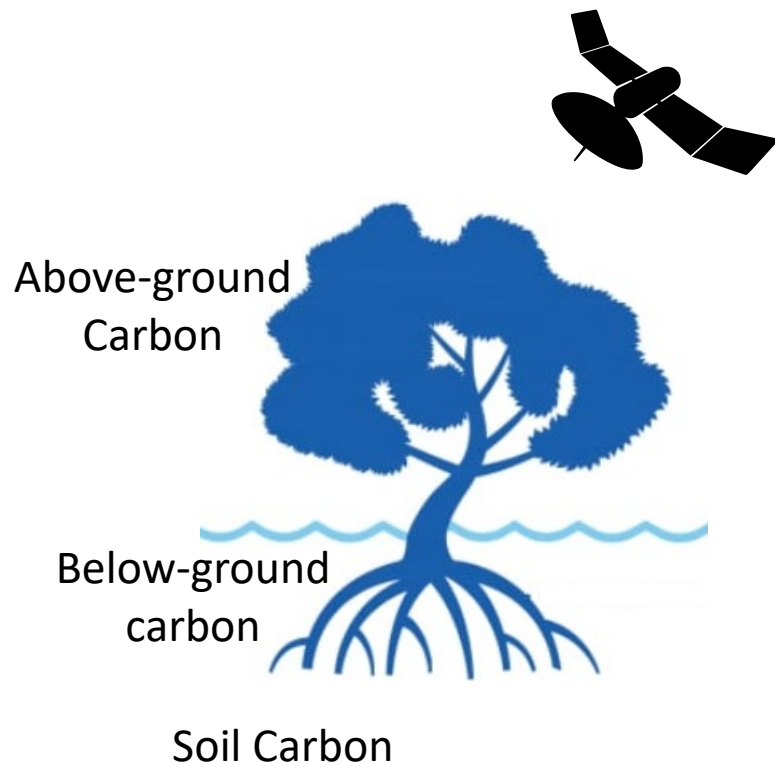
Aim: to improve mapping and monitoring of mangrove above-ground carbon stocks over time and across large areas, using EO

1. to map carbon in French Guiana mangroves in 2017, 2020 and 2023
2. Extrapolate to mangroves along the Amazon coast

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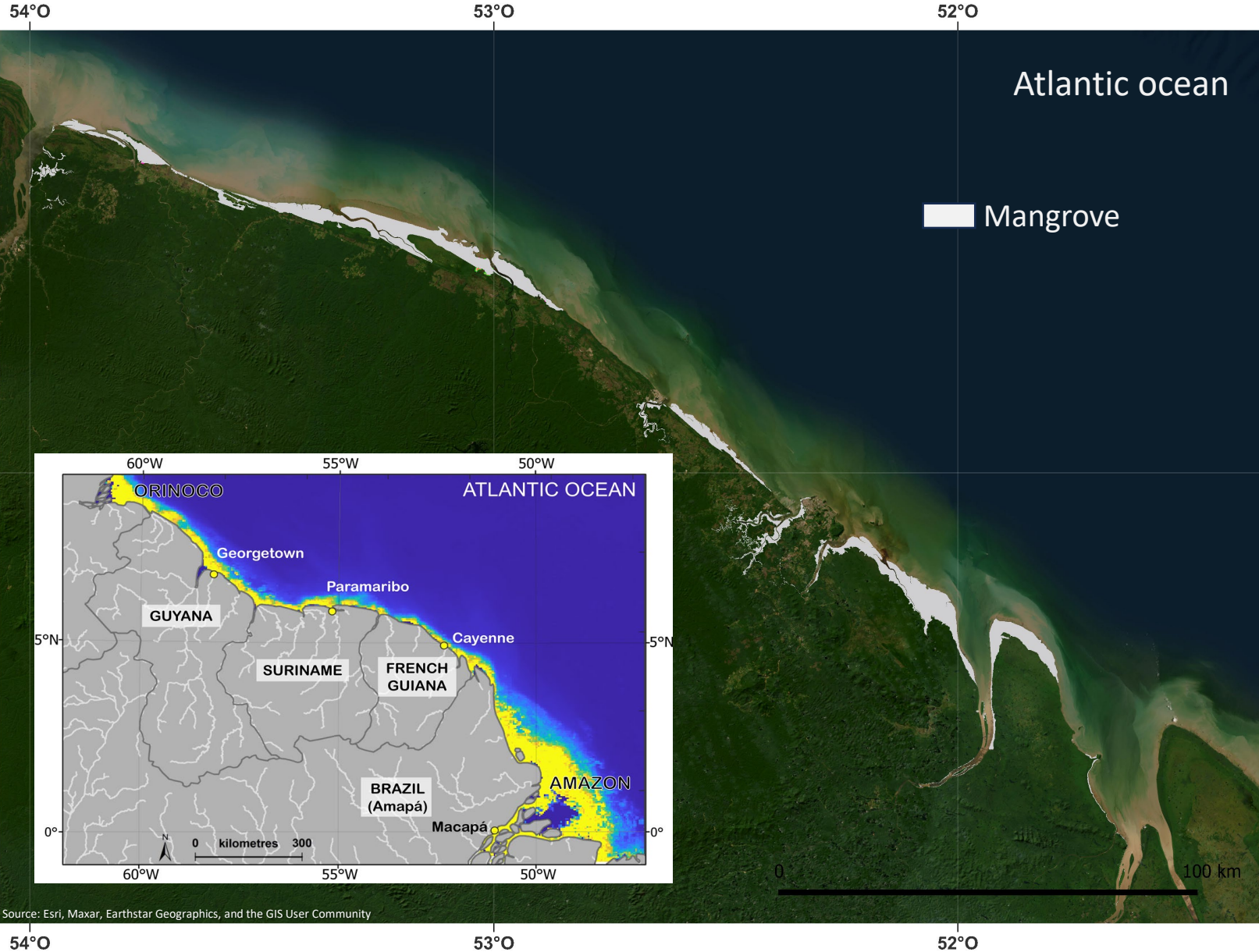


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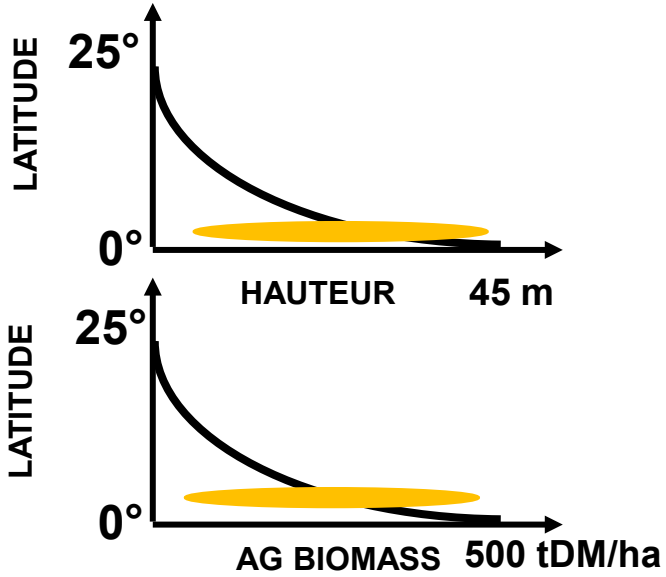


# Study site



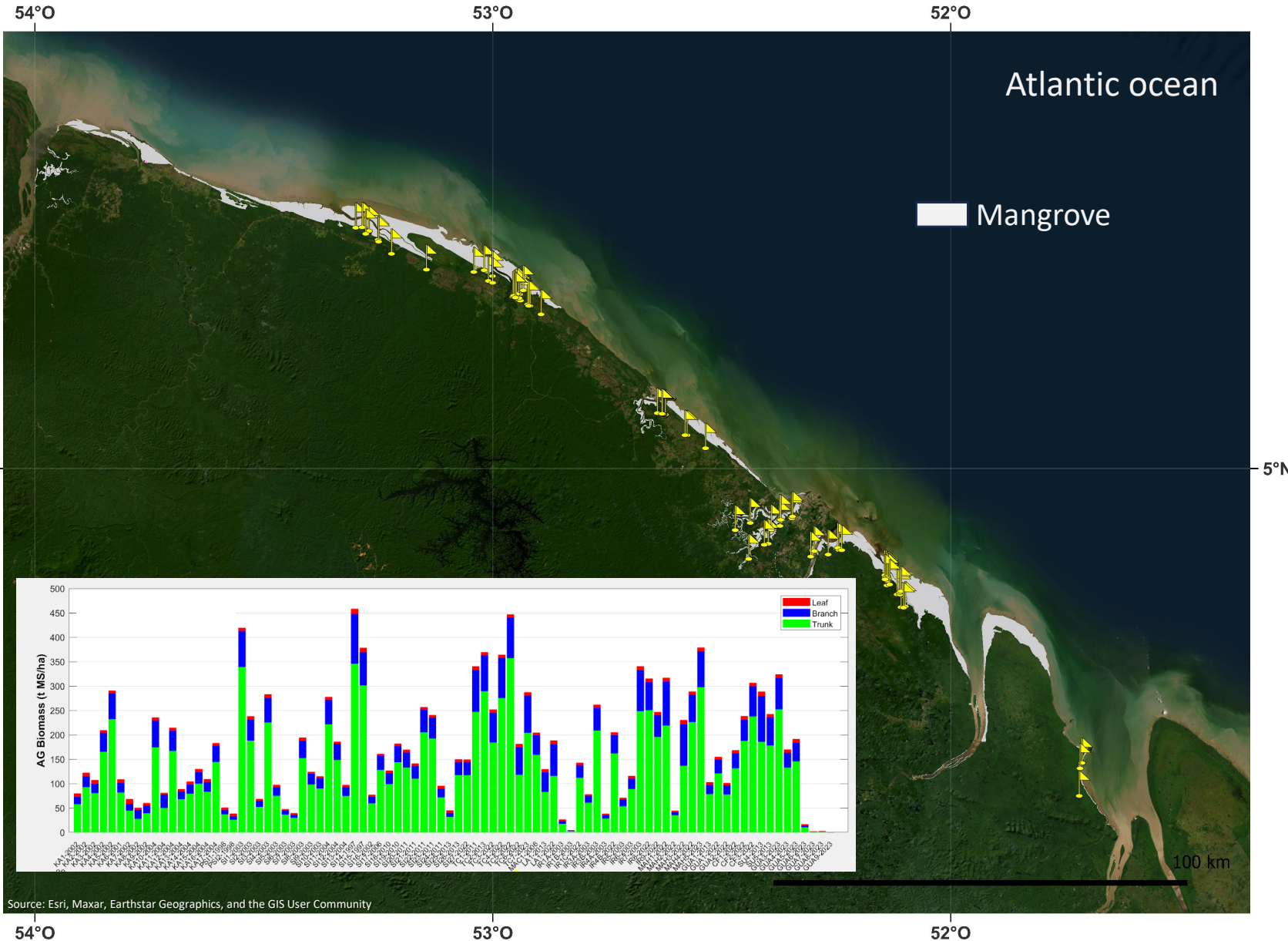
## French Guiana (320 km coast)

Diversity of mangrove habitats, reaching 45 m, 500 t DM/ha & > 800 t C/ha.



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

# Forest data



## Forest inventories

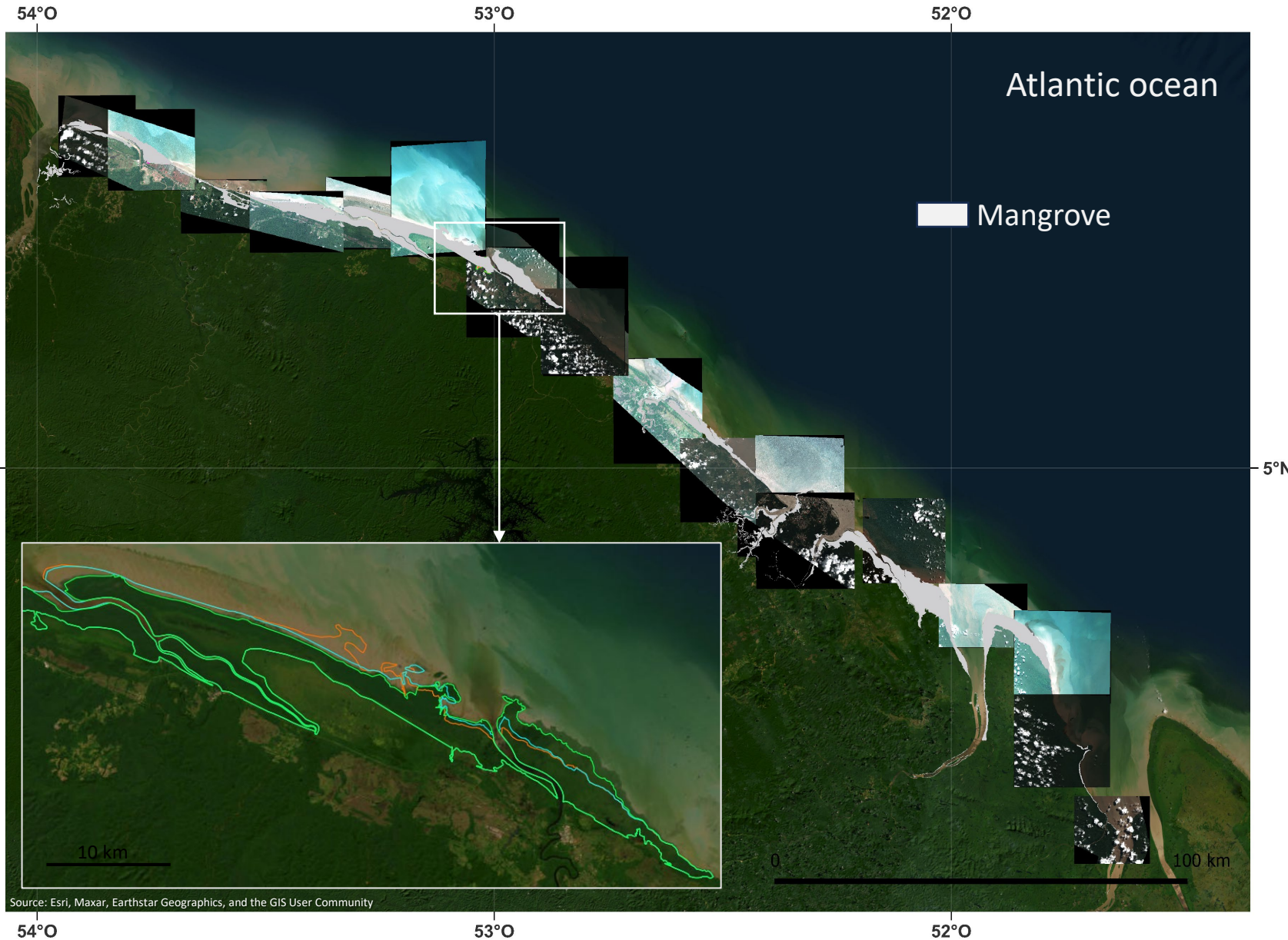
Tree density, DBH, height + species + date of acquisition + area

- From 1997 to 2025
- 105 forest plots, 20 m<sup>2</sup> to 1 ha

➔ **A UNIQUE DATABASE**



# Image data



## Pleiades images

- 80 panchromatic images
- Spatial resolution 50 cm
- Pleiades coverage on 3 dates:
  - 2017
  - 2020
  - 2023
- Vectors of mangrove extent for 2017, 2020 and 2023



# Method: canopy texture analysis

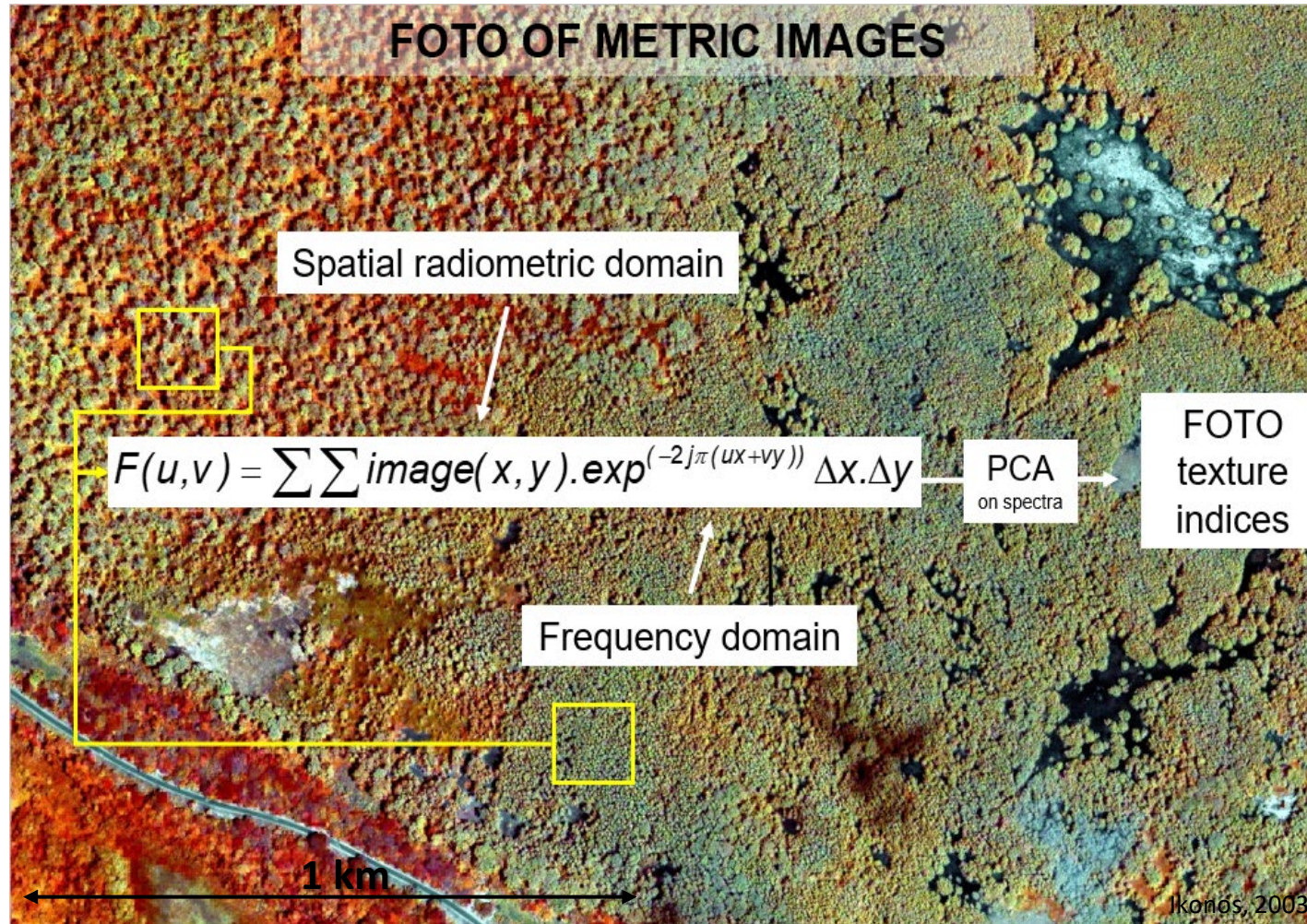
**FOTO Method**, Fourier Transform Textural Ordination (Couteron et al. 2005; Proisy et al. 2007)



Senescent Mangrove



Young Mangrove



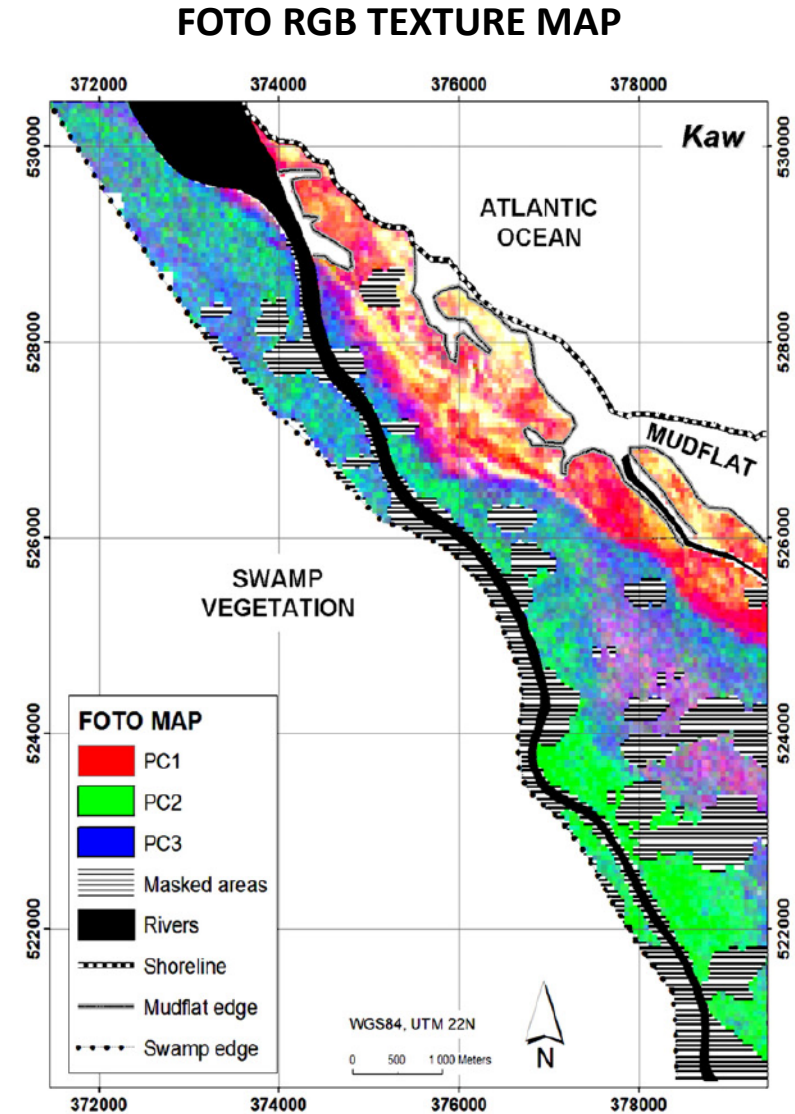
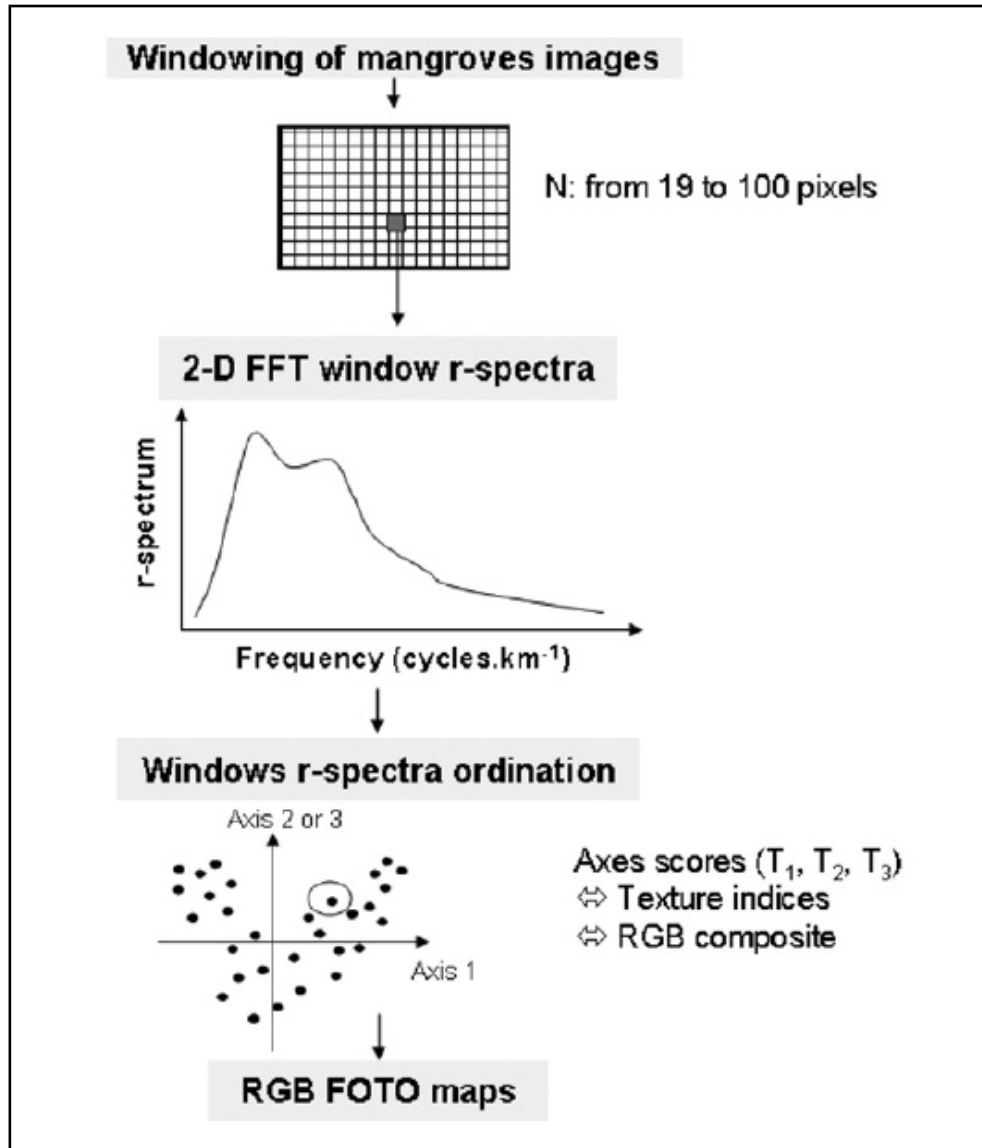
CANOPY TEXTURE

CANOPY STRUCTURE

FOREST STRUCTURE



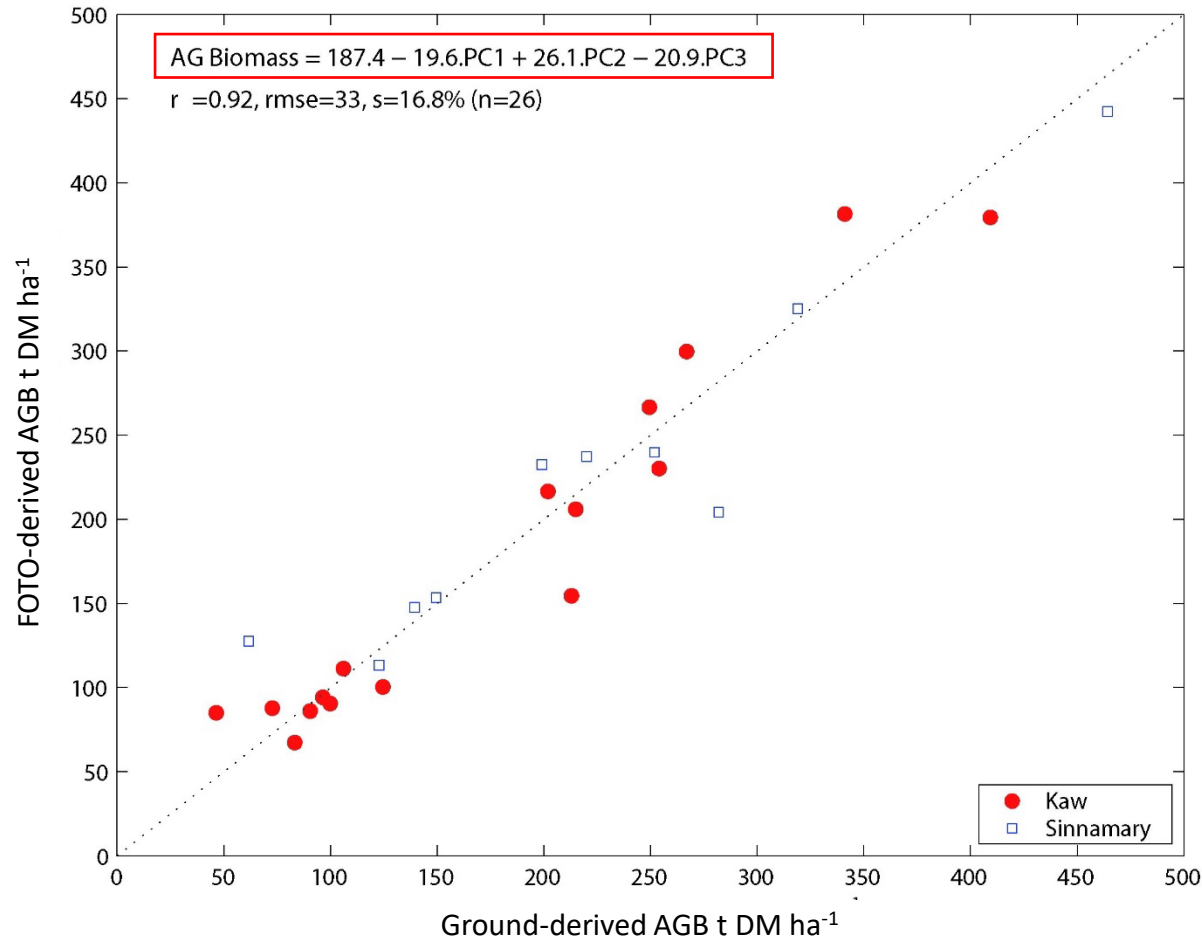
# Method: canopy texture analysis



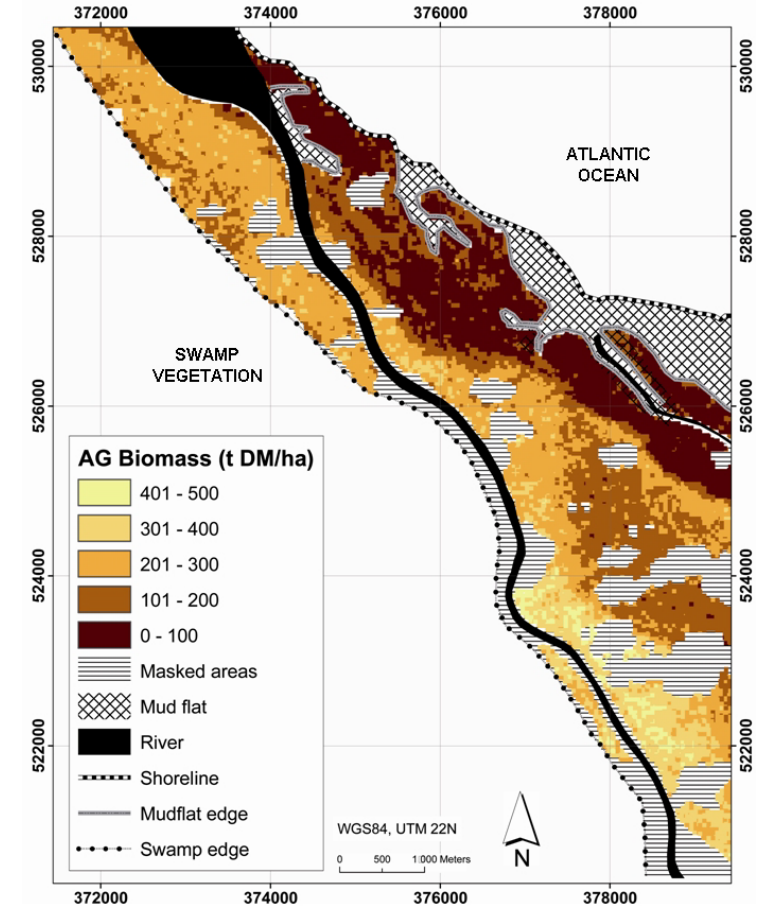


# Method: above-ground biomass map

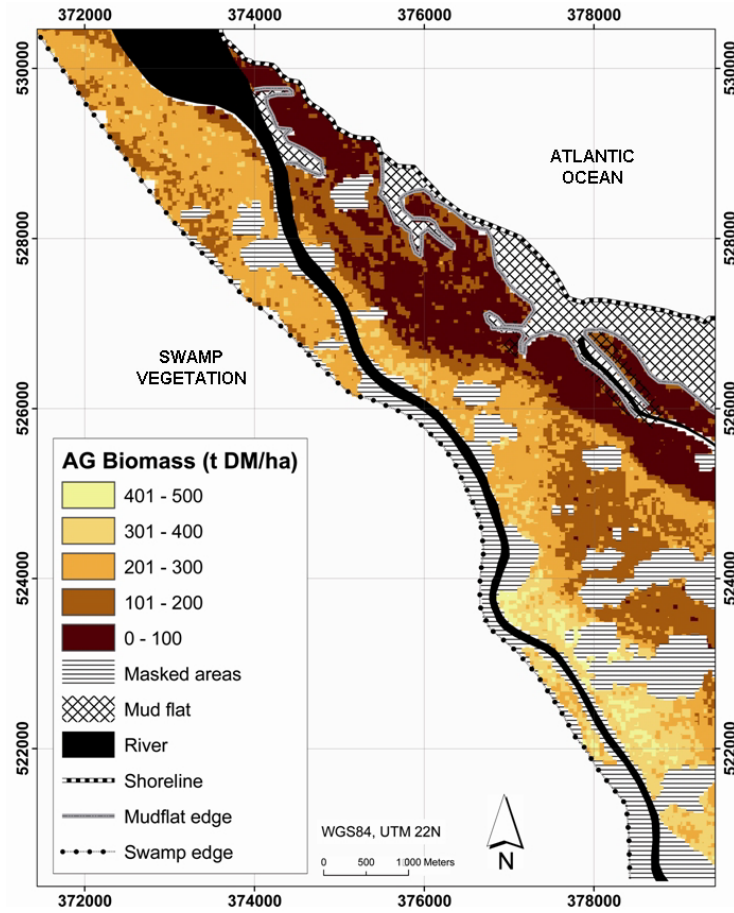
## ABOVEGROUND BIOMASS PREDICTION



## ABOVEGROUND BIOMASS MAPPING

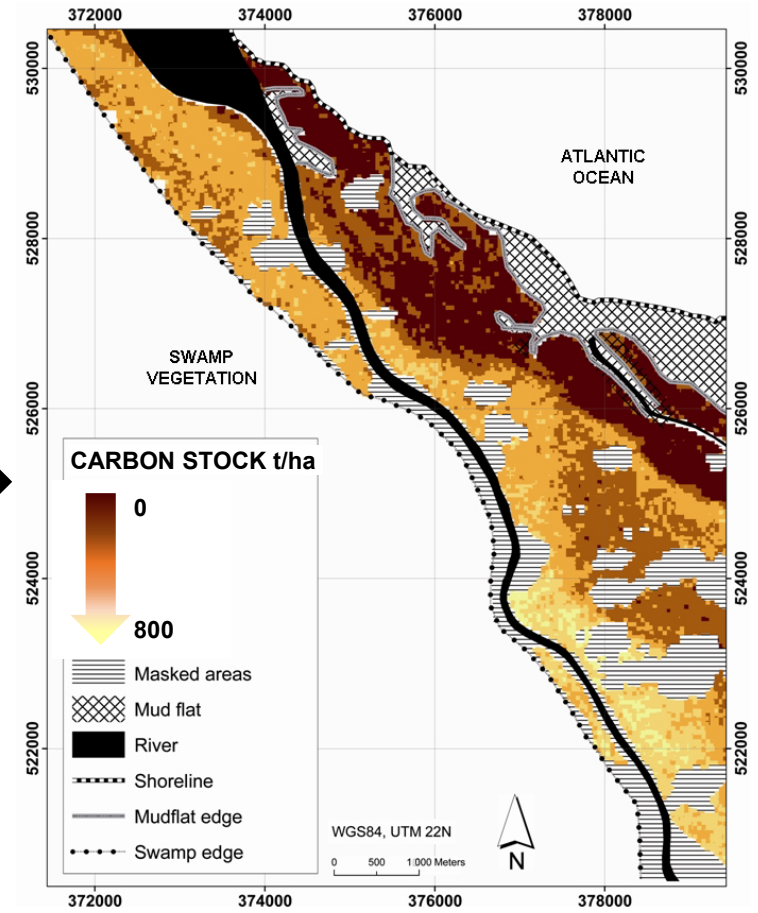


# Method: above-ground carbon map



## CARBON STOCK MAPPING

$$C=f(\text{Biomass})^*$$



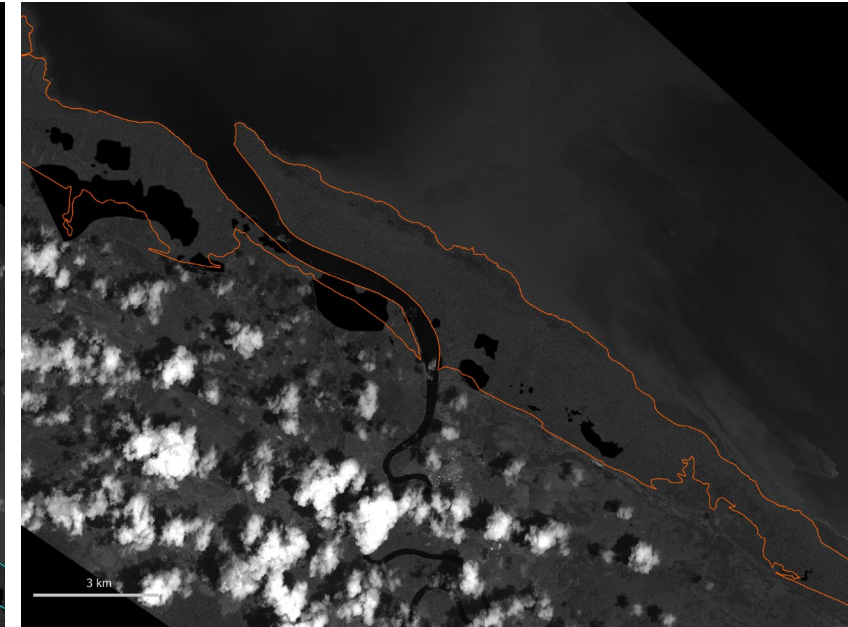
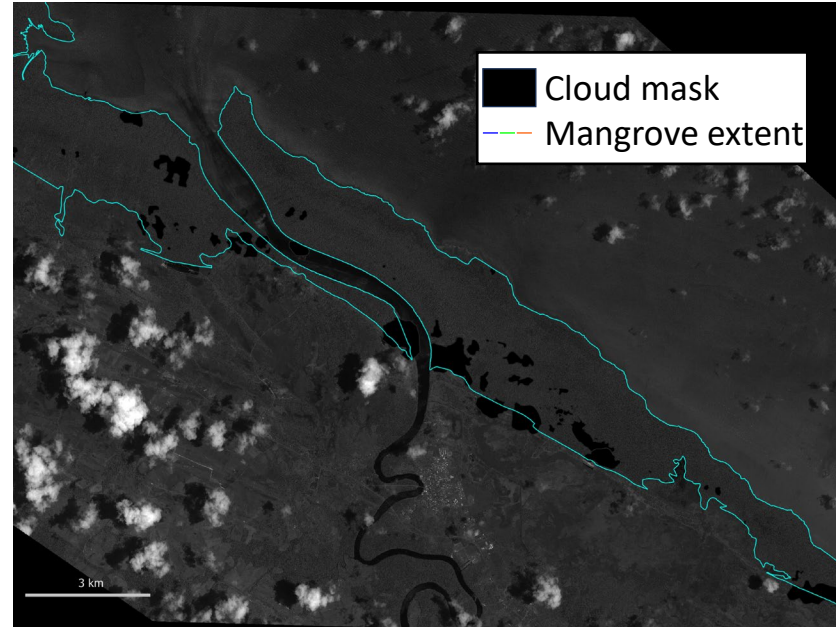
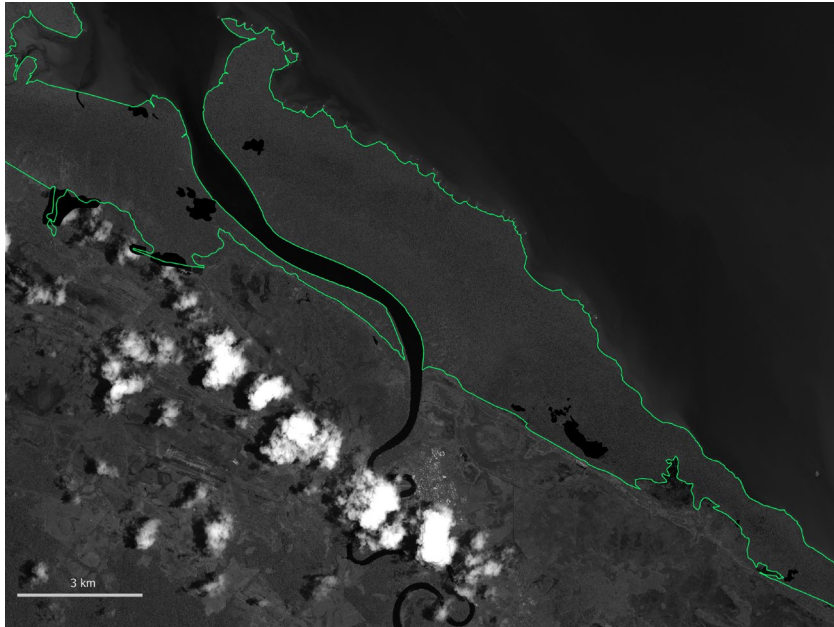
\*Walcker et al. (2018). Control of "blue carbon" storage by mangrove ageing: Evidence from a 66-year chronosequence in French Guiana. *Global Change Biology*, 24, 2325-2338.

# Results

2017

2020

2023



Pleiades panchromatic images, resolution 50 cm

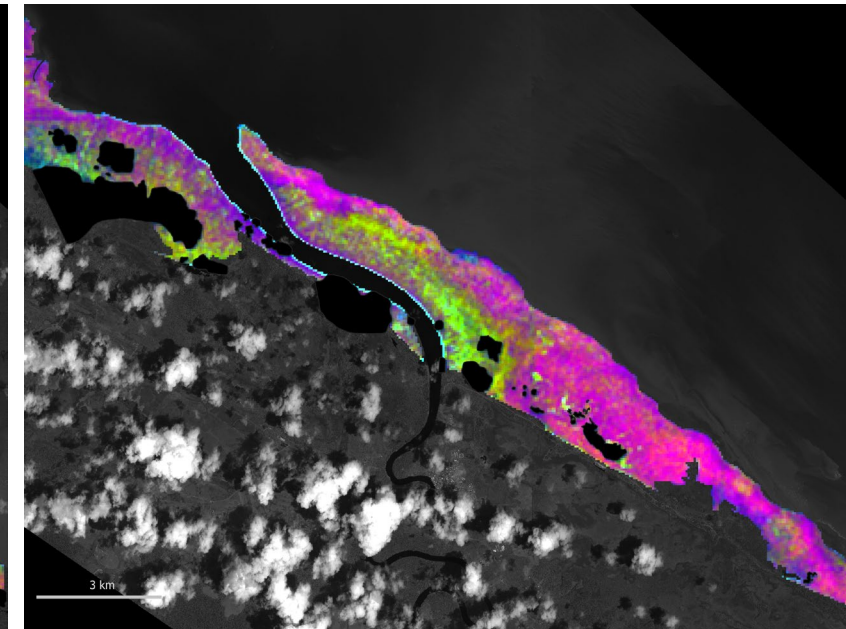
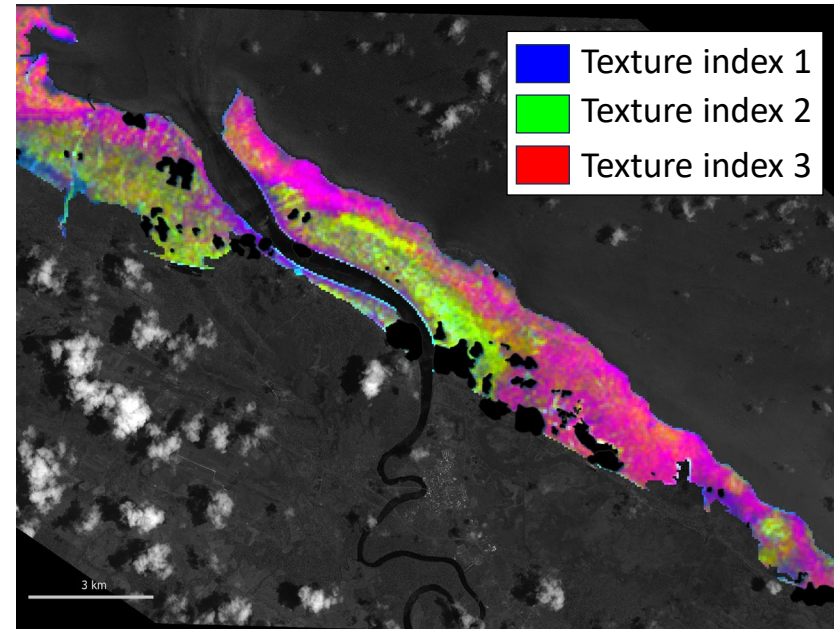
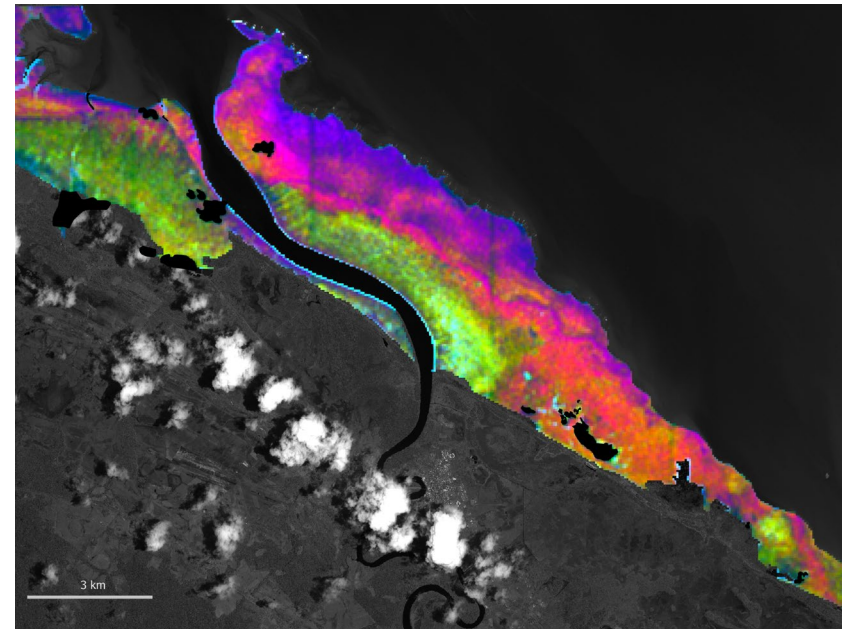


# Texture maps

2017

2020

2023



**FOTO RGB texture maps @ 50 m**

**FOTO window = 201 pixels  
Sliding window = 100 pixels**

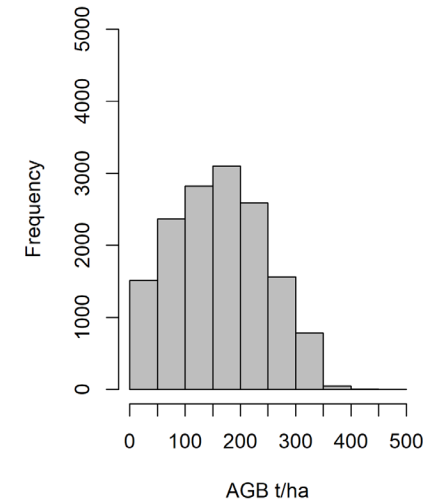
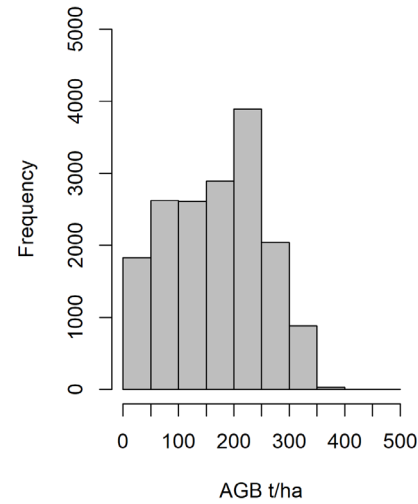
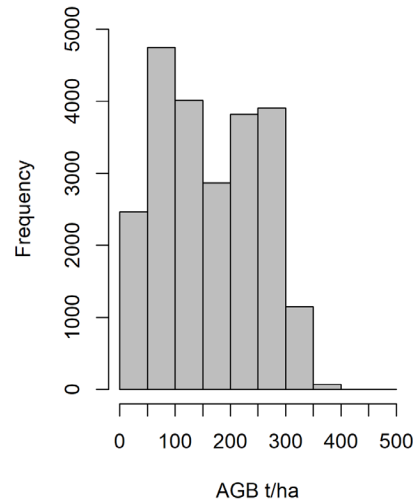
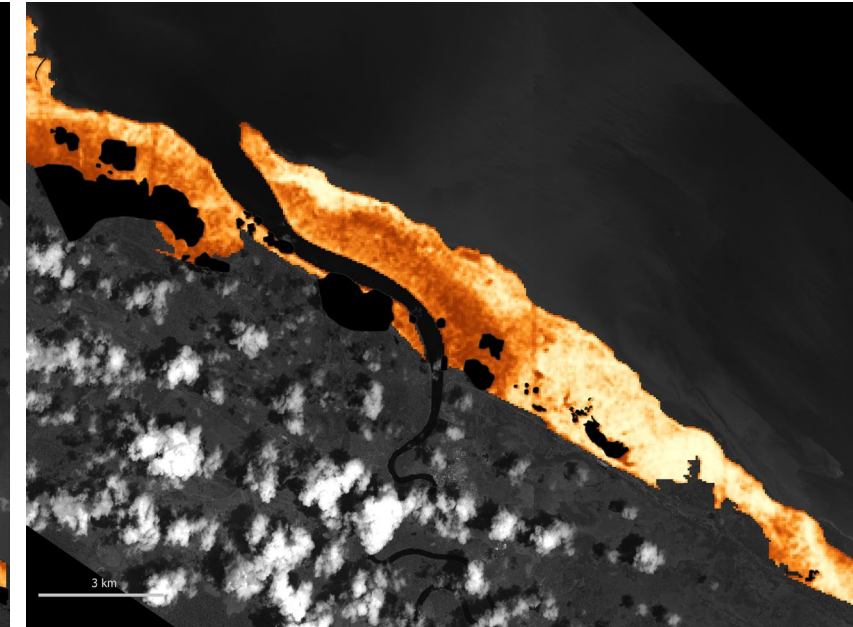
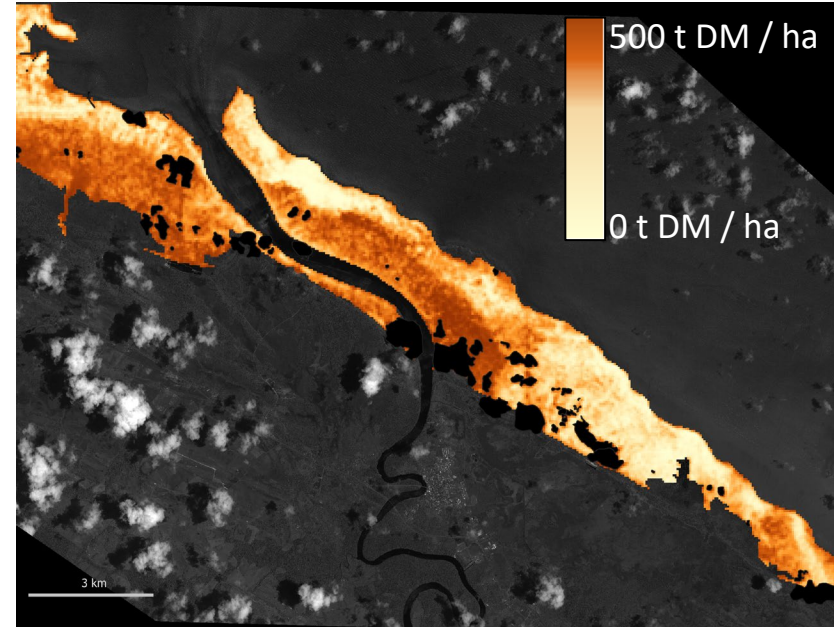
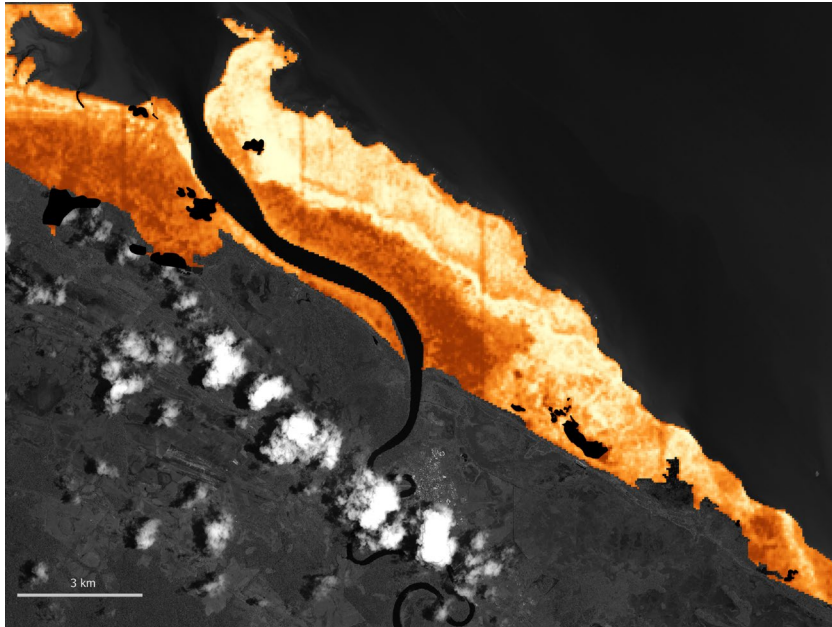
**3 FOTO axes**  
**Very sensitive description of canopy grain  
texture**

# Above-ground biomass maps

2017

2020

2023



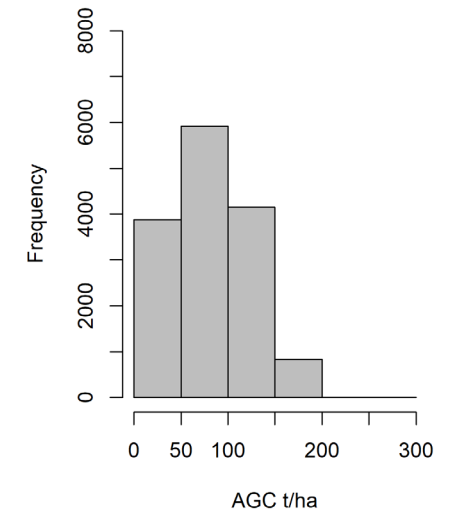
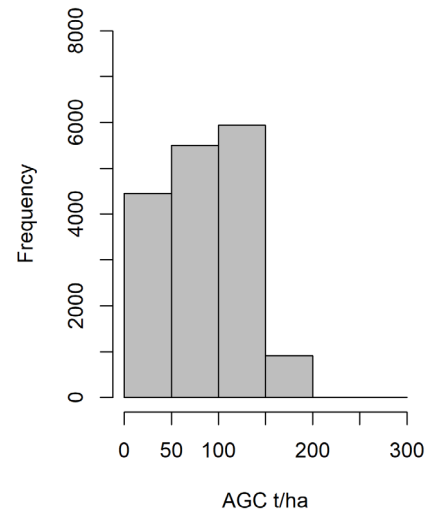
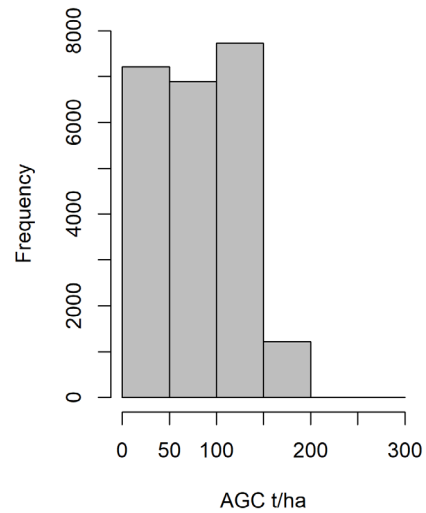
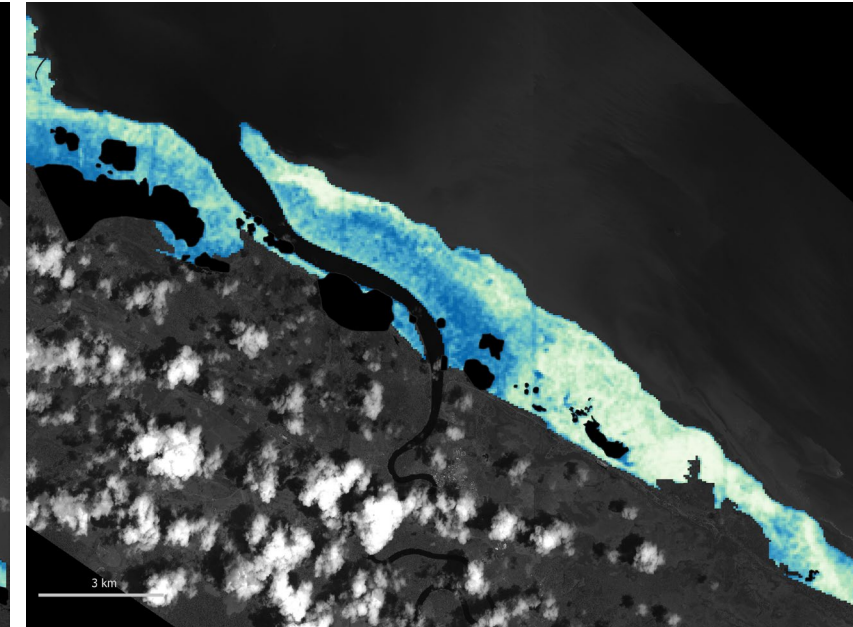
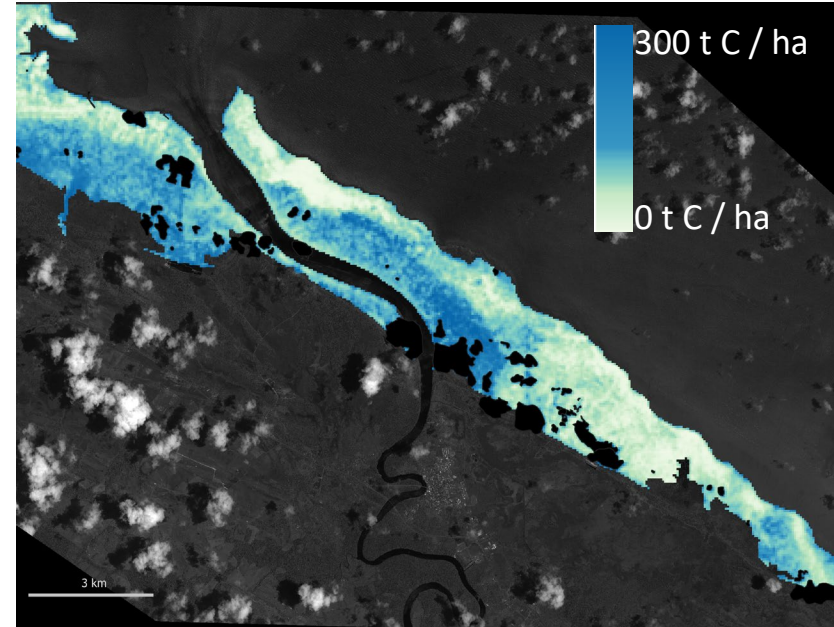
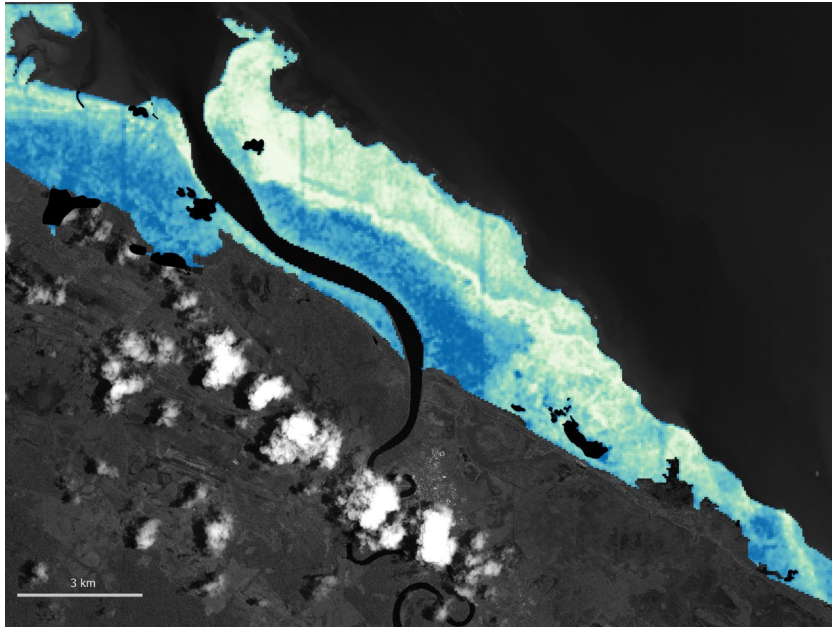


# Above-ground carbon stocks maps

2017

2020

2023





# Future work

- Mapping mangrove carbon stock from FRENCH GUIANA (320 km) to AMAZON-INFLUENCED COAST (1500 km)
- Improving models for predicting below-ground and soil carbon stocks BUT FIELD DATA STILL NECESSARY  
    ➔ INPUTS FROM FAIR CARBON DEDICATED CARBON PROGRAM
- Annual mapping (because extreme costal changes; Augusseau et al 2025)  
    Is there a regional potential of time series of SENTINEL-2 images for C stock mapping?
- COMPONENTS OF THE NATURE BASED SOLUTIONS - SOLU BIOD PROGRAM

# Key recommendations

## STEP UP EFFORTS TO COLLECT FIELD DATA IN ORDER TO :

- improve remote sensing Carbon models
- better inform about the uncertainties of global models for predicting Carbon stocks
- provide more accurate data on the amount of carbon stored by ecosystems, particularly at the level of root and soil systems, which are still poorly understood.

# Thank you for your attention

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