

Post-K&C – First Report

Above-ground biomass change in the woodlands and savannas of Southern Africa

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Africa)*

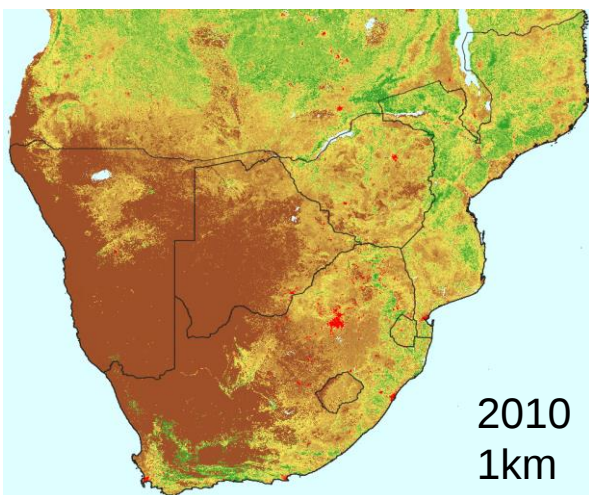
Importance of savanna ecosystems in Africa

- **Shrublands and savannas** cover 50% of the African continent, and represent **46% of the carbon storage** (only 16% in Latin America and Southeast Asia) (Baccini et al., 2012)
- The **C balance of Africa**:
 - currently dominated by the uptake and release from **terrestrial ecosystems** (low fossil fuel emissions)
 - controlled by climate and human activities: significant role of LUC and fires, **especially in savannas and woodlands**
 - a **small sink** of C on an annual scale, but large uncertainties: $-0.61 \pm 0.58 \text{ Pg.C.yr}^{-1}$ (Valentini et al., 2014)
 - a source of **interannual variability** in the global atmospheric CO_2
- Provide a number of important **ecosystem services**, especially to rural communities (fuel wood, grazing areas, etc)
- The **distribution and amount** of African savannas woody carbon stocks are **uncertain**.

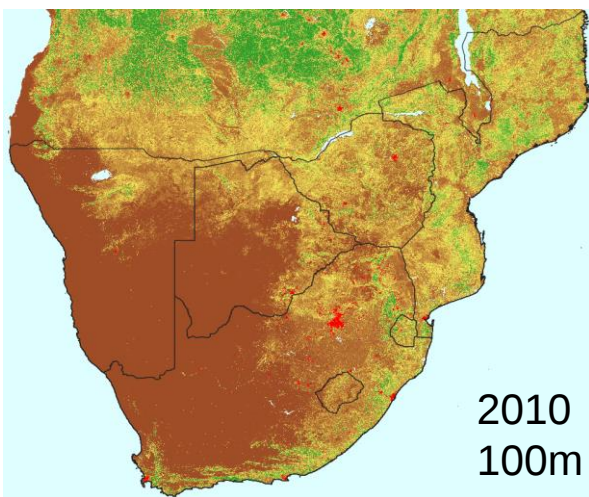
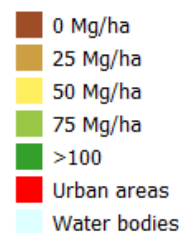
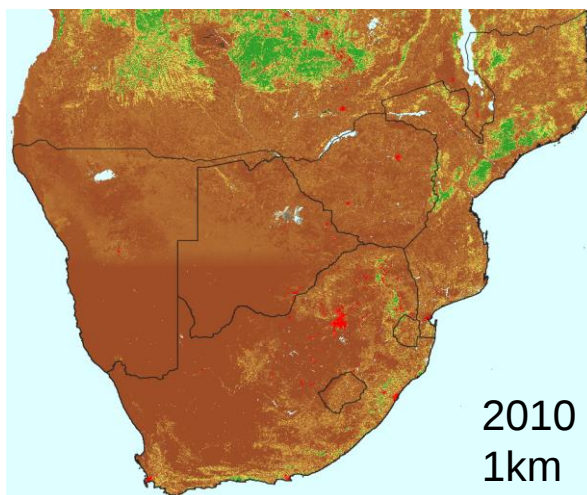
⇒ Need to quantify carbon stocks and changes in savanna ecosystems.

Divergent AGB estimates

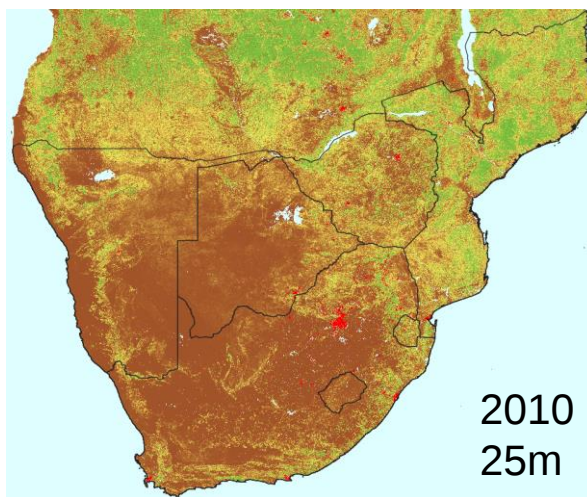
Saatchi et al. (2011)



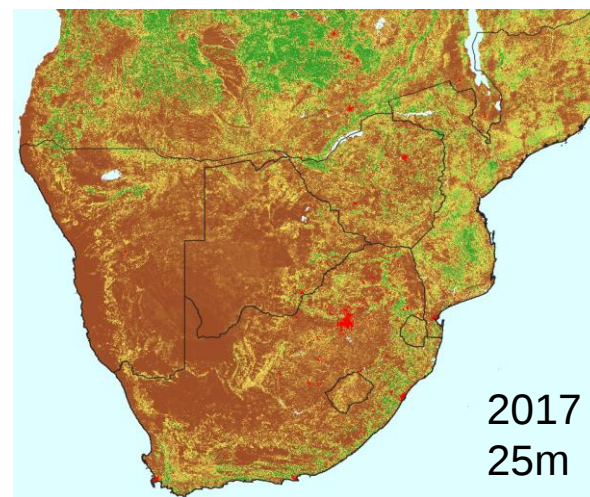
Avitabile et al. 2016



ESA GlobBiomass



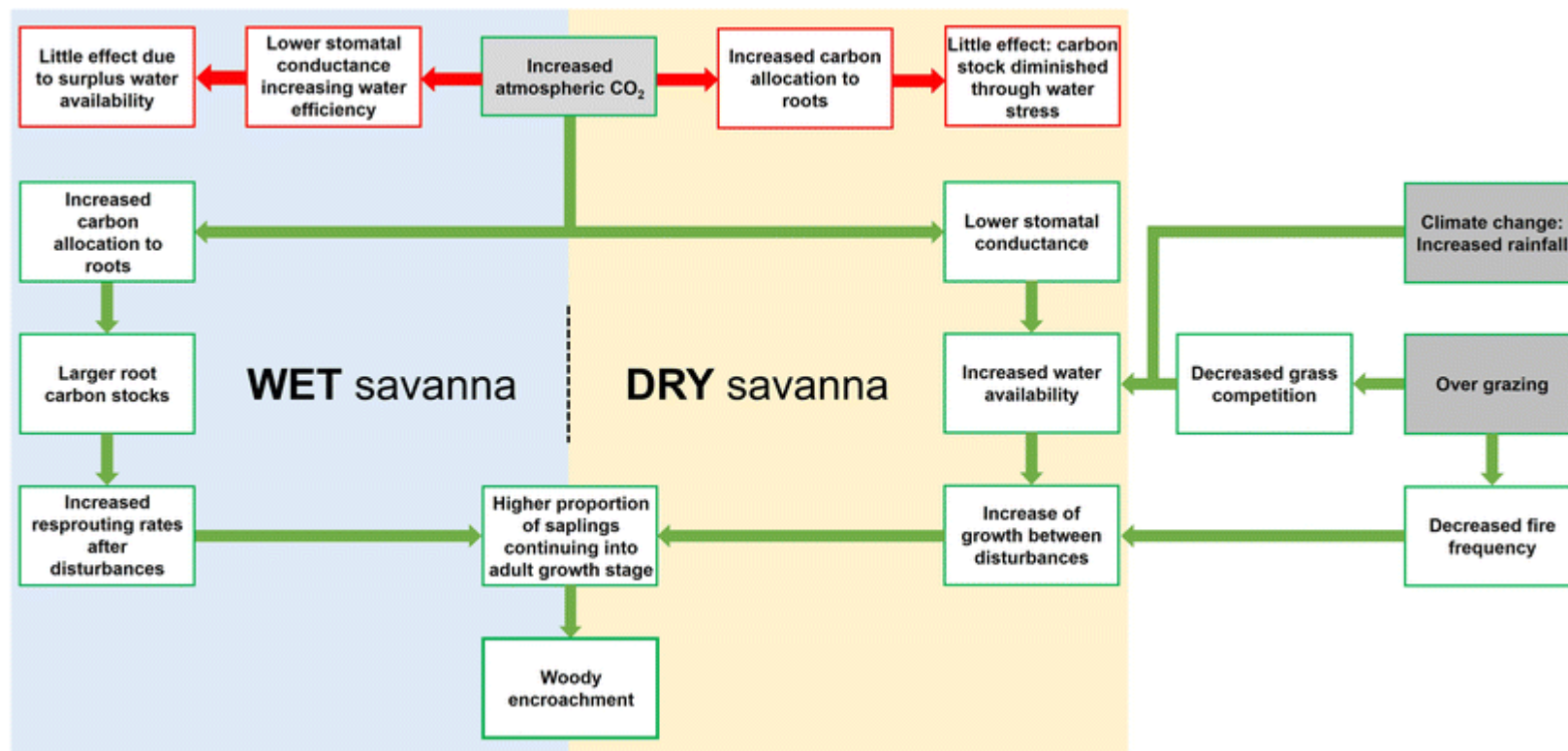
Bouvet et al. (2018)



ESA CCI Biomass

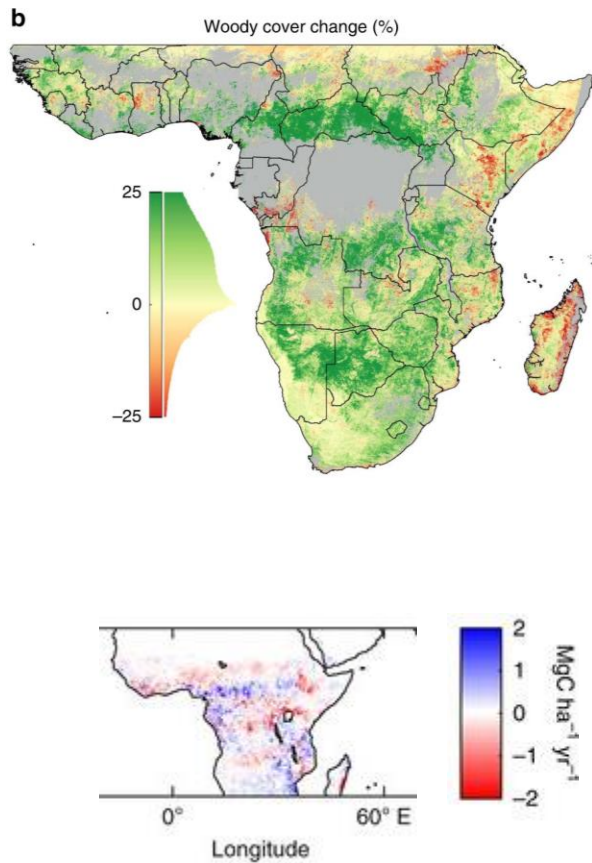
PALSAR

Woody encroachment



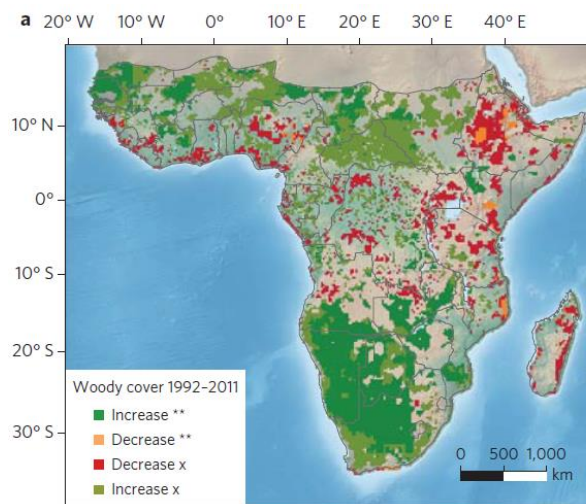
(From Devine et al. 2017, Oecologia)

1986-2016 (Landsat)
Venter et al. 2018, Nature Com.

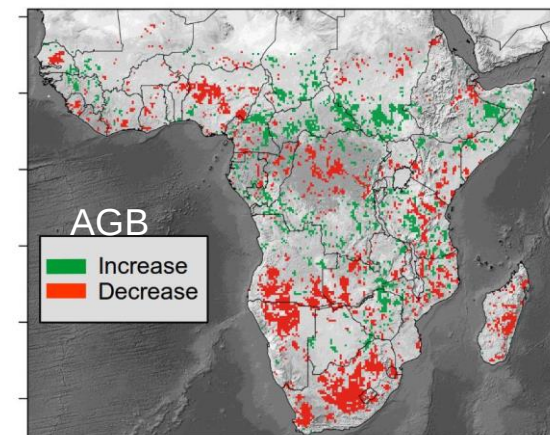


AGB change estimates

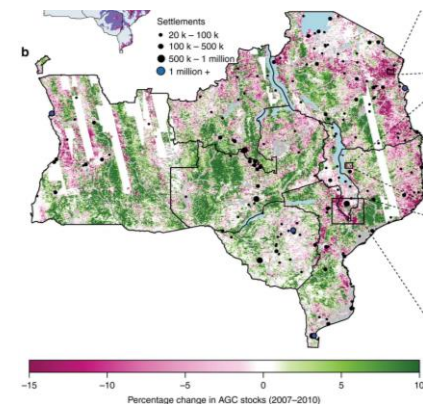
1992-2011 (VOD from SSMI, AMSR)
Brandt et al. 2017, Nature EE



2010-2016 (VOD from SMOS)
Brandt et al. 2017, Nature EE



2010-2017 (SMOS L-VOD)
Fan et al. 2019, Nature Plants



2007-2010 (ALOS PALSAR)
McNicol et al. 2018, Nature Com.

Project outline and objectives

Project objectives:

Use the potential of the L-band data from ALOS-1 and ALOS-2 to estimate the changes in the above-ground biomass of the woodlands and savannas of Southern Africa at a decadal time scale

Project area(s):

- Local scale: selected areas
- Regional scale over 7 countries (South Africa, Lesotho, Swaziland, Namibia, Botswana, Zimbabwe and Mozambique)

Support the following 4 *K&C thematic drivers*:

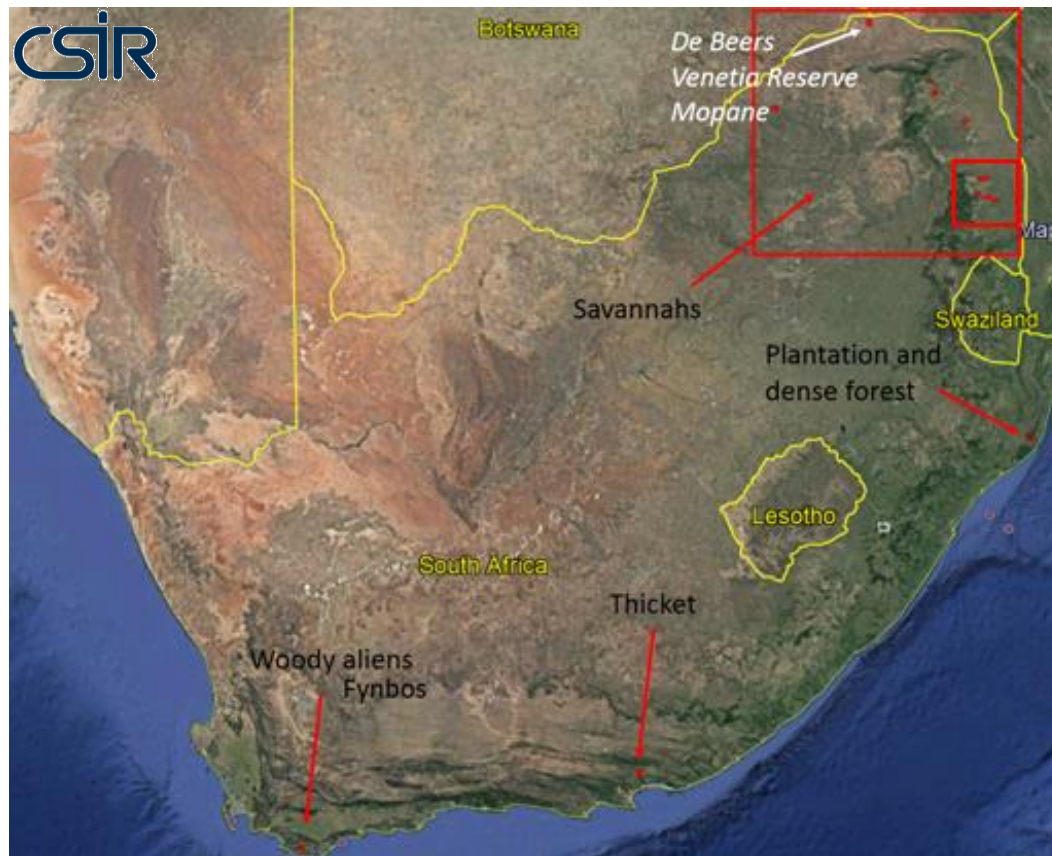
Carbon cycle science, **C**limate Change

Test sites - Regional



→Global Mosaics

Test sites - Local



→ FBD scenes (time series)

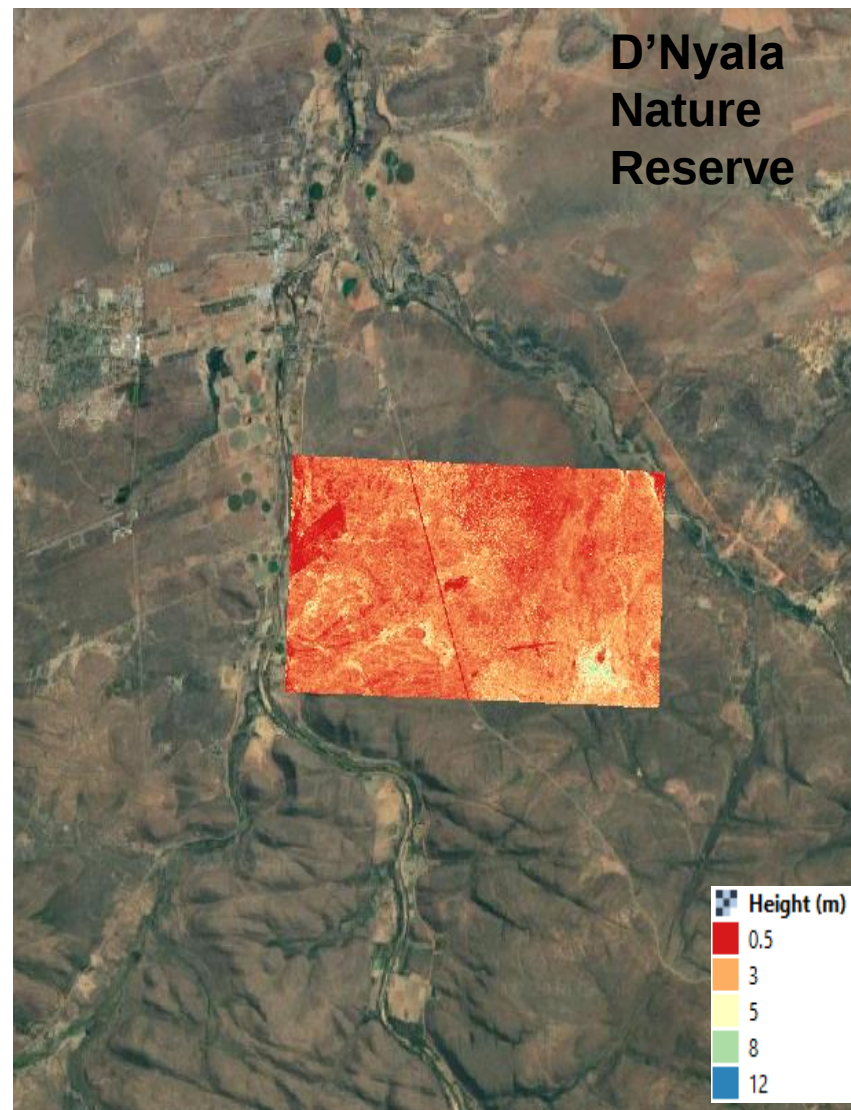
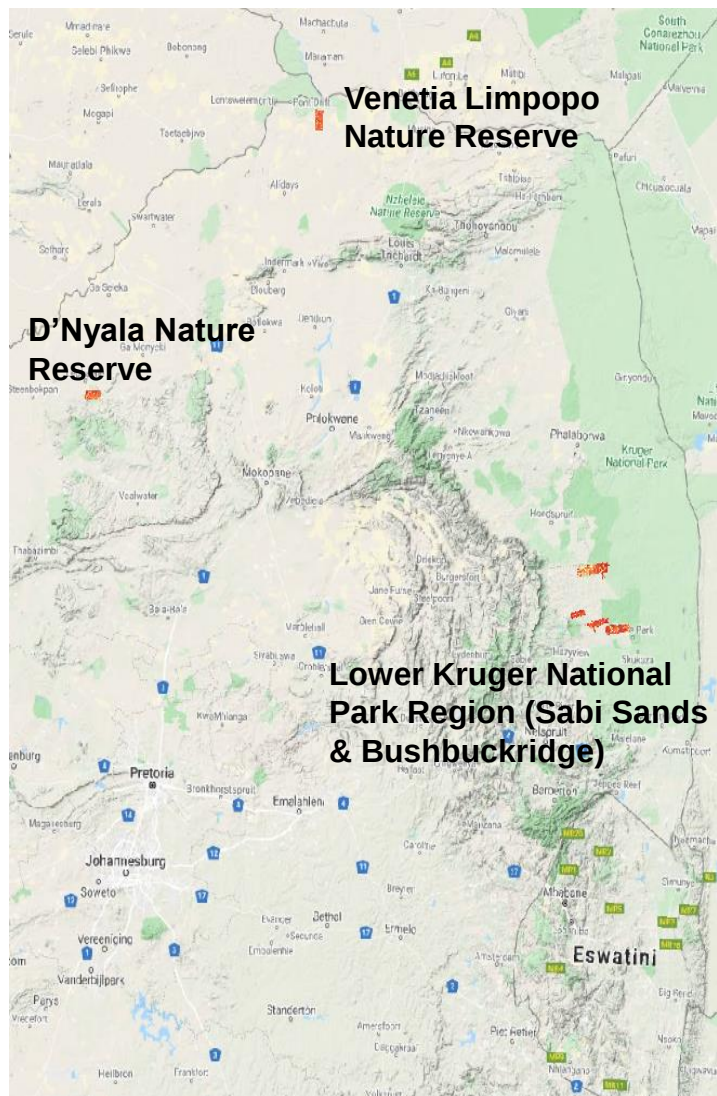
- KwaZulu-Natal Savannahs and Coastal Forests: coastal forests and wetland sites of the iSimangaliso Wetland Park, adjacent commercial plantations and savannahs / woodlands landscape of the Hluhluwe-iMfolozi Park
- Eastern Cape Thickets: subtropical thickets at the interface between savannas, arid shrub lands and coastal forests, Addo National Park
- Agricultural / fynbos landscape matrix: landscape with patches of woody invasive plants, including *Pinus spp.*, *Acacia spp.*, and *Eucalyptus spp.*
- Lowveld Savannahs: Kruger National Park and adjacent western populated landscapes
- Mopane Savannahs: Venetia De Beers Game reserve

ALOS

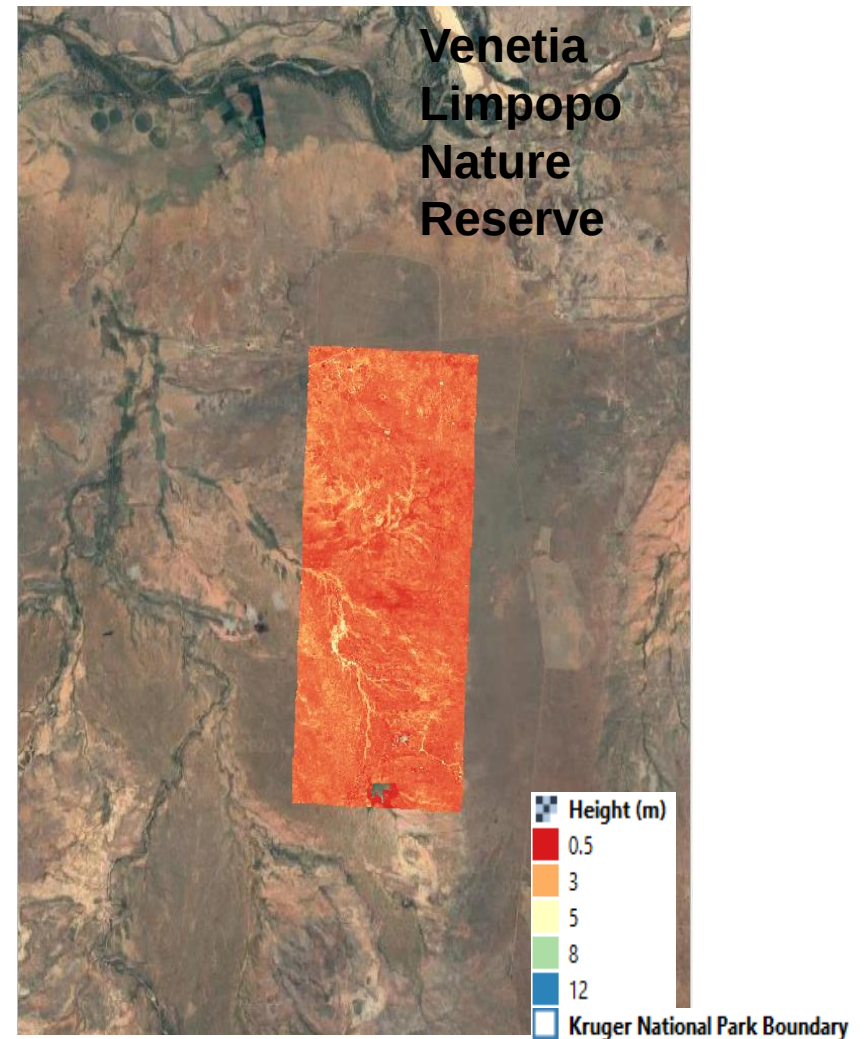
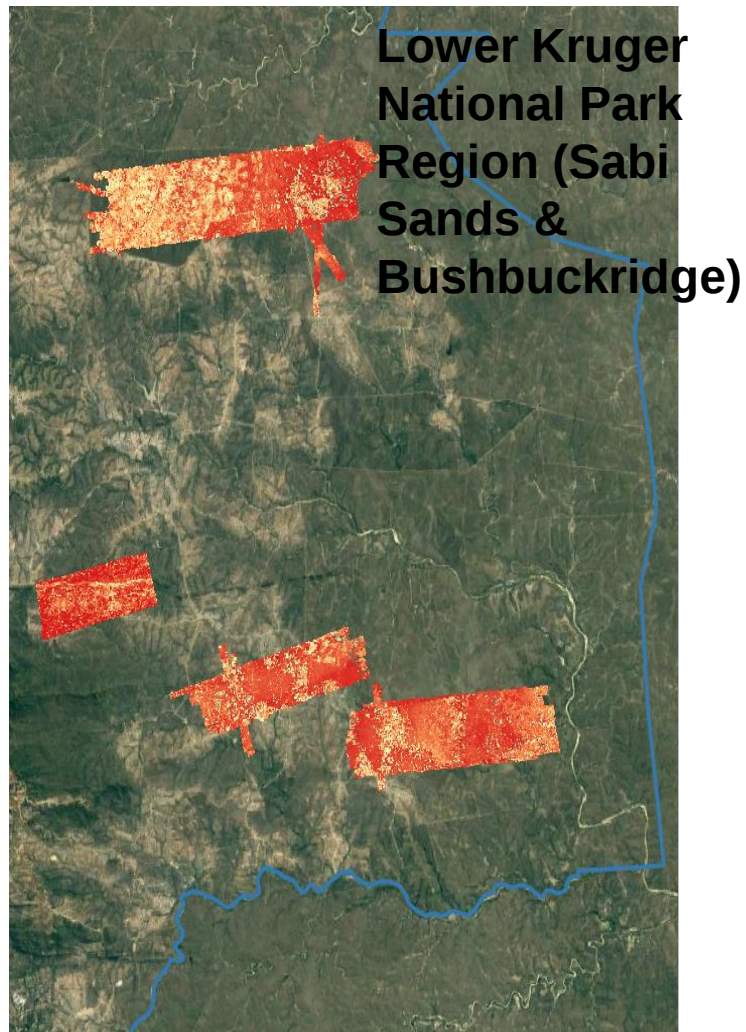
K&C Initiative
An international science collaboration led by JAXA

CSIR

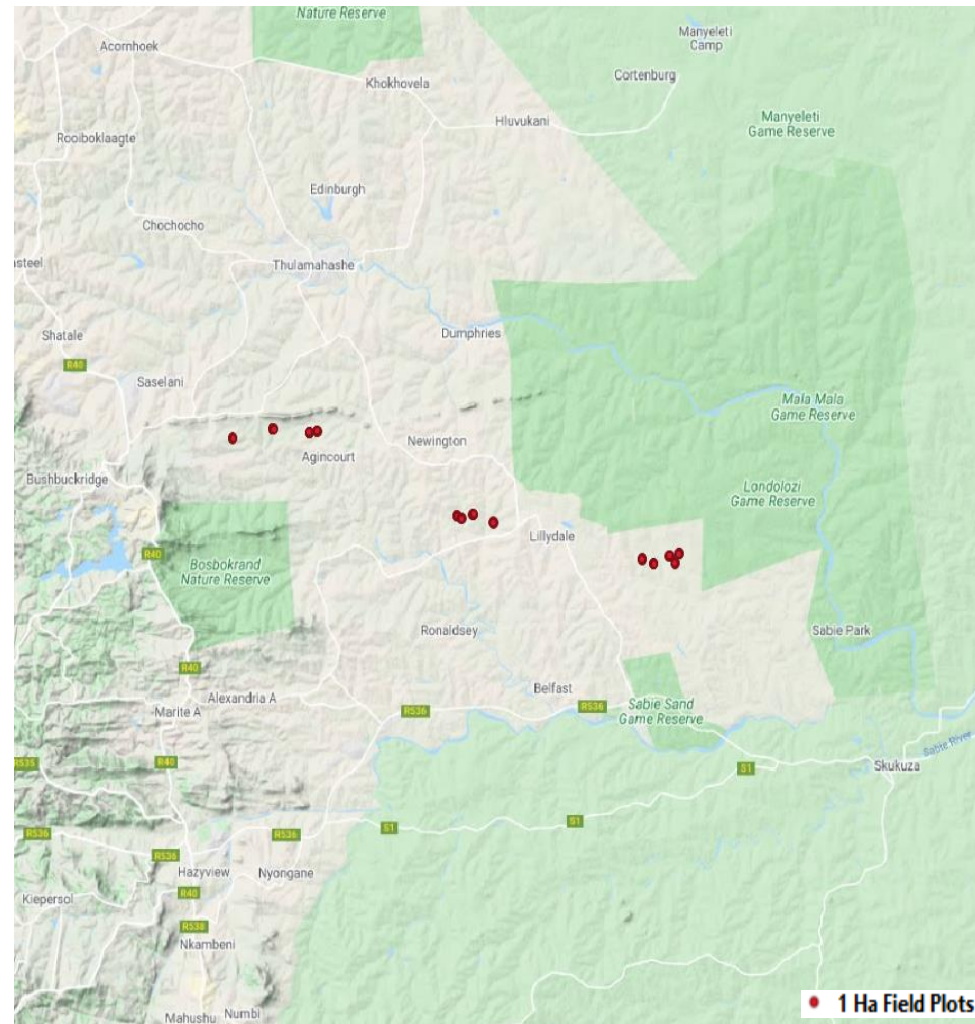
ALS data



ALS data



Field AGB measurements



Approach

Relationships between backscatter (HH or HV) and AGB
(Water-Cloud Model equation):

$$\gamma^0 = \gamma^0_{\text{ground}} \cdot e^{-c \cdot \text{AGB}} + \gamma^0_{\text{veg}} \cdot (1 - e^{-c \cdot \text{AGB}})$$

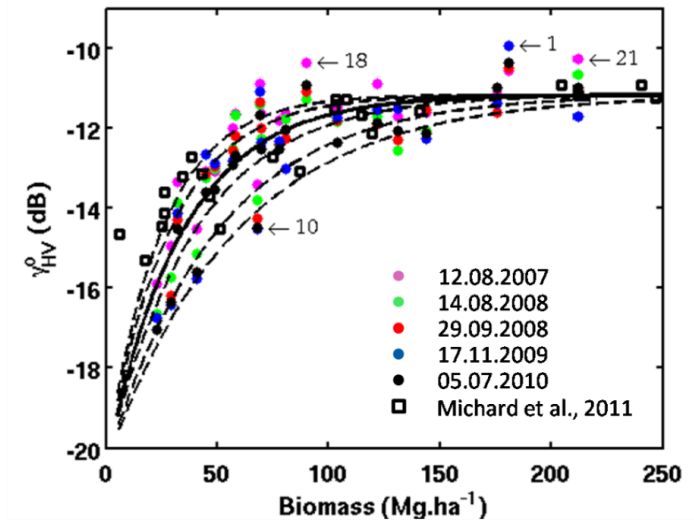
$$= a e^{-c \cdot \text{AGB}} + b (1 - e^{-c \cdot \text{AGB}})$$

a: backscatter from the ground

b: backscatter from dense vegetation

c: attenuation from the canopy

Mermoz et al., RSE, 2013

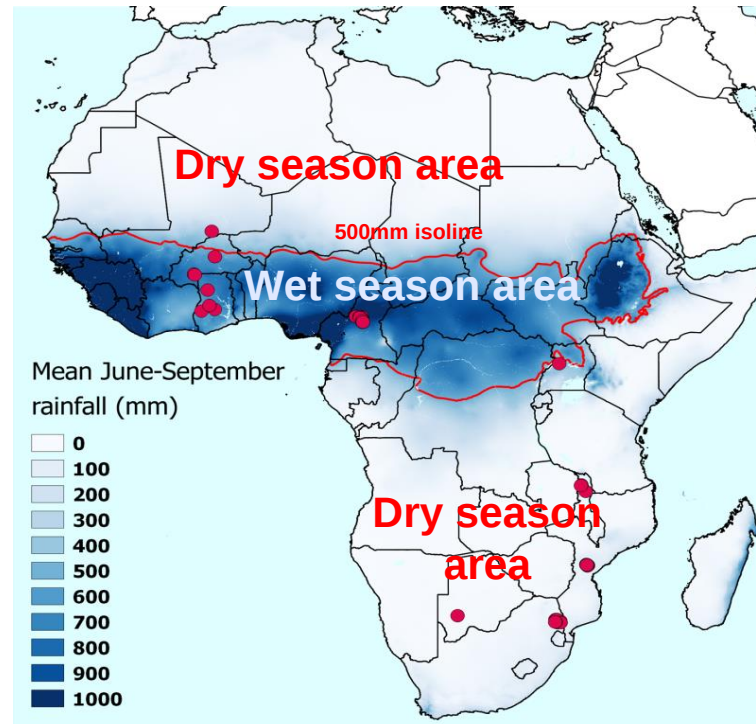
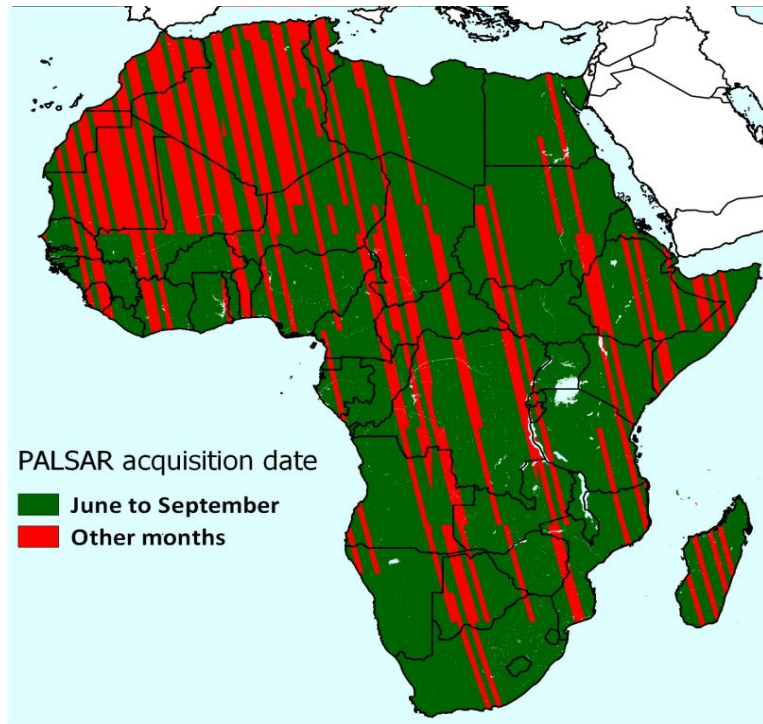


Sources of error

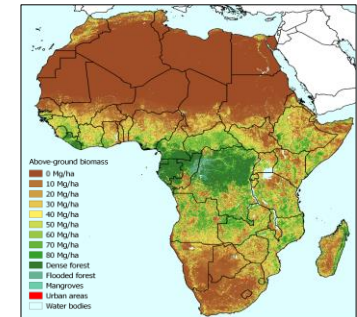
Environmental variables:

- **Soil moisture**
- Soil type
- Topography
- Forest structure

Stratification based on seasonality



Bouvet et al. 2018, RSE



⇒ Two sets of direct inversion models $HV=f(AGB)$, $HH=g(AGB)$:

- one for dry season areas
- one for wet season areas.

Outline of the project

Local scale:

Use *in situ* data (Lidar and field plots) and FBD time series to produce the best AGB maps and change maps over selected sites.

Regional scale:

Estimate AGB from mosaics (dry-season) using approach developed in Bouvet et al. (2018), at epochs 2007, 2010, 2015, 2018.

⇒ One objective is to gain experience for the coming era of L-band time series (SAOCOM, NISAR,...)

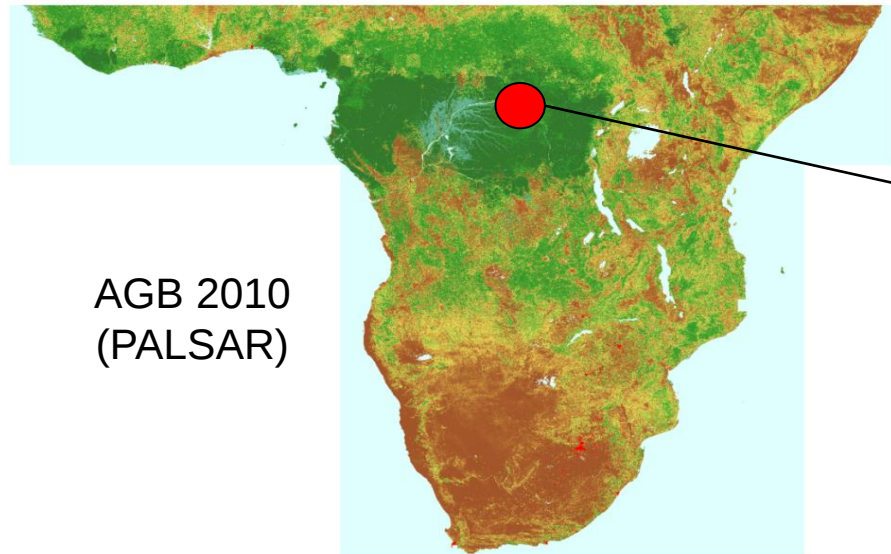
Results and significant findings

Delay in access to *in situ* data:

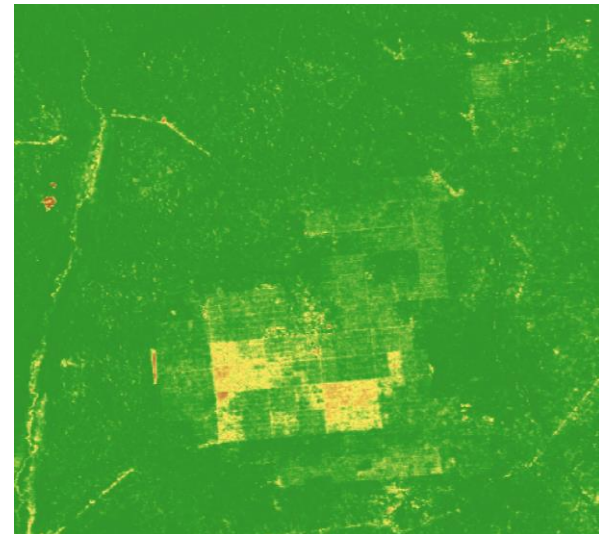
- Delay in signature of contract between JAXA and CESBIO (mid-September 2019)
- Initial Co-I Renaud Mathieu left CSIR (around mid-September 2019)
Dr. Laven Naidoo took over but their group has switched from Natural Vegetation to Crop Monitoring
→ still willing to collaborate though

No results yet on local scale.

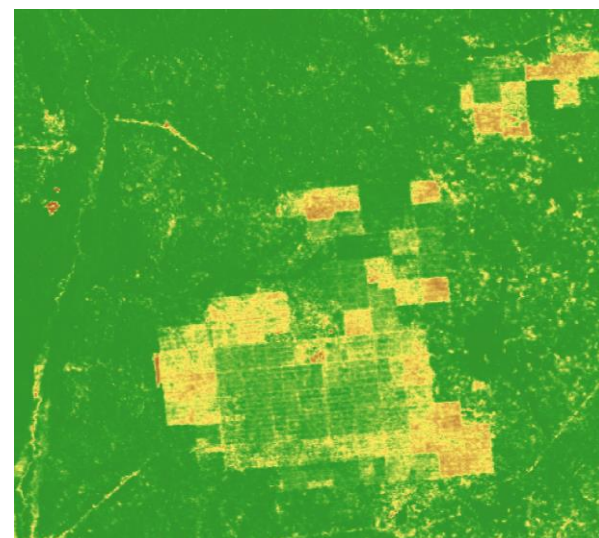
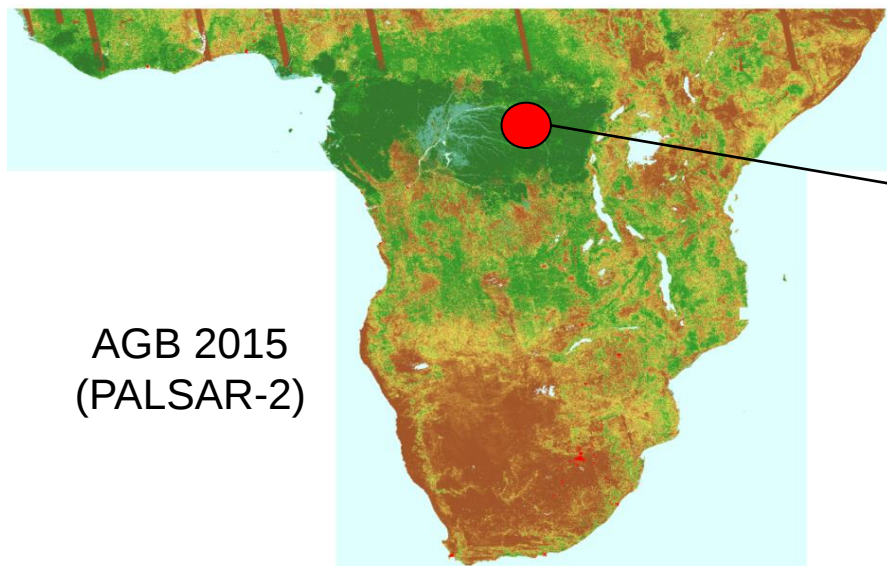
AGB 2010
(PALSAR)



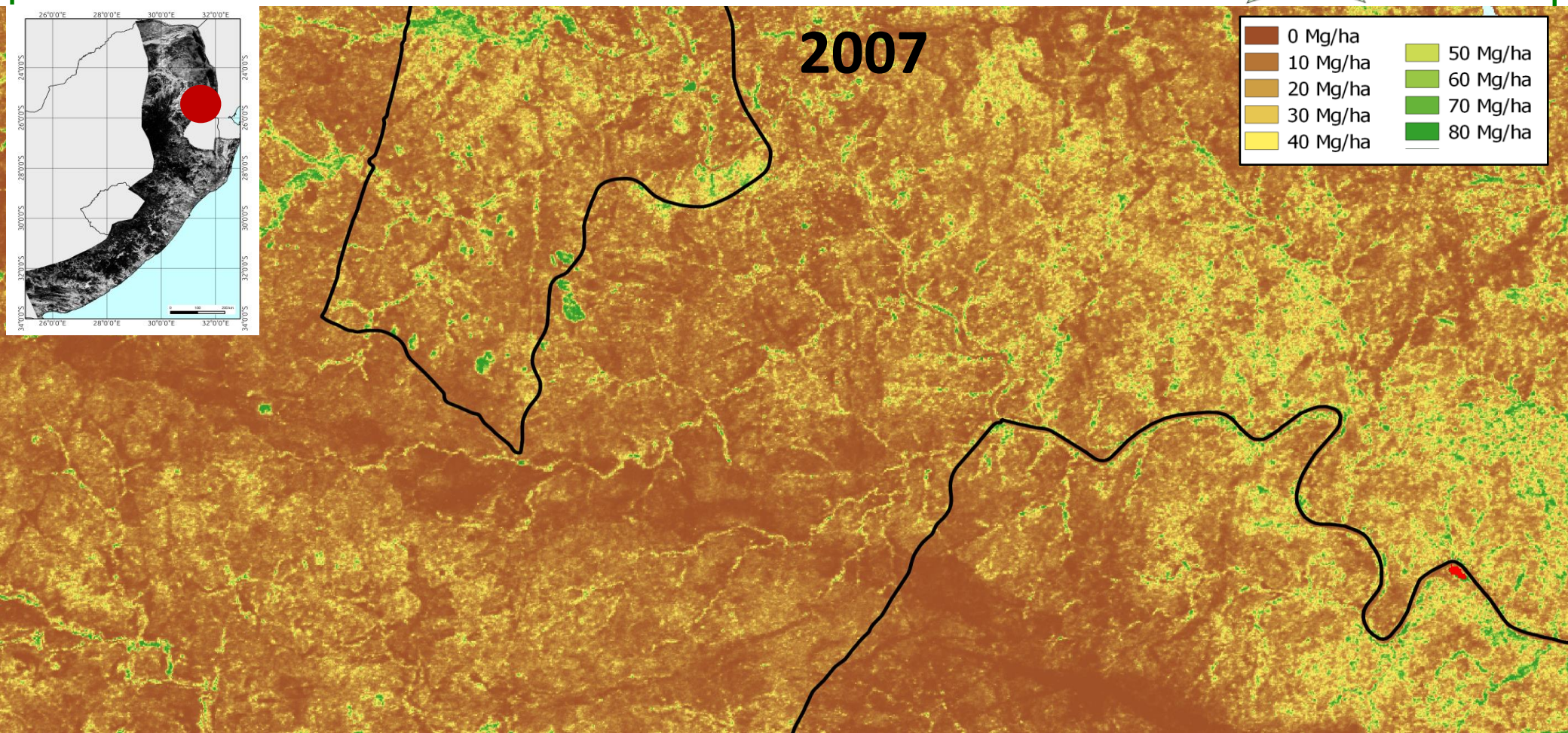
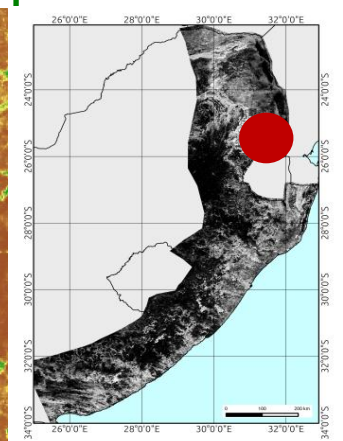
RD Congo
2.3° N,
22.9° E
20x20km



AGB 2015
(PALSAR-2)

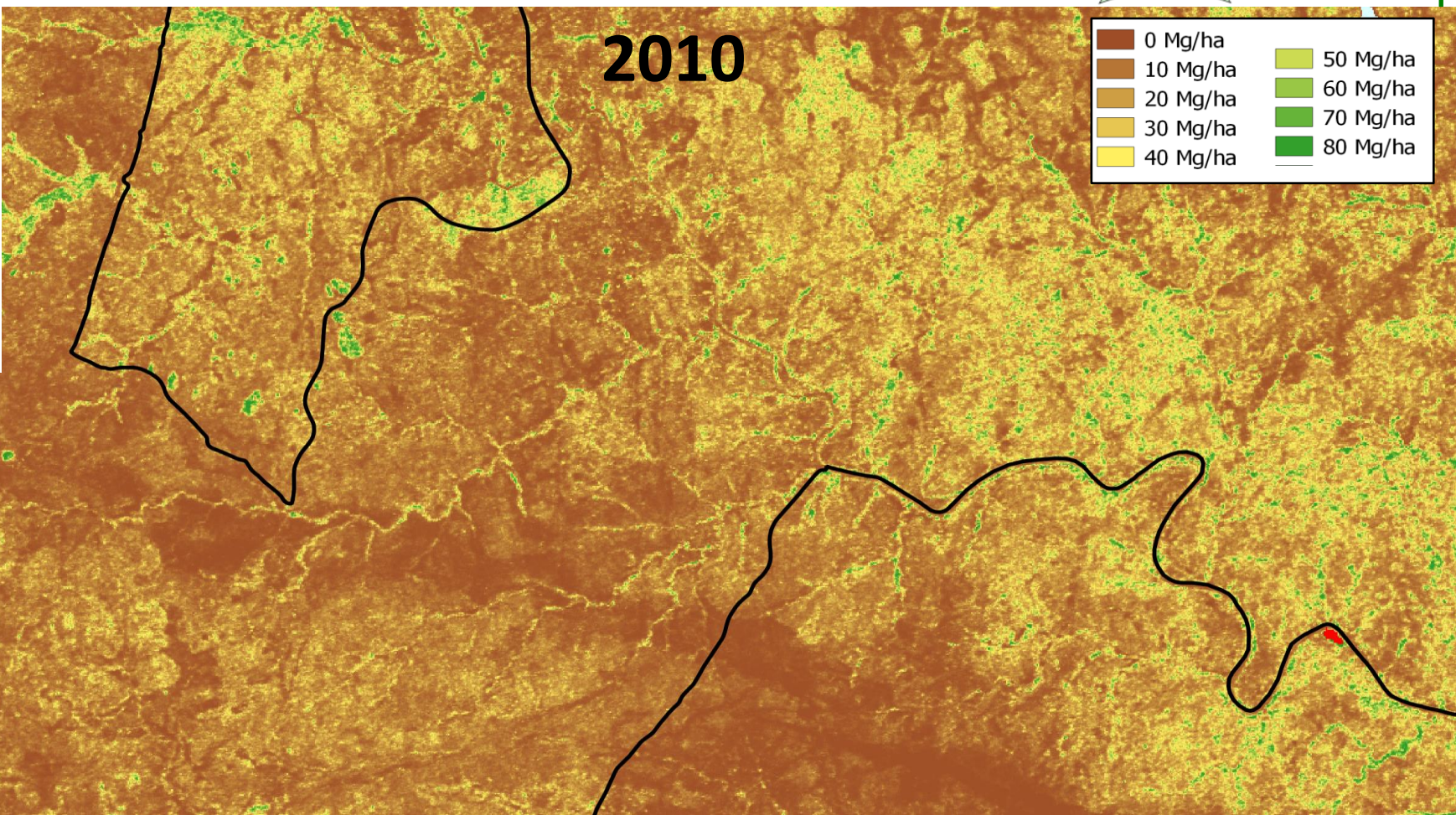
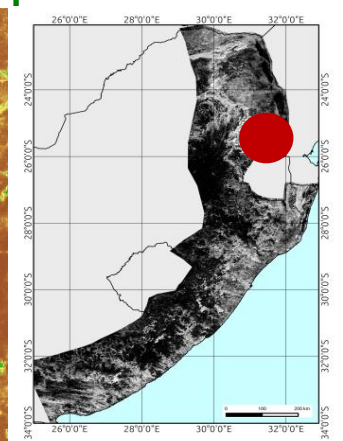


AGB changes with PALSAR/PALSAR-2



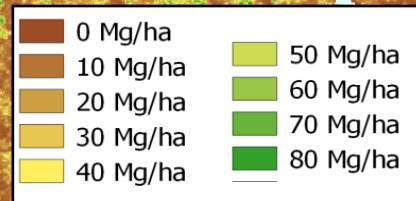
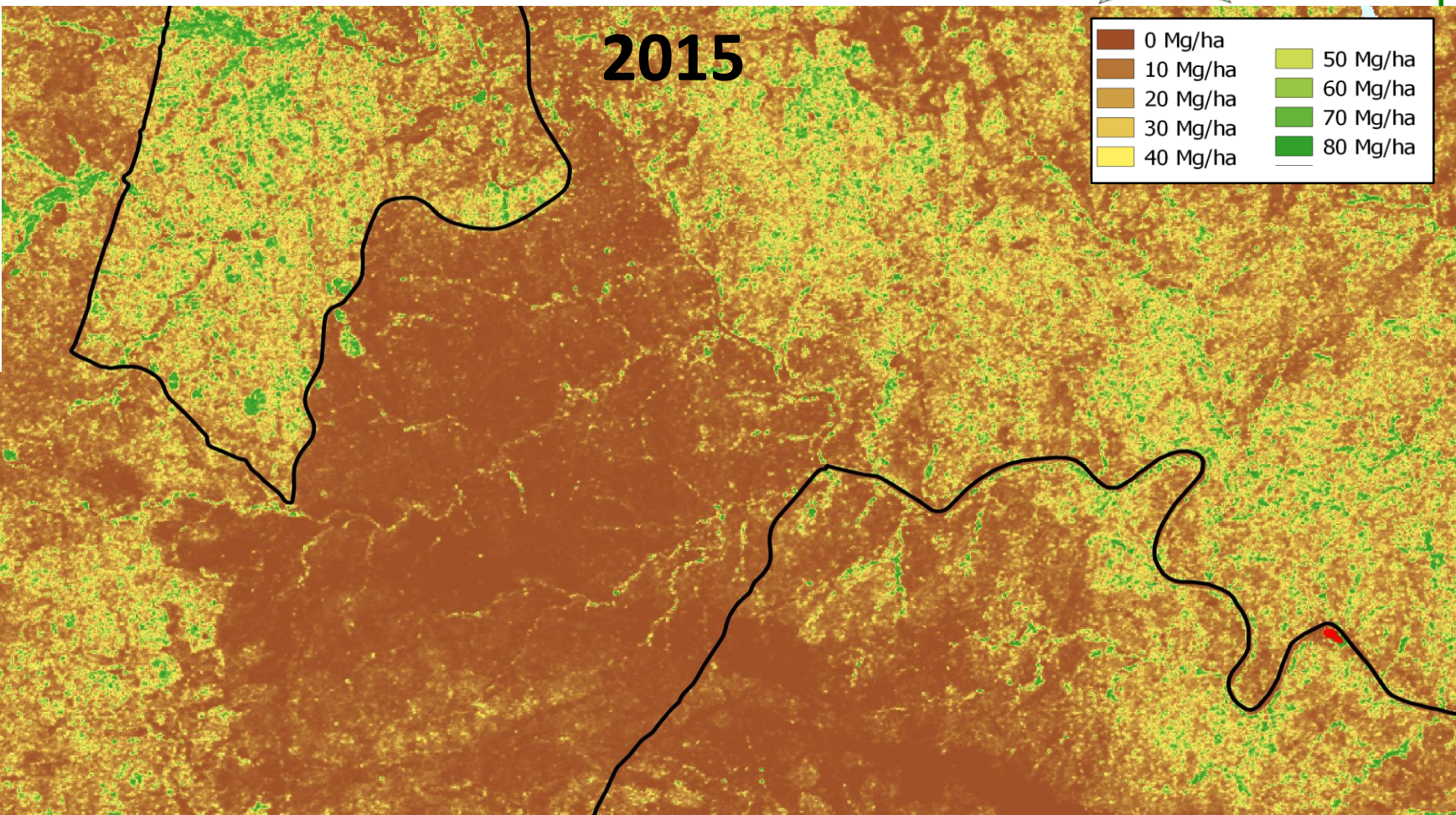
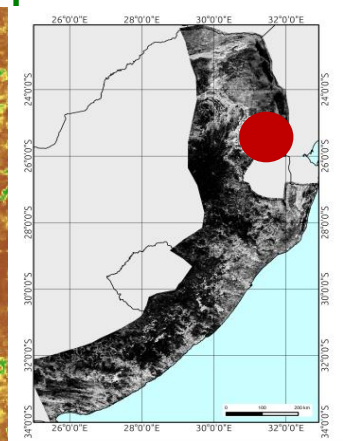
Approx. 32km

AGB changes with PALSAR/PALSAR-2

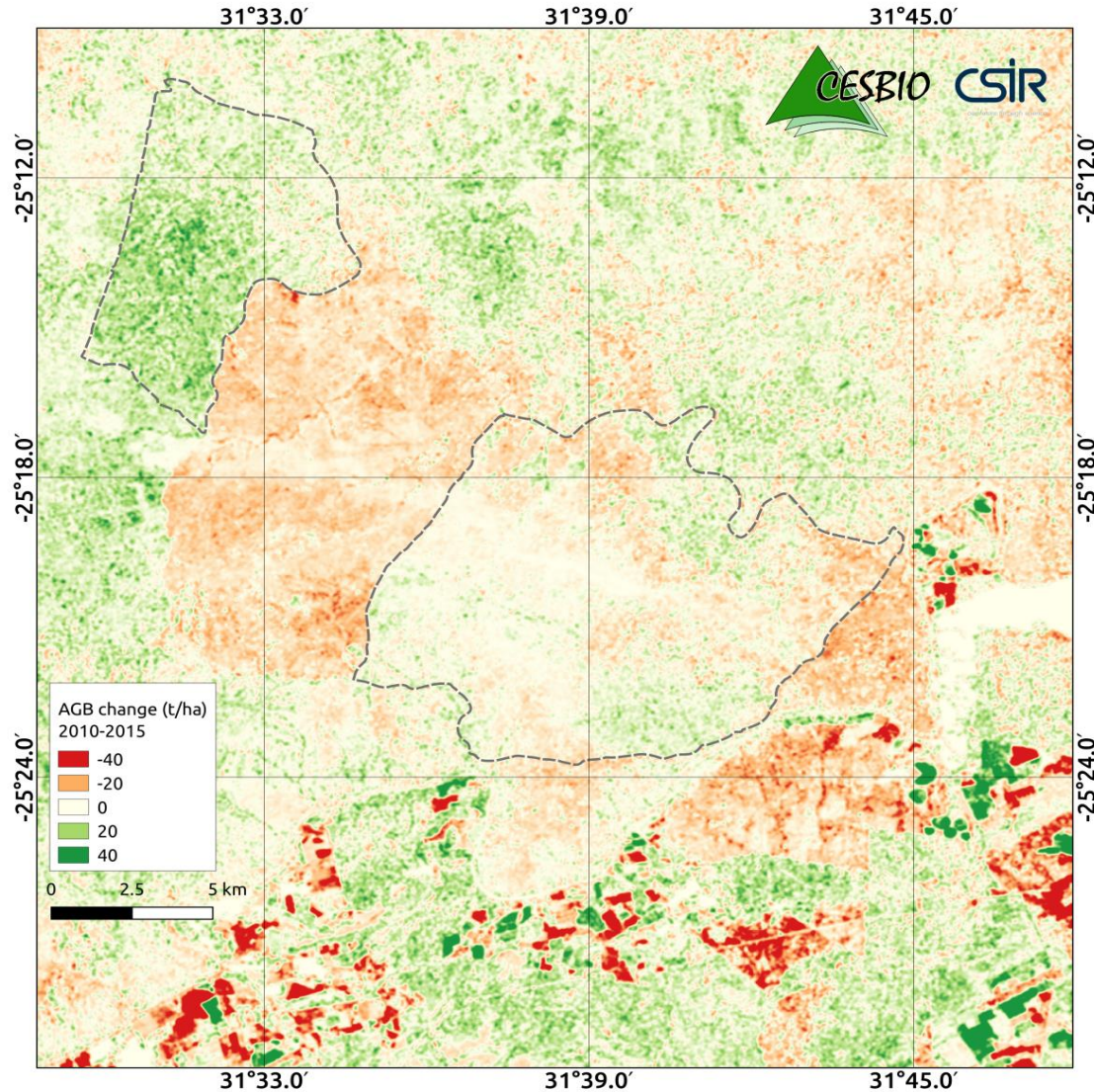


Approx. 32km

AGB changes with PALSAR/PALSAR-2



Approx. 32km



Biomass changes between 2010 and 2015 in an area within Kruger National Park.

Two private concessions are indicated with dashed lines.

The area between the concessions shows a more significant loss of biomass, probably by fires, while one concession shows a significant gain.

Deliverables and other output

Describe planned output of your project.

- ☐ Project deliverables:

AGB maps and AGB change maps over Southern Africa

- ☐ Peer-reviewed publications:

at least one

- ☐ Non-peer-reviewed publications (conference papers, reports etc.)

PALSAR/PALSAR-2 data access

Please list the PALSAR/PALSAR-2 data you have

(1) requested and (2) obtained.

→ None requested yet. Quota will be moved over and used during next JFY to carry out the local scale studies.

Have you had sufficient data to complete your research (according to your K&C agreement)?

If not, which key data sets are missing?

→ 20 scenes per year might be insufficient to carry out the analysis of time series over several sites

Thank you!

ありがとうございました