K&C Phase 4 – Status report

Forest Cover Change and Biomass Mapping

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CESBIO
Toulouse, France

Science Team meeting #22
Tokyo, Japan, February 16-18, 2016

Project Objective

To demonstrate the feasibility of forest information generated from ALOS-PALSAR to support **C**arbon **C**ycle Science, International Conventions (REDD+) and **C**limate **C**hange in 3 projects:

1. Forest cover change and biomass mapping in **Cameroon** .
2. Biomass mapping of woodland savanna, in **Africa** and also globally
3. Forest cover change and biomass mapping in **Vietnam**/Lao/Cambodia, where de/af/reforestation have been very active during the last decade.

…. and

To consolidate methodology for **forest cover change and biomass mapping**

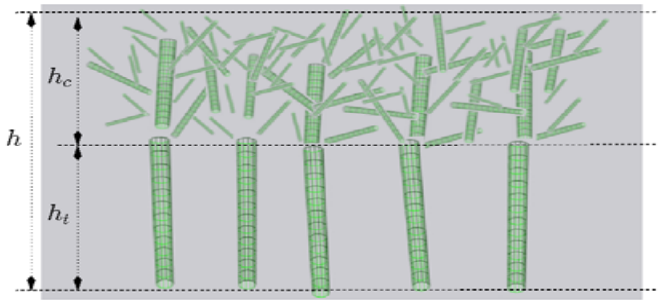
Results and significant findings

Methodology for biomass mapping

1.Low biomass forest

Woodland Savanna in Africa and worldwide

Theoretical simulations of relationships between SAR backscatter and biomass



FOREST DESCRIPTION

- Tree and forest structure:
- Number of trees per ha
- Dimensions, orientation of trunks/branches
- Wood density, moisture…

SAR PARAMETERS

- Frequency
- Incidence angle

ENVIRONMENT

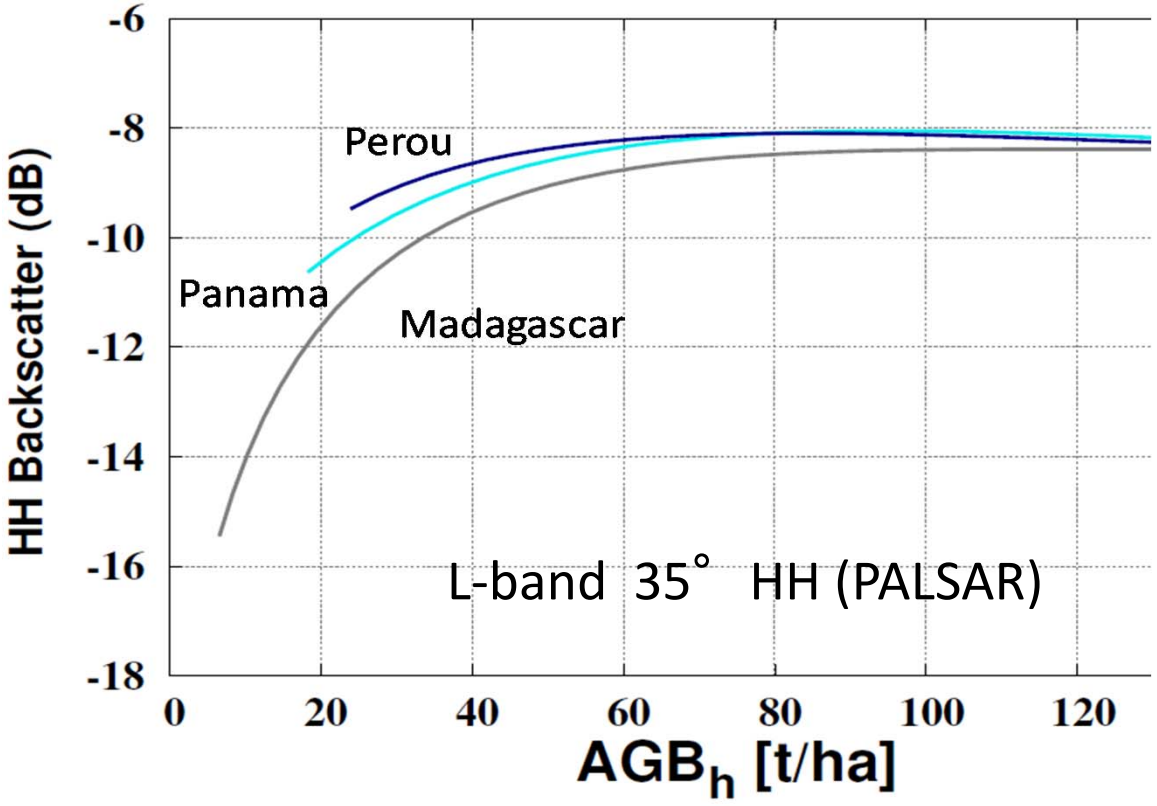
- Soil moisture
- Topography

MIPERS

Simulated SAR backscatter

Simulations of perturbing effects

Varying vegetation structure parameters



$$AGB = \frac{-1}{c} \times \ln\left[\frac{b - \gamma^{o}_{HV}}{b - a}\right]$$

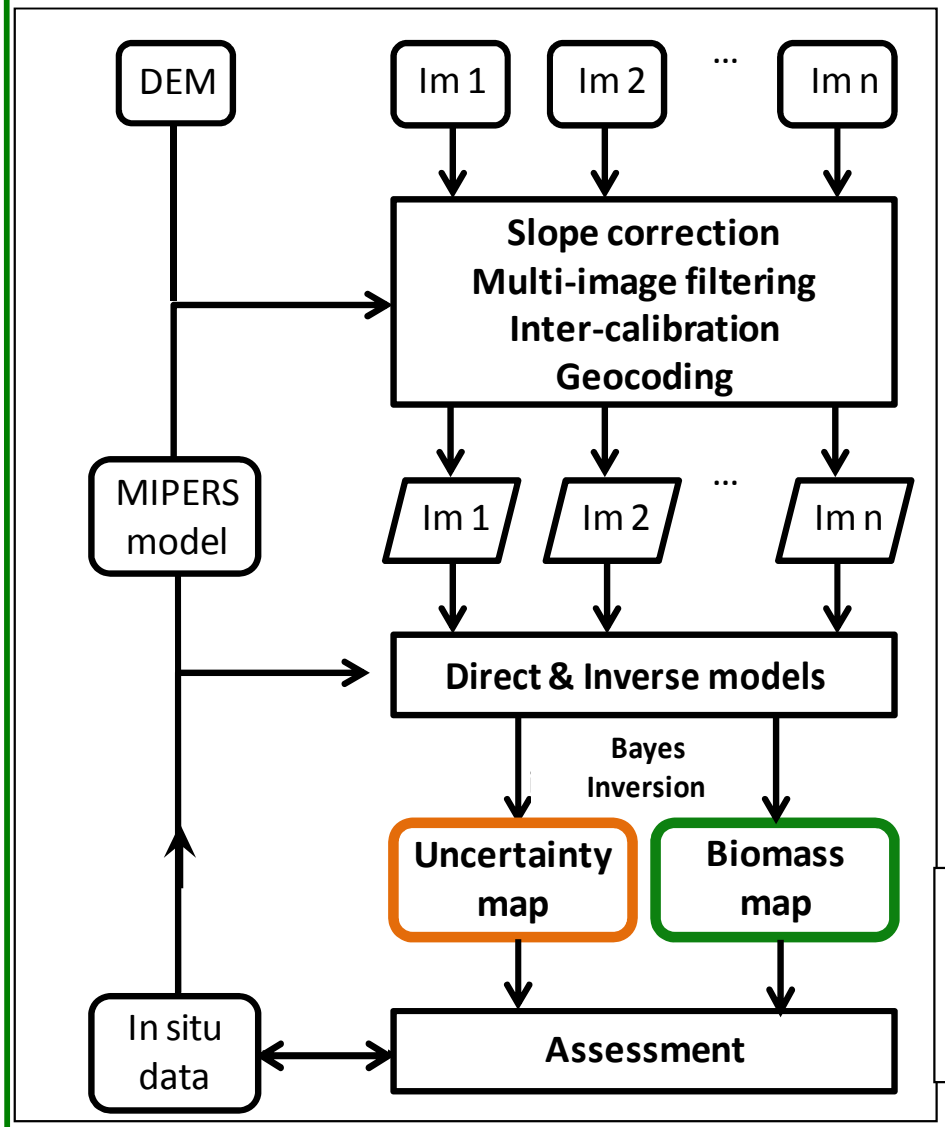
a = γ^0_{ground} = γ^0 for AGB=0 (ground)

b = γ^0_{veg} = γ^0 for AGB at saturation level

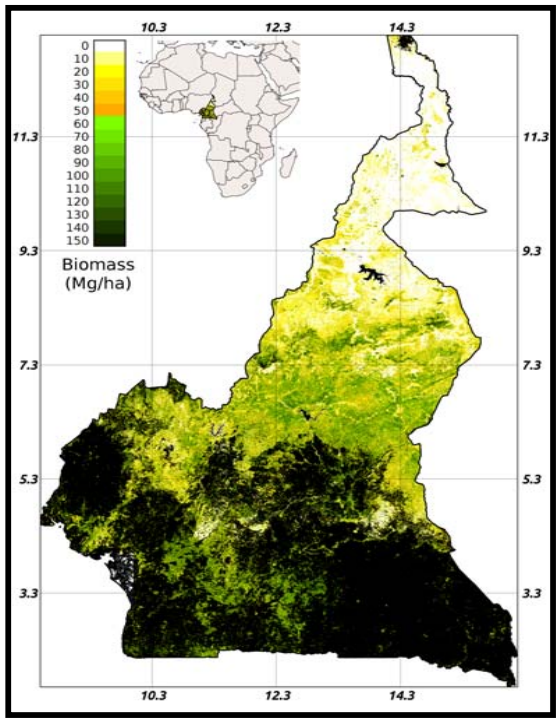
c = attenuation coefficient of the vegetation layer

a, **b** and **c** are defined by fitting the curve to field plots and/or using ancillary data.

Methodology for low biomass forests



Cameroon



Biomass assessment in the Cameroon savanna using ALOS PALSAR data

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[c] Mesa-Consult, Konstanz, Germany

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ALOS

K&C Initiative

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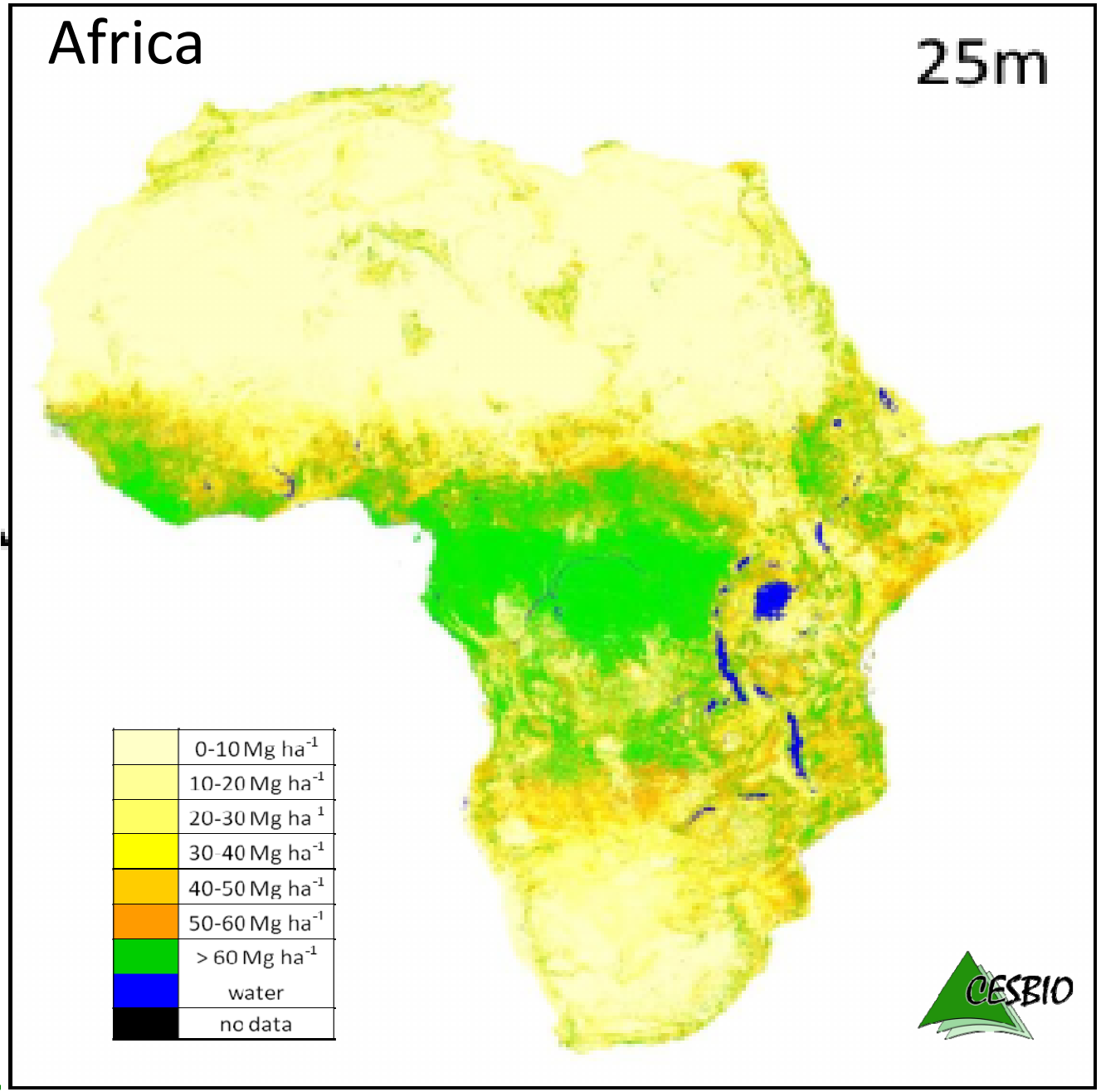
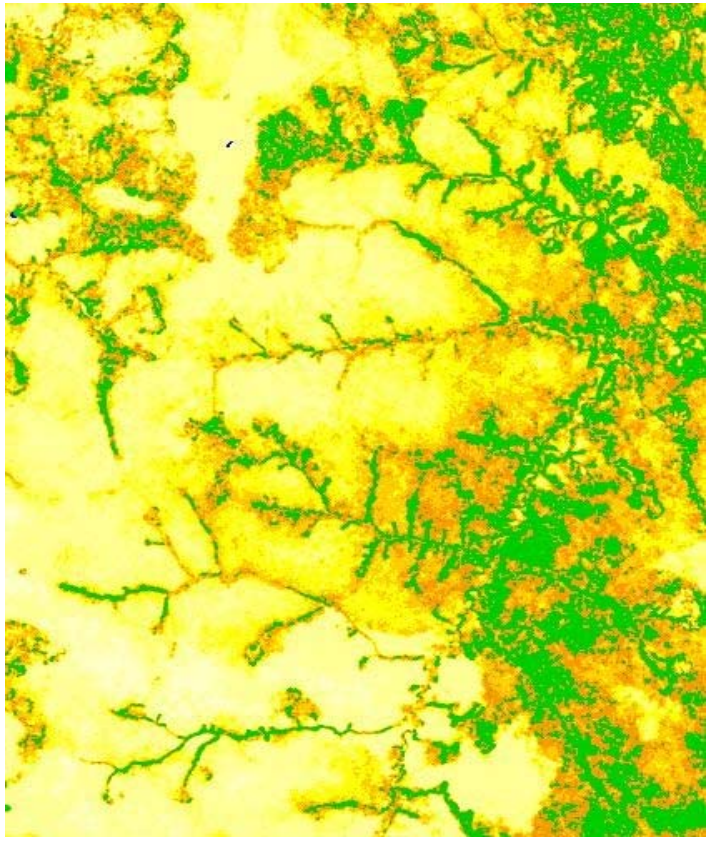
Africa

25m

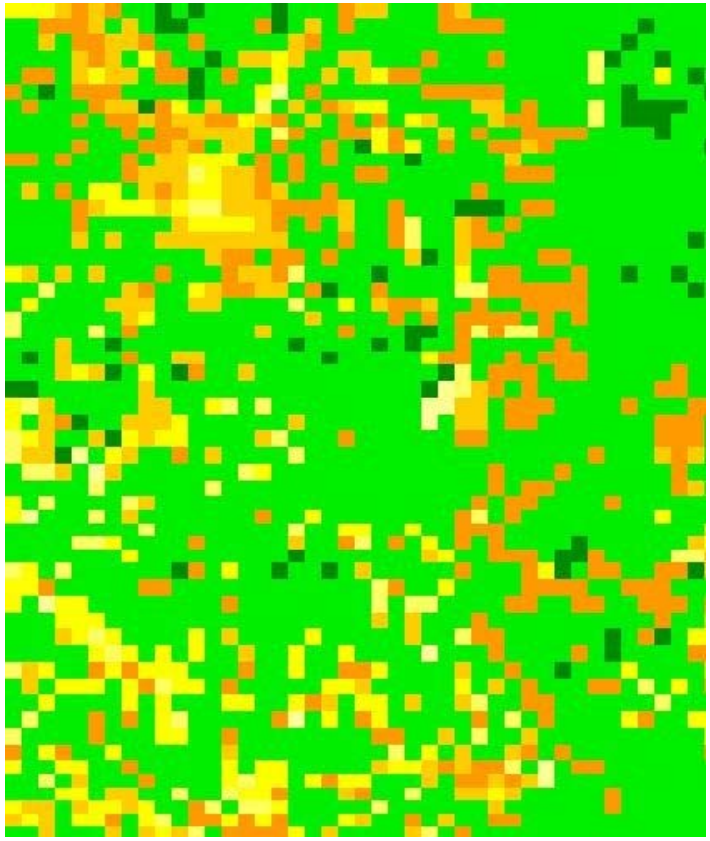


Comparison with existing maps

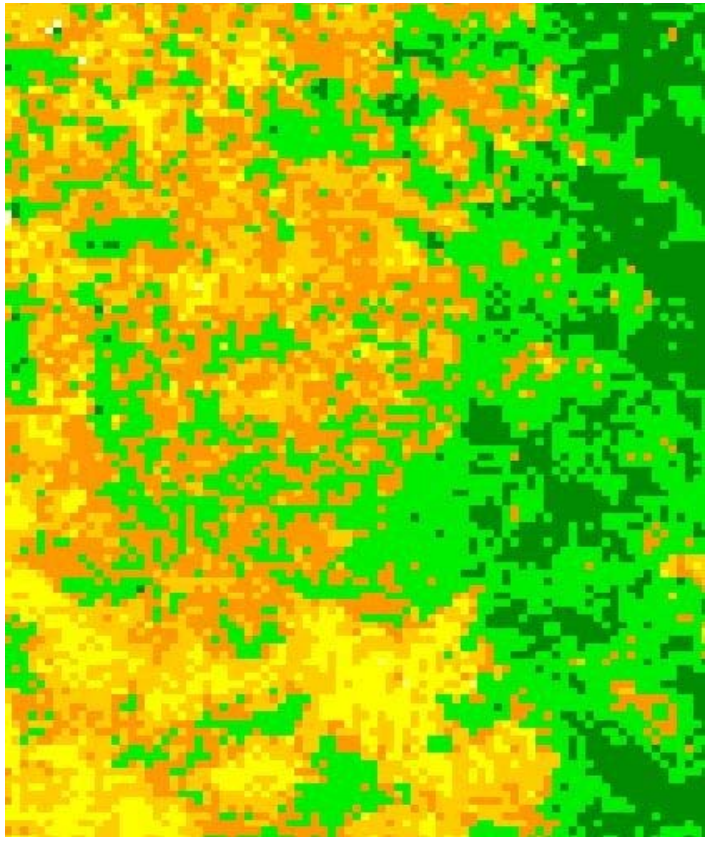
This study



Saatchi et al., 2011



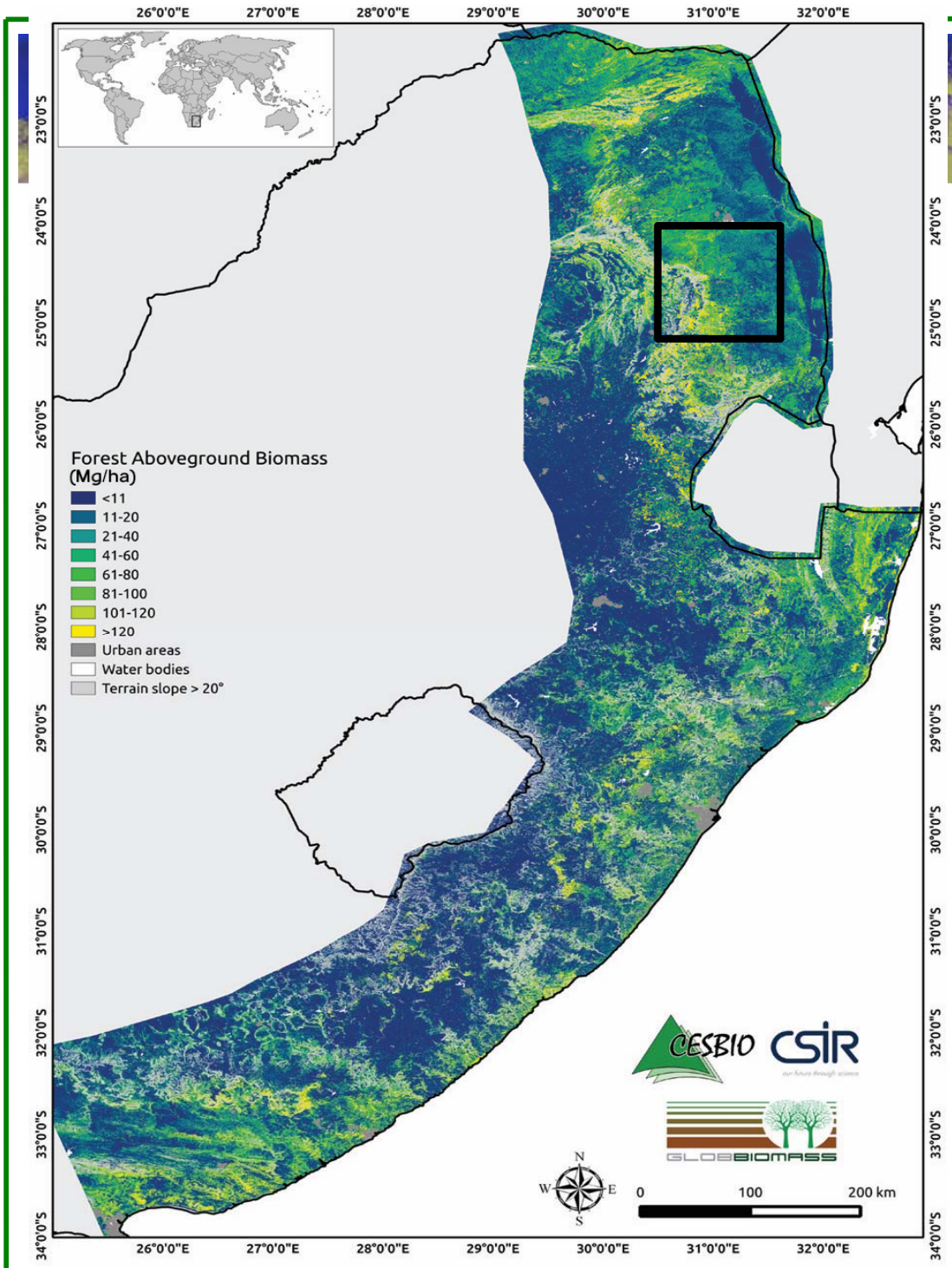
Baccini et al., 2012



	0-10 Mg ha^{-1}
	10-20 Mg ha^{-1}
	20-30 Mg ha^{-1}
	30-40 Mg ha^{-1}
	40-50 Mg ha^{-1}

	50-60 Mg ha^{-1}
	60-100 Mg ha^{-1}
	> 100 Mg ha^{-1}
	water
	no data

Subset from tile: Latitude: 10° S to 5° S
Longitude: 20° E to 25° E



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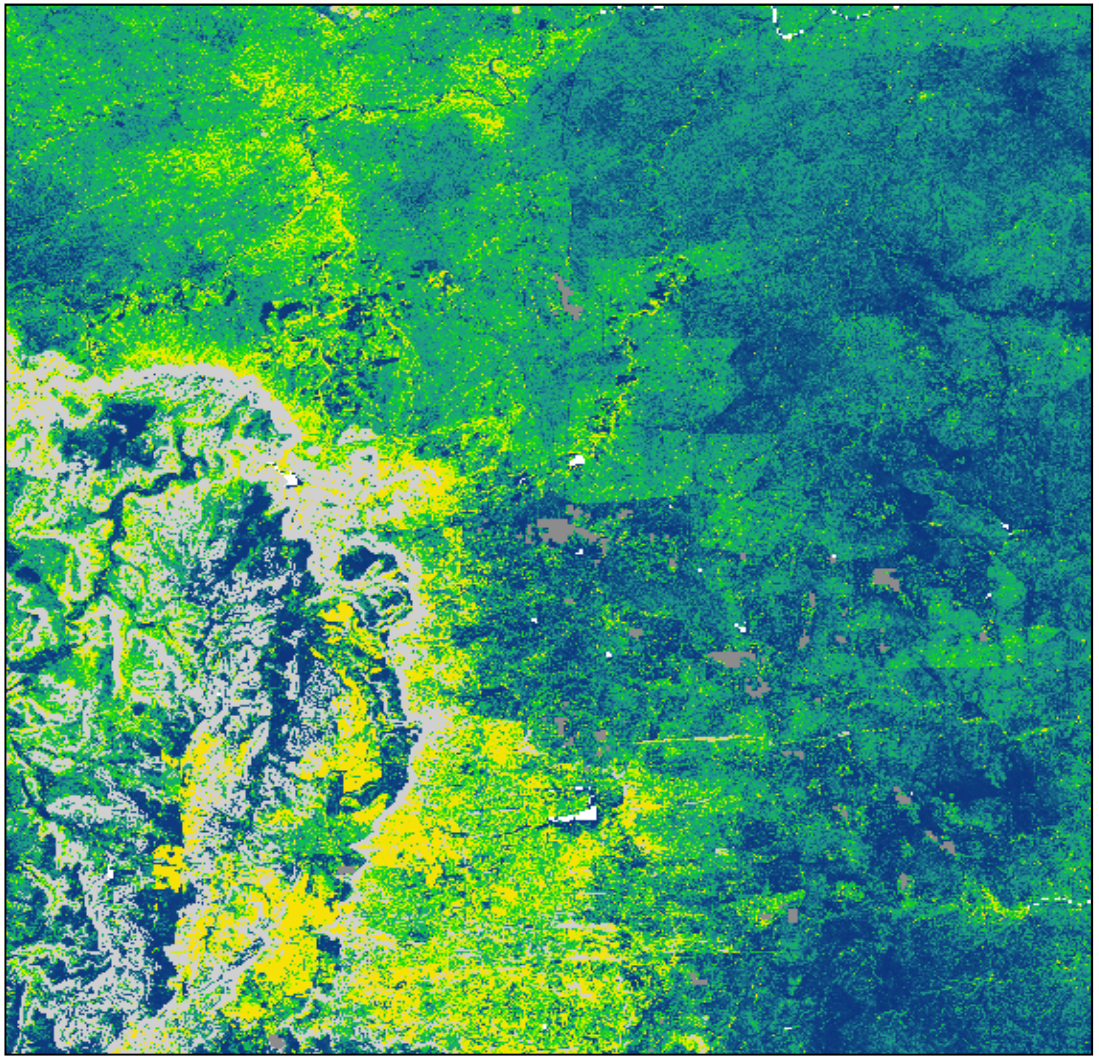
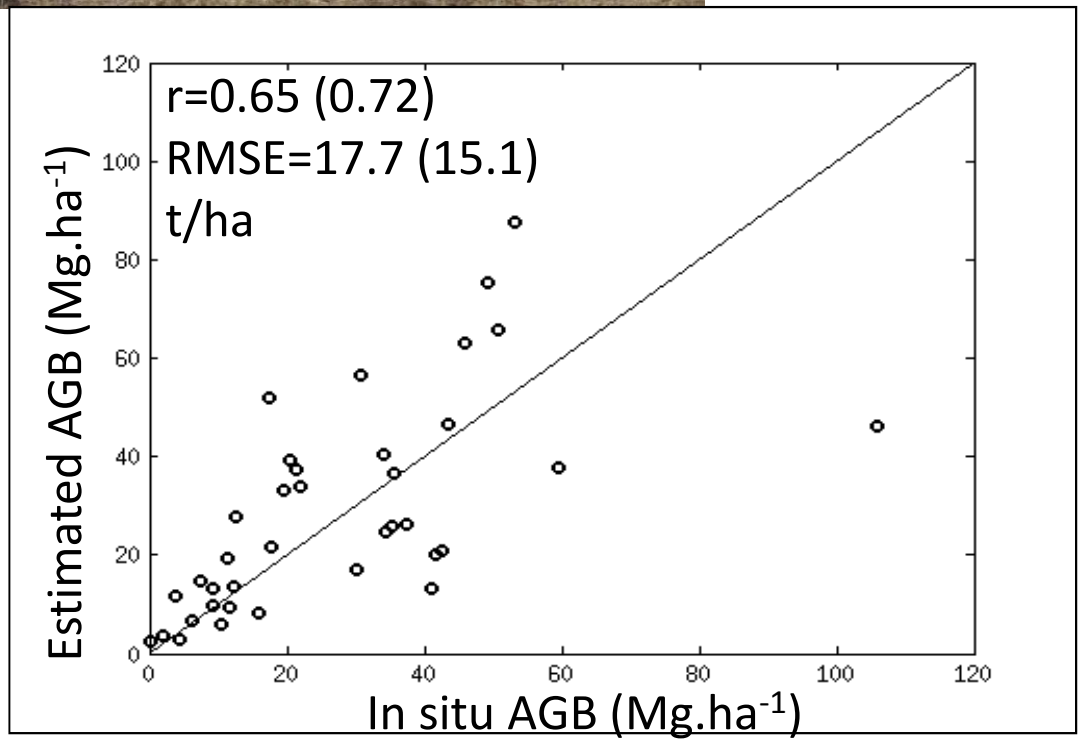
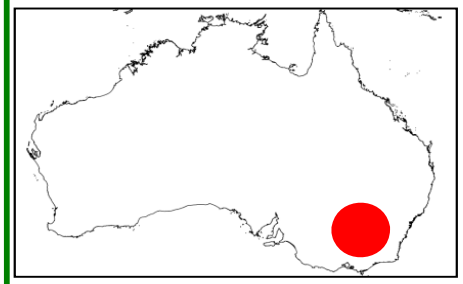
South Africa AGB map 2010 at 25m
Globbiomass project

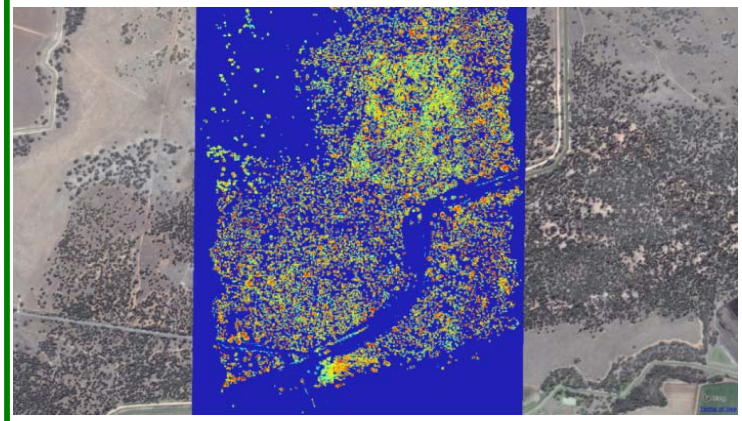


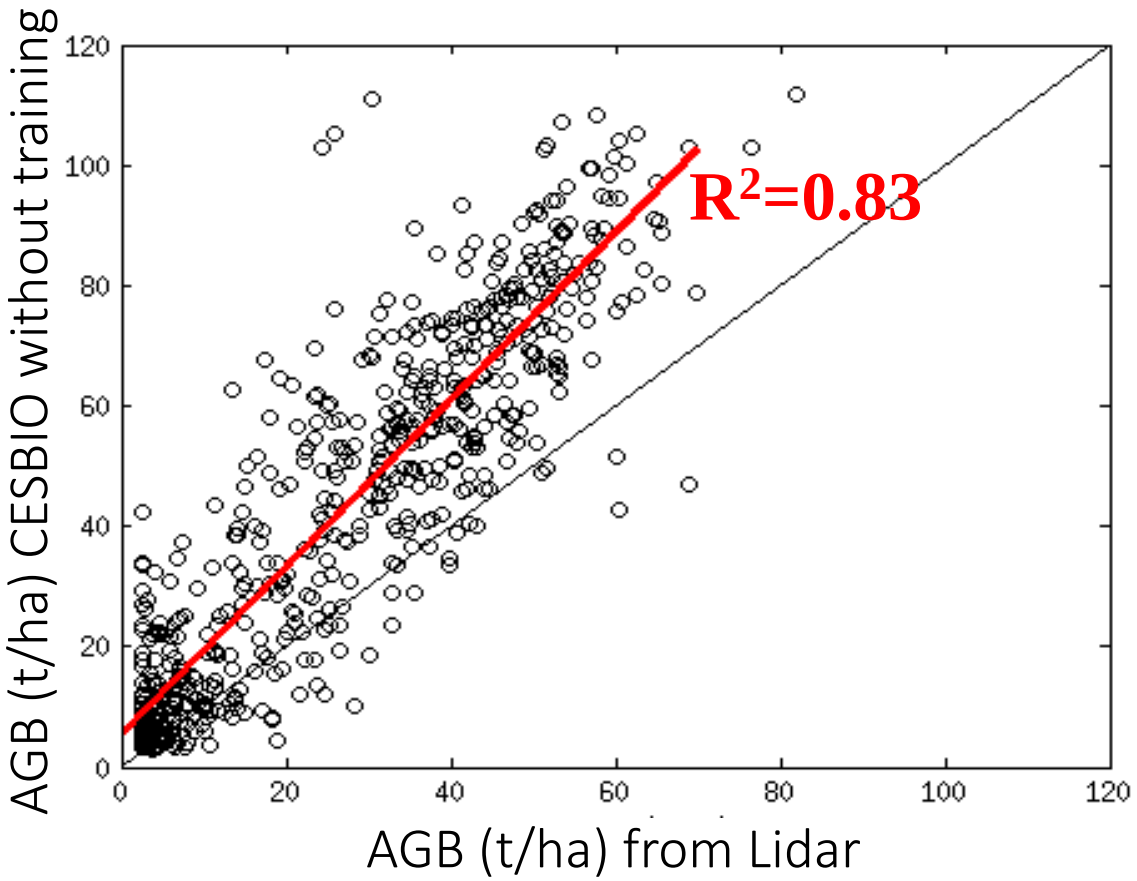

r=0.65 (0.72)
RMSE=17.7 (15.1)
t/ha
Estimated AGB (Mg.ha-1)
In situ AGB (Mg.ha-1)
0
20
40
60
80
100
120

Current work: Validation in Australia



AGB from airborne lidar





Results and significant findings

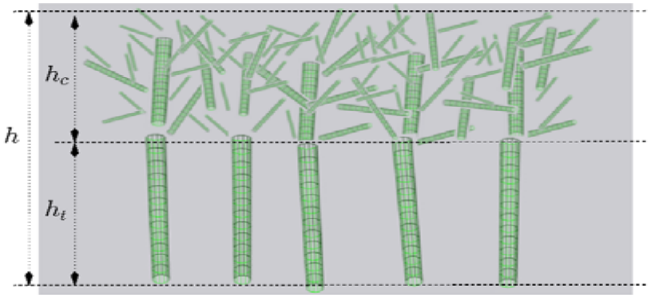
Methodology for biomass mapping

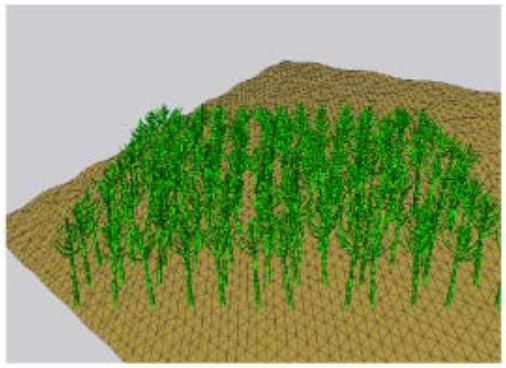
1.Dense canopy forest

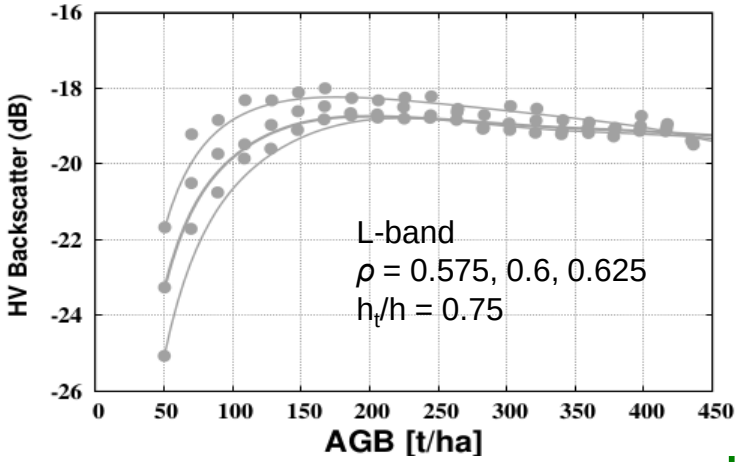
The Congo basin

CESBIO method for high AGB and dense forests under test

1..Electromagnetic modelling

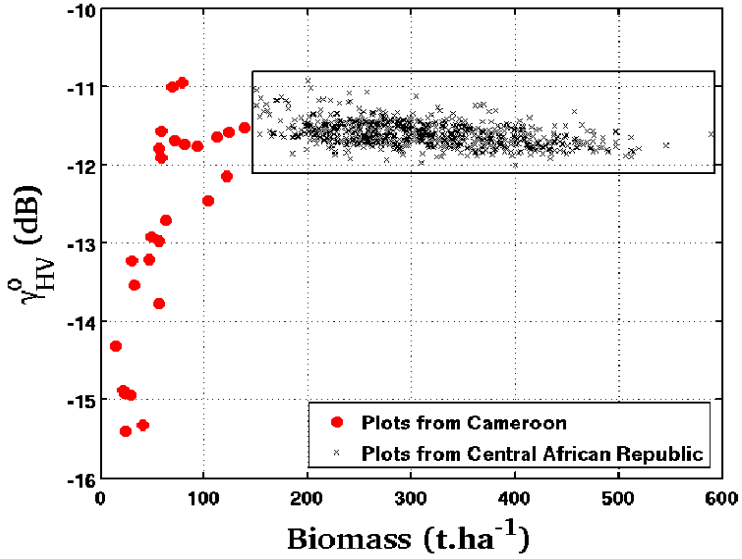






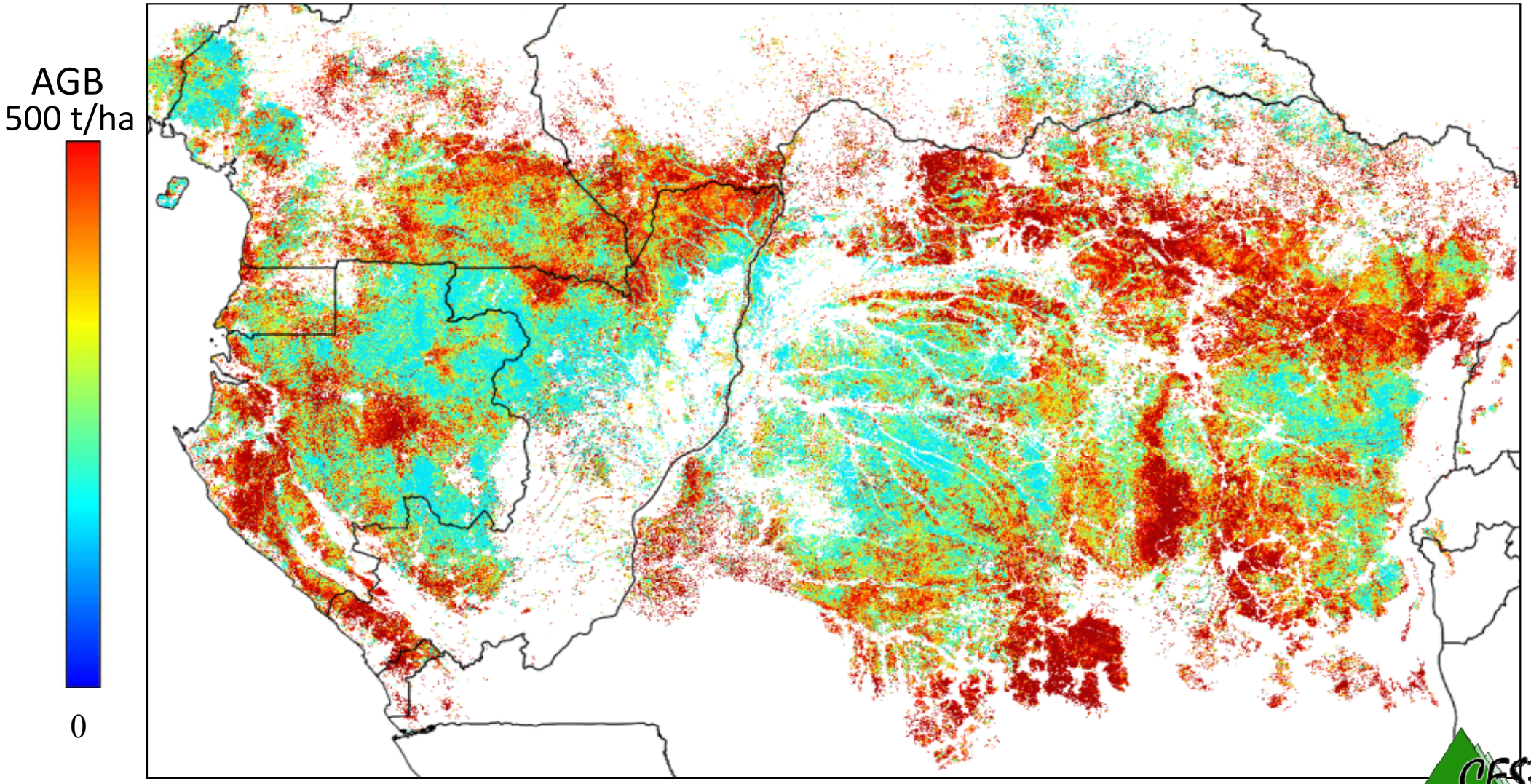
Example of a simulation of the effect of wood density ρ (linked to tree species)

2. Experimental data in Central African Republic



Mapping of high AGB forests at low resolution (500 m)

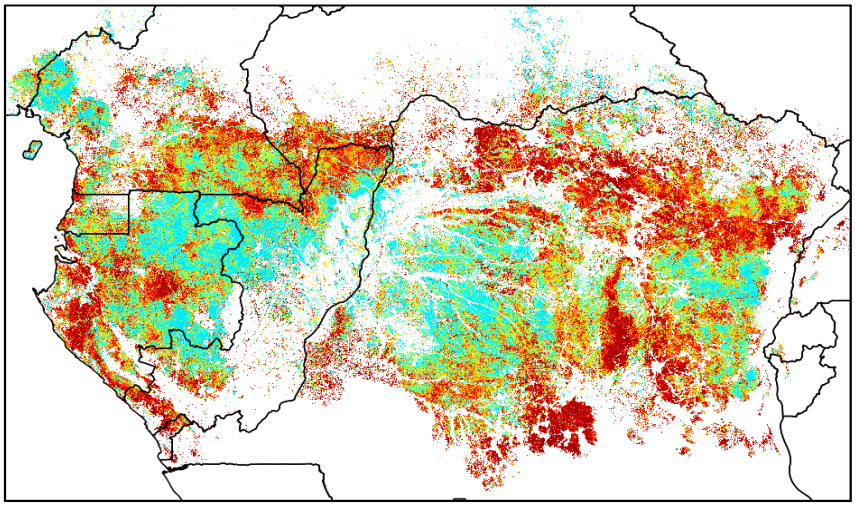
Congo basin



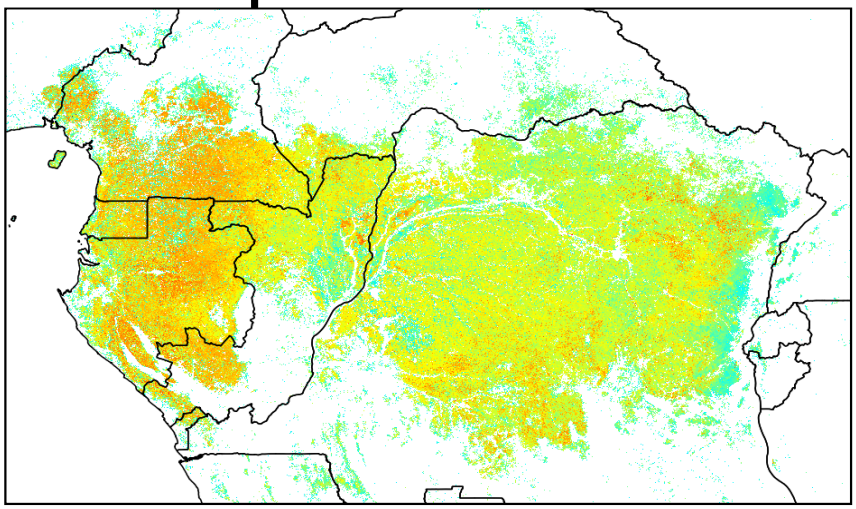
AGB
500 t/ha

0

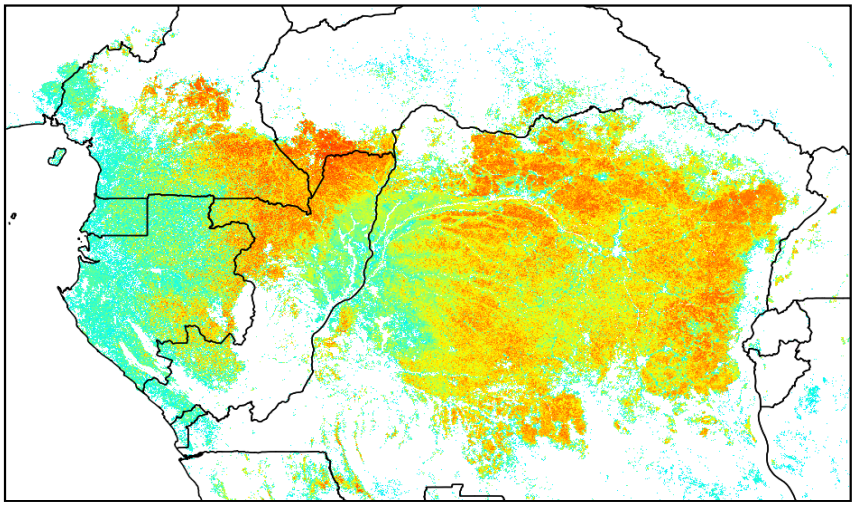
AGB map at 500 m - Cesbio



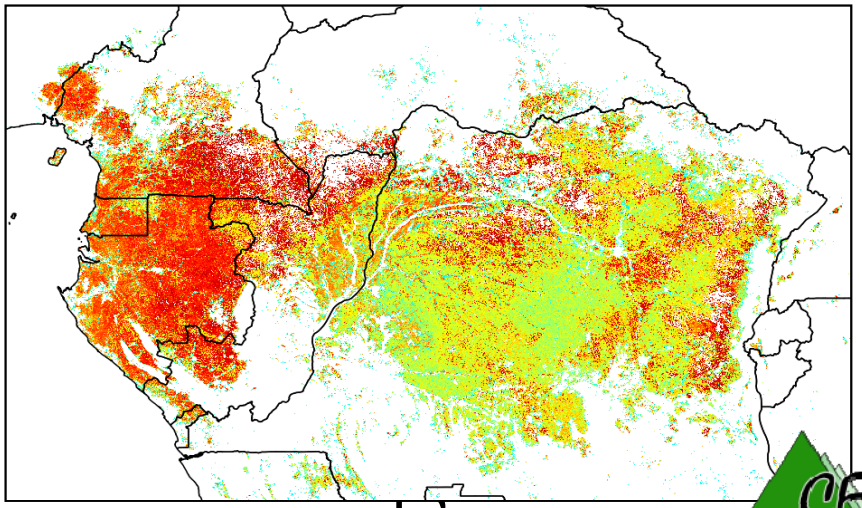
AGB map at 1 km – Saatchi et al.



AGB map at 500 m – Baccini et al.

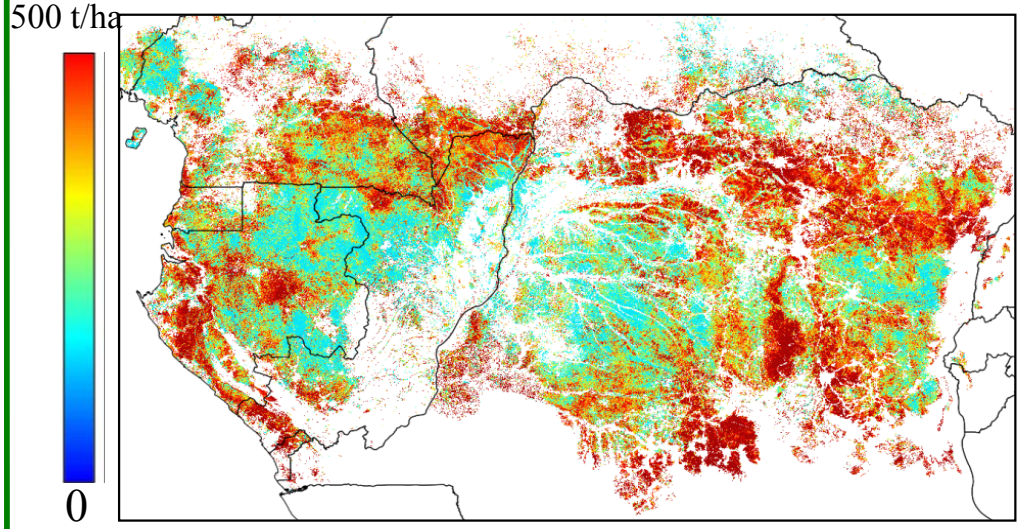


AGB map at 1 km – Avitabile et al.

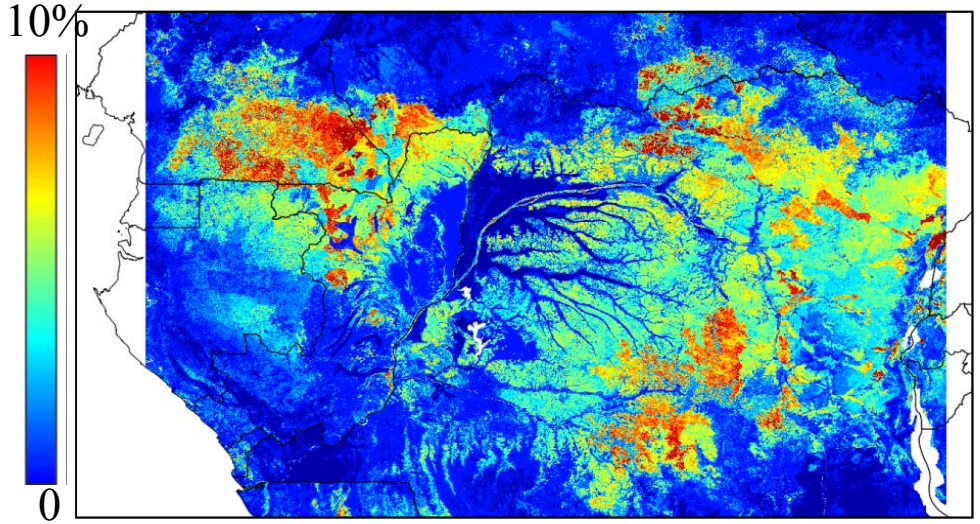


Understanding the biomass distribution

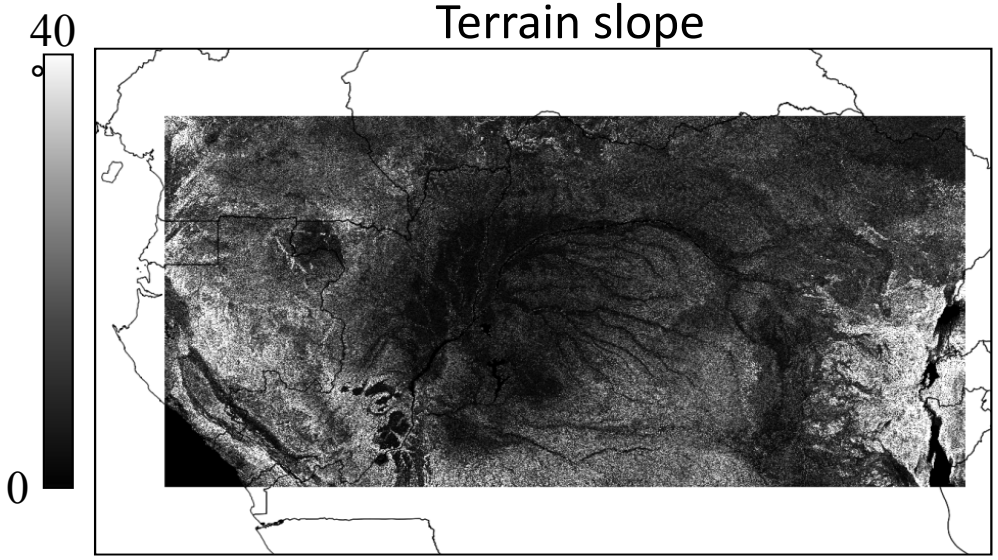
AGB from CESBIO



Soil map – kastanozems (thick layer & rich in humus)



Terrain slope

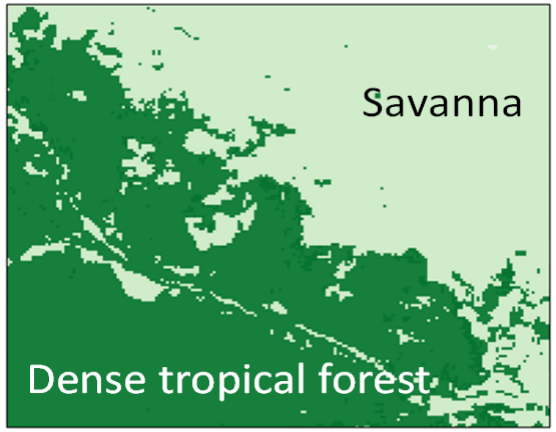


Current work to be pursued

CESBIO

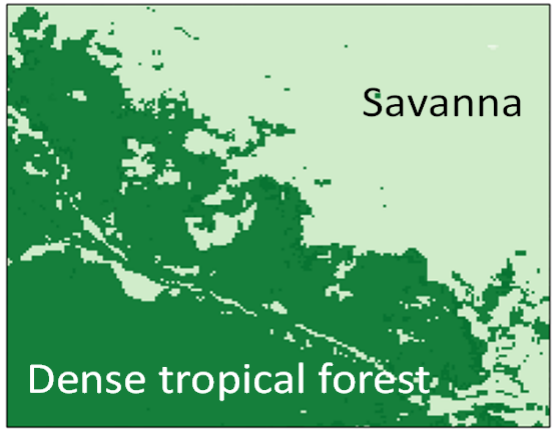
Comparison with 1 km in situ data

Land cover (500 m)

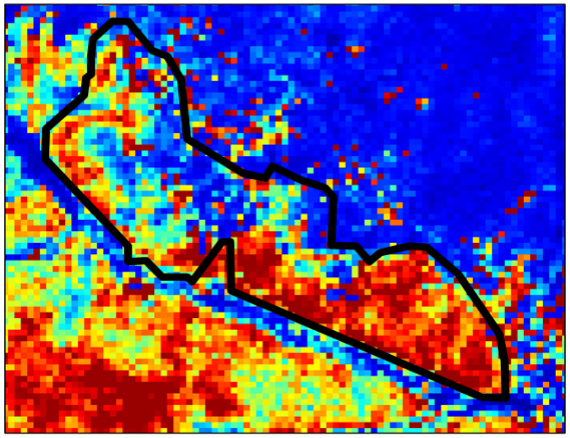


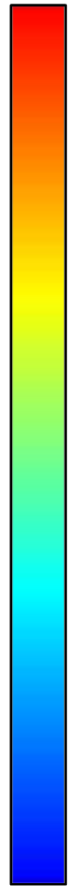
Comparison with 1 km in situ data

Land cover (500 m)



CESBIO (1 km)

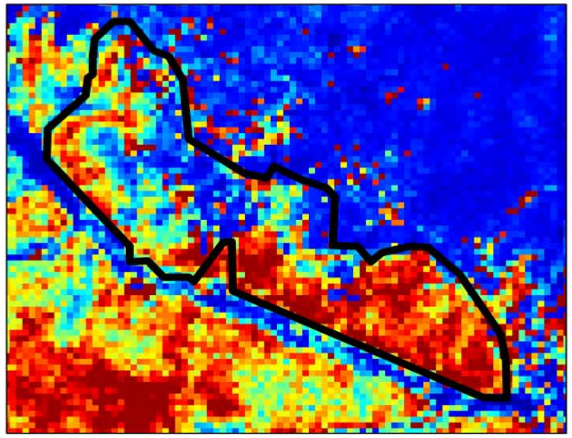




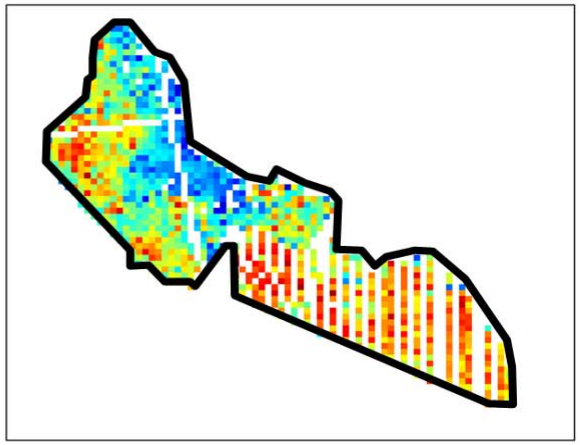
Comparison with 1 km in situ data

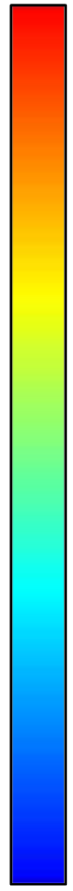
Land cover (500 m)

CESBIO (1 km)



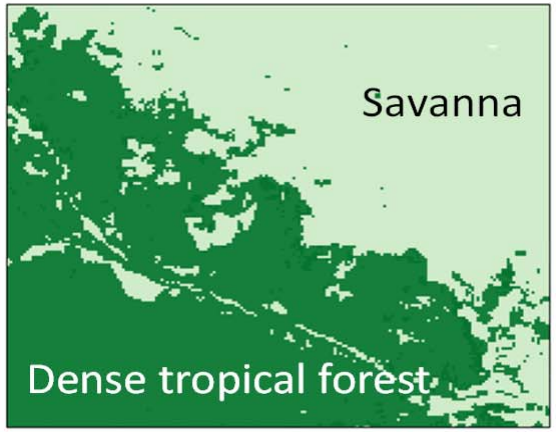
CIRAD In situ data



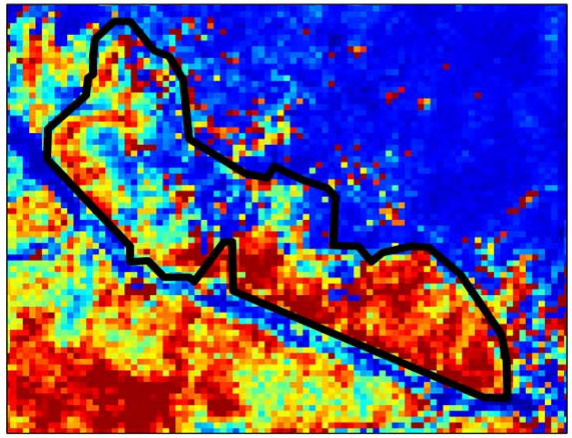


Comparison with 1 km in situ data

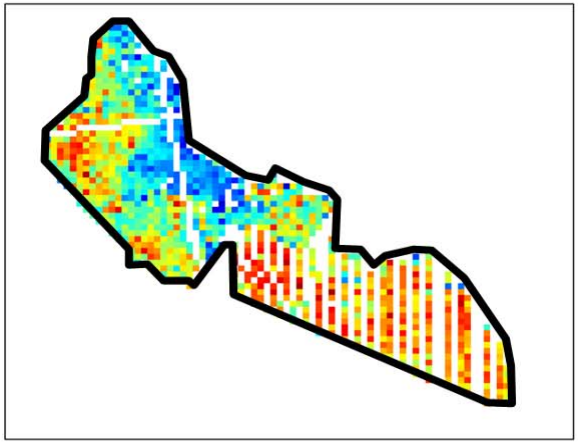
Land cover (500 m)



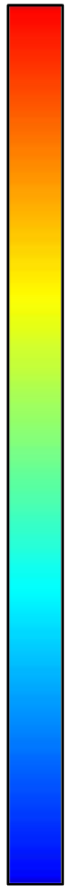
CESBIO (1 km)



CIRAD In situ data

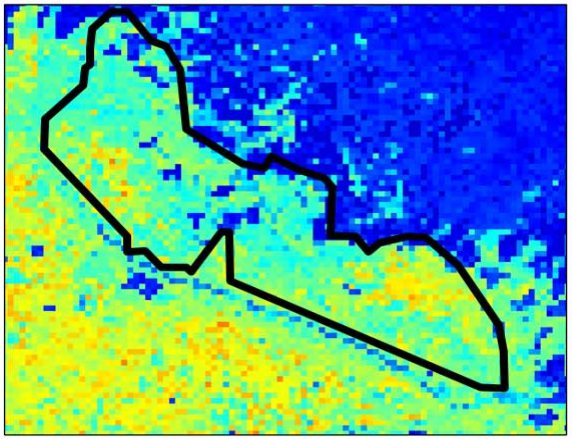


550
t/ha

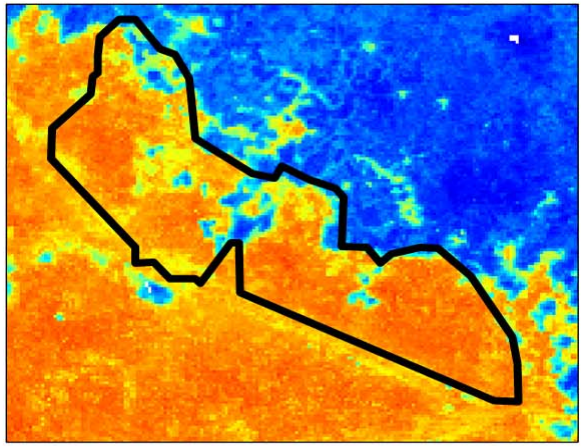


0

Saatchi et al., 2011 (1 km)



Baccini et al., 2012 (500m)



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Results and significant finding

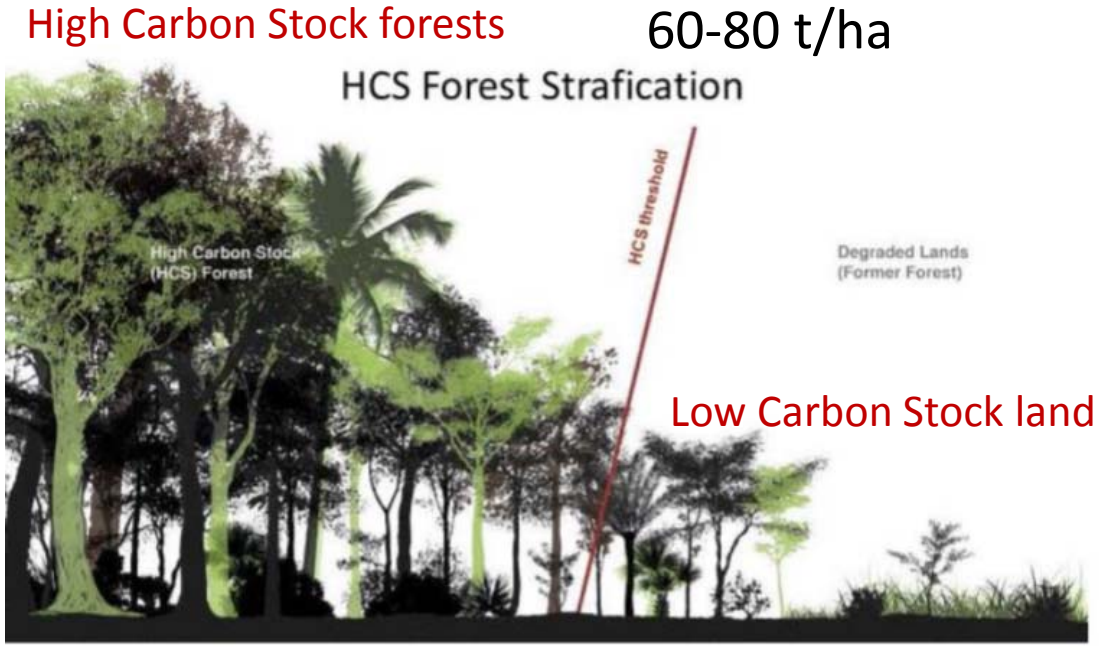
Cameroon

Biomass map to be used in High Carbon Stock approach

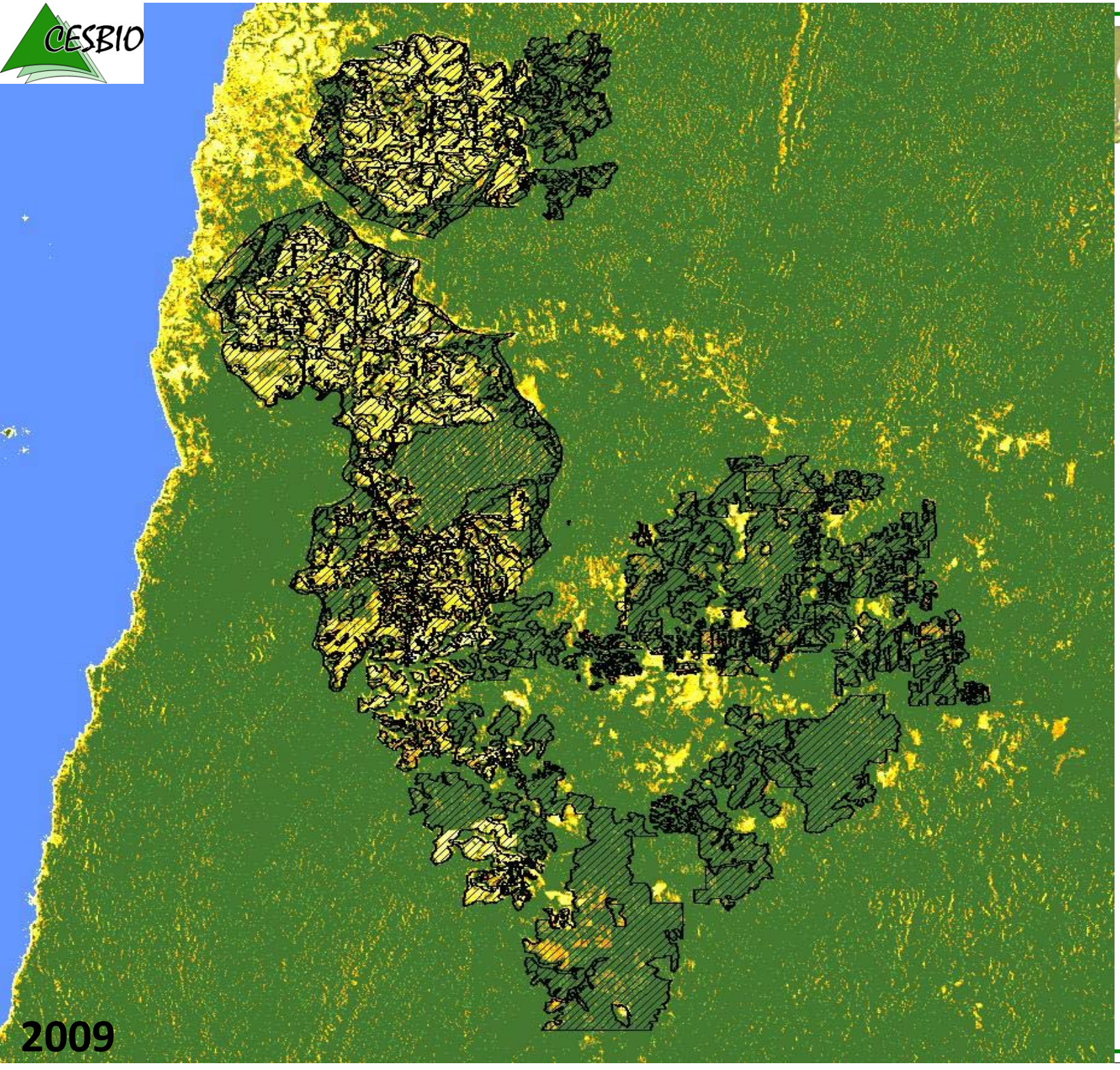
High Carbon Stock approach

The High Carbon Stock Approach is a methodology to identify:

- **areas suitable for plantation** Areas of lower vegetation (low carbon and biodiversity), such as shrub and grassland
- forest **areas to be protected** in the long term. Including young regenerating forest and secondary forest containing more carbon and higher biodiversity



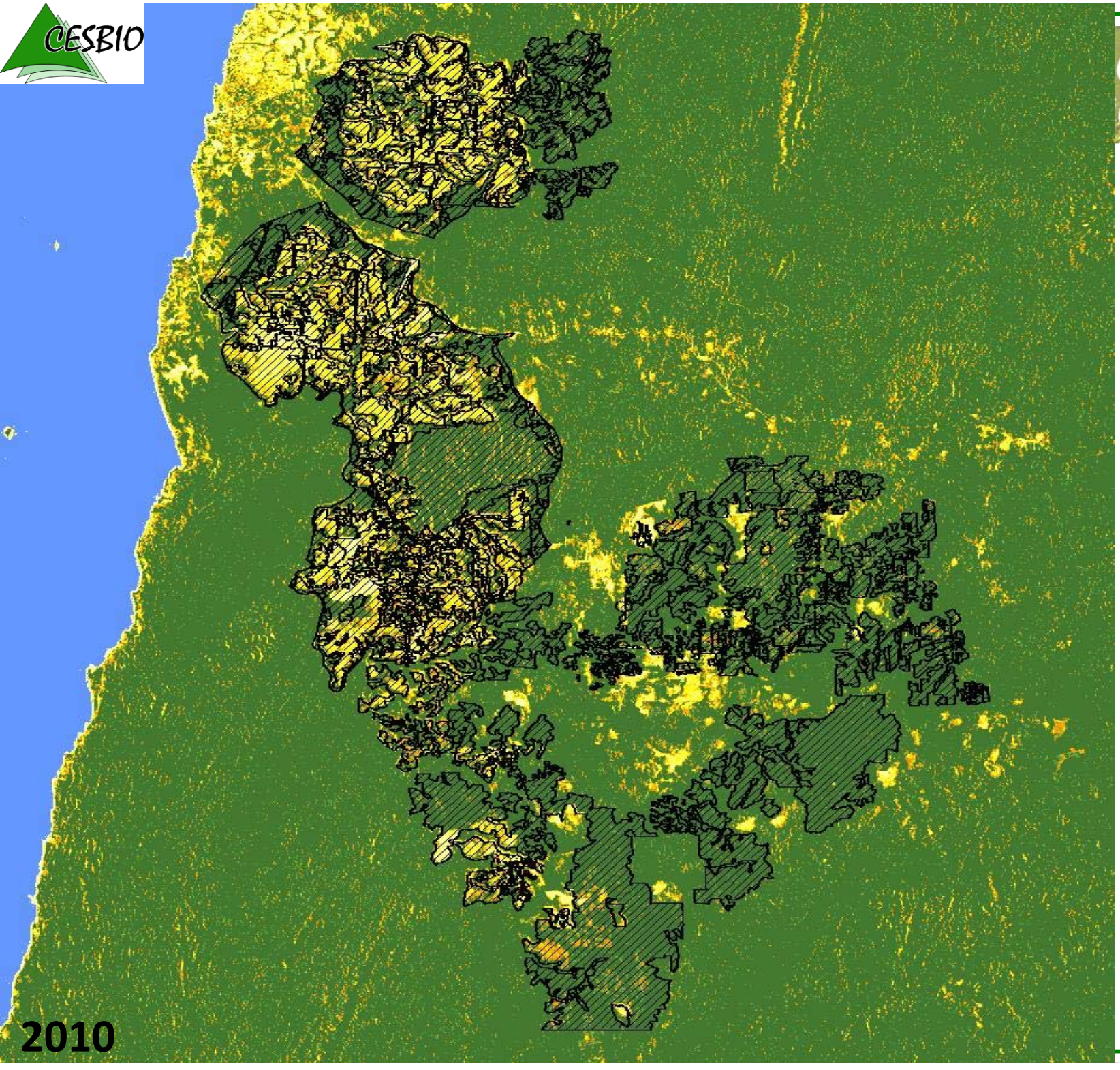
Companies that have been converting tropical forests to plantations for commodities like palm oil or paper have come under increasing pressure to prove they are not causing deforestation



C Initiative
ence collaboration led by JAXA

Above ground biomass
from ALOS PALSAR

	0-10 Mg ha^{-1}
	10-20 Mg ha^{-1}
	20-30 Mg ha^{-1}
	30-40 Mg ha^{-1}
	40-50 Mg ha^{-1}
	50-60 Mg ha^{-1}
	60-80 Mg ha^{-1}
	80-100 Mg ha^{-1}
	> 100 Mg ha^{-1}
	water



C Initiative
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from ALOS PALSAR

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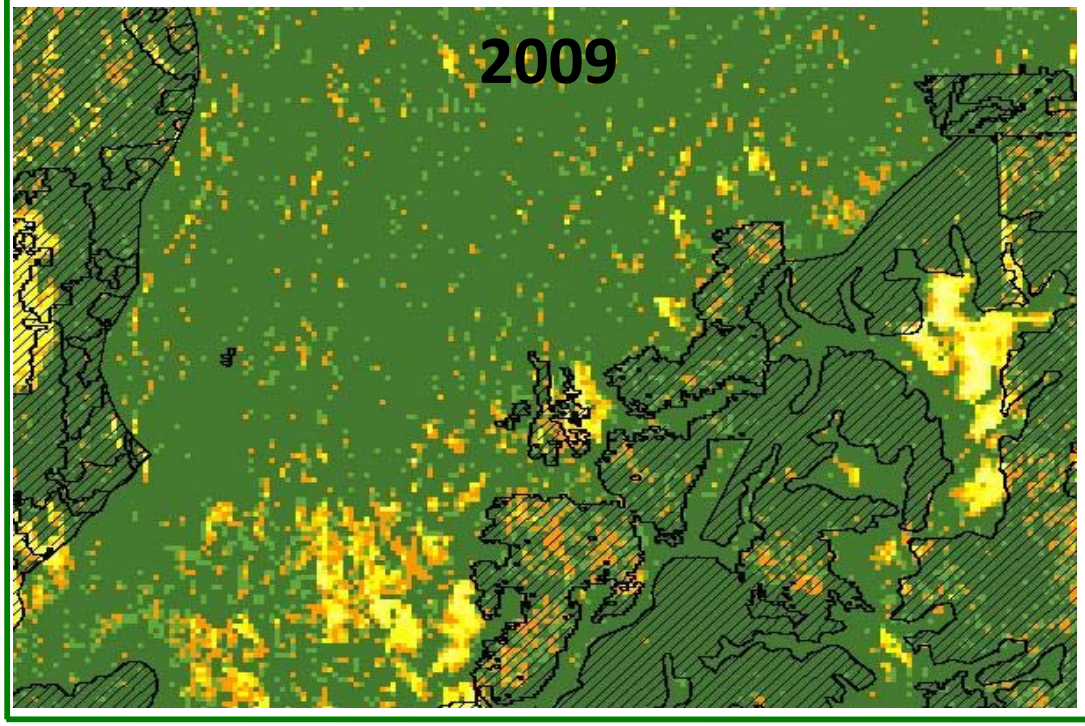
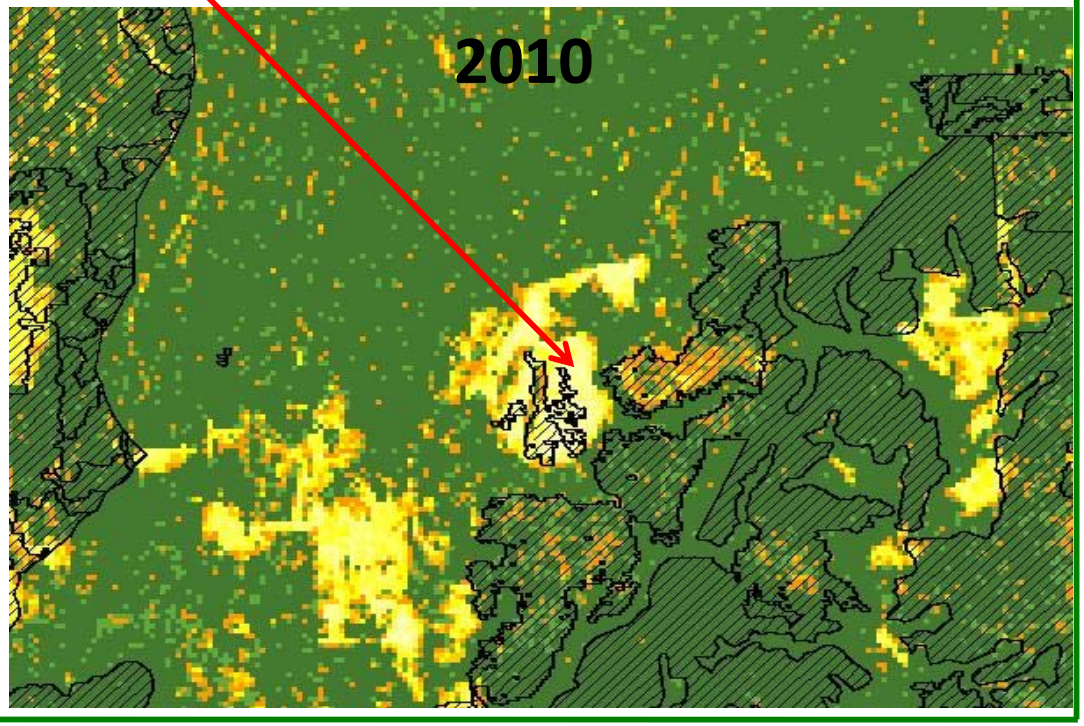
	40-50 Mg ha^{-1}
	50-60 Mg ha^{-1}
	60-80 Mg ha^{-1}
	80-100 Mg ha^{-1}
	> 100 Mg ha^{-1}
	water

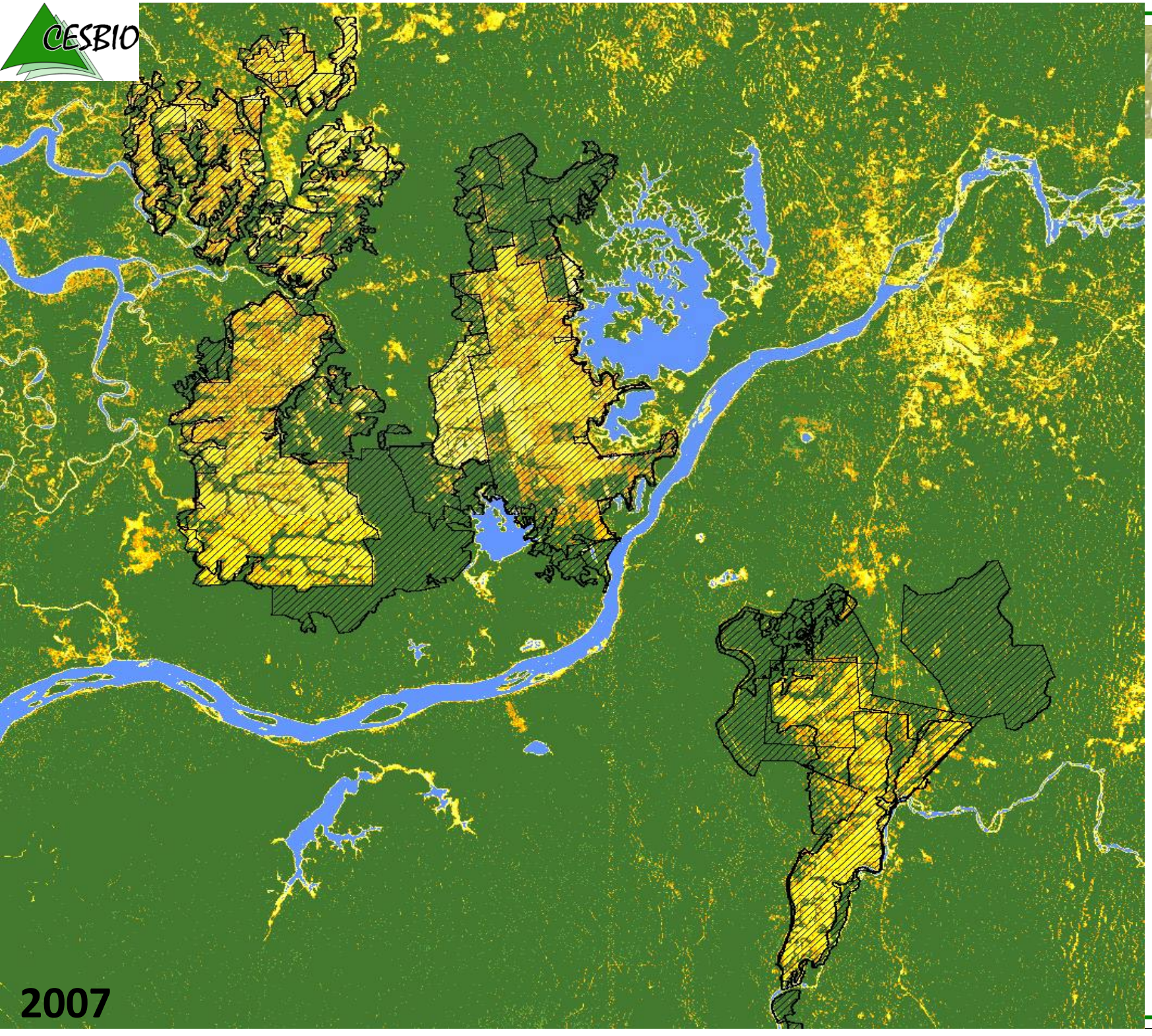
Google map 2015

	0-10 Mg ha^{-1}
	10-20 Mg ha^{-1}
	20-30 Mg ha^{-1}
	30-40 Mg ha^{-1}
	40-50 Mg ha^{-1}
	50-60 Mg ha^{-1}
	60-80 Mg ha^{-1}
	80-100 Mg ha^{-1}
	> 100 Mg ha^{-1}
	water

Clearcut outside the concession areas







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nitiative
collaboration led by JAXA

Above ground biomass from ALOS PALSAR

	0-10 Mg ha^{-1}
	10-20 Mg ha^{-1}
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	30-40 Mg ha^{-1}
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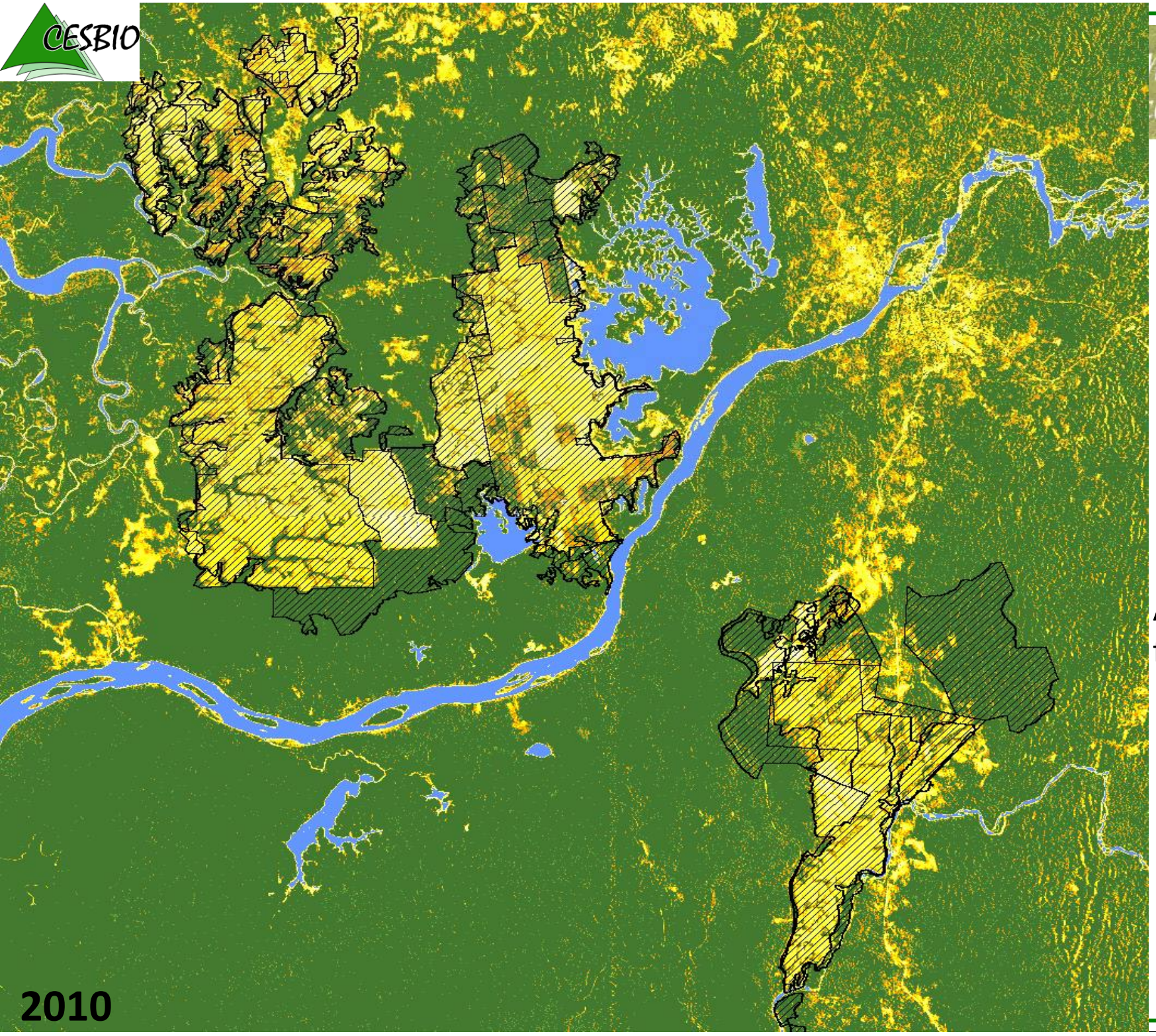
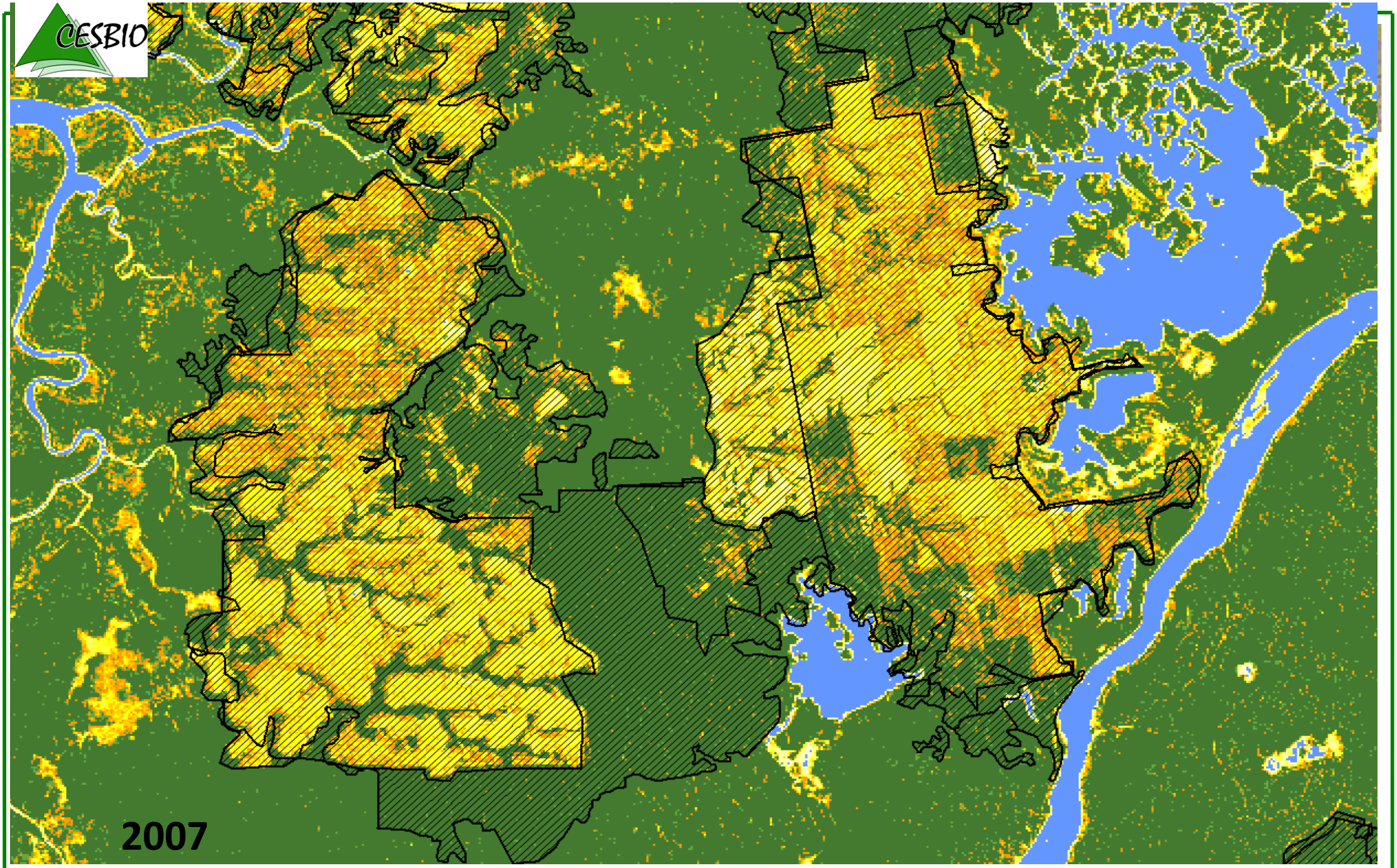
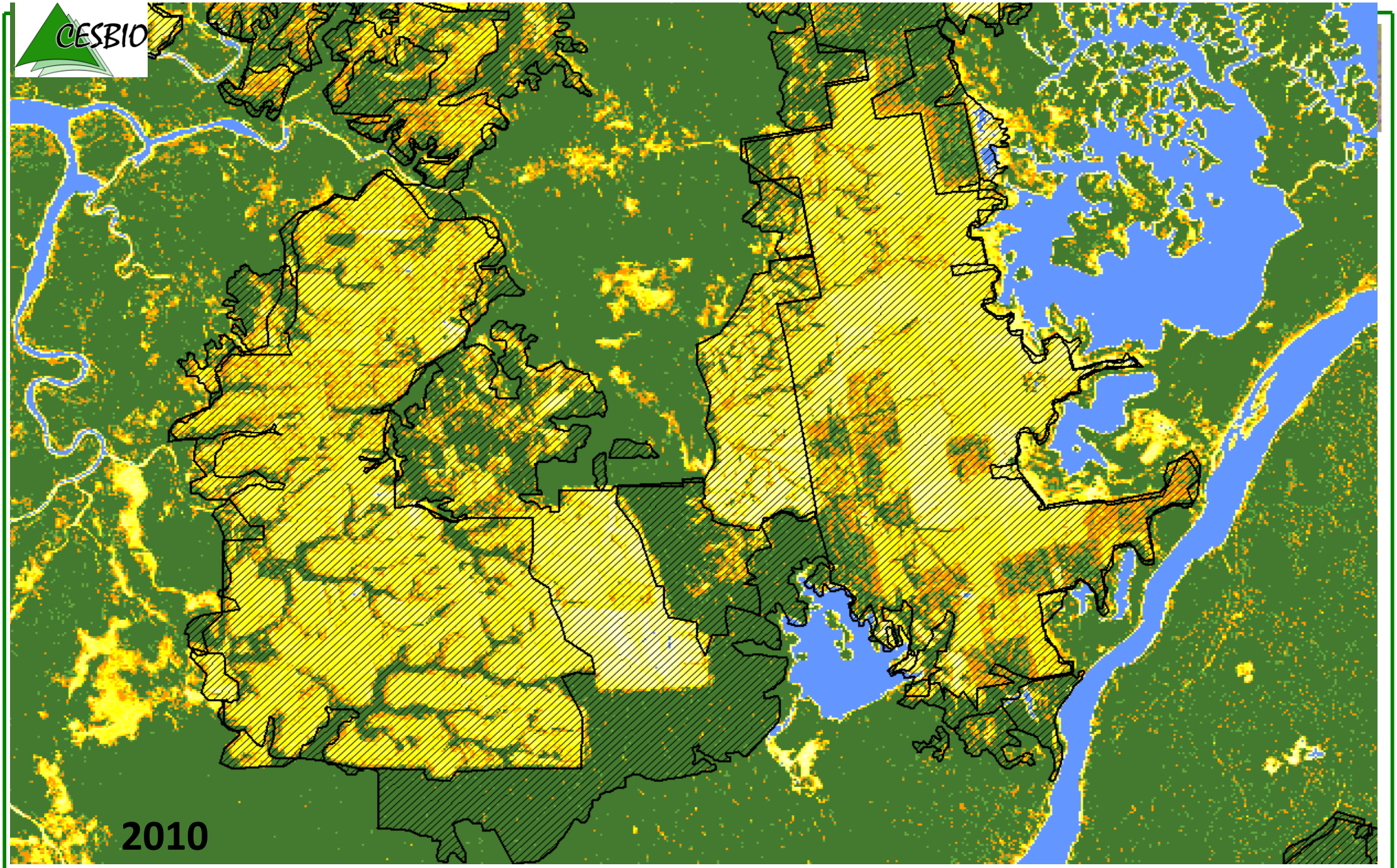
	60-80 Mg ha^{-1}
	80-100 Mg ha^{-1}
	> 100 Mg ha^{-1}
	water


CESBIO
nitiative
collaboration led by JAXA
Above ground biomass
from ALOS PALSAR
0-10 Mg ha-1
10-20 Mg ha-1
20-30 Mg ha-1
30-40 Mg ha-1
40-50 Mg ha-1
50-60 Mg ha-1
60-80 Mg ha-1
80-100 Mg ha-1
> 100 Mg ha-1
water
2010


CESBIO
2007


CESBIO
2010

Under way

Use of biomass map in carbon model for carbon flux calculation

Africa

ALOS

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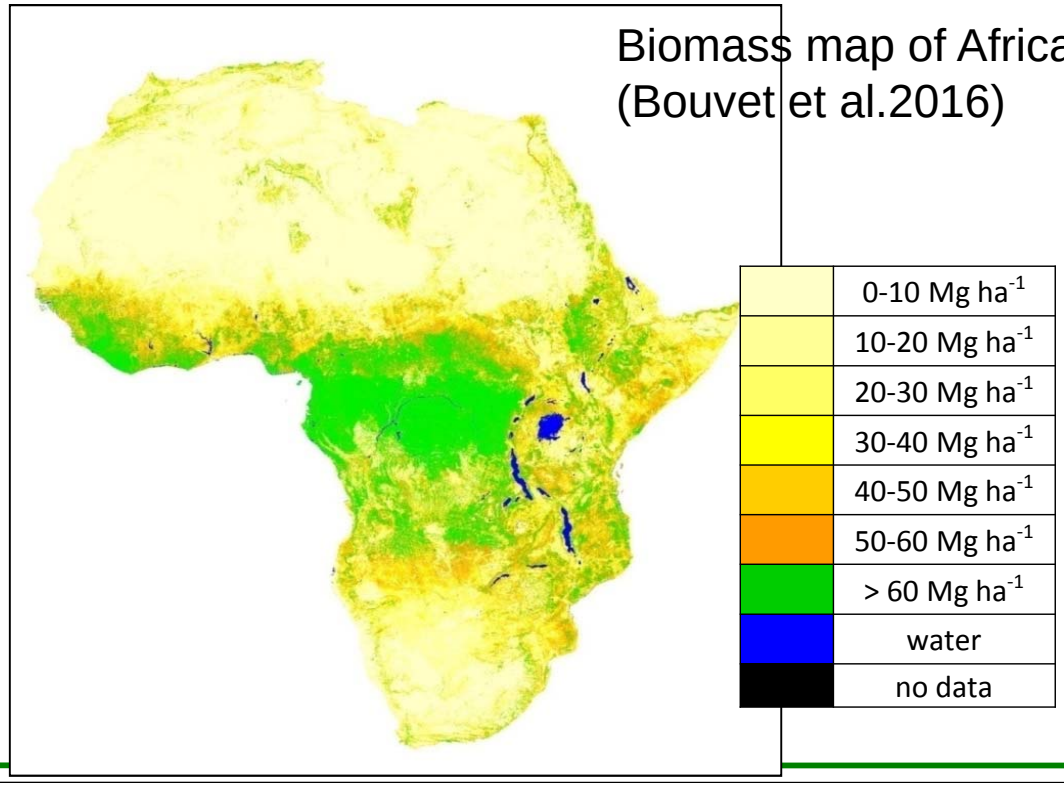
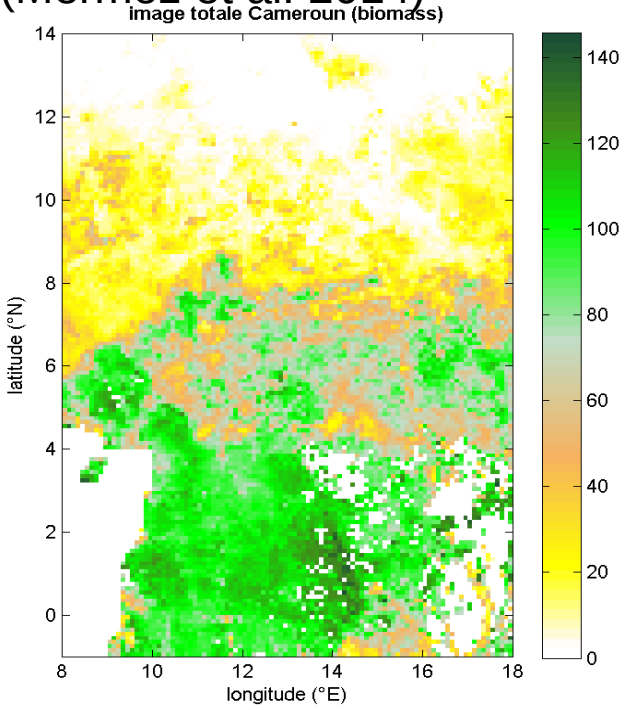
Objective: use of ALOS derived biomass maps to improve the Dynamic Vegetation Model ORCHIDEE:

1. To evaluate ORCHIDEE performances in terms of vegetation spatial distribution and of simulation of biomass
2. To improve the woodland savannah module in the model: woody/herbaceous competition, fire occurrence, biomass-annual rainfall

Biomass map of Africa (Bouvet et al.2016)



Biomass map of Cameroun (Mermoz et al. 2014)



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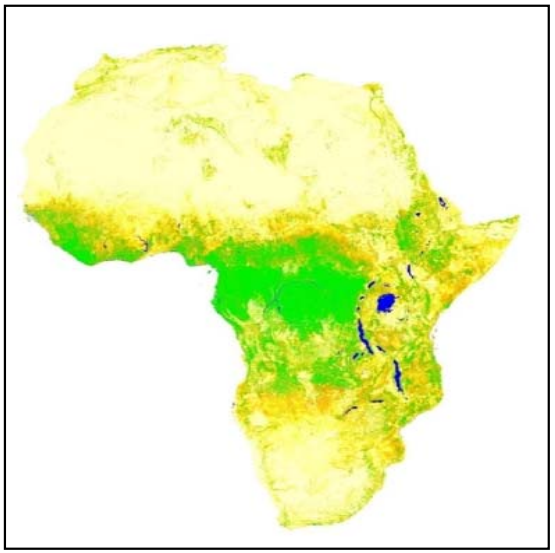
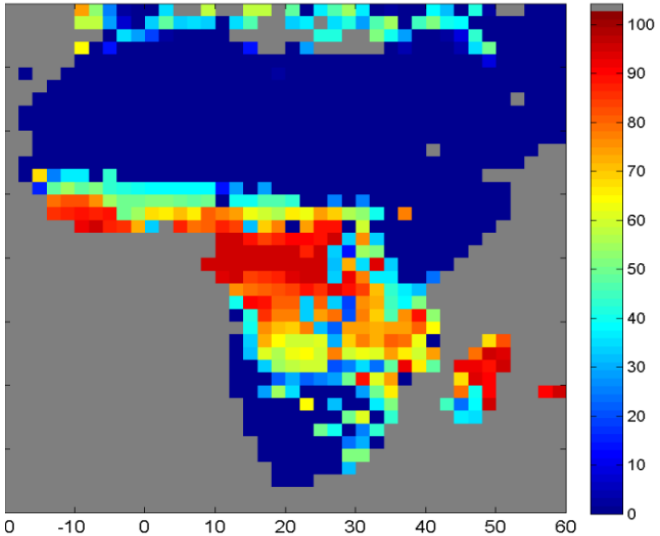
Biomass from ALOS

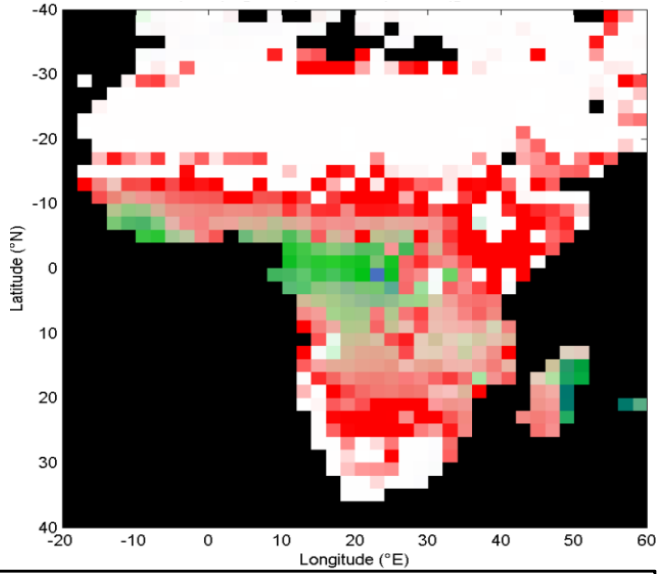


Simulation by ORCHIDEE (C. Dardel)

% of woody vegetation

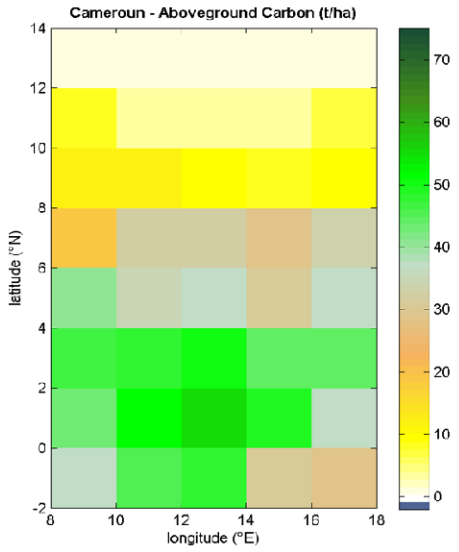


Biomass by vegetation

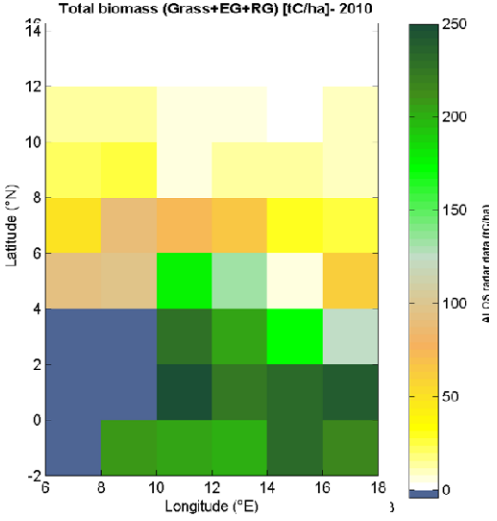


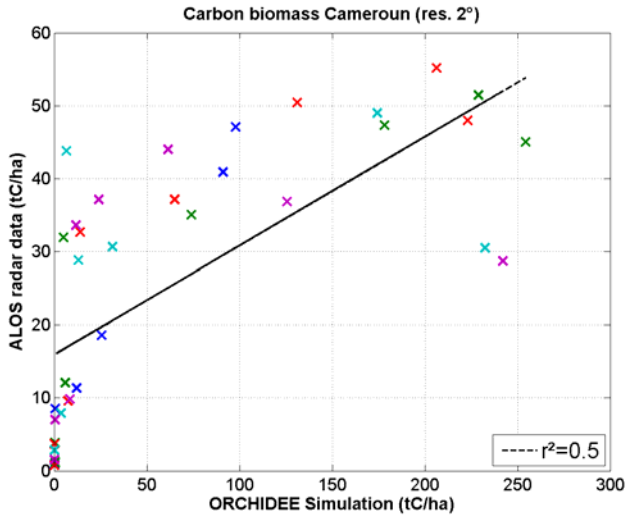
Cameroon

ALOS PALSAR



ORCHIDEE



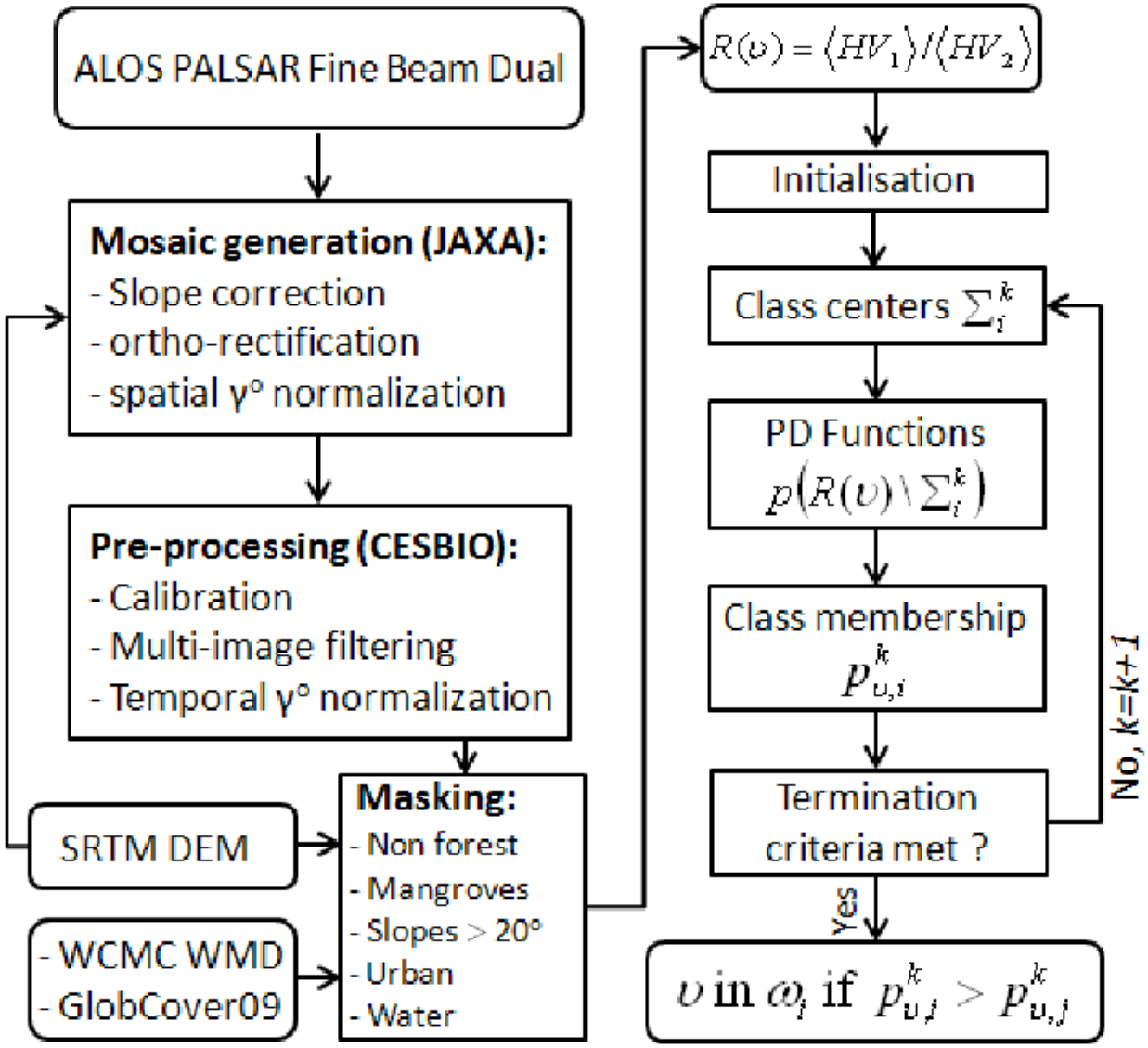


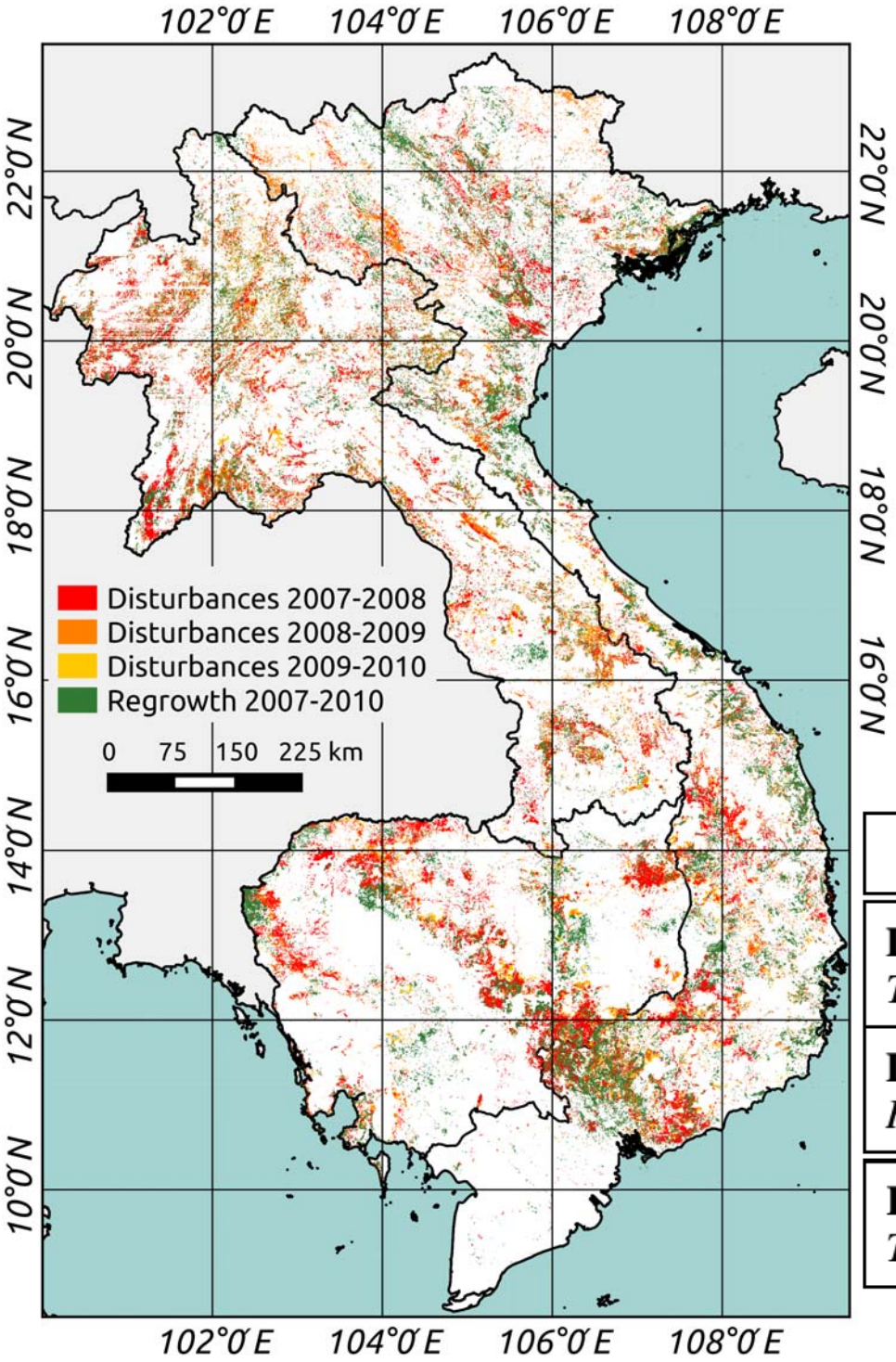
Results and significant findings

Change in forest cover

Vietnam / Lao /Cambodia

Change detection methodology





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Forest disturbances and regrowth assessment using ALOS PALSAR data from 2007 to 2010 in Vietnam, Cambodia and Lao PDR

Stéphane Mermoz [1,*], Thuy Le Toan [1]

Remote Sensing, 2016

Annual rate: 2007-2010

	Vietnam	Cambodia	Lao PDR
Disturb. rates (%) *This study*	-1.07	-1.22	-0.94
Disturb. rates (%) *Hansen*	-1.16	-1.58	-0.96
Regrowth rates (%) *This study*	0.82	0.49	0.35

ALOS

Initiative
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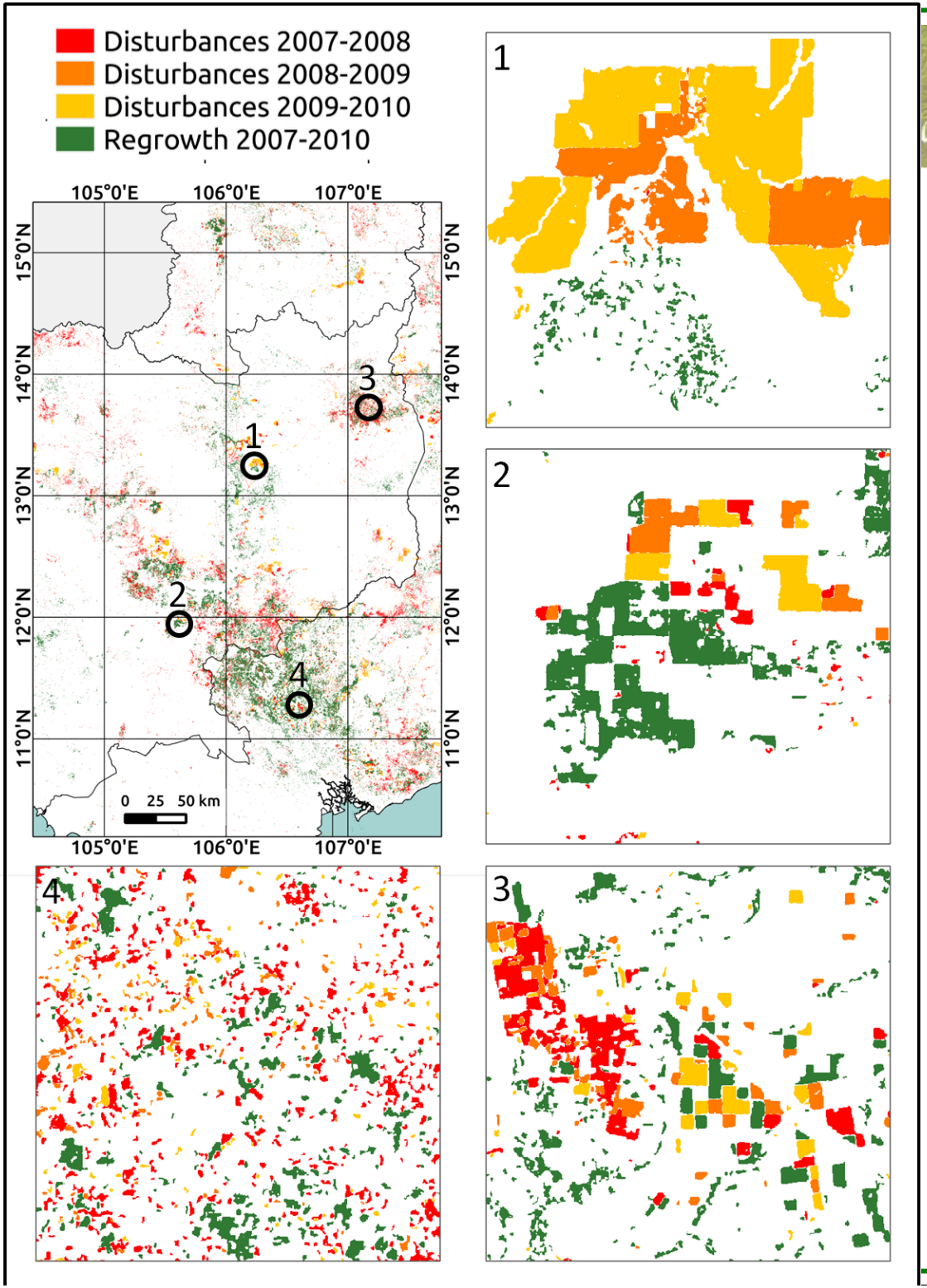

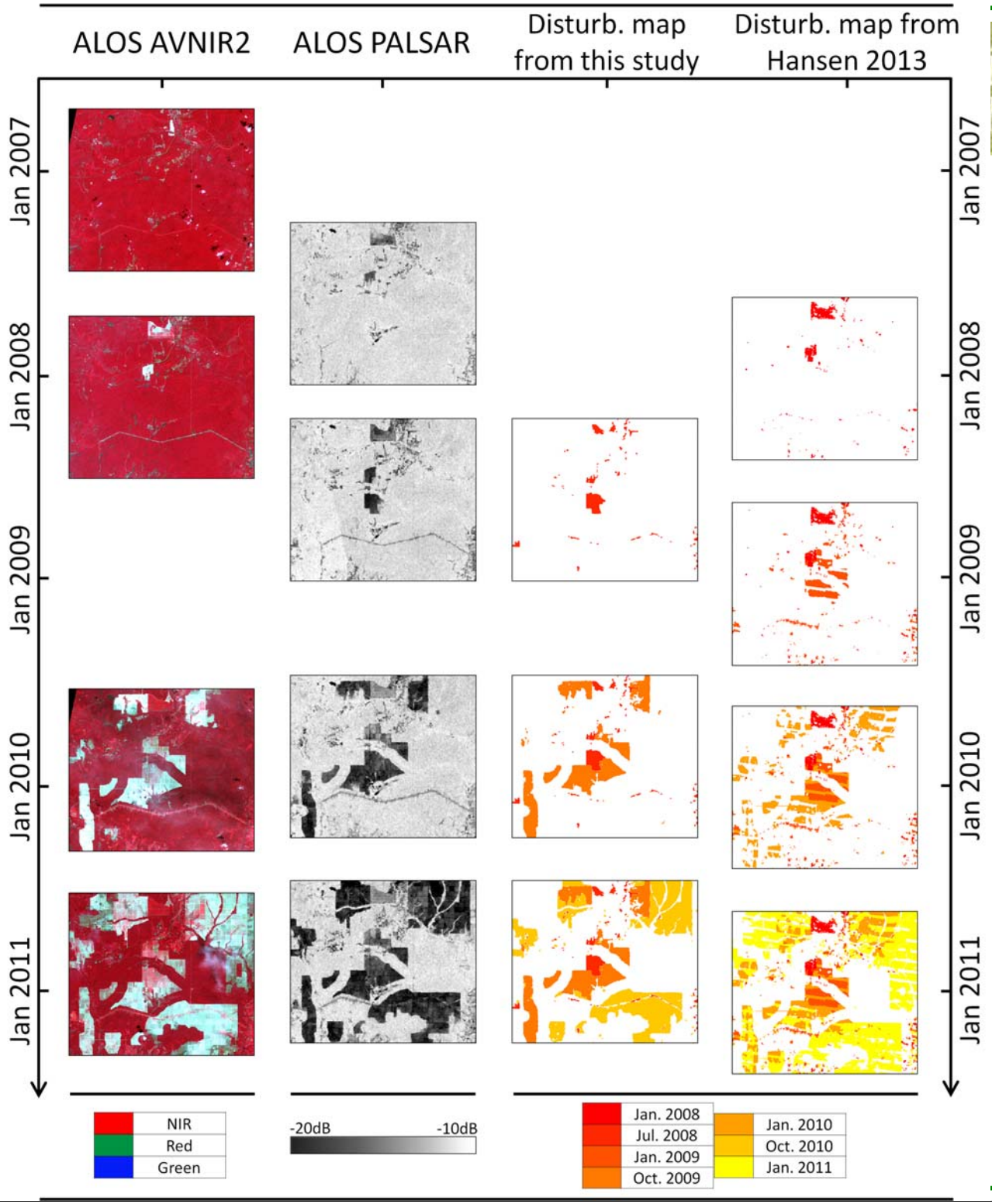
ALOS AVNIR2
ALOS PALSAR
Disturb. map from this study
Disturb. map from Hansen 2013
Jan 2007
Jan 2008
Jan 2009
Jan 2010
Jan 2011
NIR
Red
Green
-20dB
-10dB
Jan. 2008
Jul. 2008
Jan. 2009
Oct. 2009
Jan. 2010
Oct. 2010
Jan. 2011

ALOS

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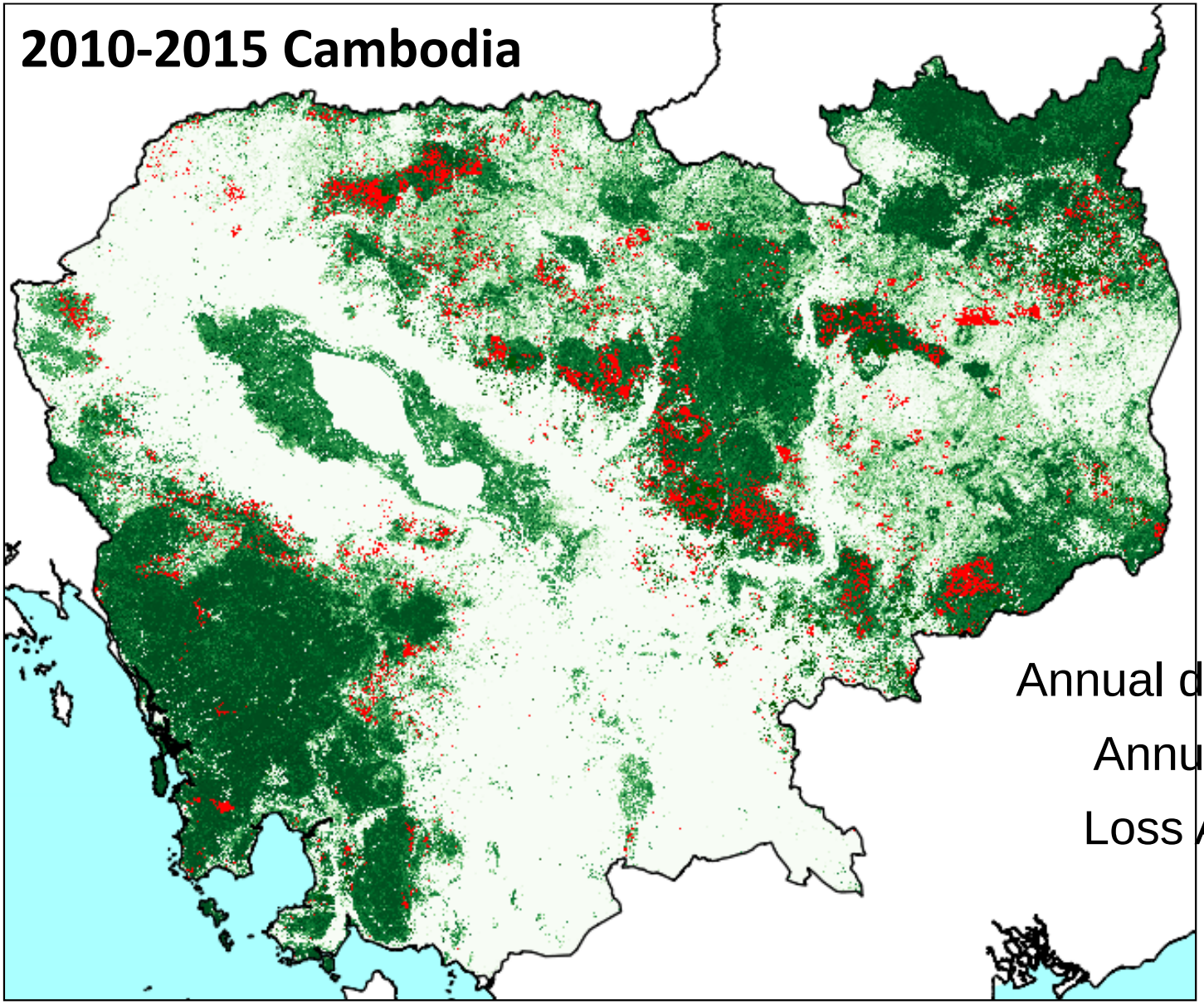

Using ALOS & ALOS-2 data

Red: loss in forest cover

Annual disturbance rate = -1.45%

Annual regrowth rate = 0.42%

Loss AGB = 134 Mt (Saatchi) / 114 Mt (Baccini)

2010-2015 backscatter change

ALOS 2010

ALOS 2015

Regrowth in 5 years

-→ **Need yearly monitoring**

Data sharing

- Reference forest plots for the calibration/validation of the biomass map (coordinates, Above Ground Biomass) belong mostly to research networks (e.g. CTFS, Afritron..) thus accessible to the community.
- Specific ground data collection for low biomass (< 150 tons/ha) during KC Phase 4. Field measurements of biomass can be shared to JAXA after the restriction delay imposed by the research project
- Field photos, forest types and general information (species, range of biomass..) at a number of points

Deliverables

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African savanna/ Cameroon/ Vietnam

- Forest biomass maps 2010, 2015 ----------→ 2017
- Forest changes 2007 2010, 2015 ----------→ 2018