

K&C Phase 4 – Status report

Mapping habitat distribution, vegetation structure and flooding dynamics in the Amazon basin wetlands

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Project outline and objectives

- Make use of the **existing PALSAR record** and **upcoming PALSAR-2 data** to derive **improved basin-wide maps of wetland habitat and flooding characteristics** for the **Amazon basin wetlands**, explicitly considering **inundation patterns and vegetation structural characteristics**.
- These improved maps will allow for **more accurate regionalizations of carbon dynamics**, and offer **much needed support for large-scale biodiversity studies and conservation efforts** in the Amazon wetlands.

Specific activities

- Mapping habitat/vegetation cover
- Mapping flood duration
- Vegetation structure
- Vegetation carbon monitoring
- Applications to conservation

Results and significant findings - Habitat/Vegetation Mapping

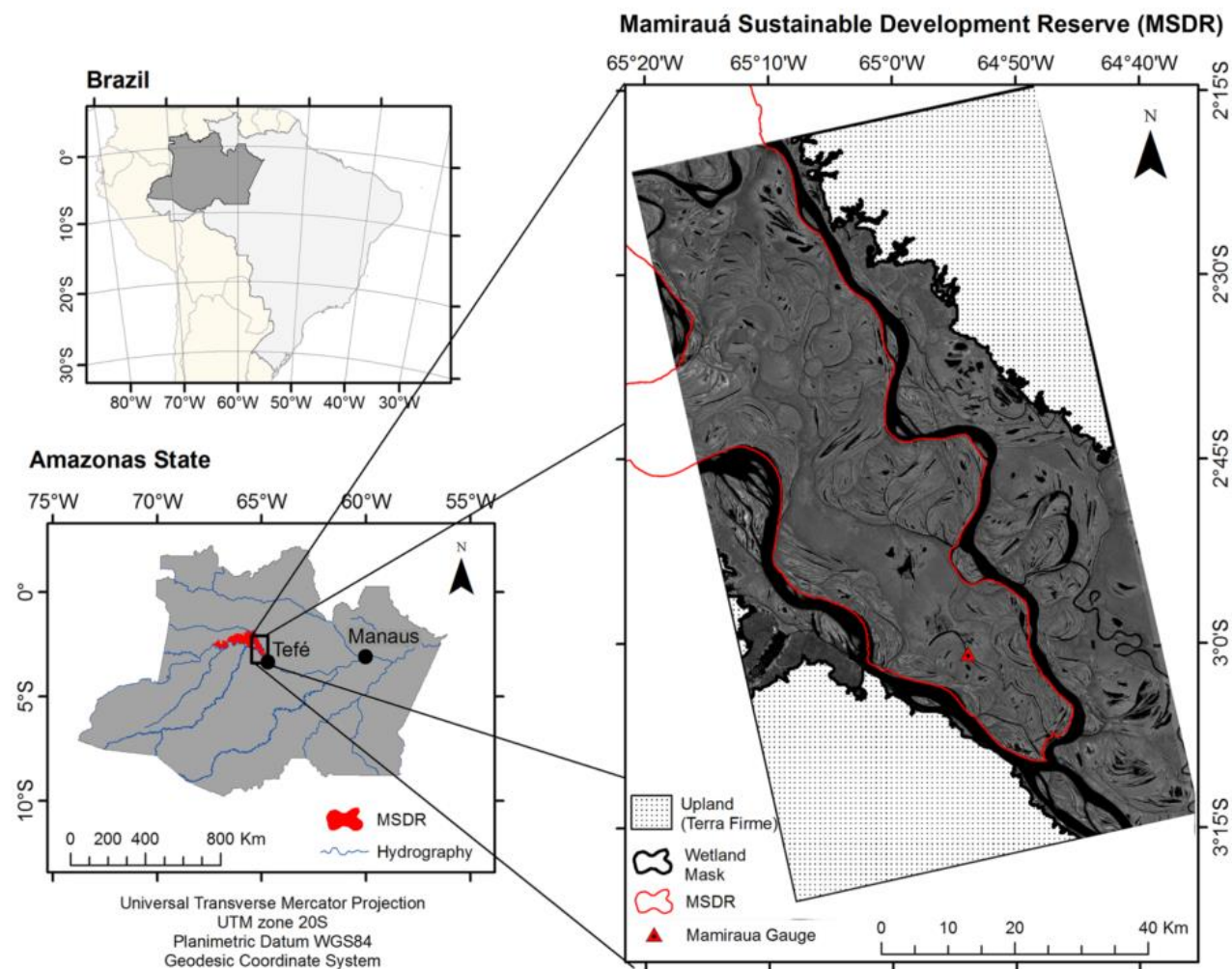
Wetlands Ecol Manage (2015) 23:41–59
DOI 10.1007/s11273-014-9359-1

ORIGINAL PAPER

Combining ALOS/PALSAR derived vegetation structure and inundation patterns to characterize major vegetation types in the Mamirauá Sustainable Development Reserve, Central Amazon floodplain, Brazil

**Jefferson Ferreira-Ferreira · Thiago Sanna Freire Silva · Annia Susin Streher ·
Adriana Gomes Affonso · Luiz Felipe de Almeida Furtado · Bruce Rider Forsberg ·
João Valsecchi · Helder Lima Queiroz · Evelyn Márcia Leão de Moraes Novo**

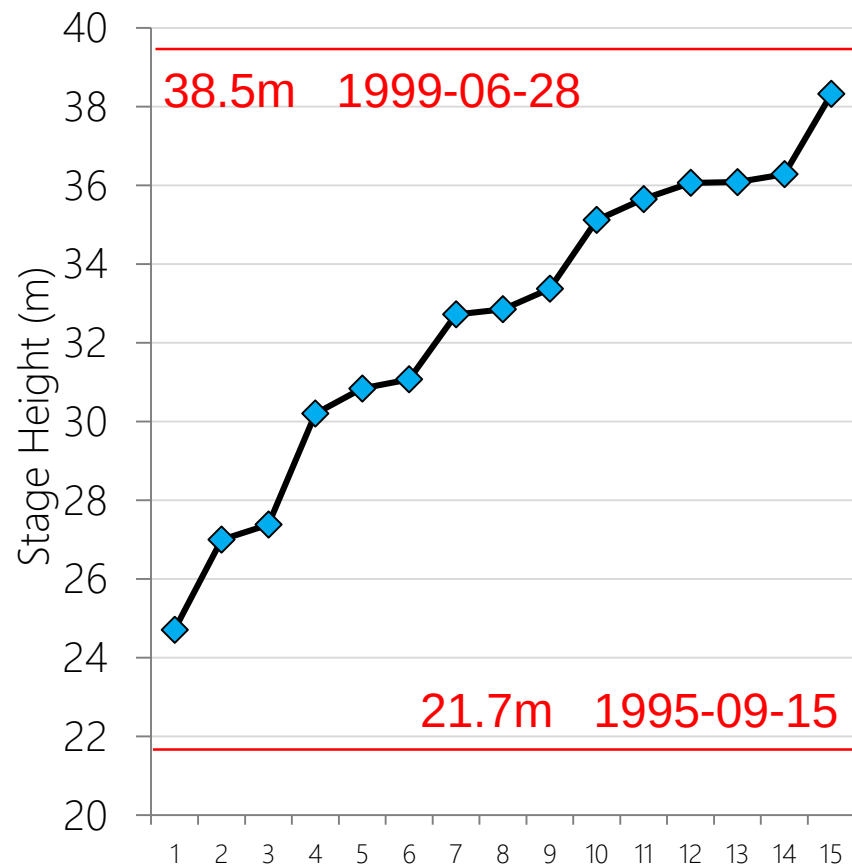
Results and significant findings - Habitat/Vegetation Mapping

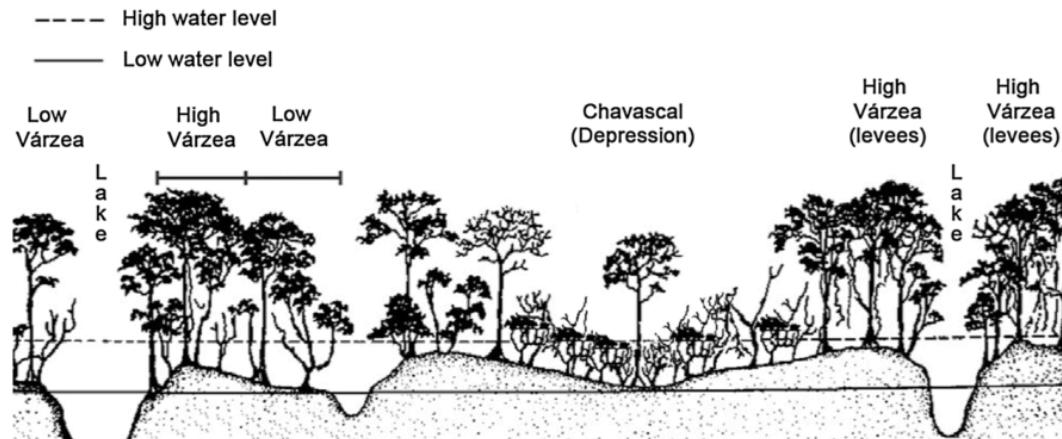
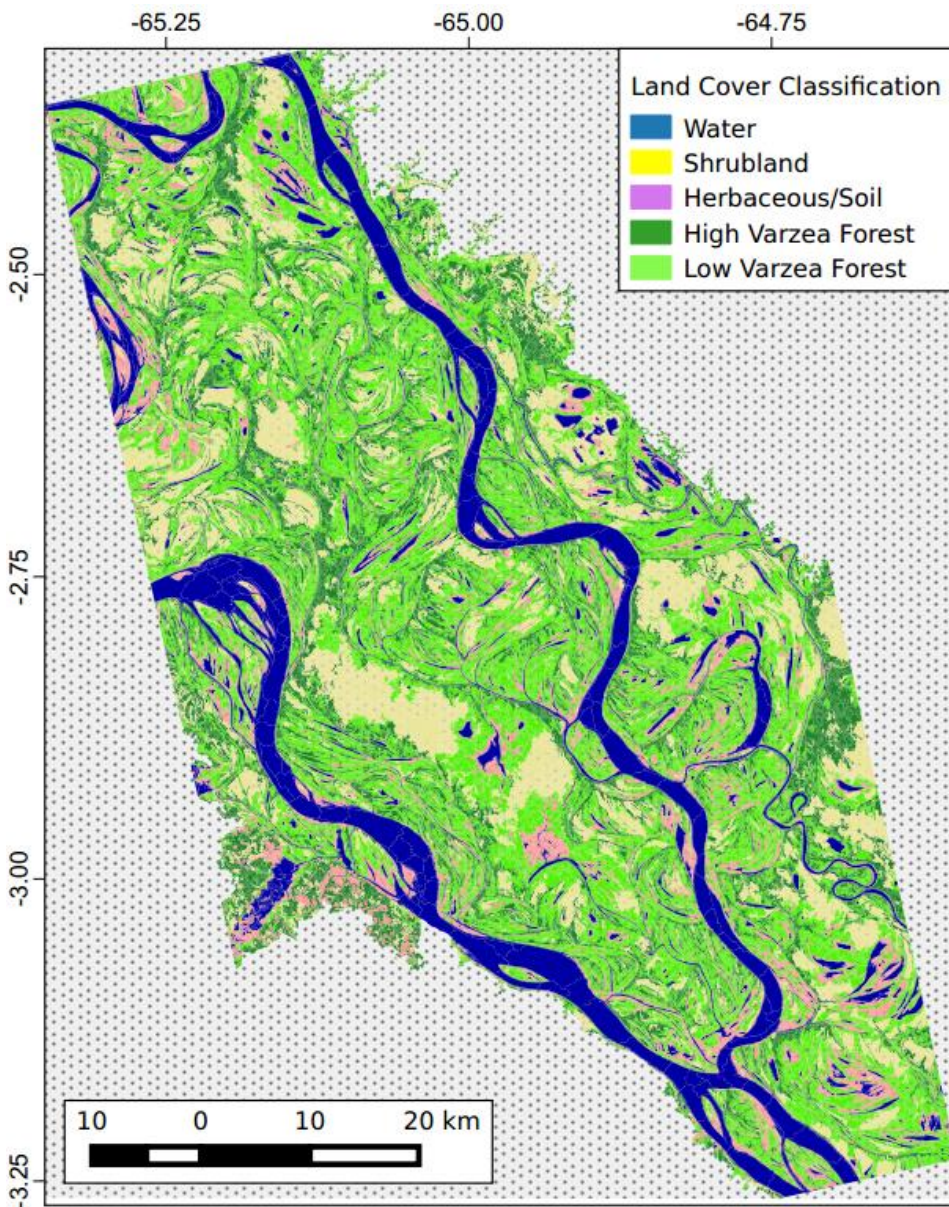


Results and significant findings - Habitat/Vegetation Mapping

Multitemporal PALSAR-1 data

- FBS/FBD imagery
- Covering the largest possible hydrological range
- Image segmentation and feature extraction using eCognition (hopefully RSGISlib for now on!)
- Supervised classification using Random Forests

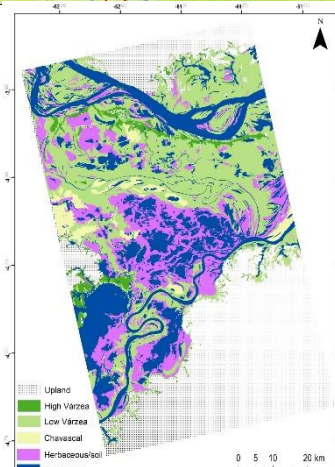
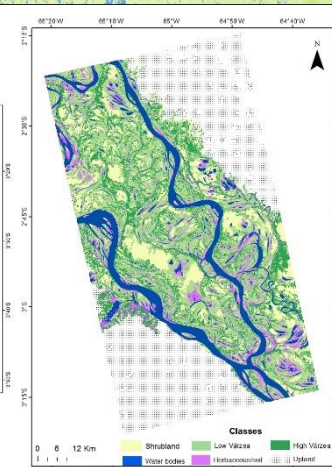
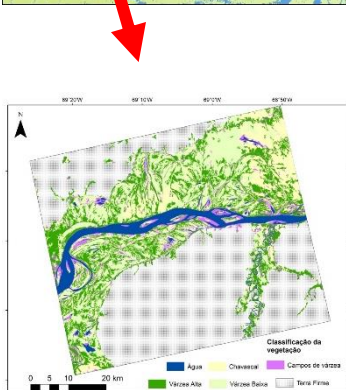
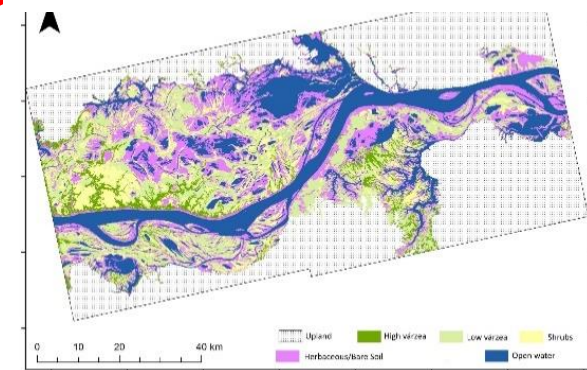
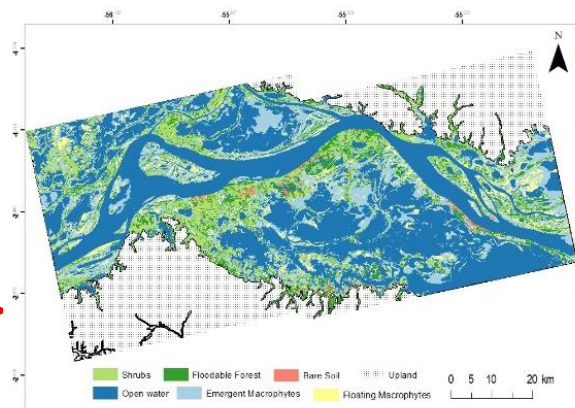
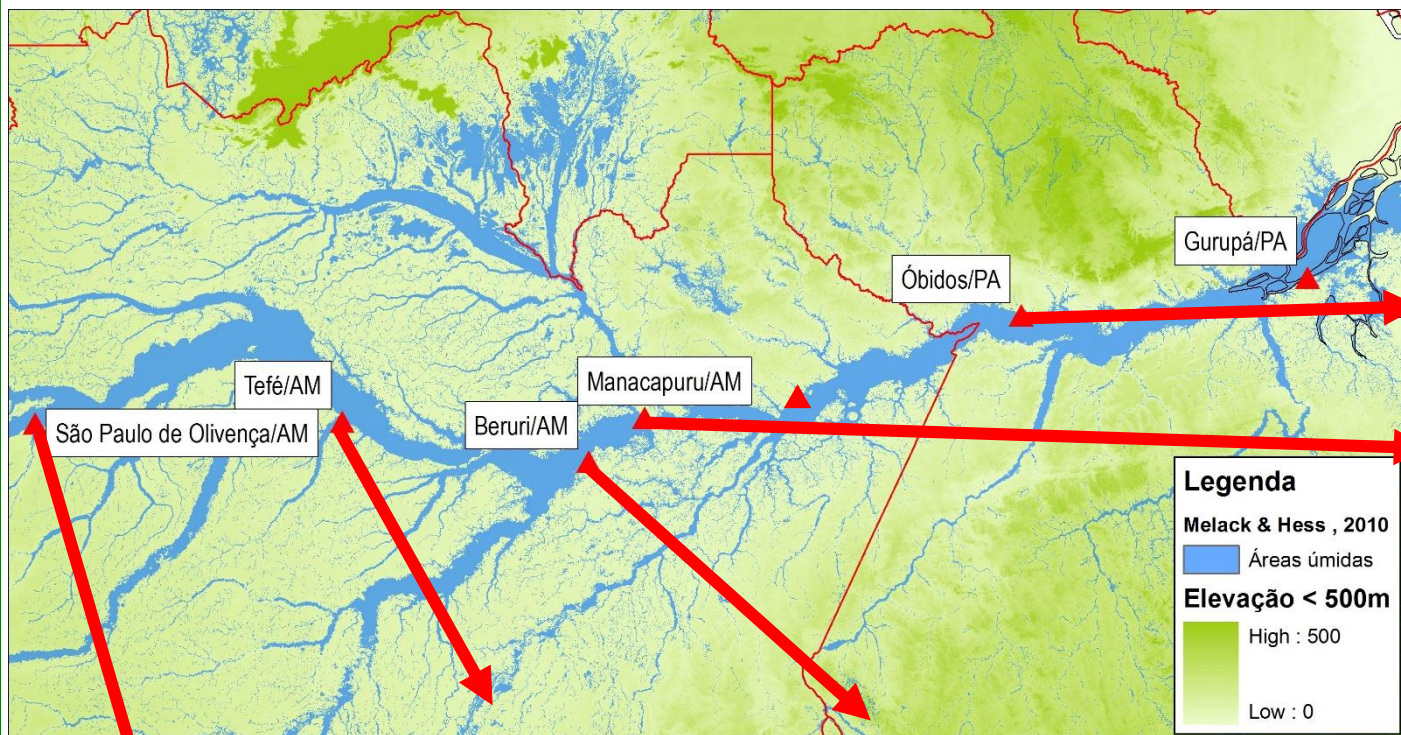




- 83% accuracy (kappa 0.8)
- 10% Allocation, 5% Quantity Disagreement
- Low várzea sites are very heterogeneous
- Difficulty in mapping sparse herbaceous vegetation / bare soil

ALOS

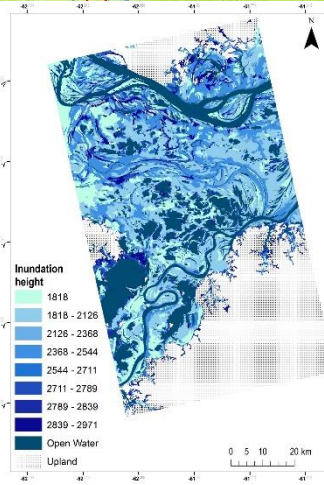
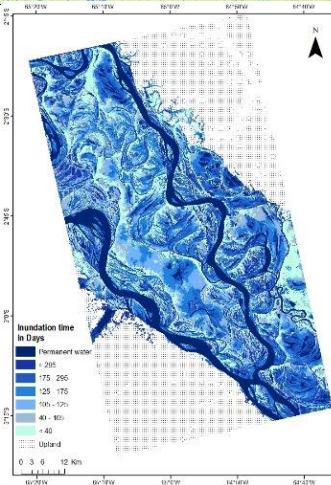
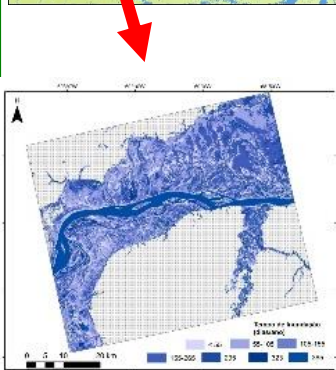
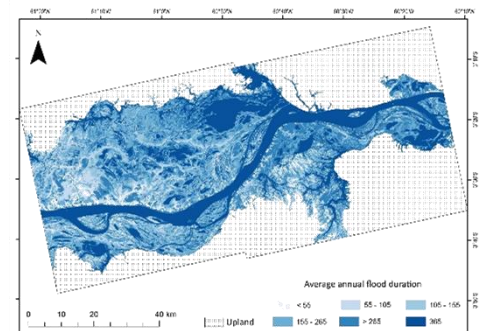
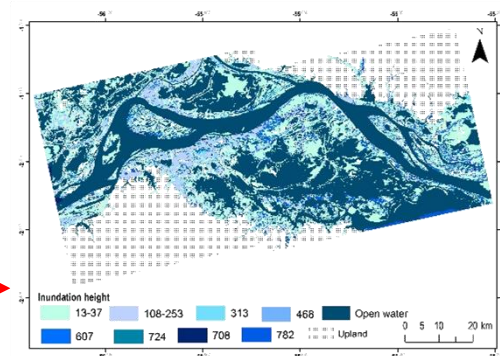
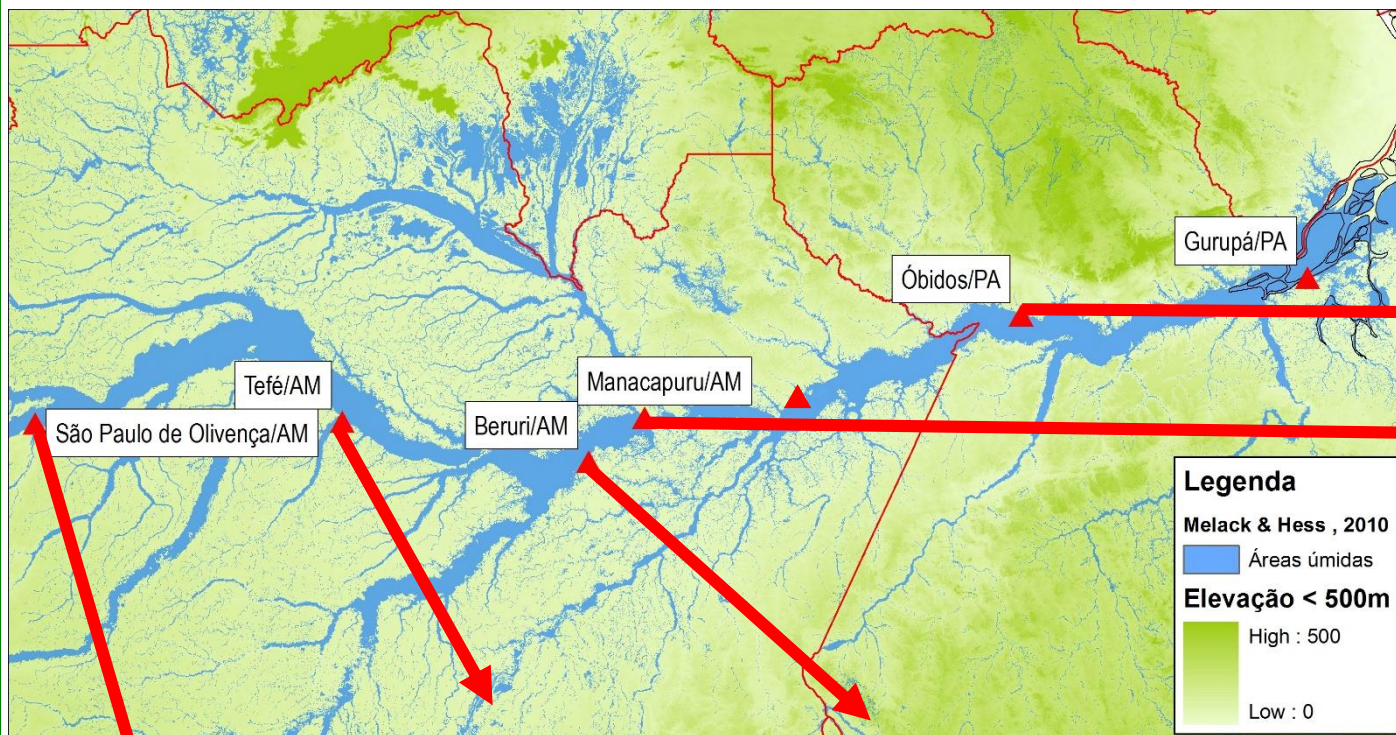
K&C Initiative
An international science collaboration led by JAXA



- Progressively expanding to new sites "on demand"
- Limited by training/validation data

ALOS

K&C Initiative
An international science collaboration led by JAXA



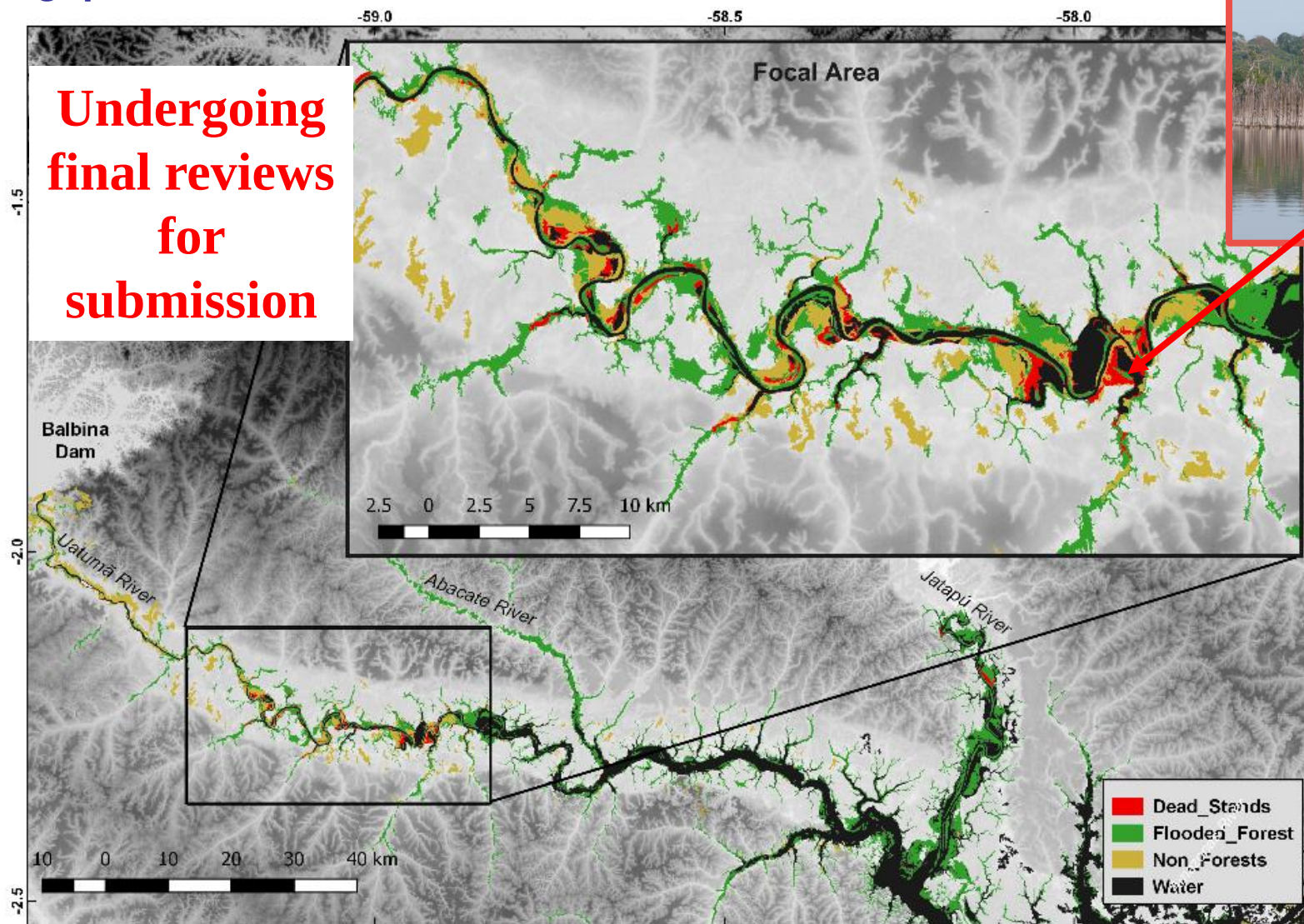
- Coarse inundation "steps"
- VERY Limited validation data

ALOS

K&C Initiative
An international science collaboration led by JAXA

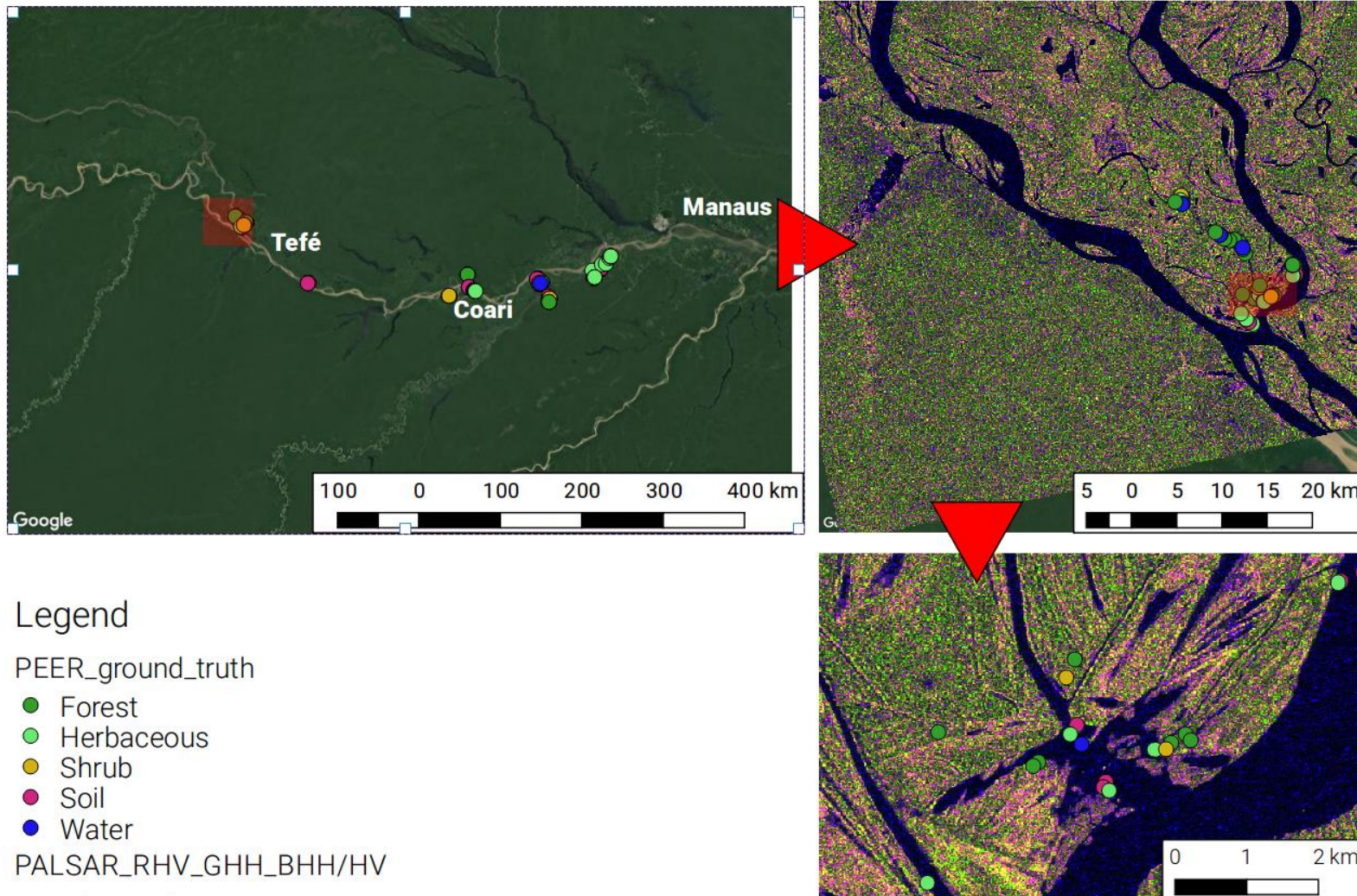
Igapó - Black water forest

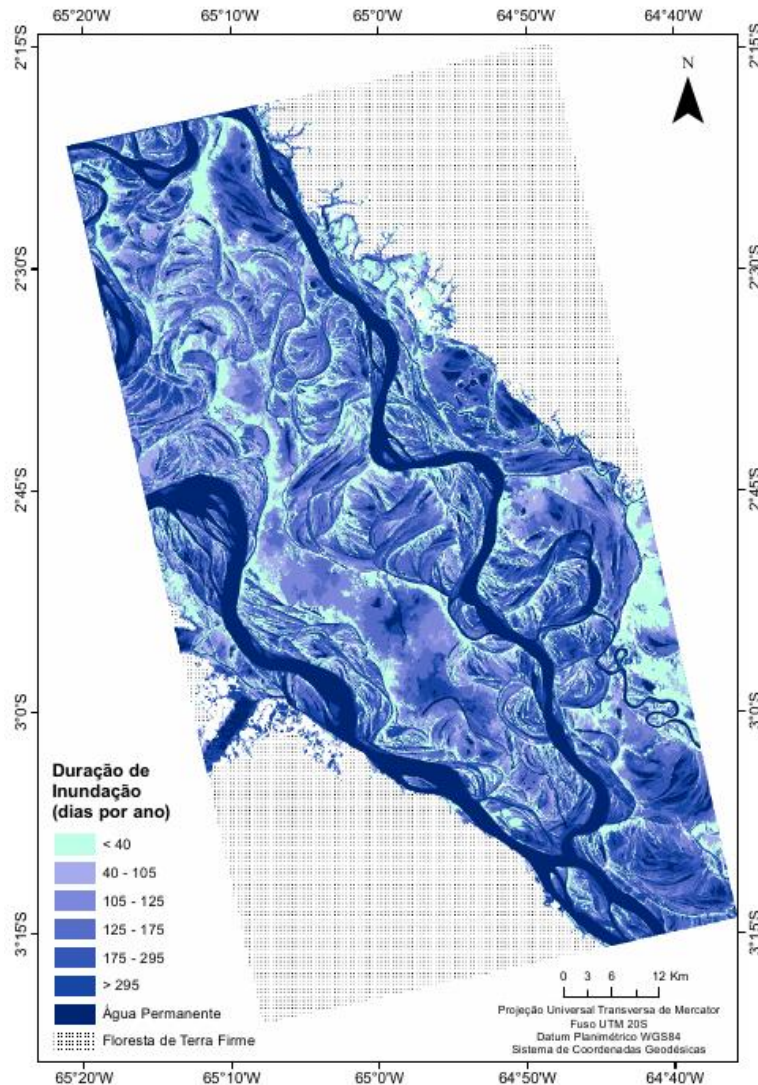
**Undergoing
final reviews
for
submission**



Angelica Resende
INPA

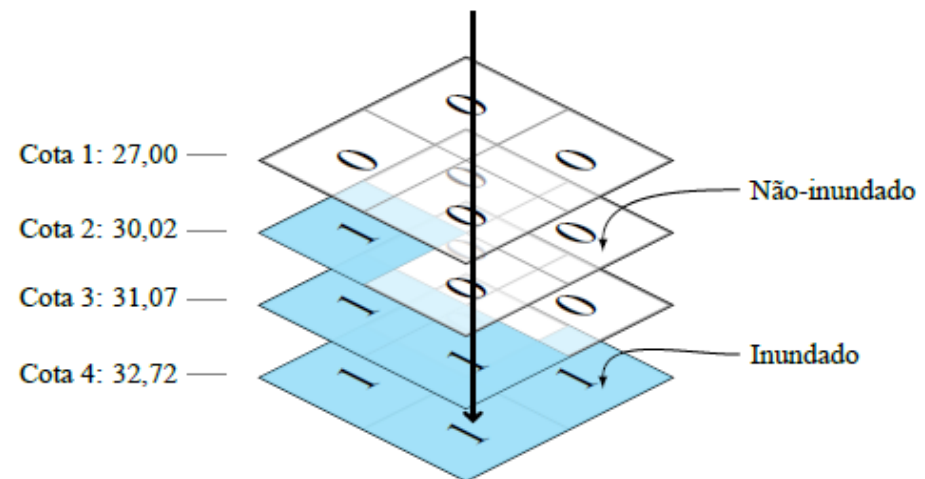
Ground training and validation data for large-scale mapping (Oct;Nov 2017)

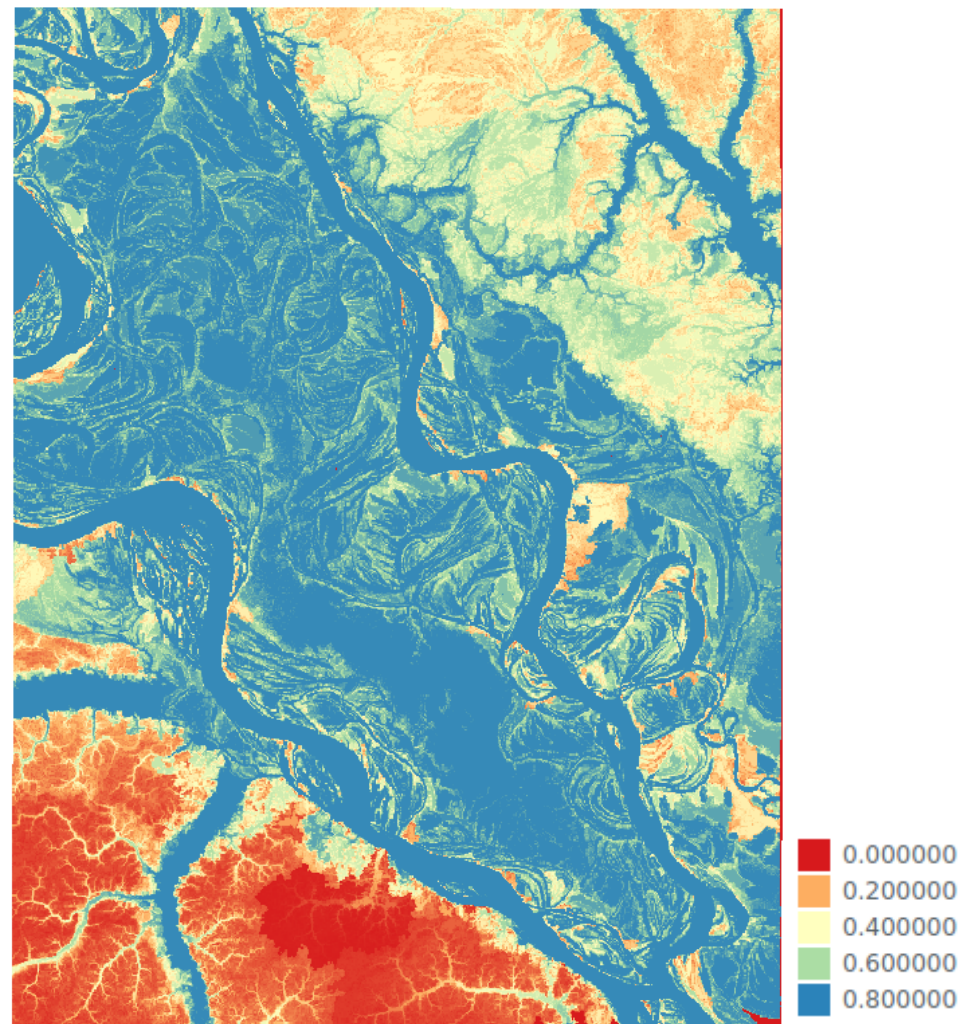
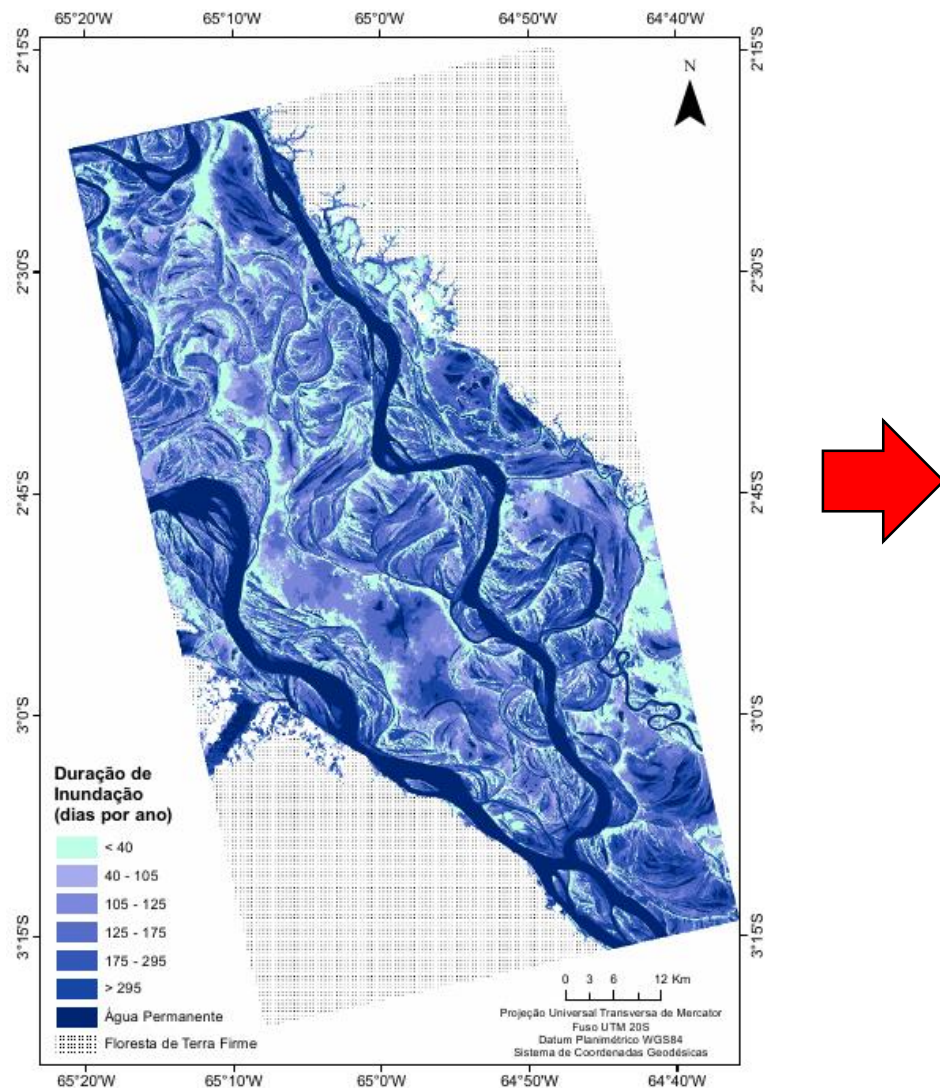




Probability of Inundation:

- Stage height (Mamirauá Lake)
- Distance to nearest water body
- Height above the nearest drainage (HAND)







(a)



(b)



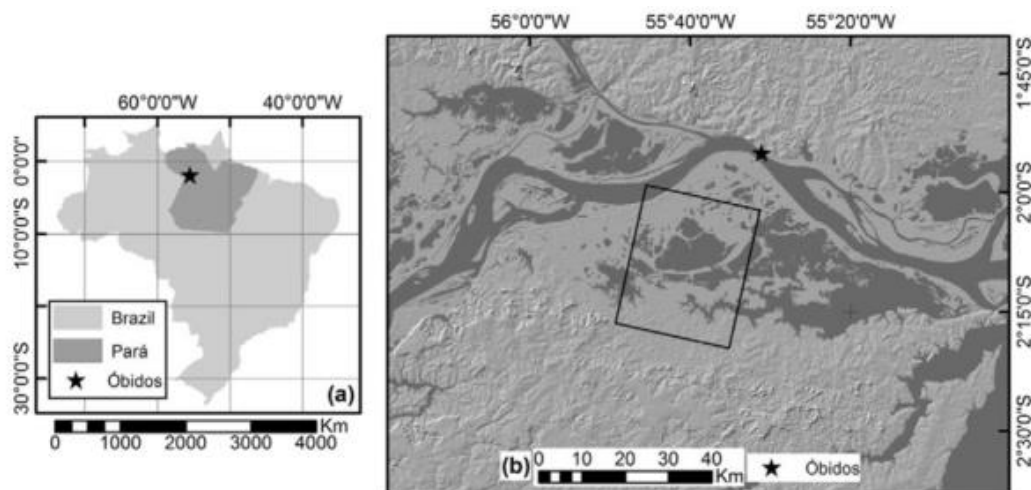
(c)



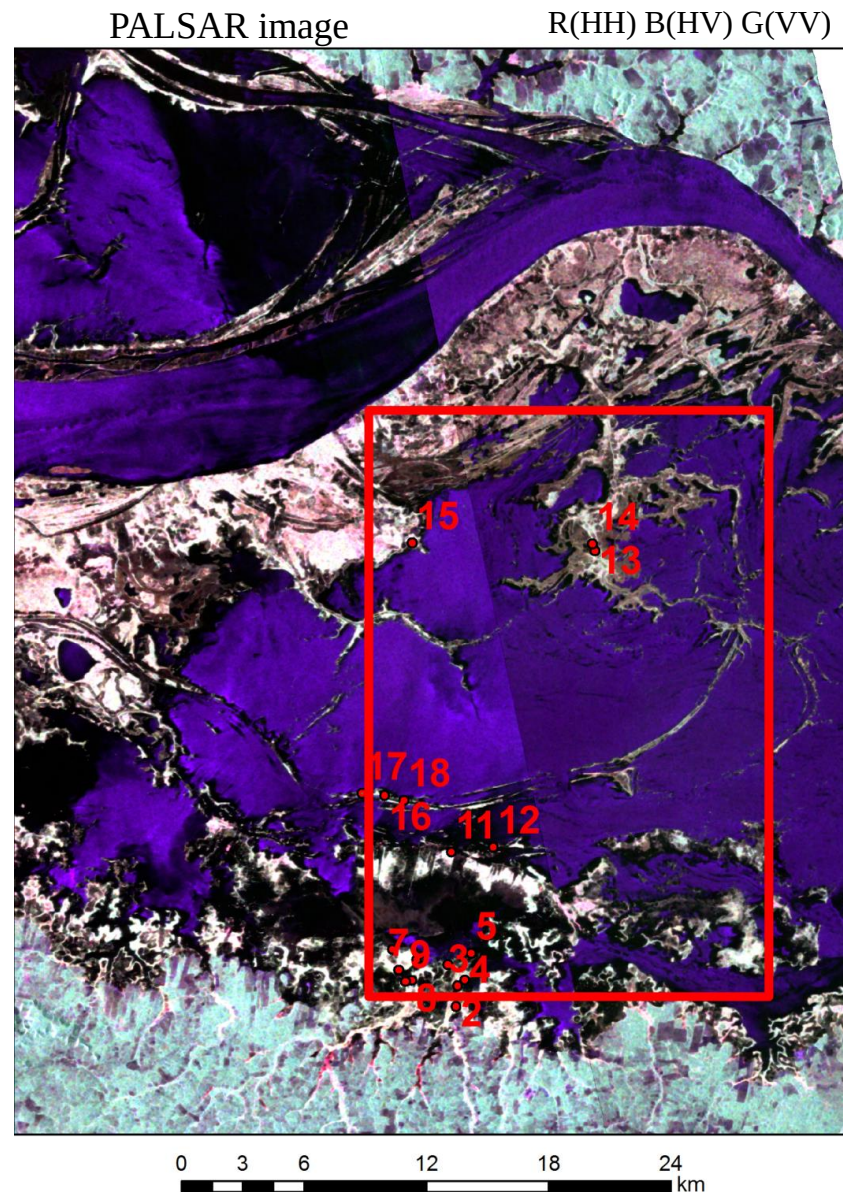
(d)

Levellogger ID	Habitat	Flood duration class	Flood duration			Day of flood			Day of ebb		
			mapped	mapped	levelloggers model disagreement	levelloggers	model	disagreement	levelloggers	model	disagreement
1	VB	40-105	168	152	19	77	85	-8	245	234	11
2	VB	125-175	220	212	8	32	37	-5	252	249	3
3	CH	<40	145	205	-57	90	45	45	235	247	-12
5	VB	105-125	162	184	-19	79	63	16	241	244	-3
6	VB	<40	132	141	-8	96	91	5	228	231	-3
7	VB	175-295	250	212	38	12	37	-25	262	249	13
8	VA	<40	116	116	-7	101	102	-1	217	225	-8
9	VB	125-175	129	212	-83	99	37	62	228	249	-21
10	CV	>295	244	212	32	19	37	-18	263	249	14

Vegetation Structure



Sensor	Operation Mode	Observation Start Date	Rainfall(mm)
PALSAR	PLR	30/03/2009	14.9
PALSAR	PLR	15/05/2009	0.2
TerraSAR-X	HH	19/10/2011	x
RadarSAT	Polarimetric	20/10/2011	x
PALSAR	FBD (HH-HV)	08/10/2010	0
PALSAR	FBD (HH-HV)	25/10/2010	0
Field work 18 (25m x 25m) data(18-29/10/2013)			





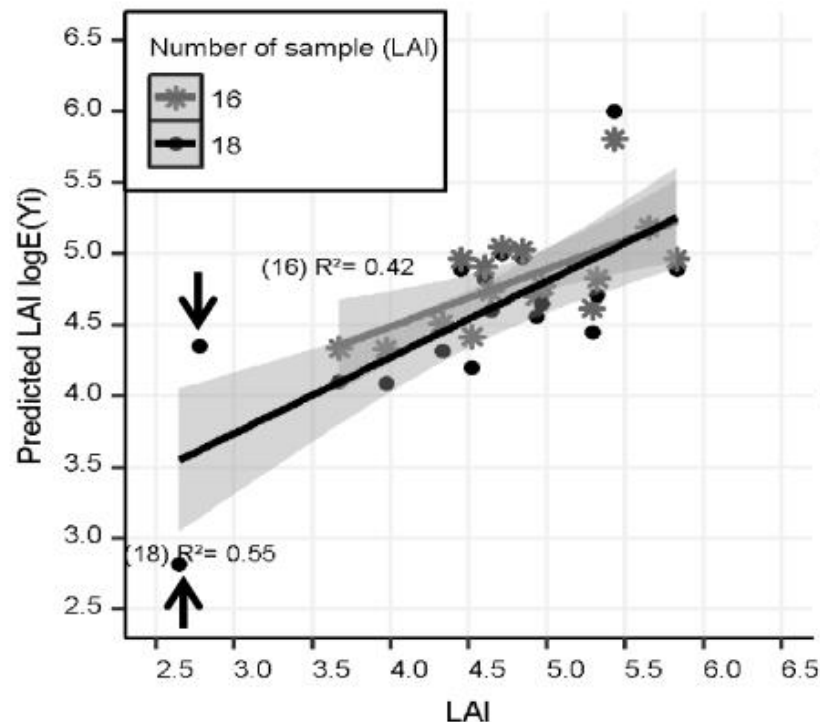
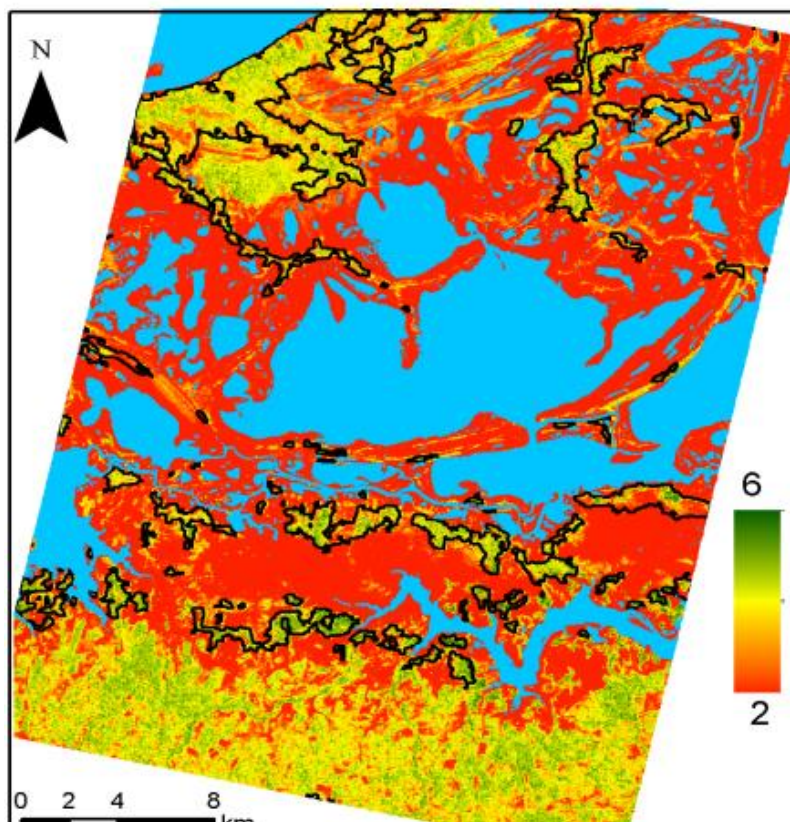
Floodable Forest



Water (month: Oct.)



Confidence interval – 95%



RMSEcv (18) = 0.65

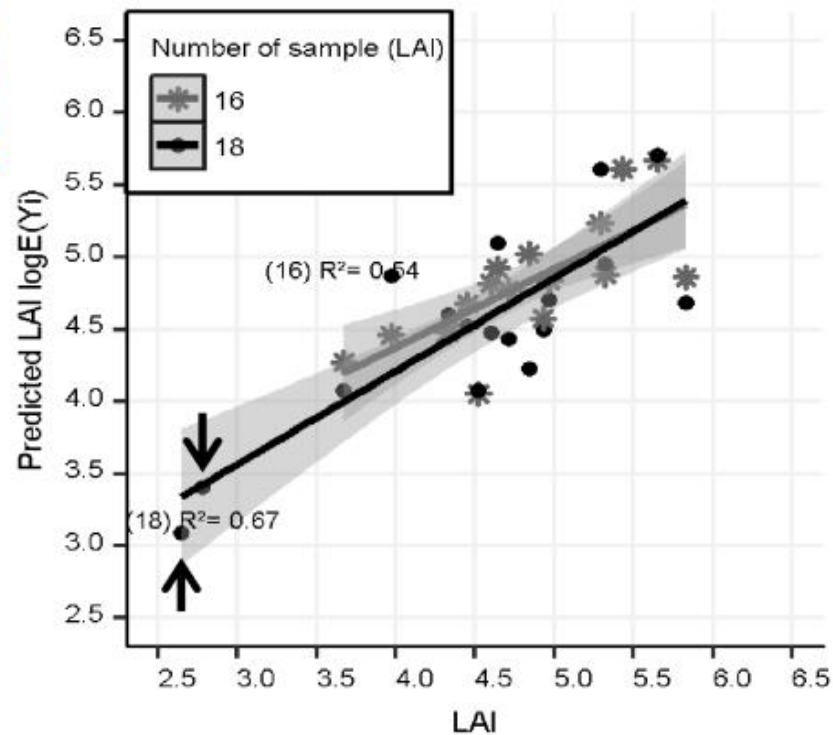
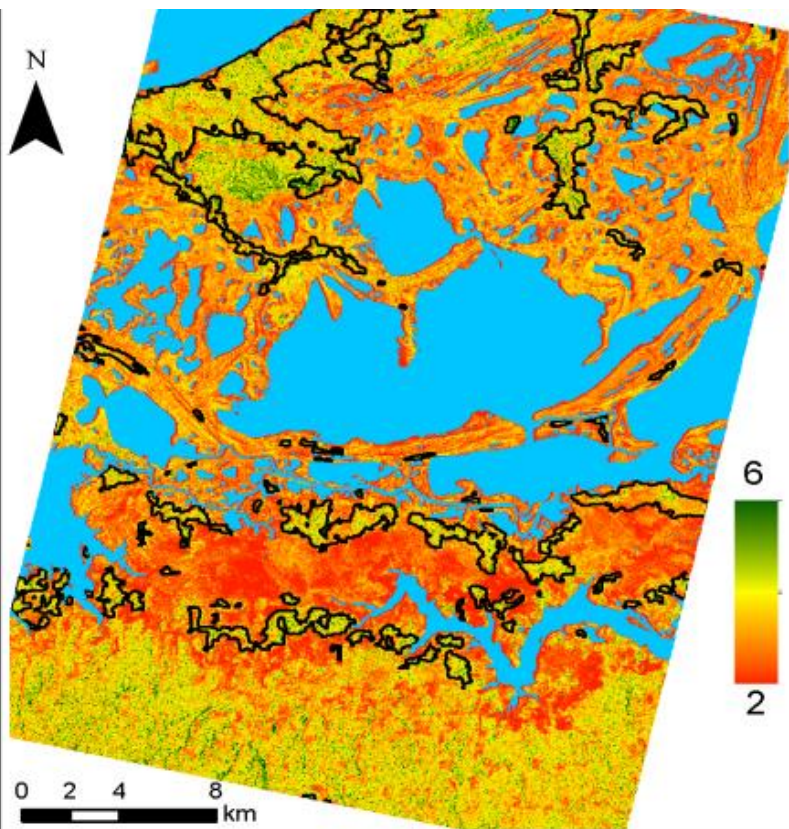
RMSEcv (16) = 0.52

Model:

$$y_{16} = 2.76 + 0.10 * PL(HV-dB)$$

a

Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: a) PL-FBD



$$\text{RMSE}_{\text{cv}}(18) = 0.57$$

$$\text{RMSE}_{\text{cv}}(16) = 0.48$$

Model:

$$y_{18} = 1.8 +$$

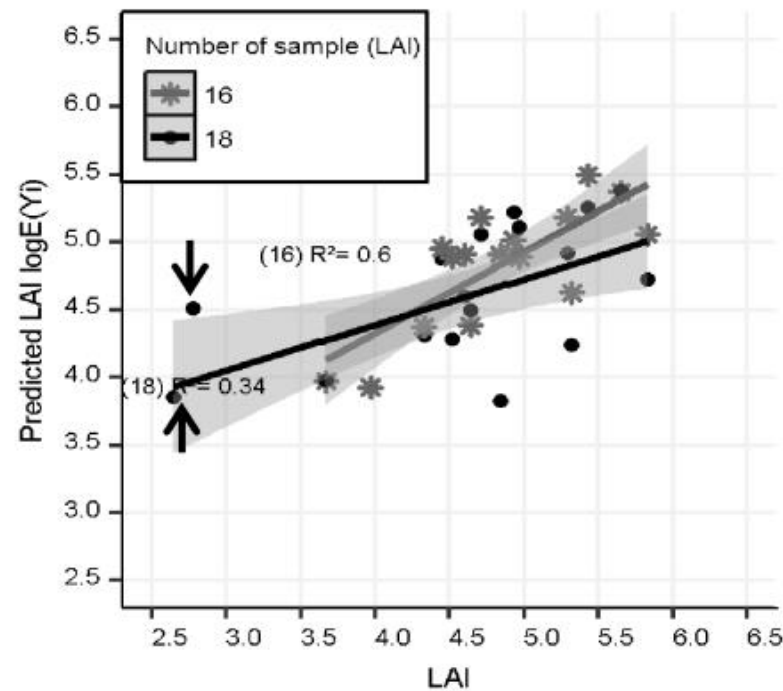
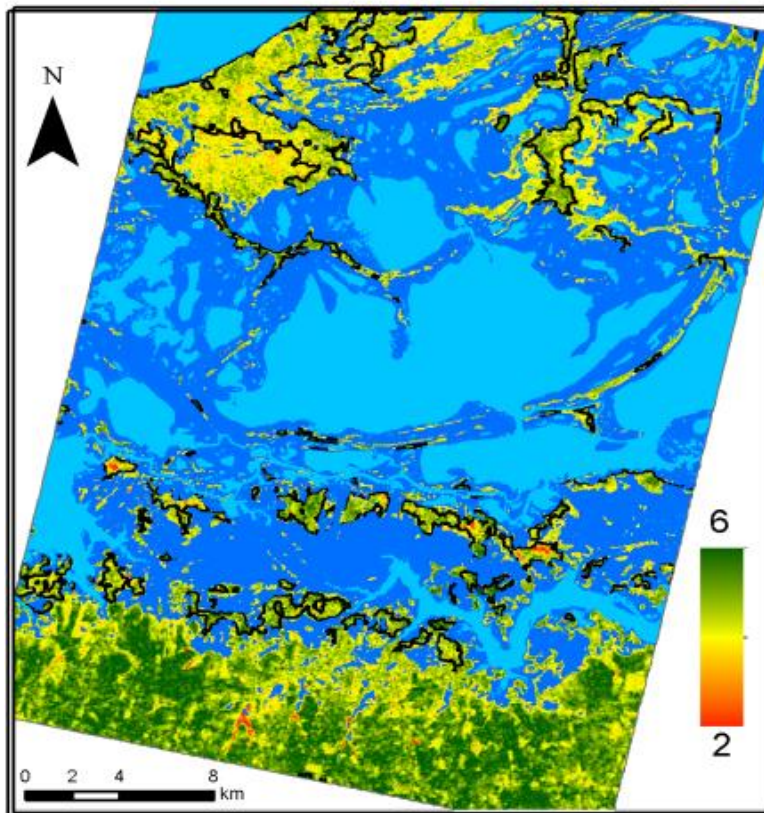
$$1.44 \cdot \text{PL}(\text{HV}/\text{HH}) +$$

$$0.13 \cdot \text{TX}(\text{HH-dB})$$

b

Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: b) PL-FBD+TX

Floodable Forest
 Water ((month: Oct.) $\cap$ (month: Mar.-May.))
 Water (month: Mar.-May.)
 Confidence interval (95%)



RMSEcv (18) = 0.85

RMSEcv (16) = 0.41

Model:

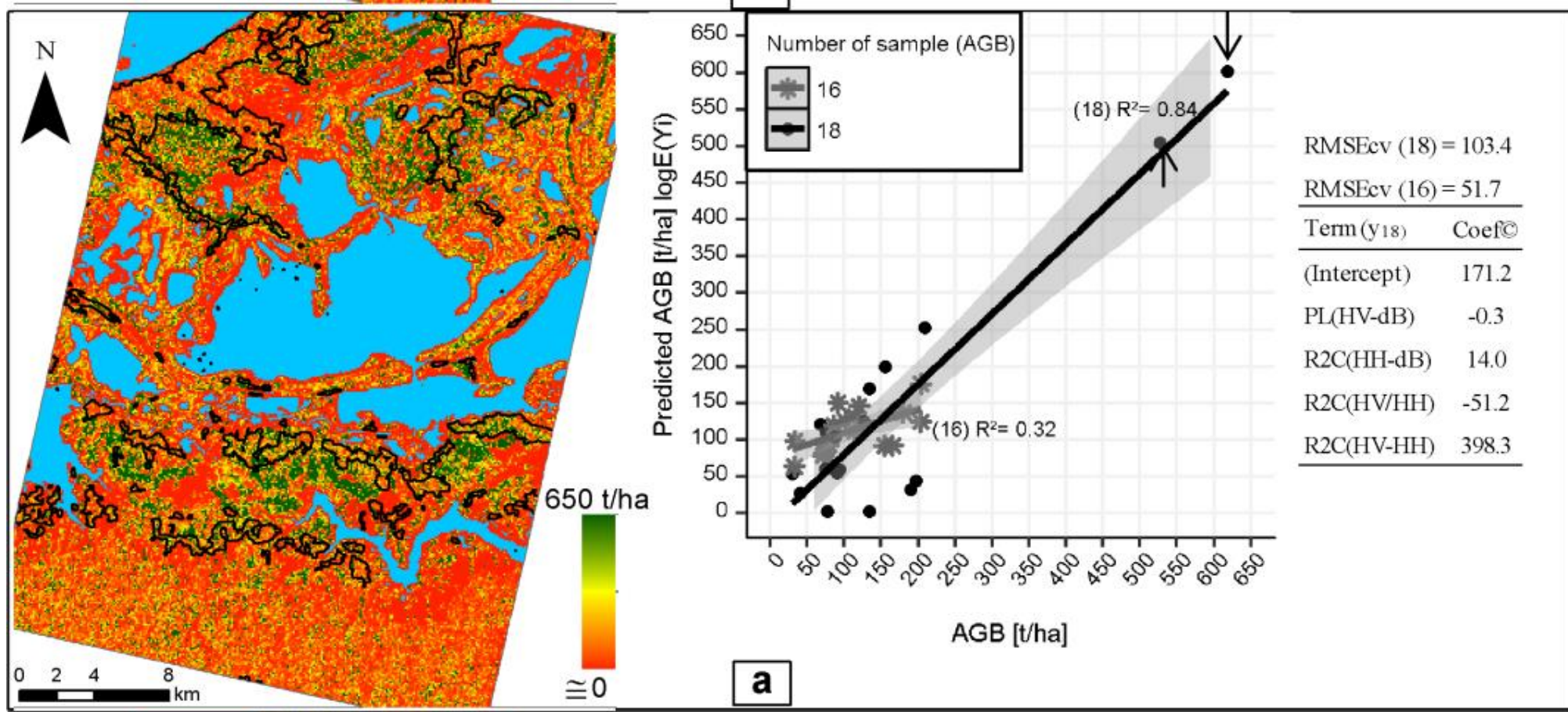
$y_{16} = 2.48 +$

$0.06 \cdot \text{PLR}(\text{HV-dB}) +$

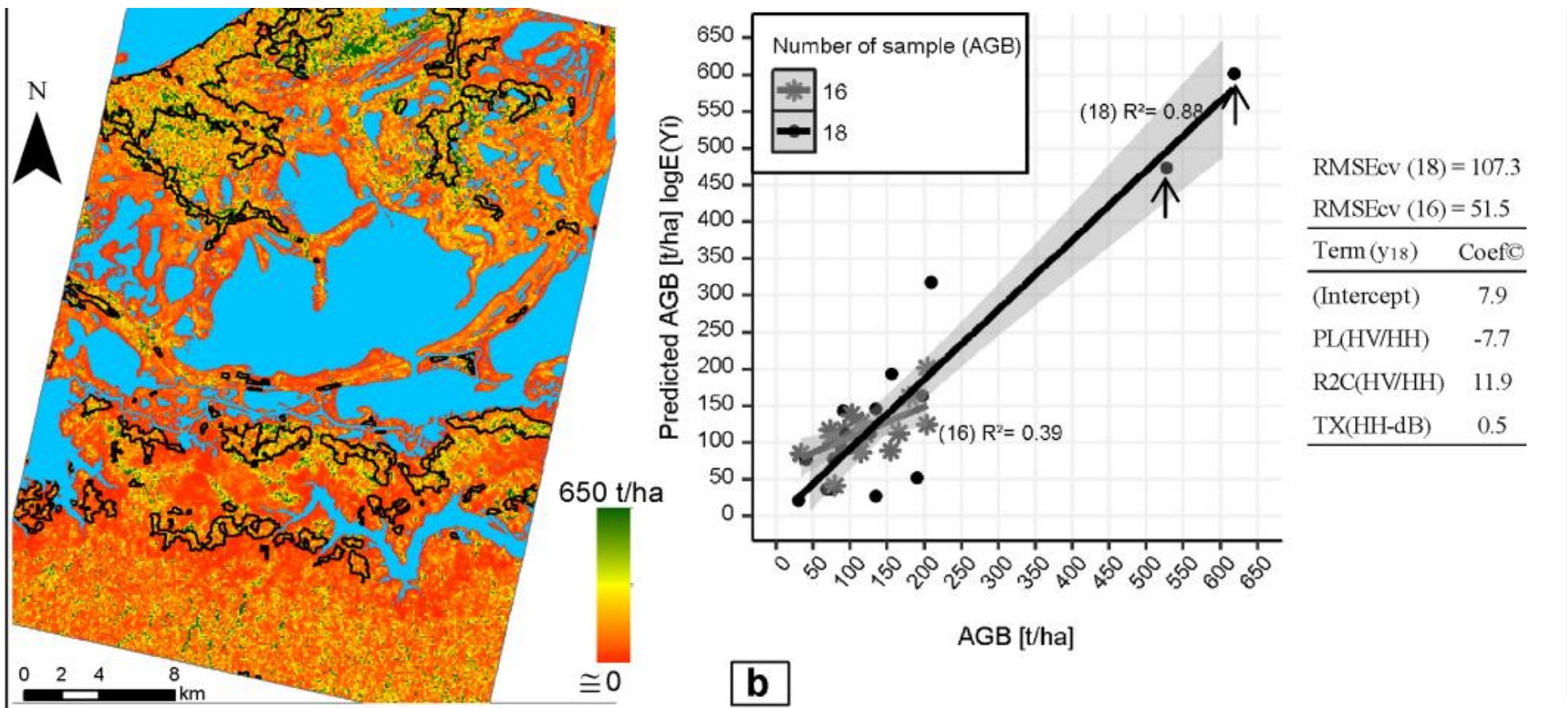
$1.53 \cdot \text{PLR}(\text{HV-HH})$

C

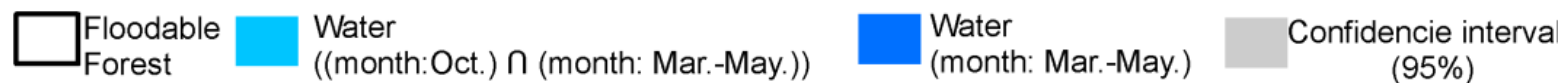
Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: c) PL-PLR

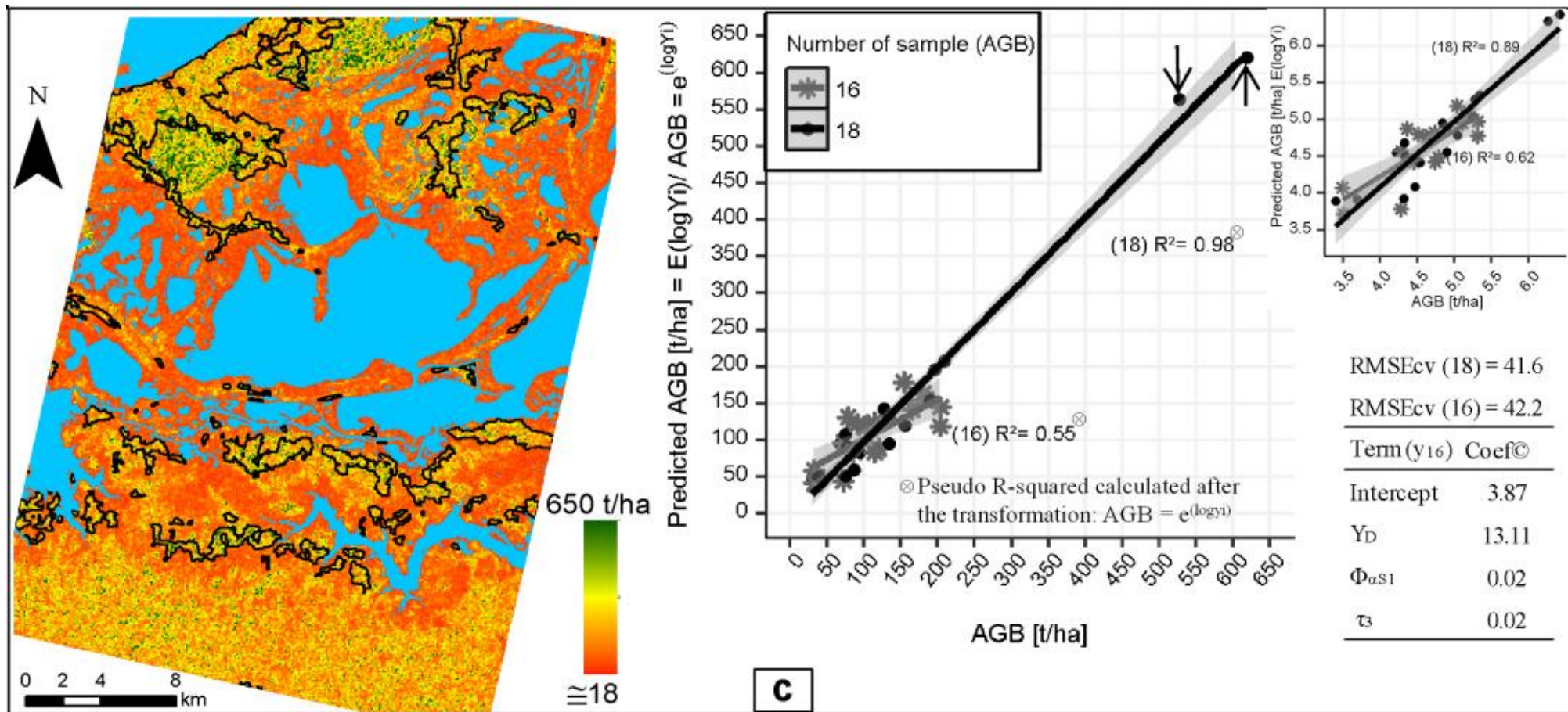


Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: a) PL-FBD+ RS2



Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets:
b) MULT

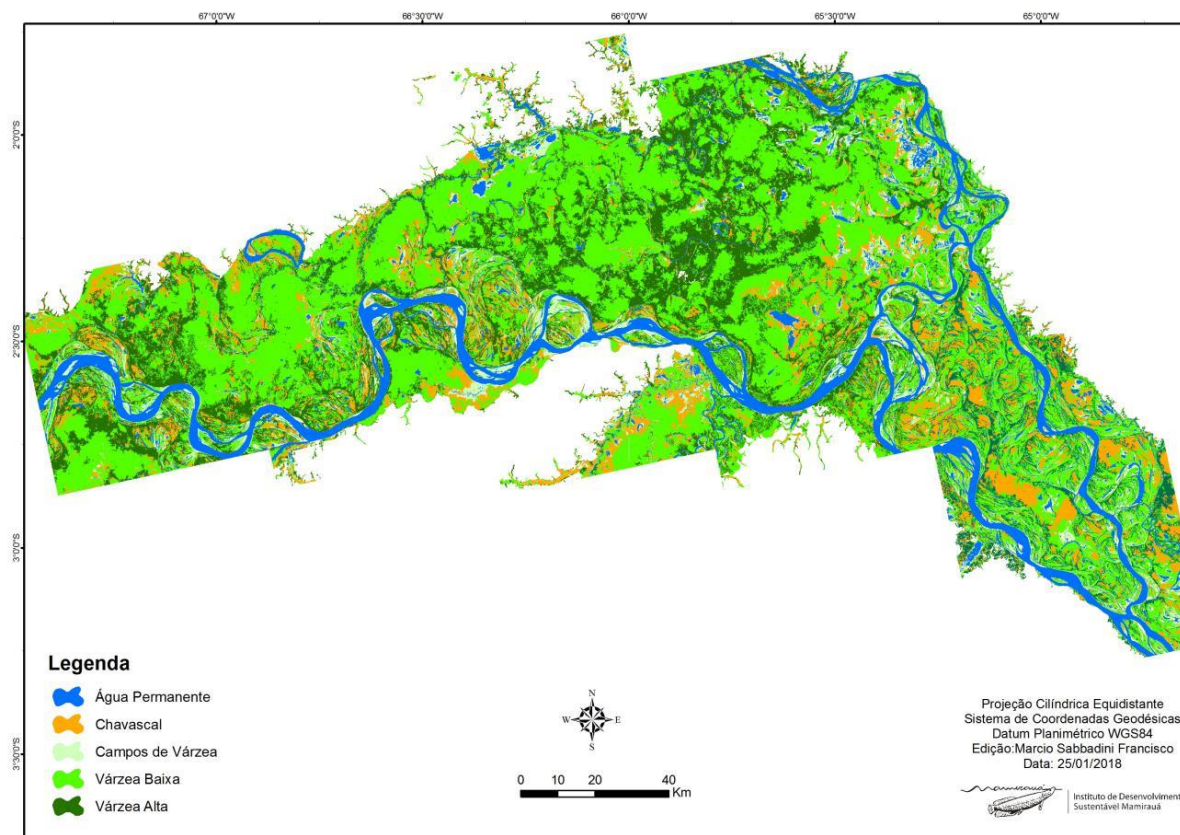




Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets:
e) RC2(POL)16

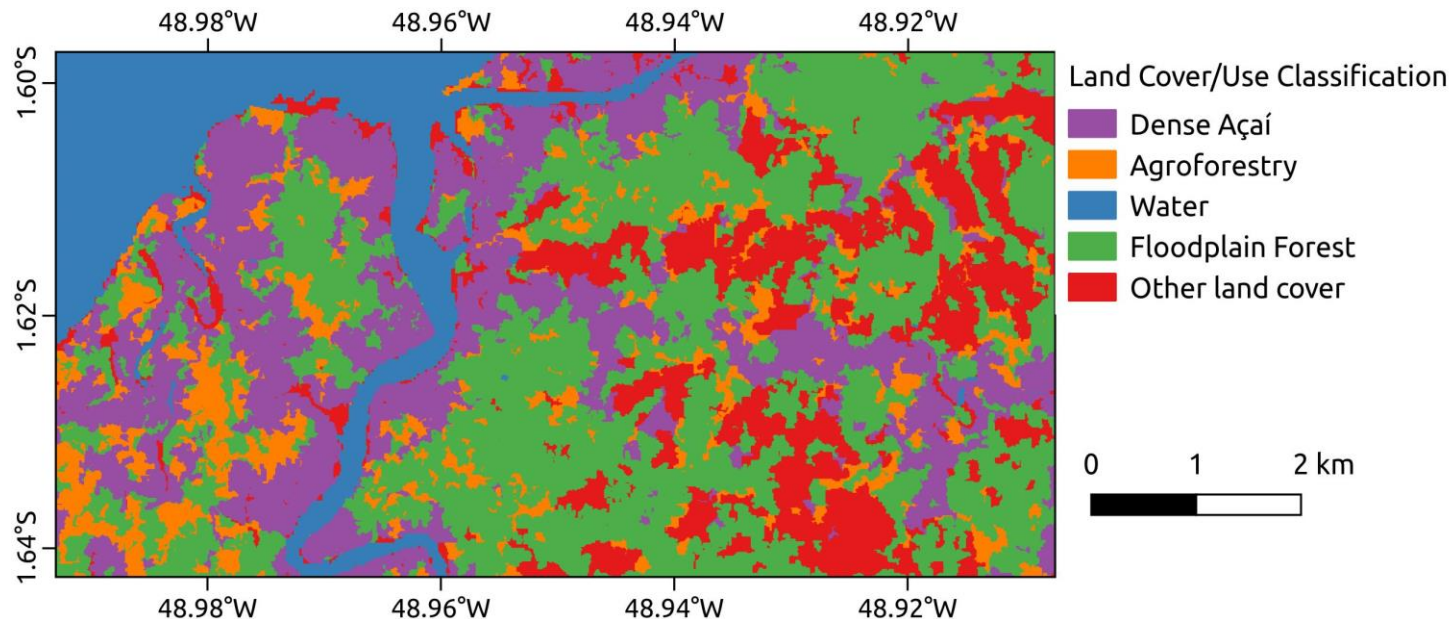
Collaborative Developments: wall-to-wall habitat mapping for the Mamirauá Sustainable Development Reserve

- Developed method applied to produce first wall-to-wall habitat map.
- Map will be used to guide conservation and sustainable extraction planning in the reserve.



Collaborative Developments: mapping açai palm expansion

- Using the developed methodology to differentiate between monoculture, mixed forest-plantation, and untouched floodplain forest near Belém (PA, Brazil) (collaboration with Madson Freitas and Allistair Campbell)



Project milestones so far

- ✓ Fine scale maps of land cover and flood recurrence for key areas of the Amazon floodplains, based on FBD data
- ✓ Working, semi-automated algorithm for classifying land cover and flood duration for large areas of the Amazon basin
- ✓ Analysis of polarimetric capabilities to predict vegetation structure from PALSAR-2 for selected floodplain sites

Project milestones for 1-yr extension

- Derivation of an updated and improved habitat and flooding map for the central Amazon wetlands
- Validation of the basin wide map using high resolution imagery and available ground data
- Comparisons between fine beam and mosaic mapping accuracies

Deliverables for 1-yr extension

- Fine scale habitat and flood duration maps for the Amazon river and main tributaries
- Method to model flood duration from inundation mapping
- Publications:
 - Ferreira-Ferreira et al. (2018). Empirical modeling of flood duration in Amazon floodplain environments based on time-series of ALOS/PALSAR-1 fine beam imagery. To be submitted to Remote Sensing of Environment by March 2018
 - Resende et al. (2018) Tree mortality from flood pulse disturbances in Amazonian floodplain forests: the collateral effects of hydropower production. To be submitted by March 2018, journal not yet determined.
 - Silva et al. (2018) Mapping the expansion of açai palm (*Euterpe oleracea*) in the lower Amazon using combined PALSAR-1 and Sentinel-1 synthetic aperture radar imagery. **To be submitted to the Remote Sensing K&C special issue.** Preferred submission on second quarter of 2018.
 - Silva et al. (2018) Mapping fine scale distribution of floodplain habitats for major Amazon Rivers. **To be submitted for the Wetlands K&C special issue.** Preferred submission on third quarter of 2018.

PALSAR/PALSAR-2 ScanSAR mosaics

We will compare results obtained with the Fine Beam imagery with results obtained using the PALSAR-2 mosaics, to assess if a larger scale / more automated mapping method could be achieved by using the mosaics instead.