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K&C Phase 4 – Status report

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

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ECOSYSTEM DYNAMICS OBSERVATORY
ECODYN

Science Team meeting #23
Hatoyama, Japan, January 18-20, 2017

unesp

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

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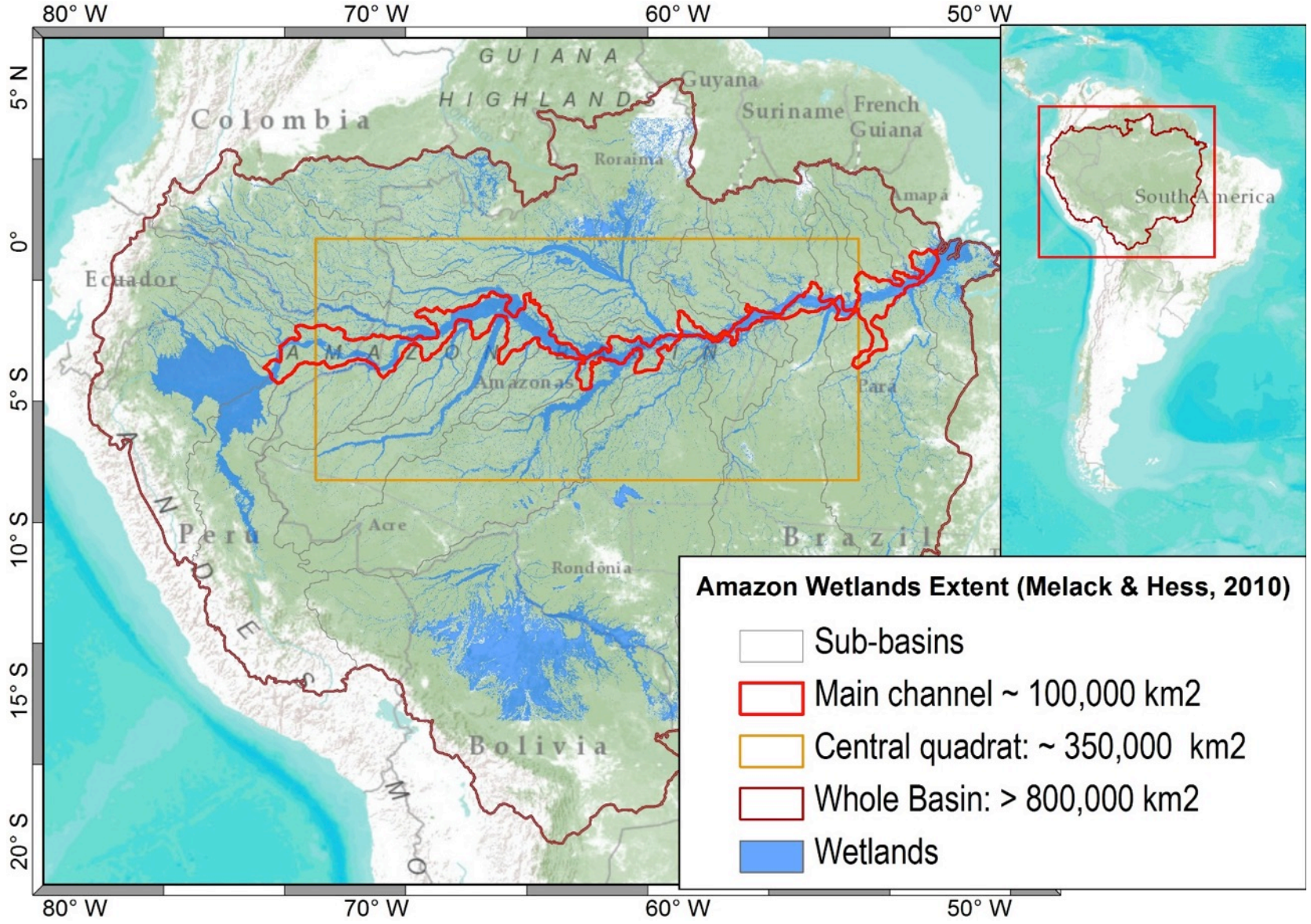
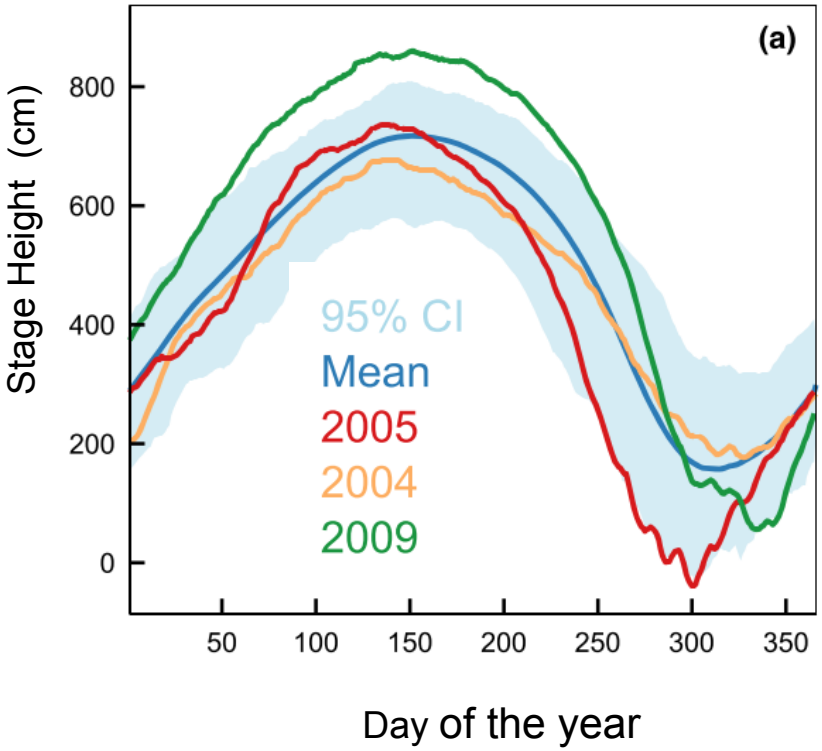


The Flood Pulse

Óbidos gauge: 1971 - 2011



Silva et al. Global Change Biology, 2013

Annual monomodal flood wave

Interannual variability

Controls plant distribution and ecosystem functioning

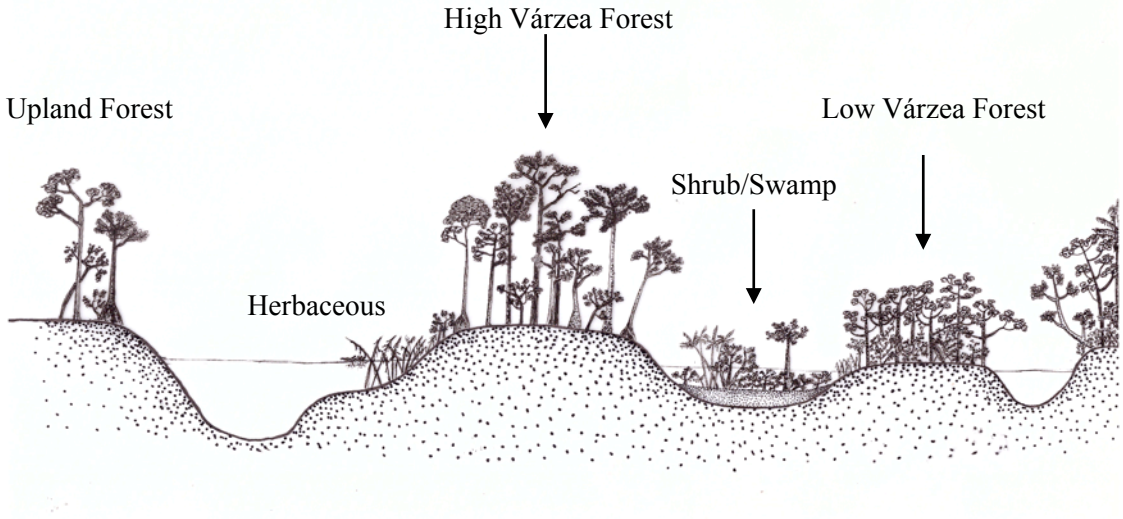


Illustration: CLO Cordeiro

The Flood Pulse

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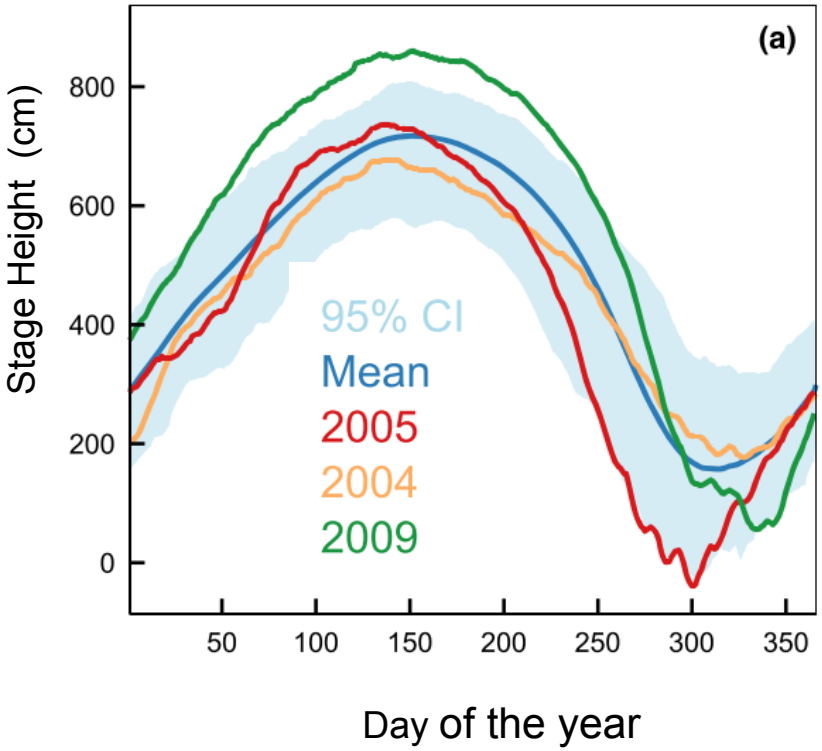

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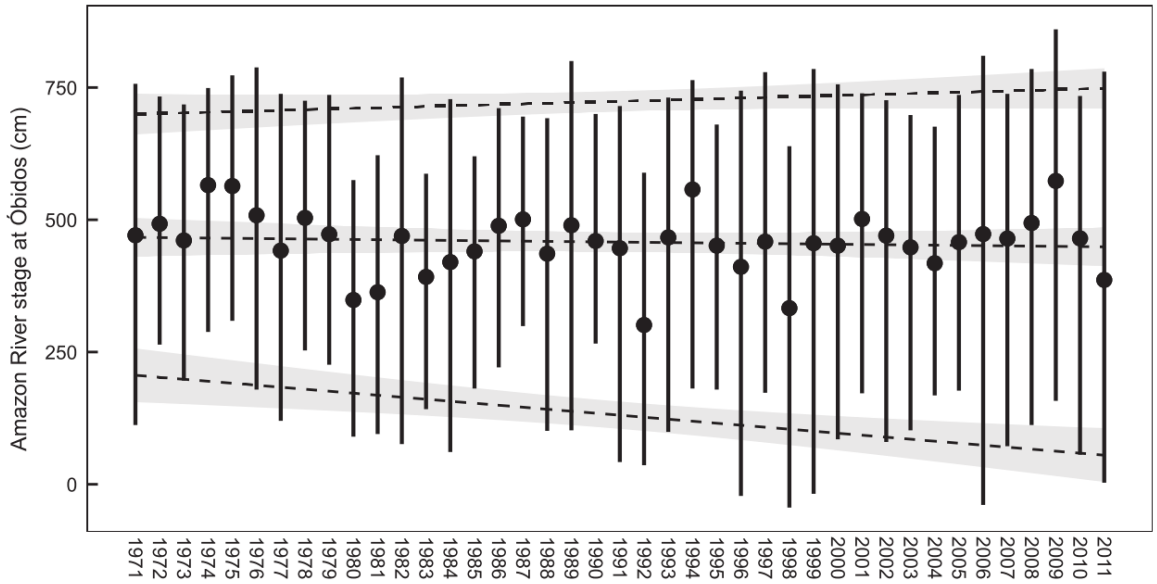


Ferreira-Ferreira et al. Wetlands, 2015

Results and significant findings - Habitat/Vegetation Mapping

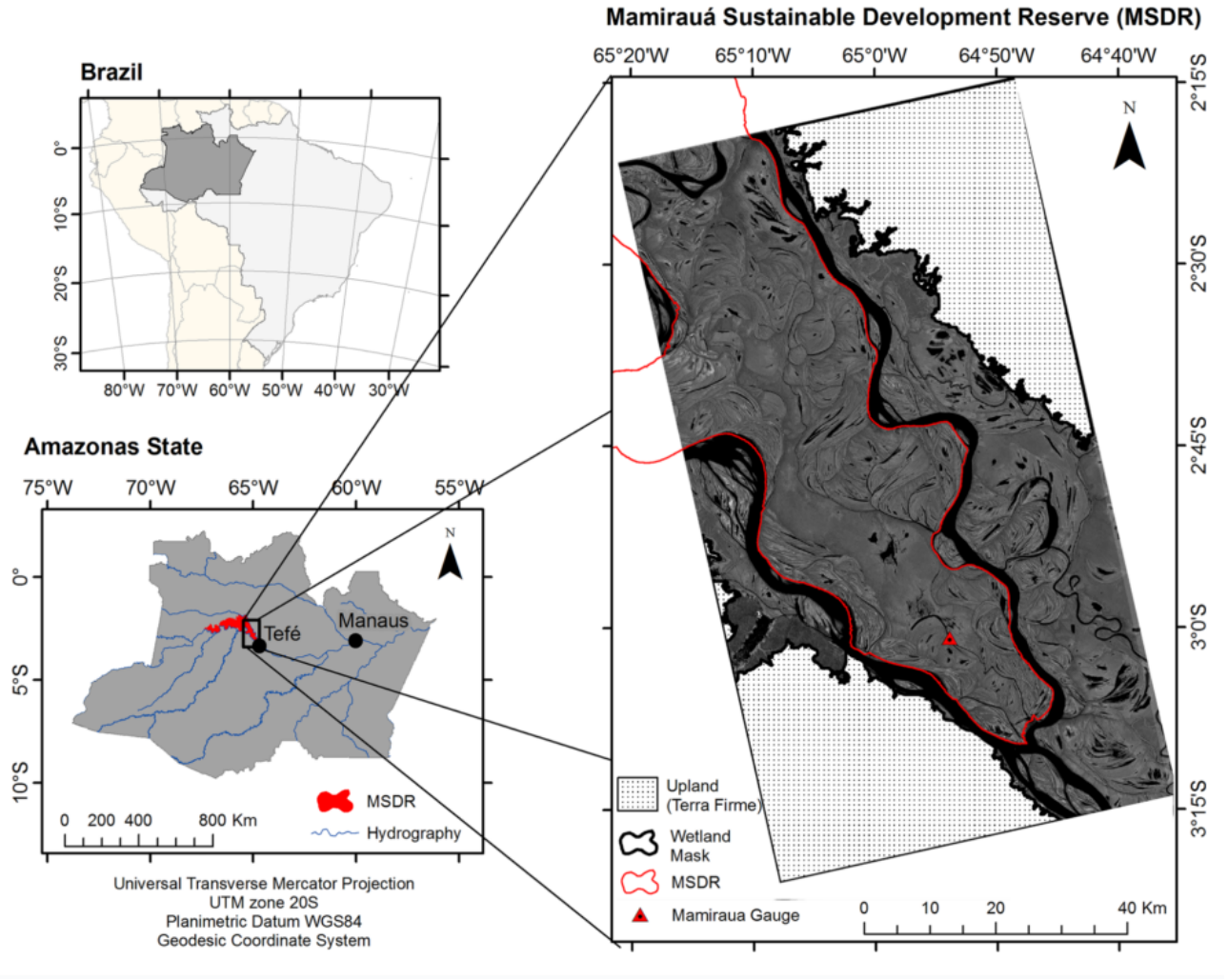
Wetlands Ecol Manage (2015) 23:41–59
DOI 10.1007/s11273-014-9359-1

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 · Evlyn Márcia Leão de Moraes Novo

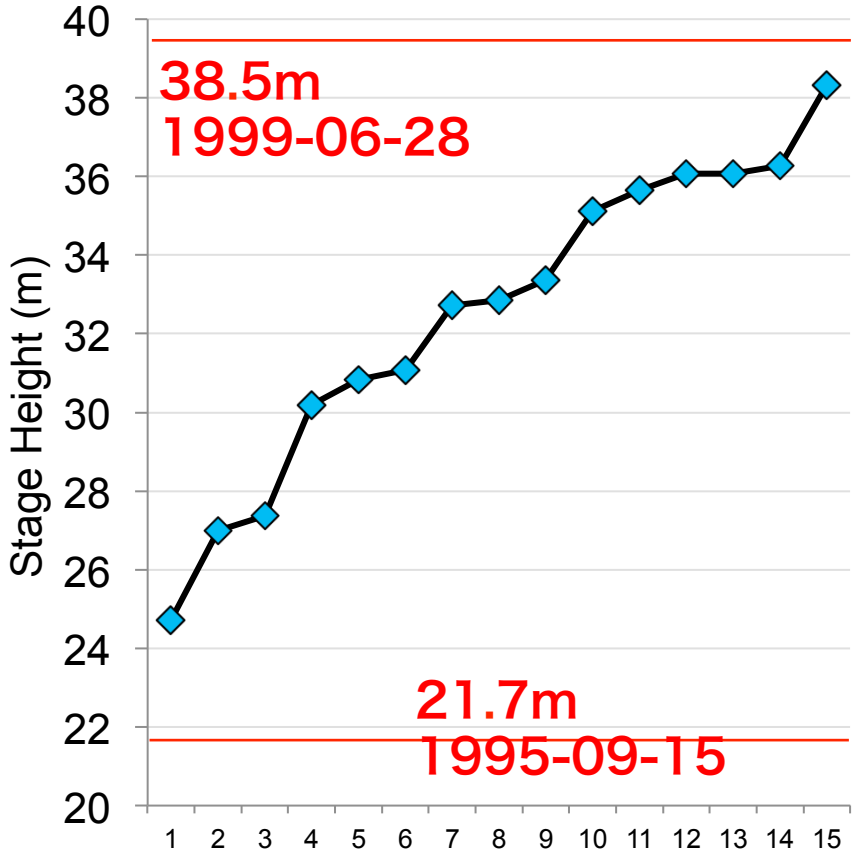
Results and significant findings - Habitat/Vegetation Mapping

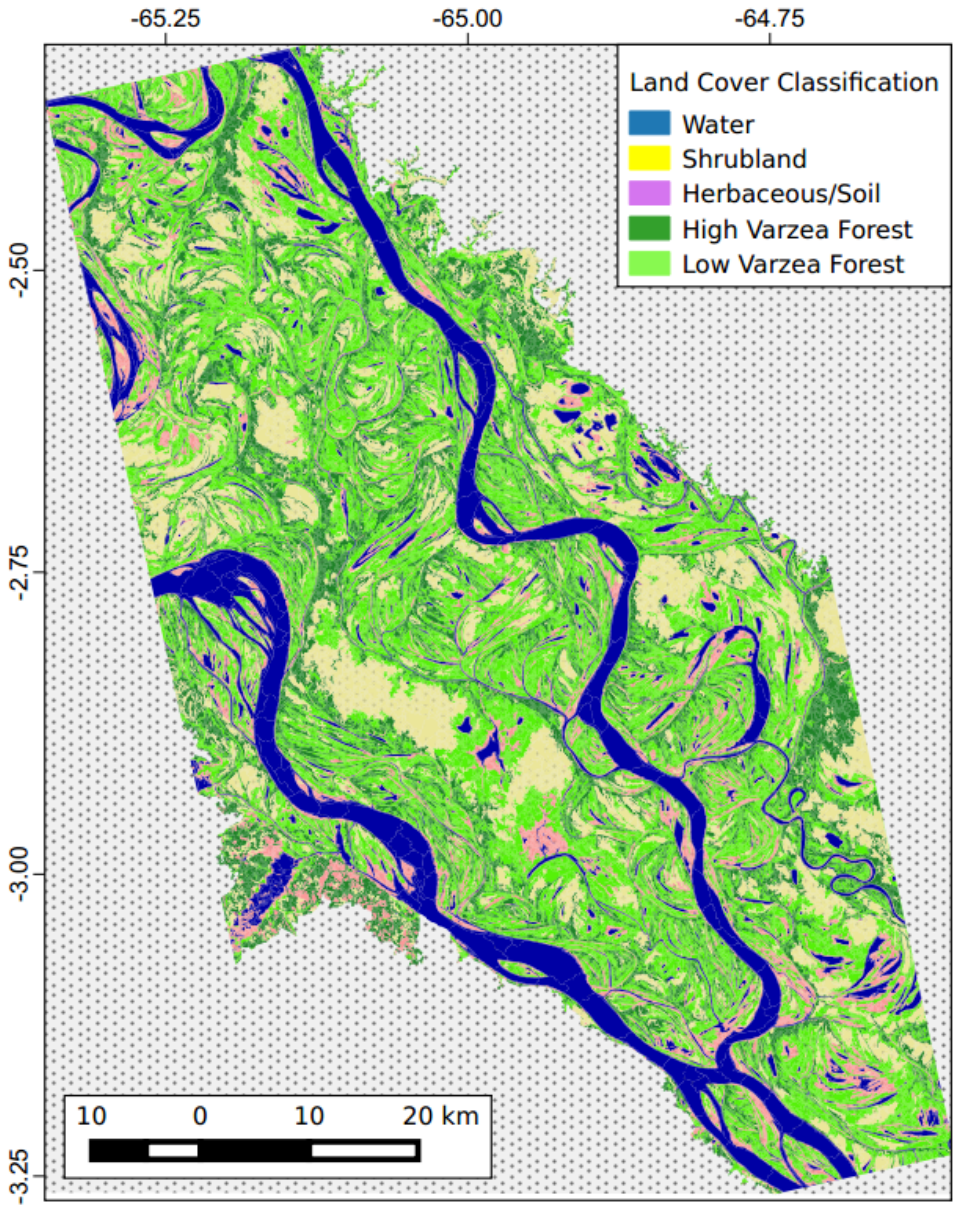


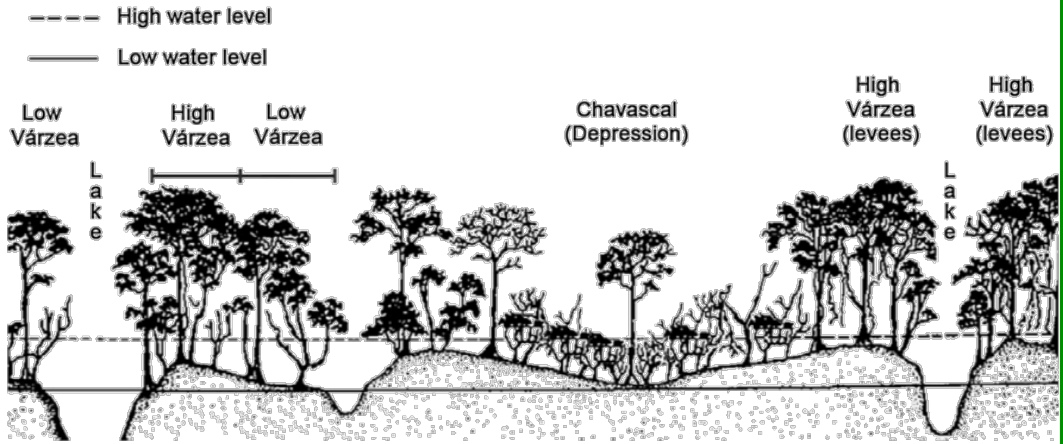
Results and significant findings - Habitat/Vegetation Mapping

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

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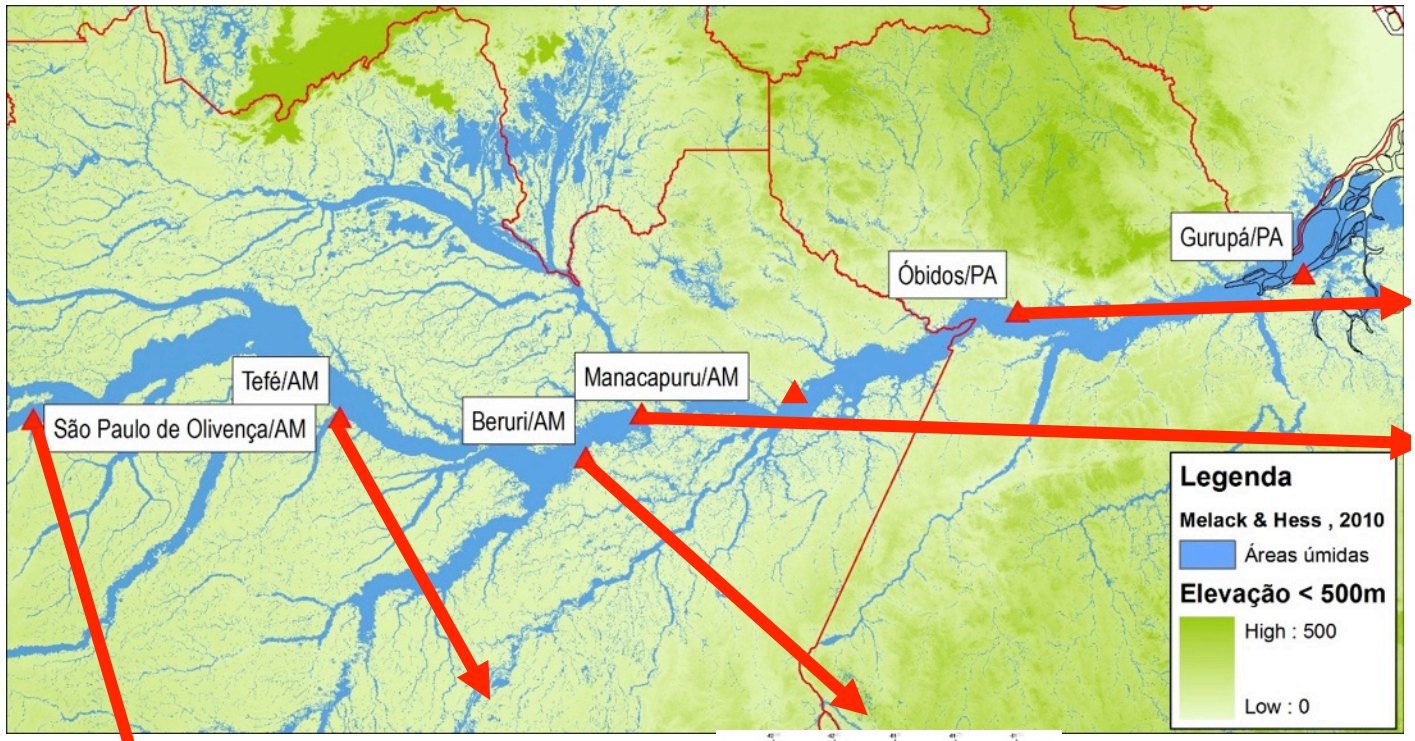

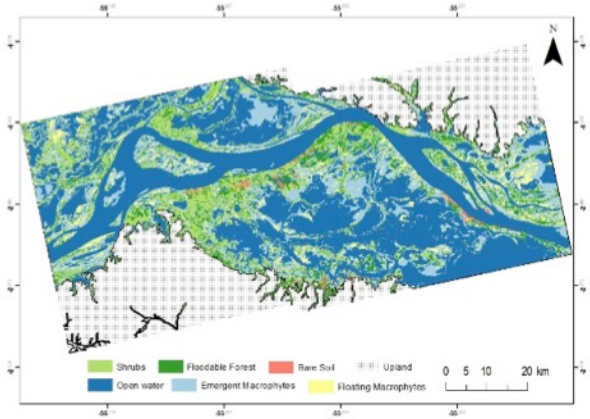

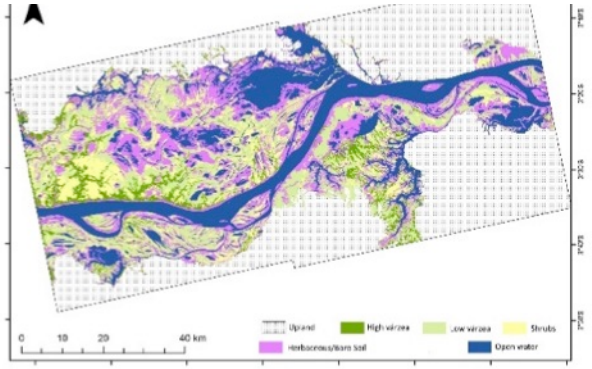

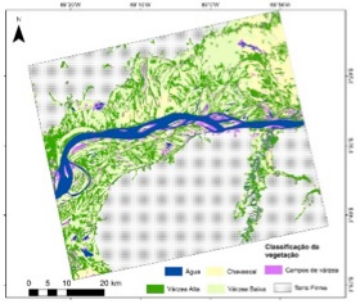

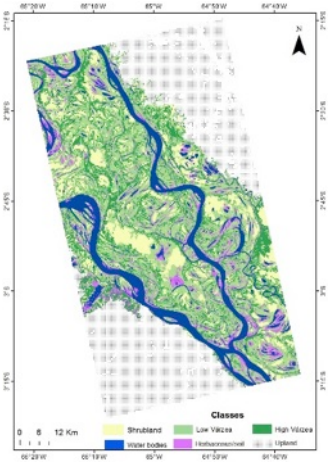

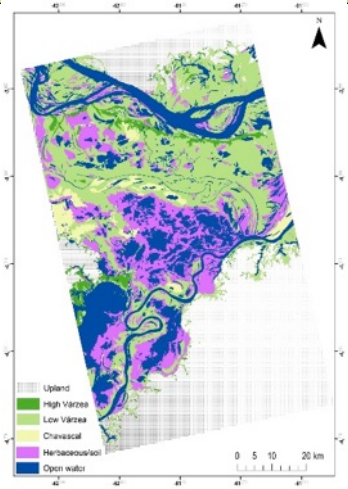

- Progressively expanding to new sites "on demand"
- Limited by training/ validation data

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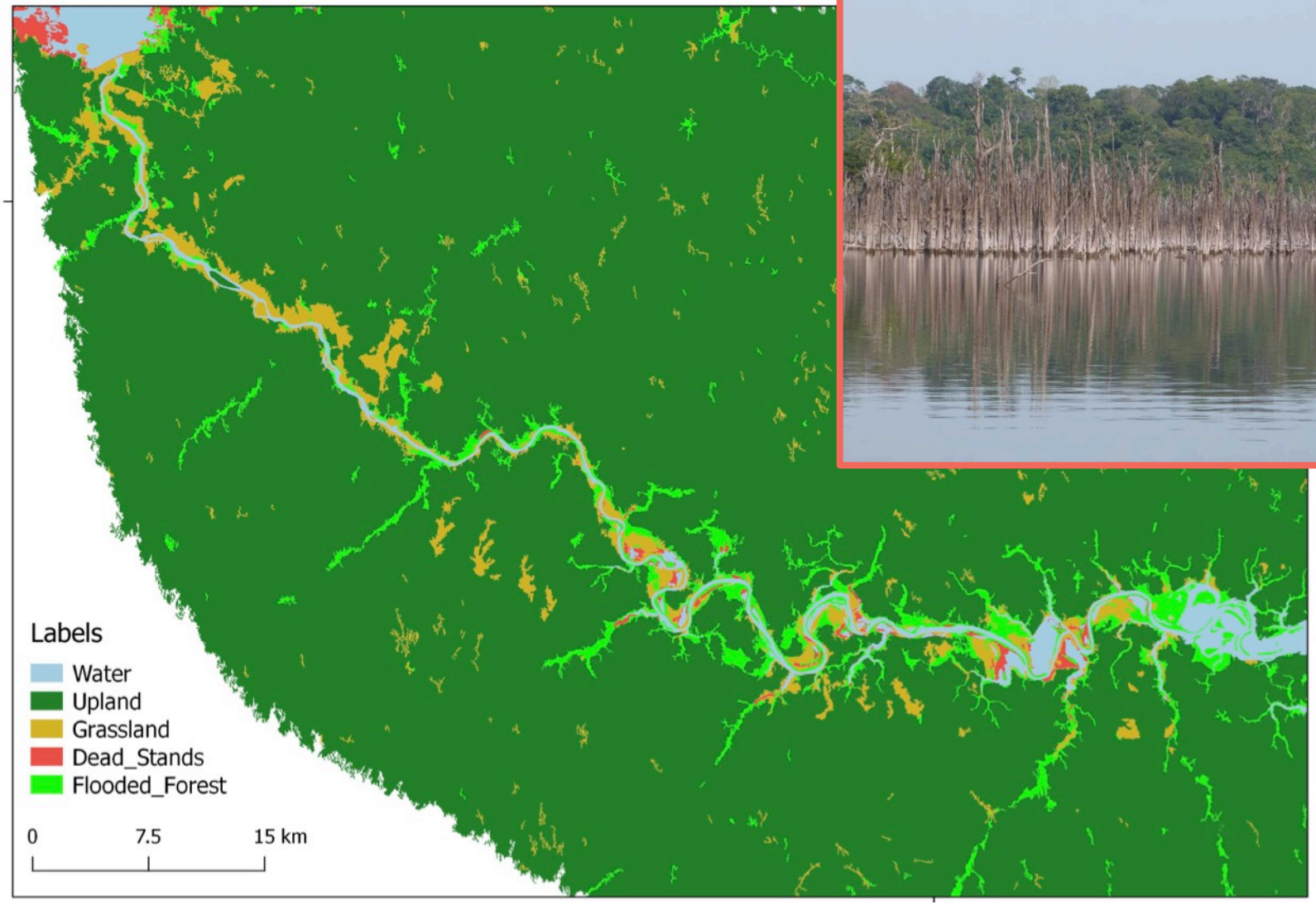
Igapó - Black water forest



Angelica Resend
INPA

Results and significant findings - Flood Duration Mapping

Why flood duration?

- Vegetation zonation strongly responds to duration (stress)
- Habitat use by aquatic and terrestrial fauna
- Complex hydrology requires fine resolutions
- Fine Beam Imagery

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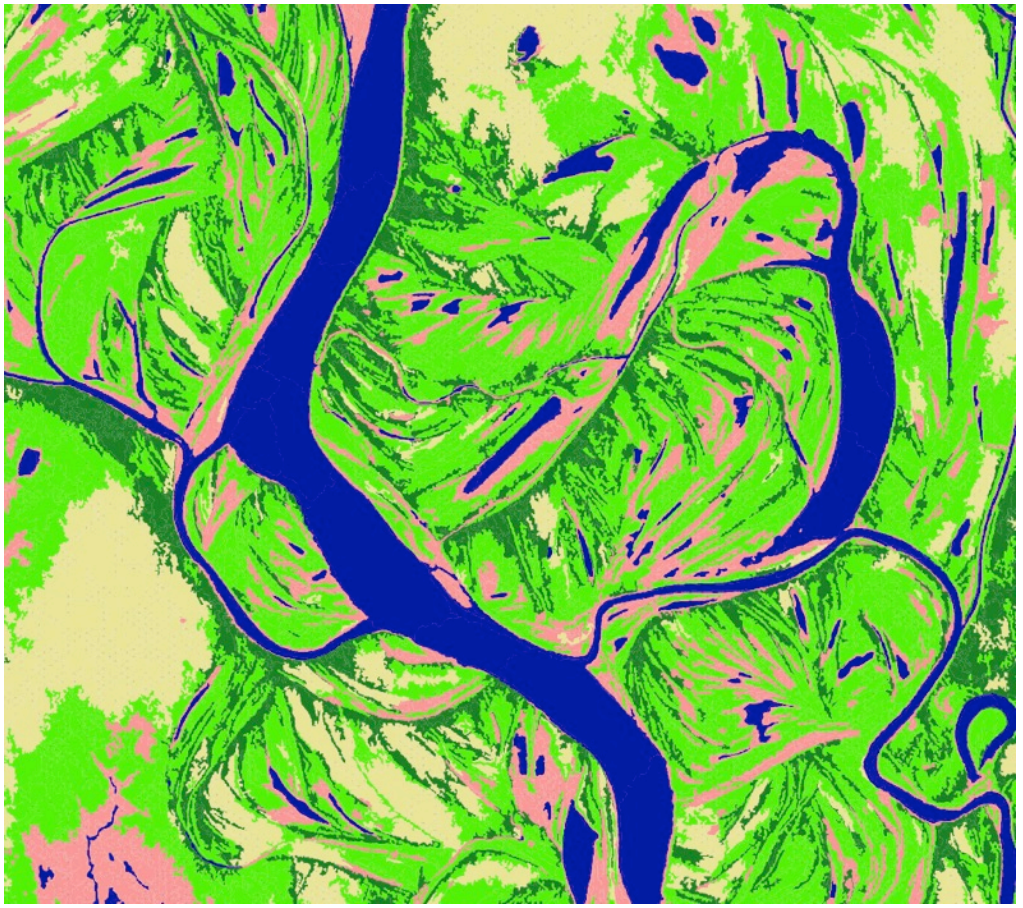
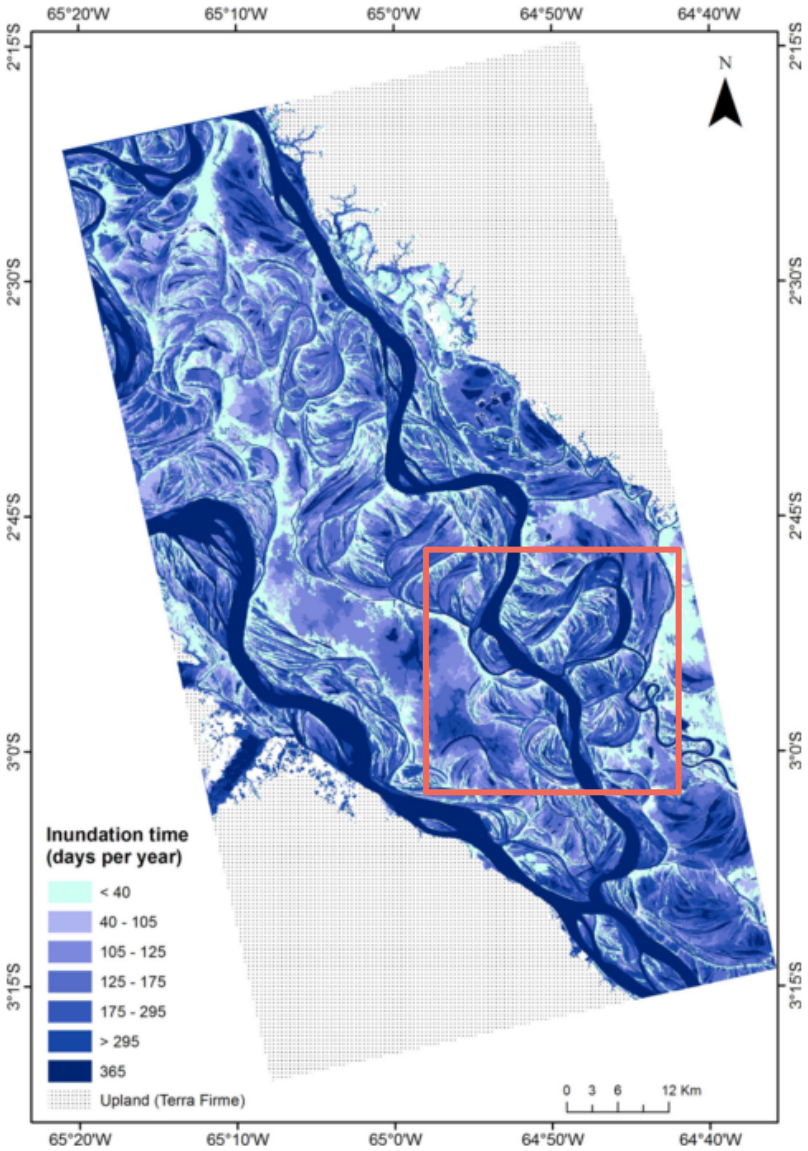
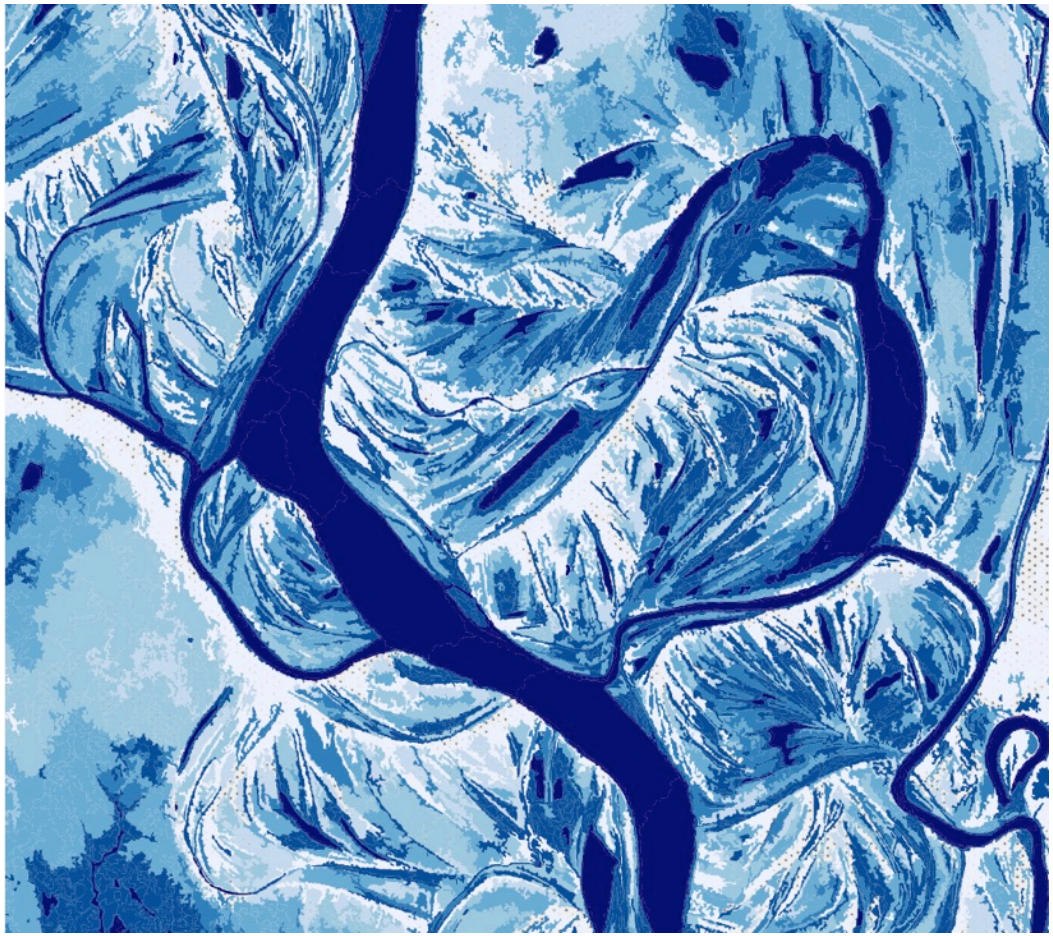
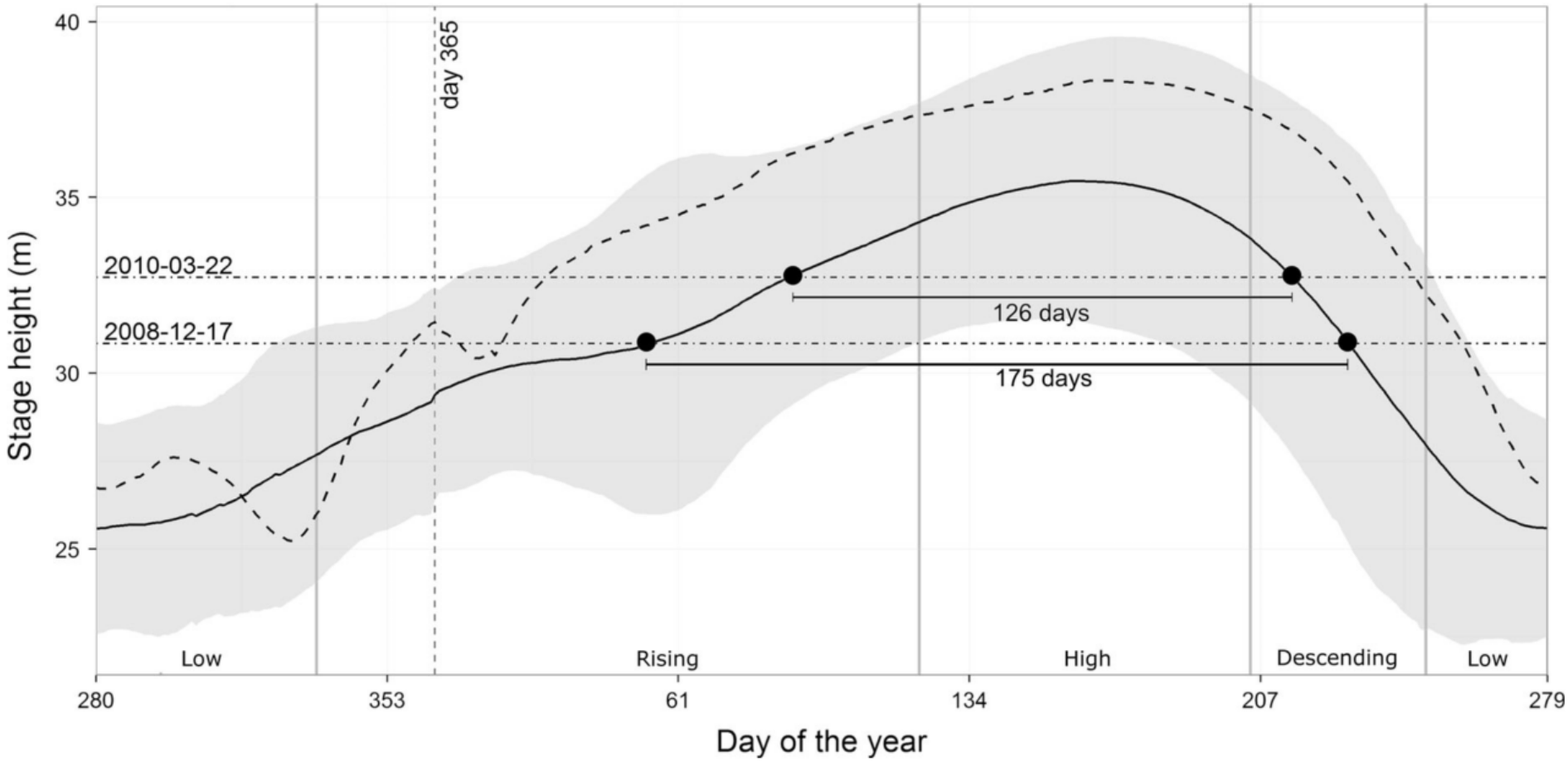


Ferreira-Ferreira et al. Wetlands Ecology and Management, 2015





Ferreira-Ferreira et al. Wetlands Ecology and Management, 2015



Ferreira-Ferreira et al. Wetlands Ecology and Management, 2015

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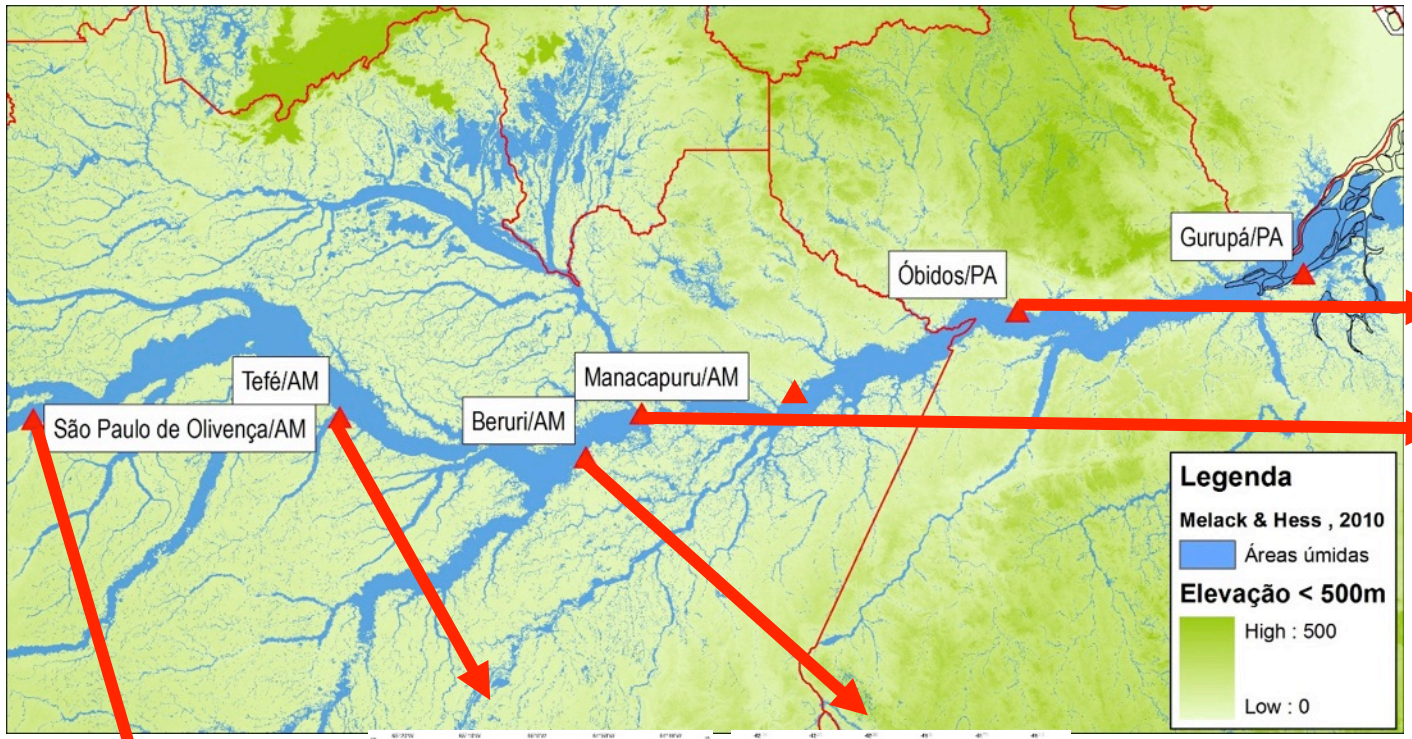
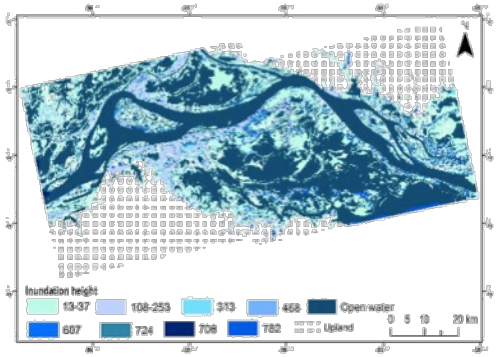
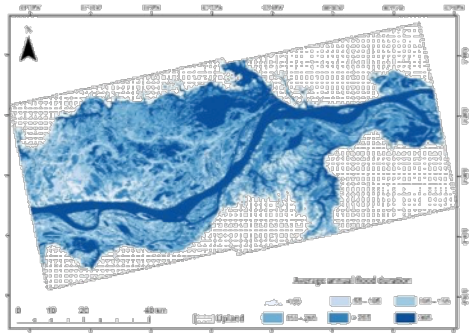
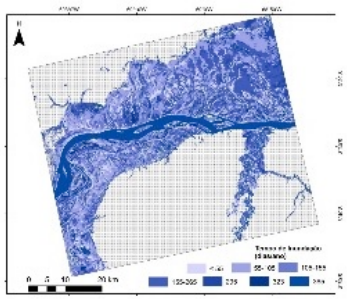
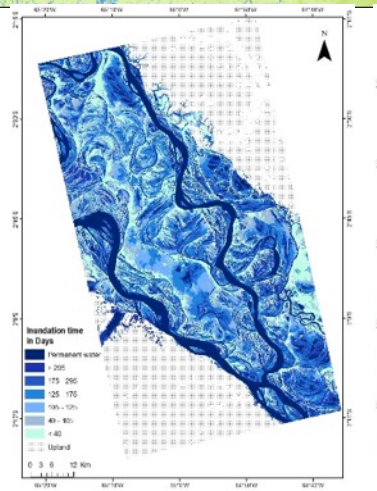
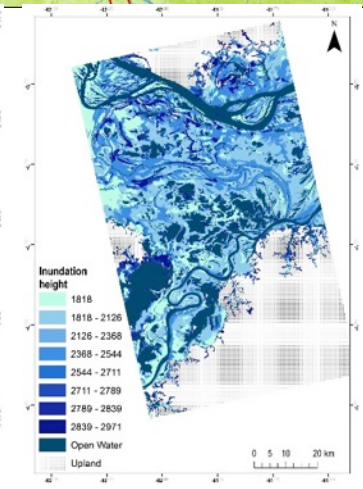




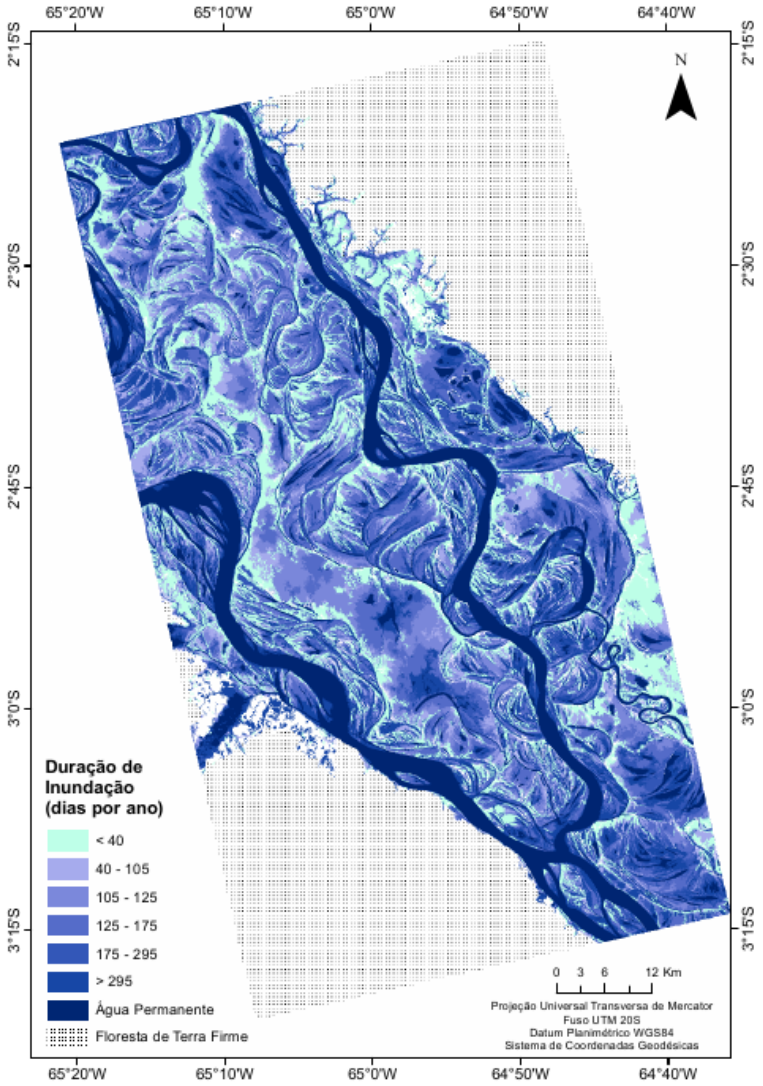






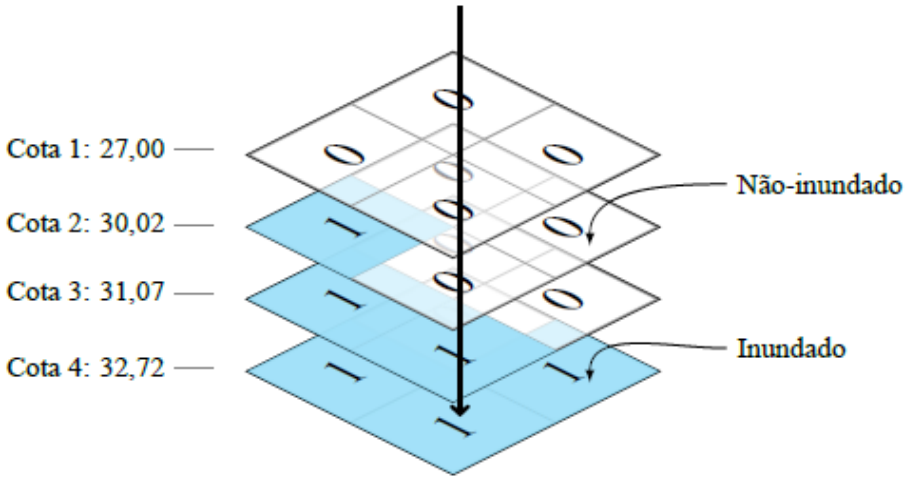


- Coarse inundation "steps"
- VERY Limited validation data

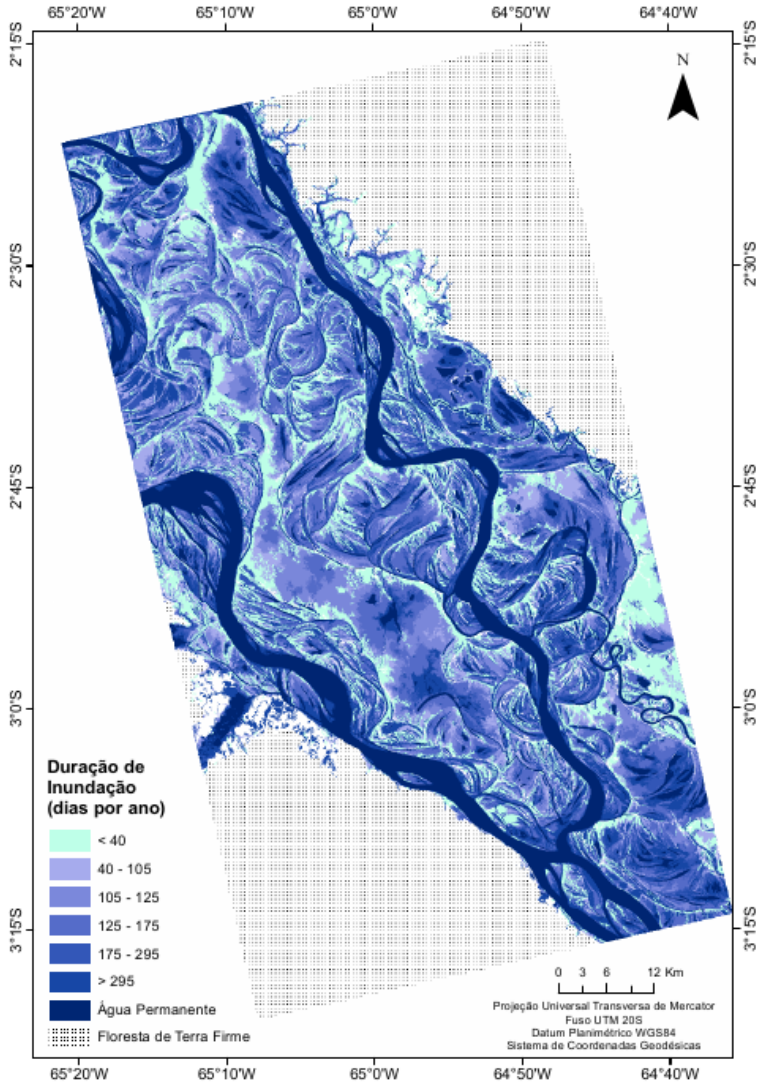


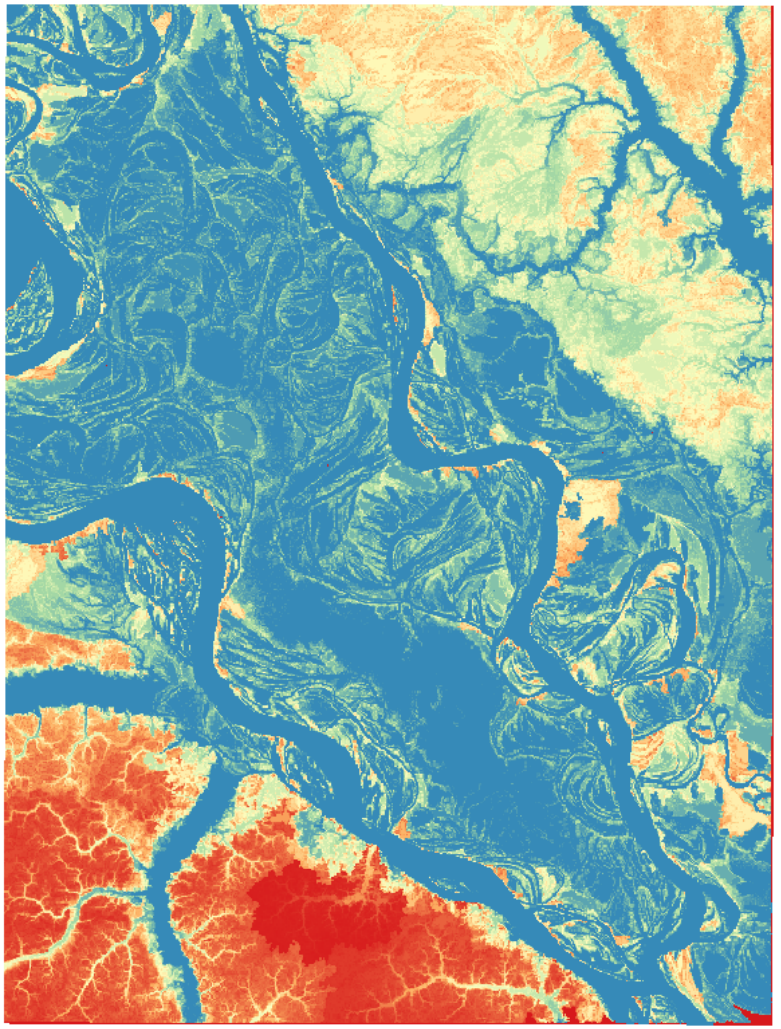
Probability of Inundation:

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



Ferreira-Ferreira et al. **(in prep for submission**





Ferreira-Ferreira et al. **(in prep for submission**

(a)


(b)

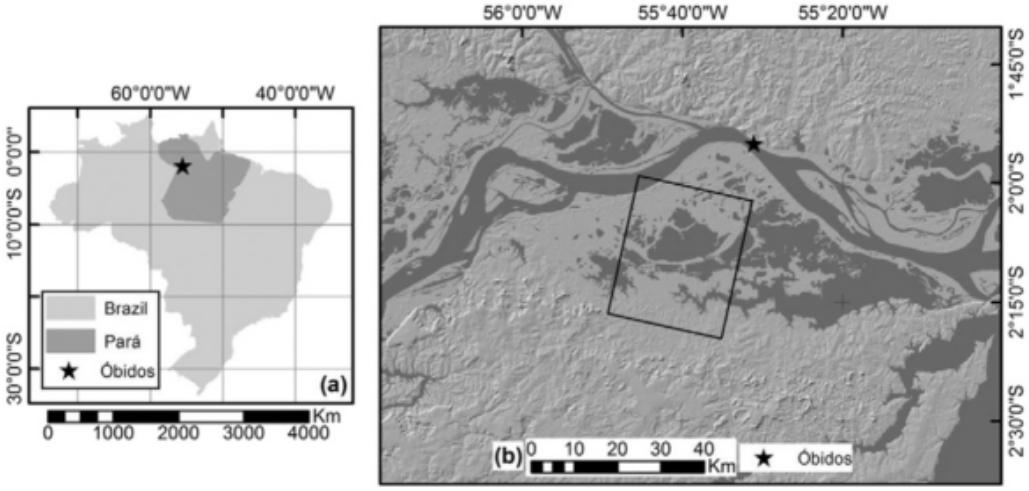

(c)


(d)

Levelogger ID	Habitat mapped	Flood duration class mapped	Flood duration			Day of flood			Day of ebb		
			leveloggers	model	disagreement	leveloggers	model	disagreement	leveloggers	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

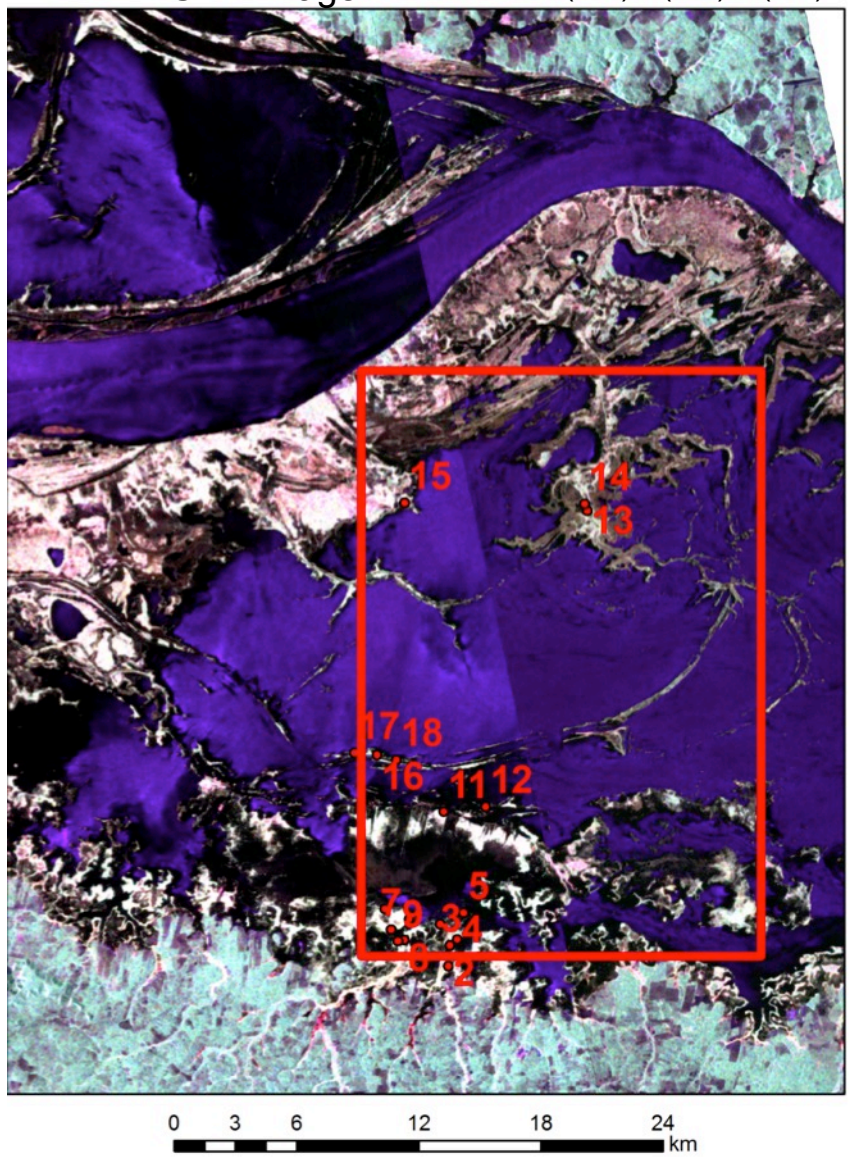
Ferreira-Ferreira et al. **(in prep for submission**

Vegetation Structure

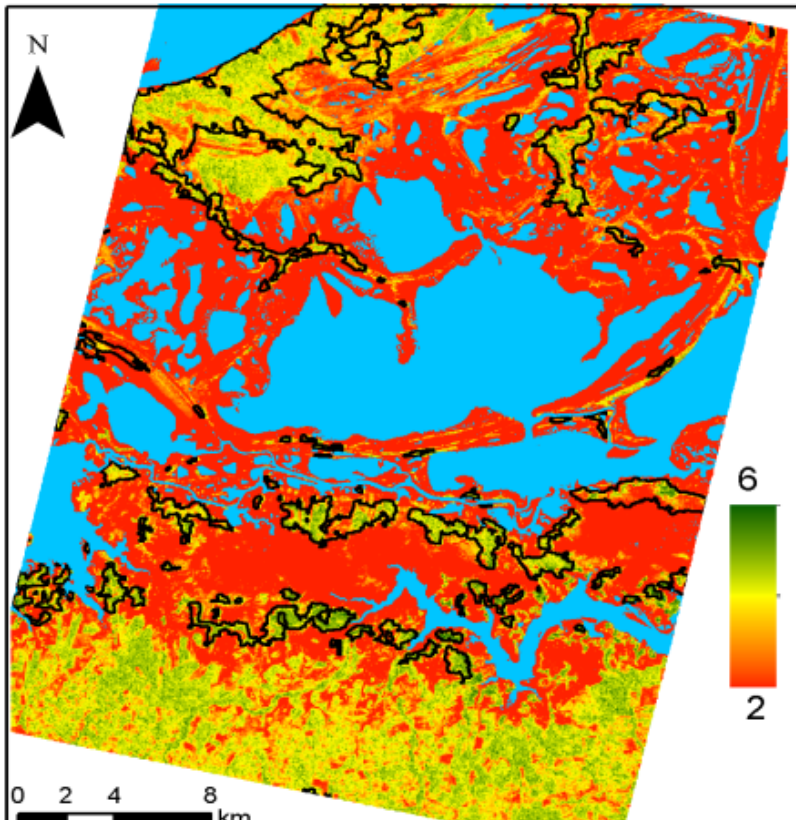


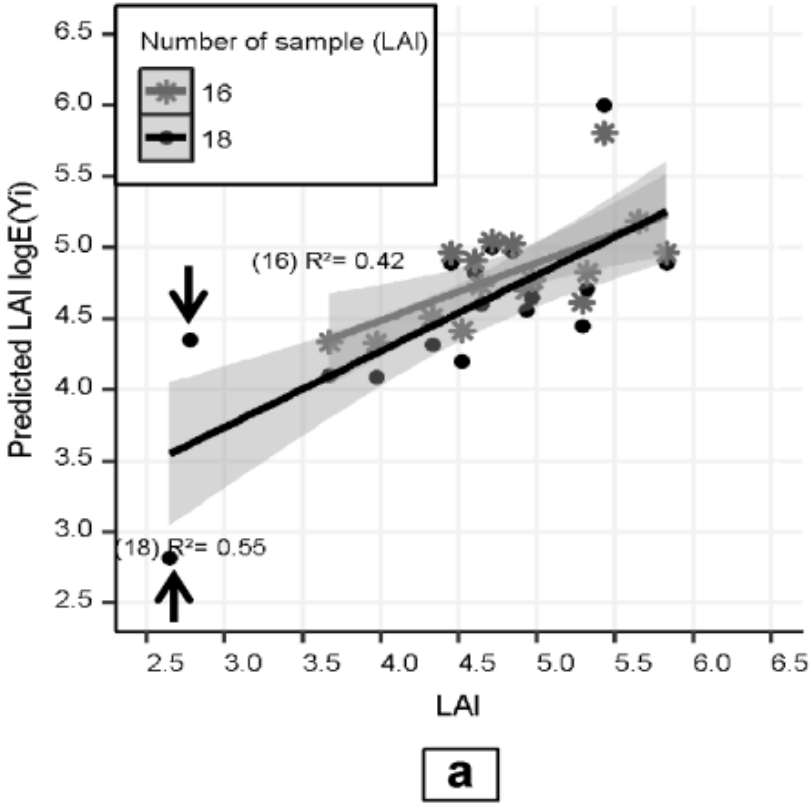
Sensor	Operation Mode	Observation Start Date	Rainfall(mm)
PALSAR	PLR	**30/03/2009**	14.9
PALSAR	PLR	**15/05/2009**	0.2
TerraSAR-X	HH	19/10/2011	x
RadarSAT	Polarimetric	20/10/2011	x
PALSAR	FBD (HH-HV)	**08/10/2010**	0
PALSAR	FBD (HH-HV)	**25/10/2010**	0
Field work 18 (25m x 25m)		data(18-29/10/2013)	

PALSAR image R(HH) B(HV) G(VV)



Floodable Forest | Water (month:Oct.) | Confidencie interval – 95%





RMSEcv (18) = 0.65

RMSEcv (16) = 0.52

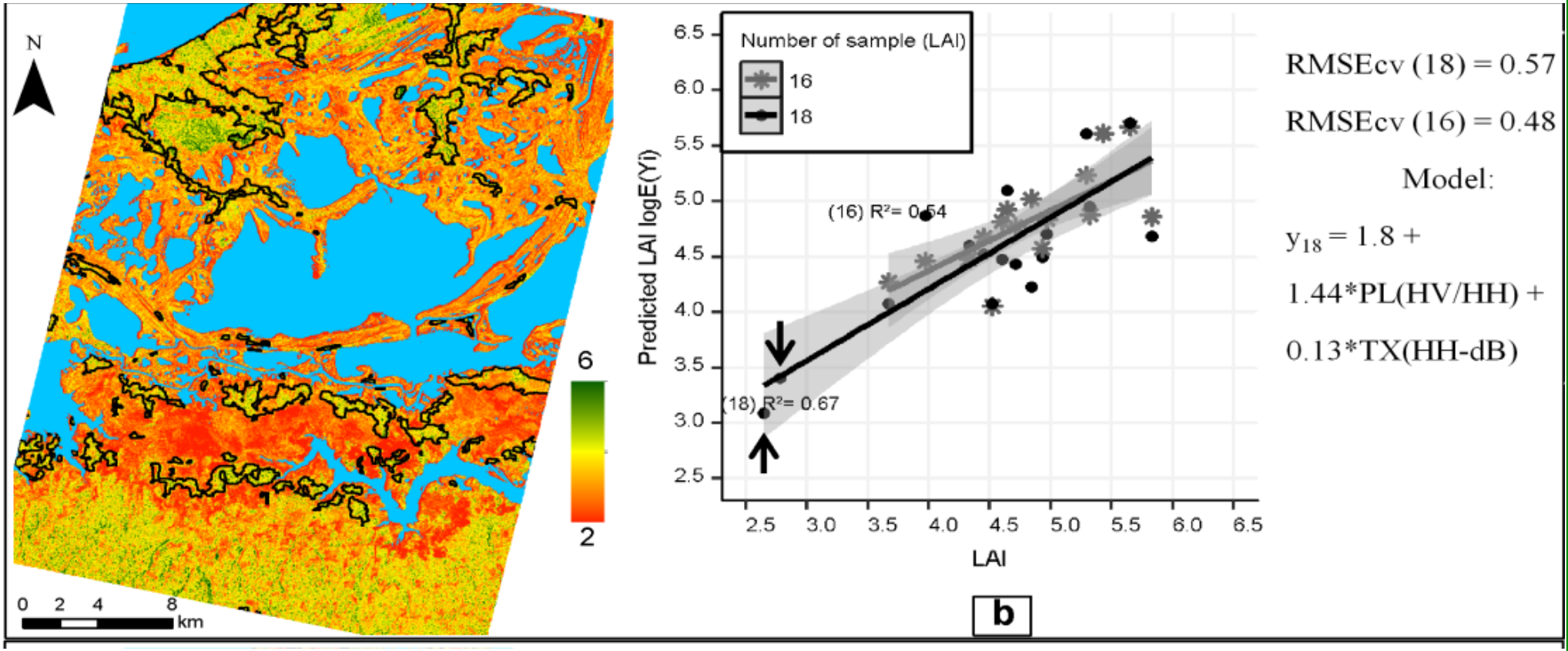
Model:

$y_{16} = 2.76 +$

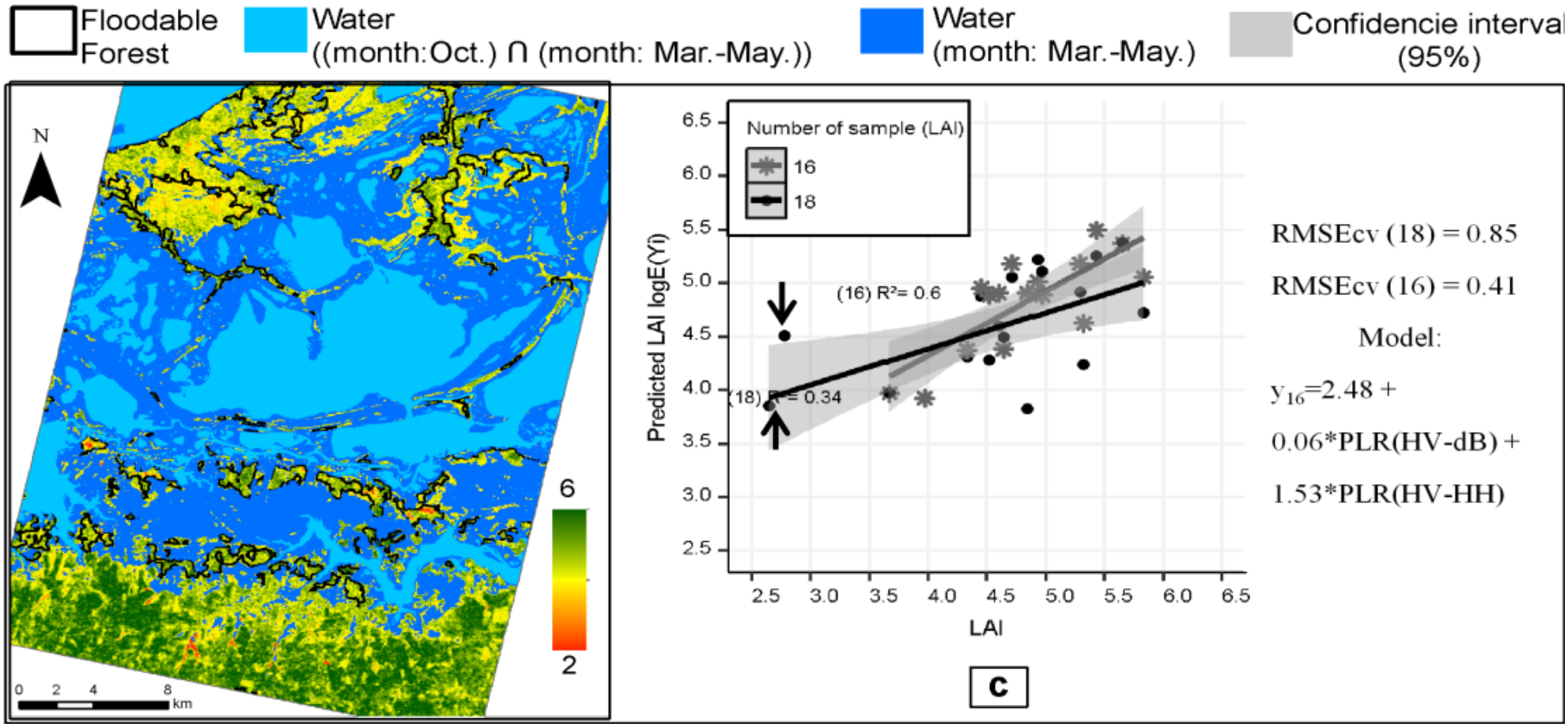
0.10* PL(HV-dB)

a

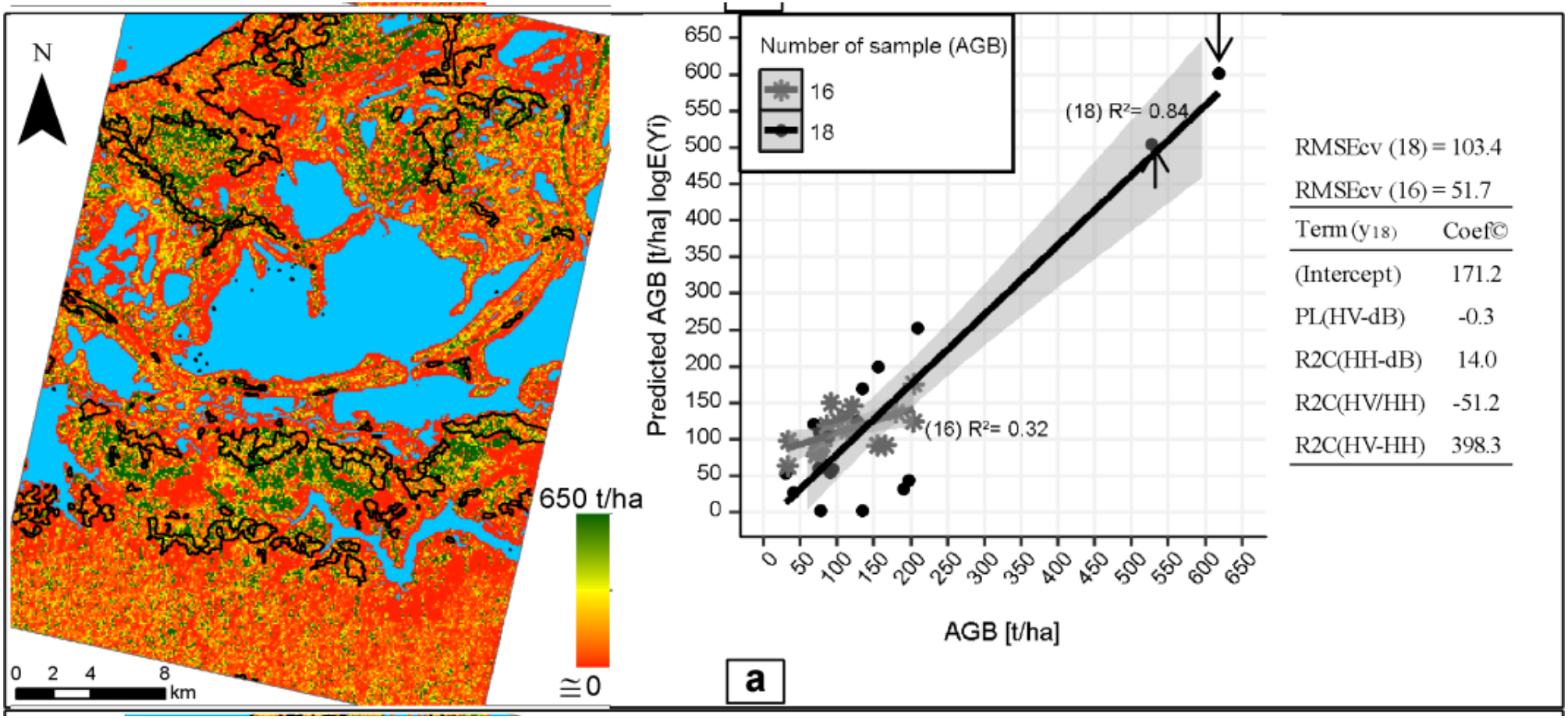
Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: a) PL-FB**D**



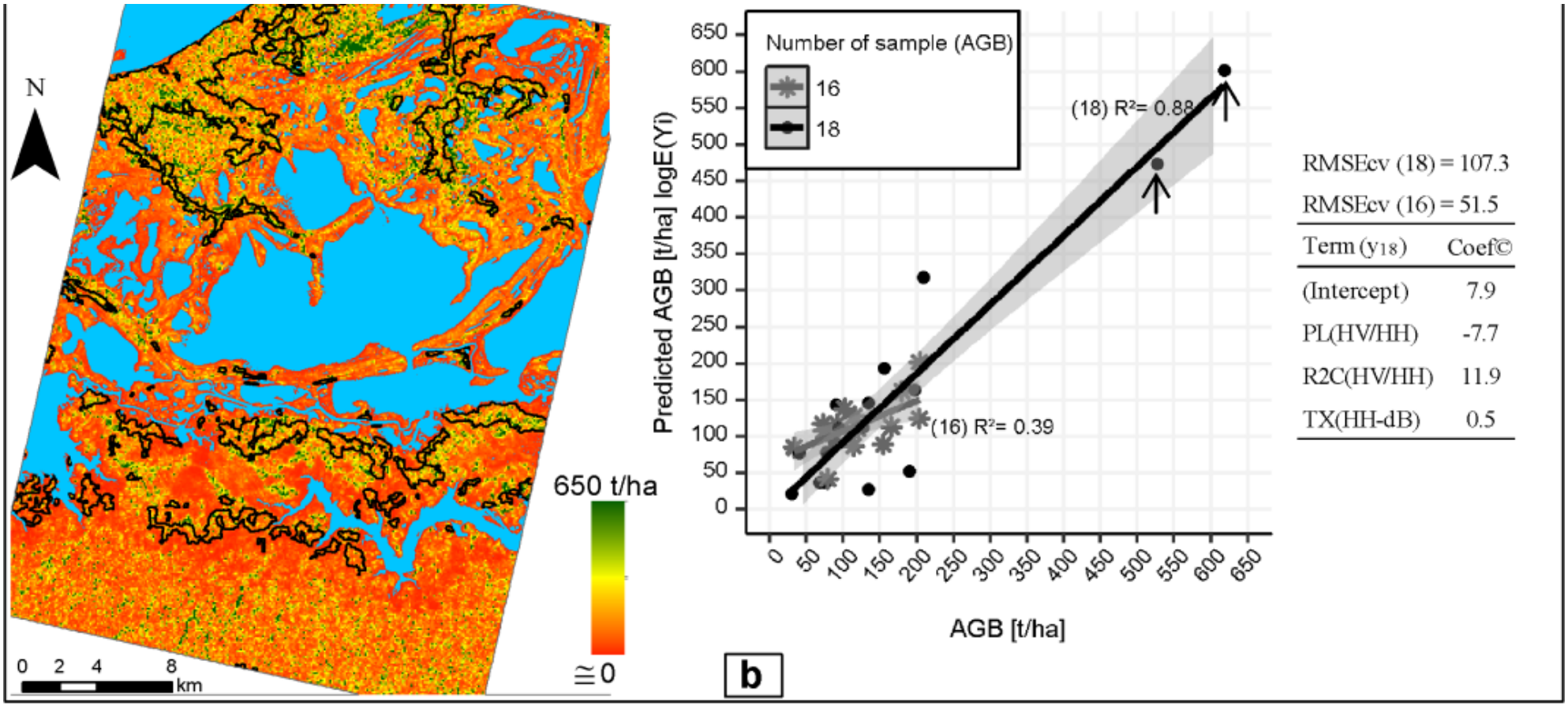
Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: b) PL-FB**D**+TX



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

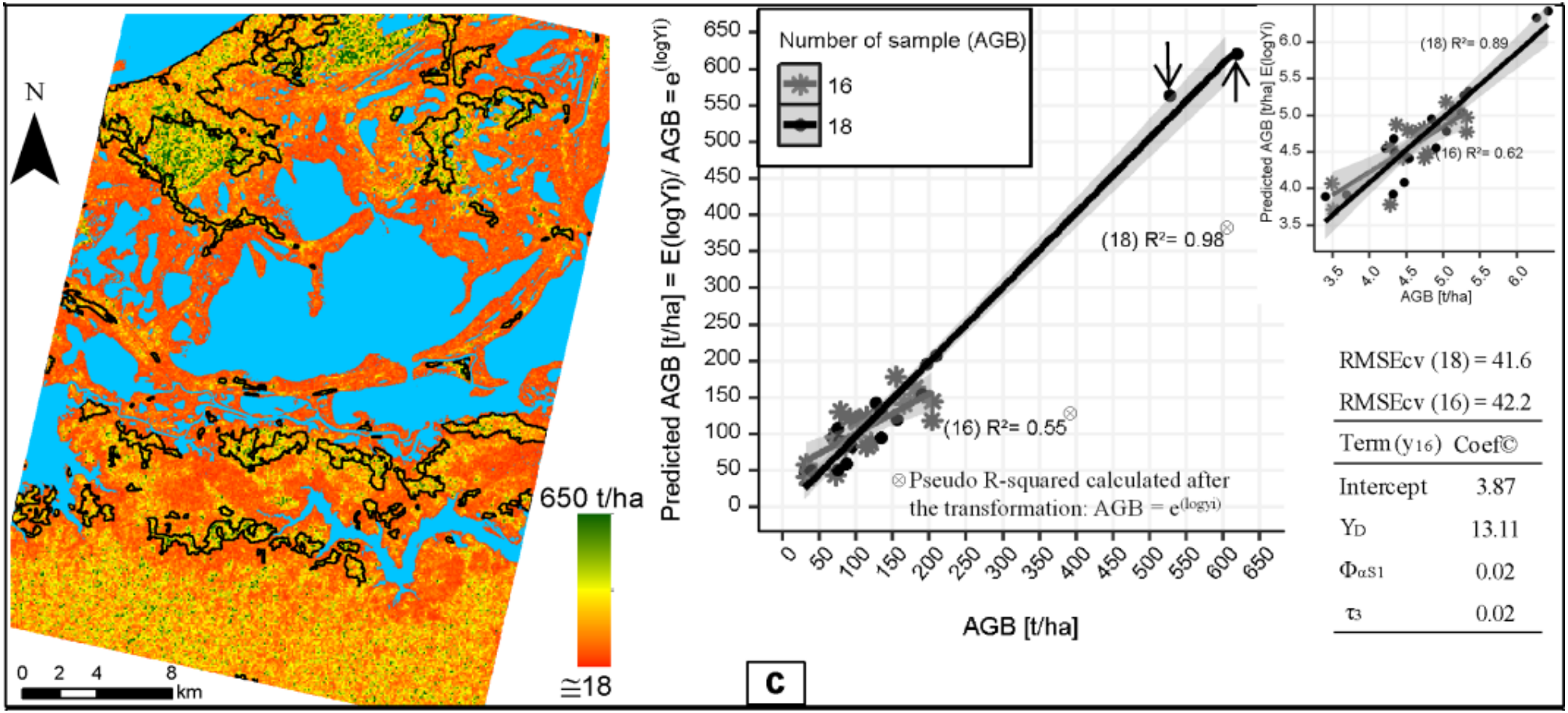


Graphic OBS vs. PRED and LAI map results from the application of model selected from the datasets: a) PL-FB**D**+ R**S**2



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

Floodable Forest
Water ((month:Oct.) ∩ (month: Mar.-May.))
Water (month: Mar.-May.)
Confidencie interval (95%)



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

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Carbon Monitoring

Mamirauá

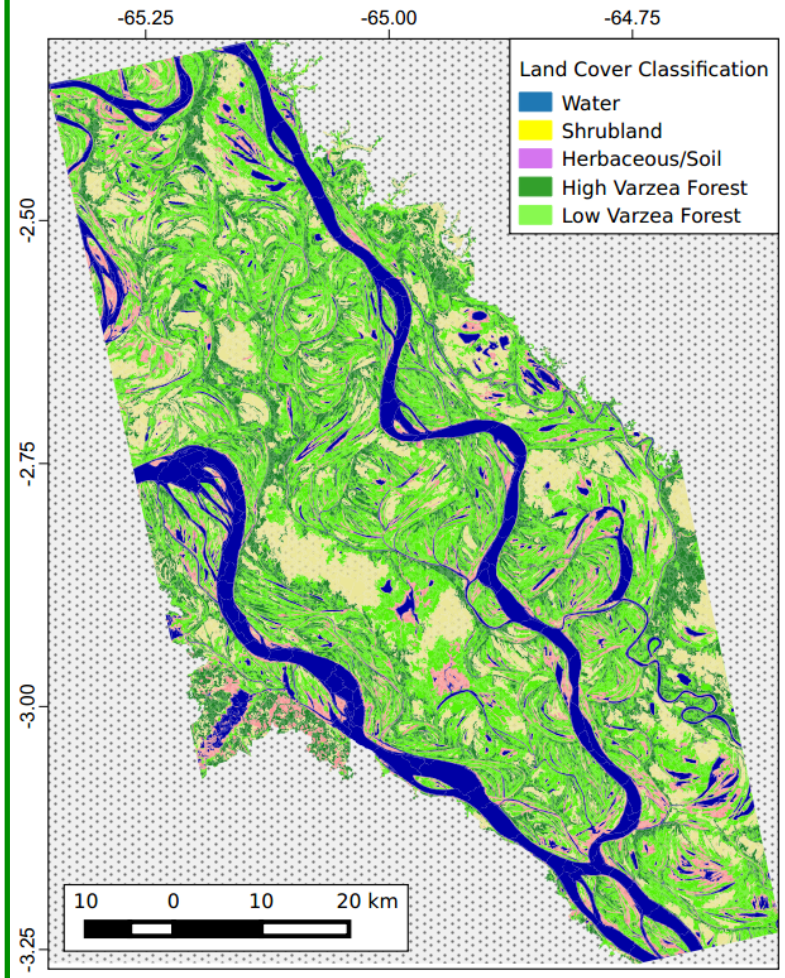
18 plots (50 x 50m)

Forest inventory

Tree rings

Literfall Monitoring

Flood monitoring



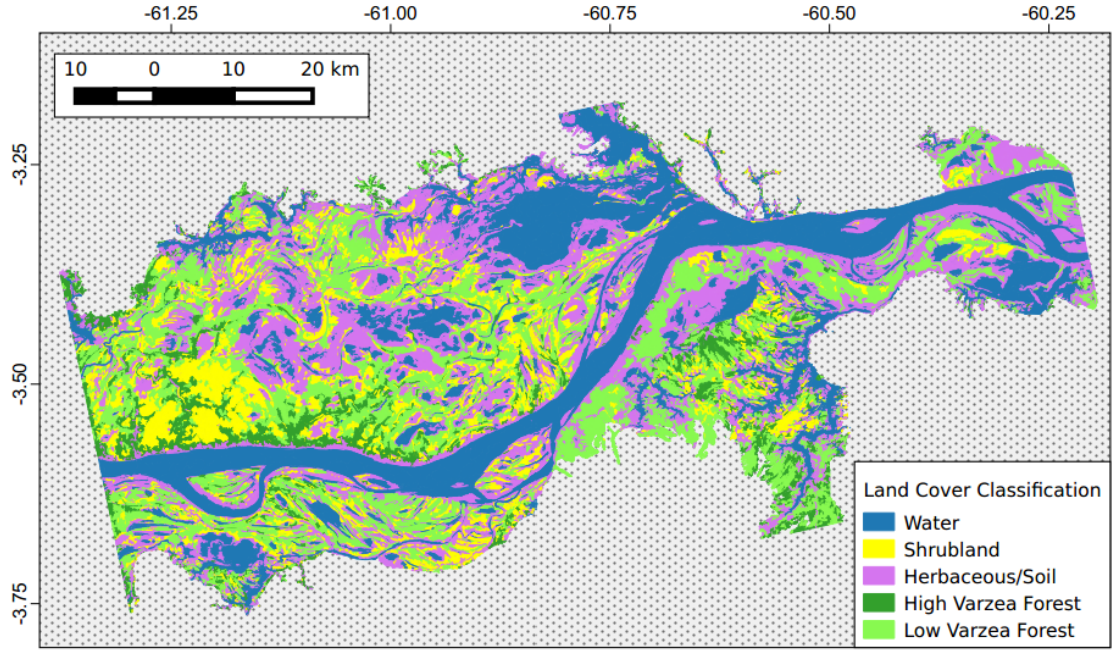
Janauacá

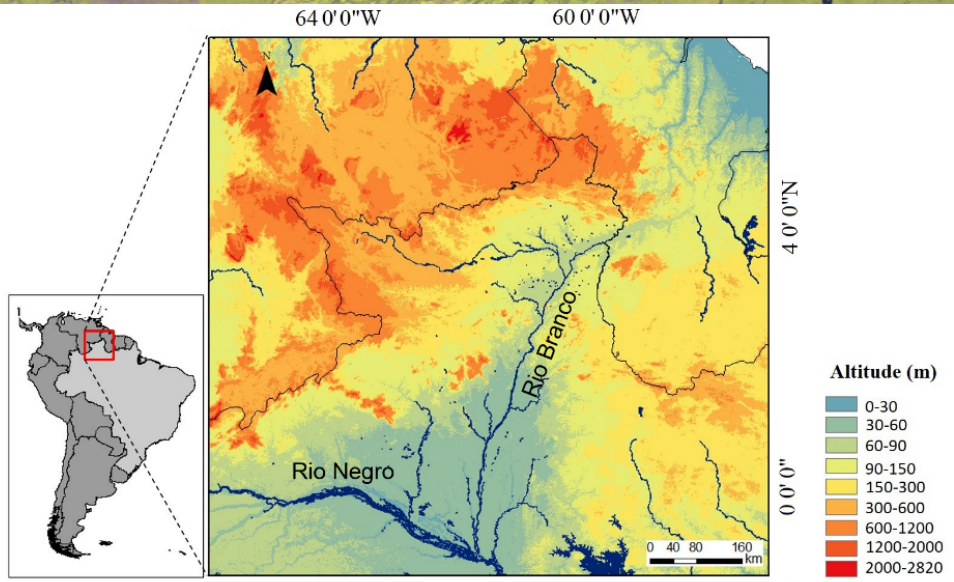
Herbaceous NPP

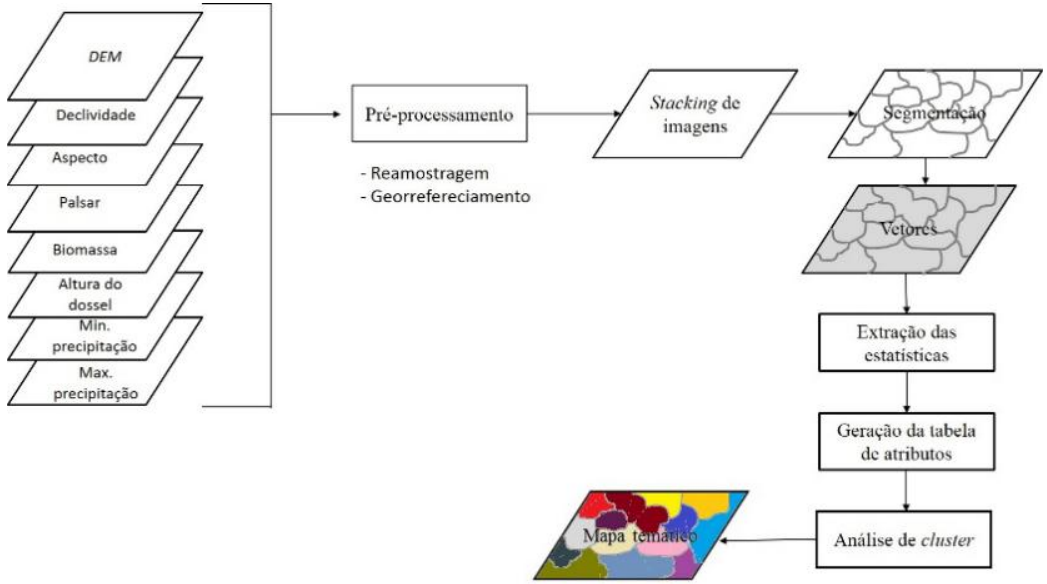
Gas exffluxes

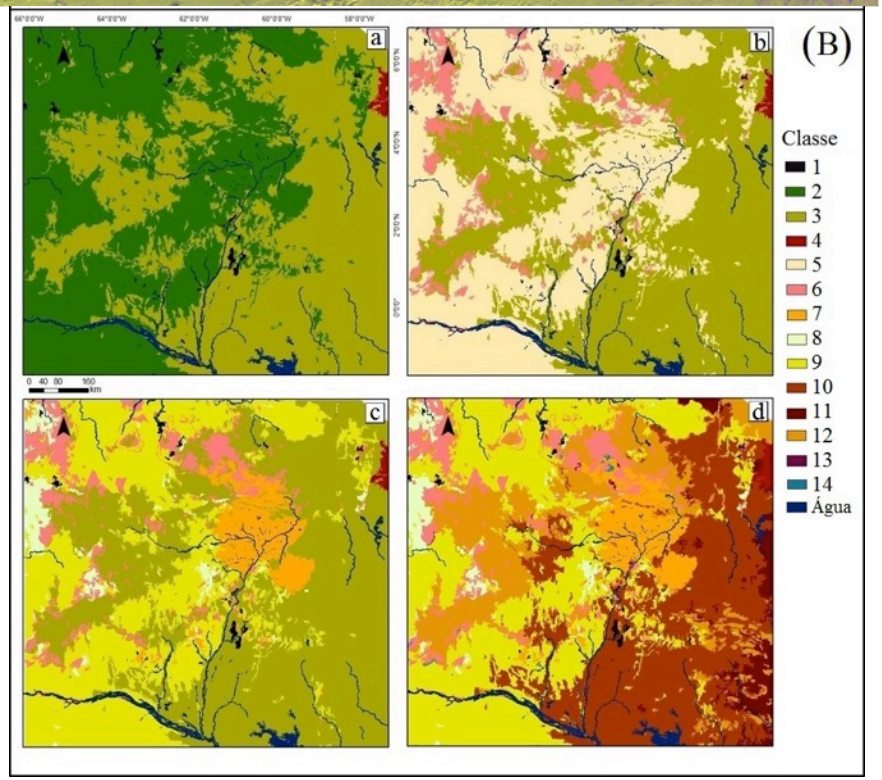
Literfall monitoring

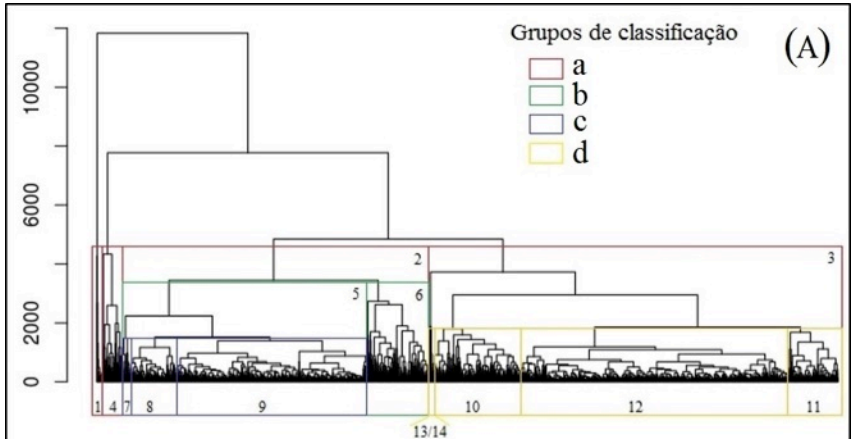
Decomposition ratesFlood monitoring




64 0' 0"W
60 0' 0"W
4 0' 0"N
0 0' 0"
Rio Branco
Rio Negro
0 40 80 160
km
Altitude (m)
0-30
30-60
60-90
90-150
150-300
300-600
600-1200
1200-2000
2000-2820


DEM
Declividade
Aspecto
Palsar
Biomassa
Altura do dossel
Min. precipitação
Max. precipitação
Pré-processamento
- Reamostragem
- Georrefereciamento
Stacking de imagens
Segmentação
Vetores
Extração das estatísticas
Geração da tabela de atributos
Análise de cluster
Mapa temático


a
b
c
d
(B)
Classe
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Água


(A)
Grupos de classificação
a
b
c
d
10000
6000
2000
0
1
4
7
8
9
10
12
11
13/14

Synergistic Projects

Mamirauá Forest Carbon Balance - Nat Geo Explorer's grant

- PhD candidate: Jefferson Ferreira-Ferreira

Janaucá Lake Carbon Balance - CNPq/LBA and NASA/IDS

- NASA PI: Leandro Castello (Virginia Tech)

Basin-wide habitats/flood duration - USAID/NSF PEER

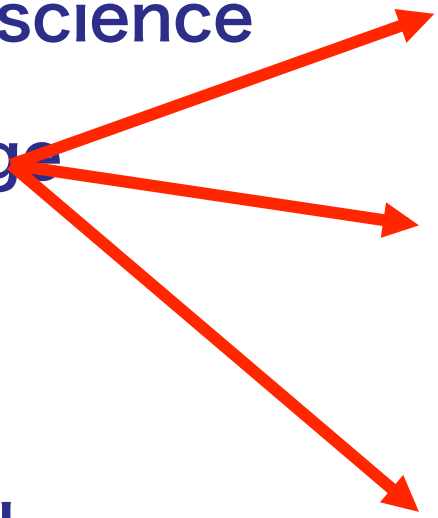
- PI: Camila Ribas (INPA) / /Joel Cracraft (AMNH)
- Threats to avian biodiversity in the Amazon basin

FAPESP/NSF BIOTA/Dimensions of Biodiversity

- PI: Lucia Lohmann (USP) / Joel Cracraft (AMNH)

Thematic support

- Carbon cycle science
- Climate Change
- International Conventions
- Environmental Conservation



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

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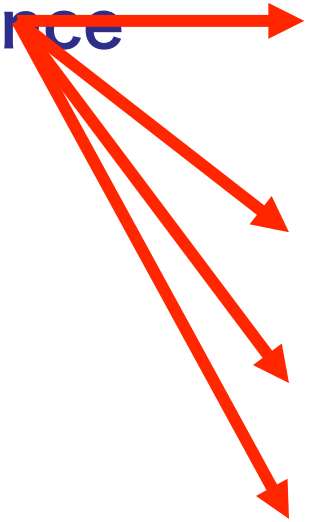

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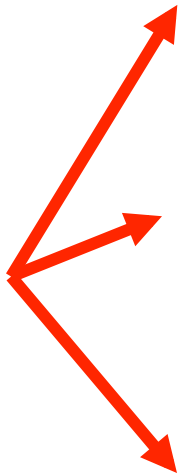

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Project milestones

- ✓ 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
- Derivation of an updated and improved habitat and flooding map for the central Amazon wetlands (Dec/2017)
- Validation of the basin wide map using high resolution imagery and available ground data (Early 2018).

Deliverables

Products:

- Updated wetlands and habitat map for the central Amazon basin
- Map of flood duration for the central Amazon basin

Methods:

- Integration of PALSAR-2 to the workflow
- Working, reproducible method for mapping habitats and flood duration
- Analysis of PALSAR-2 capabilities for vegetation structure

Scientific Articles

- Mapping method (Ferreira-Ferreira et al. 2015)
- Flood duration modeling (Ferreira-Ferreira et al. in prep - April 2017)
- Vegetation structure from SAR (Pereira et. al in prep - March 2017)
- Updated large scale maps (Late 2017)
- Scaling up of carbon balances - Janauacá (Mid 2017)
- Scaling up of carbon balances - Mamirauá (Mid 2018)

Thank you!

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JAXA

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

INPE

UCSB

NASA

LBA
Programa de Grande Escala Biosfera-Atmosfera na Amazônia
FASE 2

USAID
FROM THE AMERICAN PEOPLE

NSF

Partnerships for Enhanced Engagement in Research (PEER) Science

NATIONAL GEOGRAPHIC

Science Team meeting #23
Hatoyama, Japan, January 18-20, 2017