The use of ALOS imagery to investigate the carbon dynamics of the Amazon river system

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Original Objectives

We proposed to use a combination of field measurements and classified ALOS imagery to:

1)investigate the role of seasonal flooding in inter-fluvial and alluvial wetlands in the export and dynamics of DOC in the Amazon river system,

2)estimate the carbon balance along a 100k reach of the central Amazon floodplain and

3)use the latter results and regional ALOS mosaics to estimate the carbon balance of alluvial wetlands across the entire Amazon basin.

Expected contribution to RAMSAR

By providing consistent evidence of net carbon sequestration in alluvial wetlands we hope to contribute to the conservation of these environments, furthering the objectives of the international RAMSAR convention

Methodological limitations

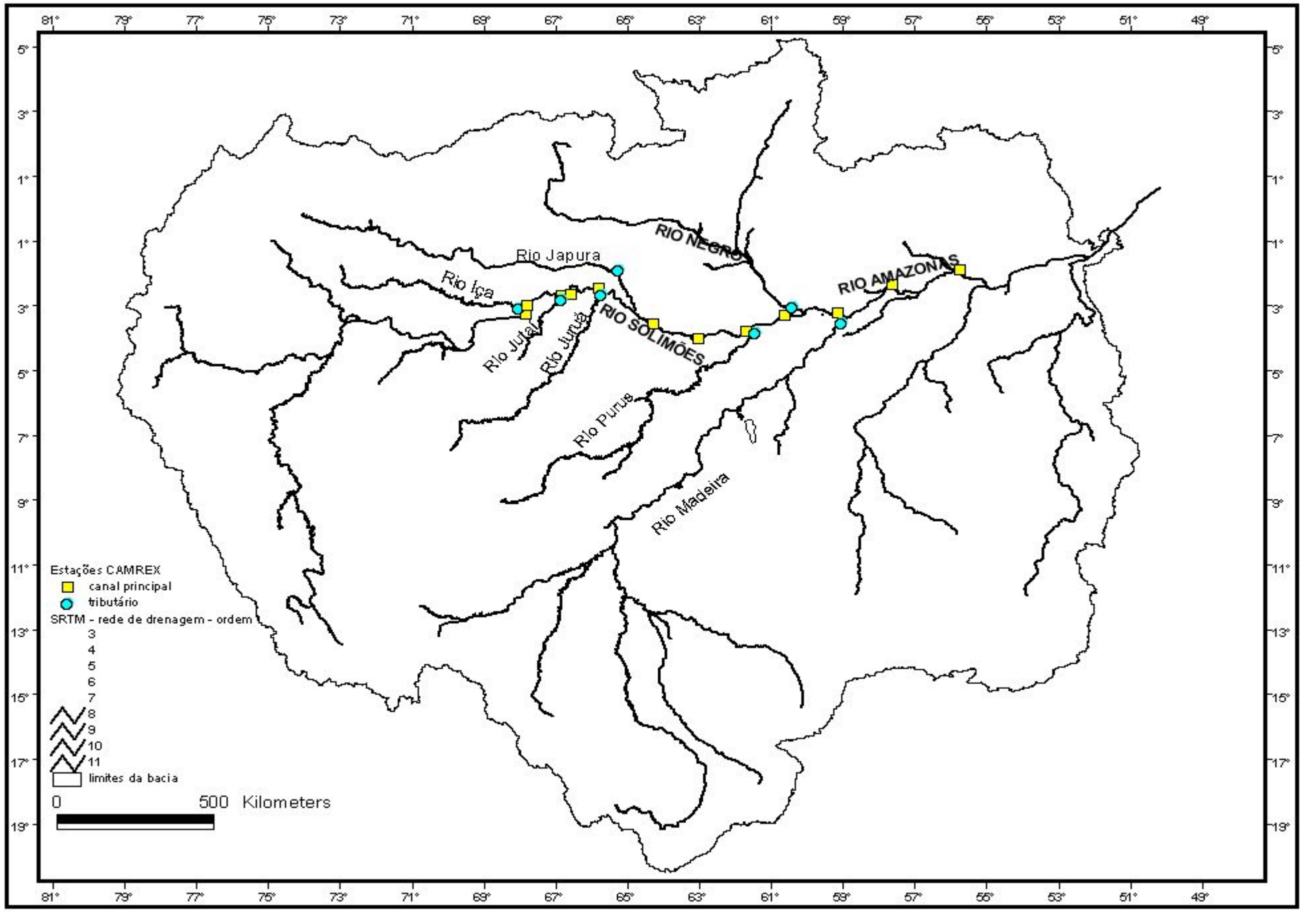
Many of the proposed objectives depended on the development and use of multi-temporal regional scale SCANSAR mosaics. The development of radiometrically consistent mosaics at this scale has proven difficult due to the technical challenges posed by the large range and acquisition angles characteristic of the SCANSAR product. One of the first consistent large scale products developed to date is the multi-temporal maximum flooding mosaic for SA recently produced by Bruce Chapman's (PI) K&C project. The regional scale results presented here were derived largely from the use of this and other L-band products (JERS-1 – GFRM mosaics).

The role of wetland inundation in the export of dissolved organic carbon (DOC) in the Amazon river system

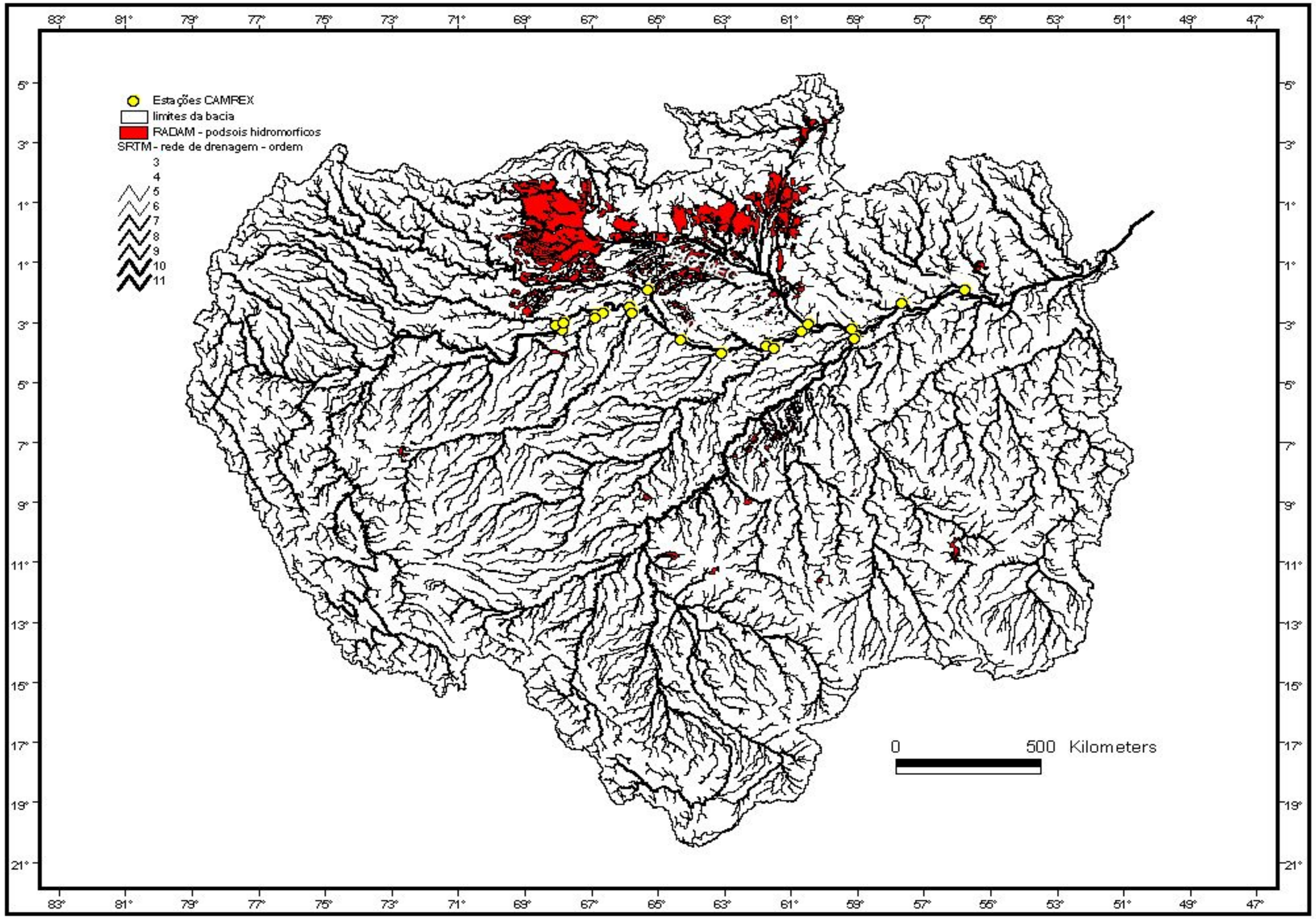
- The dissolved orgânic carbon in rivers is derived primarily from hydromorphic environments where anoxic conditions prevent the complete degradation of orgânic matter

- In the Amazon basin DOC is thought to be derived predominantly from:
  - Hydromorphic podsols and
  - Aluvial and interfluvial wetlands

To test the latter hypothesis we investigated the effect of the maximum % of inundated wetlands (% IW) and the % of hydromorphic podsols (% HP) in the upstream drainage basin on the average DOC concentrations encountered at 18 points along the Amazon main channel and its principal Brazilian tributaries.

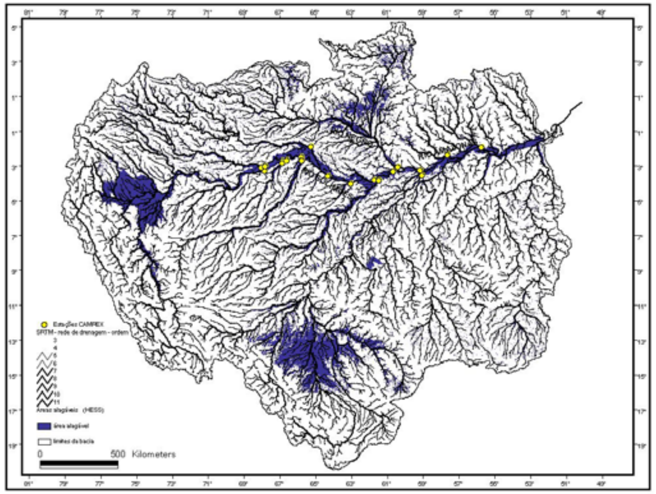


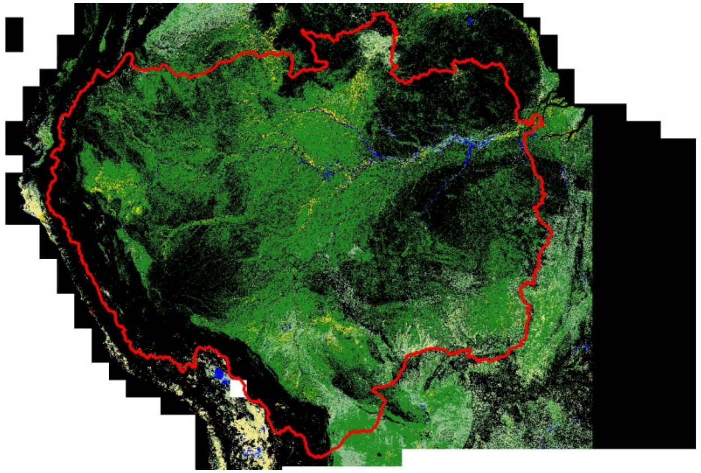
Points along the Amazon main channel (yellow squares) and it major Brazilian tributaries (blue points) where average DOC concentrations were determined. Data derived from 13 cruises of the CAMREX Project, 1982-91.



The distribution of hydromorphic podsols in the Amazon Basin, in red. Data from Project RADAM Brasil (1972)

Maximum extent of wetland inundation derived independently from JERS-1 and ALOS SCANSAR





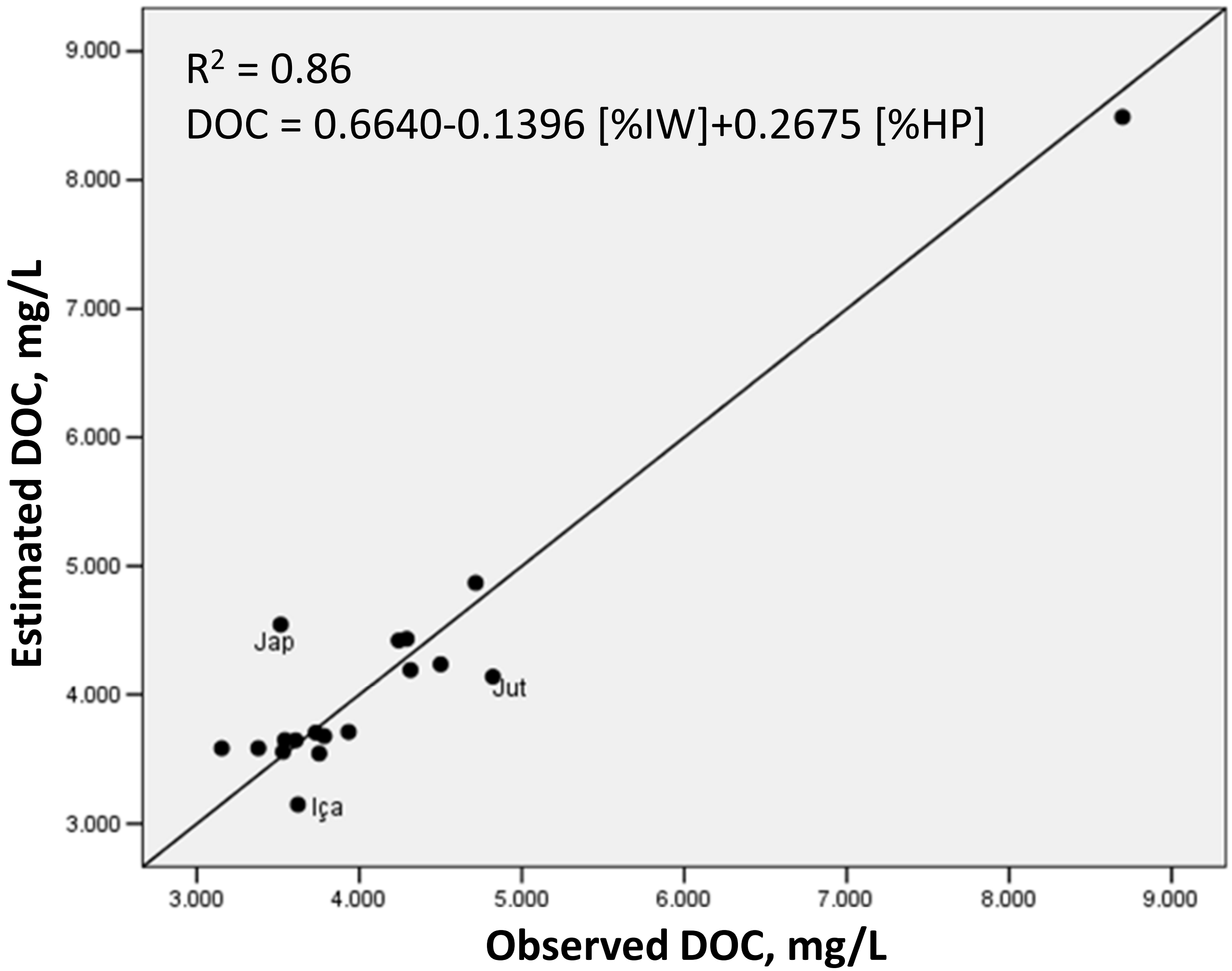
Estimated by Hess et al (2002), based on the analysis of the JERS-1 high water mosaic, potentially flooded area shown in blue.

Estimated by Chapman et al (un-published), based on the analysis of the multitemporal SCANSAR imagery (wetland classes shown shown here were agregated for the analysis.

Multiple linear regression model

$$DOC = B_0 + B_1 [\% \, IW] + B_2 [\%HP]$$

both JERS-1 and ALOS data were used to estimate % IW



Influence of max % inundated wetland (%IW) and % hydromorphic podsol (%HP) in upstream drainage basins on the average concentration of DOC in the Amazon main channel and its principal Brazilian tributaries. Regression equation and plot of predicted vs observed DOC.

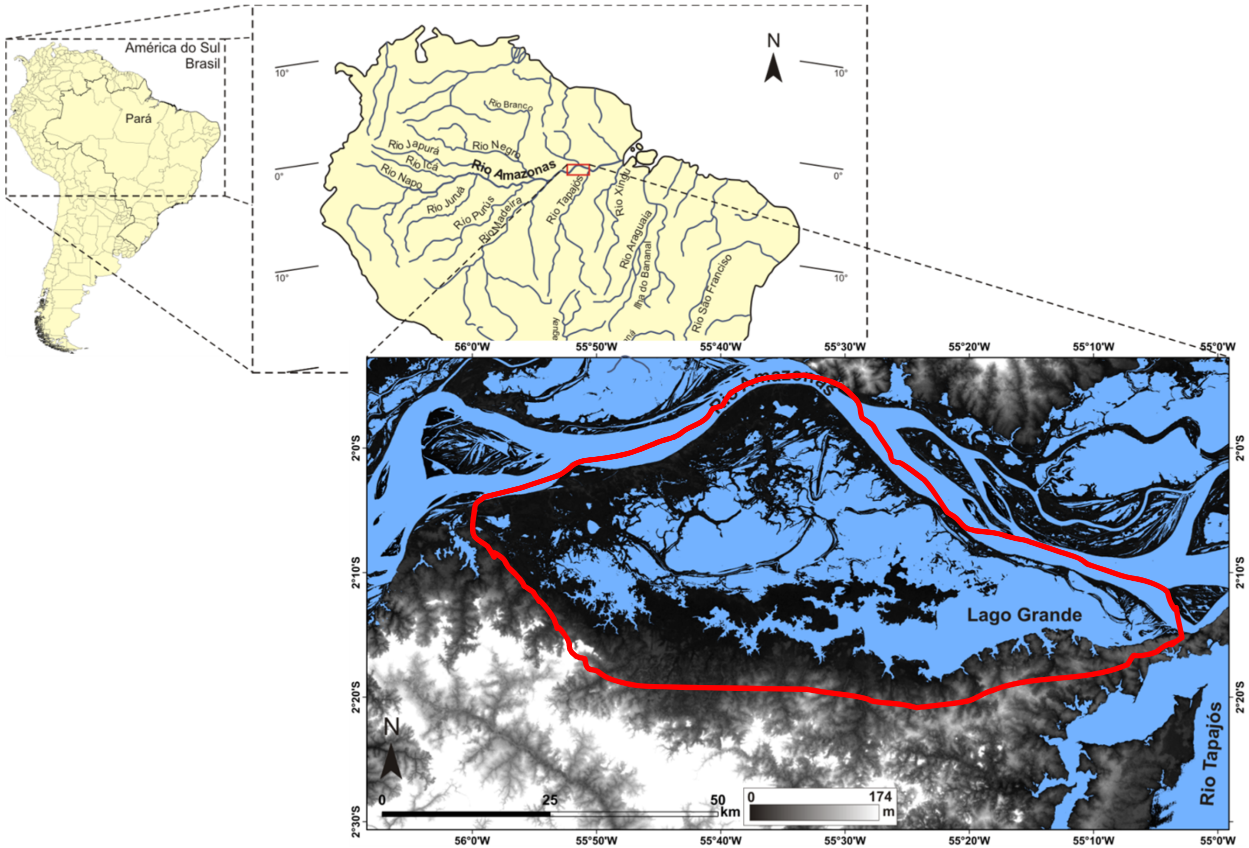
- Observation: the influence of wetland inundation on DOC was only significant using the Hess et al (2002) wetland mask, derived from JERS-1

- Conclusion: The SCANSAR mosaics and inundation classification are still not as reliable as the JERS-1 products for delineating potentially flooded wetlands at the regional scale.

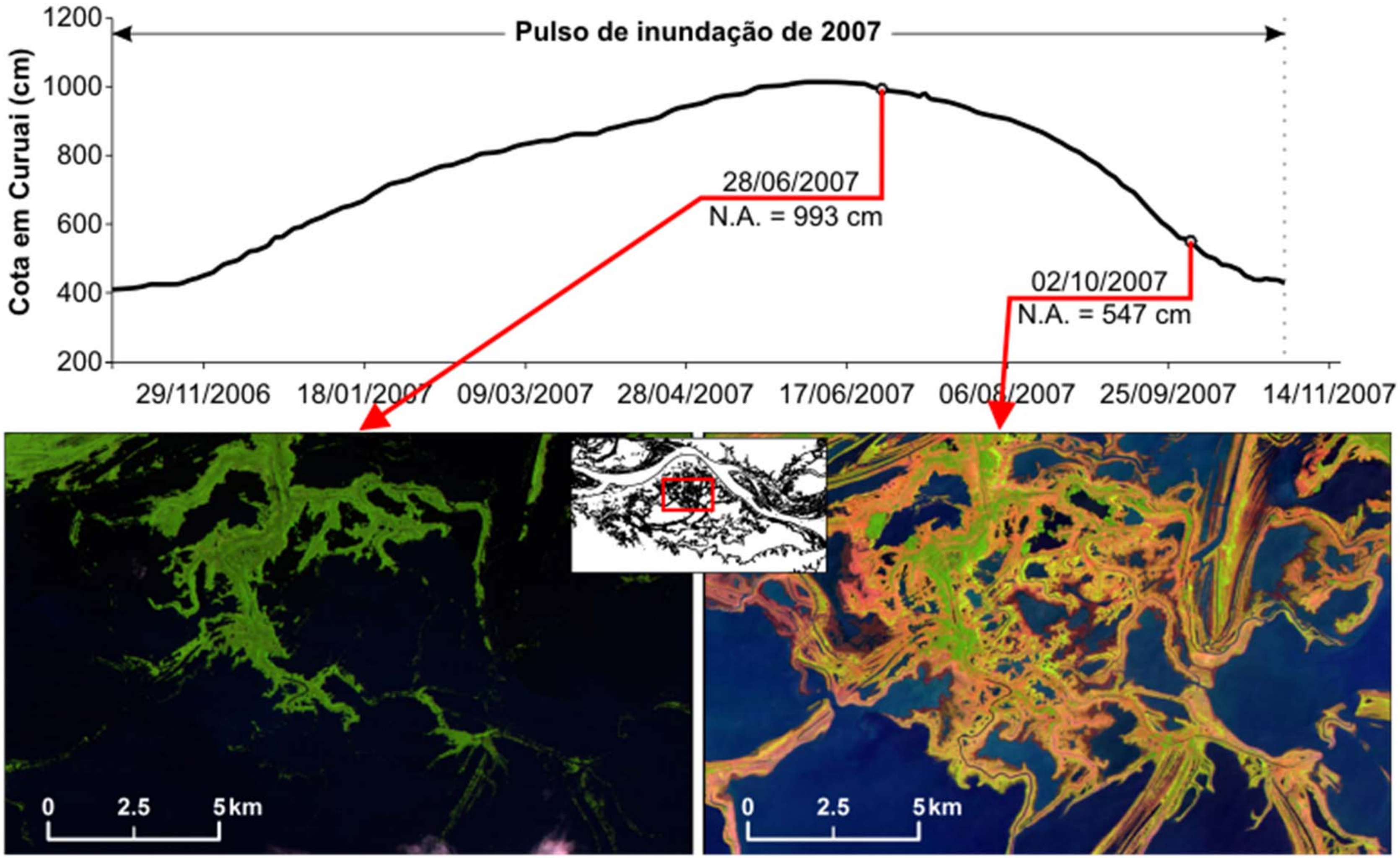
Flood Mapping in the Curuai Lake region

Arnesen AS, Silva TSF, Hess LL, Novo EMLM, Rudorff CM, Chapman BD, McDonald KC (2013). **Monitoring flood extent in the lower Amazon River floodplain using ALOS/PALSAR ScanSAR images**. *Rem. Sens. of Env.*, **130**, 51–61.

- Large lake complex in the Eastern portion of the Amazon floodplain
- More impacted by human activities and deforestation than central and western areas



- Unlike the central and western portions of the floodplain, the eastern portion has extensive non-forested areas, which respond differently to inundation.

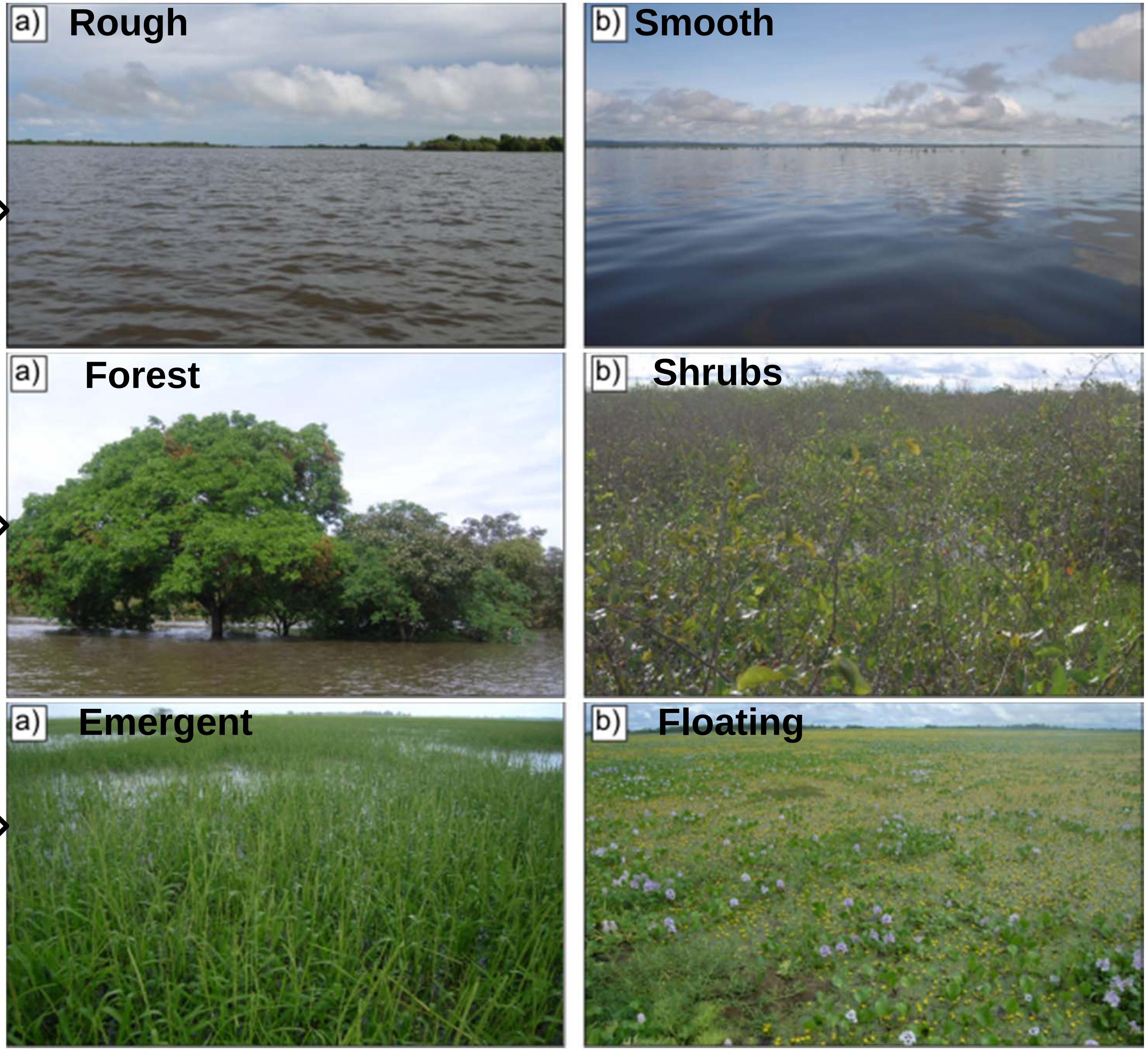


- Land cover types identified:

Open Water (OW)

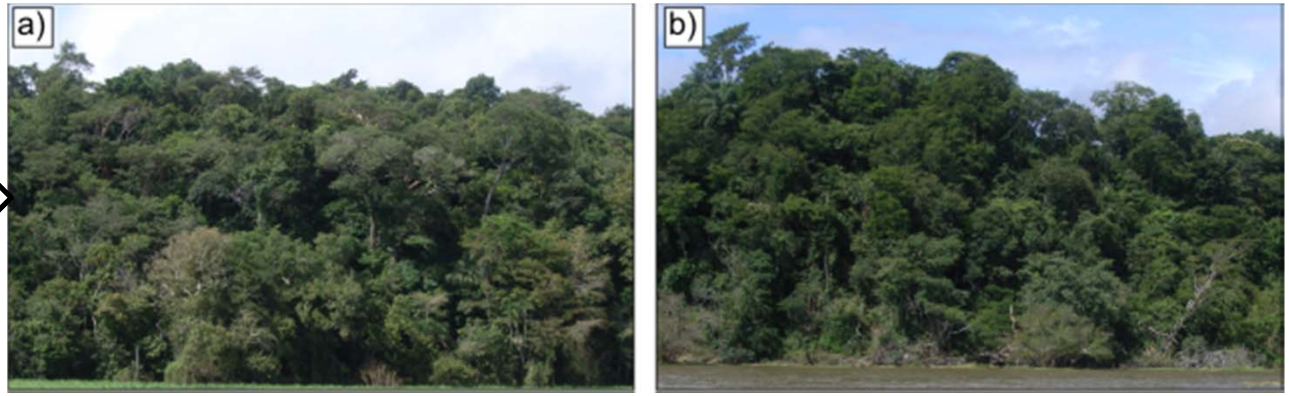
Flooded forests and shrubs (FF)

Herbaceous vegetation (macrophytes)

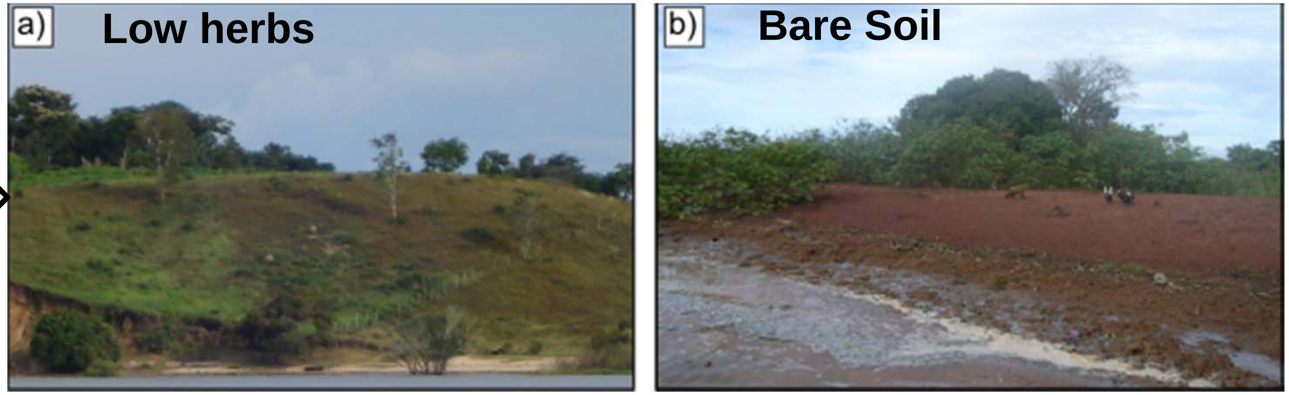


- Land Cover types identified:

Non-flooded
forest
(NFF)

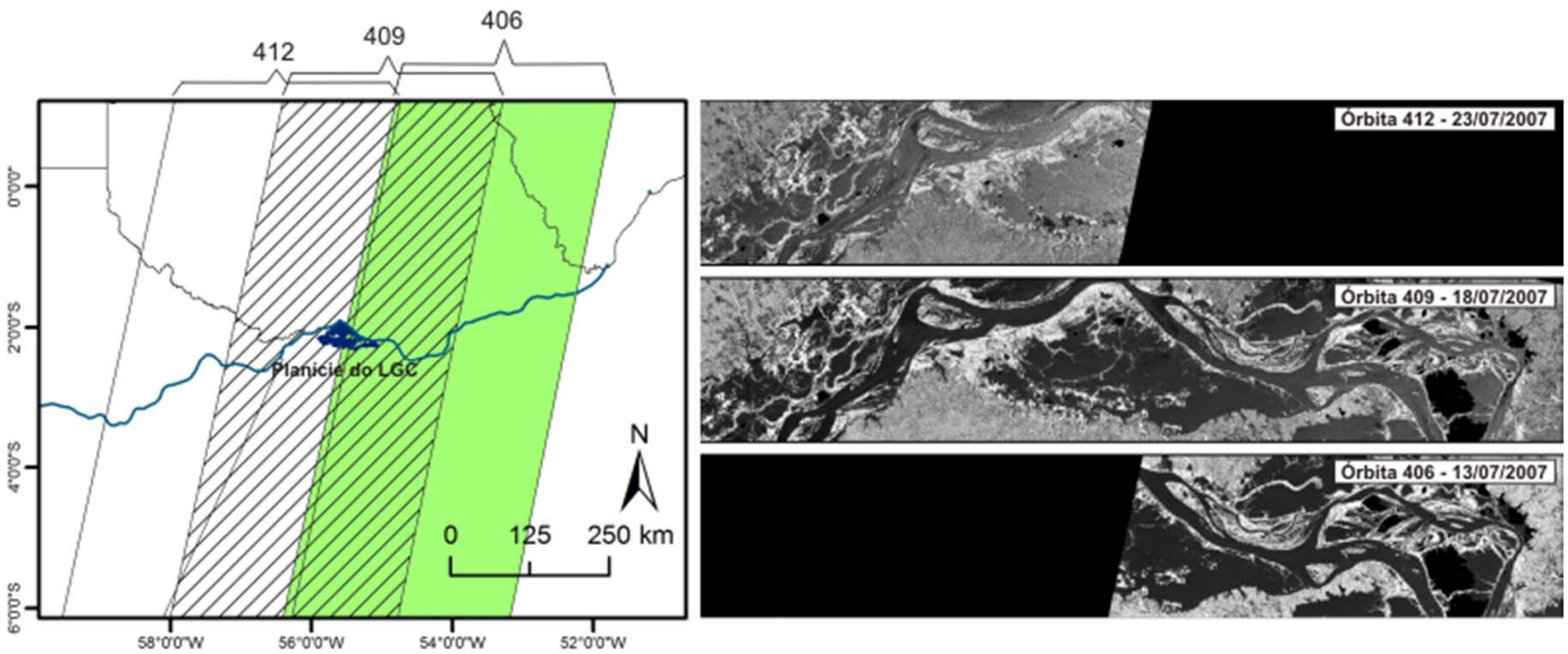


Bare soil / low
herbs
(S)



- Data:

- ScanSAR orbit 409, 12 images
- MODIS Terra/Aqua – surface reflectance, 12 images
- Landsat 5/7 – Path 227, 228



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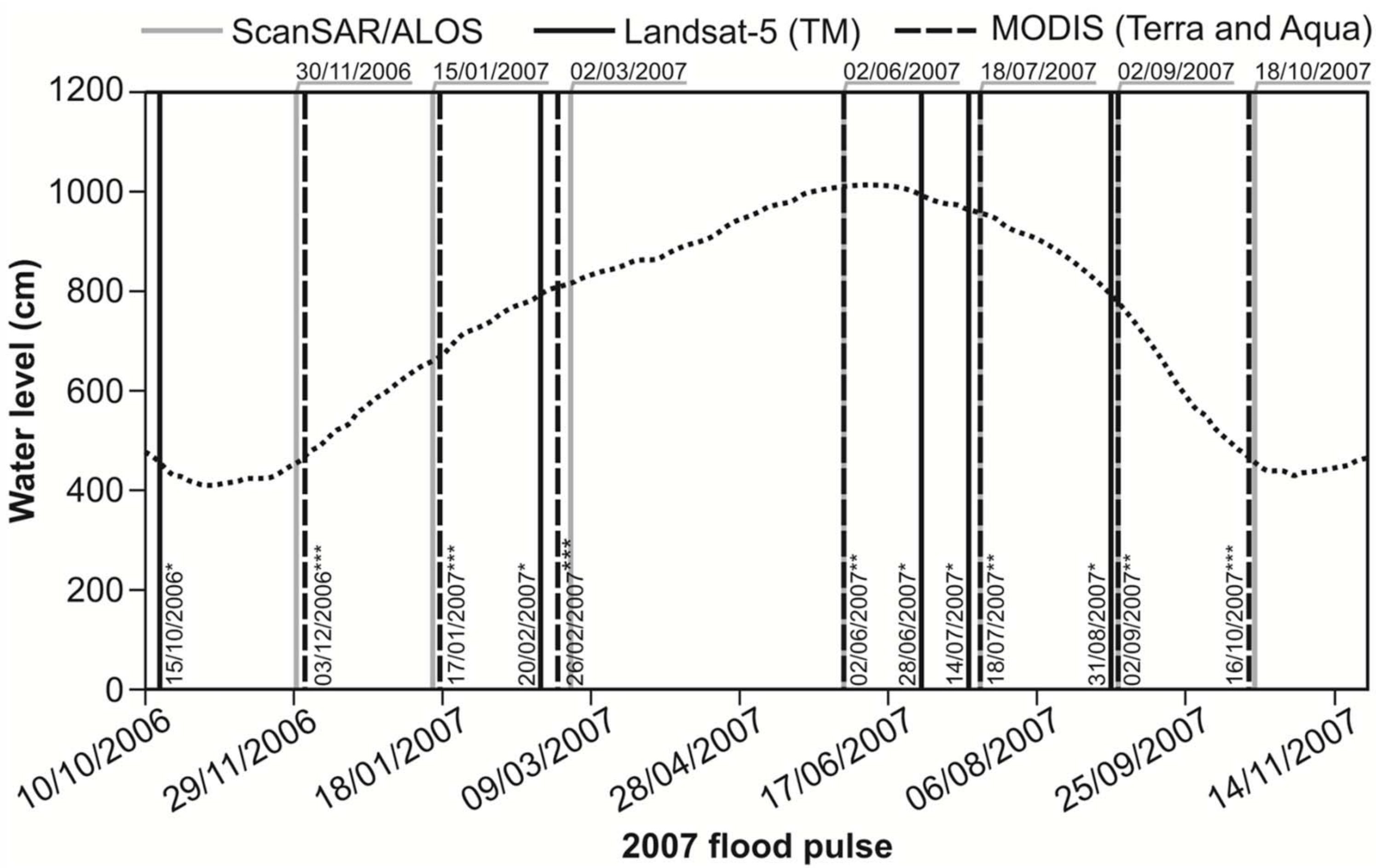
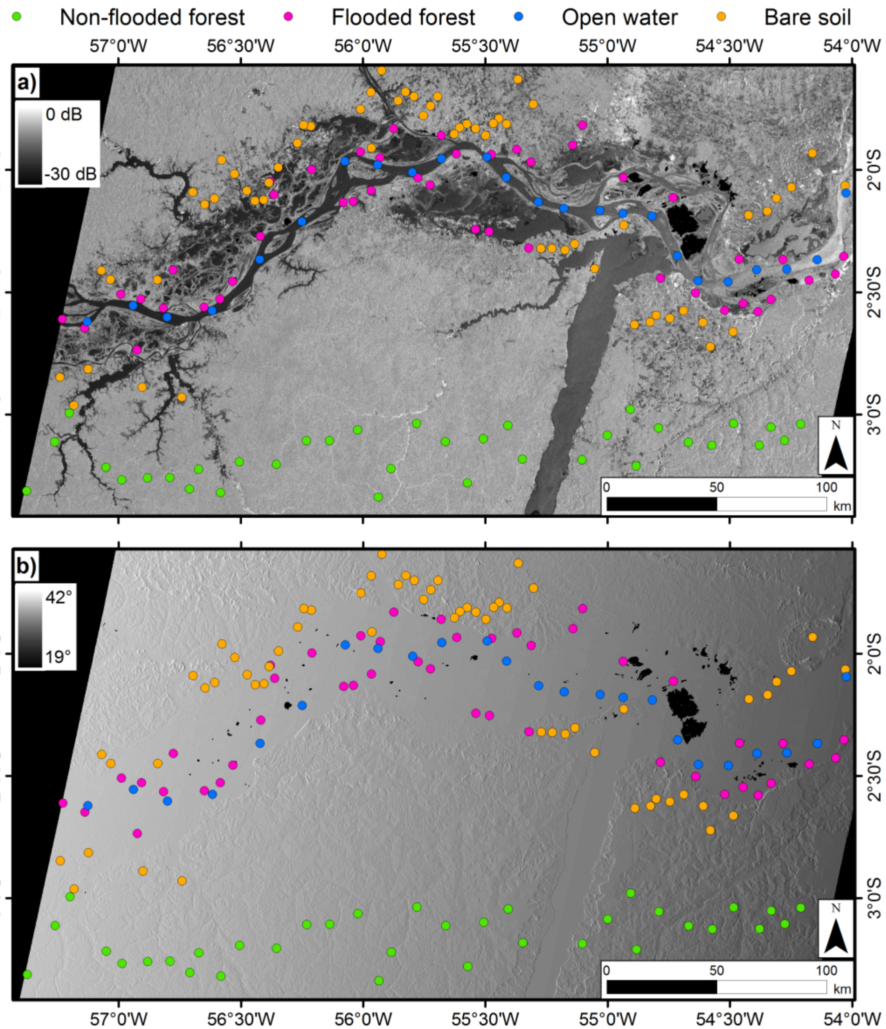
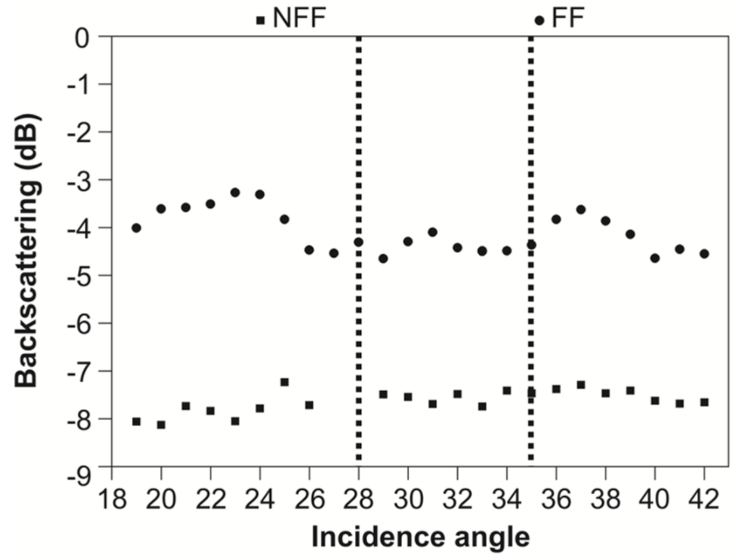
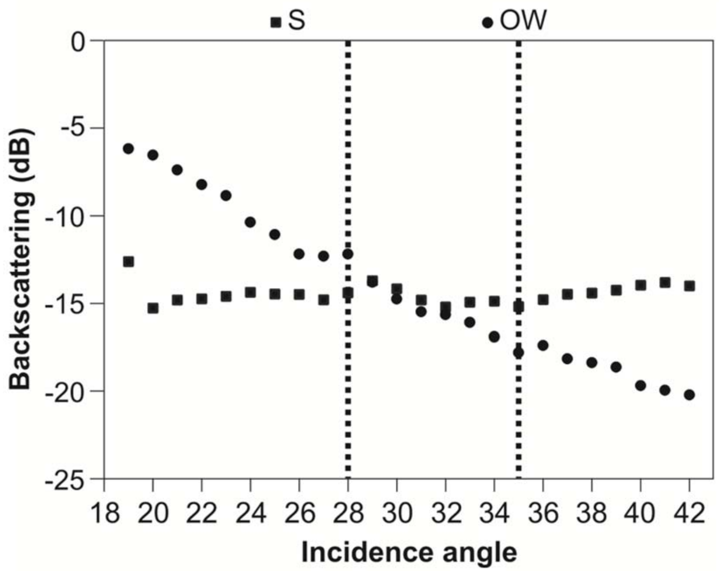


- Incidence angle analysis

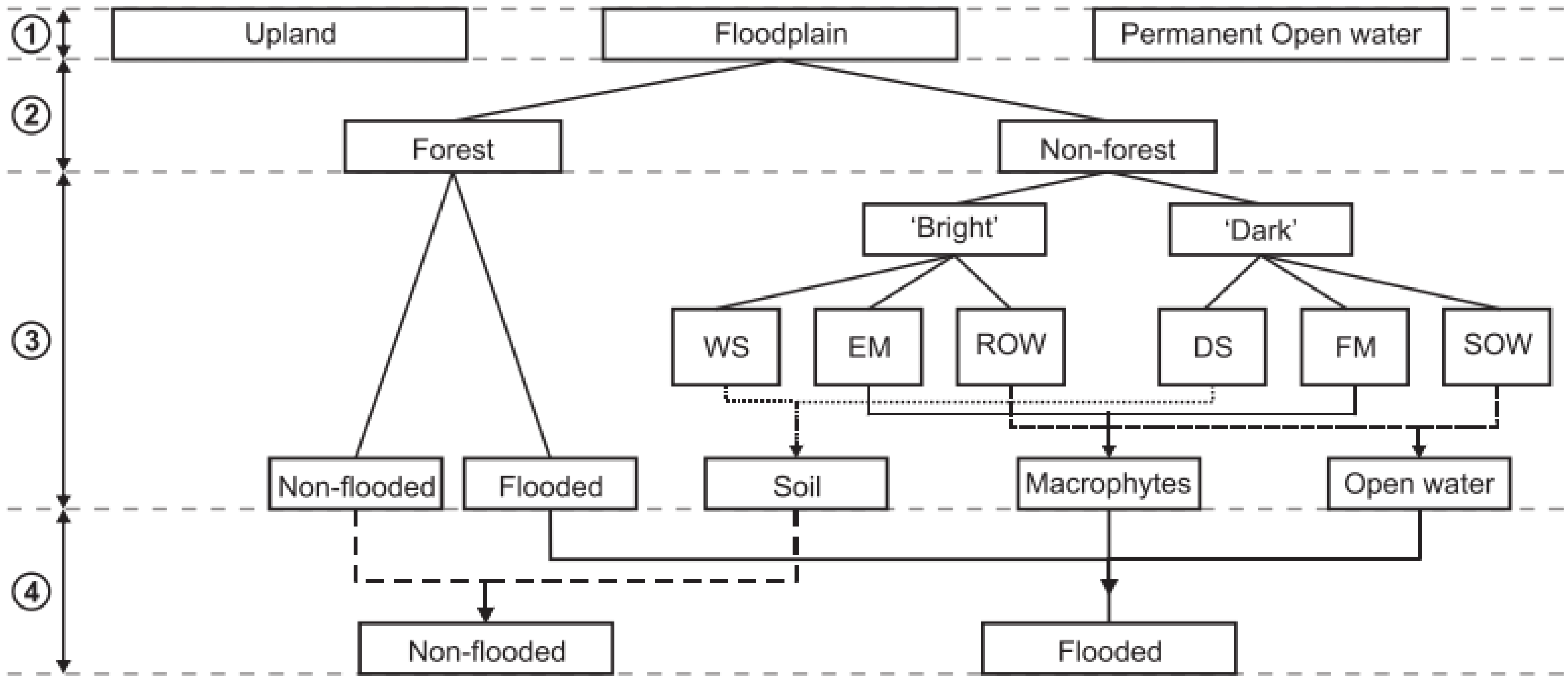






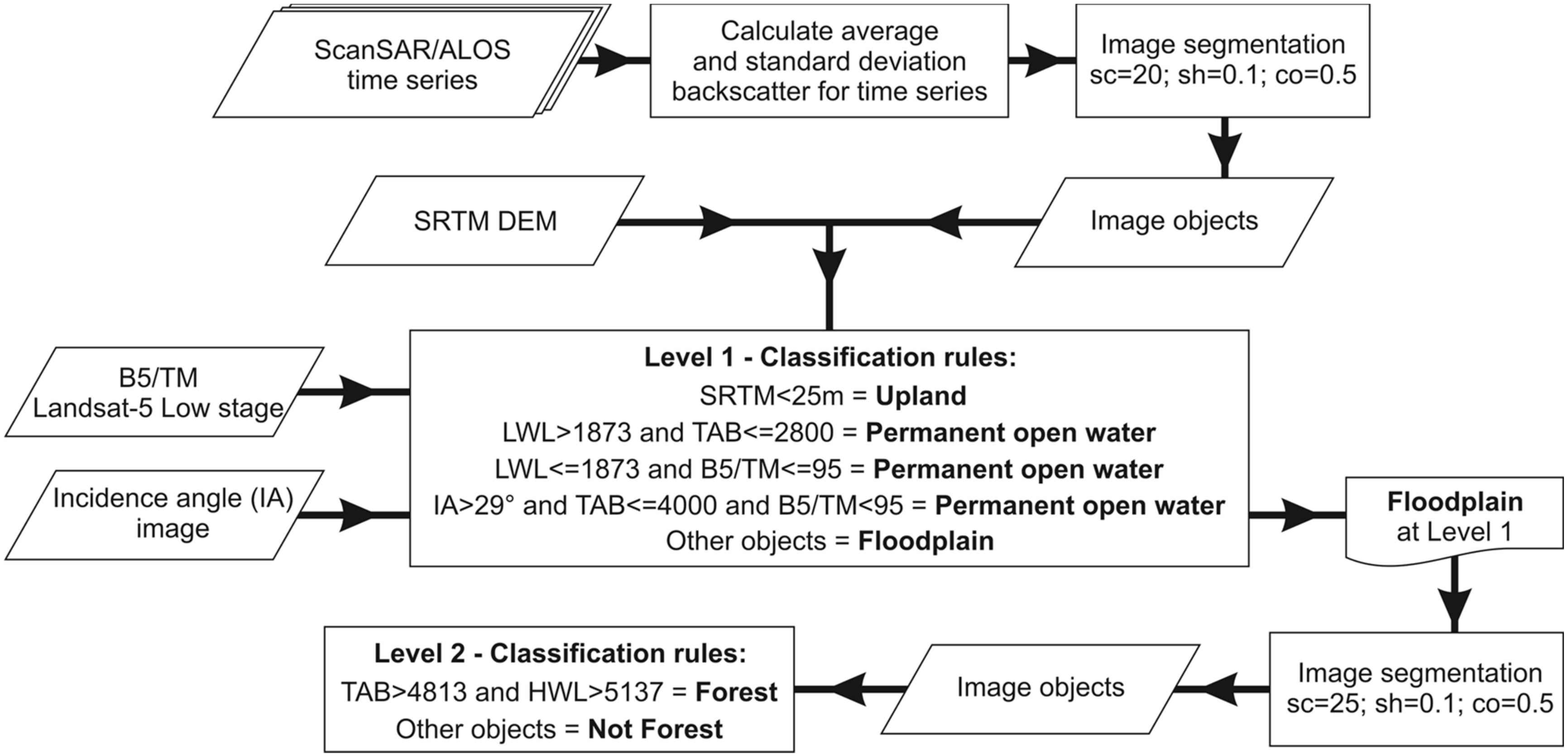
- # Object-Oriented Image Classification

- Hierarchical approach based on Silva et al. RSE 114:1998-2010 (2010)



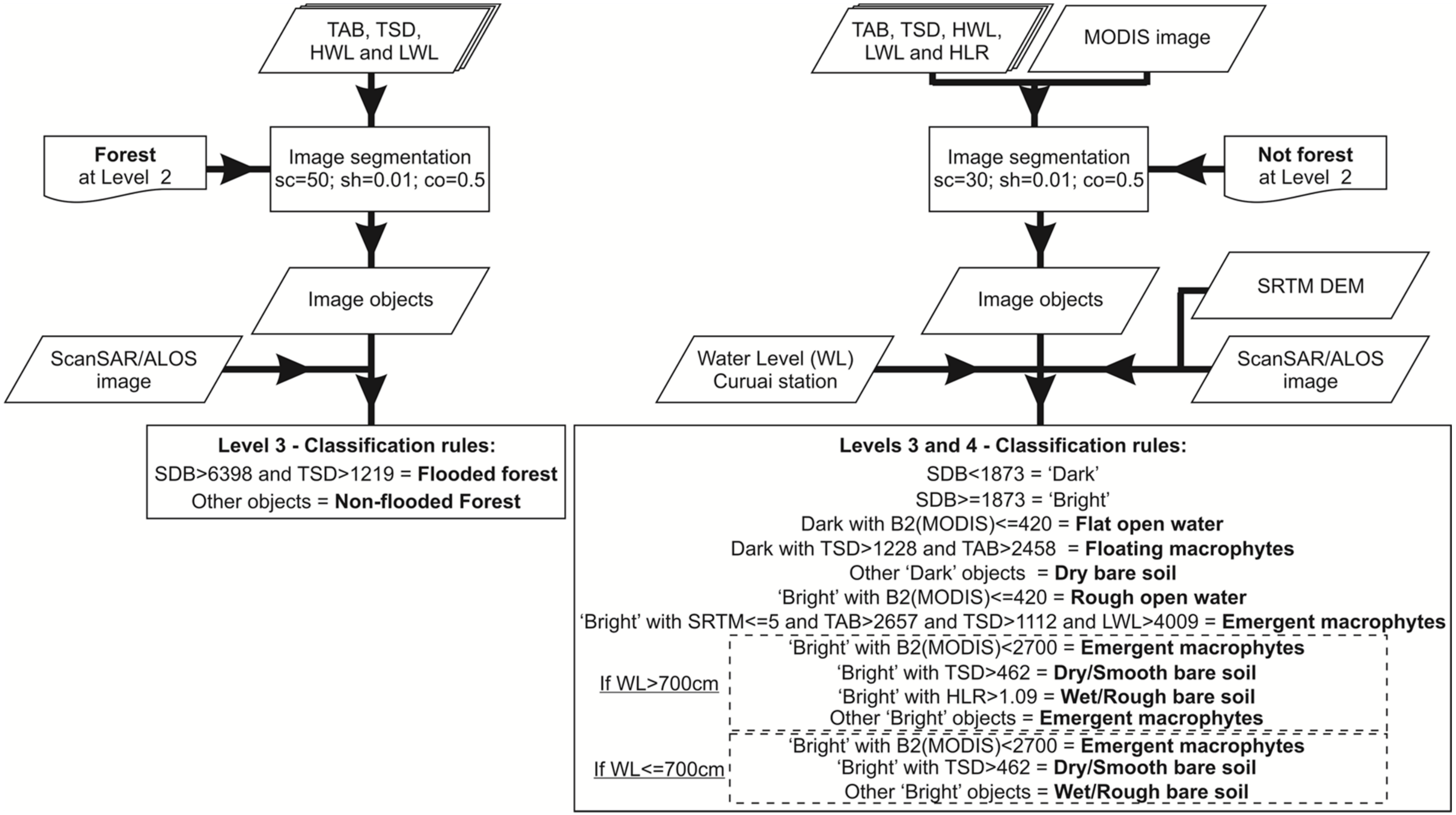
WS = wet soil, EM = emergent macrophytes, ROW = rough open water, DS = dark soil, FM = floating macrophytes, SOW = smooth open water

- Object-Oriented Image Classification



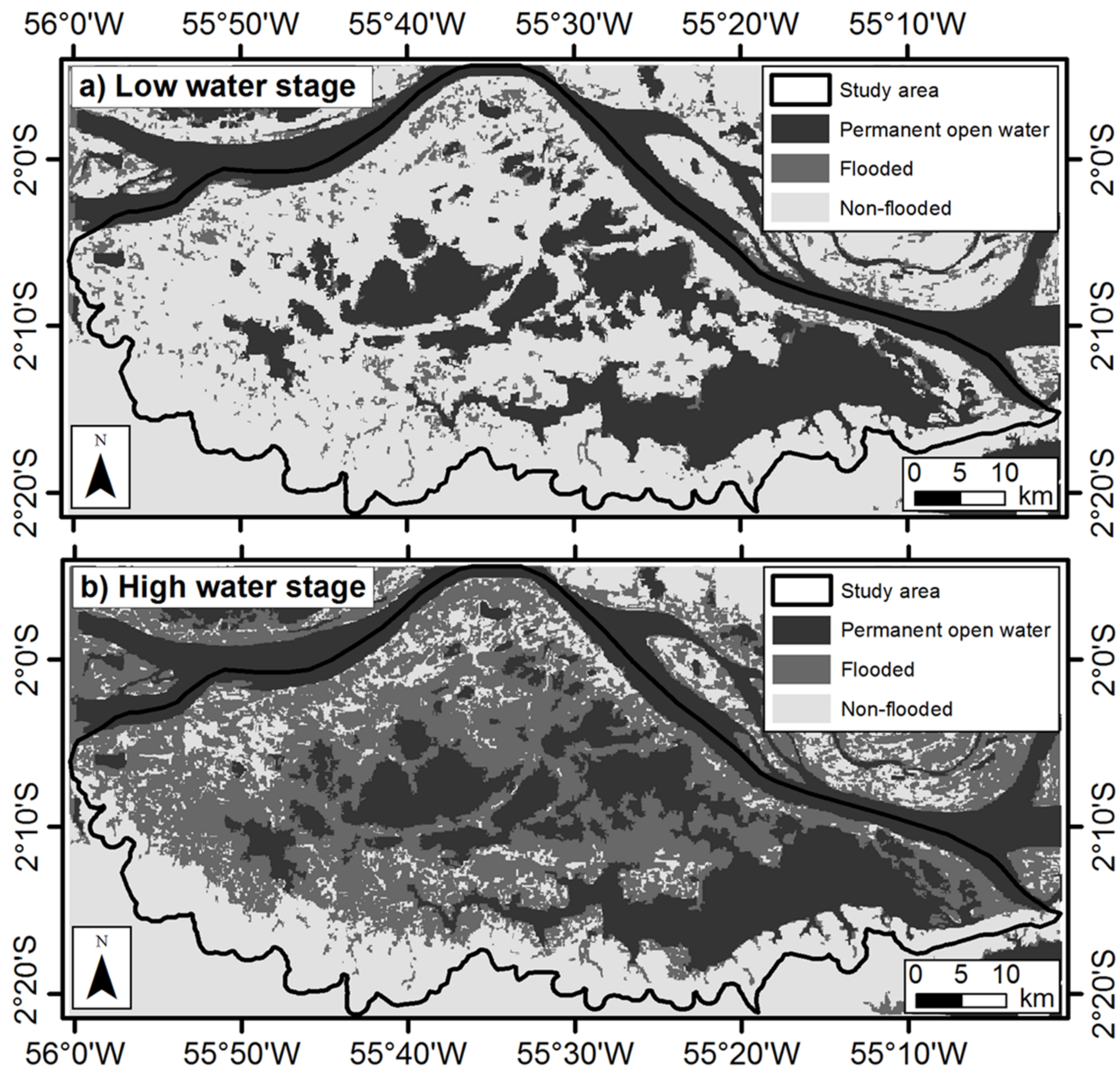
TAB = Temporal Average Backscattering, LWL = lowest water level bakcscattering

- Object-Oriented Image Classification



TAB = Temporal Average Backscattering, TSD = Temporal Standard Deviation of backscaterring
LWL = lowest water level bakcscattering, HWL = highest water level backscattering

- Results



Mapping accuracy:

L1: 91% (κ = 0.86)

L2: 83% (κ = 0.77)

L3 (LW): 76% (κ = 0.67)

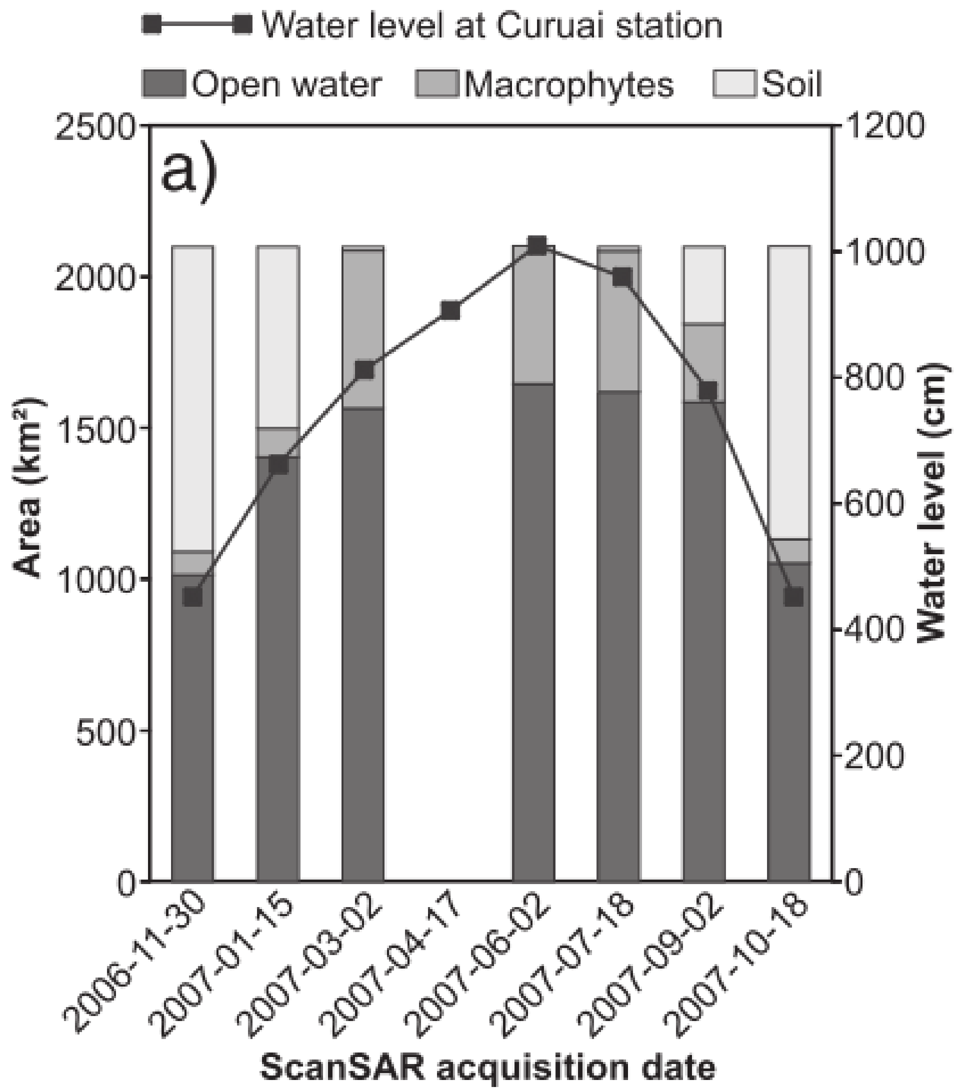
L3 (HW): 78% (κ = 0.65)

L4 (inund.): 84% – 94%

- Results

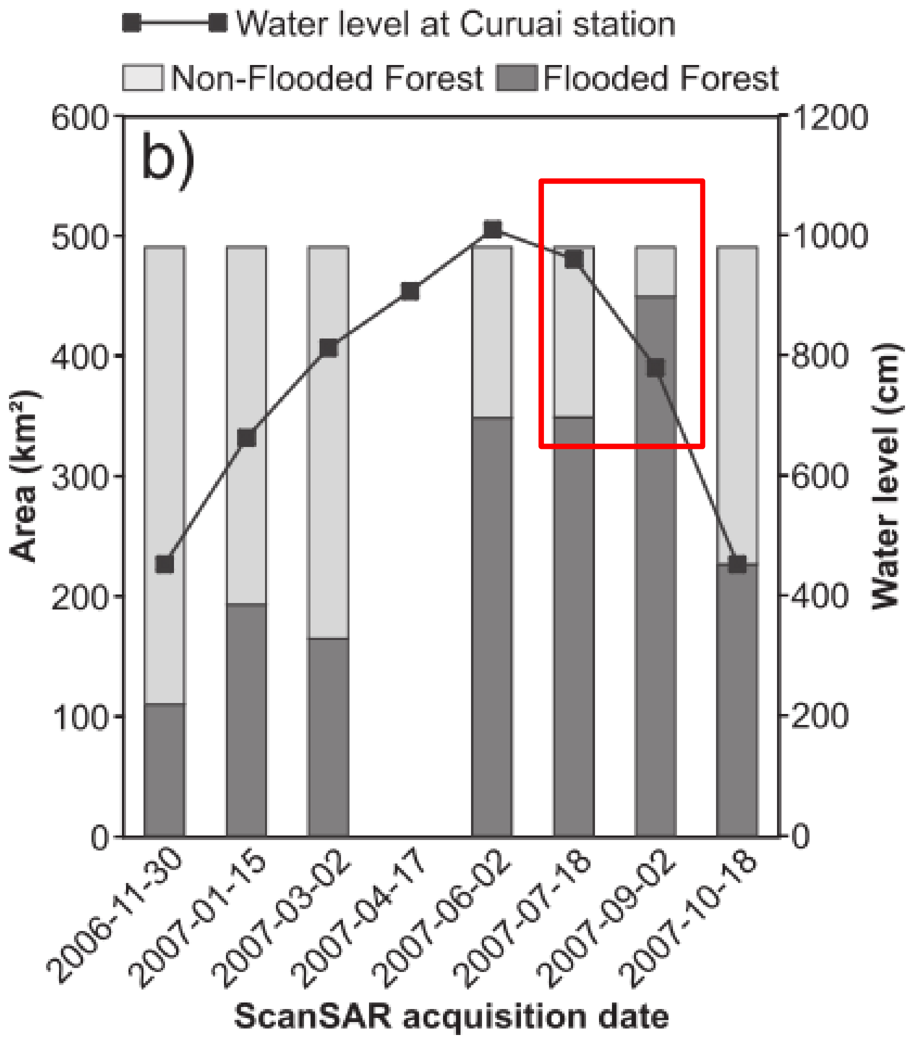
- Low sensitivity to sparse/short herbaceous vegetation misclassified large areas of early growth as soil or water, during the low water season

- Inverse pattern from expected (more macrophytes during high water)

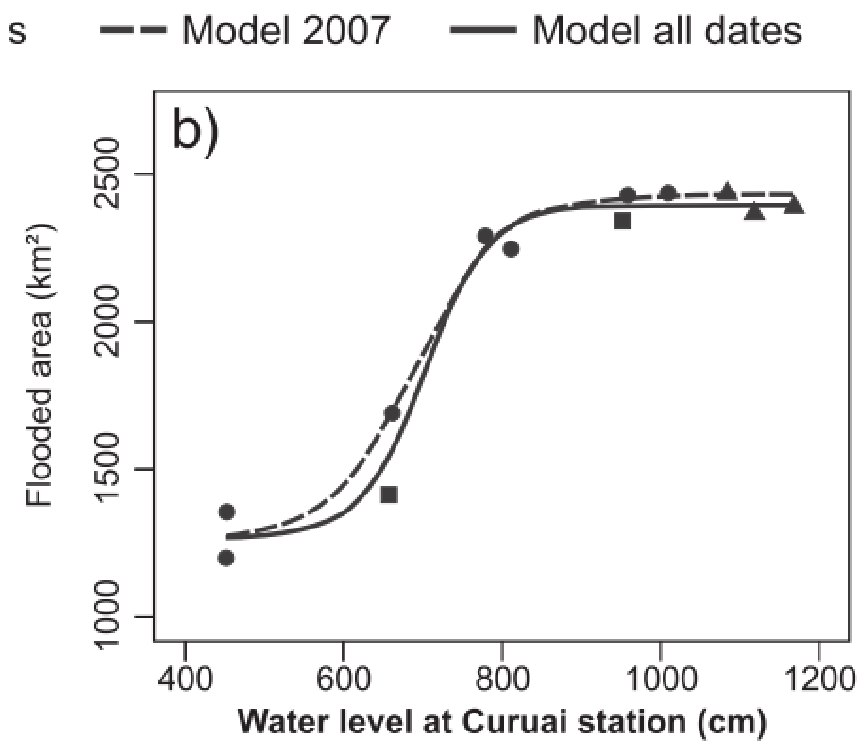


- Results

- Some disconnection between flooded forest area and water level:
  - hydraulic resistance in the forest?
  - local differences between the observed areas and the gauge (~100km)?
  - Classification error?



- The relationship between inundated area and water level for Curuai lake follows a logistic curve
- > 90% agreement with inundated area predicted using LISFLOOD (Conrado Rudorff, unpublished data)



- Conclusions

- Incidence angle variations negligible for the studied area, but considerable for smooth targets across the swath

- The hierarchical approach recognized the variable responses to flooding (brighter for densely vegetated areas, darker for sparse herbaceous vegetation), which are not well handled by thresholding algorithms

- Correct separation of wet soil and open water areas, and confusion between rough water surfaces and vegetation remain a major challenge, requiring the inclusion of optical data, but could be overcome with dual-pol acquisitions.

- Next steps

- Method will be applied to other test areas along the floodplain
- Algorithm will be extended to include more detailed vegetation and habitat mapping (synergy between KC 1642 and ALOS RA4 1483 proposals)