2019 SWAT-SEA Conference & Workshops
October 21-26, Siem Reap, Cambodia

Land cover dynamics by agricultural activities over the Upper Paraná River Basin (UPRB)

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Outlines

1. Goal
2. Area of study and its importance
3. Historical land cover changes (that may have impacted UPRB hydrology)
4. Recent land cover changes (ongoing research activities)

1. Goal

The main goal of this study is present an overview of the land cover dynamics caused by agricultural activities over the region identified as the Upper Paraná River Basin and present updated map in high resolution (30 m) based on Landsat images.

2. Area of study

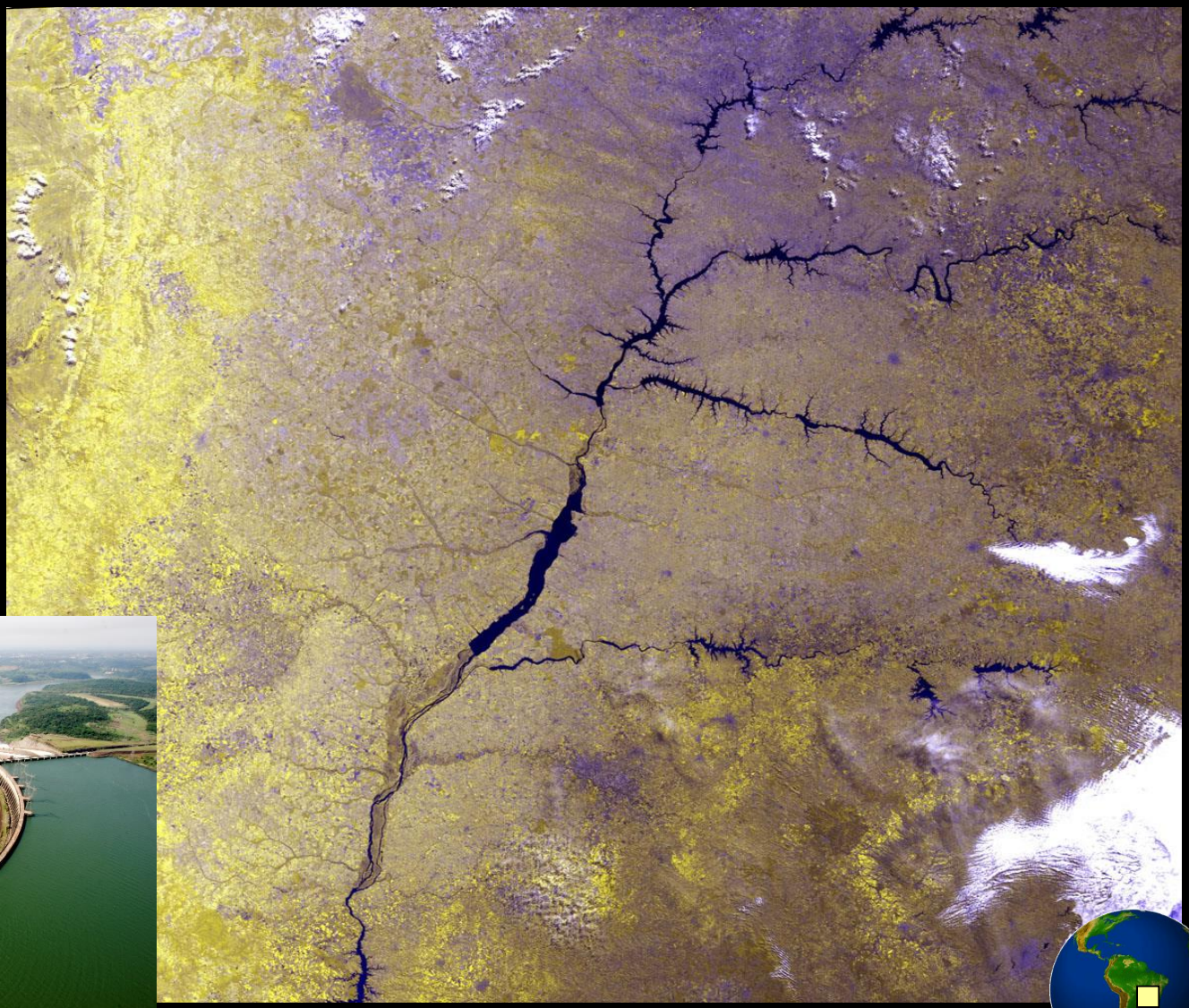
La Plata Basin and the Upper Paraná River Basin

La Plata
Average streamflow: 28,000 m^3/s;
Area: 3,000,000 km^2

UPRB
Average streamflow: 14,000 m^3/s
Area: 879.860 km^2

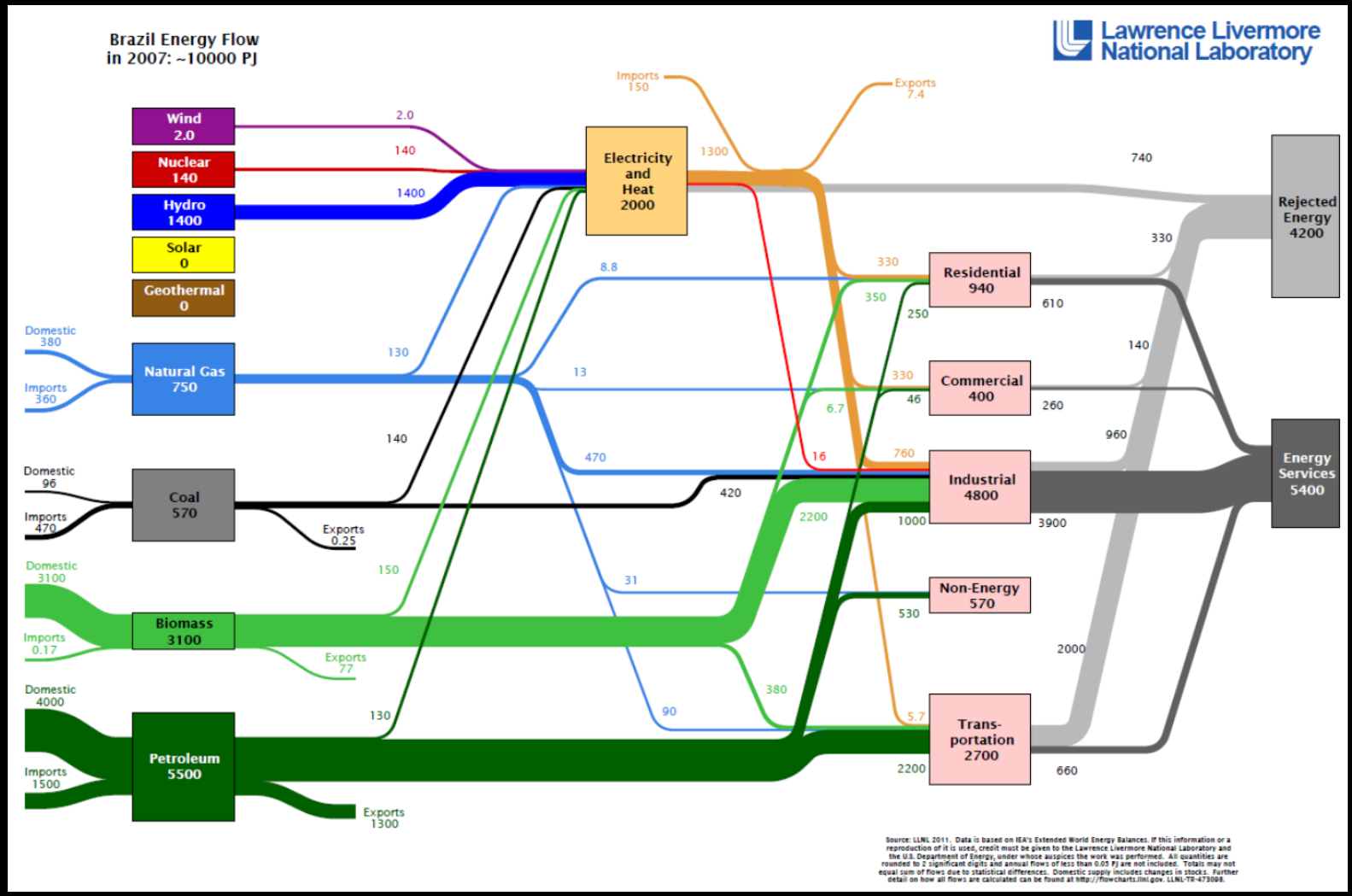
2. Area of study and its importance

UPRB
Pop.: 65 mi (32%)
Prod.: 75% of hydro
Cons.: 30% of hydro
Itaipu: 11.4 GW (15% of the total electricity)



2. Area of study and its importance

Strong dependence on biomass



BR: Fossil = 60%; Biomass = 27%; Hydro = 12% (70% of the electricity)

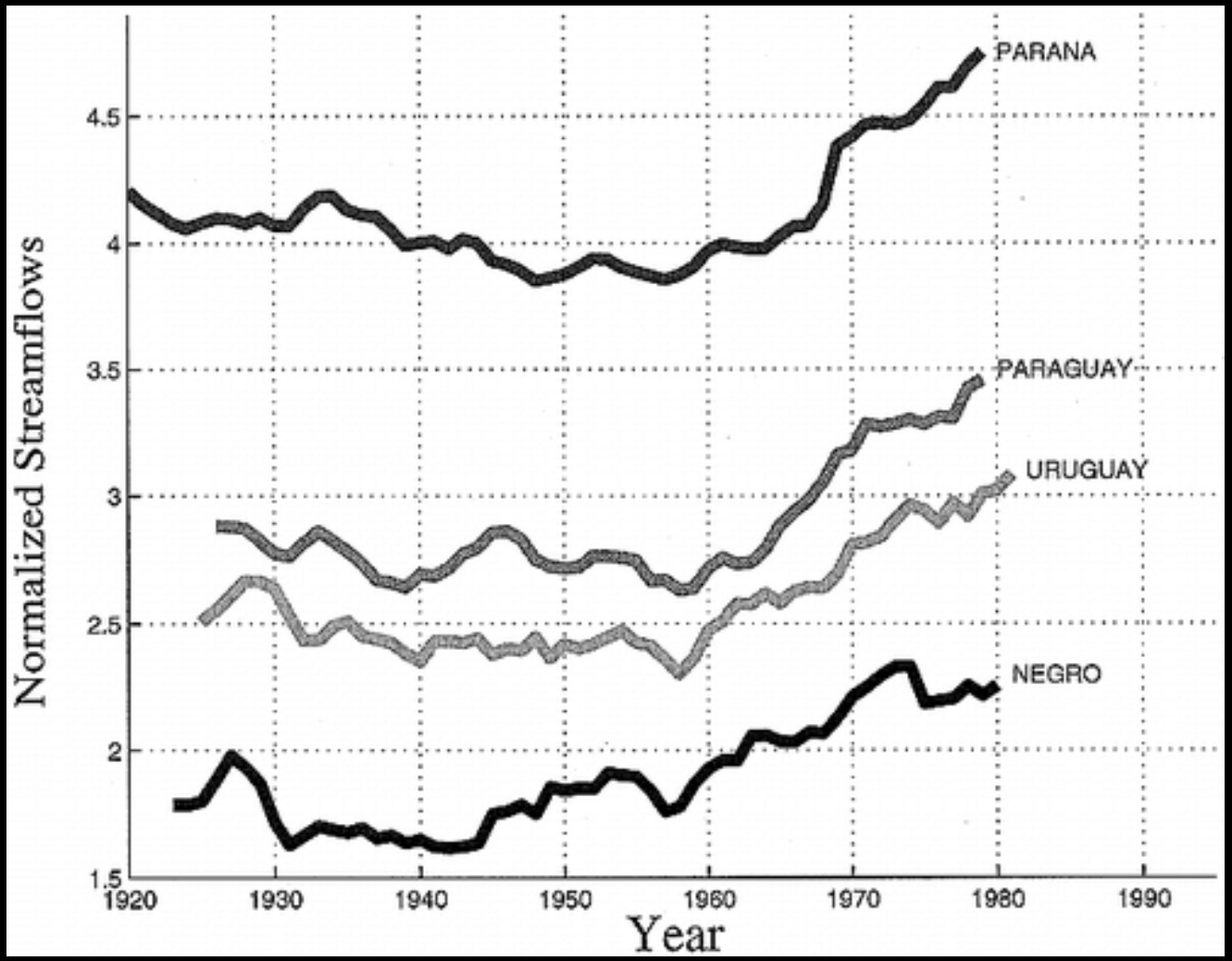
2. Area of study and its importance

Suitable areas for planting sugar cane

Biomass: 50% of fuel burned by light fleet (ethanol); 8% of the electricity (burning sugar cane bagasse)

2. Area of study and its importance

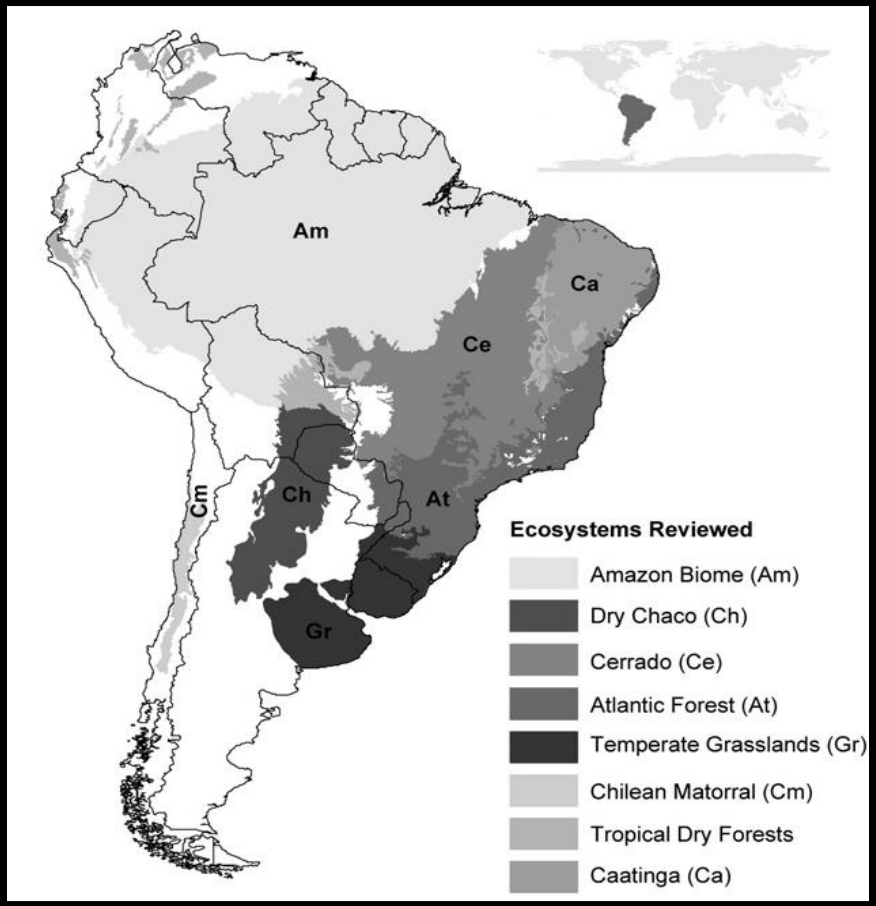
Long-term trends in streamflow



Genta, J.L., G. Perez-Iribarren, and C.R. Mechoso, 1998: A Recent Increasing Trend in the Streamflow of Rivers in Southeastern South America. J. Climate, 11, 2858–2862

3. Historical land cover changes

Land-use/cover changes – Studies on the effects of LUCC on the local and regional climate have focused the Amazon region



****Peer-reviewed literature about LUCC:**

Amazon region: 54 studies*

Non-Amazonian regions: 19 studies

Historical Amazon deforestation:

0.8 million km^2 (≈17%)

Non-Amazonian South America deforestation:

3.6 million km^2 of the original natural vegetation cover were converted into other types of land use (about 4 times greater than the historical Amazon deforestation).

*Web of Science database from year 1900 to 2013

**Salazar, A., Baldi, G., Hirota, M., Syktus, J., McAlpine, C. Land use and land cover change impacts on the regional climate of non-Amazonian South America: A review. Global and Planetary Change, 128, 103–119, 2015.

3. Historical land cover changes

Land-use/cover changes – Removal of original forest cover

Removal of original forest cover: About 90% of the original forest cover (Atlantic Rain Forest: 1,500,000 km^2) has been deforested.

Mechanization and erosion: 50-60’s - crops were cultivated under no soil conservation techniques

Erosion control practices: 80´s - Terraces retain a significant part of the surface runoff

Direct seeding: Began in the 80's, but only succeeded in the 90’s. In direct seeding, soil is not tilled before planting and most of the crop residue remains on the surface,

Areas of permanent protection – APP: Began in the 2000's

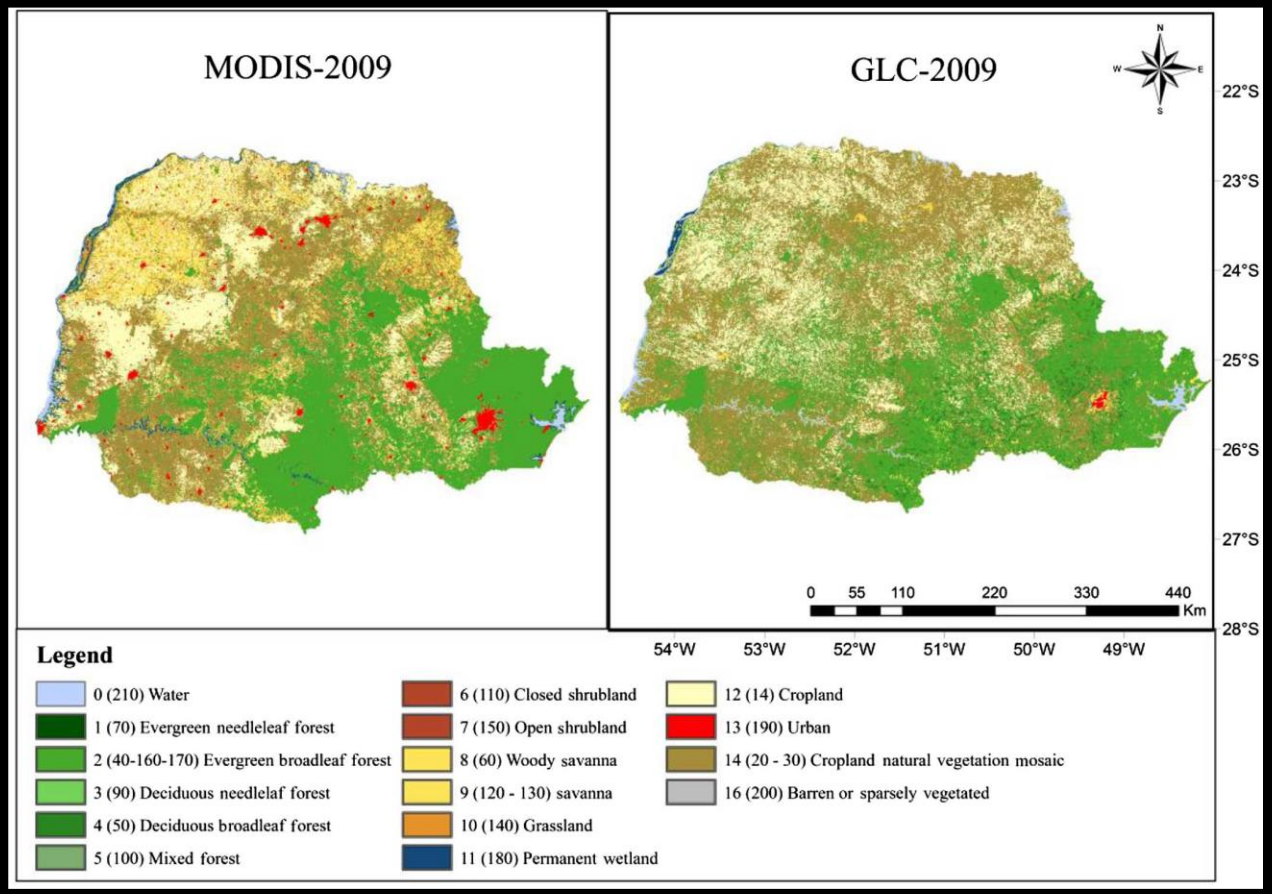
4. Recent land cover changes

What is the problem?

what is the challenge?

4. Recent land cover changes

Major gap – Land Cover Database



File I		File II	
A	B	B	A
C	D	C	D

Territorial dimension problem and the impact on different land-use/cover files.

Disagreement in the classification of land cover classes

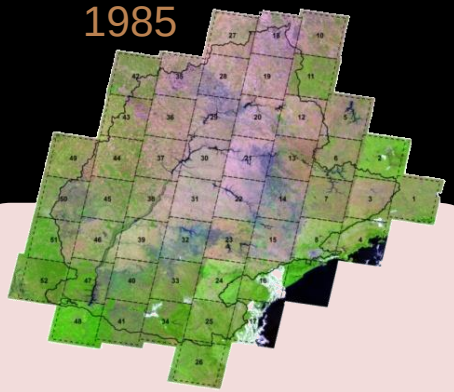
Capucim, M. N. et al., 2015. South America land use and land cover assessment and preliminary analysis of their impacts on regional atmospheric modeling atudies. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 8, no. 3, pp. 1185-1198, doi: 10.1109/JSTARS.2014.2363368

4. Recent land cover changes

What to do?

We propose land cover mappings with a more regional focus

1985



Landsat 5

30 m

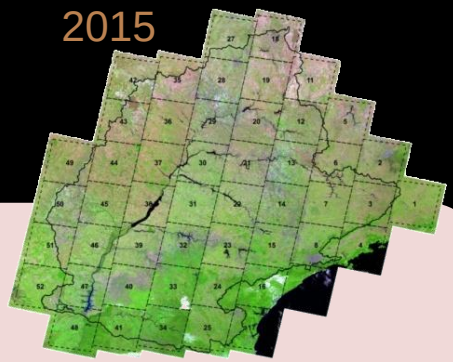
52
(170x183km)

- Satellite -

- Spatial resolution

- Nº of scenes

2015



Landsat 8

30 m

50
(185x185km)

April to September 1985/2015 (dry period in most of the UPRB)

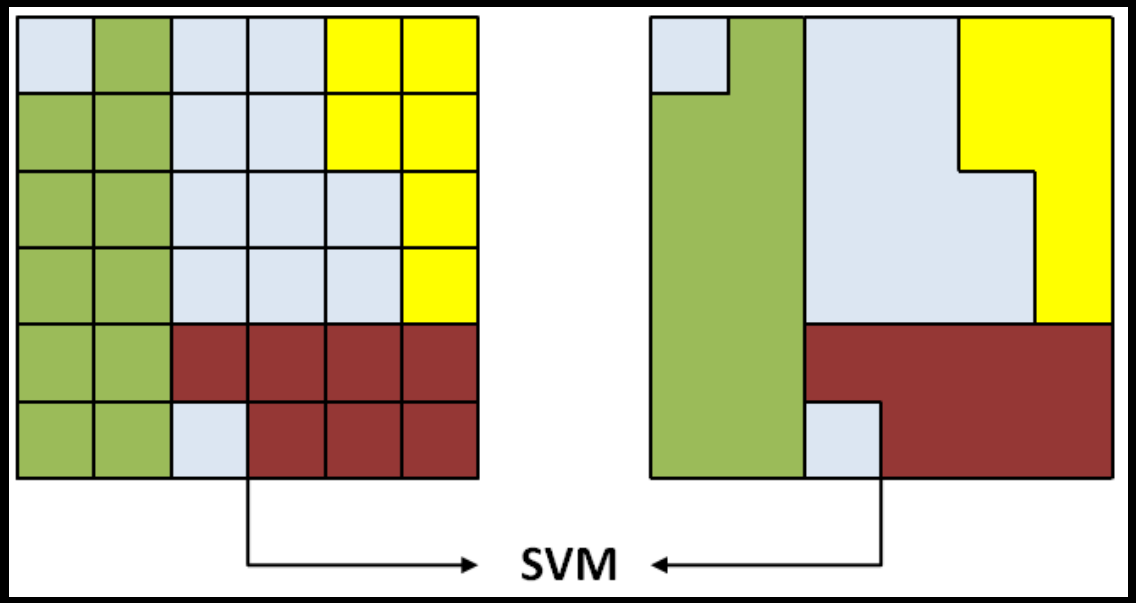
Images freely available at the United States Geological Survey (USGS) webpage

4. Recent land cover changes

Data and Methodology

SVM classificator (support-vector machines)

Pixel-based x Object-based classifications

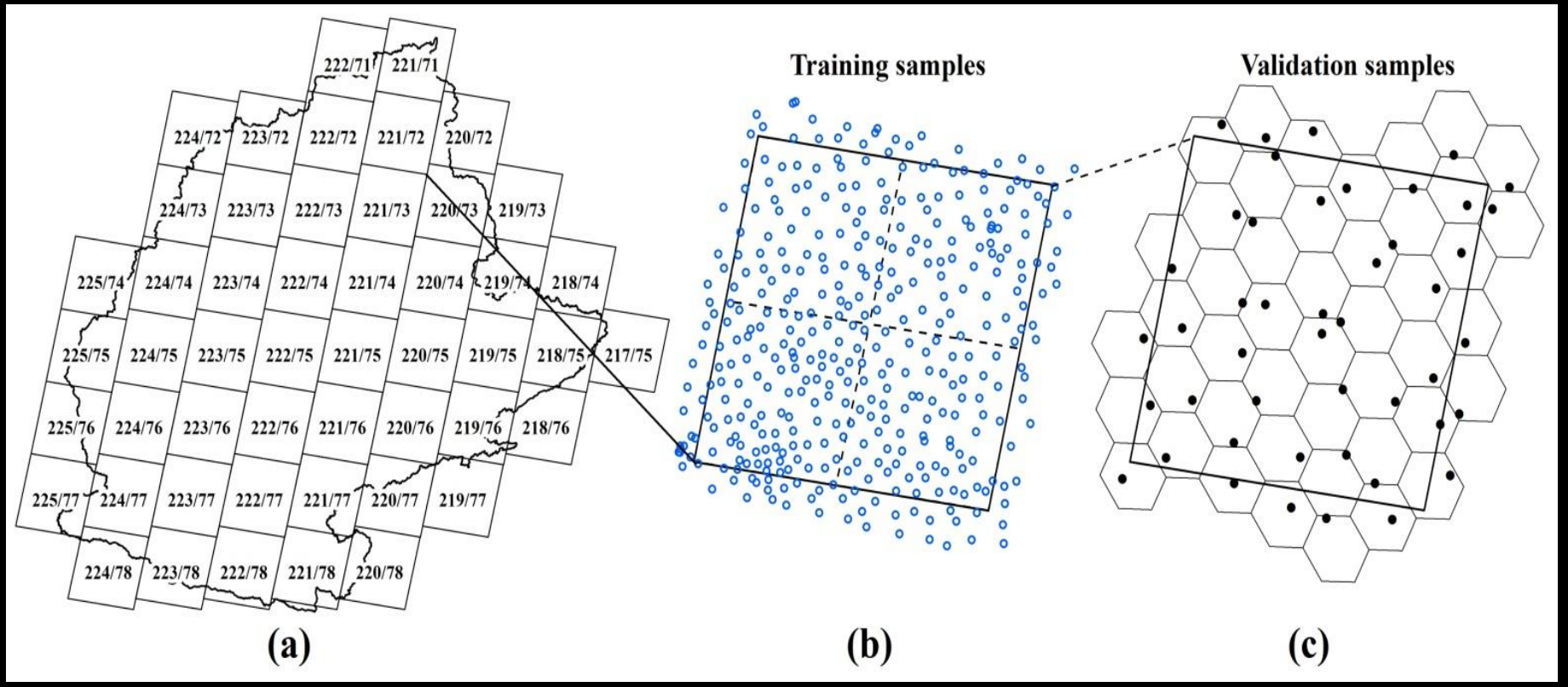


Pixel-based classification: individual image pixels are analyzed by the spectral information that they contain.

Object-based classification: identification of image objects, or segments, that are spatially contiguous pixels of similar texture, color, and tone.

4. Recent land cover changes

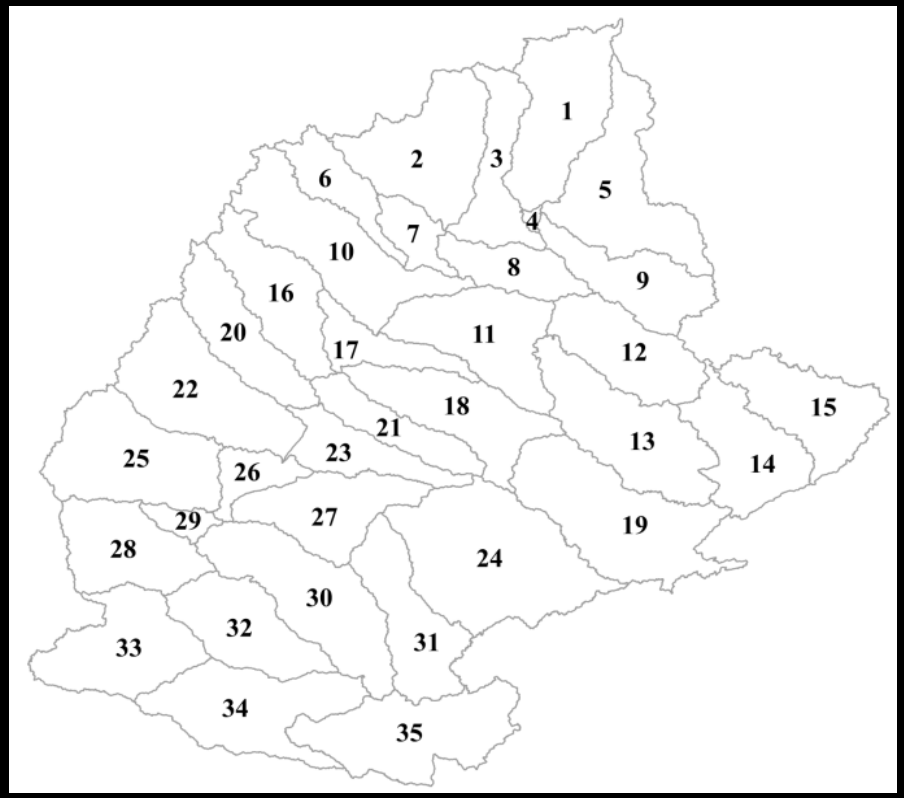
Training and validation samples: 17,000 training samples; 1,000 points for validation



a) Path and row of the Landsat images used in the classification process; b) training samples collected in quadrants (represented by blue dots) and c) validation samples allocation design.

4. Recent land cover changes

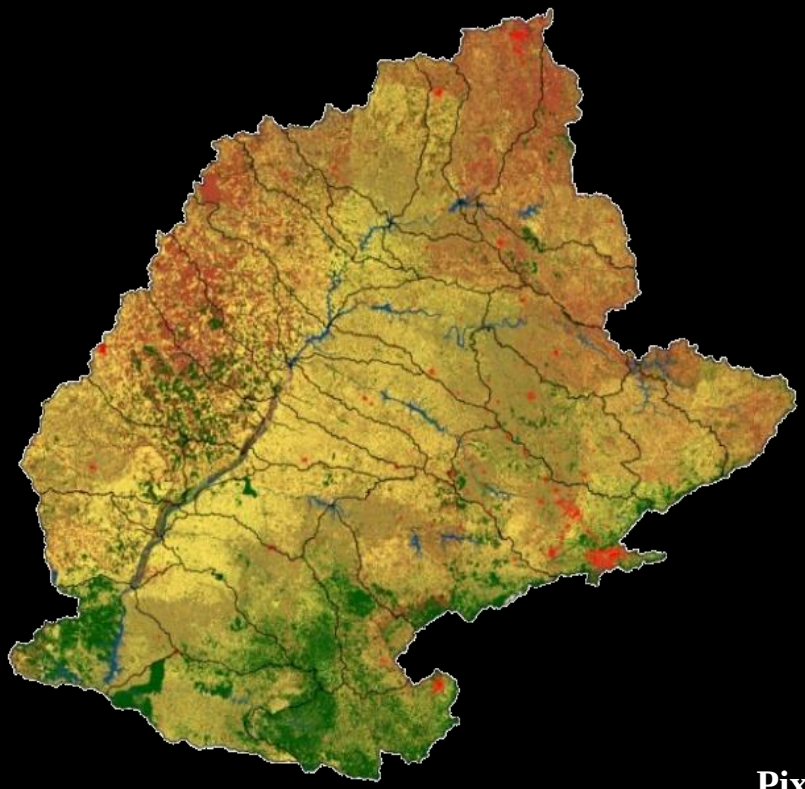
UPRB sub-basins

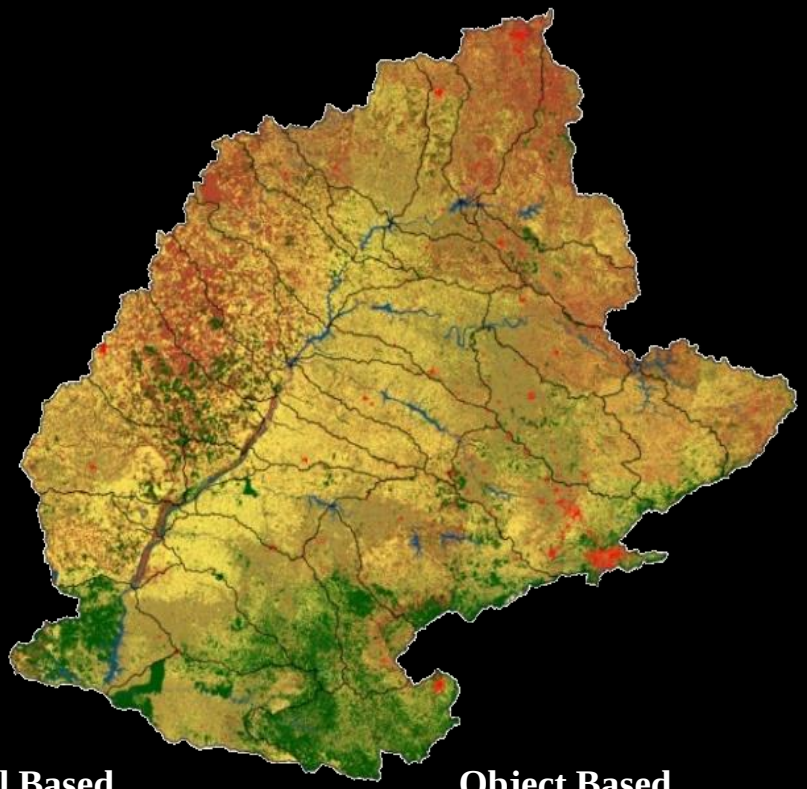


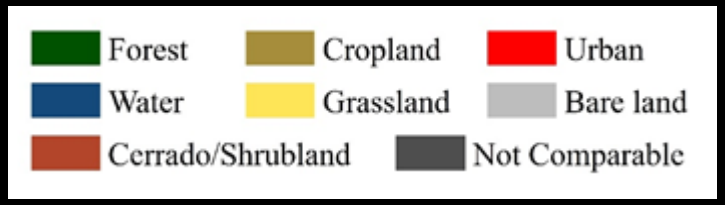
Map of the 35 sub-basins along the UPRB, identified by numbers in the range 1–35, and nominated as: (1) São Bartolomeu; (2) Bois; (3) Paraná - Meia Ponte; (4) Confluence of the Grande and Paranaíba rivers; (5)Parnaíba; (6) Claro; (7) Paraná - Preto; (8) Tijuco; (9) Araguari; (10) Paraná - Aporé, Corrente and Verde; (11) Lower Grande; (12) Middle Grande; (13) Mogi-Guaçú; (14) Sapucaí; (15) Upper Grande; (16) Sucuruí; (17) Paraná - Quitéria and São José dos Dourados; (18) Lower Tietê; (19) Upper Tietê; (20) Verde; (21) Paraná - Feio; (22) Pardo; (23) Paraná - Peixe and others; (24) Upper Paranapanema; (25) Ivinhema; (26) Paraná - Samambaia and others; (27) Lower Paranapanema; (28) Paraná - Iguatemi, Maracaí and Amambaí; (29) Paraná - Laranjal and others; (30) Ivaí; (31) Tibagi; (32) Piquiri; (33) Paraná - Guaçu, São Francisco Verdadeiro and others; (34) Lower Iguaçu (35) Upper Iguaçu.

4. Recent land cover changes

Results: 1985







Pixel Based

Kappa index: 0.52

Global Accuracy: 62%

Accuracy by class:

Agriculture: 73%

Pasture: 53%

Object Based

Kappa index: 0.53

Global Accuracy: 63%

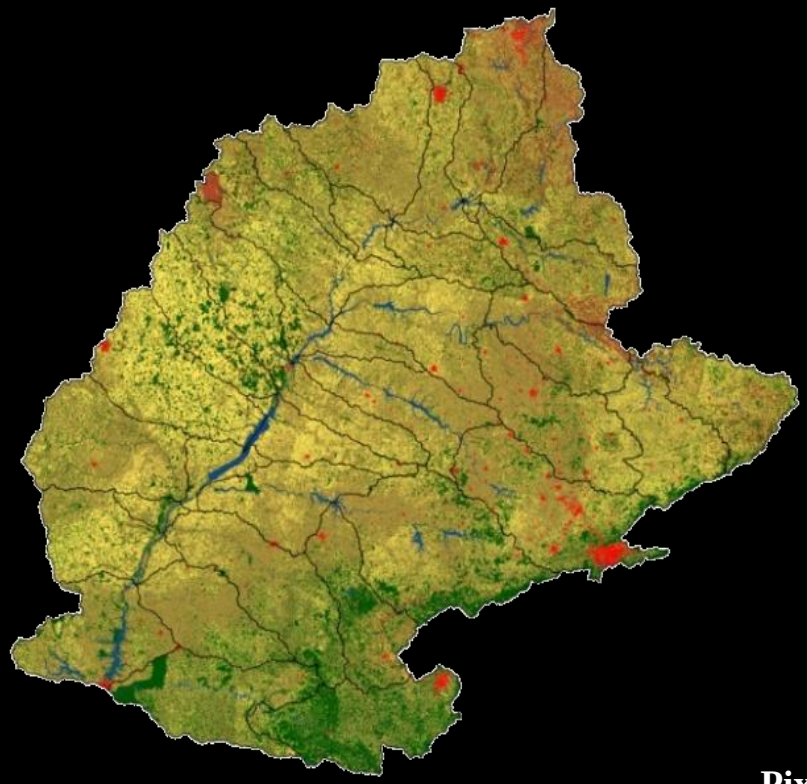
Accuracy by class:

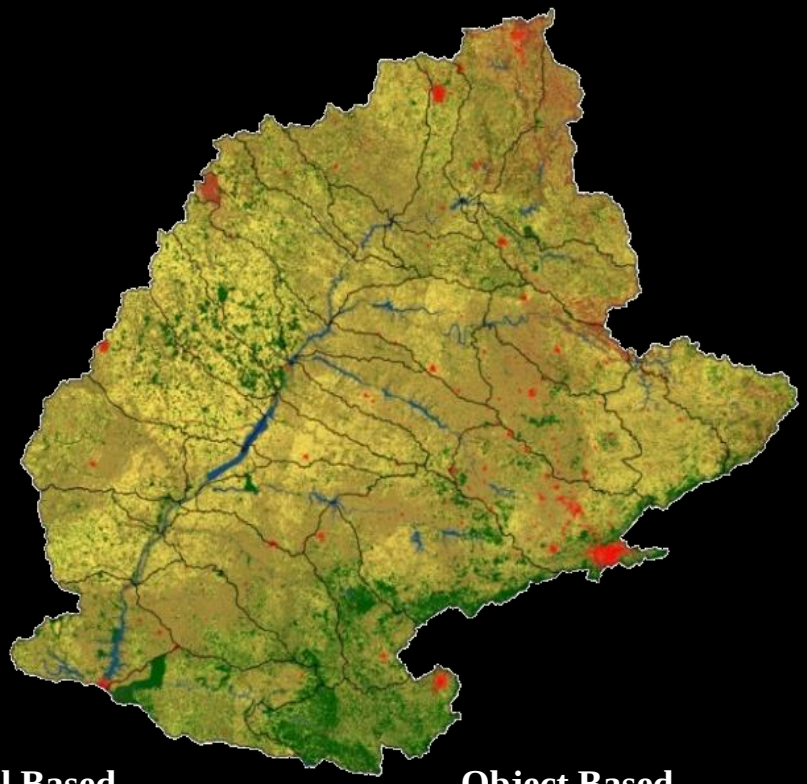
Agriculture: 75%

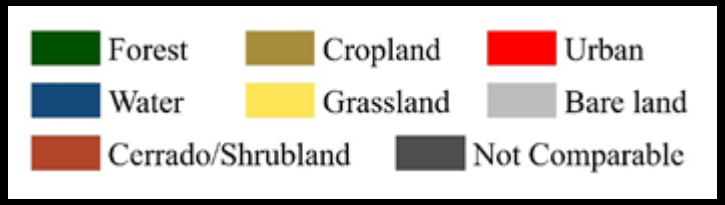
Pasture: 54%

4. Recent land cover changes

Results: 2015







Pixel Based

Kappa index: 0.73

Global Accuracy: 80%

Accuracy by class:

Agriculture: 87%

Pasture: 72%

Object Based

Kappa index: 0.70

Global Accuracy: 78%

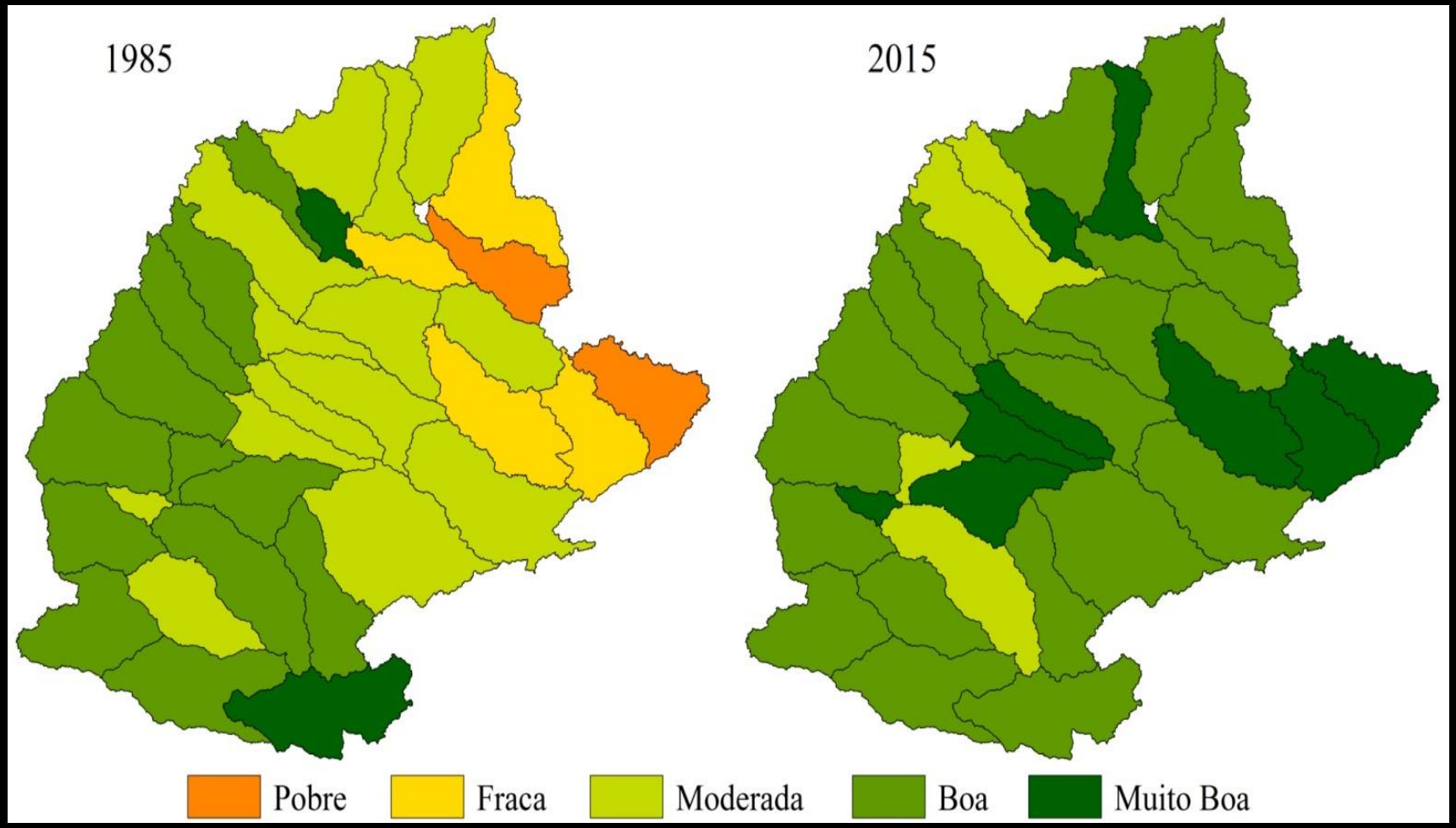
Accuracy by class:

Agriculture: 88%

Pasture: 71%

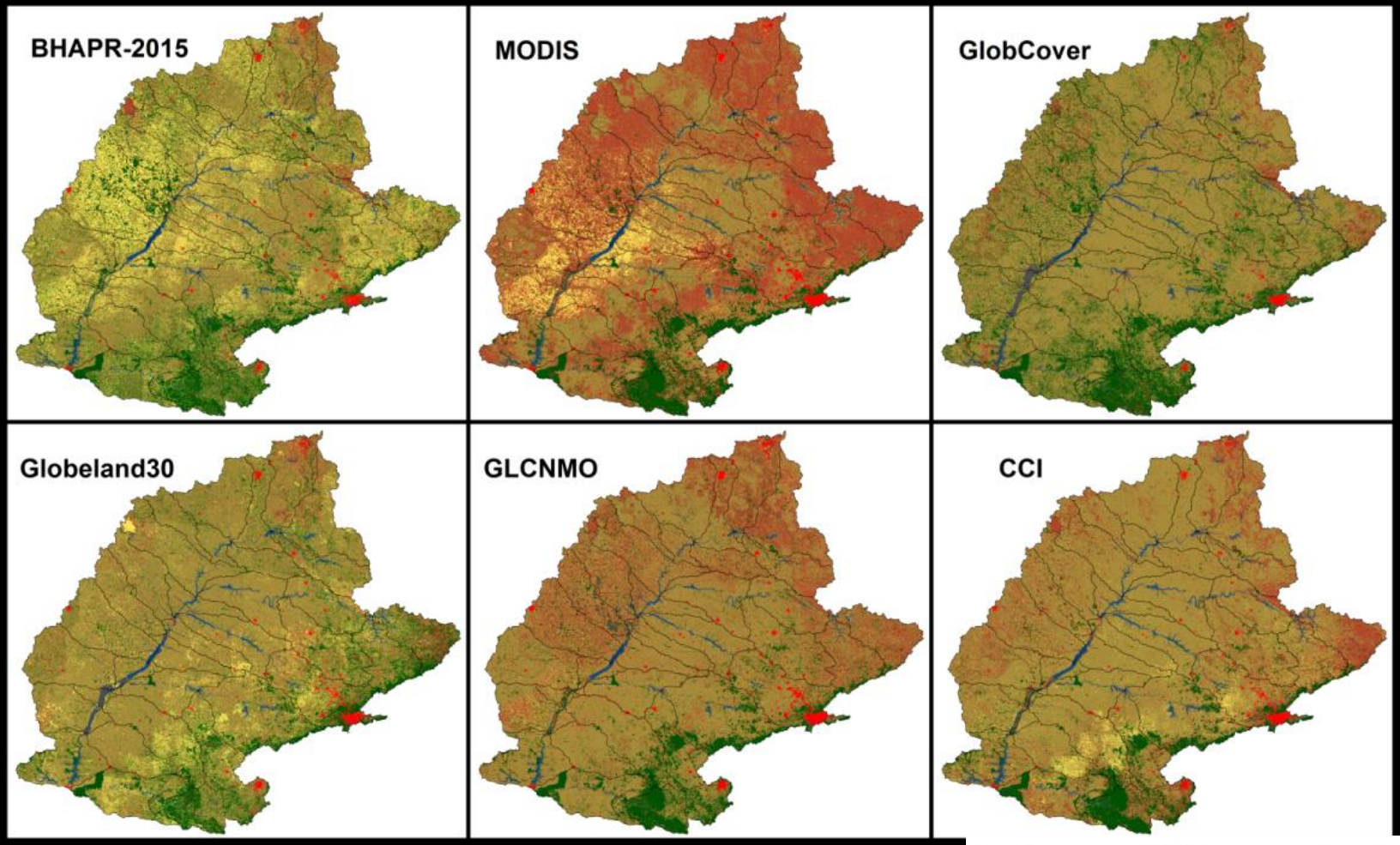
4. Recent land cover changes

Spatial distribution of accuracy



4. Recent land cover changes

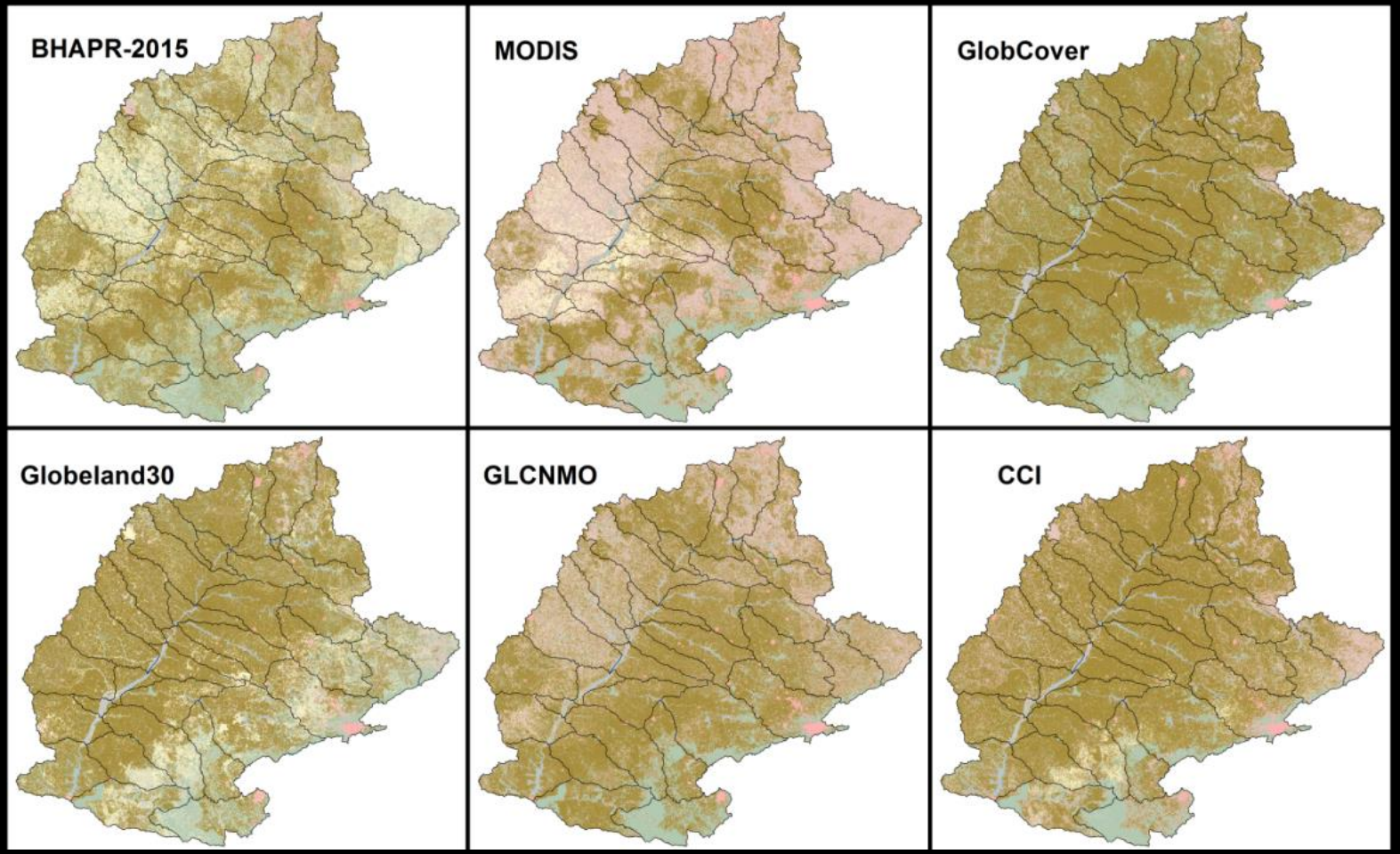
Comparison with global mappings (database freely accessible) for the year 2015



MODIS - 2013 (FRIEDL et al., 2010); GlobCover - 2009 (SOPHIE; PIERRE; ERIC, 2010); Globeland30 - 2010 (CHEN et al., 2015); GLCNMO - 2013 (TATEISHI et al., 2014); CCI - 2015 (KIRCHES et al., 2016)

4. Recent land cover changes

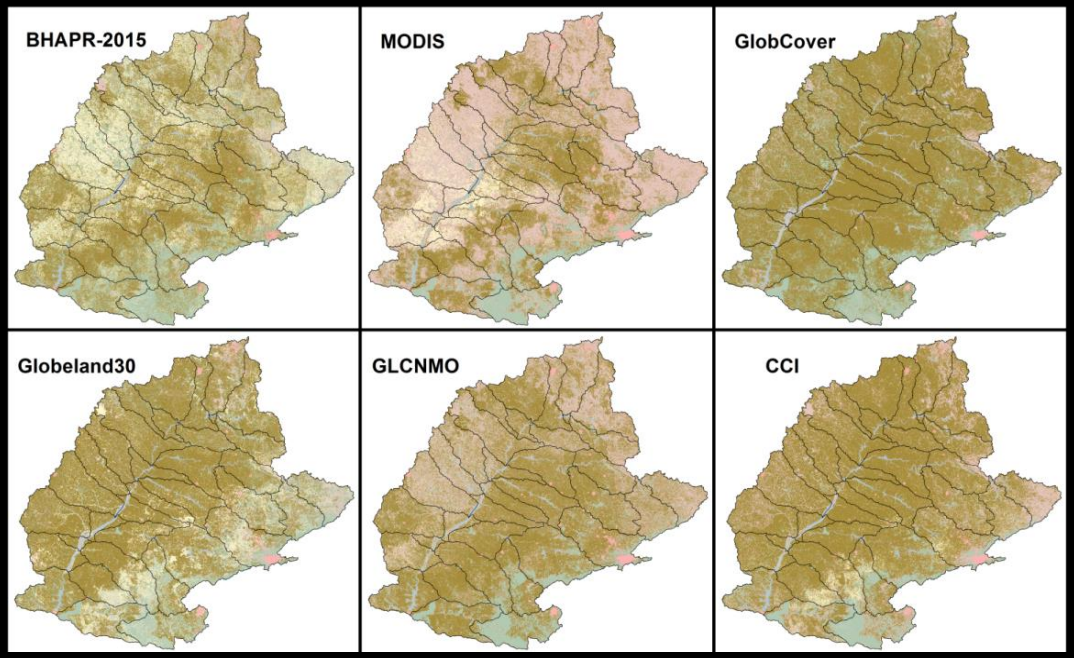
Comparison with global mappings (database freely accessible) for the year 2015: Cropland

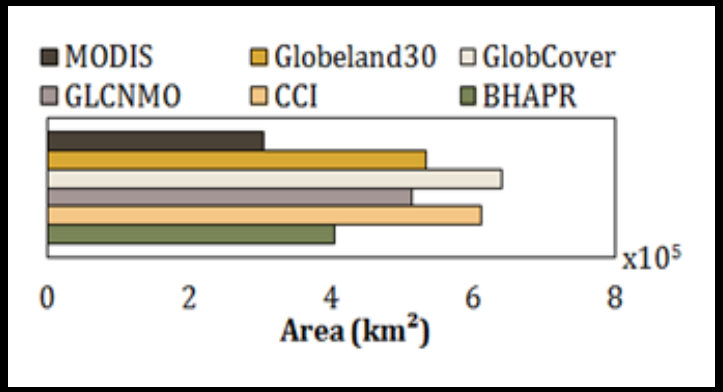


Cropland is the dominant land cover class in UPRB, except for the MODIS product

4. Recent land cover changes

Comparison with global mappings for the year 2015: Cropland

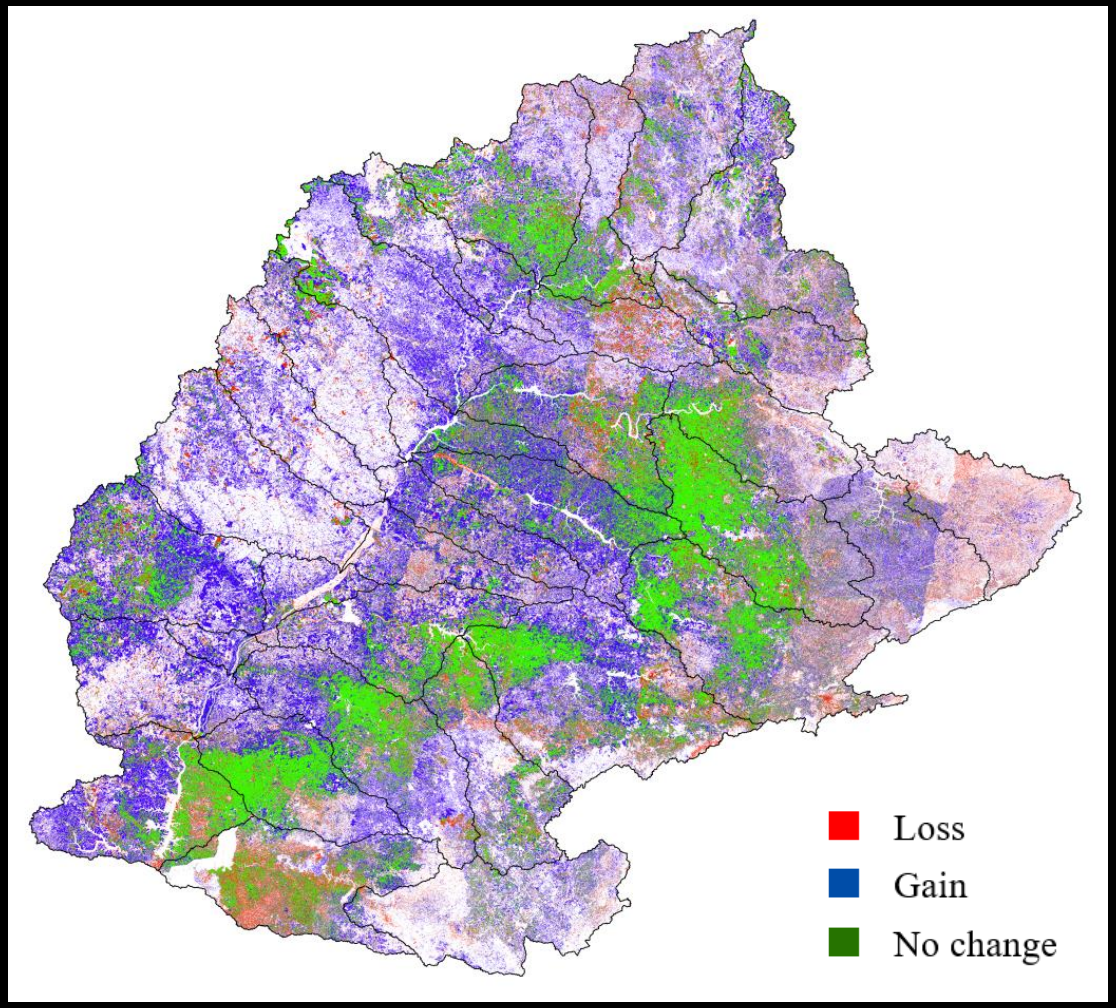




- Cropland represents 46.0% for the UPRB-2015 (BHAPR in the Figure);
- The participation of the class in each mapping are: GlobCover (71.2%), CCI-LC (67.8%), Globeland30 (59.2%), GLCNMO (57.0%), MODIS (33.8%);
- None of the products showed coverage fraction comparable to the UPRB-2015;
- GlobCover and CCI-LC overestimate, MODIS underestimate the Cropland areas;
- Most reliable estimates for cropland areas in Brazil point to about 600,000 km2 (FAO, 2016), which corresponds to more than 2/3 of the UPRB area;
- The percentages associated with GlobCover and CCI-LC products indicate that there are more cropland areas within the UPRB than in Brazil as a whole (inconsistency).

4. Recent land cover changes

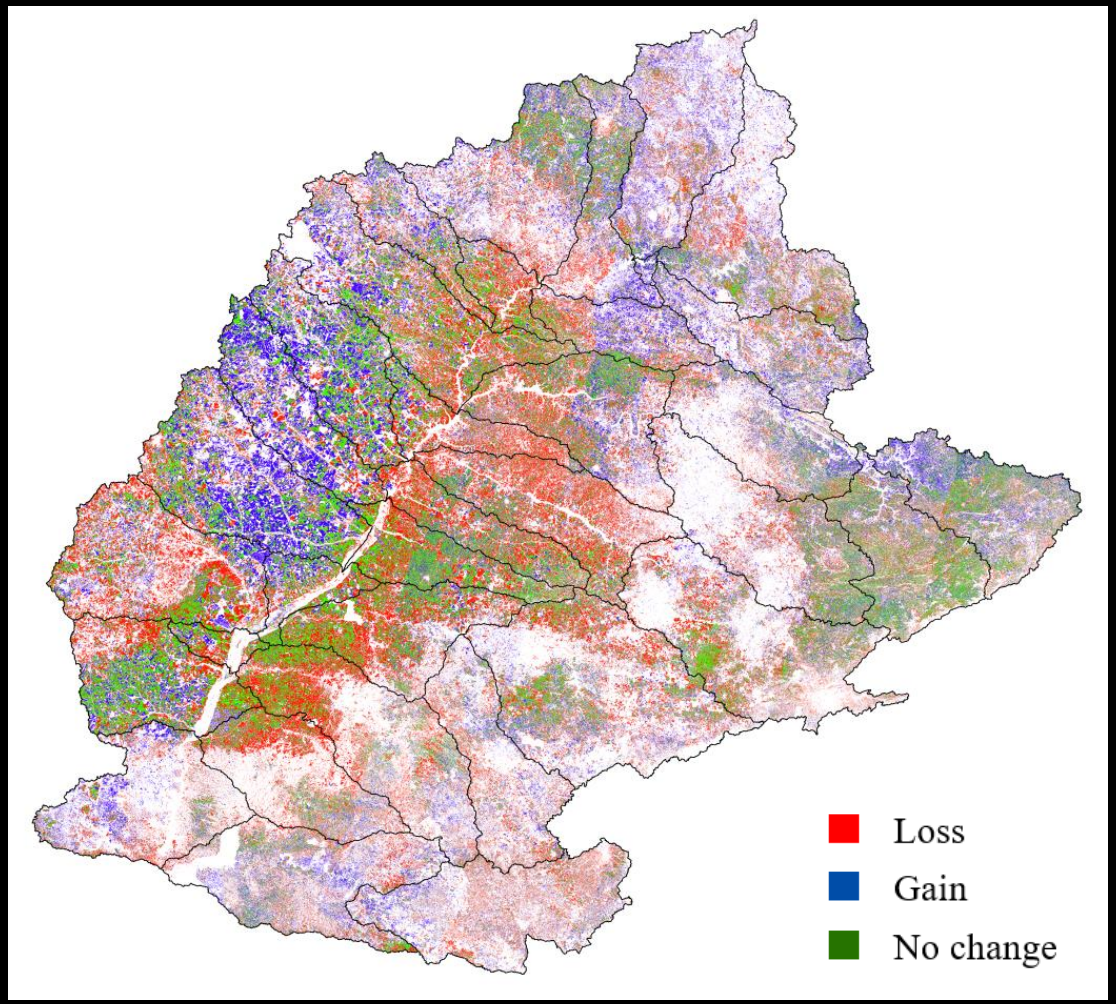
Changes in Agriculture areas in the period 1985-2015



- Cropland areas increased from 249,765 km2 (27.8%) to 413,623 km2 (46.0%);
- Most sub-basins showed significant increases in the participation of the Cropland class;
- In 1985 only the Mogi-Guaçú sub-basin had more than 50% of the area covered by Agriculture, in 2015 the number of sub-basins jumped to 13.

4. Recent land cover changes

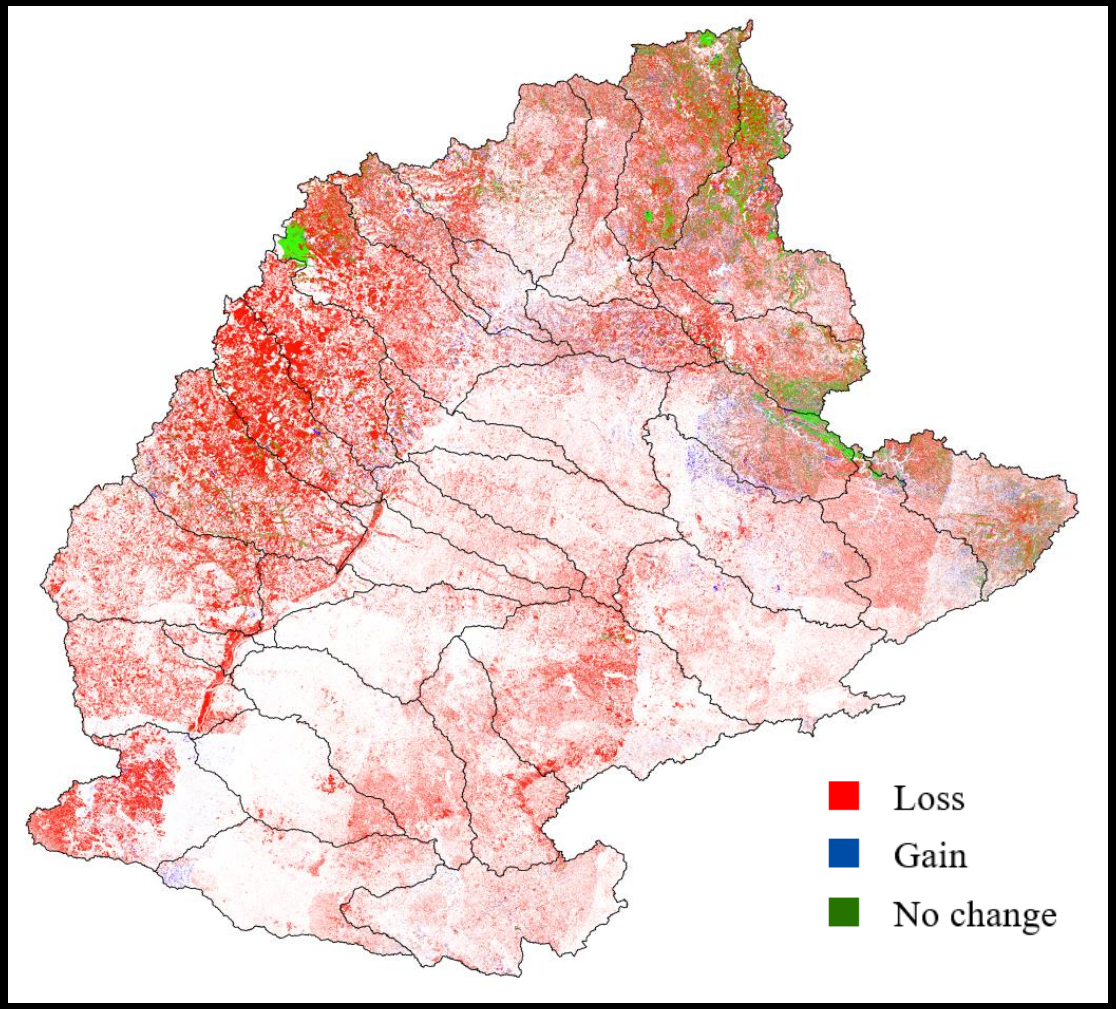
Changes in Agriculture areas in the period 1985-2015



- The increase of Cropand areas in the left bank sub-basins coincides with the reduction in grassland areas in the region;
- Grassland areas decreased from 272.237 km2 (30,3%) to 230.348 km2 (25,6%).

4. Recent land cover changes

Changes in Agriculture areas in the period 1985-2015



- Cropland also occupied significant savanna areas, but the great pressure on this biome came from grassland;
- Savanna (Cerrado) was the class that underwent the biggest change between 1985 and 2015;
- The class reduced from 195,067 km2 (21.7%) to 45,125 km2 (5.0%).

Conclusions

- ✓ **There have been significant and widespread changes over the entire UPRB drainage area over the last century;**
- ✓ **Similarly, there were significant changes in river flow;**
- ✓ **These changes are highly likely to have had an effect on river flow;**
- ✓ **But any definitive conclusion about the causes of the changes in hydrology depends on a good understanding of how much and where the land cover changes occurred;**
- ✓ **The dynamics of agricultural activity are certainly one of the most important actors in the streamflow changes, but it is probably not alone.**

“Using the past to safeguard the future”

Thank you for your attention!

Acknowledgment:

ANA
AGÊNCIA NACIONAL DE ÁGUAS

CAPES