

An aerial photograph of a river network, showing a large, winding river channel in the center, surrounded by a dense network of smaller tributaries. The water is a light brownish-tan color, contrasting with the surrounding green and brownish terrain. A semi-transparent, light-colored rectangular box is overlaid on the image, containing the title text.

# **HYDROLOGICAL RESPONSE OF A BRAZILIAN CATCHMENT TO DIFFERENT LAND USE AND LAND COVER PRODUCTS**

**Anderson Paulo Rudke, T. Fujita, M. V. B. de Moraes, S. A. A. Rafee, R. A. F. de Souza, R. V. A. de Souza, E. D. de Freitas, L. D. Martins, Jorge Alberto Martins.**

**2017 International SWAT Conference in Warsaw, Poland**

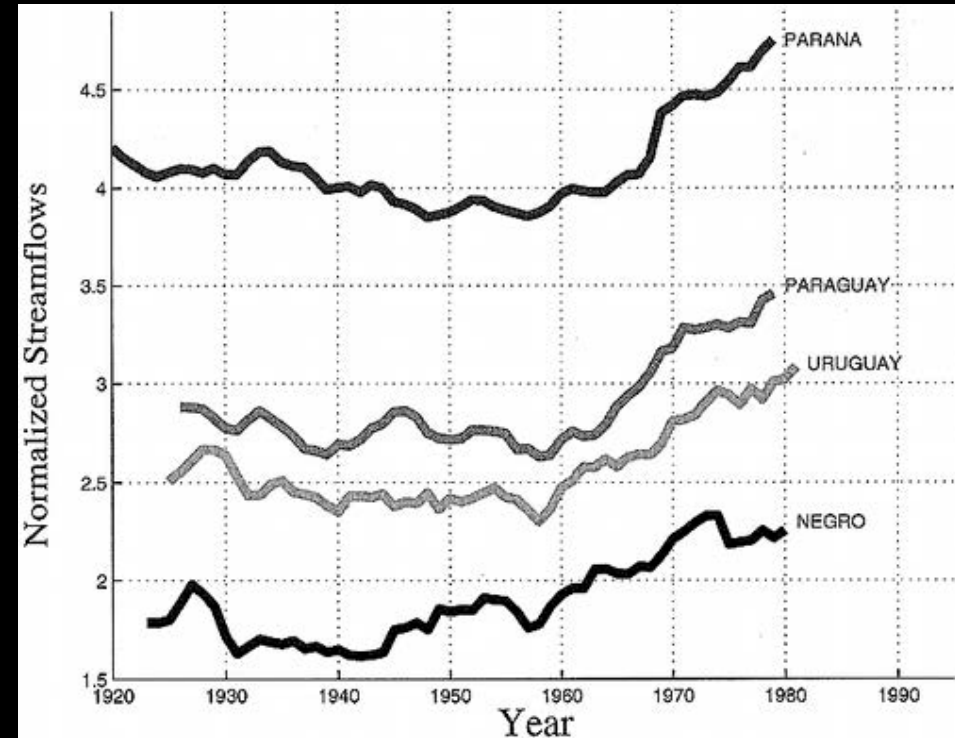
# LA PLATA RIVER BASIN

- DRAINAGE AREA: 3,170,000 km<sup>2</sup>;
- LENGTH: 4,500 km;
- WATER DISCHARGE: 28,000 m<sup>3</sup>/s.
  - PARANÁ RIVER;
  - PARAGUAY RIVER;
  - URUGUAY RIVER;
  - NEGRO RIVER.



# LA PLATA RIVER BASIN

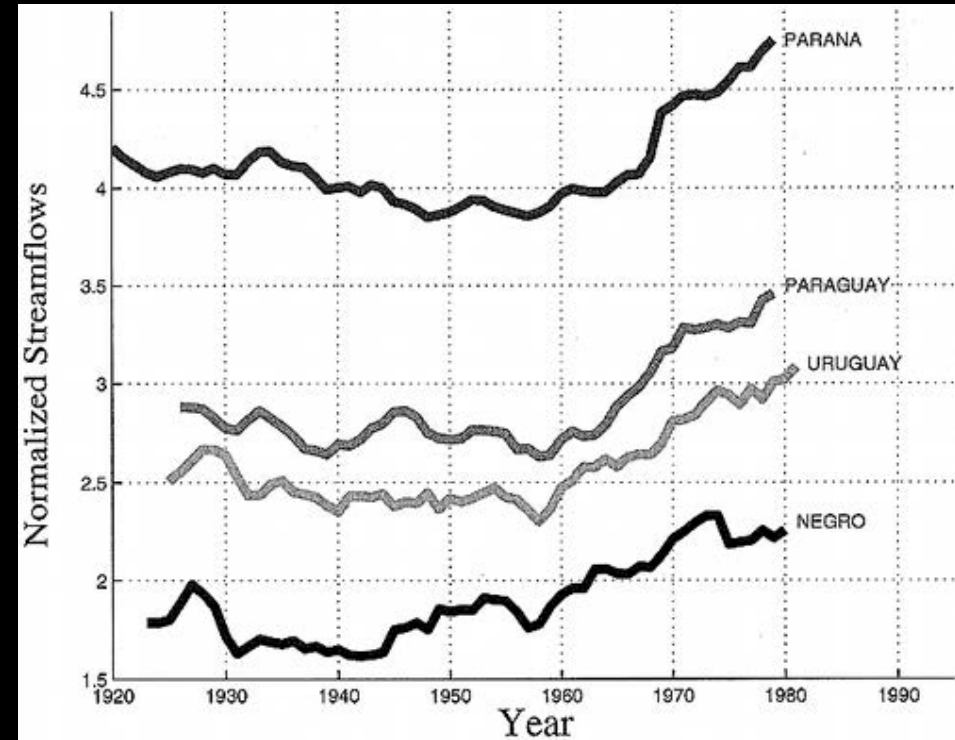
- LONG-TERM TRENDS IN STREAMFLOW



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.

# LA PLATA RIVER BASIN

- LONG-TERM TRENDS IN STREAMFLOW
  - PRECIPITATION PATTERNS
    - FREQUENCY AND INTENSITY
    - POSITIVE/NEGATIVE ANOMALIES
  - EVAPORATION PATTERNS
    - LAND USE CHANGES;
    - DEFORESTATION;
  - SURFACE RUNOFF
    - SOIL EXPOSURE



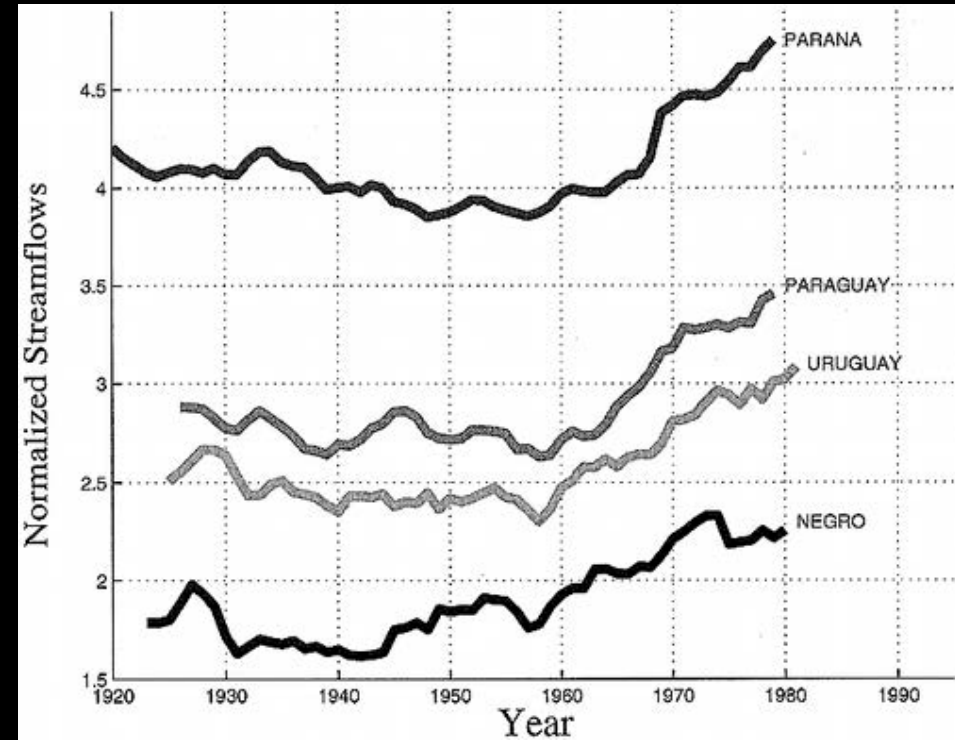
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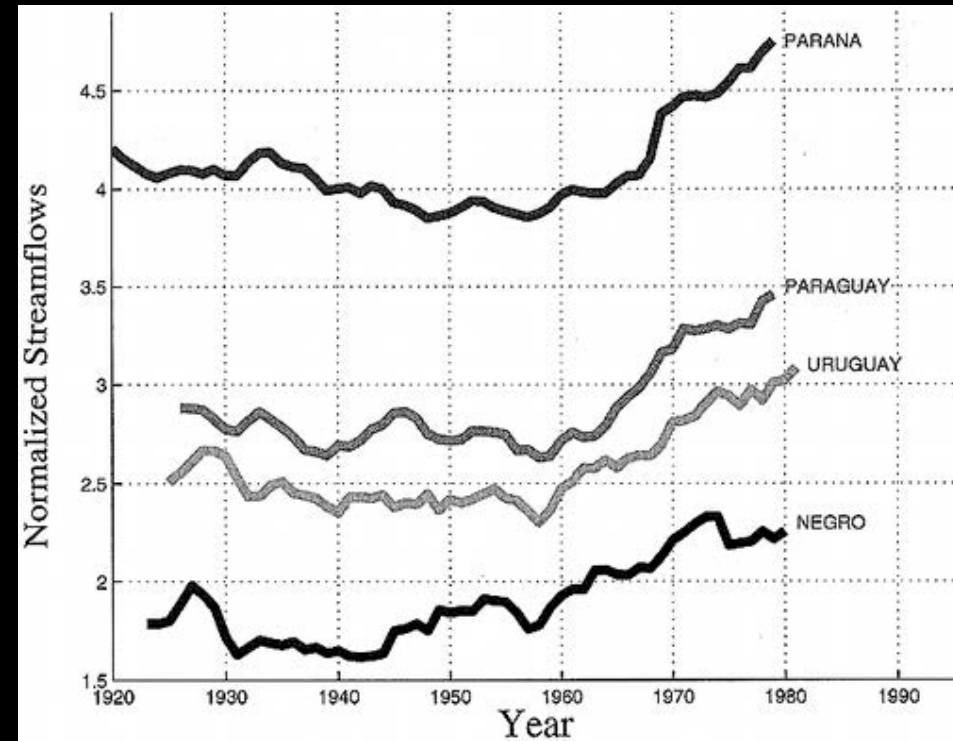


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THE ROLE OF HUMAN ACTIVITIES  
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# LAND USE AND COVER CHANGES

- 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;
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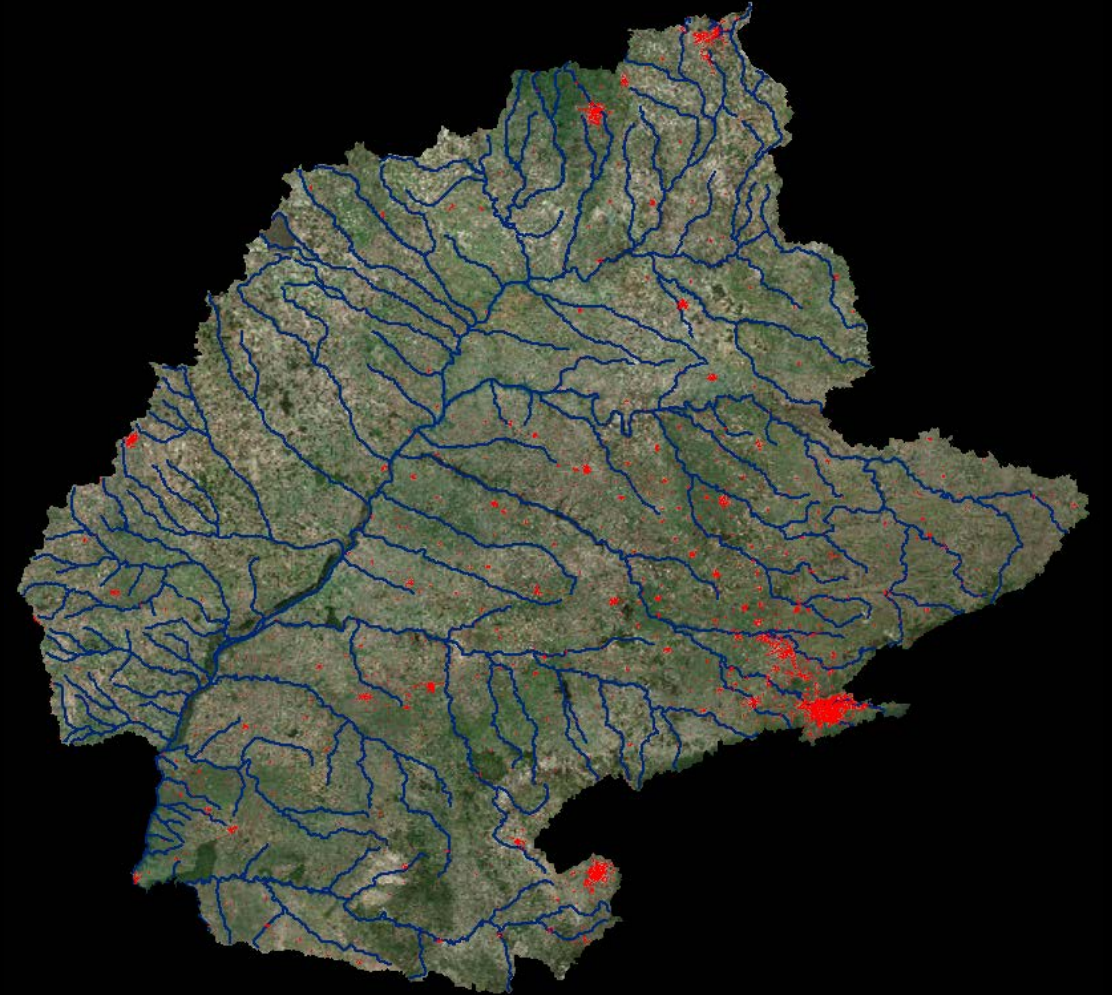
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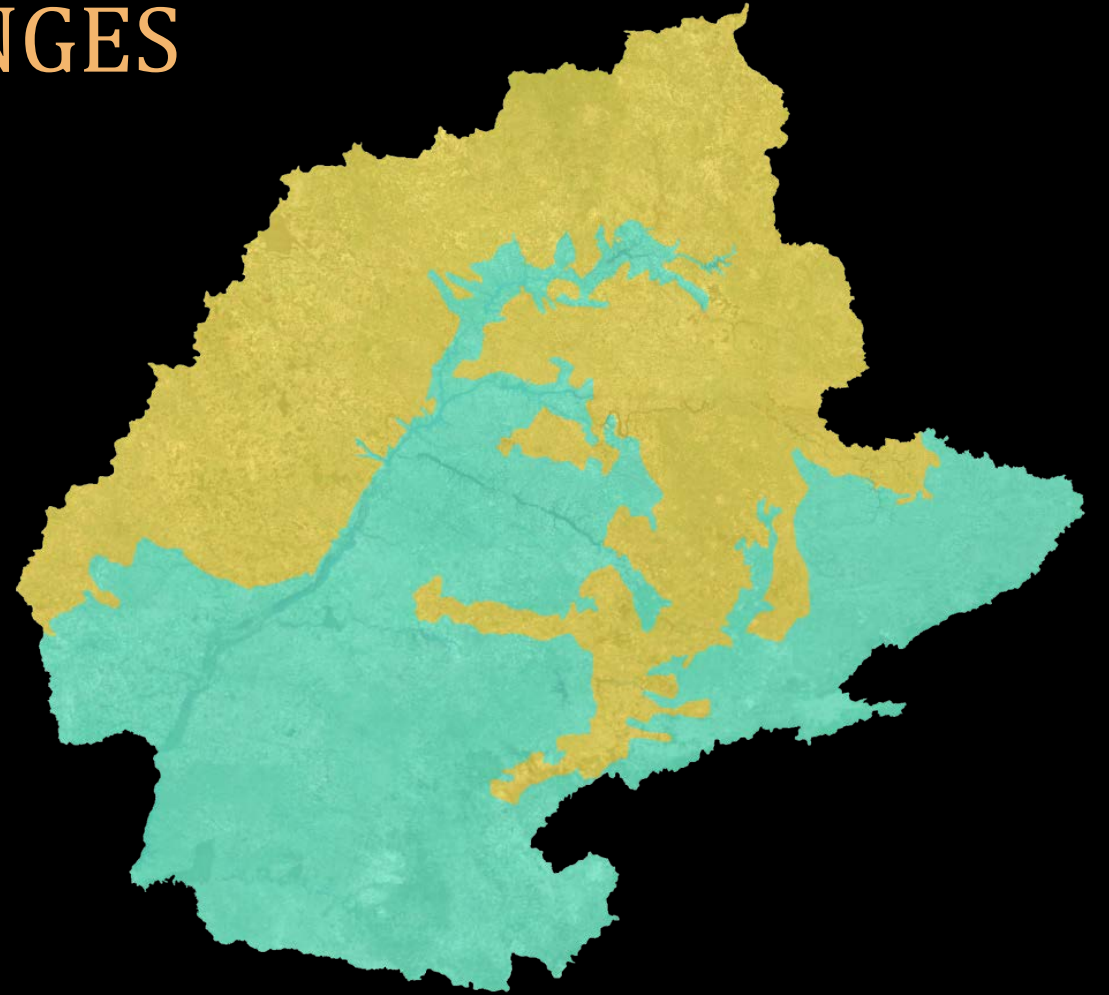
# PARANÁ RIVER BASIN

- DRAINAGE AREA: 879,860 km<sup>2</sup>
- LENGTH: 1,280 km;
- WATER DISCHARGE: 14,000 m<sup>3</sup>/s.



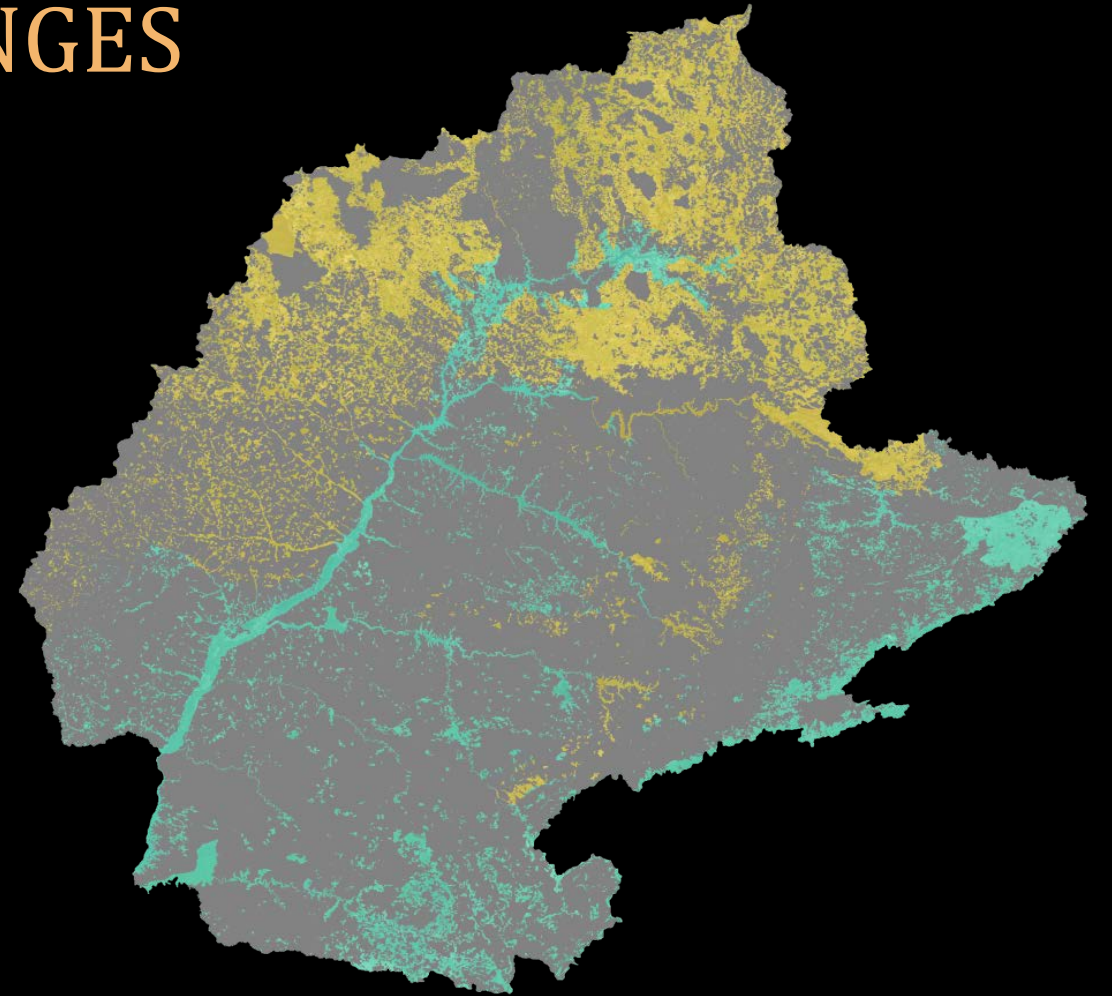
# PARANÁ RIVER BASIN LAND USE AND COVER CHANGES

- ORIGINAL ATLANTIC FOREST: 1,500,000 km<sup>2</sup>
- ORIGINAL CERRADO: 1,585,000 km<sup>2</sup>



# PARANÁ RIVER BASIN LAND USE AND COVER CHANGES

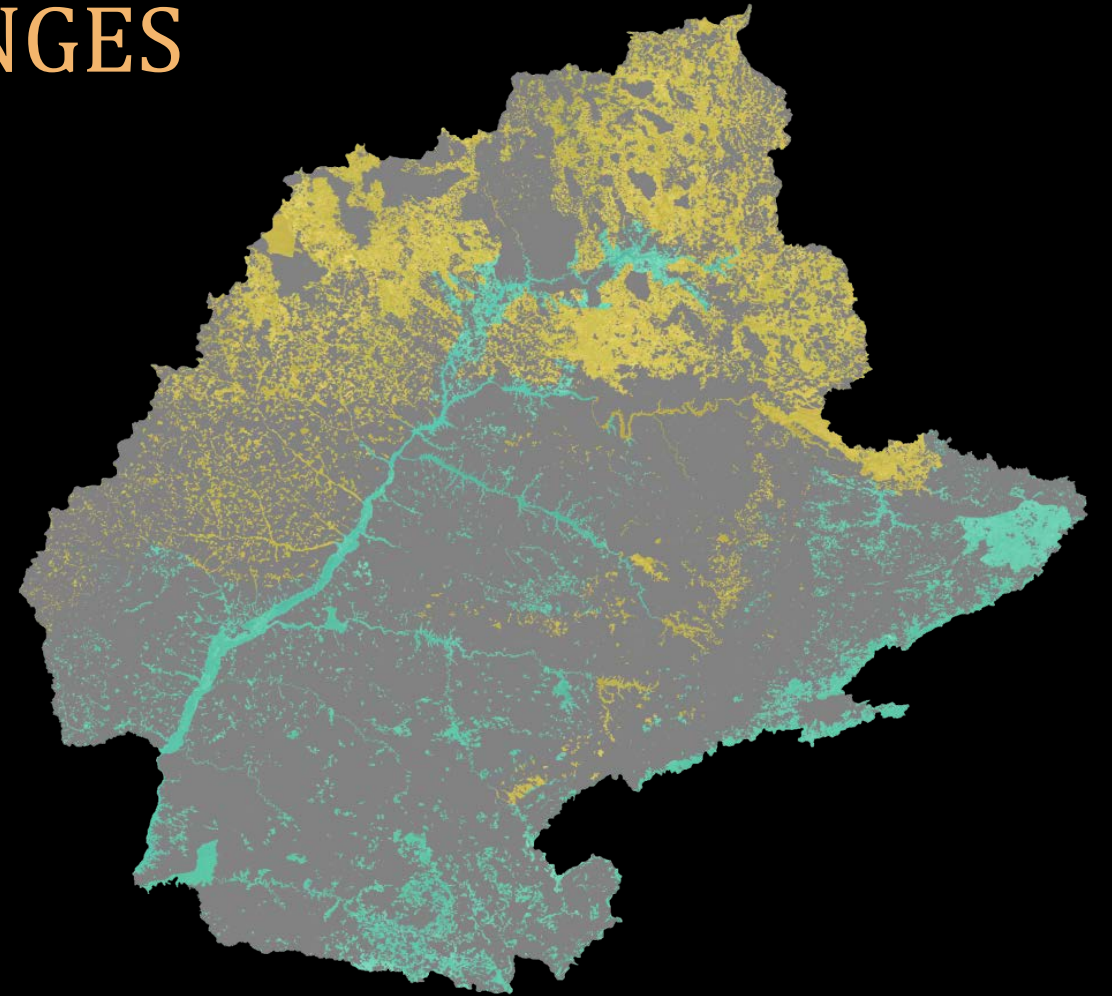
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# LAND USE AND COVER CHANGES MECHANIZATION [1950 - 1960]

- AGRICULTURAL MACHINERY
  - INCREASE CROP PRODUCTIVITY/EFFICIENCY;
  - LARGE SCALE PRODUCTION;
  - IMPROVE THE QUALITY OF FARM PRODUCT;
  - HIGHER PLANTING DENSITY;



# LAND USE AND COVER CHANGES MECHANIZATION [1950 - 1960]

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  - HIGHER PLANTING DENSITY;
  - SOIL COMPACTION;
  - EROSION;
  - SEDIMENT RELEASE.



# LAND USE AND COVER CHANGES EROSION CONTROL [1970 - 1990]

- **CONTOUR PLOWING:** terraces retain a significant part of the surface runoff.



# LAND USE AND COVER CHANGES EROSION CONTROL [1970 - 1990]

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- **DIRECT PLANTING TECHNIQUES:** in direct seeding, soil is not tilled before planting and most of the crop residue (straw) remains on the surface.
- **AGRICULTURE MACHINERY:** succeeded in the 90's with straw cutting discs development.



# LAND USE AND COVER CHANGES PROTECTED AREAS [2000]

- **PERMANENT PROTECTED AREAS (PPA):** minimum range of 30 meters in each margin, for rivers up to 10 meters wide, widening this range as the width of the river increases.
- **CONSERVATION UNITS:** protect remaining vegetation.



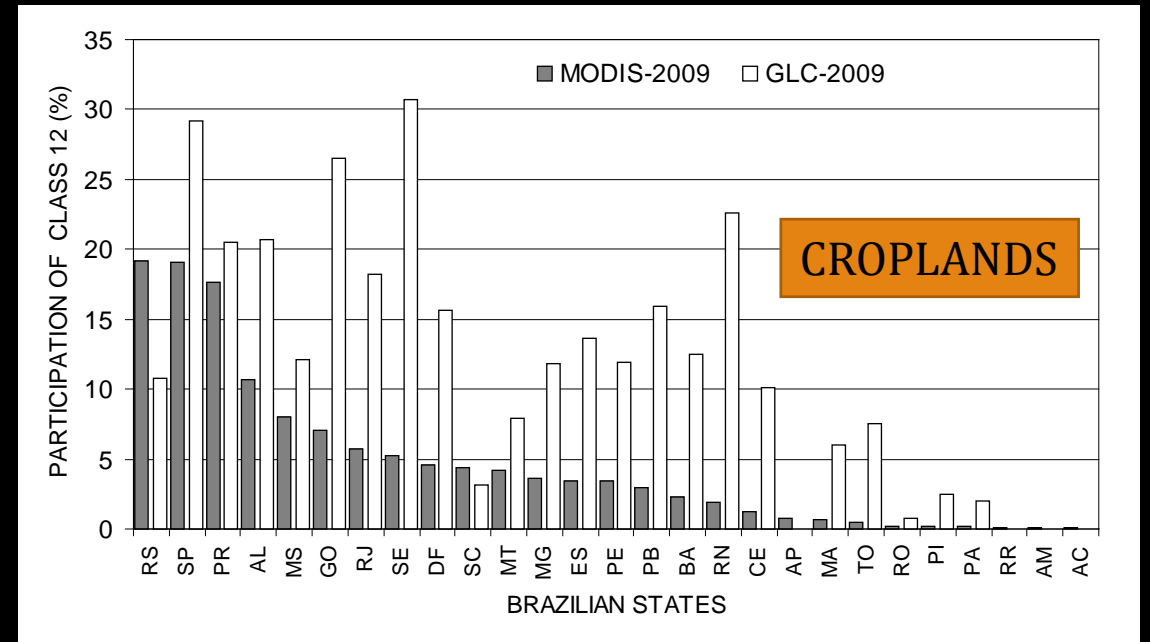
# LAND USE AND COVER CHANGES URBANIZATION

- RURAL DISPLACEMENT;
- DISORDERED OCCUPATION AND WITHOUT PLANNING;
- PROXIMITY WITH WATER BODIES.



# LAND USE AND COVER CHANGES PRODUCTS DATABASE

- DISAGREEMENT IN THE CLASSIFICATION OF LAND COVER CLASSES;
  - GLOBCOVER vs. MODIS.

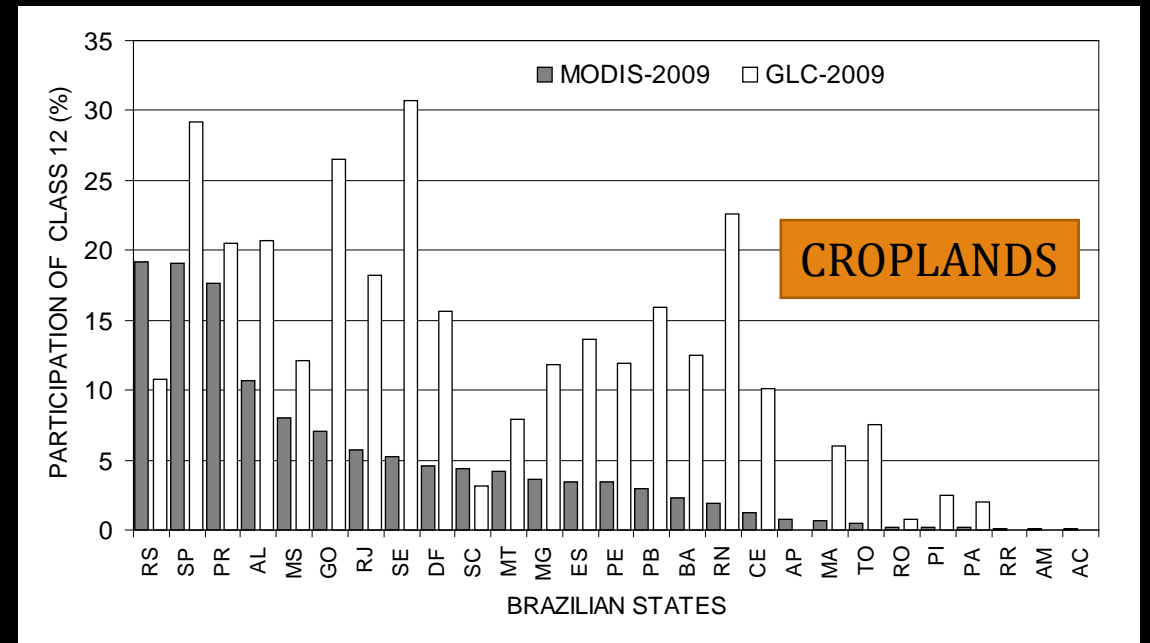


CAPUCIM, M. N. ET AL., 2015. SOUTH AMERICA LAND USE AND LAND COVER ASSESSMENT AND PRELIMINARY ANALYSIS OF THEIR IMPACTS ON REGIONAL ATMOSPHERIC MODELING ATUDIES. IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, VOL. 8, NO. 3, PP. 1185-1198, DOI: 10.1109/JSTARS.2014.2363368

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- DISAGREEMENT IN THE CLASSIFICATION OF LAND COVER CLASSES;
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- NUMERICALLY EQUAL vs. SPACIALLY DIFFERENT;

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



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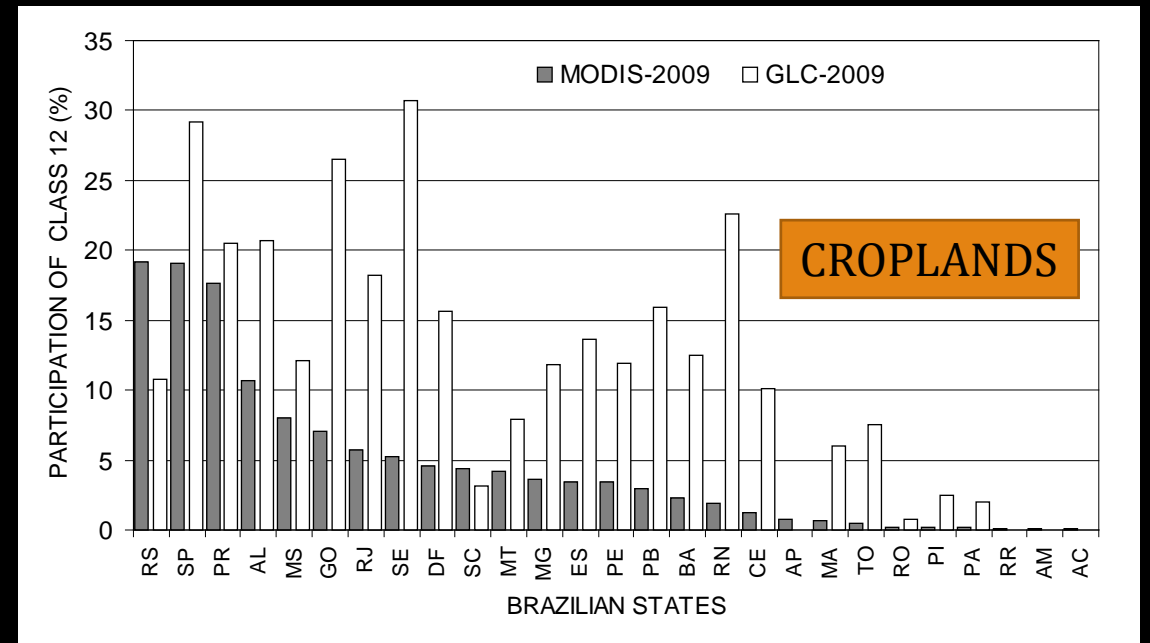


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ARE THEY PROPERLY REPRESENTING LUCC?

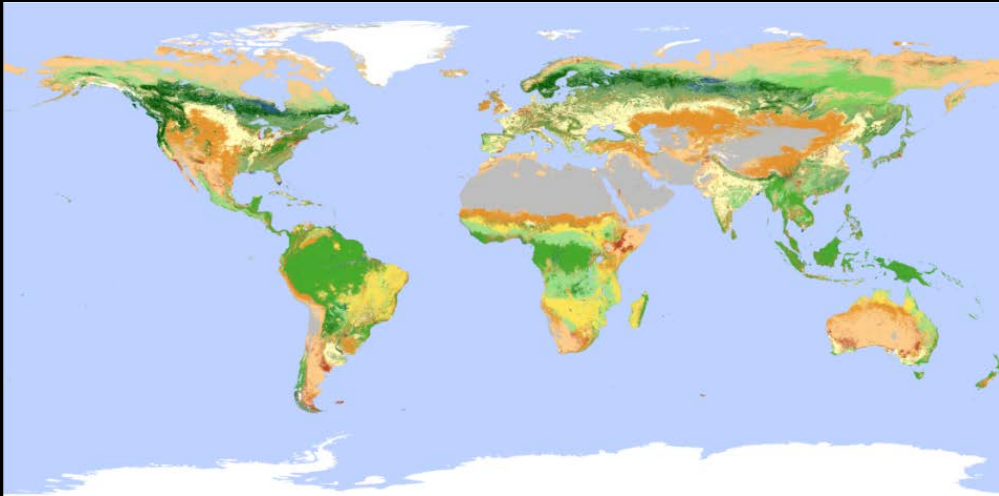


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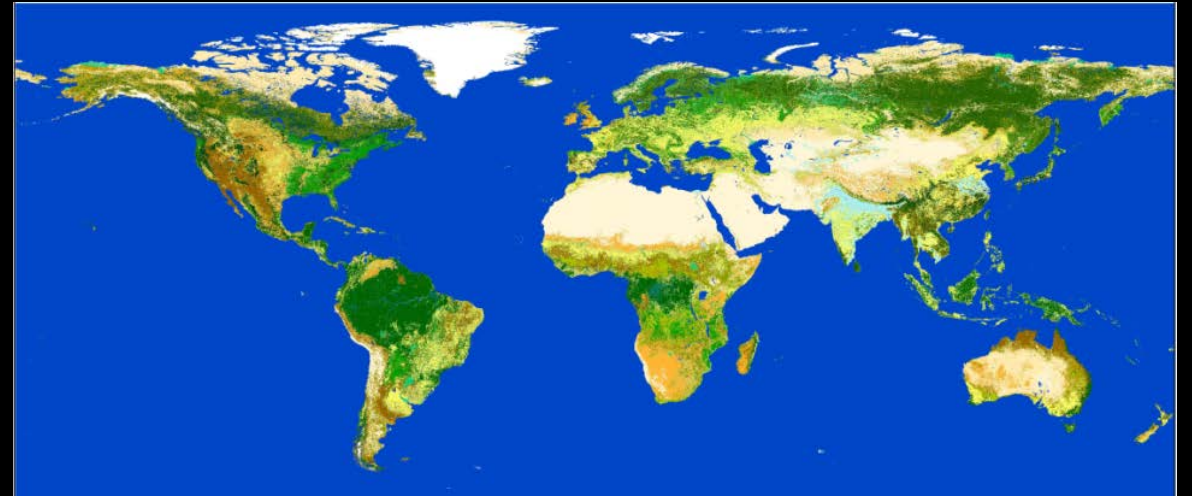
# LAND USE AND COVER CHANGES PRODUCTS DATABASE – GLOBAL SCALE

MODIS - 500m (FRIEDL et al., 2010)

GLOBCOVER - 300m (ARINO et al., 2008)



- MODIS SENSOR;
- 17 LAND COVER CLASSES;
- SUPERVISED CLASSIFICATION:
  - 1860 TRAINING SITES; (ONLY 6 IN THE BASIN)
- OVERALL ACCURACY - 74.8%;
- CLASSIFICATION YEAR – 2009.



- MERIS SENSOR;
- 22 LAND COVER CLASSES;
- UNSUPERVISED CLASSIFICATION;
- OVERALL ACCURACY - 67.5%
- CLASSIFICATION YEAR – 2009.

# LANDSAT DATABASE – 30m



MIXED FOREST



AGRICULTURE



PASTURE



SHRUBLAND



WATER



URBAN



BARREN



CERRADO

# LANDSAT DATABASE

LANDSAT	MODIS	GLOBCOVER
Mixed Forest	Evergreen Needleleaf Forest (1)	Closed Needleleaved Evergreen Forest (70)
	Evergreen Broadleaf Forest (2)	Closed to open Broadleaved Evergreen or Semi-deciduous Forest (40) Closed to open Broadleaved Forest Regularly Flooded - Fresh or Brackish Water (160) Closed Broadleaved Forest or Shrubland Permanently Flooded - Saline or Brackish Water (170)
	Deciduous Needleleaf Forest (3)	Open Needle-leaved Deciduous or Evergreen Forest (90)
	Deciduous Broadleaf Forest (4)	Closed Broadleaved Deciduous Forest (50)
	Mixed Forest (5)	Closed to open Mixed Broadleaved and Needle-leaved Forest (100)
Agriculture	Croplands (12)	Rainfed Croplands (14)
	Cropland/Natural Vegetation Mosaic (14)	Mosaic Cropland/Vegetation (20) Mosaic Vegetation/Cropland (30)
Pasture	Grasslands (10)	Closed to open Herbaceous Vegetation (140)
Water	Water (0)	Water bodies (210)
	Permanent Wetlands (11)	Closed to open Grassland or Woody Vegetation on Regularly Flooded or Waterlogged Soil - Fresh, Brackish or Saline Water (180)
Urban	Urban and Built-Up (13)	Artificial Surfaces and Associated Areas (190)
Barren	Barren or Sparsely Vegetated (16)	Bare Areas (200)
Shrubland	Closed Shrublands (6)	Mosaic Forest or Shrubland/Grassland (110)
	Open Shrublands (7)	Sparse Vegetation (150)
Savanna	Woody Savannas (8)	Open Broadleaved Deciduous Forest/Woodland (60)
	Savannas (9)	Mosaic Grassland/Forest or Shrubland (120) Closed to open Shrubland (130)

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FRIEDL, M.A.; SULLA-MANESHE, D.; TAN, B.; SCHNEIDER, A.; RAMANKUTTY, N.; SIBLEY, A.; HUANG X. MODIS COLLECTION 5 GLOBAL LAND COVER: ALGORITHM REFINEMENTS AND CHARACTERIZATION OF NEW DATASETS. REMOTE SENSING OF ENVIRONMENT, V.114, N.1, P. 168-182, 2010.

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# LANDSAT DATABASE OF UPPER GRANDE RIVER BASIN

- DRAINAGE AREA: 26,490 km<sup>2</sup>;
- AVERAGE STREAMFLOW: 420 m<sup>3</sup>/s;



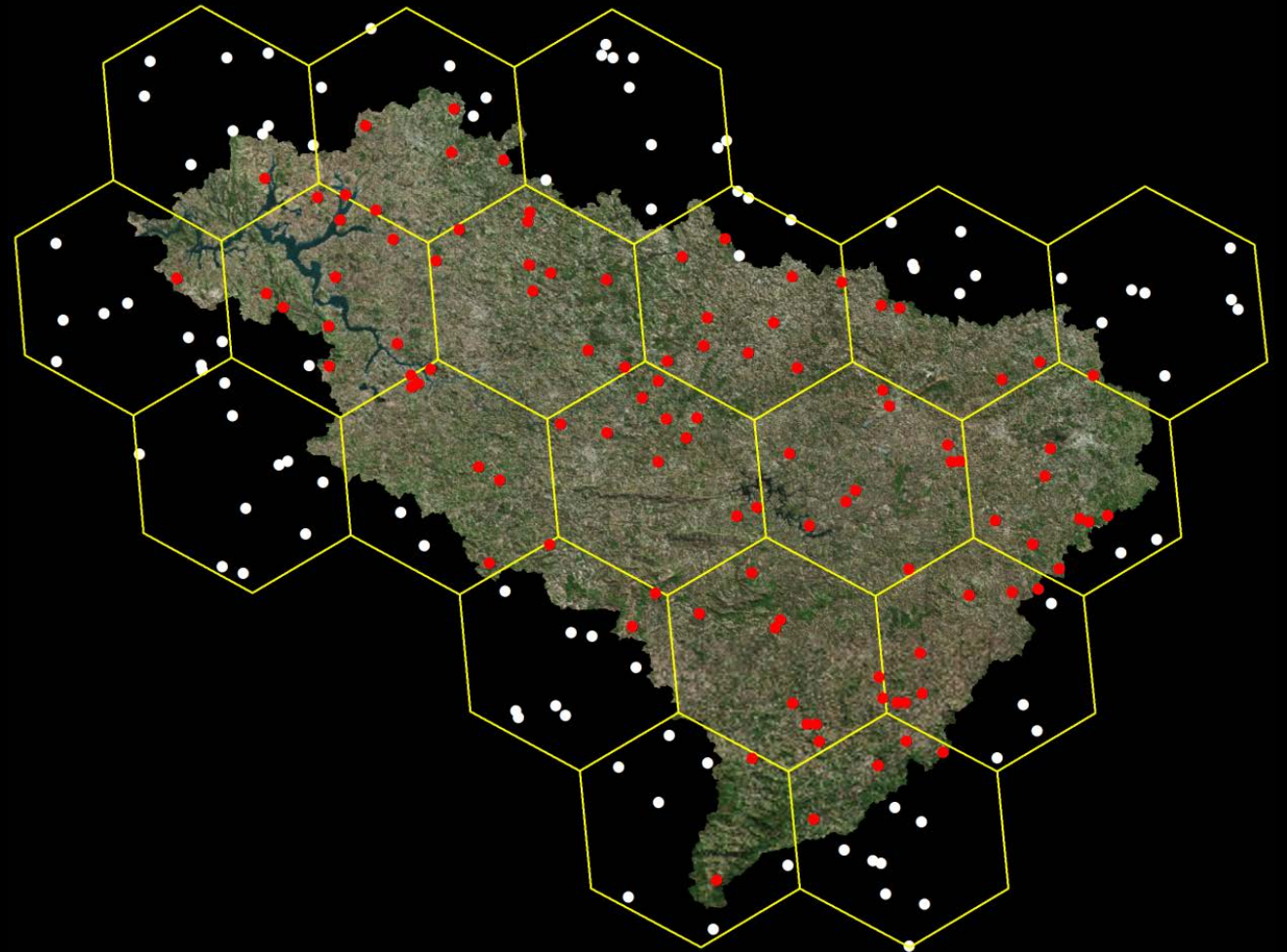
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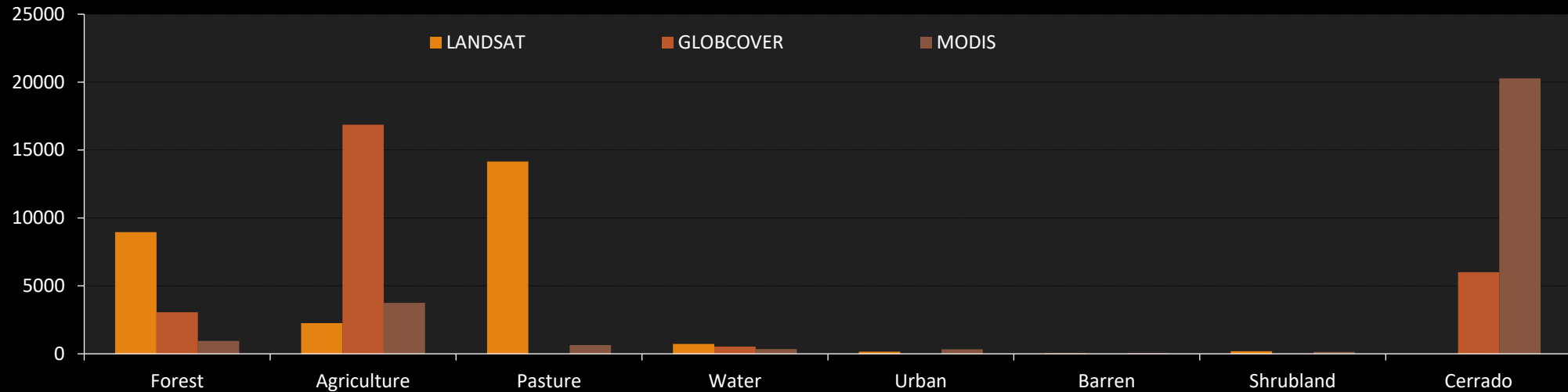
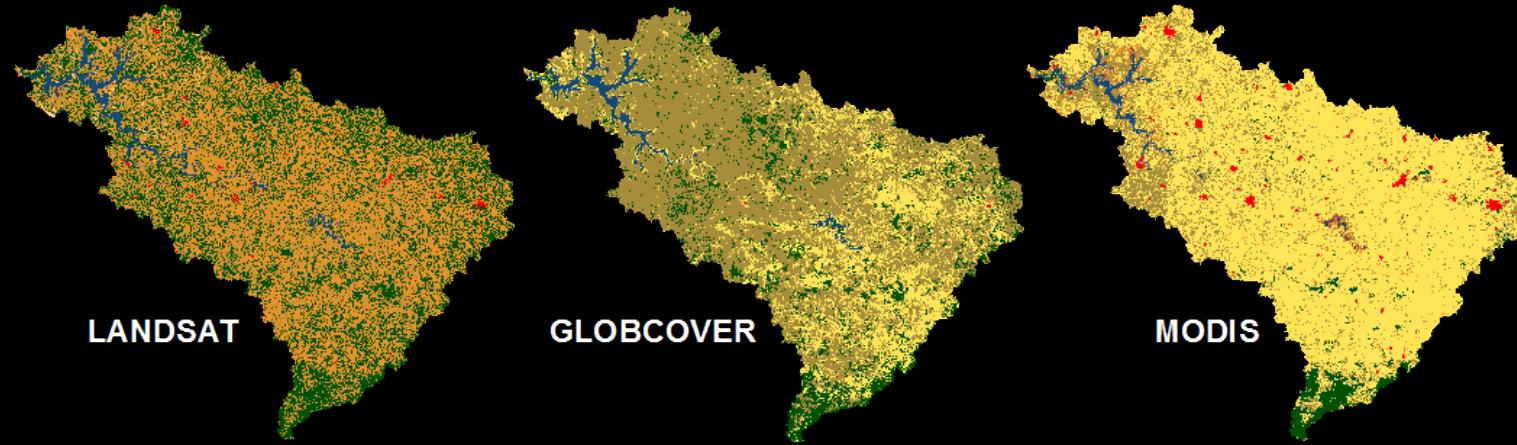


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- ACURACY ASSESSMENT POINTS:
  - 19 HEXAGONS
    - 10 RANDON POINTS FOR EACH
  - 103 POINTS WITHIN THE BASIN
    - 94 CERTAIN POINTS

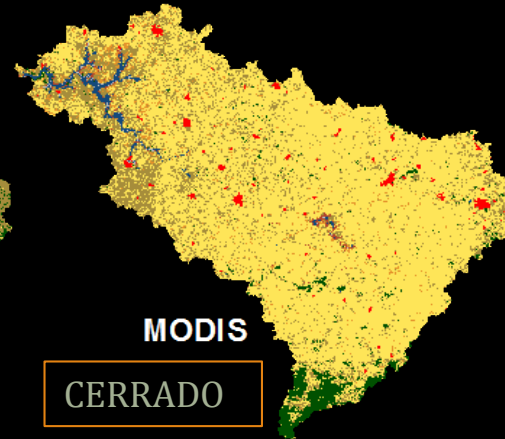
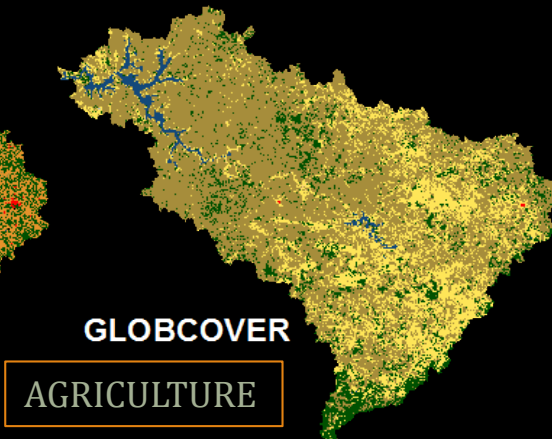
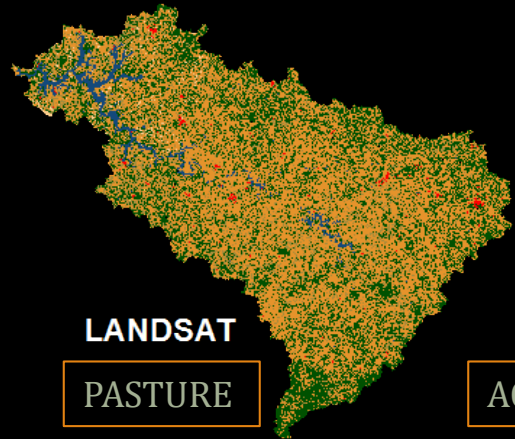


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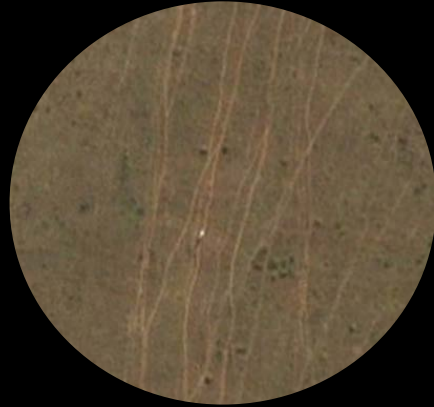




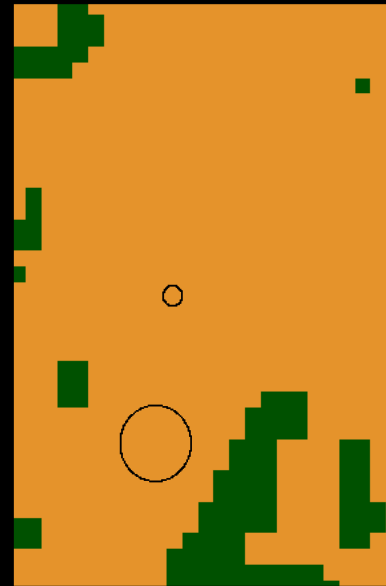
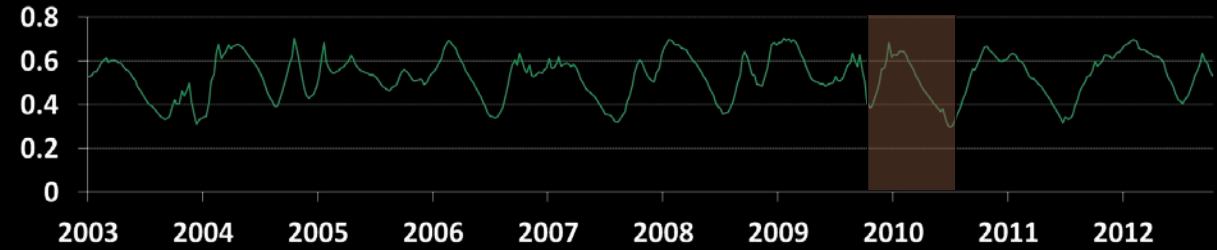
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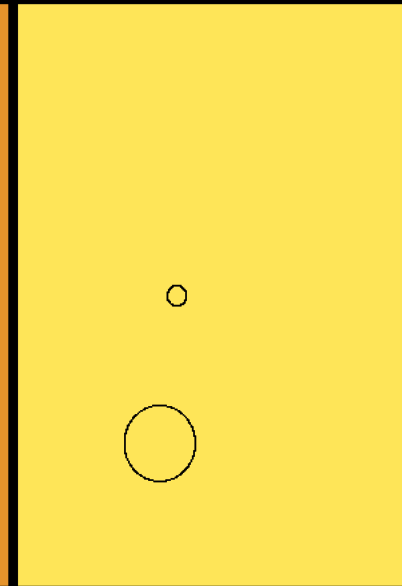


NDVI = Normalized Difference Vegetation Index



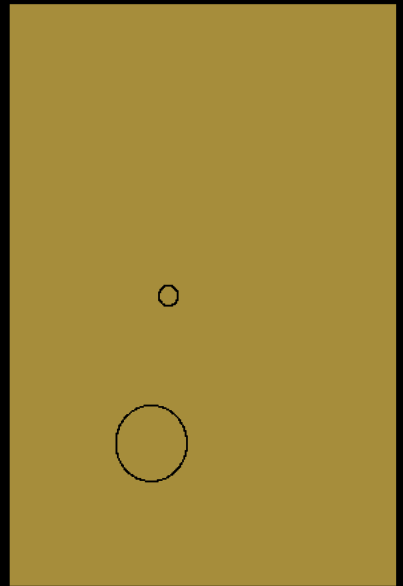
PASTURE

LANDSAT



AGRICULTURE

GLOBCOVER



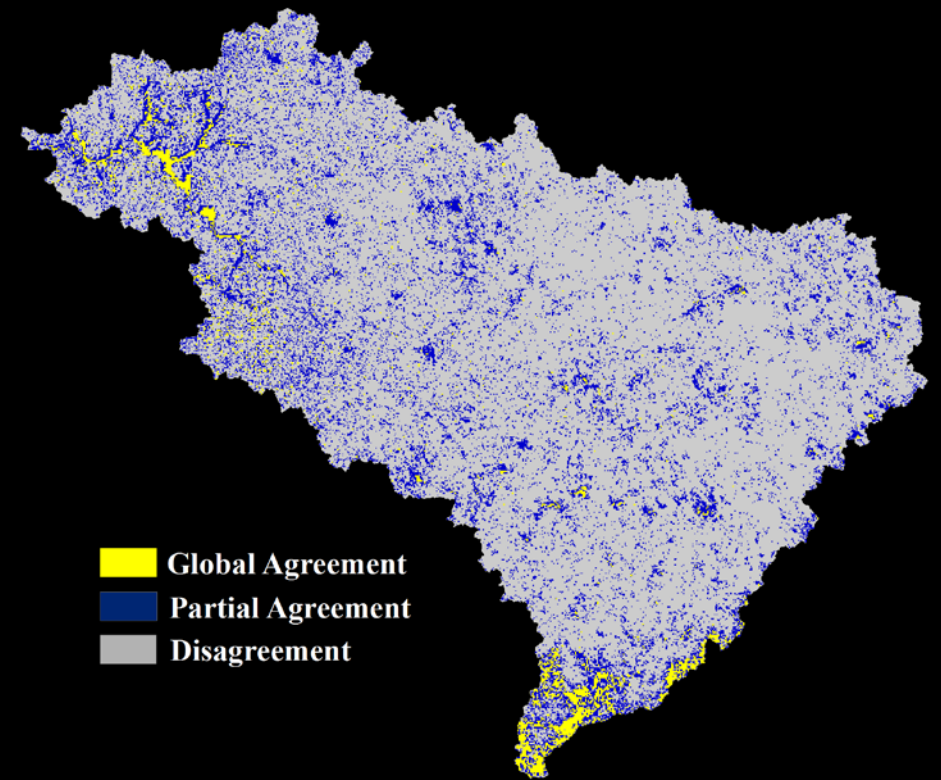
CERRADO

MODIS

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**Table 1** – Accuracy evaluation.

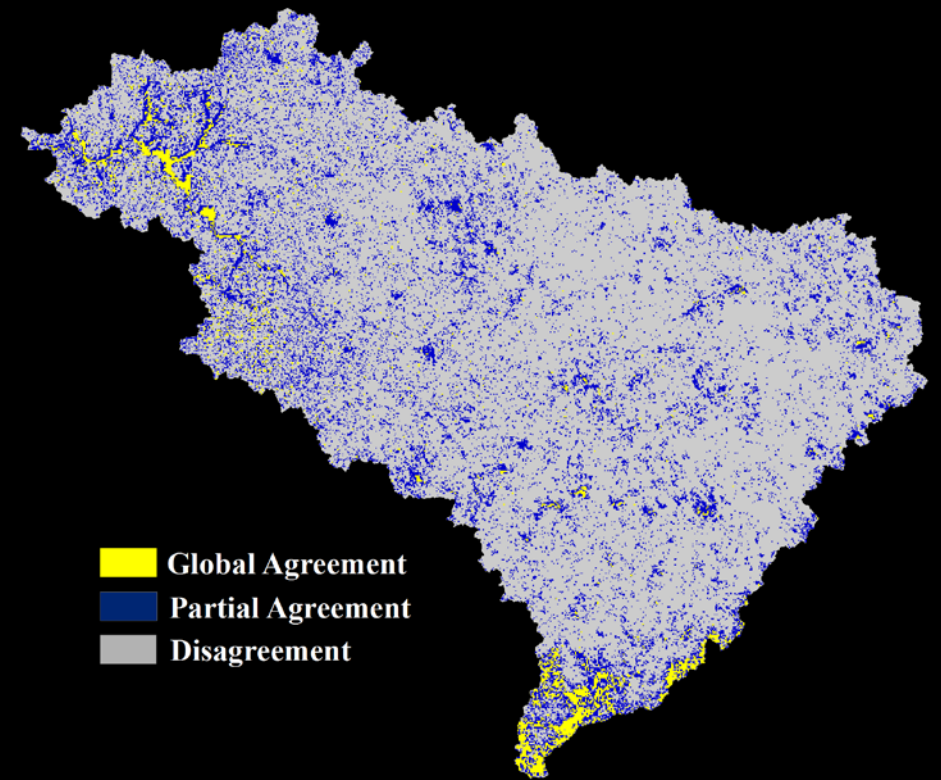
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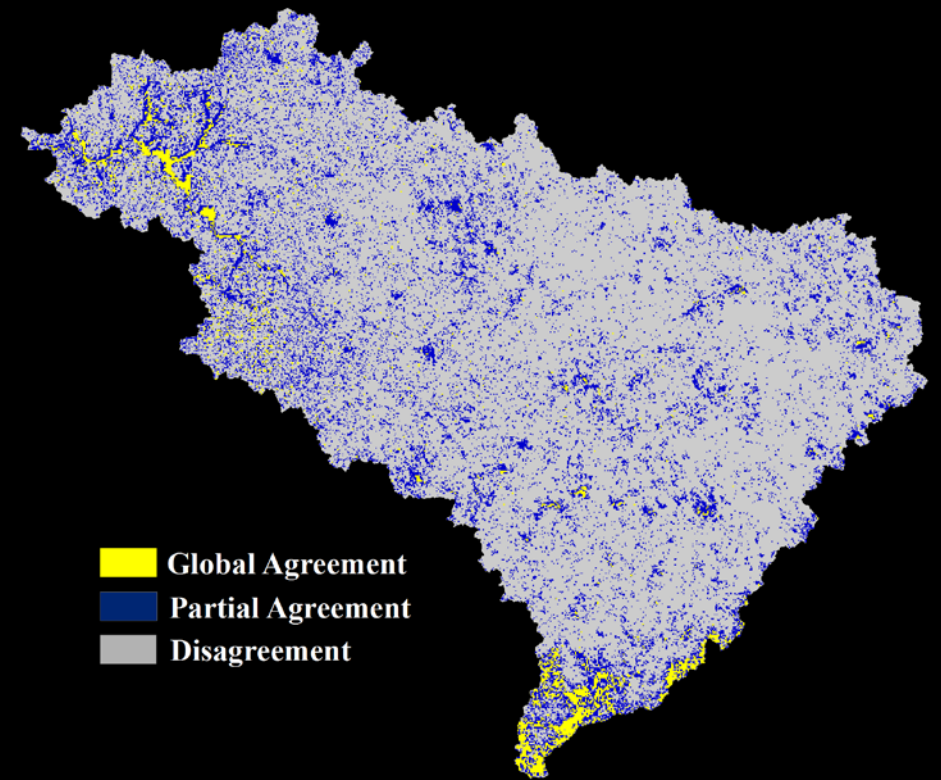


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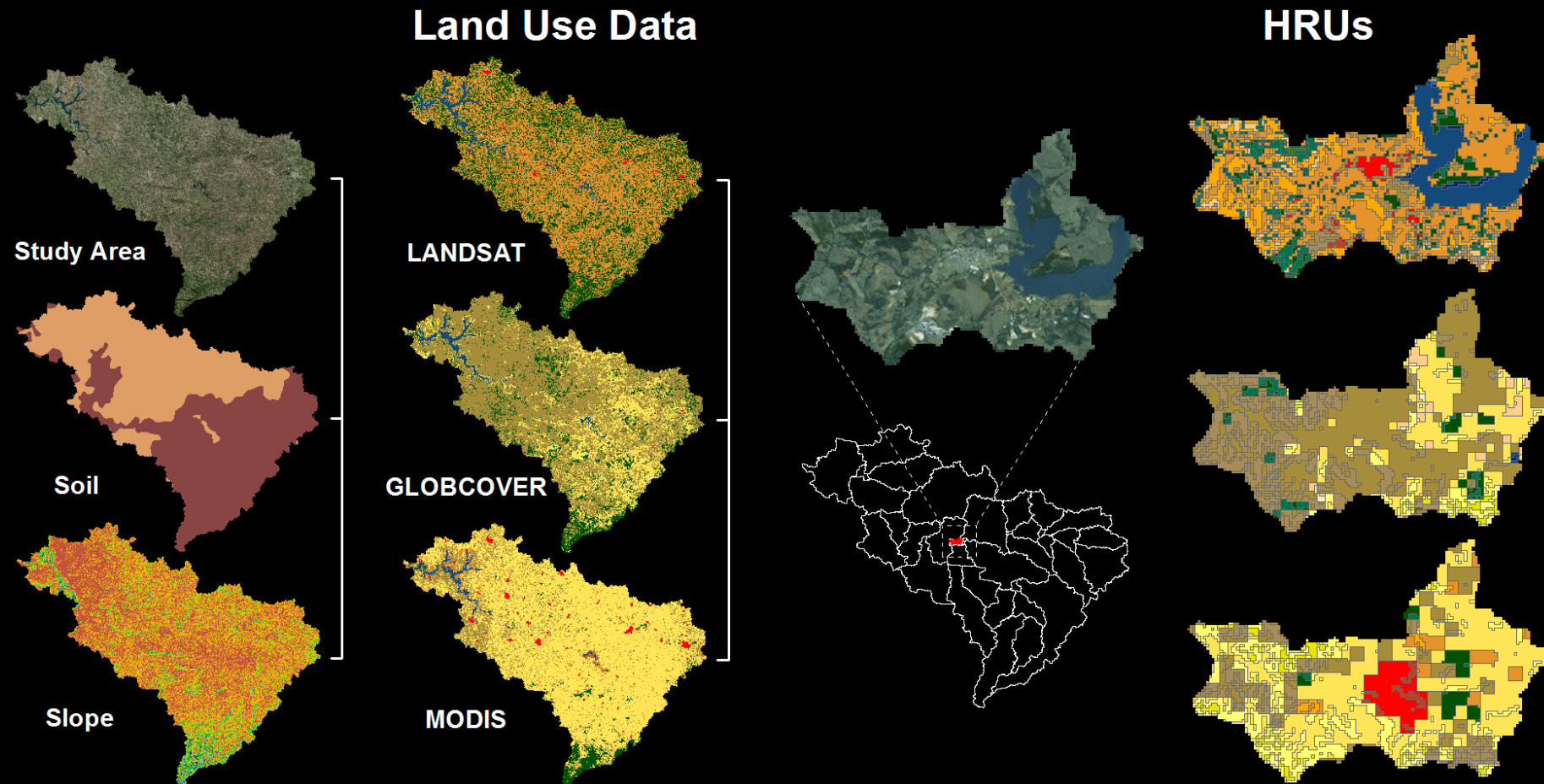
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MODIS CONSIDERED  
MOST AREAS AS SAVANNA  
INSTEAD OF PASTURE...  
BETTER INDEXES!?

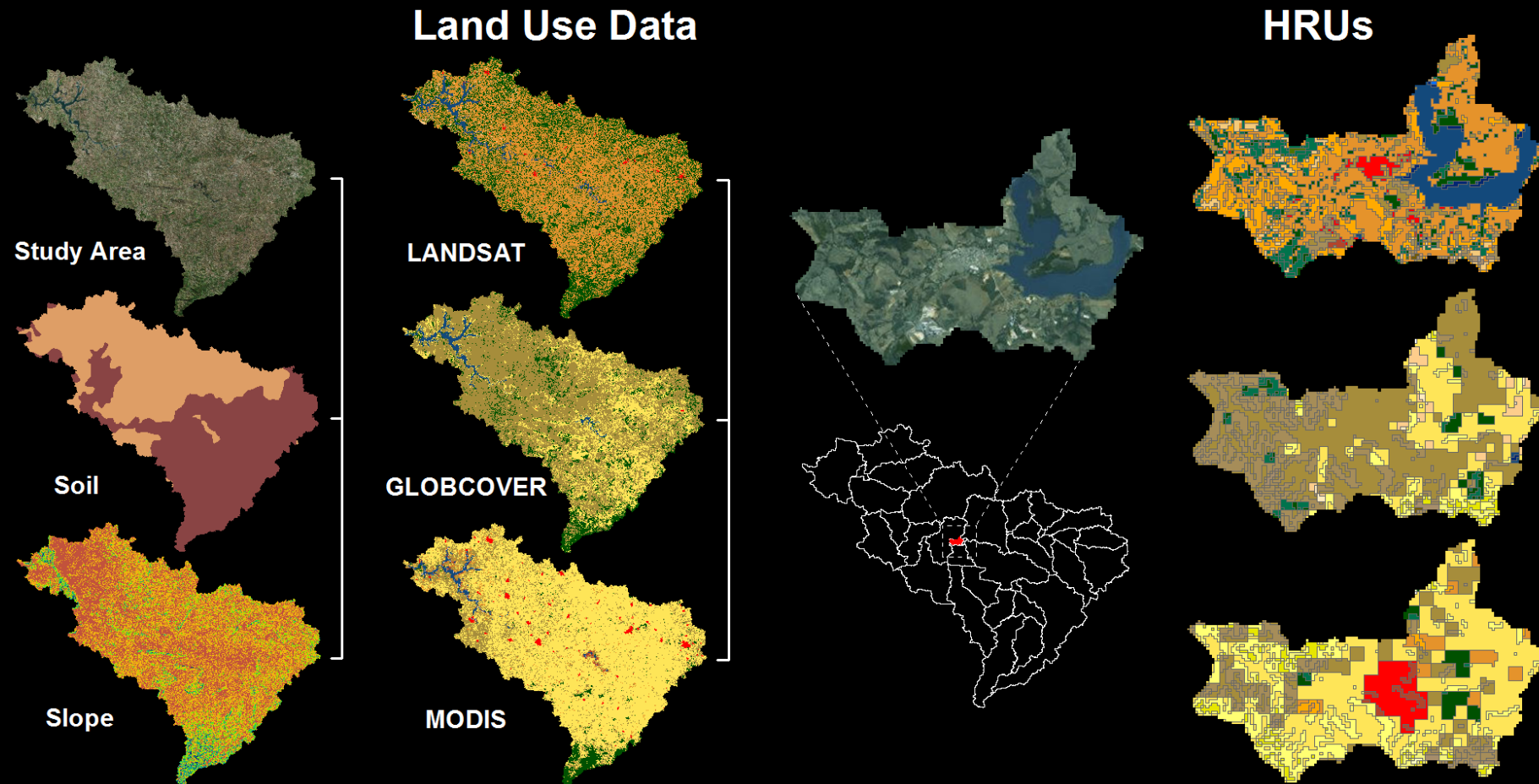


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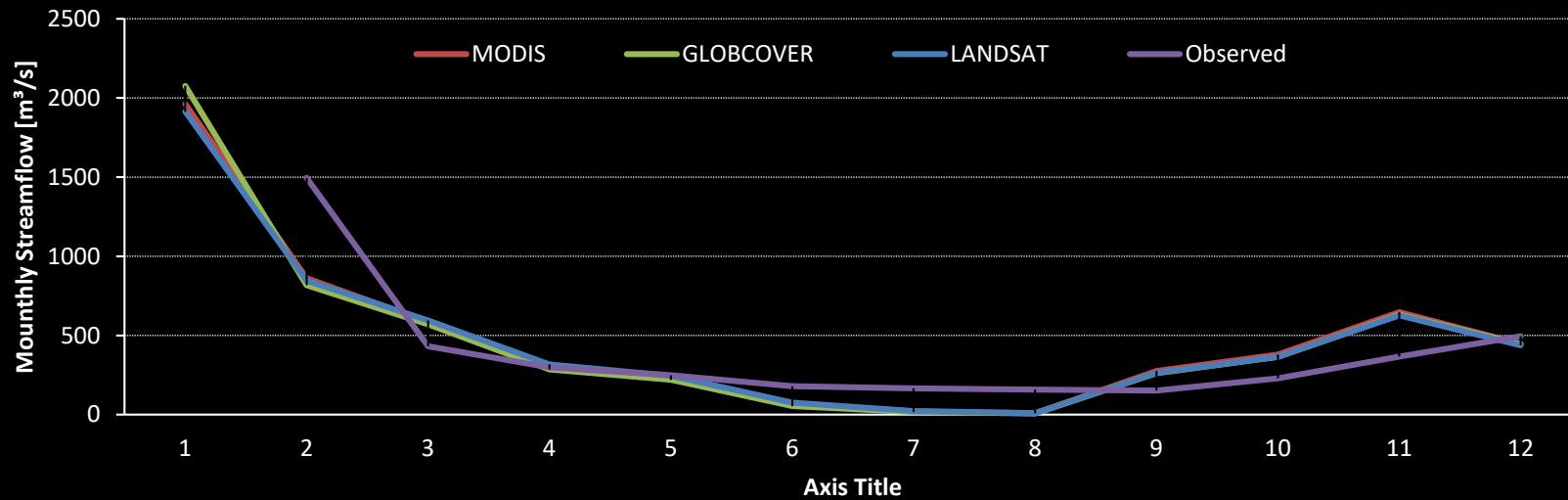


# LUCC DATABASE OF UPPER GRANDE RIVER BASIN

	TOTAL_HRUs	HRU	RESOLUTION
LANDSAT	1277	21	30
GLOBCOVER	919	19	300
MODIS	1215	18	500



# LUCC DATABASE OF UPPER GRANDE RIVER BASIN



Observed –  $312 \text{ m}^3\text{s}^{-1}$   
 LANDSAT -  $369.9 \text{ m}^3\text{s}^{-1}$   
 GLOBCOVER -  $379.5 \text{ m}^3\text{s}^{-1}$   
 MODIS -  $379.1 \text{ m}^3\text{s}^{-1}$

	LANDSAT	MODIS	GLOBCOVER	
E		-1.01	-1.16	-1.44
R <sup>2</sup>		0.57	0.56	0.54



# LUCC DATABASE OF UPPER GRANDE RIVER BASIN

- NEXT STEPS:
  - PARAMETER SENSITIVITY ANALYSIS;
    - Does the Landsat product reduce uncertainties?
    - Does the calibration is more efficient?
  - CALIBRATE AND VALIDATE;
  - PRODUCE PRODUCT DATA FOR THE WHOLE AREA – 2010;
    - 1975
    - 1980
    - 1985
    - 1990
    - 1995
    - 2000
    - 2005
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# THANK YOU!

DETECTION OF THE ROLE IN CLIMATE CHANGE AND LAND USE AND LAND COVER CONDITIONS IN THE PARANA RIVER BASIN HYDROLOGY

[1] PAST LULC CHANGES AND THE IMPACT ON HYDROLOGY



[2] POTENTIAL IMPACTS OF CLIMATE CHANGE SCENARIOS



[3] EFFECTS OF LARGE-SCALE CLIMATE VARIABILITY



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