



The role of climate and land use changes on the hydrological regime of the Parana River Basin, Brazil: Project goals and collaboration perspectives

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Outlines

- 1. Goals**
- 2. Motivation for the study**
- 3. Region of study and its importance**
- 4. Major gaps and research questions**
- 5. Ongoing research activities**
- 6. Potential collaborations (open discussion)**

First (of all)

La Plata River Basin



Average streamflow: $28,000 \text{ m}^3/\text{s}$; Area: $3,000,000 \text{ km}^2$

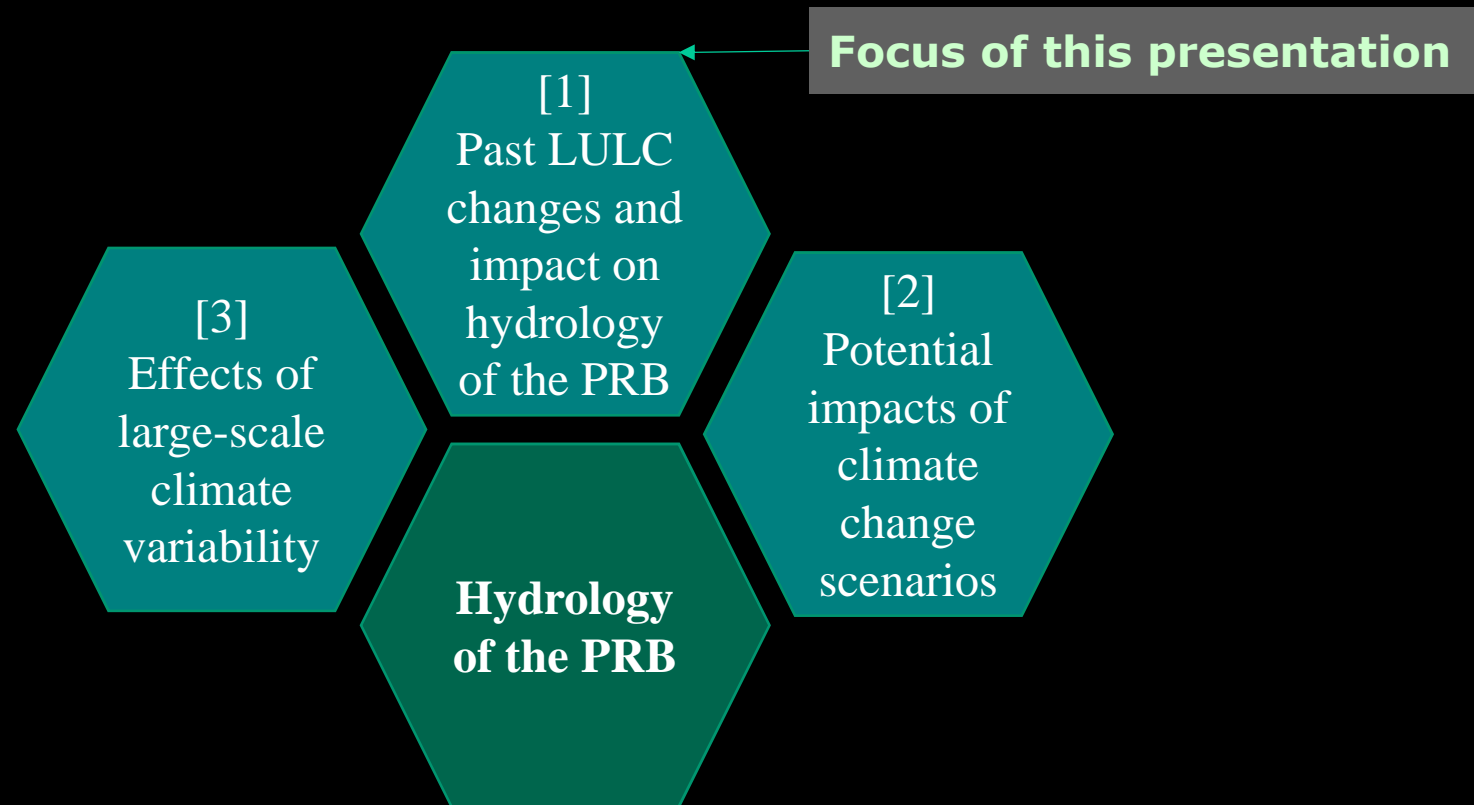
1. Goals

The main goal of this project is the evaluation of the recent hydrological past of the Paraná River Basin, by using of modeling tools and a large number of collected data, in order to determine the individual contributions, such as natural variability, climate and land use changes

- A sub basin scale will be considered in the analysis;
- Extreme hydrological events, in particular the occurrence of severe droughts will be analyzed;
- Hydrological modeling will be applied as an evaluation tool on the relative role of climate and land use changes inside the Basin.

1. Goals

Main components of the project



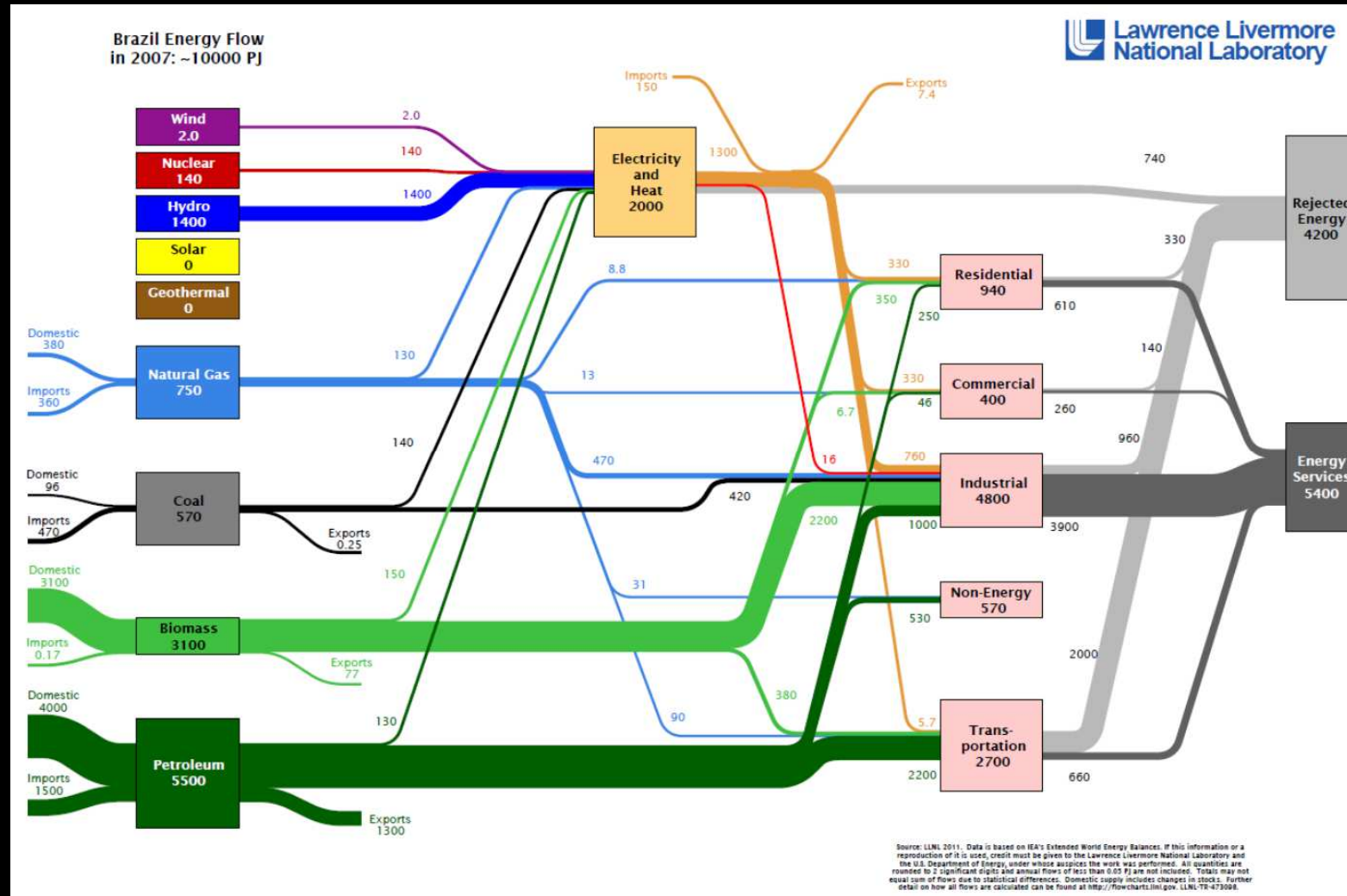
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2. Motivation

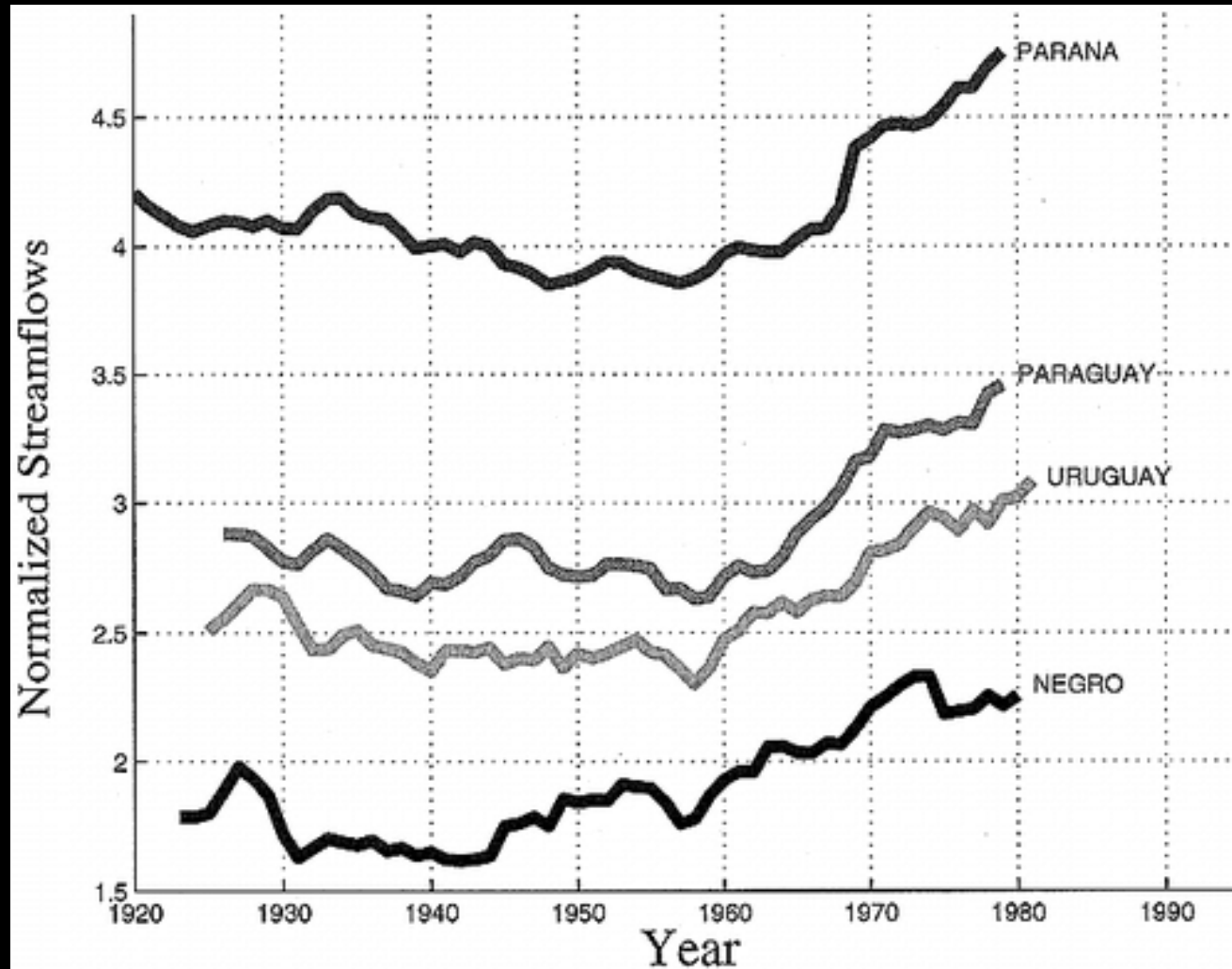
Strong dependence on hydrological conditions



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

2. Motivation

Long-term trends in streamflow



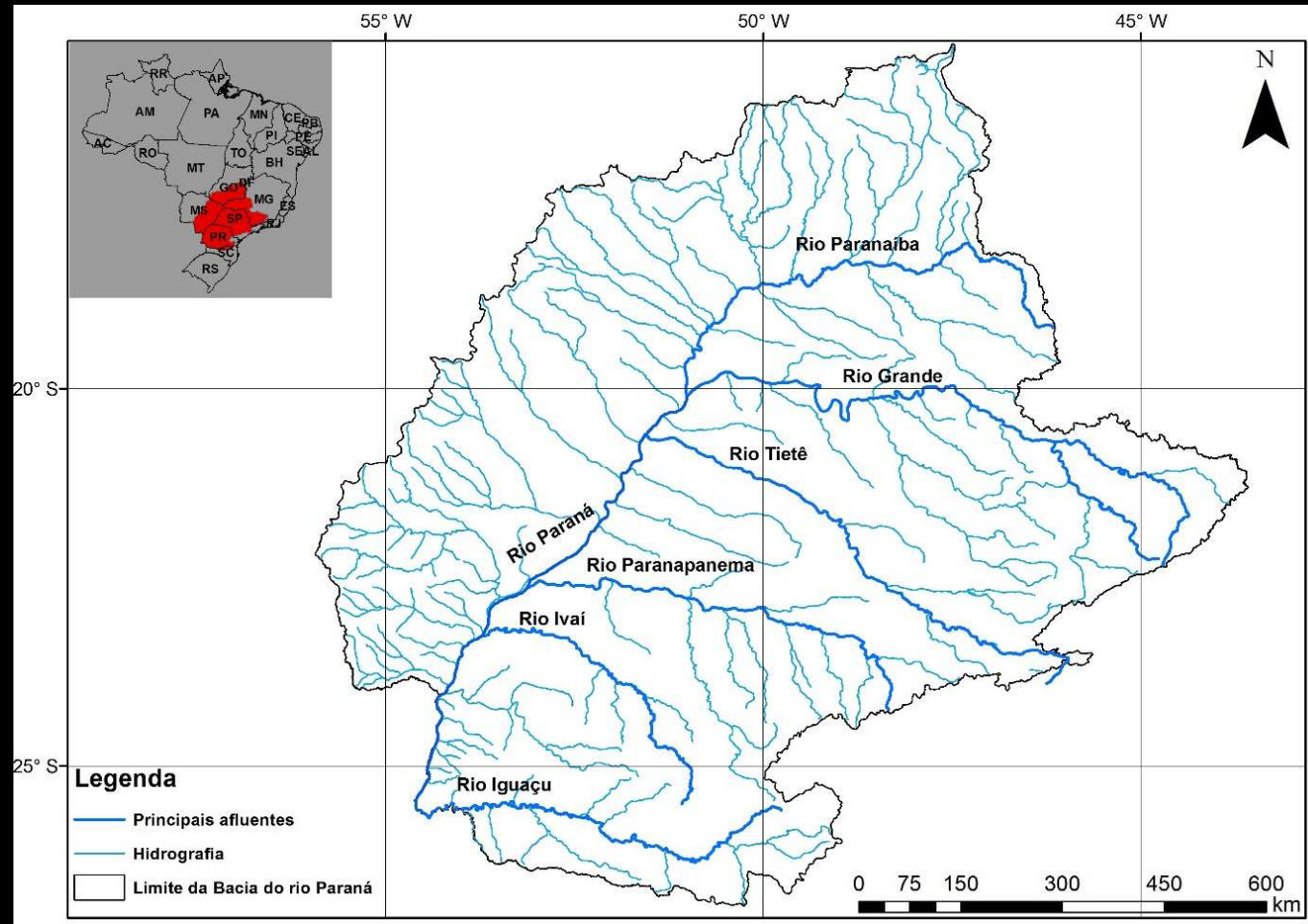
Genta, J.L., G. Perez-Iribarren, and C.R. Mechoso, 1998: A Recent Increasing Trend in the Streamflow of Rivers in Southeastern South America. *J. Climate*, 11, 2858–2862

3. Area of study

Paraná River Basin

Average streamflow: 14,000 m³/s

Area: 879.860 km²



3. Area of study and its importance

Paraná River Basin

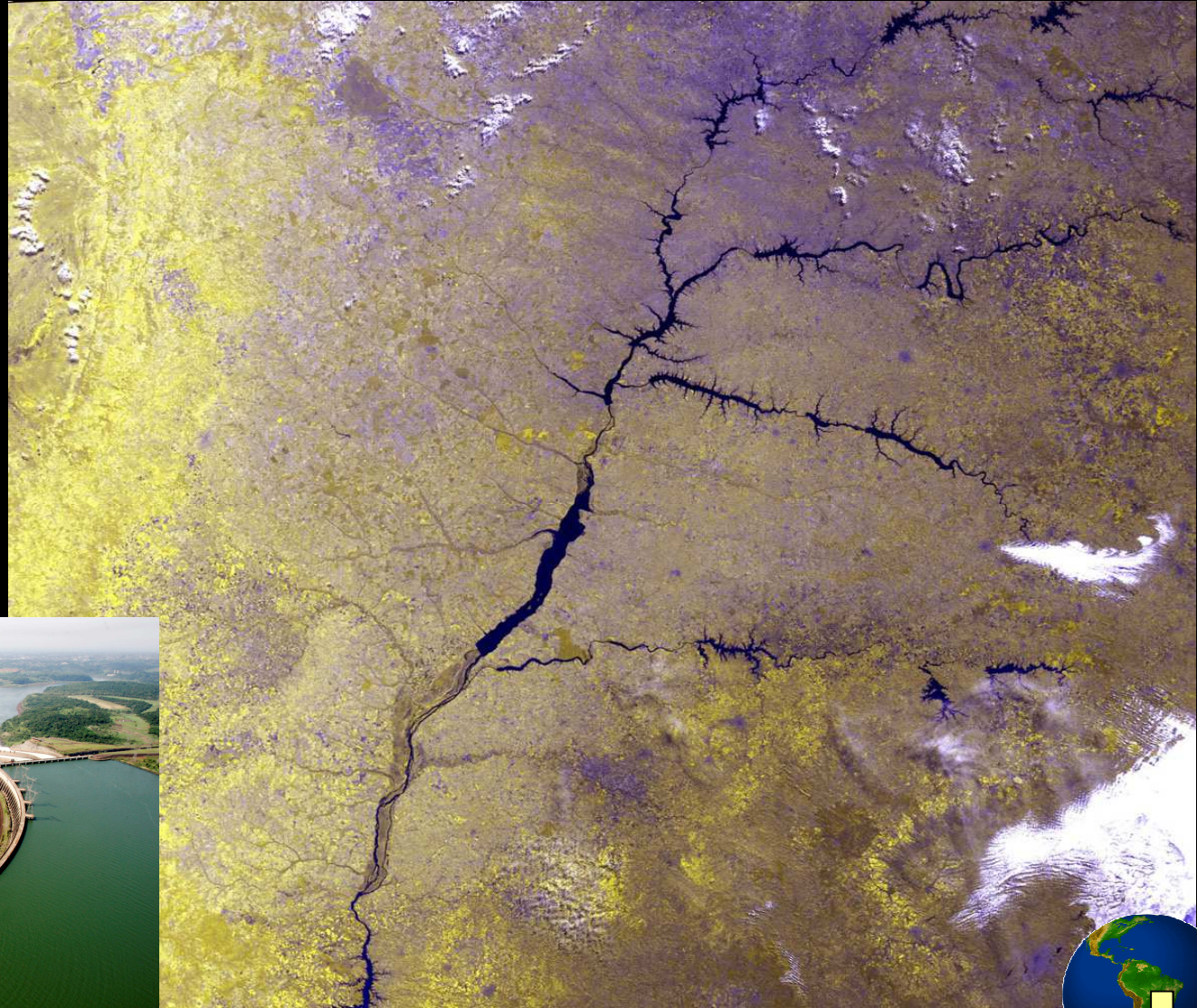
Pop.: 65 mi (32%)

Prod.: 75% of hydro

Cons.: 30% of hydro

Itaipu: 11.4 GW

(15% of the total
electricity)



3. Area of study and its importance

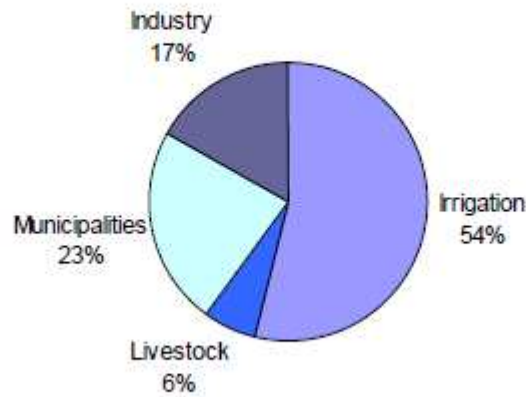
Suitable areas for planting sugar cane



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

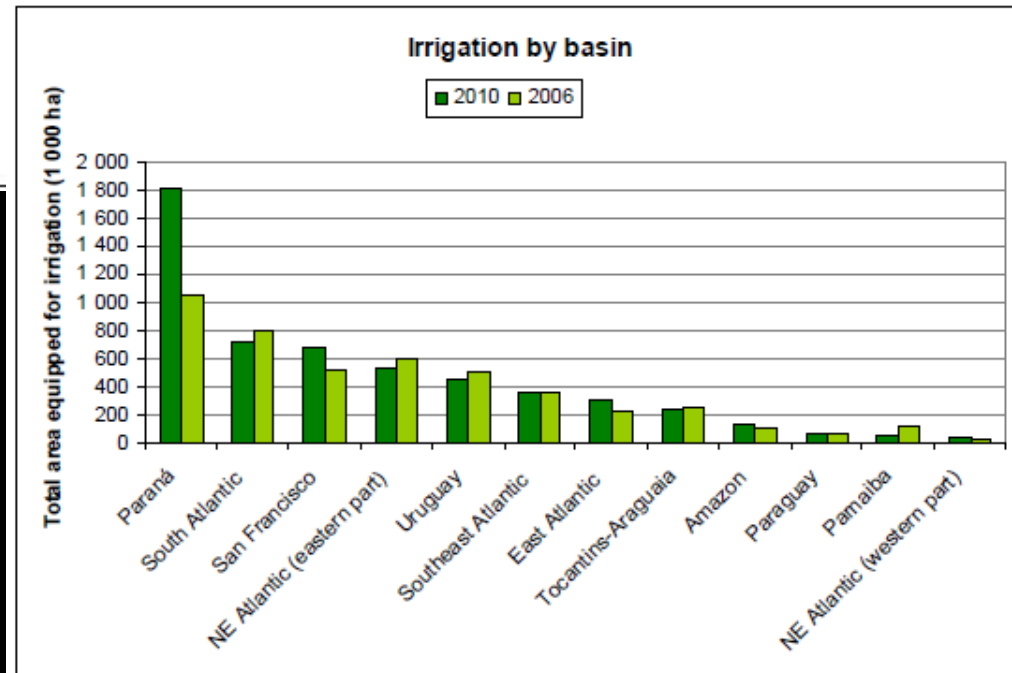
3. Area of study and its importance

FIGURE 1
Water withdrawal by sector
Total 74 830 million m³ in 2010



Water consumption in Brasil:
2,400 m³/s – more than 50%
with irrigation

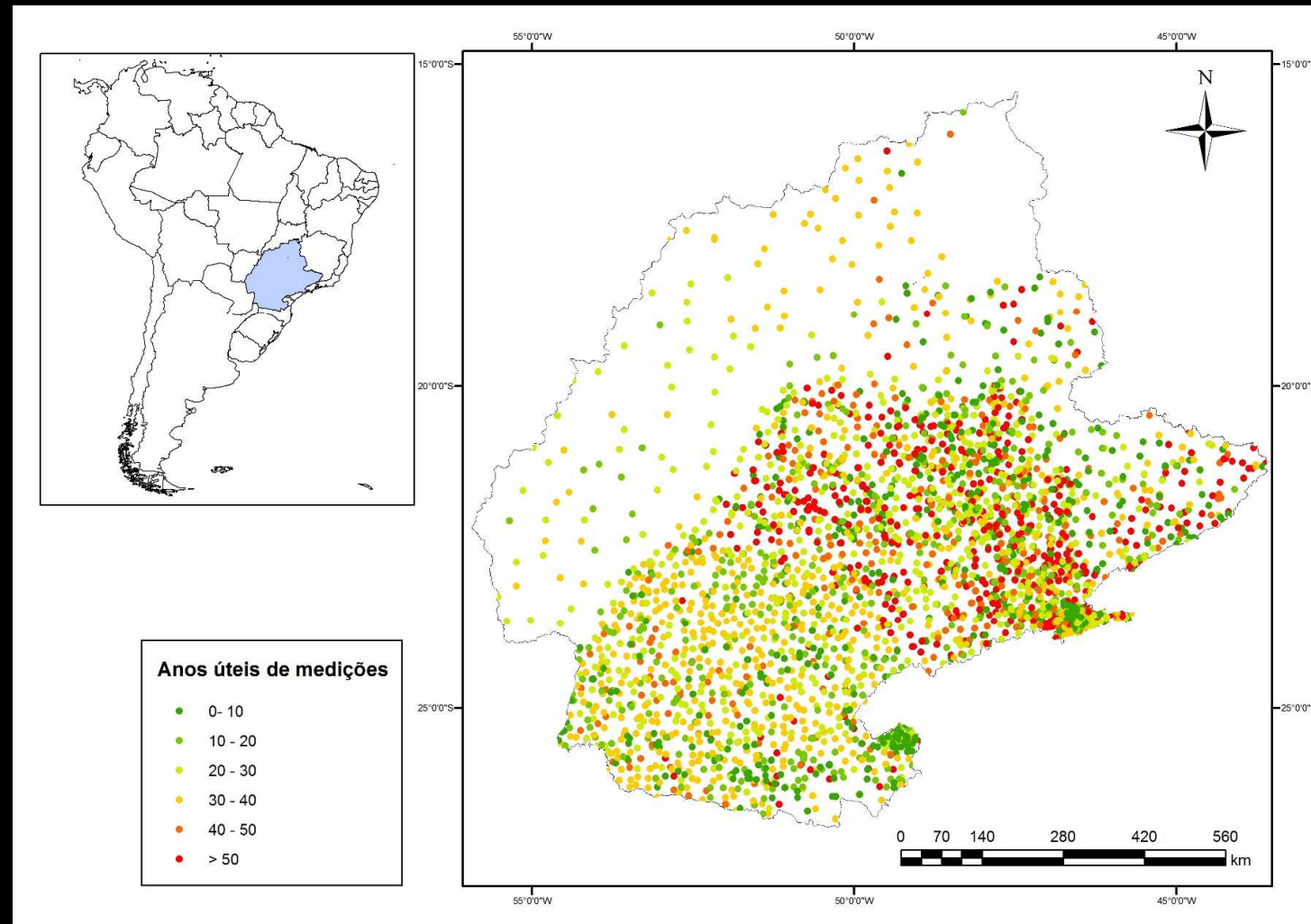
FIGURE 2
Irrigation by basin (2006 and 2010)
Total: 4 601 288 ha in 2006 and 5 400 000 ha in 2010



Source: FAO's global water information system - Land and Water Division

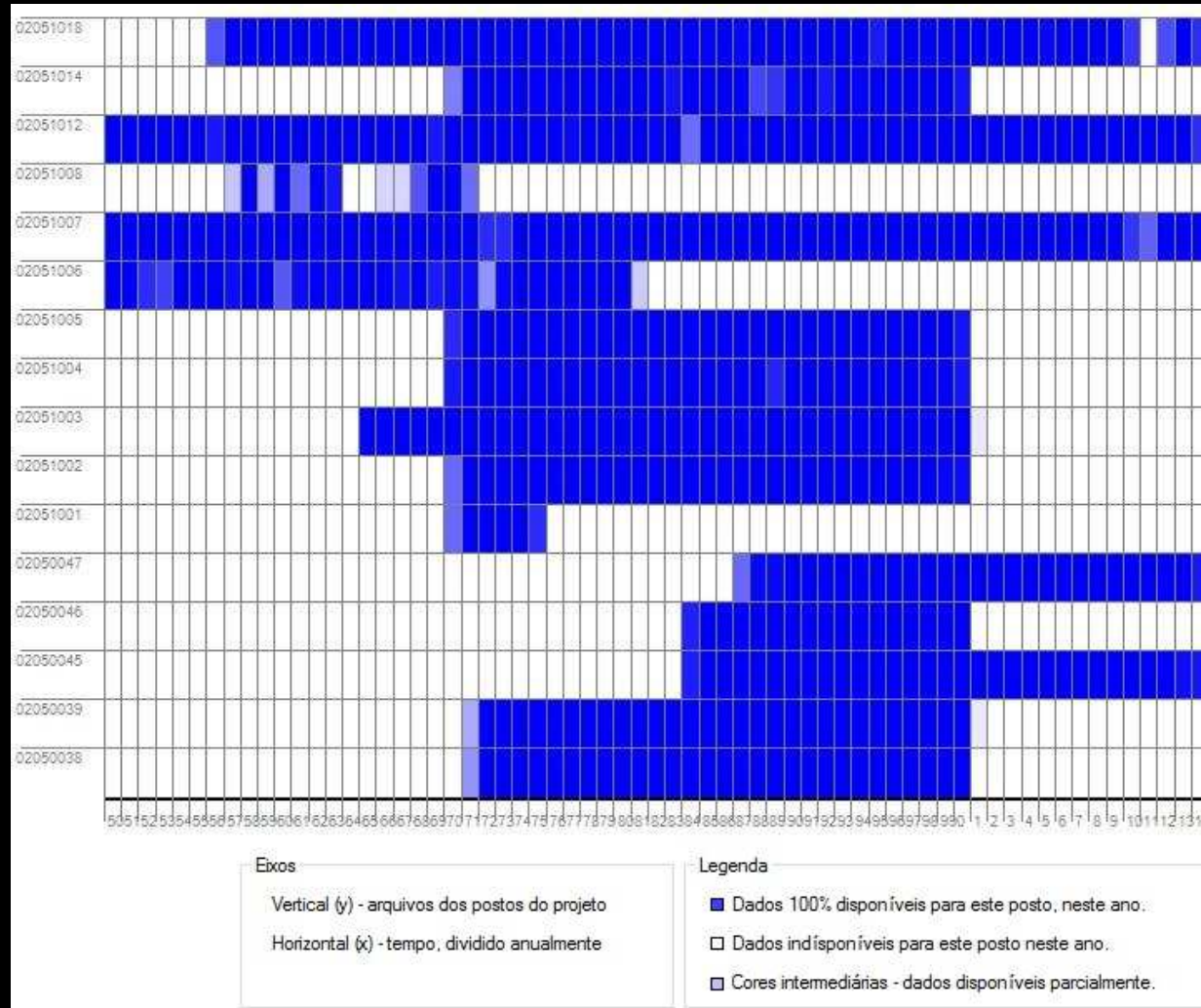
4. Major gaps and research questions

Dataset – Non-homogeneous spatial distribution, lack of long time series & discontinuities



4. Major gaps and research questions

Dataset – Non-homogeneous spatial distribution, lack of long time series & discontinuities



Total raingauges: 6000
Good quality: 1500

4. Major gaps and research questions

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 km² (≈17%)

Non-Amazonian South America deforestation:

3.6 million km² 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.

4. Major gaps and research questions

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

Original Atlantic Forest:
1,500,000 km²

About 89% of the original
forest cover has been
deforested



The major portion of human land use change in the Atlantic Rain Forest was for agriculture

4. Major gaps and research questions

Land-use/cover changes – Mechanization and erosion



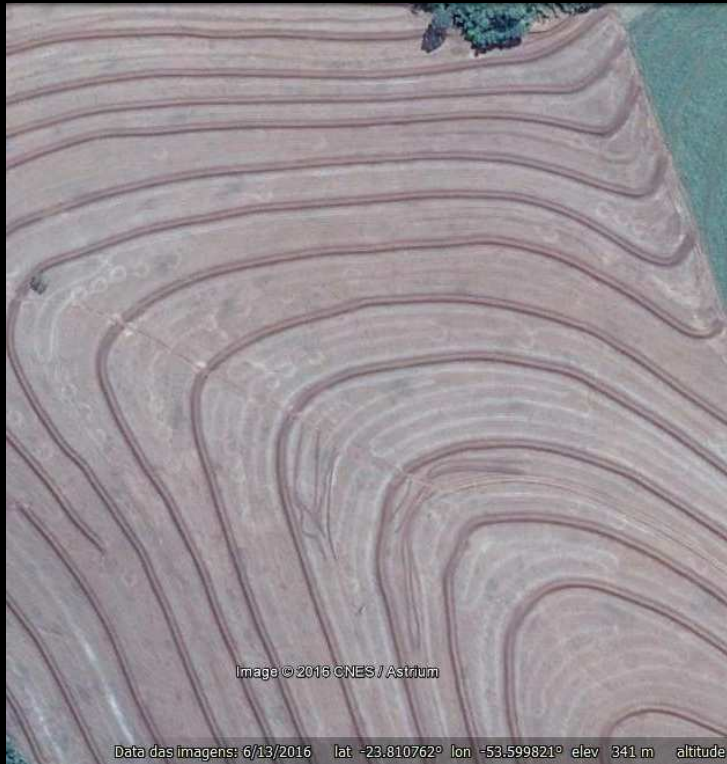
Began in the 50-60's



In the first steps of the mechanized agriculture in Brazil, crops were cultivated under no soil conservation techniques

4. Major gaps and research questions

Land-use/cover changes – Erosion control practices



Began in the 80's



Terraces retain a significant part of the surface runoff

4. Major gaps and research questions

Land-use/cover changes – Direct seeding



Began in the 80's, but only succeeded in the 90's

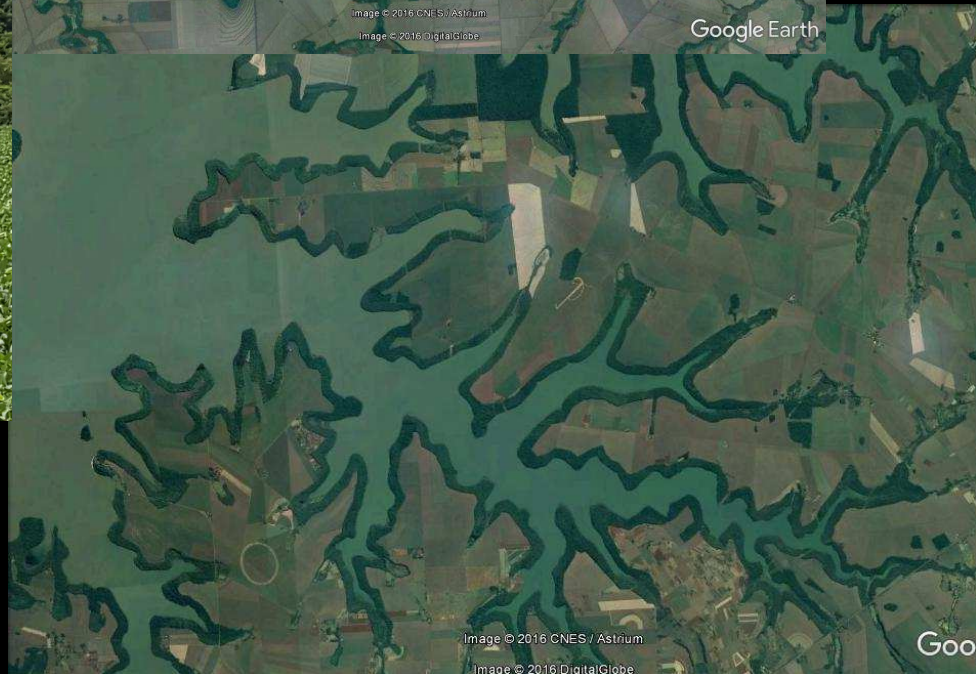


In direct seeding, soil is not tilled before planting and most of the crop residue remains on the surface

4. Major gaps and research questions

Land-use/cover changes – Areas of permanent protection - APP

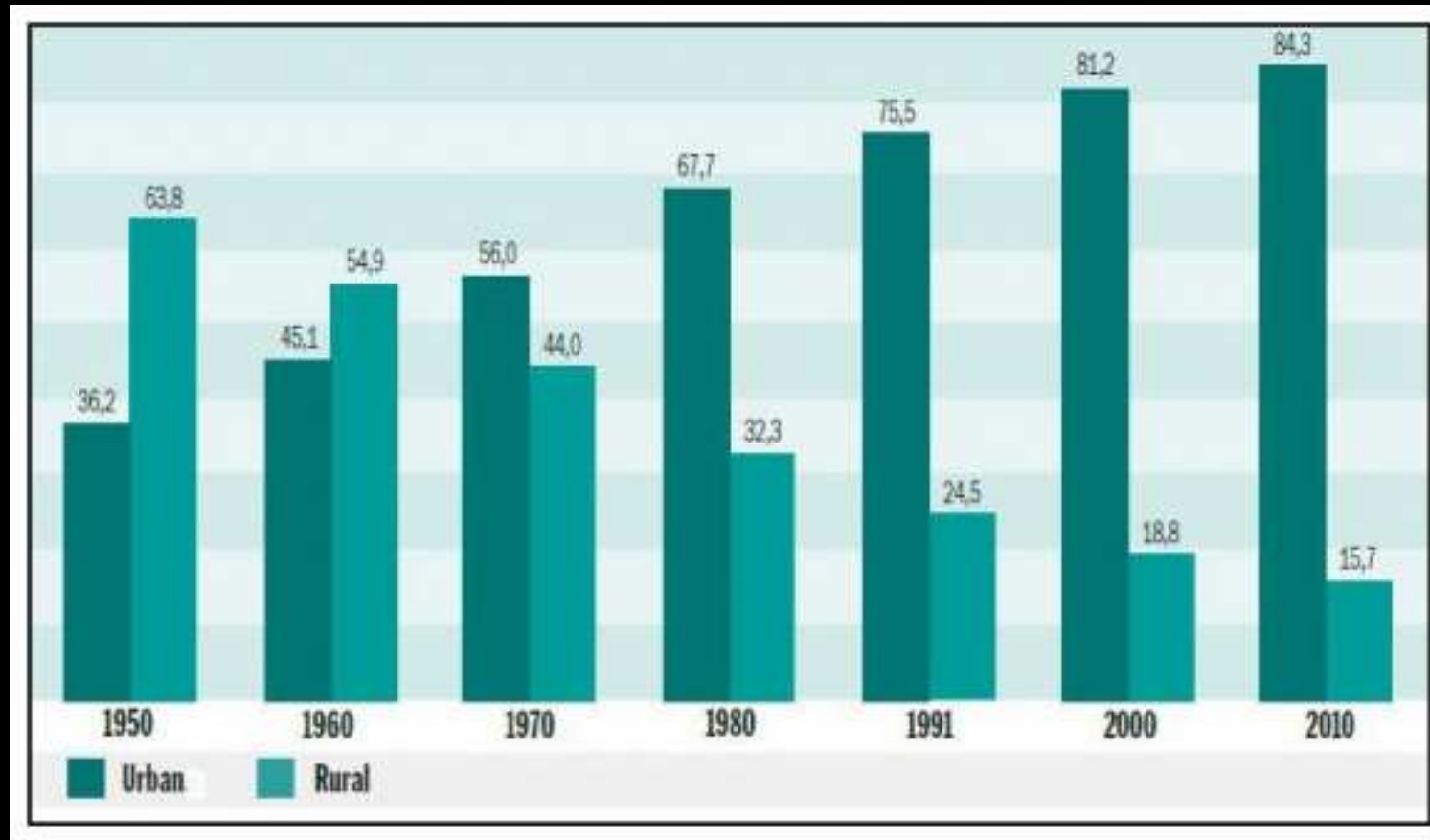
Began in the 2000's



It starts with a 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

4. Major gaps and research questions

Land-use/cover changes – Urbanization

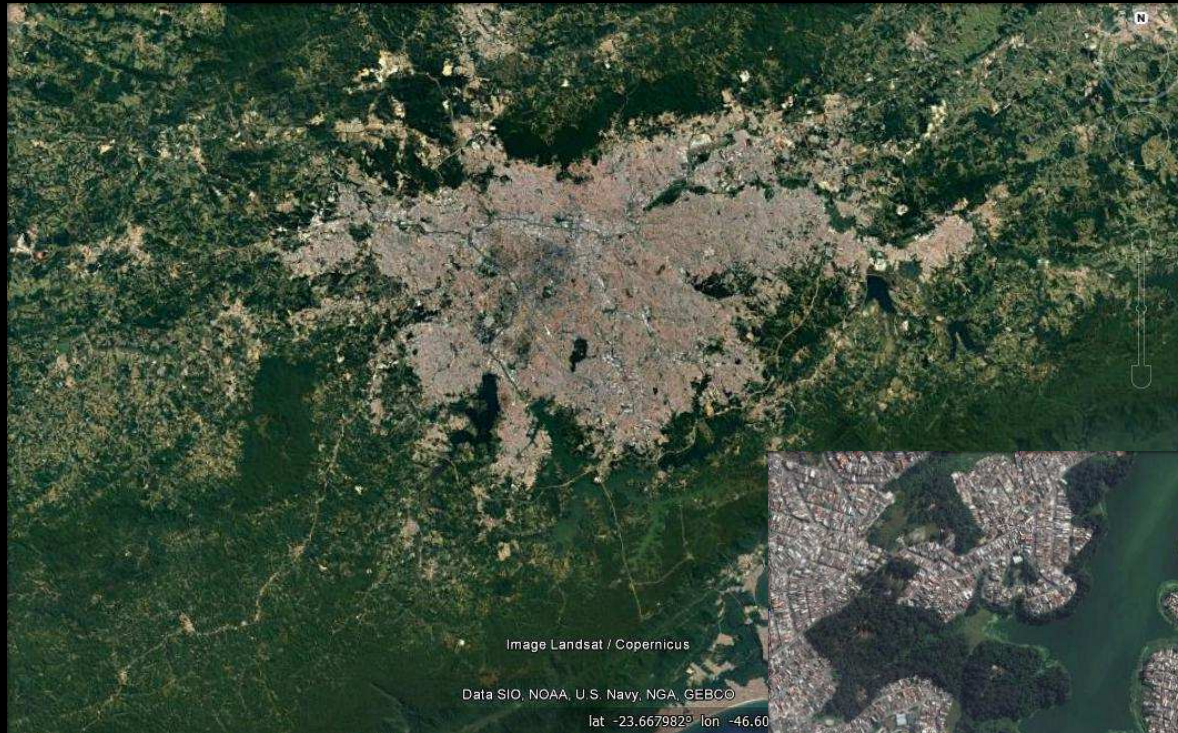


Population evolution by place of residence – Brazil, 1950 – 2010 (in %)

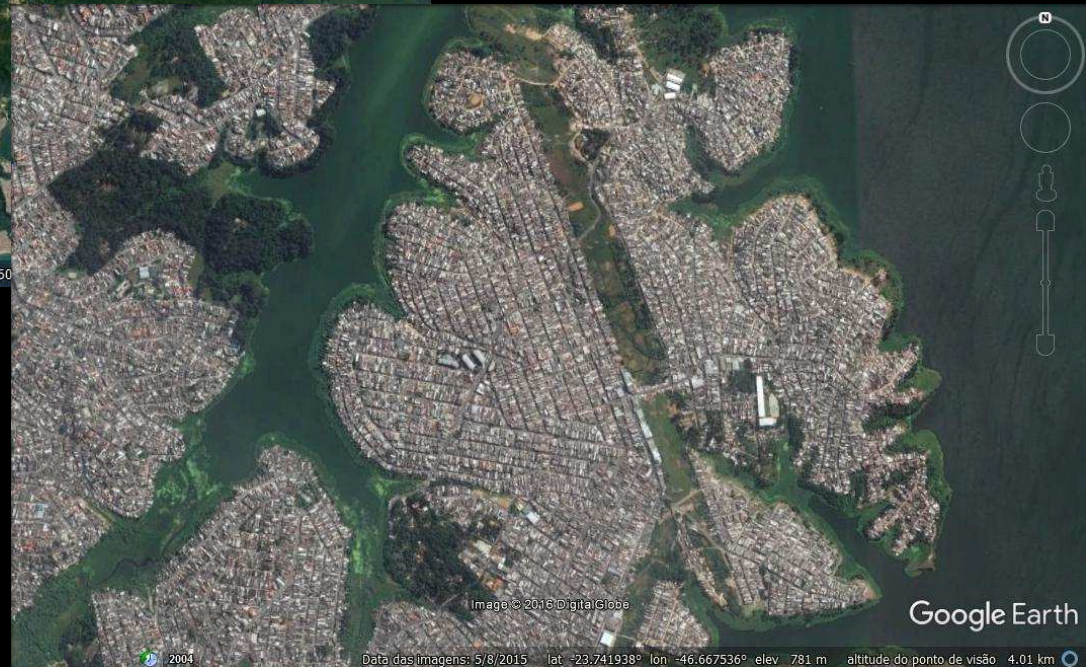
Source: DIEESE (2011, p.63), based on IBGE Censuses data.

4. Major gaps and research questions

Land-use/cover changes – Urbanization



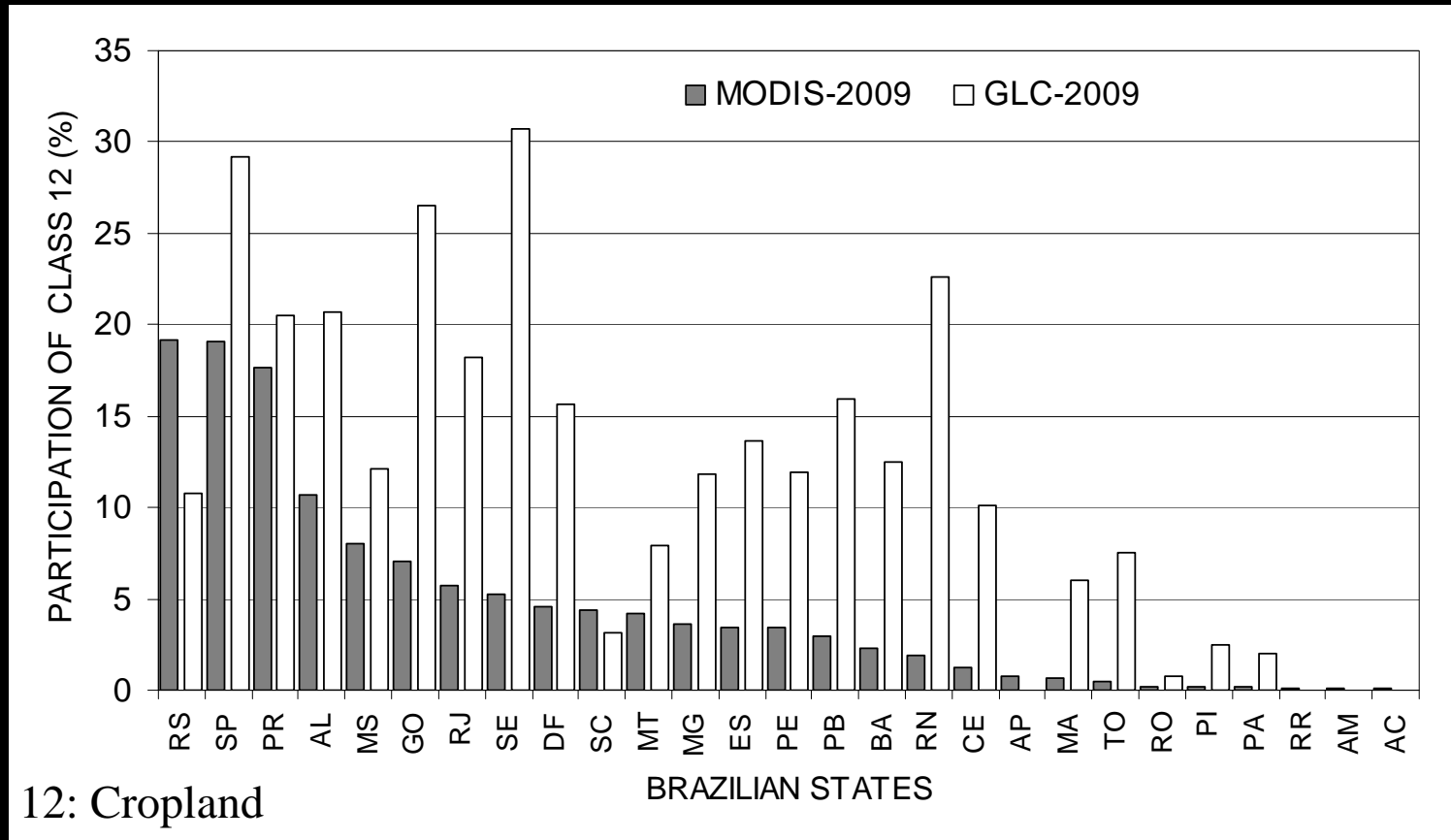
MASP



Water bodies under pressure due to rapid urbanization

4. Major gaps and research questions

Land-use/cover changes – Land Cover Database

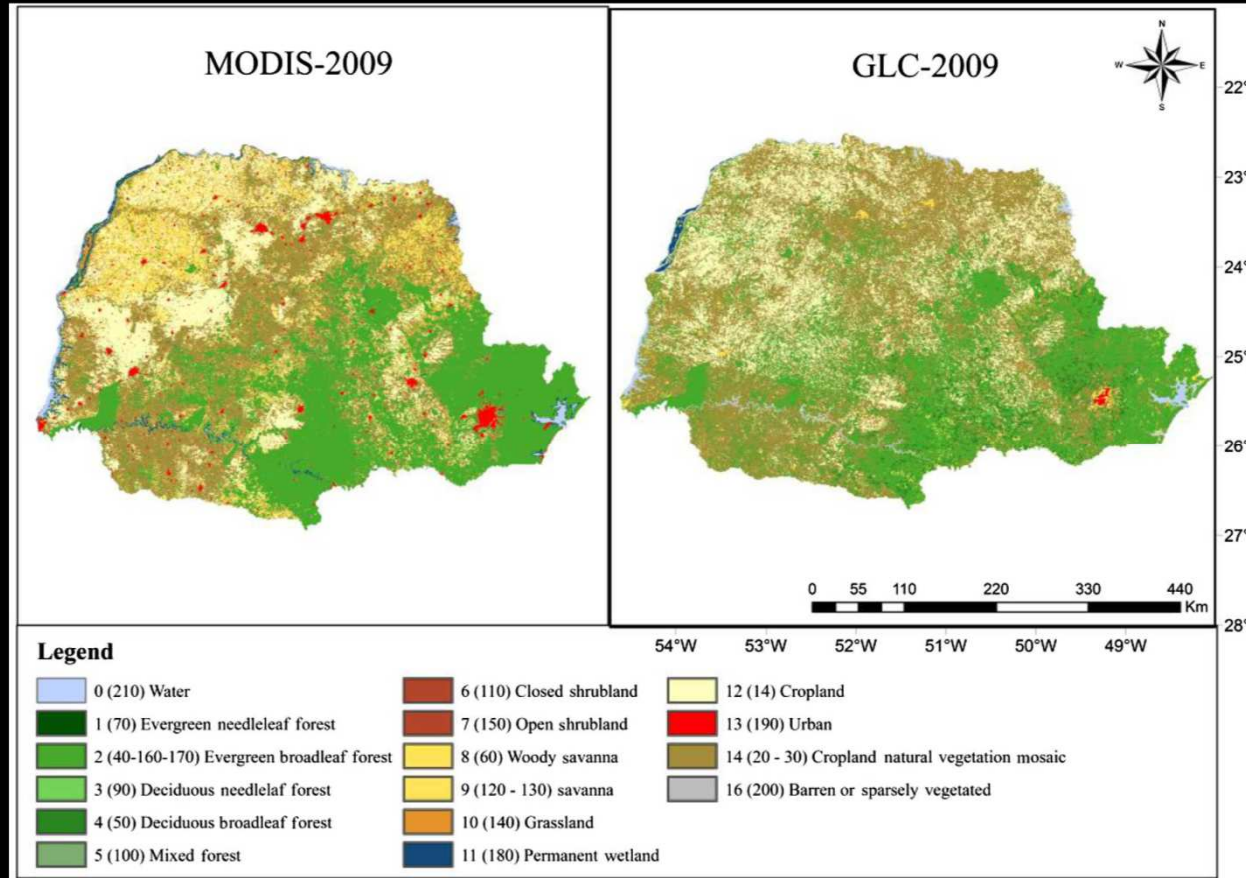


Land-use/cover changes – Disagreement in the classification of land cover classes

Capucim, M. N. et al., 2015. South America land use and land cover assessment and preliminary analysis of their impacts on regional atmospheric modeling studies. *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. Major gaps and research questions

Land-use/cover changes – 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.

4. Major gaps and research questions

Changes in extreme weather and climate events



In 2014 Brazil experienced a crisis of water shortage of unprecedented dimensions and not anticipated by the climate predictions.

4. Major gaps and research questions

Changes in extreme weather and climate events



Maximum recorded precipitation in Londrina (24h): Jan 1993 – 113,0 mm; 20/06/2012 – 205,0 mm; 12/01/2016 – 274,8 mm

Source: Angela Beatriz F. da Costa IAPAR/SIMEPAR

4. Major gaps and research questions

Water resources management – Decision-making: hard and paralyzing task



4. Major gaps and research questions

Water resources management – Closing the gaps



Improve scientific knowledge and provide technical solutions



- 1) Local technical information with spatial refinement allow specific actions in the region of interest;
- 2) Atmospheric and hydrological models calibrated for the region of interest are more suitable to water resources management;

4. Major gaps and research questions

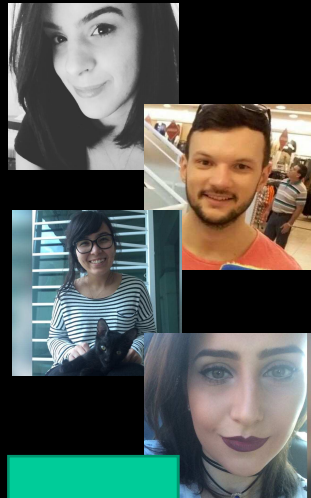
Water resources management – Closing the gaps

- 3) LUCC within non-Amazonian regions is a subject largely understudied in South America;
- 4) Considering a typical sub-basin area ($\sim 40,000 \text{ km}^2$), know the true land cover and how has it evolved over the decades of change;
- 5) To know the relative contribution of global (climate change) x local forces (LUCC) to amplify or attenuate the changes in hydrological cycle;
- 6) Know the consequences of the intense urbanization process for water flows (irrigation, energy & water supply).

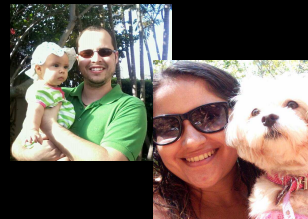
5. Ongoing research activities

Team

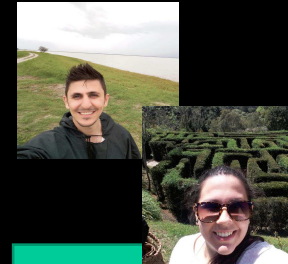
Master's Degree students



Pos-doc



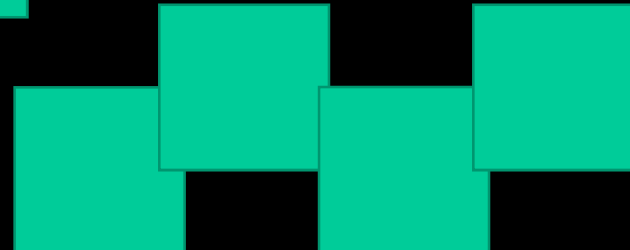
PhD students



Coordinators

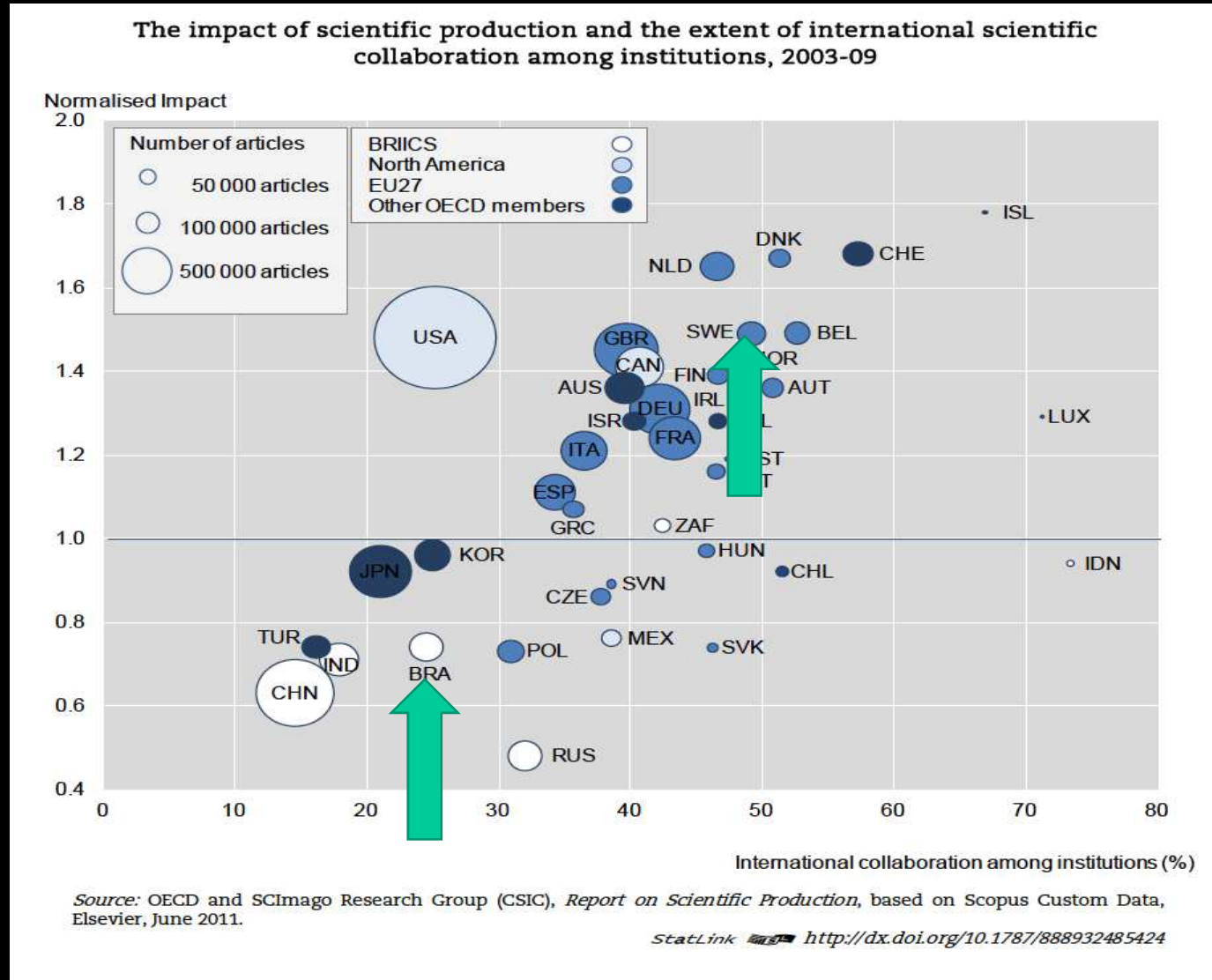


New partners



5. Potential collaborations (open discussion)

Worldwide scientific collaboration



5. Potential collaborations (open discussion)

Funding agencies

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Personnel

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“Using the past to safeguard the future”



Thank you for your attention!

Acknowledgment:

