

Impacts of Climate Changes and Extreme Weather Events in Brazil

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CEMADEN



- Underpin capability in climate modelling in Brazil;
- Gain understanding of recent climate changes and Brazil's role in mitigation activities;
- Understanding the risk and causes of climate-related extremes and impacts



Work package 1: Improved carbon cycle modelling to inform mitigation policy



Work package 3: Climate impacts and disaster risk reduction

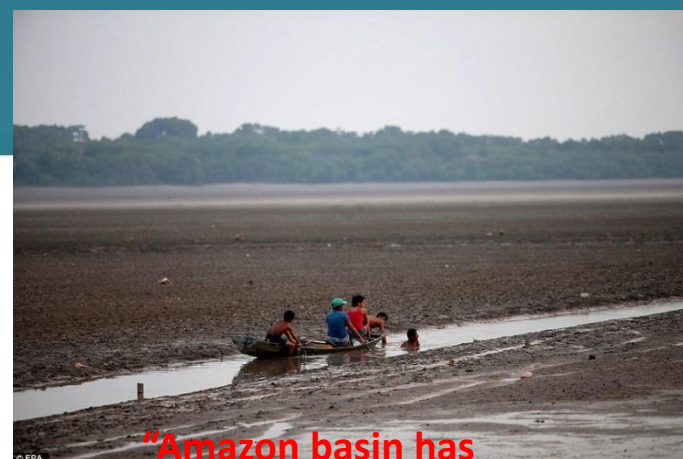


Work package 2: Climate modelling



“Unprecedented wet conditions are reported in the 2014 summer (December–March) in South-western Amazon, with rainfall about 100% above normal.”

Espinoza et al., Environ. Res. Let., 2014



“Amazon basin has

experienced several intense droughts among which were highlighted last recent ones in 2005 and 2010.”

Panisset et al - EGU2017 proceedings.

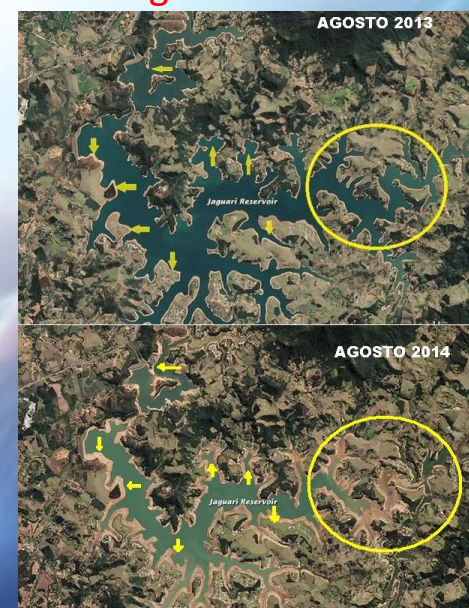


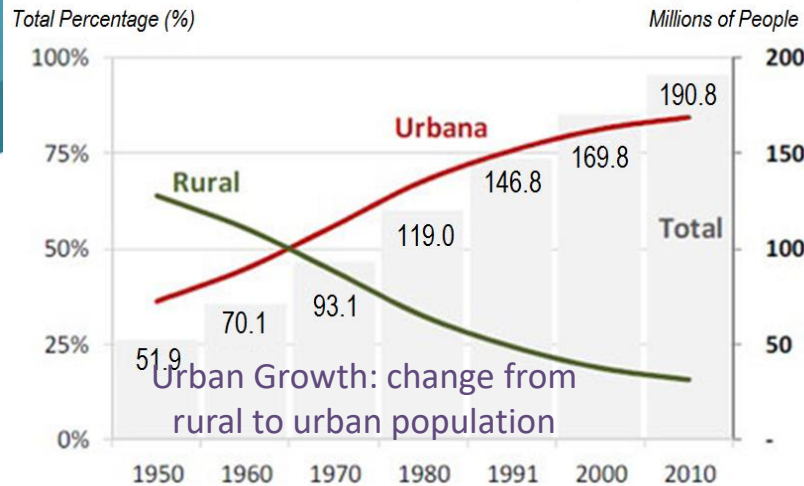
Floods and flash floods represent 32% of ND
Source: Brazilian Atlas of ND

“The drought conditions that started in 2010 in northeastern Brazil persisted in 2016” - STATE OF THE CLIMATE IN 2016 - Special Supplement to the Bulletin of the American Meteorological Society, 2017

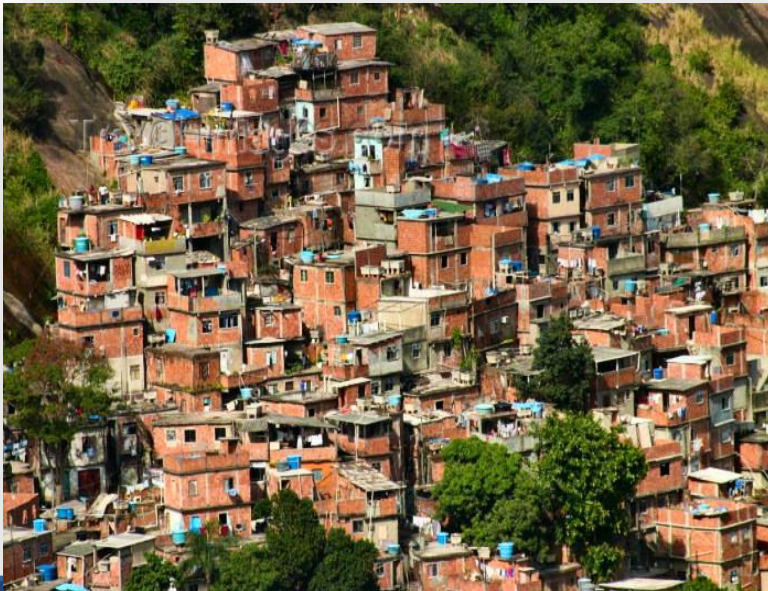


“By January 2015, main reservoirs had reached storage levels of only 5% of their 1.3 billion m3 capacity”
– Nobre et. al., Journal of Water Resource and Protection, 2016.





Source: IBGE, 2010

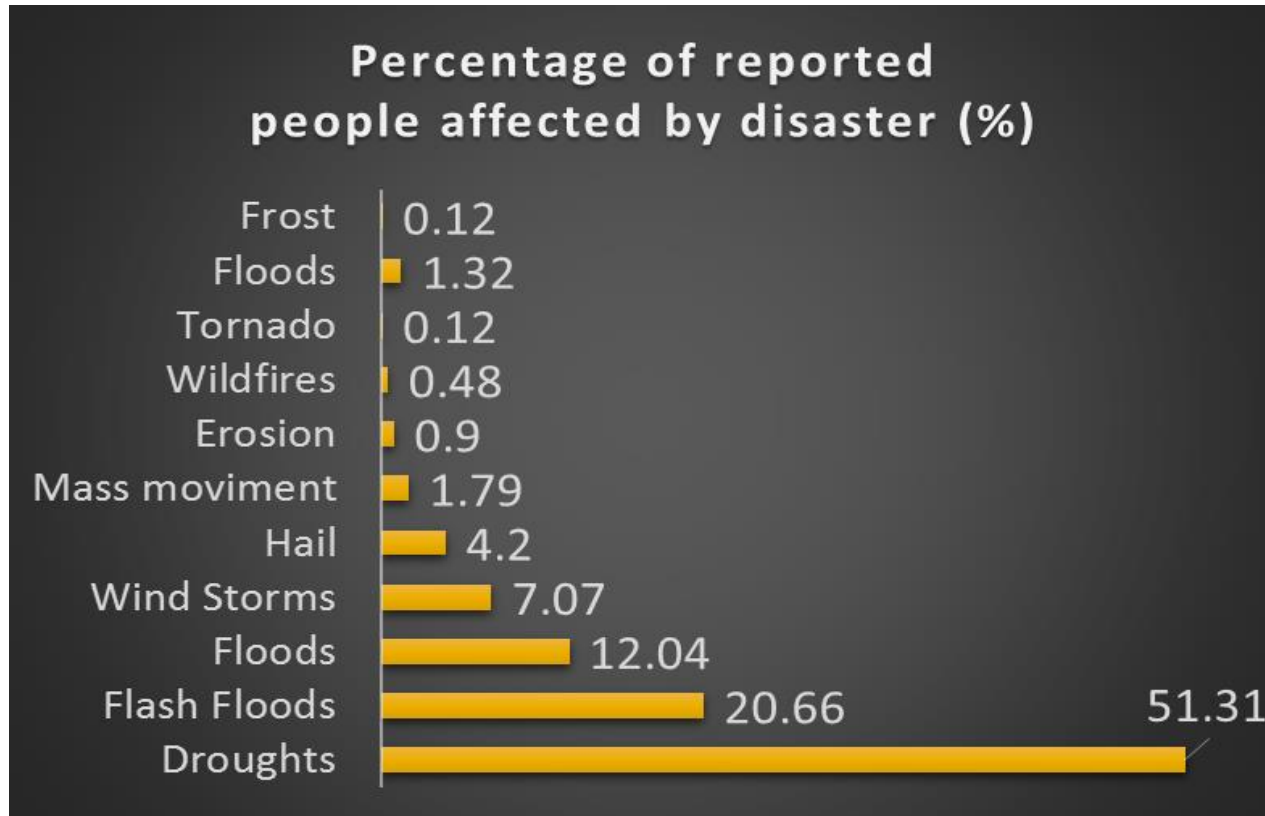


Natural disaster of 11-12 January 2011 in the mountains west of Rio: over 900 fatalities and a catalyst to DRR policies focused on prevention → Creation of CEMADEN



Over 5 million people mostly poor and vulnerable living in areas of high disaster risk in Brazilian cities

Natural Disasters in Brazil



Landslides and flash floods cause over 90% of fatalities!

Natural Disasters in Brazil: over 95% of disasters are climate-related



Forest fires, Floods,
Drought, Mass Moviments



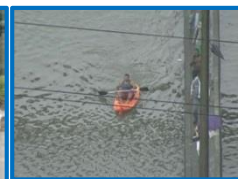
Droughts, Floods, Flash
Floods



Wildfires, Floods, Erosions



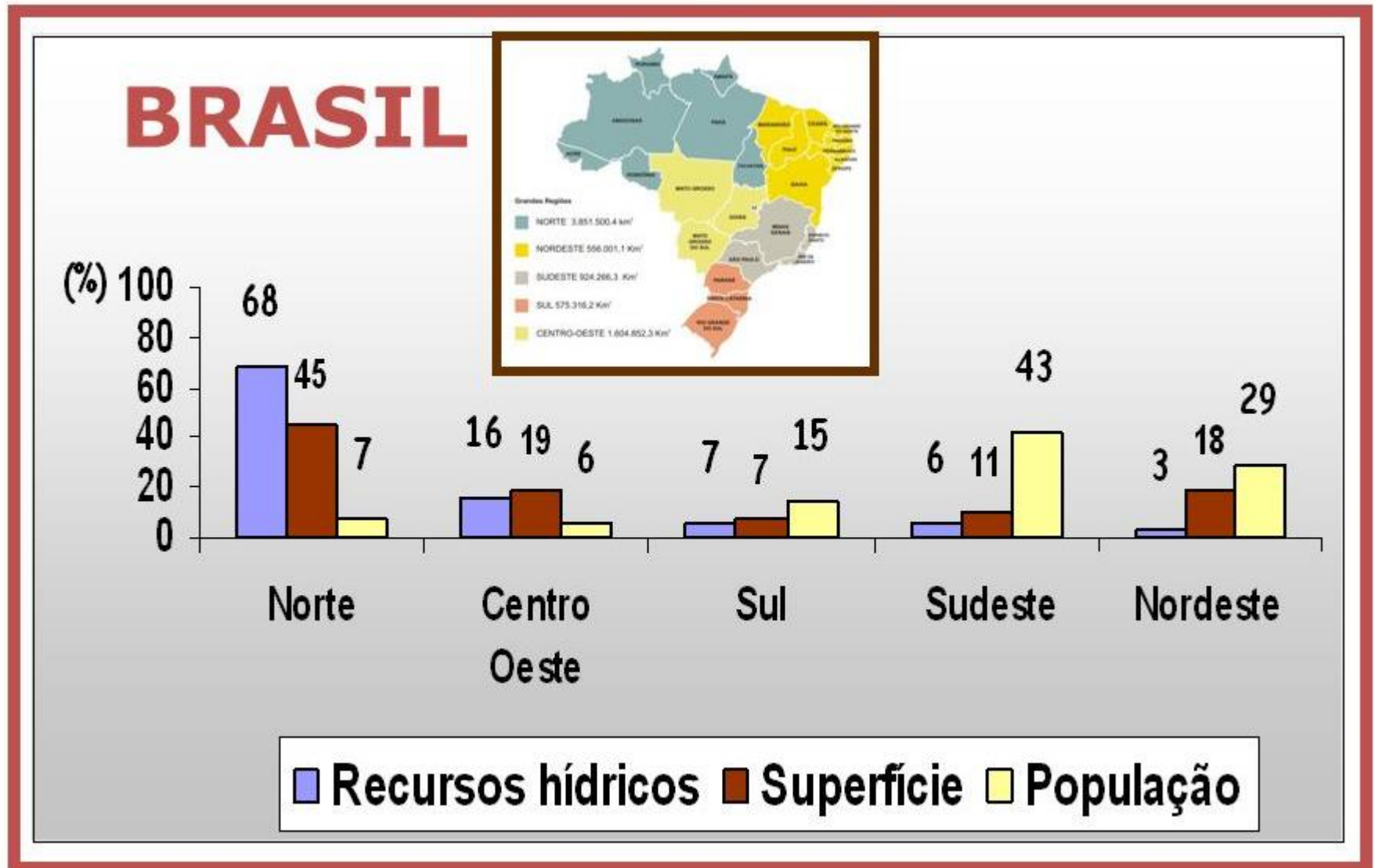
Wildfires, **Flash Floods**,
Floods, Droughts, **Landslides**



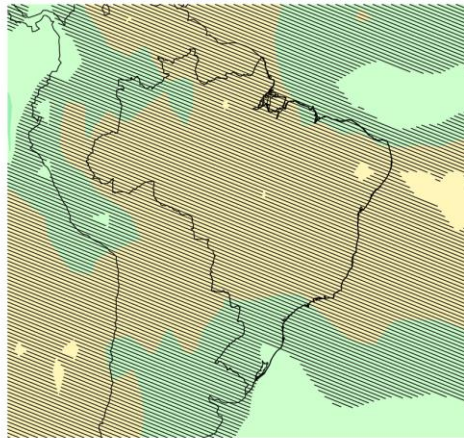
Flash Floods, Wind Storms,
Hails, Landslides



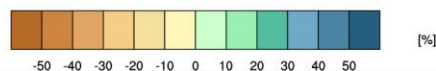
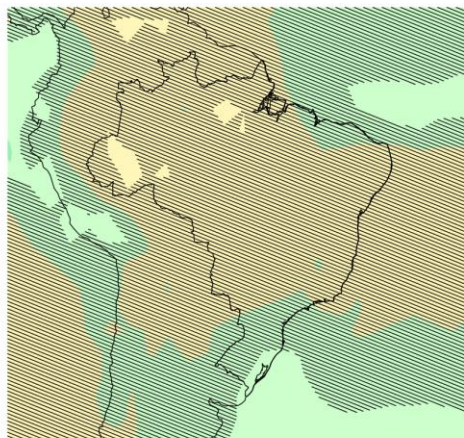
Inhomogeneous distribution in BR regions: water resources, surface, population



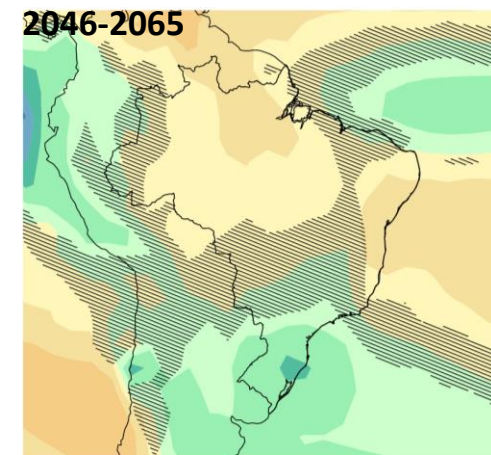
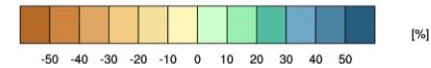
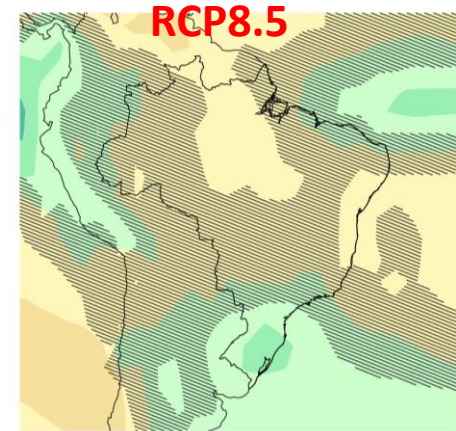
Projected changes in Annual Precipitation to South America 2046-2065 and 2081-2100 for low (RCP2.6) and high (RCP8.5) emission scenarios



RCP2.6



mid-21st Century
2046-2065



Difference from 1986-2005 (%)
ipcc
INTERGOVERNMENTAL PANEL ON climate change

Brazil cities at risk due to sea-level rise

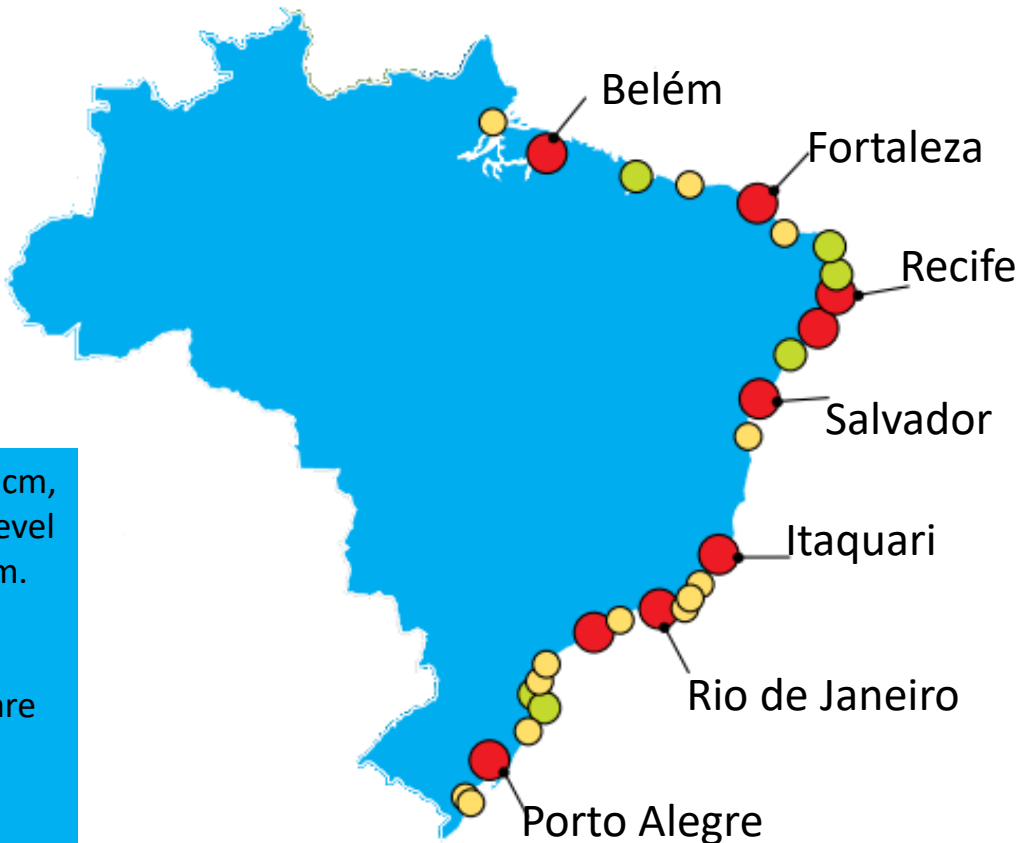
In the 20th century, sea levels rose by an estimated 17 cm, and the conservative global mean projections for sea-level rise between 1990 and 2080 range from 22 cm to 34 cm.

Oceans, which have been absorbing 80% of the temperature increase attributable to global warming, are expanding as ice sheets in the North and South poles melt.

These events have led to a rise in sea levels and increased flooding in coastal cities.

The projected rise in sea levels could result in catastrophic flooding of coastal cities.

Thirteen of the world's 20 megacities are situated along coastlines.

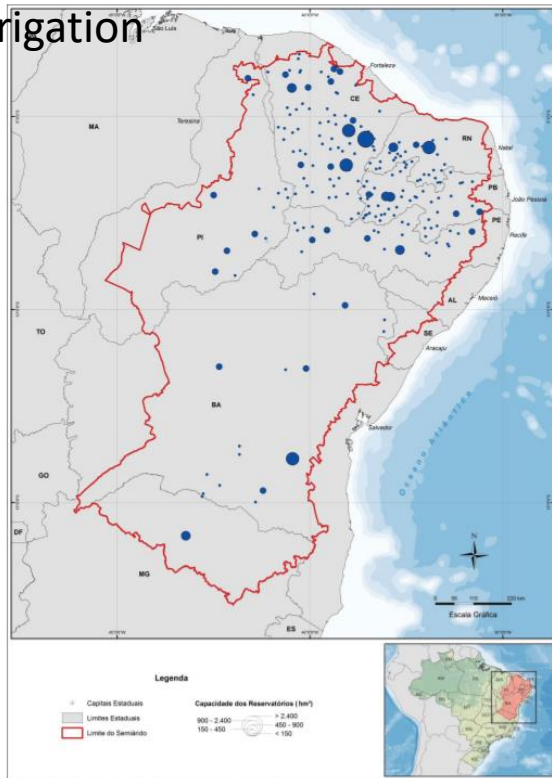


City size

- Small
- Intermediate
- Big

Population of cities
Small: 100 - 500 thousand
Intermediate: 500 thousand - 1 million
Big: More than 1 million

Main reservoirs in NE used for human supply and irrigation



Main reservoir in BR used for electric supply

● Apesar dos avanços, o sistema brasileiro está mais vulnerável as condições climáticas

SISTEMA NACIONAL

QUANTIDADE DE ÁGUA

EM MW MÉDIOS*

● VOLUME DE ÁGUA QUE CAIU
○ PREVISÃO INICIAL PARA JANEIRO

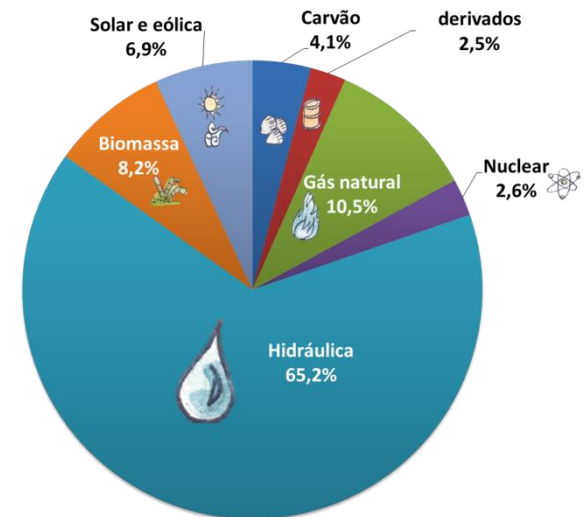
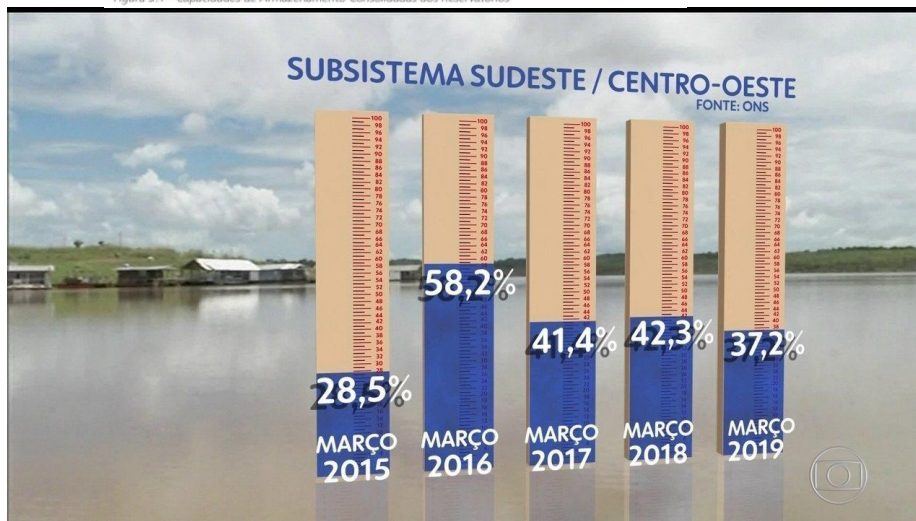


COM 90% DA CAPACIDADE DE ARMAZENAMENTO DO PAÍS, OS SISTEMAS SUDESTE/CENTRO-OESTE E NORDESTE SOFREM COM A ESTIAGEM DESDE NOVEMBRO DO ANO PASSADO

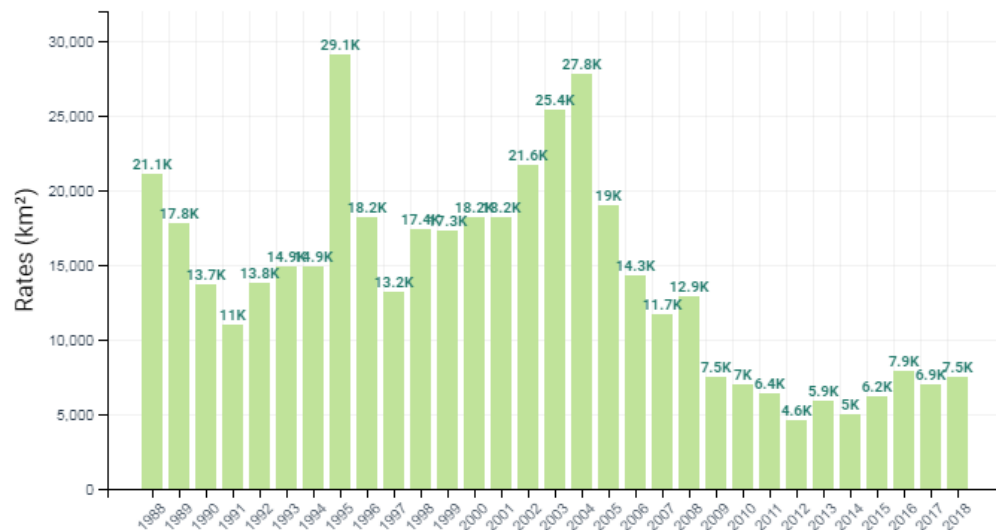
EMBORA EM ALGUMAS REGIÕES AS CHUVAS ESTEJAM ADEQUADAS OU ACIMA DO PREVISTO, O LOCAL ONDE ESTÃO AS PRINCIPAIS HIDRELÉTRICAS TEM RECEBIDO UM VOLUME BAIXO DE ÁGUA. AS CHUVAS PRECISAM CAIR NAS CABECEIRAS DOS RIOS PARA ENCHER OS RESERVATÓRIOS

SUBSISTEMA SUDESTE / CENTRO-OESTE

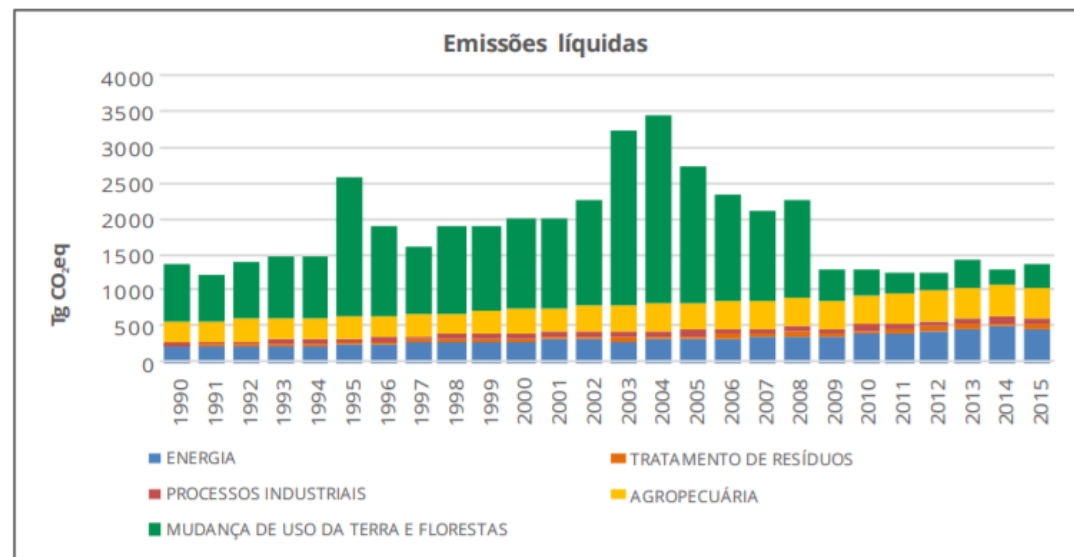
FONTE: ONS



Deforestation rates - Legal Amazon



source: INPE



Source: MCTIC, in:

https://sirene.mctic.gov.br/porta/export/sites/sirene/backend/galeria/arquivos/2018/10/11/Estimativas_4ed.pdf



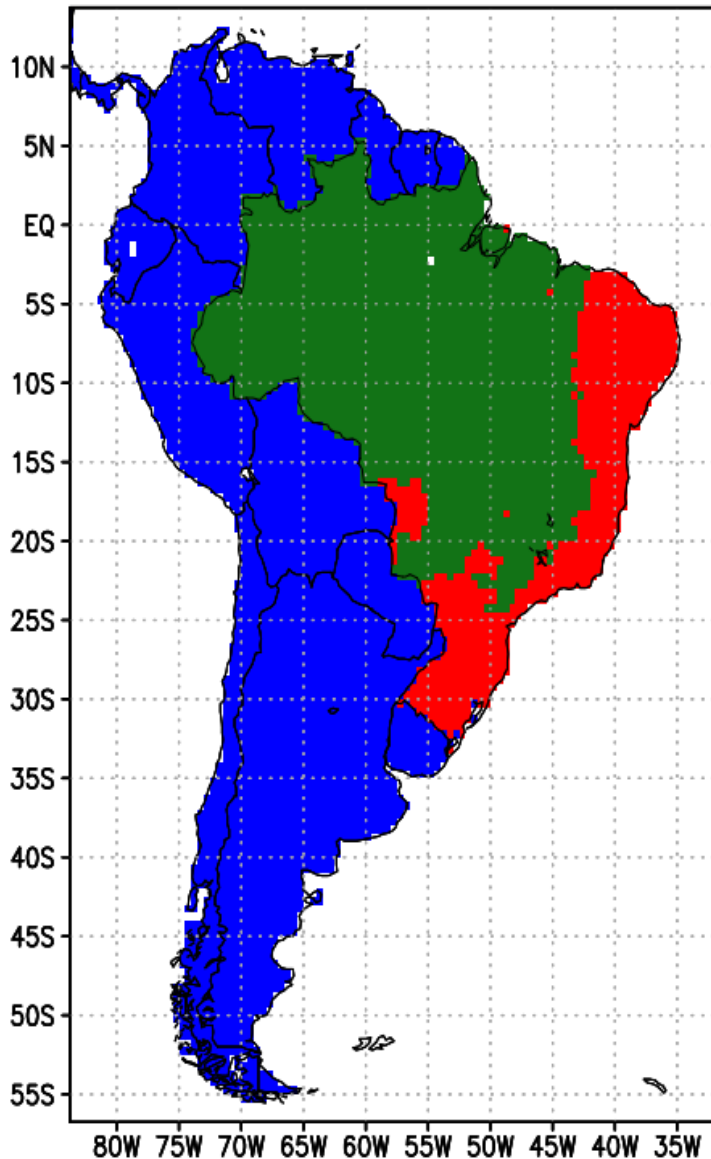
Joint German-Brazilian project



Objectives

- How does the Amazon forest interact with climate and the water cycle?
- What is the role of the Amazon forest in the global cycles of greenhouse gases such as carbon dioxide, methane, and nitrous oxide?
- How do volatile organic compounds emitted from vegetation and soils affect atmospheric chemistry and the formation of aerosols and clouds?
- How will Amazon forests be affected by climate change?

LAND COVER AND LAND USE - INPE



- Land Use data → composition using:
 - **PRODES AMAZÔNIA¹** e **PRODES CERRADO²**;
 - **IBGE³** → from satellite images (MODIS, LANDSAT 8), for the years 2000, 2010, 2012 e 2014¹;
 - **LUH2⁴** (Land Use Harmonization 2) → currently used in CMIP6.

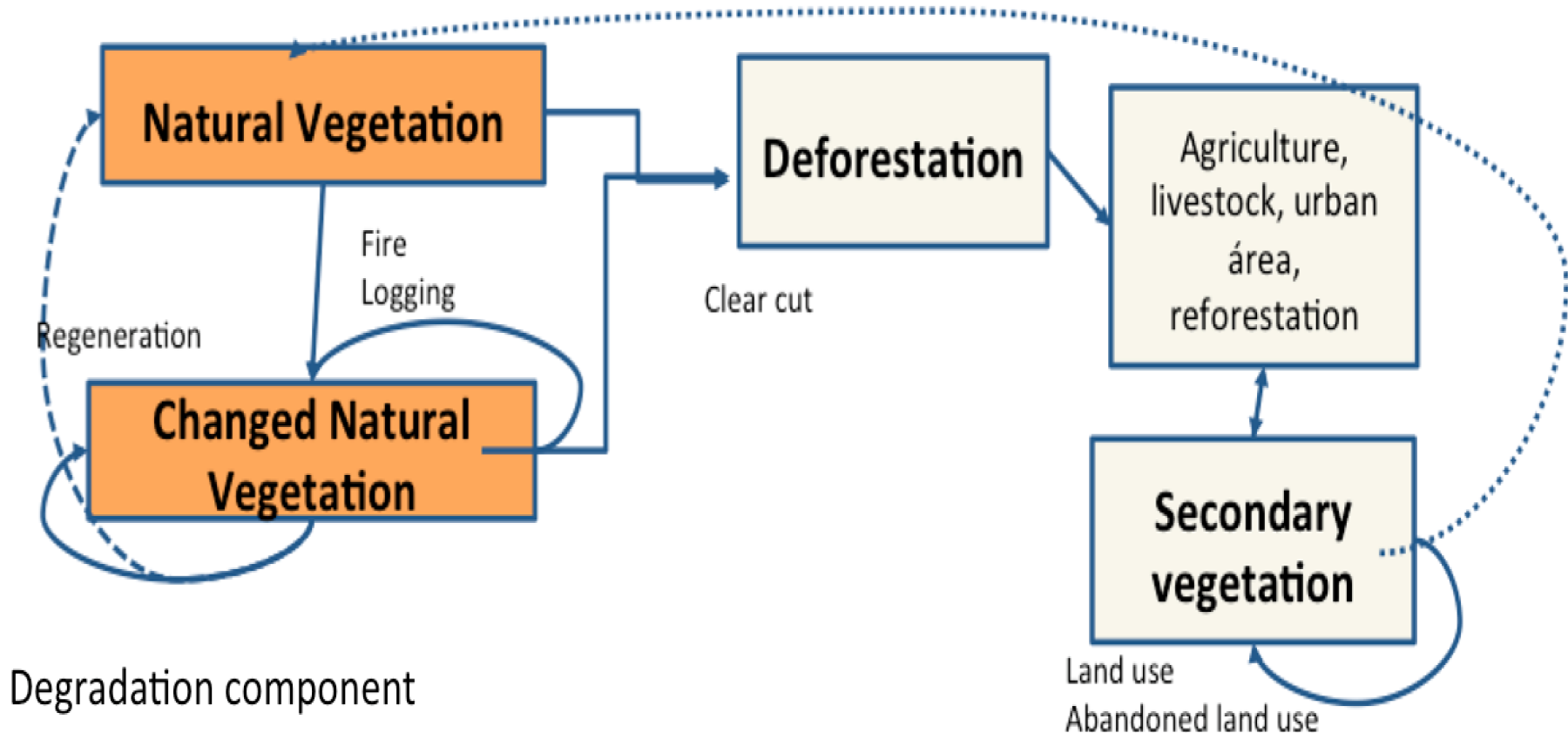
1) <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes>

2) <http://www.obt.inpe.br/cerrado/>

3) Brazilian Institute for Geography and Statistics

4) <http://luh.umd.edu/>

INPE Emissions Model (INPE-EM)



inpe-em.ccst.inpe.br/

www.ccst.inpe.br/projetos/inland/

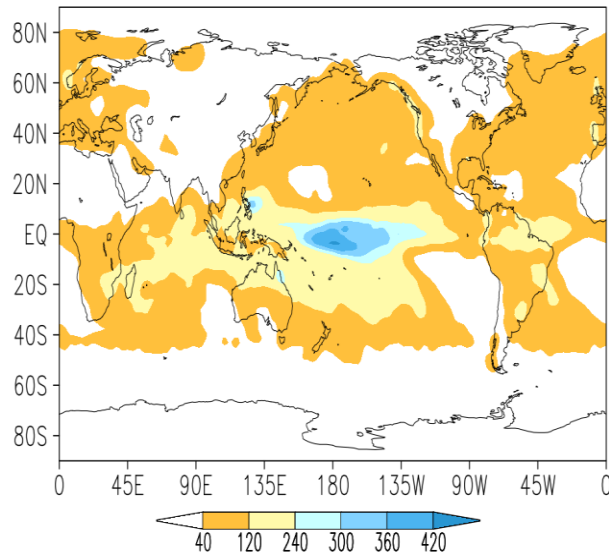
Example of performed analysis by BAM

How it represents precipitation variability?



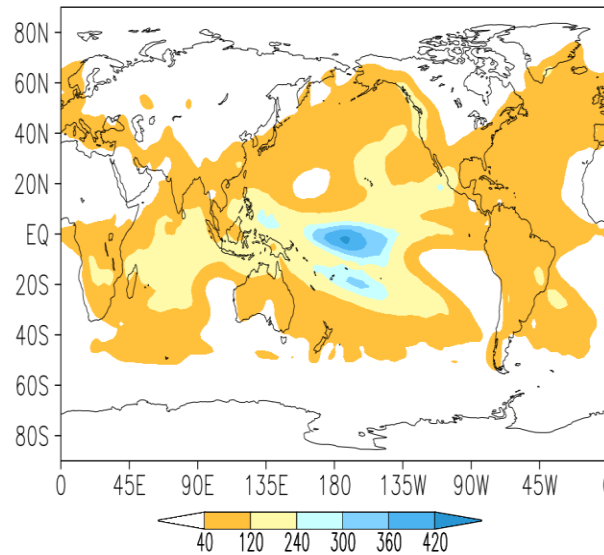
GPCP

a) GPCP precip climat
st dev (mm) DJF 1981–2100



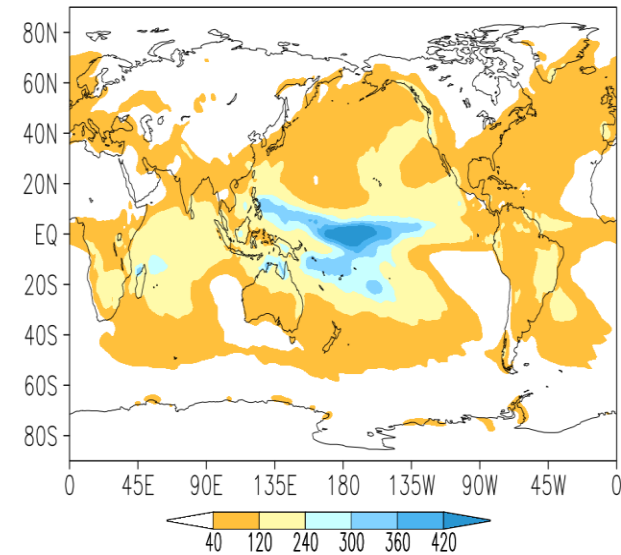
BAM TQ62 (180 Km)

b) BAM TQ62L42 precip climat
st dev (mm) DJF 1981–2100



BAM TQ126 (100 Km)

c) BAM TQ126L42 precip climat
st dev (mm) DJF 1981–2100



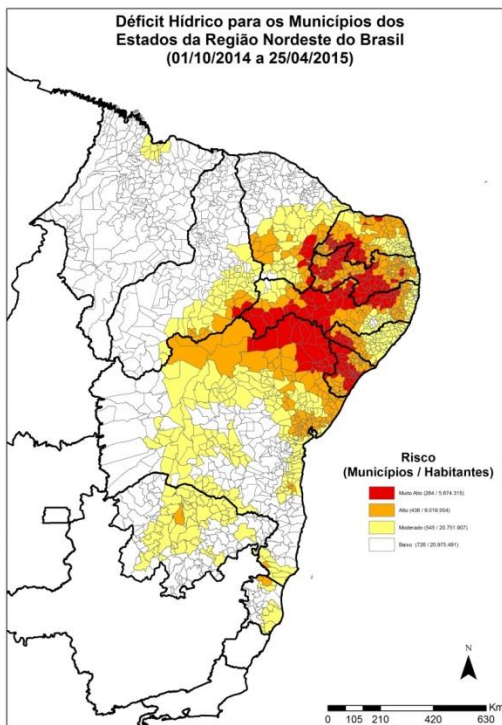
- Model climatological variability spatial patterns resembles observed pattern
- Increased spatial resolution increases precipitation variability particularly over the tropical Pacific

Courtesy: Dayana Castilho, Paulo Kubota and Caio Coelho

Drought Impacts at municipality level

Water Budget Model

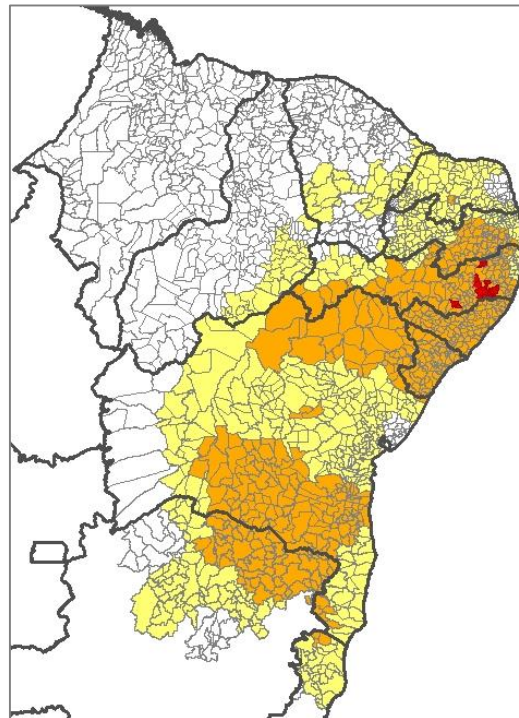
1) Days with hydric deficit



Fonte: PROCLIMA: CPTEC/INPE

Surface Observational Network

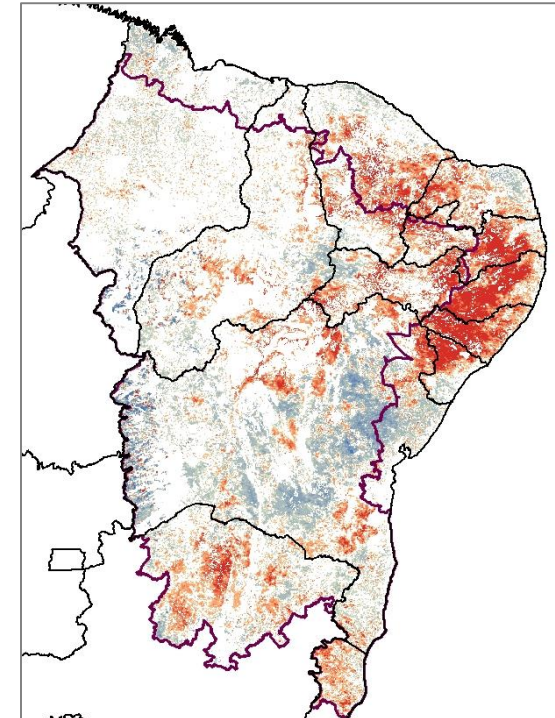
2) Data integration



Fonte: Centros Nacionais (INMET, INPE, ANEEL e CEMADEN) e Centros Estaduais de Meteorologia de cada Estado da área de atuação da SUDENE.

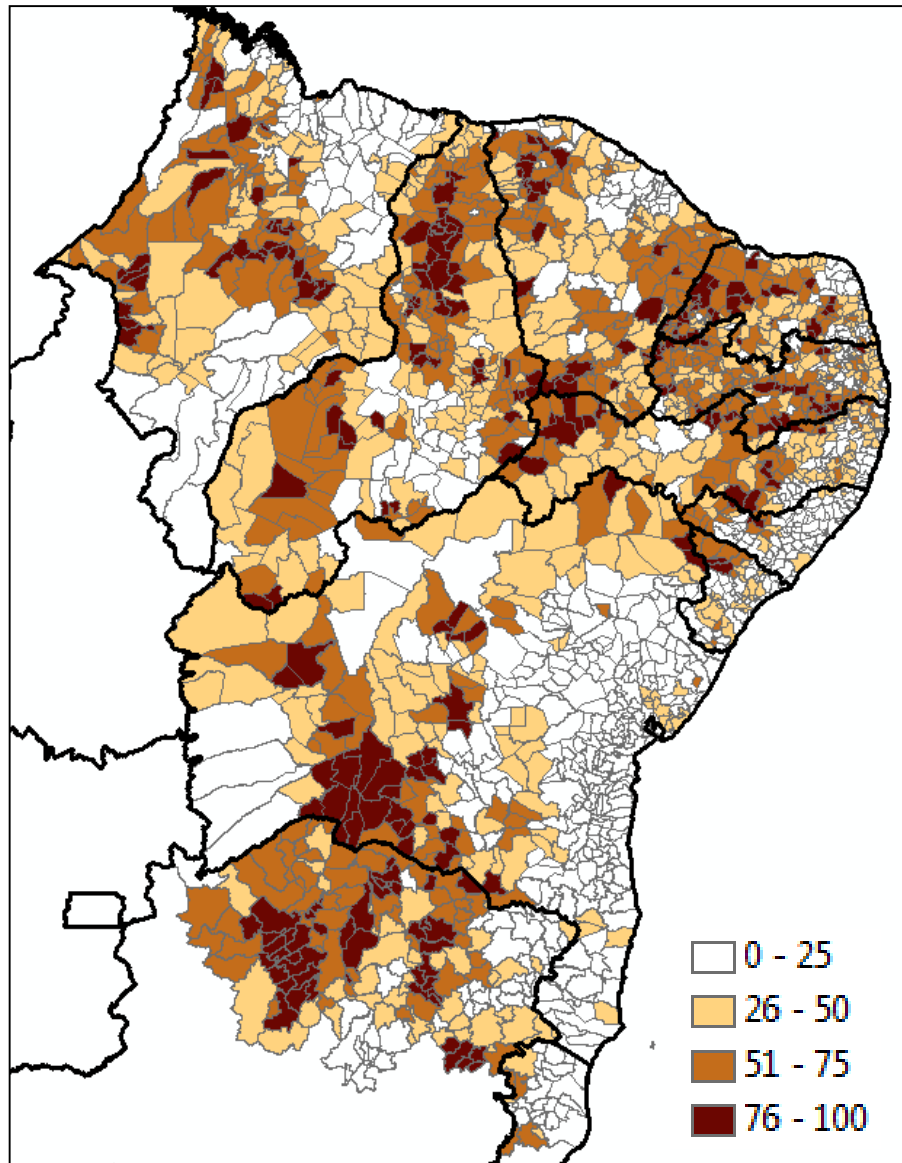
Remote Sensing

3) VSWI anomaly



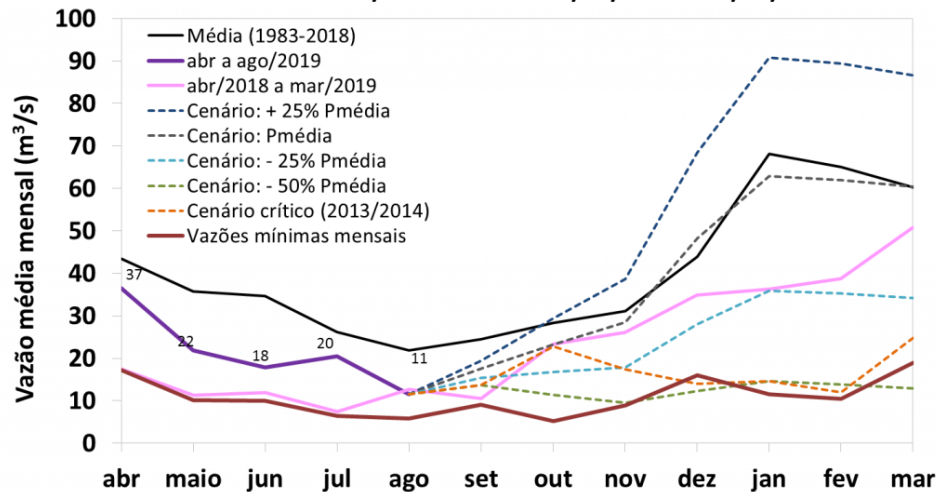
Produto CEMADEN gerado a partir de NDVI e TS (MODIS/NASA)

Percentage of municipality impacted by drought



- 210 municipalities with more than 80% of their area impacted by drought
- 758 municipalities with more than 50% of their area impacted by drought
- .

Sistema Cantareira: Simulação da Vazão Afluente Média Mensal
Previsão: 05 a 14/09 - Cenários: 15/09/2019 a 31/03/2020

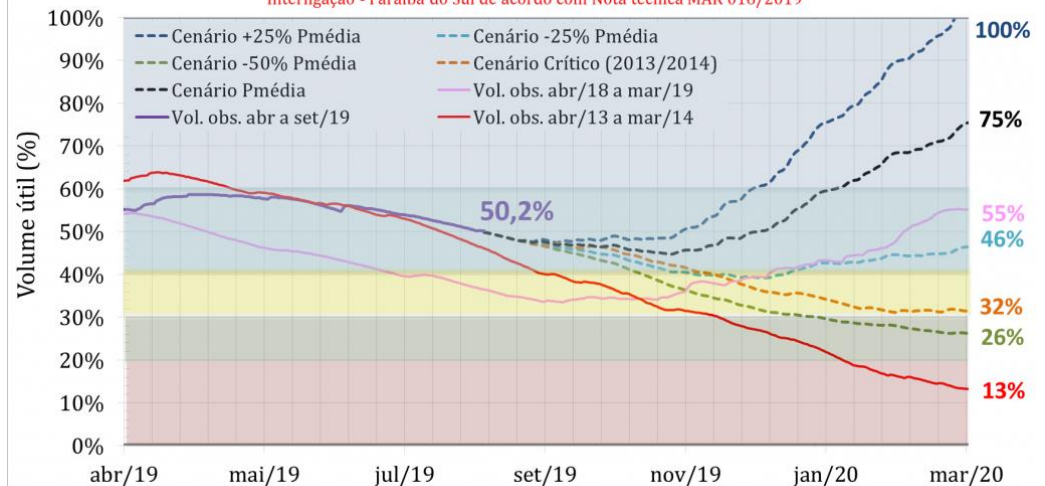


**Discharge in the Cantareira reservoir:
 Observations and projections**

**Water storage in the Cantareira reservoir:
 Observations and projections**

Evolução do Armazenamento do Sistema Cantareira
05/set/2019 a 31/mar/2020

Extrações (Qesi) segundo a Resolução conjunta ANA/DAEE Nº 925
 Q Jusante Nov-Mar: 1,55 m³/s e Ago-Out: 2,09 m³/s
 Interligação - Paraíba do Sul de acordo com Nota técnica MAR 016/2019



Thanks for your attention

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