Cemaden
Centro Nacional de Monitoramento e Alertas de Desastres Naturais

UNIDADE DE PESQUISA DO
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

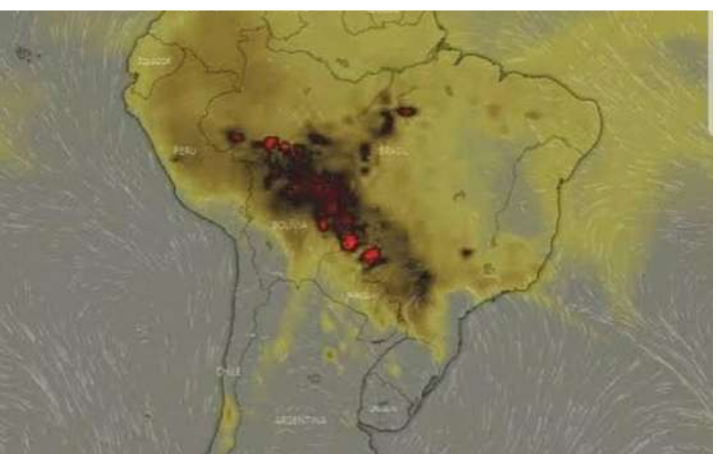
PÁTRIA AMADA BRASIL
GOVERNO FEDERAL



Christopher Cunningham

Osvaldo Morais, Victor Marchezine, Giovanni Dolif, Silvia Saito, Marcio Andrade, Ana Cunha, Marcelo Zeri

National Center for Monitoring and Early Warning of Natural Disasters



www.cemaden.gov.br

American monsoons: progress and future plans
ICTP-SAIFR/UNESP
August 19-24, 2019
São Paulo, SP, Brazil

OUTLINE

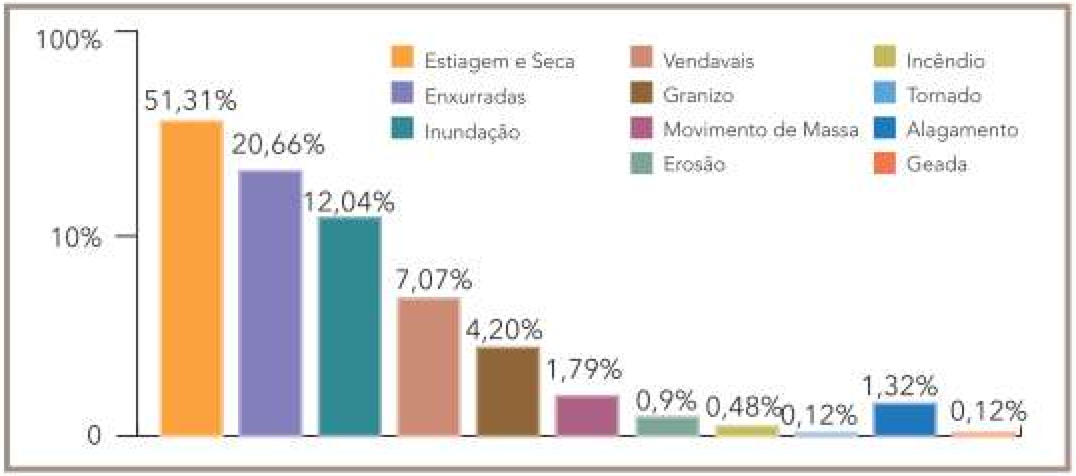
Disaster Risk Reduction – concepts that underpin Cemaden's activities

Cemaden – operation during Monsoon

Development and Research

Disasters in Brazil: a snapshot

PEOPLE AFFECTED BY WEATHER-CLIMATE HAZARD



Source: Brazilian Atlas of Natural Disasters; CEPED/UFSC

What are the most recurrent disasters? How they impact the population?

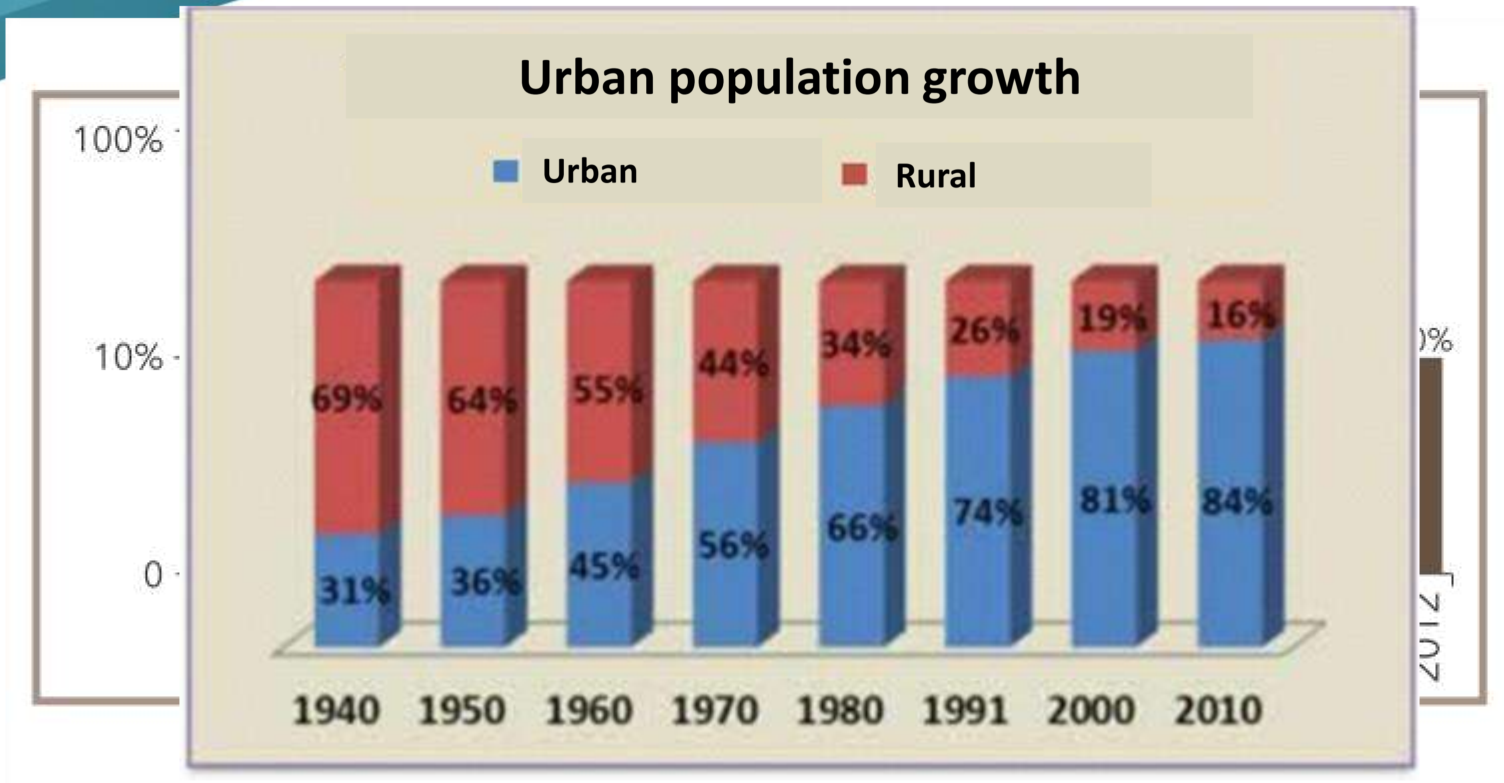
Droughts, flash-floods and floods, and wind-storms cause trouble for more than 90% of the Brazilian ever impacted by natural hazards

The most lethal are the flash-floods and the landslides (> 70%)

DECEASED BY WEATHER-CLIMATE HAZARD

Source: Brazilian Atlas of Natural Disasters; CEPED/UFSC

Disasters in Brazil: a snapshot



The counts of reported disasters have been increasing since the 1990s.

Not directly related to changes in weather extremes, though not totally unlinked

Early Warning Systems

HYOGO FRAMEWORK FOR ACTION 2005-2015: Building the Resilience of Nations and Communities to Disasters

>> **Creating Early Warning Systems people-centered**

SENDAI FRAMEWORK FOR DRR 2015-2030: Making the difference for poverty, health and resilience

>> Seventh Global Target: Substantially increase the availability of and access to ***multi-hazard early warning systems*** and disaster risk information and assessments to the people by 2030.

Int J Disaster Risk Sci (2015) 6:164–176
DOI 10.1007/s13753-015-0050-9

CONCEPTUAL FRAMEWORK: WHAT IS AN EARLY WARNING SYSTEM?

"An early warning system is the set of capabilities needed to

i) **generate and disseminate information**

ii) **in a timely and understandable manner**

iii) that enables disaster-prone individuals, communities and organizations to prepare and **act appropriately** and in a timely manner to reduce possibility of injury and/or loss"(UNISDR, 2012)

Data ? → **Information** ? → **Knowledge** ? → **Wisdom**

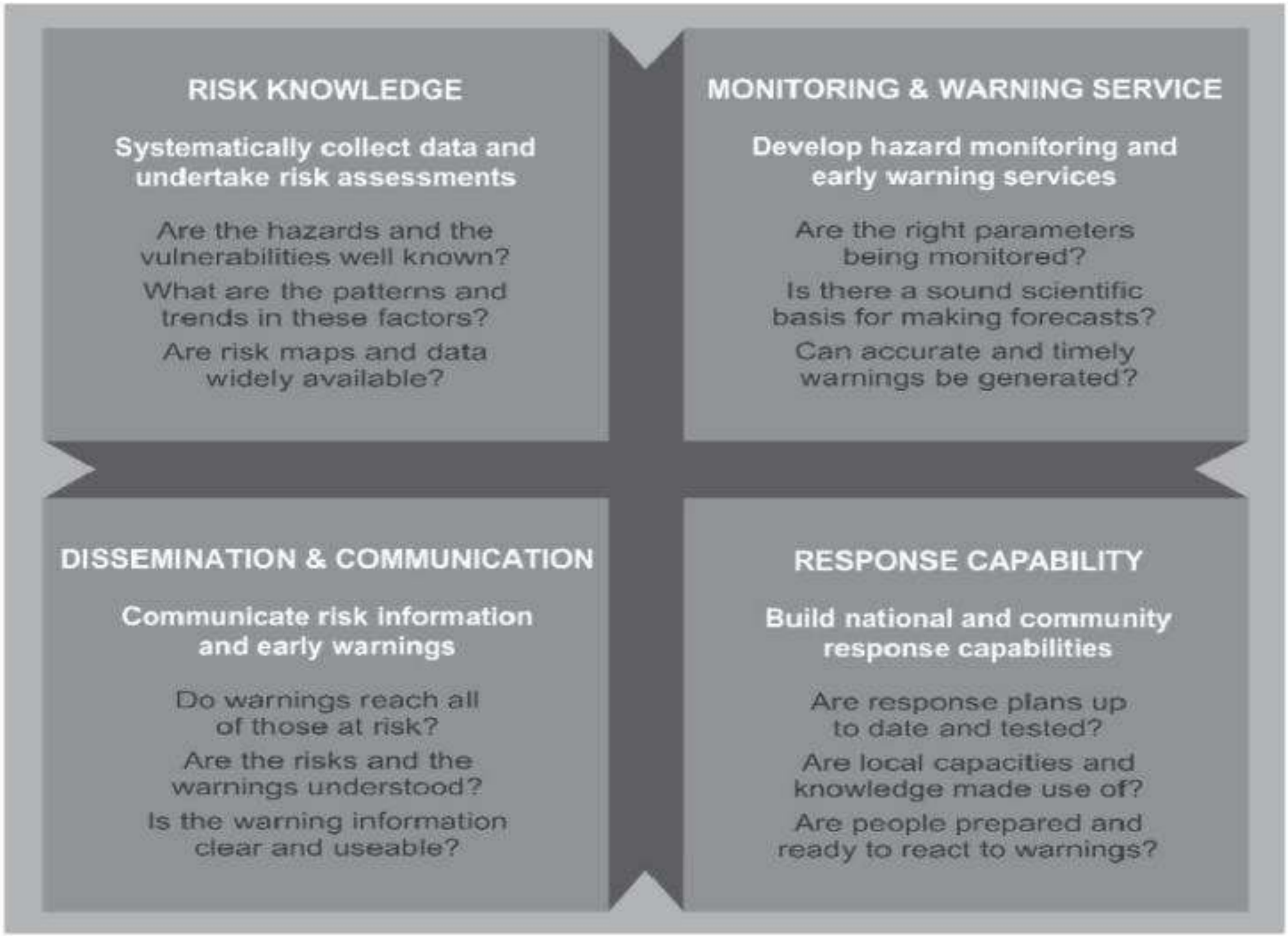
Information: Is the data endowed with meaning, interpreted, understood.

Knowledge: Information analyzed over time by reason and/or experience to find regularities /patterns

Wisdom: Ability to use accumulated knowledge to act correctly

Source : SPIEKERMANN et al, 2015

CONCEPTUAL FRAMEWORK: WHAT IS AN EARLY WARNING SYSTEM?



Source: UNISDR, PPEW, 2006.

[1] United Nations International Strategy for Disaster Risk Reduction, Platform for the Promotion of Early Warning (UNISDR, PPEW), 2006. Global Survey of Early Warning Systems: An assessment of capacities, gaps and opportunities toward building a comprehensive global early warning system for all natural hazards. Geneva.

CONCEPTUAL FRAMEWORK: WHAT IS AN EARLY WARNING SYSTEM?

Last mile approach	The first mile approach
Top-down	Bottom-up
Defines needs	Identifies needs
Alert’s delivery is the end	Development of the EWS is people-centered
Activated by the hazards	Hazards + vulnerabilities
Waiting for the disaster	DRR
Mainly technical components	Technical + social components
Knowledge is “alien” to the communities	Traditional knowledge is incorporated

Source: Marchezini et al (2017)

EARLY WARNING SYSTEM IS ABOUT REDUCING THE RISK

$$R = (H \times [V / C]) - M$$

Risk	Hazard	Vulnerabilities	Capacities	Mitigation
Disaster risk is expressed as the likelihood of loss of life, injury or destruction and damage from a disaster. Hence is the combination of two likelihoods: **i)** probability of hazards' occurrence and **ii)** chance of a negative impact	A hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be natural, anthropogenic or socionatural in origin (UNISDR, 2016).	The characteristics determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.	Physical, social and economics means, knowledge and abilities to anticipate and cope and recover from the impacts.	Policies to create preparedness.

Source: Wisner et al (2012)

OUTLINE

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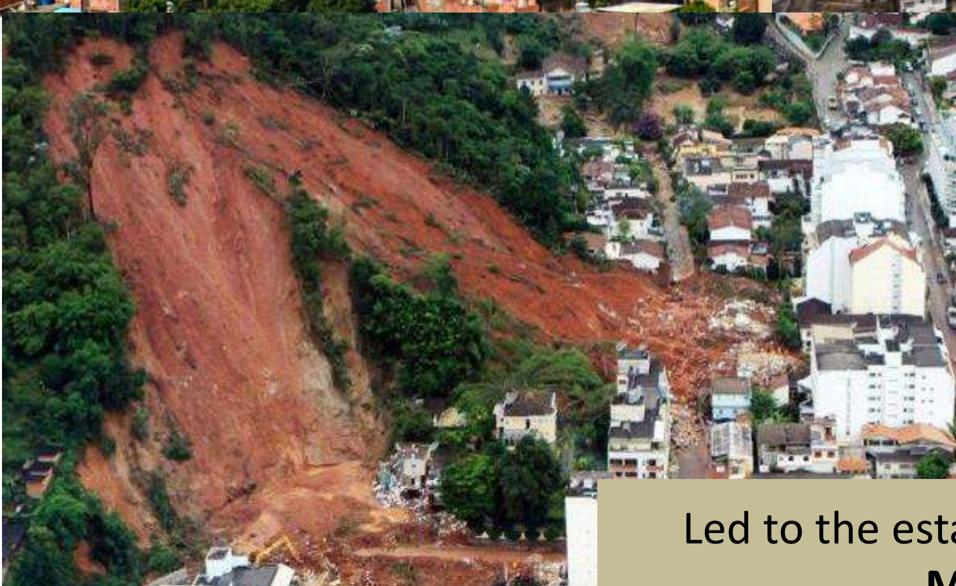
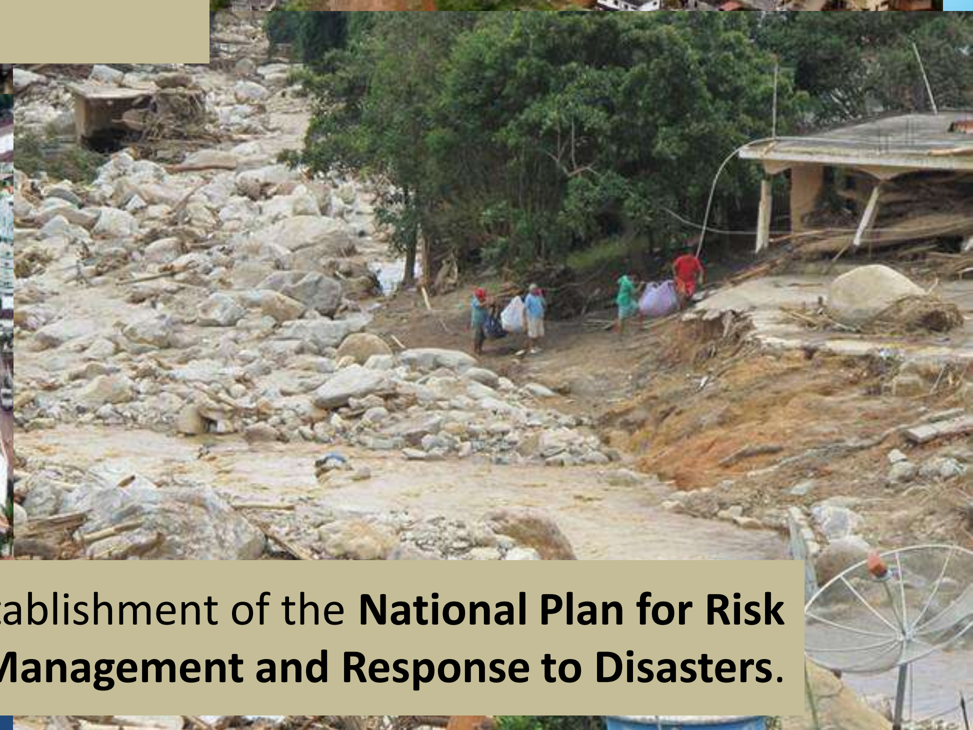
Development and research

The greatest weather-related disaster

January 12, 2011 the greatest climate disaster in our recorded history.

Over 900 fatalities. Non-official data claims for over 10,000.00 people affected.





Led to the establishment of the **National Plan for Risk Management and Response to Disasters**.

Post-2011 DRR Policy in Brazil: A Paradigm Shift
National Plan for Risk Management and Response to Disasters

Relief and recovery

MINISTRY OF NATIONAL INTEGRATION

MINISTRY OF URBAN AFFAIRS

Building structural resilience (slope, stabilization, drainage and flood control)

MINISTRY OF SCIENCE, TECHNOLOGY, INNOVATION AND COMMUNICATIONS

Strengthening of early warning networks

BRAZILIAN GEOLOGICAL SURVEY

High resolution mapping of risk areas for 1000 municipalities

National Centre for Monitoring and Early Warning of Natural Disasters (CEMADEN)

As part of the National Strategy for Natural Disaster Management, CEMADEN was created by the Presidential Decree nº 7513, of July 1st, 2011. **The Centre aims to develop, test and implement a system for predicting the occurrence of natural disasters in vulnerable areas throughout Brazil.**

CEMADEN's DUTIES

(i) to **produce early warnings** of relevant natural disasters for protective and civil defense actions across the country, **supporting the actions of National Centre of Risk and Disaster Management – CENAD** (Ministry of National Integration);
(ii) to **produce and release studies** aiming the production of necessary information for planning and promotion of actions against natural disasters;
(iii) to **develop scientific, technological and innovation capacity**, for continuing improving the natural disasters early warning;
(iv) to develop **and implement observation systems** for monitoring natural disasters;
(v) to develop and **implement computational models**, to operate computational systems needed to the elaboration of alerts;
(vi) to promote capacity building, training and support to research in correlated areas of action.

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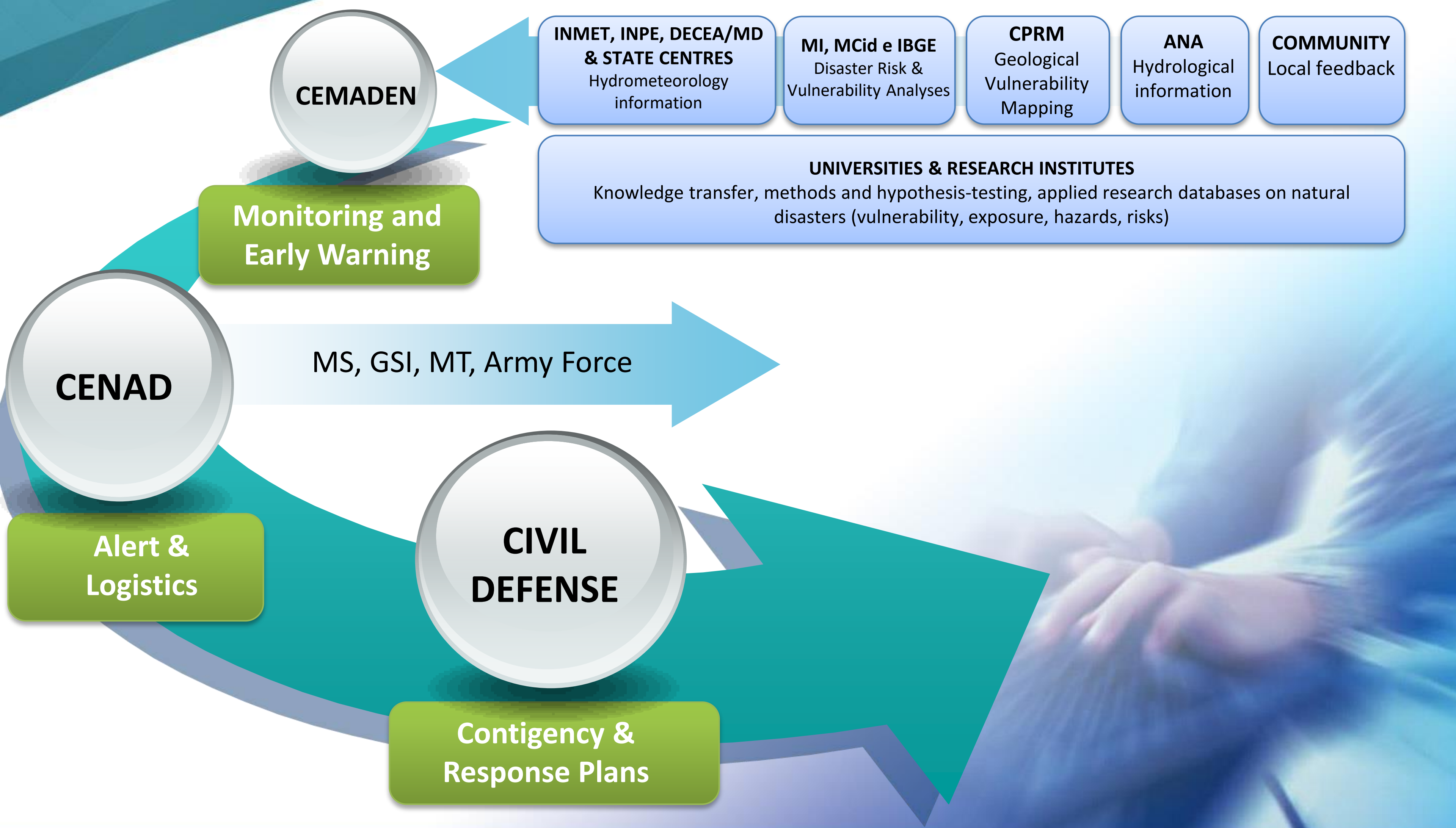
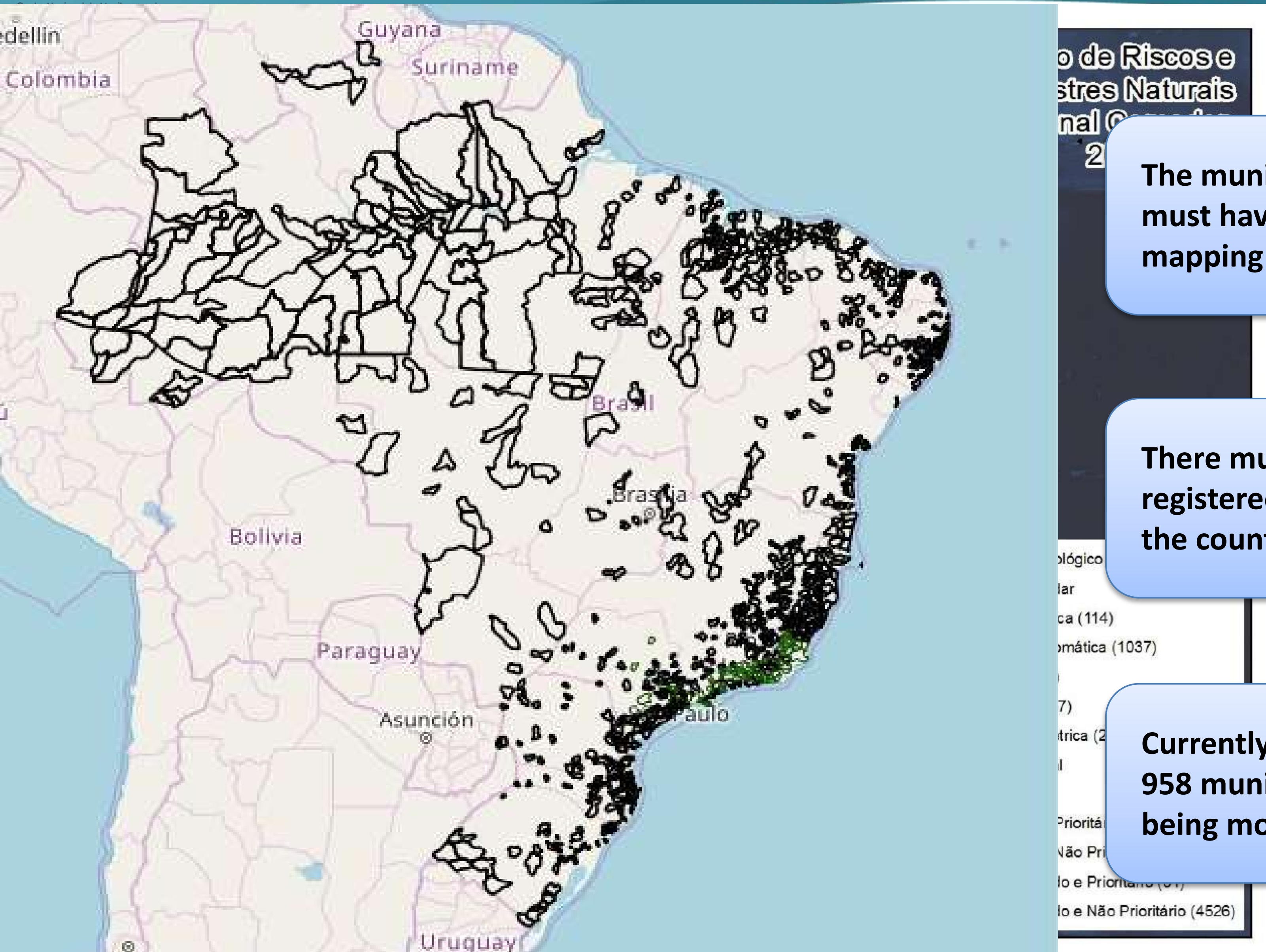
National Strategy for Disaster Risk Management



Monitoring Network and locations



The municipality must have the risk mapping (CPRM)

There must be a registered disaster in the county

Currently, there are 958 municipalities being monitored

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Non-stop operations Room

- **7x24, 365-DAY A YEAR** MONITORING
- BEGAN IN **DECEMBER, 2011**
- **MULTIDICIPLINARY TEAM** (GEOLOGISTS, GEOGRAPHERS, ENGINEERS, HYDROLOGISTS, METEOROLOGISTS, IT PROFESSIONALS)
- **EARLY WARNINGS** FOR LANDSLIDES, MUDSLIDES, FLOODS, FLOODINGS, FLASHFLOODS AND SEVERE DROUGHT IMPACTS IN SEMI ARID REGION

Weekly-to-seasonal operations

Weekly meetings with representatives of the Mining and Energy Ministry, the Water Nacional Agency, states and municipalities and energy sector stakeholders. The purpose is supporting the decision-making process in some of the main hydro-power generation basins (São Francisco, Madeira, Parnaiba and Tocantins).

Monthly Report about Drought over Brazil. Monitoring by means of the Integrated Drought Index (IDI) and impacts on the vegetation. Monitoring and projections for the Tres Marias, Serra da Mesa and Cantareira reservoirs.

Monthly Meetings for Assessment and Scenarios of Potential Impacts for Strategic. Given the actual conditions and scenarios for rainfall in the next weeks/months we estimate the impacts on strategic sectors in Brazil. Evaluation of the alerts. Hydrological impacts. Impacts on the vegetation and small holder farmers.

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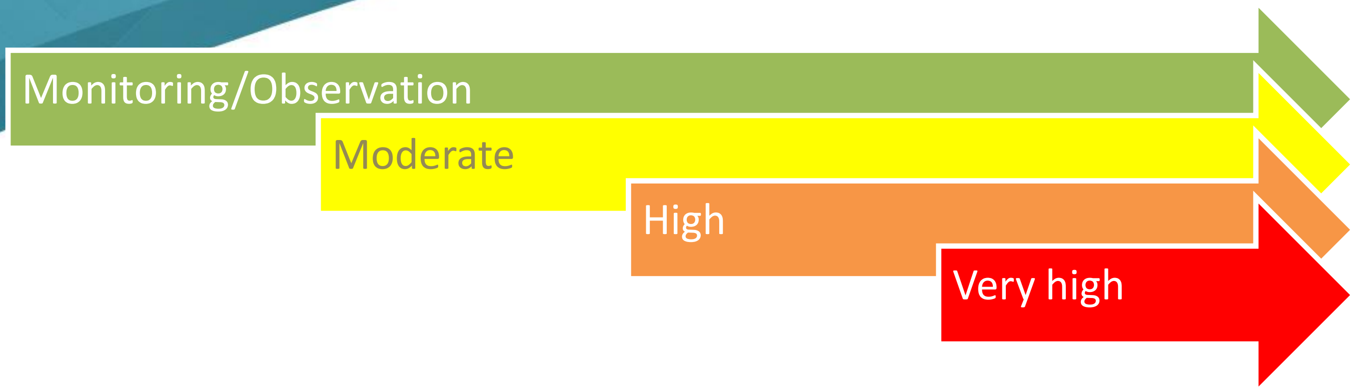
Warning levels



MATRIX FOR WARNING LEVELS

		Potential Impact		
		Moderate	High	Very high
Likelihood for occurrence	Very high	***Moderate***	***High***	***Very High***
	High	***Moderate***	***High***	***High***
	Low	***Monit./Observ.***	***High***	***Moderate***

INTER-MINISTERIAL DECREE Nº 314, OCT-17-2012

Alert issuing process

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ALERTA

ALERTA Nº	ABERTO EM	ATUALIZADO EM	MUNICÍPIO	UF
0268/2019 Abertura	**04/02/2019 21h12**		**RIO DE JANEIRO**	**RJ**

TIPO DE EVENTO/NÍVEL: **MOVIMENTOS DE MASSA / MODERADO**

Cenário de Risco:

As áreas de risco de movimentos de massa no município caracterizam-se pela densa ocupação de encostas de alta declividade por moradias de alta vulnerabilidade, em locais com recorrência de deslizamentos, taludes de corte e aterro e indícios de movimentação do terreno. Também ocorrem afloramentos rochosos sujeitos a quedas e rolamentos. Esta situação associada à precipitação incidente e acumulada, somada à previsão meteorológica indica que podem ocorrer deslizamentos pontuais e induzidos nas áreas de risco mapeadas.

Situação Atual:

Os acumulados de precipitação são de até 35 mm em 1 hora(s) e de 84 mm em 24 hora(s) . A estimativa de precipitação instantânea do radar Pico do Couto indica áreas de instabilidade com potencial para chuvas de intensidade moderada.
Considere: chuva fraca < 10 mm/h, chuva moderada de 10 a 40 mm/h, e chuva forte > 40 mm/h.

Tendência:

A previsão meteorológica indica continuidade de chuva com possibilidade de pancadas.

Recomendações:

Atenção às áreas de risco mapeadas pela Geo Rio (2011).

Ações de Proteção e Defesa Civil recomendadas pelo CENAD:

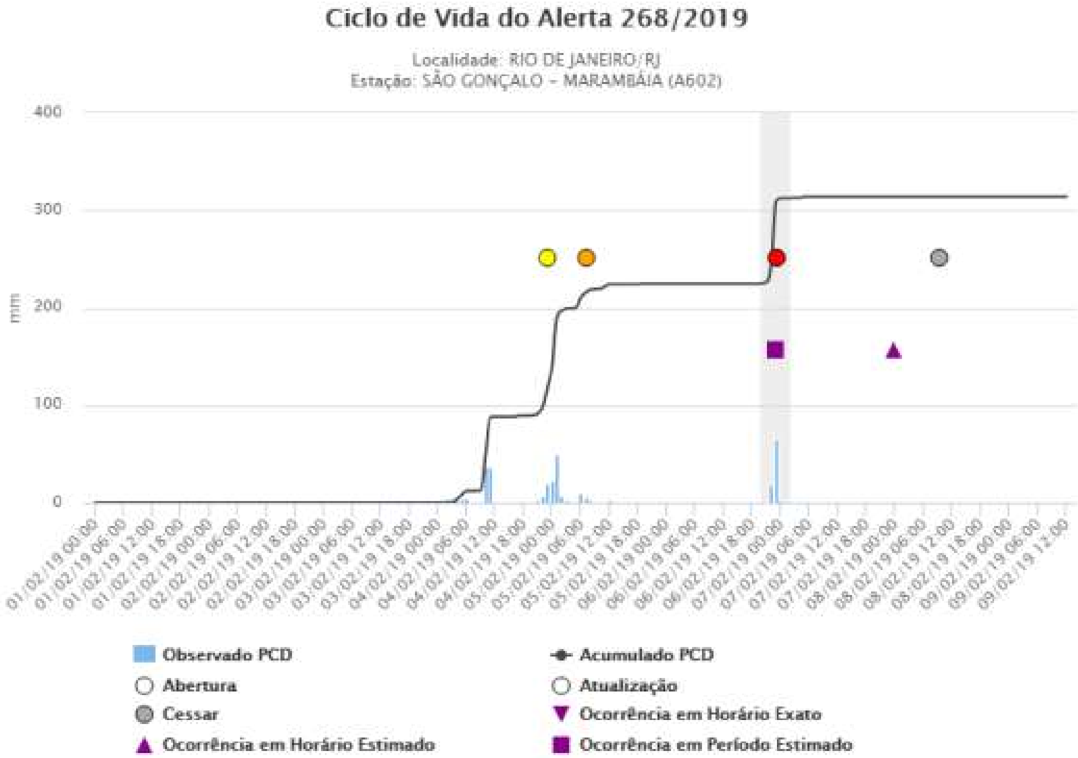
Em caso de alerta de risco de nível MODERADO não se descarta a possibilidade do fenômeno alertado **e, caso ocorra, espera-se impacto moderado para a população. Recomendam-se ações previstas no plano de contingência, tais como: sobreaviso das equipes municipais, etc.**

Risk scenario: area prone to landslides (exposure), dense occupation (vulnerability), previously recorded landslides, etc

35 mm over the last hour
84 mm / 24 h

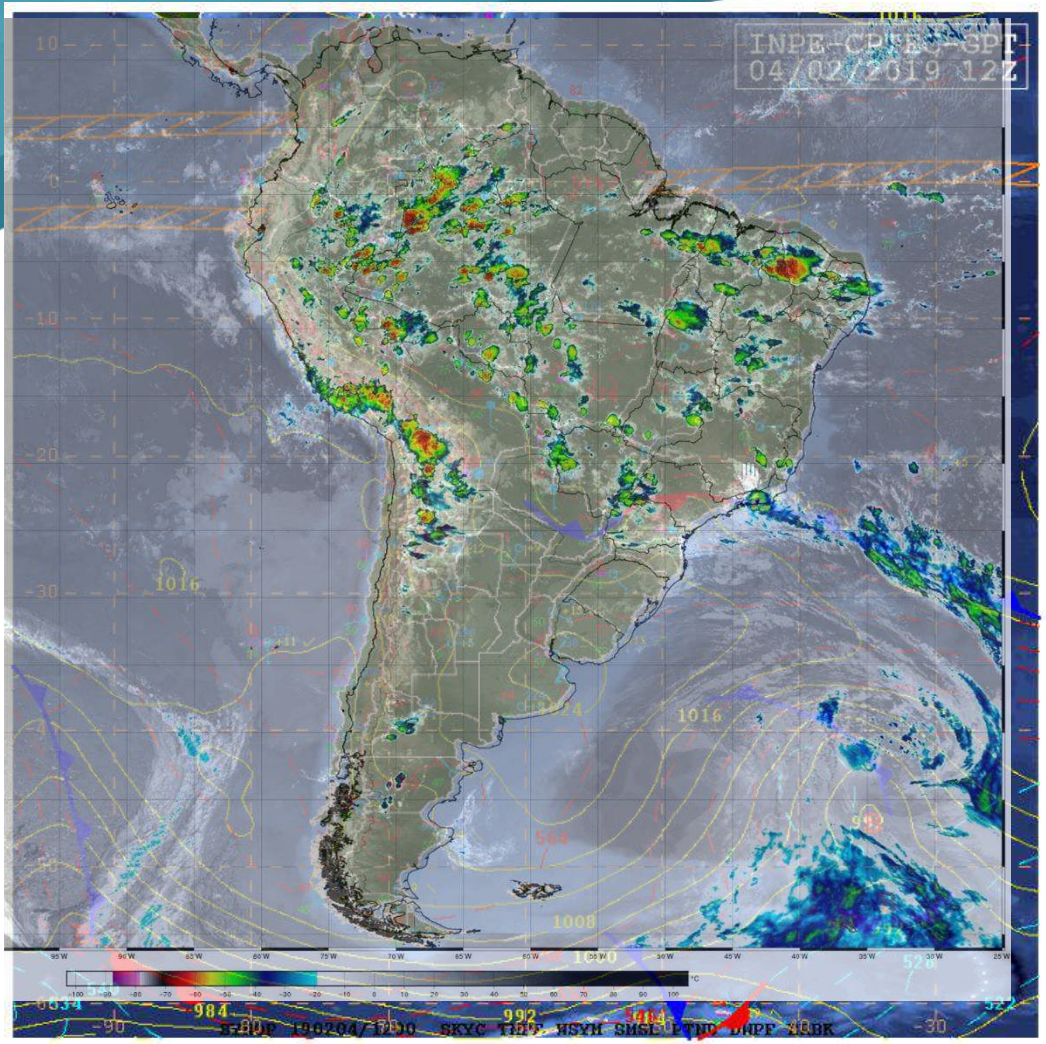
No NWP, only observed rainfall rates

Alert’s Life Cycle



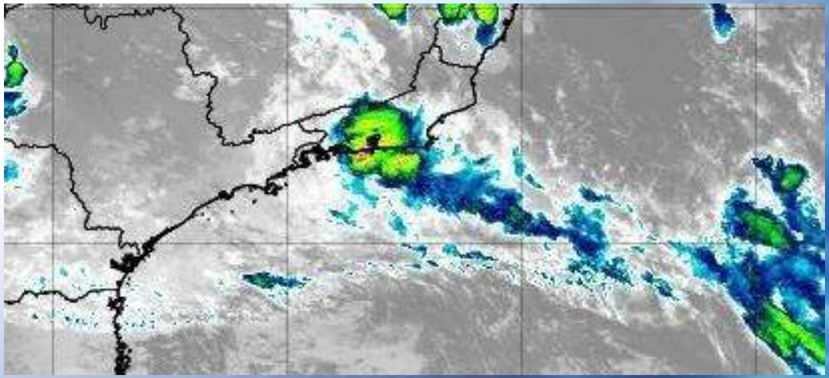
Moderado Abertura 04/02/2019 21:12 Movimentos de Massa	Alto Atualização: 1 05/02/2019 05:25 Movimentos de Massa	Muito Alto Atualização: 2 06/02/2019 21:22 Movimentos de Massa	Moderado Atualização: 3 08/02/2019 07:36 Movimentos de Massa

Synopse



A cold front mostly over the ocean intensified local/regional convection over the Rio de Janeiro state.

Diurnal Cycle



GOES 16 Channel 07 (3.9 μm) 23:45

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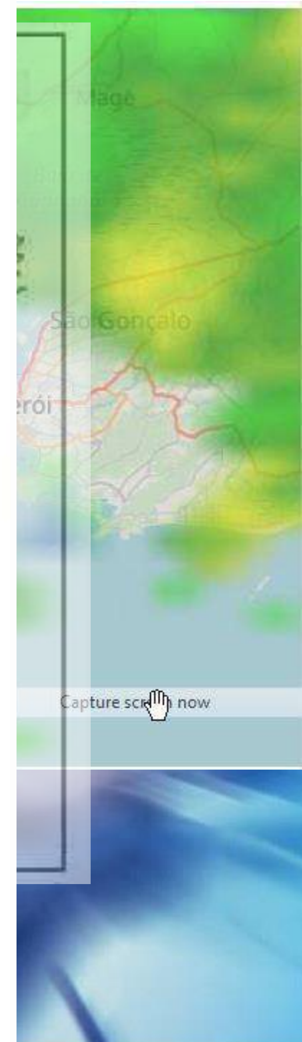
...ble scale

Ra... ...ates



OUTLINE

Disaster Risk Reduction – concepts that underpin Cemaden's activities

Cemaden – operation during Monsoon

Development and Research

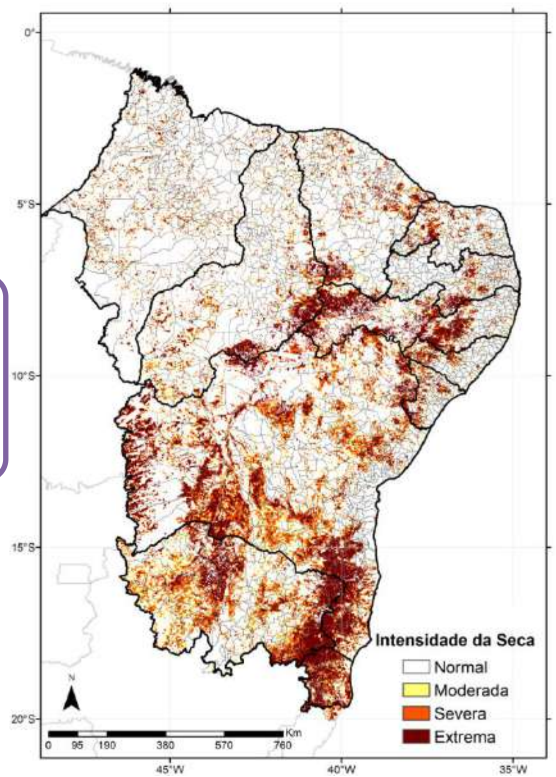
VSWI anomalies

Vegetation Supply Water Index (VSWI)

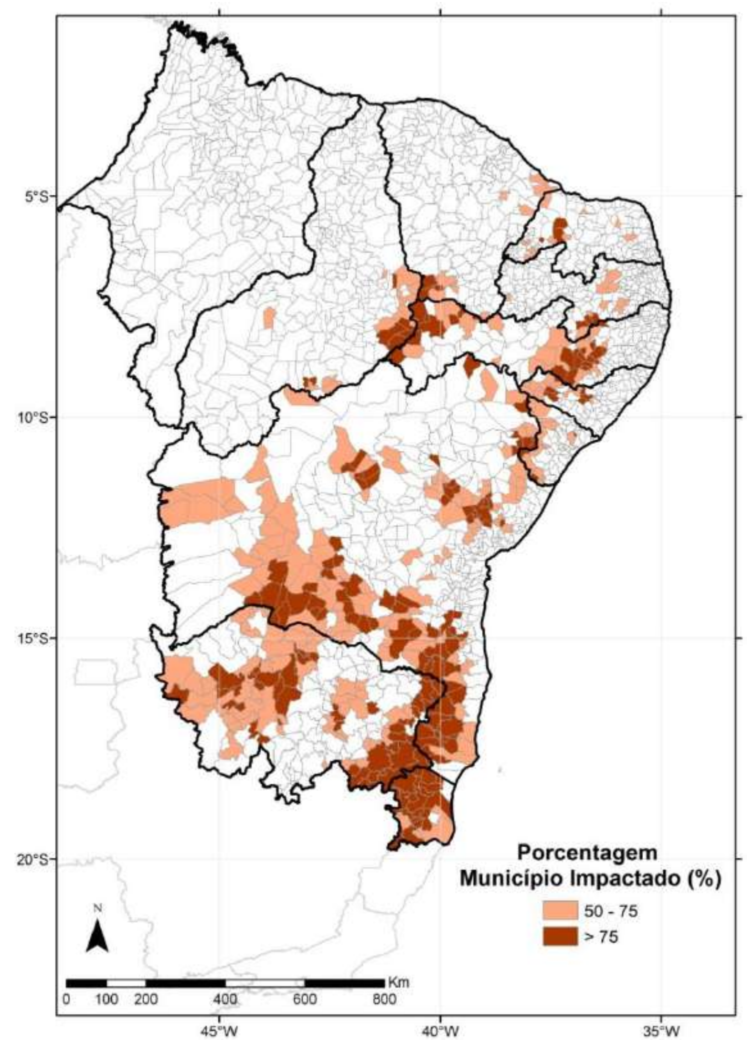
Source: NDVI and LST – MODIS/NASA
***Processed by Cemaden**

Since 2002

Spatial res. **1km**



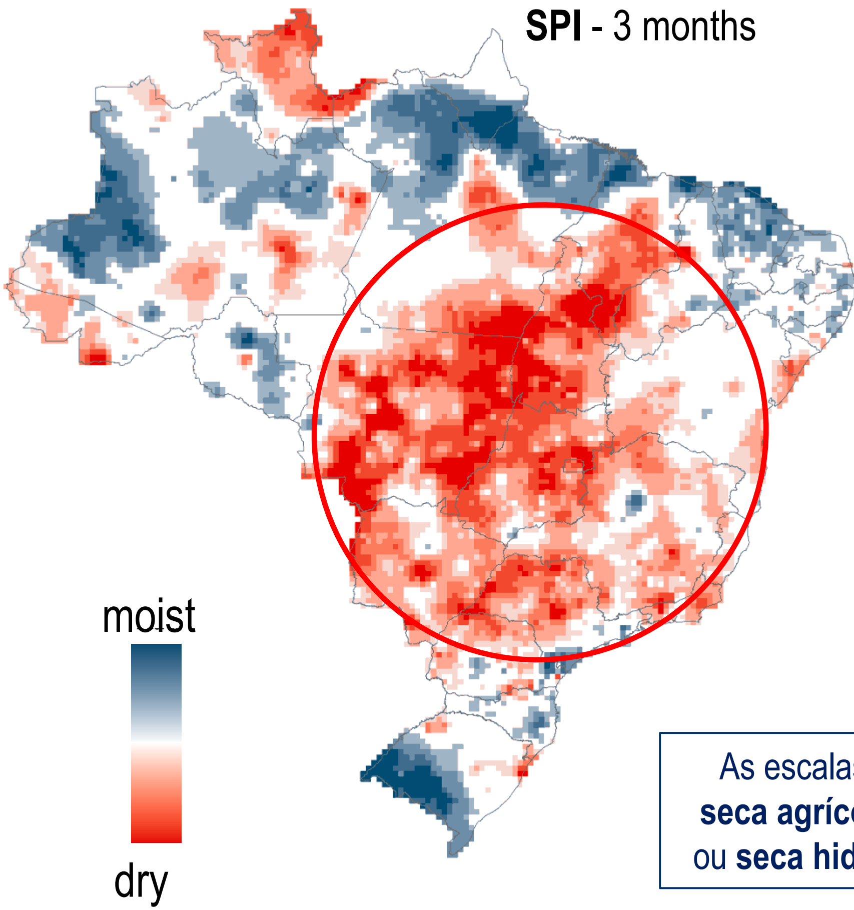
Municipality area percentage affected by drought according to VSWI anomaly percentage



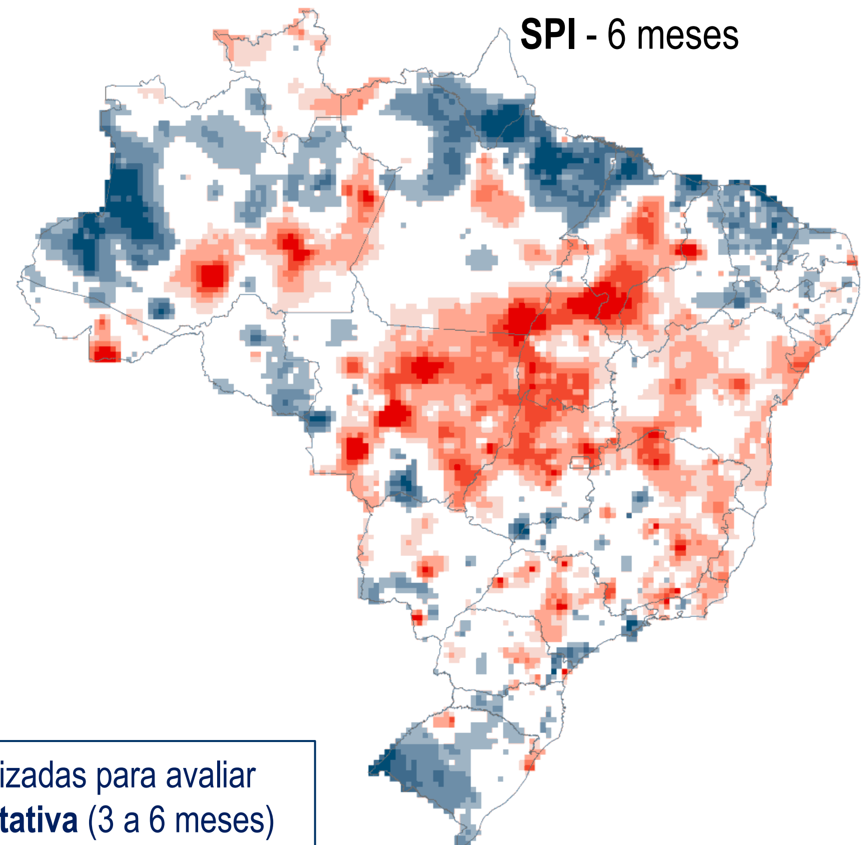
Support to “Garantia Safra”: agricultural insurance program

Standardized Precipitation Index (SPI)

Feb/2019
SPI - 3 months



Feb/2019
SPI - 6 meses



As escalas são utilizadas para avaliar **seca agrícola/vegetativa** (3 a 6 meses) ou **seca hidrológica** (6 meses ou mais).

Source: CPTEC/INPE (data) - Cemaden (maps)

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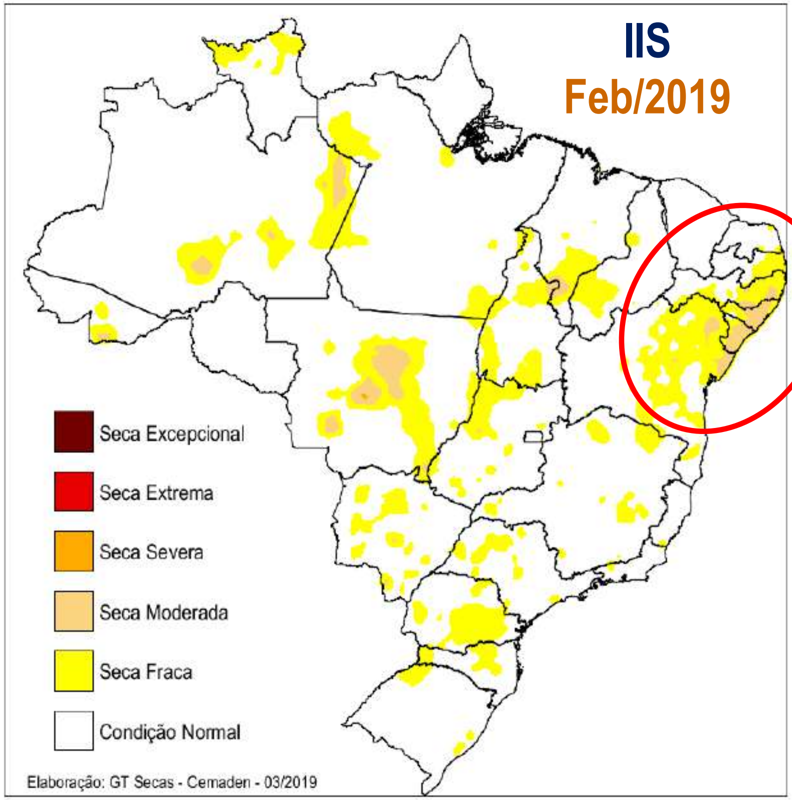
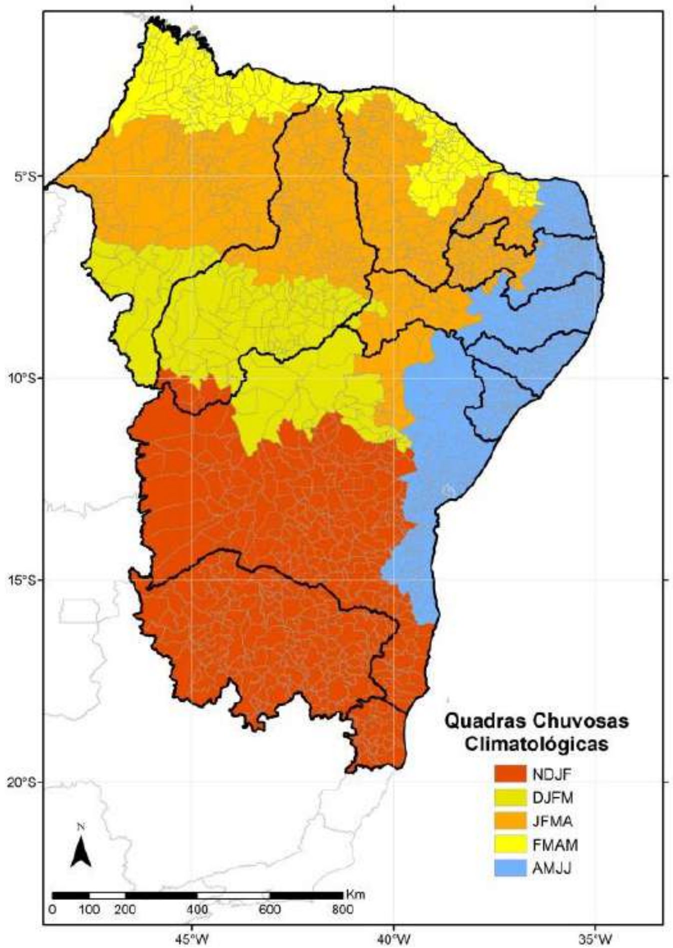
Integrated Drought Index (IIS)
SPI + VHI (Vegetation Health Index)

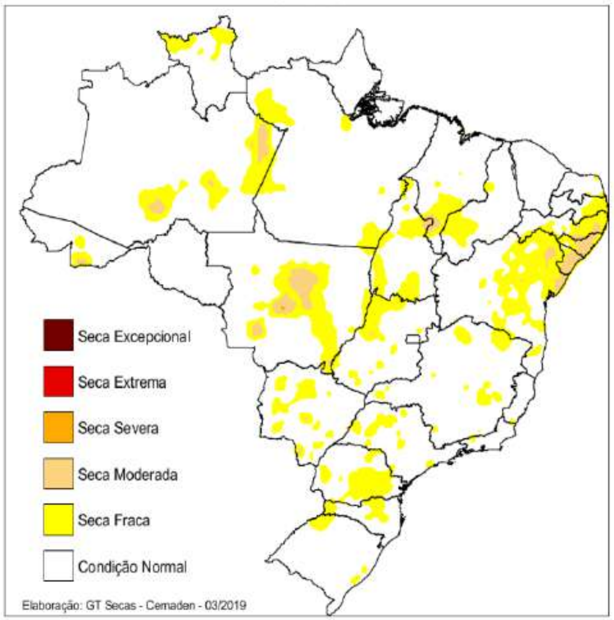




Moderate to severe drought for Sergipe, Alagoas, Bahia, Pernambuco.

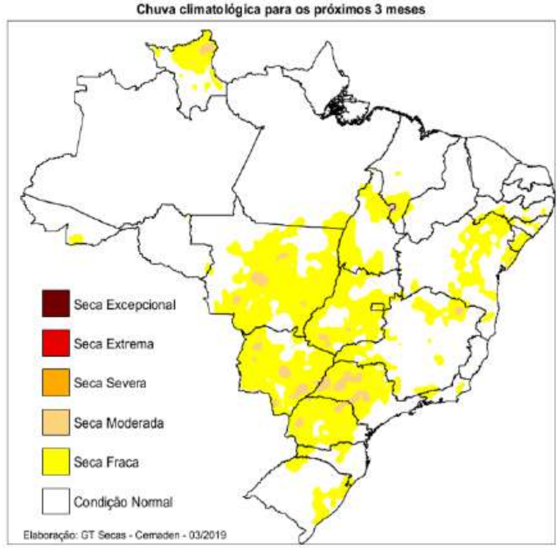
IIS: Cenários SPIs + VHI
Trimestre MAM/2019

IIS – FEB/2019



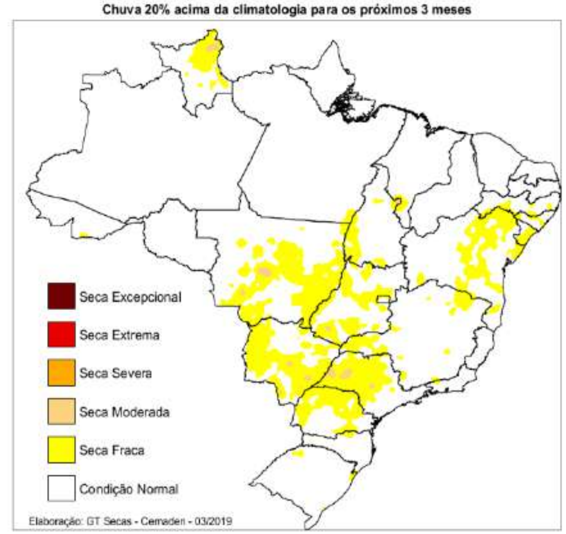
Scenario Ave Pcp

Chuva climatológica para os próximos 3 meses



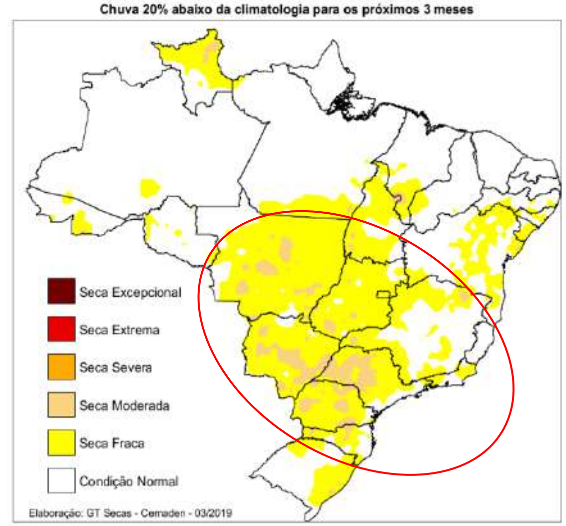
Scenario 20% above ave

Chuva 20% acima da climatologia para os próximos 3 meses



Scenario 20% below ave

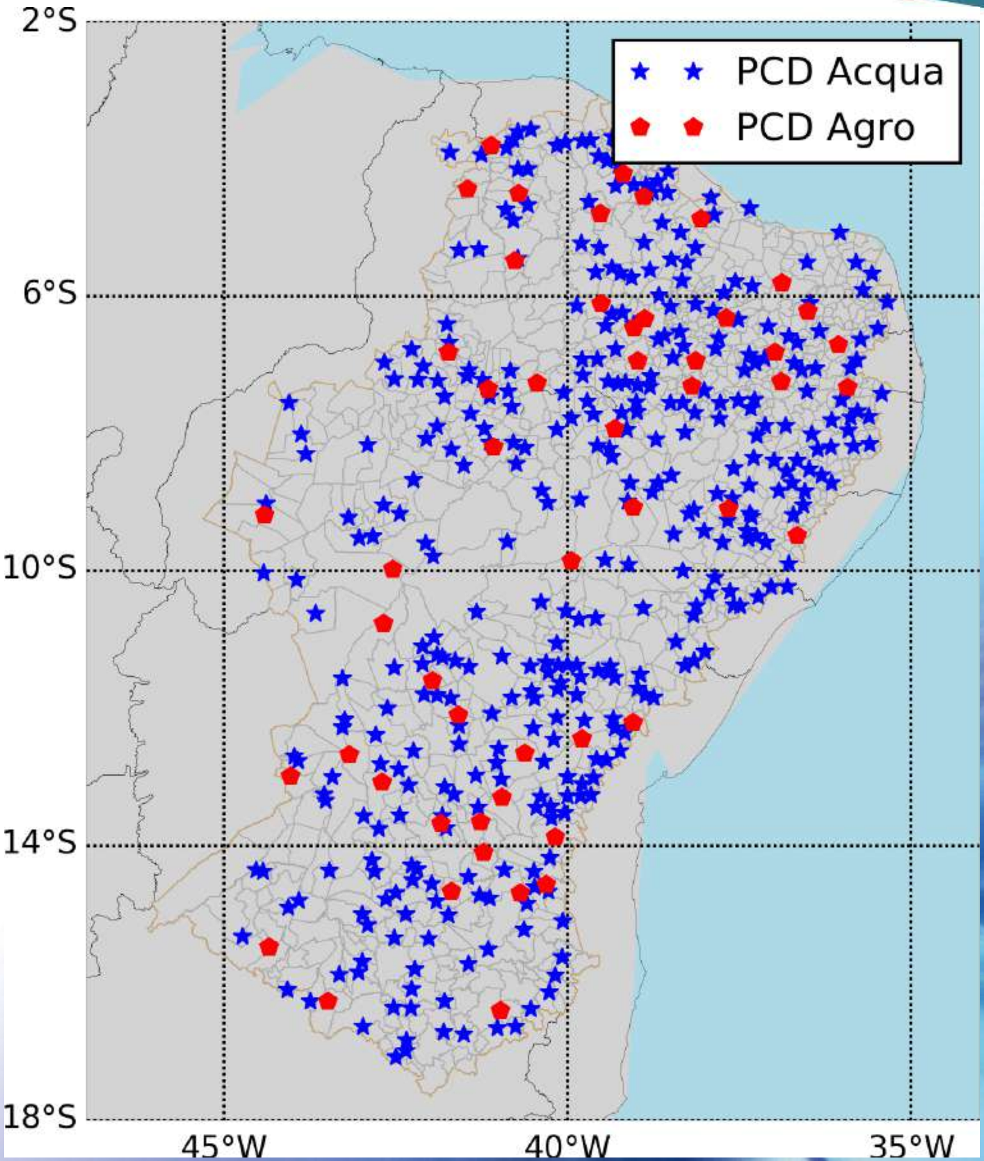
Chuva 20% abaixo da climatologia para os próximos 3 meses



WATCHING: moderate to severe drought remains even though the scenario is above average.

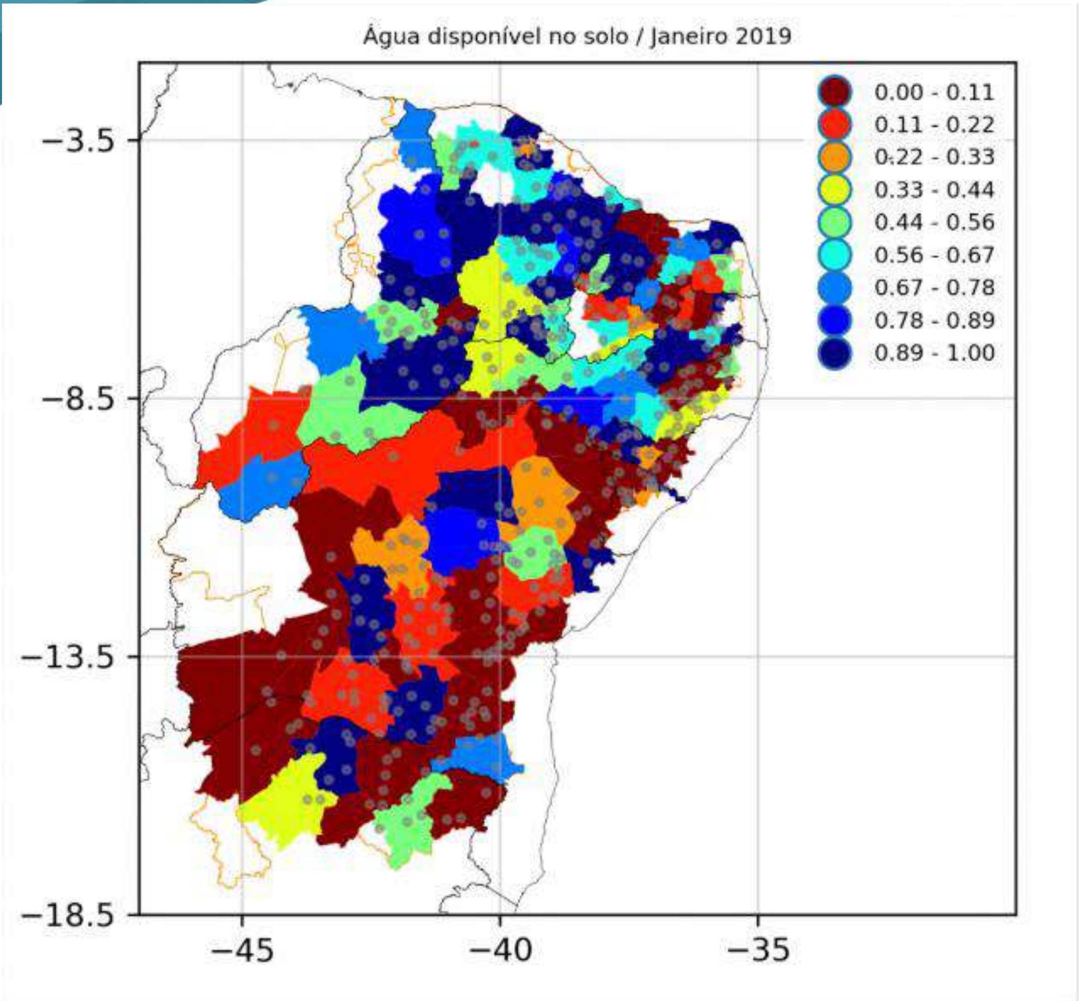
AGROMETEOROLOGY – MONITORING STATIONS

- Monitoring to support the research on agrometeorology
- Measurements of soil moisture, soil temperature, air temperature, rainfall, etc
- 600 locations (rural sites) since 2015



MONITORING STATIONS

Application: soil moisture index



Water available in the soil. Measured at 20 cm.

- Normalization of soil moisture by field capacity and wilting point (from soil samples)

Averaged over regions of interest (micro-regions = clusters of municipalities)

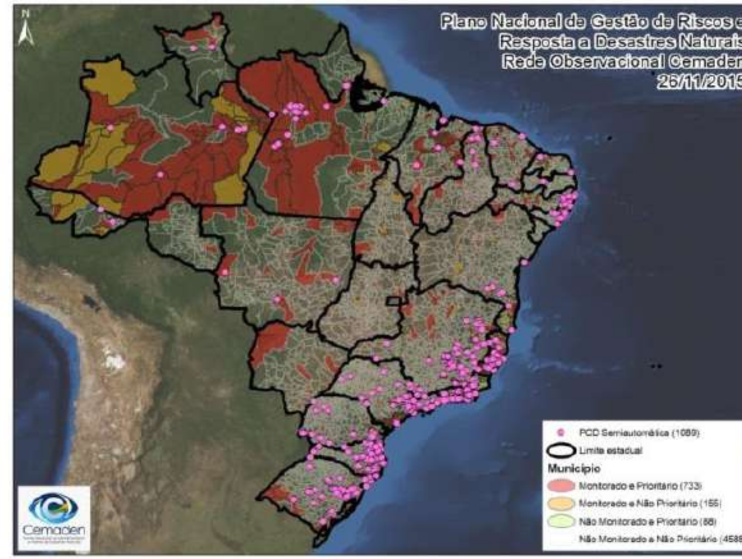
Estimation of chances of crop failure during critical crop periods

PROJECT “RAIN GAUGES IN THE COMMUNITIES”

Objective: To introduce the culture of risk perception of natural disasters in Brazil

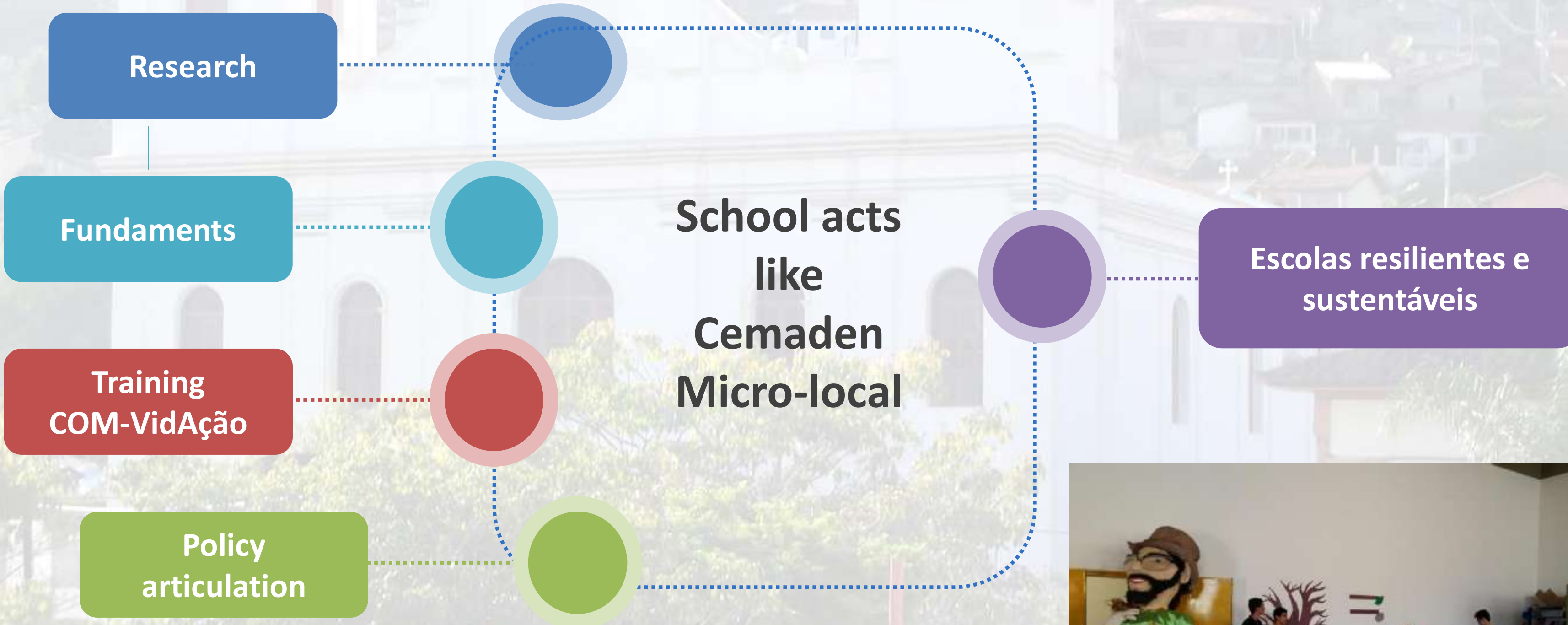
Semiautomatic pluviometers installed in risk areas and they are operated by local community teams, which are trained, aiming to promote the engagement and awareness of local inhabitants that live on areas of risk

1375 rain gauges installed; 286 municipalities; 52 training courses; 750 attendees;



Cemaden Edu-action (Education) Project: Schools and communities' networks for prevention

The project aims to engage communities around schools in areas at risk for socio-environmental disasters and increase their perception of the potential risk. Through sharing scientific knowledge to aid their protection, sustainability and resilience, these communities will be able to better practice citizen science. This will be accomplished through two seminars with 200 school in each of the two most vulnerable states.

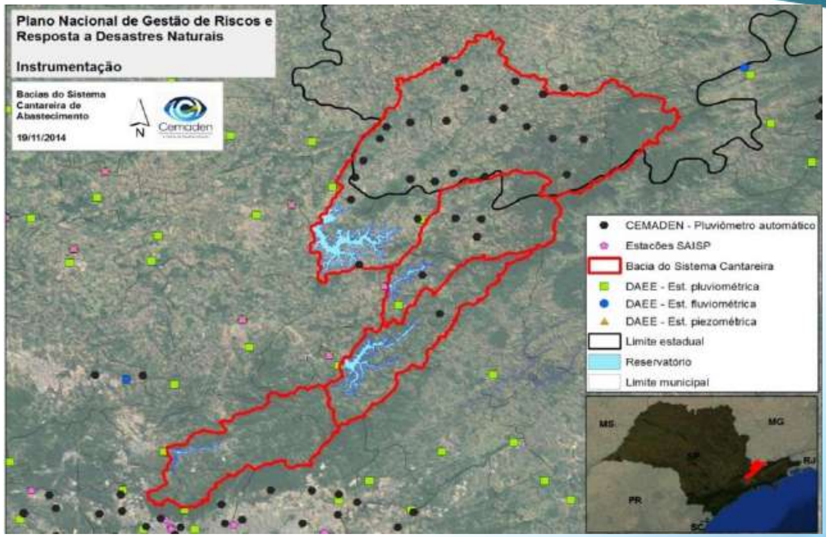


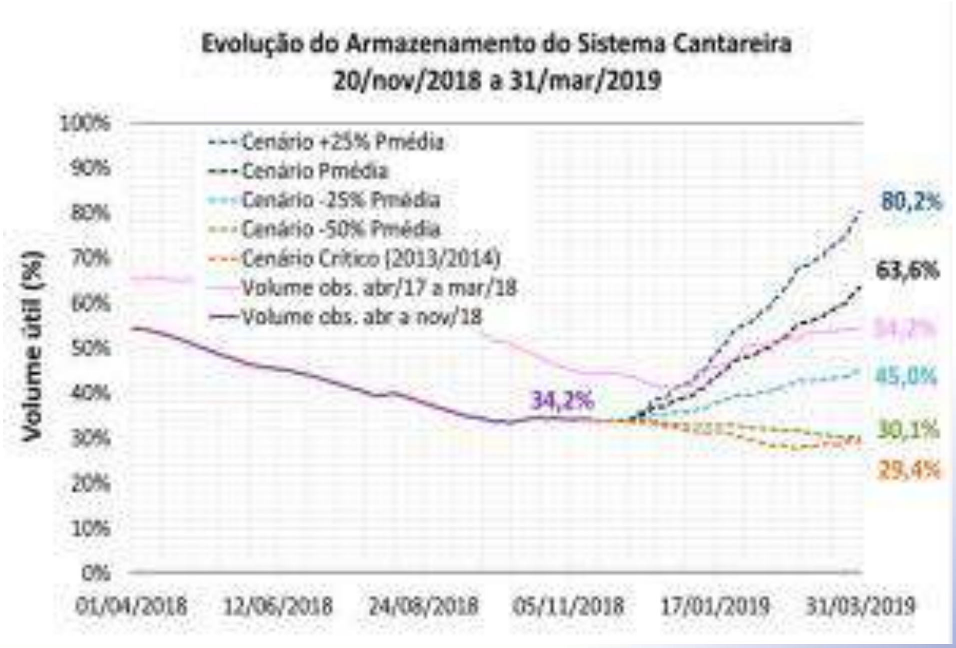
Recently the Campaign #*Learn2prevent* was granted among 100 projects over the world (3 in South America) by American Geophysical Union, as an outstanding project in the category Education and Diversity

COM-VidAção

Water Security – Cantareira Water Supply System

The Cantareira System:
This reservoir system supplies water for around half of the city's population. The city of São Paulo depends, among other reservoirs, on this system.





Modelling of the reservoir volume through the incoming precipitation.

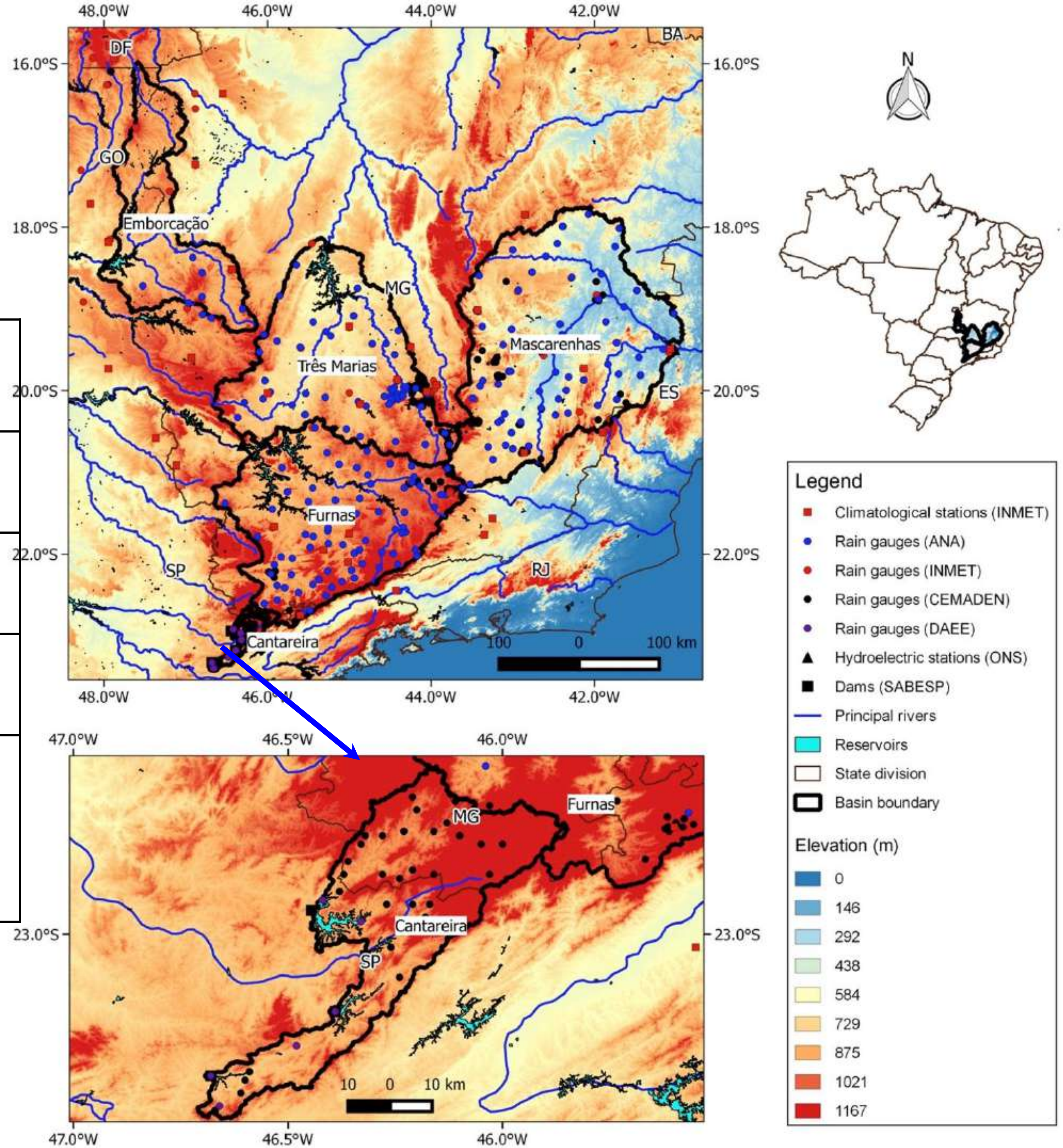
Comparison with prior occurrences

Estimation of future volume by using scenarios

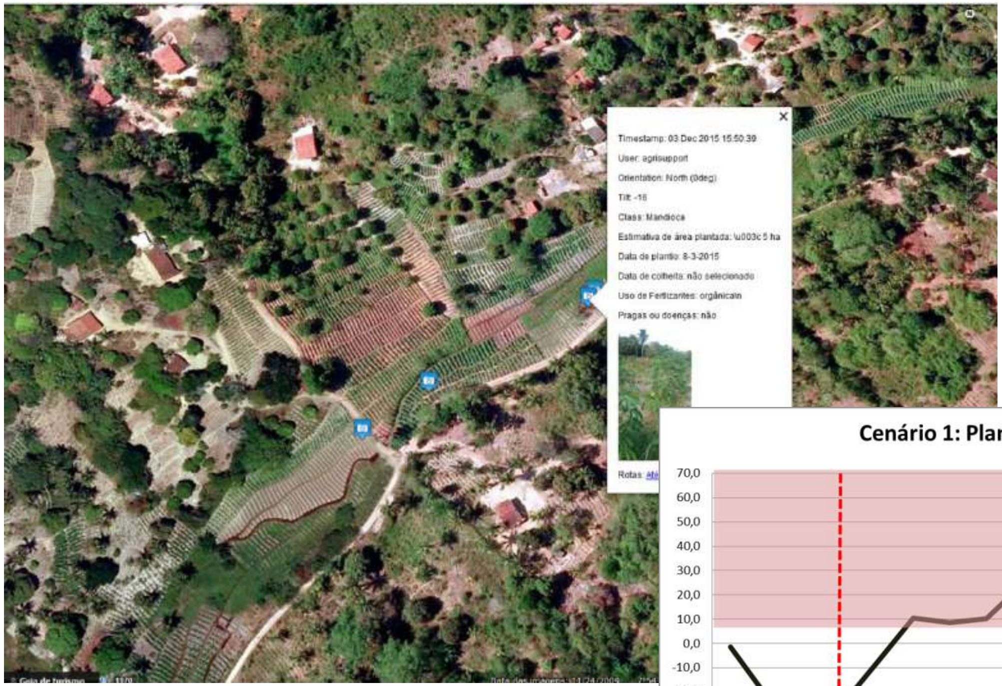
First steps investigating the usefulness of S2S predictions

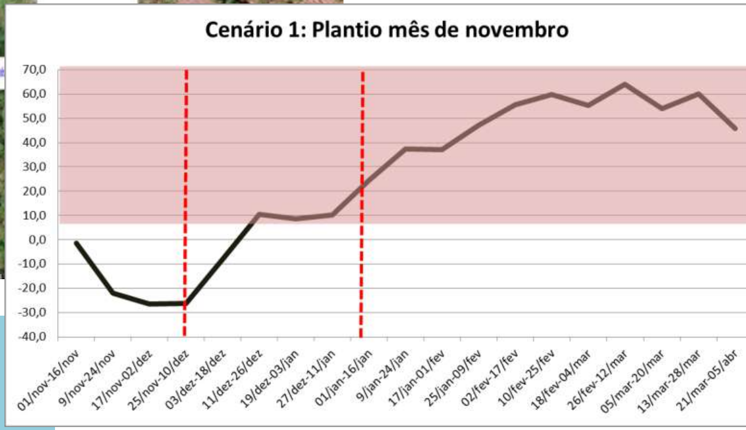
Hydropower and Water Supply Systems in Southeast Brazil

Reservoir	Basin area (km^2)
Emborcação Paranaíba river	29076
Três Marias São Francisco river	51576
Furnas Grande river	52197
Cantareira Jaguari-Jacareí, Atibainha and Cachoeira rivers	2279



Crowdsourced data applied to support the agricultural drought monitoring in the Brazilian Semiarid





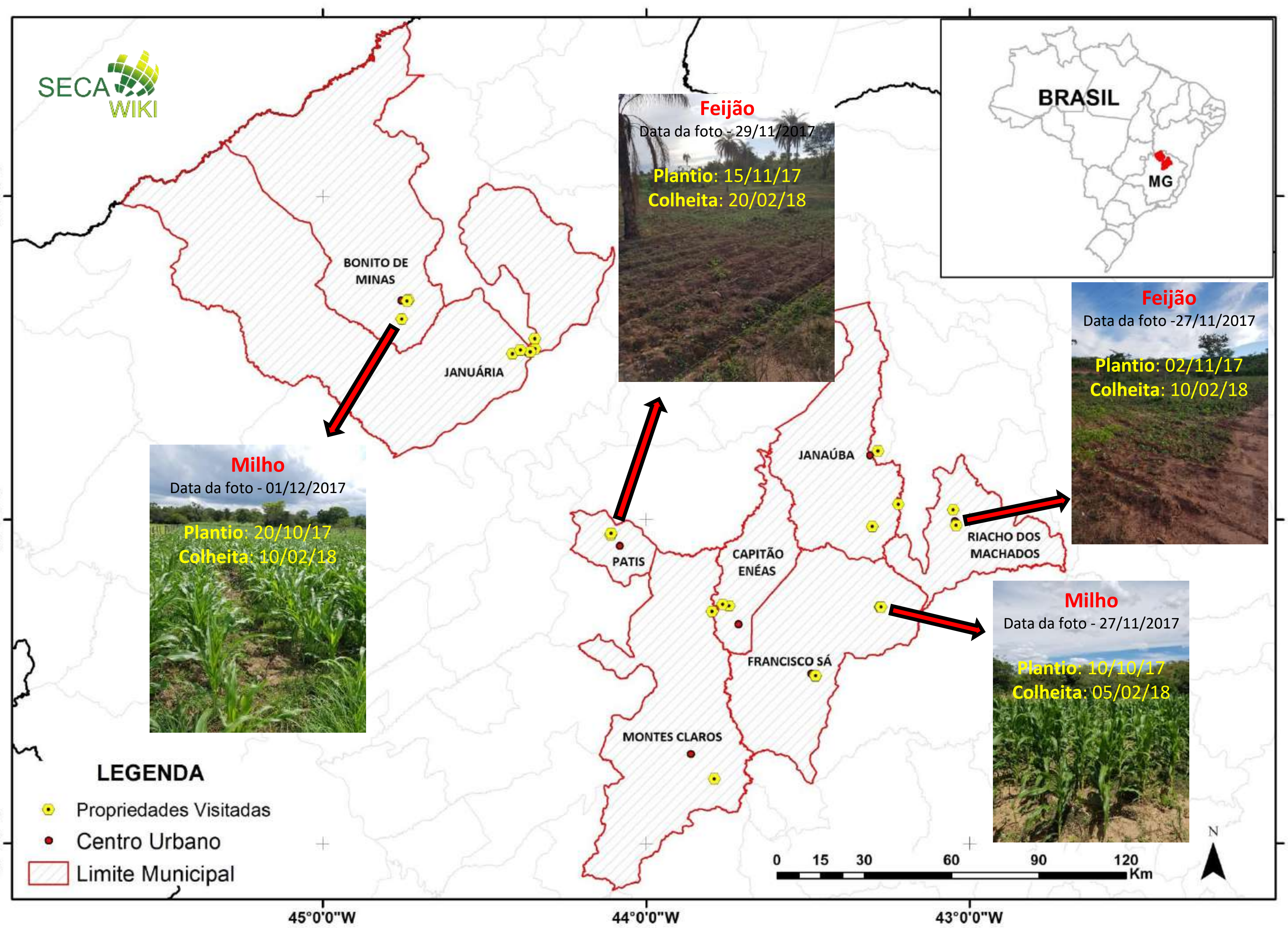
- Picture os crop lands (location)
- Crop type
- Planting date
- Cultivated and harvested area
- Management Information:

(soil, Fertilizers and Pesticides use)

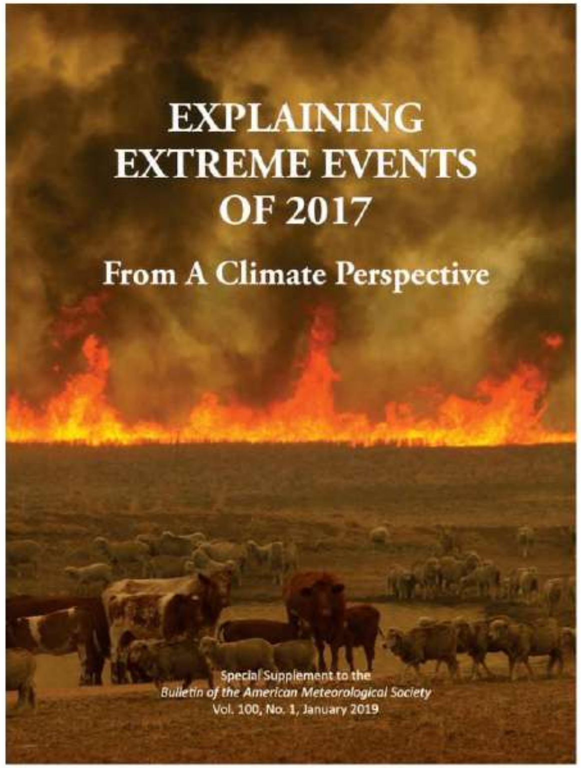
- Disease incidence

In loco agricultural drought monitoring!

Crowdsourced data >> preliminary results: MINAS GERAIS



Attribution study



Anthropogenic climate change has increased the risk of the April-May 2017 extreme rainfall in the Uruguay River basin, which has caused extensive flood and major socioeconomic impacts, by at least two fold.

hapter 8

CONTRIBUTION OF ANTHROPOGENIC CLIMATE CHANGE TO APRIL–MAY 2017 HEAVY PRECIPITATION OVER THE URUGUAY RIVER BASIN

Rafael C. de Abreu, Christopher Cunningham, Conrado M. Rudorff, Natalia Rudorff, Abayomi A. Abatan, Buwen Dong, Fraser C. Lott, Simon F. B. Tett, and Sarah N. Sparrow

Met Office

Cemaden

INPA
INSTITUTO NACIONAL DE PESQUISAS DA AMAZÔNIA

INPE

Newton Fund

Attribution study

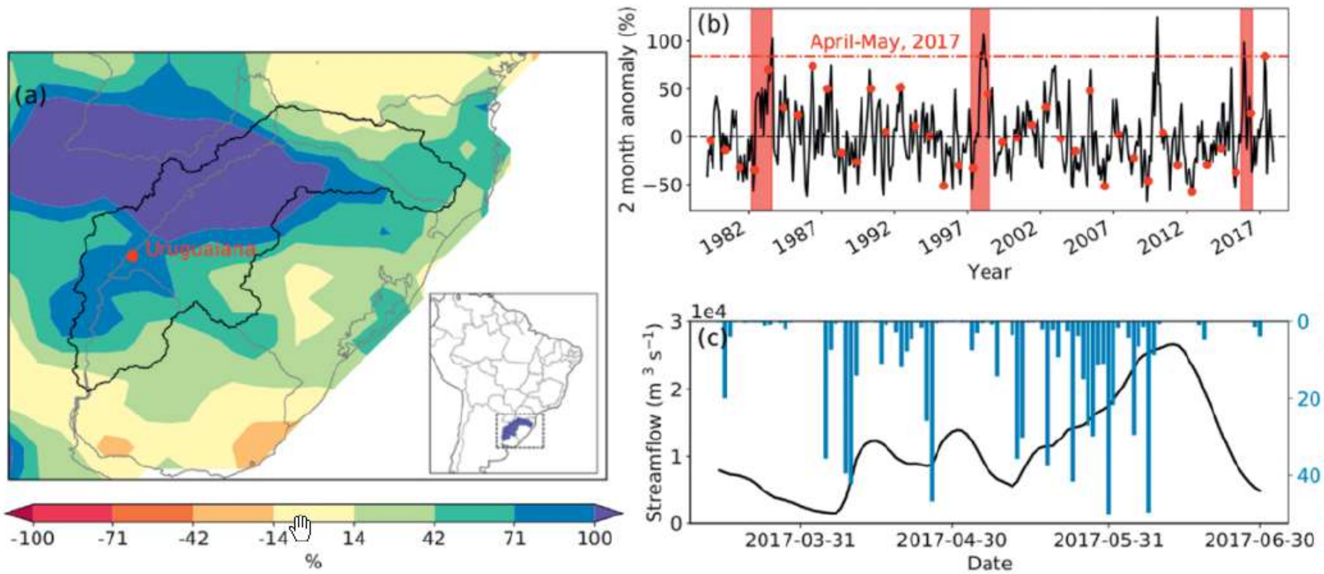


Fig. 1. (a) 2017 April and May anomalous precipitation in the Uruguay basin as percentage difference from a 1979–2013 climatology, based on the Climate Prediction Center (CPC) Global Unified Precipitation data. The gray borders indicates the geographic boundaries for coastlines, countries and Brazilian states, while black line indicates the boundaries of the Uruguay River basin. (b) Two-month precipitation anomaly related to the period of 1979–2017 as percentage difference from the 1979–2013 climatology, based on the Uruguay catchment average calculated using the CPC data (black line). Red bars in (b) highlight very strong El Niño events, where the Oceanic Niño Index (ONI) was greater than 2°C for more than 3 consecutive months; red dots indicate April–May precipitation anomaly and the red dashed dotted line the 2017 April–May anomaly. (c) Daily streamflow from Uruguaiana (black line) and daily precipitation for the average CPC data in the catchment area upstream of Uruguaiana (blue line).

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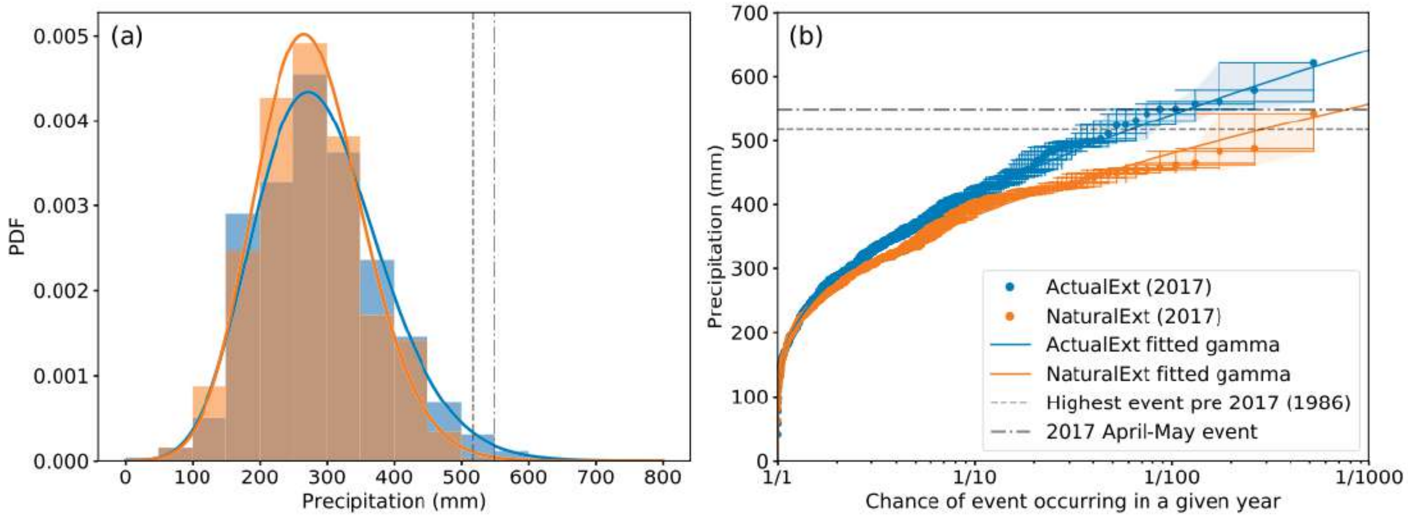

FIG. 2. (a) Probability distribution function for fitted gamma distributions of ActualExt and NaturalExt simulations of 2017 April and May accumulated precipitation in the Uruguay basin. (b) Return time for the ActualExt and NaturalExt experiments. Each marker represents an ensemble member and the blue and orange lines are the fitted gamma return period for the ActualExt and NaturalExt, respectively. The errors bars indicate the 95% confidence interval using bootstrap resampling. Black dashed line indicating the 517 mm threshold based on the 1986 event and the 2017 rainfall of 549 mm as dashed dotted line.

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The Brazilian Semiarid

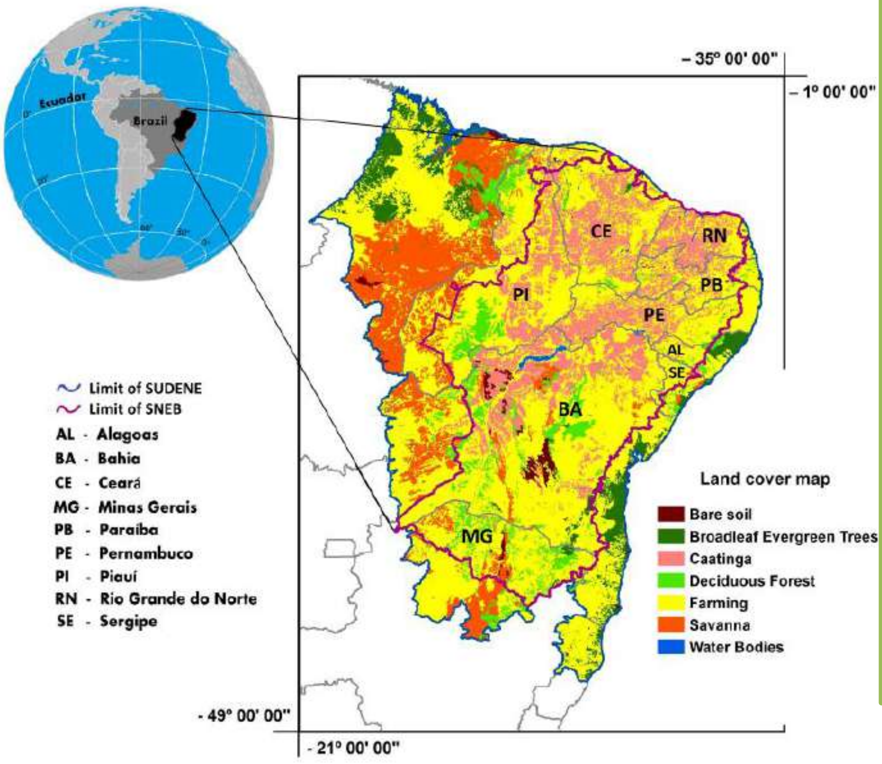


Figure 1. Geographical location of SNEB. [Colour figure can be viewed at wileyonlinelibrary.com].

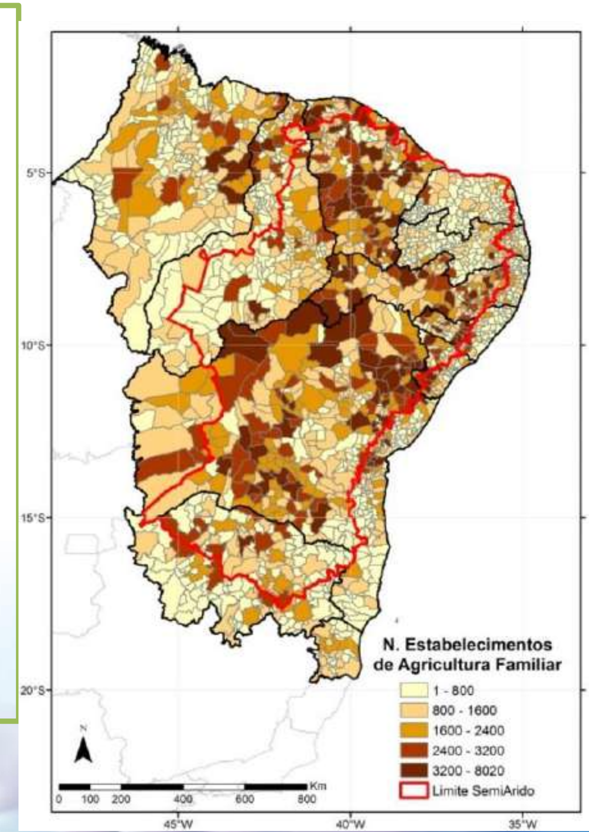
Population: 23,5 million hab. (IBGE,2014)

Nº of municipalities: 1.135

Nº of family farming properties: 1.493.852 (IBGE, 2009)

Mean area of family farming property in the Brazilian semi-arid: 16,5 ha

Mean Annual Precipitation: Less or equal to 800 mm.



Extreme drought in semiarid (NE Brazil)

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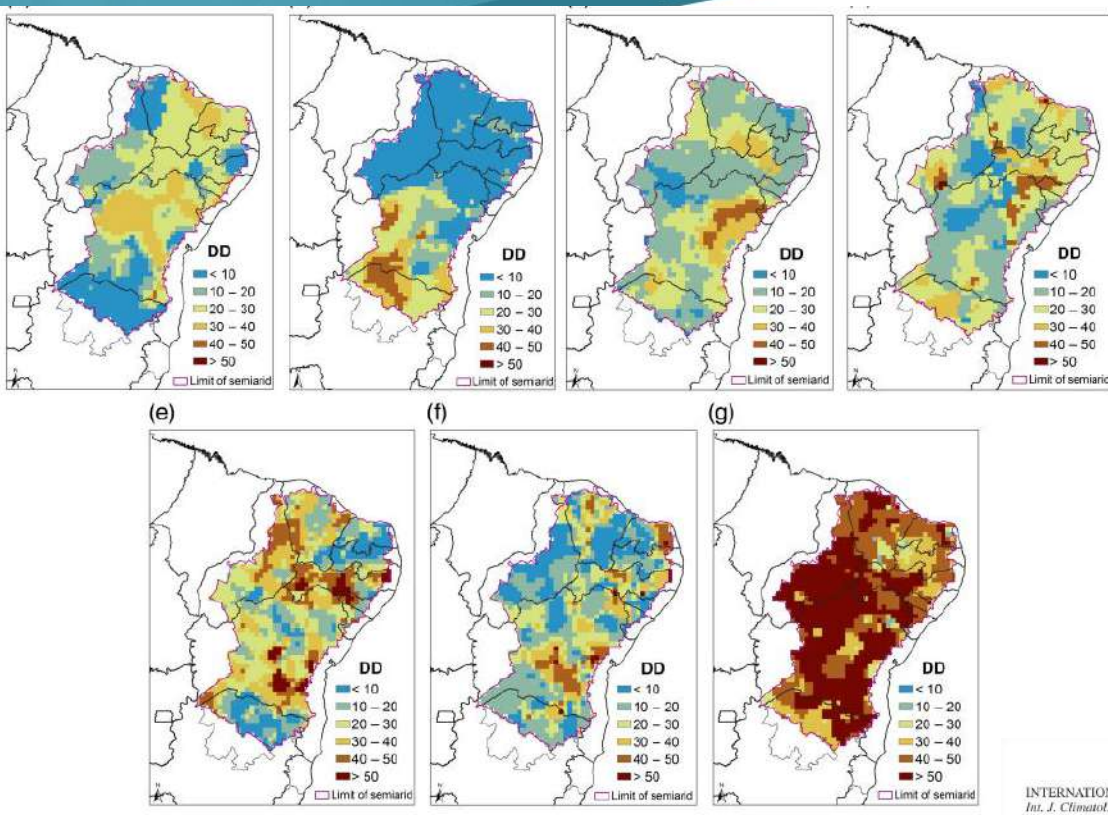

Figure 2. Drought duration maps for (a) 1981–1986, (b) 1986–1991, (c) 1991–1996, (d) 1996–2001, (e) 2001–2006, (f) 20
2011–2016 quinquennia, according to SPI data. [Colour figure can be viewed at wileyonlinelibrary.com].

The most severe and prolonged drought occurred in 2011–2016. In a clear contrast to previous droughts in past decades, during these
last 5-years period drought were more frequent, severe and affected a larger area with significant impacts for population

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RMetS
Royal Meteorological Society

Review

Frequency, duration and severity of drought in the Semiarid Northeast Brazil region

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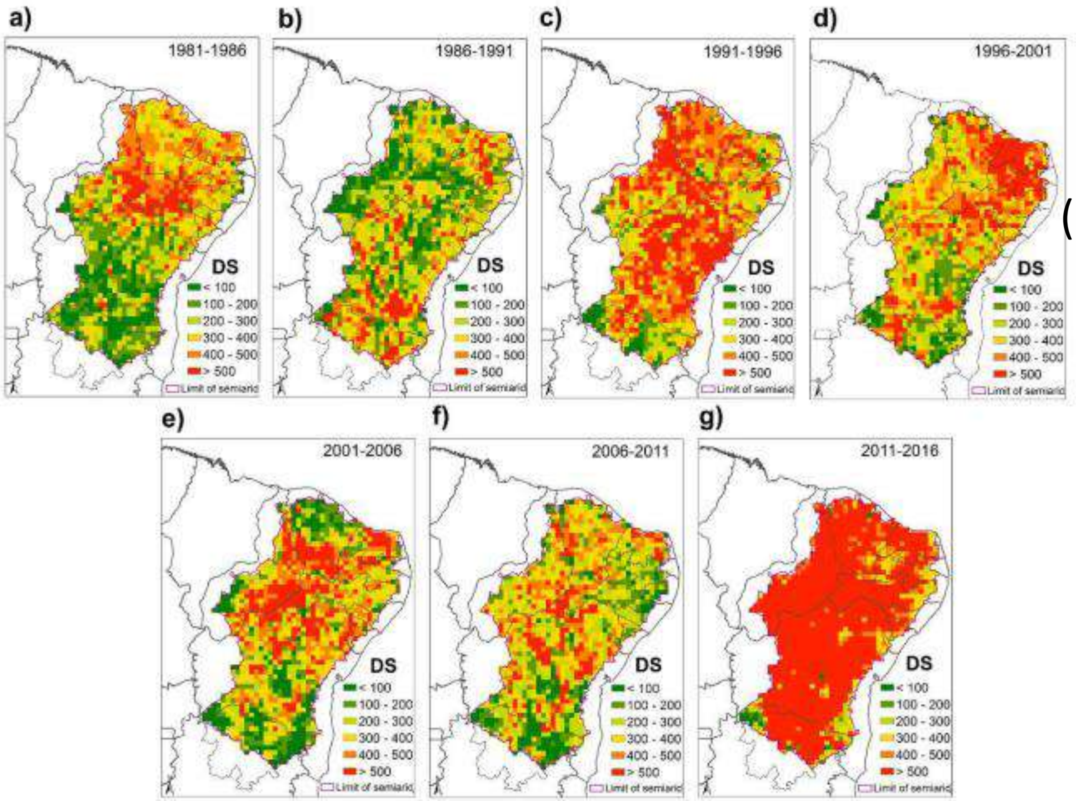
Cemaden
Centro Nacional de Monitoramento e Alertas de Desastres Naturais

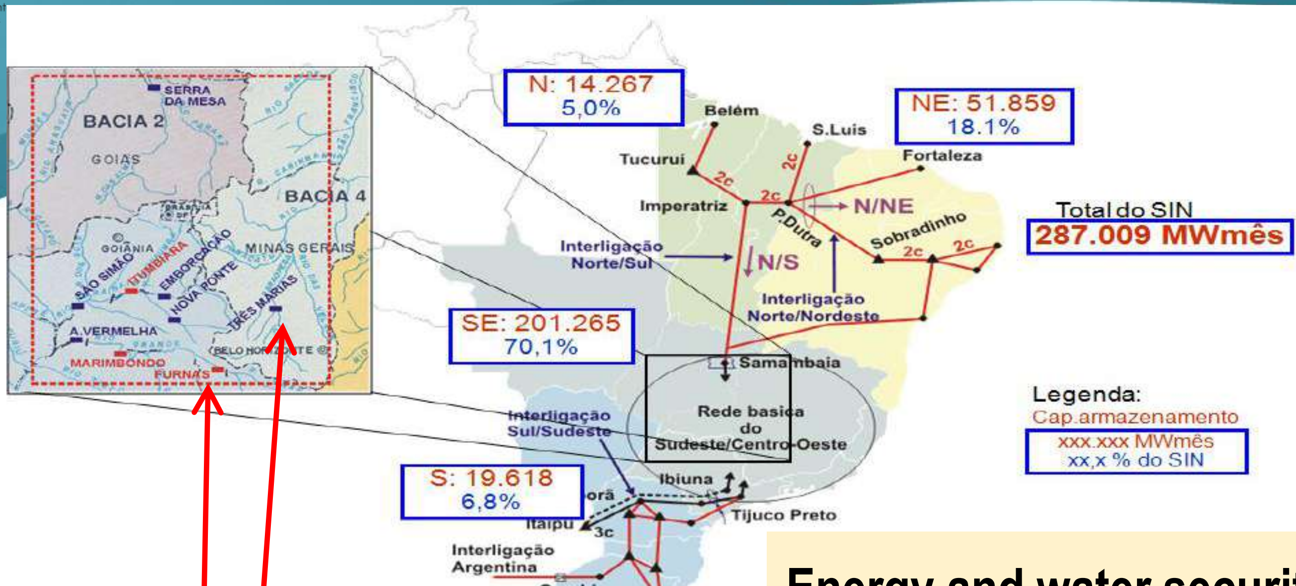
Extreme drought in semiarid (NE Brazil)

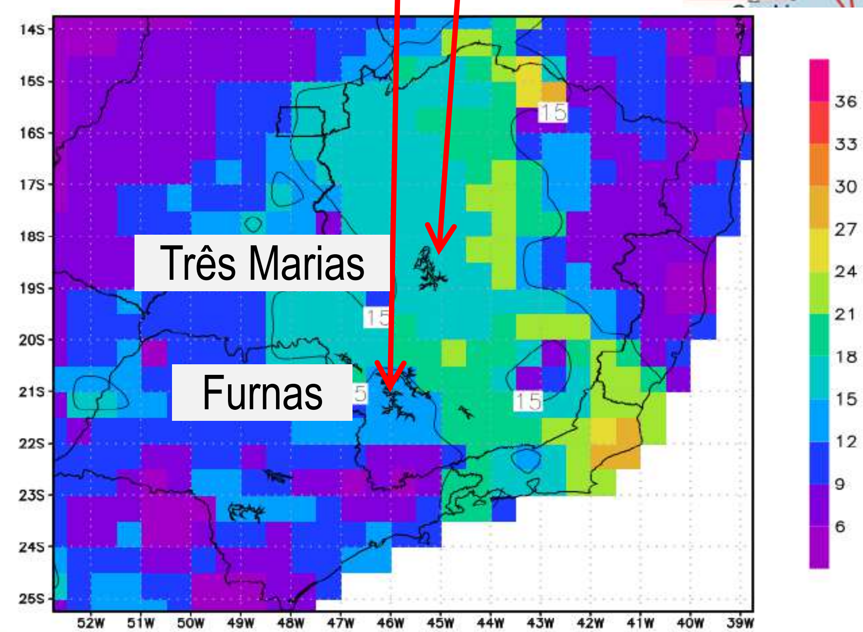


Drought severity maps for a) 1981-1986, b) 1986-1991, c) 1991-1996, d) 1996-2001, e) 2001-2006, f) 2006-2011 and g) 2011-2016 quinquennials, according to SPI data. (Source: Brito et al., 2017).

A recent study performed by the National Center for Monitoring and Early Warning of Natural Disasters (Cemaden) showed that the **2012-2016 NEB** drought was **more intense drought in terms of duration, severity and recurrence in the semiarid region at last 35 years throughout** (Brito et al., 2017). The Figure 4 shows that during 2011-2016, unlike all others, the semiarid region presented **more than 50% of area impacted by prolonged drought events with duration of over 50 months**. The main climatological features of the drought in NEB are detailed in Marengo et al (2017).

Dry spells over Southeastern Brazil - Reasoning





Energy and water security: some of the most important reservoirs for generation of electricity are located in this very region

Also for **food security**: dry spells are one of the main factor behind crop failure. If they happen during the flowering period of the crop.

DUBSTEP

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Collaboration with the CSSP-Brazil DUBSTEP project

- What is the skill of the S2S forecasts for dry spells (duration, magnitude and intensity) over SEB?
- Assess how the skill beyond day 15 is influenced by large-scale tropical and extra-tropical atmospheric circulations (MJO and PSA)
- How to improve forecast skill beyond day 15? (e.g.: removing bias, calibrating the probabilities, machine learning techniques?)

WORDS TO THINK ABOUT

How to convert the scientific knowledge about the American Monsoon to wisdom (useful information) for the decision makers?

For DRR spatial scale and diurnal cycle matters. The real-world happens in polygons (watersheds, metropolitan-regions, counties)

Atempt to walk on the users' shoes. Incorporate and promote the "First mile" approach.

Gracias! Thanks!

Questions? Comments?