

# An overview of Brazilian experience in organizing the flood management: an institutional and technical approach

Köln, Deutschland  
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## Institutional setting

- The political and administrative organization of the Federative Republic of Brazil comprises the Union (represents the Federal Government), 26 States, the Federal District and 5,565 municipalities, all autonomous (self-organization).
  - General data:
    - Population: 202 million (IBGE's estimative for 1<sup>st</sup> July 2014)
    - Area: 8,5 million Km<sup>2</sup> (45% on North; 18% on Amazon State)
  - Federative Republic:
    - 1 Federal Constitution (CF 1988)
    - 1 National Water Resources Policy (Law 9433/1997)
  - 26 States + Federal District:
    - 27 State Constitution
    - 27 Water Resources Policies
  - 5.565 Municipalities:
    - 5.565 norms for land use and occupation

## Institutional setting

- Brazilian legal framework
  - Constitutional provisions (1988):
    - Water resources domain (Art. 20-III; Art. 26-I)
    - Flood (Art. 21-XVIII): The Union has the exclusive (neither privative nor common) competence to plan and promote the continuous defense against public calamities, mainly, droughts and floods.
    - Civil Defense (Art. 22-XXVIII): The Union has the privative competence to legislate.



 **Federal Rivers .....** 105.810 km  
 **State Rivers .....** 1.526.825 km



**watersheds of border and transboundary rivers**

## Institutional setting

- Brazilian legal framework
  - Constitutional provisions (1988):
    - Union's competence (Art. 21)
    - State's competence (Art. 25)
    - **Municipality's competence (Art. 30-VIII): planning and controlling the use, subdivision and occupation of the urban land.** All municipalities with more than 20 thousand inhabitants should have a master plan (Art. 182-§1º).
    - Finances (Art. 159): Union must deliver 49% of the collected taxes and earnings to special funds (21,5% to FPE-States, 24,5% to FPM-Municipalities and 3% to others)



Population density (IBGE, 2010)

## Institutional setting

- Public policies related:
  - National Policy of Environment (Law 6938/1981): environmental permit;
  - National Water Resources Policy (Law 9433/1997): “prevention and defense against the hydrological critical events of natural origin or due to improper use of natural resources”; water resources plans and permits;
  - City’s Statute (Law 10257/2001): “land use control and organization to avoid the risks of disasters to the population”; master plan; zoning; land use and occupation;
  - Dam Safety (Law 12334/2010): Emergency Action Plan. The authorities and the civil defense should be communicated;
  - National Policy of Protection and Civil Defense (Law 12608/2012): The management of the risks and disasters should focus in prevention, mitigation, preparation, response and recovery actions. The three federatives levels are involved;
  - Native Forest Protection (Law 12651/2012): Defines the permanent protection areas (APP);

## Institutional setting

# National Plan of Risk Management and Response to Natural Disasters (2012)

Actions divided in 4 subject axis:

- **Prevention** – Constructions related to the natural disasters risk reduction - Development Acceleration Program (PAC);
- **Mapping** – Mapping of areas with high risk of landslide, flood and rushing stream of water in 821 priority municipalities (the list is under review, using improved technical criteria);
- **Monitoring and alert** – Observation equipments and situation rooms to improve the weather and hydrological forecasts and warnings;
- **Disasters responses** – To improve the Government capacity to act in disasters occurrences (Ex: Nacional Emergency Force).



## Institutional setting

### FEDERAL NORMATIVES SYSTEMATIZATION (this is not an exhaustive list)

Subject	Land use	Civil Defense	Flood risk management
Constitucional Provisions	X	X	X
Law 6938/1981 - National Policy of Environment	X		
Law 9433/1997 - National Water Policy	X		X
Law 10257/2001 - City's Statute	X		
Law 12334/2010 - Dam Safety		X	X
Law 12608/2012 - National Policy of Protection and Civil Defense		X	X
Law 12651/2012 - Native Forest Protection	X	X	
National Plan of Risk Management and Response to Natural Disasters	X	X	X

# Institutional setting

	FEDERAL														P R I V A T E	STATE				LOCAL
	MMA – ANA	MMA – IBAMA	MCTI-CEMADEN	MI – Direct execution	MI- SEDEC	MI- CENAD	MI- DNOCS	MI-CODEVASF	MI-ME-EPE	MIME-CPRM	MIME - DNPM	M CIDADES	MI-D Army	ONS		ENTREPRENEUR	ENVIRONMENT	WATER RESOURCES	CIVIL DEFENSE	
PR	PR01	X	X													X				
	PR02																			X
	PR03	X														X				
	PR04	X		X				X			X						X			
	PR05	X		X		X	X									X	X	X		
	PR06	X	X							X										X
PT	PT01			X		X	X					X		X					X	X
	PT02			X		X	X					X		X					X	X
	PT03			X		X	X					X		X					X	X
	PT04																		X	X
	PT05	X	X		X									X			X			
	PT06	X					X	X						X			X			X
PP	PP01		X														X			
	PP02	X	X				X	X	X	X							X			
	PP03	X															X			
	PP04	X	X			X		X	X								X			
	PP05		X																	
	PP06					X												X		X
	PP07					X												X		X
	PP08					X								X			X			X
RE	RE01			X	X	X												X		X
	RE02			X	X	X												X		X
	RE03			X	X	X												X		X
RA	RA01				X	X												X		X
	RA02				X	X														
	RA03				X	X												X		X

**Macro functions for risk management:**  
institutional tasks to be executed

**Law 12608/2012:** prevention, mitigation, preparedness, response and recovery;

**Recommended elements  
(CEC/COM(2004)472) and examples:**

- Prevention (PR): plans, risk areas mapping;
- Protection (PT): civil works, reservoirs operation;
- Preparing for floods (PP): forecast system, contingency plans;
- Emergency response (RE): training, shelters;
- Recovery and learning (RA): reports (damage and alerts), database, .



## Starting point

### Some flood events that occurred in Brazil

#### SC: Itajaí River Basin (nov/2008)



**This area suffers with frequent floods (each 3-5 year)**

The floods in Santa Catarina in 2008 occurred after the period of heavy rains during the month of November 2008, affecting around sixty towns and over 1.5 million people in the state of Santa Catarina, Brazil.

135 people died, two were missing, 9,390 residents were forced to leave their homes and 5,617 homeless.

## Starting point

### Some flood events that occurred in Brazil

#### AL/PE: Mundau, Una e Paraíba do meio River Basin (jun/2010)



**This area had huge economic and social  
damages due to the last flood**

#### Alagoas State:

- 29 municipalities affected
- 27 people died
- 72,261 had to leave their houses
- 18,823 houses were damaged or destroyed.

#### Pernambuco State:

- 68 cities affected
- 20 people died
- 82,609 had to leave their houses
- 14,136 houses were damaged or destroyed.

## Starting point

Muriaé River in Cardoso Moreira  
58770000 [1928-2012]

Ordem	Data	Máxima (cm)
1	4/2/1979	1015
2	20/1/1985	966
3	5/1/2012	963
4	9/1/2009	894,5
5	29/12/2008	874
6	24/12/1943	870
7	30/12/2010	870
8	5/2/1937	851
9	17/1/2007	830,5
10	12/12/1983	810

**At these river  
basins, the flood  
recurrence and  
magnitude seem to  
be increasing**

Pomba River in Cataguases  
58770000 [1930-2012]

Ordem	Data	Máxima (cm)
1	18/12/2008	980
2	4/2/1979	895
3	3/1/2012	860
4	19/1/1991	722
5	21/1/2003	693
6	1/1/2009	679
7	5/1/2007	676
8	15/2/1961	674
9	14/1/1983	673
10	16/1/2004	669



Itaperuna/RJ (Muriaé river), flood mark of 1997



Cataguases/MG (Pomba river), flood of 2008

## Starting point

### Some flood events that occurred in Brazil

#### AC: Acre River Basin (fev/2012)



- Flood cost: more than R\$ 1 billion (approx US\$ 370 million)
- The Rio Acre flooding in 2012 is the highest ever achieved in number, according to the Civil Defense
  - almost **90,000 people** were affected in **38 districts** and **14 rural communities**



**At this area, the urbanization has been done in an inappropriate way. The old houses are elevated (people more resilient to flood), but the new houses are not.**

## Starting point

# Some flood events caused by dam break in Brazil

## Structures can fail and increase the flood impact



Dam break of Pampulha by structural failure, State of Minas Gerais, May/1954  
The surrounding area was evacuated, including the Pampulha Airport

Dam break of Orós by overtopping, State of Ceará, mar/1960  
50 deaths and 170,000 people affected



Dam break of Barragem Euclides da Cunha (State of São Paulo) by overtopping and Armando de Salles Oliveira (located downstream) by cascade effect, jan/1977

Dam break of Camará by structural failure, State of Paraíba, jun/2004  
5 deaths and 3,000 people homeless



Dam break of Algodões, State of Piauí, may/2009  
499 families of Cocal and Buriti dos Lopes were affected and 15 people died

## Starting point



SC (Itajaí): nov/2008



AL/PE (Mundaú, Una, Paraíba, etc): jun/2010



RJ (região serrana): jan/2011

**Challenge: deal with uncertainty and make a comprehensive damage assessment (human life, environment, etc)**

In addition of refuting the myth that Brazil is a country free of natural disasters, these events show how these disasters can be devastating to local economies. According to a recent evaluation of the World Bank, the losses on these 3 disasters were approximately R\$ 15 billion (approx US\$ 5.5 billion).

Source: World Bank

<http://www.worldbank.org/pt/news/feature/2012/11/19/Brazil-natural-disaster-management-costs-development>  
<https://www.understandrisk.org/page/publicações%20%20>

## Starting point

**Challenge: Enforce the law**  
**Permanent Preservation Areas (APPs) are being**  
**occupied and the population is getting in risk**

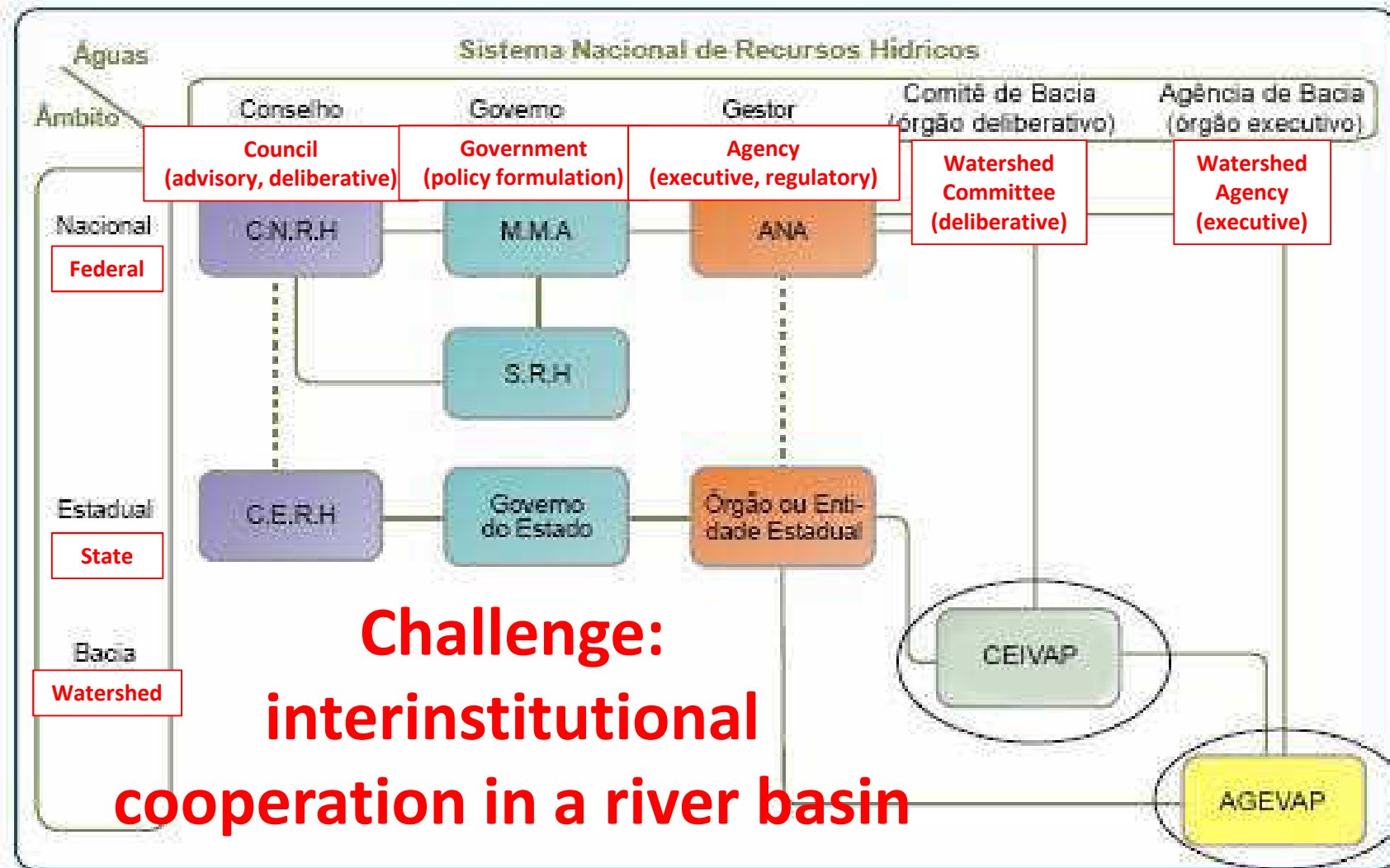


União dos Palmares, 80 km of Maceió-AL. The more affected area was in the APP (50 meters from each bank of the river).



Aerial View of the neighborhood of Campo Grande in Teresópolis. The more affected areas are in the APPs (limite by the yellow line). Date: January, 24th, 2011.

## Starting point

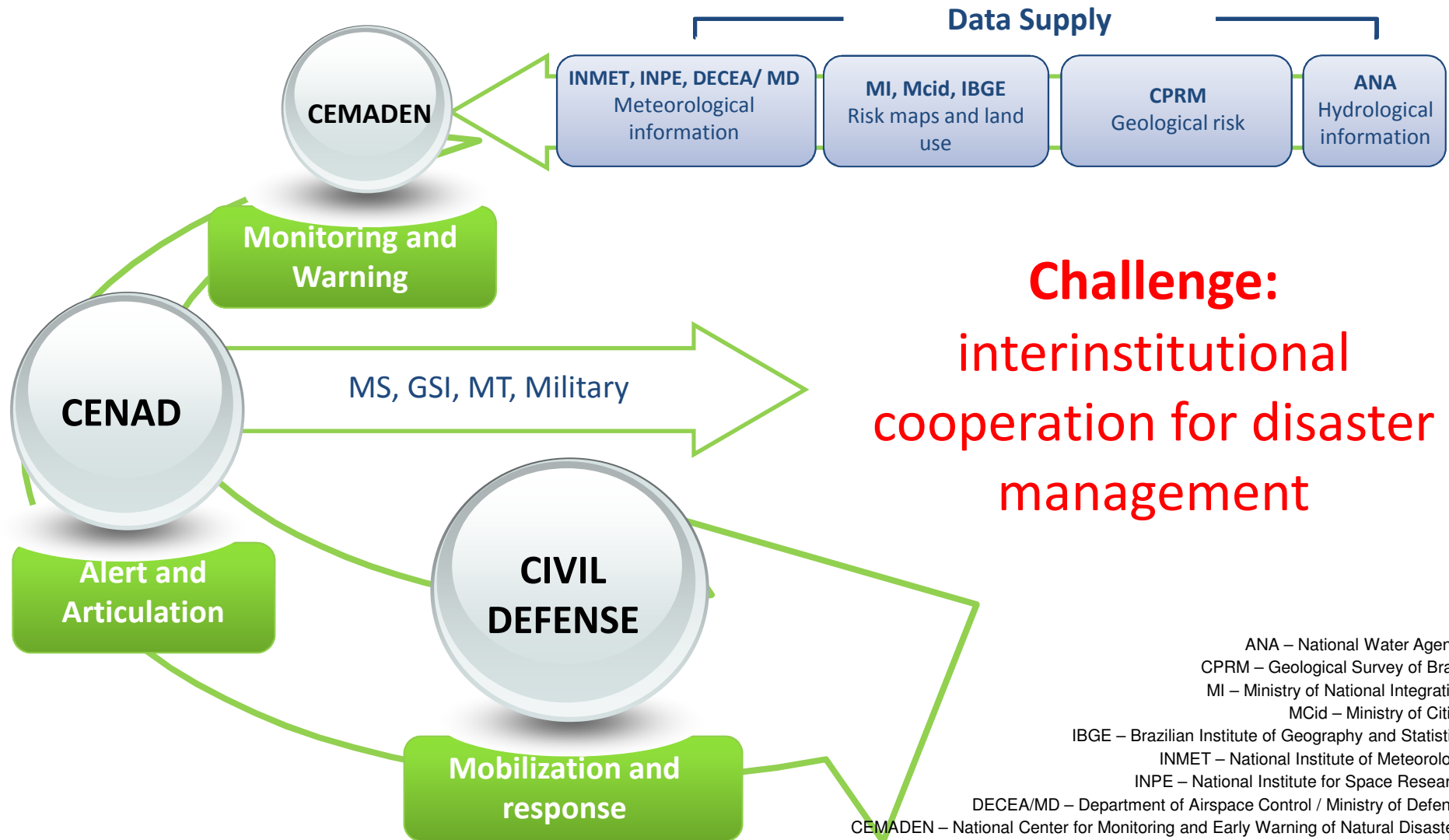


Institutions of the National Water Resources Management System (SINGREH) related to the Paraíba do Sul River Basin management



# Starting point

## FEDERAL DISASTER MANAGEMENT CYCLE



ANA – National Water Agency  
 CPRM – Geological Survey of Brazil  
 MI – Ministry of National Integration  
 MCid – Ministry of Cities  
 IBGE – Brazilian Institute of Geography and Statistics  
 INMET – National Institute of Meteorology  
 INPE – National Institute for Space Research  
 DECEA/MD – Department of Airspace Control / Ministry of Defense  
 CEMADEN – National Center for Monitoring and Early Warning of Natural Disasters  
 CENAD – National Center for Risk and Disasters Management

# Approach

## Flood Vulnerability Atlas



Reference: <http://www2.snirh.gov.br/home/>



Workshop to explain the methodology for each state.

- Considering the lack of data about the impacts, recurrence and vulnerability to floods in Brazil, it was developed a single methodology to evaluate this issues that was applied for all the states;
- It was a qualitative process that involved experts in different areas (water resources, environment, geological survey, civil defenses, universities, etc);
- It allowed to identify the most critical areas to floods and rank them. This is an important tool to the national planning to prevent the floods impact.

## Approach

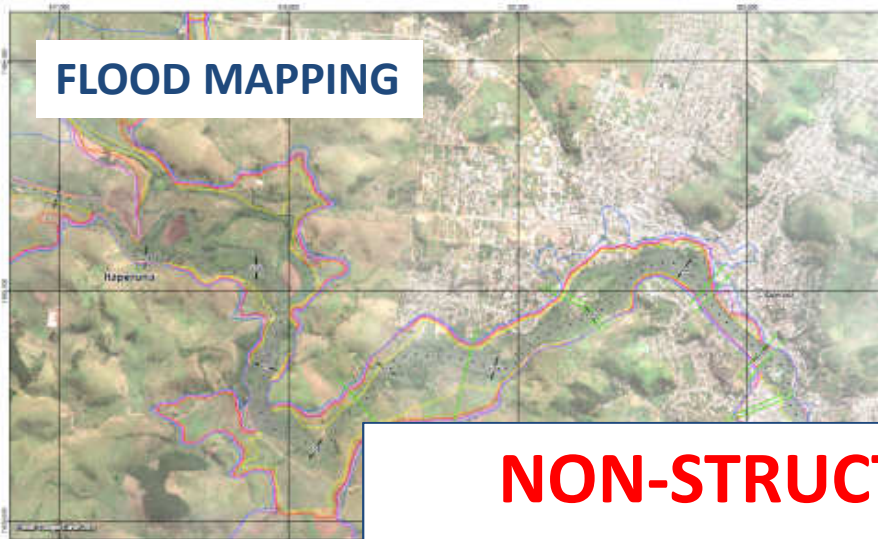
### Hydrometeorological monitoring network (automatic and telemetric gauges) and Situation monitoring room



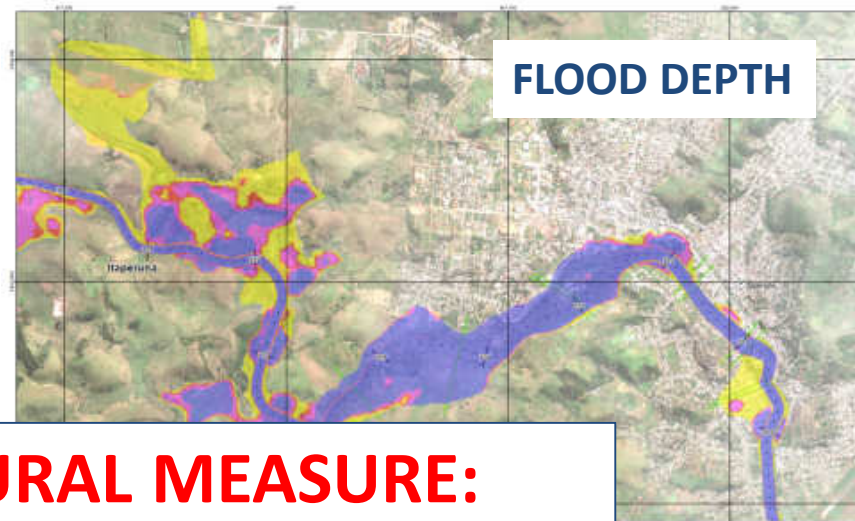
- Integration and improvement on the hydrometeorological monitoring network;
- Providing computational tools and training to the State and other federal agencies team;
- Periodic technical discussions, through videoconference systems, with experts from the states, the National Water Agency (ANA/MMA), the National Center for Risk Management and Disaster (CENAD/MI), National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN/MCTI) and the Geological Survey of Brazil (CPRM/MME).

# Approach

FLOOD MAPPING

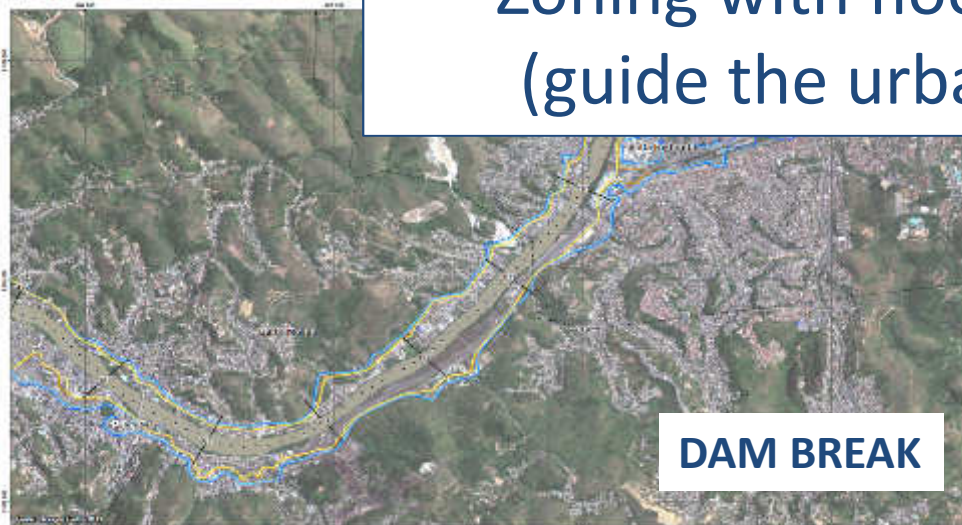


FLOOD DEPTH

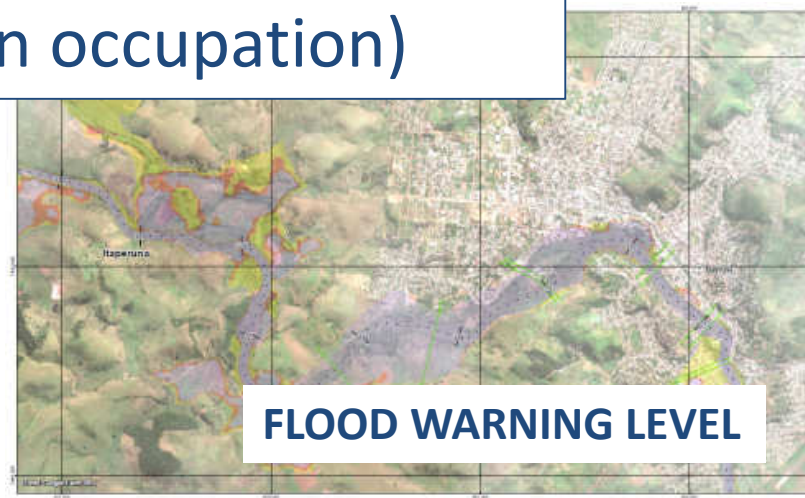


**NON-STRUCTURAL MEASURE:**  
Zoning with flood hazard maps  
(guide the urban occupation)

DAM BREAK

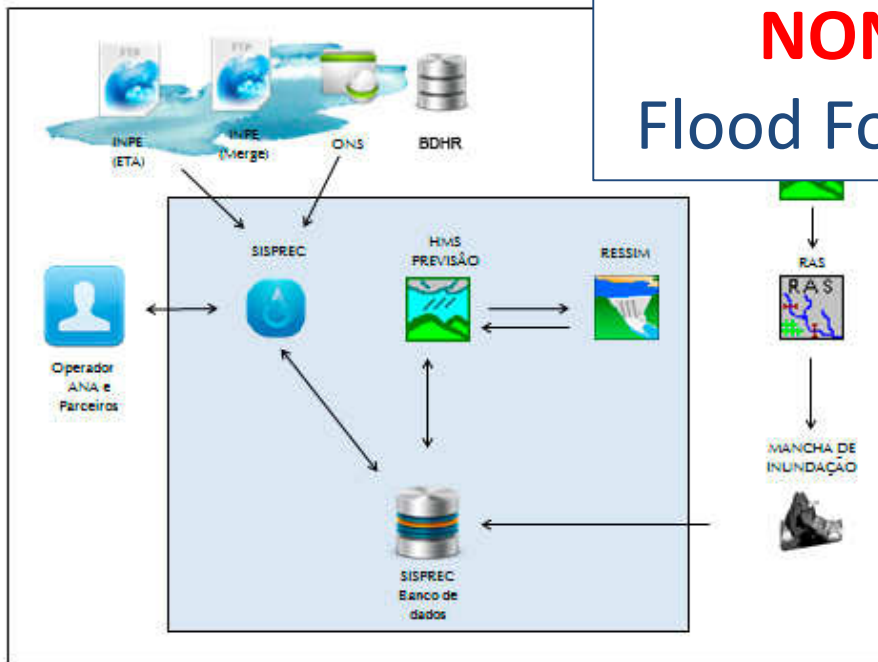


FLOOD WARNING LEVEL



# Approach

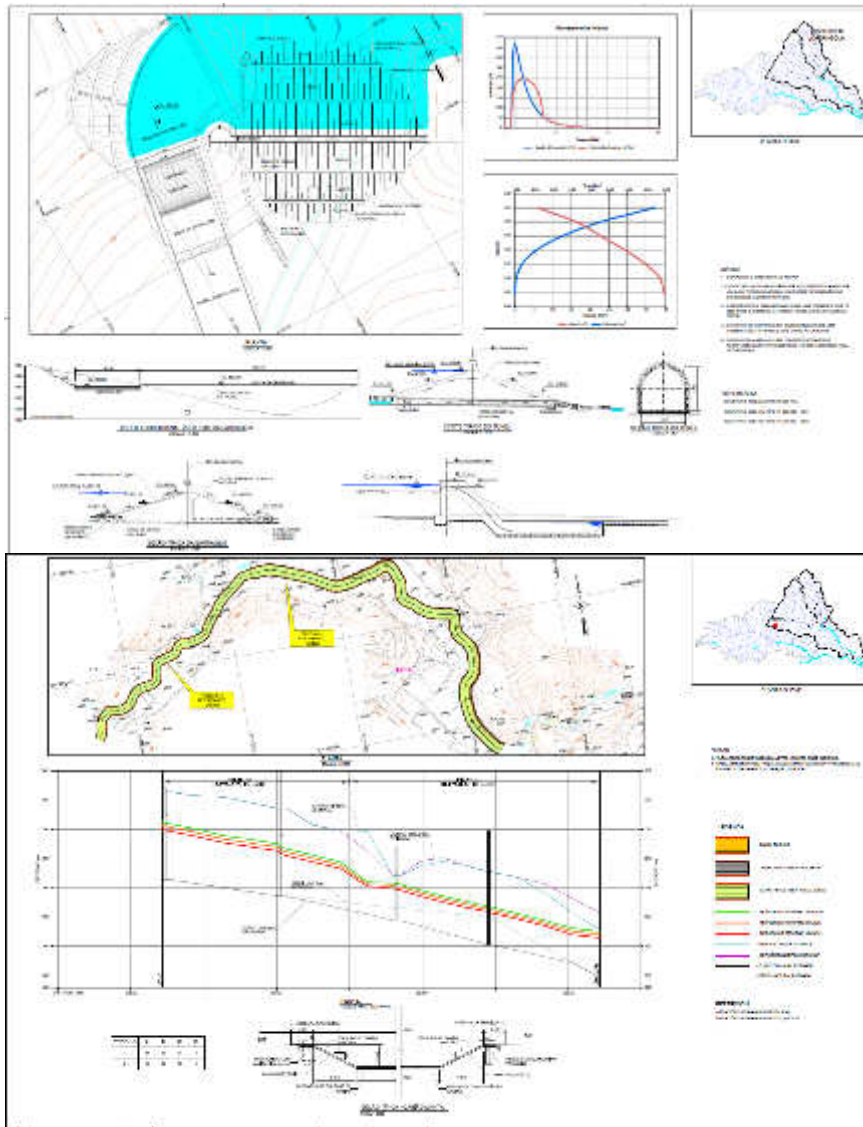
## NON-STRUCTURAL MEASURE: Flood Forecast System (reduce impact)



## Approach

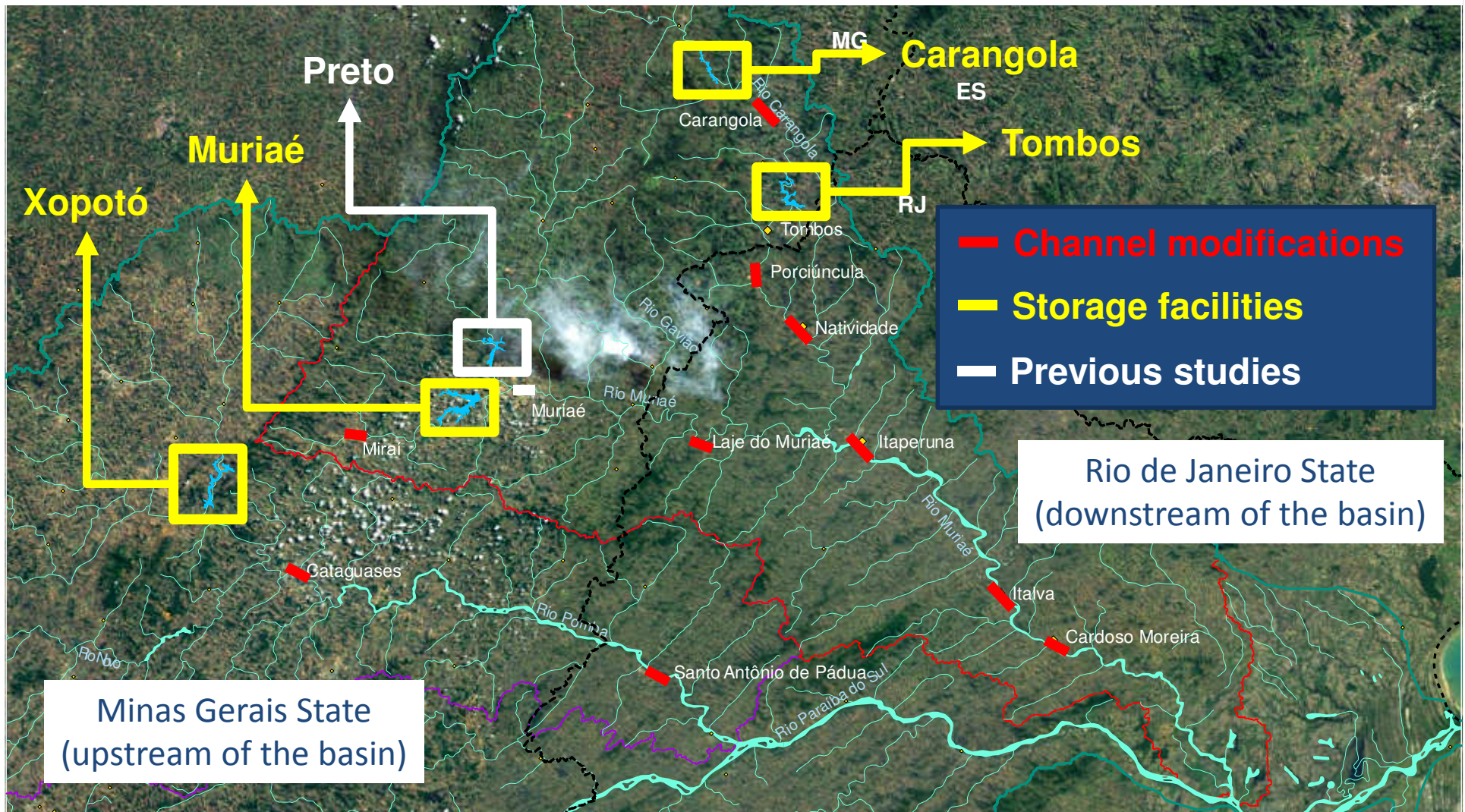
### STRUCTURAL MEASURES:

- Storage facilities (reduce the flood's peak)
- River channel modifications (improve the river streamflow capacity)
- Diversion facilities (diverse the flood streamflow)



# Approach


## STRUCTURAL MEASURES: INTEGRATED VIEW OF THE RIVER BASIN

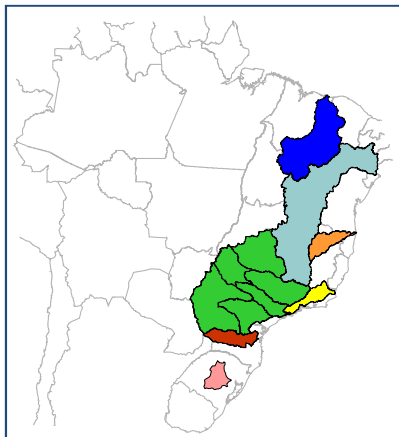



# Approach

## Operational Constraints of National Integrated Electrical System and guidelines for flood control operation (SIN's Reservoirs)




 Operador Nacional do Sistema Elétrico  
**INVENTÁRIO DAS RESTRIÇÕES OPERATIVAS HIDRÁULICAS DOS APROVEITAMENTOS HIDRELÉTRICOS**




 Operador Nacional do Sistema Elétrico  
**DIRETRIZES PARA AS REGRAS DE OPERAÇÃO DE CONTROLE DE CHEIAS - BACIA DO RIO PARANÁ ATÉ PORTO SÃO JOSÉ (CICLO 2014-2015)**

Watersheds that have a Annual Flood Plan

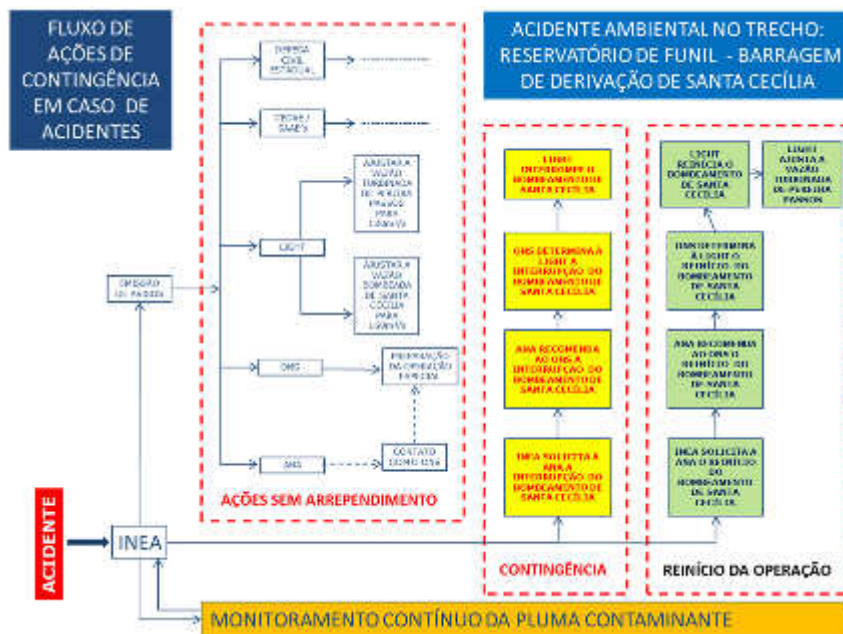


Operational constraints are established in order to meet the environmental conditions and the multiple uses of water, **including flood control.**



# Approach

## Interinstitutional protocol for accidents in Paraíba do Sul river basin, downstream to Funil dam



The protocol involves the electrical sector (local electrical generating company and national electrical system operator), state environmental institution, local water supply system company and National Water Agency.

The protocol aims to reduce the impact on the water supply system by changing the operation of reservoirs used to generate electricity.

It is used basically in case of release of pollutants on the river, but the institutional arrangement can be also applied in case of droughts and floods.

# Approach

## SECRETARIA NACIONAL DE DEFESA CIVIL

PORTARIA CONJUNTA Nº 148, DE 18 DE DEZEMBRO DE 2013

Estabelece o Protocolo de Ação Integrada para os casos de Inundação Gradual entre a Agência Nacional de Águas - ANA, o Centro Nacional de Monitoramento a Alertas de Desastres Naturais - CEMADEN, representado pela Secretaria de Políticas e Programas de Pesquisa e Desenvolvimento - SEPED/MCTI, o Centro Nacional de Gerenciamento de Riscos e Desastres - CENAD, representado pela Secretaria Nacional de Defesa Civil - SEDEC/MI e a Companhia de Pesquisa de Recursos Minerais - CPRM.

O DIRETOR-PRESIDENTE DA AGÊNCIA NACIONAL DE ÁGUAS GRAMAS D TÊRIO DE C TL o SECR NISTÉRIO I RETOR-PRE CURSOS MI Con dição e mon enfrentament Com tadas todos e desastre: Com integradas p relacionados

**SECRETARIA NACIONAL DE DEFESA CIVIL**

PORTARIA Nº 314, DE 17 DE OUTUBRO DE 2012(\*)

Cria e estabelece o Protocolo de Ação entre o Centro Nacional de Gerenciamento de Riscos e Desastres (CENAD/MI) e o Centro Nacional de Monitoramento a Alertas de Desastres Naturais (CEMADEN/MCTI).

O Secretário Nacional de Defesa Civil do Ministério da Integração Nacional - MI e o Secretário de Políticas e Programas de Pesquisa e Desenvolvimento do Ministério de Ciência, Tecnologia e Inovação - MCTI, no uso de suas atribuições e considerando a necessidade de desenvolvimento de ações integradas para a gestão de risco e o gerenciamento de desastres, em âmbito nacional, resolvem:

Art. 1º Estabelecer um Protocolo de Ação Integrada entre o CEMADEN, o CENAD da Secretaria Nacional de Defesa Civil, na forma do Anexo I, com a finalidade de especificar as competências e ações referentes aos alertas e a integração das ações dos Centros com órgãos estaduais e municipais correlatos.

Art. 2º Os casos omissos serão deliberados pelos Centros de acordo com suas competências institucionais.

Art. 3º Esta Portaria entra em vigor na data de sua publicação.

HUMBERTO DE AZEVEDO VIANA FILHO  
Secretário Nacional de Defesa Civil/MI

CARLOS AFONSO NOBRE  
Secretário de Políticas e Programas  
de Pesquisa/MCTI

## Protocol ANA/CPRM/CENAD/CEMADEN

– Ordinance 148/2013

Establishes the institutional actions, looking for an integrated system of forecast and monitoring, which enables to prepare measures for coping with flood-related disasters.

## Protocol CENAD/CEMADEN – Ordinance 149/2013 and 314/2012

Identifies the competences and actions related to alerts and guides about the CENAD and CEMADEN's articulation with states and municipalities.

## Outputs

- Which were the concrete tangible results, outcomes and/or impacts of the good practice and how do they ensure sustainability to the practice?
- A comprehensive flood risk management plan, considering the interinstitutional cooperation, a wide evaluation of non-structural and structural measures on the whole river basin;
- It is still difficult to ensure long-term sustainability because these plans take so long to be developed and implemented that even the stakeholders may change along the process (institutional fragility). Formal protocols and norms may help to ensure the sustainability.



## Lessons

- To involve the stakeholders earlier:
  - To involve federal, state and municipal level (and river basin);
  - To involve different agencies (water resources, environment, civil defense, infrastructure, housing, etc);
- To establish formal protocols among the institutions and clearly define each institution roles;
- To continue improving the technical methods used to map the flood impact and to assess the alternatives;
- To develop a database to store all inventoried data;
- Train and keep a technical staff to follow up the plan;
- Publish and promote the plan among the stakeholders;

## Follow up

- Are there any open questions that need to be dealt with?
- Ensure long-term sustainability (follow up and review the plan, engage decision makers, financial support, keep a good technical staff, etc)
- Continue to improve the interinstitutional cooperation within the three levels of government;
- The uncertainty and damage assessment are still critical, because it can change the feasibility of a plan (inappropriate zoning, underestimated flood, etc);

# Thank you!

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