

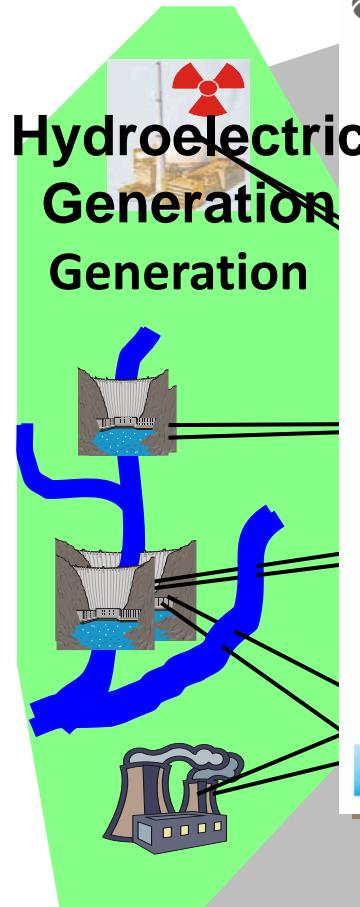


Operador Nacional  
do Sistema Elétrico

# Brazilian Interconnected Power System: flood and drought control operation

December 3th, 2019

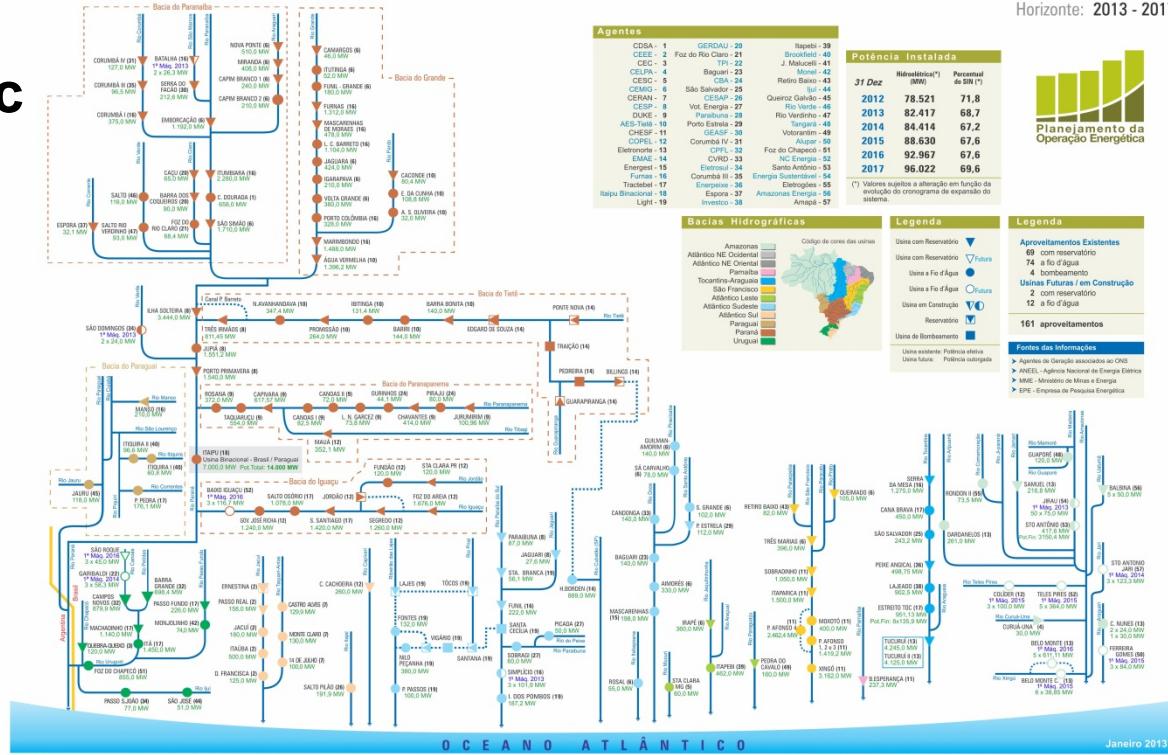
# Brazilian Interconnected Power System - BIPS



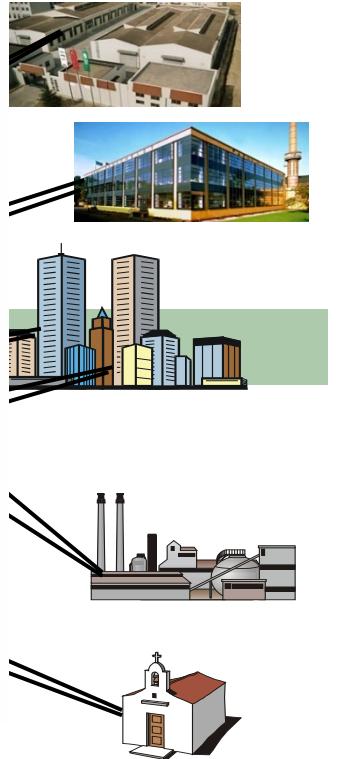
**ONS**  
Operador Nacional  
do Sistema Elétrico

## Diagrama Esquemático das Usinas Hidroelétricas do SIN Usinas Hidroelétricas Despachadas pelo ONS na Otimização da Operação Eletroenergética do Sistema Interligado Nacional

Horizonte: 2013 - 2017



Consumption



Distribution

168 hydropower plants

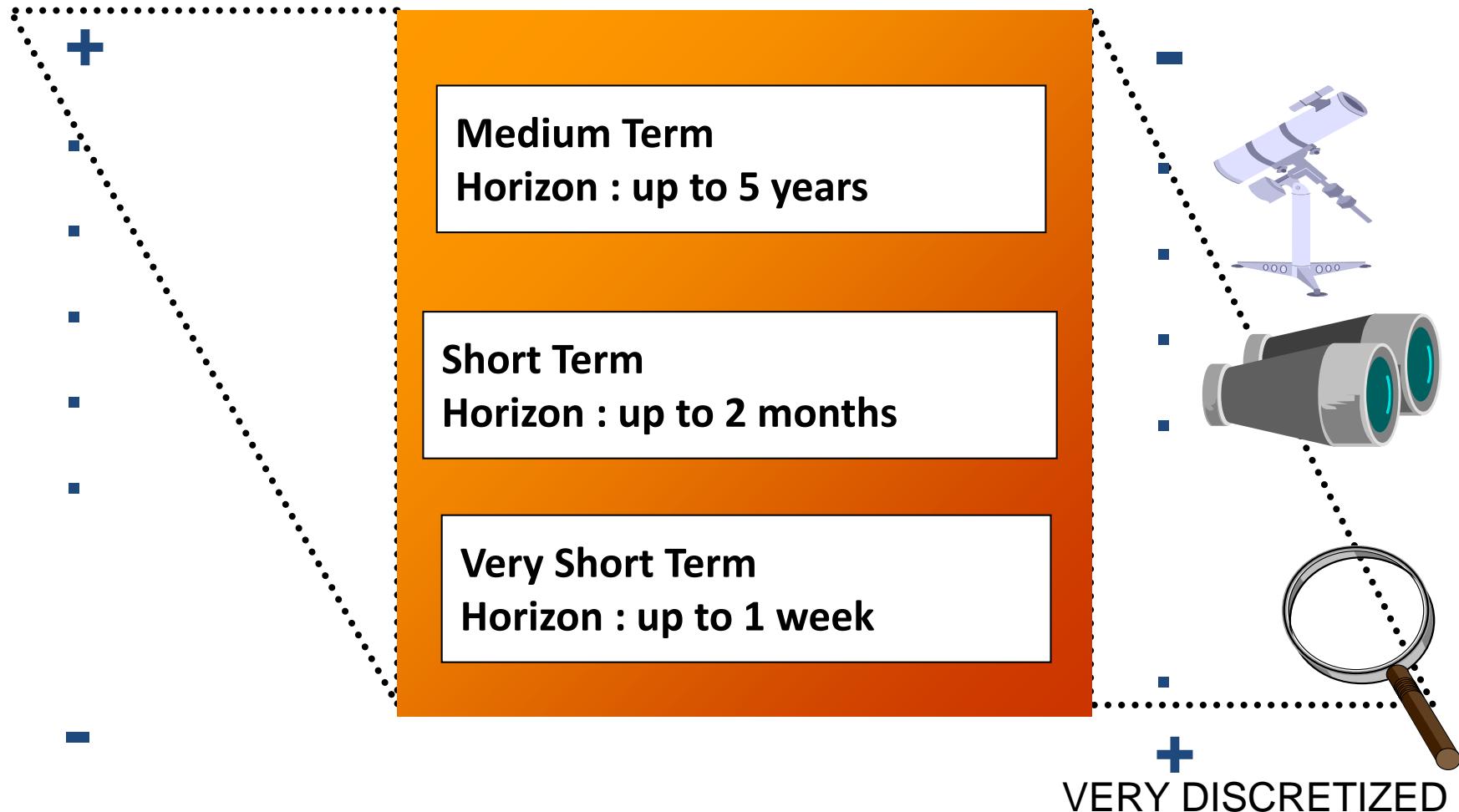
96 Reservoir without Regularization

72 Regularization Reservoir

# Brazilian Interconnected Power System - BIPS

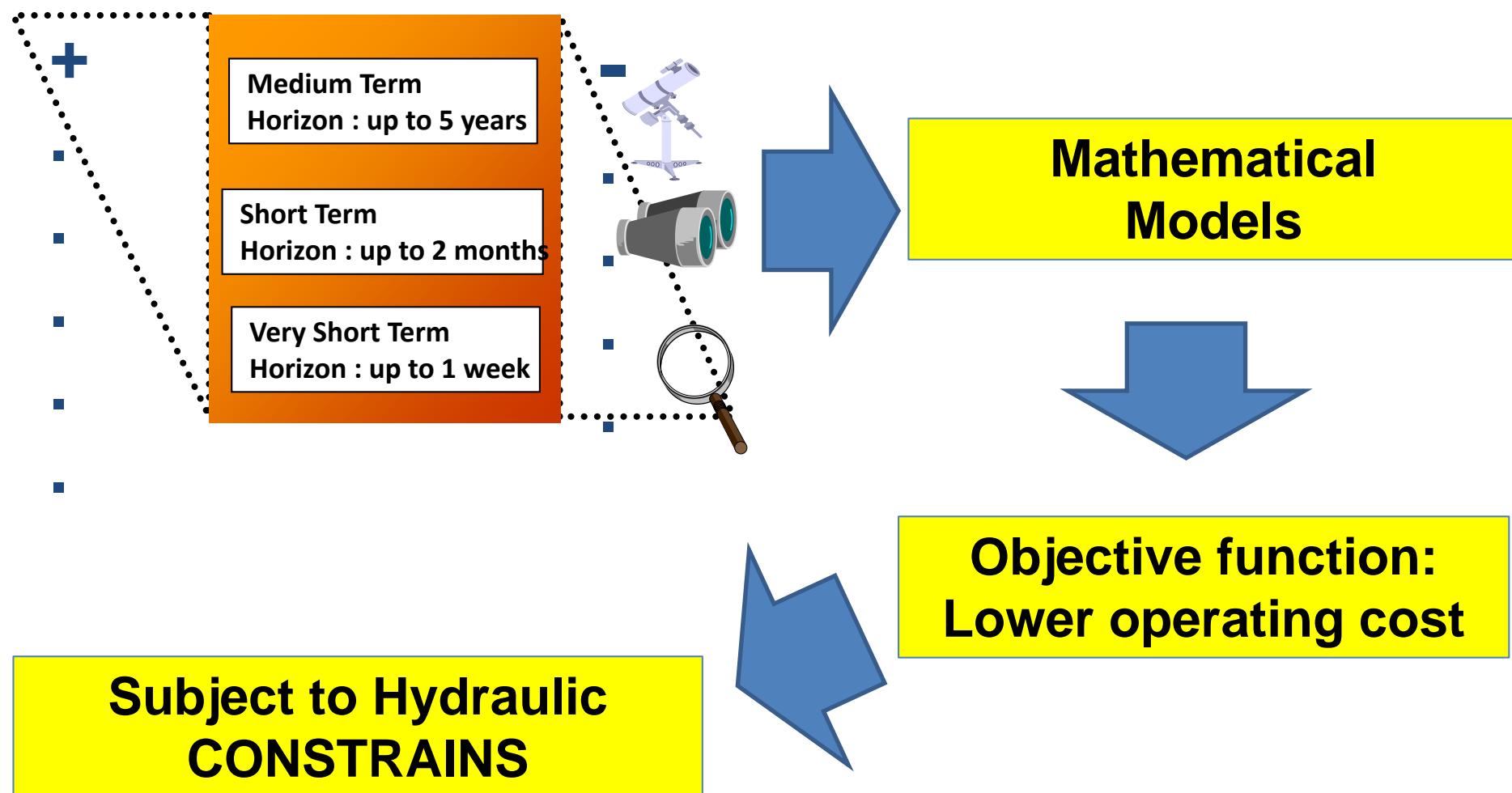
## BIPS - Operation Planning

### UNCERTAINTY IN RESOURCES



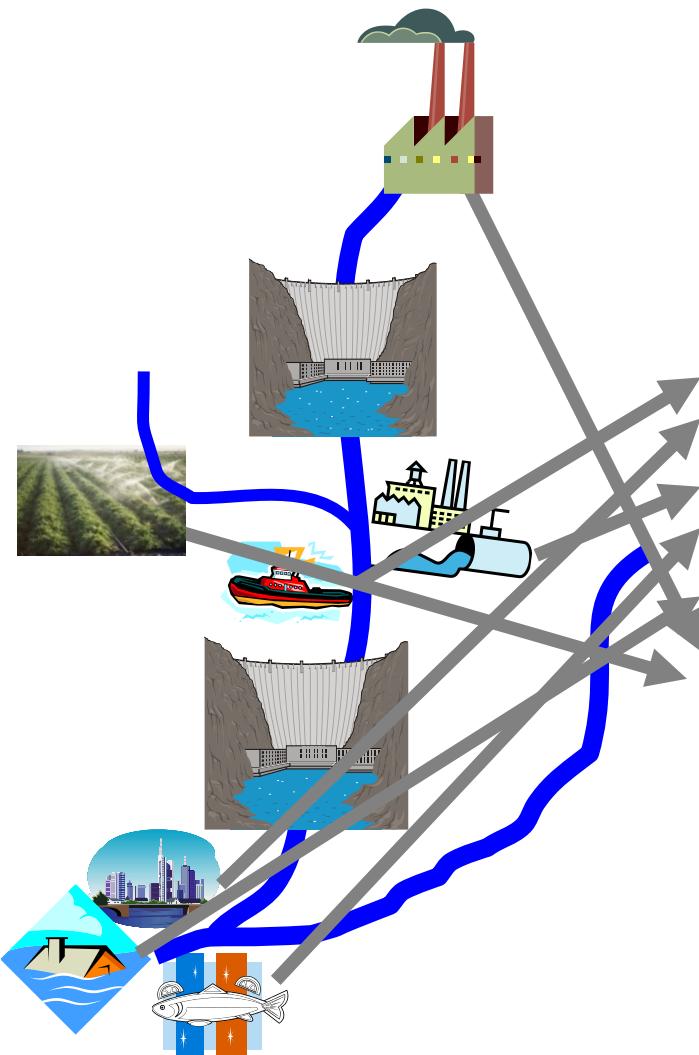
# Brazilian Interconnected Power System - BIPS

## BIPS - Operation Planning



# Brazilian Interconnected Power System - BIPS

## BIPS - Operation Planning



### Hydraulic CONSTRAINTS

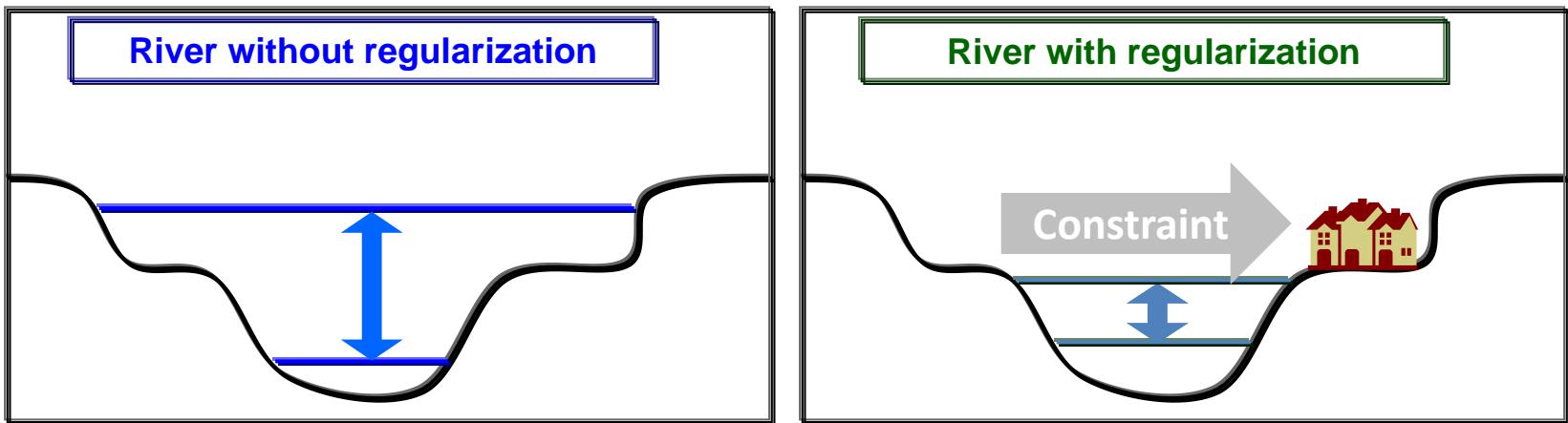
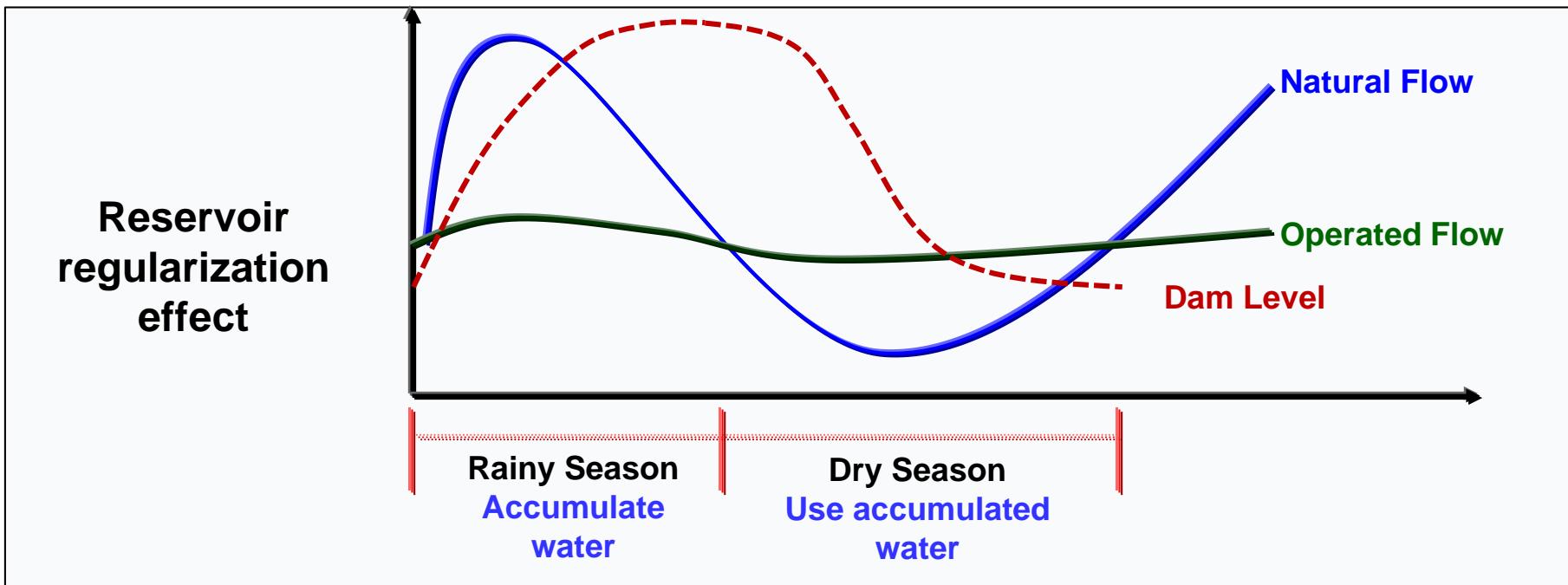
MULTIPLE WATER USES  
ENVIRONMENTAL CONDITIONS  
FLOOR CONTROL  
CONSUMPTIVE USES OF WATER

# **Brazilian Interconnected Power System**

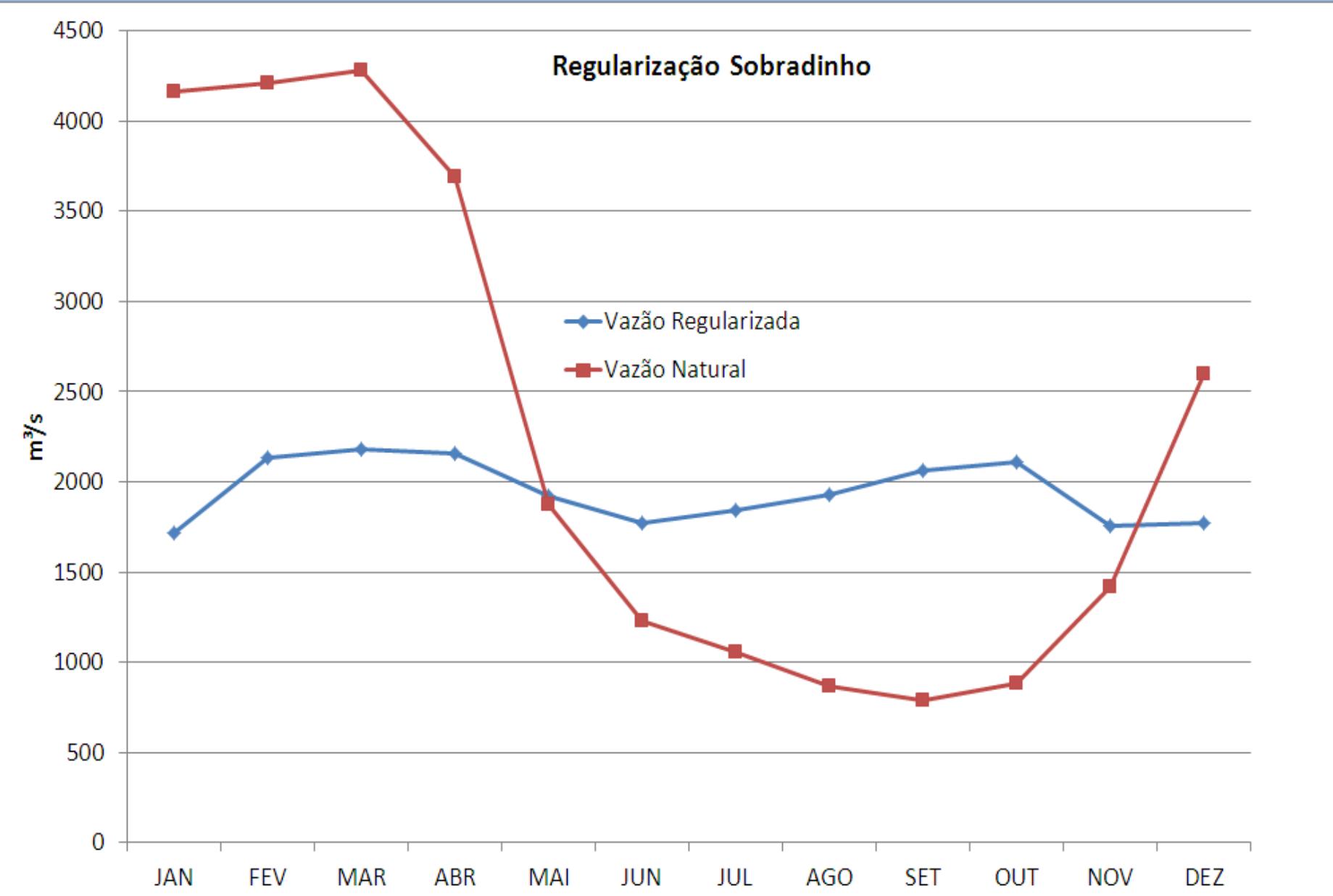
**&**

# **Flood Control**

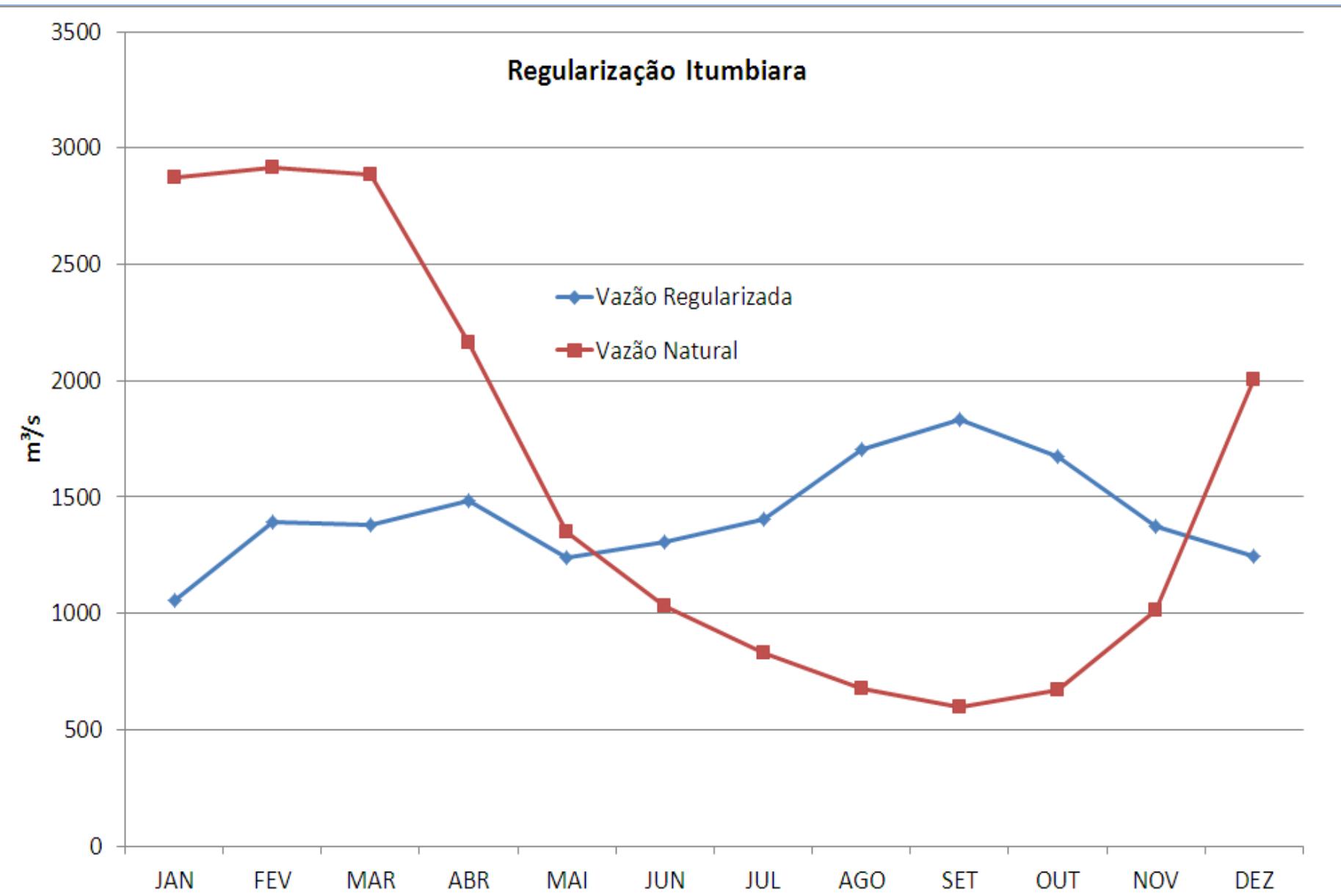
# The outflow constraint genesis



# Examples of regularizations



# Examples of regularizations





# Some occupied areas – Paraíba do Sul River

Natural Flood area preserved



Natural Flood area occupied



Guararema City Upstream

Guararema



# Some occupied areas – Paraíba do Sul River

Natural Flood area preserved



Natural Flood area occupied



**Montante de Jacareí**

**Jacareí**



# Some occupied areas – Paraíba do Sul River

Natural Flood area preserved



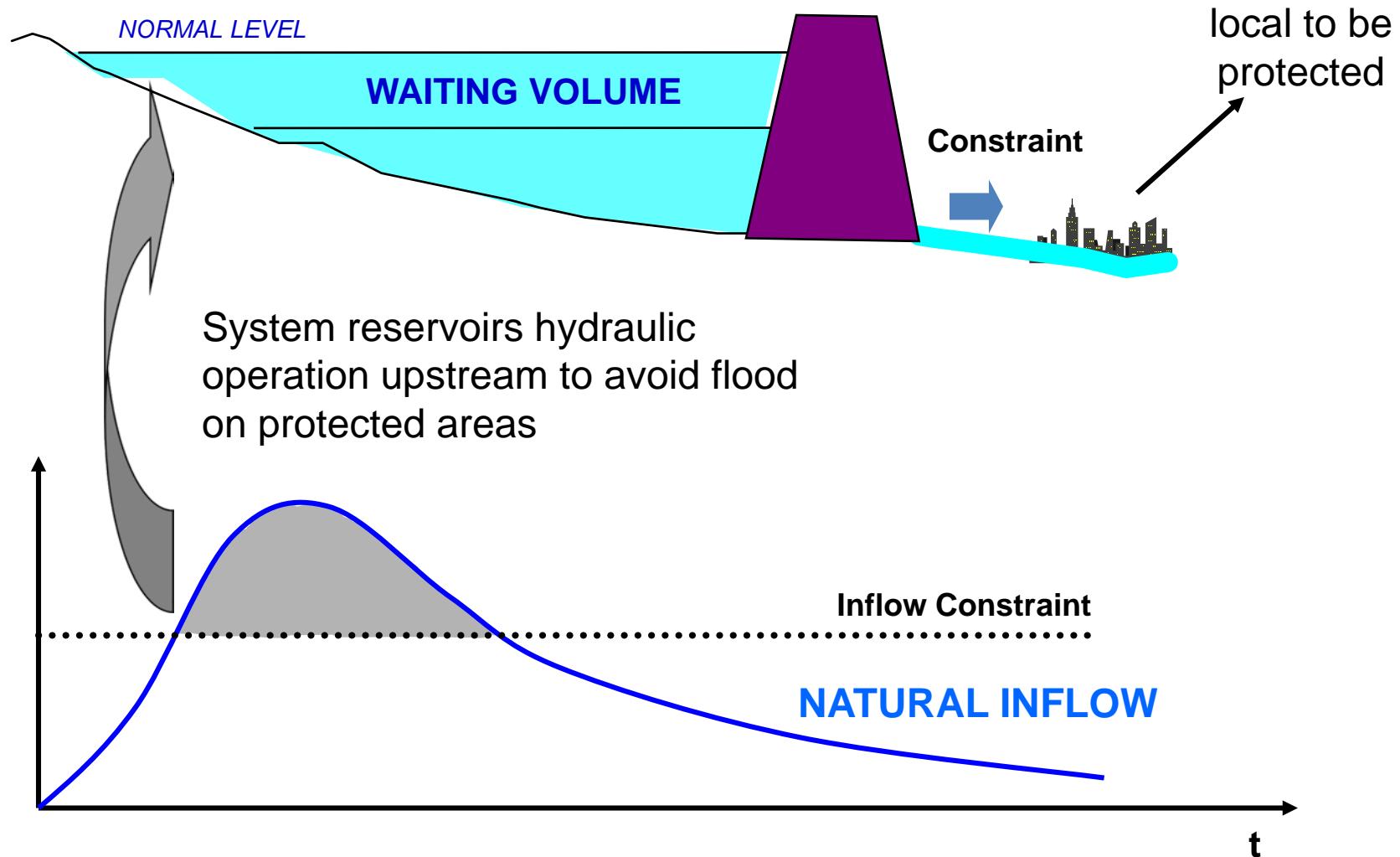
Natural Flood area occupied



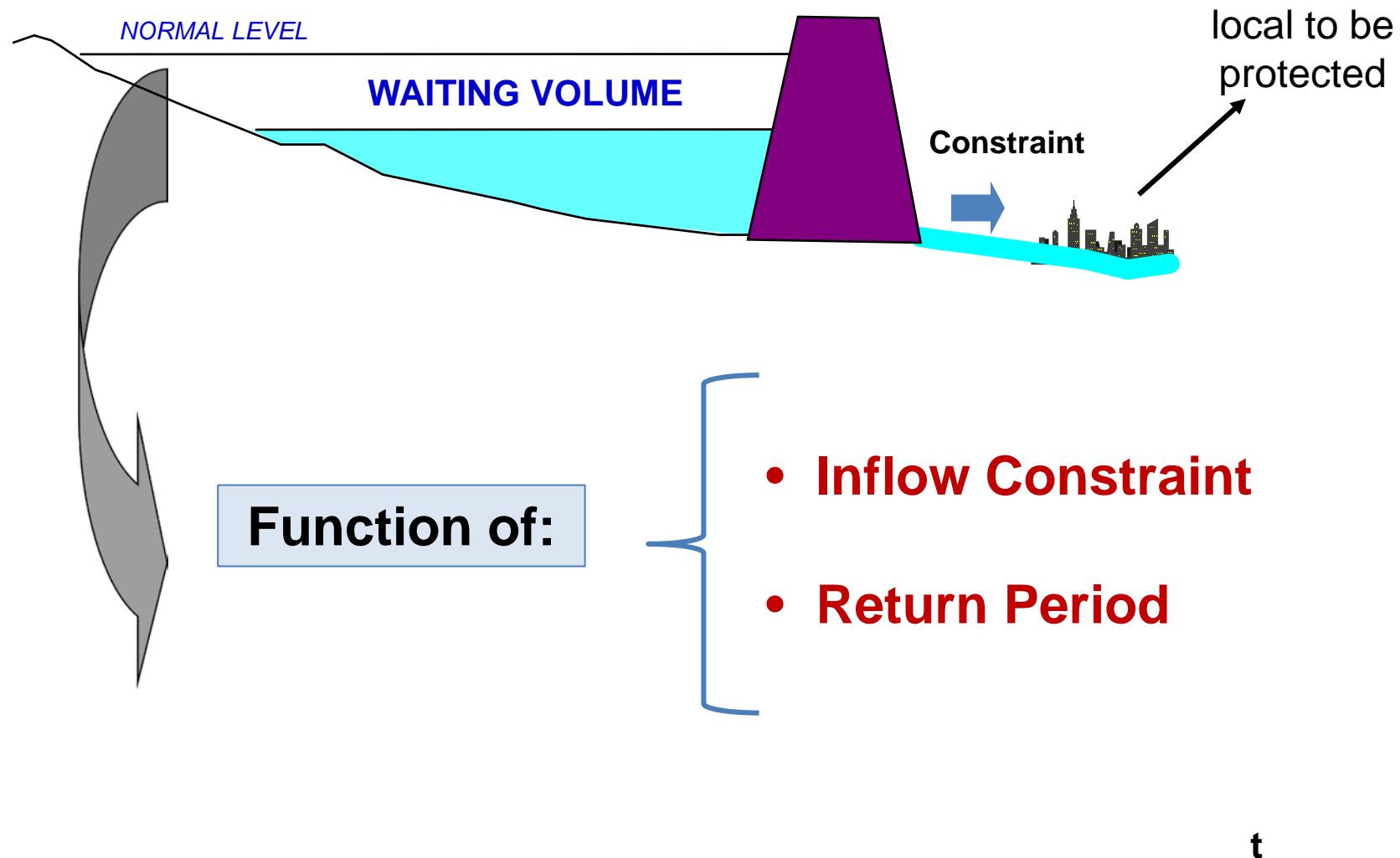
**Montante de Barra Mansa**

**Barra Mansa**

# Flood control problem - concept

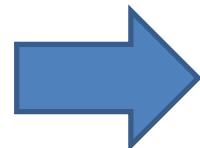


# Flood control problem - concept

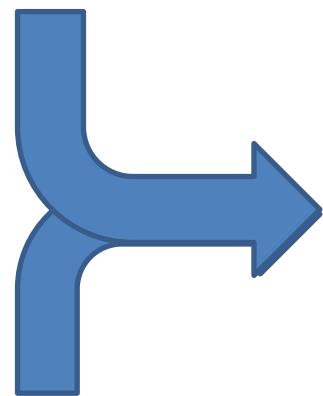


# Flood control problem - responsibilities

**ONS**

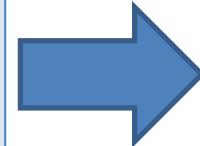


- Waiting Volumes Calculation
- Operation Coordination
- Energetic impacts valuation
- Articulation with the National Agency of Water



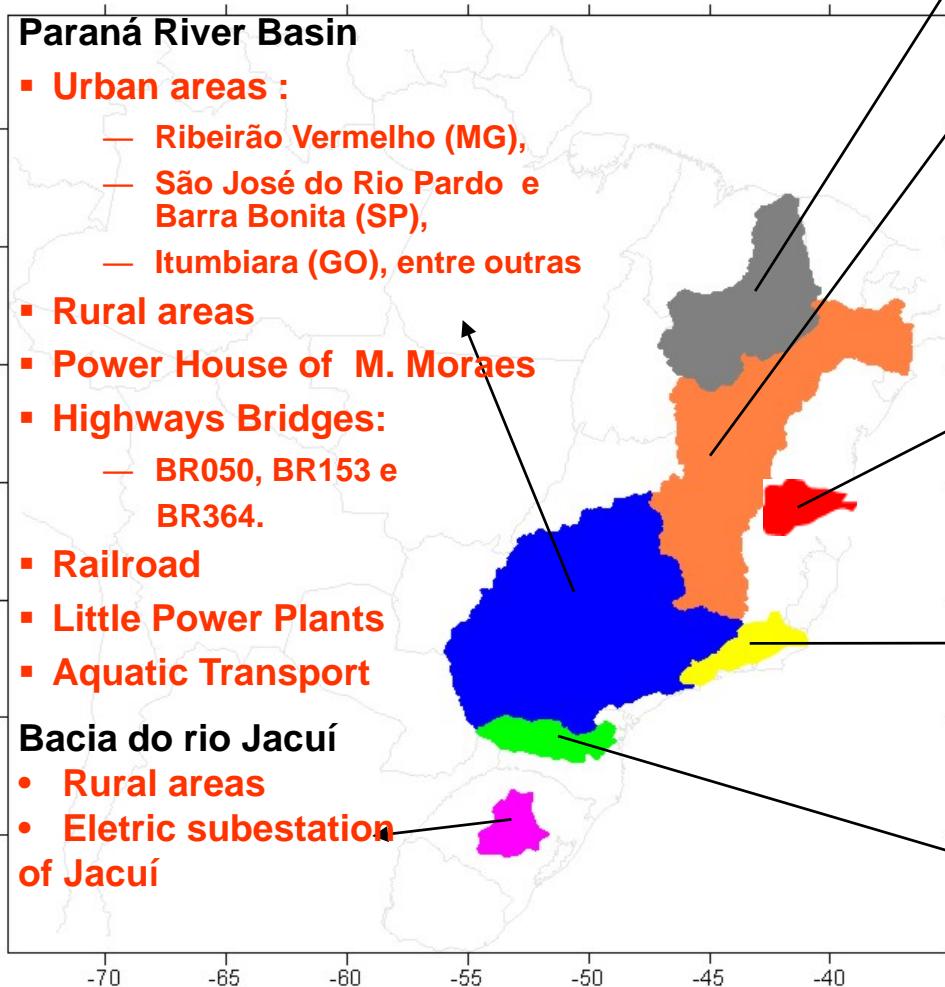
- Rules Establishment

**Generation Agents**



- Inflow Constraint
- Return Period

# Basins with flood control planning at BIPS



## Parnaíba River Basin

- **Urban areas:**
  - Teresina e Floriano (MA)

## São Francisco River Basin

- **Urban areas:**
  - Pirapora (MG),
  - Juazeiro (BA),
  - Petrolina (PE),
  - Traipu e São Brás (AL) , entre outras

## Jequitinhonha River Basin

- **Urban areas:**
  - Coronel Murta (MG)

## Paraíba do Sul River Basin

- **Urban areas:**
  - Guararema e Jacareí (SP),
  - Resende, Barra Mansa e Volta Redonda (RJ)

## Iguaçu River Basin

- **Urban areas:**
  - União da Vitória e Porto União (PR)
- **Power House of Salto Santiago**

# BIPS Flood Control Steeps

## Planning

Yearly

### Elaboration of Flood Control Plan

- Establish the waiting volumes for the reservoir.
- Valuate the energetic impacts that may be caused for the waiting volumes.

Yearly

### Elaboration of Directives for the Rules of Flood Control Operation

- Establish the rules for flood control situations;
- Establish the rules for waiting volumes revision;
- It is the base to elaborate the flood control hydraulic operation program.

Yearly

### Elaboration of Operation Instructions

- Establish the procedures for the Real Times areas, from ONS and Generation Agents, to execute the flood control hydraulic operation program.

# BIPS Flood Control Steeps

## Program

Weekly-Daily

Weekly-Daily  
Hydraulic Operation  
Program on Flood  
Control Period

- Waiting volumes revision application;
- Elaboration of Flood Control hydraulic program;
- Realization of phone calls with involved agents.

## Operation

Real Time

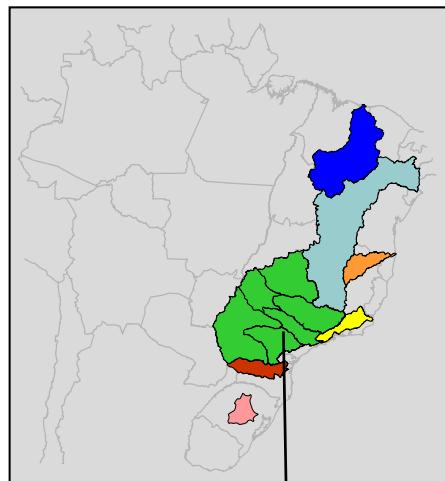
Operation Execution

- Real Time operation execution.

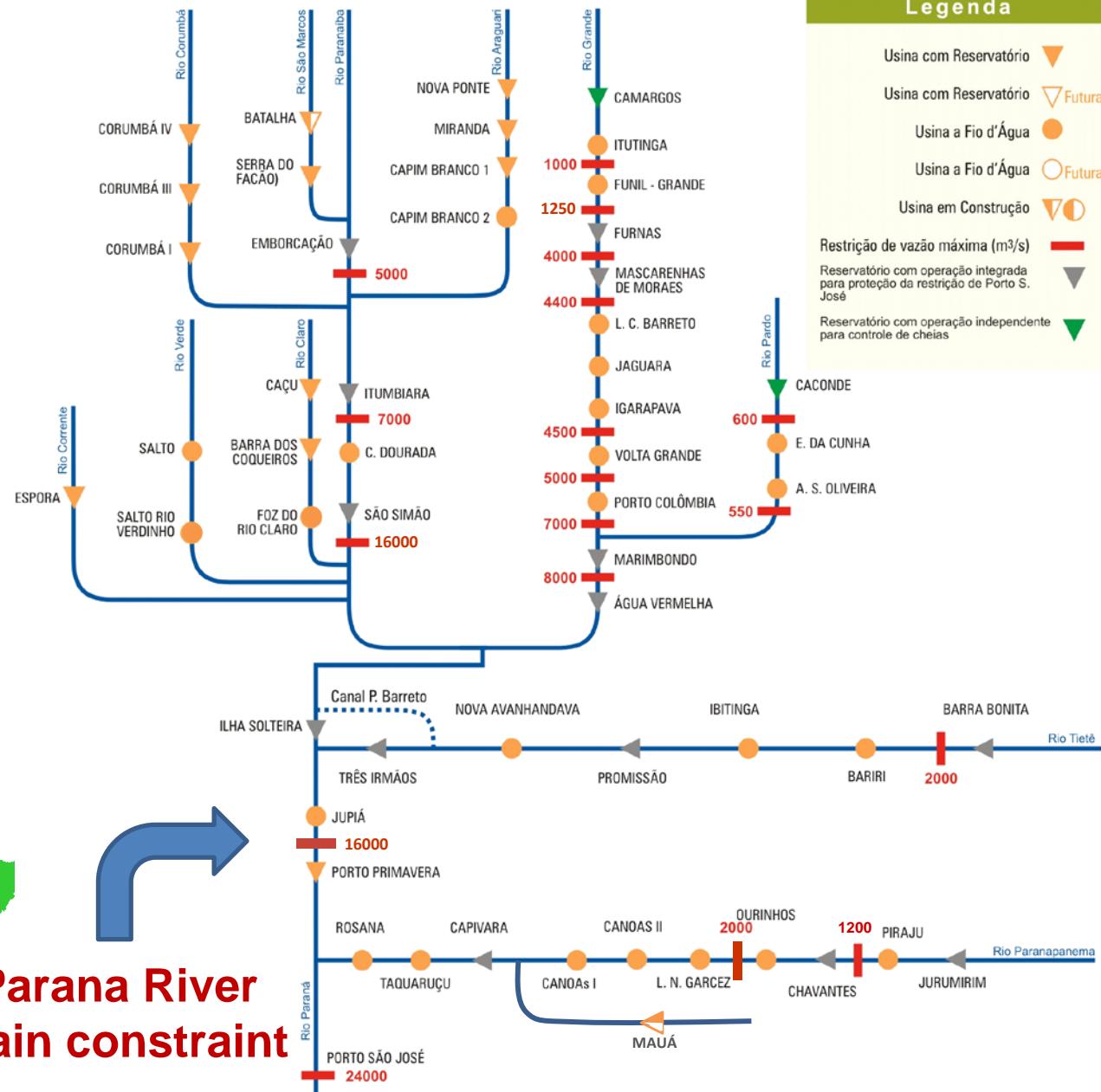
# BIPS Flood Control Situations

Operation Situations	DESCRIPTION
Normal	<b>The is no flood characterization, the is no waiting volumes occupation and the is no constrain violation indication.</b>
Attention	<b>The is flood characterization or the is waiting volumes occupation; and the is no constrain violation indication.</b>
Alert	<b>The is flood characterization and the is waiting volumes occupation; and the is constrain violation indication.</b>
Emergency	<b>The is flood characterization and the is waiting volumes occupation; and the is constrain violation.</b>

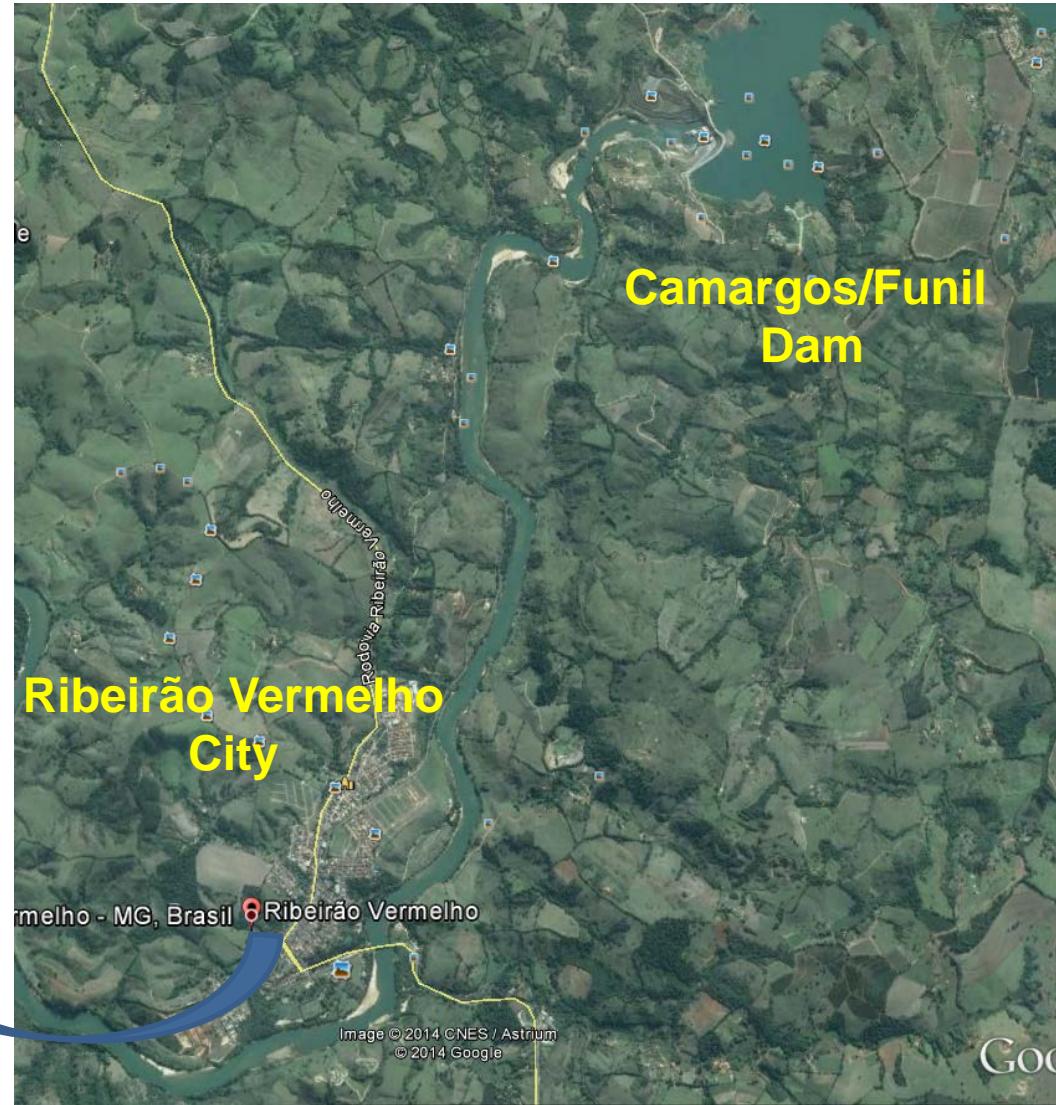
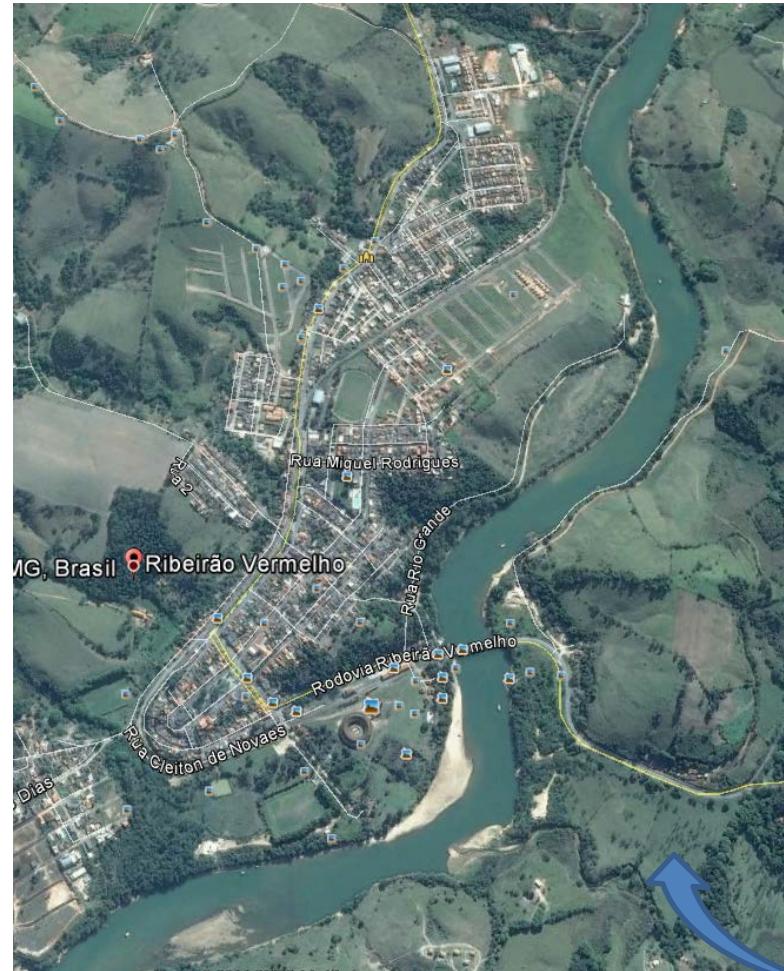
# Parana River flood control



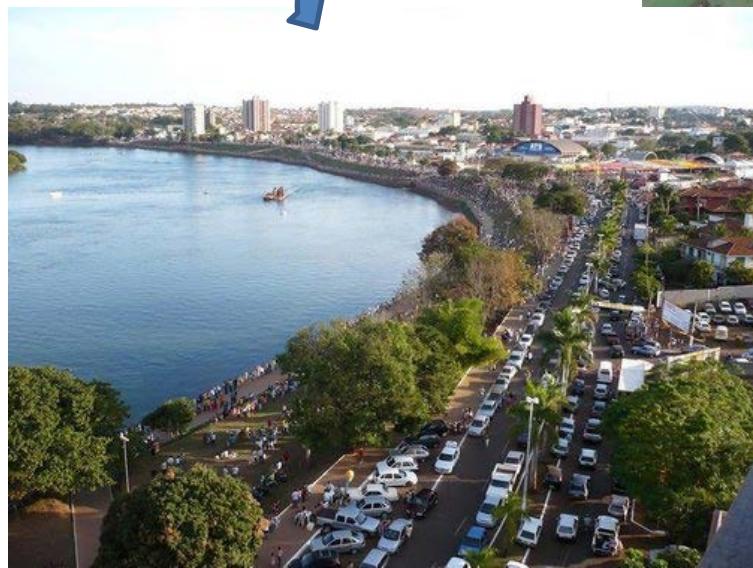
Parana River  
main constraint



# Some protected areas - Parana River



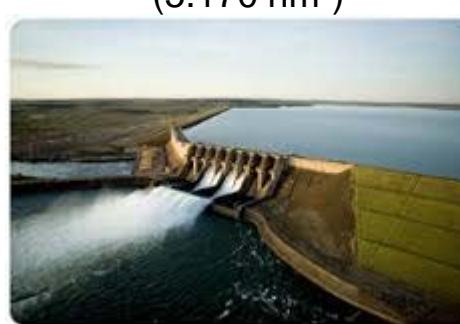
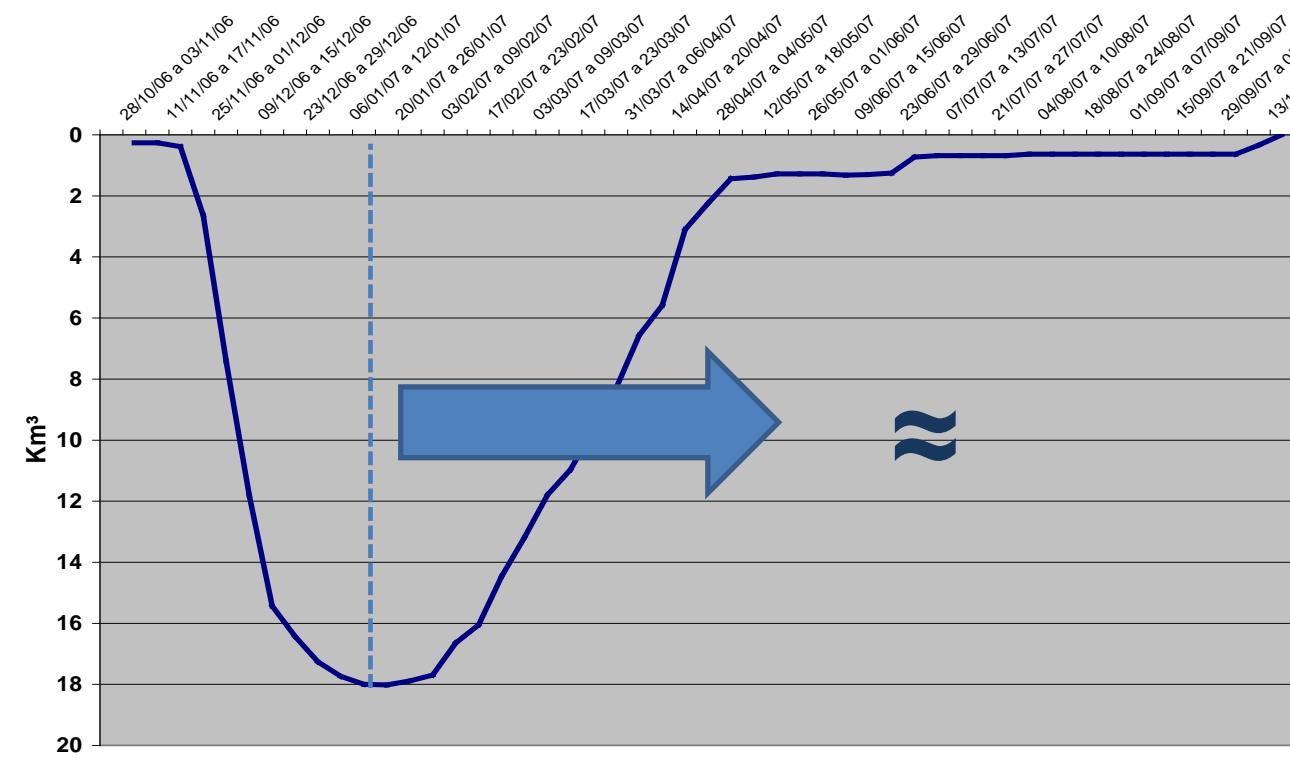
# Some protected areas - Parana River



# Some protected areas - Parana River



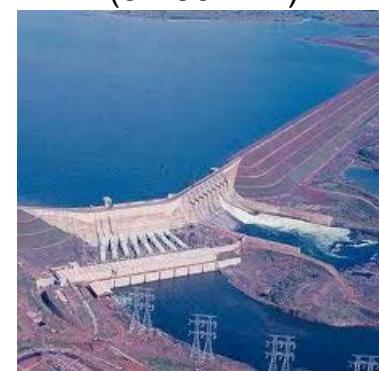
# Total Allocation of waiting volumes at Parana River basin (2006/2007)



Mascarenhas de Moraes  
(2.500  $\text{hm}^3$ )



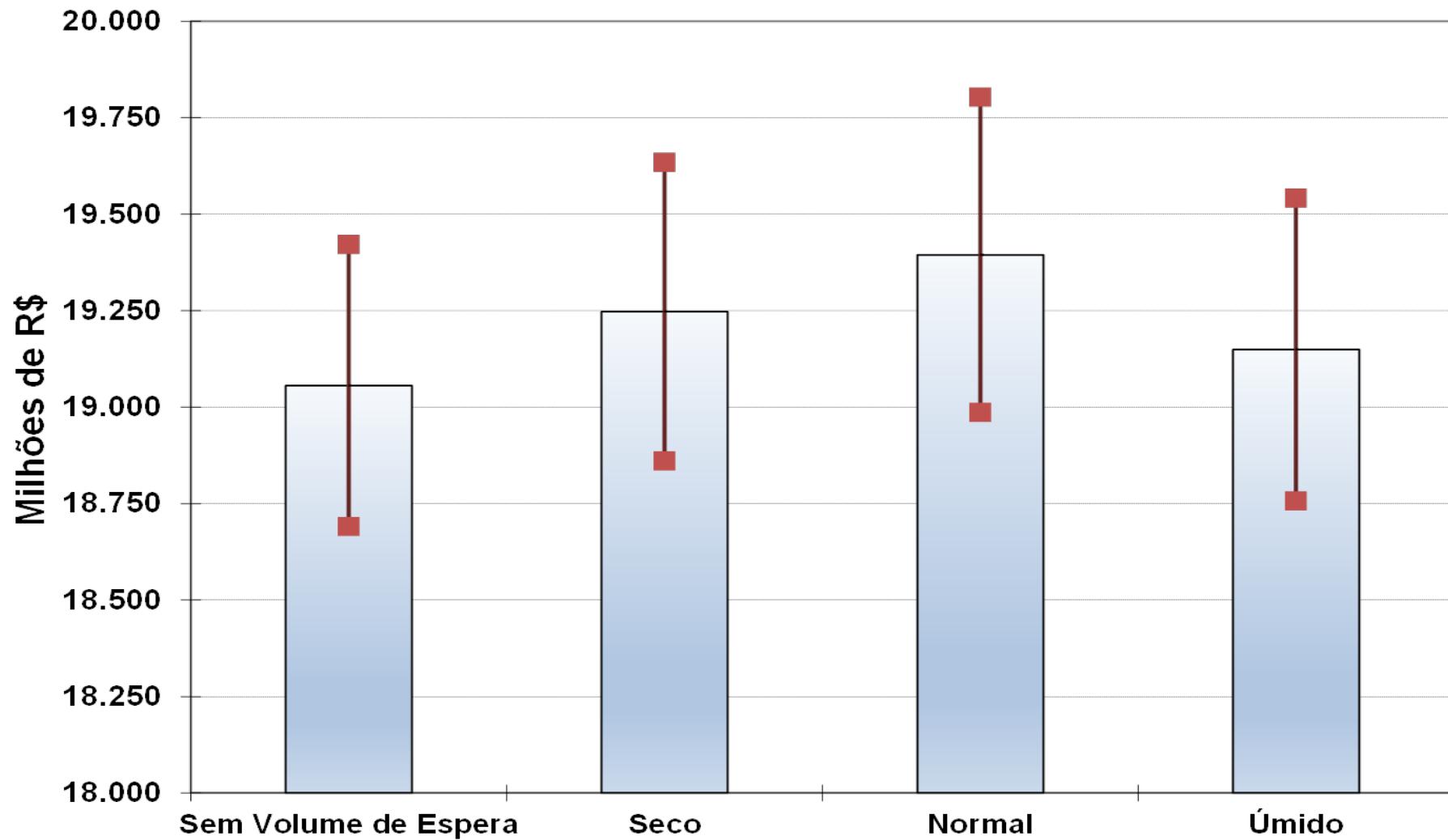
Marimbondo  
(5.260  $\text{hm}^3$ )



# Flood Control x Energetic Impacts - Valuation

## Energy Evaluation of Waiting Volume Allocation at BIPS

Expected Value of Operation Total Cost – Cycle 2019/2020

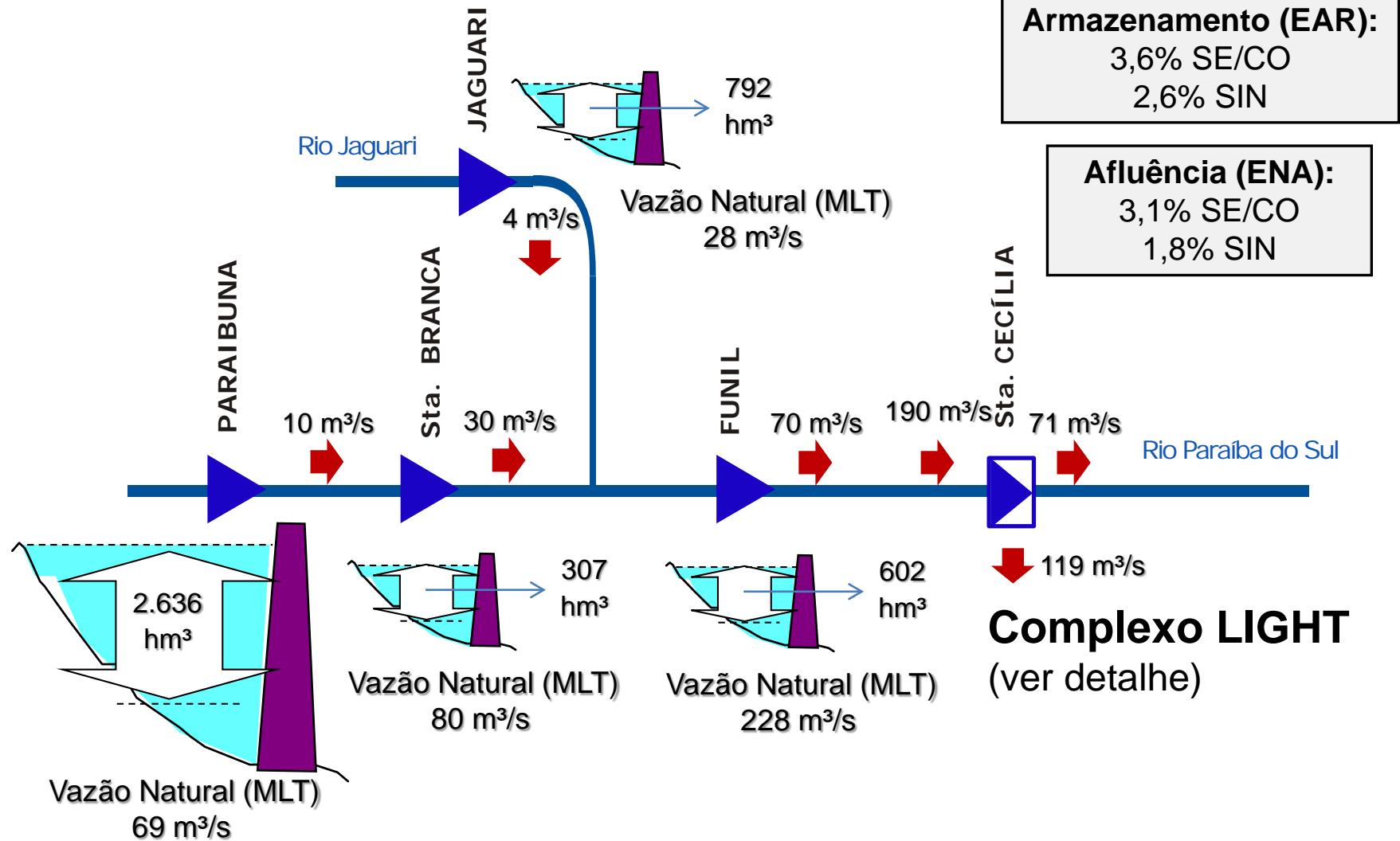


# **Brazilian Interconnected Power System**

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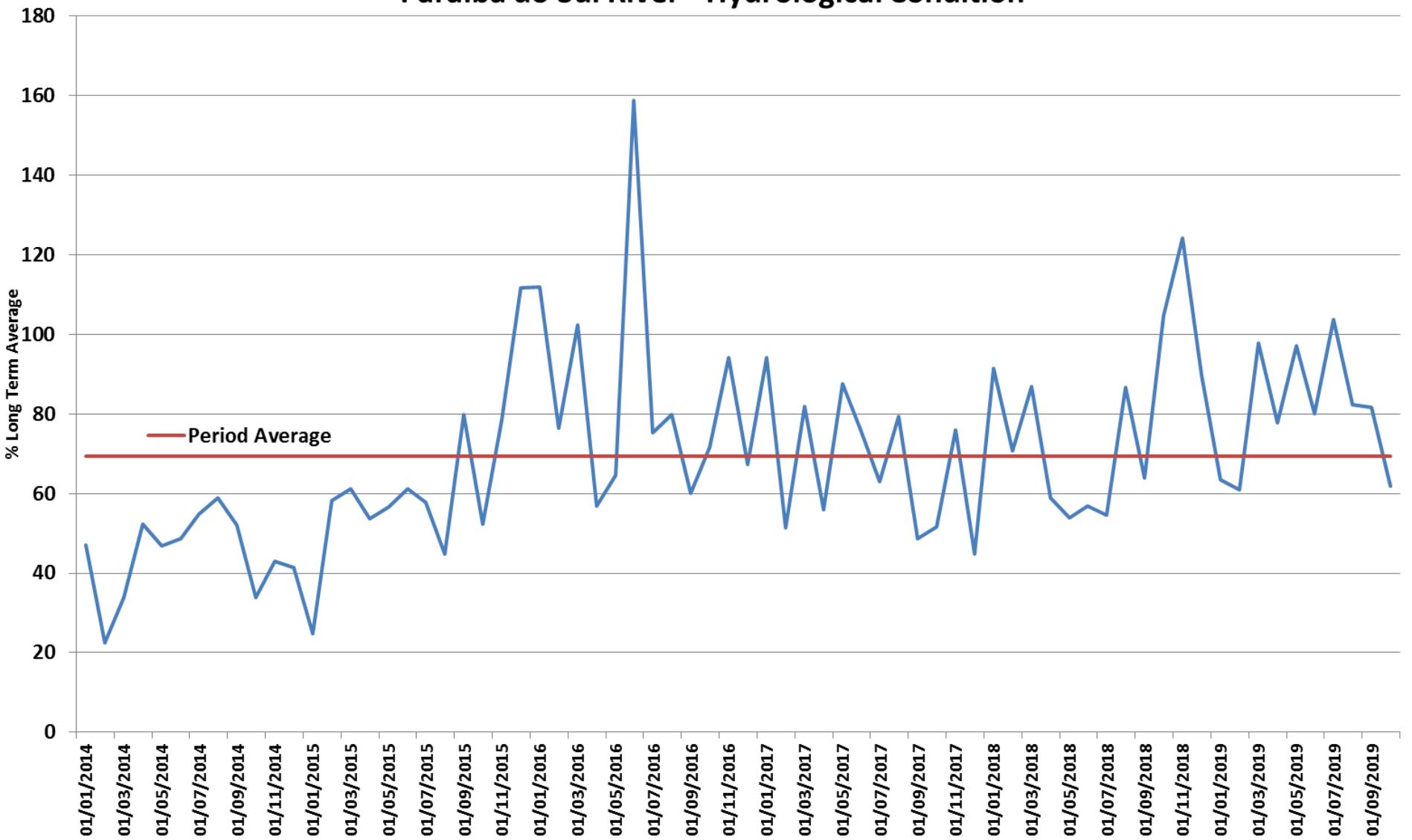
## **Drought Control**

# BIPS case of drought control Paraíba do Sul River



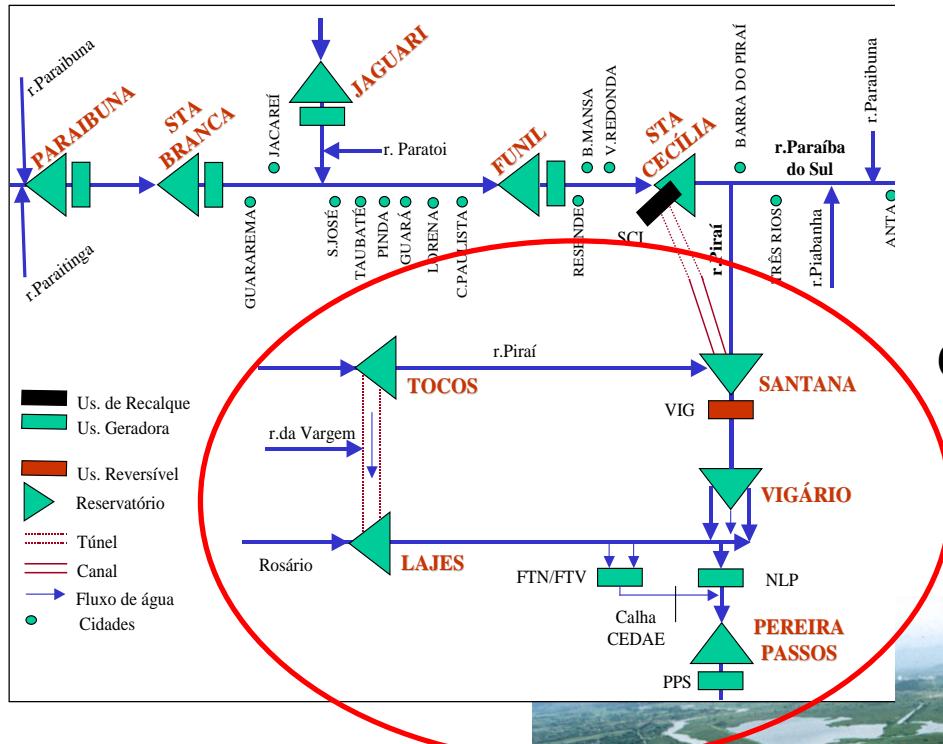
# BIPS case of drought control Paraíba do Sul River

Paraíba do Sul River - Hydrological Condition



# BIPS case of drought control

# Paraíba do Sul River

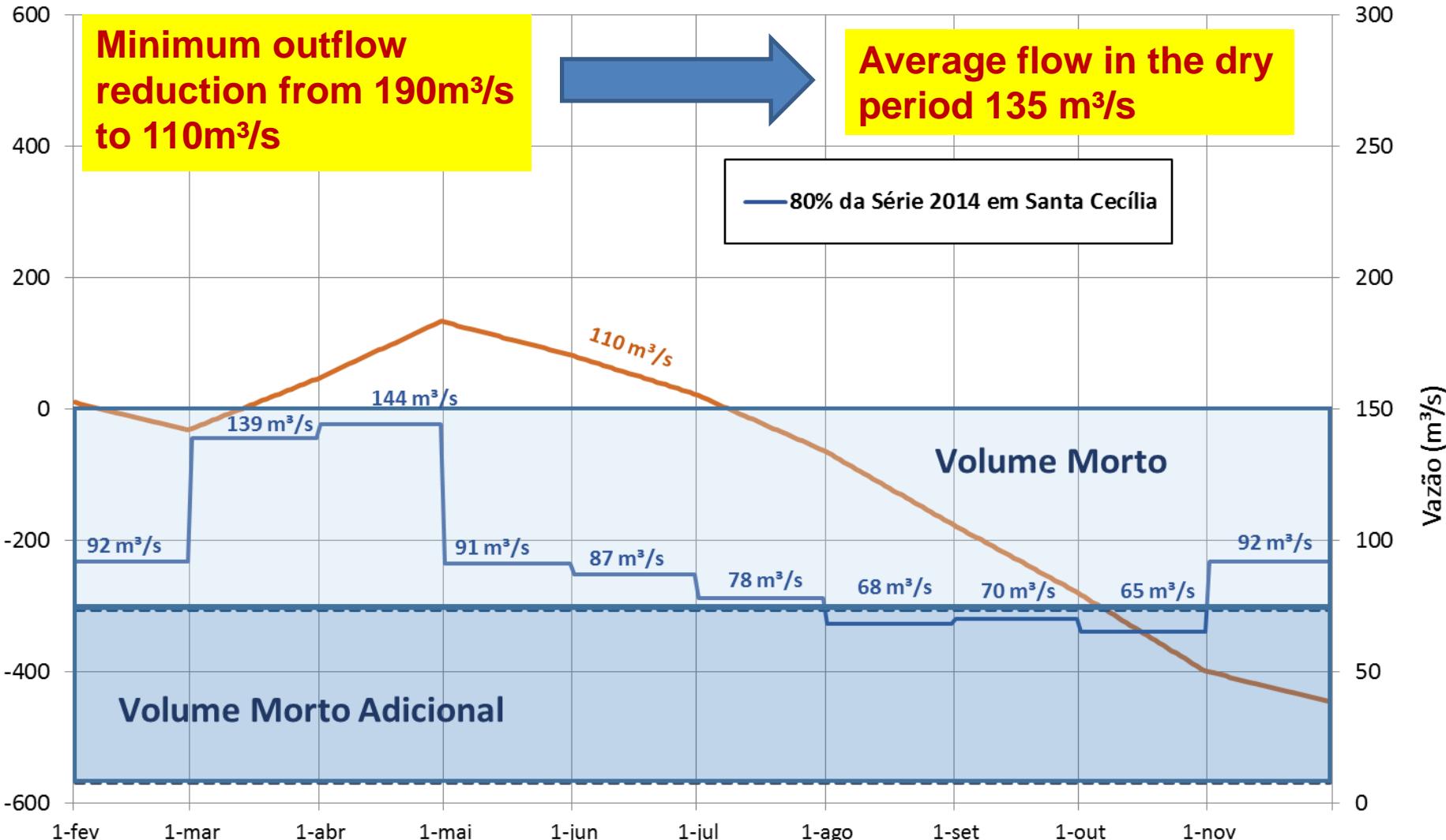


Complexo LIGHT



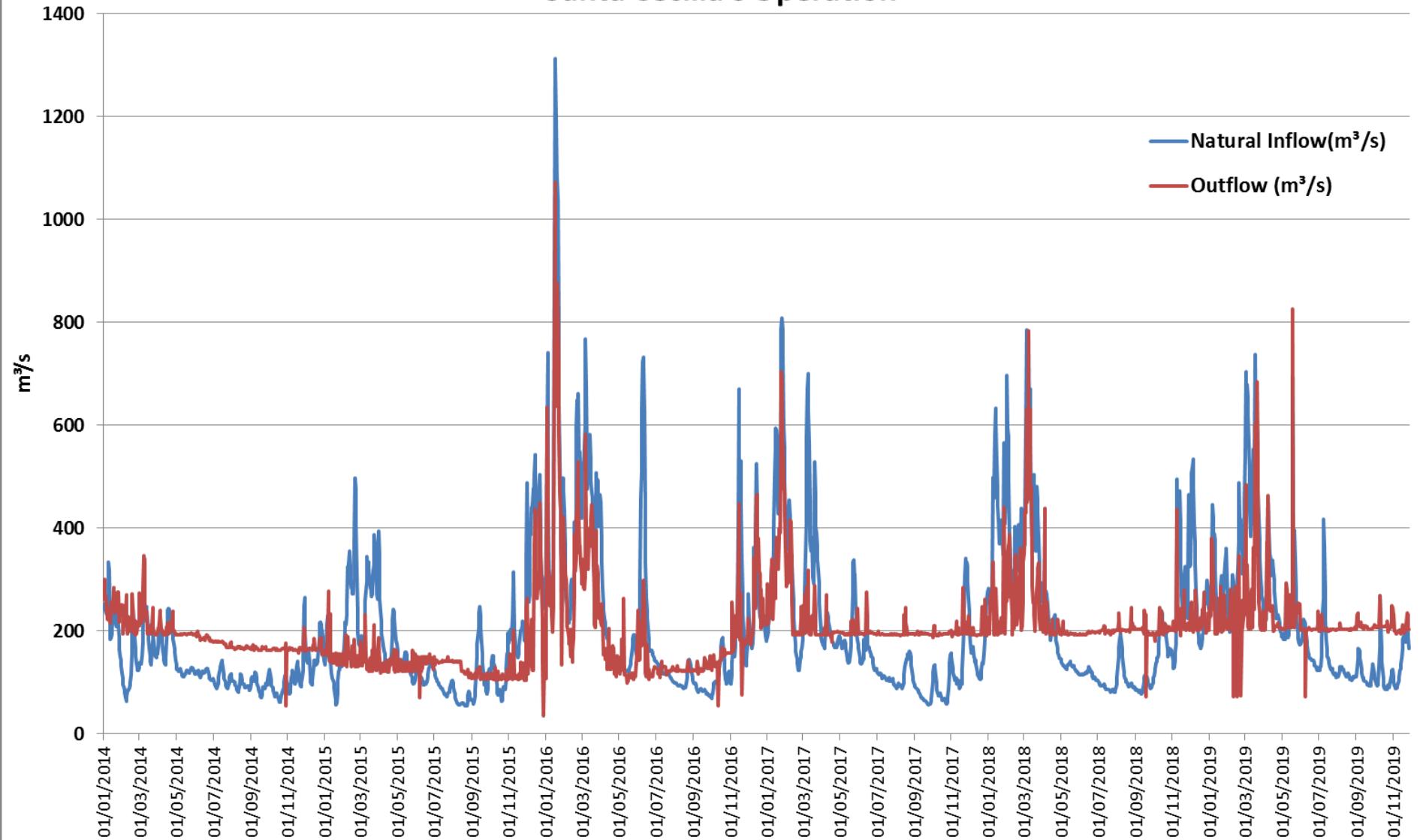
# BIPS case of drought control Paraíba do Sul River

## Vazão mínima de Santa Cecília em 2015

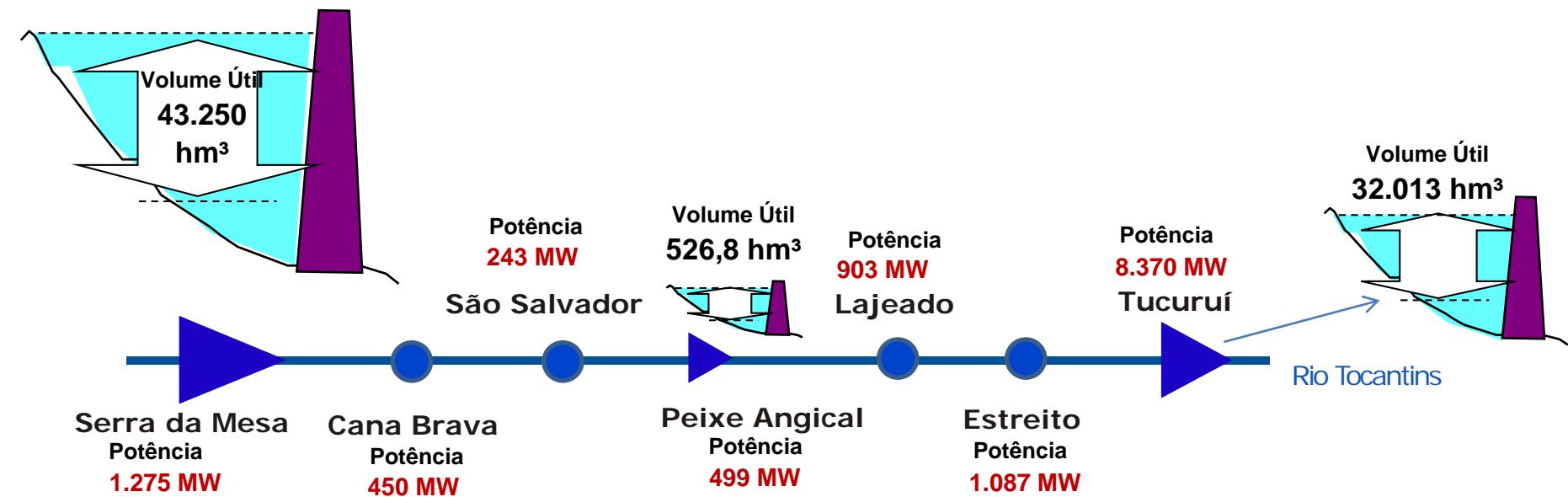


# BIPS case of drought control Paraíba do Sul River

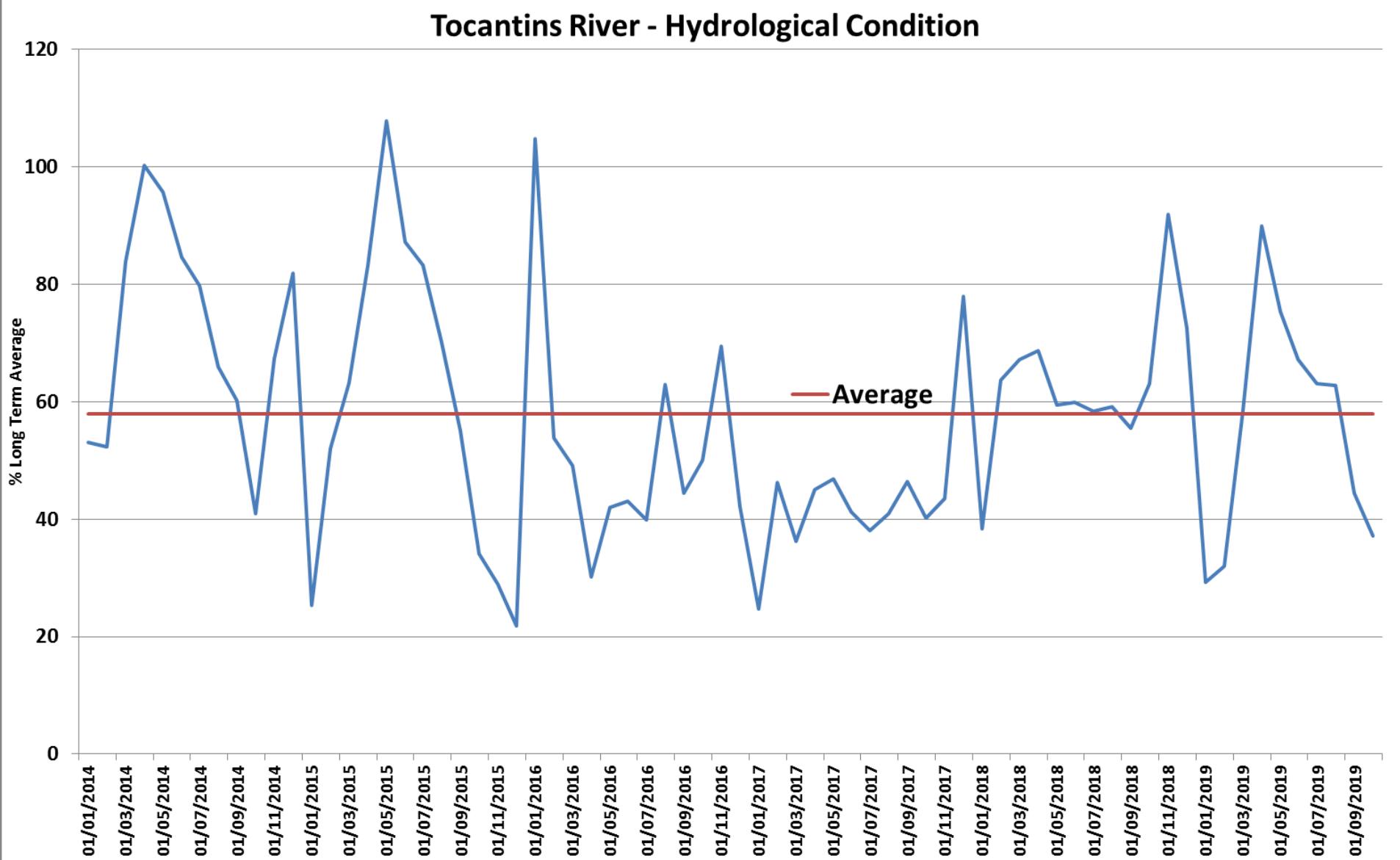
## Santa Cecília's Operation



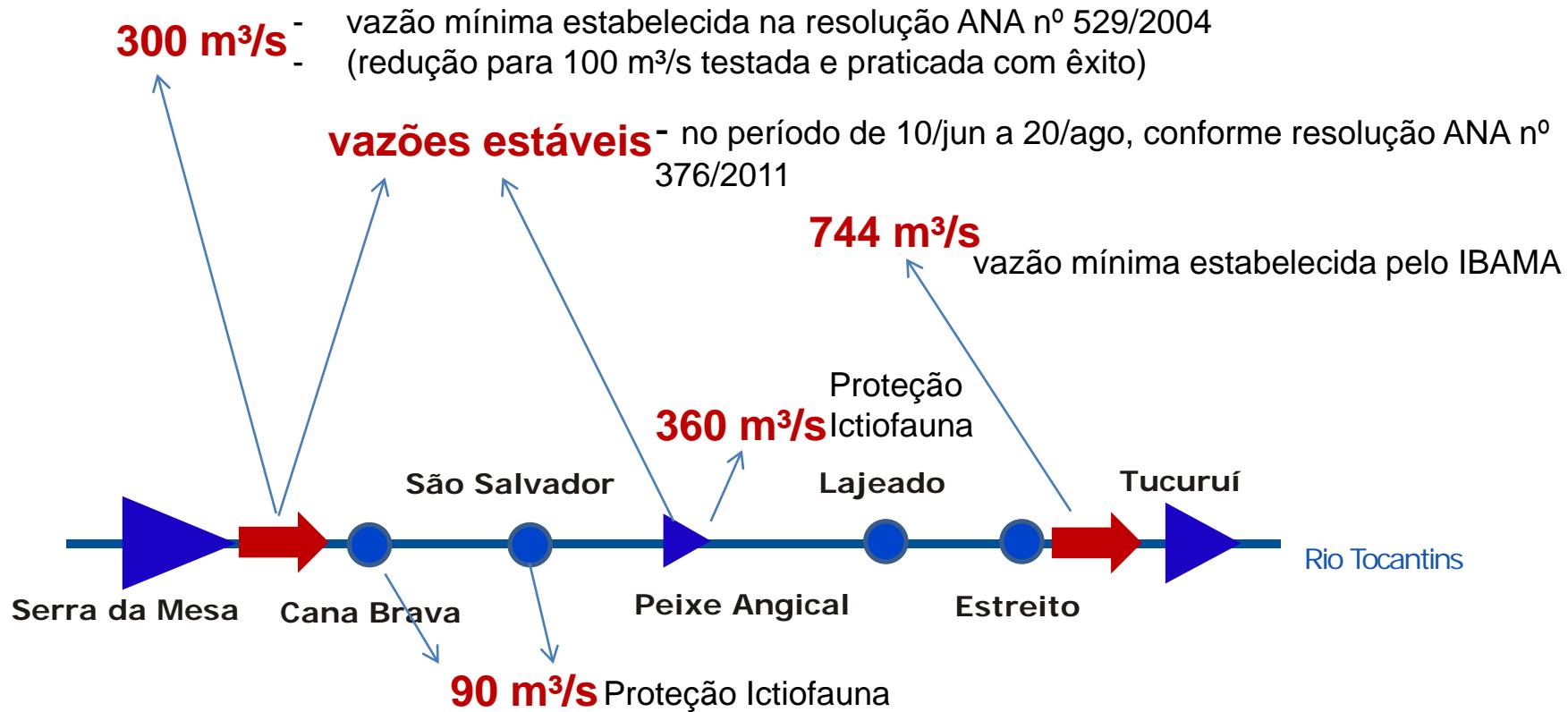
# BIPS case of drought control Tocantins River



# BIPS case of drought control Tocantins River



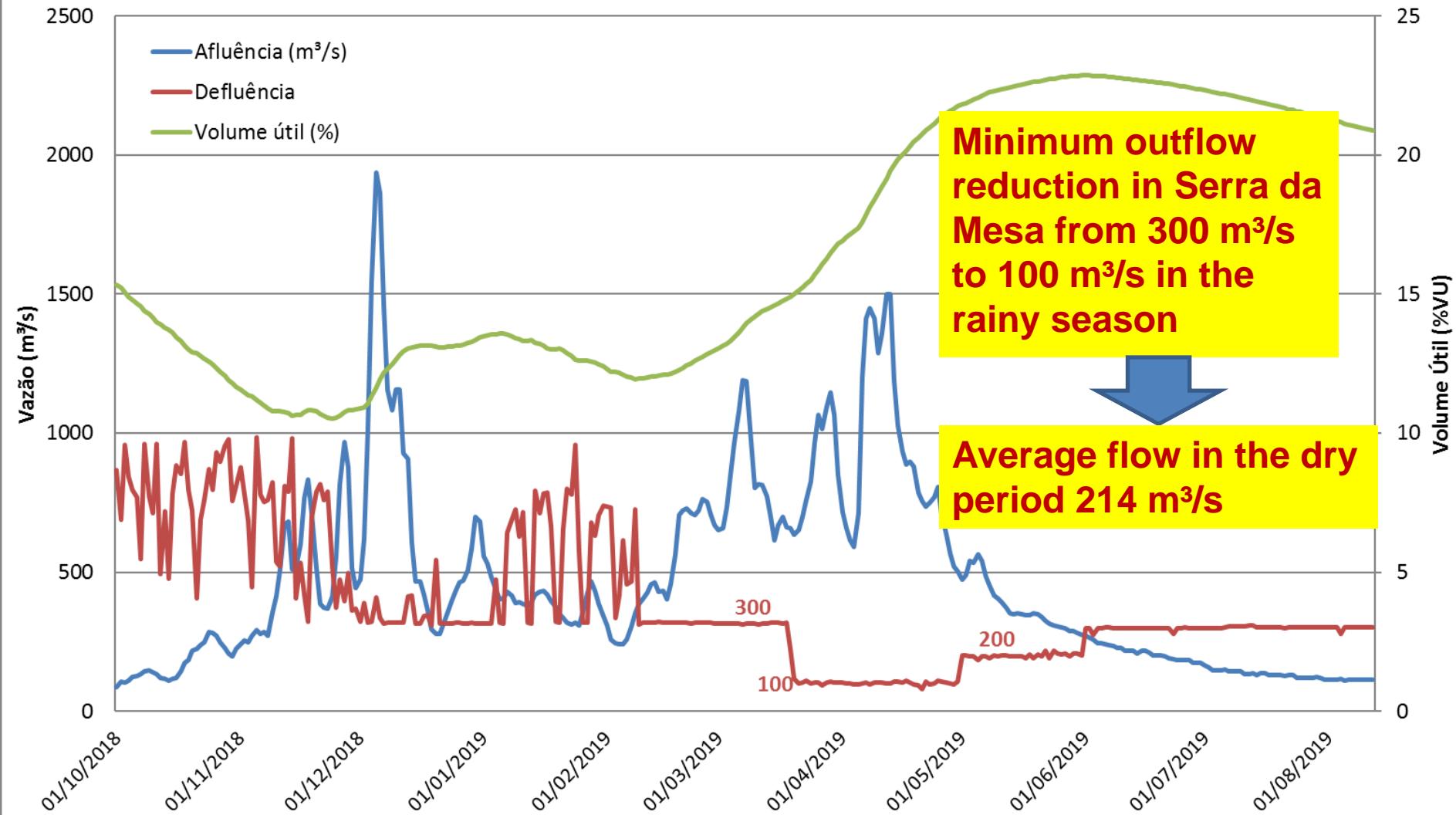
## Minimum Outflows



- Vazão mínima em Estreito – **744 m<sup>3</sup>/s** (até 2016 era de 1.000 m<sup>3</sup>/s)

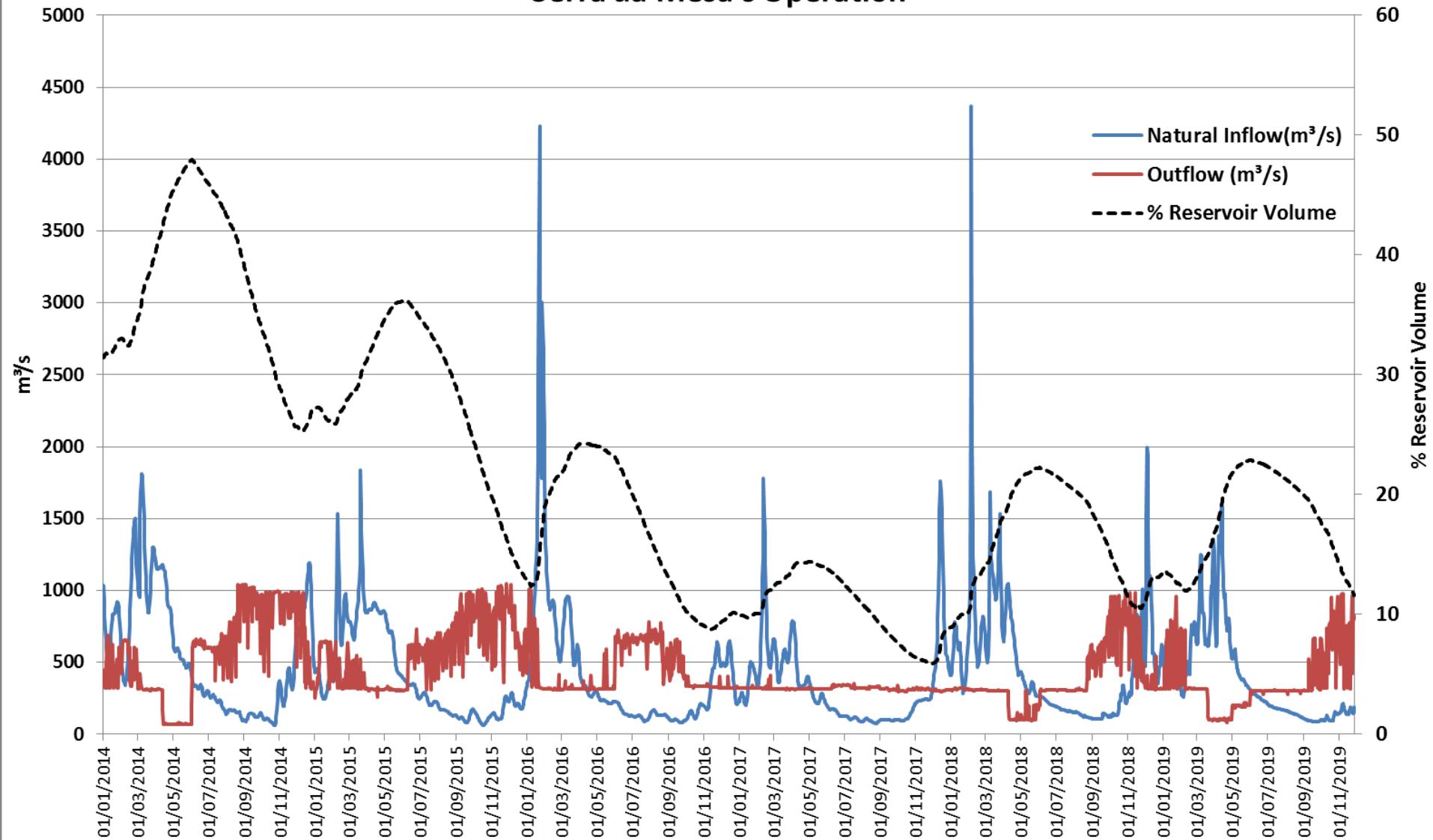
# BIPS case of drought control Tocantins River

Operação Reservatório de Serra da Mesa

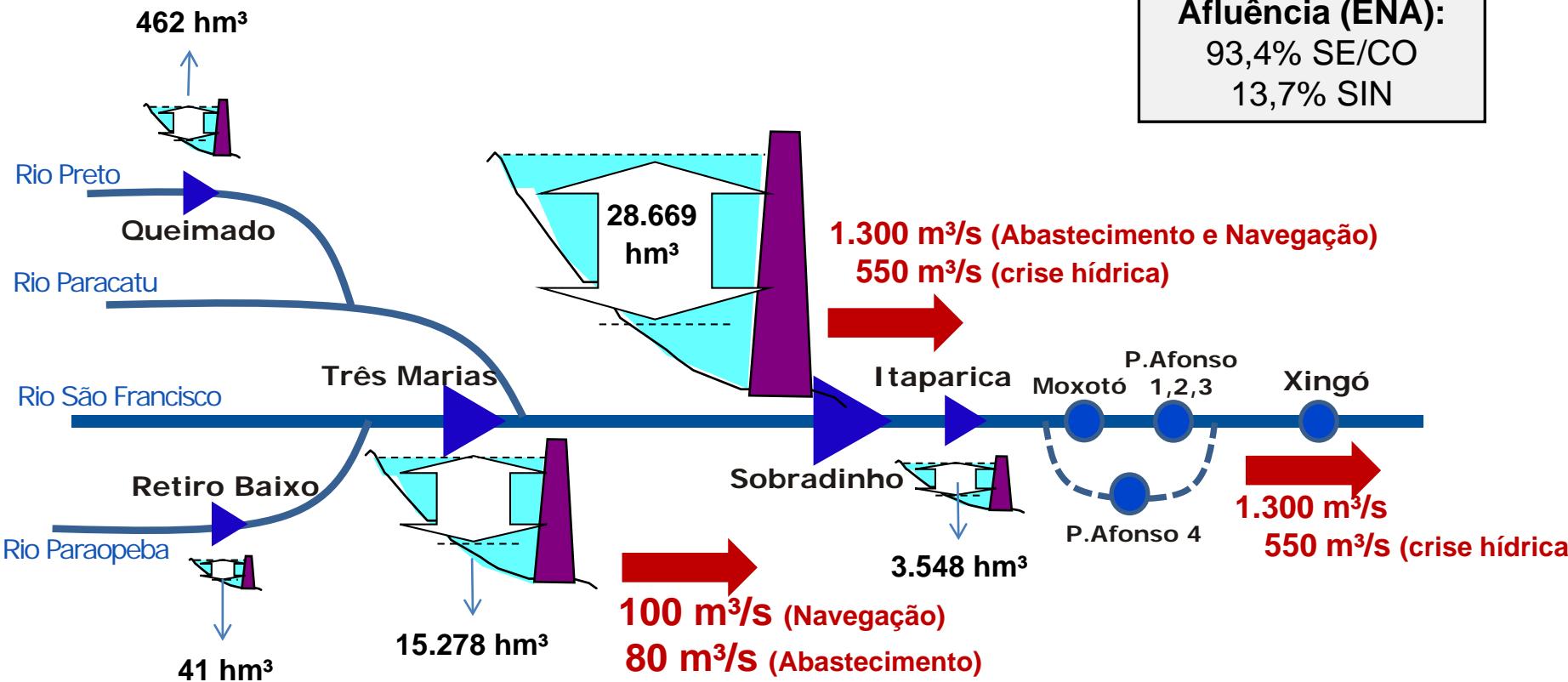


# BIPS case of drought control Tocantins River

## Serra da Mesa's Operation



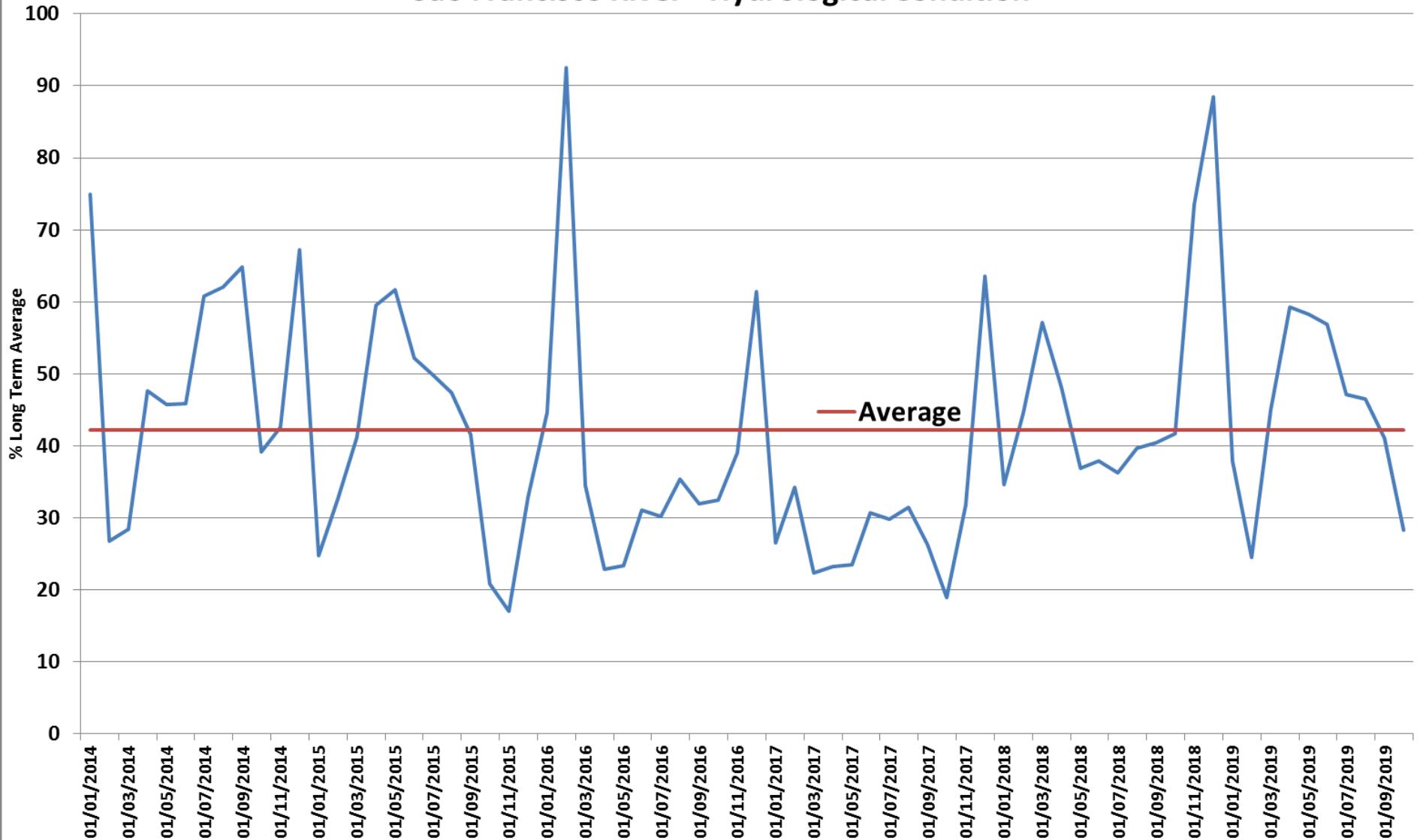
# BIPS case of drought control São Francisco River



**Referência:** Restrições de vazões mínimas estabelecidas pela ANA, IBAMA e pela CEMIG.

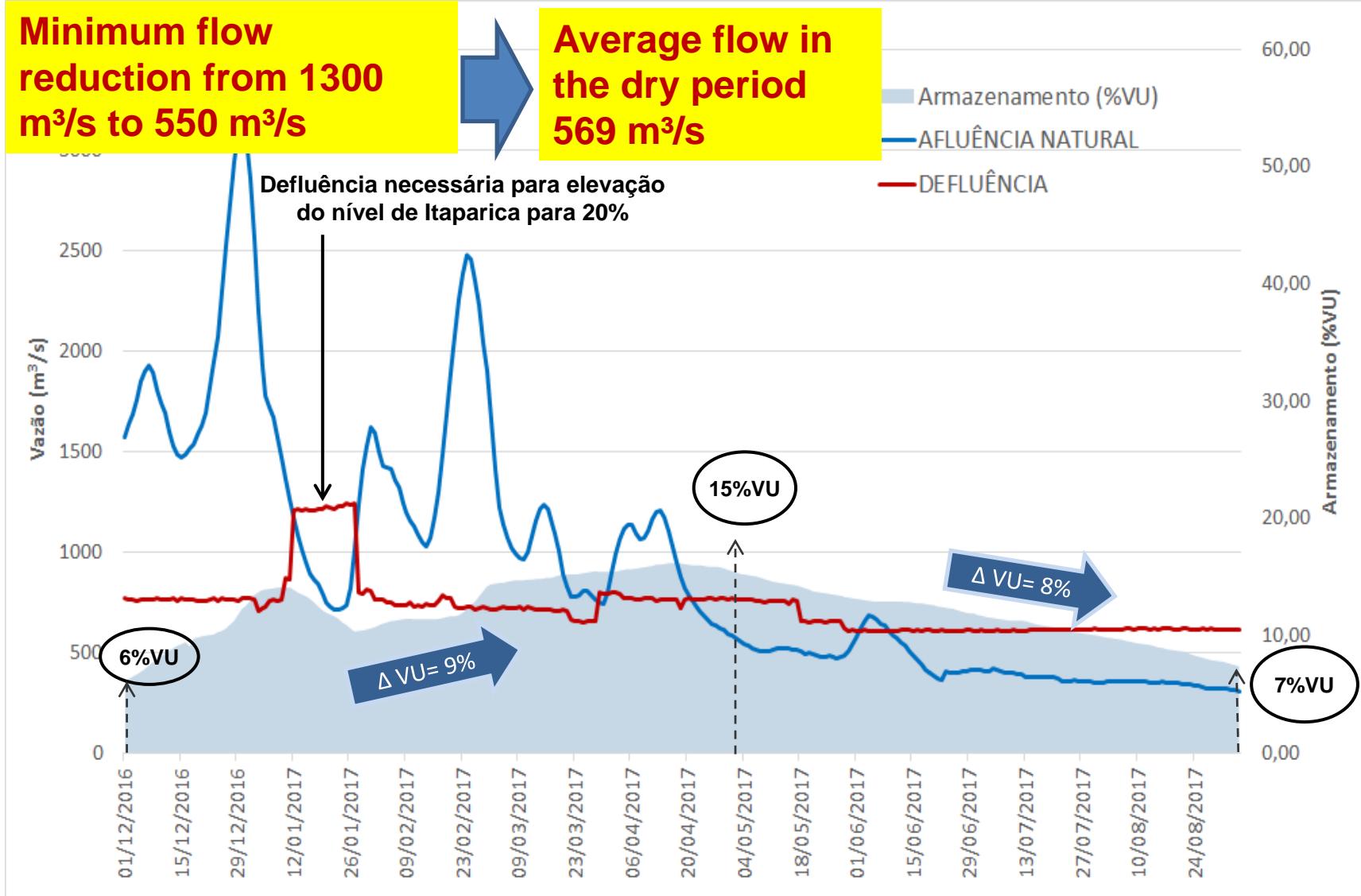
# BIPS case of drought control São Francisco River

São Francisco River - Hydrological Condition



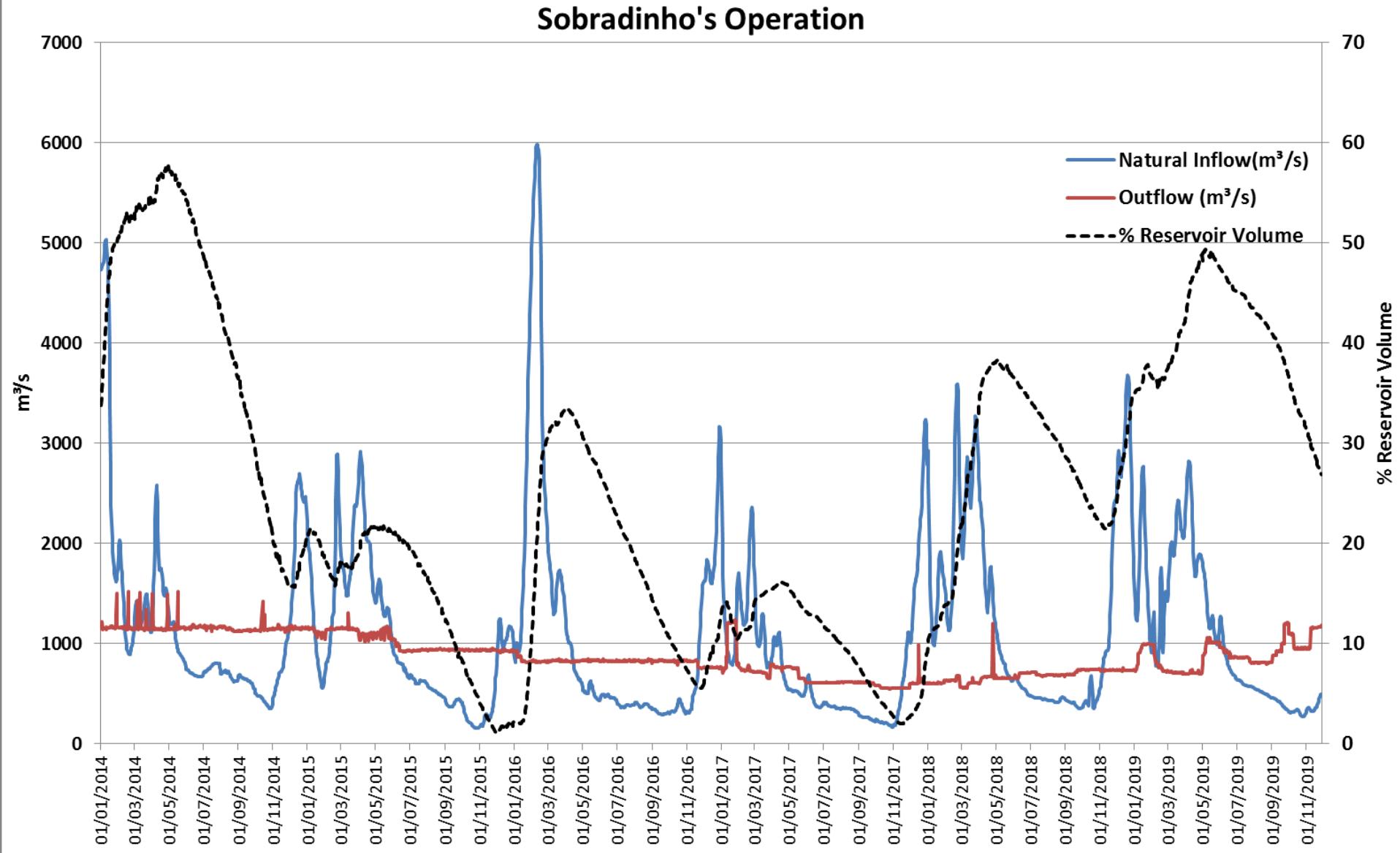
# BIPS case of drought control São Francisco River

## Sobradinho's Reservoir



# BIPS case of drought control São Francisco River

## Sobradinho's Reservoir



**Paulo Diniz**



Operador Nacional  
do Sistema Elétrico

**Thanks!**