INNOVATE WP5: Modeling of global change impacts on water resources and key species in the basin of the Itaparica reservoir

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Outline

1. **Objectives**
2. **The Research Modules**
3. **The Model System**
4. **First results**
5. **Outlook**

Objectives

INNOVATE: Interplay among multiple uses of water reservoirs via inNOVative coupling of substance cycles in Aquatic and Terrestrial Ecosystems (INNOVATE) -> Focus area: Itapararica Reservoir, Brasil

Sub-Project 5:

- **Modelling of water resources and nutrient/ matter dynamics in the São Francisco River basin and the Itaparica reservoir and specific research sides;**
- **Up-scaling of local-level results to the catchment level, down-scaling of global change impacts (climate, land use)**
- **Link to the coordination project GLUES**
- **Start: 1/2012**

Research Modules

1. Water quantity: Impacts of climate and land use change on hydrology and vegetation
2. Water quality: Nutrient emissions into river system from point and diffuse sources
3. Reservoir: Hydrodynamic and water quality simulations in the reservoir
4. Landscape modelling: Land-use maps of future landscapes and biodiversity
5. Input from other WPs

Quantification of land use and climate change impacts: different scales

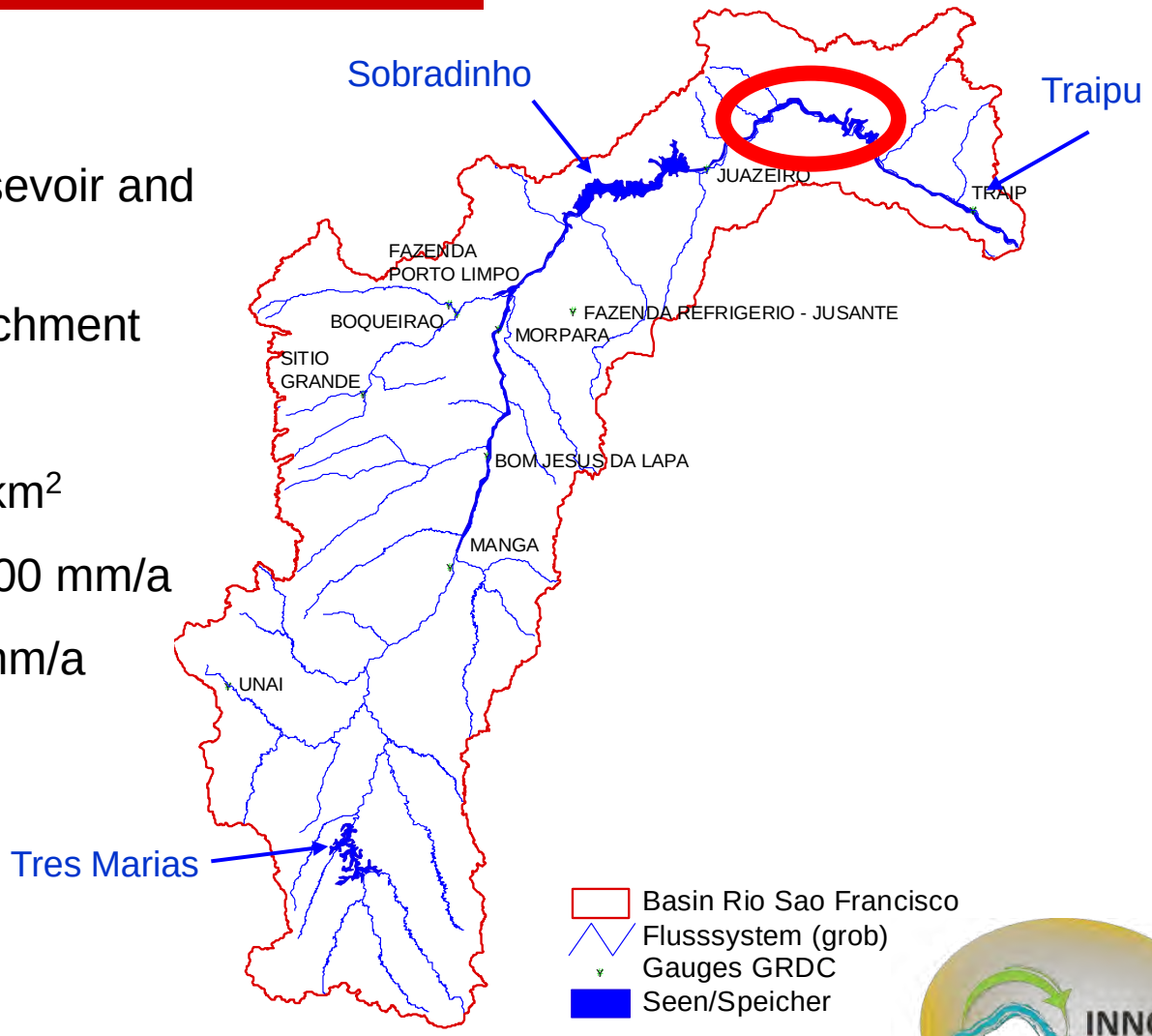
Local scale: Itaparica Resevoir and surrounding area

Basin scale: total river catchment

Total basin about 600.000 km^2

South wet, precip. up to 2000 mm/a

North dry, lower than 300 mm/a



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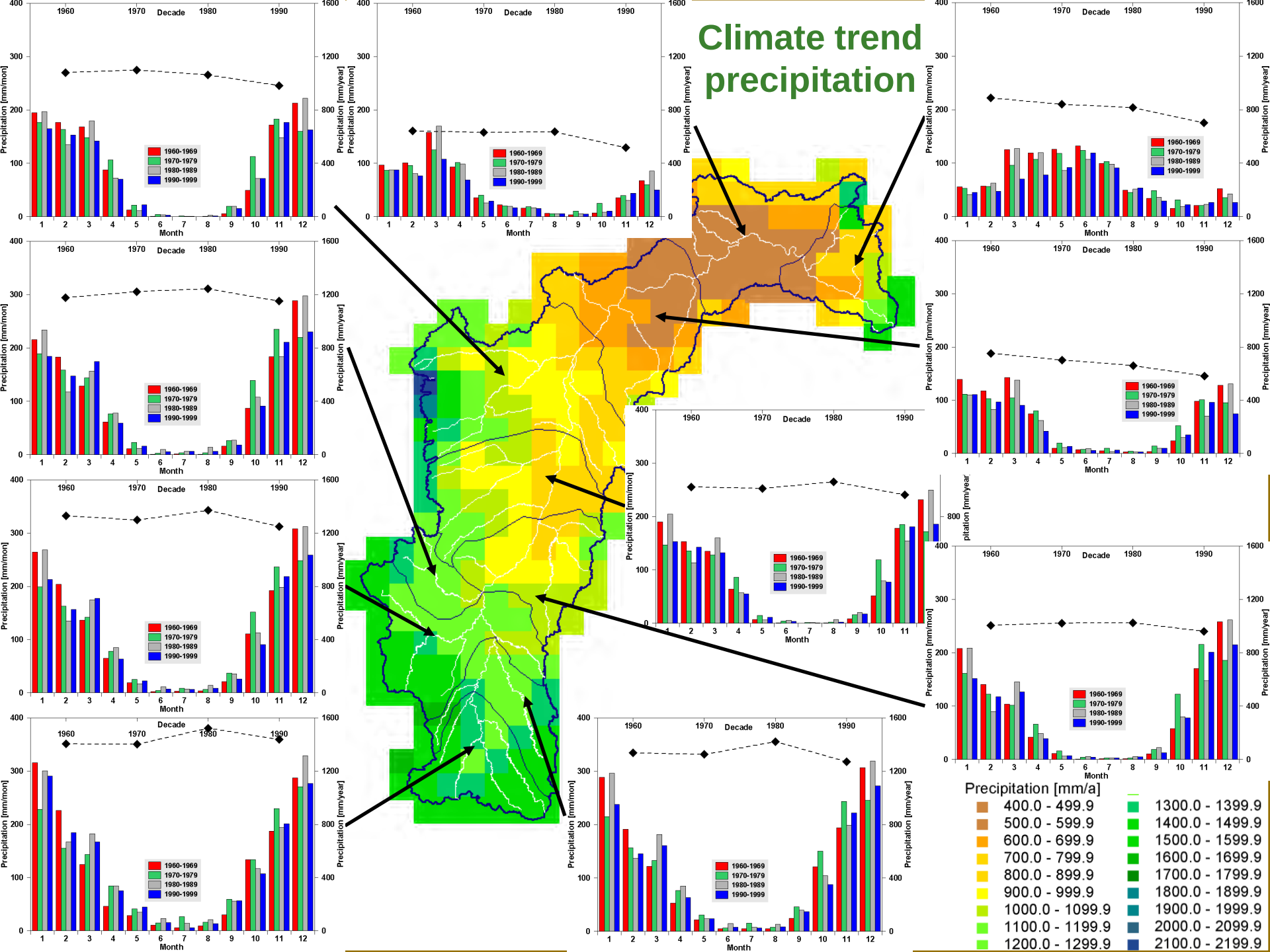
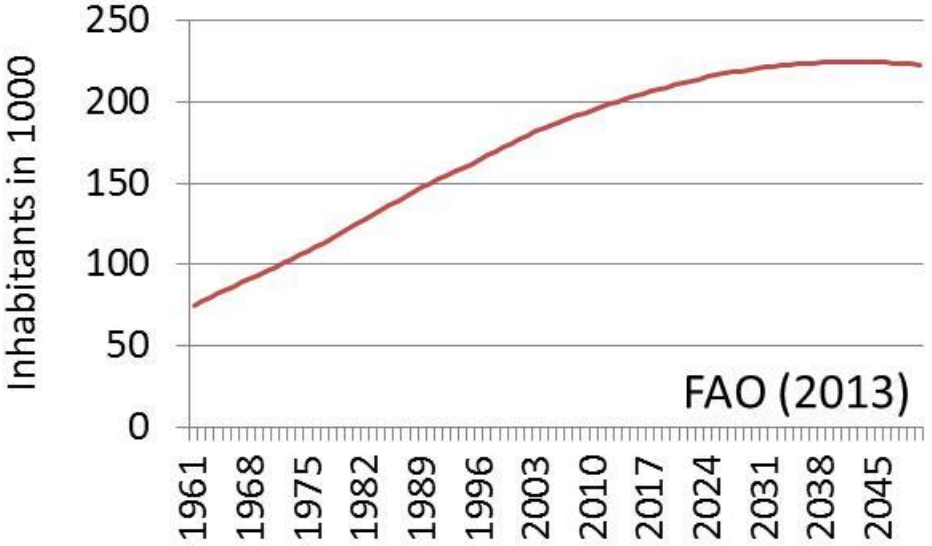
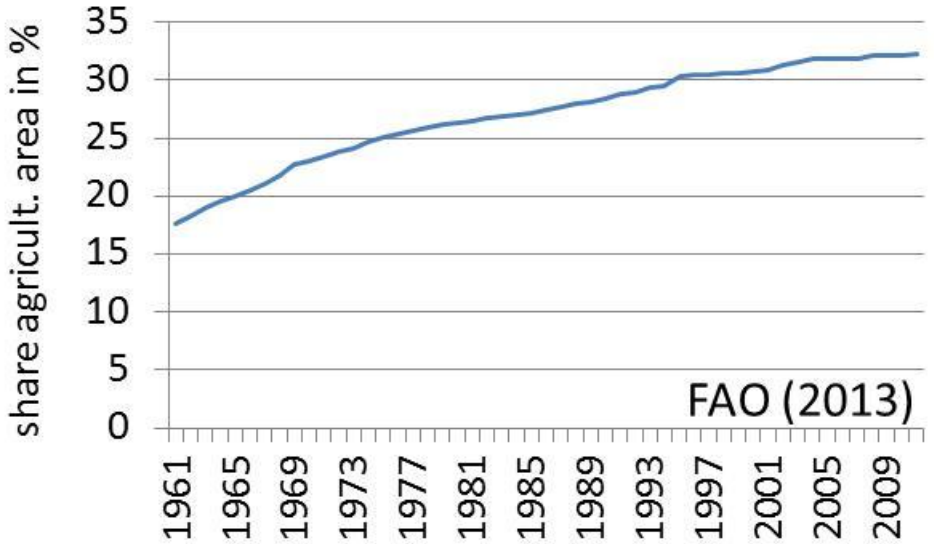
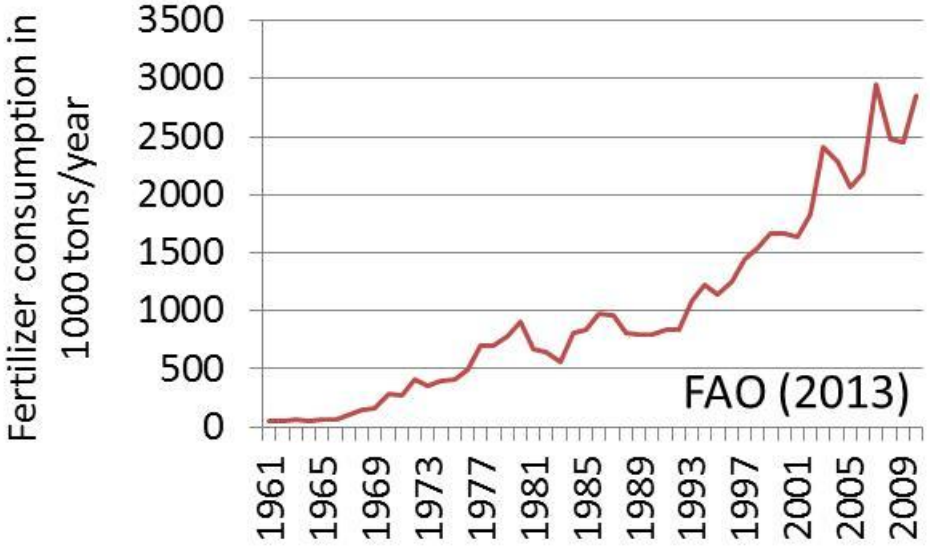
Climate trend precipitation



Causes for an intensified agriculture and increased emissions







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Model System and Flow of Information

Up-scaling

Down-scaling

Landuse ⇄ **Coordination project GLUES** ⇄ **Climate**

MAgPIE*

Agricultural sector and land use model for Brazil and the São Francisco region

STAR/ CCLM

Statistical or dynamical climate down-scaling or combination of for the model region

SWIM

Eco-hydrological modeling of the São Francisco basin integrating water, vegetation (crops), soil and carbon

MONERIS

Modeling of nutrient transport and retention considering point and diffuse sources in the basin

HMS/ Telemac

Modeling of the hydrodynamic and water quality in the Itaparica reservoir considering changing boundary conditions

GIS model

Modeling and evaluation of land use changes and spatial pattern

Economy*

Modeling and evaluation of economical impacts

Local investigations in TP 1-4

Continental Global

Scenarios of global change will be based on information given by the coordination project GLUES and regionalized to investigate the impacts at the regional scale.

Landscape Regional

The Impacts at the regional scale will be simulated. Visa versa, land use changes at the local scale will be regionalized using GIS models to understand their impact at the river basin scale.

Flow of land use related information

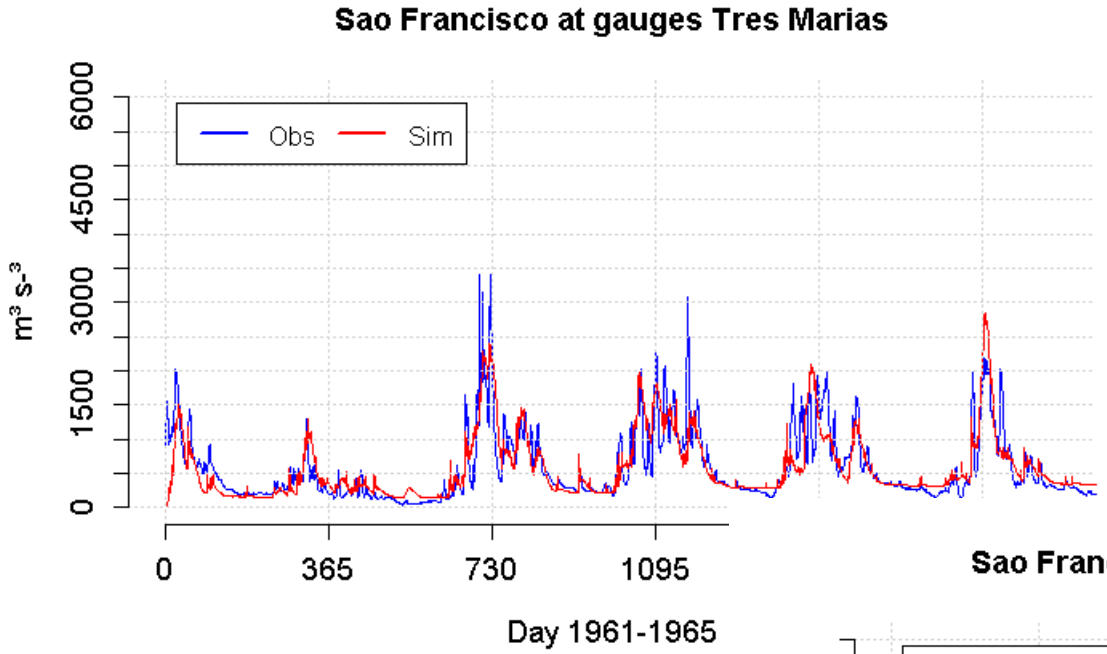
Flow of hydrological information

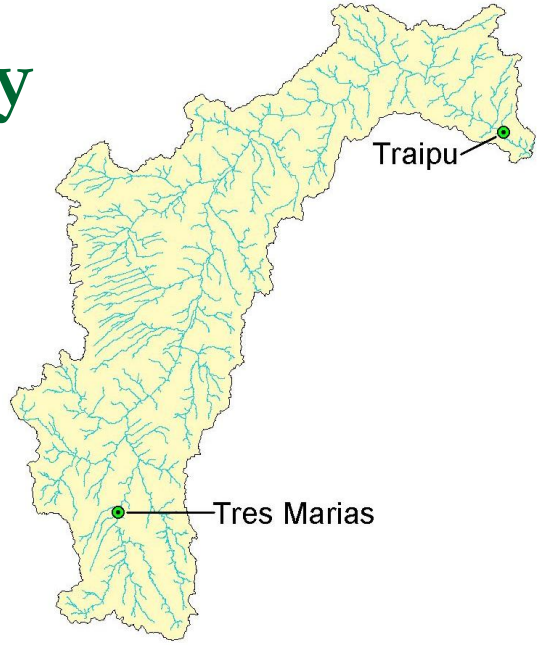
Flow of nutrient related information

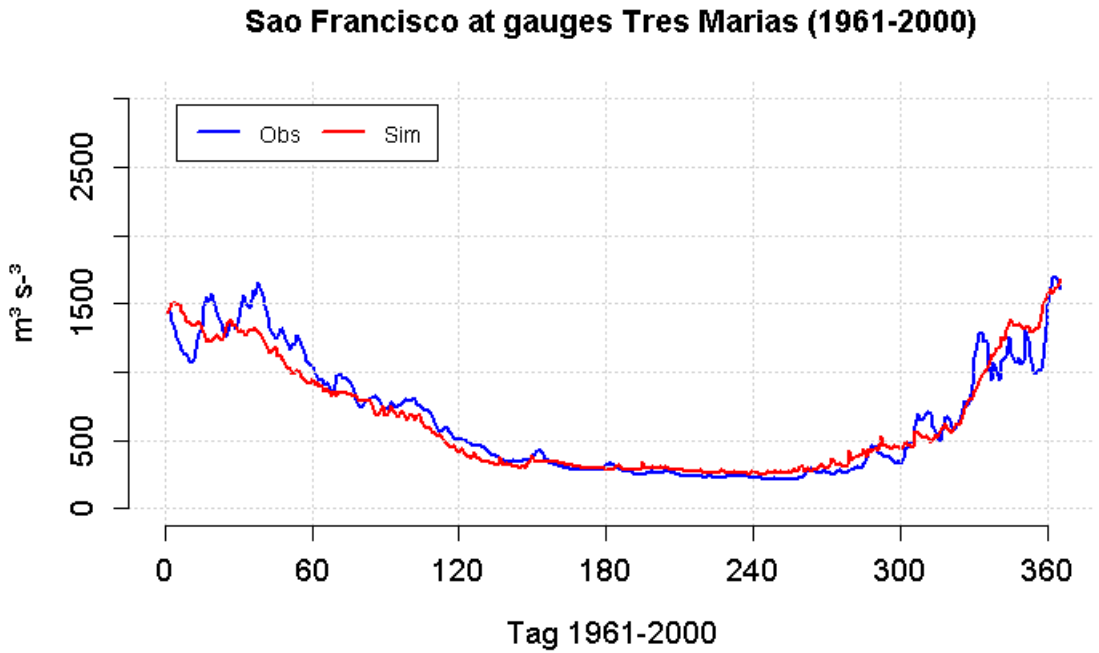
SWIM Model

* Model applied in SP6

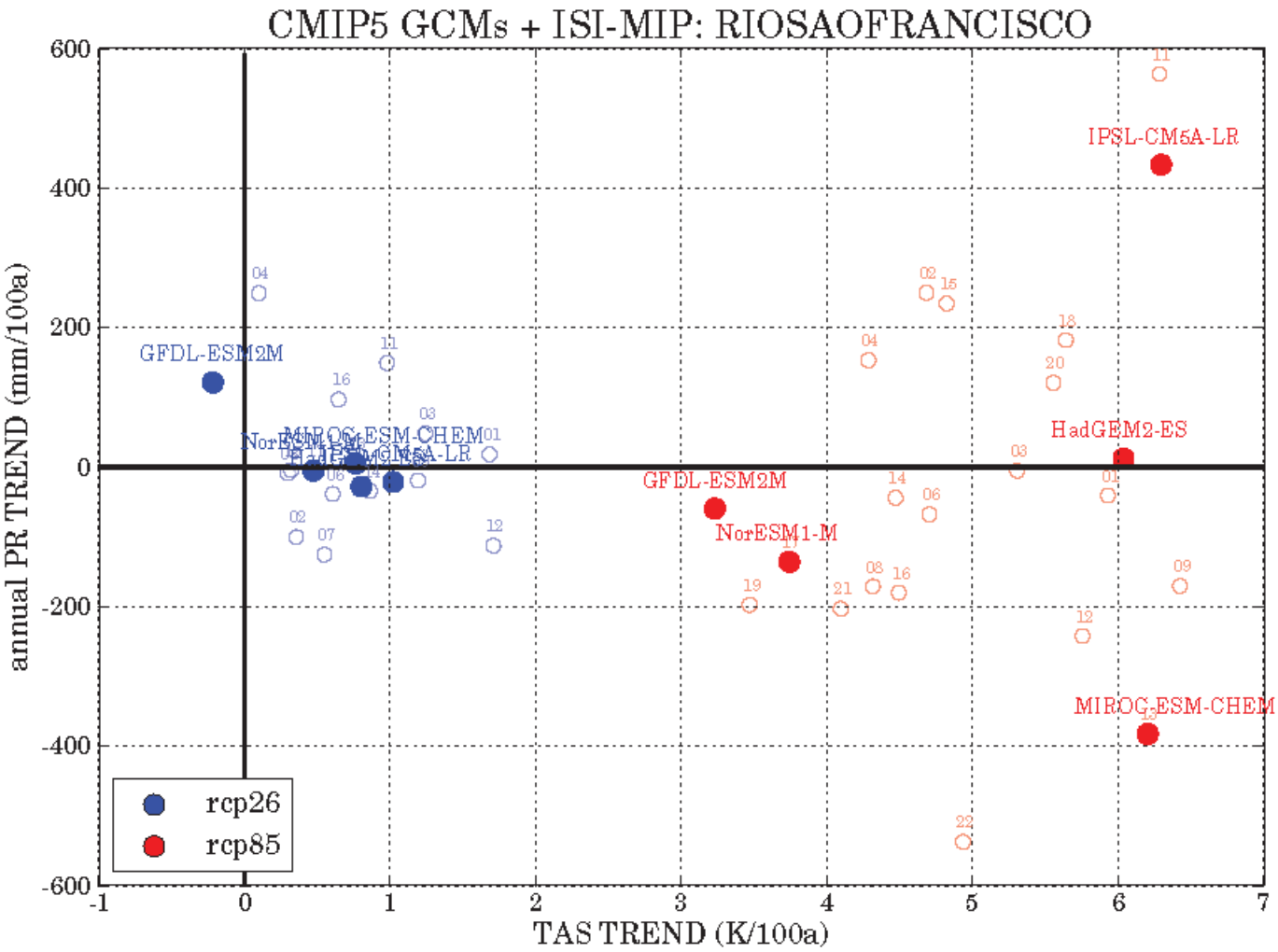
First results RM 5.1: Water Quantity



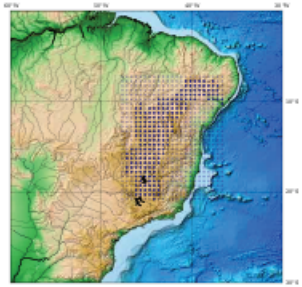




Climate szenario
Representative Concentration Pathways (RCPs)

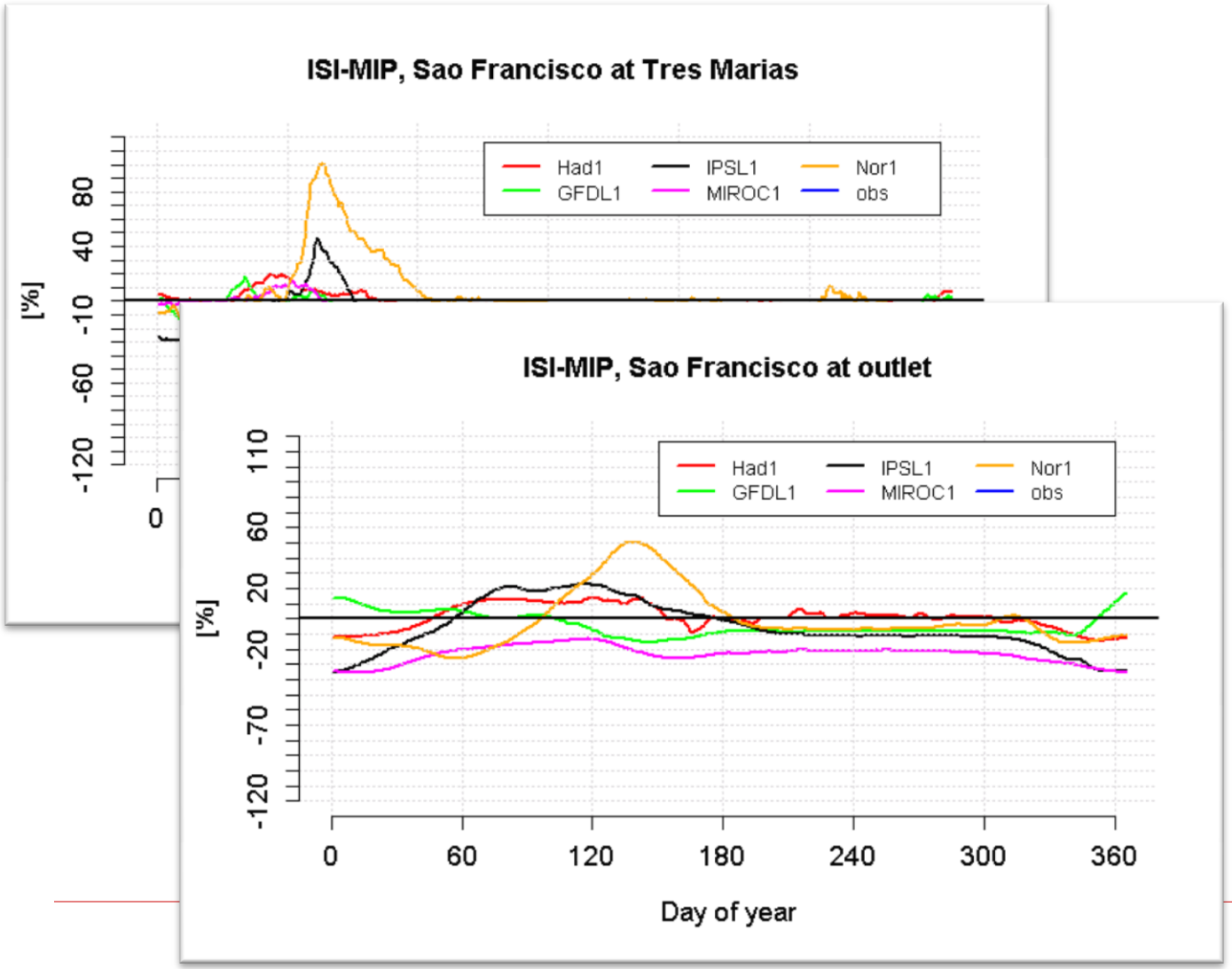


01	CSIRO-Mk3-6-0
02	MPI-ESM-MR
03	CESM1-CAM5
04	FIO-ESM
05	HadGEM2-AO
06	BNU-ESM
07	bcc-csm1-1-m
08	CCSM4
09	CanESM2
10	FGOALS-s2
11	IPSL-CM5A-MR
12	MIROC-ESM
13	MIROC-ESM-CHEM
14	MIROC5
15	MPI-ESM-LR
16	MRI-CGCM3
17	NorESM1-M
18	ACCESS1-0
19	inmcm4
20	ACCESS1-3
21	CESM1-BGC
22	IPSL-CM5B-LR
23	IPSL-CM5A-LR



CC impacts on water resources and seasonal flow

(RCP 8.5, difference runoff 2021-2060 minus 1961-2000)



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First results RM 5.2: Water quality

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Lowest live stock densities in vast parts of Pernambuco and northern Bahia
→ lower importance for the direct catchment of the Itaparica Reservoir

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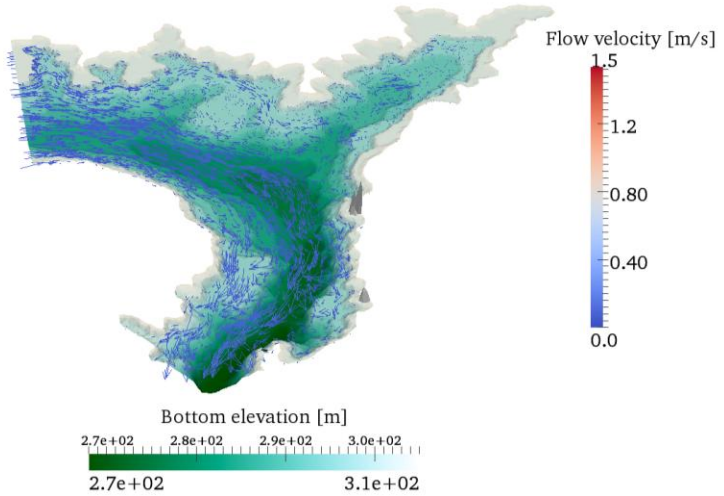
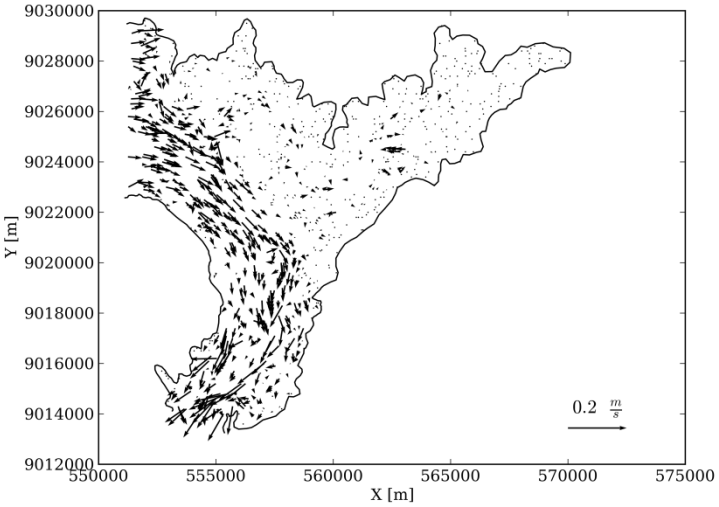
First results RM 5.3: Modelling of the Itaparica reservoir





Velocity field

- 40,000 cells (100x100 m)
- steady state reached after 10 days
- inflow = 2060 m^3/s
- water elevation = 302.8 m

- max flow velocity = 0.11 m/s
- mean flow velocity = 0.02 m/s
- no water exchange between bay and river

- change of bottom roughness from 19 to 75 $m^{1/3}/s$ leads to 37.5% difference in mean flow velocities

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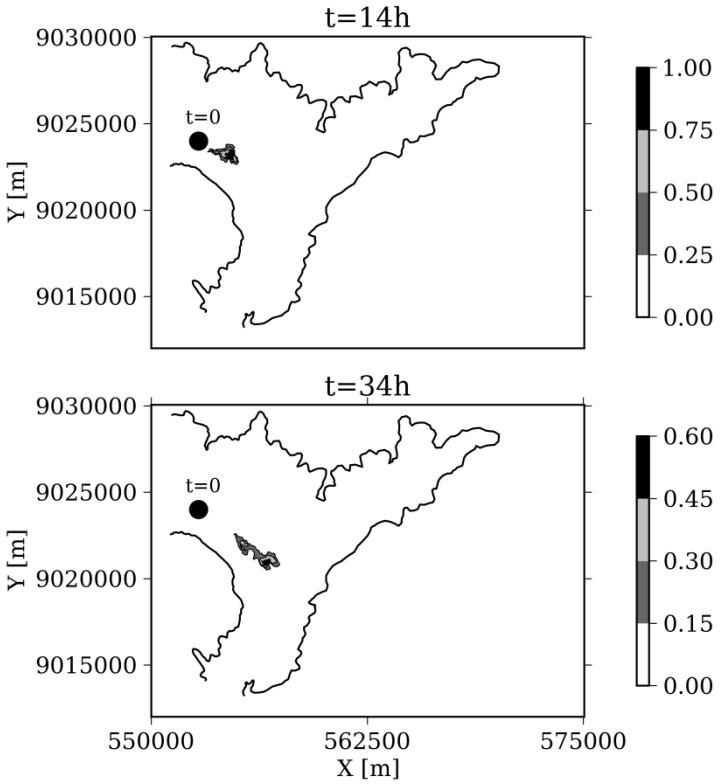
Modelling of the Itaparica reservoir

A tracer injected at the upstream boundary did not enter the bay and was transported further downstream



Tracer concentration in the domain

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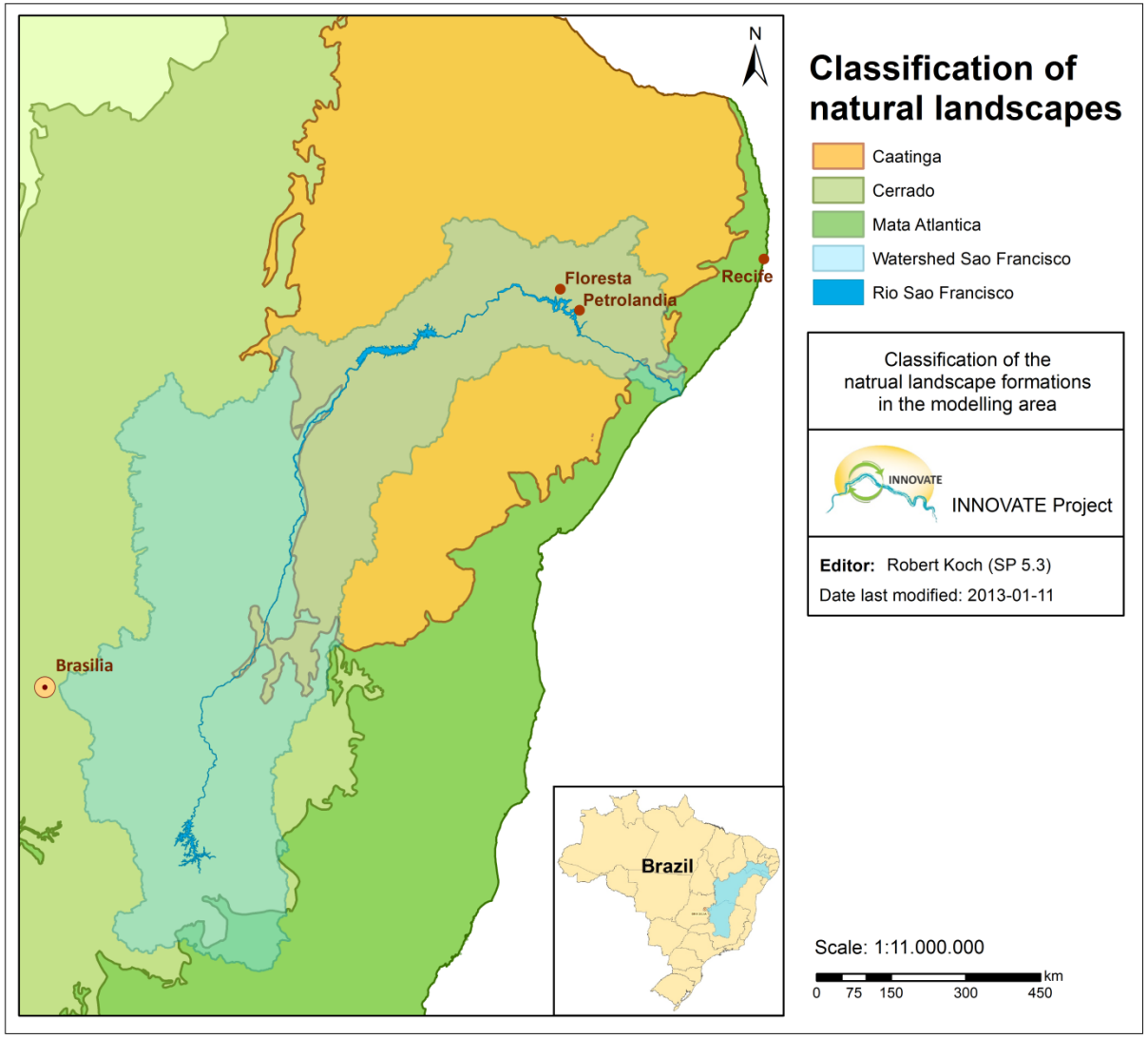
First results RM 5.4: Modelling of species distribution



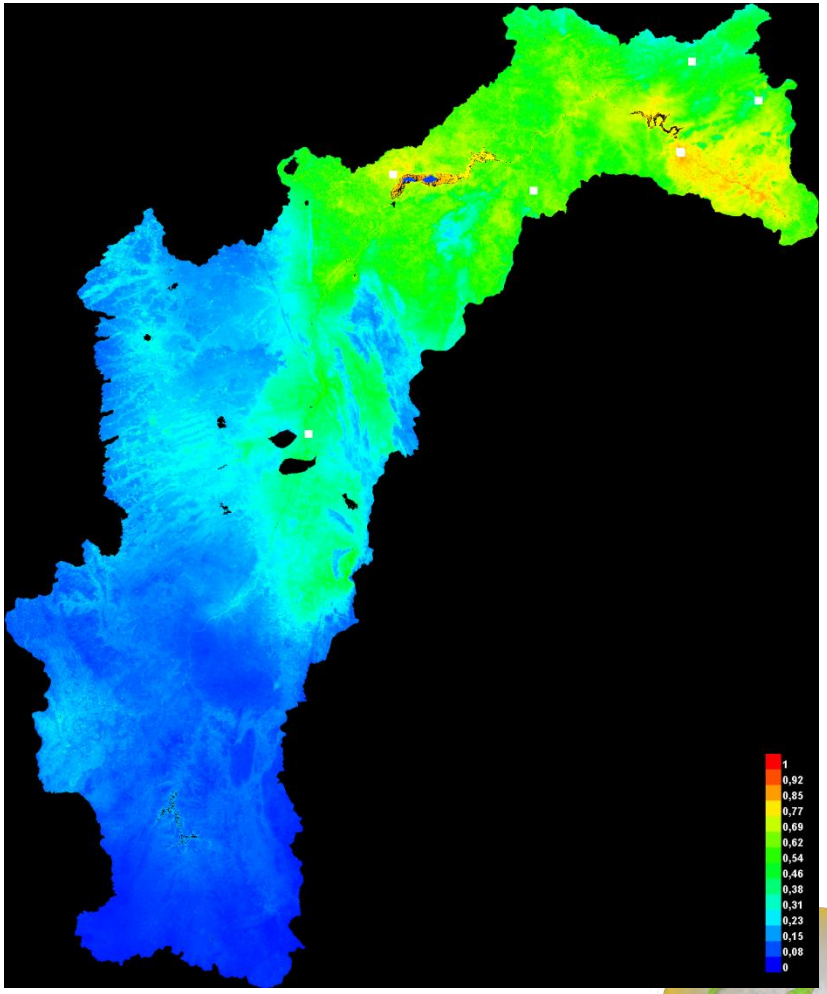
Typical plant of the Catinga: *Caesalpinia pyramidalis*

INNOVATE

Modelling of species distribution

Preliminary distribution map of *Caesalpinia pyramidalis* including Normalized Differenced Vegetation Index (NDVI) in the entire Sao Francisco catchment area. The used colors indicate predicted probability (red: high).

Modeled using MaxEnt



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Summary and outlook

- The project is well in time
- Cooperation with Brasilian partners well developed
- The models have to be further developed
- Linking of the models and to other WPs
- GLUES scenarios regionalized for the basin

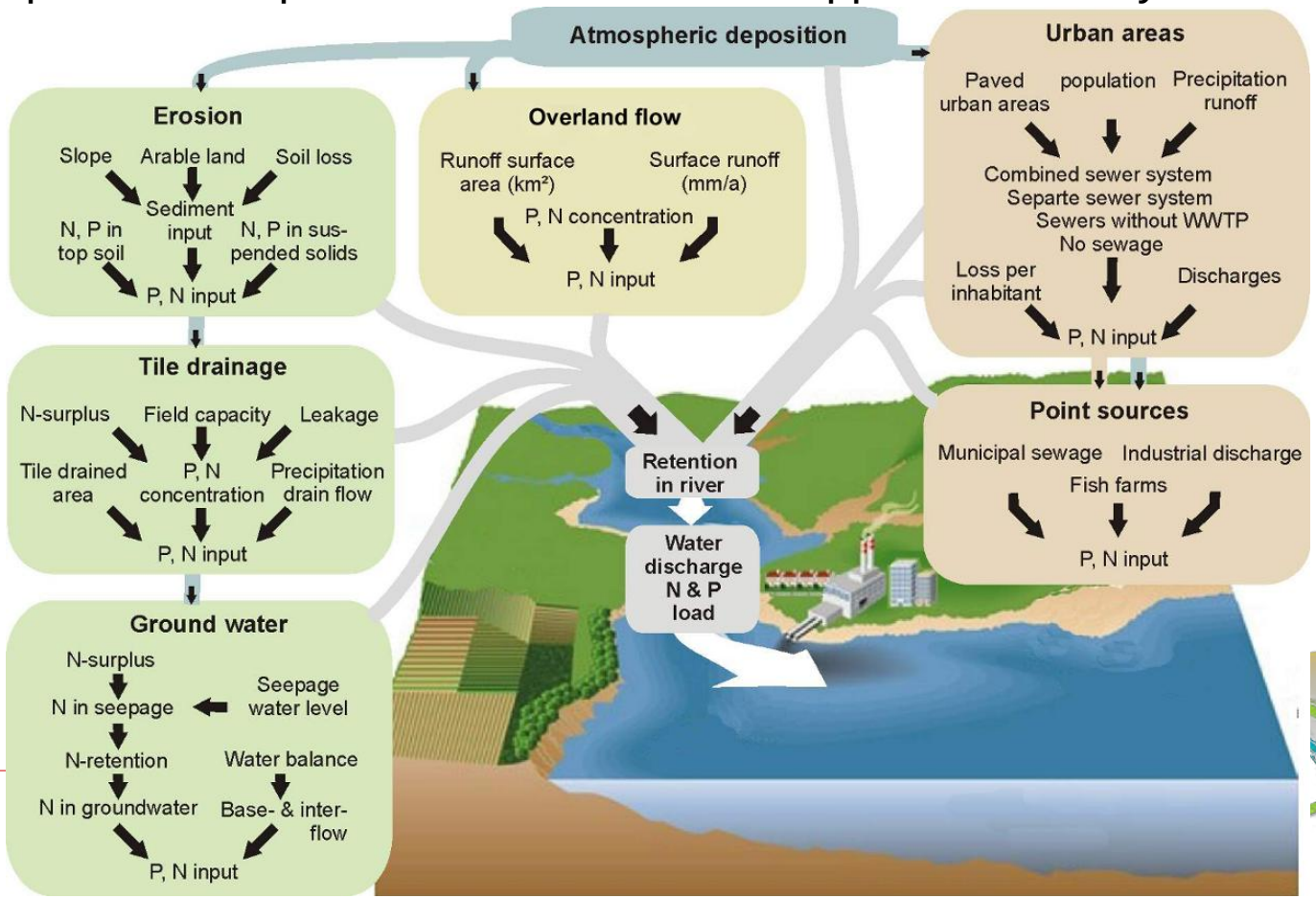
Main stakeholders:

- CHESF – Hydropower company of the Sao Francisco basin
- CEMIC – Electricity company (Minas Gerais)
- CODEVASF – Company for the development of the Sao Francisco basin

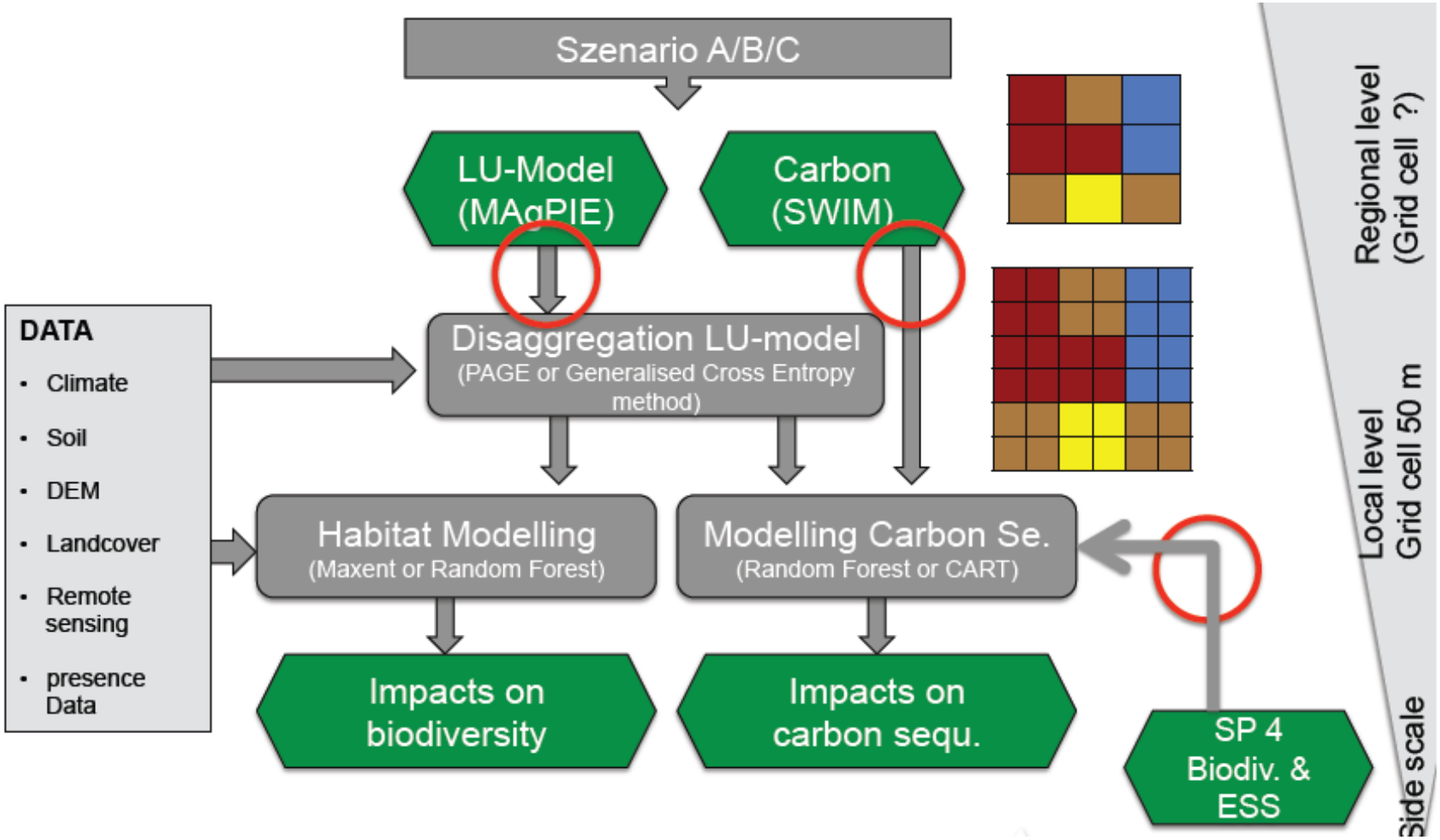
Many thanks!

MONERIS

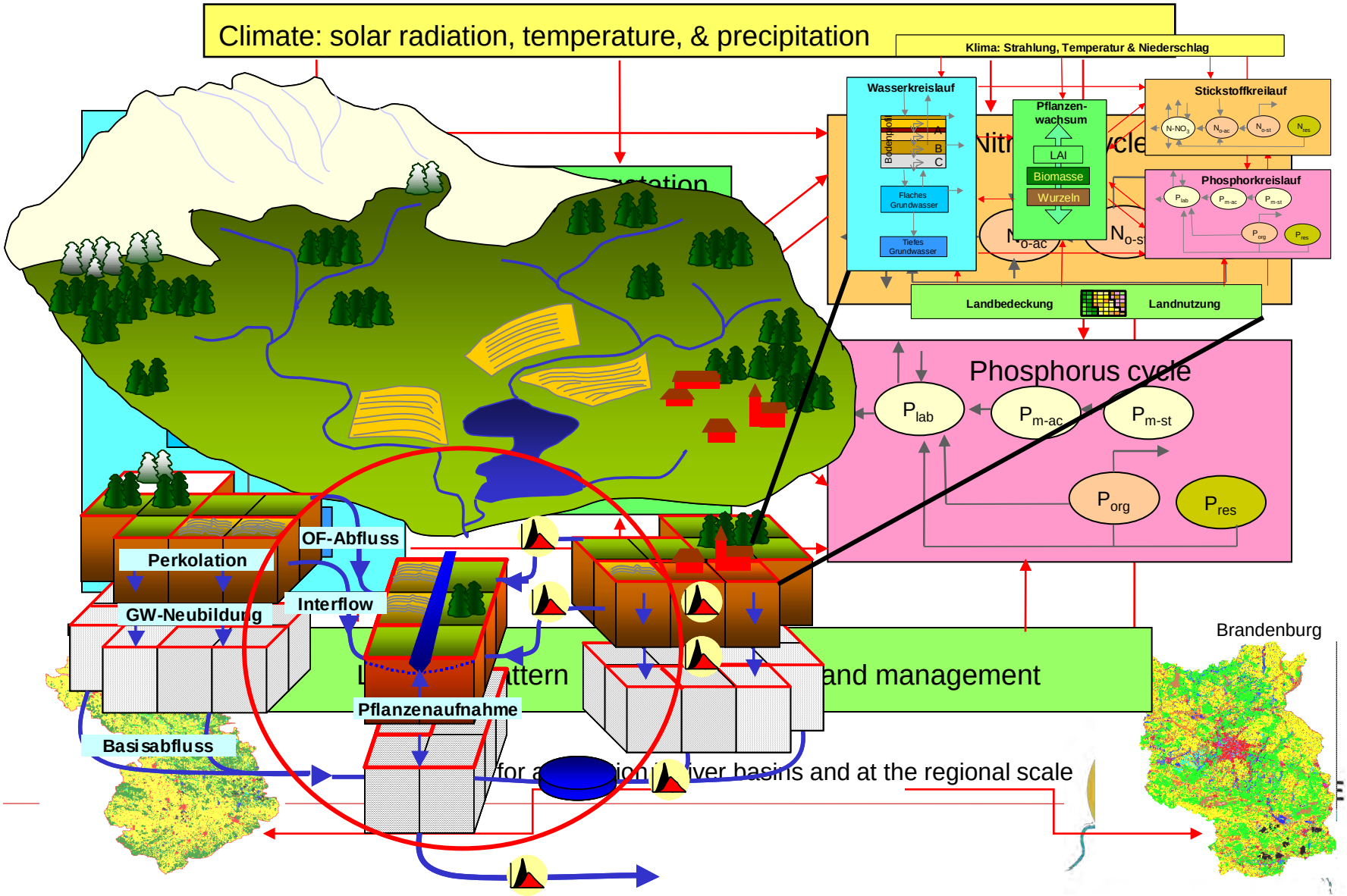
- calculates nutrient emissions from catchment to surface waters in large river systems
- considers transport and retention in surface waters
- estimates the effect of management options (e.g. change of fertilizer application) on the water quality
- developed for European conditions, but also applied to river systems world wide



Landscape (GIS) Modelling



The Model SWIM (Soil and Water Integrated Model)

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