Advances in Scenario Modelling Using Ecosystem Accounting

Scenario Analysis Pilot in Brazil:

The Impact of LULC Changes on Water Availability and Soil Loss

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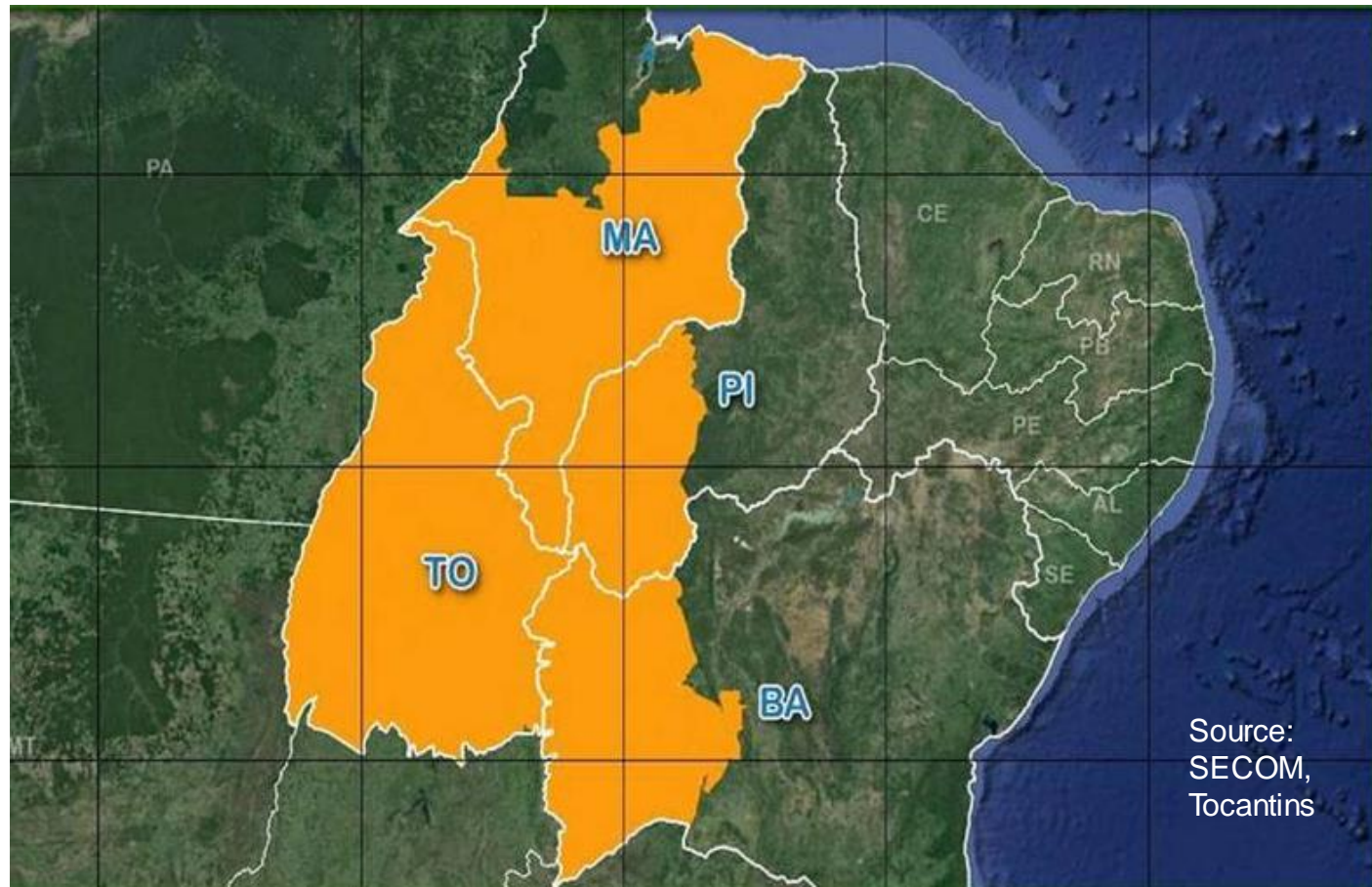Federal University of Rio de Janeiro, UFRJ, Brazil

Main Ideia

- Model the effects of land use and land cover changes (LULCC) on river discharge and soil loss in areas undergoing a rapid expansion of mechanized agriculture in Brazil
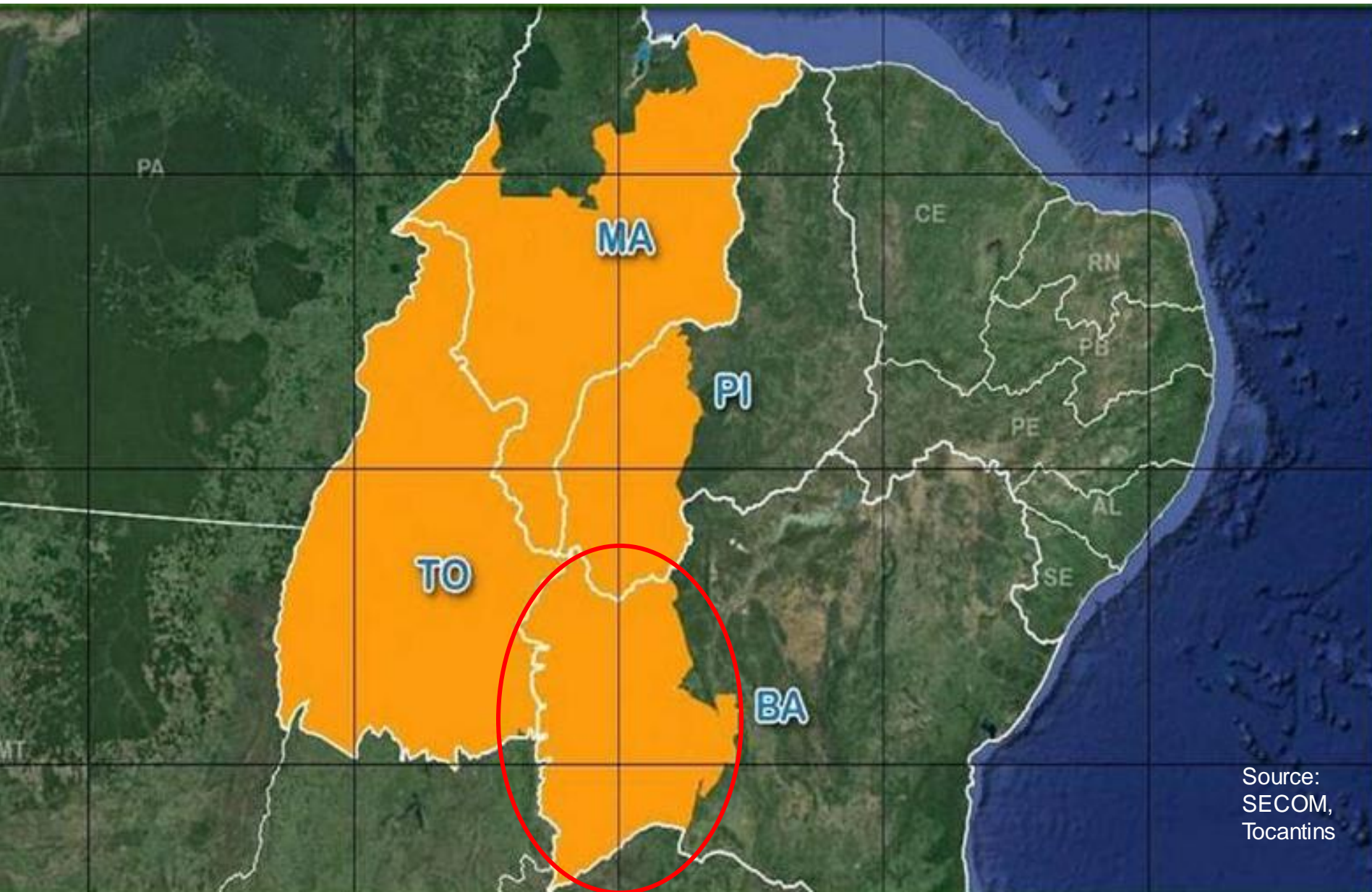
Study Area

MATOPIBA Region
New Frontier for Brazilian Agriculture

Source: SECOM, Tocantins

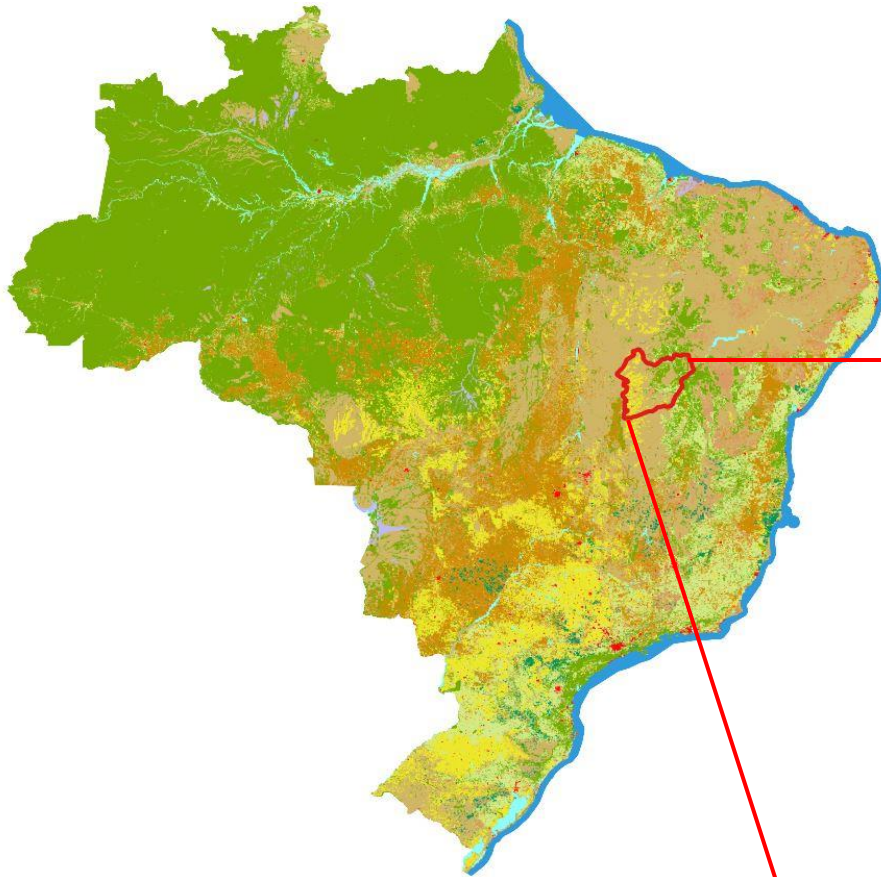# Selected Area - Western Portion of Bahia State

Source: SECOM, Tocantins
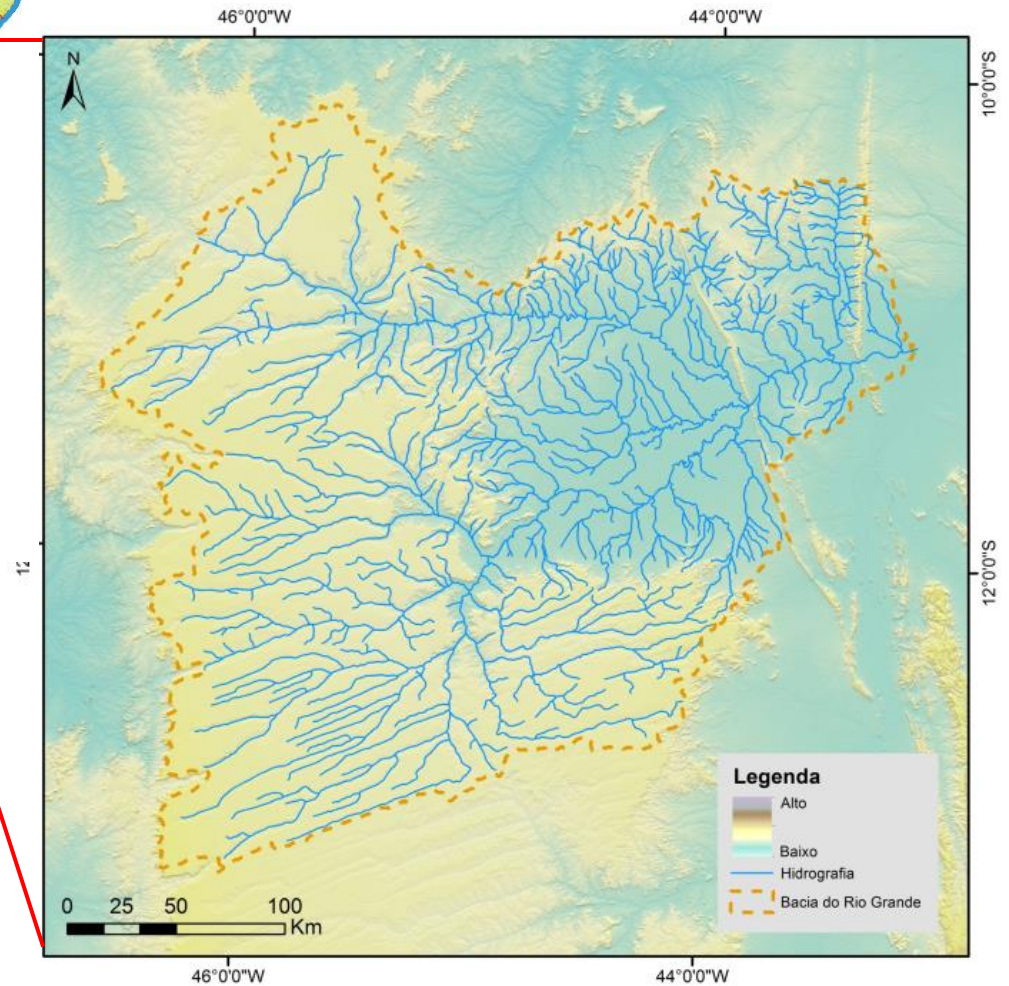
Grande river basin
(Western portion of Bahia State)

(~76,000 km^2)

Land use and land cover map of Brazil – 2016. IBGE

Legenda
Alto
Baixo
Hidrografia
Bacia do Rio Grande

46°0'0"W   44°0'0"W
10°0'0"S
12°0'0"S

0 25 50 100 Km

Grande River Basin

Continuous mapping of LULC (since 2000)
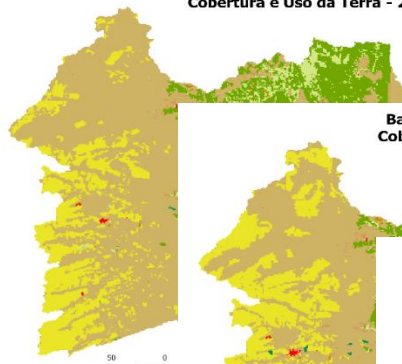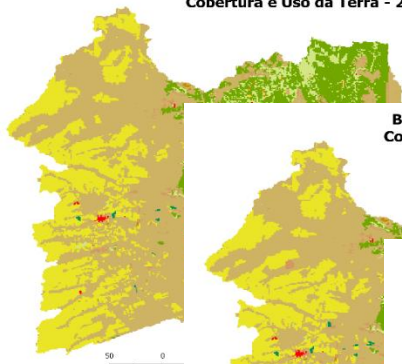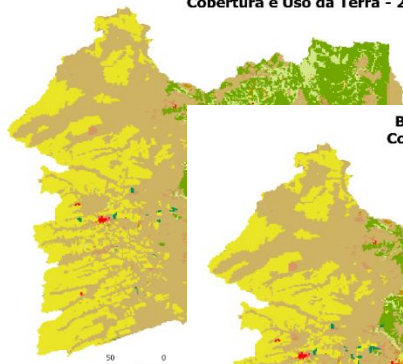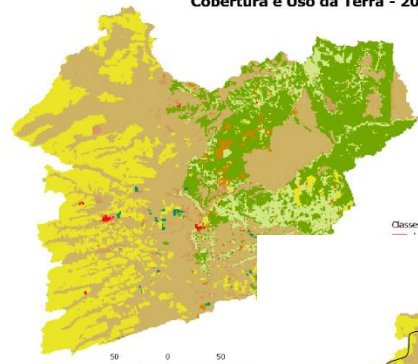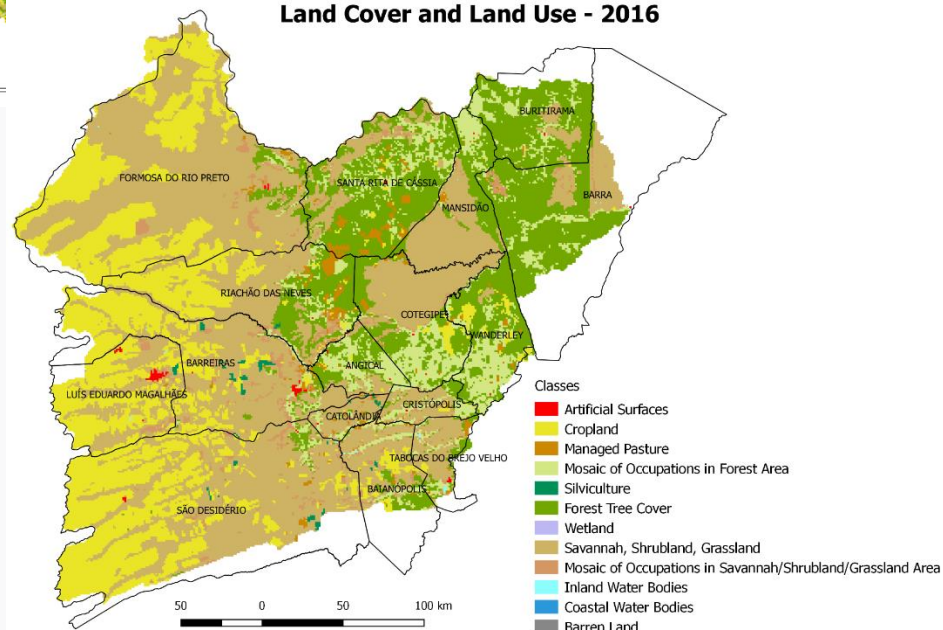
Major LULCC

Barreiras - BA
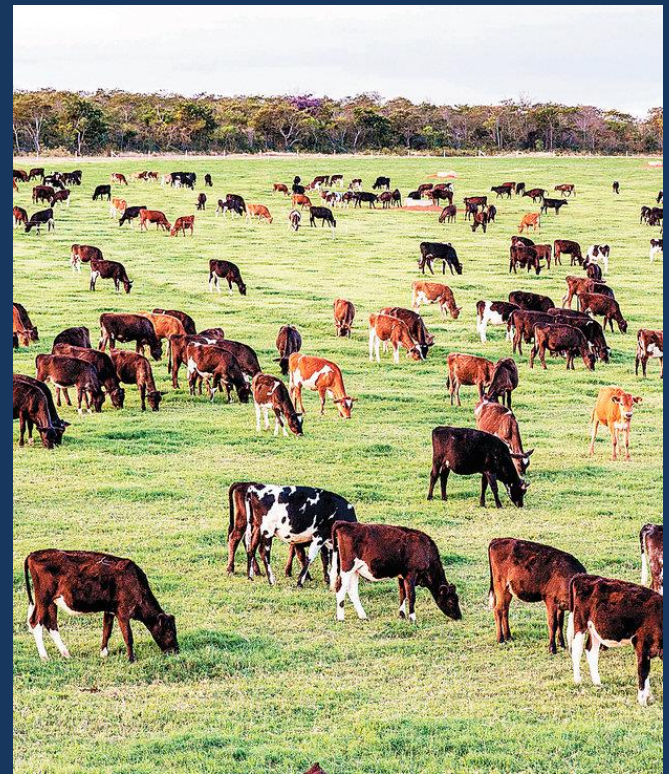
best areas for agriculture expansion → flat plateaus (sandstones)

Sandy Oxisol

Barreiras city

More dissected areas (even with better soils – from limestones) are not used for agriculture

Topography limits agriculture expansion

SWAT Model
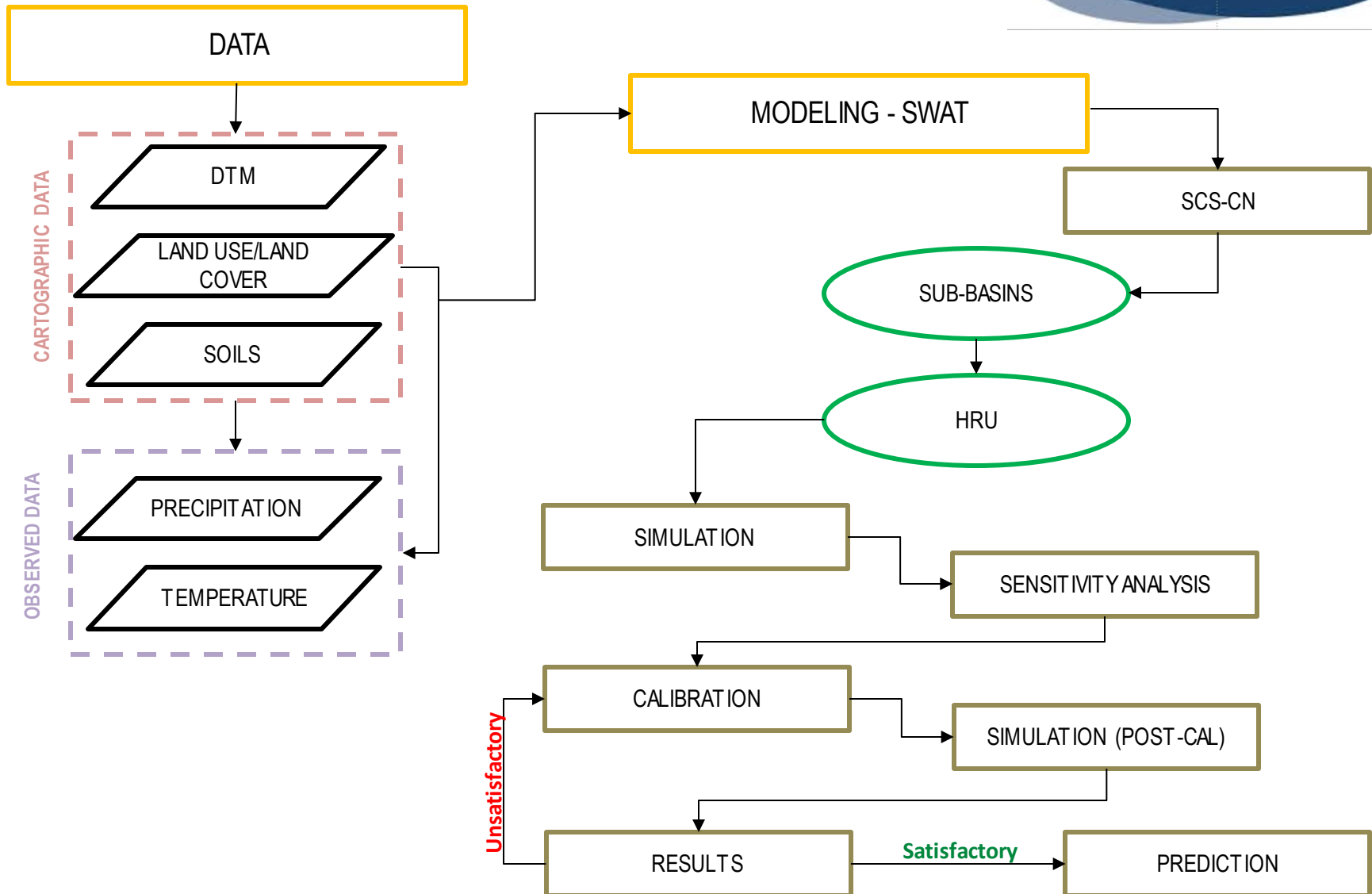
(modified from NEITSCH *et al*., 2009)

Implementation

- We are using hydrologic data from:
  - 2000-2004 for warming-up
  - 2005–2014 for calibration
  - 2015–2016 for validation

- Results: streamflow and soil erosion responses to projected past and future LULC scenarios

18 SUB-BASINS
(points for calibration and validation)
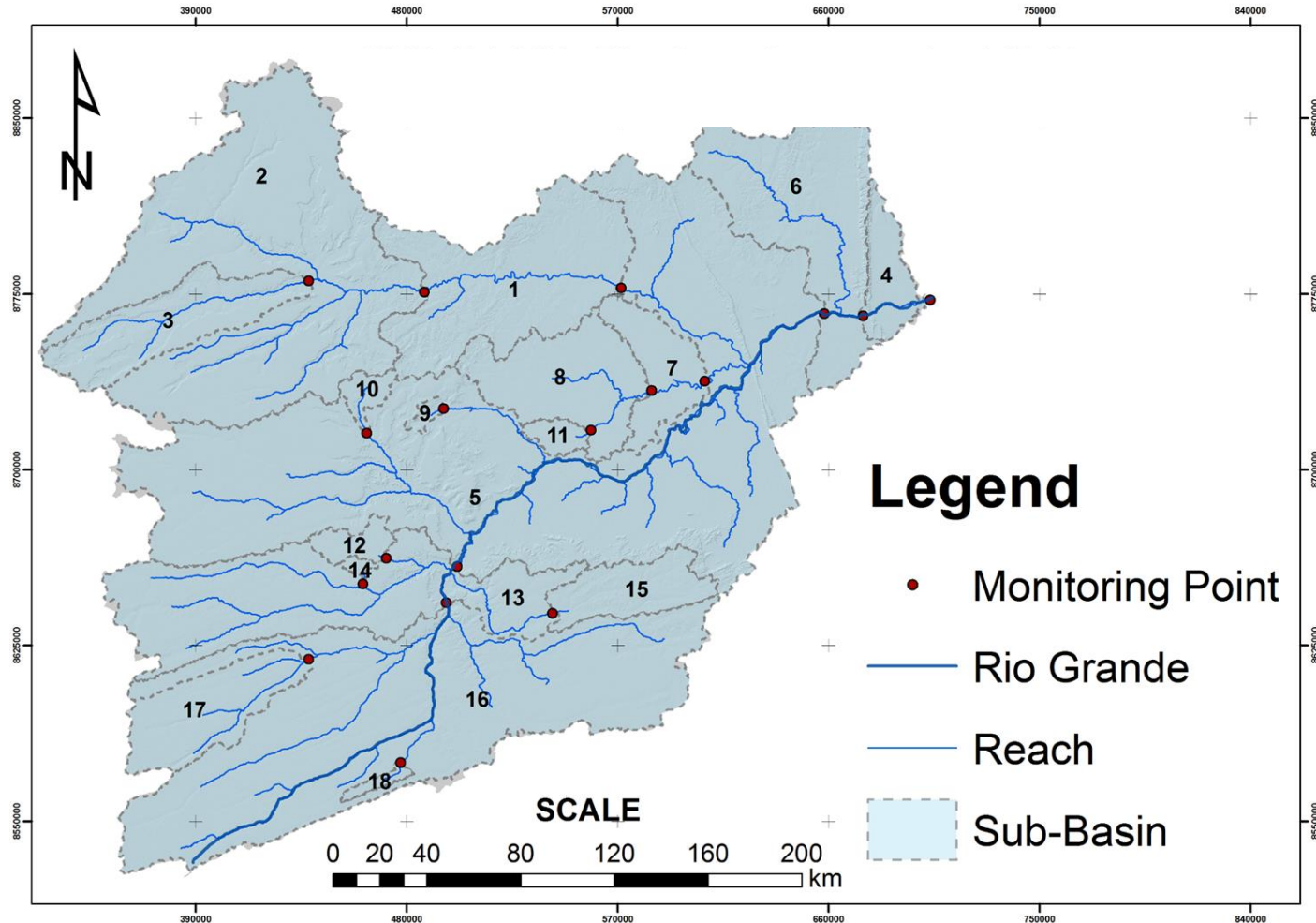
Multi-site calibration ensures that the model is capable of reproducing hydrological heterogeneity within the watershed

SWAT
Definition of the Hydrological Response Units (HRUs)
[combining topography, soils and LULC]

Soils

- CXa - Cambissolo (Inceptisol) Háplico Aluminico
- CXve - Cambissolo (Inceptisol) H áplico
- Continental Water
- FFc - Plintossolo (Alfisols Plintaqualfs) Pétrico Concreci
- GXbd - Gleissolo (Entisols Aquents) Háplico Tb Distrófic
- LAd - Latossolo (Oxisols) Amarelo Distrófico
- LVAd - Latossolo (Oxisols) Vermelho-Amarelo Distrófico
- LVe - Latossolo (Oxisols) Vermelho Eutrófico
- PVAd - Argissolo (Ultisols) Vermelho-Amarelo Distrófico
- PVAe - Argissolo (Ultisols) Vermelho-Amarelo Eutrófico
- PVe - Argissolo (Ultisols) Vermelho Eutrofico
- RLd - Neossolo Litólico (Entisols Lithic) Distrofico
- RLe - Neossolo Litólico (Entisols Lithic) Eutrófico
- RQo - Neossolo Quartzarênico (Entisols Quartzipsamme
- RYve - Neossolo Flúvico (Entisols Fluvents)Ta Eutrófico
- SXe - Planossolo (Ultisols) Háplico Eutrofico
- TCp - Luvissolo (Alfisols) Crômico

SRTM_30m

Value

High : 1034

Low : 381

LULC 2016
- Agriculture
- Artificial area
- Water
- Mosaic of herbaceous vegetation
- Mosaic of forests
- Pasture
- Silvicultura
- Herbaceous vegetation
- Forest

Grande river basin: examples of HRUs
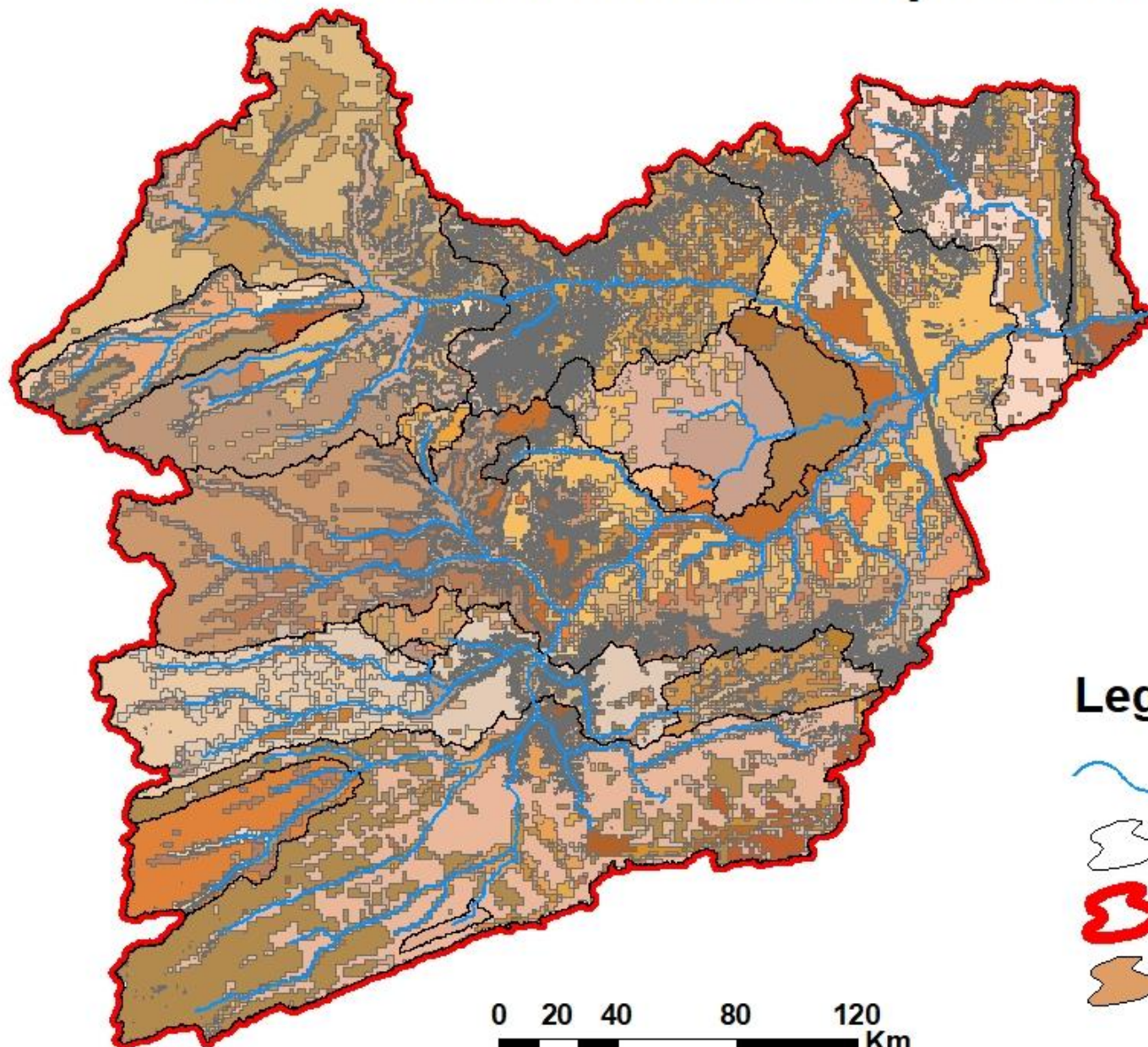
Legend:

〰️ River

Subbasins

Grande river basin

HRUs

0 20 40 80 120 Km

Defining Scenarios

MEETING LOCAL STAKEHOLDERS

FIELD MAPPING
(Geology, Topography, Soils, Land Use)

Scenarios for Hydrological Simulations
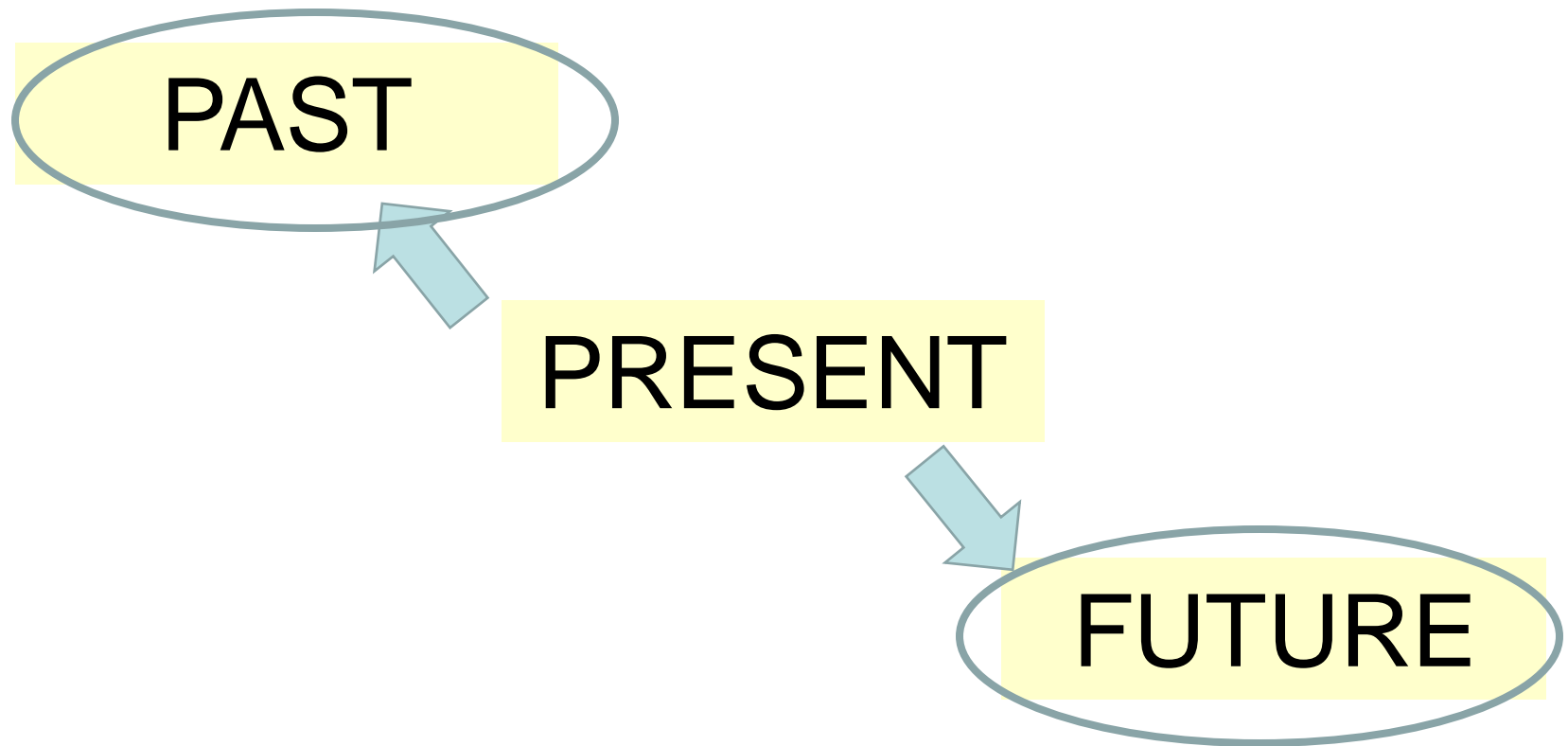
I. TODAY – present conditions

a) Condition in 2016

Rio Grande Basin
Land Cover and Land Use - 2016

Classes
- Artificial Surfaces
- Cropland
- Managed Pasture
- Mosaic of Occupations in Forest Area
- Silviculture
- Forest Tree Cover
- Wetland
- Savannah, Shrubland, Grassland
- Mosaic of Occupations in Savannah/Shrubland/Grassland Area
- Inland Water Bodies
- Coastal Water Bodies
- Barren Land
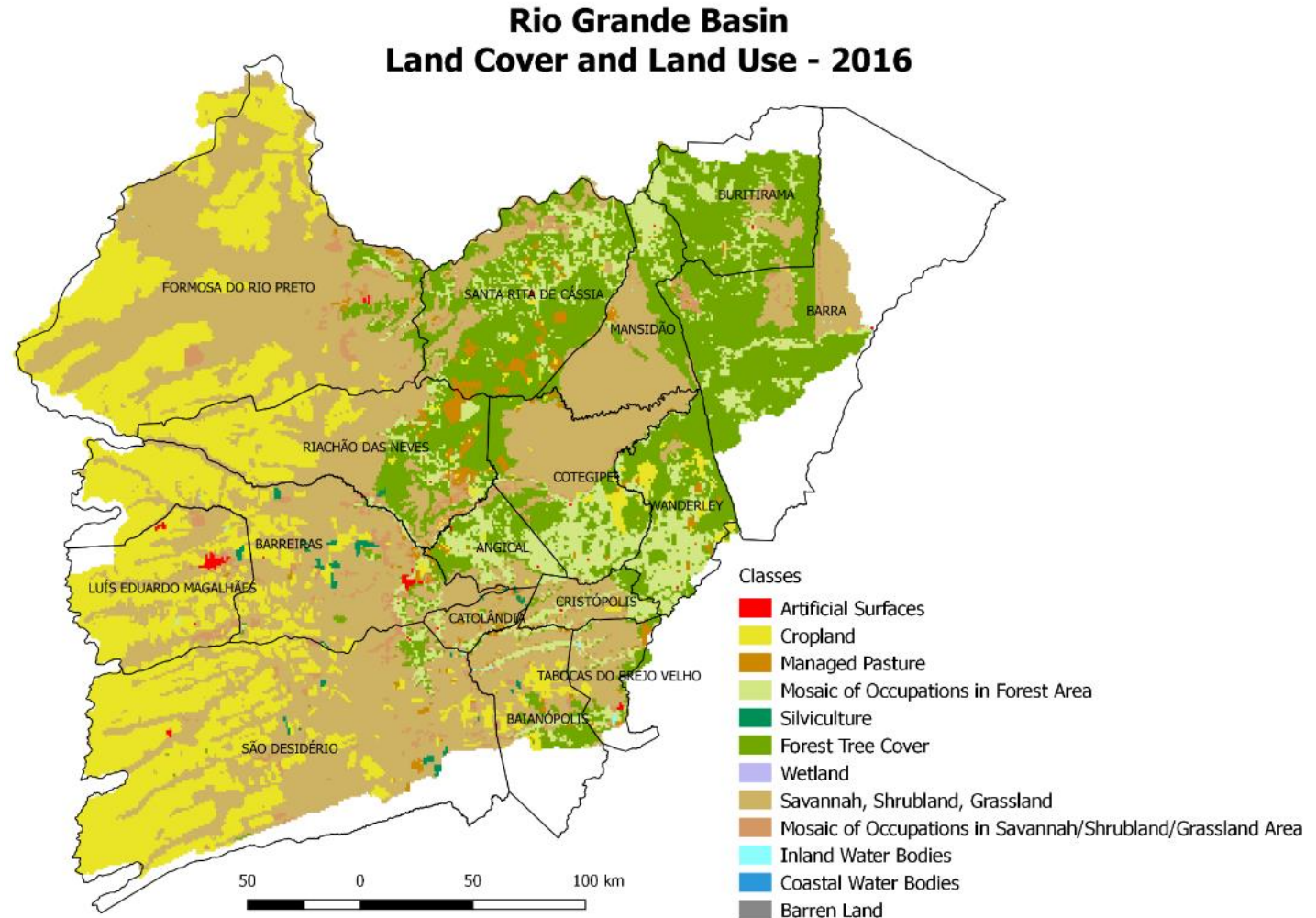
II. PAST SCENARIOS
– simulating 3 previous conditions

a) Natural (initial) condition

- 100% savanna everywhere in the basin

b) Condition in 1980

- Before main agriculture expansion

c) Condition in 2000

- IBGE began to monitore LULCC (main expansion)

III. FUTURE SCENARIOS

- expansion of agriculture & pasture
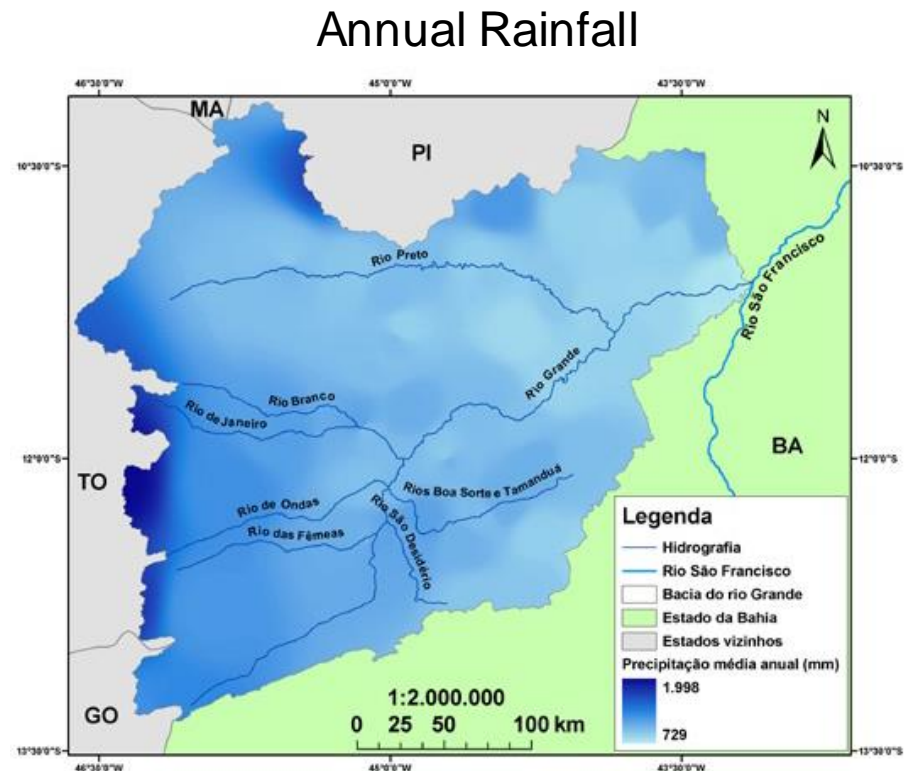- based on Topography, Rainfall and Soil Conditions (mechanization)

ELEVATION: Rio Grande watershed (BA)

Legend
- Rio Grande
- Drainage network
- Rio Grande Watershed

ELEVATION (m)
- 811 - 1.030
- 719 - 810
- 611 - 718
- 500 - 610
- 381 - 499

Annual Rainfall

Legenda
- Hidrografia
- Rio São Francisco
- Bacia do rio Grande
- Estado da Bahia
- Estados vizinhos

Precipitação média anual (mm)
- 1.998
- 729
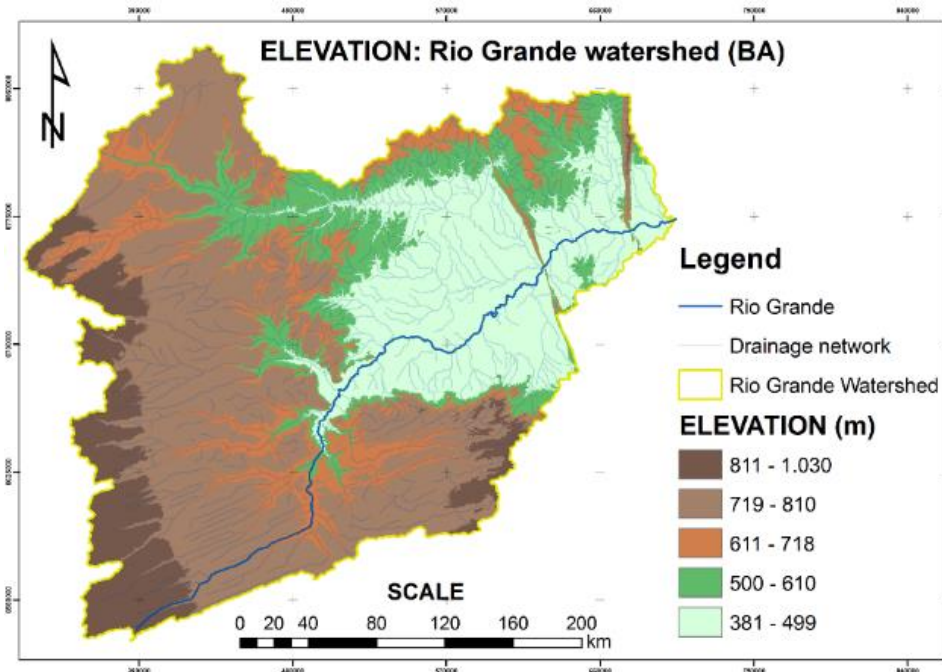
III. FUTURE SCENARIOS

- simulating 3 future conditions

a) 100% agriculture all over the plateau
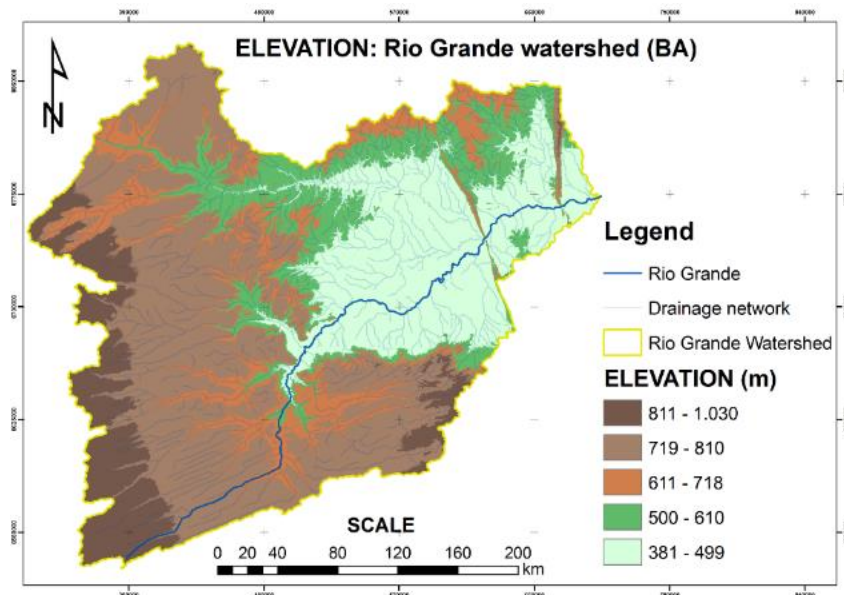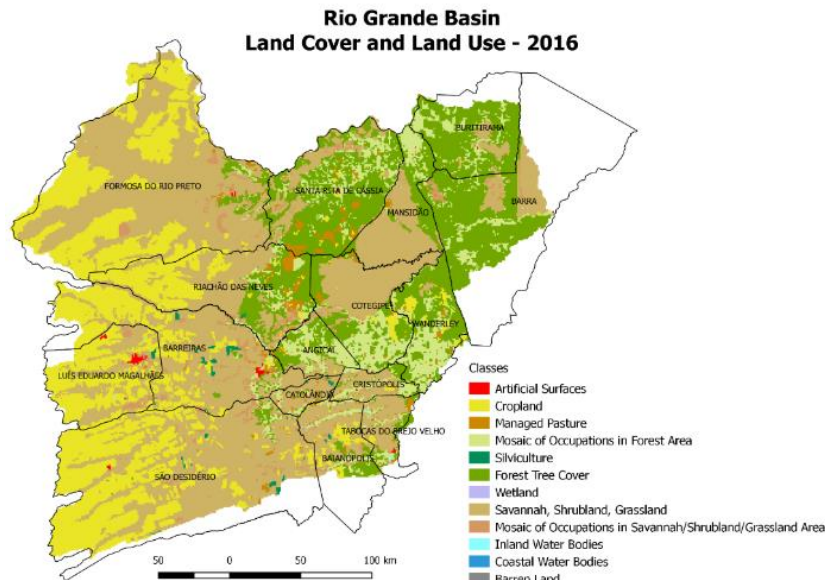   - flat topography + high & medium rainfall values

b) 100% agriculture on the plateau and on the flat areas of the lowlands (smooth topography + low rainfall values)

c) 100% agriculture on the plateau and 100% pasture on the flat areas of the lowlands

Rio Grande Basin Land Cover and Land Use - 2016

Classes
- Artificial Surfaces
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SCALE
0 20 40 80 120 160 200 km

Next Steps

- SWAT calibration and validation

- Simulation of the Different Scenarios

- Run SWAT with Global DATA

- Compare SWAT results with those obtained using:
  - InVEST
  - RUSLE + Global Data (Bethanna Jackson)

Research Team

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