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Comparative hydrology using the SWAT model in Pernambuco State watersheds, Northeast of Brazil for SUPer system development

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June/2017

Brazil

Federative Republic

8.5 million Km²

190 million inhabitants (year 2012)

26 States

01 Federal District

5,561 Municipalities

5 Geopolitical Regions

- North
- NE
- SE
- Midwest
- South



Brazil: Institutional Complexity

Federative Republic:



1 Federal Constitution
1 Federal Water Law

27 States

27 State Constitutions
27 State Water Laws

5.561 Municipalities

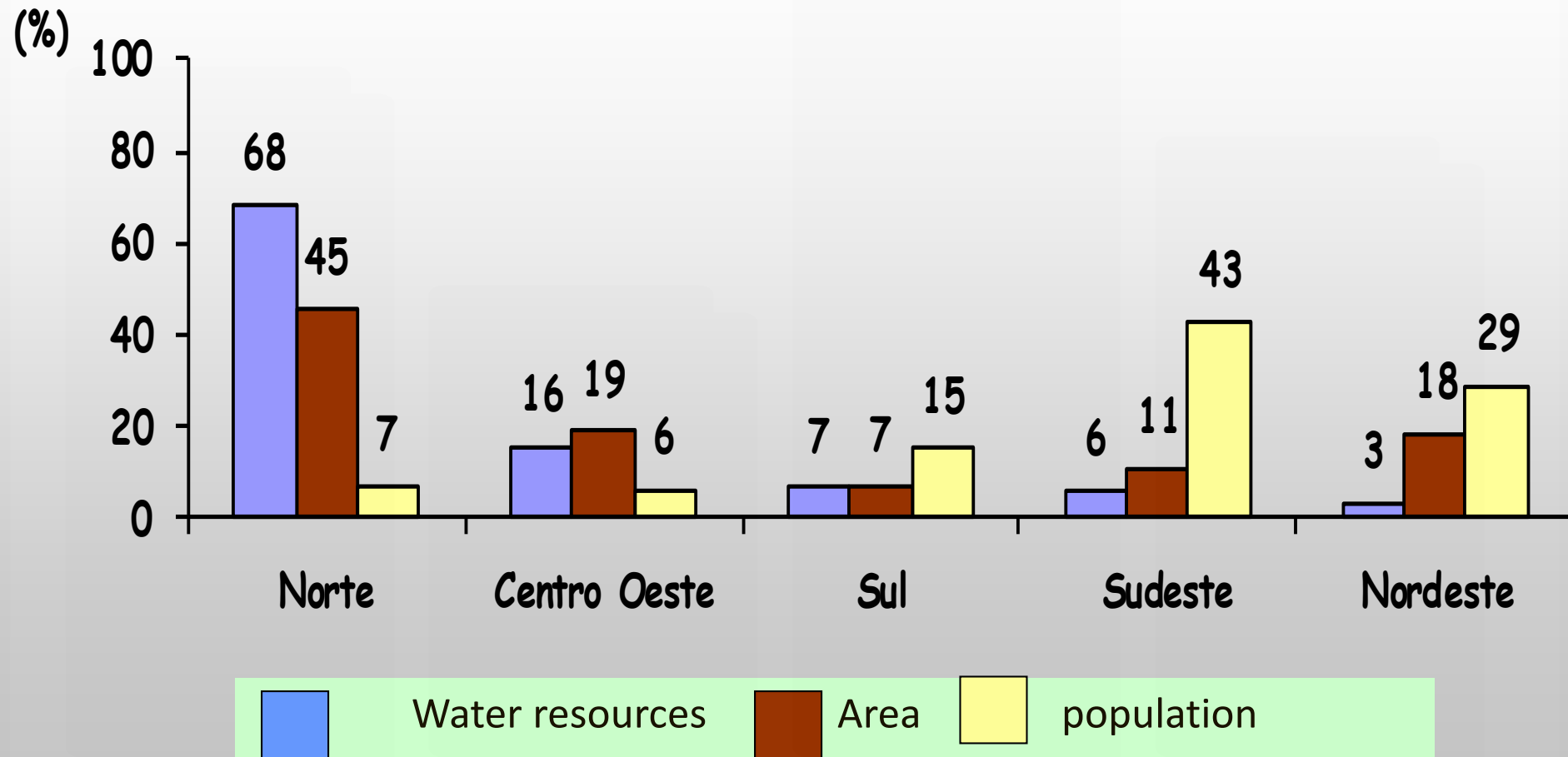


5.561 Land use Laws

Municipalities responsible for
concessions of water supply
and sanitation services



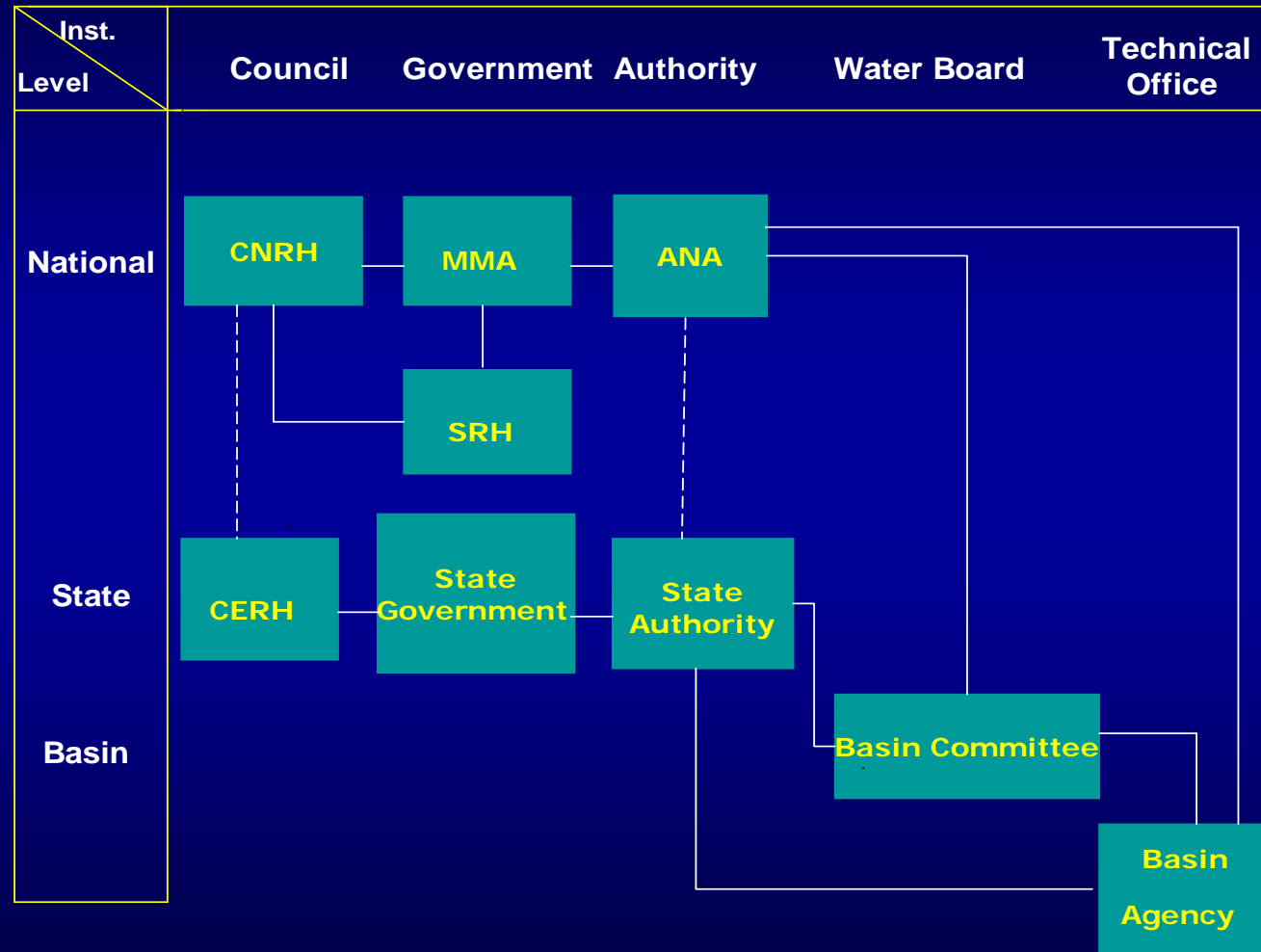
Distribuição dos recursos hídricos, superfície e população



EXTREME EVENTS

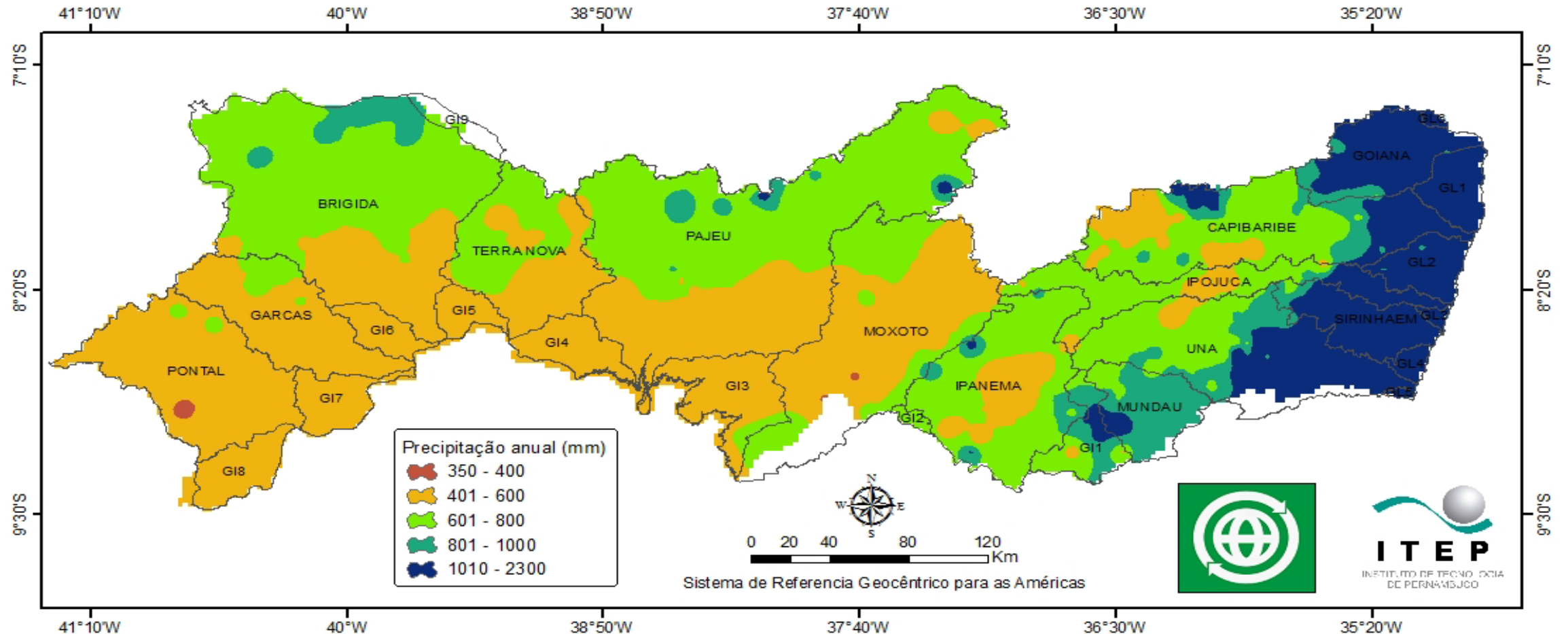


National Water Resources Management System - SINGRH



Pernambuco State (Northeast)

Annual Precipitation (historical series)

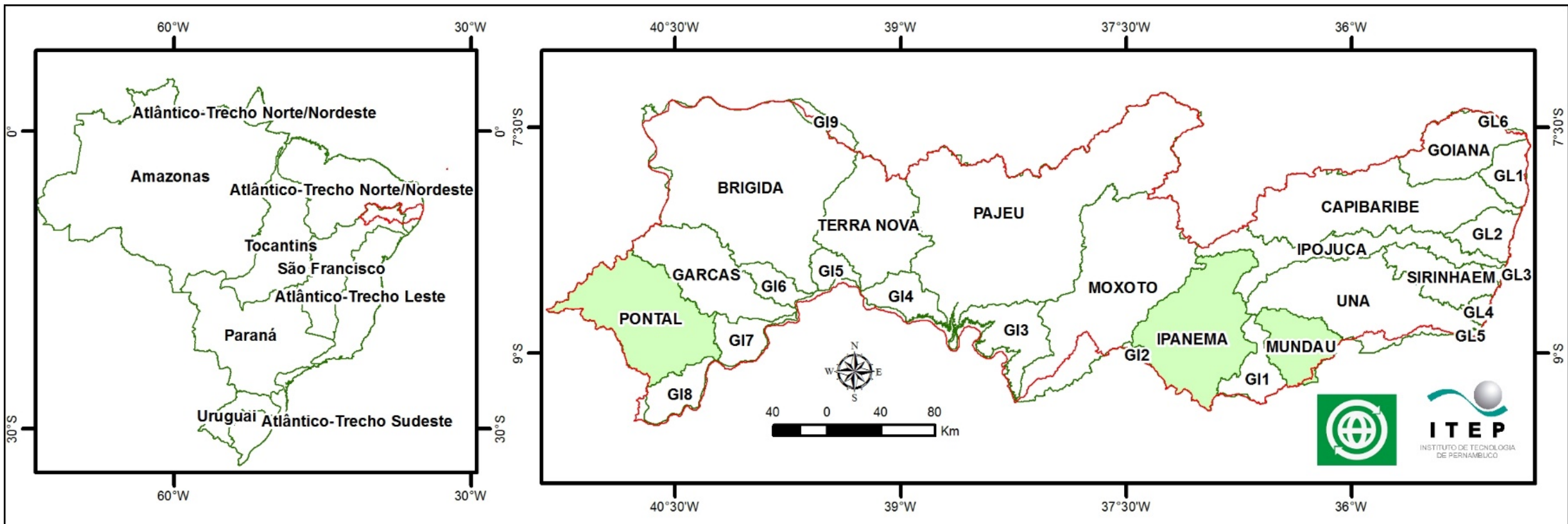


OBJECTIVE

The objective of this work is to perform a comparative analysis among hydrological features in experimental and representative basins of the semiarid region of Northeast Brazil, using the SWAT model, as a basis for developing the SUPer Sysyem.

MATERIAL AND METHODS

Study Areas



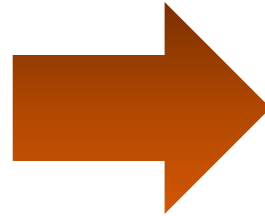
MATERIAL AND METHODS

Study Areas

Alto Mundaú River Watershed

Alto Ipanema River Watershed

Pontal River Watershed

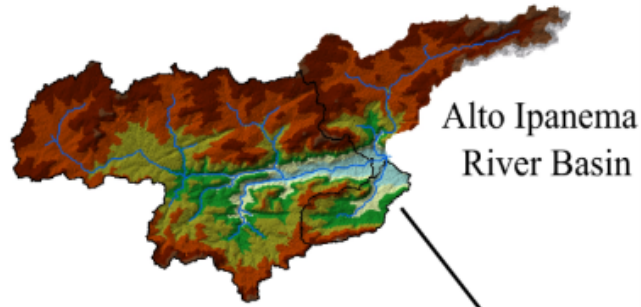


Base for developing a
“System of Hydrological
Response Units for the
State of Pernambuco” -
SUPer.



Study Areas

Alto Ipanema

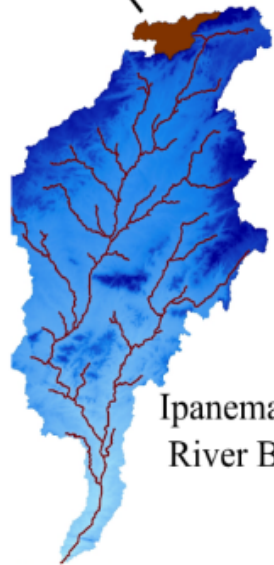


São Francisco River Basin

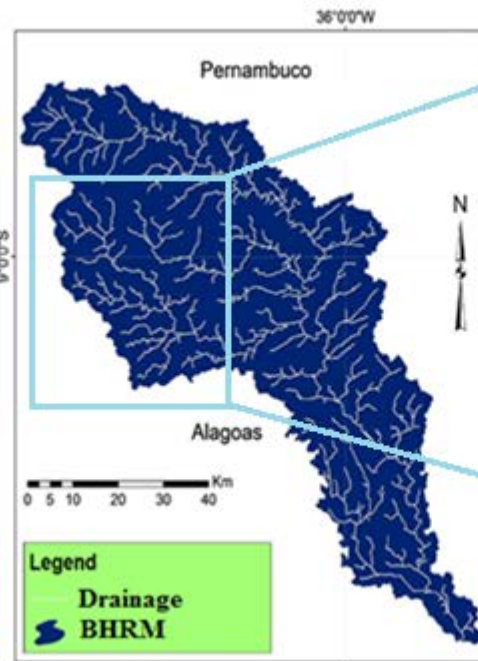


0 750 1500 3000 Kilometros

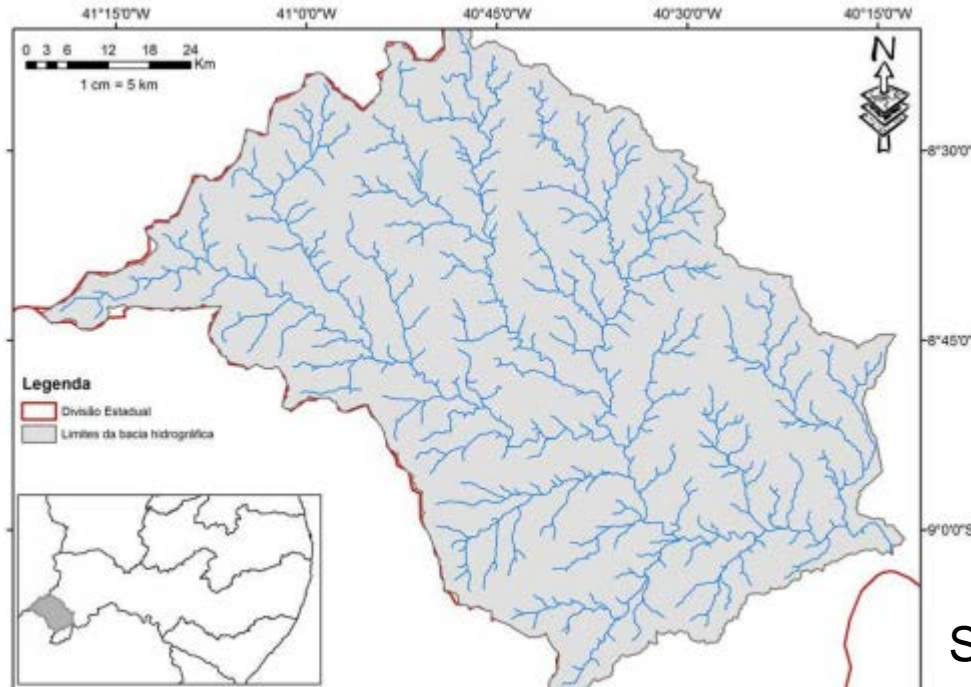
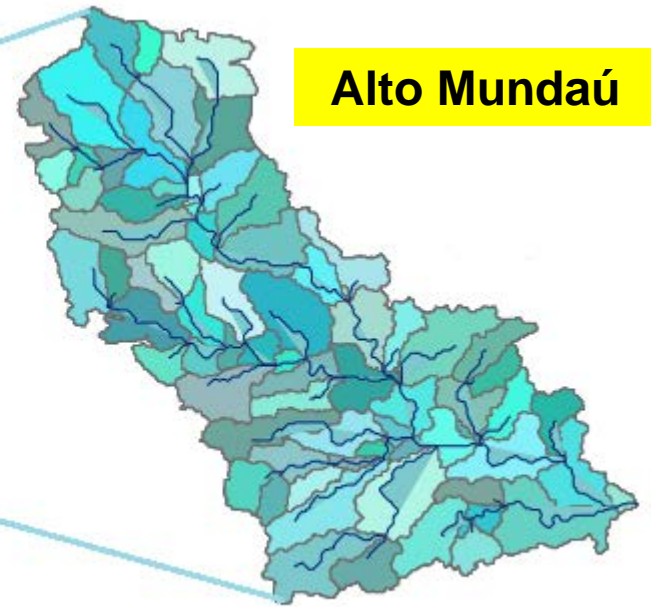
Ipanema River Basin



0 8 16 32 Kilometros



Alto Mundaú

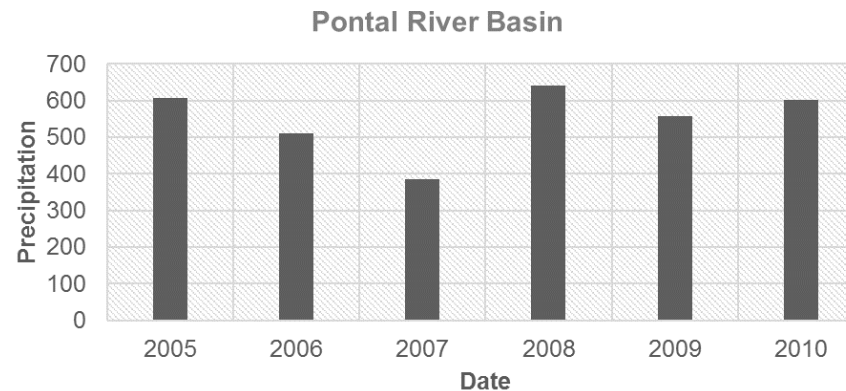
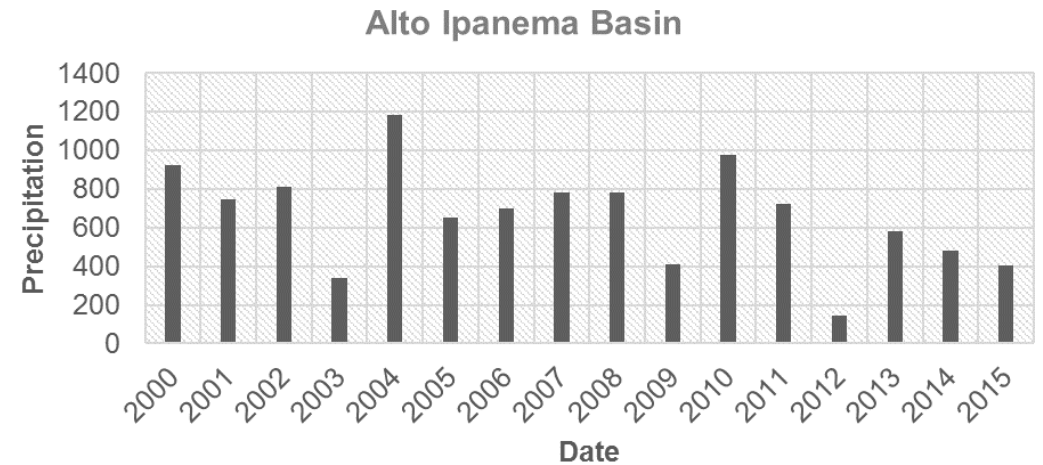
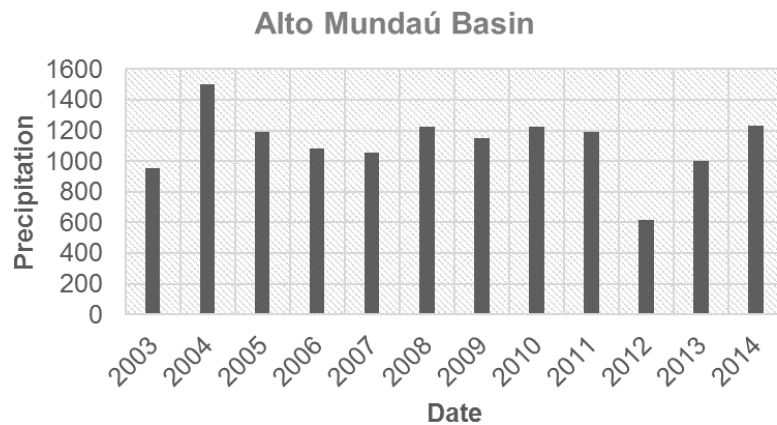


Pontal River

Source: Silva et al. (2012)

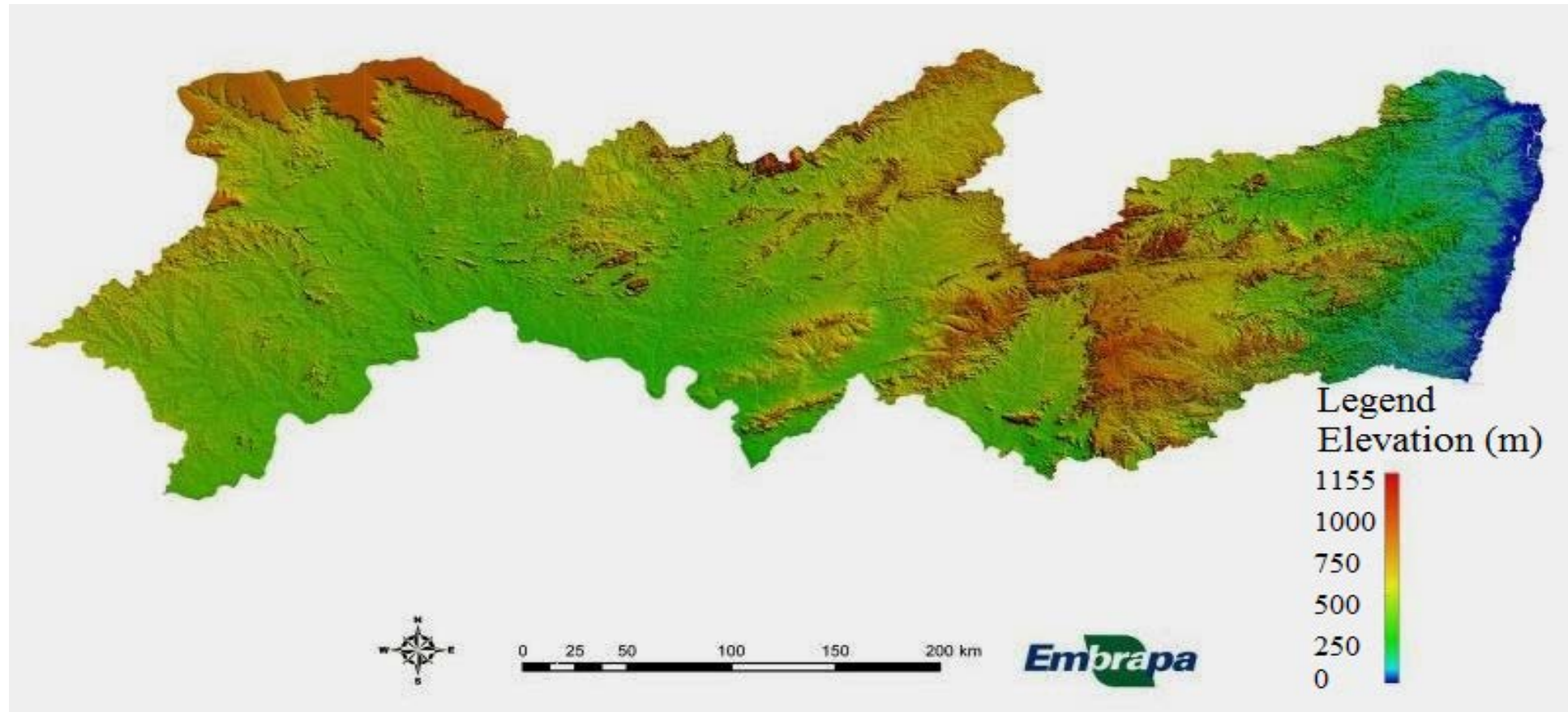
MATERIAL AND METHODS

Annual Precipitation (historical series)



MATERIAL AND METHODS

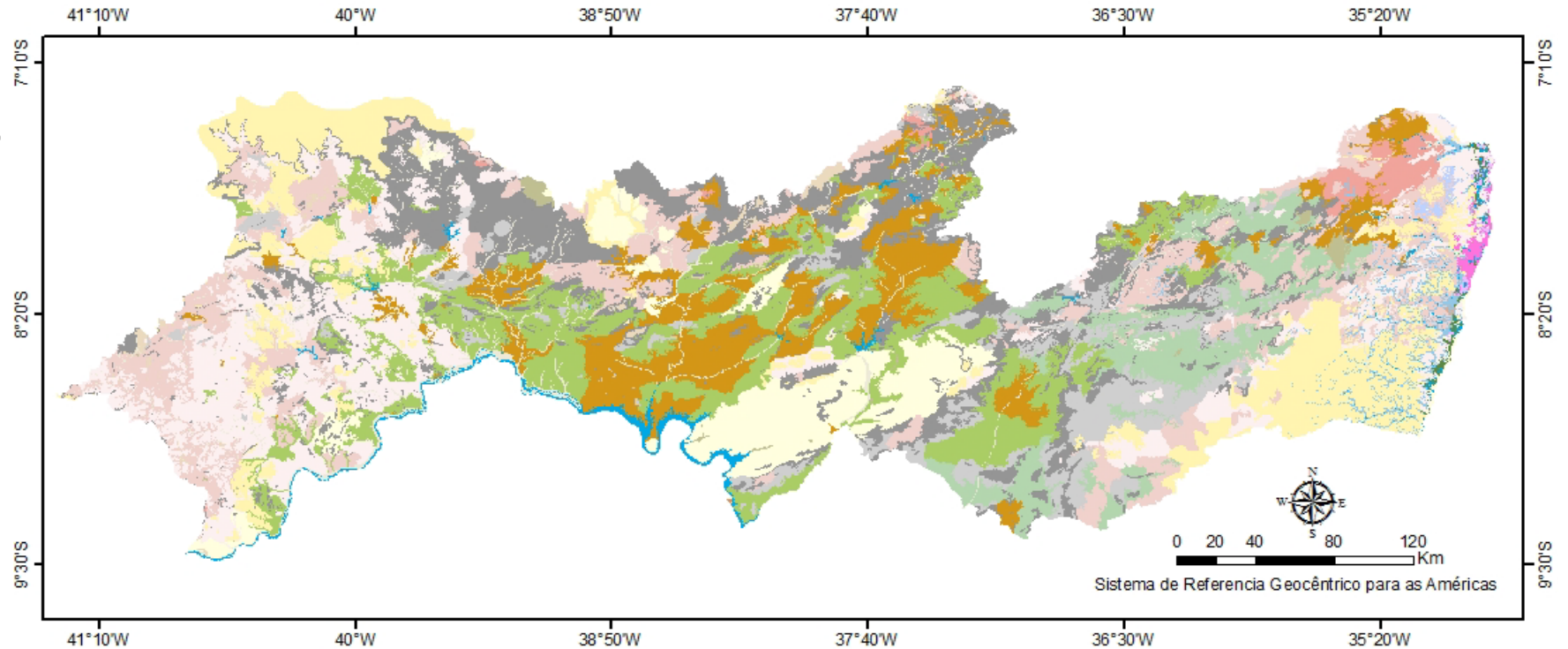
Elevation, Pernambuco State, Brazil



Source: EMBRAPA (2012)

MATERIAL AND METHODS

Soils, Pernambuco State, Brazil



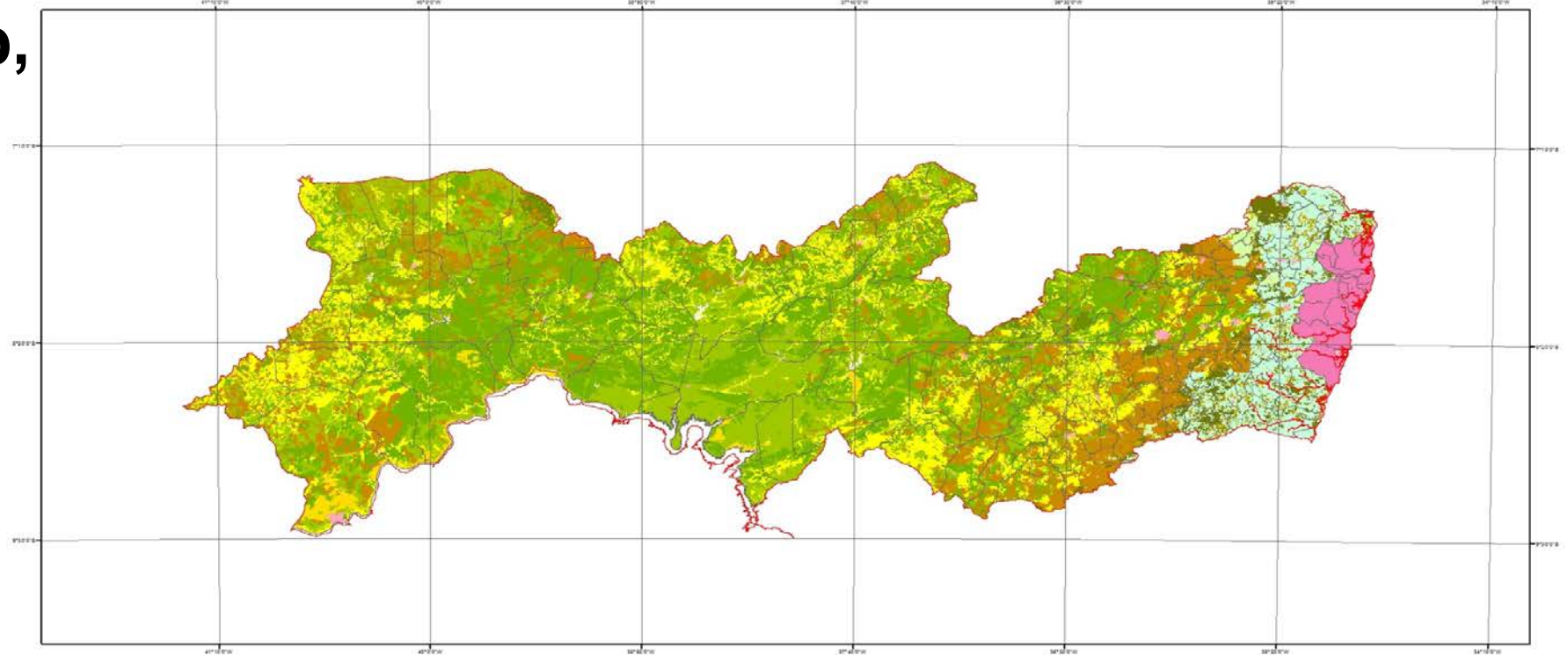
Tipo de Solo

Argissolo Amarelo	Ilha	Nitossolo
Argissolo Vermelho	Latossolo Amarelo	Planossolo Hápico
Argissolo Vermelho Amarelo	Luvisolo	Planossolo Hápico e Planossolo Nátrico
Cambissolo	Neossolo Flúvico	Solos Indiscriminados de Mangue
Espodossolo Cárbico	Neossolo Litólico	Vertissolo
Espodossolo Cárbico Hidromórfico	Neossolo Regolítico	Água
Gleissolo	Neossolos Quartzarêncios	Área Urbana



MATERIAL AND METHODS

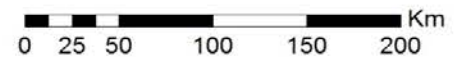
Land use map, Pernambuco State, Brazil



Classes de Uso e Cobertura



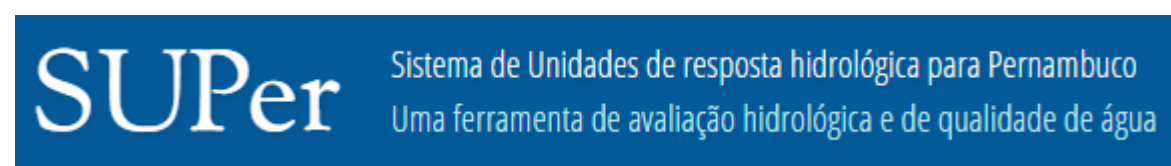
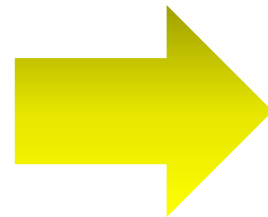
Escala 1:100.000



Projeção Geográfica: Albers Equal Area Conic
Sistema Geodésico de Referência: WGS 84
Fonte da Imagem: Landsat 8 OLI
Interpretação visual da Imagem Landsat 8 OLI

MATERIAL AND METHODS

- **Data Base → developing a “System of Hydrological Response Units for the State of Pernambuco” - SUPer.**



EUA Data base

Command structure to propagate the sediment and agrochemicals through the basin. Include hydrology, sediments, nutrients, temperature, soil, climate, plant growth, pesticides and agricultural management (Arnold et al., 1998).

Pernambuco State (Brazil) Data base

Adapted version to the state of Pernambuco. Free, easy access and friendly interface.

MATERIAL AND METHODS

SUPer

Sistema de Unidades de resposta hidrológica para Pernambuco
Uma ferramenta de avaliação hidrológica e de qualidade de água

➔ Conecte-se

O que é o SUPer?

O Sistema de Unidades de resposta hidrológica para Pernambuco (SUPer) é um sistema interativo de modelagem hidrológica e de qualidade de água que utiliza como mecanismo de modelagem a Ferramenta de Avaliação do solo e da Água - Soil and Water Assessment Tool (SWAT). O SUPer fornece uma interface interativa da web e mapas; dados de entrada pre-carregados; resultados que incluem tabelas, gráficos e dados de saída; um guia do usuário, e projetos de modelagem com desenvolvimento, execução e armazenamento online para os usuários.

O SUPer aumenta substancialmente a usabilidade do SWAT para simular os efeitos das práticas de gestão baseadas em uma ampla variedade de culturas, solos, tipos de vegetação natural, usos da terra e cenários de mudanças climáticas para hidrologia e parâmetros de qualidade de água, como:

- Sedimento
- Patógenos
- Nutrientes
- Demanda biológica de oxigênio
- Oxigênio Dissolvido
- Pesticidas

Como o SUPer funciona?

- 1 [Conecte-se](#) ou [registre-se](#) em uma nova conta para começar
 - Leia o nosso [guia do usuário](#) 📖 obter ajuda adicional.
- 2 Crie um projeto
 - Selecione sua bacia hidrográfica a partir de um mapa
- 3 Crie um cenário
 - Especifique a frequência e duração de execução do modelo
- 4 Faça outras personalizações para o seu modelo
 - Defina HRUs para eliminar pequenos usos da terra, solos e declividades
 - Edite dados gerais de entrada da bacia e banco de dados (bacia, fertilizantes, urbanização, eficiência de nutrientes, atualização de uso da terra)
 - Edite entradas das sub-bacias (curva número, marmitta, roteamento de sedimentos, alterações climáticas/ sensibilidade, fontes de poluição)
 - Modifique as saídas do SWAT selecionando o alcance, sub-bacia e parâmetros de HRU

MATERIAL AND METHODS

Parameters analyzed and compared

Climate, soil, slope, morphometric parameters (circularity ratio, hypsometric curve and mean stream length) and land use characteristics from all the basins.

Swat Model Parameters

Sensitivity Analysis (SWAT-CUP)

Calibration Statistics (NSE, PBIAS, R^2)

Calibration period:

BHAI → 2002-2004

BHAM → 2003-2009

BHRP → 2005-2010



SWAT Soil & Water
Assessment Tool

RESULTS AND DISCUSSION

Table 1. Comparison of some physical and morphometric characteristics of the studied basins

Characteristics	Alto Ipanema	Alto Mundaú	Pontal
Area (km ²)	195	756	6,032
Biome	Caatinga	Caatinga	Caatinga
Climate	Semiarid	Semiarid/ Semi-humid	Semiarid
T _m (°C)	23	24	27
RH _m (%)	70	73.2	56.5
Elevation (m)	600-1000	13 – 63	316-730
Agricultural area (%)	26.4	6.35	25.25
Circularity ratio	0.20	0.18	0.12
Hypsometric curve (m)	836.88	38.28	462.54
Main stream length (km)	28.04	63.43	165.68

RESULTS AND DISCUSSION

Table 2. Representation of the water balance in the studied basins

Hydrological process	Alto Ipanema	Alto Mundaú	Pontal
Biome	Caatinga	Caatinga	Caatinga
Area (km ²)	195	756	6,032
Precipitation (mm/ year)	738	1,118	532.4
Surface Runoff (mm/ year)	103	171.29	63.89
Lateral flow (mm/ year)	88.56	1.23	60.53
Percolation to shallow aquifer (mm/ year)	76.04	357.94	44.12
Revap from shallow aquifer (mm/ year)	72.44	26.14	27.55
Recharge to deep aquifer (mm/ year)	4	17.9	2.32
Average Curve Number	81.89	76.66	59.54
Evaporation and Transpiration (mm/ year)	546.12	593.6	351.8
Potential Evaporation and Transpiration (mm/ year)	1,591	1,309.6	1,377.6

RESULTS AND DISCUSSION

Table 3. Parameters identified as the most important for the flow simulation using the SWAT model in the four basins studied

Sensitivity Ranking	Alto Ipanema	Alto Mundaú	Pontal
1	ALPHA_BF.gw	GWQMN.gw	SOL_AWC.sol
2	CN2.mgt	ESCO.hru	FRGRW2{..}.plant.dat
3	SURLAG.bsn	SOL_AWC.sol	DLAI{..}.plant.dat
4	GWQMN.gw	CN2.mgt	ESCO.hru
5	SHALLST.gw	RCHRG_DP.gw	CN2.mgt

RESULTS AND DISCUSSION

Table 4. Statistical indexes used to evaluate the performance of the SWAT model in the four basins studied

Statistical indexes	Alto Ipanema	Alto Mundaú	Pontal
NSE	0.79	0.68	0.72
PBIAS (%)	26.4	0.2	0.79
R ²	0.92	0.73	0.73

CONCLUSION

The data obtained in this study will serve as a basis for the initiation of the System of Units of Hydrological Responses for the State of Pernambuco - SUPer, promoting in this way, integrated hydrological modeling, with easy data access, in different scales, and for different hydrographic basins of all Pernambuco State.

ACKNOWLEDGMENTS



ITEP
INSTITUTO DE TECNOLOGIA
DE PERNAMBUCO

