2014 International SWAT Conference
Porto de Galinhas, Brazil

Hydrologic assessment in a Brazilian forest watershed using SWAT model

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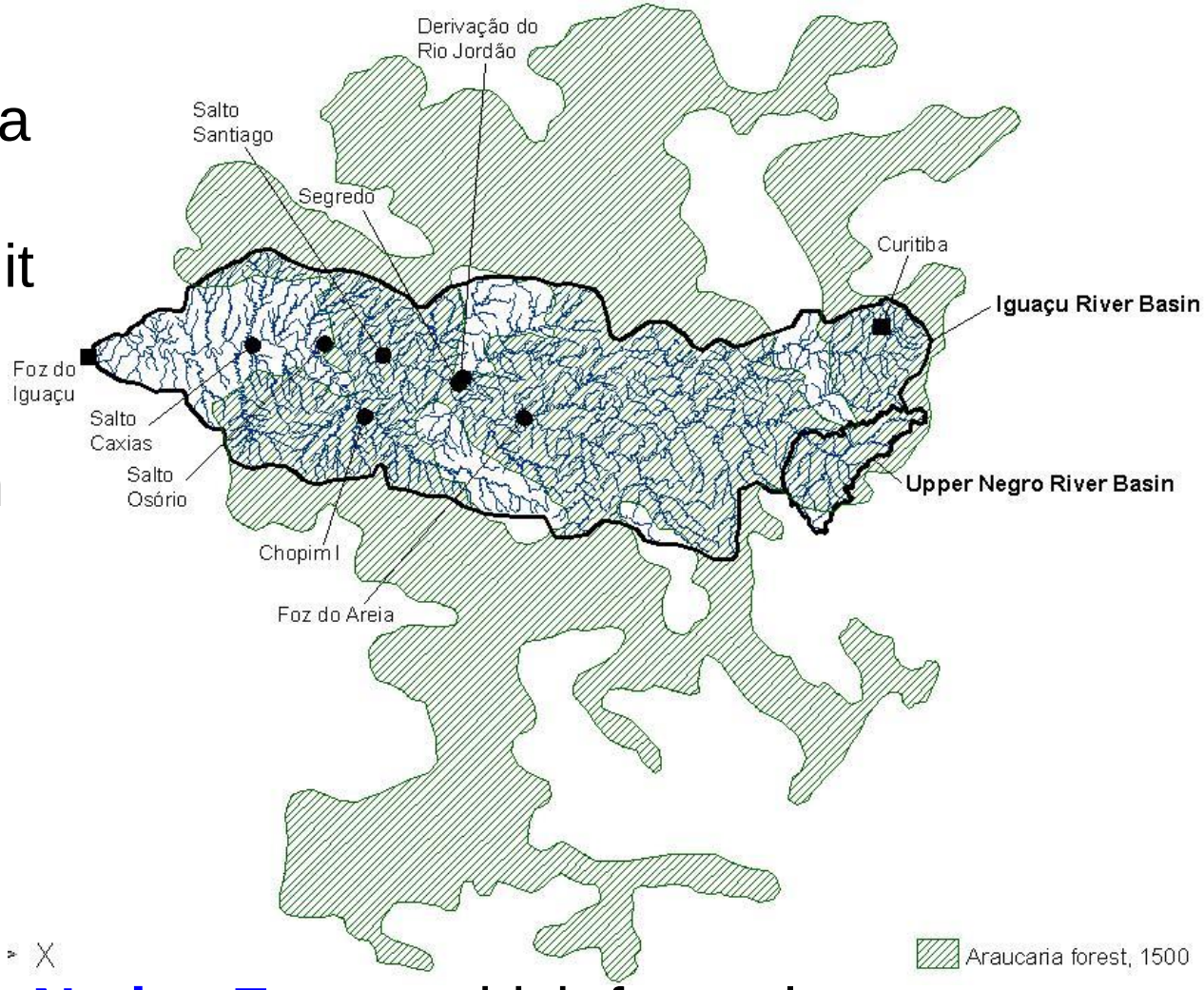
MOTIVATION

The Iguaçu River basin (68,410 km²) is a important basin of Southern Brazil since it has the largest hydroelectric power generation capacity in Brazil.



The remainders of the **Native Forest** which formerly covered the plateau region of the Southern Brazil are now **only 2%** of its original area.

MOTIVATION

The original Araucaria (Subtropical Ombrophilous Forest) has been replaced by reforestation, agricultural activities and reservoir constructions in Santa Catarina State, Southern Brazil.

MOTIVATION

How the changes in **land use** (native forest, pine, agriculture and reservoirs operation) affect the **hydrological processes** in this region?

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OBJECTIVES

The aim of the study was to estimate the **hydrological process** with the SWAT model for the **Rio Preto watershed**, located in the Northern Plateau of **Santa Catarina State**:

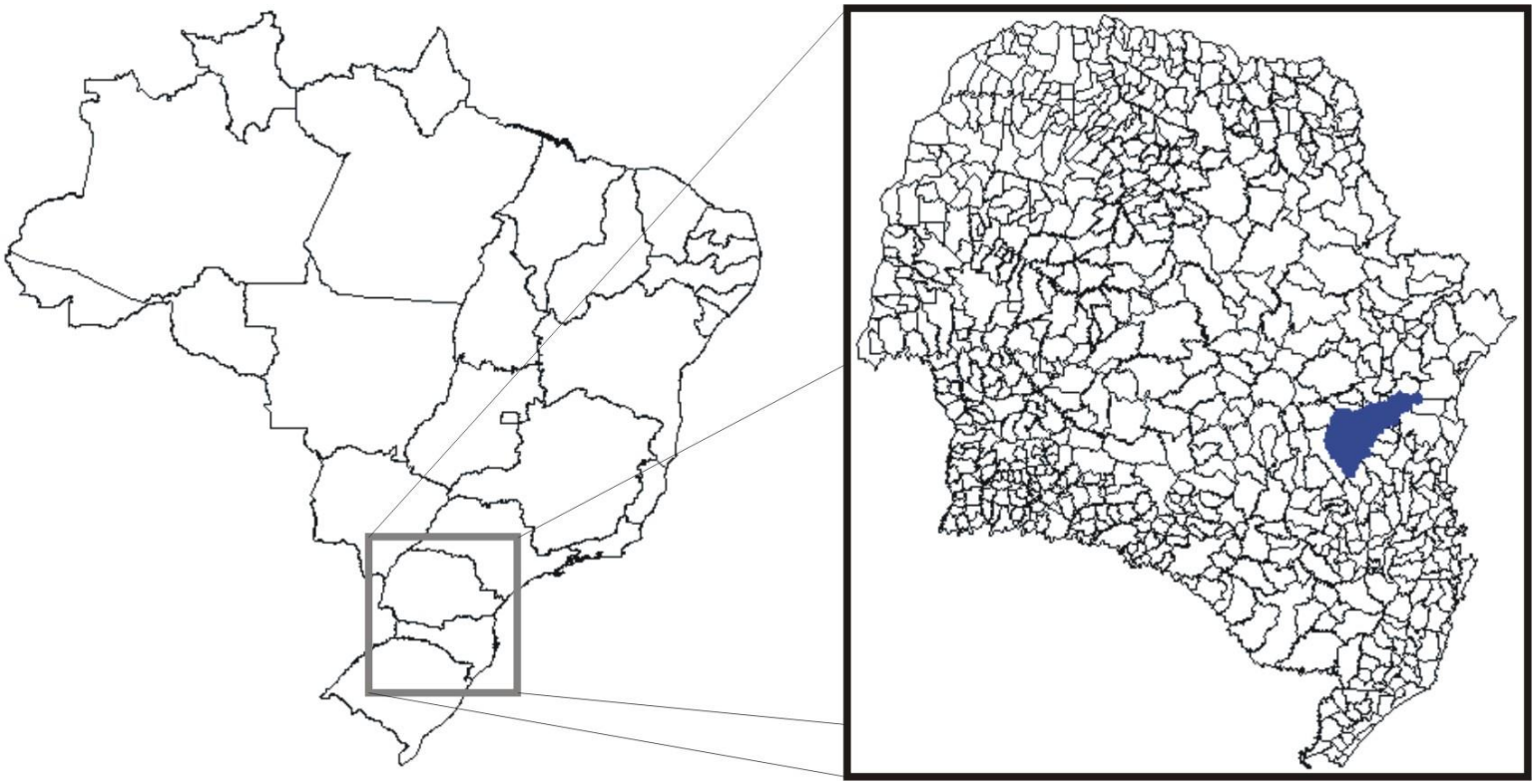
i. To assess the **water balance** simulated with SWAT model;

ii. Compare **measured** and **simulated streamflow**.

iii. To conduct model sensitivity analysis to selected parameters.

STUDY AREA

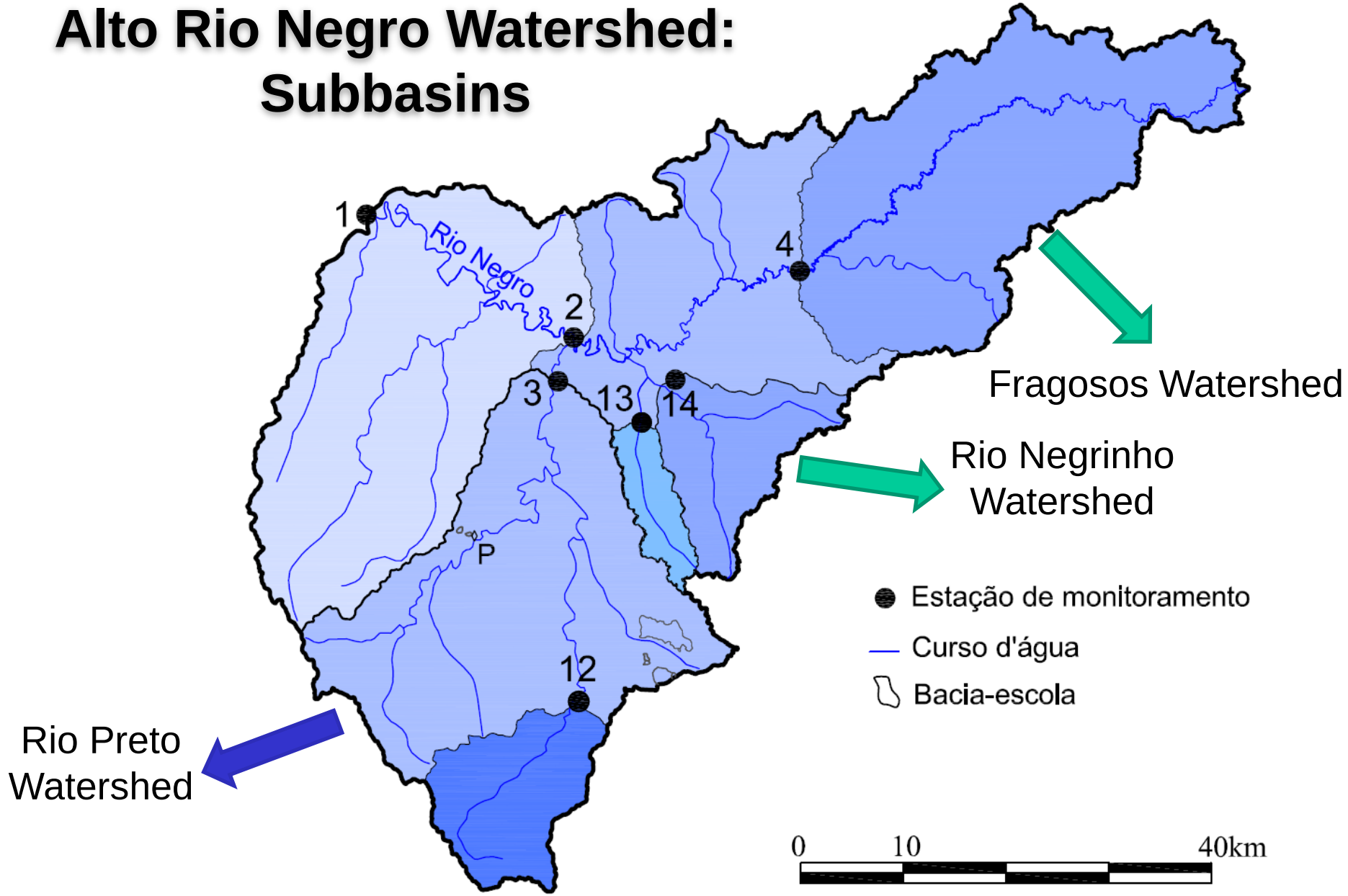
Alto Rio Negro (Upper Negro River) Watershed



- Santa Catarina and Parana States;
- Area: 3454 km^2;
- Topography: hilly (Average altitude - 910 m) ;
- Annual rainfall: 1700 mm

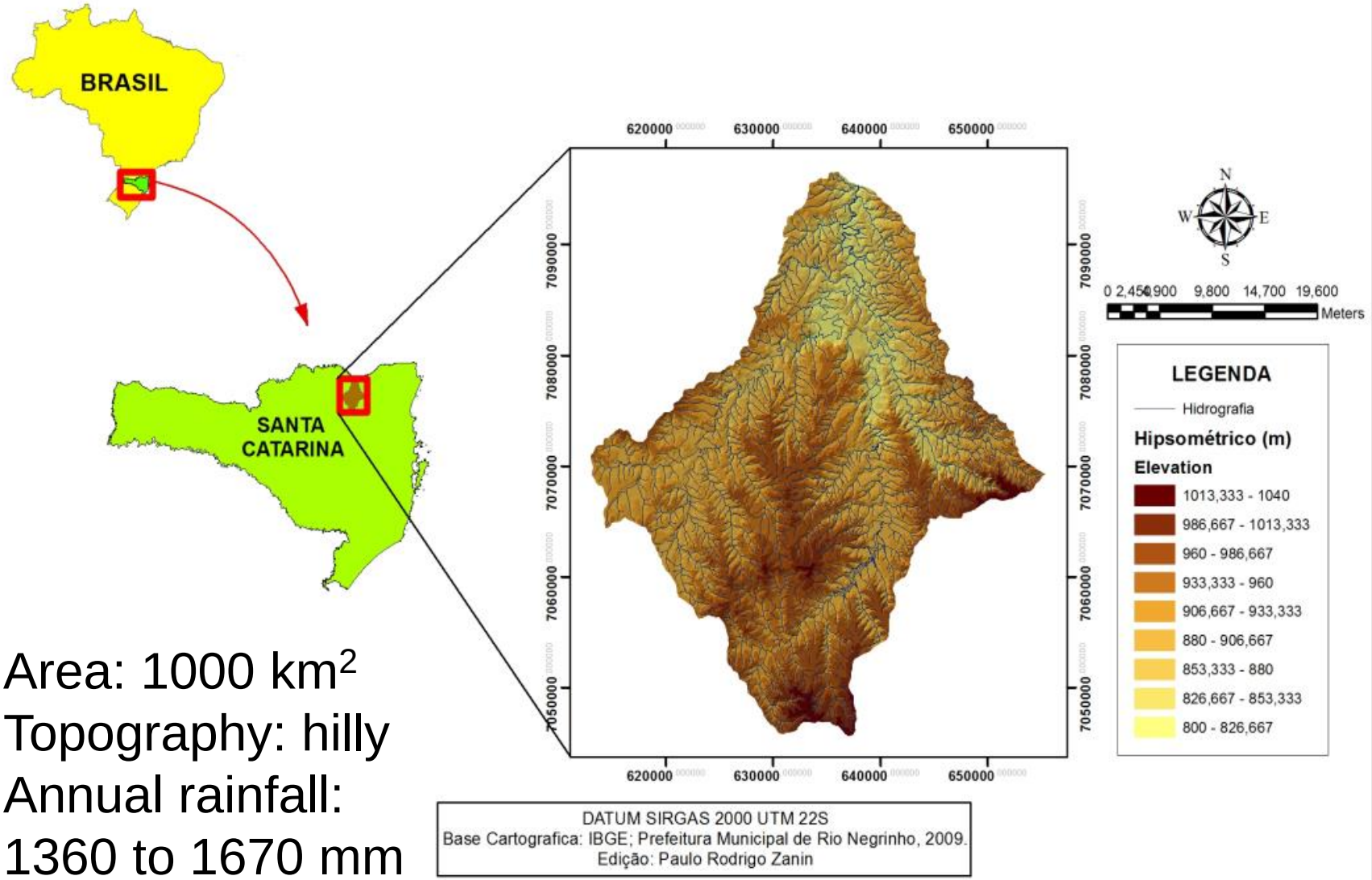
STUDY AREA

Alto Rio Negro Watershed: Subbasins



STUDY AREA

Rio Preto Watershed:

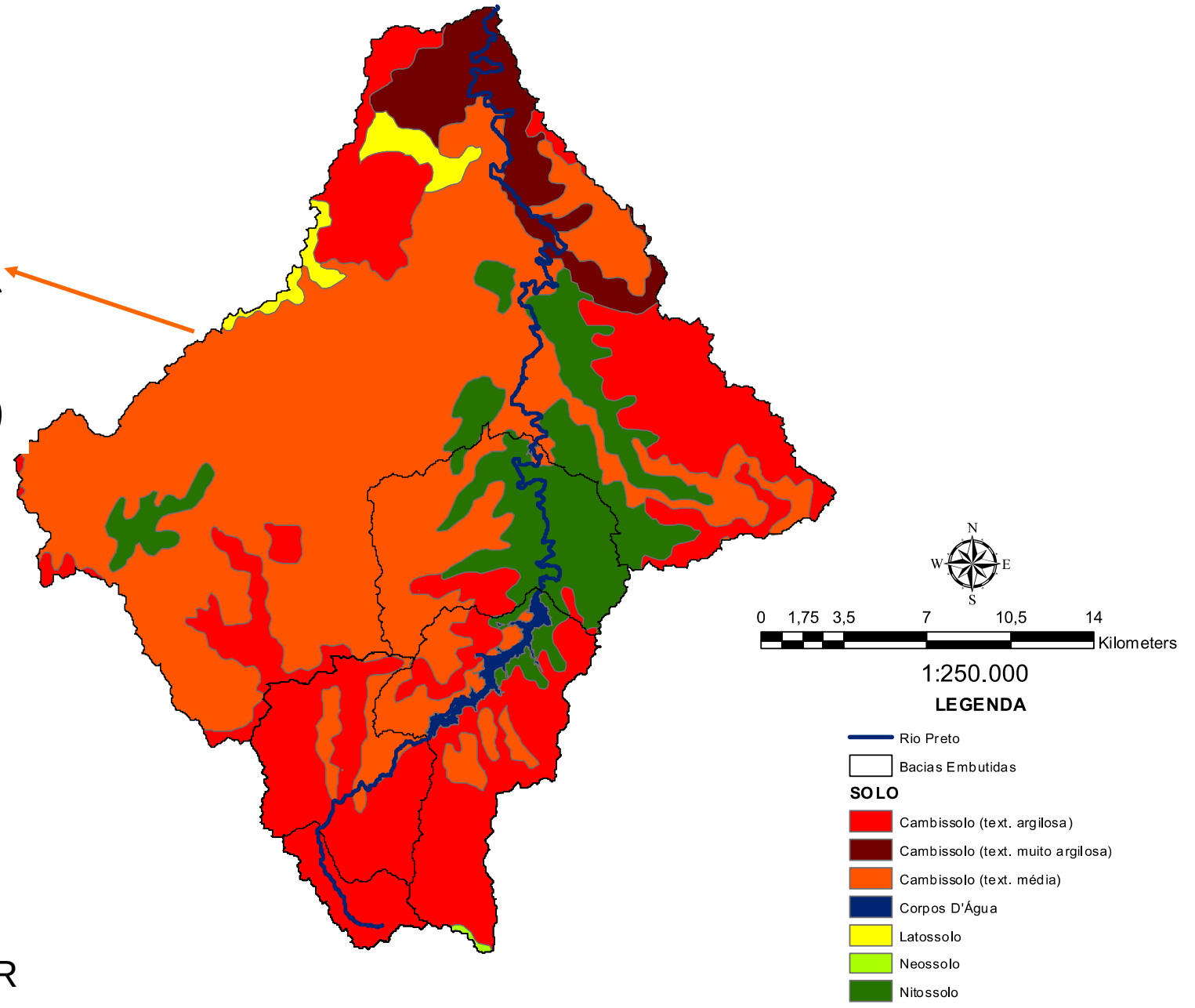


Area: 1000 km^2
Topography: hilly
Annual rainfall:
1360 to 1670 mm

INPUT DATA

SOILS:

The main soils are Cambissolos ~ Inceptisols *(clay texture)*

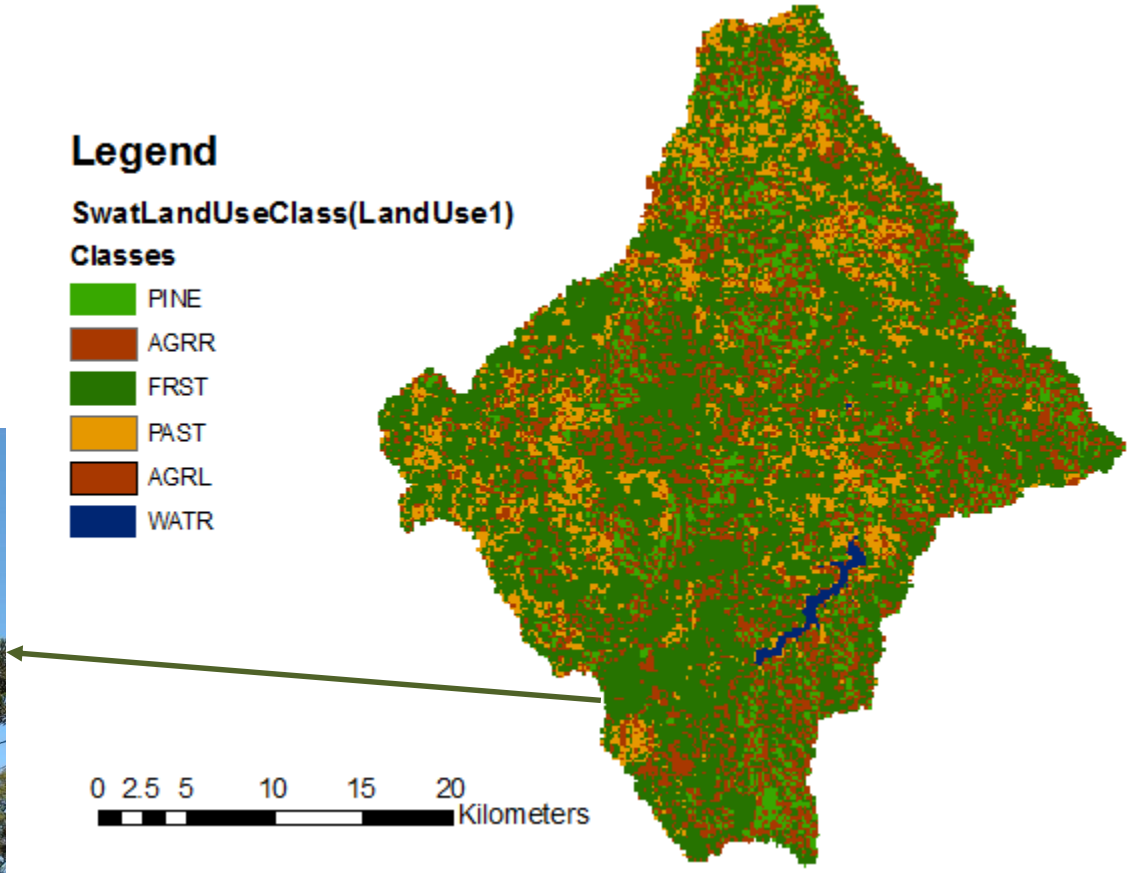


Source: Zanin, P.R

INPUT DATA

LAND USE:

Native Forest
(~38%)



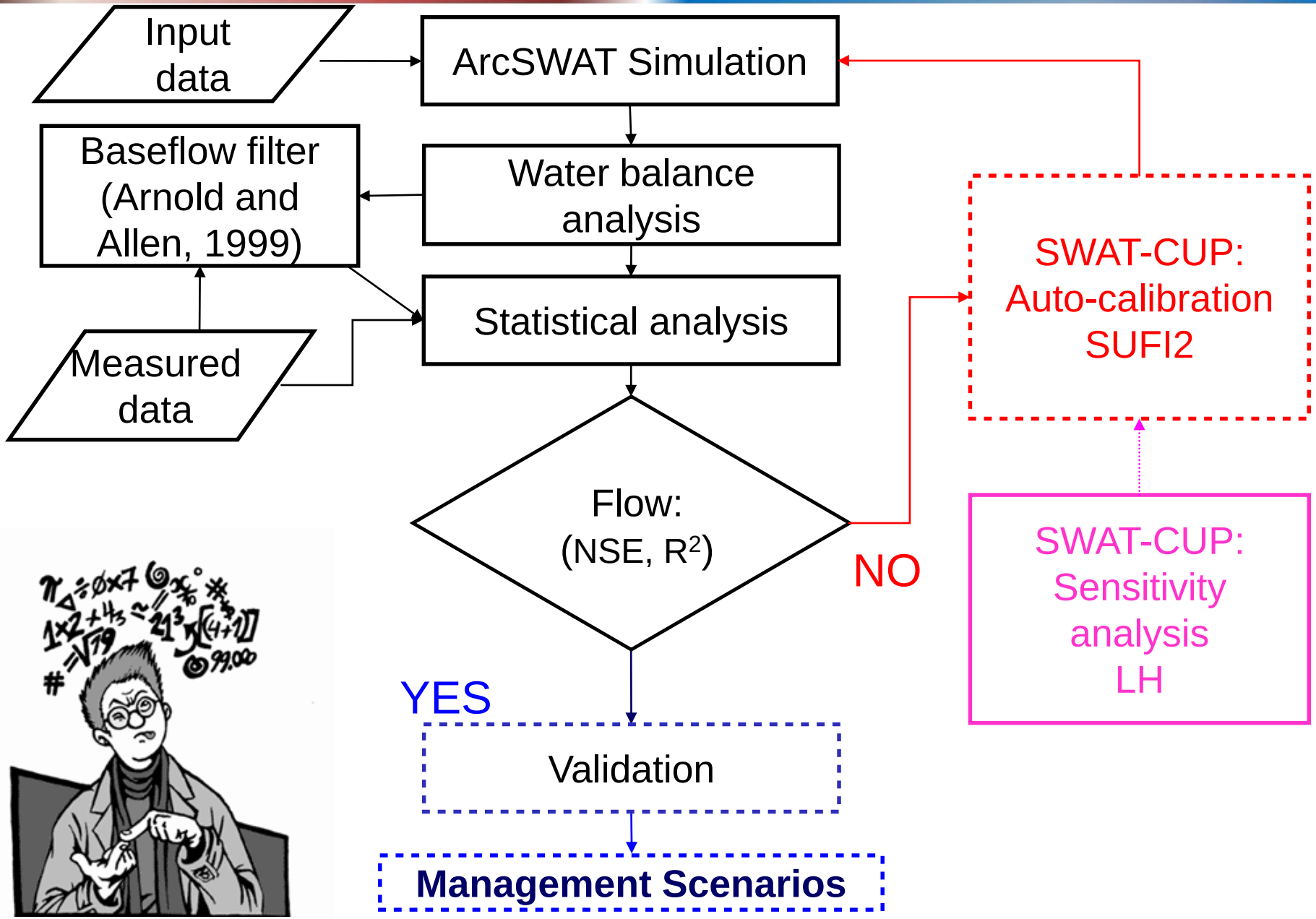
Source: Zanin, P.R

Climate data:

Station	Code	Name	Time period	Source
Flow gage	65094500	Rio Preto	1976 - 2014	ANA
Flow gage	65094500	Rio Preto	1976 - 2014	ANA
Rain gage	2649055	Corredeira	1976 - 2014	ANA
Weather	84	Rio Negrinho	1990 - 2008	EPAGRI/CIRAM-INMET
Weather	1511	Rio Negrinho	2008 - 2013	EPAGRI/CIRAM-INMET
Rain Gage		CVG	2008 - 2014	CVG
Rain Gage		Caunal	2003 - 2014	CVG
Reservoir - Water level		Caunal	2003 - 2014	CVG
Reservoir - Gate Operation		Caunal	2003 - 2014	CVG

Source: Zanin, P.R

METHODS


Input data
ArcSWAT Simulation
Baseflow filter (Arnold and Allen, 1999)
Water balance analysis
Statistical analysis
Measured data
Flow: (NSE, R^2)
NO
SWAT-CUP: Auto-calibration SUFI2
SWAT-CUP: Sensitivity analysis LH
YES
Validation
Management Scenarios

RESULTS AND DISCUSSION

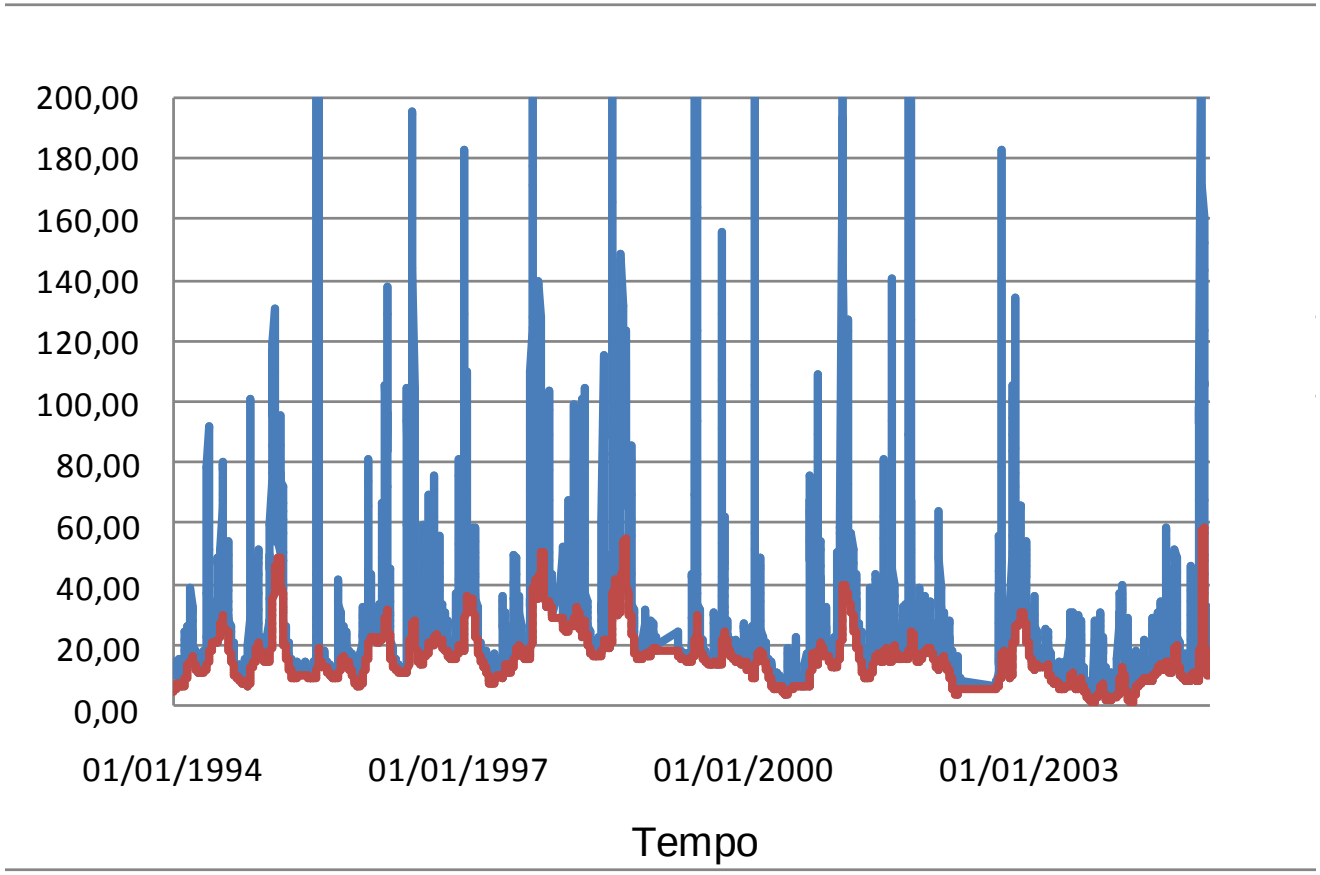
Water Balance:

Month	PREC (mm)	SURF Q (mm)	LAT Q (mm)	WY (mm)	ET (mm)	PET (mm)
Jan	196	55.42	0.63	83.76	82.89	165.37
Feb	154.65	37.53	0.63	67.66	78.39	179.22
Mar	118.17	26.13	0.67	62.16	67.95	136.98
Apr	88.55	22.5	0.61	55.48	47.23	98.69
Mai	114.98	40.88	0.58	69.09	35.14	78.97
Jun	121.25	36.93	0.55	62.27	31.45	79.38
Jul	138.01	43.93	0.62	76.26	44.37	107.13
Ago	100.96	30	0.61	66.91	57.89	143.99
Sep	159.34	46.12	0.58	76.58	61.97	145.27
Oct	185.19	55.87	0.67	89.49	86.96	175.56
Nov	150.16	43.21	0.64	78.74	82.45	161.26
Dez	148.13	36.78	0.62	69.27	92.73	178.84
Mean	**139.62**	**39.61**	**0.62**	**71.47**	**64.12**	**137.56**

The results indicated that 46% of the annual PREC is lost by ET in the watershed

RESULTS AND DISCUSSION

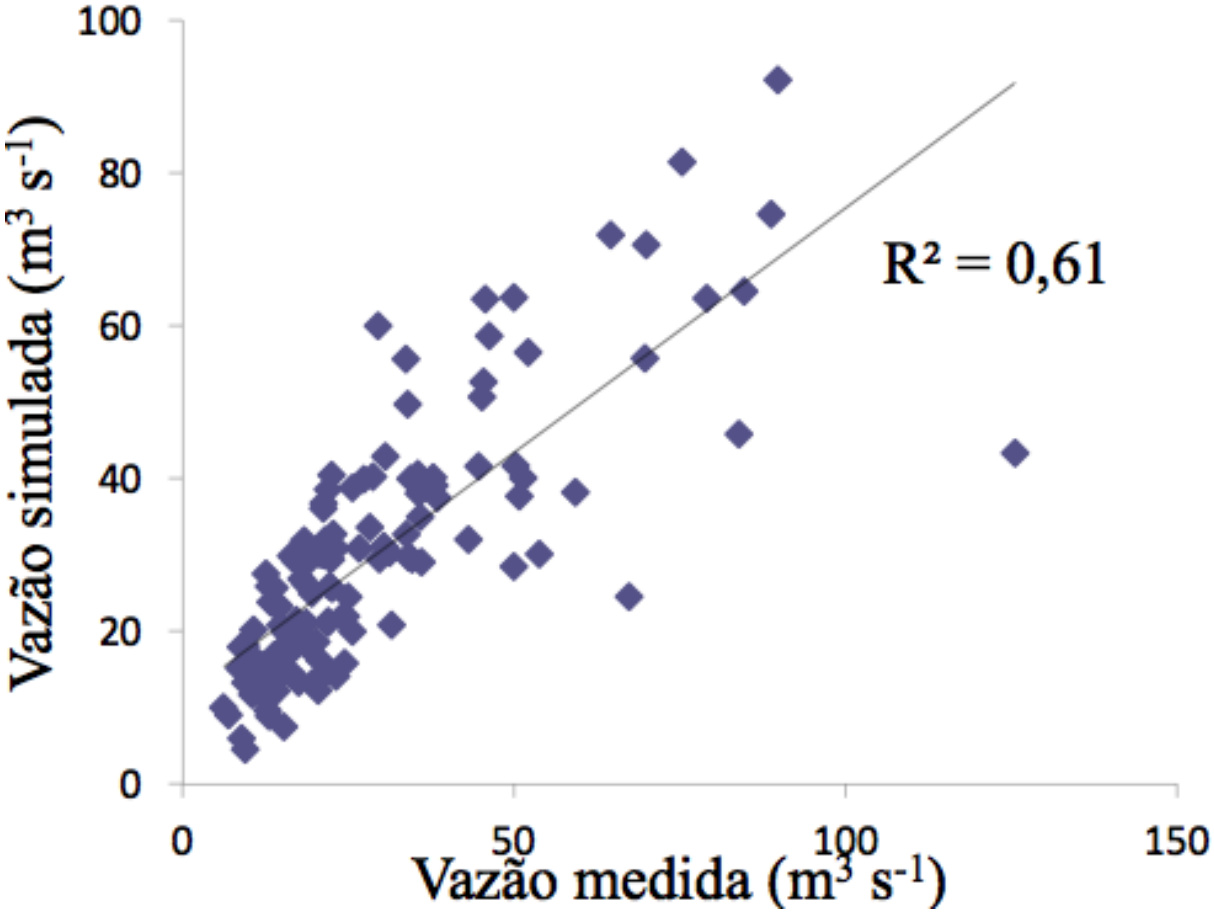
Baseflow separation:



The simulation indicated that the baseflow, which is an important component of total yield, is **54% of measured and simulated runoff.**

RESULTS AND DISCUSSION

Measured and simulated streamflow

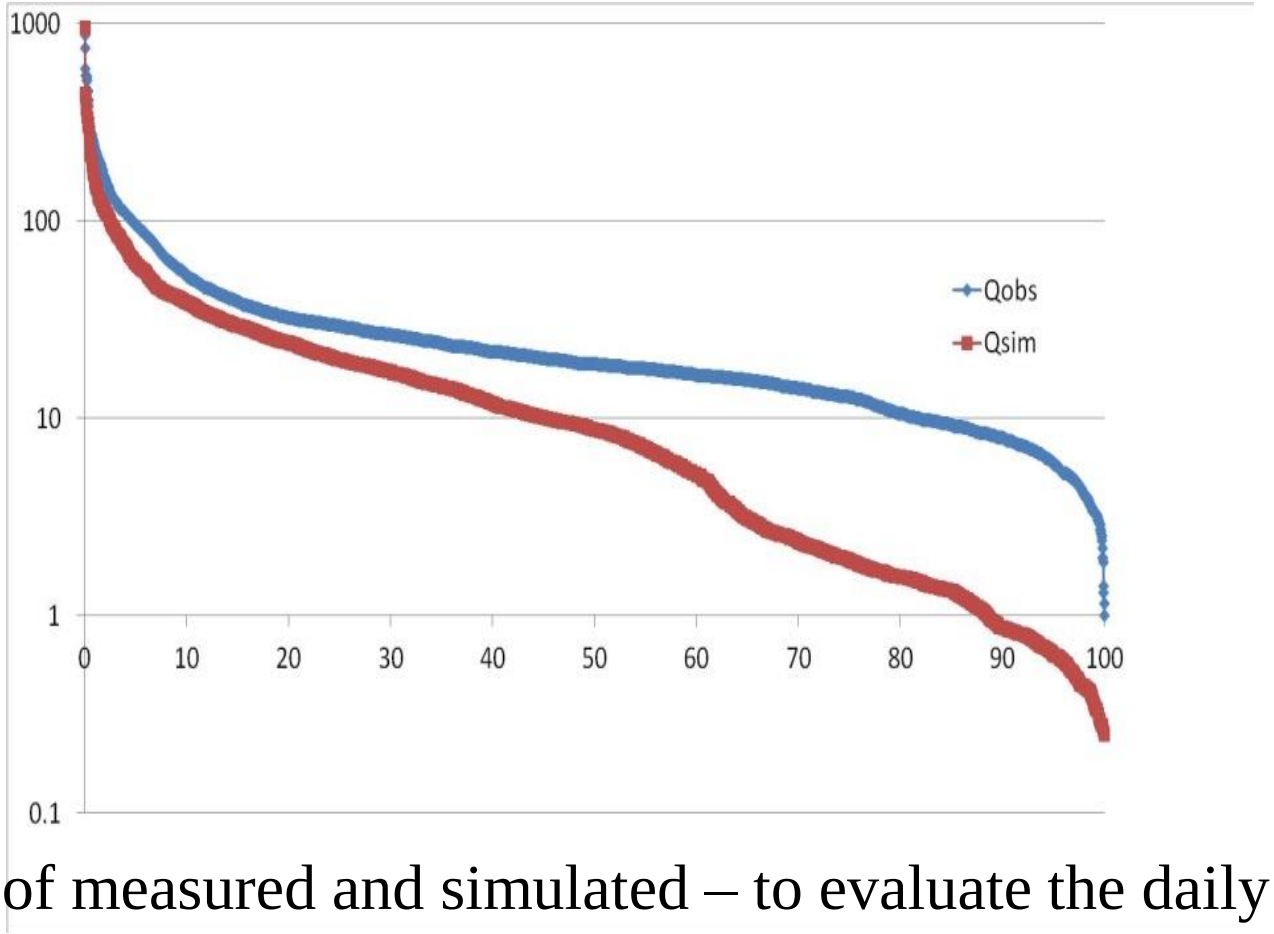


Model performance:

R^2 = 0.61, NSE = 0.63

RESULTS AND DISCUSSION

Flow Duration Curves (FDC)



The FDCs of measured and simulated – to evaluate the daily streamflow variability.

The FDC derived from the simulated hydrographs indicated an underestimation of the low flows by SWAT model.

RESULTS AND DISCUSSION

Sensitivity analysis (LH)

- The **CN2** parameter's variation had the highest sensitivity. Increased values of CN2 imply an increase in the surface runoff.
- The second parameter with the greatest effect was the soil evaporation compensation factor (**ESCO**). Kannan et al. (2007) noticed that a change in the value of the ESCO affects all the water balance components.
- The third most sensitive parameter was the threshold depth of water in the shallow aquifer required for return flow to occur (**GWQMN**).

CONCLUSIONS

Performance of the model:

- NASH = 0.63 and R^2 = 0.61 for monthly simulations.

Water Balance:

- **ET**: 46% of the annual PREC is lost by ET in the watershed.
- **Baseflow**: The simulation indicated that the baseflow, which is an important component of total yield, is **54% of measured and simulated runoff.**
- **FDC: Underestimation** of the **low flows** by SWAT model.

Sensitivity Analysis:

- CN2, ESCO and GWQMN.

RECOMMENDATIONS

- Based on the results - SWAT model can be used for further analysis of the **effect of climate** and **land use changes** on **hydrological processes**.

Future work:

- **Data:** include a longer period of time (more data) in order to improve the simulations**;**
- **Auto-calibration**: SWAT-CUP;
- **Uncertainty analysis:** of measured data (Harmel and Smith, 2007) and model parameters (SWAT-CUP);
- **Management scenarios**: land use and climate changes.

ACKNOWLEDGEMENTS

CVG

Thank you for your attention!

Obrigada pela atenção!

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