Calibration of the SWAT model for a watershed in Aracruz, ES, with the predominant land use eucalyptus

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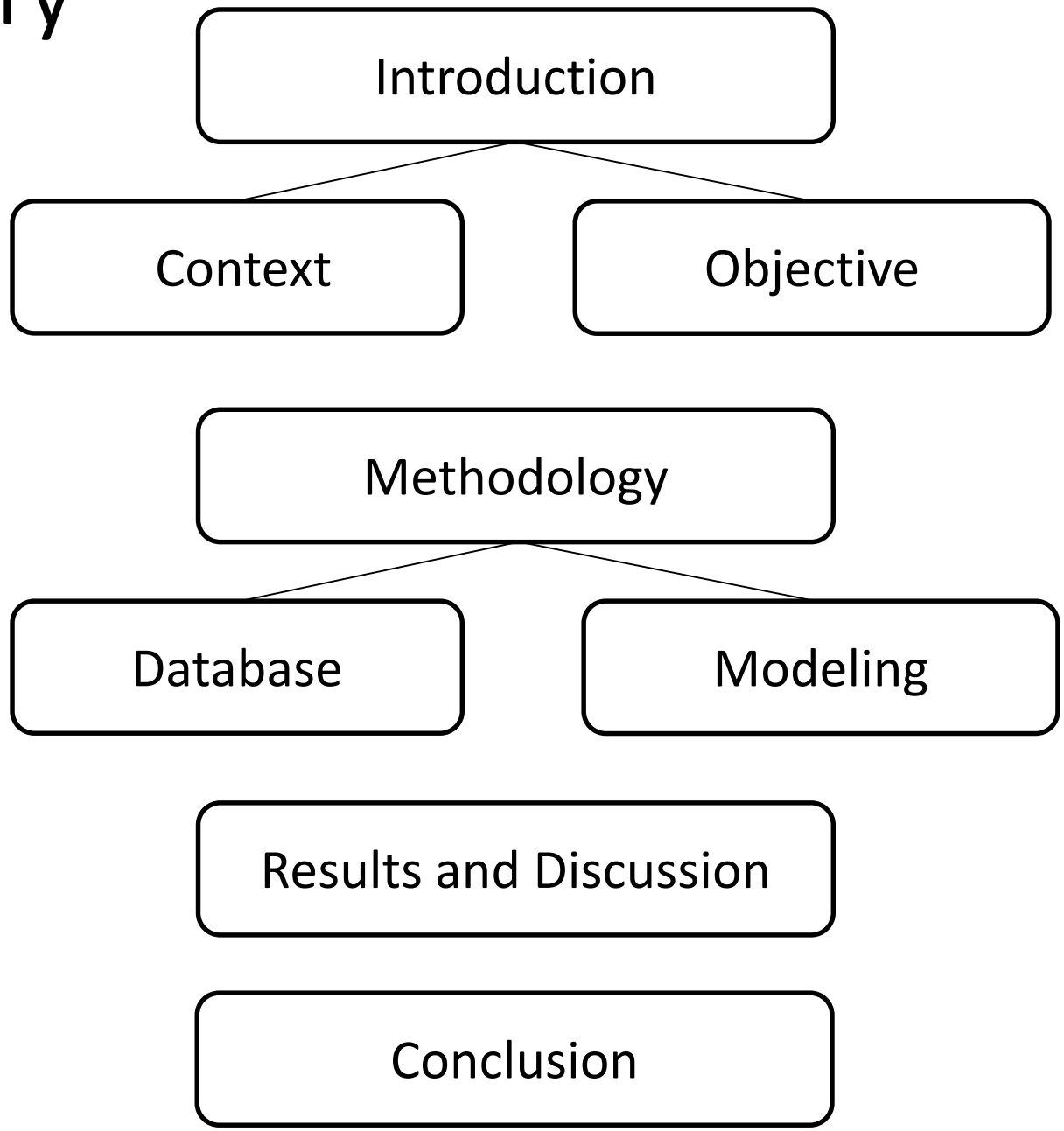
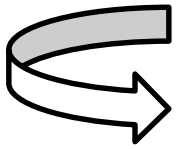
Summary


Introduction
Context
Objective
Methodology
Database
Modeling
Results and Discussion
Conclusion

Introduction

- Hydrologic studies in watershed:
  - Understand the processes that control the movement of water and the impacts of the use and occupation of soils on water resources.

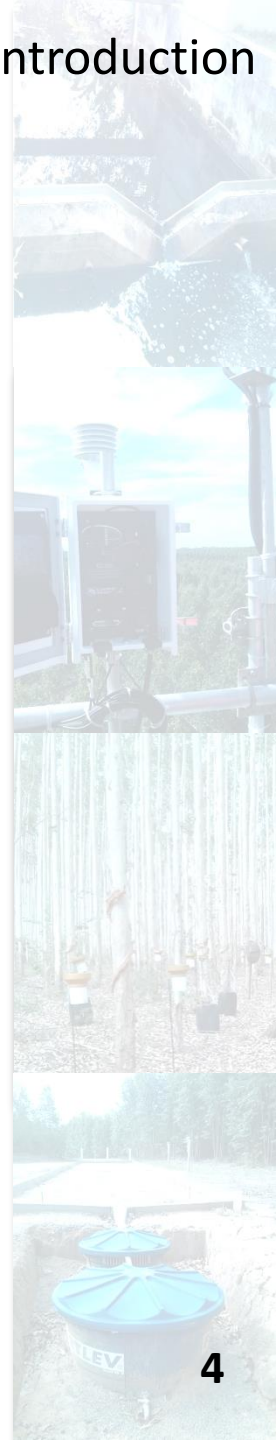
- The estimate of these processes and quantification of such impacts has been performed based in utilization hydrologic models, especially those computational.



SWAT

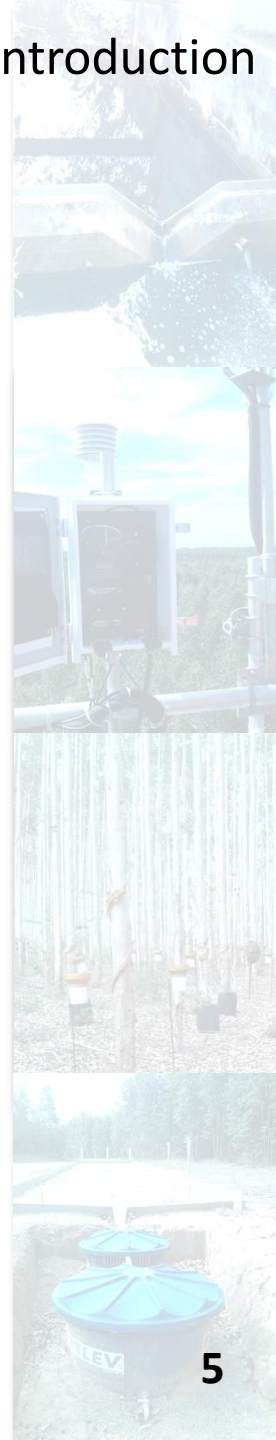
- SWAT applications in different scales of watershed in Brazil:

  - Machado e Vettorazzi (2003) (59.73 km²)
  - Guarrido (2003) (6900 km²)
  - Lopes (2008) (0.15 km², 0.24 km², 0.1 km², 0.21 km², 0.082 km², 2.34 km², 8.56 km²)
  - Paim e Menezes (2009) (2,840 km²)
  - Sarmento (2010) (825 km²)
  - Durães *et al*. (2011) (10,200 km²)
  - Carvalho Neto *et al.* (2011) (13.5 km² e 3.3 km²)
  - Strauch *et al.* (2012) (215 km²)
  - Lelis *et al*. (2012) (54.22 Km²)
  - Uzeika *et al.* (2012) (1.19 km²);
  - Bonumá *et al.* (2013) (4.8 km²).

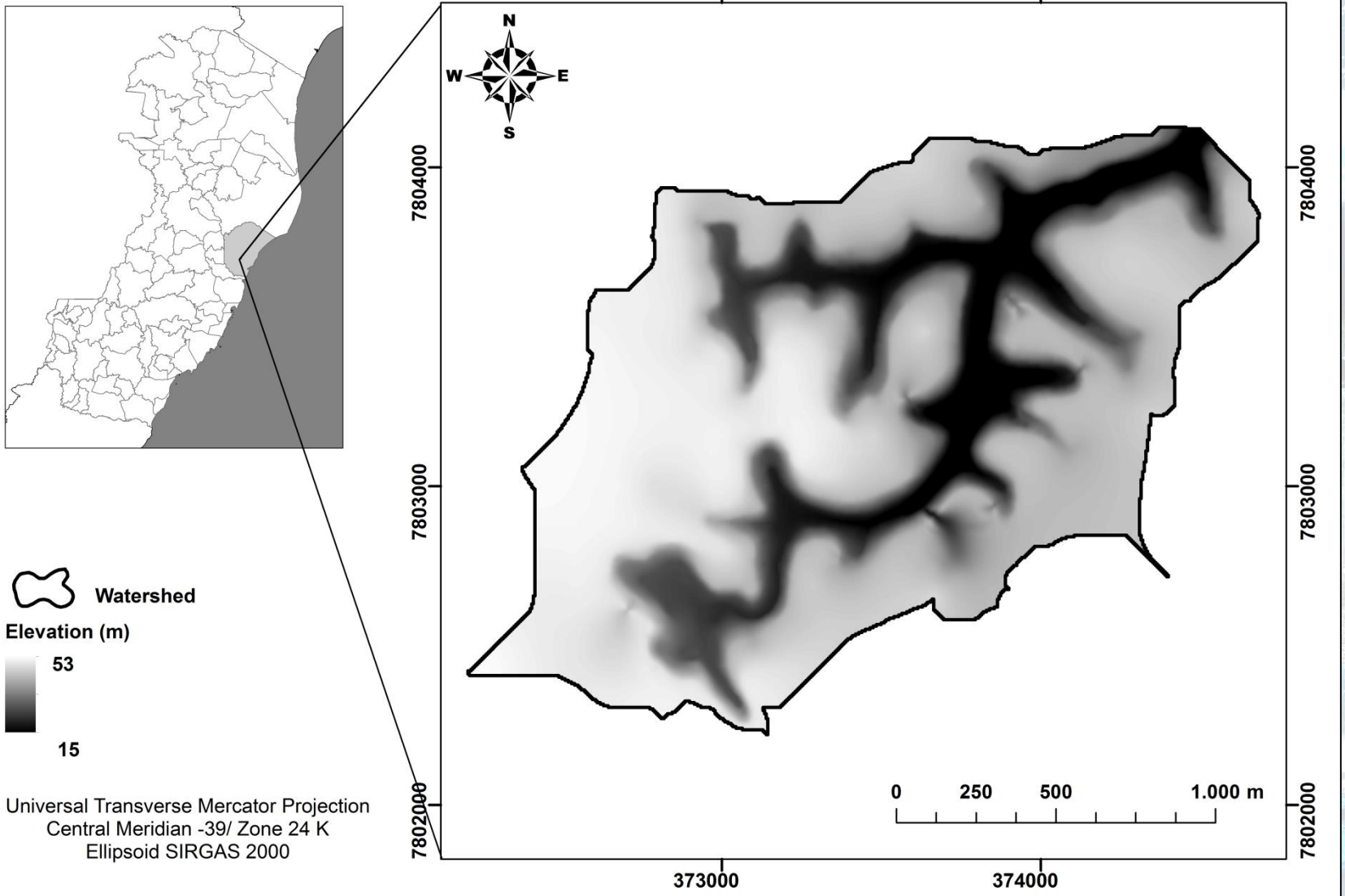


Aim

- Assess the applicability of SWAT to estimation flow in an experimental watershed (MBE) with an area of 2.84 km², in the city of Aracruz, ES.



Methodology



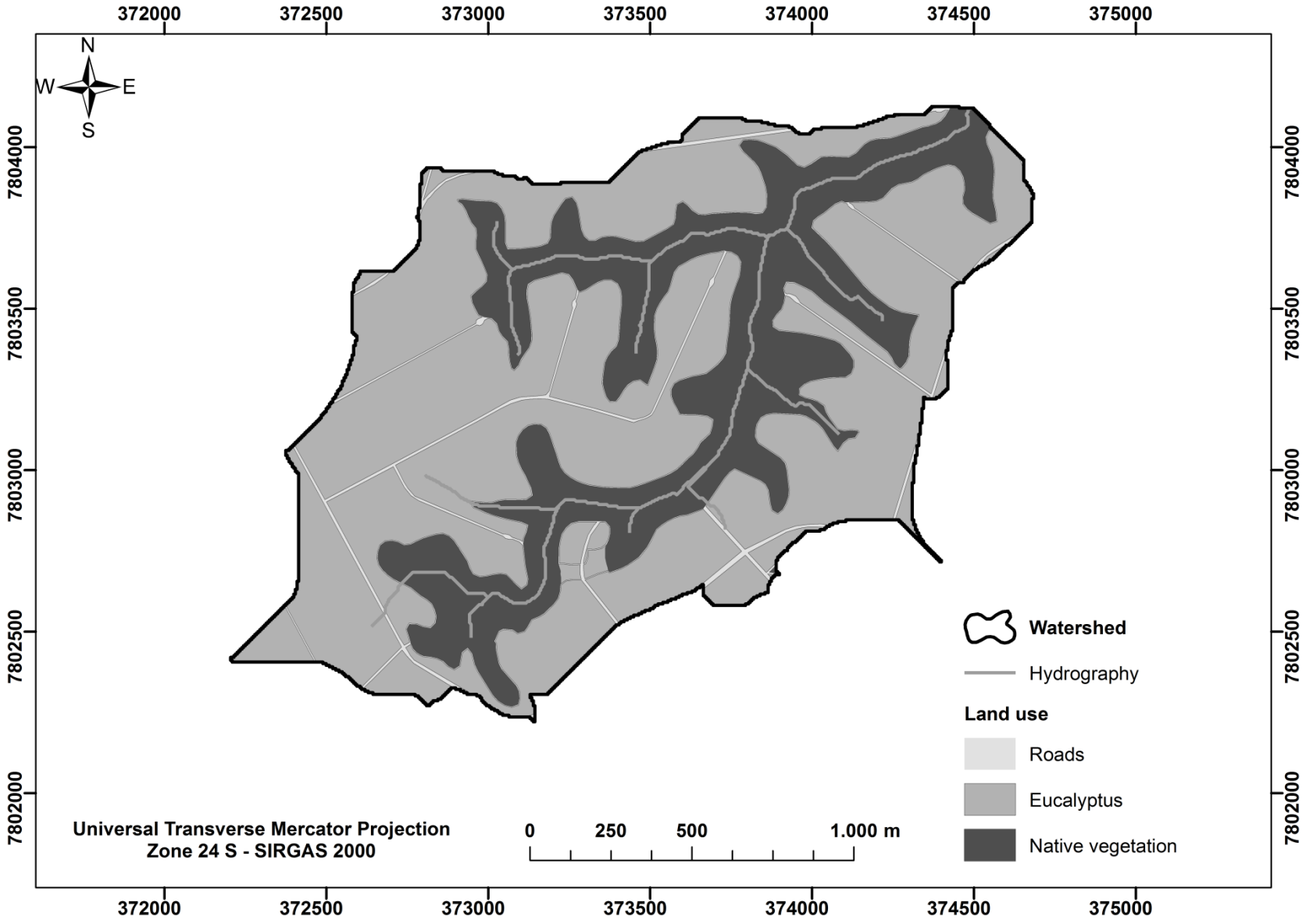
Database

- Fibria Celulose S. A.
- Watershed Project: 1994-2004

DEM

Land use | Soils | Climatic

Land use


372000
372500
373000
373500
374000
374500
375000
N
W
E
S
7804000
7803500
7803000
7802500
7802000
Watershed
Hydrography
Land use
Roads
Eucalyptus
Native vegetation
Universal Transverse Mercator Projection
Zone 24 S - SIRGAS 2000
0
250
500
1.000 m

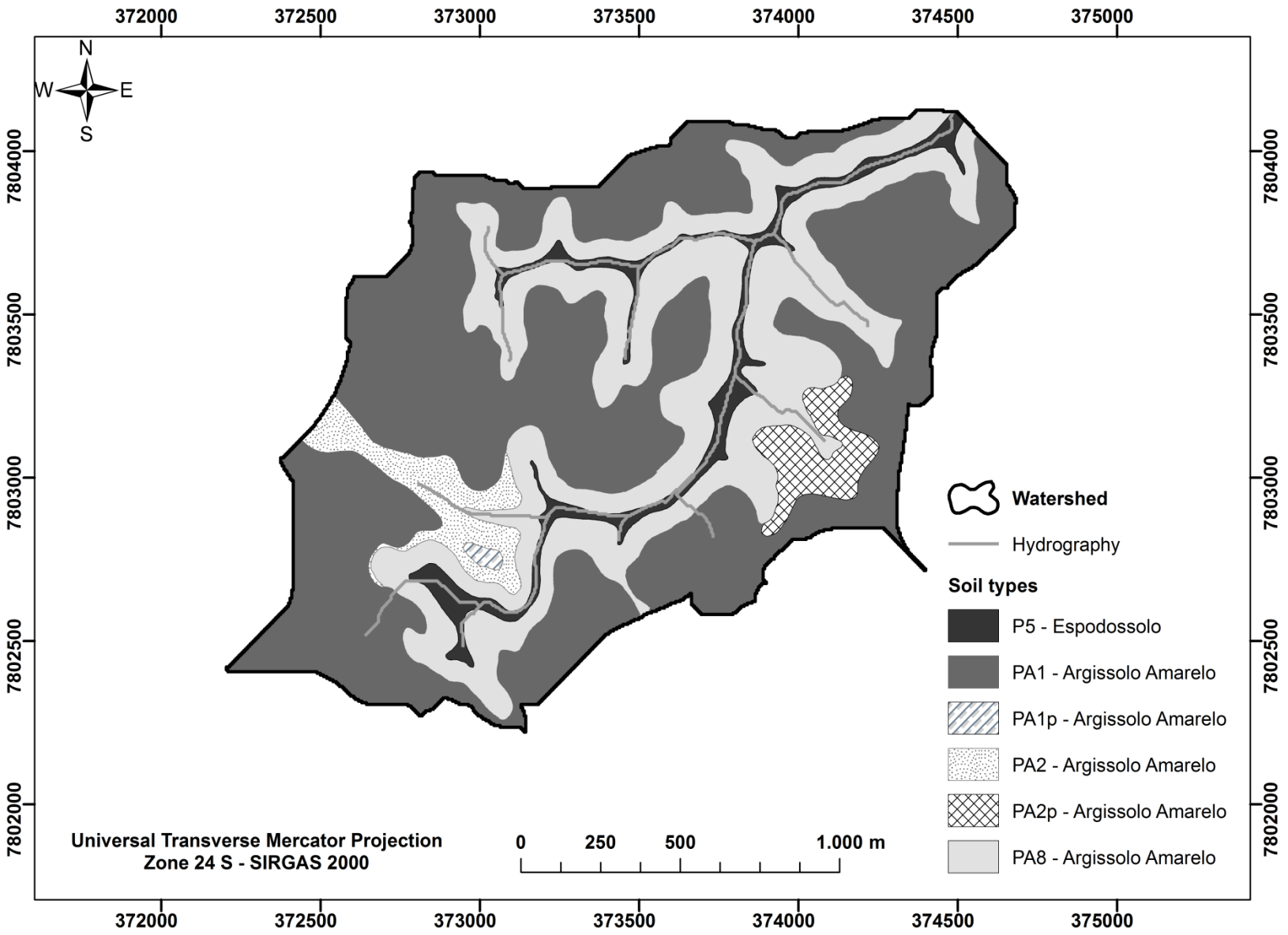
Land use

Table 1 - Types of existing land use in MBE study and the correlation with the database SWAT

Land use	Representative area (%)	Correlation SWAT
Eucalyptus	66.05	EUCA
Native vegetation	30.01	FRSE
Roads	3.94	URLD

- Adjustment the parameters of Eucalyptus.
  - HVSTC
  - BLAIC
  - CHTMXC
  - RDMXC
  - TOPT
  - TBASE
  - GSIC
  - MAT_YRS

Soils


372000
372500
373000
373500
374000
374500
375000
N
W
E
S
7804000
7803500
7803000
7802500
7802000
Watershed
Hydrography
Soil types
P5 - Espodossolo
PA1 - Argissolo Amarelo
PA1p - Argissolo Amarelo
PA2 - Argissolo Amarelo
PA2p - Argissolo Amarelo
PA8 - Argissolo Amarelo
Universal Transverse Mercator Projection
Zone 24 S - SIRGAS 2000
0
250
500
1.000 m

Soils

- 17 input parameters:
  - 9 parameters: reports Watershed Project.
  - 5 parameters: pedotransfer function developed by Saxton and Rawls (2006).
    - Marco excel: SWAT_usersoil

Climatic

Diaries

Rainfall (mm)

Maximum and minimum temperature(^{o}C)

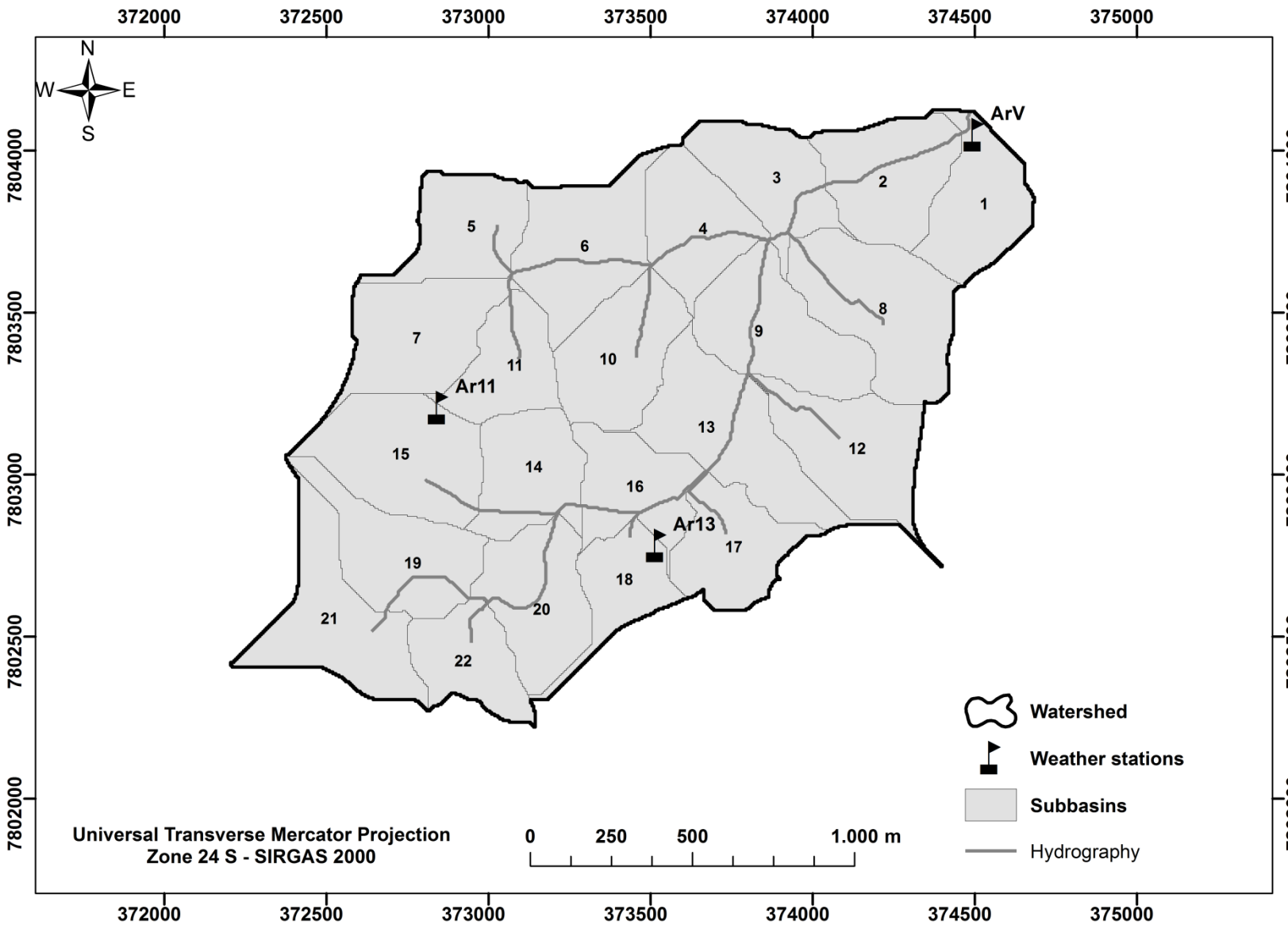
Solar radiation (MJ/m^2)

Relative humidity (%)

Wind (m/s)

Same period of observations

Modeling


372000
372500
373000
373500
374000
374500
375000
N
W
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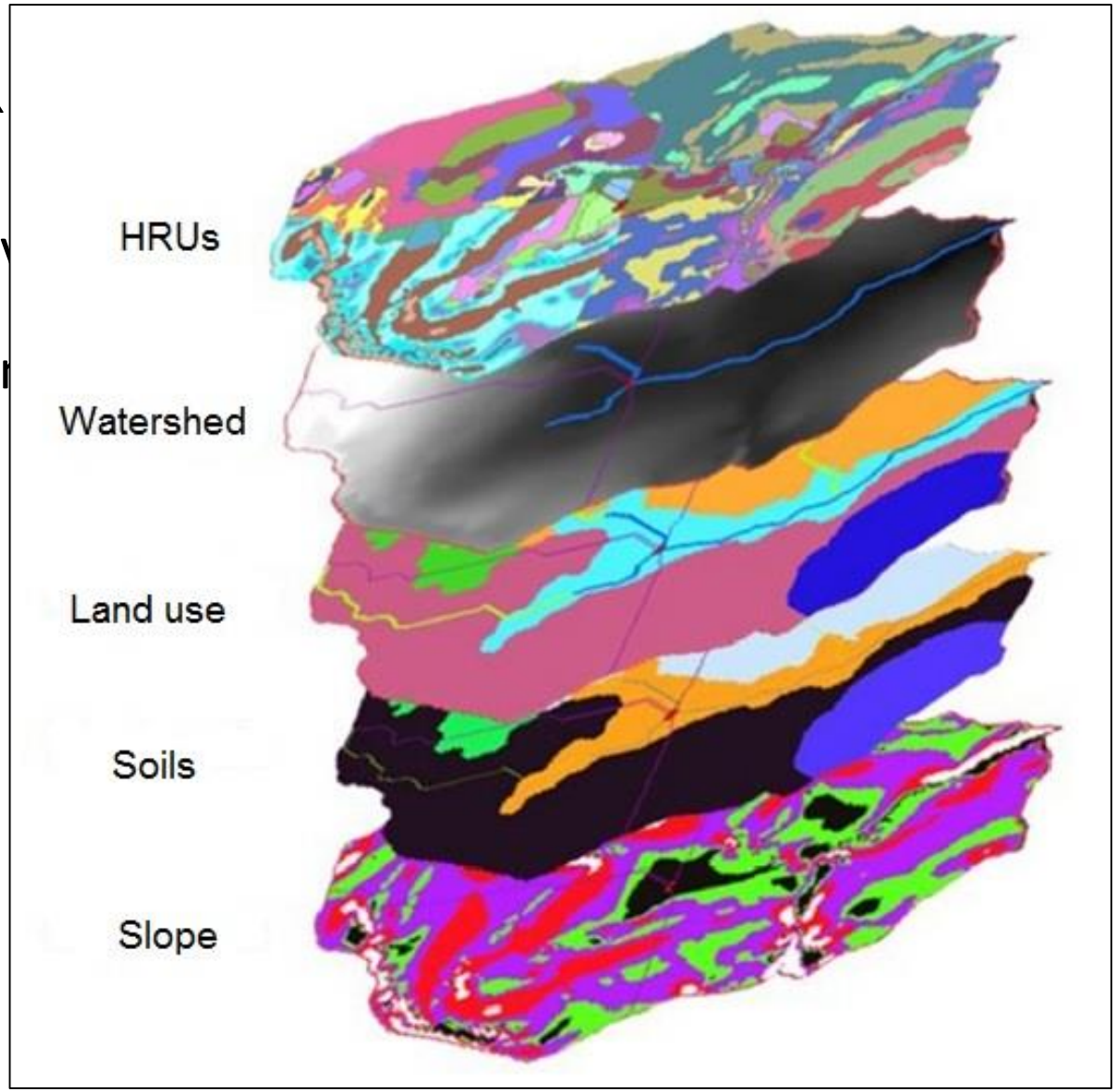
S
7804000
7803500
7803000
7802500
7802000
ArV
Ar11
Ar13
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
Watershed
Weather stations
Subbasins
Hydrography
Universal Transverse Mercator Projection
Zone 24 S - SIRGAS 2000
0
250
500
1.000 m

- HRU`
  - Ov
  - Ur

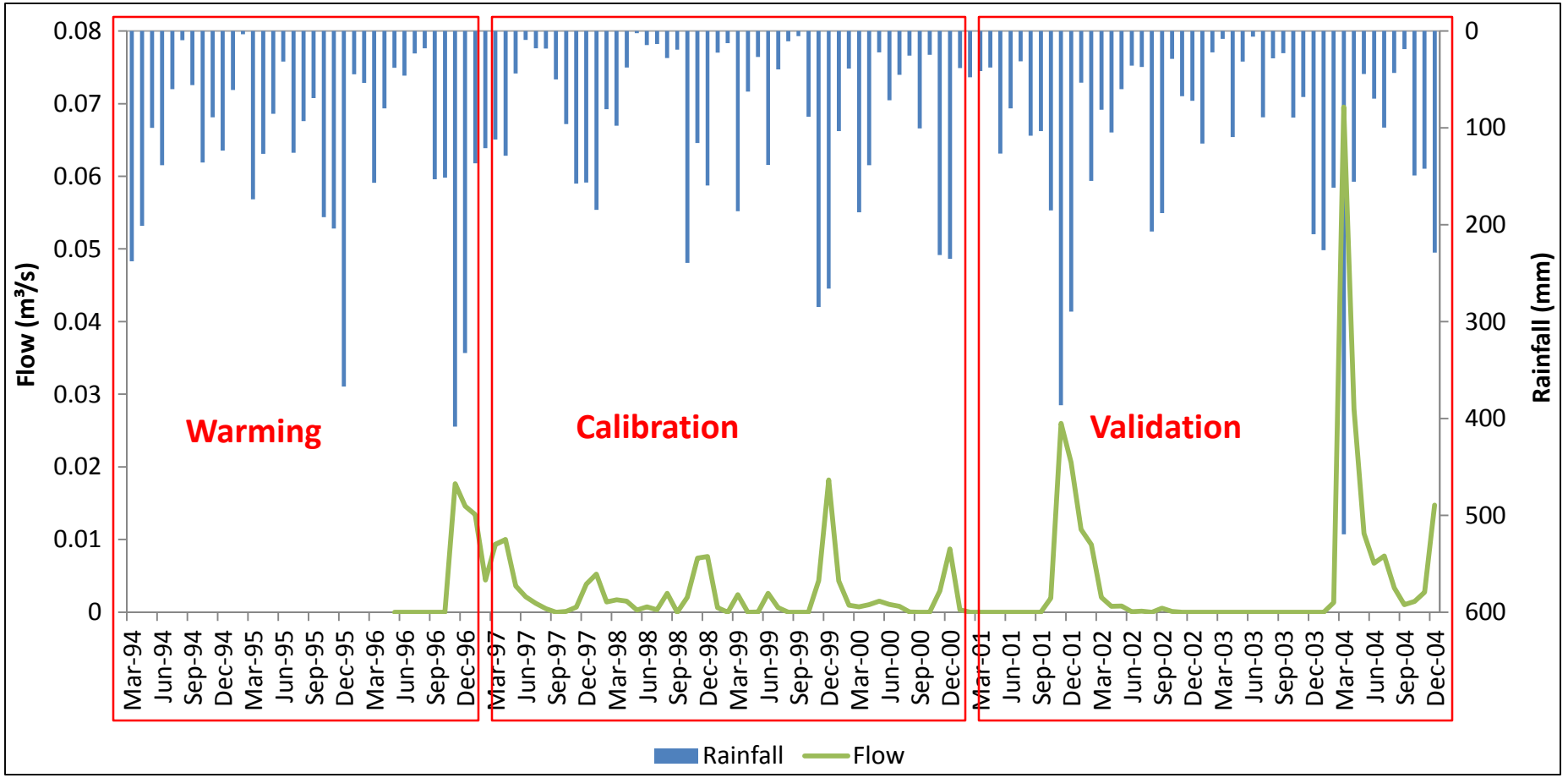


Fonte: Adapted from Fukunaga (2012, p. 17)

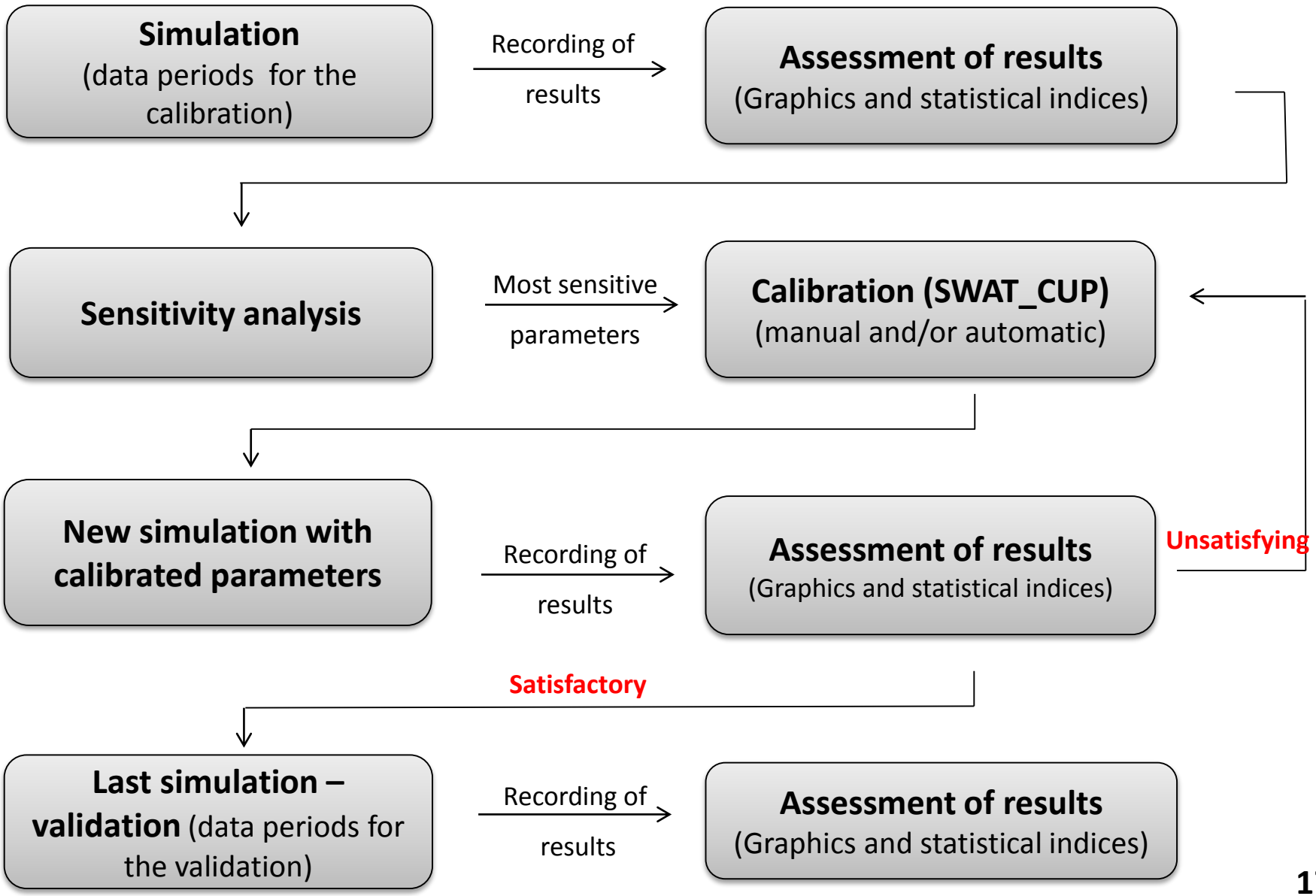
- Insertion of climate data.
- Edition of management for eucalyptus.
- Separation of the climatic serie:
  - Climate
  - Flow
- Simulation periods.
- Assessment of the applicability of the SWAT model.

Simulation

Figure 4 - Series of rainfall data flow and the relevant periods used for hydrologic modeling steps of the SWAT model in the MBE in Aracruz, ES.



Applicability of the model



Statistical indices

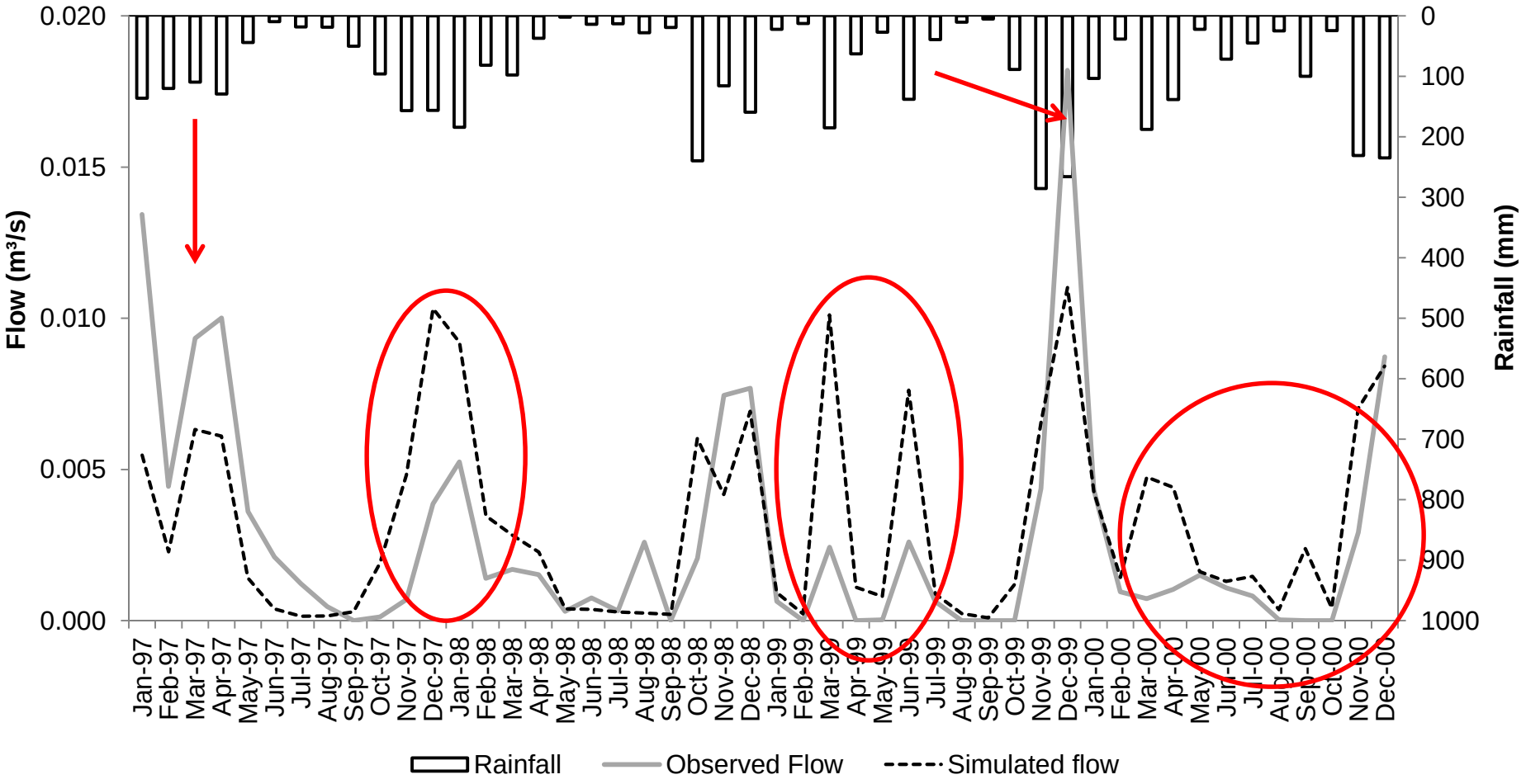
Table 2 - Classification of simulation results of the simulated daily flow for the SWAT model

Statistical indices	Abbreviation	Satisfactory
Efficiency coefficient of Nash and Sutcliffe	NS	≥ 0.4
Coefficient of determination	r^2	≥ 0.4
Percentage of tendency (%)	PBIAS	-25 ≤ PBIAS ≤ 25
Average normalized standard error	RSR	≤ 0.7

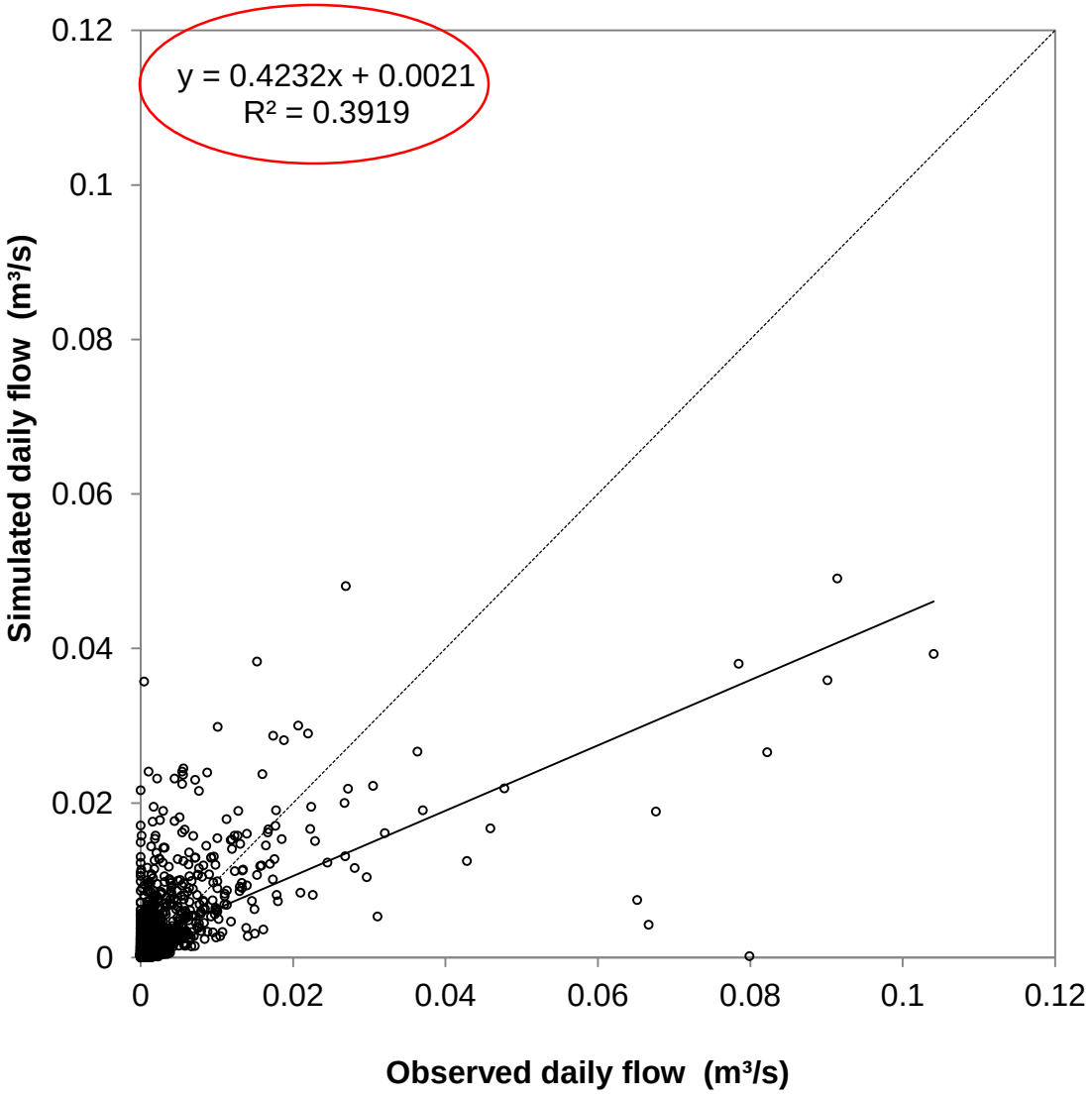
Results and discussion

- Calibration: key parameters
  - CN2
  - CANMX
  - GW_DELAY
  - SOL_AWC
  - SOL_K
  - ALPHA_BF
  - ESCO

- Calibration



- Graphic evaluation

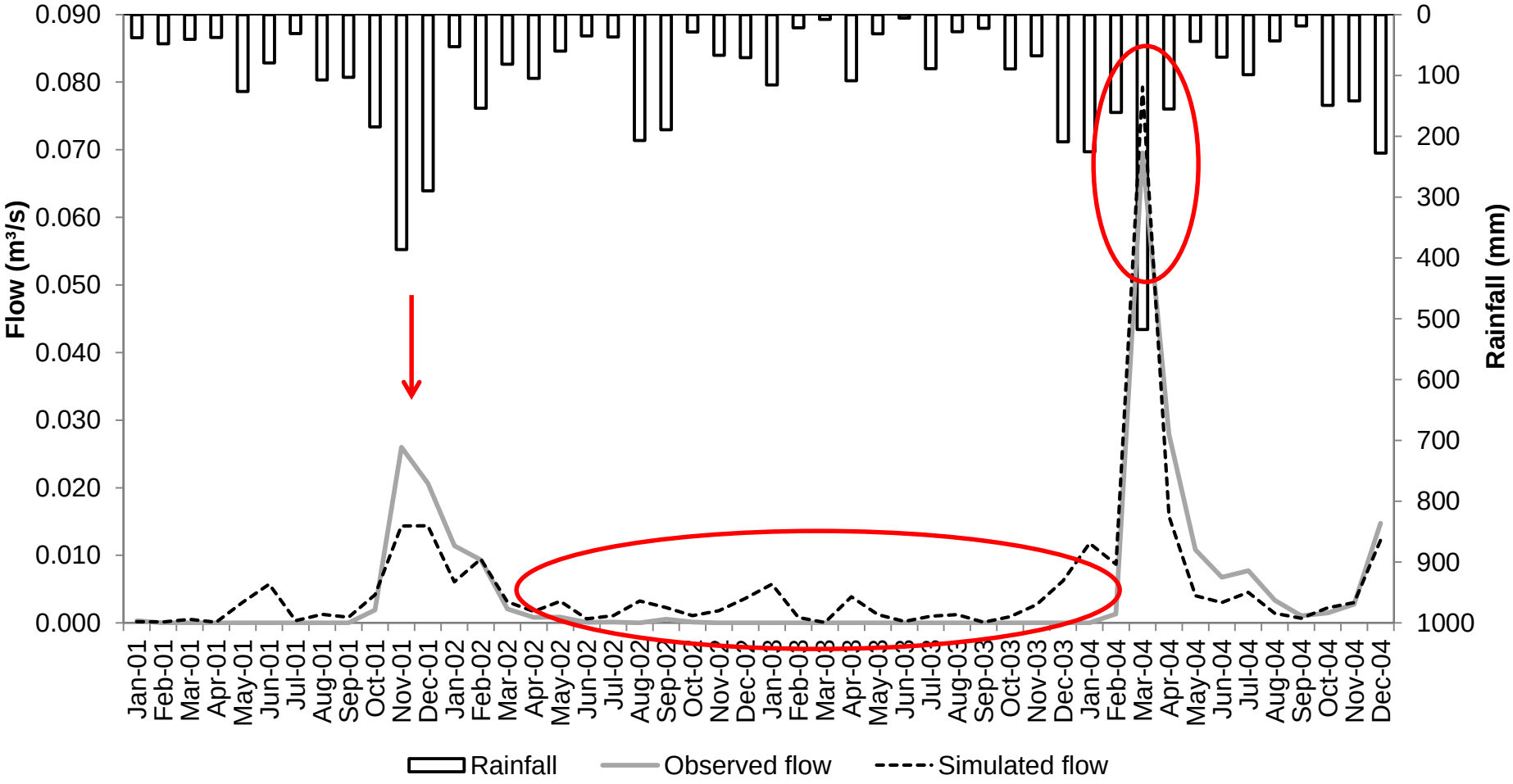


- Statistical indices: calibration
  - Daily serie

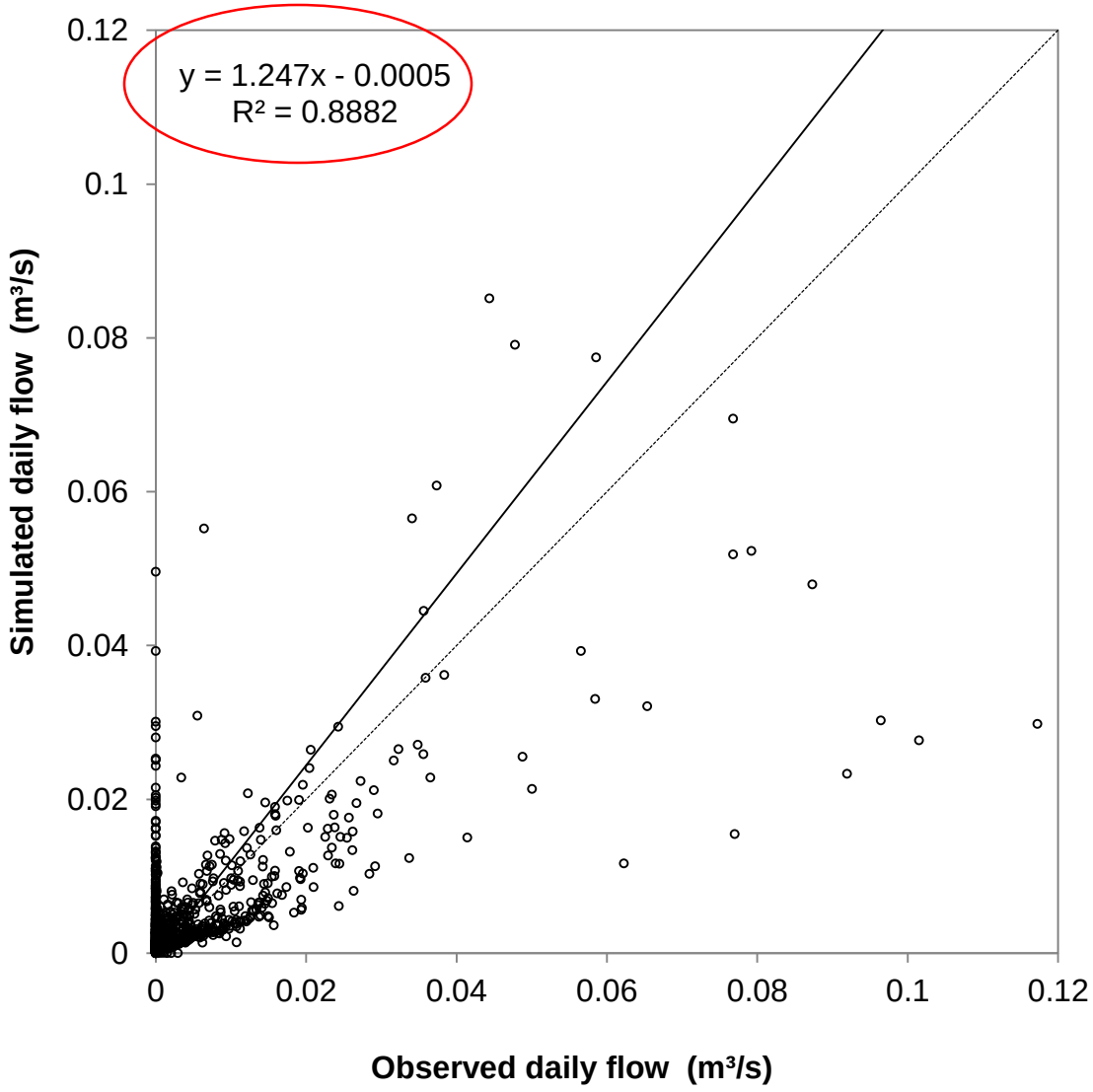
Table 3 - Final results of the statistical verification of daily simulation after the final calibration of the model parameters

Statistical	**Abbreviation**	**Values**	**Classification**
Efficiency coefficient of Nash and Sutcliffe	NS	0.3854	Satisfactory
Coefficient of determination	r^2	0.3919	Satisfactory
Percentage of tendency (%)	PBIAS	-17.53	Satisfactory
Average normalized standard error	RSR	2.44	Unsatisfying

- Validation


Flow (m³/s)
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
Rainfall (mm)
0
100
200
300
400
500
600
700
800
900
1000
Jan-01 Feb-01 Mar-01 Apr-01 May-01 Jun-01 Jul-01 Aug-01 Sep-01 Oct-01 Nov-01 Dec-01 Jan-02 Feb-02 Mar-02 Apr-02 May-02 Jun-02 Jul-02 Aug-02 Sep-02 Oct-02 Nov-02 Dec-02 Jan-03 Feb-03 Mar-03 Apr-03 May-03 Jun-03 Jul-03 Aug-03 Sep-03 Oct-03 Nov-03 Dec-03 Jan-04 Feb-04 Mar-04 Apr-04 May-04 Jun-04 Jul-04 Aug-04 Sep-04 Oct-04 Nov-04 Dec-04
Rainfall
Observed flow
Simulated flow

- Graphic evaluation



- Statistical indices: validation
  - Daily serie

Table 4 - Final Results of the statistical verification daily for the period of simulation model validation

Statistical	**Abbreviation**	**Values**	**Classification**
Efficiency coefficient of Nash and Sutcliffe	NS	0.7429	Bom
Coefficient of determination	r^2	0.8882	Satisfactory
Percentage of tendency (%)	PBIAS	-14.34	Bom
Average normalized standard error	RSR	0.5071	Satisfactory

Conclusions

- Calibration was indispensable for better correspondence between the model simulated and observed streamflow in monitoring.

- Even overestimating peak flows, modeling showed good representation for minimum flows and peak flows of lower intensity, and could even overestimating the flow, follow the trend of the observed flows.

- The applicability of the SWAT model in MBE study for simulating flow, was considered valid:
  - The parameters of soil, climate and vegetation were adjusted to the conditions of MBE, having configured the model with all the necessary information.

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Programa de Pós Graduação em Ciências Florestais

Thanks!

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