Simulation of stream discharge from an agroforestry catchment in NW Spain using the SWAT model

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INTRODUCTION

Predict the impact of man-made changes and management practices

Predict the impact of potential climate change

Water discharge, sediment, nutrients

Important topics in catchment

The first step for the evaluation of water resources in light of future climate change and/or land use is to know the adequacy of the model to reflect adequately current conditions

OBJECTIVE

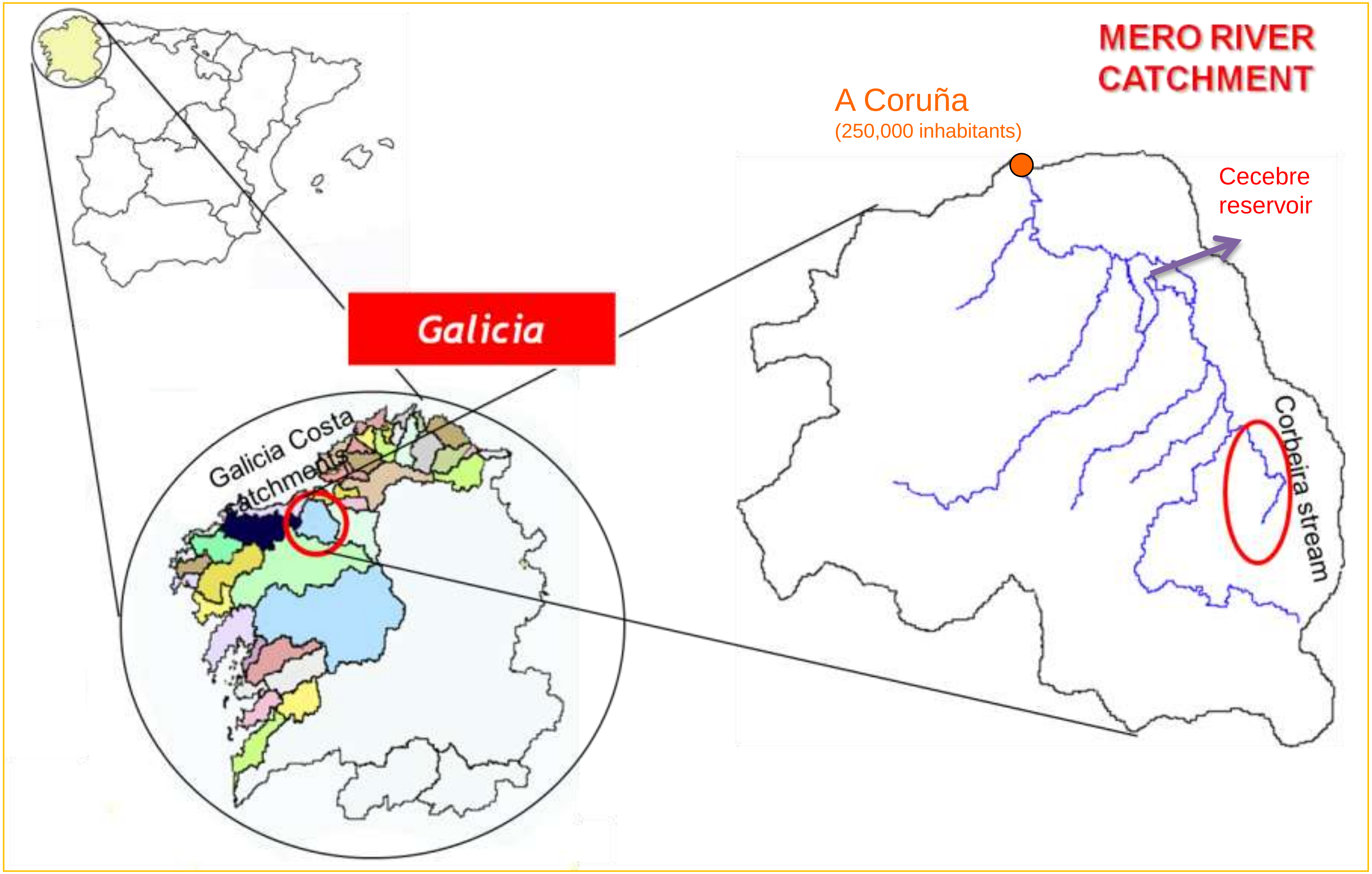
- Test the performance and feasibility of the SWAT model (ArcSWAT 2009) in the prediction of the stream discharge in a rural catchment located in NW Spain.
- Establish the adequacy of the model to local conditions, considering the possibility of its use in future studies in a wider area.

In a further step

- Predict the effects of climate change and land management practices on the water discharge, sediment and nutrients in the study area.

MATERIAL AND METHODS

STUDY AREA: CORBEIRA CATCHMENT

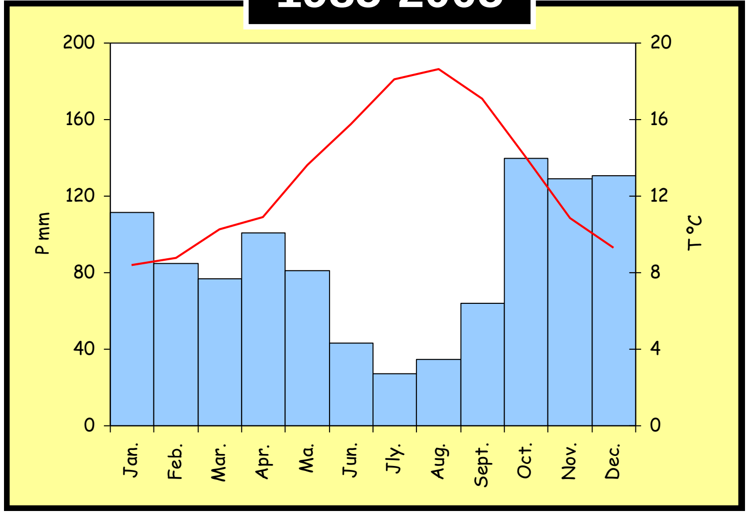


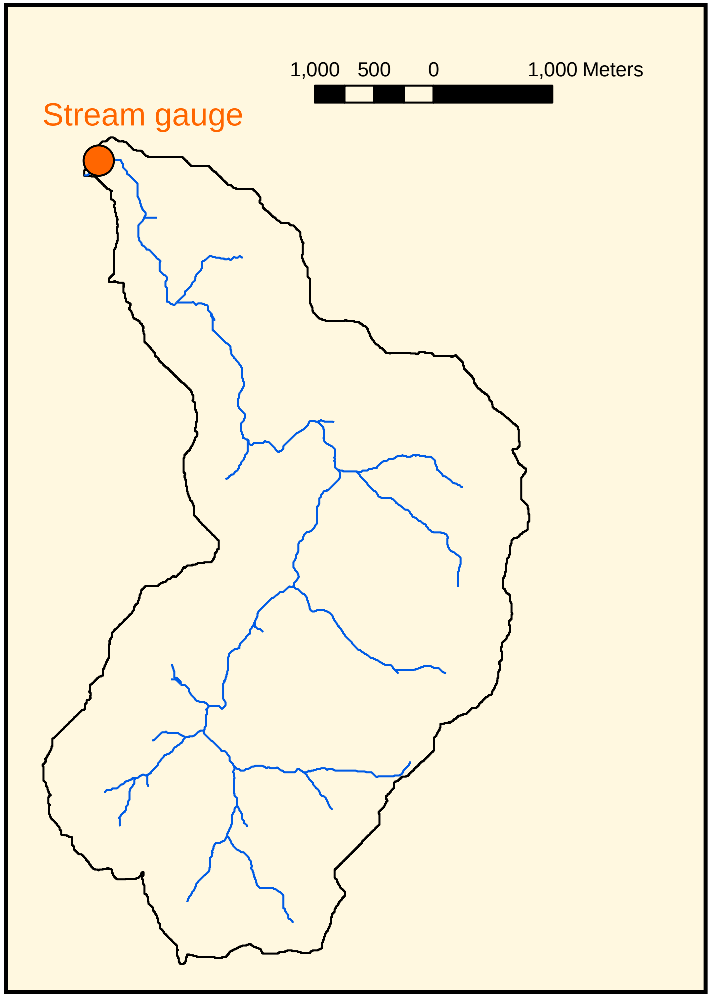
CORBEIRA CATCHMENT

- Catchment area: 16 km^2
- Length of the main stream: 10 km
- Mean annual discharge: 0.20 $m^3 s^{-1}$

- Climate: humid temperate
- Mean annual rainfall: 1024 mm
- Mean temperature: 13ºC

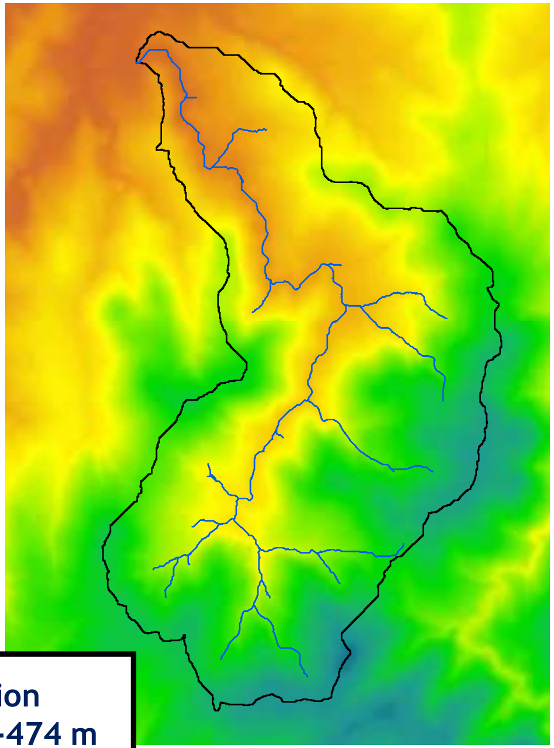
1985-2005





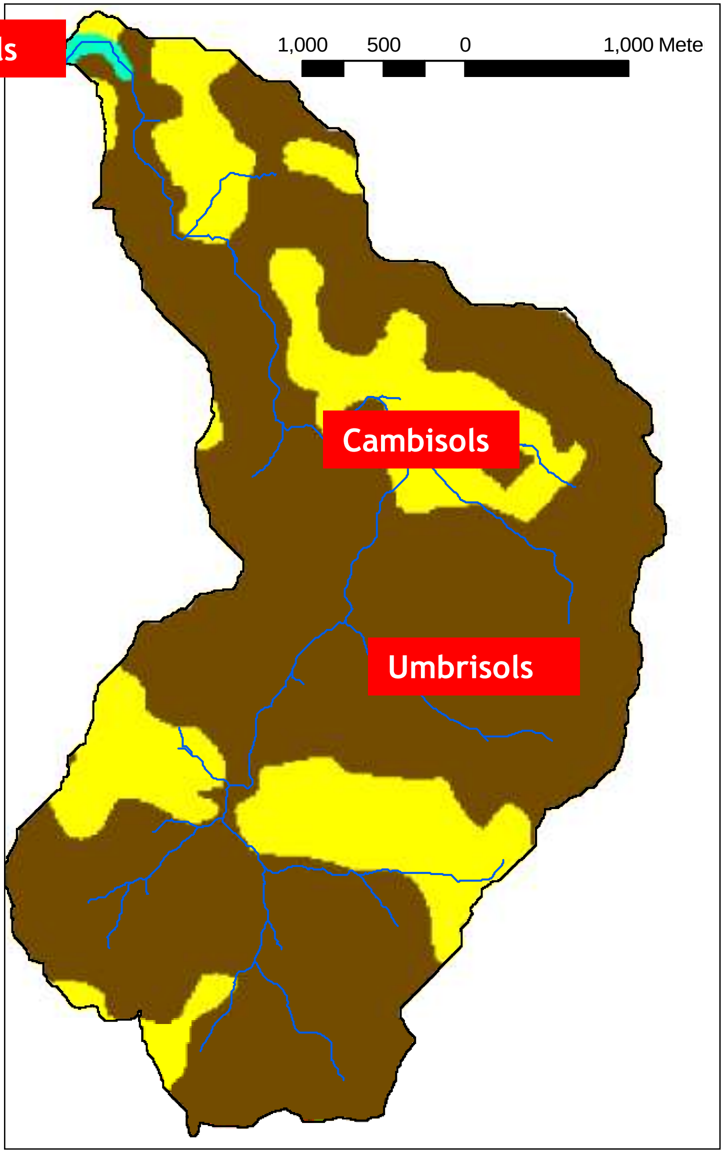
MODEL INPUT DATA

Digital Elevation Model (DEM)



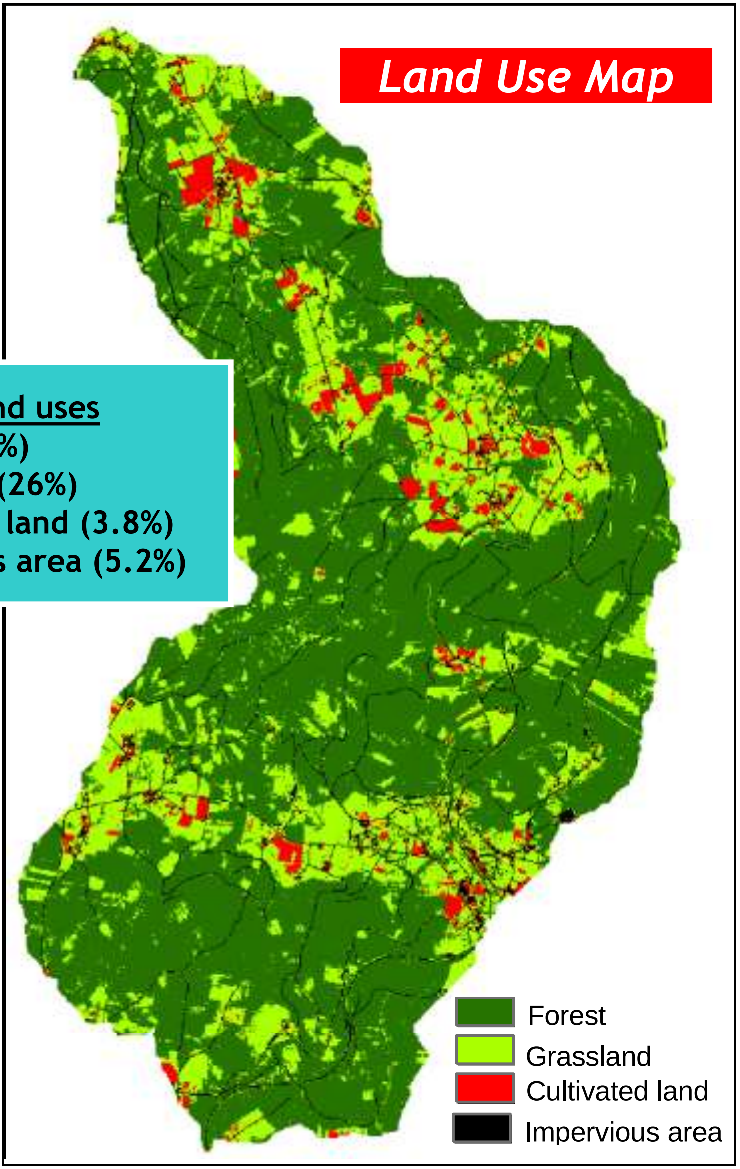
Elevation
Range: 65-474 m
Mean: 267 m

Soil Map



SOILS CHARACTERISTICS:
-Silt-silty loam texture
- High organic matter content
- Acid pH

MODEL INPUT DATA



<u>Land uses</u>

Forest (65%)
Grassland (26%)
Cultivated land (3.8%)
Impervious area (5.2%)

Eucaliptus forest

Pinus forest

Grassland

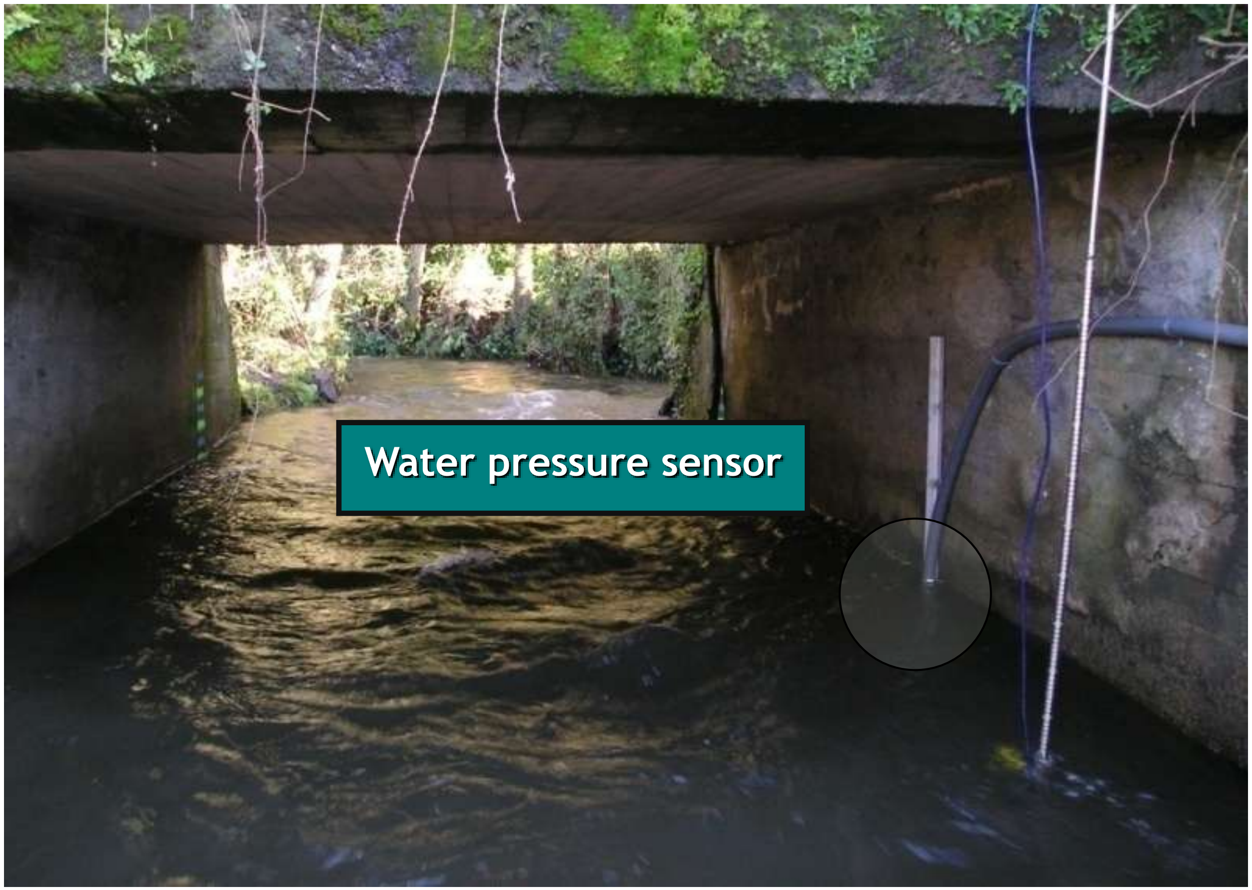
Maize

Meteorological Information: Mabegondo station

Closest station to the study area

OBSERVED DATA

Stream water level



Data from Oct 2004 (10 min)

METHODOLOGY

SENSITIVITY ANALYSIS

- Latin hypercube (LH)-one-factor-at-a time (OAT)

MANUAL CALIBRATION

- Trial-and-error basis
- Selecting as final values
  - maximize model efficiency
  - minimize stream deviation

AUTOCALIBRATION: Parasol Uncertainly analysis

- Initial values: final parameter values of the manual calibration
- Parameters selected by range of sensitivity analysis

CALIBRATION AND VALIDATION

- Observed data at the catchment outlet
- At daily step
- 5 hydrological years (2005/06-2009/10) of data divided into two time series:
  - 2005/06-2007/08: CALIBRATION
  - 2008/09-2009/10: VALIDATION
- Evaluation of the results using R2, PBIAS,NSE


PRELIMINARY RESULTS

PRELIMINARY RESULTS: discharge predictions

INITIAL RUN (default flow-related parameter values)

Significant differences between observed and simulated discharge. NSE<<<0.36

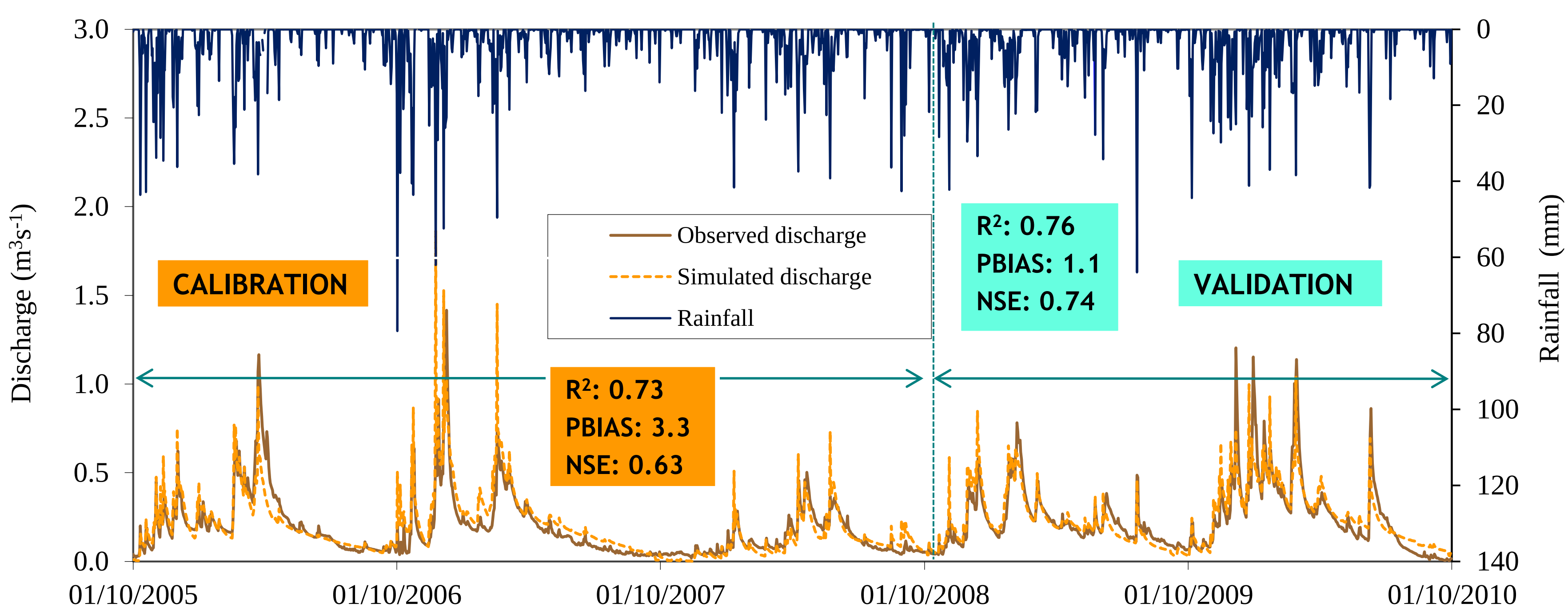
SENSITIVITY ANALYSIS (both with and without the use of observed discharge data)

The most sensitive parameters: related to groundwater

- Qwqmn:Threshold water depth in the shallow aquifer for flow
- Rchrg_Dp : Deep aquifer percolation fraction

PRELIMINARY RESULTS: discharge predictions

MANUAL CALIBRATION



- Calibration period comprises more extreme conditions:

2006/07: VERY WET

2007/08: DRY

PRELIMINARY RESULTS: discharge predictions

MANUAL CALIBRATION

- The SWAT model tends to overestimates peak discharge. This is more evident at the beginning of the rainy season.

- The largest discrepancies occur in summer, when SWAT underestimates discharge and predicts a somewhat quicker recession curves than those observed.

- The discharge peaks simulated by SWAT anticipate the catchment response

Heaviest rainfall in the last hours of the day

- Some discharge peaks were not captured by SWAT. On the other hand, some predicted discharge peaks were not observed at the catchment outlet

Local rainfall

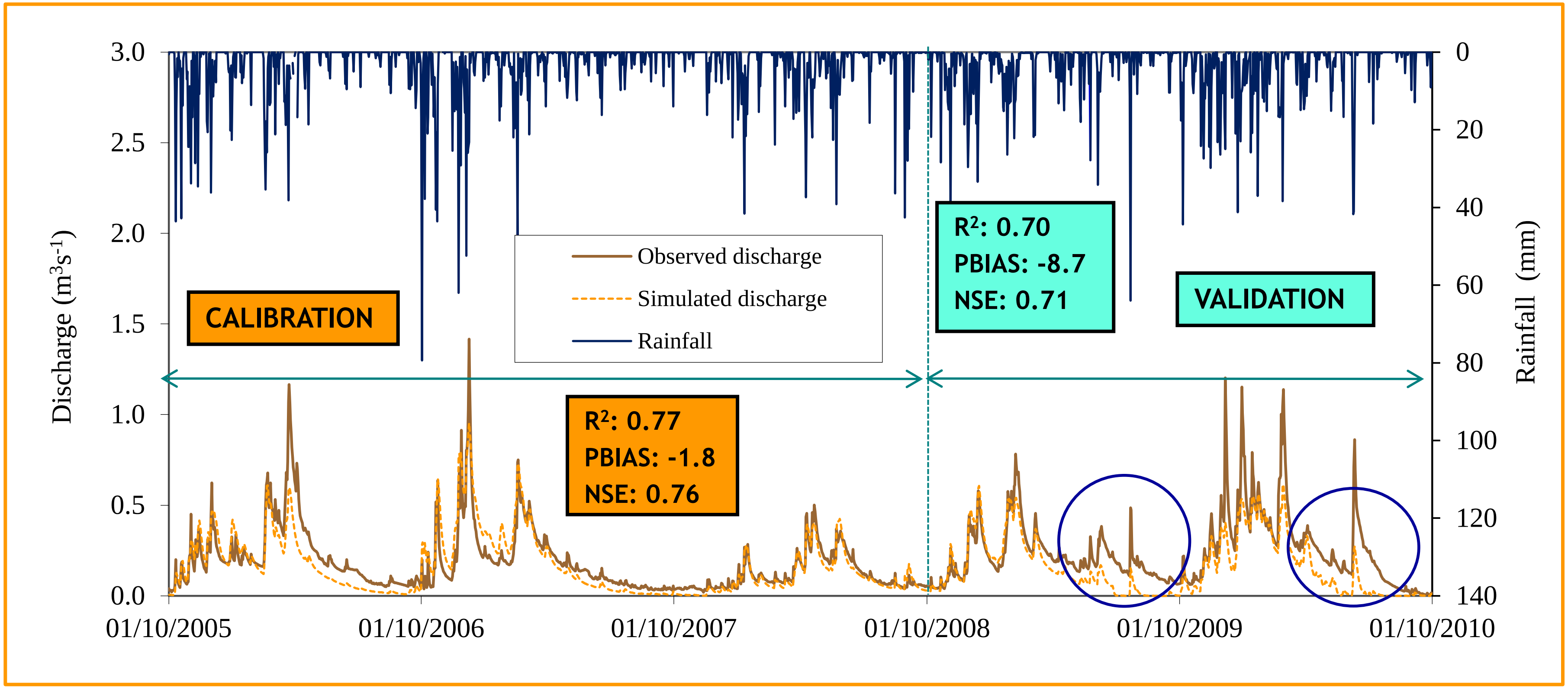
PRELIMINARY RESULTS: discharge predictions

SENSITIVITY ANALYSIS with observed data

Parameter	Descripcion	Sensitivity rank	Range used in autocalibration
Blai	Maximum potential leaf area index	10	0-1
Canmx	Maximum canopy storage	8	0.1-10
Ch_K2	Channel hydraulic conductivity	13	0-150 (mm hr^{-1})
CN2	Initial SCS CN II value	5	-25% to 25%
EPCO	Plant updake compensation factor	14	0-1
ESCO	Soil evaporation compensation factor	4	0-1
Gw_Delay	Groundwater delay	12	0-50 days
Gw_Revap	Groundwater revap coefficient	9	0.02-0.2
Qwqmn	Threshold water depth in the shallow aquifer for flow	3	0-1
Rchrg_Dp	Deep aquifer percolation fraction	2	0-1
Slope	Mean slope steepnes	6	-25% to 25%
Sol_Alb	Moisture soil albedo	15	-25% to 25%
Sol_AWC	Available water capacity	1	-50% to 50%
Sol_K	Saturated hydraulic conductivity	7	-25% to 25%
Sol_Z	Soil depth	11	-25% to 25%

PRELIMINARY RESULTS: discharge predictions

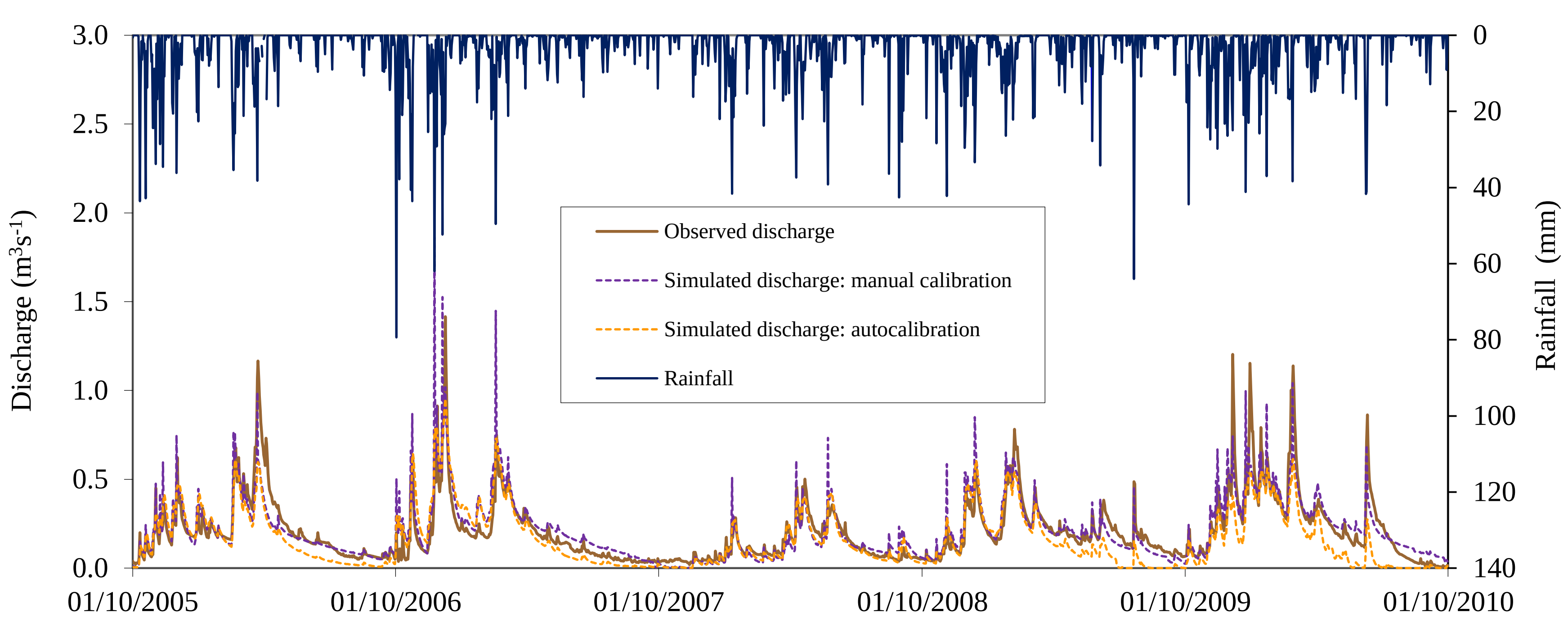
AUTOCALIBRATION



- Acceptable performance of SWAT
- High deviation: dry season of the validation period

PRELIMINARY RESULTS: discharge predictions

MANUAL CALIBRATION vs. AUTOCALIBRATION



Autocalibration only provided better results during the calibration period

Useful tool that can be used to facilitate the manual process

CONCLUSIONS

CONCLUSIONS AND FURTHER WORKS

- Both manual and autocalibration produce a satisfactory performance of SWAT to predict daily discharges of the Corbeira catchment. Autocalibration approach only improves model performance during the calibration period.

- The SWAT parameterization obtained in this study will be used as a starting point in the Mero Basin, but it will be combined with the existing knowledge of the basin to guarantee reliable results. This information will be also used to analyse the impact of possible climate change on water resources.

- For more adequate modelling of stream discharge, a large effort will be needed to improve the quality of available information concerning groundwater, soils and rainfall in the catchment.

Thank you for your attention!