# Malfunctioning of stream-gauge stations in the Chanza and Arochete rivers (Huelva, Spain) detected from hydrological modeling with SWAT.

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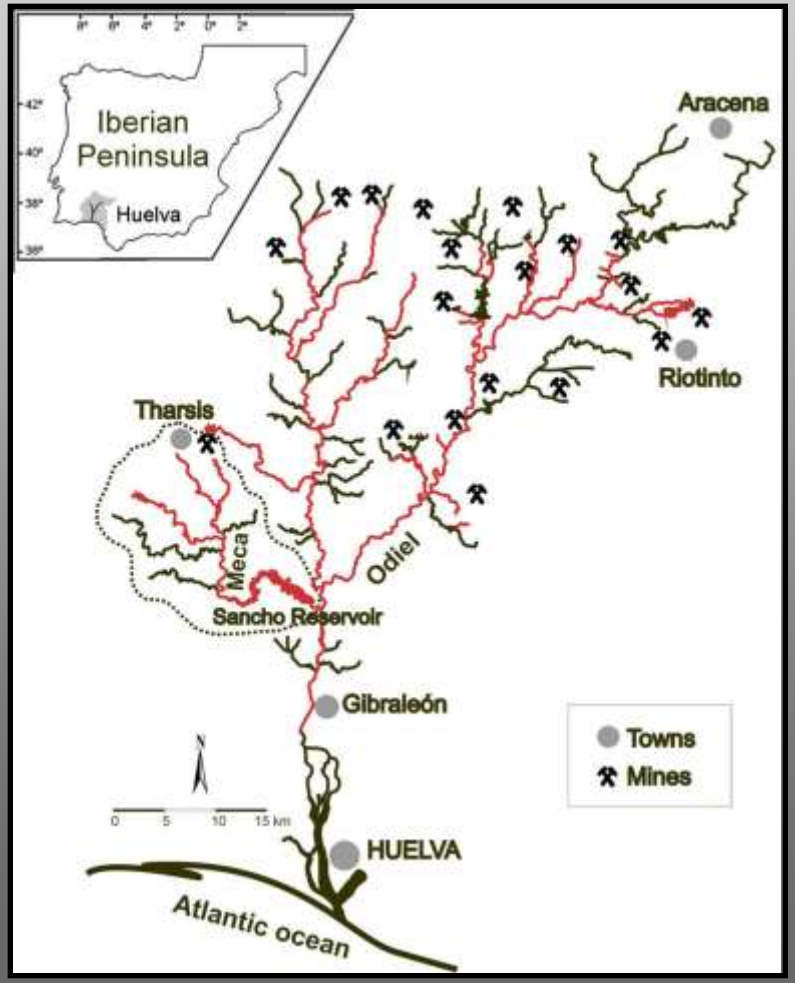
# Introduction

The Odiel river drainage network is highly contaminated by acid mine drainage




To assess the contaminant load transported by Odiel river is important to have water quality analysis and spatial and temporal continuous flow data

SWAT is used to generate flow series data for the Odiel basin.

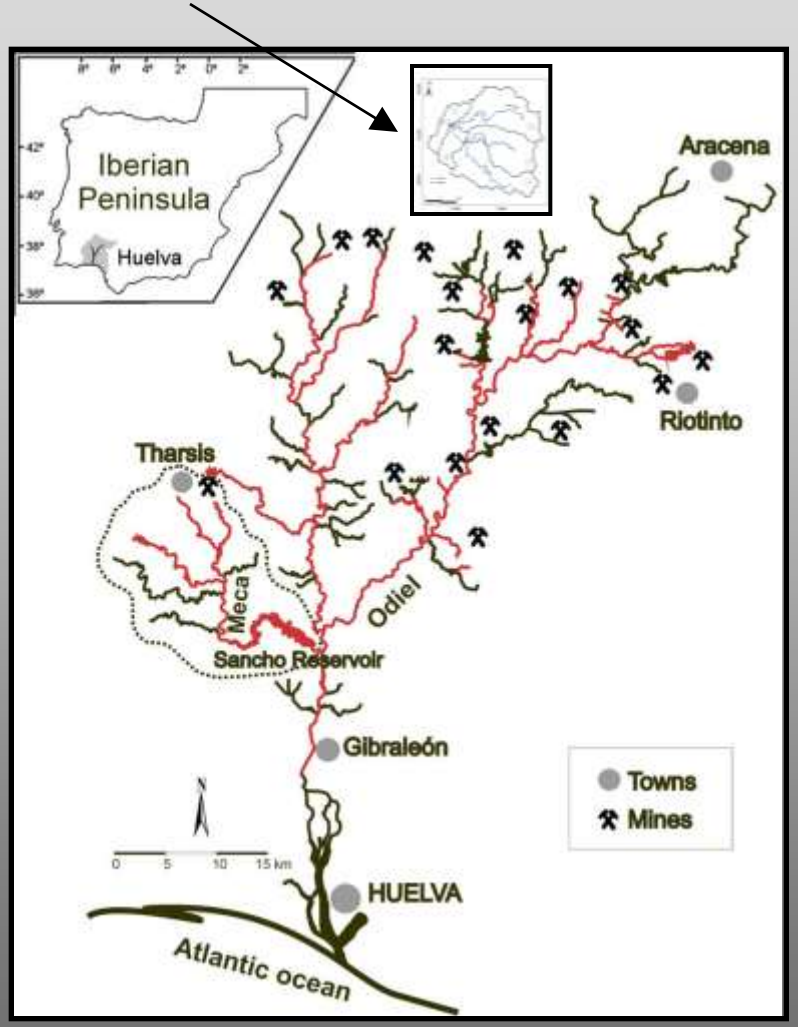
To calibrate this model only two points with streamflow data were used, both located at the south zone of the basin.

Good results were obtained (NSE = 0.75 monthly level)

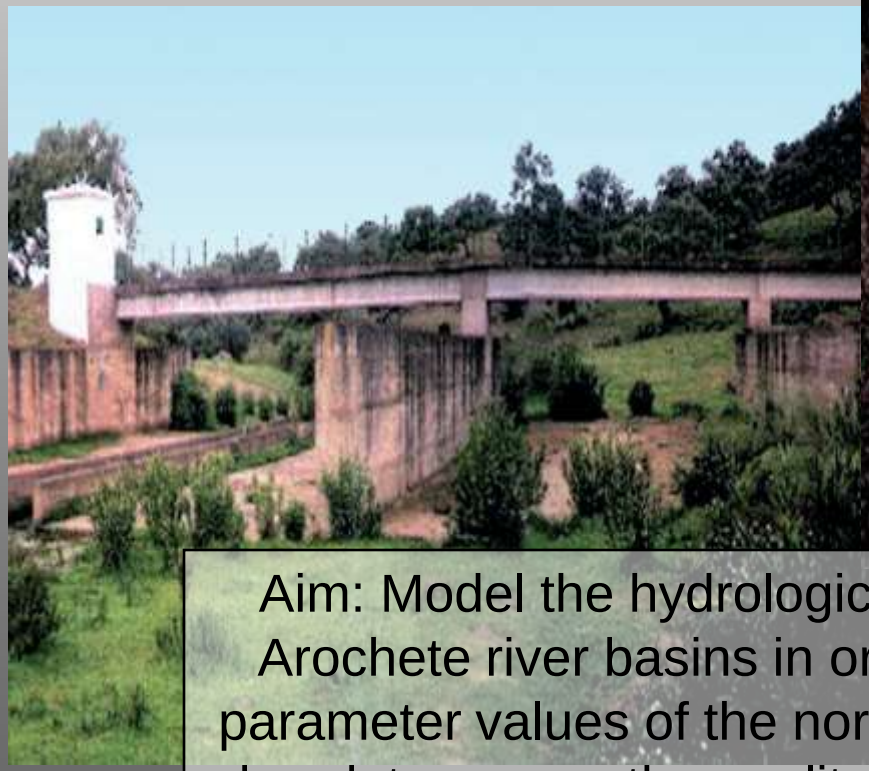
Despite of good results is necessary some points to calibrate the model in the north area

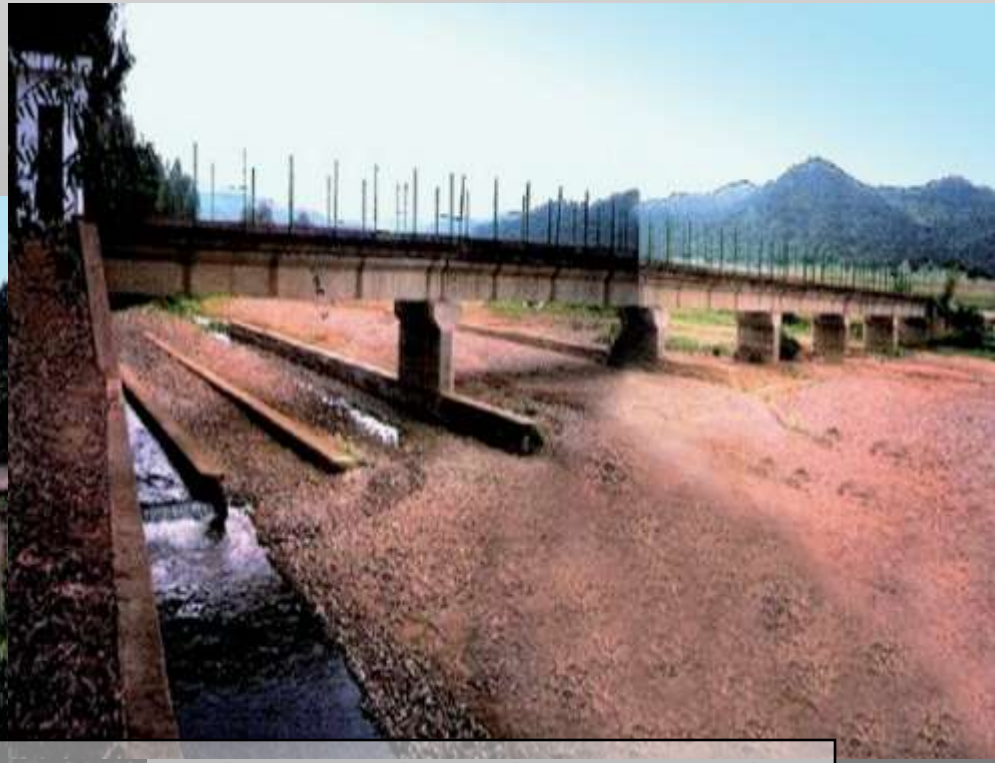
Why? Because there are carbonate materials outcropping in the north of the basins and present hydrogeological behaviour different from the rest of the basin

For this, bordering the north of the Odiel basin and with similar characteristics, two stream-gauge stations are found.



The stream-gauge stations are placed over Chanza and Arochete rivers



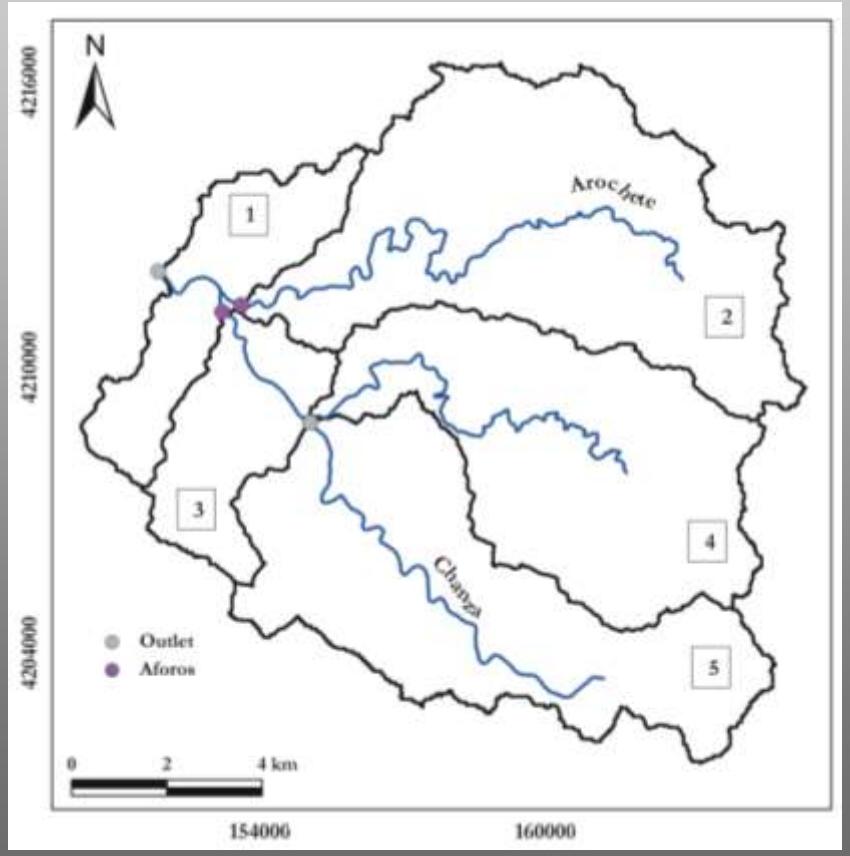


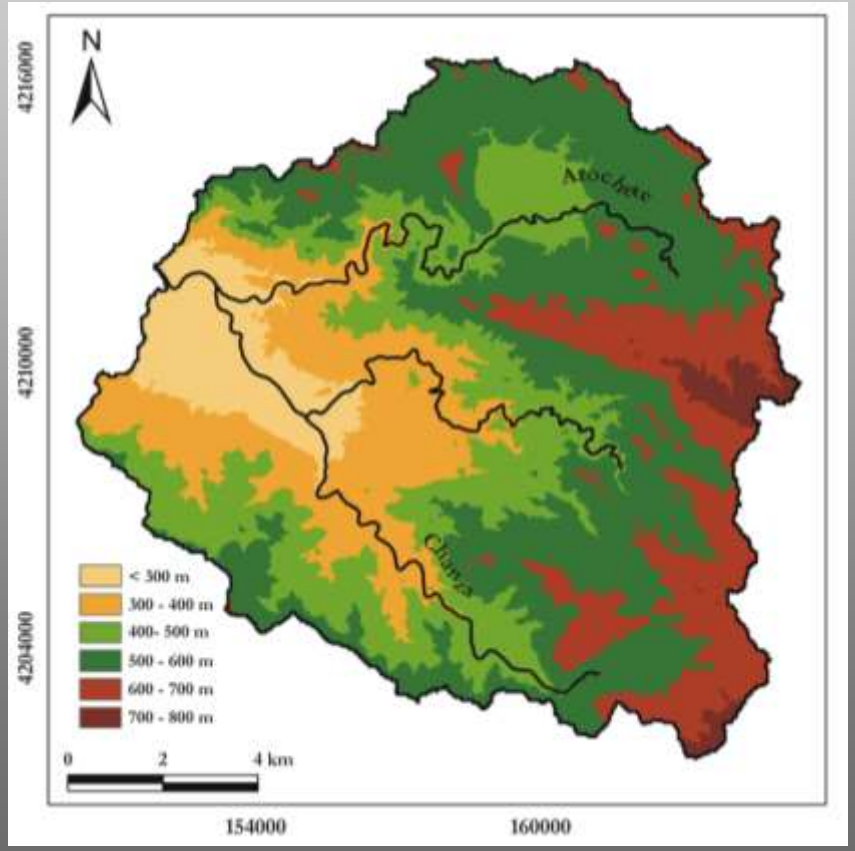
Aim: Model the hydrological behaviour of the Chanza and Arochete river basins in order to obtain the representative parameter values of the north of the Odiel basin, by the other hand, to assess the quality of the available streamflow data

# Study area

Chanza basin has a surface area of 87 $km^2$ and Arochete basin has 46 $km^2$

The maximum altitude is 762 m and its mean height  548 m



# Study area

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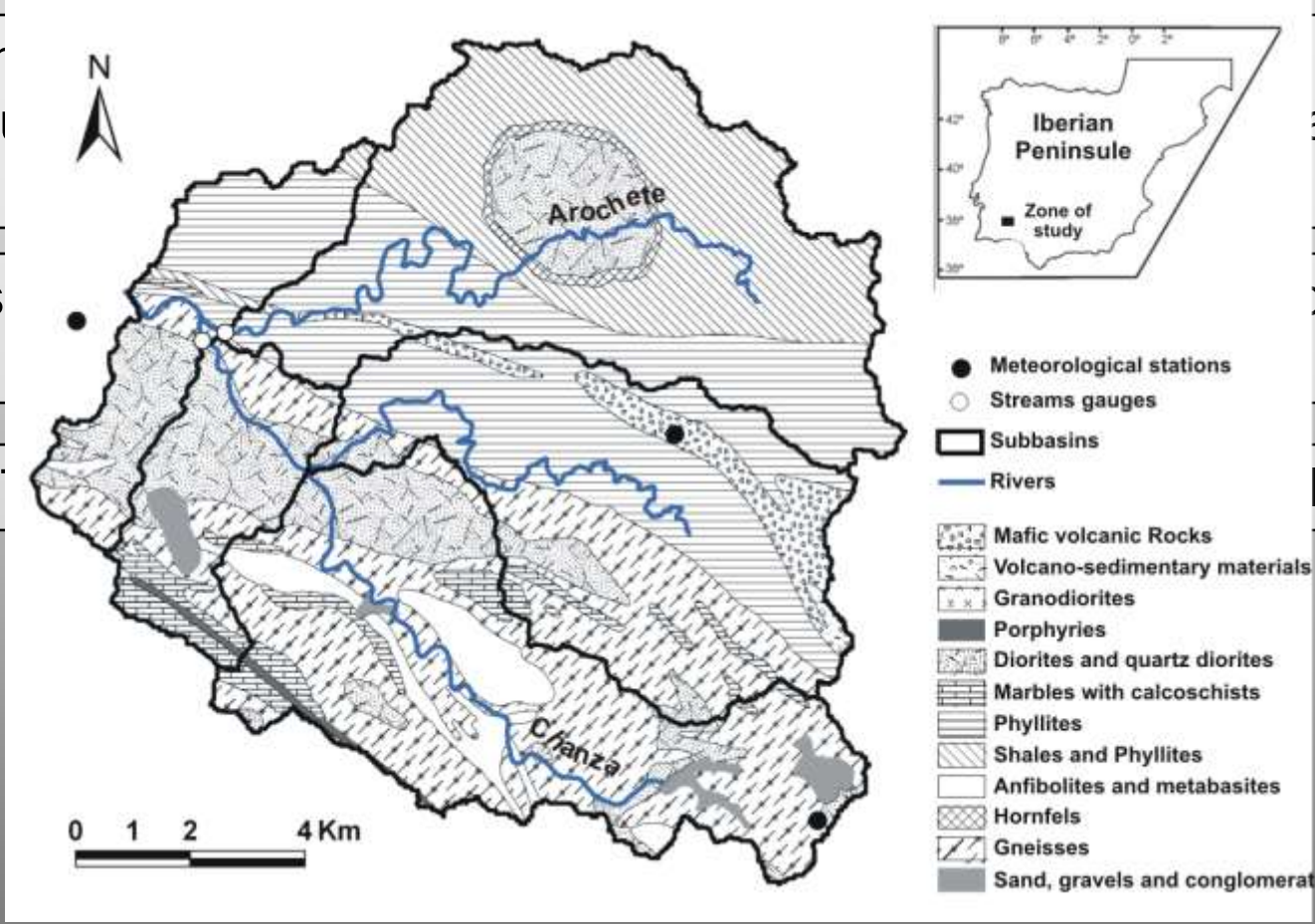
interannu… ature is

Land us… cultural

Soil: T… lisol

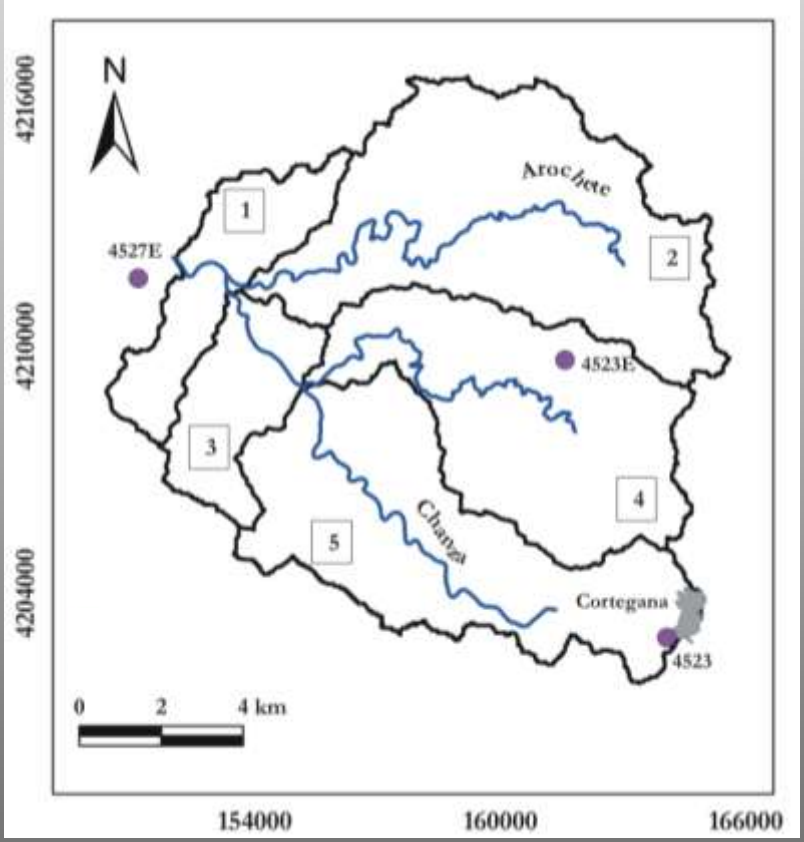



The carbonate materials (marbles) are more abundant in the Chanza subbasin

The software SWAT 2005 and the extension of ArcGIS 9.2 called ArcSWAT 2.1.6 has been used.

- The Digital Elevation Model (DEM) has a spatial resolution of 10 m/pixel
- The subbasins have been established with a threshold area value of 800 ha, obtaining five subbasins.
- The land use map comes to the photointerpretetion of a flight realized in 1999
- The soil information was obtained from edaphic study of the zone.
- 157 HRU's generated with a threshold of 2% for land uses, soil and slope

Three meteorological stations exist with rainfall and minimum and maximum temperature daily data.




The potencial evapotranspiration is calculated using Hargreaves methods.

To account the oragraphic effects on precipitacion is established an oragraphic rainfall gradient of 0.79 mm/m

# Results and discussion

**Table .** Object parameter calibration and obtained values for manually calibration

| Parameter | Descripiton | Chanza | Arochete |
|---|---|---|---|
| GW_DELAY | Groundwater delay time (days) | 70 | 70 |
| ALPHA_BF | Baseflow alpha factor (days) | 0.024 | 0.048 |
| GWQMN | Threshold depth of water in the shallow aquifer required for return flow (mm $H_2O$) | 1500 | 1500 |
| GW_REVAP | Groundwater “revap” coefficient | 0.02 | 0.02 |
| REVAPMN | Threshold depth of water in the shallow aquifer for “revap" (mm $H_2O$) | 1 | 1 |
| RCHRG_DP | Deep aquifer percolation fraction | 0.05 | 0.05 |
| SURLAG | Surface runoff lag coefficient | 0.15 | 0.15 |
| ESCO | Soil evaporation compensation factor | 0.01 | 0.01 |
| CN2 | SCS runoff number | -30% | -30% |
| SOL_AWC | Available water capacity of the soil layer (mm $H_2O$/ mm soil) | 25% | 25% |

**To assess the fit quality between measured and simulated flows has been calculated several statistical index: Pearson correlation coefficient, efficient coefficient of Nash and Sutcliffe, mean square error and runoff volume deviation**

**Table 4.** Statistics index values (daily) to calibration period for manually calibration

| | Manually calibration | |
|---|---|---|
| **Index** | **Chanza** | **Arochete** |
| **r** | 0.69 | 0.63 |
| **NSE** | 0.46 | 0 |
| **RMS ($m^3/s$)** | 0.92 | 0.37 |
| **DV** | 1.02 | 1.31 |

# Results and discussion

To optimize the manually calibration the autocalibration program SWAT-CUP (SUFI-2) has been applied.

**Table.** Inicial range, optimizad range and optimized value of SWAT-CUP and SUFI-2. The letter at the beginning of the parameter name means: *v* the existing parameter value is to be replaced by a given value; *a* a given quantity should be added to the existing parameter value; and *r* the existing parameter value should be multiplied by a given value.

**Table.** Statistics index values (daily) for calibration period.

| | | SWAT CUP | | | |
|---|---|---|---|---|---|
| | | Index | Chanza | Arochete | Arochete |
| Parameter | Initial Range | Optimized Range | Optimized value | Optimized Range | Optimized value |
| v_GW_DELAY | 0 - 80 | 66.78 - 80.32 | 75.58 | 7.37 - 17.14 | 12.41 |
| v_ALPHA_BF | 0 - 1 | 0.13 - 0.71 | 0.28 | 0.38 - 1 | 0.51 |
| a_GWQMN | 0 - 1500 | 400 - 1202 | 2261 | 383 - 1016 | 2666 |
| v_GW_REVAP | 0.02 - 0.2 | 0.02 - 0.02 | 0.02 | 0.02 - 0.02 | 0.02 |
| v_REVAPMN | 1 - 500 | 159 - 481 | 305 | 339 - 569 | 391 |
| v_RCHRG_DP | 0 - 1 | 0.063 - 0.65 | 0.33 | 0.44 - 0.79 | 0.612 |
| v_SURLAG | 0.15 - 4 | 1 - 5 | 1.18 | 0.79 - 2.93 | 4.34 |
| v_ESCO | 0.01 - 1 | 0.070 - 0.64 | 0.035 | 0.02 - 0.48 | 0.015 |
| r_CN2 | -25 % - 25% | - 4.8% - 0.5% | -2% | - 95% - 36% | -43% |
| r_SOL_AWC | -25 % - 25% | -4% - 38% | 6.50% | 6.5% - 50% | 28% |

| | Chanza | Arochete |
|---|---|---|
| r | 0.76 | 0.74 |
| NSE | 0.54 | 0.52 |
| RMS ($m^3/s$) | 0.85 | 0.25 |
| DV | 0.95 | 1.13 |

The presence of the carbonates materials in the Chanza basin has been reflected in the value of the ALPHA_BF, indicating the presence of material with slow response to recharge.

SWATCUP increase RCHRG_DP in both subbasin without apparent reason, especially in Arochete river. In the area there is a small aquifer , but in the rest of the basin there is not outcropping of aquifer materials. Therefore, there is no possibility of a significant amount of water flowing from the studied basins to others through deep flow

**Table.** Average annual basin values for Chanza and Arochete river (in mm)

| | **Chanza** | **Arochete** |
|---|---|---|
| PRECIP | 726.3 | 775.5 |
| SURFACE RUNOFF Q | 23.07 | 1.16 |
| LATERAL SOIL Q | 74.92 | 103.69 |
| GROUNDWATER Q | 8.14 | 0 |
| REVAP | 17.99 | 8.57 |
| DEEP AQ RECHARGE | 52.98 | 108.26 |
| TOTAL AQ RECHARGE | 162.04 | 177.01 |
| ET | 462.1 | 488.7 |
| TRANSMISSION LOSSES | 0.73 | 0.05 |

Even though an acceptable fit have been obtained between measured and simulated flows, the specific flows obtained are low:

Chanza = 3.07 L $s^{-1}$ $km^{-1}$

Arochete = 3.11 L $s^{-1}$ $km^{-1}$

Basins with similar characterisitics (more humid mean annual rainfall of 922 mm):

Múrtigas = 12.8 L $s^{-1}$ $km^{-1}$

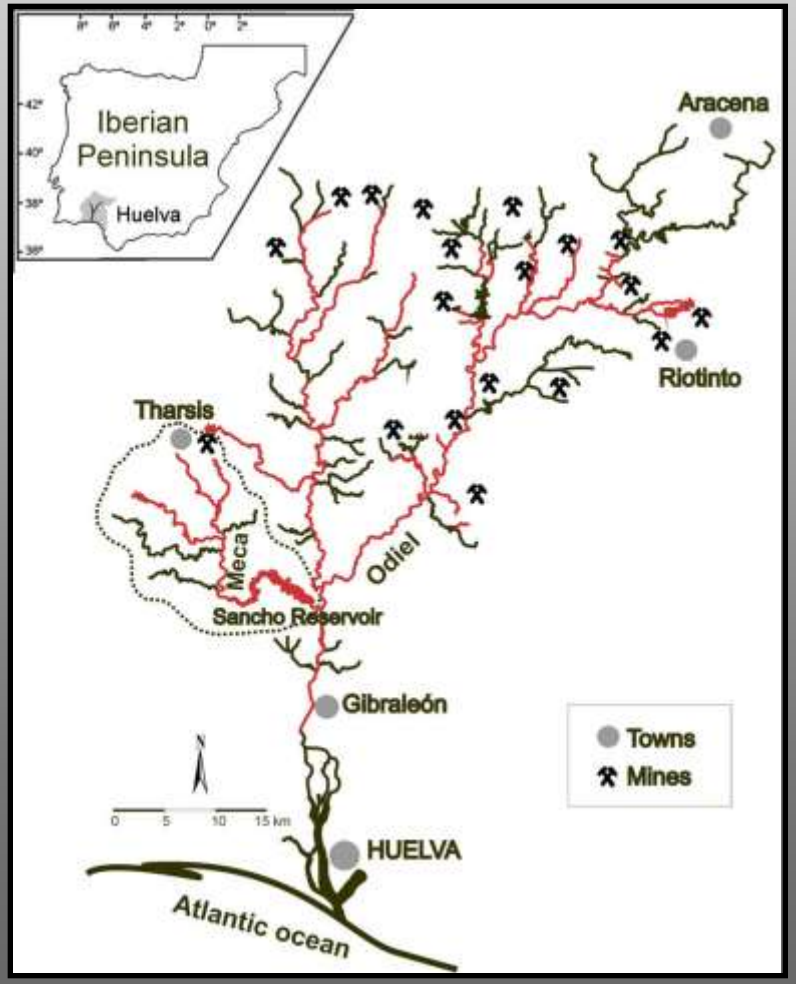
Caliente = 10.6 L $s^{-1}$ $km^{-1}$

Meca basins with mean altitude of 152m and mean annual rainfall of 632 mm:

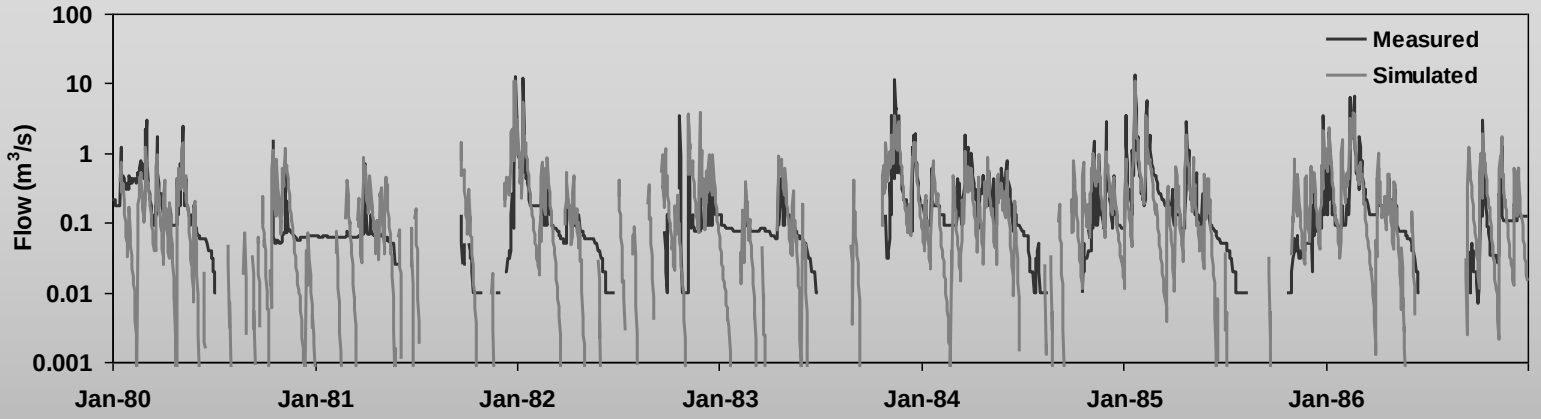
Meca = 5.4 L $s^{-1}$ $km^{-1}$

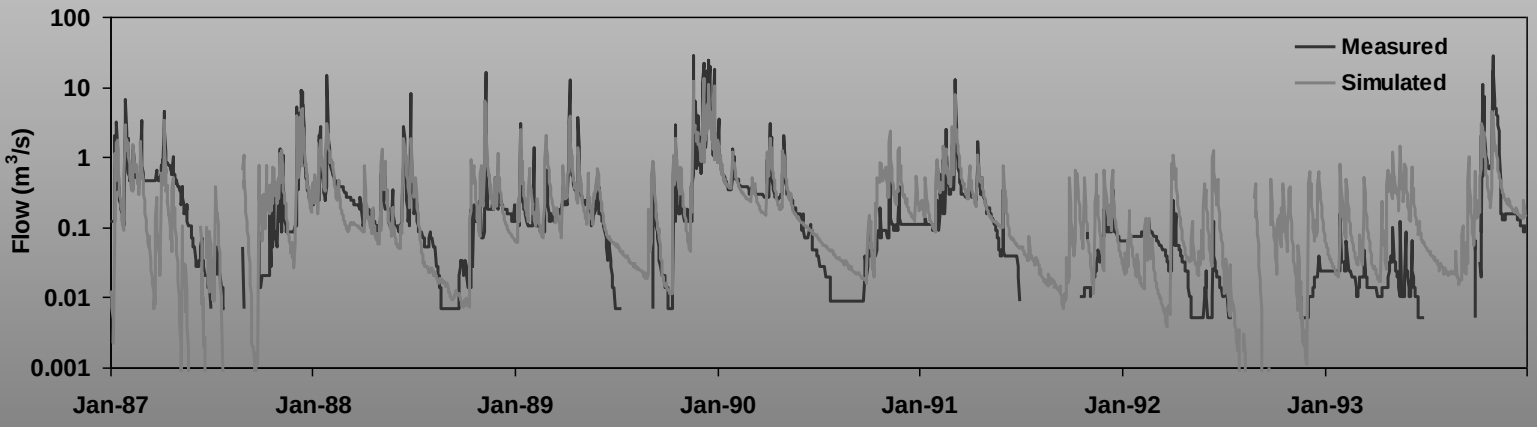
Odiel river basins with mean altitude of 270 m:

8.4 L $s^{-1}$ $km^{-1}$



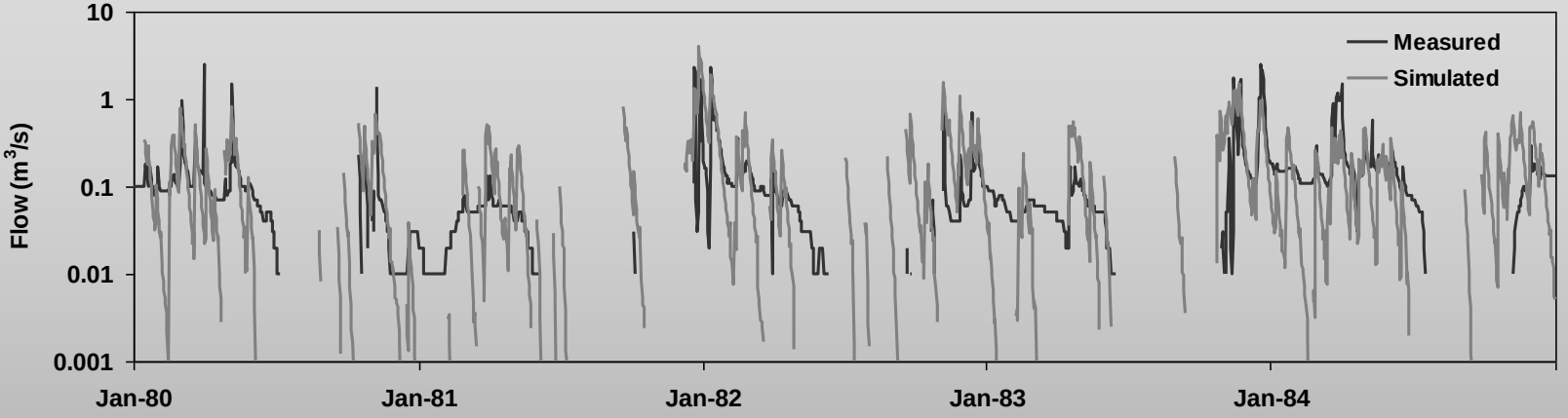
# Results and discussion

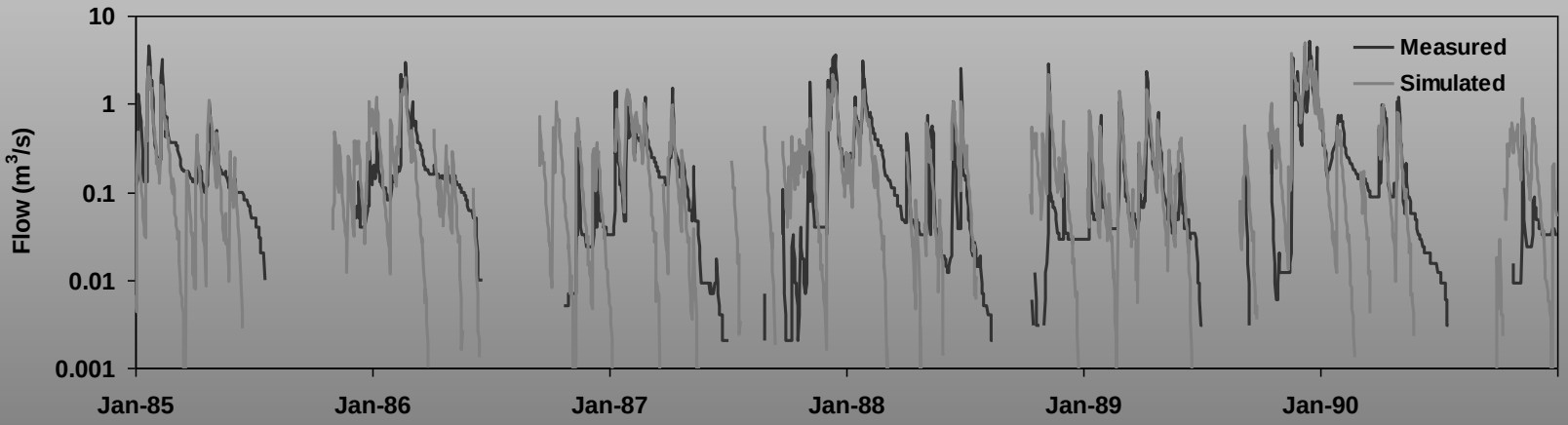



Daily evolution of measured and simulated flows for Chanza river. Calibration with SWAT-CUP.

# Results and discussion




The streamflow data in both basins are of poor quality and are highly underestimated. Therefore, these data are not reliable to calibrate the model, reason why the validation has finally not been carried out.

# Conclusions

In the manual calibration, insatisfactories values of NSE, according to Moriasi et al., (2007), were obtained in both Chanza and Arochete rivers.

To optimize the manually calibration the autocalibration program SWAT-CUP (SUFI-2) has been applied obtaining satisfactory daily values (Moriasi et al., 2007).

Parameter ALPHA_BF reaches a value of 0.28 in the Chanza subbasin which indicates the presence of aquifer materials with a slow response to recharge.

Despite the results achieved by SWAT-CUP, it is important to point out the need of the software to reduce the flow by reducing the variable CN2, increasing SOL_AWC, and unjustified increasing RCHRG_DP.

The specific flow in both subbasins is low when compared with other watersheds with similar characteristics what point outs the bad quality of stream flow data used in the calibration.

The results obtained in this work show the need of stream-gauges stations in the area with spatial and temporal continuous recorded flows, i.e. with good quality, that would allow to reproduce the hydrological behaviour of the basins.

# *Thanks for your attention!!*

***Acknowledgements***

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