SWAT 2015
PULA / SARDINIA / ITALY

Hydrological impact assessment of the Guadalupe River Basin (Mexico) under climate change scenarios

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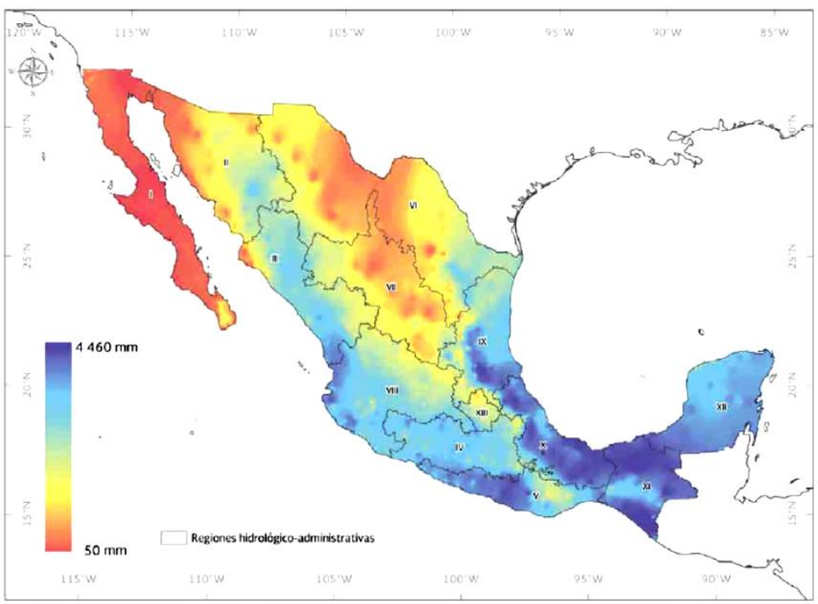
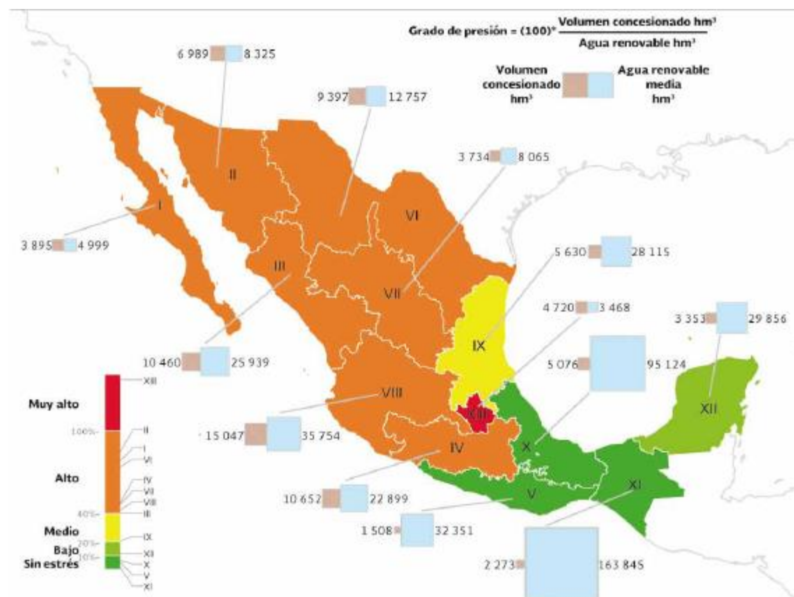
Introduction

Water issues in Northwest Mexico

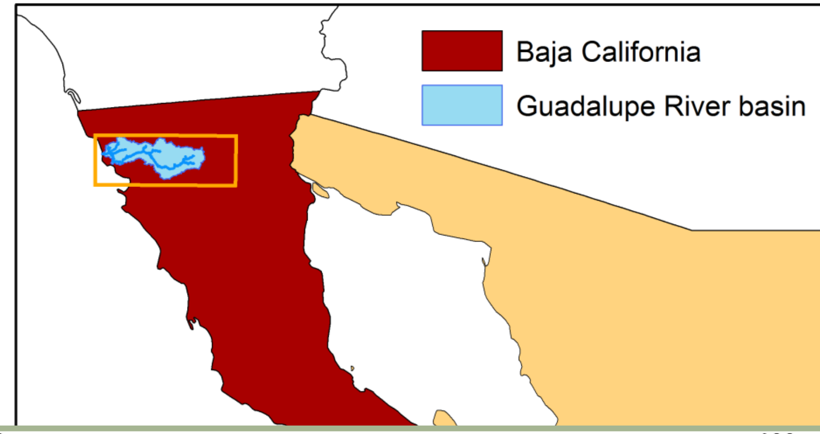
- Semiarid climate
- Recurrent droughts since 1994
- Increasing pressures because of population growth
- Particularly vulnerable to climate change

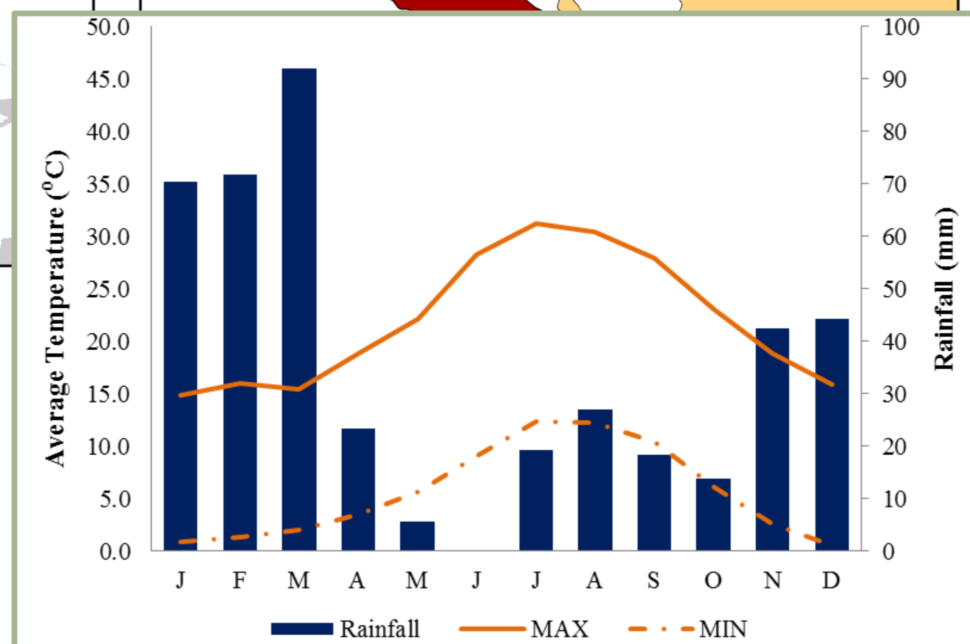




Conagua (2013)

Guadalupe River basin

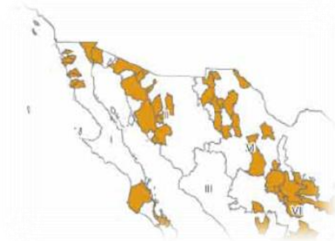




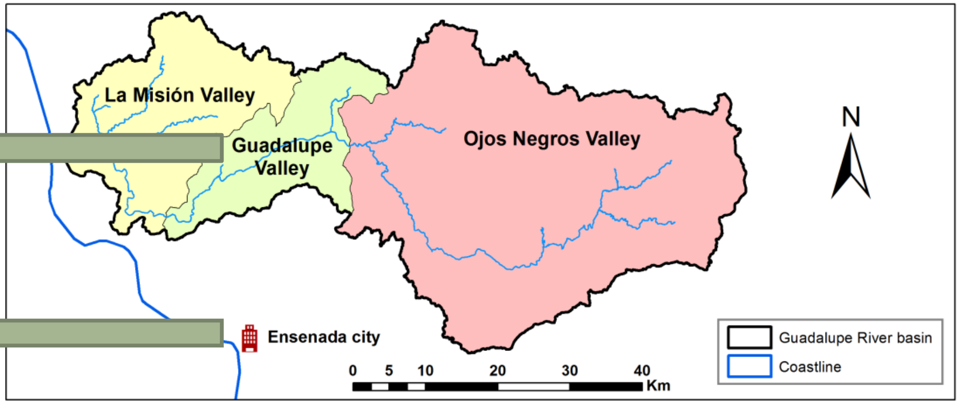
- Area: 2380 km²
- Rainfall ranges from 12 to 750 mm (average ≈ 300 mm)
- Monthly temperature: 0.6 – 30 °C

Guadalupe River basin

- 90% of Mexican wine production



- Aquifers declared overexploited



- 30% of Ensenada city supply

- P ⇩ 10-20%
- T ⇧ 1.5 – 2.5 °C

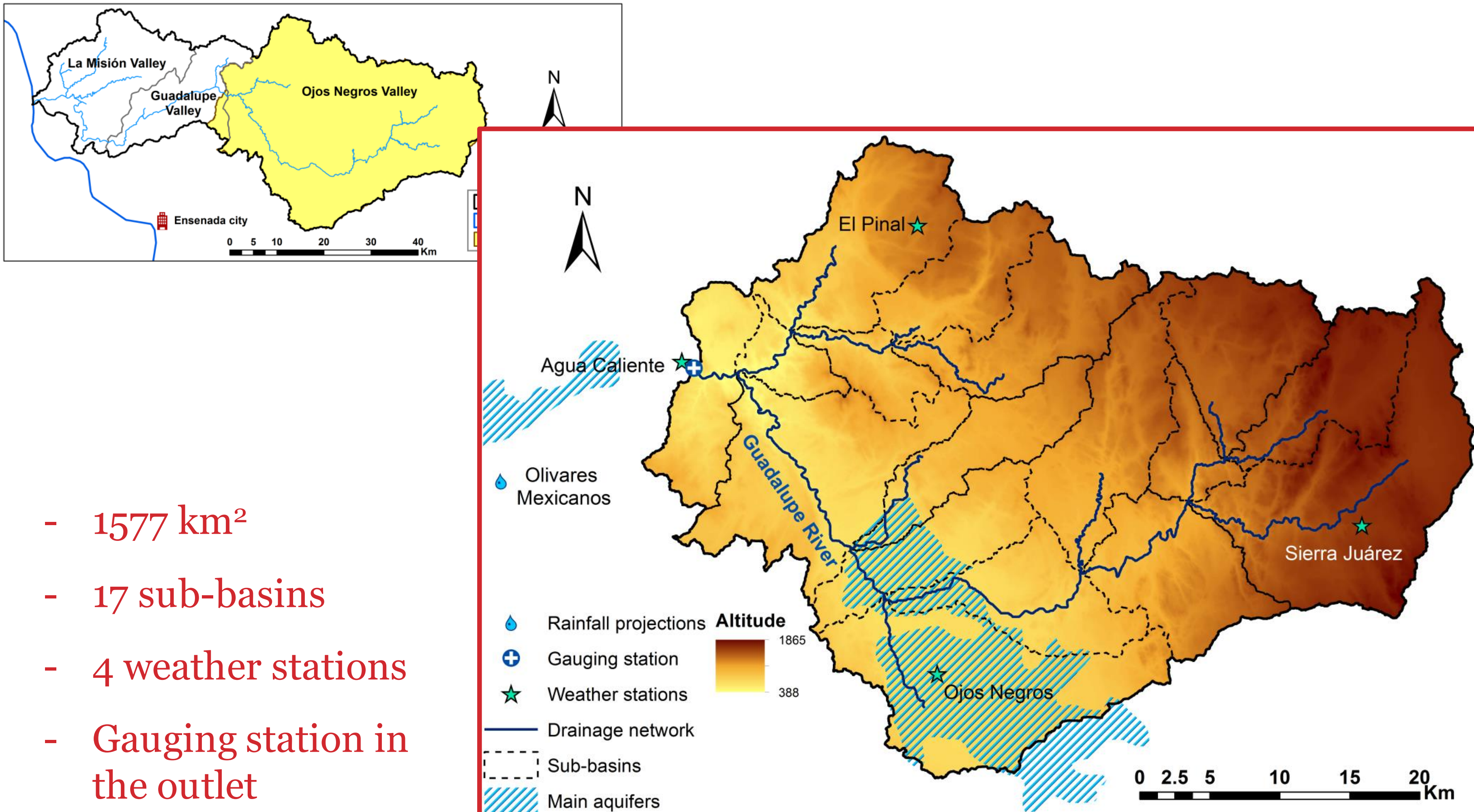
(next 50 years)

Objective

- Assess the potential impact of climate change in the Guadalupe River basin with SWAT
  - Set-up the SWAT model in the basin for hydrology
  - Evaluate the impact of climate change scenarios
  - Quantify impacts in dry, normal and wet years

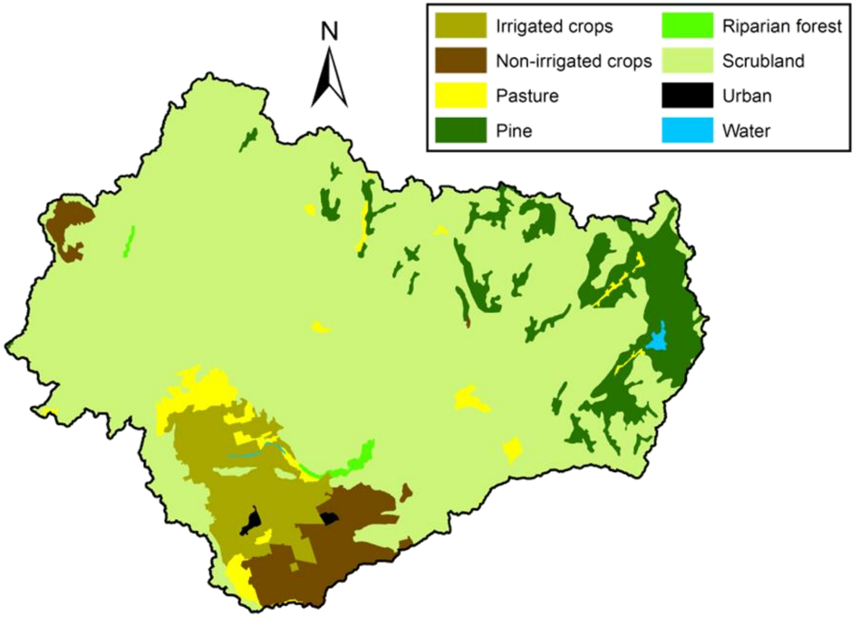
Methodology

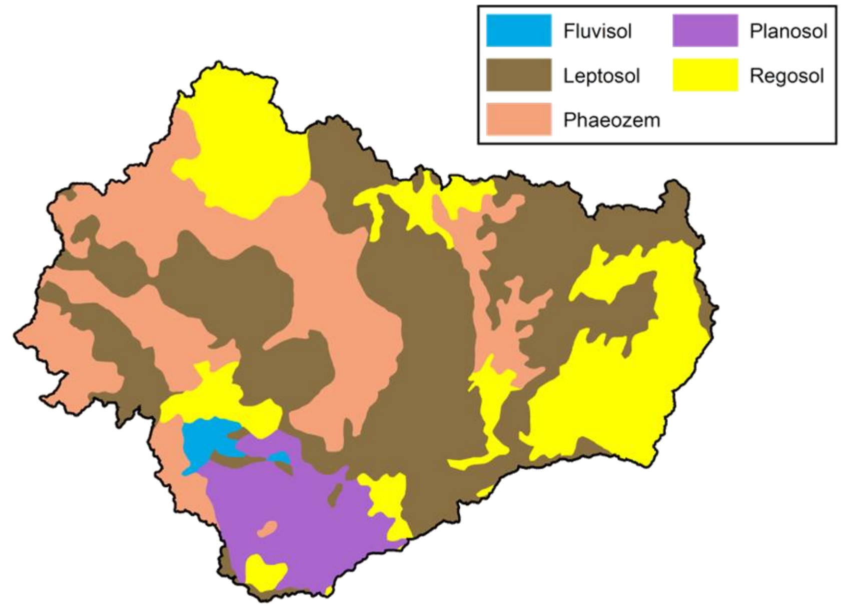
Model Set-up

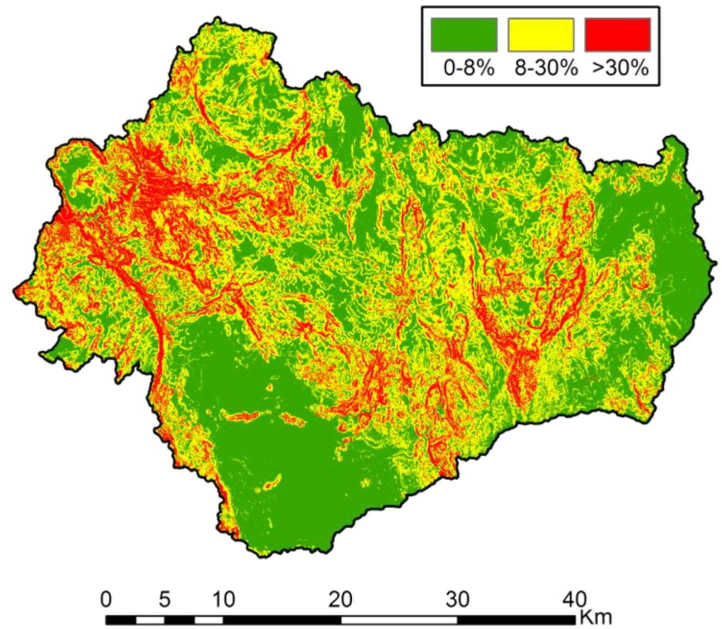


- 1577 km²
- 17 sub-basins
- 4 weather stations
- Gauging station in the outlet

Model Set-up







- Threshold levels: 10%-10%-10%
- 136 HRUs (4-15 per sub-basin)

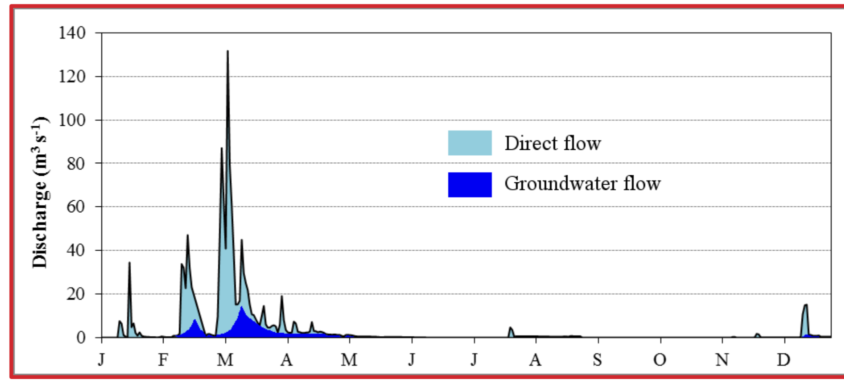
Calibration and validation

DRY years: P < P_{avg}-15%

NORMAL years: P_{avg}-15% < P < P_{avg}+15%

WET years: P > P_{avg}+15%

Hydrograph separation (1978)



1973-1974 | 1975-1981 | 1982-1986

SKIP | CALIBRATION | VALIDATION

LH-OAT (280 runs) SWAT-CUP (SUFI2, 2500 runs)

Climate change scenarios

- Projections from PEACC (2008)
  - **Precipitation:** Monthly values based on daily projections at "Olivares Mexicanos" station
  - **Temperature:** Seasonal projections for the city of Ensenada

4 SCENARIOS:

Low & High emissions

2010-2039 & 2070-2099

Results and discussion

Model performance

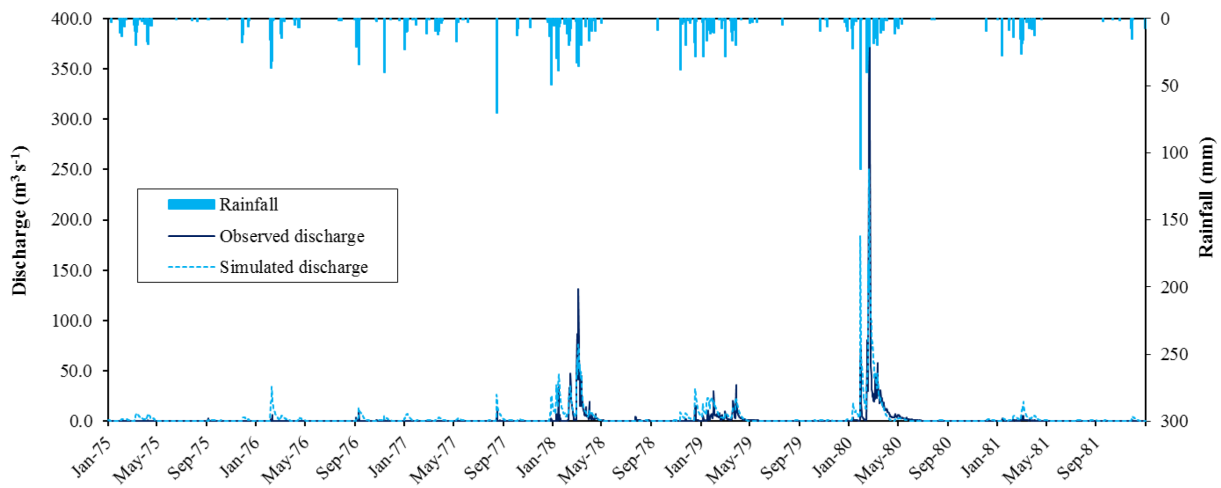
- Sensitivity analysis and auto-calibration:

Parameter	Description	Initial Value	Best Value
ALPHA_BF (days)	Baseflow recession coefficient	0.048*	0.441
CH_K2 (mm h^{-1})	Effective hydraulic conductivity in main channel alluvium	0.0*	89.4
CN2	Initial Soil Conservation Service runoff curve number for moisture condition II	25-89	20-70
ESCO	Soil evaporation compensation factor	0.95*	0.05
GWQMN (mm)	Threshold depth of water in the sallow aquifer for return flow	1000	370
GW_REVAP	Groundwater "revap" coefficient	0.15	0.16
RCHRG_DP	Deep aquifer percolation fraction	0.05	0.13
REVAPMN (mm)	Threshold depth of water in the shallow aquifer for "revap"	500	339
SOL_AWC (1-4) (mm mm^{-1})	Available water capacity	0-0.17	0-0.22
SOL_K (1-4) (mm h^{-1})	Saturated hydraulic conductivity	0-550	0-113
SOL_Z (1-4) (mm)	Depth from soil surface to bottom of layer	102-1524	125-1872
SURLAG	Surface runoff lag coefficient	4.0*	0.28

*Default values

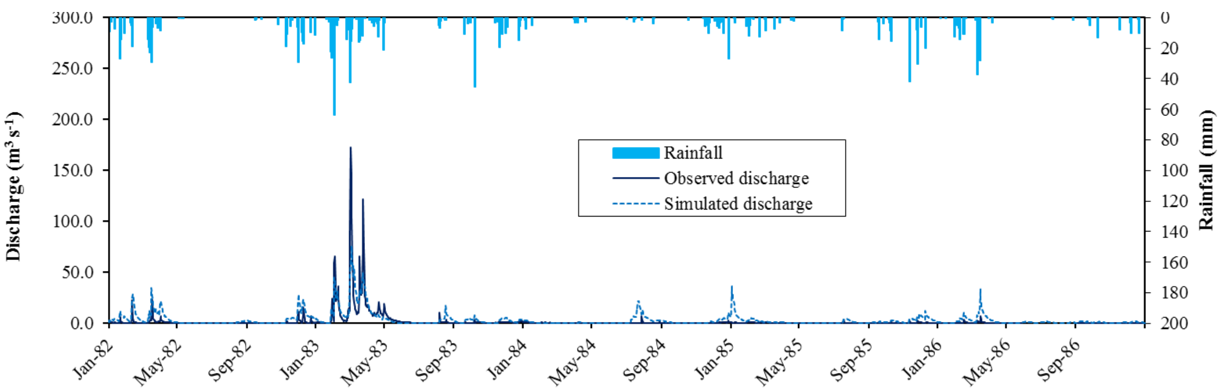
Model performance

- Daily calibration and validation:



	Daily	Monthly
R^2	0.67	0.91
NSE	0.66	0.86
RSR	0.58	0.38
"Very Good"		

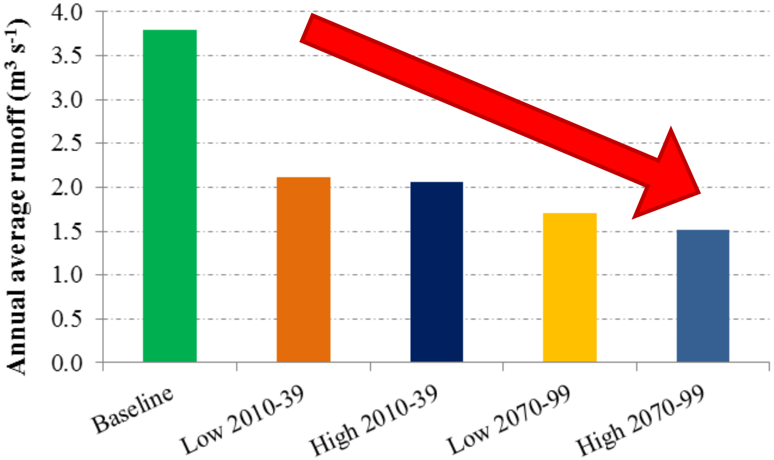
(Moriasi et al., 2007)



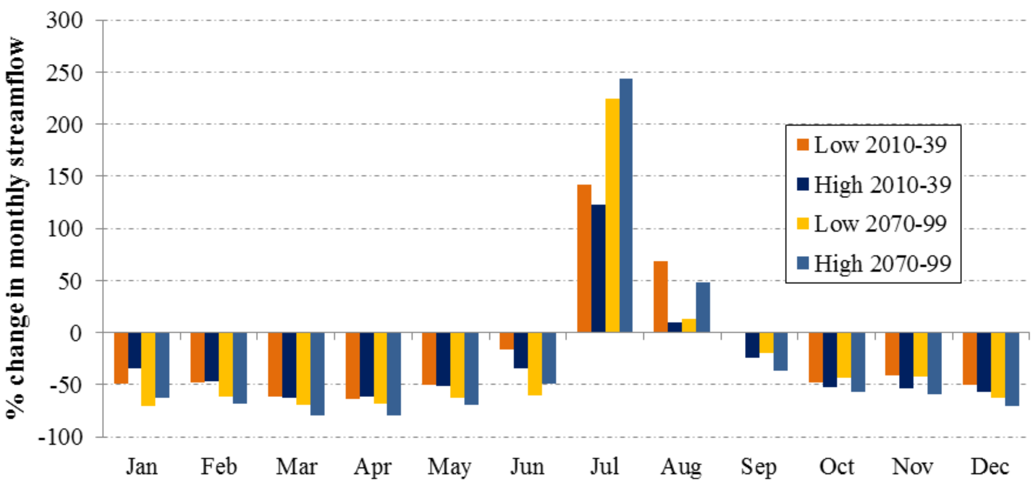
	Daily	Monthly
R^2	0.55	0.82
NSE	0.52	0.76
RSR	0.69	0.49
"Very good"		

(Moriasi et al., 2007)

Climate Change Impacts



- ❖ Discharge decreases with CC, up to ≈60%
- ❖ Main driver: P, along with increased ET
- ❖ Runoff: very sensitive to ⇩P

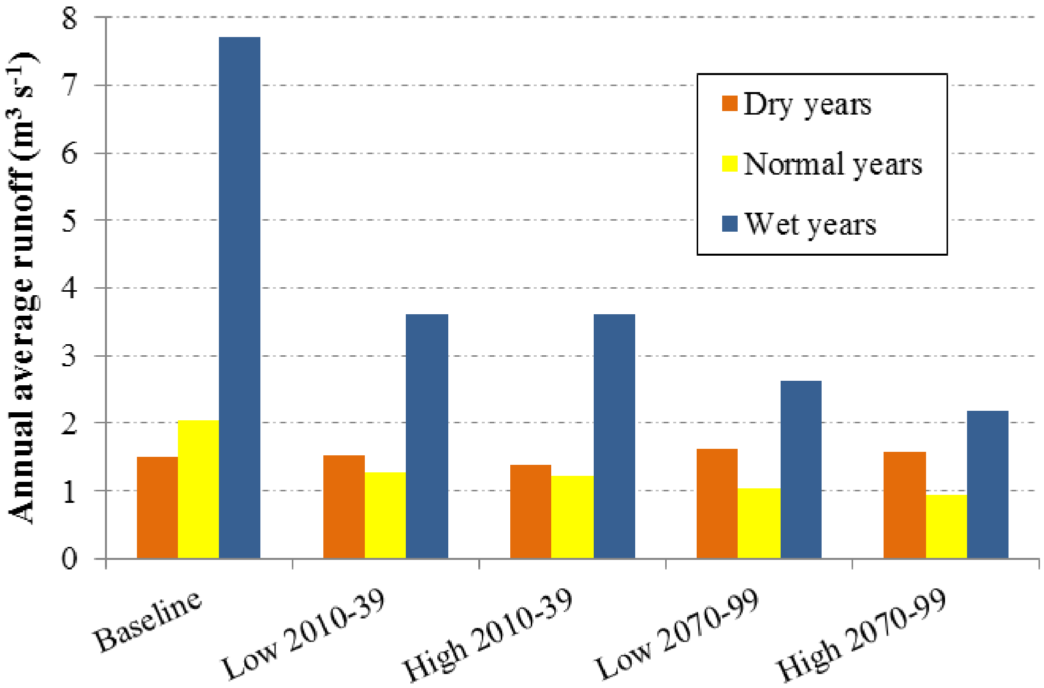


CHANGE IN COMPONENTS

- ❖ % of water loss via AET increases in all the scenarios
- ❖ Aquifer recharge decreases up to -74% in the worst case
- ❖ GW flow decreases from 21% to 4%

Climate Change Impacts

- Different year types contribution:

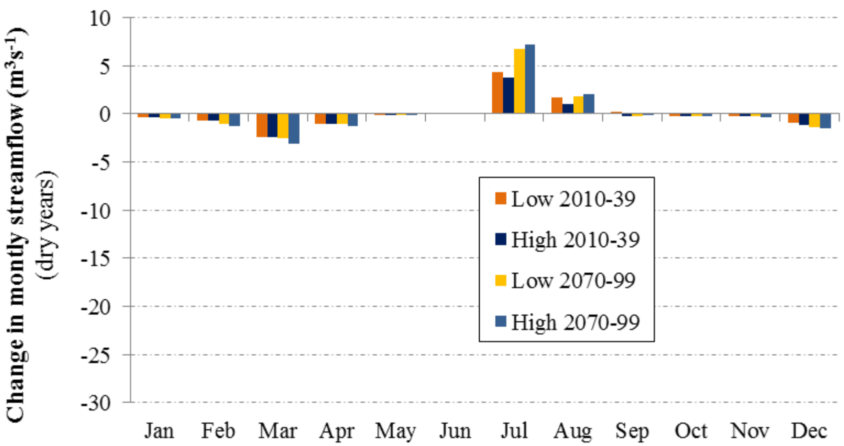


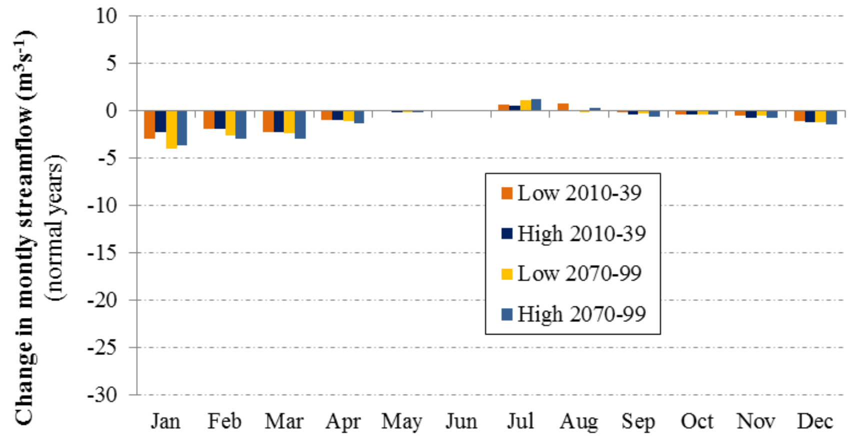
❖ Wet years: The most affected, Q reduction up to 72%

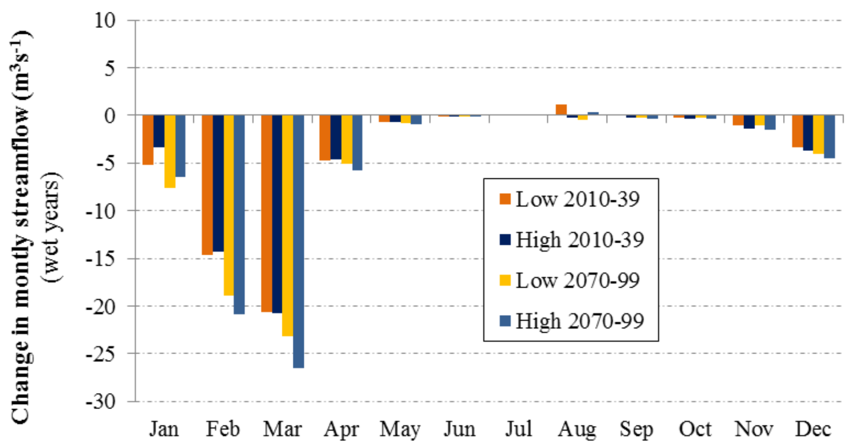
❖ Slight runoff increase during dry years

Climate Change Impacts

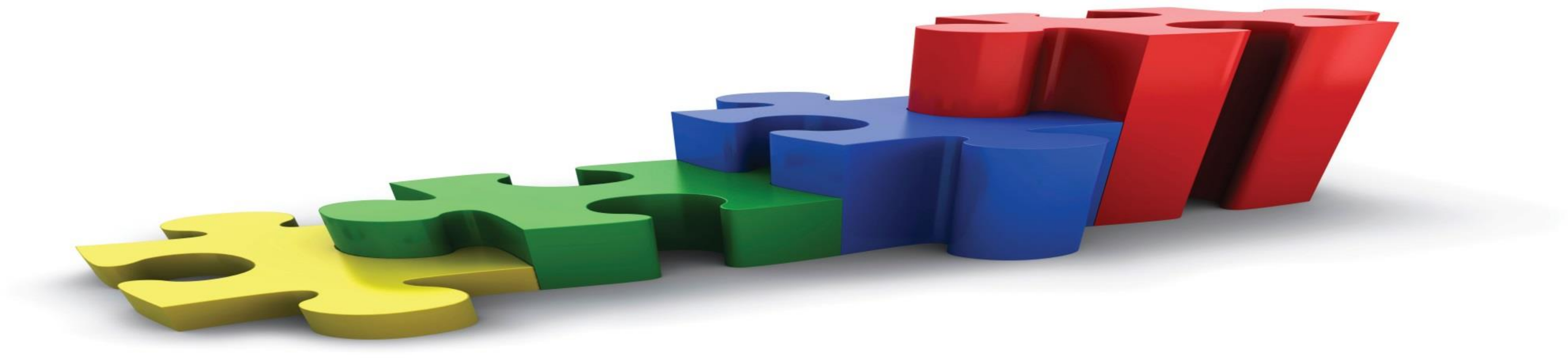
- Different year types contribution:







Conclusions



- The SWAT model has been applied in the upper Guadalupe River basin and it showed a general good performance.
- Climate change scenarios showed a noticeable impact on water flow, decreasing up to 60%. Groundwater contribution will be reduced.
- Wet years will be the most affected, especially during winter and spring.
- Simulated impacts may have strong implications in this region, where water resources are already under strong pressures.
- The model provides guidelines to decision makers and sets the possibility to test further scenarios.

Acknowledgements

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THANKS FOR YOUR ATTENTION!!

Grazie per l'attenzione!!