Analysis of future climate scenarios to assess regulatory and cultural ecosystem services using an integrated SWAT+ and GOTM-WET model

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Inmaculada C. Jiménez-Navarro, Adrián López-Ballesteros, Jorrit P. Mesman, Don Pierson, Dennis Trolle, Anders Nielsen, Javier Senent-Aparicio

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SMART LAGOON

Ecosystem services

- Provisioning
- Regulation
- Cultural

"Positive contribution to the people provided by nature itself"

Carpenter et al. 2009

AIMS:

- Study the evolution of RES in a watershed and its lagoon (Mar Menor) under two climate scenarios

Climate change

SWAT+

GOTM-WET

CMIP6

SSPs

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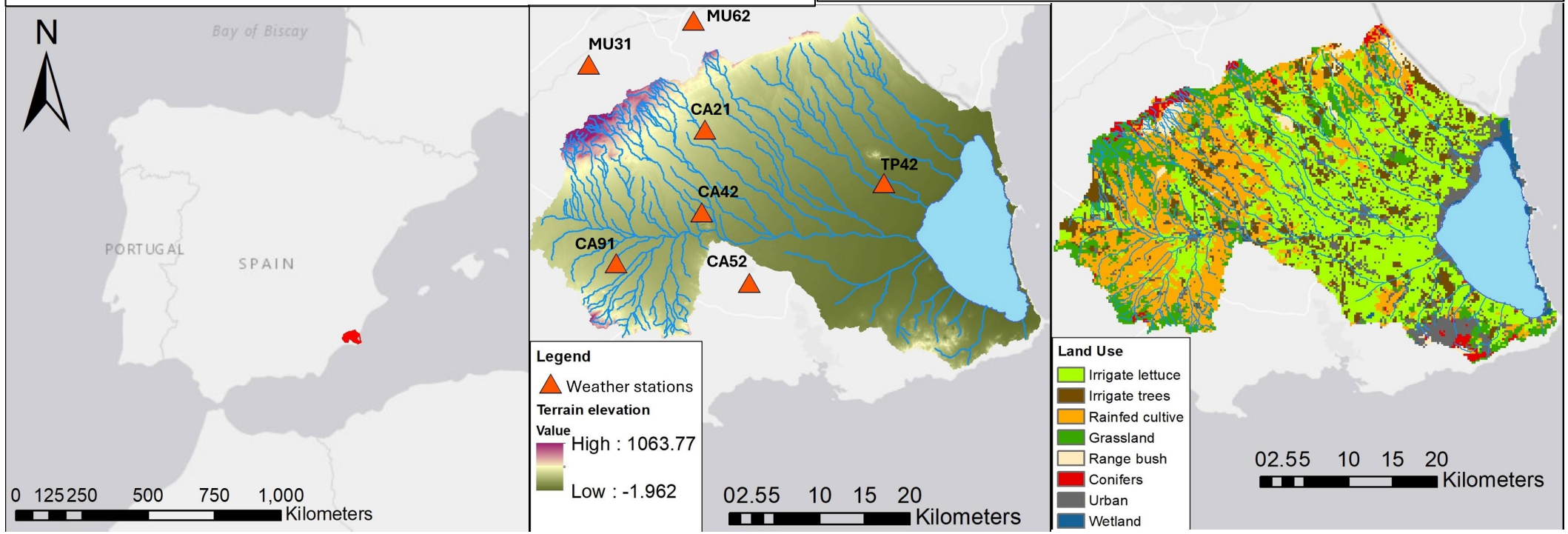
MAR MENOR

- Area 135 km2
- Average depth 4m, deepest point 7m
- Singular conditions: hypersaline and warm
- Eutrophication

CAMPO DE CARTAGENA

- Area 1600 km2
- Highly anthropized
- Irrigated agriculture
- Stacionary rivers and aquifers



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MAR MENOR

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RES of the watershed

- Soil erosion control (sediment yield)
- Natural hazard protection (daily outflow)
- Waterflow regulation (Green water and blue water)
- Mediation of nuisances of anthropogenic origin (nitrogen and phosphorus)

RES of the lagoon

- WATER CONDITIONS
  - Chlorophyll a
  - Water temperature
  - Oxygen concentration
  - Nitrogen concentration
  - Phosphorus concentration

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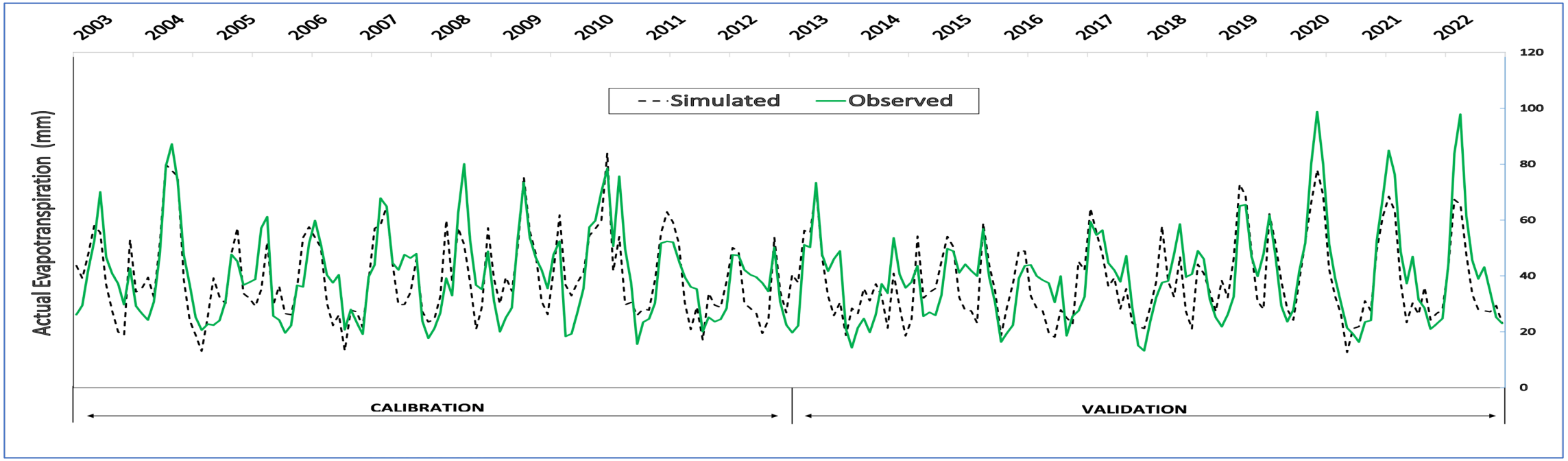
SWAT+ calibration



Monthly AET GLEAM 3.7b (2003 – 2022):

Calibration [2003-2012] (R^2 = 0.62, PBIAS = 1.86 %, NS = 0.59 and KGE = 0.77)

Validation [2013-2022] (R^2 = 0.63, PBIAS = 5.89 %, NS = 0.61 and KGE = 0.73)

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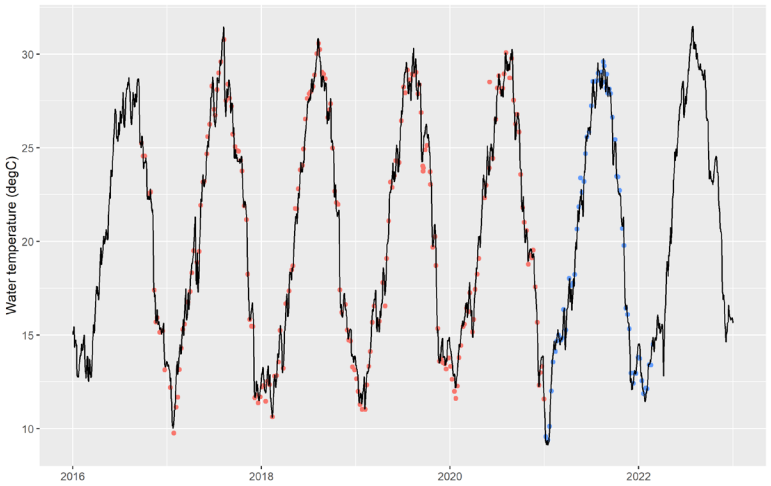
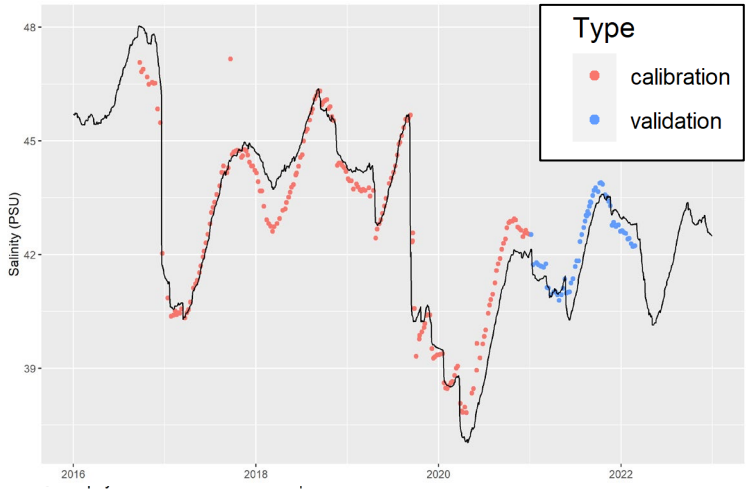
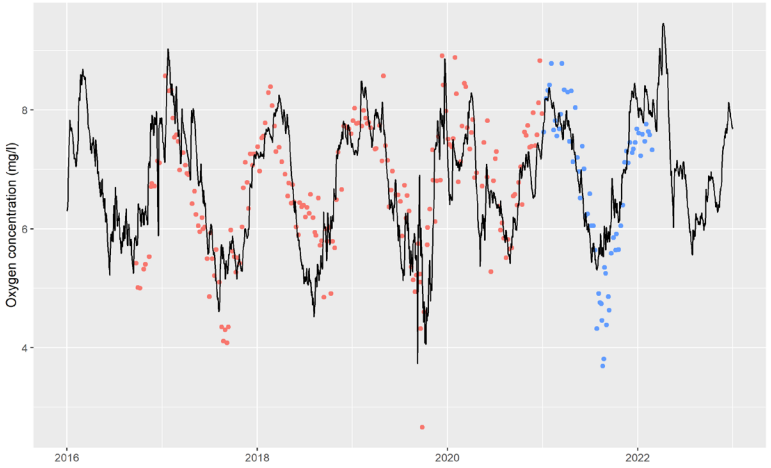
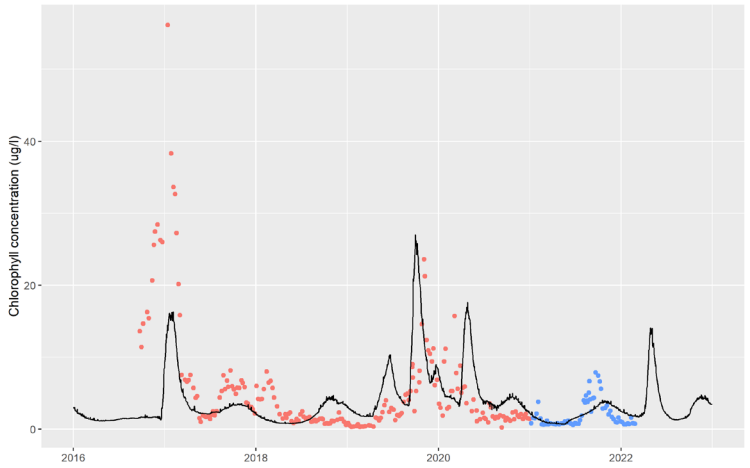
GOTM-WET calibration









Variable	Period	RMSE	NSE
Water temperature	Cal	0.561	0.992
	Val	0.414	0.996
Oxygen concentration	Cal	0.949	0.209
	Val	0.968	0.448
Salinity	Cal	0.864	0.863
	Val	0.936	0.007
Chlorophyll concentration	Cal	6.839	0.181
	Val	1.675	0.195

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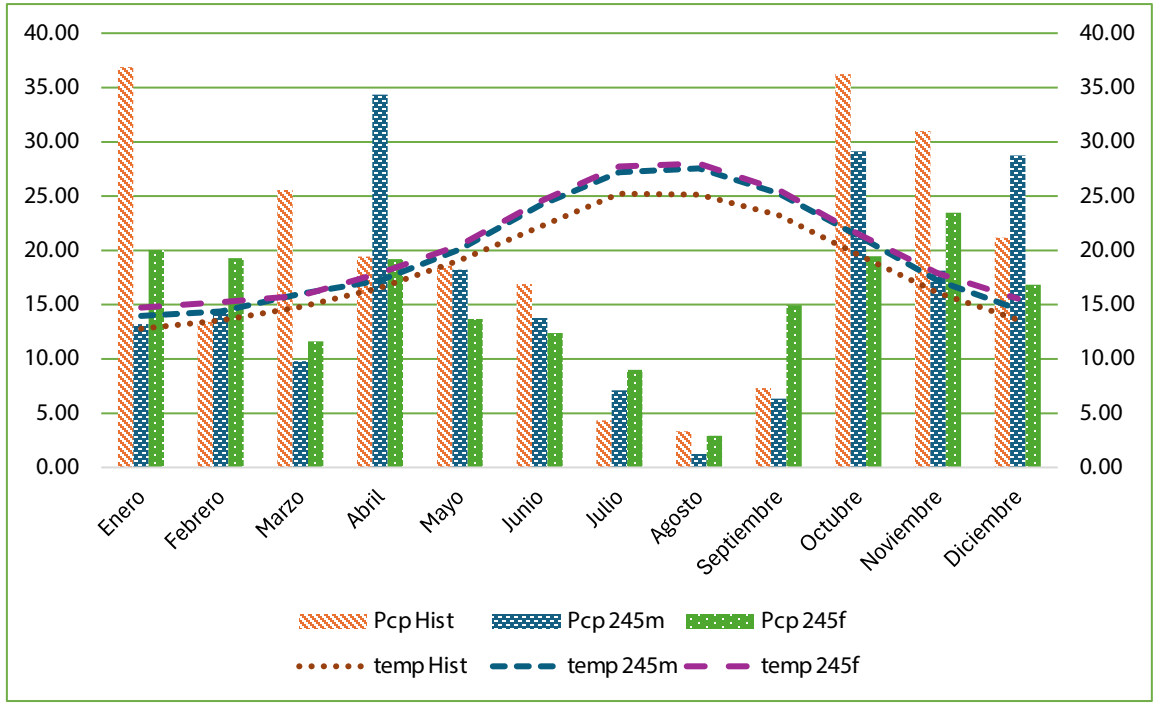
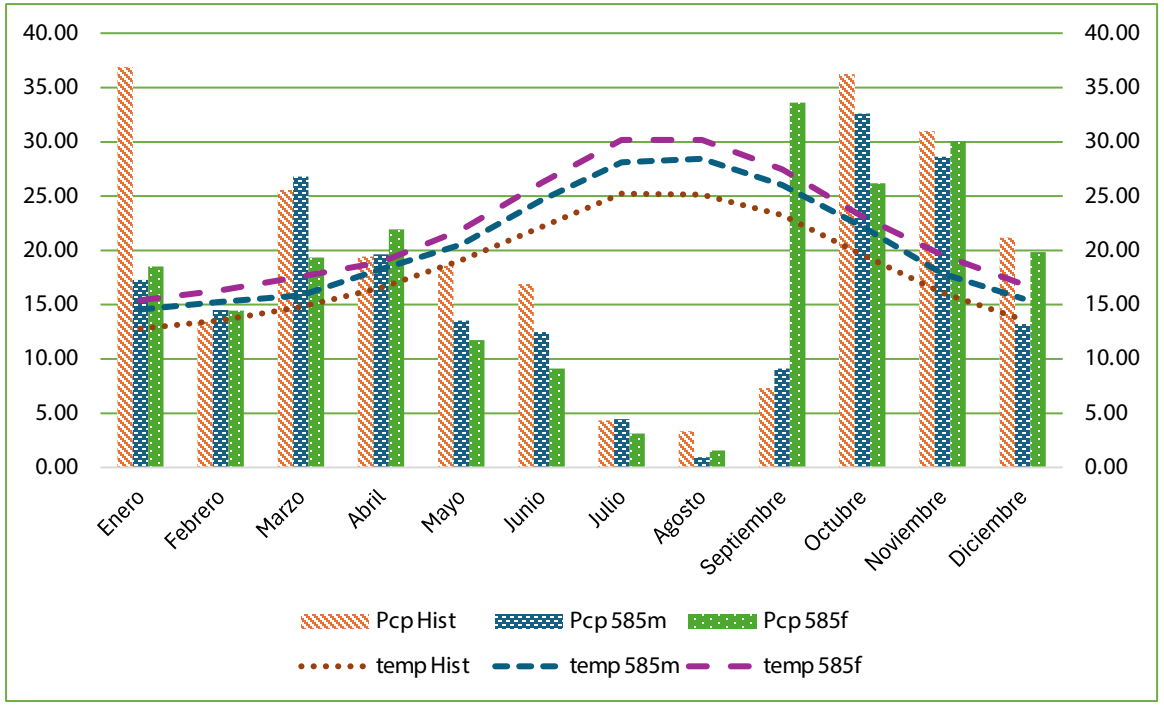
Climatic variation

	ΔPC (%)	ΔTemp (ºC)	D.Tor.(d)
Hist	-	-	11
SSP 2-45 M	-17%	1.4	9
SSP 2-45 F	-22%	1.9	11
SSP 5-85 M	-17%	2.1	11
SSP 5-85 F	-11%	3.5	14





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	Hist	SSP 2-45 M	SSP 2-45 F	SSP 5-85 M	SSP 5-85 F
Daily outflow (mm)	0.58	0.61	0.50	0.66	1.51
	-	5%	-14%	12%	158%
Nitrogen inputs (tons)	76.52	58.07	55.85	92.41	142.15
	-	-24%	-27%	21%	86%
Phosphorus inputs (tons)	38.99	45.71	41.52	55.23	121.94
	-	17%	6%	42%	213%
Sediment yield (t/ha)	0.06	0.05	0.05	0.05	0.11
	-	-5%	-11%	-4%	96%
Green water	628.59	564.11	536.83	552.38	563.17
	-	-10%	-15%	-12%	-10%
Blue water	58.03	32.12	25.37	31.51	51.42
	-	-45%	-56%	-46%	-11%

RES evolution in the watershed

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RES evolution in the lagoon

	Hist	SSP 2-45 M	SSP 2-45 F	SSP 5-85 M	SSP 5-85 F
Water temperature (ºC)	20.24	21.69	22.17	22.48	23.67
	-	7%	10%	11%	17%
Oxygen concentration (g/m3)	5.47	5.59	5.66	5.51	5.08
	-	2%	4%	1%	-7%
Nitrogen concentration (gN/m3)	0.0054	0.0046	0.0044	0.0079	0.0103
	-	-14%	-18%	72%	92%
Phosphorus concentration (gP/m3)	0.0084	0.0108	0.0117	0.0099	0.0231
	-	29%	40%	-8%	176%

	Hist	SSP 2-45 M	SSP 2-45 F	SSP 5-85 M	SSP 5-85 F
No. of anoxias	3	2	1	3	6
Duration in days	47	44	39	21	91
Average duration	16	22	39	7	15
Min. oxygen value	0.91	0.70	0.81	1.47	0.91
Mean oxygen value	1.43	1.02	0.81	1.63	1.58

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Climate change

RES worsening in the watershed

- Soil erosion control
- Protection against natural hazards
- Water flow regulation
- Mediation of nuisances of anthropogenic origin

This will affect water availability and increase the risk of flooding, affecting ecosystem resilience

RES worsening in the lagoon

- Increased water temperature
- Altered nutrients (increased phosphorus and nitrogen)
- Decreased oxygen concentration

This will alter the physical, chemical and biological conditions of the lagoon

Negative impact in the cultural ecosystem services, related to leisure and tourism

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PROBLEMS OF THE STUDY

- Only one GCM (MRI-ESM2-0) → No variability, more uncertainty
- Bias-correction for precipitation → empirical quantile VS monthly linear-correction
- Average data → Extreme values go unnoticed

FUTURE IMPROVEMENTS

- Create an ensemble with more models to reduce uncertainty and consider variability
- Compare different methods of bias-corrections
- Analyze the variability of each component

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icjimenez@ucam.edu

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