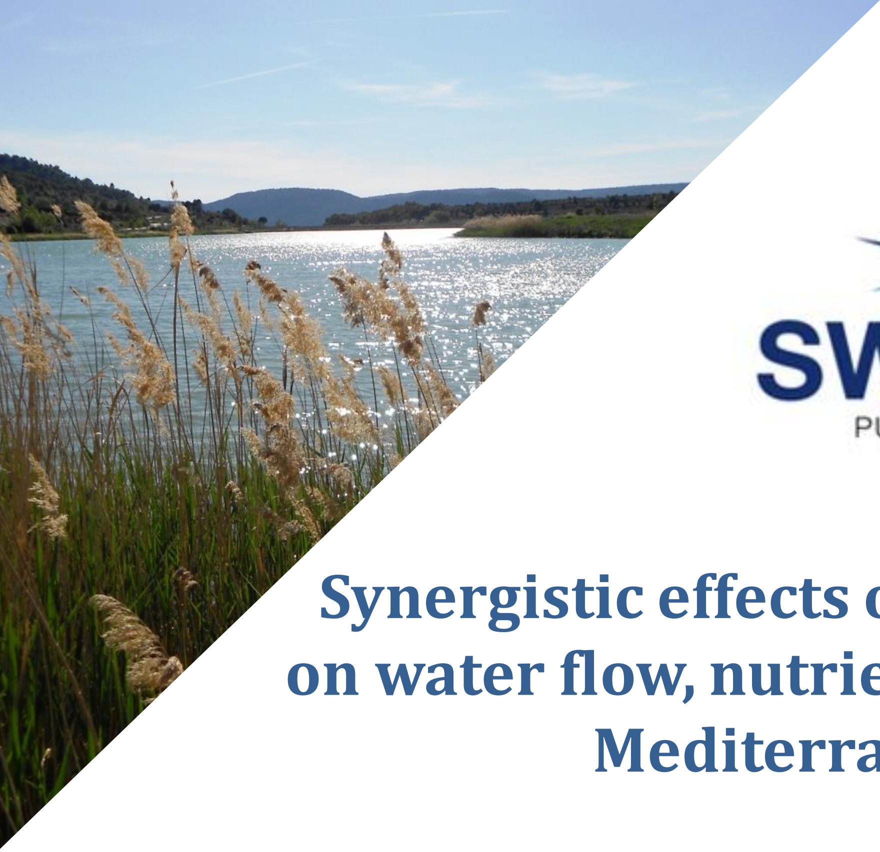

SWAT 2015

PULA / SARDINIA / ITALY

Synergistic effects of climate and land use changes on water flow, nutrient exports and trophic state in a Mediterranean limno-reservoir

E. Molina-Navarro, D. Trolle, S. Martínez-Pérez, A. Sastre-Merlín & E. Jeppesen

Universidad de Alcalá

AARHUS UNIVERSITY

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- **4. Conclusions**

1. Introduction

Mediterranean climate and large reservoirs

Mediterranean climate

Challenge for water management → Construction of reservoirs → > 1200 large dams in Spain → Storage of 40% of water resources

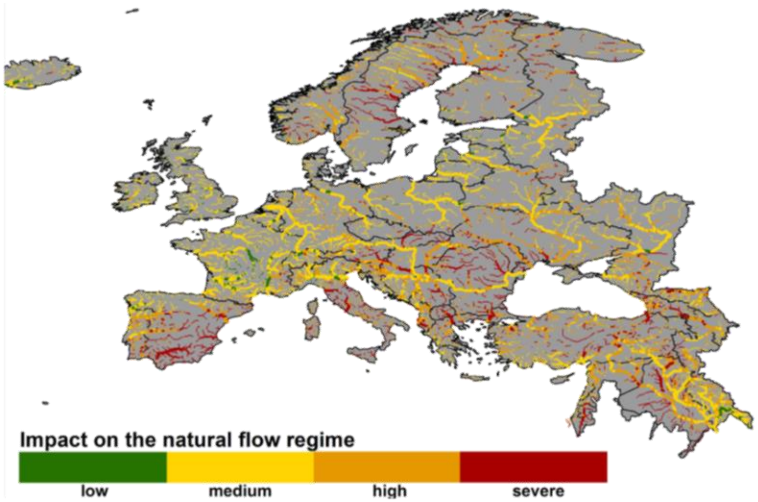
Exploitation regime

Wide water level fluctuations

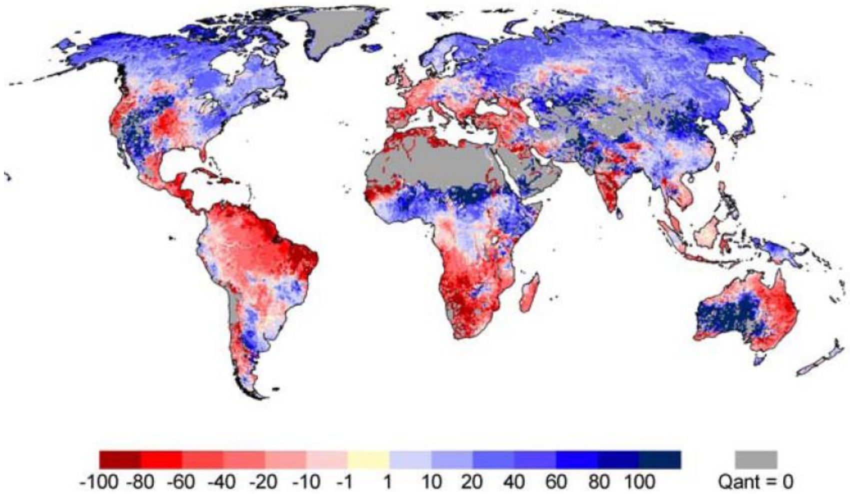
- Environmental and landscape impacts: ***Arid band***
- Socioeconomic impacts
- Climate change

Arid band in the Entrepeñas Reservoir

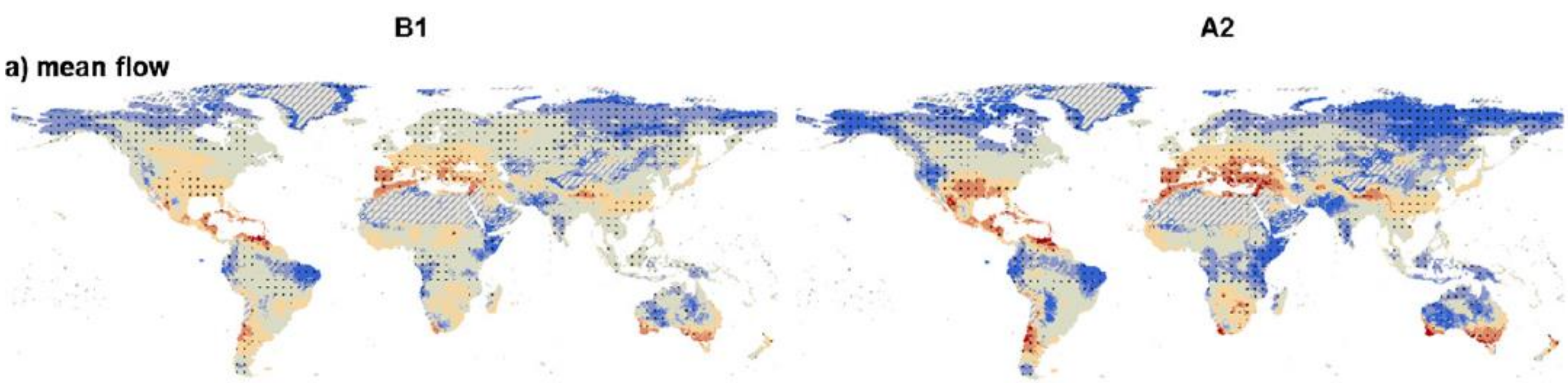
Impact of climate change on river discharge



Schneider et al. (2013)



Döll & Zhang (2010)



van Vliet et al. (2013)

Mediterranean climate and large reservoirs

Mitigation action:

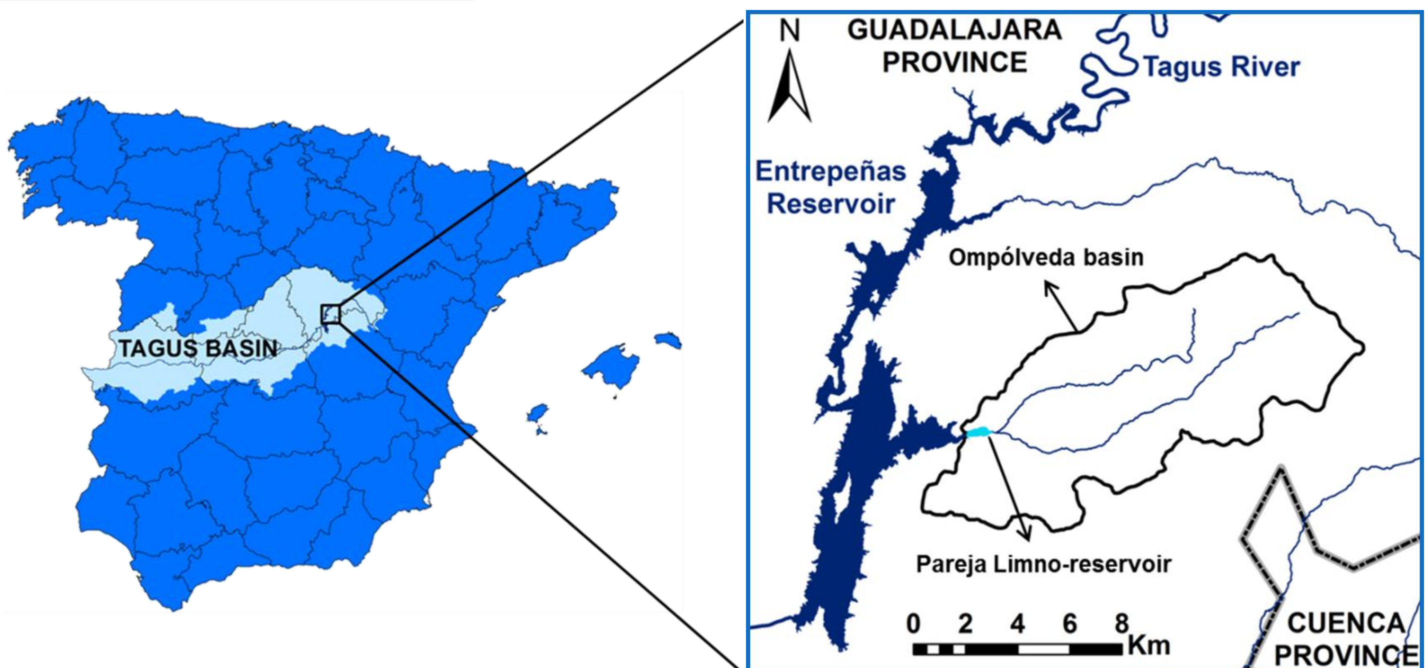
- Small dams in the riverine zone of large reservoirs
- Develop a small water body in the drawdown zone of the large reservoir
- Independent: preserve a constant water level
- Rather resemble a lake than an ordinary reservoir

LIMNO-RESERVOIRS

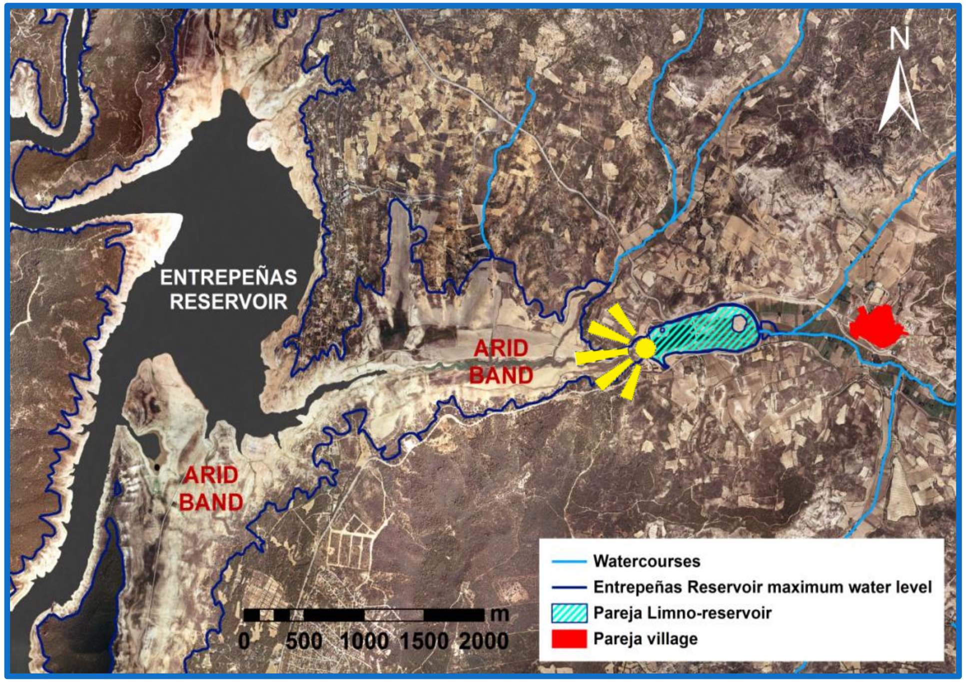
Pareja Limno-reservoir view

The Ompólveda River basin

- Area: 88 km^2
- Population: 300 inhabitants
- Average temperature: 13 °C
- Average rainfall: 600 mm
- Average discharge: 5 hm^3



The Pareja Limno-reservoir



October 2008

April 2011

February 2013

The Pareja Limno-reservoir

- Capacity: 0.94 hm^3
- Maximum depth: 12.5 m
- Retention time: ≈ 70 days
- Maximum area: 26 ha
- Average depth: ≈ 4 m
- First with a **dual function**

OBJECTIVES

- Sufficient water avaliability?
- Water quality good enough?

MAIN OBJECTIVES

a) ASSESS THE IMPACTS OF CLIMATE AND LAND USE CHANGE SCENARIOS ON WATER AVAILABILITY AND QUALITY USING THE SWAT MODEL DEVELOPED

(Molina-Navarro et al., 2014a; 2014b)

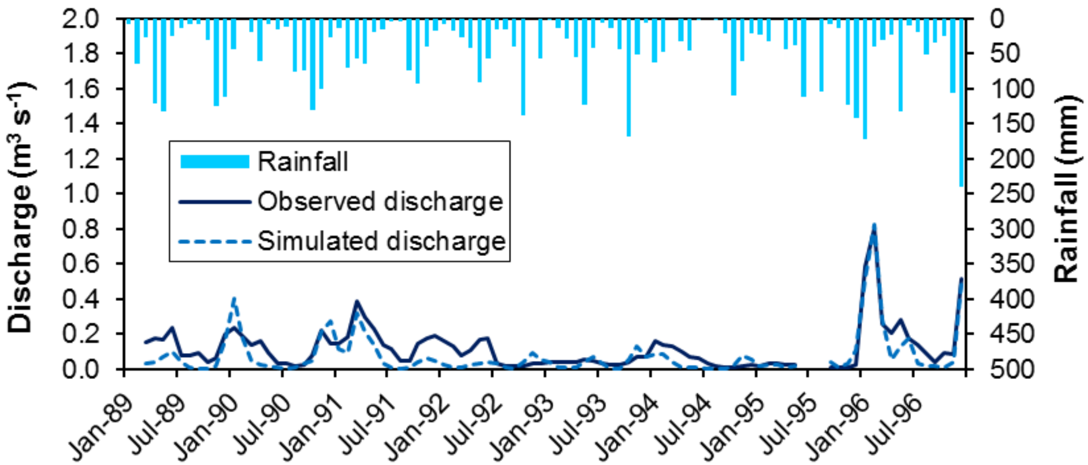
b) CHECK THE POSSIBLE SYNERGISTIC EFFECTS OF CHANGES IN CLIMATE AND LAND USE ON WATER FLOW, CATCHMENT NUTRIENT EXPORTS AND TROPHIC STATE OF THE PAREJA LIMNO-RESERVOIR

Results may be useful for water managers

2. Previous Work and Individual Scenarios Results

Previous work: Hydrological Modelling

Calibration

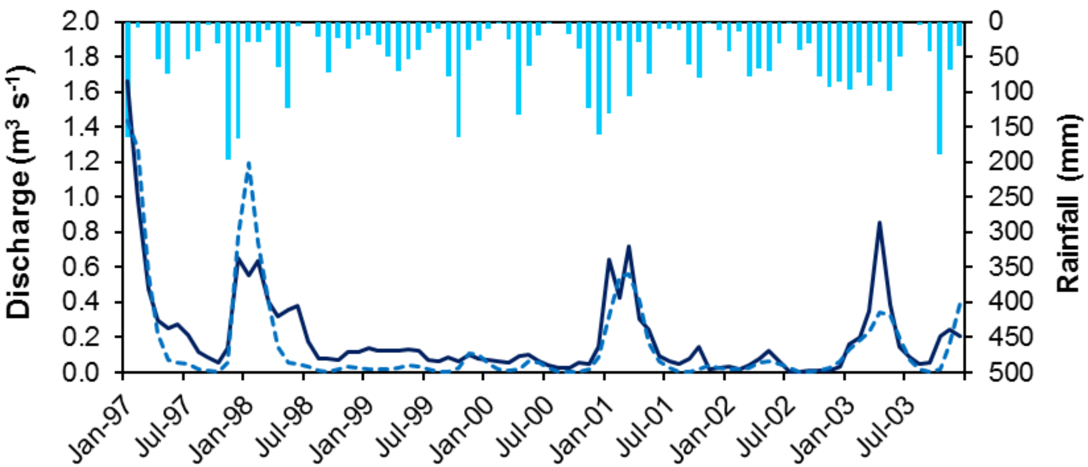


	Monthly	Annual
R^2	0.78	0.85
NSE	0.67	0.60
RSR	0.57	0.59
"Satisfactory" / "Good"		

(Moriasi et al., 2007)

Validation

Molina-Navarro et al. 2014a

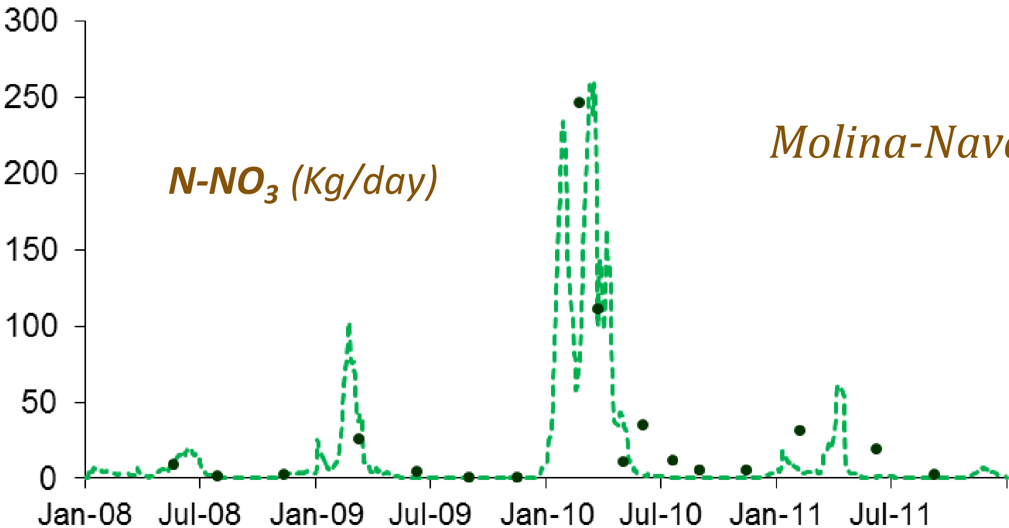


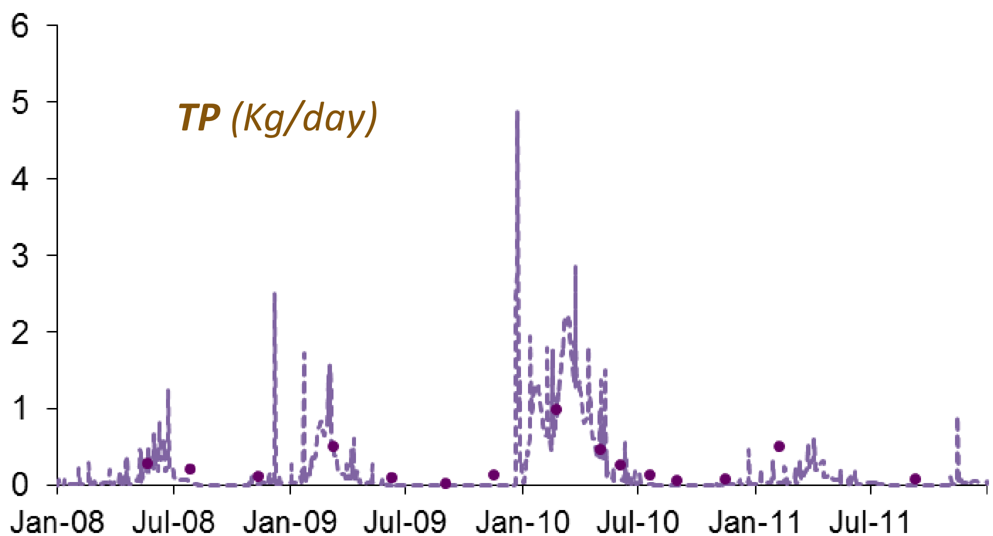
	Monthly	Annual
R^2	0.77	0.98
NSE	0.70	0.83
RSR	0.55	0.38
"Good" / "Very good"		

(Moriasi et al., 2007)

Previous work: Nutrients modelling

NUTRIENTS CALIBRATION





Molina-Navarro et al. 2014b

	$N\text{-}NO_3$	TP
R^2	0.66	0.80
NSE	0.51	0.57
PBIAS	45.2	38.0

Satisfactory statistical performance

(Gassman et al., 2007; Moriasi et al., 2007)

Scenarios

CLIMATE CHANGE (6 Scenarios)

Regional projections based on A1B, A2 and B1 scenarios for the time frames 2046-65 (i) and 2081-00 (ii)

LAND USE CHANGE (6 Scenarios)

LA

AS

RF

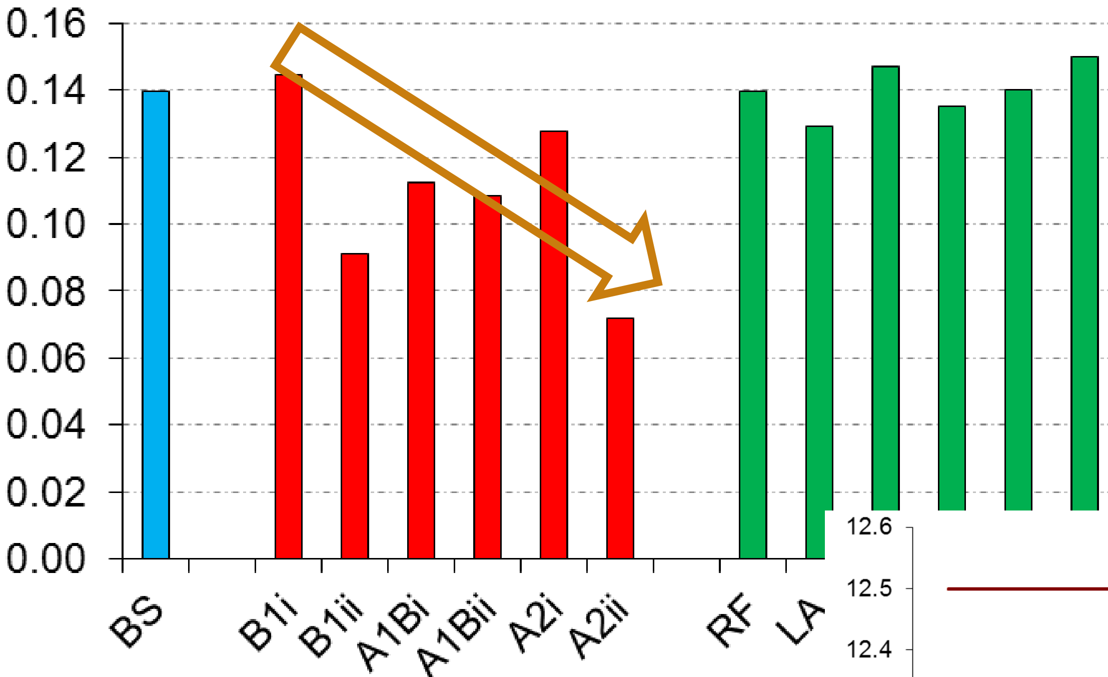
AE

WBP

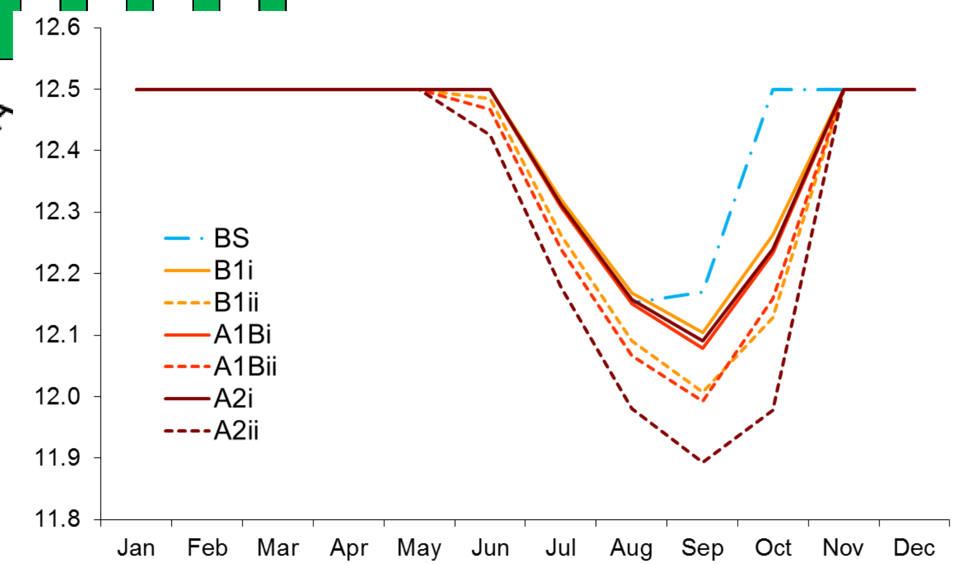
SF

Individual results: Water availability

Annual runoff (m^3/s)

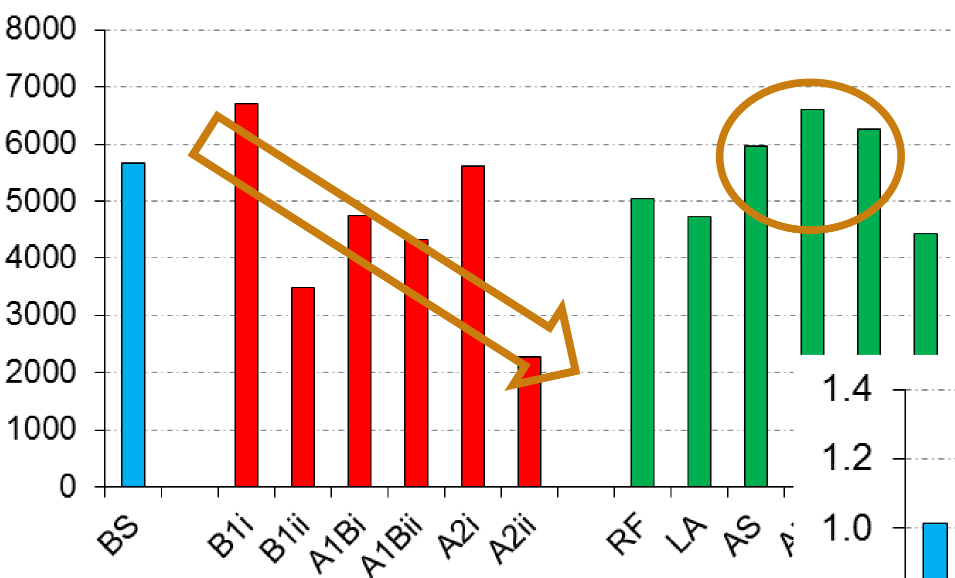


Predicted water level (m)

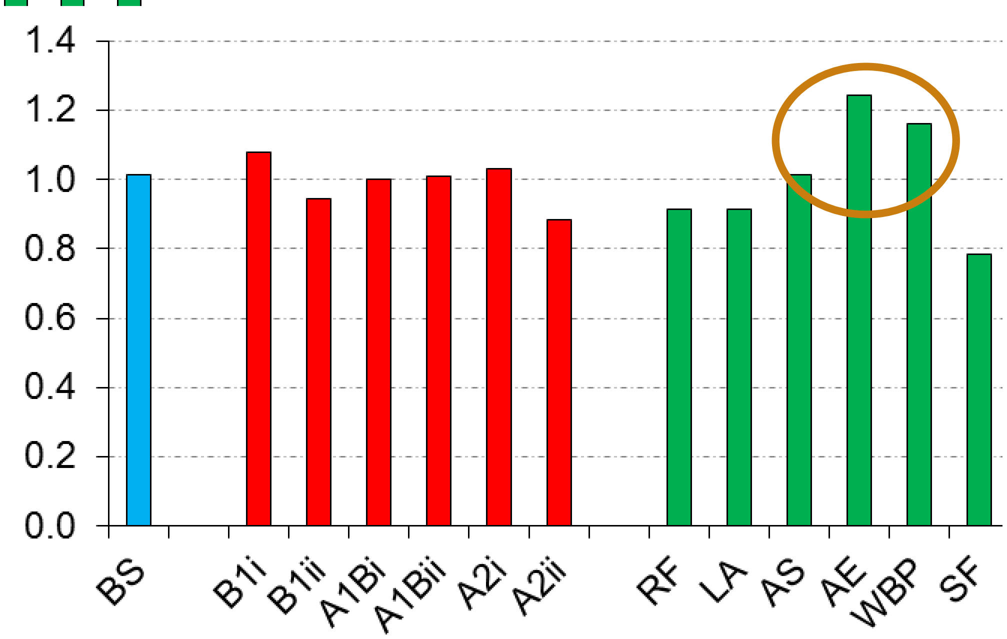


Individual results: Nitrate

N-NO$_3$ export (Kg/year)

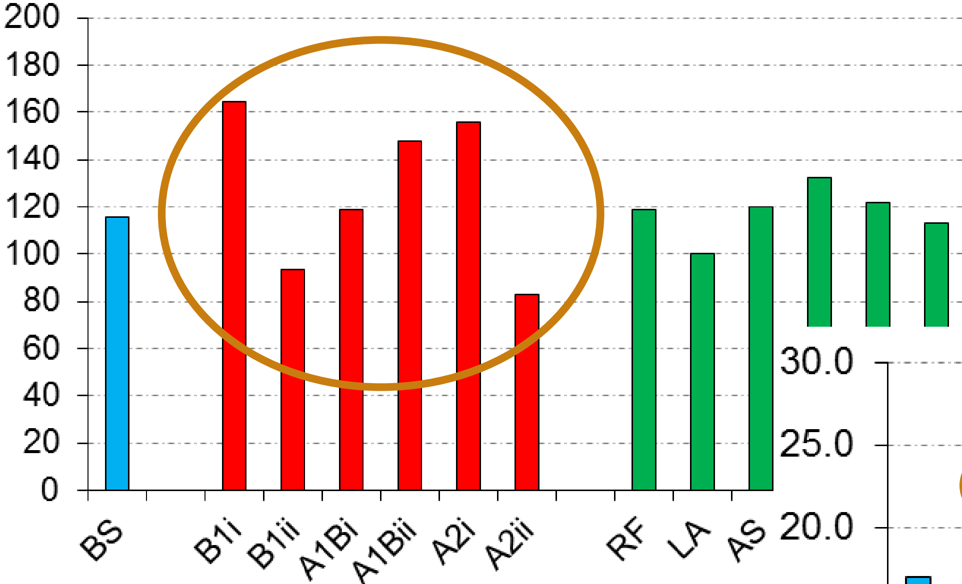


N-NO$_3$ concentration (mg/L)

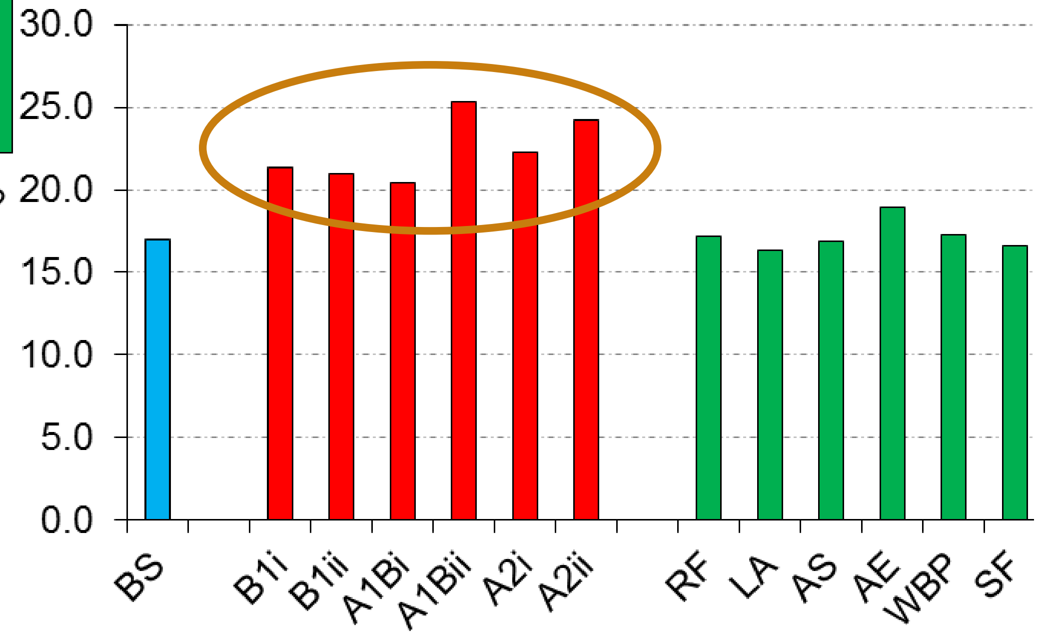


Individual results: TP

TP export (Kg/year)



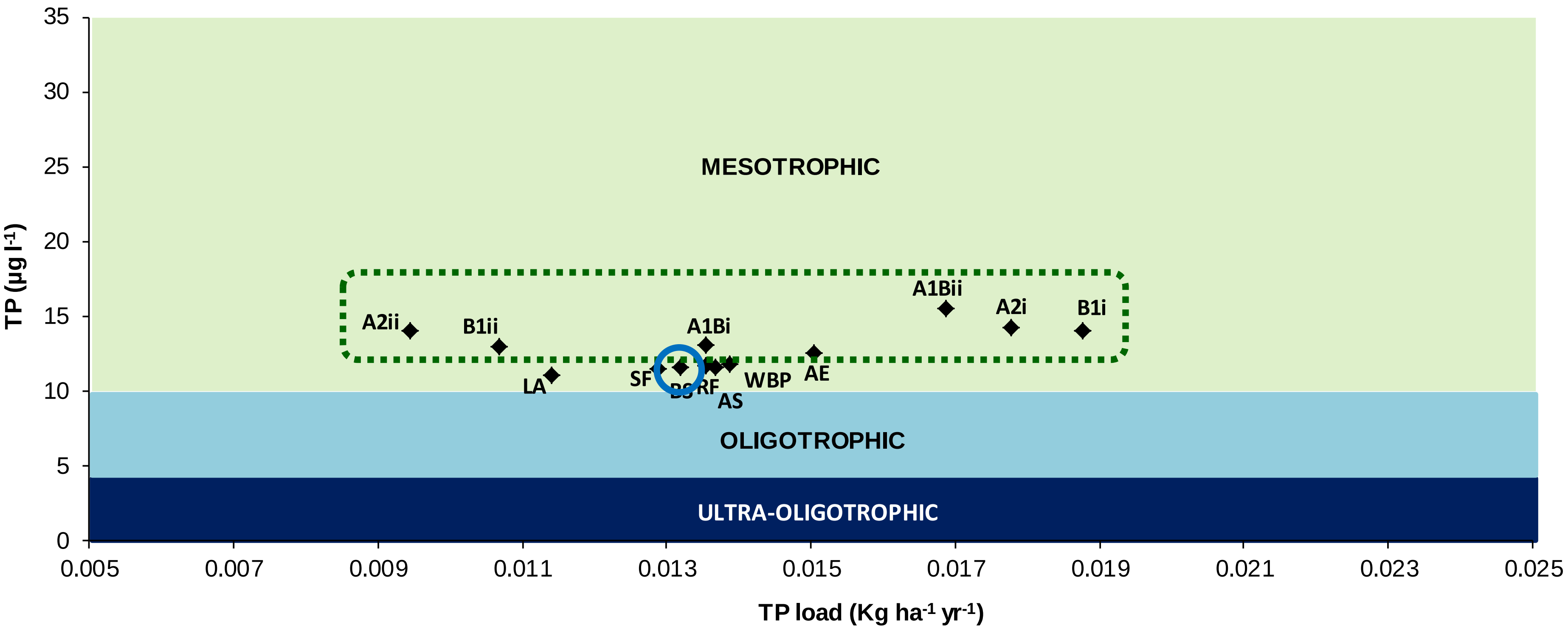
TP concentration (µg/L)



Individual results: TP

Limno-reservoir water quality impact

Vollenweider and Kerekes empirical model (OECD, 1982):



Combined scenarios selected

MOST OPTIMISTIC AND PESIMISTIC CC SCENARIOS (both time frames)

B1i (1946-65) A1i (1946-65)
B1ii (1981-00) A1ii (1981-00)

+

MOST OPTIMISTIC AND PESIMISTIC LUC SCENARIOS

LA

AE

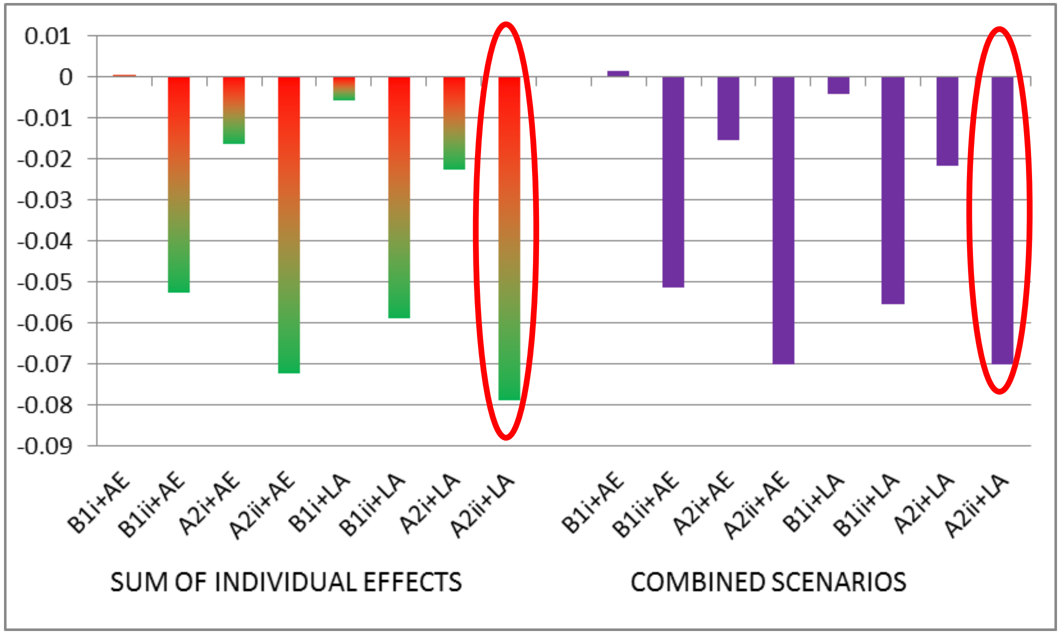
= ***8 COMBINED SCENARIOS***

¿There will be any synergistic effects of climate and land use changes on runoff and nutrient exports?

3. Combined Scenarios Results and Discussion

Water availability

Annual runoff variation (m³/s)

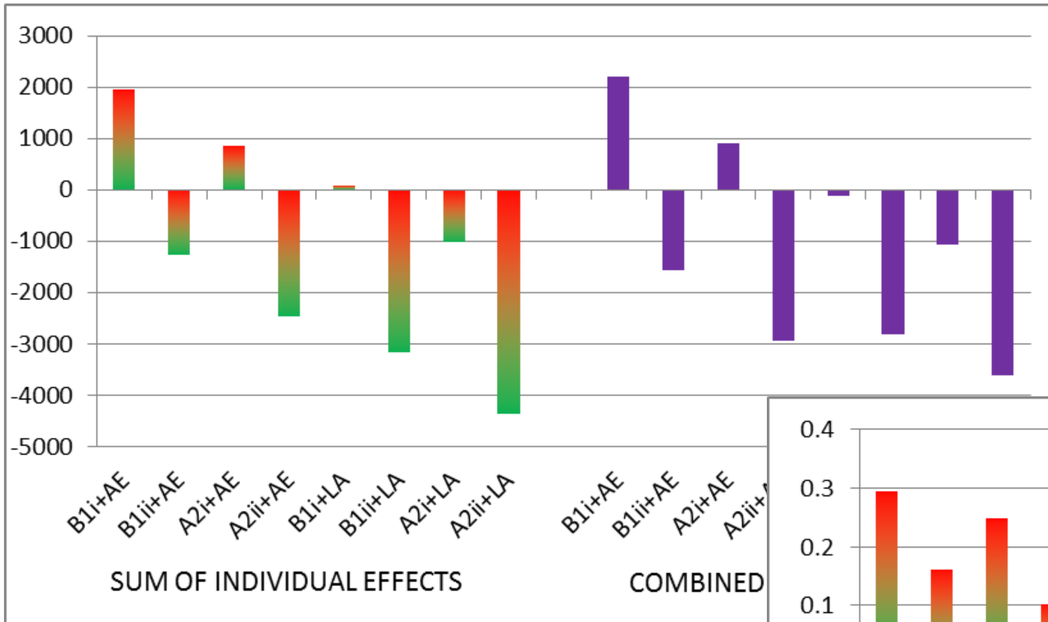


¡THE COMBINED SCENARIOS DID NOT DEMONSTRATE ANY SIGNIFICANT SYNERGISTIC EFFECT ON HYDROLOGY!

Only A2ii + LA → Lower reduction than the sum when running scenarios individually (-0.070 m^3/s vs. -0.079 m^3/s)

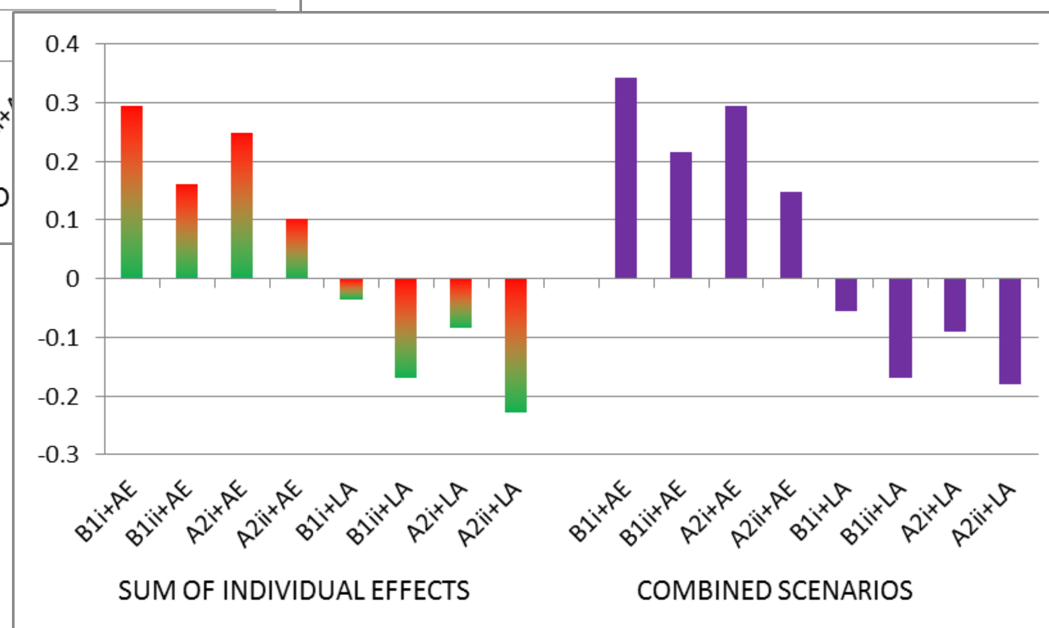
Nutrient loads: Nitrate

N-NO$_3$ variation (Kg/year)



Under climate change, both land uses would play a less relevant role in N-NO$_3$ exports

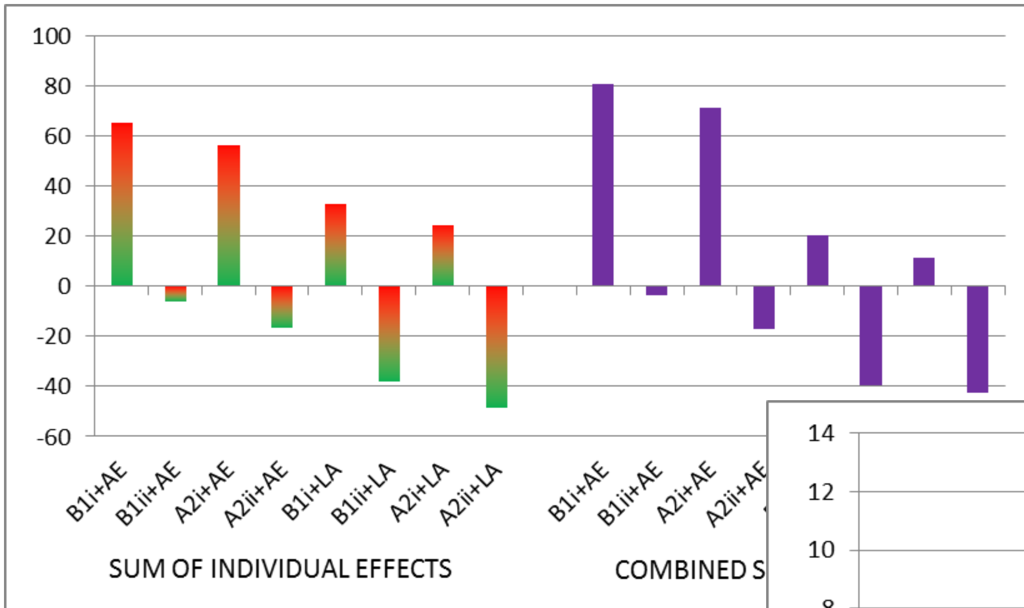
N-NO$_3$ variation (mg/L)



Synergistic effect increasing N-NO$_3$ concentration → reduced runoff diminishes the dilution capacity

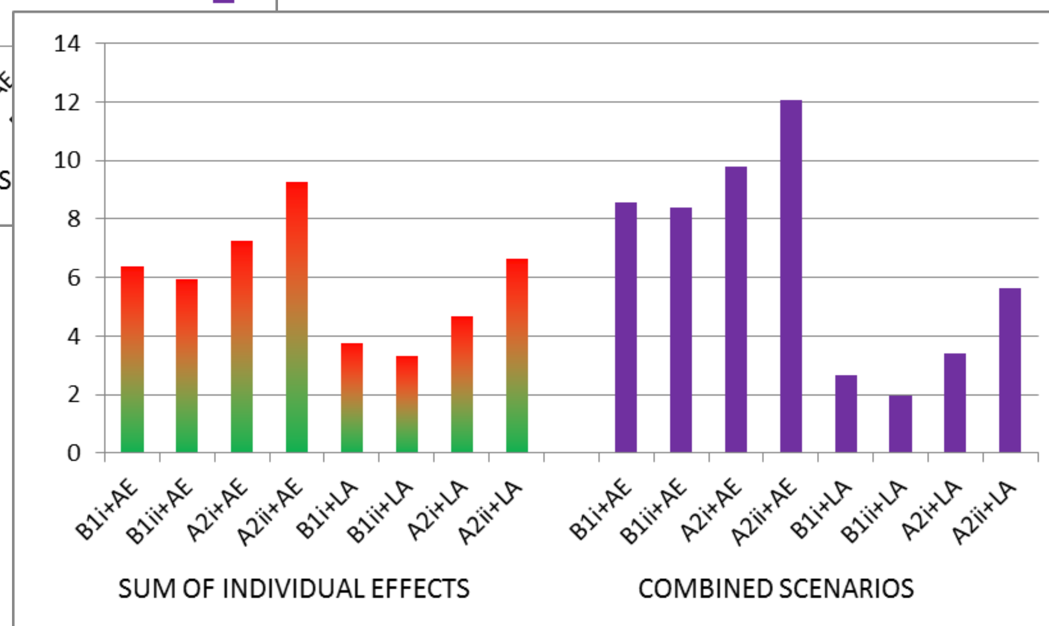
Nutrient loads: TP

TP variation (Kg/year)



Contrary to N-NO_3, AE and LA will play a more harmful/reducing role for TP under climate change

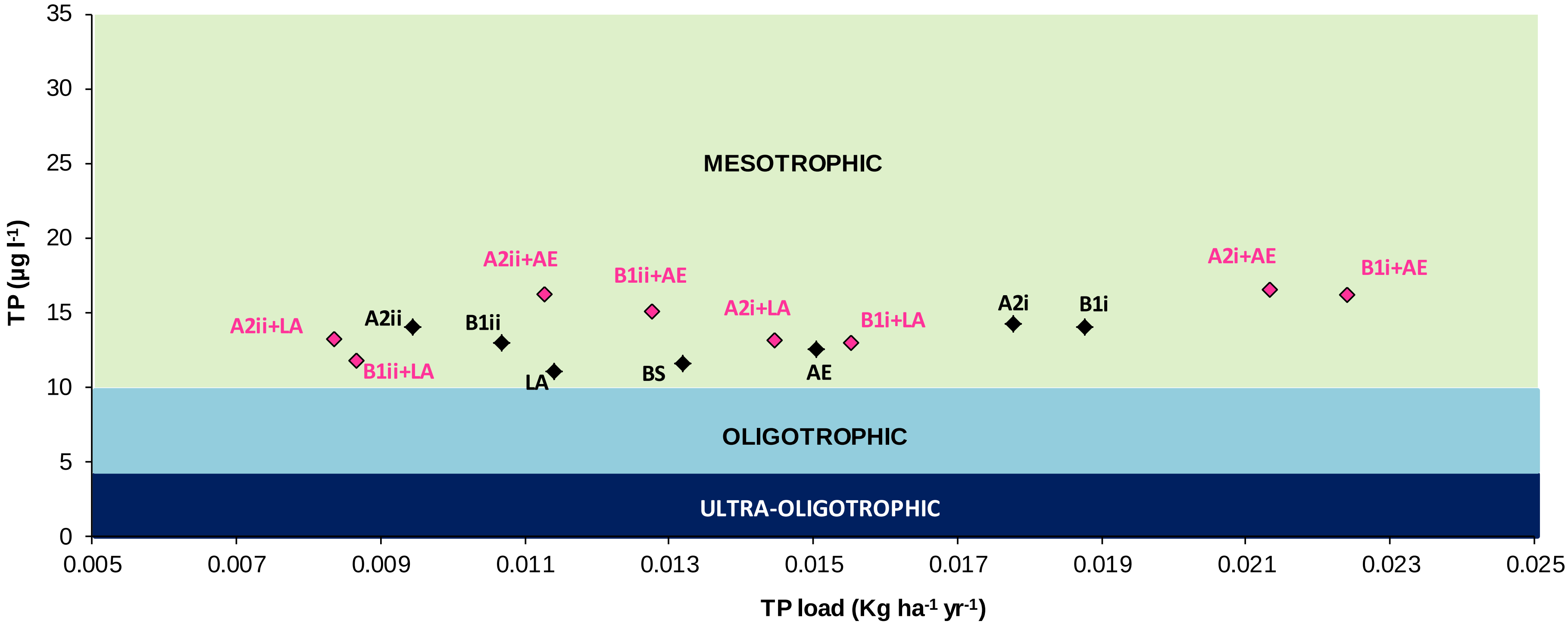
TP variation (µg/L)



Increased TP in the most pessimistic scenarios potentially constitutes a threat to water quality

Limno-reservoir water quality

Limno-reservoir water quality impact



¡HIGHER TP INPUT LED TO DETERIORATION OF TROPHIC CONDITIONS, ESPECIALLY IN THE COMBINED SCENARIOS!

4. Conclusions

4. Conclusions

1. Combined climate and land use change scenarios did not show significant synergistic effects on annual runoff. However, they showed **noticeable synergistic effects on nutrients exports**, relative to running the scenarios individually.

2. The **impact of agriculture** expansion or abandonment (increasing/decreasing fertilization) **on nitrate export is projected to be reduced with warming**, although concentrations increase due to diminished dilution capacity

3. However, **agriculture** may have a **more harmful effect on the TP load within climate change**: It is a land use prone to erosion and erosive rainfall events seem to increase with climate change. A **deteriorating water quality** may prevent the **Pareja Limno-reservoir** from fulfilling its function as a recreational infrastructure.

4. The model provides the **deciding policy makers** with an approximation of how land uses and climate changes may affect the Pareja Limno-reservoir in the near future. The implementation of **fertilizer and land use management plans** could be appropriate in the catchment.

Acknowledgements

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iberCaja

Obra Social y Cultural

THANKS FOR YOUR ATTENTION!!

Grazie per l'attenzione!!