Evaluation of the measures to reduce sediments and nitrogen inputs to the Mar Menor coastal lagoon (Spain)

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INTRODUCTION

In the past few decades, the Mar Menor coastal lagoon has experienced an **environmental deterioration**, mainly caused by:

- the intensive agriculture
- past open-pit mining activities

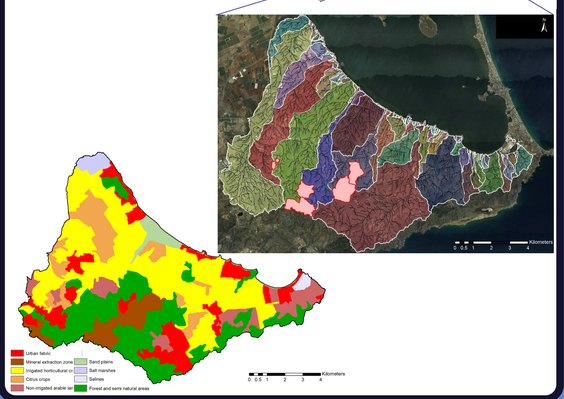
This leads to **elevated nitrate concentrations** in the superficial aquifer, which is connected to the lagoon, and **high soil erosion rates**.

The present study aims to

- estimate the **current nitrogen and sediment inputs** to the lagoon
- propose and **evaluate pollution reduction measures.**

STUDY AREA

- **South Mar Menor basins**
  - Murcia, south-East of Spain
  - Semi-arid climate:
    - Annual average precipitation: 280 mm
    - Annual average ET0: 1060 mm
  - Area: 100 km^2
  - 88 sub-basins
    - 66 small coastal basins
    - 6 endorheic basins
  - 45% irrigated and fertilized
    - 10% citrus orchards
    - 35% horticultural crops



MODEL IMPLEMENTATION

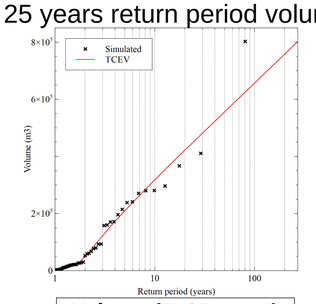
Lack of actual monitorization → Non-traditional calibration

Conceptual distributed model **TETIS** [1]

Hydrological calibration

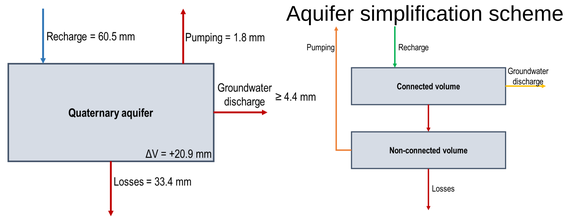
Runoff → Flood study [2]

- 1971-2016
- 25 years return period volume



Volume (T=25 years)	
Flood study	457.000 m^3
Calibration	455.016 m^3

Groundwater → 1990 Annual balance [3]



Impossible to reproduce the 1990 conditions → 2 models

Sediment cycle calibration

- USLE annual medium soil loss
- 1971-2016

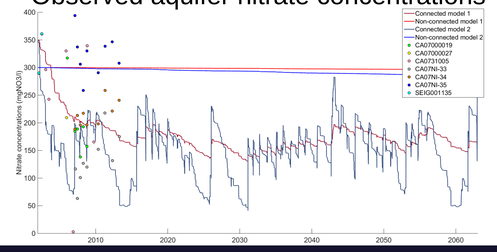
Annual medium soil loss	
USLE	9.29 t/ha
Calibration	9.27 t/ha

Nitrogen cycle calibration

- Nitrogen annual vegetation demand
- 2002-2011

Model validation

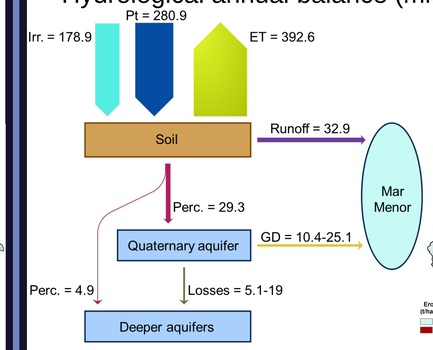
- 61 years in current basin situation
- Climate repetition (2002-2016-1971-2016)
- Observed aquifer nitrate concentrations



RESULTS

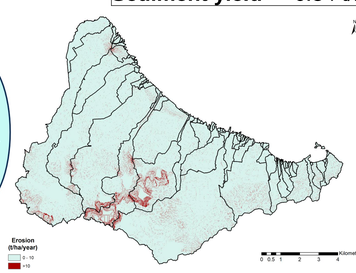
Current basin situation

- Hydrological annual balance (mm)

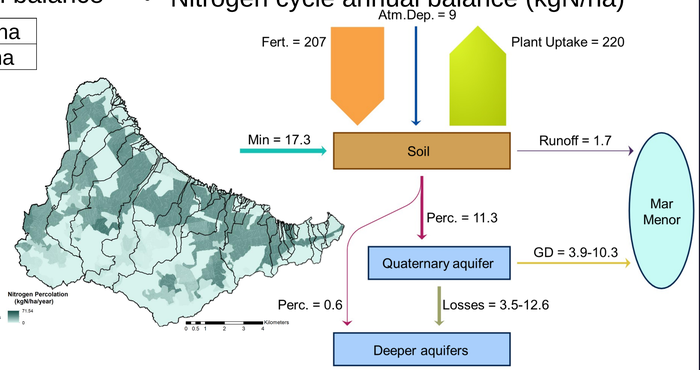


- Sediment cycle annual balance

Erosion	37.18 t/ha
Sediment yield	6.34 t/ha



- Nitrogen cycle annual balance (kgN/ha)



Scenario analysis

- P05: contouring practices
- P005: contouring practices + hedgerows
- Buffer500: transformation of the horticultural crops into natural vegetation in a buffer of 500 m from the coast
- Reforestation: mineral extraction zone reforestation with coniferous
- Fertilizer adjustment: adjusting the fertilizer rates to the vegetation demand and a 3 months crop exemption period.
- Pumping: pumping water from the Quaternary aquifer in order to reduce the discharge to the lagoon

General lagoon inputs variation

Scenario	Sediments	Nitrogen
Current situation	6.34 t/ha	5.7-12.1 kgN/ha
P05	-6.48%	-1.95%
P005	-12.68%	-4.33%
Buffer500	+0.05%	-2.41%
Reforestation	-42.20%	-5.41%
Fertilizer adjustment	+1.70%	-34.32%
Pumping	0.00%	-68.32%

Sediment production and lagoon inputs variation

Scenario	Erosion	Sediment yield
Current situation	37.18 t/ha	6.34 t/ha
P05	-2.68%	-6.48%
P005	-5.09%	-12.68%
Buffer500	+0.04%	+0.05%
Reforestation	-72.81%	-42.20%
Fertilizer adjustment	+0.60%	+1.70%
Pumping	0.00%	0.00%

Lagoon nitrogen inputs variation

Scenario	Runoff	Percolation
Current situation	1.74 kgN/ha	11.82 t/ha
P05	-8.73%	+0.04%
P005	-19.39%	+0.08%
Buffer500	+0.06%	-3.41%
Reforestation	-9.22%	-1.78%
Fertilizer adjustment	-8.13%	-44.84%
Pumping	0.00%	0.00%

CONCLUSIONS

- The **reforestation** of the mineral extraction zone is **crucial to reduce** the **sediment yield** and the high **erosion rates**.
- The use of **support practices** like hedgerows and contouring is not significant in the case of sediments, however, it shows a **significant reduction** in the case of the **nitrogen pollution associated to the runoff**.
- The **adjustment of the fertilizer** used is **essential** in order to **reduce** the lagoon **nitrogen input** associated to the **runoff** and the nitrogen **percolation** to the aquifers.
- The **concentration** in the Quaternary aquifer will be **high during a long time**. For this reason, **pumping water** from the Quaternary aquifer in order to **reduce the discharge to the Mar Menor lagoon**, is a transient solution that will reduce the nitrogen inputs drastically.
- In this case the study area is not covering all the aquifer, consequently, a necessary improvement is the **modelling of the overall Campo de Cartagena hydrogeological unit** with a groundwater model, whose inputs can be generated by TETIS.

ACKNOWLEDGEMENTS

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