Modeling the impacts of climate change on streamflow and nitrate export in a Mediterranean agricultural watershed in Spain

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Introduction

- Agricultural activities have significant and diverse effects on streamflow and water quality.
- The **magnitude** and **severity** of these effects are not well understood due to the **high spatial** and **temporal variability**.
- Predicting the water quality and quantity response to climate change is very difficult due to the **complexity** and **uncertainties** in estimating and understanding the future hydrological conditions.
- However, mathematical models, such as **the SWAT model**, could aid in **predicting hydrological impacts** of agricultural activities.

Objectives

- To **predict** the **impacts of climate change** on **streamflow** and **nitrate exportation** in a Mediterranean rainfed agricultural watershed using the **Soil Water Assessment Tool (SWAT) model**.
- First, the SWAT model was calibrated and validated in the Cidacos River watershed.
- Then, the climate change impacts on streamflow and nitrate load were analyzed for CO_2 emission scenarios **RCP4.5** and **RCP8.5** in the **short-**, **medium-**, and **long-term** projections relative to the **baseline (historical)** period.

Methodology

Study Area: Cidacos River watershed

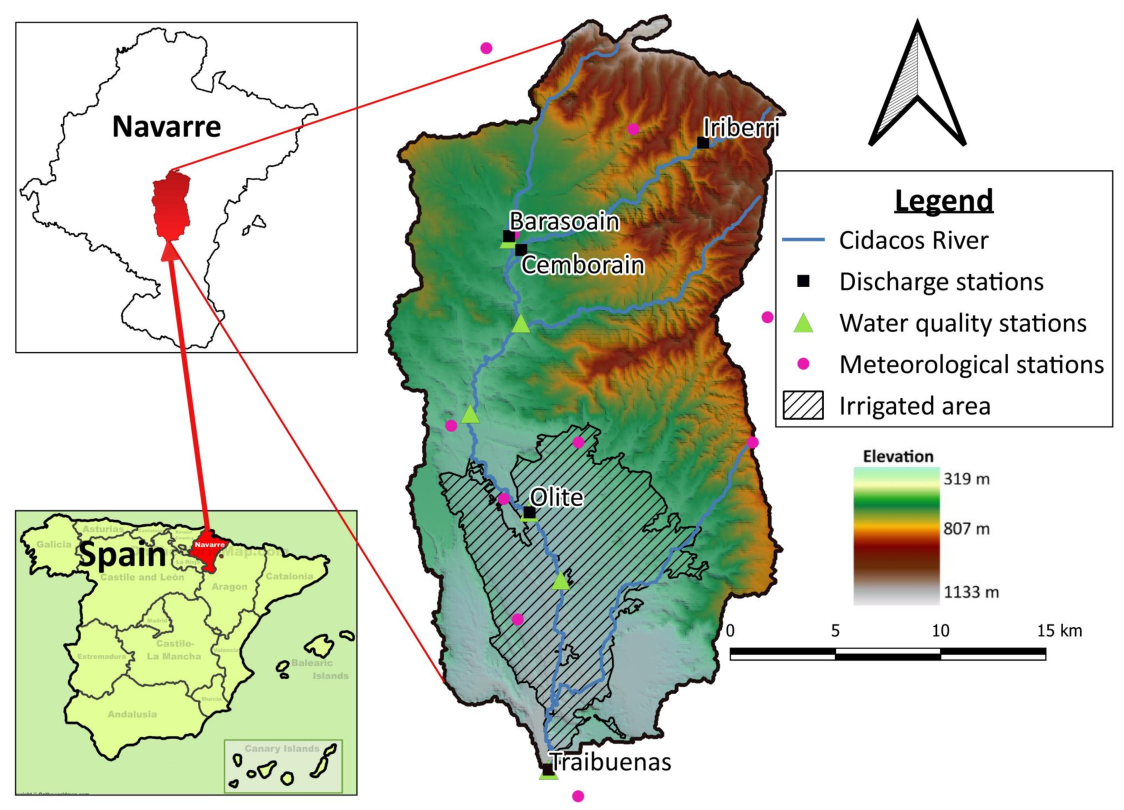

Fig. 1: Location of the Cidacos River watershed

- **Cidacos River** is a tributary of the **Aragón River**, a tributary to **Ebro River**
- Total Area: approx. **477 km²** **(55% rainfed; 16% irrigated)**
- Altitude: approx. **300 - 1100m** **(S-N)**
- Climate: **Mild-Mediterranean**
- Annual Precipitation: **400mm** to **800mm** **(S-N)**
- Annual Evapotranspiration: **1500mm**

The SWAT modeling process

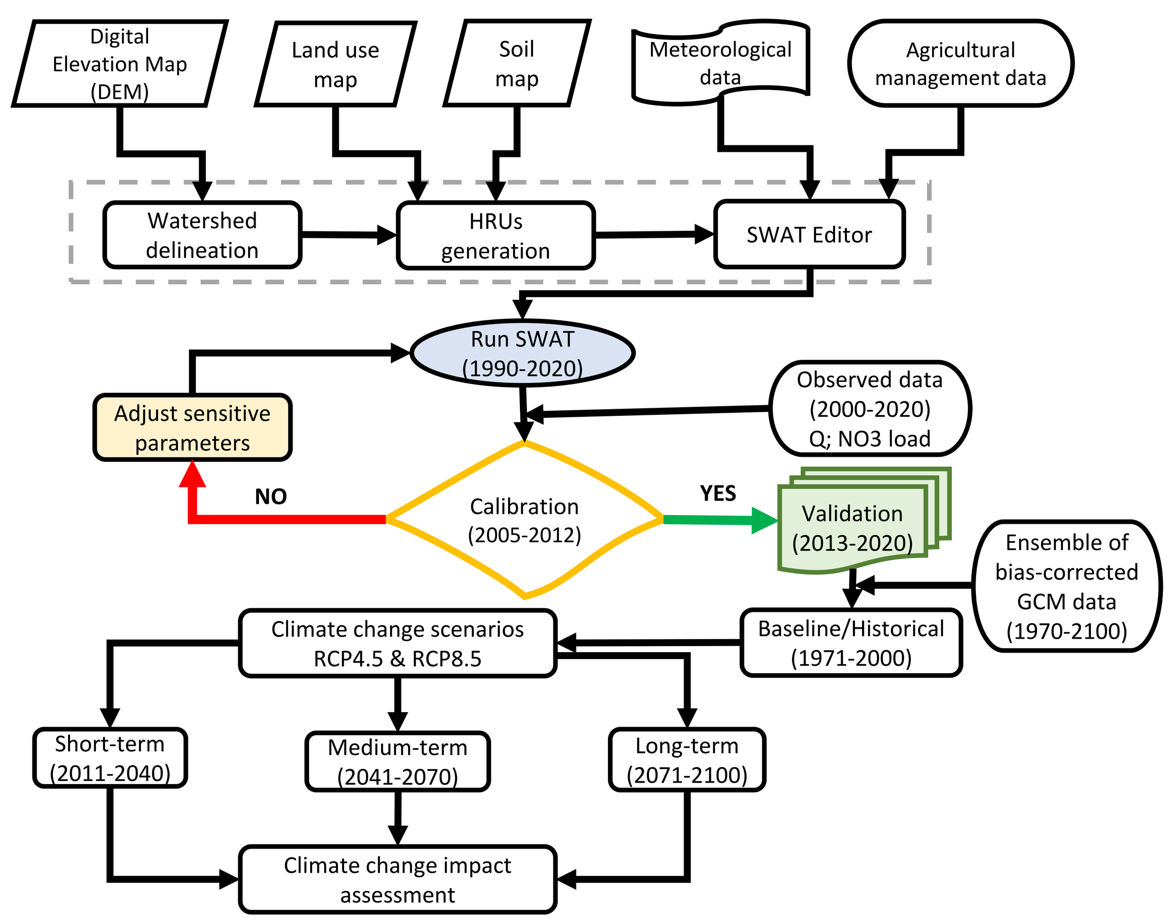

Fig. 2: Flow diagram of the SWAT model CC simulation in the Cidacos River watershed

Results

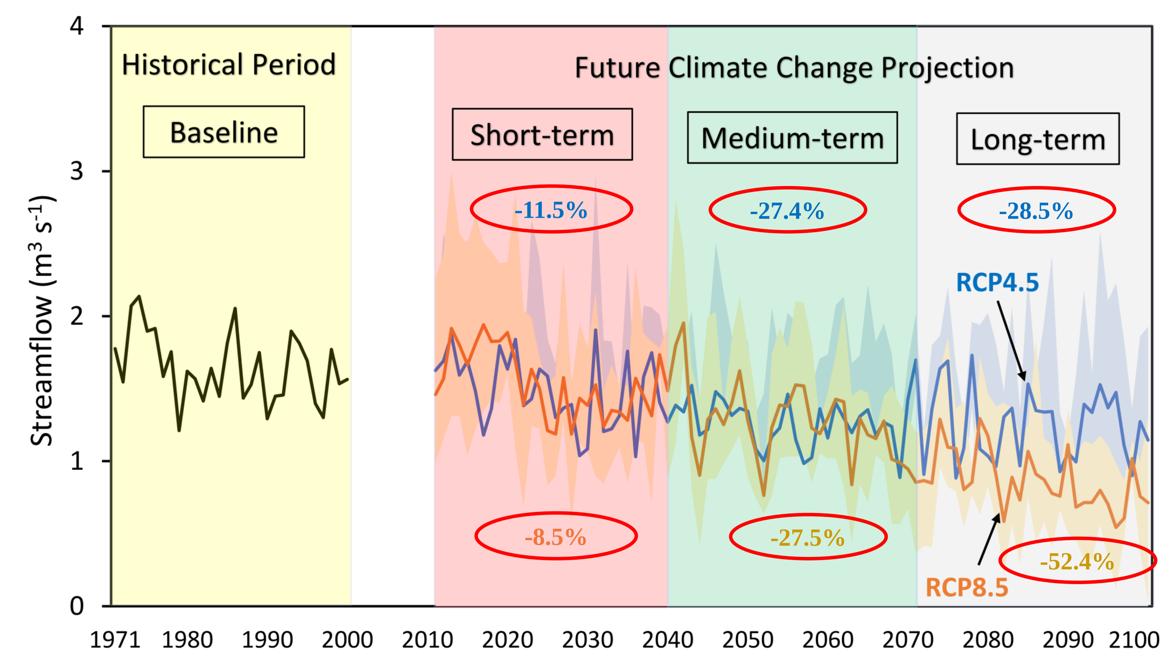

Fig. 3: Streamflow climate change projections

- **Decline** in future streamflow projections was attributed to the **increasing temperature** and **decreasing precipitation**

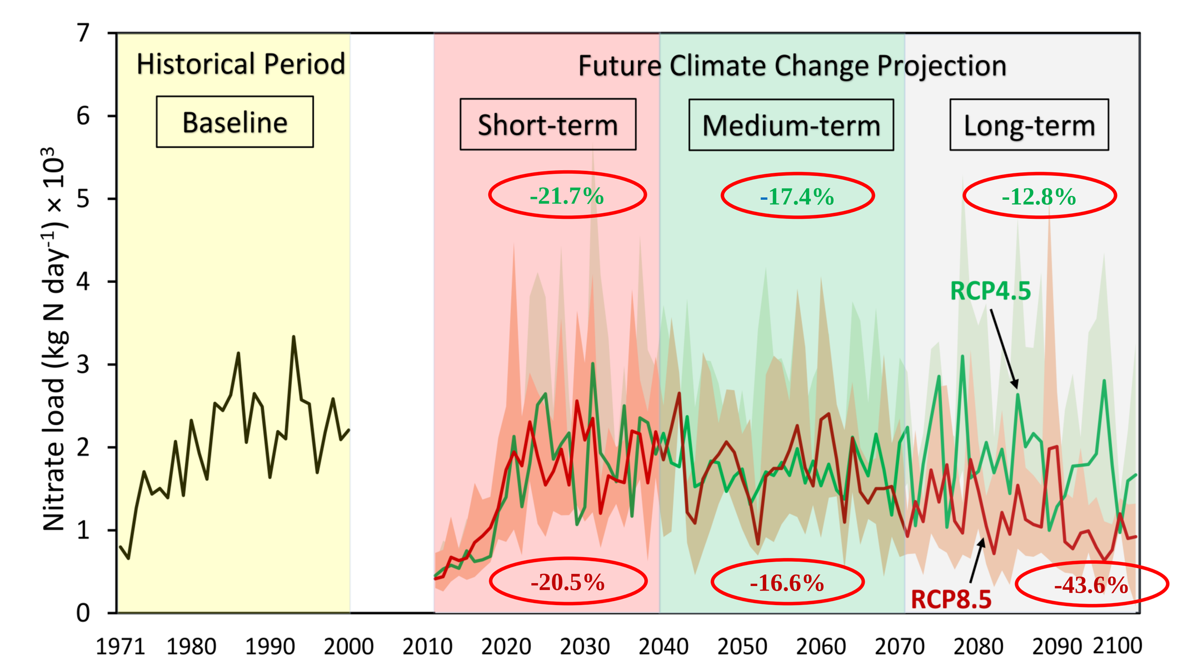

Fig. 4: Nitrate load climate change projections

- **Decline** in future nitrate export projections was due to the projected **decrease in streamflow**, as loads are a function of flow and concentration.

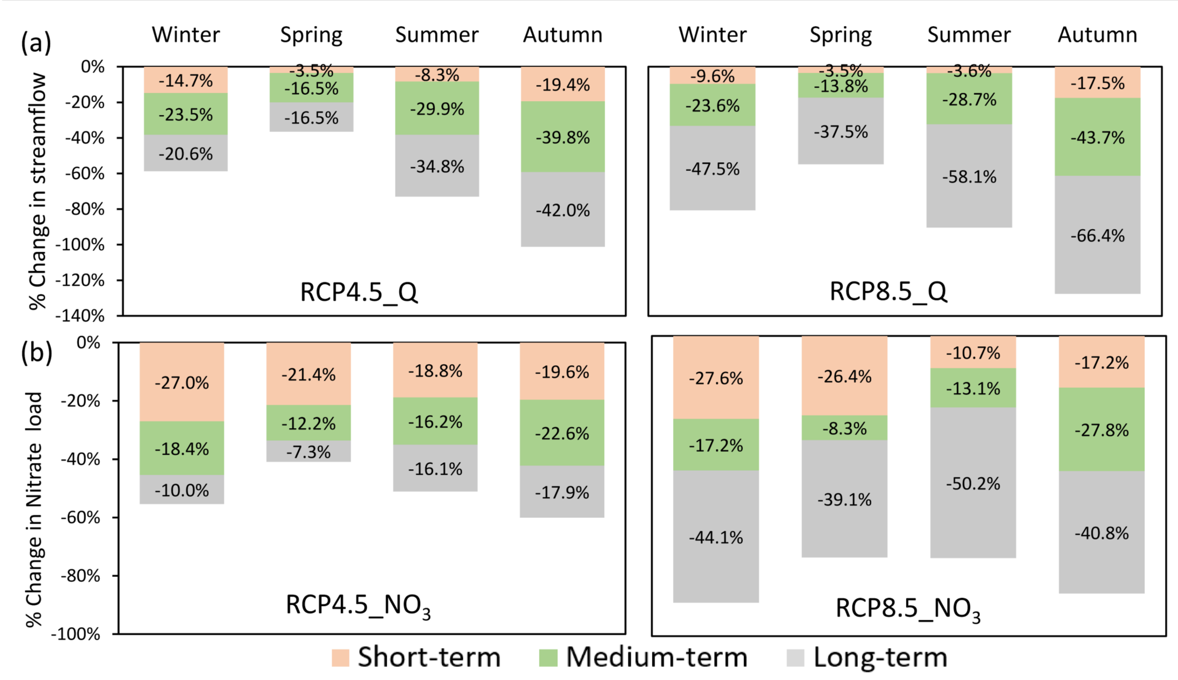

Fig 5: Seasonal climate change projections on streamflow and nitrate loads

Conclusion

- The SWAT model simulated streamflow and nitrate loads well with **very good** statistical performance.
- **General decline** in future streamflow and nitrate loads with **significant decline** in the **long-term scenario for RCP8.5**.
- Streamflow decline was **highest in autumn** whereas nitrate load decline **varied** for each scenario.
- The main climate change driver is the **increasing temperature** hence **increased evapotranspiration**.

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