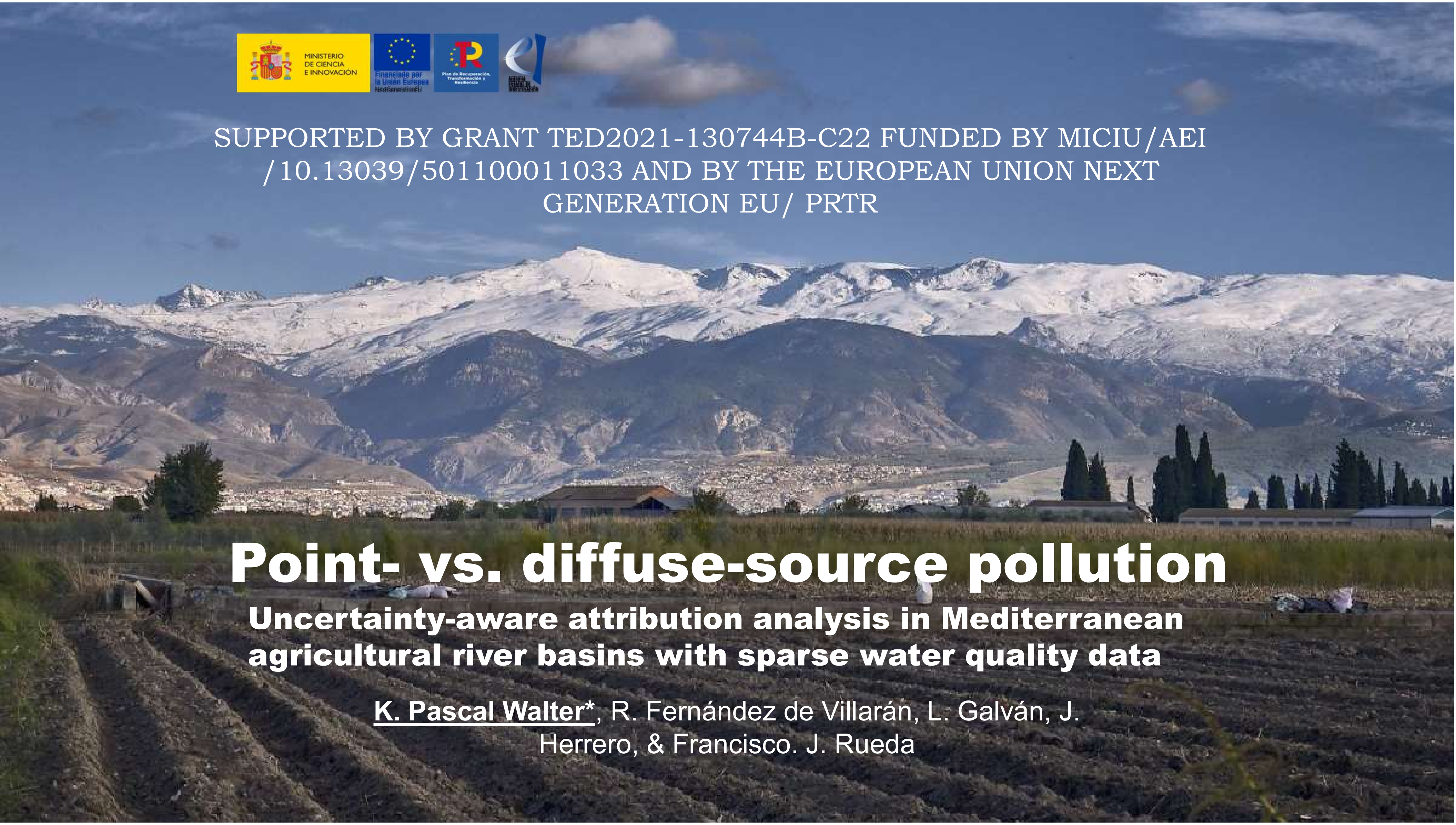


SUPPORTED BY GRANT TED2021-130744B-C22 FUNDED BY MICIU/AEI /10.13039/501100011033 AND BY THE EUROPEAN UNION NEXT GENERATION EU/ PRTR

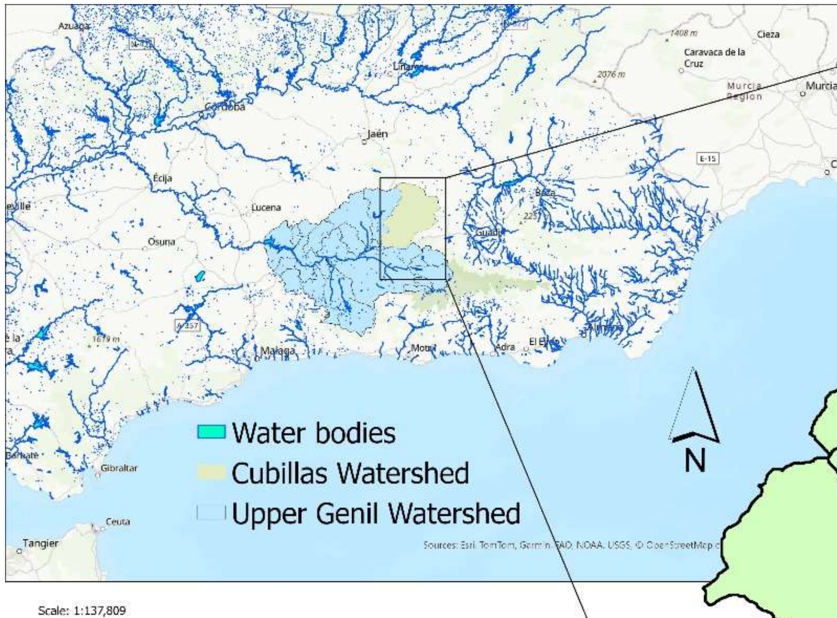
Point- vs. diffuse-source pollution

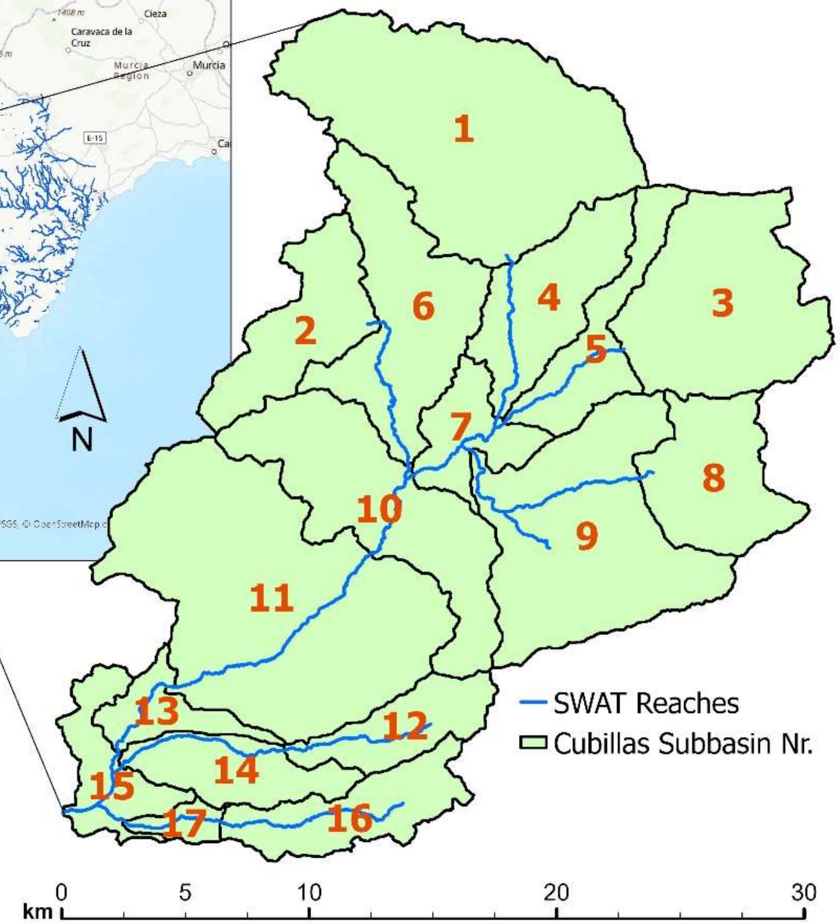
Uncertainty-aware attribution analysis in Mediterranean agricultural river basins with sparse water quality data

K. Pascal Walter*, R. Fernández de Villarán, L. Galván, J. Herrero, & Francisco. J. Rueda

Upper-Genil & Cubillas River Basins

- Water quality in mediterranean river networks is highly variable in time and space.
- Point (weakly variable) and non-point (highly variable) sources





- Cubillas sub-basin: complex land use pattterns and mediterranean hydrologic regime (large seasonal and short-term flow changes)

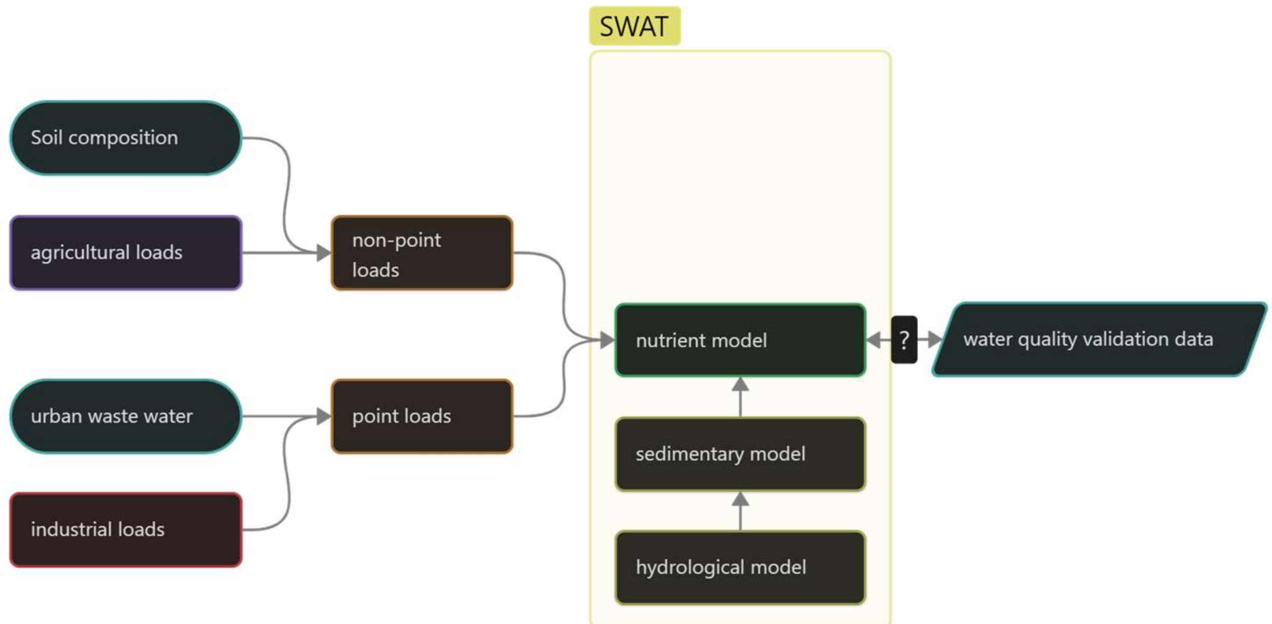
Goals

1) How sensitive are SWAT outputs in Cubillas basin to changes in soil organic matter and nutrient content, and to the magnitud of urban wastewater loads?

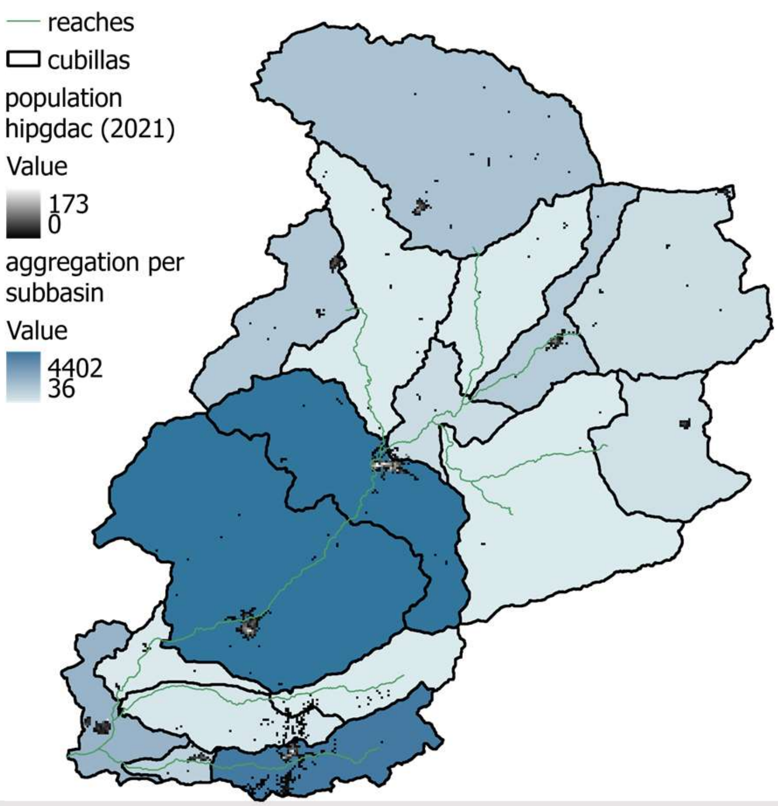
2) To what extend the ranges of uncertainty in these sources can explain observed water quality variable in Cubillas river??

SWAT: Model background

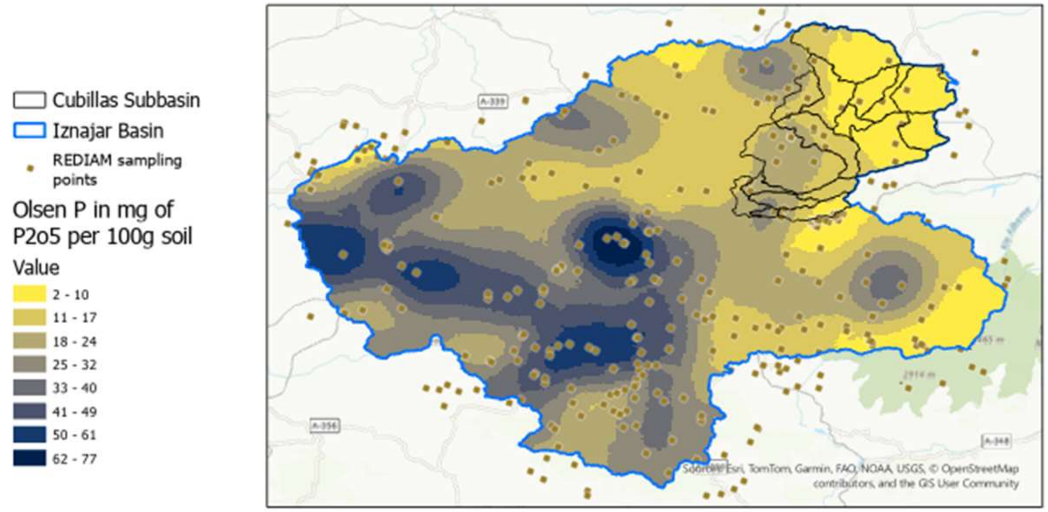
- Watershed and erosion model
- Nutrient fluxes and pathways
- **Point** vs. **non-point** sources
  - **Non-point: soil initial conditions**
  - **Point: urban wastewater**

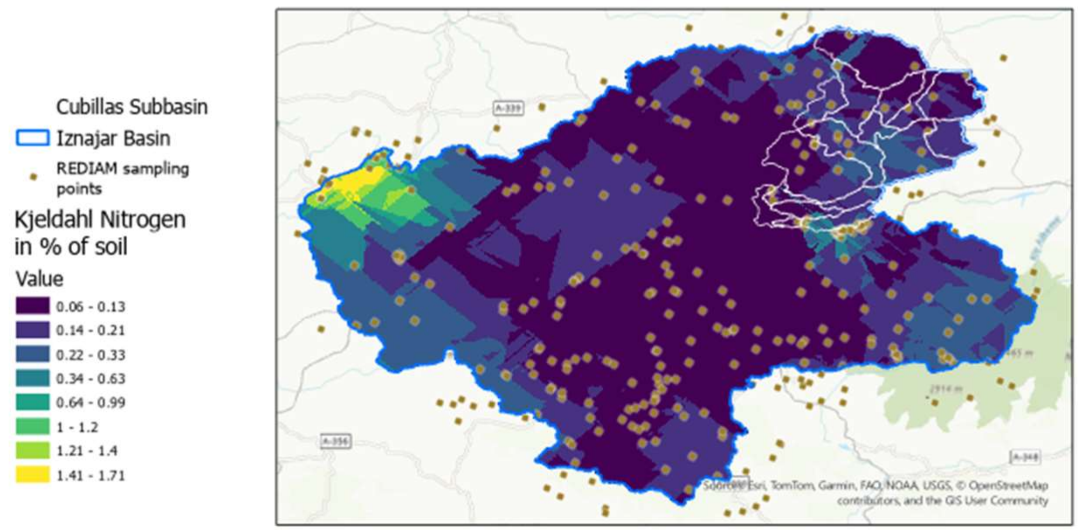


Soil databases



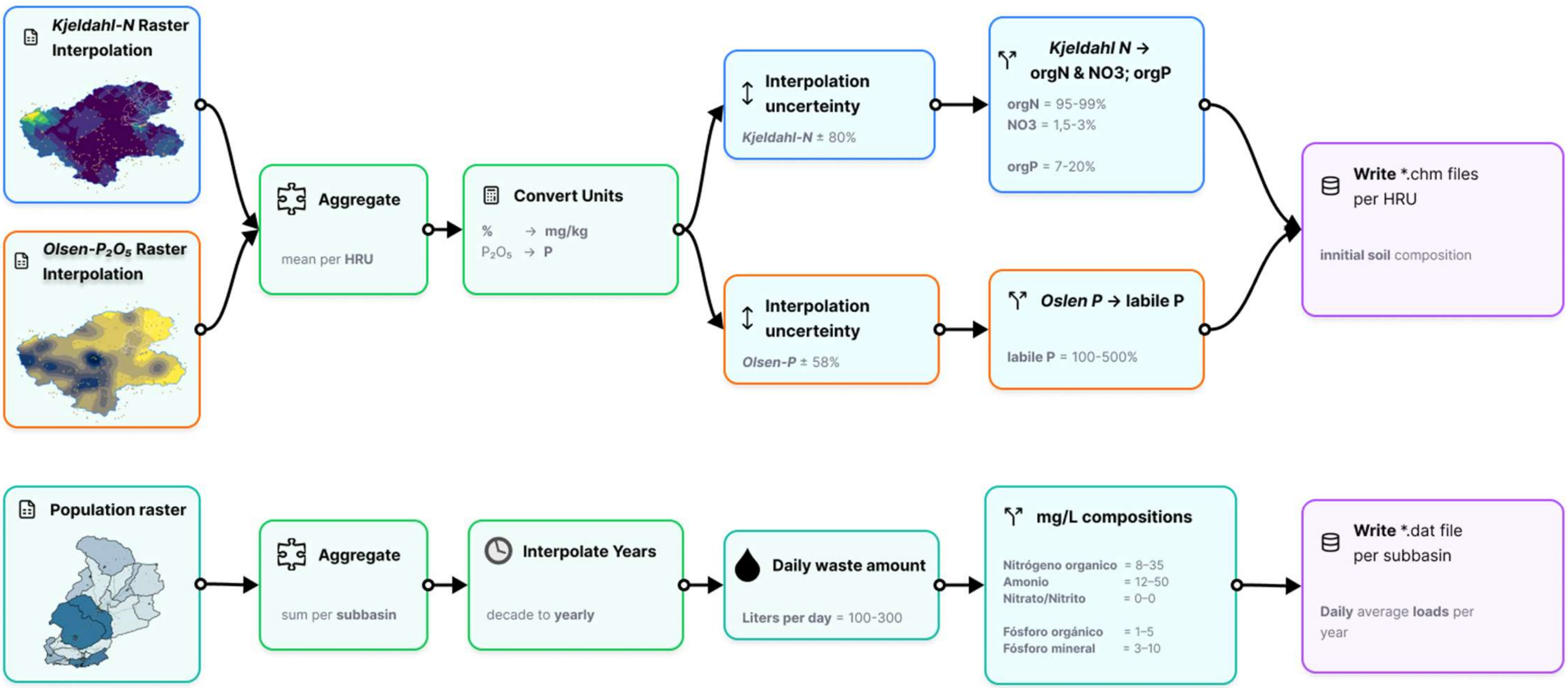
Goerlich, F. J. (2025). HIPGDAC-ES: Historical population grid data compilation for Spain (1900–2021).





Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, “Perfiles de suelos en Andalucía.” 2019.

Sources of uncertainty



Ensembles of model realizations

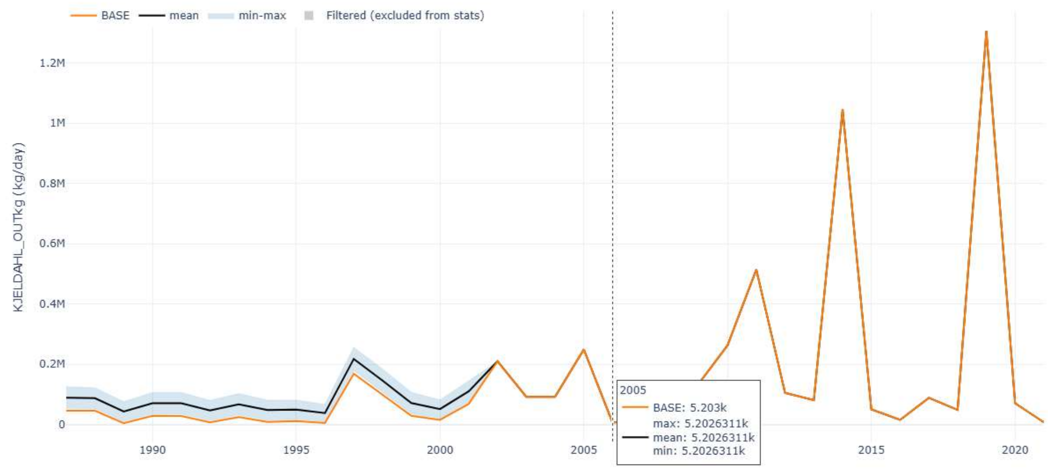
Scenario	Description
BASE	Hydrologic/sediment model (calibración "219") + **land uses**
WASTE (point)	BASE + **urban wastewater** (*min–max ensembles*)
SOIL (non-point)	BASE + initial soil nutrient content (*min–max ensembles*)
WASTE+SOIL	**BASE + WASTE + SOIL** (*min–max ensembles*)

Storm events: periods of at least 2 days when flow rate is ≥ 75-percentile

Sensitivity tests

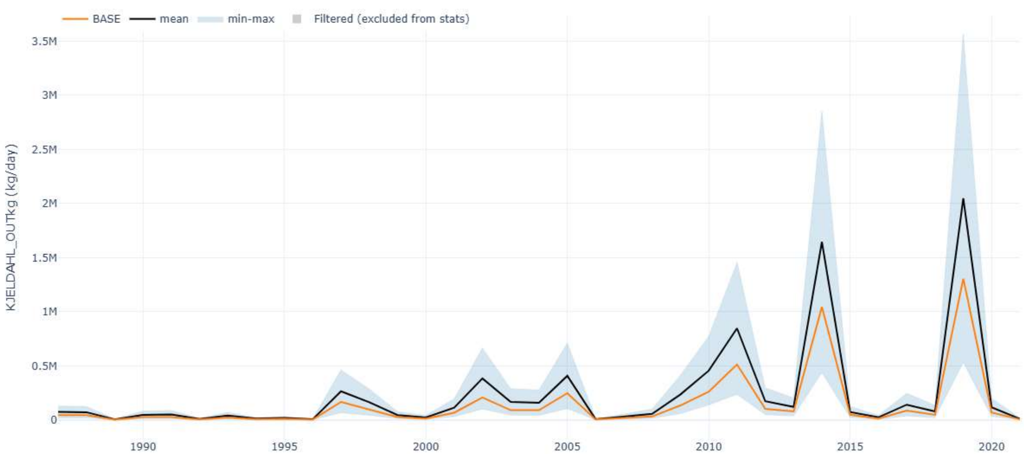
WASTE

- Annual average Kjeldahl N



KJELDAHL_OUTkg - Reach 13 (1A, sum) [Load kg/day] vs. NITROGENO KJELDAHL

SOIL



KJELDAHL_OUTkg - Reach 13 (1A, sum) [Load kg/day] vs. NITROGENO KJELDAHL

- BASE vs. WASTE
  - Purely additive loads
- BASE vs. SOIL
  - compare the default (automatic) soil initialization procedures in SWAT vs. manual or data-driven procedures

Sensitivity tests

- Total Phosphorus (TP)
- Kjeldahl Nitrogen (TKN)

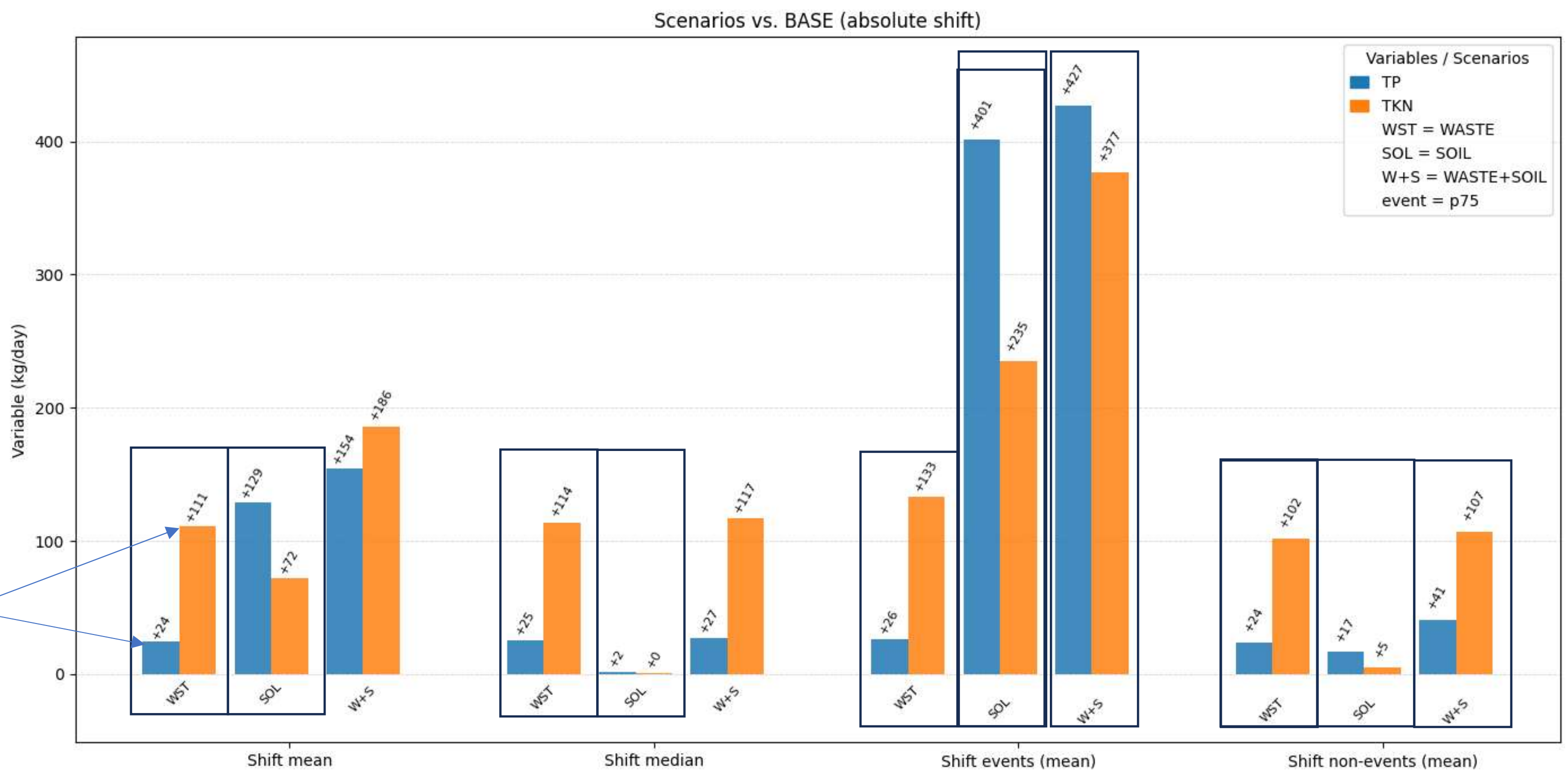
$$M_{\square} = N \cdot L \cdot c_{\square} \cdot 10^{-6}$$

$$M_{TP} = 15{,}500 \cdot 200 \cdot 8 \cdot 10^{-6}$$

$$\boxed{M_{TP} = 24.8\ \text{kg/day}}$$

$$M_{TKN} = 15{,}500 \cdot 200 \cdot 40 \cdot 10^{-6}$$

$$\boxed{M_{TKN} = 124\ \text{kg/day}}$$



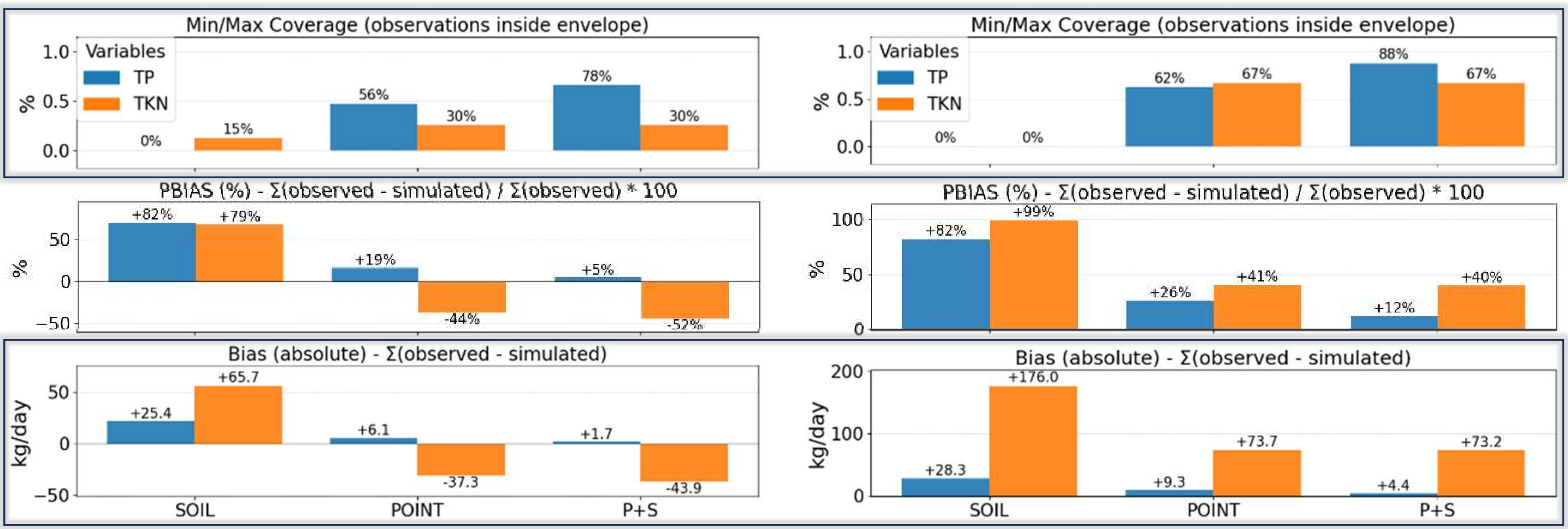
Observations and model uncertainty ranges

Filtering observations

- 1) LDM = 0.1 mg/kg
  - Set LDM to half LDM
- 2) only data > LDM
  - Much less

*Cobertura y sesgo: **20 TKN** y **9 TP** mediciones*

*Cobertura y sesgo: **9 TKN** y **8 TP** mediciones*

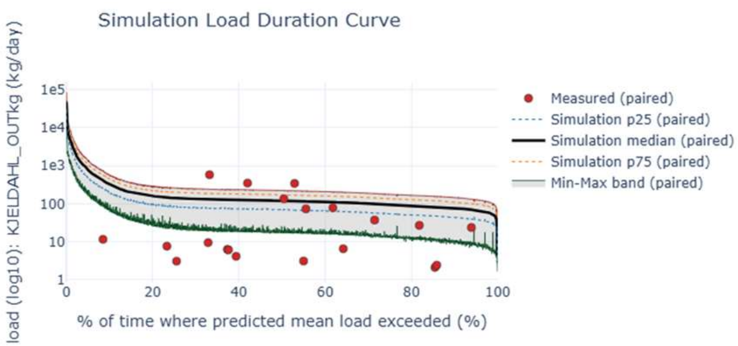


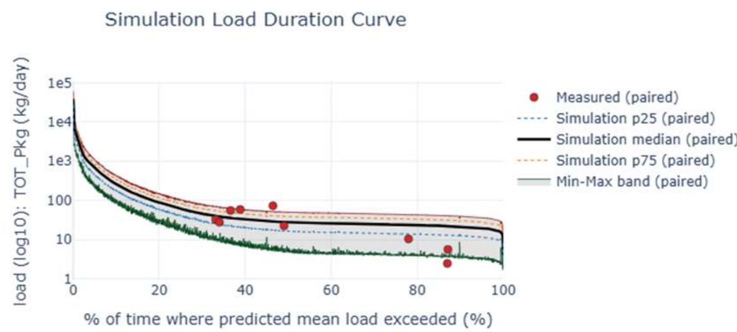
Observations and model uncertainty ranges

Kjeldahl Nitrogen

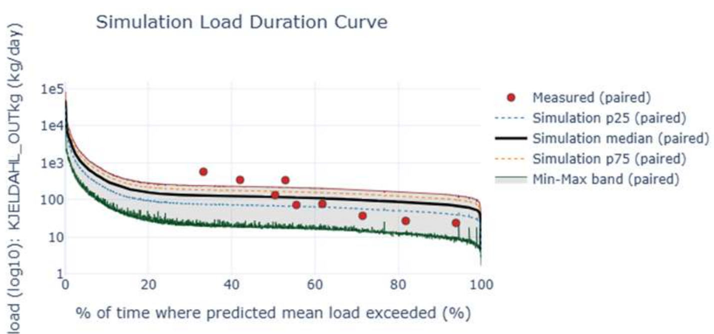
Total Phosphorus

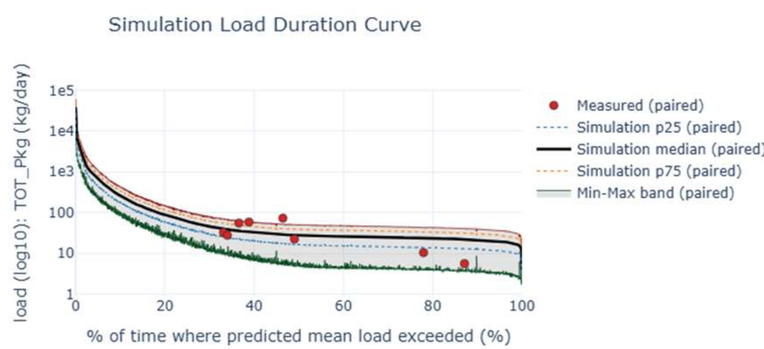
With values below LDM





With no values below LDM





Discussion

- **Atribution**
  - TP more sensivity to soil initialization procedures and number of events/year [1]
  - TKN more sensitive to urban wastewater loadings (consistent with input)
- **Water quality model, needs to be improved (for dailly loads)**
- Need to account for wastewater loads + soil initialization uncertainty so that observed are within uncertainty ranges
  - TP with/without data < LDM: coverage ~ 80%; underestimating 2-4 kg/day
  - TKN with data < LDM: coverage 30%; overestimating - 44 kg/day
  - TKN without data < LDM: coverage 67%; underestimating 73 kg/day

[1] H. K. M. Mihiranga et al., “Nitrogen/phosphorus behavior traits and implications during storm events in a semi-arid mountainous watershed,” 2021.

Conclusions

- Soils, per-se, have a limited explanatory potential
  - For non-point sources: focus on uncertaintys resulting from agricultural managemente
- Mas falta de atribución para Nitrógeno que para Fosforo [2]
- **Global Warming= ↑ affecting non-point sources** [3,4]
- Need to **identify** additional sources of uncertainty (structural and data)
- Need to more-comparable data, particularly, during events.
- **Need for clear protocols to deal with values < LDM** (key)

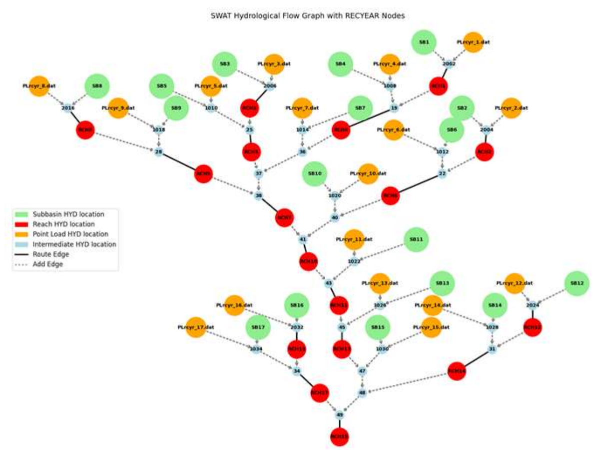
[2] O. US EPA, "Nonpoint Source Pollution with Nitrogen and Phosphorus." 1998. pdf: http://www.esa.org/esa/wp-content/uploads/2013/03/issue3.pdf

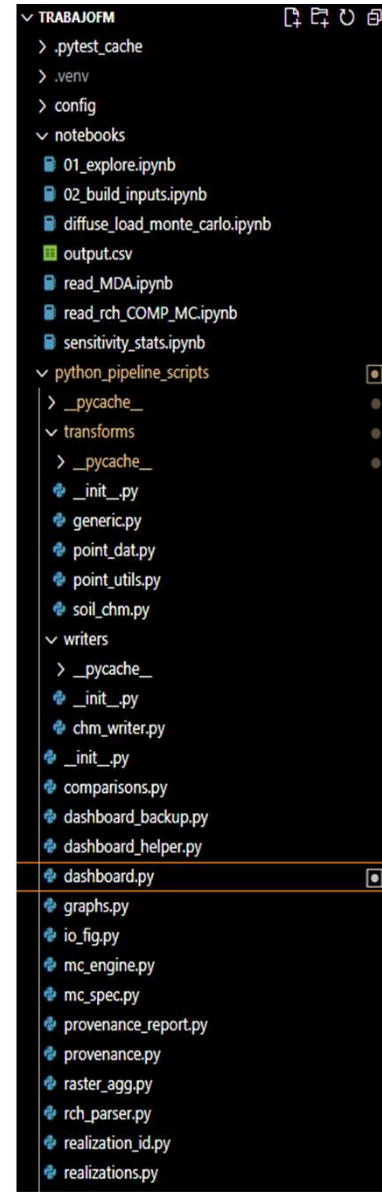
[3] T. Johnson *et al.*, "A review of climate change effects on practices for mitigating water quality impacts," 2022, doi: 10.2166/wcc.2022.363.

[4] J. Ide *et al.*, "Impacts of Hydrological Changes on Nutrient Transport From Diffuse Sources in a Rural River Basin, Western Japan," 2019, doi: 10.1029/2018JG004513.

Discussion

- ~10.000 Python lines, fairly complex but shared …
  https://github.com/bvorak/swat_pipeline
  - transparent, automatable and extendable
- Use it in server for MonteCarlo simulations
- Extended calibration will improve the method *[4]*





[4] C. Schürz et al., "A sensitivity and uncertainty analysis for discharge and nitrate-nitrogen loads under future changing conditions," 2019, doi: [10.5194/hess-23-1211-2019](https://doi.org/10.5194/hess-23-1211-2019).