Predicting the impact of water demand and river flow regulation over riparian vegetation through mathematical modeling (EP51B-0705)

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1. INTRODUCTION

Vegetation of the riversides:

- Main part of the complex riparian ecosystems
- Important role maintaining fluvial ecosystems

Semi-arid Mediterranean areas → vegetation growth and distribution controlled by water accessibility

Human interventions → river hydrology alterations

- Determine riparian vegetation wellbeing and distribution

The RibAV model (García-Arias *et al.*, 2013a):

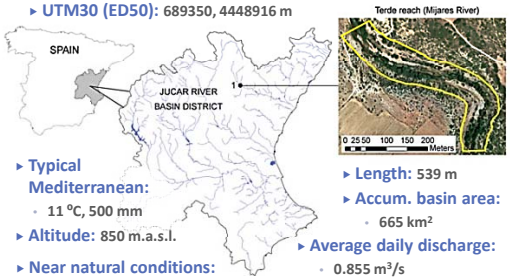
- Reproduces the vegetation performance on the riverside throug its evapotranspiration index, E_{idx} *(relation between the actual ET calculated by RibAV and the potential ET corrected by the coverage factor of the analysed PFT)*
- Allows scenarios analysis (vegetation distribution and wellbeing)

Scenarios analysis → theoretical alterations of the natural flow regime (Reference period : 1949-2009)

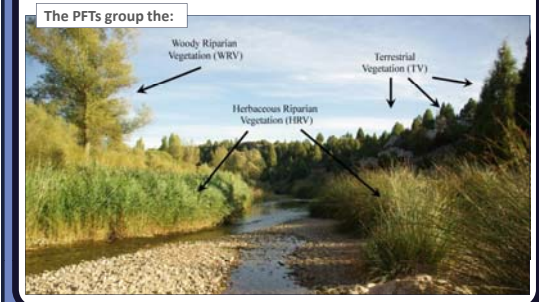
2. STUDY CASE

Terde reach (Mijares River, Spain)

- UTM30 (ED50): 689350, 4448916 m
- Typical Mediterranean:
  - 11 ºC, 500 mm
- Altitude: 850 m.a.s.l.
- Near natural conditions:
  - Willows and poplars are dominant
  - The substrate is varied (gravel, cobbles and scattered boulders)
- Length: 539 m
- Accum. basin area:
  - 665 km²
- Average daily discharge:
  - 0.855 m³/s



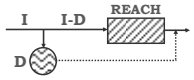
The PFTs group the:

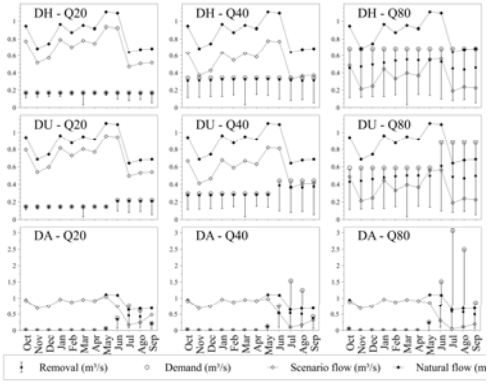


3. SCENARIOS

Water demand upstream scenarios: the demands encompass different seasonality and magnitude

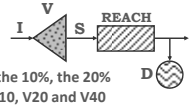
- **Seasonality:** hydroelectric demands (HD, constant all over the year), urban demands (UD, increased during the summer period) and agricultural demands (AD, monthly seasonality)
- **Magnitude:** varied considering the 20%, the 40% and the 80% of the mean daily flow (Q20, Q40 and Q80 respectively)

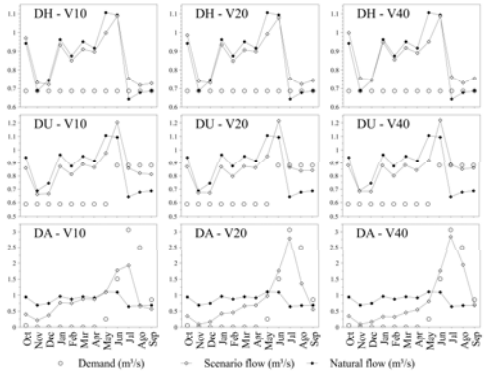




Flow regulation scenarios: a theoretical upstream reservoir to attend the demands located downstream

- **Demands:** encompass different seasonality (HD, UD and AD) and a fixed magnitude of Q80
- **Reservoir capacity:** varied considering the 10%, the 20% and the 40% of the annual contribution (V10, V20 and V40 respectively)

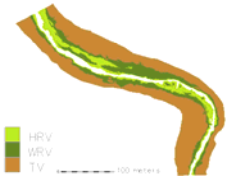




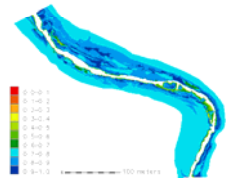
4. RESULTS

No Impact

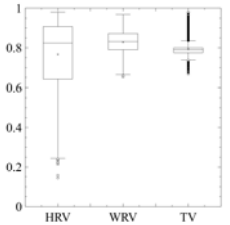
(Reference period : 1949-2009)



Simulated PFTs under natural conditions

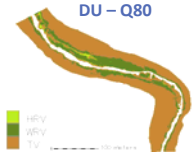


Simulated E_{idx} under natural conditions

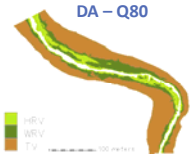


E_{idx} values obtained by each PFT simulated under natural conditions

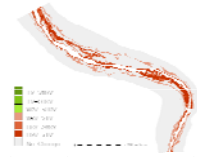
Water demand scenarios



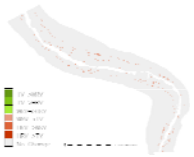
Simulated PFTs under DU-Q80 scenario



Simulated PFTs under DA-Q80 scenario



Changes on the PFTs comparing natural conditions and the DU-Q80 scenario



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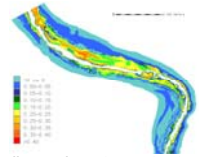
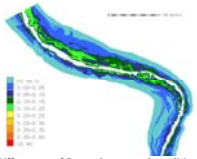
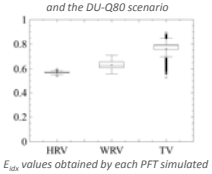


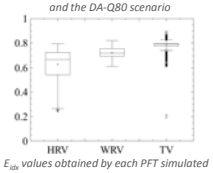
Differences of E_{idx} under natural conditions and the DU-Q80 scenario



Differences of E_{idx} under natural conditions and the DA-Q80 scenario

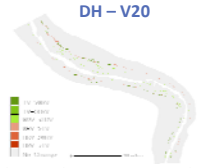


E_{idx} values obtained by each PFT simulated under DU-Q80 scenario

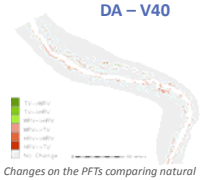


E_{idx} values obtained by each PFT simulated under DA-Q80 scenario

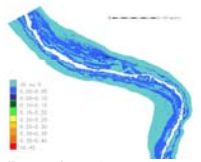
Flow regulation scenarios



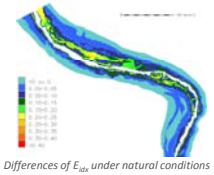
Changes on the PFTs comparing natural conditions and the DH-V20 scenario



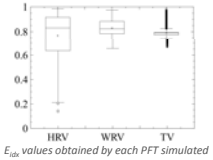
Changes on the PFTs comparing natural conditions and the DA-V40 scenario



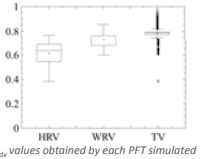
Differences of E_{idx} under natural conditions and the DH-V20 scenario



Differences of E_{idx} under natural conditions and the DA-V40 scenario



E_{idx} values obtained by each PFT simulated under DH-V20 scenario



E_{idx} values obtained by each PFT simulated under DA-V40 scenario

Different effects of flow regulation, depending on the downstream demand

- **DH and DU → favors the riparian vegetation. The volume of the reservoir does not condition the results significantly**
- **DA → affects negatively the riparian vegetation. The bigger is the reservoir, the more affected is the riparian vegetation**

5. CONCLUSIONS

RibAV model is useful to predict the impact of water demand and river flow regulation on the riparian vegetation

Hydroelectric and urban demands upstream → riparian vegetation (especially HRV) is replaced by TV

- The higher is the magnitude, the bigger are the impacts
- The E_{idx} of the riparian PFTs is lower, the wellbeing of TV is favored

Agricultural demands upstream → riparian vegetation less impacted than with DH or DU

- No many differences when the magnitude increases. Zones more affected: limits between 2 PFTs
- E_{idx} lower but not enough to affect the vegetation distribution

Flow regulation can favor the riparian vegetation in short term

- Riparian plant communities aging promotes the replacement by terrestrials in the long term → **Necessity to consider flood impacts on the Riparian zone (García-Arias et al., 2013b)**

6. ACKNOWLEDGEMENTS

SCARCE project: Assessing and Predicting Effects on Water Quantity and Quality in Iberian Rivers caused by Global Change. CONSOLIDER Plan, Ministerio de Ciencia e Innovación (ref.: CSD2009-00065).
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7. REFERENCES

García-Arias A, Francés F, Morales-de la Cruz M, Real J, Vallés-Morán F, Garófano-Gómez V & Martínez-Capel F, 2013a. Riparian evapotranspiration modelling: model description and implementation for predicting vegetation spatial distribution in semi-arid environments. *Ecohydrology.* DOI: 10.1002/eco.1387

García-Arias A., Francés F., Ferreira T., Egger G., Martínez-Capel F., Garófano-Gómez V., Andrés-Doménech I., Politti E., Rivaes R., Rodríguez-González P. M. 2013b. Implementing a dynamic riparian vegetation model in three European river systems. Ecohydrology. 6(4):635-651. doi: 10.1002/eco.1331

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