Analysis of the riparian vegetation dynamics through the RIPFLOW model. Climate change scenarios in three European countries

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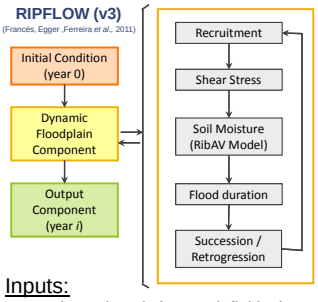
INTRODUCTION

RIPFLOW (v3) → Riparian vegetation distribution modeling in space and time

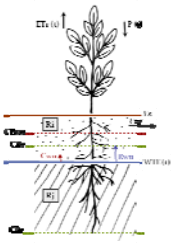
→ vegetation succession or retrogression in response of physical parameters (Garófano-Gómez *et al.*, 2011)

Practical tool to tackle water management issues and restoration projects uncertainties (Egger *et al.*, 2011; Rivaes *et al.*, in press)

RIPFLOW (v3) (Francés, Egger ,Ferreira *et al.*, 2011)



RibAV Model (Morales & Francés, 2009)



Inputs:
- Database (yearly inputs definition)
- Sub-models parameters and maps

Outputs:
- Vegetation maps (years= {1, 2, …, n})
- ETidx maps (years= {1, 2, …, n})

Evapotranspiration index

$$ET_{idx} = \frac{ETR_{tot}}{ET_0 \cdot Cov}$$

Where,
- *ETRtot* is the real evapotranspiration
- *ETO* is the potential evapotranspiration
- *Cov* is the plant cover

The model has been already calibrated for Ribeira (Portugal), Terde (Spain) and Drau (Austria) with good results. (Francés, Egger ,Ferreira *et al.*, 2011)

CASES OF STUDY

1. RIBEIRA
Odelouca River (Portugal)

Characteristic	YES	NO
permanent flow regime		X
flow regulation upstream		X
restored channel		X

- reach length: 400 meters
- characteristic Mediterranean environment
- riparian area: the floodplain has much more vegetation than the river bed
- riparian main vegetation: *Fraxinus angustifolia*, *Salix salviifolia* and *Tamarix africana*

2. TERDE
Mijares River (Spain)

Characteristic	YES	NO
permanent flow regime	X	
flow regulation upstream		X
restored channel		X

- reach length: 539 meters
- characteristic Mediterranean environment
- riparian area: continuous and connected with forest areas
- riparian main vegetation: *Salix eleagnos*, *Salix purpurea* and *Populus nigra*

3. DRAU
Drau River (Austria)

Characteristic	YES	NO
permanent flow regime	X	
flow regulation upstream		X
restored channel	X	

- reach length: 700 meters
- characteristic Alpine environment
- riparian area: the bank zone has very little vegetation while the floodplain zone is completely covered
- Riparian main vegetation: *Salix alba* and *Alnus incana*

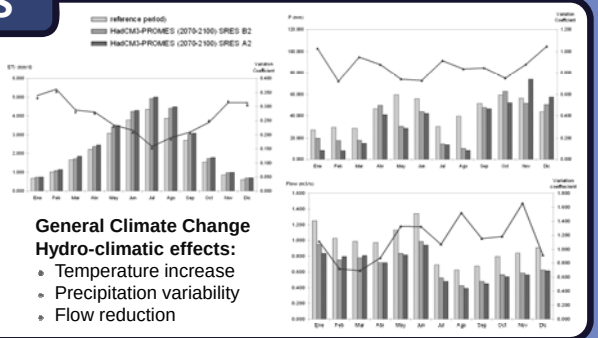
DATA & SCENARIOS

CLIMATE CHANGE SCENARIOS

Reference period (1961 - 1990)

Optimistic scenarios (Period 2071 – 2100)
- Spain: model **HadCM3-PROMES**, scenario **SRES B2**
- Portugal: model **HadCM3**, scenario **SRES B2**
- Austria: model **GCM ECHAM5**, scenario **SRES A1B**

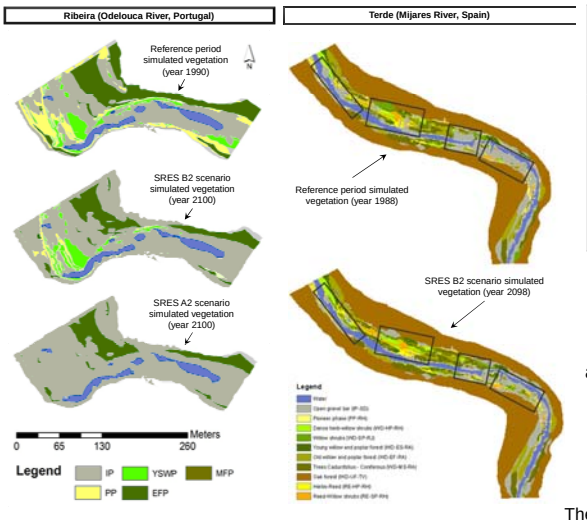
Pessimistic scenarios (Period 2071 – 2100)
- Spain: model **HadCM3-PROMES**, scenario **SRES A2**
- Portugal: model **HadCM3,** scenario **SRES A2**
- Austria: model **GCM ECHAM5**, scenario **SRES A2**

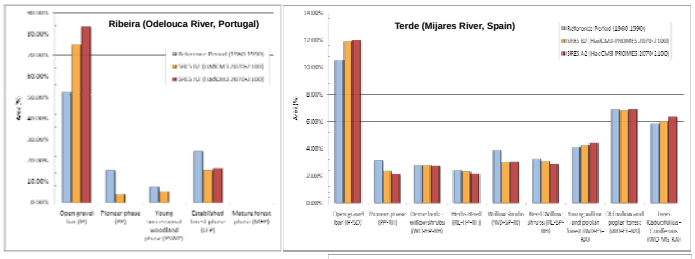


General Climate Change Hydro-climatic effects:
- Temperature increase
- Precipitation variability
- Flow reduction

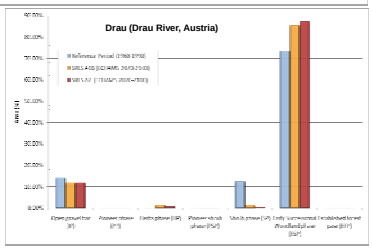
RESULTS

The results were coherent in both Mediterranean study sites, Terde (Spain) and Ribeira (Portugal): All the analyzed scenarios showed a **decrease of the early succession phases**, leading to **species lost**

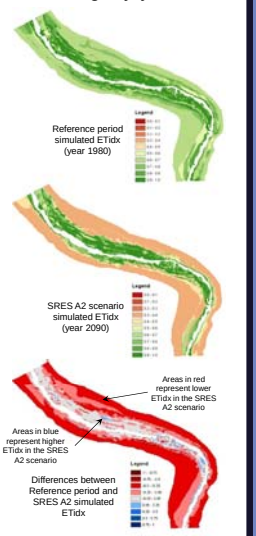




This trends were **more pronounced** in the **worst scenario**, suggesting that extreme climatic change will promote a widening of the river bed and the **disappearance of pioneer or young succession stages** of the riparian woodlands in Mediterranean rivers, specially in Portugal.

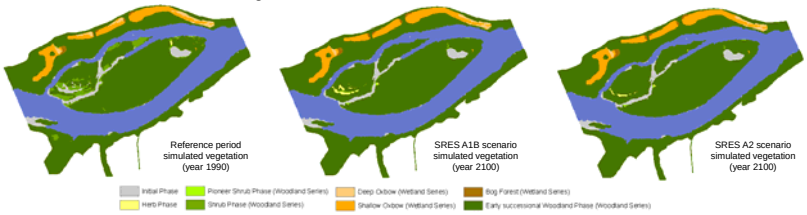


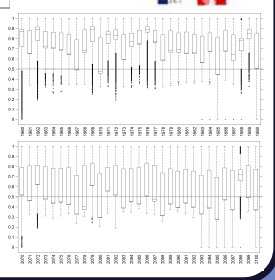
In addition, the scenarios produced a generalized **ETidx reduction** in the reaches, harder during dry years and for the pessimistic scenario



The Drau case study (Austria) highlighted:
- a **stationary percentage** composition of the **older succession phases** (not heavily affected even by large floods)
- the **younger succession phases** abundance **fluctuate** (in response of the flow variations determined by the climate change scenarios)

The analyses in the Austrian case Drau case showed lower climate change effects in terms of vegetation distribution than the observed for Mediterranean sites





CONCLUSIONS

- Lower differences as expected between scenarios, in spite of the great variations between hydrological inputs
- Early succession phases are more sensitive under climate change hydro-meteorological expected conditions
- The climate change scenarios simulations showed a generalized reduction on evapotranspiration capabilities
- The results showed that Mediterranean riparian zones will probably suffer harder climate change effects

ACKNOWLEDGEMENTS

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***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). http://www.idaea.csic.es/scarceconsolider

REFERENCES

Egger, G.; Politti, E.; Habersack, H.; Kloesch, M.; Ferreira, T. (2011). Using a Dynamic Vegetation Model as Follow-Up for River Restoration. Submitted to the 2nd Biennial Symposium of the International Society for River Science ISRS. Berlin, August 08-12, 2011.

Frances, F.; Egger, G.; Ferreira, T.; Angermann, K.; Martínez-Capel, F.; Politti, E. (2011). Riparian vegetation dynamic modelling using the succession-retrogression concept: the RIPFLOW project. EGU General Assembly 2011. Geophysical Research Abstracts Vol. 13, EGU2011-11851, ISSN.1029-7006

Garófano-Gómez, V.; Martínez-Capel, F.; Rodríguez-González, P.; Rivaes, R.; Albuquerque, A.; Ferreira, T.; Egger, G.; Politti, E.; Vallés, F.; Andrés, I. (2011). Analyses of succession-retrogression for dynamic modelling of riparian vegetation in the RIPFLOW project. EGU General Assembly 2011. Geophysical Research Abstracts Vol. 13, EGU2011-13094, ISSN.1029-7006.

Morales, M.; Frances, F. (2009). Vegetation and water use modelling in a semi-arid riparian zone in Guatemala, by coupling basin and river reach hydrological processes. In: Proceed. Internat. Conf. Sci. Inf. Tech. Sust. Manag. Aq. Ecosyst., Concepcion, Chile, ISE-1B2-PH1 (conf187a223), p.93.

Rivaes, R.; Rodríguez-González, P.; Albuquerque, A.; Ferreira, M.T.; Pinheiro, A. (2011). Uma nova ferramenta de restauro: aplicação de um modelo preditivo da evolução da vegetação ripícola em função das alterações hidrológicas. *Recursos Hídricos* (in press).