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European Regional Development Fund

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Aguamod

Development of a water resource management platform during low water periods in the SUDOE region

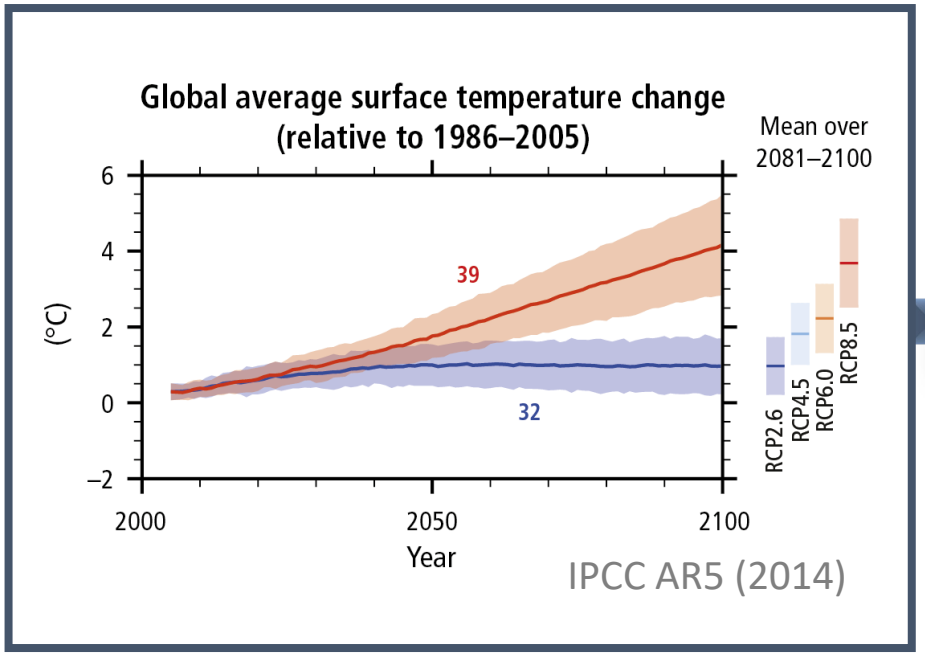
Water quality regulation functions under climate change in South-Western Europe catchments

Mélanie Raimonet, Roxelane Cakir, Sabine Sauvage, Magali Gerino, Robert Vautard, José Miguel Sánchez-Pérez

Brussels, 19 Septembre 2018

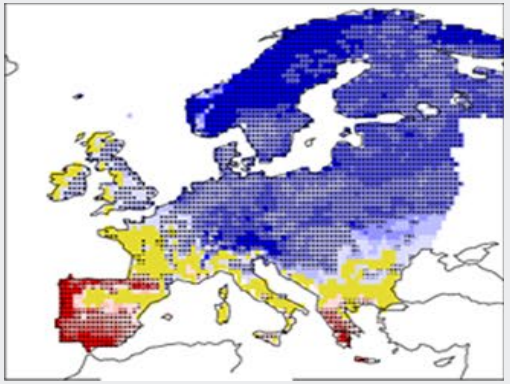
cnrs
Universidad del País Vasco
Euskal Herriko Unibertsitatea
CSIC Consejo Superior de Investigaciones Científicas
irstea
iniav Instituto Nacional de Investigação Agrária e Veterinária, I.P.
IST TÉCNICO LISBOA
UCLM Universidad de Castilla-La Mancha
UCA Universidad de Cádiz
UNIVERSITAT POLITÈCNICA DE VALÈNCIA

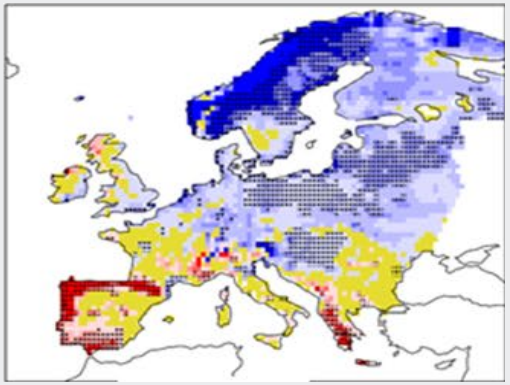
Climate change impacts on hydrology in Europe



IPCC AR5 (2014)

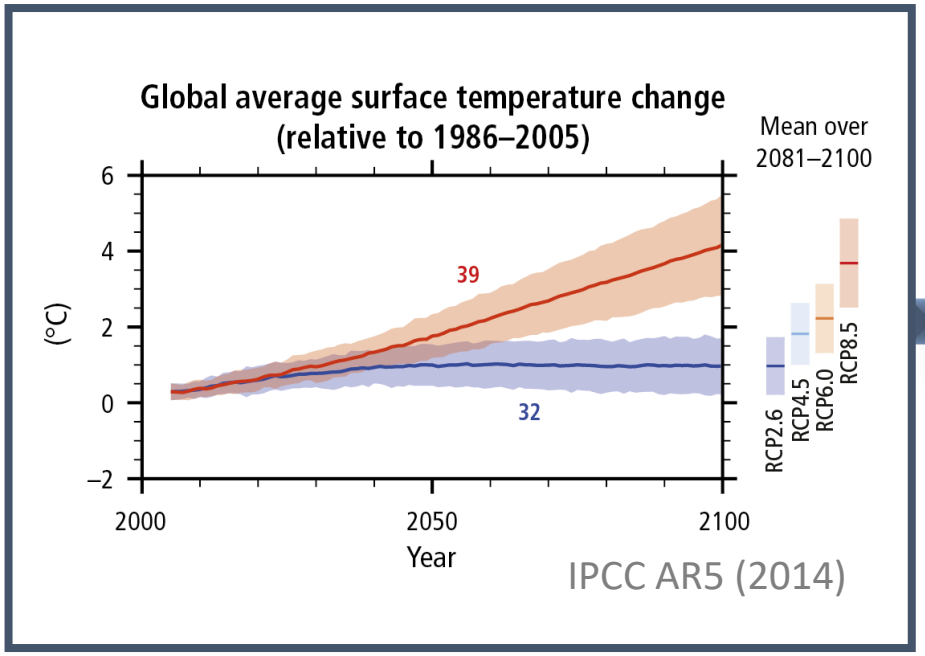
+3°C





Donnelly et al. (2017)
Climatic change

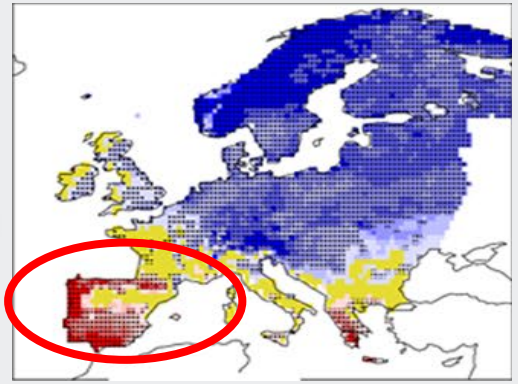
Climate change impacts on hydrology in Europe



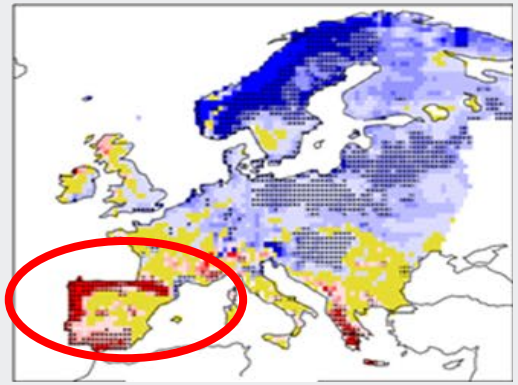
IPCC AR5 (2014)

+3°C

↘ precipitation (<-0.25 mm/d)



↘ streamflow (<-0.15 mm/d)



Donnelly et al. (2017)
Climatic change

Major impacts in the South of Europe :
- ↘ water ressource
- changes in hydrological regime
- ↗ extreme events

Climate change impacts on biogeochemistry?

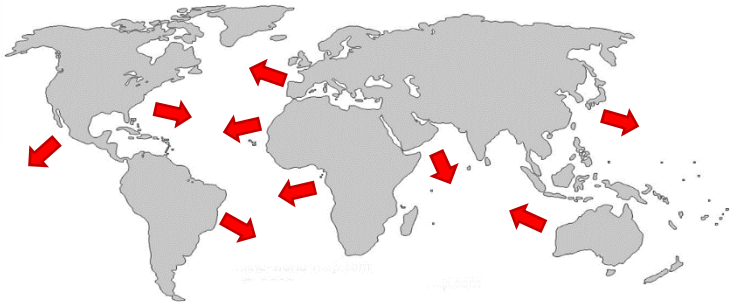
Water quality

- **Nutrient**
- **Sediment**

Ecological functions

- **Sediment retention**
- **Nitrate removal**

Export to the ocean



Climate change impacts on biogeochemistry?

Water quality

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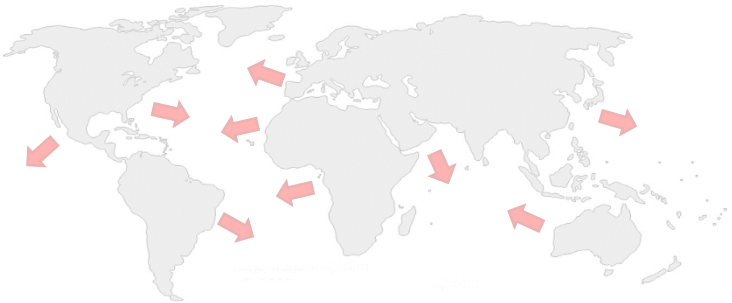
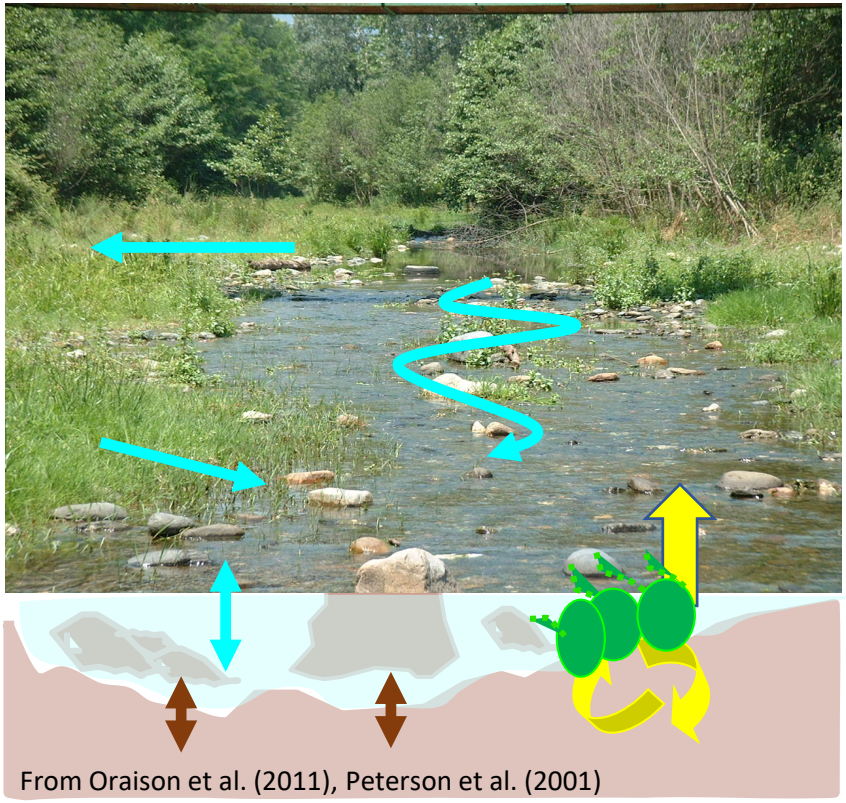


Ecological functions of water quality regulation

result from a group of physical / biological / biogeochemical processes

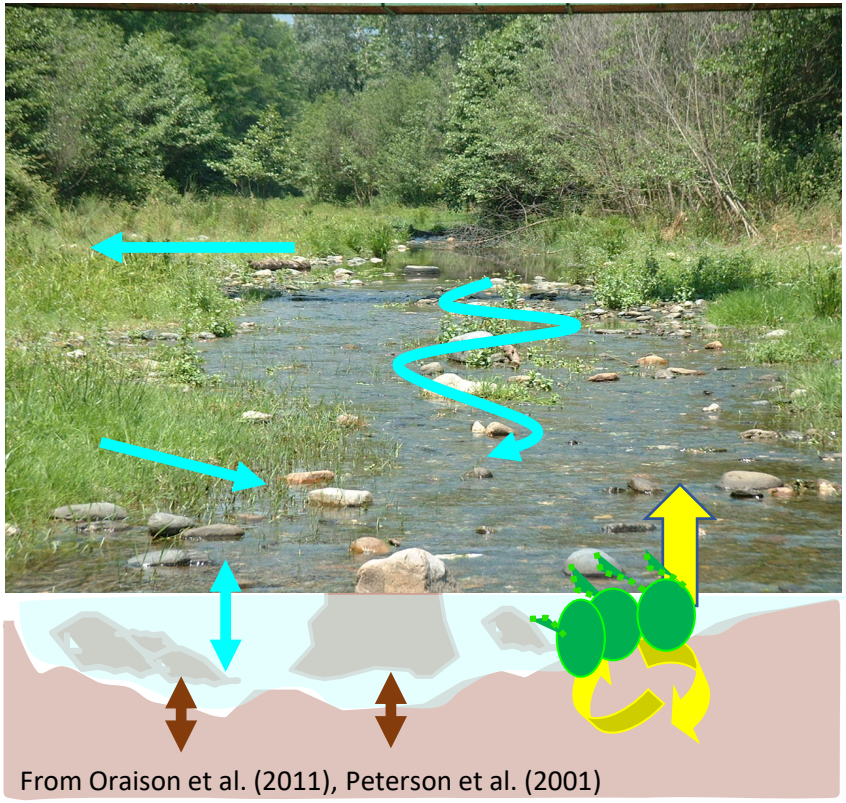


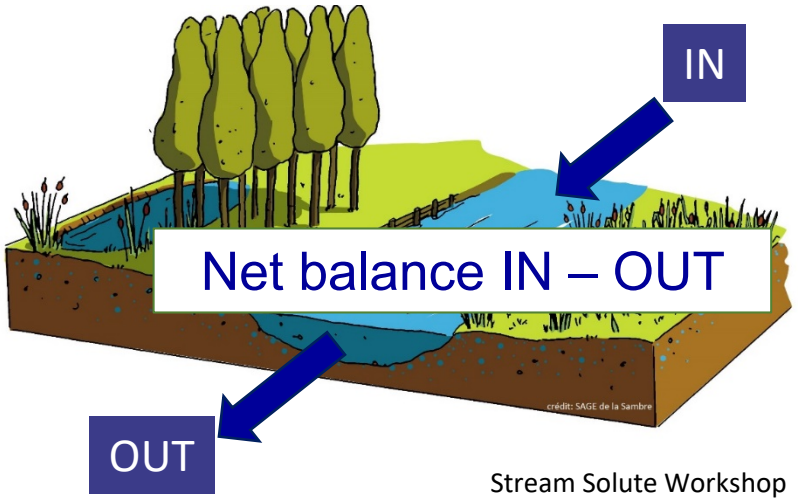
From Oraison et al. (2011), Peterson et al. (2001)

Ecological functions of water quality regulation

result from a group of physical / biological / biogeochemical processes

- **sediment retention**
- **nitrate removal**





Stream Solute Workshop (1990)

The AGUAMOD project

talk Dr. Sánchez-Pérez et al., session I1, Friday @12am

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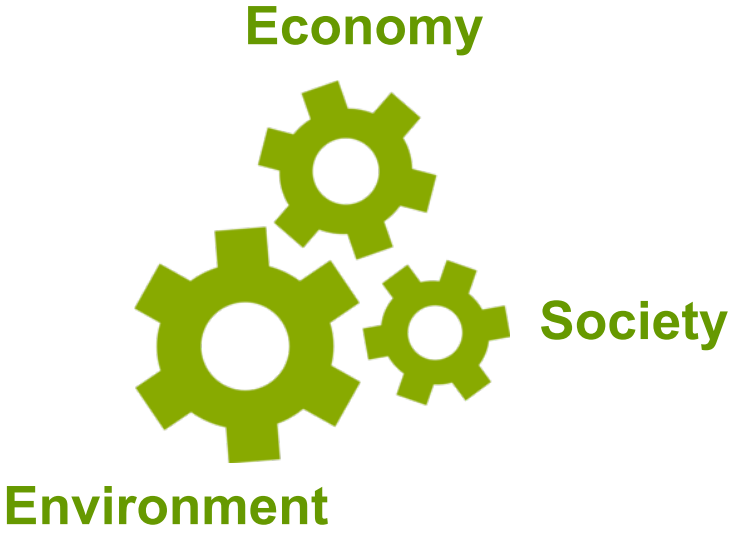

The AGUAMOD project

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Development of a water resource management platform during low water periods in the SUDOE region

Economy

Society

Environment

Soil & Water Assessment Tool | SWAT

***One objective*: to evaluate impacts of global changes on ecological functions of water regulation**

SWAT modelling

Soil & Water Assessment Tool | SWAT

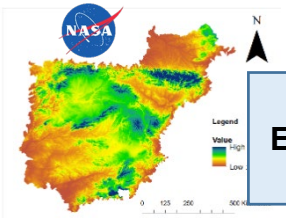
- 263 subbasin ~ streames
- 12 834 HRUs
- 633 000 km²

Human activities:

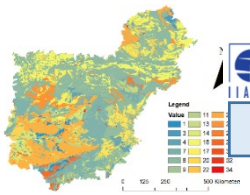
- 44 dams
- 44 urban releases

Sampling stations

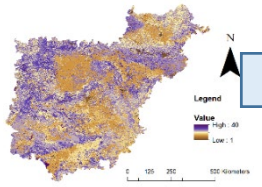
- 19 hydrological
- 28 physical-chemical



Digital Elevation Model

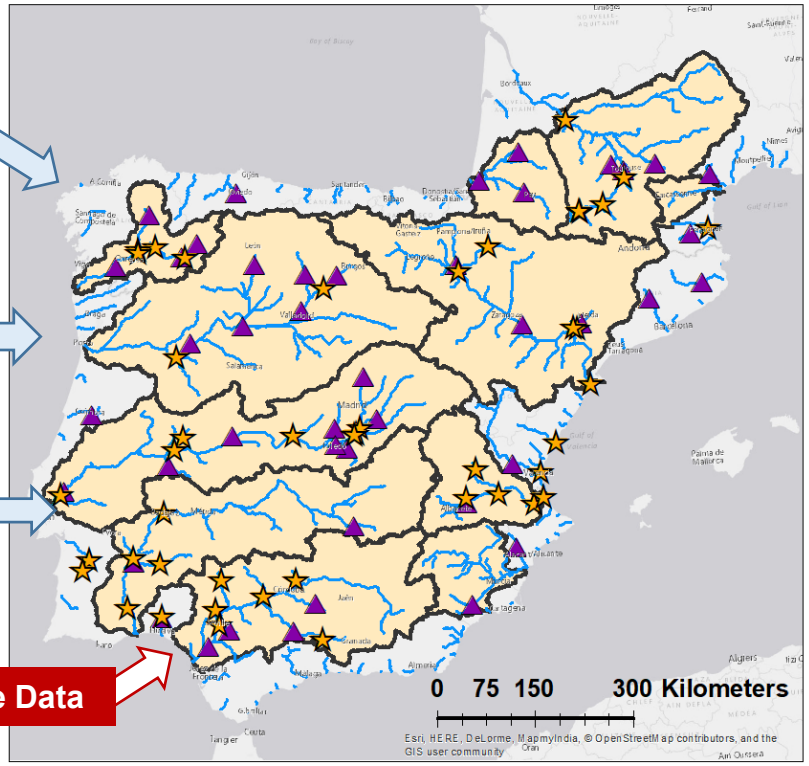


Soils



Land use

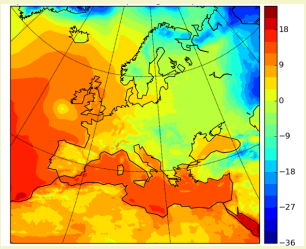
Climate Data



Calibration/Validation: past talk Ms. Cakir et al. today @2:40pm

Climate forcing

Europe
(11 km x 11 km)
Precip & **Temp**



1 set of reanalyses **MESAN**
1989-2010 SMHI

Climate forcing

Europe
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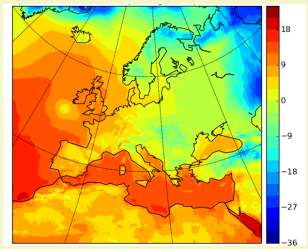
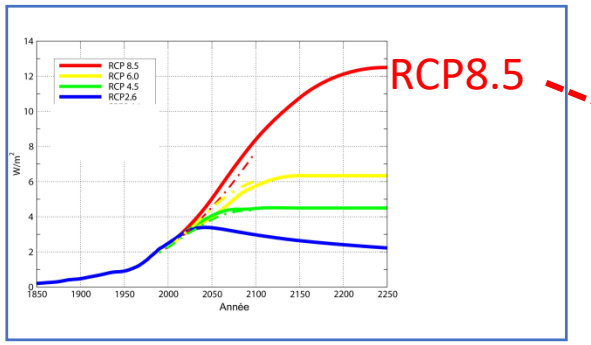


1 set of reanalyses **MESAN**
1989-2010
SMHI

4 sets of projections **BC-CORDEX**
1951-2100
Institut Pierre Simon Laplace



RCP8.5

GCM (4)

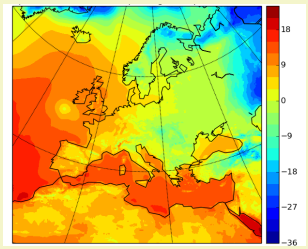
RCM (4)

RCP (1)

Bias-correction (1)

Climate forcing

Europe
(11 km x 11 km)
Precip & **Temp**



1 set of reanalyses **MESAN**
1989-2010
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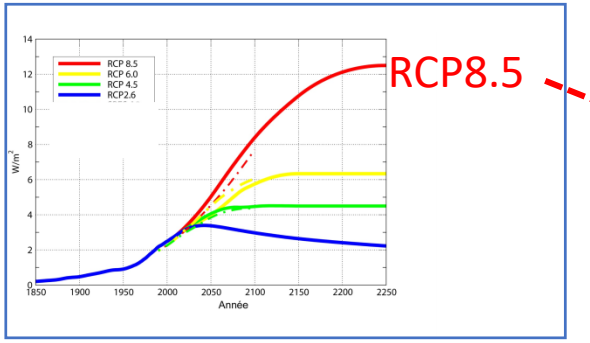
1951-2100
Institut Pierre Simon Laplace

Reference = 2000/10

Trend = 1990/2059



RCP8.5

GCM (4)

RCM (4)

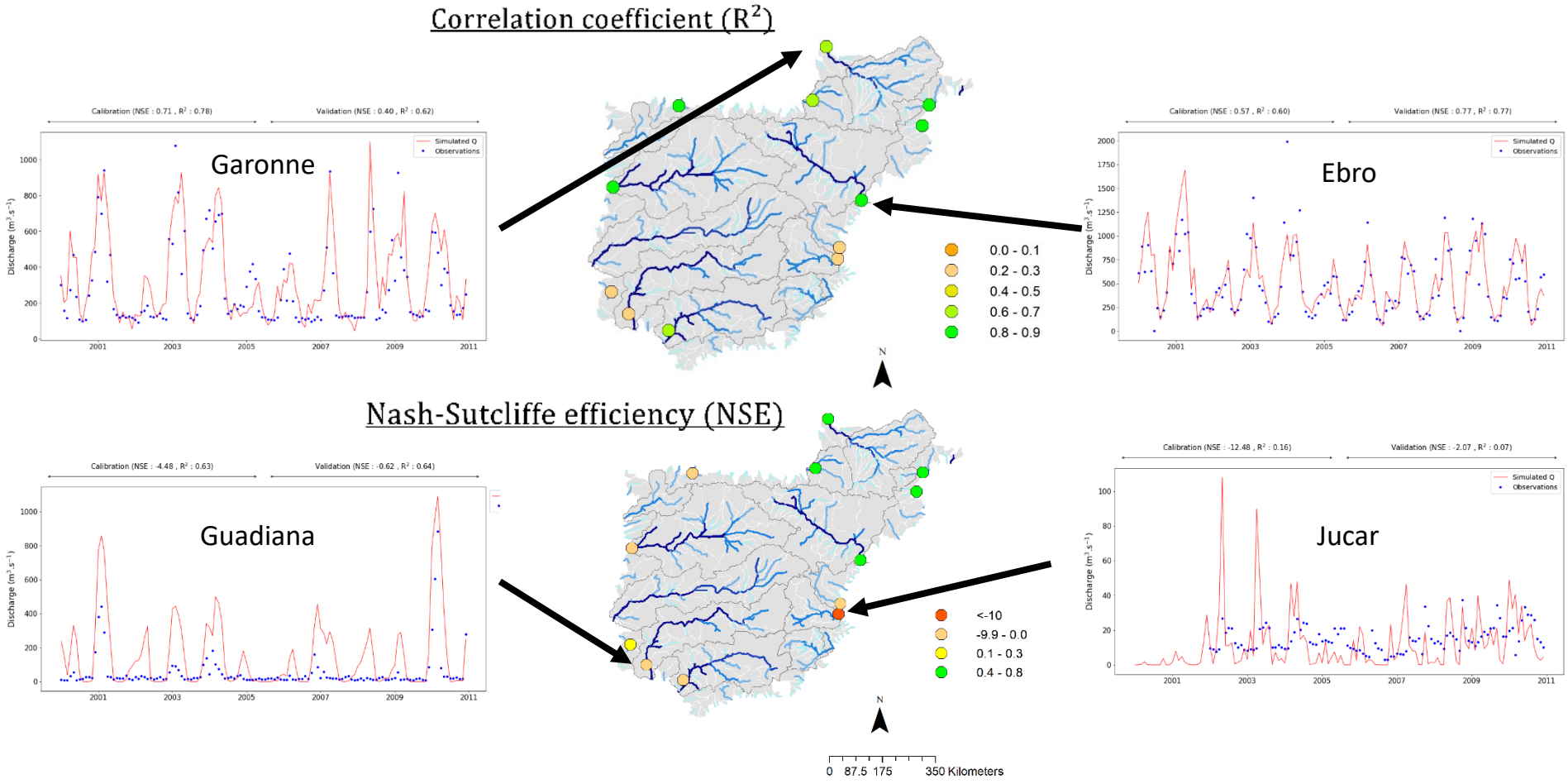
RCP (1)

Bias-correction (1)

Calibration/validation of hydrology with MESAN reanalyses

2000/10

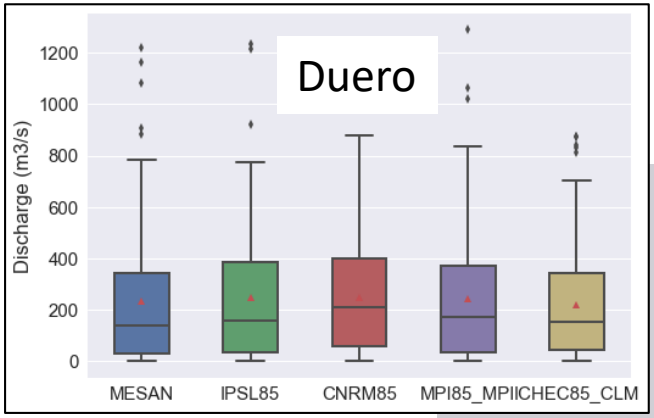
Calibration: 2000/05
Validation: 2006/10

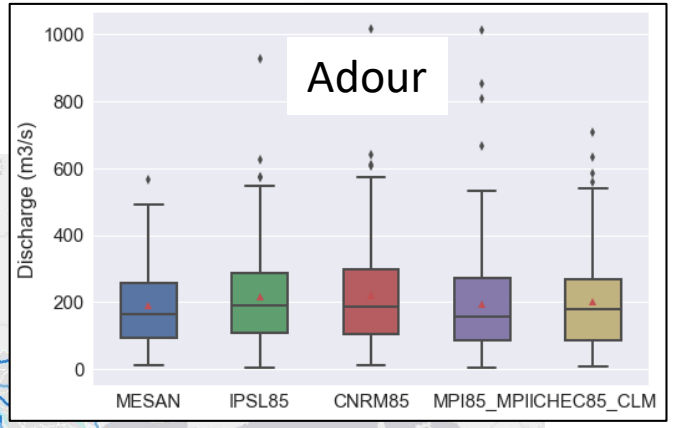


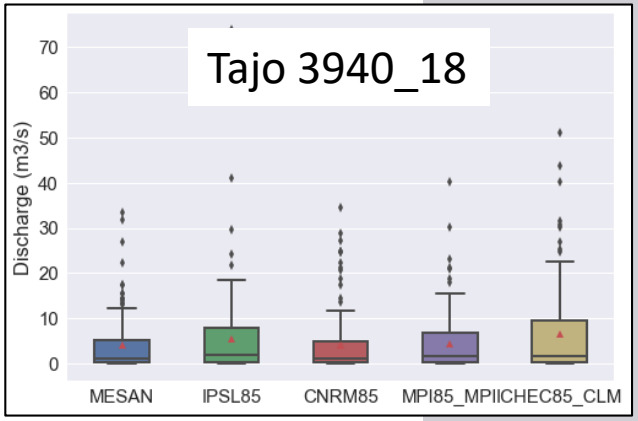
Calibration/Validation: past talk Ms. Cakir et al. today @2:40pm

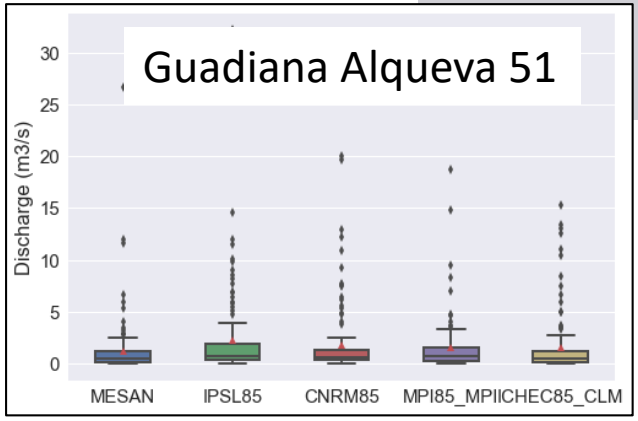
Validation of hydrology with climate models (BC-CORDEX)

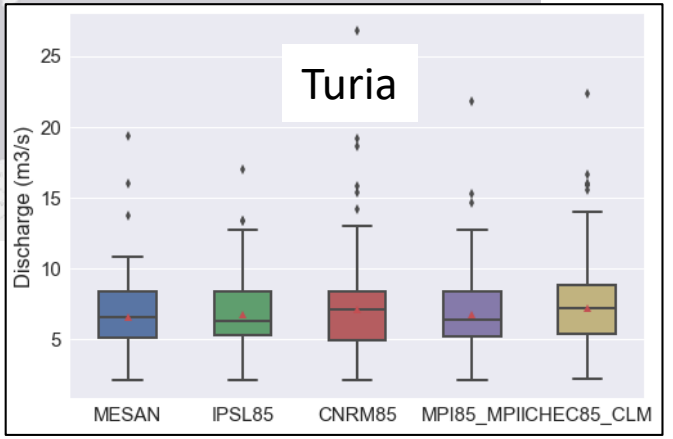
2000/10





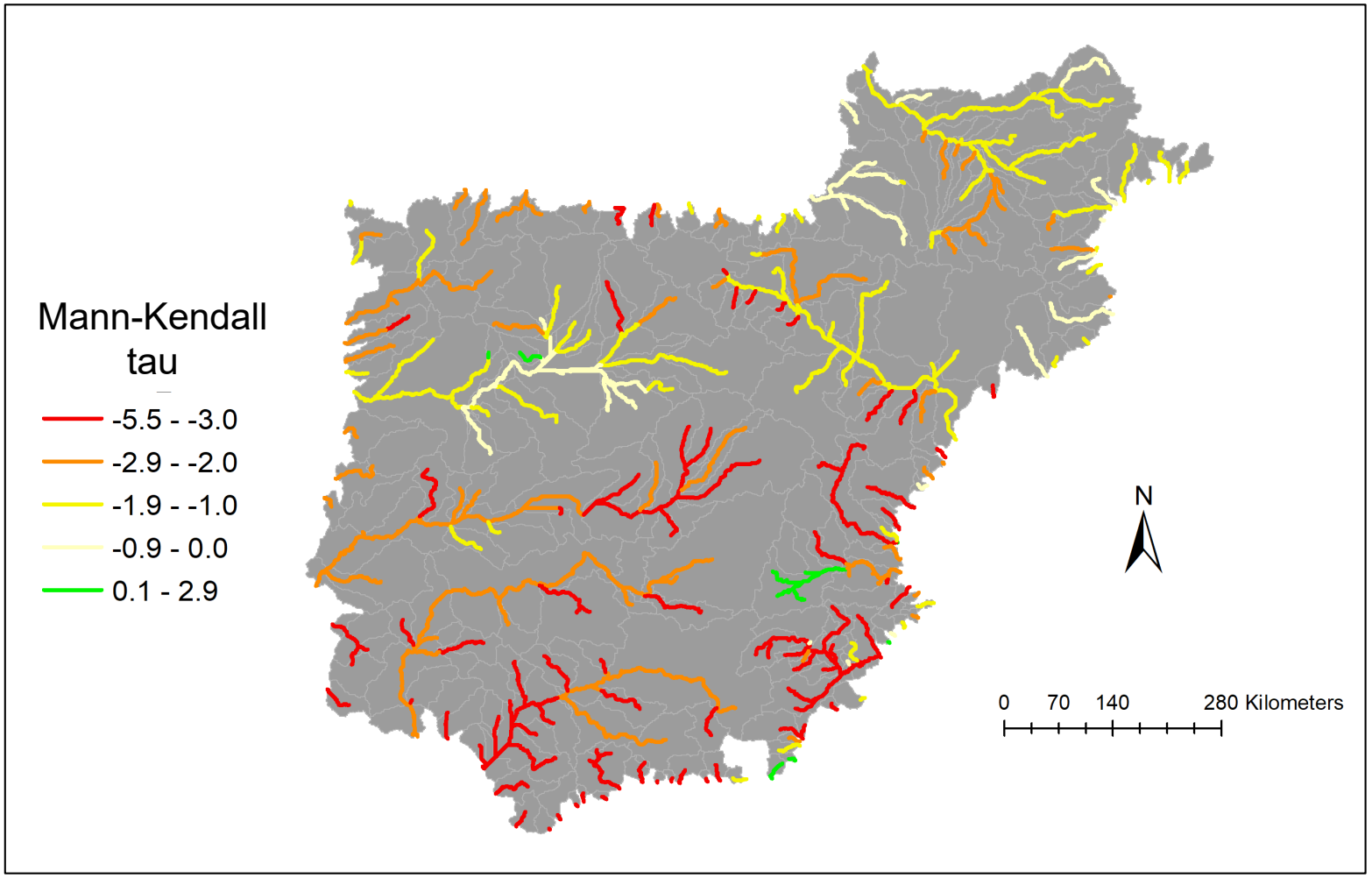






Trends of hydrological changes

1990/2059



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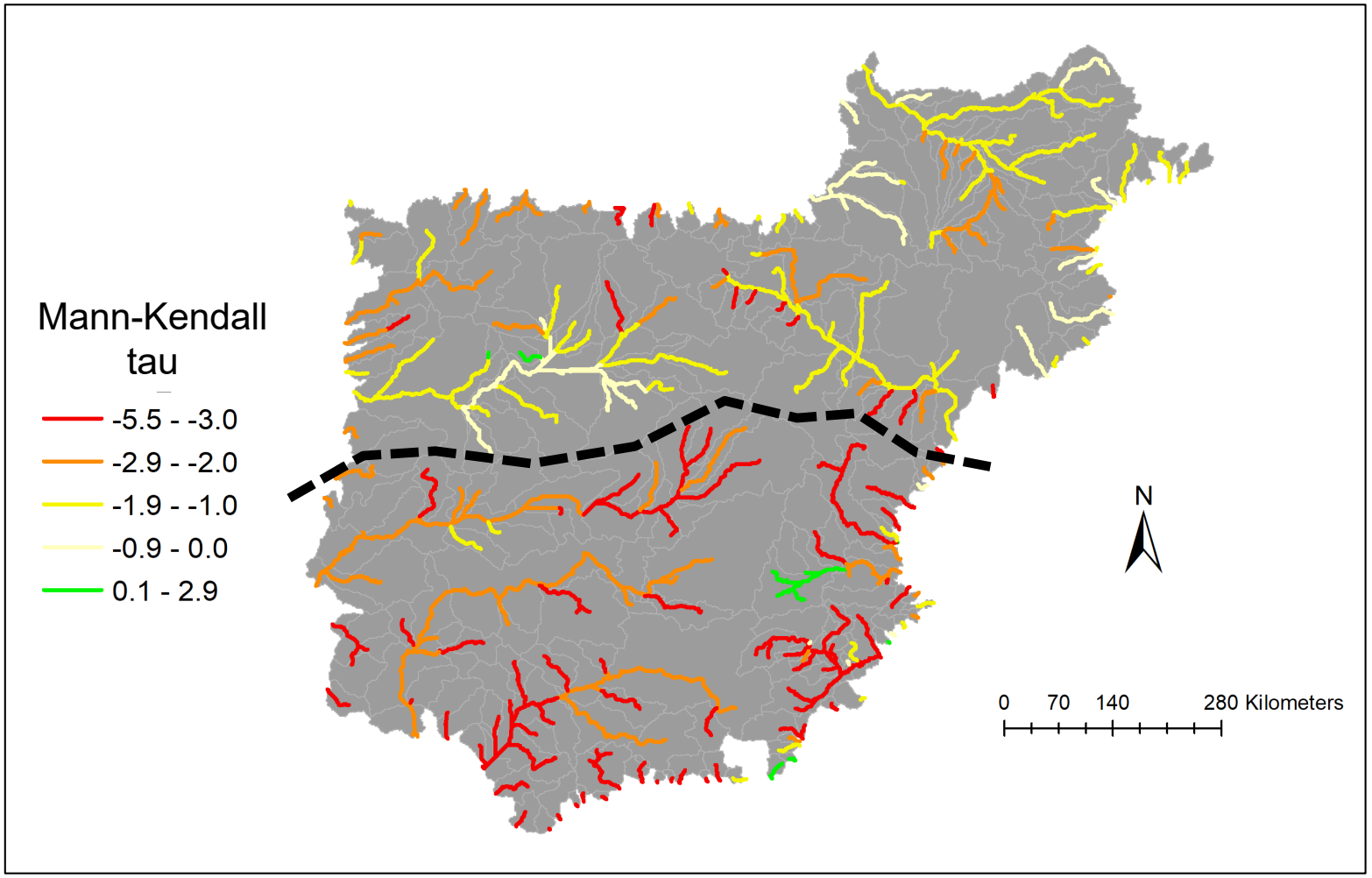
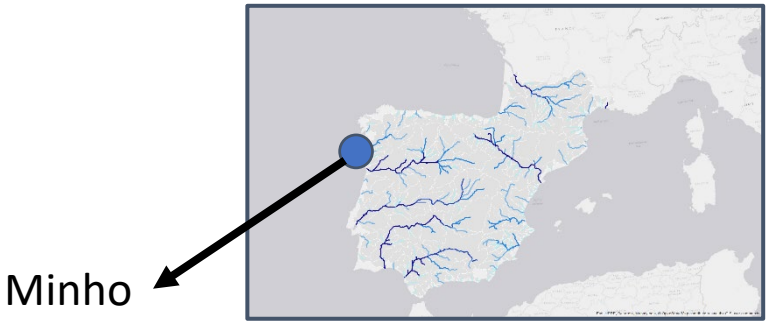
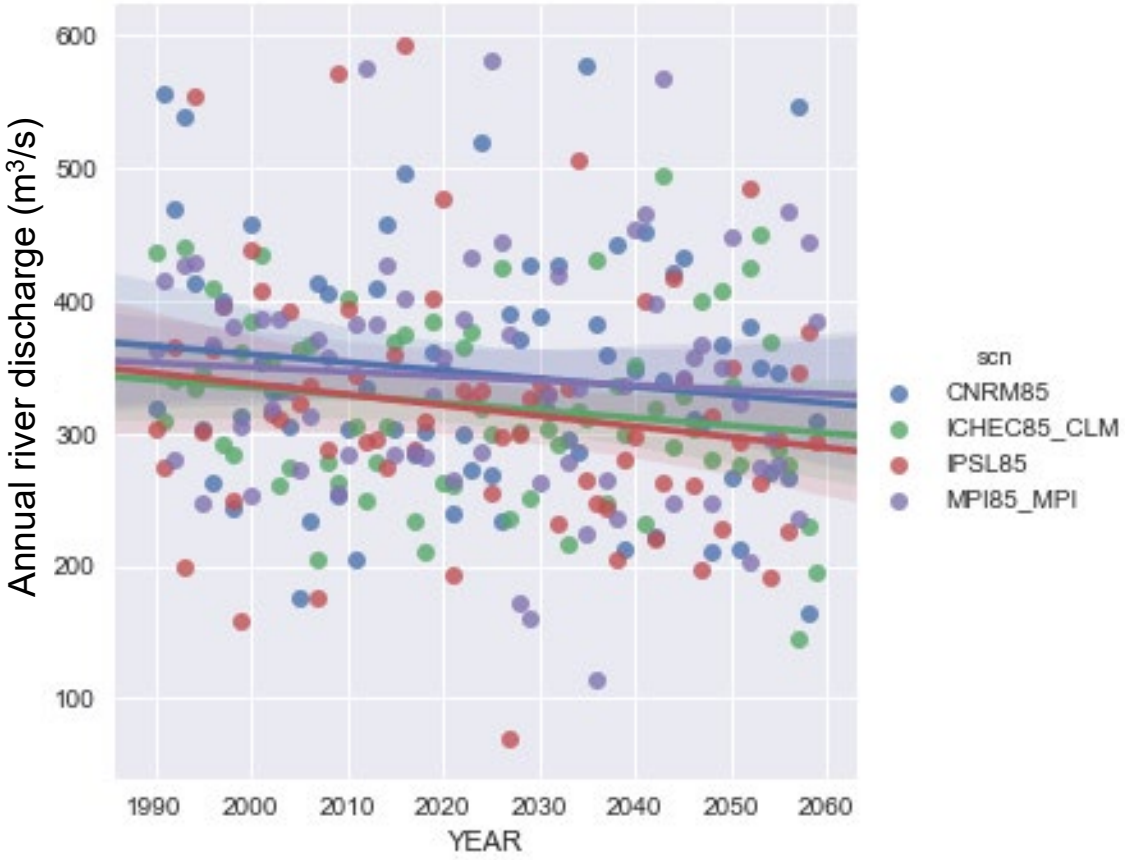


General annual streamflow decrease, more intense in the South

Trends of hydrological changes

1990/2059





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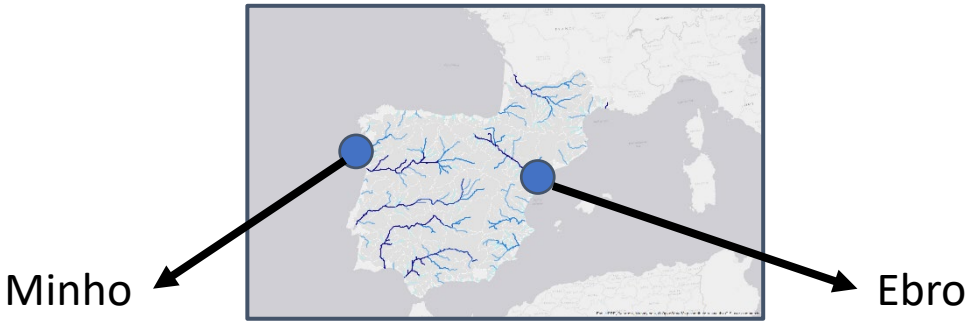
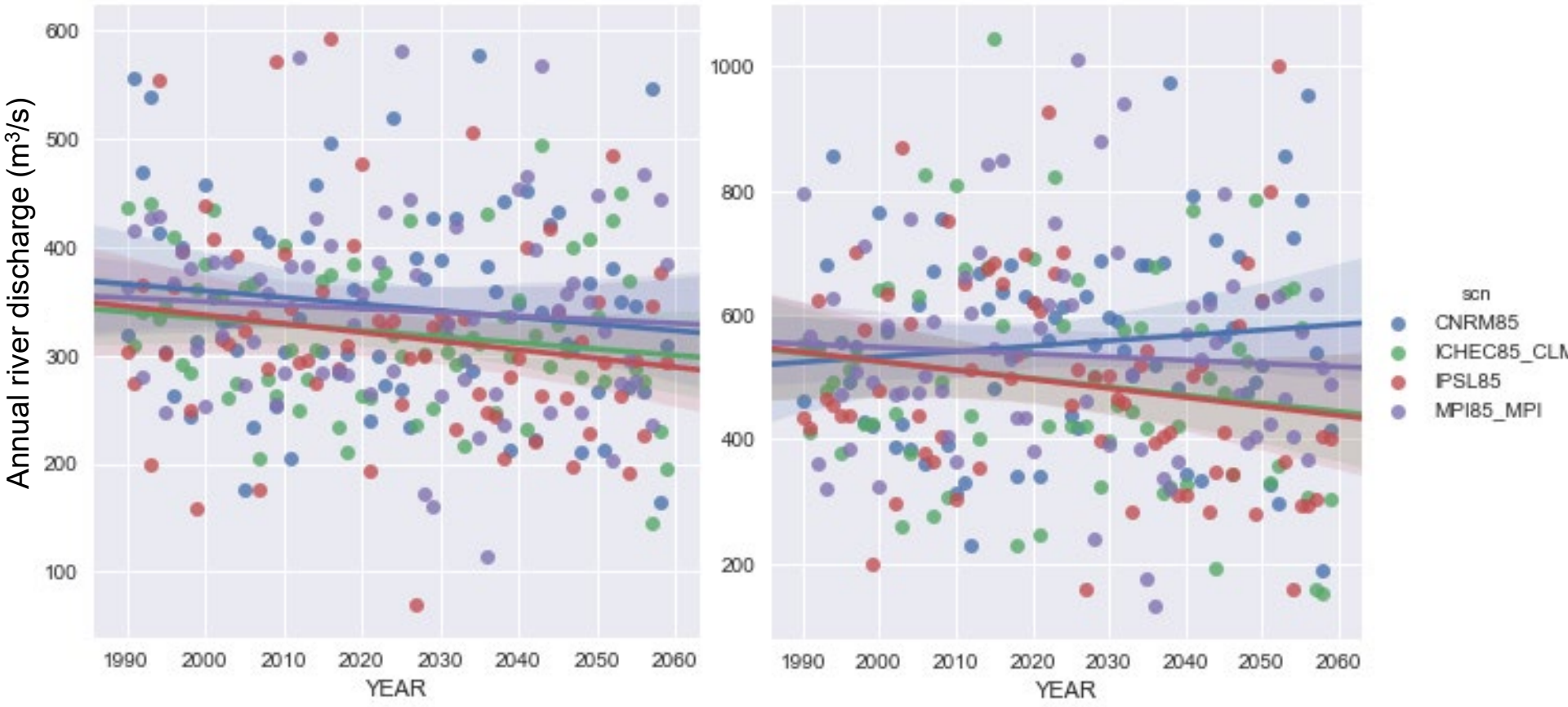
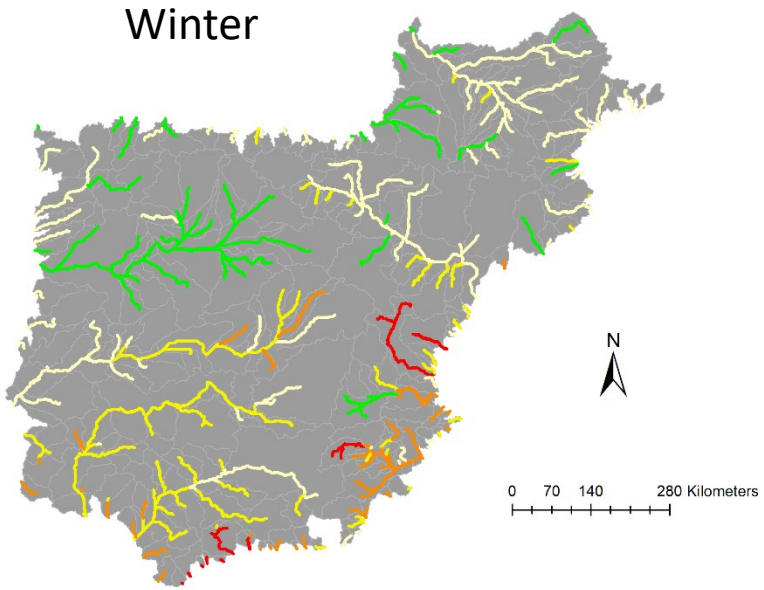




Trends of hydrological changes

1990/2059

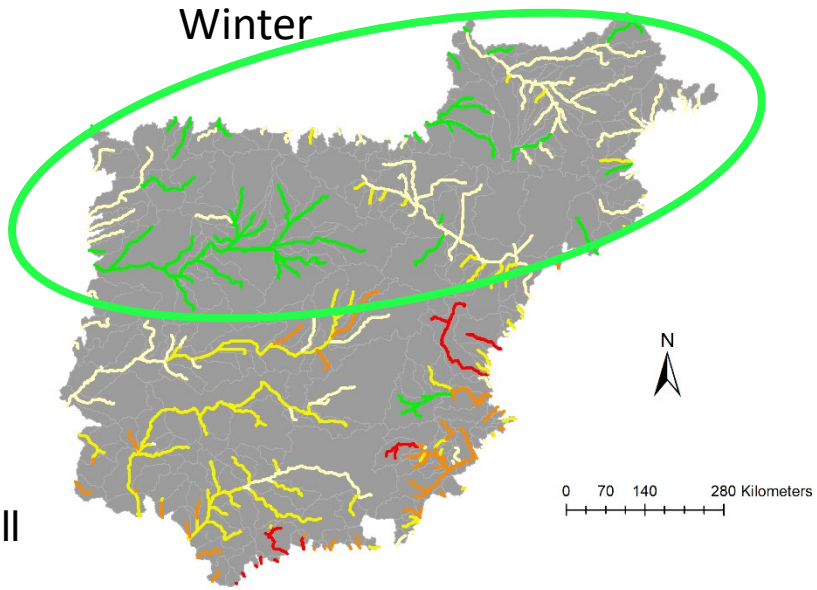


Tau
Mann-Kendall

- -5.0 - -3.0
- -2.9 - -2.0
- -1.9 - -1.0
- -0.9 - 0.0
- 0.1 - 2.3

Trends of hydrological changes

1990/2059



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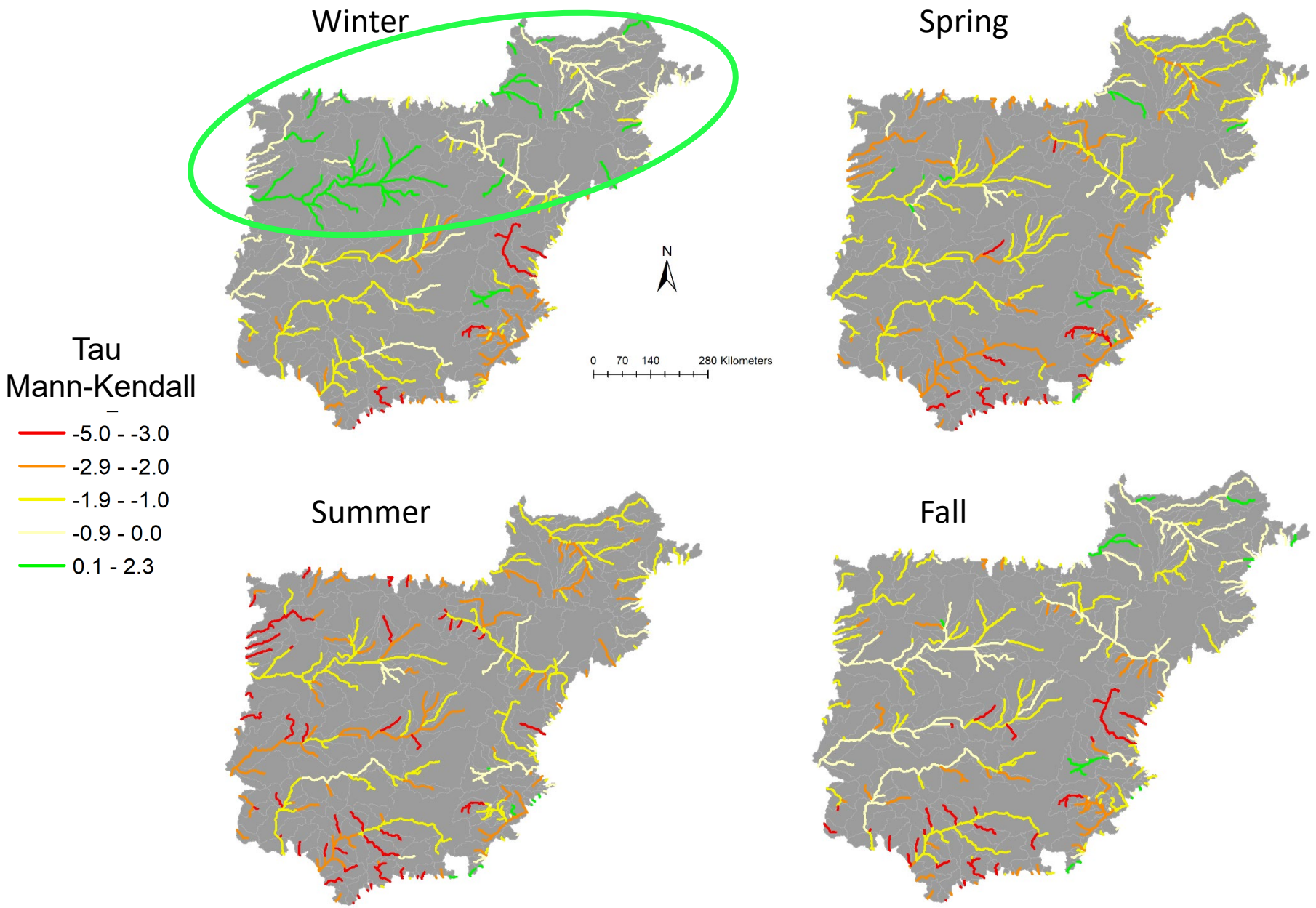
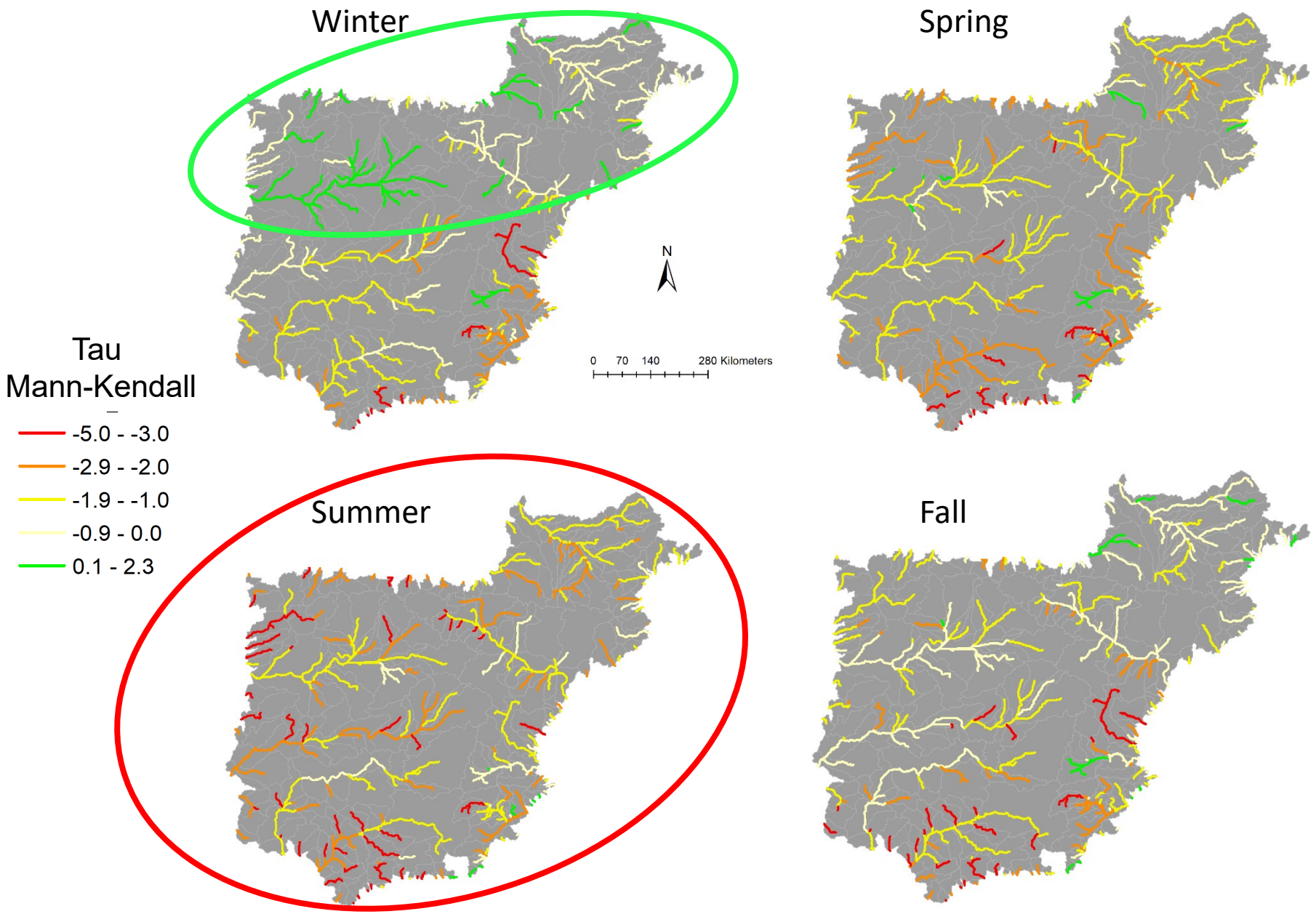


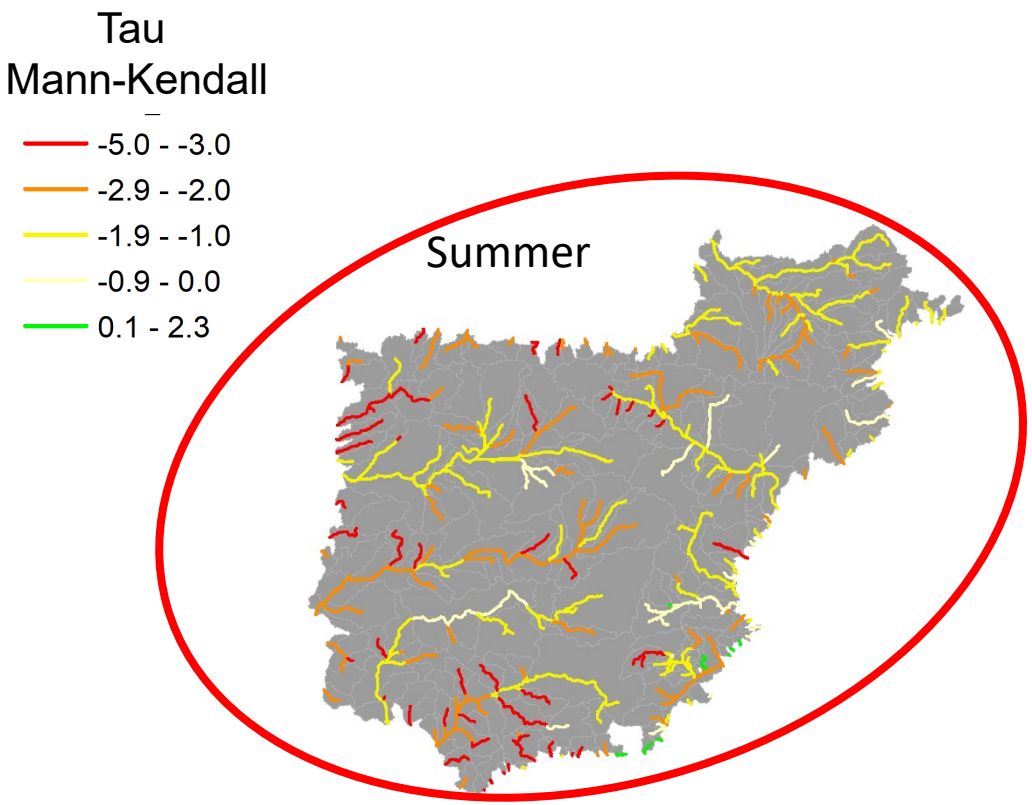
Trends of hydrological changes

1990/2059



Trends of hydrological changes

1990/2059



Max average decrease in 70 yrs:

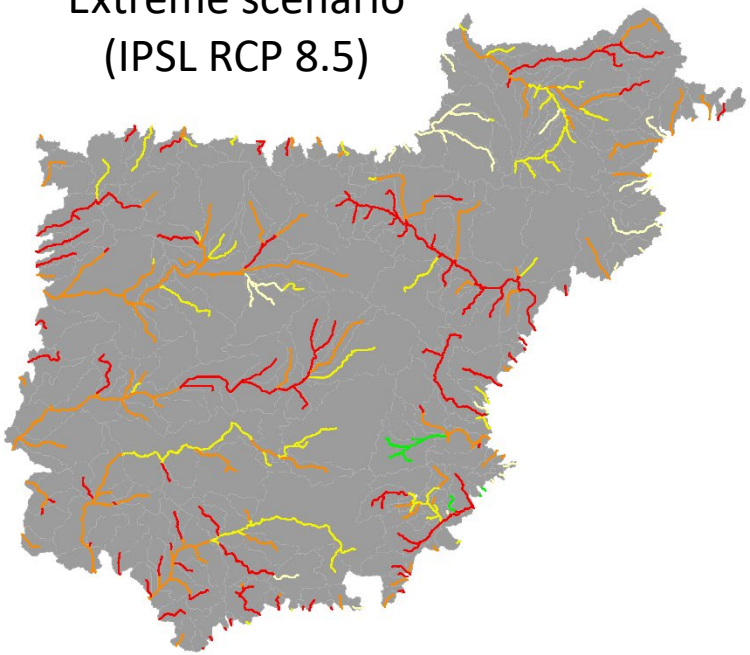
-185 m3/s

-98% summer streamflow

Trends of hydrological changes

1990/2059

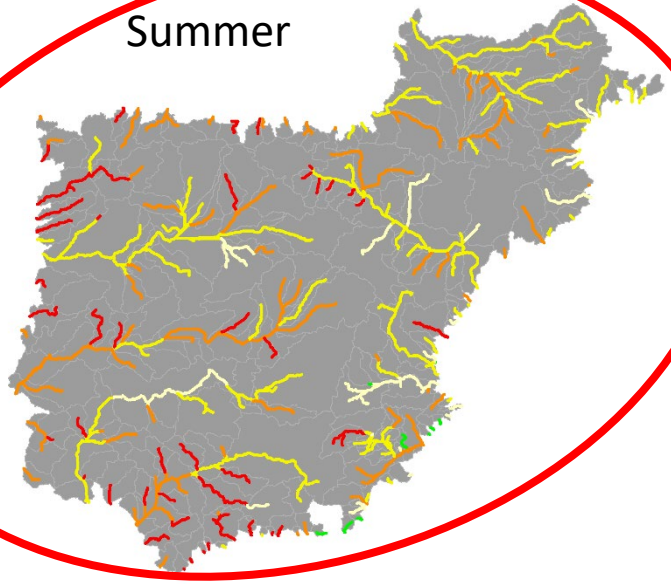
Extreme scenario
(IPSL RCP 8.5)



Tau
Mann-Kendall

- -5.0 - -3.0
- -2.9 - -2.0
- -1.9 - -1.0
- -0.9 - 0.0
- 0.1 - 2.3

Summer



Max average decrease in 70 yrs:
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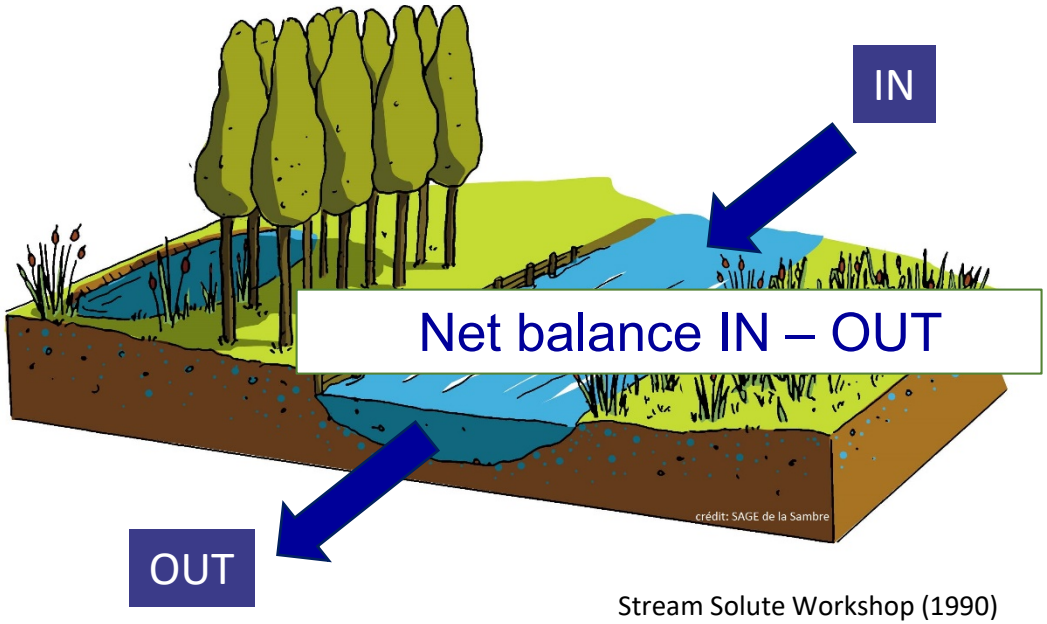
-98% summer streamflow

Impacts of climate change on ecological functions

Ecological function = group of physical / biological / biogeochemical processes (e.g. **sediment retention**, **nitrate removal**)



Stream Solute Workshop (1990)

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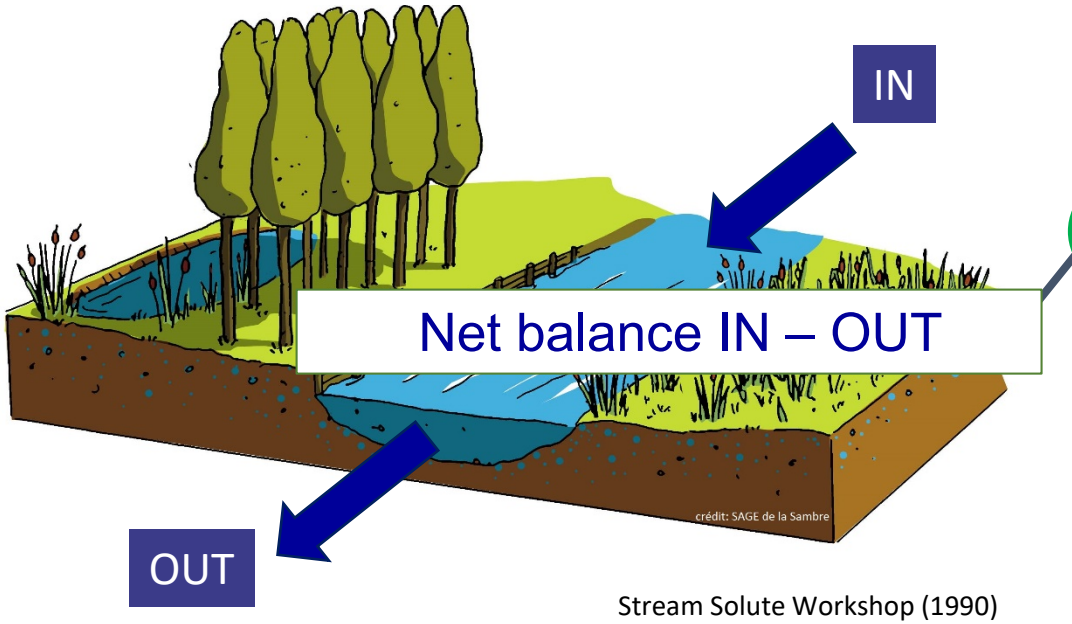
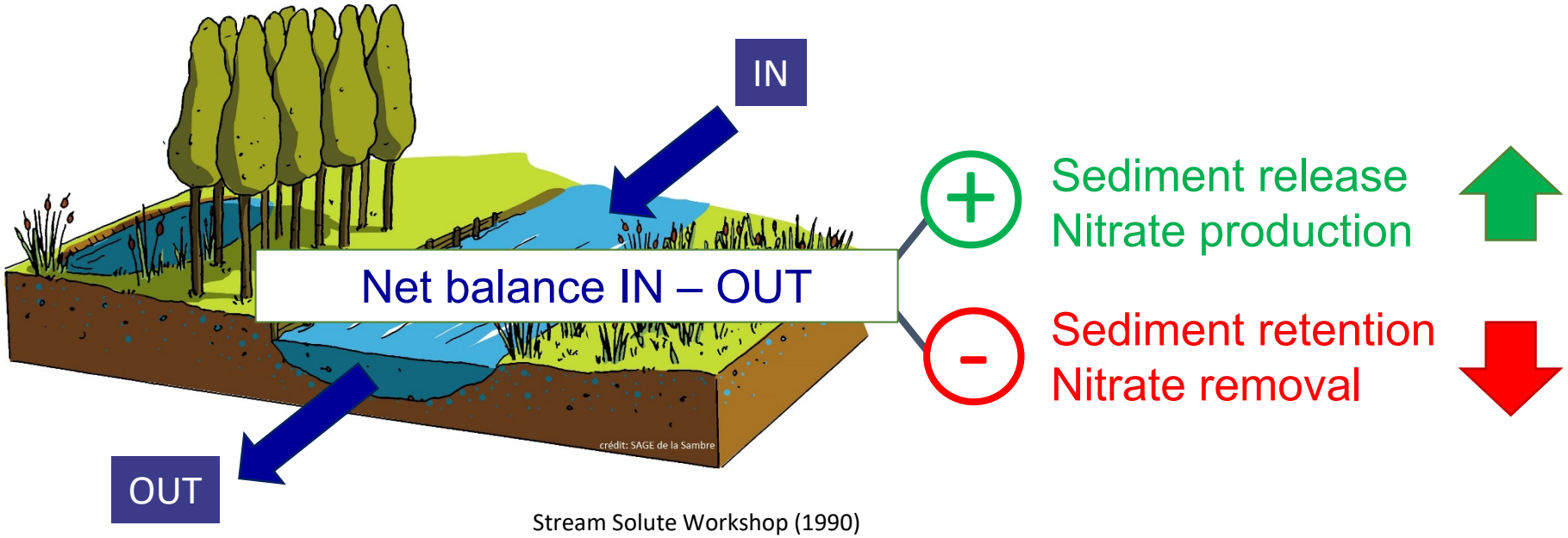


Stream Solute Workshop (1990)

Sediment release
Nitrate production

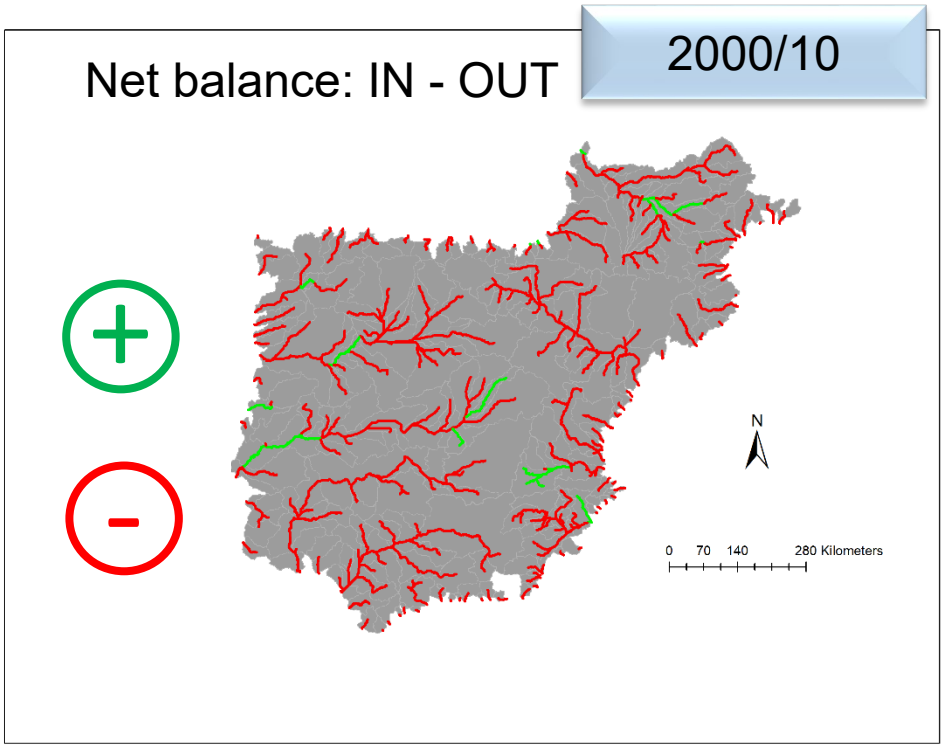
Impacts of climate change on ecological functions

Ecological function = group of physical / biological / biogeochemical processes (e.g. **sediment retention**, **nitrate removal**)



Stream Solute Workshop (1990)

Impacts of climate change on sediment retention

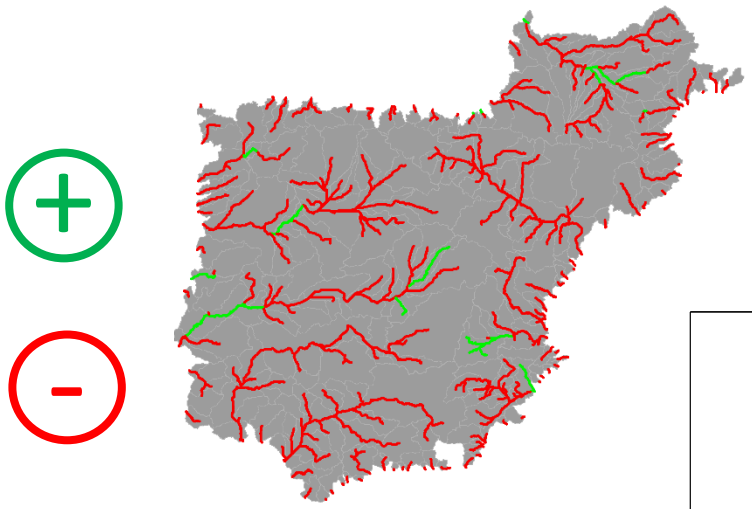


Dominance of sediment retention in rivers of South-Western Europe

Impacts of climate change on sediment retention

Net balance: IN - OUT

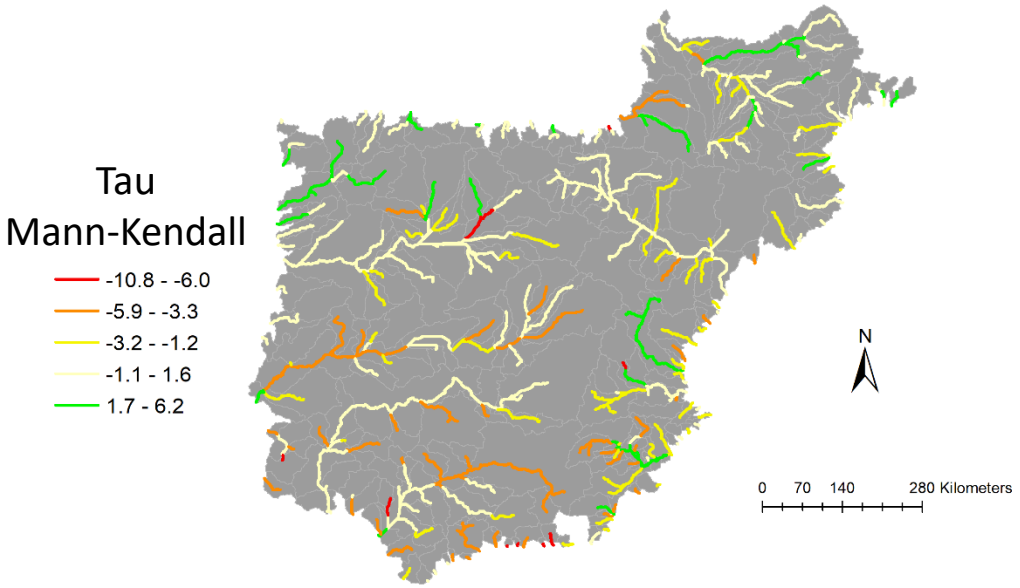
2000/10



Dominance of sediment retention in rivers of South-Western Europe

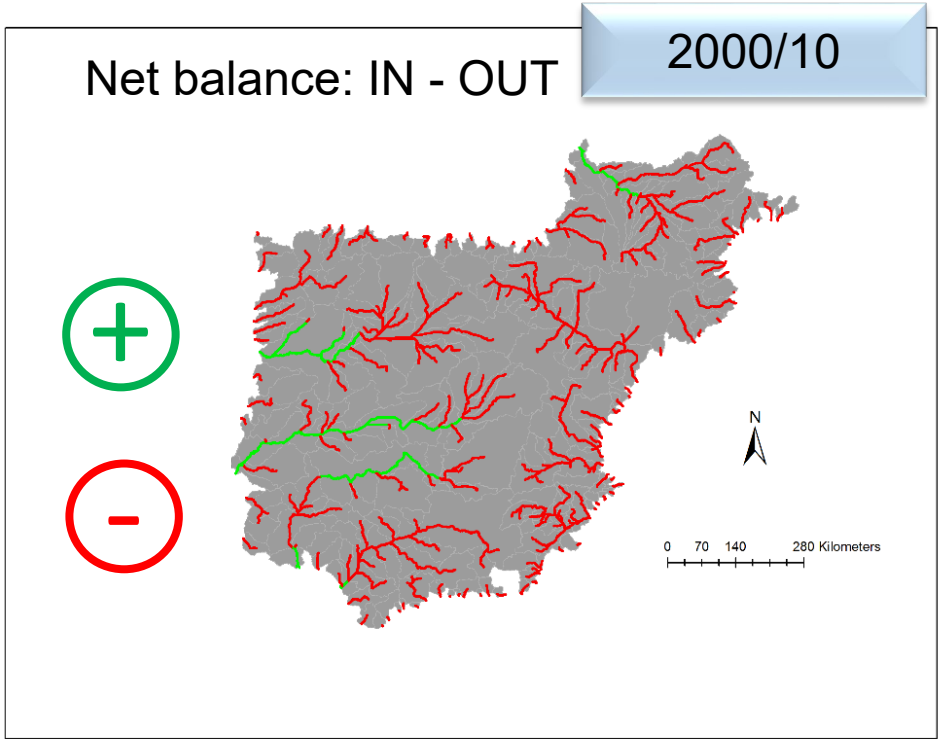
1990/2059

Trend of net balance



Dominance of ↗ sediment retention

Impacts of climate change on nitrate removal

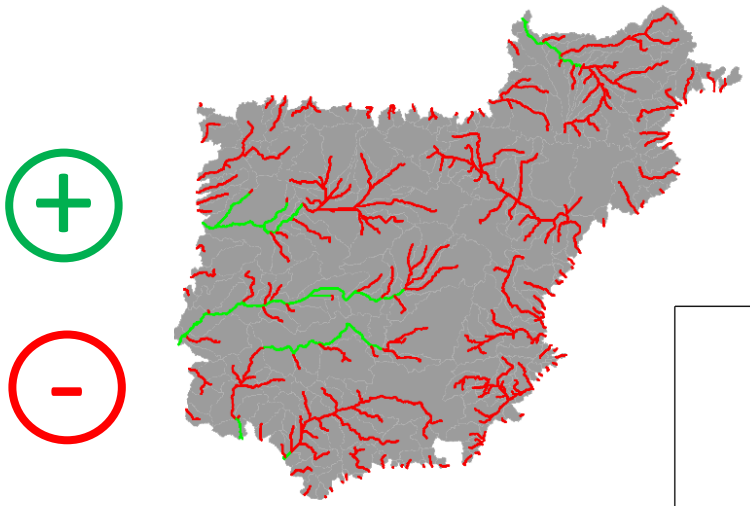


Dominance of nitrate removal in rivers of South-Western Europe, except large downstream rivers

Impacts of climate change on nitrate removal

2000/10

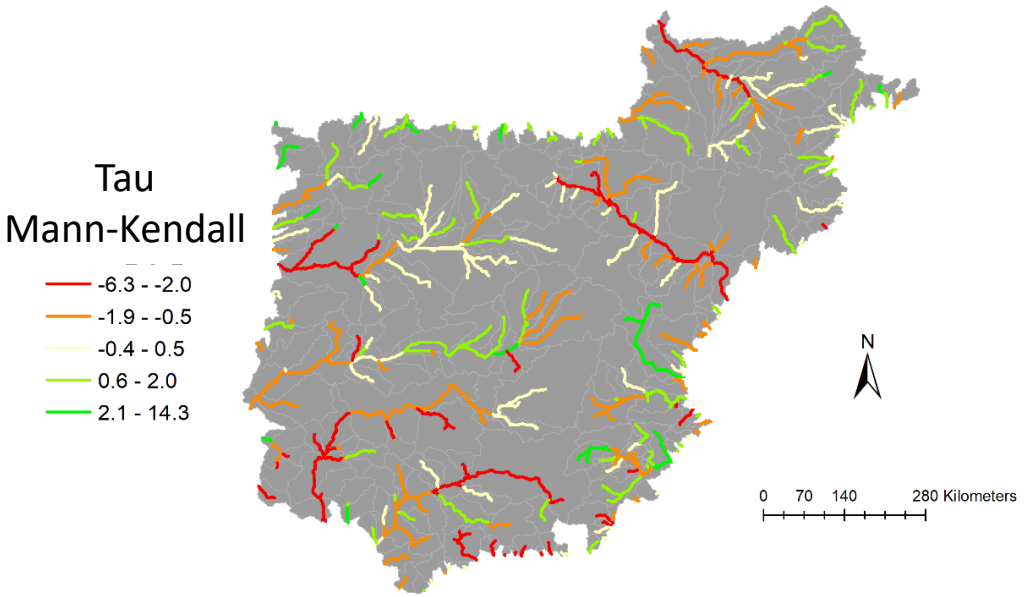
Net balance: IN - OUT



Dominance of nitrate removal in rivers of South-Western Europe, except large downstream rivers

1990/2059

Trend of net balance

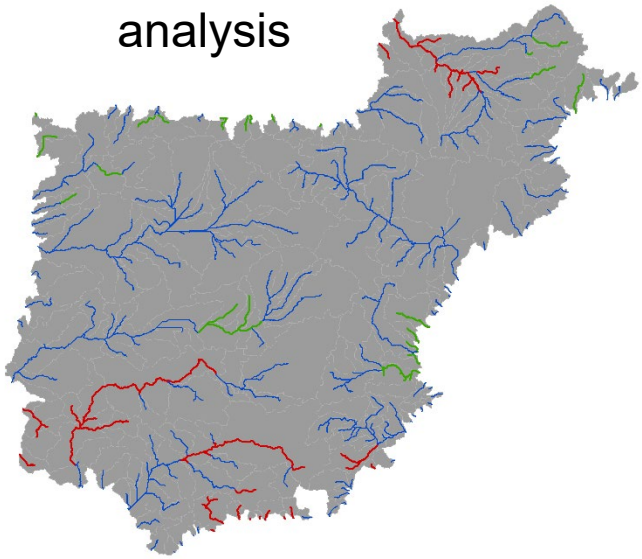


↗ nitrate removal in main rivers

↘ nitrate removal in smaller streams

Explanatory factors

Spatial analysis



↗ NO3 removal

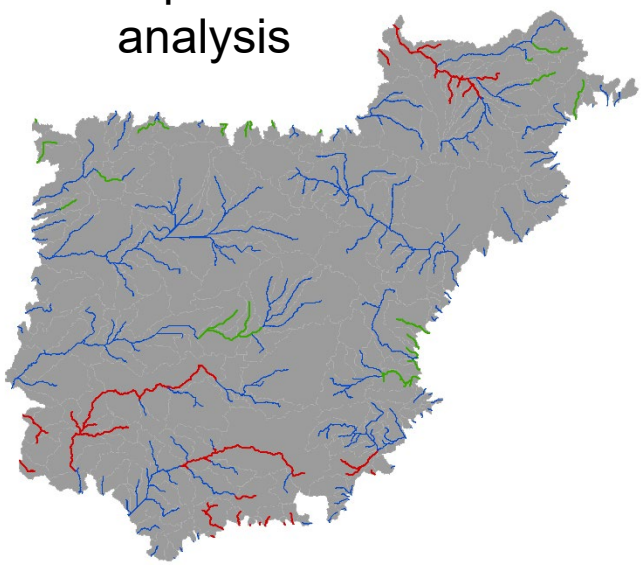
not significant

↘ NO3 removal

Explanatory factors

Preliminary analysis

Spatial analysis

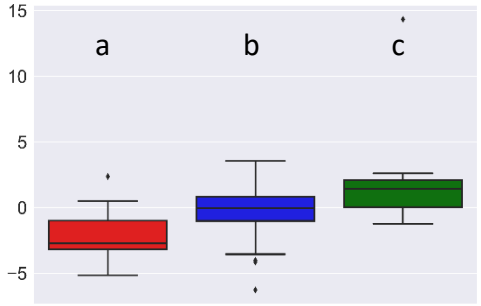


↗ NO3 removal

not significant

↘ NO3 removal

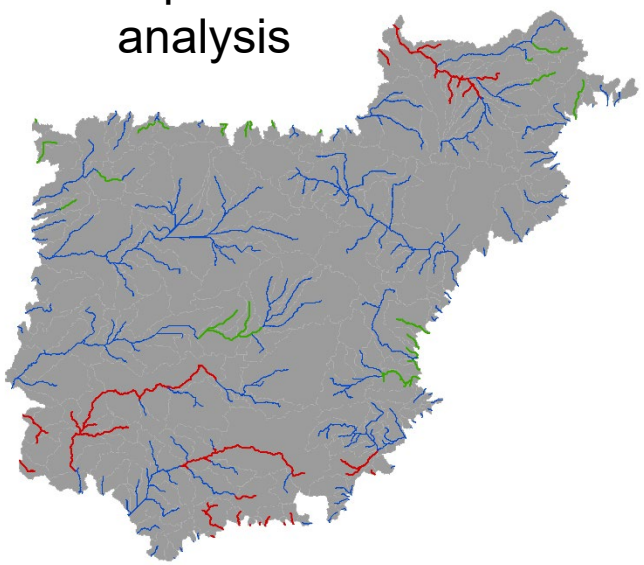
Trend Net balance NO3



Explanatory factors

Preliminary analysis

Spatial analysis

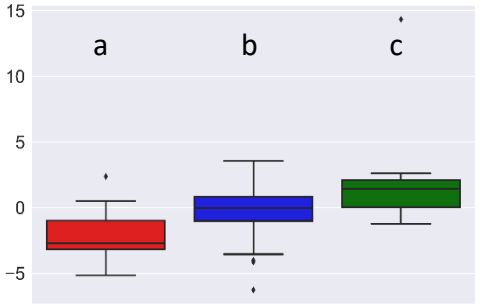


↗ NO3 removal

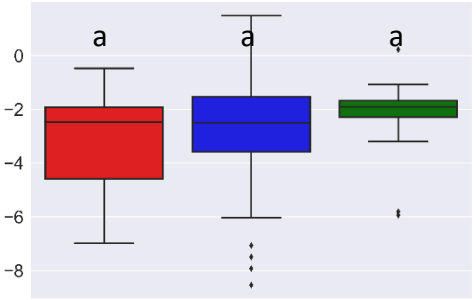
not significant

↘ NO3 removal

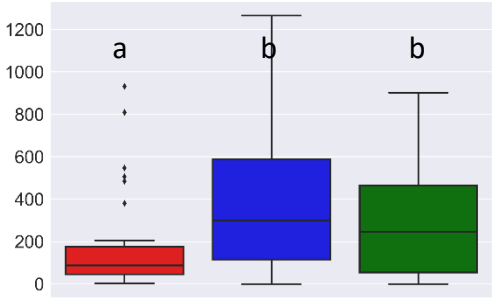
Trend Net balance NO3



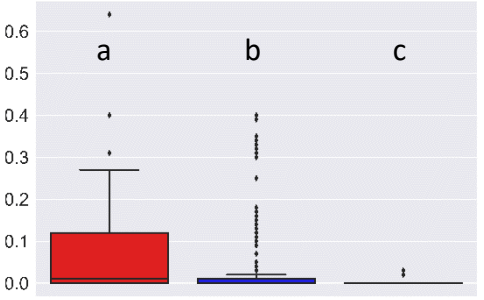
Trend Streamflow



Altitude



%agro-forestry (landuse)



Explanatory factors

Preliminary analysis

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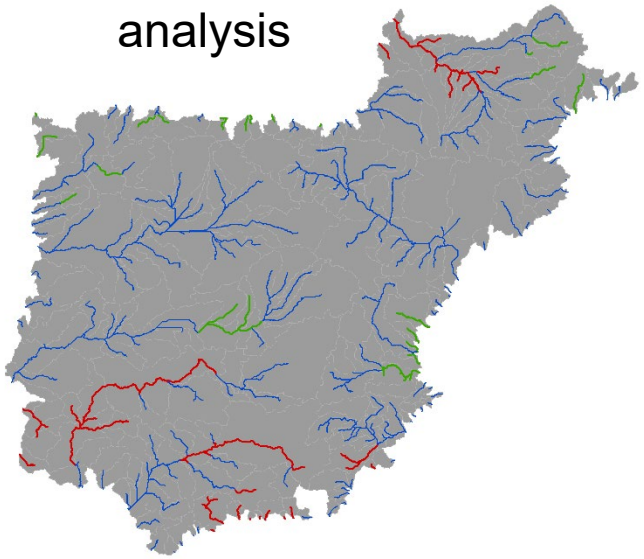
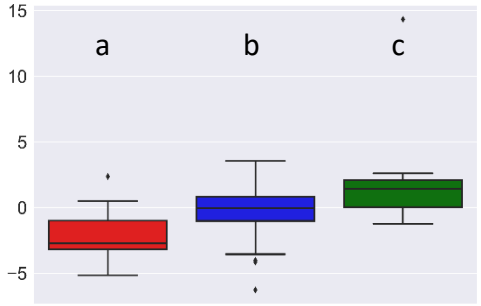


↗ NO3 removal

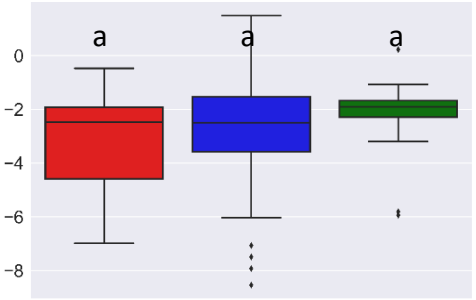
not significant

↘ NO3 removal

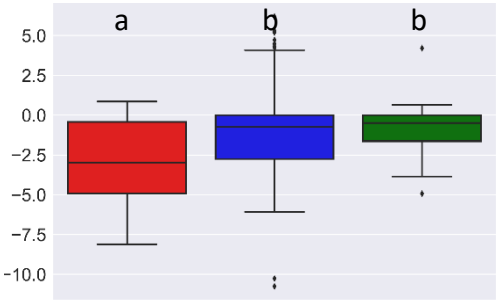
Trend Net balance NO3



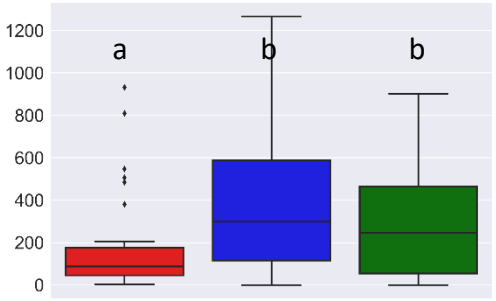
Trend Streamflow



Trend Net balance SED



Altitude



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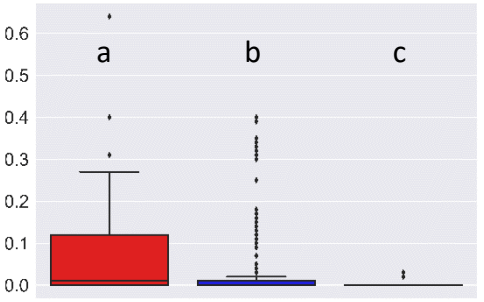
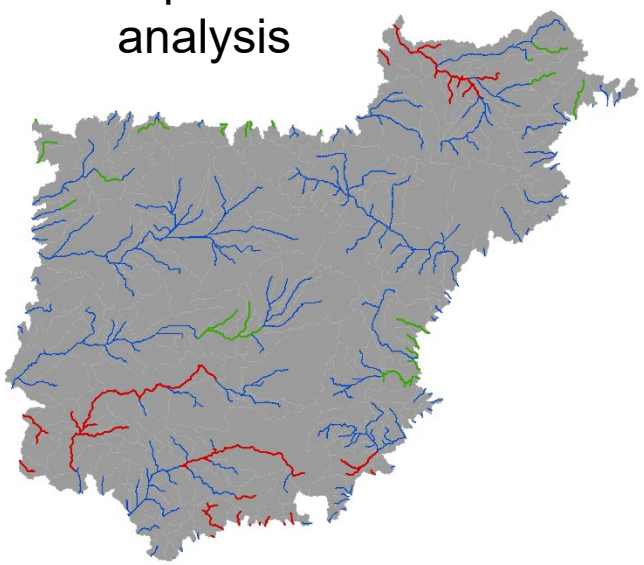


Explanatory factors

Preliminary analysis

Spatial analysis



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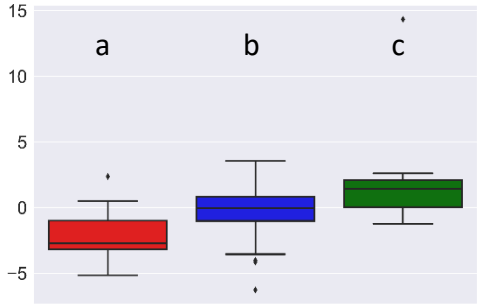
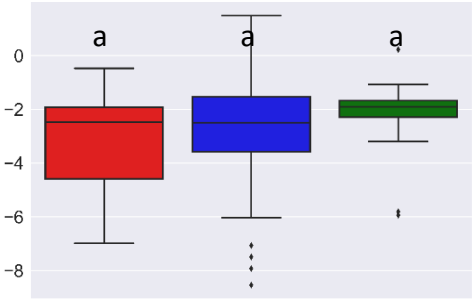
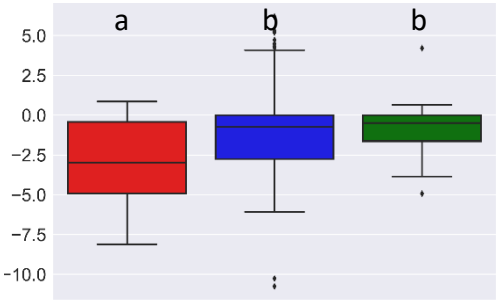


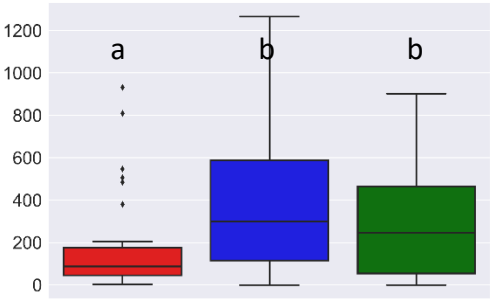
Trend Streamflow



Trend Net balance SED



Altitude



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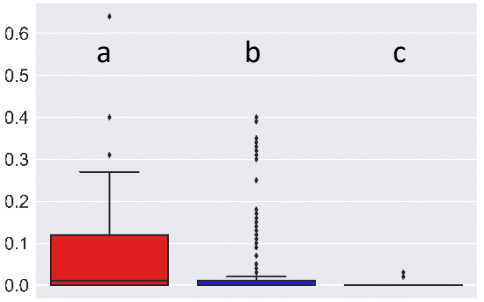

Hotspots of ‘nitrate removal increase’ :

- downstream of large rivers
- where %agro-forestry is high
- where sediment retention also increases

Conclusions and perspectives

Conclusions

- Effects of climate change in South-Western Europe (1990-2059):

Streamflow	↘
Sediment retention	↗
Nitrate removal	↗ in main rivers ↘ in small streams

Conclusions and perspectives

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Explanatory factors : upstream/downstream landuse

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Perspectives

- Investigate multiple factors explaining ecological functions variations

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Perspectives

- Investigate multiple factors explaining ecological functions variations
- Include more climate projections and combine climate scenarios with changes in direct human pressures (e.g. population, landuse)

Conclusions and perspectives

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Explanatory factors : upstream/downstream landuse

Perspectives

- Investigate multiple factors explaining ecological functions variations
- Include more climate projections and combine climate scenarios with changes in direct human pressures (e.g. population, landuse)
- Quantify impacts on export to the ocean

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Development of a water resource management platform during low water periods in the SUDOE region

Thank you for your attention.

cnrs

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CSIC Consejo Superior de Investigaciones Científicas

irstea

iniav Instituto Nacional de Investigação Agrária e Veterinária, I.P.

IST TÉCNICO LISBOA

UCLM Universidad de Castilla-La Mancha

UCA Universidad de Cádiz

UNIVERSITAT POLITÈCNICA DE VALÈNCIA