

The effect of dam regulation under climate change scenarios: analysis of changes in water availability in Europe

Luis Garrote de Marcos & Alfredo Granados García
Universidad Politécnica de Madrid (UPM)



RUNOFF



Climate change



Balance

DEMANDS

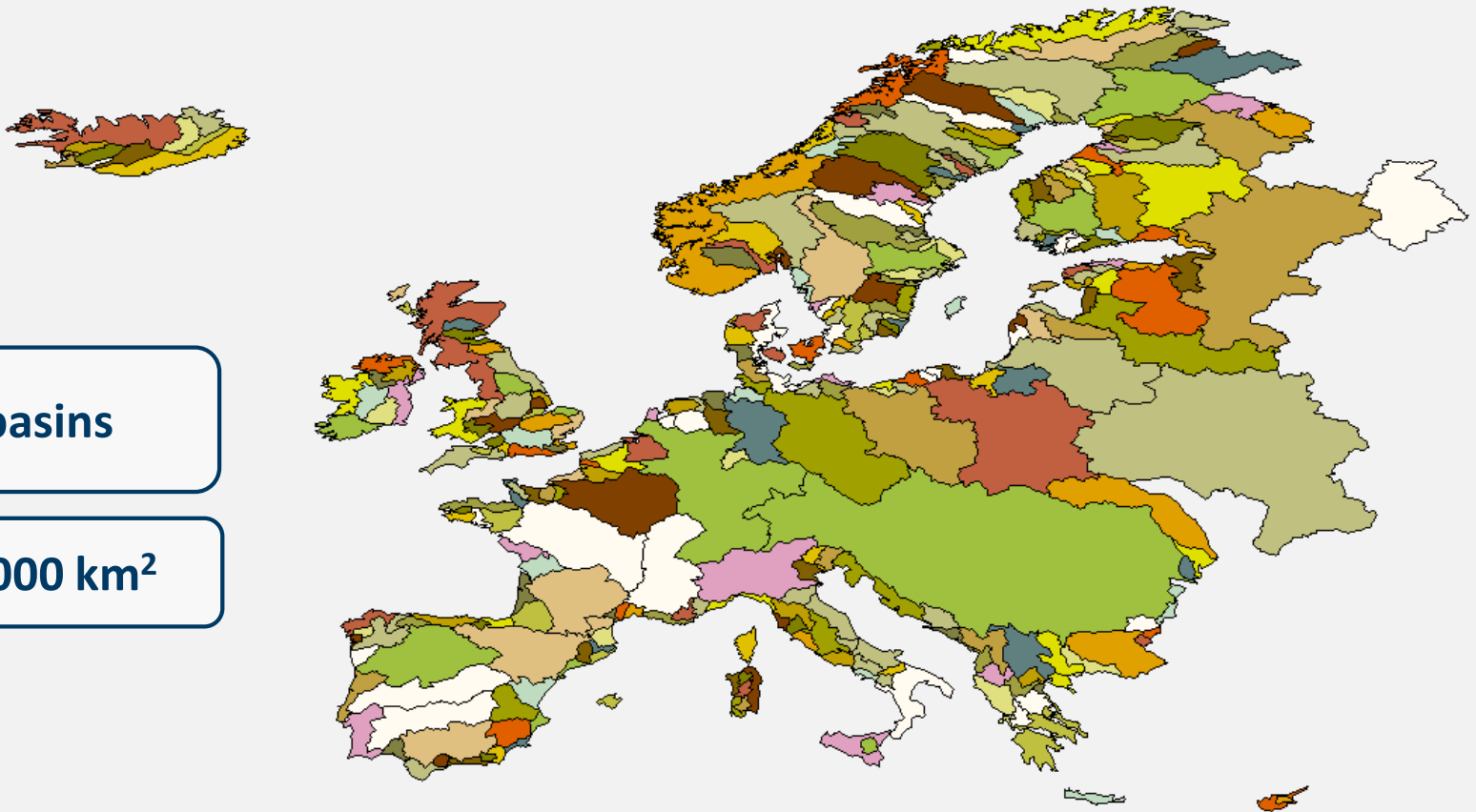


AVAILABILITY



**Storage
regulating effect**

- To analyse the role of storage in surface water availability, to detect vulnerabilities and to assess adaptation measures



360 basins

6.200.000 km²

- To analyse the role of storage in surface water availability, to detect vulnerabilities and to assess adaptation measures



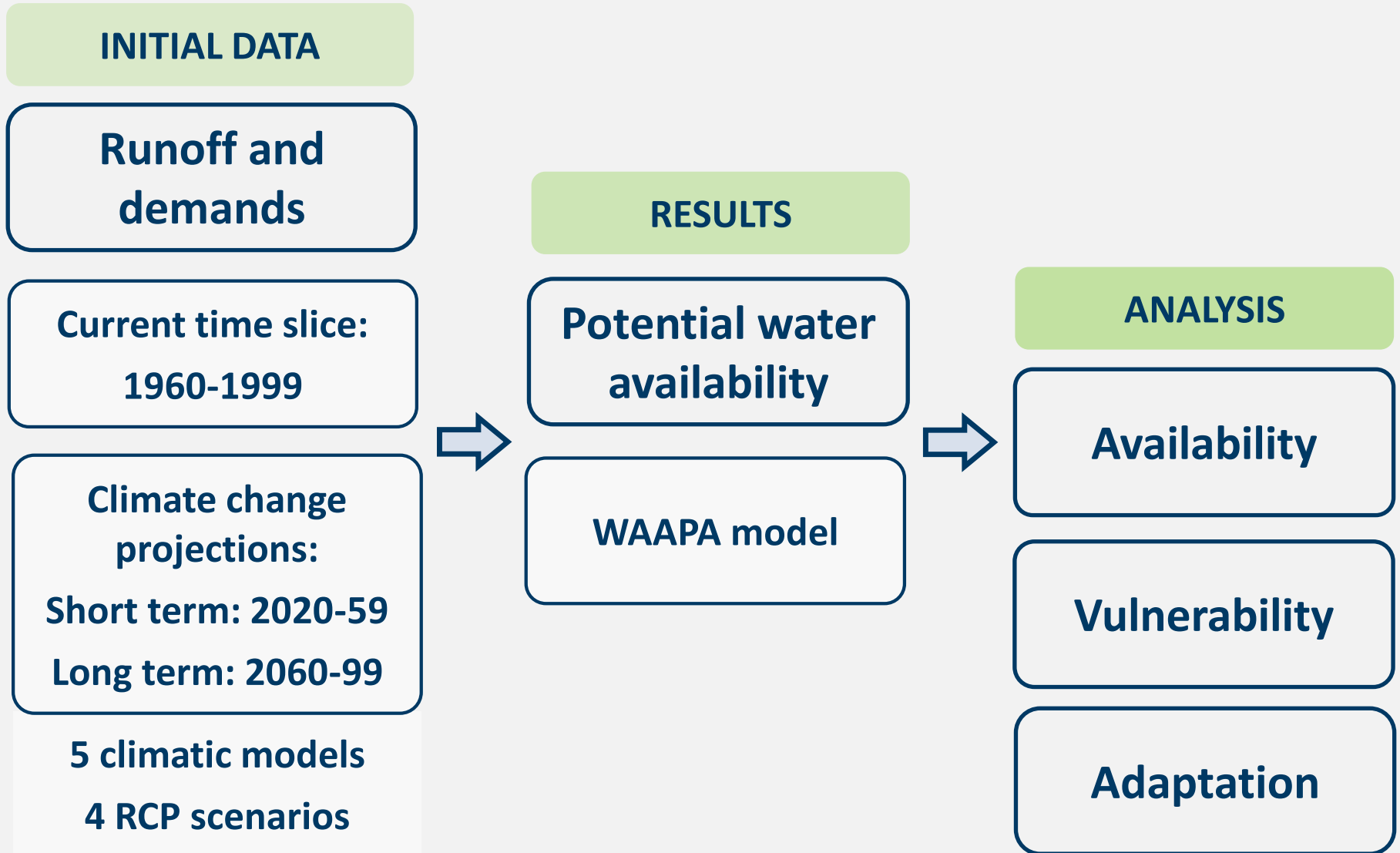
1.260 sub-basins

**Average surface
5.000 km²**

**HYDRO1K (USGS)
dataset**

**ICOLD World
Register on Dams**





RUNOFF PROJECTION

Simulation model

**PCRGLOBWB
model**

Climatic models

GFDL-ESM2NM
HadGEM2-ES
IPSL-CM5A-LR
MIROC-ESM-CHEM
NorESM1-M

RCP scenarios

RCP2.6
RCP4.5
RCP6.0
RCP8.5

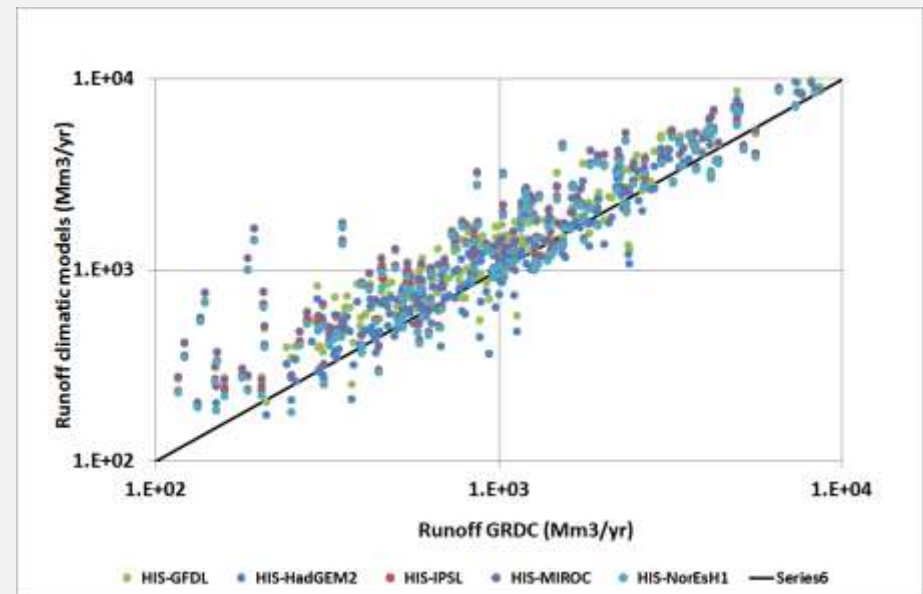
Simulation
1960-2100



Given by:
H. Winsemius
L. Bouwer
(DELTA RES)

Bias correction

Adjustment to GDRC data



Time slices of study: control (1960-1999),
short term (2020-2059) and long term
(2060-2099)

DEMAND PROJECTION

Initial data

World Bank
database

Domestic supply
Industry
Irrigation

Geographical
distribution:

- Population density
- Irrigation surface

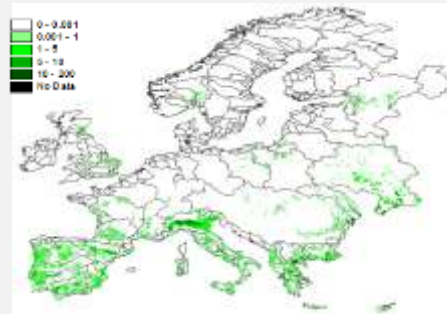
Domestic supply



Industry



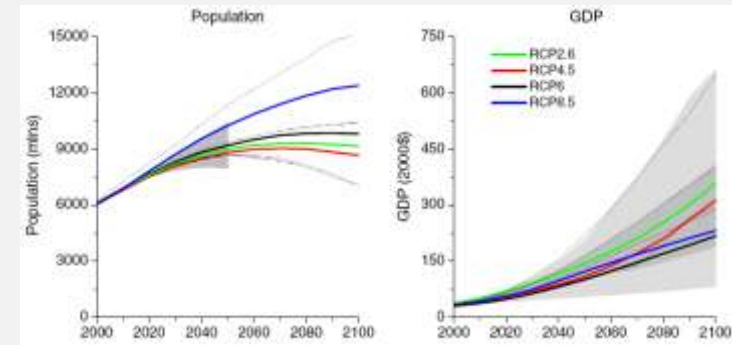
Irrigation



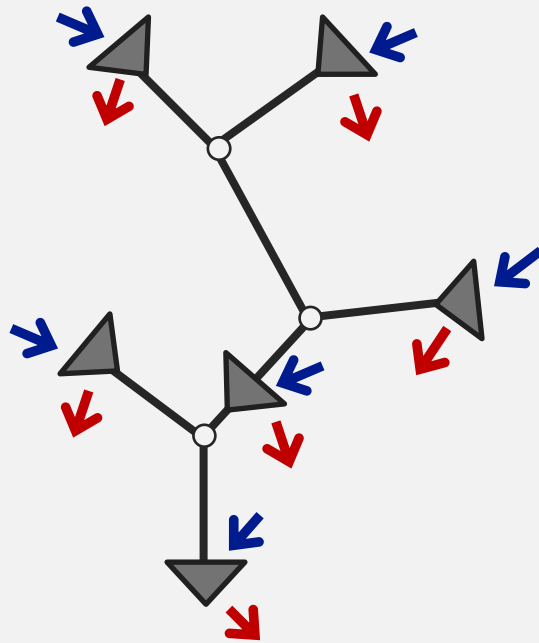
Projection

Regression

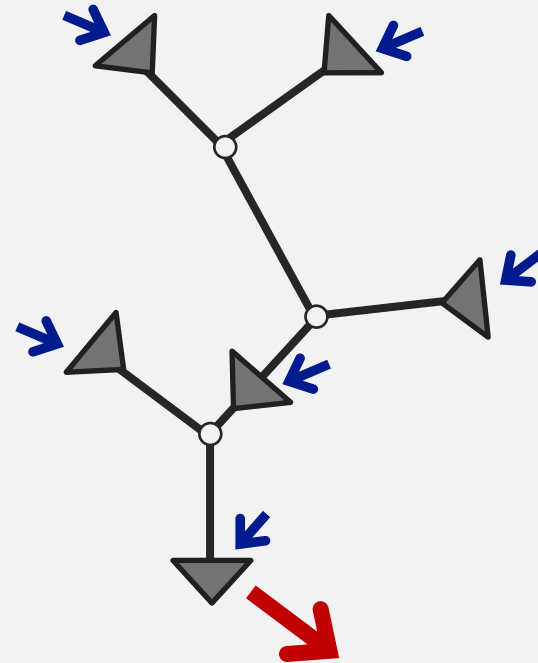
RCP Projections of
population and
GDP



- **WAAPA: Water Availability and Adaptation Policy Analysis**

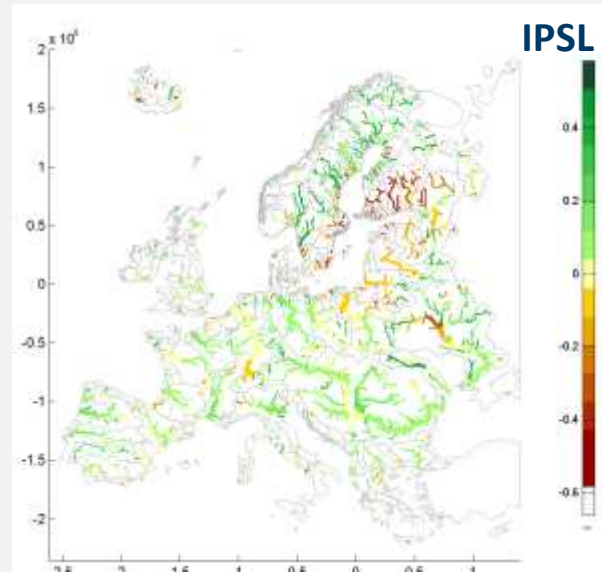
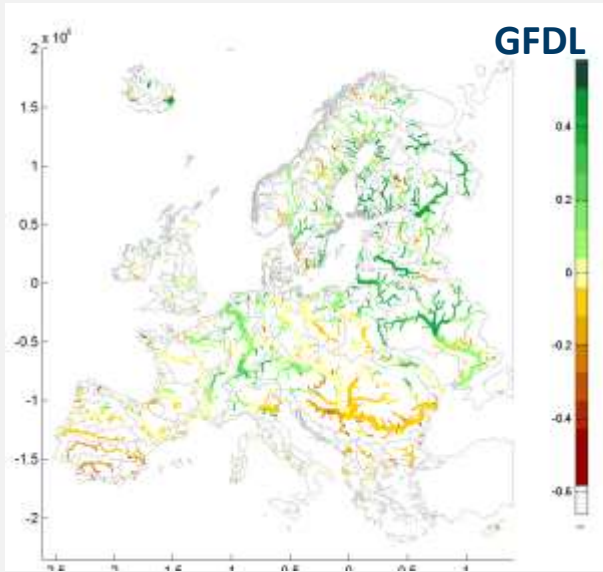


**Local
management**



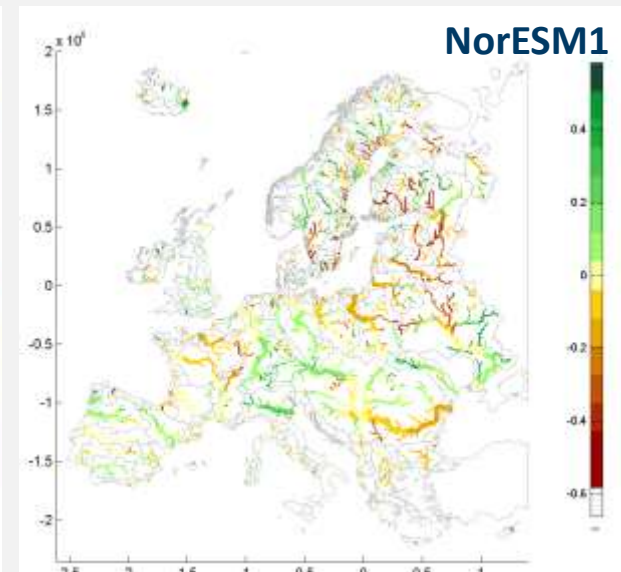
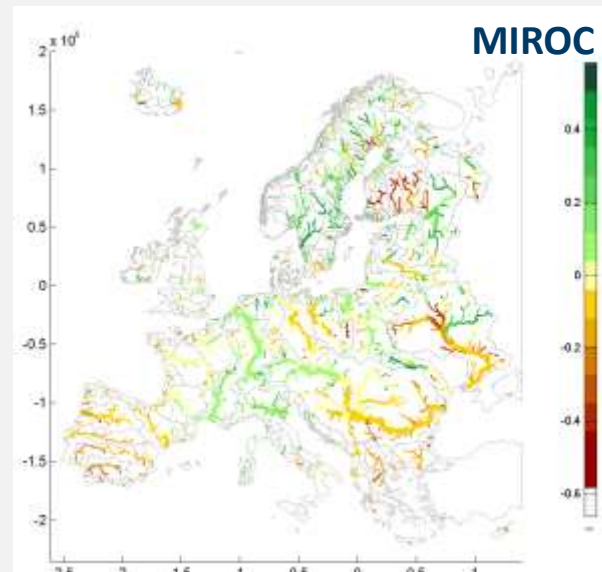
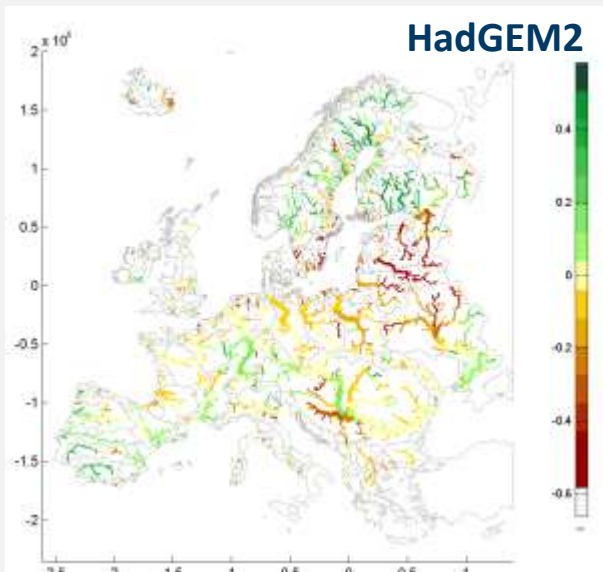
**Coordinated
management**

AVAILABILITY ANALYSIS (I)



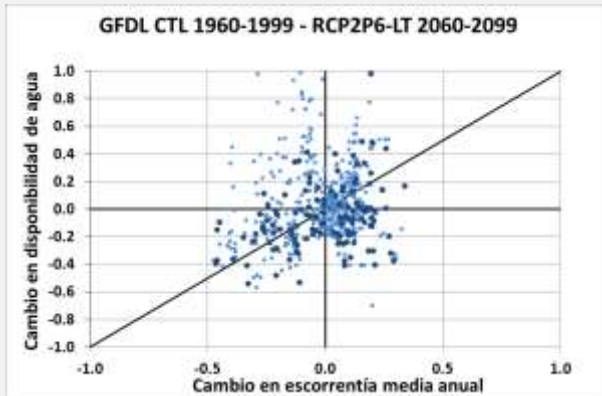
Future availability
2060-99 / Current
availability 1960-99

The four RCP analyzed
scenarios are presented
looping

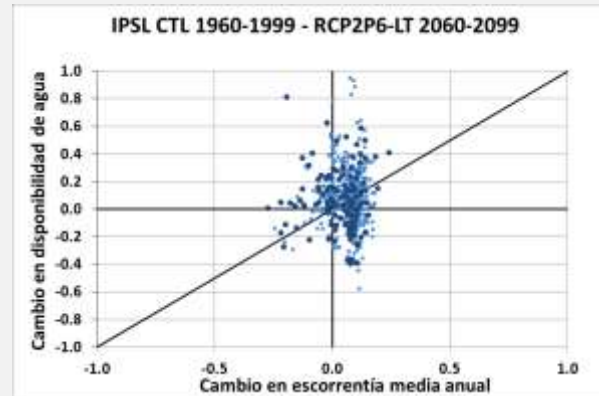


AVAILABILITY ANALYSIS (II)

GFDL



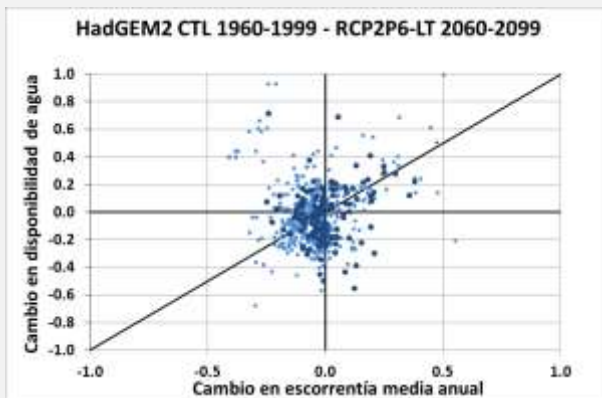
IPSL



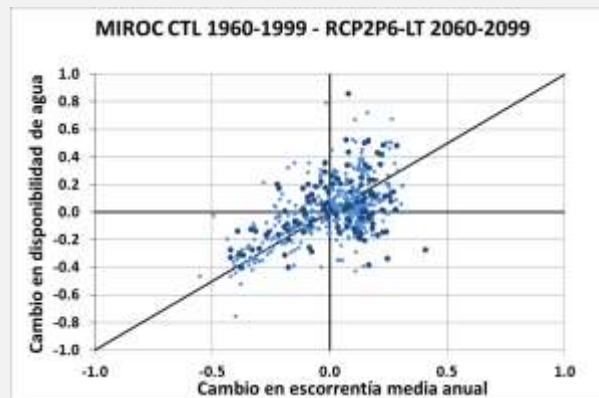
Comparison between the changes in runoff and the changes in availability

The four RCP analyzed scenarios are presented looping

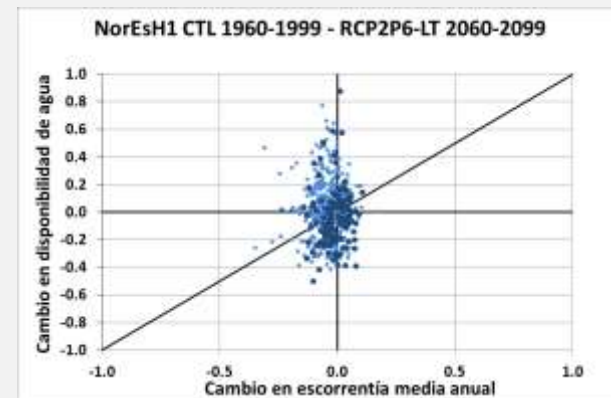
HadGEM2



MIROC



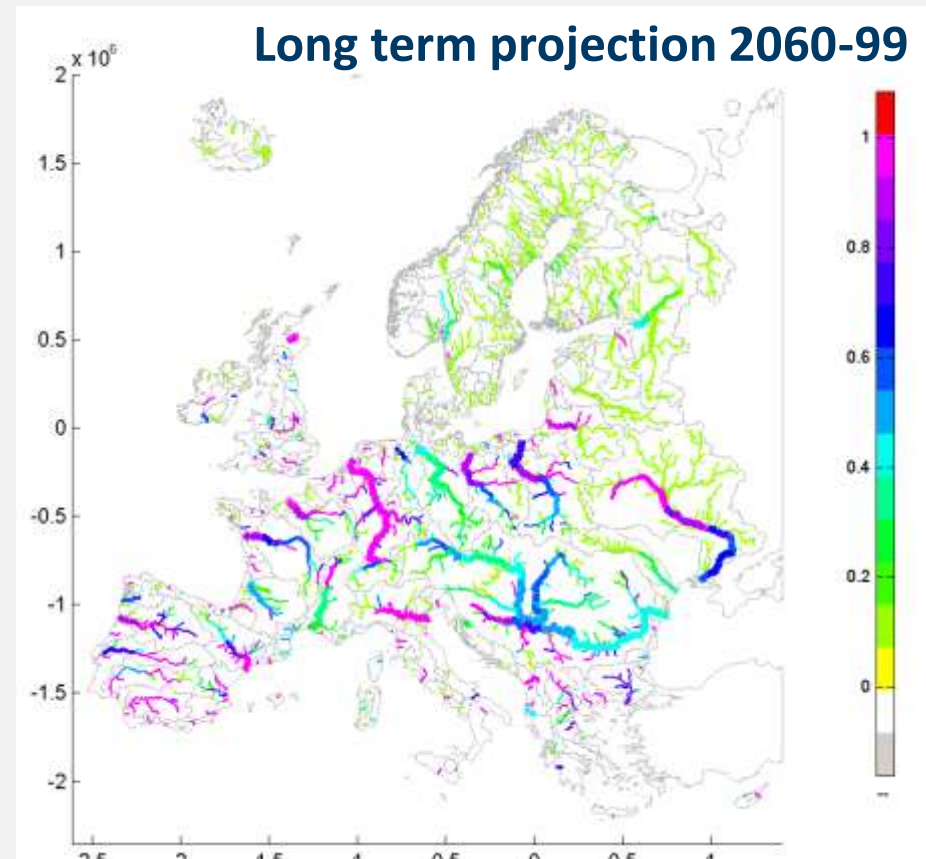
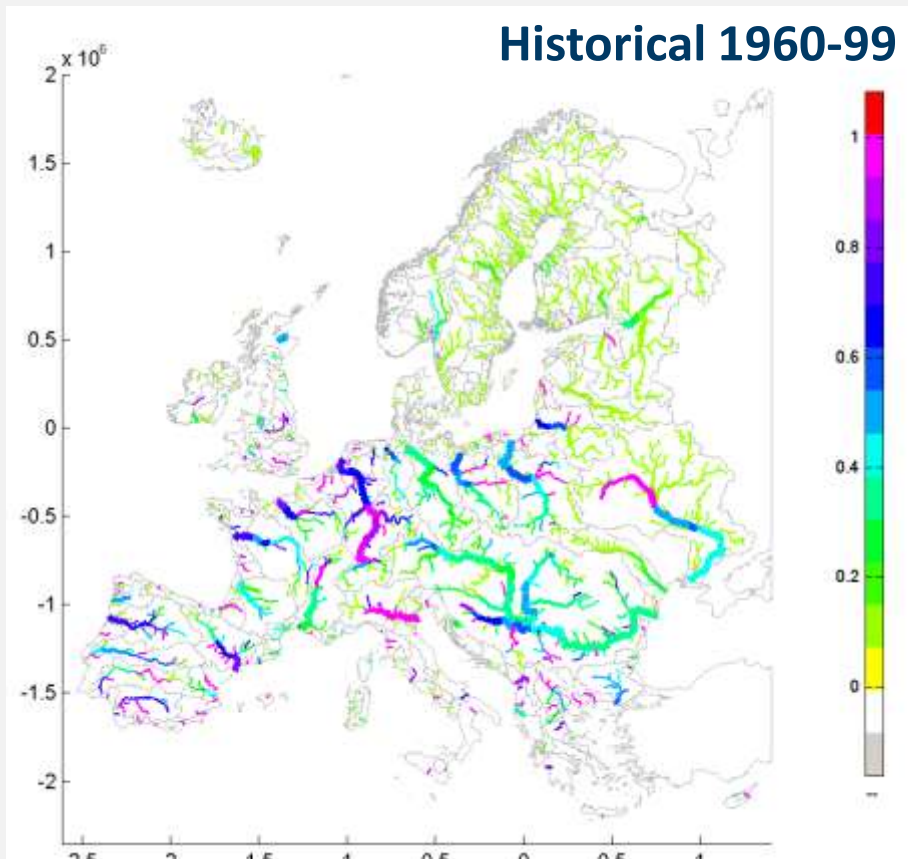
NorESM1



VULNERABILITY ANALYSIS

DEMANDS/AVAILABILITY: Comparison of current and long term projection

Model GFDL - RCP4.5

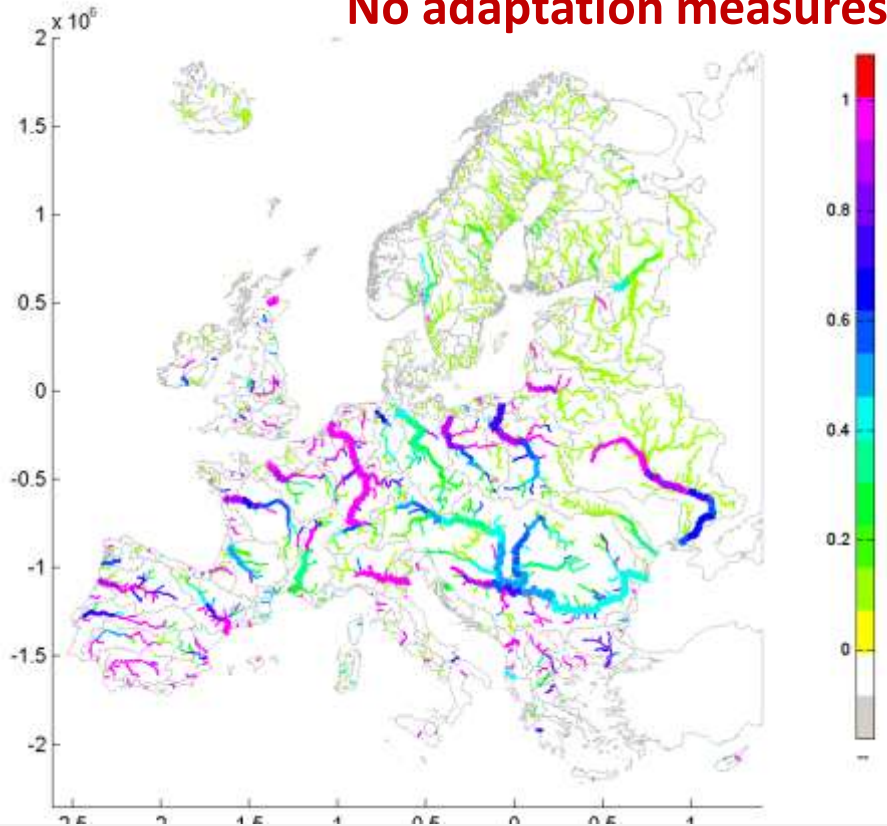


ADAPTATION POLICY ANALYSIS (I)

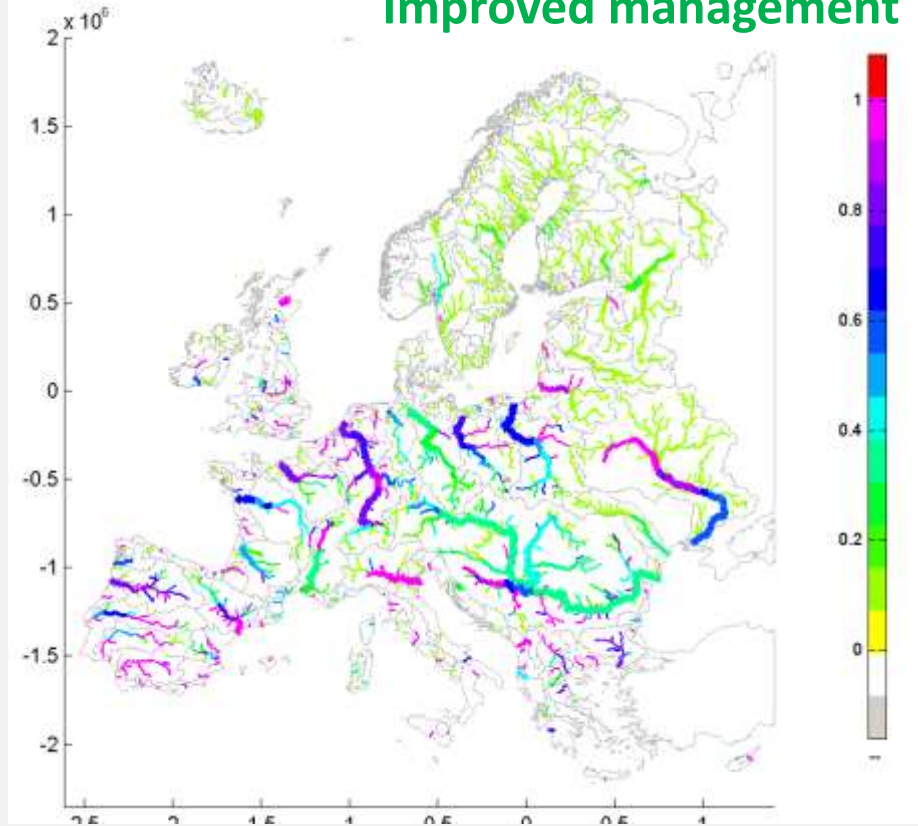
DEMANDS/AVAILABILITY: Comparison between projections
with and **without** adaptation measures

Model GFDL - RCP4.5 - Long term projection 2060-99

No adaptation measures



Improved management

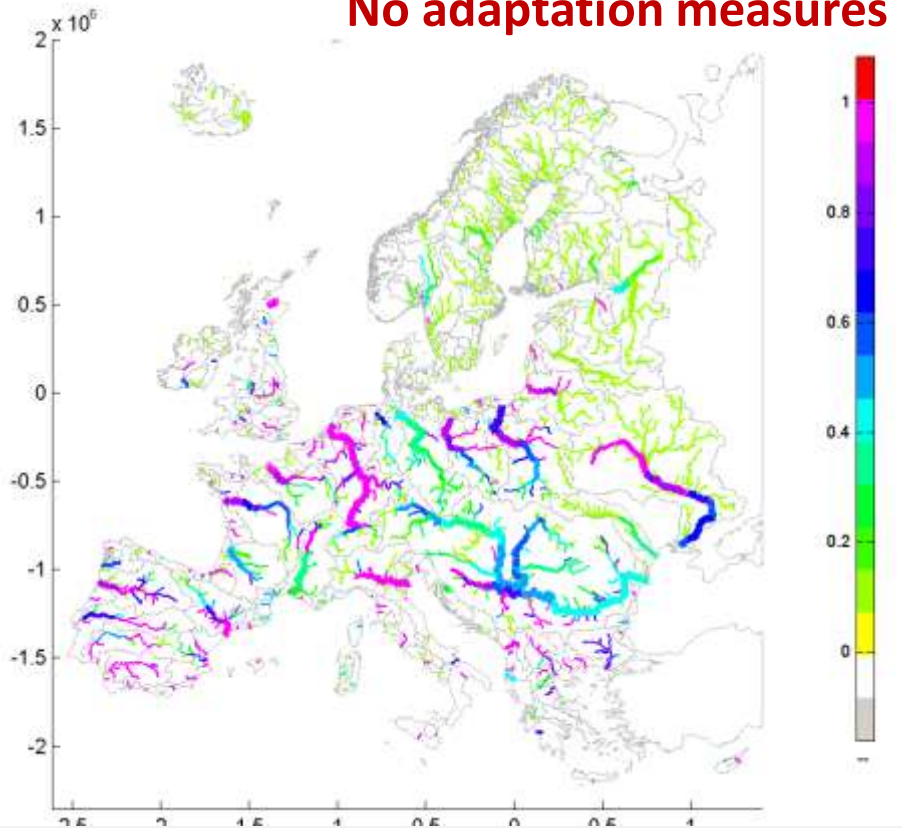


ADAPTATION POLICY ANALYSIS (II)

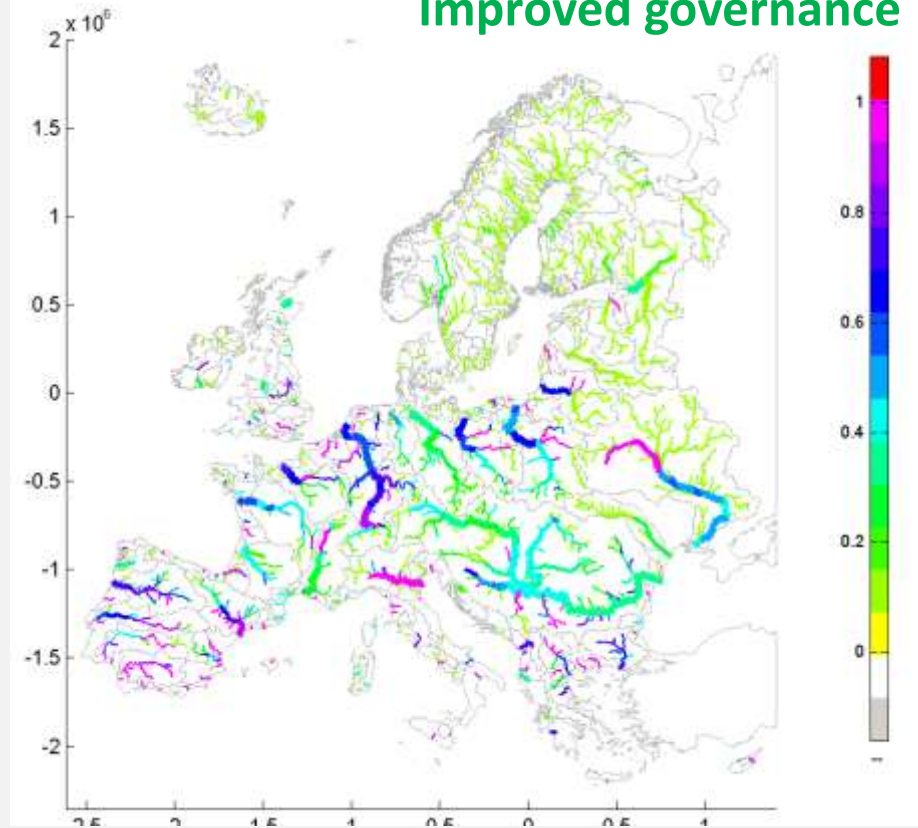
DEMANDS/AVAILABILITY: Comparison between projections
with and **without** adaptation measures

Model GFDL - RCP4.5 - Long term projection 2060-99

No adaptation measures



Improved governance

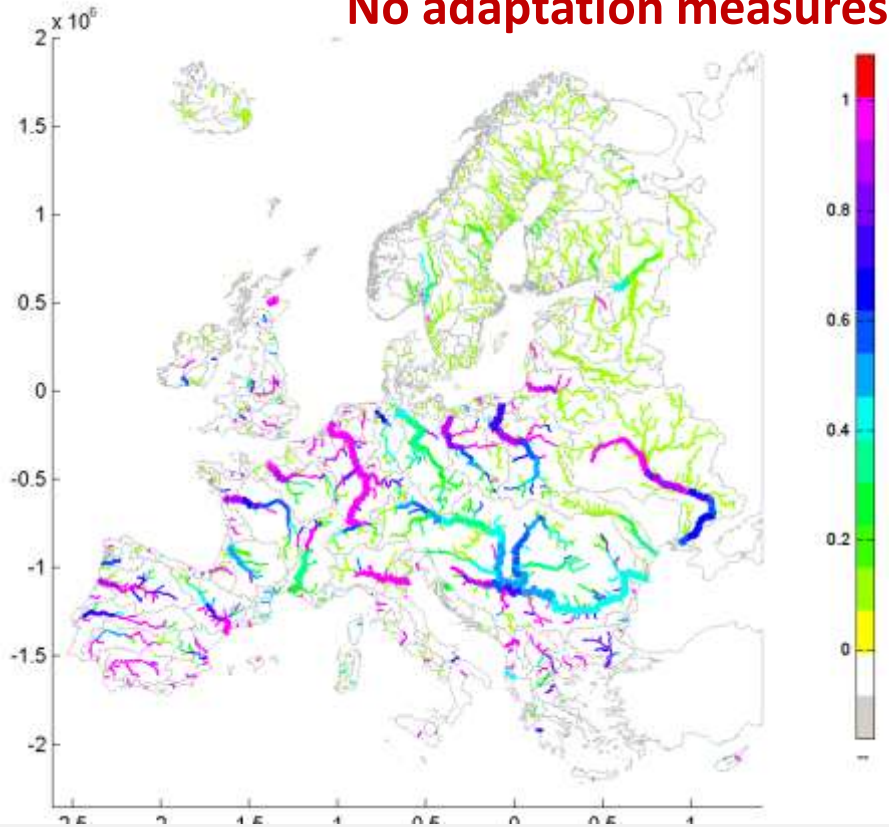


ADAPTATION POLICY ANALYSIS (III)

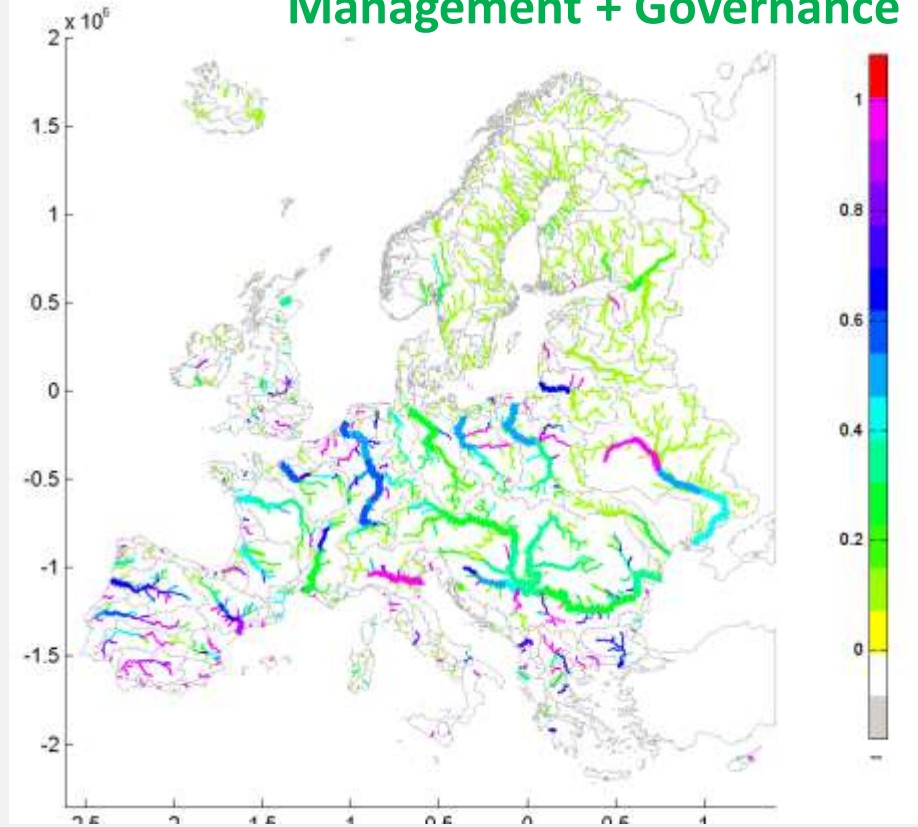
DEMANDS/AVAILABILITY: Comparison between projections
with and **without** adaptation measures

Model GFDL - RCP4.5 - Long term projection 2060-99

No adaptation measures



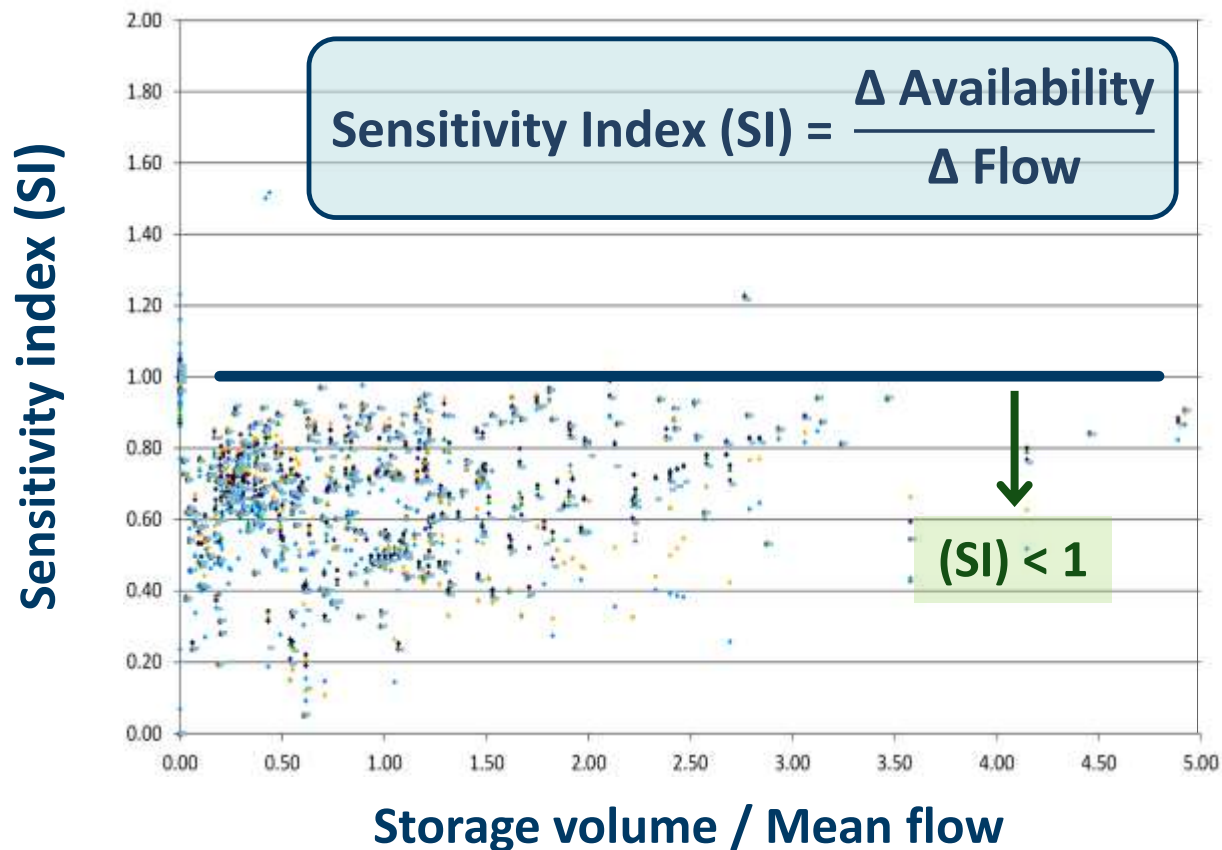
Management + Governance



- **The results show that the balance between water availability and demands is threatened in some regions.**
- **Impacts of climate change on water availability are uncertain and heterogeneous among the different climatic models.**
- **However, it is possible to identify areas of Southern Europe and some areas of Central Europe highly populated and low regulated that are vulnerable.**
- **Improved water management and water governance may compensate adverse effects of climate on water availability.**

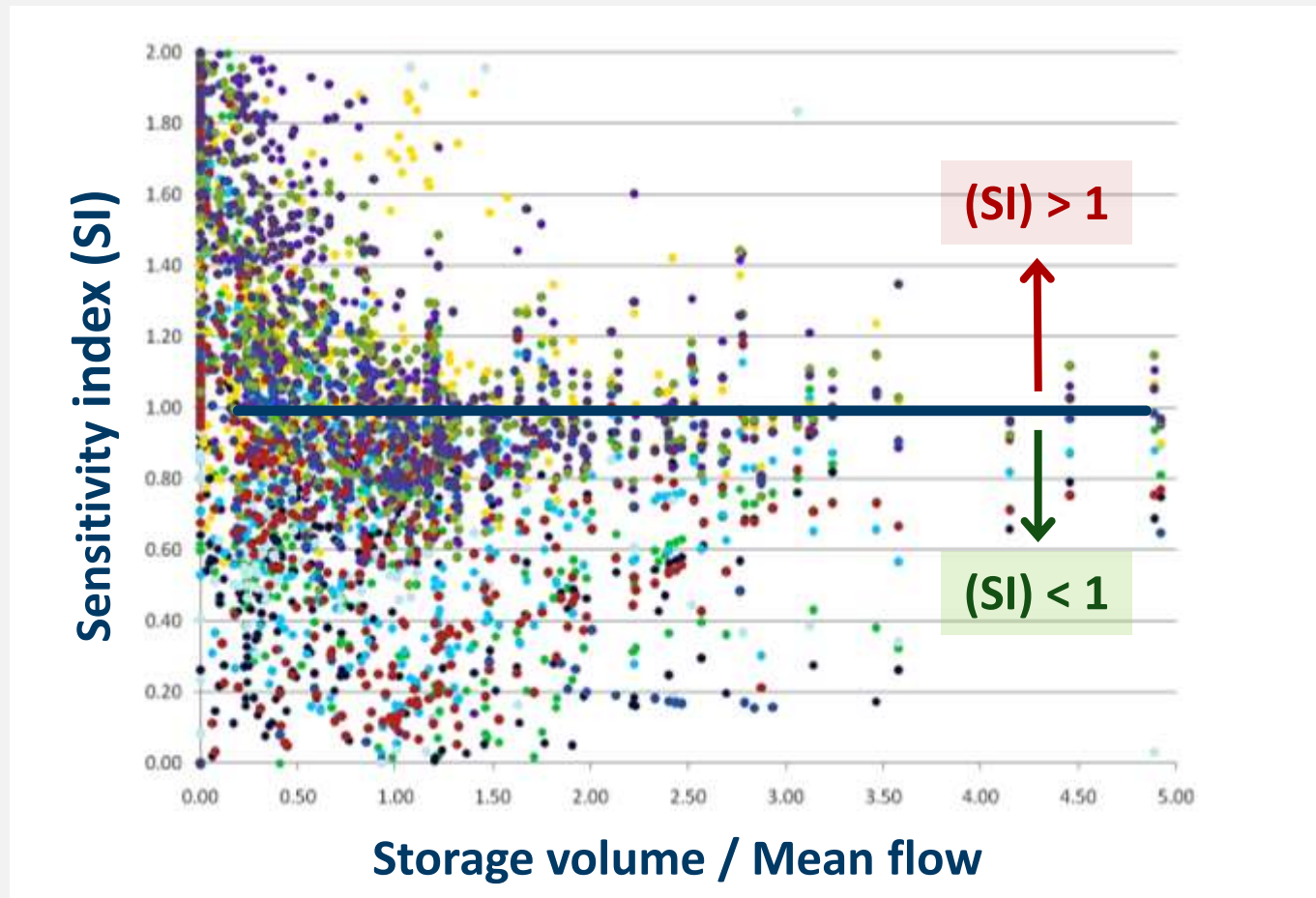
RESPONSE OF THE SPANISH RESERVOIRS TO CLIMATE CHANGE

Initial study: CEDEX climatic projections



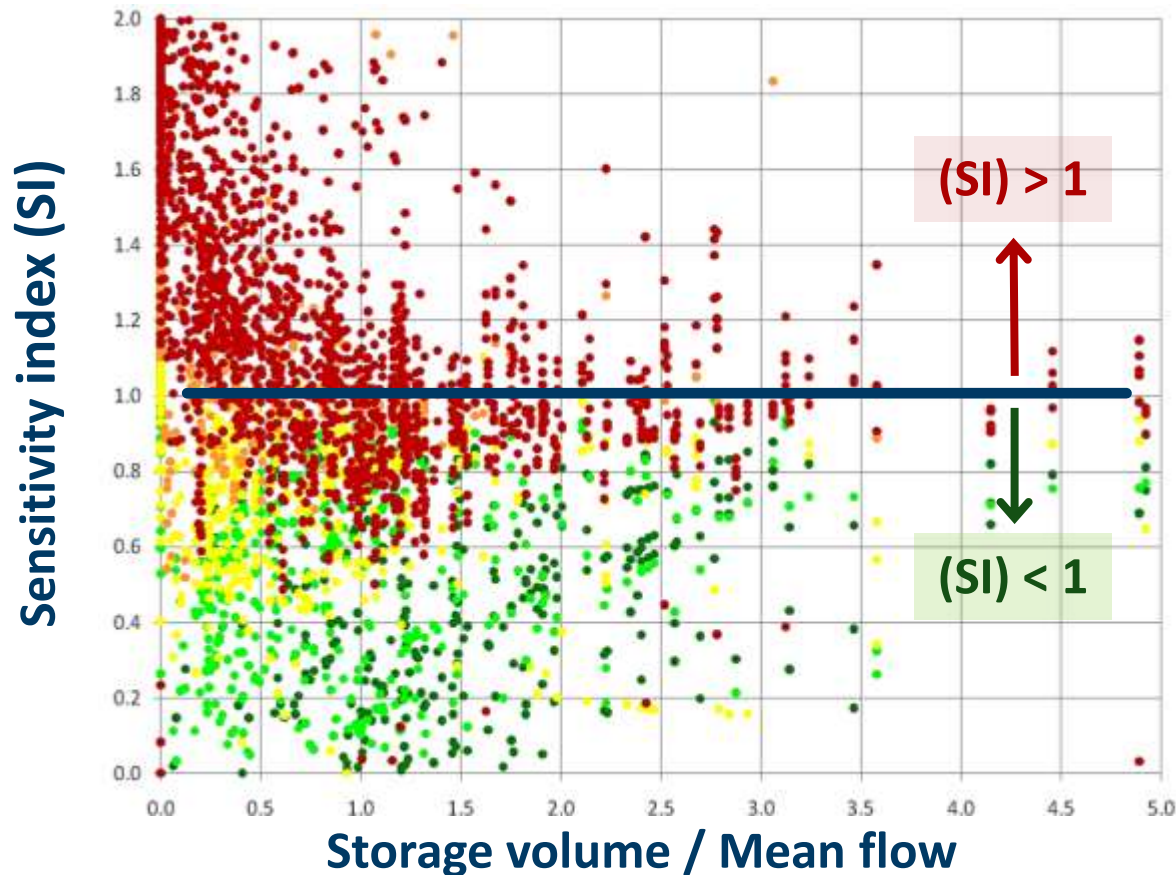
RESPONSE OF THE SPANISH RESERVOIRS TO CLIMATE CHANGE

Initial study: PRUDENCE climatic projections

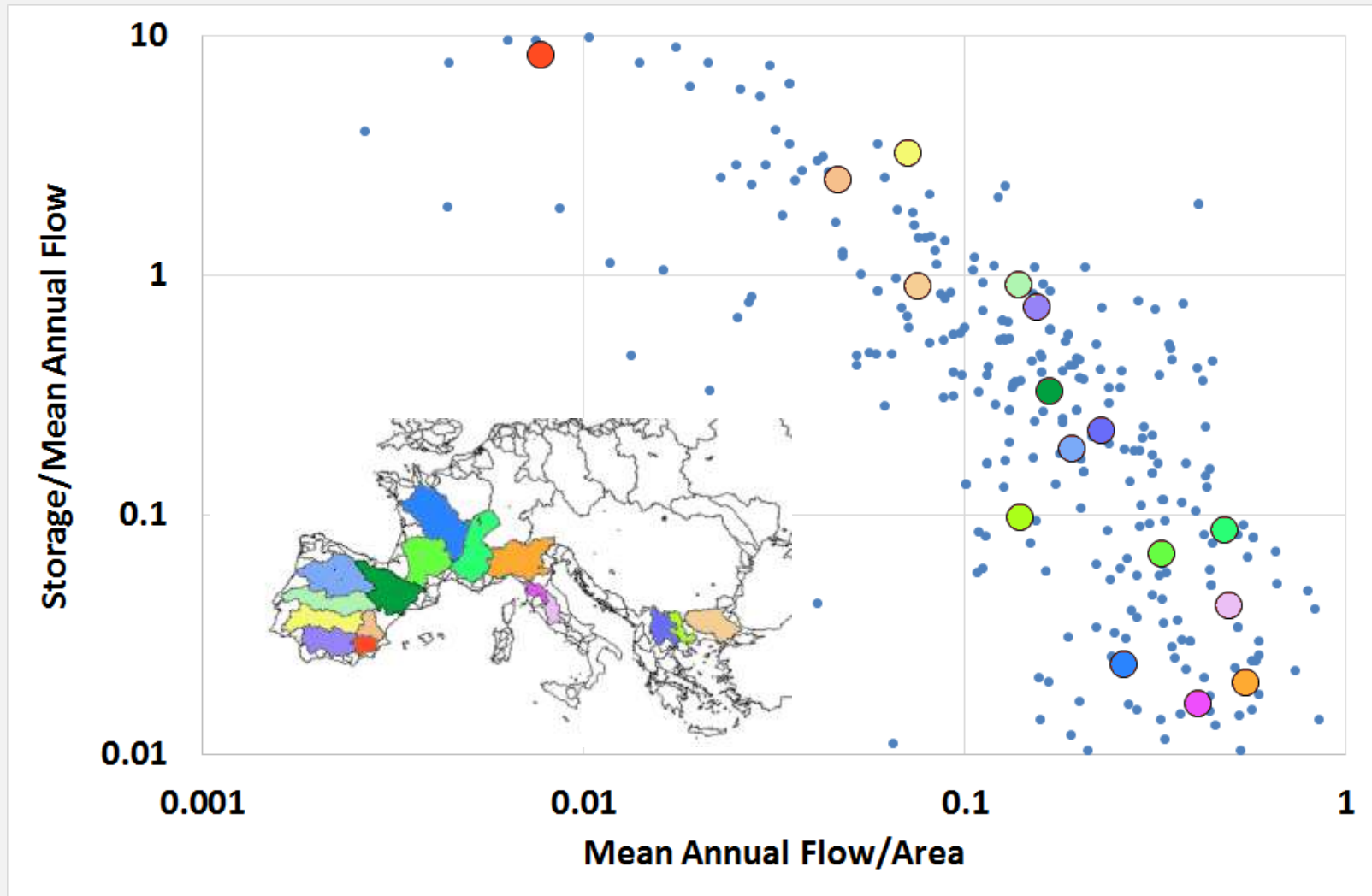


RESPONSE OF THE SPANISH RESERVOIRS TO CLIMATE CHANGE

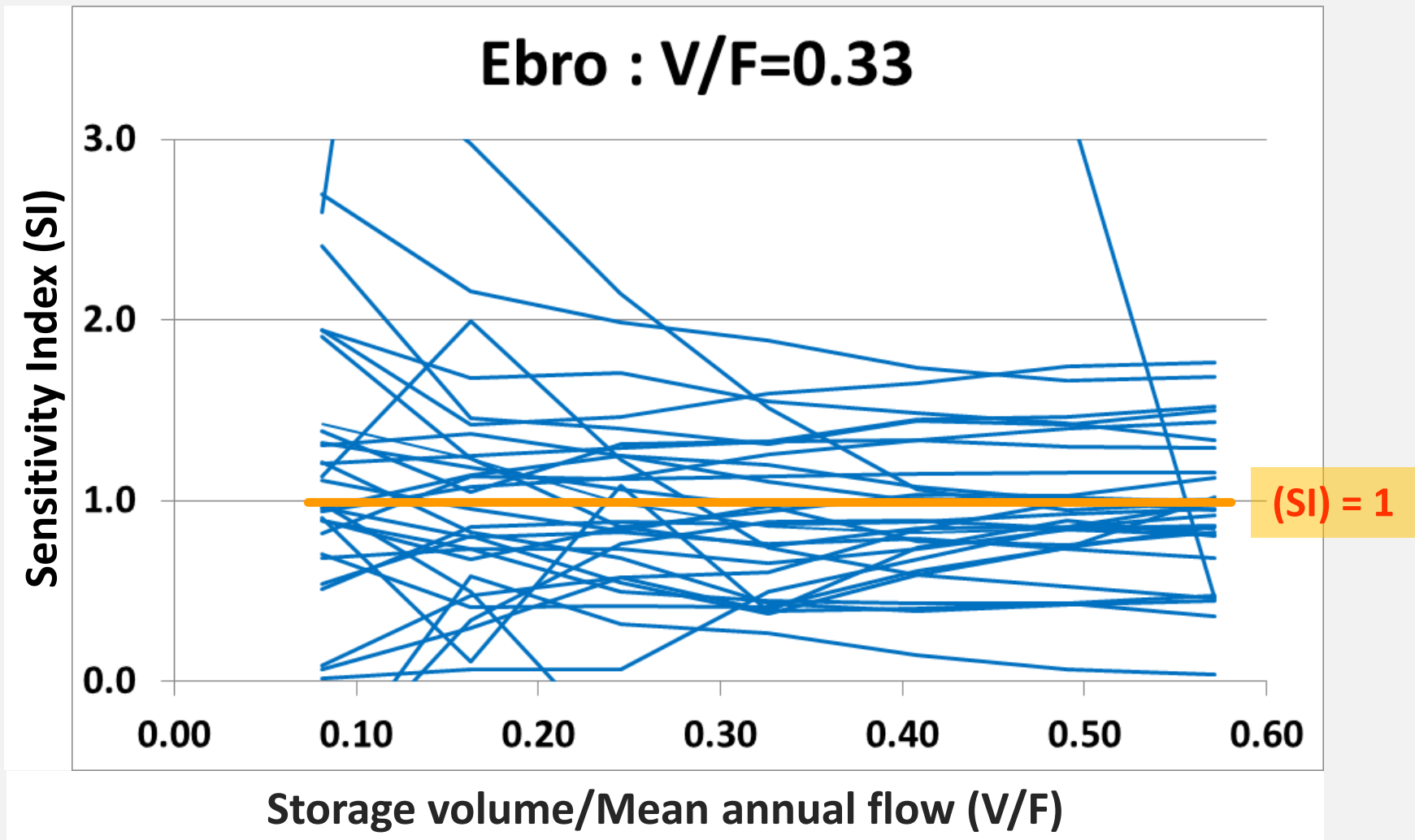
Initial study: PRUDENCE climatic projections



RESPONSE OF THE SOUTHERN EUROPE RESERVOIRS TO CLIMATE CHANGE

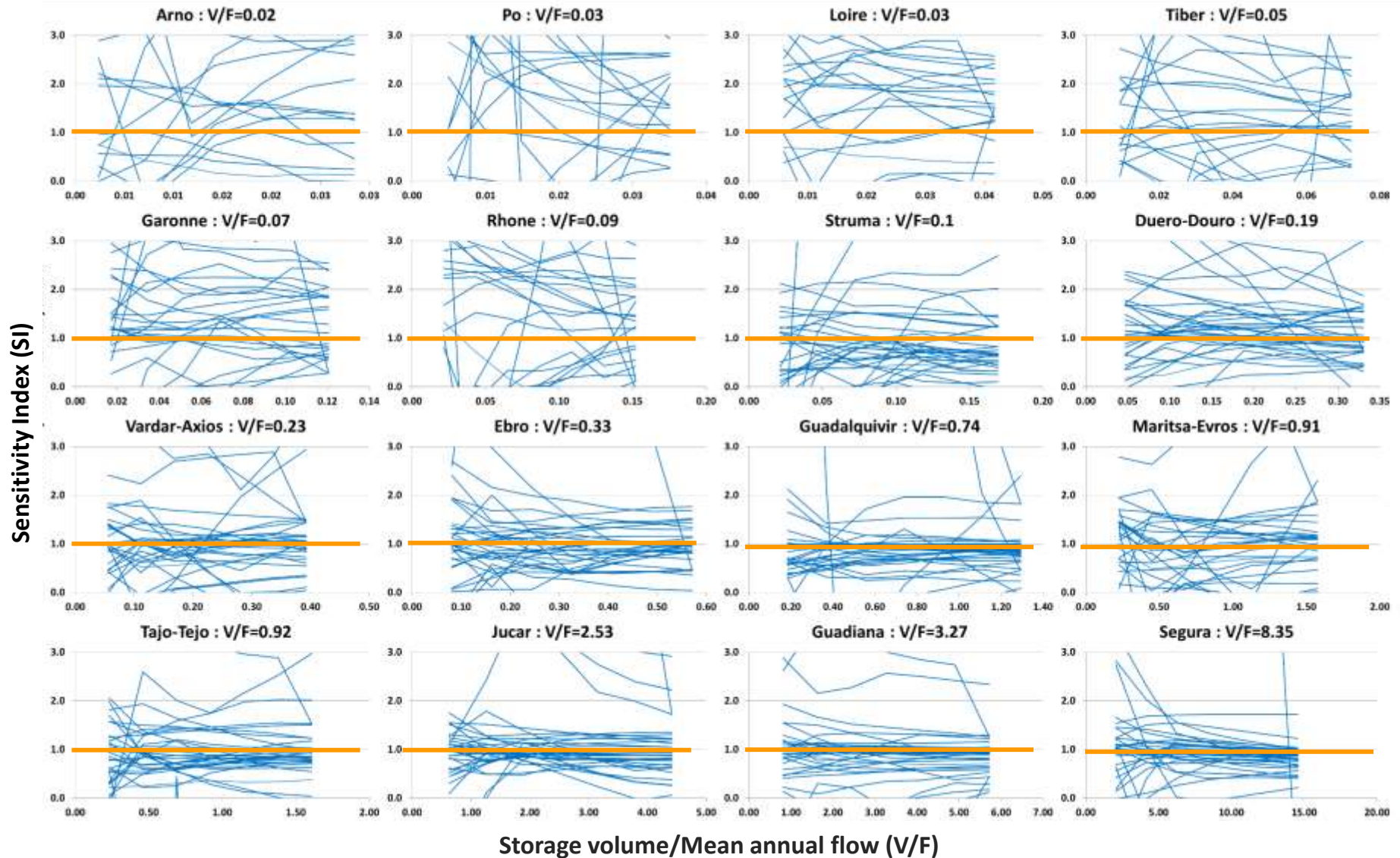


RESPONSE OF THE SOUTERN EUROPE RESERVOIRS TO CLIMATE CHANGE



Variability of sensitivity index is reduced for larger reservoir storage

Reservoir storage attenuates the effects of climate change on availability



ACKNOWLEDGEMENTS

- To European Project BASE *“Bottom-up Climate Adaptation Strategies Towards a Sustainable Europe”*
- To Hessel Winsemius and Laurens Bouwer, from DELTARES, as they provided the simulation results of the PCRGLOBWB model.

Merci de votre attention

Luis Garrote de Marcos & Alfredo Granados García

l.garrote@upm.es & a.granados@upm.es

