Effects of water scarcity and human occupation on river eutrophication

Sergi Sabater

Eutrophication, part of global change

Global change refers to planetary-scale changes in the Earth system.

….

More completely, the term "global change" encompasses: population, climate, the economy, resource use, energy development, transport, communication, land use and land cover, urbanization, globalization, atmospheric circulation, ocean circulation, the carbon cycle, the nitrogen cycle, the water cycle and other cycles, sea ice loss, sea-level rise, food webs, biological diversity, pollution, health, over fishing, and more.

http://en.wikipedia.org/wiki/Global_change

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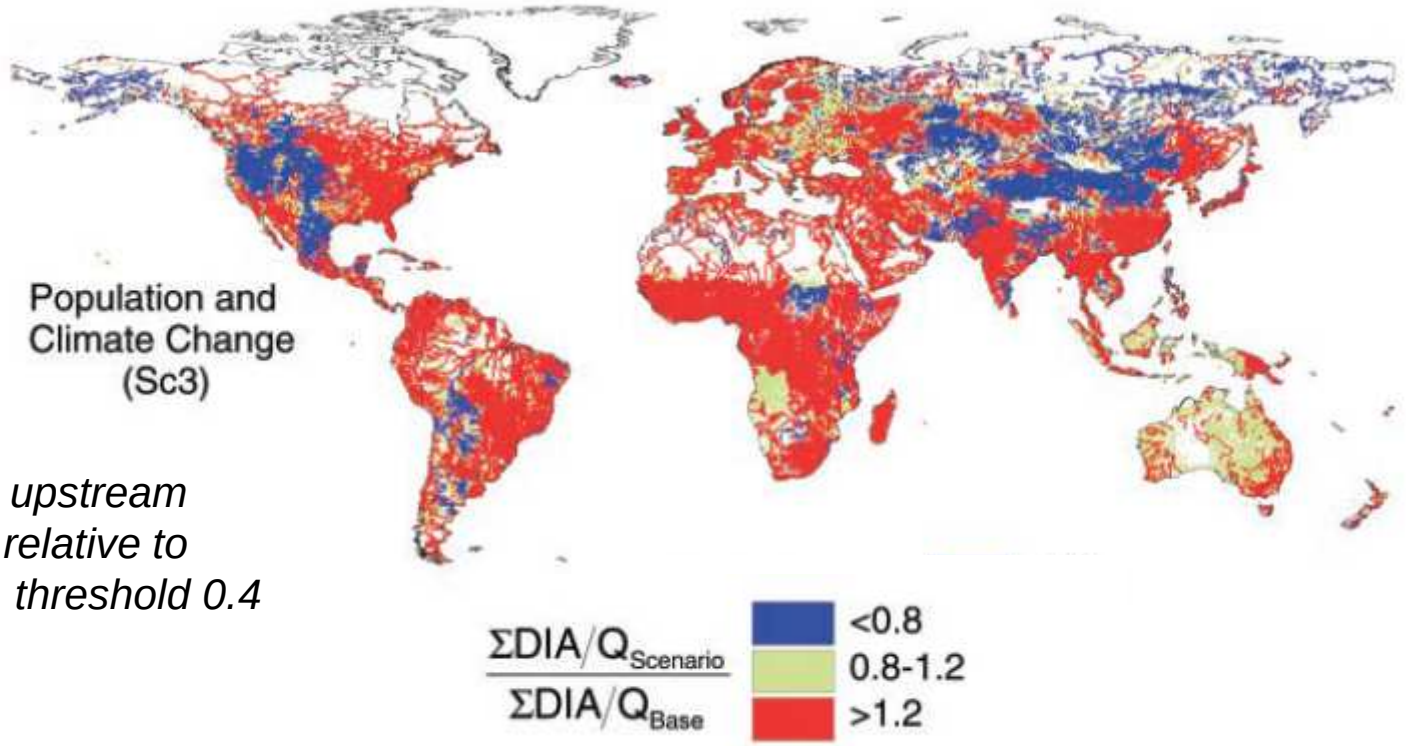
Global change affects water resources and freshwaters

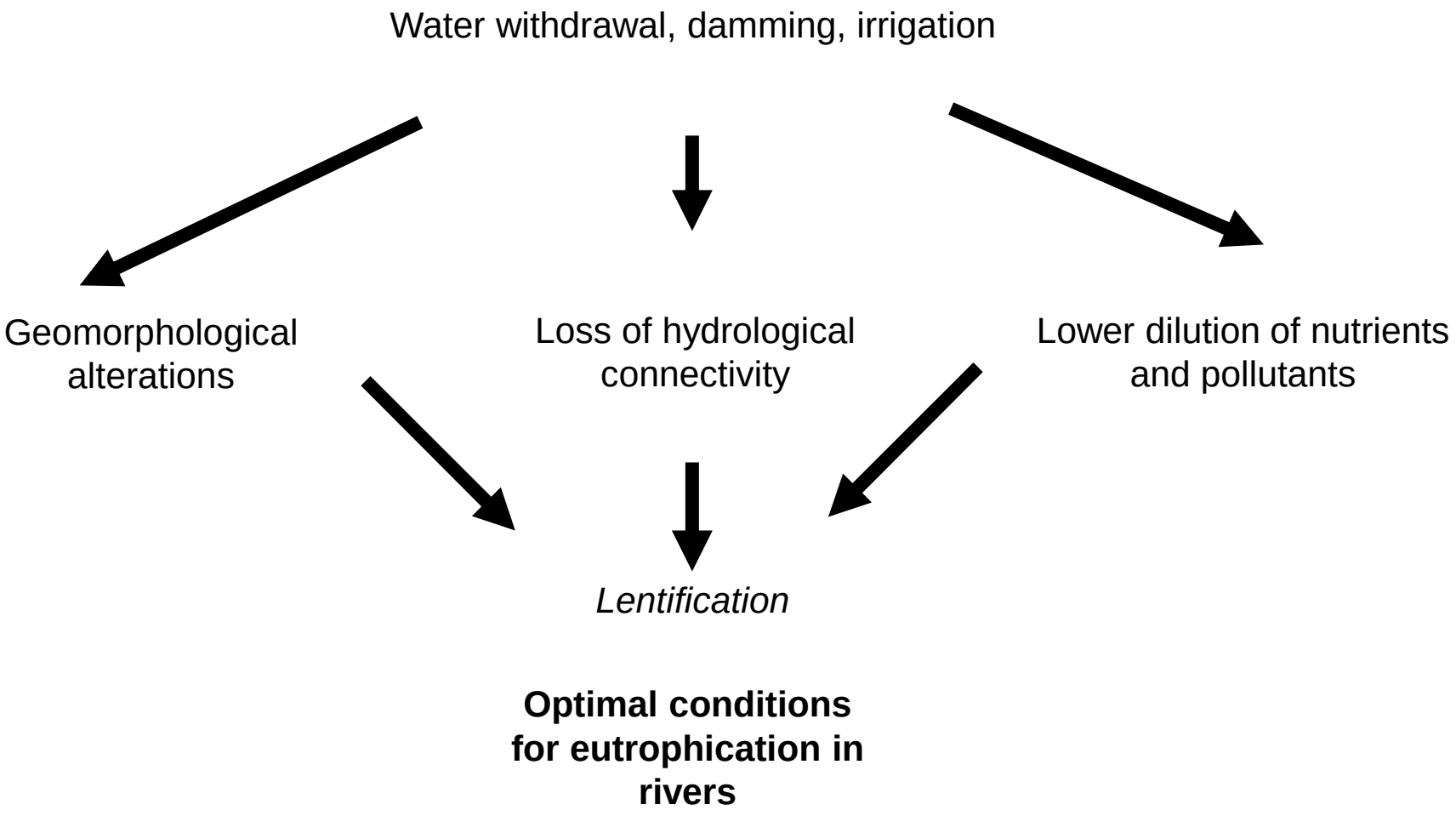
Predicted change (2025) on water resources
because of *climate change and population increase*



aggregate upstream water use relative to discharge, threshold 0.4

Vörösmarty et al. 2000 Science

Eutrophication, water scarcity and human occupation

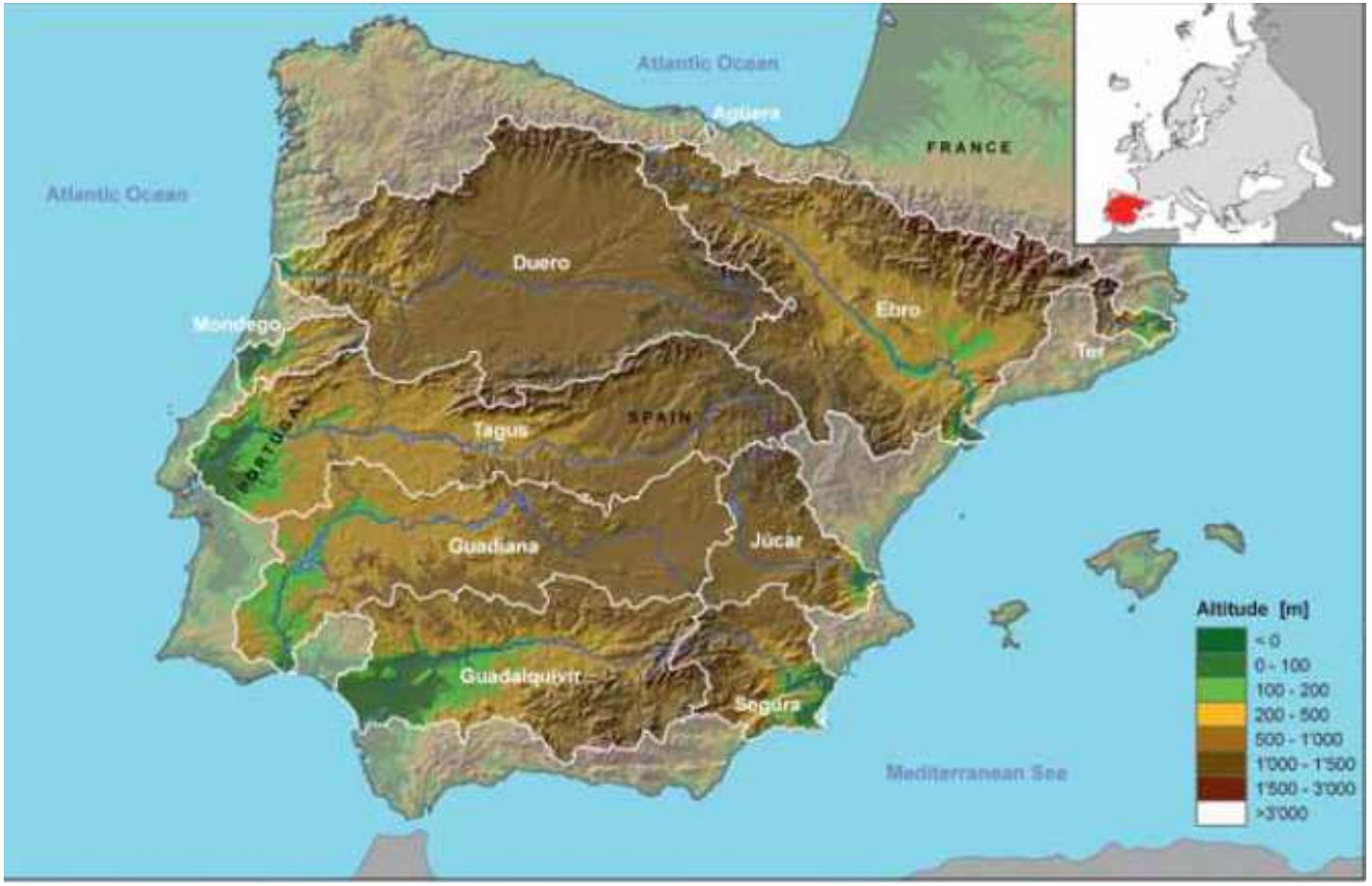


Eutrophication, water scarcity and human occupation

Lentification

•Loss of sedimentary dynamics
•Higher frequency and duration of low water flows (hydrological stability)
•Higher water temperature
•Higher nutrient concentrations (lower dilution)

The Ebro River as a case study

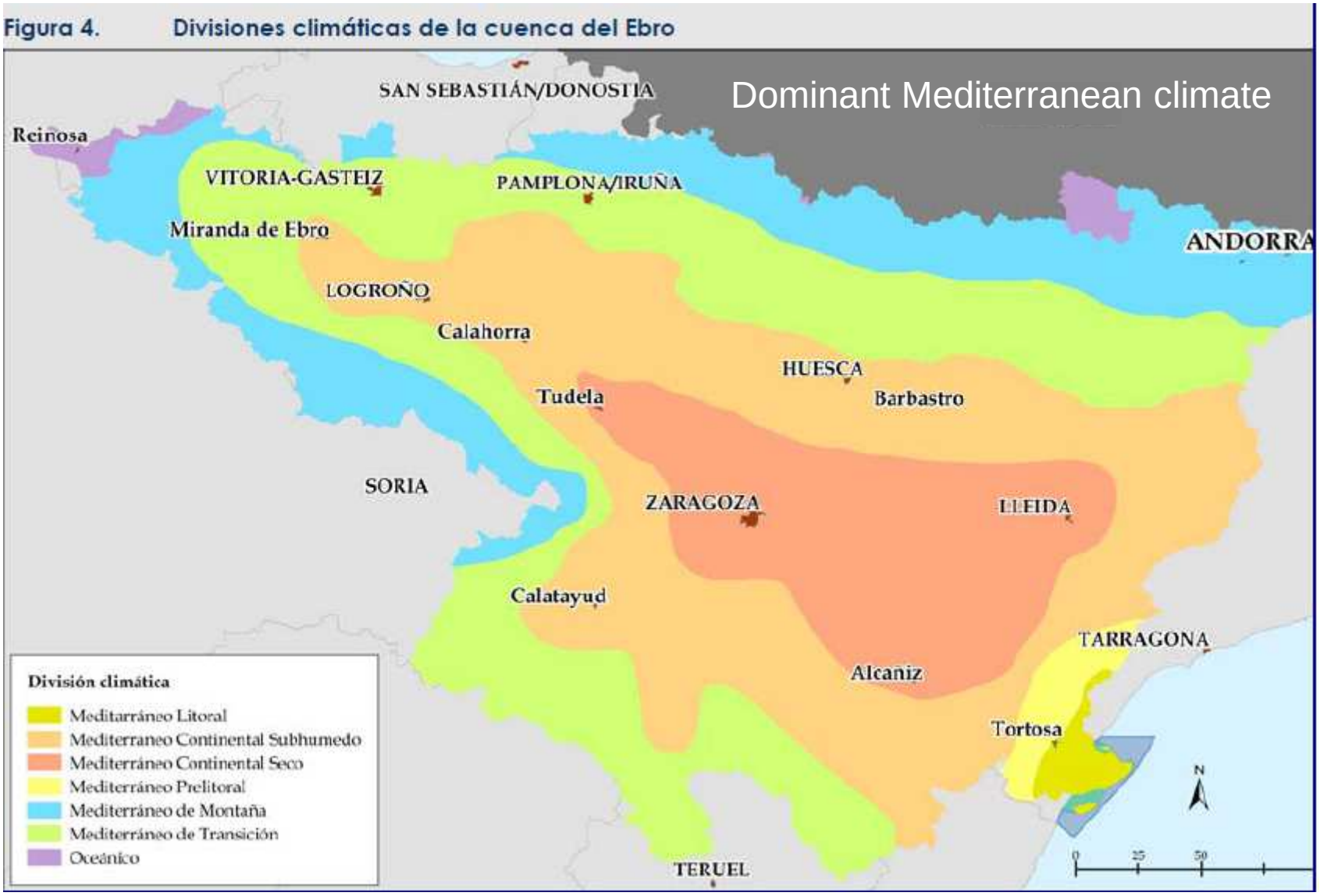


Sabater et al. 2009- Iberian Rivers In: Rivers of Europe (Tockner et al. Eds.)

The Ebro River as a case study

Plan Hidrológico de la parte española de la Demarcación Hidrográfica del Ebro, 2015-2021

The Ebro River - climate



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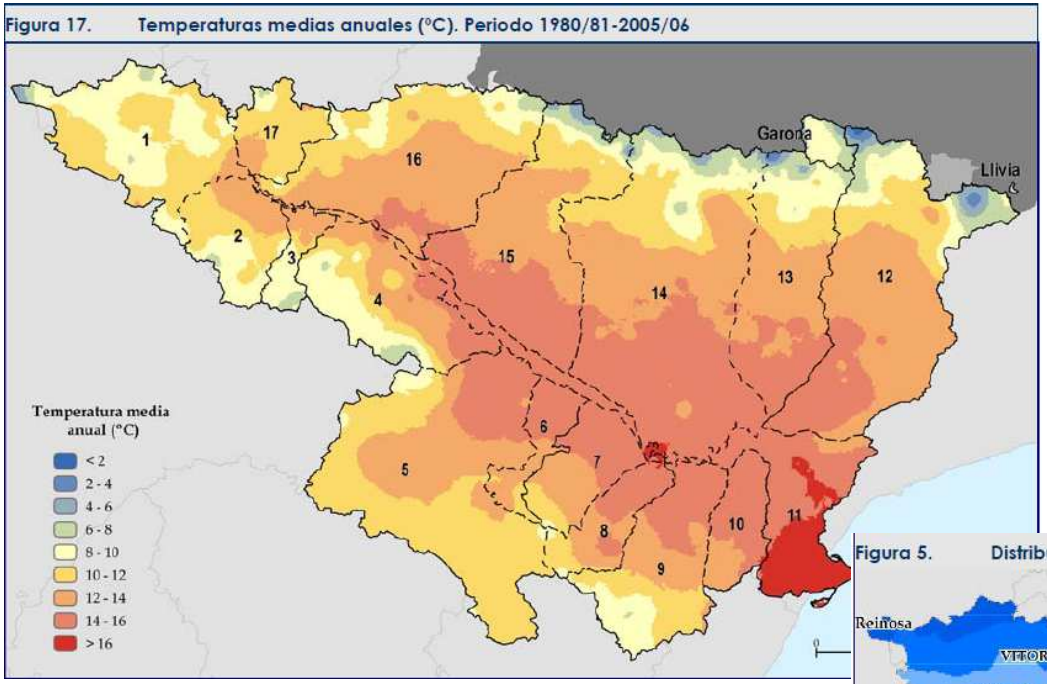
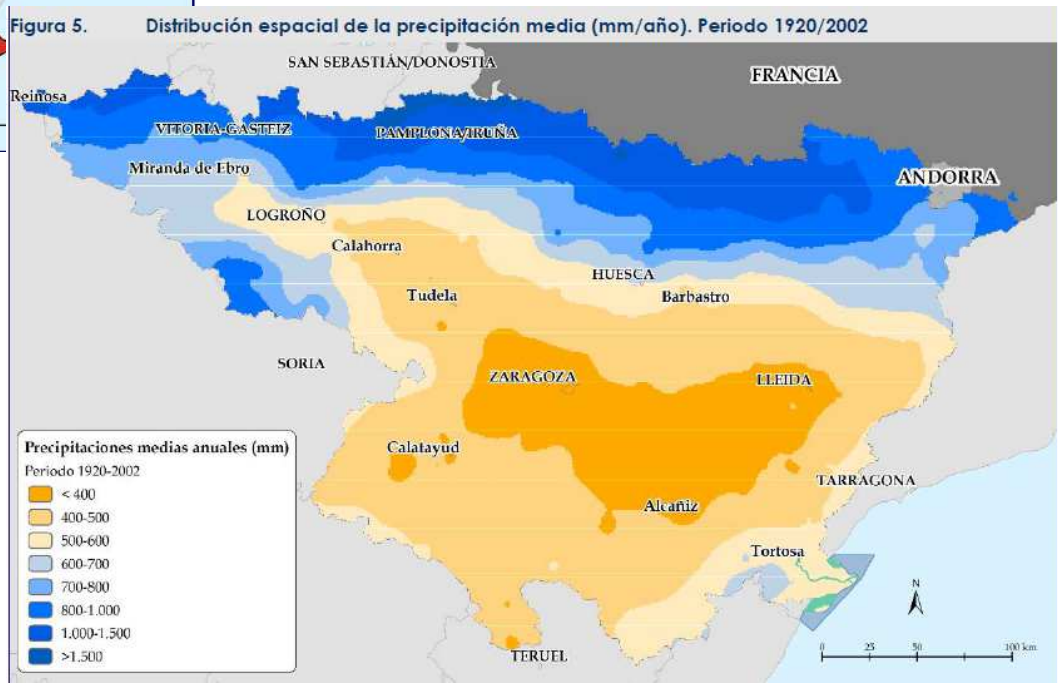


Extensive areas with very low precipitation and high temperatures



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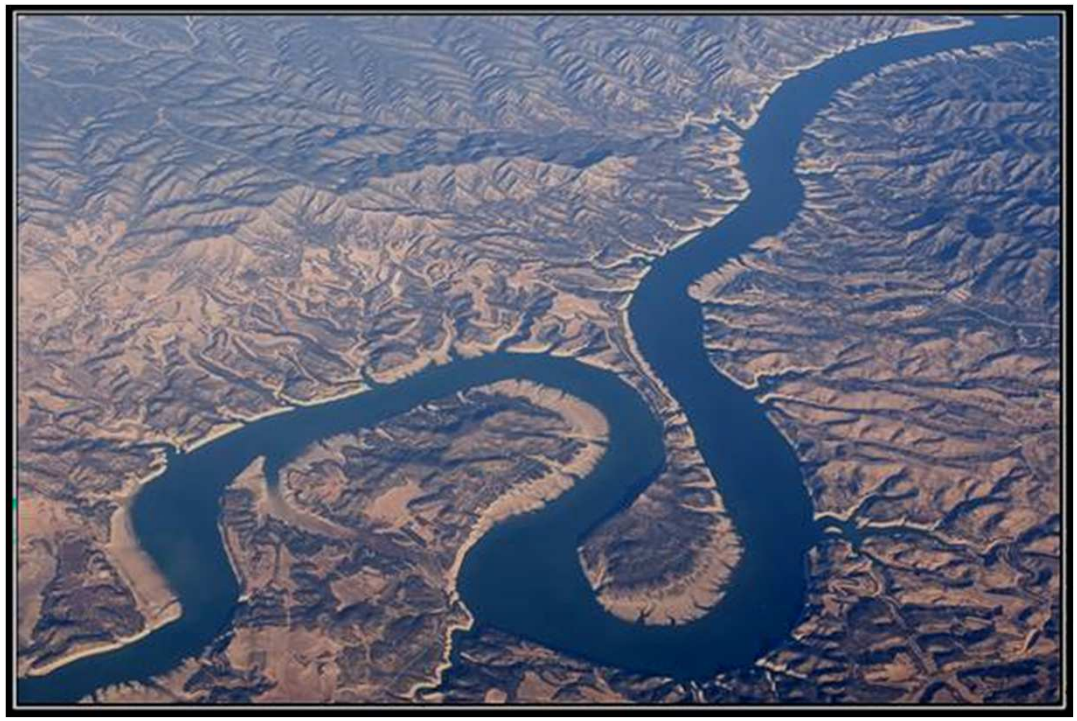
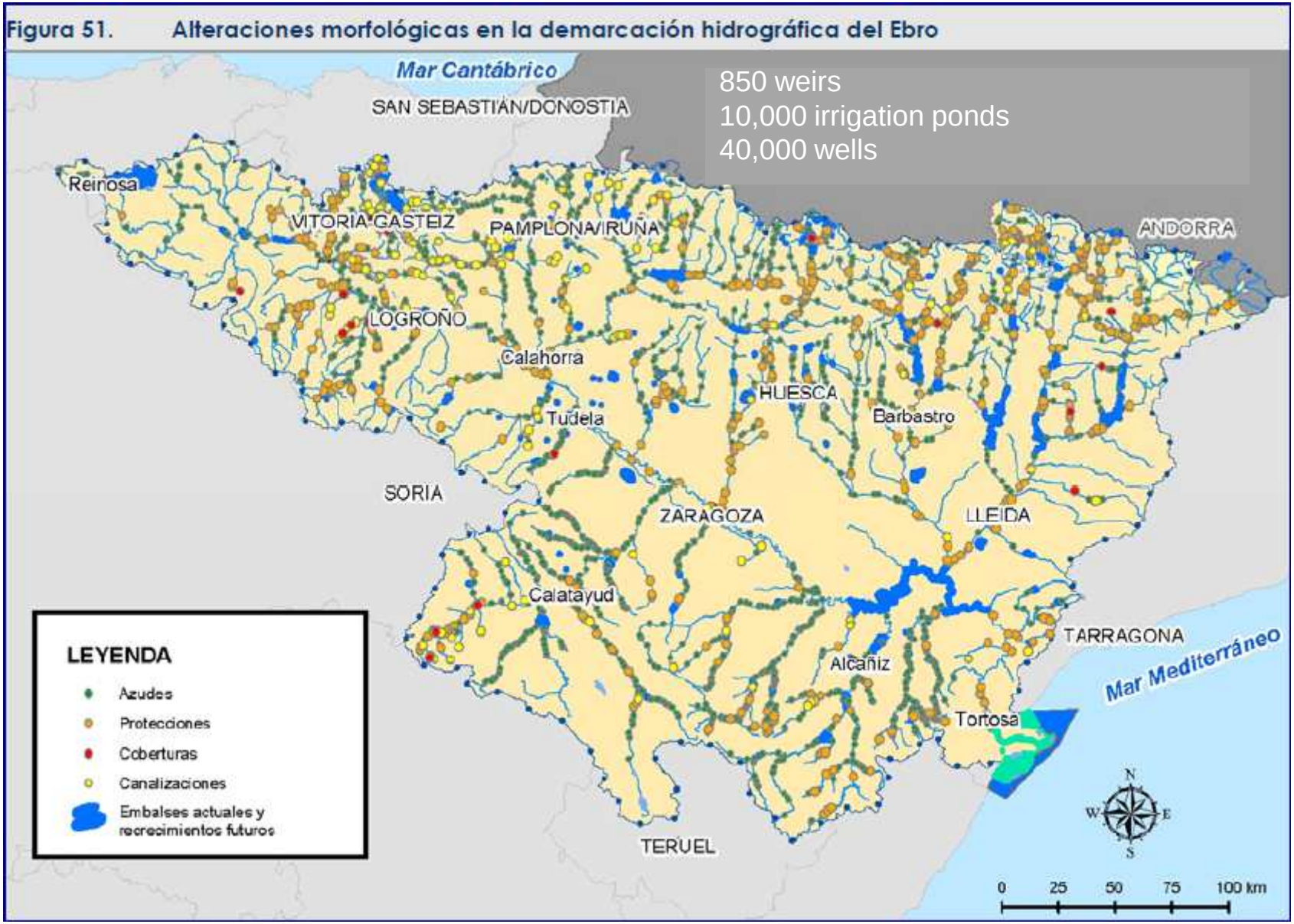
The Ebro River – a regulated system



The Ebro River –a regulated system



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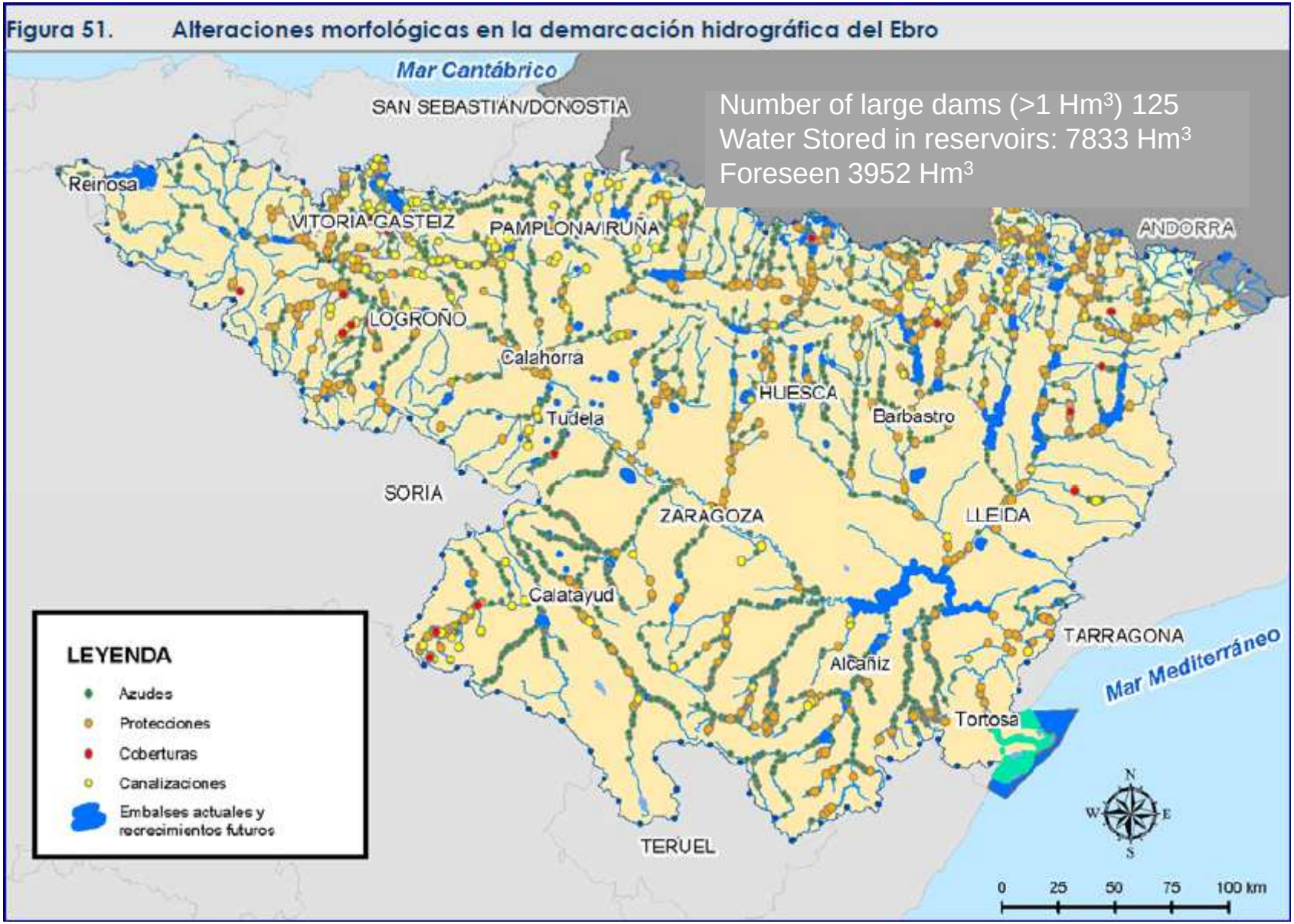

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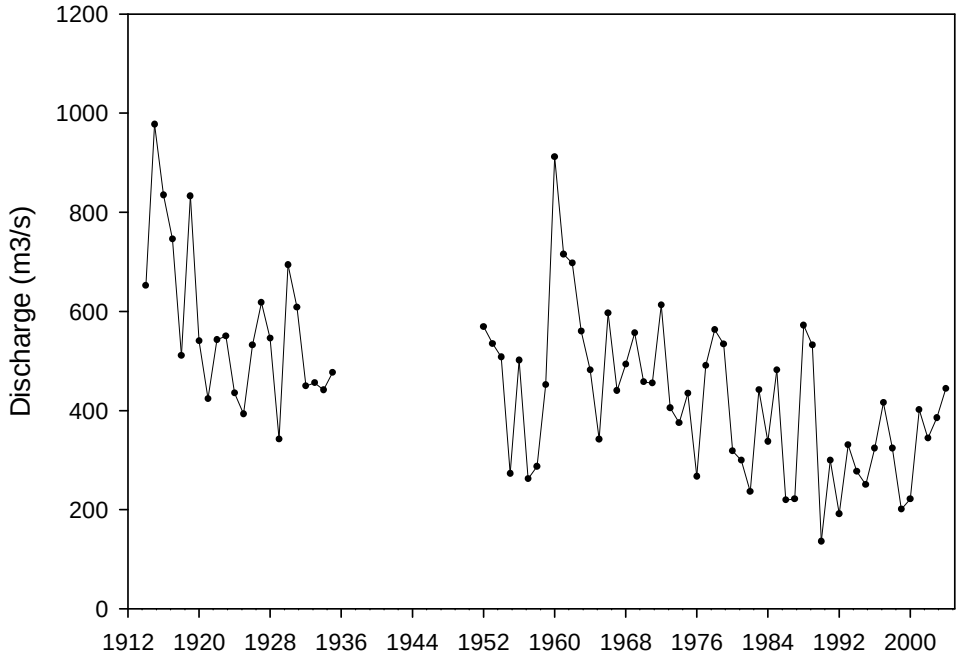
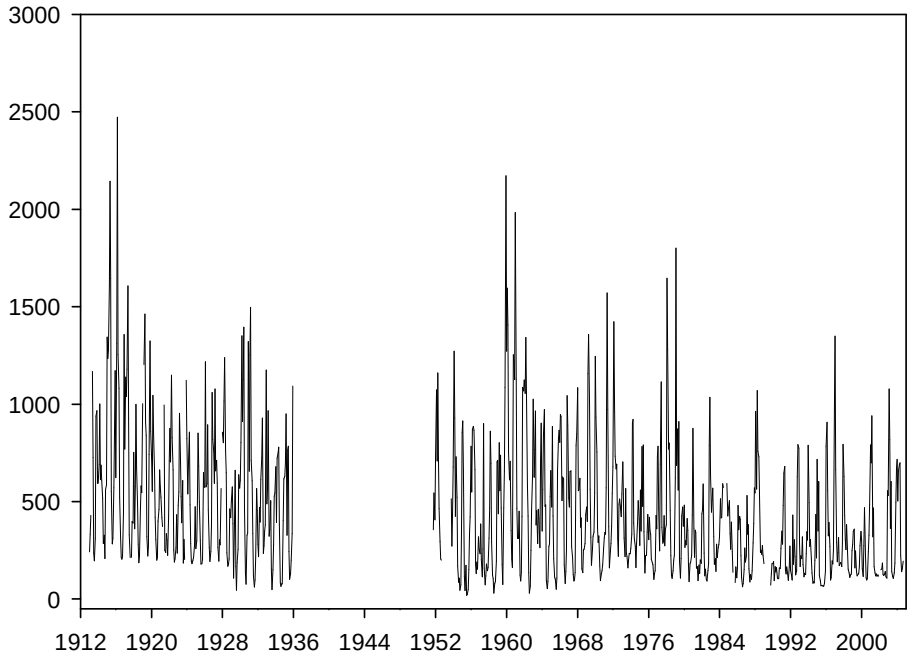
The Ebro River – decreasing flows, decreasing intrannual variability

Water flow at the river mouth (Tortosa)

Annual means



Monthly means



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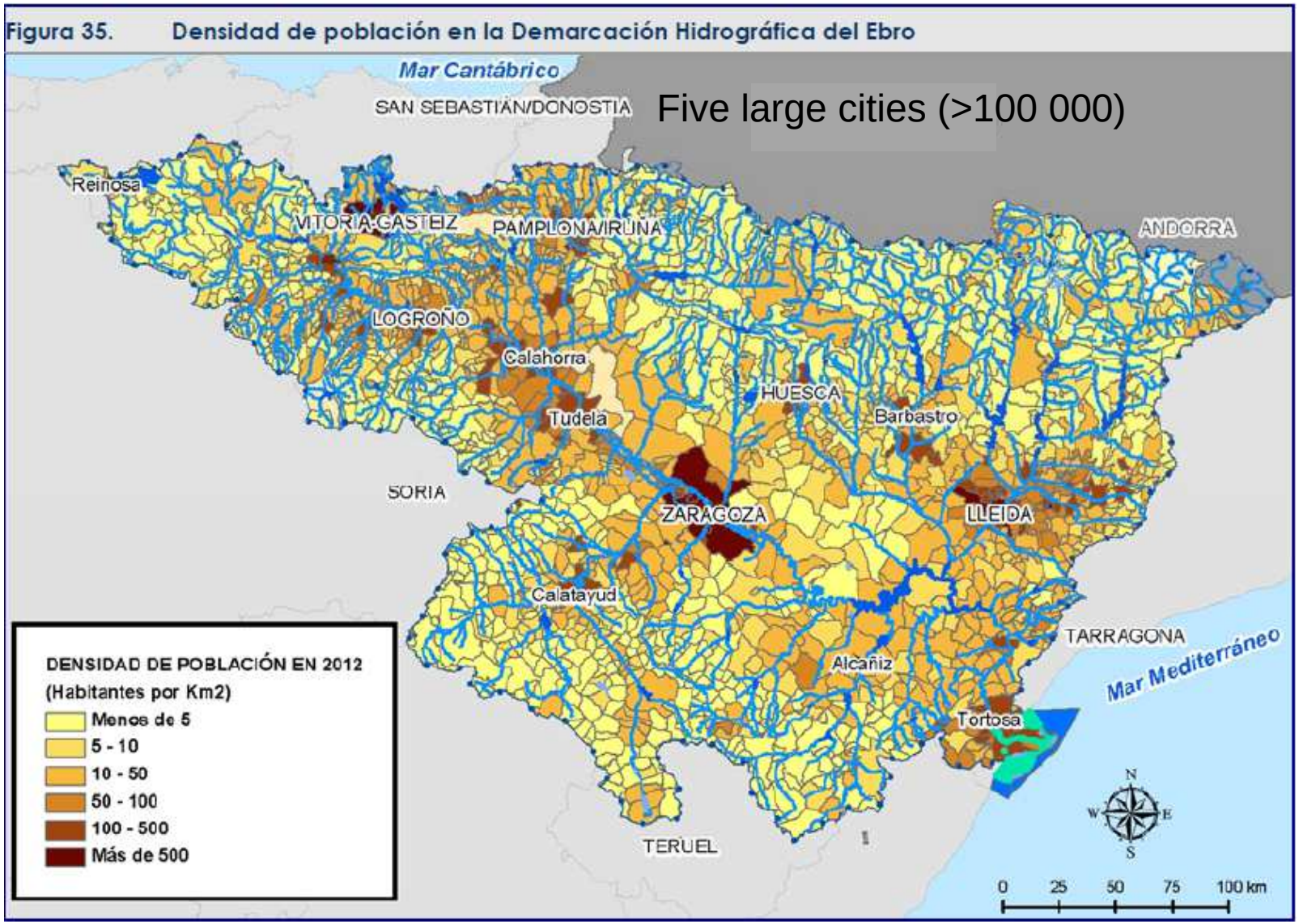
The Ebro River – intense but unequal human pressure



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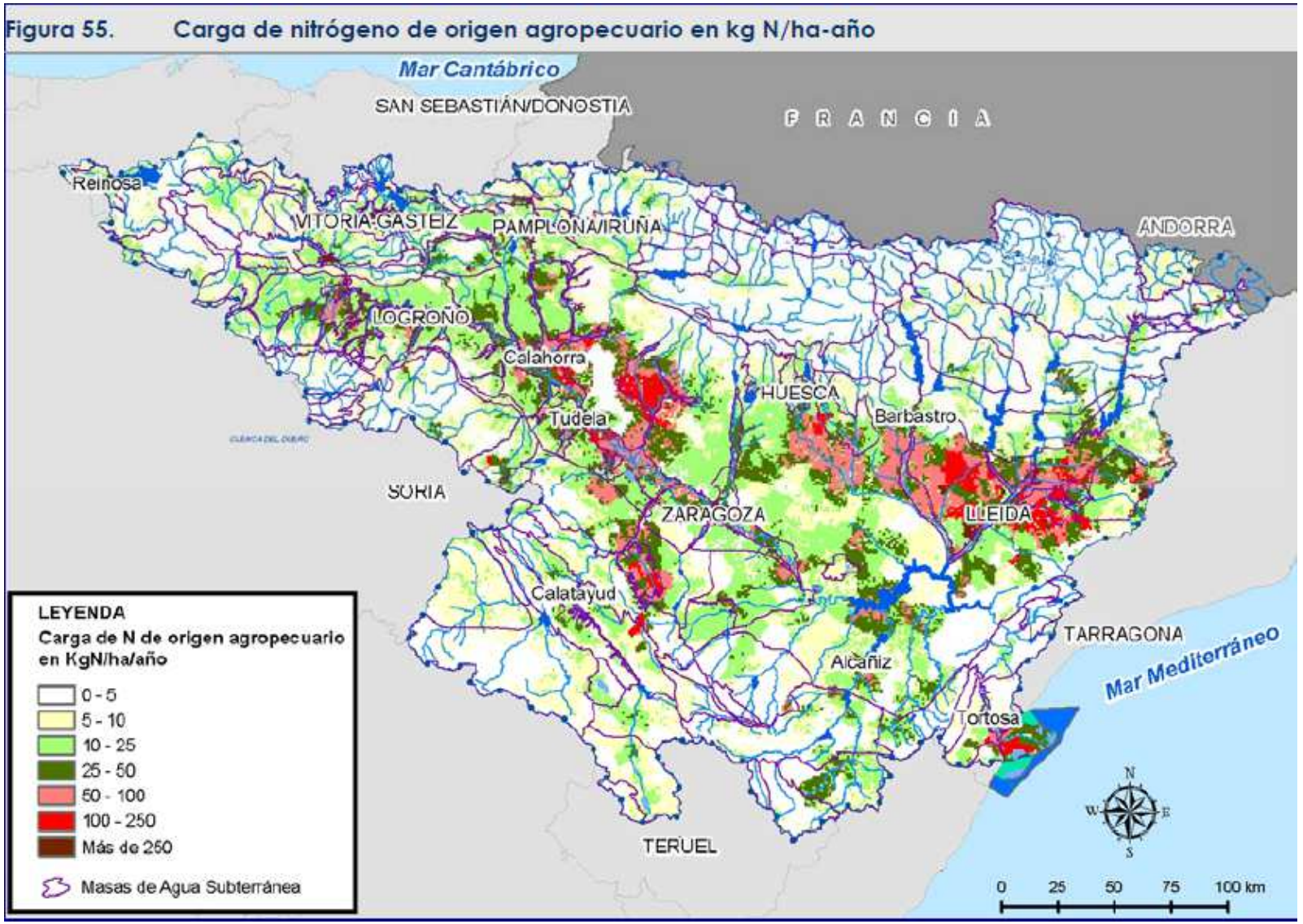
The Ebro River – intense farming pressure



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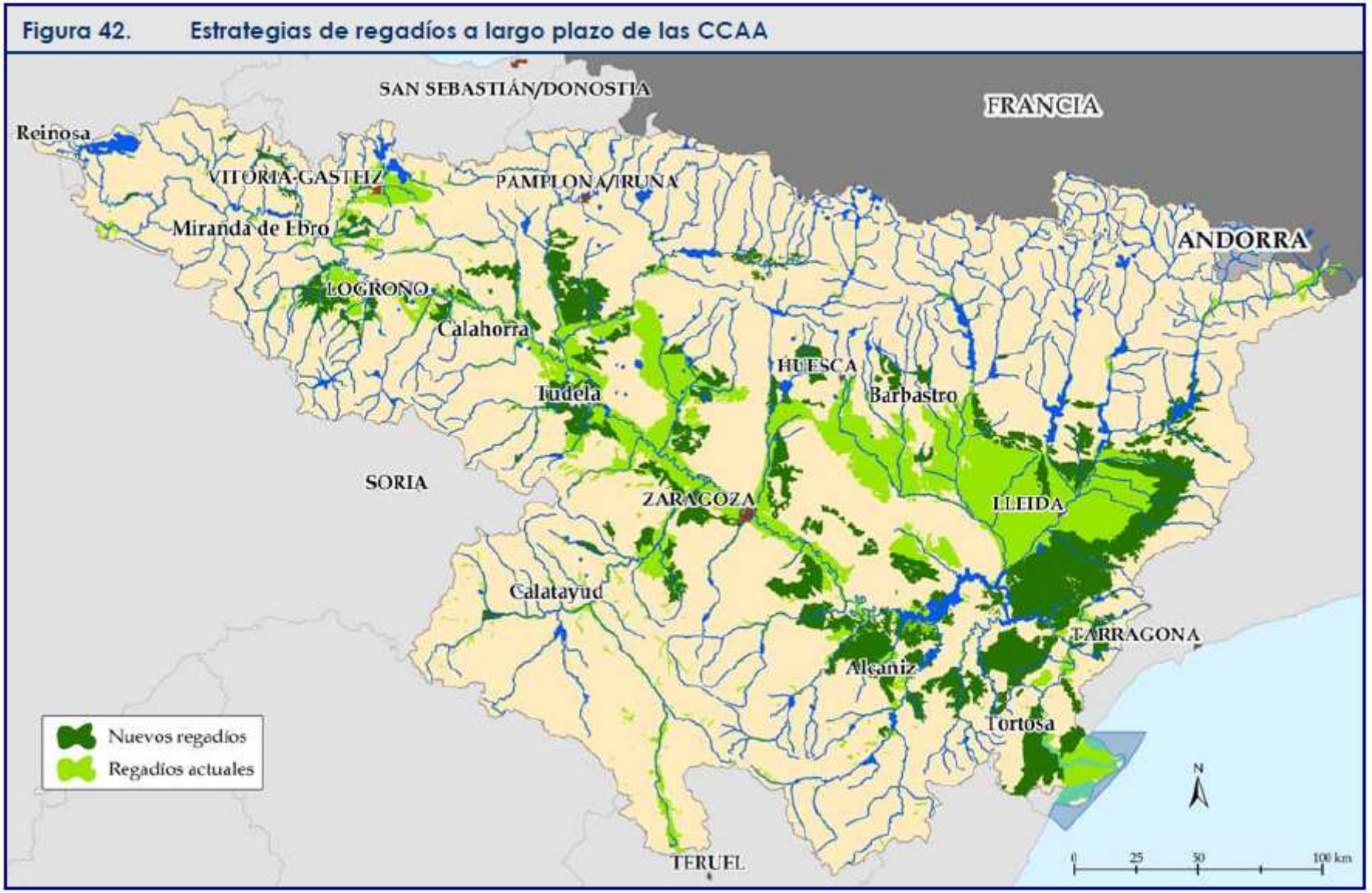
The Ebro River – intense irrigation



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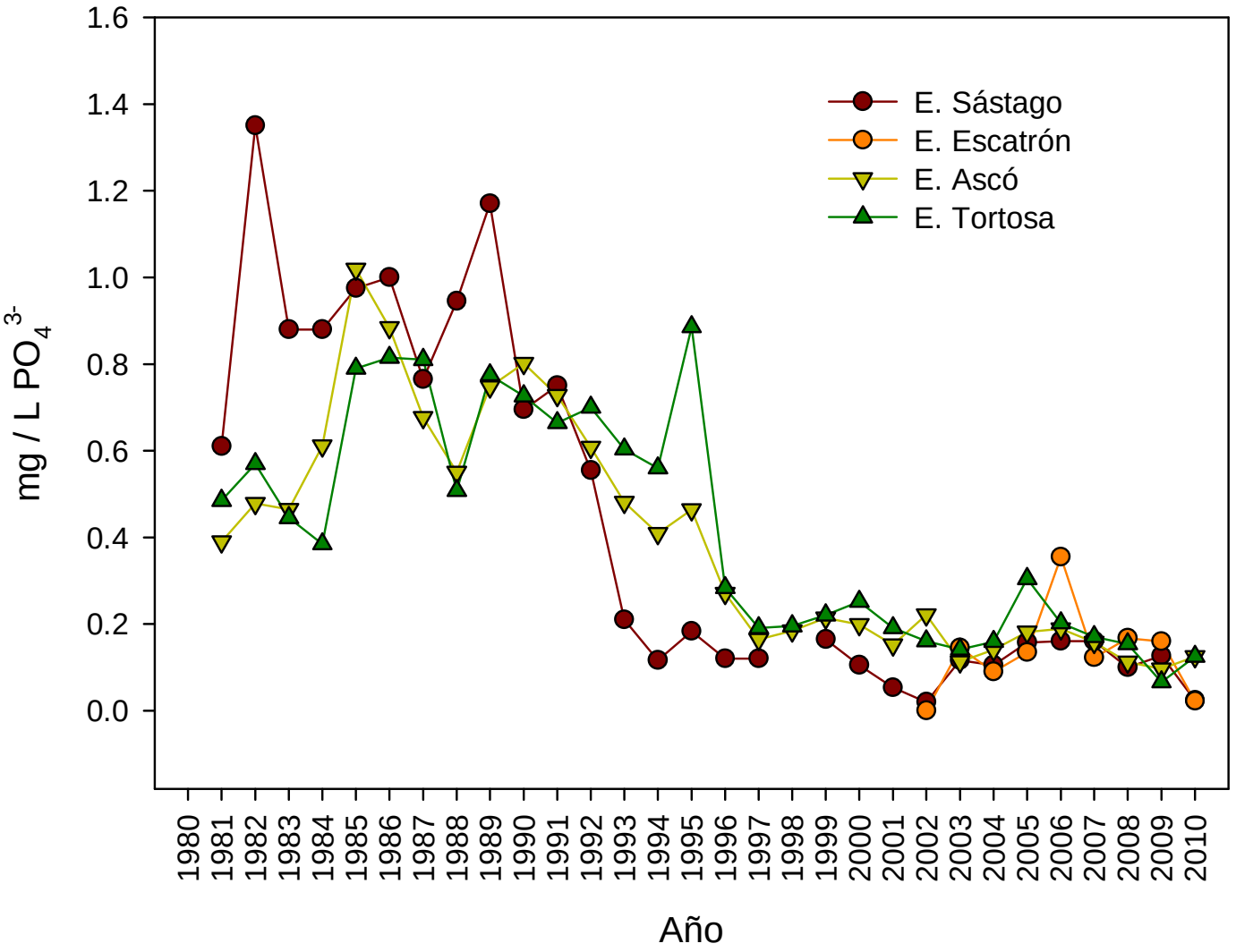
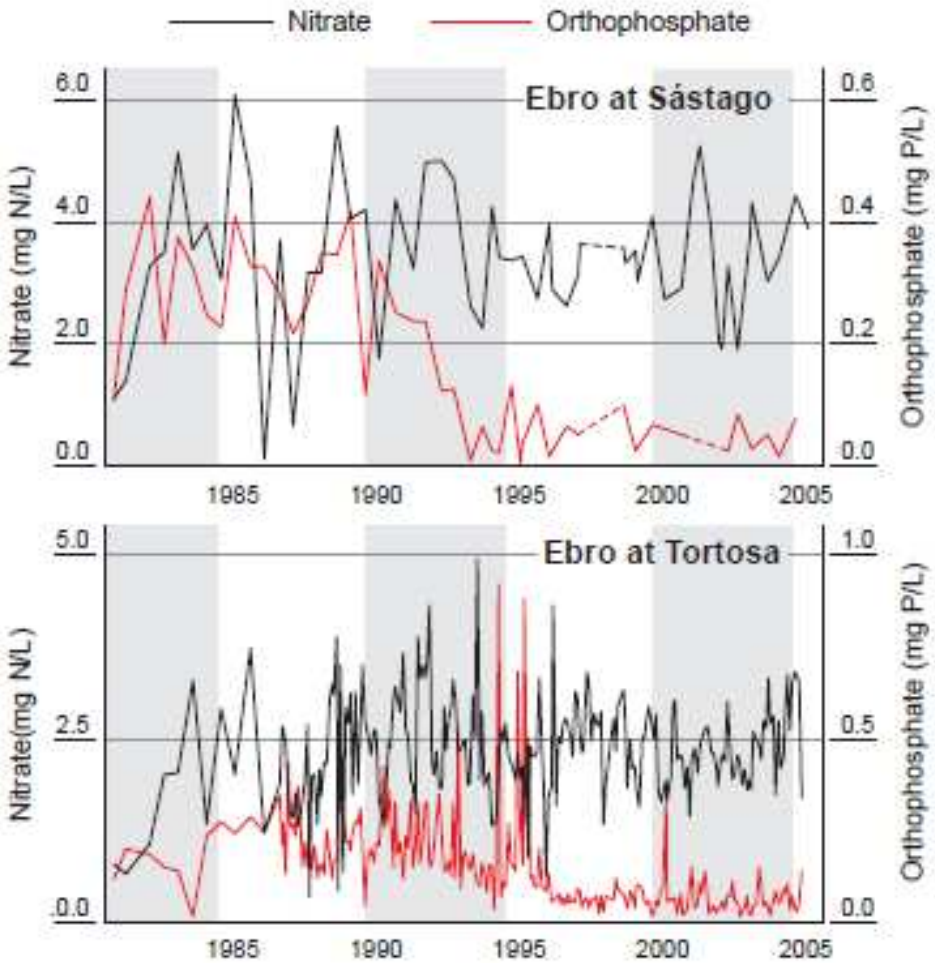
The Ebro River – P temporal dynamics



The Ebro River – nutrient temporal dynamics



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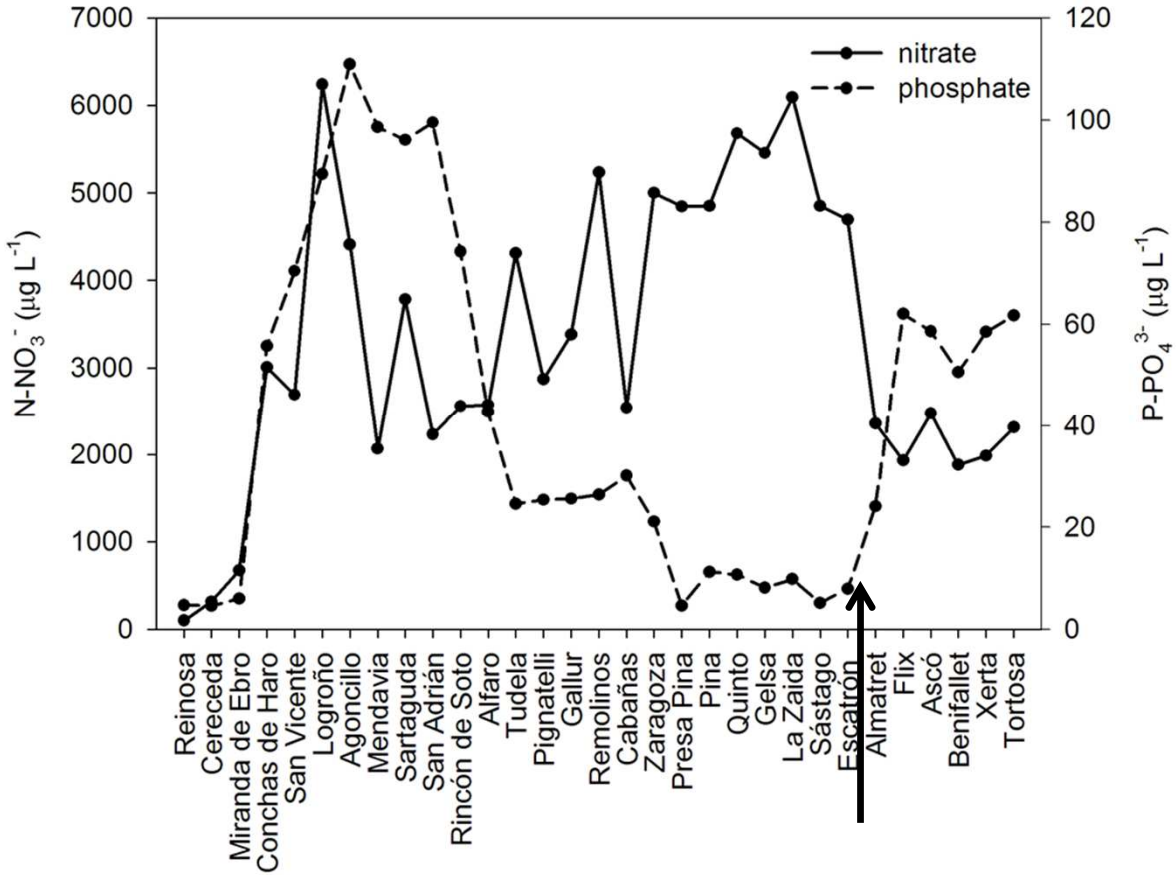
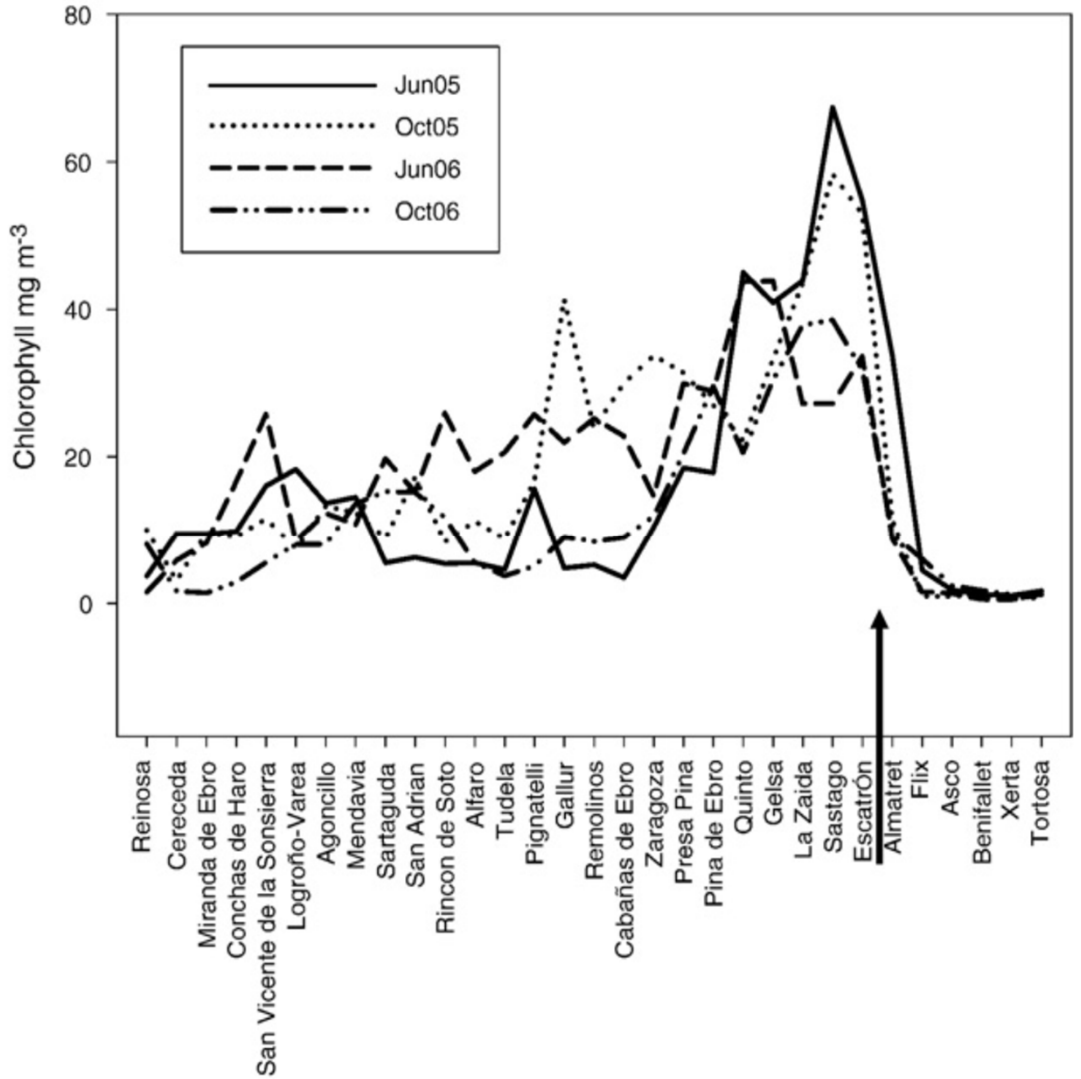
The Ebro River – nutrient longitudinal dynamics



Artigas et al. 2012- Science of the Total Environment

The Ebro River – Chl-*a* longitudinal dynamics



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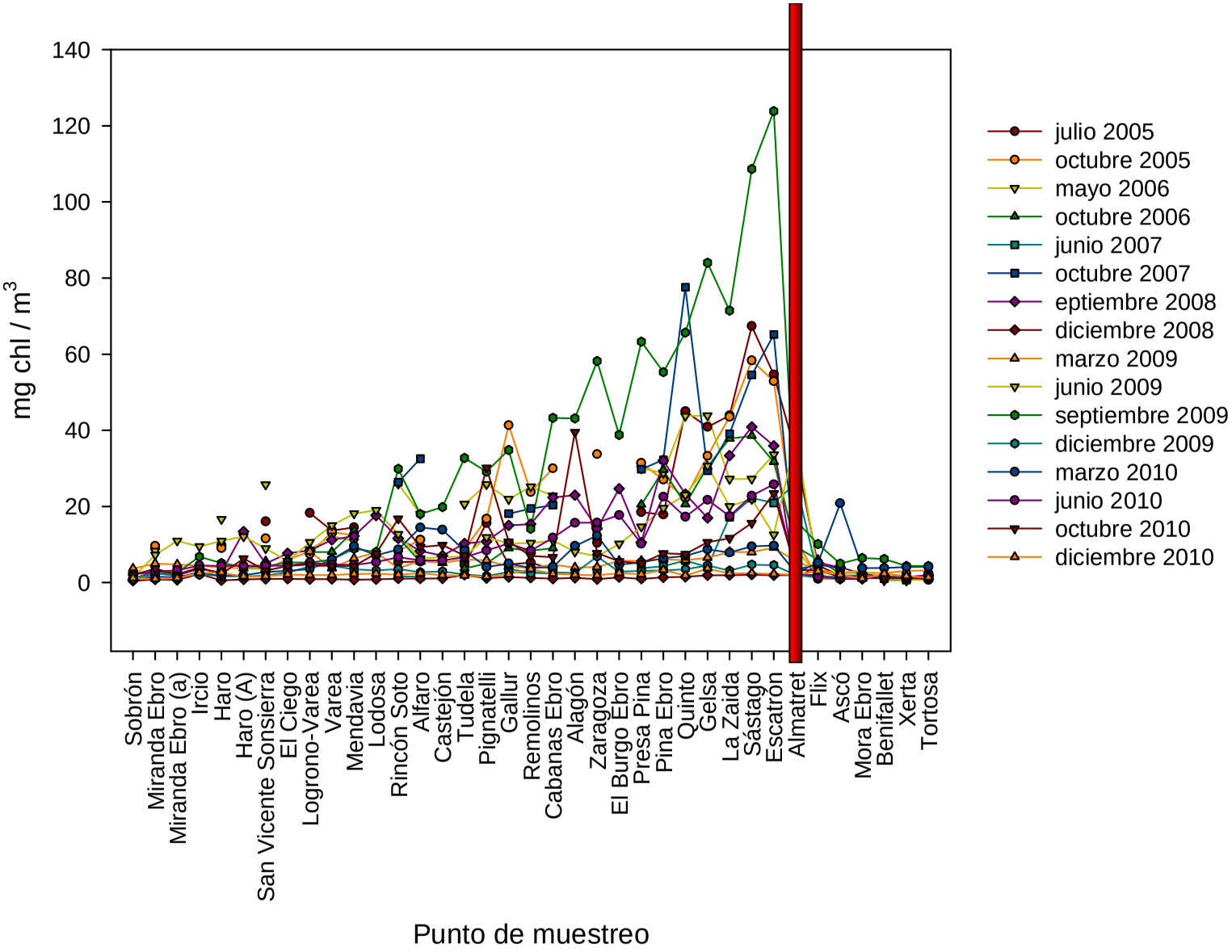
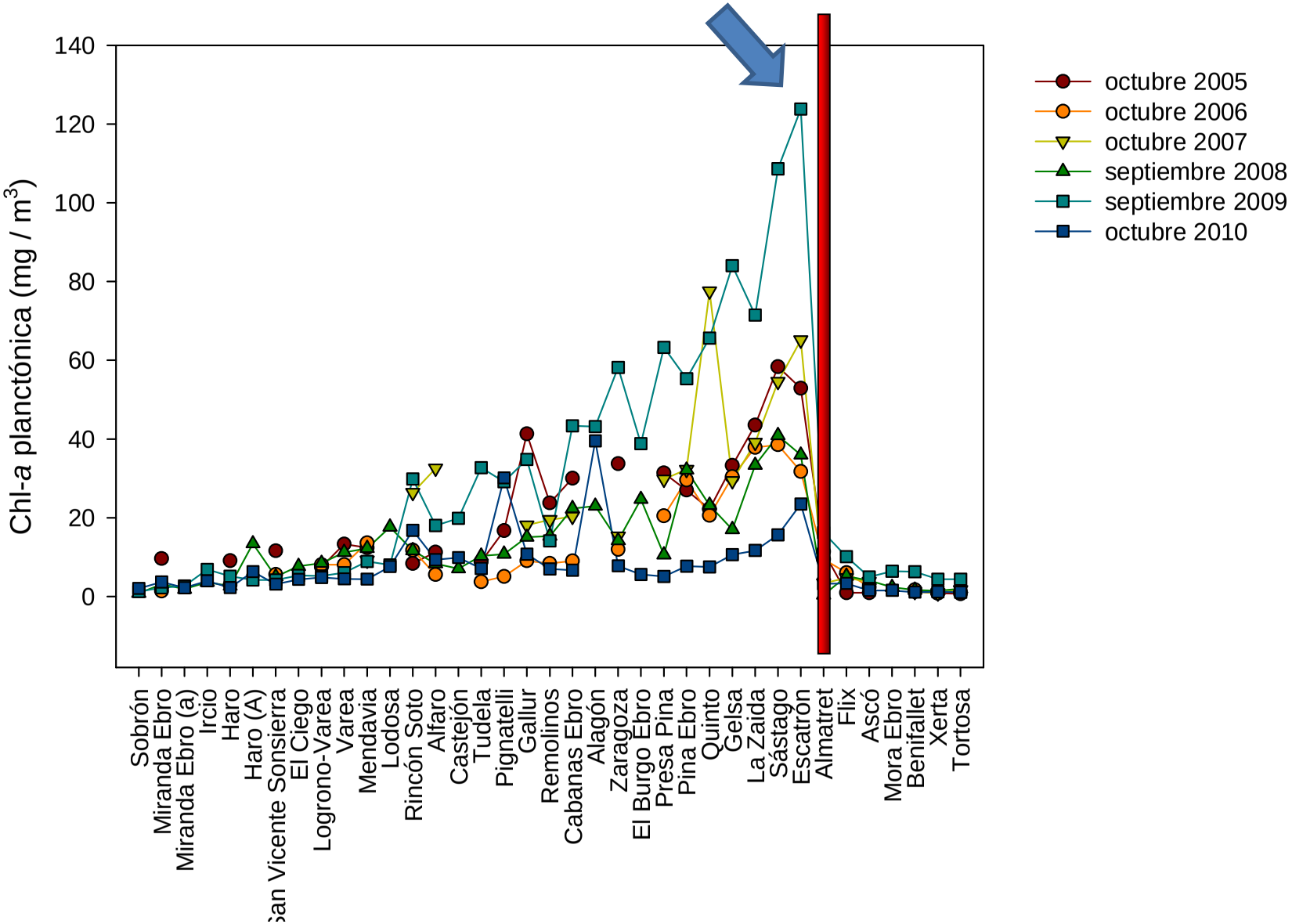
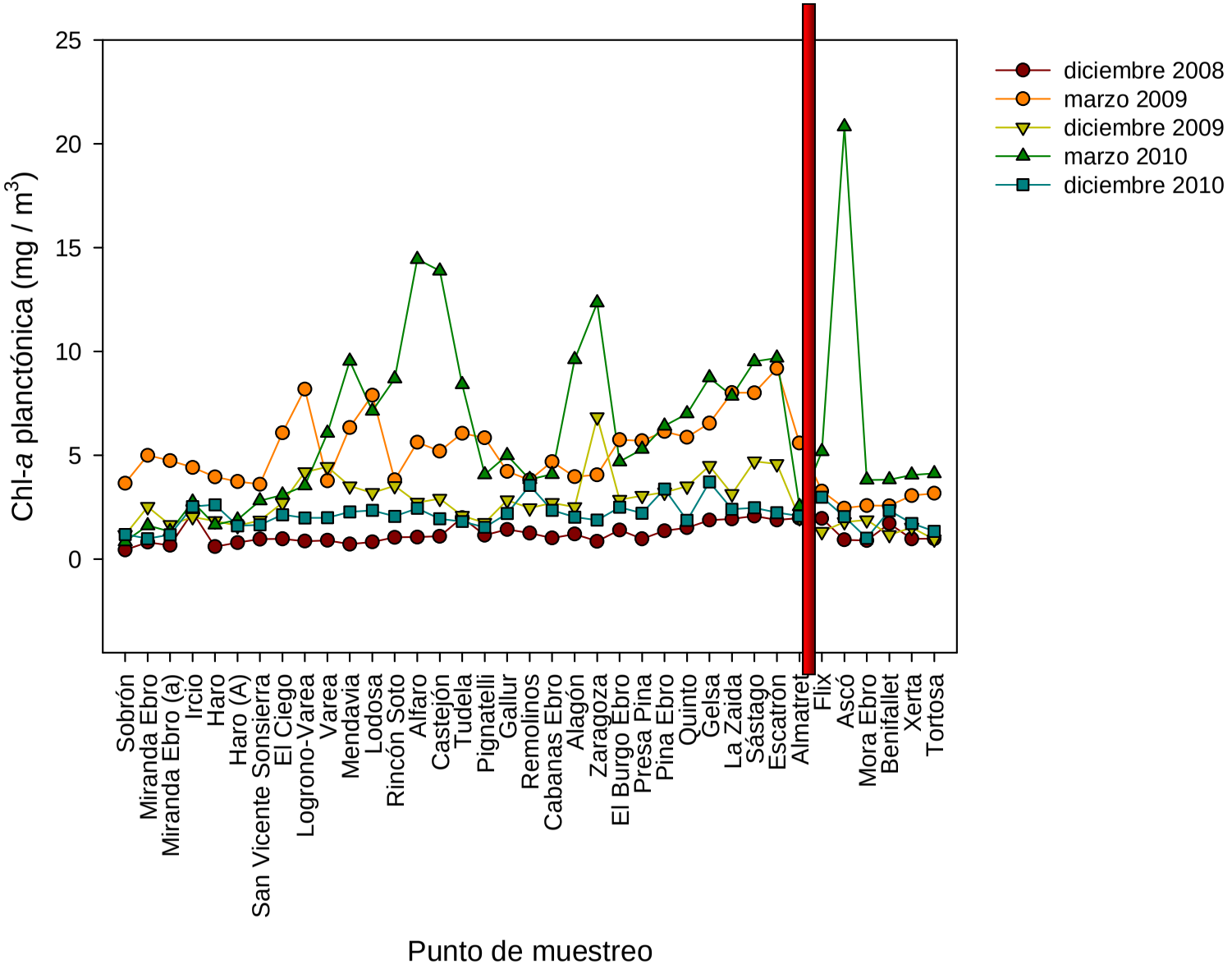
The Ebro River – Chl-*a* longitudinal dynamics



The Ebro River – Chl-*a* longitudinal dynamics in low water flows



The Ebro River – Chl-*a* longitudinal dynamics in high water flows



The Ebro River - empirical relationships

Chl = 0.39 -0.382 PRS + 0.382 COND (n= 102; r^2 =0.435, p< 0.00001)

Low water periods:

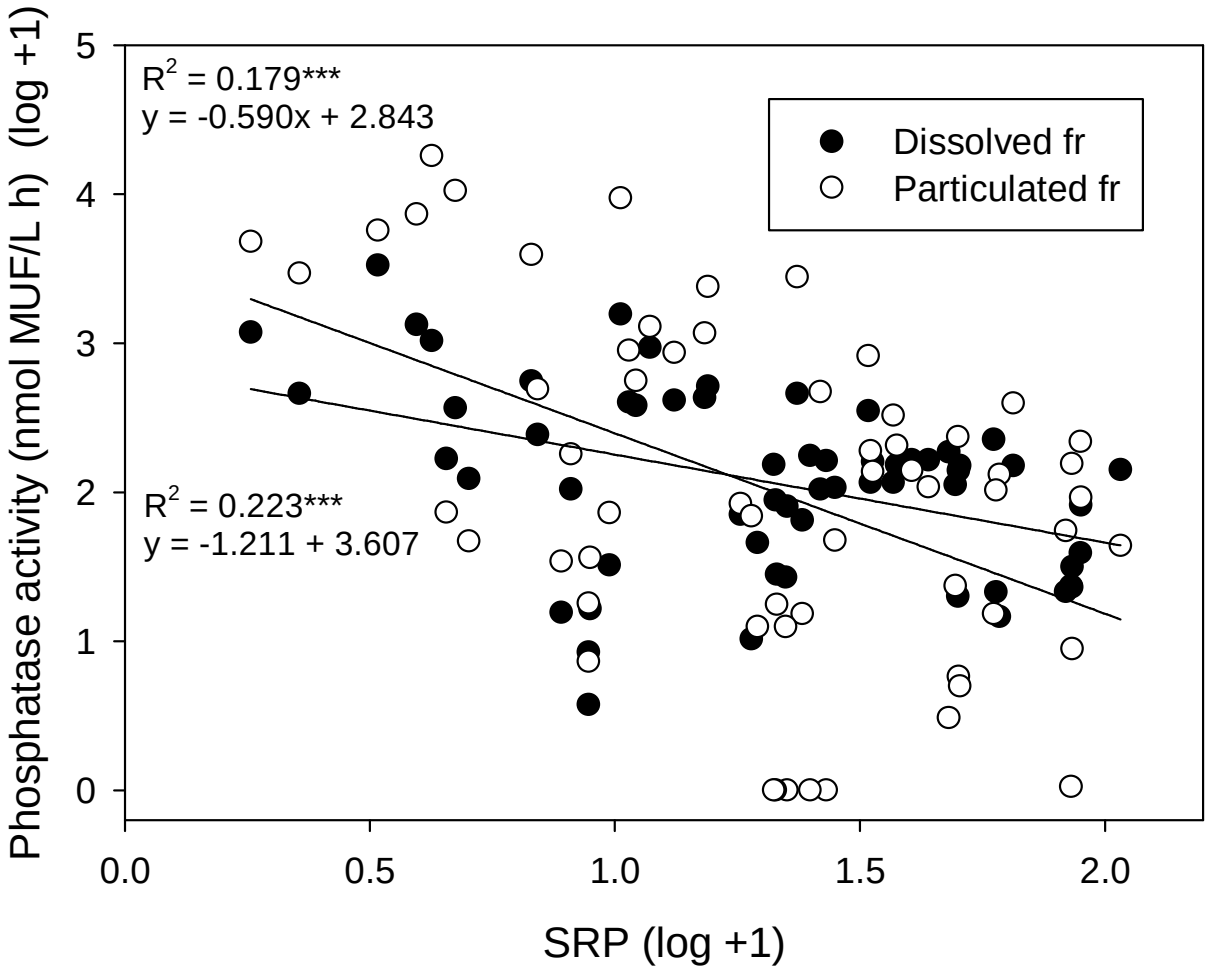
Chl = -99.89 -0.42 PRS (n= 66; r^2 =0.35, p< 0.0003)

High water periods:

Chl = -7.9 -1.3 PRS + 1.18 COND + 0.298 pH (n= 36; r^2 =0.63, p< 0.00007)

The Ebro River – AP vs SRP

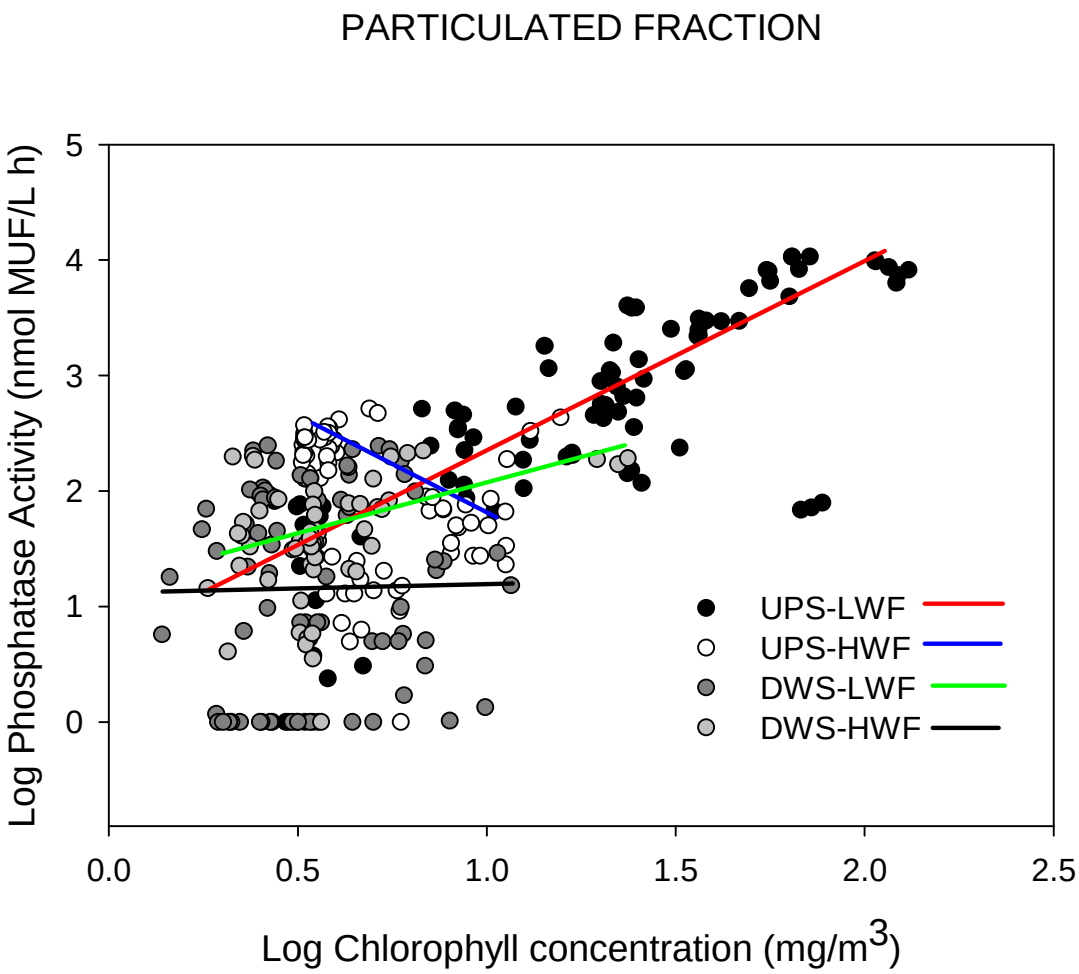
Low Water Flow (LWF)



Phosphatase activity increases with decreasing SRP content

Artigas et al. 2012- Science of the Total Environment 426

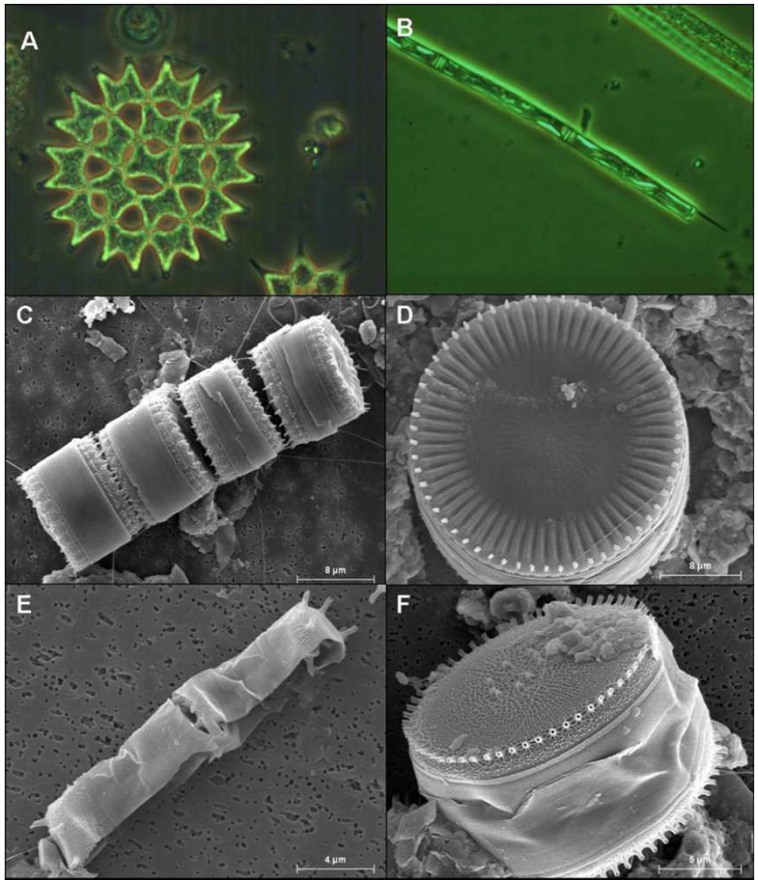
The Ebro River – AP vs Chl



Phosphatase activity increases with chl concentration- particularly during LWF and UPS

Artigas et al. 2012- Science of the Total Environment 426

The Ebro River – shifting to macrophytes growth



Present data of planktonic chlorophyll in the lower part of the Ebro:

2 - 15 mg m^{-3}

Historical data (1989-90) of planktonic chlorophyll in the lower part of the Ebro (Sabater and Muñoz 1990):

20 - 45 mg m^{-3} in low water flows

5 -12 mg m^{-3} in high water flows

The lower Ebro River – shifting to macrophytes growth

The lower Ebro River – shifting to macrophytes growth

Deep hydrosedimentary
(and biological) changes
in the river downstream

The lower Ebro River – shifting to macrophytes growth

The lower Ebro River – shifting to macrophytes growth

Mass growths of blackflies (Simuliidae) at the lower Ebro

The Ebro River – summarizing figures

Surface Area 85660 Km^2 (17.3% of Spain)

Present irrigation surface area 965,000 Ha

Planned irrigation surface area 1,065,000 Ha

Present water demand (total) 7,680 Hm^3

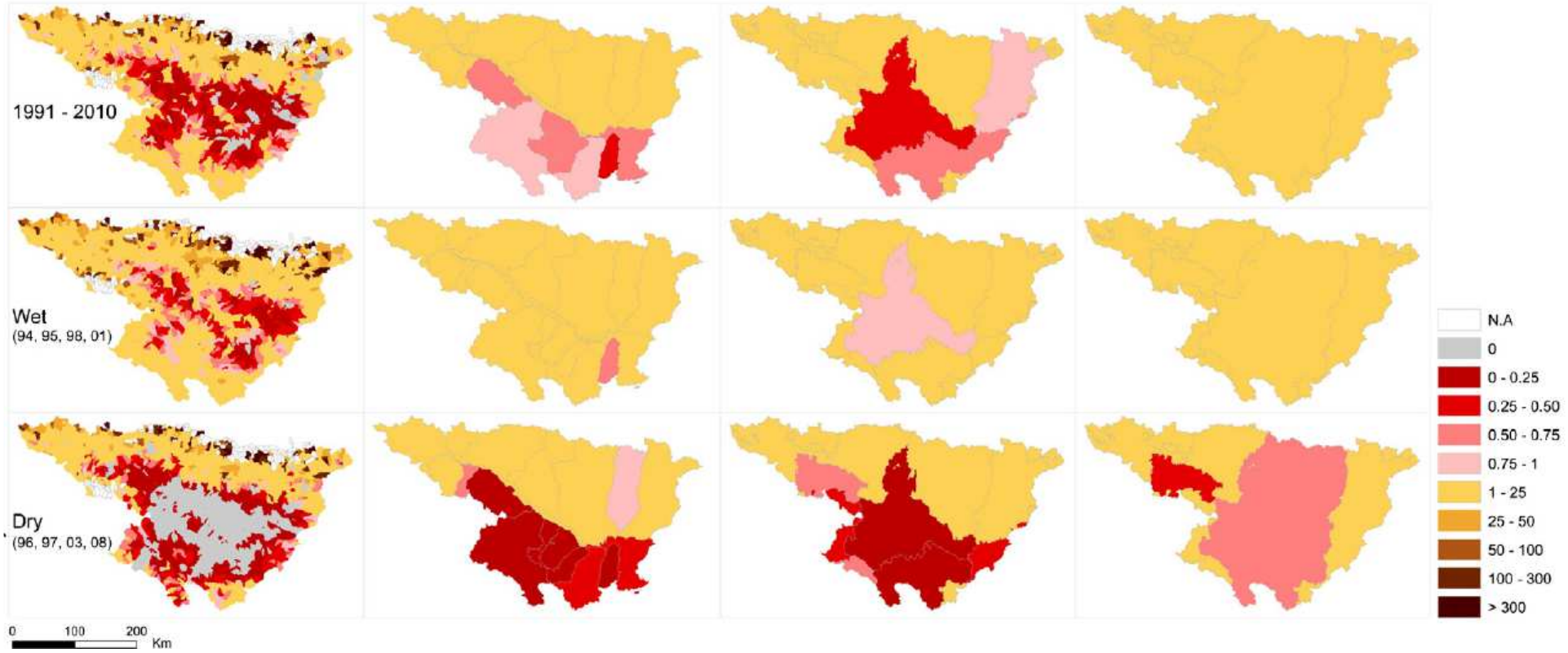
Planned water demand (total) 8,386 Hm^3

Total Discharge 18,217 (8,402- 24,019) Hm^3

Foreseen discharge decrease by 12-17% by 2040

CHE, several sources

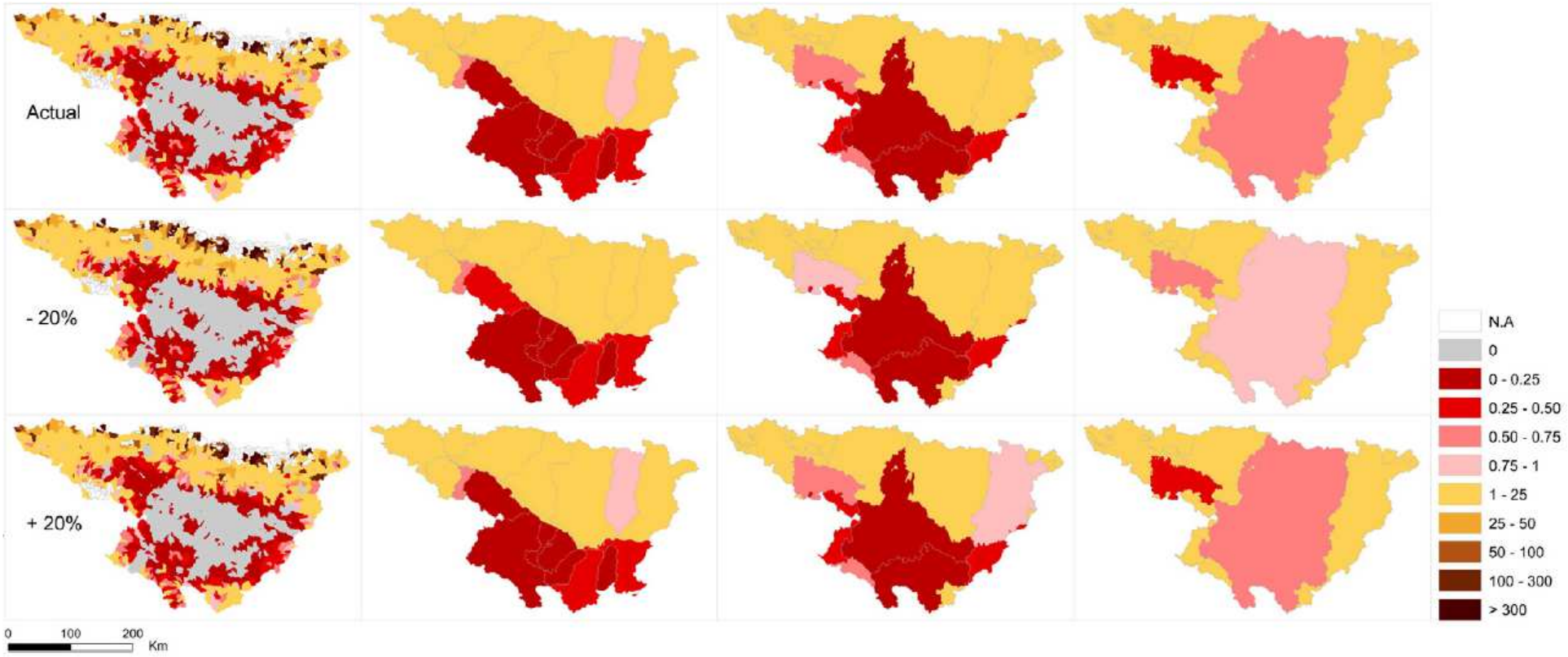
The Ebro River – impact of climate on water resources



Ebro basin supply-to-demand S:D ratio changes at 4 spatial scales for 3 precipitation scenarios: (a) average annual precipitation from 1991 to 2010; (b) average annual precipitation for the wettest years (94, 95, 98, 01); and (c) average annual precipitation for the driest years (96, 97, 03, 08).

Boithias et al- 2014. Science of the Total Environment

The Ebro River – impact of land uses on water resources



Ebro basin supply-to-demand S:D ratio changes at 4 spatial scales for 3 irrigated area scenarios: (a) actual irrigated area; (b) actual irrigated area reduced by 20%; and (c) actual irrigated area increased by 20%.

Boithias et al- 2014. Science of the Total Environment

Concluding remarks

- ***Water scarcity is a driver for eutrophic conditions in intensively managed rivers (promotion of lower dilution and higher water stability)***
    - ***high phytoplankton growths***
    - ***potential for massive macrophyte growths***
- ***Water regulation (dams and weirs) facilitate lentification and preceed eutrophication, giving way to unpredicted scenarios***
    - ***particles sedimentation and hydraulic conditions favour macrophytes growth***
- ***Social and economic pressures may further impair eutrophic conditions***
    - ***development plans for expanding agriculture and farming may enhance water scarcity***


Merci pour votre attention!
Thanks for listening!