ENVIRONMENTAL RESTORATION OF THE LOWER EBRO RIVER AND ITS DELTA (CATALONIA, SPAIN)

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IRTA Aquatic Ecosystems

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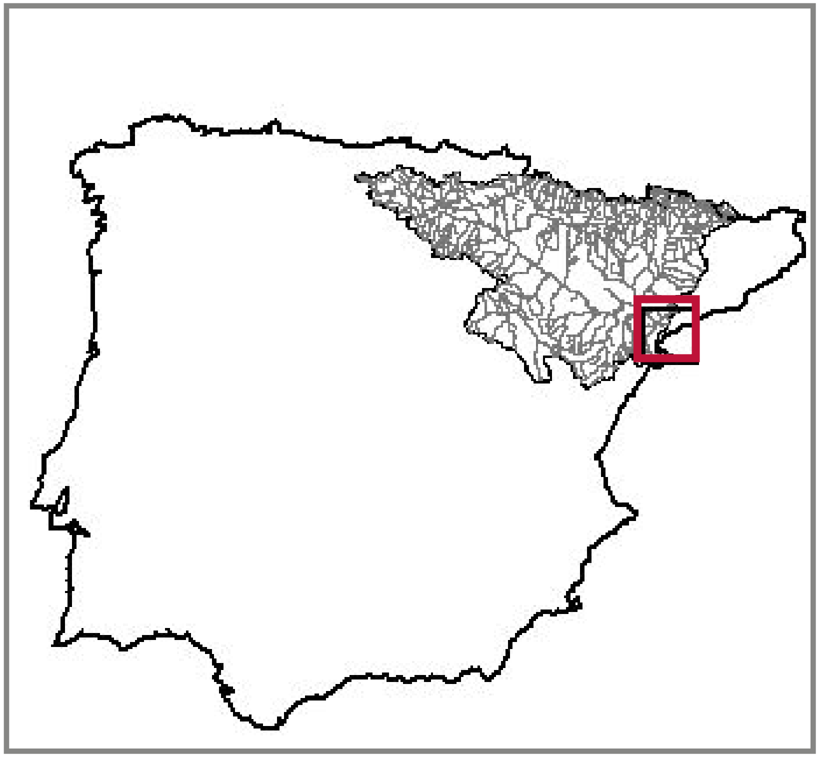
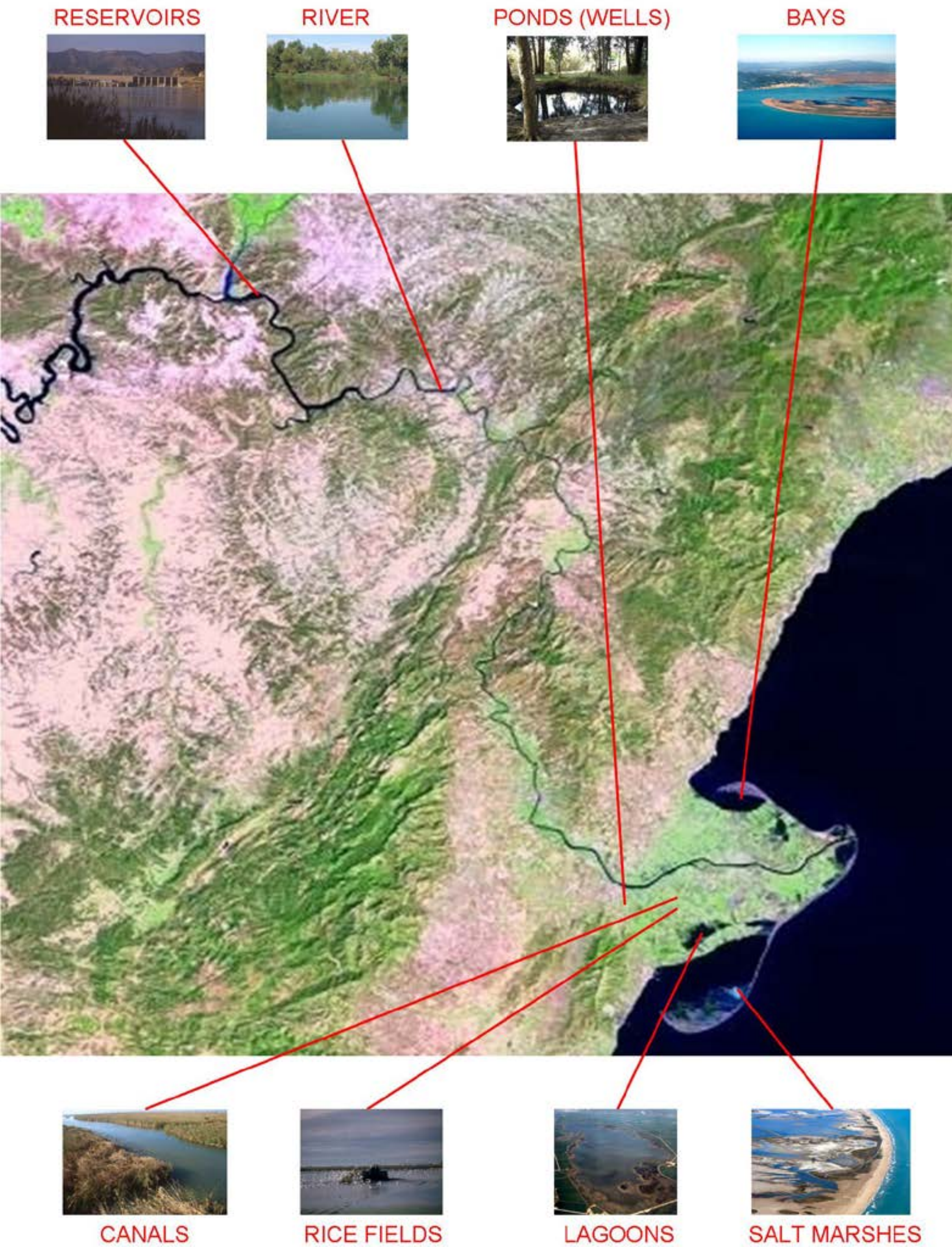
Summary

1. Recent changes in the ecological processes of the lower Ebro River (*A novel ecosystem*)
2. Effects on the biological communities
3. Possible management solutions, but…
4. Flix toxic wastes
5. Restoration actions and Environmental Indicators network

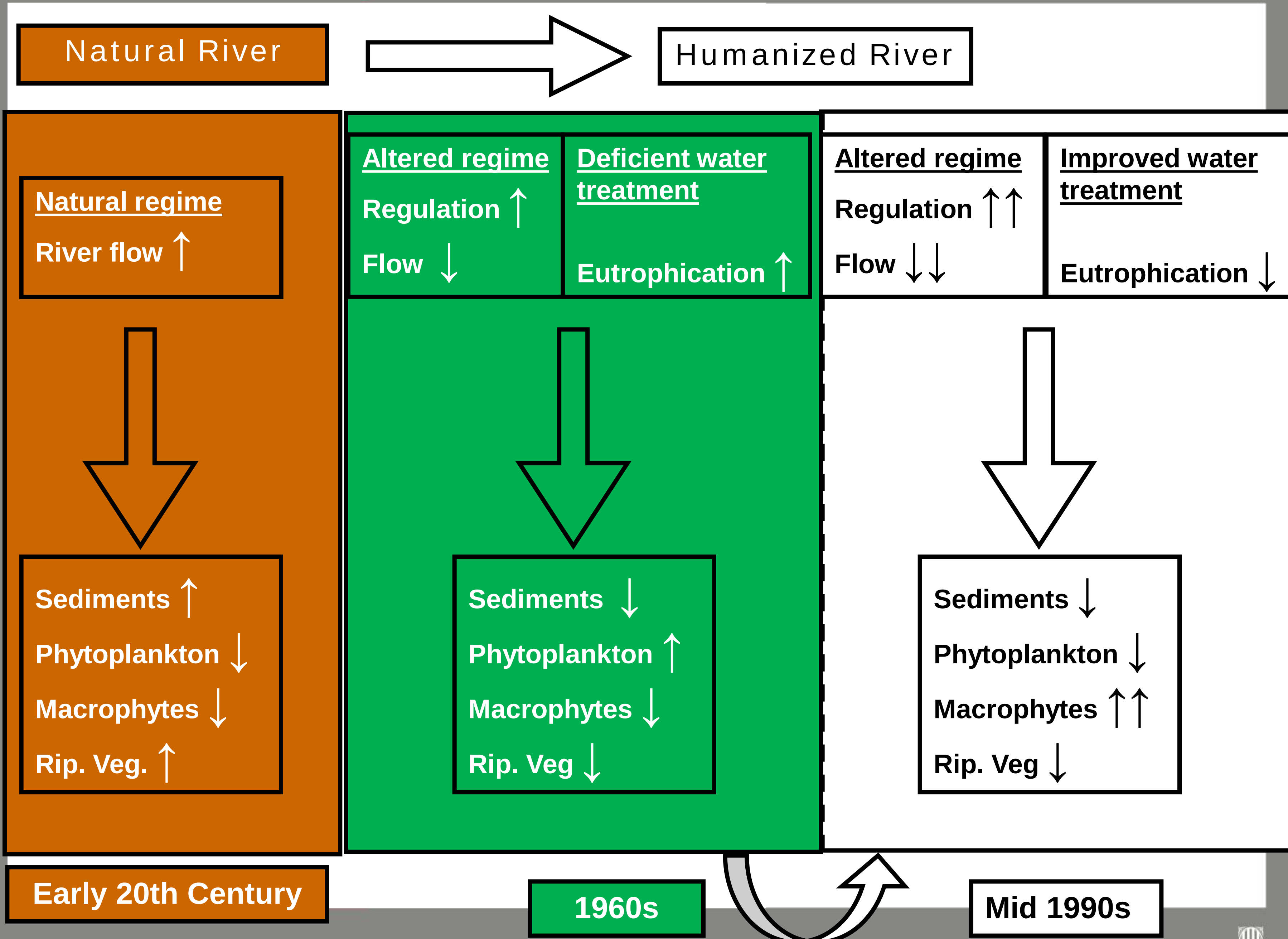
Ebro basin





Lower Ebro aquatic systems

- The Ebro is the largest river in Spain (85.000 km^2 of watershed).
- Large reservoirs (Mequinensa and Ribaroja) built in the 60's (up to 200 in the Ebro basin).
- Decreasing river flow due to intensive water uses (irrigation), from 600 m^3/s to 300 m^3/s.
- Flood plain occupation due to agriculture and margin erosion due to sediment deficit.
- High biodiversity (fish, invertebrates) endangered by invasive species.
- The Ebro delta is the second most important wetland in Spain, with 10.000 Ha of protected habitats and 20.000 Ha of rice fields.
- The last part of the river is a salt wedge estuary (tidal range of 20 cm).


Natural River
Humanized River
Natural regime
River flow ↑
Sediments ↑
Phytoplankton ↓
Macrophytes ↓
Rip. Veg. ↑
Early 20th Century
Altered regime
Regulation ↑
Flow ↓
Deficient water treatment
Eutrophication ↑
Sediments ↓
Phytoplankton ↑
Macrophytes ↓
Rip. Veg ↓
1960s
Altered regime
Regulation ↑↑
Flow ↓↓
Improved water treatment
Eutrophication ↓
Sediments ↓
Phytoplankton ↓
Macrophytes ↑↑
Rip. Veg ↓
Mid 1990s

A NOVEL ECOSYSTEM?

New conditions: low P, low discharge, low sediment concentration and alien species

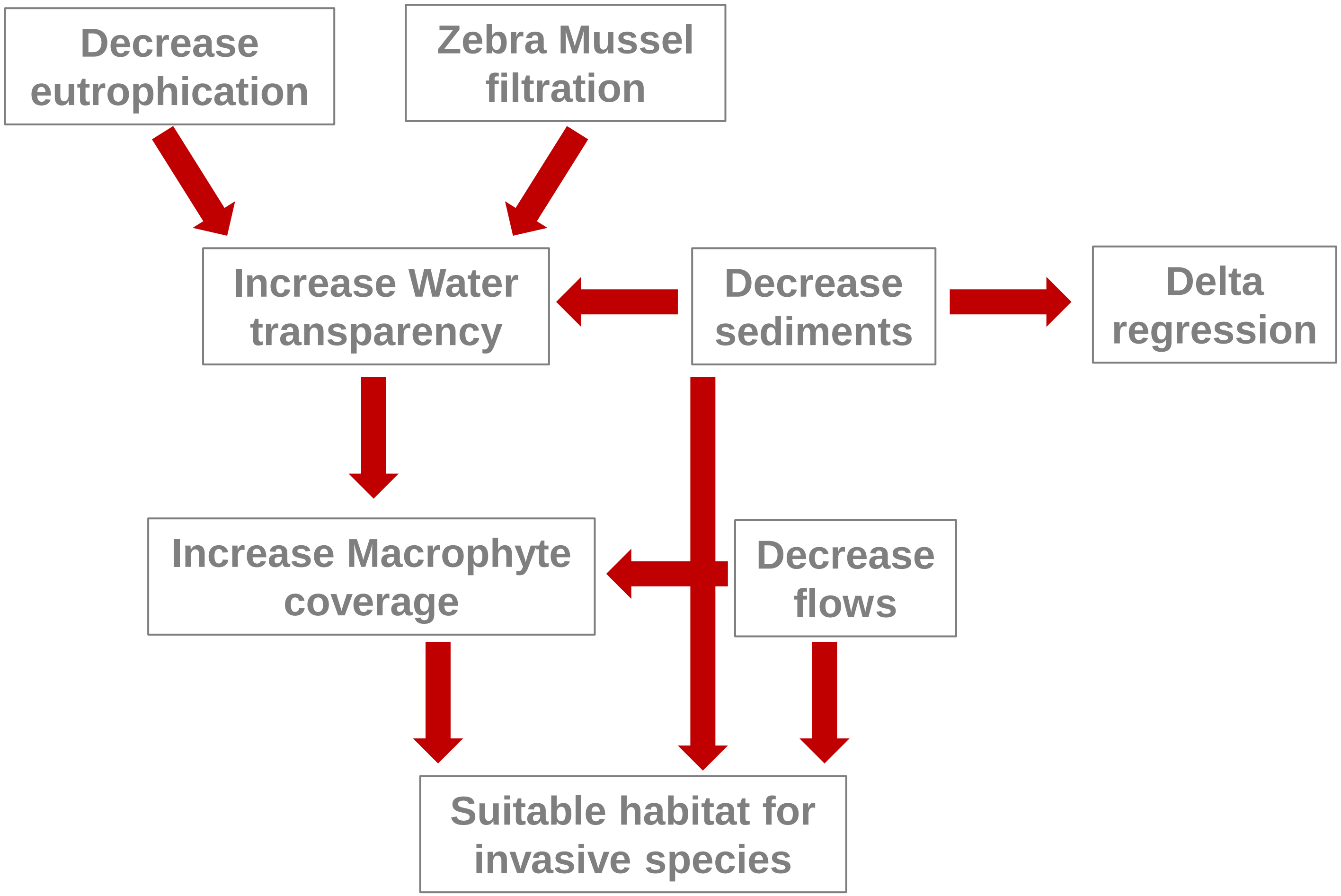
Potamogeton pectinatus

Simulium erytrhocephalum

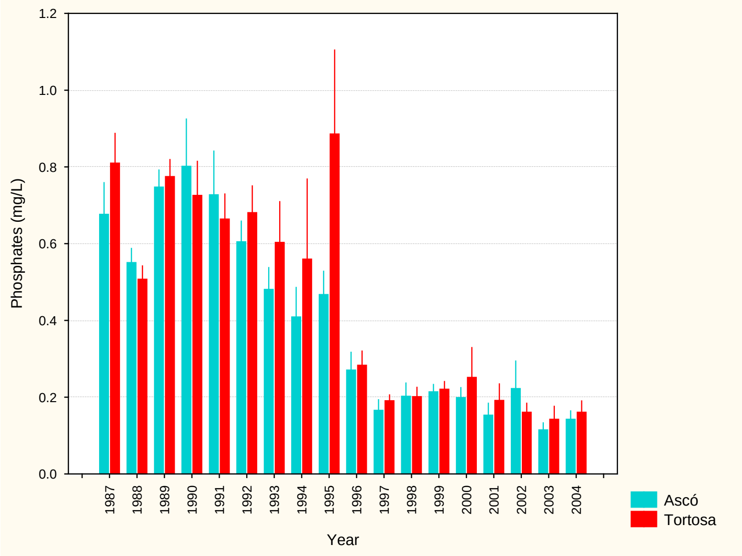
Dreissena polymorpha

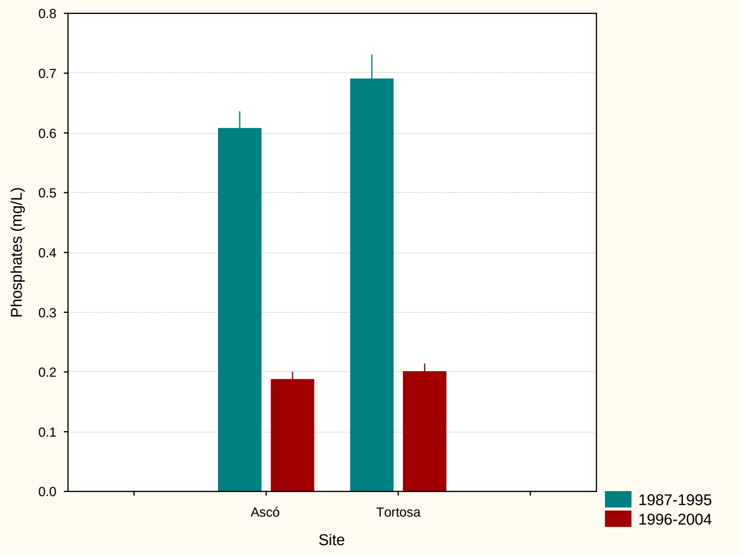
Silurus glanis

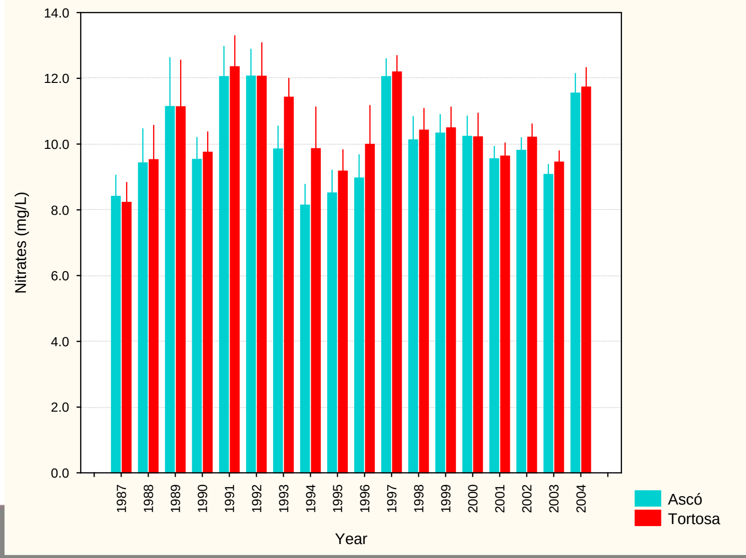
Hypothesis

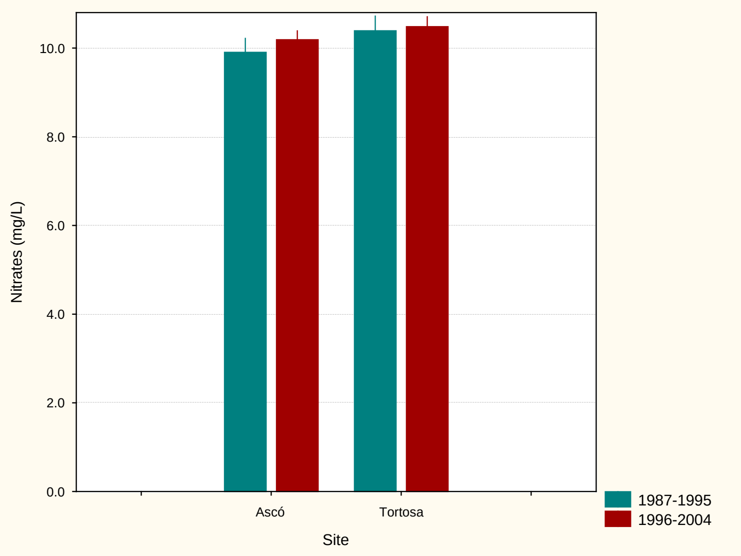

Decrease eutrophication
Zebra Mussel filtration
Increase Water transparency
Decrease sediments
Delta regression
Increase Macrophyte coverage
Decrease flows
Suitable habitat for invasive species

Dissolved P And N

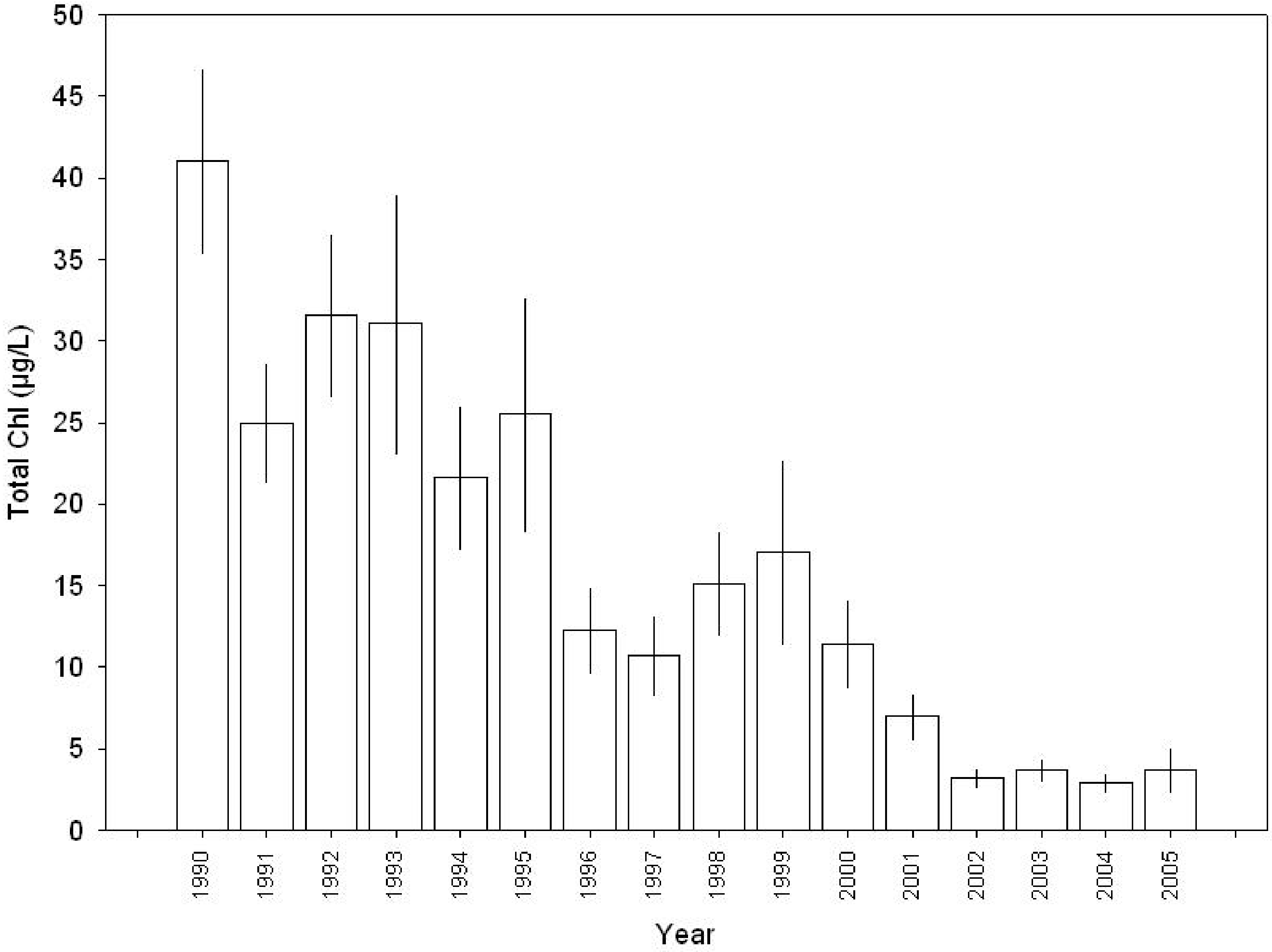




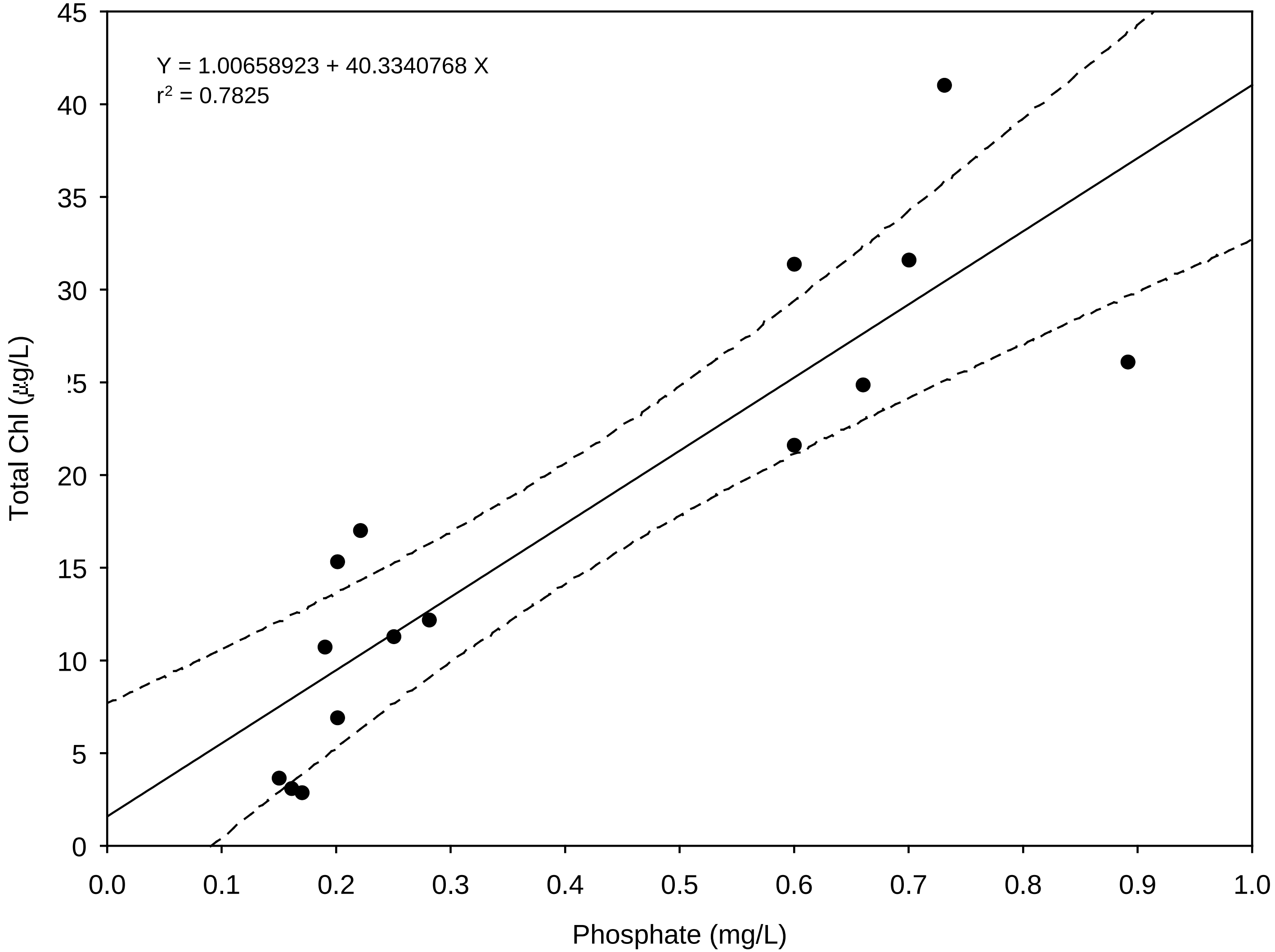




Chlorophyll trends

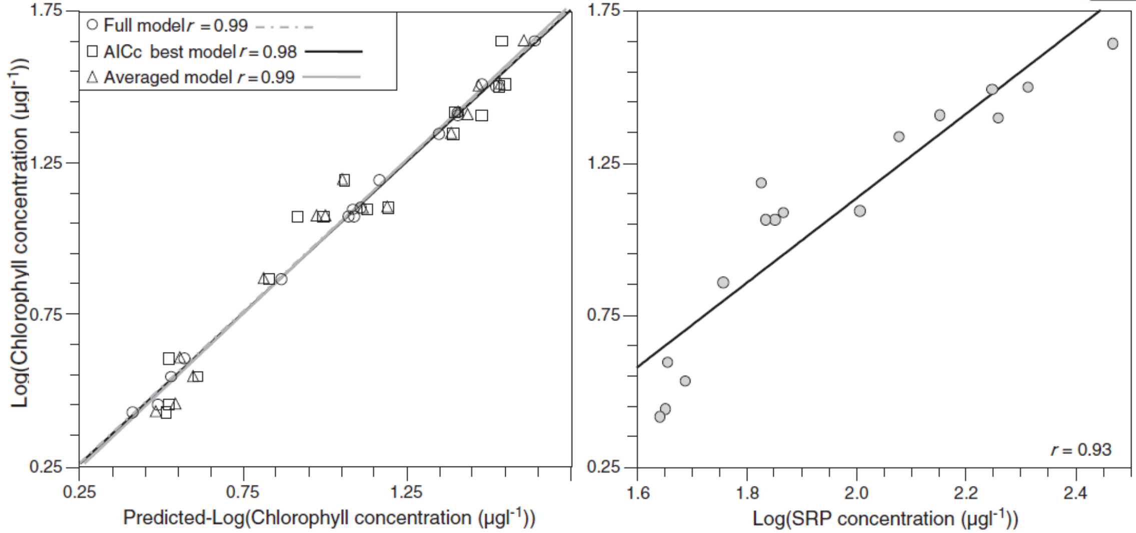


Chlorophyll versus Phosphorus



Relationship between chlorophyl and environmental descritors

Model parameter	Annual model $N = 25$		
	β	SP	Bias
Intercept	– 3.777		2.472
Period	– 0.108	0.037	– 0.656
Mean flow ($m^3 s^{-1}$)	– 0.215	0.008	– 2.395
SRP ($\mu g\ l^{-1}$)	0.961	0.989	0.252
N–NO^2 ($\mu g\ l^{-1}$)	1.629	0.485	0.019
N–NO^3 ($\mu g\ l^{-1}$)	0.796	0.023	0.666
N–NH^4 ($\mu g\ l^{-1}$)	– 0.401	0.373	0.549
TOC ($\mu g\ l^{-1}$)	1.067	0.301	2.136
Silicate ($\mu g\ l^{-1}$)	– 0.505	0.145	0.036
TSS ($mg\ l^{-1}$)	0.529	0.787	– 0.326
Water Tª (ºC)	1.655	0.047	1.609
Cond. (μScm^{-1} 20ºC)	– 1.147	0.289	– 0.672
Zebra mussel(ind m^{-2})	– 0.073	0.071	0.498



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Science of the Total Environment

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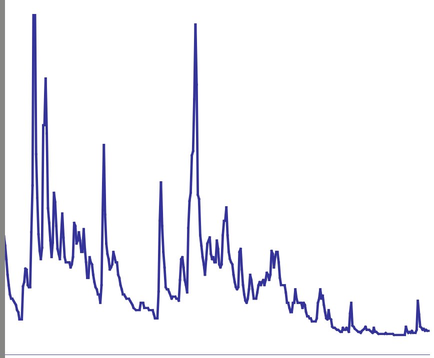
Regime shift from phytoplankton to macrophyte dominance in a large river: Top-down versus bottom-up effects

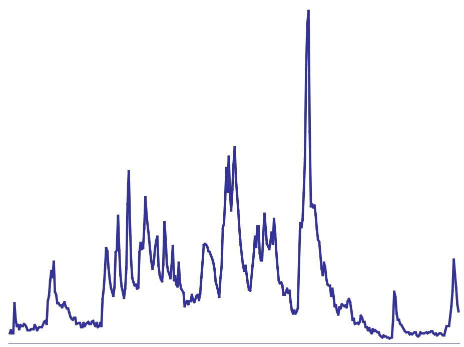
Carles Ibáñez [a,*], Carles Alcaraz [a], Nuno Caiola [a], Albert Rovira [a], Rosa Trobajo [a], Miguel Alonso [b], Concha Duran [c], Pere J. Jiménez [d], Antoni Munné [e], Narcís Prat [f]

River discharge and sediment load changes

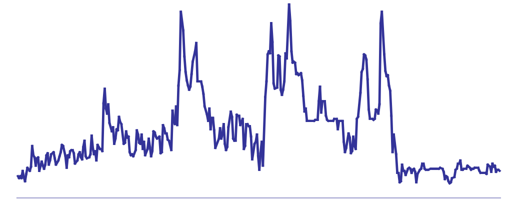
DECADA 1920



DECADA 1950

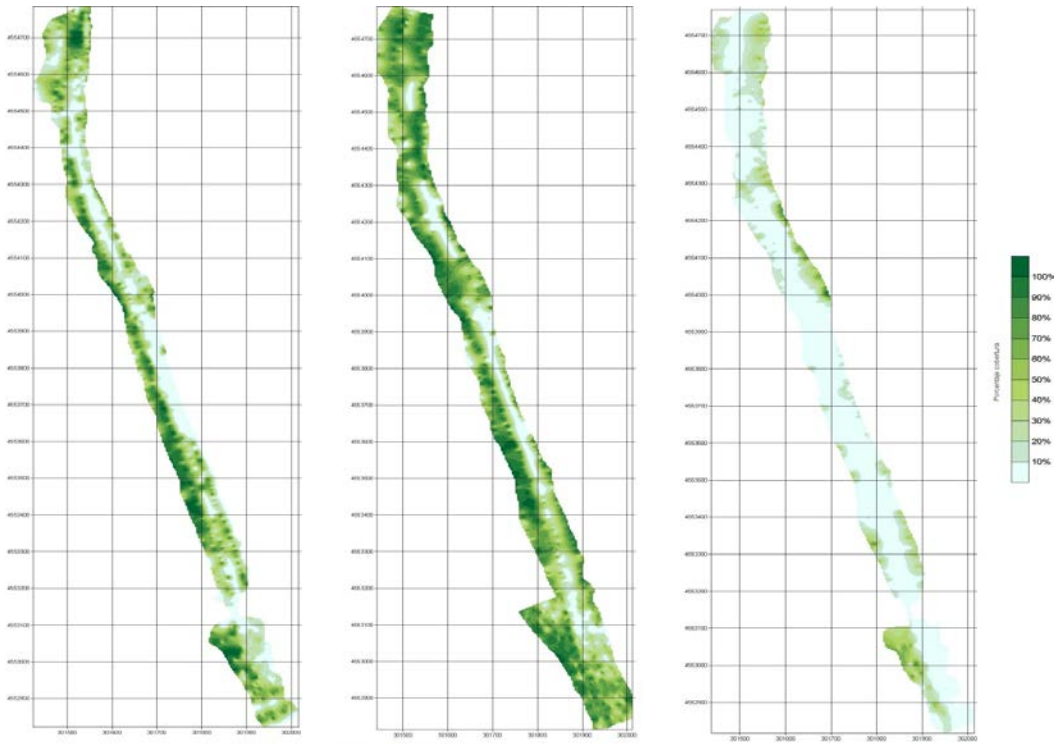


DECADA 1980



Year	Impoundment capacity (Km^3)	Sediment yield (milions t/a)	Data source
1877	0	30	Gorría (1877)
1964	3,45	8,7	Varela et al. (1986)
1976-1982	6.24	0,32	Varela et al. (1986)
1976-1990	6.24	0,26	Sanz et al.(1999)
1983-1986	6.28	0,15	Palanques (1987)
1986-1987	6.28	0,13	Muñoz (1990)
1988-1990	6.28	0,12	Guillén & Palanques (1992)
1998-1999	6.28	0,30	Roura (2004)
2002-2003	6.50	0,26	Vericat & Batalla (2006)
2003-2004	7.64	0,29	Vericat & Batalla (2006)

Macrophyte coverage



Science of the Total Environment 440 (2012) 132–139

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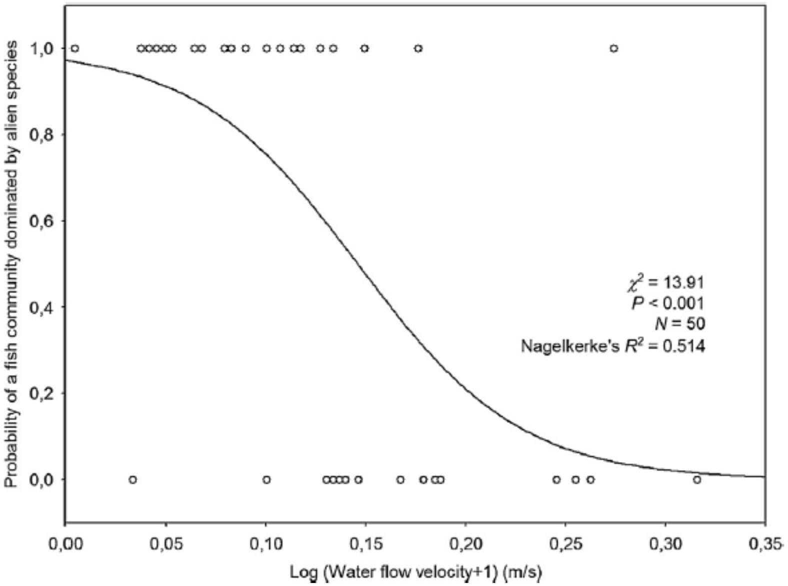
Monitoring the effects of floods on submerged macrophytes in a large river

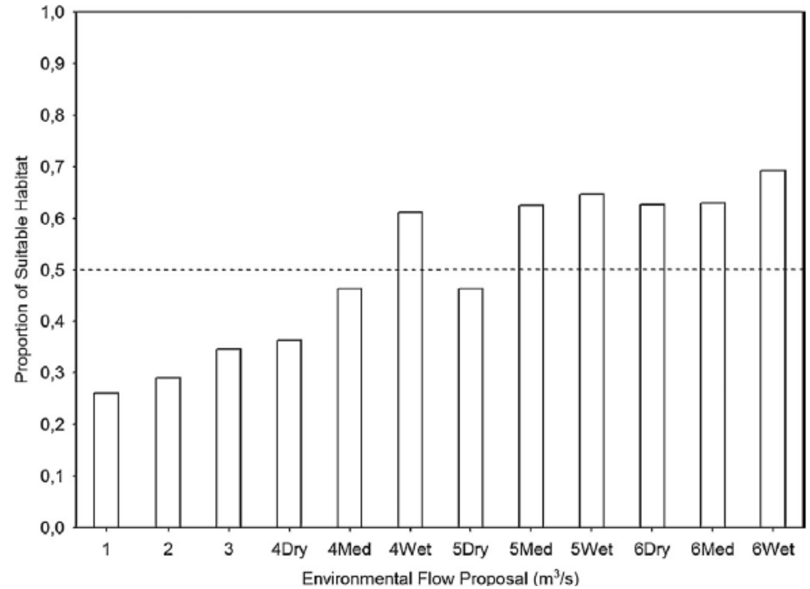
Carles Ibáñez [a,*], Nuno Caiola [a], Albert Rovira [a], Montserrat Real [b]

The Spanish and Catalan administrations know that the Ebro River flows is a key issue

Proposal code	Data source	Time series	Hydrological year type	Hydrological method	Mean annual flow (m^3/s)
1	River flow in Tortosa	1953–1964	All	QBM	89
2	River flow in Tortosa	No information	All	No information	100
3	Sacramento	1986–1998	All	QBM	122
4Dry	SIMPA1	1985–2006	Dry	RVA_{NGPRP}	131
4Med	SIMPA1	1985–2006	Medium	RVA_{NGPRP}	187
4Wet	SIMPA1	1985–2006	Wet	RVA_{NGPRP}	266
5Dry	SIMPA2	1985–2006	Dry	RVA_{NGPRP}	188
5Med	SIMPA2	1985–2006	Medium	RVA_{NGPRP}	248
5Wet	SIMPA2	1985–2006	Wet	RVA_{NGPRP}	336
6Dry	Sacramento	1940–1985	Dry	RVA_{NGPRP}	227
6Med	Sacramento	1940–1985	Medium	RVA_{NGPRP}	302
6Wet	Sacramento	1940–1985	Wet	RVA_{NGPRP}	398

Biological validation of “environmental” flows





Ecological Indicators 45 (2014) 598–604

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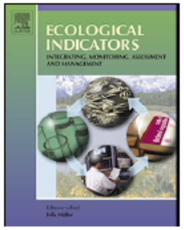


Effects of flow regulation on the establishment of alien fish species: A community structure approach to biological validation of environmental flows

CrossMark

Nuno Caiola [a,*], Carles Ibáñez [a], Joan Verdú [b], Antoni Munné [b]

IRTA

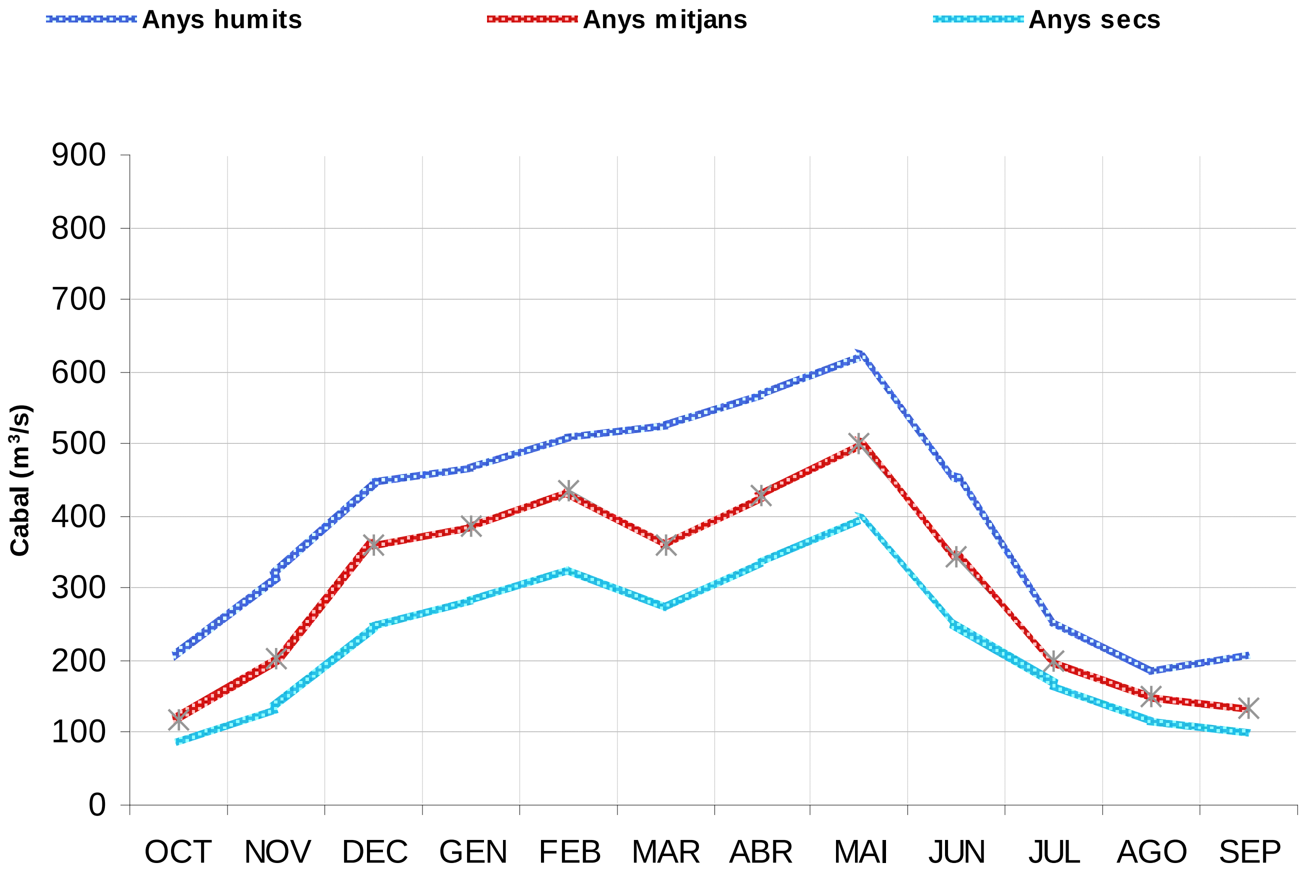
Conclusions and Management Options

1. Maintain the management criteria regarding nutrient load.

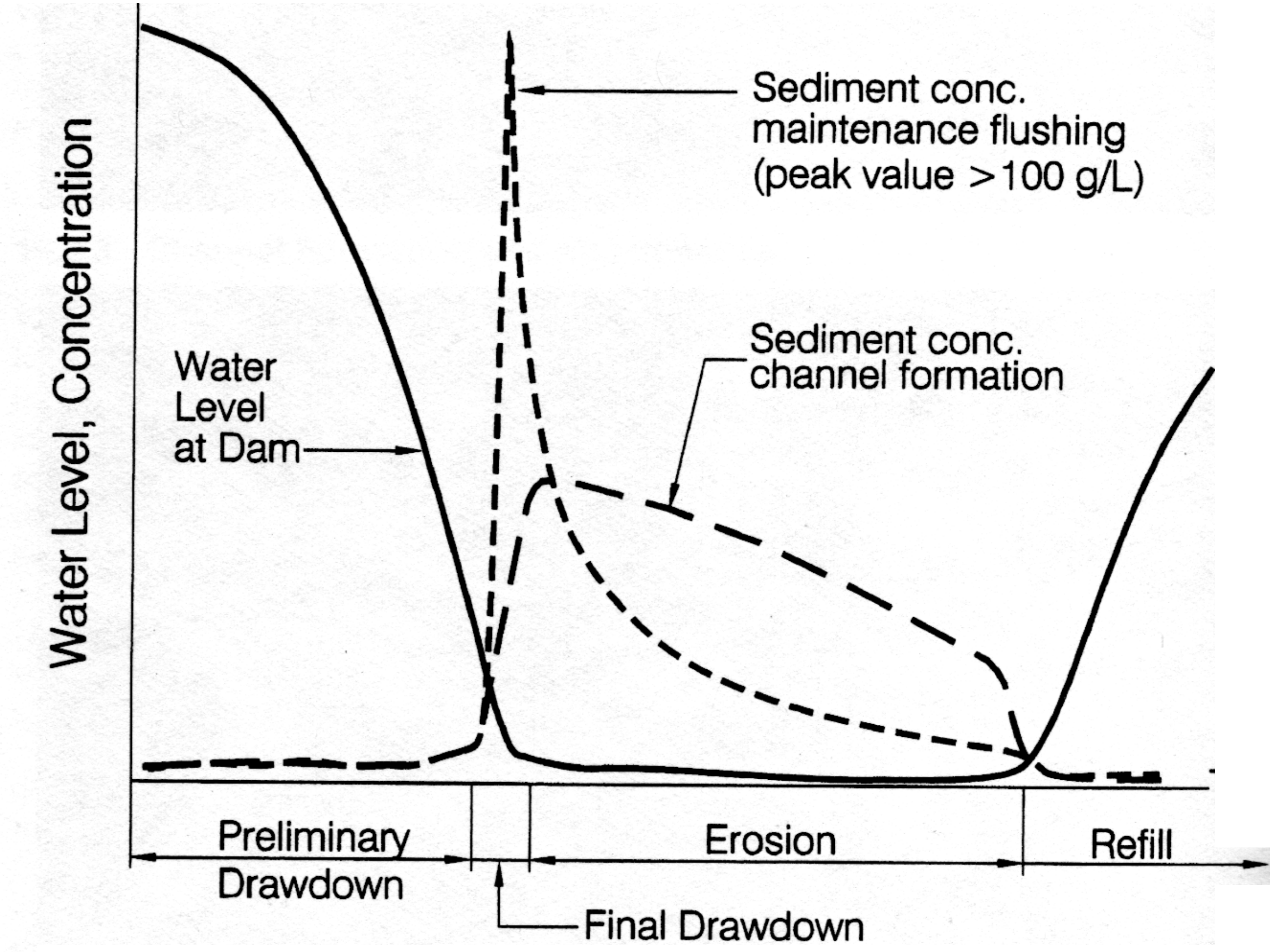
2. Establish an environmental flows regime in order to recover the good ecological status in the lower Ebro River

3. Mobilize the trapped sediments in the dams to restore the sediment load

Environmental flows proposal

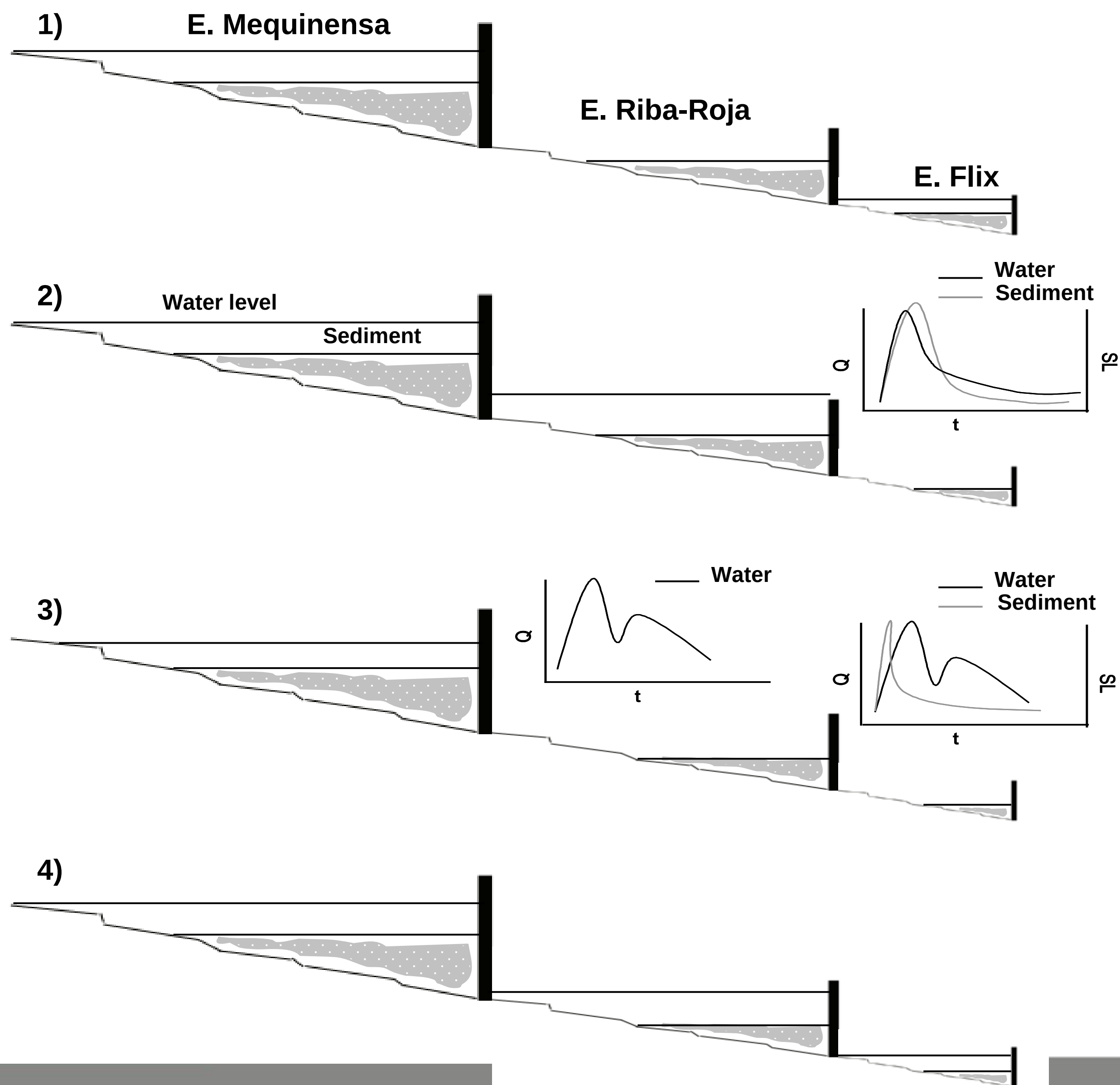


Flushing general proceedings:



From: Morris & Fan (1998)

Flushing Procedures in the lower Ebro river

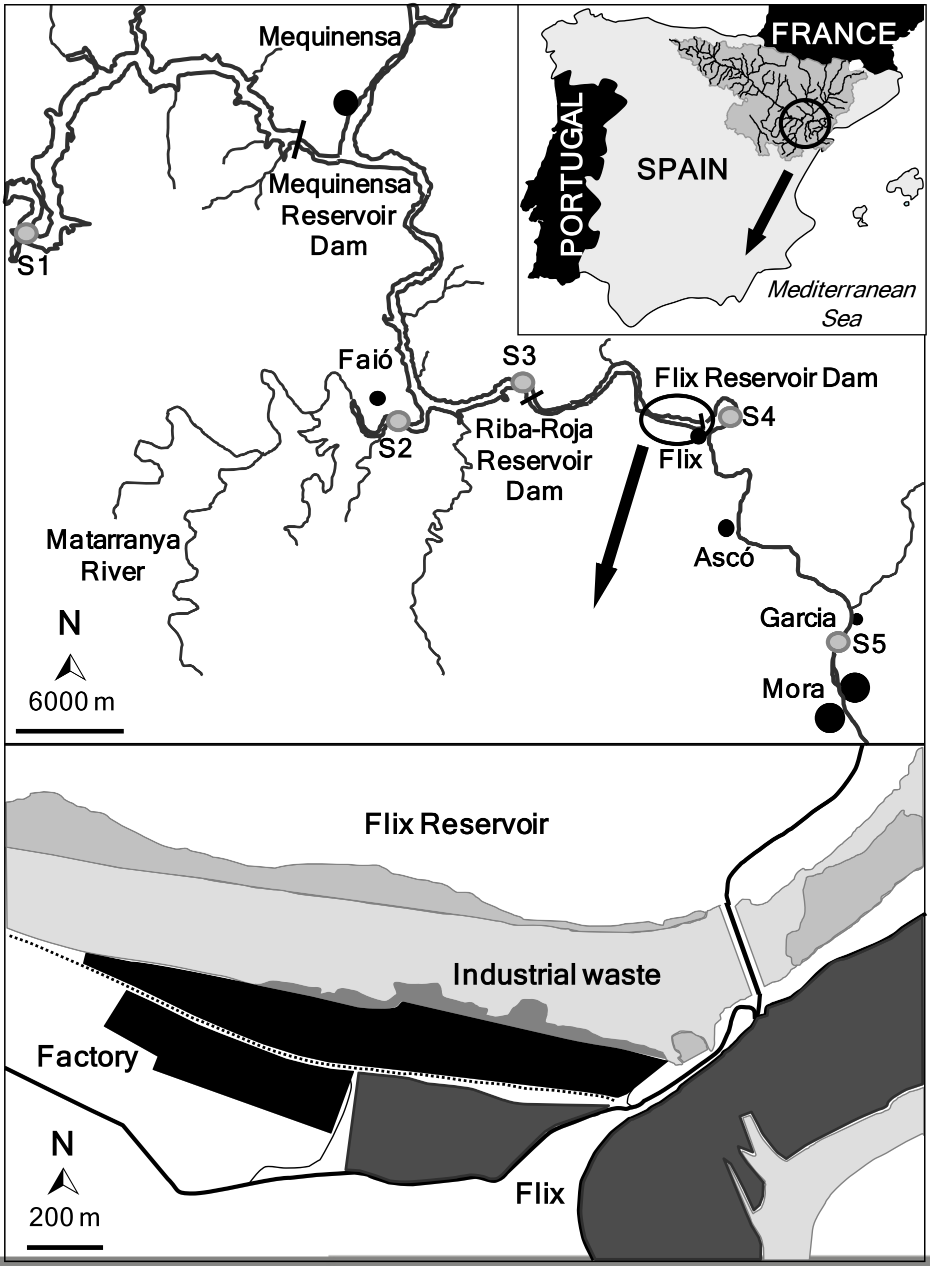


Flix Dam

1. Approximately 3 × 10^5 tons of contaminated sediments

2. Sediments are mobilized with flows above 400 m^3/s

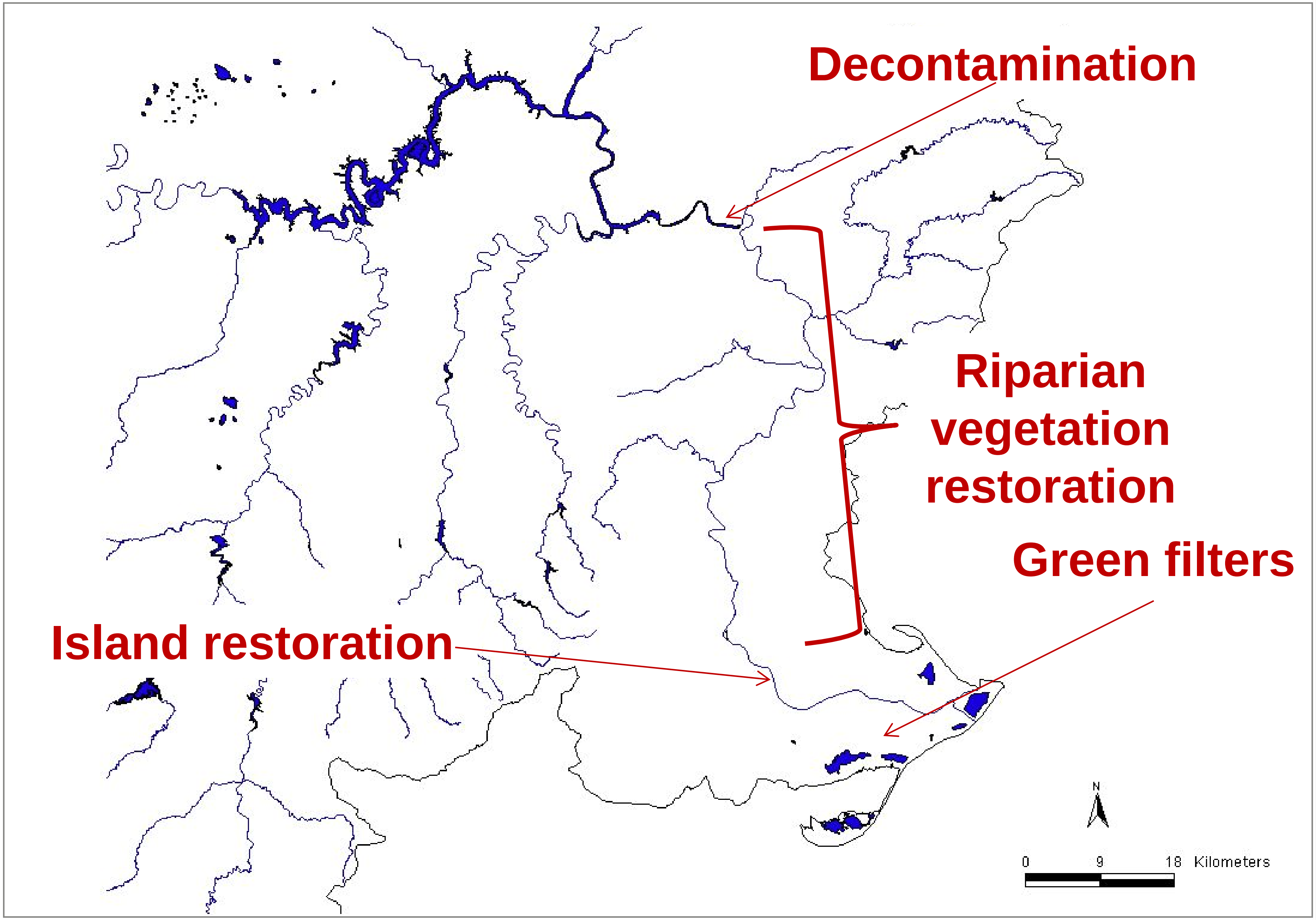
3. Moreover, contaminants such as heavy metals are probably in the trophic network, downriver the chlor-alkali plant



How to solve the problem

1. Accept and face it
2. Political will
3. Budget

1. Spanish government paid for studies
2. Restoration actions - 200 M EUR (260 M USD)
3. Environmental Monitoring Network

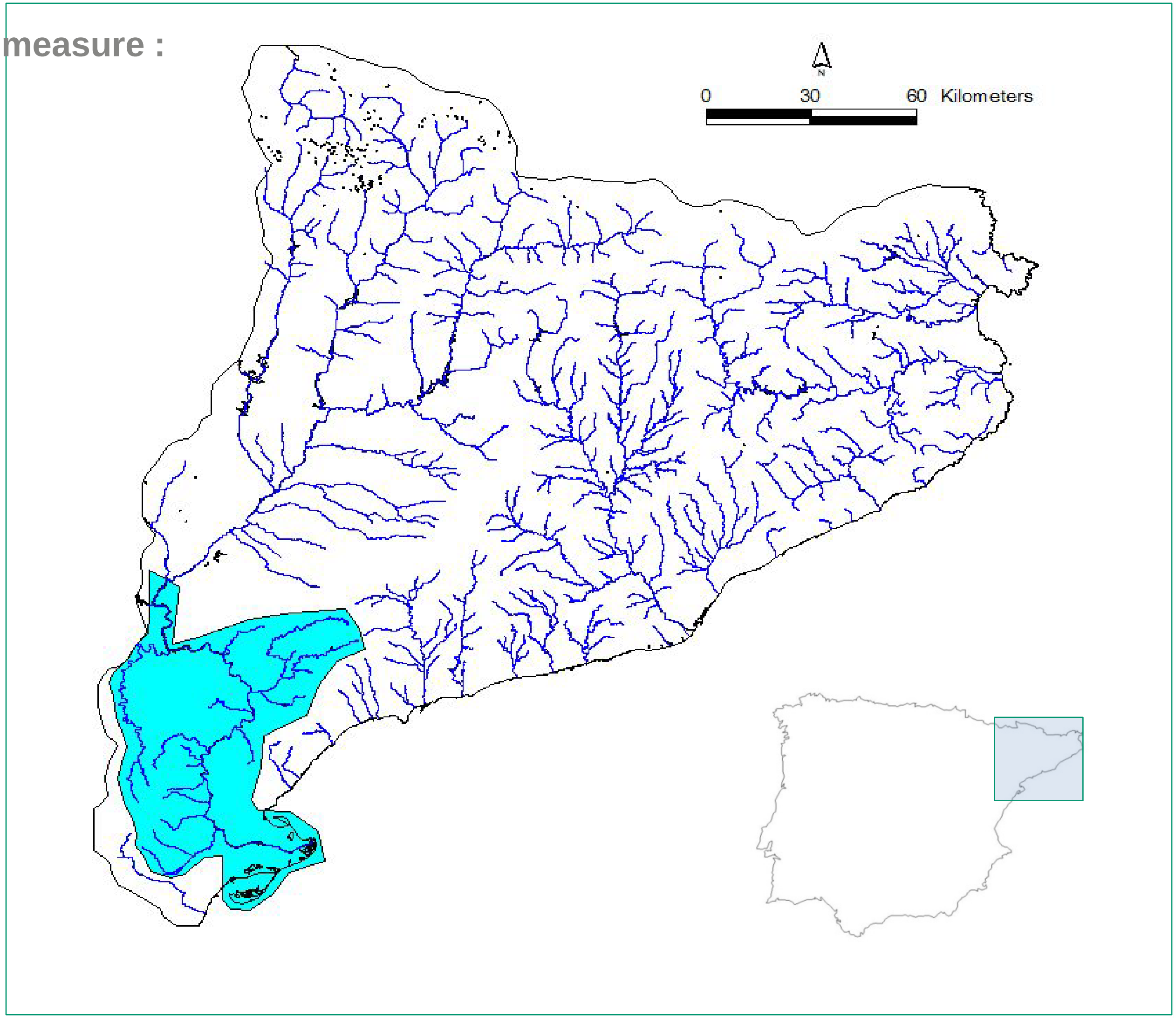


Decontamination
Riparian vegetation restoration
Green filters
Island restoration
N
0 9 18 Kilometers

Monitoring network

- 161 automatic stations to measure :
  Water quality
  Flow regime
  Sediment transportation
  Subsidence

- 57 manual stations:
  WFD biological indicators
  Bioaccumulation
  Etc…



Thanks for your attention!