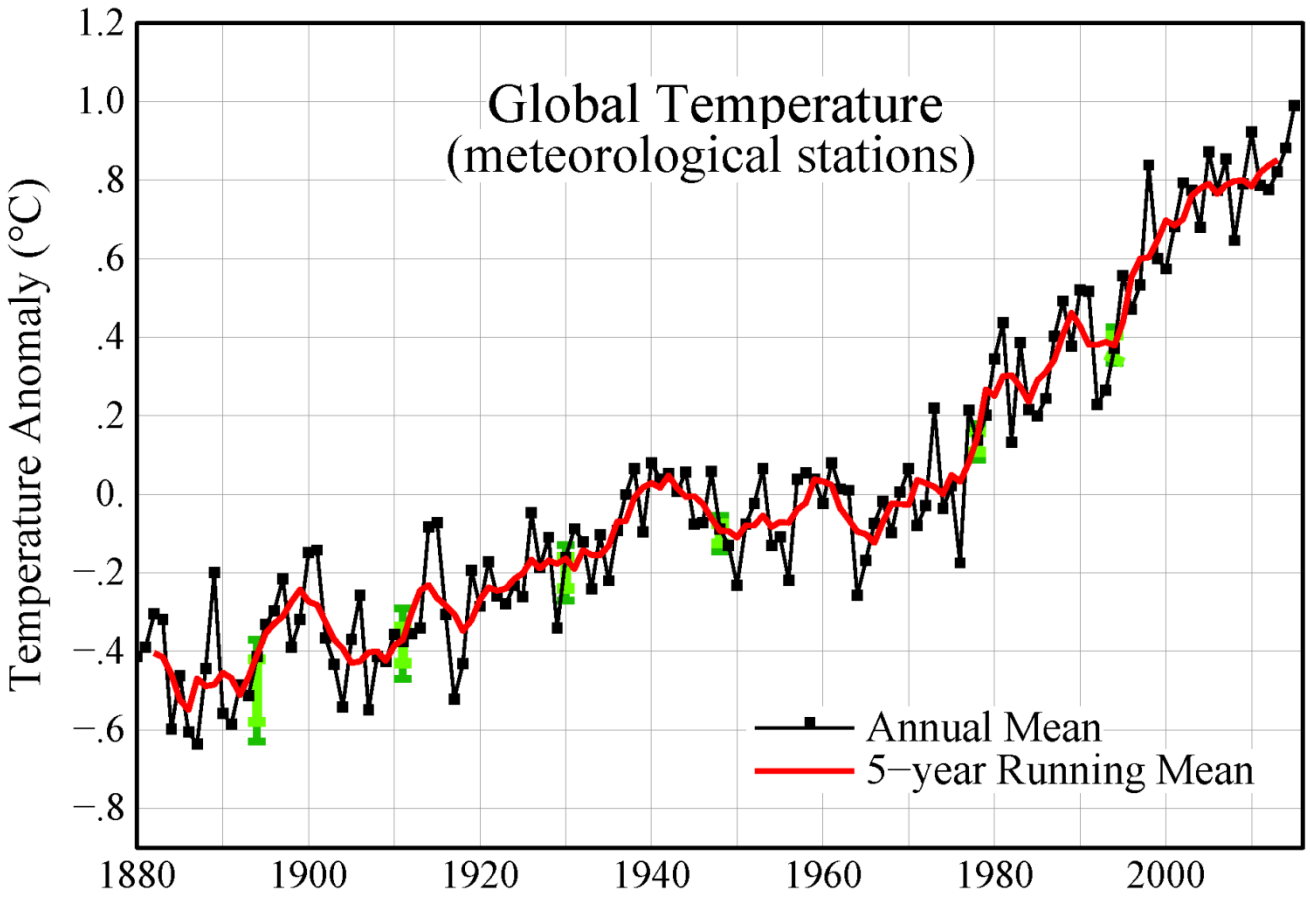
Proyectos SCARCE y GLOBAQUA: gestión del agua y el cambio global

Damià Barceló[1,2], Antoni Ginebreda[1] and coworkers
[1]IDAEA-CSIC, Barcelona, Spain
[2]ICRA, Girona, Spain

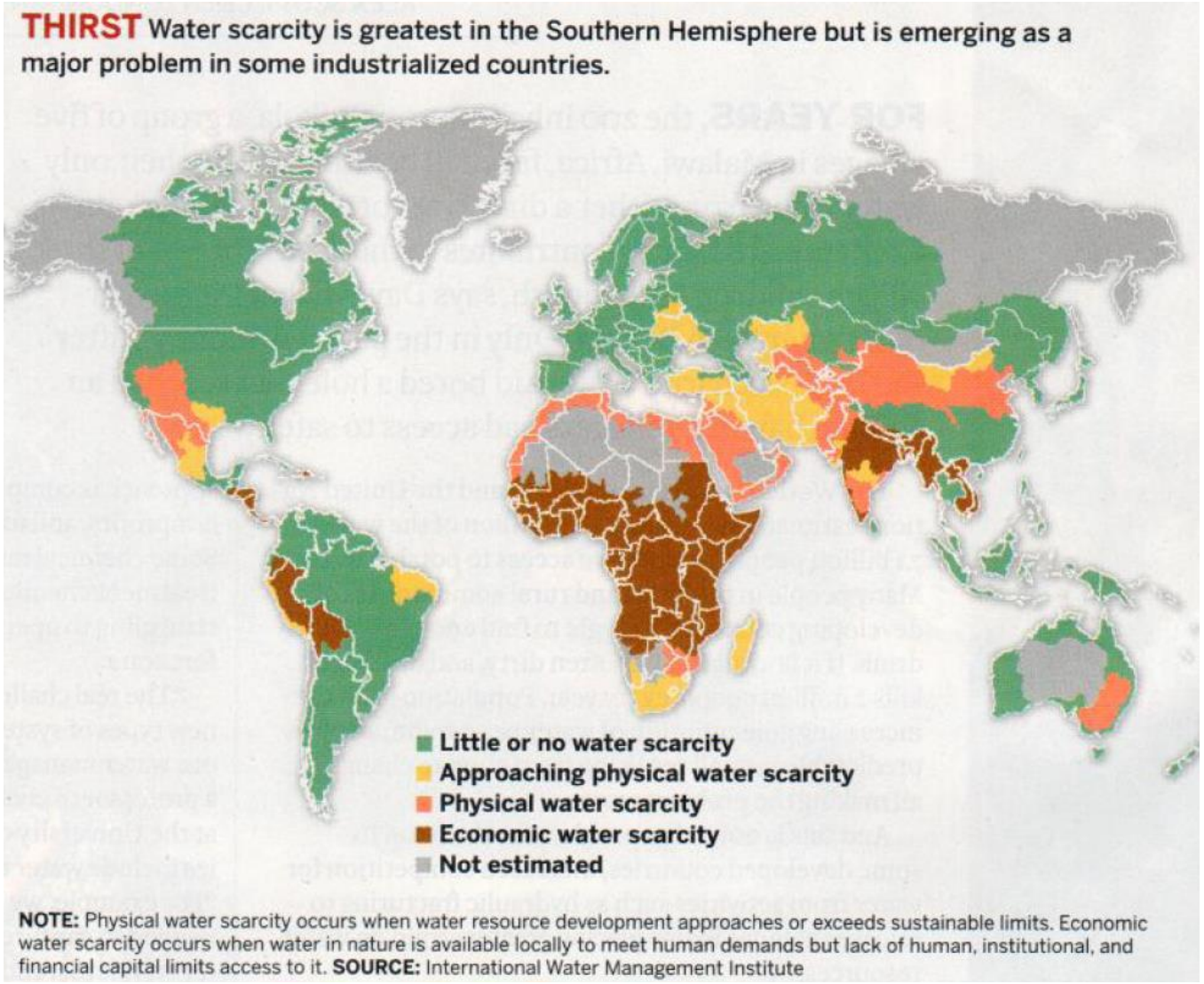
Barcelona, 3 de Mayo, 2018

Global Temperature

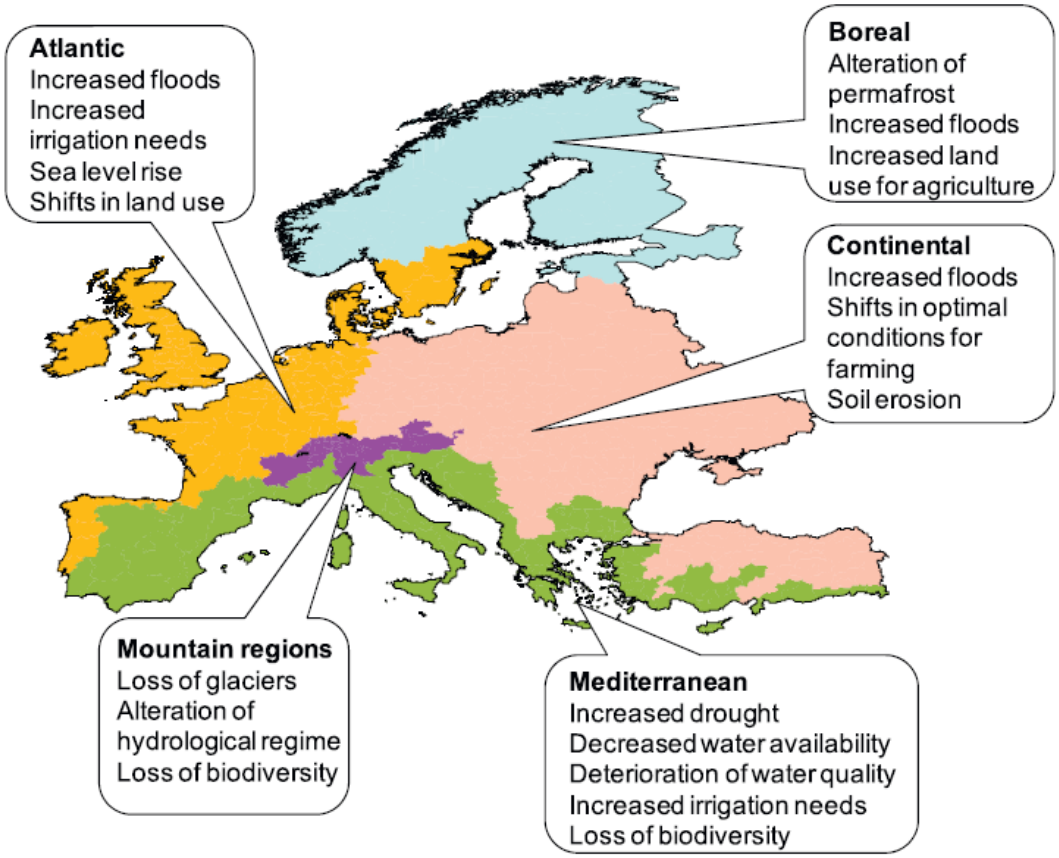


Source: National Aeronautics and Space Administration
Goddard Institute for Space Studies

Water scarcity world map



Changes in the risk of climate change

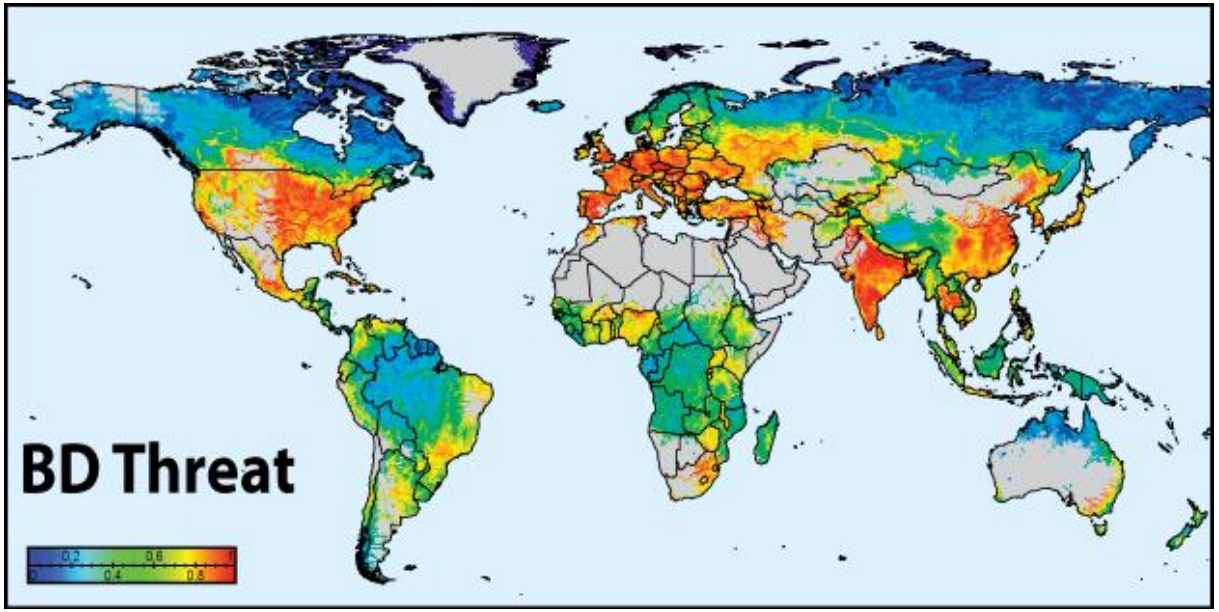


Summary of changes in the risk of climate change for agricultural water management in Europe

Source: Iglesias et al. Agricultural Water Management (2015)

Impairment of aquatic ecosystems

- Freshwater ecosystems are one of the most heavily altered ecosystems
- Loss of taxonomical and functional biodiversity
- **Multiple environmental stressors (including chemicals)** threaten the biodiversity of 65 percent of the world's rivers



Vörösmarty et al., Nature, 2010

Motivation: Specificity of Mediterranean rivers

Natural conditions

Global change

Seasonality:

Drougths



Floods



↑ hydrologic variability

Climate change:





Predicts ↑ extreme hydrological situations

Human activity:



↓ natural hydrodynamics



Reduced flow and dilution capacity:

↑Conductivity

↑Nutrients

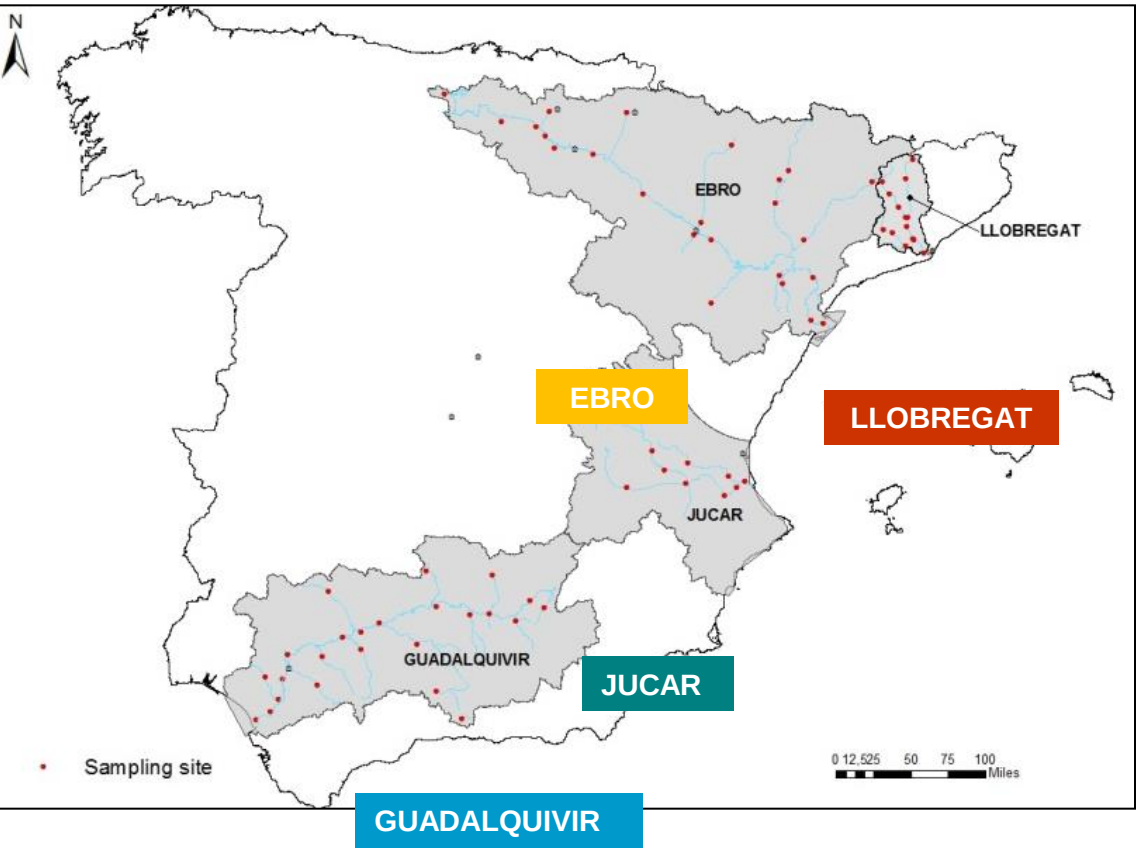
↑Toxicants

Effects on river ecosystems?

Water quantity and **quality** is altered due to global change

SCARCE

Assessing and predicting effects on water quantity and quality in Iberian rivers caused by global change



EBRO

LLOBREGAT

JUCAR

GUADALQUIVIR

Funded by

CONSOLIDER Ingenio 2010

GOBIERNO DE ESPAÑA

MINISTERIO DE CIENCIA E INNOVACIÓN

[CONSOLIDER-INGENIO CSD2009-00065]

Duration

2010 - 2014

Budget

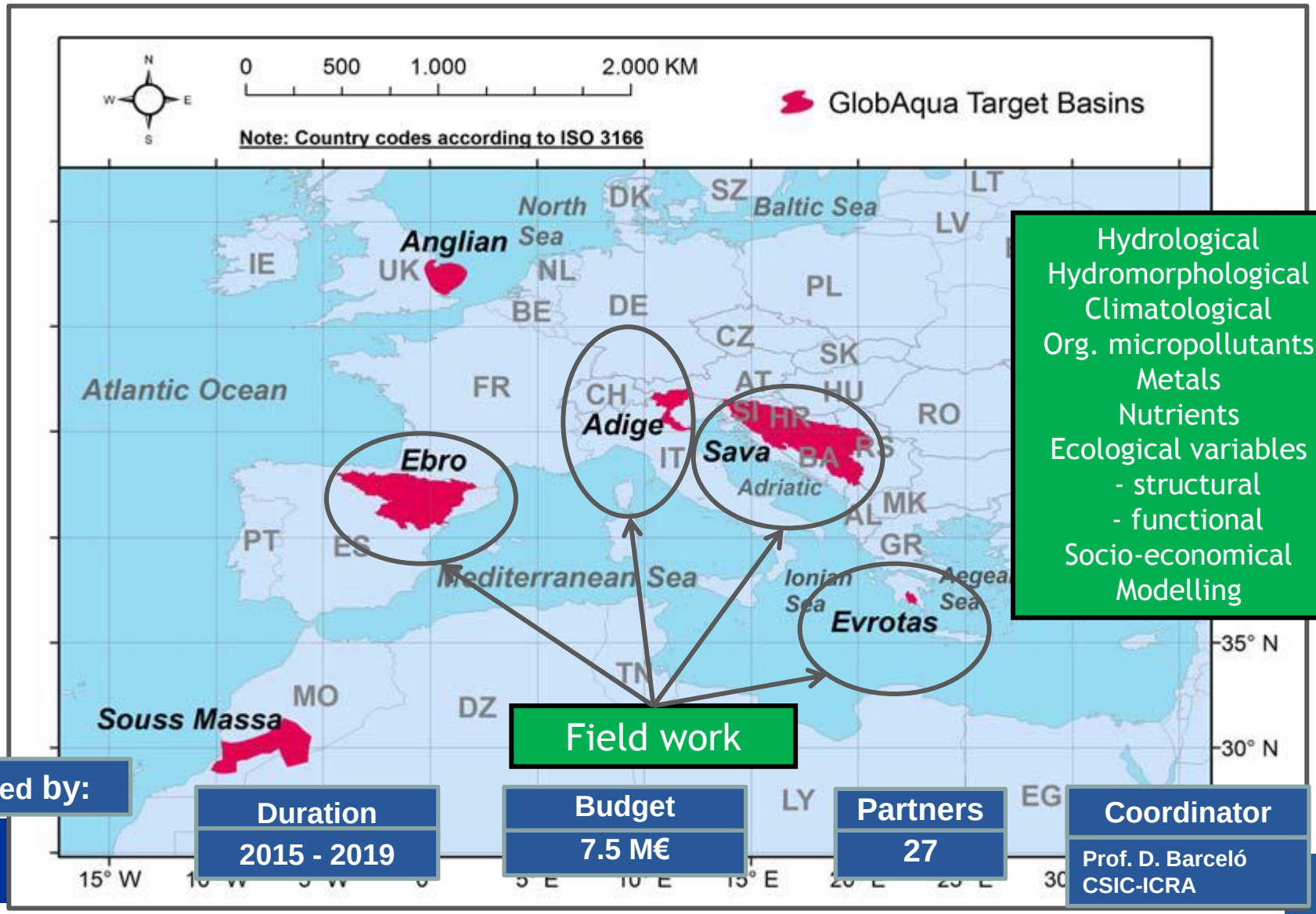
4.5 M€

Coordinator

Prof. D. Barceló
CSIC-ICRA

GLOBAQUA

Managing the effects of multiple stressors on aquatic ecosystems under water scarcity



Hydrological
Hydromorphological
Climatological
Org. micropollutants
Metals
Nutrients
Ecological variables
- structural
- functional
Socio-economical
Modelling

Funded by:

Duration	Budget	Partners	Coordinator
2015 - 2019	7.5 M€	27	Prof. D. Barceló CSIC-ICRA

SCARCE & GLOBAQUA approach

SCARCE & GLOBAQUA are a **multipurpose** projects that aim to:

- Identify the prevalence, interaction and linkages between stressors in **multiple stressor situations,** and assess their **effects** in the **chemical** and **ecological** status

- **Water scarcity** as a central stressor.
- **Holistic approach**, including **water quality**, **hydrology/hydromorphology**, and **ecosystems status** with the effects on **socio-economical** regional development
- From chemical cocktails to **stressors cocktails,** from traditional stressors to **emerging stressors (***climate change, invasive species, emerging cont***)**
- Establish **cause-effect relationships** using experimental manipulation and integrative modelling
- Focus on the **cumulative impact of multiple stressors** affecting structure(biodiversity), functioning , ecosystem health and species
- Improve **water management practice** and policies by taking into consideration the influence of multiple stressors
- **Consider the WFD (2000/60/EC)** and other related regulations
- **Analysis of current policies and scenarios** of alternative management practices and policies
- Involvement of stakeholders

A hierarchy of effects in Mediterranean rivers

POLICYFORUM

CONSERVATION

Why Should We Care About Temporary Waterways?

Intermittently flowing streams and rivers should be recognized, afforded protection, and better managed.

V. Acuña,[1] T. Datry,[2] J. Marshall,[3,4] D. Barceló,[1,5] C. N. Dahm,[6] A. Ginebreda,[5] G. McGregor,[3] S. Sabater,[1,7] K. Tockner,[8,9] M. A. Palmer[10,11]*

A proposed ruling by the U.S. Environmental Protection Agency (EPA), aimed at clarifying which bodies of water that flow intermittently are protected under law (*1*), has provoked conflict between developers and environmental advocates. Some argue that temporary streams and rivers, defined as waterways that cease to flow at some points in space and time along their course (see the figure, left) (Fig. 1) (*2*), are

Failure to recognize, understand, and manage temporary waterways leads to serious degradation of aquatic ecosystems accompanied by negative impacts to the societies that depend upon them.

Current Conservation Status

Traditional flow-gauging systems have vastly underestimated the number of intermittently flowing streams and rivers in most regions,

and services. They are critical conduits for water, energy, material, and organisms even when surface water is not present (*10*). Shallow subsurface flows may connect dry parts of a stream or river to downstream sections that have permanent flows, are often critical for the supply of water in permanent downstream parts of a river basin, and support diverse hyporheic biota (*11*).

Temporary waterways are also important conduits for lateral exchanges, as they

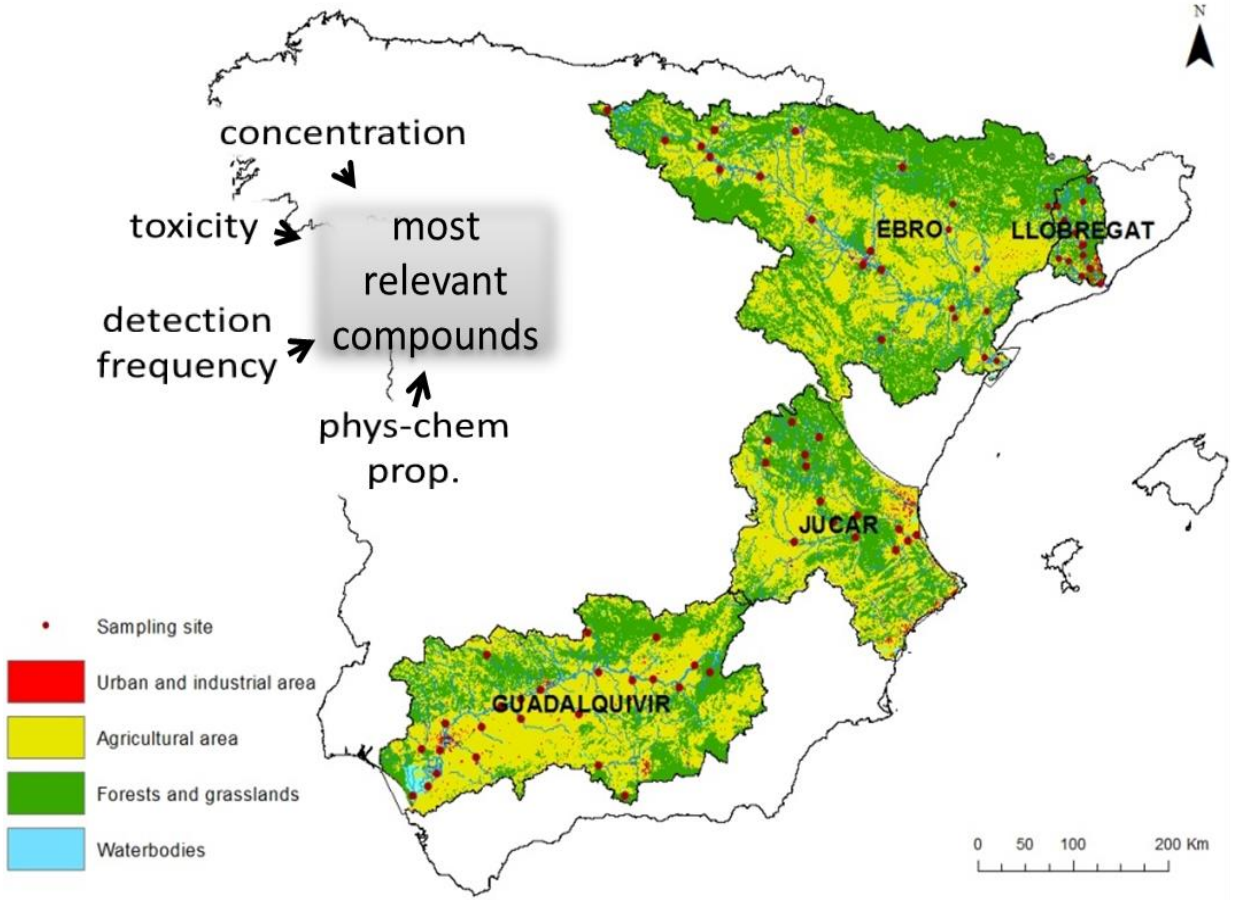


d from www.sciencemag.org on March 7, 2014

Geo… excess/ currence …

Science, 2014

Organic Micropollutants: Occurrence & Risk



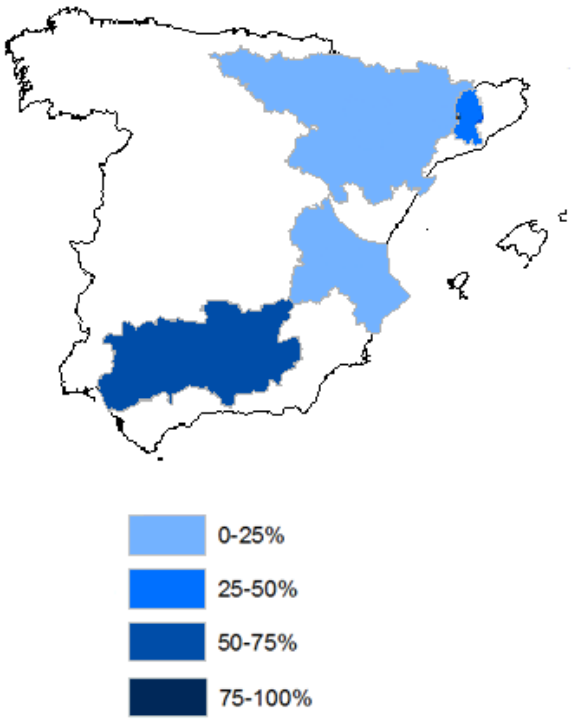
WATER	Chlorfenvinphos	
	Chlorpyriphos	
	Diclofenthion	
	Prochloraz	
	Ethion	
	Diazinon	
	Carbofuran	
	OPs/NPs	
	Diuron	
SEDIMENT	Chlorpyriphos	
	Chlorfenvinphos	
	Nonylphenol	
	Diazinon	
	Malathion	
	Ciprofloxacin	
	Methiocarb	
BIOTA	PFOS	(1)
	Cypermethrin	
	BDE-47	(1)
	Dechlorane 602	
	Permethrin	
	Methylparaben	

(1) Excedance of EQS in several samples was observed

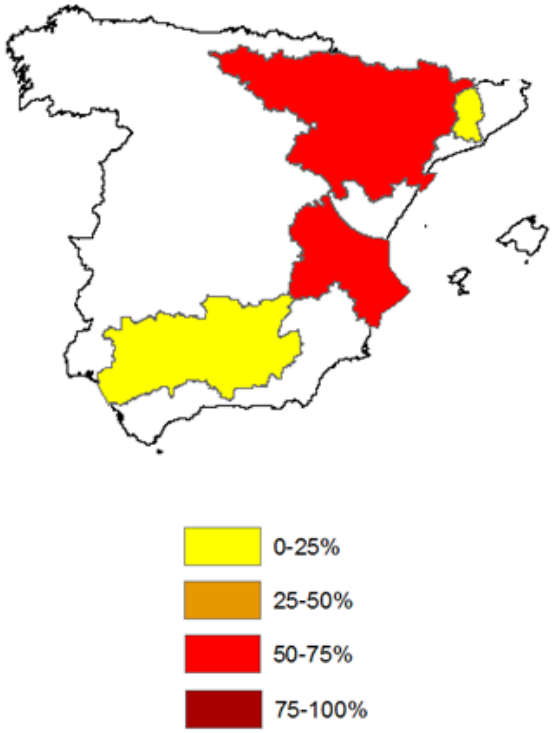
Spatial Extent of Risk-Acute and Chronic Risk

GLOBAQUA

Metals-Acute risk
Total 44% of sites

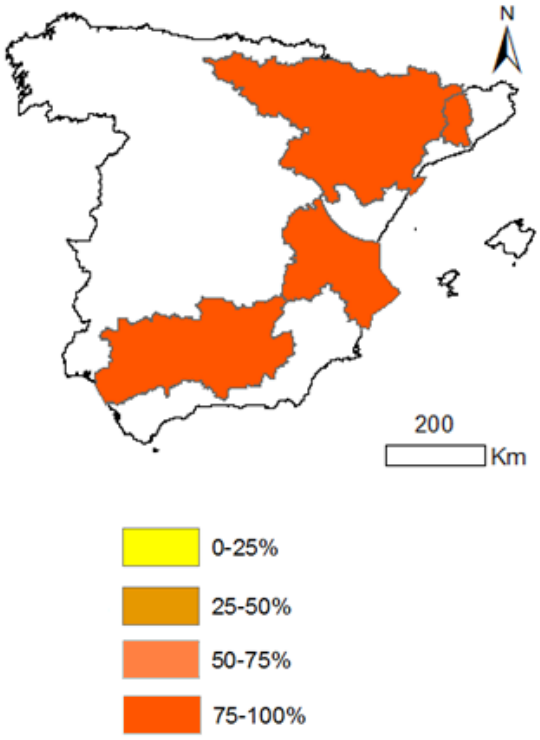


Organic pollutants-Acute risk
Total 42% of sites



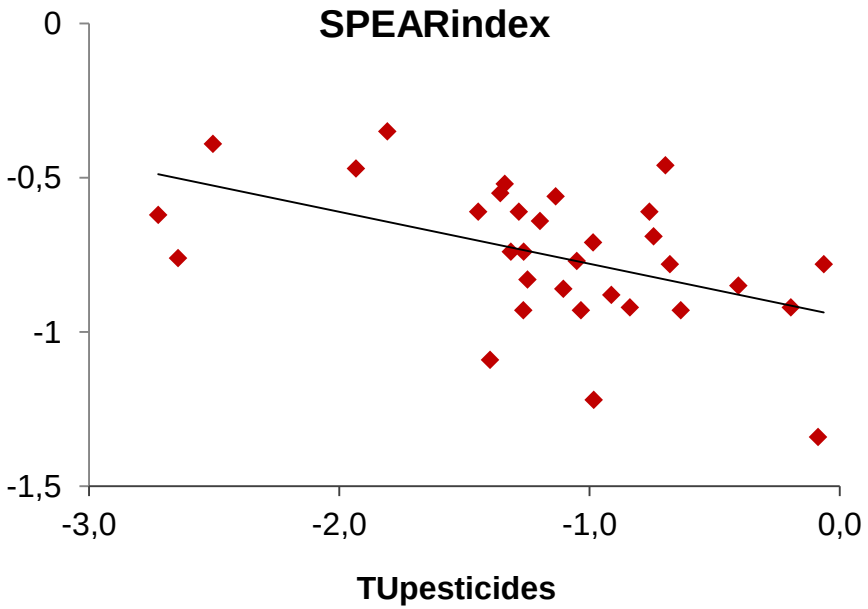
Percentage of the sampling sites with the Acute Risk

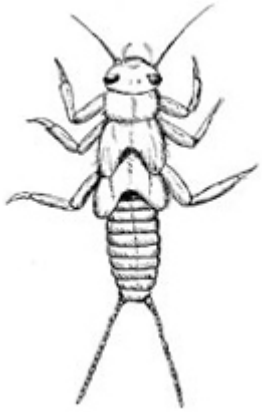
Organic pollutants-Chronic risk
Total 100% of sites



Percentage of the sampling sites with the Chronic Risk

Relationship between invertebrate communities and toxic stress

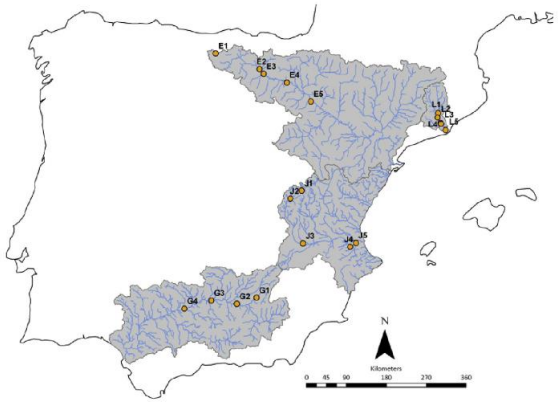




- **SPEAR *(«SPECIES AT RISK») index* decreased with increase of pesticide toxicity**
- **Evidence of pesticide effects im macroinvertebrate communites**
- SPEAR index -correlated **only to TUpesticides**
- No correlation of the agricultural land use and SPEARindex (pesticides were also present at sites **with mostly natural land use)**

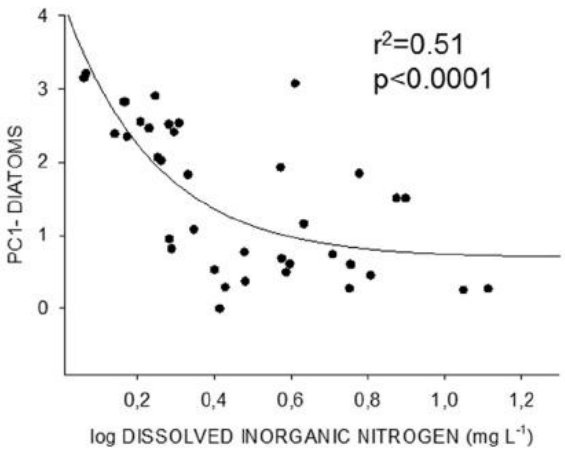
Kuzmanović, M et al. *Sci Total Environ* **2015,** 540, 324-333

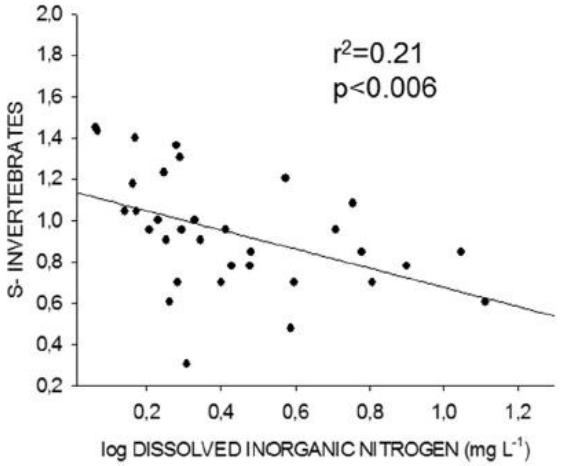
Medidas estructurales de la comunidad biológica; respuestas a los estresores químicos e hidrológicos

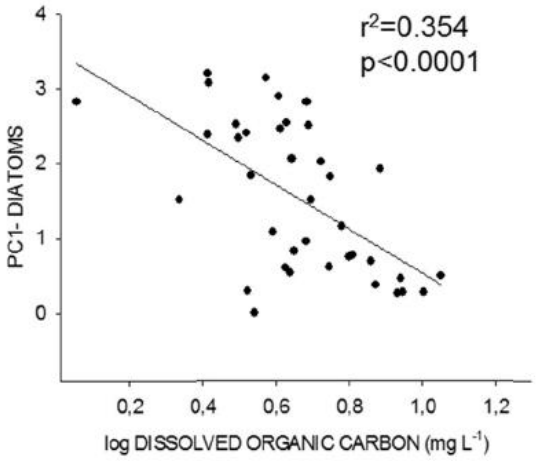


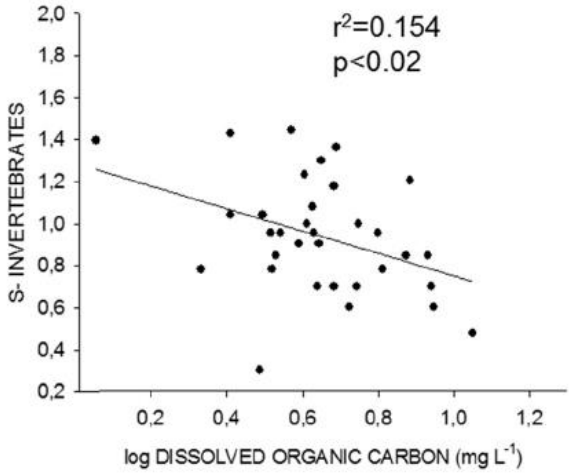
Respuestas complementarias entre biofilm y macroinvertebrados

Sabater et al, 2016









Concurrent effects of multistressors on ecosystems in Mediterranean rivers

GLOBAQUA

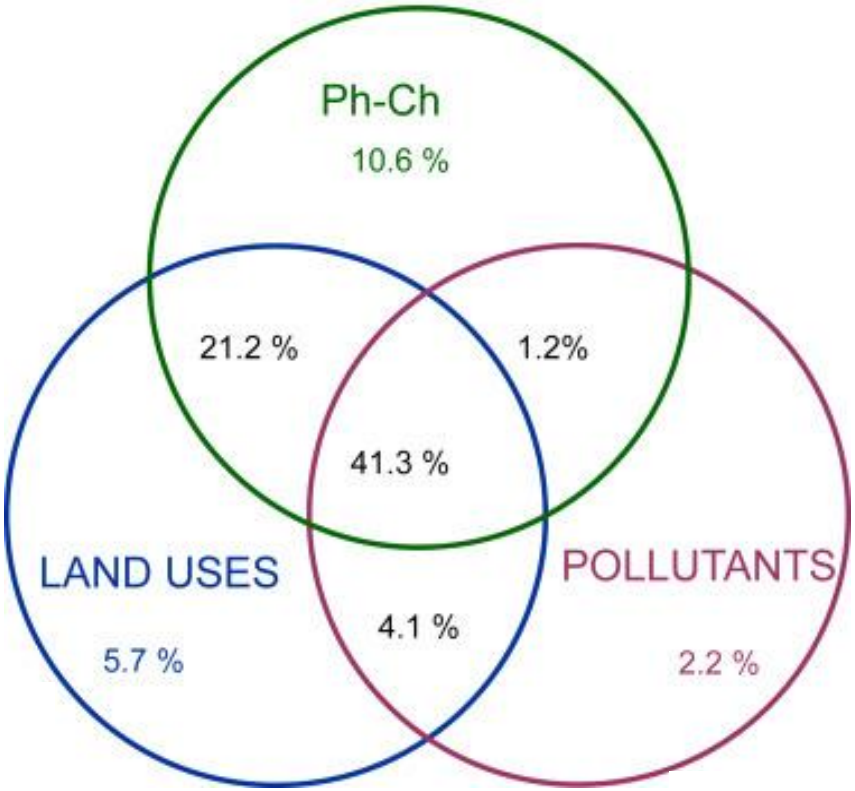
PARTIAL RDA

Phys- Chem variables

TP
DOC
DIN
Cond
Temp
Water flow

Land uses

Artificial surface areas
Agricultural surface areas



% explained variance

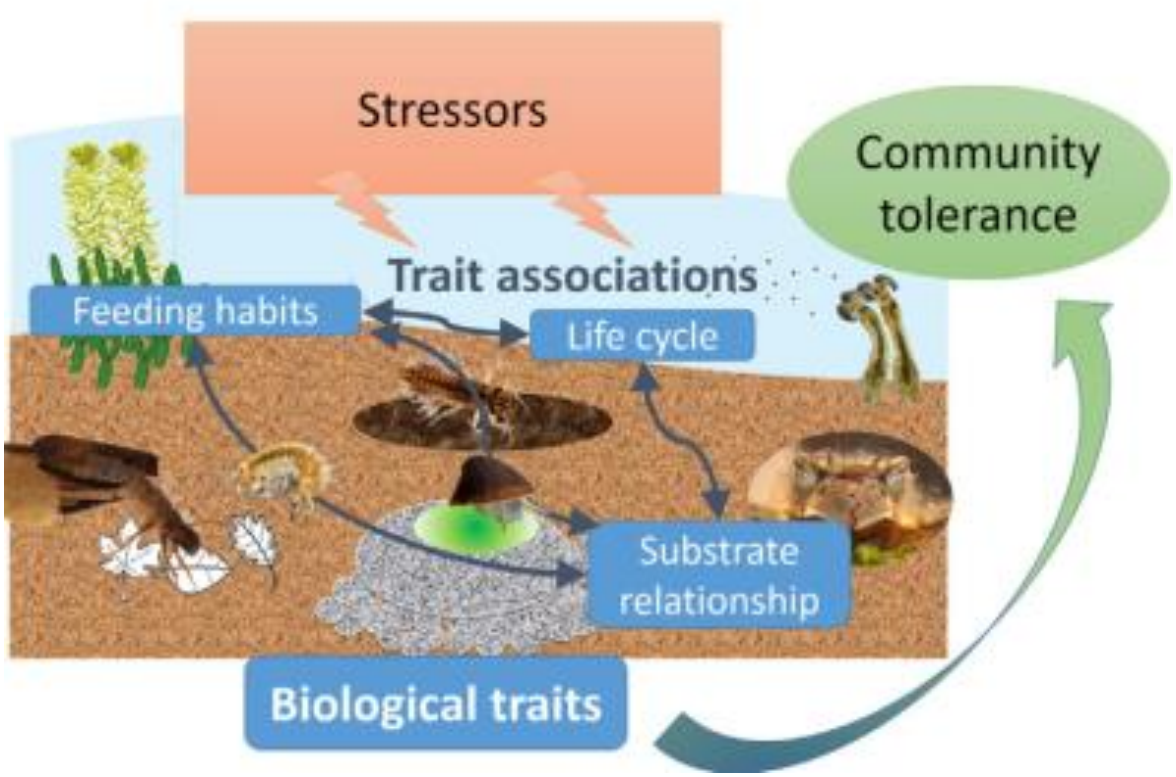
TOTAL: 85.1

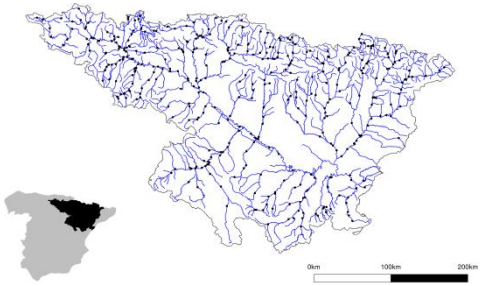
Pollutants

Herbicides
Pharmaceuticals non-antibiotics
Industrial products

S. Sabater et al..*Environmental Pollution* **2016**, 210, 303-314

Identificación de rasgos biológicos en comunidades biológicas afectadas por perturbaciones ambientales





- 414 puntos
- 1508 datos (puntos x fecha)
- 148 taxones
- Nutrientes, SOM, Insecticidas, presencia de embalses, extracción de agua, hidromorfología (IHF)

Mondy et al. 2016, STOTEN
Kuzmanovic et al. 2017, STOTEN

Accounting for the effects of multiple stressors in Mediterranean streams





Permanent streams vs temporary



Control



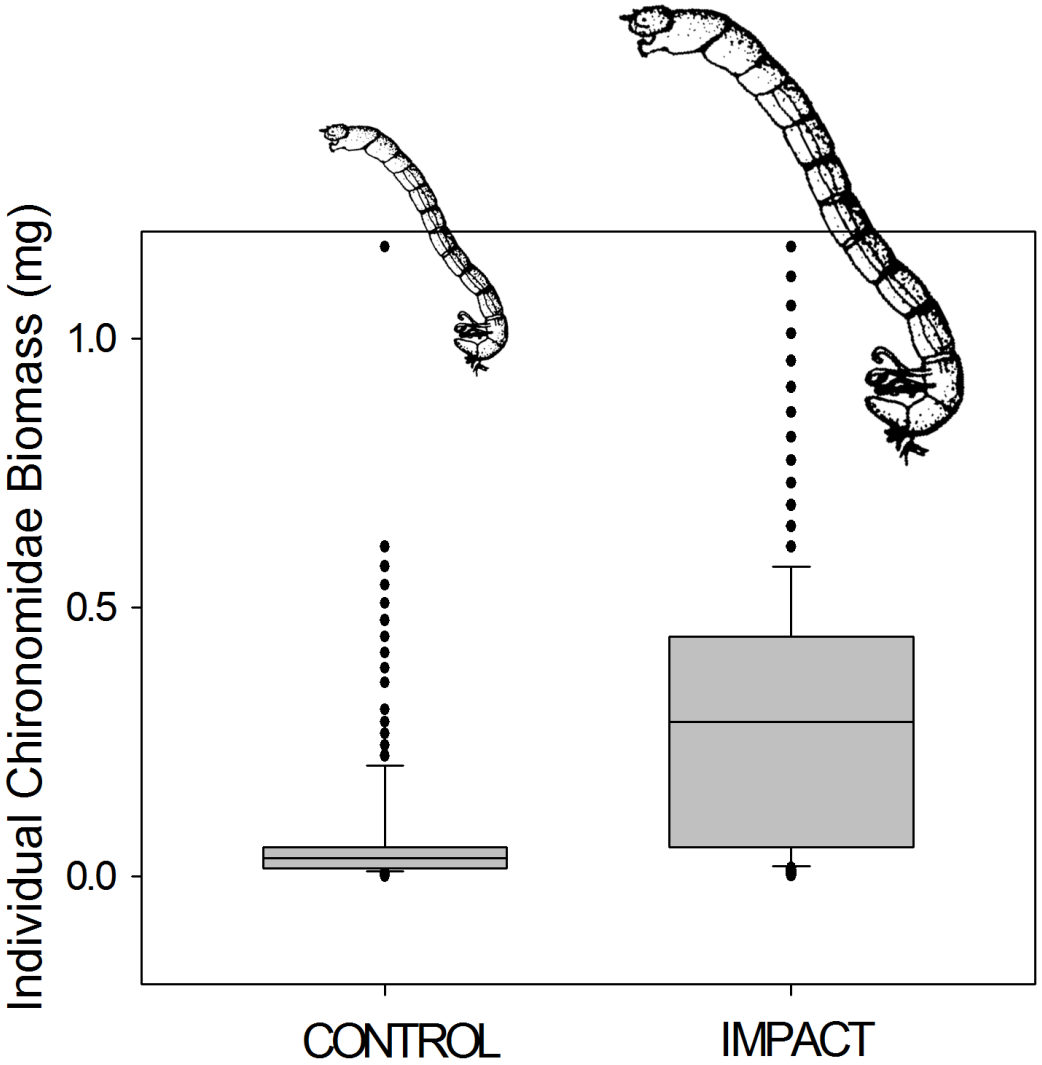
Impact



WWTP



WWTP effluent effects on invertebrates: stress or subsidy?



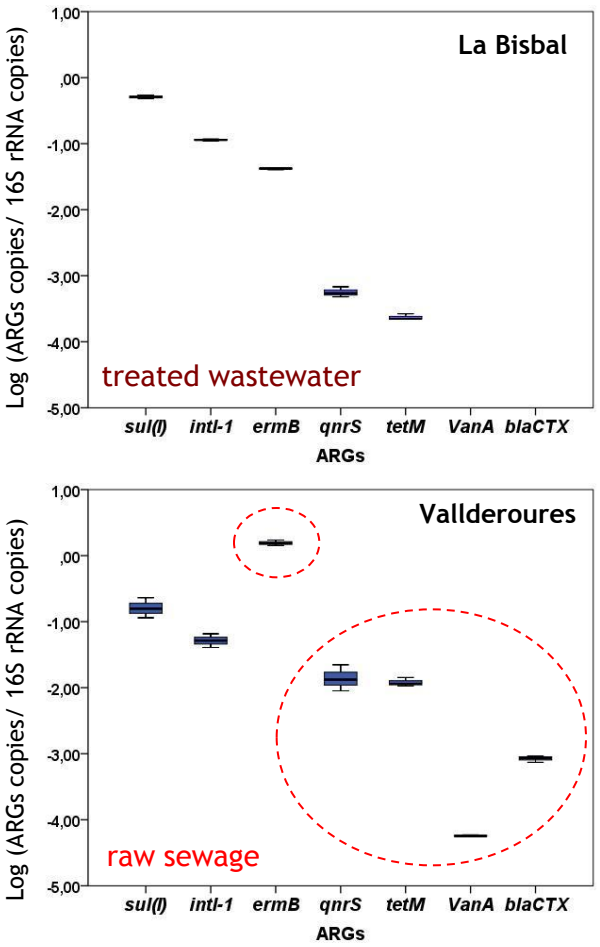
Higher size of individuals in the impact sites

Effects on the distribution of Antibiotic Resistance Genes

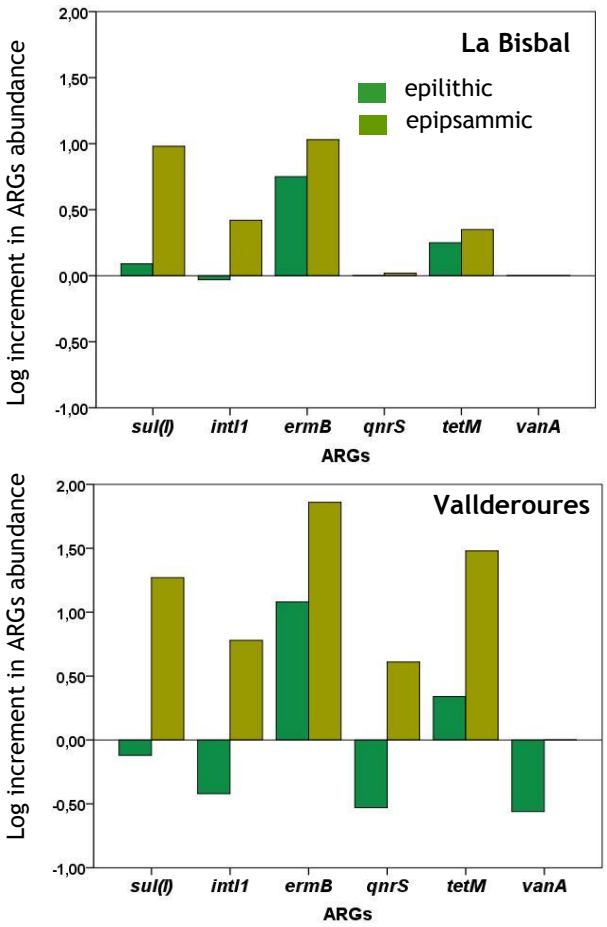
TREATED SEWAGE (La Bisbal)

UNTREATED SEWAGE (Vallderoures)

Analysis: Quantification of target ARGs (*Sul-I* , *Sul-II*, *qnrS*, *ermB*, *vanA* , *tetM*, *tetW*, $bla_{TEM,}$ *Intl-1*) by qPCR.



Relative abundance of target ARGs.
ARGs copies were normalized to 16S rRNA gene copies



Increment in ARGs abundance at the impact vs upstream biofilms

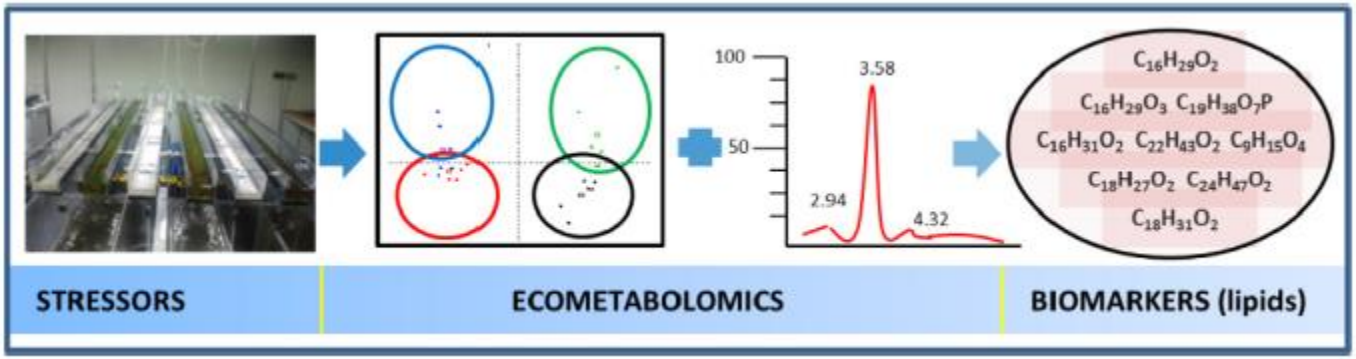
Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Fluvial biofilms exposed to desiccation and pharmaceutical pollution: New insights using metabolomics

Albert Serra-Compte [a], Natàlia Corcoll [a,b], Belinda Huerta [a], Sara Rodríguez-Mozaz [a], Sergi Sabater [a,c], Damià Barceló [a,d], Diana Álvarez-Muñoz [a,d,*]



- **Biofilm metabolome** was profiled after desiccation and pharmaceutical pollution.
- **Biosynthesis of fatty acids** was the **main metabolic pathway** disrupted in biofilms.
- **Desiccation was the major stressor** when co-occurring with pharmaceuticals exposure.
- A link was established between biofilm metabolome and structural parameters.

Summary

There was a double gradient of stressors acting at the sites:

- One defined by chemical inputs (DIN, TP, DOC; Pharmaceuticals)
- Another associated to water flow alteration

The biota received two simultaneous, and somehow contradictory, effects:

- One of **subsidy**, expressed by higher nutrients and DOM
- One of **stress**, caused by the excess of nutrients and the organic contaminants

The streams submitted to such a simultaneous chemical stress and altered hydrological conditions:

- the chemical inputs could be hardly diluted in some of the sites
- the production of **ARG was higher in waters receiving untreated waters**
- the microbial community was inhibited on their P-uptake rate in the impact sites
- the invertebrate community showed effects on their overall composition, food-web strategies**: decrease shredders and increase of filter feeders**
- but the **size of invertebrates increased- expression of subsidy effects**?
- **Desiccation** was the major stressor, s compared to PPCP-metabolomics
- **Trait diversity** was high in pesticide impacted sites versus urban sites

Incorporación de medidas de funcionamiento a la diagnosis y gestión de los ecosistemas fluviales

- ✓ Funcionamiento explica como se transfiere energia y materiales en los ecosistemas
- ✓ *Ejemplos*: producción, respiración, asimilación de nutrientes, eliminación de materiales (incluidos contaminantes)
- ✓ Componente esencial de la salud de fluvial
- ✓ Puede afectar a la estructura
- ✓ Del funcionamiento dependen los servicios ecosistémicos
- ✓ Está explícitamente contemplado en la DMA

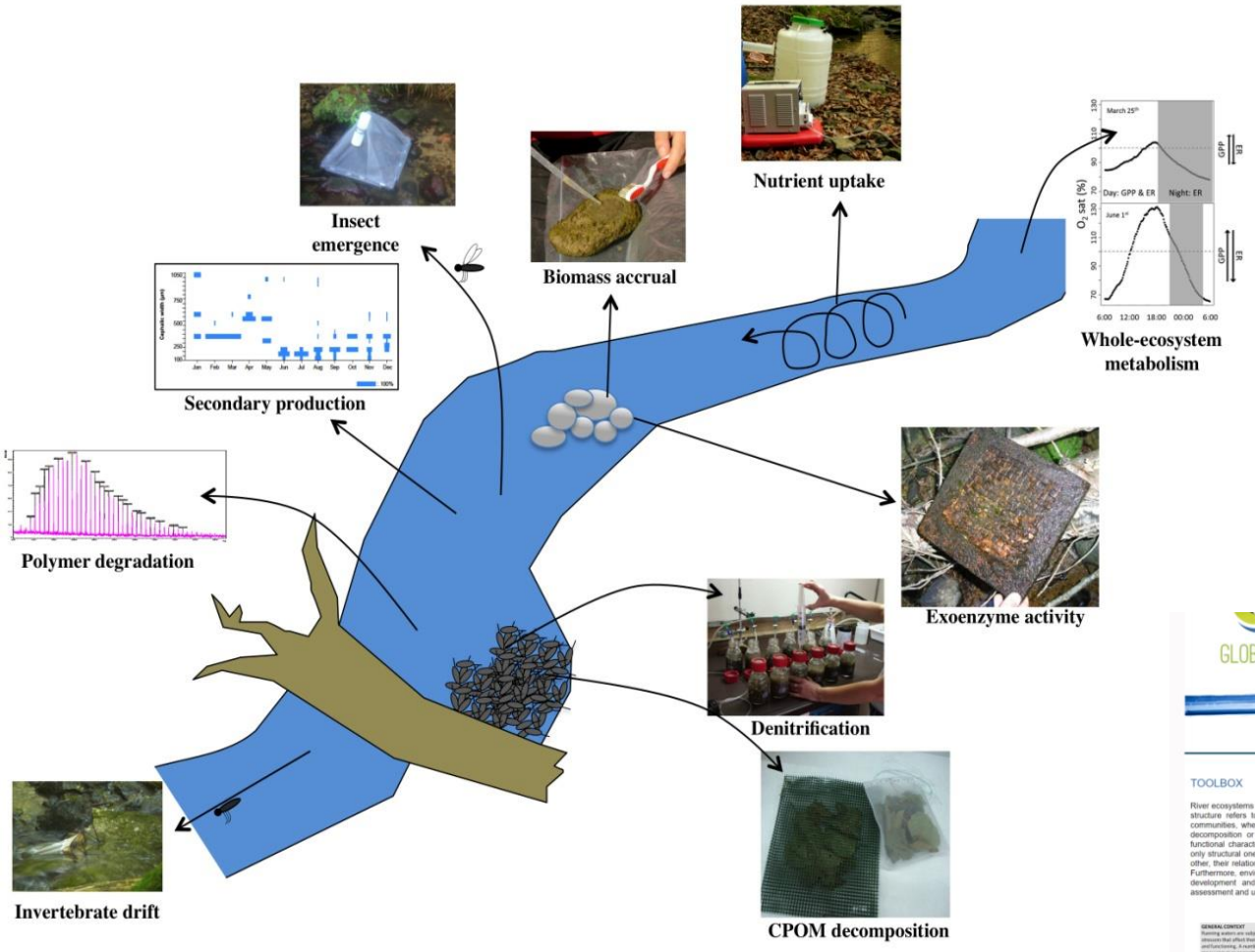
DIRECTIVA 2000/60/CE DEL PARLAMENTO EUROPEO Y DEL CONSEJO

de 23 de octubre de 2000

por la que se establece un marco comunitario de actuación en el ámbito de la política de aguas

21) «estado ecológico»: una expresión de la calidad de la estructura y el funcionamiento de los ecosistemas acuáticos asociados a las aguas superficiales, que se clasifica con arreglo al anexo V;

Incorporación de medidas de funcionamiento a la diagnosis y gestión de los ecosistemas fluviales





http://www.globaqua-project.eu/en/content/Toolbox.50/



THANK YOU FOR YOUR ATTENTION !

Acknowledgements:

[Grant agreement no: 603629]

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(Consolider-Ingenio CSD2009-00065)

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