The SCARCE Consolider project on Iberian river basins: The study of sediments

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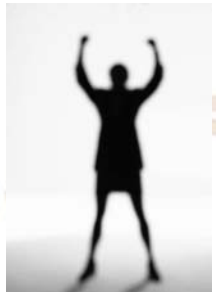
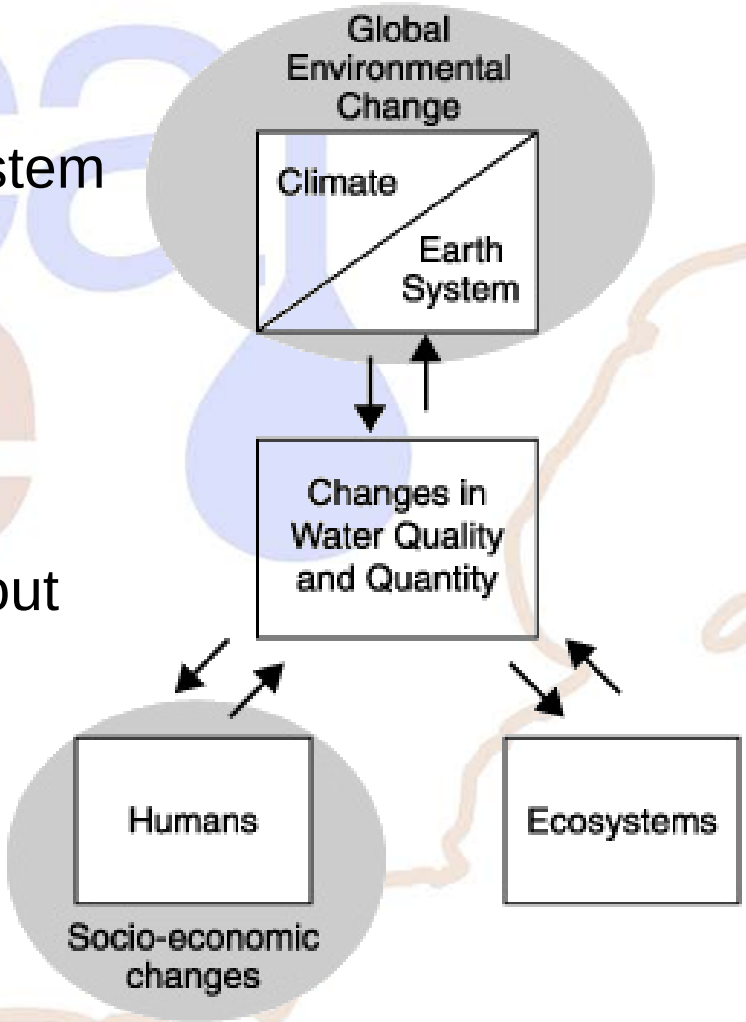
The global water system

- Water *Cycling* Deeply Embedded in Earth System
- Interconnections are Strong
- Change to One Part Reverberates Throughout





Water scarcity

drought
water scarcity
water security *(sensu Vörösmarty et al. 2010)*

Irregular water supply and rising water demands.

Direct impact on citizens and economic sectors that use and depend on water (agriculture, tourism, industry, energy and transport)

Enhanced impact on ecosystems: remaining water is not sufficient

Example: 2007-2008 drought in NE Spain, with an extremely high societal, economical and environmental cost

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Potential alternatives facing water scarcity

Humans resource needs and use

Ecosystems needs and protection

WATER SCARCITY

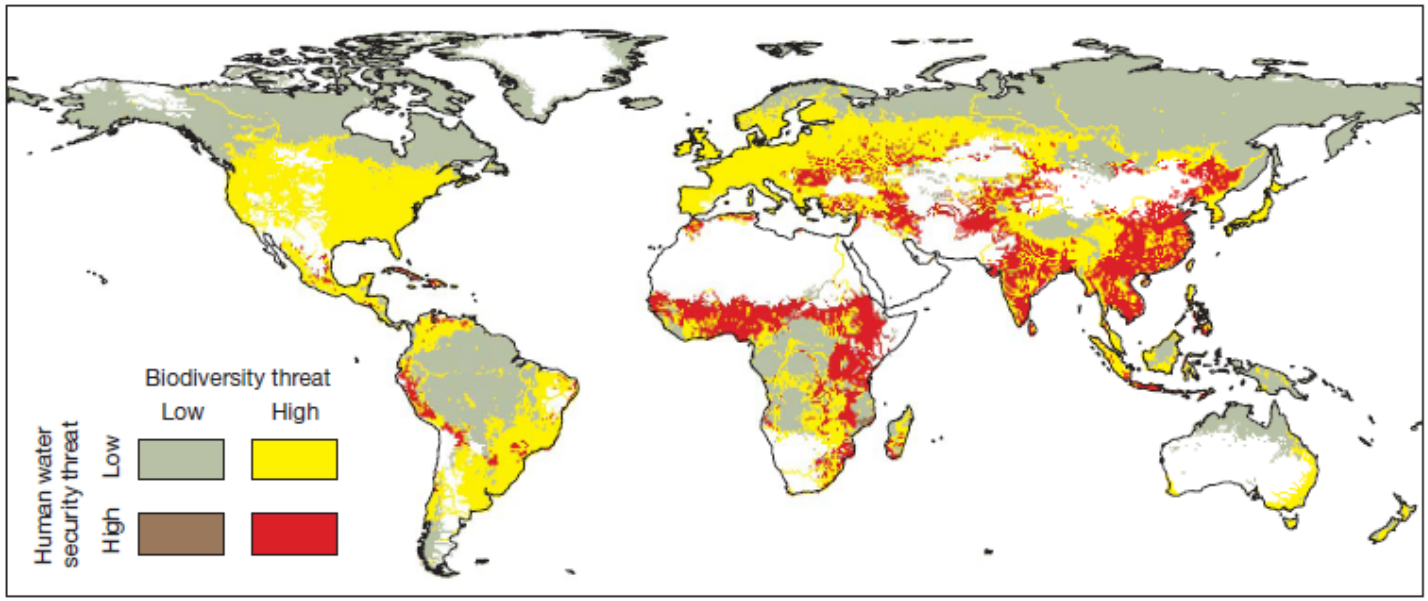
PROVISIONING ADDITIONAL WATER RESOURCES

PROMOTING WATER-SAVING AND EFFICIENCY USE

TECHNOLOGY-DRIVEN

ECOSYSTEMS-DRIVEN

Effects on water availability and biodiversity



80% of human population under risk
72% of large rivers show high threat level

doi:10.1038/nature09440

Global threats to human water security and river biodiversity

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Multiple stressors affect the response to scarcity

- Higher hydrological stability
- Higher frequency of extreme events (floods, droughts)
- Higher water temperature
- Higher nutrient concentrations
- Presence of inorganic pollutants
- Presence of emerging contaminants

Project goals

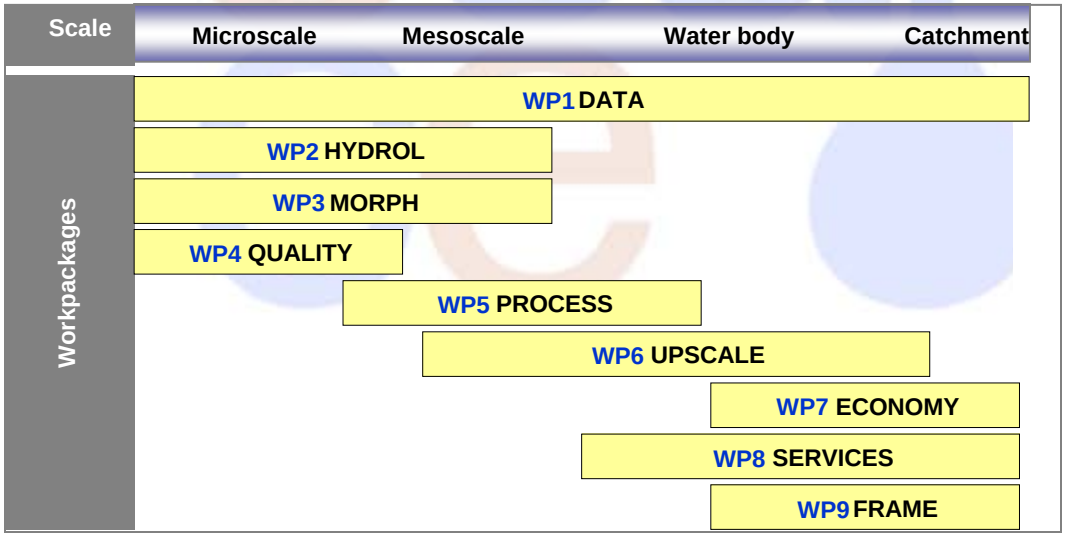
Multipurpose project, aims to:

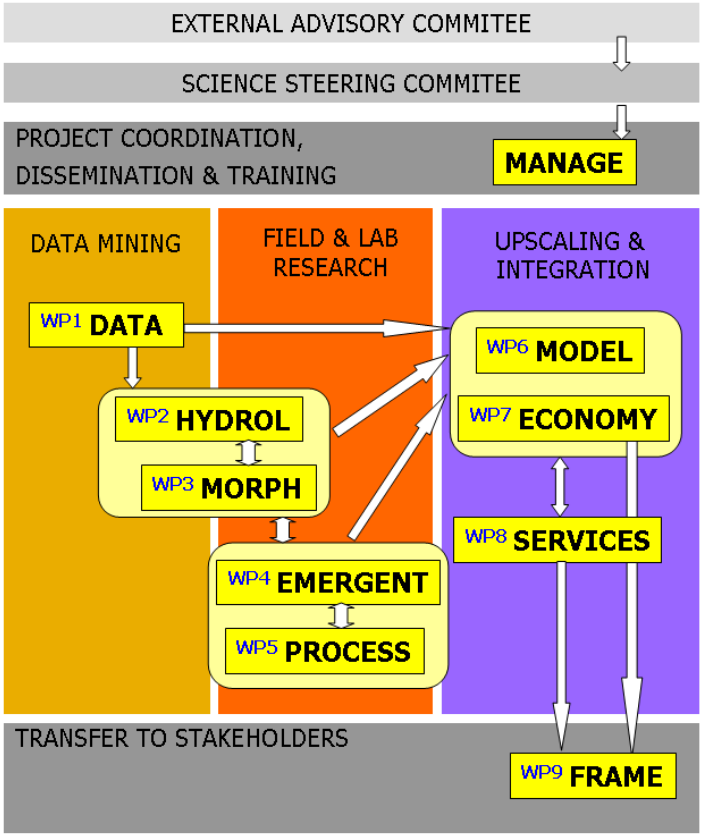
- Describe and predict the relevance of global change impacts on water availability, water quality and ecosystem services in Mediterranean river basins of the Iberian Peninsula
- Describe and predict the effects of climate and human footprint on the freshwater ecosystem services. Finalize, implement, and eventually refine the River Basin Management Plans (RBMP) demanded by the EU Water Framework Directive.

Multidisciplinary team of leading scientists (hydrology, geomorphology, chemistry, ecology, ecotoxicology, economy, engineering and modelling)

Active involvement of Water Authorities and other relevant agents as stakeholders

The role of SCARCE





Covering multiple stressors and scales
Using multidisciplinary approaches
Providing transfer to policy-makers

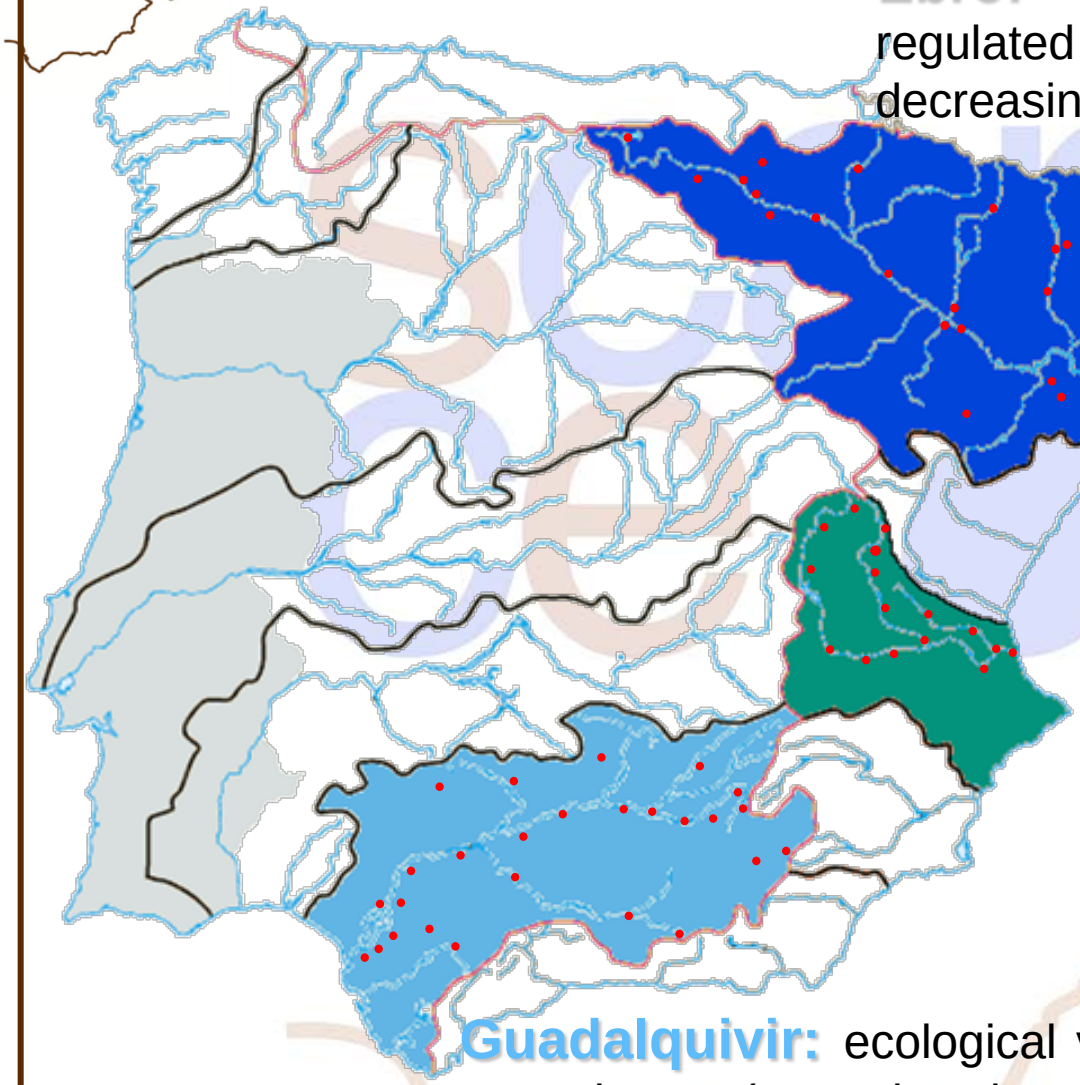
WP 3. MORPH: Impacts of changing hydrology on sediment transport, channel morphology and physical habitat

WP3 aims at describing patterns and understanding trends of **sediment transport** and **channel morphosedimentary processes**, relevant to assess fish and invertebrate **habitat** conditions, and to **predict directions of** change.

From patch to reach scales

From baseline data to field monitoring

Study approach



Ebro: intensive agricultural activity, largely regulated (200 dams and channels), decreasing of 30% of the mean annual flow

Llobregat: Heavily managed in its lower course, Barcelona's major drinking water resources, extensive urban and industrial waste water discharges

Júcar: designated as a European Pilot River Basin for the implementation of the WFD, overextraction of groundwater, water quality problems in the medium and lower parts

Guadalquivir: ecological value of the Doñana National Park, many inputs (natural and anthropogenic origin), navigable up as far as Seville (serious environmental problem)

Strategy of field work: General extensive monitoring

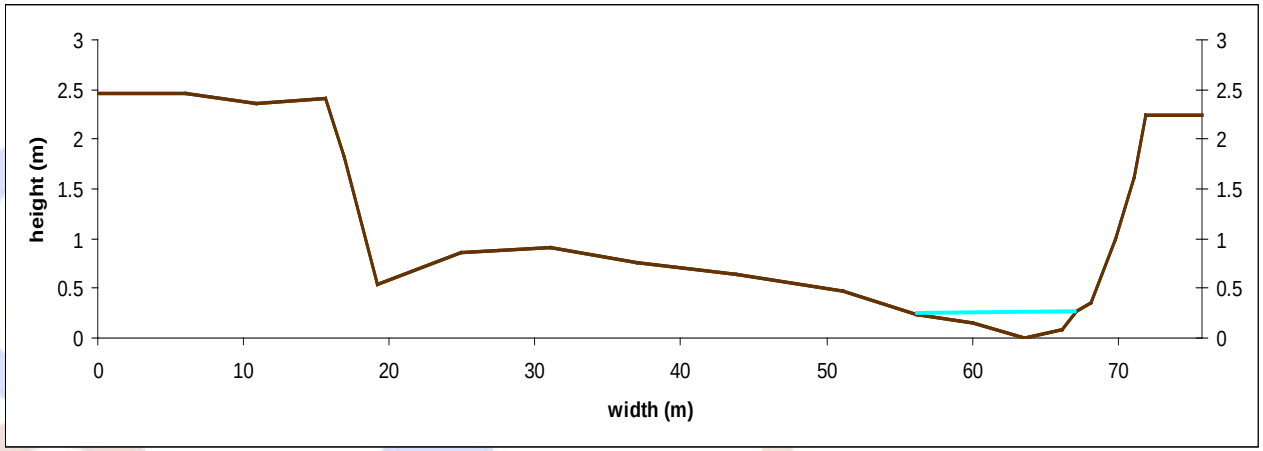
Transversal component: Characterization

Vertical component: Field monitoring

- **Wide spatial coverage:** 4 river basins (main river + tributaries, reference sites + contaminated sites), different contamination and hydrological gradients)
- **Three hydrological regimes:** low, medium, high flow
- **WP3:** Extensive physical characterisation (morphology, sedimentology, impacts…)
- **WP4:** wide range of contaminants (priority and emerging)

WP3: General sampling

Hydraulic geometry

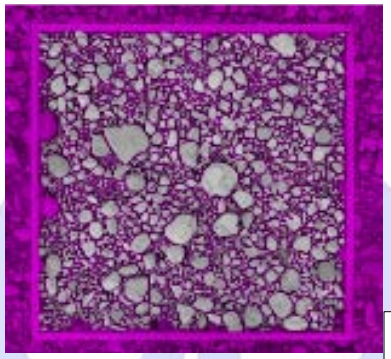


Velocity

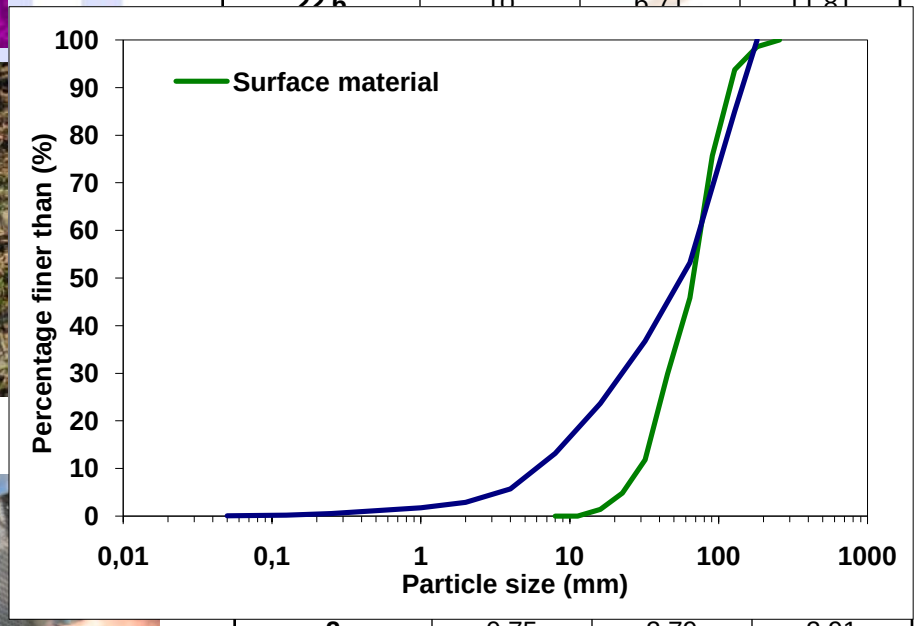
	Right Bank	Center	Left Bank
SECTION 1			
Width (cm)	55	31	37
Velocity (m/s)	0.653	0.596	0.517
SD	0.053	0.044	0.049
SECTION 2			
	Right Bank	**Center**	**Left Bank**
Width (cm)	28	43	35
Velocity (m/s)	0.914	1.114	0.789
SD	0.062	0.007	0.066
SECTION 3			
	Right Bank	**Center**	**Left Bank**
Width (cm)	32	40	53
Velocity (m/s)	0.477	0.791	0.873
SD	0.055	0.044	0.072
SECTION 4			
	Right Bank	**Center**	**Left Bank**
Width (cm)	24	34	32
Velocity (m/s)	0.686	0.699	0.552
SD	0.051	0.062	0.041

WP3: General sampling

Surface material



Surface material			
Size class (mm)	No. of Particles	Percentage (%)	Percentage finer than (%)
<8	5	3.36	0.00
8	0	0.00	0.00
11.3	2	1.34	1.39
16	5	3.36	4.86
22.6	10	6.71	11.81



Subsurface material

2	0.75	2.79	2.91
4	2.00	7.48	5.70
8	2.80	10.48	13.19
16	3.50	13.10	23.66
32	4.40	16.46	36.76
64	8.50	31.81	53.23
128	4.00	14.97	85.03
181	0.00	0.00	100.00

WP3: General sampling

Impacts

In river-channel	Gauging station Upstream bridge
In banks	Picnic area at the right bank Orchard on the left bank
Punctuals	Not detected
Close	Main road
Longitudinal continuity	Gauging station
Lateral continuity	Not detected
Local processes	Not detected

Vegetation

IN RIVER CHANNEL						
1. Submerged macrophytes						
Yes; up to a 50% of coverage						
2. Emerged macrophytes						
Yes; up to a 60% of coverage						
3. Present species						
Thypha sp., Phragmites sp., Scirpus sp., Juncus sp., Paspalum paspaloides, Chara sp.						
IN BANKS						
1. Coverage(%)						
Very few bank-vegetation. Mainly shrubs and Pinus halepensis at both banks						
2. Longitudinal continuity (m)						
Yes; from the upstream gauging station to the downstream bridge.						
3. Vegetation width						
Very few bank-vegetation. Above the slope just Pinus halepensis.						
SPECIFICAL COMPOSITION						

Type	Species
Trees	*Pinus halepensis, fraxinus sp.*
Shrubs/Mattoral	*Rubus sp., Salix eleagnus, Salix purpurea, Pistacia lentiscus*
Herbaceous stratum	*Euphorbia sp., Foeniculum vulgare, Rosmarinus Officinalis, Mentha sp, Dorycnium sp, Helichrysum stoechas*

WP 4. QUALITY: Linking the effects of chemical quality and environmental stressors on biodiversity and human risks

Field and laboratory work

- Collection and chemical analysis of water/sediment/biota samples
- Biological characterization (biofilm, macroinvertebrates, community of fish)

Development of tools

- Development, optimization and validation of advanced analytical methodologies
- Development of functional and structural biomarkers

Risk-based analysis

- Human health risk assessment models
- Application of Intelligent testing strategies

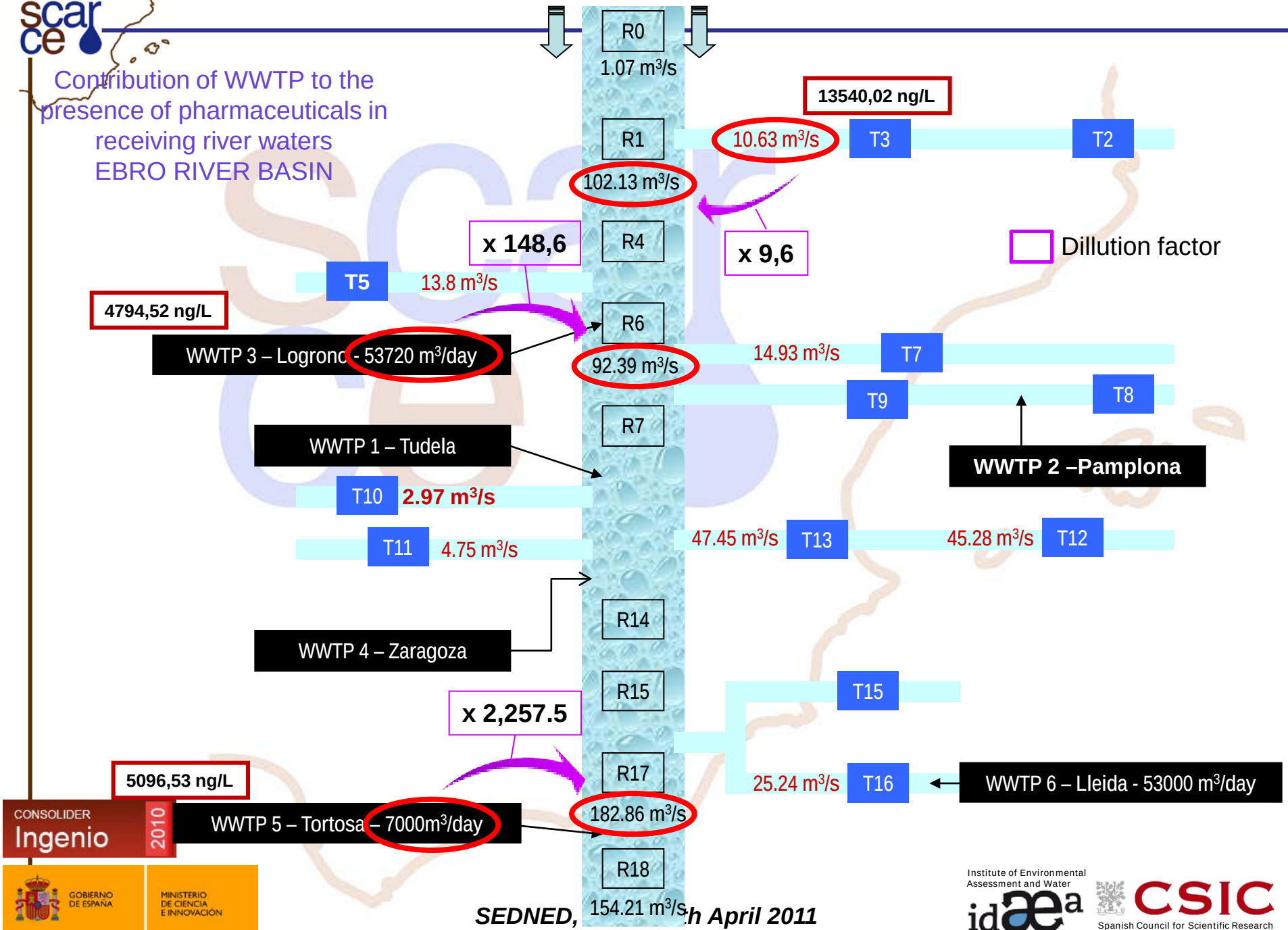
WP4: Target compounds

- **Pharmaceuticals:** 43 compounds including: Analgesis/anti-inflamatories, Phenazone drugs, Lipid regulators, Psychiatric drugs, Histamine H2 receptor antagonists, Diuretic, Macrolide antibiotics Sulfonamide antibiotics, Other antiobiotics, Beta-blockers, Beta-agonists, Barbiturates, Anti-hypertensive, Anti-diabetic

- **UV filters**: 5 parent compounds (Octocrylene, 4(*E*)Metylbenzilidene Camfor, Ethylhexyl metoxycinnamate, Ethylhexyl dimetyl-*p*-aminobenzoic acid, Benzophenone 3) and 5 degradation products (2,2'-Dyhidroxy-4-metoxybenzophenone, 2,3,4-Trihydroxybenzophenone, Benzophenone 1, 4,4'-Dihydroxybenzophenone, 4-Hydroxybenzophenone)

- **Flame retardants**: 19 compounds including: Tri-BDE-28, TetraBDE-47, Penta-BDE-100, Penta-BDE-99, Hexa-BDE-154, Hexa-BDE-153, Hepta-BDE-183, Deca-BDE-209, HBB, PBEB, DBDPE, •-HBCD, •-HBCD, •-HBCD, TBBPA, Tri-BBPA, Di-BBPA, Mono-BBPA, BPA

Contribution of WWTP to the presence of pharmaceuticals in receiving river waters EBRO RIVER BASIN



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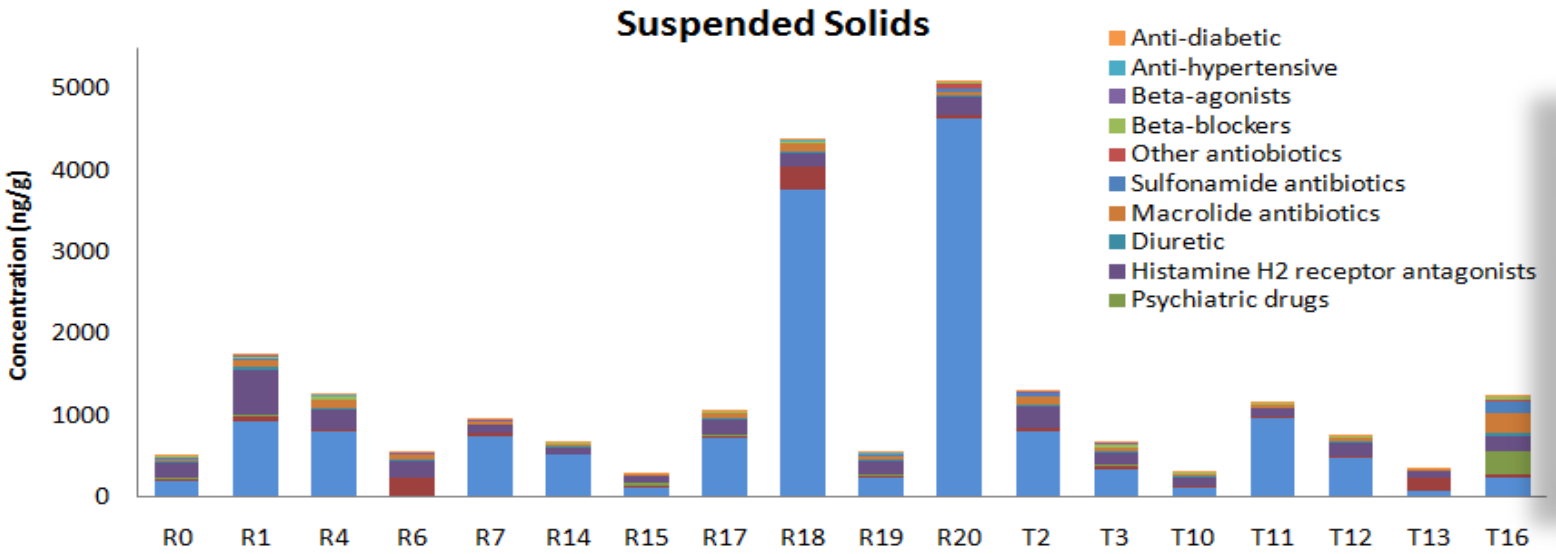
WP4: Sample preparation

	Pharmaceuticals	UV filters	BFRs, PBDEs, Emerging	BFRs, HBCD, TBBPA
Pre-treatment	Freeze-drying (-40 °C, 0.044 bar), store at -20 °C and Homogenization			
	1g of sediment			
Sample extraction	PLE, ASE 300 Dionex			Sonication
	$MeOH/H_2O$ (1:2) Temperature: 100°C 3 static cycles total flush volume 100%		CH_2Cl_2:hexane (2:1) Temperature: 100°C Pressure: 2000 psi Cycles: 2	CH_2Cl_2:MeOH (1:9) Time: 60 min. Temperature: 30°C
Clean-up	SPE OASIS HLB Elution: 2x4mL MeOH 1mL $MeOH/H_2O$ (25:75)	Extract filtration 0,45 um	alumina	SPE: C18 cartridges
Instrumental analysis	HPLC-MS/MS (QqLIT)	UPLC- MS/MS	GC-NCI-MS	LC-QqLIT-MS-MS

WP4: Pharmaceuticals in suspended solids vs. sediments

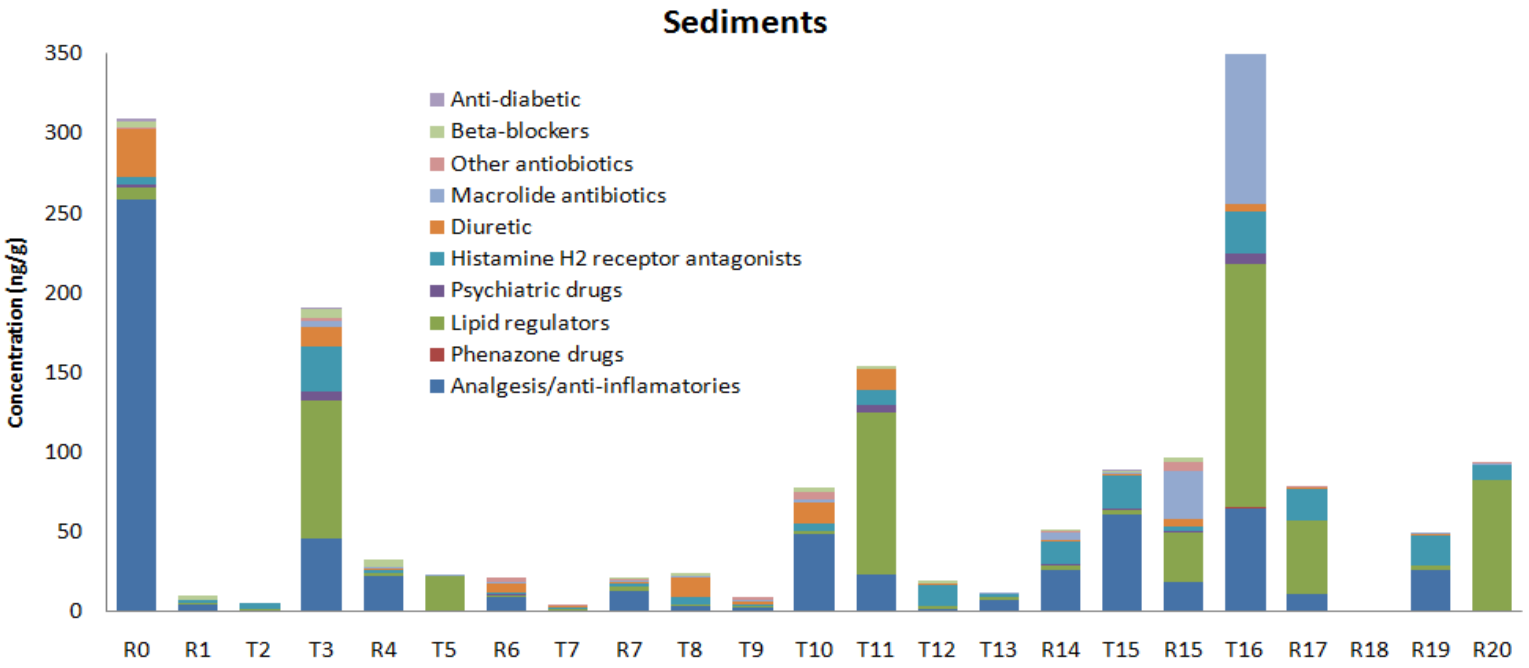


Range:
336 – 5104 ng/g

Analgesics/anti inflamatories

Beta-agonists

Other antibiotics



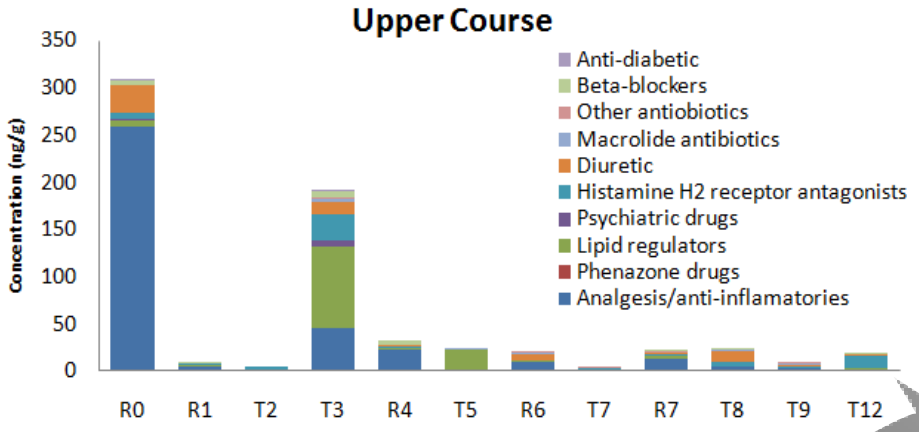
Range:
5 – 382 ng/g

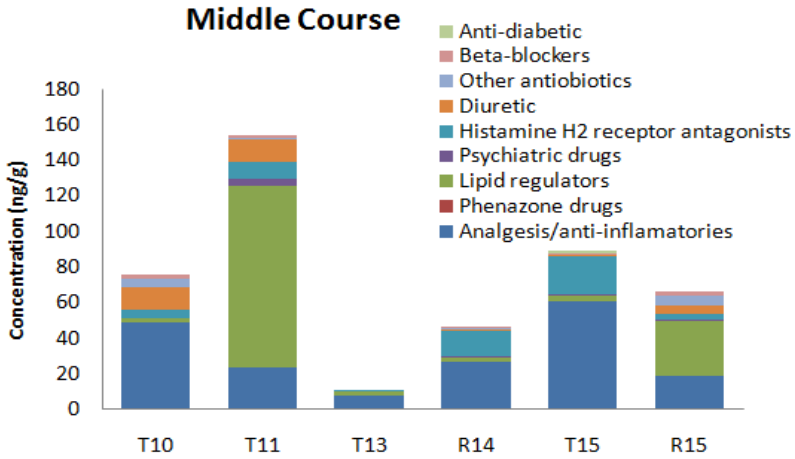
Analgesics/anti inflamatories

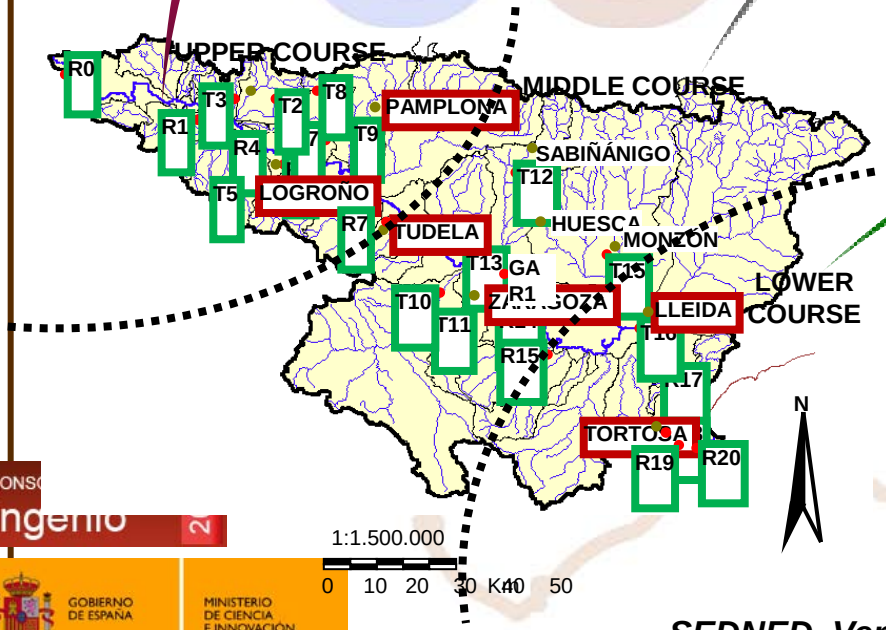
Lipid regulators

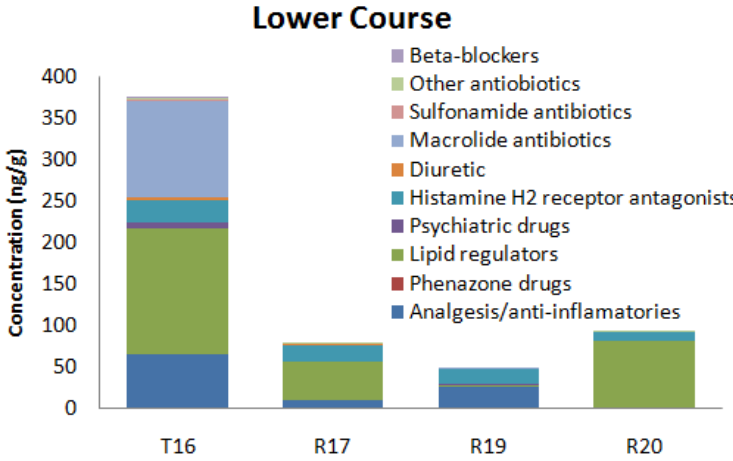
Other antibiotics

WP4: Pharmaceuticals in sediments sites



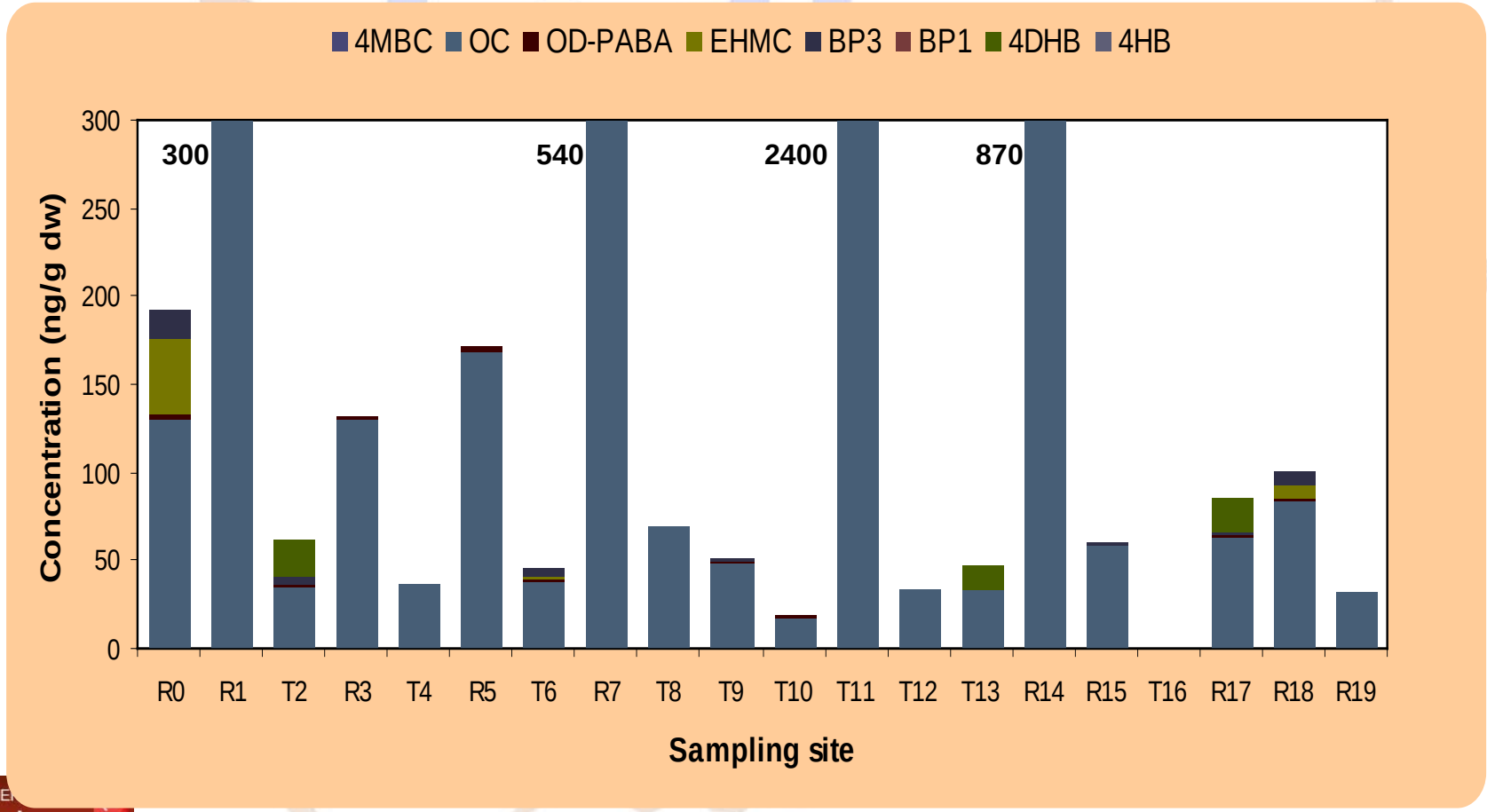




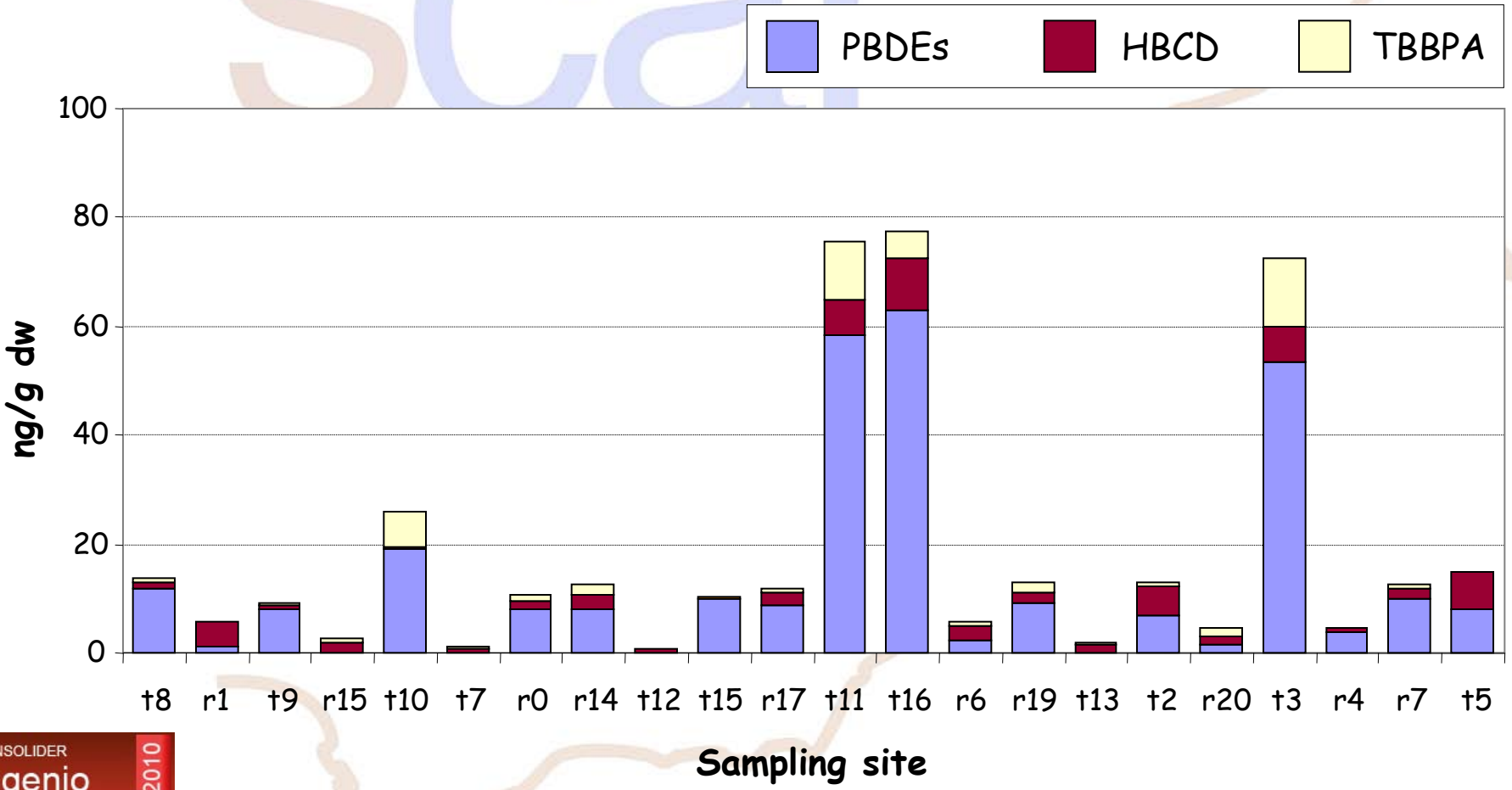


OCCURRENCE DATA

Data from Gago-Ferrero, P; Díaz-Cruz, MS. and Barceló, D. Anal. Bioanal. Chem. (2011) In press. (DOI:10.1007/S00216-011-4951-1)



BFRs – PBDEs + HBCD + TBBPA



Conclusions

Pharmaceuticals, UV-filters: Total concentration in river water 70% in aqueous phase and 30% in suspended solids (suspended matter cannot be neglected!!)-

Some compounds preferentially found bound to suspended solids (one order of magnitude higher concentrations than in sediment)

- Surface Water (Pharamaceuticals, UV filters):
  - Effluent water – high concentration (4557 – 9486 ng/L);
    - Analgesics/antiinflamatories; Diuretics.
  - River water – 16 – 1335 ng/L (river sites);
    - Tributaries (27 – 13540 ng/L);
    - Analgesics/antiinflamatories.
- Solid samples:
  - Suspended solids – 336 – 5104 ng/g;
    - Analgesics/antiinflamatories; Beta-agonists.
  - Sediments – 5 – 2400 ng/g;
    - Pharmaceuticals, UV filters and BFR.

EU Council conclusions on water scarcity, drought and adaptation to climate change

11-june 2010

“Highlights the adverse effects in the quality and availability of water resources and possible negative effects on biodiversity and human health”

“Underlines the importance of latest data by IPPC and Climate change is expected to magnify regional differences so that a higher frequency and severity of droughts can be expected, particularly in Southern Europe”

The role of SCARCE

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

www.idaea.csic.es/scarceconsolider

Thanks!