Water Management in Catalan basins

A general overview on water management and drought challenges in Catalonia

Agència Catalana de l'Aigua

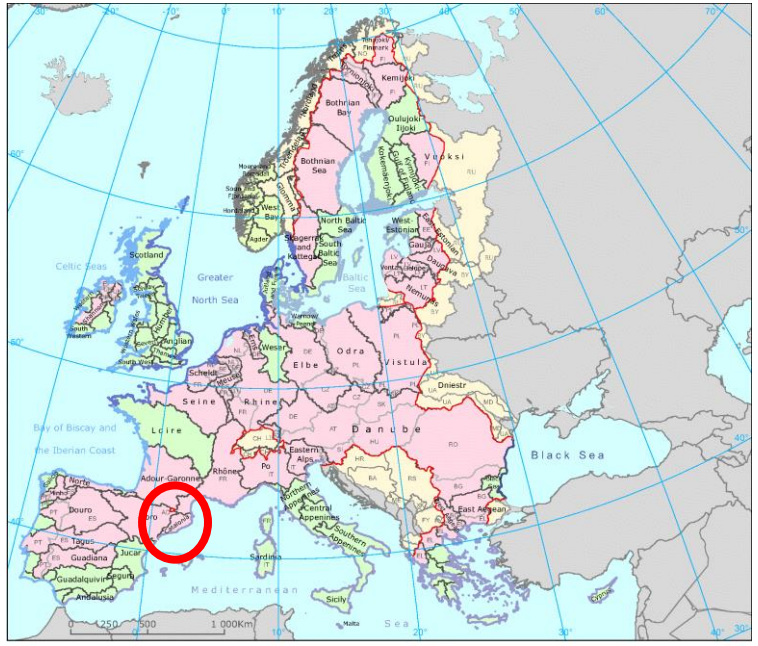
Generalitat de Catalunya

Topics

1. Introduction to the Catalan region and the Catalan River Basin District
2. Monitoring Program and outcomes (water quality)
3. Main issues and coming challenges:
    - Chemical status and contaminants of concern
    - Hydromorphological quality (river protection and restoration)
    - Diffuse pollution from agricultural activities (nitrates and pesticides)
    - Climate change
4. Coping with drought periods (Indirect Potable Water Reuse in Barcelona)

Location (Catalan basins)

River basin districts in Europe according to the **EU Water Framework Directive (2000/60/EC)**

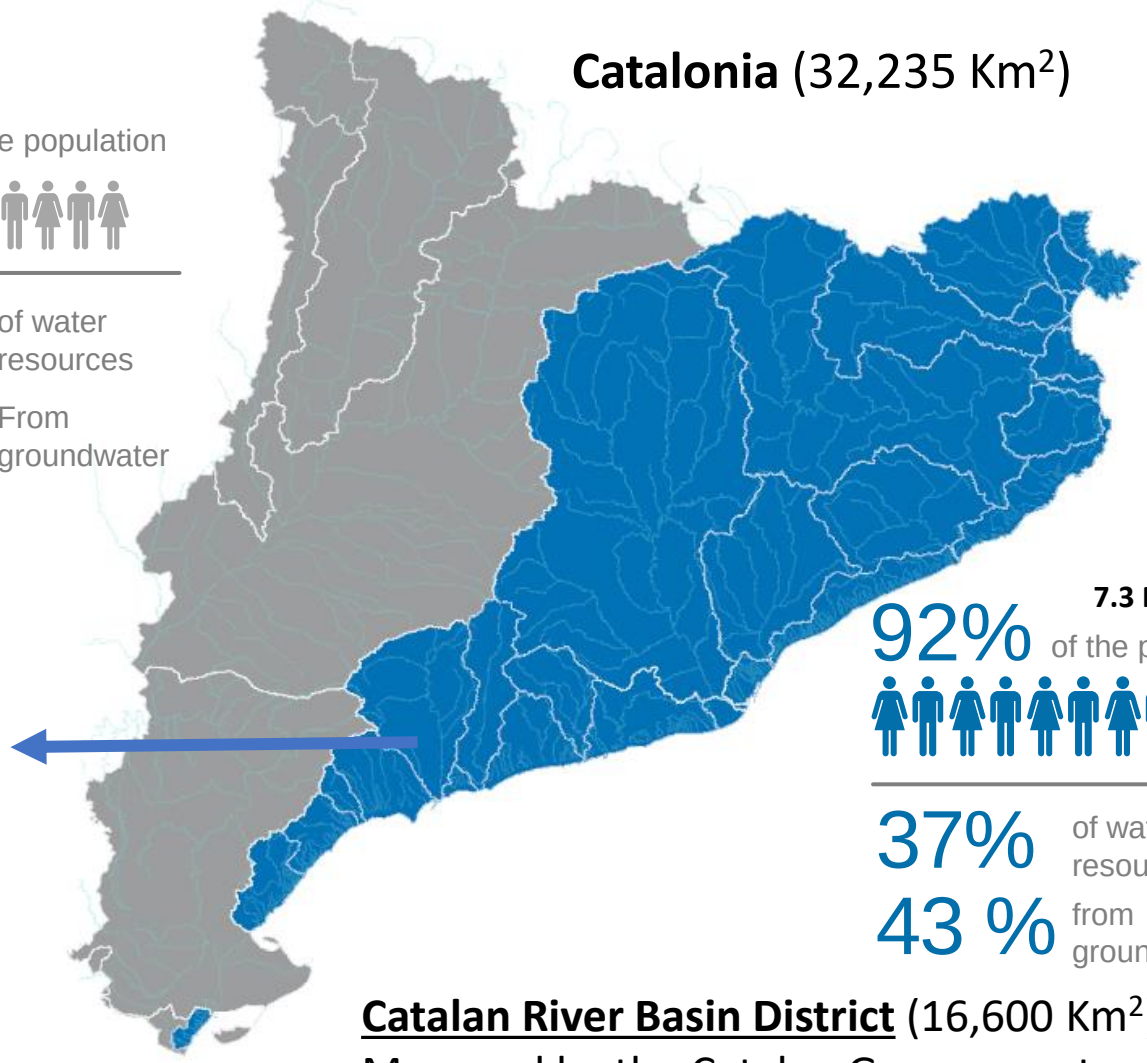


Catalonia (32,235 Km^2)

8% of the population

63% of water resources

5% From groundwater



7.3 M people

92% of the population

37% of water resources

43 % from groundwater

WATER CONSUMPTION

Urban	44%
Industrial	20%
Agriculture	36%

<u>Catalan River Basin District</u> (16,600 Km^2)
Managed by the Catalan Government
(Catalan Water Agency)

Mediterranean flow regime

Catalan rivers have sequential seasonal events with **high flow regime variability** (combining drought and wet seasons, with sudden floods)

This situation must be taken into account in order to correctly manage water, and to develop a suitable Monitoring Programme

Topics

1. Introduction to the Catalan region and the Catalan River Basin District
2. Monitoring Program and outcomes (water quality)
3. Main issues and coming challenges:
    - Chemical status and contaminants of concern
    - Hydromorphological quality
    - Diffuse pollution
    - Climate change
4. Coping with drought periods (Indirect Potable Water Reuse in Barcelona)

Monitoring programme

A suitable monitoring program is applied according to the **EU Water Framework Directive (2000/60/EC).**

The Catalan Government approves and updates the **Water Monitoring Program** every 6 years:

- **Surveillance monitoring network:**
  - General overview of the basin quality status
  - Assessment of long-term changes due to natural or anthropogenic causes
- **Operational monitoring network:**
  - Assess changes in the status of WBs resulting from the Program of Measures
- **Protected areas monitoring network:**
  - Additional monitoring requirements established by the legislation that gave rise to the protection
- **Investigative monitoring network:**
  - To be applied when causes of bad quality are unknown (identification of pollution sources), or in single events (accidents, natural catastrophes, waste spillages, etc.)

Outcomes are reported to the **European Commission** trough the Spanish authorities

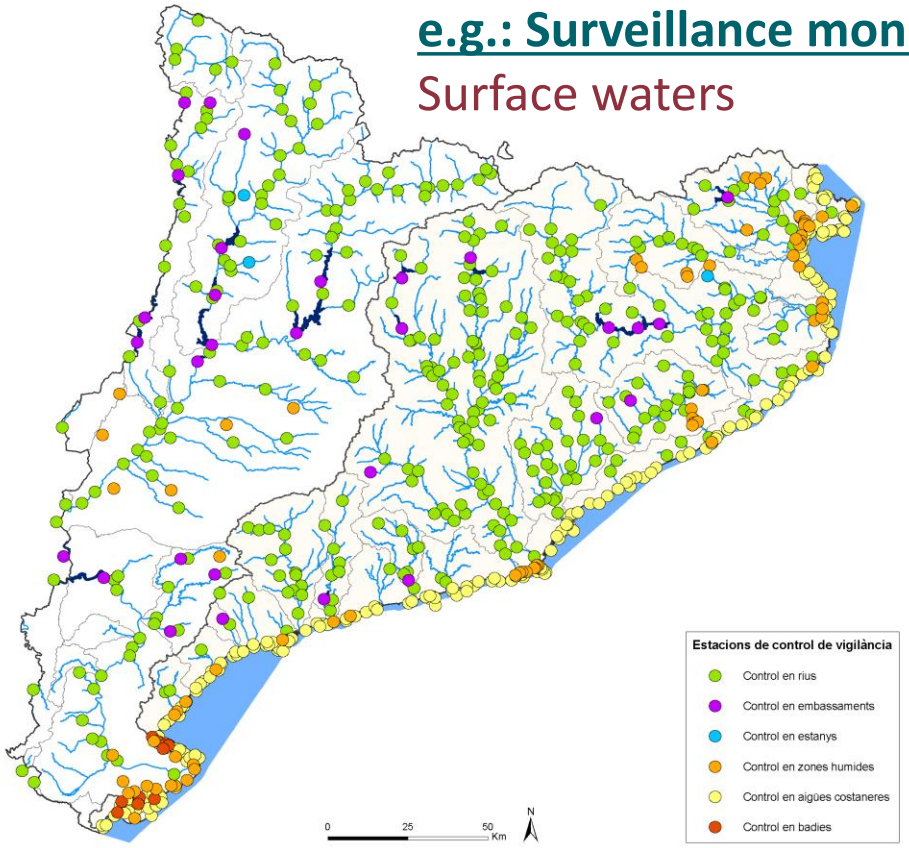
Monitoring programme

Sampling sites are widely spread over the Catalan River Basin District, and the Ebro basin located in Catalonia, to obtain a representative water quality assessment.

	Catalan River Basin District	Ebro basin in Catalonia	Total (32,000 Km²)
Rivers	400	98	498
Lakes	1	2	3
Wetlands	56	27	83
Coastal waters	485	73	558
Groundwater	1,402	381	1,783
Total	**2,344**	**581**	**2,925**

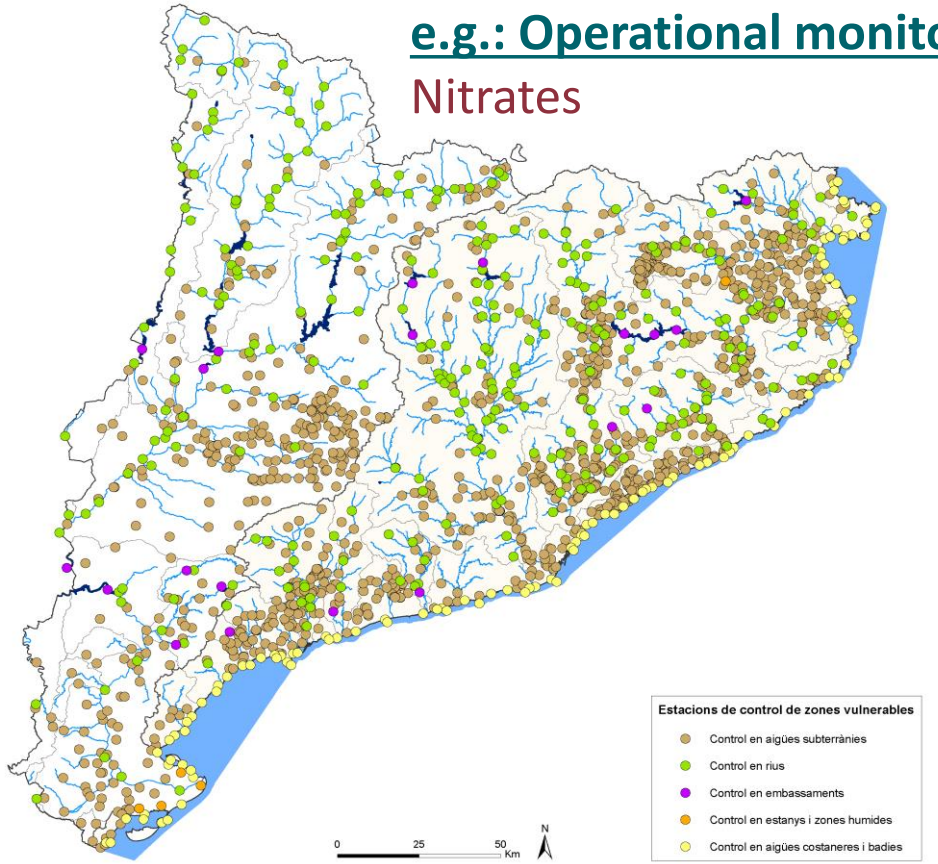
e.g.: Surveillance monitoring

Surface waters



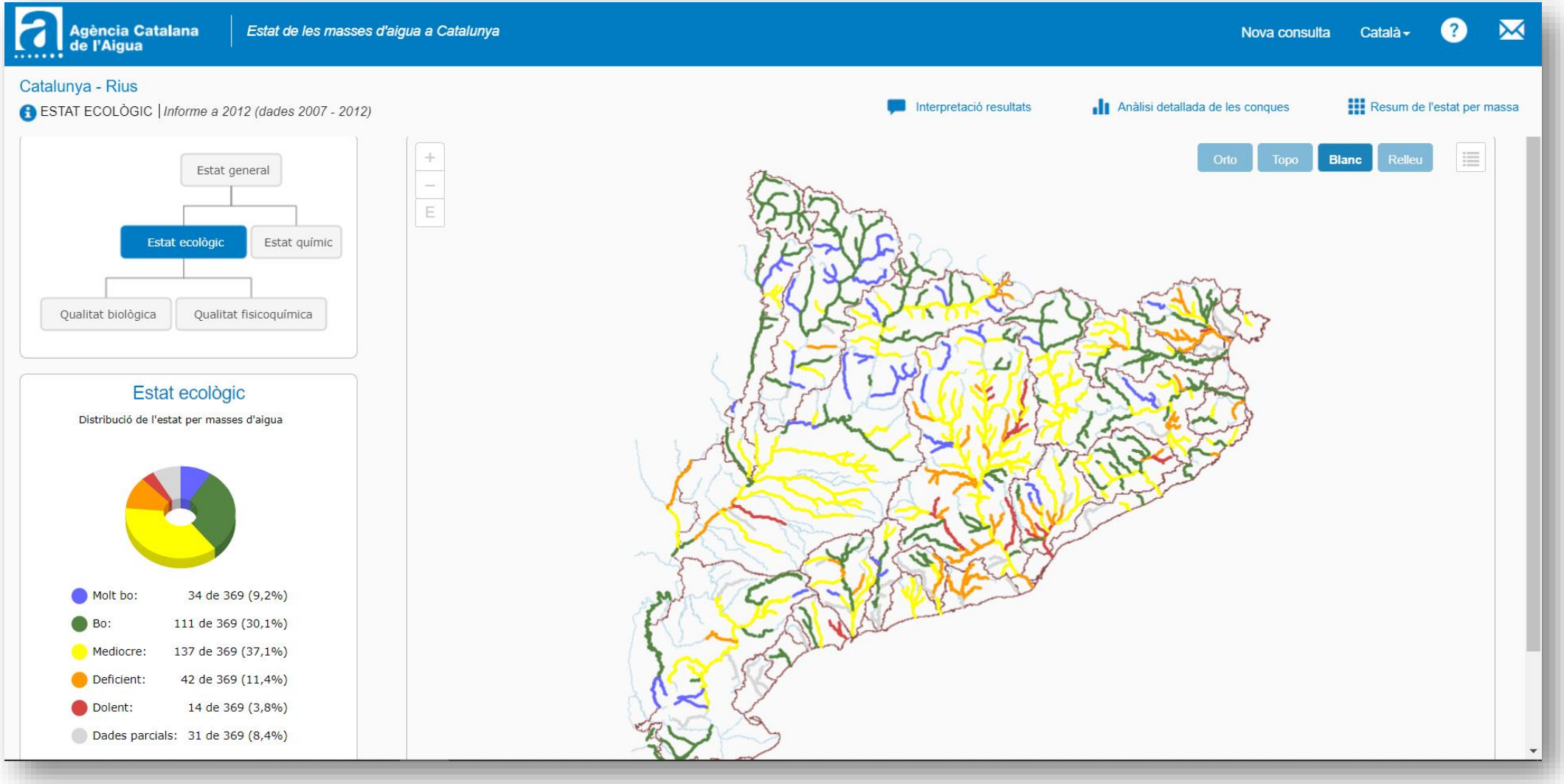
e.g.: Operational monitoring

Nitrates



Monitoring programme

Data and results are fully available at the Catalan Water Agency webpage: https://aplicacions.aca.gencat.cat/sdim21 and https://aplicacions.aca.gencat.cat/WDMA/



Monitoring programme. Main outcomes

Current water status in Catalan RBD water bodies and **targets to be achieved by 2027**:

Water body category	Num. water bodies with good status	Num. water bodies with good status by 2027
Rivers	89 (36%)	174 (70%)
Reservoirs	7 (54%)	8 (62%)
Wetlands	17 (36%)	28 (59%)
Lakes	1 (100%)	1 (100%)
Costal waters	20 (61%)	22 (67%)
Groundwater	9 (24%)	24 (55%)
TOTAL	**143 (38%)**	**260 (66%)**

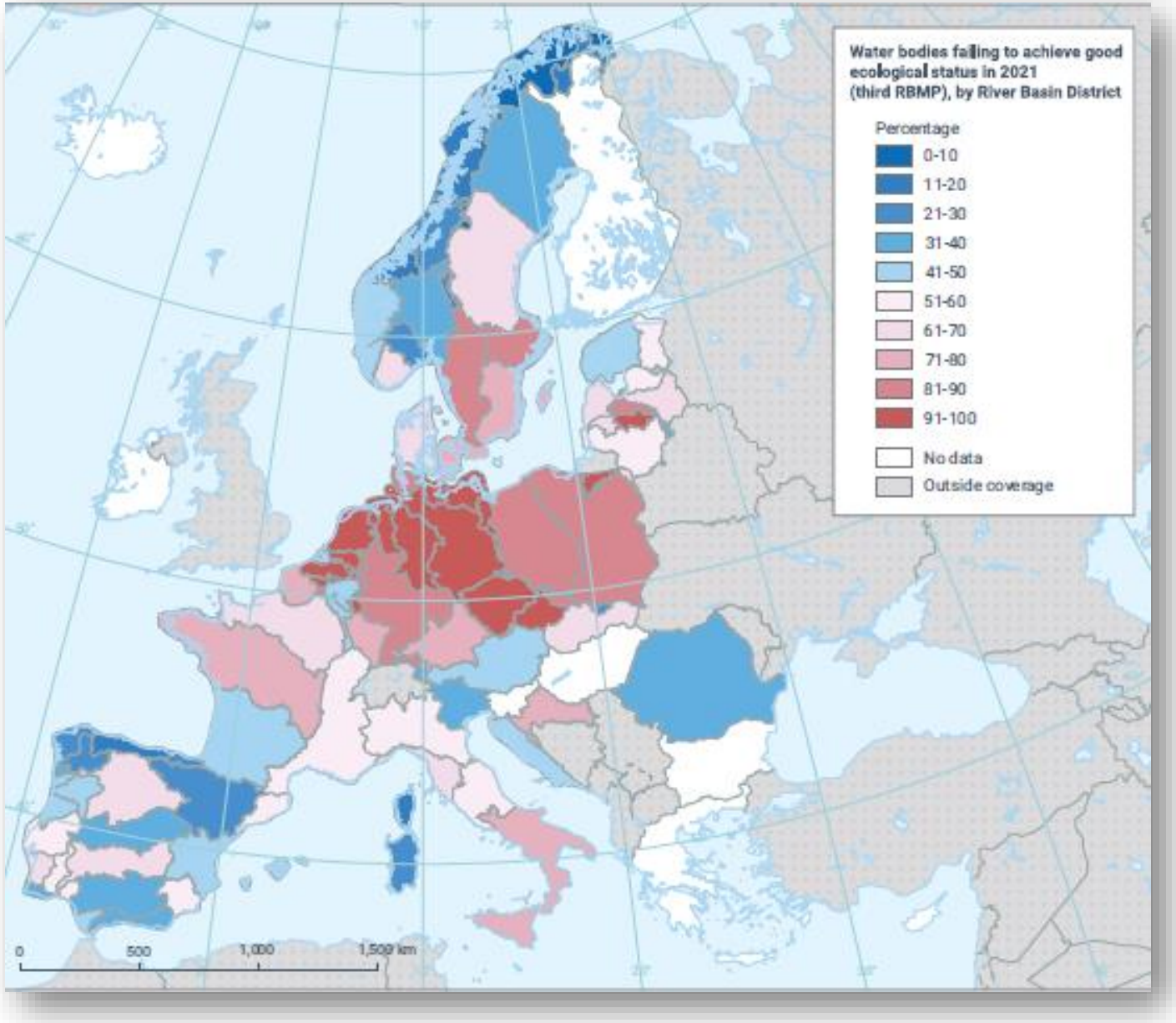
Monitoring programme. Main outcomes

In Europe, most of Member States declare **over 60% of their water bodies below good conditions**.

Achieving good ecological status according to the Water Framework Directive requires considerable effort on palliative and corrective measures.

Europe's state of water 2024. European Environmental Agency (EEA) Report 07/2024: https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024

Map viewer: https://www.eea.europa.eu/en/analysis/maps-and-charts/water-framework-directive-rbmp



Topics

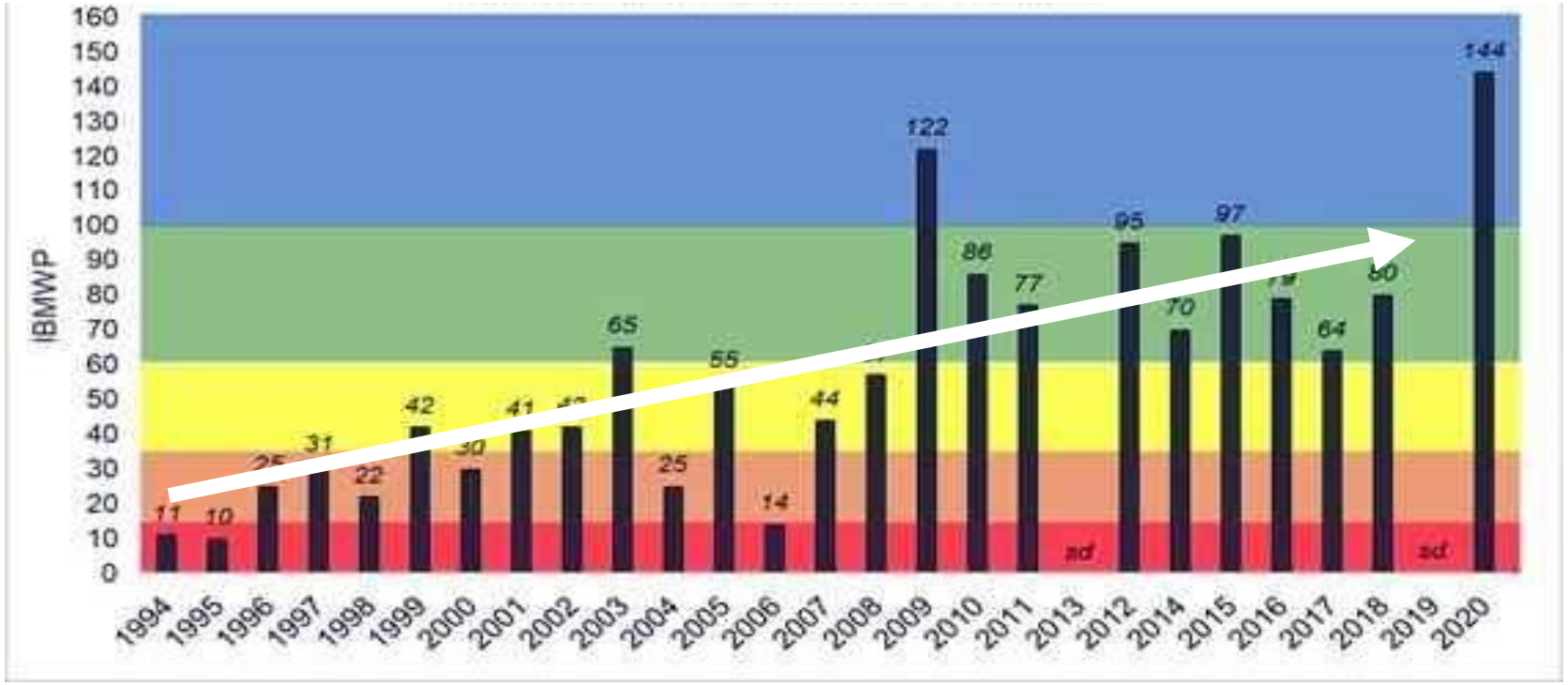
1. Introduction to the Catalan region and the Catalan River Basin District
2. Monitoring Program and outcomes (water quality)
3. Main issues and coming challenges:
    - Chemical status and contaminants of concern
    - Hydromorphological quality
    - Diffuse pollution
    - Climate change
4. Coping with drought periods (Indirect Potable Water Reuse in Barcelona)

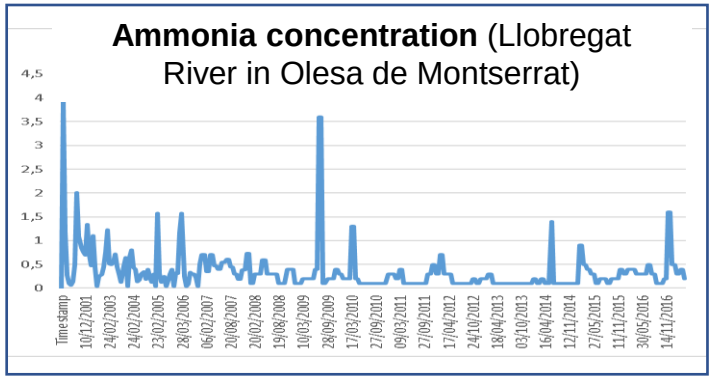
Progressive improvement. Nutrients and ecological quality

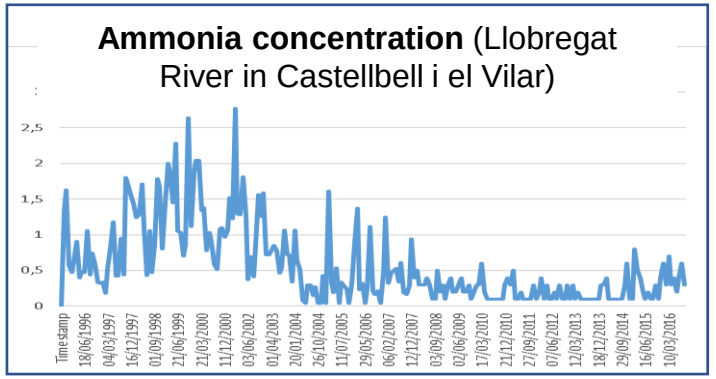
Over 550 Urban Waste Water Treatment Plants have been built over the last decades in Catalonia (by the Catalan Water Agency) which currently **covers 97% of the Catalan population**.

The improvement in physicochemical quality has translated into an **environmental improvement** and in the communities of invertebrates and algae (a clear link with the reduction of ammonia in the rivers).

Biological quality Index based on macroinvertebrates (Llobregat River. Source: Carimed FEHM)

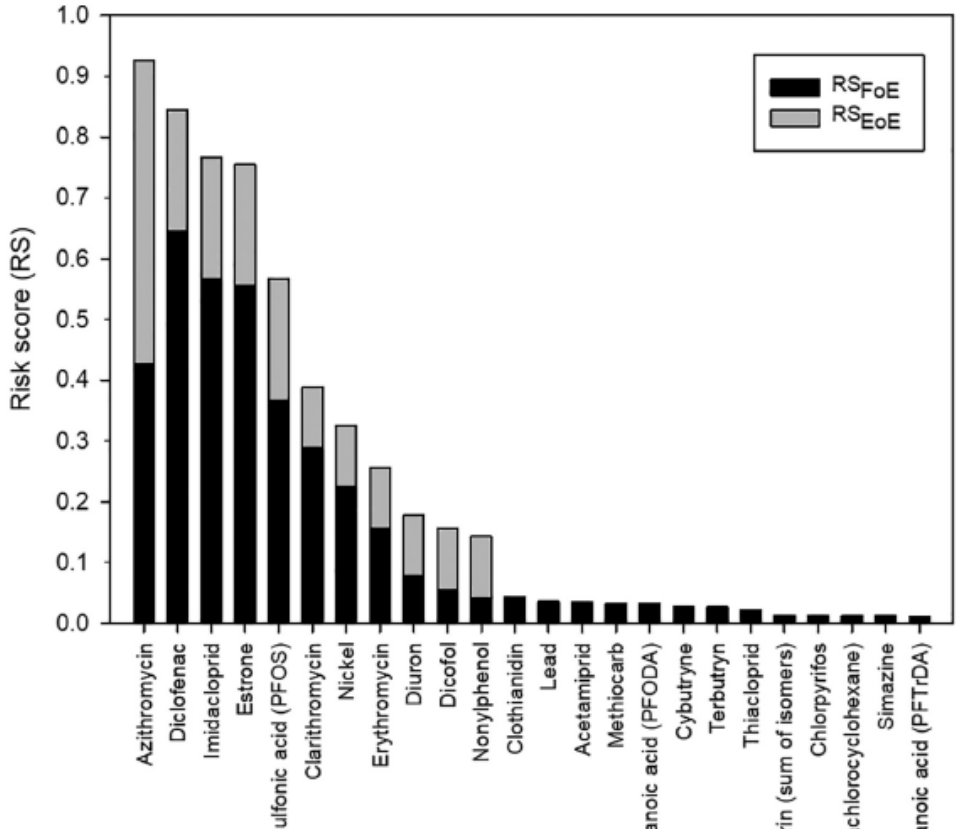


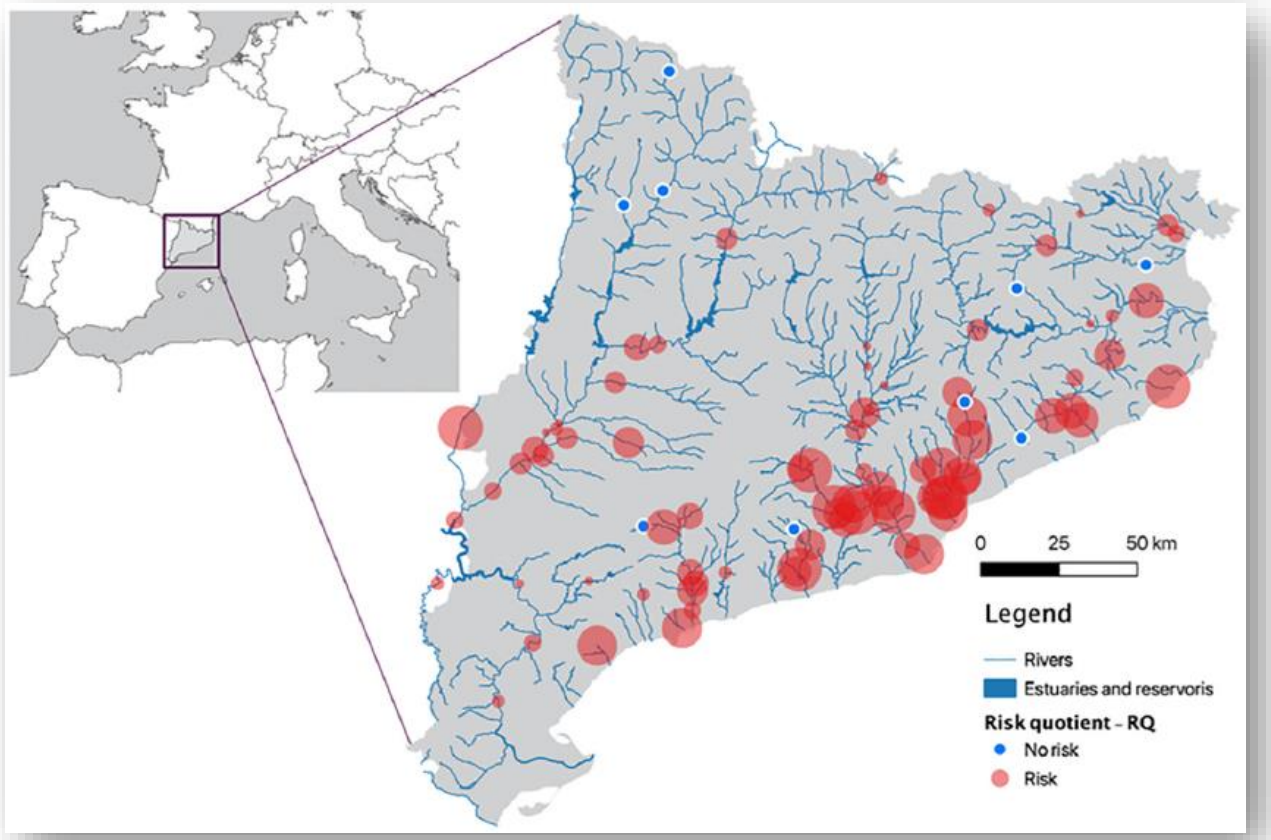




Main issues. Chemical status and contaminants of concern

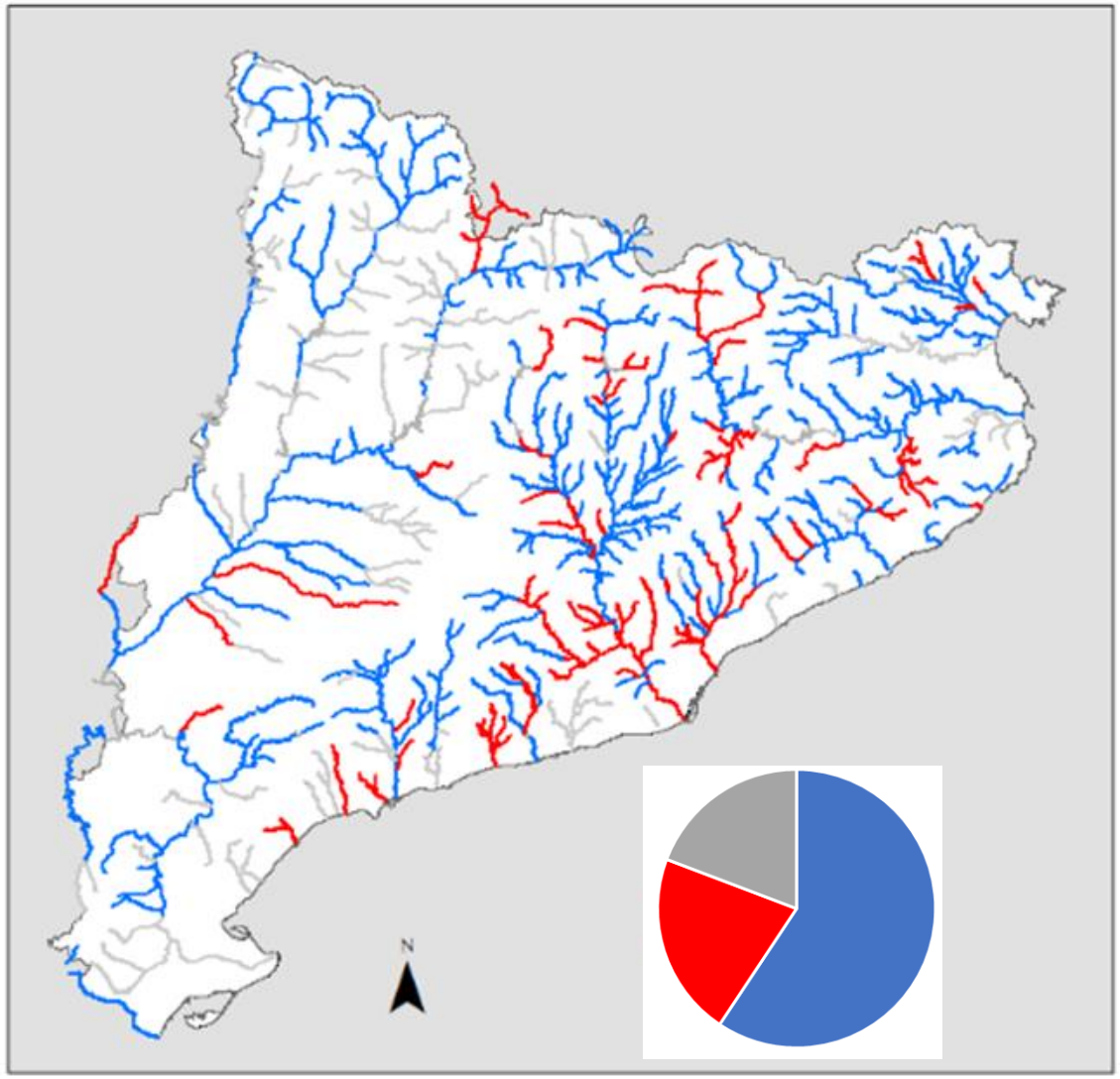
The Catalan Water Agency (ACA) and the Catalan Water Research Institute (ICRA) have collaborated in the analysis and **detection of emerging pollutants** in the Catalan rivers: *(Llorens et al, 2020. Occurrence of regulated pollutants in populated Mediterranean basins: Ecotoxicological risk and effects on biological quality. Science of the Total Environment, 747)*. The frequency and concentrations detected, and the environmental risk are analyzed:





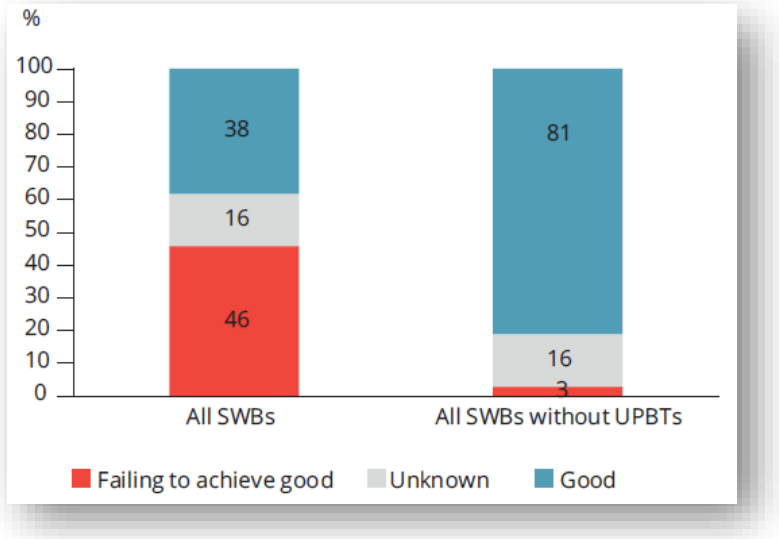
Chemical status in the Catalan river water bodies

Water bodies with a bad chemical status (2024):



Good	Not good	Unknown
219	79	71
59%	21%	19%

Europe's state of water 2024. European Environmental Agency (EEA) Report 07/2024: https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024

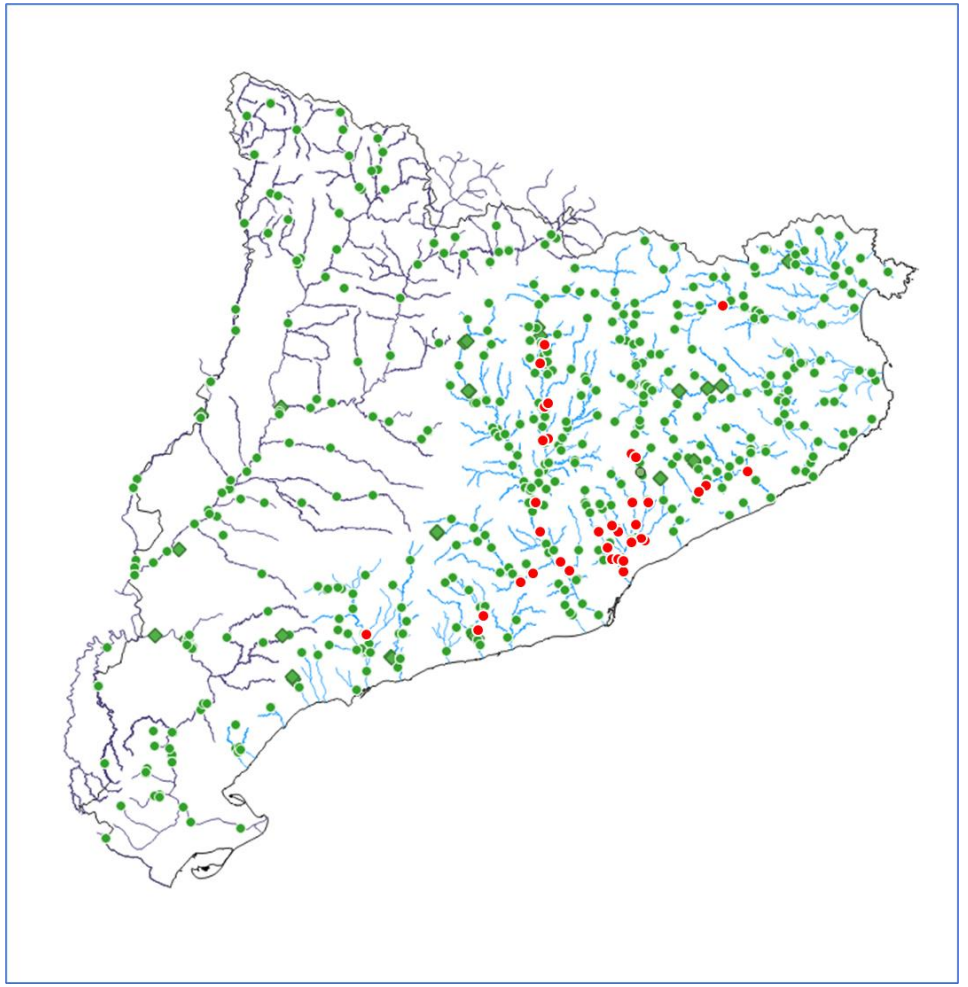


PFAS. Surface water

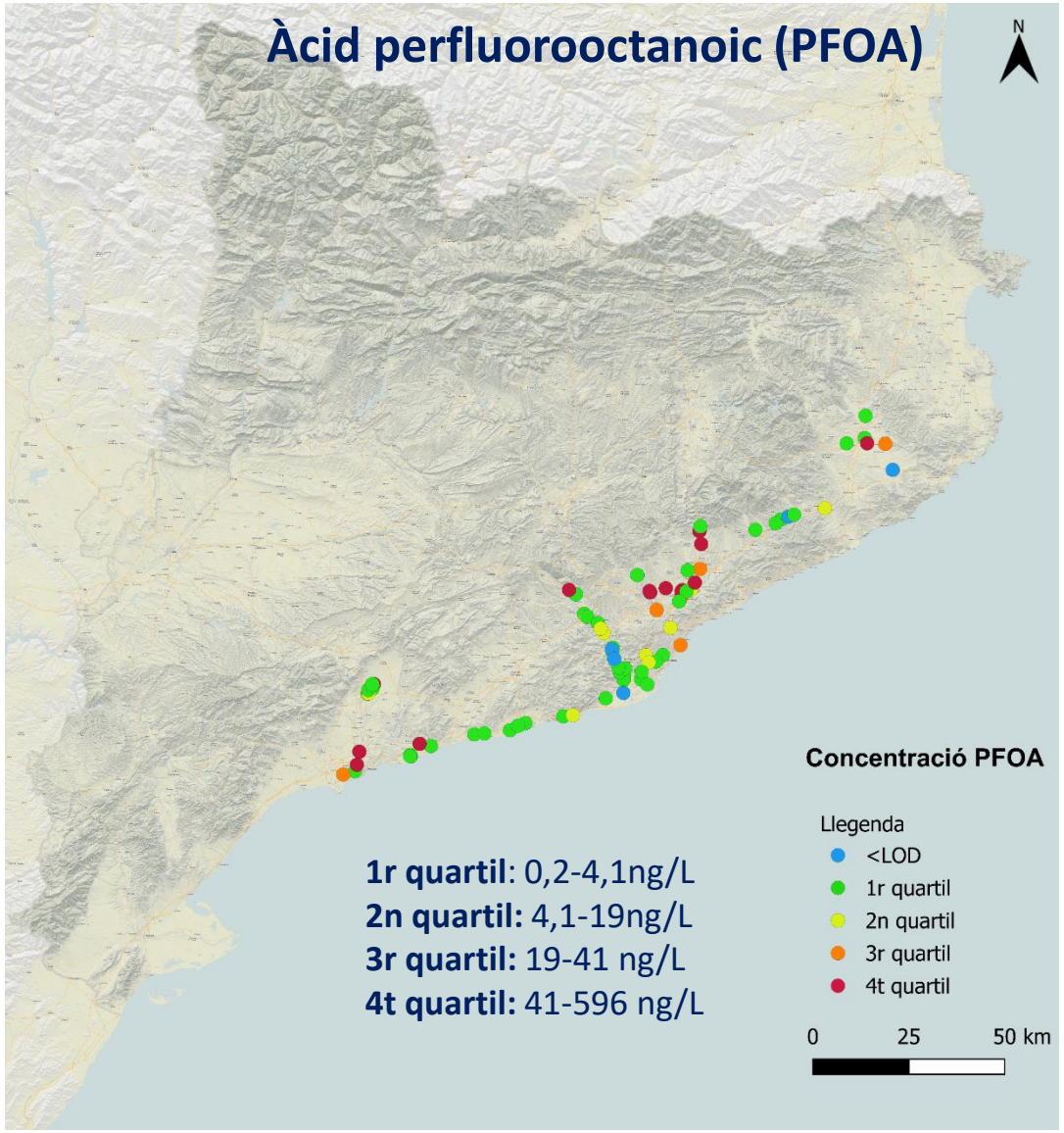
- Currently, **PFOS** is analyzed in nearly all inland surface water bodies, with analytical frequencies based on chemical pressure and previous PFAS results.
- Regarding **Σ_{20} PFAS,**
  - from 2023-2024, they were analysed in relevant catchment areas.
  - since 2025, analyses have been extended to all freshwater bodies.

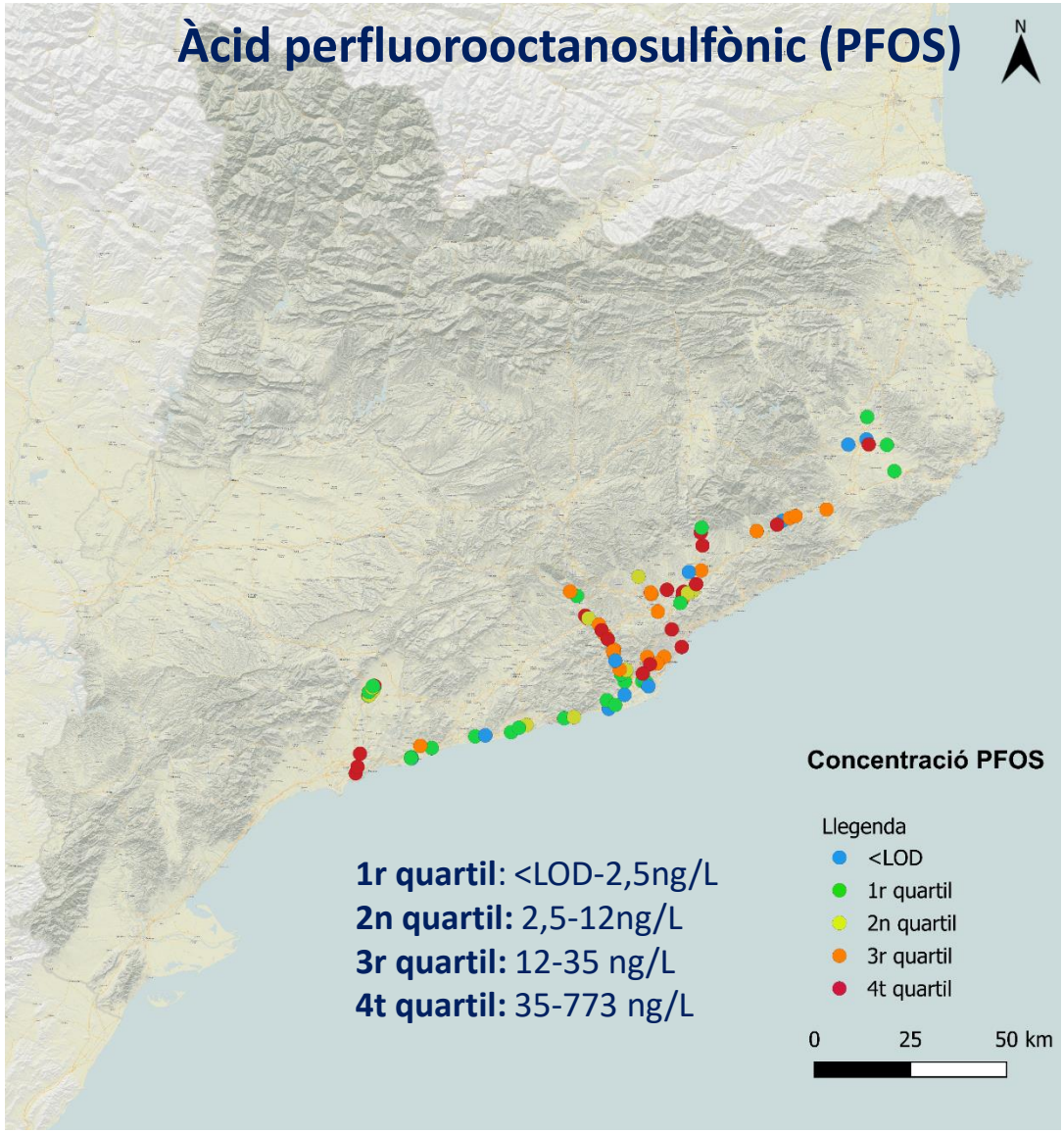
		2023	2024	2025*
Number of analyses	only PFOS	343	361	0
	20 PFAS	71	69	~437
Number of monitored sites	only PFOS	163	96	0
	20 PFAS	25	24	161
Sites with bad PFOS status		**4 (2%)**	**10 (8%)**	**22 (14%)**
Sites with Σ_{20} PFAS > 100 ng/L		**11 (3%)**	**14 (4%)**	**1 (<1%)**

*Estimated figures by the end of the year.

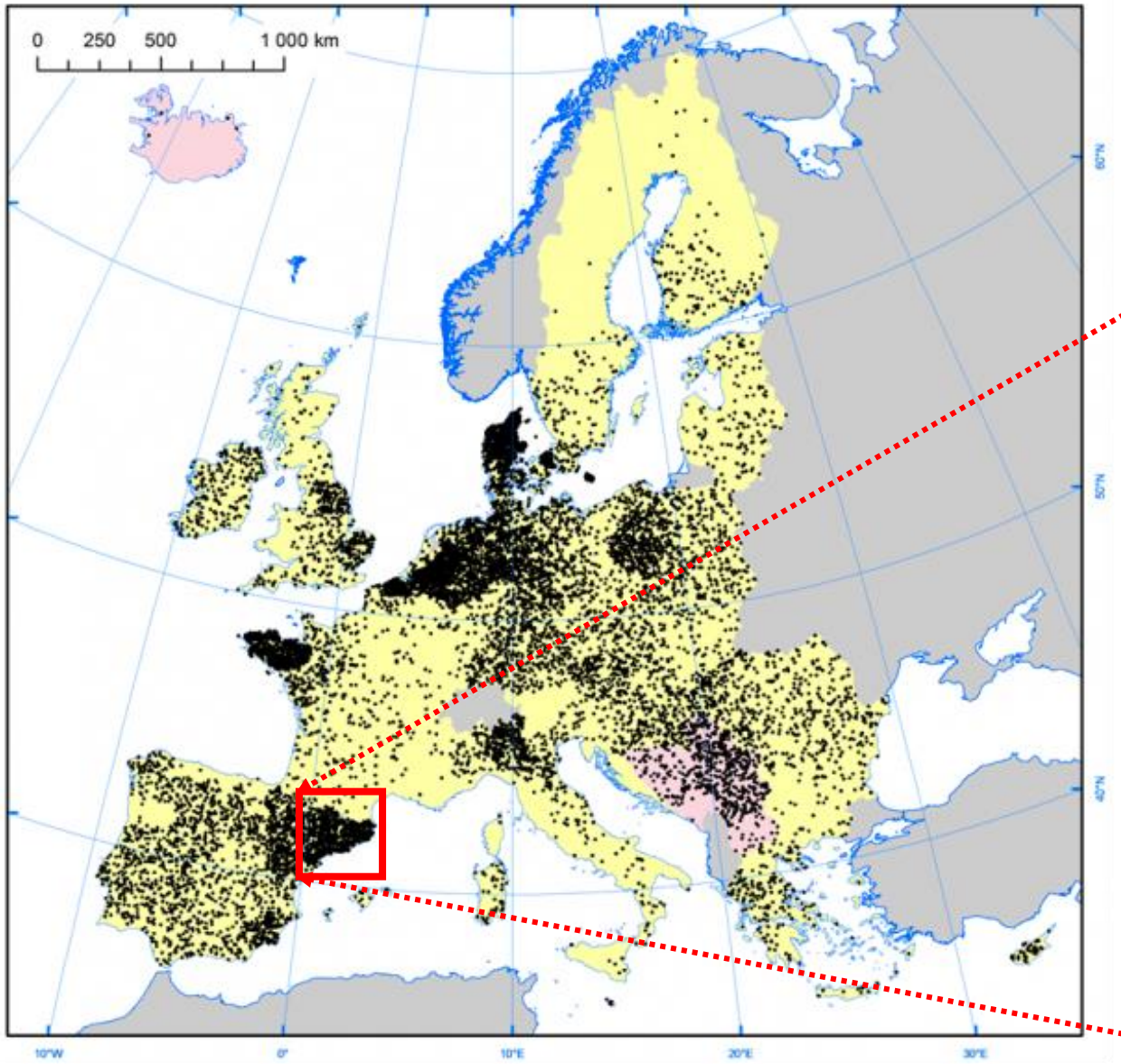


PFAS. Groundwater



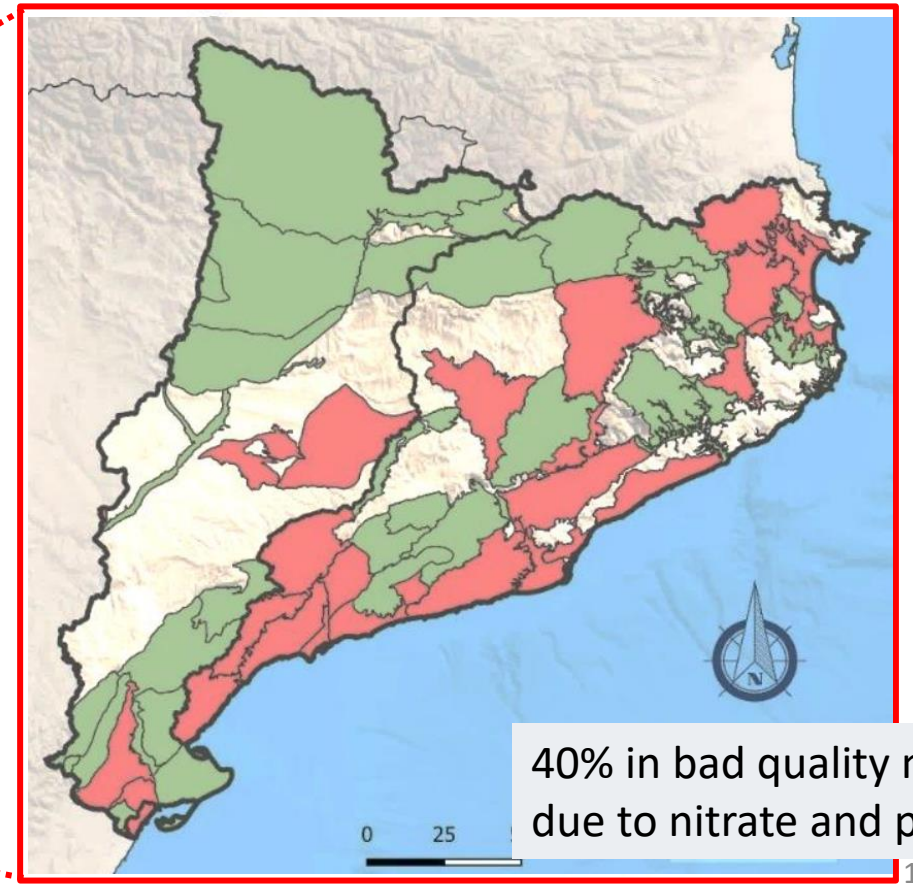


Main issues. Diffuse pressures. Farm density (nitrate)



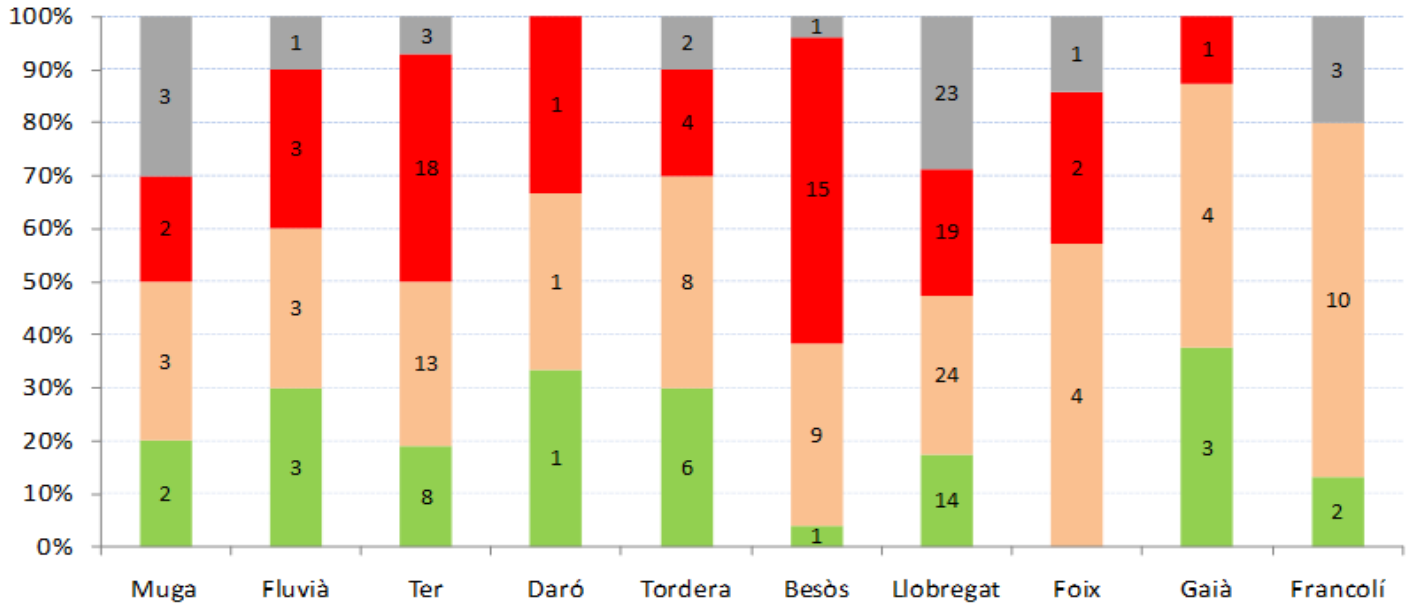
Nitrogen surplus has been calculated by total production and crop ability to uptake:

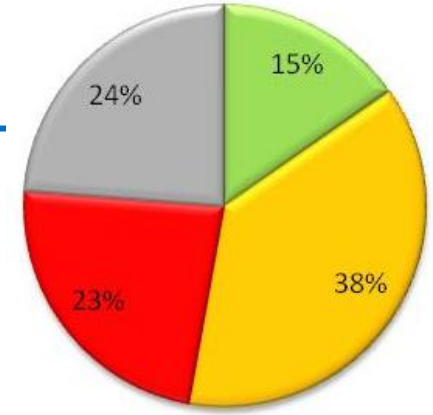
- Total N production (estimated): **88,971 Tm/y**
- Total potential uptake (estimated): **148,404 Tm/y**

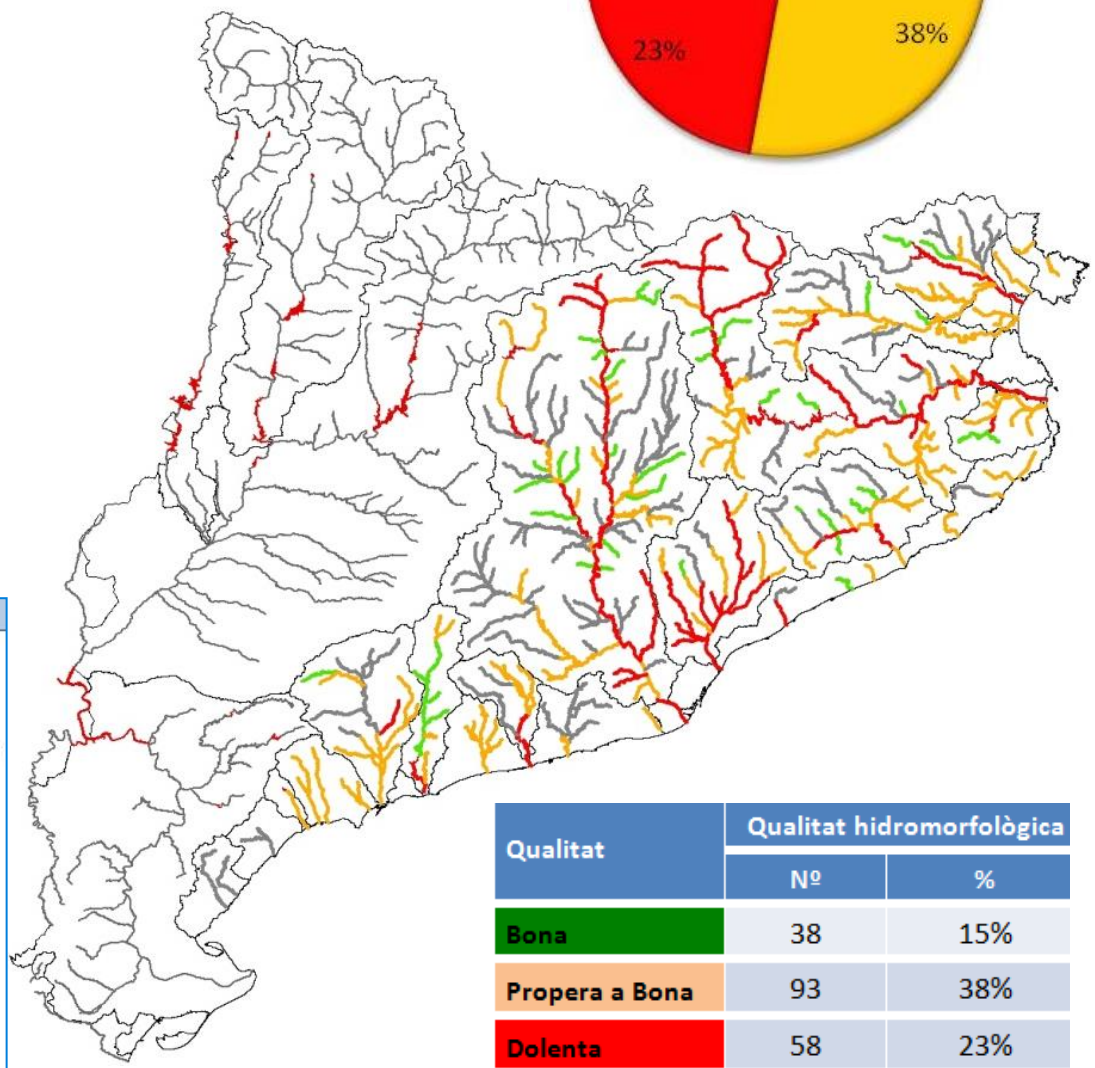


40% in bad quality mainly due to nitrate and pesticides

Main issues. Hydromorphological conditions

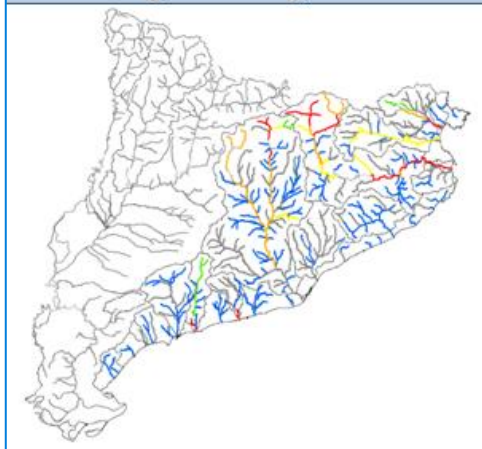




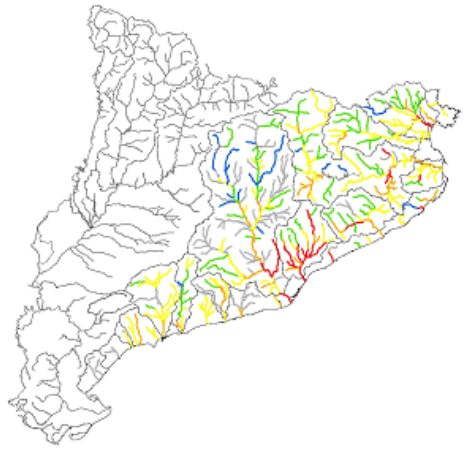


Qualitat	Qualitat hidromorfològica	
	Nº	%
Bona	38	15%
Propera a Bona	93	38%
Dolenta	58	23%
Sense valoració	59	24%

Regim hidrològic



Condicions morfològiques



Continuïtat fluvial

Measures to increase ecosystem resilience (Nature Based Solutions)

Special attention in **protected areas** (Habitat and birth Directives: 92/43/CEE and 79/409/CEE).

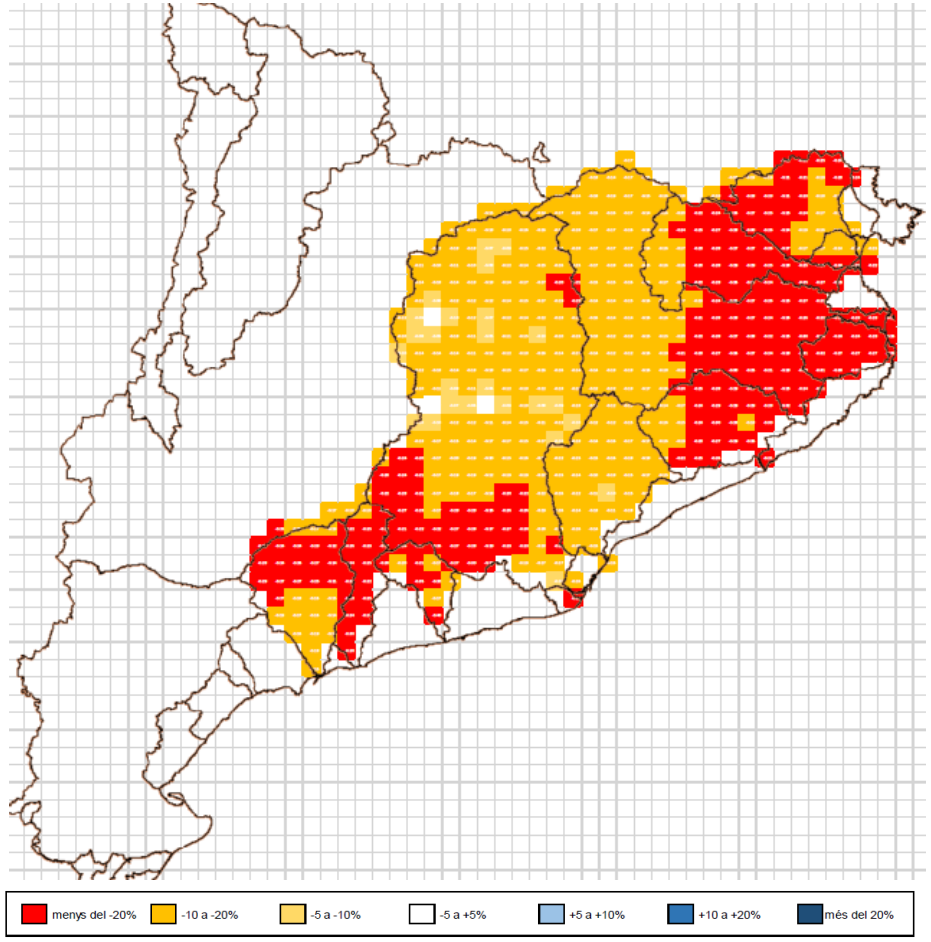
Threatened species (e.g):

- *Anodonta anatine*
- *Anodonta woodiana*

River restoration and river connectivity – free flowing rivers (according to Art. 9, **Nature Restoration Law**). Over **50 M€** are planned to restore aquatic ecosystems.

Main issues. climate change

An **SRES-A1B** scenario is considered as reference (equivalent to **RCP 6.0**), for the horizon 2039 based on projections of the **ESCENA model** applied on a semi-distributed monthly passage hydrological model (5x5 km)..

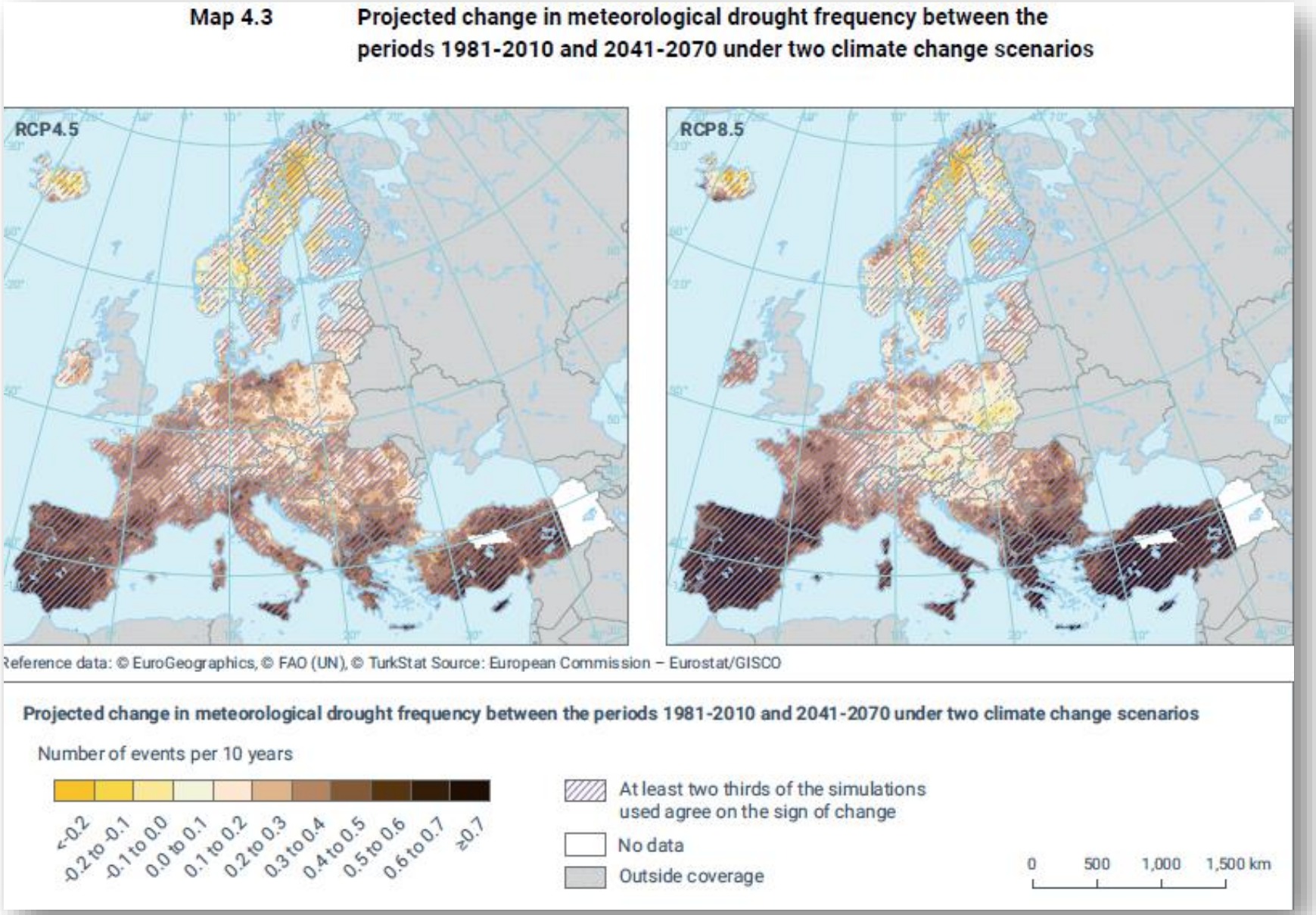


Basins	Average 2021-2050 vs. 1971-2000
Muga	-20.9%
Fluvià	-22.7%
Ter a Ripoll	-16.0%
Ter a Sau	-15.4%
Ter complet	-18.4%
Tordera	-23.9%
Besòs	-14.4%
Llobregat a Sallent	-13.1%
Cardener a Cardona	-20.7%
Anoia complet	-13.1%
Llobregat complet	-14.8%
Foix	-22.3%
Gaià	-22.8%
Francolí	-20.6%
Catalan RBD	**-18.3%**

Main issues. climate change

An increase in the frequency and duration of droughts is expected from 0.5 to 0.7 per decade by the middle of the century.

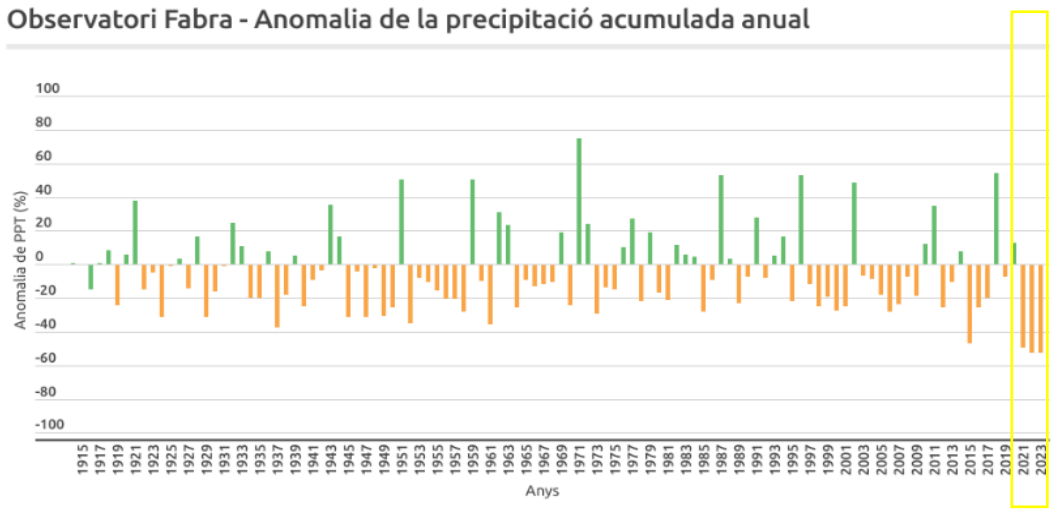
Europe's state of water 2024. European Environmental Agency (EEA) Report 07/2024: https://www.eea.europa.eu/en/analysis/publications/europes-state-of-water-2024



Topics

1. Introduction to the Catalan region and the Catalan River Basin District
2. Monitoring Program and outcomes (water quality)
3. Main issues and coming challenges:
    - Chemical status and contaminants of concern
    - Hydromorphological quality (river protection and restoration)
    - Diffuse pollution from agricultural activities (nitrates and pesticides)
    - Climate change
4. Coping with drought periods (Indirect Potable Water Reuse in Barcelona)

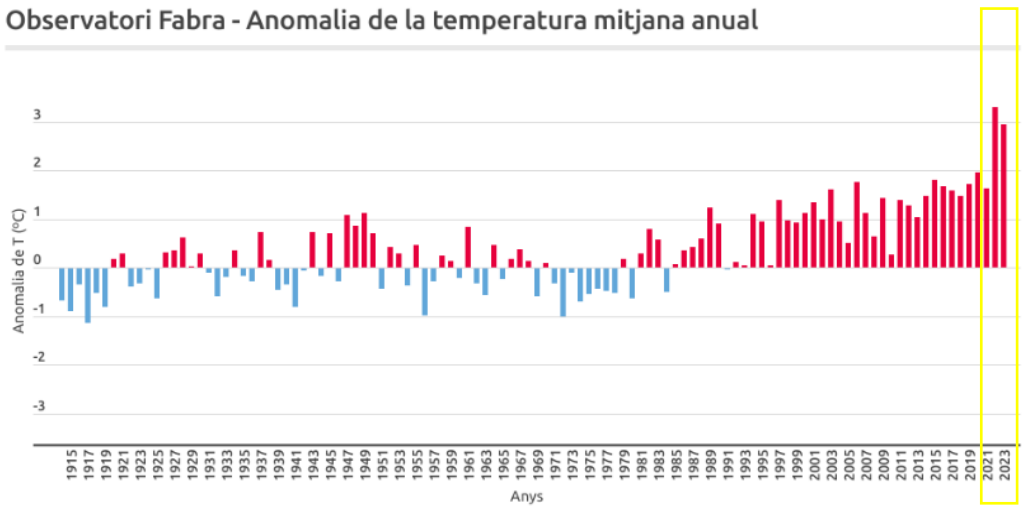
An unprecedented four-year drought



Rainfall deficit of 50%

On the graph:
Annual precipitation anomalies (%)

Sept. 21



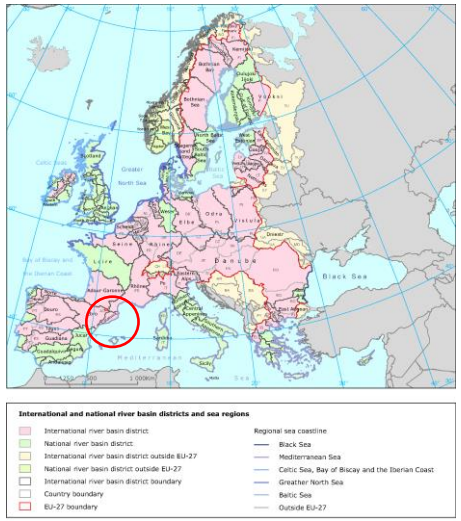
Record temperatures

On the graph:
Annual average temperature anomalies (ºC)

March 24

An unprecedented four-year drought

Barcelona Water Supply System



Sept. 21

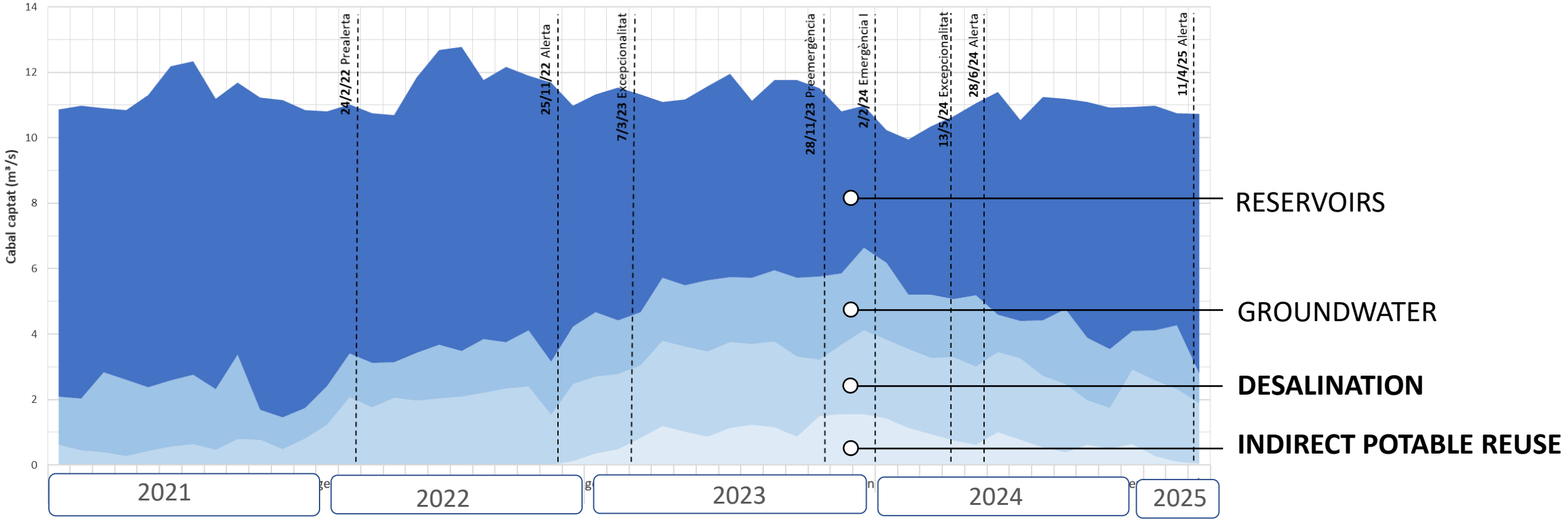
March 24

Sustained rainfall deficit + **Record temperatures**

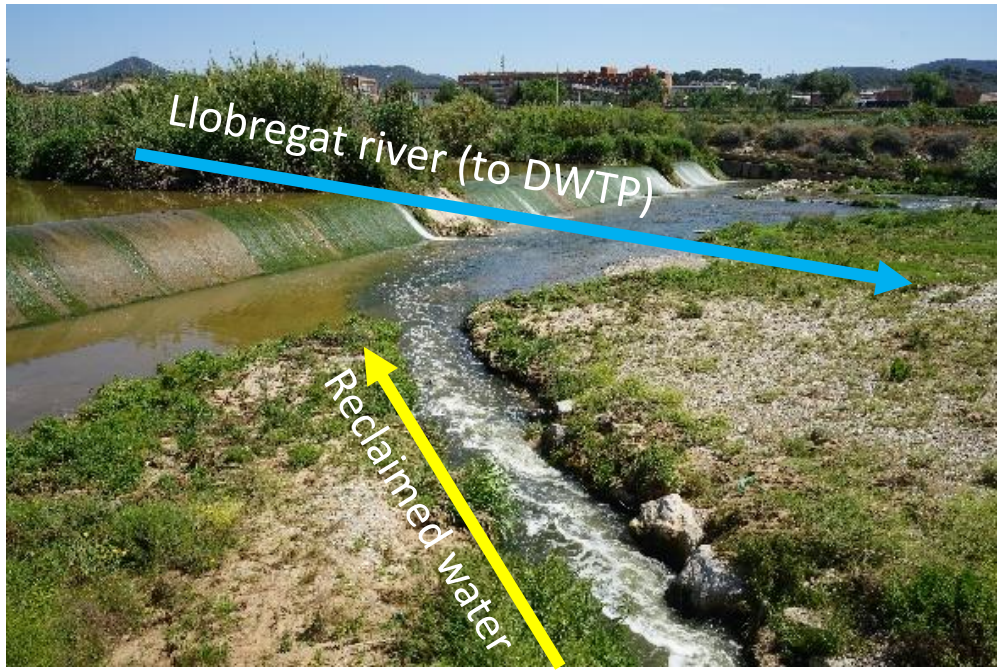
River flows declined a 51% on average

Alternative water resources

Origin of the bulk water supplied to the Greater Barcelona Area during the drought



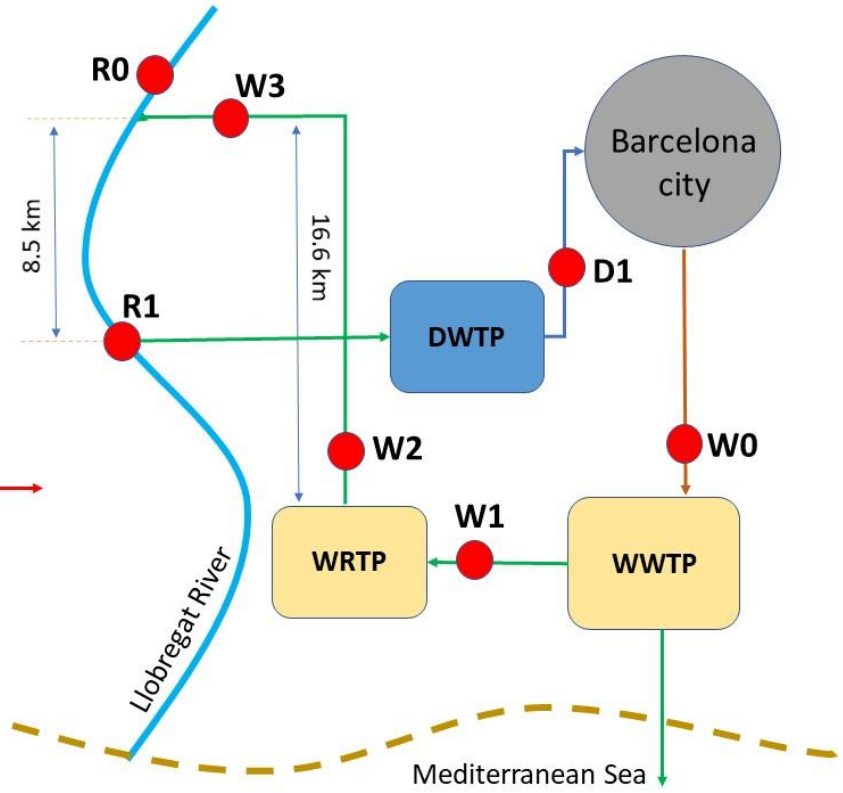
Indirect Potable Reuse in Barcelona



- Tested in 2019 and included in the Drought Plan
- Reclaimed water has been introduced into the river 8 km upstream from Barcelona's Drinking Water Treatment Plant (DWTP).
- This practice has been ongoing for the last 28 months.
- IPR has saved 62 hm^3 in reservoirs.
- This contribution has been crucial in preventing water shortages in Barcelona.

Towards water security: Indirect potable water reuse (IPR)

In 2019, the Catalan Water Agency carried out a trial of IPR in Barcelona drinking water supply. We analysed contaminants of concern which can pose a risk in terms of human health and aquatic life.



- Conducted by a working team, integrated by ACA, the Catalan Health Authority, the local authority, and the DWTP operator.
- Advised by a multidisciplinary expert panel.

Towards water security: A new approach to meet a safety IPR

Approach carried out so far:

Sources are checked to set a preliminary list of compounds of concern, to lately analyze the efficiency of the entire treatment train (WWTP-WRTP-River buffer- DWTP) and chose the most relevant ones to be analyzed:

Preliminary list of compounds. In the Llobregat IPR a list of 835 micropollutants was drafted for consideration

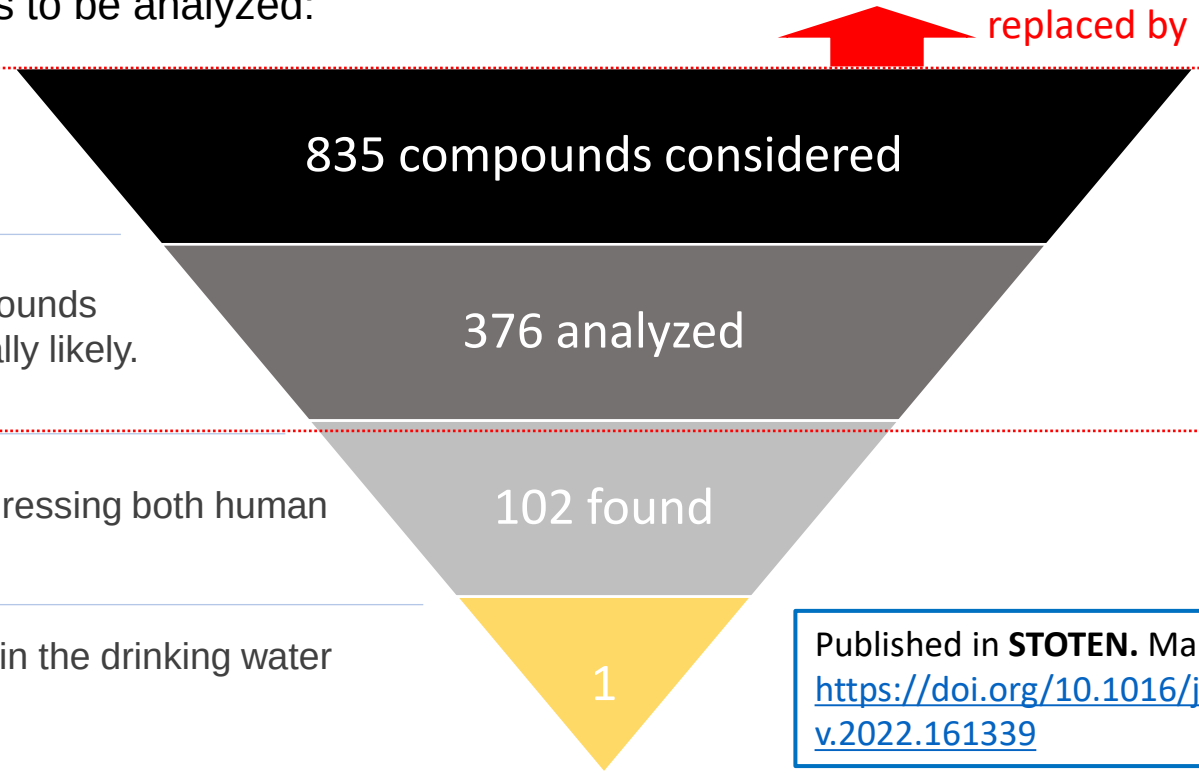
A **"short-list"** was agreed upon, consisting of those compounds whose presence in treated wastewater was judged minimally likely.

Guide values were established for these compounds, addressing both human health and environmental health concerns.

Only one compound (**1,4-dioxane**) was found near its GV in the drinking water

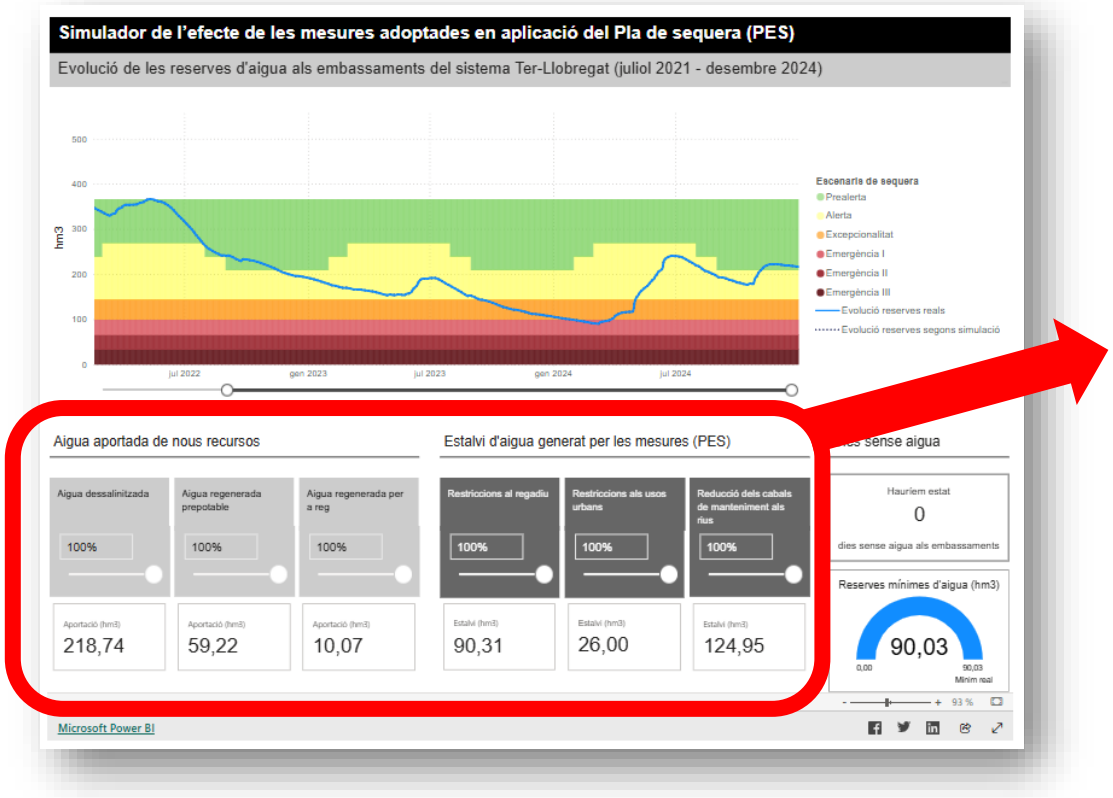
Non-target analysis:

The preliminary list can be replaced by a non-target analysis, that can provide a comprehensive list of micropollutants detected in wastewater and treated reclaimed water.



Published in **STOTEN.** March 2023: https://doi.org/10.1016/j.scitotenv.2022.161339

Contribution of the various measures to reducing reservoir outflows



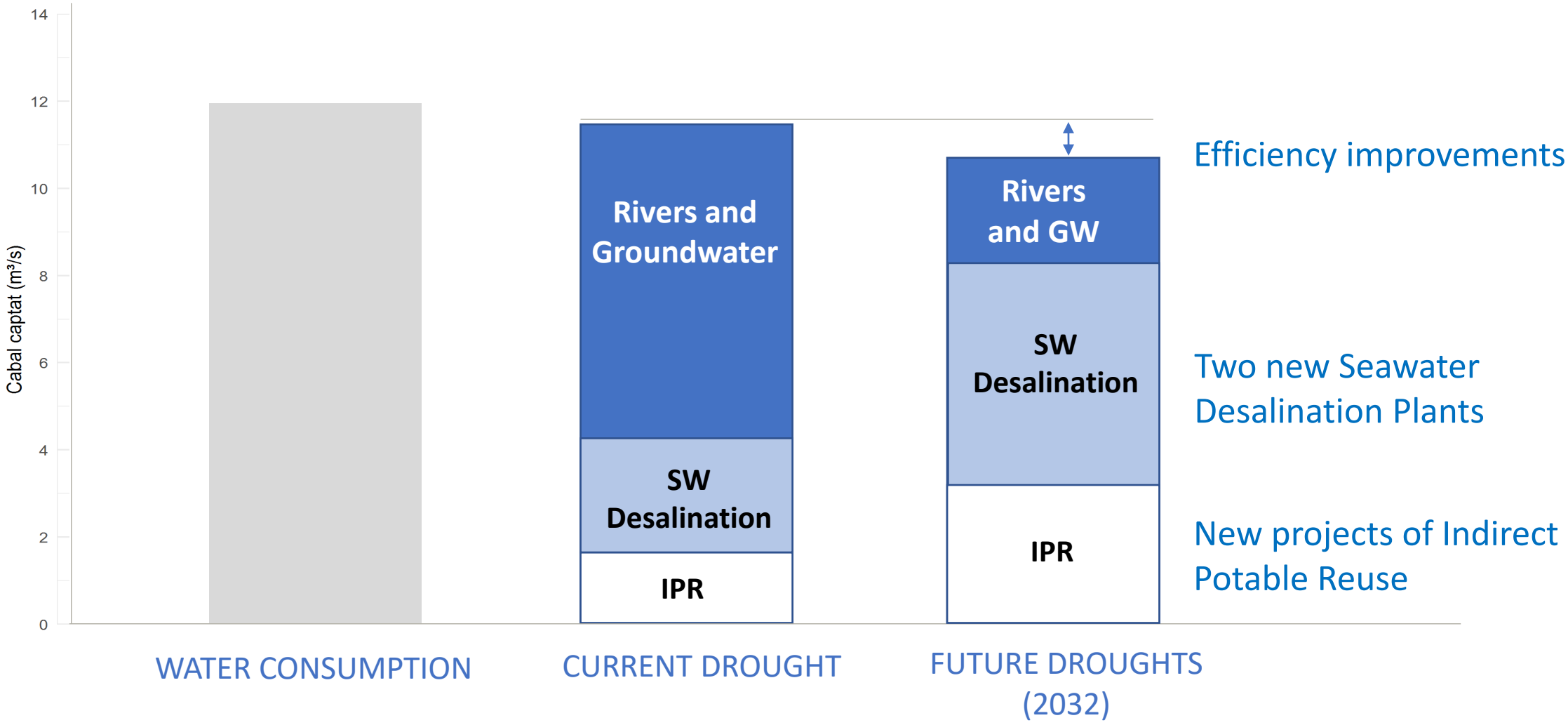
Simulated period: July 2021 – December 2024

Measure	Reduction of reservoir releases
Seawater desalination	219 hm^3
Indirect Potable Reuse	59 hm^3
Reuse for agriculture	10 hm^3
Restrictions on agricultural water withdrawals	90 hm^3
Urban water-use restrictions	26 hm^3
Adjustment of reservoir releases to meet ecological flow requirements	125 hm^3
Total	**529 hm^3**

The measures adopted have reduced reservoir releases by 529 hm^3. Despite this, a critical situation was reached with only 90 hm^3 remaining in the reservoirs.

Our roadmap to water security

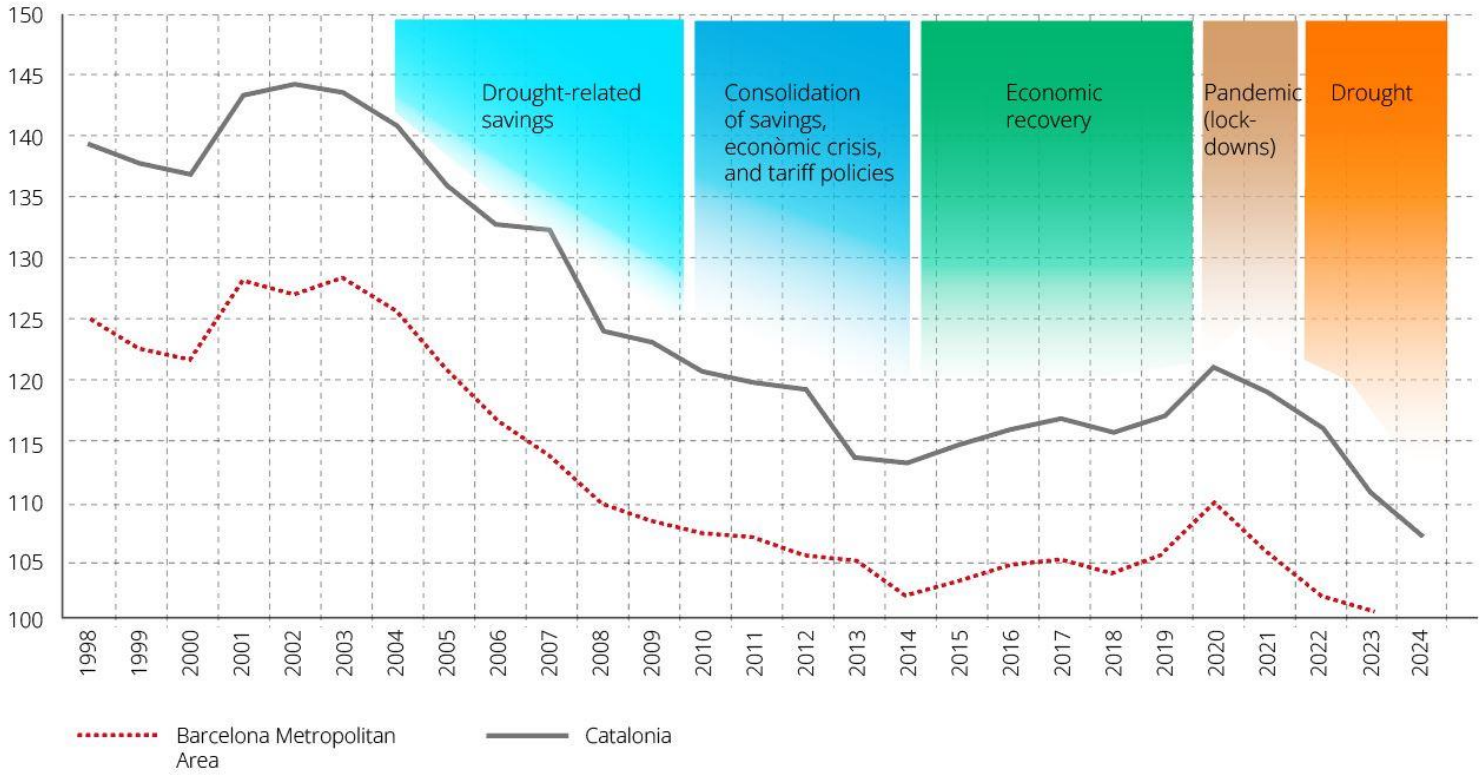
Planned sources of the water supplied to the Greater Barcelona Area during droughts

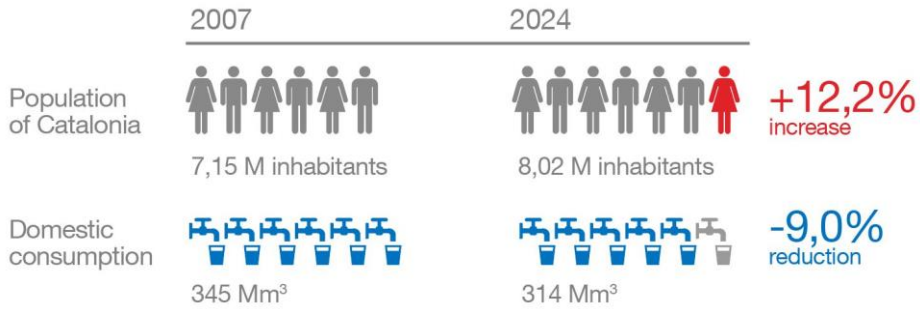


IPR: Indirect Potable Reuse

Water saving

Domestic water consumption

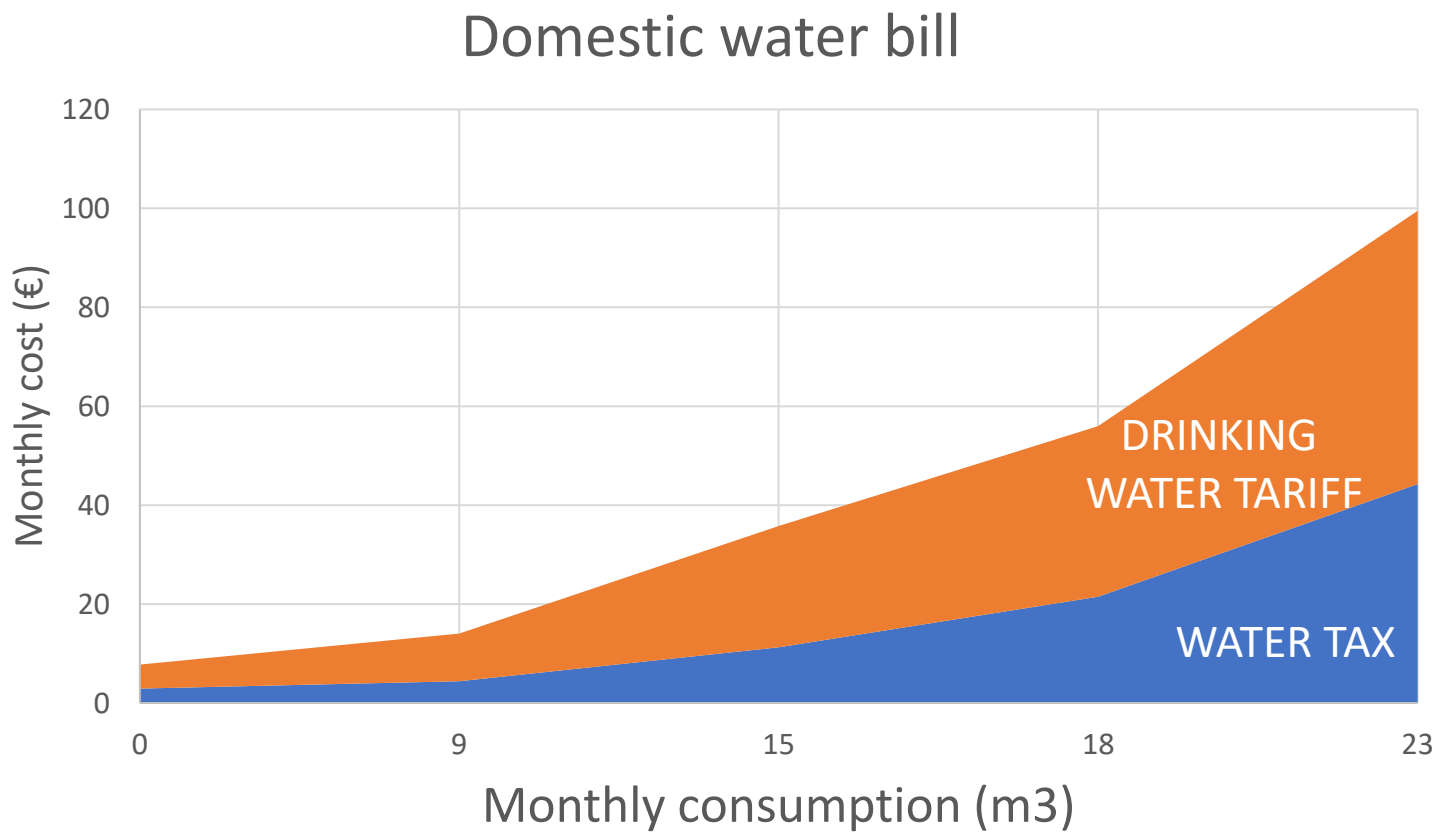




The data are calculated based on the resident population (IDESCAT). The seasonal or floating population is not considered.
Updated: July 2024. The data shown are the latest available.

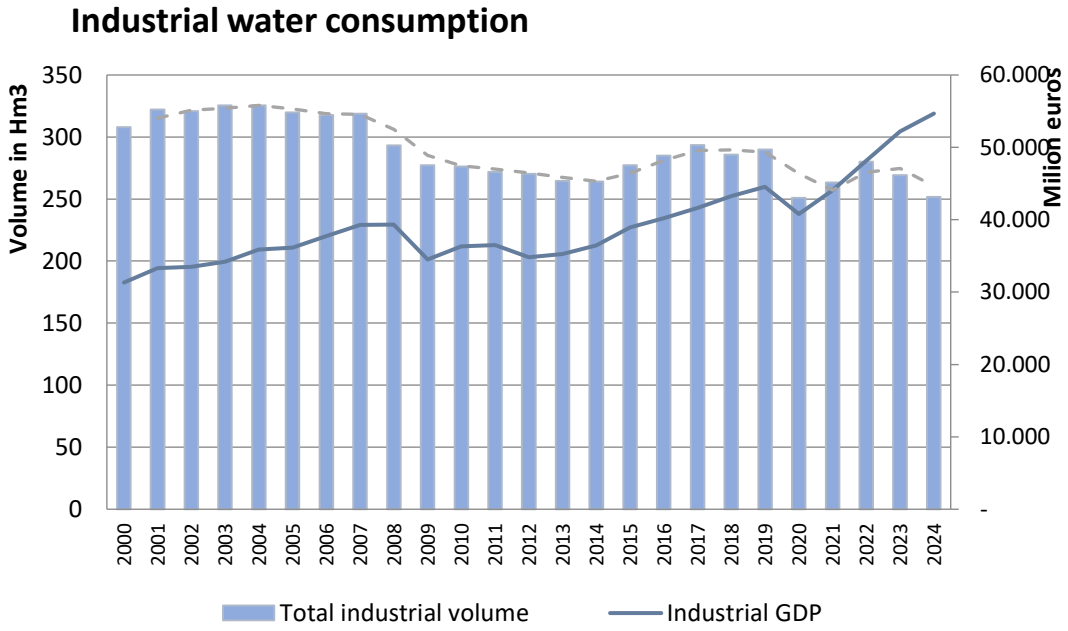
Water saving

Highly progressive pricing for domestic water consumption.



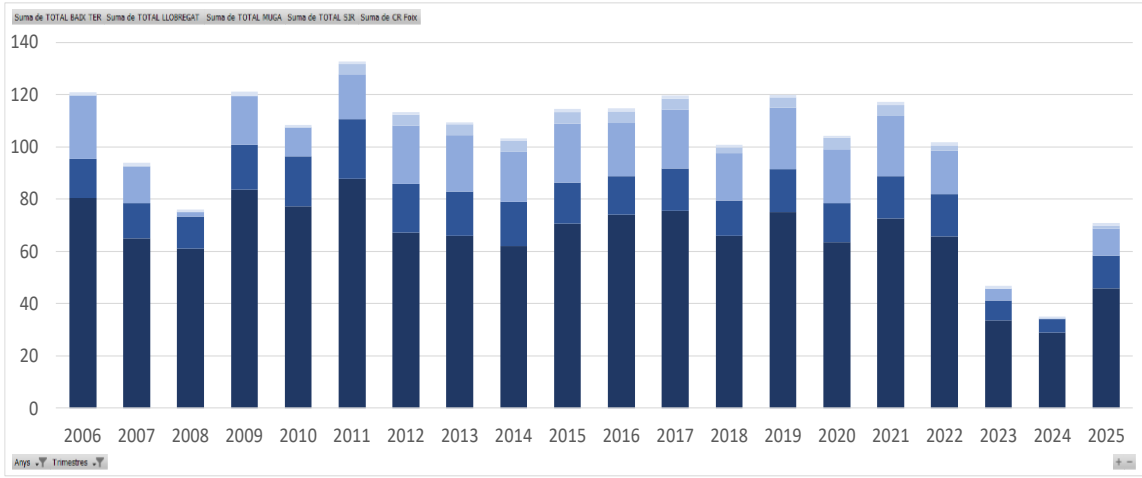
Water saving

Industrial water consumption



Industrial water consumption decreased by 17% during the 2003–2023 period, while industrial added value increased by 53%.

Irrigation water consumption



Irrigation water consumption from surface reservoirs is restricted during droughts. These restrictions are managed mainly through crop substitution (for example, sunflower instead of corn).

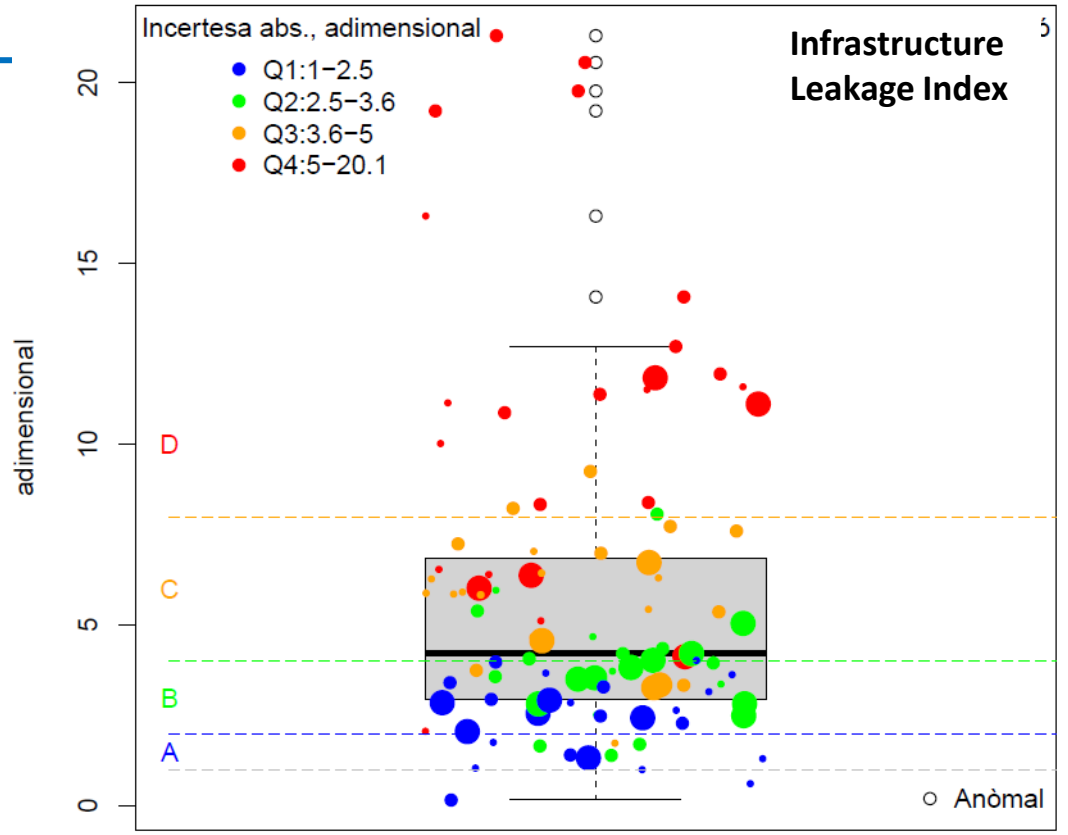
Hydraulic efficiency audits

Under Catalan law, water companies are required to conduct and publish an audit of the hydraulic efficiency of water supply services with more than five thousand subscribers every two years. Audits have been published for 2022 and 2024.

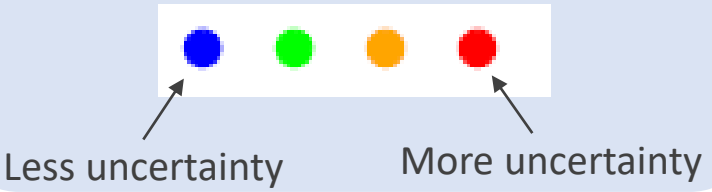
Guide for conducting audits on hydraulic efficiency

- Water Balance, distinguishing apparent and real losses
- 12 performance indicators for leakage management
- 1 qualitative indicator for pressure management
- 102 questions to assess traceability and accuracy

The Agency has produced a **comparative assessment report** of the published audits, comparing the results obtained and evaluating their reliability. It also assesses them in relation to international reference values.



Allocation into quartiles based on the indicator's uncertainty



Efficiency. Reducing leaks in distribution networks

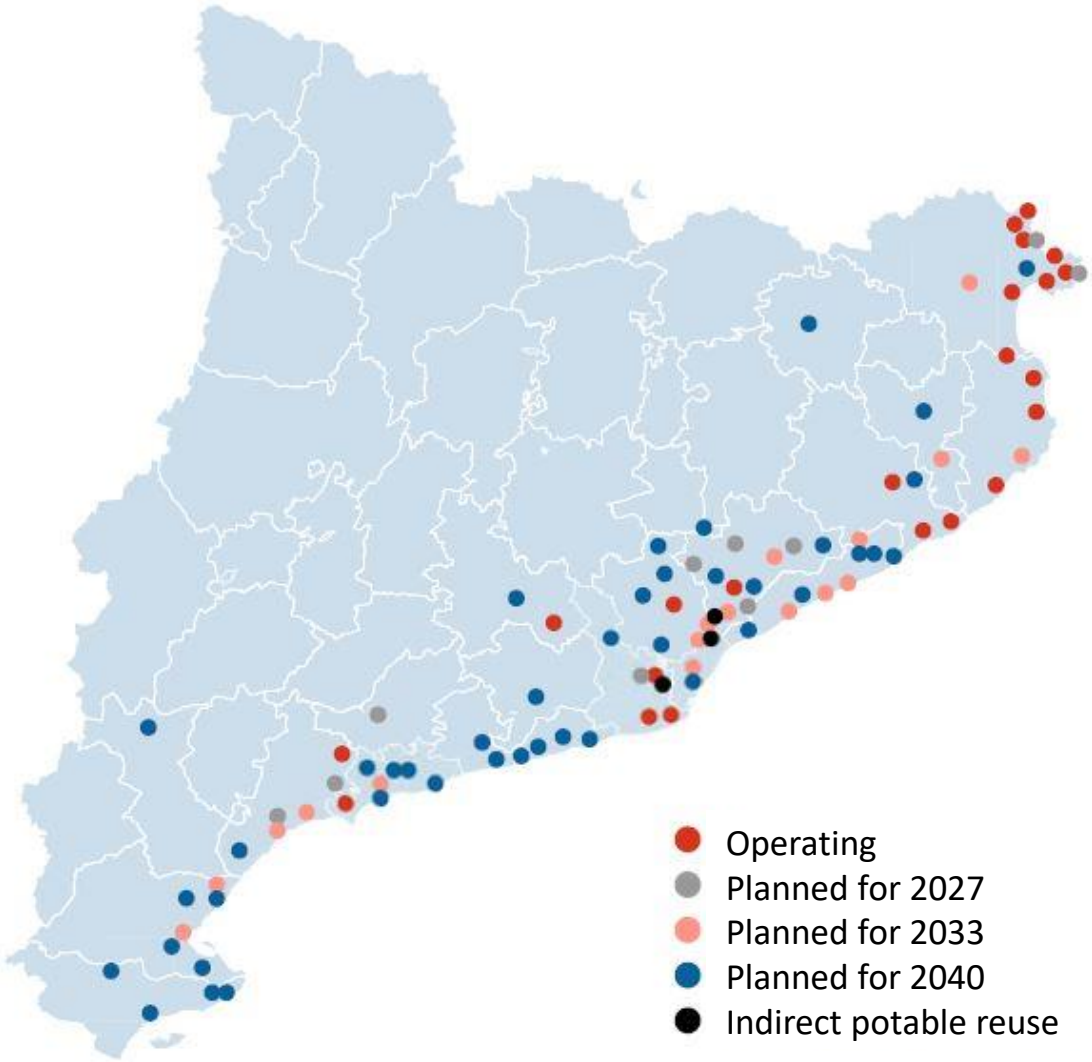
- In 2023 a €130 million aid program was launched to improve municipal water supplies, focusing on digitalization, sectorization, and loss reduction

Subsidies have been awarded to improve municipal distribution networks in 707 municipalities in Catalonia

Supply network repairs	**(682 actions)**
Rehabilitate or waterproof tanks	**(81 actions)**
Network digitization and remote reading	**(299 actions)**
Leak detection and repair campaigns	**(95 actions)**

Total: 1.157 actions

Water reuse. Actions up to 2040



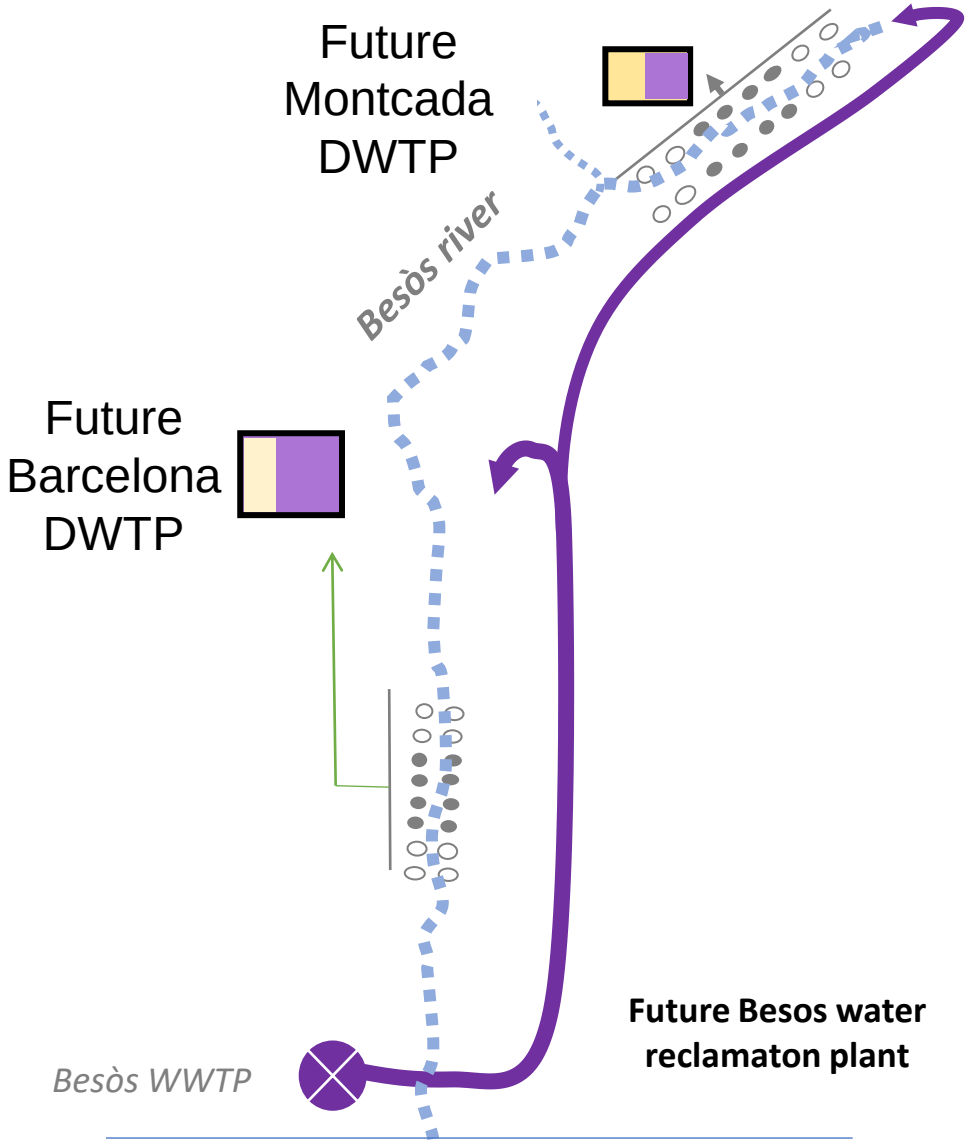
Strong synergies with the new WWT Directive (2024/3019)

Potencial for water reuse

(under study, depending on the water situation and the demand for different uses)

- ❑ Time Horizon 2027: 98 hm^3
- ❑ Time Horizon 2033: 147 hm^3
- ❑ Time Horizon 2040: 245 hm^3

Undergoing project: indirect potable reuse in the Besos river



Thank you very much for your attention

Agència Catalana de l'Aigua
Web: aca.gencat.cat
Twitter: @aigua_cat
Instagram: @aigua_cat
Facebook: facebook.com/aiguacat
YouTube Canal ACA

Agència Catalana de l'Aigua

Generalitat de Catalunya

© L'Agència Catalana de l'Aigua permet la reutilització dels continguts i de les dades sempre que se citi la font i la data d'actualització, que no es desnaturalitzi la informació i que no es contradigui amb una llicència específica.