



FREEWAT

Free and Open Source Software Tools for Water Resource Management
EU HORIZON 2020 Project



 **ict4water.eu**

Open Workshop

ICT tools for innovating Groundwater Management in a changing world

September 22nd 2017

IDAEA. CID - CSIC

16 Jordi Girona. 08034 Barcelona

A general overview on Water Quality Monitoring in Catalonia

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(Catalan Water Agency)



**Agència Catalana
de l'Aigua**



Generalitat de Catalunya
**Departament de Territori
i Sostenibilitat**

EIP Water Online Market Place

Matchmaking for water Innovation

**MAR Solutions - Managed Aquifer
Recharge Strategies and Actions
(AG128)**

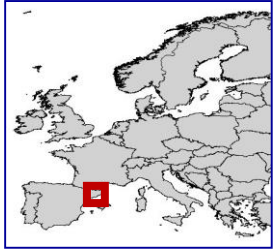


CENTRE D'INVESTIGACIÓ I DESENVOLUPAMENT 1967-2017

Índex

- 1. Introduction to the Catalan basins and the Catalan Water Agency**
- 2. Monitoring Program**
- 3. Quality status assessment (Results):**
 - Groundwater chemical and quantitative status
- 4. The River Basin Management Plan (2n Cycle) of the Catalan River Basin District. Water quality expected to be achieved at the end of 2021 and for long term (2027...)**
 - Boundaries between exemption 4(4) and 4(5)

Catalonia and its basins

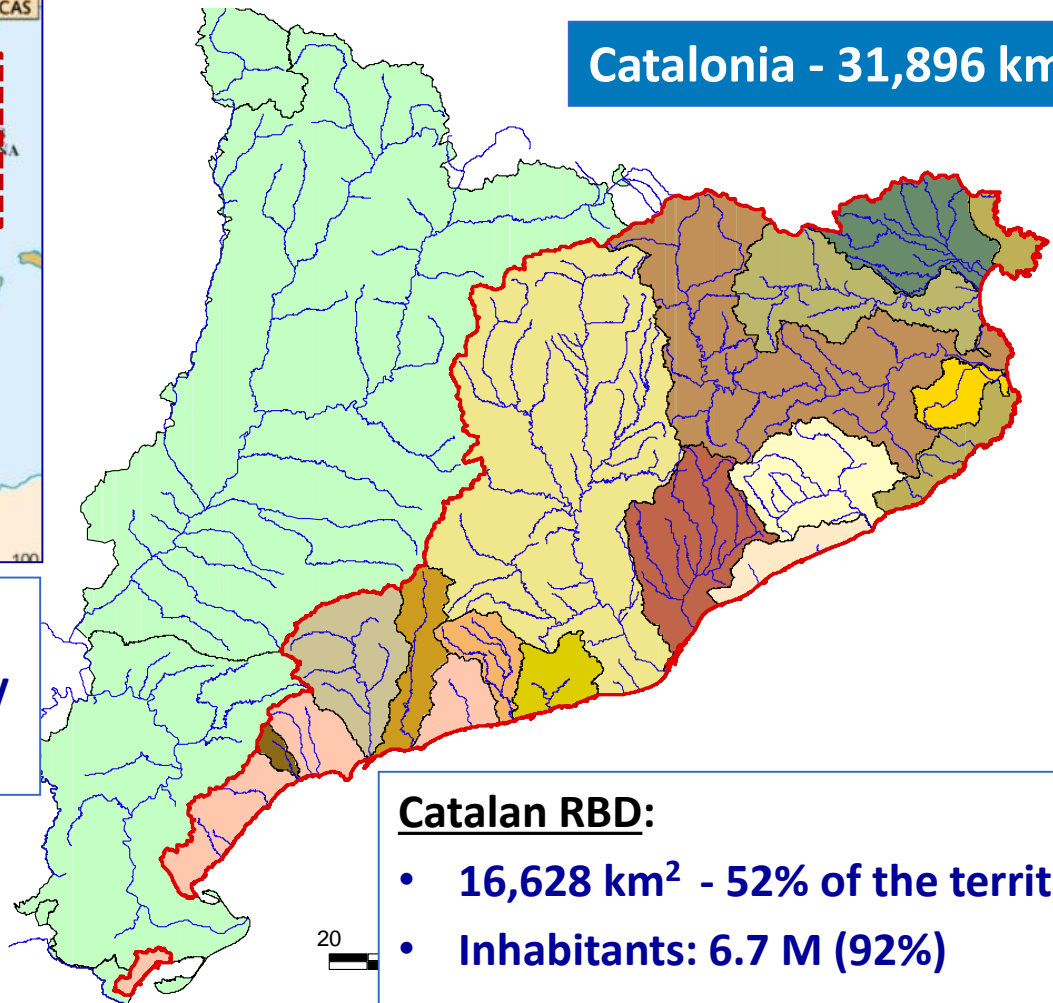


The Catalan Basins constitute a water management unit which is under the authority of the Government of Catalonia (*Generalitat de Catalunya*), and are managed by the Catalan Water Agency



Catalan part of Ebro RBD:

- 15,268 km² - 48% of the territory
- Inhabitants: 0.7 M (8%)



Catalonia - 31,896 km²

Catalan RBD:

- 16,628 km² - 52% of the territory
- Inhabitants: 6.7 M (92%)

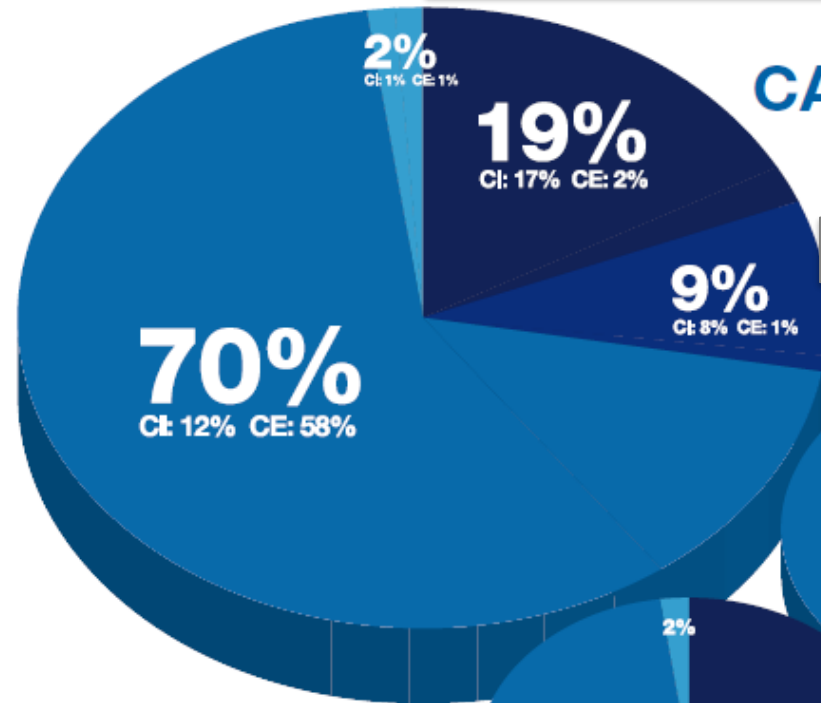
Two different River Basin Districts in Catalonia

Different water uses:

Water uses in Catalonia

Water use: **2,785 hm³/y**

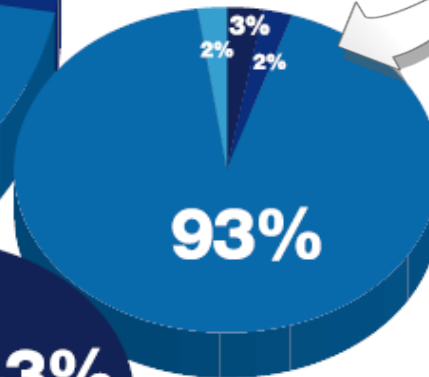
CATALONIA



- Household
- Industrial
- Irrigation
- Cattle

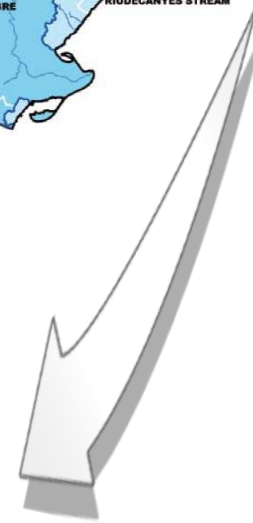
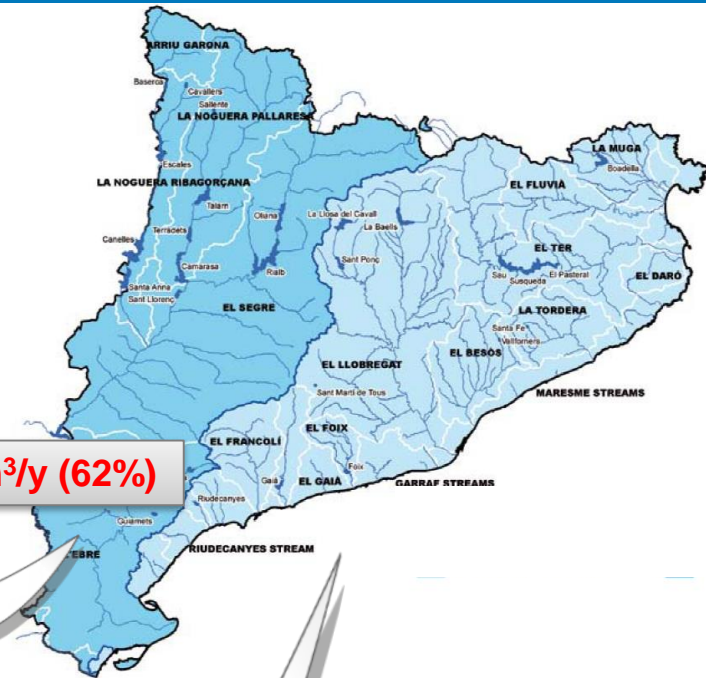
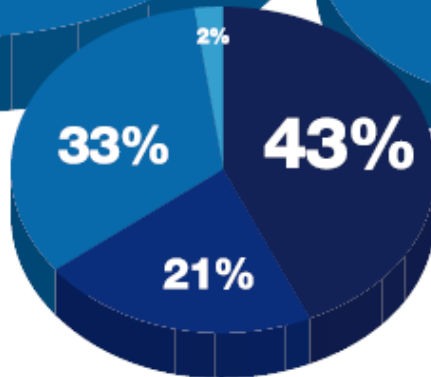
Water use: **1,740 hm³/y (62%)**

EBRO BASINS (C)



INTERNAL BASINS (CI)

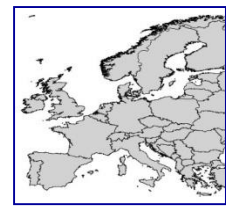
Water use: **1,045 hm³/y (38%)**



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Water Framework Directive (WFD) implementation



**Water Framework Directive
(2000/60/CE)**

**Analysis of pressures and impacts on water
bodies from human activity, and economic
analysis of water use (IMPRESS document)**

**Water Management Plan
1st Cycle (2009-2015)**

**Reviewing pressures and impacts on water
bodies from human activity, and economic
analysis of water use (IMPRESS document)**

**Reviewing Water Management Plan
2nd Cycle (2016-2021)**

**Reviewing Water Management Plan
3rd Cycle (2022-2027)**

**Monitoring
Programme
(2007-2012)**

**Reviewing
Monitoring
Programme
(2013-2018)**

2000

2004

2009

2013

2015

2021

Water bodies:

Catalan River Basin District (16,600 km²)

	Rivers	Lakes (wedlads)	Transitional waters (costal lagoons)	Costal waters	Groundwater	Total
Surface water bodies (SWB)	261 (248 + 13 reservoirs)	27	25	33		346
Groundwater bodies (GWB)					37	37
TOTAL						383

**We set monitoring programmes for a 6 years period:
2007-2012 (1st Cycle), 2013-2018 (2nd Cycle), ...**

Our monitoring programme includes:

1. Sampling sites definition (at least one for each water body).
Constitute several monitoring networks
2. Several quality elements and protocols are used (biological indicators, chemical, hydromorph. etc.)
3. Different frequencies for each quality element are measured
4. Data analysis, target analysis, interpretation, and output system (WEB page) <http://aca-web.gencat.cat/WDMA/>

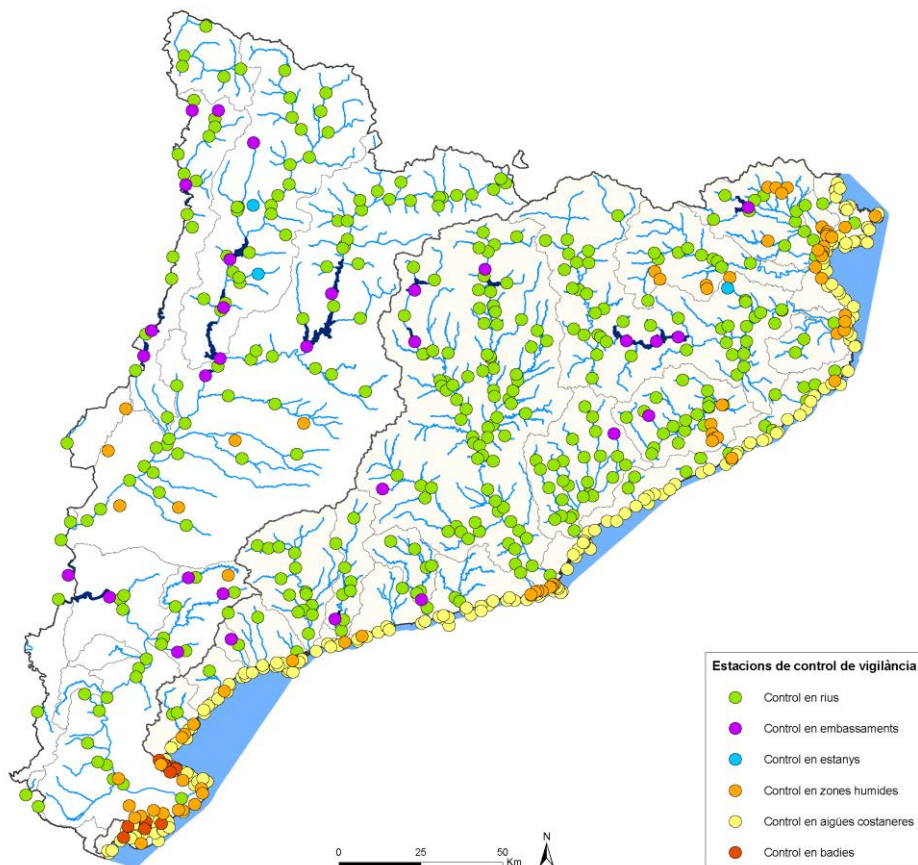
Monitoring programme

- **Surveillance monitoring network:**
 - General overview of the basin quality status
 - Impact assessment
 - Assessment of long-term changes due to natural or anthropogenic causes
- **Operational monitoring network:**
 - Establish the status of WBs identified as being in risk of failing to meet the WFD objectives
 - 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 has given rise to the protection
- **Investigative monitoring network:**
 - To be applied when causes of non compliance are unknown (identification of pollution sources), or in single events (accidents, natural catastrophes, etc.)

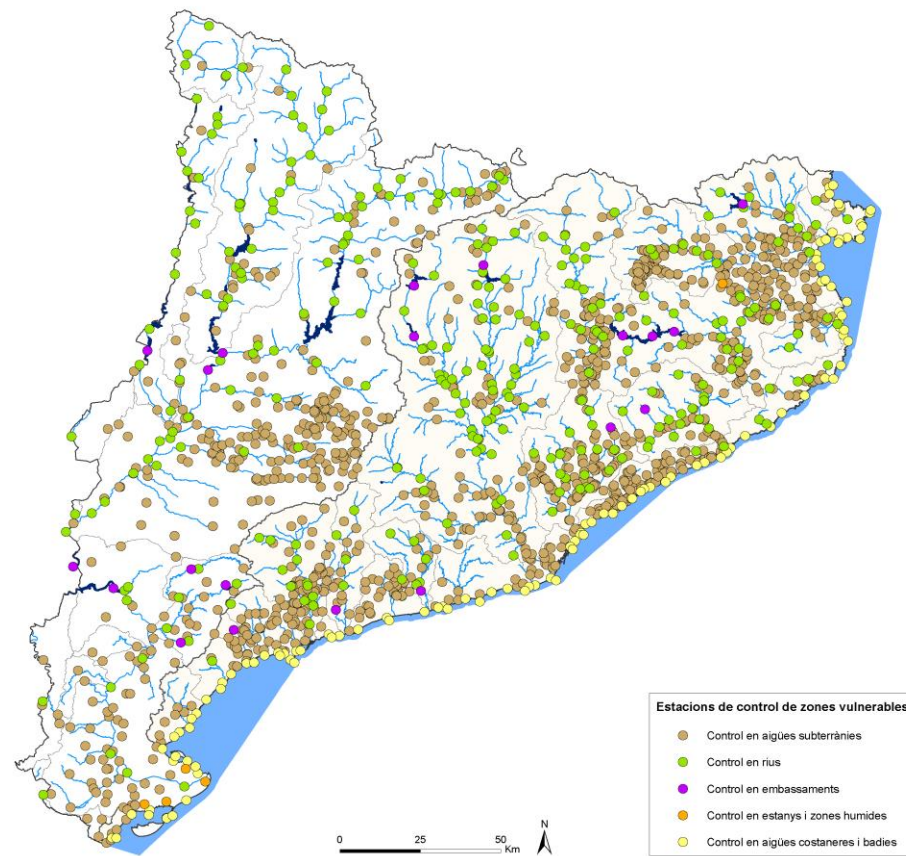
Monitoring programme

Surveillance monitoring

Surface waters:



Operational monitoring Nitrates:

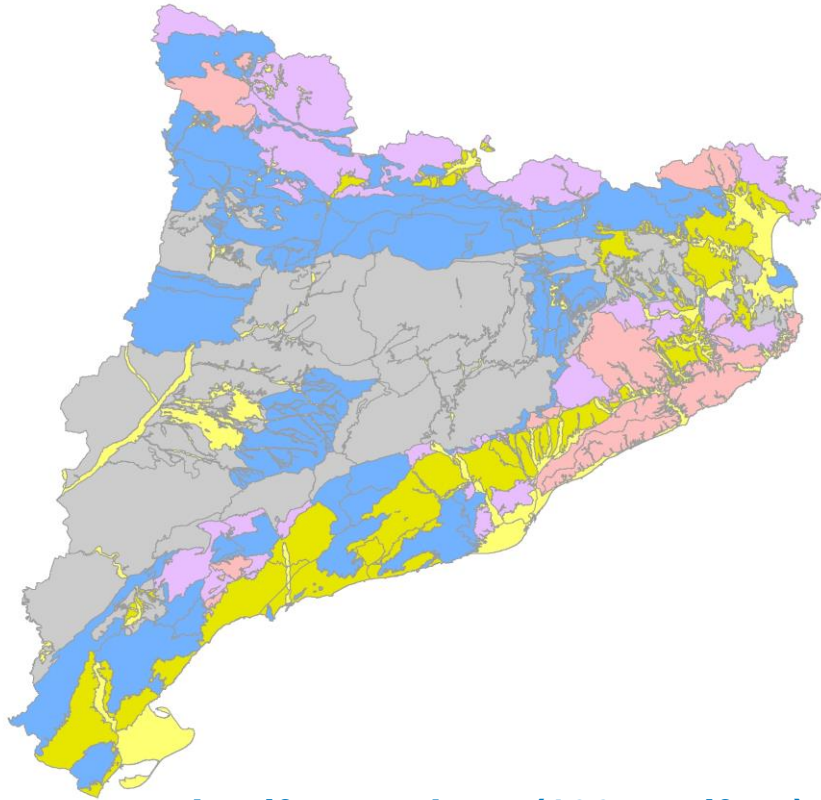


Monitoring programme: frequencies

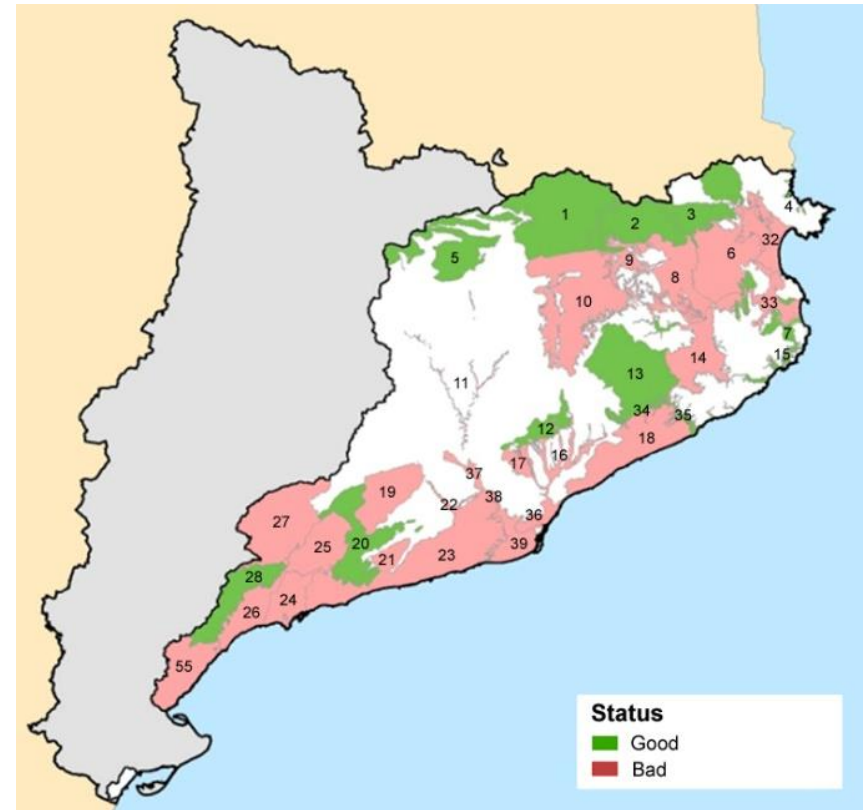
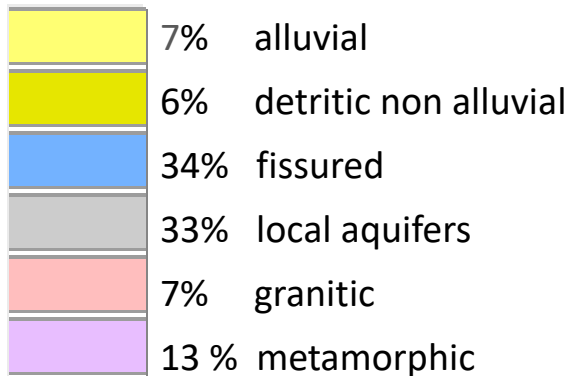
e.g. Monitoring in rivers:

WATER BODY condition	ECOLOGICAL STATUS							CHEMICAL STATUS
	Biological			Hydromorphological			Phys.- chem	Priority substances
	Macro invert.	Fish	Phytoben thos	Hydrologic regime	Continuity	Riparian quality		
On risk	6	2	6	contin.	2	2	72	12
Reference	3	1	3	2	1	1	24	3
Without risk	1	1	1	2	1	1	24	1
Heavily modified	3	2	3	2	1	1	72	12

Frequencies expressed in number of interventions per sampling site, along the six year period (2007-2012 or 2013-2018)



Aquifer typology (199 aquifers)

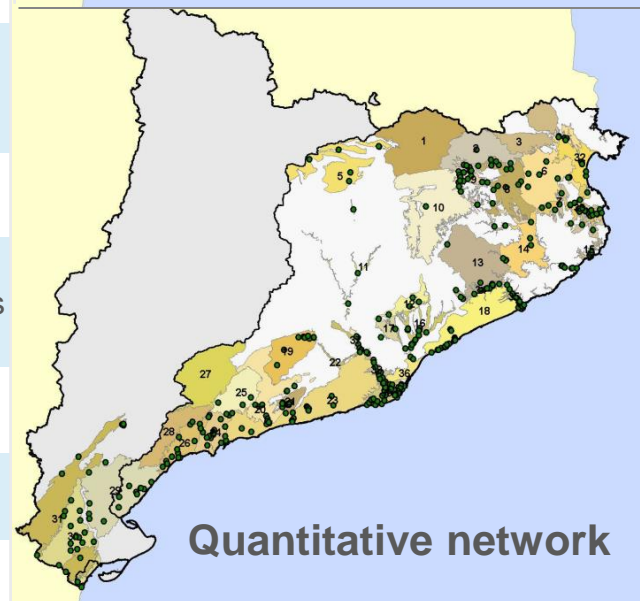
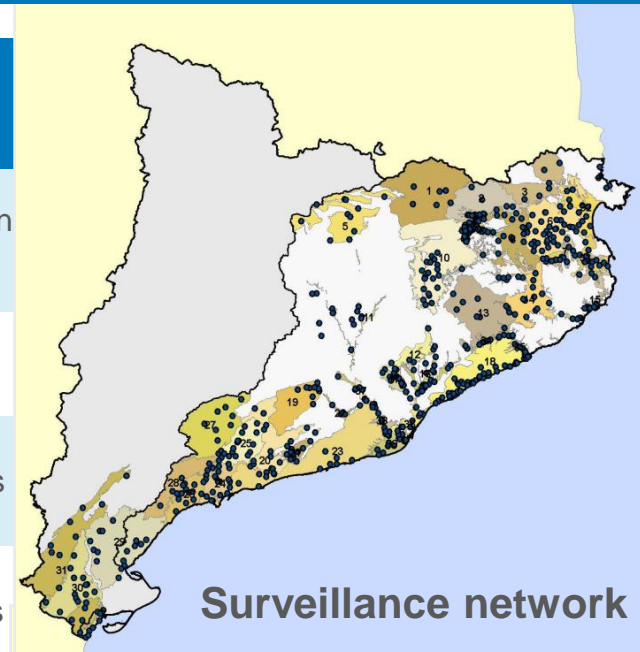


37 Groundwater Bodies

- 23 alluvial, 17 detritic non alluvial, 14 carbonates, 8 Granitic and Paleozoic, 6 low permeability aquifers, 1 fluviovolcanic
- Size from 6 to 763 Km²
- 24 GWB'S (65%) do not achieve WFD environmental objectives

Groundwater monitoring networks

	Sampling sites	Parameters
Surveillance (chemical status)	577	Major ions, metals, Nitrogen cycle parameters
Operational – Seawater Intrusion	183	Major ions
Operational – Nitrate	279	Nitrogen cycle parameters
Operational – Pesticides	84	Pesticides and metabolites
Operational – Industrial pollution	239	Organic micro pollutants
Operational – Saline dumps	11	Chlorides
Vulnerable zones	476	Nitrogen cycle parameters
Drinking water protected areas	138	Specific
Quantitative control	207	Water level



Quality Standards

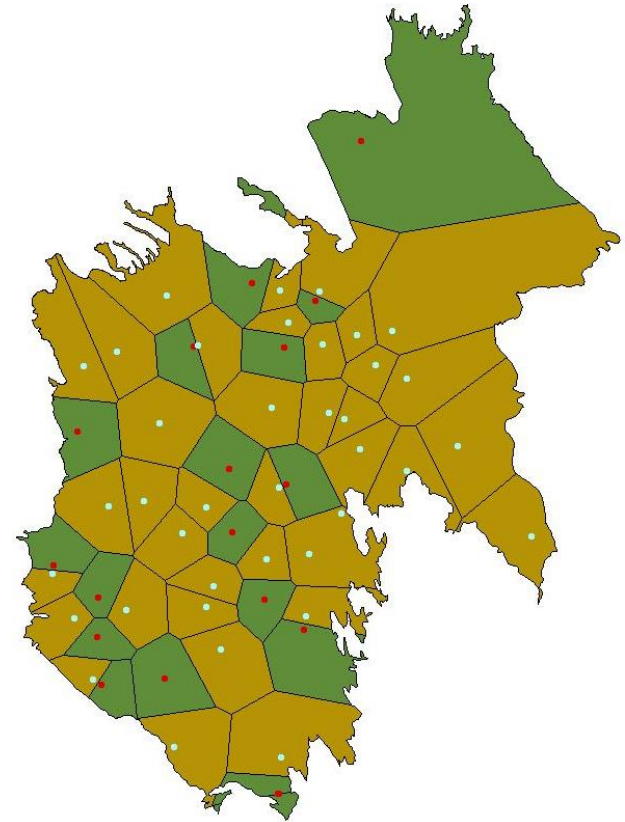
Parameters	Values
NO3 mg/L	50
Pesticides / Compound µg/L	0,1
Pesticides / Total µg/L	0,5

Threshold values established at GWB level

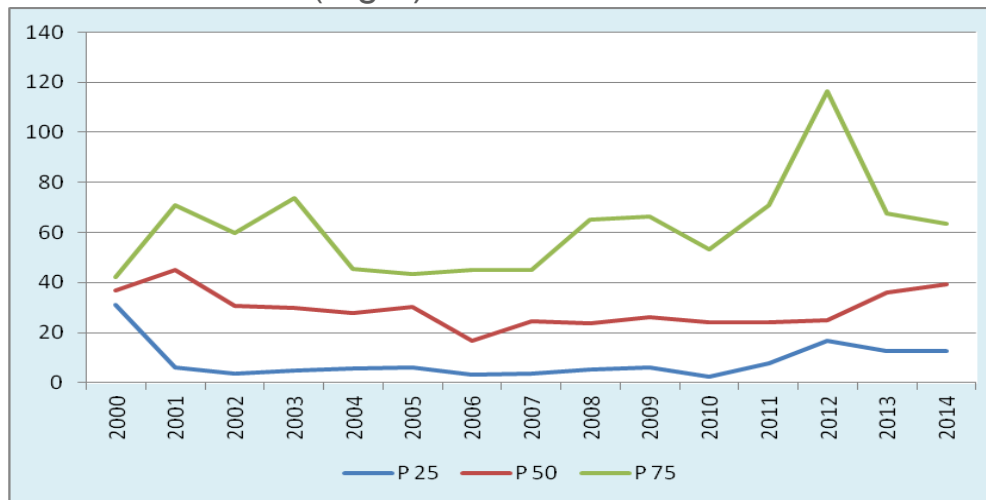
	Parameters	Threshold value or range
GWD Annex II substances	As µg/L	7 – 30
	Cd µg/L	4
	Pb µg/L	18
	Hg µg/L	1
	NH4 mg/L	0,5
	Cl mg/L	40 – 480
	SO4 mg/L	100 – 450
	PCE µg/L	5
	TCE µg/L	5
	CE a 20°C µS/cm	1200 – 3000
Added parameters	Cr µg/L	30
	B µg/L	700 – 1000

Chemical Groundwater Assessment

1. Monitoring data **were aggregated** and compared to Quality Standards and to Threshold values.
2. The **extent of the exceedance** were assess by drawing Thiessen polygons (<20% of the whole GWB area is acceptable).
3. The **trend** assessment of pollutants, the **hydrogeological model** and the **impacts identified** are taken into account.



Evolution of NO₃ (mg/L) concentration in GWB # 21

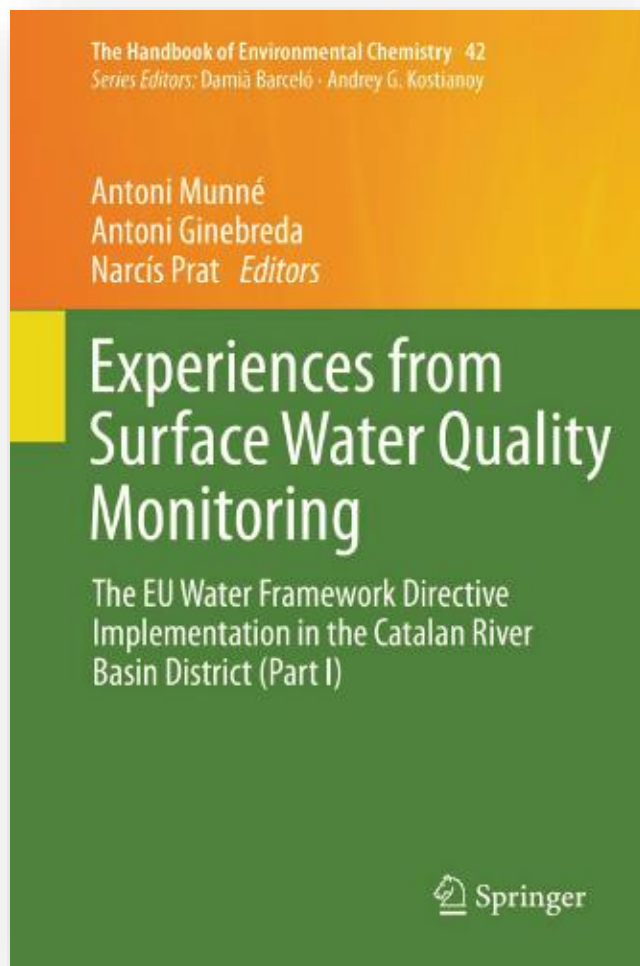


Thiessen polygons at good status

Thiessen polygons at bad status

Ecological and chemical status assessment

We published two books (early 2016) where you can get additional information on Monitoring in Catalan water bodies:



Índex

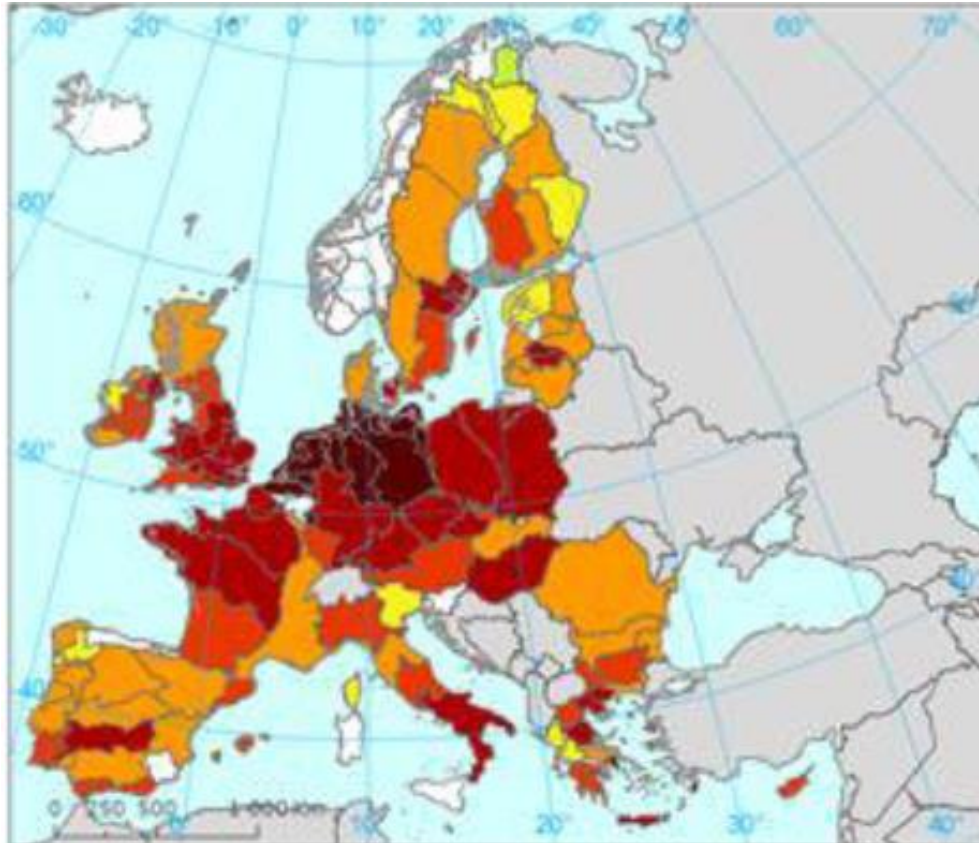
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Results from Monitoring Programme applied in the Catalan River Basin District:

Diagnosis 2015:

WB classes	Good	Bad	Without enough data*	Total
Rivers	86 (35%)	145 (58%)	17 (7%)	248 (65%)
Reservoirs	10 (77%)	3 (23%)	-	13 (3%)
Lakes (wetlands)	8 (30%)	16 (59%)	3 (11%)	27 (7%)
Transitional waters (coastal lagoons)	5 (20%)	17 (68%)	3 (12%)	25 (7%)
Coastal waters	16 (49%)	15 (45%)	2 (6%)	33 (9%)
Groundwater	13 (35%)	24 (65%)	-	37 (10%)
Total	138 (36%)	220 (58%)	25 (6%)	383 (100%)

Assessing the Ecological Status in the European Union (EU)



In Europe, most of Member States declare over 50% of their water bodies under good conditions.

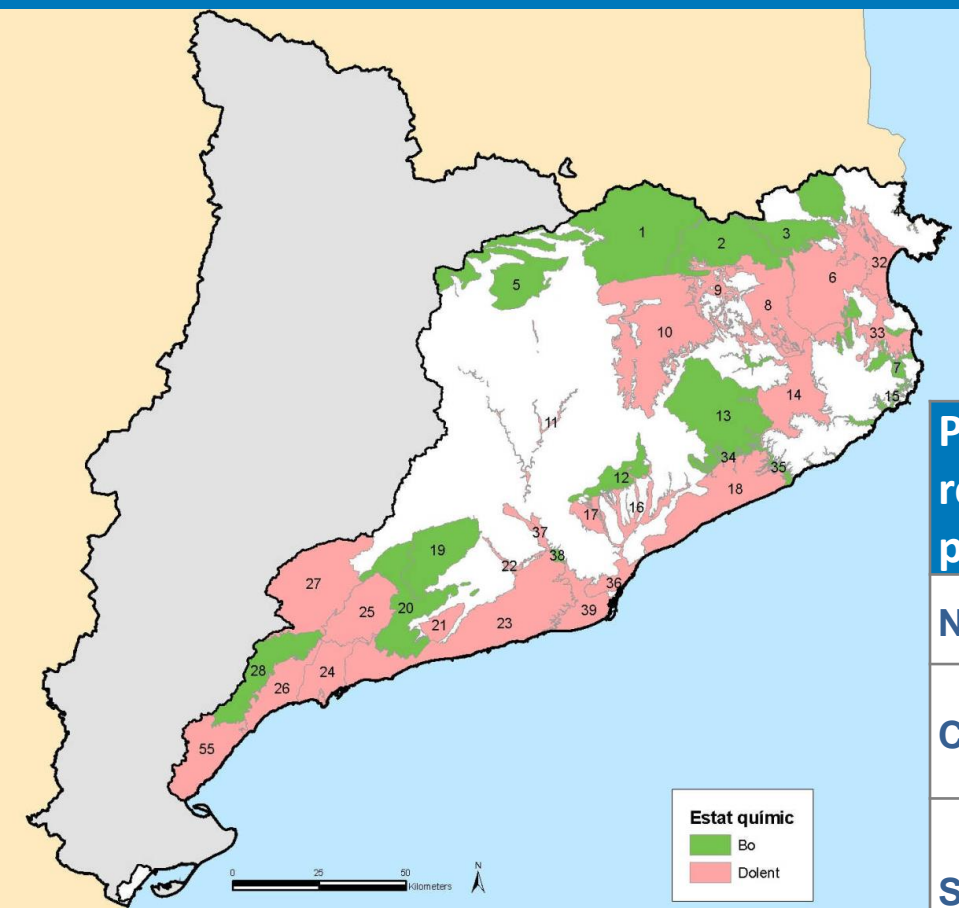
Achieving good ecological status according to the Water Framework Directive requires considerable effort on palliative and corrective measures.

It is important to set a suitable Program of Measures in order to achieve the milestones in the subsequent planning cycles (**2015, 2021 and 2027**)

% of classified water bodies in less than good ecological status or potential
(left map: rivers and lakes, right map: transitional and coastal waters)

no data reported <10 % 10-30 % 30-50 % 50-70 % 70-90 % ≥90 %

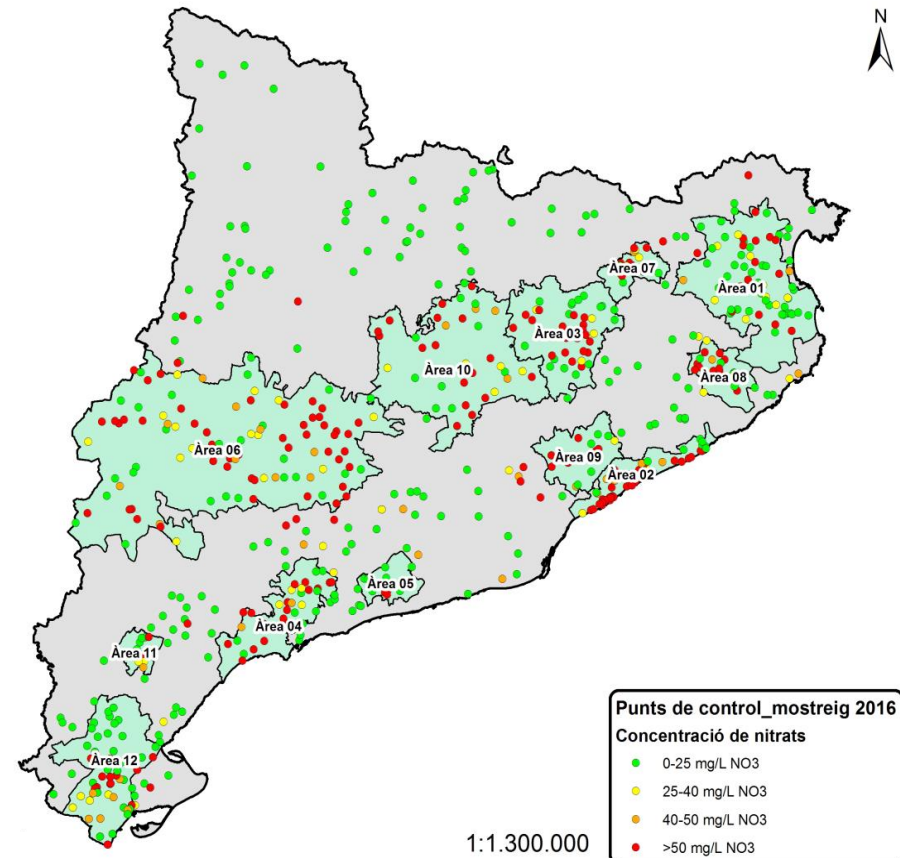
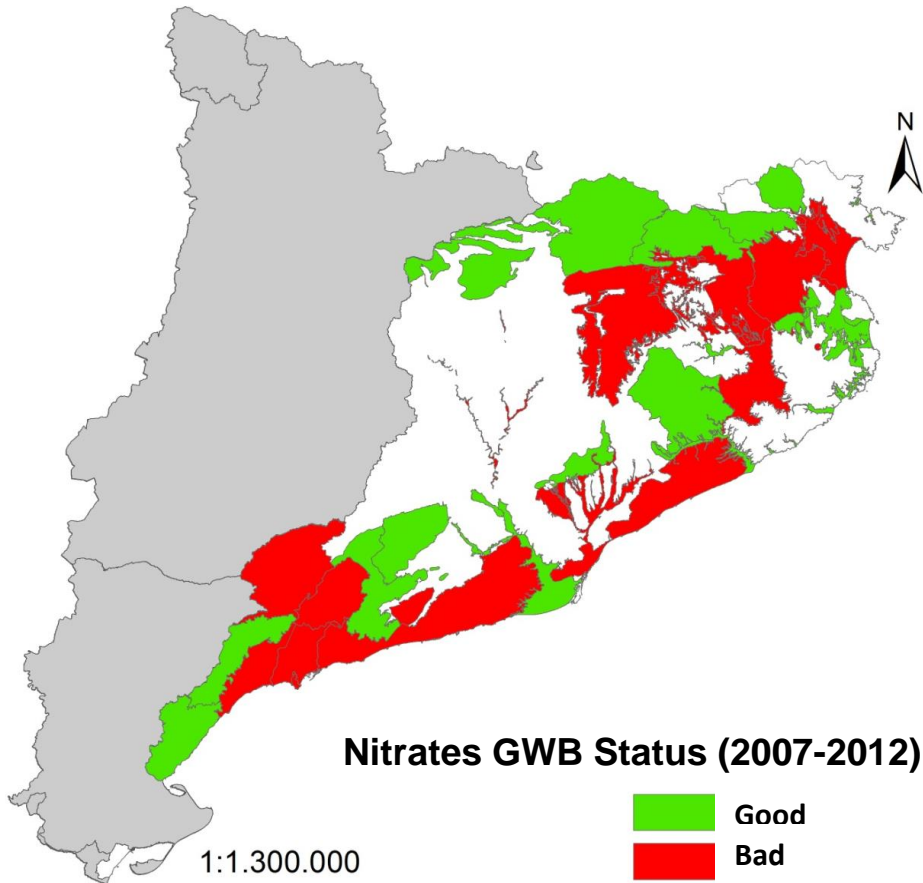
Chemical groundwater assessment: Results



	Number of GWB's	Percentage of GWB's
Good	15	41
Poor	22	59

Parameter responsible of poor status	% of GWB	Pollution origin
NO ₃	46 %	Agricultural diffuse pollution
Cl ⁻	27 %	Seawater intrusion, industrial point sources, mining activity
SO ₄	19 %	Seawater intrusion, industrial point sources, mining activity, agricultural diffuse pollution
NH ₄ and As	5 %	Urban and industrial point sources
PCE – TCE	11 %	Industrial point sources
EC	14%	Seawater intrusion industrial point sources, mining activity, agricultural diffuse pollution

Main aspects of groundwater pollution: Nitrates



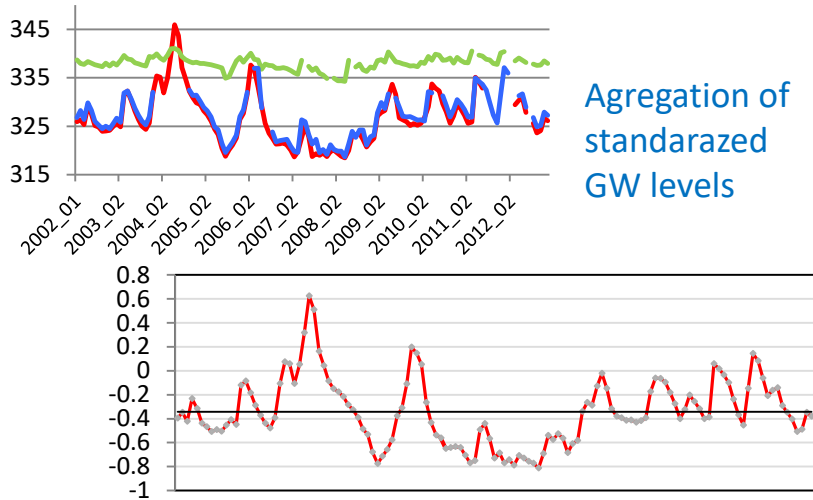
24 GWBs at poor status due to nitrates
(41% of GWBs in Catalonia):

- 7 in Ebre Catalan basin
- 17 in Catalan RBD



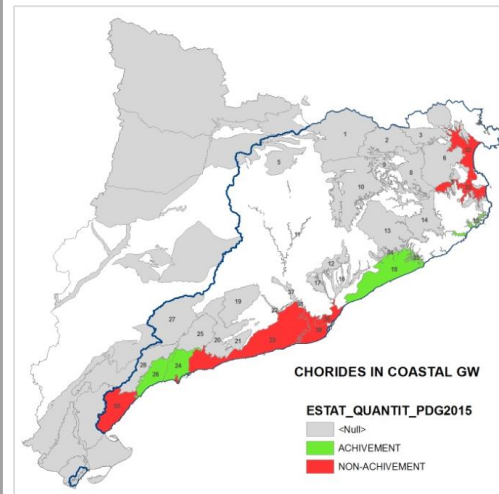
Quantitative groundwater assessment: Results

BALANCE TEST

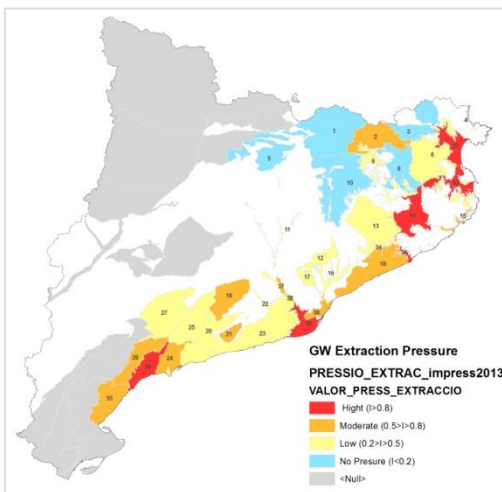


SALINE INTRUSION TEST

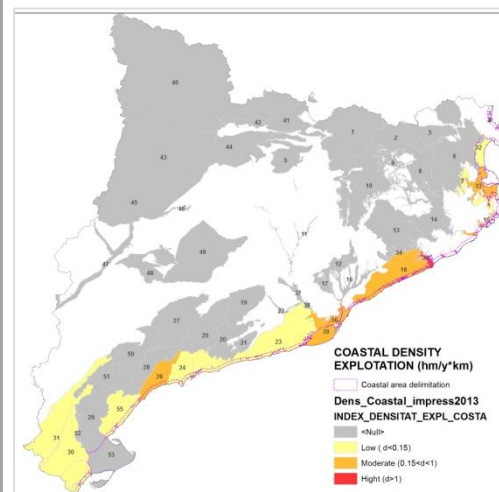
Chlorides impact



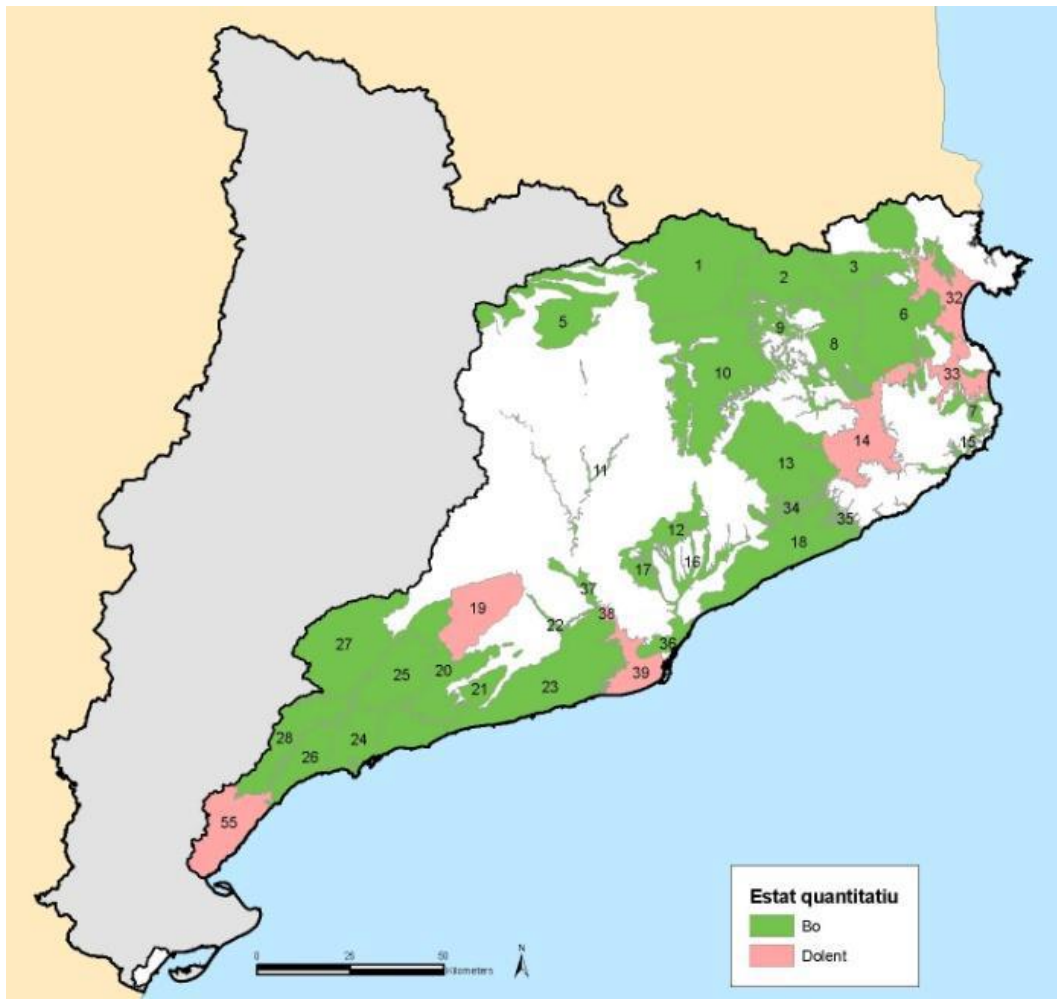
Water withdrawal index



Coastal density of water withdrawal



Quantitative groundwater assessment: Results



	Number of GWB's	Percentage of GWB's
Good	30	81
Poor	7	19

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Programme of Measures (PoM): budget

Cost of measures (€):

Type of measures	Mesures	Total Cost	Cost covered by ACA	Cost covered by other entities
A1	Environmental flow regime implementation	8.735.000	8.735.000	-
A2	Hydromorphological restoration	13.425.206	8.704.517	4.720.688
A3	Wetlands restoration	17.902.656	1.065.000	16.027.656
A4	Invasive species control and mitigation	1.639.945	902.905	737.040
A5	Coastal protection and improvement	24.857.781	200.000	24.657.781
A6	Aquifers protection and improvement	33.380.000	1.380.000	32.000.000
A7	Navigation rules and licences	1.769.976	24.000	1.745.976
B1	Sustainable water use (surface/groundwater)	9.671.547	7.671.547	2.000.000
B2	Enhance water use guarantee	289.790.000	60.630.000	229.160.000
B3	Drought management	592.000	-	592.000
B4	Water reuse	6.250.000	5.000.000	1.250.000
B5	Enhance water regulation (management of dams)	17.134.000	17.134.000	-
B6	Enhance water irrigation management (agricultural uses)	43.397.683	-	43.397.683
C1	Enhance waste water treatment plants	228.874.000	226.304.000	2.570.000
C2	Building new waste water treatment plants	92.120.351	89.090.500	3.029.851
C3	Reducing industrial contamination	710.892	676.280	34.612
C4	Reducing waste water discharge after raining events	26.366.667	2.600.000	23.766.667
C5	Reducing nitrate concentrations from agricultural activities	17.837.240	800.000	17.037.240
C6	Reducing pesticides from agricultural activities	850.000	200.000	650.000
C7	Reducing salt concentrations from mine activity (Llobregat)	64.646.400	25.563.469	39.082.931
C8	Aquifers remediation	7.050.000	1.000.000	6.050.000
D1	Flood Risk Management Plan (FRMP)	66.612.750	44.000.000	22.612.750
E1	Research and Innovation (R+I)	1.000.000	1.000.000	-
TOTAL COST (2016-2021)		973.804.094	502.681.219	471.122.875

Results. Current water body quality status:

Total WB
383



36 % = good

58 % = bad

6 % = without data

Expected results. Water body with GOOD quality status:

Categoria	WB number	2021	2027 or long term	Tentatively less stringent environmental objectives
Rivers	248	112 (45%)	219 (88%)	29 (12%)
Water reservoirs	13	10 (77%)	12 (92%)	1 (8%)
Ponds and wetlands	27	9 (33%)	23 (85%)	4 (15%)
Transition WB	25	10 (40%)	22 (88%)	3 (12%)
Coastal WB	33	17 (52%)	20 (60%)	13 (39%)
Groundwater WB	37	15 (41%)	25 (67%)	12 (32%)
Total	383	173 (45%)	321 (84%)	62 (16%)

Thank you so much for your attention

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