United Nations Educational, Scientific and Cultural Organization

Intergovernmental Hydrological Programme

DRIN CORDA

Global Water Partnership Mediterranean

IW LEARN

Session 3
Locating monitoring wells & networks. Establishing monitoring programs

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UNESCO Technical Webinar - October 2020
Guidelines for Monitoring Strategies in Transboundary Aquifers: Goals, Methods and Tools.
The Case of the DRIN project (ALB-MTN)

Contents

Photos: J M-P

1. Justification

As presented, monitoring programs are based on,

a) Fulfilling ***knowledge*** gaps and ***legal*** requirements,

b) A ***conceptual*** model of the hydrogeological System.

Monitoring networks programs are defined by,

a) Selecting appropriate ***locations***,

b) Setting the sampling site ***density***,

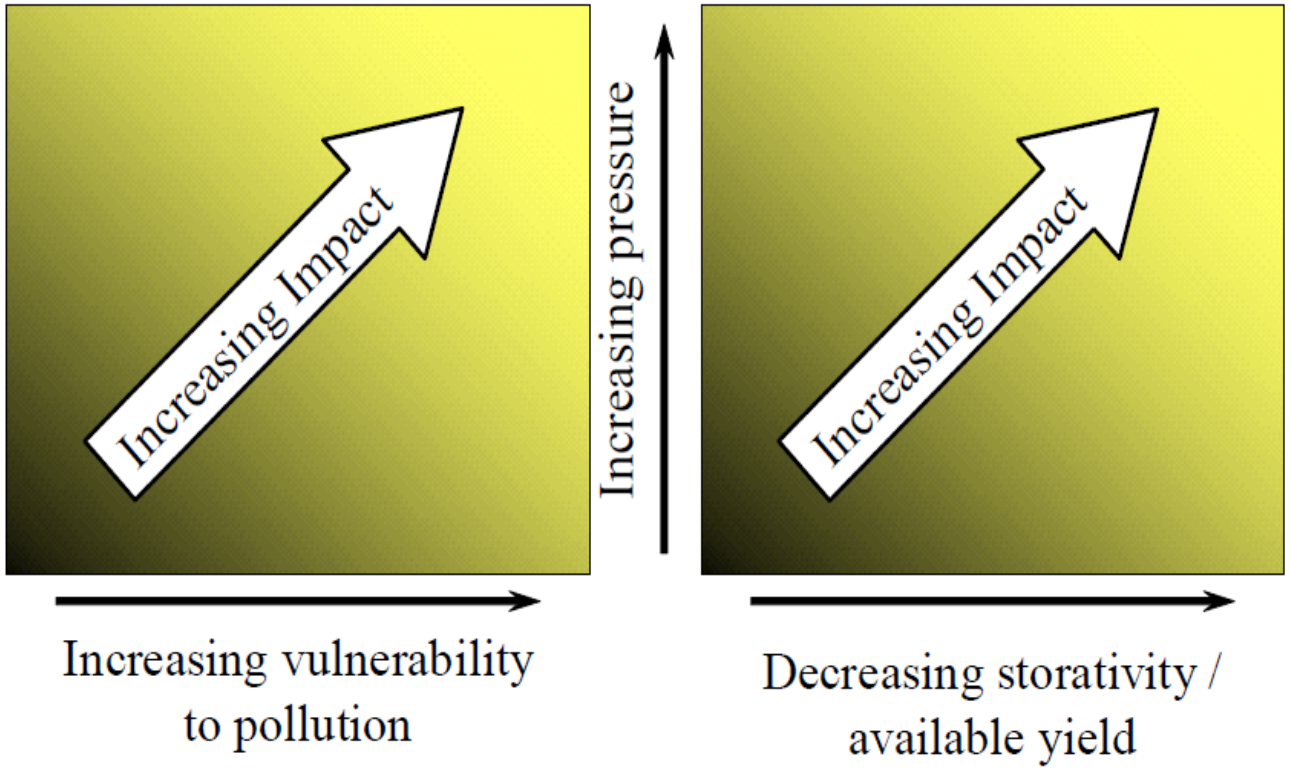
c) Setting the sampling ***frequencies***.

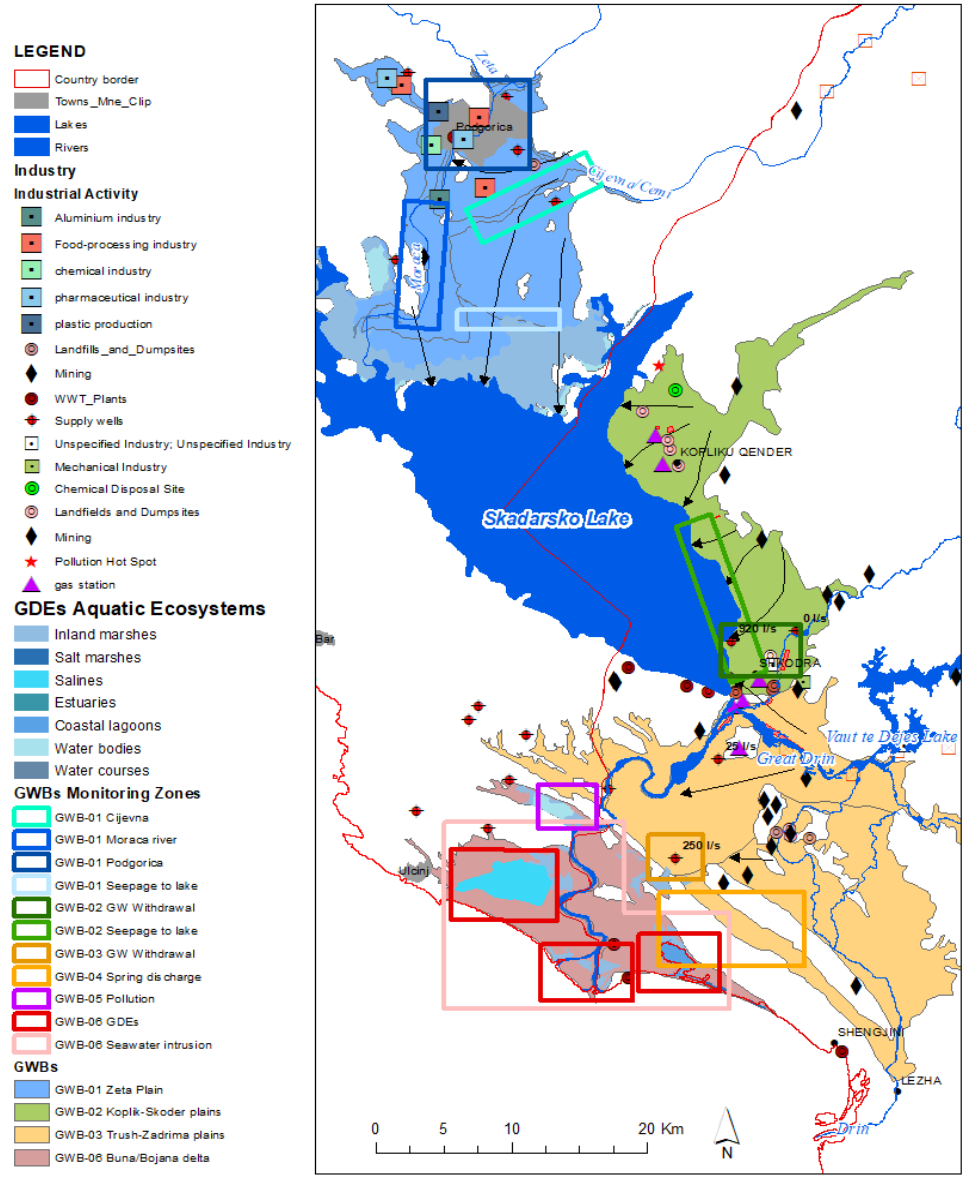
Photos: J M-P

2. Pressure and impacts

Qualitative status

Quantitative status

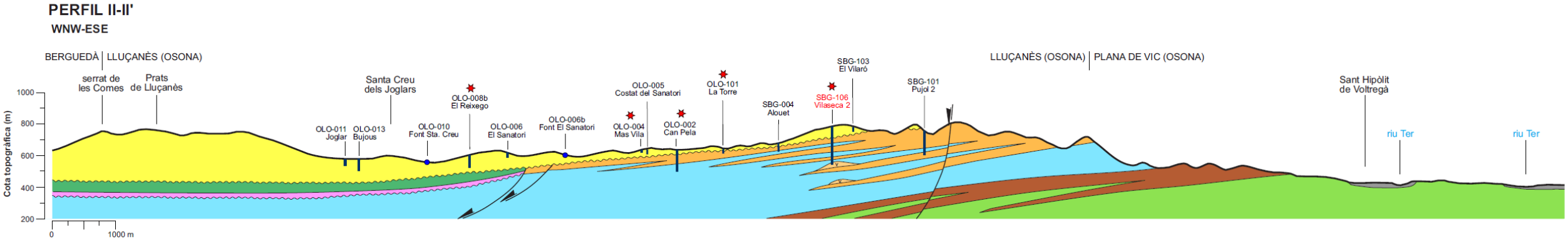




3. Monitoring in inland aquifers

Aspects to be considered:

a) Geological structure and main geological units: their geometry and lithology
b) Groundwater **flow paths**,
c) Areas with specific interest; that is, where **pressures** are located,
d) Previous knowledge of the **impact** magnitude,
e) Prioritize locations upon the ***certainty*** of geological knowledge and the ***effectiveness*** to assess the status of the aquifer.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OLO-006 El Sanatori
OLO-006b Font El Sanatori
OLO-004 Mas Vila
OLO-005 Costat del Sanatori
OLO-002 Can Pela
OLO-101 La Torre
SBG-004 Alouet
SBG-106 Vilaseca 2
SBG-103 El Vilaró
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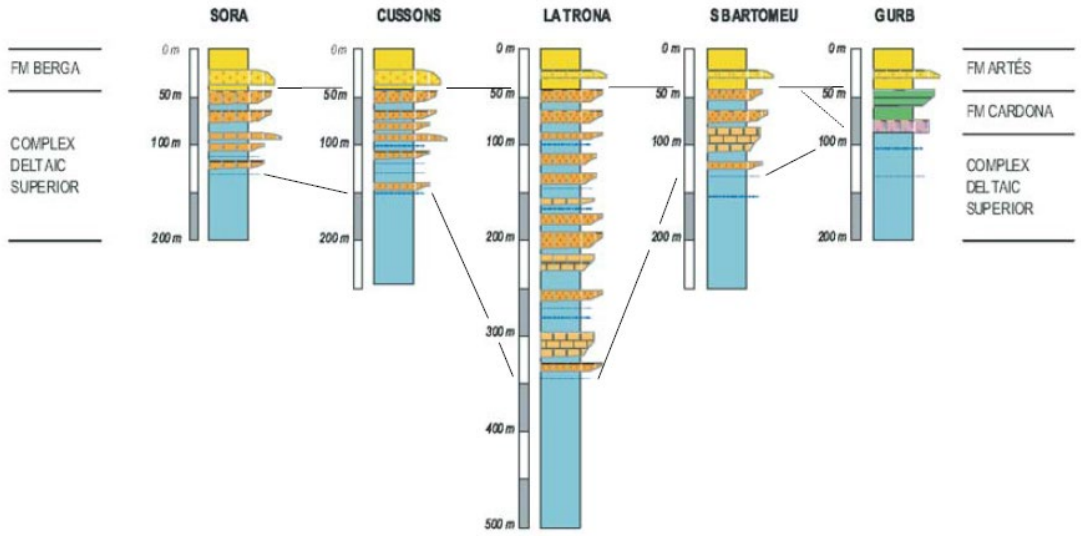
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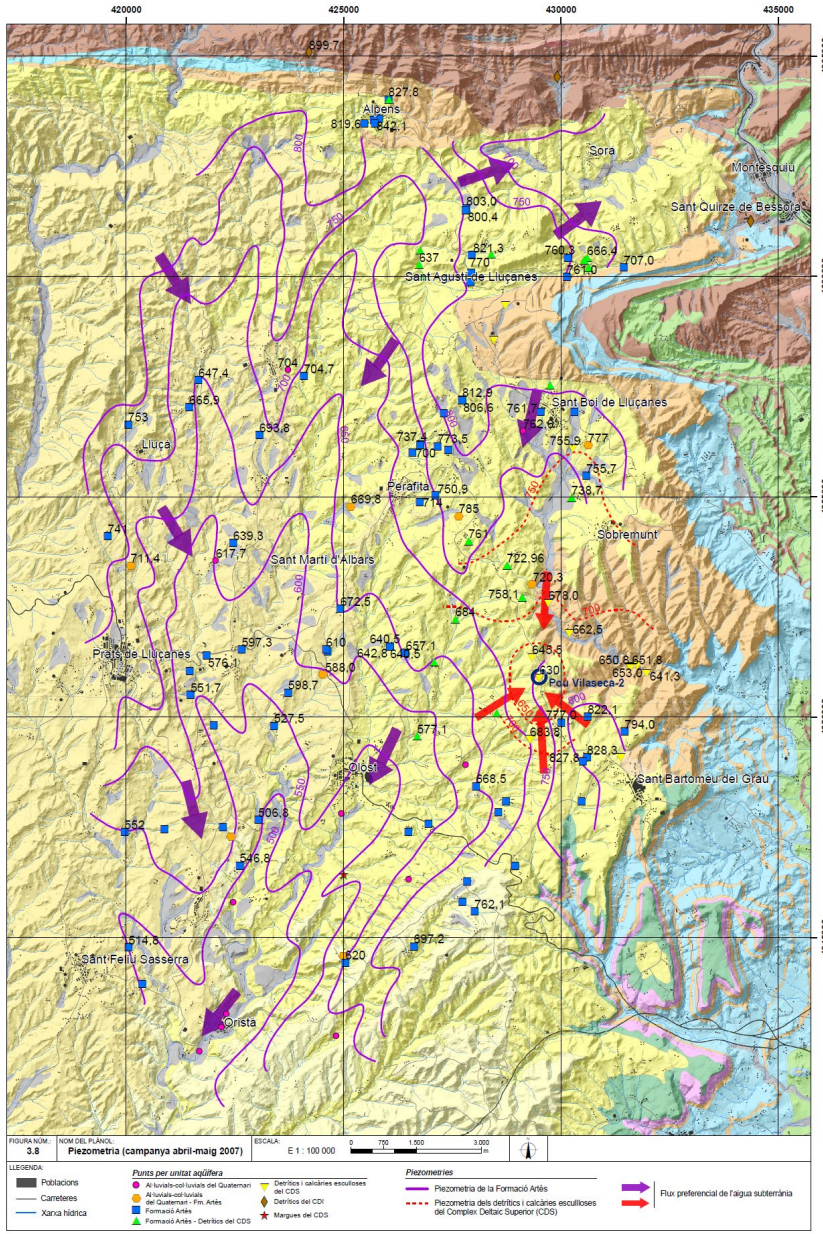
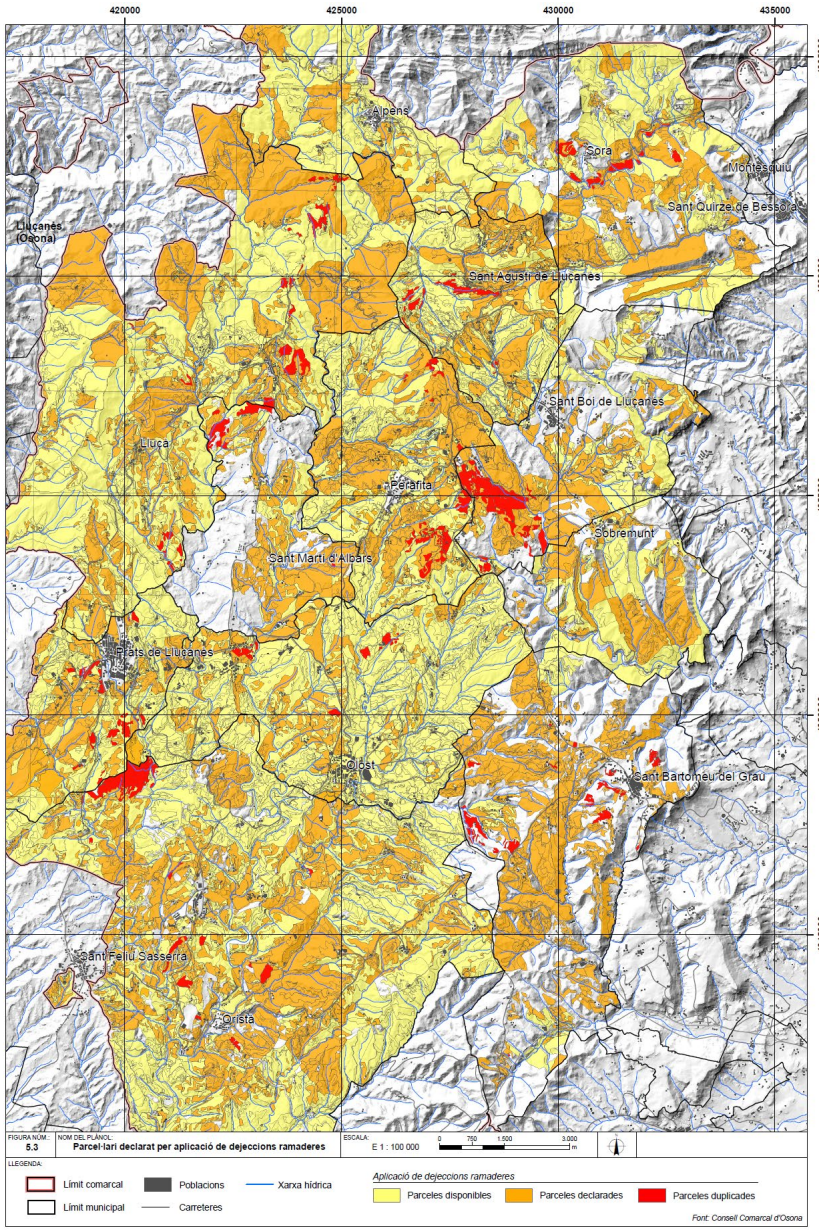
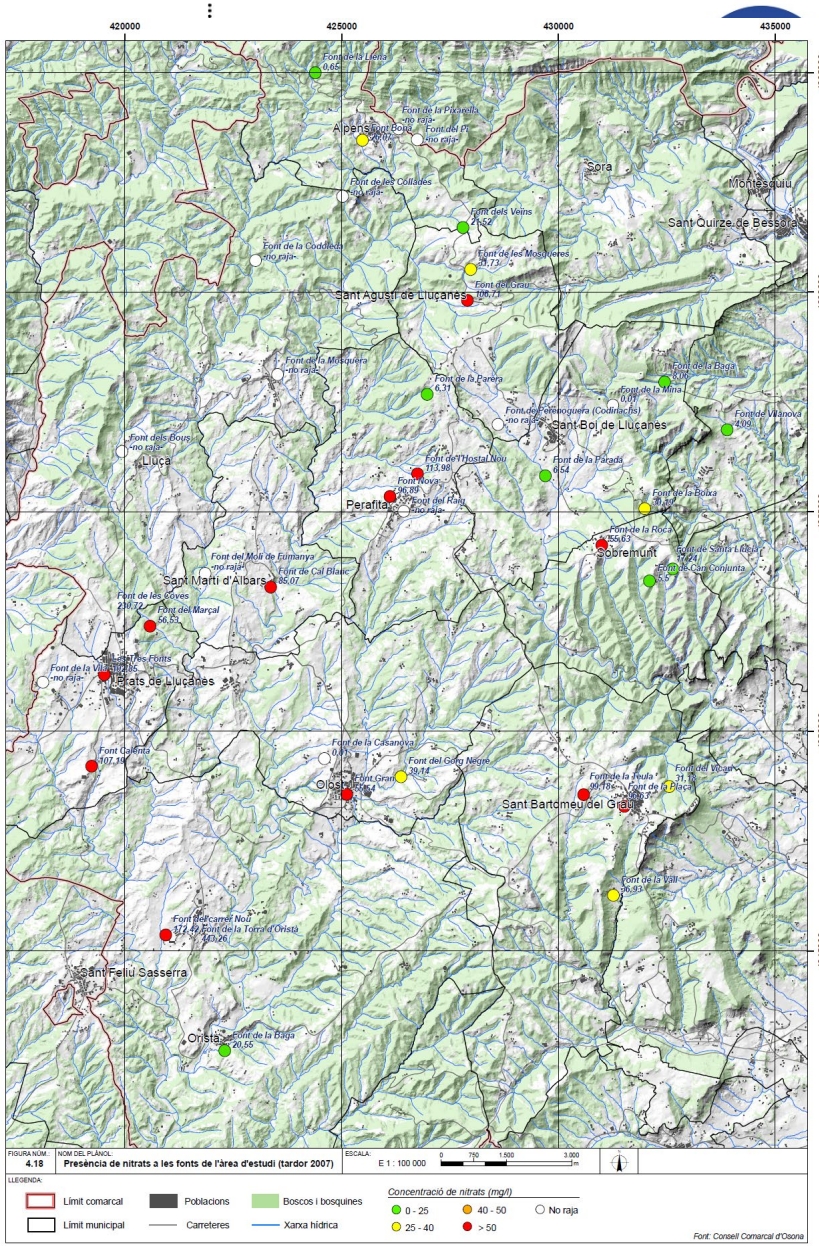
Photos: J M-P







UdG, UB, Geoservei, 2008. *Estudi hidrogeològic del Lluçanès*. ACA.

4. Monitoring in coastal aquifers

Aspects to be considered:

a) Geological structure and main geological units: their geometry and lithology

b) Groundwater **flow paths**,

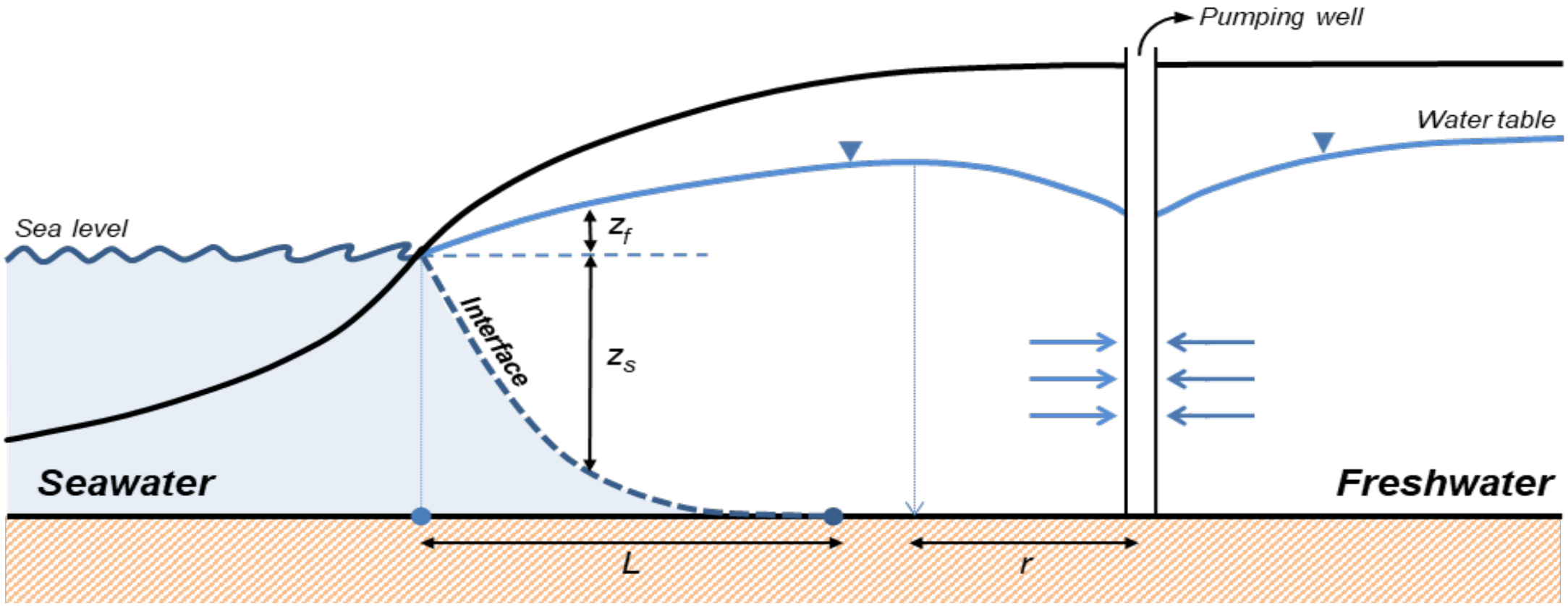
c) Analysis of the seawater intrusion magnitude and its drivers,

d) Areas with specific interest; that is, where **pressures** are located,

e) Previous knowledge of the **impact** magnitude,

f) Prioritize locations upon the ***certainty*** of geological knowledge and the ***effectiveness*** to assess the status of the aquifer.

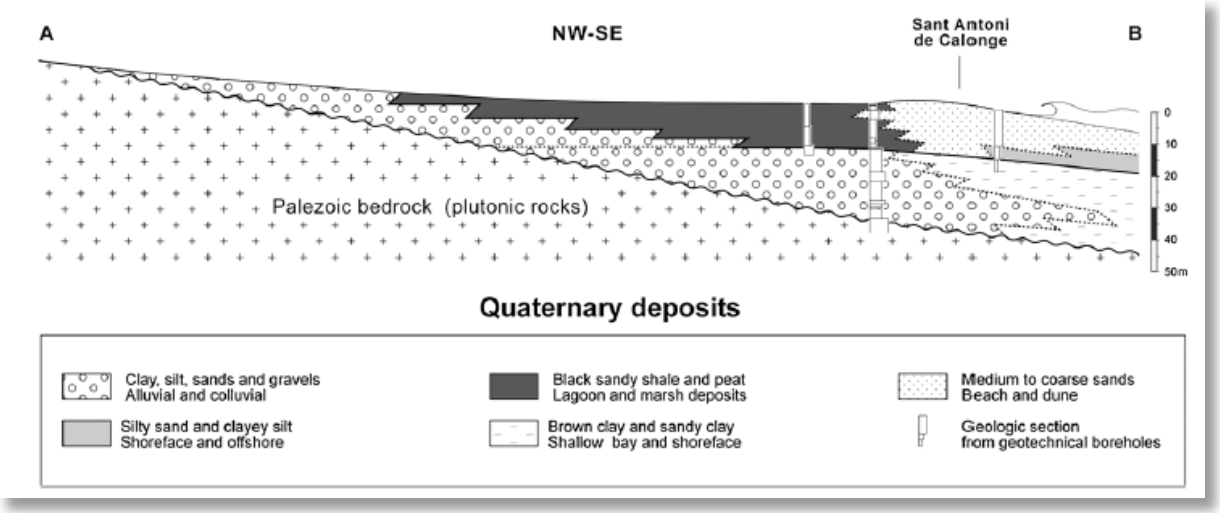
4. Monitoring in coastal aquifers



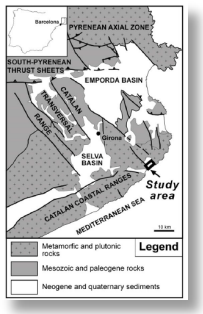
Mas-Pla et al., 2014. *Contributions to Science*, 10: 171-184

4. Monitoring in coastal aquifers

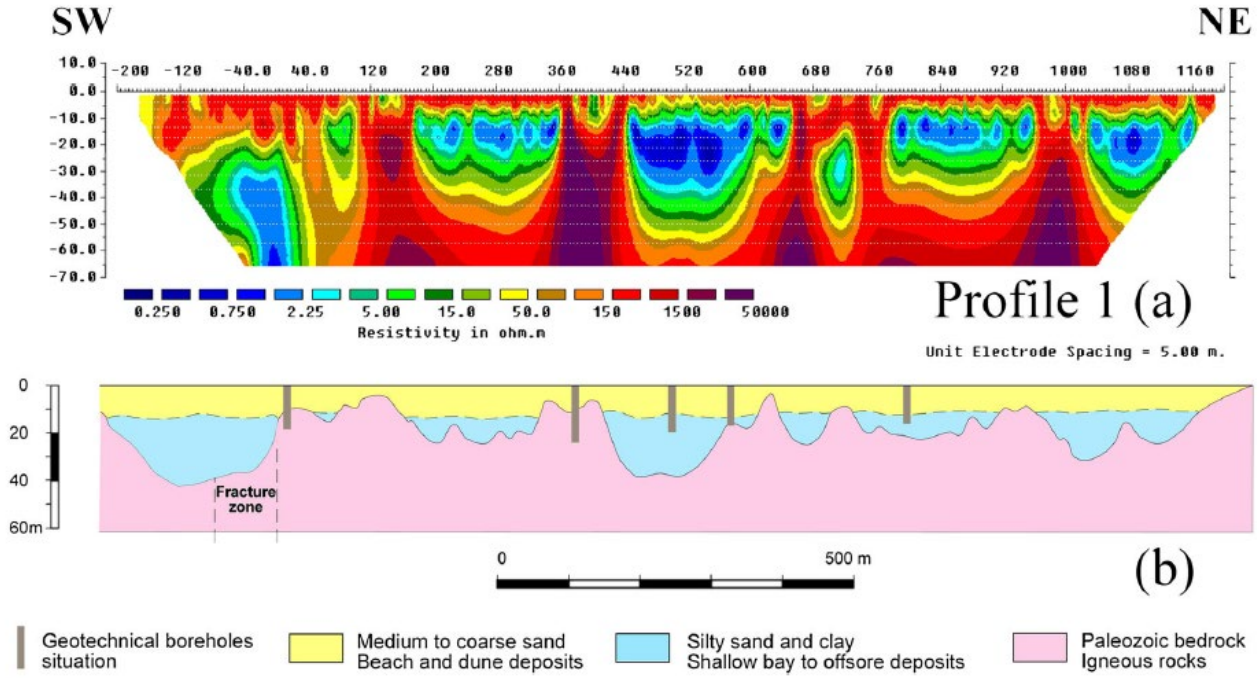
Stratigraphic scheme



Mas-Pla et al., 2013 *Hydrol. Process. 27, 2352–2366*



Geophysical information



5. Monitoring well location

The selection/location of appropriate sampling sites and site density should be based on the conceptual understanding and by using existing information:

- existing **previous data** (length, frequency, range of parameters),
- **construction** characteristics of existing sites and their abstraction regime,
- the spatial distribution of existing sites compared to the **scale** the groundwater body,
- **practical** considerations: easy and long-term access, security and safety.

USGS (1995) Open-File Report 95-398

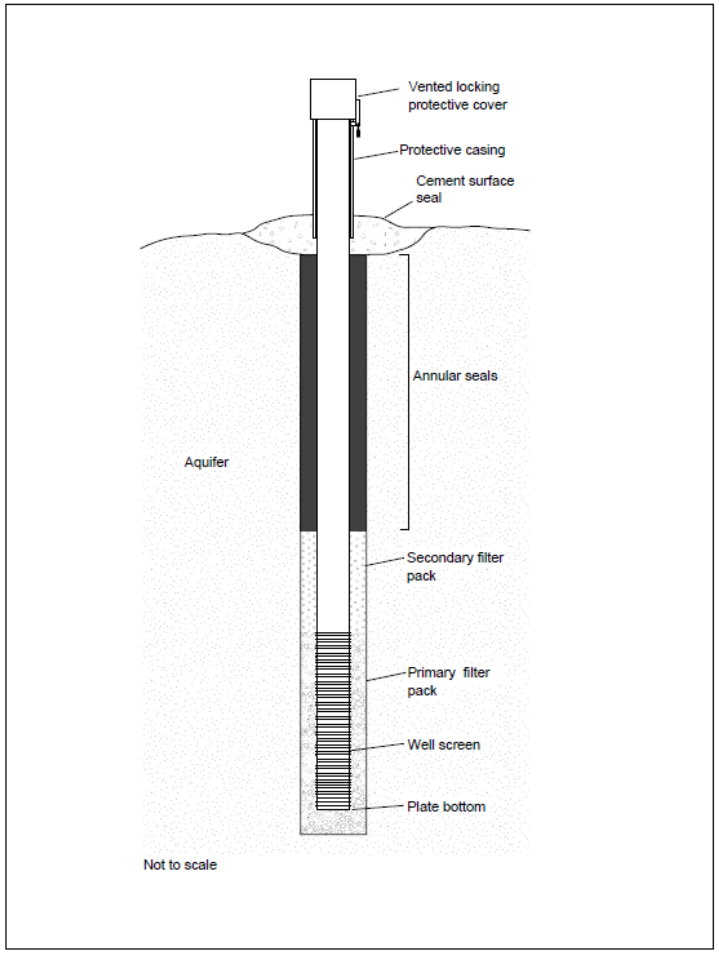


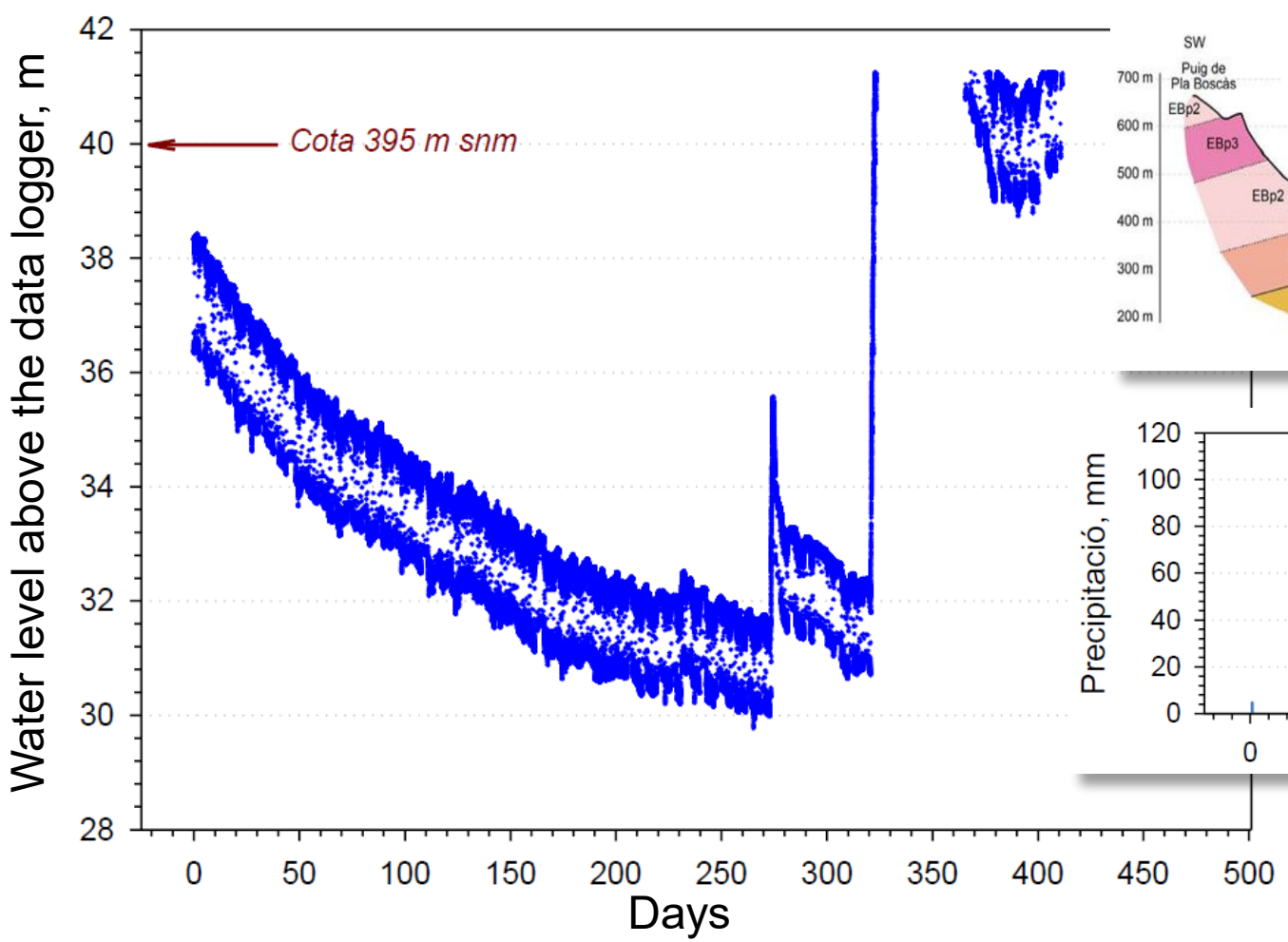
Figure 4. General design of a monitoring well in unconsolidated deposits for National Water-Quality Assessment Program Land-Use and Flowpath Studies.

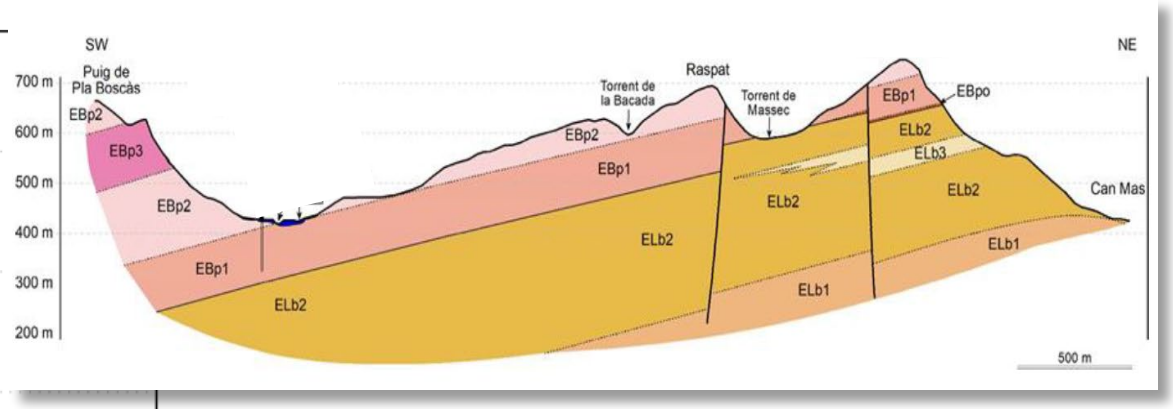
6. Monitoring networks

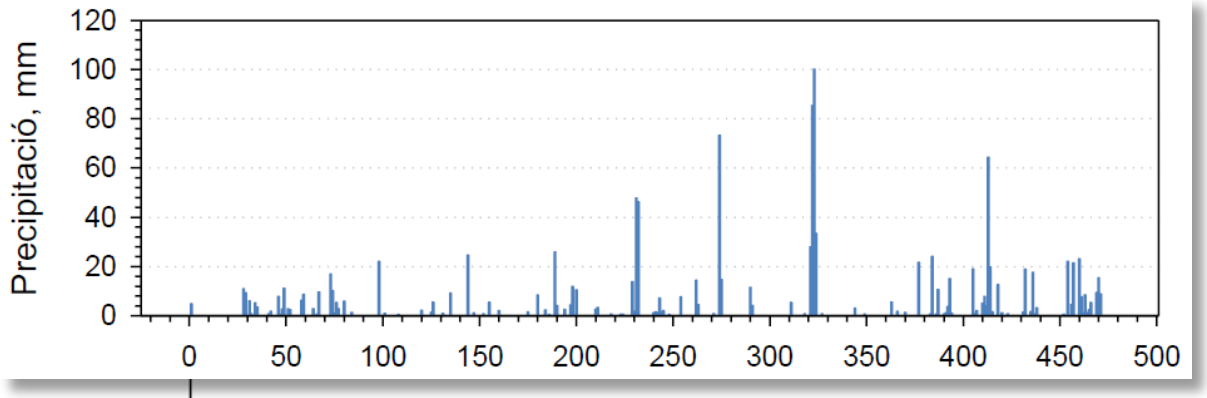
- **Quantity monitoring**: provides quantitative status assessment.
- **Surveillance monitoring**: define background and risk to achieve a good chemical status, assess on log-term trends, establish operational monitoring.
- **Operational monitoring**: establish the groundwater chemical status, control established upward trends.

Photos: J M-P

7. Quantity monitoring networks







ICRA, 2020. Unpublished

8. Surveillance monitoring networks

This network is required to 1) validate risk assessment, 2) classify groundwater bodies, 3) assess trends for bodies “at risk” and “not at risk” of failing the WFD objectives.

Goals:

i. Monitor impacts of identified pressures,
ii. Control the evolution of groundwater quality along the flow paths,
iii. Useful for determining background levels.

Main parameters: dissolved oxygen, pH-value, electrical conductivity, nitrate, ammonium, temperature and a set of major and trace ions, as a minimum database.

8. Surveillance monitoring networks

Table 2: Proposed monitoring frequencies for surveillance monitoring (where understanding of aquifer systems is inadequate).

Note: This table proposes monitoring frequencies that can be used as a guide where the conceptual understanding is limited and existing data are not available. Where there is a good understanding of groundwater quality and the behaviour of the hydrogeological system, alternative monitoring frequencies can be adopted as necessary.

		Aquifer Flow Type				
		Confined	Unconfined			
			Intergranular flow significant		Fracture flow only	Karst flow
			Significant deep flows common	Shallow flow		
Initial frequency – core & additional parameters		Twice per year	Quarterly	Quarterly	Quarterly	Quarterly
Long term frequency – core parameters	**Generally high-mod transmissivity**	Every 2 years	Annual	Twice per year	Twice per year	Twice per year
	Generally low transmissivity	Every 6 years	Annual	Annual	Annual	Twice per year
Additional parameters (on-going validation)		Every 6 years	Every 6 years	Every 6 years	Every 6 years	-

COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC) Guidance Document No 15, Groundwater monitoring, 2007

9. Operational monitoring networks

This network is required to 1) determine the chemical status of bodies “at risk”, 2) prove the occurrence of induced upward trends, 3) assess the effectiveness of implemented measures. Only for groundwater bodies “at risk”!

Goals:

i. Link quality data to the related pressure,
ii. Evaluate the development of a pollution hazard,
iii. Control the impact on vulnerable systems, whether natural or artificial.

Main parameters: same as in the surveillance network, plus those specific to track the impact and its progress.

9. Operational monitoring networks

Table 3: Proposed frequencies for operational monitoring.

		Aquifer Flow Type				
		Confined	Unconfined			
			Intergranular flow significant		Fracture flow only	Karst flow
			Significant deep flows common	Shallow flow		
Higher vulnerability groundwater	**Continuous pressures**	Annual	Twice per year	Twice per year	Quarterly	Quarterly
	Seasonal / intermittent pressures	Annual	Annual	As appropriate	As appropriate	As appropriate
Lower vulnerability groundwater	**Continuous pressures**	Annual	Annual	Twice per year	Twice per year	Quarterly
	Seasonal / intermittent pressures	Annual	Annual	As appropriate	As appropriate	As appropriate
Trend assessments		Annual	Twice per year	Twice per year	Twice per year	-

COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC) Guidance Document No 15, Groundwater monitoring, 2007

10. Integrated monitoring networks

The WFD considers the water environment as a continuum.

Monitoring programs for surface water and groundwater should therefore be designed and operated in an **integrated way** where the environmental objectives of surface waters and groundwater are dependent on each other.

This is of the utmost relevance in **transboundary aquifers**, where resources of both types of water bodies are shared.

Photos: J M-P

11. *Starting* monitoring programs

Starting monitoring programs face distinct difficulties,

1. Setting a conceptual model of all potential groundwater bodies, and the existing pressures,
2. Drilling and creating a real network to deal with WFD goals.

Therefore, existing monitoring infrastructure should be used to set a surveillance network, and new investments used to create/reinforce an operational network.

Nevertheless, **effort must be focused to acquire as much knowledge as possible from the very beginning** using the existing facilities.

11. *Starting* monitoring programs

Advantages of using available wells:

1. Continuously operated, for instance public supply or private wells.
2. Use springs, if they are representative; however, avoid small local springs.

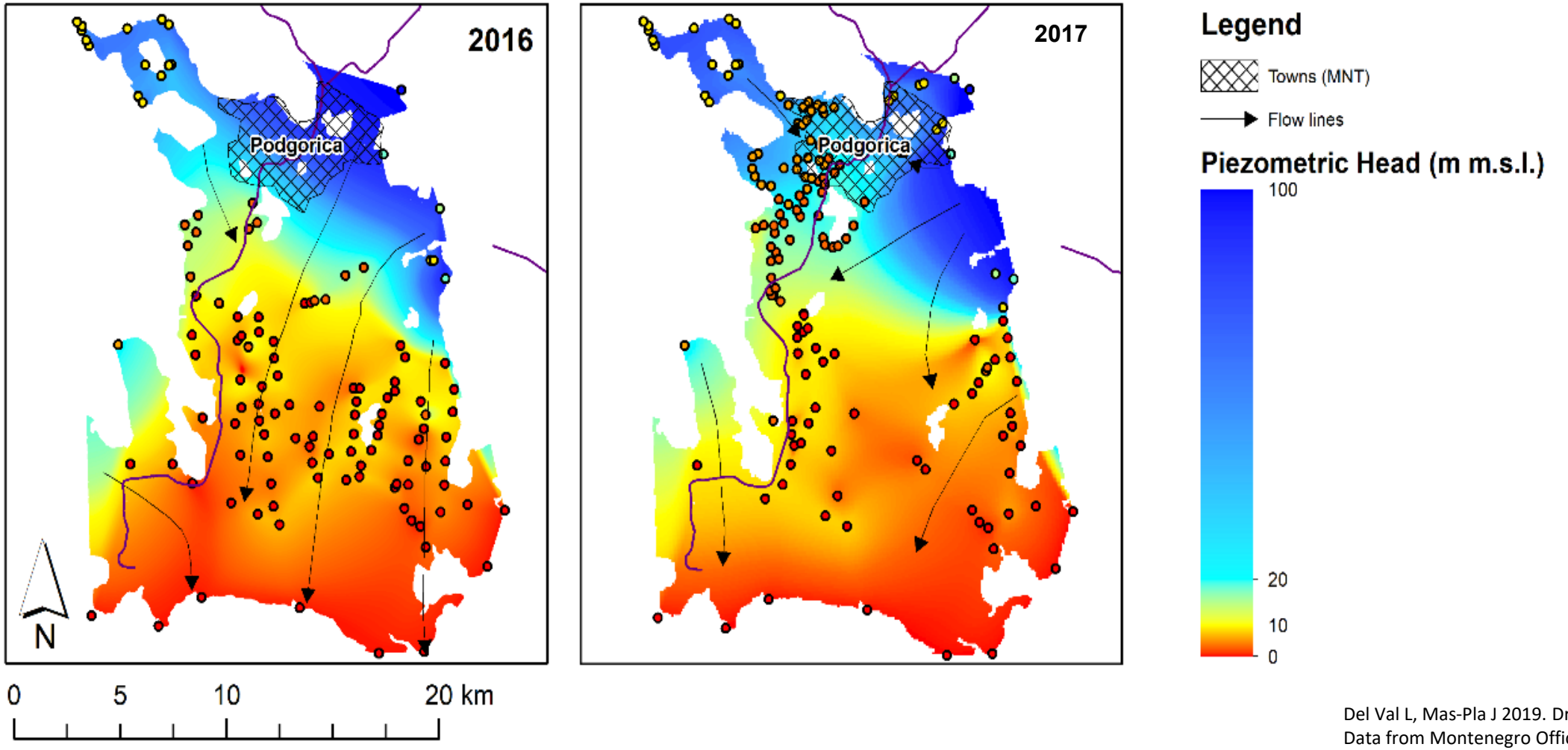
Disadvantages of using available wells:

1. Geological information sometimes is uncertain, as they were drilled long ago.
2. Avoid dug wells, specially for quality sampling; correct for head measurements.
3. Exploitation wells usually are screened in most of its length, so the true origin of the sample is uncertain.
4. May never be in non-influenced conditions because of continuous pumping.

12. Real case

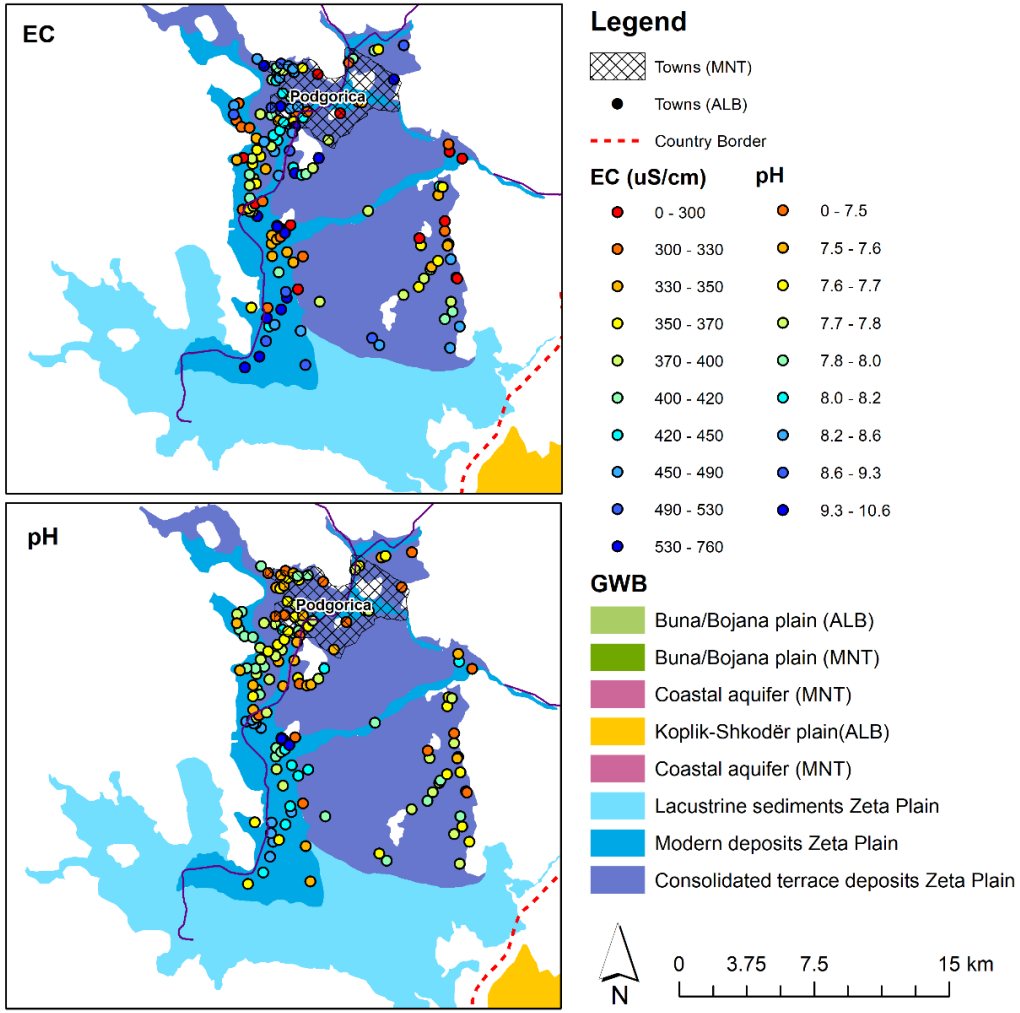
The case of the Skadar/Shkoder - Buna/Bojana transboundary aquifer

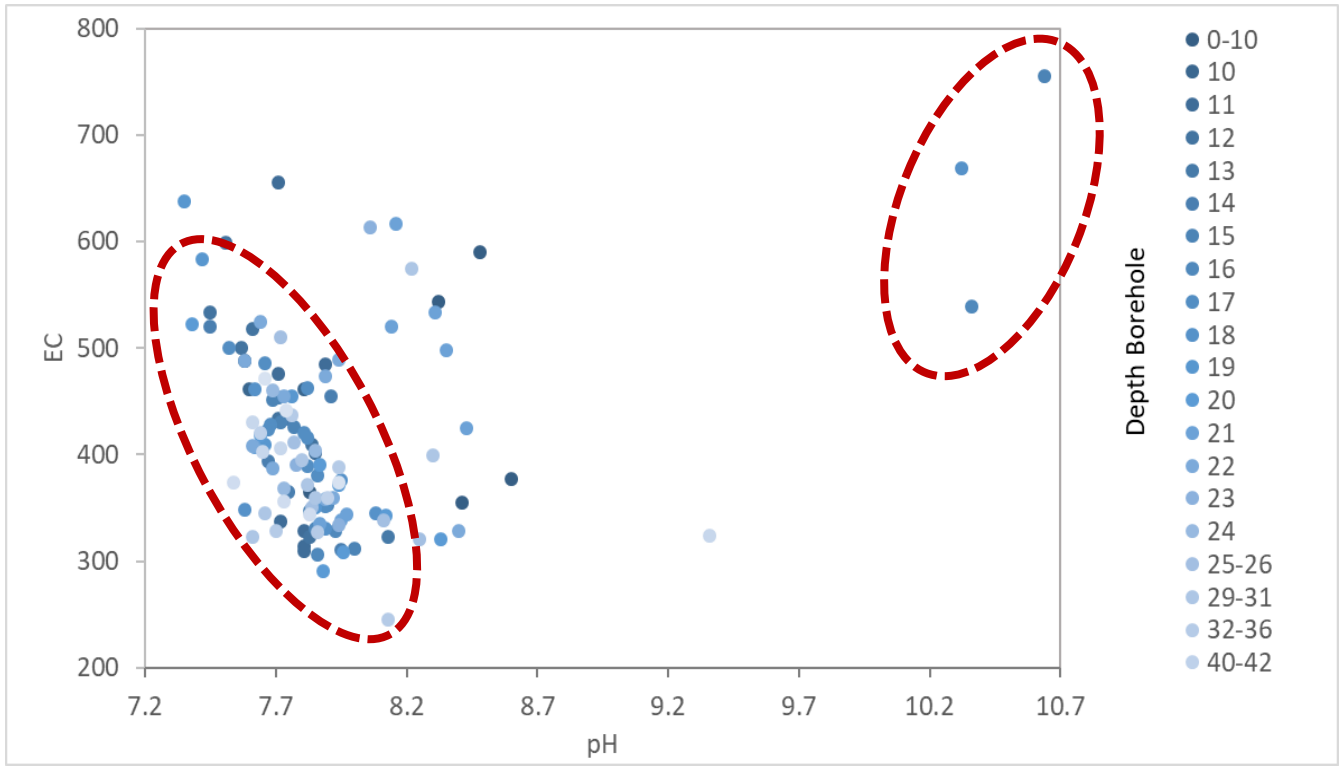
Quantitative monitoring



Del Val L, Mas-Pla J 2019. Drin Project. UNESCO
Data from Montenegro Officials

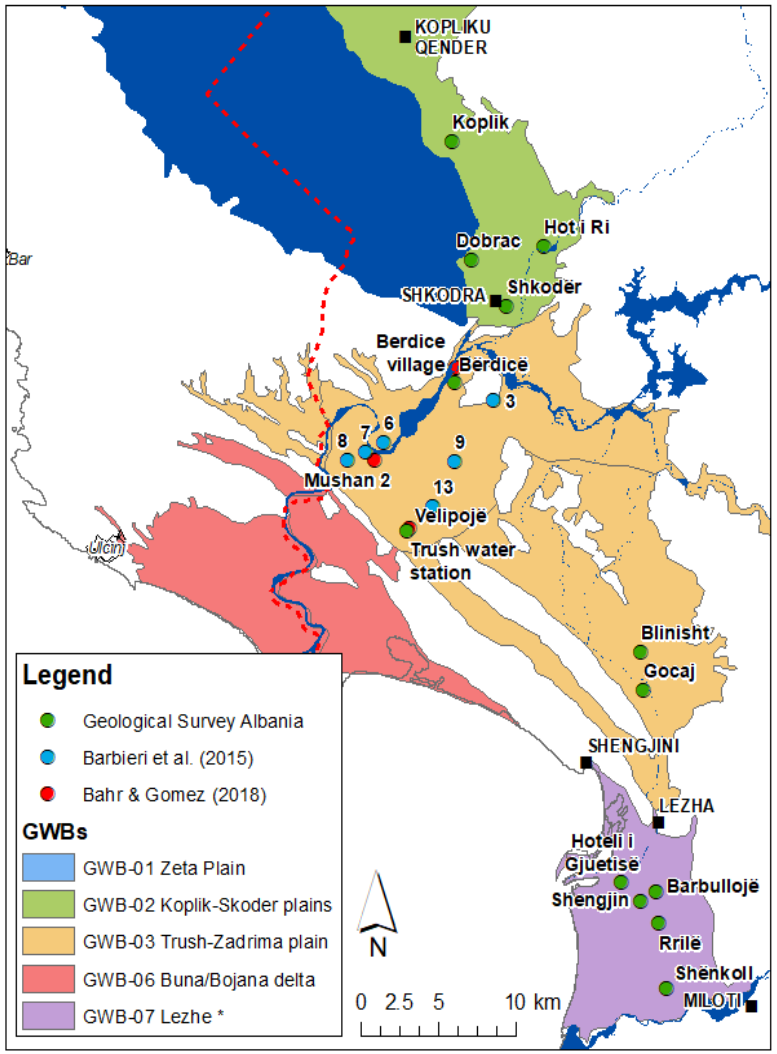
Surveillance monitoring

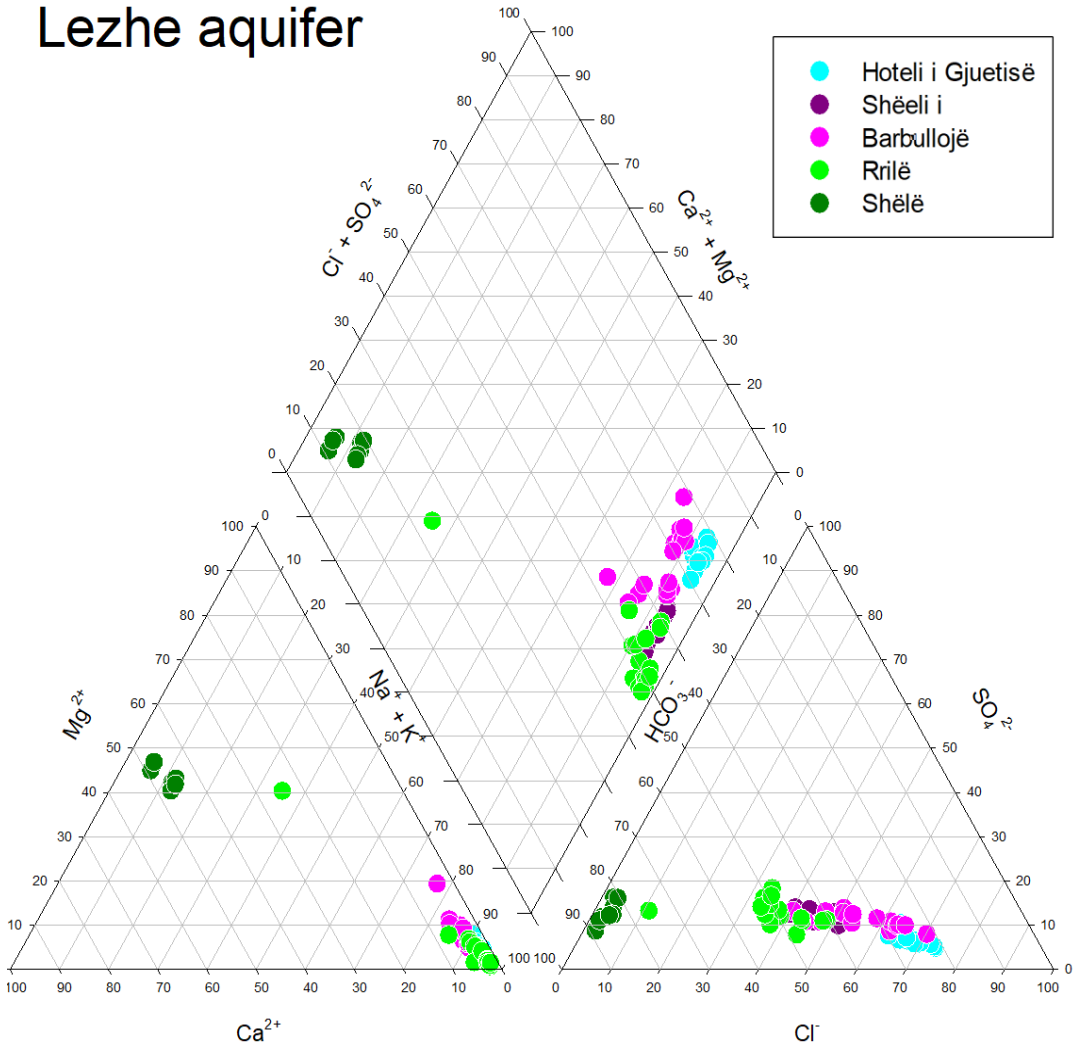




Del Val L, Mas-Pla J 2019. Drin Project. UNESCO
Data from Montenegro Officials

Surveillance monitoring





Del Val L, Mas-Pla J 2019. Drin Project. UNESCO
Data from Albania Officials

Further reading

- EU-WFD Guidelines Document 15 on “Groundwater Monitoring”.
- U.S. Geological Survey Open-File Report 95-398 “Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Selection, Installation, and Documentation of Wells, and Collection of Related Data” by W.W. Lapham, F.D. Wilde, and M.T. Koterba.

Thank you!

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