Water Quality Assessment Needs New Tools

micro-sensor networks for a better monitoring

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1- Context: Water Framework Directive

Europe's flagship legislation on water protection

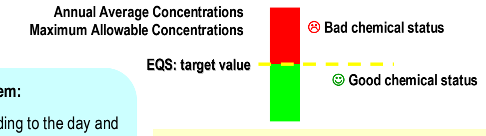
Environmental monitoring is the cornerstone of any policy for managing, protecting and restoring surface and groundwater resources. As the Water Framework Directive (WFD) gradually comes into effect, the environmental metrology market is bound to increase over the coming years. In view of the high cost of the laboratory analyses required and the potential artefacts that may be introduced during the conventional sampling sequence, viz, collection-packaging-transport, new environmental monitoring strategies must be designed.

WFD's Objectives

- **Protect or Restore all Surface Water Bodies**
- **Give Precise & Measurable Objectives**
- **Reach the "Good Chemical & Ecological Statuses" in 2015**

2- Chemical Status (a normative definition)

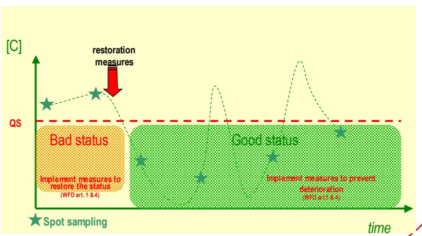
Regulatory texts enforce a normative definition: the law fixes a list of "priority substances" with target values: Environmental Quality Standards (EQS). Then, these EQS values are used for compliance testing



Problem:

According to the day and hour of sampling (i.e. during the working days and hours), the water body status will be consider good or bad.

This protocol do not allow a synthetic and realistic view of water body status.



3- Ecological status (no normative definition)

"Quality of the structure and functioning of aquatic ecosystems"

We have to develop a functional analysis of water bodies

not only to closely examine the organisation of major communities, but also

analyse the **connections** & **exchanges** between their **functional units** and with their **biotope**

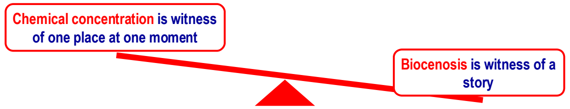
Move from an anatomical view ...

...to a physiological view

4- Compare Comparable Metrics

at present Environmental Scientists compare

Concentration *vs.* **biocenosis** (single datum *vs* integrated data)

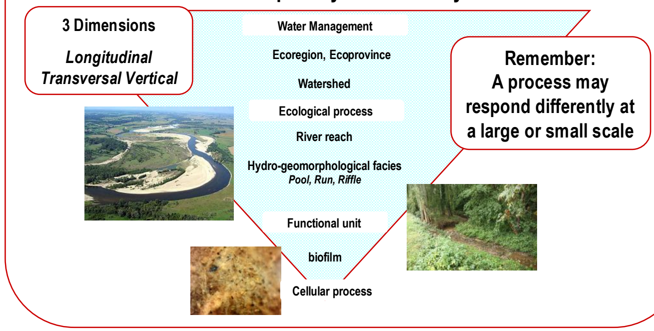


This unbalance leads to data interpretation difficulties

A relevant water monitoring have to respect the space & time scales of the hydrosystem

5- Measurements must fit to river spatial scales

Rivers are spatially structured systems



5bis- Measurements must fit to river time scales

Could we understand a symphony, if we only hear one note every minute or two?

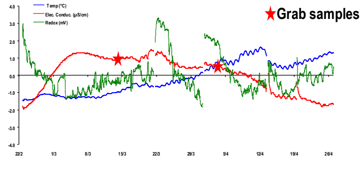
Obviously no!

We cannot reduce a symphony to 25 or 50 notes.

But we make that, when we use grab sampling techniques.

The grab sampling techniques cannot properly inform us on real dynamics of river processes

the magnitude of this metrological challenge demands a paradigm shift and new tools



Physical-chemical variations in hyporheic zone (values centred and scaled)

6- Methodological challenges

Field chemistry fitted to properly inform us, has to be adapted to river characteristics & its dynamics

These new tools must be:

- Integrated: **reduce risks of errors (sampling, transport, ...)**
- Cheap: **multiply measurement points**
- Autonomous: **limit maintenance costs**
- Fast: **follow transient events in real time**
- Reliable & Accurate: **keep the lab data quality**
- Non-destructive: **at the vicinity of the measure point**

7- Micro-sensor network can meet these challenges

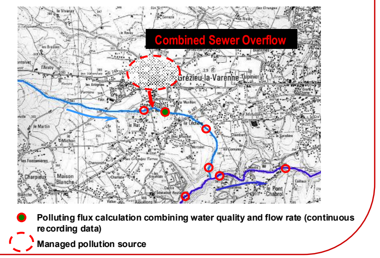
As an example, organic pollution impact in river depends on its self-purification capability, itself depending on hydrological conditions

A sensor network helps to:

1st: Detect critical conditions (length of impacted river, according to hydrological conditions);
2nd: Check improvement and management efficiency. Then, the network will be reduced to one reference and one control point.

○ **Water quality sensors** for:
- know the reference, or close to natural state
- detect pollutions
- measure the river length necessary for water quality restoration

● **Pressure sensors** for:
- get flow rate time series using rating curves
- detect supply or water loosing periods (gradient between GW and surface water levels)
- detect temporary connexions in wet-weather (water depth)



8- Water Quality Assessment needs new tools

Real needs

- **Normative (regulation, monitoring)**
- **Cognitive (functional ecology)**

Limits of conventional monitoring

- **Metrology (grab sampling) not adapted to variable spatiotemporal scales of river processes**
- **Divergence between legal requirements & good monitoring practices**

Relevant alternative: micro-sensors

- **Temporal & Spatial Resolution**
- **Low cost**

But technological obstacles remain

- **Ruggedization**
- **Miniaturisation, Wireless communication & Eco-design**
- **Design a new cyber-infrastructure to manage data**