WATER MICROPOLLUTANTS: FROM DETECTION TO REMOVAL – 26-28 NOV 2018

ASSESSING THE PERFORMANCES OF SENSORS AND DEVICES FOR WATER QUALITY MONITORING: WHY AND HOW?

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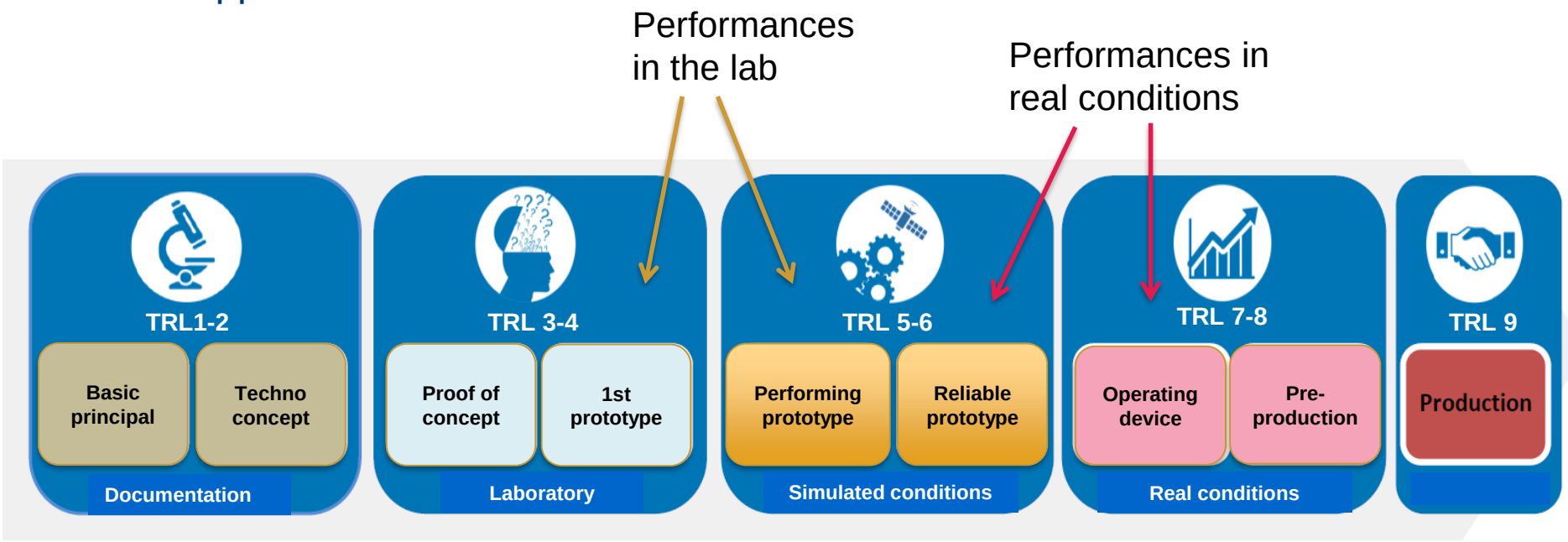
WHY DO WE NEED TO ASSESS THE PERFORMANCES OF SENSORS?

WHY?

From a sensor developper point of view

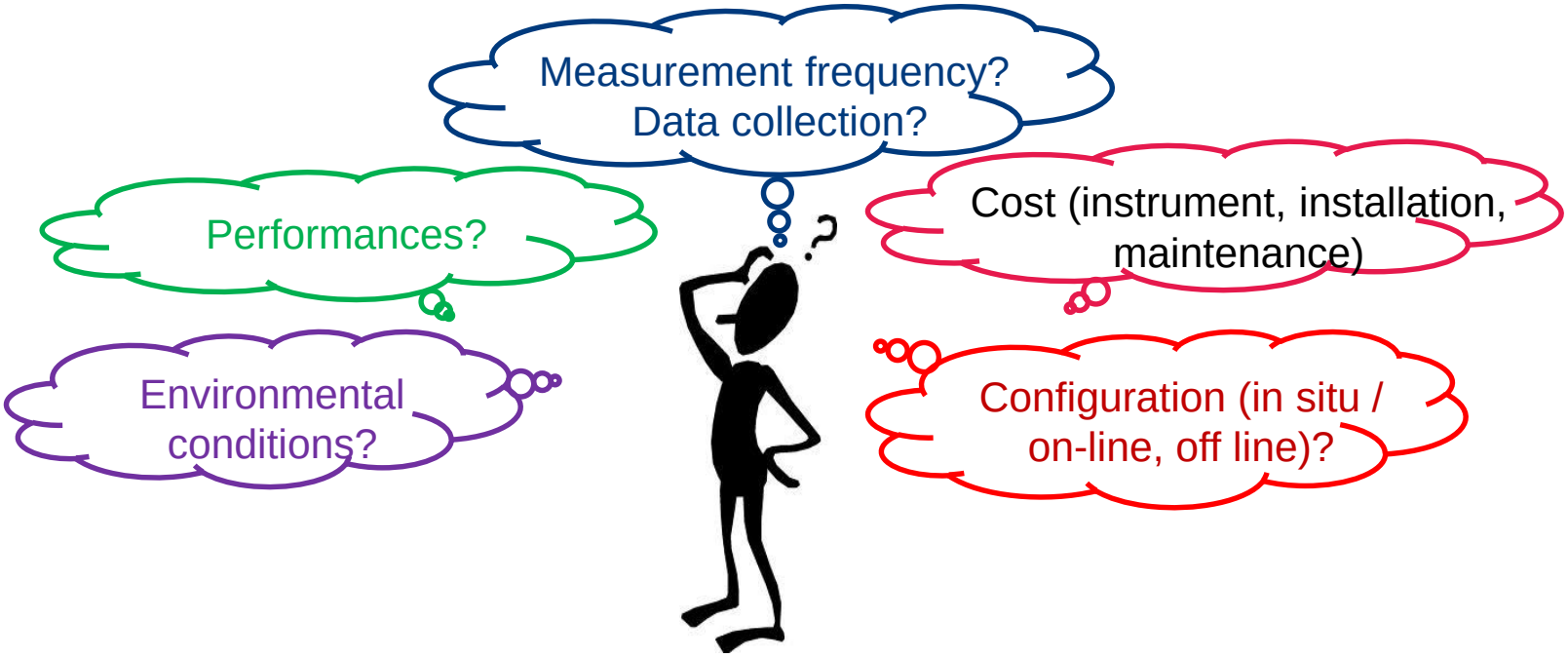
- To optimise and improve the sensor / device
- To check that the sensor / device is fit for purpose for its intended application



WHY?

From an end user point of view

- To have confidence in the performances stated by the developper
- To select the most appropriate sensor / device with regard to the monitoring objective



WHICH PERFORMANCES ARE TO BE ASSESSED?

WHICH PERFORMANCES?

It will depend on:

- The nature of the property to be measured :
  - **Quantitative**
  - **Qualitative**

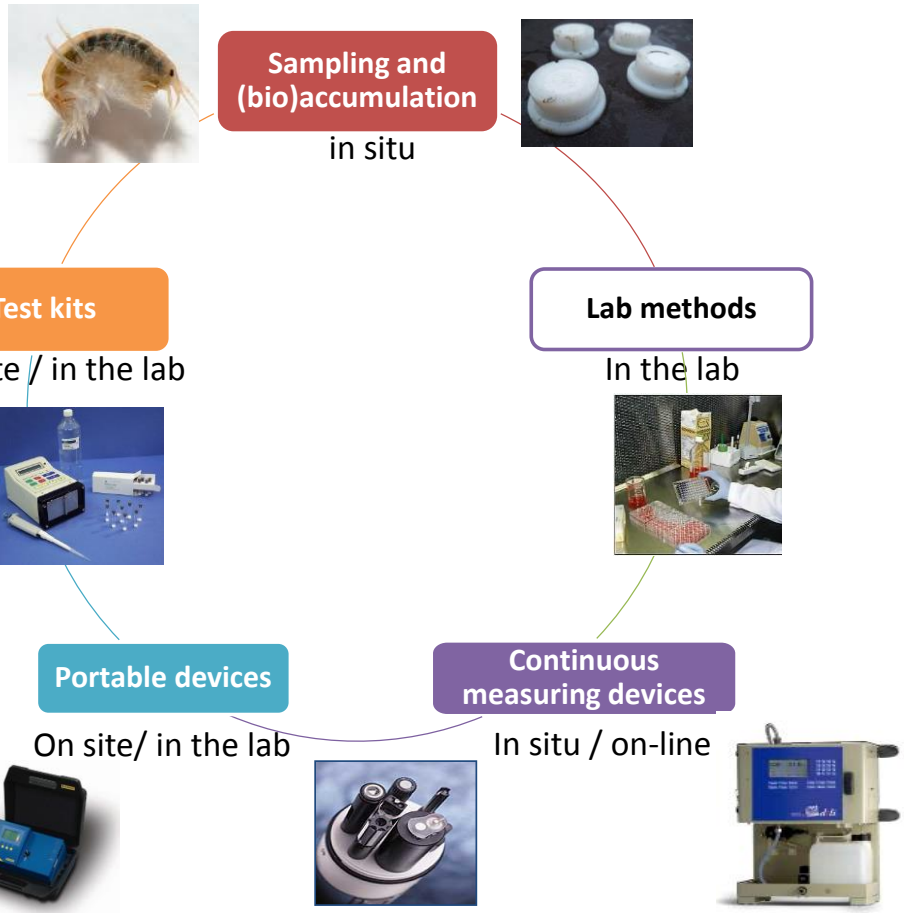
- The type of parameter(s) to be measured:
  - **Physico-chemical (including micropolluants)**
  - **Microbiological**
  - **Ecotox**
  - **Others?**

WHICH PERFORMANCES?

It will also depend on:

- Where the measurement is carried out:
  - **In the lab**
  - **On site**
  - **In situ**

- The type of response:
  - **Snap shot**
  - **Integrated response**
  - **Continuous response**

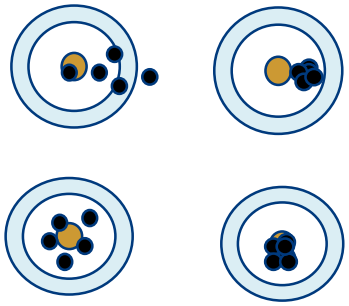


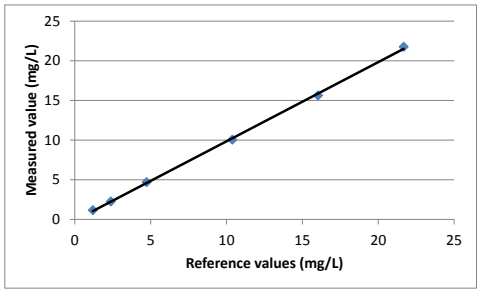
WHICH PERFORMANCES?

Example : quantitative response / physico-chemical parameter

Metrological performances:

- **Fidelity (e.g. repeatability),**
- **Bias,**
- **Sensitivity (e.g. slope of a linear model),**
- **Limit of detection or quantification**
- **Measurement uncertainty**





And also:

- **Physical, biological or chemical interferences**
- **Response time**

WHICH PERFORMANCES?

Other performances of interest:

- **Sample temperature,**
- **Sample flow rate**
- **Drift (continuous device)**
- **Warm up time (portable device)**
- **Variation in supply voltage**
- **Etc.**

→ **Contribution to the measurement uncertainty**

HOW CAN WE ASSESS THESE PERFORMANCES?

HOW?

Existence of various protocols:

- **US EPA Environmental Technology Verification (ETV) program**
- **Alliance for Coastal technologies**
- **UK certification scheme MCERT**
- **Standardization (ISO and CEN)**

HOW?

US EPA ETV – Enviromental Technology Verification

Program started in 1995 and ended in 2014

- **Immunoassay Test Kits for Atrazine – 2004**
- **Multi-Parameter Water Quality Probes – 2002**
- **Arsenic Test Kits – 2000**
- **Lead in Drinking Water – 2012**
- **Nitrate Sensors for Ground Water Monitoring – 2010**
- **Etc.**

https://archive.epa.gov/nrmrl/archive-etv/web/html/vt-ams.html

HOW?

US EPA ETV

Exemple for:
Immunoassay Test Kits for Atrazine

Table 1. Sample Summary for Verification of Test Kits for Atrazine in Water

Type of sample	Description	Replicates for test kit analysis	Total No. laboratory reference analyses	Performance Factor[1]
Quality Control				
Reagent blanks (10%)	minimum 10% frequency	20	1	False positive/negative
Calibration check samples	As required by the test kit protocol	TBD	0	-
Performance Test				
Performance test #1	0.1 ppb atrazine	3	1	
Performance test #2	0.5 ppb atrazine	3	1	Accuracy, precision, linearity, false positive/negative
Performance test #3	1 ppb atrazine	3	1	
Performance test #4	3 ppb atrazine	3	1	
Performance test #5	5 ppb atrazine	3	1	
Method detection limit	Atrazine concentration 2X vendor-stated detection limit	7	-	Method detection limit
Cross-reactivity test #1	3 ppb hydroxyatrazine	3	1	Cross-reactivity, false positive/negative
Cross-reactivity test #2	3 ppb desethyl atrazine	3	1	
Environmental				
Fresh water	Fresh surface water, unspiked	3	1	
Fresh water spike #1	Fresh surface water with 1 ppb atrazine spike	3	1	
Fresh water spike #2	Fresh surface water with 3 ppb atrazine spike	3	1	
Brackish water	Brackish water, unspiked	3	1	
Brackish water spike #1	Brackish water with 1 ppb atrazine spike	3	1	
Brackish water spike #2	Brackish water with 3 ppb atrazine spike	3	1	Accuracy, precision, matrix effects, false positive/negative
Groundwater	Groundwater, unspiked	3	1	
Groundwater spike #1	Groundwater with 1 ppb atrazine spike	3	1	
Groundwater spike #2	Groundwater with 3 ppb atrazine spike	3	1	
Treated drinking water	Chlorinated drinking water	3	1	
Treated drinking water spike #1	Chlorinated drinking water with 1 ppb spike	3	1	
Treated drinking water spike #2	Chlorinated drinking water with 3 ppb atrazine spike	3	1	
Performance Evaluation Sample		-	1	-
Total		84	21	-

[1] Other performance factors to be evaluated qualitatively include ease of use and reliability.

HOW?

US Alliance for Coastal Technology (ACT)

On going program

- **In situ probes or in situ analysers**
- **Estuarine and lake application**
- **List of parameters with evaluation performed or on going:**

HYDROCARBON	pH	DISSOLVED OXYGEN II
pC02	SALINITY	NUTRIENT
TURBIDITY	FLUOROMETER	DISSOLVED OXYGEN
ALGAL TOXINS	FLUOROMETER II	NUTRIENT II

http://www.act-us.info/evaluations.php

HOW?

US Alliance for Coastal Technology (ACT)

Exemple for nutrients

- **Bias and fidelity over working range (laboratory tests)**
- **Temperature, salinity, turbidity and DOC influences (laboratory tests)**
- **Completeness of data return under varying field deployment lengths – 3 sites**

Report code	Detailed Protocols used for Verification Testing of Next-Generation Nutrient Sensors are available for download here
ACT VS17-01	Performance Verification Statement for the Systea WIZ Probe Nitrate Analyzer
ACT VS17-02	Performance Verification Statement for the Systea WIZ Probe Phosphate Analyzer
ACT VS17-03	Performance Verification Statement for the NOC Nitrate Analyzer
ACT VS17-04	Performance Verification Statement for the NOC Phosphate Analyzer
ACT VS17-05	Performance Verification Statement for the Real Tech Real Nitrate Analyzer GL Series
ACT VS17-06	Performance Verification Statement for Sea-Bird Scientific HydroCycle-Phosphate Analyzer

HOW?

UK EA MCERT certification scheme

UK Environmental Agency's scheme for monitoring emissions to air, land and water

- **MCERTS is used to approve instruments, people and laboratories**
- **Water monitoring - performance standards and test procedures for:**
  - Continuous water monitoring equipment
  - Portable water monitoring equipment
  - Automatic sampling equipment
- **Certification of equipments for pH, conductivity, dissolved oxygen, turbidity, TOC**

http://www.siraenvironmental.com/mcerts/
http://www.environment-agency.gov.uk/business/regulation/31829.aspx

HOW?

International and European Standards

ISO 15839 (2005)	versus	EN 17075 (to be published early 2019)
Characterization of new sensors / devices to establish technical specifications		Verification of manufacturer's claims Estimation of a measurement uncertainty
Useful for manufacturers		Useful for end users and third party evaluation
Continuous measuring devices		Continuous measuring devices Portable devices

HOW?

European Standards: EN 17075

Water quality - General requirements and performance test procedures for water monitoring equipment - Measuring devices

- **Performances estimated in controlled conditions (in the lab)**

Estimate each individual performance
Combined them to estimated the measurement uncertainty

- **Performances estimated in real conditions (on site)**

Demonstrate the sensor / device performance is maintained under representative operational conditions

At least 3 months field trial

CONCLUSION

Performances should be evaluated:

- **In controlled conditions**
- **In real conditions, representative of the intended application, to demonstrate their applicability**
- **Using existing protocols (e.g. EN 17075)**

Field testing

- **Test in real conditions several sensors / devices targeting the same parameters**
- **Use existing plateforms**

Third party assessment

- **Impartiality**
- **Harmonised protocols** → ETV (EU), ACT, MCERT etc.
- **Statement (publication) of the performances**

THANK YOU FOR YOUR ATTENTION