Water Quality assessment

Assessment, monitoring and analysis

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Topic/Lesson

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Introduction

This lesson will provide an overview of selected aspects of water quality assessment, monitoring and analysis

This lesson will develop on knowledge learnt in the “Water Quality - Importance and Regulatory Settings” and “Contamination of water” lessons.

Objectives

- To be able to identify why the monitoring of water quality is important
- To be able to compare and contrast the relative advantages and disadvantages of field based and laboratory based analysis
- To be able to discuss some of the considerations involved in the design of a monitoring programme

KEY DEFINITIONS

Assessment & monitoring

- “Water quality assessment is the overall process of evaluation of the physical, chemical and biological nature of the water” [1].
- “Water quality monitoring is the collection of the relevant information” for assessment [1].

[1] Pg. 40, Chapman (1996)

Types of monitoring

- Monitoring can be split into three types of activities. These are based on long-term, short-term and continuous monitoring programmes:
  - Monitoring: “long-term, standardised measurement and observation to define status and trends”.
  - Surveys: “short duration, intensive programmes to measure and observe the quality of water for a specific purpose”.
  - Surveillance: “continuous, specific measurement and observation for the purpose of water quality management” [1]

[1] Pg. 41, Chapman (1996)

WHY MONITOR WATER QUALITY?

Why monitor water quality

1. Characterize waters and identify changes and trends in water quality over time.

2. Identify specific existing or emerging water quality problems.

3. Helps the setting up of pollution prevention and management strategies [1]

[1] https://www.envirotech-online.com

Why monitor water quality

4. Track compliance with water quality guidelines.

5. Needed for emergency strategies (e.g. oil spills, mass erosion or chemical spills).

[1] https://www.envirotech-online.com

Monitoring water quality

- The overall purpose of monitoring is to make sure water systems are protected and, if problems emerge, to be the start of corrective measures [1].

- Monitoring programmes are not intended to simply be data collection exercises [1].

[1] Pg. 48, UNICEF (2008)

APPROACHES TO WATER QUALITY MONITORING

Planning for monitoring

- Before a programme, need to define
  - What information is needed
  - What information is available
  - Aims and objectives of intended programme [1]
- The answers to these questions will change how the monitoring programme will be set.

[1] Pg. 18, Bartram and Balance (1996)

Design of monitoring

- The objectives of the monitoring inform the approach required

- Different monitoring programmes may look like:
  - A rapid assessment (a one off event) [1]
  - Routine monitoring programmes [2]
  - Community-based monitoring programmes [3]
  - Single parameter versus multi parameter [1]

[1] Pg. 45 UNICEF (2008). [2] Pg. 47 UNICEF (2008). [3] Pg. 49 UNICEF (2008).

Rapid assessments

- Two types of rapid assessment can be carried out: multi-parameter or single parameter assessments.

- Multi-parameter assessment
  - Used for establishing a water quality baseline and predicting water quality patterns and trends [1].
- Single-parameter assessment
  - Used in response to a public health problem caused by a specific contaminant [2].

[1] Pg. 45 UNICEF (2008). [2] Pg. 46 UNICEF (2008).

Field and lab analysis

- Chemical analysis can be conducted in the field (in-situ) or in the laboratory and depends on analytical, project and technical requirements [1]
- Some analytes, particularly unstable parameters, are recommended to be measured in-situ [1]
- Adequate sample storage and preservation must be considered for samples intended for laboratory analysis; this can be parameter-dependent [2]
- Data quality and assurance measures should be considered for ALL analysis undertaken [3]

[1] Pg. 59 UNICEF (2008). [2] Pg. 60 UNICEF (2008). [3] Pg.68 UNICEF, 2008

Field analysis

- Advantages
  - In-situ measurements much better for unstable or labile parameters
  - Immediate results for spot checks and/or to inform decision making [1]

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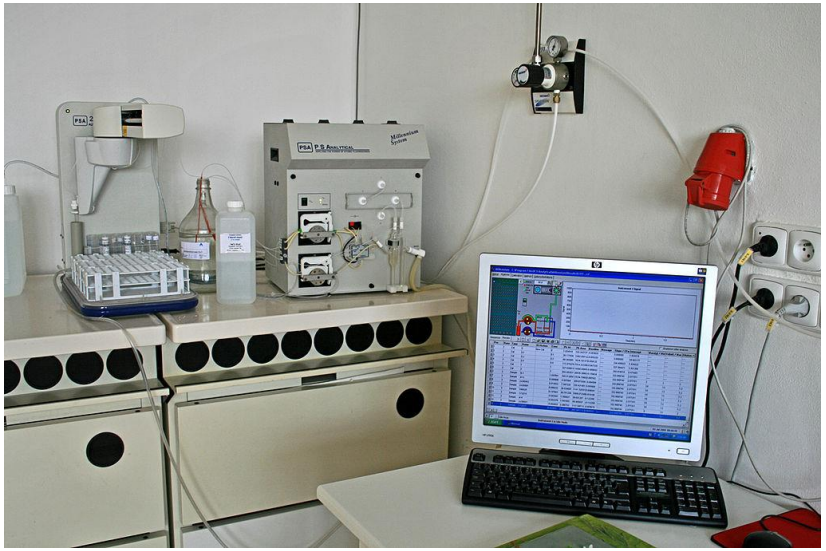
- Disadvantages
  - Less controlled environment (some methods might be sensitive to ambient temperature, humidity and other environmental conditions)
  - Some methods may have lower precision or accuracy as compared to lab-based methods [1]

[1] Pg. 52 UNICEF (2008)

Laboratory analysis

- Advantages
  - Typically higher accuracy and lower detection limits
  - Controlled environment reduces some analytical uncertainties [1]



By Karelj (Public Domain), https://commons.wikimedia.org/w/index.php?curid=9800700 (Accessed 30/04/2021)

- Disadvantages
  - Not as quick as field based analysis
  - Added complications such as preserving, transporting and storing samples [1]

[1] Pg. 52 UNICEF (2008).

REPRESENTATIVENESS

Temporal changes

- Within any water body water quality can change with time. Changes can occur over a range of different scales of time:

1. Minute-to-minute - e.g. water mixing, redox changes and inputs
2. Diurnal (24-hour) – e.g. biological and daylight/darkness cycles
3. Seasonal – e.g. biological and hydrological cycles
4. Year-to-year – e.g. increased human activities in the watershed
5. Irregular patterns – e.g. irregular sources of pollution [1]

[1] Pg. 30, Bartram and Balance (1996)

Spatial changes

- Within any one water body water quality can differ with place [1] as inputs can change
- In a lake variations may occur due to:
  - feeder streams or effluents
  - isolated bays and poorly mixed inlets
  - wind action
  - shape of surface water bodies
  - vertical stratification [2].

[1] Pg. 52, Polya and Watts (2017), [2] Pg. 51, Bartram and Balance (1996)

Sampling time and location

- Given temporal and spatial changes, representativeness needs to be considered in a sampling or monitoring campaign
- Appropriate sampling will depend on project objectives
- Examples of ways that try to be more representative include:
    - Monitor the water on a monthly basis to account for changes in pollution levels
    - Monitor the water across a river channel to evaluate the extent of mixing

[1] Pg. 51, Bartram and Balance (1996)

SUMMARY

Summary

Monitoring has a range of purposes but most importantly is used to make sure water systems are protected and, if problems emerge, to be the start of corrective measures

There are a range of ways that water quality monitoring can be approached – in the laboratory and in the field or both.

Planning is necessary to ensure monitoring is representative and so takes in to account the spatial and temporal changes that impact water quality

LEARNING EXERCISE

Learning Exercises

Think of developing your own water quality monitoring programme. What would you test for, what approach would you take and how would you make sure that your monitoring strategy was representative.

REFERENCES & FURTHER RESOURCES

References

- Bartram, J. and Ballance, R. eds., 1996. *Water quality monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes*. CRC Press. (OA) https://apps.who.int/iris/handle/10665/41851
- Chapman, D.V. ed., 1996. *Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring*. CRC Press. (OA) https://apps.who.int/iris/handle/10665/41850
- Polya, D.A. and Watts, M.J., 2017. Sampling and analysis for monitoring arsenic in drinking water. *Best Practice Guide*, p.49. (OA) https://doi.org/10.2166/9781780404929_049
- UNICEF, 2008. UNICEF Handbook on water quality. *United Nations Childrens Fund, New York/USA*. (OA) https://www.unicef.org/documents/2008-unicef-handbook-water-quality
- https://www.envirotech-online.com/news/water-wastewater/9/breaking-news/why-is-water-quality-monitoring-important/34104 (OA)

Further Resources

- This chapter provides a overview of many considerations involved in water quality sampling – particularly representativeness.
  - Polya, D.A. and Watts, M.J., 2017. Sampling and analysis for monitoring arsenic in drinking water. *Best Practice Guide*, p.49. (OA) https://doi.org/10.2166/9781780404929_049

- This chapter provides a case study of how these considerations such as representativeness were applied.
  - Polya, D.A., Richards, L.A., Al Bualy, A.A.N., Sovann, C., Magnone, D. and Lythgoe, P.R., 2017. Groundwater sampling, arsenic analysis and risk communication: Cambodia case study. *Best Practice Guide*, p.247. (OA) https://doi.org/10.2166/9781780404929_247

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