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THE CONTRIBUTION OF SAMPLING ACTIVITIES TO OBTAINING RELIABLE DATA IN ENVIRONMENTAL STUDIES

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Introduction

Water quality monitoring provides essential information for assessing aquatic environments and pollution control. The reliability of the final analytical result depends on the entire analytical chain, from sampling to laboratory analysis. Sampling is a critical stage because a non-representative, contaminated or altered sample may lead to erroneous conclusions even when laboratory analysis is correctly performed. The ISO 5667 series provides guidance on sampling programme design, sampling techniques, preservation and handling, while ISO 19458 addresses sampling for microbiological analysis [1–3]. The underlying in-house analysis identified sampling as an important source of uncertainty and emphasized the need to consider technical requirements, field conditions, human factors and quality-control measures in an integrated manner.

The objective was to develop a methodological framework linking the main sampling activities with potential sources of error, their effects on sample representativeness and appropriate control measures.

Materials and methods

The methodological framework was developed from an institutional technical study concerning the contribution of sampling activities to obtaining reliable environmental data. The analysis considered four components: (i) sampling stages; (ii) factors affecting sample representativeness; (iii) potential consequences for sample integrity; and (iv) measures for error reduction and QA/QC.

The sampling process included planning, selection of sampling locations, equipment preparation, container selection, collection, labelling and traceability, preservation and transport. The sampling strategy was considered in relation to the monitoring objective, water-body characteristics and target parameters. Grab, composite and integrated samples may be selected according to the purpose of the investigation.

Factors affecting representativeness were grouped as physical (temperature, light, flow, turbulence, depth and meteorological conditions), chemical (redox processes, volatilization, adsorption and contamination) and human (handling, site selection, labelling, procedural deviations and training). Their cumulative effects were also considered.

The QA/QC component included field duplicates, field blanks, spiked samples and equipment controls, together with standardized procedures and complete traceability.

Results and conclusions

The analysis resulted in an integrated sequence: sampling stage → potential error → effect on sample representativeness → control measure. During planning and site selection, inadequate sampling strategy or selection based mainly on accessibility may result in non-representative samples. Sampling locations should therefore be defined according to monitoring objectives and environmental conditions.

During collection, temperature, light, flow, turbulence and sampling depth may influence sample characteristics. Excessive turbulence may promote sediment resuspension, while inappropriate depth may result in collection of water that does not represent the intended sampling layer. Field conditions should be recorded and sampling procedures standardized. Chemical changes may occur through volatilization, redox reactions, adsorption or contamination. Appropriate equipment and containers, adequate preservation and controlled transport are therefore essential. Human factors may affect all stages through inadequate handling, incomplete documentation or deviations from procedures. Training, standardized procedures and traceability are consequently essential for reducing uncertainty.

The analysis also showed that several factors may act simultaneously. For example, increased temperature combined with light exposure and prolonged transport may affect the stability of sensitive compounds, while turbulence combined with inappropriate collection may increase sediment resuspension. QA/QC measures provide additional evidence regarding sampling reliability. Field duplicates can indicate sampling variability, field blanks can reveal contamination, spiked samples can provide information on recovery, and equipment controls can verify field instruments. These measures complement standardized procedures and traceability.

Water sampling is a critical component of reliable environmental monitoring because sampling errors may affect sample representativeness and propagate through the analytical chain.

The main contribution of this work is an integrated QA/QC approach linking sampling stages, potential error sources, effects on sample integrity and corresponding control measures. This framework provides a practical basis for identifying critical points in field activities and reducing sampling-related uncertainty.

Standardized procedures, appropriate equipment and containers, controlled preservation and transport, traceability, personnel training and field QA/QC are essential for obtaining reliable and comparable monitoring data. The approach can support the improvement of institutional procedures and the development of a standardized guide for water sampling.