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Uncertainty arising from sampling – the different approaches described in the Eurachem guide

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One of the main objectives of environmental monitoring is often to compare measurements to (regulatory) thresholds. However, this depends strongly on the knowledge of the uncertainty associated with these measurements. The two main contributions of measurement uncertainty are the uncertainty resulting from sampling and that resulting from the analysis. As much as analytical uncertainties tend to be well controlled and well reported, sampling uncertainties are often undescribed and underestimated.

Two types of approaches to estimating measurement uncertainty including the contribution from sampling are described in the Eurachem guide “Uncertainty arising from sampling”¹:

- Empirical methods (top-down) based on duplication of measurements
- Modeling methods (bottom-up) based on the identification and estimation of different components of uncertainty through a mathematical model.

The empirical approach (top down) based on the duplication of sampling and analysis is the most commonly used method to estimate variability and measurement uncertainty (including sampling and analysis) as it is relatively simple to implement and the associated cost is generally acceptable when using unbalanced design. This approach presents the advantage of including all sources of uncertainty without having to quantify them individually. However, the duplicate method allows for the estimation of the precision (random error) of both sampling and analysis in repeatability conditions.

The modelling approach (bottom up) uses a predefined model that identifies each of the component parts of the uncertainty, making estimates of each component, and sums them in order to make an overall estimate. Models from sampling theory can sometimes be used in this approach to estimate some of the components from a knowledge of the characteristics of particulate constituents.

Examples from the Eurachem guide or from a specific study designed at the Loire River Basin scale in France for water quality monitoring will be presented to illustrate these two approaches.

¹ H Ramsey, S L R Ellison and P Rostron (eds.) Eurachem/EUROLAB/CITAC/Nordtest/AMC Guide: Measurement uncertainty arising from sampling: a guide to methods and approaches. Second Edition, Eurachem (2019). ISBN (978-0-948926-35-8).