DERIVING METAL BIOAVAILABILITY PARAMETERS FOR EU ENVIRONMENTAL COMPLIANCE ASSESSMENT

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Introduction

Zinc, like other substances, is being monitored and risk assessed by EU member states as a 'specific pollutant' under the EU 'Water Framework Directive' (WFD). Under the WFD, 'Good' chemical status is defined in terms of compliance with the Environmental Quality Standard (EQS), i.e.10.9 µg/L for zinc.

It is important to note that this EQS is a bioavailability derived value and it reflects conditions of maximised bioavailability of zinc in the water. It is therefore, protective of the most sensitive surface waters in the EU. It is important to note that metals like zinc interact with various constituents of water, and water chemistry will define the bioavailable (free ion) zinc.

Biotic Ligand Models (BLMs) have been developed to calculate the bioavailable metal concentration. By inputting the concentration of zinc from a given water sample (expressed as 'dissolved zinc') into a BLM, along with environmental parameters, these models are able to calculate the bioavailable fraction of zinc. This bioavailable zinc concentration can then be compared to the EU reference EQS to determine if the sample achieves 'Good' chemical status. In cases where the reference EQS is exceeded, the application of a subsequent bioavailability correction is implicit, i.e. if no such correction can be done, the EQS does not apply.

The primary environmental parameters needed to determine zinc bioavailability in freshwaters are pH, calcium and dissolved organic carbon (DOC) concentrations. The ideal situation for checking compliance of measured zinc concentrations with the EQS is to use matched data, i.e. the measurement of the zinc concentration and all parameters from the same sampling location at the same time. However, the main parameters driving bioavailability, DOC, is not widely measured, unlike pH and calcium. The question is therefore, what data can be used if matched data are not available or are inaccessible?

To overcome the lack of matched data and fill in data gaps, we propose to select relevant bioavailability parameters from publicly available, good quality datasets, and use them for checking compliance at the country, or even the regional level.

Methods

Two publicly available datasets have been used to derive relevant bioavailability parameters for zinc in freshwaters: The WISE (Water Information System for Europe) dataset; and the FOREGS (FORum of European Geological Surveys) dataset. By comparing statistical values (e.g. 50P) from both datasets, and considering specific information from FOREGS maps (Figure 1), relevant values were selected for missing bioavailability parameters. Zinc bioavailability was then calculated with selected parameters fed into the Biomet© BLM calculation tool. In doing this, EQS compliance can be determined.

Usually, the most common missing parameter is DOC. Therefore, the assessment of bioavailability parameters was started with DOC, and data for pH and Ca were matched accordingly for the whole country; we propose that, if necessary, to take this a step further and use the FOREGS DOC map to regionalise areas of DOC within a country.

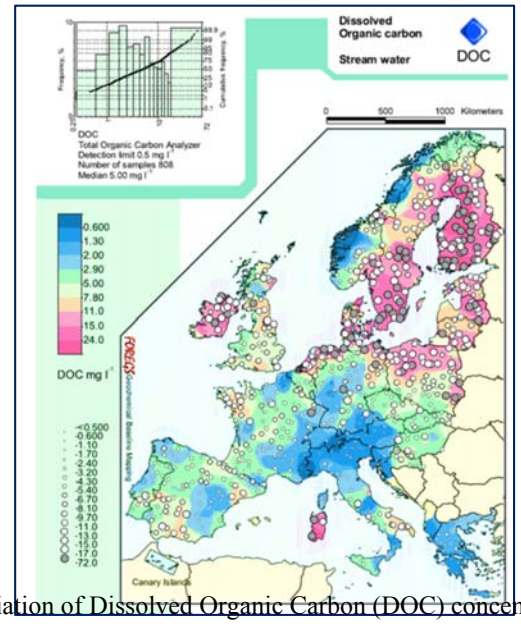

Figure 1. Map showing the variation of Dissolved Organic Carbon (DOC) concentrations across Europe.

Results

When bioavailability data are missing from a country dataset, it is still possible to perform a compliance assessment by using median values (50P) for each parameter. The 'bioavailability correction factor' (BIOF) can then be calculated and applied to the zinc monitoring data, as presented in Table 1.

Table 1. Selected bioavailability parameters (most conservative median values from FOREGS or WISE) and corresponding bioavailability correction factor (BIOF) for zinc (calculated with Biomet version 3.03).

Country	pH	Ca (mg/l)	DOC (mg/l)	BIOF
CZ	7.8	29	3.7	0.43
SK	8.0	51	4.4	0.32
HU	8.0	98	3.4	0.37

Further refinements can be made by adopting the FOREGS regional approach for obtaining missing bioavailability parameters. Rather than just applying a single median value throughout, if regional values are used, our results showed that there are actually fewer exceedances, or fewer 'false-positives'. Examples of this regional approach and the effects on EQS compliance checking will be presented.

Conclusions

These approaches will enable member states to more accurately assess whether they are in compliance with 'Good' chemical status for zinc under the WFD.

References

http://weppi.gtk.fi/publ/foregsatlas/