science summary

Environment Agency

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SCHO0209BPJJ-E-E

Using biotic ligand models to help implement environmental quality standards for metals under the Water Framework Directive

Science Summary SC080021/SS7b

Scientists have developed a simple, user-friendly model that should help the Environment Agency analyse a high volume of water quality monitoring data and make initial assessments about which sites comply with regulatory standards for metal concentrations. The new package is designed to be used by non-specialists as a rapid screening tool and should enable regulators to better monitor water for metal pollution under the European Water Framework Directive (WFD).

The WFD requires EU Member States to aim to achieve 'good' water quality status for all inland and coastal waters by 2015. This goal will be realised through a range of measures, including the use of environmental quality standards (EQSs) for a number of individual chemicals. The most-polluting chemicals, including the metals cadmium, nickel, lead and mercury, are identified as priority substances or priority hazardous substances, for which standards will be set at an EU level. Other pollutants that are discharged to water in 'significant quantities' are referred to as Annex VIII substances. The WFD requires Member States to develop their own standards for these substances. In the UK, and most likely also in many other Member States, the list of Annex VIII substances will include copper and zinc.

Biotic ligand models (BLMs) have been developed for copper and zinc that are able to estimate the fraction of measured dissolved metal concentrations in freshwater that are biologically relevant, i.e. able to exert toxic effects, based on physico-chemical input parameters. Accounting for bioavailability through the use of the BLMs offers a more ecologically relevant metric with which to assess metal risk.

The BLMs have been rigorously tested in the laboratory and field and predict accurately the ecological effects to many aquatic taxa across a wide range of water chemistries. However, the models can be complex, time-consuming to run and are best understood by experts.

This collaborative project has simplified the copper BLM to produce a practical and accessible tool (the Cu PNEC Estimator) for regulators and stakeholders. With just a few input parameters, the Cu PNEC Estimator can calculate the copper predicted no-effect concentration (PNEC) for a site with sufficient accuracy and conservatism to make it suitable for the first level of screening in compliance assessments.

To make the Cu PNEC Estimator a useful regulatory tool, the project also investigated the implication of using default values for the input parameters of dissolved organic carbon and calcium concentrations. While there is a preference for measured data, the Cu PNEC Estimator was able to prioritise samples using default values. The researchers recommended these defaults should be derived on a waterbody basis where possible and that they should be reviewed and revised periodically.

Tests with actual data from several rivers in England and Wales confirmed that the Cu PNEC Estimator could provide reasonable predictions of bioavailability, although some aspects of the tool were identified for further improvement.

Other implementation issues, such as the use of ambient metal background concentrations (ABCs) within assessments, are also considered in the report. Several precautionary approaches for the use of ABCs are suggested; however, the selection and use of such values remains a scientific and policy challenge.

A final compliance package is proposed that integrates consideration of bioavailability and ABCs. This tiered approach to metal compliance assessment involves the initial screening of samples against a generic PNEC or EQS, followed by their comparison with outputs from the Cu PNEC Estimator. Sites that then fail this tier would be assessed using the full BLM with matched measured data. The use of ABCs would be considered after the assessments with the speciation-based models. Failure at this latter tier of analysis would trigger remediation action. The authors explore each level of the assessment from a scientific standpoint.

This project supports the introduction of BLMs into compliance assessment procedures. The project also highlights a number of issues at the operational and policy levels that must be addressed to ensure that the BLM approach is successfully embedded into working practice.

This summary relates to information from Science Project SC080021/HOEP670085, reported in detail in the following output:

Science Report: SC080021/SR7b
Title: Using biotic ligand models to help implement environmental quality standards for metals under the Water Framework Directive
ISBN: 978-1-84432-983-0 **February 2009**
Report Product Code: SCHO0209BPJI-E-E

Internal Status: All regions
External Status: Publicly available

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This project was jointly funded by the Environment Agency's Science Department, which provides scientific knowledge, tools and techniques to enable us to protect and manage the environment as effectively as possible, and the Metals Industry (International Copper Association, represented by the European Copper Institute – ECI, and the International Lead Zinc Research Organisation – IZA-Europe).

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