European Commission

Science for Environment Policy

7 January 2016
Issue 441

Subscribe to free weekly News Alert

Advances in freshwater risk assessment: experiences with Biotic Ligand Models

To assess the risk posed by metals in the aquatic environment, Biotic Ligand Models (BLMs) were developed, and are now considered suitable for use in regulatory risk assessments. This study reviews the advantages of BLMs and BLM-based software tools, providing examples from across the EU, and offers recommendations for their widespread implementation.

Metals, though naturally present in surface waters, can represent a threat to freshwater organisms. They are therefore an important group of compounds for chemical risk assessment. The risk is difficult to assess however, because toxicity does not correlate with total or dissolved metal concentrations. Only a selective portion of the total amount of metal in the environment can be taken up by organisms and cause adverse effects, and toxicity is dependent on other factors, such as the characteristics of the water.

Recognition of this complexity led to techniques that predict toxicity based on more than just metal concentration, using the concept of bioavailability. A metal is bioavailable when it is free for uptake by an organism and can react with its metabolism, possibly causing a toxic effect. This concept recognises that the toxic effect of a metal depends not only on its concentration, but also interactions with chemical and biological factors.

Based on this understanding, Biotic Ligand Models (BLMs) were developed to predict metal bioavailability in aquatic environments and their ability to cause effects in living organisms. They were originally developed to predict acute (short-term) toxicity to fish, but more recently have been adapted to predict longer-term effects on growth and reproduction to aquatic organisms of many different trophic levels.

BLMs represent a landmark in the ecological risk assessment of metals, yet their practical use has been limited by their large data requirements, often including over 10 different water measurements. However, more recently developed user-friendly BLM-based software tools can assess the toxicity of metals using a basic set of easy to measure water parameters, such as pH, hardness and dissolved organic carbon. These simplified tools are more appropriate for routine site-specific water quality assessments and can be used by non-experts.

Thanks to these developments, BLMs can now be used effectively for regulatory risk assessment purposes. Compared to the traditional approach, based on total or dissolved concentration, BLMs provide a more realistic assessment of the effects metals may be having on aquatic communities.

As such, a number of countries have now adopted BLM-based water quality assessments. The US has legally implemented a BLM-based tool, as has the UK, which uses the Metal Bioavailability Assessment Tool (M-BAT). Likewise, in the Netherlands a user-friendly tool called PNEC.pro has been endorsed by the Dutch Ministry of Infrastructure and the Environment.

BLM tools are likely to be increasingly implemented across the EU with the coming into force of amendments to the Environmental Quality Standards (EQS) Directive[1], which include bioavailable EQS for lead and nickel.

However, to achieve widespread implementation, the authors say further guidance from authorities such as the European Commission is needed to ensure use in different Member States follows the same principles. They say recommendations on how to manage values that exceed the range of BLMs and sites containing high background levels of metals would be particularly helpful, and describe recommendations for delivery via webinars, workshops and tutorials.

Source: Rüdel, H., Díaz Muñiz, C, Garelick, H., Kandile, N.G., Miller, B.W., Pantoja Munoz, L., Peijnenburg, W.J., Purchase, D., Shevah, Y., van Sprang P., Vijver, M., & Vink, J.P. (2015) Consideration of the bioavailability of metal/metalloid species in freshwaters: experiences regarding the implementation of biotic ligand model-based approaches in risk assessment frameworks. *Environmental Science and Pollution Research International*, 2015 May; 22(10):7405-21. DOI: 10.1007/s11356-015-4257-5

Contact:
heinz.ruedel@ime.fraunhofer.de

Read more about:
Chemicals, Environmental technologies, Risk assessment, Water

1. Directive 2013/39/EU. See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:226:0001:0017:EN:PDF