A Framework for Ecological Risk Assessment of Metal Mixtures in Aquatic Systems

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INTRODUCTION

The combined effects of chemicals is a key element of the EU Commission's Chemicals Strategy for Sustainability. We studied the combined effects of metals in freshwater and develop a tiered risk assessment scheme for metal mixtures (Nys et al., 2018, Environmental Toxicology and Chemistry 37, pp. 623-642).

METHODOLOGY

We used existing data on chronic metal mixture toxicity at the species level with in silico metal mixture risk predictions based on species sensitivity distribution (SSD) at the community level for mixtures of Ni, Zn, Cu, Cd, and Pb.

RESULTS

Generally, the assumption of independent action (IA) predicts chronic metal mixture toxicity at the species level most accurately, whereas concentration addition (CA) is the most conservative model. Mixture effects are non-interactive in 69 % (IA) and 44 % (CA) of the experiments and antagonistic in 15 % (IA) and 51 % (CA) of the experiments, whereas synergisms are only observed in 15 % (IA) and 5 % (CA) of the experiments.

We found that the simplest method in which concentration-addition is directly applied to the species sensitivity distribution is also the most conservative method. When our methods were applied to a geochemical baseline database, we found that this method yielded a considerable number of mixture risk predictions, even when metals were at background levels (8 % of the water samples). In contrast, metal mixture risks predicted with more complex but theoretically more consistent methods (e.g. independent action applied to the dose-response curves of individual species) were very limited under natural background metal concentrations (<1 % of the water samples).

DISCUSSION

Based on the combined evidence of chronic mixture toxicity predictions at the species level and evidence of in silico risk predictions at the community level, a tiered risk assessment scheme for evaluating metal mixture risks is presented. Guidance is given on how to deal with 'data-poor' metals. We will illustrate how this framework can help to assess the combined toxicity of a broader range of chemical substances, and help to meet the EU Commission's goals of including such assessments in REACH and other regulations.