FACULTY OF BIOSCIENCE ENGINEERING

Does the concentration addition model become a more conservative predictor of aquatic metal toxicity with increasing number of metals in the mixture?

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Introduction

- The European Chemicals Strategy for Sustainability (CSS) will introduce a Mixture Allocation Factor (MAF) for Chemicals Management and other regulatory uses.
- Risk assessment of chemical mixtures is most often and most conveniently regulated following the concentration addition (CA) model.
- At low chronic effect concentrations, CA tends to overestimate mixture effects[1,2].
- The independent action model (IA) is a better alternative for predicting chronic metal mixture toxicity[1,2].
- MIF (mixture interaction factor) is a quantifier used to assess the deviations of observed toxicity from toxicity predicted with CA. It indicates additivity (MIF = 1), or synergistic (MIF<1) and antagonistic (MIF>1) interactions, relative to CA.
- This work is part of the comprehensive Eurometaux "Metals Environmental Exposure Data" program (MEED), as project 4.

Goal

Better understanding of the joint toxicity of complex metal mixtures in realistic environmental combinations and concentrations.

→ More accurate risk assessment of metal mixtures.

Hypotheses

- IA is generally a better predictive model than CA for chronic metal mixture toxicity.
- MIF increases with an increasing number of metals in the mixture.

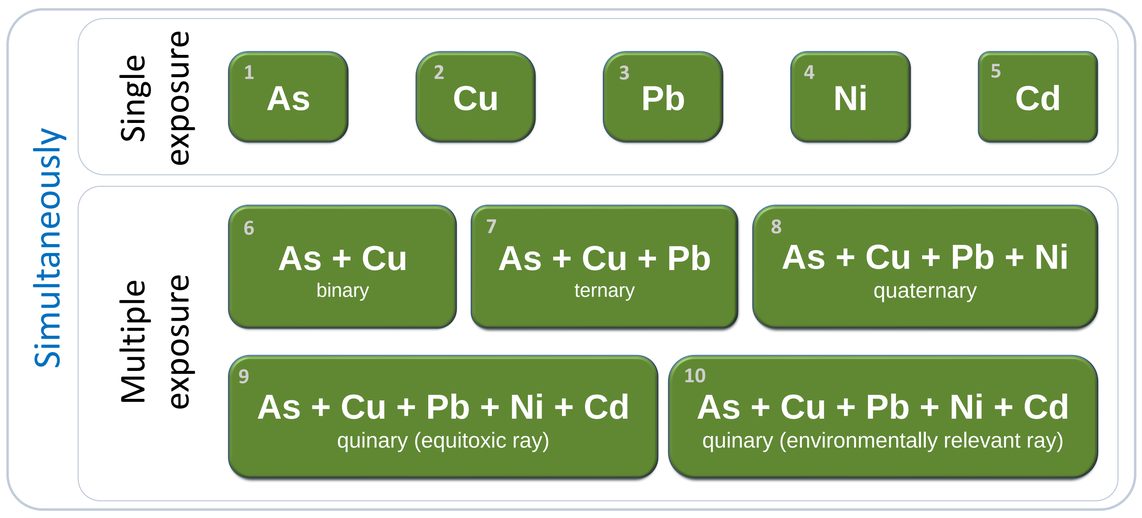
Background

In a prioritization study based on metal toxicity data and European freshwater monitoring data, the metals As, Cu, Pb, Ni and Cd and the algae species *Raphidocelis subcapitata* were selected to test the hypotheses experimentally.

Do you want to know more about it? Check poster No. We344!

Test design

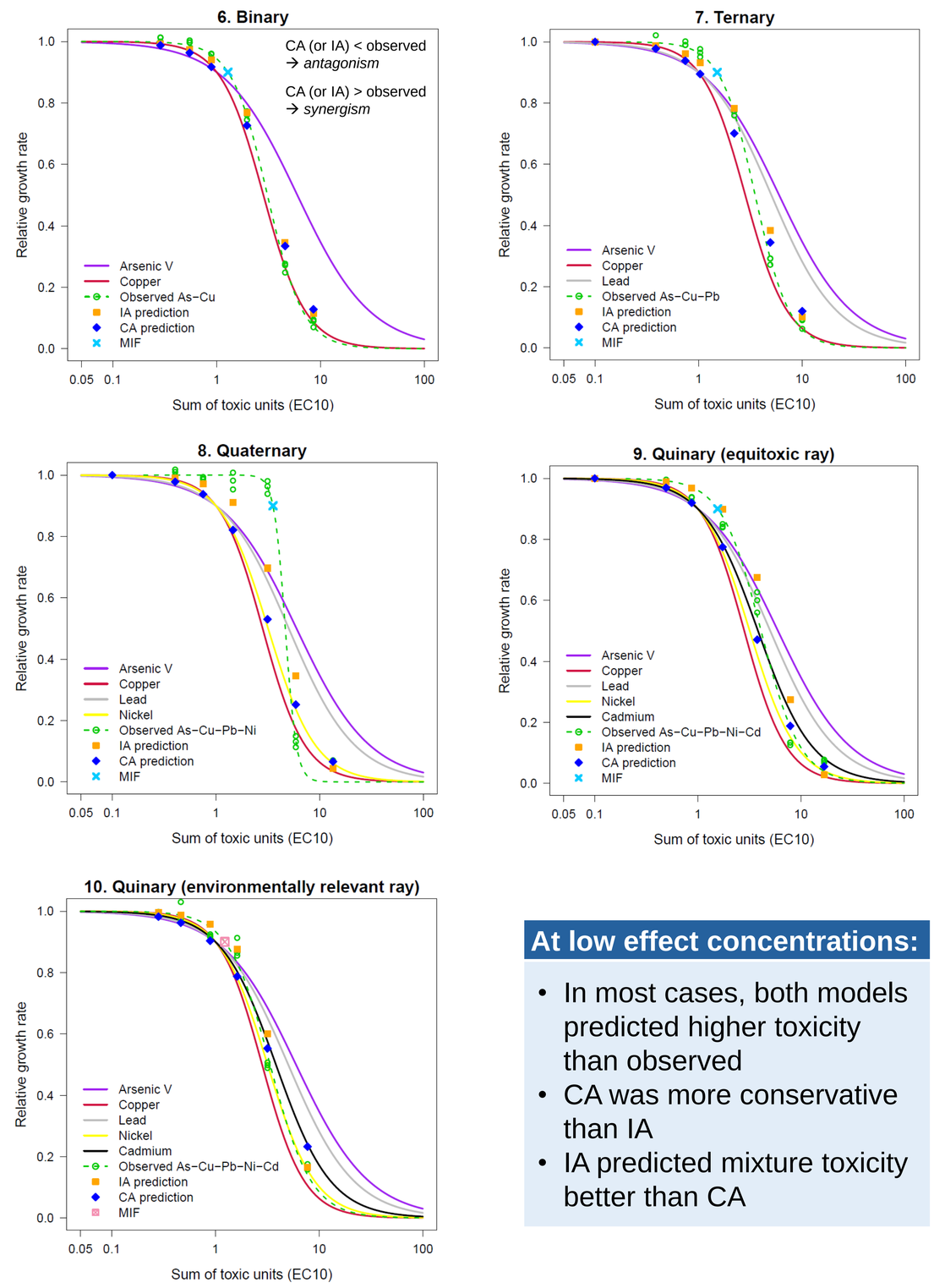
- All 10 tests performed simultaneously
- Test 6 to 9 at equitoxic concentrations
- Test 10 at environmentally relevant concentrations
- OECD 201 guidelines 72h growth inhibition test - *R. subcapitata*



Equitoxic ray → all metals in the mixture contribute equally to the joint mixture toxicity.

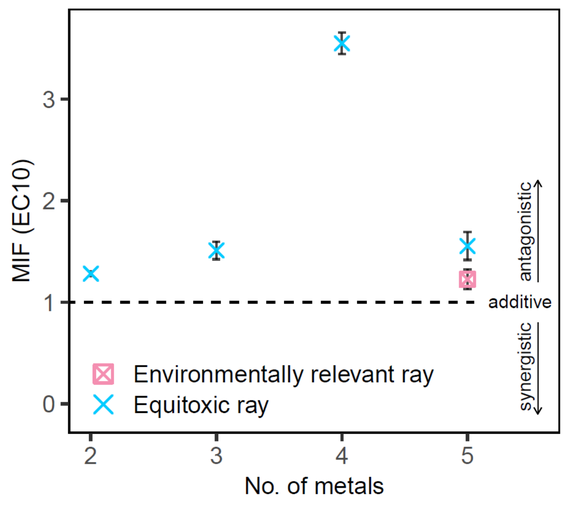
Environmentally relevant ray → concentrations and ratios based on European freshwater monitoring data to ensure environmental relevancy.

Results and discussion



At low effect concentrations:

- In most cases, both models predicted higher toxicity than observed
- CA was more conservative than IA
- IA predicted mixture toxicity better than CA



- All MIF higher than 1 → CA overestimates mixture effects.
- The quaternary mixture showed strong antagonism relative to CA.
- The addition of Cd in the quinary mixture mitigated the antagonistic effects.
- In the quinary mixtures, the environmentally relevant ray MIF is lower than the equitoxic one.
- No continuous increase of MIF with the number of metals in the mixture.

Conclusion

- ➢ At environmentally relevant concentrations both CA and IA models were protective for mixture effects.
- ➢ In most cases, IA was better in predicting mixture toxicity, while CA was the most conservative.
- ➢ MIF did not increase steadily with the number of metals in the mixture.

References:
1. Nys C, et al. "Systematic evaluation of chronic metal-mixture toxicity to three species and implications for risk assessment." *Environmental Science & Technology* 51.8 (2017): 4615-4623
2. Nys C, et al. "A framework for ecological risk assessment of metal mixtures in aquatic systems." *Environmental toxicology and chemistry* 37.3 (2018): 623-642.

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