Can freshwater toxicity models (FIAM and BLM) be applicable to marine ecosystem?

Dong, Yan; Owsianiak, Mikolaj; Christiansen, Karen S.; Hauschild, Michael Zwicky

Publication date:
2011

Quantitative Sustainability Assessment
Department of Management Engineering
Technical University of Denmark

Can freshwater toxicity models (FIAM and BLM) be applicable to marine ecosystem?

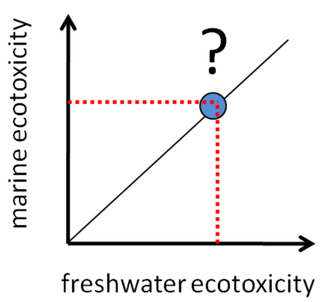
Yan Dong[yado@man.dtu.dk1], **Mikołaj Owsianiak**[1], **Karen S. Christiansen**[1,2], **Michael. Z. Hauschild**[1]

1. Section for Quantitative Sustainability Assessment, Department of Management Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark
2. Department of Basic Sciences and Environment, Faculty of Life Sciences, University of Copenhagen, Frederiksberg, Denmark

Introduction

- Predictive models for metal ecotoxicity such as Biotic Ligand Models (BLM) or Free Ion Activity Models (FIAM) are scarce for saltwater organisms.
- Metal uptake rates by saltwater organisms are comparable to those of freshwater (FW) organisms, while several studies reported higher sensitivities of saltwater (SW) organisms to toxic metals.
- In hypothesis, the difference of toxicity may be caused by difference in ionic strength of saltwater when compared with freshwater.

The aim of this work is to test the applicability of freshwater FIAMs and BLMs to predict ecotoxicity of copper to saltwater organisms.



Conclusions

1. **Freshwater FIAMs cannot be directly used to predict metal ecotoxicity to saltwater organisms.**
2. **FIAM geomeans correlate with BLMs for freshwater organisms.**
3. **BLMs developed from freshwater organisms can predict Cu ecotoxicity to saltwater organisms.**
4. **Lower sensitivity of marine organisms to Cu follows differences in ionic strength between freshwater and saltwater.**

Results

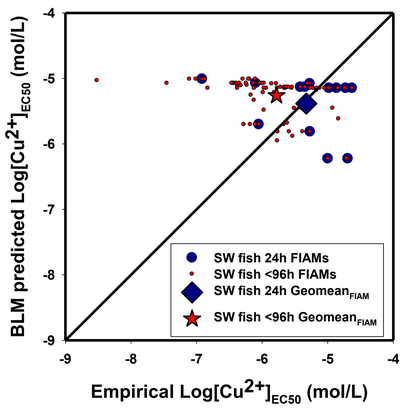


Fig.1 Comparison of $[Cu^{2+}]_{EC50}$ derived with FIAM and those calculated with extrapolated BLM for saltwater fish.

BLM predicted saltwater fish $[Cu^{2+}]_{EC50}$ values shows up to 1.5 orders of magnitude difference with empirical data.

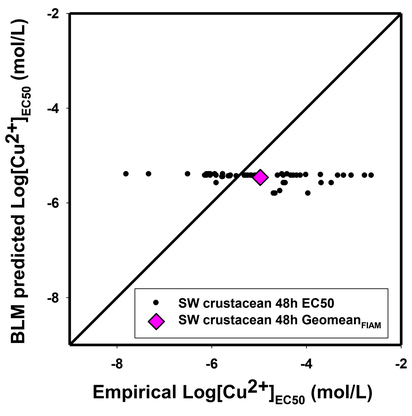


Fig.2 Comparison of $[Cu^{2+}]_{EC50}$ derived with FIAM and those calculated with BLM for saltwater crustacean.

Within a narrow range of test media, BLM predicted a narrow range of $[Cu^{2+}]_{EC50}$ for crustacean, while empirical data gives a much wider range up to 4 orders of magnitude difference.

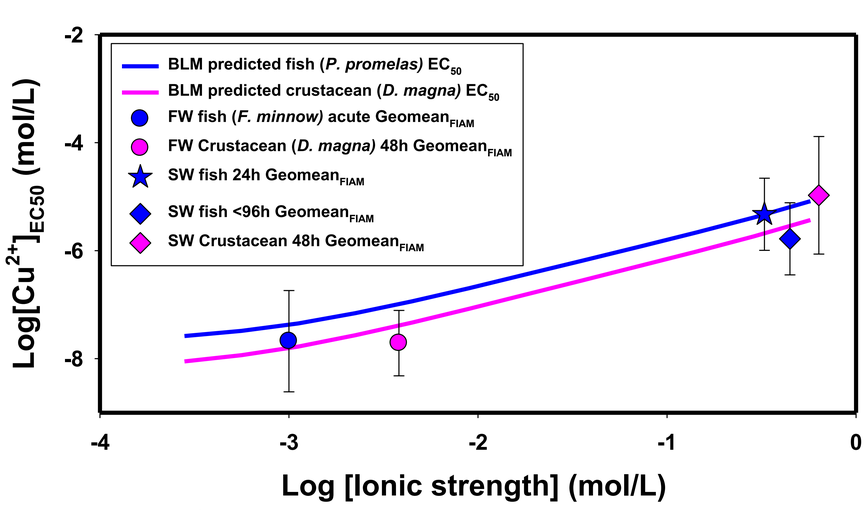


Fig.3 $[Cu^{2+}]_{EC50}$ predicted with FIAMs and BLMs as affected by ionic strength.

- Copper ecotoxicity for saltwater organisms is 2 orders of magnitude lower than for freshwater organisms.
- A good correlation is obtained between freshwater FIAM geomeans and BLMs.
- Interestingly, a good correlation is observed between saltwater FIAM geomeans, and BLM predicted saltwater organisms $[Cu^{2+}]_{EC50}$ (assuming that intrinsic sensitivities of freshwater and saltwater organisms are the same).

Method

Comparison of freshwater FIAMs and saltwater FIAMs

Acute total-metal based Cu EC_{50} (mortality) and media composition for various saltwater fish and crustaceans are obtained from literature. Speciation modeling (WHAM 6.0) is done to derive $[Cu^{2+}]_{EC50}$. Results are compared with FIAMs derived for freshwater fish (*F. minnow*) and crustacean (*D. magna*) [1].

Comparison of freshwater BLMs and extrapolated saltwater BLMs

Published BLMs for freshwater fish (*P. promelas*)[2] and crustacean (*D. magna)*[3] are used to calculate $[Cu^{2+}]_{EC50}$. These models are also employed to calculate theoretical $[Cu^{2+}]_{EC50}$ for various saltwater fish and crustaceans, taking differences in ionic strength into account.

References

1. Christiansen K. S., *et al. Int. J. LCA* **16**, 761 (2011)
2. Santore R. C., *et al. Env. Tox. Chem.* **20**, 2397 (2001).
3. de Schamphelaere K. A. C., *et al. Env. Sci. Technol.* **36**, 48 (2002).