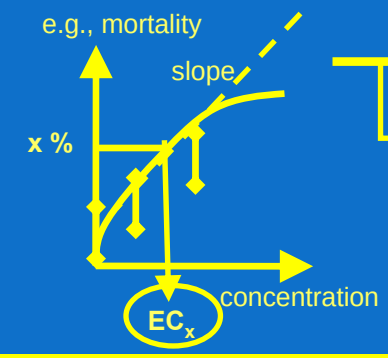
Influence of the slope of concentration-response relationships on community effects

A theoretical exercise for divalent metals

F. De Laender[1,2], K.A.C. De Schamphelaere[1], P.A. Vanrolleghem[2], C.R. Janssen[1]

(1) Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, J. Plateaustraat 22, B-9000 Ghent, Belgium,
(2) BIOMATH, Departement of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium,
contact: frederik.delaender@UGent.be

Introduction



extrapolation: only using EC_x data

if species had different slopes, then the same HC_5 would still be obtained

Hazardous Concentration for 5% of tested species (HC_5)

implies the hypothesis:

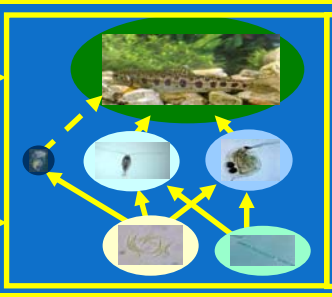
"when exposed to low (environmentally realistic) toxicant concentrations, the influence of slope on community dynamics is less important than the influence of EC_x"

The research question: what is the influence of the slope and EC_x of single species concentration-response relationships on dynamics of exposed community?

Methodology

toxicity profiles of model populations: EC_x and slope values, typical for divalent metals[1,2]

examine influence of changing the parameters slope and EC_x



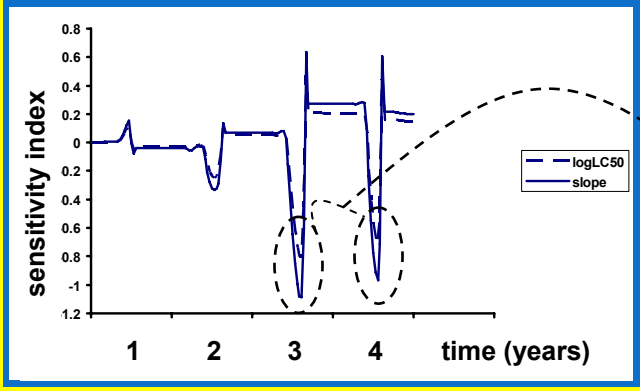
mechanistic ecosystem model simulates community dynamics exposed to toxicant exposure

the change of which parameter has largest influence on dynamics: slope or EC_x?

Quantify these influences by means of mathematical sensitivity analysis:
Sensitivity Index$_{parameter}$ = Δ(biomass) / Δ(parameter), with parameter = logEC50 or slope

Results

example: influence of both parameters on cladoceran dynamics



- influence of slope ≥ influence of EC_x
- influence of both parameters increases with exposure time
- influence largest in late spring, early summer
- influence can be both positive and negative: an ecosystem ≠ linear

- For divalent metals, the influence of concentration-response slope on population dynamics of cladocerans was demonstrated.
- These results confirm the need for methodologies incorporating the slope in ecological effect assessments
- Ecosystem models provide such methodologies

→ see TH1/VG/PS2 "Derivation of safe concentrations for freshwater communities using modelling"

Cited literature:
[1]Smit, M. G. D.; Hendriks, A. J.; Schobben, J. H. M.; Karman, C. C. and Schobben, H. P. M. The variation in slope of concentration-effect relationships. Ecotox. Environ. Safe. 2001, 48, 43-50.
[2]Brix,K.V.; DeForest, D.K.; Burger, M. and Adams, W.J. Assessing the Relative Sensitivity of Aquatic Organisms to Divalent Metals and Their Representation in Toxicity Datasets Compared to Natural Aquatic Communities. Human and Ecol. Risk Assess. 2005, 11, 1139–1156.

Acknowledgements: This research was funded by the Flemish Institute for the Promotion of Scientific and Technological Research in Industry (IWT, Belgium). Website: www.iwt.be