Evaluating the Sensitivity of Environmental Threshold Derivation of Cu in Europe to the Use of Geographically Relevant Species

Charlotte Nys[1], Karel Vlaeminck[1], Patrick Van Sprang[1], Stephen Lofts[2], Stijn Baken[3], Karel De Schamphelaere[4]

[1]ARCHE Consulting, Belgium; [2]United Kingdom Centre for Ecology & Hydrology (UKCEH), United Kingdom; [3]International Copper Association (ICA), Belgium; [4]SYRALUTION, Belgium
Contact: charlotte.nys@arche-consulting.be

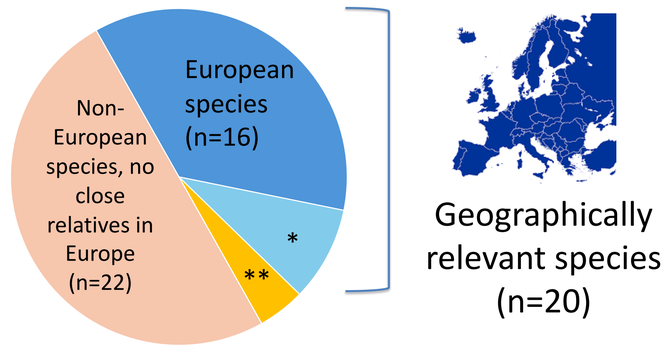
Introduction

The environmental threshold derivation approach for Cu in the aquatic environment has recently been updated. The update considered both a new ecotoxicity dataset[a] and an optimized bioavailability modelling approach[b]. Ecotoxicity datasets of **data-rich metals** used for environmental threshold derivation typically contain toxicity data of numerous species. For Cu, **more than half of the species in the chronic toxicity database do not occur in Europe.** For some species, no close relatives (at the genus level) occur in Europe, as their genus or even family is endemic to other regions.

Research hypothesis I:
The consideration of non-European species has no influence on environmental threshold derivation for Cu

Research hypothesis II:
The current bioavailable Environmental Quality Standard (EQS: 1 µg dissolved Cu/L[c,d]) can still be used under the most recent environmental threshold derivation approach, i.e., site-specific 5% hazardous concentrations (HC5) are for most waters in Europe > 1 µg dissolved Cu/L.

Species in the updated Cu aquatic toxicity database

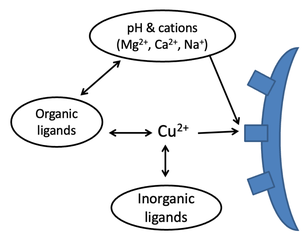


*Non-European species, but a relative at genus-level occurring in Europe & genus not already represented in SSD by a European species (n=4)
** Non-European species and a relative at genus-level occurring in Europe, but genus already represented in SSD by another European species (n=2)

Methodology

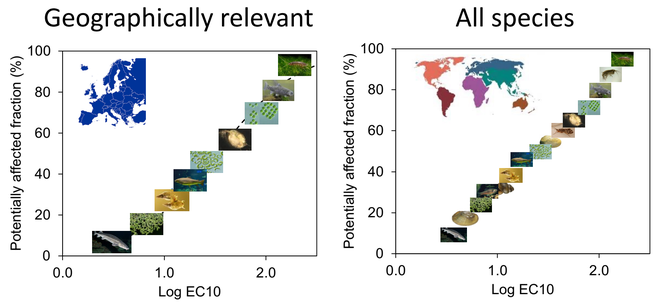
1. Updated database compilation
Cu VRAR database + new literature search
Updated reliability & relevancy evaluation cfr. PNEC derivation 2022[a]

2. Bioavailability modeling
(approach of Nys et al. 2024[b])



Application ranges: pH: 5.5-8.6, Ca 2.4-124 mg/L

3. Species sensitivity distribution (SSD) fitting
Site-specific 5% hazardous concentration (HC5)



Best-fit approach: normal, log-normal, gamma, weibul, logistic, gumbel, selected based on Anderson-Darling

4. Environmental Quality Standard (EQS) derivation
Using Water Framework Directive (WFD) approach[e]

Present study: Tier 1
identify regions with high Cu bioavailability (low HC5) using FOREGS database[f]

Only waters within application ranges were considered

Results

Distribution of Cu sensitivity in European freshwaters

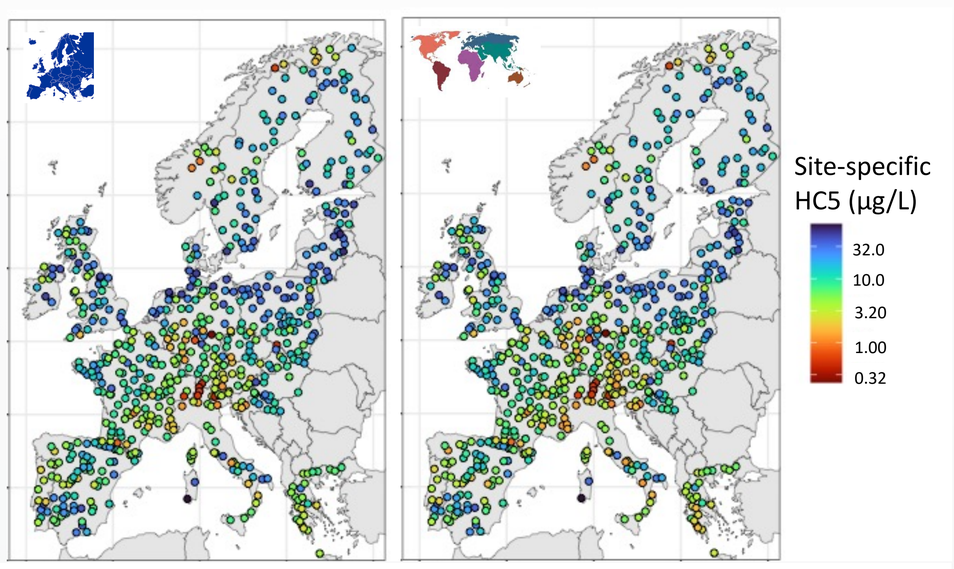


Fig. 1 Distribution of site-specific HC5 in European freshwaters (FOREGS) based on only geographically relevant species (left) and all species (right)

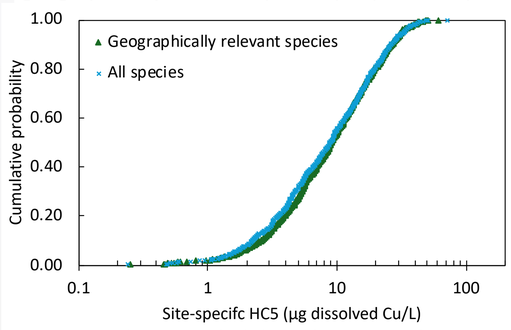


Fig. 2 Cumulative probability of site-specific HC5 in European freshwaters (FOREGS)

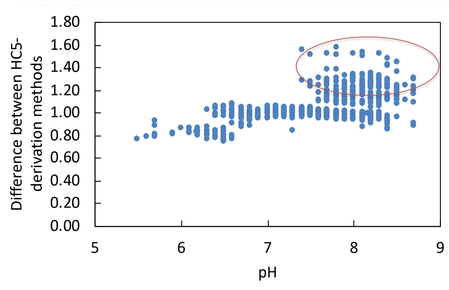


Fig. 3 Difference in HC5 between scenarios (i.e., geographically relevant HC5/ all species HC5) as a function of pH (FOREGS)

Research hypothesis I:

- The consideration of only geographically relevant species has **overall limited effect on the site-specific HC5 distribution** if the entire FOREGS database is considered (Fig. 1 & 2). If the entire distribution is considered there is no significant difference in HC5-calculation (Kruskal-Wallis test p=0.44) when only geographical relevant species or all species are considered.
- At the **site-level**, the species selection can have **an important influence** on site-specific HC5 calculations (Fig. 3). This is mainly related to specific bioavailability conditions. For instance, at high pH (>7.4) , where the sensitive Papua New Guinean green algae *Chlorella* sp. drives the HC5
- **The alpine region** (Switzerland, Italy, Austria and Slovenia) and **Norway** are the **regions** with the highest Cu bioavailability conditions (Fig. 1).

Research hypothesis II:

- **The current bioavailable EQS for Cu in Europe (1.0 µg/L) is protective for most freshwaters in Europe**, as only 2% of European waters (using the FOREGS database) have a site-specific HC5 <1.0 µg/L under both species-selection scenarios. The 5th percentile of HC5 in European freshwaters (Fig. 2) is equal to
  - Geographical relevant species: 1.6 µg dissolved Cu/L
  - All species: 1.7 µg dissolved Cu/L

Next step:

- Calculation of **country-specific EQS*** for regions with the highest Cu bioavailability conditions using country-specific datasets (e.g. MERA-database)

  ***Country-specific EQS**= 5th percentile of the site-specific HC5 for the considered country
- The continental EQS under the WFD[e] represents the lowest country-specific EQS

Conclusion

- Ecotoxicity databases contain toxicity data for a multitude of non-geographically relevant (i.e., non-European) species.
- The consideration of non-geographically relevant species has limited influence on environmental threshold derivation, if the entire distribution of site-specific HC5 in European waters is considered
- Under specific bioavailability conditions, non-geographically relevant species may influence the site-specific HC5 derivation.
- The current bioavailable EQS (1.0 µg dissolved Cu /L) is protective for most freshwaters in Europe
- As a next step, country-specific EQS will be calculated to derive a continental EQS.

Acknowledgements: This work was funded by the International Copper Association.

References: *[a]European Copper Institute. 2022. https://reach-copper-consortium.eu/substances/; [b] Nys et al. 2024. Environ Toxicol Chem 43: 450-467; [c] Peters et al. 2019. B Environ Contam Tox 102: 153-159; [d] Wilson et al. 2023. Environ Toxicol Chem 19: 1570-1580; [e] EU Water Directors. 2018. Guidance document No. 27: Technical Guidance for deriving environmental quality standards; [f] http://weppi.gtk.fi/publ/foregsatlas/; [g]https://mera-rapps.shinyapps.io/EU_PhysChem_DB_Tool/*