FACULTY OF BIOSCIENCE ENGINEERING

Influence of Environmentally Realistic Organic Micropollutant Mixtures on Metal Mixture Toxicity: Toward more Ecologically Relevant Risk Assessment

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Introduction

Regulatory schemes assume that substance-by-substance risk assessments underestimate mixture toxicity. Hence, a mixture allocation factor (MAF) is proposed as a default value to address this concern.

Objective

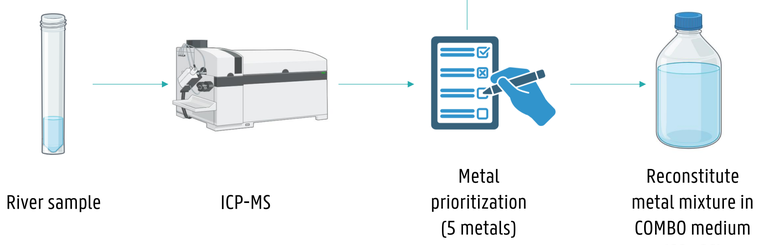
This study investigates whether a separate or combined MAF is relevant for organic-metal mixtures. If realistic organic mixtures do not influence the toxicity of realistic metal mixtures, this could indicate that organics and metals can be regulated independently within environmental risk assessment frameworks with respect to mixture toxicity.

Research Question

Do low concentrations of organic mixtures influence the toxicity of regulatory relevant metal mixtures?

Methodology

1 Metal mixture



Per study area, a concentration series was generated using varying relative enrichment factors (REF)

2 Organic mixture

Per study area, each metal concentration series is exposed to 4 organic treatments: no organic mixture (none) , organic mixtures representative of river water (river) , organic mixtures representative of WWTP effluent (WWTP) and a procedural control (PrC)

Non-target screening of extracts to identify potential organic compounds affecting metal mixture toxicity

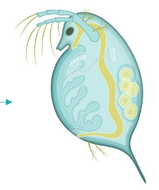
$$(1)\ TU_{i,j} = \frac{c_i}{EC10_{i,j}}$$

$$(2)\ TU_{mix,j} = \sum_{i=1}^{n} TU_{i,j} = \sum_{i=1}^{n} \frac{c_i}{EC10_{i,j}}$$

$$(3)\ MixContr_{i,j}(\%) = \frac{TU_{i,j}}{TU_{mix,j}} * 100\%$$

- i: metal
- j: species
- c_i: measured concentration of metal i

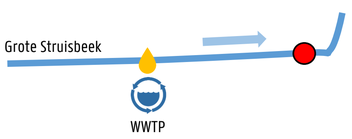
3 OECD 211



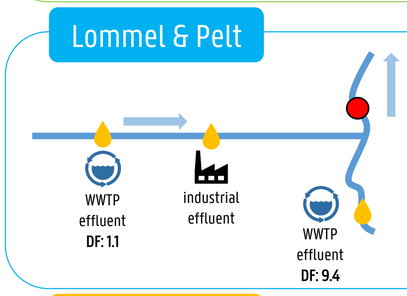
- Reproduction
- Survival

Study Areas

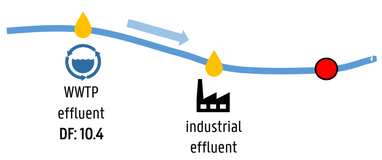
Aartselaar



Lommel & Pelt



Geel



Sampling point — River flow direction
Effluent discharge point — DF Dilution factor

Results

1 Metal prioritization

Aartselaar

Metal	$C_{river,\ diss}$ (µg/L)	EC10 (µg/L)	%TU
Zn	22	86	42
Ni	4.3	42	17
Mn	187	2317	13
Cu	3.0	45	11
Cd	0.04	0.7	11

Lommel & Pelt

Metal	$C_{river,\ diss}$ (µg/L)	EC10 (µg/L)	%TU
Zn	85	86	47
Cd	0.3	0.7	21
Ni	11	42	13
Co	4.7	24	9
Se	1.0	18	3

Geel

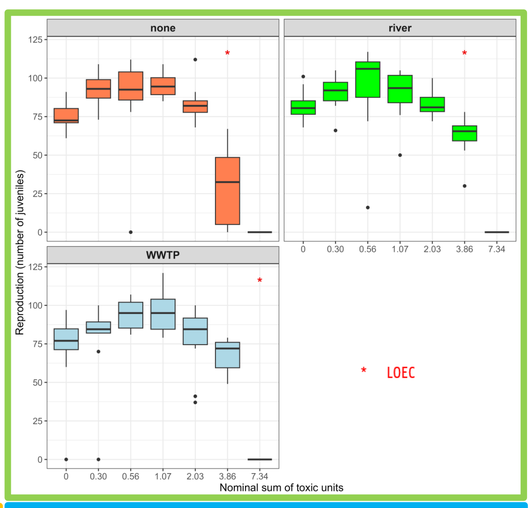
Metal	$C_{river,\ diss}$ (µg/L)	EC10 (µg/L)	%TU
Co	7.9	24	43
Zn	18	86	27
Ni	4.0	42	12
Se	0.9	18	6
Cu	1.4	45	4

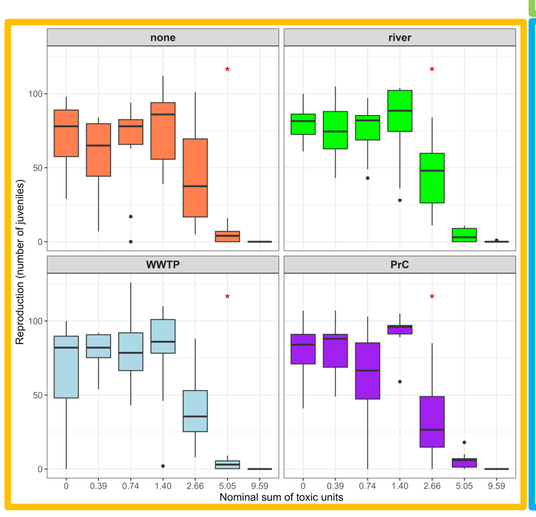
2 Total reproduction

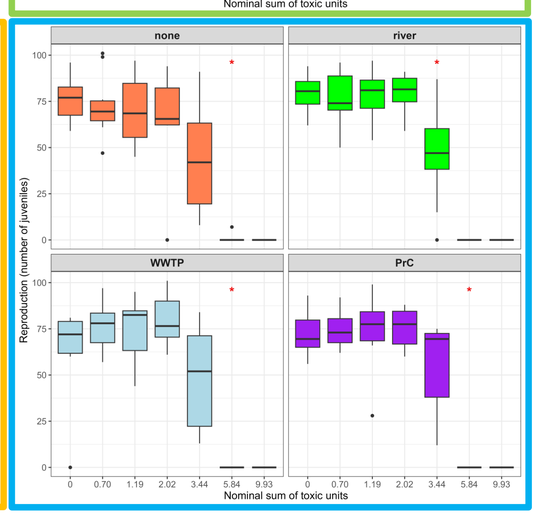
Negative binomial GLM

Aartselaar
- No effect of organics
- **Antagonistic** interaction effect between organic treatment and metal mixture toxicity

Geel + Lommel & Pelt
- No effect of organics
- **No** interaction effect between organic treatment and metal mixture toxicity







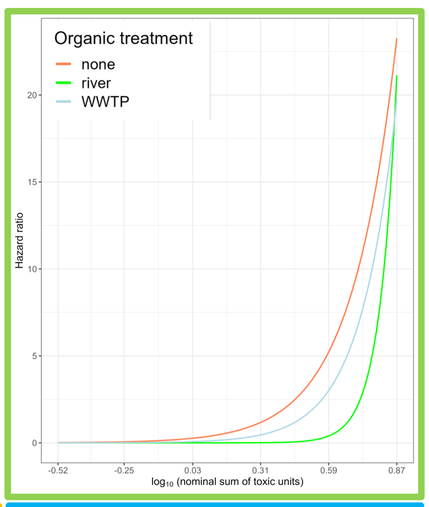
3 Survival: hazard ratio

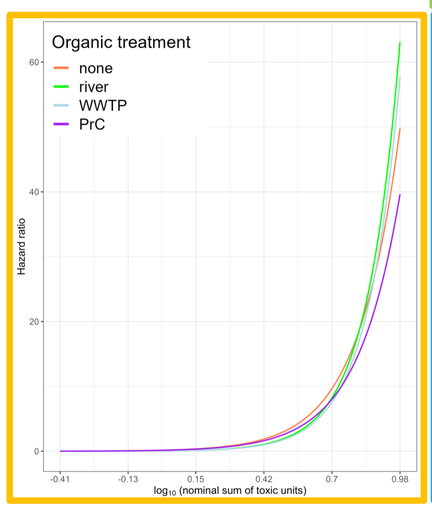
Cox proportional hazards model

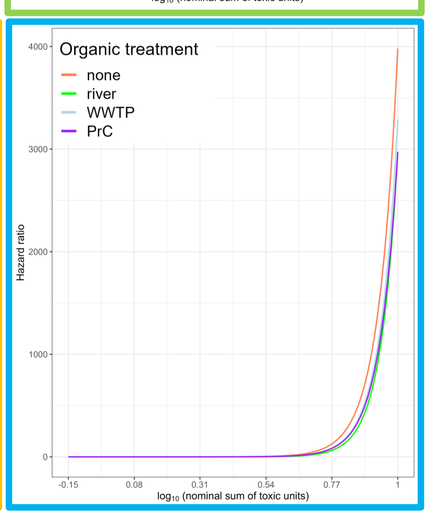
Aartselaar
- Effect of organics
- **Antagonistic** interaction effect of river-level organics on metal mixture toxicity

Geel
- No effect of organics
- **No** interaction effect between organic treatment and metal mixture toxicity

Lommel & Pelt
- Proportional hazards assumption not met (time-dependent treatment effects)







Conclusions

- **Limited to no effect** of field-relevant complex organic mixtures on the toxicity of environmentally relevant metal mixtures.
- The only statistically significant interaction observed was antagonistic, and only for 1 of 3 field sites investigated.
- Based on this dataset, it could be argued that **metals and organics could be considered separately in mixture risk assessment.** However, further testing under different conditions is recommended to confirm its broader applicability.

Next steps

- **EDTA analysis** will be conducted to assess the presence of chelating compounds in the extract.
- **Analytical confirmation** of metal concentrations via ICP-MS.

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MEED Metals Environmental Exposure Data

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