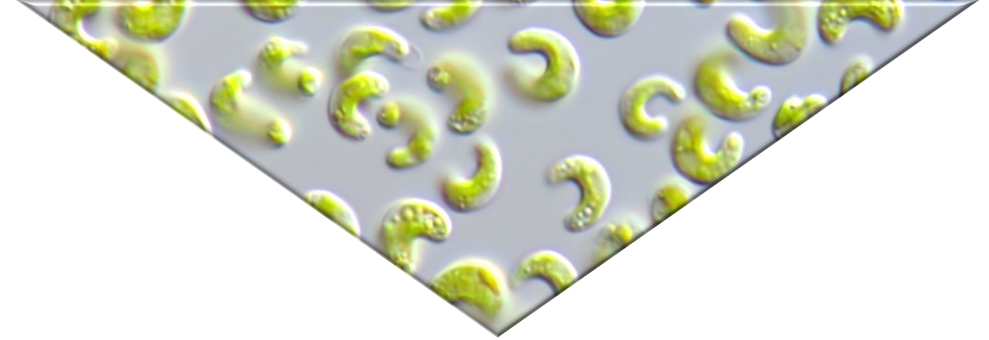
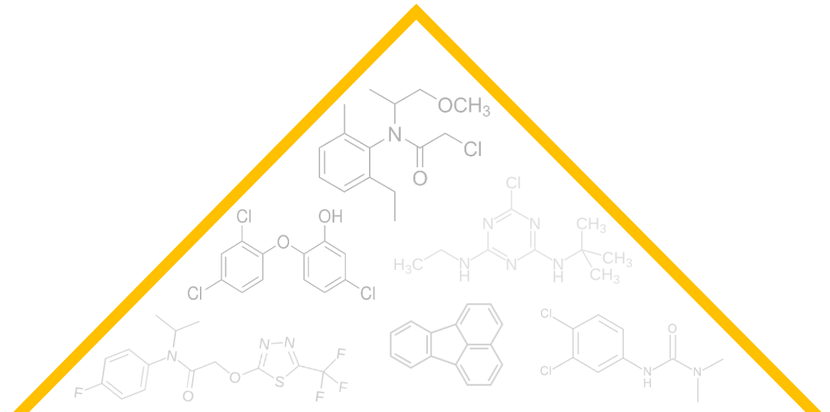
SETAC VIENNA 2025



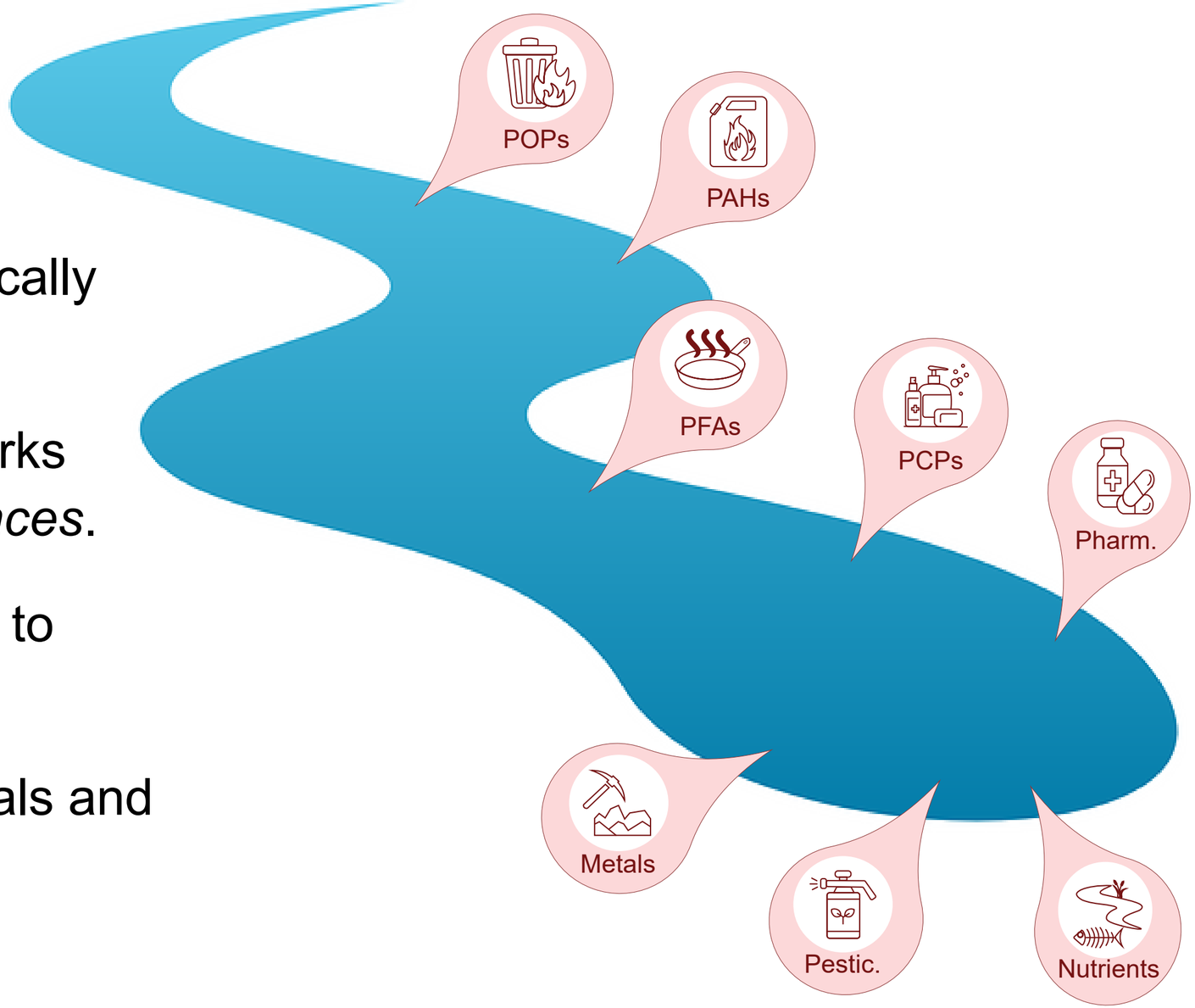
Aquatic Ecotoxicity of Environmentally Realistic Metal-Organic Mixtures to the Algae *Raphidocelis subcapitata*

Laura De Donno, Franz Marius Schmitt, Charlotte Nys, Karel Viaene, Hugo Waeterschoot and Karel De Schamphelaere



BACKGROUND

- Chemicals in the environment typically occur as *complex mixtures.*
- Existing risk assessment frameworks mostly focus on *individual substances*.
- Current lack of consensus on how to best assess *mixture risk*.
- Lack of studies of mixtures of metals and organics.

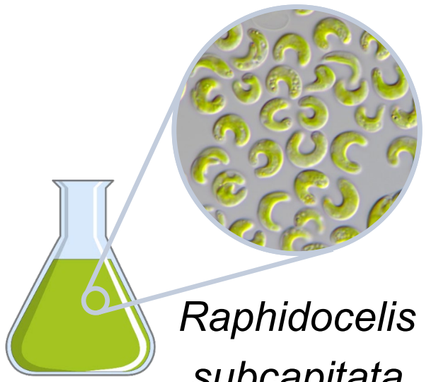


GHENT UNIVERSITY

RESEARCH QUESTIONS

1. Independent action (IA) vs Concentration Addition (CA) : which mixture model is most accurate for predicting mixture toxicity?
2. Do organics <$EC10_{Org}$ affect the toxicity of metals?
3. Do metals <$EC10_{Me}$ affect the toxicity of organics?

In regulatory frameworks, should metals and organics be assessed separately or together?



Raphidocelis subcapitata

- 72h algae growth inhibition test
- OECD 201 guidelines

TEST DESIGN

Selection of the metal-organic combinations 

*Which **organic substances** occur most frequently in hazardous and **environmentally relevant binary mixtures** with metals in European freshwater?*

Waterbase:
Data filtering

European Environment Agency

Risk Quotient based
PNEC prioritization

Toxic unit based
toxicity prioritization

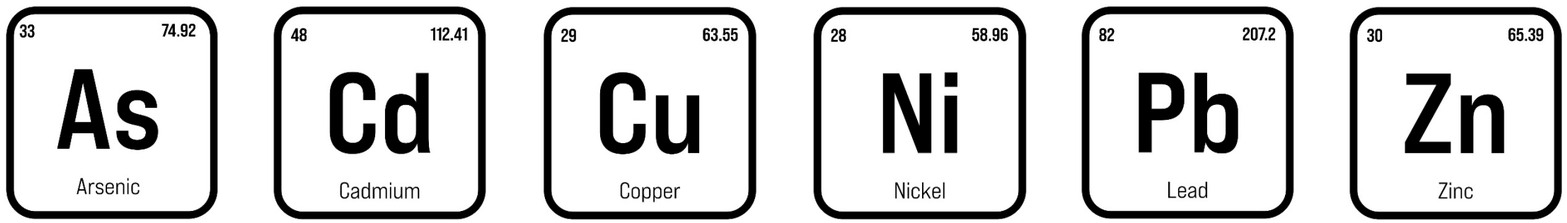
ECHA
EUROPEAN CHEMICALS AGENCY

GHENT UNIVERSITY

ARCHE CONSULTING

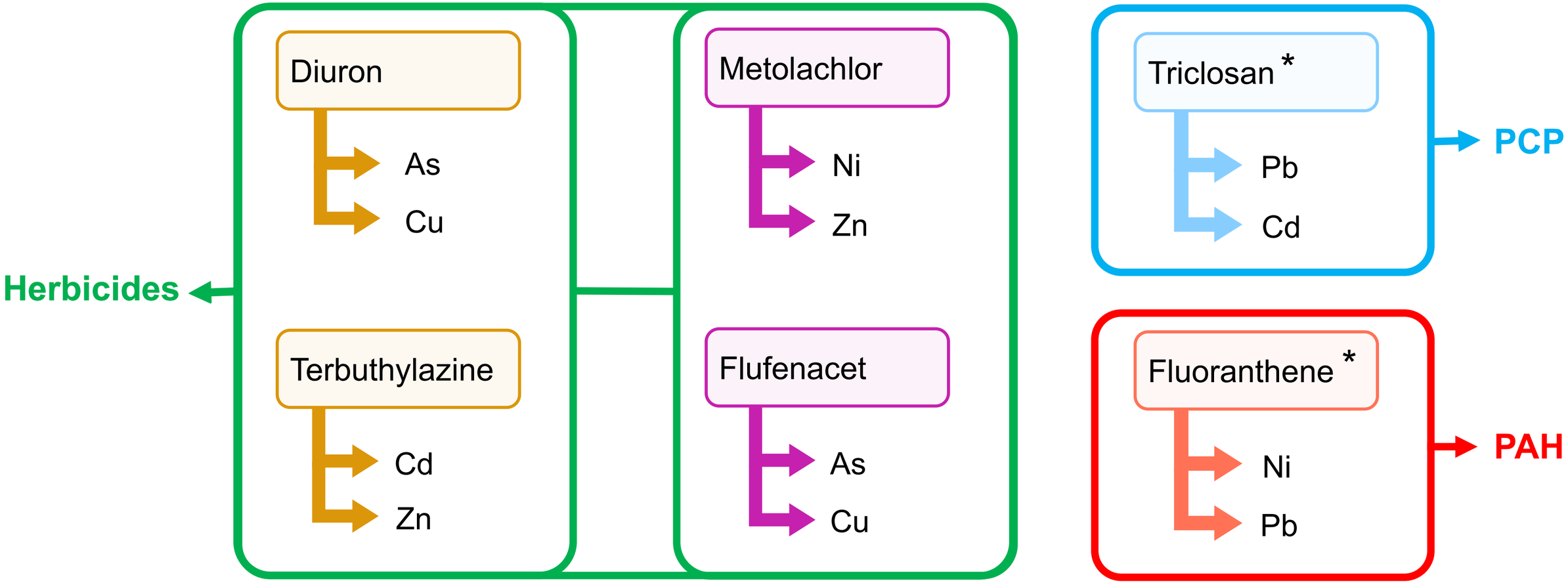
TEST DESIGN

- Diuron
  - As
  - Cu
- Metolachlor
  - Ni
  - Zn
- Triclosan
  - Pb
  - Cd
- Terbuthylazine
  - Cd
  - Zn
- Flufenacet
  - As
  - Cu
- Fluoranthene
  - Ni
  - Pb



GHENT UNIVERSITY

TEST DESIGN



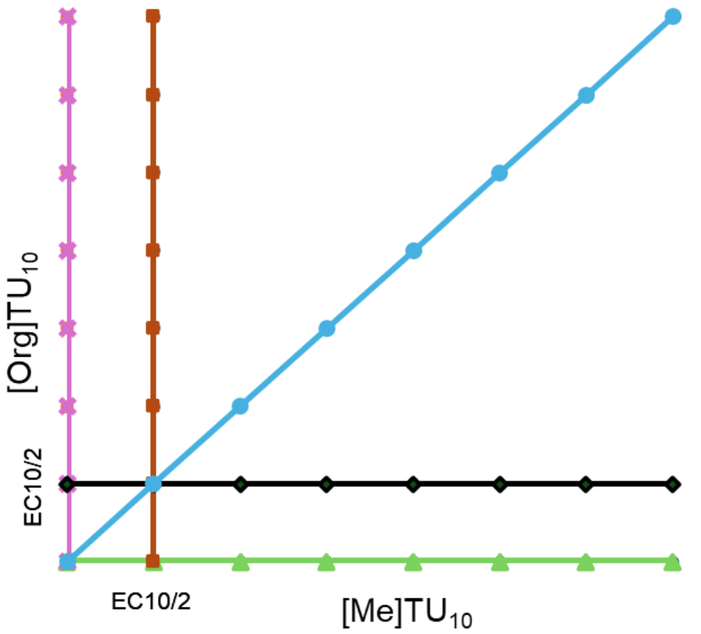
MoA: Inhibition of Photosynthesis at PSII

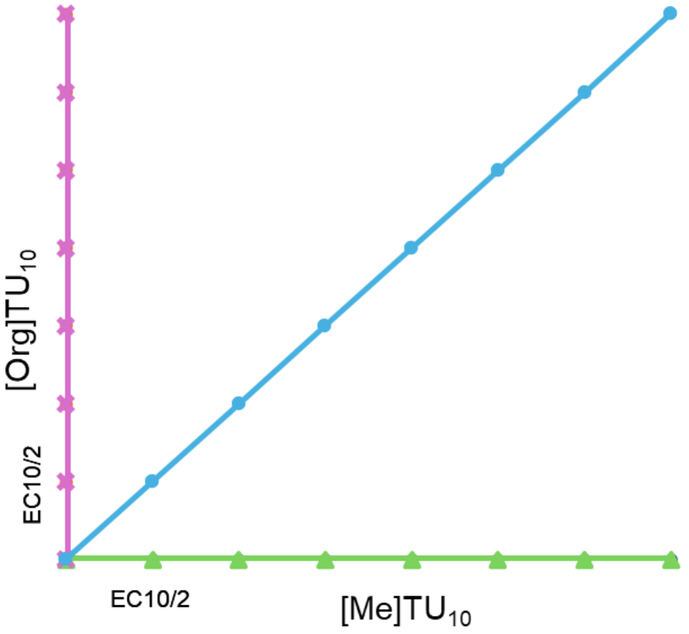
MoA: Inhibition of Very Long-Chain Fatty Acid Synthesis

**nominal values*

GHENT UNIVERSITY

TEST DESIGN



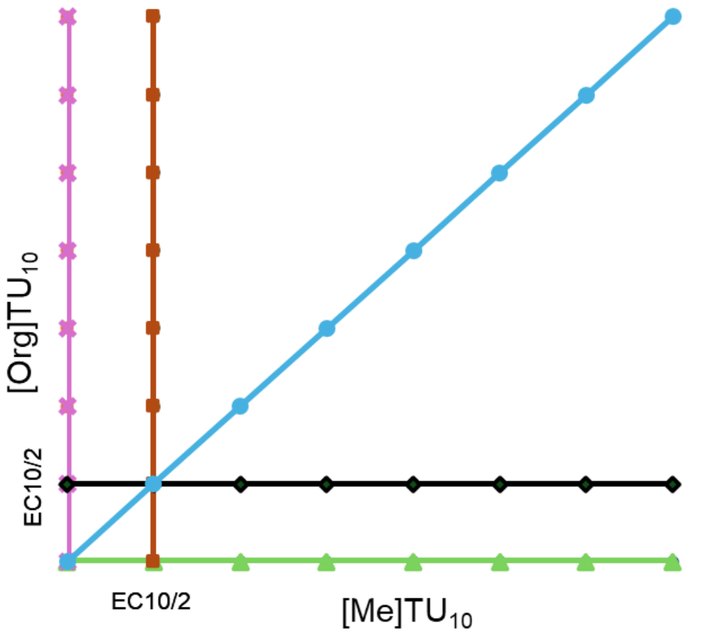


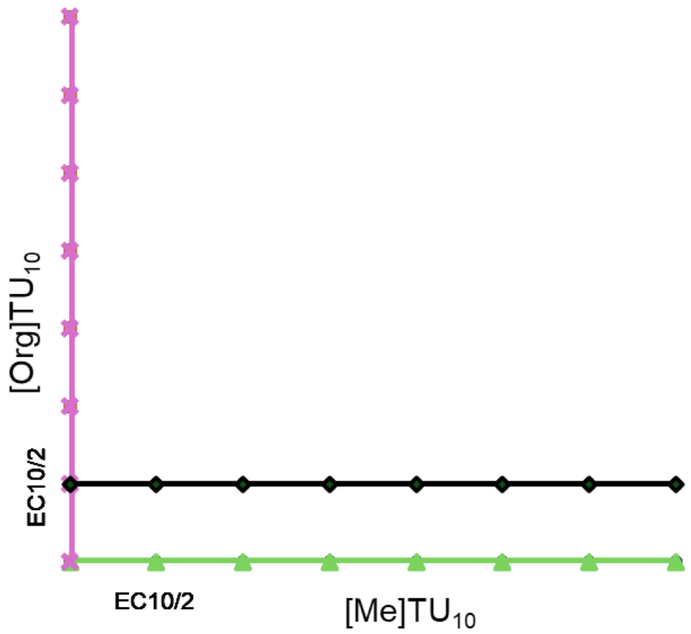
3 test designs for each metal-organic combination

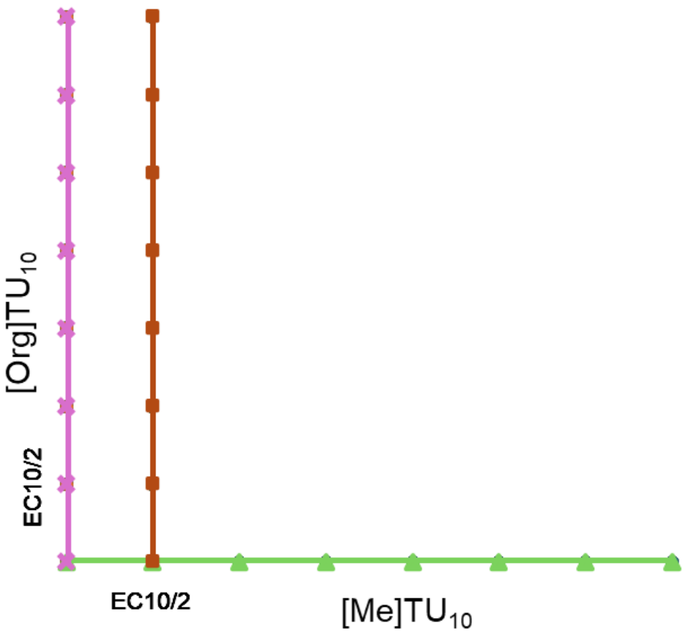
1. CA vs IA: Which mixture model is most accurate for predicting the mixture toxicity?

GHENT UNIVERSITY

TEST DESIGN







3 test designs for each metal-organic combination

2. Do organics <$EC10_{Org}$ affect the toxicity of metals?

3. Do metals <$EC10_{Me}$ affect the toxicity of organics?

Keeping **constant one variable** (i.e., $EC_{10}/2_{Org}$ or $EC_{10}/2_{Me}$) and **changing the other** (i.e., the toxicity of the metal or organic)

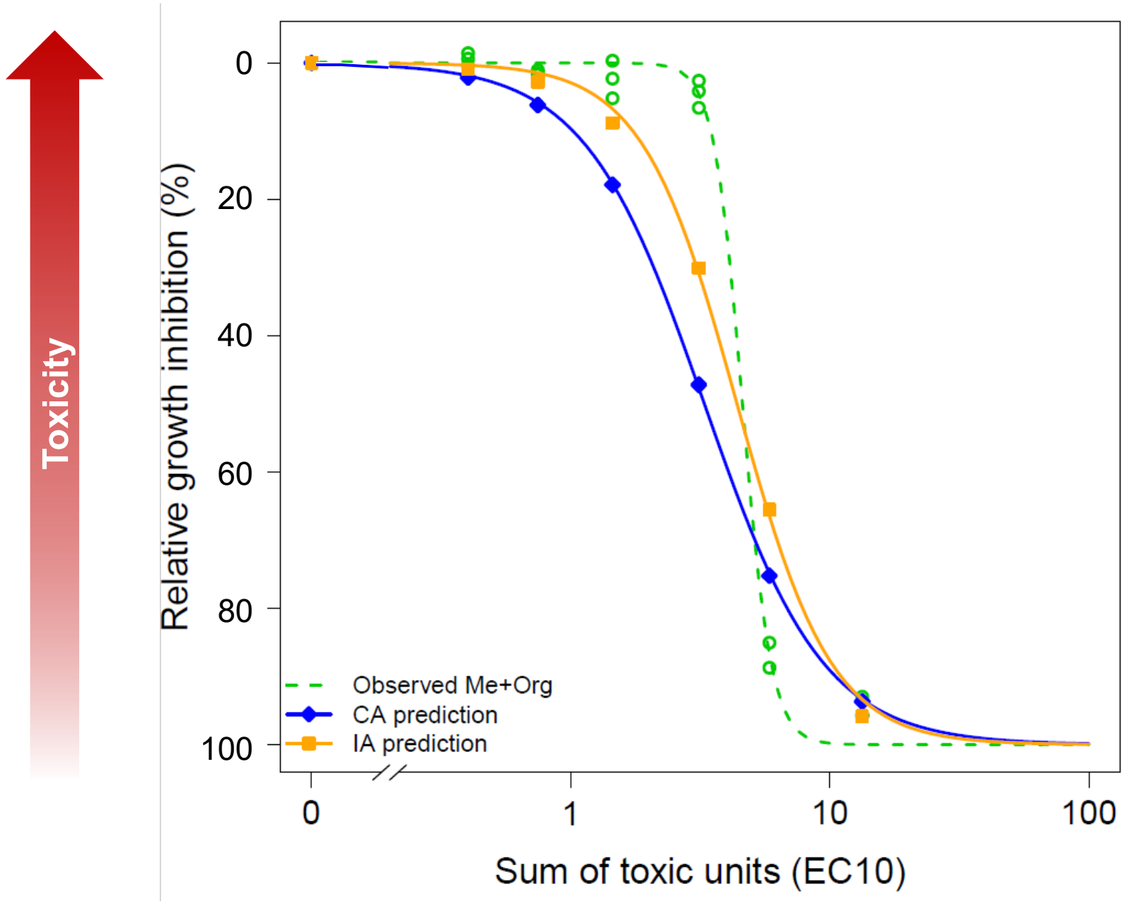
GHENT UNIVERSITY

RESULTS - CA vs IA

1. Which mixture model is most accurate for predicting the mixture toxicity?

GHENT UNIVERSITY

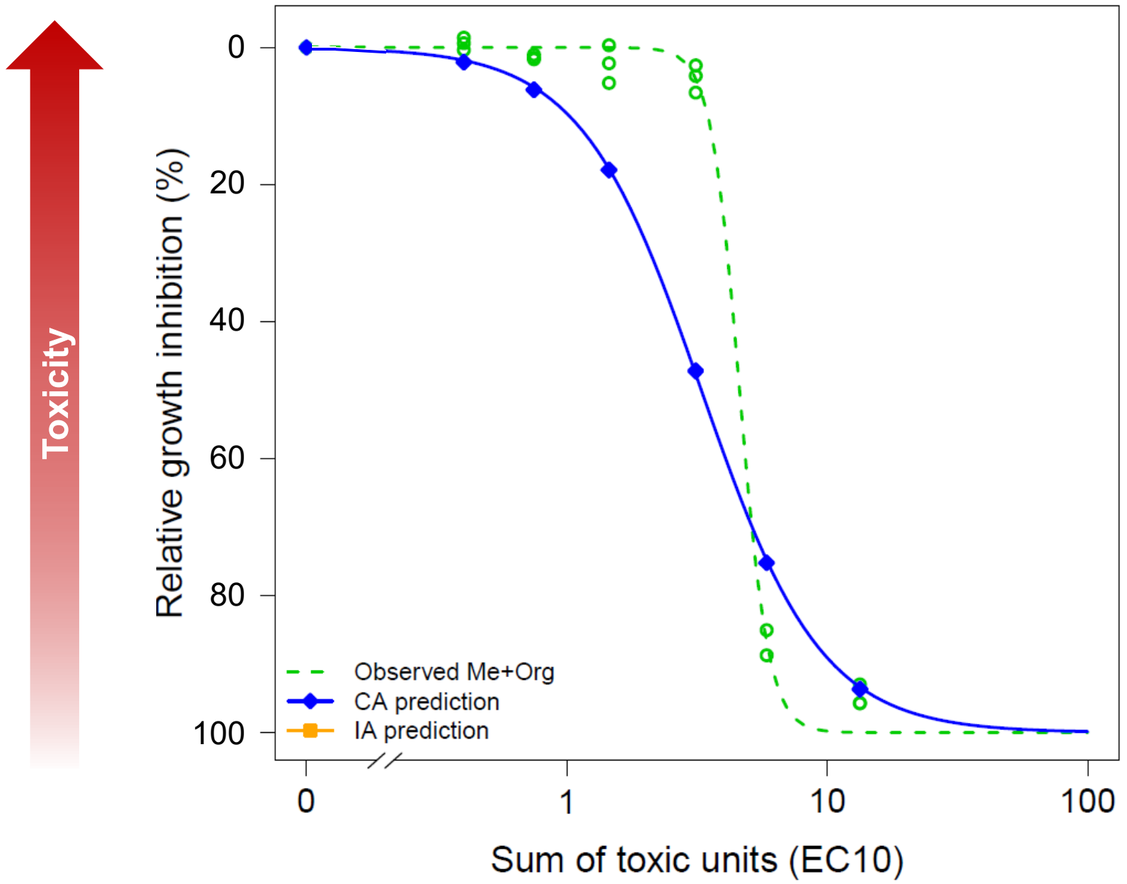
RESULTS - CA vs IA

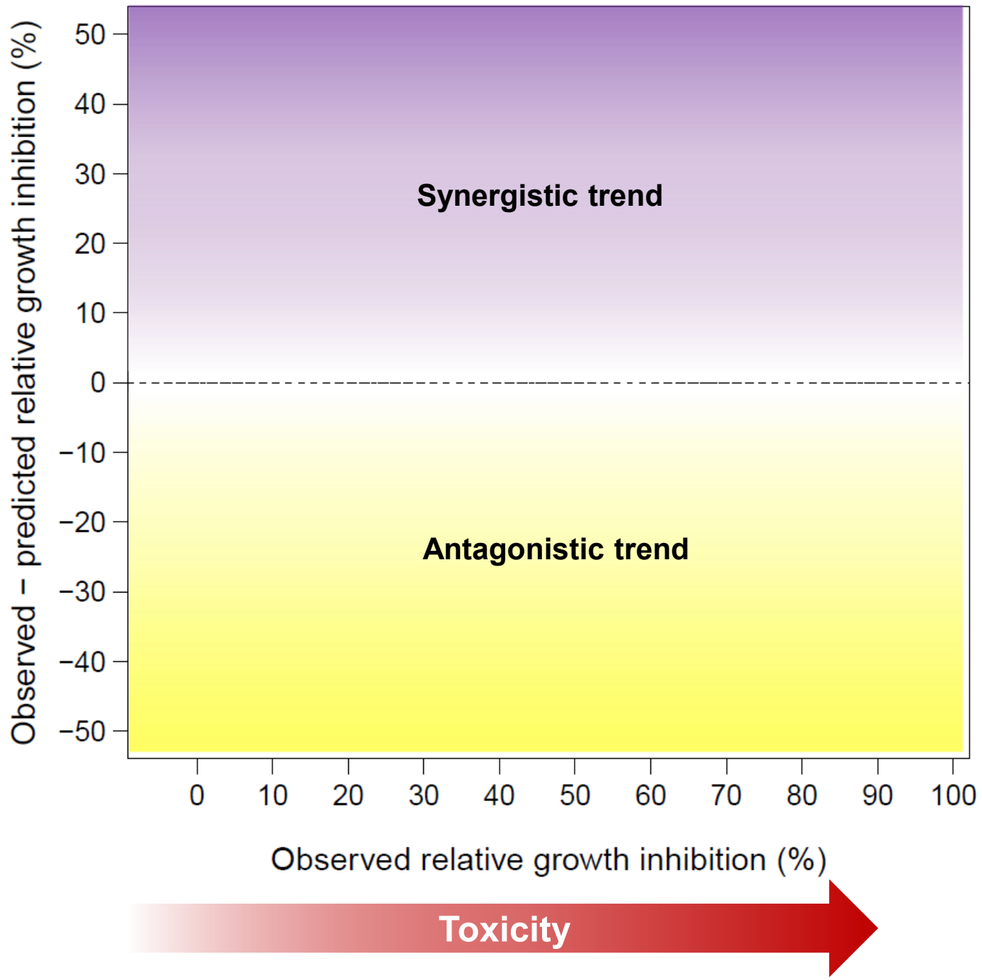


GHENT UNIVERSITY

1. Which mixture model is most accurate for predicting the mixture toxicity?

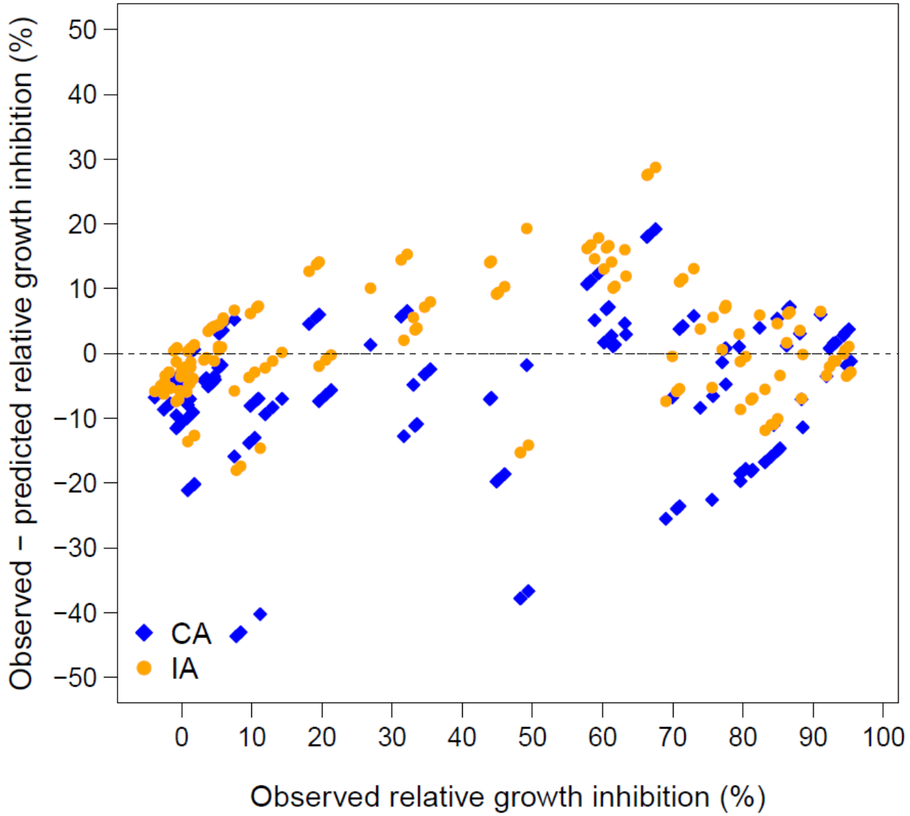
RESULTS - CA vs IA



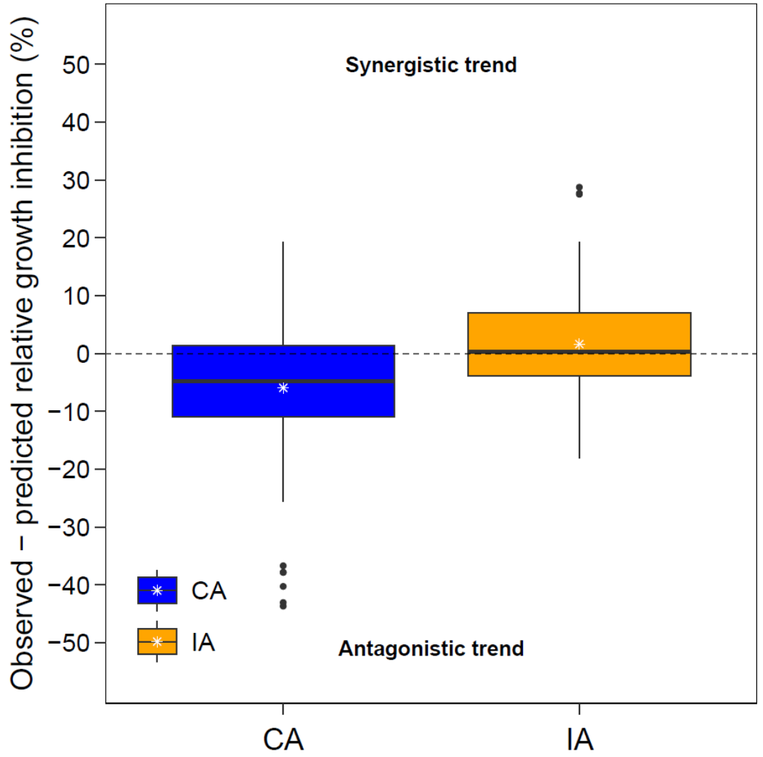


1. Which mixture model is most accurate for predicting the mixture toxicity?

RESULTS - CA vs IA



*based on measured values



*based on measured values

On *average*:

- IA was a *more accurate* predictor than CA.
- CA showed a *trend toward antagonism*.

GHENT UNIVERSITY

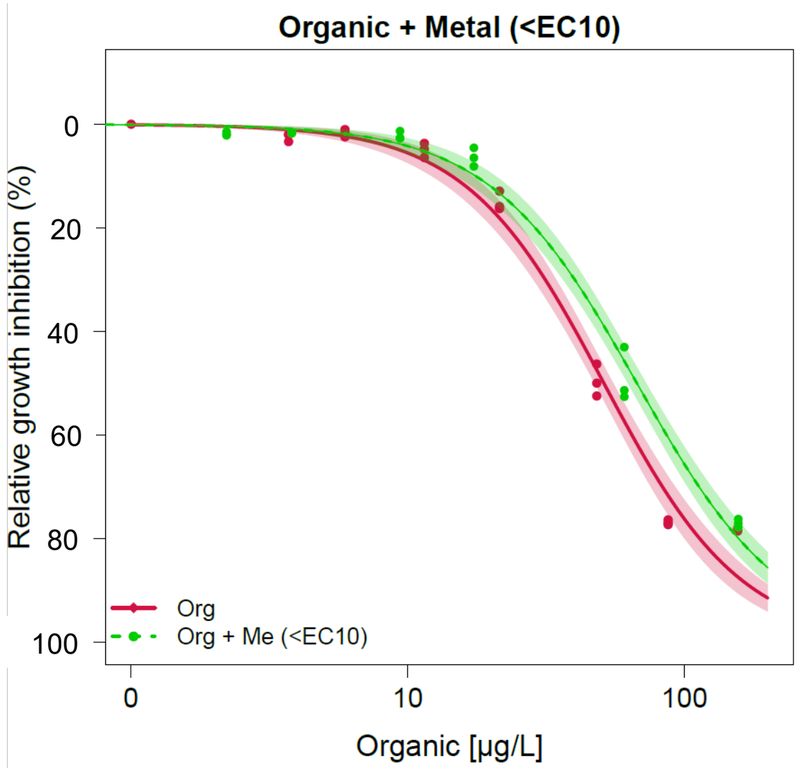
RESULTS

2. Do organics <$EC10_{Org}$ affect the toxicity of metals?

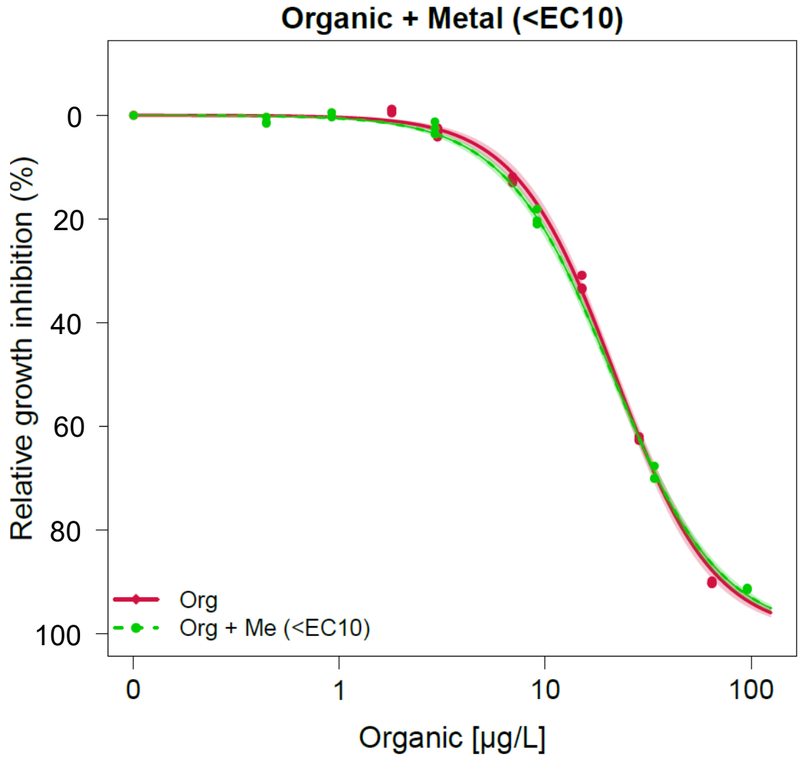
3. Do metals <$EC10_{Me}$ affect the toxicity of organics?

GHENT UNIVERSITY

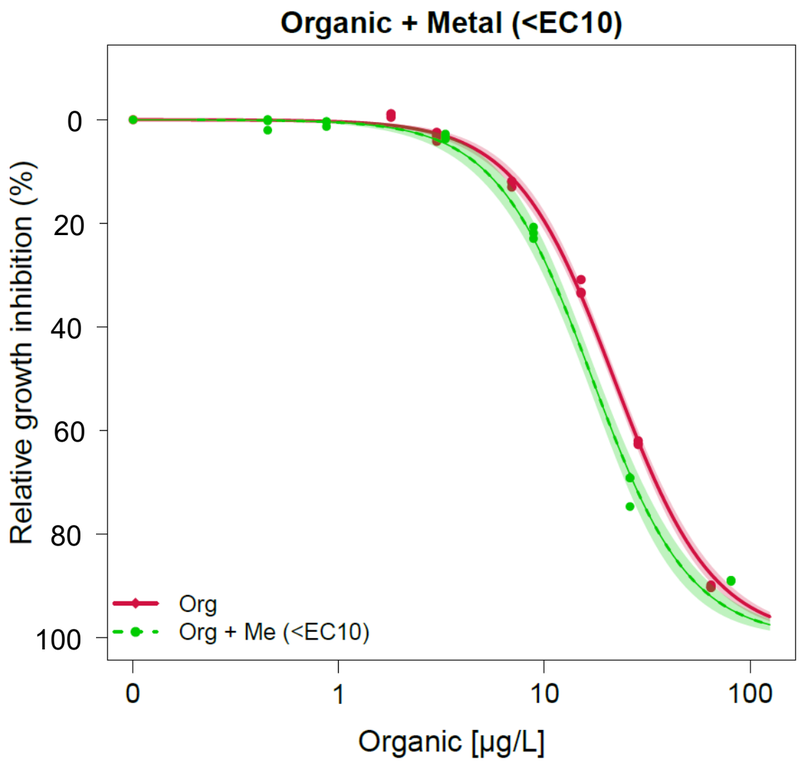
METAL-ORGANIC INTERACTIONS



IF_{EC10}= 0.8



IF_{EC10}= 1.0



IF_{EC10}= 1.2

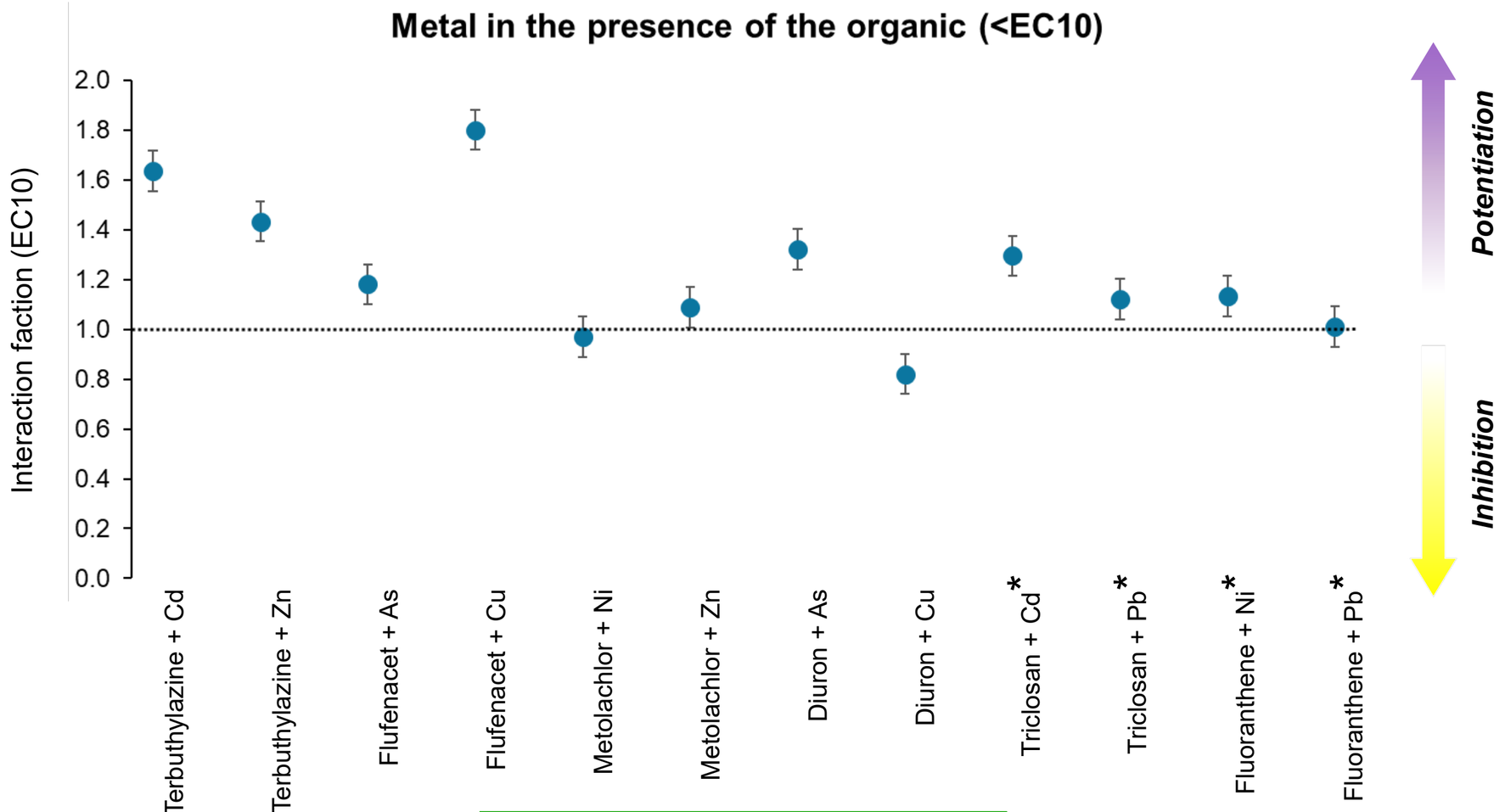
GHENT UNIVERSITY

$$\boldsymbol{Interaction\ factor_{EC10}} = \frac{EC10_{Alone}}{EC10_{Mixture}}$$

- $IF_{EC10} < 1.0$ → *Toxicity inhibition*
- $IF_{EC10} = 1.0$ → *No interaction*
- $IF_{EC10} > 1.0$ → *Toxicity potentiation*

METAL-ORGANIC INTERACTIONS

$$IF_{EC10} = \frac{EC10_{Metal}}{EC10_{Metal+Organic(<EC10)}}$$



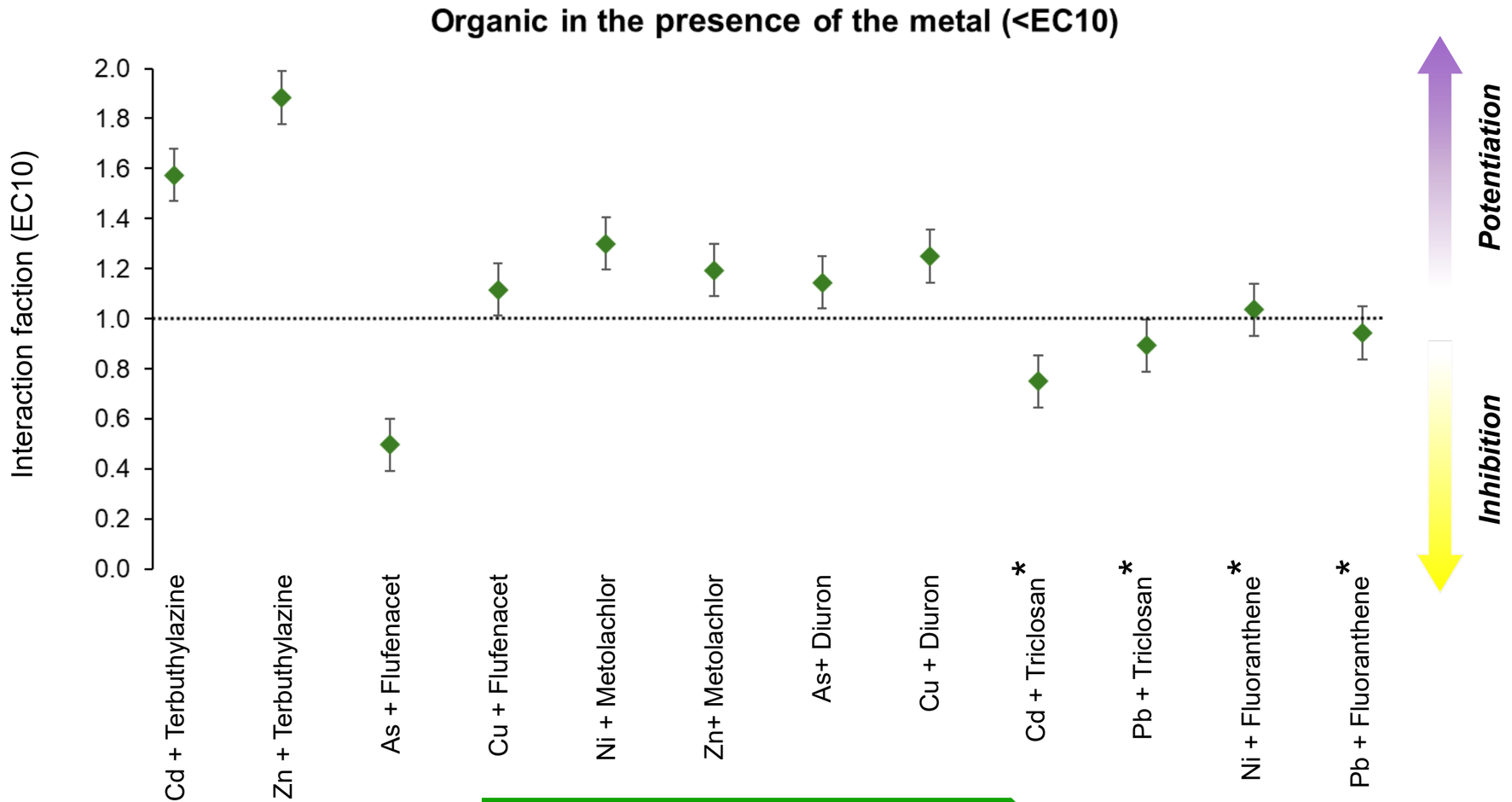
- Average IF_{EC10}= *1.2*

*results based on nominal values

GHENT UNIVERSITY

METAL-ORGANIC INTERACTIONS

$$IF_{EC10} = \frac{EC10_{Organic}}{EC10_{Organic+Metal(<EC10)}}$$



- Average IF_{EC10}= *1.1*

*results based on nominal values

GHENT UNIVERSITY

CONCLUSIONS

On average:

The two models showed rather similar results.

Trend toward antagonistic interactions relative to both models.

The presence of low concentrations (<EC10) of a compound can have an impact on the toxicity of another one.

Future directions:

Tests with more complex and field-realistic metal-organic mixtures.

GHENT UNIVERSITY

FACULTY OF
BIOSCIENCE ENGINEERING

Laura De Donno

PhD student

Laboratory of Environmental Toxicology
and Aquatic Ecology

MariaLaura.DeDonno@UGent.be

Universiteit Gent
@ugent
@ugent
Ghent University

GHENT
UNIVERSITY