MEED: Progress with the multi-year Metals Environmental Exposure Data Program (MEED) to anticipate the challenges of the EU Zero Pollution Ambition Policy and the Chemicals Strategy for Sustainability

[1]Hugo Waeterschoot,[2]Marnix Vangheluwe and [1]Violaine Verougstraete

[1]Eurometaux, Tervurenlaan 168, 1150 Brussels, Belgium; [2]ARCHE Consulting, Liefkensstraat 35D, 9032 Ghent, Belgium

Contact: waeterschoot@eurometaux.be

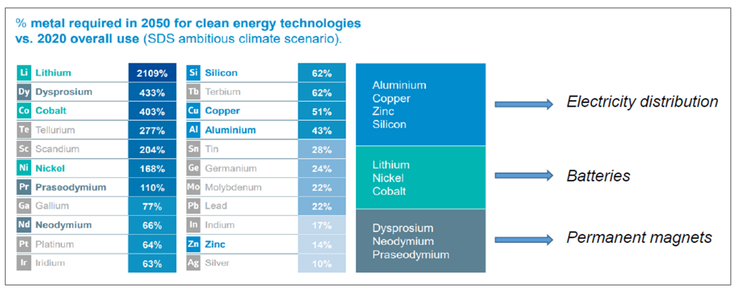
Background

As part of **the EU Green Deal**, the **Zero Pollution Ambition (ZPA)** aims at reducing *exposures of chemicals to levels that are no longer expected to be harmful to health and the environment*. **The Chemicals Strategy for Sustainability (CSS)** is one of the 3 pillars of this ambition. It is implemented through revisions of key chemicals legislations, in particular REACH and includes new challenges like the **Mixture Allocation Factor (MAF)** to demonstrate safe use and lack of impact on ecosystems of unintentional mixtures. **The Biodiversity strategy** of the EU is implemented in parallel aiming for reducing impacts, including releases from chemicals manufacturing and use, on Biodiversity.

Volumes of metals in use are expected to sharply increase, considering the critical role metals play in reaching the climate and circularity objectives of the Green Deal (e.g., in (Electric Vehicle (EV)-batteries, solar and fuel cells). Hence, it is crucial to define today's ambient exposure situation and demonstrate that exposure to metals and their mixtures in the receiving environments will meet the objectives of the ZPA, the MAF, environmental compartments legislation and biodiversity at regional and at local scale, now and in the future.

The EU metal sector has set up **MEED** as a comprehensive "**Environmental Exposure Data Gathering Program"**, complemented by development of scientific concepts, to comply with these objectives. Its timeline (2022-'25) allows to feed the outcomes into ongoing regulatory debates (e.g., REACH 2.0, ZPAP, revision Soil & Water frameworks).

Expected growth rate of metals in EU by 2050[1]

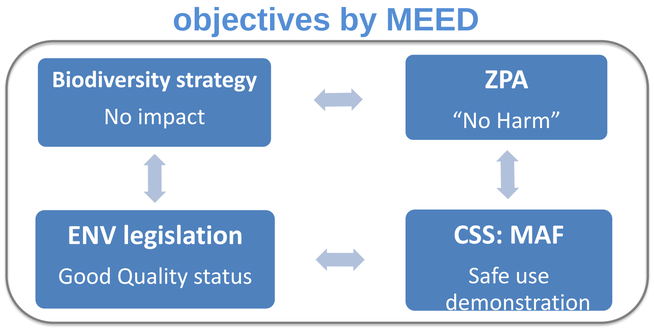


Recent new uses even suggests these values are an underestimation

Need for metals and emission challenges

- ✓ The **increased need** for a large series of metals requires new EU-mining activity, boost recycling and longer lifecycles of substances in articles for a given function (e.g., mobility, energy storage), to fill the growth gap.
- ✓ Hence the need for a clear **benchmark** of todays ambient metal status (from monitoring) and **modeling** of releases from additional volumes
- ✓ Such evidence is also valid to understand **combined effects** of metals at environmental relevant concentrations and their impact on **biodiversity**
- ✓ **MEED provides the basis for this for a long series of metals (> 20)**

Anticipated regulatory protection objectives by MEED



Pillars (objectives) of the MEED program

Pillar 1: Anticipate the MAF in REACH

- Define I-PCS "**Inorganic-Priority Contributing Substances**" (P6) to provide focus and efficiency
- Determine combined metal mixture effects for I-PCS (P5) and combined metals-organics effects (P4)?
- Can we demonstrate "**no harm** to environmental compartments & biodiversity" for "future proof" with ZPA and SDG 15 (P3)?

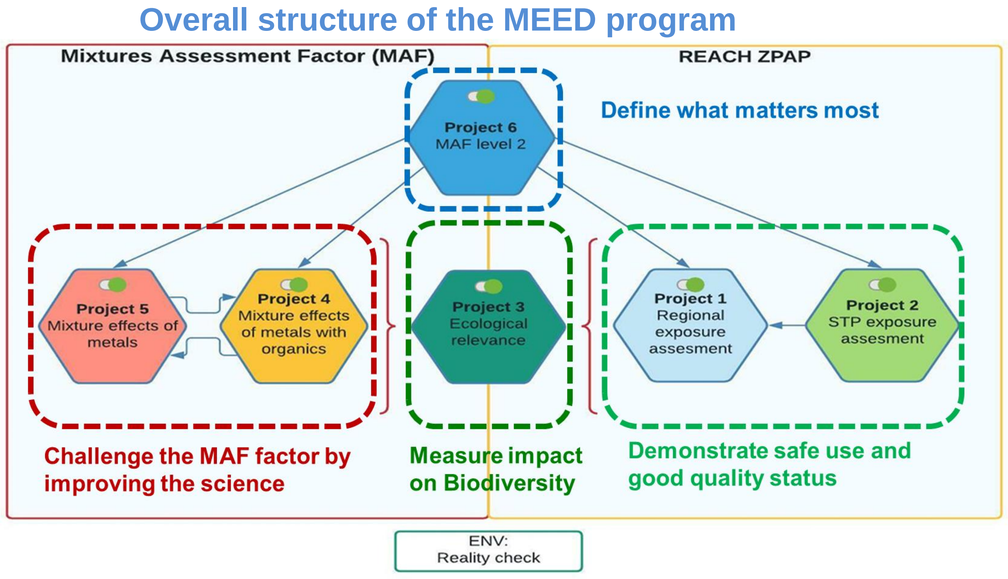
Pillar 2: Update regional exposure levels

- Map **today's metal concentrations** and combined risks across the EU, trends & predicted future concentrations due to volume increase (P1)
- Improve the assessments of **consumer and professional releases**, given a weak link (P2)
- Demonstrate **Good Quality Status** and "no harm to the environment" (P3)

Pillar 3: Impact on Biodiversity

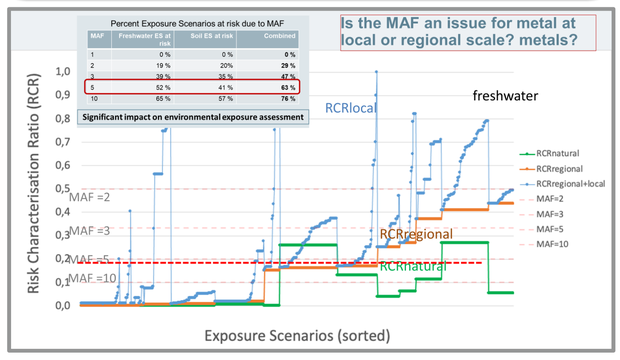
- Provide toolbox to assess impact on Biodiversity
- Run pilot trials to develop efficient assessment

Overall structure of the MEED program



Already achieved 6 milestones in '22-'23

1. Confirm the extent of the **MAF factor impact**
2. Identify **what metals matters most** (I-PCS)
3. Review existing knowledge on **todays's regional background** for metals (water, soil and sediments)
4. Review existing **knowledge on** metals mixtures and metal-organic **mixture interactions**
5. **Design & launch test phase** on mixture interactions
6. Design a **toolbox to assess biodiversity impact**



Some results so far

Project 1: Regional exposure update

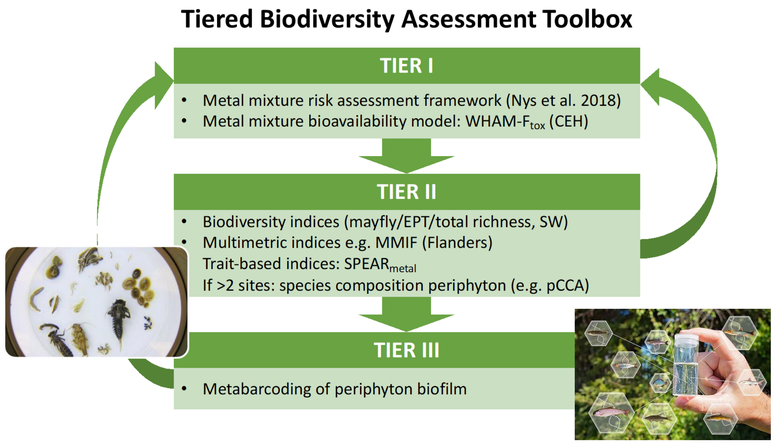
Table 1: Inorganics in the Waterbase (surface water) and number of samples before and after data processing.

Inorganic	Before data processing	After data processing
Ag	20 954	5 595
As	189 824	163 341
Ba	35 274	33 917
B	48 674	40 102
Cd	278 072	233 094
Co	45 785	30 033
Cr	222 037	185 970
Cu	245 462	184 935
Hg	212 579	178 944
Li	1 783	489
Mn	95 172	71 170
Mo	25 465	25 342
Ni	275 291	240 689
Pb	280 208	241 503
Sb	30 551	30 145
Se	49 235	37 156
Ti	14 749	14 267
V	55 094	49 220
Zn	210 488	145 225

Metal samples in Waterbase

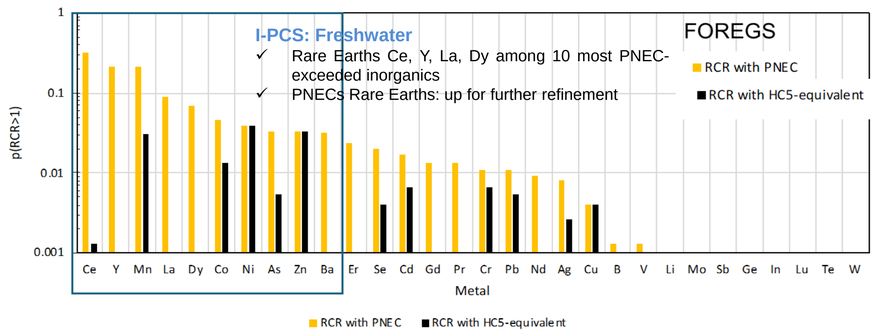
Interpretation: Existing monitoring datasets are extensive. Data quality (LOQ) and lacking data on critical metals relevant for the Green Deal (e.g. lithium, Rare Earths) is a challenge.

Project 3: Ecorelevance



Status: Sampling program at 4 sites using biofilms started. Results and experience with the toolbox will be available by the end of the year.

Project 6: I-PCS

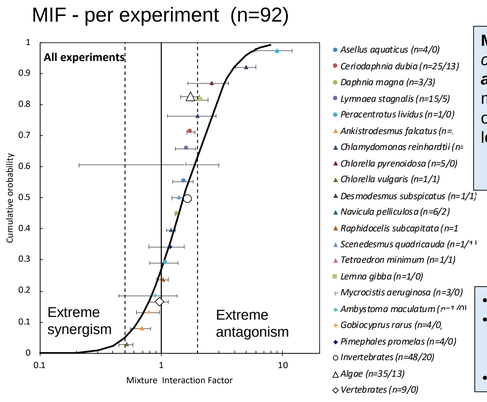


Category	Criterion	Original I-PCS	Refined I-PCS selection
Usually risk drivers in mixtures	Contributing to the 90th percentile of the Hazard Index (HI) in >50% of the mixtures	As, Ba, Co, Cu, Mn, Ni, Se, Zn	As, Ba, **Ce**, Co, Cu, **Dy**, Mn, Ni, Se, **Y**, Zn
Sometimes risk drivers in mixture	Contributing to the 90th percentile to HI in ≥10-50% of the mixtures	Ag, Cd, Cr, Pb, V, W	Ag, Cd, Cr, **Er**, **Gd**, **La**, Pb, V
Usually not risk drivers in mixtures	None of the above	B, Ce, Gd, Ge In, La, Li, Mo, Sb, Te, Ti, Zr	B, Ge In, Li, **Lu**, Mo, **Nd**, **Pr**, Sb, Te, **W**, Zr

Project 5 : Literature reappraisal metal-mixtures

Accuracy of CA in predicting mixture effects at low effect concentrations?

MIF - per experiment (n=92)



Mixture Interaction Factor = *degree of conservatism that* ***concentration addition (CA;*** standard regulatory mixture model) provides relative to observed mixture effects at low effect levels (i.e. 10% mixture effect)

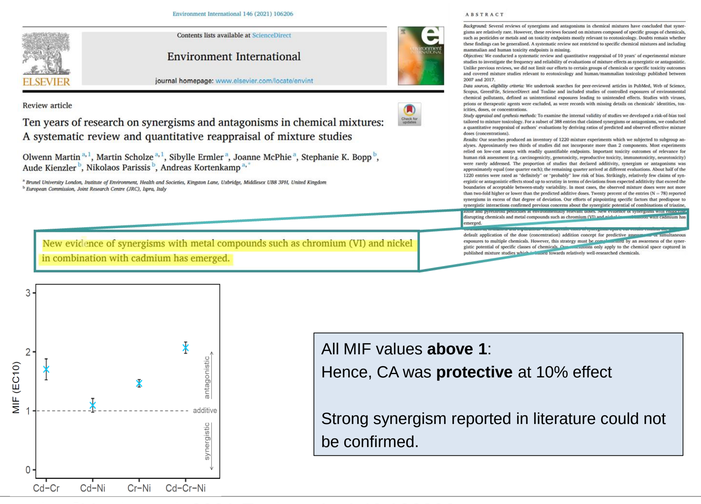
MIF < 1 = synergism
MIF > 1 = antagonism

$$MIF = EC10_{\sum TU_{EC10}}$$

with $$\sum TU_{EC10} = \sum \frac{x_{Me_i}}{EC10_{Me_i}}$$

- **Median MIF = 1.3**
- MIF ranged between 0.52 (*Chlorella vulgaris)* and 8.93 (*Tetraedron minimum)*
- No strong synergisms (MIF<0.5)

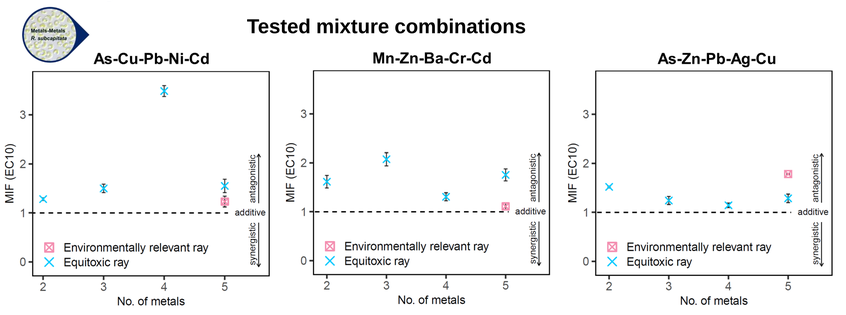
Project 5: Recheck of metal synergism combination[2]



All MIF values **above 1**:
Hence, CA was **protective** at 10% effect

Strong synergism reported in literature could not be confirmed.

Project 5: First outcome testwork on M-M mixtures



All MIF **higher than 1 → CA overestimates** mixture effects at 10% effect (Median: 1.6)

Data set on 3 mixtures of 4 metals, available on *Daphnia magna*

References: [1]Metals for Clean Energy – Pathways to solving Europe's raw materials challenge" , [2]Martin et al. 2021 Environ. Int l 46 106206

Detailed SETAC-Seville Posters: MO178 (STP exposure assessment), MO179 (Freshwater exposure assessment), WE494 (Metal mixture risk assessment impact), WE495 (Metal mixture toxicity to Daphnids), WE496 (Impacts of metal emissions on biodiversity).

Conclusions on MEED so far

- ✓ **Metal volumes** manufactured, used and recycled, will increase significantly due to the Green Deal objectives, hence questioning the combined impact on water, soil and on Biodiversity.
- ✓ **MEED aims** at collecting up to date exposure evidence to anticipate the ZPA, MAF and new and updated EU environmental compartment legislations
- ✓ **Aquatic, soil and sediment regional monitoring data**sets for a long series of metals were collected and checked for metals combined concentrations and risks. Datasets for some metals that are key for the Green Deal like Li and Rare Earths are limited or lacking. Rare Earths showed to be risk drivers, but improvement of environmental threshold level feasible.
- ✓ The **Mixture Interaction Factor (MIF)** allows to define the level of conservatism provided by the Concentration Addition model
- ✓ The literature on metals mixtures and metal-organic mixtures was **updated and reappraised demonstrating** that MIFs for metals mixtures are on average larger than 1 (median MIF 1.3), hence leaning more to antagonistic than synergistic.
- ✓ A **smart testing design was applied** to complement gaps on environmentally relevant metals-mixtures. First results confirm MIFs > 1 and reported synergism could not be reconfirmed.
- ✓ The **outcome of the MEED program** will be published and available for research on mixtures and regulatory compliance demonstration

Acknowledgements: this research is funded by Eurometaux and its members