Interreg
North Sea Region
Sullied Sediments
European Regional Development Fund
EUROPEAN UNION

First steps towards a new approach for interpretation of ecotoxicological data for sediment and dredged material classification

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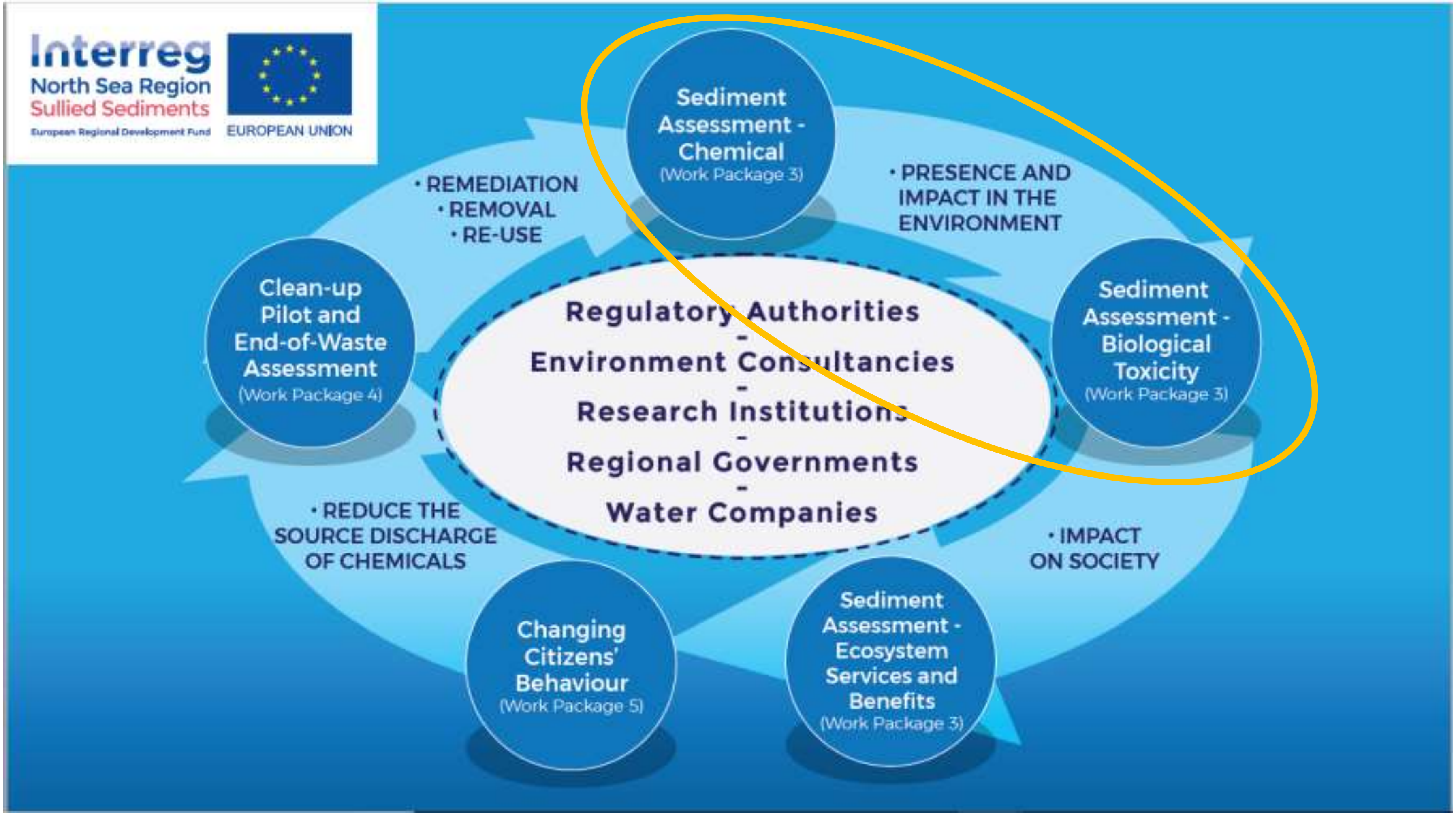
Sullied Sediments – Interreg Project



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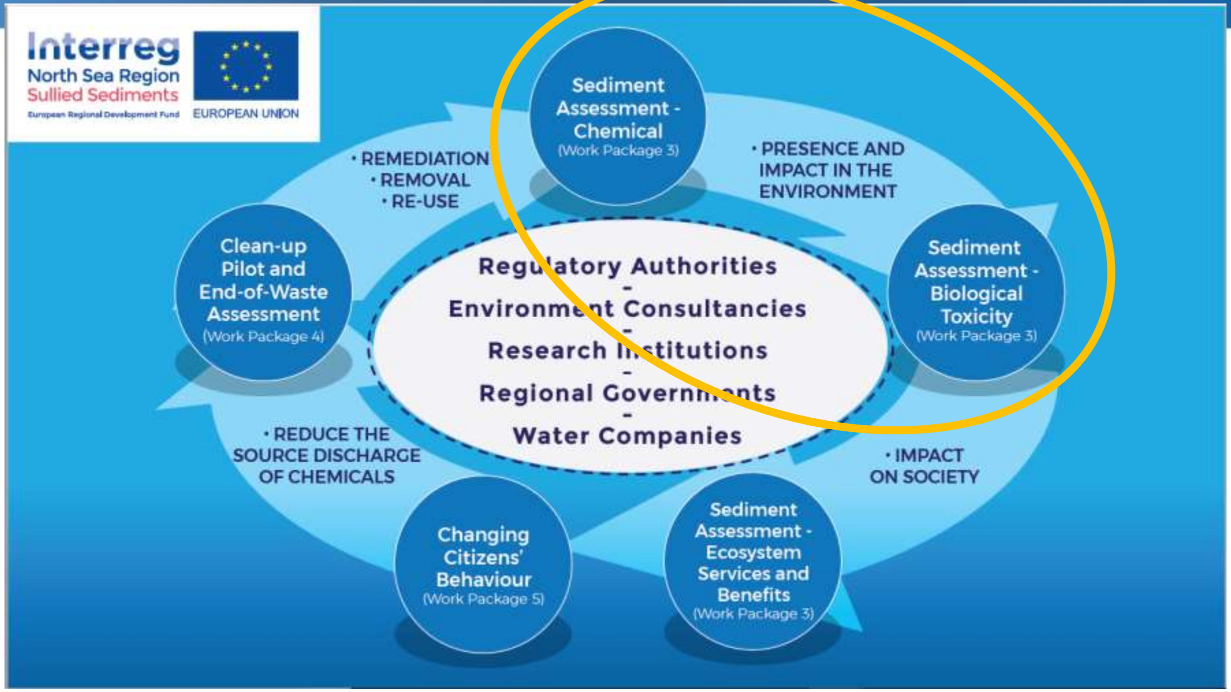
http://northsearegion.eu/sullied-sediments

Sullied Sediments – Interreg Project



- Focus on Watch List Chemicals, especially endocrine disruptors
- Aim: to enable managers and regulators to make better decisions on sediment management issues
- While reducing the costs and the impact of these pollutants on the environment.

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Sullied Sediments – WP3 –"Better Assessment"

3 sampling locations per Humber-, Elbe, Scheldt-catchment

6 sampling surveys

Each sediment:

Analysis for 130 chemical substances (incl. Watch List chemicals)

>10 biotests

Macrozoobenthos community

Meiobenthos community

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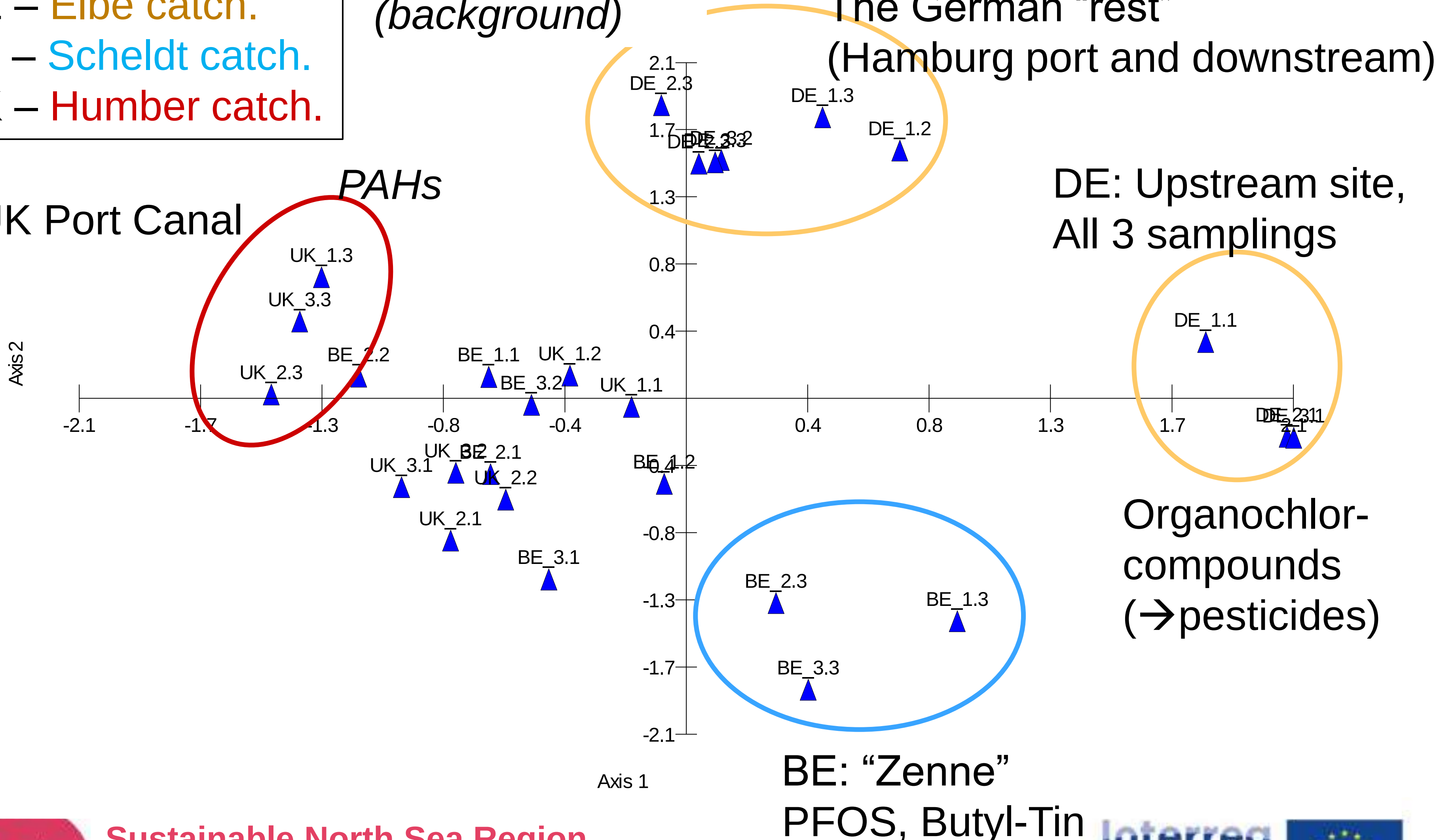
Description of sites on the basis of chemical analysis

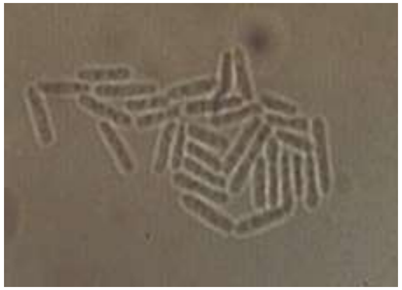
DE – Elbe catch.
BE – Scheldt catch.
UK – Humber catch.



Bioassays

Sediment bacteria

BCT



Arthrobacter globiformis

Sediment/Soil Contact

Nematodes

C. elegans

Biotestbattery

Green algae

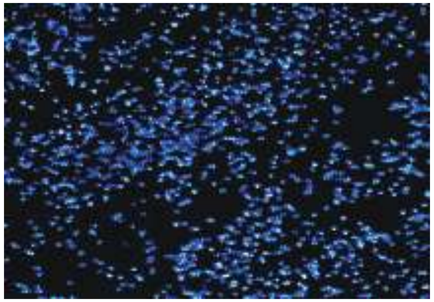
AGI

Rhaphidocelis subcapitata
Desmodesmos subspicatus

Elutriate

Elutriate and Methanol-extract

Fluorescing bacteria



LBT

Allivibrio fischeri

+ Daphnia magna, Myriophyllum, Lumbriculus variegatus, Thamnocephalus platyrus, Heterocypris incongruens.

→ Database

Database will be used to answer these questions regarding DM/sediment management:

Should the list of chemicals for DM characterization be extended (emerging substances, WL chemicals),

restricted (only some contaminants as indicators),

or oriented towards river-basin specific substances?

What is the minimal data set that is needed for a risk assessment of contaminated sites?

What other „lines of evidence“ should be included (e.g. passive sampling)?

How should biotest batteries be designed?

Are biotests for specific effects needed (endocrine disruption, PS inhibition)?

Development of an improved assessment framework

… which

–includes effect-data,

–is widely applicable to sites with different characteristics

–ensures environmental safety

–and cost-efficient!

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Ecotoxicity data in decision making on natural sediments

Pro:

Bioassays….

…measure effects, not concentrations (what we want to protect against)

…measure effects of all available substances (not only those that are analyzed)

…measure combined effects of all available substances (e.g. synergistic effects)

Contra.

Bioassays…

…do not identify the effective pollutant.

.. do not represent the whole biological community.

… are carried out under specific lab conditions → ecologically relevant?

What decision makers are concerned with:

"When in contrast to chemical data, biotesting increases costs unnecessarily."

Do decision frameworks that use ecotoxicological data as one line of evidence indeed **increase the costs at all?** And if yes, is it unnecessary or is it – on the opposite - **really necessary**?

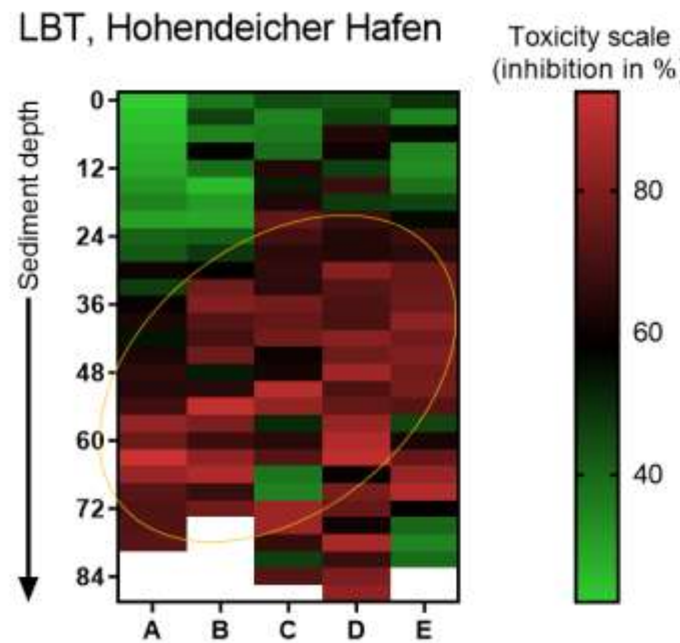
"Different labs = different results. If biotesting is that unreliable, how can we base decisions on them?"

Are biotests indeed **unreproducible** between labs, and why? And does that mean, ecotoxicity testing is **unreliable**?

Step 1: Investigating Reproducibility of Tests on Natural Sediments in Our Own Lab

Sediment cores of up to 80 cm depth
every 2 weeks
3 to 5 times

Biotests of 3 cm thick slices
elutriates (AGI, LBT)
sediment (BCT)



Luminescence bacteria test (Microtox)
Reproducible results for natural sediments!

For more information, please visit our poster!

Poster nr. 104

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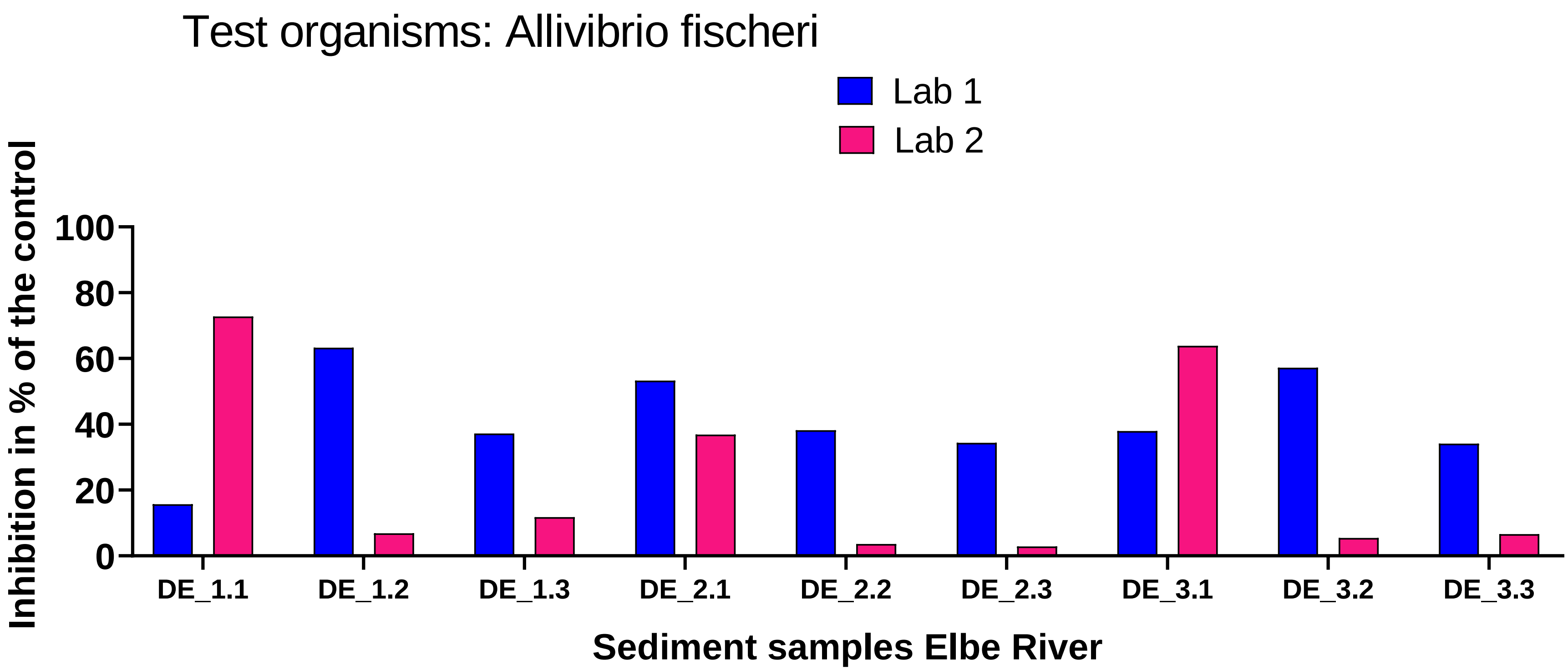
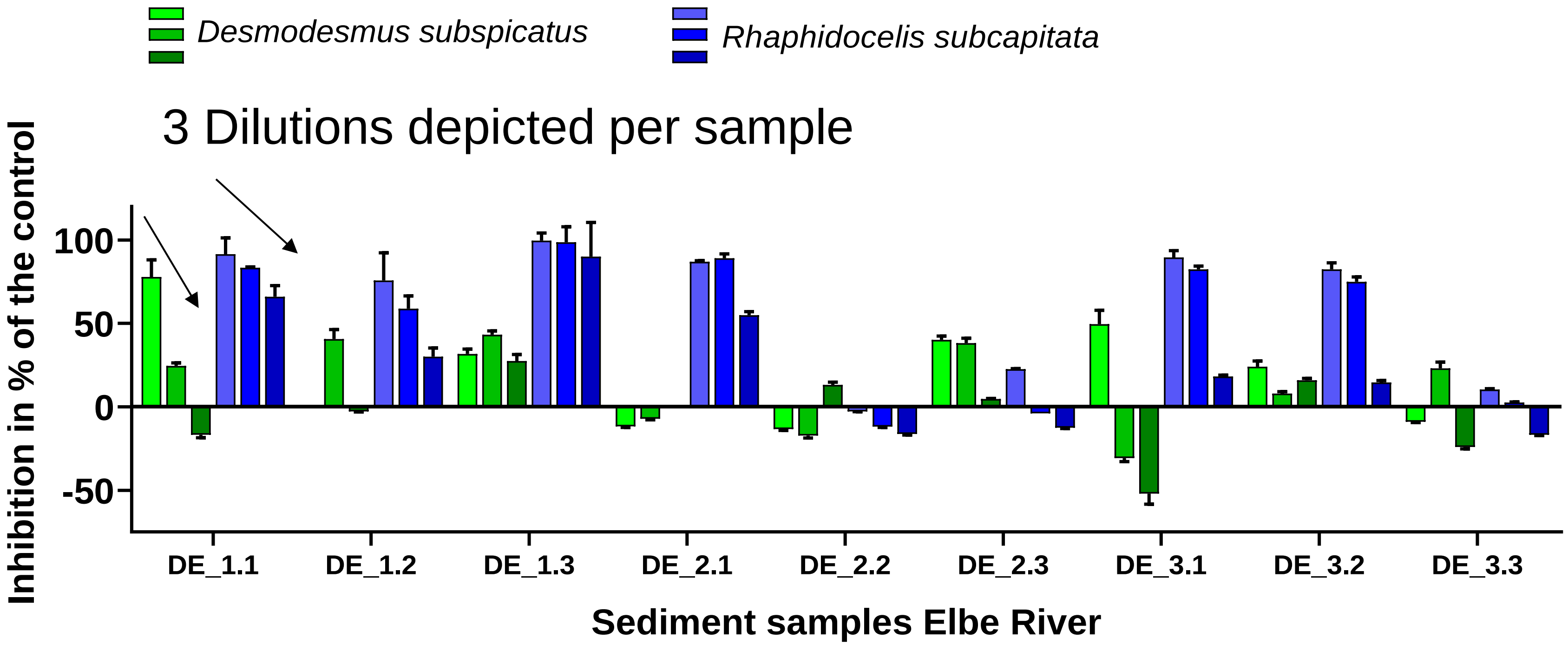
Luminescence bacteria test (LBT) different protocols, same species (n=9)



Very different results, despite it being the same organism. Not even close!

Algae growth inhibition test (AGI) same protocol, different species

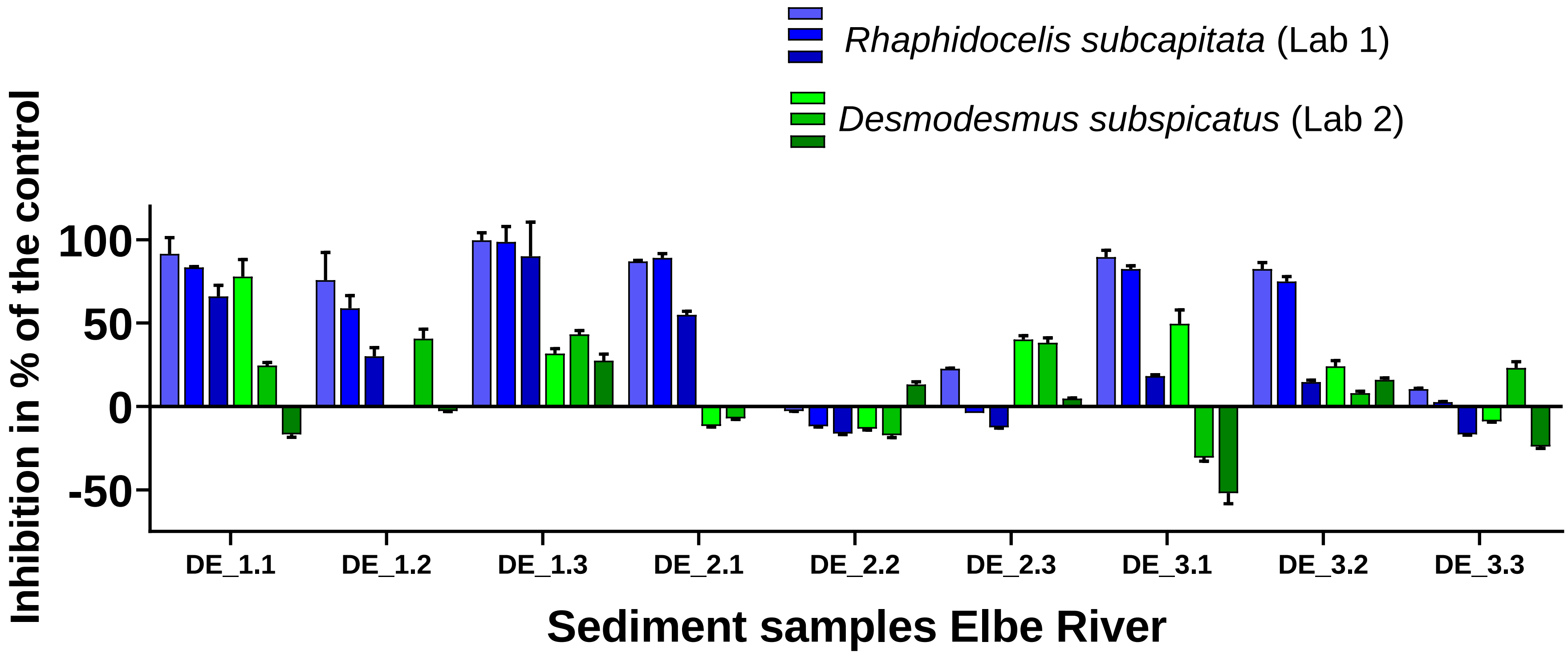


Also here: strong differences:

Inhibition (*D. subspicatus*) < inhibition (*R. subcapitata*)

Less stimulation in *R. subcapitata*

Algae growth inhibition test (AGI) same protocol, different species



Also here: strong differences:

Inhibition (*D. subspicatus*) < inhibition (*R. subcapitata*)

Less stimulation in *R. subcapitata*

Testing of differently diluted elutriates?

Correlations between all selected tests (lab 1 & lab 2)

	AGI (El) -Lab 1	BKT - Lab 1	AGI (El) Lab 2	AGI (PW) Lab 2	LBT (El) Lab 2
AGI (PW) Lab 2	0.825	-0.551	0.525	1.000	0.728
LBT (El) Lab 2	0.550	-0.694	0.637	0.728	1.000
LBT (PW) Lab 2	0.672	-0.837	0.589	0.687	0.830

AGI-EL (lab 1): not correlated with AGI-El (lab 2)

AGI-EL (lab 1): strongly correlated with **porewater-testing** of AGI & LBT (lab 2)

The LBT-EL (Lab 1): not correlated with LBT-El (lab 2)

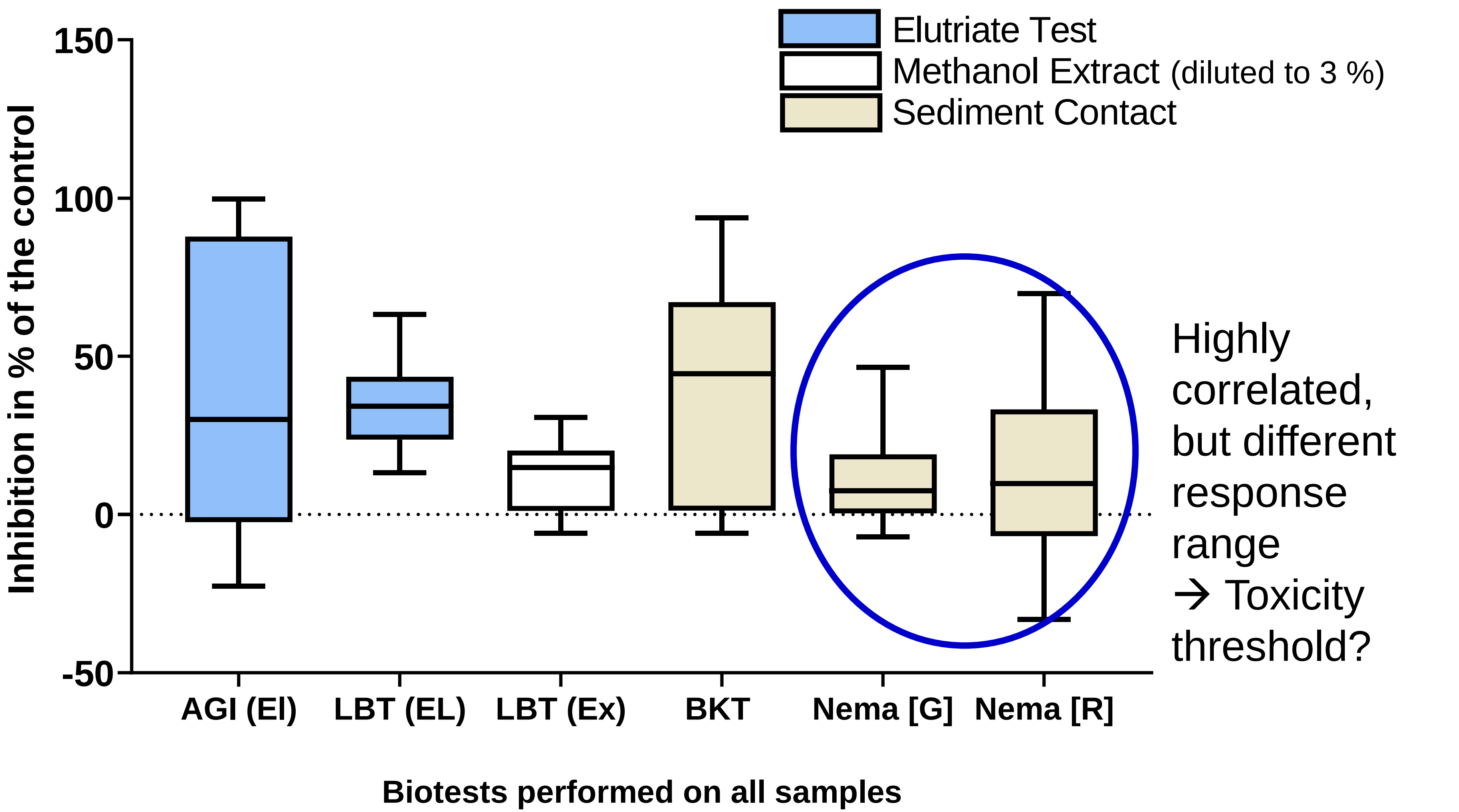
LBT (El and PW, lab 2): inversely correlated with bacterial contact test of lab 1.

Some issue with preparation:
If ecotoxicity of elutriates of one lab resembles the ecotoxicity of porewater (but not of elutriates) in the other.

Stay tuned

For the new framework: new/revised biotest classification

Response range of biotests (n=27 samples)

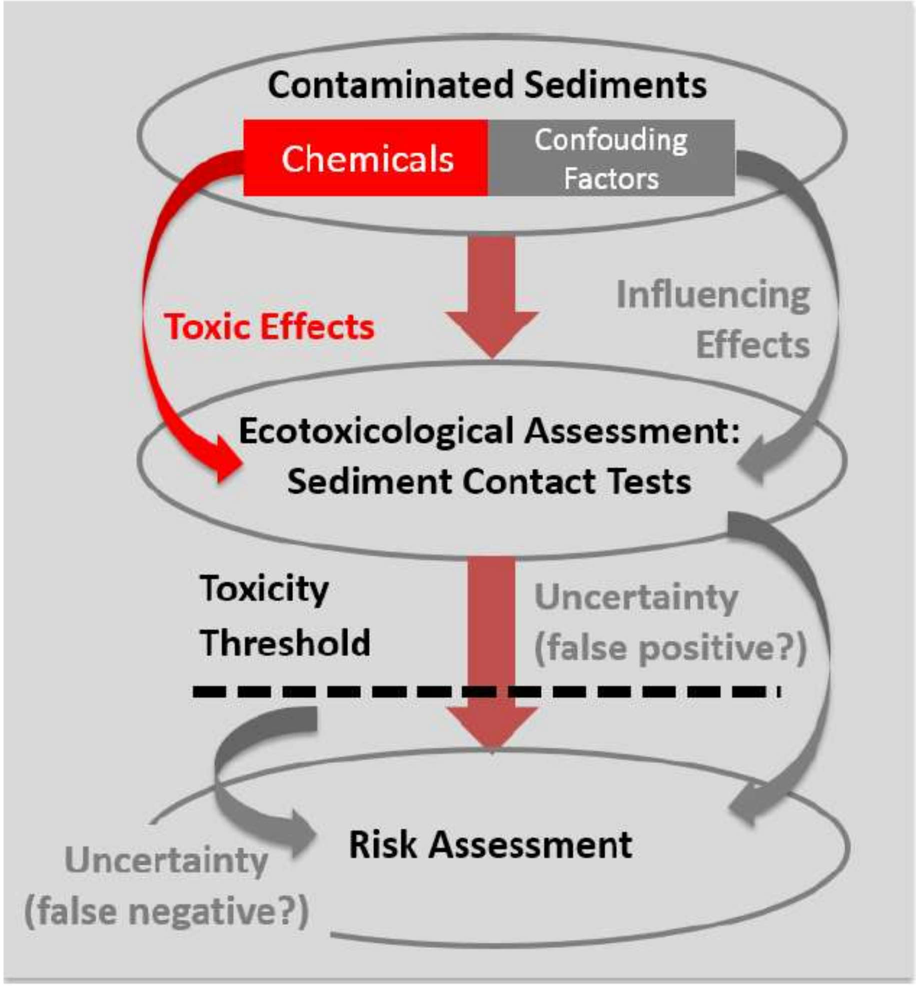


Step 2: Revision of toxicity thresholds

False positive: we interpret biotest data as toxic, even though they are in the range or normal responses or a reaction to confounding factors.

False negative: Toxicity thresholds are set “reluctantly” and too high, effects are not identified.

Ongoing work together with colleagues from outside SuSe: Visit us at poster 120.



(Graph: Sebastian Höss)

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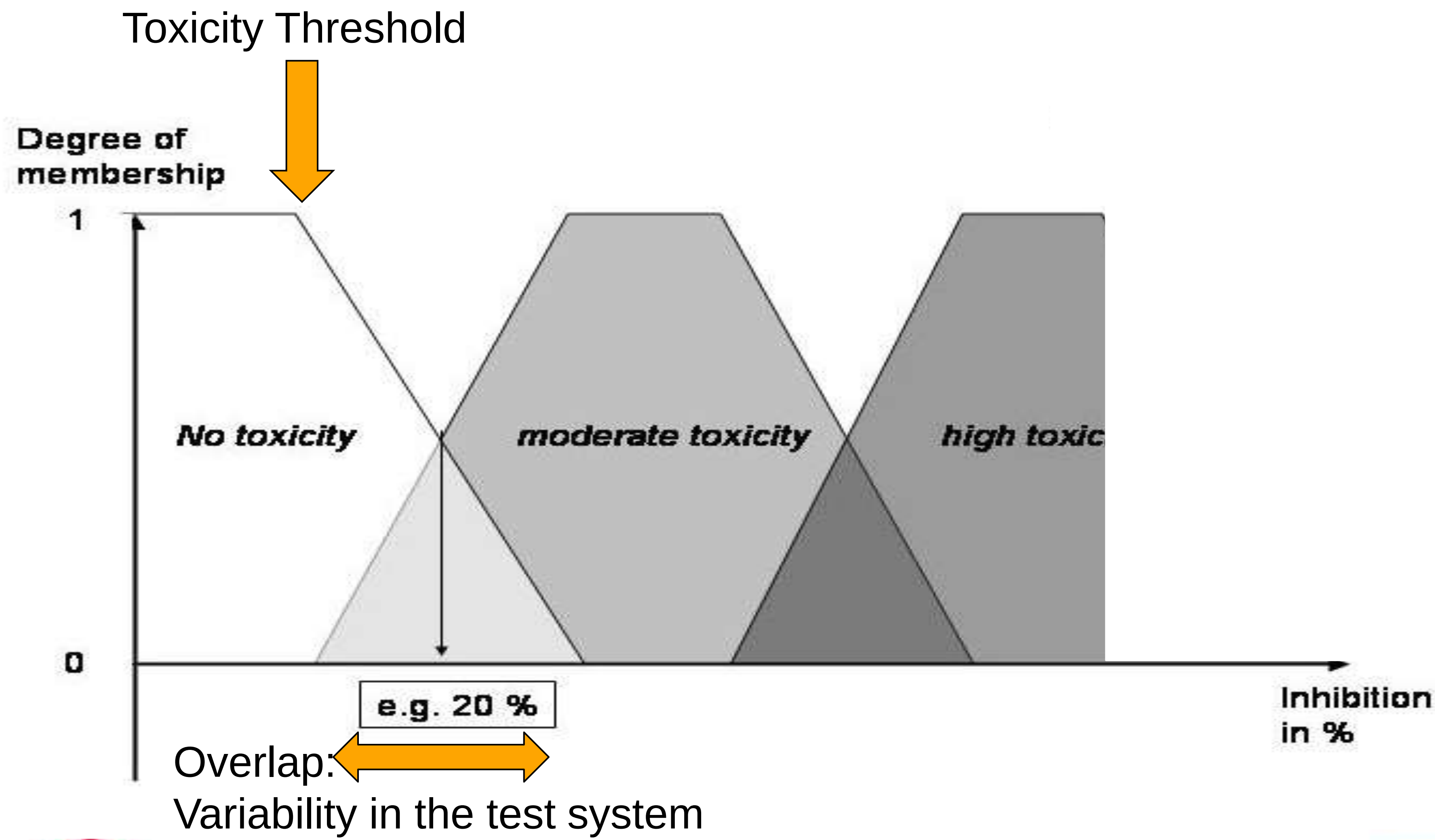
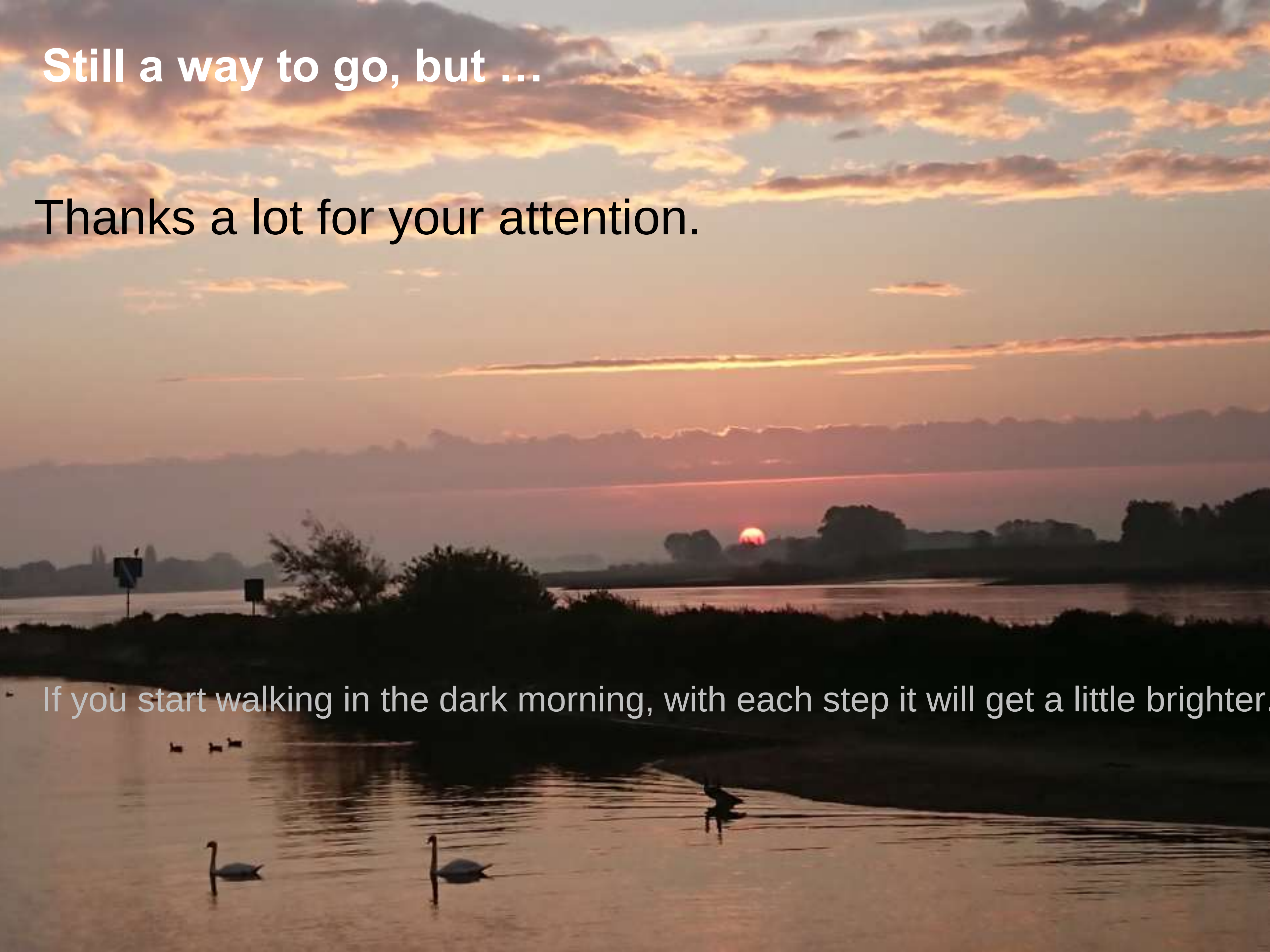
Step 3:
Addressing test-intrinsic variability with fuzzy sets





Still a way to go, but …

Thanks a lot for your attention.

If you start walking in the dark morning, with each step it will get a little brighter.

New assessment scheme from old stuff

Responses from test organisms vary naturally → no strict thresholds between toxicity classes (e.g. fuzzy classes) (Heise & Ahlf, 2008; Keiter et al. 2009)

Sediment triad – integrated assessment based on chemical, ecotoxicological and community data (Chapman 1997)

Sullied Sediments:

Testing the approach for applicability to different sites and cost efficiency in comparison to established decision making frameworks

What will be new (in development, next SedNet conference):

Lab-specific thresholds for biotests → synchronization of management decision?

Differently comprised biotest batteries → synchronization of management decisions?

Inclusion of dilution factors in the interpretation of ecotoxicity for DM management (in response to pT values of the German classification)

Environmentally safe with regard to emerging problems? → Integration of tests for endocrine disruption and Photosynthesis inhibitors.

Fuzzy Logic Expert Systems

1. Fuzzy sets allow for grey zones between classes or groups, instead of strict black and white classification

2. Overlaps of fuzzy sets reflect the uncertainty of the information behind data

Development of an improved assessment framework

- Reproducibility of Ecotox-Data on natural sediments (poster number 104)

→Only for one lab, carrying out measurements on natural sediments from the same site, which have been sampled multiple times.

→What about different labs. Could small changes in the process cause big differences? Assumption: They are systematic → adaptation.

- Threshold levels of ecotox-Data → (poster number 120)

→ Especially to reflect: what is “no or low contamination” in order to remove false positive as well as false negative results. Testing with lowly contaminated reference sediments.

- “

Correlations between all selected tests

No Correlations with any other tests:

- ➢miniaturized LBT (microtox) with elutriates and extracts
- ➢Nematode contact tests
- ➢No correlation between LBT and AGI

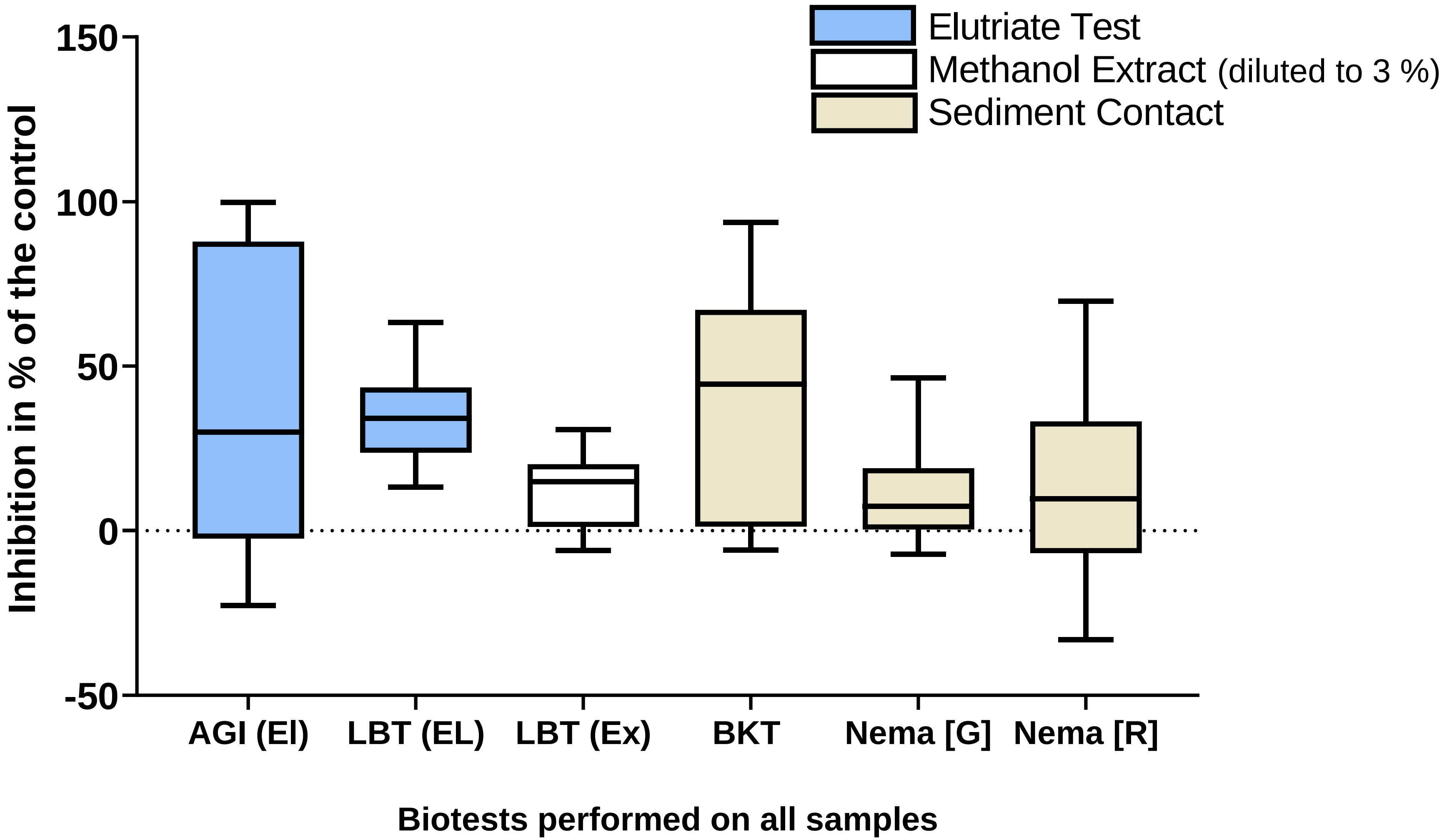
➡ These tests contribute specific information to the analysis

Conclusions –between labs? Within one lab?

- unsere Abbildung vom Poster: dass reproduzierbarkeit in EINEM Lab gut ist.

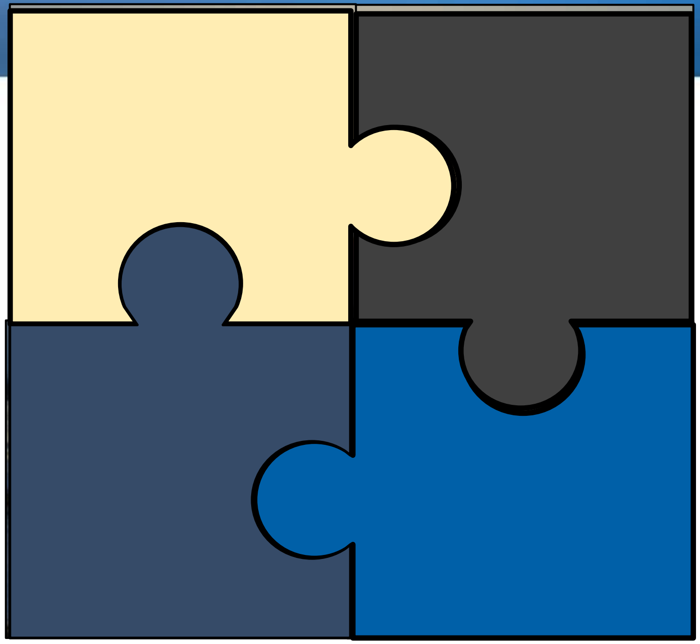
Wenn kleine Änderungen große wirkung haben: Kalibrierung auf das jeweilige Labor?

Response range of biotests (n=27 samples)



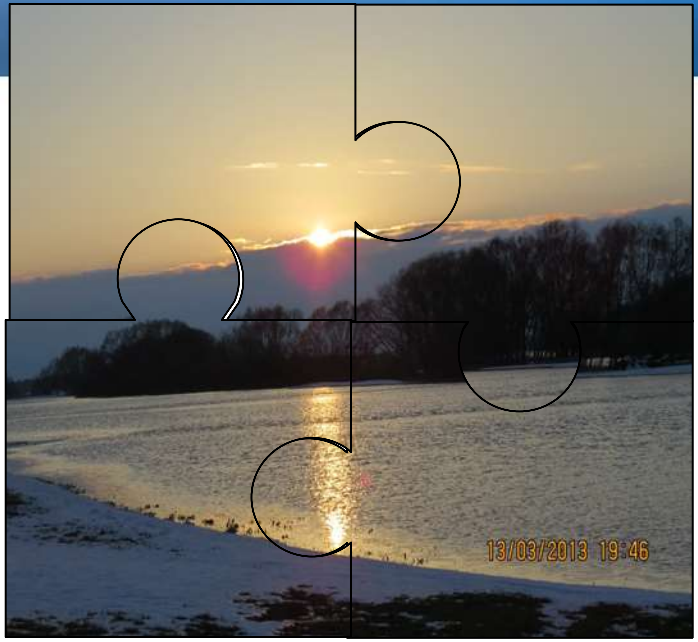
Description of sites on the basis of chemical analysis

Multiple Lines of Evidence



Integrating the information from different lines of evidence increases the reliability of assessment, improves the overall picture and allows prioritization for sediment management.

Multiple Lines of Evidence



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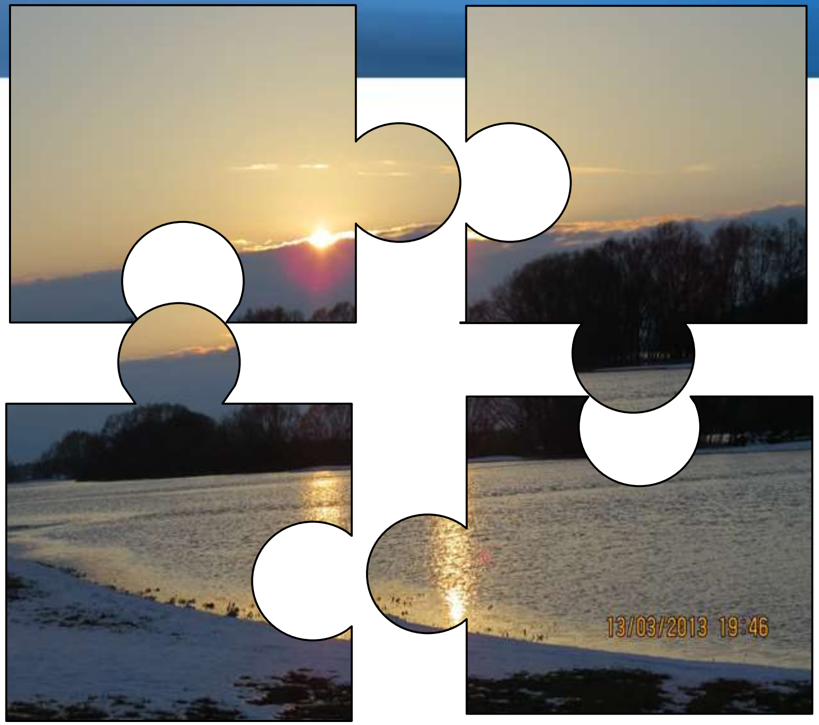

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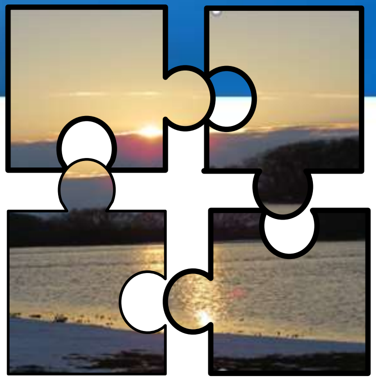
Uncertainties



- **Determination of sediment volume**

  only few measurement points
- **Chemical data**:

  only 30 substances measured

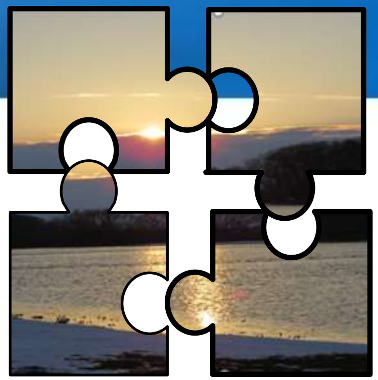
- **Ecotoxicity:**

  limited amount of test species

- **Erodibility**:

  Only surface sediment is tested. No information on deeper layers (other devices, other disadvantages)

Sullied Sediments – Interreg Project (2017-2020) in the Hamburg area



What is the minimal data set that is needed for a risk assessment of contaminated sites?

What other lines of evidence should be included? (e.g. passive sampling?)

How should biotest batteries be designed and how evaluated?

What chemical data should be analysed?

Should the data pool be extended (emerging substances),

restricted (only some contaminants as indicators),

or oriented towards to river-basin specific substances?

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Chemical data:

usually only 30 substances measured → >130 substances are measured, incl. WL chemicals, passive sampling

Ecotoxicity:

limited amount of test species → 10 different ecotox tests

Community data:

Makrozoobenthos diversity

Nematode diversity

Nema-SpeaR Index

Sullied Sediments – Interreg Project (2017-2020)

Our task in Sullied Sediments (WP3):

Improvement of a sediment classification scheme, comprising and integrating different lines of evidence, and being applicable to widely diverse sites.

Study regions in SuSe

For more information, please visit our poster WE189

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earegion.eu/sullied-
Sustainable North Sea Region
http://northsearegion.eu/sullied-sediments

Thank you for your attention!

Integrated Data for Prioritization Purpose

Sampl. site	Back-water	Sediment volume	Chemical contam.	Ecotoxicity	Erodibility
1	1				
2					
3	2				
4	3				
6	4				
7	5				
8	6				
9					
15	7				
16	8				
17	9				
18					
19	10				
20					

Integrated Data for Prioritization Purpose

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20					

Little sediment, severely contaminated, but not bioavailable, and sediment surface very stable.
→ Low risk for downstream sites

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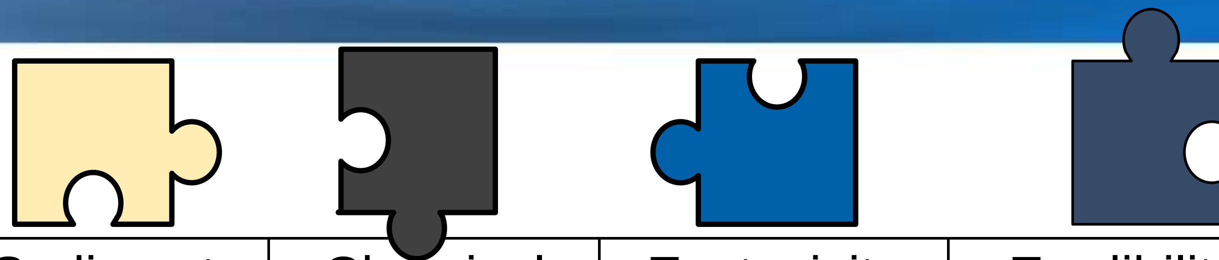

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17	9				
18					
19	10				
20					

A lot of sediment with high contamination and high ecotoxicity which is easily resuspended
→ High risk for downstream sites