Ecological modelling in support of sediment remediation: impact of nature-based remediation on *Hyalella azteca* populations

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Introduction

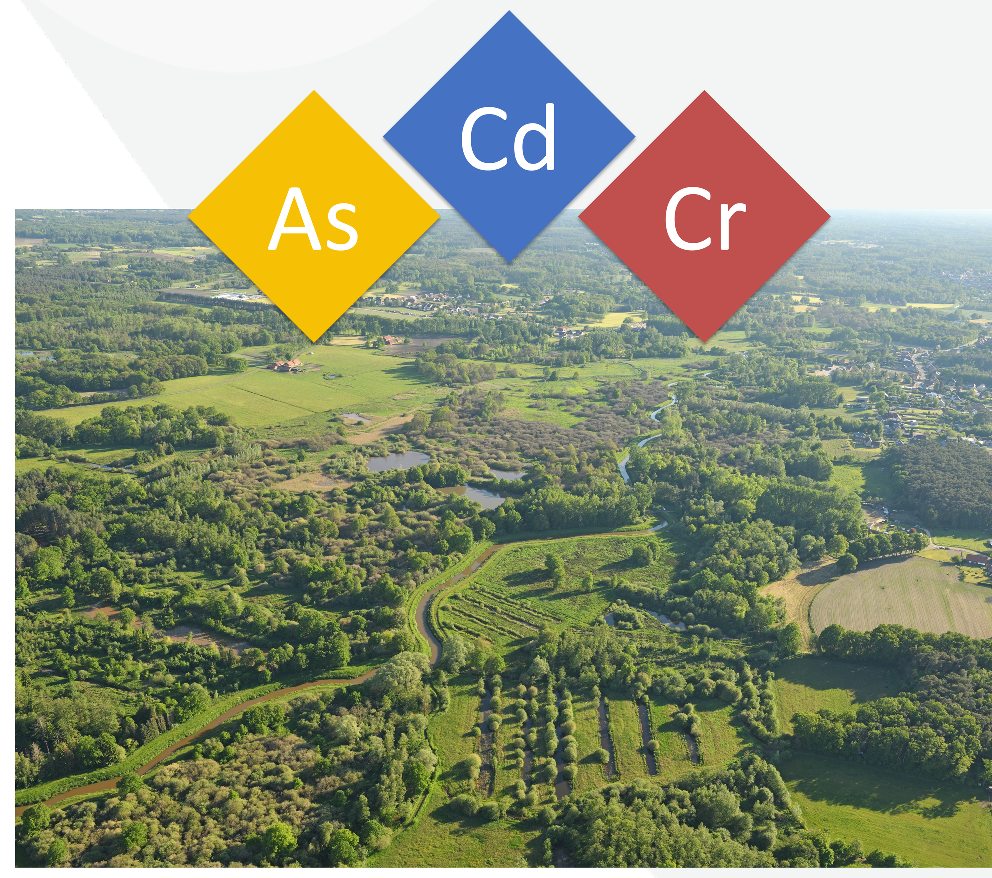
Hyalella azteca (amphipod)

Historical metal pollution in river sediment and soils in Flanders:
Excavation of polluted sediment would lead to complete destruction of the local environment (i.e., complete loss of nature and biodiversity)

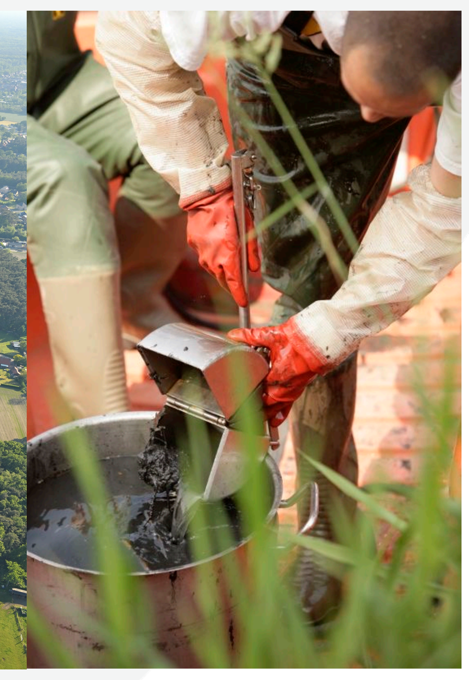
➔ LIFE NARMENA project
NAture-based Remediation of MEtal pollutants in Nature Areas to increase water storage capacity

Non-invasive, Nature-Based soil and sediment Remediation (NBR):
- Bacteria-assisted phytoremediation (BAP)
- Constructed wetlands (CW)

Ecological modelling to compare different risk management scenarios:
- Mathematically model impact of heavy metals (As, Cd, and Cr) on *Lemna minor*, and populations of *Daphnia magna* and *Hyalella azteca*
- Comparison between conventional and nature-based remediation



Zammelsbroek (Grote Laak), Geel, Belgium



Sediment sampling

Methods

1 Ecotoxicological testing

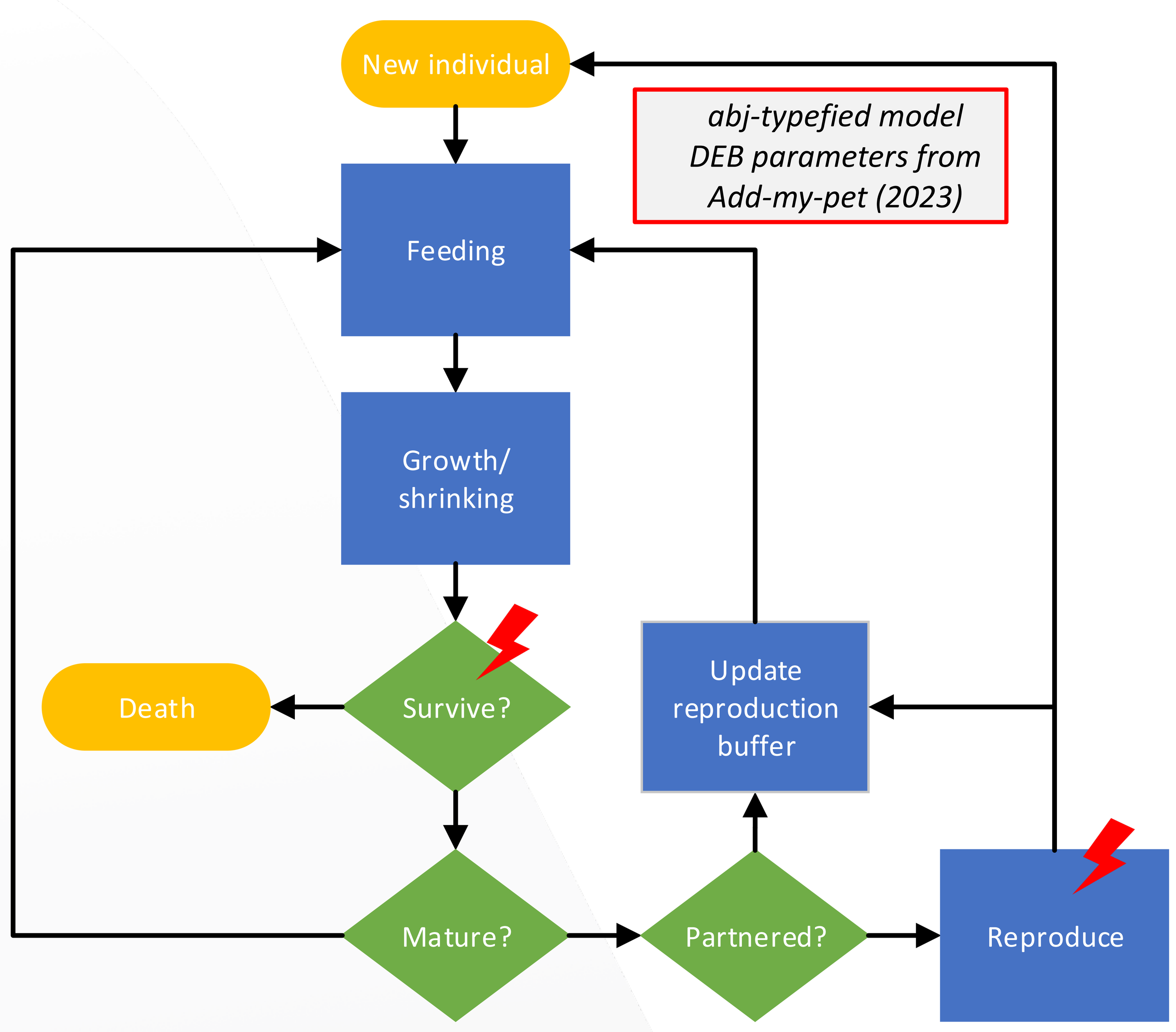
42-day sediment toxicity with *H. Azteca*
Measured endpoints:
- Reproduction at the end of the test (day 42)
- Survival at two timepoints (day 28 and 42)

Derived dose-response curves implemented into a **dynamic energy budget individual-based model (DEB-IBM)**

Metal	42d-EC50 (µg/kg dw)		42d-EC10 (µg/kg dw)	
	Surv.	Repro.	Surv.	Repro.
Cd	21.2	9.6	11.7	0.8
As	NA	21.3	NA	1.1
Cr	NA	3700*	NA	990*

*based on nominal concentrations

2 DEB-IBM for Hyalella azteca



3 Scenario analysis

Sediment analyses on 3 polluted sites in Flanders:
Grote Laak, Winterbeek, and Grote Calie**
- Metal concentrations (As, Cd, Cr)
- Metal bioavailability (AVS-SEM, Ca-extraction)

Evaluated scenarios with the DEB-IBM:
- No action (worst-case approach)
- Excavation (conventional remediation)
- NBR approaches applied in the field
- Predict effects on amphipods: pop. abundance, biomass, size distribution, persistence/extinction

Scenario	Expected impact
No action	0% of pollutants removed
Excavation	100% of pollutants removed, but direct impact as well
NBR	*To be assessed!*

***results not shown, sampling ongoing*

Results

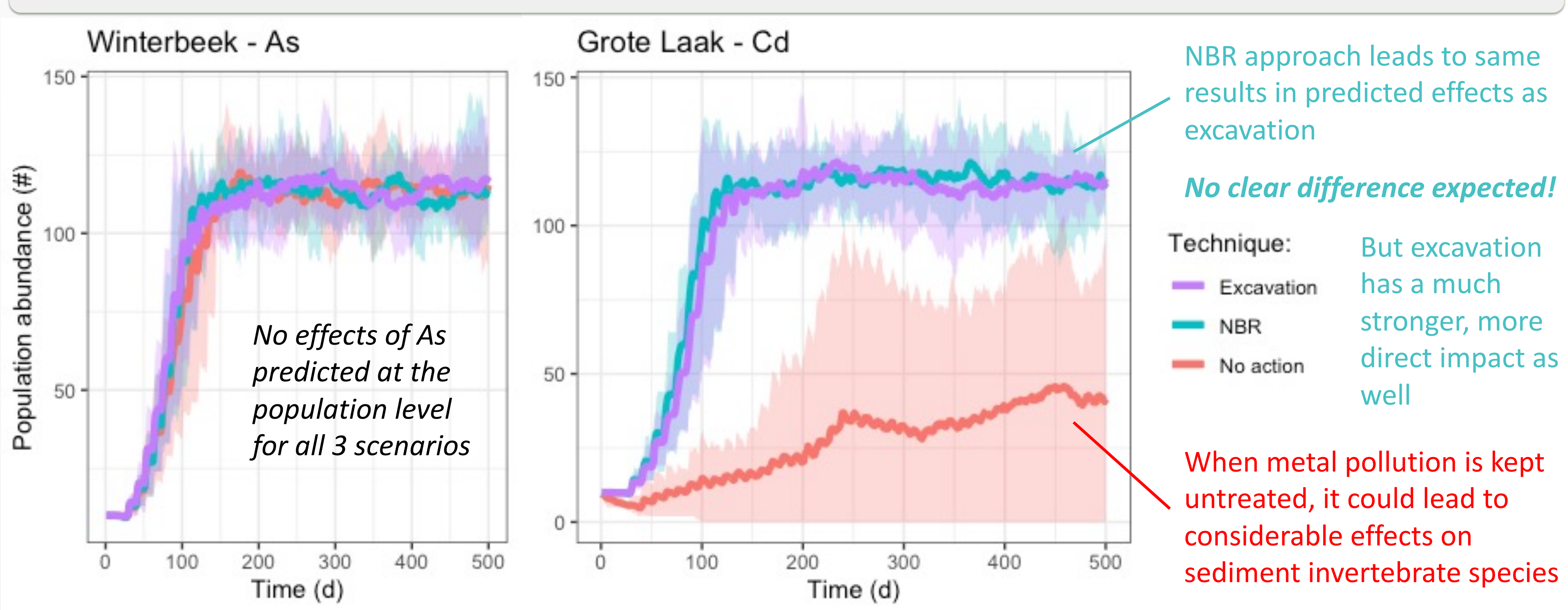
1 Sampling and monitoring

Table shows **estimated risk quotient** based on the measured concentration range (per metal and per sampled location) and the observed minimum EC10-values at the individual level for *H. azteca.*

Location	Metal	Conc. range (µg/kg dw)	Risk quotient (-)
Grote Laak	Cd	143 – 2527	>178
	As	18 – 1376	>16
Winterbeek	Cd	6 – 330	>7.5
	As	3 – 190	>2.7
Grote Calie	Cr	20	0.02

Considerable risk when comparing the measured metal concentrations with the chronic EC10 of *H. azteca*

2 Population-level impact predicted with DEB-IBM



Predicted population-level impact is less strong than expected when compared to individual-level effects

Conclusion

The combination of sediment analysis, ecotoxicological testing, and ecological modelling leads to an estimation of the impact of NBR techniques for the mitigation of metal pollution in river sediments:
- NBR leads to a considerable (predicted) reduction in metal effects of As and Cd to *H. azteca* in Winterbeek and Grote Laak. This is mainly caused by **a reduction in bioavailable fraction of metals** in the sediment.
- Our findings underscore the value of combining laboratory data, in-field measurements, and mechanistic effect modelling to comprehensively evaluate the impact of mitigation strategies in real-world environmental settings.
- NBR techniques offer promising alternatives to conventional and more disruptive soil remediation methods.

More info:
www.narmena.com

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