Integrating multiple lines of evidence into polluted soils risk assessment: Insights from the EDAPHOS project

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SoilVer Meeting – 20 March 2026

The « TRIAD » approach for Ecological Risk Assessment (ERA)

ERA methods based on **simple soil benchmark values** to capture the risk posed by **mixture of contaminants** at site level are generally **not sufficient.**

→ Requires **multidisciplinary approaches** to better integrate the **complexity of diffusely contaminated soil**

→ Among methods : **TRIAD approach** for the ERA of contaminated soil (ISO 19204; RIVM_Jensen & Mesman 2006)

⇨ **Combination of informations** from different disciplines to enhance the risk assessment

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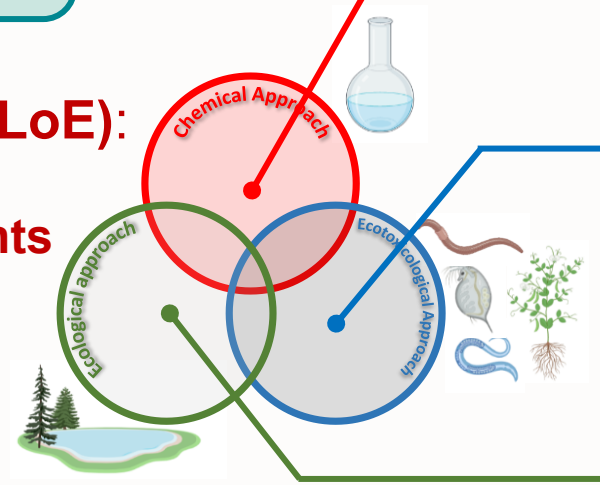
Combination of informations from different disciplines to enhance the risk assessment

The term "**TRIAD**" relates to **three lines of evidence (LoE)**:

→ Each LoE is analyzed according to **several measurements**

→ **Weight of evidence:** the limitation of one LoE is counterbalanced by the strength of another



Chem-LoE → reflects the soil contamination : chemical **concentrations** and their potential **bioavailability**

Ecotox-LoE → reflect the **toxicity** of all **bioavailable contaminants in mixture** within the **soil matrix**

Eco-LoE → reflects environmental characteristics and functioning of the habitat

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The « TRIAD » approach for Site-Specific ERA

ERA methods based on **simple soil benchmark values** to capture the risk posed by **mixture of contaminants** at site level are generally **not sufficient.**

→ Requires **multidisciplinary approaches** to better integrate the **complexity of diffusely contaminated soil**

→ Among methods : **TRIAD approach** for the ERA of contaminated soil (ISO 19204; RIVM_Jensen & Mesman 2006)

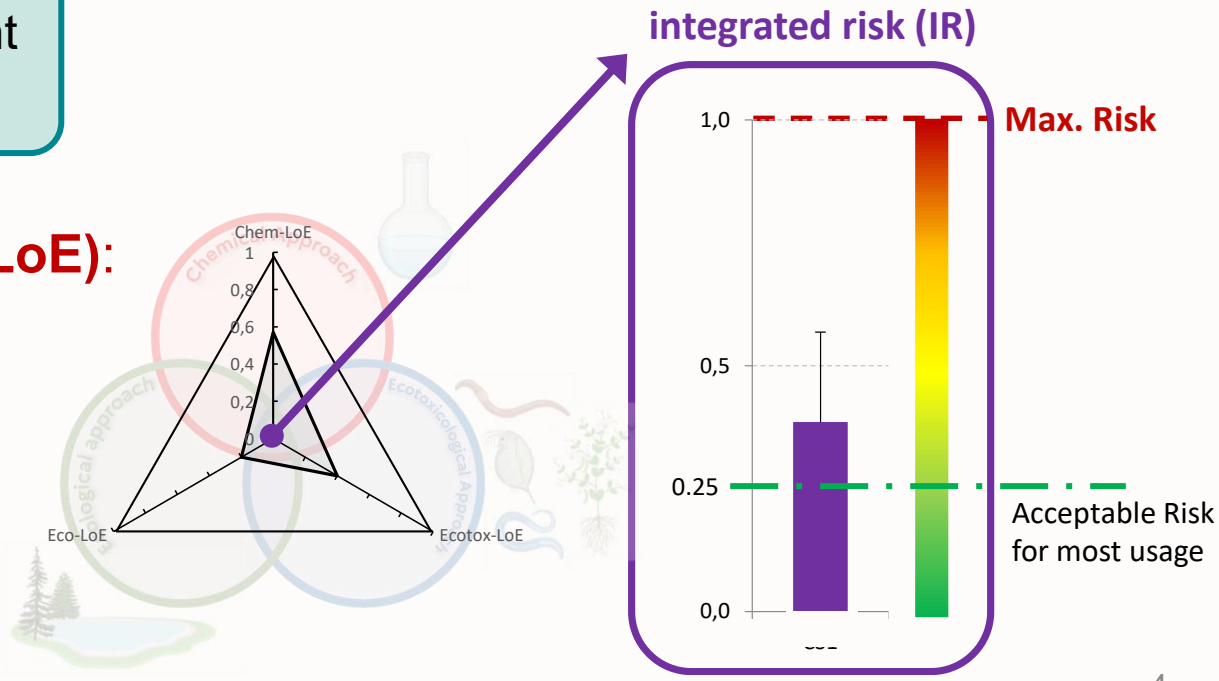
Combination of informations from different disciplines to enhance the risk assessment

The term "**TRIAD**" relates to **three lines of evidence (LoE)**:

→ LoE measurement are **scaled from 0 to 1**

→ One score per LoE

→ The three LoE scores are combined to represent an **integrated risk (IR).**



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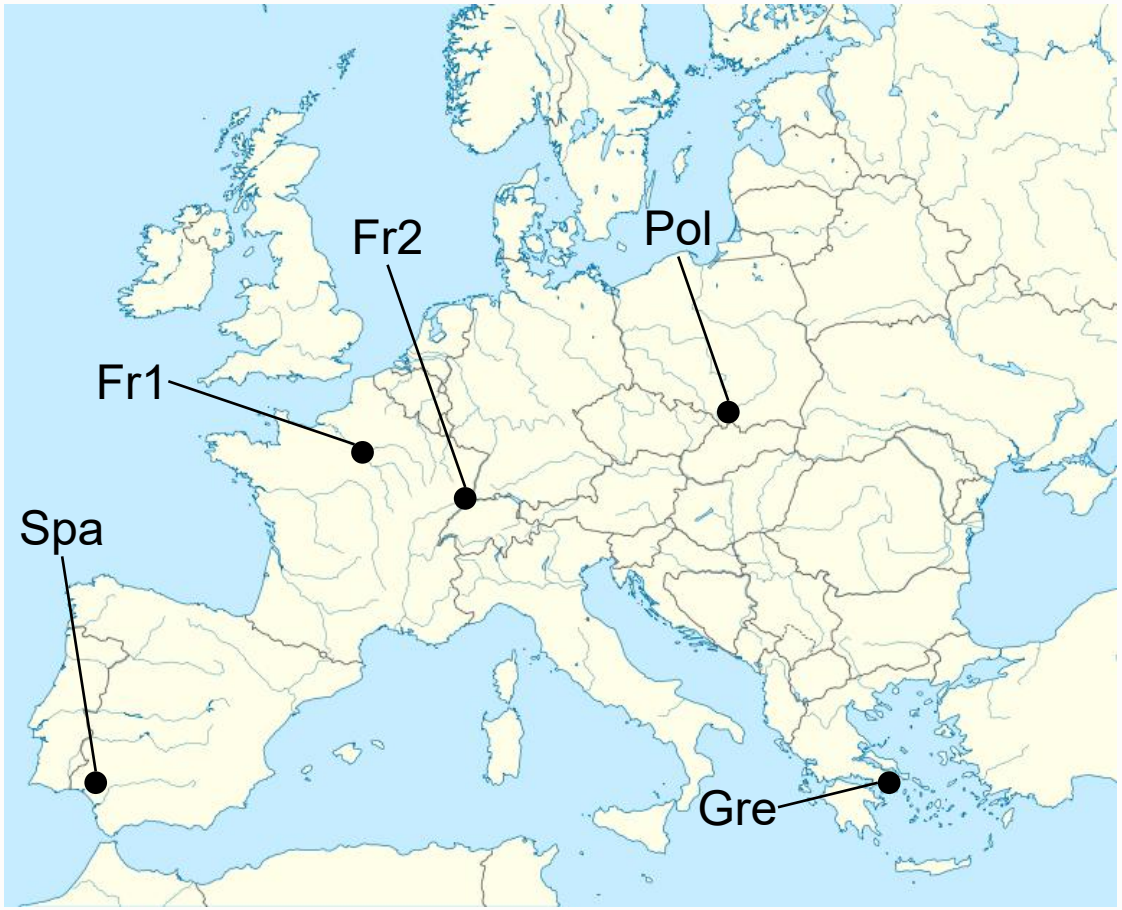
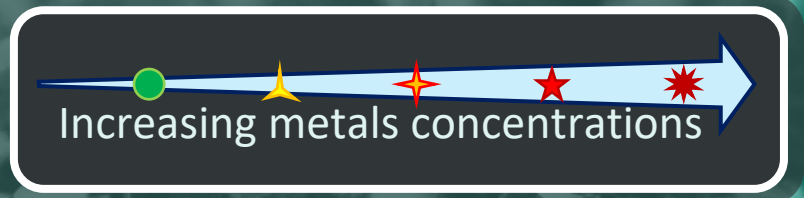
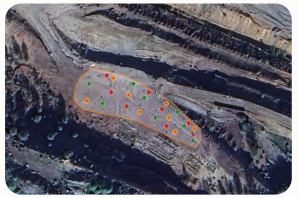
EDAPHOS project quick background information

- Consortium from 6 EU countries, made up of 12 partners
- Horizon Europe call: Research and Innovation actions to support the implementation of the Soil health and Food Mission - HORIZON-MISS-2022-SOIL-01
- The project aims to **accelerate the land rehabilitation and ecological restoration** of contaminated soils through innovative nature-based solutions

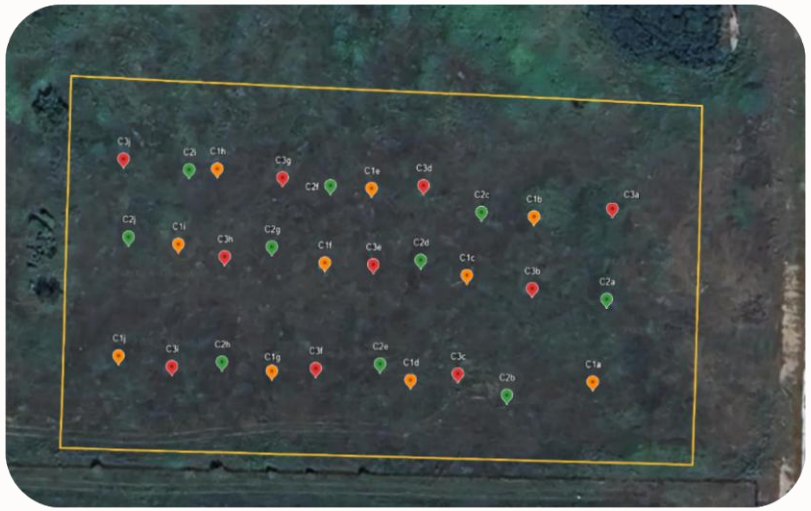


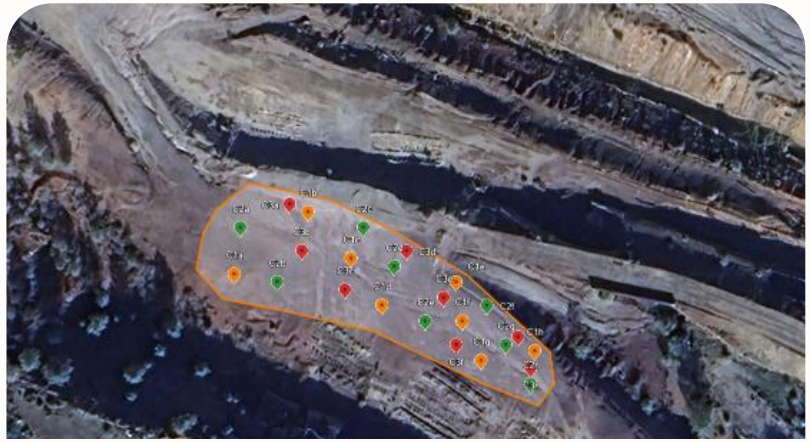
EDAPHOS case studies



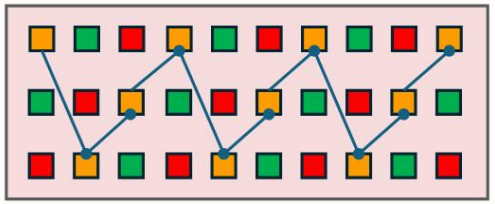
Localisation	Picture of the site	Sampling plan	Main characteristics	Main contaminants
Fr1 Carrière-sous-Poissy (fr)			**Abandoned agricultural area** received untreated wastewater from the city of Paris throughout the 20th century	HM: As Cd Cr Cu Fe Ni Pb Sn Zn Others: PAH & Pesticide residues + unknown
Spa Odiel Basin Area (Sp)			**Mining area** polluted by acid mine drainage leachates and phosphate fertilizer industry effluents	HM: As Cd Cr Cu Fe Ni Pb Sn Zn Others: No
Pol Silesian Voivodship (Pl)			**Post-mining area** contamination results from industrial activities conducted in the area	HM: As Cd Cr Cu Fe Ni Pb Sn Zn Others: No
Fr2 Vieux -Charmont (fr)			**Industrial wastelands** contamination mainly results from car industry	HM: As Cd Cr Cu Fe Ni Pb Sn Zn Others: PAH and Hydrocarbons
Gre Lavrio			**Agricultural area close to former mining exploitations** contamination results from a long term copper and other minerals resources exploitation	HM: As Cd Cr Cu Fe Ni Pb Sn Zn Others: Unknown

EDAPHOS: 2024 Soil collection in the field (year 0)

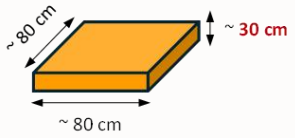




Area corresponding to the location for NBS implementation



Sub-sampling plot



- *Sub-sampling plots for the soil composite 1*
- *Sub-sampling plots for the soil composite 2*
- *Sub-sampling plots for the soil composite 3*

Based on LUCAS soil sampling procedure and specific requirements for EDAPHOS

f

Generating site-specific data for the ERA

Edaphos "Toolbox" for to TRIAD (equivalent to tiers 3), on year 0

Chemical LoE

- Total concentrations
- Mobile concentration (e.g. after chemical extraction) ← impending
- Bioaccumulation in invertebrates (snails)
- ~~Bioaccumulation in higher plants~~

Ecotox. LoE

Ecolog. LoE

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Ecotox. LoE

Soil toxicity

- Higher plants root growth inhibition test (ISO 11269-1)
- Higher plants growth inhibition test (ISO 11269-2)
- *Arthrobacter globiformis*, dehydrogenase inhibition test (ISO 10871
- Earthworms (acute toxicity test) (OECD 207)
- Earthworms (reproduction test) (OECD 222)
- *Caenorhabditis elegans*, mortality, growth and reproduction test (ISO 10872)

leachate tox.

- Daphnia sp. Acute immobilisation test (OCDE 202)
- Freshwater microalgae growth inhibition test (OCDE 201)
- ~~MICROTOX Acute Toxicity (*Vibrio fischerii*) (ISO 11348-3)~~

Ecolog. LoE

Higher plants Growth inhibition test

Worm tests and roots elongation test

Nematods growth and reproduction

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Ecolog. LoE

Biodiv.

- Determination of soil nematods diversity (ISO 23611-4)
- Microbial diversity (qPCR methods)

Soil function

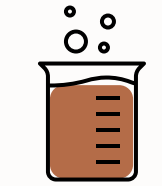
- Estimation of organic matter décomposition (ISO 23265)
- Soil enzymes activities (biogeochemical cycles C, N, S, P) (ISO 20130)
- Soil microbial respiration rate (ISO 16072)

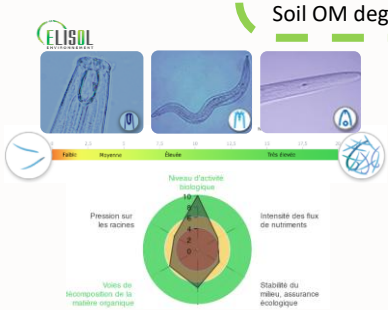
Higher plants Growth inhibition test

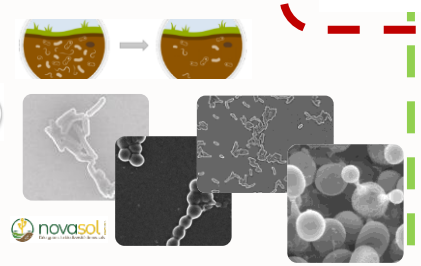
Nematods growth and reproduction

Worm tests and roots elongation test

Soil OM degradation measurment







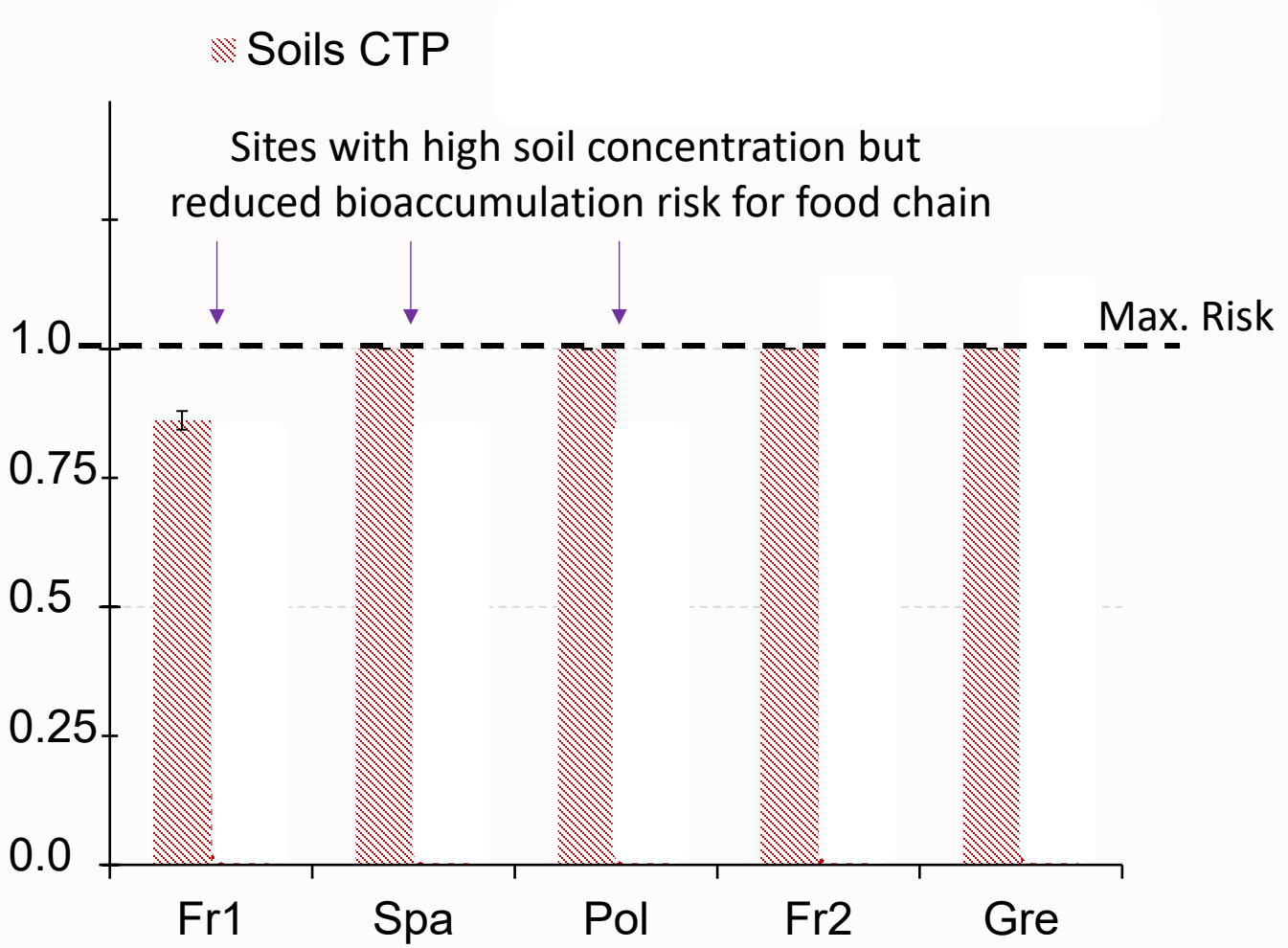
Agro-chemical data (pH, WHC, structure, OM)

Chemical LoE analyses

Chemical Lines of Evidences

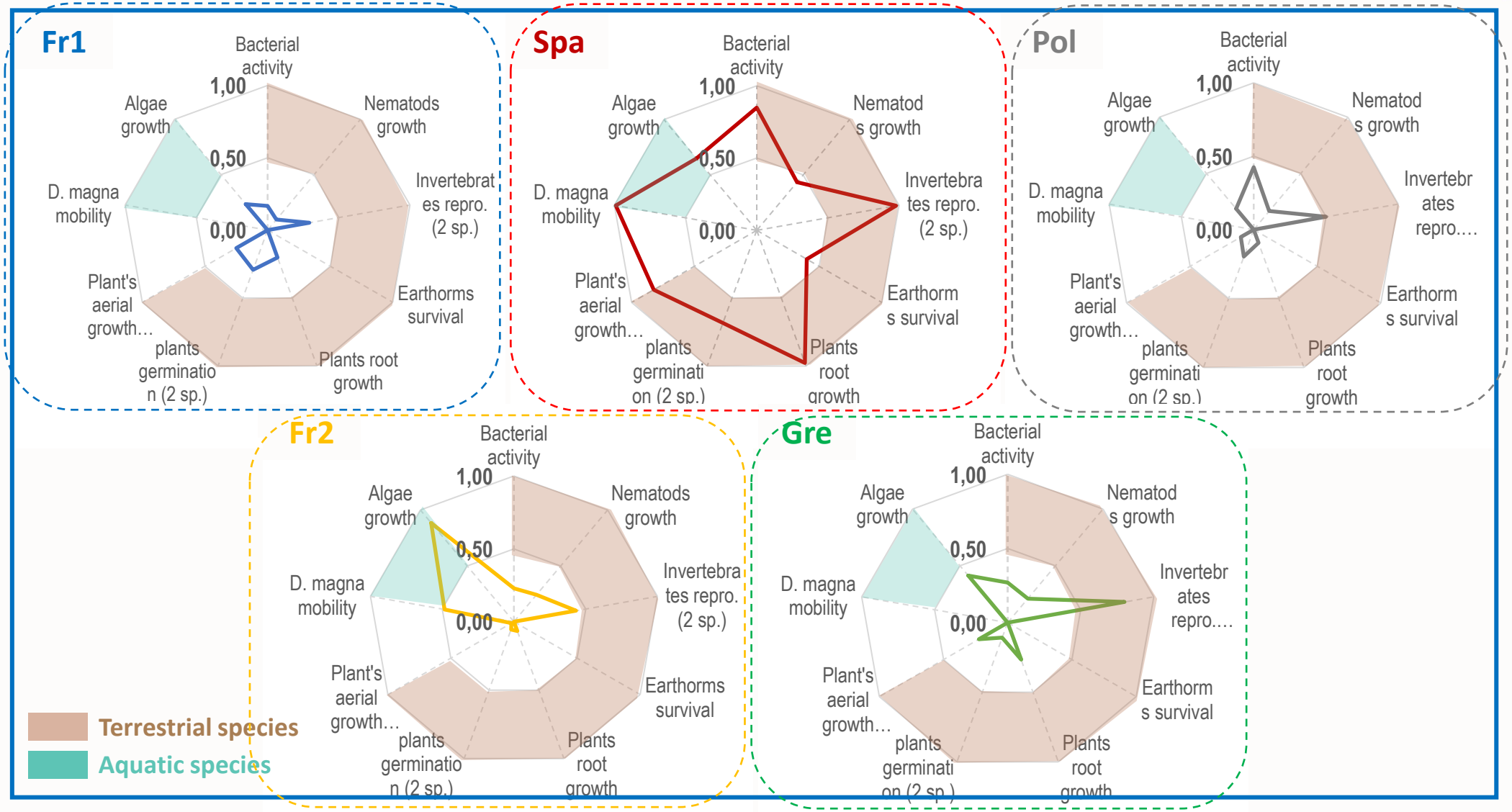
Calculation of the « **toxic pressure** » using **combi-PAF method** (combined-substance Potentially Affected Fraction), based on **SSD values**

***In vivo* bioaccumulation** in invertebrates (Snails), compared to concentrations known to induce a reproductive delay.



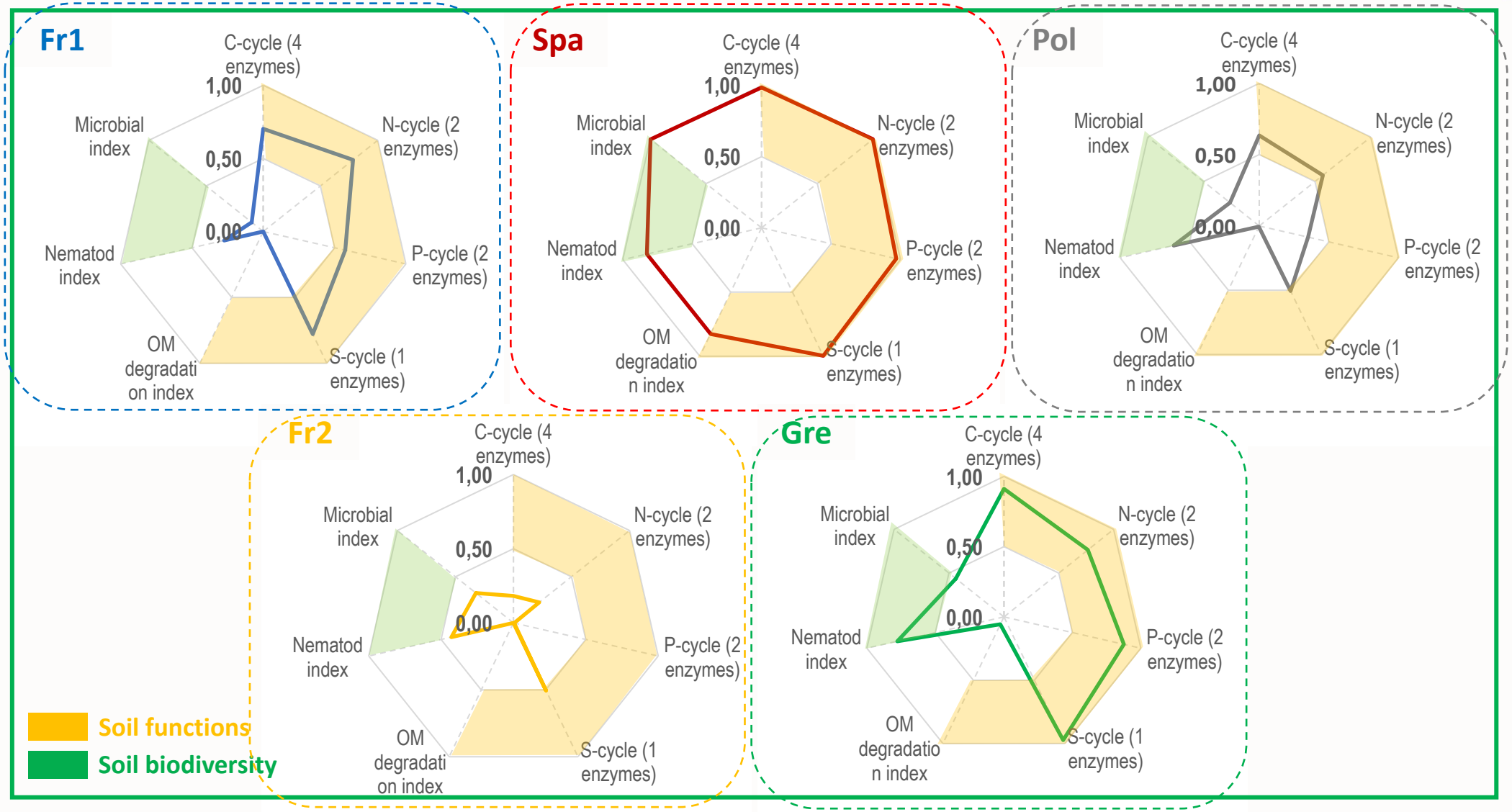
Ecotoxicological LoE analyses

Ecotoxicological Lines of Evidences

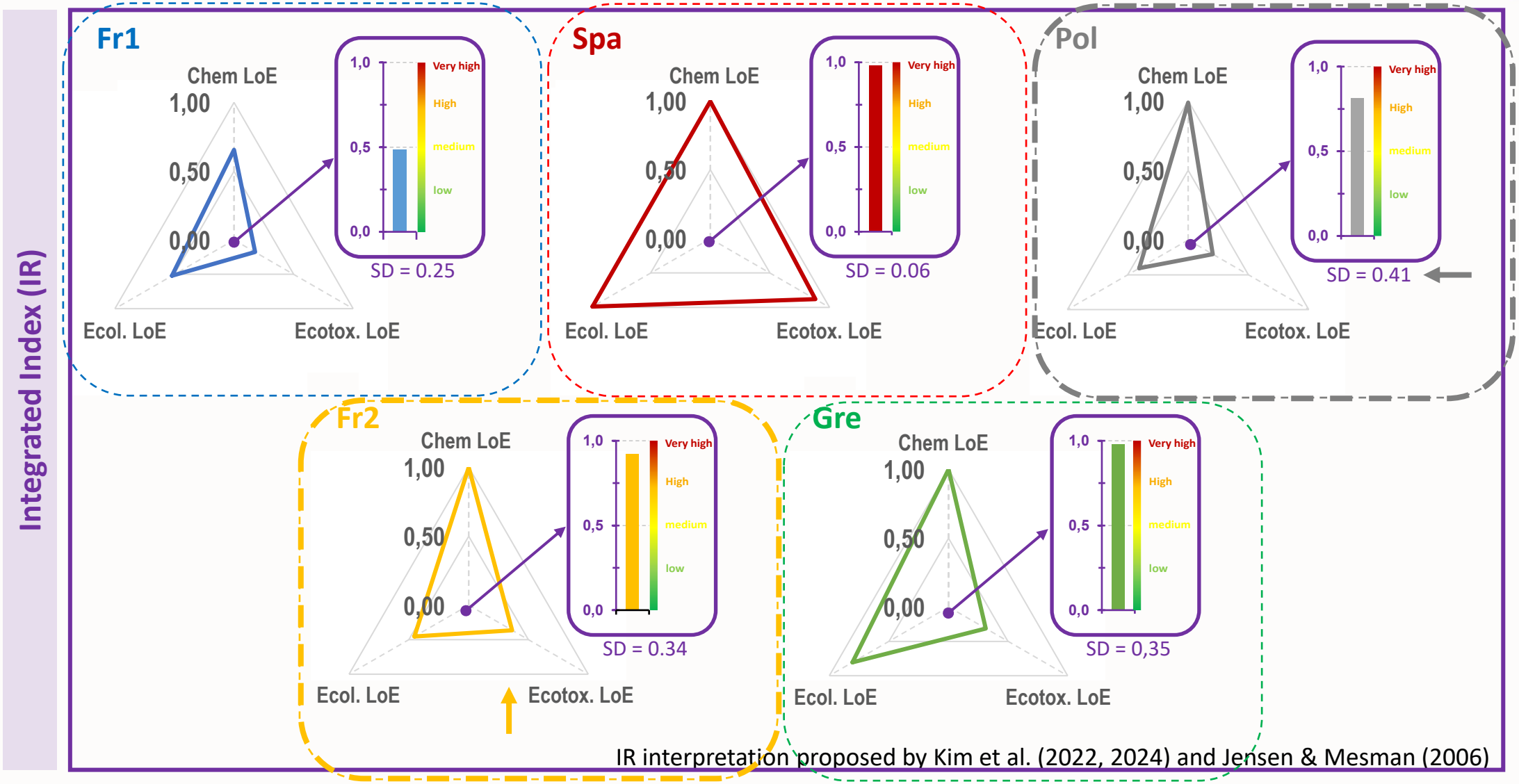


Ecological LoE analyses

Ecological Lines of Evidences



Integration of LoE scores and IR interpretation



IR interpretation proposed by Kim et al. (2022, 2024) and Jensen & Mesman (2006)

Next steps

Step 1 → Refine the preliminary assessment

Refine r-chem determination

- Select backgrounds for metal conc. correction (ex. EU vs local soil background)
- Refine hazard threshold values for TP calculation (EC*x*, HC*x*, PNEC, …)
- Add mobile/soluble concentrations & higher plant bioaccumulation concentration

Refine r-ecotox. determination

- Ponderation of the toxicity endpoints / Management of correlated endpoint
- Refine the biological interpretation
  - -- Establish minimal tolerable toxicity threshold
  - -- Assess robustness of current tests for different type of soils

Refine r-ecol. determination

- Control local site for ecological endpoint → Not always easy to find
- Need to establish referential or target values for the ecological indicators

Step 2 → Refine the indicator toolbox

Ind. 1
Ind. 2
Ind. 3
Ind. 4
Ind. 5
Ind. 6
Ind. 7

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Project EDAPHOS

Questions?

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Want to learn more about the Triad approach and EDAPHOS?
Watch previous SOILverR presentation: → https://soilver.eu/coffee-break-meetings/

SOILveR Coffee break meeting EDAPHOS Project 29112024, November 29th, 2024
SOILveR Coffee break meeting June 22th 2023

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