

IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

ERA for legacy sites: what about the environment?

Impact on non-human biota

PSE-ENV/SRTE/LECO
March 2019
Karine Beaugelin-Seiller
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Objectives of the workshop

➤ Learning from past actions...

- Discuss the risk assessment process as applied to radioactively contaminated legacy sites
 - Our experience on a former uranium mining site
- How to better present the assessment findings and associated uncertainties to stakeholders
 - Our feedback from our participation within a pluralistic expert group
 - Authorities
 - Operators
 - NGOs
 - Technical experts and scientists

➤ ...to do better in the future?

The GEP-mines experience

General context



The second pluralist French initiative

➤ Inspired by the proven concept of GRNC

- 80's: progressive closing of uranium mining sites in the center of France (Limousin)
- Regulatory constraints: protection objectives met or not?
- Objectives:
 - Exhaustive and rigorous investigation of actual impacts
 - Technical analyze of the present situation starting with actual cases to clarify the options for management and monitoring
 - Recommendations on option development
 - to reduce the current impacts and
 - to foresee those in the long term according to the preparation of a long term plan





The second pluralist French initiative

➤ The method

- Detailed analyze of the sites of the mining division of Crouzille
 - Identification of risks specific to former mining sites
 - Development of an analyze of the risks and potential impacts
 - Evolution of methods for monitoring and impact assessments



- Generalization of the approach to any former U mining site



The second pluralist French initiative

➤ The group structure

Plenary group



- Public institutes
- Authorities
- NGOs
- operators
- foreign experts

WG1
Source term
Transfers in the
environment



WG2
Environmental
impact
(people and
wildlife)
Human health
monitoring



WG3 regulatory
framework and long
term survey



WG4
measurements



24 people, among which ca ½ public experts

Three periods of activities

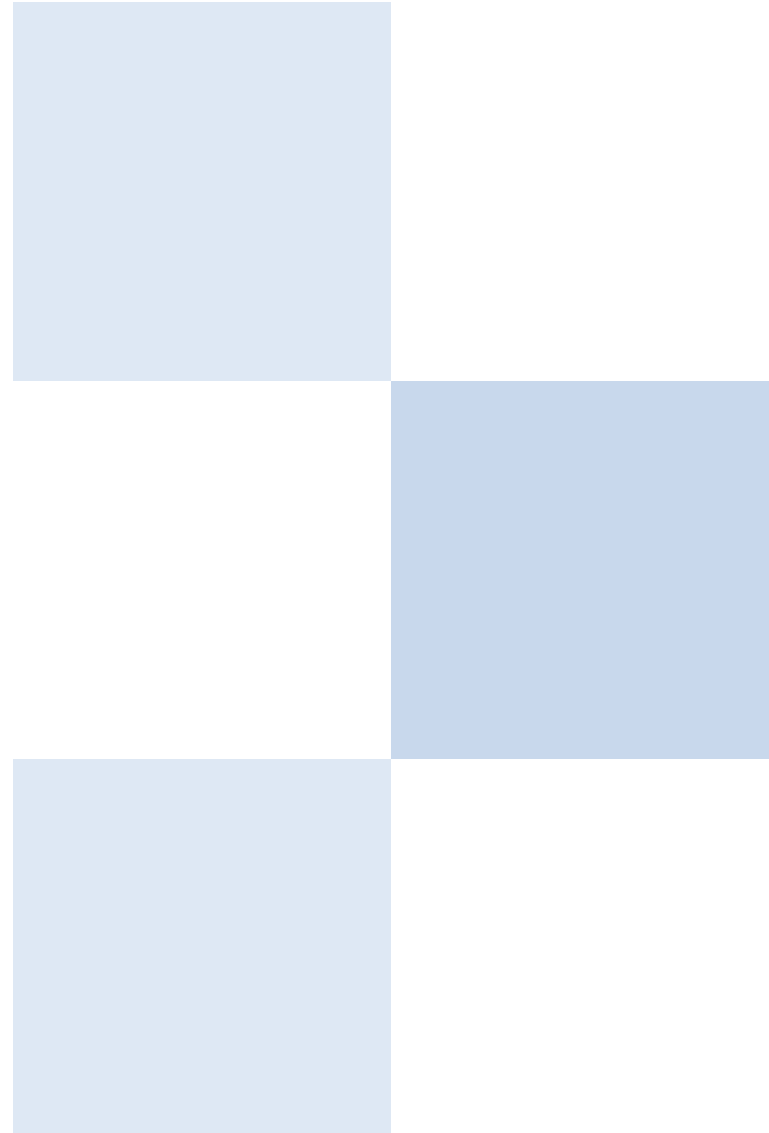
■ From 2005 to 2011, a logical continuation of works

- 2005-2007: steering of the initial third expertise of the mine operating report and closure and follow-up of its progress
- 2007-2011: recommendations for the medium and long term future of former mining and tailing sites in the Limousin area
- 2011-2012: dissemination on results and opinion on the follow-up given to the previous recommendations.



The GEP-mines experience

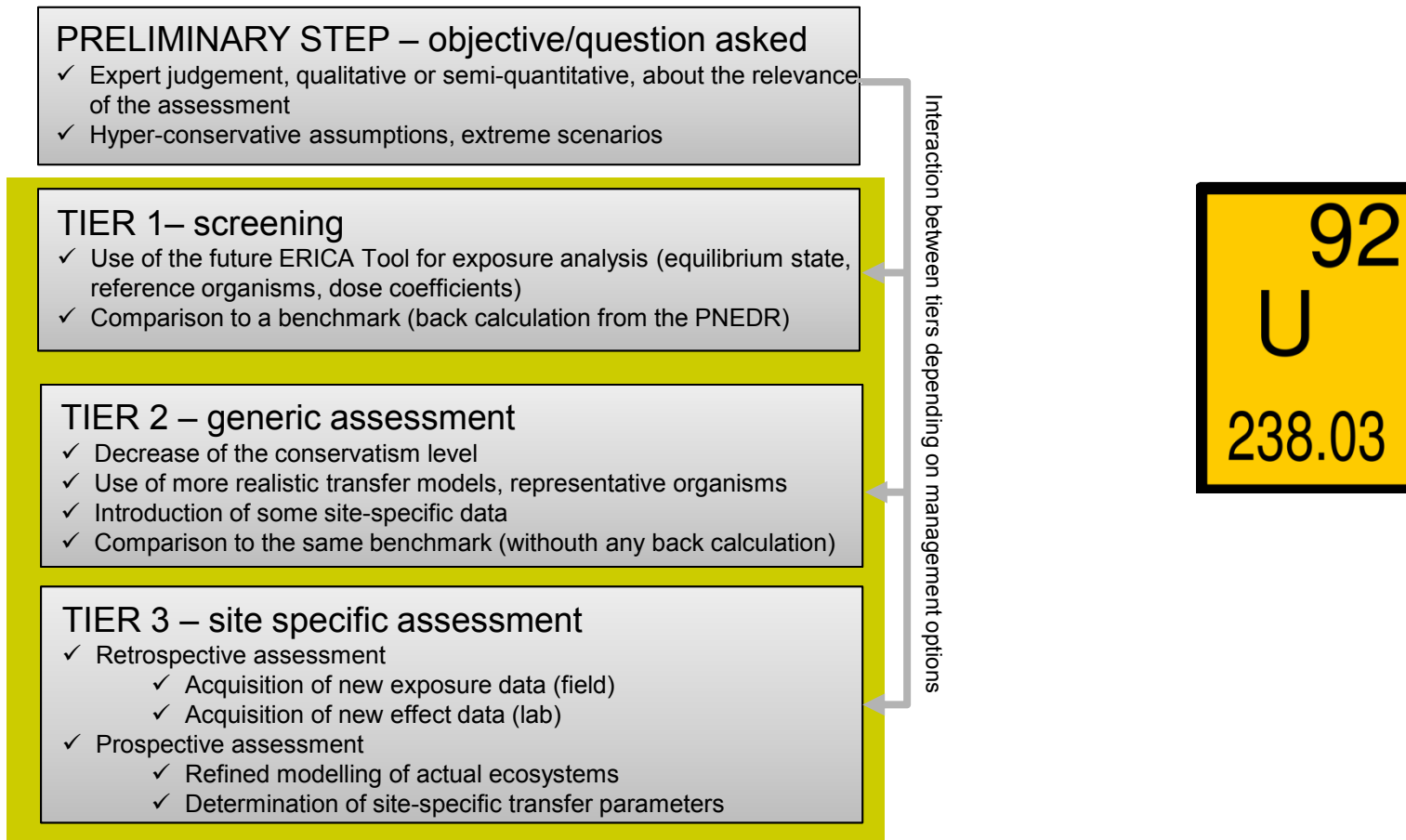
The ERA approach and its application





The ERA, a graded approach

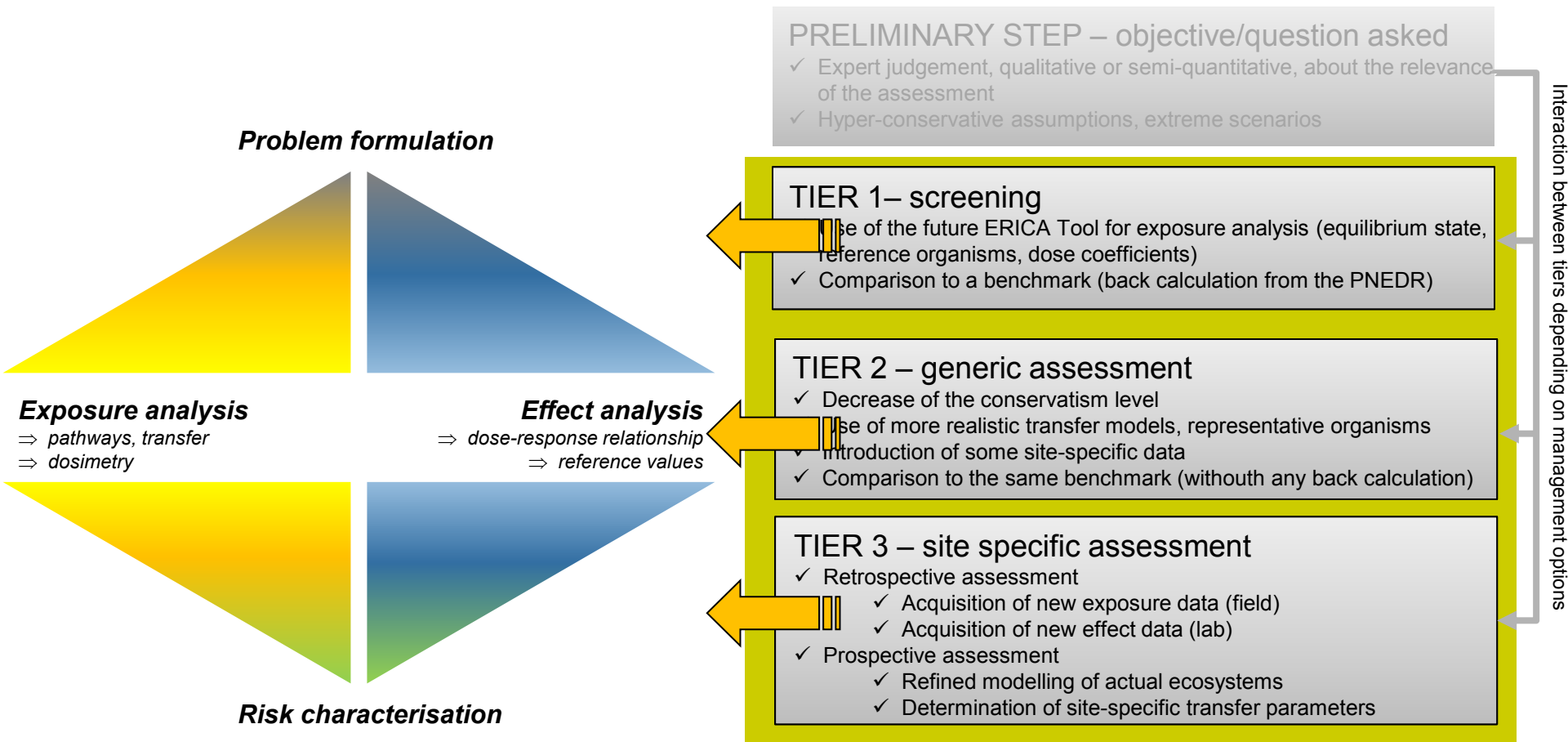
➤ General principles





The ERA, a graded approach

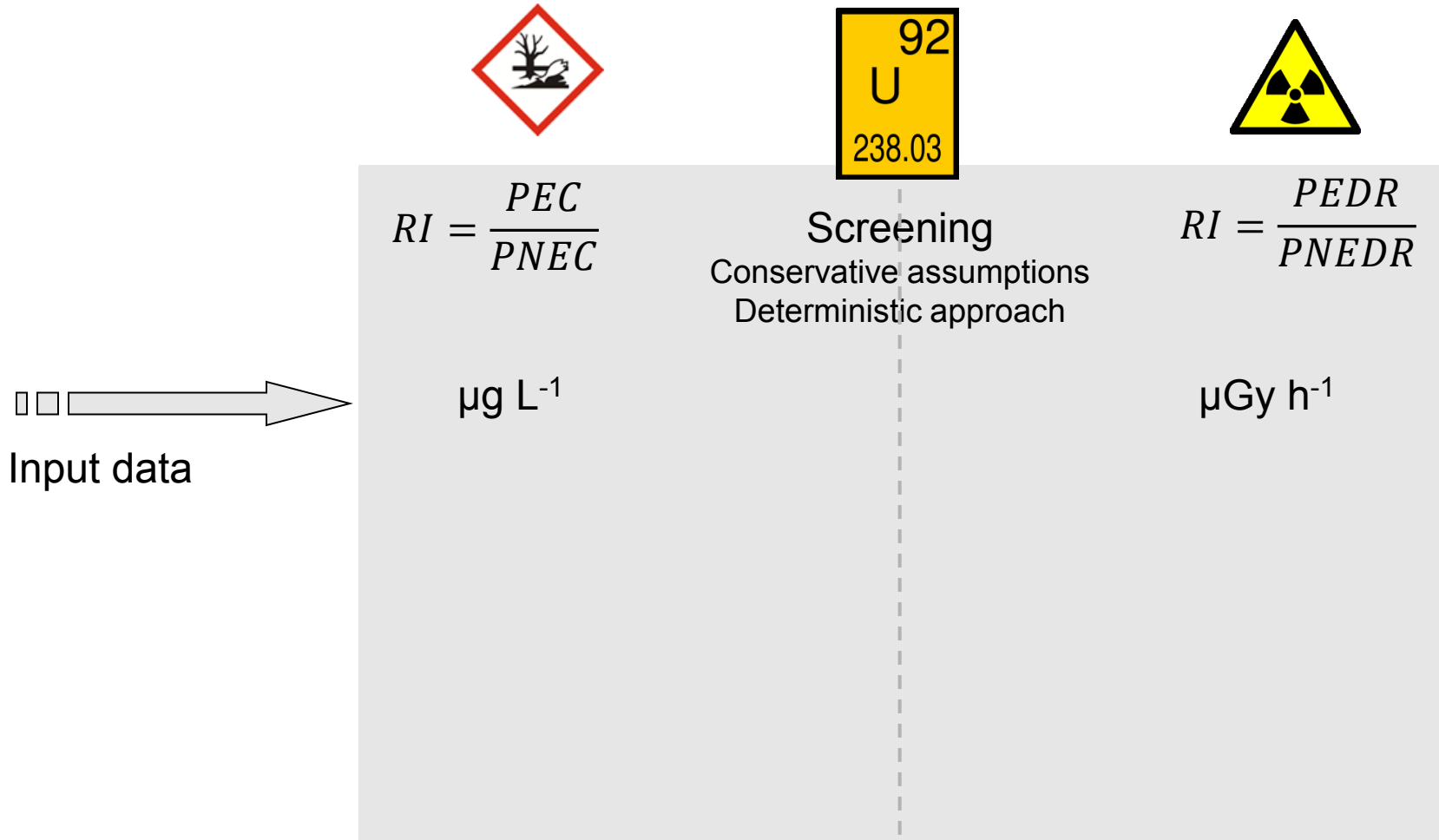
➤ General principles





The ERA, a graded approach

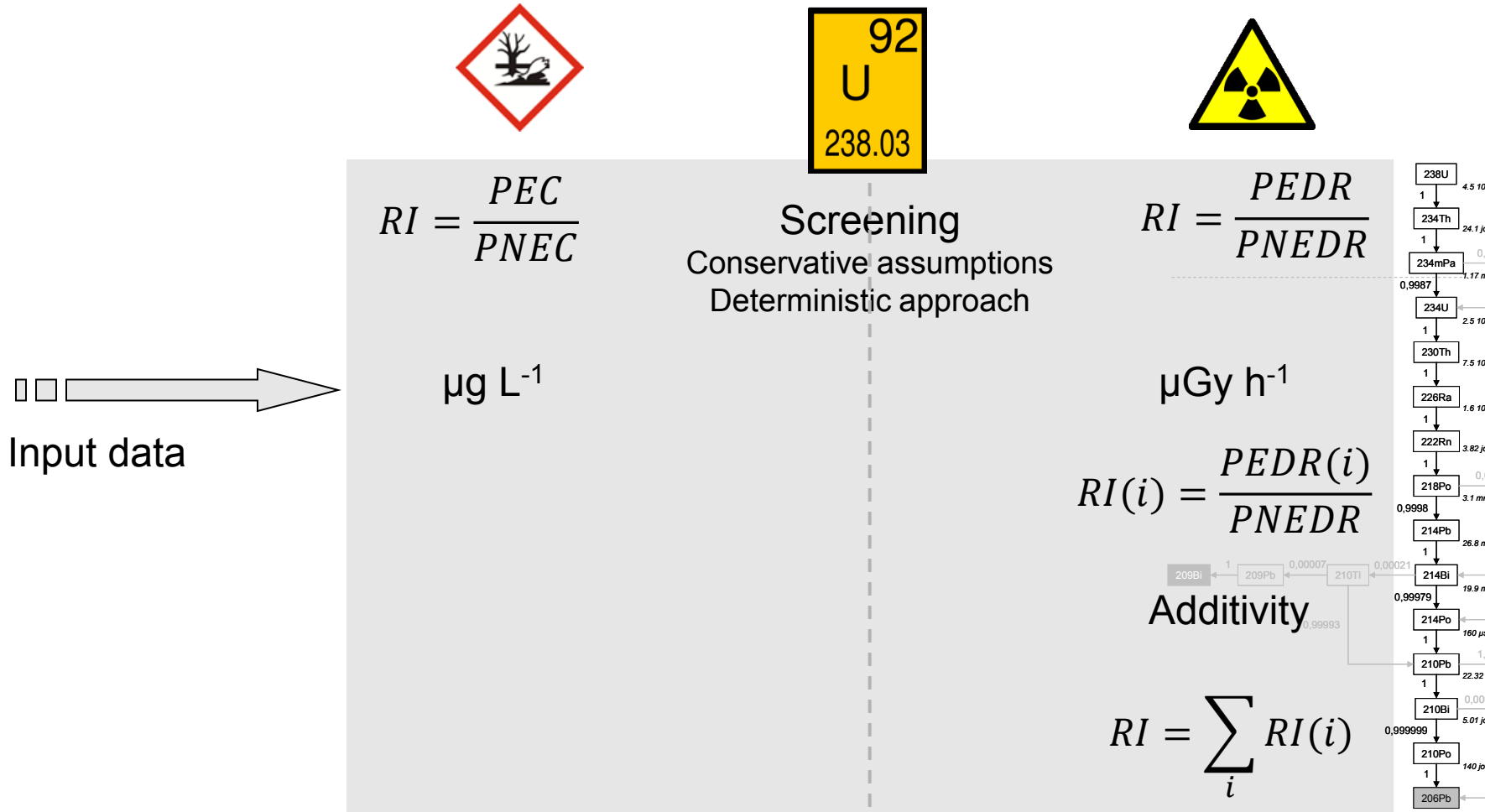
➤ The same approach whatever the kind of toxicity





The ERA, a graded approach

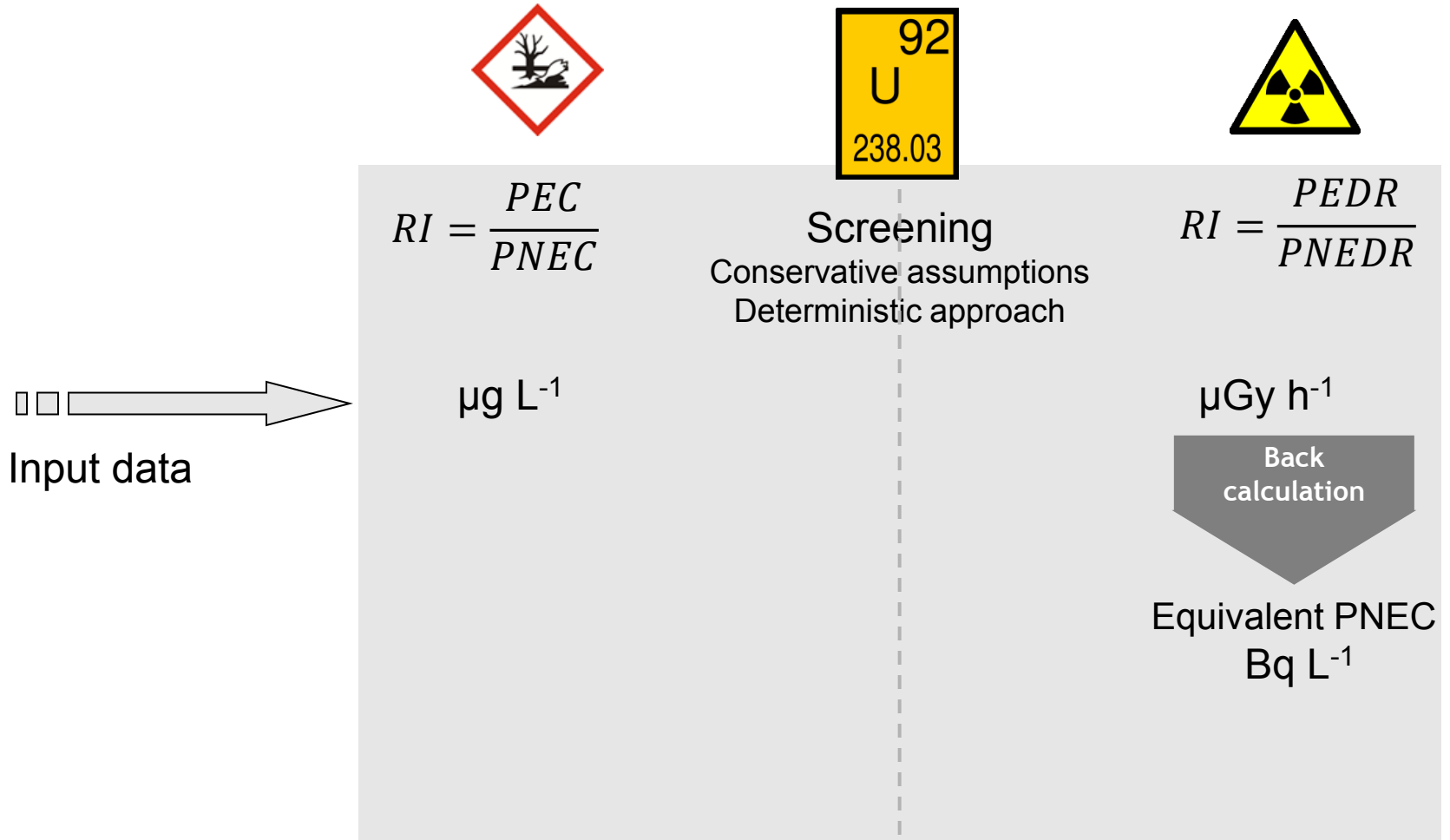
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The ERA, a graded approach

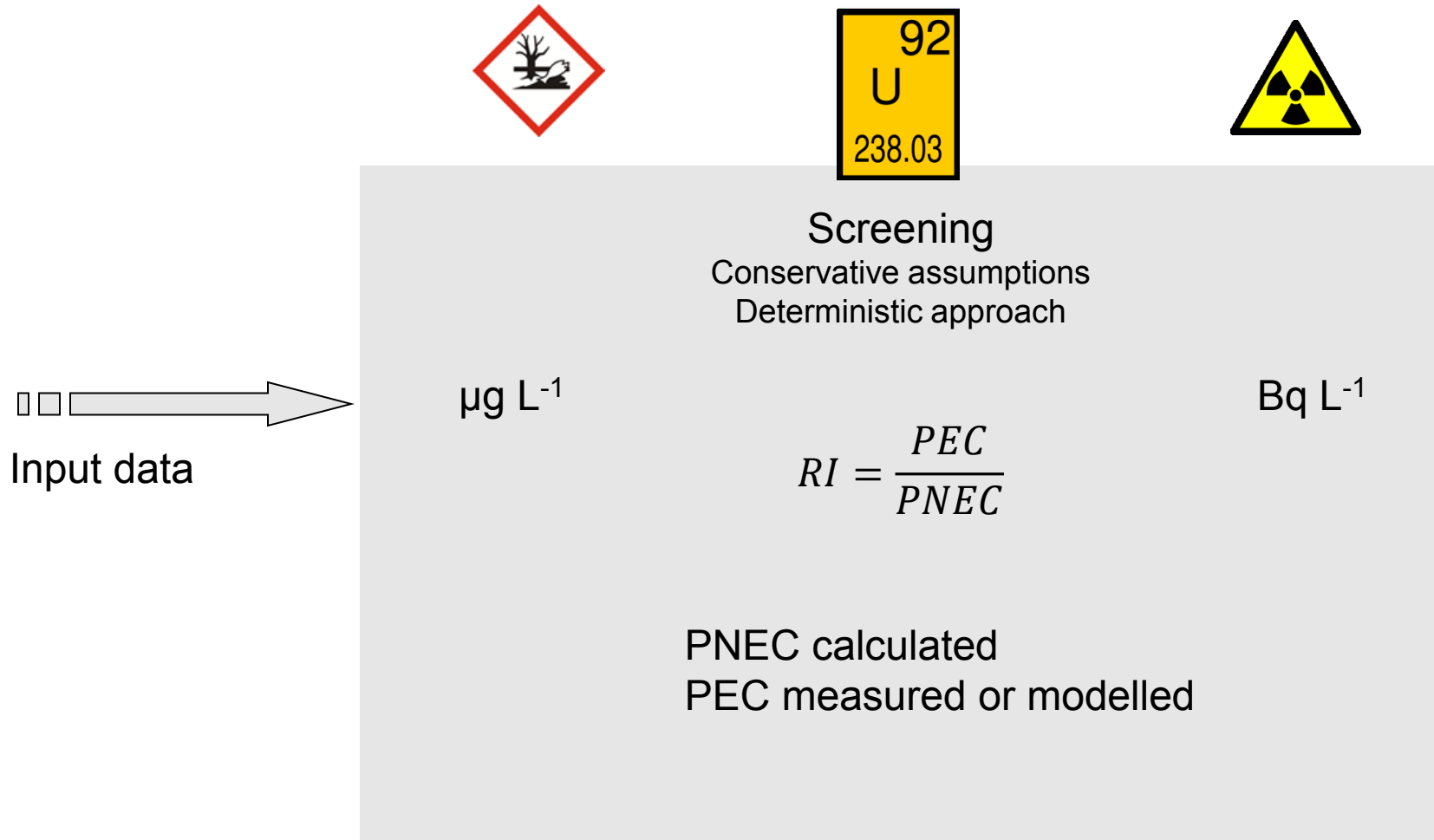
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The ERA, a graded approach

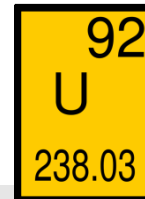
➤ The same approach whatever the kind of toxicity



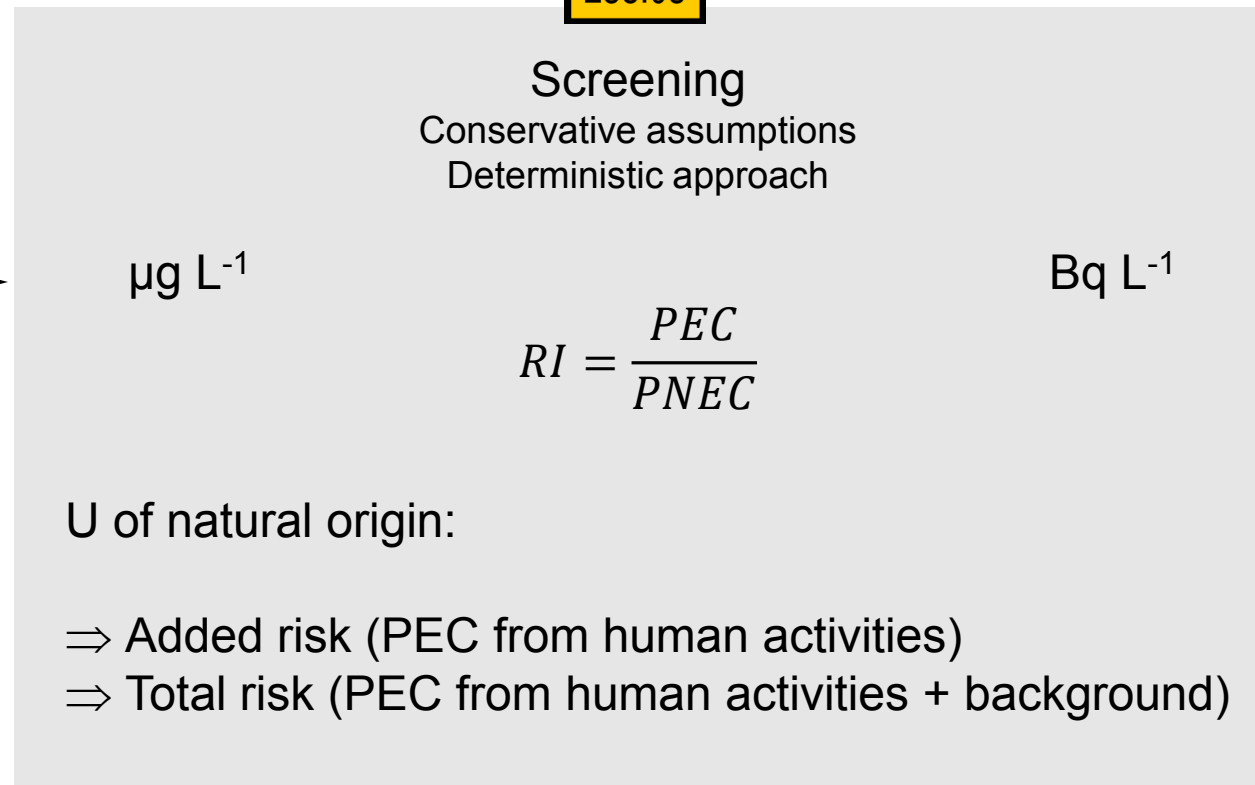


The ERA, a graded approach

➤ The same approach whatever the kind of toxicity



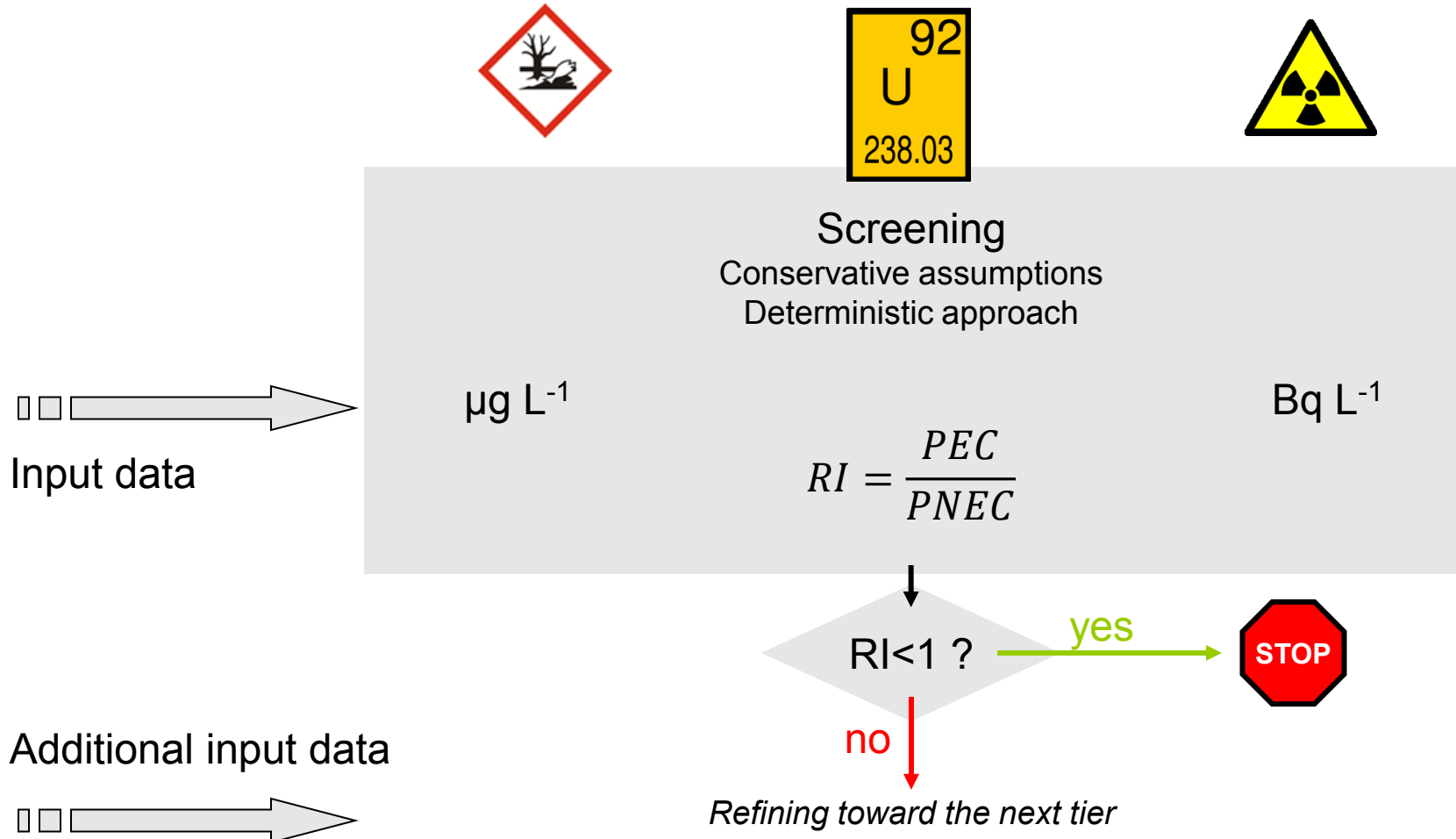
Input data





The ERA, a graded approach

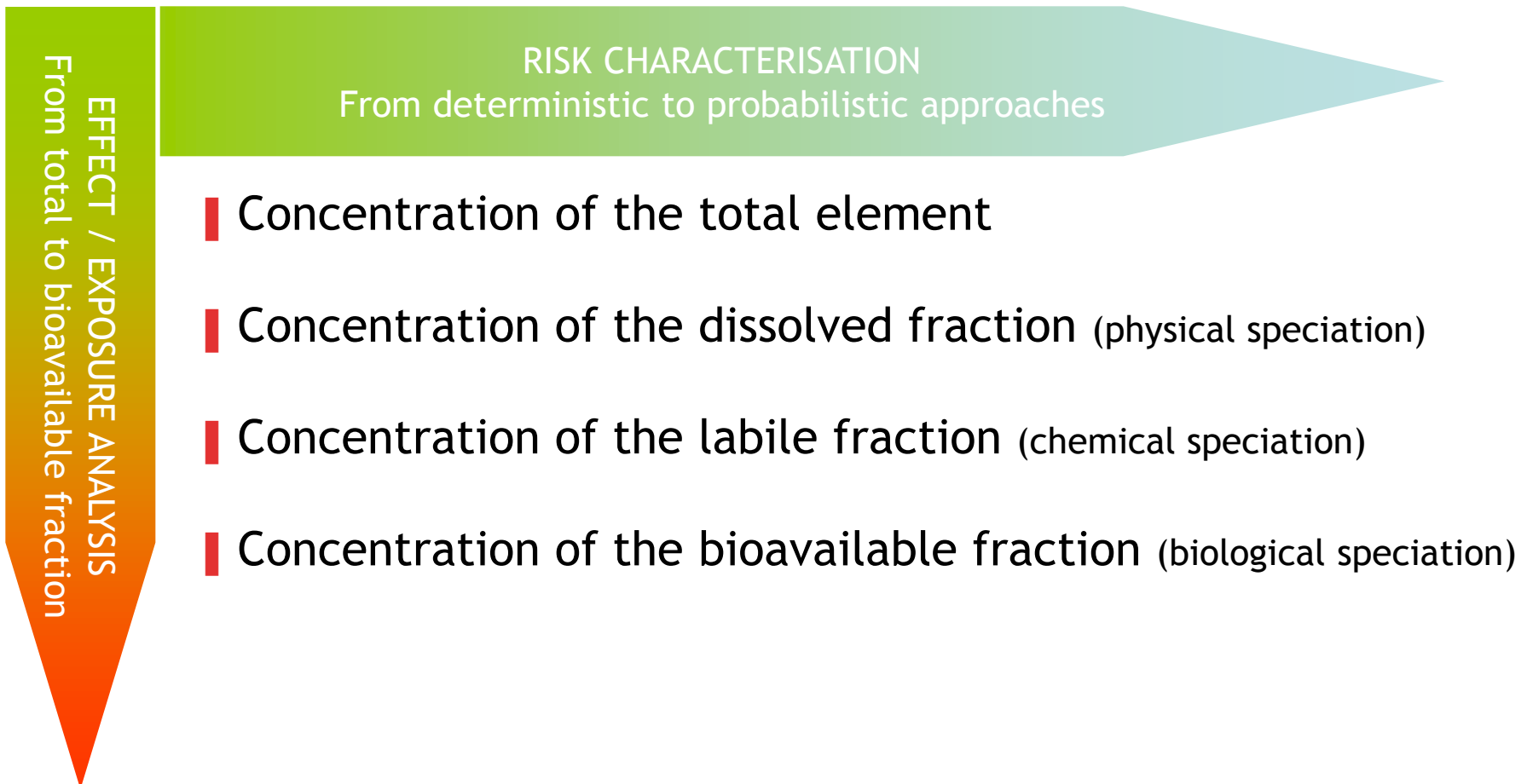
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The ERA, a graded approach

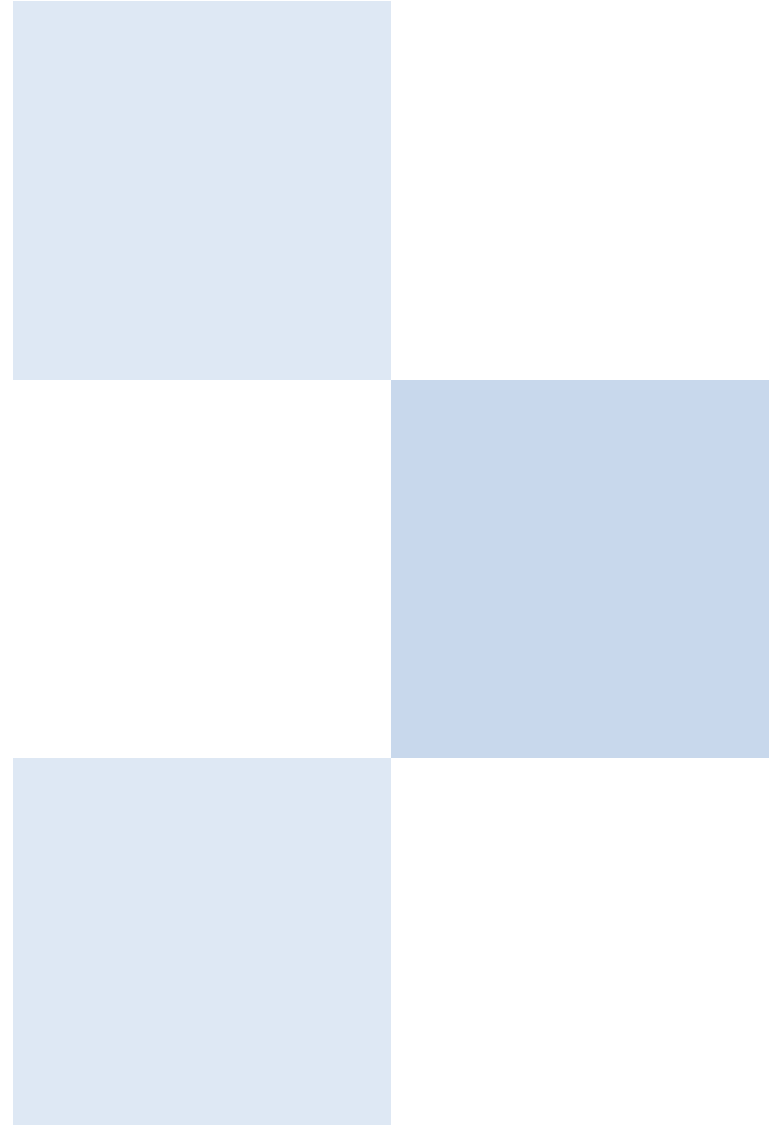
➤ The possible ways of refinement





The GEP-mines experience

Results - screening





The assessment context

➤ **Protecting the ecosystem (structure and functions)**

■ An annual average assessment at the watershed scale

PS

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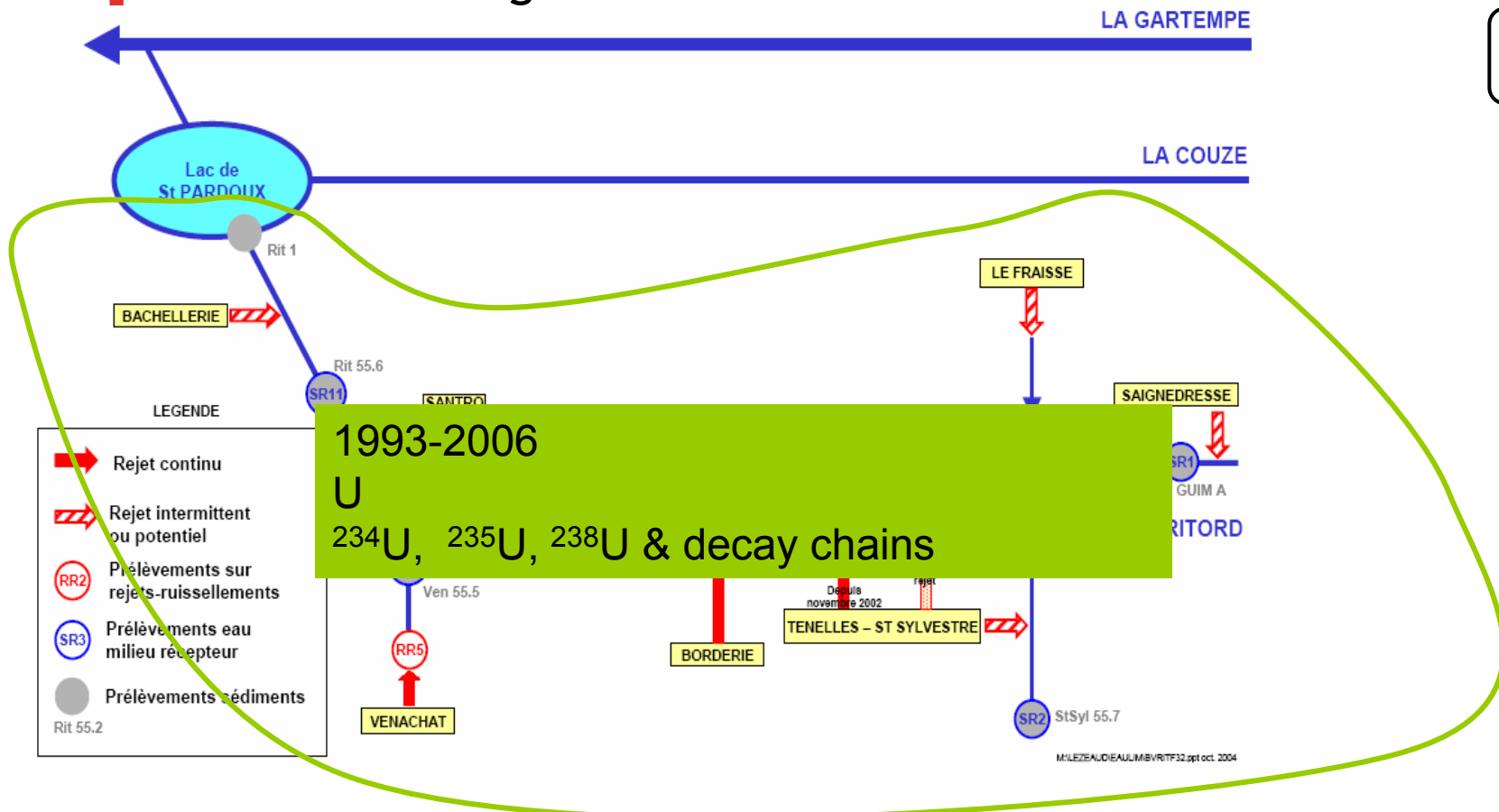
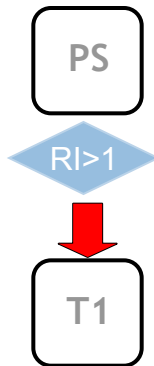
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The assessment context

➔ Protecting the ecosystem (structure and functions)

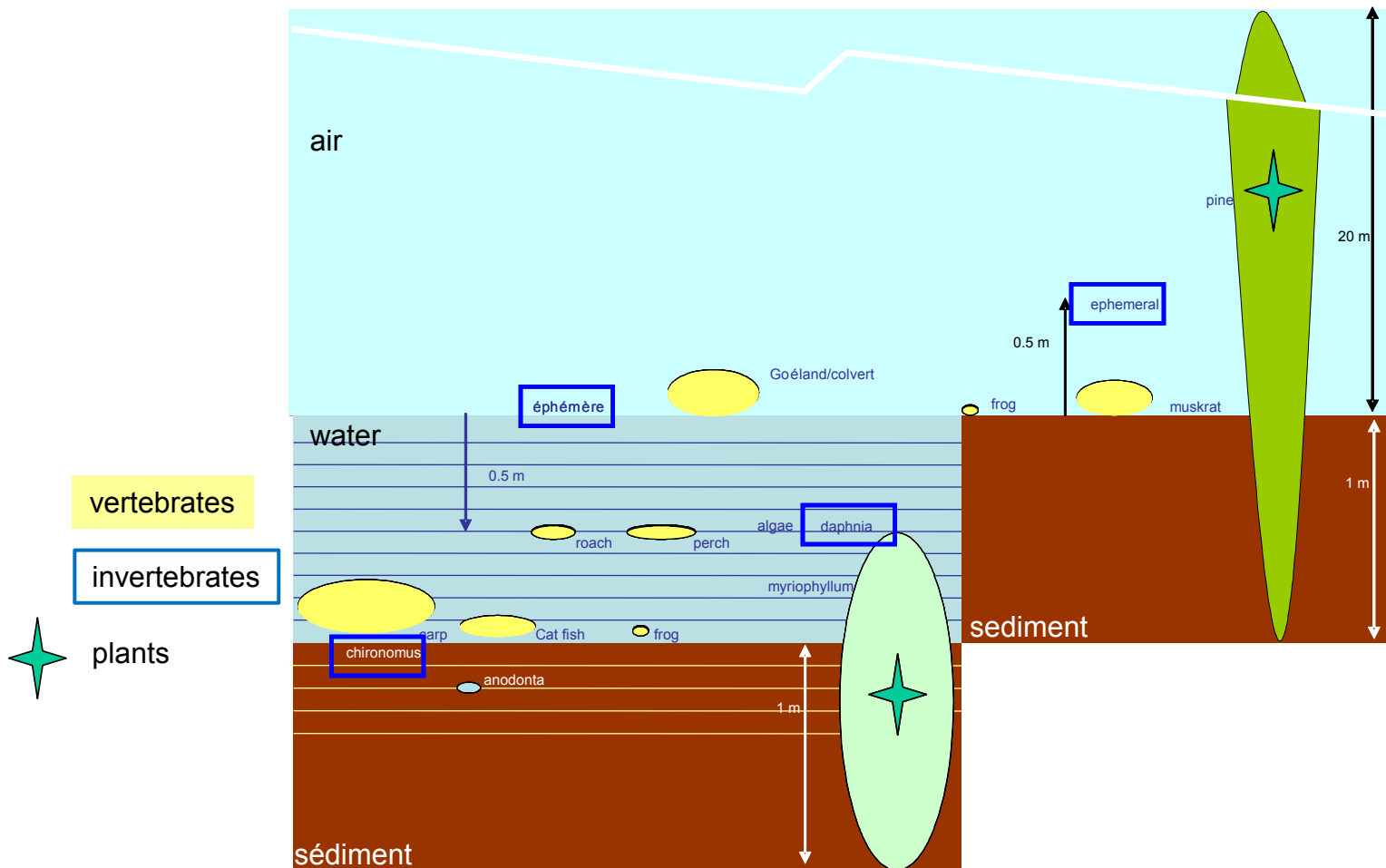
An annual average assessment at the watershed scale





The assessment context

➔ The conceptuel model of ecosystem





Exposure and effects

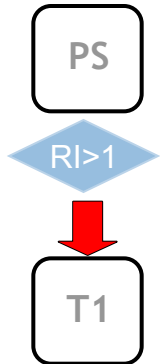
➤ The values we used

█ Exposure

- Water: measurement (annual maximal values)
 - Missing data: extrapolations
 - Decay products at secular equilibrium
 - Ratios between substances when potentially constant
 - ...

Make the most we can of the available data

- Sediment and biota: modelling at equilibrium
 - Use of the K_d approach
 - Use of Concentration Ratios





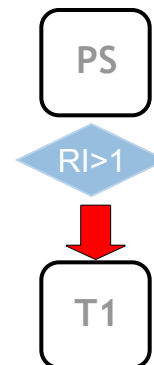
Exposure and effects

➤ The values we used

█ Exposure

█ Effects

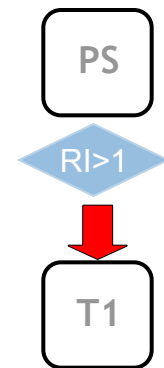
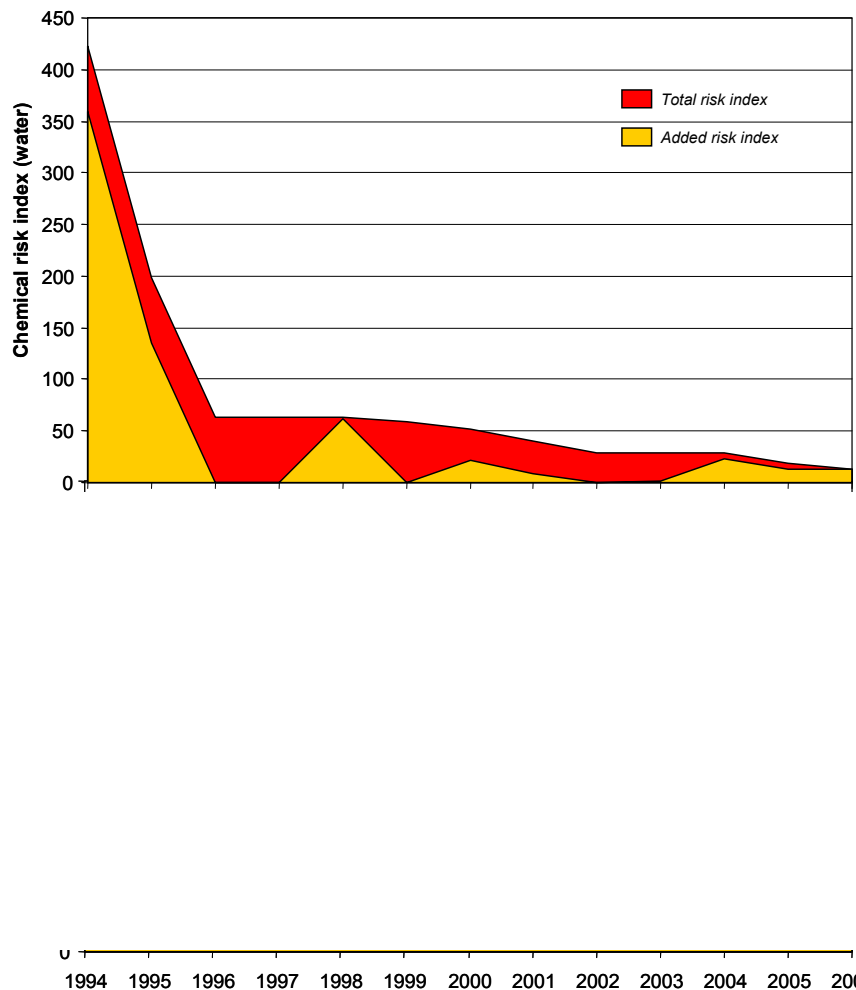
- Favor the most robust methods (=> SSDs)
- PNEC for freshwater: $3 \mu\text{g L}^{-1}$ in total U, site specific
- PNEDR for ecosystem: $10 \mu\text{Gy h}^{-1}$ for all RNs (from scientific consensus)





Risk characterisation

➔ A deterministic approach





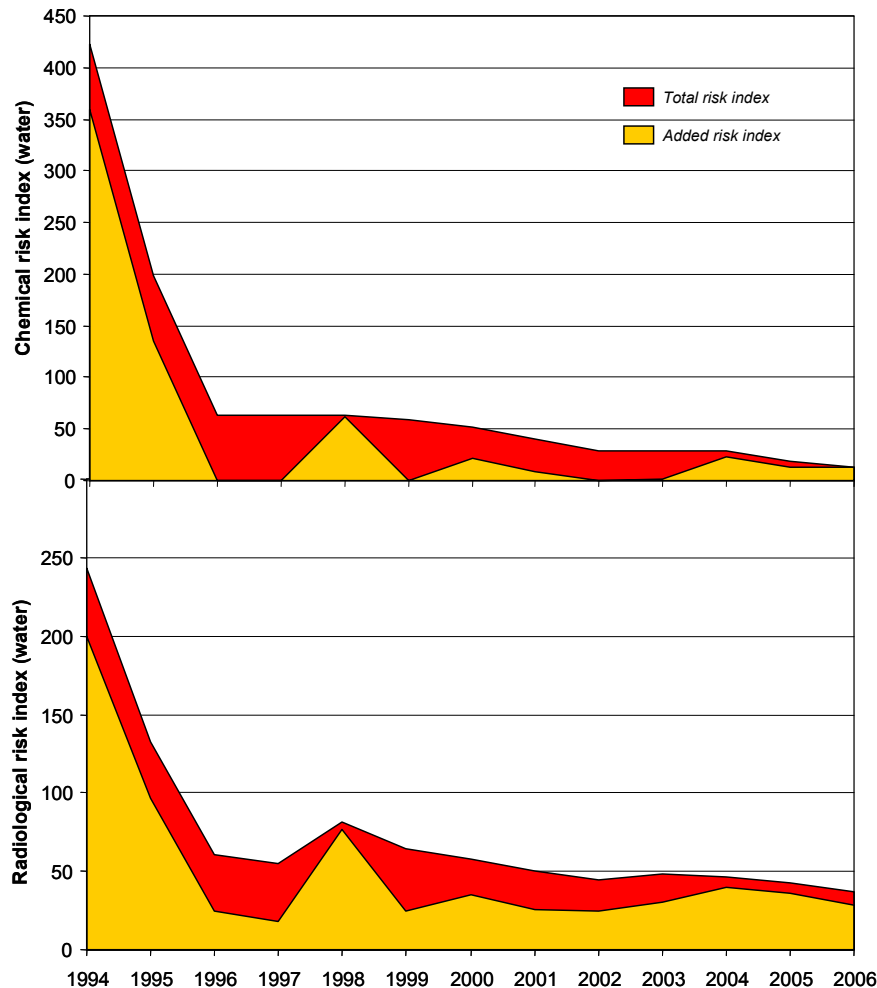
Risk characterisation

➔ A deterministic approach

PS

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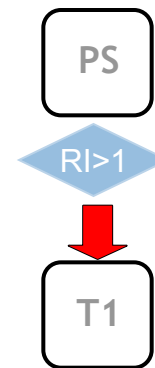




Screening conclusion

➔ A contrasted situation

	Water	Sediment
		n.a

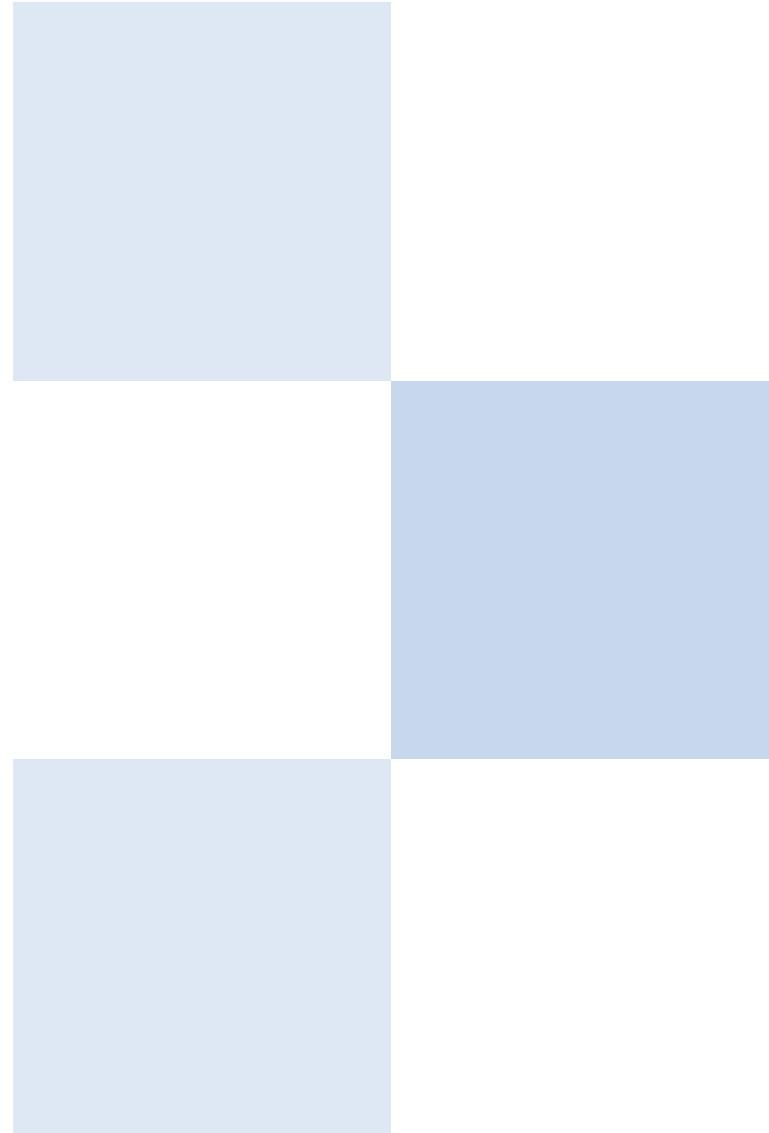


➔ Tier 2 for water!



The GEP-mines experience

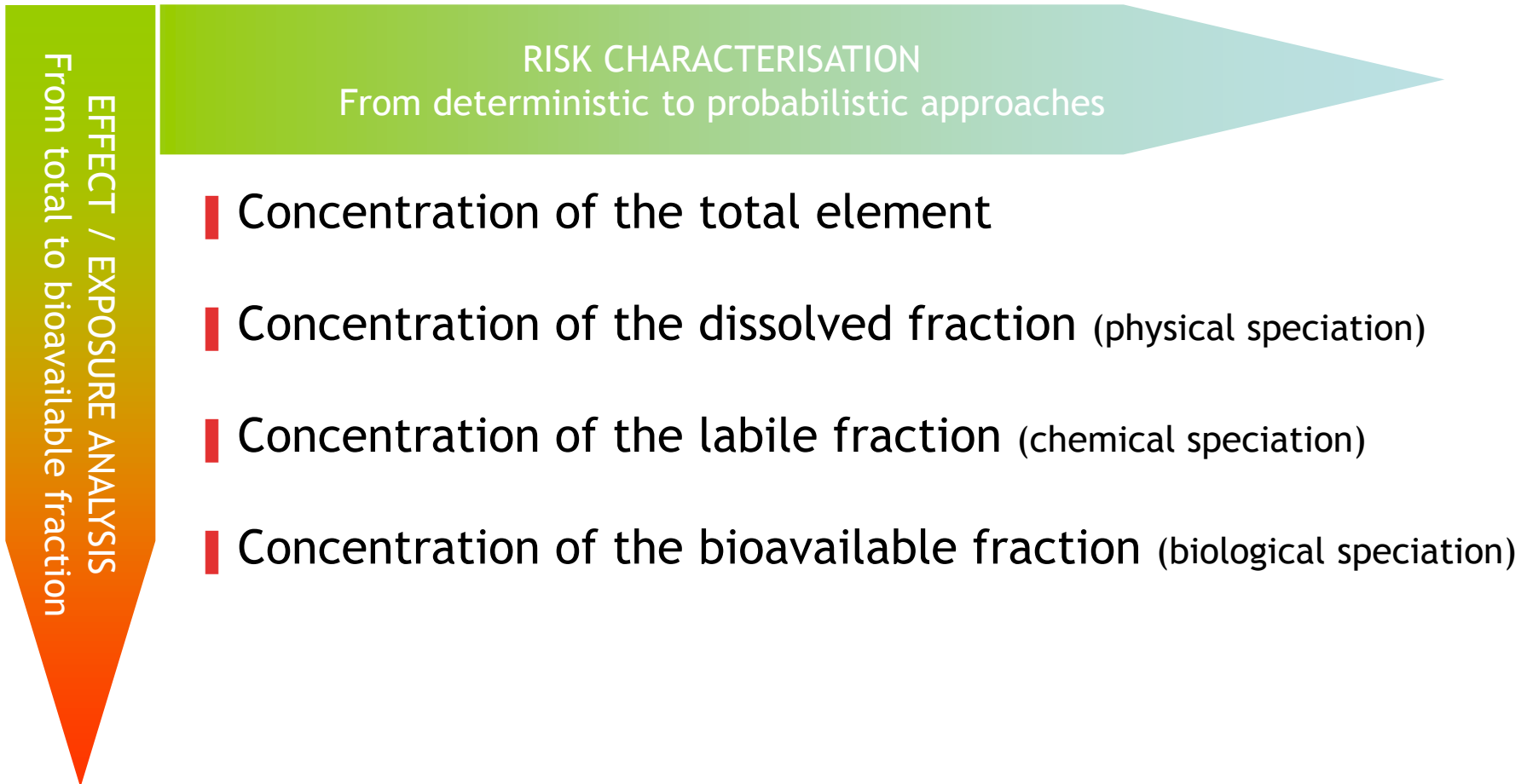
Results - tier 2





Which refinement at this mid stage?

➤ Playing with both axes





Which refinement at this mid stage?

➤ Playing with both axes

RISK CHARACTERISATION

From deterministic to probabilistic approaches

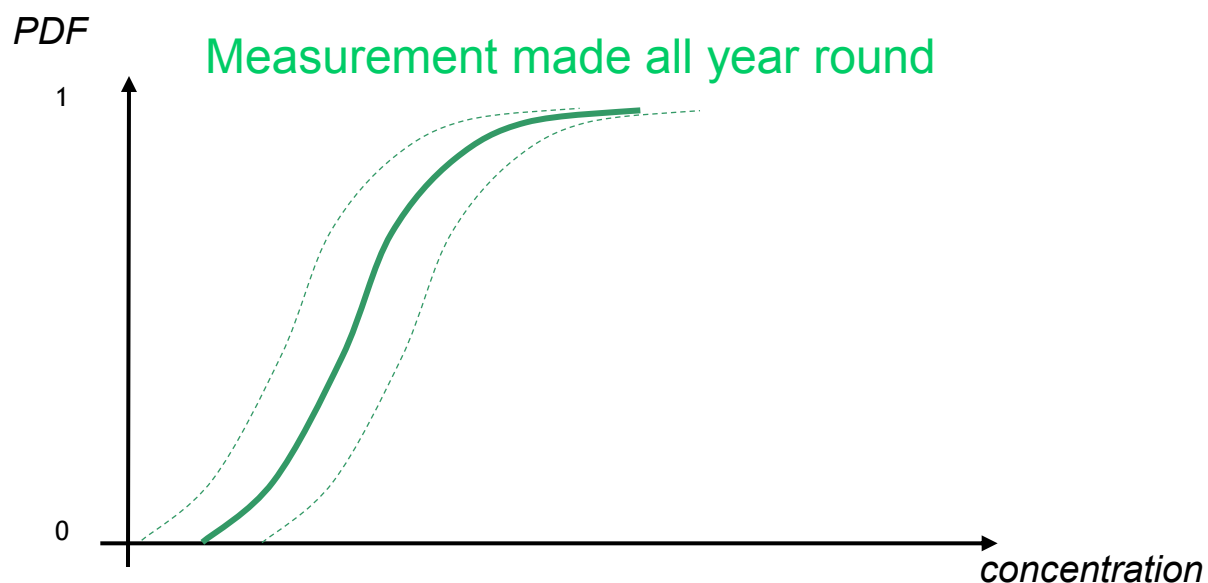
- Concentration of the total element
- Concentration of the dissolved fraction (physical speciation)
- Concentration of the labile fraction (chemical speciation)
- Concentration of the bioavailable fraction (biological speciation)

EFFECT / EXPOSURE ANALYSIS
From total to bioavailable fraction



Probabilistic risk characterization

➔ Use of all the available data



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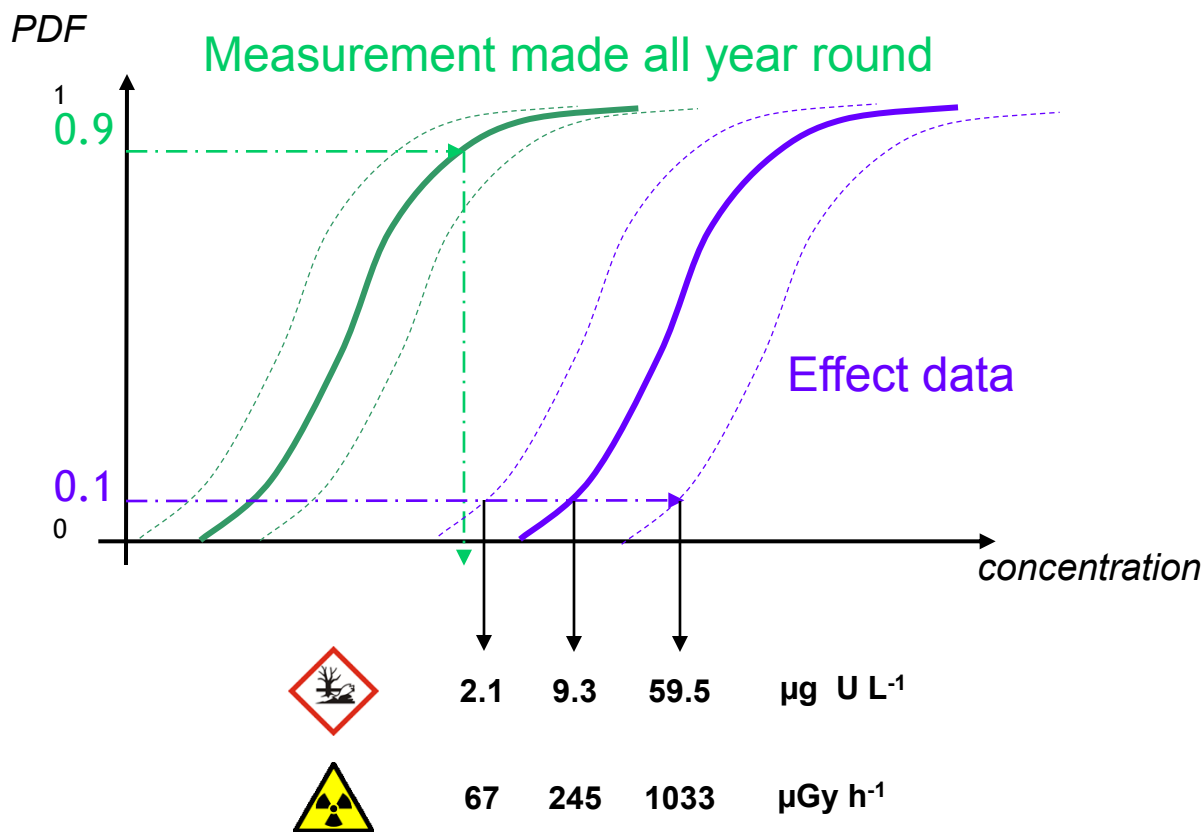
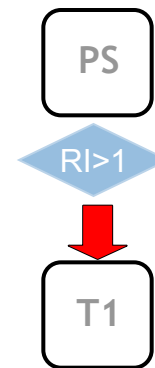
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Probabilistic risk characterization

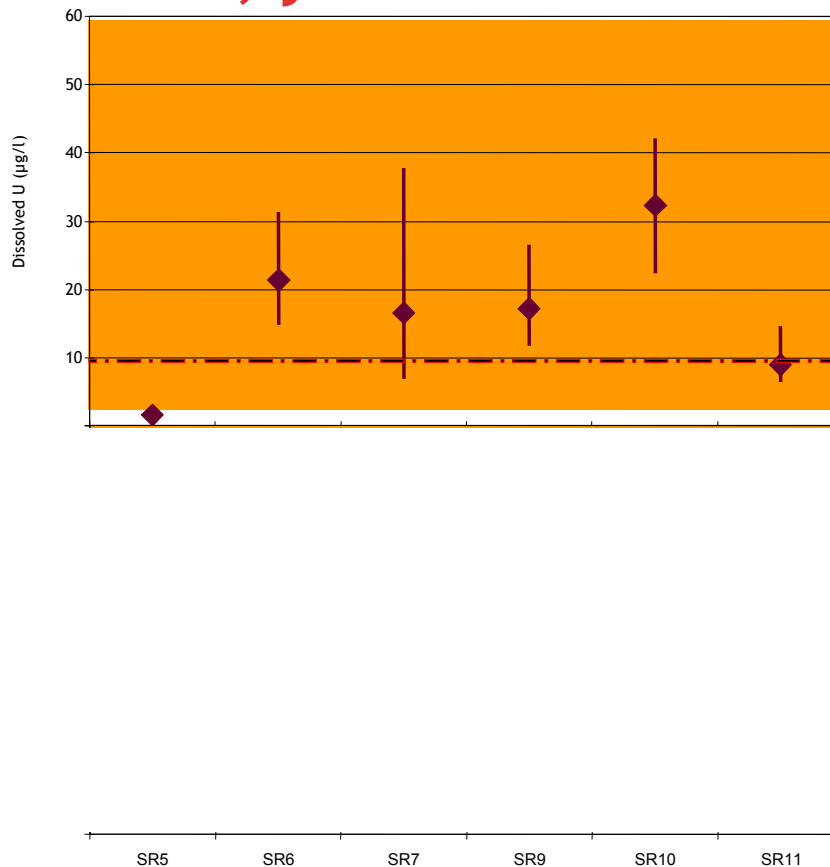
➔ Use of all the available data





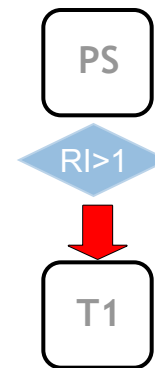
Probabilistic risk characterization

➔ Exposure to water, year 2006



Effect data : 10th percentile (concentration ; dose rate)
 95% confidence interval

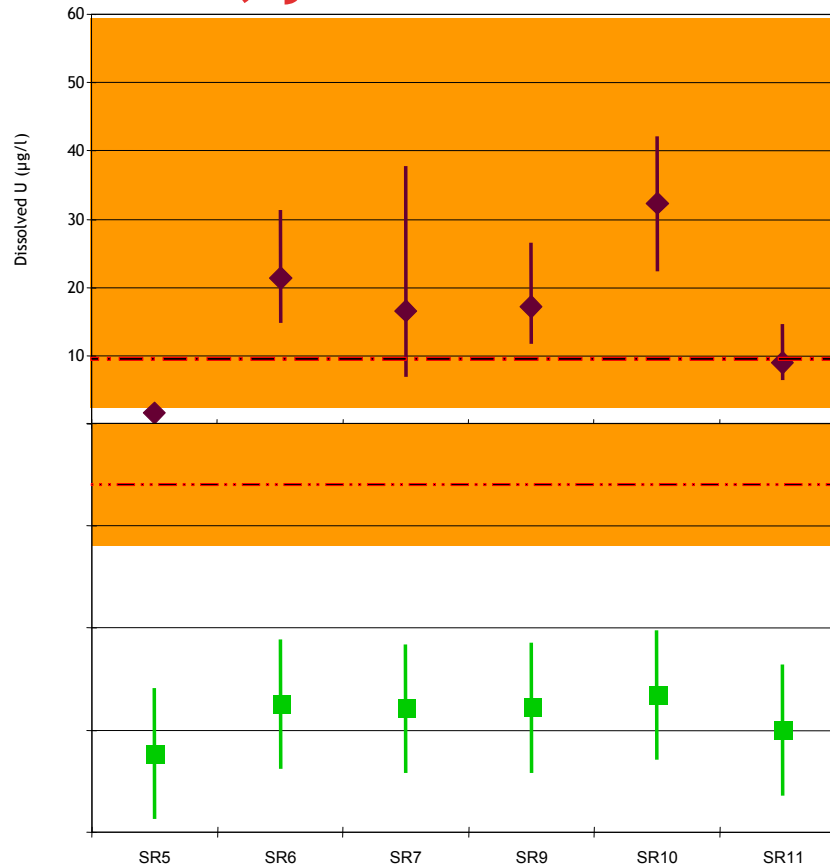
Exposure data : symbol () 90th percentile
 bar 95% confidence interval



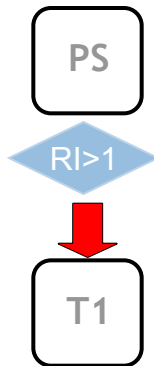


Probabilistic risk characterization

➔ Exposure to water, year 2006



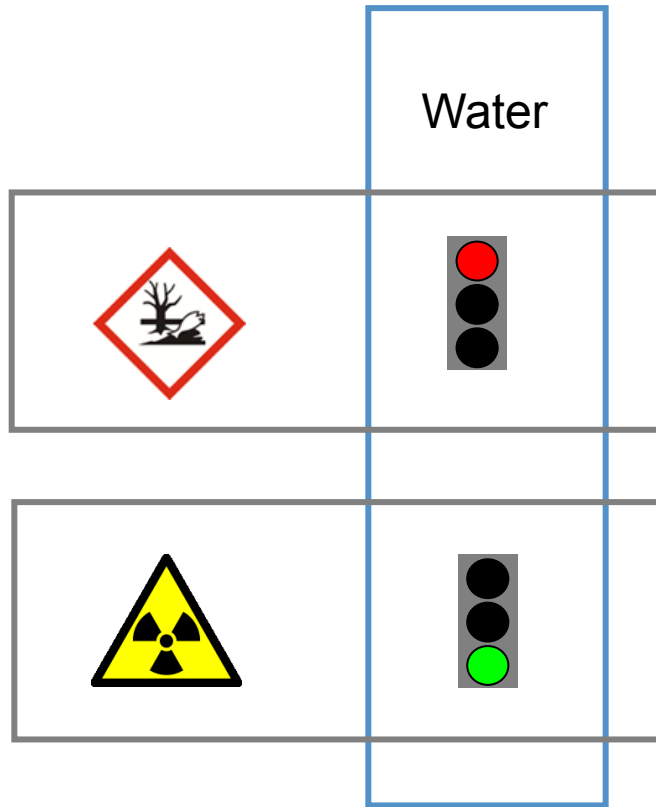
Effect data : 10th percentile (concentration - - - ; dose rate - . . .)
 95% confidence interval [shaded orange bar]
 Exposure data : symbol (◆■) 90th percentile
 bar 95% confidence interval





Probabilistic risk characterization

➔ Exposure to water, year 2006



➔ Tier 3 for chemotoxicity in water!

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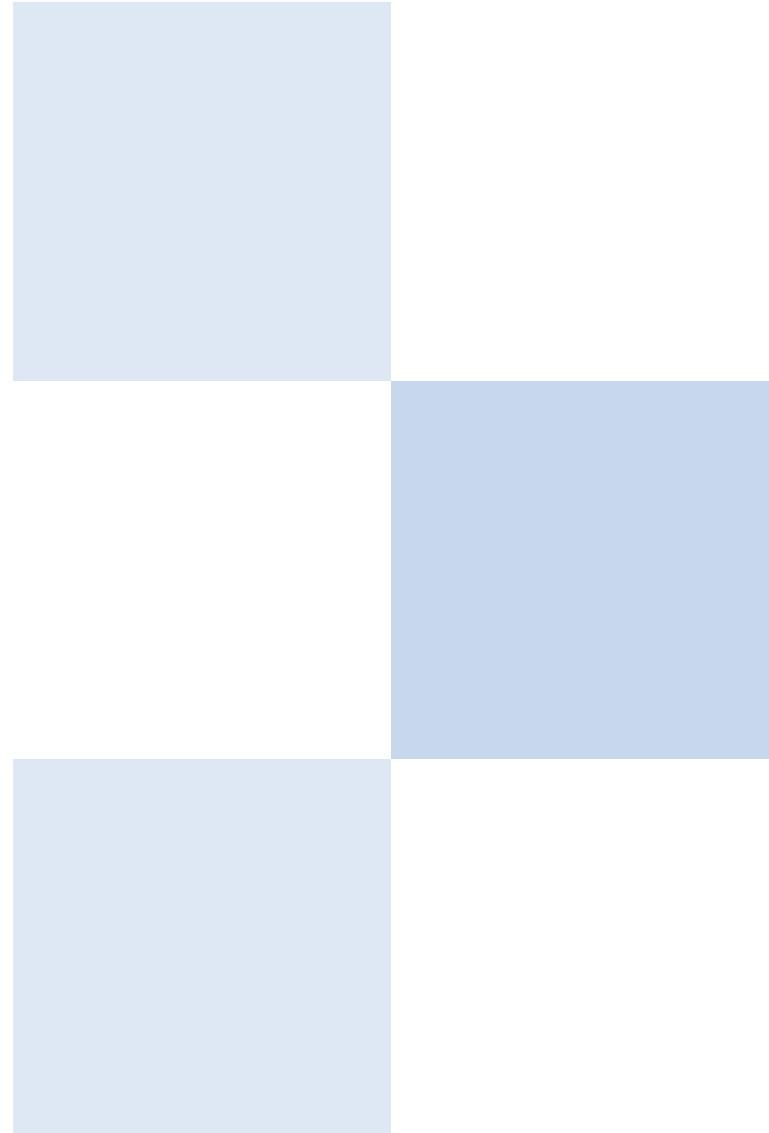
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The GEP-mines experience

Results - tier 3





Which refinement at this last stage?

➤ Playing with speciation

RISK CHARACTERISATION

From deterministic to probabilistic approaches

- Concentration of the total element
- Concentration of the dissolved fraction (physical speciation)
- Concentration of the labile fraction (chemical speciation)
- Concentration of the bioavailable fraction (biological speciation)

EFFECT / EXPOSURE ANALYSIS
From total to bioavailable fraction



Which refinement at this last stage?

➤ Playing with speciation

RISK CHARACTERISATION

From deterministic to probabilistic approaches

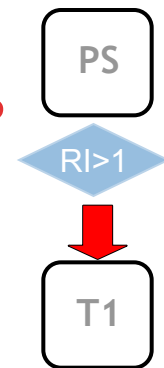
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EFFECT / EXPOSURE ANALYSIS
From total to bioavailable fraction



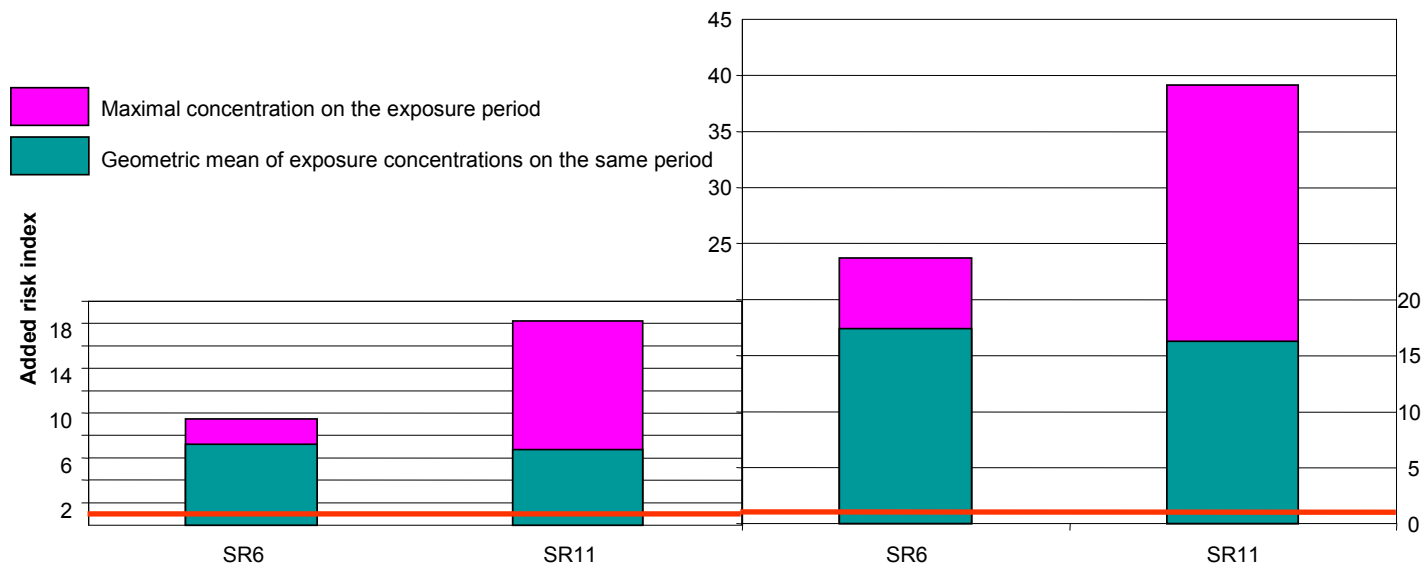
Chemical speciation

➔ Thermodynamic modelling: which species available?



Assumption 1 (2 species)

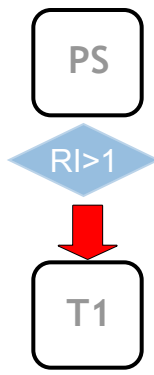
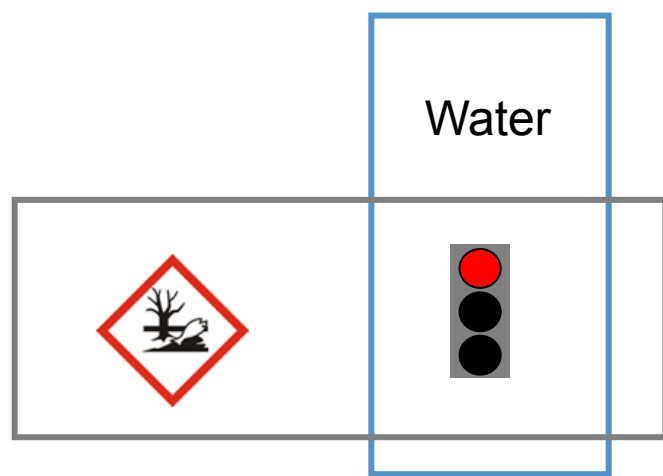
Assumption 2 (4 species)





Risk characterization

➔ A persistent risk

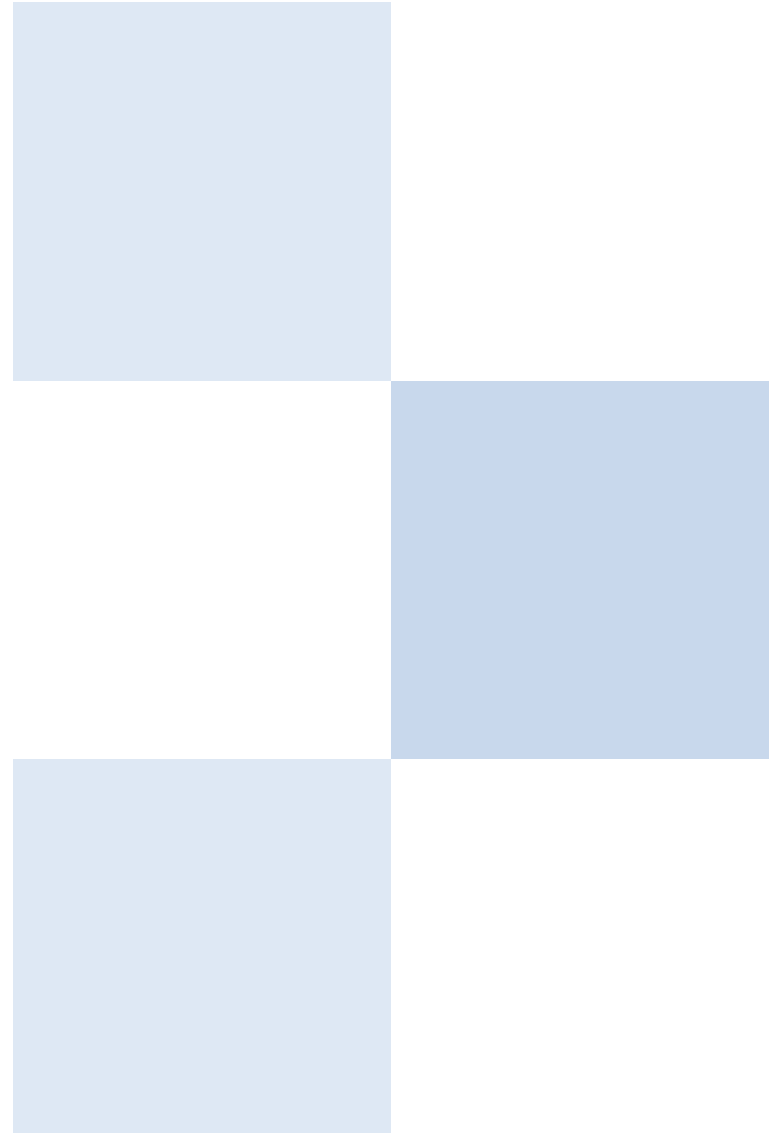


➔ Conclusions ?



The GEP-mines experience

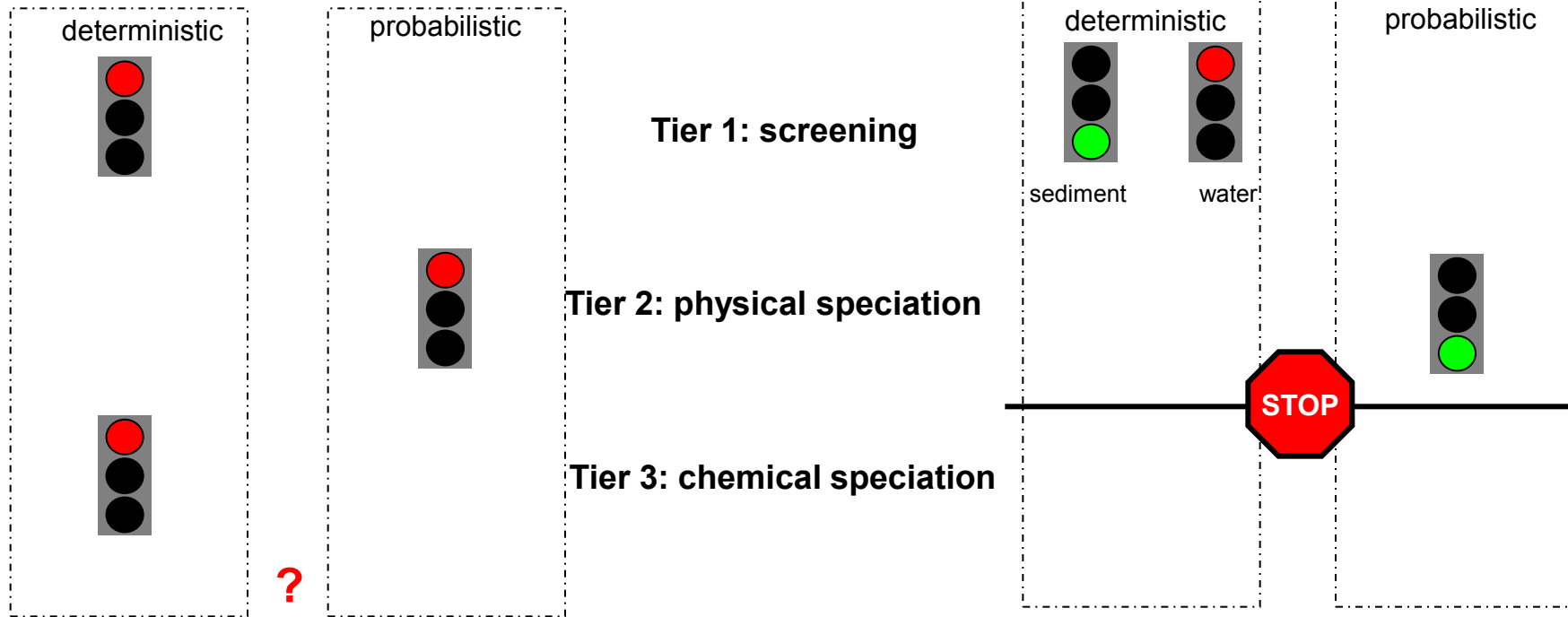
Conclusions



Summary

Chemotoxicity

Radiotoxicity



Some recommendations

➤ A persistent risk

- Application of the method => exhaustive inventory
 - Stressors (stable substances/radionuclides, others?)
 - Exposure media (water AND sediments for all stressors)
 - Exposure pathways (internal, external - contact, distance)
- Complementary data to acquire
 - To characterize the background
 - To characterize the state of decay chains (equilibrium?)
 - To characterize local ecosystems (species of interest)
 - To characterize the U speciation (physico-chemical data)
- Needs in terms of research & development
 - Quantification of labile forms of uranium
 - Which relationship between labile forms and ecotoxicity of the metal?
 - Uranium ecotoxicity in sediments



Ritord watershed, Haute Vienne (France)

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