THE ROLE OF BIOAVAILABILITY IN RISK REDUCTION OF CONTAMINATED SITES

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How to handle the 3,000,000 contaminated sites in the world

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Traditional approach

- Suspected site (Problem)
  - Sampling and analysis
- Assessment
  - Compare with target
  - Human and ecological risks
- Solution
  - Remediation (removal of soil)
  - Treatment on special sites (thermal treatment)

- Logistic problems
- Sampling
- Analysis

- Insufficient or not the proper data

- Logistic problems
- Distance
- Costs

- Not available
- costs

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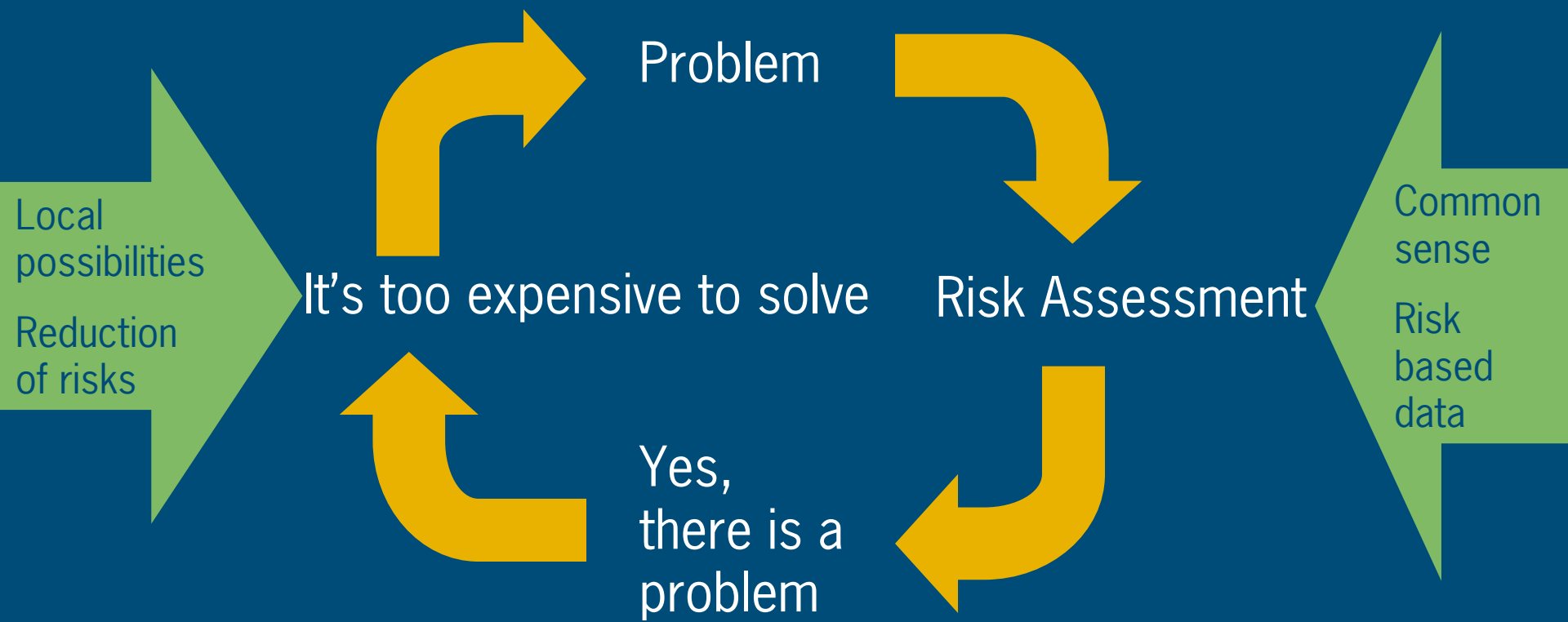
The assessment circle



Bioavailability

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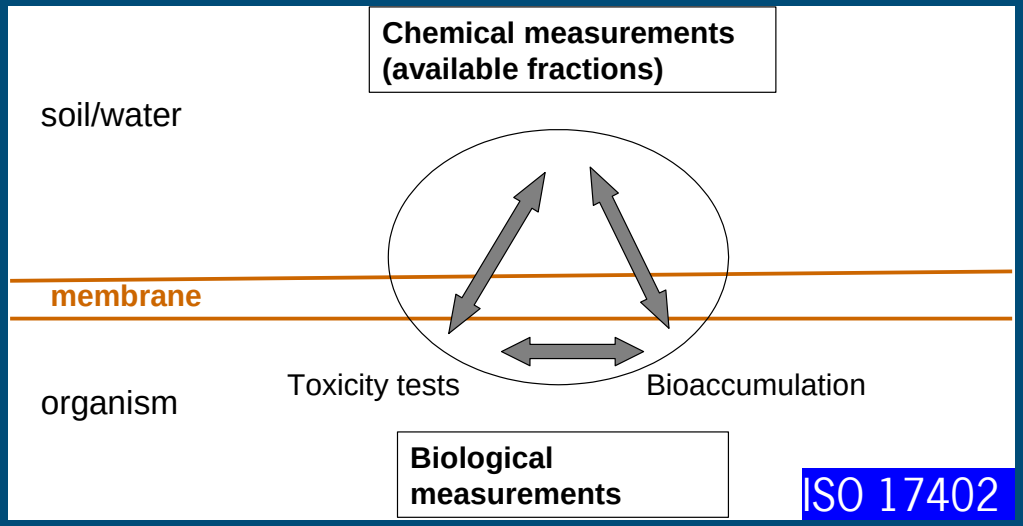
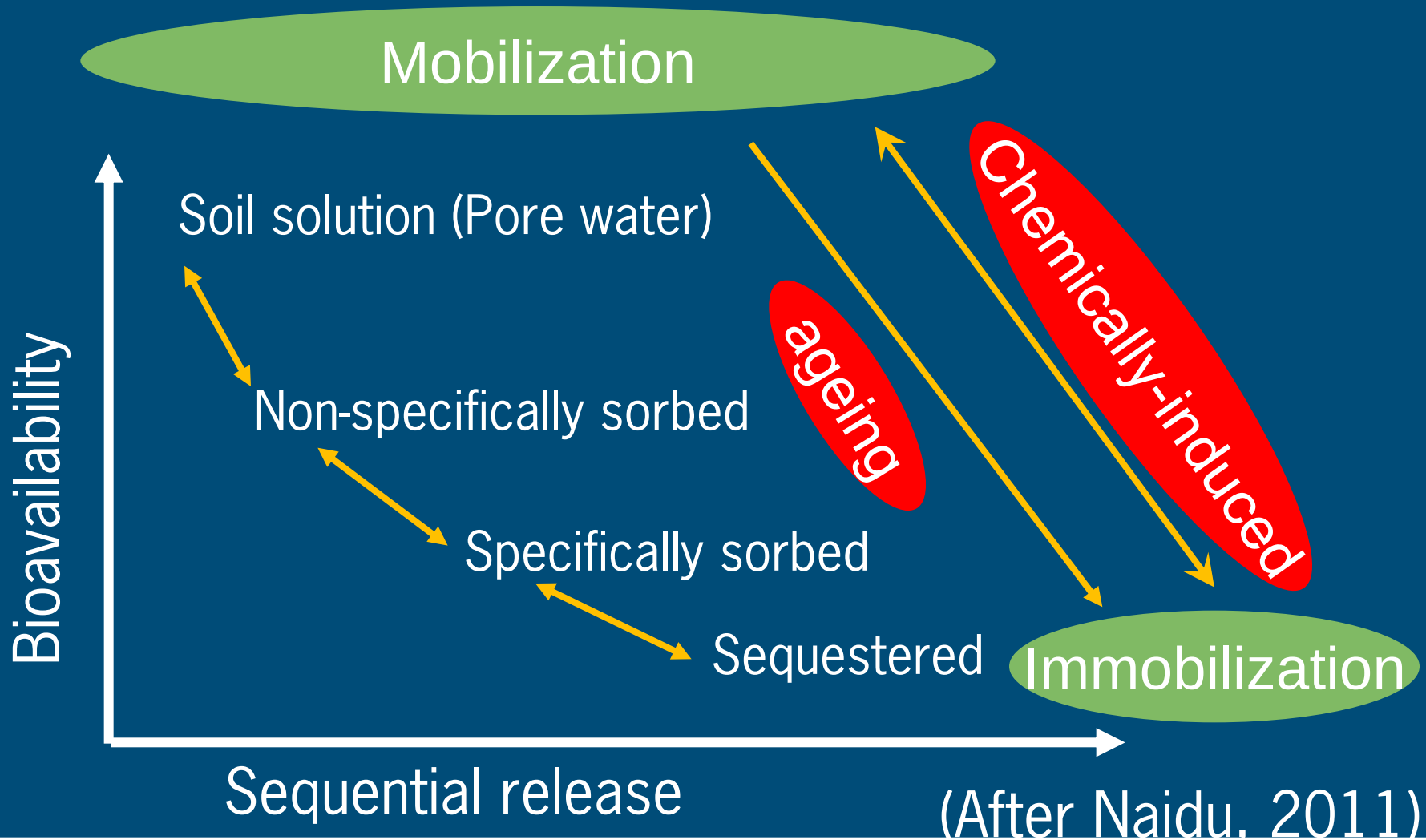
What is Bioavailability?



Dynamics of bioavailability



How can Bioavailability Make a Difference?

- If contaminants are not physically accessible, or chemically or biologically available, they should not be included in the calculation of risk
- Can optimize the extent of cleanup required to be protective
- Can provide optimization of remedial approach and cost
- Can be an important factor in balancing the risks caused by remedial action

Situation in 2012 - Better understanding

- Bioavailable part is causing risks
  - Bioavailable part can be measured (ISO 17402)
- Actual available (concentration in pore water)
  - Heavy metals (0.001 M $CaCl_2$)
  - POP's (Passive sampling)
- Potential available (amount in equilibrium with pore water, reactive fraction)
  - Heavy metals (0.43 M HNO_3)
  - POP's (Tenax, Cyclodextrine)
- Models on fate of contaminants including availability

Fate of POP's

- Limited solubility
- Adsorption mainly to organic matter
- Most are biodegradable
  - Important exceptions DDD, DDE, Dieldrin, PFOS

PAH degradation in sediments Kreekraksluizen

Landfarming Change of conditions:
Anaerobic > Aerobic

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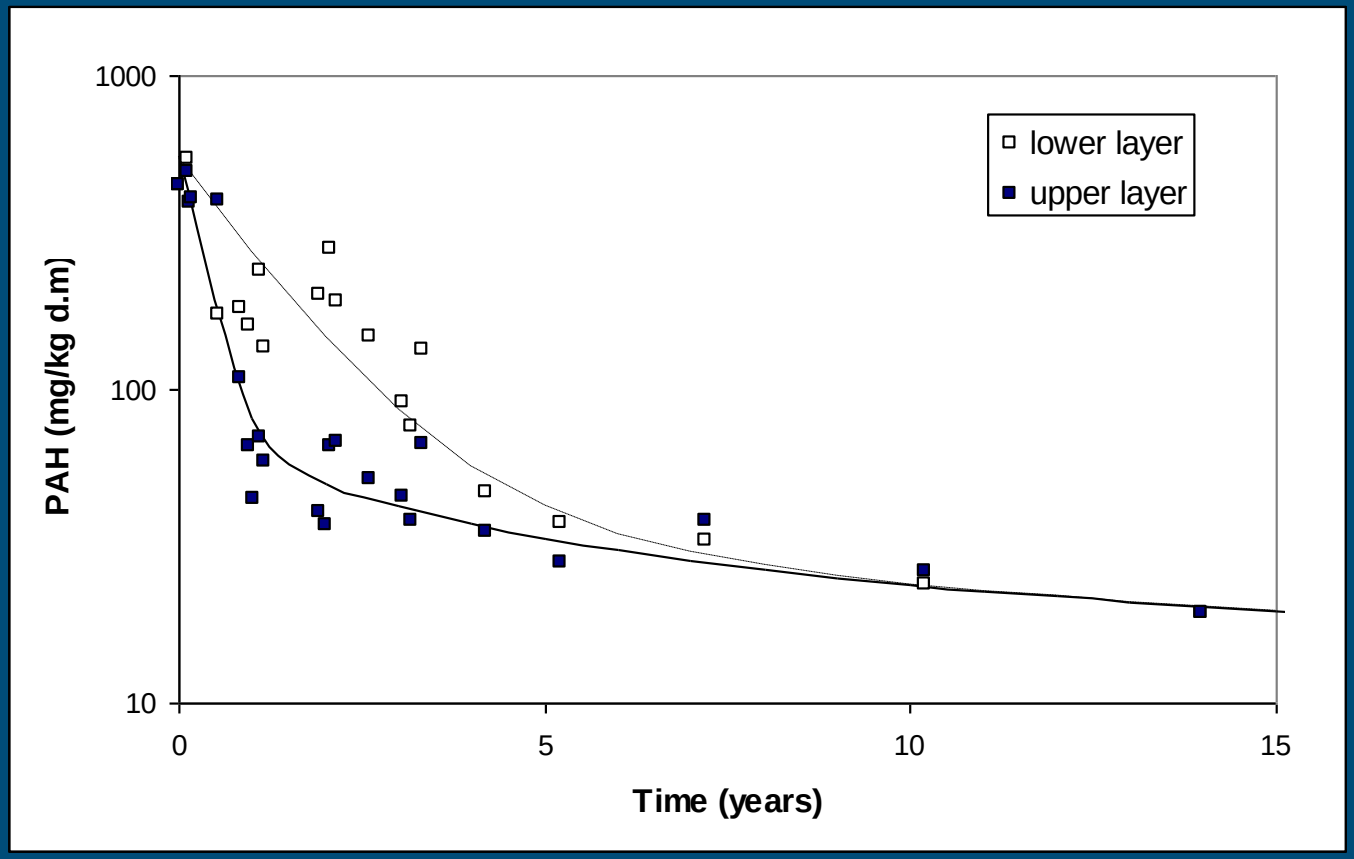
Petroleum Harbor, from chemical waste to reusable soil



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Applicability of passive landfarming

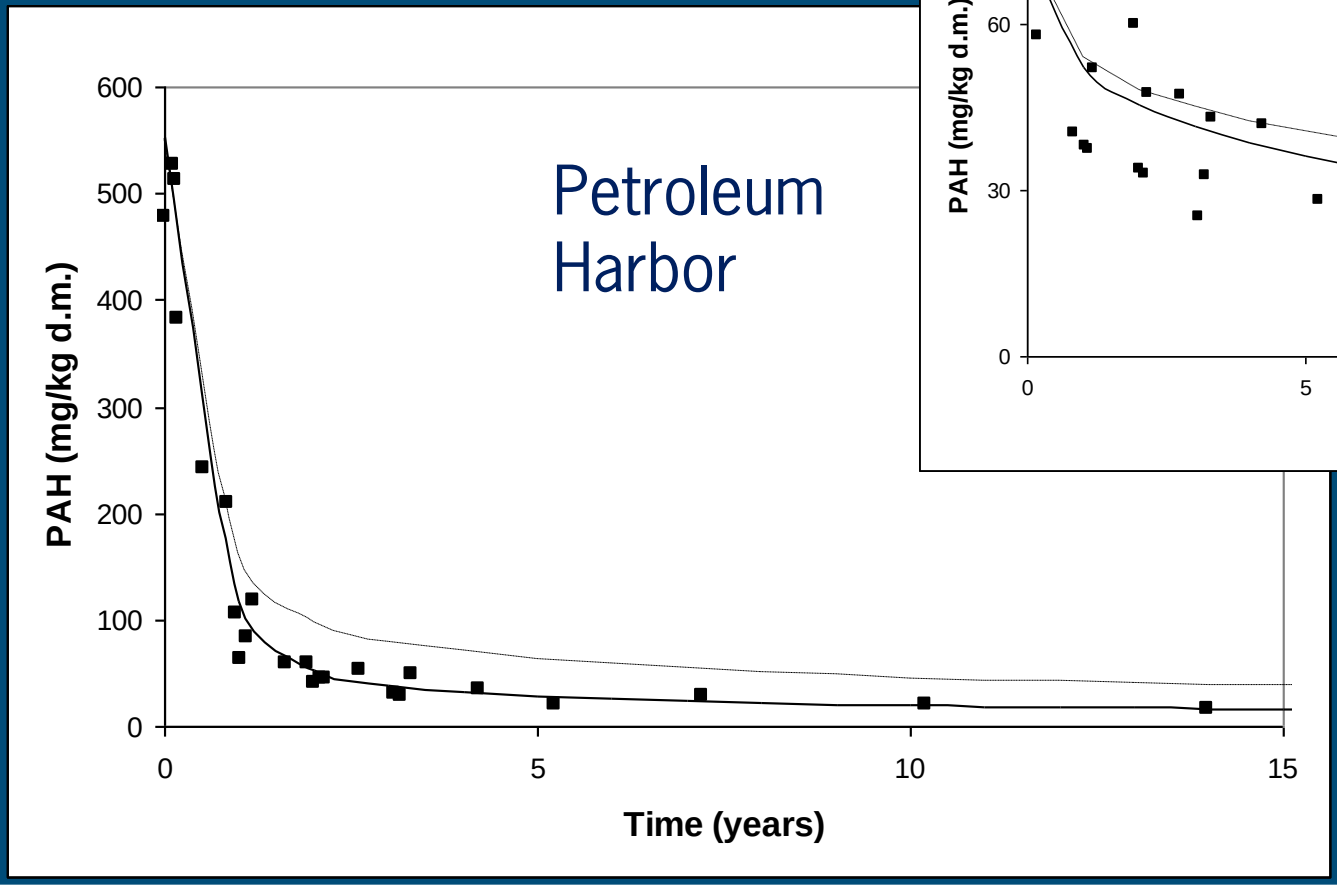
- Results have to

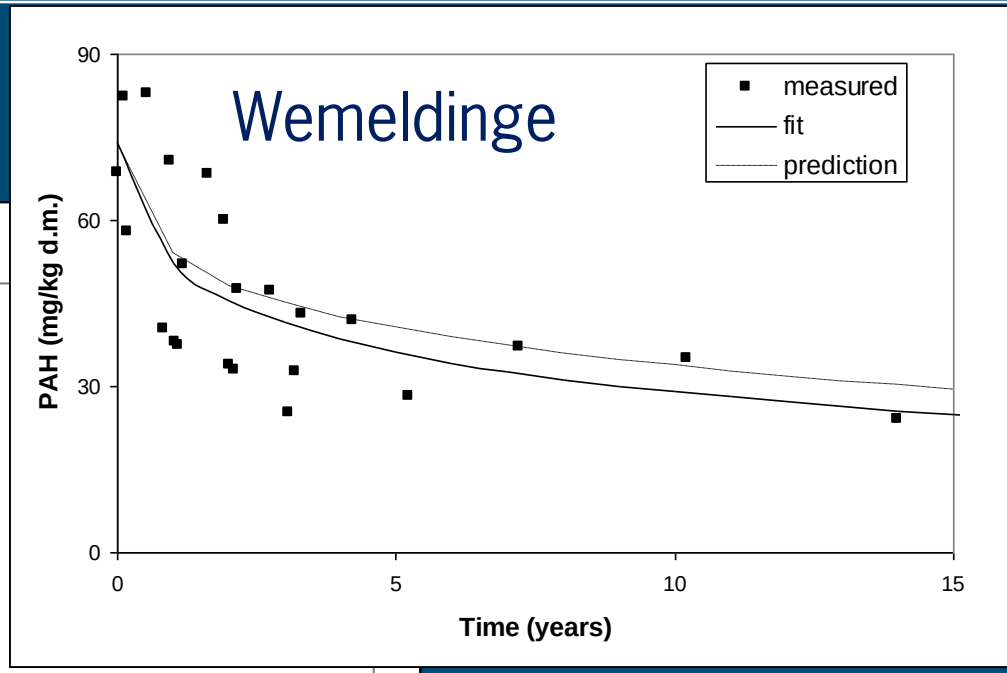
Bioavailable (long term) Tenax 60 ˚C

$$\frac{C_t}{C_0} = F_{fast} \cdot e^{-k_{fast} \cdot t} + F_{slow} \cdot e^{-k_{slow} \cdot t} + F_{very\ slow} \cdot e^{-k_{very\ slow} \cdot t}$$

Bioavailable (short term) Tenax 20˚

Prediction PAH's degradation





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Use of this knowledge

- Create situations were PAH's degradation will continue
  - Combination with energy crop
  - Creation of temporary depot
- Improve local conditions (vegetation, ground water level)

Africa

- Mali
  - Molodo
  - Sévaré
  - Niogoméra
- Mauretania
  - Nouakchott
  - Letfetar
  - Kiffa

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Increase adsorption (non degradable POP's)

- Black carbon (soot, activated carbon….) increases adsorption
  - Use natural (river sediment) and added activated carbon
- Dieldrin contamination in Mali (Africa)
  - OM is low (high temperture)
  - Char coal is locally available
  - Use for isolation in depot

Isolation, prevent contact and decrease leaching

- Cover
  - Stabilization
  - Evaporation of rainfall
  - Fence vegetation, non consumable, *Vetiver, Jatropha*
- Define use

Conclusions

- If contaminants are not physically accessible, or chemically or biologically available, they should not be included in the calculation of risk
- Use of bioavailability
  - Optimizes the extent of cleanup required to be protective
  - Provides optimization of remedial approach and cost
  - Is an important factor in balancing the risks caused by remedial action
- Changing conditions can increase and decrease risks (bioavailability)
- Knowledge on bioavailability and fate of contaminants have to be used to anticipate on possible changes and to (further) minimize risks (Sustainability)

Thank you for your attention