



Stability of contaminated sediments

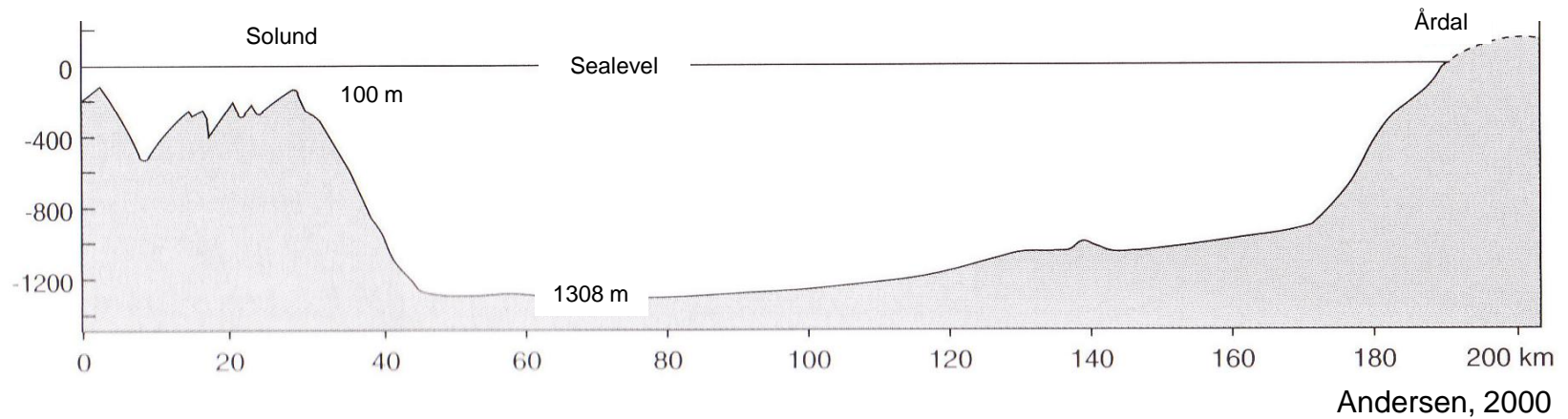
Gijs D. Breedveld, Gerard Cornelissen, Amy Oen,
Espen Eek, Anne Kibsgaard, Arne Pettersen,
Tore Kvalstad, Audun Hauge
Norwegian Geotechnical Institute

Norway

- Area: 324000 km²
- Population: 4.6 mill.
- Coastline:
 - 2650 km netto,
 - with fjords 25000 km,
 - with islands 57000 km



Sognefjord - length profile



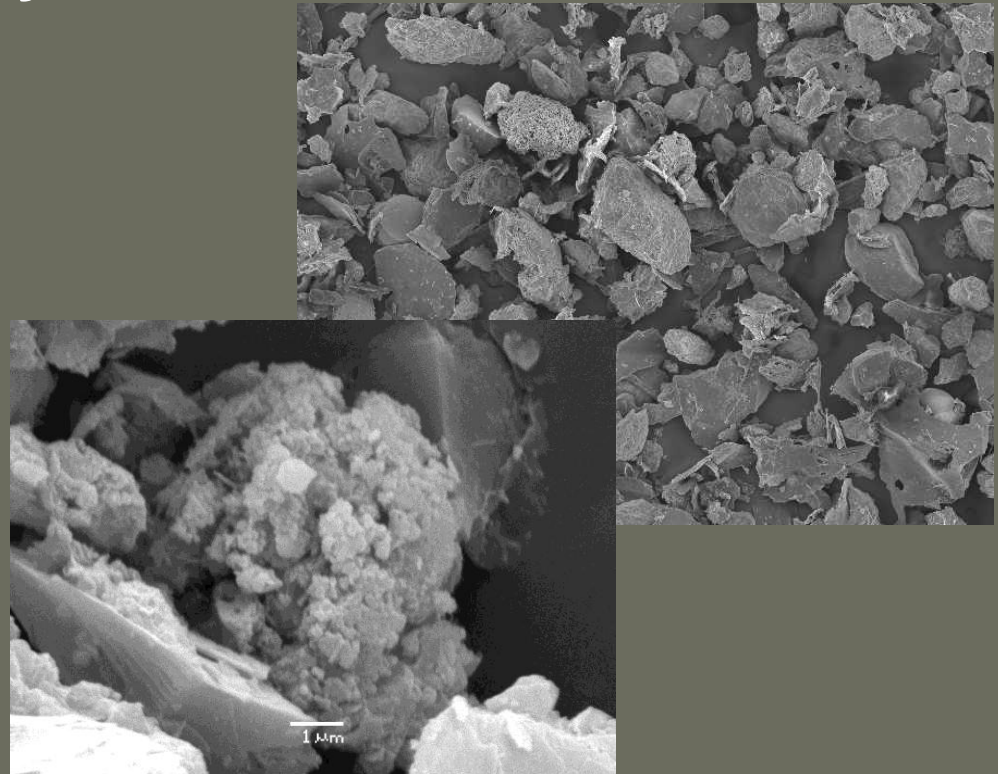
Contamination History

- Industrial sources
- Urbanisation
- Wastewater treatment
- Traffic



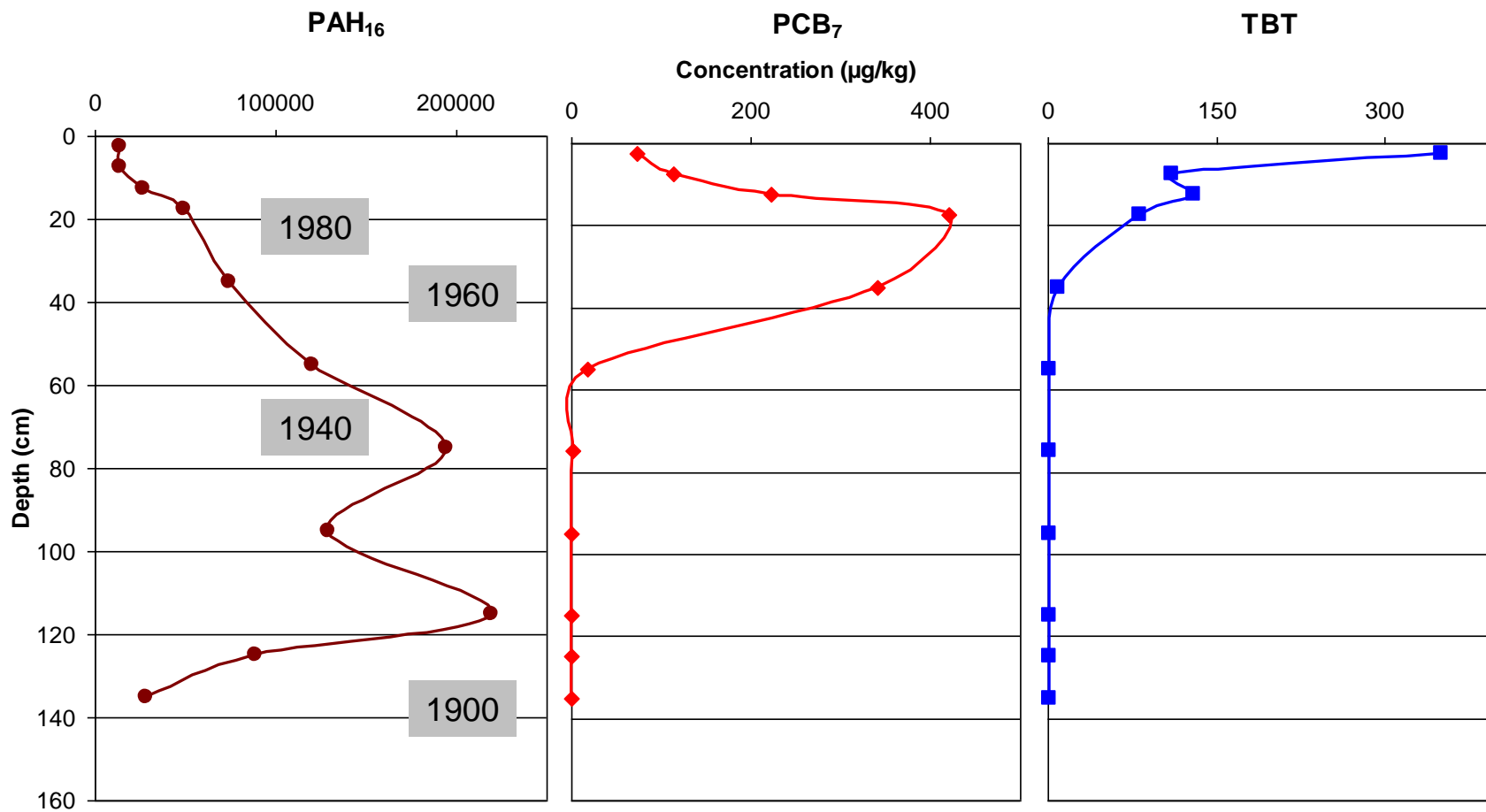
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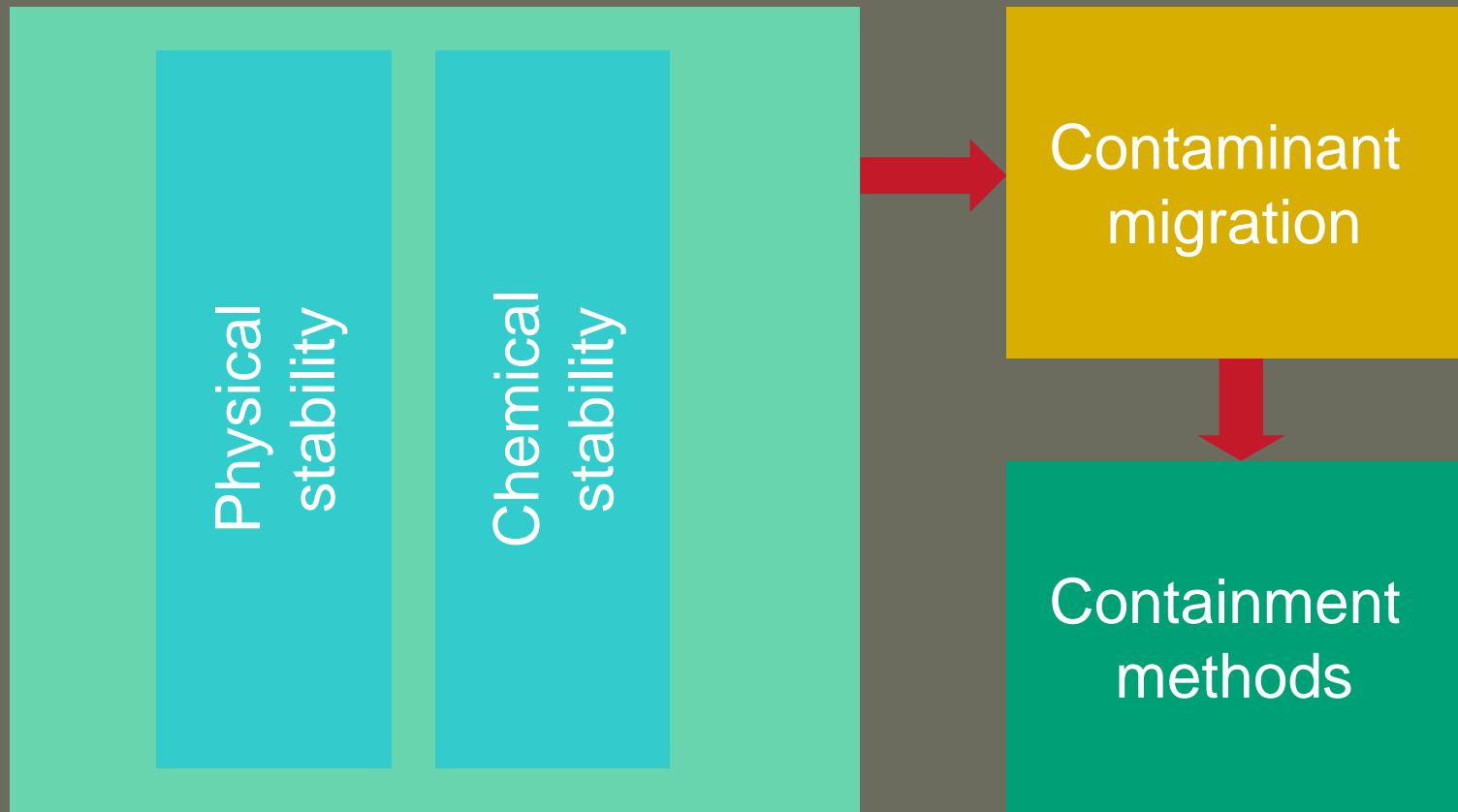


Oen et al. , Env. Poll., 2006

Contamination History

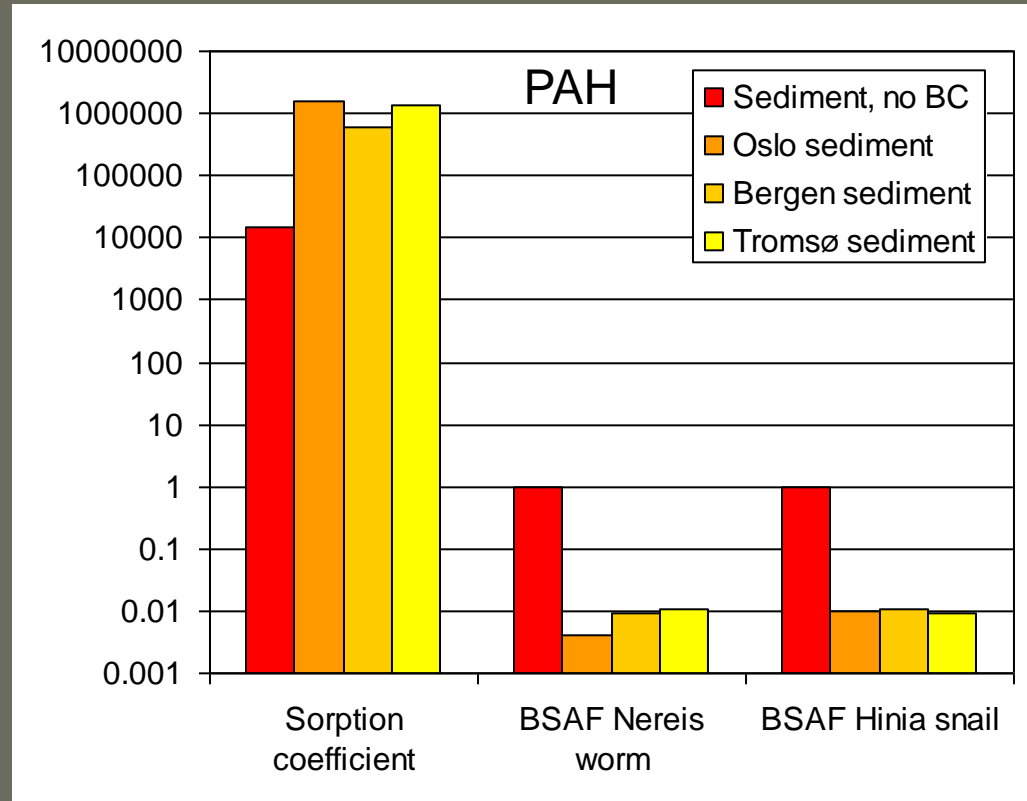


Stability of Contaminated Sediments Strategic Research Program (2003-2008)



Sink or Source

- Sequestration
- Activity ratios
- Fluxes and direction



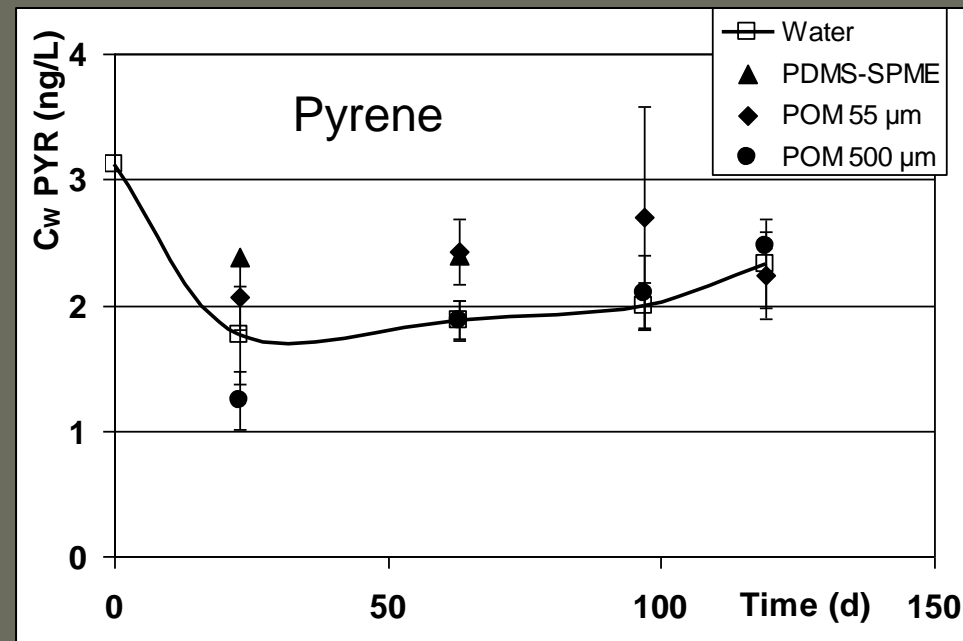
Cornelissen et al, ET&C, 2006; ES&T, 2006

Monitoring using passive samplers



Passive sampling

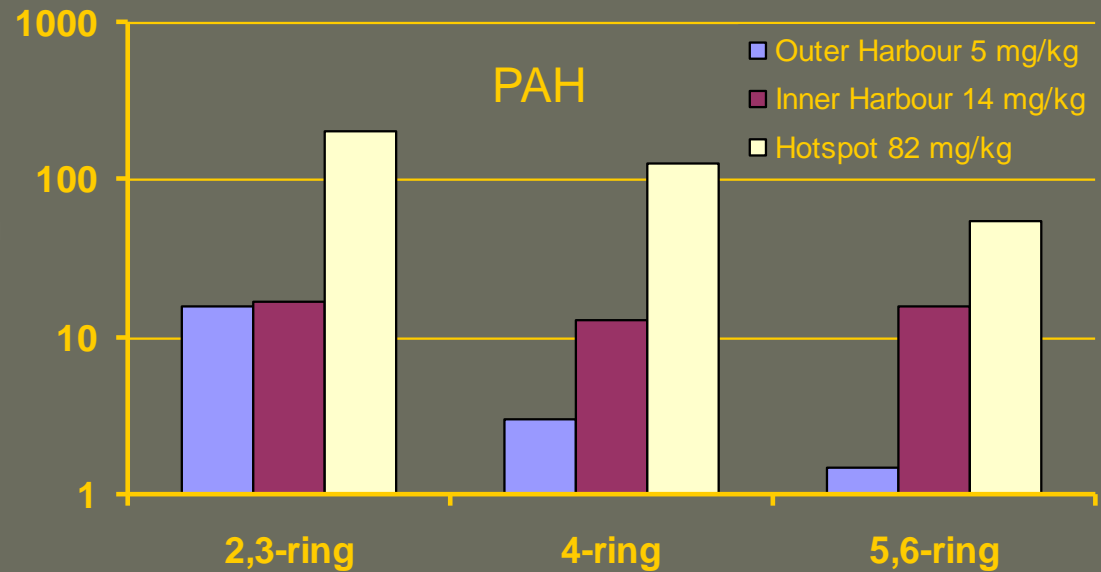
- 3-6 weeks time integrated sampling
- dissolved contaminants
- at low levels < 0,1 pg/L



Cornelissen et al, ET&C, 2008

Sink or Source

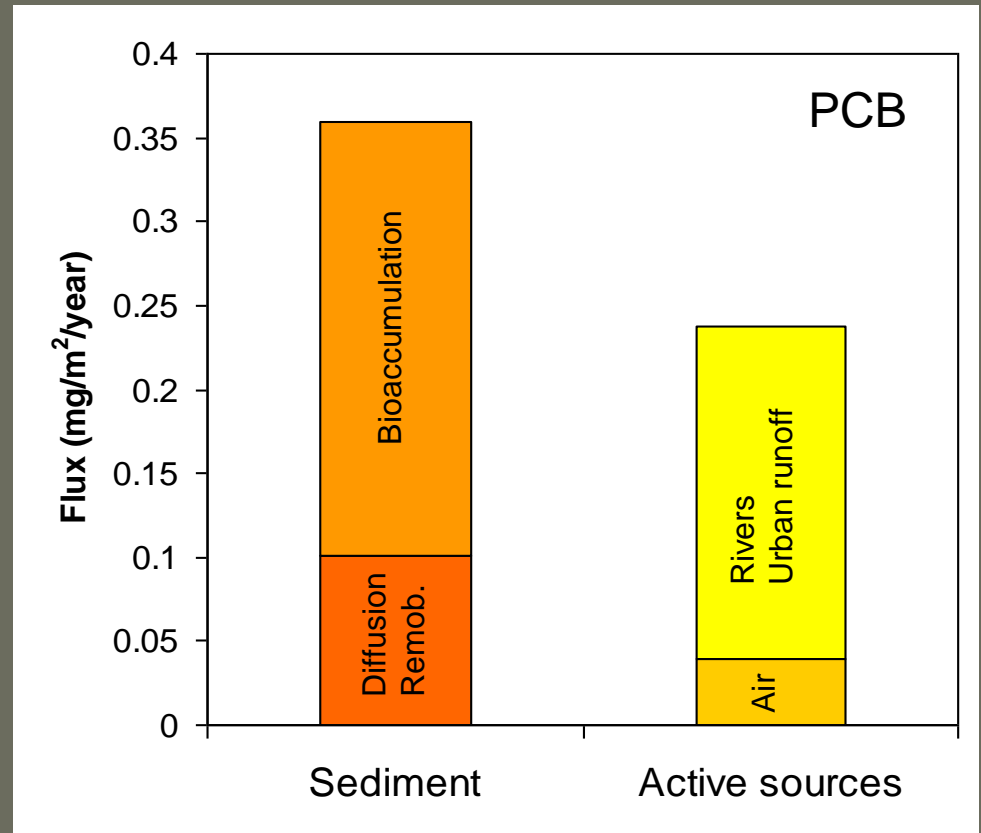
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Cornelissen et al, ET&C, 2008

Sink or Source

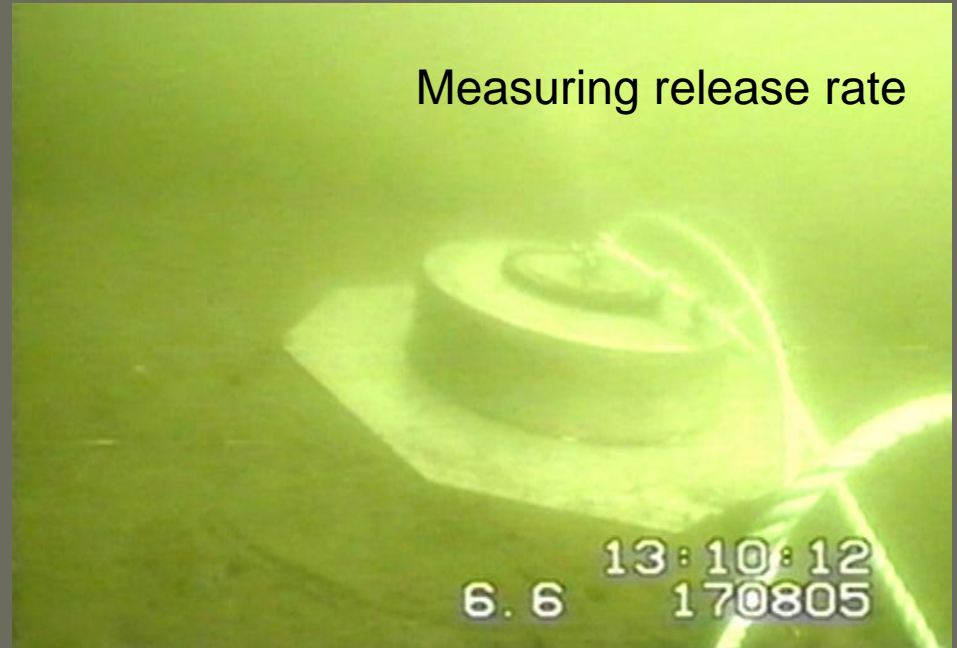
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- Fluxes and direction



Schaanning et al., NIVA, 2005

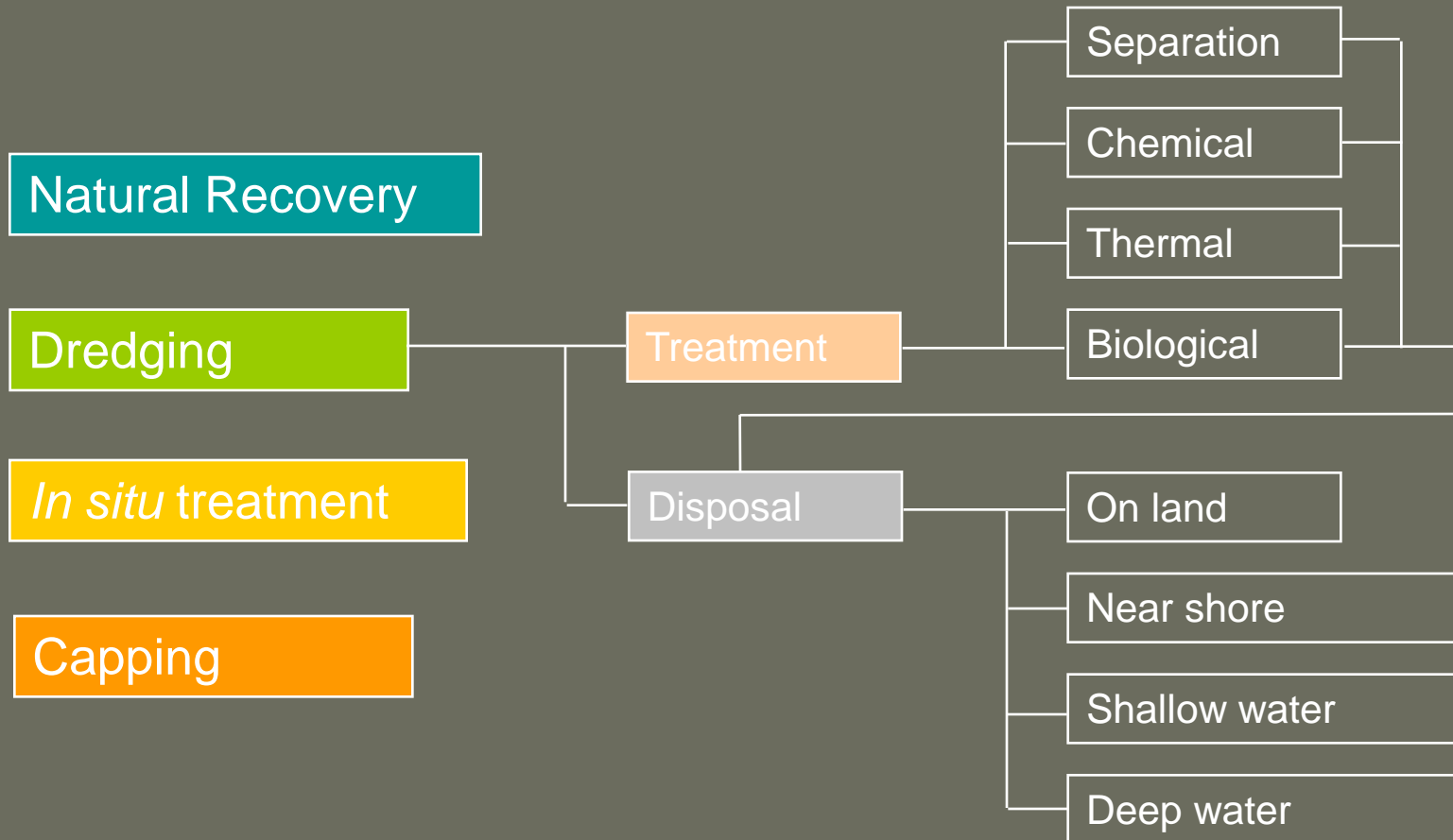
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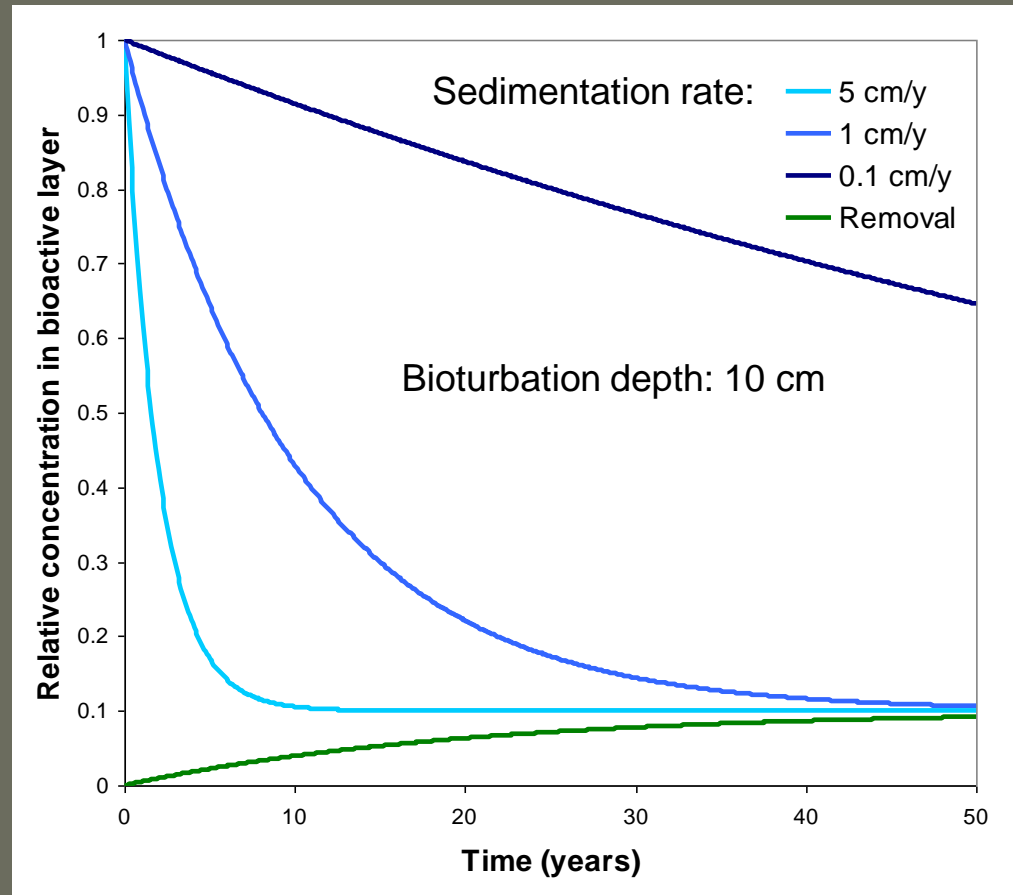
Eek, PhD thesis UiO, 2008

Finding solutions for contaminated sediments



Natural Recovery

- Remove sources
- Resedimentation
- Bioturbation



Eek, PhD thesis UiO, 2008

Capping

- Covering with clean sediment
- Prevent contact with benthic organisms
- Prevent remobilisation



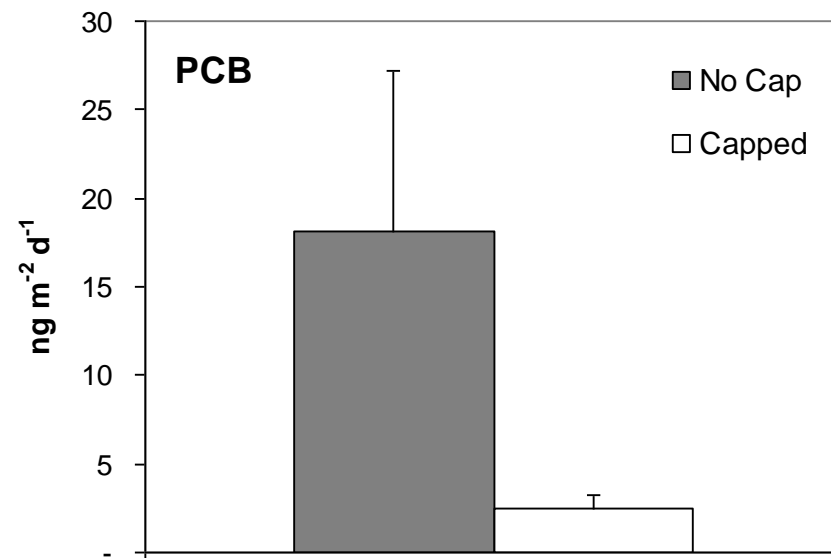
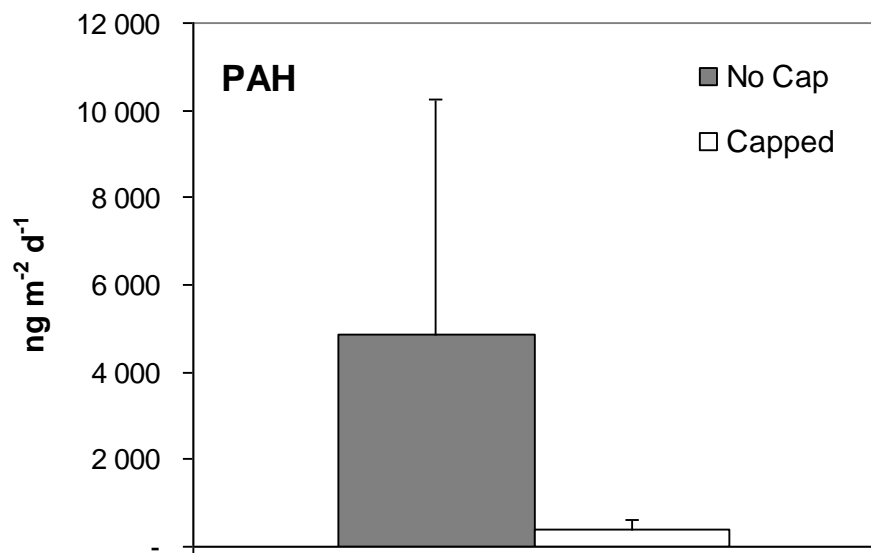
Nilsson, NIVA, 2007



Pilot capping Malmøykalven, bearing capacity



Capping efficiency

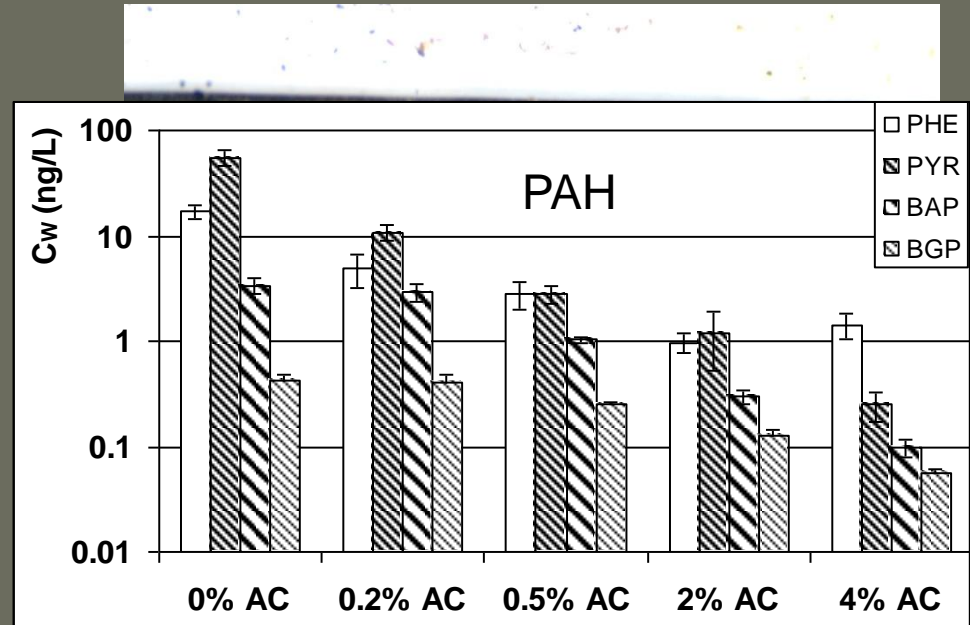
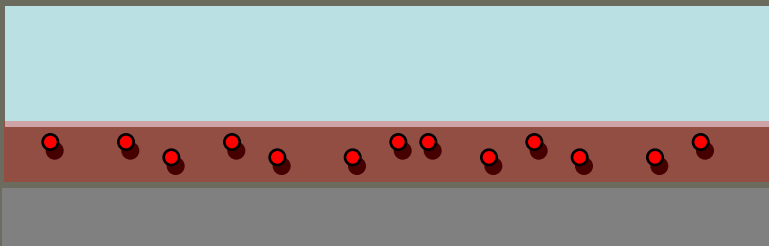


Eek et al, Chemosphere, 2008

In-situ remediation

Chemical stabilisation

- Amendment with strongly sorbing material
- Reduced aqueous concentration
- Reduced uptake in benthic organisms



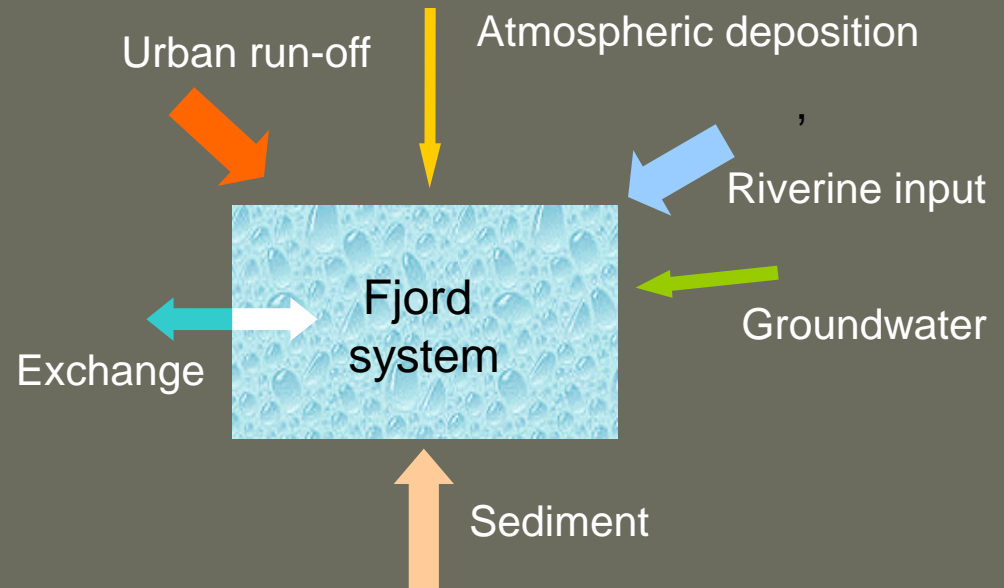
Cornelissen et al, ES&T, 2006

worm burrows

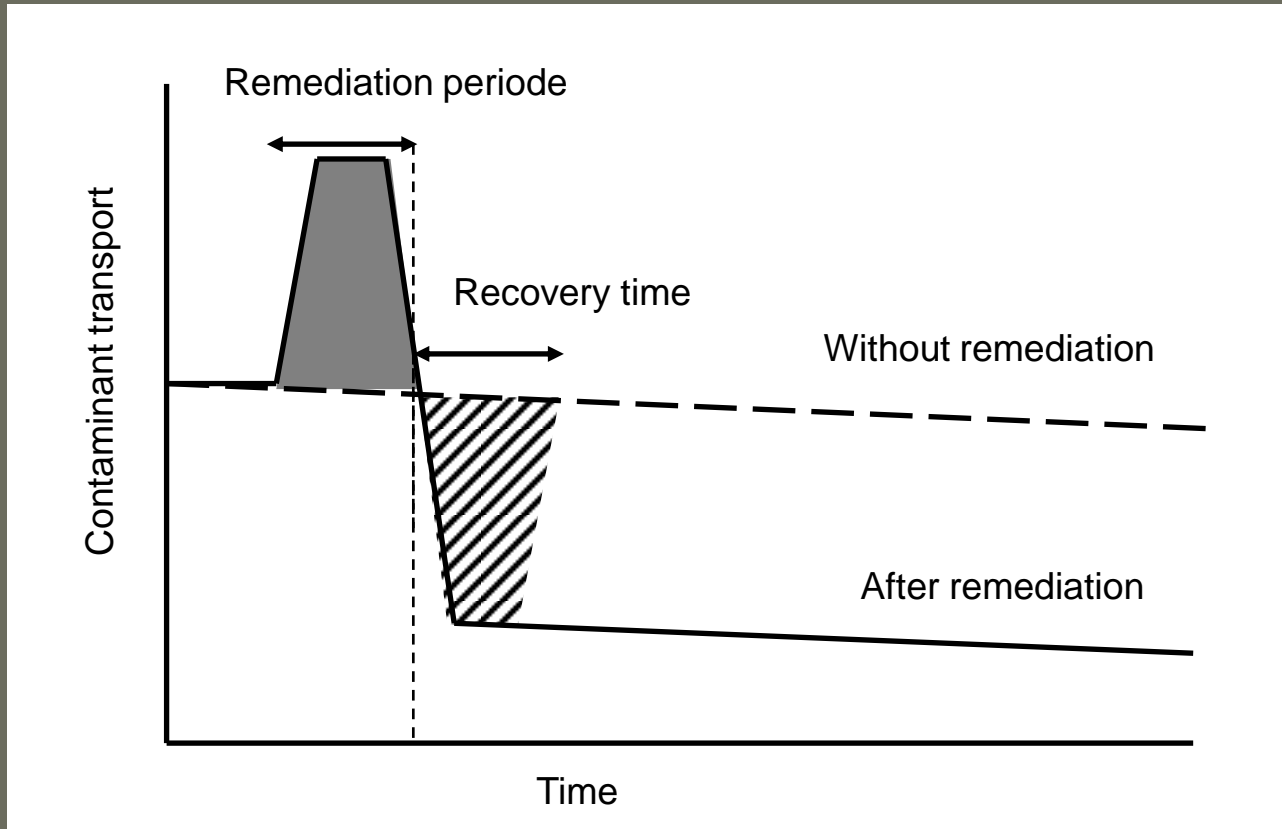
Foto U. Ghosh

Effectiveness of solutions

- Sediments as part of a system
- Realistic expectations
- Source control



Contaminant budget



Site-specific solutions

- Based on local conditions
- Support nature's recovery potential
- Understand the fate of the contaminants
- Optimal environmental effect
- "Toolbox" of methods





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