Long term effect of sediment remediation – mechanisms of failure and success – based on case studies

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Background

Polluted sediments in Norway – completed and planned projects

- Many harbor remediation projects have been completed, some are on-going and more projects are planned for the near-future
- The 100 most polluted shipyards have been assessed and remediation is considered

http://www.miljostatus.no/forurenset-sjobunn

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Background

- Capping
  - The preferred method
  - Low impact on the sea floor
  - Limited transport of contaminants
  - Fast to complete
- Dredging
  - Only when it is not deep enough for capping
  - If the concentration of contaminants are to high

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Environmental goal

Typical environmental goals include:

- Contaminant levels in sediment below certain environmental quality standards (class II in the Norwegian classification system)
- Cap thickness
- Cap integrity

In order to achieve these environmental goals extensive investments are required. But will the results last?

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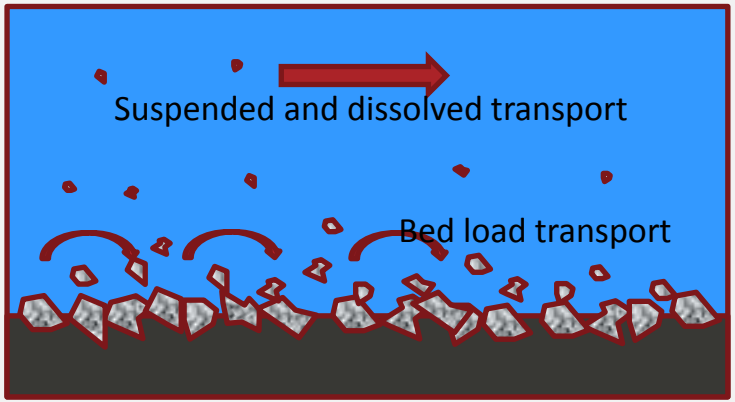
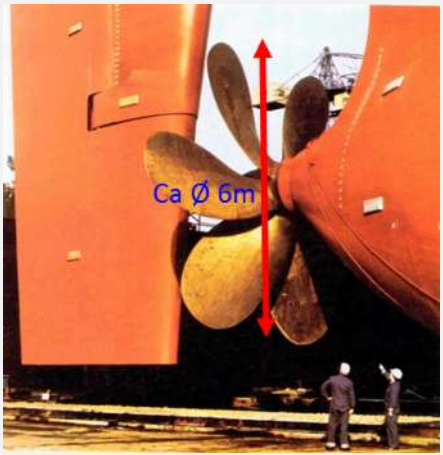
Erosion (case study Sandefjord and Oslo)

- Erosion along the docks caused by the ferry traffic required change in the design of the cap layer.
- Erosion is a local effect
- Should the whole sediment cap be designed for propeller erosion in a limited area?





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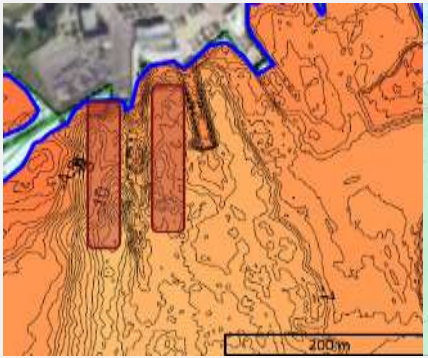
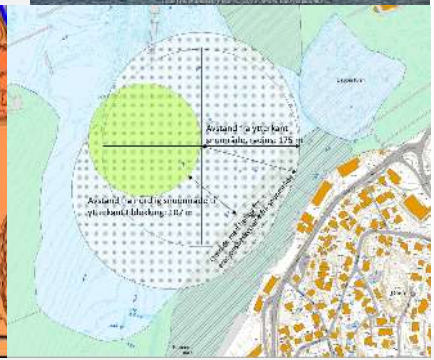
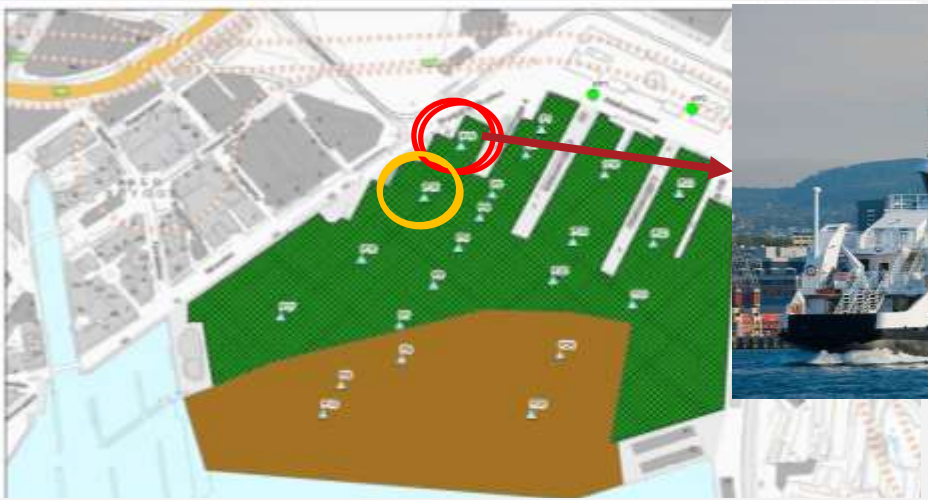
Capping design in Sandefjord

- Main capping with 15 cm mineral material
- Erosion capping by the docks, 10-40 cm
- Some areas by the docks, no capping.





Erosion of capping layer: Pipervika Oslo Havn



- No capping material (0-8 mm in red circle)
- Only coarse material in yellow circle
- No erosion damage found in other areas

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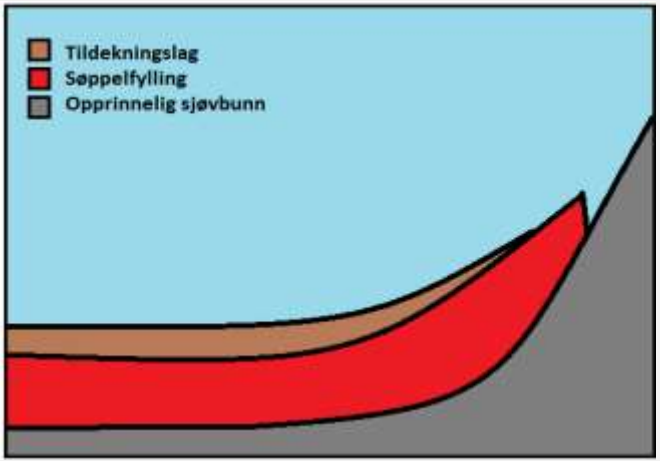
Stability and settlements (case study Kollevågen)

- Underwater waste disposal facility. Geotechnical instability influenced capping efficiency.



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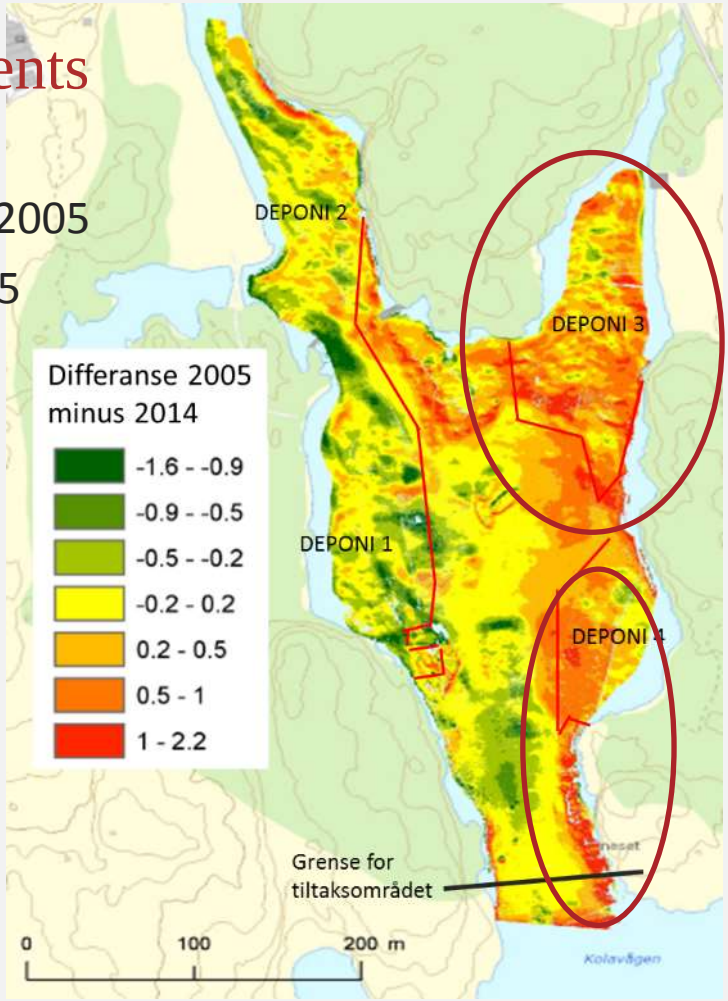
Bathymetric measurements

Red and orange: Deeper since 2005

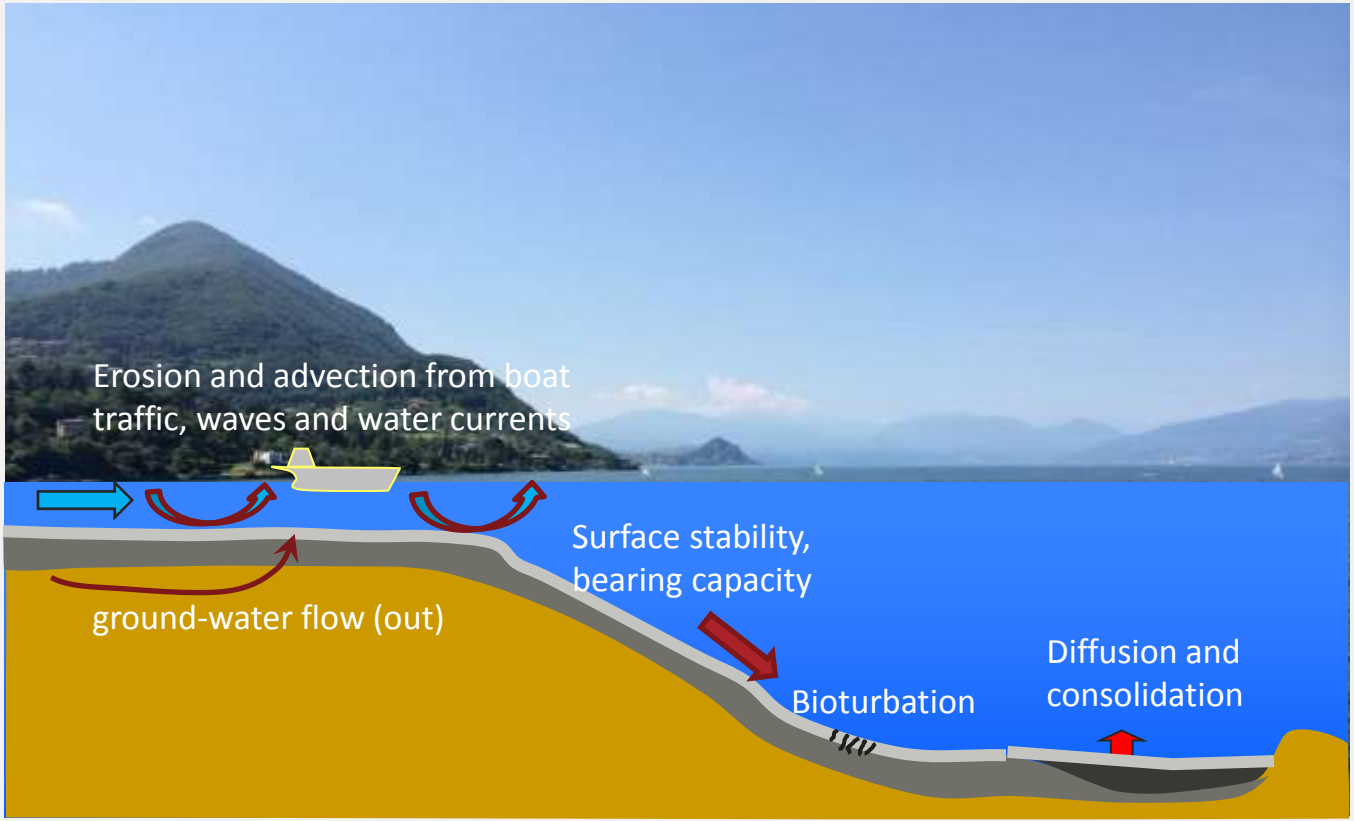
Yellow: Little change since 2005

Green: Shallower than 2005

Area has settled since 2005



Critical factors in capping



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Choice of capping material
(case study Oslo harbor)

- Dredging and capping of the inner harbor area. Recolonization of benthic organisms on the new mineral capping layer.
  - New benthic community depends on the substrate of the new seabed
  - Should we add a biological design in the cap layer?
  - “Do you want lobster or sea worms?”

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Recontamination (case study Oslo harbor)

- Long-term recontamination observed since the project was finished in 2009.
- Urban runoff and river transport to the remediated area has been monitored.

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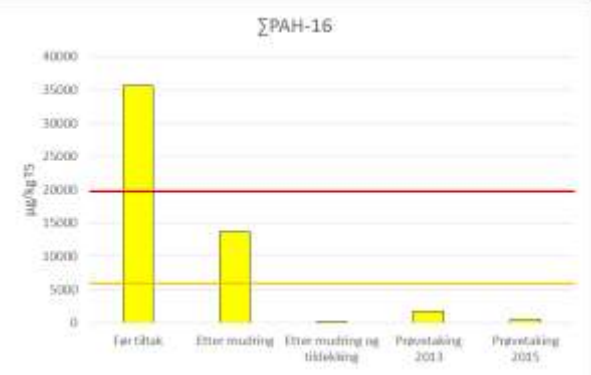
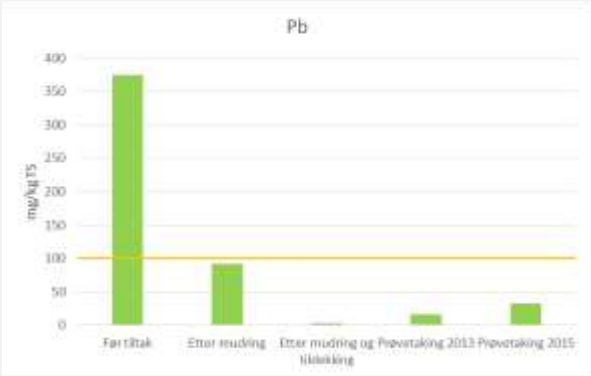
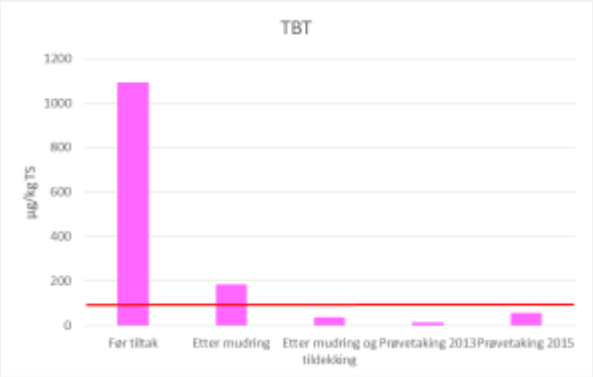
Pipervika: Before and after remediation







- Dredging removed approx. 95% of pollutants
- Capping achieved class II
- Storm and river water transport new sediments
- Contaminant levels increase

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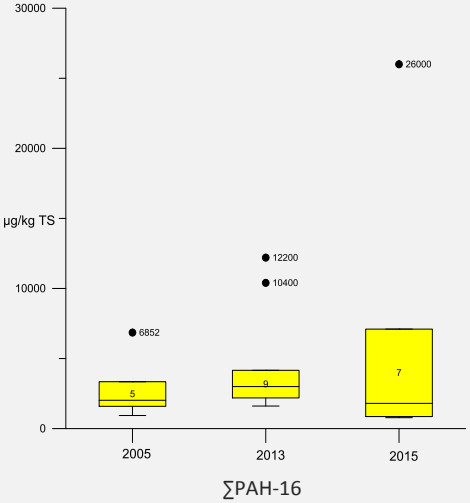
Run-off from land?
Sediment traps



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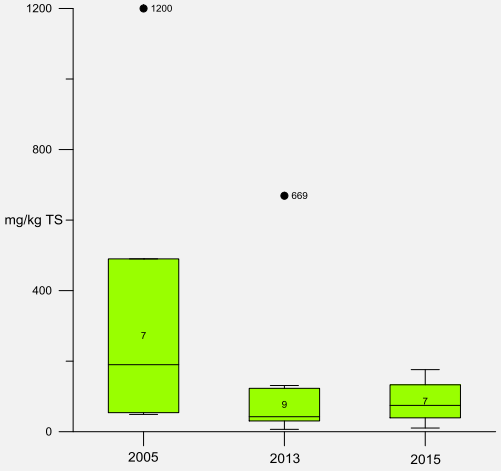

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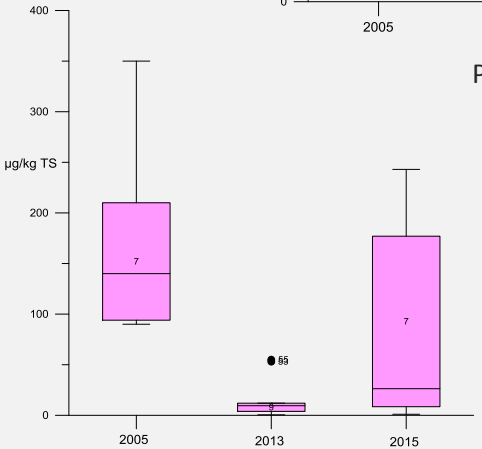

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Environmental goals

- What are realistic long term environmental goals that can be achieved?
- Which mechanisms and factors are critical and most likely to influence the remedial design and environmental outcome?
- Can a more realistic and efficient solution be designed by looking at the long-term remedial achievements rather than environmental quality classes?
- To what extent is maintenance and repair acceptable in the long term life expectancy of remedial measures?

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Take home messages

- Short term goals (environmental quality class I-II) easy to achieve given that proper capping material is selected.
- However, long term effects of sediment remediation will depend on on-going diffuse contaminant sources.
- Is it useful to cap a dredged area to achieve a short term goal (class II) if we end up with environmental quality class III anyhow?
- The biological recolonization can be controlled by design of a proper top layer substrate

Don’t forget to do a proper geotechnical design !

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