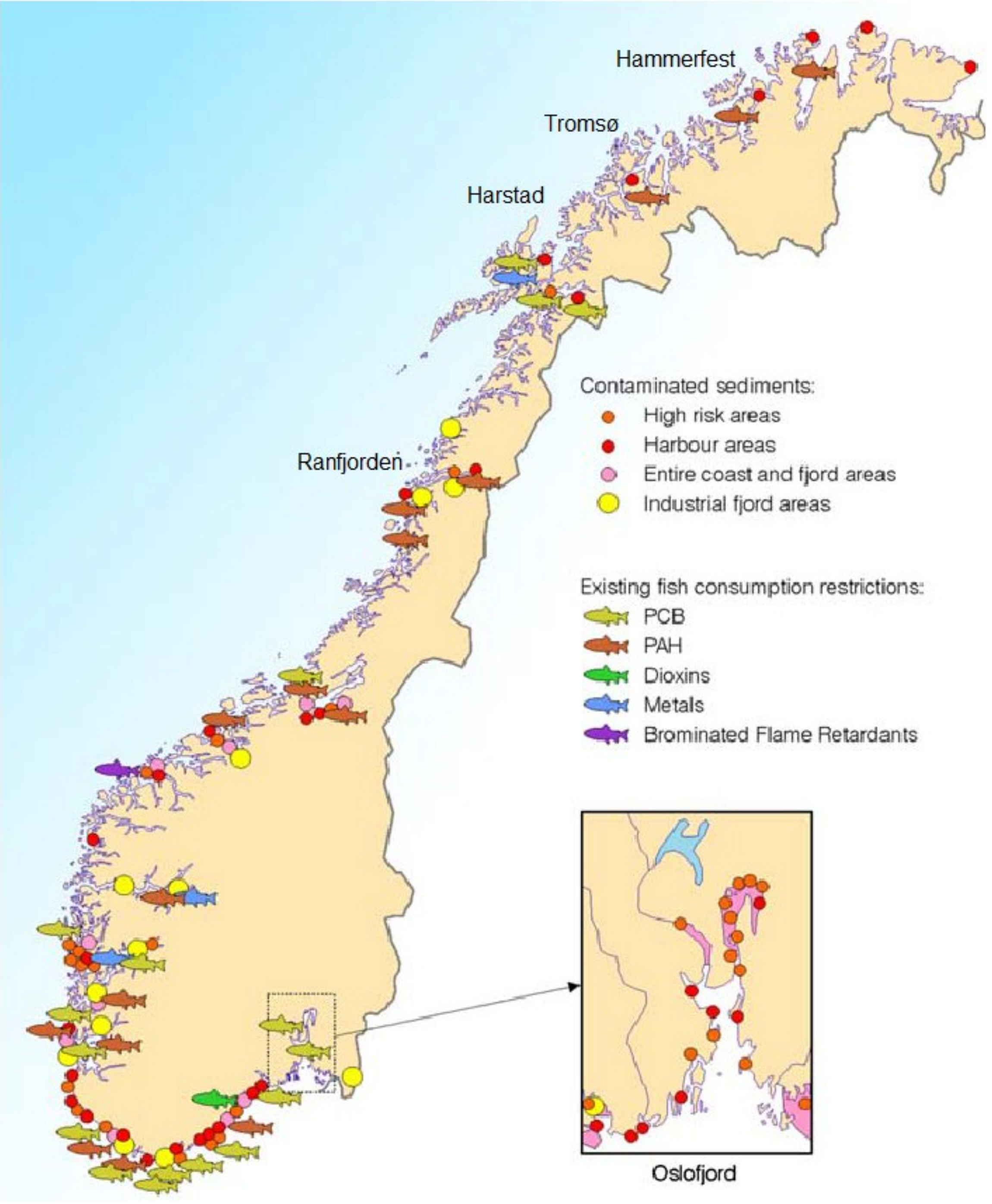
Polluted Harbour Sediments in Norway

Two PhD –projects about remediation methods within EWMA project

Management of polluted marine sediments

Aquatic sediments act as sinks for a wide variety of organic and inorganic pollutants. Once contaminated, sediments subsequently may become sources of contamination. In 2006 the Norwegian Parliament adopted an action plan for remediating polluted seabed (St.melding nr. 14) which based on environmental mapping and assessments.

In municipal harbours pollutions usually originate from several sources spanning several decades of polluting activities and are often of a complex composition with various pollutants. The action plan has prioritised 17 municipal harbours where remediation is carried out in the first phase. 4 of these harbours are located in the Northern part of Norway (Hammerfest, Tromsø, Harstad and Ranfjorden).



Remediation project of Oslo harbour.

Classification of polluted sediments in Norway

KLIF has developed a classification system for assessing the impact of pollution on the environment. It is based on ecotoxicology of the different pollutants. The classification system does not take the total amount of pollutants into account. Based on the environmental risk assessment necessary remedial actions are determined.

I Background	II Good	III Moderate	IV Bad	V Very bad
Background levels	No toxic effects	Toxic effects following chronic exposure	Toxic effects following short term exposure	Severe acute toxic effects

Remediation, ex-situ and in-situ approaches

Current approaches to the remediation of contaminated sediments include ex situ and in situ treatments. The ex-situ treatments rely heavily on dredging and disposal of the contaminated sediment, which is the most common remedial action practice used in Norway.

Developing in situ remediation techniques have recently drawn more interest. Approaches for in situ remediation of contaminated sediments include e.g. capping, solidification/stabilization, chemical and biological treatment.

Background for EWMA –project

During the last years there has been an increase in the industrial activities in the Arctic part of Norway. There is hence an increasing need for environmental management of industrial waste, including pollution. There is increasing national and international focus on the impact of human activities on the vulnerable Arctic environment.

Remediation techniques in the EWMA project

Within the EWMA, two projects have been developed within remediation of polluted harbour sediments:

- Electrochemical remediation
- Capping technology

Objective is to develop cost-effective in-situ methods for management of polluted harbour sediments adapted to the Arctic. Developing several remediation methods increases the opportunity of choosing best site specific practice. Until now the focus of research on pollution has mainly been focused on mapping pollution and assessing the impacts.

Project participants

Research institutions in the two projects include: Narvik University College, University in Tromsø and Technical University of Denmark

The industry is present in the projects via Ramboll Norway and Akvaplan-Niva. The projects acknowledge the Norwegian Research Council and ENI Norway for financial support.

UNIVERSITY OF TROMSØ UiT

MOBILE ELECTROCHEMICAL REMEDIATION OF ARCTIC SEDIMENTS

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Background

- Increasing focus on the environment and climate.
- Increasing industrial activities in the High North.
- Increasing need to develop cost-efficient methods for reducing the amount of hazardous waste.
- Challenging logistics and climate in the Arctic Region

The electrochemical remediation method

- Cost-efficient method for reducing amount of hazardous waste
- Adaptable to the Arctic challenges
- In-situ/ex-situ possibilities
- Uses low current technology to mobilise and remove pollutants from soil, sediments, construction materials, wood, fly ash, sewage water, etc….

Project objectives

- Develop and strengthen knowledge within on-site remediation technologies.
- Develop and strengthen knowledge within electrochemical remediation technologies for multi-polluted material in the High North.
- Develop mobile remediation test units for use in the High North.

Figure 1: Areas sampled for electrochemical remediation tests

Project content

- Sampling of sediments in the Arctic Region in Norway, NW Russia and Greenland.
- Develop remediation method for removing multi-pollutants such as heavy metals, oil products, PAH, PCB and TBT.
- Remediation tests in laboratory scale (cells), pilot scale (stack) and full scale (mobile remediation test unit).

Figure 2: Electrochemical stack (pilot scale)

The project in an international and scientific context

- Spanning several Arctic countries.
- Co-operation with the Technical University. of Denmark (ARTEK – Arctic Technology).
- Developing remediation method for removing multi-pollutants simultaneously.
- Statistical design and optimisation of the remediation tests..

Development of mobile remediation test unit

- Trailer with electrochemical test unit(s). Possibility of adding other remediation test. units in the future, e.g. chemical/biological.
- Used in the project for full scale remediation testing.
- Future use – remediation tests to design remediation solutions.
- Renewable energy sources produce the necessary electricity for the test unit.

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Capping technology

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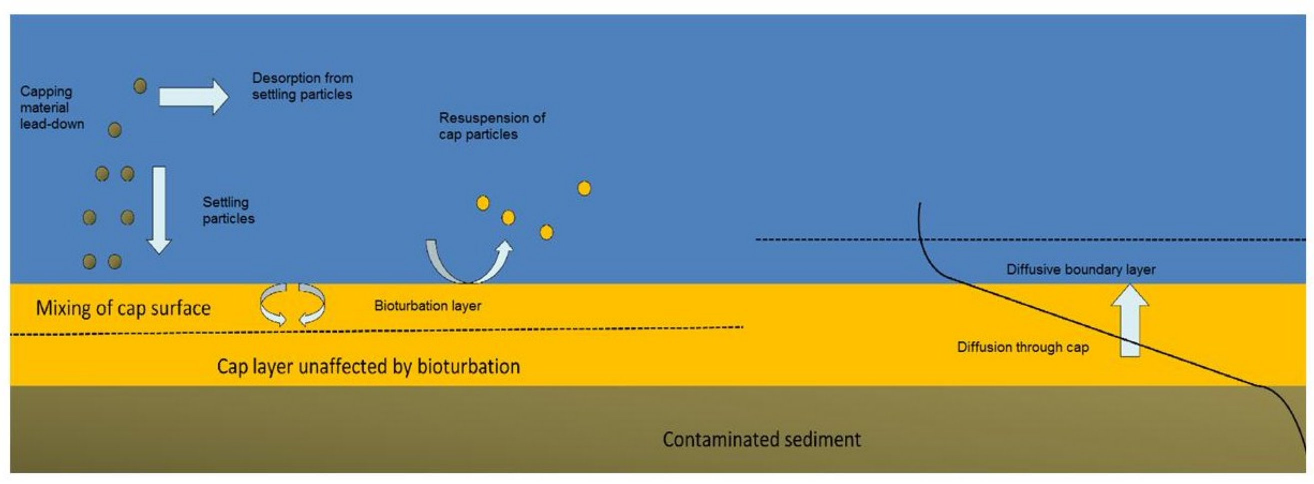


Capping projects have been conducted also in full-scale since the early 1980s under a variety of site conditions. (mainly in U.S.)

Projects in Norway, e.g:

- Capping of Malmøykalven deposit in Oslofjord
- Harstad Harbour (2012-)

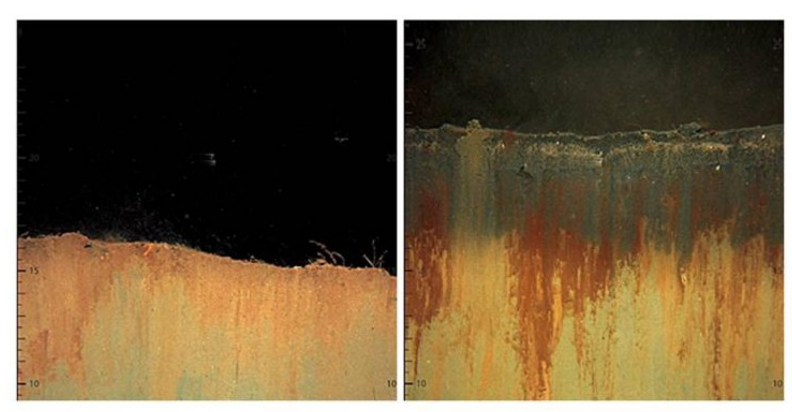
Functions of cap layer (generally 5-50 cm)

Cap layer is designed to reduce risk of contaminant release by:

- Physical isolation (protect from bioturbation)
- Stabilization / erosion protection
- Chemical isolation (reduction of the flux of dissolved contaminants)

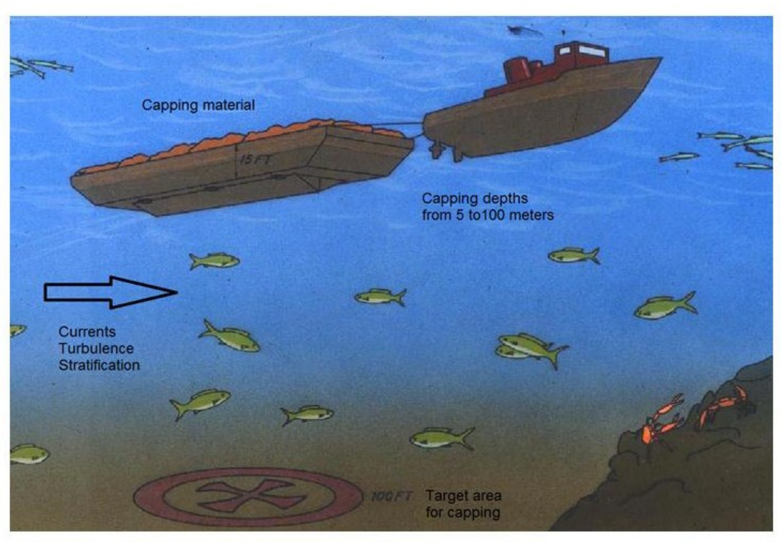
Capping Materials:

- Sand, clay, silt, crushed rock, sorbents (e.g. AC)
- Amendments (sorbets) are used mainly in thin cap approaches (<20 cm): "Active caps"
- Conventional thick caps (>20 cm) are generally constructed by "passive" materials



Seabottom before (on the left) and after capping, approximately 5 cm cap layer. (Photo: NIVA)

PhD-project: "Capping technology, settling studies, modeling of cap placement" (NUC, UiT, Ramboll)



The focus of the PhD-project is on:

- Behaviour of capping materials during lead-down
- Settling of active capping materials, especially the placement of AC-clay mixture
- Predictability of cap placement, better control of the spreading of the material during lead-down to
  - obtain uniform cap layer, and
  - minimize loss of capping material
- Developing modeling tools for cap placement
- Verifying the models in field capping projects (e.g. Harstad harbour)

Main objective is to provide model to predict both active and passive cap placement and archieve more knowledge in material behaviour during lead-down.

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