Modeling environmental impact caused by spreading of dredged material during dredging and deposition

by

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1. Modeling of currents
2. Modeling of spreading during dredging and deposition
3. Modeling of environmental risk
Area considered:

10°30'E 11°00'E

30 km

Oslo

Glomma archipelago
Problem considered:
Length scale: 50 units = 1600 m  
Color: Depths, scale to the right:
Problem considered:

Length scale: 10 units = 320 m

Color: Depth, scale to the right:
Simulation of currents, river entrance:

Surface currents:

Currents at 10 m depth:
Currents modeled at the deposition location:

**Surface currents:**

**Currents at 20 m depth:**
Spreading of particle matter during dredging in the Glomma entrance area:
Dredged material characterization:

■ Clean masses:
  ■ Unconsolidated clay (5 %, particle size < 2 µm)
  ■ Consolidated clay (45 %, particle size > 1 cm)
  ■ Unconsolidated silt (40 %, particle size 2 – 60 µm)
  ■ Silty sand (10 %, particle size 60 – 100 µm).

■ Polluted masses in local areas:
  ■ Unconsolidated clay/mud (particle size < 2 µm)
Materials and Chemistry

Stokes law

Constant drag

$\text{Particle diameter, m}$

$\text{Sinking velocity, m/s}$

$1.0 \times 10^{-05}$  $1.0 \times 10^{-04}$  $1.0 \times 10^{-03}$  $1.0 \times 10^{-02}$  $1.0 \times 10^{-01}$  $1.0 \times 10^{00}$
Particle concentration in the water column:
Materials and Chemistry
Deposition on the sea floor:
Deposition of dredged material from a barge:
Materials and Chemistry

Deposition area:

Barge location:
Deposition of dredged material:
Deposition of dredged material:
Water column conc.:
Example calculation for the environmental risk (PEC/PNEC approach):

Spreading during dredging:
Hg in sediment dredged = 6 mg/kg.
PNEC for Hg in sediment = 0.62 mg/kg.
Average over the upper 3 cm sediment layer calculated for the re-deposition

PEC = Predicted Environmental Concentration
PNEC = Predicted No Effect Concentration
Environmental risk example calculation:

Red area: PEC/PNEC > 1
Potential for environmental risk encountered.
Concentration above PNEC level of 0.62 mg Hg/kg sediment
SUMMARY:

- Three-dimensional hydrodynamic models, combined with the use of three-dimensional models for spreading of particle matter and pollutants, have a potential for assessing environmental impacts caused by dredging and deposition activities.

- The spreading model (DREAM) was originally developed by the offshore oil companies for simulating environmental risks caused by discharges of drill cuttings and mud. This model has a potential for application to environmental issues related to dredging and deposition of dredged material as well.
Thank you for your attention!

- Web site for the DREAM model:
  - http://www.sintef.com/erms

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