Contamination of fjords by urban run-off

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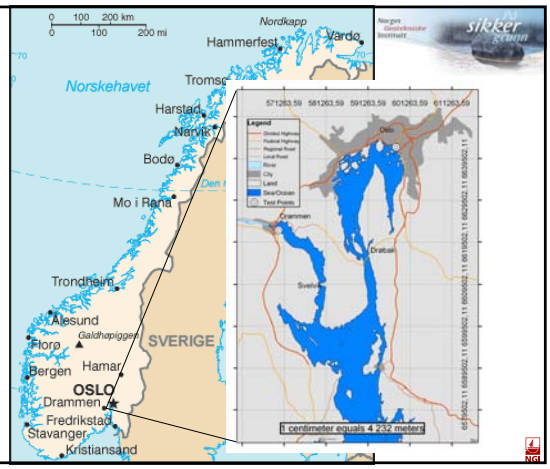
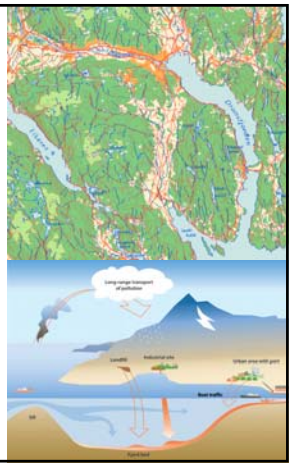


Contaminated sediments in the Drammensfjord

- The Drammensfjord has an area off 45 km^2
- The Drammensriver is one of the largest in Norway, catchment area off 17000 km^2
- Typical Norwegian fjord, circulation restricted by a sill
- User interests like harbor activity, recreation, fishing, industry, ship yard
- Contaminated fjord sediments from former industrial activity
- Restrictions on consumption of sea food as a result of contamination levels

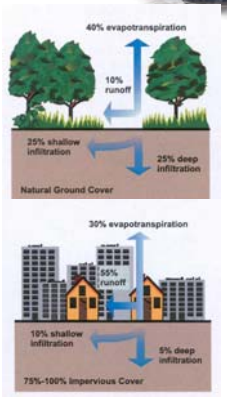


Scope of work

- Plan of remediation for contaminated harbor sediments in the Drammensfjord (NGI, NIVA 2005)
  - *Quality of sediments after remediation efforts*
  - *Realistic level of ambition on the possible effect of remediation efforts*
  - *The sequence of remediation. Is sources control sufficient to start sediment remediation?*
- Quantify urban run-off as a source of contamination

Urban run-off

- Solid surfaces in urban areas have little infiltration
  - *Storm water*
- Sources of contaminants
  - *Industry*
  - *Contaminated soil*
  - *Traffic*
  - *Asphalt*
  - *Paint and surfaces of buildings*
  - *Building materials*
  - *Contaminated soil*
  - *Sewer, household chemicals*
  - *Several other sources*



Calculating the load of contaminants

- Volume of water from solid surfaces
  - *Data on the precipitation and evaporation*
  - *Area off impermeable surfaces*
  - *Area use (industrial, roads, suburban)*
- Concentration of contaminants in storm water
  - *Water sampling*
  - *Water analysis*
  - *Template concentration values (Lindholm 2003)*

Challenges

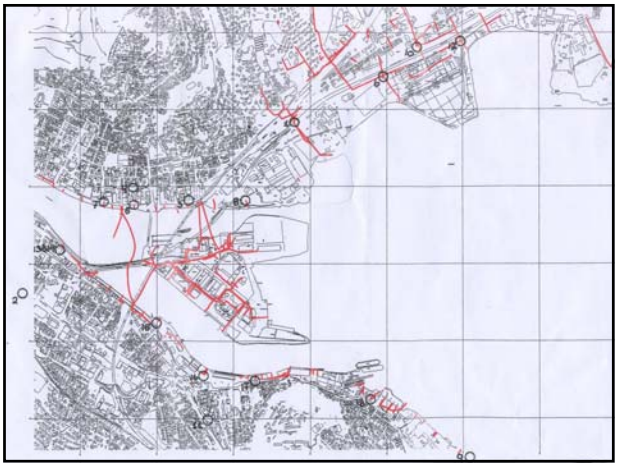
- Large seasonal variation of storm water
- “First flush” events
- Large number of water analysis
- Equipment for time- or volume integrating water sampling
- Template values
  - *Not site specific*
  - *Not available for all contaminants of interest*

Our approach

- Sampling of material from sediment traps in the storm water system
  - *Fine grained material can be sampled*
  - *Low cost equipment*
  - *Analysis of chemical parameters off interest*
  - *Large number off sediment traps can be sampled with little effort*
  - *Data can cover variation in time and space*
  - *Able to trace sources*
  - *Mainly hydrophobic compounds*

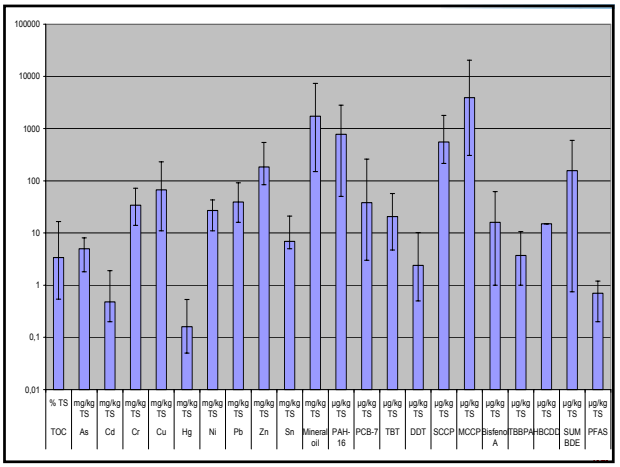
Sampling strategi

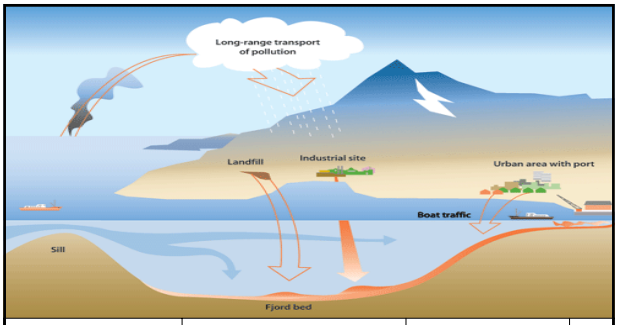
- Large number of sampling points
- Central points in the storm water system collecting water from large areas
- Sediment traps containing fine grained solids
- Close to the waterfront
- Local knowledge from the technical division of Drammen



Chemical analysis

The samples were analyzed for:
Heavy metals
PCB
PAH
Mineral oil
tinorganic compounds (TBT)
Several brominated flameretardants
Chlorinated paraffines- short and medium chained
Perfluorinated alkylated substances (PFAS)





Source	TBT	PAH	BaP	PCB	DDT	Cd	Cu	Hg	Pb	ΣBDE
	µg/kg					mg/kg				µg/kg
The harbour sediments	1820	6940	350	37	2,4	0,4	62	0,3	39	15
Sedimenting material (Sediment traps deployed in sea)	790	2662	168	9,9	5,0	0,3	89	0,2	44	?
The Drammenriver	26	614	25	9,6	1,6	1,0	133	0,13	36	?
Urban runoff from the city	21	777	29	38	2,4	0,5	67	0,2	39	156
Shipyard	9800	11000	740	i.p	i.p	5,3	5400	0,13	1700	?
Industrial area	66	22000	14	120	i.p.	1,7	92	0,69	60	?

Conclusions from sediment and storm water investigation

- Storm water sediments from urban areas contains little contaminants compared with the sediment
- Storm water sediments from some industrial areas contains large concentrations of many contaminants
- Storm water sediments contains many ”new” contaminants
- Storm water run off can be a considerable source of contaminants to the fjord

Suggested remedial efforts for contaminated sediments in the Drammensfjord

1. Urban runoff from industrial areas must be addressed as first priority
2. Identify and control source of PCB in runoff from the city
3. Capping and dredging of contaminated sediments

Summary

- Advantages of sediment sampling from the storm water system to quantify urban run-off of contaminants
  - *Integrated samples*
  - *Sampling from a large number of sites can easily be done*
  - *Low cost equipment*
  - *Site specific data*
  - *Chemical compounds of interest can be quantified*
  - *Method can be used to locate sources of contaminants*
  - *Powerful tool to quantify the contribution of urban run-off as a source of contamination*