Contamination of fjords by urban run-off

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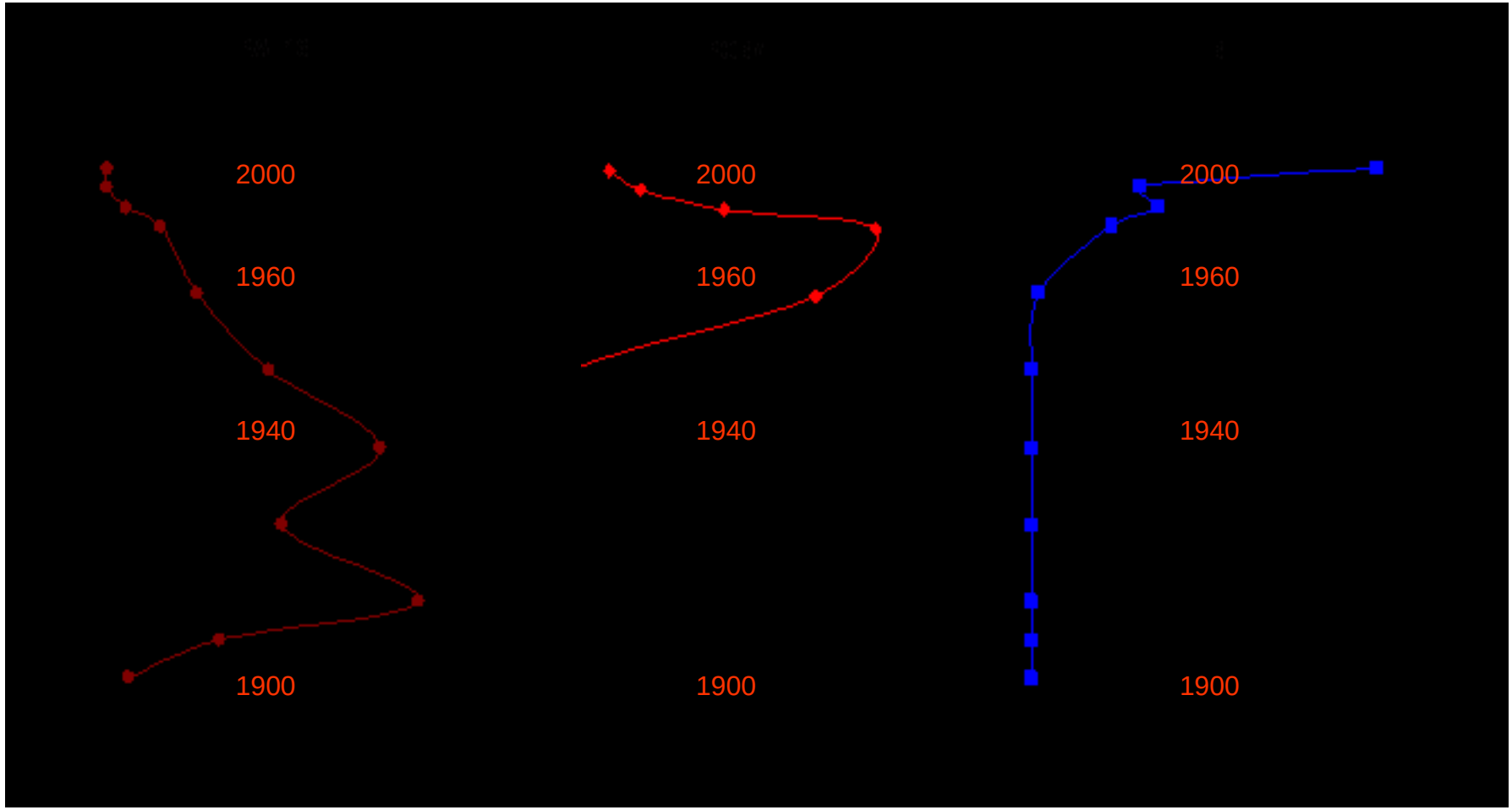
Sediment remediation.
The ambition of a clean fjord.

- Sediments in Norwegian harbors are generally contaminated with heavy metals and organic constituents.
- These contaminants were transported to the sediments by various industrial sources and municipal sewer.
- These historic sources are often strongly reduced
- In the absence of major point sources the sediment themselves are found to be a potential source.

Contaminant profile in sediments



Environmental goals

- Prior to remedial action environmental goals are set
- These goals can be ambitious. The Norwegian sediment quality criteria class II is in several project defined as the desired level of contaminants in the seabed after remediation.

Parametre	Tilstandsklasser				
	I Ubetydelig–Lite forurenset	II Moderat forurenset	III Markert forurenset	IIV Sterkt forurenset	V Meget sterkt forurenset
Arsen (mg As/kg)	<20	20-80	80-400	400-1000	>1000
Bly (mg Pb/kg)	<30	30-120	120-600	600-1500	>1500
Fluorid (mg F/kg)	<800	800-3000	3000-8000	8000-20000	>20000
Kadmium (mg Cd/kg)	<0.25	0.25-1	1-5	5-10	>10
Kobber (mg Cu/kg)	<35	35-150	150-700	700-1500	>1500
Krom (mg Cr/kg)	<70	70-300	300-1500	1500-5000	>5000
Kvikksølv (mg Hg/kg)	<0.15	0.15-0.6	0.6-3	3-5	>5
Nikkel (mg Ni/kg)	<30	30-130	130-600	600-1500	>1500
Sink (mg Zn/kg)	<150	150-700	700-3000	3000-10000	>10000
Sølv (mg Ag/kg)	<0.3	0.3-1.3	1.3-5	5-10	>10
TBT ** [1] (µg/kg)	<1	1-5	5-20	20-100	>100
Σ PAH [2] (µg/kg)	<300	300-2000	2000-6000	6000-20000	>20000
B(a)P [3] (µg/kg)	<10	10-50	50-200	200-500	>500
HCB [4] (µg/kg)	<0.5	0.5-2.5	2.5-10	10-50	>50
Σ PCB$_7$** [5] (µg/kg)	<5	5-25	25-100	100-300	>300
EPOCl [6] (µg/kg)	<100	100-500	500-2000	2000-15000	>15000
TE$_{PCDF/D}$ [7] (ng/kg)	<0.01*	0.01-0.03	0.03-0.10	0.10-0.5	>0.5
Σ DDT** [8] (µg/kg)	<0.5	0.5-2.5	2.5-10	10-50	>50

Management tools

- There is a need for management tools in the process of defining realistic level of ambition including
  - Are there any active sources of contaminants?
  - Will sediment remediation be the optimal solution to reach the goals?
  - Should sources on land be restored as the first priority?
  - What is the natural background level in urban areas?
  - Are the environmental goals realistic?

Management tools

- Quantifying the contamination of fjords by urban run-off
- Industrial and urban areas
- Transport of particulate matter from surfaces
- Need to be combined with other methods
  - Sediment investigations
  - Flux measurements
  - Risk assessment
  - Cost/benefit analysis

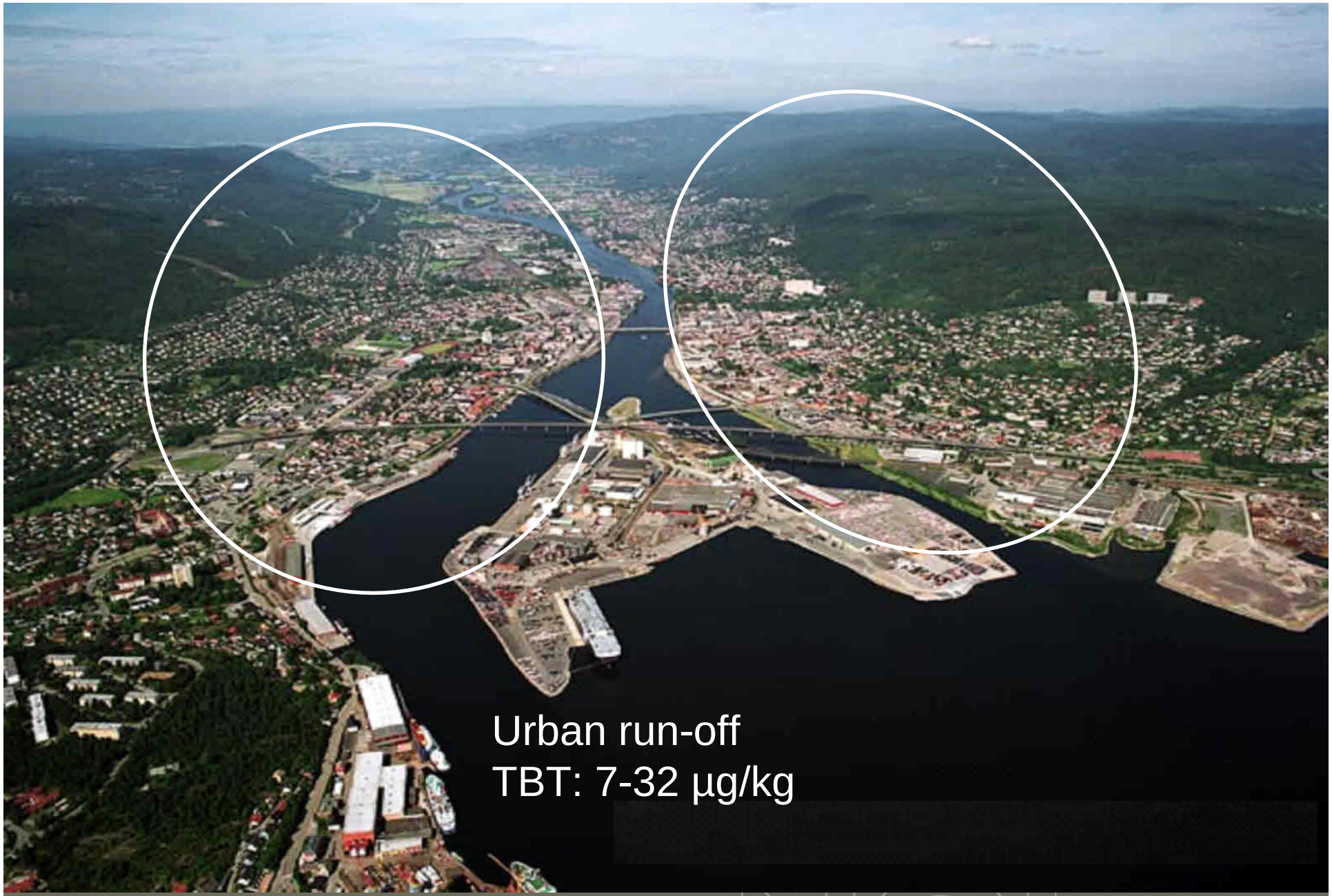
A case: Port of Drammen
Remedial plan of the Drammensfjord

- Sediments are found to represent an unacceptable environmental risk.
- Define the optimum remedial efforts.
  - Is source control at a satisfactory level
  - Should the remedial effort be focused on land sources or or contaminated sea sediments
- Extensive data collection
  - Characterization of particulate load from rivers
  - Run-off from urban areas
  - Run-off from industrial areas
  - Flux quantification by sediment traps
  - Sediment sampling
- Data collection from one year to cover annual variations


Sediment
TBT: 300-2700 µg/kg


Fresh Sedimenting material
TBT: 360-670 µg/kg


River transported matter
TBT: 60-230 µg/kg


Urban run-off
TBT: 7-32 µg/kg


Shipyard and industry
TBT: 200-11000 µg/kg

Goal for improvement

Assessment

Compound	Sediment	Sedimenting material	River	Urban run-off	Run-off industrial area
PAH (mg/kg)	3,0-4,8	1,4-2,6	0,1-1,0	0,2-1,0	1,7-16
TBT (µg/kg)	300-2700	360-670	60-230	7-32	200-11000
DBT (µg/kg)	60-300	170-240	95-210	8-41	100-2300
MBT (µg/kg)	15-43	75-119	60-120	9-45	60-1300

Low contribution from land

Assessment

Compound	Sediment	Sedimenting material	River	Urban run-off	Run-off industrial area
PAH (mg/kg)	3,0-4,8	1,4-2,6	0,1-1,0	0,2-1,0	1,7-16
TBT (µg/kg)	300-2700	360-670	60-230	7-32	200-11000
DBT (µg/kg)	60-300	170-240	95-210	8-41	100-2300
MBT (µg/kg)	15-43	75-119	60-120	9-45	60-1300

Fresh sediment still contaminated

Assessment

Compound	Sediment	Sedimenting material	River	Urban run-off	Run-off industrial area
PAH (mg/kg)	3,0-4,8	1,4-2,6	0,1-1,0	0,2-1,0	1,7-16
TBT (µg/kg)	300-2700	360-670	60-230	7-32	200-11000
DBT (µg/kg)	60-300	170-240	95-210	8-41	100-2300
MBT (µg/kg)	15-43	75-119	60-120	9-45	60-1300

Assessment

Source control not sufficient
1. priority

Compound	Sediment	Sedimenting material	River	Urban run-off	Run-off industrial area
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TBT (µg/kg)	300-2700	360-670	60-230	7-32	200-11000
DBT (µg/kg)	60-300	170-240	95-210	8-41	100-2300
MBT (µg/kg)	15-43	75-119	60-120	9-45	60-1300

2. priority

Assessment

Compound	Sediment	Sedimenting material	River	Urban run-off	Run-off industrial area
PAH (mg/kg)	3,0-4,8	1,4-2,6	0,1-1,0	0,2-1,0	1,7-16
TBT (µg/kg)	300-2700	360-670	60-230	7-32	200-11000
DBT (µg/kg)	60-300	170-240	95-210	8-41	100-2300
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Achievable results

Assessment

Compound	Sediment	Sedimenting material	River	Urban run-off	Run-off industrial area
PAH (mg/kg)	3,0-4,8	1,4-2,6	0,1-1,0	0,2-1,0	1,7-16
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Summary

- Urban run-off is a source of contamination and should be included when considering sediment remediation
- Characterization of sources necessary for the proper assessment of priority of remedial action
  - Active sources found in Drammen
  - Source control and source tracing must continue
- The methods allow realistic identification of environmental goal
- The use of sediment quality criterion (class II) is not very realistic, especially for TBT
- Natural recovery could be a remediate alternative as a result of high material transport from rivers in the Drammen area

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The contribution of urban runoff to organic contaminant levels in harbour sediments near two Norwegian cities

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THANK YOU FOR YOUR ATTENTION