Sediment transport in Norwegian rivers and anthropogenic impacts.

Case studies of importance to sediment management plans

1. Natural background sediment yields
2. Impact of hydropower development
3. Impact of erosion protection works
4. Long term dispersion of mine waste

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NORWAY AREA

Mountains and glaciers 48%

Lakes 4%

Marshes and impediment 23%

Forests 22%

Cultivated 3%
Sediment yield of Norwegian rivers

Spesific sediment yield of various source areas:

<table>
<thead>
<tr>
<th></th>
<th>Clay</th>
<th>Glacier</th>
<th>Agric</th>
<th>Moun</th>
<th>Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>1016</td>
<td>3789</td>
<td>160</td>
<td>34</td>
<td>2</td>
</tr>
<tr>
<td>Water discharge</td>
<td>525</td>
<td>160</td>
<td>160</td>
<td>34</td>
<td>2</td>
</tr>
</tbody>
</table>

Selected example: river Atna:
Concentration and water discharge

Annual mean transport
Sediment transport Svartisen power plant
Rule of operation determine flux

Satellite image 1999

Svartisen power station
Storglomvatn - reservoir
New generator 2008 – give more sediments
Construction of dam
Drawdown of reservoir

Graph: Sediment transport Svartisen kraftverk

- Bars for years 1987 to 2007
- Y-axis: Gt tons
- X-axis: Years

- 1987 to 1991: 0 to 10,000 Gt tons
- 1992 to 1995: 10,000 to 20,000 Gt tons
- 1996 to 1999: 20,000 to 30,000 Gt tons
- 2000 to 2003: 30,000 to 40,000 Gt tons
- 2004 to 2007: 40,000 to 50,000 Gt tons

Legend:
- Red: 1987 to 1991
- Blue: 1992 to 1995
- Yellow: 1996 to 1999
- Purple: 2000 to 2003
- Pink: 2004 to 2007
• Water $m^3/s$

Suspended mg/l

[Graph showing water discharge and suspended sediment levels over time, with peaks and valleys indicating variations in water discharge and sediment concentration.]
SVARTISEN POWER PLANT
Diversion tunnels and intakes

Reservoir volume: 3500 mill m³
Drawdown: 125 m
Hydraulic head: 585 m
45 Intakes

CONTRIBUTION FROM SEDIMENT SOURCES
NORDFJORD 1994-1995

Reservoir erosion
Reservoir glaciers
Southern tunnel
eastern tunnel

Intake
Fluvial erosion has triggered numerous large quick-clay slides. Erosion protection works have been made to prevent major slides.
To prevent channel degradation the river bed was covered by an armouring layer.
Erosion protection works did reduce the sediment load.
Suspended sediment concentration and water discharge
Dispersion of mine waste in the Glomma river basin - 40 000 km²

Copper mines 300 yrs in upper part

The Øyeren delta
The copper concentrations in the overbank sediment of the Øyeren delta is increasing with time.
Large magnitude floods convey Cu - sediments

• Floods in lake Øyeren since 1789
Conclusions

- Largest natural background sediment yields in glacier-fed rivers and clay areas
- Hydropower development caused significant increase in sediment load
- Sediment load was decreased due to erosion protection works
- Copper concentration of floodplain sediments increase due to long term dispersion of mine waste