Sediment management and reservoir flushing in Austria

Gabriele Harb
Sediment management in reservoirs

- Deposition control
- Removal of deposited sediments - desilting
- Compensation of reservoir silting

Quelle: Batuca & Jordaan, Silting and Desilting of Reservoirs, 2000; modified
Sediment management in reservoirs

Deposition control

Conservation measures in the catchment area

Reduction of the sediment inflow rate

Reduction of sediment deposition

Soil conservation:
- non-structural measures: vegetative practice, ..
- structural measures: diversion canals for agriculture, ...
- Sediment trapping reservoirs
- River regulation works
- Slope and bank protection works
- Bypassing structures
- Off-stream reservoirs

- Sediment sluicing
- Turbidity currents venting

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Sediment management in reservoirs

Removal of deposited sediments - desilting

Hydraulic removals
- Flushing
- Sediment Syphoning
- Slottet Pipe Sediment Sluicer

Mechanical removals
- Dredging
- Excavation
Reduction of sediment inflow rate

- Bank and slope protection works
- River regulation works
- Groynes and/or guidewalls
- Energy dissipating structures
- Sediment trapping structures
- Sediment bypass

(Morris und Fan 1998)
Hydraulic Removal - Flushing

- min. discharge approx. 50%-70% of the 1-year-flood
- Rainfall-runoff-forecast of the catchment
- Lowering of the water level at the weir:
  - Begin at the raising part of the flood wave to prevent an increase of the flood risk downstream
- Flushing process with observation of:
  - Suspended load concentration
  - Runoff-forecast of the discharge
  - Interruption in case of too high concentration rates
- Closing of the gates according to available discharge
Mechanical Removal

- **Dry dredging**
  Advantages: economical, short duration of work, equipment available
  Disadvantages: restricted to low-flow period (especially in winter), partial filling necessary, greater adverse ecological impact

- **Wet dredging**
  Advantages: continuous evacuation at top water level, less adverse ecological impact, flexible timing possible
  Disadvantages: higher costs, longer duration of work, special equipment required

- **Suction dredging**
  Advantages: continuous evacuation at top water level, less adverse ecological impact, independent timing
  Disadvantages: higher costs, special equipment needed, intermediate storage and drainage facilities required
Mechanical Removal

- **Redistribution in the river**
  reservoir: shallow-water or/and ecological zones, limited downstream: in case of longer free flow stretches

- **Utilization**
  construction material (concrete)
  fill material

- **Dumping ground**
  dumping ground necessary, transport, environment, costs
Sediment management in reservoirs

- Adding of new sluicing facilities
- Changing of the operation management

Compensation of reservoir silting

Reorganisation of operation

Raising the dam

New reservoir

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**Basic information for decision**

- Kind and geometry of the reservoir, HPP and the river downstream?
- Hydrological parameters?
- Grain-size-distribution in the reservoir and in the river?
- Deposition rates, bed load and suspended load fractions?
- Necessary duration of the measures?
- Contamination of the sediments?
- Volume concentration of sediments in case of normal operation and flood events?

**AIM:** Rehabilitation of the sediment balance and sediment connectivity in the river

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Selecting or combination of measures!
Basic information for decision

- Kölnbrein
- Pernegg-Zlatten/Mur
- Schütt/Gail
- Mürzzuschlag/Mürz
- Bodendorf/Mur
- Ybbs-Persenbeug/Danube

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PILOT CASE - SEE HYDROPOWER

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Hydropower Plant Leoben

The total volume of the reservoir is 0.36 mil m³.  
• Hydropower generation -9.9 MW  
• Fish pass (minimum) – 0.3 m³/s  
• Annual sedimentation rate of 5.5%  
The hydropower generation is the only use.
Status Quo

No flushing since the start of operation due to regulations
Difference in the storage volume between 06.2010 u. 03.2006:
77.339 m³ (5% annual sedimentation rate)

Mur

Mean annual discharge (MQ): 79.76 m³/s lt. Government of Styria
design discharge: 150 m³/s
1-year flood: 335 m³/s
5-year flood: 510 m³/s
10-year flood: 580 m³/s
30-year flood: 750 m³/s
100-year flood: 930 m³/s

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Geometrie Telemac2D

45,000 triangle elements with 2.5m edge length
conversation of the natural break lines
Profil weir

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Additional input data for flood risk analysis
Flow field 100-year flood
Sediment transport 100-year flood

0 Days 00:00:00
Flood risk 100-year flood (930m³/s)

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Flood risk 100-year flood (930m3/s)
Bed shear stress 1-year flood

water level at maximum operation level

water level 1.8m lowered
## Evaluation of the flushing impact

<table>
<thead>
<tr>
<th>before flushing</th>
<th>during flushing</th>
<th>after flushing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphology in the reservoir/tailwater/downstream</td>
<td>Oxygen concentration</td>
<td>Photo documentation</td>
</tr>
<tr>
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<td>Sediment concentration</td>
<td>Fish population in the reservoir and downstream</td>
</tr>
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<td>Sediment concentration</td>
<td></td>
<td>Macrobenthos</td>
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<tr>
<td>Fish population in the reservoir and downstream</td>
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<tr>
<td>Fish population in a reference stretch</td>
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<tr>
<td>Macrobenthos</td>
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<tr>
<td>Water quality</td>
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<tr>
<td>Acoustic sounding of the river bed</td>
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<td>Acoustic sounding of the river bed</td>
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<tr>
<td>Grain-size-distribution in the reservoir</td>
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<tr>
<td>Oxygen conditions</td>
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</table>

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## Reference project Alpreserv

<table>
<thead>
<tr>
<th></th>
<th>Year 0</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4+</th>
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</thead>
<tbody>
<tr>
<td><strong>Flushing</strong></td>
<td></td>
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<tr>
<td>Spring (April-Mai)</td>
<td>--</td>
<td>&gt;61/100 m³/s</td>
<td>&gt;61/100 m³/s</td>
<td>&gt;69/123 m³/s</td>
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<tr>
<td>Early Summer (Juni-Juli)</td>
<td>&gt;61/100 m³/s</td>
<td>&gt;61/100 m³/s</td>
<td>&gt;69/123 m³/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Summer (Aug.-Sept.)</td>
<td>&gt;61/100 m³/s</td>
<td>&gt;61/100 m³/s</td>
<td>&gt;69/123 m³/s</td>
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</tr>
<tr>
<td><strong>Total Opening</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Broader Time Window</strong></td>
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<td></td>
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<td></td>
<td>&gt;100/230 m³/s, throughout the entire year</td>
</tr>
</tbody>
</table>

The flow is related to start of lowering the reservoir / start of total opening.

Further adaptation to ecological and water management parameters

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**Gabriele Harb** (Graz University of Technology)
DI Gabriele Harb

Institut für Wasserbau und Wasserwirtschaft

Technische Universität Graz

Stremayrgasse 10

8010 Graz, Österreich

gabriele.harb@tugraz.at