Restoration concepts for large rivers – experiences from the Danube

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Scope

1. Danube – a major W-E corridor in Europe
2. major river engineering works, ecological consequences
3. restoration scenarios: scope, approaches, constraints
4. developing guidelines
Danube – a major W-E corridor in Europe

- Length: 2,900 km
- Catchment area: 805,000 km²
- Mean discharge at mouth: 6,500 m³/sec.
River engineering - chain of dams, regulation

River km
Immediate effects:
- loss of
  - riverine inshore zones
  - hydrol. connectivity
  - geomorphic processes
Long-term consequences of river regulation
Restoration scenarios

1. Vienna–Bratislava  
2. Lobau  
3. Bratislava–Budapest

- environmental state  
- restoration scope and reversibility  
- stakeholder interest  
- constraints
Scenario 1: Vienna to Bratislava
floodplain scenarios:
- ecological state
- connectivity
- reversibility

“Integrated River Engineering Programme”
Restoration goal: sidearm reconnection

A first large scale pilot programme (Schiemer et al. 1999)

1. Lowering of riverside embankments
2. Increasing flow capacities between floodplain lakes
Restoration goal: rehabilitation of inshore zones

Inshore Retention Concept
Schiemer et al. 2001
Navigation:

Pan European Transport Corridor
Requested navigation corridor: 120m x 3.2m

MLWL-regulation achieved by:
- gravel excavation
- groynes
Approach to resolve controversy

- Scientific board (ecologists, hydrologists, navigation experts, socio-economists)

- Planning team (civil engineers plus ecology consultants)

- Stakeholders

- Public participation
3 years process

joint planning principles

12 scenarios

ecological benchmarking
Achieved compromise

1. reduced waterway transect:
   100x2.7m instead of 120x3.2 m

2. added restoration measures:
   a) “granulometric bed improvement” (N,E)
   b) river bank restoration (E)
   c) side arm reconnection (E)

EIA, Implementation 2008 - 2020
Bratislava-Budapest

“Strategic environmental impact assessment”
Directive 2001/42/EC
A general “standard operating procedure” (SOP) for Large River Restoration

1. Legal framework
   - “Water Framework directive” 2000/60/EC
   - “Habitats Directive” (92/43/EC)

2. Guidelines for a scientific approach

3. Integrated planning approach
Guidelines for a scientific approach to large river rest.

1. reference standards, hierarch. framework of application
2. ecological targets, reversibility and sustainability
3. formulation of prognostic eco-hydrological parameter
4. interdisciplinary monitoring programmes
**Restoration**

“re-establishment of predisturbance aquatic functions and related physical, chemical and biological characteristics”

**Reference standard**

Original landscape pattern as the dynamic equilibrium of fluvial processes; defined by geomorphology, hydrology and bed load transport
Hierarchical framework to be followed in the application of reference standards

- **key processes**
  (hydrology & geomorphic dynamic)

- **landscape composition**
  dynamic equilibrium in habitat composition & connectivity

- **Characteristic ecological processes**
  and biotic diversity
Development and promotion of restoration

- Scope and necessity for restoration high (acc. WFD)
- Legal framework not sufficient to promote programs with exclusively environmental orientation
- Strong stakeholder interests for: flood control, water abstraction, navigation, (hydropower)
- From a conservationist point of view it is necessary to build alliances and develop win-win situations
Integrative Planning Approach

- interdisc. teams (experts, planners)
- define planning objectives & priorities
- transparent planning process
- stepwise, adaptive implementation

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The functional response between connectivity and biodiversity
„Regelsbrunn“ before restoration

The graph shows the connectivity (months) on the x-axis and the species number on the y-axis. The species are classified into three categories: macrophytes, molluscs, and rheophilic fish. The graph indicates a decrease in macrophytes and an increase in molluscs and rheophilic fish over the months.
„Regelsbrunn“ after restoration

![Graph showing the recovery of species numbers and connectivity over time.](Image)
Scenario: Lobau

Restoration goals:

- maintaining wetlands by water enhancement
- upstream connection with the river

Stakeholders:

- flood control
- drinking water supply

Resolution:

- interdisciplinary planning process

Implementation: 2012?
Functional response of limnological parameters to „water-age“

![Graph showing the relationship between water age and Chl a, PIM, PO4 concentrations.](image)

- Chl a, PIM, PO4 (µg l⁻¹)
- Water age (days)
- Connected
- Disconnected
- Flooding

Graph labels:
- Chl a
- PIM
- PO4
Functional response of limnological parameters to „water-age“

- **Chl a, PIM, PO₄ (µg l⁻¹)**
- **Water age (days)**

Graph showing the change in Chl a, PIM, and PO₄ concentrations over time (water age) in a flooded and disconnected water system.
Functional response of limnological parameters to „water–age“

Water age (days)

Chl a, PIM, PO4 (µg l⁻¹)

flooding

connected
disconnected

0 10 20 30 40 50 60

Chl a

PIM

PO4

water age (days)
Chl $a$, PIM, PO$_4$ ($\mu$g l$^{-1}$)

Bakterien ($\mu$g C l$^{-1}$)

flooding

connected
disconnected

water age (days)

Bakterien
Chl $a$
PIM
PO$_4$
Scenario: Bratislava - Budapest

Ecological requirements:
  - water diversion

Stakeholder:
  - national politics
  - hydropower: Slovakia yes, Hungary no
  - navigation

Resolution:
  “strategic environmental impact assessment”
  Directive 2001/42/EC
## Comparison of scenarios

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Scenario 2: urban floodplain Lobau
1.5 m$^3$ s$^{-1}$

- Drinking water abstraction
- Backflow of floods

Levees
80 m³ s⁻¹

1,5 m³ s⁻¹

drinking water abstraction

backflow of floods

levees
Integrative Planning Approach

1. Restoration planning steps based on „Scientific guidelines“

   - assess deficiencies
   - assess irreversible changes
   - define constraints by other water uses
   - delineate ecol. targets
   - assess feasibility of restoration measures
   - predict long-term dynamic endpoints
2. Recommended approach

- interdisc. teams (experts, planners, managers)
- transparent planning process
- define planning objectives, priority ranking
- stepwise, adaptive implementation
- interdisciplinary monitoring programmes