The Christian-Doppler-Laboratory for Advanced Methods in River Monitoring, Modelling and Engineering and related ideas for the common implementation of the Danube Strategy

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Contents

1. Introduction
2. Danube River – pressures and impacts
3. The CD Laboratory for Advanced Methods in River Monitoring, Modelling and Engineering
4. Ideas for the common implementation of the Danube Strategy
Existing situation at large rivers

- Multifunctional demands: energy supply, navigation, drinking water supply, flood protection, ecology, tourism etc.
Danube Basin
Catchment area: 801.463 km²
Length: 2.857 km
Mean discharge: 6.500 m³ s⁻¹

Legende
- Hydraulic Structures
- Danube
- Tributaries
- Country border

UPPER DANUBE
MIDDLE DANUBE
LOWER DANUBE
DANUBE DELTA
Existing Situation

Driving forces and impacts – Danube River Basin

- Hydropower plants
- Flood protection
- Navigation
- Climate change
- Changes in land use
- Point and diffuse source pollution
Hydroelectric Energy

Danube River Basin – Hydropower

78 barriers along the Danube
5 free-flowing sections

Schiemer et al., 2004
International Waterway

Danube River Basin - Navigation

2411 km navigable (Sulina-Kelheim)

Waterway transport in the Danube aims to be increased from 10 mio to 30 mio t/year (e.g. in Austria)
Flood Risk Management

Danube River Basin – Flood protection

Ecological potential of floodplains in the Danube River Basin

Loss of 80% of the original floodplain area
River Bed Degradation

*Upper Danube - Consequences*

Danube bed degradation: despite an artificial gravel supply of up to 200,000 m³/year river bed erosion of 2 cm/year East of Vienna
River Morphology

**Hydromorphological conditions**

Overall total hydromorphological assessment in five classes – longitudinal visualisation

1/3 good hydromorphological conditions

1/3 strongly altered

Upper Danube - most affected by significant hydromorphological changes

ICPDR, JDS, 2008
Lower Danube

Hydromorphological situation

Originally partially anastomosing morphology, sandbed river

Actual situation:

- Bifurcations
- Wide sections
- Islands

Island development

Side / bank erosion

Number of islands increased from 93 (1934) to 135 (1992)

Bondar & Teodor, 2008
Habersack et al., 2010
The CD-Laboratory for Advanced Methods in River Monitoring, Modelling and Engineering

Aims

- Development of *innovative methods* for the improvement of river monitoring (shear stress, sediment transport, morphodynamics etc.)
- Development and programming of *numerical models* (3D hydrodynamics, sediment transport and habitat modelling)
- Development and optimisation of *river engineering measures* to minimize river bed degradation, improve navigation, flood protection and ecology
Overview of modules

- MODULES
  1 – River Monitoring
  2 – River Modelling
  3 – River Engineering
River Monitoring


River Modelling

3D-Hydrodynamics

Flow field

Particle Tracing

Sediment transport

- Suspended sed., bedload
- Lagrange' modelling by particle tracing
- Euler modelling by new sediment transport model

→ Habitat modelling


River Engineering

Existing groins

Modified groins

Side erosion

Sediment Input

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Before…

…after river bank restoration

Via donau, donauconsult

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Ideas for Danube Strategy (1)

(1) Connecting the Danube Region
To improve mobility and multimodality
(a) Inland Waterways
(b) Road, rail and air links
To encourage more sustainable energy
To promote culture and tourism, people to people contacts

(2) Protecting the Environment in the Danube Region
To restore and maintain the quality of waters
To manage environmental risks
To preserve biodiversity, landscapes and the quality of air and soils

(3) Building Prosperity in the Danube Region
To develop the knowledge society through research, education and information technologies
To support the competitiveness of enterprises, including cluster development
To invest in people and skills

(4) Strengthening the Danube Region
To step up institutional capacity and cooperation
To work together to promote security and tackle organised and serious crime
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Ideas for Danube Strategy (2)

Research Infrastructure Needs

- two large hydraulic and environmental engineering laboratories: one in the upper/middle part of the Danube (Responsible River Modelling Center RRMC) and one in the lower part (Hydraulic Engineering Lab); the reason for two labs (upstream/downstream): gravel bed vs sand bed river, up to ten times slope difference and different problem areas

- cluster/network of river engineering simulation tools to be used by Danube countries (common software development and implementation), being applied both on computer clusters and individual servers
Ideas for Danube Strategy (3)
Research Infrastructure Needs

- Network of field study sites along the Danube River (each country should nominate a certain river stretch, specific problem area, work program etc.) for process analysis, model calibration and validation AND test of advanced river engineering solutions (examples, to be commonly agreed on: Austria: National Park Donauauen, Slovakia: Reservoir Gabcikovo, Hungary: Mosoni Danube, Serbia, Croatia: Kopacki Rit, Romania, Bulgaria: border section).

- Research diving shaft for the whole Danube (e.g. operated by Serbia)
Ideas for Danube Strategy (4)

Research Infrastructure Needs

- Especially for optimizing river engineering measures there are infrastructural needs for performing large scale hydraulic models, being able to simulate the hydrodynamic, sediment transport, morphodynamic and ecological situation in the various parts of the Danube Basin. Therefore adequate hydraulic and environmental engineering laboratories should be available.

- Key data:
  - Large discharge (about 5 m$^3$ s$^{-1}$)
  - Water level difference → water supplied free flowing
Suggestion for two large hydraulic and environmental engineering laboratories

Upper and Middle Danube
Responsible River Modelling Center RRMC

Lower Danube
Hydraulic Engineering Lab
Idea for Upper and Middle Danube Danube
3-5 m water level difference
5 m$^3$s$^{-1}$ laboratory discharge

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