Adaptation and mitigation of inland waterways to weather extremes

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Weather related effects on infrastructure (1)

- **Drought:**
  - Water levels low =>
    - insufficient navigation conditions
  - Increase in accidents (grounding)
  - low flow velocities => little sedimentation
  - Recent examples for drought: 2003, 2011

![Distribution of daily water levels at the gauge Wildungsmauer on the Austrian Danube in 2006.](image)

![Development of grounding events on the Upper and Central Rhine within 2002 and 2009. Based on WSD Südwest.](image)
Weather related effects on infrastructure (2)

- High water and floods:
  - Suspension of navigation
  - Changes in river morphology
  - Sedimentation
    - Aschach on the Danube:
      - 13.8.2002: 1,800,000 m³
      - Total in 2002: 5,000,000 m³
  - Aggradation
  - Damage of towpaths
  - Damage of banks and flood protection installations

Changes in the river cross-section geometry of the Danube at river kilometre 1887.1 in 2002, being partly caused by the flood in August.
Weather related effects on infrastructure (3)

• Ice:
  • Suspension of navigation
  • Prevented operation of locks
  • Damage of navigation signs

Ice occurrence in locks on the Danube preventing their operation. Source: via donau.
Waterways – system elements

- General dimensions (width, depth)
- Impounded or free-flowing stretch
- Hydromorphological characteristics (incline, flow velocity, river bed material, sediments balance)
- Dimension of the navigation fairway as part of the river

River
(hydromorphology)

Waterway infrastructure
(groins, training walls, rip-rap)

Water
(temporal distribution)

- Position of river engineering elements (groynes, training walls, rip-rap) in the river (in free flowing sections)
- Position of dams (for impounded sections)

- Temporal distribution of water discharge (e.g. reference period one year) at selected cross sections of the river
Waterway infrastructure (1)

- Training wall
- Groyne
Waterway infrastructure (2)

Rip-Rap  Source:http://www.orn.usace.army.mil/cof/Copy%20of%20Copy%20of%20MVC-021S.JPG}
Fairway maintenance (1)

Fairway maintenance cycle

**Surveying**
- Continuous monitoring and general bathymetrical survey of the fairway in order to identify shallow areas (fords)
- Detailed bathymetrical survey of shallow areas in order to plan and monitor dredging measure

**Information**
- Continuous information on the current status of the fairway for the clients = navigation sector
- Different tools: Notices to Skippers, websites, locks, electronic navigational charts

**Dredging**
- Dredging of shallow area (ford) by assigned dredging company
- Monitoring (Success control) of works: Bathymetrical survey of dredged area
- Internal documentation and external communication to target groups (e.g. shipping companies)

**Planning**
- Planning of necessary dredging works in identified shallow areas (fords), based on results of detailed bathymetrical survey
- Contracting of works - assignment of dredging company
Fairway maintenance (2)

Improved fairway information. Source: via donau.
Example infrastructure adaptation pilot project Witzelsdorf (1)

River bank restoration and removal of the existing groyne field

By-pass route for young fish and for reducing sedimentation in the groyne field

Smaller scour at the groyne head

New downstream-facing groynes lead to higher dynamics along the river bank

innovative groyne shapes – advantages for ecology and navigation by interdisciplinary planning

- Removal of old groynes and river bank restoration
- Construction of new groynes
Example infrastructure adaptation pilot project Witzelsdorf (2)
Climate change effect 2021-2050

Danube at Vienna

Source: Kliwas

Conclusions

• Projected climate change effects minor, but extreme events today

• Measures with significant effect on nature problematic

• Integrative approach recommended (e.g. Joint Statement)

• First measures to be taken now (improved maintenance)
  • High potential for improvement related to waterway management and usage of ICT

• On medium and long term:
  • infrastructure measures (e.g. groynes)
  • Implementation of TEN-T priority projects in EU
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