

## Infrastructure measures

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- Weather related effects on infrastructure
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# OBJECTIVES



- Identify and analyze suitable **adaptation strategies** to climate change with regard to the **waterway infrastructure**
- Strategies for **short term adaptation** (continuous maintenance works) and for **medium/long term adaptation** (structural infrastructure measures)
- Adaptation strategies for **different rivers** resp. stretches (Rhine and Danube)

# Weather related Effects on Infrastructure

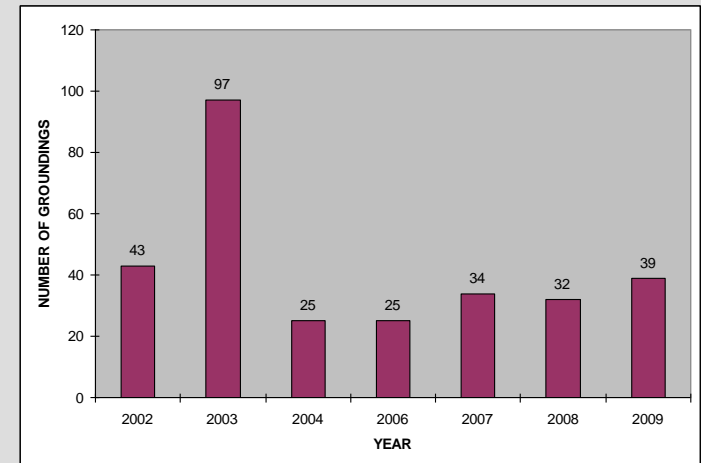


- **Drought:**

- 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.

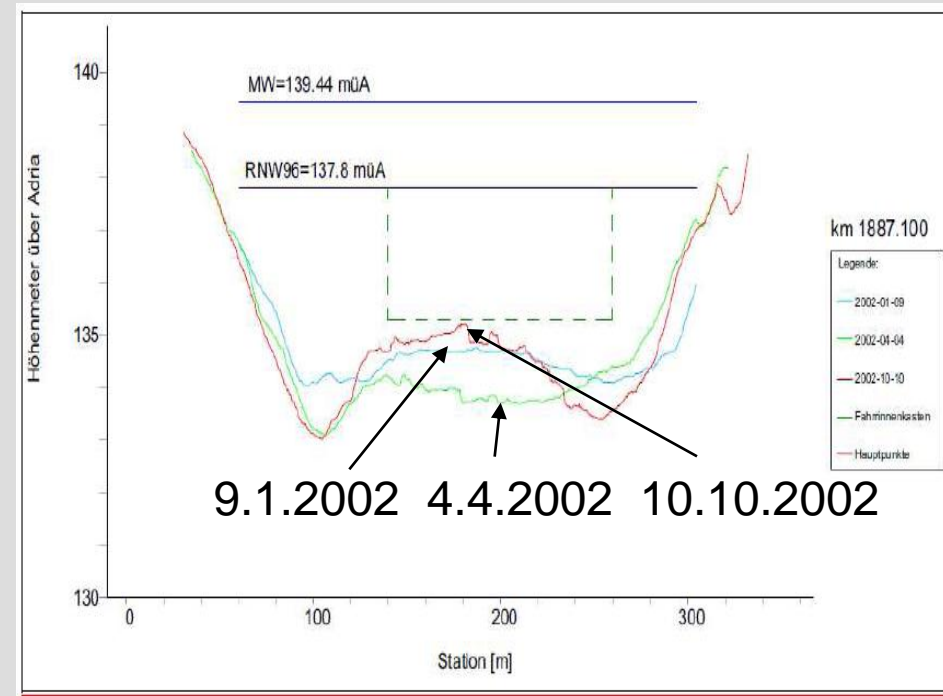


Development of grounding events on the Upper and Central Rhine within 2002 and 2009. Based on WSD Südwest.

# Weather related Effects on Infrastructure



- **High water and floods:**
  - Suspension of navigation
  - Changes in river morphology
  - Sedimentation
    - Aschach on the Danube:
      - 13.8.2002: 1 800 000 m<sup>3</sup>
      - Total in 2002: 5 000 000 m<sup>3</sup>
  - Aggradation
  - Damage of towpaths
  - Damage of banks and flood protection installations
  - Recent example: August 2002
  - Costs e.g.:
    - Austrian Danube: 3 Mill EUR (2002)
    - and 2 Mill EUR (2003)
    - Total transport infrastructure: 110 Mill EUR



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



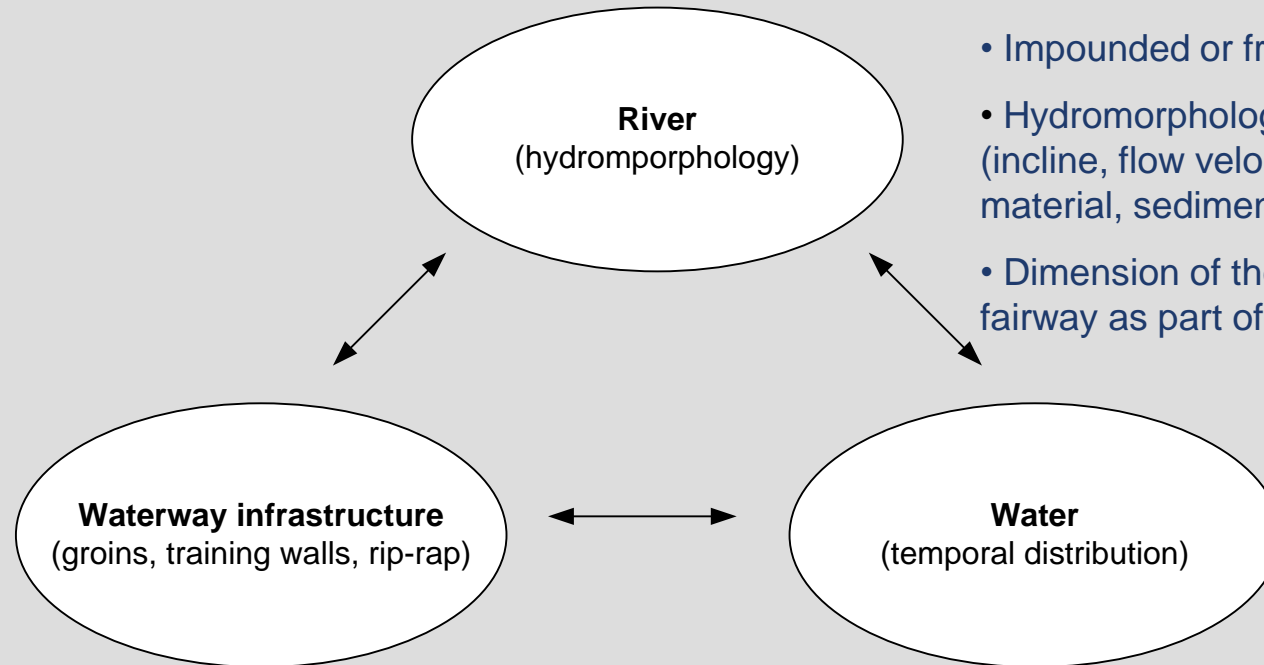
- **Ice:**

- 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

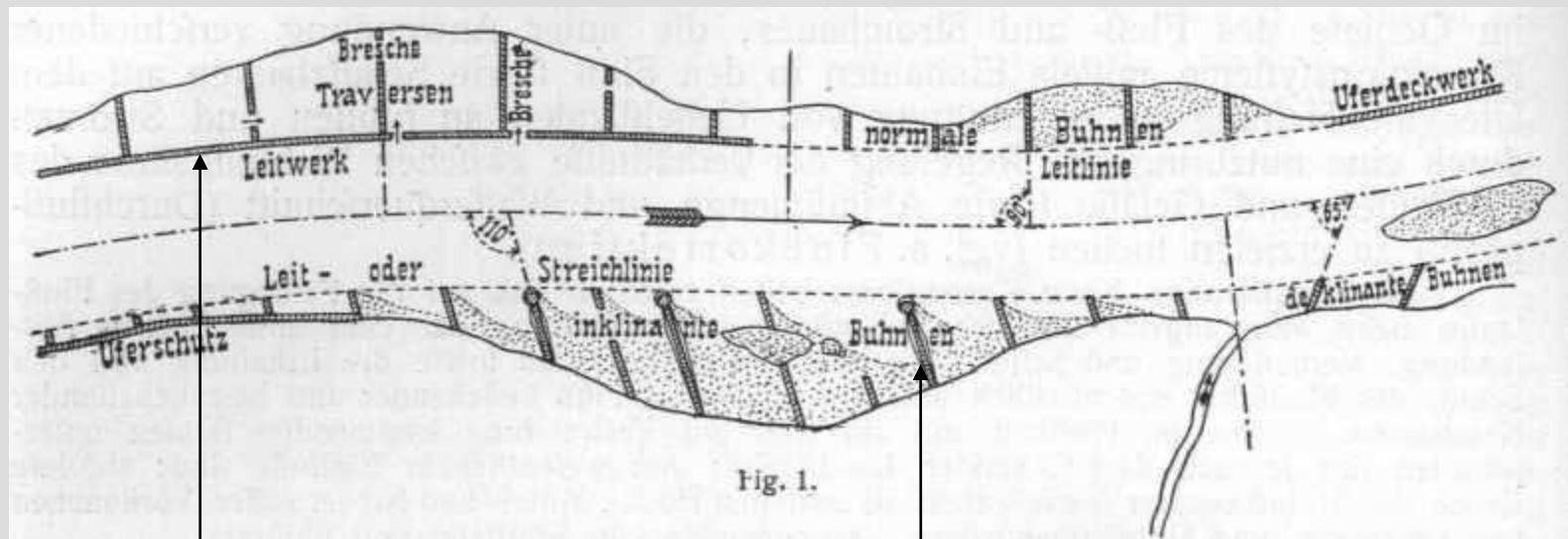


- General dimensions (width, depth)
- Impounded or free-flowing stretch
- Hydromorphological characteristics (incline, flow velocity, river bed material, sediments balance)
- Dimension of the navigation fairway as part of the river

- 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)

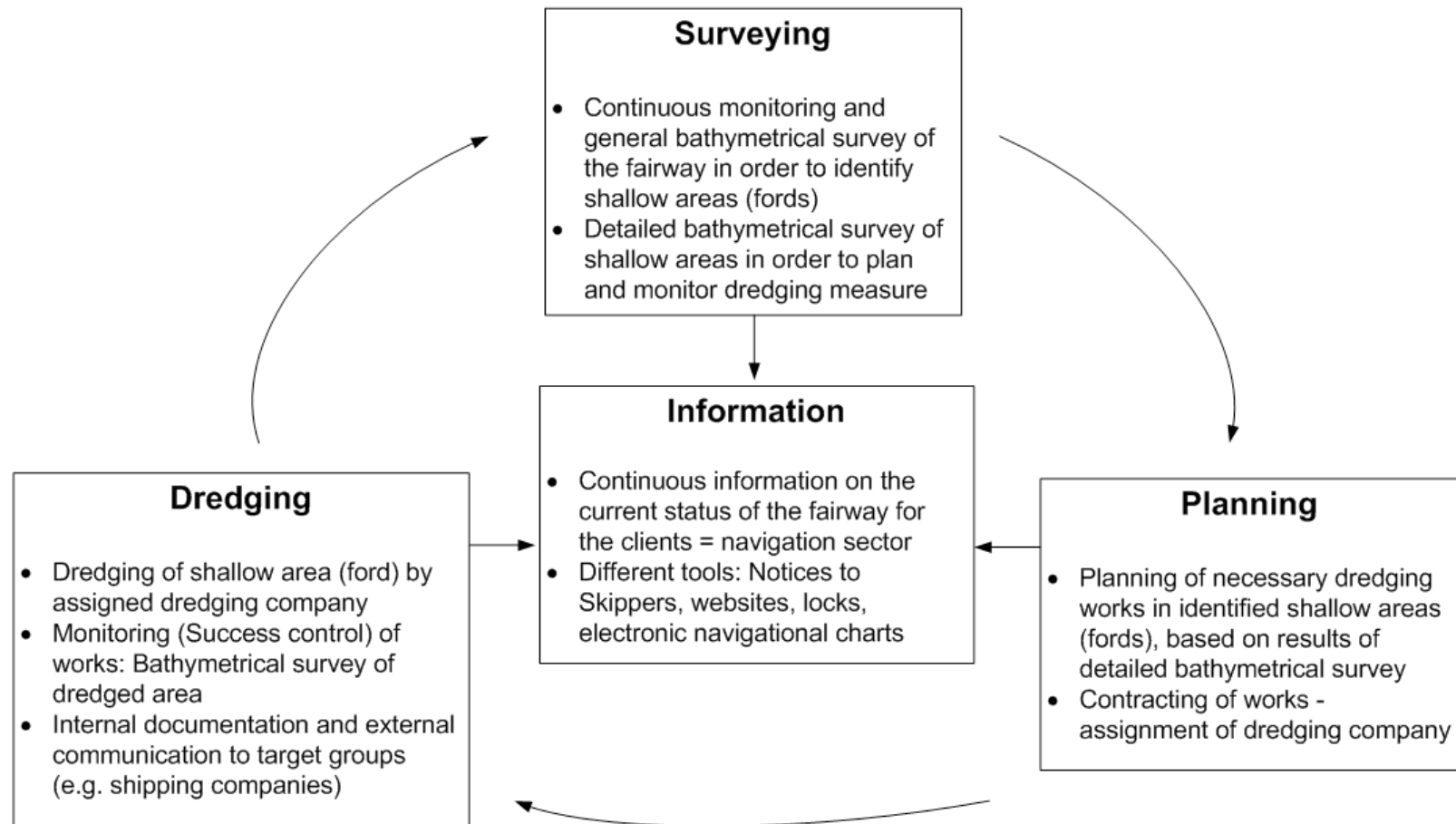


Rip-Rap Source:<http://www.orn.usace.army.mil/cof/Copy%20of%20Copy%20of%20MVC-021S.JPG>)

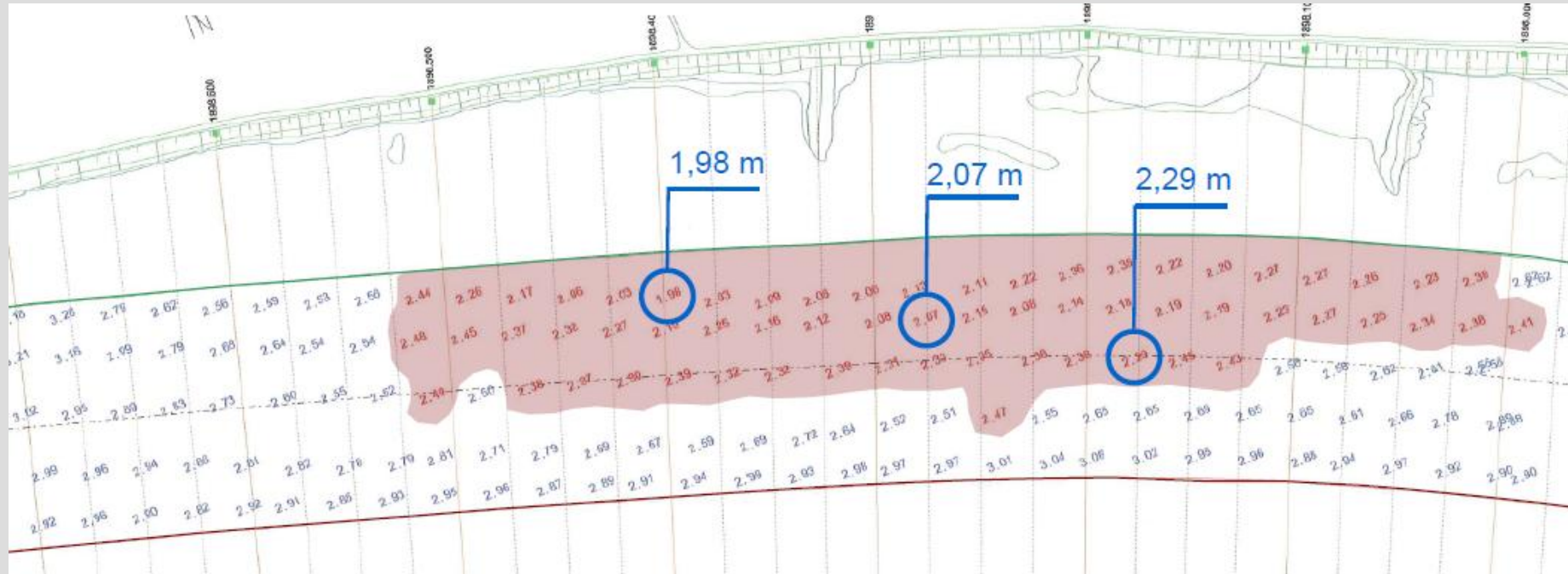
# Fairway maintenance (1)



## Fairway maintenance cycle



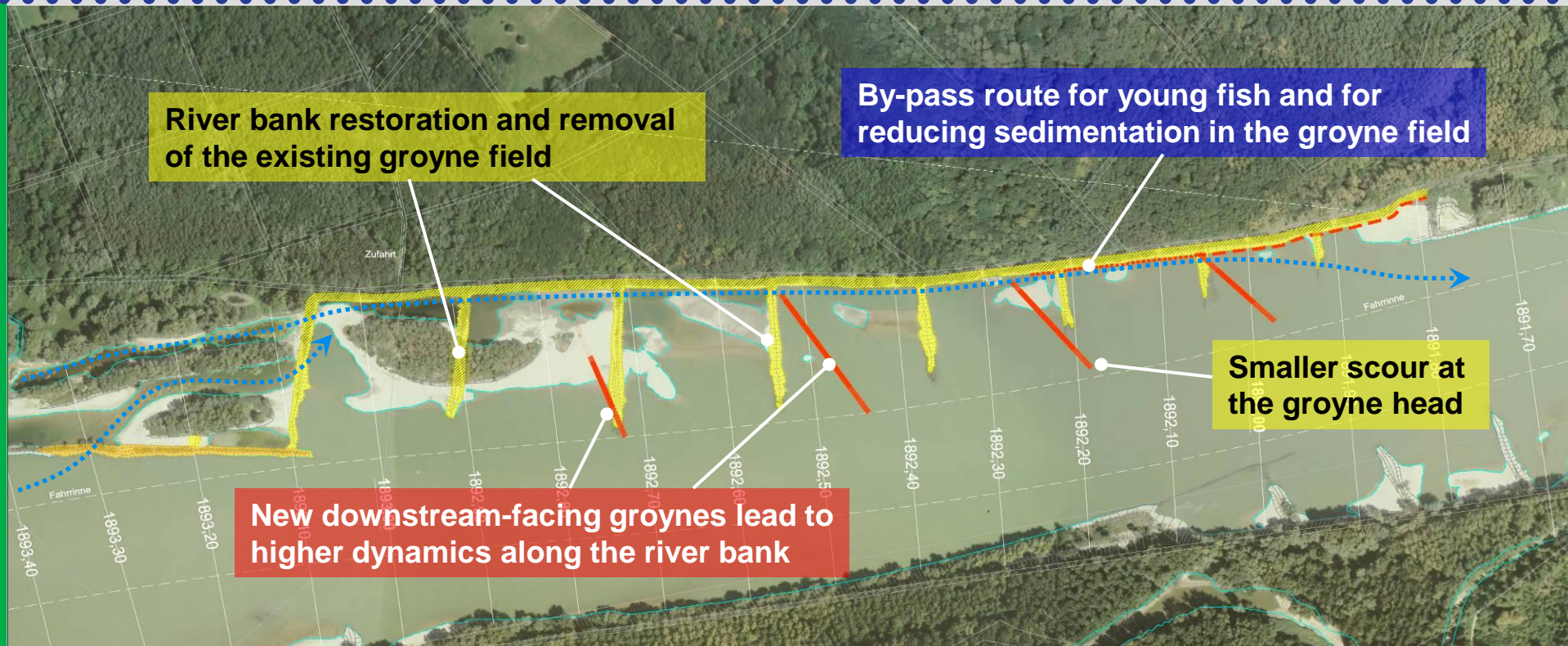
# Fairway maintenance (2)



Improved fairway information. Source: via donau.



# Example infrastructure adaptation Pilot project Witzelsdorf (1)



**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)





# Strategic issues related to Waterway adaptation (1)



- 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)

# Strategic issues related to Waterway adaptation (2)



- Commitment by the EC related to promotion of IWT /TEN-T projects)
- Internationally agreed standards are to be fulfilled =>
  - Inland waterway transport will benefit from infrastructure measures
  - Fairway conditions expected to be better than today
- Provision of determined fairway conditions allows the economical usage of the current fleet as well as the proper design of the future fleet as framework conditions are known
- High water occurrence and floods need to be considered more in detail



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