TECHNISCHE UNIVERSITÄT DRESDEN

DRESDEN concept

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Detection of cavities in levees and forelands caused by beavers (1) & mitigation measures (2)

EUCOLD WG Levee & Flood Defences - Workshop
June 30, 2021

IWD Institut für Wasserbau und Technische Hydromechanik

Introduction
Burrowing Animals

Species (selected)
Wild boar
Beaver
Muskrat
Nutria
Vole
Mole
Rabbit
Ant
Alligator
Groundhog
...

Muskrat

Nutria

Beaver

Source: DVWK-Merkblatt 247/1997

- Conflict: natural habitat vs. cultural landscape

→ regional and species-specific problems

- Damages (beaver):
  - flooding due to dam building,
  - feeding damages (agriculture),
  - cavities due to burrowing action
- Beaver: 95% of damages at levees with foreland <20m
- Update of German guidelines in progress → DWA-M 608/2

Hazards

- Cavities (tunnels, tunnel systems, dens) and surface damages at
  - River banks → erosion and sediment input
  - Foreland → danger to river maintenance works
  - Levees (on water- and landside) → reduced reliability → risk increase

Source: Krüger

Source: Van der Steen

Hazards

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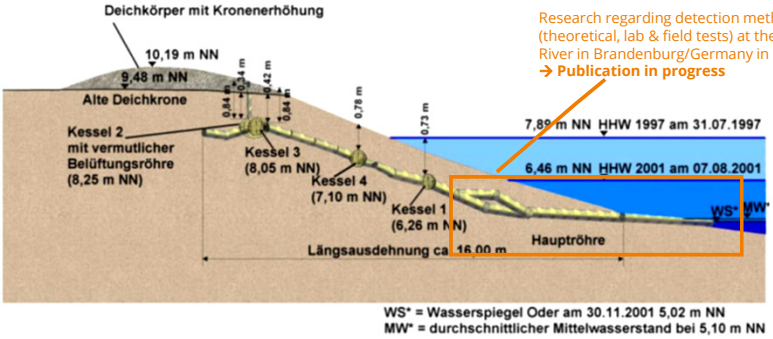
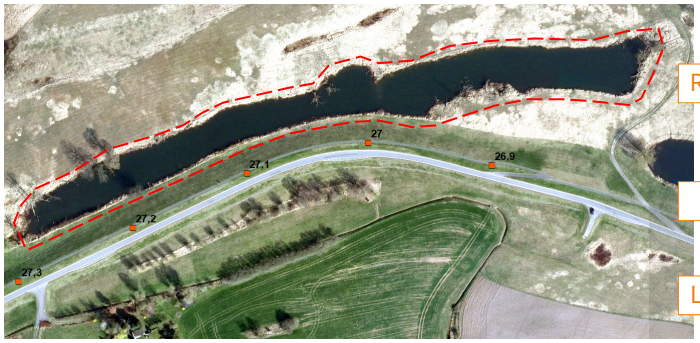


Source: Hahmann (2004)

Research (Oder River)

partner: Leibniz Centre for Agricultural Landscape Research (ZALF)

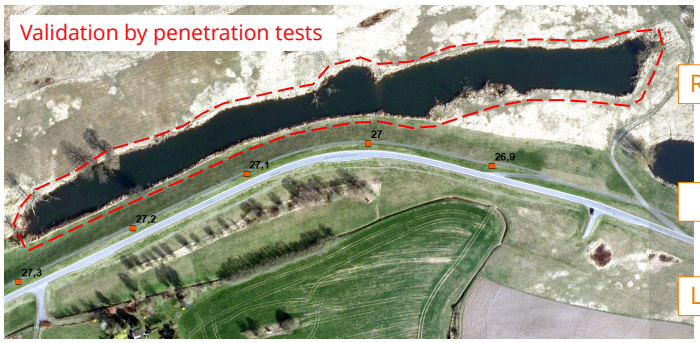
- Aim: detect cavity systems and entrances (under water)
  → identification of possible methods; lab & field tests
- Compare methods regarding suitability and applicability in practice
  - Monitoring of several kilometers per day
  - Real-time monitoring vs. permanent protection (1,4 Mill. € / km)



Research (Oder River)

Ground penetrating radar (GPR)
Frequency domain electromagnetics (FDEM)
Microwave sensing
Electrical resistivity tomography (ERT)
Geomagnetics

Tracking dog
Multispectral imaging
Thermal imaging
drone based
Satellite radar interferometry (InSAR)
UW-photogrammetry (UUV, GoPro)



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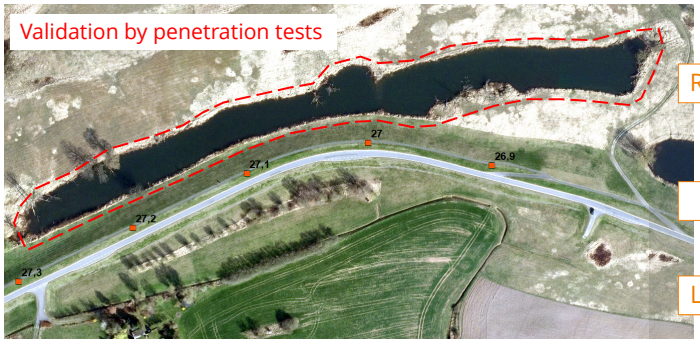
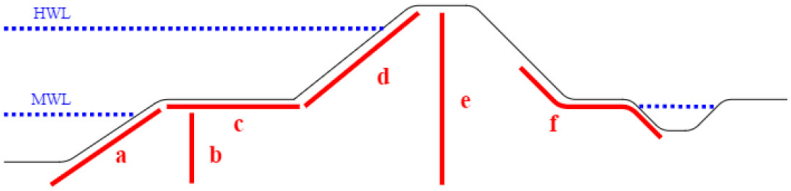


Thermal Imagery

Mitigation measures

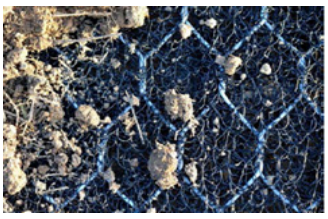
- Relocate populations to other areas with low flood risk
- Reduce habitat suitability (reduce staple, natural enemies)
- Repellents (optical, acoustical, biological, electrical)
- Insert mechanical barriers



Mitigation measures
Mechanical Barriers

- Coated wire grids (corrosion!), natural & artificial stones, sheet pile walls, …
- Appropriate placement (location, extent) and construction crucial for effectiveness
- Durability und sustainability must be considered (maintenance and environmental issues!)

Source: Krüger



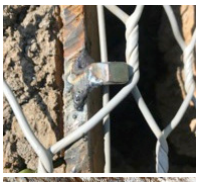
Source: Arndt

Source: Munke

Mitigation measures
Vertical Barriers

- massive walls:
  sheet pile walls

  costs ?

- single panels:
  welded steel panels

  corrosion ?


- flexible mesh rolls:
  polymer coated hexagonal netting

  120 y (EN 10223-3)


Slides on behalf of M. Arndt (Secon Systems GmbH, Berlin)

Mitigation measures
Vertical Barriers – trenchless netting installation

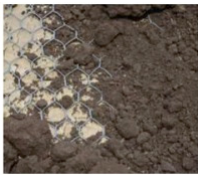
- Flexible netting installed without trench using sheet pile technique


Slides on behalf of M. Arndt (Secon Systems GmbH, Berlin)

Mitigation measures
Near Surface Barriers

– Flexible netting covered with top soil after installation



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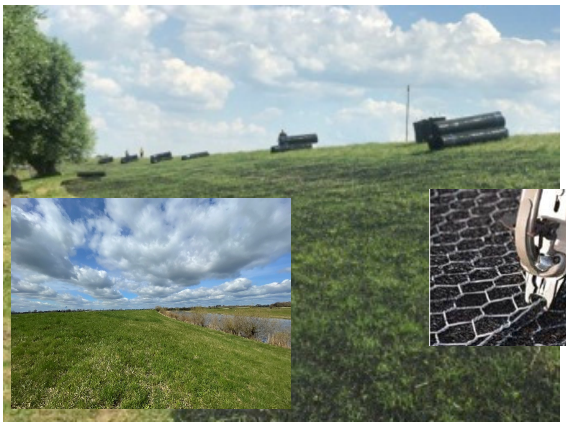
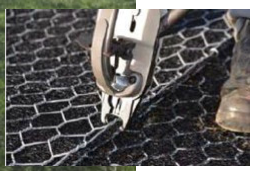
Mitigation measures
Near Surface Barriers

– Flexible netting + integrated erosion mat fixed directly on existing vegetation

→ increased erosion resistance (overtopping)





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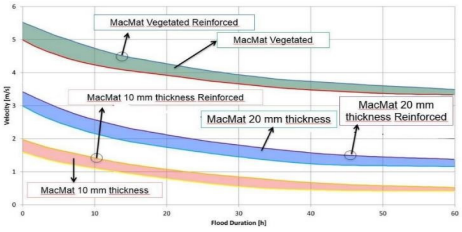
Mitigation measures
Near Surface Barriers

– Flexible netting + integrated erosion mat fixed directly on existing vegetation

– resistance against overtopping:

  5,5 - 4,3 m/s (< 24 h)
  4,3 – 3,7 m/s (< 48 h)
  3,7 – 3,2 m/s (> 48 h)

– 3-times higher compared to grass vegetation without reinforcement



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Mitigation measures
Near Surface Barriers – Small Rodents

– Flexible netting + geosynthetic grid with small opening size underneath

– Geogrids with small openings as “add on” to steel mesh solution to prevent levee infestation by small rodents
– hybrid solution nominated for the “German Economy Innovation Award” in 2020

Slides on behalf of M. Arndt (Secon Systems GmbH, Berlin)

Conclusions & Perspective

- in Europe (goal: close-to-nature redevelopment of rivers): increasing influence of biota on levee reliability
  - → special focus in flood risk analysis and management,
  - → interdisciplinary cooperation required
- Mitigation measures (non-technical and technical) are available
  → effectiveness, costs and sustainability are issues
- Mechanical barriers:
  - → effective, custom-fit solutions are available
  - → positive secondary effects (overtopping) can be achieved

Further research about effective and feasible methods for cavity detection and for damage prevention in levees and forelands is required!

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