TECHNISCHE UNIVERSITÄT DRESDEN

DRESDEN concept

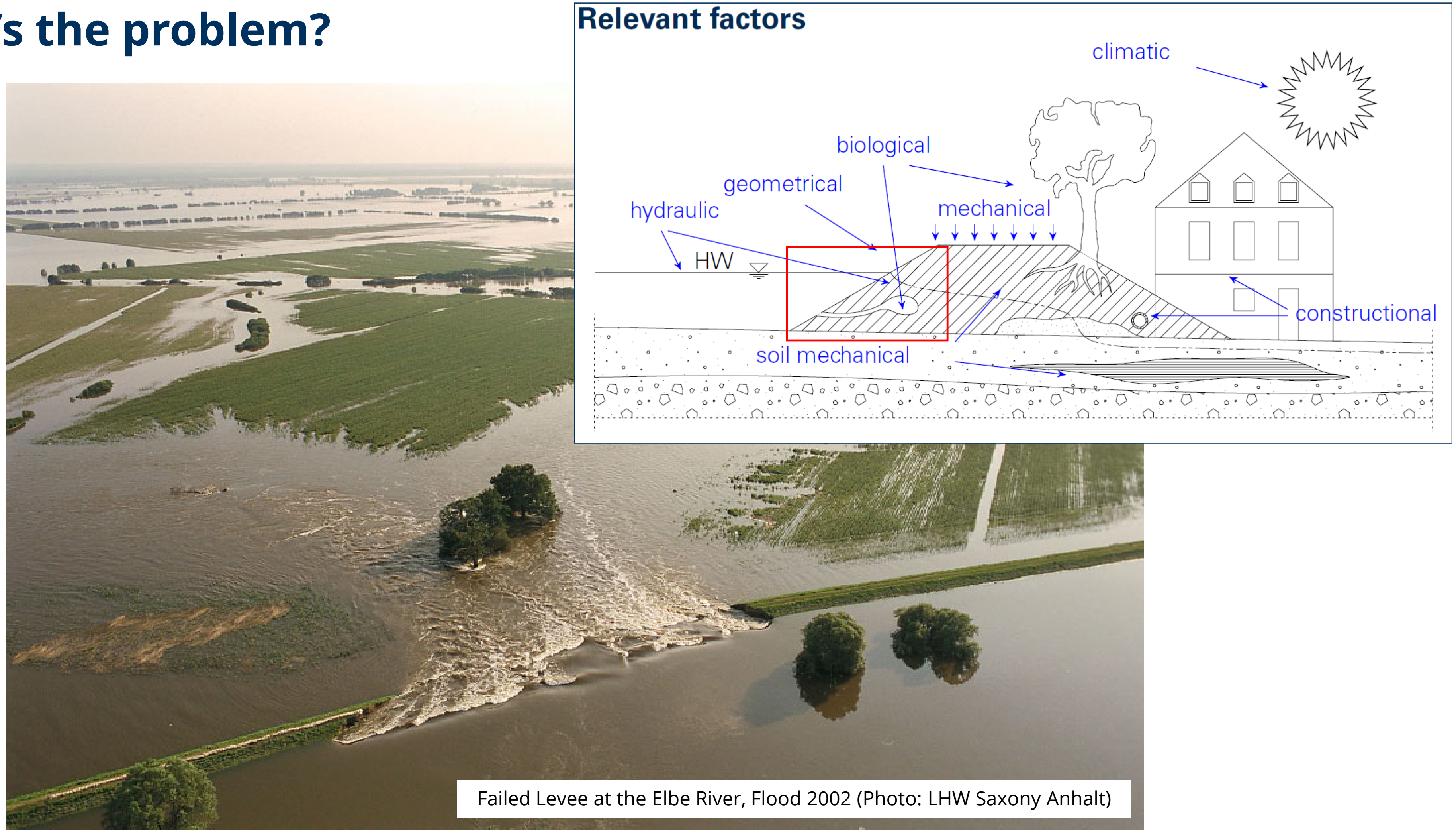
Institute of Hydraulic Engineering and Technical Hydromechanics
Dr.-Ing. Torsten Heyer

Beaver Burrowing Activity in Levees

Characteristics, Countermeasures, Cavity Detection

International Beaver Burrowing in Infrastructure Symposium (IBBI)
Wageningen (NL), February 3rd, 2025

What's the problem?

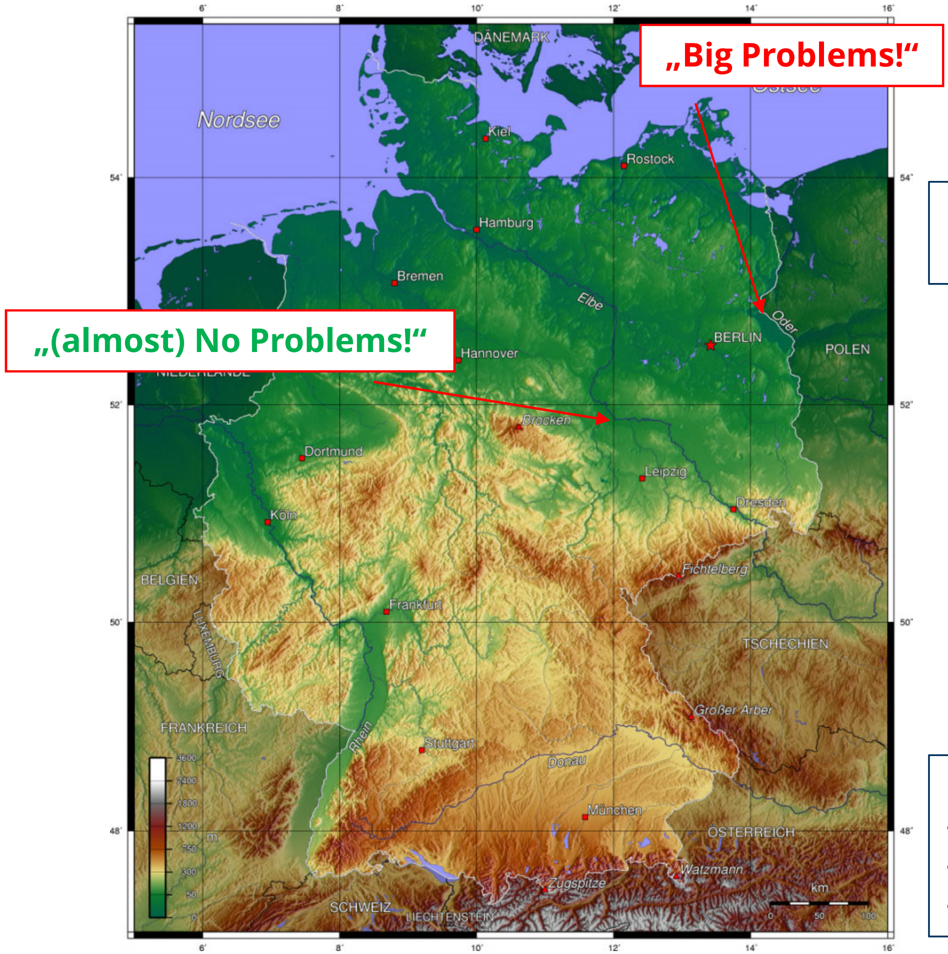


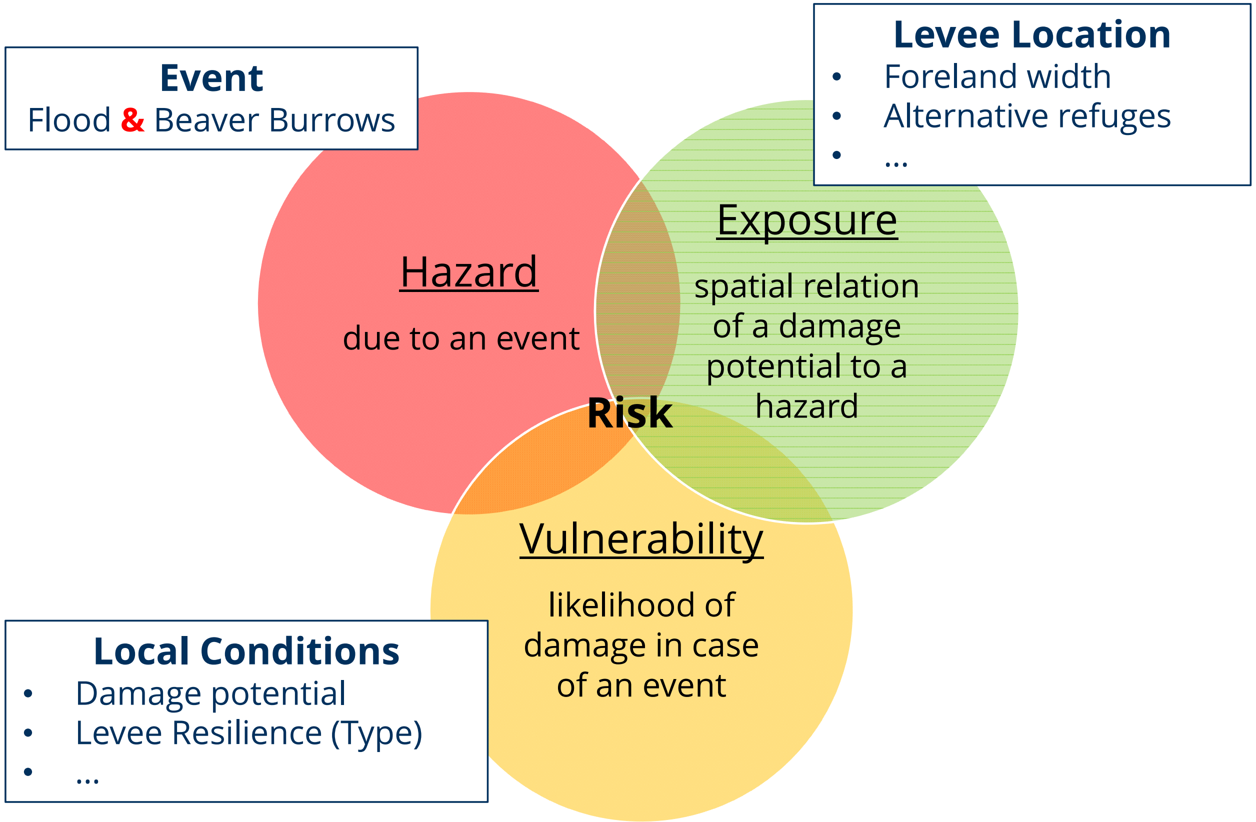
Failed Levee at the Elbe River, Flood 2002 (Photo: LHW Saxony Anhalt)

Levees at (Beaver) Risk?

$$\text{Risk}_{\text{Event}} = \text{Probability}_{\text{Event}} * \text{Damage}_{\text{Event}}$$

[EUR] = 0,0…1,0 * [EUR]





What's the problem?

- Cavities (tunnels, tunnel systems, dens) and surface damages at
  - River banks → erosion and sediment input (small water courses)
  - Foreland → danger to river maintenance works
  - Levees (on water- and landside) → reduced reliability → risk increase
- Flood at Oder River in 2010: 550 Damages incl. 150 larger tunnel systems in levees (10-20 m into levee)
- most damages in levees, if distance to main river bed is < 20 m

Source: F. Krüger

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Source: rbb 24

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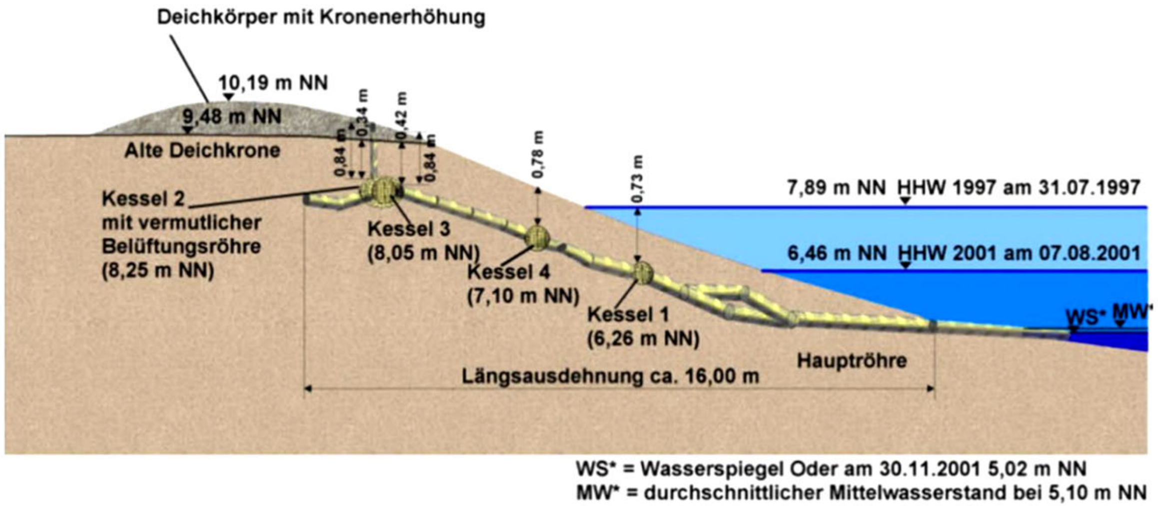
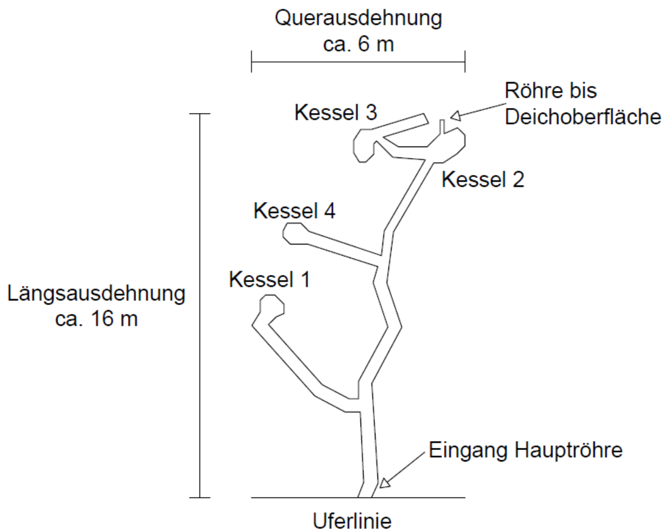


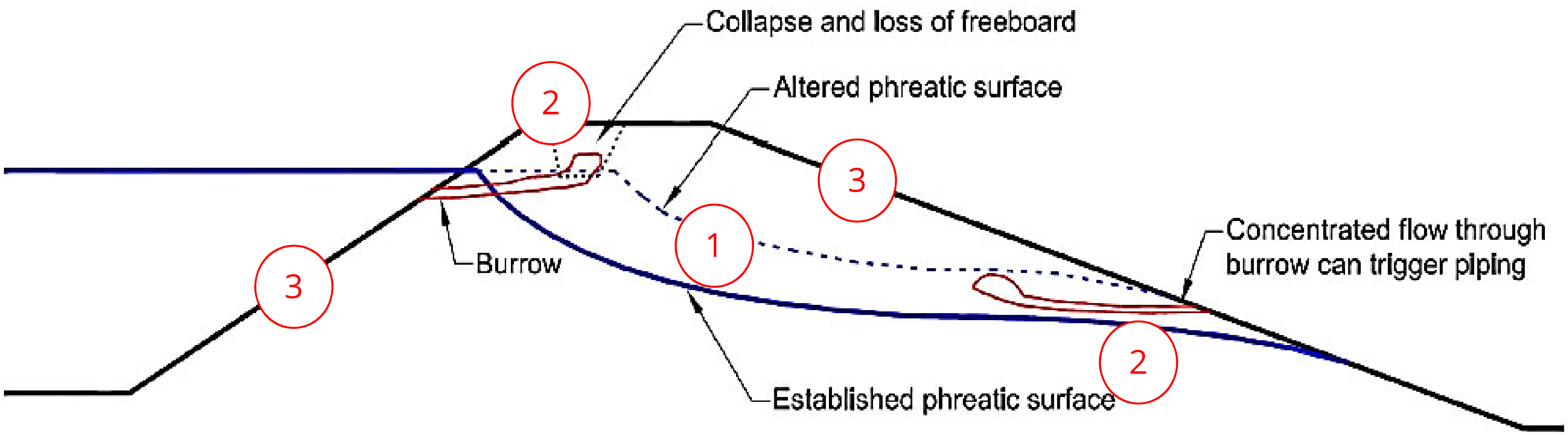


Source: Hahmann (2004)

Impact on Levee Stability

1) **Altered seepage behavior**
2) **Structural instability**
3) Decreased erosion resistance → less important with regard to beaver activity

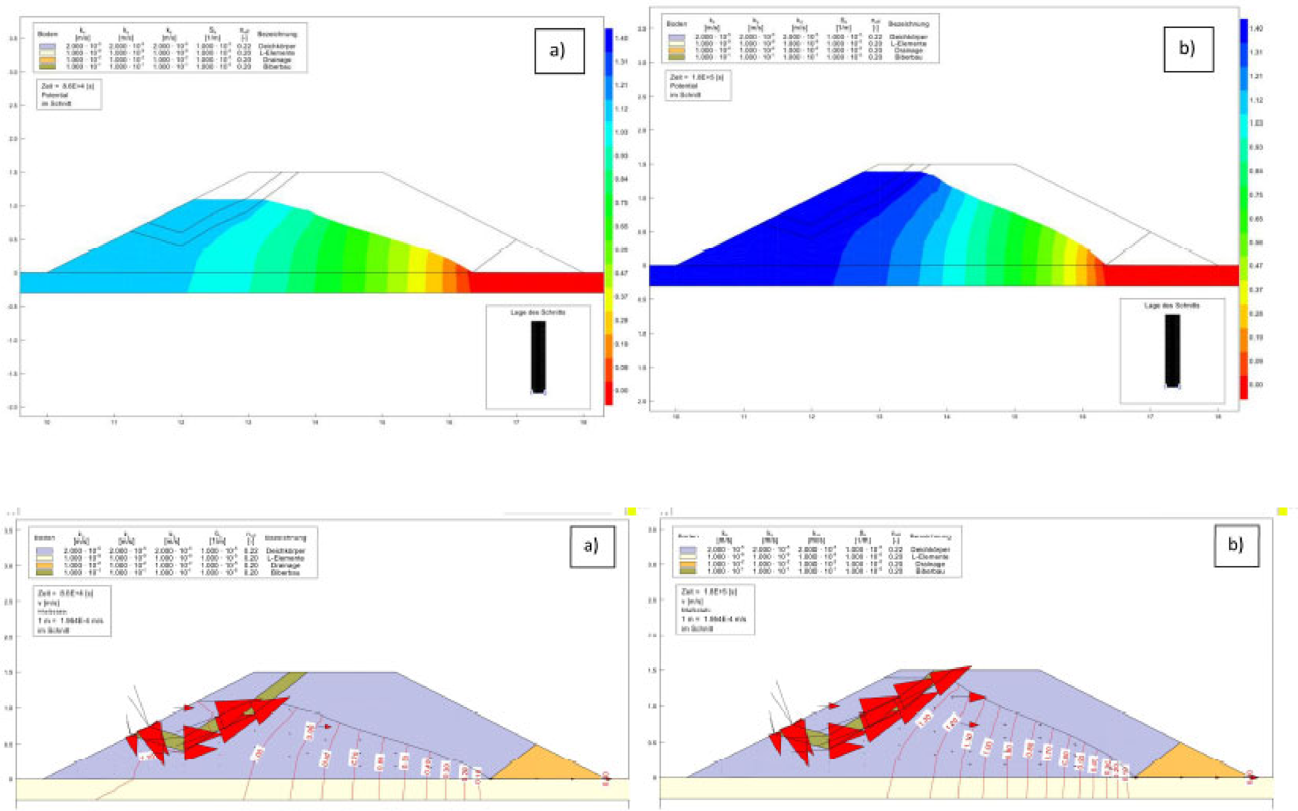
- Indirect hazards (tree felling, blocking of culverts, etc.)



Source: Cobos Roa (2015), modified

Impact on Levee Stability

- **Altered seepage behaviour**



Source: van Bonn (2022)

Length of seepage path decreases:

→ Hydraulic gradient increases

→ Seepage velocity increases, which favours piping

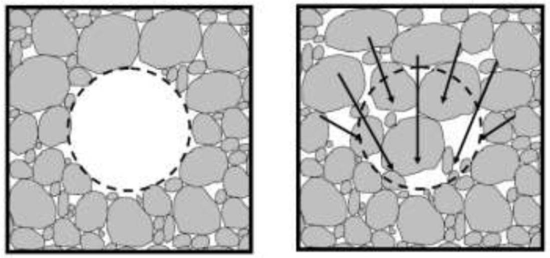
→ Phreatic surface on higher level, leading to decreased stability of landside slope

Investigations van Bonn (2022):

→ if tunnel length exceeds about 60% of levee width, failure is likely

Impact on Levee Stability

- **Structural instability**



Collapse of Tunnel System

→ Loss of Freeboard

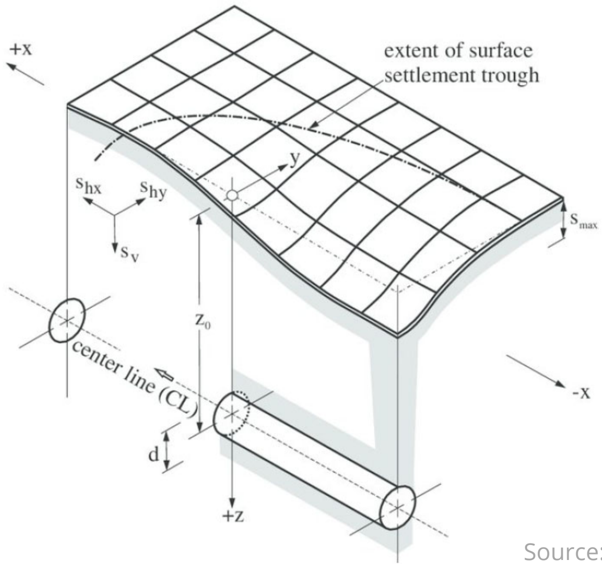
→ Overtopping

→ Breaching

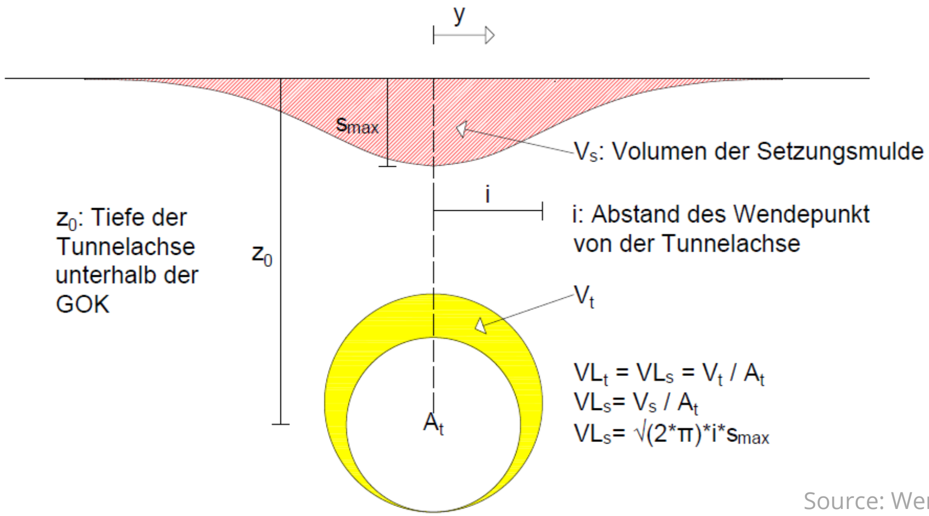
Investigations Wendler (2021):

→ Deformation of cavities and earth surface can be predicted by analytical and numerical models (Analogy: Tunnel engineering)

→ Goal: “satellite based detection” (e.g. InSAR) could not be achieved



Source: Attewell (1986)

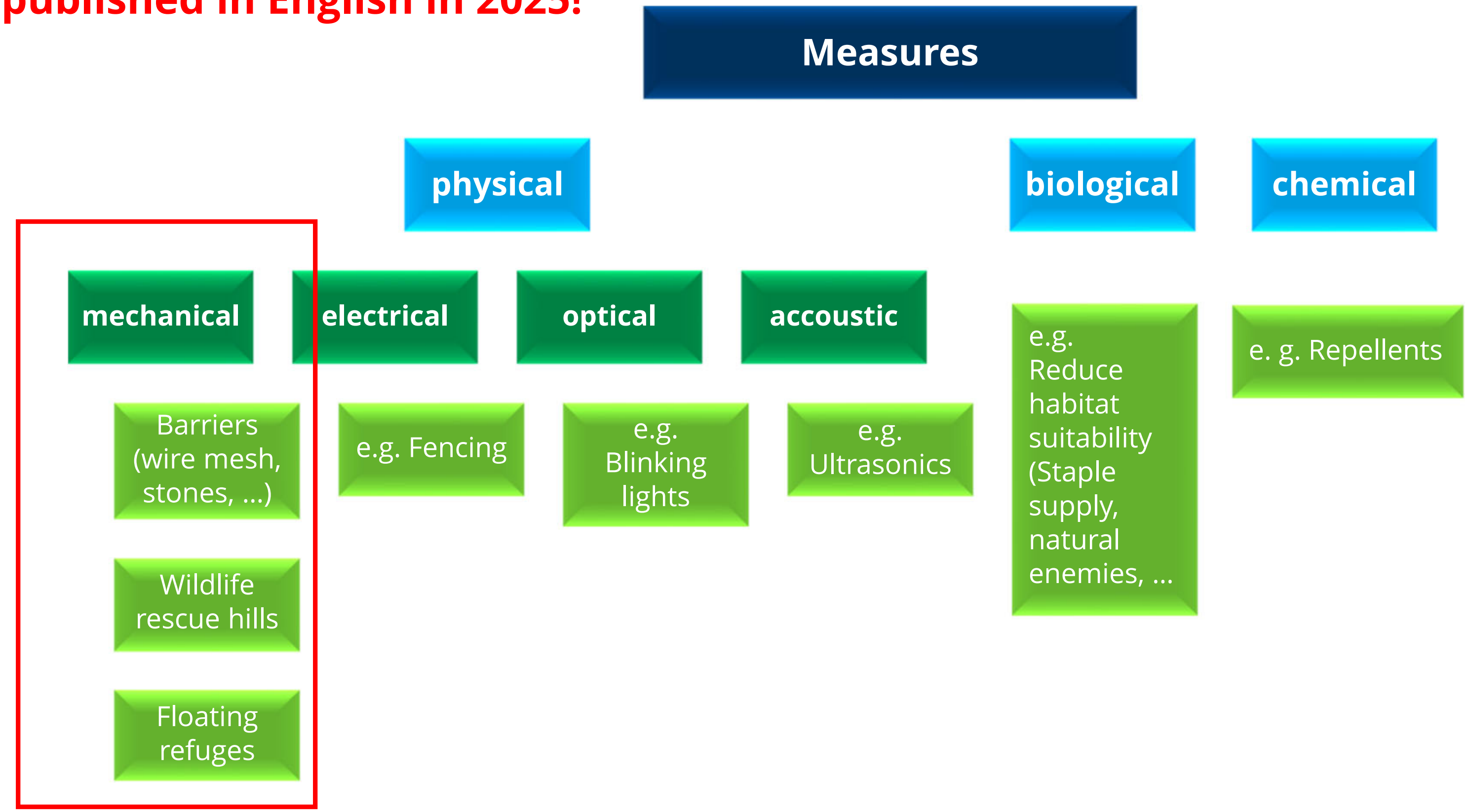


Source: Wendler (2021)

Countermeasures

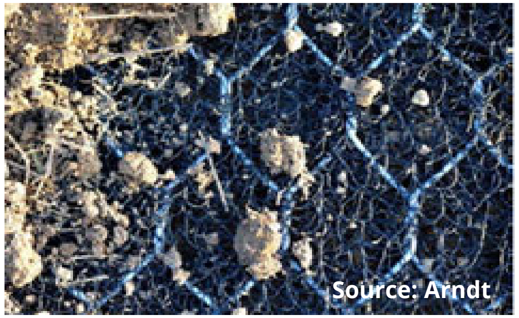
→ **DWA-Guidelines M 608-2:**
„Muskrat, Beaver, Nutria – Technical design and protection of river banks, dikes and dams"

- **to be published in English in 2025!**



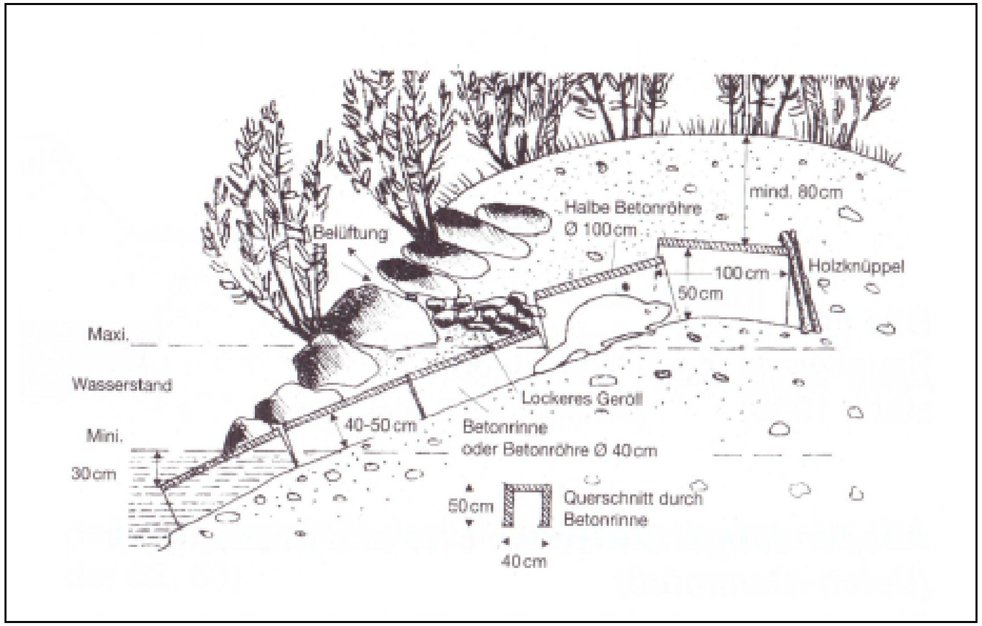
Mechanical Barriers

- Technical solutions: Coated wire mesh (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!)



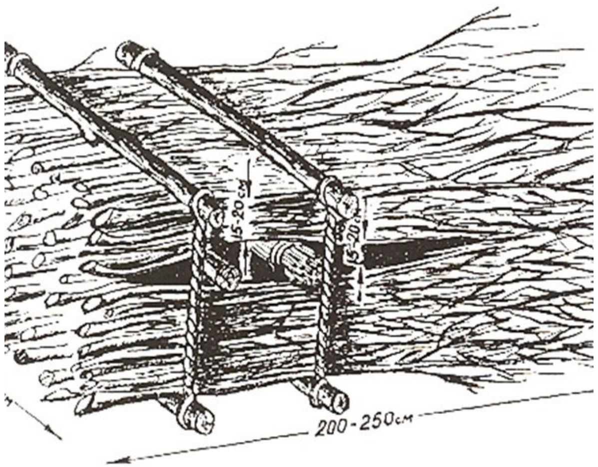
Wildlife Rescue Hills

- Only in locations, where hills are not critical from a hydraulic point of view, e.g. wide flood plains
- Not applicable in narrow river sections due to backwater effect

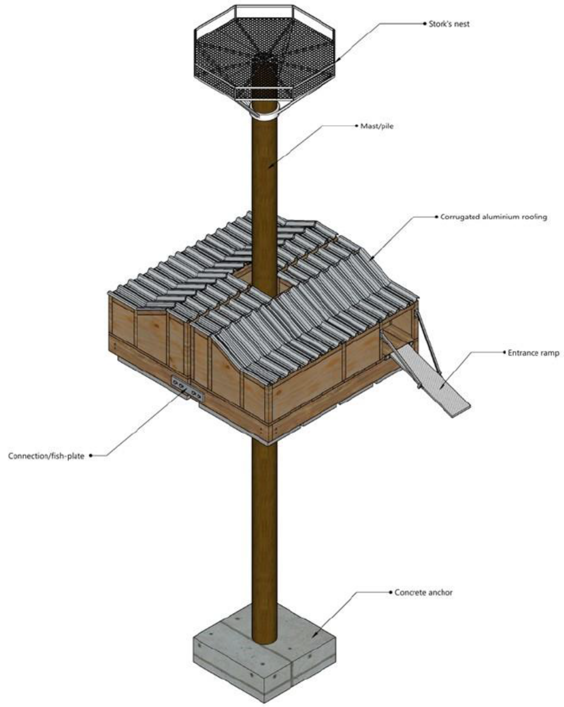


Floating Beaver Refuges

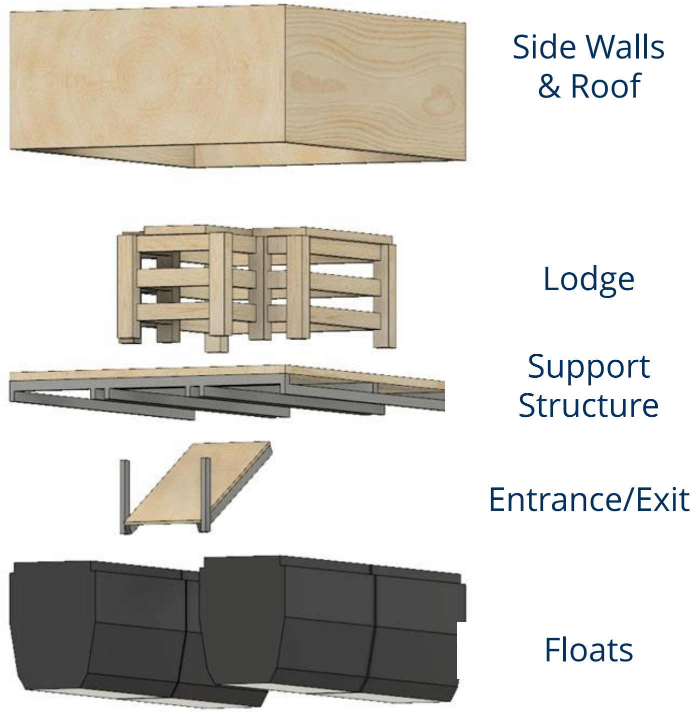
- Idea: provision of alternative (better?) shelters
- Feasible from technical point of view → reasonable from biological point of view?



Source: Safonow (1972)



Source: Gerrits (2022)



Source: Gautier (2024)

Cavity Detection

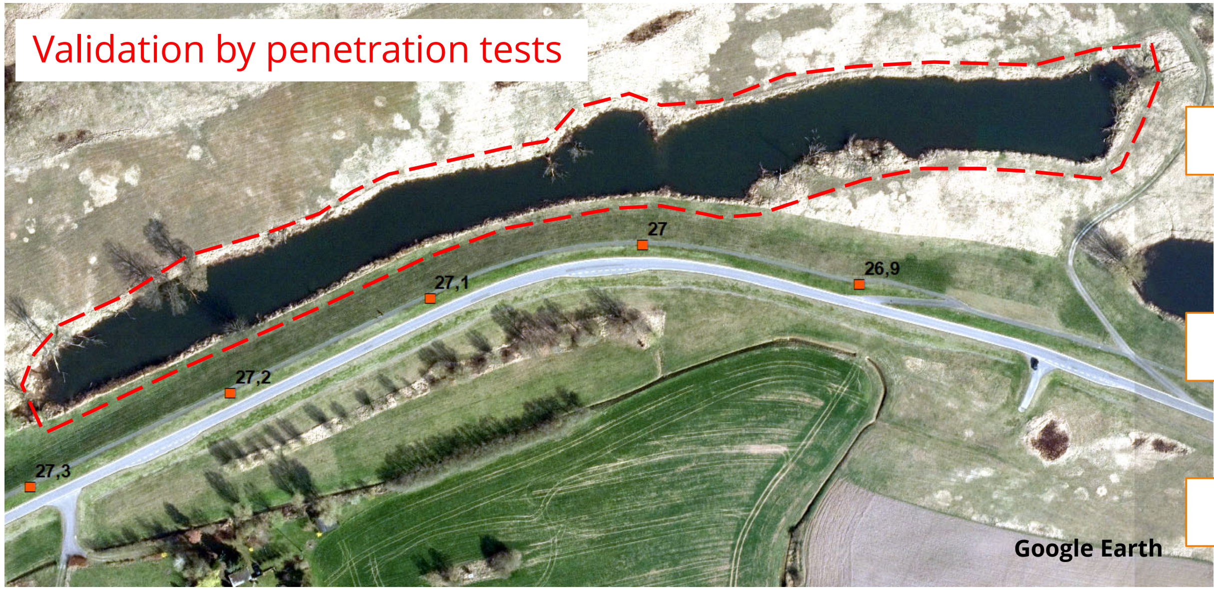
- **Unsolved problem → Call for joint research!**

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)

Other:

- Horizontal sonar
- Bees
- Avalanche transmitter
- …



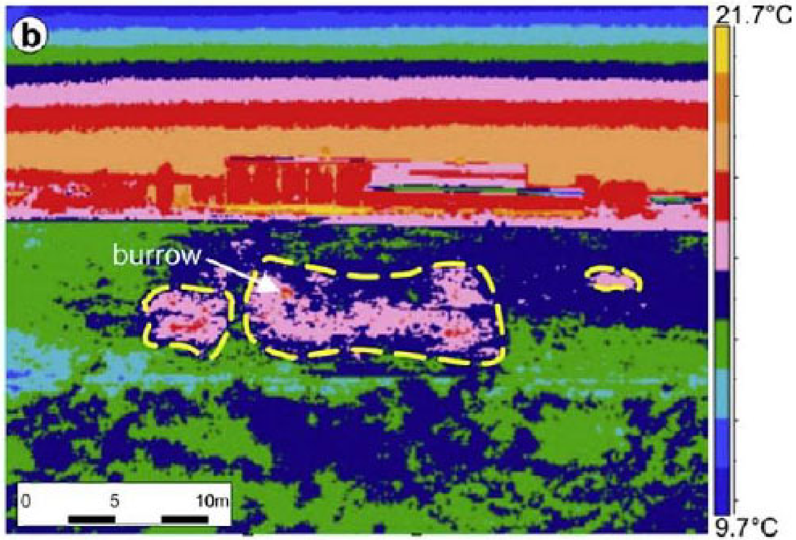
Riverside
Levee
Landside

Potential Methods

Field Survey

Cavity Detection

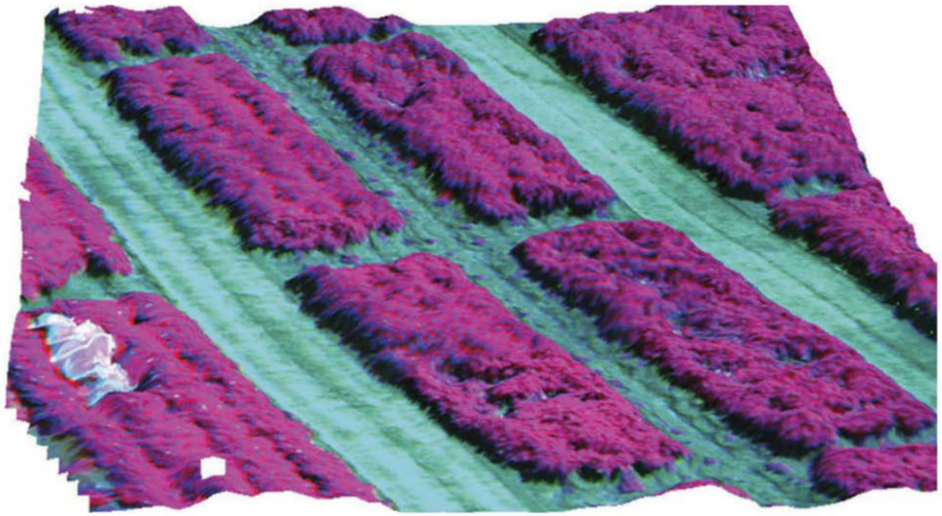
Thermal Imaging



Borgatti (2017)

→ **Surface Temperature**
cooler or warmer?

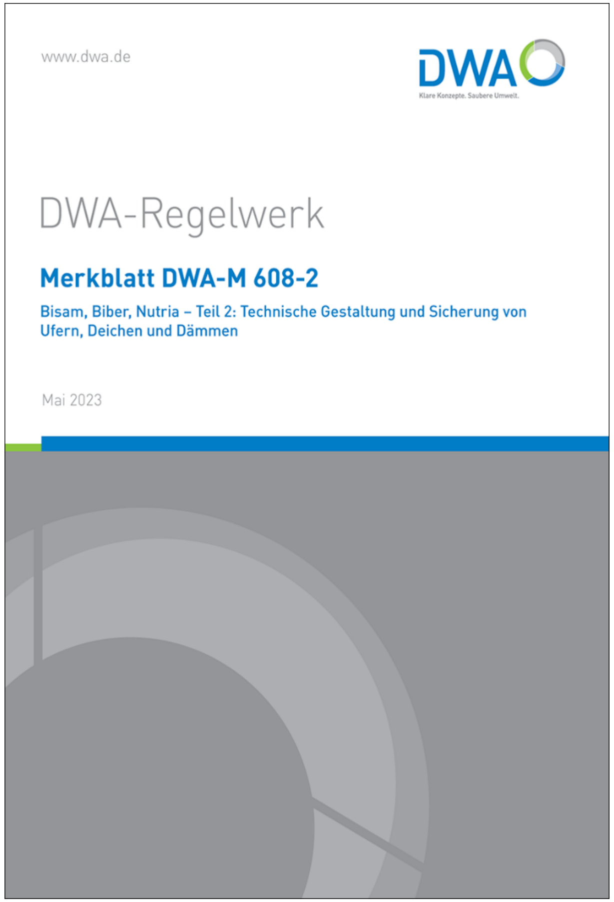
Multispectral Imaging

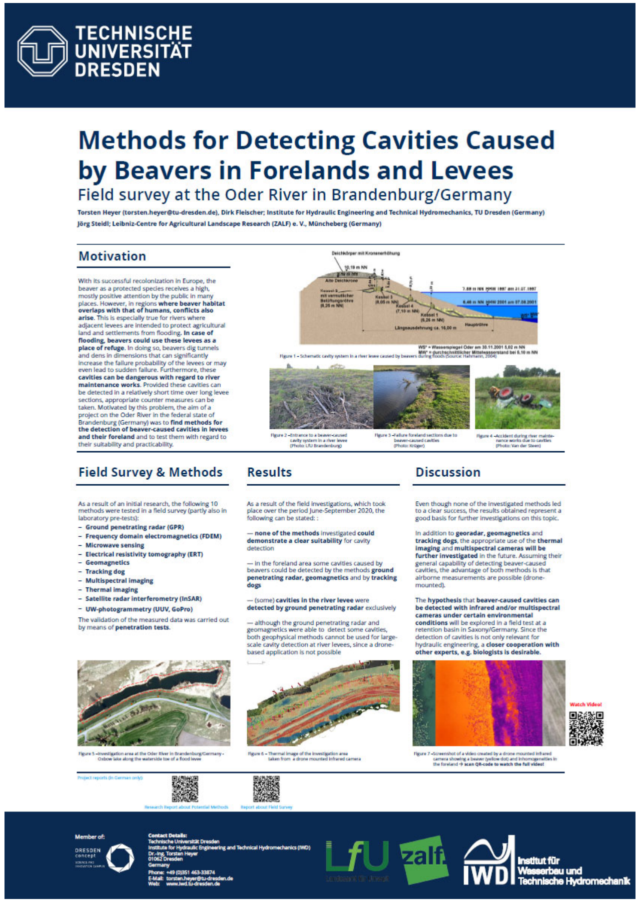


Hunt (2018)

→ **Plant Stress**
low soil moisture content?

Final Remarks





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