

Flood Calender

1993



West Germany
Rhine

1995



West Germany
Rhine

1997



East Germany
Oder

1999



Bavaria
Iller, Danube...

2002



East Germany
Elbe

2005



Bavaria
Isar

2009



Austria
Danube

2010



Slovakia
Hran, Ondave

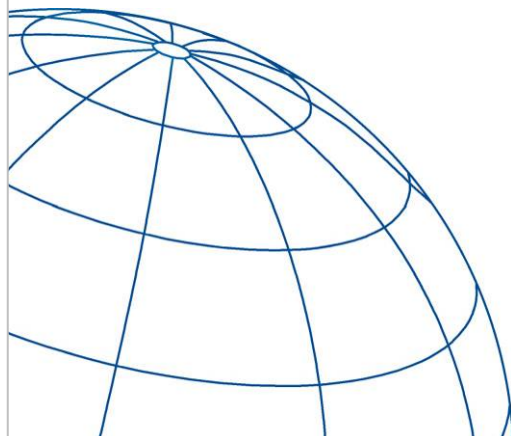


1) Slovak „Preco?“ = English „Why?“



APPLICATION OF GEOSYNTHETICS FOR OVERTOPPING LOADS AT FLOOD PROTECTION DIKES

Session 3: Specific problems for environmental consideration
Bratislava, 04.-07.06.2010



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CONSULTING & IT



ENERGY



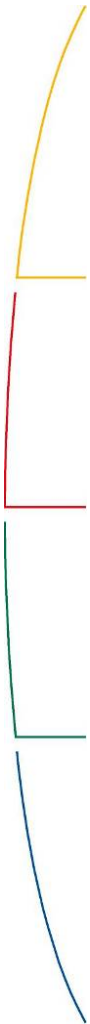
ENVIRONMENT



WATER & INFRASTRUCTURE

Outline

- Motivation
- Design Principles for Overflow Dikes using Geosynthetics
- Needs for Research
- Conclusion



Improvement of Slope Stability and Erosion Resistance

Motivation
Design Principles
Research
Conclusion



Overtopped Danube dike during flood in 1994
(Source: WWA Deggendorf)

Application of Geosynthetics

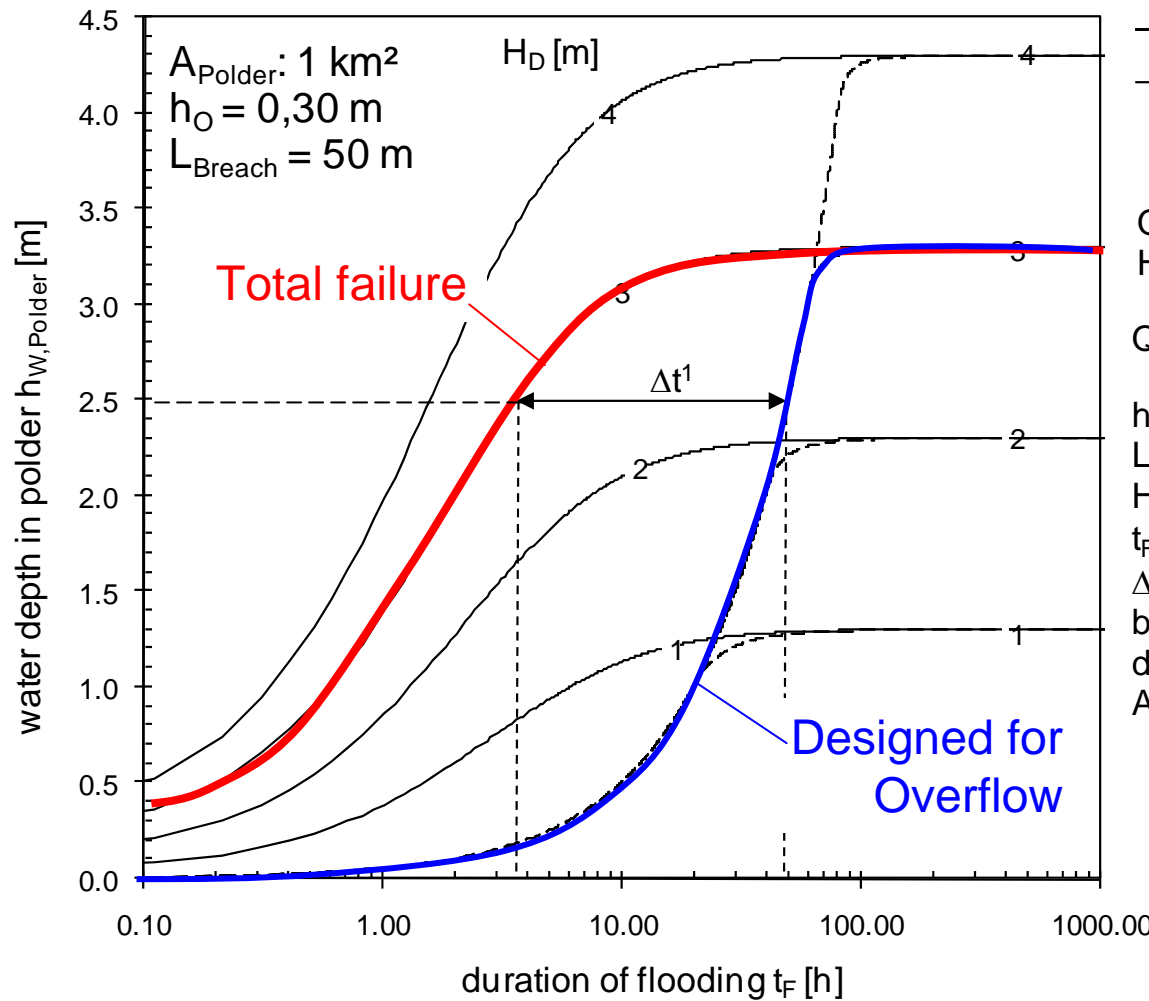
Avoidance of Total Failure

Advantages

- A. Retardation of Flooding
- B. Reduction of Damage
- C. Reduction of Construction Costs
- D. Favourable in Comparison to Classical Methods

A. Retardation of Flooding

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— Overflow of complete, abrupt dike breach
- - - Overflow of protected dike

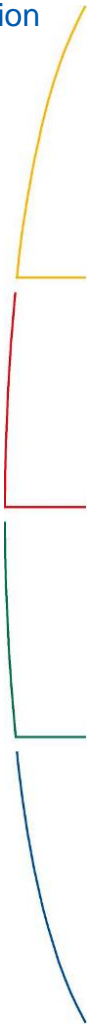
$$Q_{Breach} = f(h_{W,Polder})$$

$$H_{Breach} = H_D + h_O [m]$$

$$Q_O = Q_{Poleni}(\mu=0,577) = const.$$

h_O : Overflow height [m]
 L_{Breach} : Length of dike breach [m]
 H_D : Height of dike [m]
 t_F : Duration of flooding [h]
 Δt : Time difference (retardation) between polder flooding due to dike breach and overflow [h]
 A_{Polder} : Area of polder [km²]

¹Example:
 $\Delta t \approx 50$ h
 $H_{Breach} = 3,3$ m
 $h_O = 0,30$ m
 $h_{W,Polder} = 2,5$ m



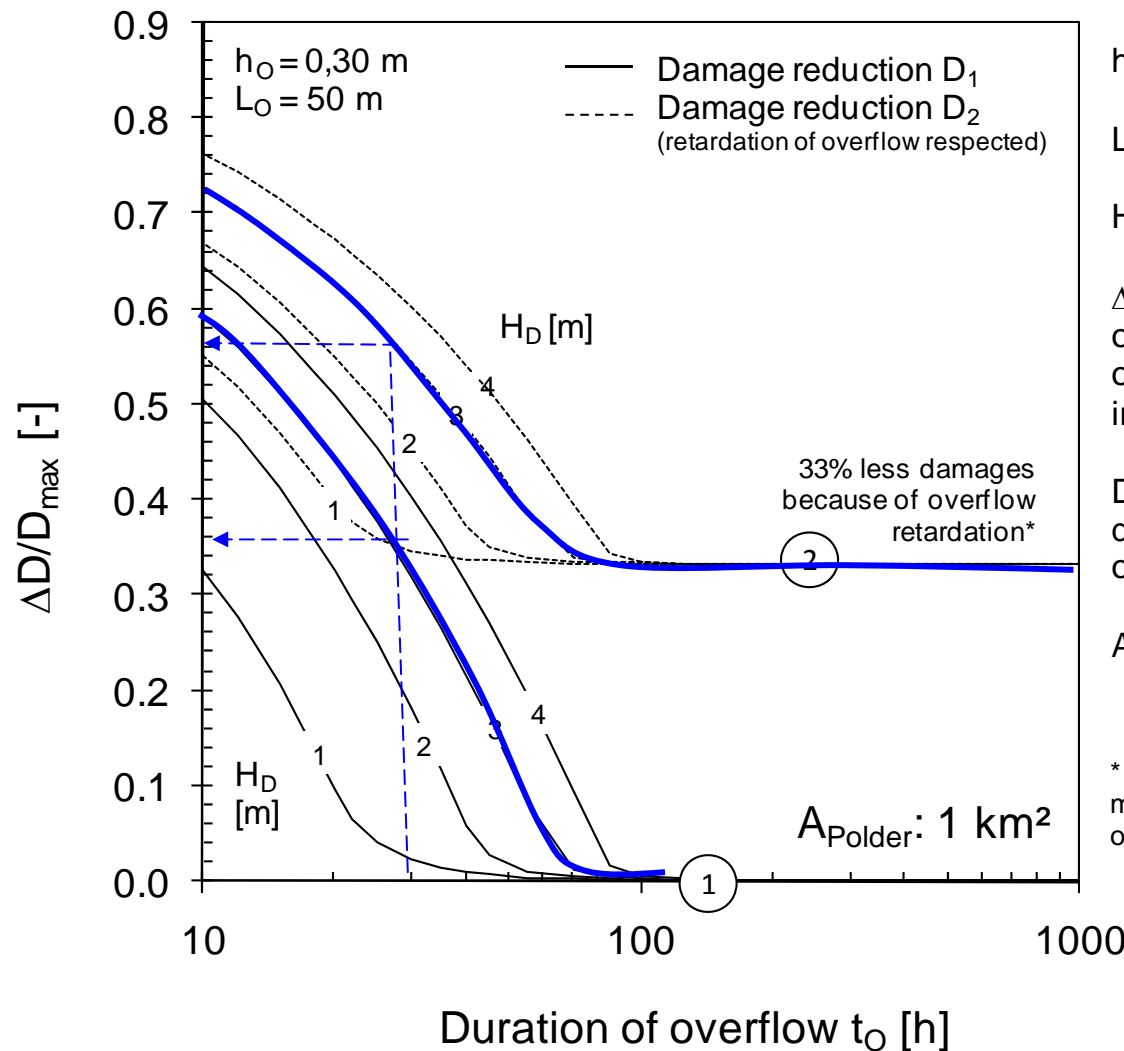
B. Reduction of Total Damage

Motivation

Design Principles

Research

Conclusion



h_O : Overflow height [m]

L_O : Overflow length [m]

H_D : Height of dike [m]

ΔD : Damage reduction due to overflow protection of dikes & avoidance of dike breaching because of overflow in comparison to dike breach [10^3 €]

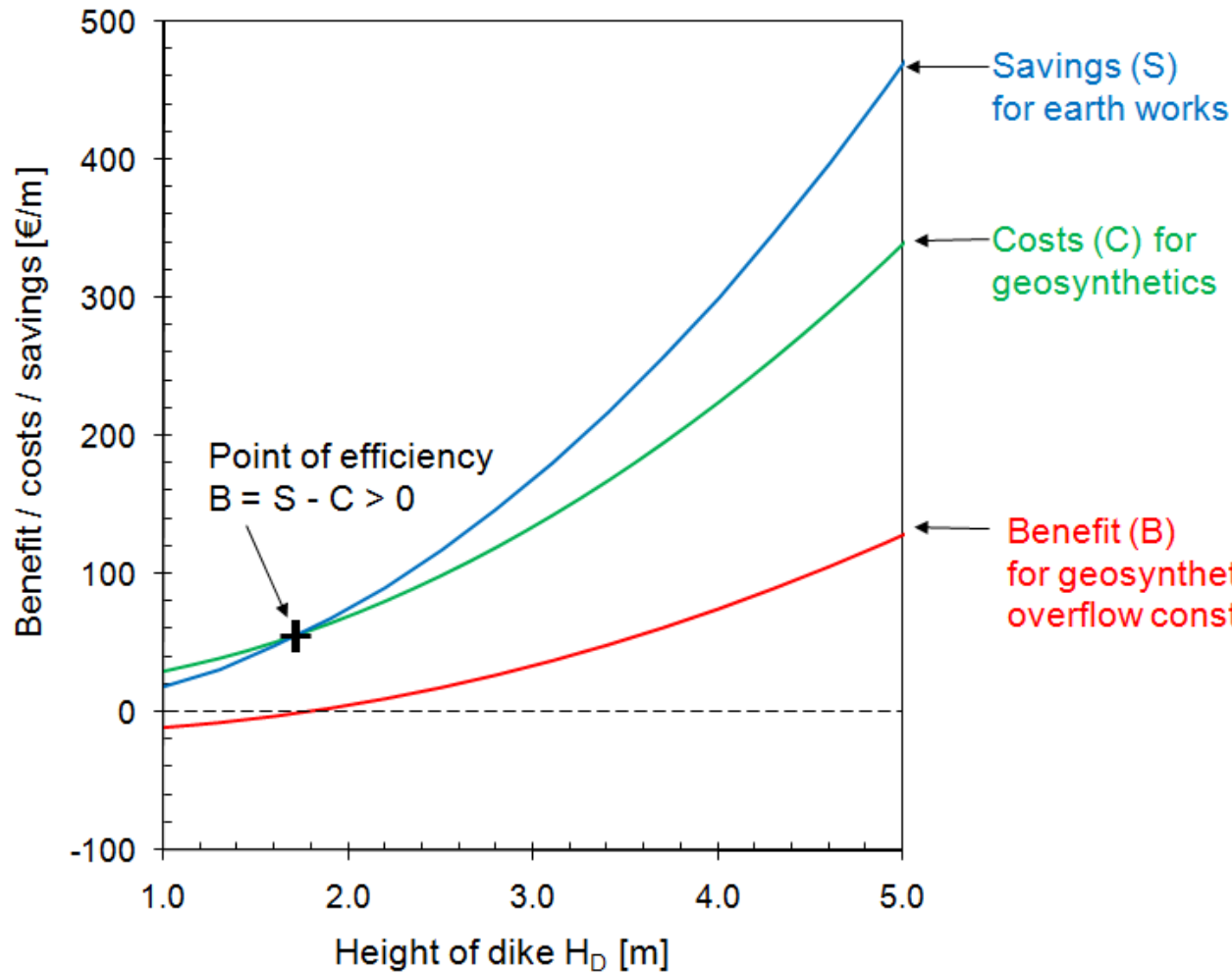
D_{max} : maximum damages S for complete dike breach caused by overflow on a length of 50 m [10^3 €]

A_{Polder} : Area of polder [km^2]

* Assumption: Afflicted inhabitants carry out measures to reduce damages (removal of goods or flood protection measures).

C. Reduction of Construction Costs

Motivation
Design Principles
Research
Conclusion



Parameters:

$$\Sigma L = n \cdot L_{\text{Layer}} + W_C$$

$$W_C = 3,0 \text{ m}$$

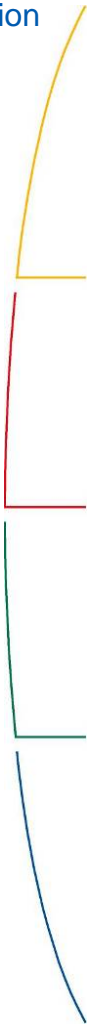
$$m_{L0} = 3,0$$

$$m_{\text{Geo}} = 1,5$$

$$d_L = 0,3 \text{ m}$$

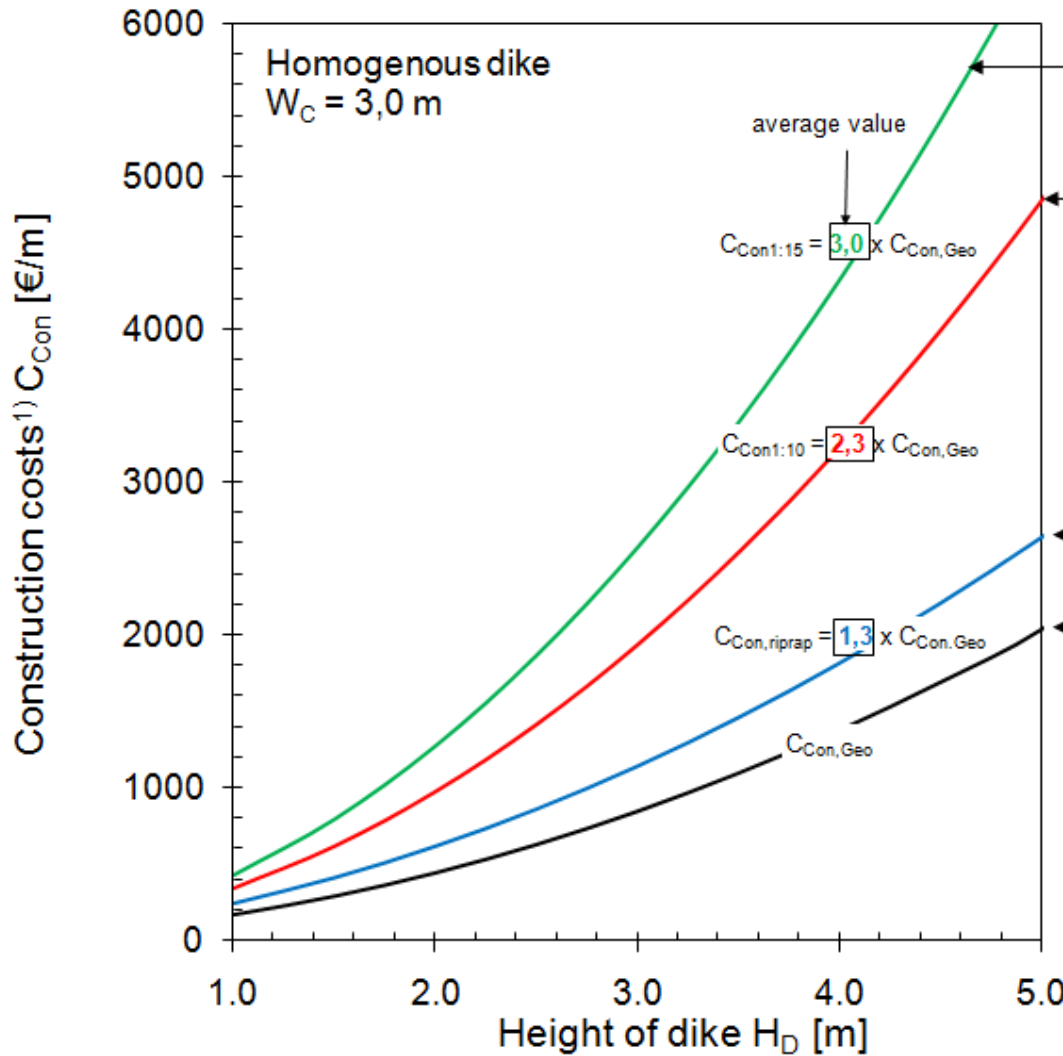
$$C_{\text{Soils}} = 25 \text{ €/m}^3$$

$$C_{\text{Geo}} = 5 \text{ €/m}^2$$



D. Comparison to Classical Methods

Motivation
Design Principles
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Only top soil vegetation layer
1:m = 1:15

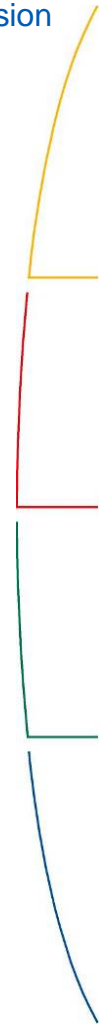
Only top soil vegetation layer
1:m = 1:10

Riprap 1:m = 1:4

Overflow dike protected with
geosynthetics, 1:m = 1:2

1) Calculation prices are added below:

Compacted soil for dike body	25 €/m³
Geosynthetic layers (total)	5 €/m²
Riprap (∅ 30 cm)	40 €/m²
Real estate (agricultural use)	5 €/m²



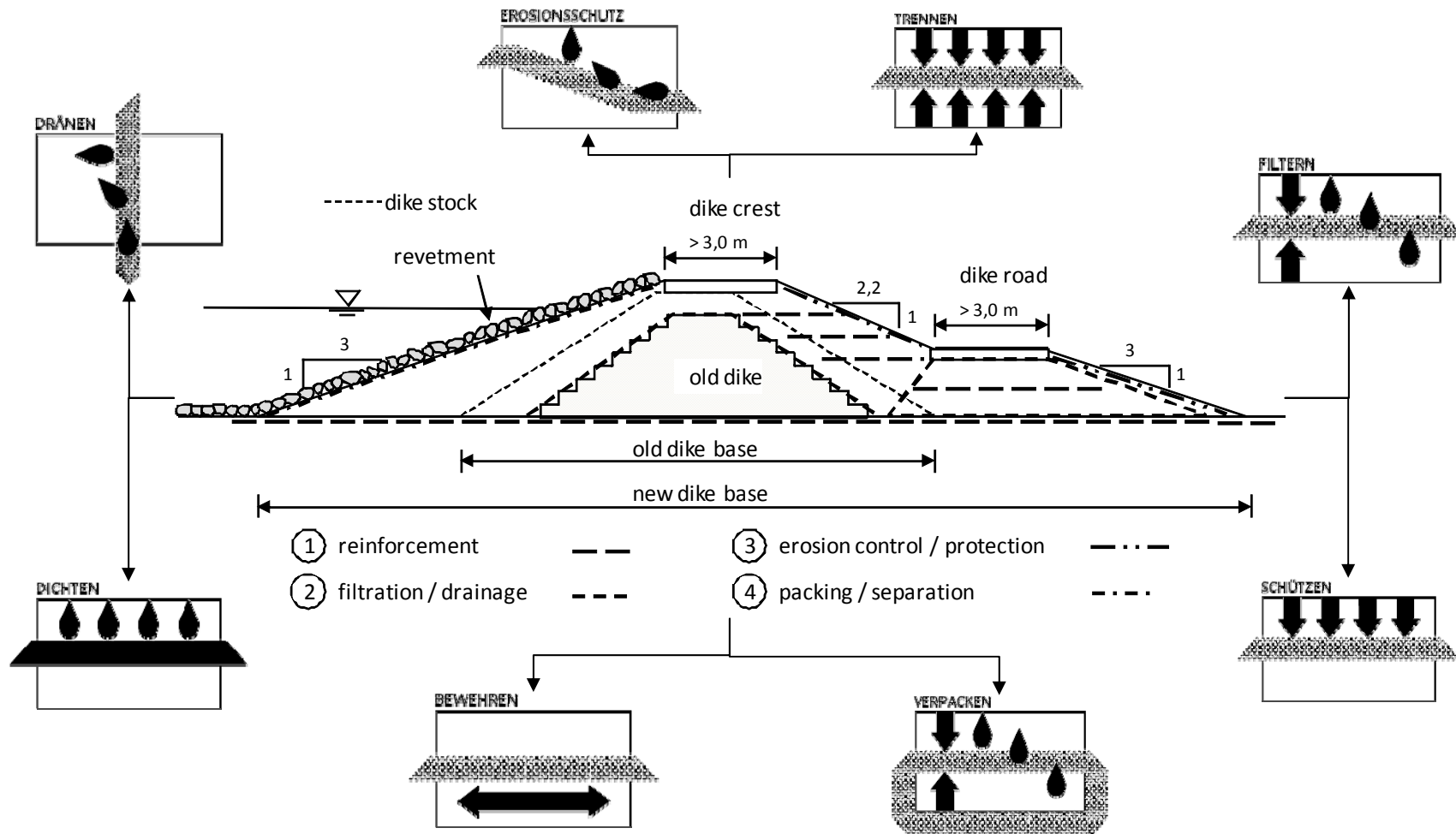
Application of Geosynthetics for Flood Protection Dikes

Motivation

Design Principles

Research

Conclusion



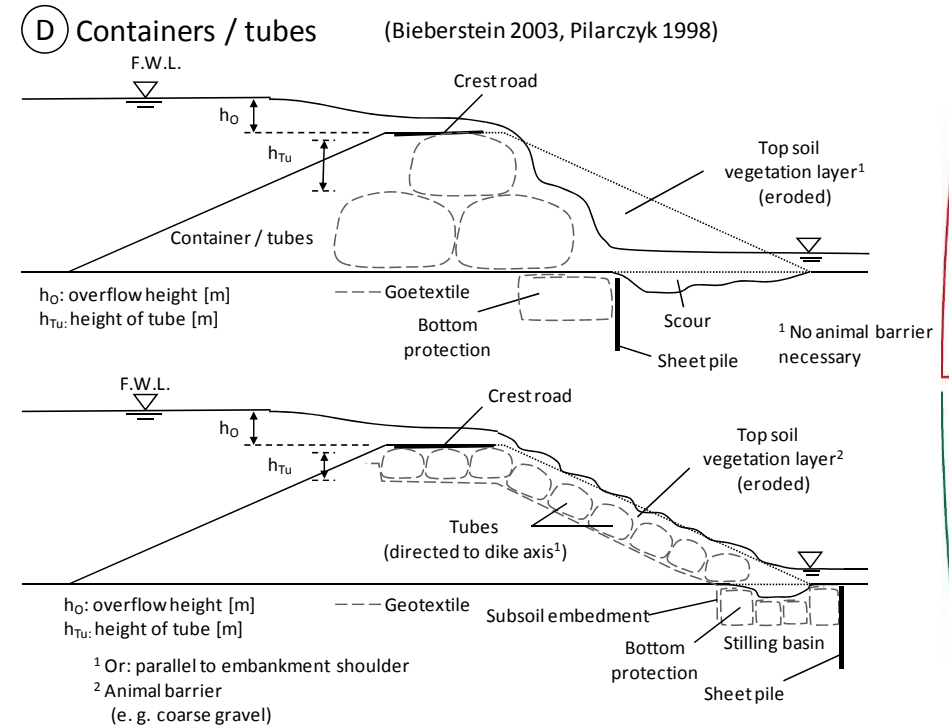
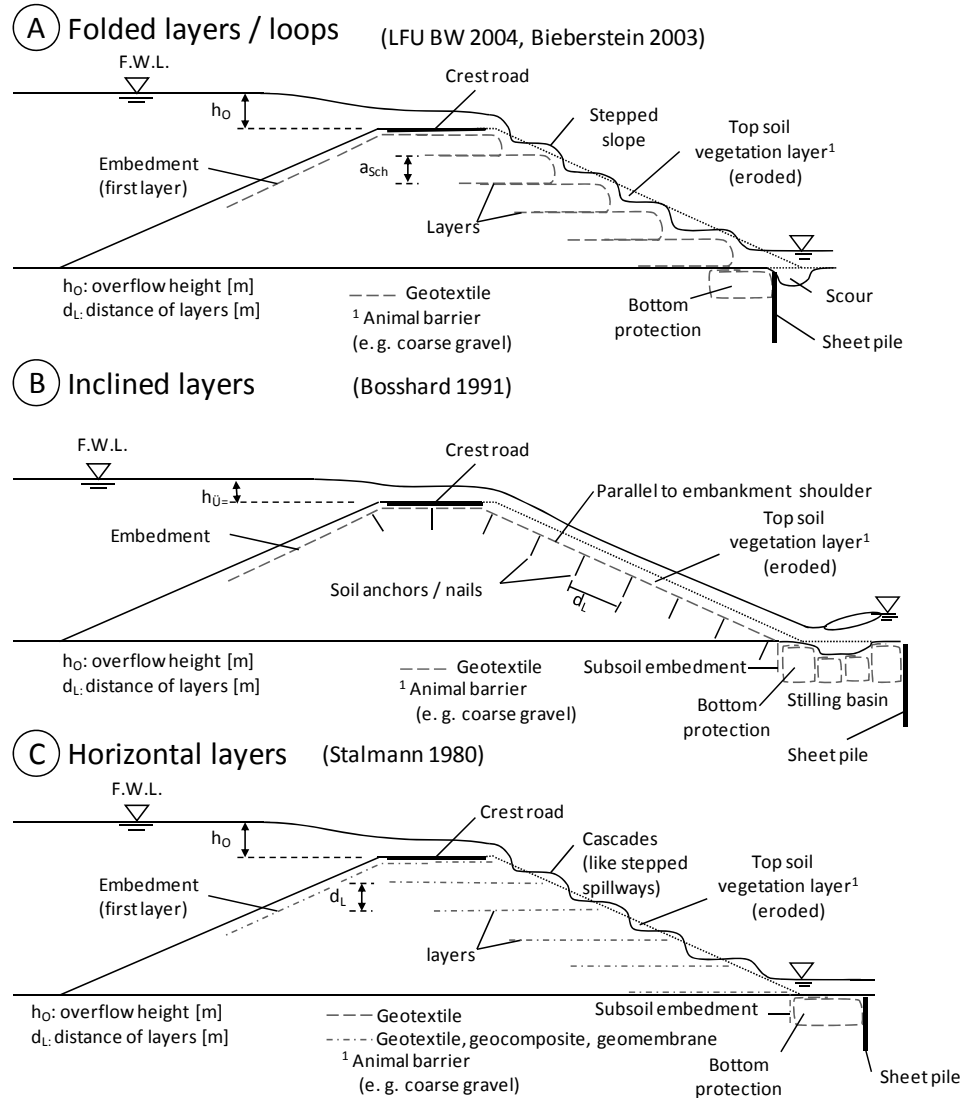
Motivation

Design Principles

Research

Conclusion

Different Designs



High Performance Solution

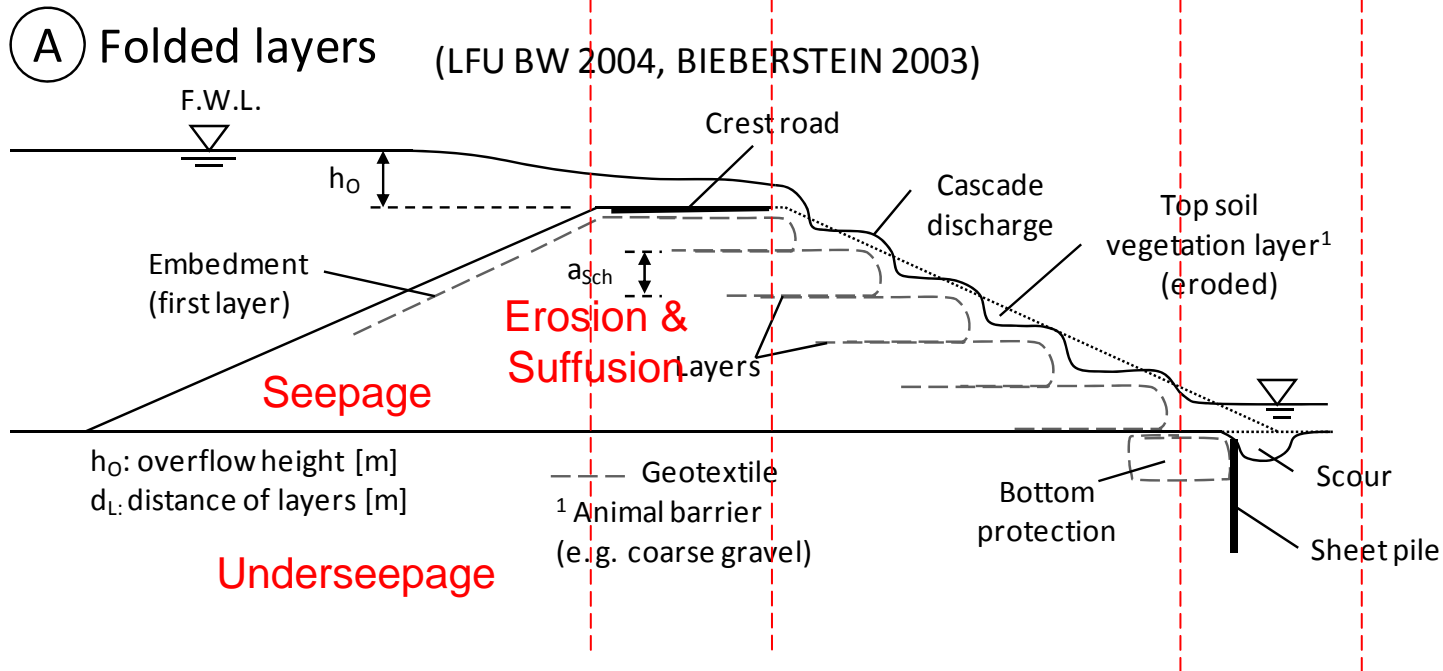
Motivation

Design Principles

Research

Conclusion

Sketch



Test rig



Research

Motivation

Design Principles

Research

Conclusion

- **Technical specifications** of the applied geosynthetic product (strength, permeability...)
 - Applicable layer **spacing** and embedment **lengths** using the wrap-around method
 - Determination and evaluation of the design of the steps in terms of **energy dissipation** and in terms of occurring loads
 - Determination of the **re-anchoring** length / technique
 - **Joint design**
- Preparation of a Design Manual

Conclusion

Motivation

Design Principles

Research

Conclusion

- **Design principles and fundamentals** are available on the fields of geosynthetics, geotechnics and hydraulics
- **Excessive laboratory tests** performed at several institutes
- Obvious **advantages** in regard to safety and economics
- Last step: Development of a **Design Manual (!)**



Thanks.
Djakujem.
Danke.
Tesekkürler.

1) Slovak „Preco nie?“ = English „Why not?“