

Conference on Flood Protection  
“Five Years after the flood”  
Concepts of Flood Protection – Design, Evaluation, Realisation  
08./09. October 2007



Fakultät Bauingenieurwesen Institut für Wasserbau und Technische Hydromechanik

# (Optimal) Realisation of refurbishment measures of dikes in consideration of prioritisation concepts

(Priorisierungskonzepte zur optimalen Umsetzung  
von Deichertüchtigungsmaßnahmen)

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**RMD CONSULT**

Dresden, 09. October 2007

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Institute of Hydraulic and  
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# Outline

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- 1) Introduction
- 2) Remediation Works
- 3) Approach
- 4) Concepts
- 5) Splitting of works
- 6) Conclusion

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# Flood Protection Action Programme

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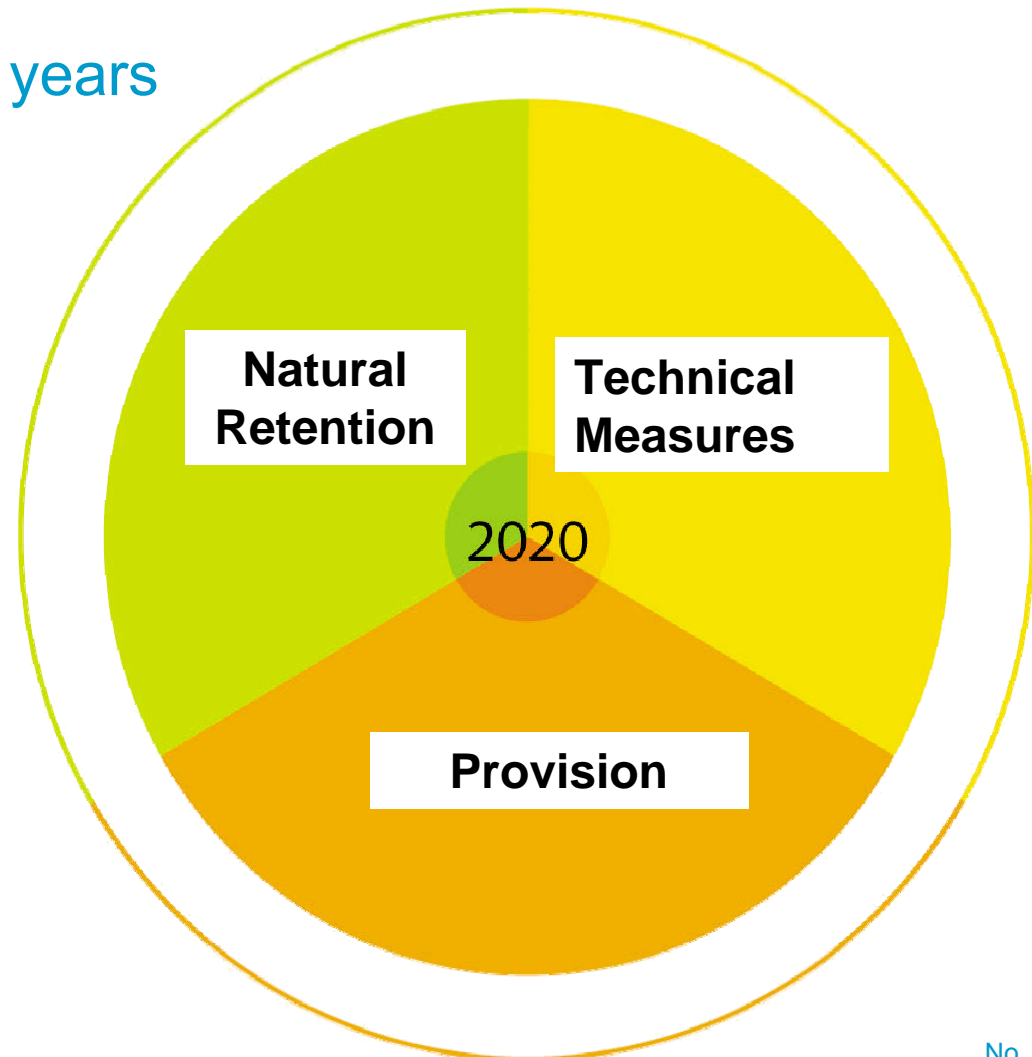


Passed in 2001

2,3 Mrd. (billions) € within 20 years

Ø 115 Mio. €/ year

150 Mio. €/ year  
in the years 2006 – 2008



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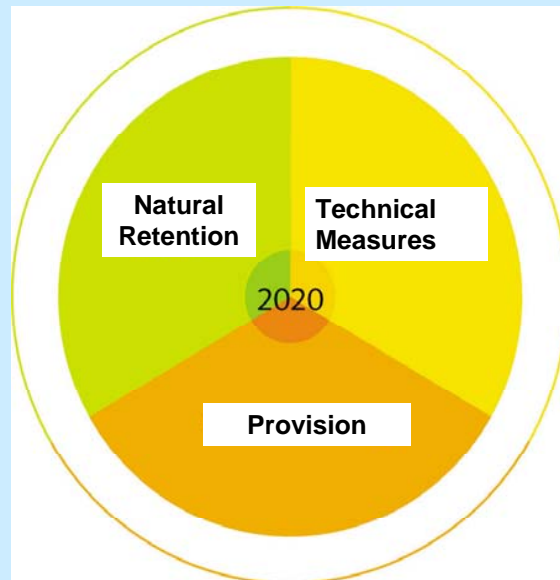
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# Flood Protection Action Programme



## flood protection action programme 2020



transform



renaturation of rivers  
relocation of dykes  
flood retention within catchment  
area



flood storage dams  
controlled Polder  
protection of cities and counties  
mountain torrents  
**refurbishment of dikes (!!)**



identification and determination of  
flooding areas  
identification of prior areas  
flood forecast

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# What is all this good for?



Tools / Know-how + Funds + Manpower



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# What is all this good for in reality?



Tools / Know-how + Funds + Manpower



administrative districts

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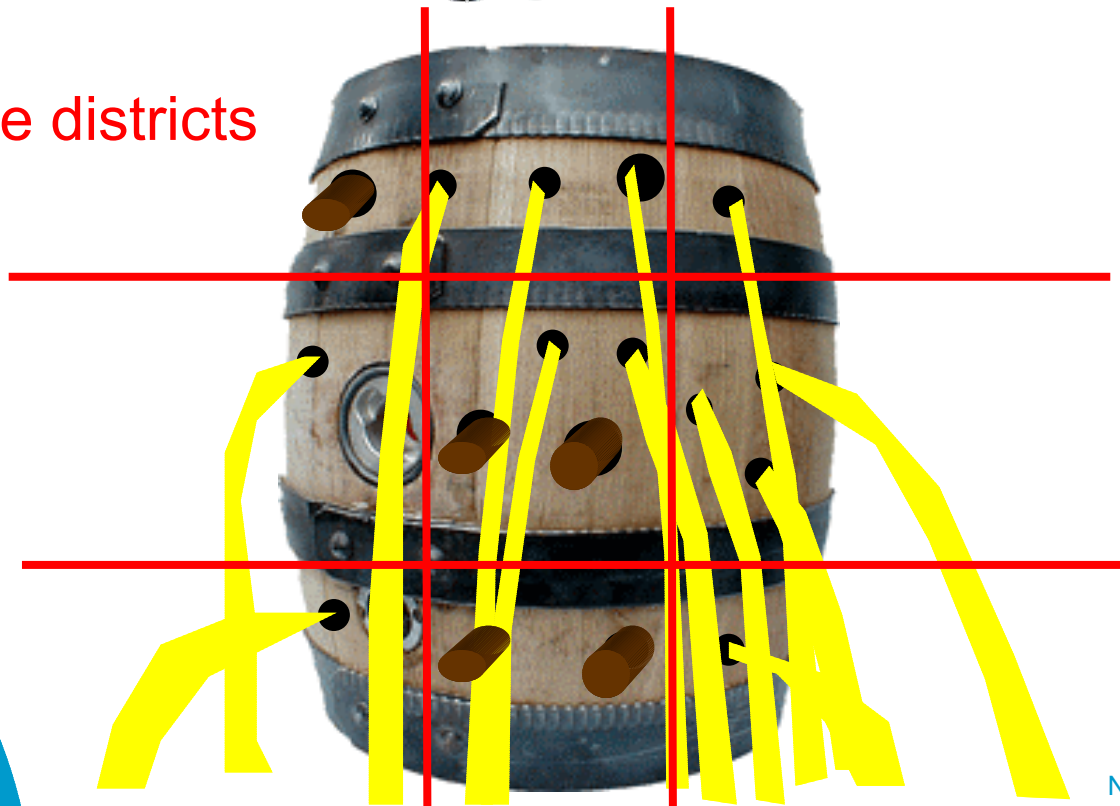
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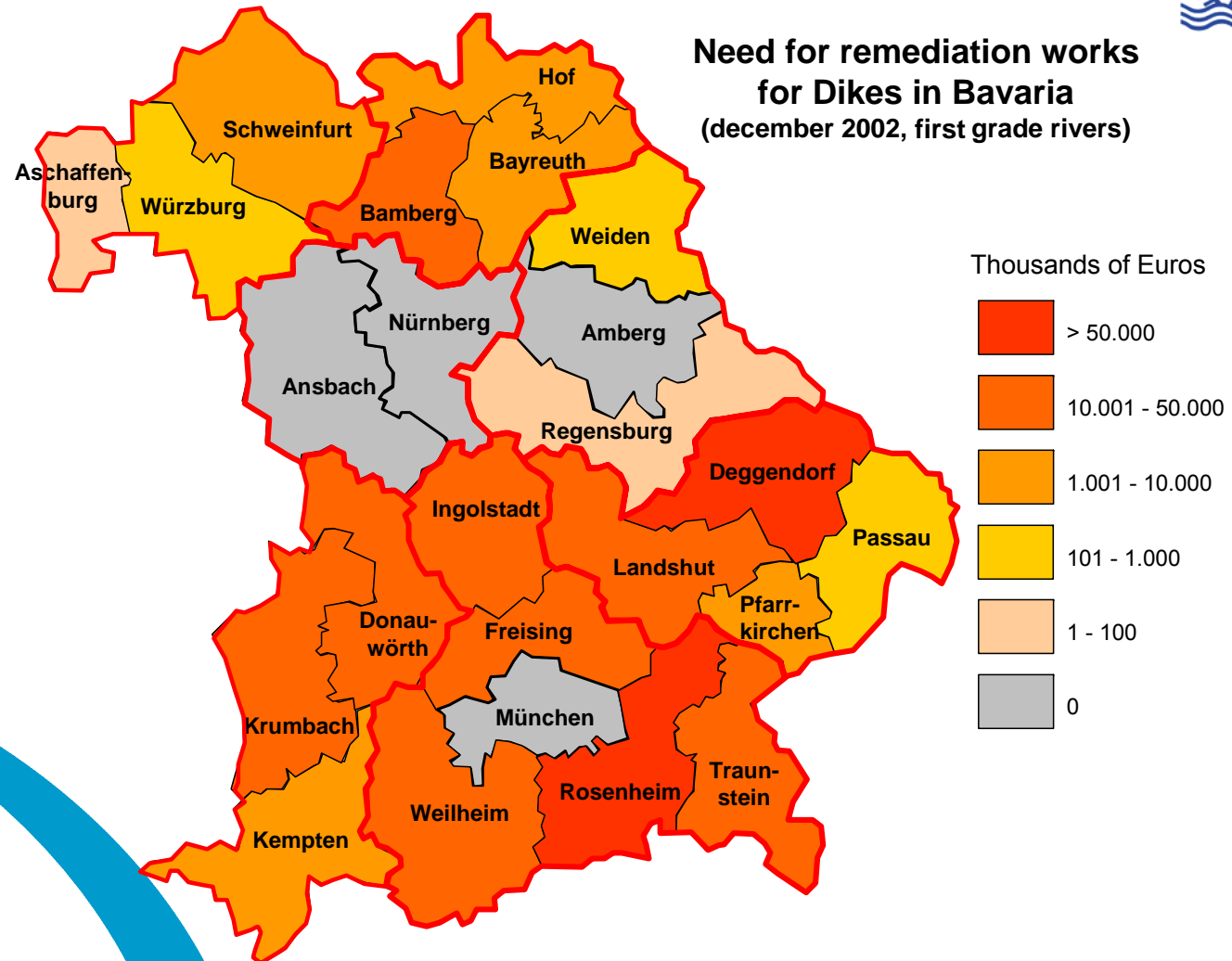


# Bavarian districts and dikes

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Need for remediation works  
for Dikes in Bavaria  
(december 2002, first grade rivers)



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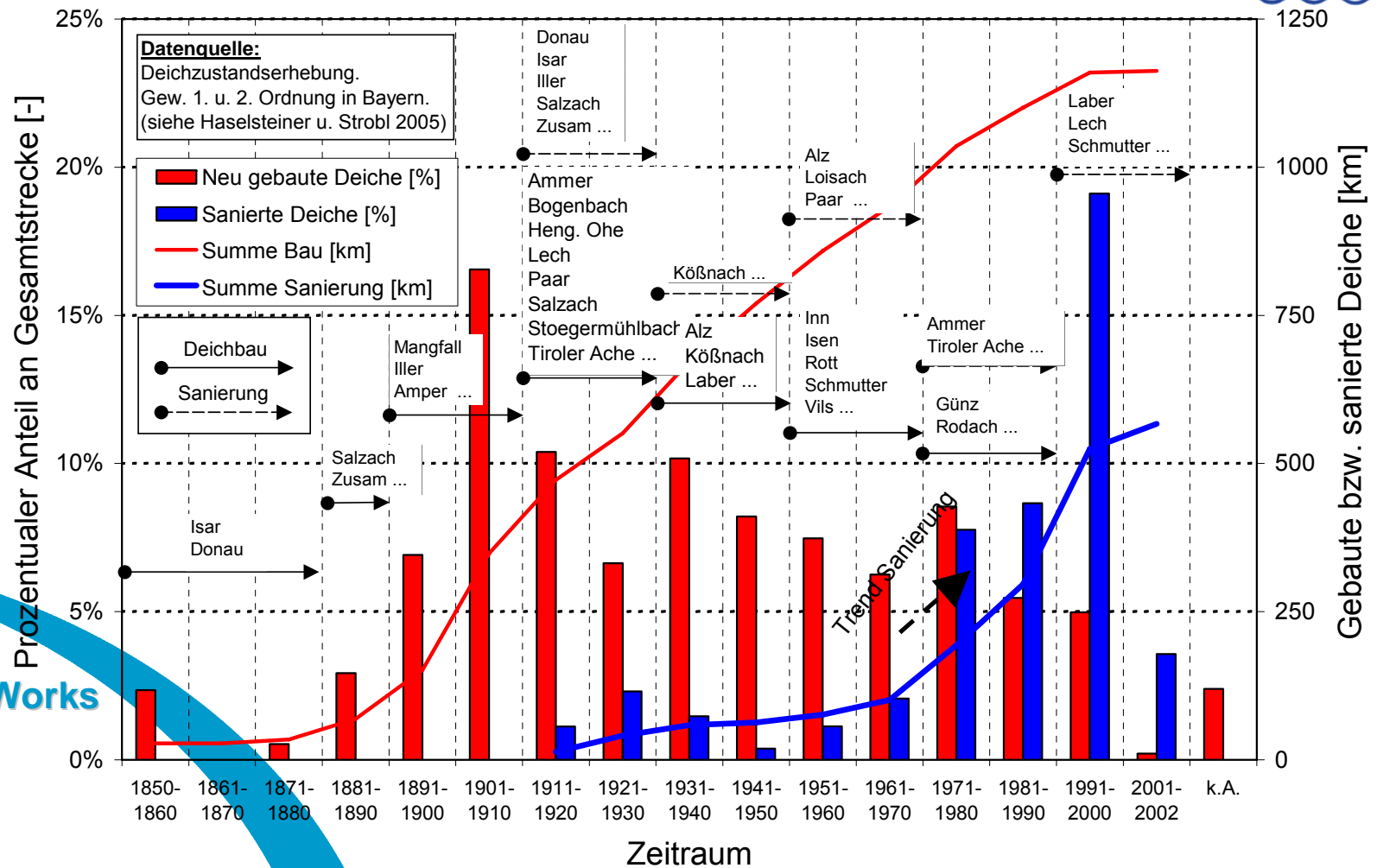
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# Carried out works / History

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# Remediation Works / Methods



- earth moving techniques
- structures & sealing elements
- soil and subsoil melioration
- surface erosion protection / overtopping protection
- adjustment of wooded dikes

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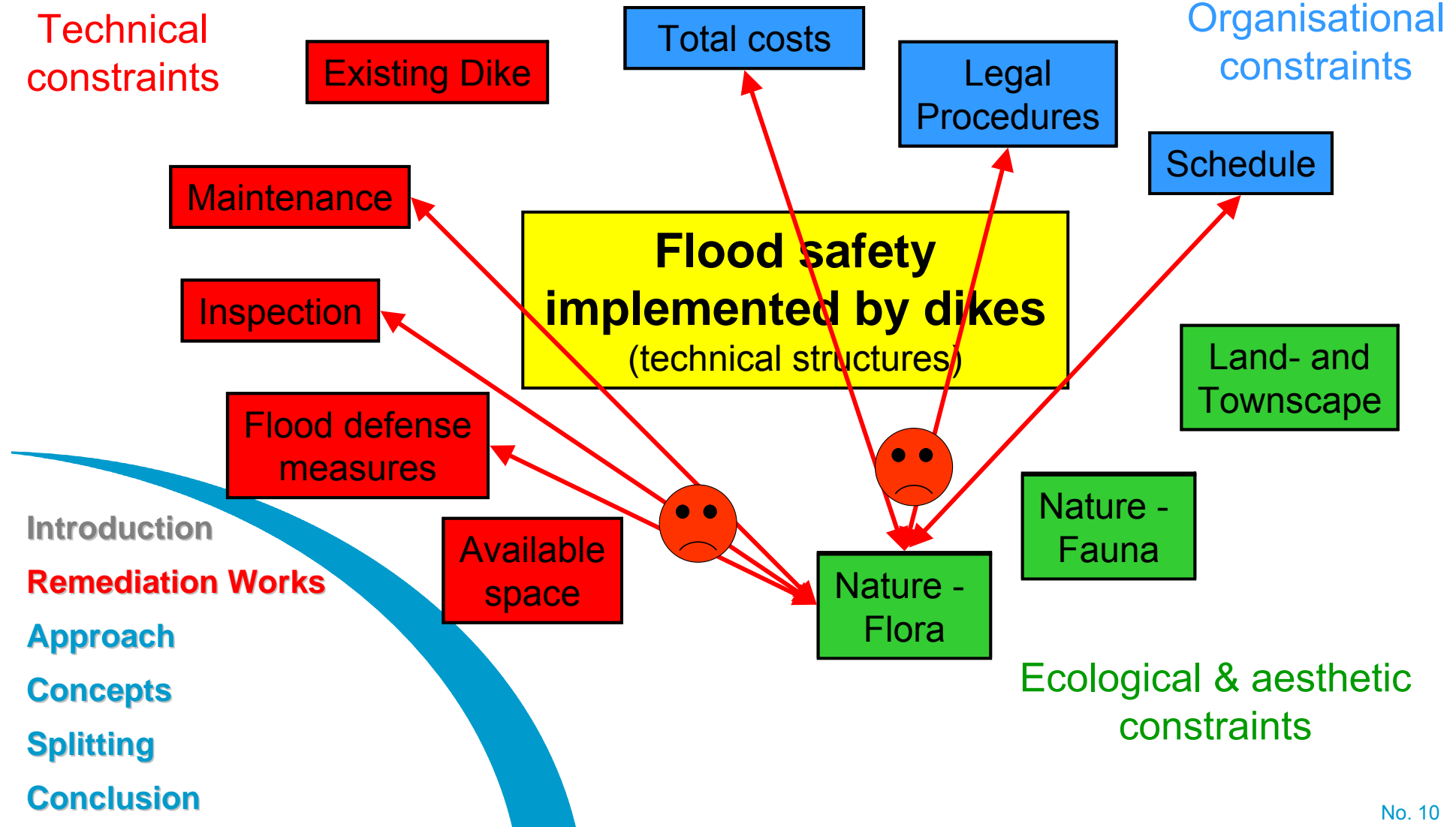
# Remediation Works / Constraints

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Organisational  
constraints

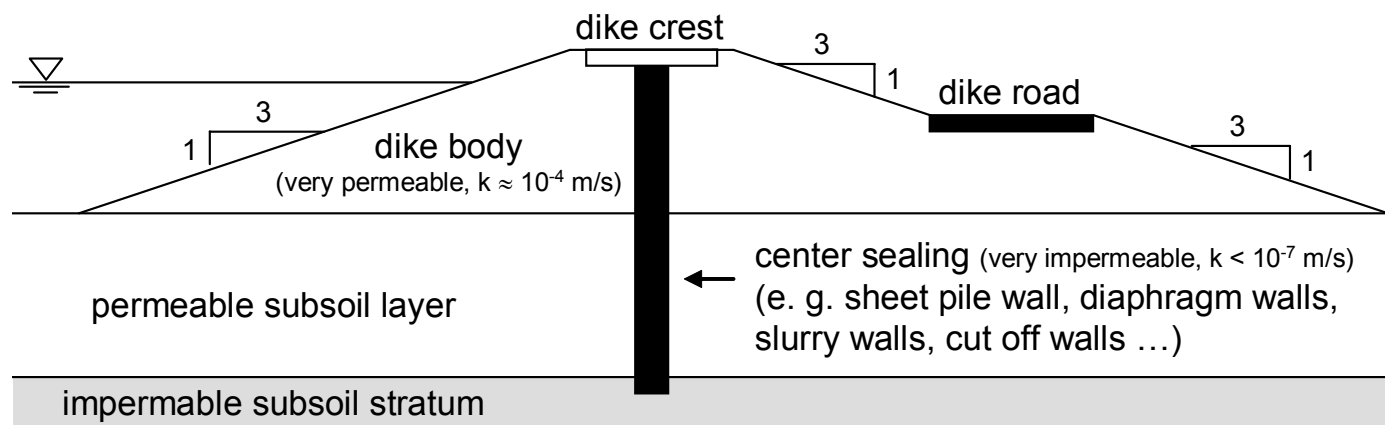
Technical  
constraints



# Remediation Works / Methods



- Simultaneous sealing of dike and subsoil
- Reduction of seepage
- Avoidance of or barrier for inner erosion
- Possibility of static properties by reinforcement



Diaphragm walls at Main River  
(Source: DWA 2005)

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Bored pile wall in dike at  
River Danube  
(Source: WWA Ingolstadt)



Milled cut off wall in dike at  
River Danube  
(Source: TUM)

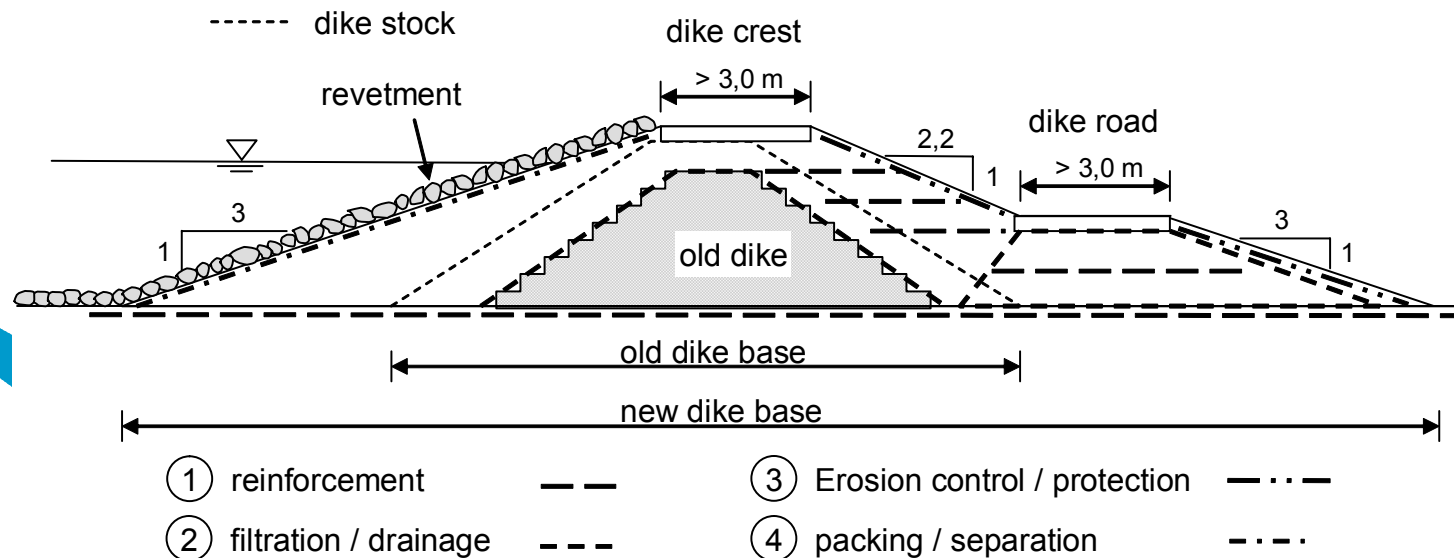


Sheet pile wall in dike at  
River Danube  
(Source: WWA Ingolstadt) No. 11

# Remediation Works / Methods



- Sealing with geosynthetic clay liners (reduction of seepage)
- Soil reinforcement with geogrids (reduction of settlement, increasement of shear strength)
- Filter and drain function by geotextiles (avoidance of inner erosion)
- Separation with geotextiles (preventing of intermixing)
- Protection, packing and erosion control



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# Basics for prioritisation

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- inquiry of dike and subsoil (design, state, soils parameters, damages, ...) → **assessment**
- examination & check of hydrological and hydraulic circumstances → degree of protection / design flood level → **failure probability**
- determination of **damage potential** → flood water level / valuables
- available **funds** / public expenditure → programme 2020
- **schedule** for construction work and approval procedures → annual budgets & construction permits

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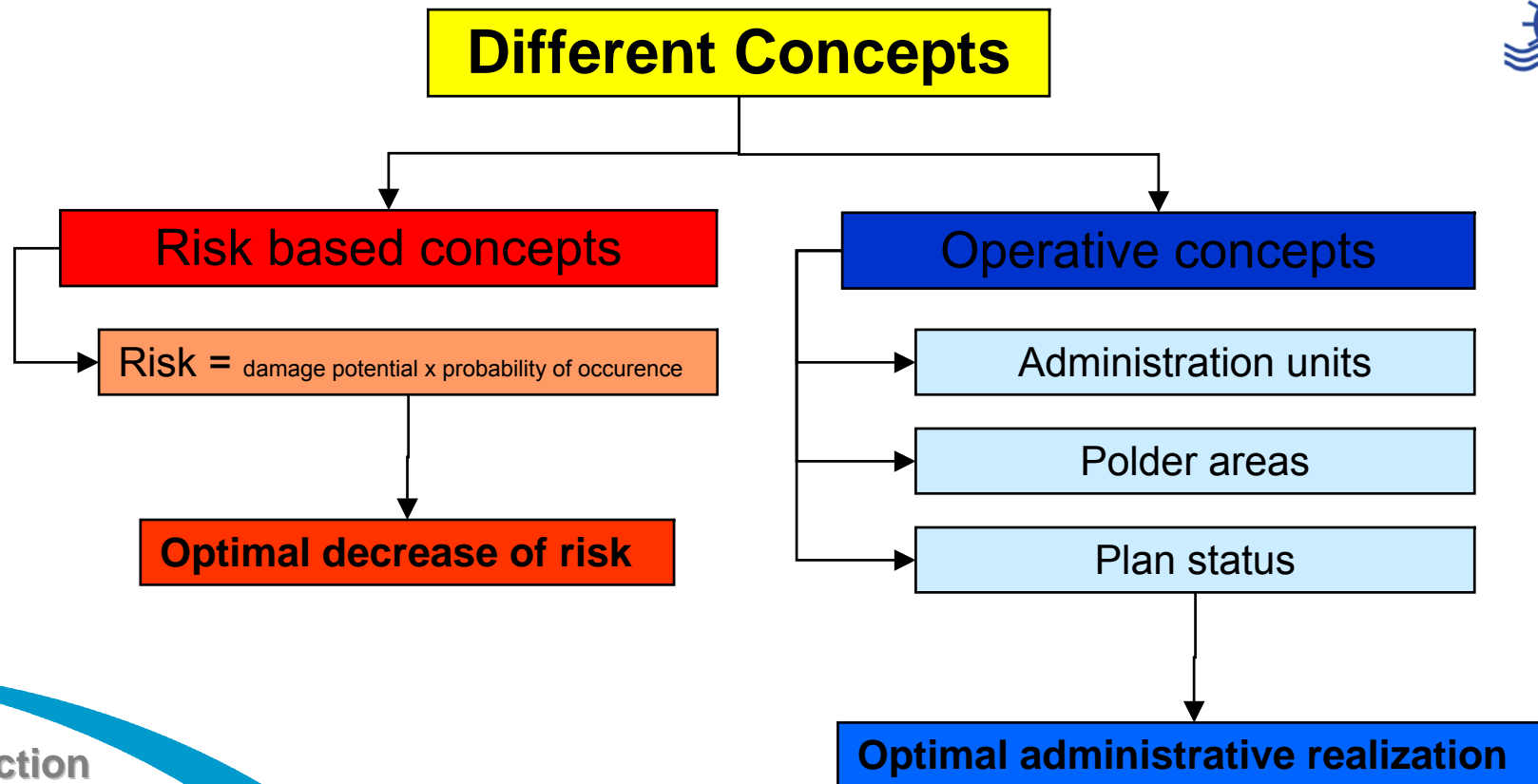
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# Concepts



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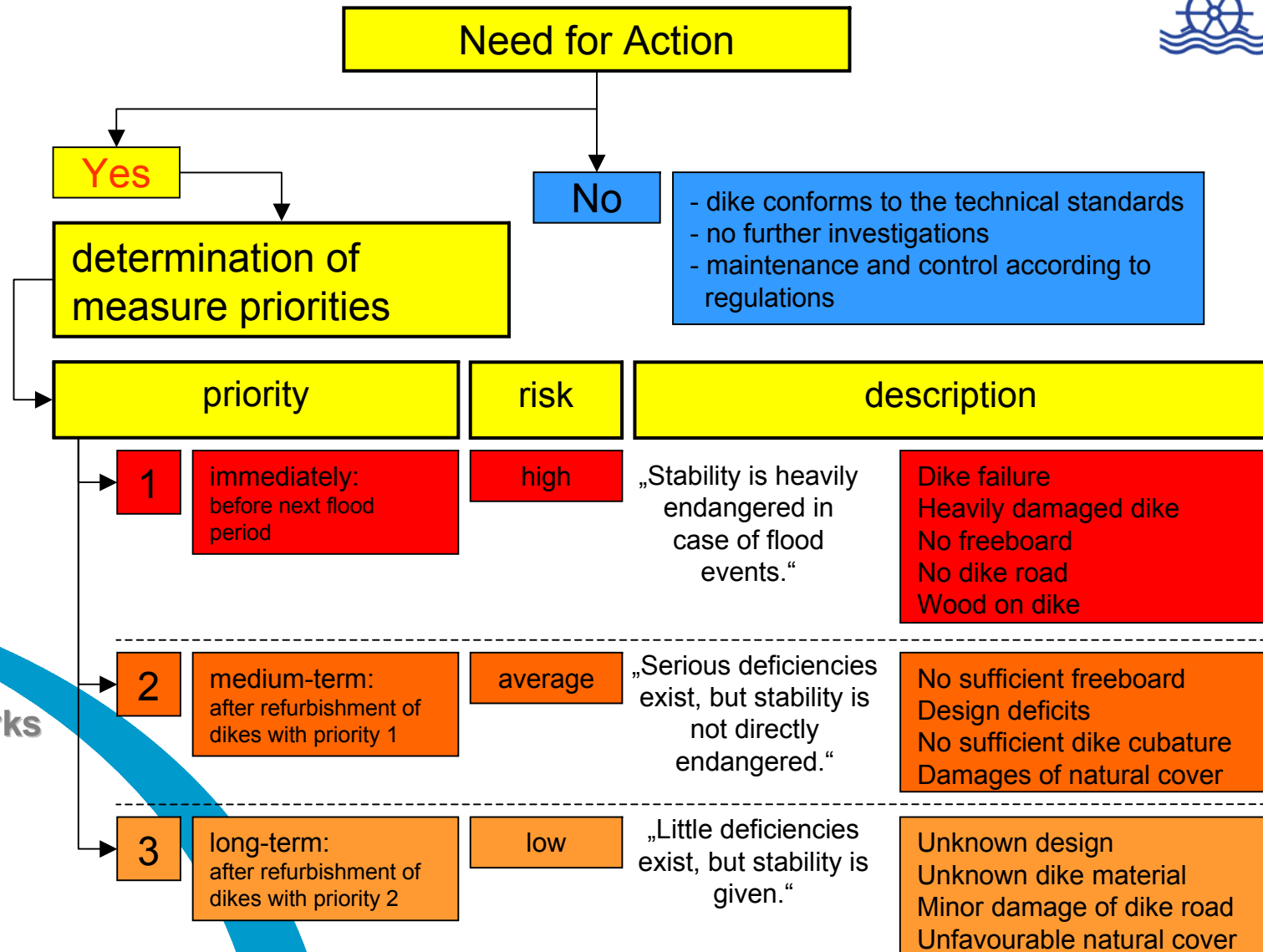
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# Risk based concepts



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# Risk based concepts



priority	risk	description	
1 immediately: before next flood period	very high	„Dike stability is critical endangered while flooding. High damages potential.“	Heavy slope slide failures Critical erosion processes in dike and subsoil Current degree of protection < Desired value Residential estate Industrial areas
2 short-term: As possible before the next flood periods (< 2 years)	high	„Dike stability may be endangered while next flooding. Medium to high damage potential, intended flood fighting measures.“	Little freeboard (< 0,50 m) Superficial slope slide failure No flood fighting road / no access roads Current degree of protection < Desired value Little crest width (< 3,0 m) Sparsely to strongly populated areas
3 medium-term: After the refurbishment of critical dikes of priority 1 & 2 (< 5 years)	medium	„Dike with serious deficiencies. Medium damage potential without an endangered stability. Efficient flood fighting measures intended.“	Heavy woody vegetation Design deficiencies Current degree of protection ≈ Desired value Sparsely populated areas / Important infrastructure
4 long-term: After the refurbishment of dikes of priority 1 & 2. (≈ 10 years)	small	„Dikes with deficiencies. Stability is not endangered and the damage potential is small.“	Little woody vegetation Unknown design and subsoil circumstances Small damages at roads and ways Current degree of protection = Desired value Agricultural areas / Negligible infrastructure
5 Very long-term: After the refurbishment of dikes of priority 1 & 2. (no temporal requirements)	very small	„Dikes with small deficiencies. Stability is not endangered and the damage potential is very small.“	Single woody vegetation objects Unknown design and subsoil circumstances Unsecured dike crest = flood fighting road Current degree of protection = Desired value Natural landscape
0 no need for action	degree of protection	„Dike conforms to the technical standards.“	no further investigations in case of reasonable evidence new investigations regular maintenance measures

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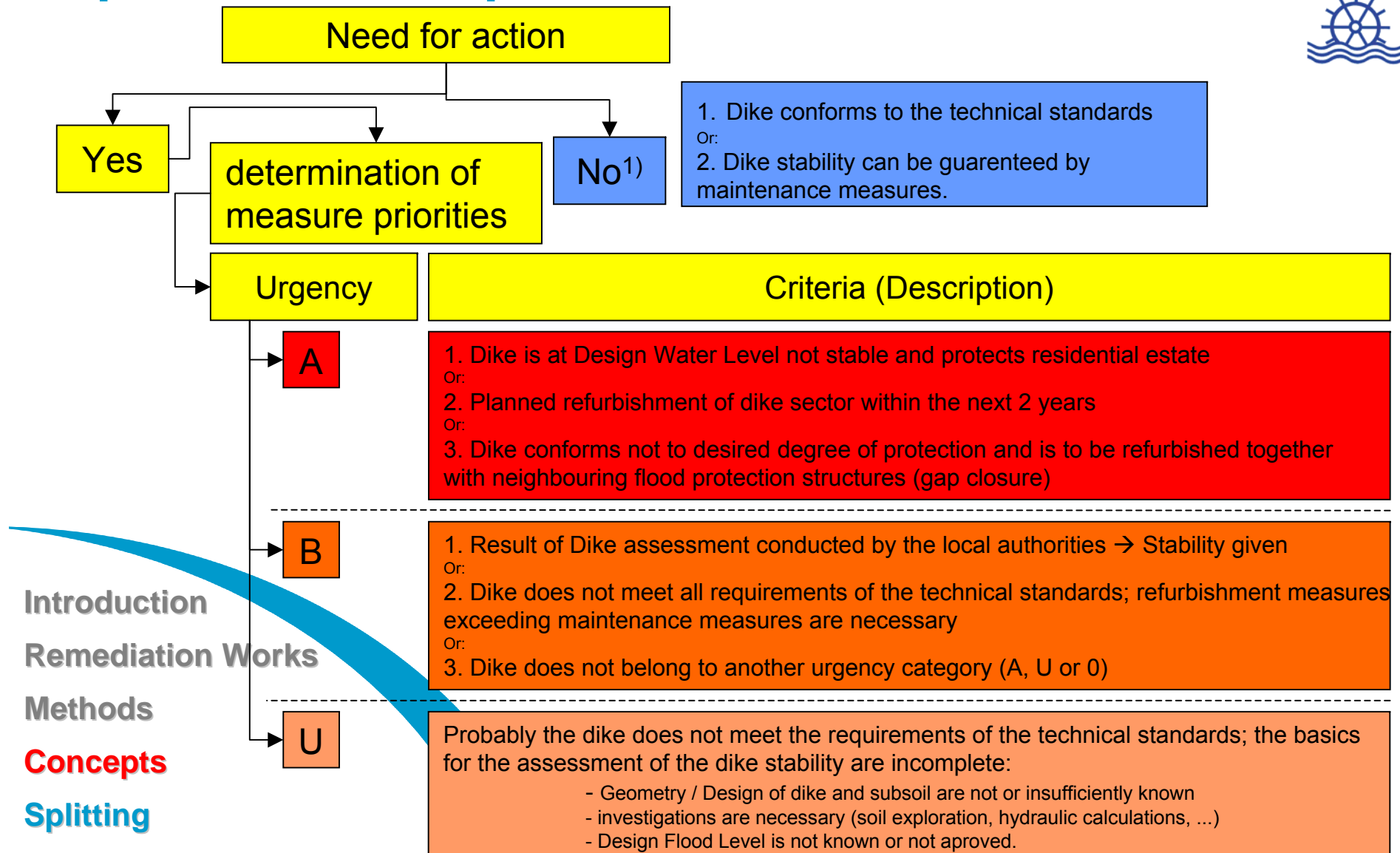
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# Operative concepts



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<sup>1)</sup> Correspond to urgency level 0 (no need for action = no urgency level)

# Splitting

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- **emergency measures** / flood fighting in case of stability is critically endangered → structures have to be removed / cannot be intergrated into refurbishment concept
- **instant measures** for safekeeping of the stability → can be but need not to be integrated into subsequent measures
- **partial measures** that ensures stability and service ability and that are completed by subsequent measures to finish refurbishment
- **accelerated measures** that are predated that can be partial measures or instant measures
- possibility to **change urgency** of need for action / refurbishment

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# Conclusion

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- Prioritisation is **necessary** for an optimal adoption of resources
- Concepts has to be
  - **reasonable** → damage potential + dike state
  - **applicable** → administrative constraints
- **Criteria** for classification of urgency should be limited (e. g. 3 classes and no need for action)
- **Splitting** may be reasonable
  - rise the effectiveness → immediate stability
  - change urgency class → detention of funding

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**Thank you for your attention!**

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# Damages

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Flood incident (River / Year)	Damages [in 1.000.000 €]	Where?	Source
Danube 1988	30	Bavaria	3
Rhine 1993	600	Rhine Area	3
Rhine 1995	320	Rhine Area	3
Oder 1997	324	Germany	1
Alpine Rivers + Danube 1999	409	Bavaria and Baden-Wuerttemberg	1
<b>Elbe 2002</b>	<b>9200</b>	<b>Mainly East Germany</b>	<b>3</b>
Alpine Rivers + Danube 2005	172	Bavaria	2

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- <sup>1</sup> Tina Plapp
- <sup>2</sup> Reuters
- <sup>3</sup> DTK