Smart Rivers 2025

PIANC · A.D. 1885 · AIPCN

NAVIGARE NECESSE

Welcome; Intro & Overview

Smart Rivers 2025

SHORT COURSE
Technical-Biological Bank Protection for Inland Waterways

PIANC
The World Association for Waterborne Transport Infrastructure

BAW
Federal Waterways Engineering and Research Institute

PIANC INCOM WG 128
Technical-Biological Bank Protection for Inland Waterways

TECHNICAL-BIOLOGICAL BANK PROTECTIONS FOR INLAND WATERWAYS

PART 1: BASICS OF A BEST PRACTICE APPROACH
PART 2: LIBRARY OF MEASURES
PART 3: DECISION SUPPORT ADVICE

InCom Working Group Report N° 128 – 2024

SMART RIVERS 2025
SHORT COURSE
Technical-Biological Bank Protection (TBPs) for Inland Waterways
INTRODUCTION AND OVERVIEW OF THE REPORT'S CONTENT

Prof. Dr.-Ing. Bernhard Söhngen (BAW) and other members of PIANC INCOM WG 128

- **PIANC principle**
- **Standardizing bank protections?**
- **What means Best Practice**
- **Structure of the report**
- **Content examples**
- **Tools**

PIANC principle

- **Trust experts** in working fields, where stringent design rules are not existing or assured knowledge lags behind the need for appropriate design rules!
- **Bring worldwide experts together** and condense their expert knowledge to a practice-oriented guideline!
- **Assessments of experts replaces assured knowledge where necessary**

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Possibilities and limitations for standardizing bank protections

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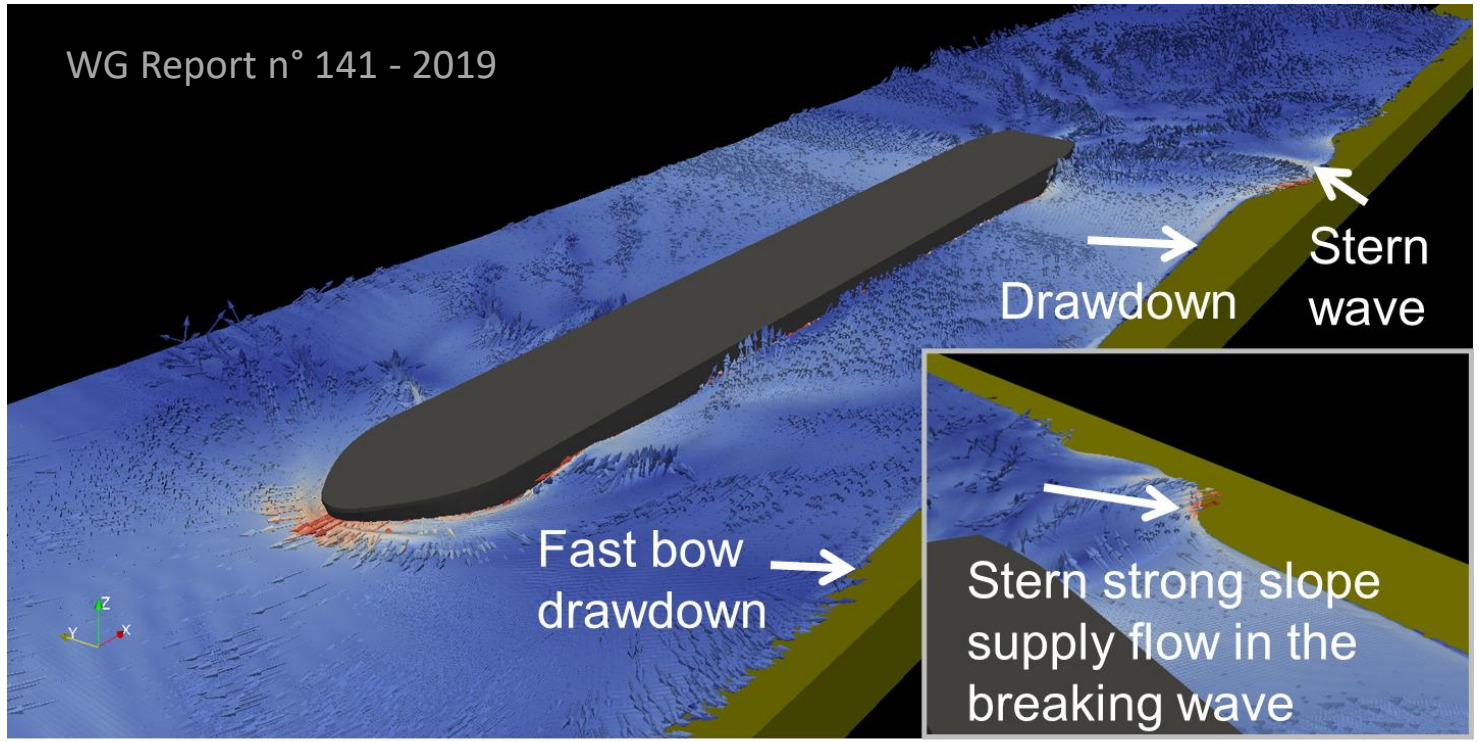
Decisive hydraulic impacts from freight vessels – drive close to v_{crit}



- Freight vessels sail usually as fast as possible and as slow as necessary from economical reasons.
- Vessel speed is thus scaled by the critical speed – unless there are other restrictions which are effective controlled and obeyed
- Therefore and because of typical water depth's and draughts:
  - Design-relevant hydraulic loads don't differ that much for inland waterways!
  - Only the reaction of the subsoil due to fast drawdown is site specific!

Possibilities and limitations for standardizing bank protections

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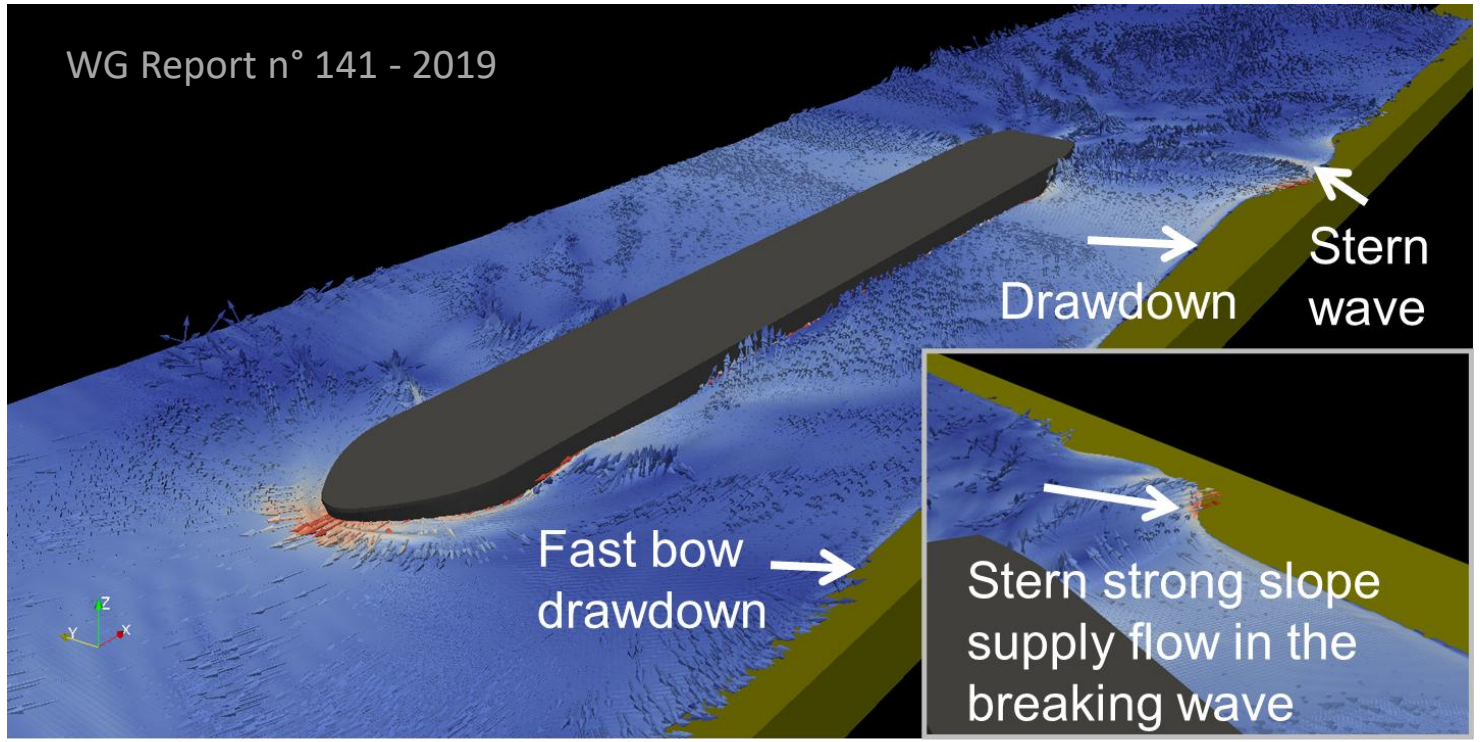
Decisive hydraulic impacts from freight vessels – drive close to v_{crit}



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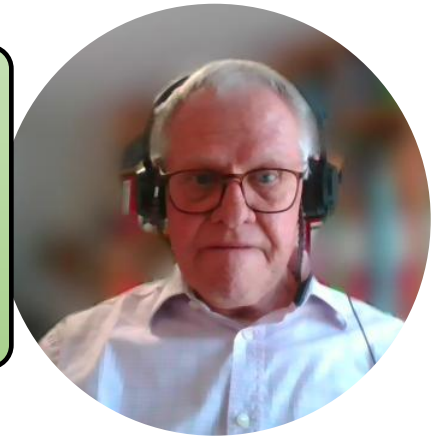
Standard technical bank protections constructions are possible and expedient, depending generally on CEMT class and the soil type only …



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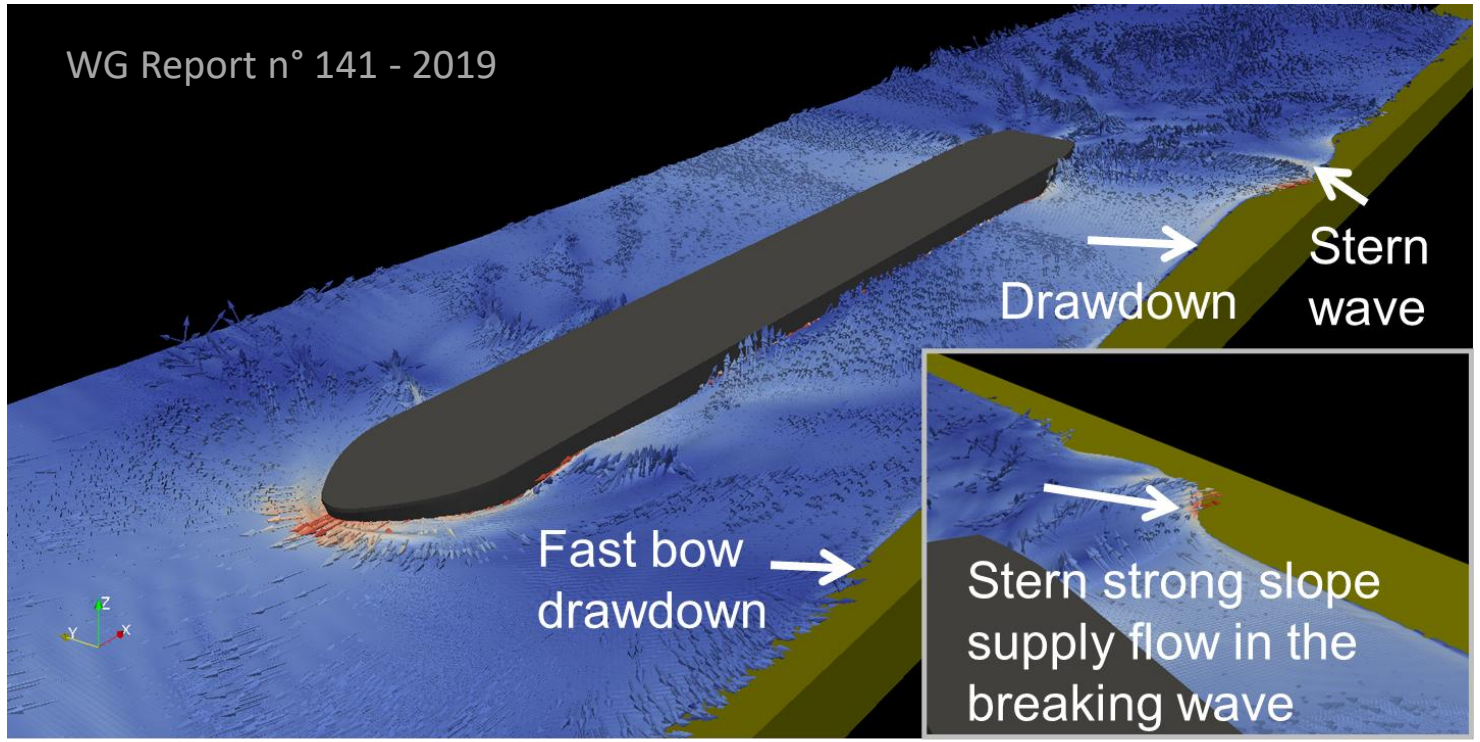

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  - **Only the reaction of the subsoil due to fast drawdown is site specific!**

Standard technical bank protections constructions are possible and expedient, depending generally on CEMT class and the soil type only …

If the main objective is stability and freight vessels are predominant (exceptions e.g. for recreational boating)

Possibilities and limitations for standardizing bank protections

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TBPs, what's different

e.g. garbage

e.g. bank failure

Generally lower impacts (otherwise alternative protections are unsuitable), **but**

- **Very different impact and failure types** (also from natural flow field, morphodynamics, usage …),

All photos: © BAW & British Waterways

Possibilities and limitations for standardizing bank protections

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TBPs, what's different

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e.g. bank failure

e.g. siltation

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- **Very different impact and failure types** (also from natural flow field, morphodynamics, usage …),
- **Strongly varying boundary conditions** (climate, target vegetation …)
- **Influence of river engineering**
- **Human demands/impact …**

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e.g. siltation

But above all:

- **Various technical, social, economical objectives, and thus**
- **Planning aspects determine selection and design of TBPs**

e.g. adventure playground

e.g. grazing land

Dominance of boundary conditions and objectives!
Stability demands are no longer uppermost!

Possibilities and limitations for standardizing bank protections

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TBPs, what's different

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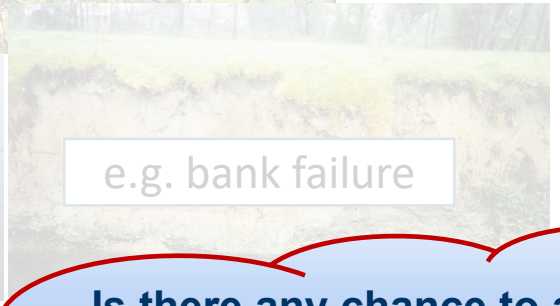
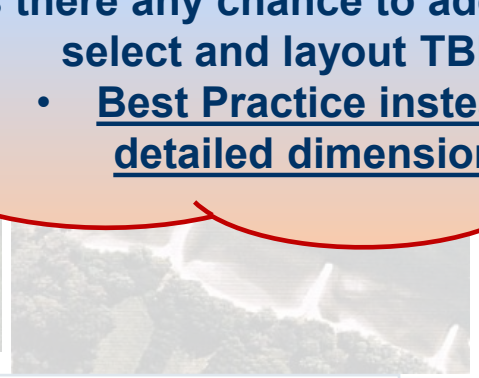


e.g. bank failure

e.g. siltation



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- **f river**
- **s/impact …**

Is there any chance to adequately select and layout TBPs?

- **Best Practice instead of detailed dimensioning**

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Dominance of boundary conditions and objectives!
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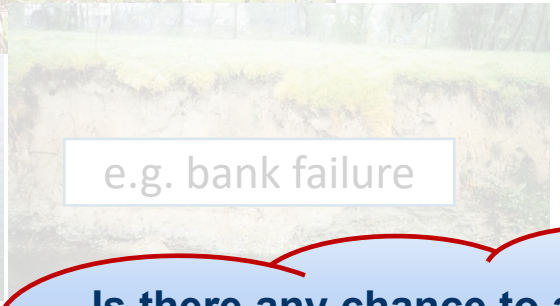

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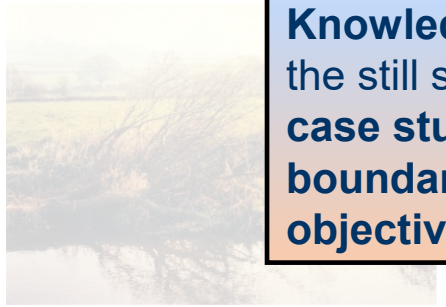

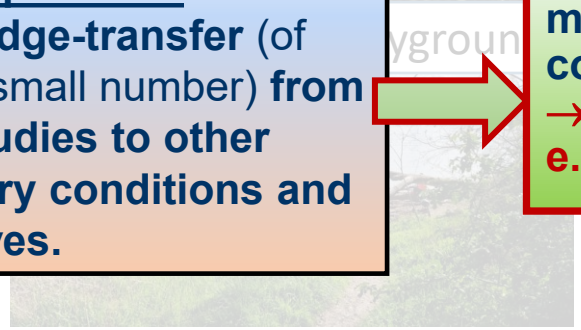

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All photos: © BAW & British Waterways

Is there any chance to adequately select and layout TBPs?

- **Best Practice instead of detailed dimensioning**

Central problem:
Knowledge-transfer (of the still small number) **from case studies to other boundary conditions and objectives.**

The overall 63 documented measures in the report are of course far too little
→ Development of a TBP-database, e.g. by using WEB-tools!

What means Best Practice Approach (BPA)?

All photos: © BAW & Chinese Waterway Authorities

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From natural development up to technical solutions with "green upgrade"

Feasible measures from a "pool of measures"

What means Best Practice Approach (BPA)?

All photos: © BAW & Chinese Waterway Authorities

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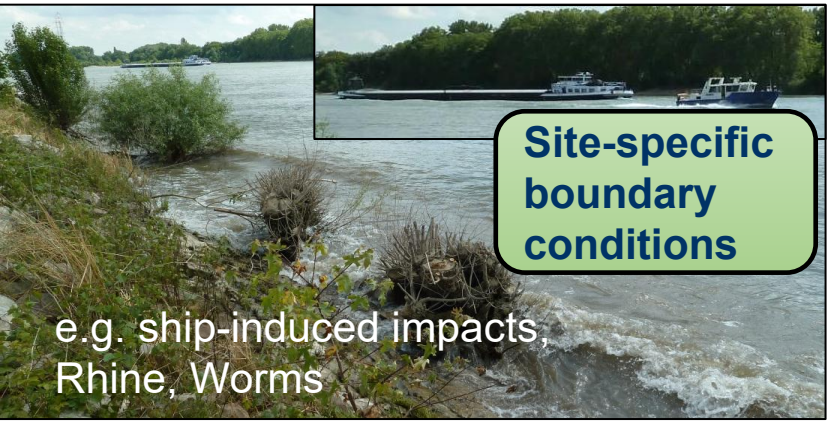
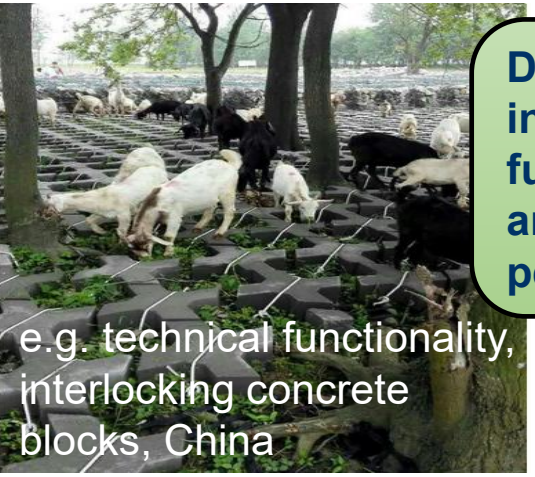


From natural development up to technical solutions with "green upgrade"

Relevant criteria from a "pool of criteria"

strong link

Feasible measures from a "pool of measures"

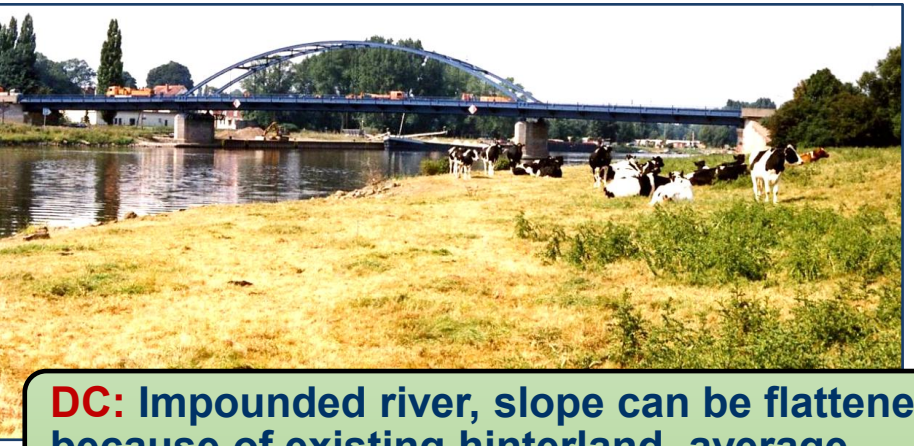


Demands on in regard to functionality and performance

What means Best Practice Approach (BPA)?

What does it mean more concrete, if boundary conditions (BCs) and possible functionality issues at planner's site (Design Case DC) differ from those at the site of realization (Analysis Case AC)?

Design Case example: Weser at Stolzenau Town



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DC: Impounded river, slope can be flattened because of existing hinterland, average terrain step height, average ship-induced impacts; main planners aim: ecological upgrade including support of shallow water zones, moderate necessary stability

What means Best Practice Approach (BPA)?

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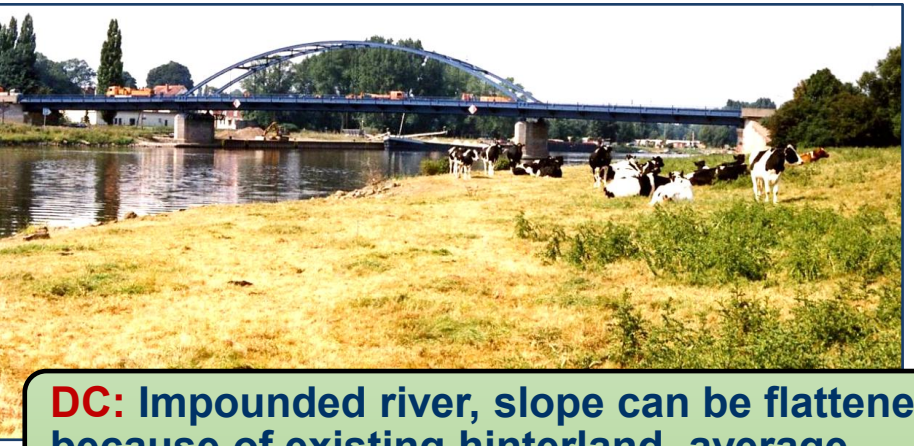

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Analysis Case example: Willow brush mattresses at Worms, Rhine

AC: Free flowing river with high water level changes, steep slope, no hinterland, high terrain step, high ship-induced impacts as low fairway-bank distance, main planners aim = ecological upgrade related to former riprap, high stability demands.

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How to transfer experience from the AC (under AC-conditions & aims) to the DC (with its unique BCs and planners aims)?

You find more information in the other presentations. In simple terms: We use a quantified scoring approach, uses to assess and weight differences of boundary conditions and between demands and properties to assess the feasibility and suitability of the AC-measure to be realized at DC site.

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Structure of the report

Part 1: Basics of the BPA

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Summary

1. Application hints
2. Relevant publications
3. Features of measure types
4. Content of Part 2 and Screening
5. Preselection (abridged version)
6. Process recommendations for detailed design (abridged version)
7. References … Glossary, abbreviations …

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2. Basic Types
3. Fact Files according to water level fluctuations
   - I. Canals and lakes
   - II. Impounded rivers
   - III. Free flowing rivers
4. Case Studies

"backbone" of the report

Teil 2: Library of measures

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Part 3: Decision making (for appliers and tutorials)

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5. Preselection (long version, step by step)
6. Process recommendations for detailed design (comprehensive version with examples – 7 Steps)

Appendix A: Working aids for detailed design
Appendix B: Elaborated German DWA M-519 code of practice (bioengineering method)
Appendix C: Extract of the UK Waterway Management Guide, extended to large channels

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"backbone" of the report

The report includes an EXCEL worksheet for performing and visualizing Screening, Preselection & decision-making tools for Detailed Design (i.a. using AHP)

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Content example from Part 1: Features of measure types - engineering

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Plants only, biotechnical and mostly technical

Content example from Part 1: Features of measure types - engineering

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Linear, combined, surface-covering

Plants only, biotechnical and mostly technical

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Content example from Part 1: Features of measure types - engineering

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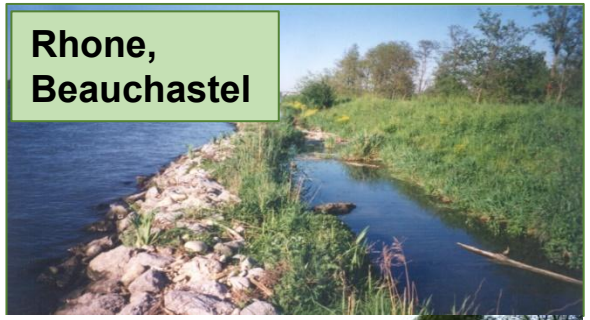

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The report focuses on bioengineering techniques, but also non-engineering measures were discussed.

Pre-embankment, combined, direct

Linear, combined, surface-covering

Plants only, biotechnical and mostly technical

Content example from Part 1: Features of measure types – non-engineering

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Ecological enhancement

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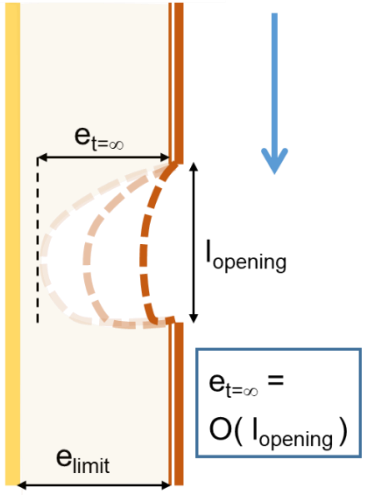
Management strategies as natural succession



Process recommendations instead of dimensioning:

- Cause-effect-relations.
- Acceptance.
- Effect of remedial measures.
- Installation of test sections …

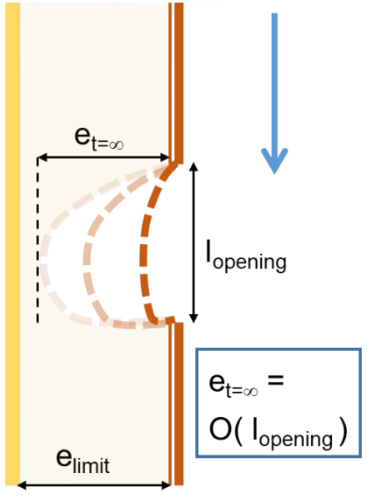
Content example from Part 1: Features of measure types – non-engineering

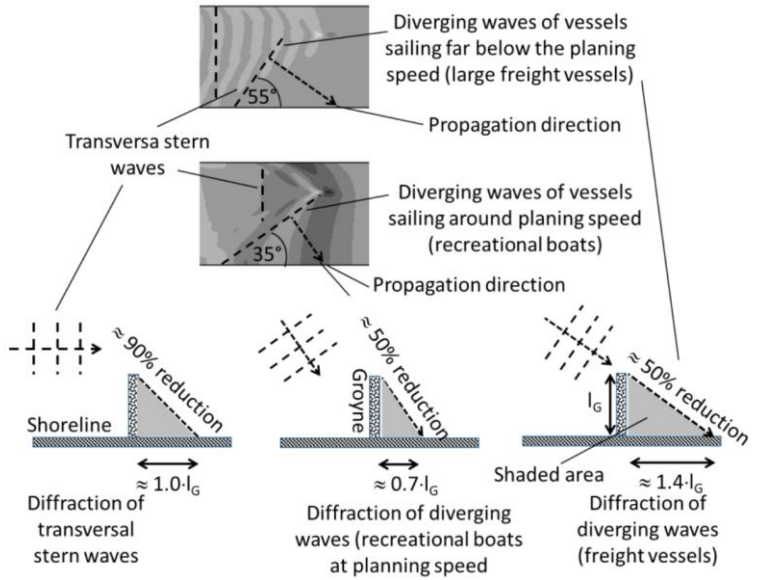
Ecological enhancement

Link to river engineering

Management strategies as natural succession

E.g. impact-reduced sections inside groyne fields





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Content example from Part 2: Basic Types, Fact Files and Case Studies

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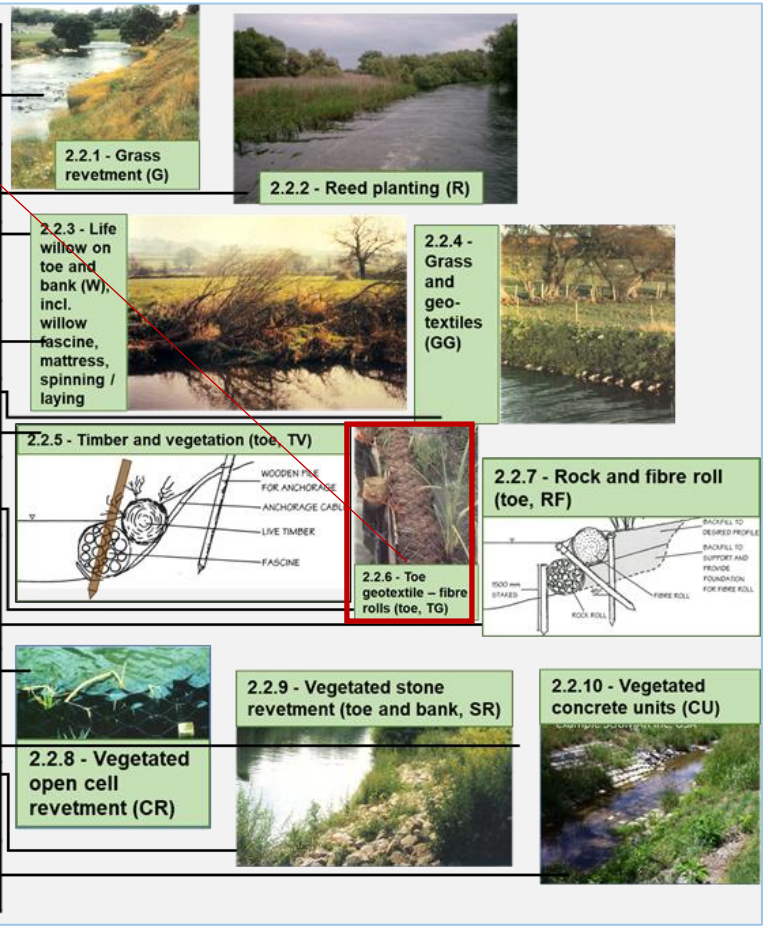
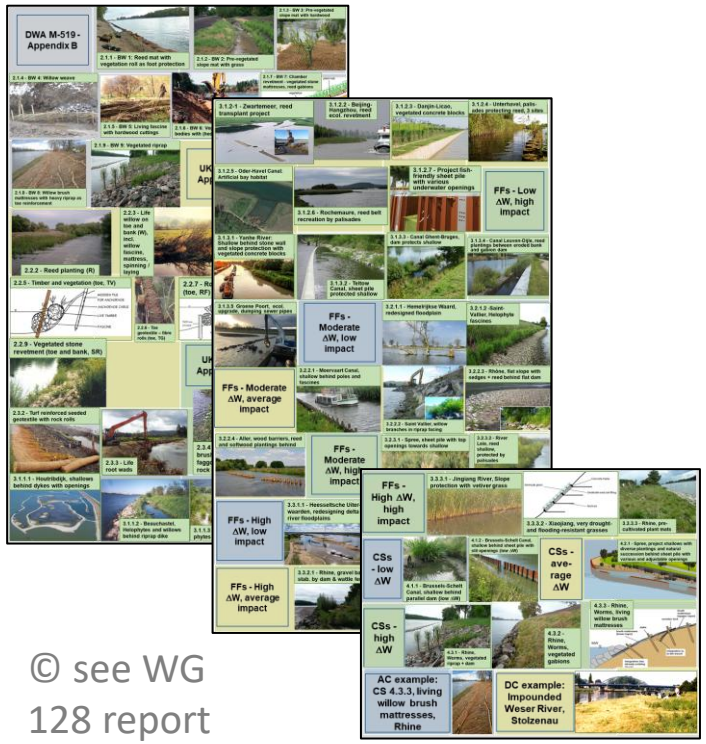
Example Geotextile Roll

Basic Types from UK Waterway Management Guide

Chapter	Designation
2.2.1	Grass revetment
2.2.2	Reed planting
2.2.3	Life willow on toe and bank
2.2.4	Grass and geotextiles
2.2.5	Timber and vegetation
2.2.6	Toe geotextile - fibre rolls
2.2.7	Rock and fibre roll
2.2.8	Vegetated open cell Revetments
2.2.9	Vegetated stone revetment
2.2.10	Vegetated concrete units revetment



63 measures, categorized according to ΔW, impact, comprehensiveness



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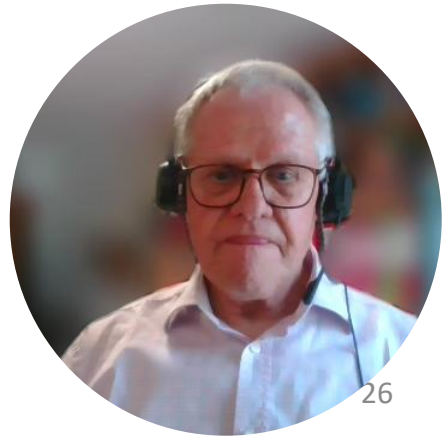

Content example from Part 3: Process recommendations for detailed design

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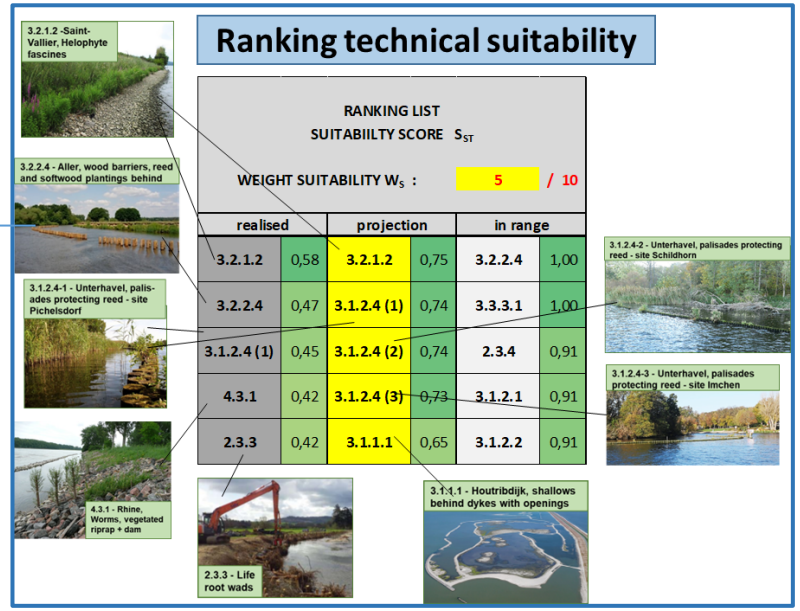
7 Steps

Step 1: Discussion of planning objectives

Step 2: Consideration of boundary conditions

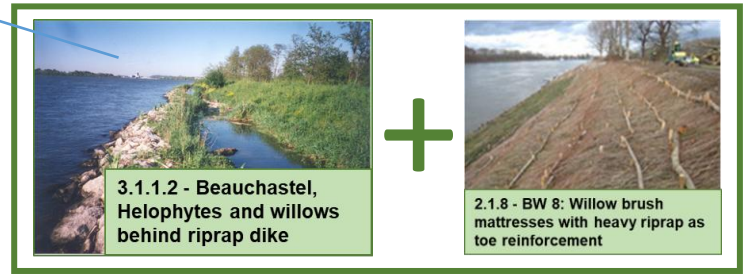
Step 3: Preselection using EXCEL tools



Step 4: Consider details of successful measures

Step 5: Check knockout criteria, e.g. impact of floating ice

Step 6: Selection and specification of variants for final choice



Step 7: EXCEL-supported decision-making, using e.g. AHP tools (Analytic Hierarchy Process

Final check and feedback to decision makers and planners

Content example from Part 3: Appendix C, extract of the UK Waterway Management Guide, extended to large navigational channels

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Example „Design strategy for bioengineering measures

© British waterways & PIANC

Solutions and conditions addressed:

G = grass revetment (bank)

R = reed planting (toe and bank)

W = willows (toe and bank)

F = fascines /faggots (toe and bank)

T = trees and shrubs (toe and bank)

NS = not suitable

Additions WG 128: These measures are not considered here as they are even not suited to small boat waves or should be applied only in combination with other measures.

Appendix C offers stringent design schemes inclusive management strategies for selected measures, considering especially local boundary conditions. This was realized here by "wave-height-equivalent" flow velocities.

Overview of provided tools - besides comprehensive information about measure types and recommended approach

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Conventional design aids such as Tables with hydraulic load limits

Boundary category	Boundary type	Permissible velocity (m/s)	Permissible breaking wave height (m)
Soils and gravel	Non colloidal alluvial silt	0.6	-
	Stiff clay and alluvial colloidal silt	1.1	0.15
	Graded silts to cobble	1.2	0.15
	Gravel, d_m = 0.02 m	1.1	0.15
Vegetation	Turf on non erosive soil	2.3	0.6
	Long native grasses	1.5	0.2
	Reed plantings	0.8	0.1
	Hardwood tree plantings	1.6	0.25
Riprap	D_{50}=0.2 m	2.6	0.65
	D_{50}=0.4 m	4.0	1.25
Bioengineering	Reed fascine	1.5	0.20
	Live fascine	2.1	0.4
	Vegetated coir mat	2.9	1.0
	Live brush mattresses (grown)	3.7	1.25
	Live willow stakes	2.0	0.45
Hard surfacing	Gabions	5.0	2.2

Extended German DWA M-519 bioengineering approach:
- **Selection tables**
- **Assessing load categories**

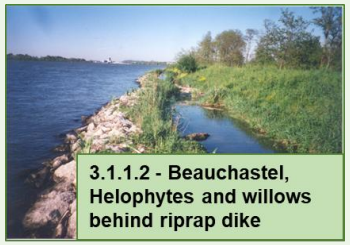
Elaborated UK Waterway management guide

"From boundary condition to appropriate measures" for special protections

Screening (simplified preselection, using exclusion criteria

Preselection

AHP-applications for comprehensive variant comparisons


3.1.1.2 - Beauchastel, Helophytes and willows behind riprap dike

+


2.1.8 - BW 8: Willow brush mattresses with heavy riprap as toe reinforcement

EXCEL-based selection and decision-making tools

Thanks for your attention