Experiences in Bangladesh with riverbank protection in a global perspective and implications for ongoing projects

Erik Mosselman
Deltares & Delft University of Technology

Workshop on Review the Innovative Design for the Polder 29 Bank Protection Works under Blue Gold Program
BWDB, WAPDA Building, Motijheel, Dhaka, Bangladesh, 24 April 2017

Rhine River, the Netherlands

Cauca River, Colombia

failed bank protection
eroded embankment
dike breach

Riverbank protection

At the boundaries of our knowledge
- Knowledge developed by trial and error, supported by scientific methods
- No recipes in engineering text books
- No part of university curriculum for hydraulic engineers
- Improvisation by consultancies in projects
- Frontier of science
- Only a few experts in the world

Yet … key knowledge developed in Bangladesh!
**Stabilization by riverbank protection**

**Objectives**

- Prevention of loss of land, infrastructure, religious places, etc.
- Prevention of flooding caused by erosion of embankments
- Reduction of migration to city slums
- Stabilization of distributary off-takes for water supply
- Stabilization of river at bridges, ports and ferry landings
- Improvement of navigability
- Land reclamation

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**FAP21/22 works in 1990s – still standing**

![Image of FAP21/22 works in 1990s – still standing](image)

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Evolving insights

Lessons learned

- Longitudinal protection causes less scour than groynes or spurs
- Any structure requires monitoring and maintenance: no strong distinction between hard and soft engineering
- Adaptive approach, seizing opportunities offered by the river in particular years
- Sand-filled geo-textile bags are a feasible alternative to stone and concrete

Evolving insights: geobags in FRERMIP

Lessons learned

- Success of FAP21/22 hardly known
- FAP21/22 design guidelines – valuable but representing only a part of the knowledge
- Knowledge often in project reports not freely available
- Reports shared in BWDB and among consultancies, but unknown at, for instance, BUET

Plea: make reports freely available after x years, e.g. by uploading on ResearchGate

Narrowing to the ideal river?

Effects of river narrowing

Favourable for offtakes
Effects of river narrowing

- Unfavourable for offtakes
- Long-term equilibrium

River bed erosion:
- Limited depth above fixed layers
- Restrictions for ship locks and river port entrances
- Instability of banks and hydraulic structures
- Draining of floodplains and wetlands
- Shift in discharge distribution at bifurcations
- and for the Netherlands... angry Germans!

As a rule, no river or stream in the world needs more than one bed

Narrowing produced up to 10 m bed degradation
Effects of river narrowing

Navigation impossible ...

Construction of lateral canal: Grand Canal d'Alsace

Effects of river narrowing

Maintenance of narrowed Rhine in Germany

Concerns for consideration

Narrowing reduces river planform response
- Decreased buffer space for sediment pulses from earthquakes
- Increased morphological changes in longitudinal profile

Narrowing enhances water level variations
- Decreased low-water levels and flows into outfalls (also in India)
- Increased flood levels

Narrowing triggers morphological responses
- Incision of the river bed (lowering water levels with negative effects on outfalls, IWT network and ecology)
- Deeper scour at structures
- Overloading of downstream reaches with eroded sediments (shoals, enhanced meander activity, increased bank erosion)
- Shorter meander wave-length (mismatch original training works)
Study in FRERMIP
- Width before arrival of effects of 1950 Assam Earthquake
- Analytical model

Innovation
Two centuries of innovation on groynes and spurs:
- Closed / permeable
- Perpendicular / oblique (repelling or attracting)
- Emerged / submerged; inflatable, pivoting
- Attached / detached
- Head shapes: hockey, inverted hockey, J-head

New fields for innovation:
- Adaptive river training (~ monitoring, modelling, organization)
- Recurrent measures
- Building with Nature

Optimum river width
Predictions from analytical model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Width = 4 km</th>
<th>Width = 6 km</th>
<th>Width = 8 km</th>
<th>Width = 10 km</th>
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<tbody>
<tr>
<td>Change in average channel level (m)</td>
<td>-2.2</td>
<td>-1.8</td>
<td>-0.8</td>
<td>0</td>
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<tr>
<td>Change in average chnl level (m)</td>
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<tr>
<td>Change in water level at 5,000 m³/s (m)</td>
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<td>-1.4</td>
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<td>Change in water level at 45,000 m³/s (m)</td>
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<td>0.3</td>
<td>0.1</td>
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</table>

Thank you!