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Closing breaches in earthen flood defences

Technical feasibility of emergency closure concept

4th International Symposium on Flood Defence:
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Institute for Catastrophic Loss Reduction

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4th International Symposium on Flood Defence 2008

Closing breaches in earthen flood defences

Technical feasibility of emergency closure concept

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Why is research on disaster mitigation needed?

- Increasing flood risk (climate change and increasing population pressure).
- The risk of dike breaches cannot be eliminated completely.
- Knowledge about the effect of embankment construction and materials on breach growth is not sufficient.


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Contents of the presentation

- Scope of the research
- Time frame between initial damage and emergency closure
- Applicability of water based measures in the Rhine river branches
- Review of feasible principles of initial repair and emergency closure
- Conclusions and recommendations

Introduction
Scope of the research
Time frame
Accessibility dike section
Applicability of vessels
Conclusions

SCOPE OF THE RESEARCH

Demonstration of the technical feasibility of water based equipment for early repair and emergency closure of a breach

- Early deployment of water-based assistance at precursor events that may lead to a breach
- Deployment of a stone dumping vessel as an effective means for emergency closure in large rivers

chaotic land based closure operations

vain sand bag dumping operations

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Issues with land based techniques

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TIME FRAME

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River dike failure:

- Different working conditions compared to coastal defences
- Proper identification of precursor events that may lead to initial breaching
- Development of real-time monitoring (Flood Control 2015)
  - remote sensing techniques for dike surveillance
  - sensor networks for dike status monitoring

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TIME FRAME

Breaching:

- breaching process is quite well-understood after initial breaching.
- understanding and modelling of extreme floods has advanced.
- the time-development of the initial events leading to breaching is less well-documented because of:
  - late discovery of precursor events
  - stochastic nature of initial breaching process.
    - large variation of erodibility of the dike materials
    - Influence of burrowing animals and other ‘disturbances’ (e.g. fences, roads)
    - large differences in weathering of the dike materials

Slide 8

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Arend Pool, 4/18/2008

TIME FRAME

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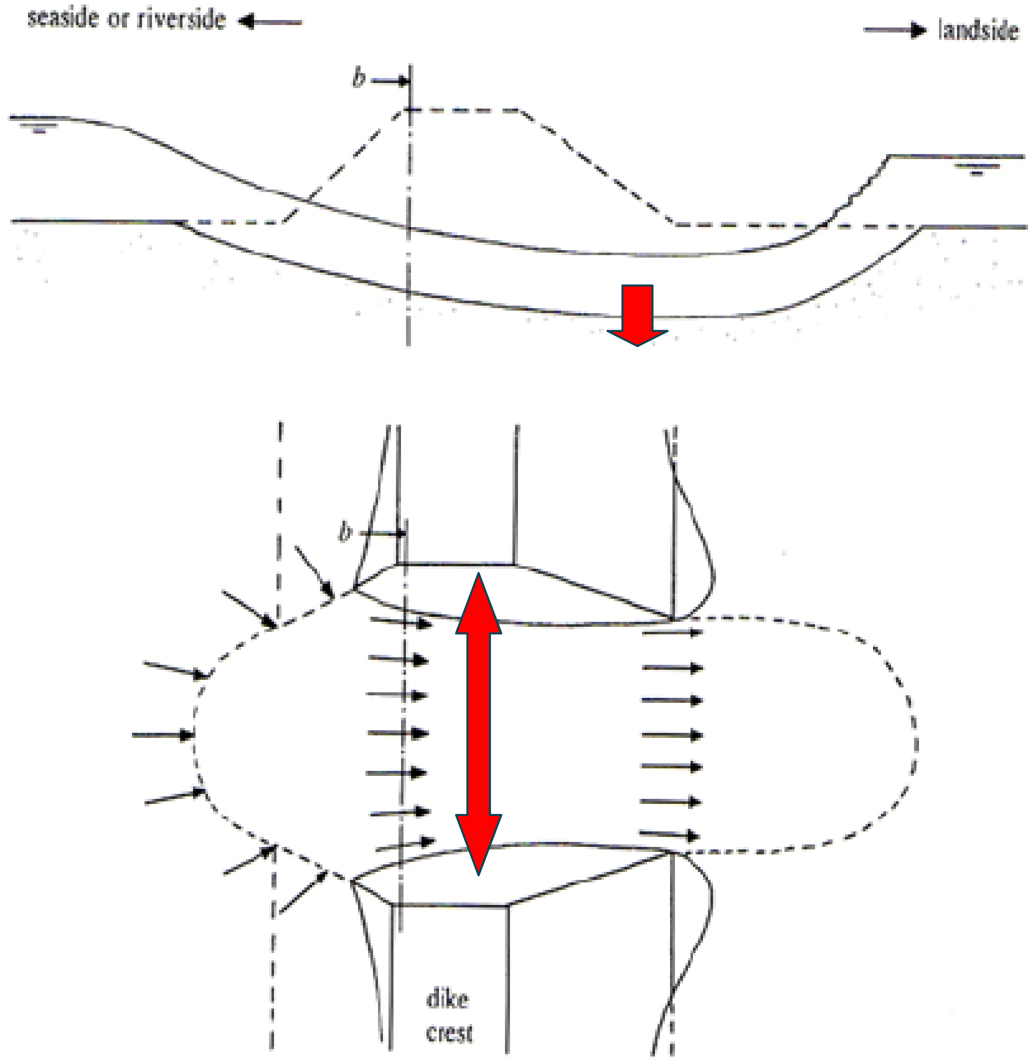
Breach width growth;

high foreland with low resistance against erosion (Visser, 1998)



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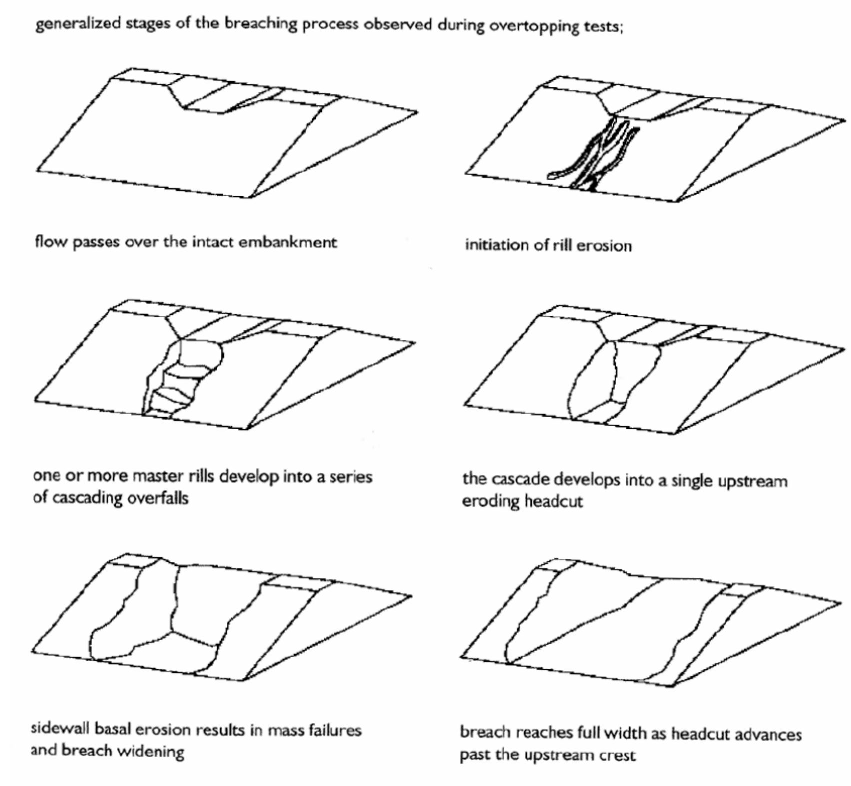
TIME FRAME

Breaching predictions of initial and ongoing stages:

- Initial stages: 2 hours (assumption)
- Ongoing stages (observations and computations)
  - Clay dikes: 20 m in 2 hours
  - Sand dikes: 40 m in 2 hours

In 4 hours time, a wide gap may have developed



ACCESSIBILITY OF DIKE SECTION

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Case study:

the largest Dutch Rhine river branch, the Waal River

Conditions:

- design water levels (1/1250 years)
- moderate flood water levels (1/100 years)

Flood plain accessibility:

- predicted water level data from the Dutch Rhine flow model (WAQUA)
- flood plain terrain data (from the Public Works Department)
- draught of some typical inland crane vessels and split barges

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ACCESSIBILITY OF DIKE SECTION

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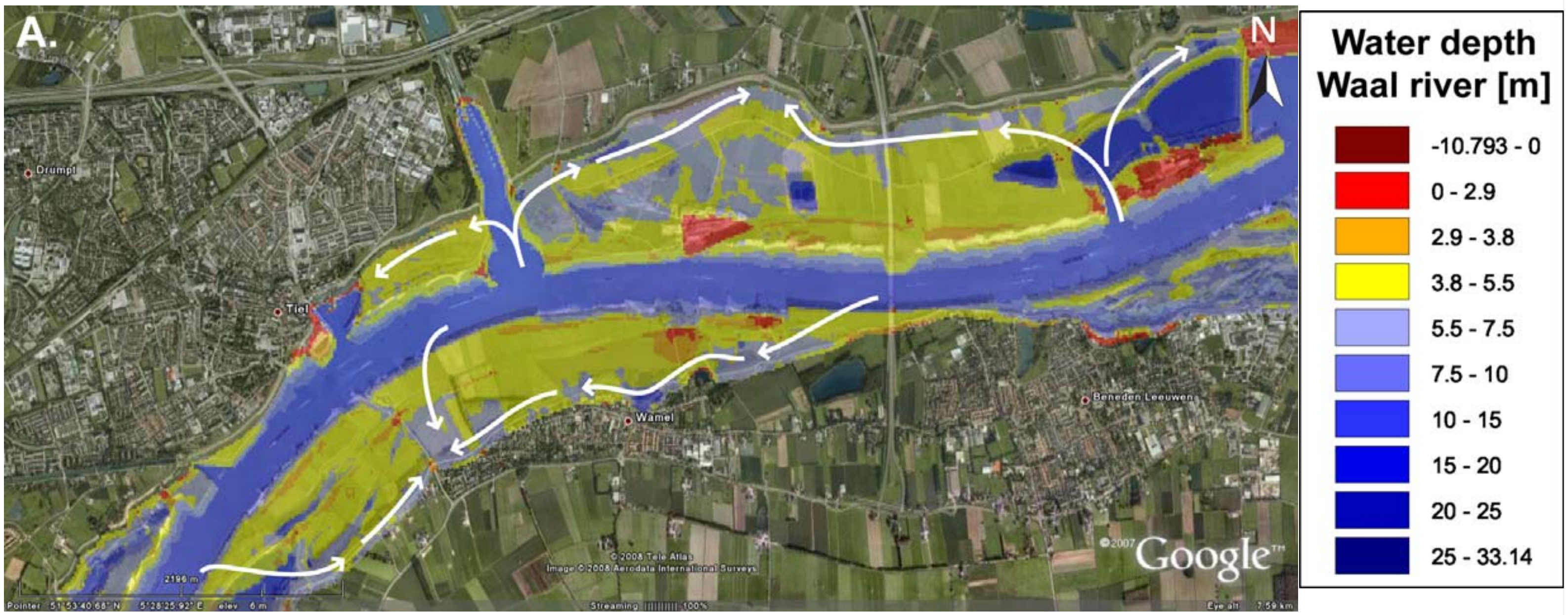
Local water depth Waal river and flood plains near Tiel for design water level (A) and moderate flood water level (B). The arrows indicate possible navigation tracks to all dike sections in the area.



Introduction

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Accessibility dike section

Applicability of vessels

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APPLICABILITY OF VESSELS

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Inland vessels

- equipped with a crane and spud poles for anchoring
- typical loading capacity of these vessels is 200-600 tons
- a maximum unloading capacity of 300 tons per hour
- fully unloading in 2 hours

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APPLICABILITY OF VESSELS

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Purpose inland vessels:

- early repair work
- reduction of the water influx, might a breach being inevitable
  - small dams may be erected along the bow and the stern
  - such dams require some 300 m³ (520 tons) of stone or big bags each
  - this will take 3.5 hours to carry out, but with more cranes it can be done faster

Assistance by other vessels, such as a crane pontoon for extra unloading capacity, small motor barges for assistance and stone barges that supply additional closure materials

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APPLICABILITY OF VESSELS

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Deployment of stone dumping barges as a last resort

Prerequisite for this operation:

- the scour hole has not yet progressed upstream
- keel clearance is within some decimeters, so the vessel gets stuck on the dumped stone dam upon dumping process

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APPLICABILITY OF VESSELS

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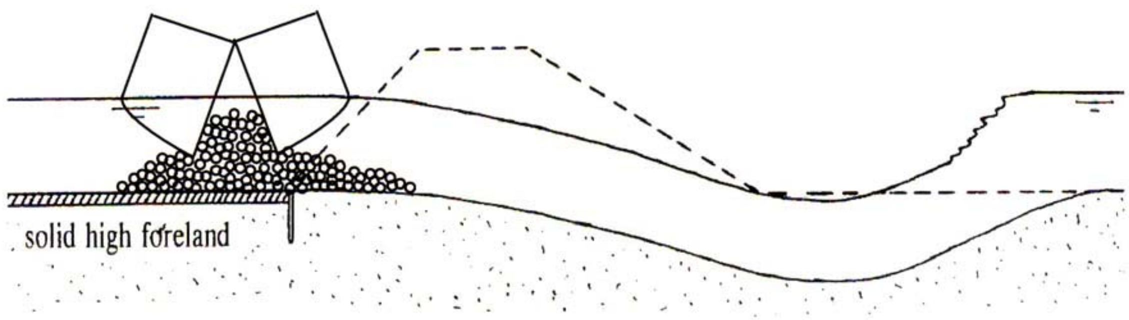
Realization:

- Route mapping for fast navigation
- Spilling the right amount of stone to adjust to the desired draught
- Upon dumping, the ship gets stuck at its pile of dumped stones
- Assistance of pontoons for final closure



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NEW TECHNIQUE?

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CONCLUSIONS & RECOMMENDATIONS

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Major conclusions

- Water-based repair measures are a feasible option as an alternative to land bases techniques (and may even be preferred)
- Good accessibility of water based equipment under extreme and moderate flood levels using modern techniques
- Inland vessels equipped with a crane and spud poles are suitable for early repair works and reduction of discharge, when breaching continues
- Building up sealing dams between the vessel and the dike might be designated as successful
- A backup option is the positioning of a split-barge at the upstream side of the (potential) breach; this may give a final resort for closure if a breach is inevitable

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Recommendations

- Further assessment of the operational and cost aspects involved for the case study conditions
- Flood managers to react on the operational and cost aspects for this type of back-up measures
- Assessment of the feasibility for more dedicated equipment abroad where flooding has a much higher frequency than in the Netherlands

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Questions?

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