Room for the River and Cyclic Floodplain Rejuvenation

Martin Baptist

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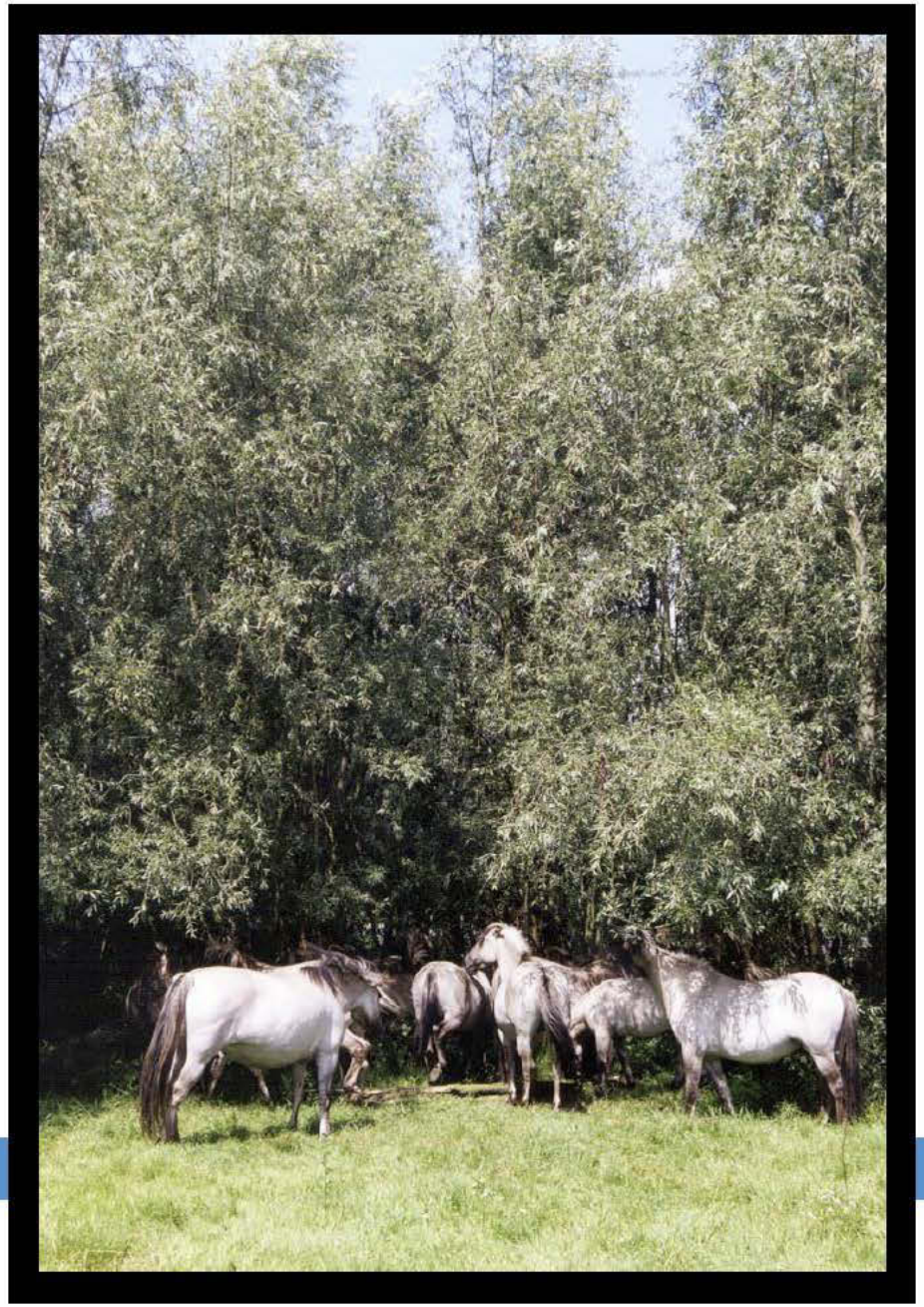
TU Delft

Delft University of Technology

Problem background

- Two main problems in the River Rhine are (i) flood safety and (ii) ecological degradation.
- In the Netherlands, more room for the rivers is created in order to increase their conveyance capacity.
- At the same time restoration of natural values in river floodplains is realised.



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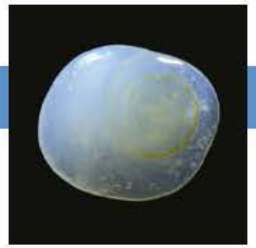
Conflicting goals

- The combination of nature rehabilitation and flood safety is conflicting.
- Natural growth of floodplain vegetation increases the hydraulic roughness and the sedimentation rate of the floodplains[1].
- Therefore there is an increasing interest in the interactions between vegetation, hydraulics, sediment transport and geomorphology.

[1] Baptist, M.J., et al. (2004). Assessment of Cyclic Floodplain Rejuvenation on Flood Levels and Biodiversity in the Rhine River. *River Research and Applications* 20(3), 285-297.

Open channel flow

- Chézy equation: $u = C\sqrt{hi}$
  - u = depth-averaged flow velocity (m/s)
  - h = water depth (m)
  - i = slope of the bed (-)
  - C = Chézy coefficient ($m^{1/2}.s^{-1}$)
- Colebrook-White equation: $C = 18log\frac{12R}{k}$ $C = \frac{R^{1/6}}{n}$
  - k = Nikuradse equivalent sand roughness height (m)



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Nikuradse roughness height of grassed floodplains

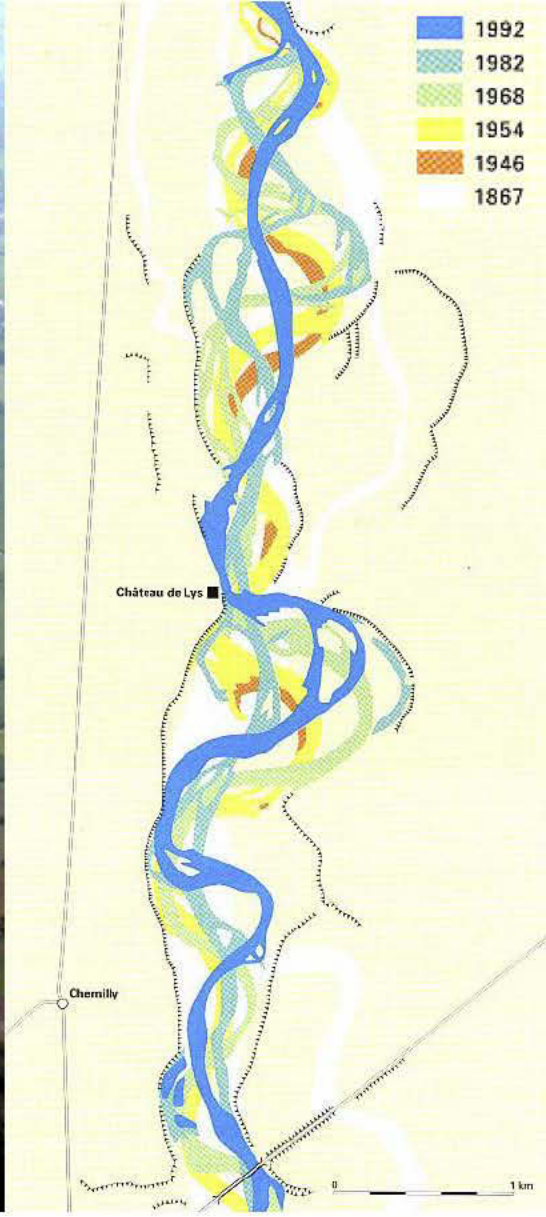
Nikuradse roughness height of grassed floodplains

- Klaassen & Van der Zwaard (1974): 0.07 m
- Klaassen & Van Urk (1985): 0.2 m in winter, 0.7 m in summer.
- RWS (1997): 0.2 m for smooth grassland, 0.5 m for normal grassland, 1.0 m for ‘rough’ grassland.
- RWS (2003): 0.26 m (at 4 m water depth).
- Baptist (2003): 1.0 m (at 4 m water depth).
- VNK (2006): 0.3 m.
- Straatsma (UU, 2006): 0.07 m.

About 2/3rd of the Rhine floodplains consists of grassland

Natural vegetation succession

- In rivers confined by dikes, vegetation development can only go one way: succession to older stages. Natural processes to remove older vegetation, such as erosion or ice scour, can not occur anymore.



The Allier River (France)

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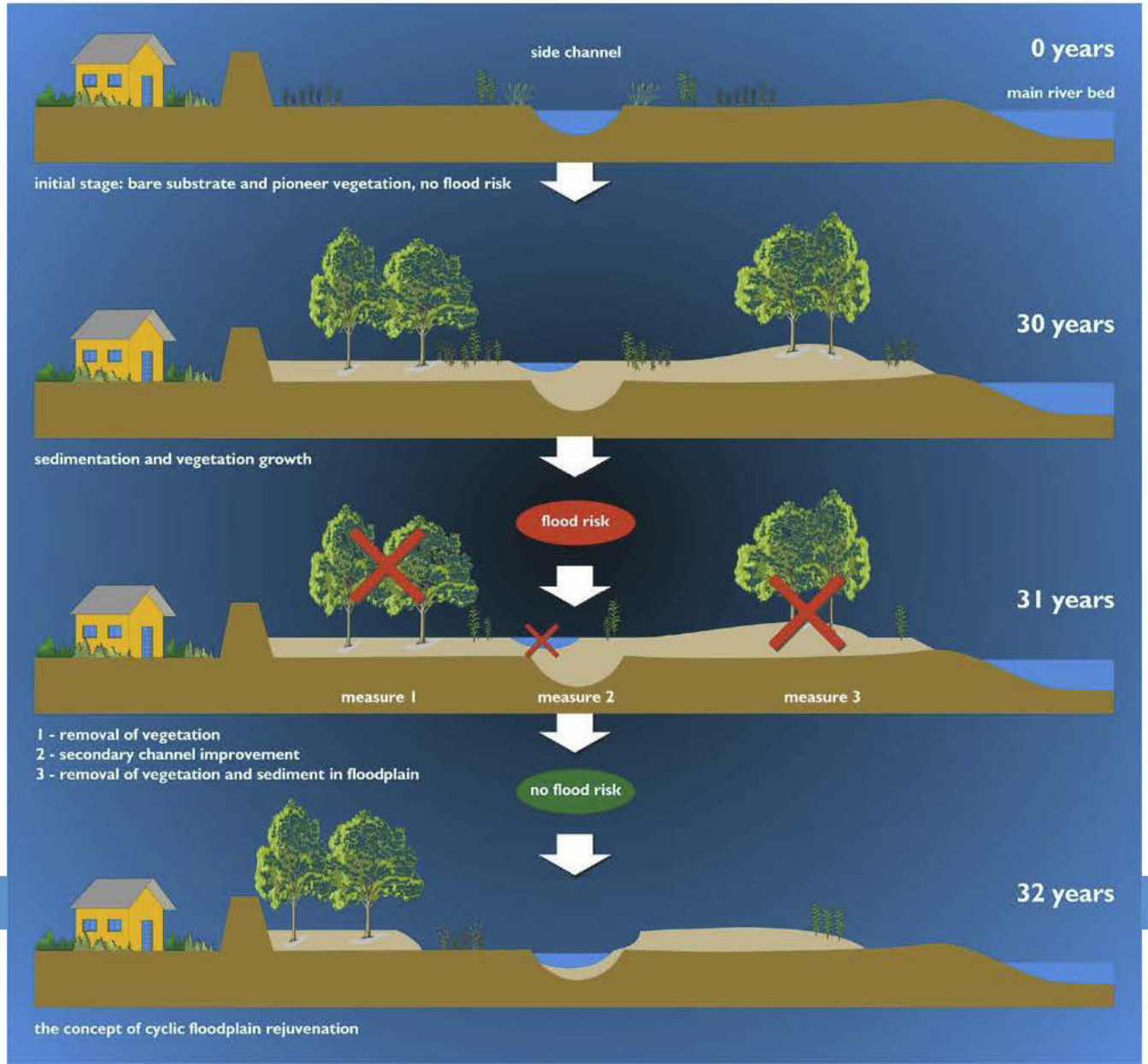
Cyclic Floodplain rejuvenation

- Cyclic Floodplain Rejuvenation (CFR) is the recurrent removal of vegetation and/or sediment,
  (i) to guard flood safety and
  (ii) to increase biodiversity.

CFR in Dutch floodplains



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Cyclic floodplain destruction?

Conclusions

- Vegetation succession in rivers can diminish the effects of flood protection measures.
- Introducing large herbivores slows down vegetation succession.
- However, floodplain vegetation may still form the bottleneck for flood protection.
- Cyclic Floodplain Rejuvenation is a strategy that might solve the dilemma between flood protection and nature rehabilitation.