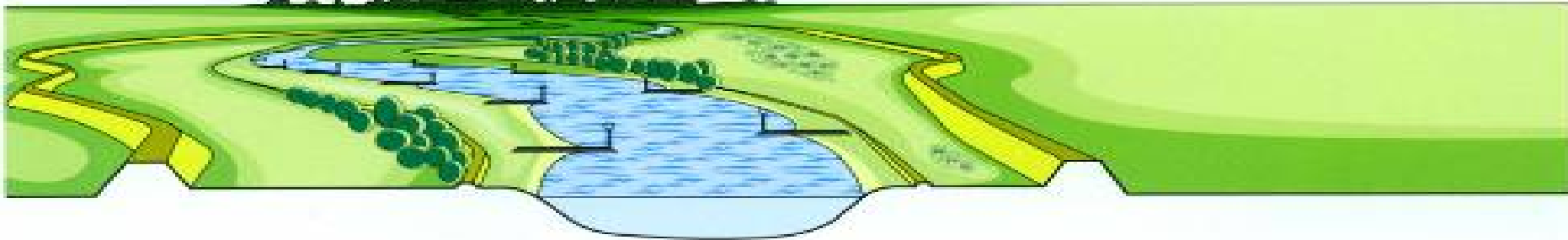


Restoring the River Rhine (NL): achievements and challenges

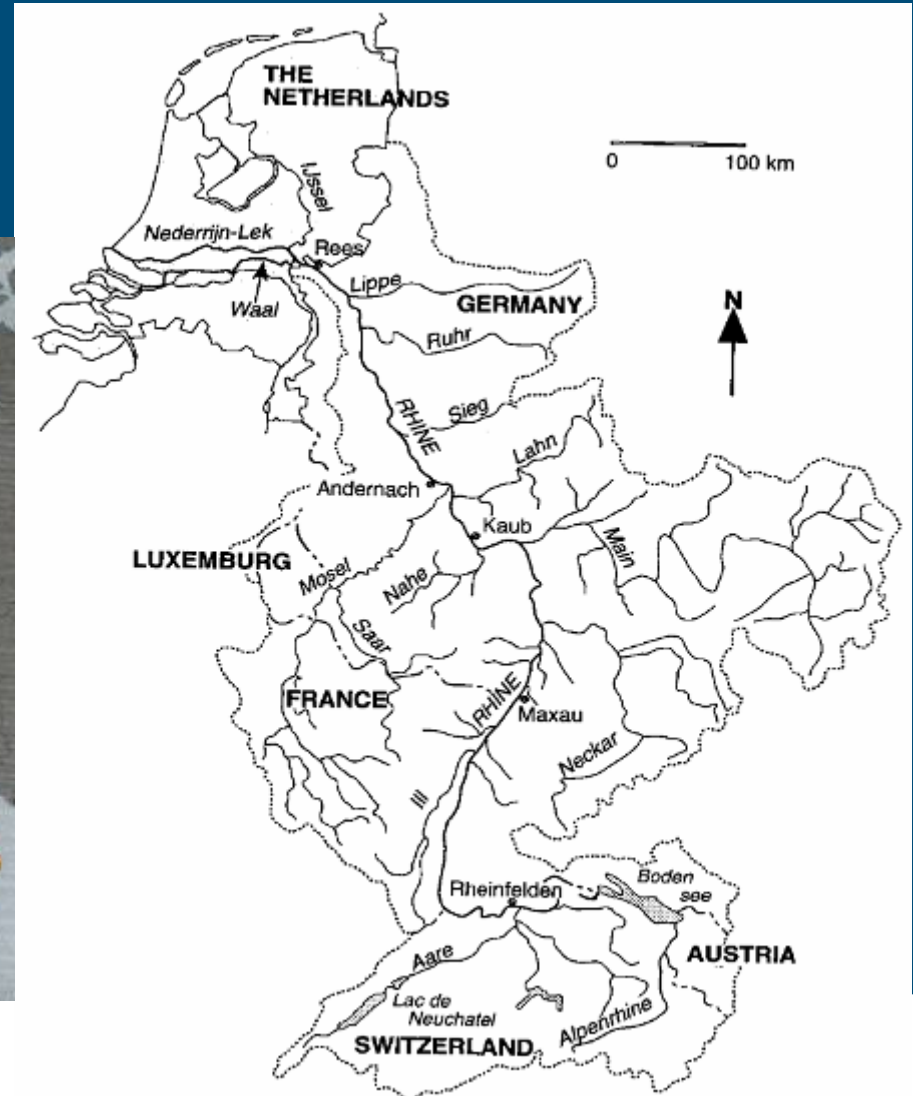
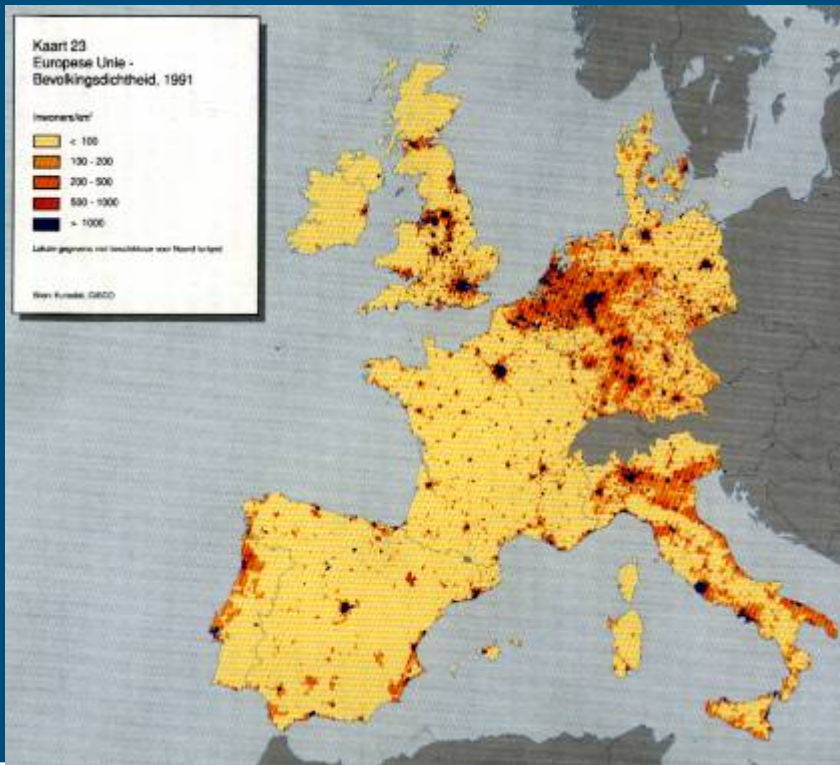
Henk Wolfert

Rhine-Traditional



The River Rhine delta metropolis

- High population density
- Shipping transport



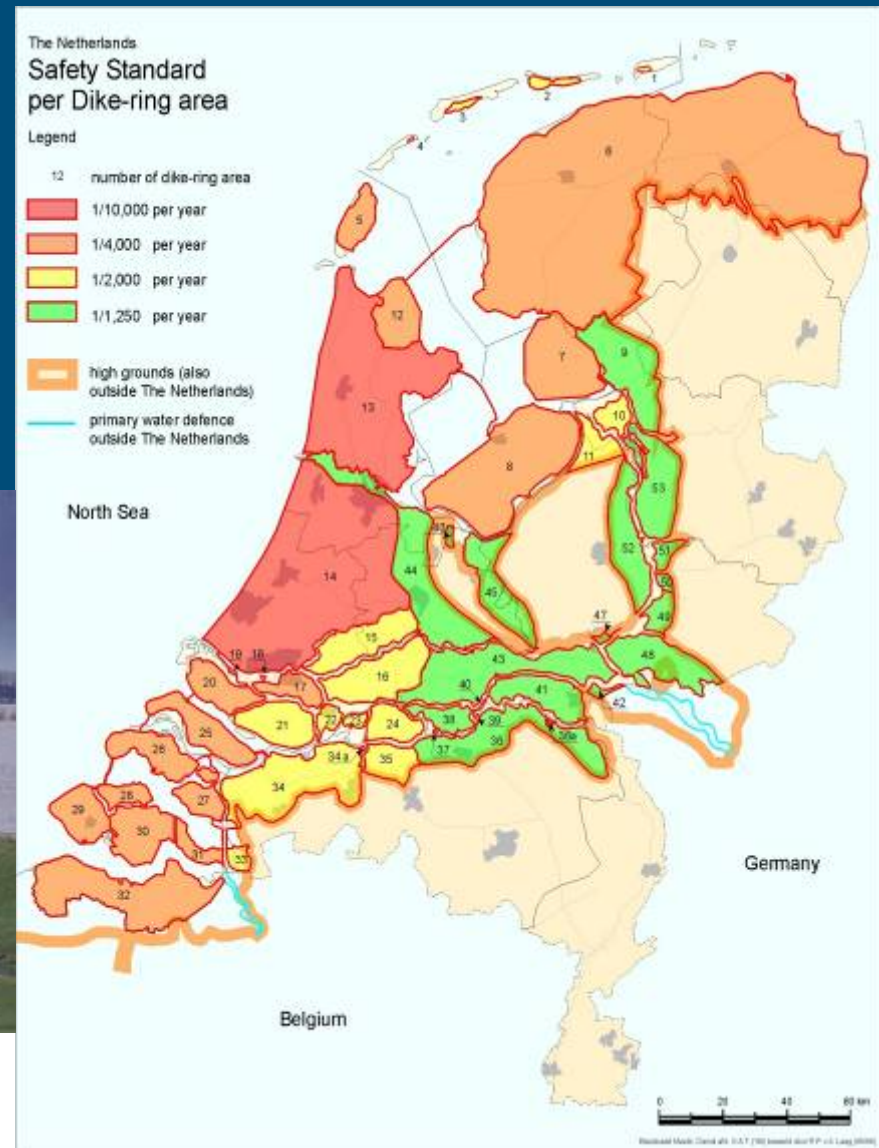
The River Rhine in the Netherlands

■ Discharge

- Mean 2,200 m³/s
- Max 12,800 m³/s

■ Safety standard dikes

- 1/1,250 – 1/10,000 /yr



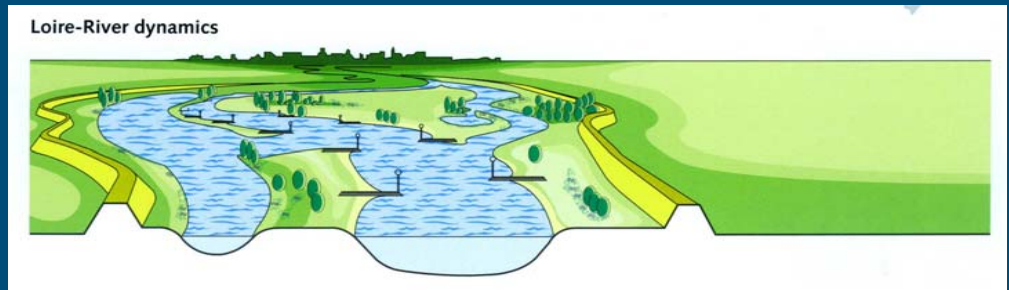
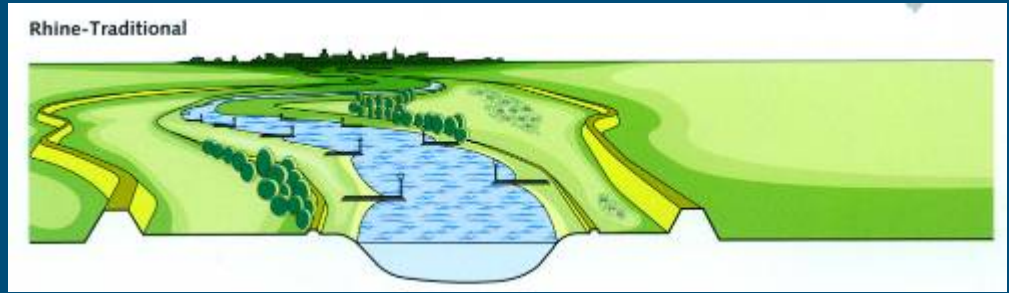
Traditional river management

- Flood control: dikes and agricultural use
 - Increased floodplain sedimentation rates: wetland loss
 - Agricultural use: no floodplain forest
- Navigation channel: groynes
 - Channel degradation: decrease of connectivity
 - Too dynamic main channel: loss of aquatic habitat
 - No lateral erosion and

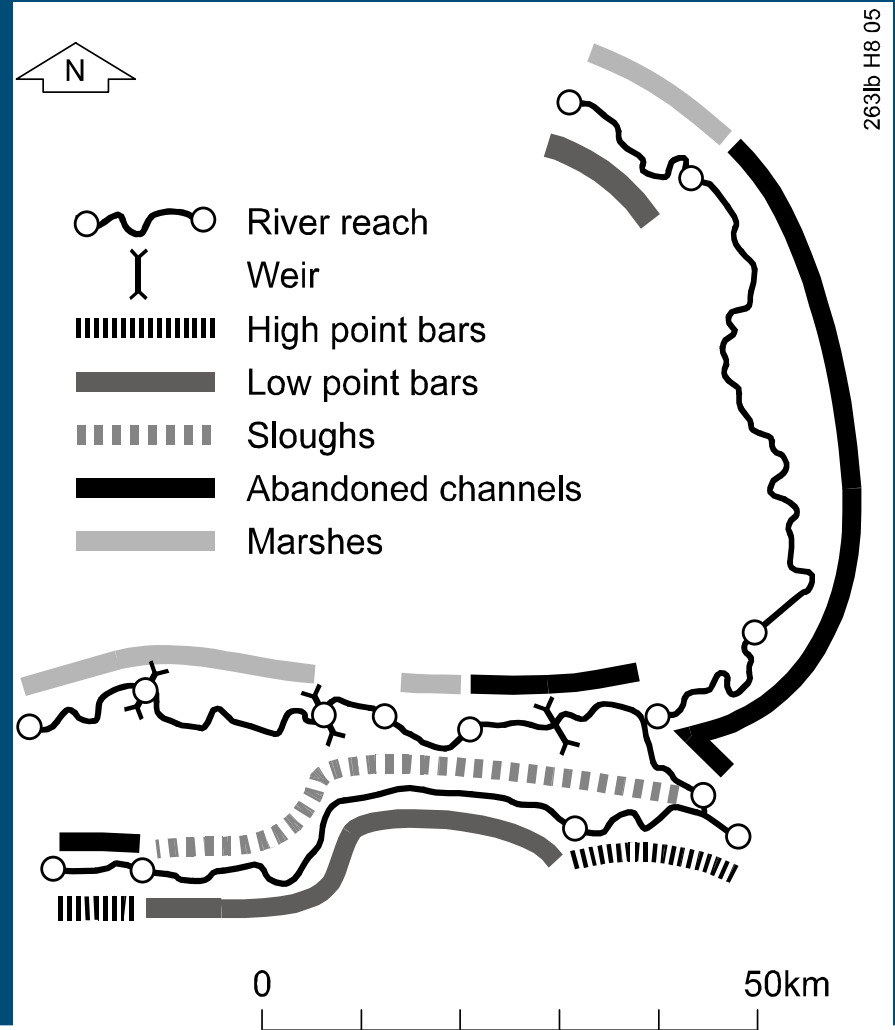
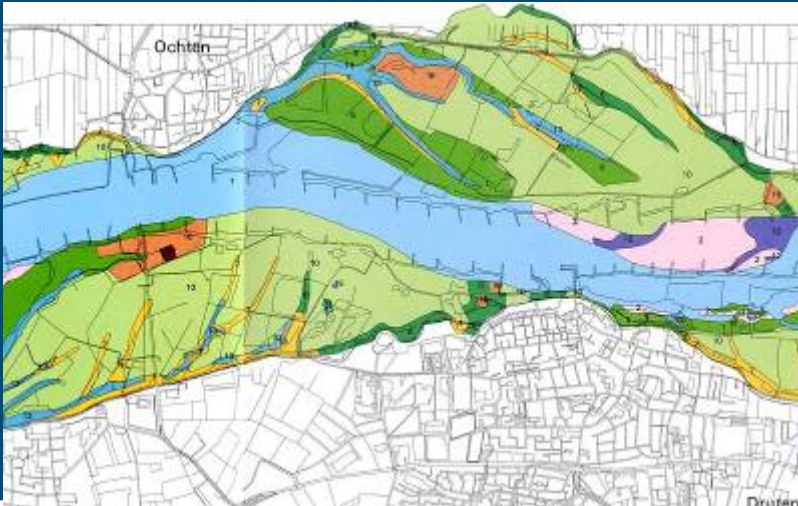
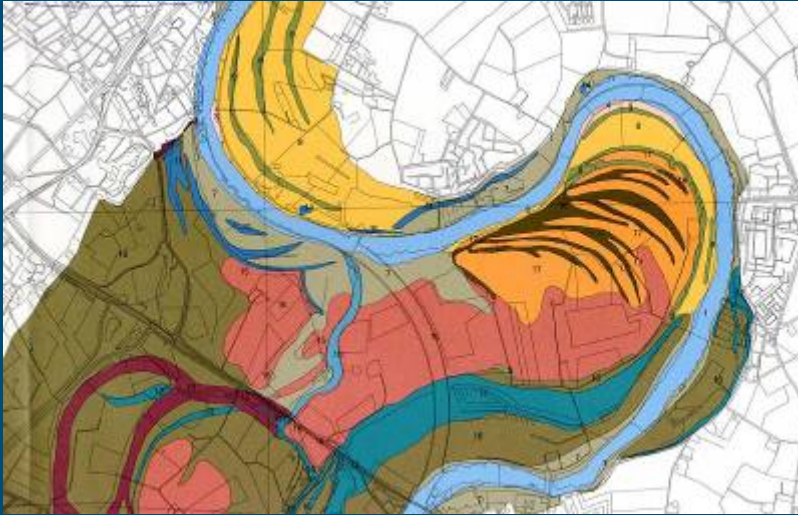


1990s: River rehabilitation policy

- Nature conservation
→ nature rehabilitation
- River rehabilitation projects
 - + 7,000 ha in 2015
- Measures
 - Patches of forests and marshes
 - Connecting floodplain channels
 - Extensive grazing for vegetation diversity



Historical references: working with nature



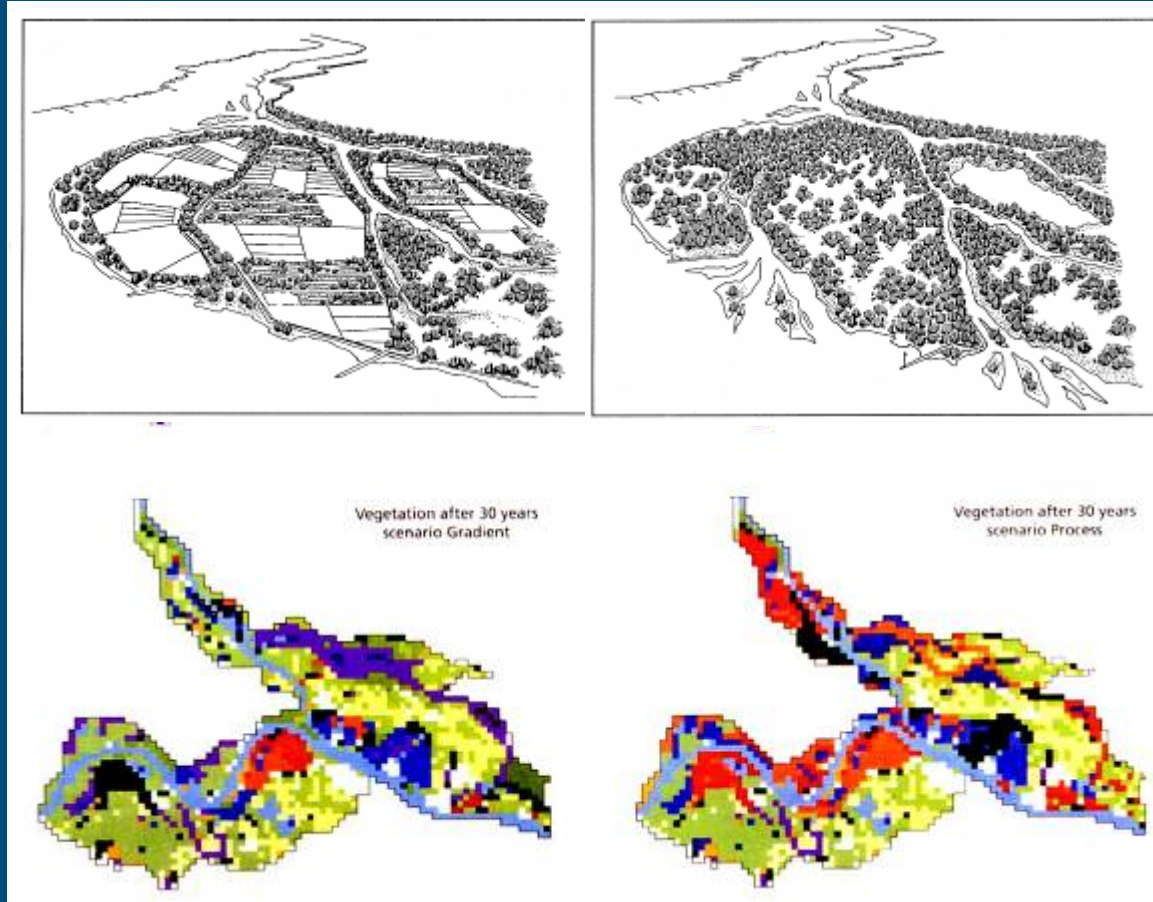
Scenarios studies

- Plan design
 - Landscape level
- Plan evaluation
 - Species level

LEDESS model

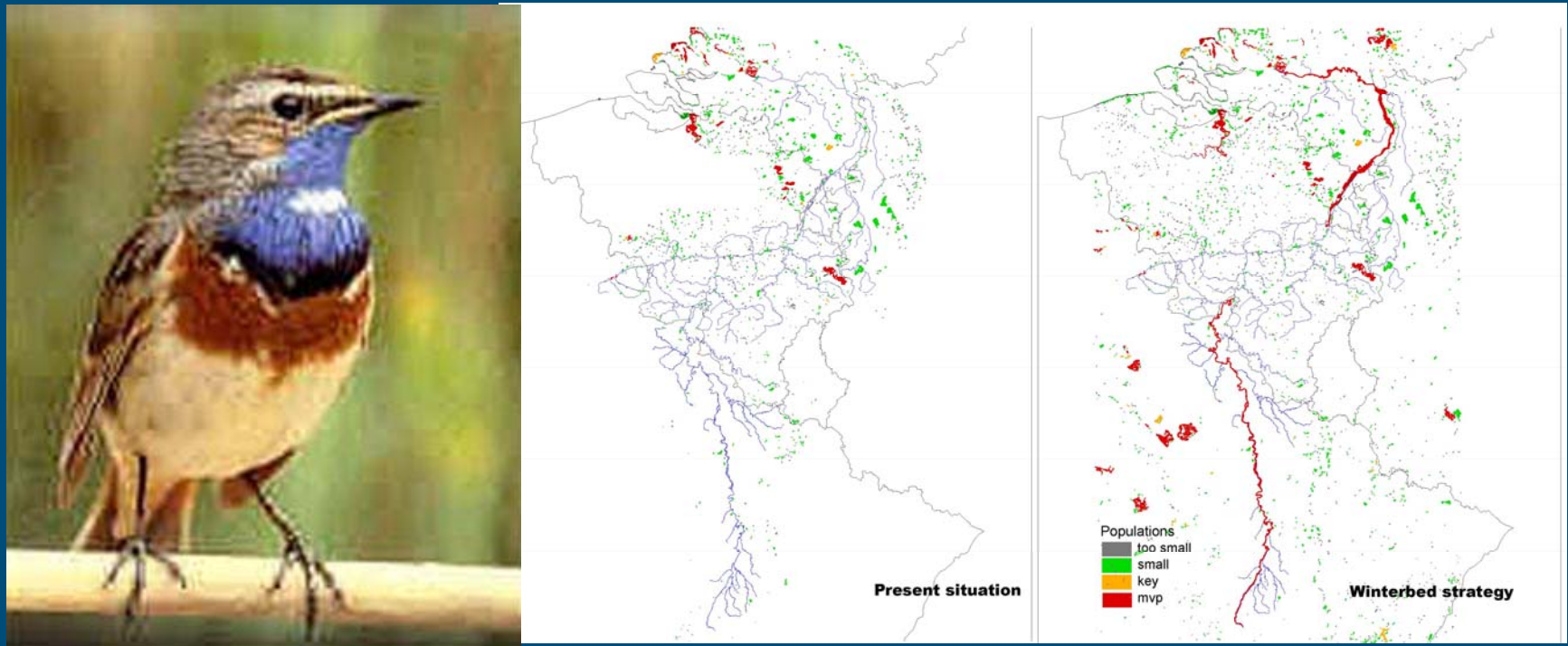
- Vegetation succession
- Habitat suitability
- Agricultural suitability
- Costs

LEDESS = Landscape Ecological Decision Support System



Network analysis

- LARCH model (species level)
 - Corridor function of rivers (Fig: Bluethroat)



LARCH = Landscape Analysis and Rules for the Configuration of Habitat

River rehabilitation = floodplain projects



- 25 Afkense en Doerliche waarden
- 38 18 Boeke uitwaarde
- 39 Bato's Erf
- 40 Hoozeltsche uitwaarde
- 41 Hoozeltsche uitwaarde
- 51 Lierderoude waard / Batenburg

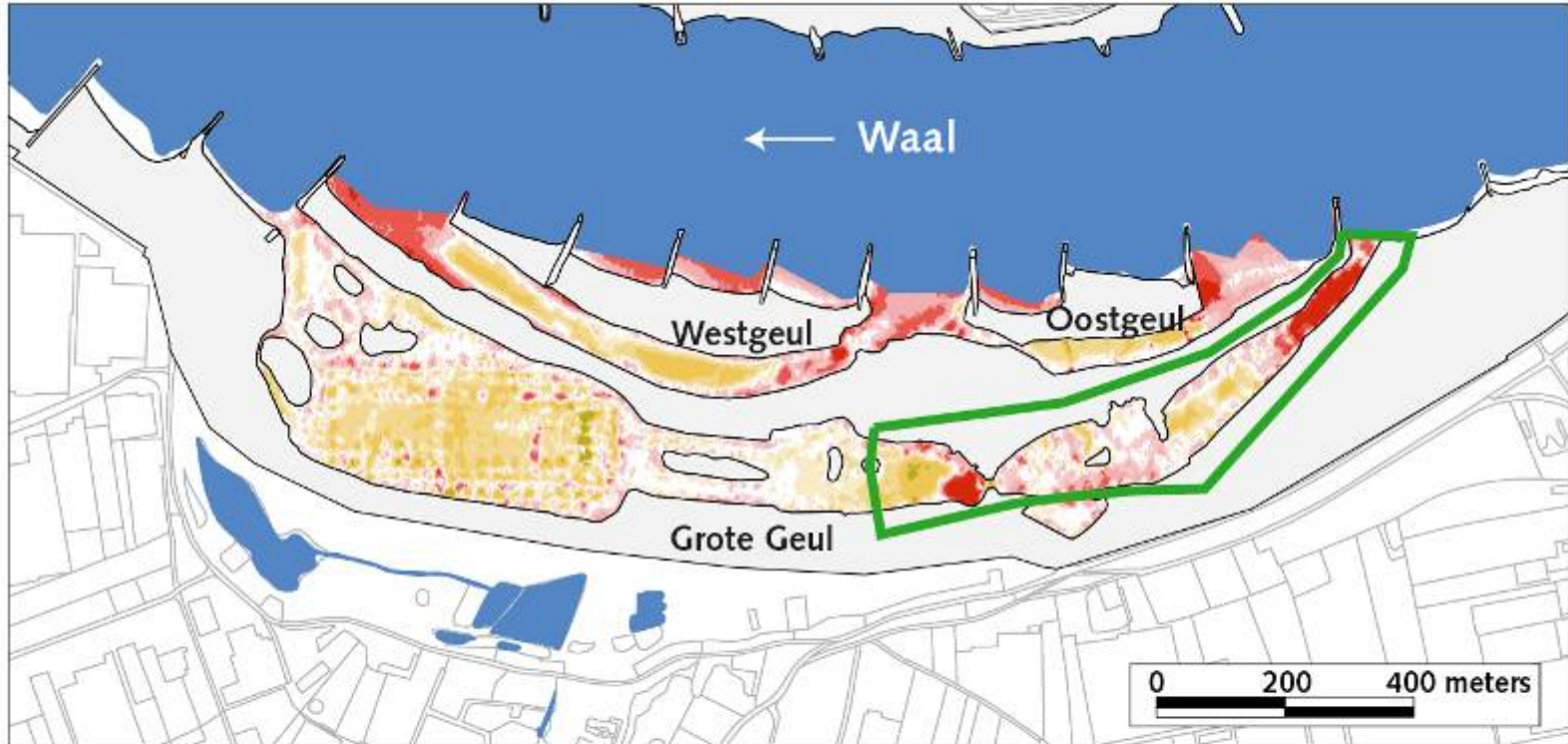
★ Realisatie / toe

- 4 Vraagrijkenwaard
- 14 Rijnwaarden
- 18 Meeuwendijkse Toes
- 20 Amswegse Rijnvelder
- 25 Zuidelijke Leukerwaarden / Deedingen
- 28 Zuidelijke Leukerwaarden / Leermard
- 29 Millingerwaard
- 31 Gemmelche Waard
- 26 Tiel / Kleine Willemspolder
- 45 Lanestele
- 49 Siedrechtse Biesbosch
- 30 Noorwaard
- 51 Keentche uitwaarde



1 juli 2003

Geomorphic processes back

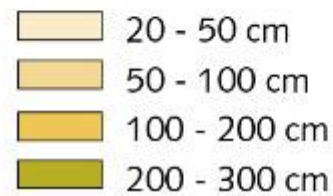


Erosie



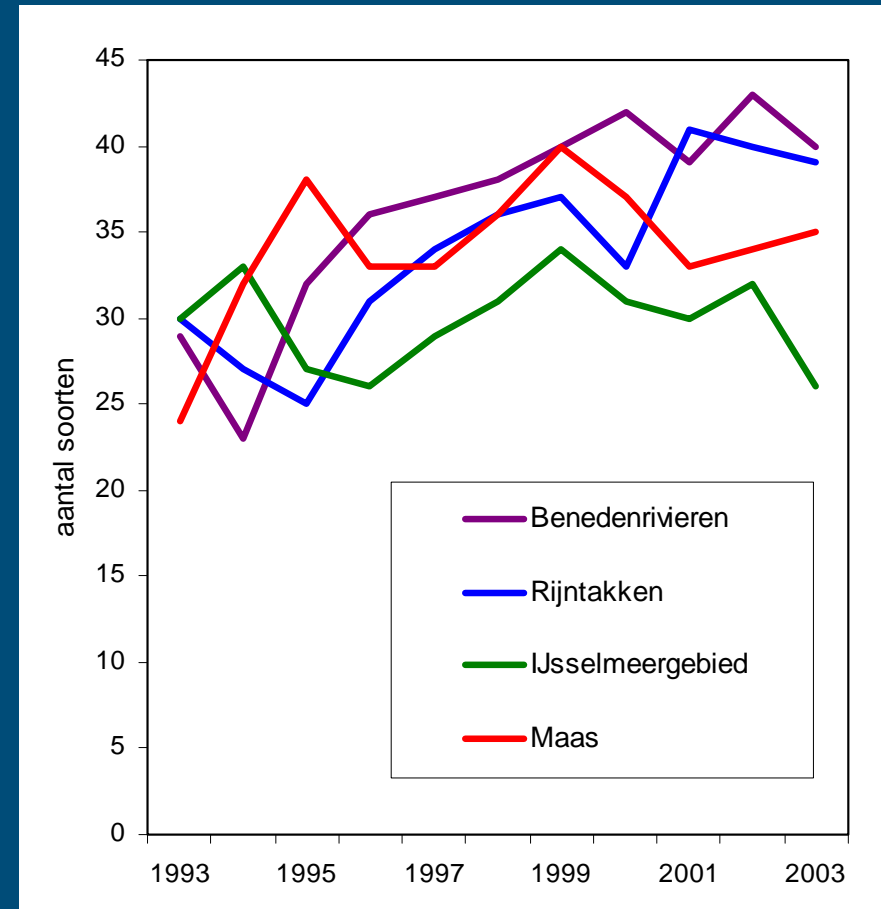
Minder dan 20 cm
netto erosie/
sedimentatie

Sedimentatie



Biodiversity increased

- Increase in low dynamic channel habitat: increase in juvenile fish
- Formation of new habitats: pioneer vegetations, insects and birds
- Overall increase in fish species diversity (Fig.)



Public perception increased

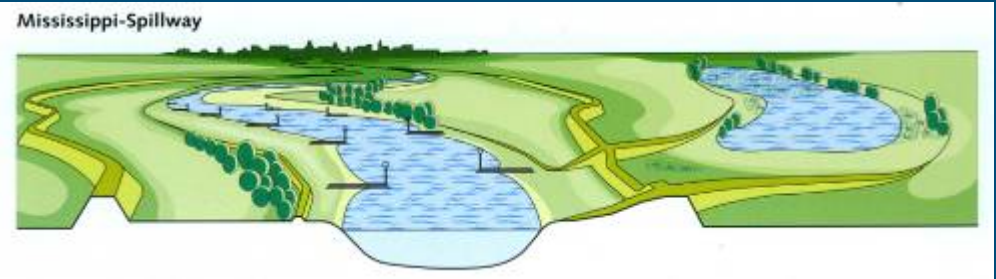
- River dynamics greatly appreciated
- Conservation of cultural heritage improves acceptance of change



2000s: Room for River policy

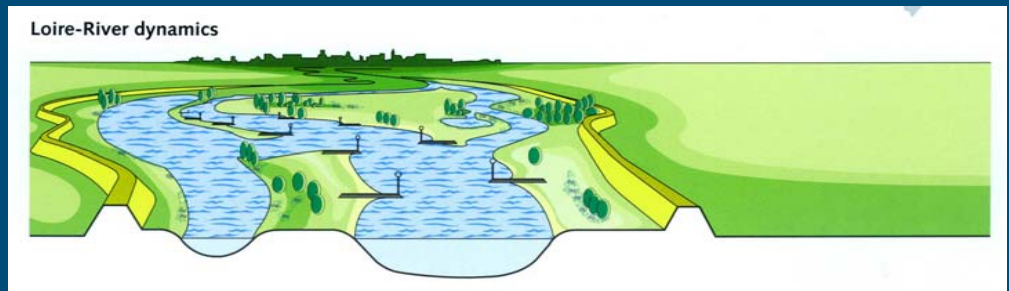
■ High discharge events 1993 and 1995

- 250,000 evacuated
- Design discharge
15,000 → 16,000 m³/s



■ Room for River projects

- 2.2 billion Euro
- In 2015

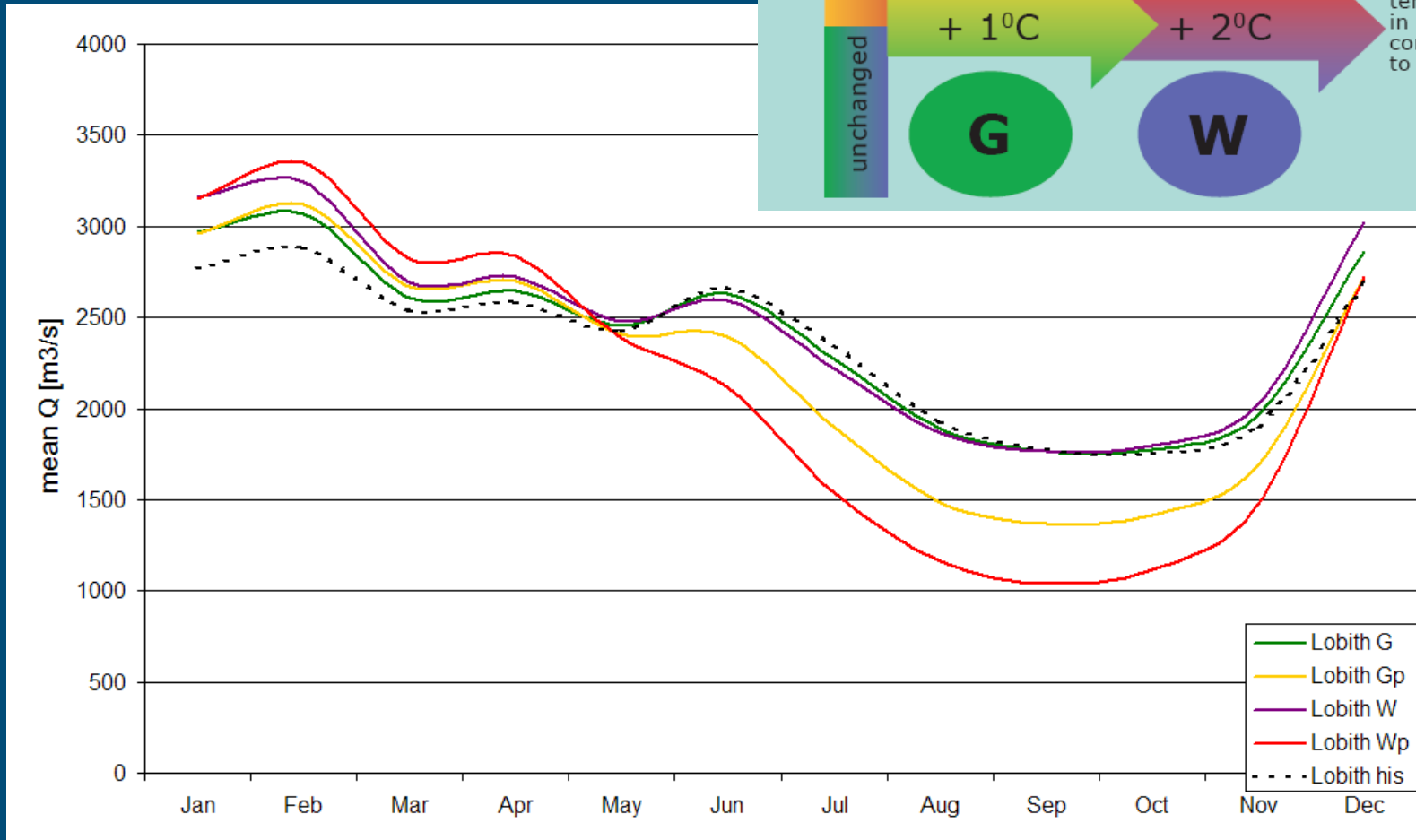
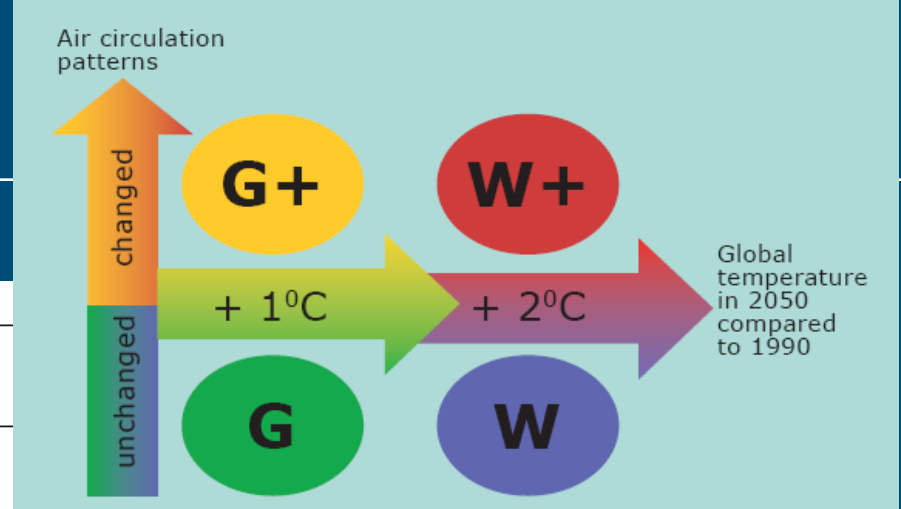


■ Measures

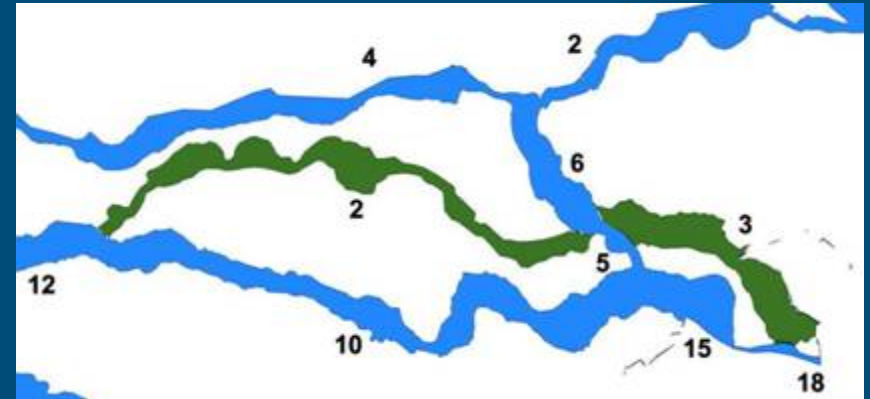
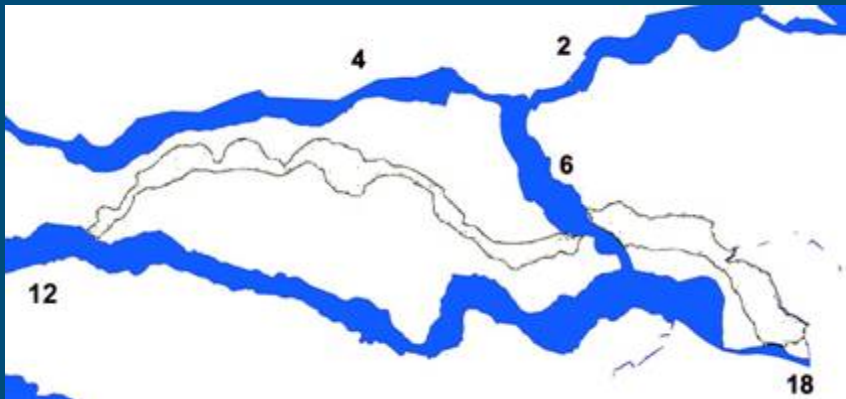
- Floodplain stripping
- Secondary channels
- Removal obstacles



Climatic change



New floodways: design and effects

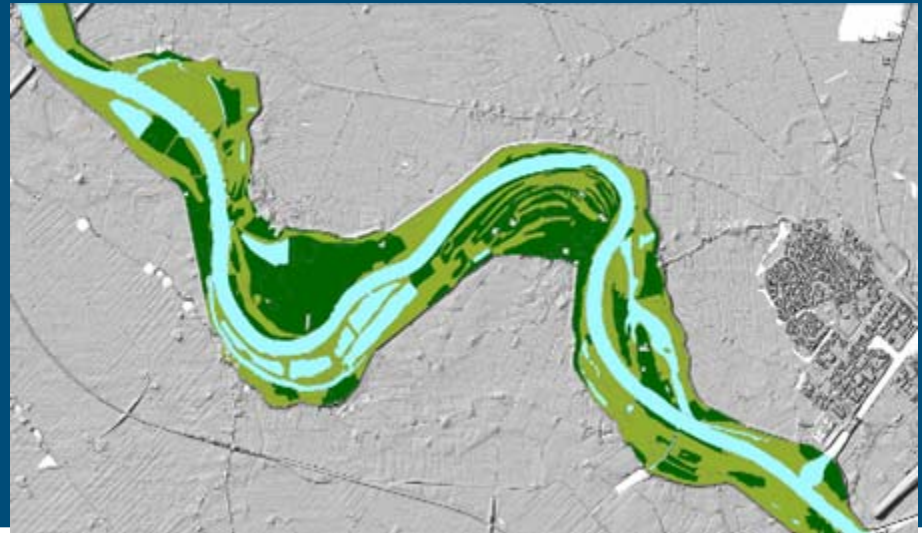
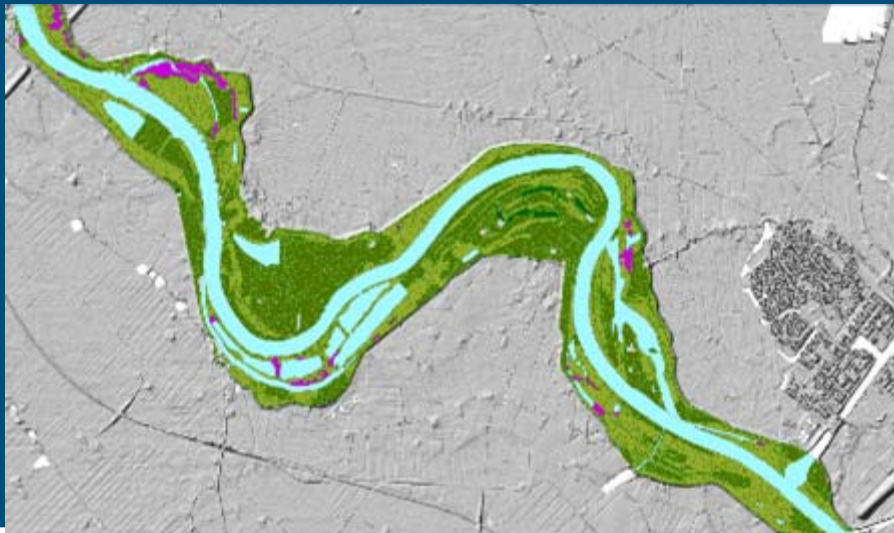
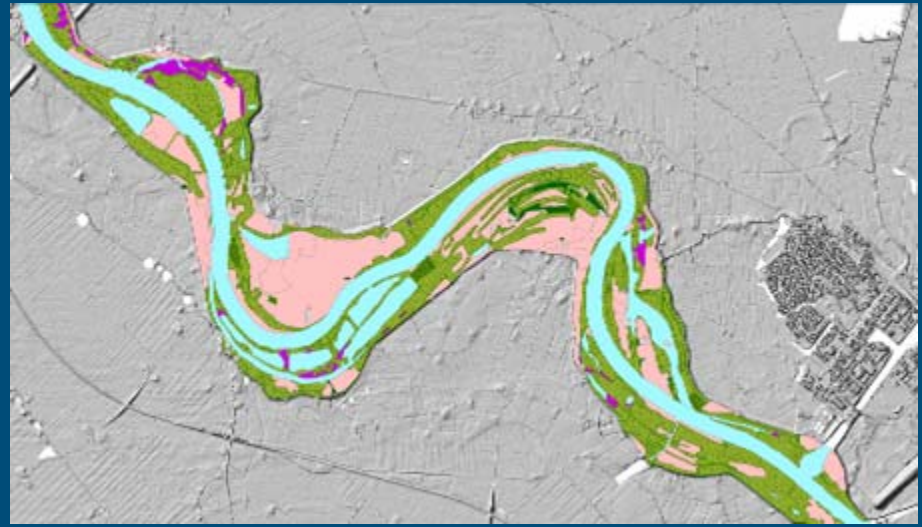
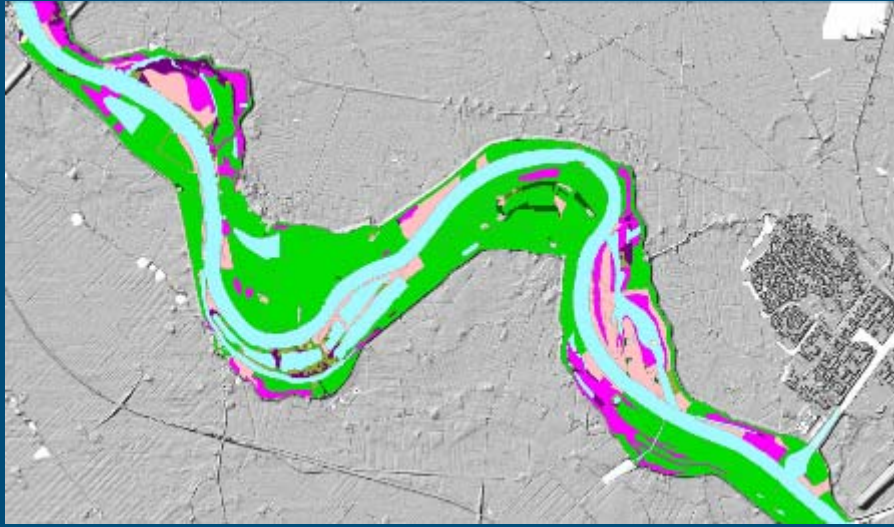


New research challenges

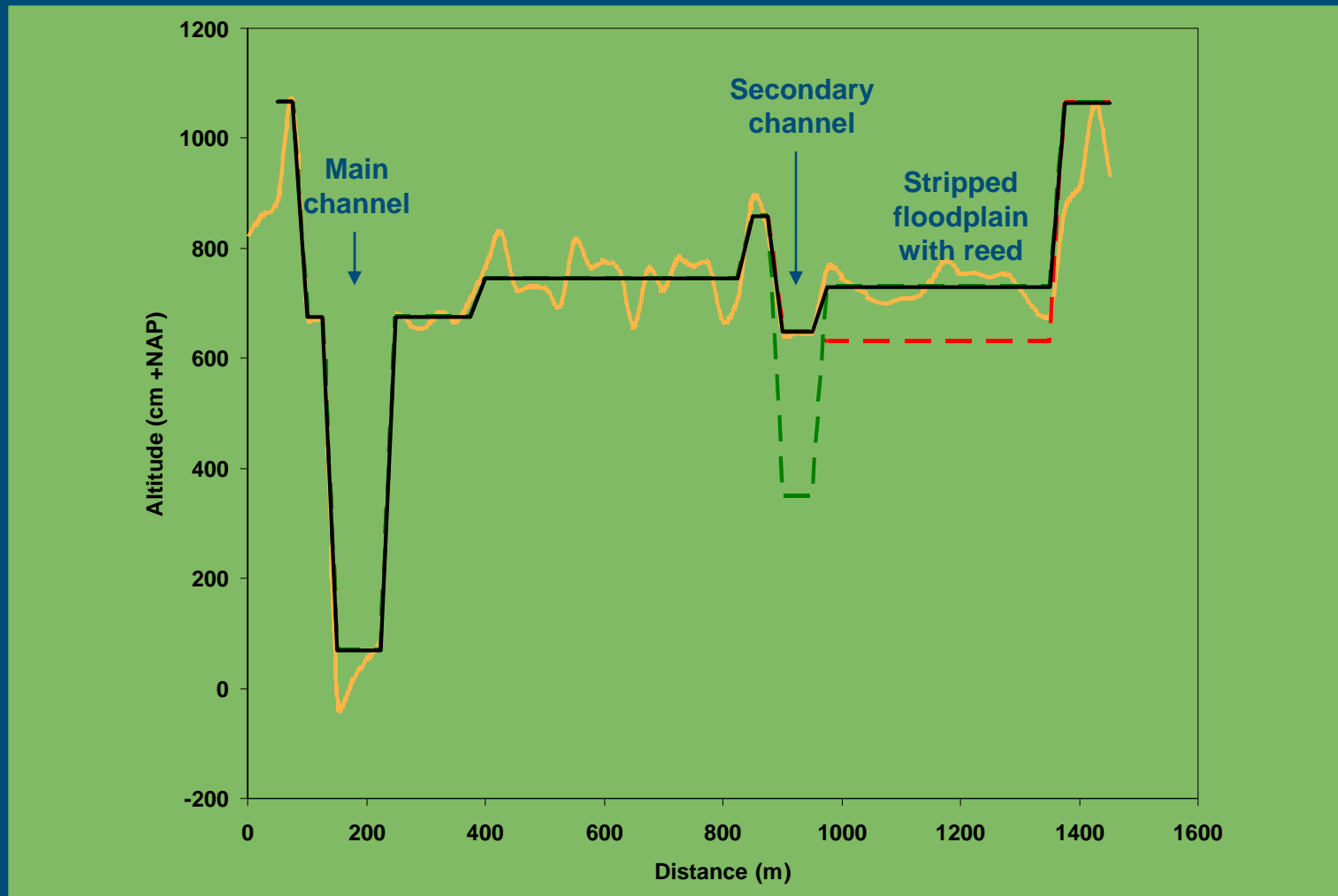
- Present Room for River measures are beneficial to nature
 - Floodplain stripping
 - Secondary channels
- But, vegetation succession increases floodplain roughness



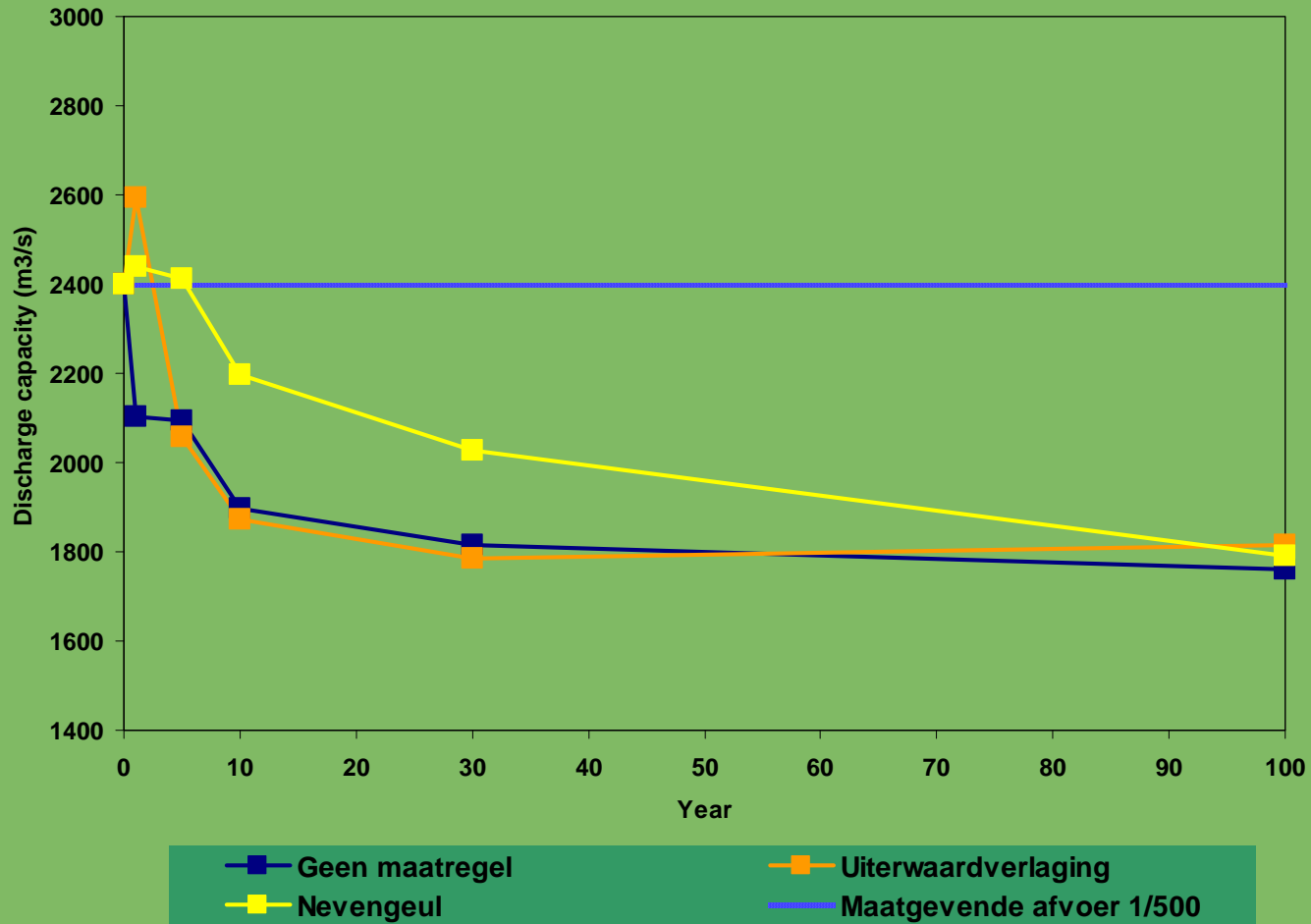
Modelling vegetation succession t=1, 5, 10, (30), 100 year



Secondary channels vs floodplain stripping



Succession + sedimentation and discharge capacity

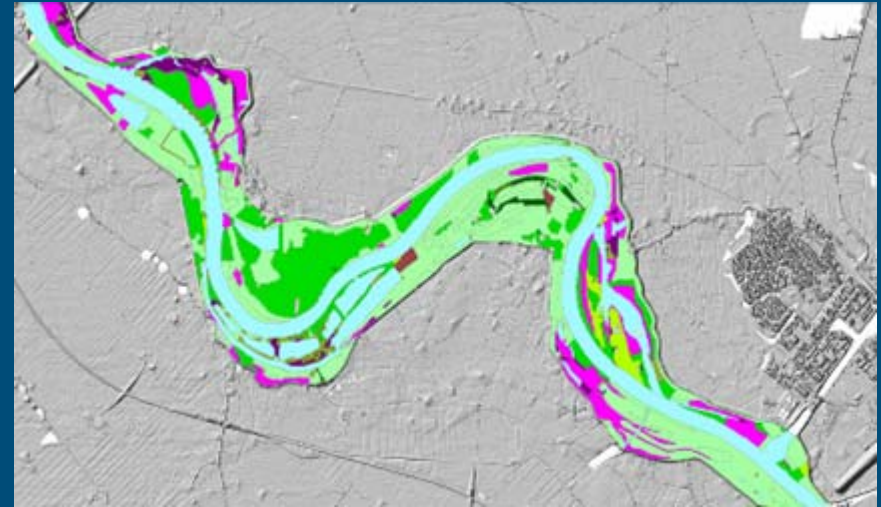
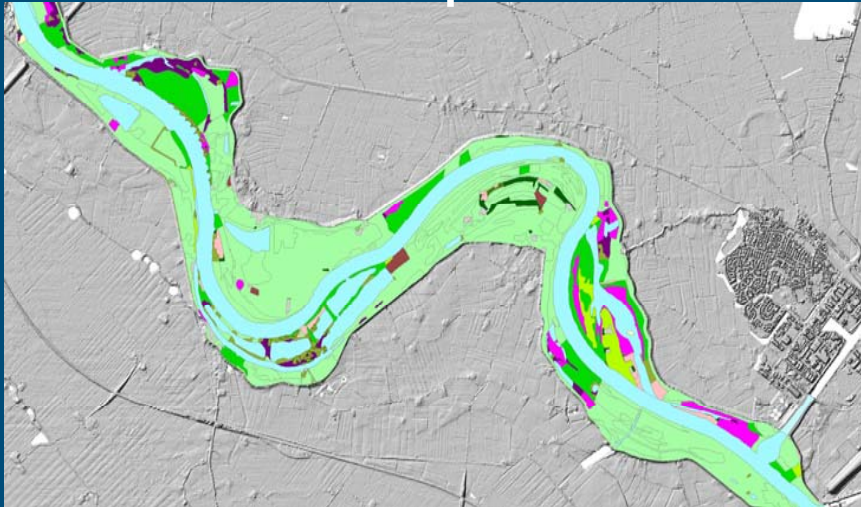


Floodplain maintenance: choices to be made

- Secondary channels are > 5x longer effective than stripped floodplains with reedland
- Maintenance costs of secondary channels are ca. 65% of the costs of stripped floodplains with reedland
- Besides, secondary channels are inherent to the river system



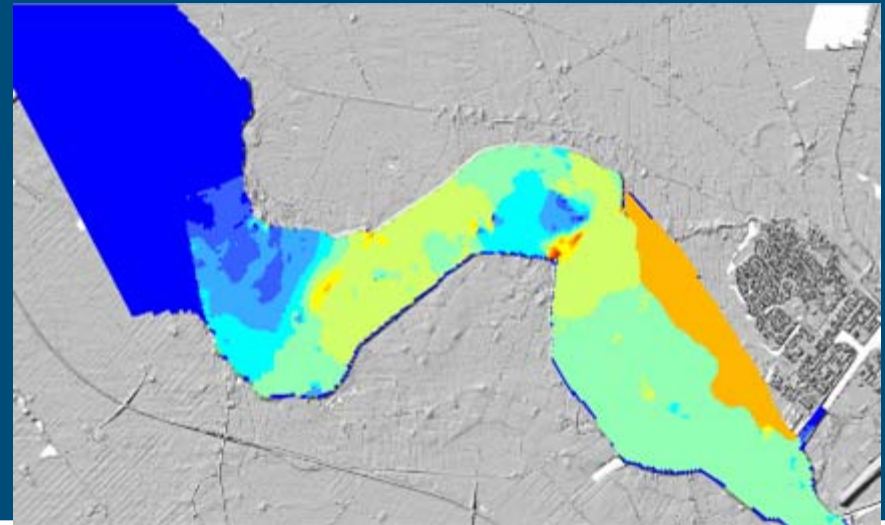
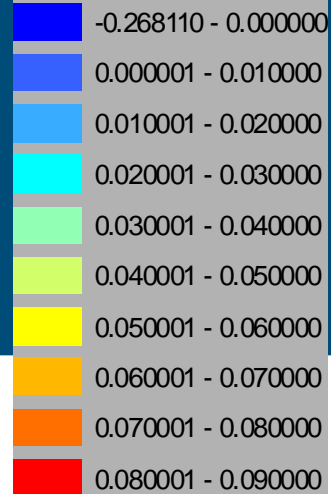
Effect varies per location



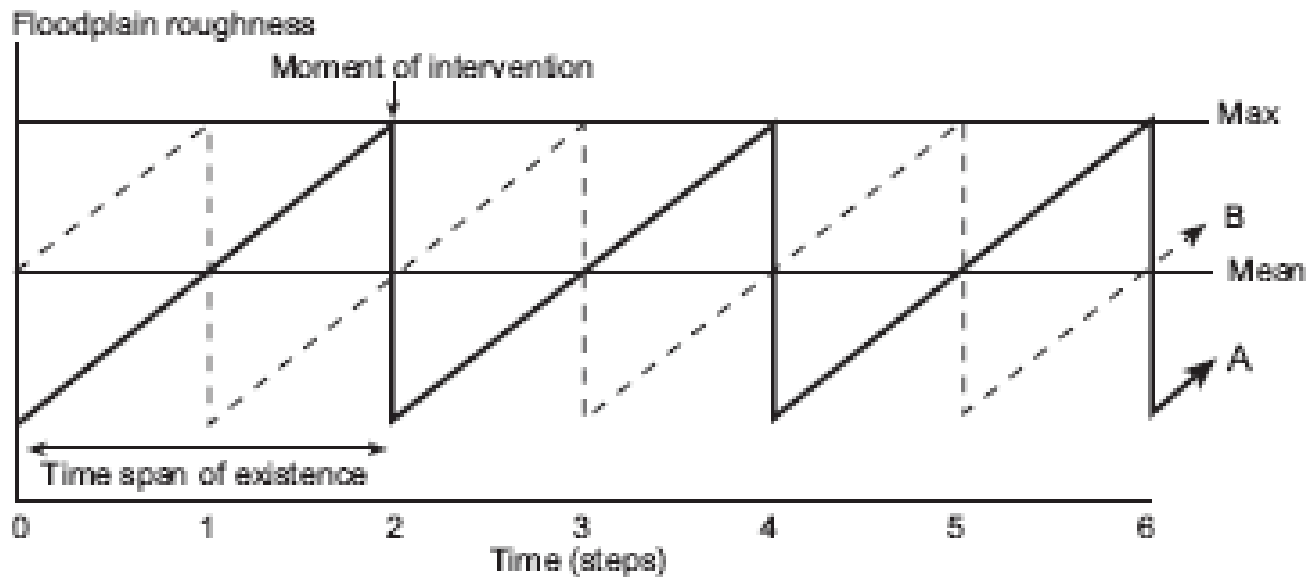
Legend

variant

DIFWL

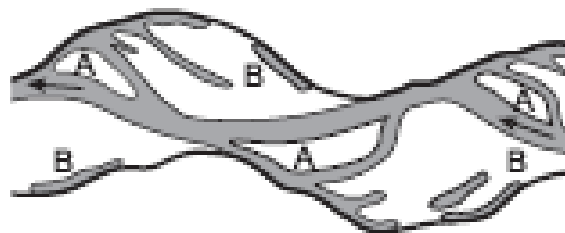


Cyclic rejuvenation concept

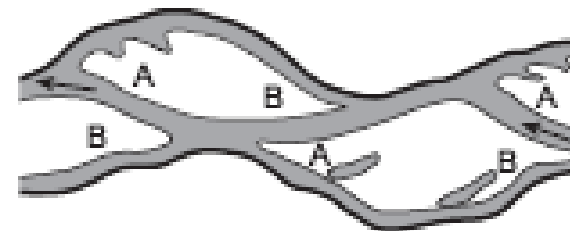


Contribution to total floodplain roughness

— at A
- - - at B



T= 0, 2, 4, etc.



T= 1, 3, 5, etc.

Conclusions

- Flood control and river navigation are serious constraints to lowland river rehabilitation
- Under these conditions, the river ecosystem can benefit from restoration of the floodplain
- Careful selection of the most beneficial sites for restoration is needed to optimize the results
- Policy goals should best be set at the river reach level
- Further transboundary cooperation is needed to tackle remaining problems

Thank you!

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Loire-River dynamics

