Restoring the River Rhine (NL): achievements and challenges

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The River Rhine delta metropolis

- High population density
- Shipping transport
The River Rhine in the Netherlands

- **Discharge**
  - Mean 2,200 m$^3$/s
  - Max 12,800 m$^3$/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 deposition
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Historical references: working with nature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
Geomorphologic processes back
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

Air circulation patterns

G+ + 1°C
W+ + 2°C

G
W

Global temperature in 2050 compared to 1990

Graph showing mean Q [m³/s] from January to December.
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

[Diagram showing the comparison between main channel and secondary channels with and without reed-covered floodplain.]
Succession + sedimentation and discharge capacity

Discharge capacity (m³/s)

Year

- Geen maatregel
- Uiterwaardverlaging
- Nevengeul
- Maatgevende afvoer 1/500
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

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Cyclic rejuvenation concept
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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