



**Side channels along the River Rhine in
the Netherlands; an effective
rehabilitation measure?**

**Wageningen
The Netherlands
October 2, 2003**

An aerial photograph of the River Rhine in the Netherlands, showing a wide river with several side channels and floodplains. The water is a light brownish-grey color, and the surrounding land is green with some buildings and roads. The text is overlaid on the image.

Side channels along the River Rhine in the Netherlands; an effective rehabilitation measure?

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Rhine/Waal



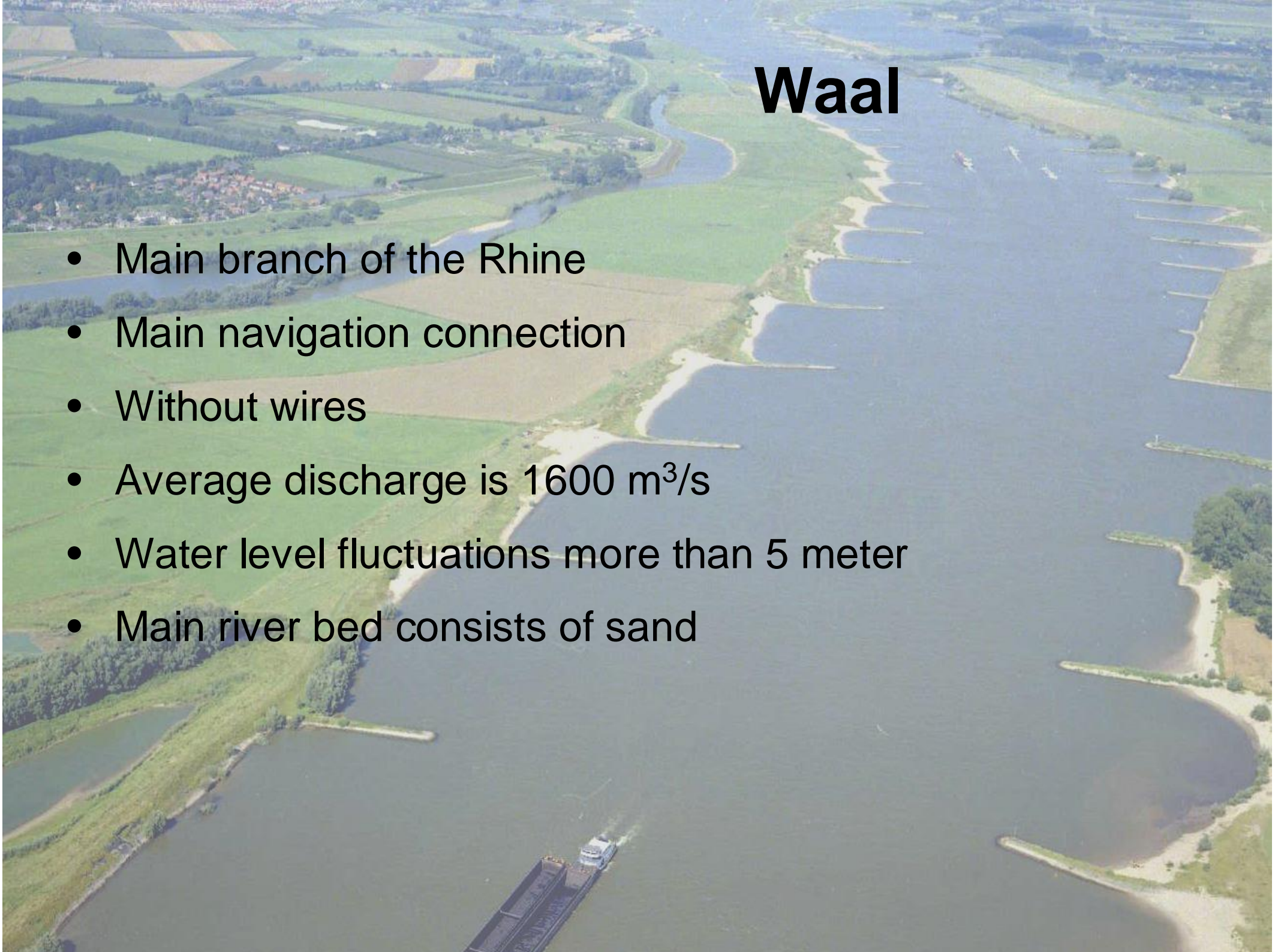
Rhine/Waal

- Regulated river (groynes)
- Embanked
- Aggradated floodplain (with clay)
- Sand and clay extraction in floodplains
- Isolated water bodies within floodplain



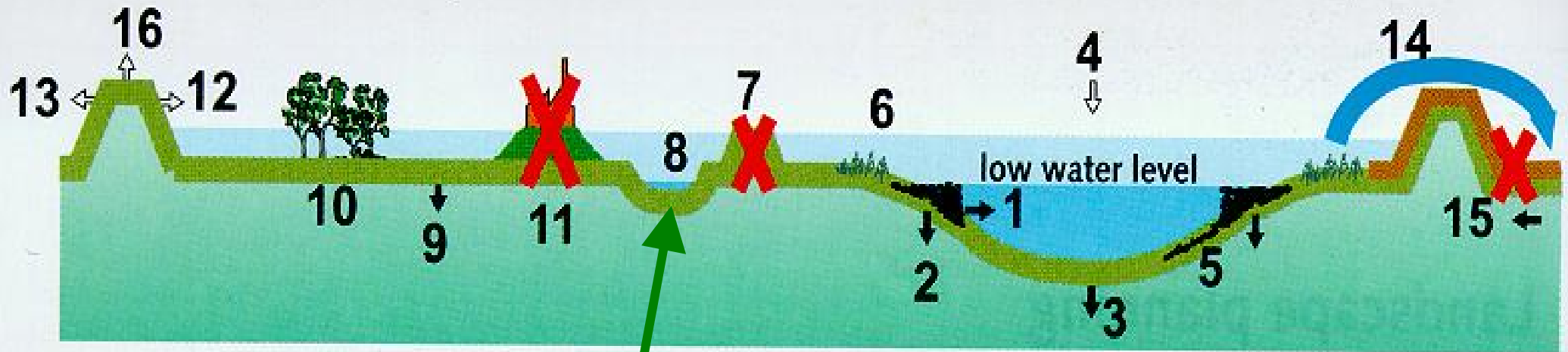
Waal

- Main branch of the Rhine
- Main navigation connection
- Without wires
- Average discharge is 1600 m³/s
- Water level fluctuations more than 5 meter
- Main river bed consists of sand



River rehabilitation

Measures for ecological restoration and flood prevention



1 = narrowing of the main channel

2 = lowering of the groynes

3 = dredging

4 = redumping of sediment

5 = permanent layer

6 = natural bank

7 = removing summer embankment

8 = **digging a side channel**

9 = lowering of the embanked flood plain

10 = nature development

11 = removing of raised areas

12 = dike reinforcement

13 = dike repositioning

14 = retention (outside the high-water bed)

15 = obstructing lateral inflow

16 = dike raising

Side channels in The Netherlands

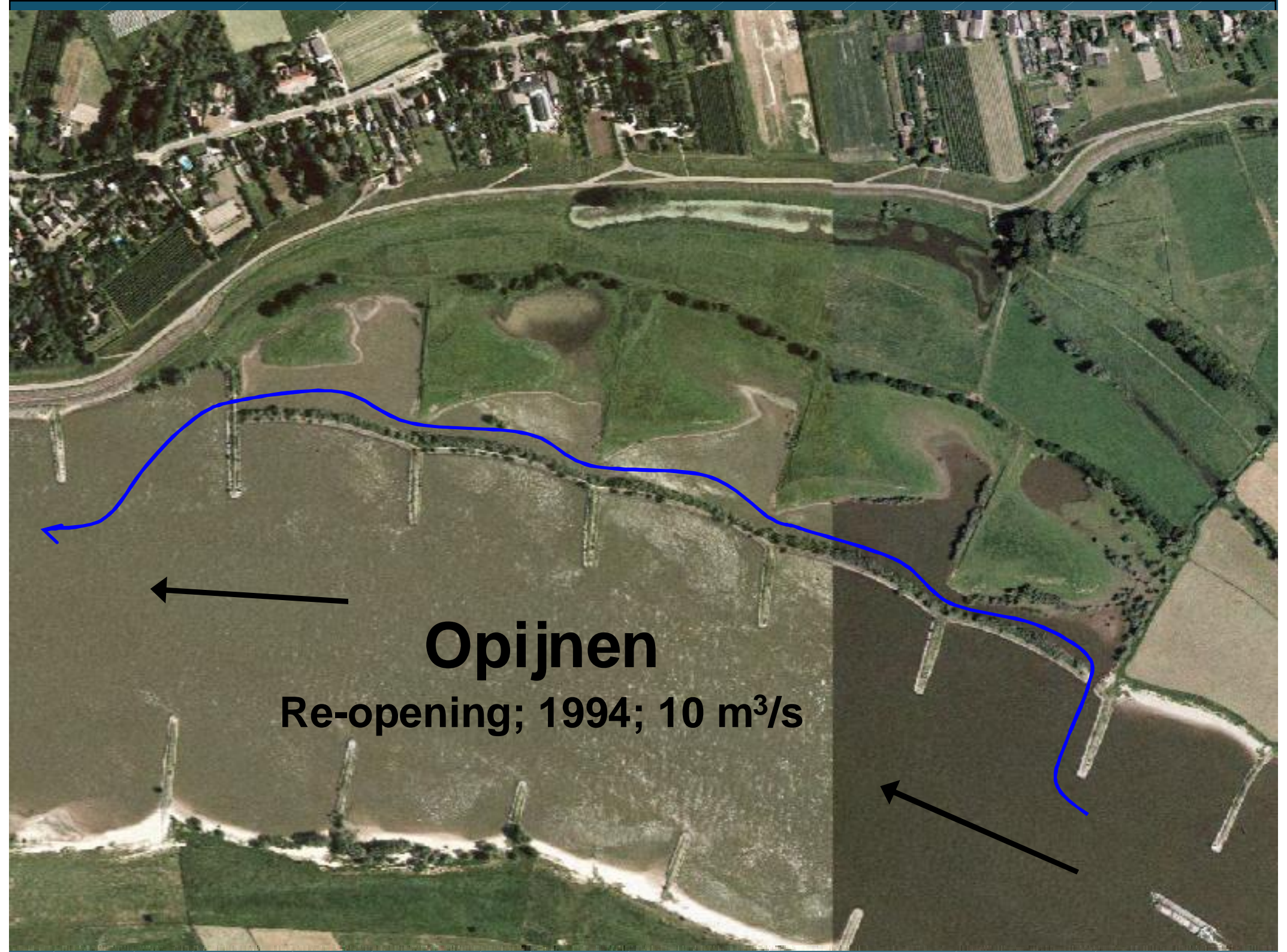
- Two main reasons: safety and ecological restoration
- Creation of man-made side channels by excavating the floodplain
- Strict preconditions because of navigation and safety
- Thus: rehabilitation freedom between clear limits



Side channels in The Netherlands

- Opijnen
- Beneden-Leeuwen
- Gamerensche Waard
Three side channels





Opijnen

Re-opening; 1994; 10 m³/s

Beneden-Leeuwen

Re-opening; 1995; 5 m³/s

Waal (Rhine)

Beneden-Leeuwen

Boven-Leeuwen

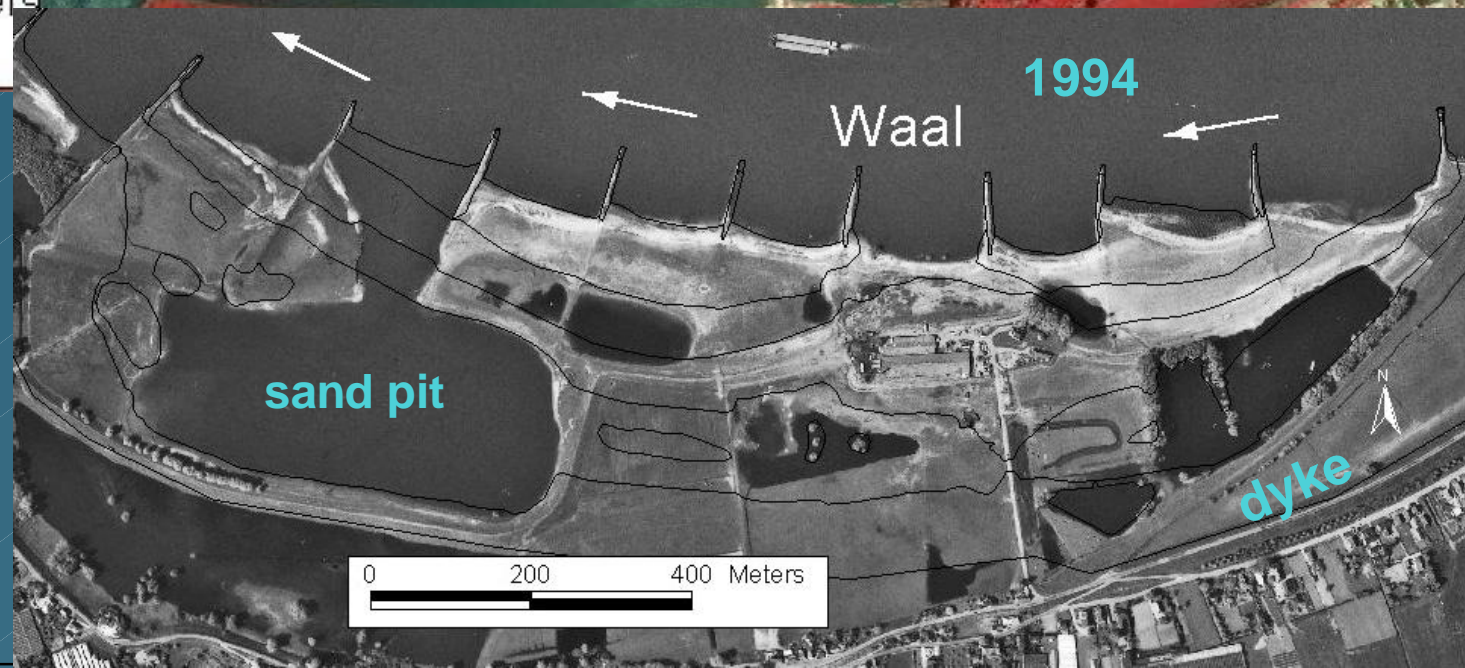


Gamerensche Waard



- East channel; 1996; Creation; shallow, slow-flowing; 0 m³/s
- West channel; 1996; Creation; shallow, fast flowing; 10 m³/s
- South channel; 1999; Creation/Connection; deep, slow-flowing; 20 m³/s

Gamerensche Waard



Side channels effective?

→ → **Monitoring!!!**

- Checking possible risks
- Evaluating ecological and water discharge targets
- Increasing knowledge



Objectives monitoring (1)

- Checking possible risks
 - Navigation: Aggradation of the main channel
 - Navigation: Cross currents
 - Safety: Destabilization of embankments
 - Maintenance: Transport polluted sediments
 - Maintenance: Filling up side channel
- Evaluating ecological and discharge targets
- Increasing knowledge



Objectives monitoring (2)

- Checking possible risks
- Evaluating ecological and water discharge targets
 - Ecological rehabilitation: Establishment of target species; fish, macro-invertebrates and plants
 - Safety: Larger discharge capacity at extreme high water
- Increasing knowledge

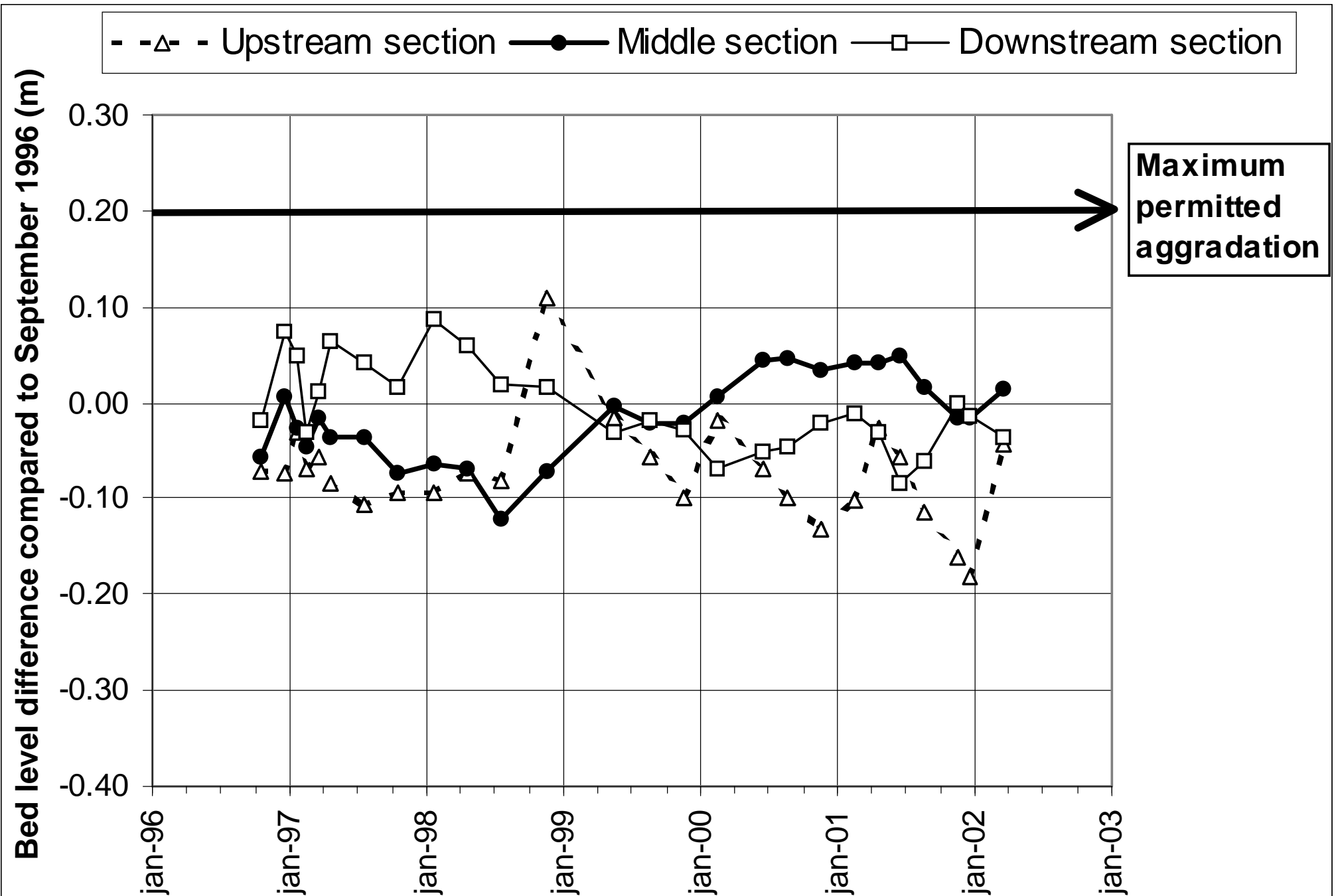


Objectives monitoring (3)

- Checking possible risks
- Evaluating ecological and discharge targets
- Increasing knowledge
 - Erosion and sedimentation processes; improving hydro morphological models
 - Failure and success factors establishment organisms (habitat and ecotoxicology)

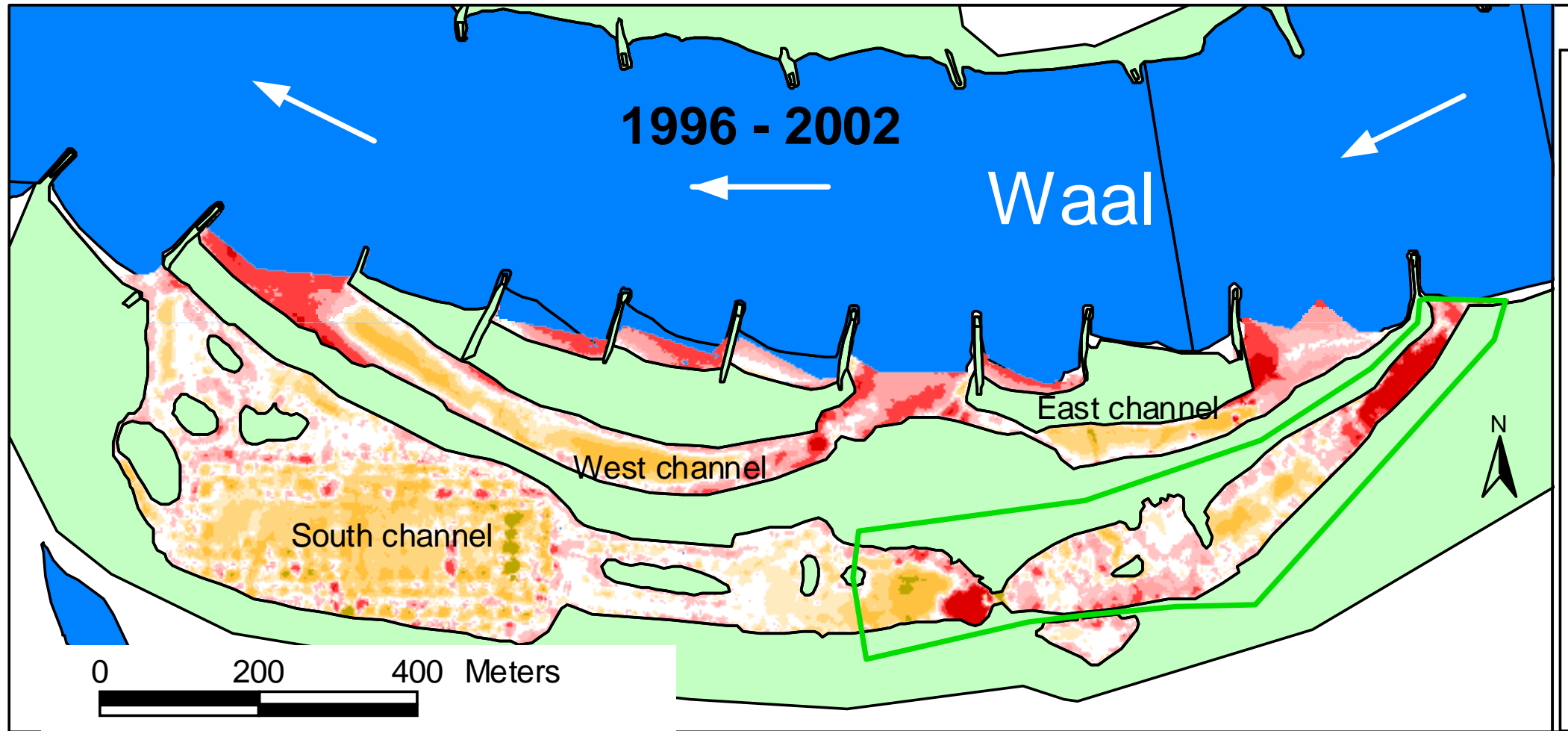


Aggradation main channel?

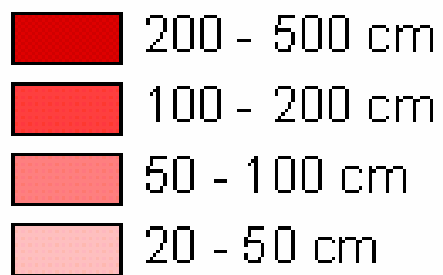




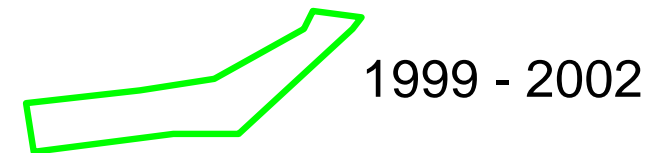
Filling up side channels?



Erosion

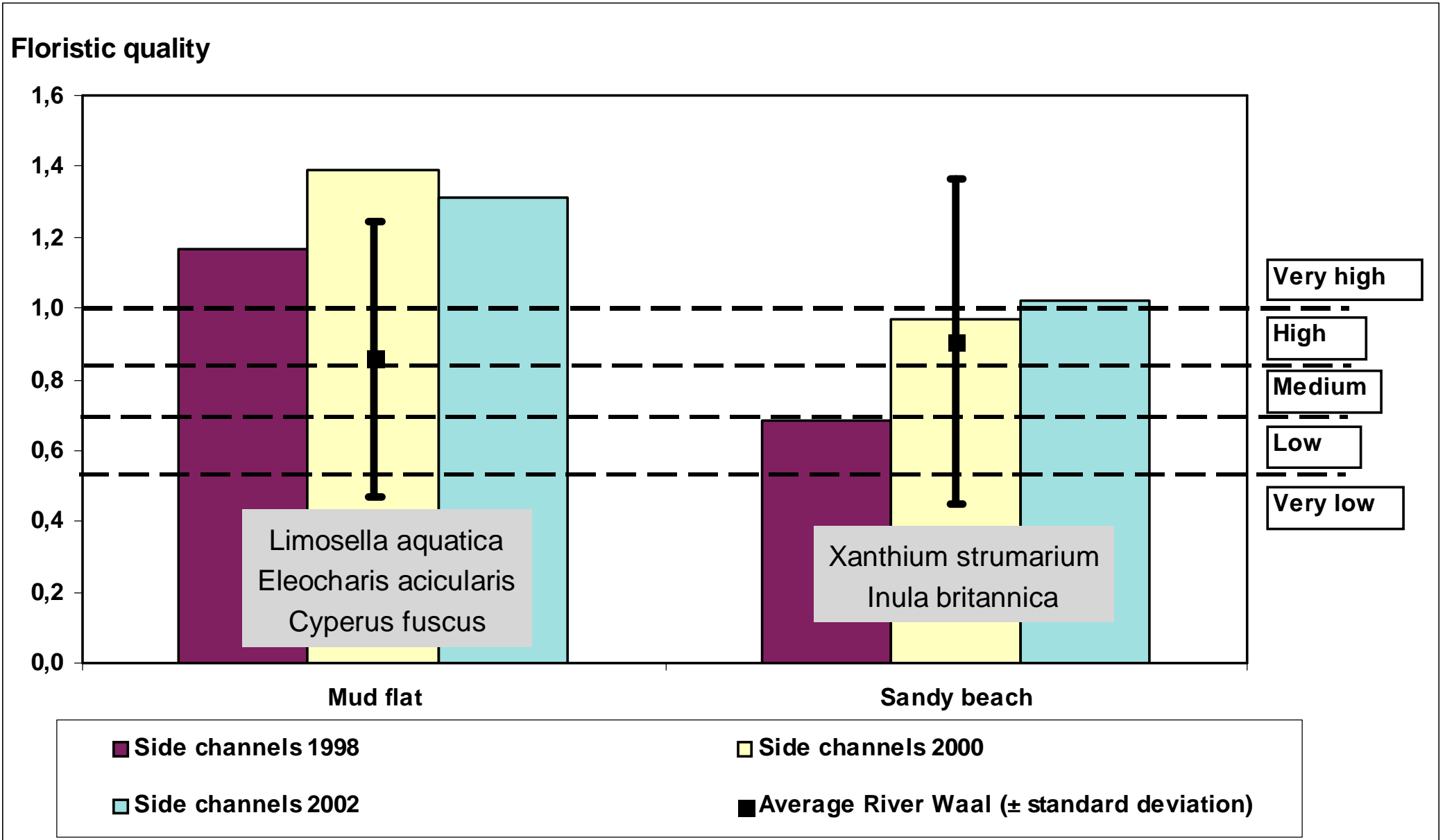


Sedimentation



Ecological rehabilitation?

Flora



Ecological rehabilitation?

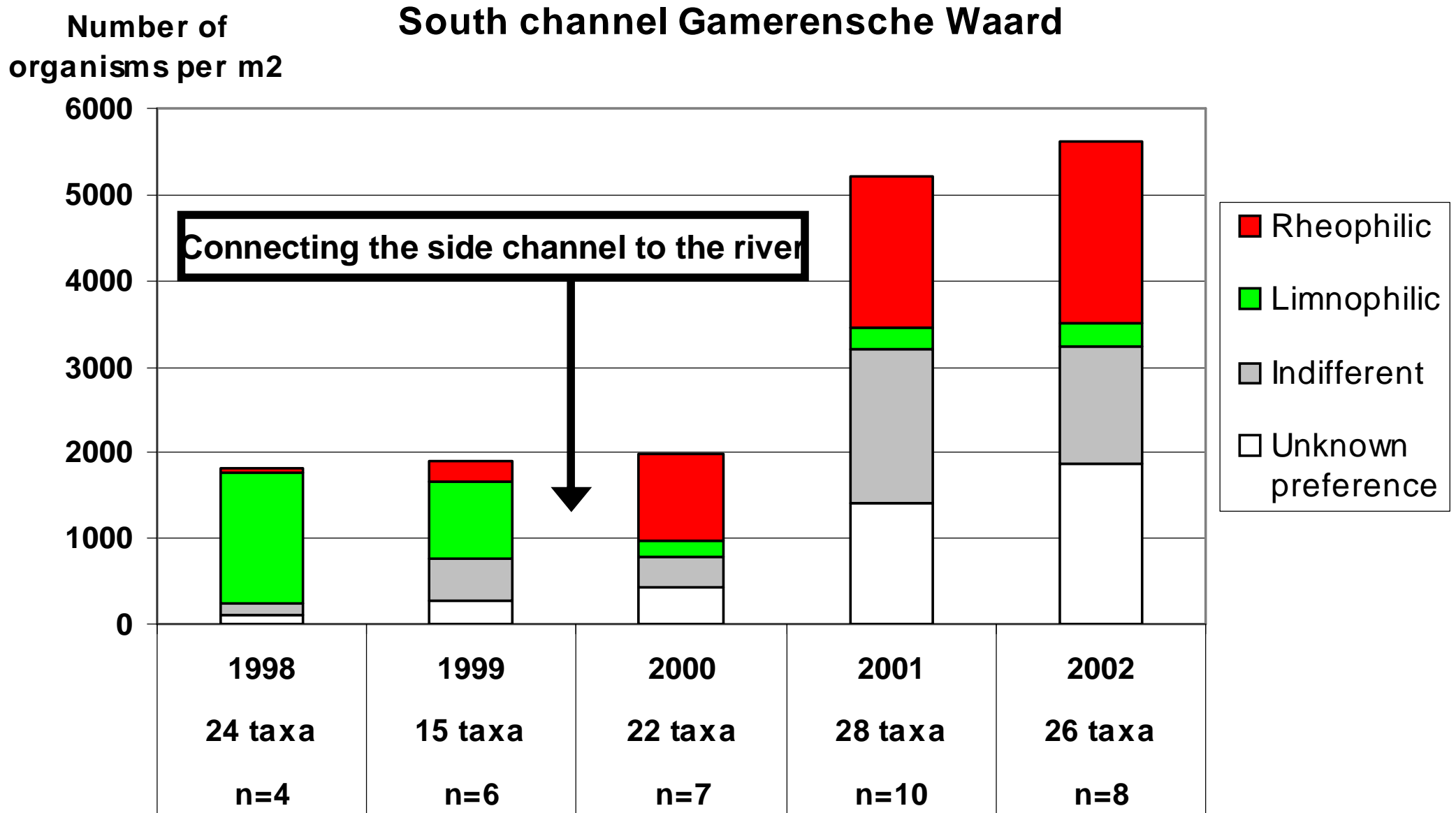
Fish

- Side channels → suitable habitats for rheophilic fish species, especially in spring during the larval phase
- Most abundant rheophilic fish species:
 - Barbel: *Barbus barbus* Ide: *Leuciscus idus*
 - Gudgeon: *Gobio gobio* Asp: *Aspius aspius*
- Suitable habitats:
 - Water depth between 0-100 cm
 - Flow between 5-30 cm/s
- Quick colonization



Ecological rehabilitation?

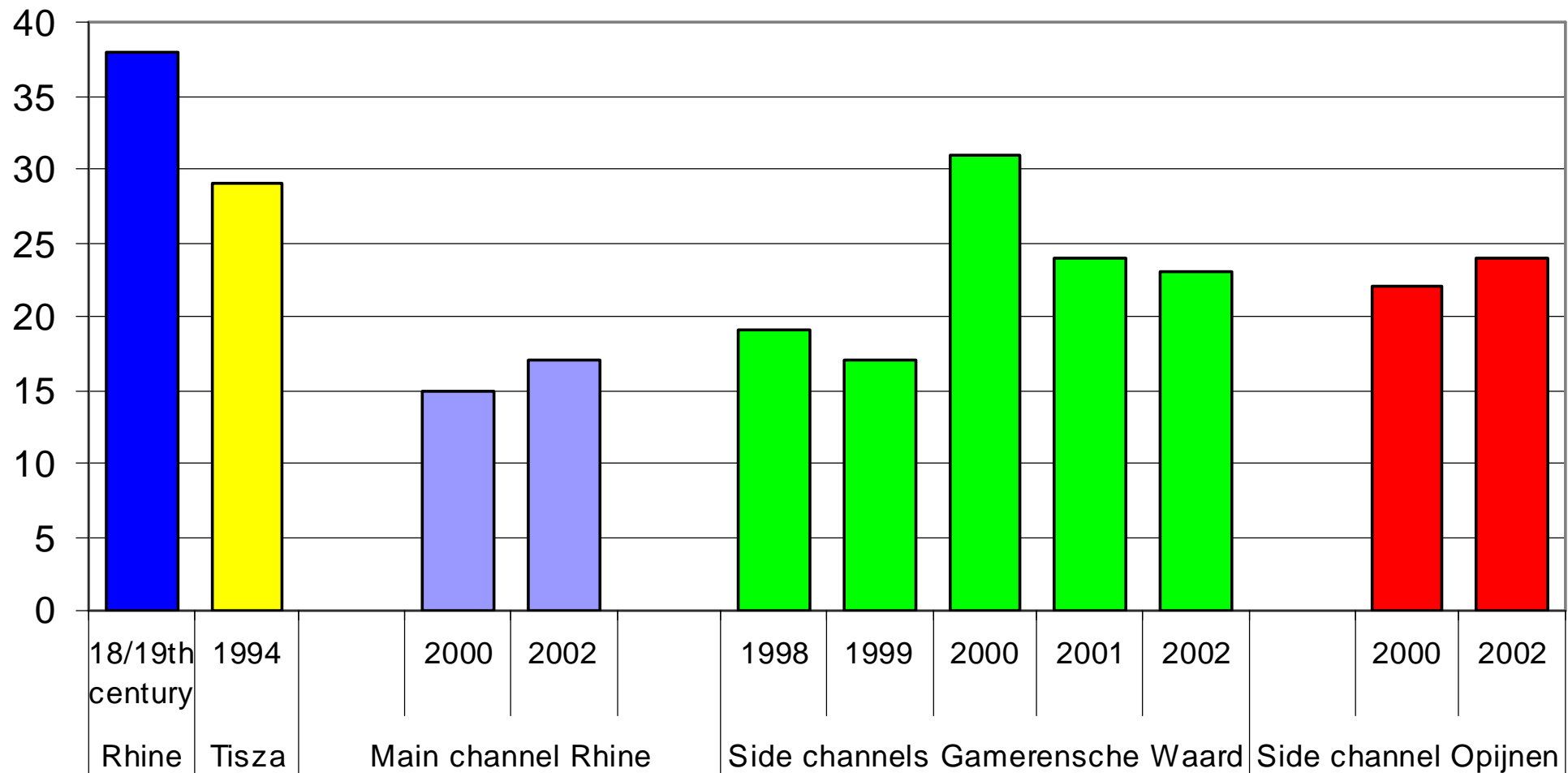
Macro-invertebrates (1)



Ecological rehabilitation? Macro-invertebrates (2)

Chironomidae

Number of taxa



Safety: larger discharge capacity?

- Excavating side channels creates larger water discharge capacity
- The high sand sedimentation rate in the side channels and the vegetation development do not influence this discharge capacity seriously up till now



Conclusions

- Checking possible risks
- Evaluating ecological and discharge targets
- Increasing knowledge



Conclusions

- Checking possible risks
 - No navigation problems:
 - Hardly any aggradation main channel
 - No undesired cross currents



Conclusions

- Checking possible risks
 - No navigation problems:
 - Hardly any aggradation main channel
 - No undesired cross currents
 - Safety:
 - Local (controllable) erosion of embankments



Conclusions

- Checking possible risks
 - No navigation problems:
 - Hardly any aggradation main channel
 - No undesired cross currents
 - Safety:
 - Local (controllable) erosion of embankments
 - Maintenance:
 - Only (non-polluted) sand transport
 - Sedimentation; no dredging so far



Conclusions

- Checking possible risks
- Evaluating ecological and discharge targets
 - High biodiversity (especially rheophilic species)
 - Continuous rejuvenation of the floodplain; pioneer habitats
 - Larger discharge capacity at extreme high water; not annulled yet by vegetation development
- Increasing knowledge



Conclusions

- Checking possible risks
- Evaluating ecological and discharge targets
- Increasing knowledge: surprises
 - Morphology
 - Hydraulics
 - Ecology



Conclusions

- Checking possible risks
- Evaluating ecological and discharge targets
- Increasing knowledge: surprises
 - Morphology:
 - Very dynamic
 - Sand in stead of clay
 - High local heterogeneity
 - Hydraulics
 - Ecology



Conclusions

- Checking possible risks
- Evaluating ecological and discharge targets
- Increasing knowledge: surprises
 - Morphology
 - Hydraulics:
 - Navigation influences flow in side channels
 - Ecology



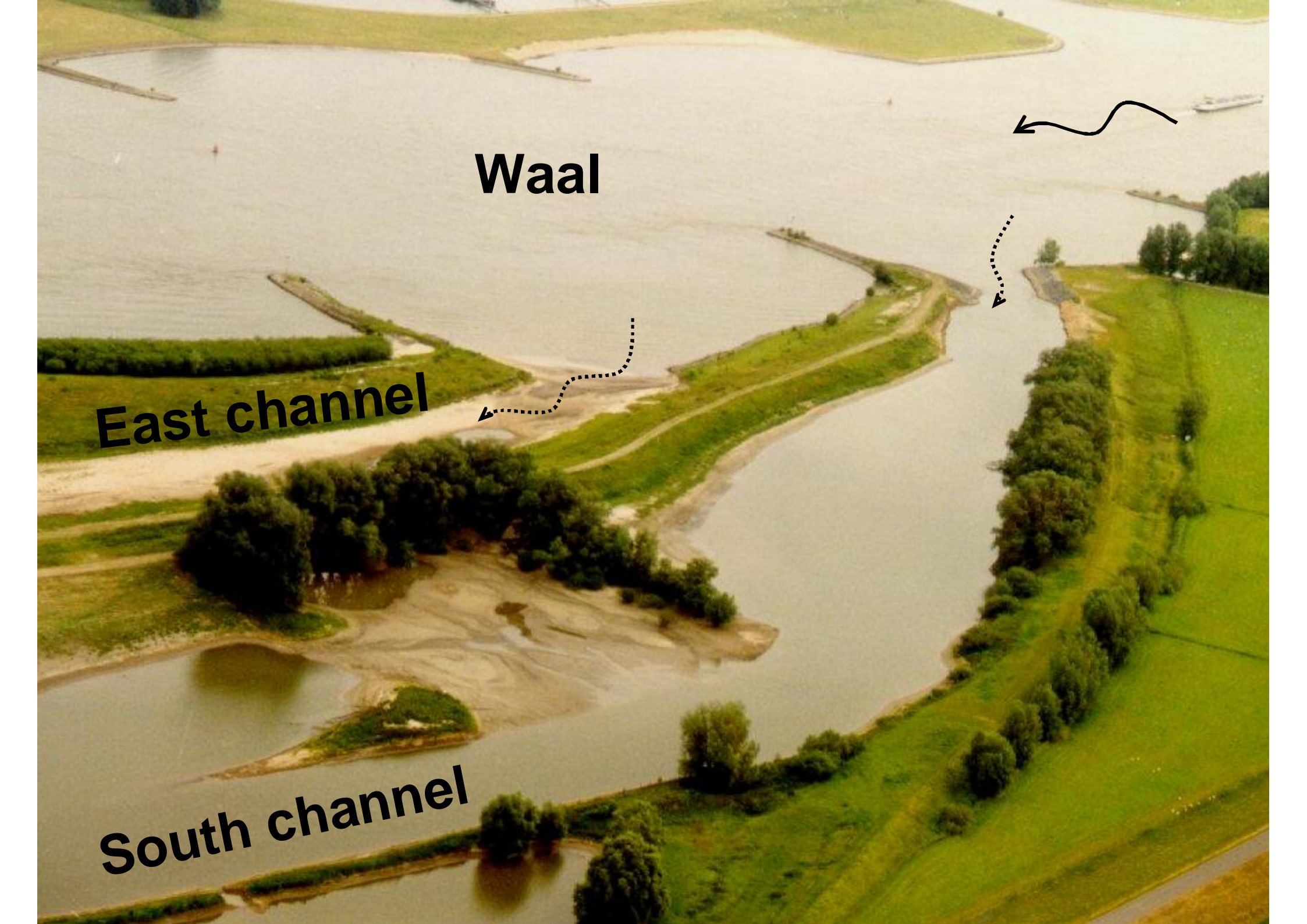
Conclusions

- Checking possible risks
- Evaluating ecological and discharge targets
- Increasing knowledge: surprises
 - Morphology
 - Hydraulics
 - Ecology:
 - Fast colonization of aquatic species
 - High variety



Some more slides





Waal

East channel

South channel





East channel



West channel





At the end

