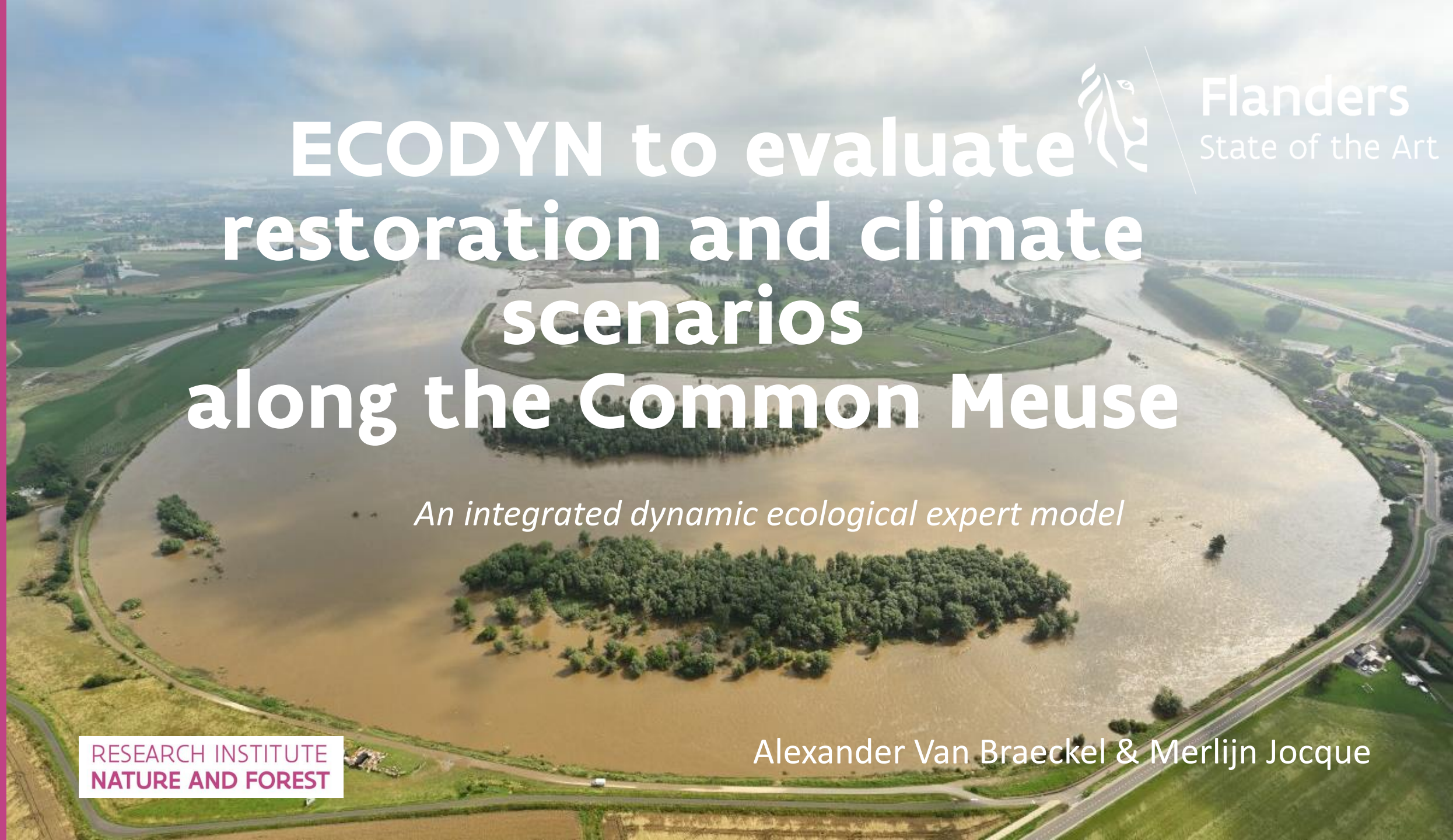

ECODYN to evaluate restoration and climate scenarios along the Common Meuse

An integrated dynamic ecological expert model

Flanders
State of the Art

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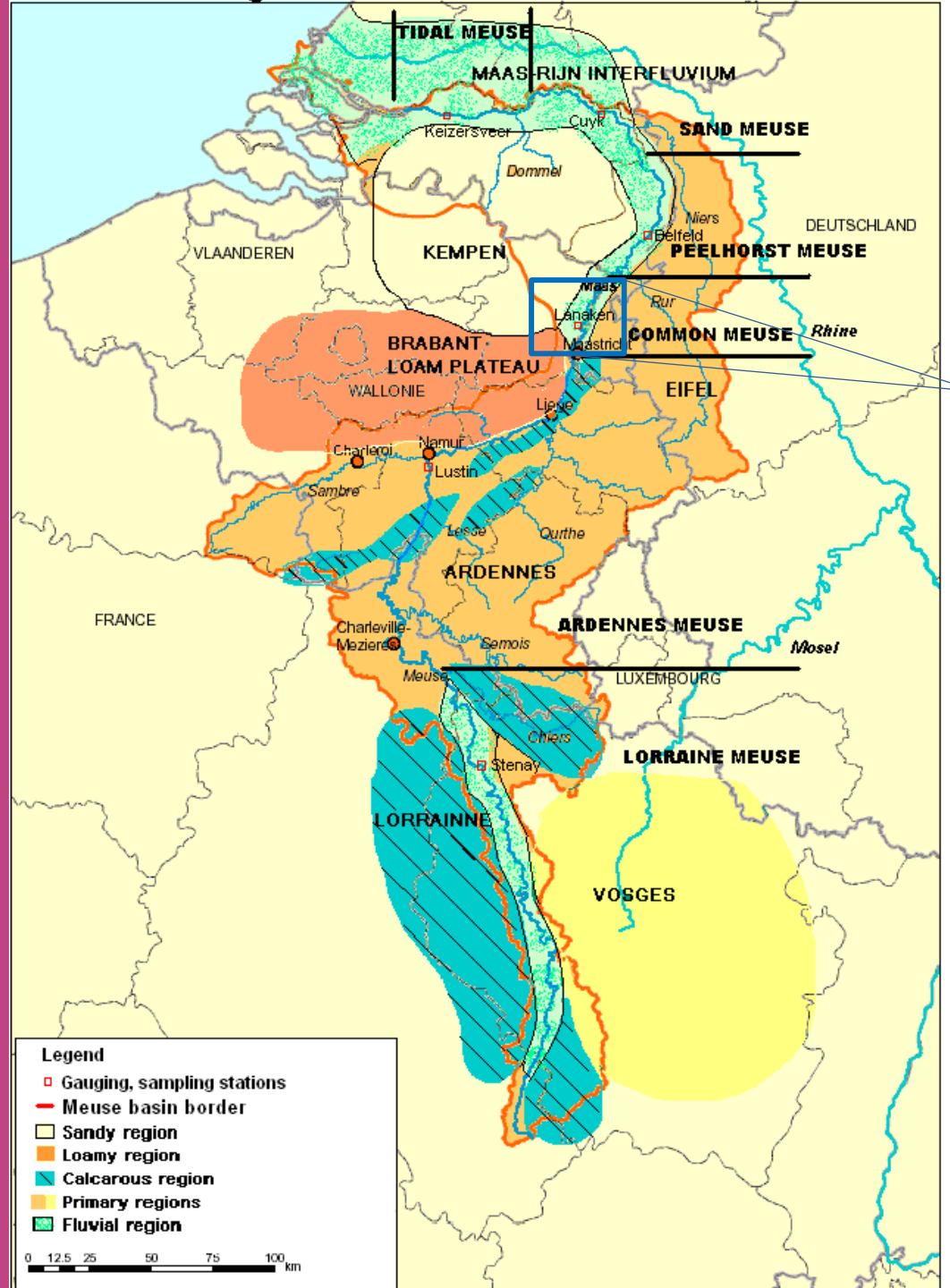
Alexander Van Braeckel & Merlijn Jocque

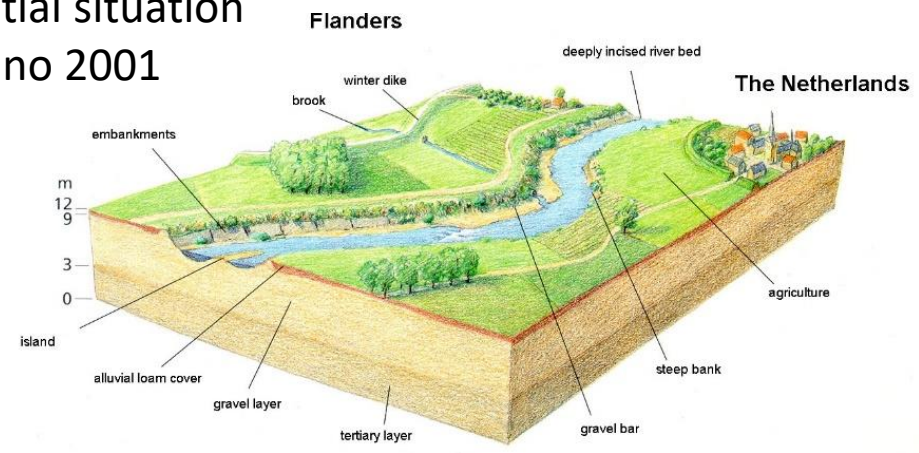


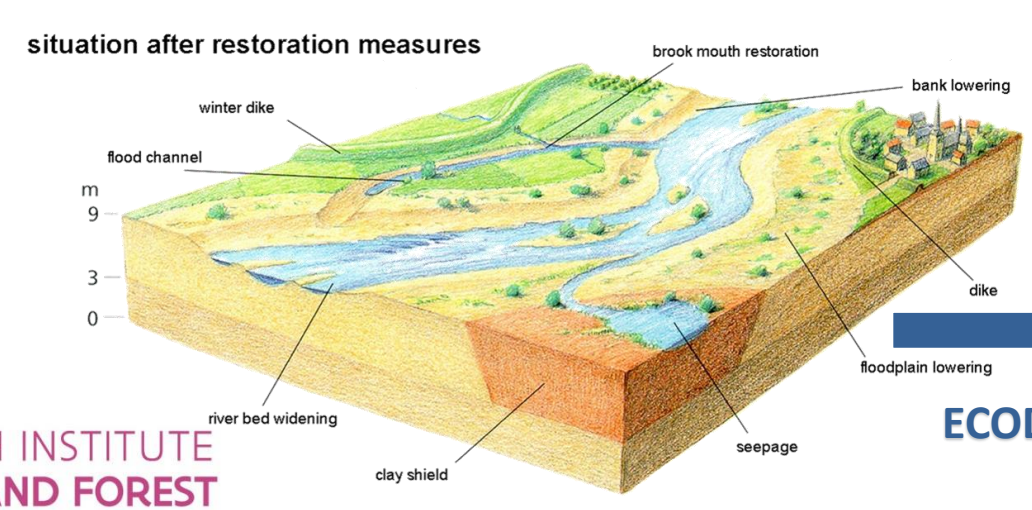
Study area

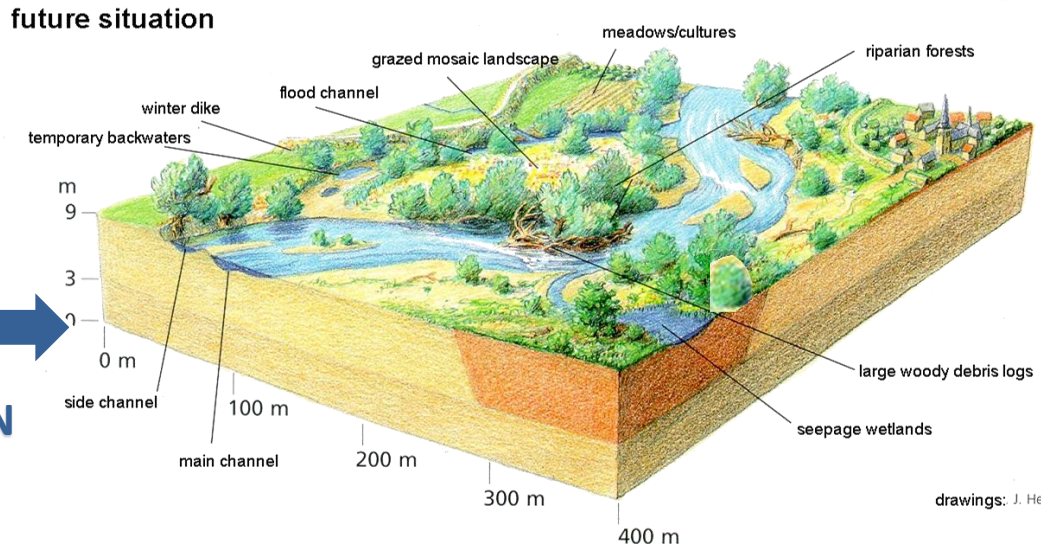
- Common Meuse/ Border Meuse
- reach km 450-500 at Belgian (*Flemish*) – Dutch border
- Floods in 1993 & 1995
  - → Large scale restoration
    - × Nature restoration
    - × Flood protection
  - → Gravel extraction
- Cumulative Design 2001
- Realizations 2008 – 2025
- Important area for Natura2000 habitats
  - → B: floodplain meadows/forests,
  - → NL: riverbed

Restoration of the Common Meuse

initial situation
anno 2001







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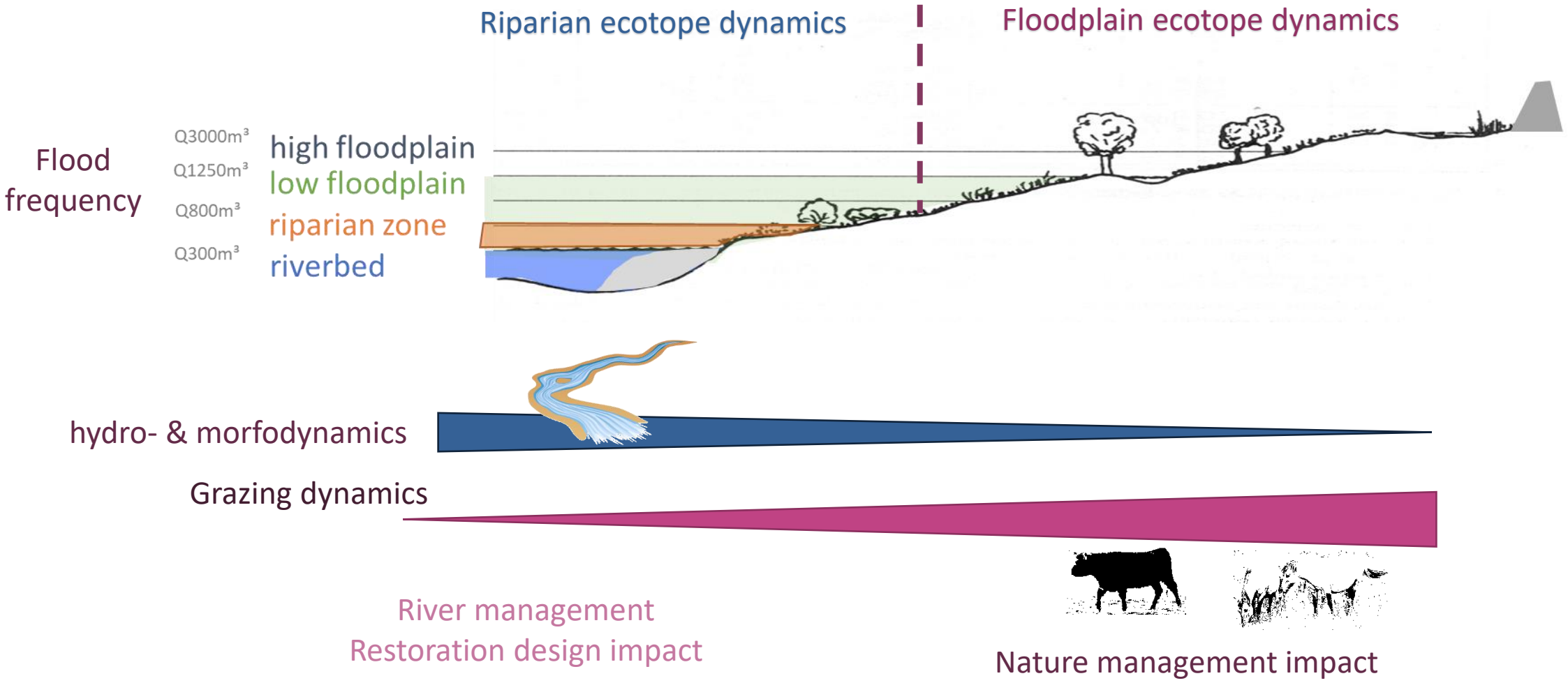
ECODYN

www.vlaanderen.be/inbo

ECODYN: from river dynamics & grazers to ecotopes



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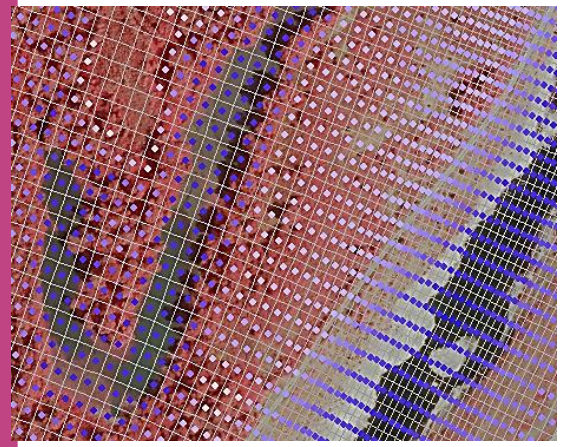
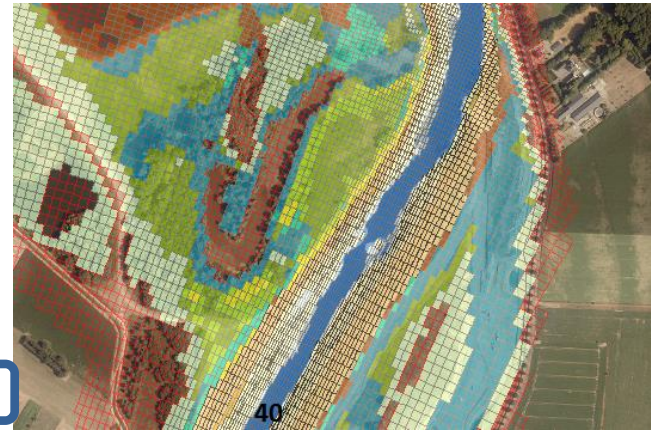
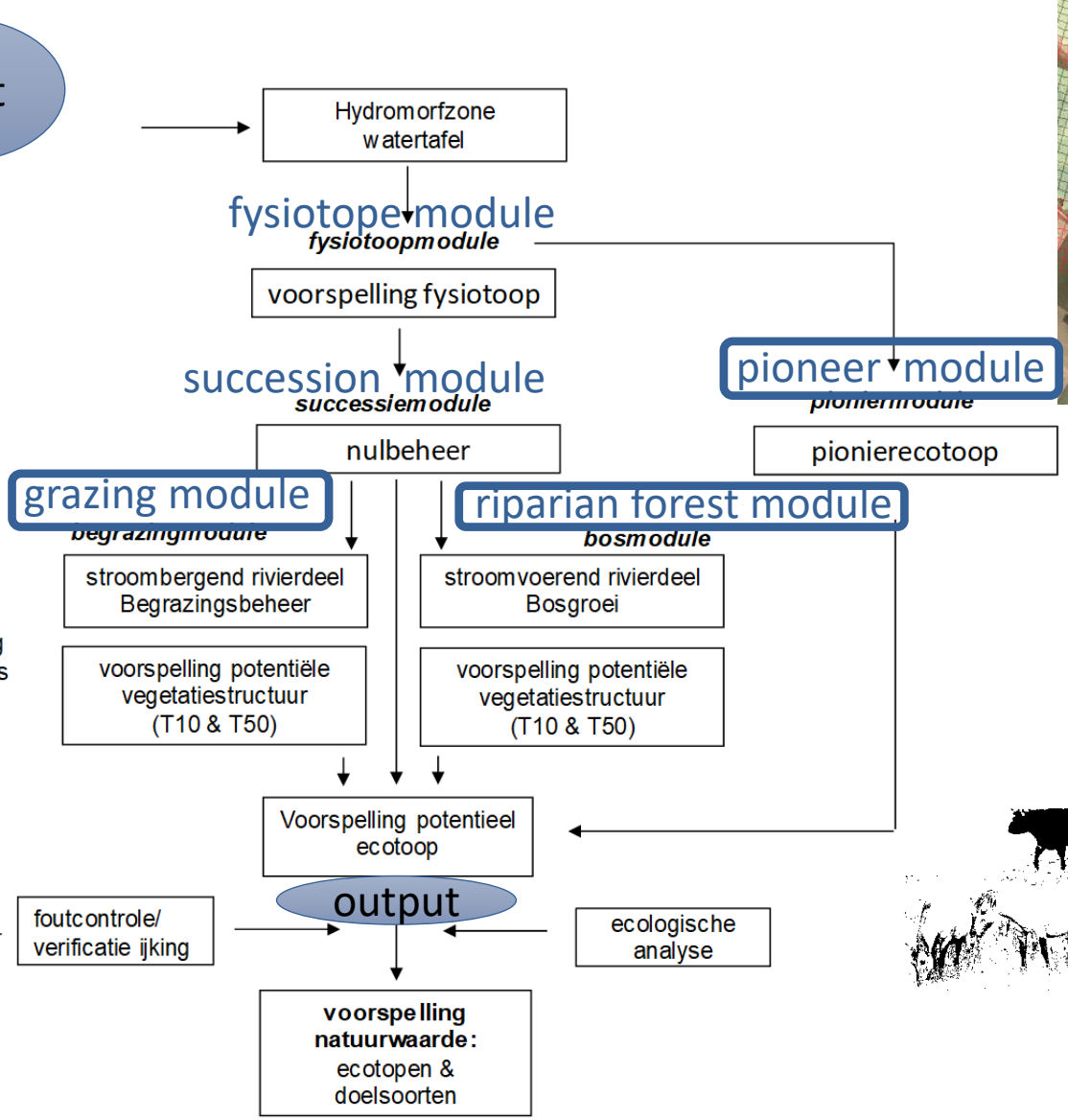
ECODYN *An integrated dynamic ecological expert model*

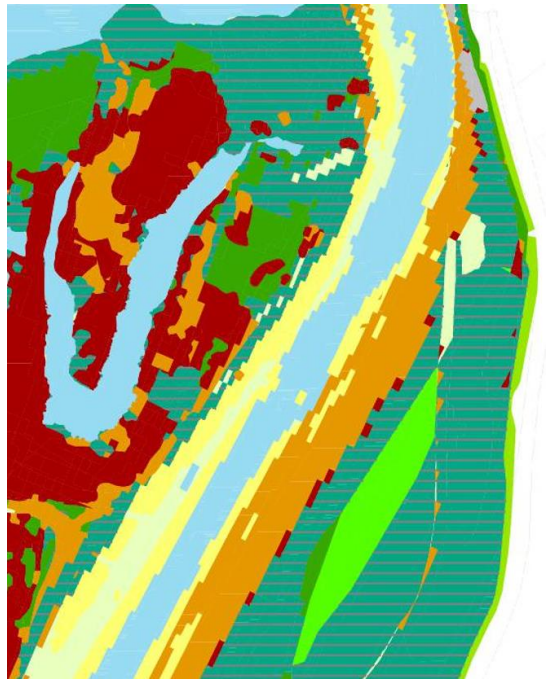






Input:

- numerical modeloutput (WAQUA)
- hydrological model output
- soil maps
- landuse: nature, agricultural management



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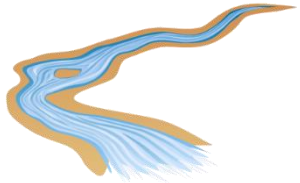
potential ecotope & species distribution in different scenarios & variants

ECODYN: Pioneer module



Riparian ecotope dynamics

Floodplain ecotope dynamics

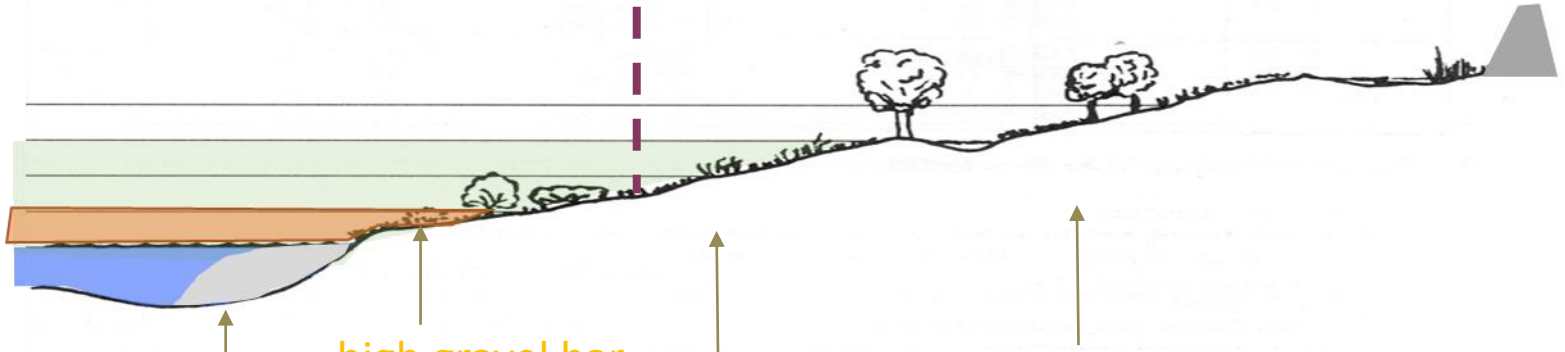
Flood frequency

Q3000m³ high floodplain

Q1250m³ low floodplain

Q800m³ riparian zone

Q300m³ riverbed



Velocity ranges at discharges Q800-Q2000 + Q3000

gravel bars

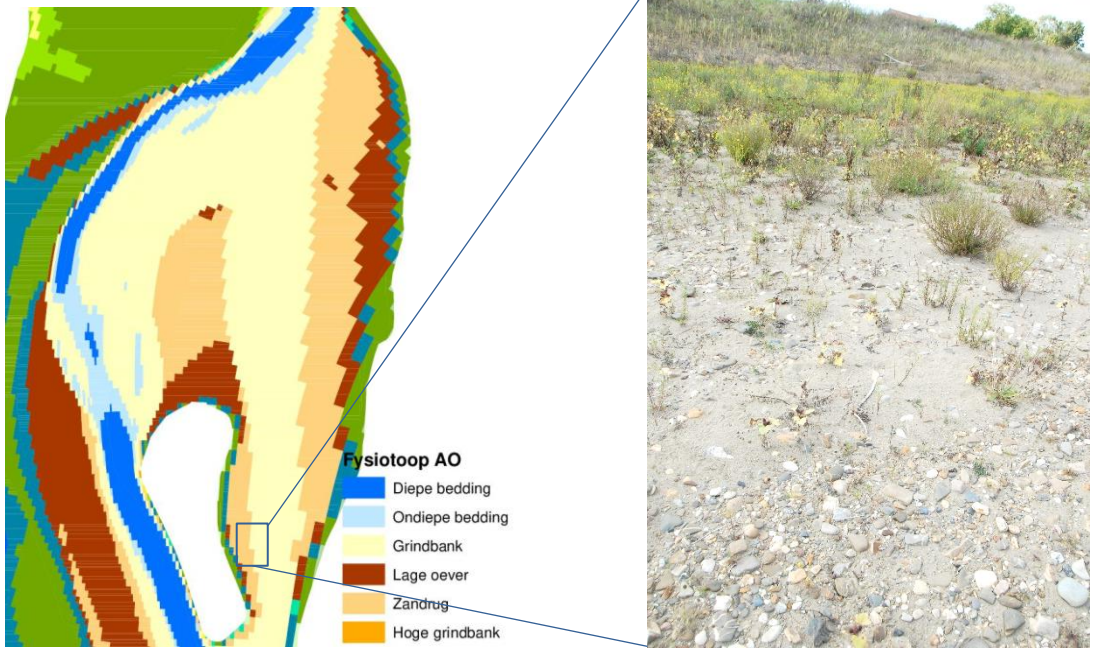
high gravel bar

sand bar

silt bank

high sandbar

high depositions of gravel, sand & silt



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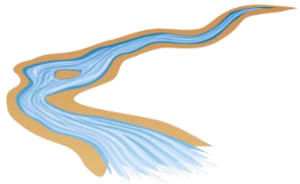
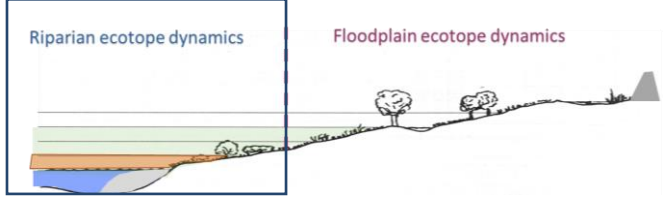
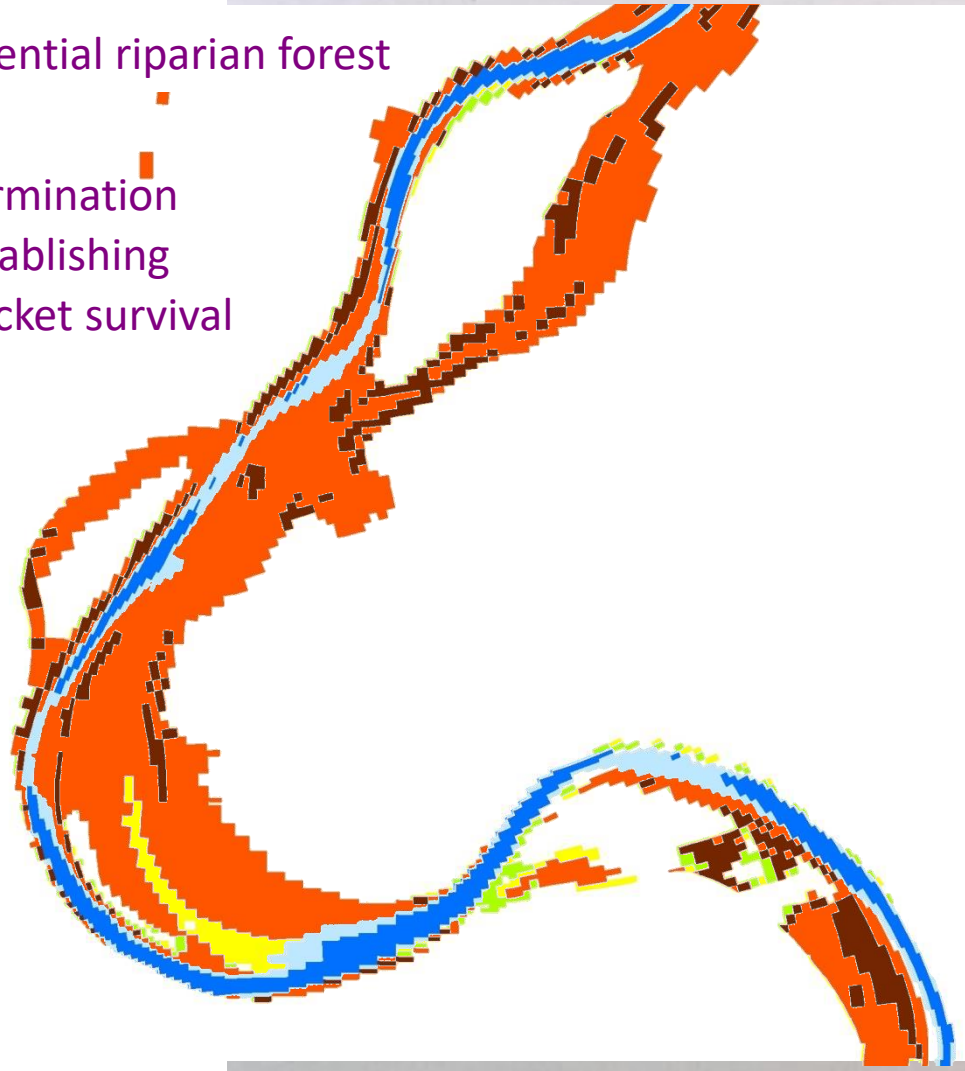
ECODYN: Riparian forest module





⇨Potential riparian forest

germination
establishing
thicket survival



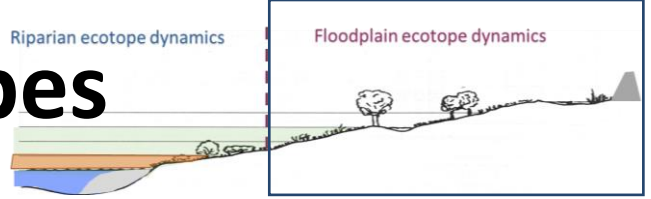
years

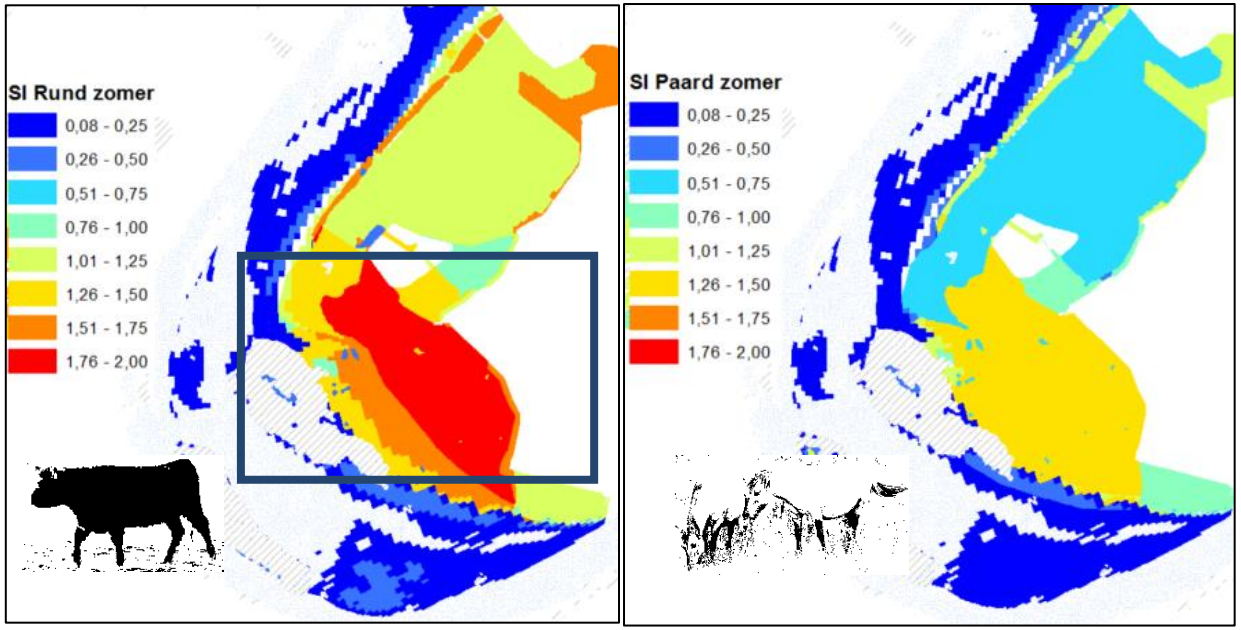
Time step *shear stress* Location	1	2-3	4-10	>10
lateral bar	0.3-6	11.5-13	13-22	35
point bar	0.3-4.5	9-11.5	13-17	32
flood channel	0.3-.76	0.3-0.6	2-4	10
flood channel levees	0.76-2	0.76-2	4-10	13
flood plain	0.1-0.3	0.1-0.3	0.3-4	10

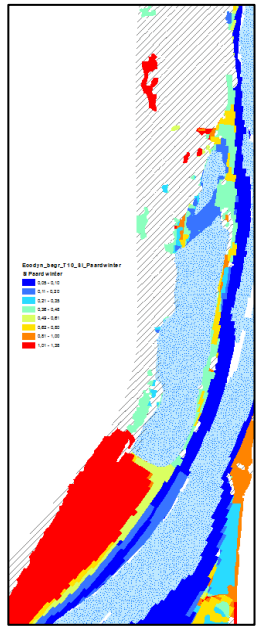
germination
establishing
thicket survival

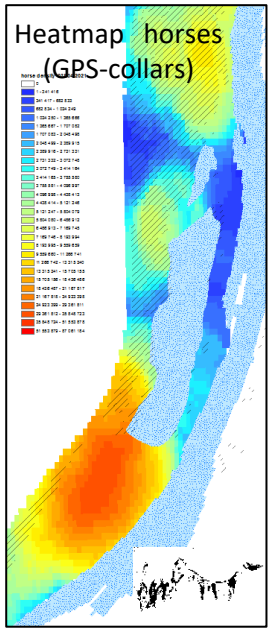
Van Looy et al. 2005 predicting patterns of riparian forest restoration

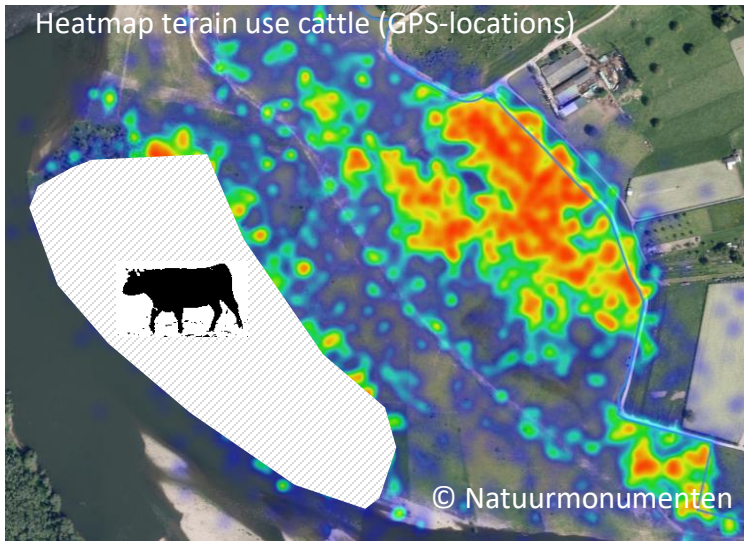
ECODYN: from grazer dynamics to ecotopes











Selection-index of cattle & horses in the open landscape

↓

Terrain use intensity distribution

↓ + *vegetation succession rate*

Potential vegetation structure map (T10 => T50yr)

↓ + *fysiotopes*

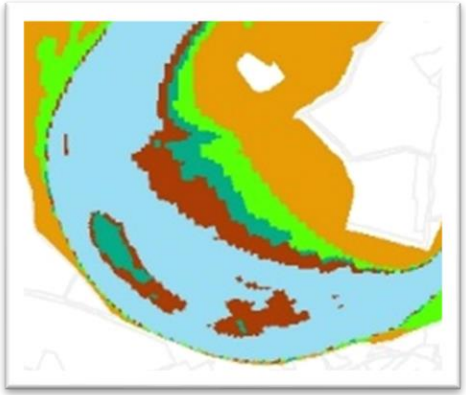
ecotope maps, natura 2000 habitats,… (T10 => T50yr)

ECODYN as an evaluation tool

ECODYN Evaluation of different river designs

Scenarios: Initial Cumulative Design 2000 ⇔ Actual Design 2020

- River zonation
- fysiotopes: abiotic river units
- ecotopes: biotic river units
- Natura 2000 habitats
- River guiding species



variants

- a natural succession scenario (no management)
- extensive yearround grazing scenario (main management type) with limited delineated hay fields

timesteps

- After 10 years & 50 years (including succession setback by gravel & sand deposits at 3000 m³/s)

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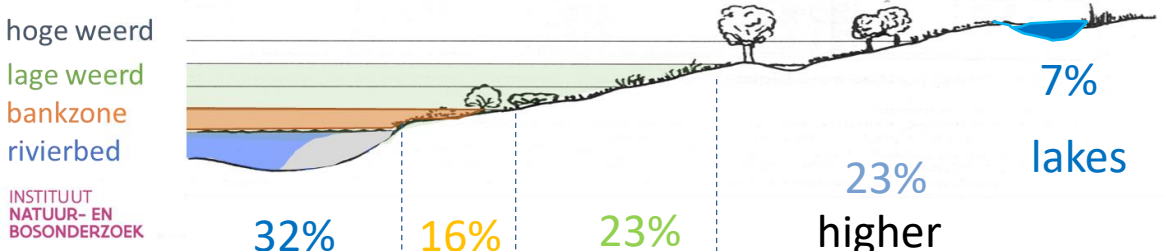
Design of river restoration

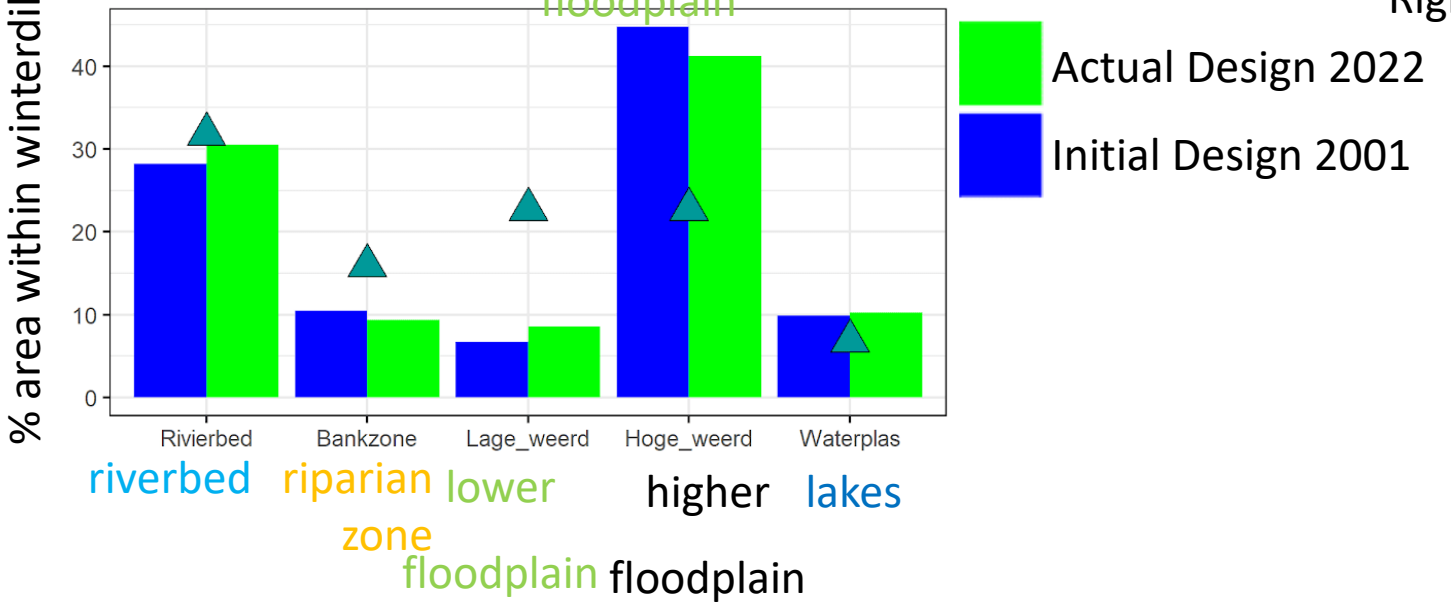
How well is the restoration design?

Reference percentage river zonations

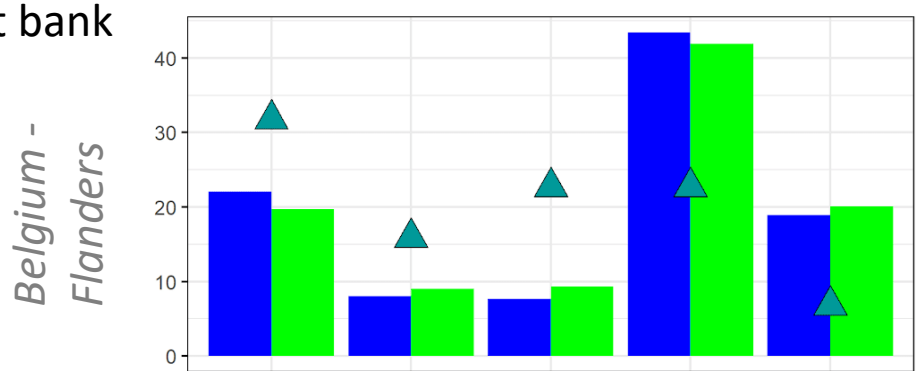
e.g. Helmer & Klink 1995



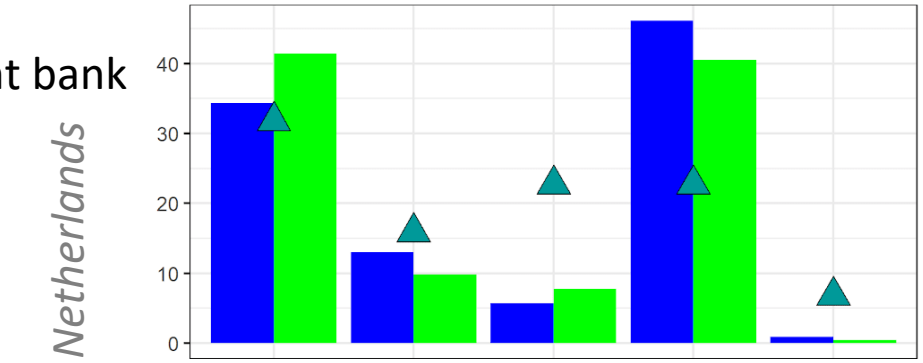
Common Meuse



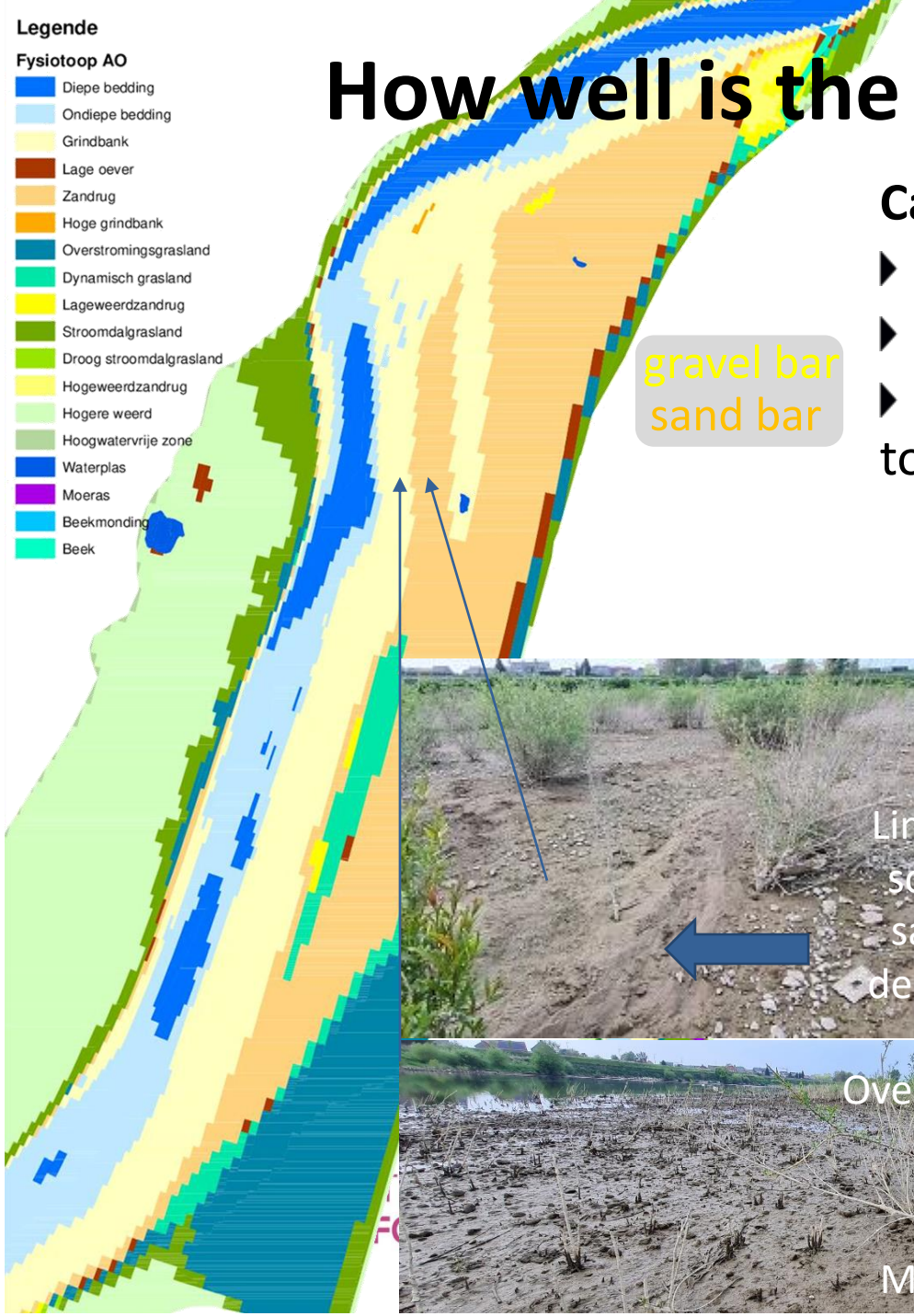
Left bank



Right bank



How well is the restoration design?



gravel bar
sand bar

Case Geulle Aan de Maas

- Vast sand bar zone modelled
- Limitation gravel & sandy sediment
- combining river restoration with gravel & sand nourishment to the river

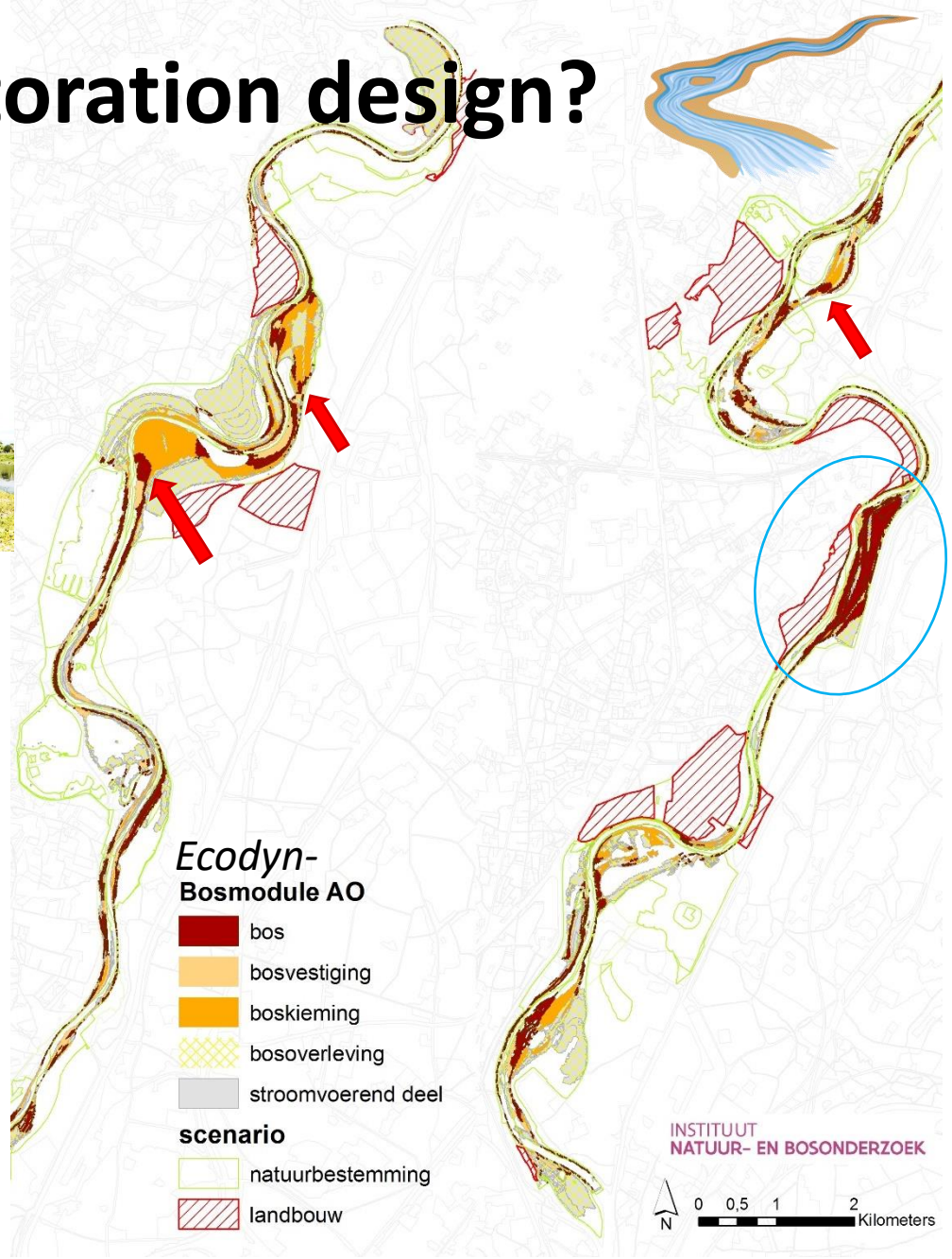
How well is the restoration design?

- Forest development in the river stream

<u>*Different spatial forest development pattern*</u>

- *Linear shrub & forest elements*
  - *e.g. salix purpurea*
  - *frequently set back by river*

- *Vast forest development*
  - *poor design*
    - *Focused cyclical management*
- *Forest development at hydraulic critical points*
  - *e.g. entrance side channel*
    - *design optimalisation*
    - *coarser substrate*
    - *tree seedling removal*



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Optimisation: Nature based solutions with riparian forest

1. forest as river current guide
2. wave attenuation effect of forest

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scientific reports

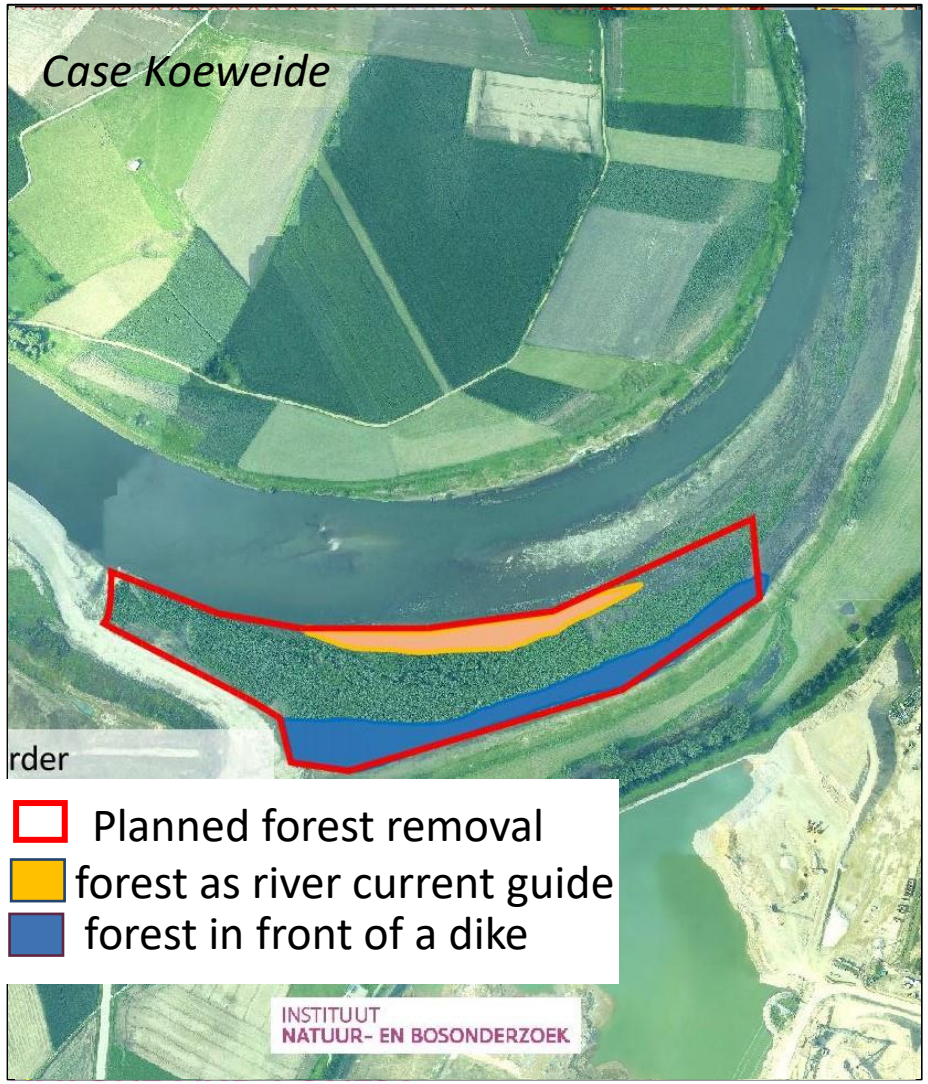
Wave attenuation through forests under extreme conditions

Bregje K. van Wesenbeeck[1,2]✉, Guido Wolters[1], José A. A. Antolínez[1,2], Sudarshini A. Kalloe[2], Bas Hofland[2], Wiebe P. de Boer[1], Ceylan Çete[2] & Tjeerd J. Bouma[3,4]

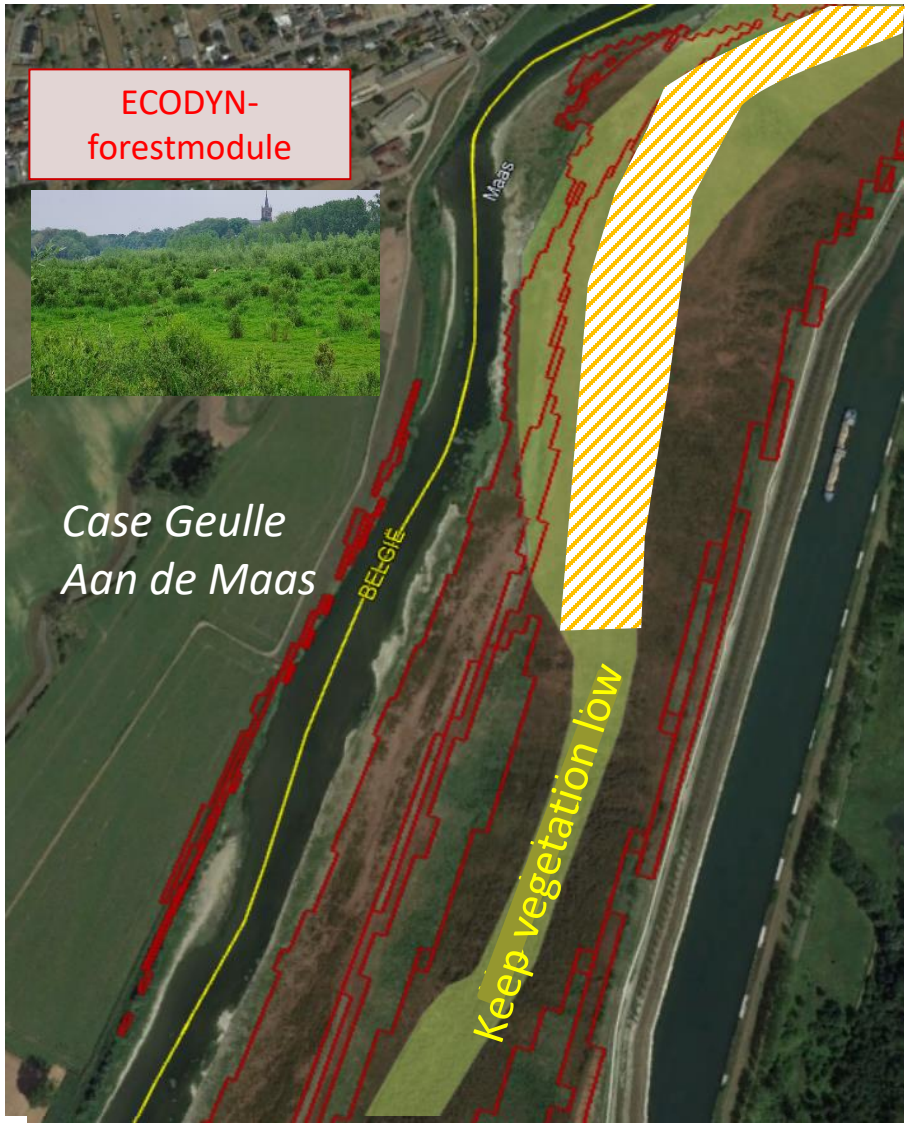
Scientific reports, 12(1), 1884.

Optimisation - NBS-riparian forest

- Maintaining linear forest elements



- Adapting management restriction areas



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Nature management

Where can nature management be optimised?

Nature management options

- natural vegetation succession (no management)
- extensive mixed grazing (+local hayfields)

ECODYN

- Structure types

  +

- Fysiotopes

  ⬇

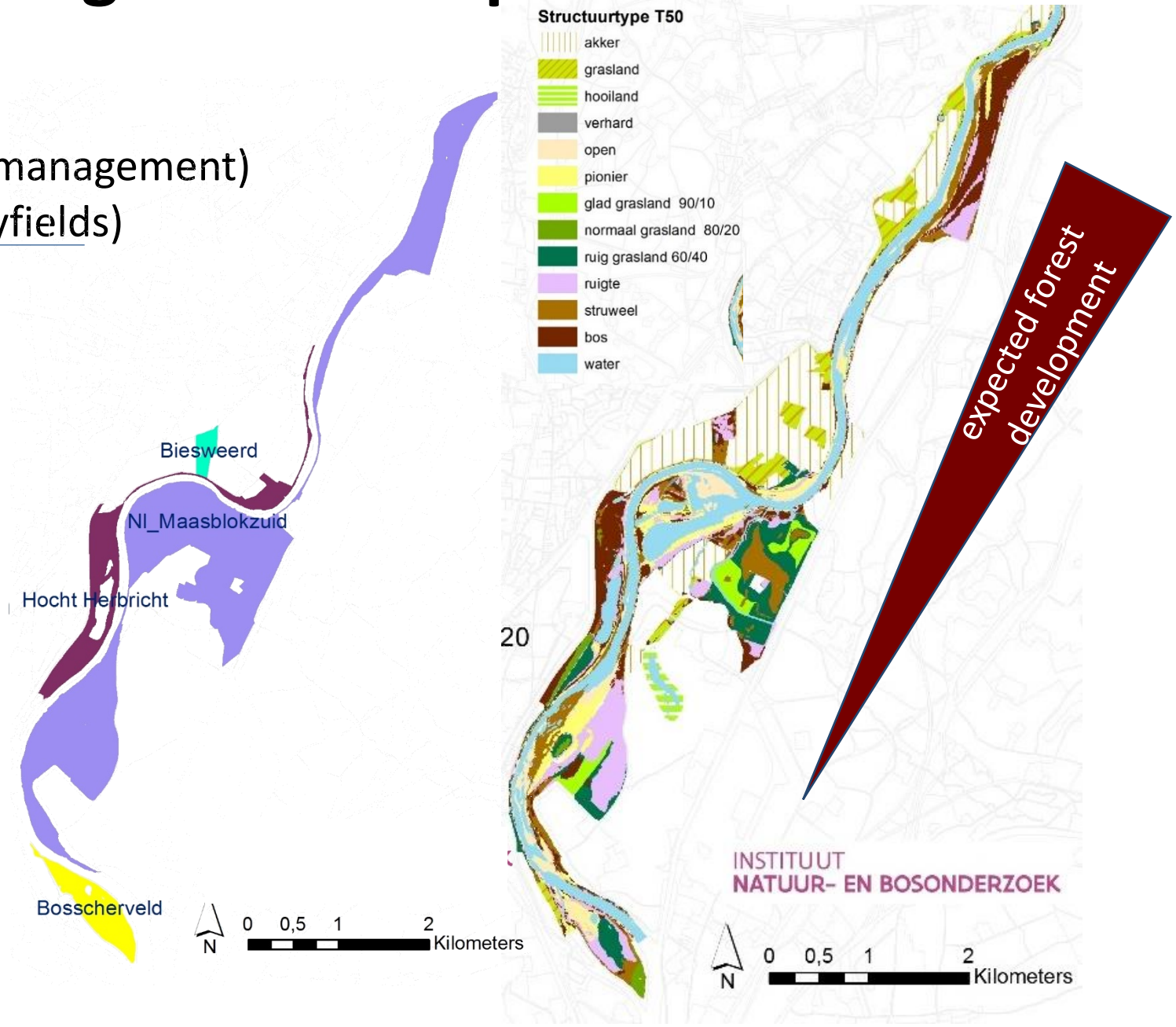
- Ecotopes

  ⬇

- Natura 2000 habitats

  ⬇

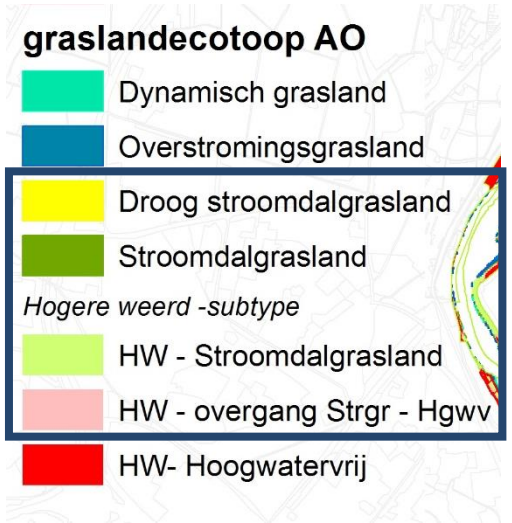
- River guiding species

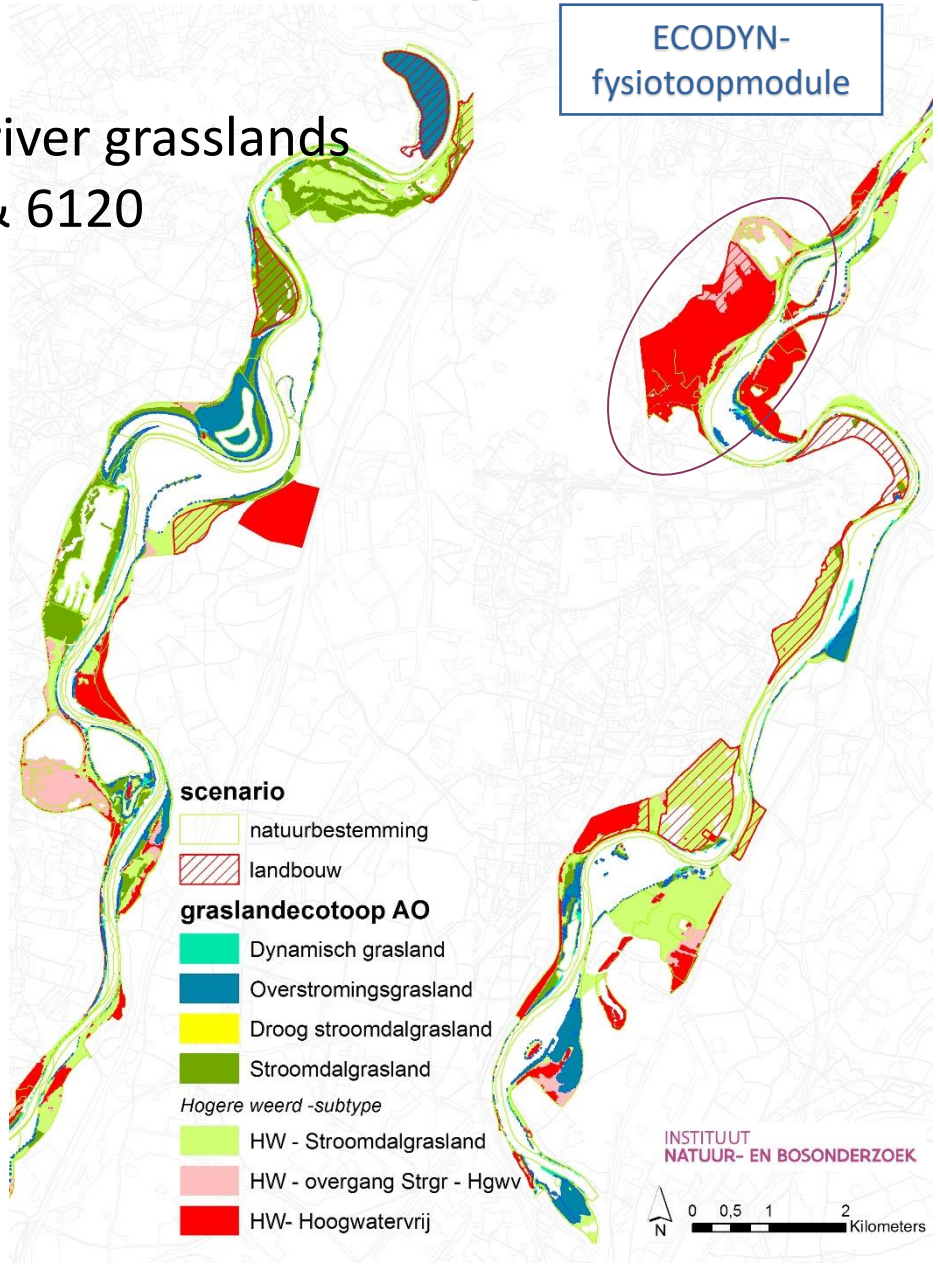


Where can nature management be optimised?

Optimising natura 2000 goals

- Optimal abiotic conditions of river grasslands
- European habitat goals 6510 & 6120





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Conclusions

ECODYN in the Common Meuse

- Evaluation different restoration design scenarios: CO versus AO
- Nature management variants at short and longue term (T10-T50)
- Early ‘problem’ detection: sediment imbalance, forest development
- Future applications?

→ effect climate scenarios on nature goals,

→ ECODYN-scenarios as input in hydraulic calculations of flood risks

Questions?

Van Braeckel A. & Jocque M. (2023). Ecologische effecten van ingrepen en beheer op Europese natuurdoelen: Lange termijn doorrekening Grensmaas met ECODYN. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2023 (7). Instituut voor Natuur- en Bosonderzoek, Brussel.
www.vlaanderen.be/inbo/publicaties/ecologische-effecten-van-ingrepen-en-beheer-op-europese-natuurdoelen-lange-termijn-doorrekening-grensmaas-met-ecodyn-afstemmen-natuurbeheer-en-hoogwaterveiligheid-in-de-gemeenschappelijke-maas