# CO-CREATION AND MULTIFUNCTIONALITY OF NATURE-BASED SOLUTIONS

Borjana Bogatinoska, MSc

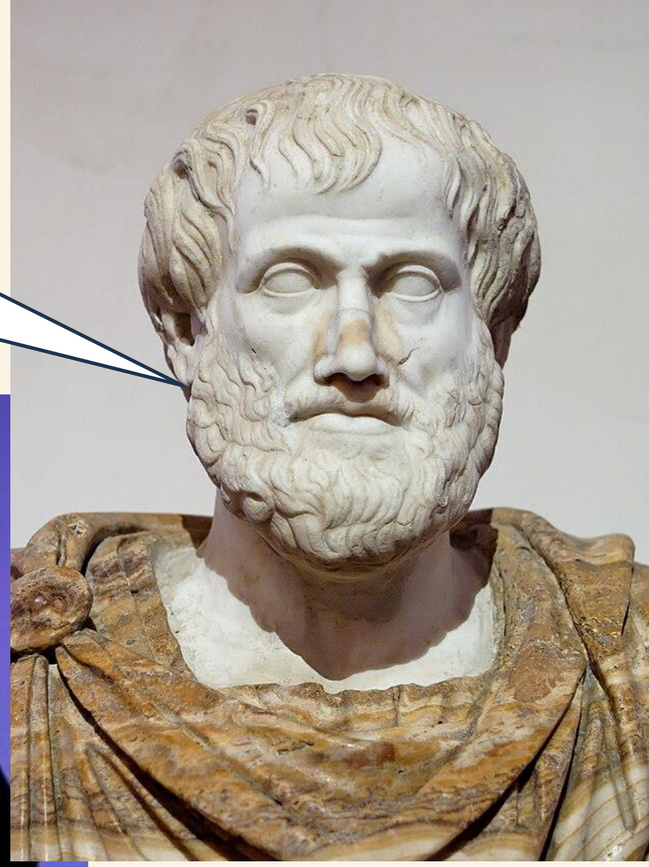
Postdoctoral Researcher in FFRM tech for rivers and coasts project

Department of Civil Engineering, Marine and Fluvial Systems
Faculty of Engineering Technology
University of Twente

UNIVERSITY OF TWENTE.

So much can be done by Nature-based Solutions

Nature does nothing in vain




Nature is our best teacher

Nature is a key alley

# In this lecture:

- What are Nature-based Solutions(NbS)?
- Examples of NbS
  - In rivers
  - In estuaries
- Co-creating NbS
- NbS Multifunctionality

# Introduction

**Climate becomes more extreme and unpredictable**

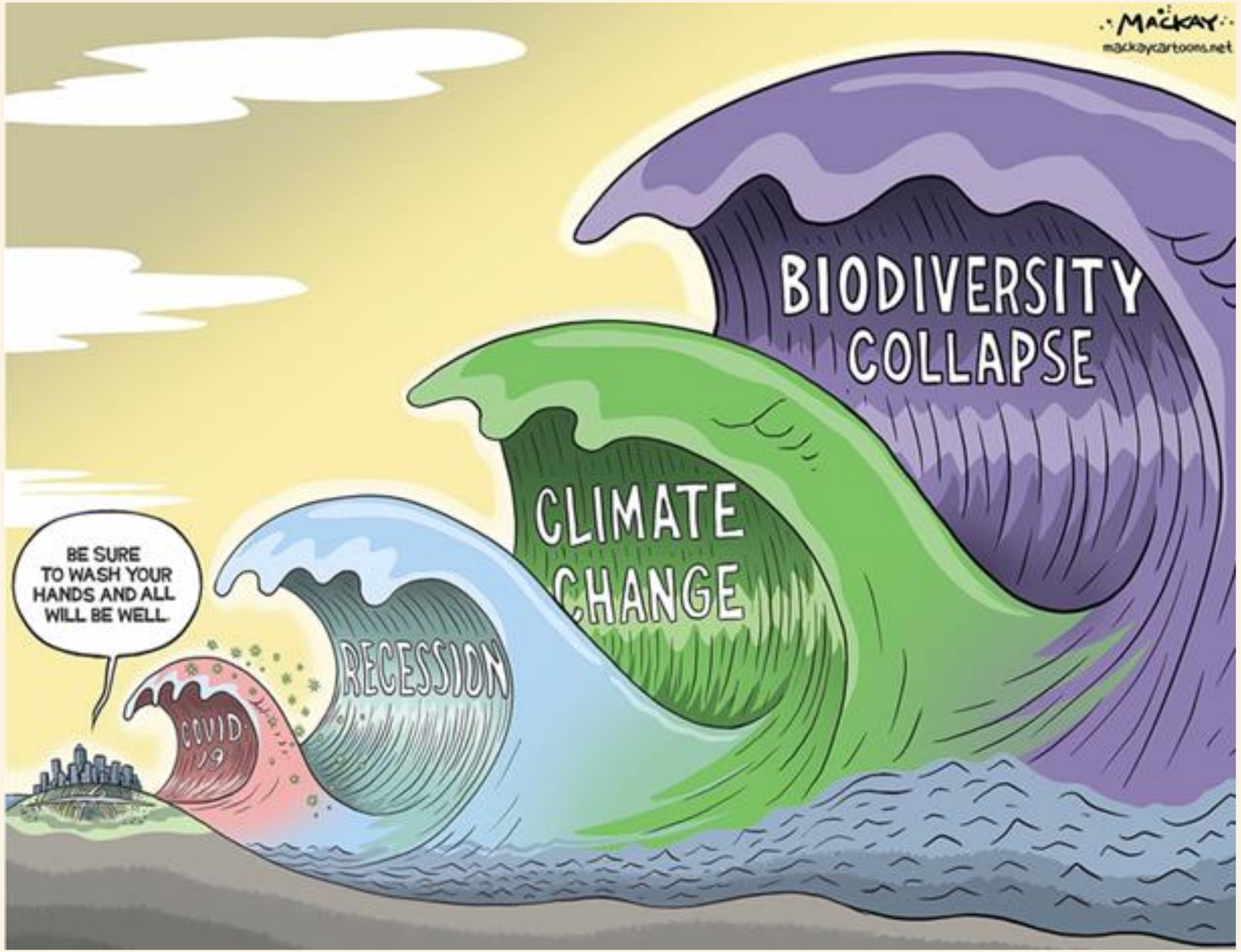
**1/3 of the dike trajectories in the Netherlands does not comply to the safety standards (> 1000 km)**

**Increasing dike height is not a sustainable solution anymore**

**We need innovative solutions**

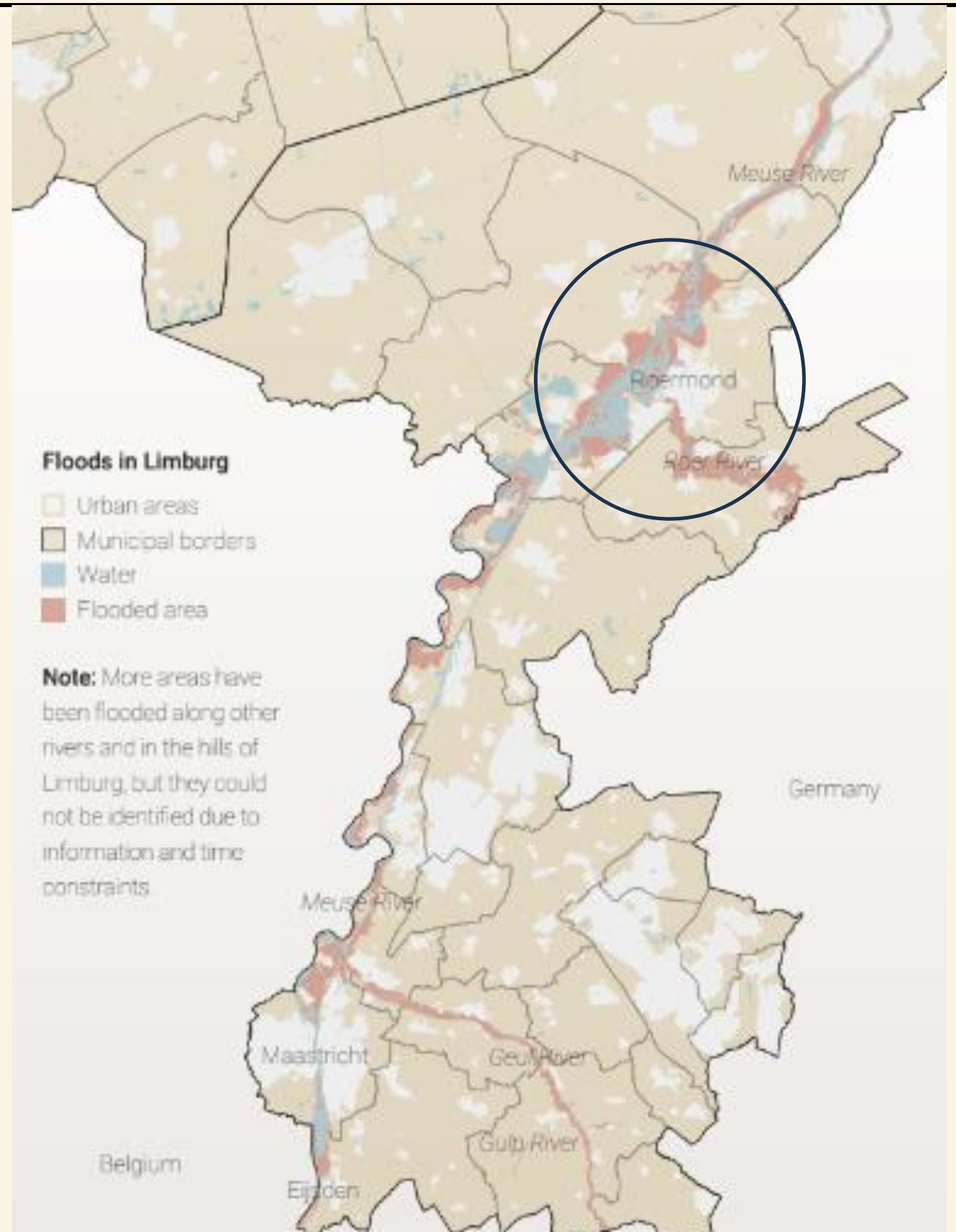
**Not only flood protection**

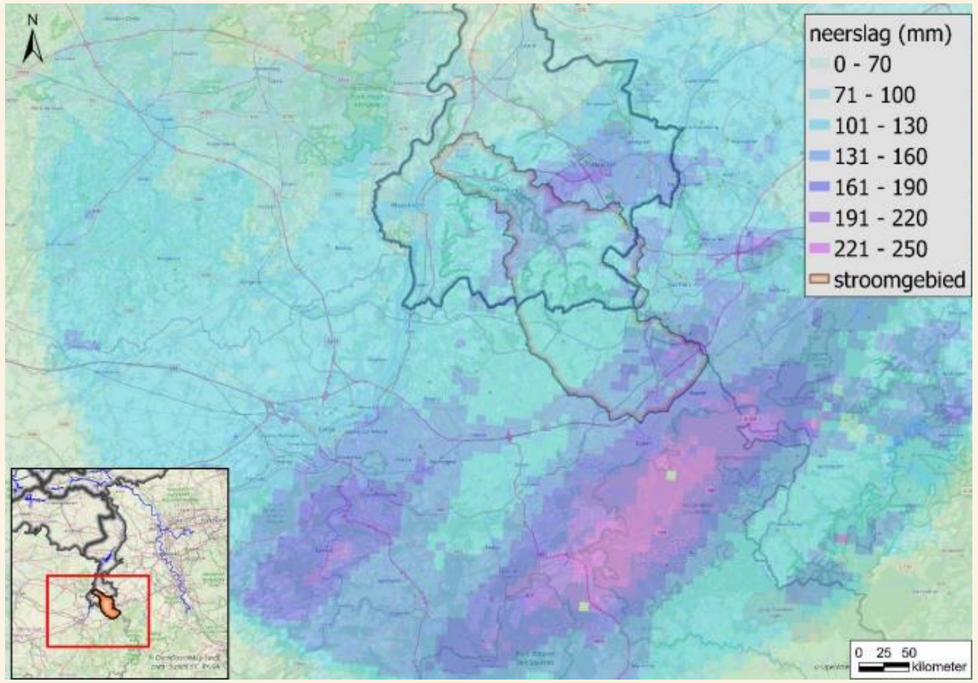
# Introduction



# Introduction

*Asselman et al. 2021*



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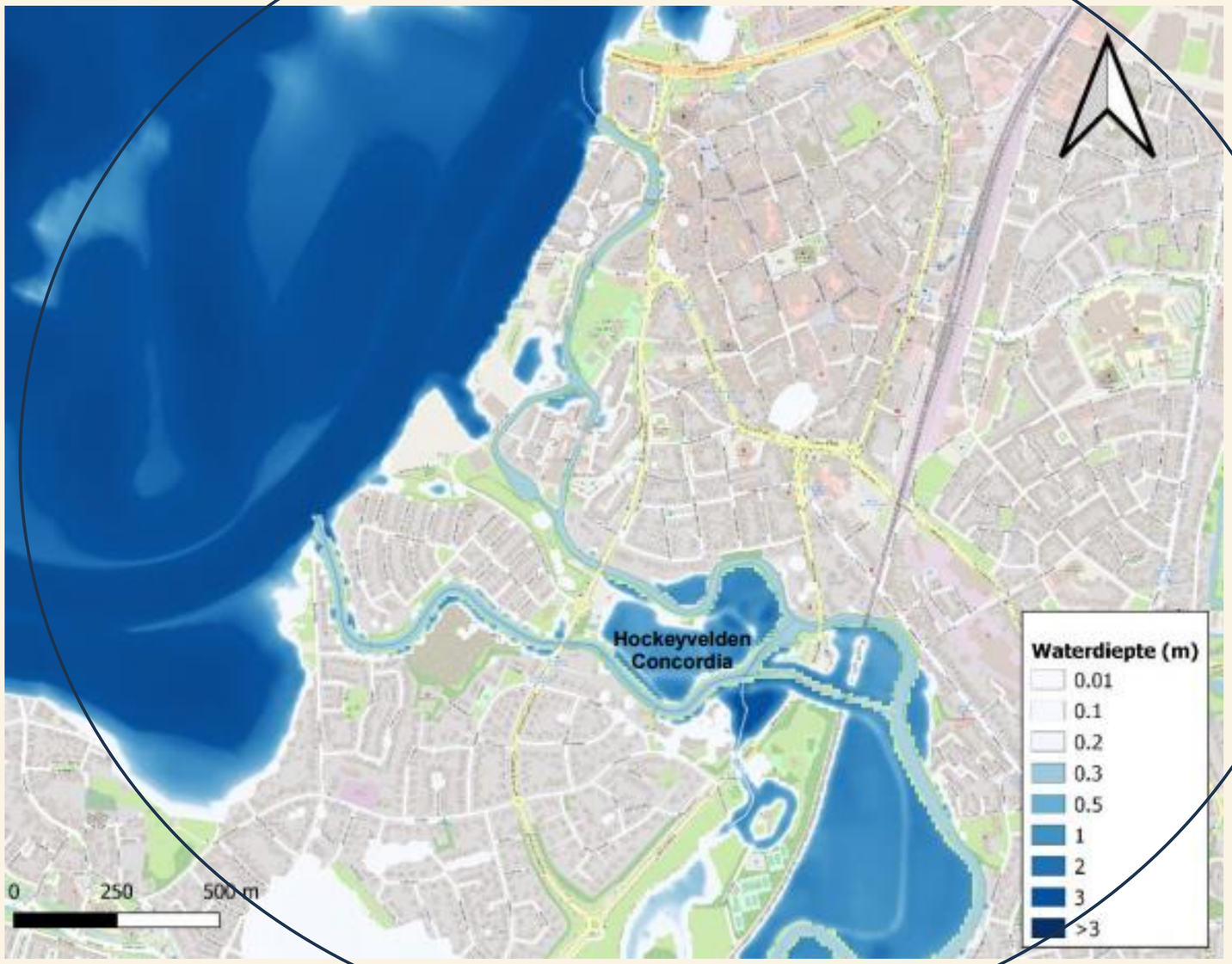


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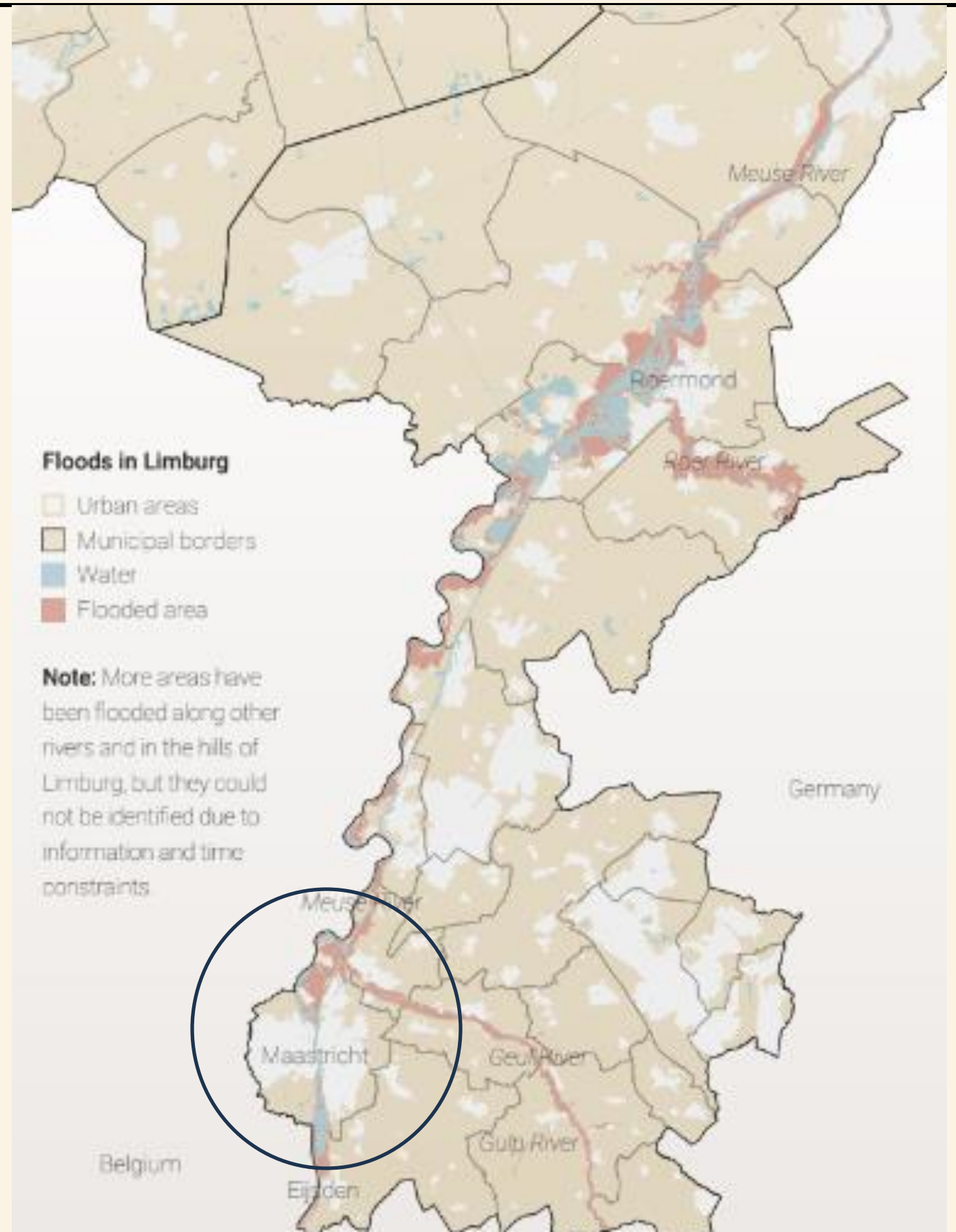


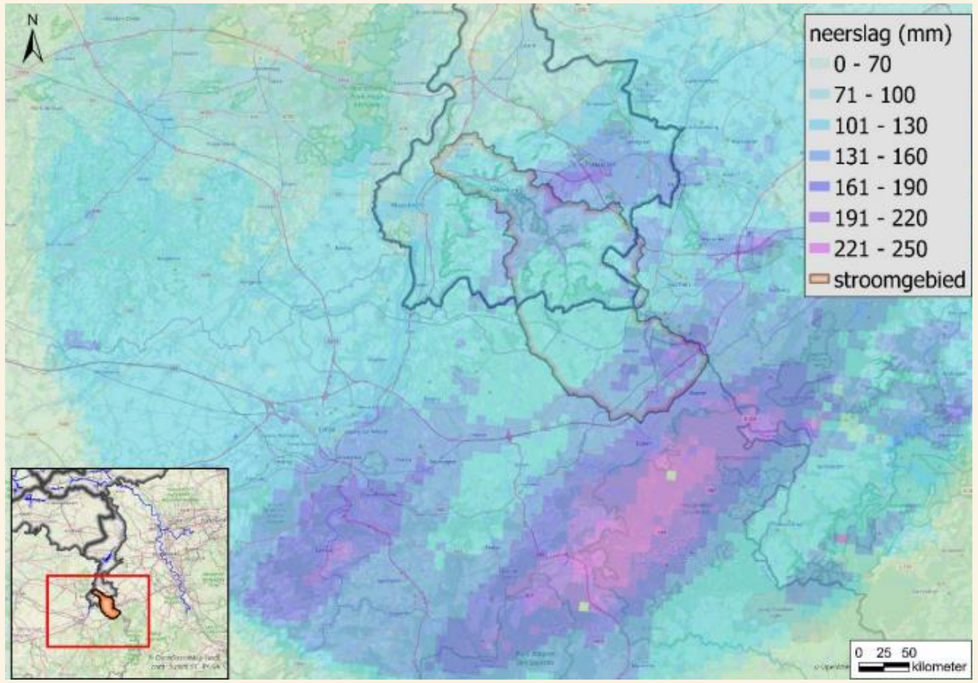

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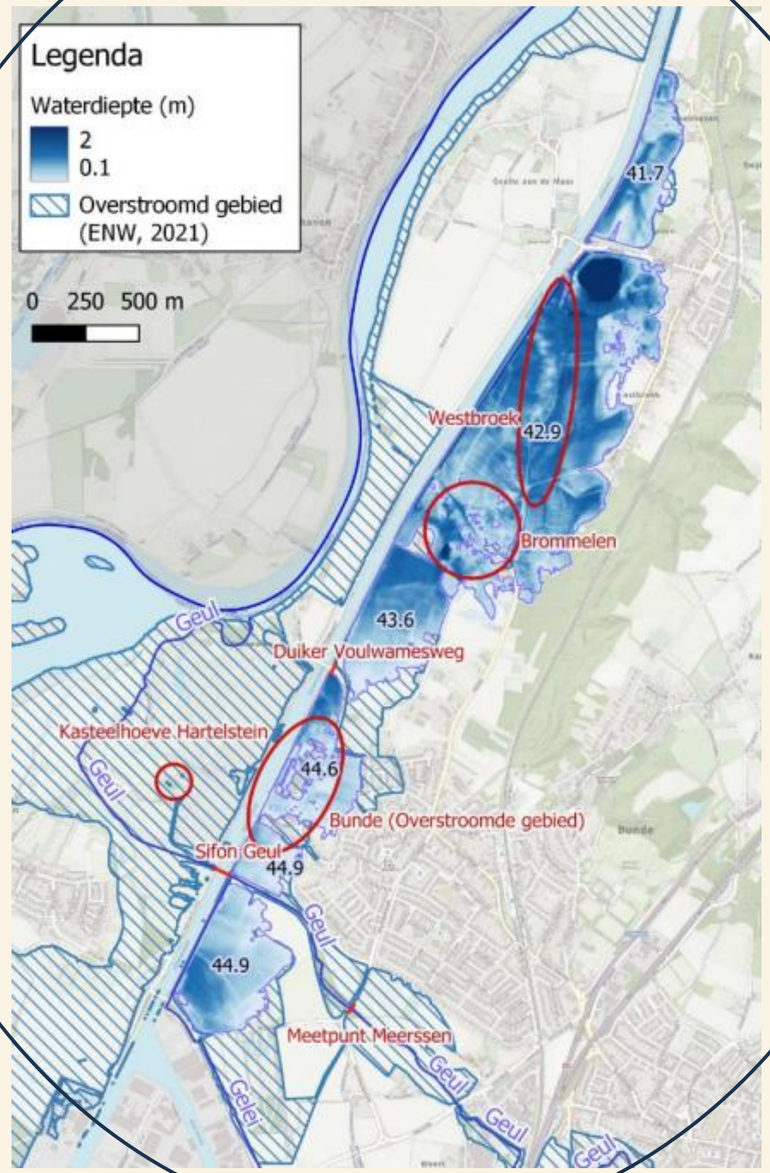

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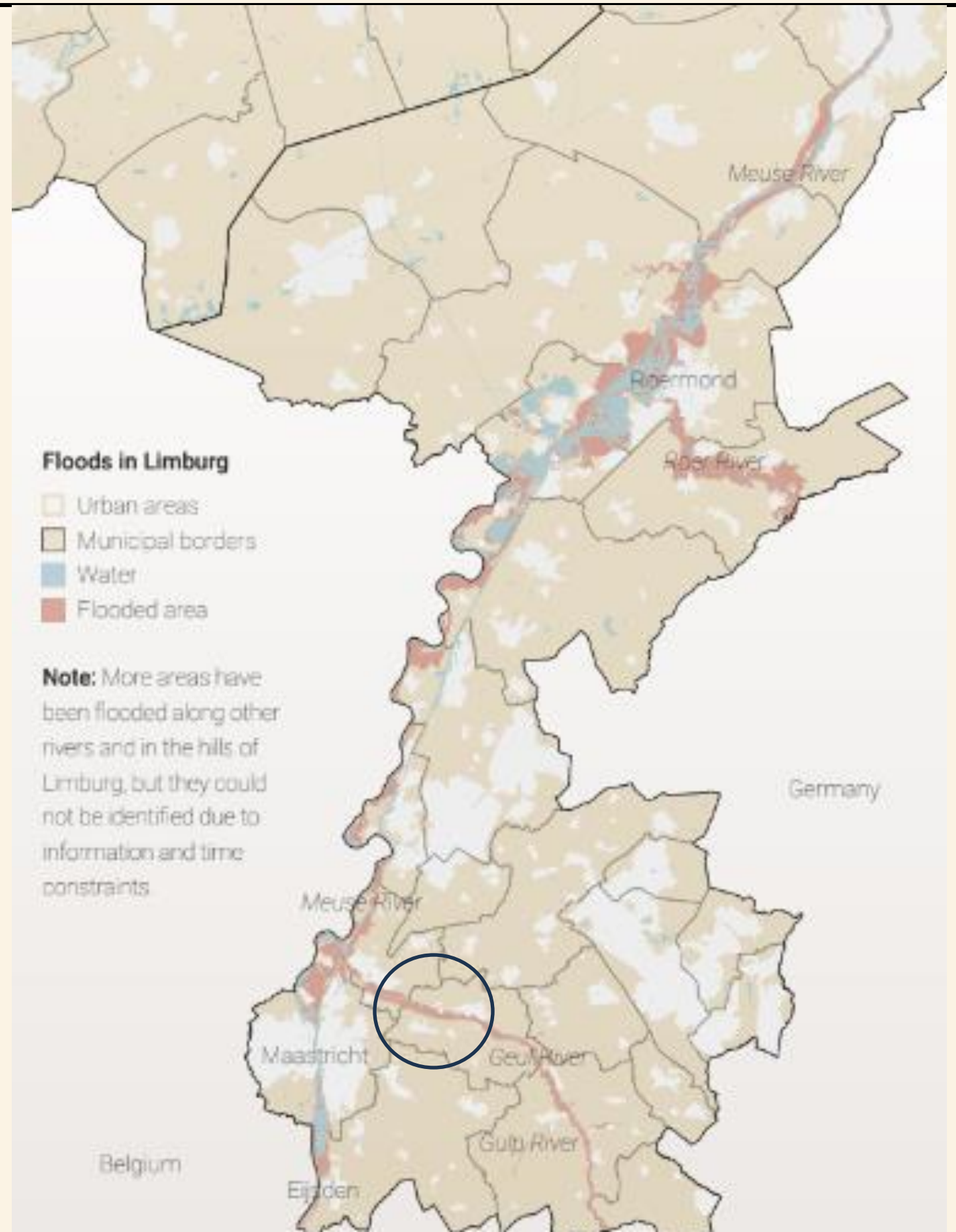


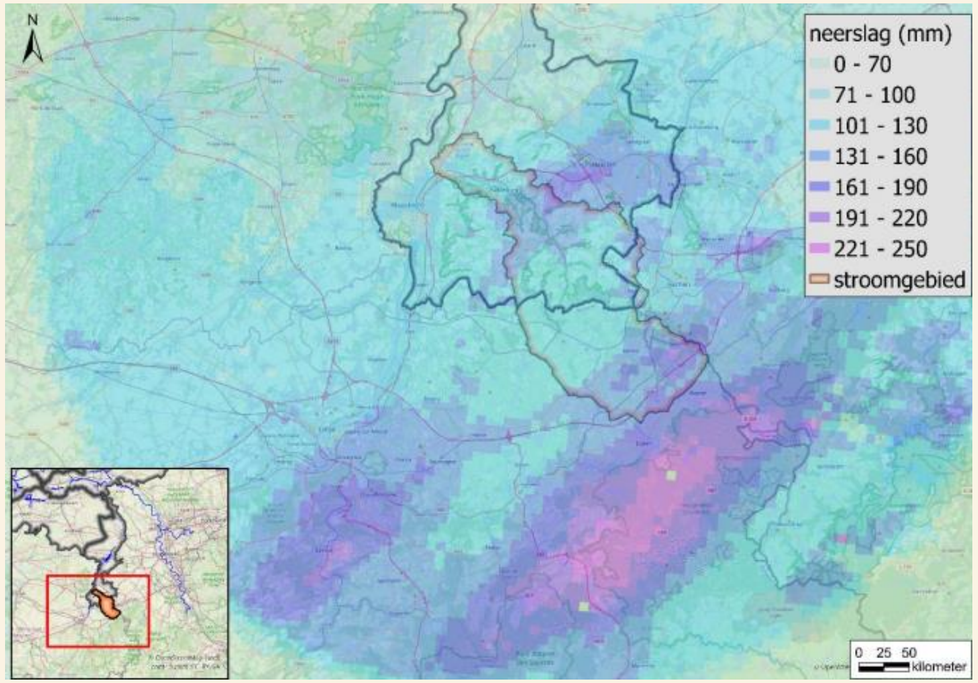

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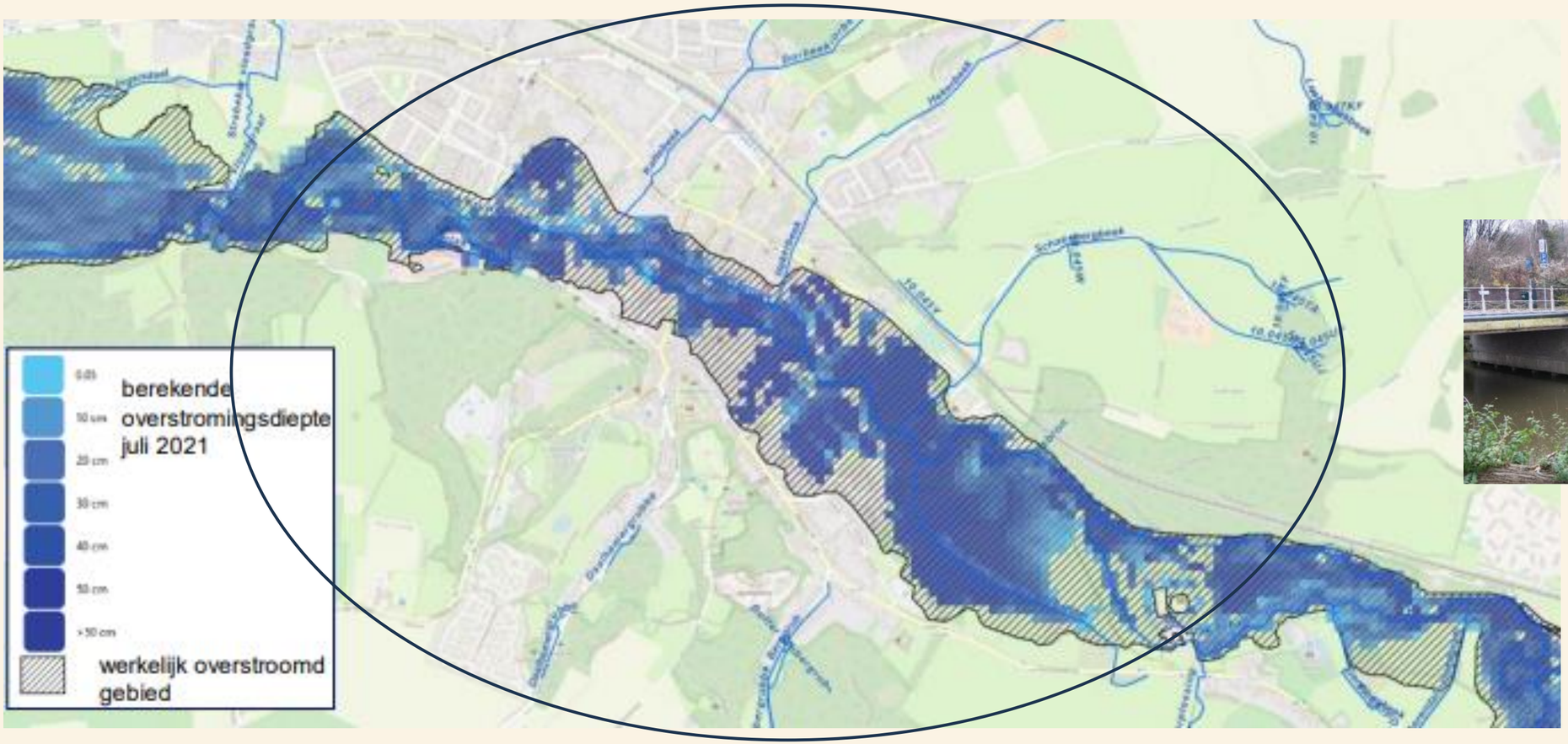



# Think about it

*Ever wondered how do we transition from the 'conquering' nature to 'collaborating' with nature mindset?*

# What are Nature-based Solutions?

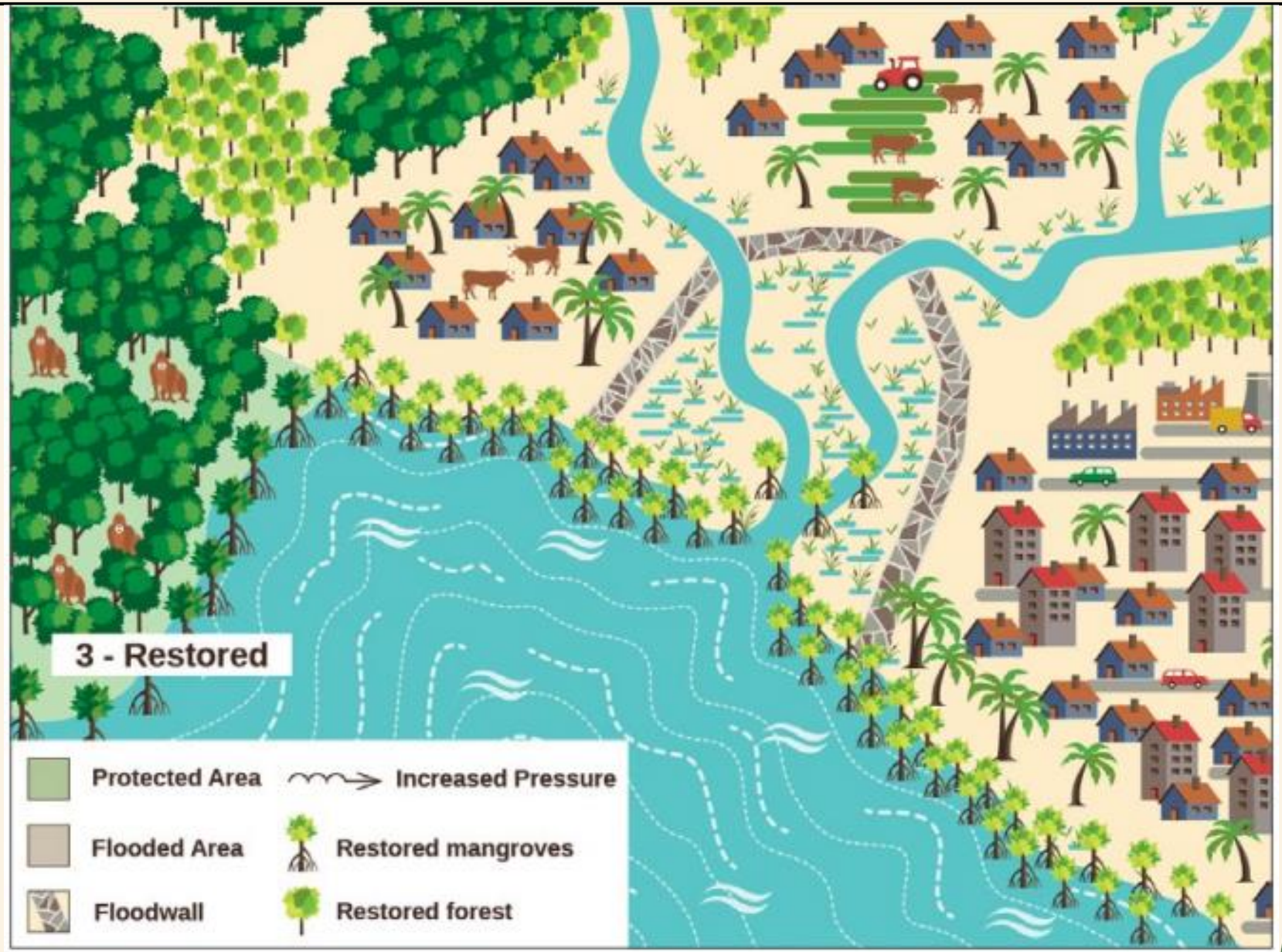
*IUCN, 2016*

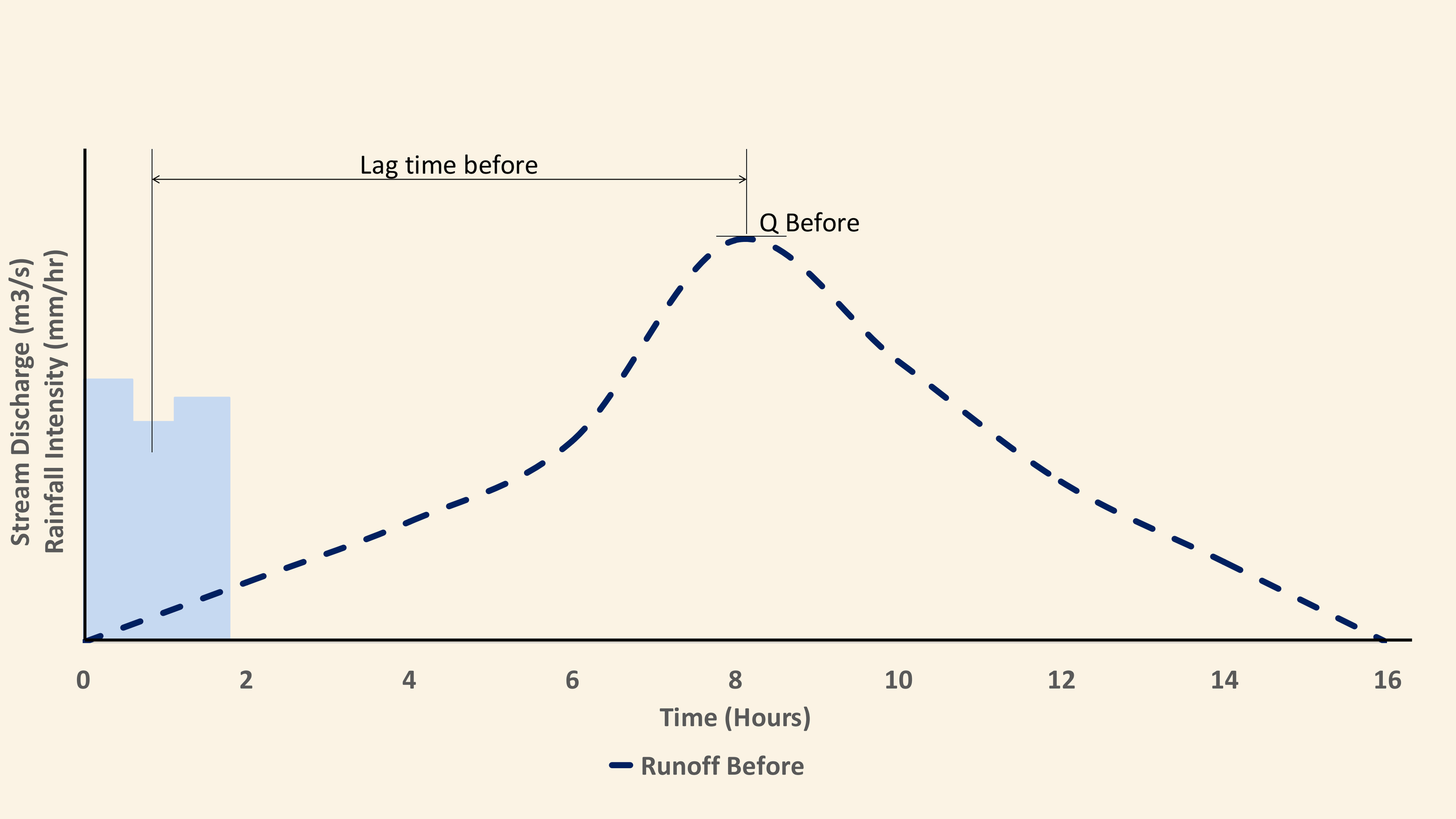


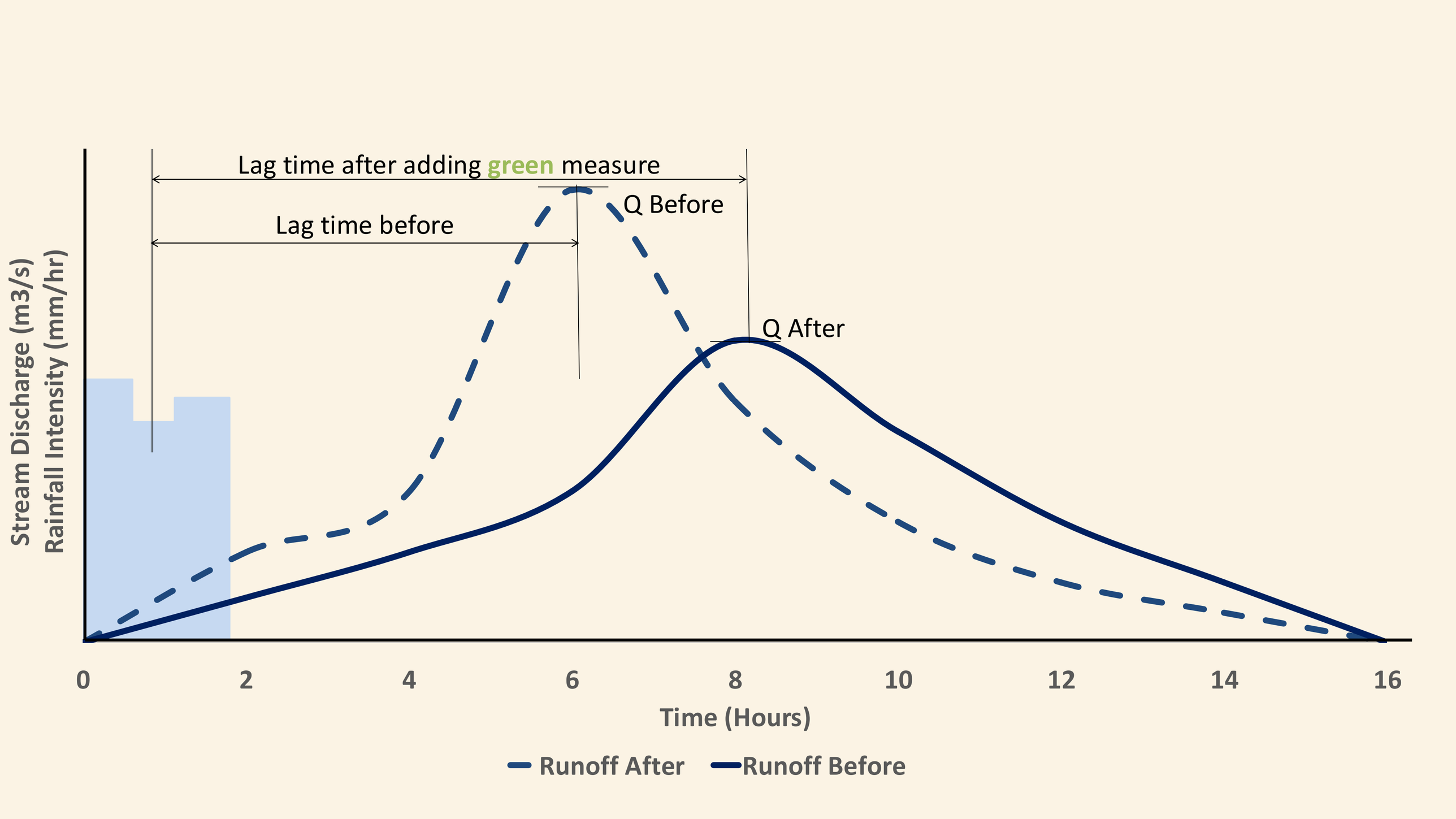
Protected Area
Increased Pressure
Flooded Area
Restored mangroves
Floodwall
Restored forest

# What are Nature-based Solutions?

*IUCN, 2016*

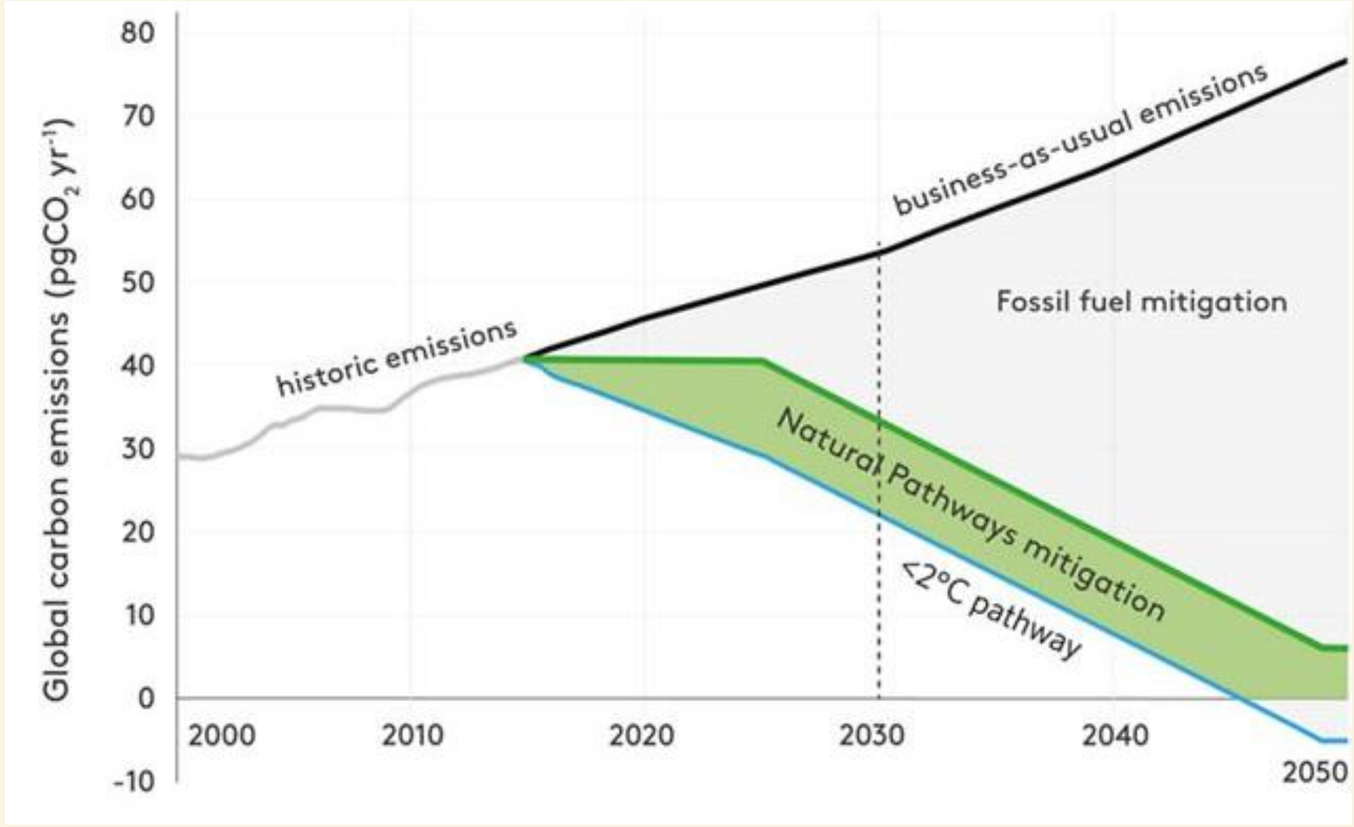



Lag time before
Q Before
Stream Discharge (m3/s)
Rainfall Intensity (mm/hr)
0
2
4
6
8
10
12
14
16
Time (Hours)
Runoff Before


Lag time after adding green measure
Lag time before
Q Before
Q After
Stream Discharge (m3/s)
Rainfall Intensity (mm/hr)
0
2
4
6
8
10
12
14
16
Time (Hours)
Runoff After
Runoff Before

# What are Nature-based Solutions?

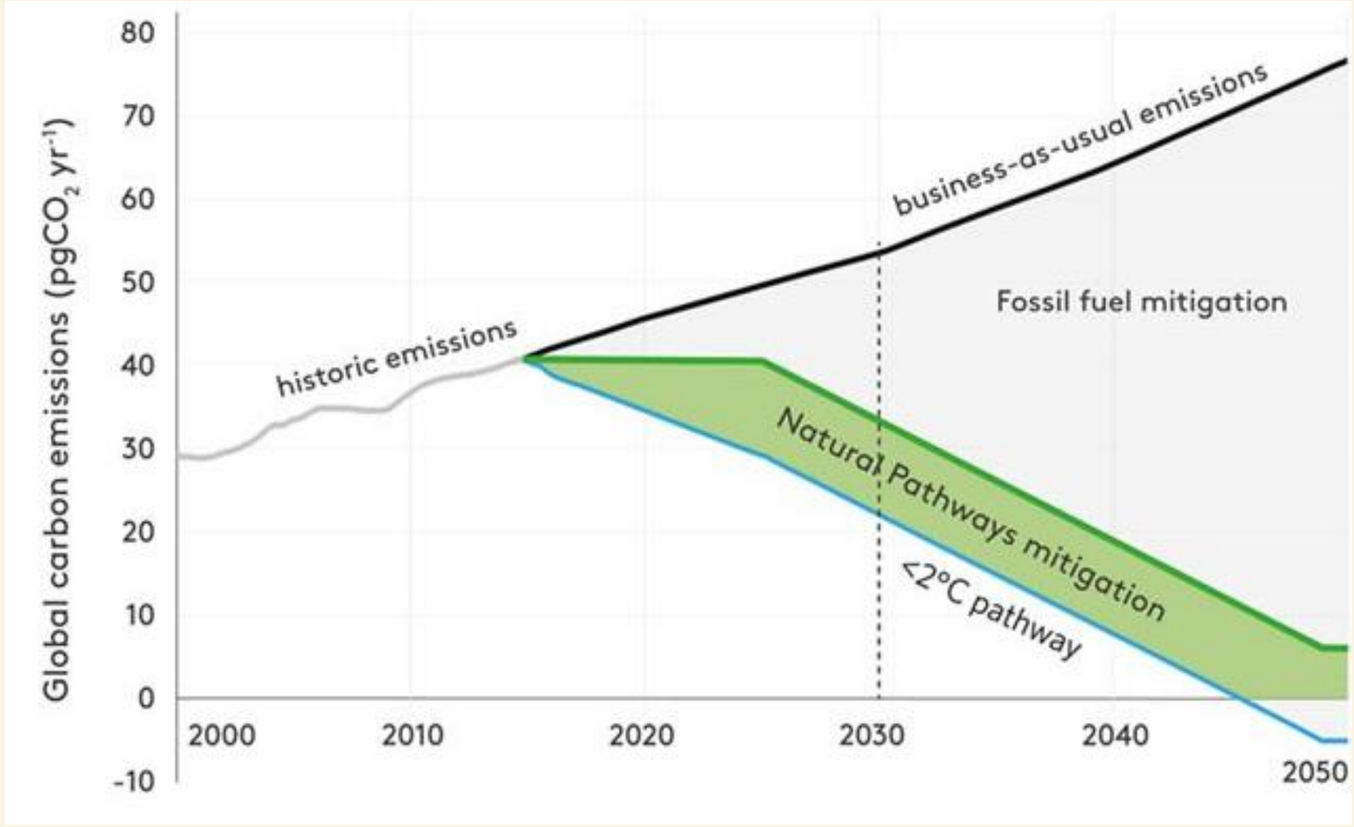
*Griscom et al., 2017*

CLIMATE CHANGE

# What are Nature-based Solutions?

*Griscom et al., 2017*

# What are Nature-based Solutions?

wetlands creation and restoration

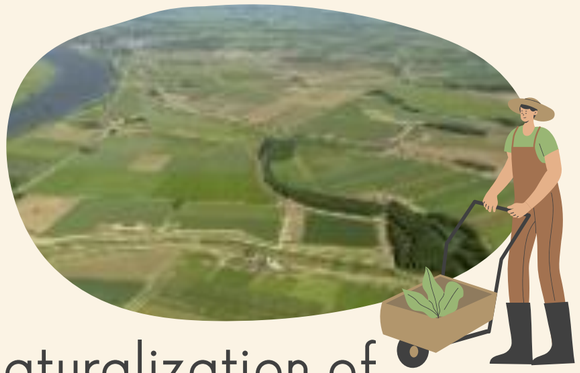
off-line storage areas

heathland restoration

riparian buffer corridor area

lowering floodplains

woody dams in streams and riparian zone



re-naturalization of polder areas

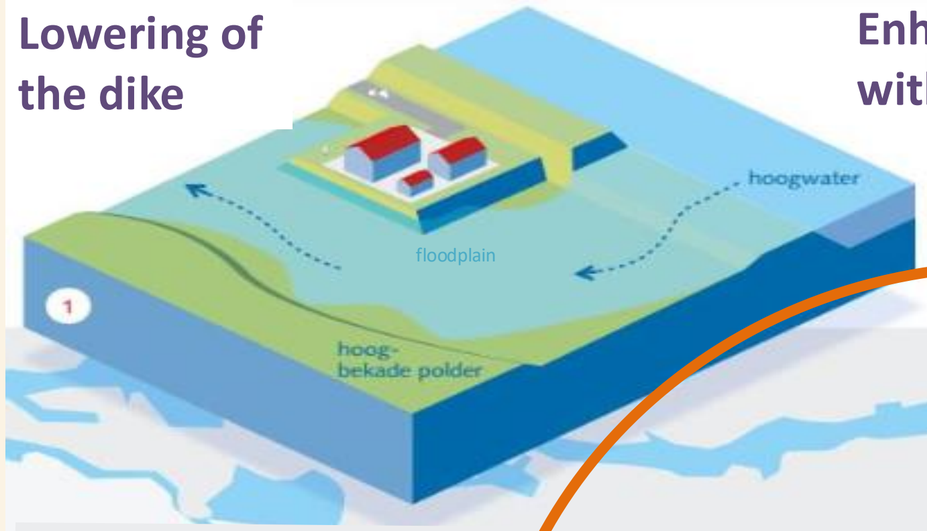
tree planting

# Examples (rivers): Room for the river

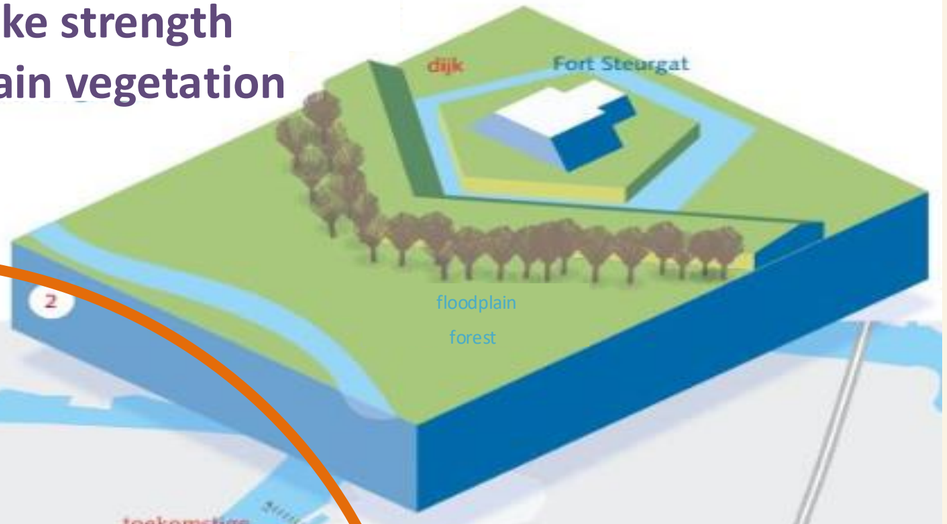
# Examples (rivers)

**Depoldering Noordwaard**

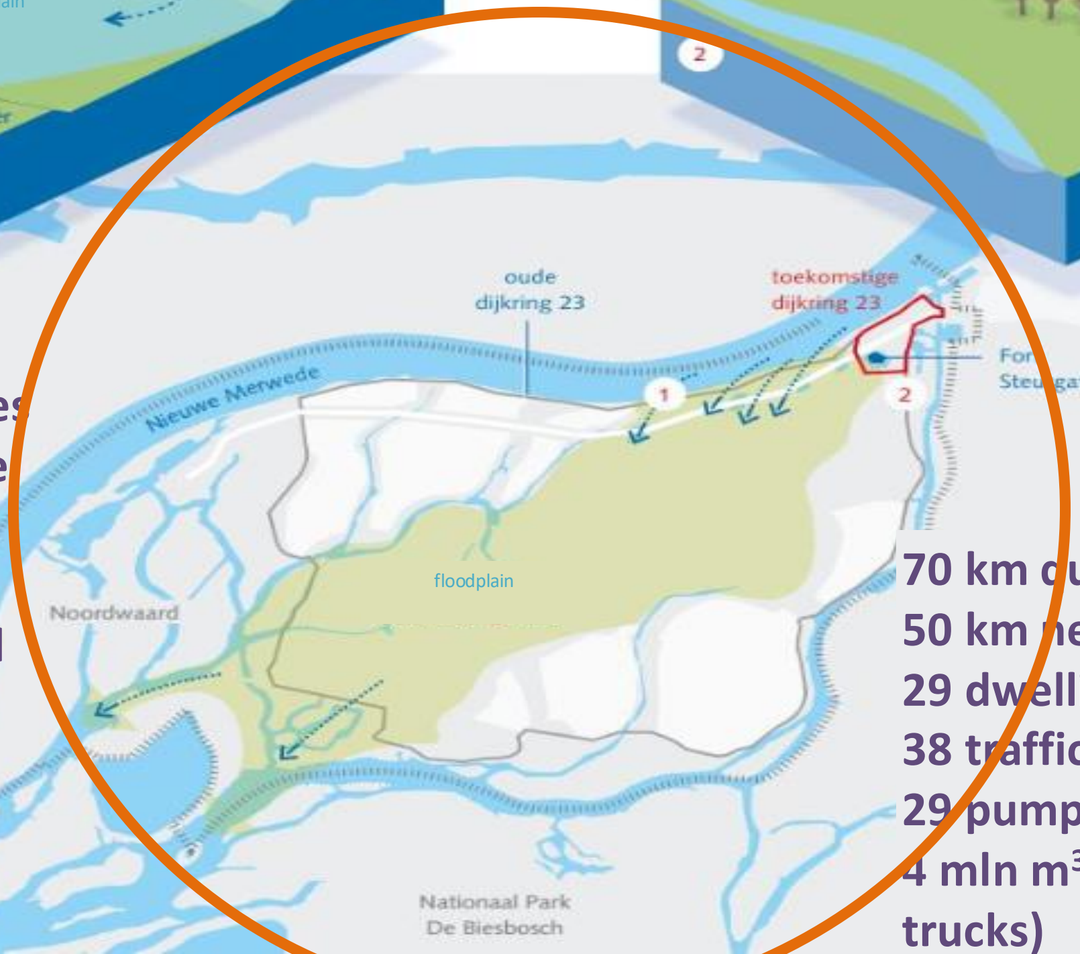
**Lowering of the dike**




**Enhancing dike strength with floodplain vegetation**



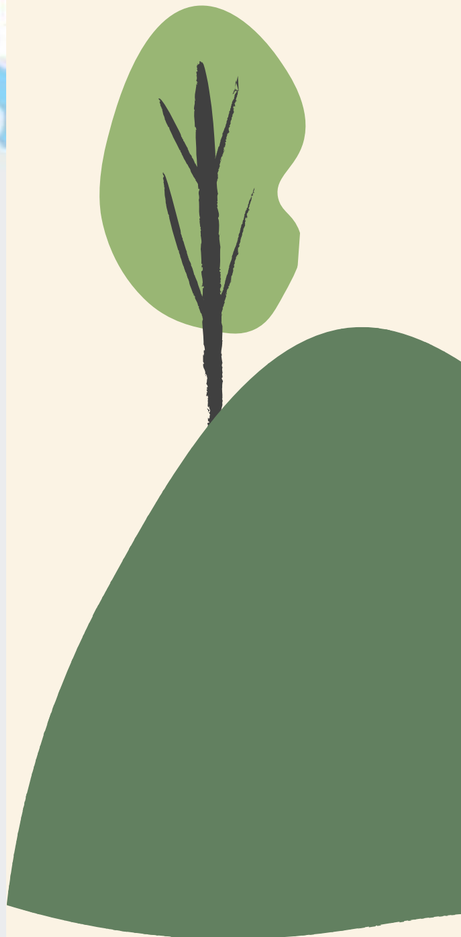

**The polder will be flooding multiple times each winter, when the water overtops the lowered river dike. Buildings are elevated on dwelling mounds (‘terpen’)**







**70 km quays and dikes**
**50 km new roads**
**29 dwelling mounds**
**38 traffic bridges**
**29 pump stations (wind/electric)**
**4 mln m$^3$ dirt transport (300,000 trucks)**



# Examples (rivers):

*Source: Rijkswaterstaat*

# Examples (estuary):

deVolkskrant

olumns Opinie Cartoons Cultuur & Media

ECOLOGIE

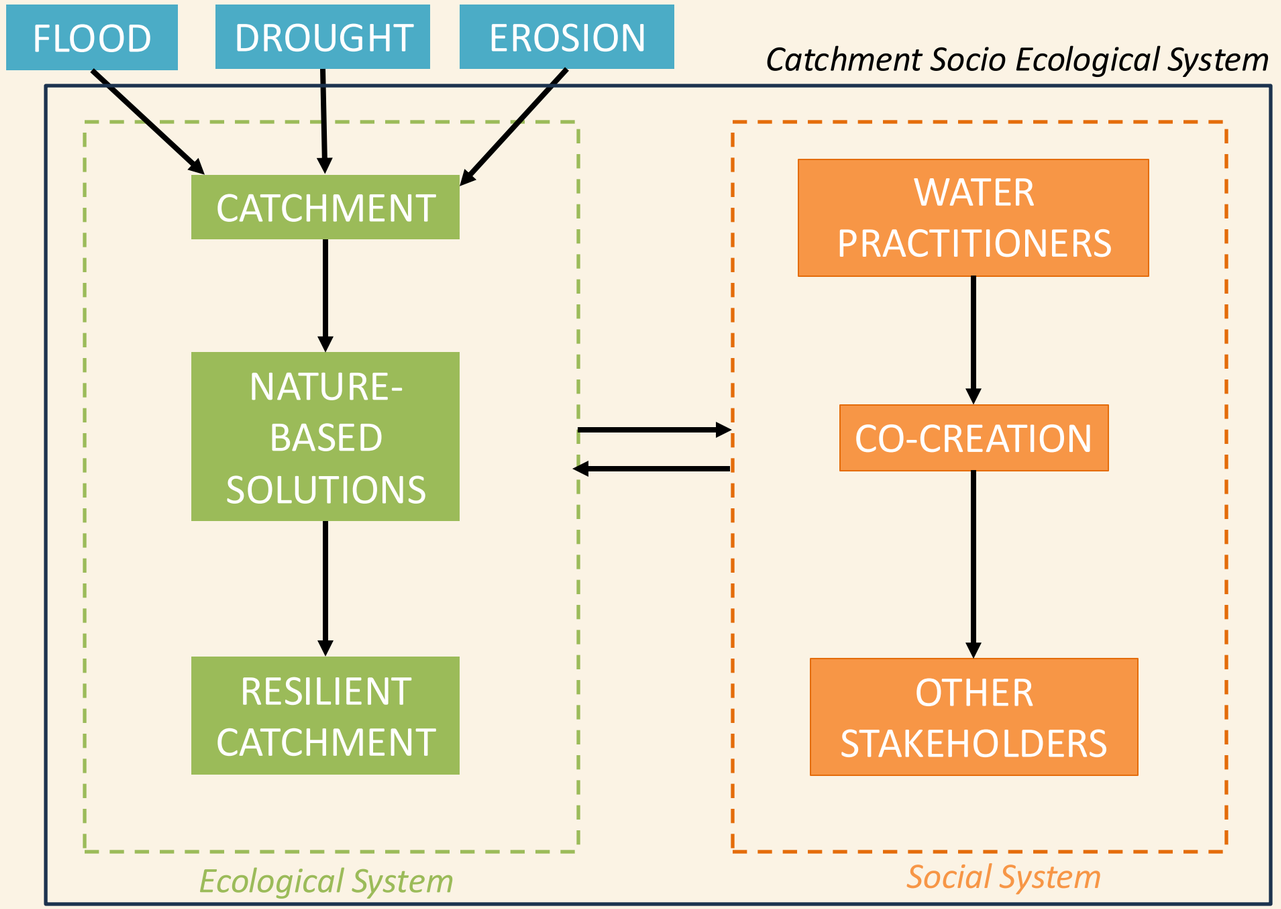
## Tegen de dijken van de toekomst golft de bloemenzee: Nijmeegse wetenschappers boeken veelbelovende resultaten

Egaal gras zie je op de meeste dijken. In en rond Nijmegen wordt gewerkt aan de dijken van de toekomst, met bloemenmengsels. Dat oogt mooier en helpt insecten, maar het gaat vooral om wat er ondergronds gebeurt.

**Jean-Pierre Geelen** 4 augustus 2023, 10:30

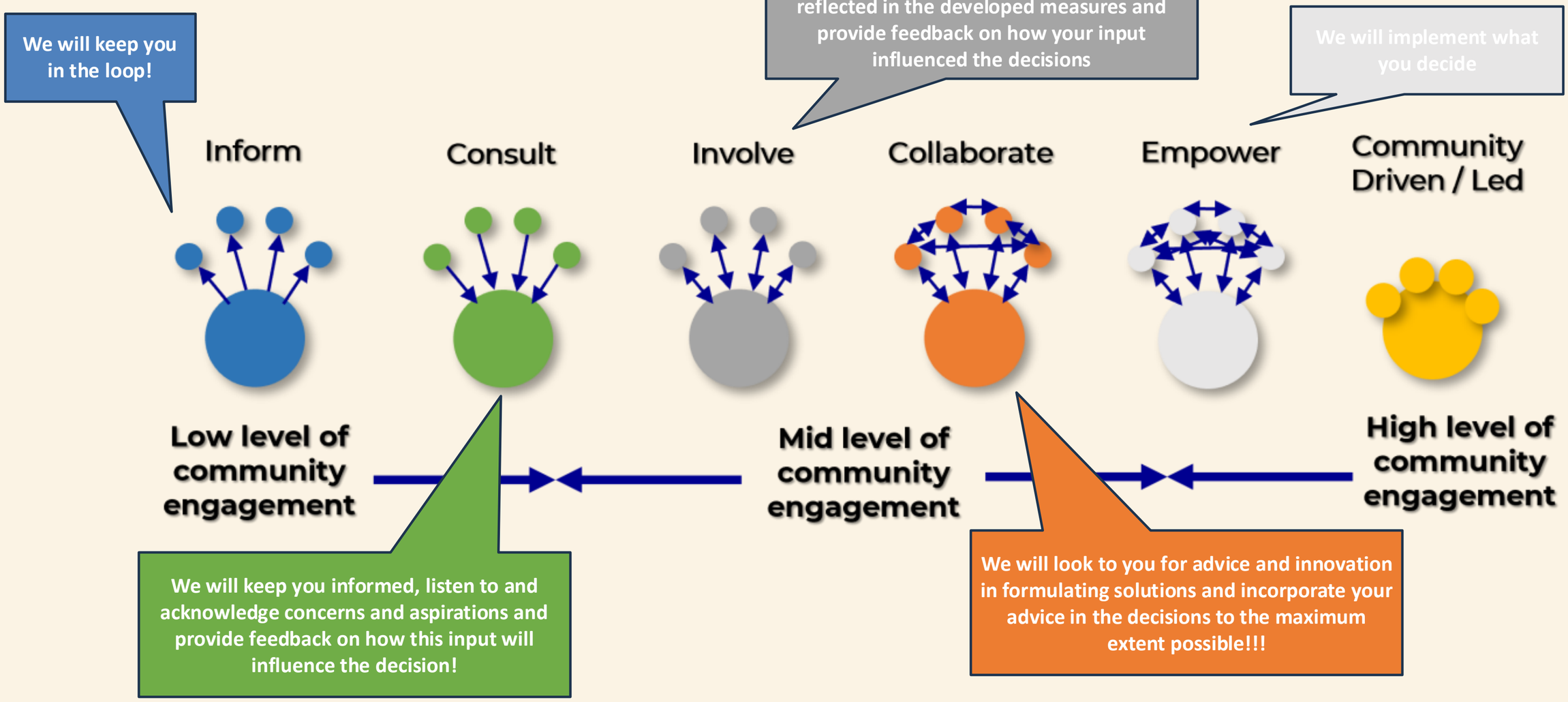
# Co-creating NbS

*Bogatinoska et al., 2022*



# Co-creating NbS

*IAPP2, 2018*



# Co-creating NbS

# Multifunctionality of NbS

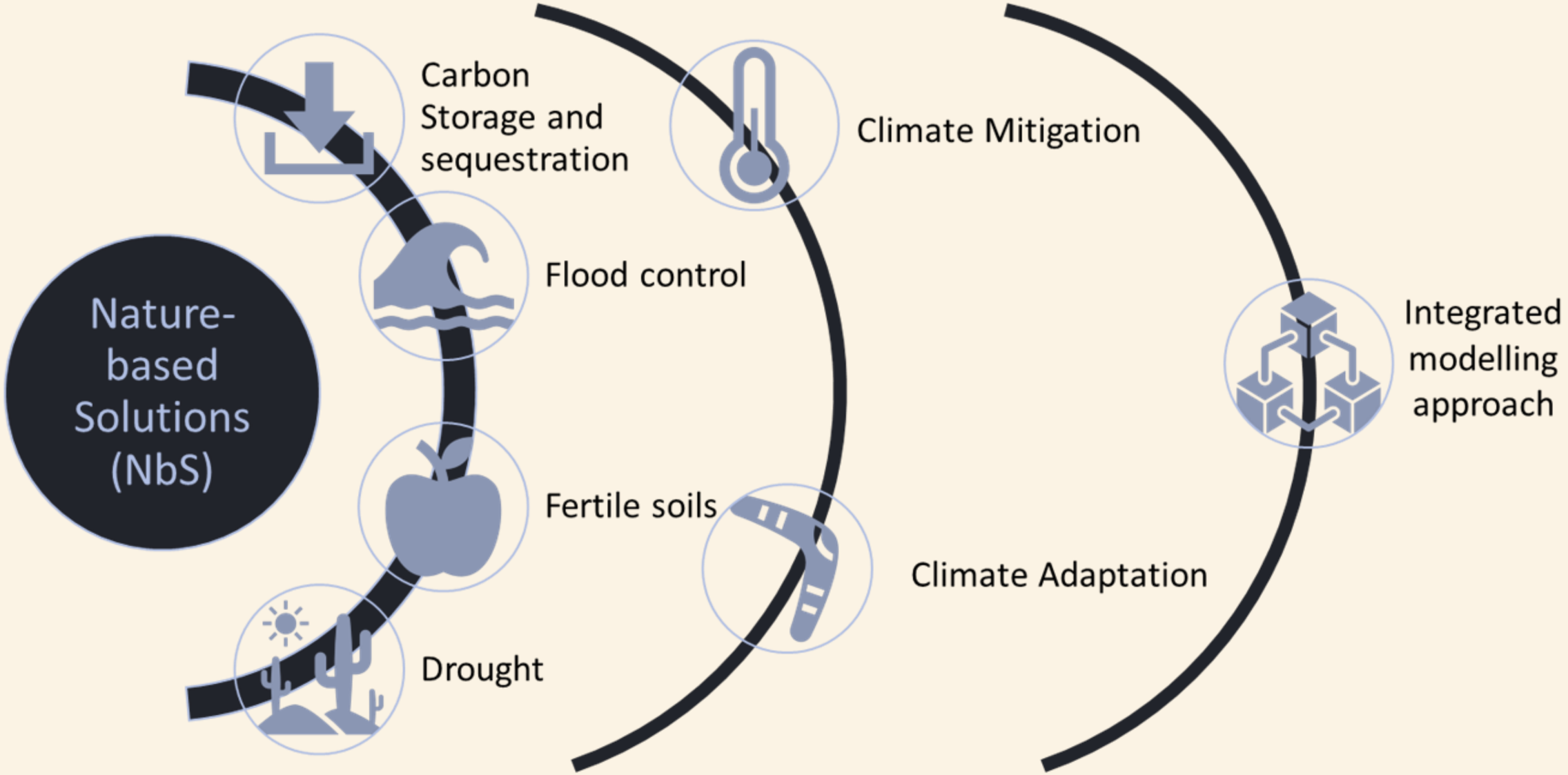
*IUCN*

# Multifunctionality of NbS

**NbS**: Beaver reintroduction, ditch blocking, river meandering, wetland restoration

**Benefits**: Flooding and drought resilience, biodiversity, carbon sequestration

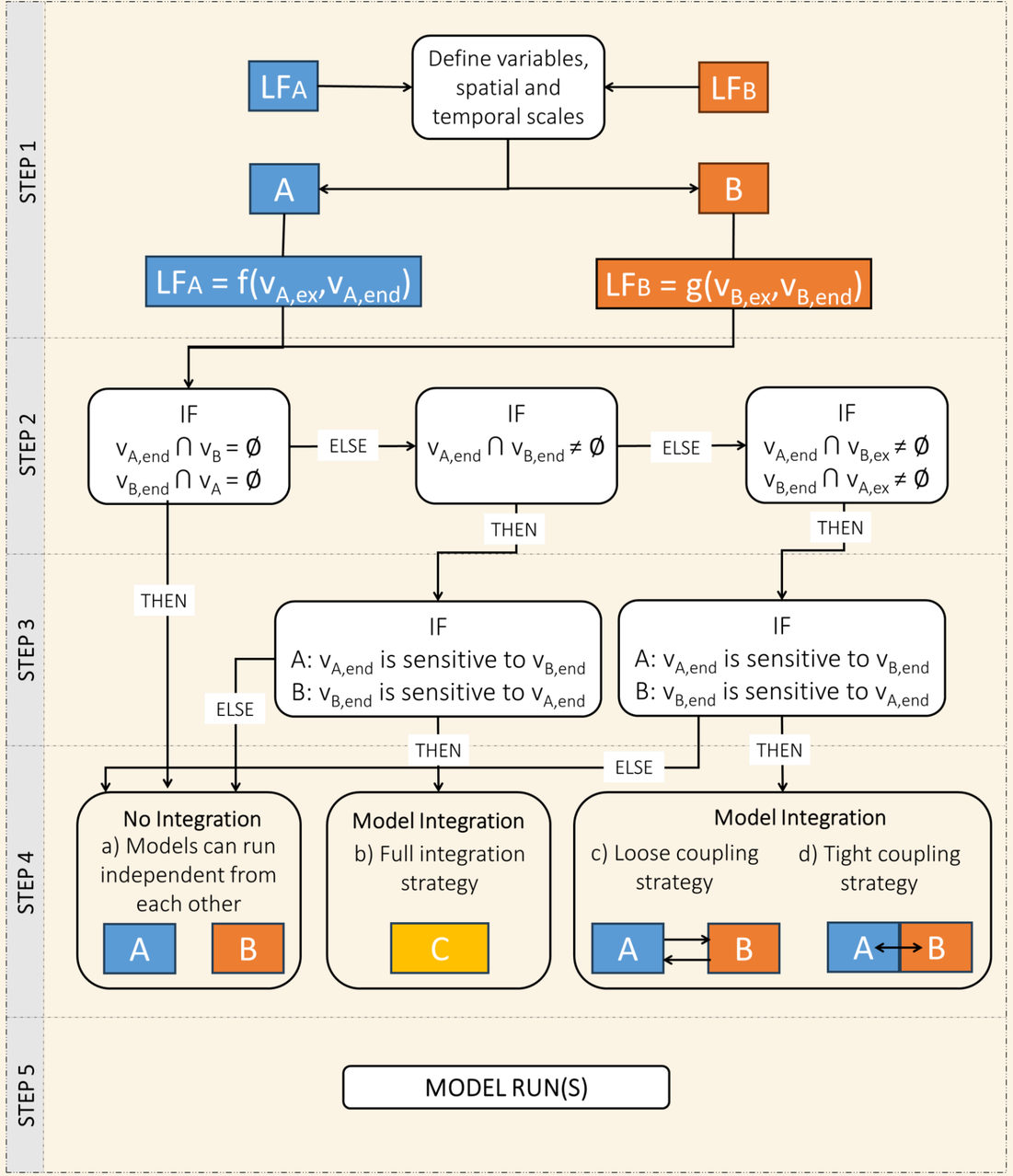
# Multifunctionality of NbS



# Integrated modelling approach

Making models communicate with each other in 5 steps

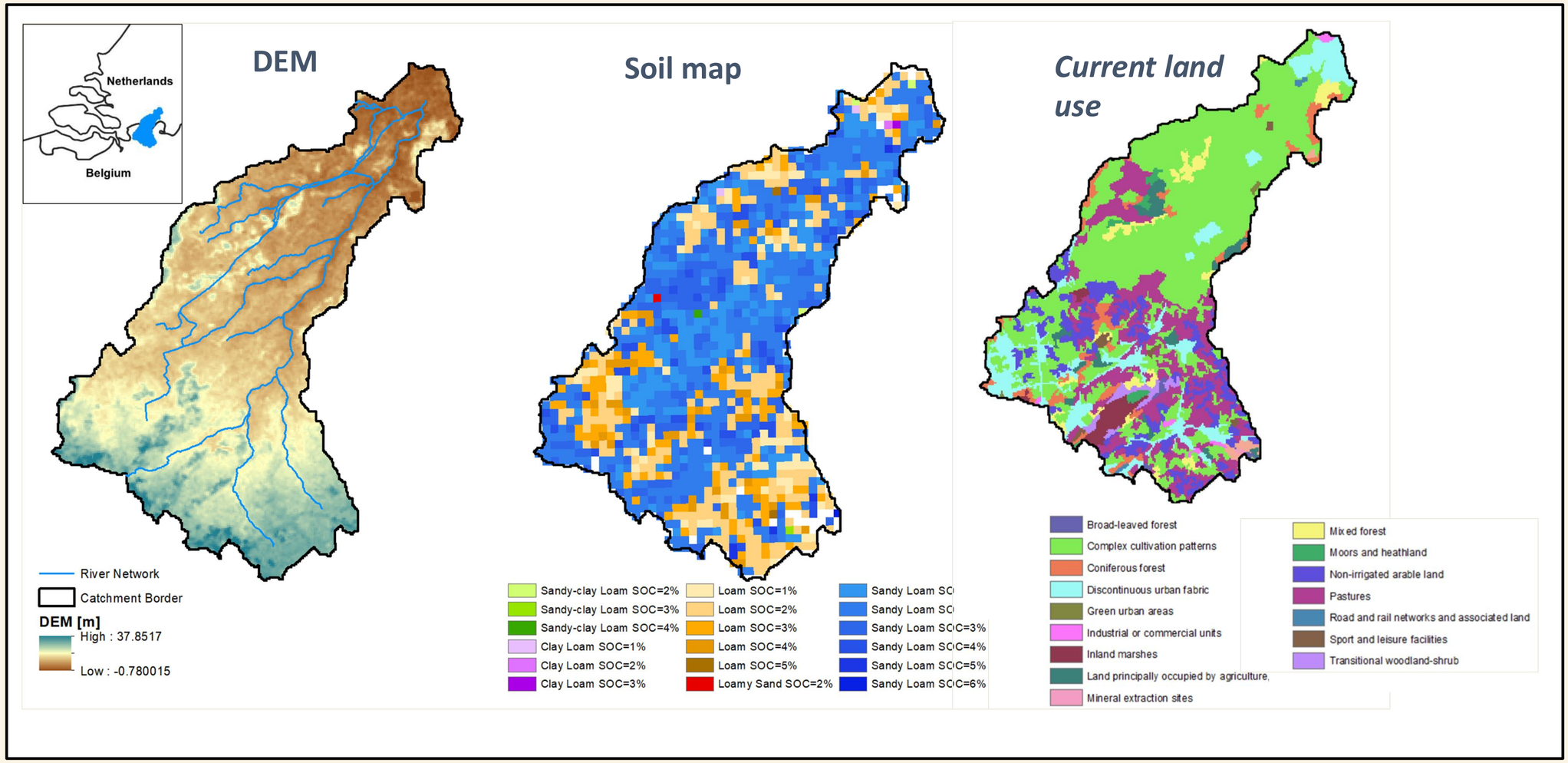
1. *Model selection*
2. *Analysis of variables and their overlapping populations*
3. *Sensitivity analysis*
4. *Integration of model A and B*
5. *Model runs*




*Bogatinoska et al., 2024*

# Case study area

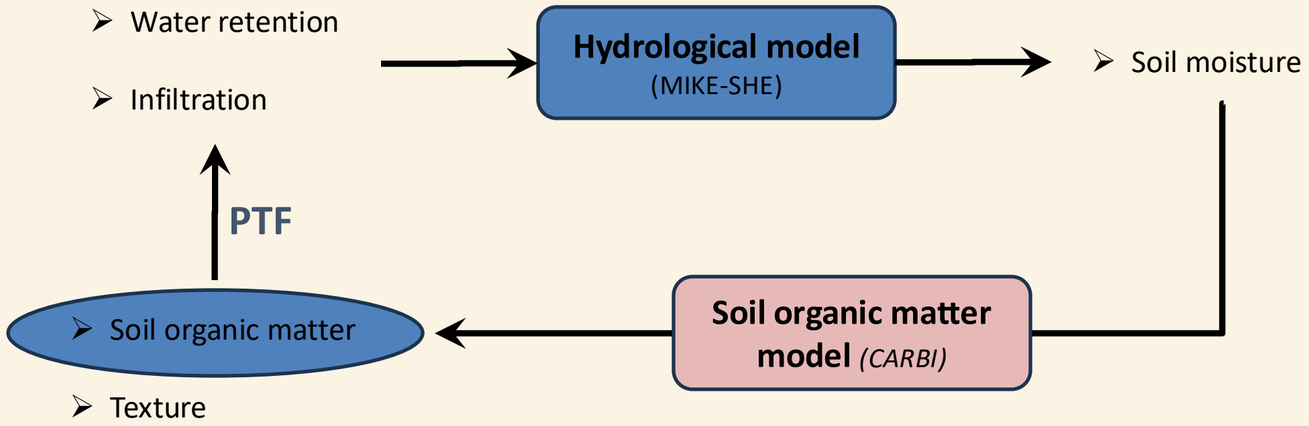
The Aa of Weerijs Catchments (The Netherlands)




*Bogatinoska et al., 2024*

# Coupling hydrological and Carbon models

Linking the hydrological model and soil organic carbon model of the Aa of Weerijs catchment




*Bogatinoska et al., 2024*

# NbS test scenarios

wetlands

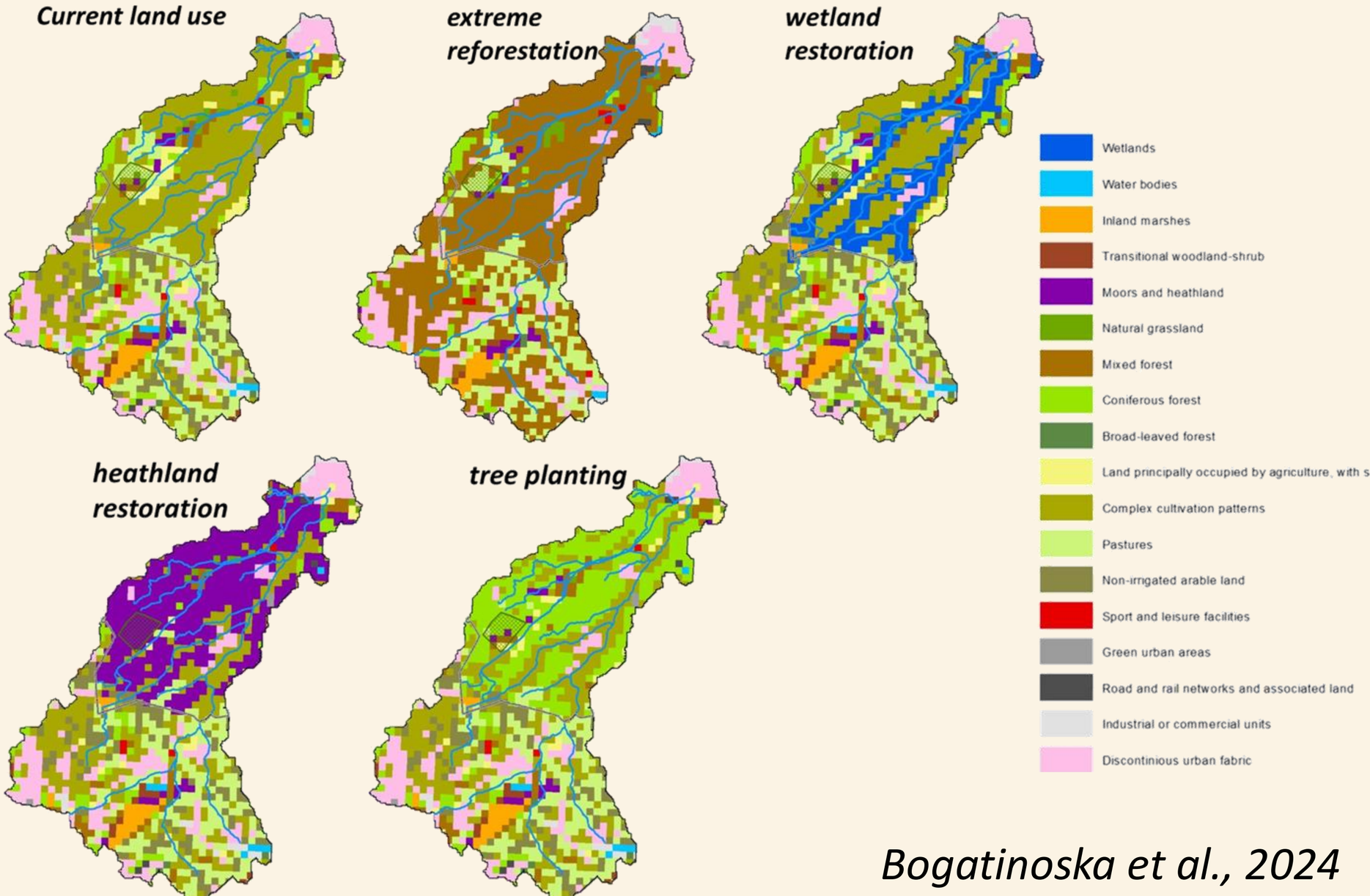
extreme reforestation

Tree planting

Heathland restoration

*Bogatinoska et al., 2024*

# Land use change scenarios



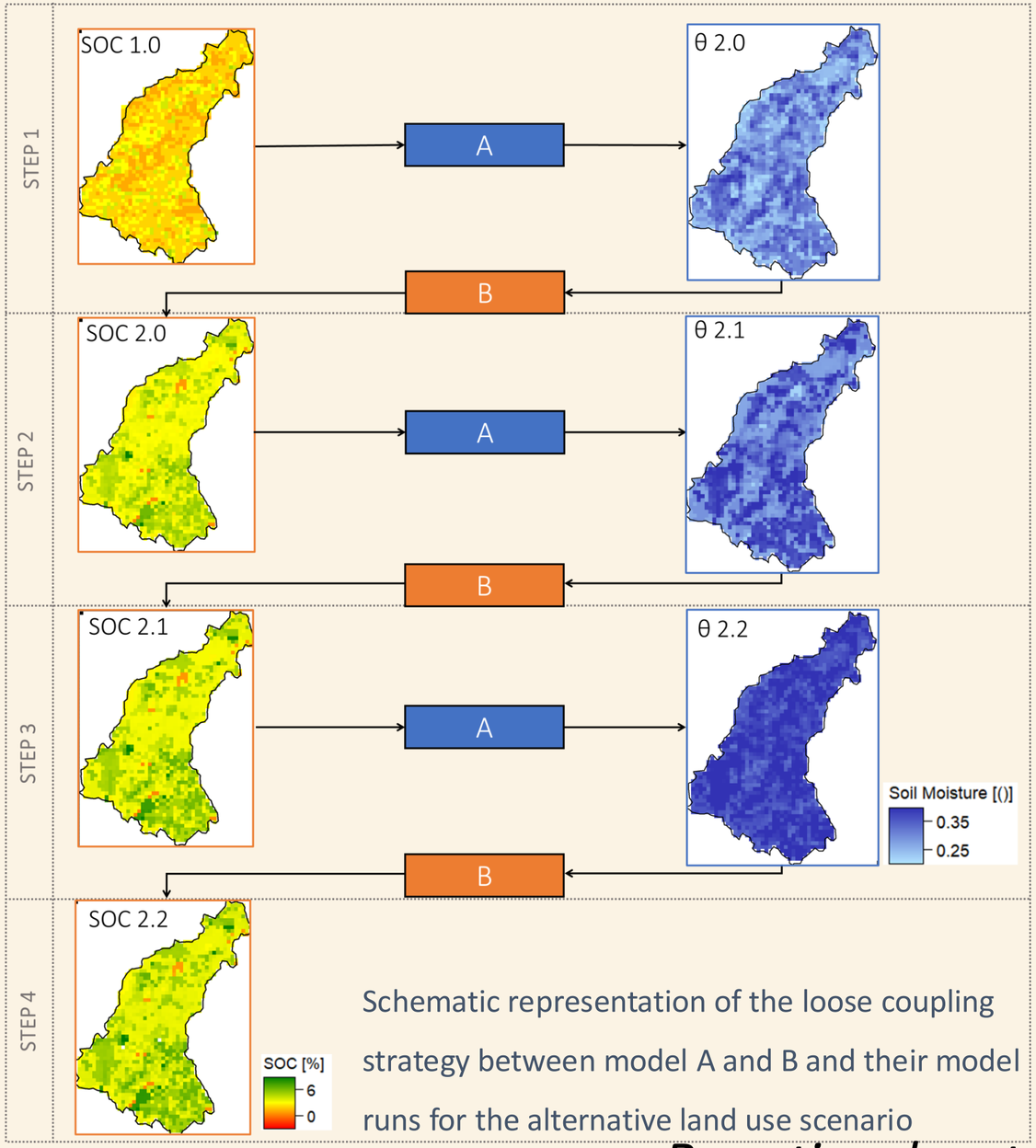

*Bogatinoska et al., 2024*

# Model iterations

## Effects from the model coupling

Spatial mean and standard deviation values for the modelling steps for the current and the alternative land use

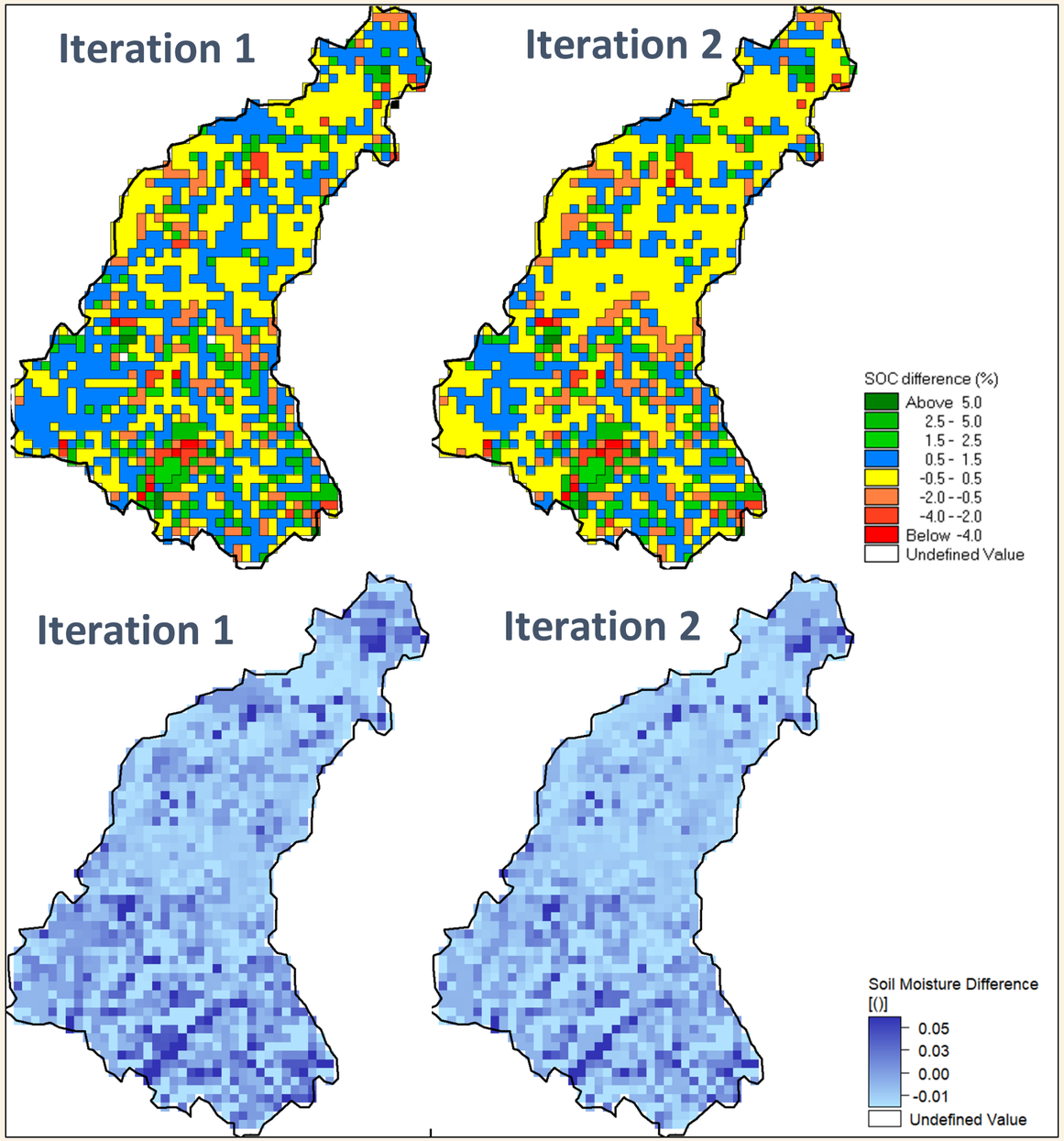
| | Current land use | | Alternative land use | |
|---|---|---|---|---|
| | SOC [%] | Soil Moisture θ [()] | SOC [%] | Soil Moisture θ [()] |
| **Run 1** | 2.00 (0.86) | 0.31 (0.05) | 2.00 (0.86) | 0.29 (0.05) |
| **Run 2** | 3.36 (1.13) | 0.33 (0.05) | 3.46 (1.10) | 0.33 (0.05) |
| **Run 3** | 3.48 (1.40) | 0.34 (0.06) | 3.51 (1.40) | 0.38 (0.03) |
| **Run 4** | 3.48 (1.50) | | 3.89 (1.40) | |




Schematic representation of the loose coupling strategy between model A and B and their model runs for the alternative land use scenario

*Bogatinoska et al., 2024*

# Effect of iterations on moisture and Carbon



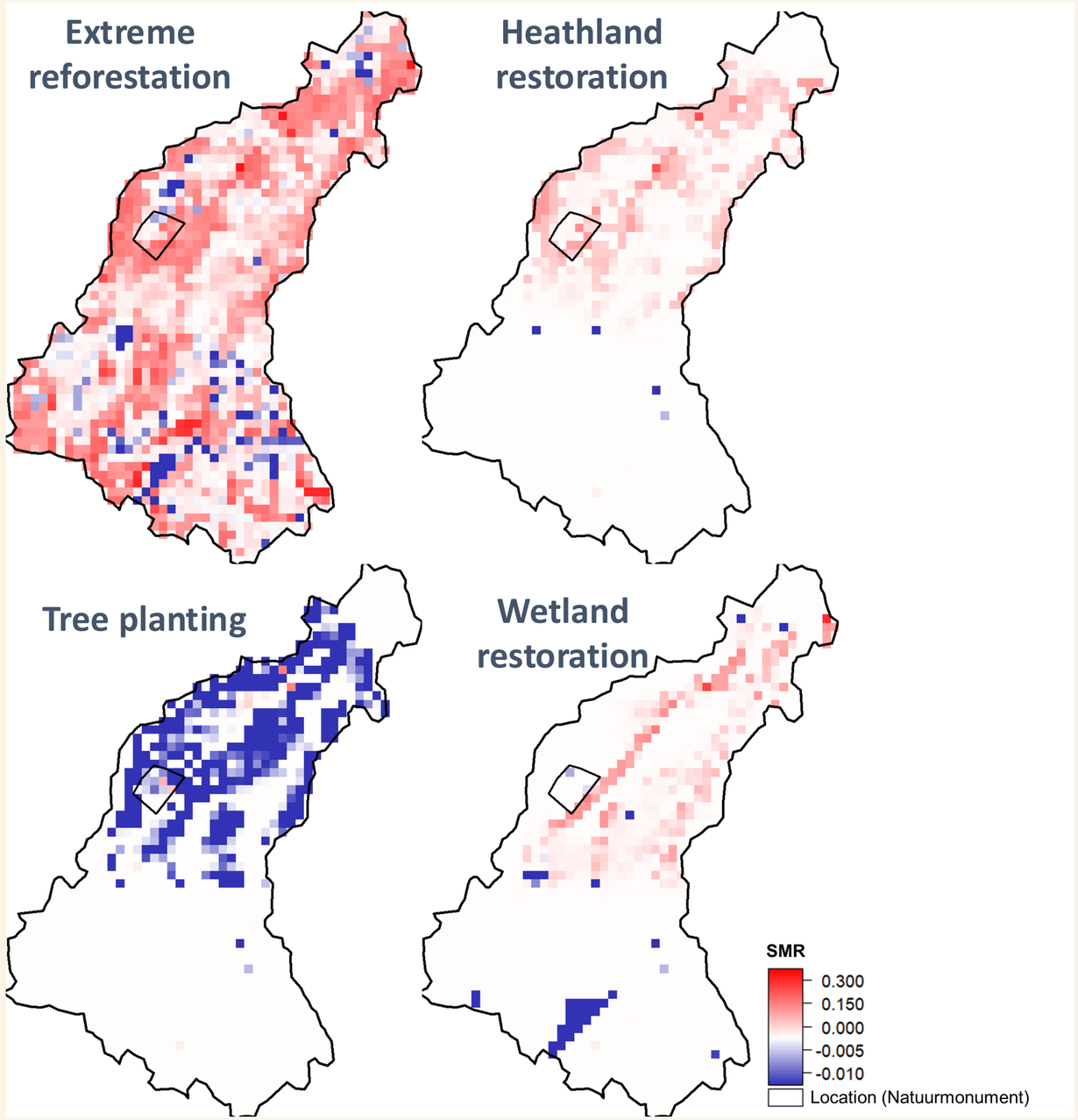

*Bogatinoska et al., 2024*

# Effects of NbS through land use change on soil moisture

$$SMI = 1 - \frac{1}{1 + (\frac{\theta}{\theta_{50}})^6}$$

$$\Delta SMI = SMI_{NBS} - SMI_{BM}$$

| | Heathland restoration | Tree Planting | Wetland Restoration |
|---|---|---|---|
| No change | 1.2% | 4.5% | 4.3% |
| Positive Change (>0) | 71.5% | 22.2% | 60.0% |
| Negative Change (<0) | 27.4% | 73.3% | 35.7% |

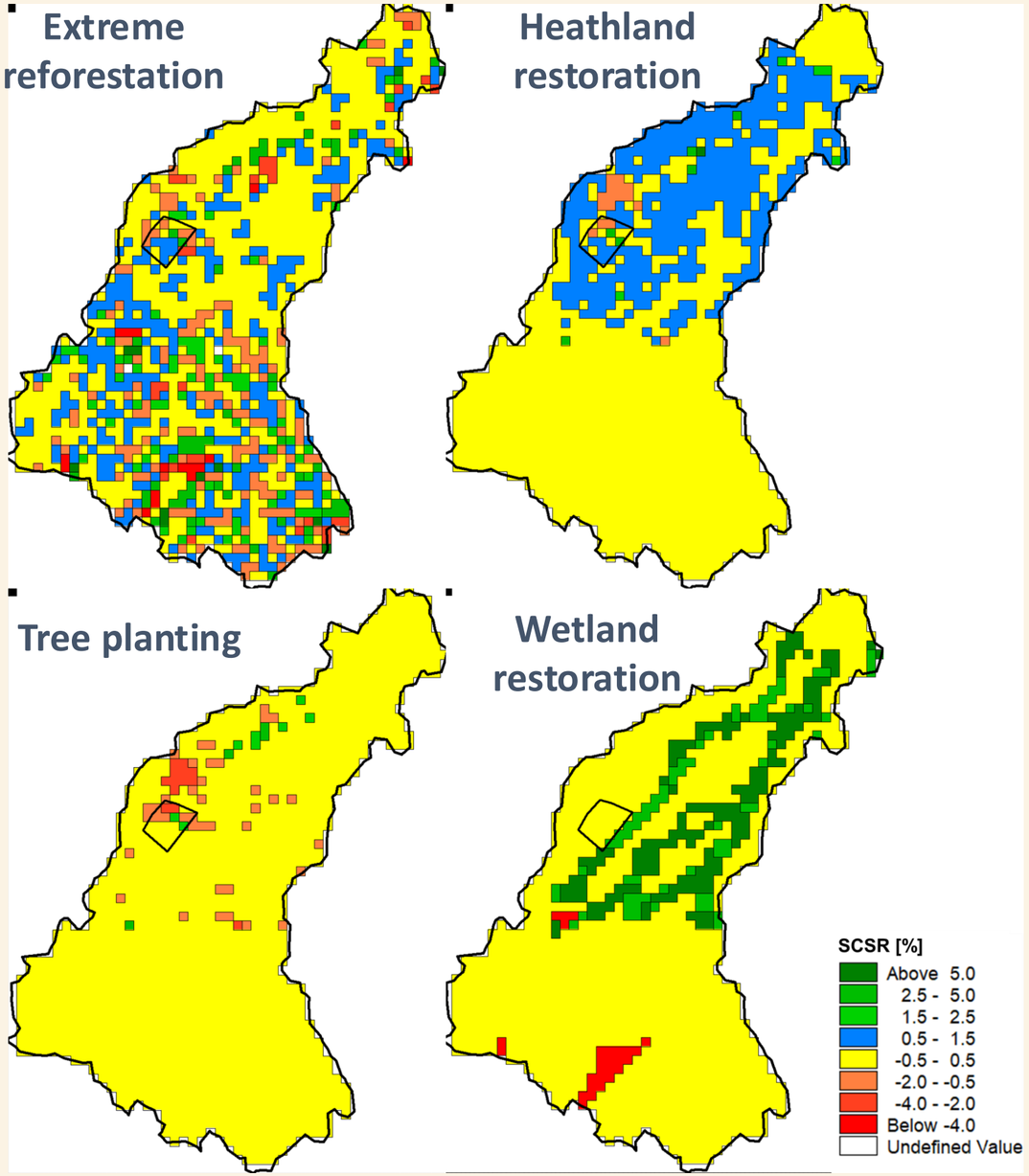



*Bogatinoska et al., 2024*

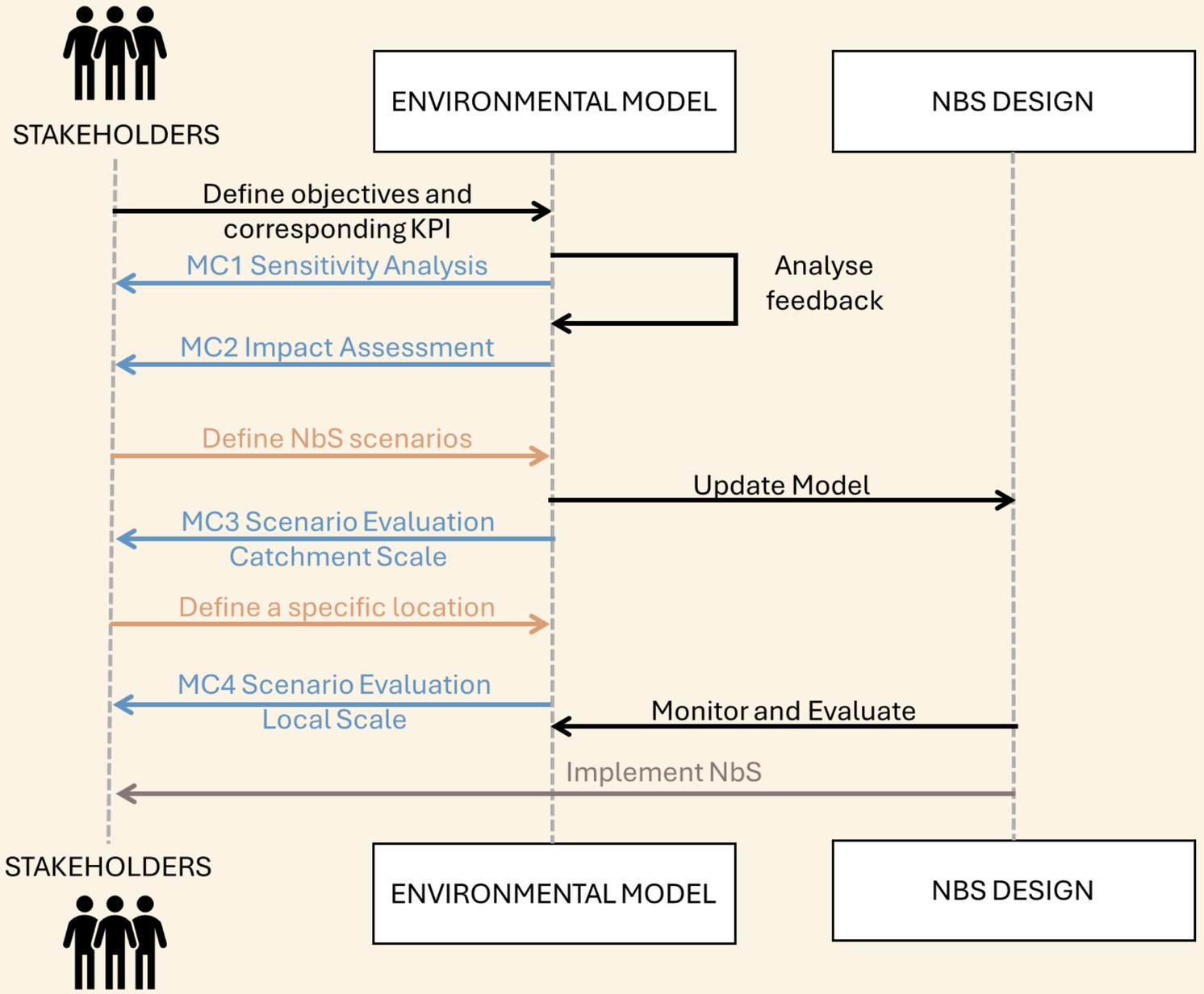
# Effects of NbS through land use change on soil Carbon

$$\Delta \mathrm{SOC} = SOC_{NBS} - SOC_{BM}$$

| | Heathland restoration | Tree Planting | Wetland Restoration |
|---|---|---|---|
| No change | 1.2% | 4.5% | 4.3% |
| Positive Change (>0) | 69.1% | 22.4% | 60.1% |
| Negative Change (<0) | 29.8% | 73.1% | 35.6% |



# Using modelling results for stakeholder discussions



# Conclusion

1. With changing climate, we need innovative and adaptive solutions
2. We need to work with nature and not try to conquer it
3. The voice of the people most affected by the impacts of climate change is important
4. NbS can tackle more environmental problems at once, but we need integrated models

# Thank you!

borjana.bogatinoska@utwente.nl

https://www.linkedin.com/in/bbogatinoska/