Effects of land use and climate change on groundwater dependant vegetation.

A case study in the Kleine Nete (Belgium).

Toon Van Daele
Research Institute for Nature and Forest (INBO), Belgium

Jef Dams, Elga Salvadore, Okke Batelaan
VUB – Free University of Brussels, Belgium

inbo
Instituut voor Natuur- en Bosonderzoek
Research Institute for Nature and Forest

www.inbo.be

Context

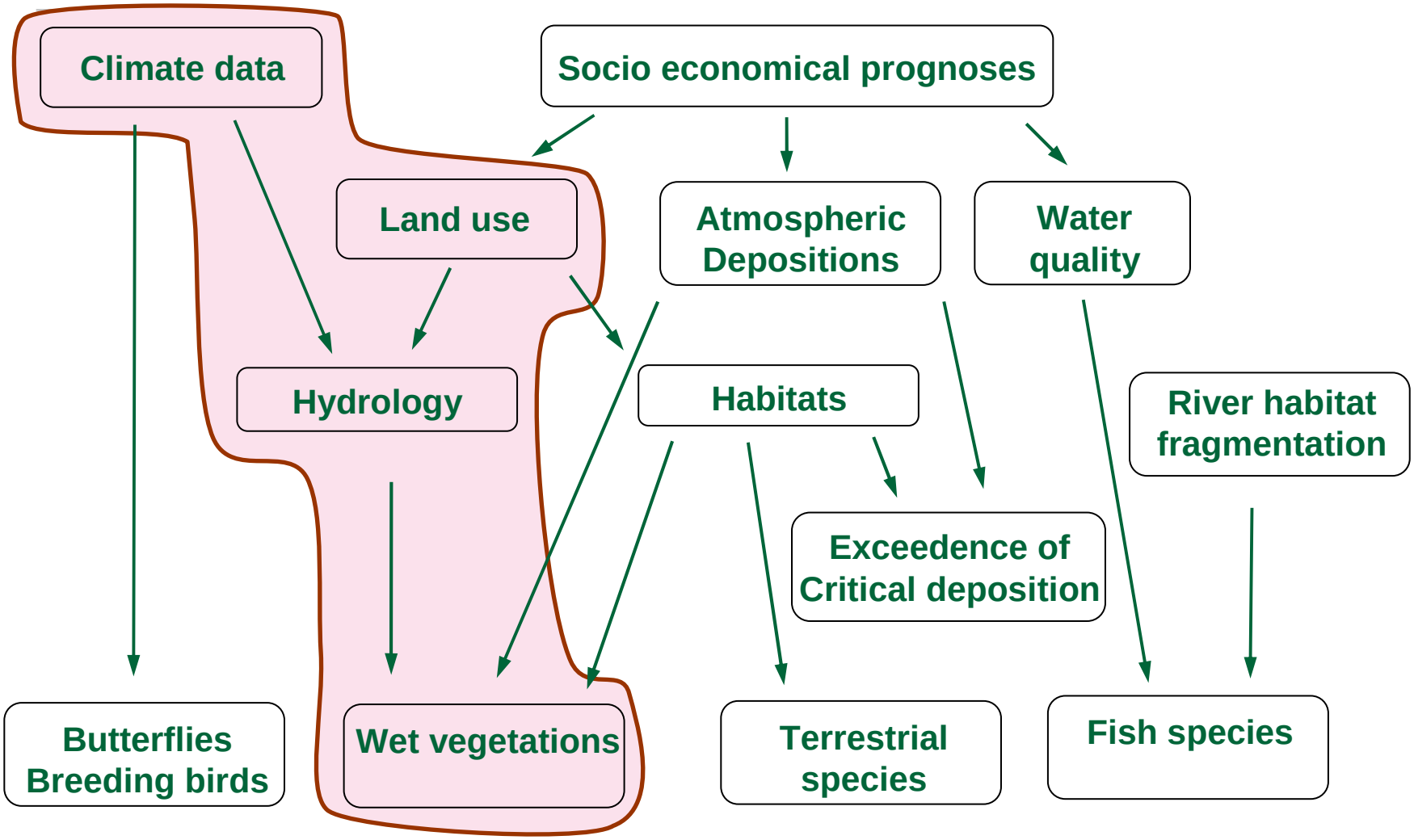
- Nature outlook 2030
  - New policy strategies for nature conservation to halt loss of biodiversity
  - Budget neutral for government

  - 6 policy scenario's:
    - land use management
    - environment conditions
    - Nature management

  - 1 socio-economic context
    - 12% population growth between 2005 en 2030
    - 2% annual grow of gross domestic product
    - Increase in energy prices
    - Stable agricultural production

  - 13 subprojects
    - Chain of existing models and tools
    - Processing and adaptation of input / output

nature outlook 2030



Natuurverkenning 2030

vito vision on technology

UNIVERSITEIT GENT

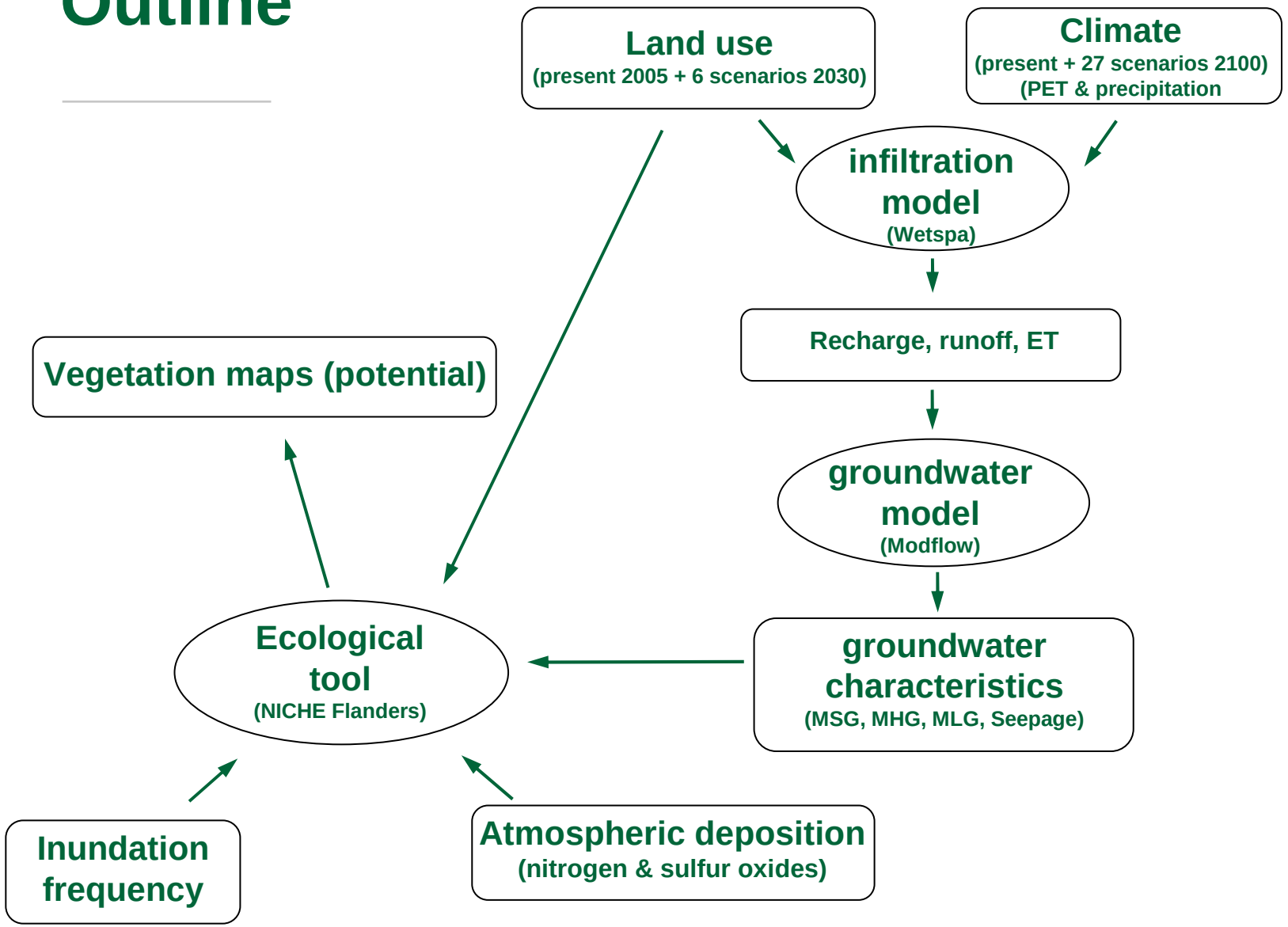
KATHOLIEKE UNIVERSITEIT LEUVEN

inbo

General questions

- What is the possible impact of climate change to groundwater dependant vegetation?
- How is this related with the impacts of changes in land use?
- Are there differences among individual vegetation types?

Outline

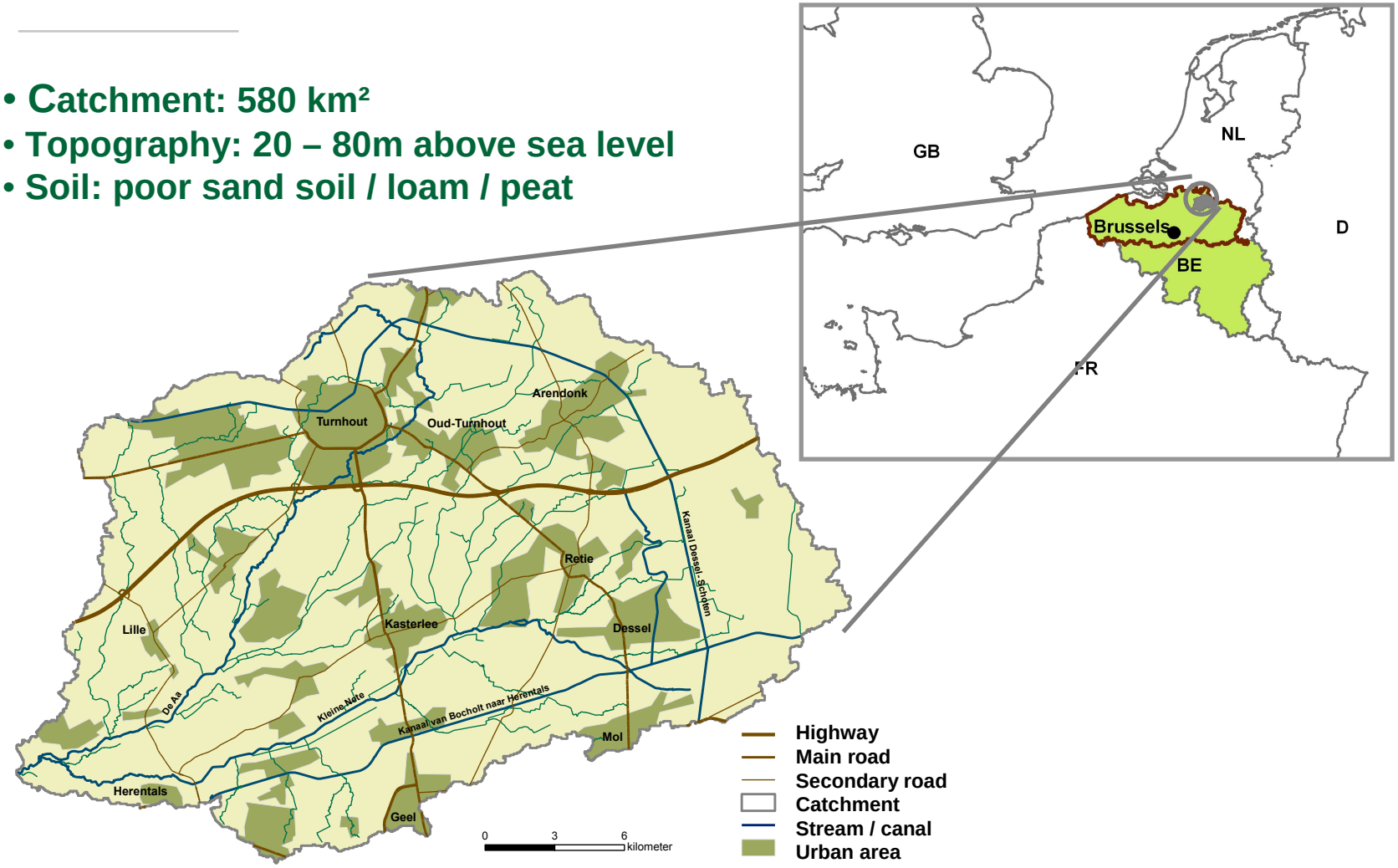


Natuurverkenning 2030

inbo

Catchment Kleine Nete (Belgium)

- Catchment: 580 km²
- Topography: 20 – 80m above sea level
- Soil: poor sand soil / loam / peat

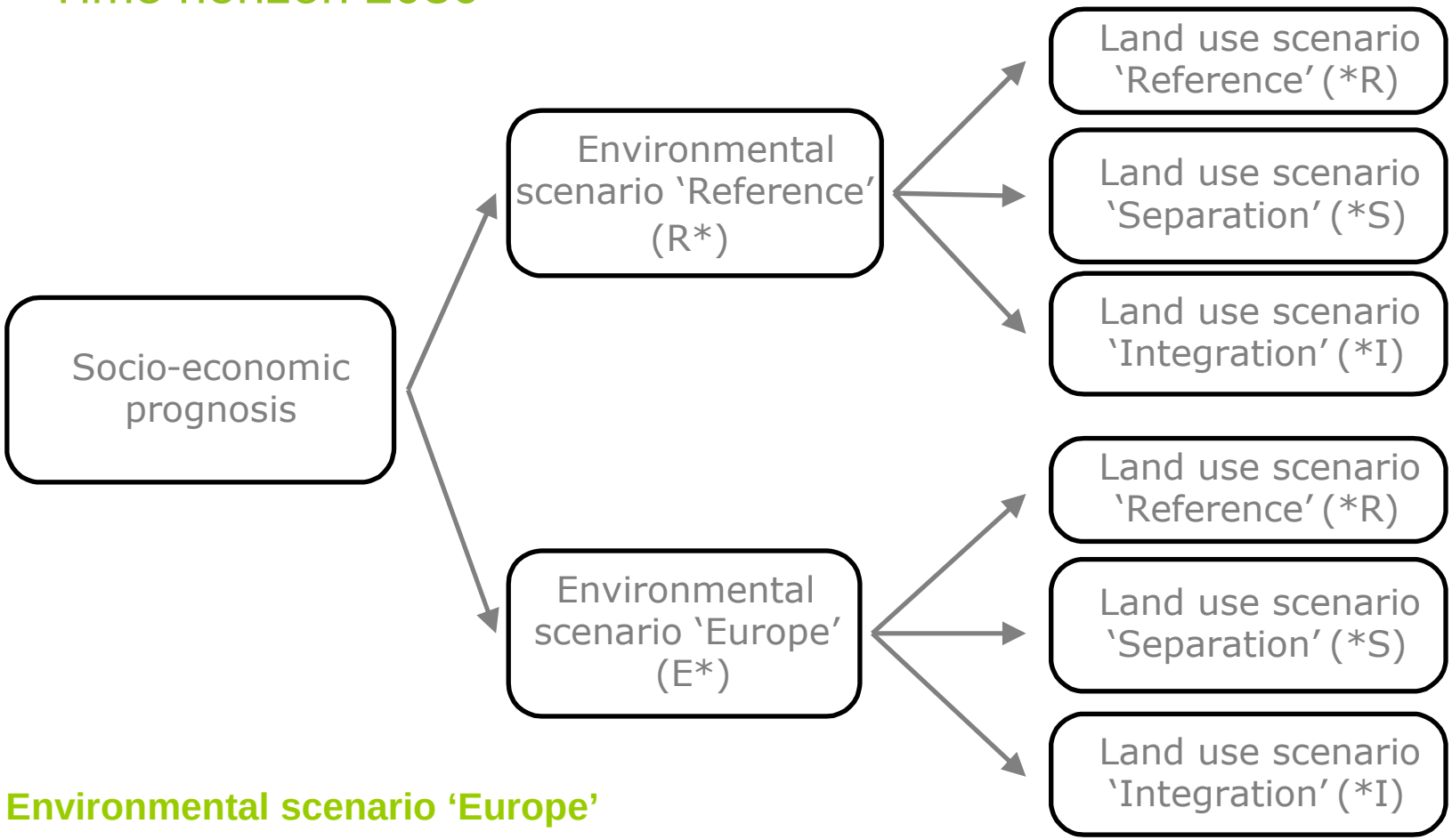


Natuurverkenning 2030

inbo

Scenarios land use

Time horizon 2030



Environmental scenario 'Europe'

- **Less urban spread**
- **Environmental (purification, agri-environmental measures,…)**

Natuurverkenning 2030

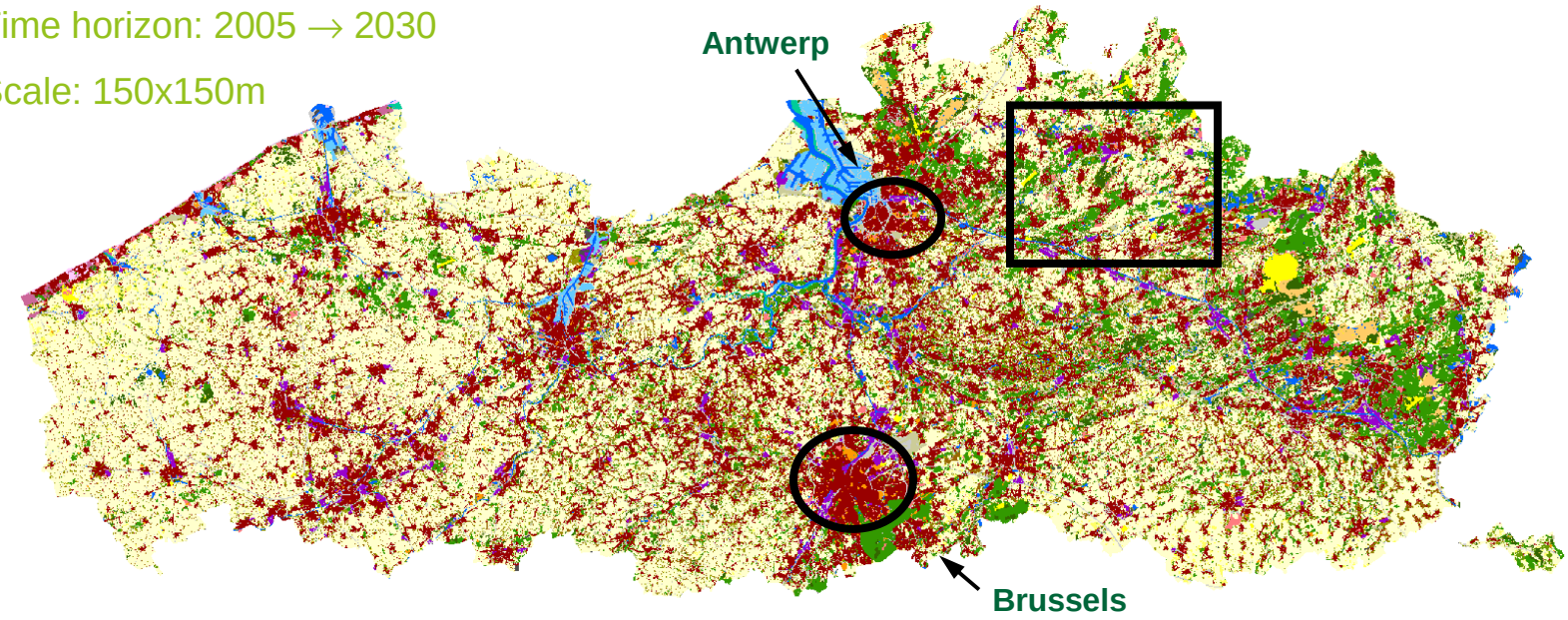
inbo

Land use

Cellular automata

Time horizon: 2005 → 2030

Scale: 150x150m



- Unregistered high nature value grassland without biodiversity management
- High nature value grassland under biodiversity management
- Marshland without biodiversity management
- Marshland under biodiversity management
- Heathland without biodiversity management
- Heathland under biodiversity management
- Coastal dune without biodiversity management
- Coastal dune under biodiversity management
- Mud flat and salt marsh
- Forest under biodiversity management
- Multifunctional forest
- Park
- Unregistered agricultural land
- Agricultural grassland with an environmental or a biodiversity target
- Agricultural grassland
- Cropland with a biodiversity target
- Cropland with an environmental target
- Cropland
- Residential and commercial building
- Agrarian building
- Business and industrial site
- Seaport
- Airport
- Recreation and sports terrain
- Military facility
- Infrastructure
- Water
- Others

N

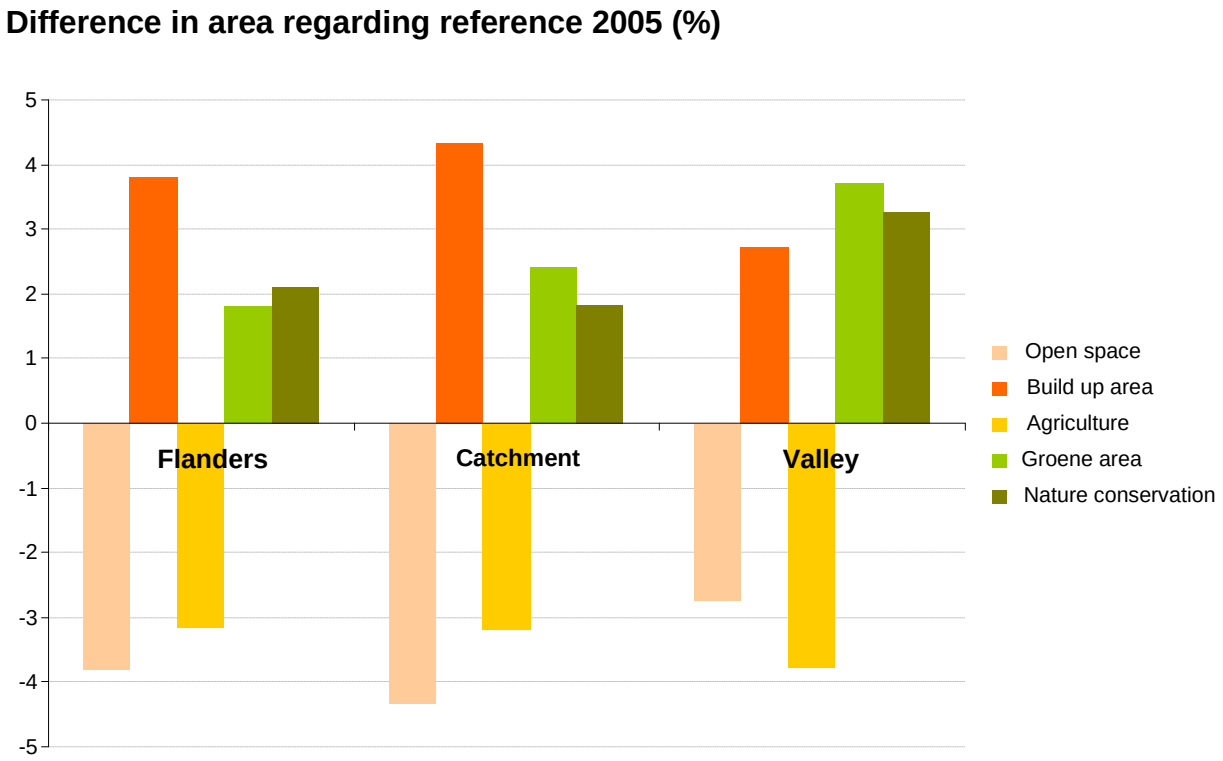
0 5 10 20 km

➢ **Increase in build up area: 27% -> 33% (total area)**

Natuurverkenning 2030

inbo

Land use in the Kleine Nete catchment



- ↓ Open area & ↑ build op area
- Green area & area for nature conservation increases in the valley

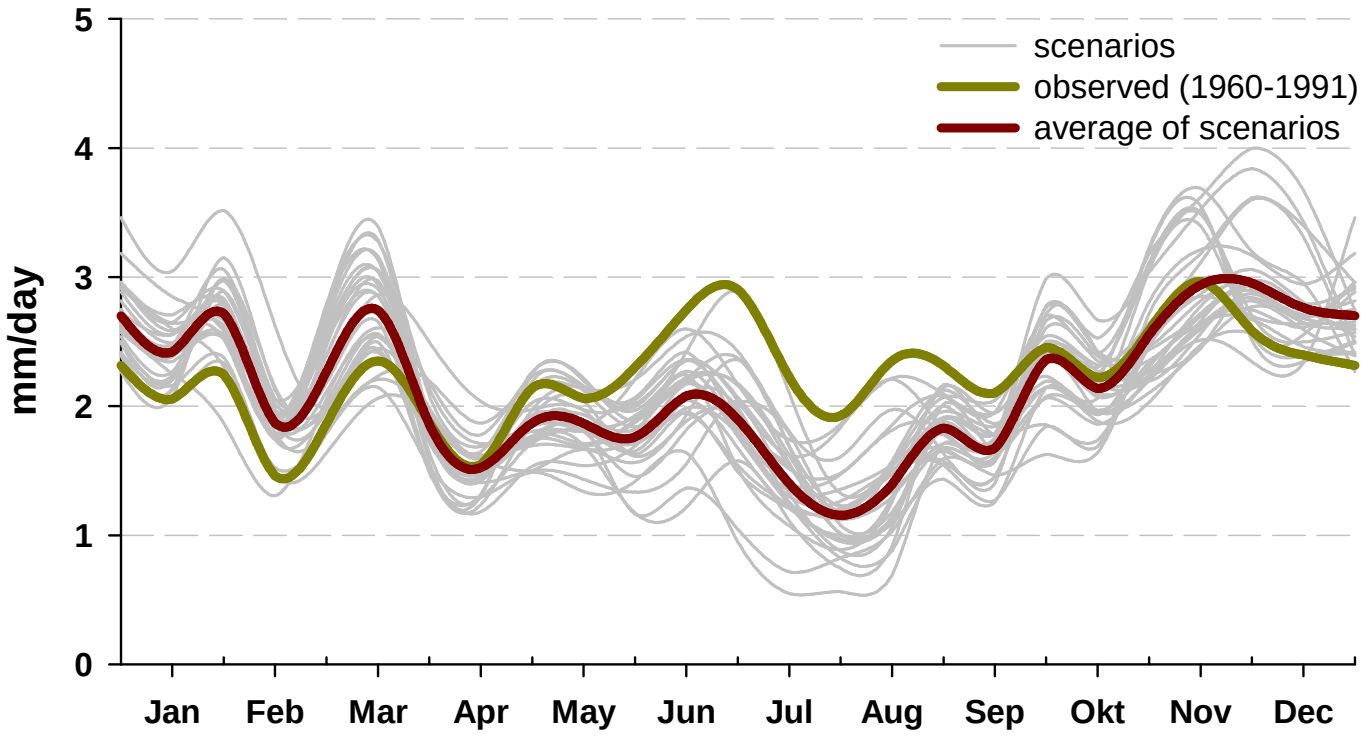
Climate data

European climate scenarios -> Climate scenarios for Belgium

- 27 Climate scenario's (based on IPCC)
  - PRUDENCE (European climate scenarios, http://prudence.dmi.dk/)
- Transformation of observed climate data series
  - Perturbation tool (KULeuven http://www.kuleuven.be/hydr/cci)
    - Precipitation
    - Potential evapotranspiration
  - Reference period: 1961 – 1990
  - 27 Scenarios: 2071-2100
- Tendencies
  - Precipitation: seasonality (↑ winter / ↓ summer)
  - Temperature: global increase
  - Potential evapotranspiration: high increase during summer

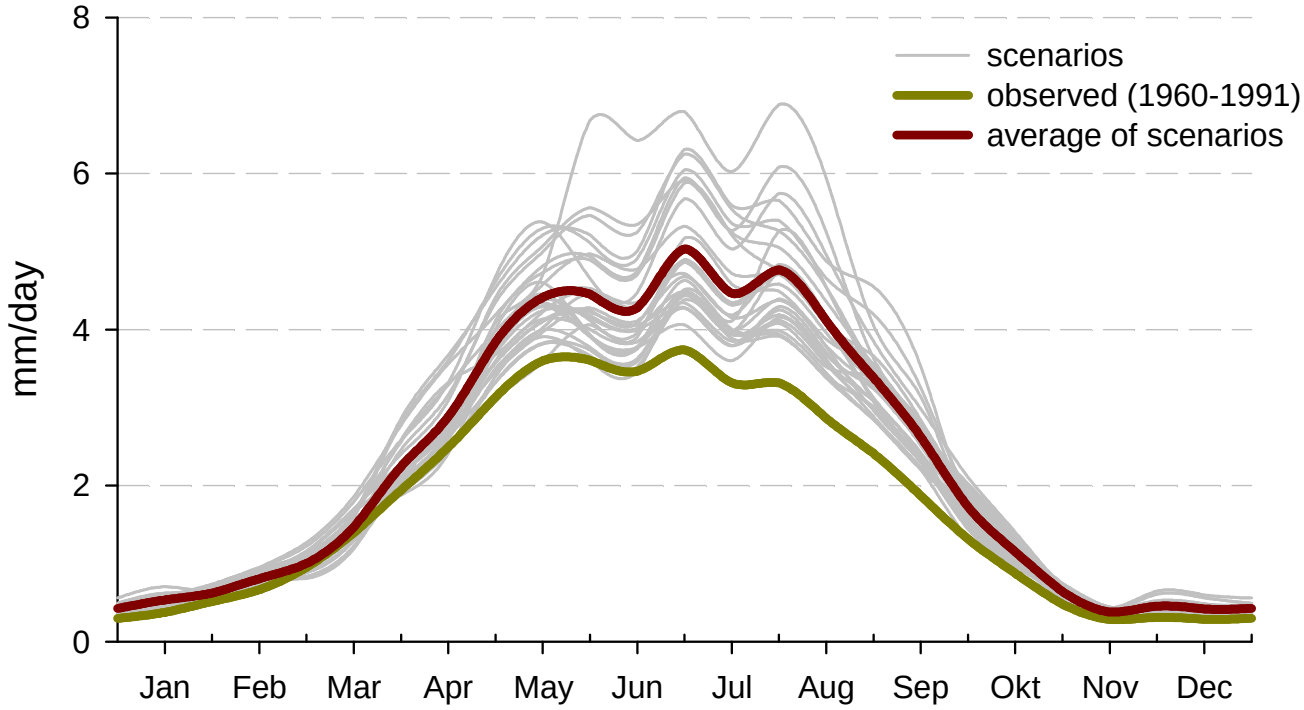
Climate

- Precipitation
  - Seasonality
  - More precipitation in winter, less in summer



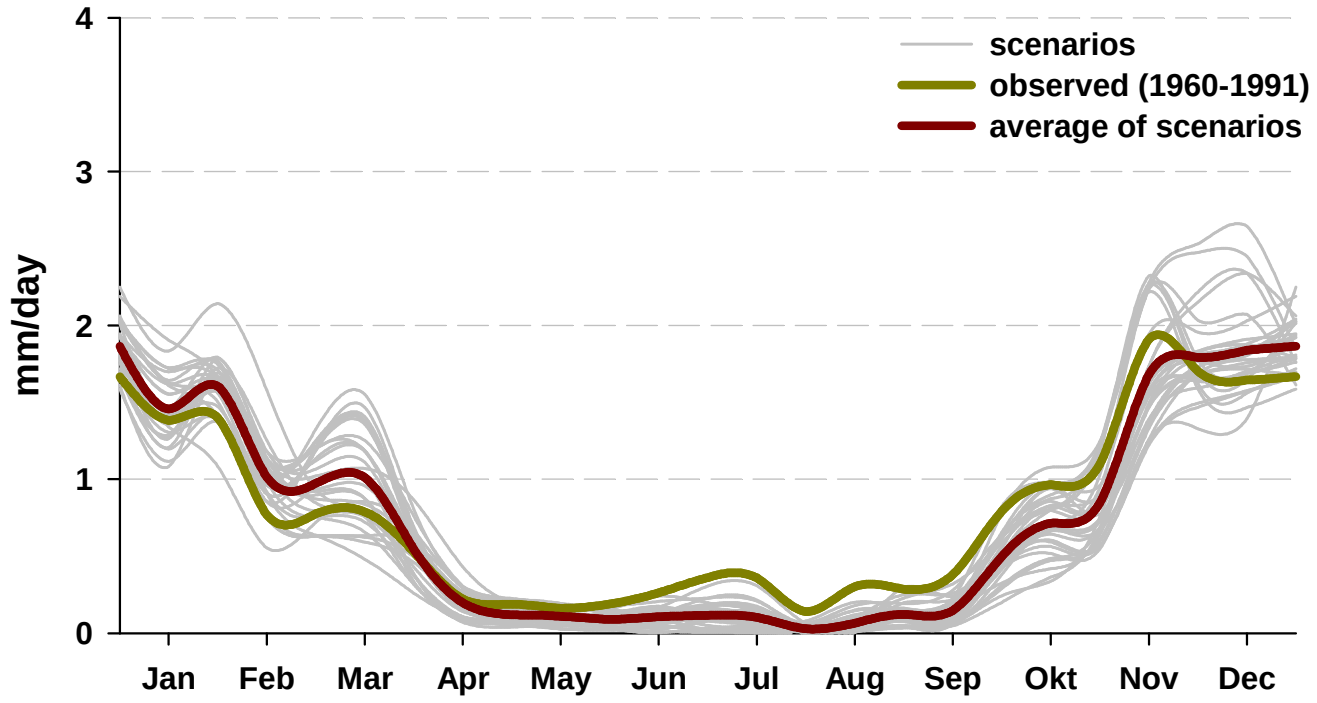
Climate

- Potential evapotranspiration
  - Much higher in summer



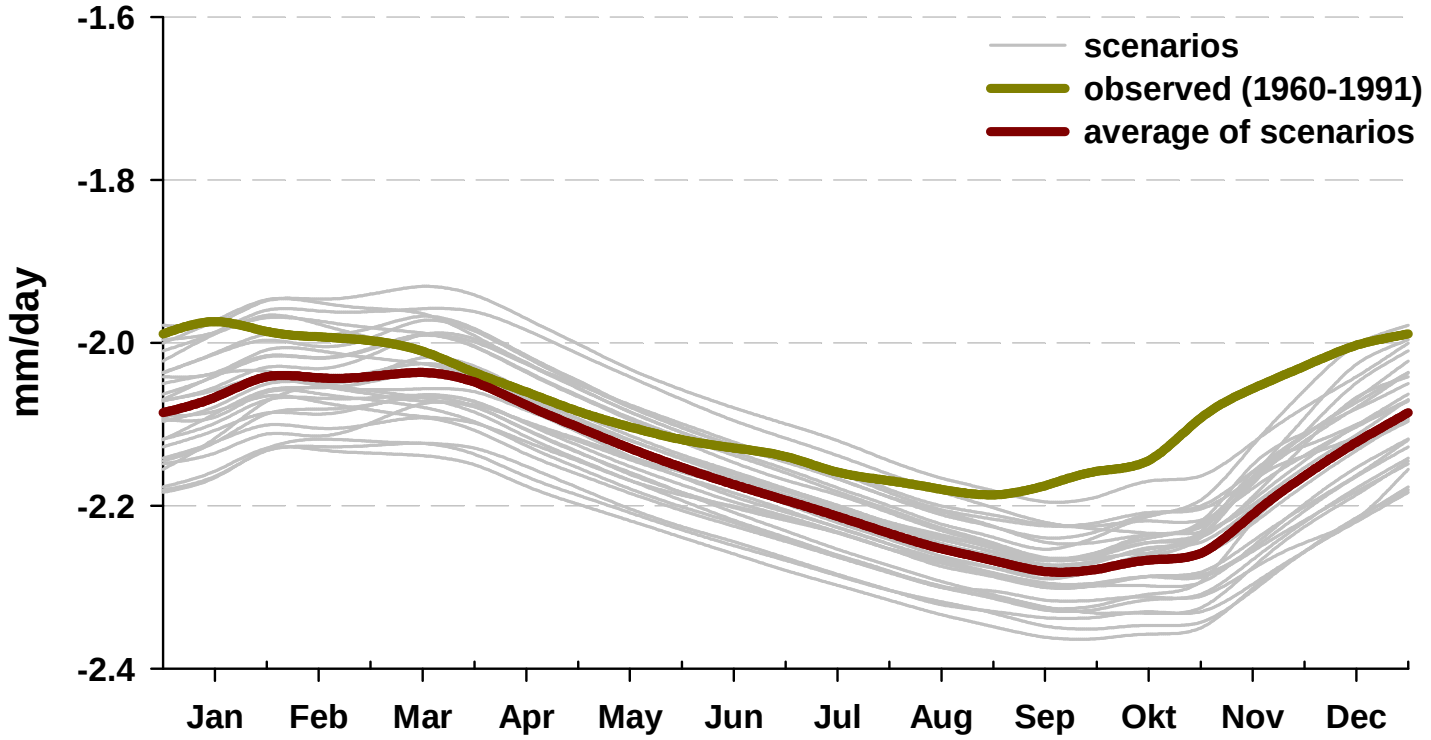
Climate

- Groundwater recharge
  - ↑ winter / ↓ summer & autumn



Groundwater

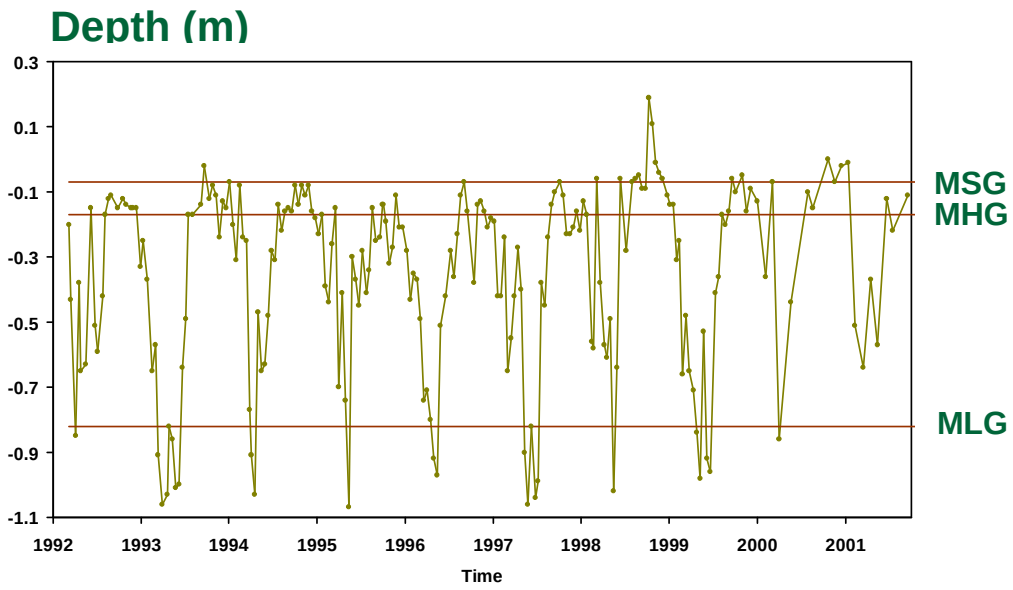
- Groundwater level
  - ↓ grondwater level, mainly in summer and autumn
  - ↑ groundwater dynamics, mainly at the interfluves



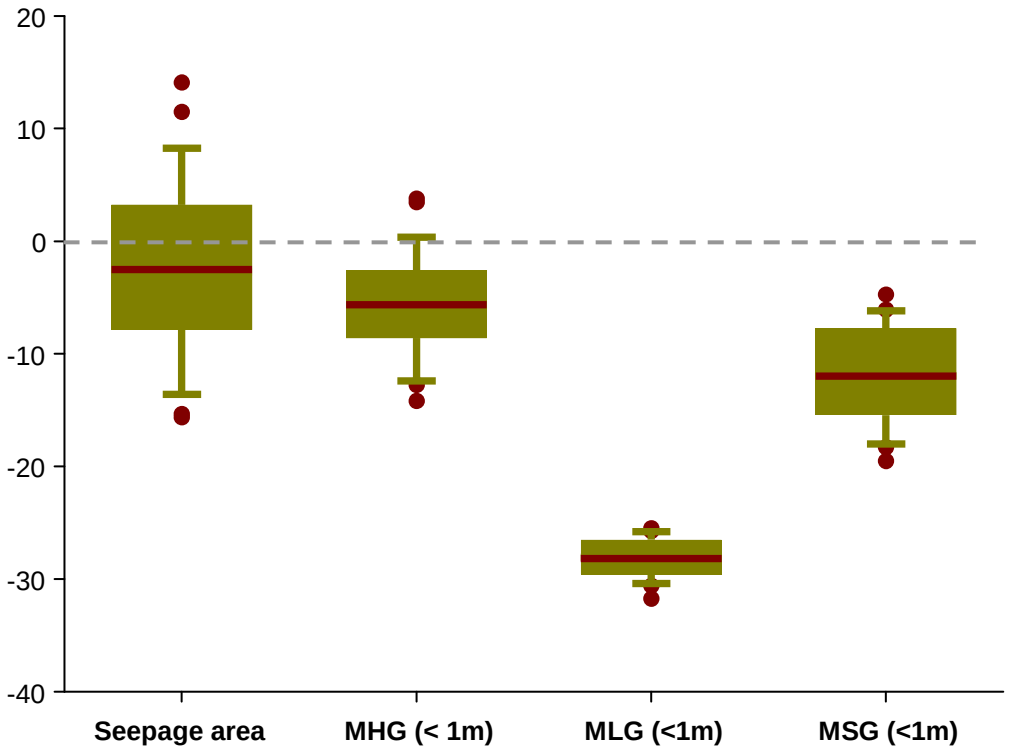
Groundwater characteristics

Output of a dynamic groundwater model → 4 variables

- Mean highest groundwater leve (MHG)
- Mean lowest groundwater level (MLG)
- Mean groundwater level in spring (MSG)
- Seepage (mm/day)



Groundwater characteristics



- Large differences for seepage area
- Increase in groundwater fluctuations
- Increase spring and lowest groundwater depth

Natuurverkenning 2030

inbo

Eco-hydrological tool → NICHE (Flanders)

- Modified NICHE (NL), developed by KIWA Water Research (Meuleman et al., 1996)
- Calculates potential occurrence of 28 vegetation types (decision rules)
- Database of 1600 reference plots of vegetations in stable site conditions:
  - Vegetation relevees
    - 3x3m in grassland
    - 10x10m in woodland
  - Site conditions
    - Soil type
    - Groundwater characteristics
    - Inundation frequency
    - Acidity
    - Nutrient availability

- 8 relevant groundwater dependent vegetation types:
  - 5 grassland types
    - Calthion palustris (94)
    - Filipendulion (65)
    - Caricion nigrae (32)
    - Caricion gracilis (76)
    - Cynosurion cristati (54)

  - 3 woodland types
    - Carici Elongatae- Alnetum (29)
    - Macrophorbio-Alnetum (43)
    - Sphagno-Betulum (24)

Some examples

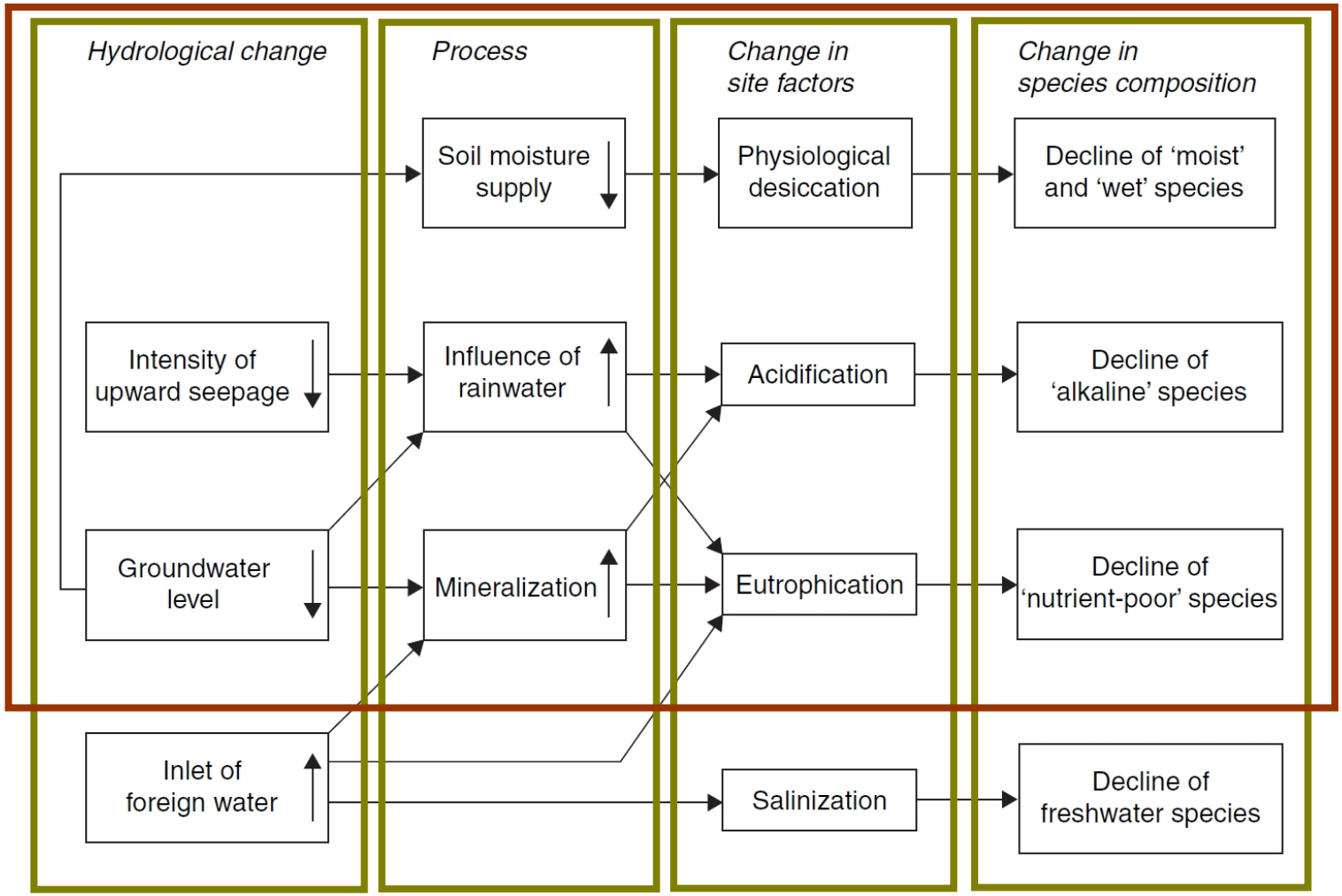
Calthion palustris

Filipendulion

Carici elongatae-Alnetum

Photos: Vildaphoto / Yves Adams

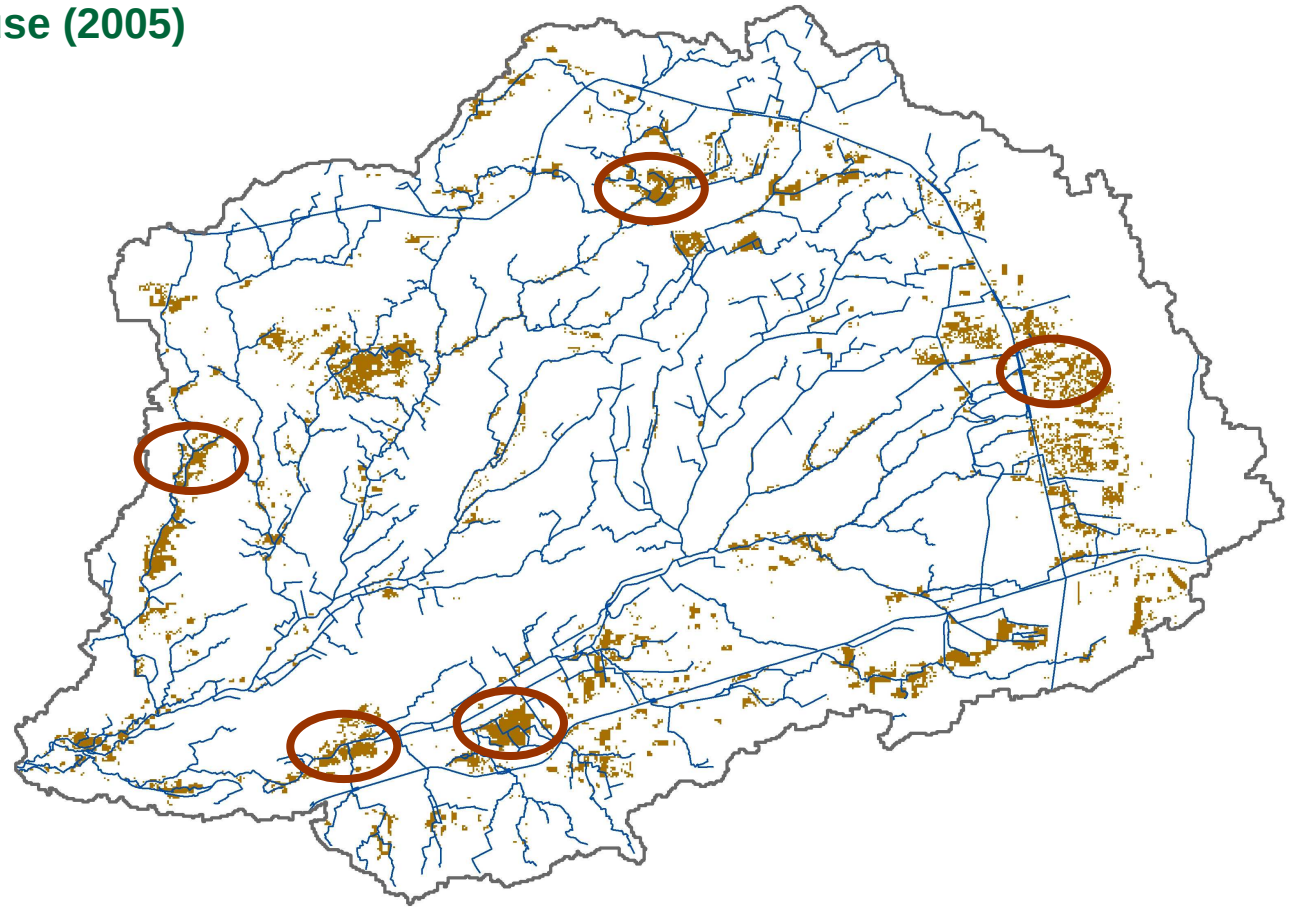
Ecohydrological processes



De witte, Runhaar & Van Ek, 2008

Groundwater dependent vegetation

- Total 8 vegetation types
- Current climate (1960 – 1991)
- Current land use (2005)

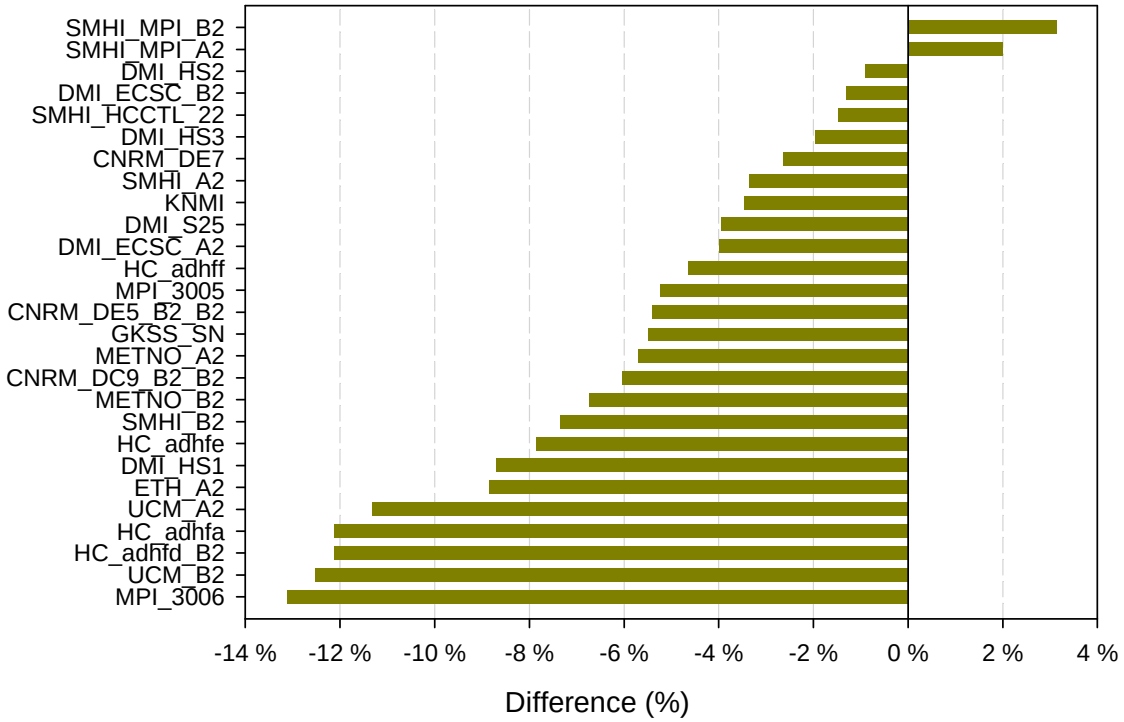


Natuurverkenning 2030

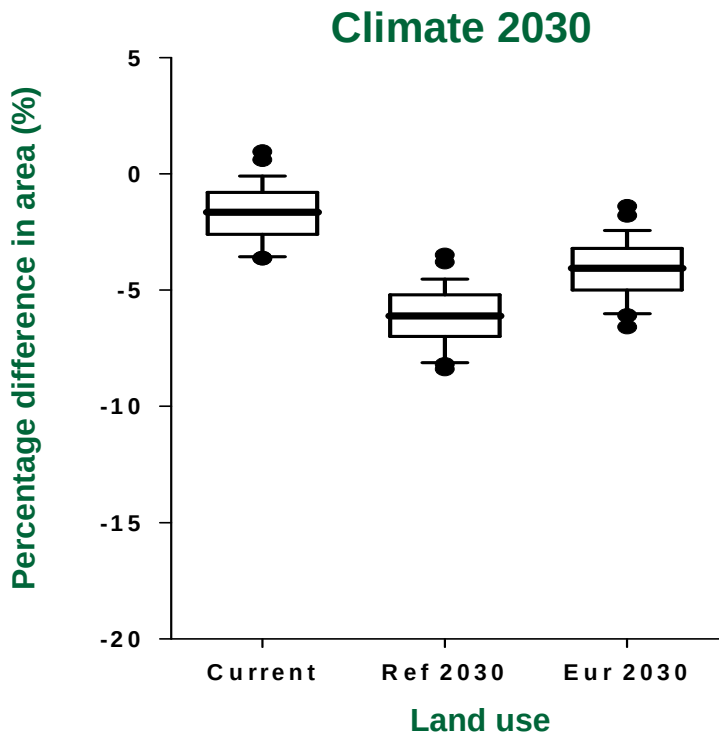
inbo

Groundwater dependent vegetation

- Current land use (2005) / Climate 2100
- Total 8 vegetation types



Groundwater dependent vegetation



- Climate effect on average -2% (2030) / -5% (2100)
- Land use reference scenario (2030) -5% extra

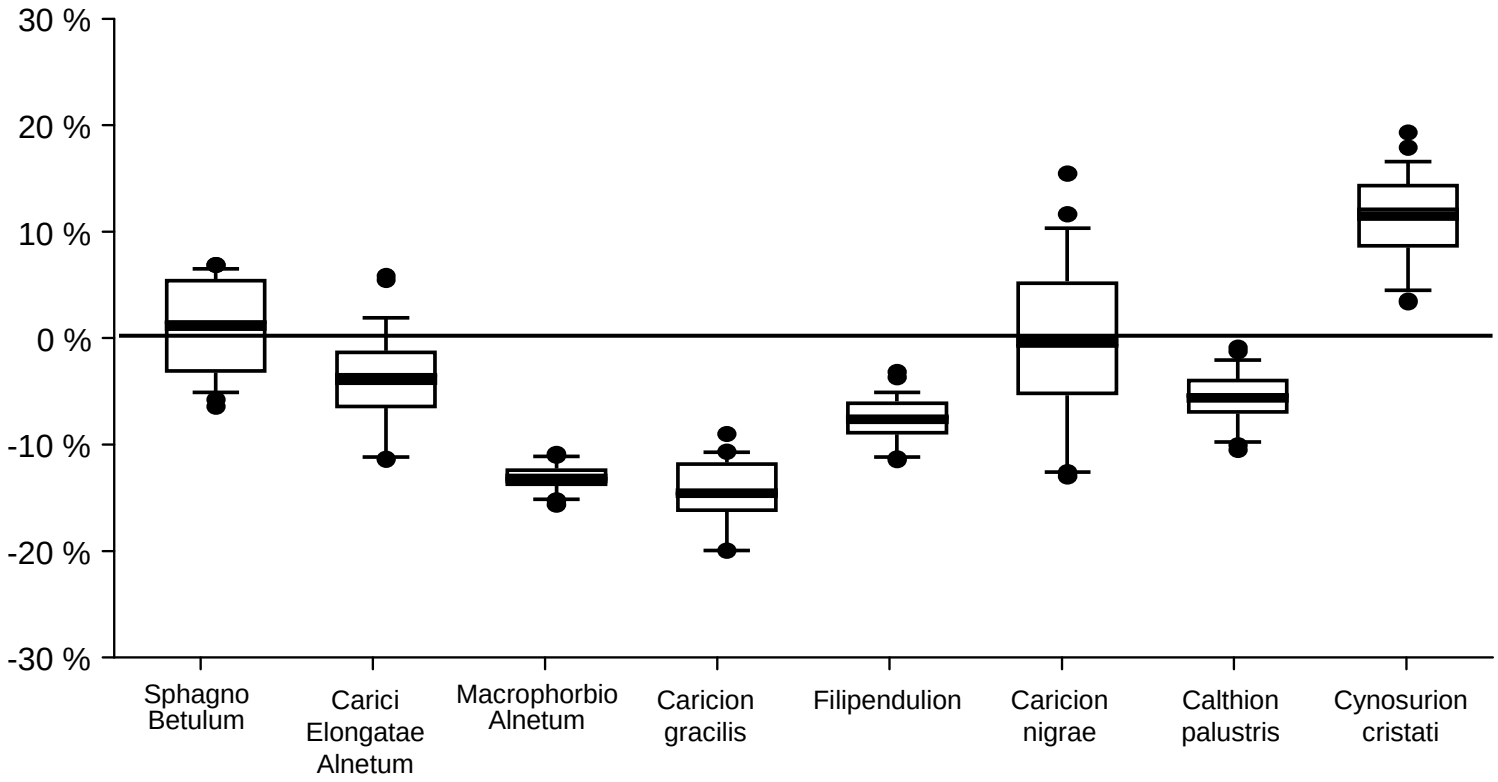
Natuurverkenning 2030

inbo

Groundwater dependent vegetation

Climate 2100 – no land use change

Percentage difference in area (%)



➢ **Big differences between vegetation types**

Natuurverkenning 2030

inbo

Conclusions

- Climate change
  - Negative impact on groundwater dependent vegetations, but high uncertainties.
  - Big differences among vegetation types
  - Higher infiltration in winter reduces negative effects
    (↑ infiltration → ↓ groundwater fluctuations)
- Land use
  - Impact of land use change is higher than climate change (2030)
  - Adapted land use and environmental policy (scenario 'Europe') cannot assure present potencies for vegetations

➢ **Climate change should be considered next to other (changing) environmental pressures in nature conservation policies.**

Thanks for your attention!