LIÈGE université
Gembloux
Agro-Bio Tech

EPICgrid : Agro-Hydrological Model in Wallonia
The way to quantify non-point source agricultural pollution

Pr Aurore Degré, Dr Catherine Sohier





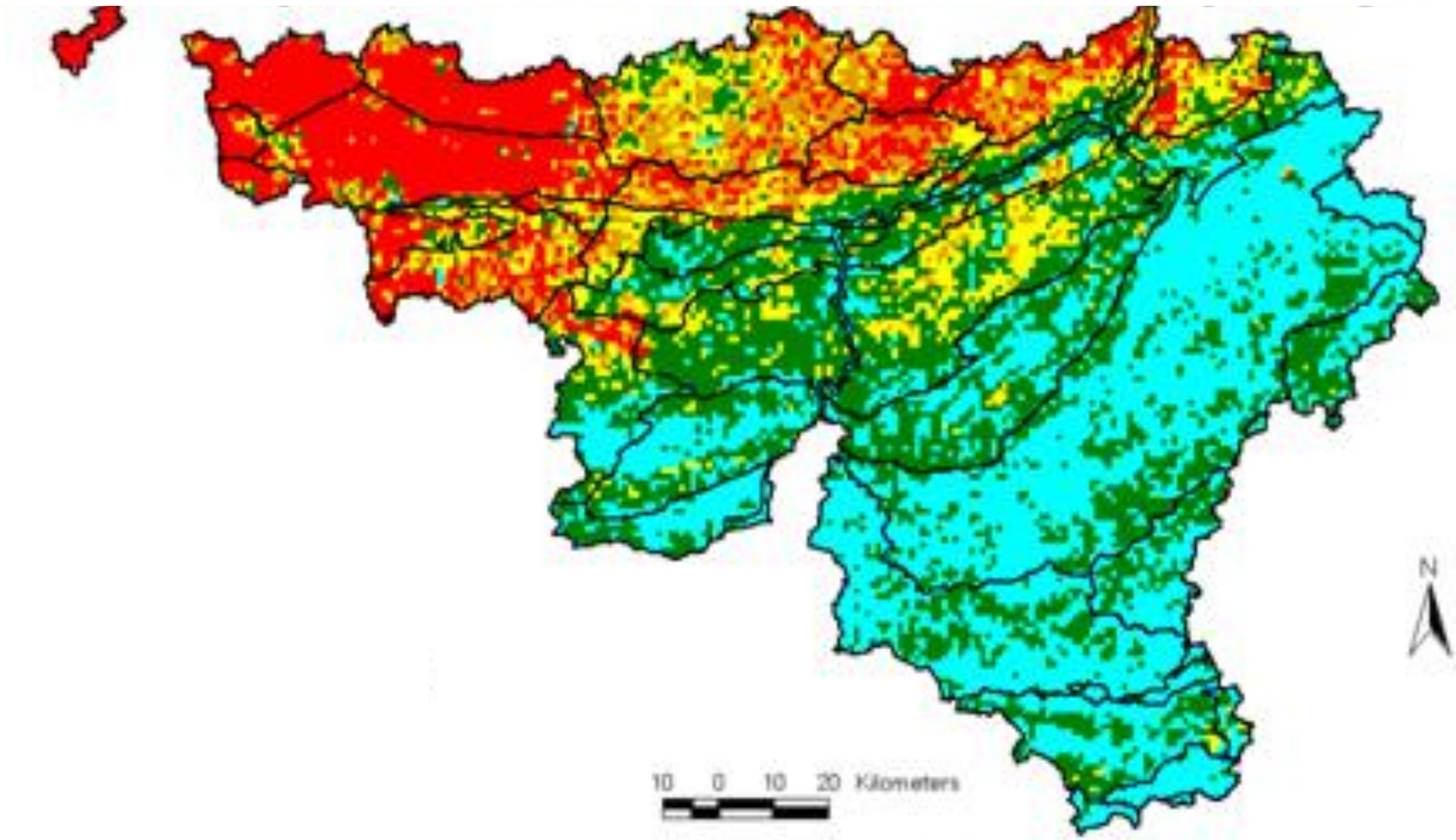



EPICgrid Model

- Based on EPIC (Williams, 1994)
- Developped through Eu, Belgian and Regional projects
- Spatially distributed
- Daily time step
- Long term runs (from 1960 to 2100 (and beyond))
- Water, N, P, OM and pesticides
- Erosion and sediment yield

Spatial coverage: Wallonia
Resolution : $1km^2$

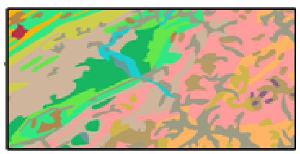
17 000 cells are used for the calculation



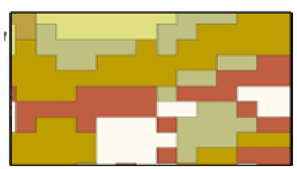
A cell and related data bases

Weather data

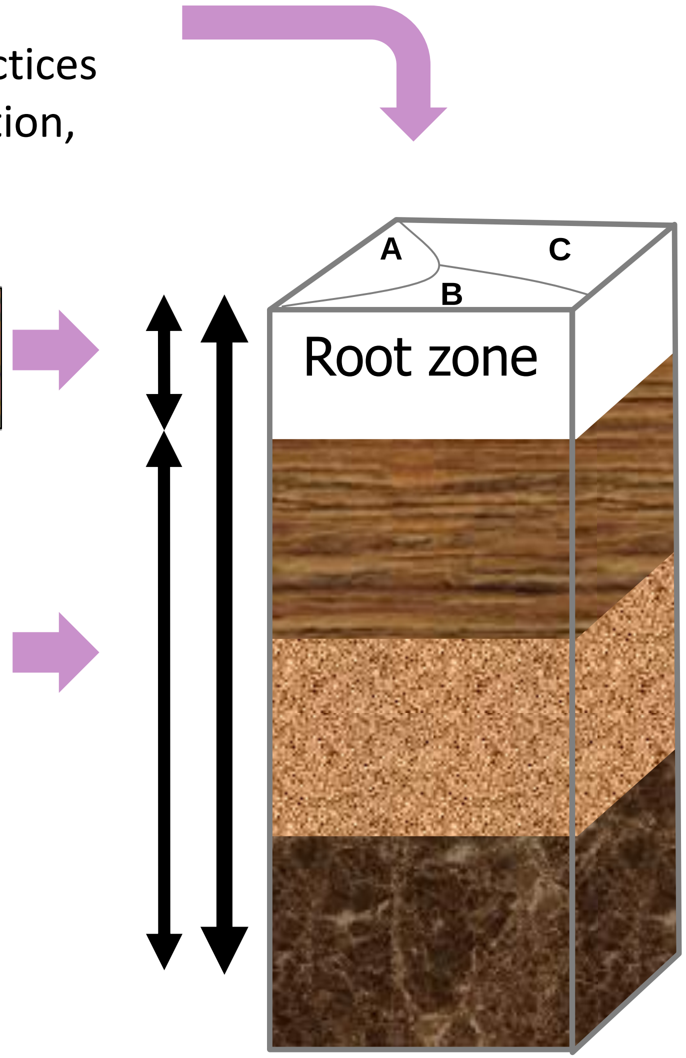
Agricultural practices (tillage, fertilization, pesticides, …)

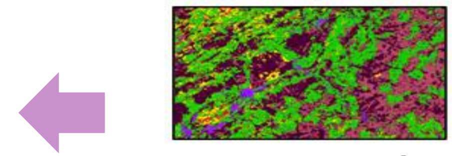


Soils

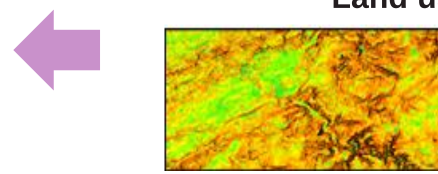


Geology





Land use

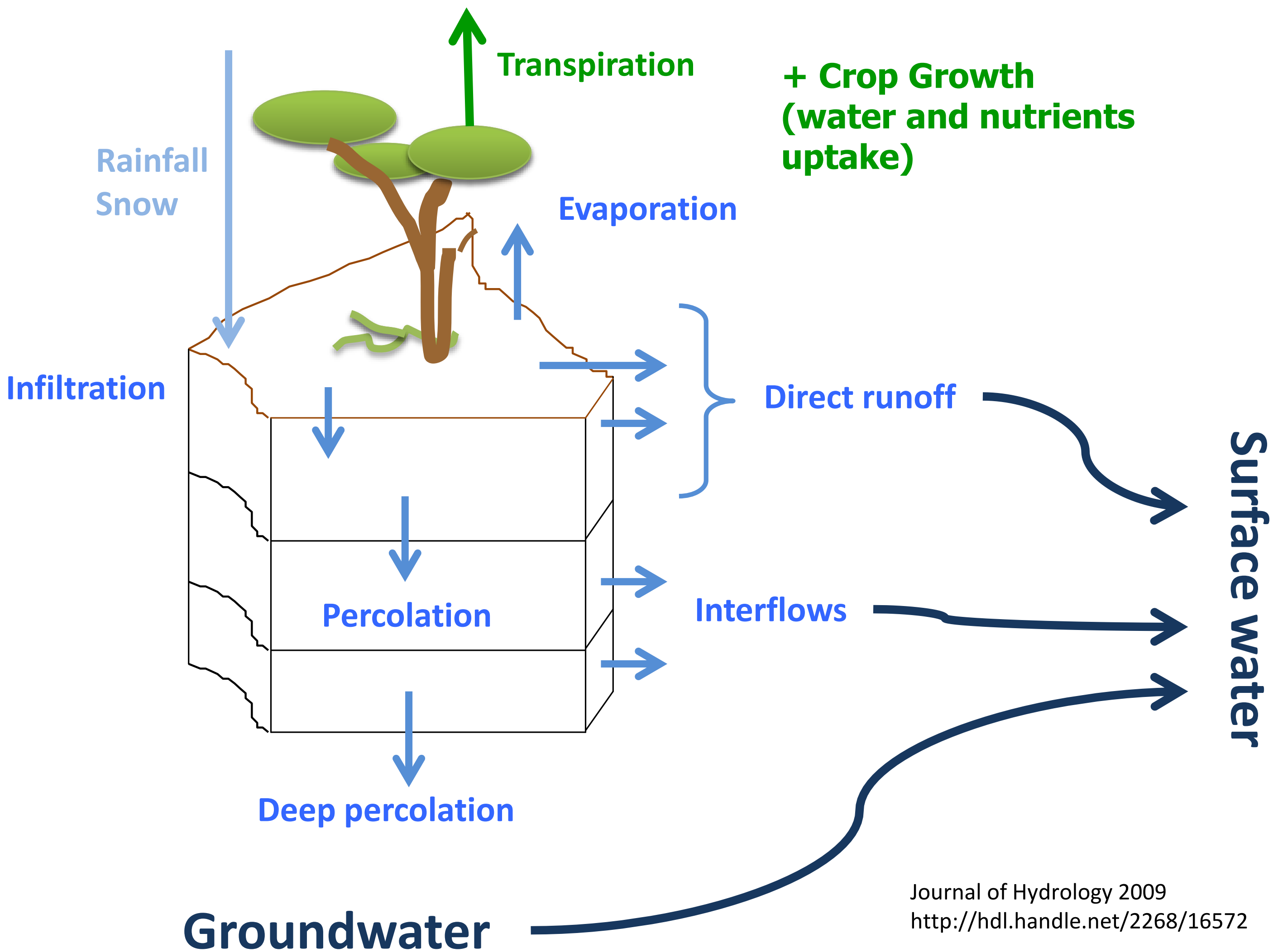


DTM

VADOSE zone :

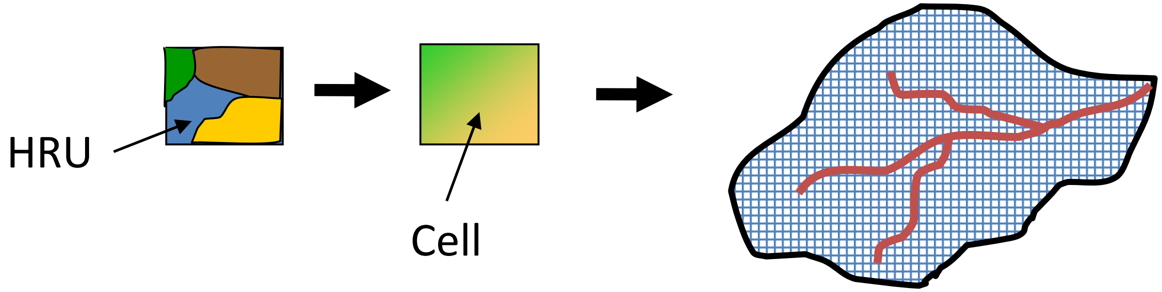
Variably saturated soil/subsoil

Modelling unit : HRU **inside** the cell

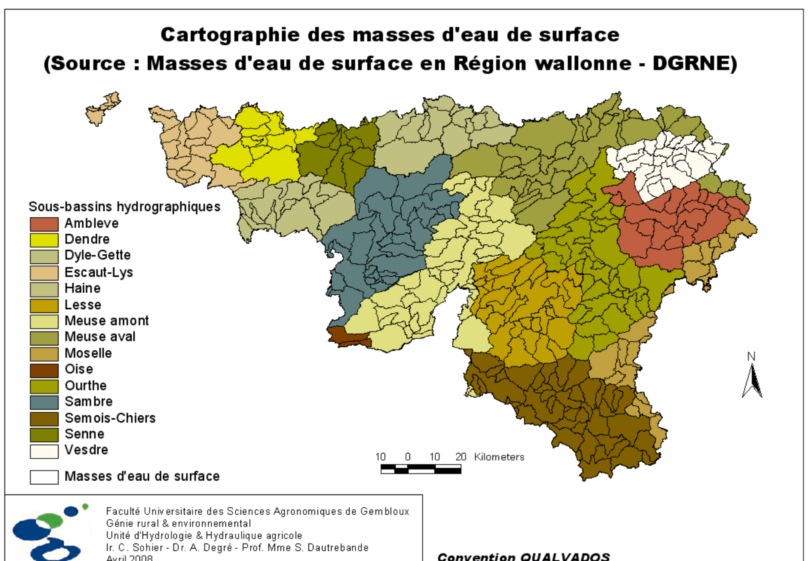


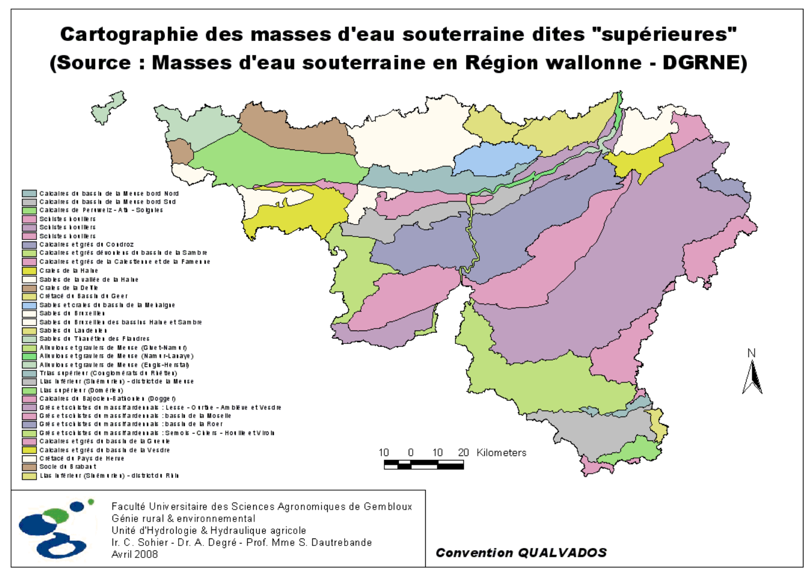
Journal of Hydrology 2009
http://hdl.handle.net/2268/16572

Flexible spatial reporting



Gridded maps, aggregation at watershed scale, surface water bodies, groundwater bodies, districts, ….



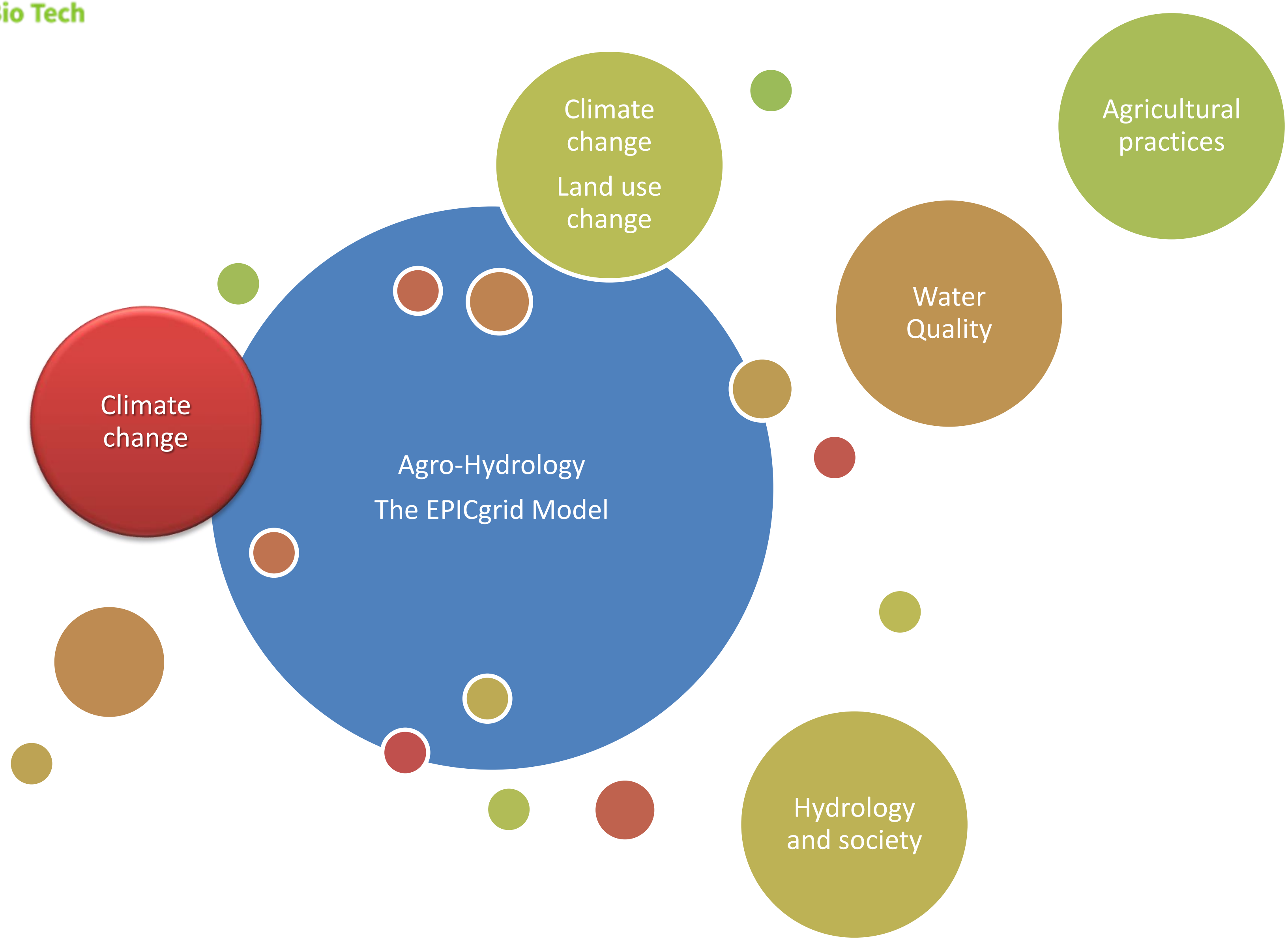


N cycle

- Plant uptake
- Nitrification
- Denitrification
- Mineralization
- Volatilization
- Symbiotic fixation
- Leaching

Erosion

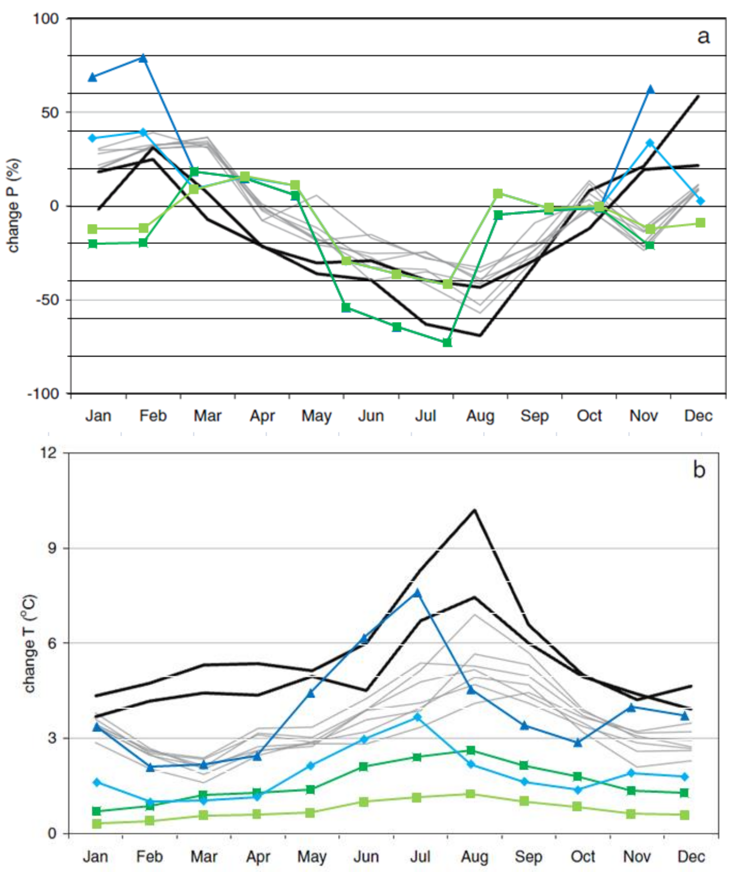
- USLE-MUSLE
- Deposition on grass strips

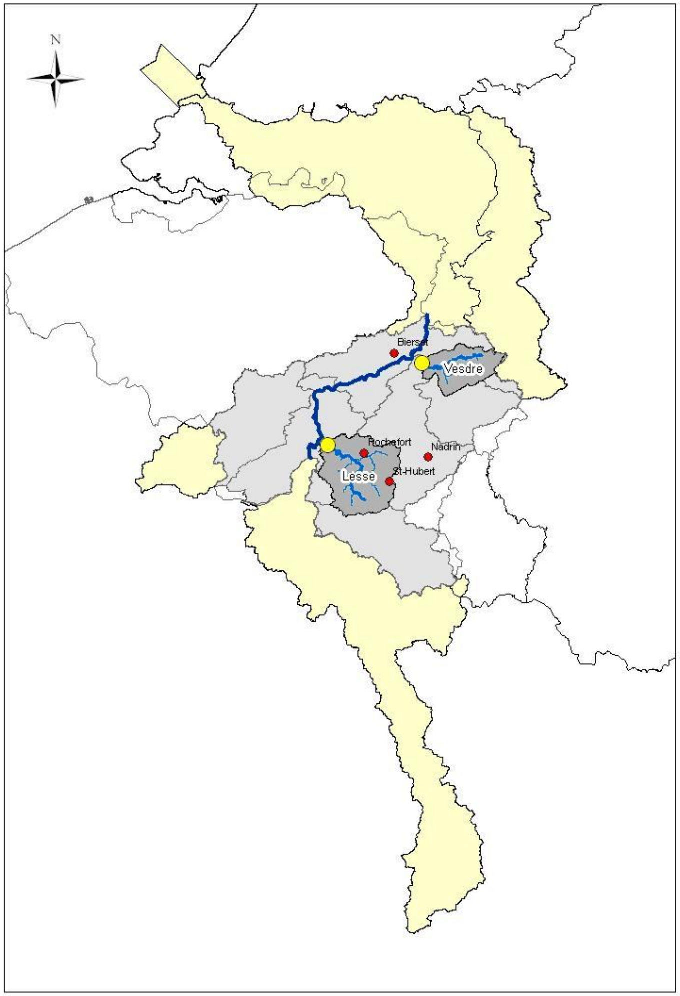


Some results…

AMICE project : **hydrology** of the Lesse and Vesdre catchments

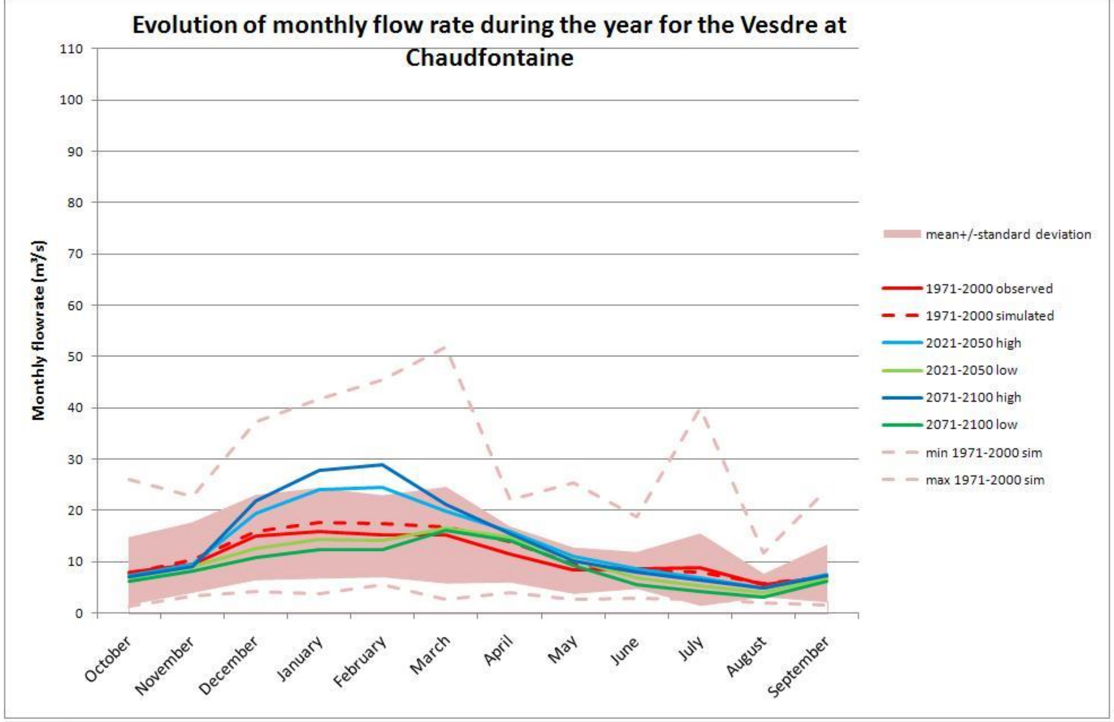
CCI-Hydr perturbation tool
high (blue) and low (green) scenarios
2020-2050 and 2070-2100

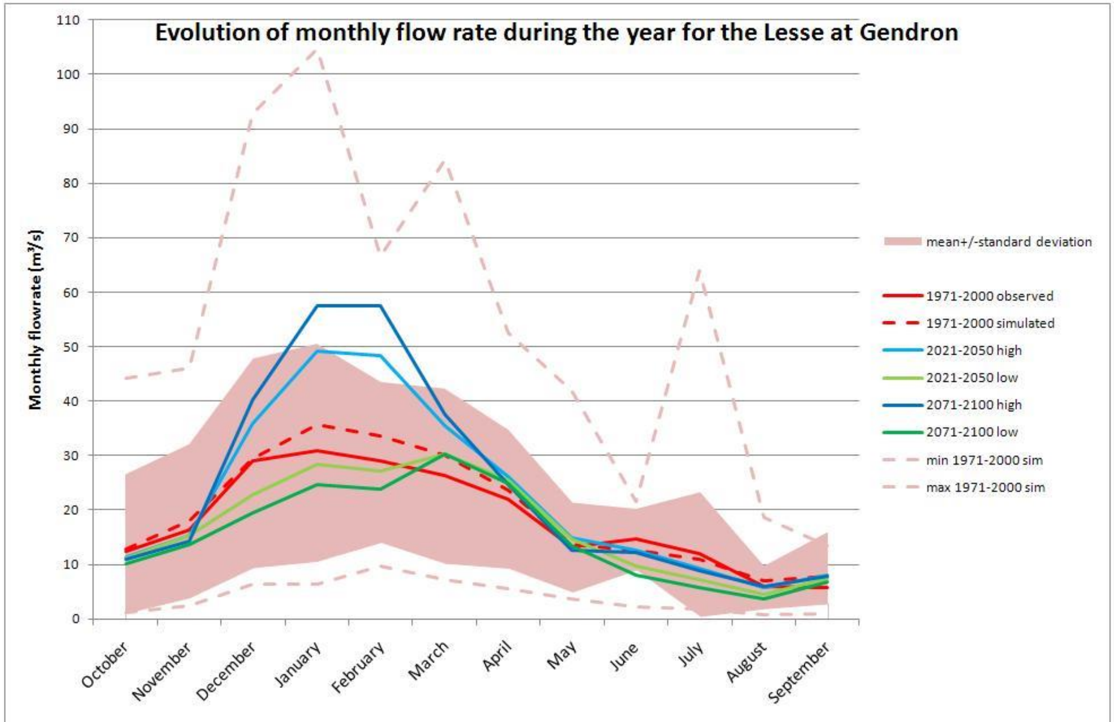




- Seasonal contrasts in river discharge could be strongly accentuated due to climate change in the Vesdre and Lesse catchments. (consistent with Wit et al. (2007) in the Meuse and other studies in surrounding catchments).

- For both high and low-flows even if far less studies have focused on low-flows





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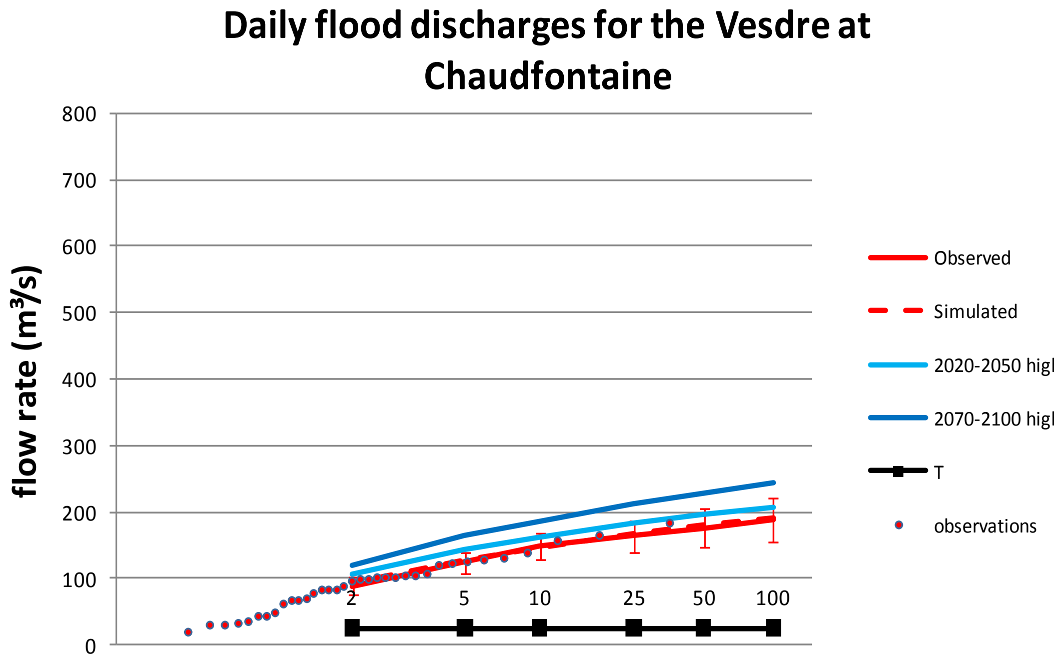
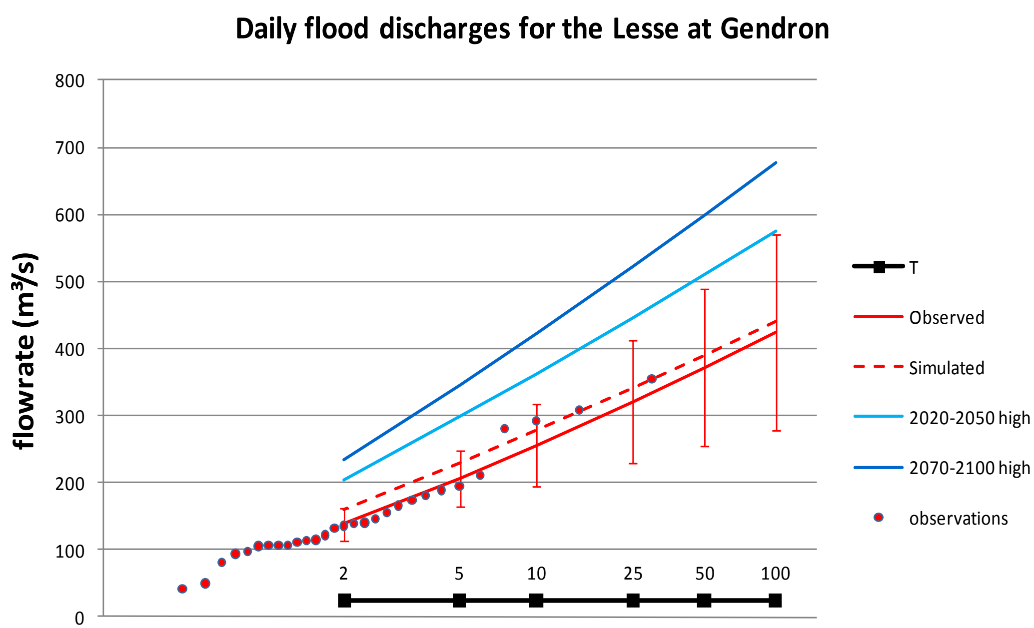
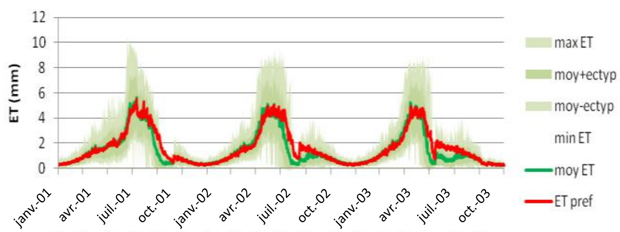


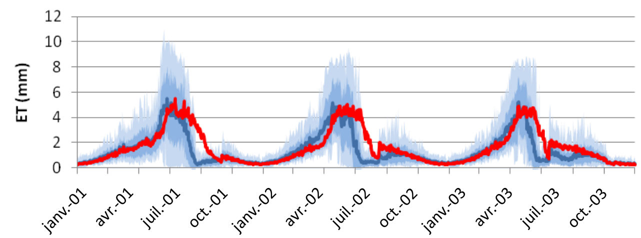


Focus on the soil-water-plant continuum

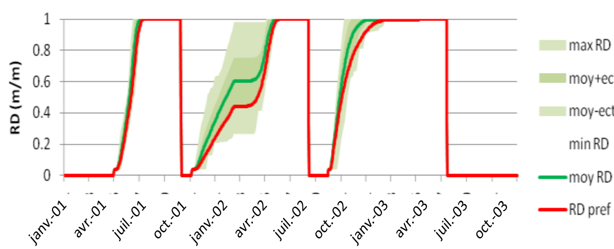
Maize Wheat Barley — Maize Wheat Barley

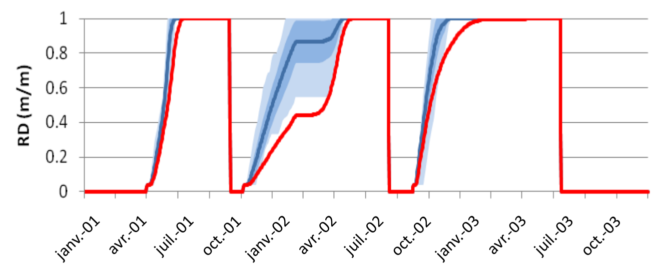
Actual evapotranspiration



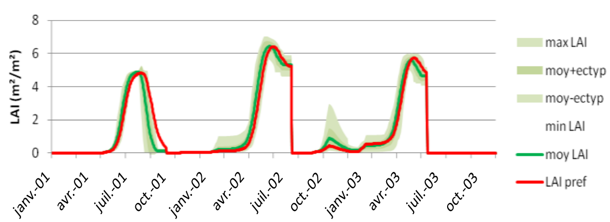


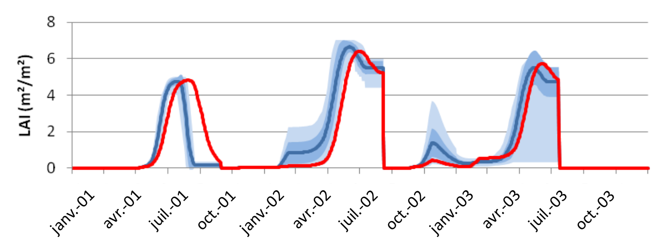
Root depth





Leaf area index (crop development)

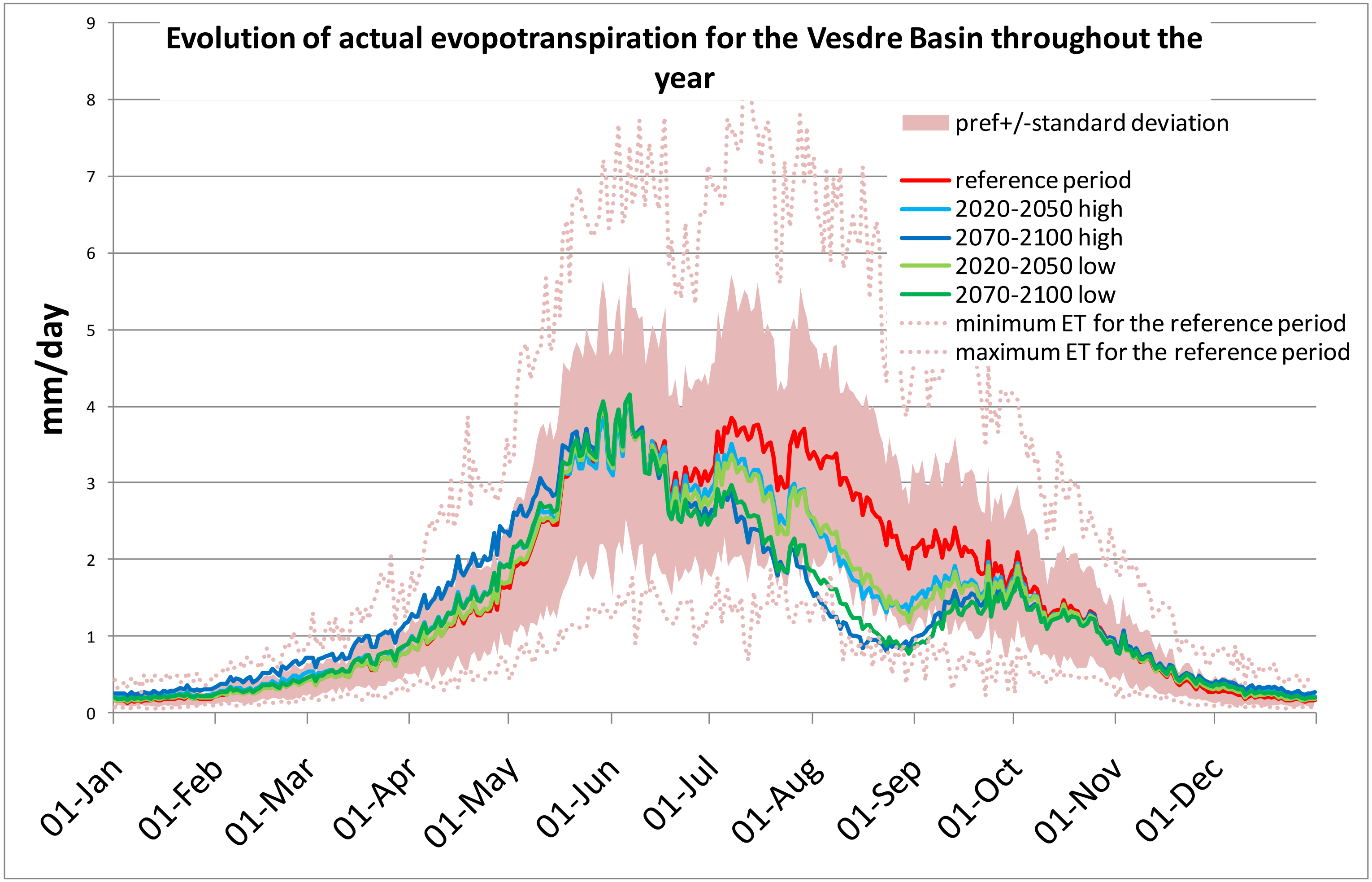




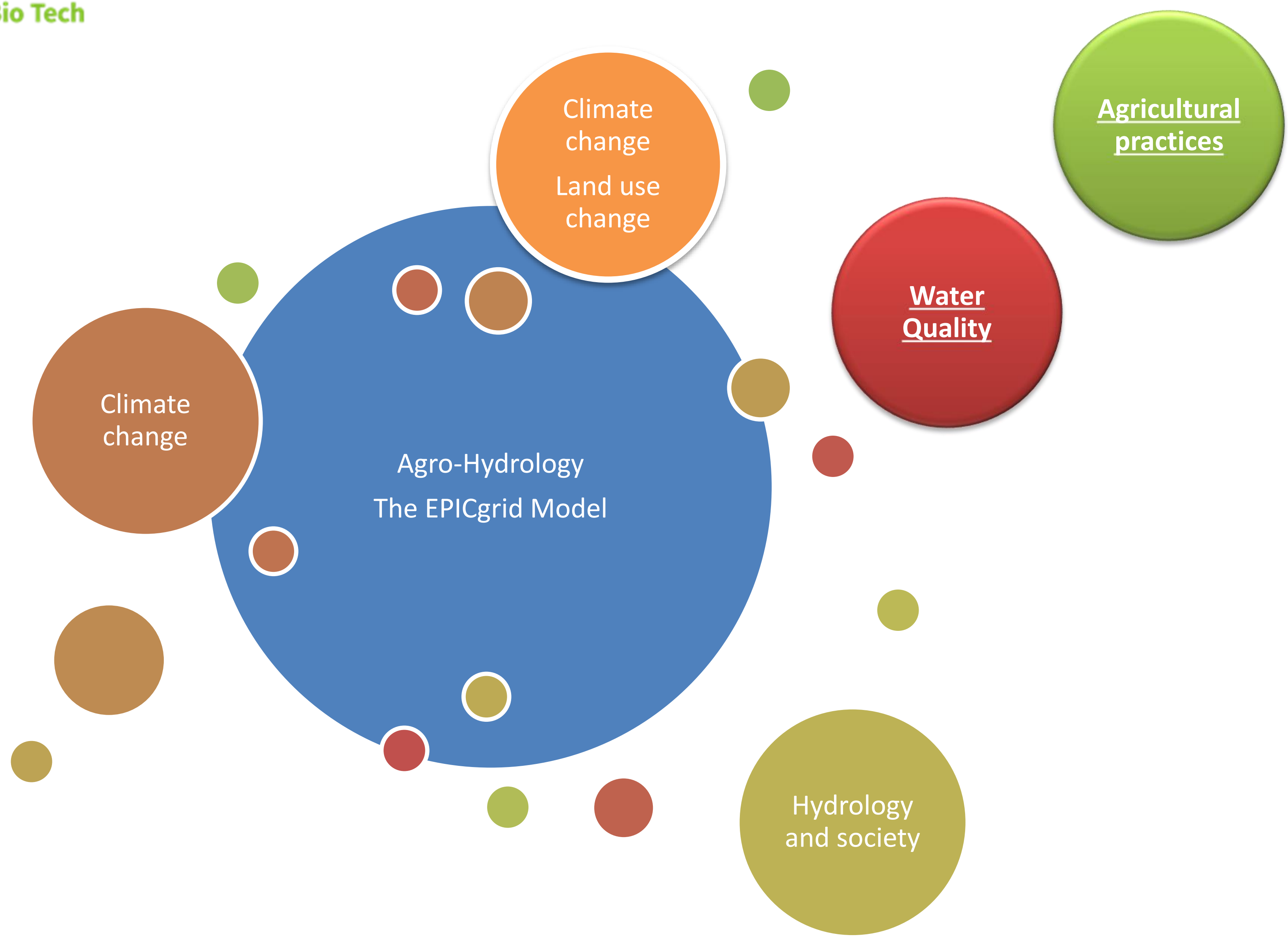
2070-2100 Low

2070-2100 High

Actual ET – CC scenarios



HESS 2011
http://hdl.handle.net/2268/91848

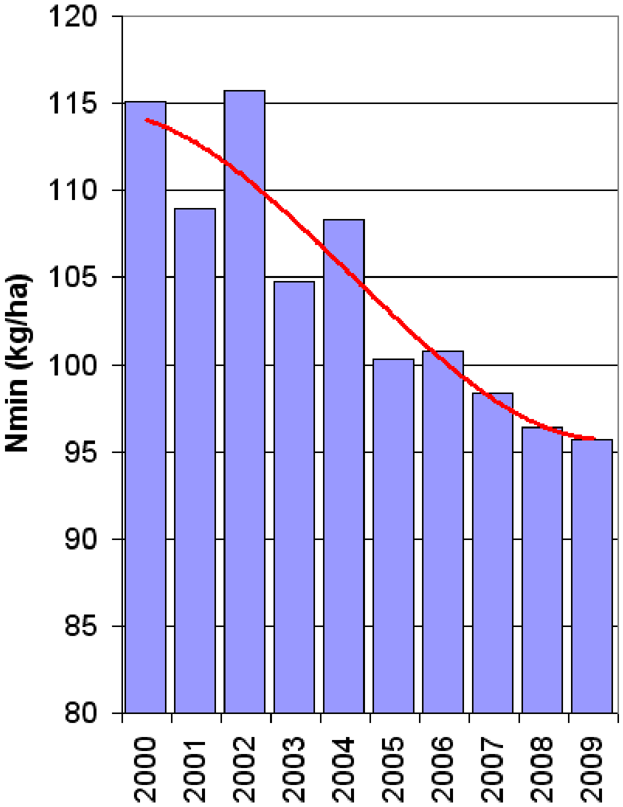


Climate change
Land use change
Agricultural practices
Water Quality
Climate change
Agro-Hydrology
The EPICgrid Model
Hydrology and society

Agronomical levers

➢ Nitrogen inputs

Nitrogen inputs decrease and supply splitting based on crop needs



Agronomical levers

➢ **Catch crop introduction**

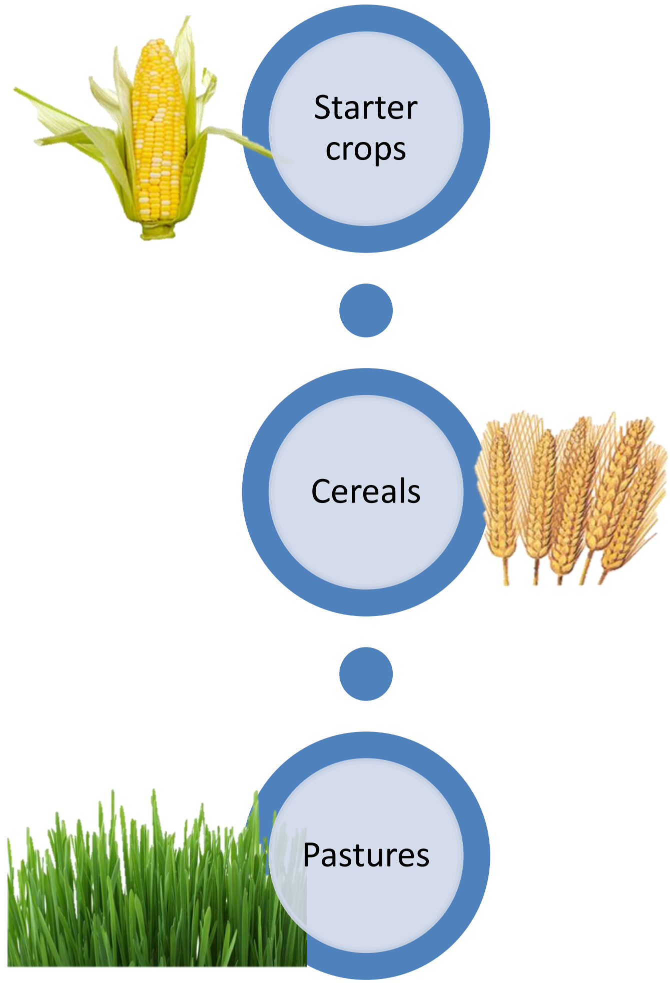
Bare soil in winter before spring crop

Catch crop introduction

Recycling of nitrogen into the root profile

Agronomical levers

➢ Modification of crop successions

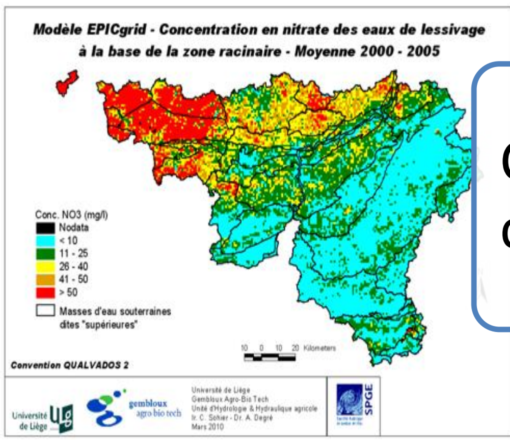


Modification of nitrogen soil content at the end of the growing season

Modelling results

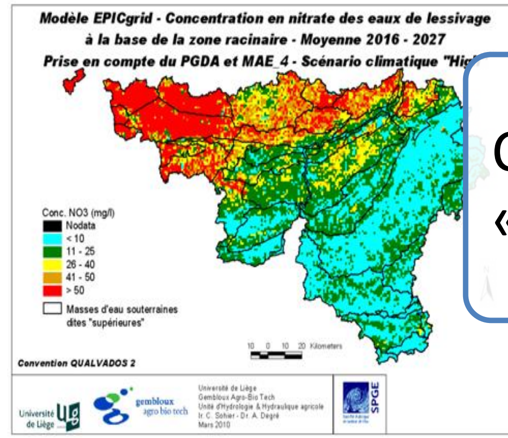
Early indicators : nitrate concentration below the root zone

2000-2005



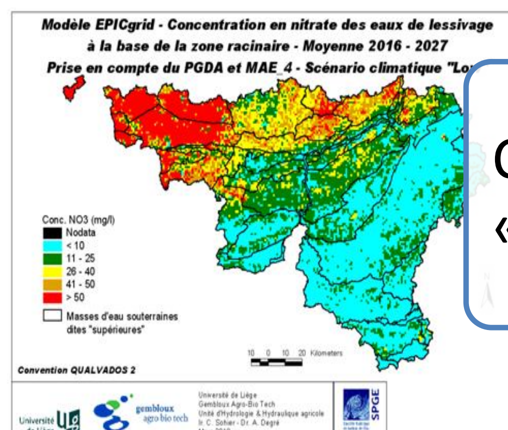
Current climate

2016-2027



CC « high »

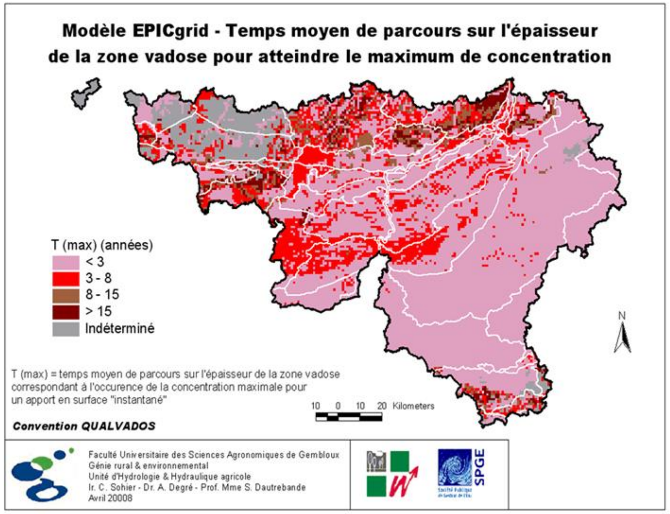
2016-2027

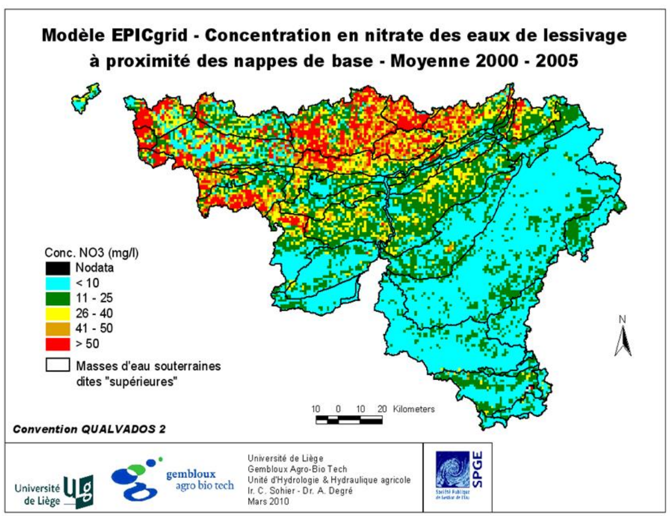


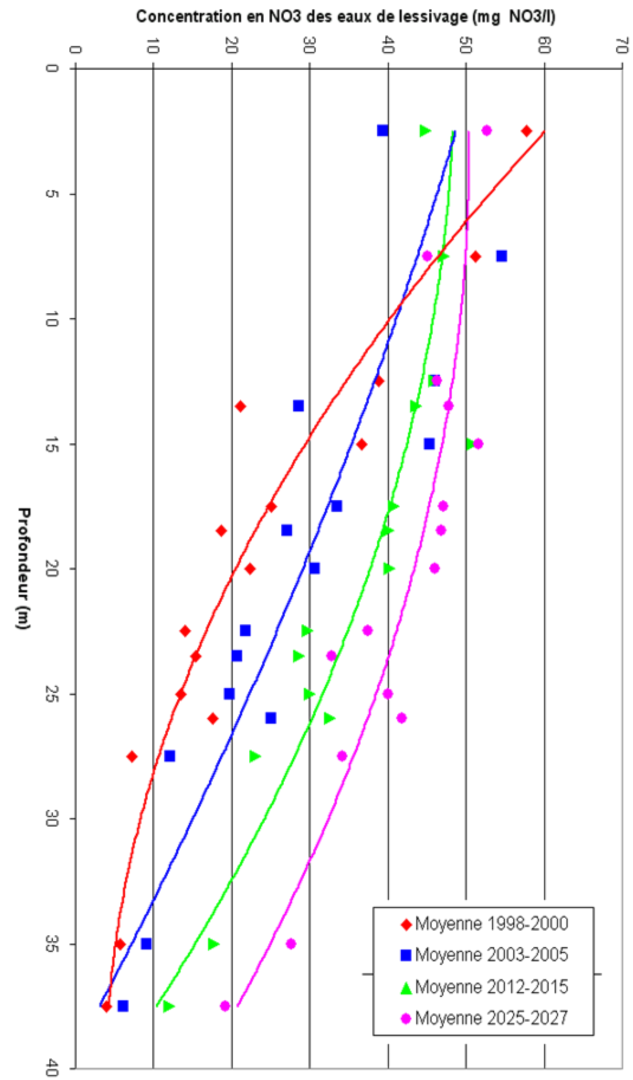
CC « low »

Modelling results :

nitrate concentration at the groundwater level

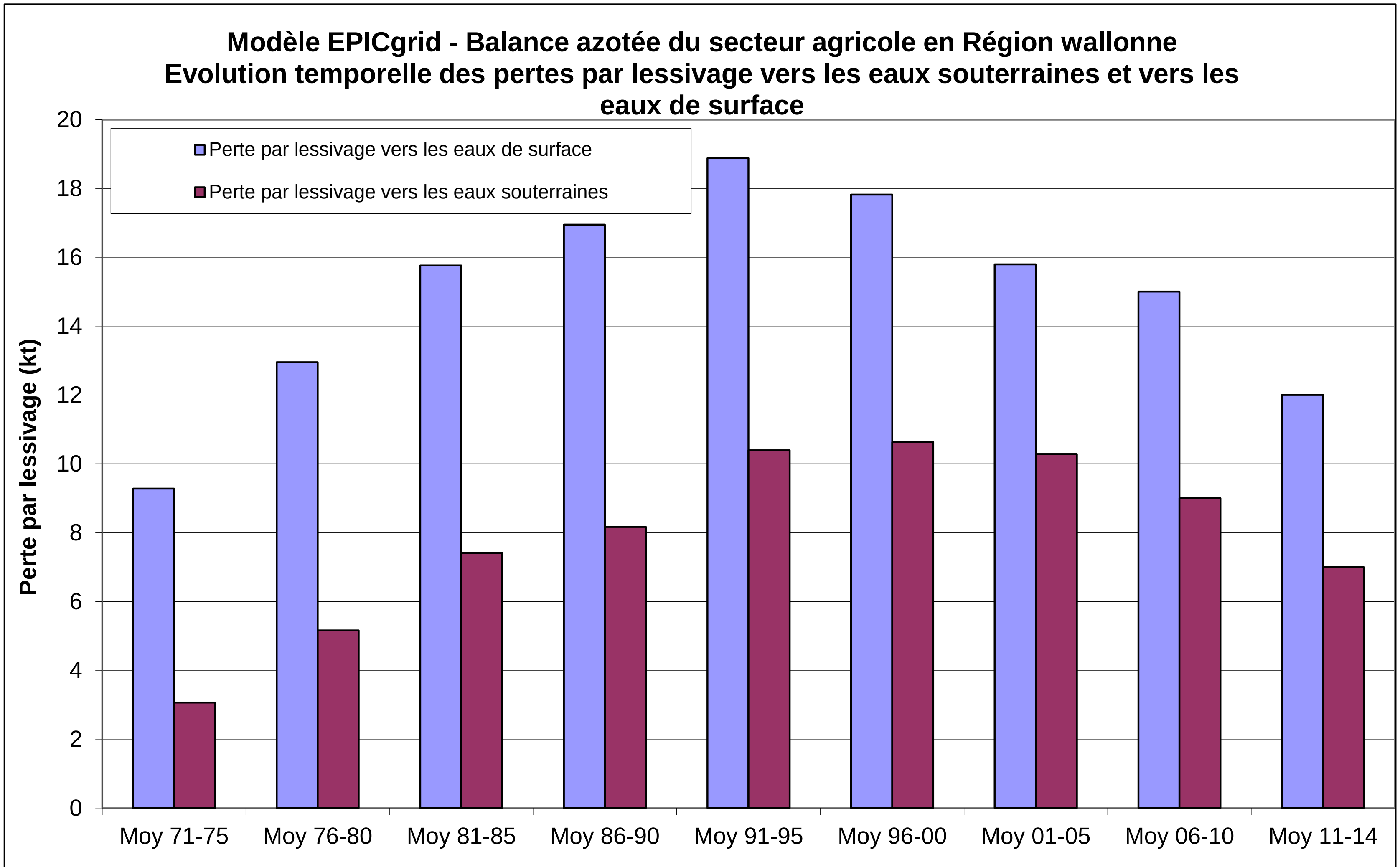




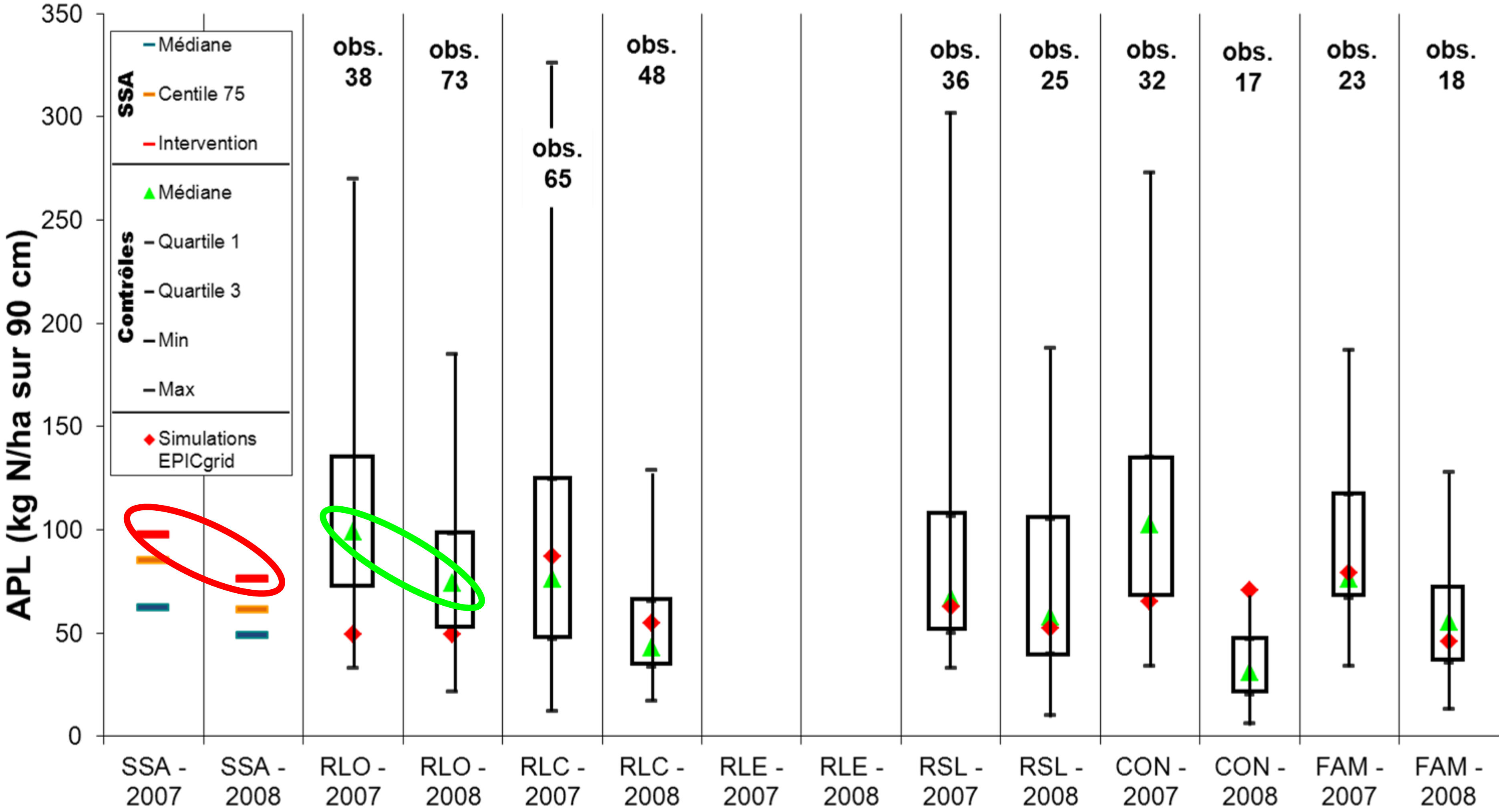


Crétacé de Hesbaye

N loss towards surface water and groundwater against time at the regional scale



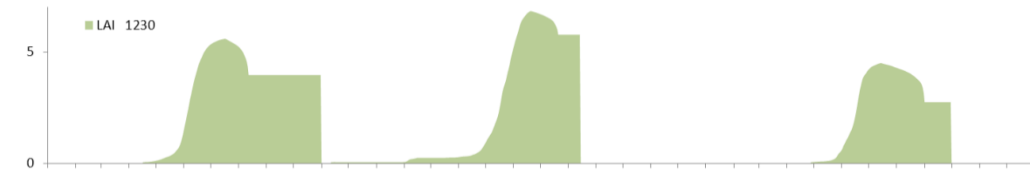
Modelling results : nitrogen stock in the root zone



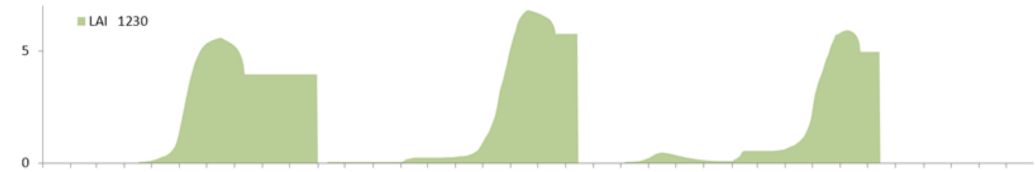
Comparison of different crop rotations

Leaf Area Index

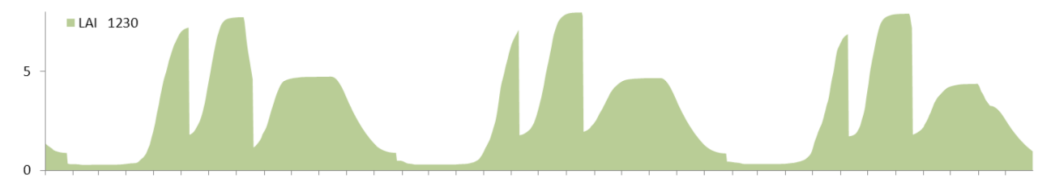
Sugar beet – Wheat - Potato



Sugar beet – Wheat - Barley

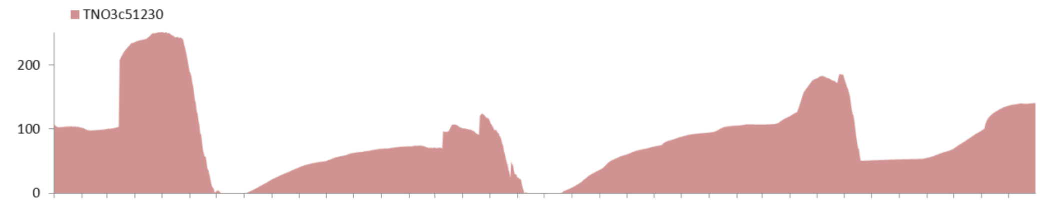


Grassland

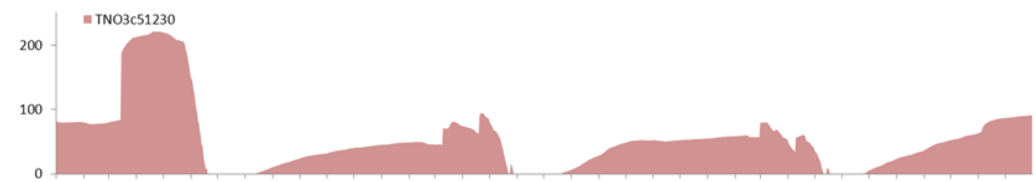


Nitrogen content in the root zone (kg/ha)

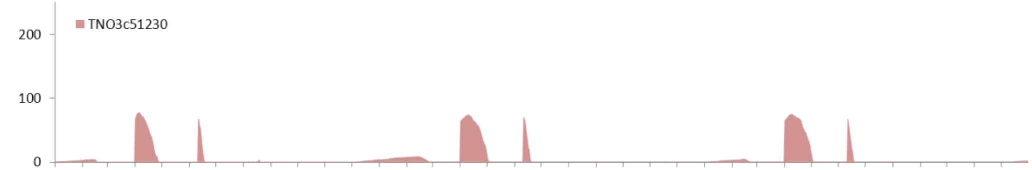
Sugar beet – Wheat – potato



Sugar beet – Wheat - Barley



Grassland



Comparison of different crop rotations

Leaf area index

Sugar beet – Wheat - Potato

Sugar beet – Wheat - Barley

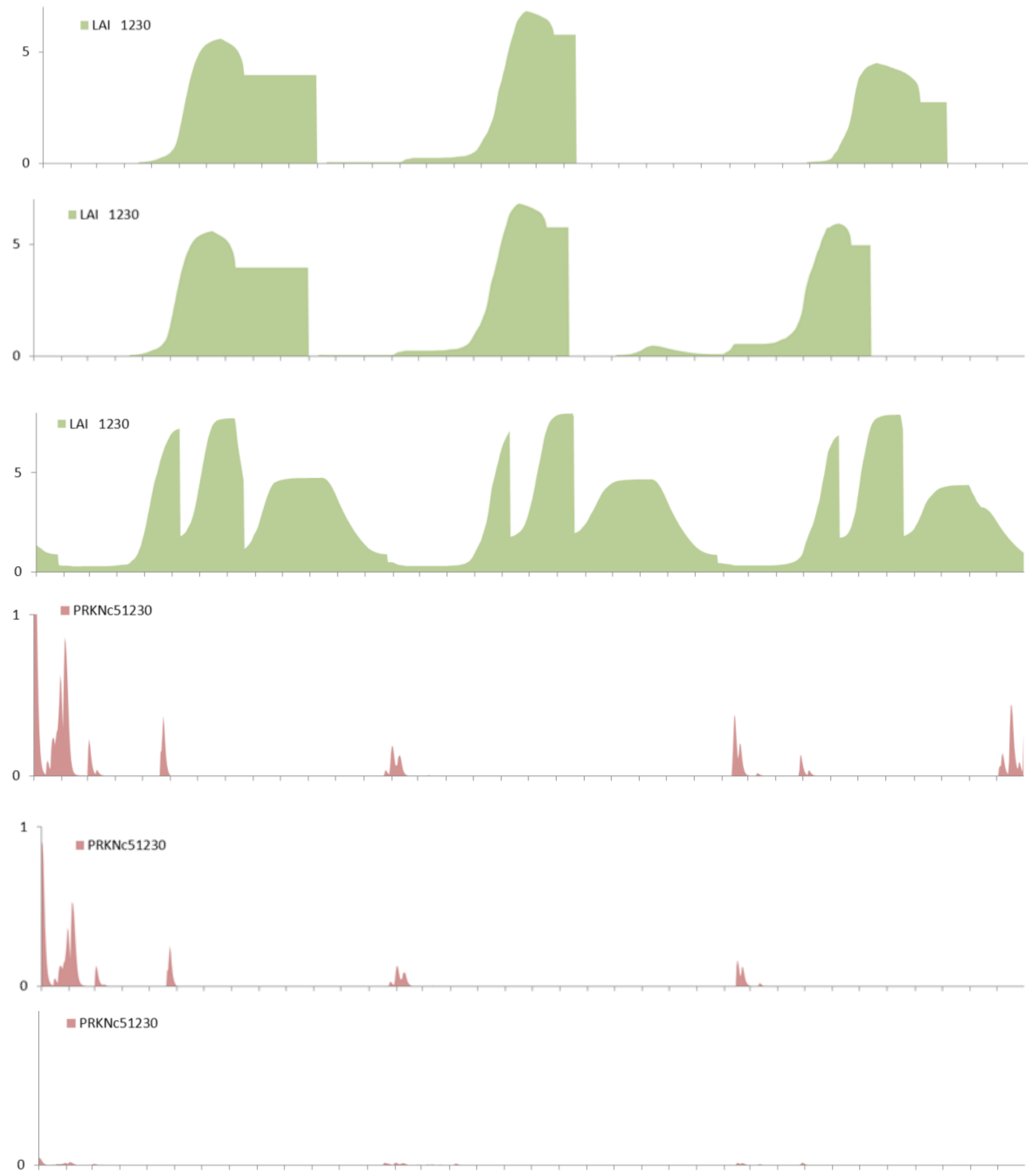
Grassland

Nitrogen loss to groundwater (kg N/ha)

Sugar beet – Wheat – potato

Sugar beet – Wheat - Barley

Grassland

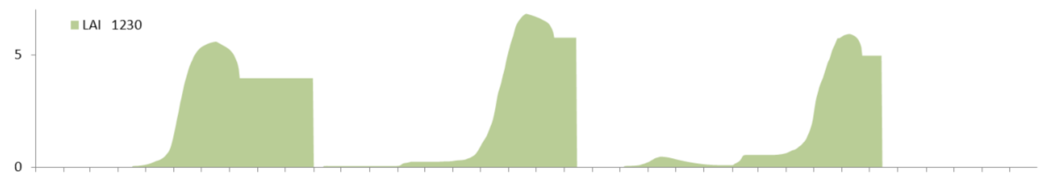


Effect of a catch crop

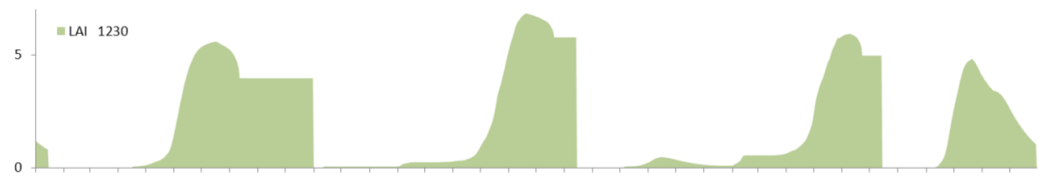
Leaf area index

Sugar beet –> Wheat -> Barley

Without catchcrop

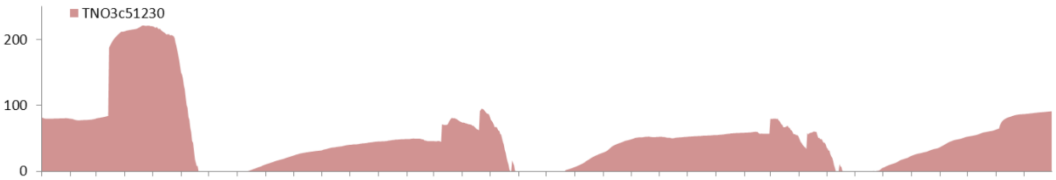


With catchcrop

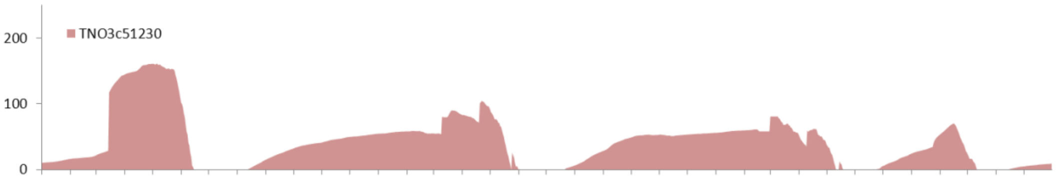


Nitrogen loss to groundwater (kg N/ha)

Without catchcrop



With catchcrop

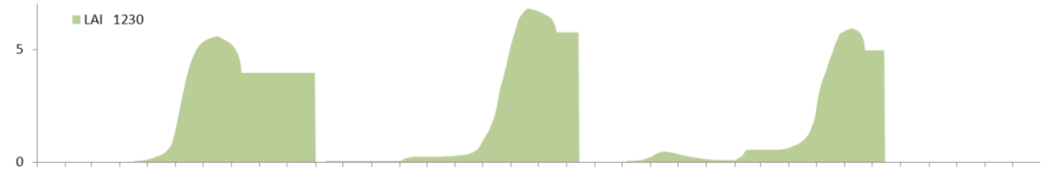


Effect of a catch crop

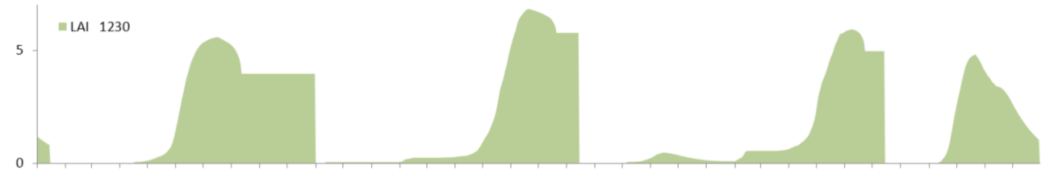
Sugar beet –> Wheat -> Barley

Leaf area index

Without catchcrop

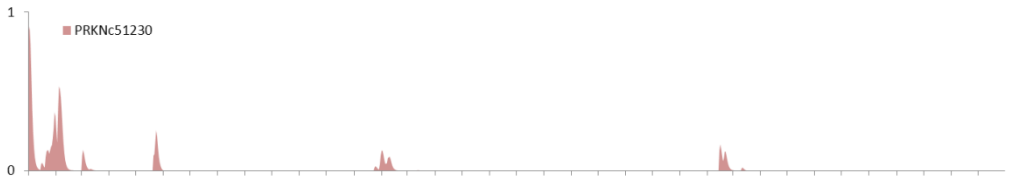


With catchcrop

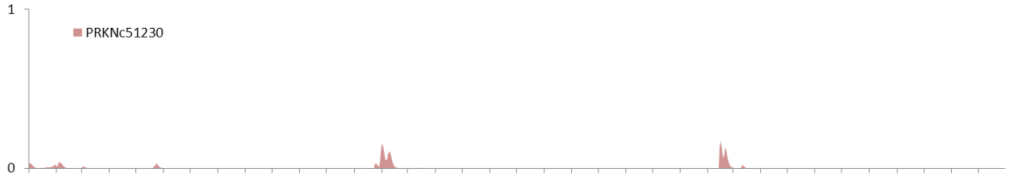


Nitrogen loss under the root zone (kg N/ha)

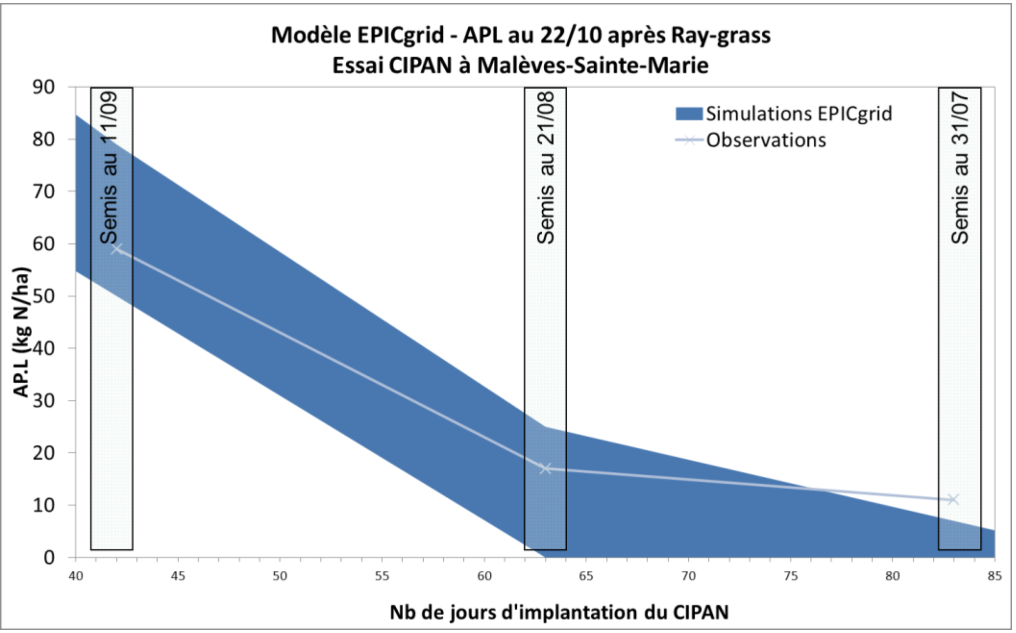
Without catchcrop



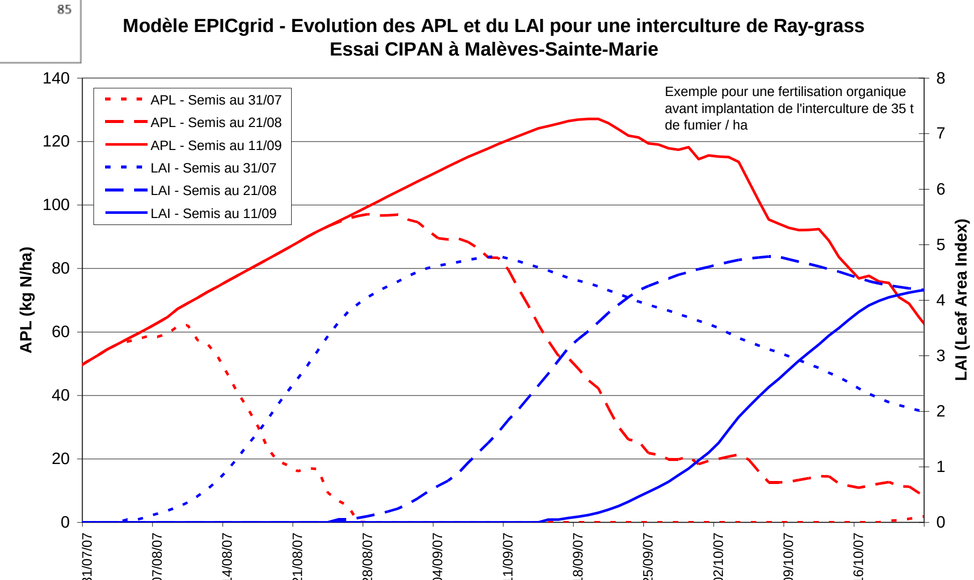
With catchcrop



Effect of a catch crop

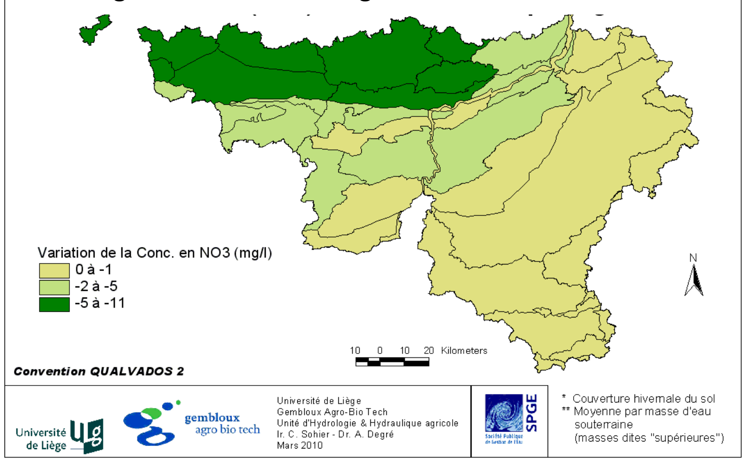


Seeding date impact
Crop development and remaining nitrogen in the soil

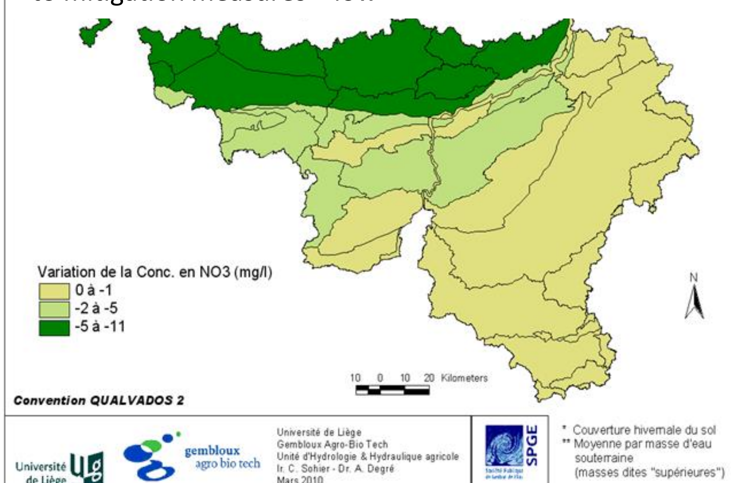


At Regional scale

Nitrate concentration decrease under the root zone due to mitigation measures – high

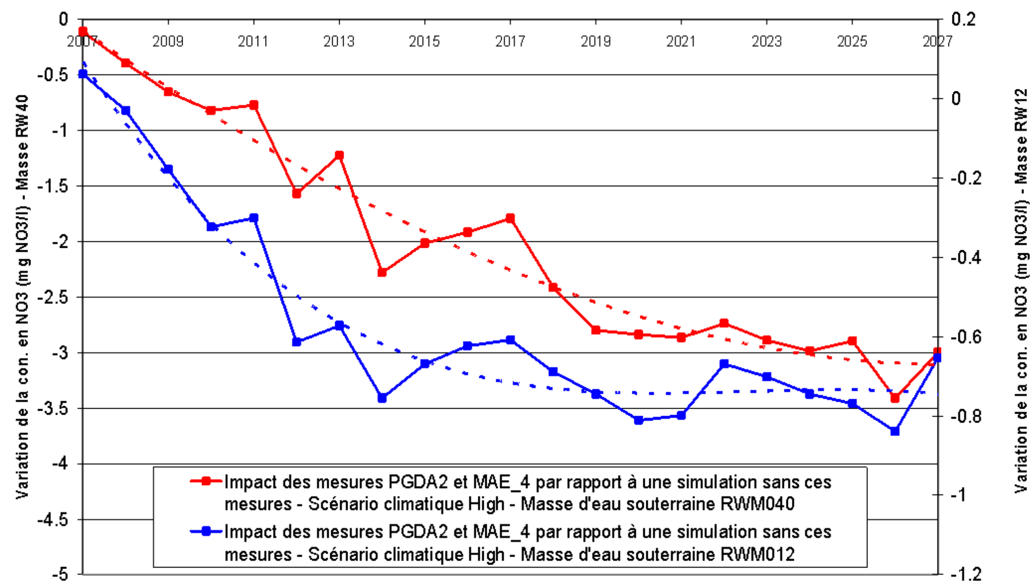


Nitrate concentration decrease under the root zone due to mitigation measures – low



Impact of all the mitigation measures put into practice in the frame of the nitrate Directive
Results presented at the groundwater bodies level

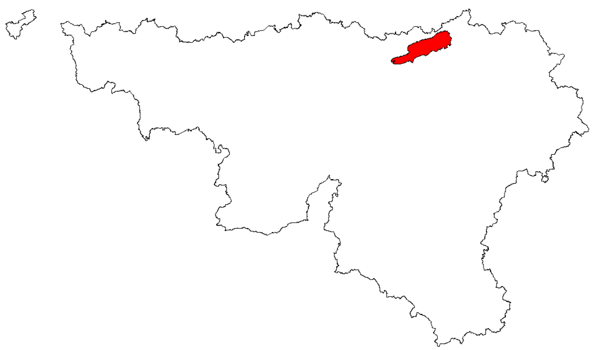
Temporal effect of the mitigation measures
(assessment of nitrate concentration decrease in the recharge water)

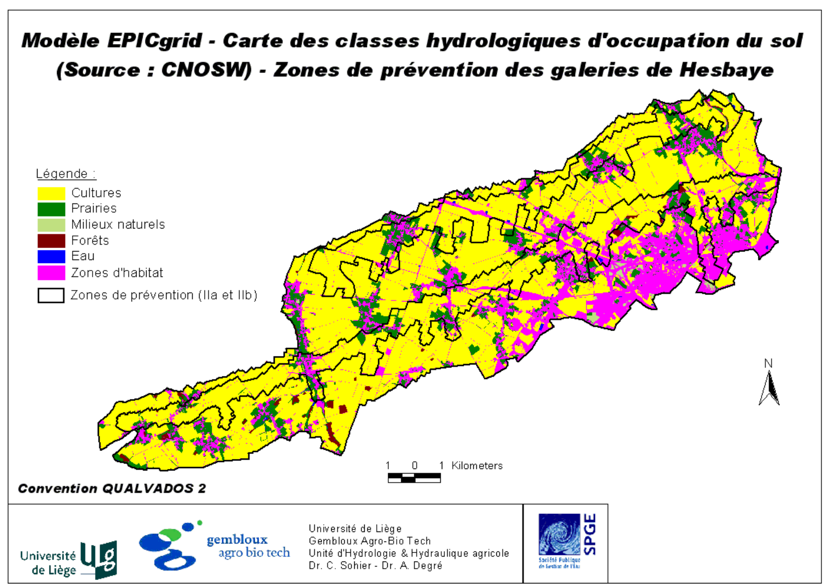


Environmental Science and Policy (2010)
http://hdl.handle.net/2268/70276

Abstraction zone protection

➢ **in a smaller zone with a strategic importance for drinking water production**

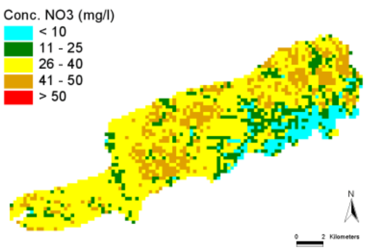




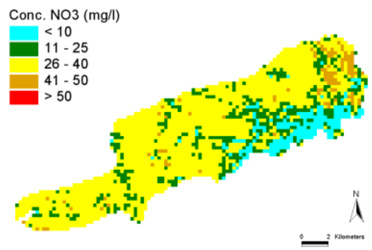
Combination of different scenarios around an abstraction zone

Reference

« High »

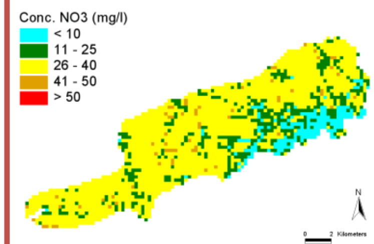


« Low »

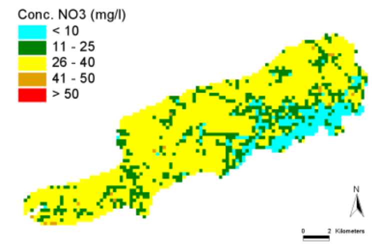


Scenario « 2/3 cereals »

« High »

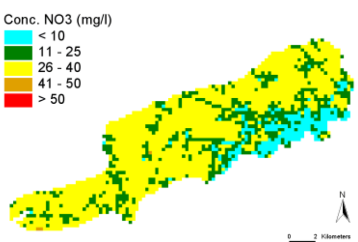


« Low »

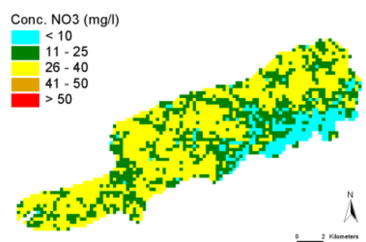


Scenario « -30 kg Nmin »

« High »

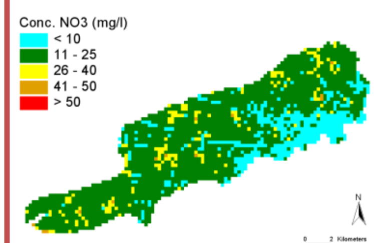


« Low »

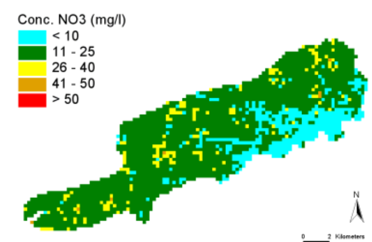


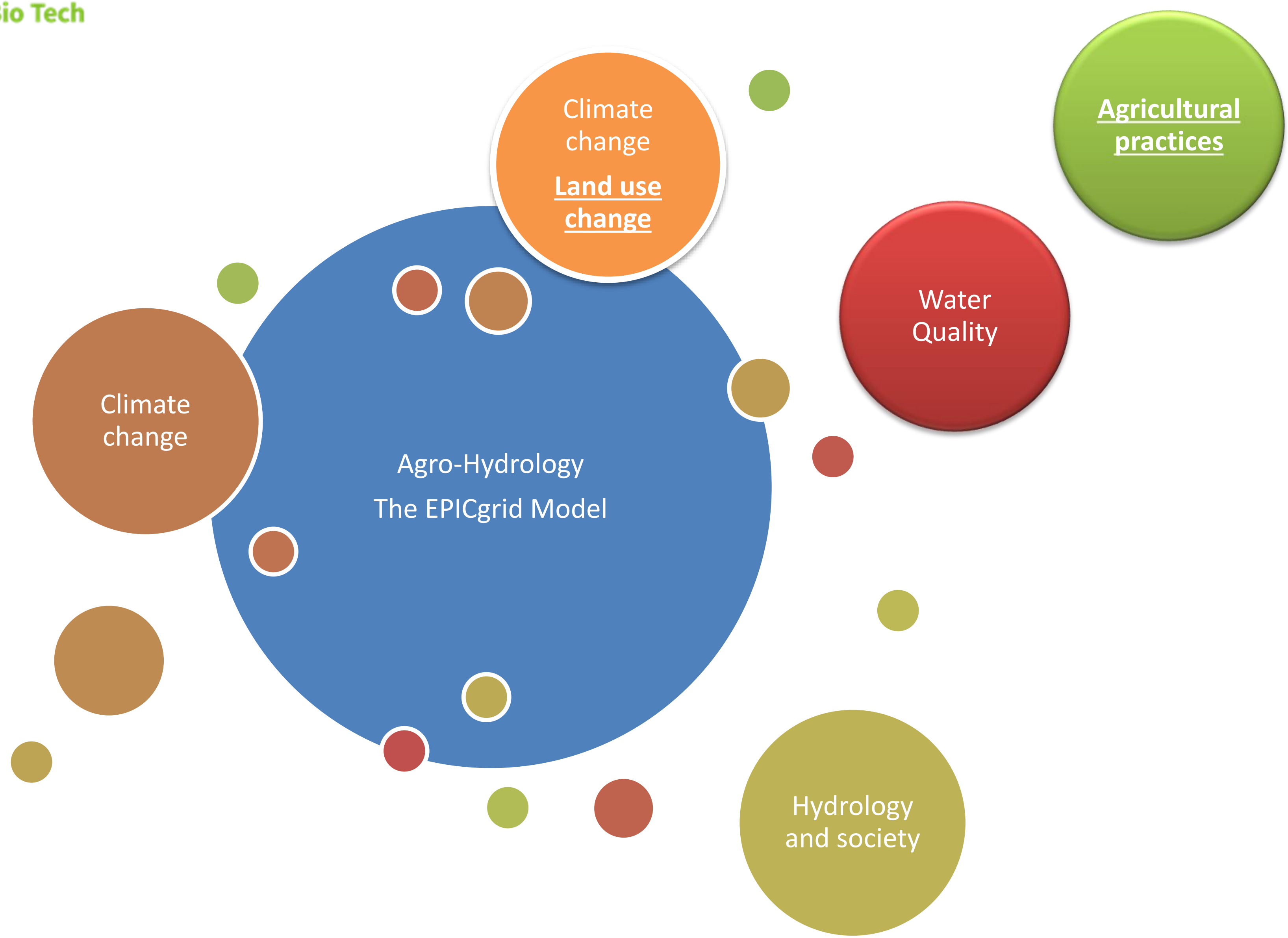
Scenario « grassland »

« High »

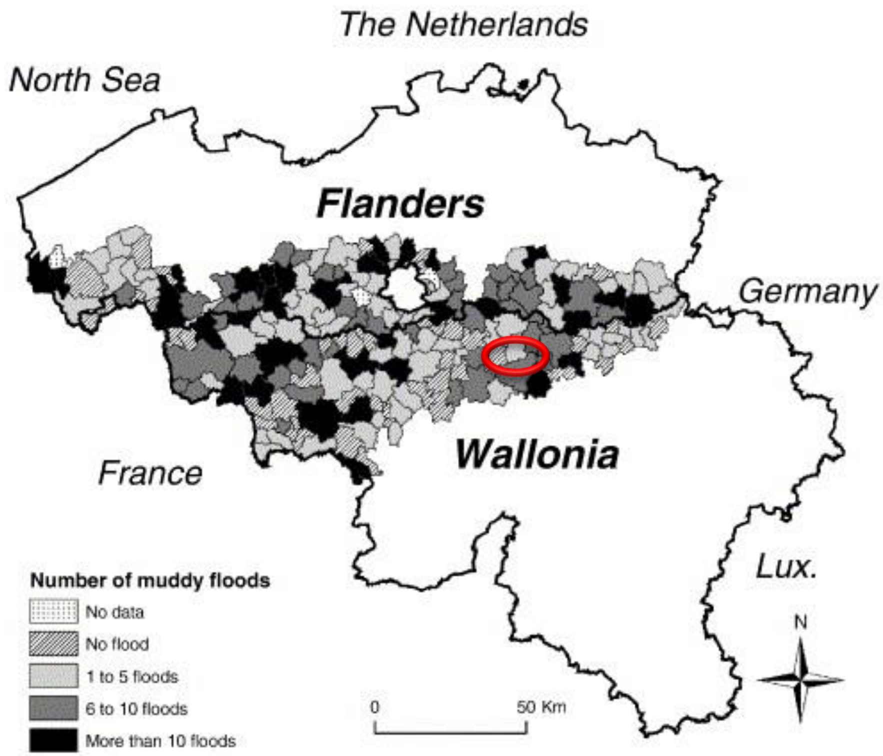


« Low »



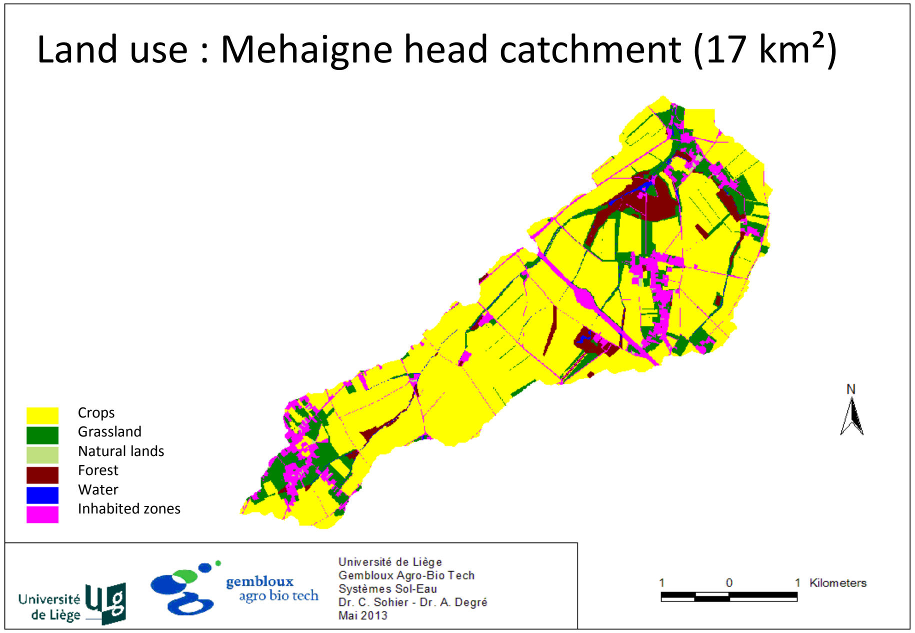

Climate
change
Land use
change
Agricultural
practices
Water
Quality
Climate
change
Agro-Hydrology
The EPICgrid Model
Hydrology
and society

Land use



Frequency of muddy floods over a 10-year period in all municipalities of the study area; data for Wallonia (1991–2000) taken from Bielders et al. (2003), data for Flanders (1995–2004) derived from a questionnaire sent to all municipalities in 2005.

O. Evrard, C. Bielders, K. Vandaele, B. van Wesemael, Spatial and temporal variation of muddy floods in central Belgium, off-site impacts and potential control measures, CATENA, Volume 70, Issue 3, 1 August 2007, Pages 443-454, ISSN 0341-8162, 10.1016/j.catena.2006.11.011.



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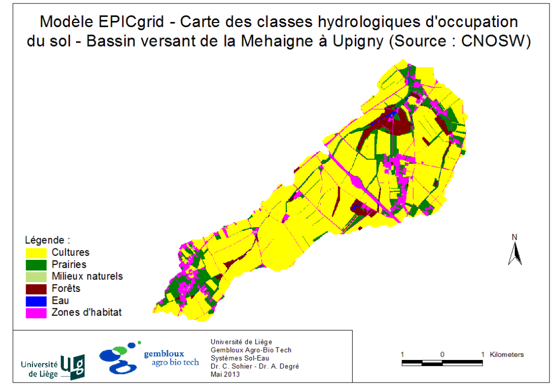
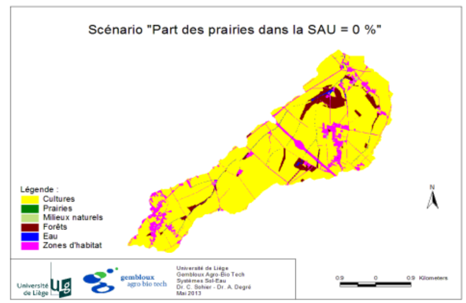
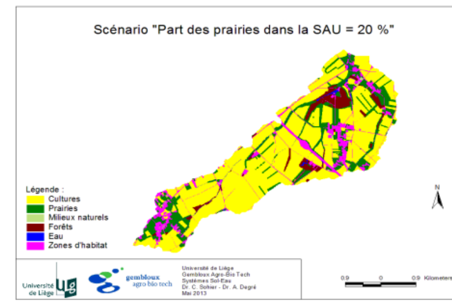
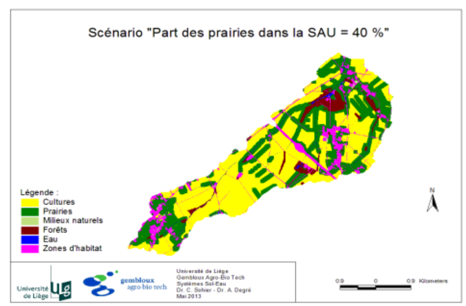
Land use change

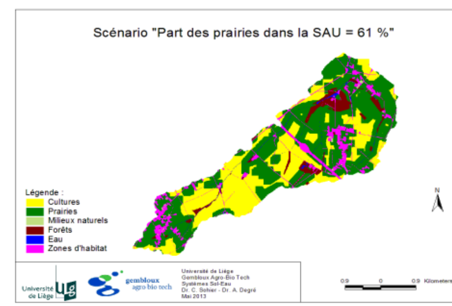
- Current situation
  - 10% settlements
  - 84% agriculture
    - 71% crops
    - 13% grasslands
- Scenarios
  - 10% settlements
  - 84% agriculture
    - From 100 to 0% crops
    - From 0 to 100 % grasslands

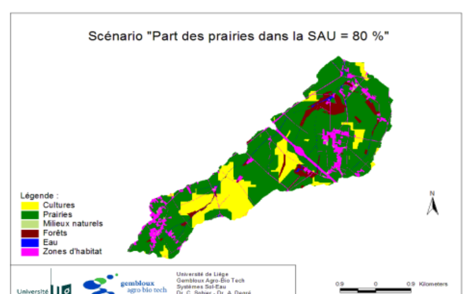


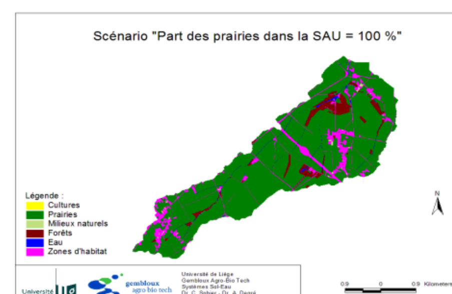






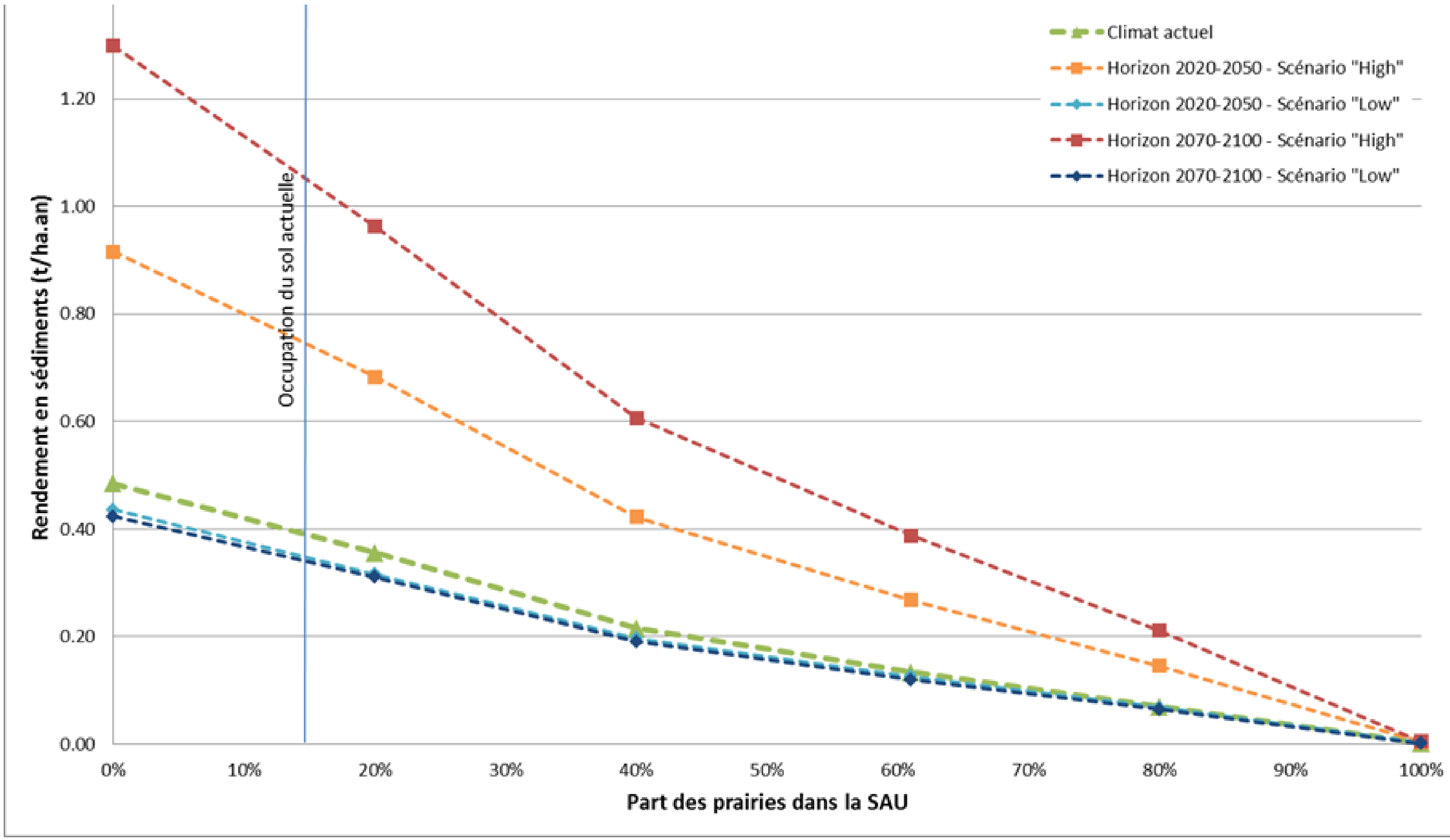






Land use change

EPICgrid – sediment yield under current climate and CCI-Hydr high and low scenarios – The Mehaigne in Upigny (17 km²)



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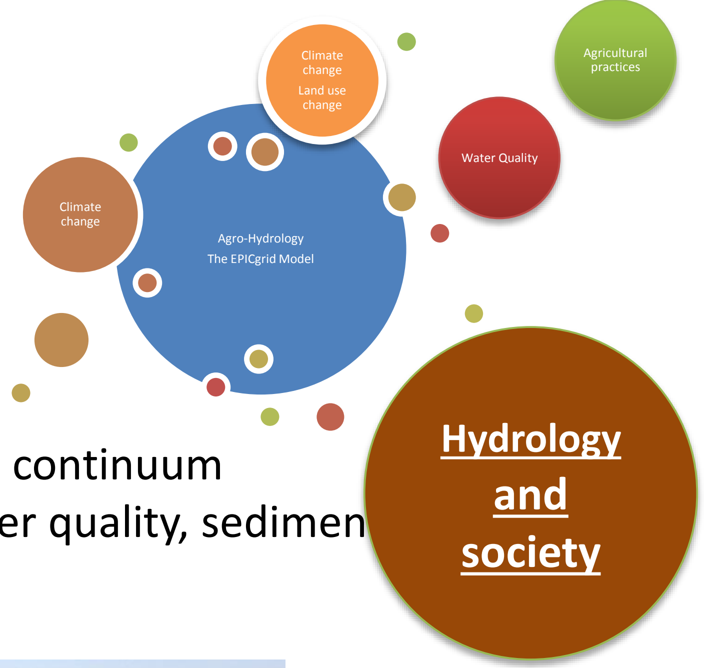
Ongoing developments

(current project : 2016-2020)

- Yearly adaptation of agricultural practices
- Diversity of the agricultural practices (Reduced tillage, organic farming, …)
- Pesticide modelling
- P modelling



Agronomy and hydrology are closely interconnected,
Agro-Hydrological model put the light on water-soil-plant continuum
It shows some open ends about (evapotranspiration, water quality, sedimen
And still open questions related to modelling

Thank You

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