Hydrology and Hydraulic Eng.
Environmental Department

Gembloux Agricultural University

gembloux
faculté universitaire
des sciences agronomiques

Walloon action plan for nitrogen sustainable management in agriculture
Prospective modelling of nutrient transfer in surface water and groundwater

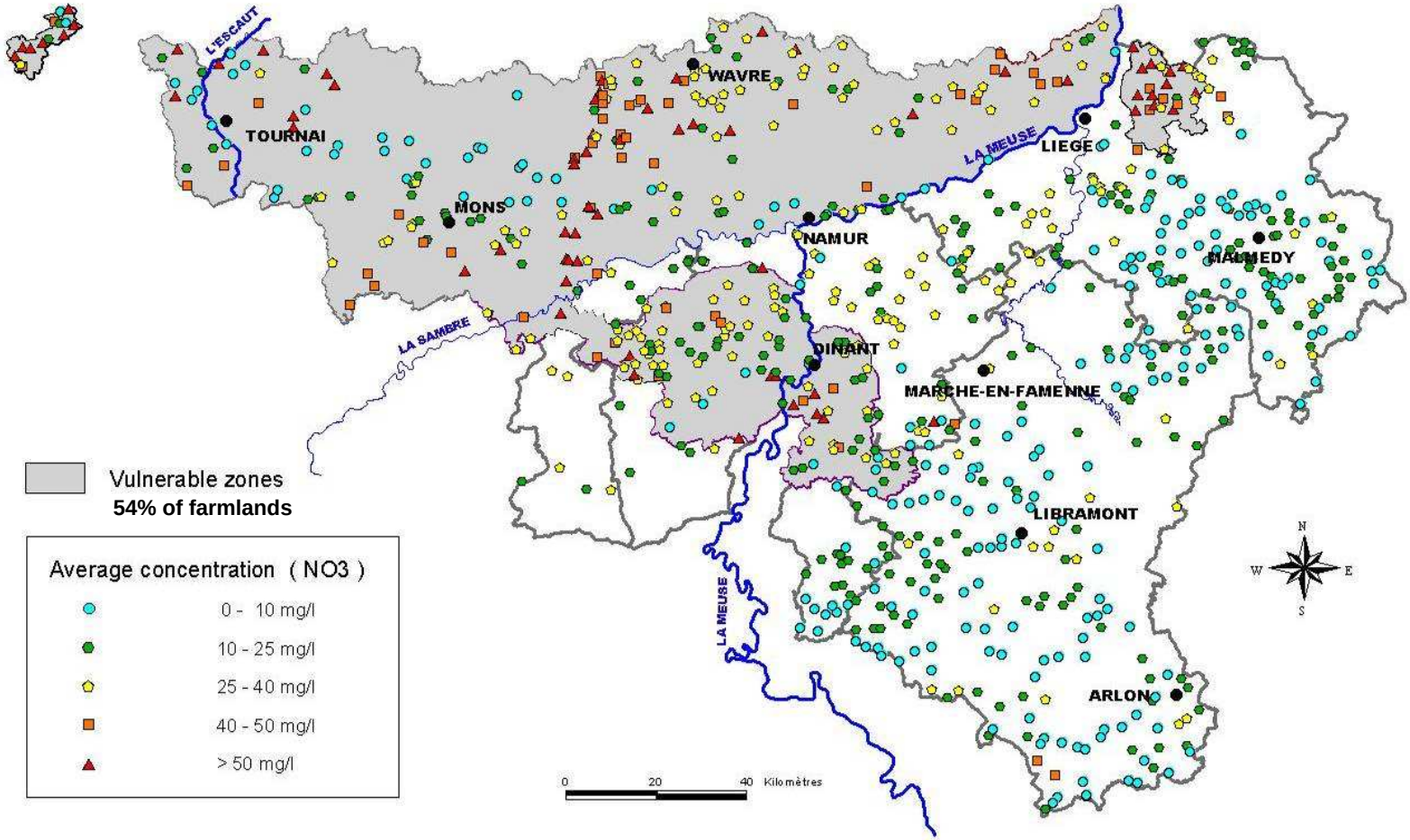
Degré A. and Sohier C.

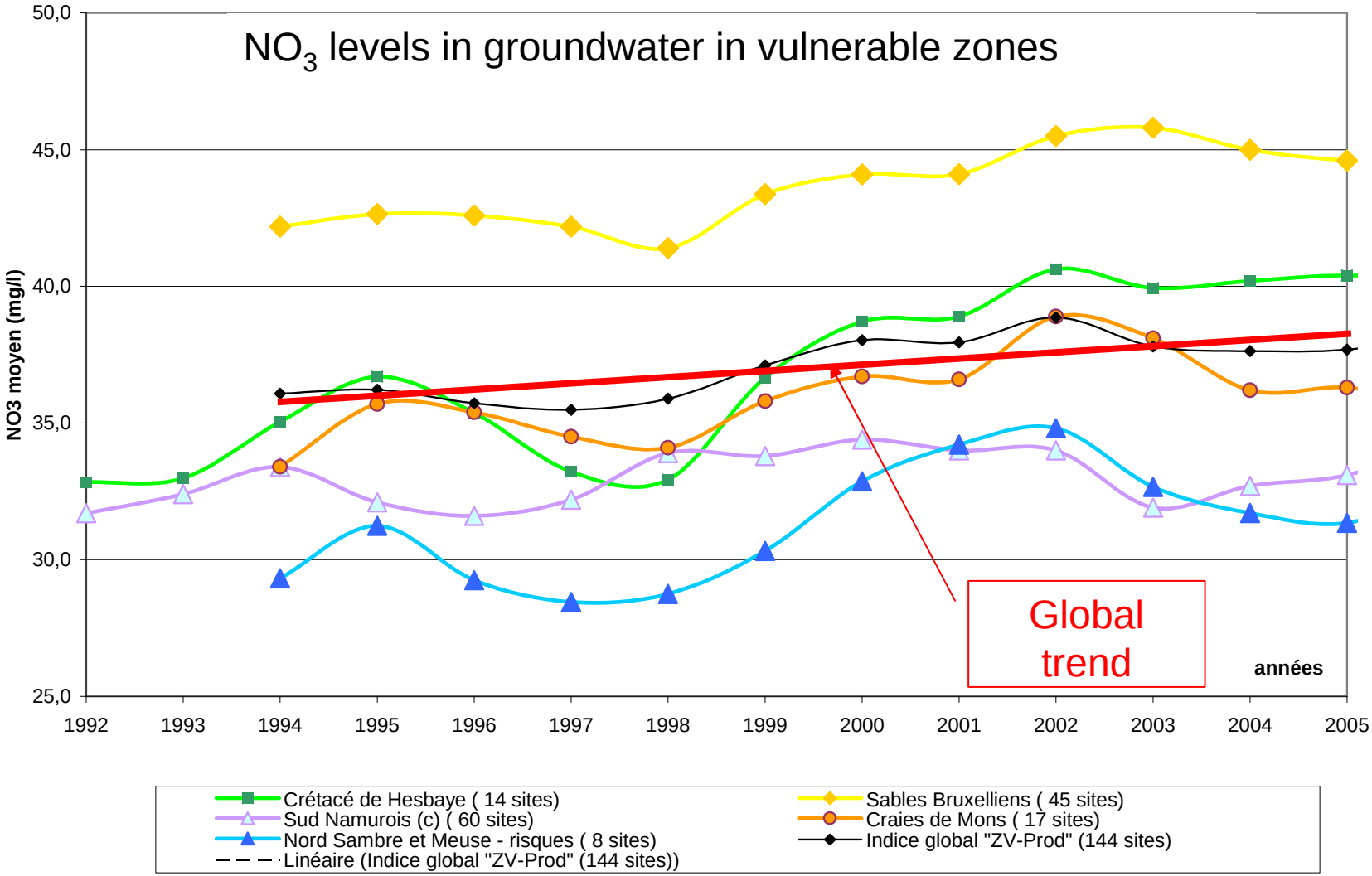
Workshop of the COST action 869
Mitigation options for nutrient reduction in surface water and groundwater
Austria May 08

Plan

- Walloon Action Plan (PGDA)
  - Nitrate Directive 1991
    - PGDA 1 – 2002
    - PGDA 2 – 2007
- Agro-hydrological modelling
  - EPICgrid model
    - Actual modelling
    - Forecasting
- Aside modelling of newly mandatory practices
- Regional modelling of PGDA2 until 2015
- Discussion and conclusions

Nitrate concentration in groundwater (2000-2004)

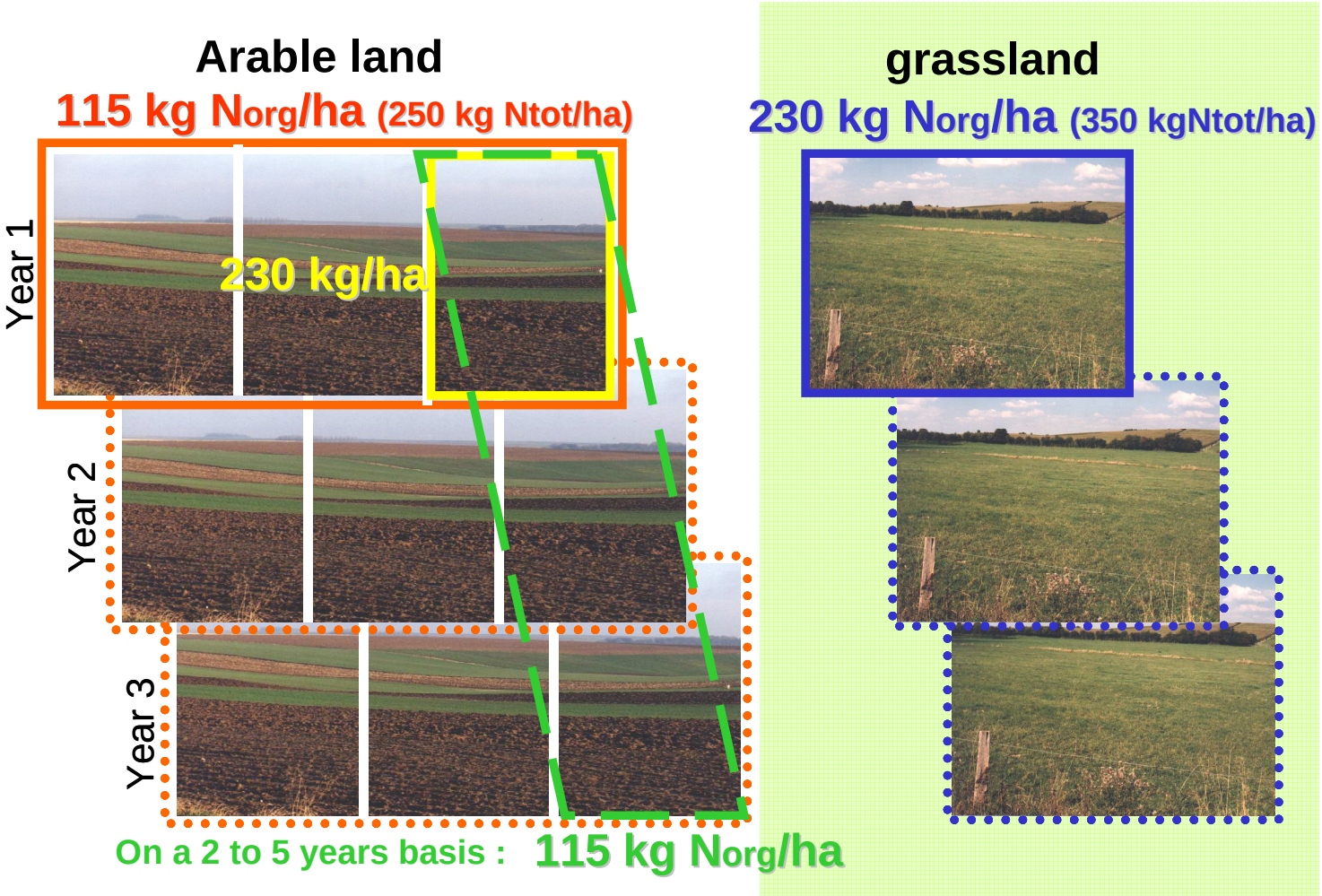



NO_3 levels in groundwater in vulnerable zones
NO3 moyen (mg/l)
50,0
45,0
40,0
35,0
30,0
25,0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Global trend
années
Crétacé de Hesbaye (14 sites)
Sables Bruxelliens (45 sites)
Sud Namurois (c) (60 sites)
Craies de Mons (17 sites)
Nord Sambre et Meuse - risques (8 sites)
Indice global "ZV-Prod" (144 sites)
Linéaire (Indice global "ZV-Prod" (144 sites))

From EEC/676/91 to PGDA 2

- Identification of vulnerable zones
- Spreading (quantities, conditions, …)
  - Spreading standards on <u>whole Region</u>
  - Particular spreading standards in <u>vulnerable zones</u>

PGDA2 : spreading standards for whole Region

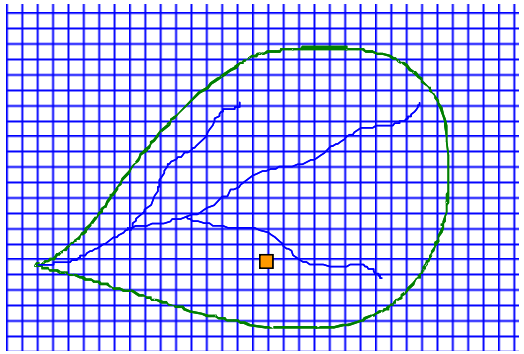


From EEC/676/91 to PGDA 2

- Intercrops on 75% of farmlands in vulnerable zones
- Monitoring of nitrate in the soil at the beginning of leaching period

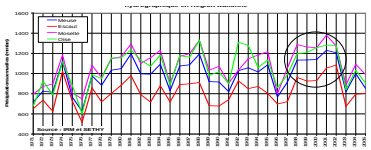
Degré A. and Sohier C. Gembloux Agricultural University

EPICGRID Catchment Modelisation Soils and vadose zone

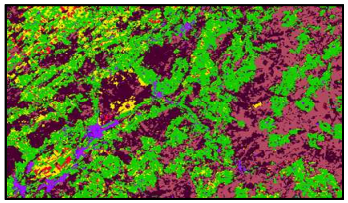


GRID SQUARE : 1 sq. km.

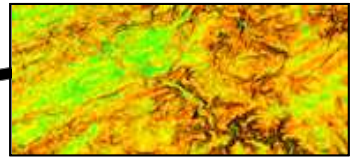
Climate data



Landuse, crop growth, agricultural practices

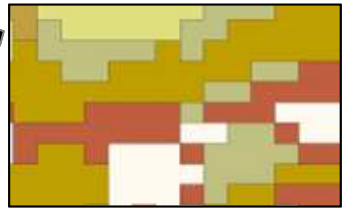


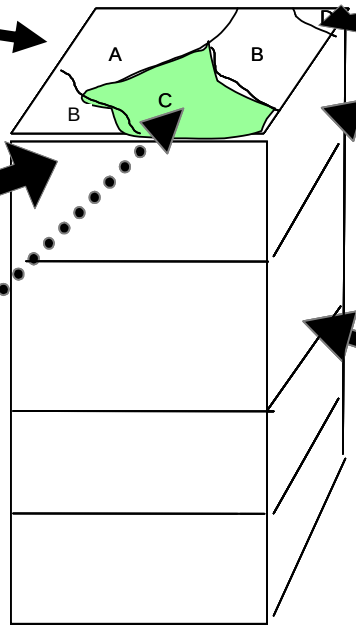
DEM



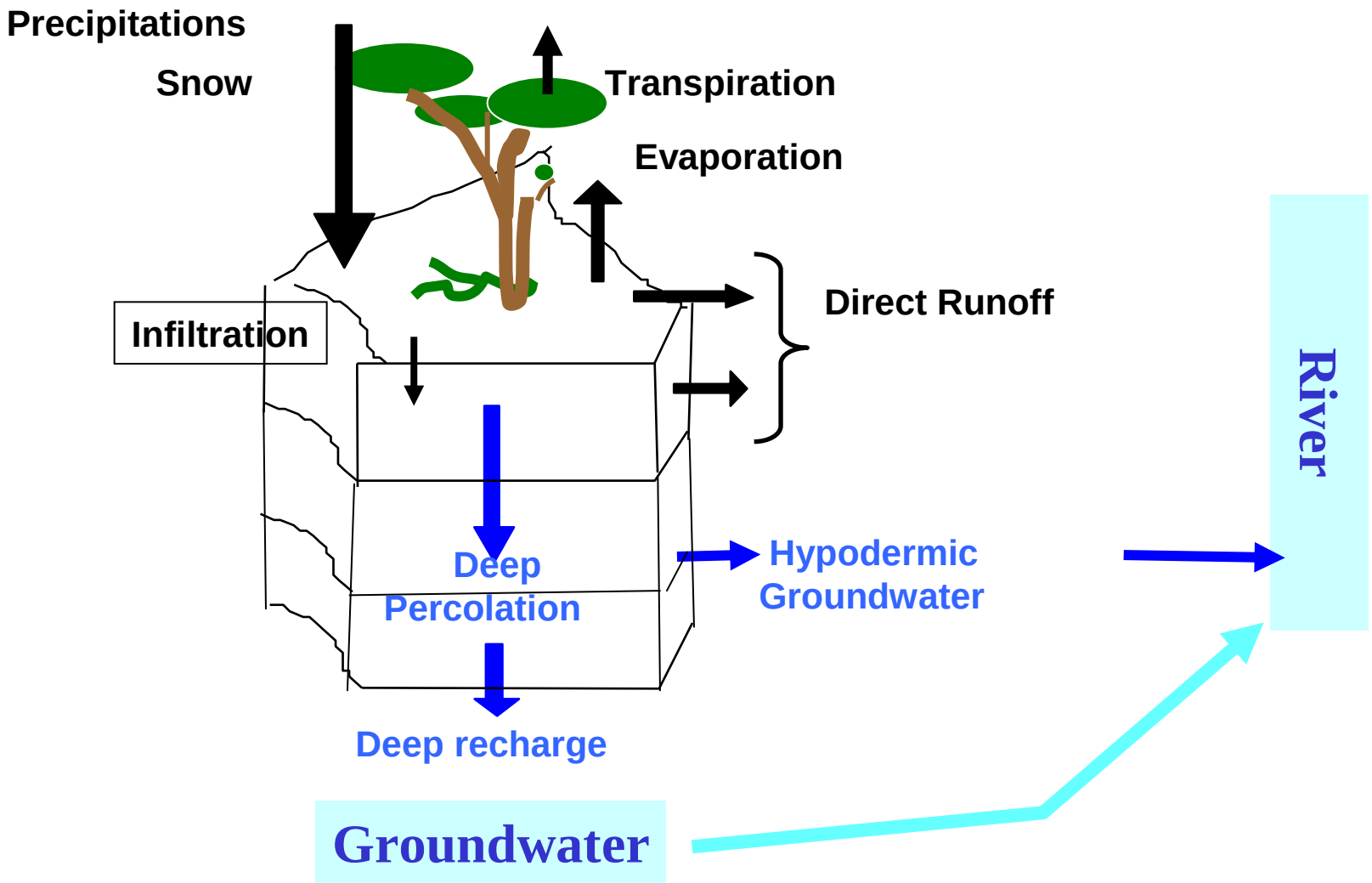
Soils

Geology

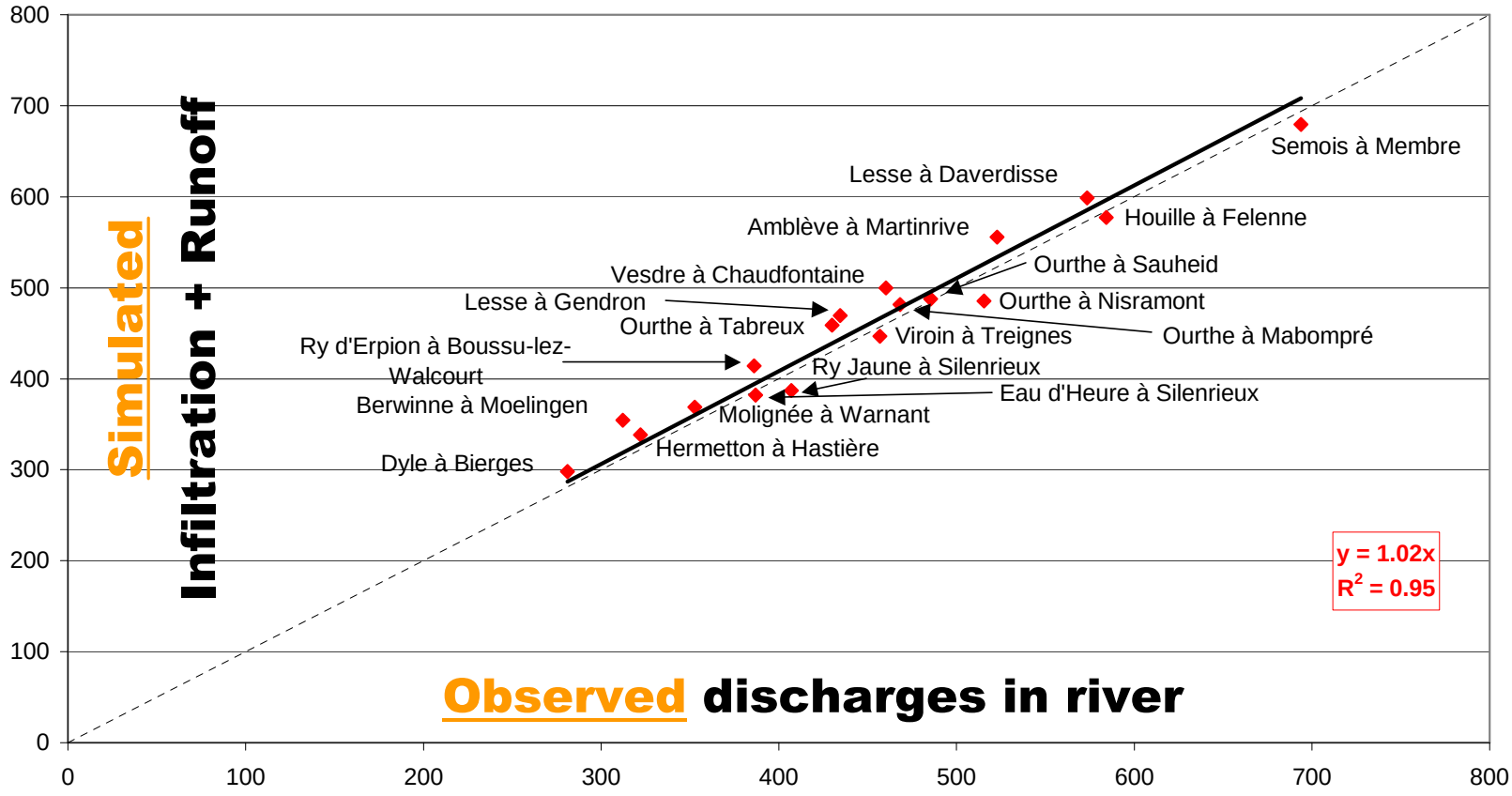




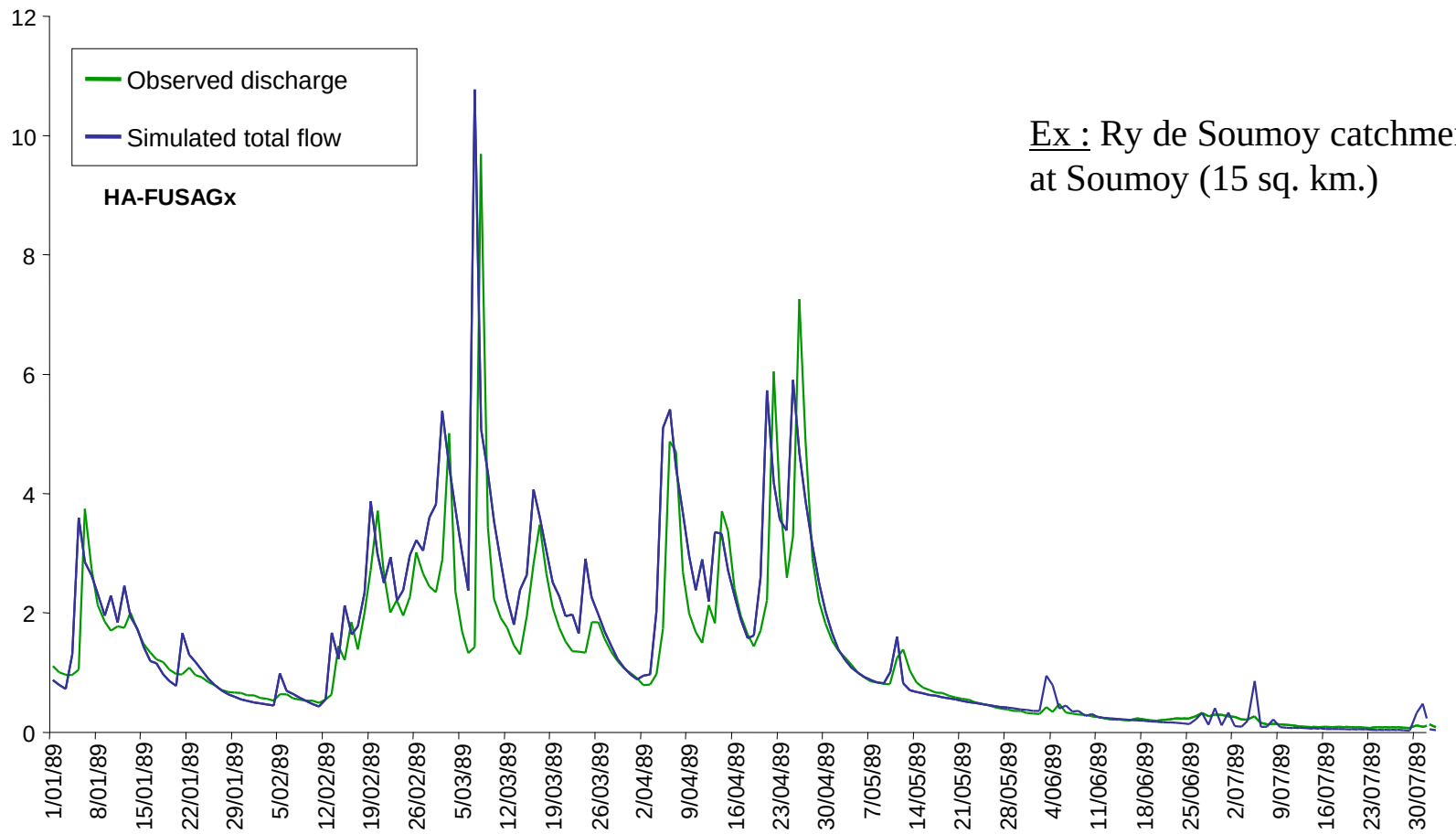
In each grid square ponderation of the different components


Precipitations
Snow
Transpiration
Evaporation
Direct Runoff
Infiltration
River
Deep
Percolation
Hypodermic
Groundwater
Deep recharge
Groundwater

Validation Water Balance-Discharges Catchment ('71-'00)

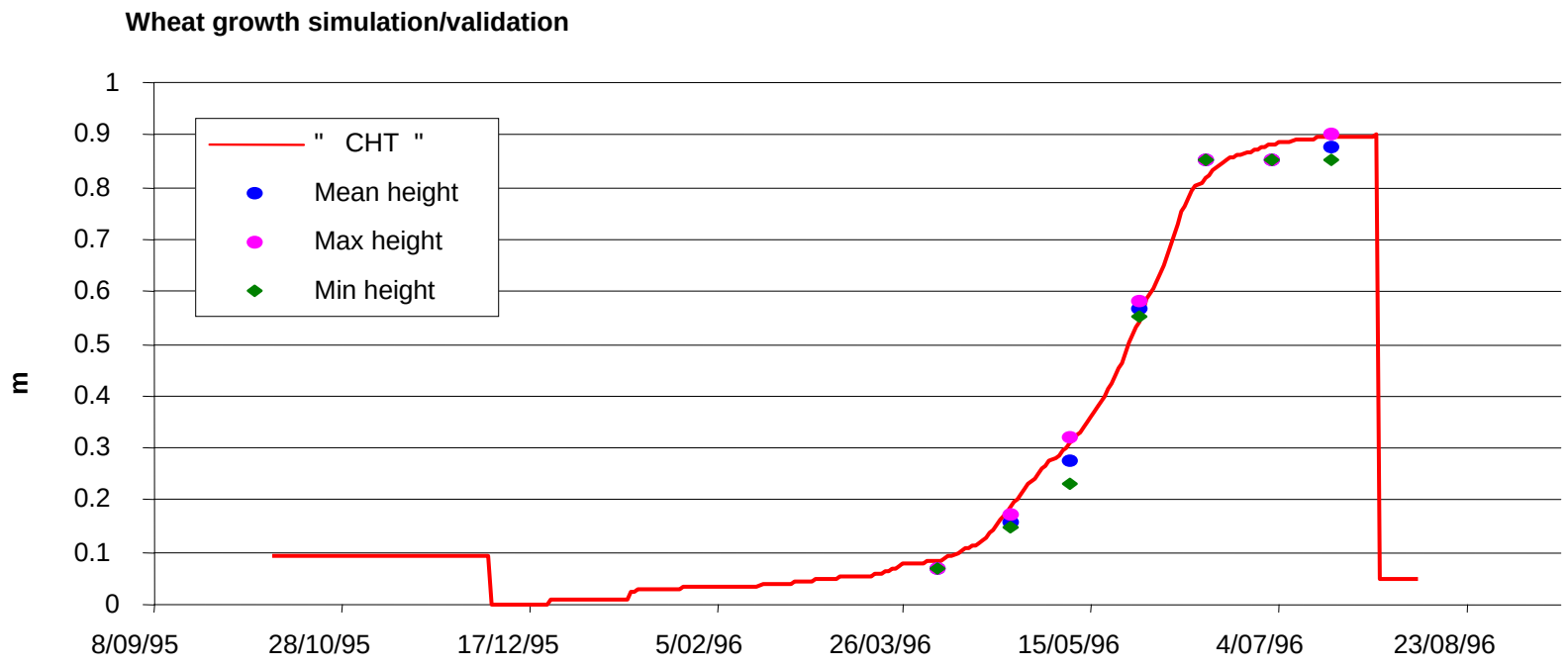


River discharge

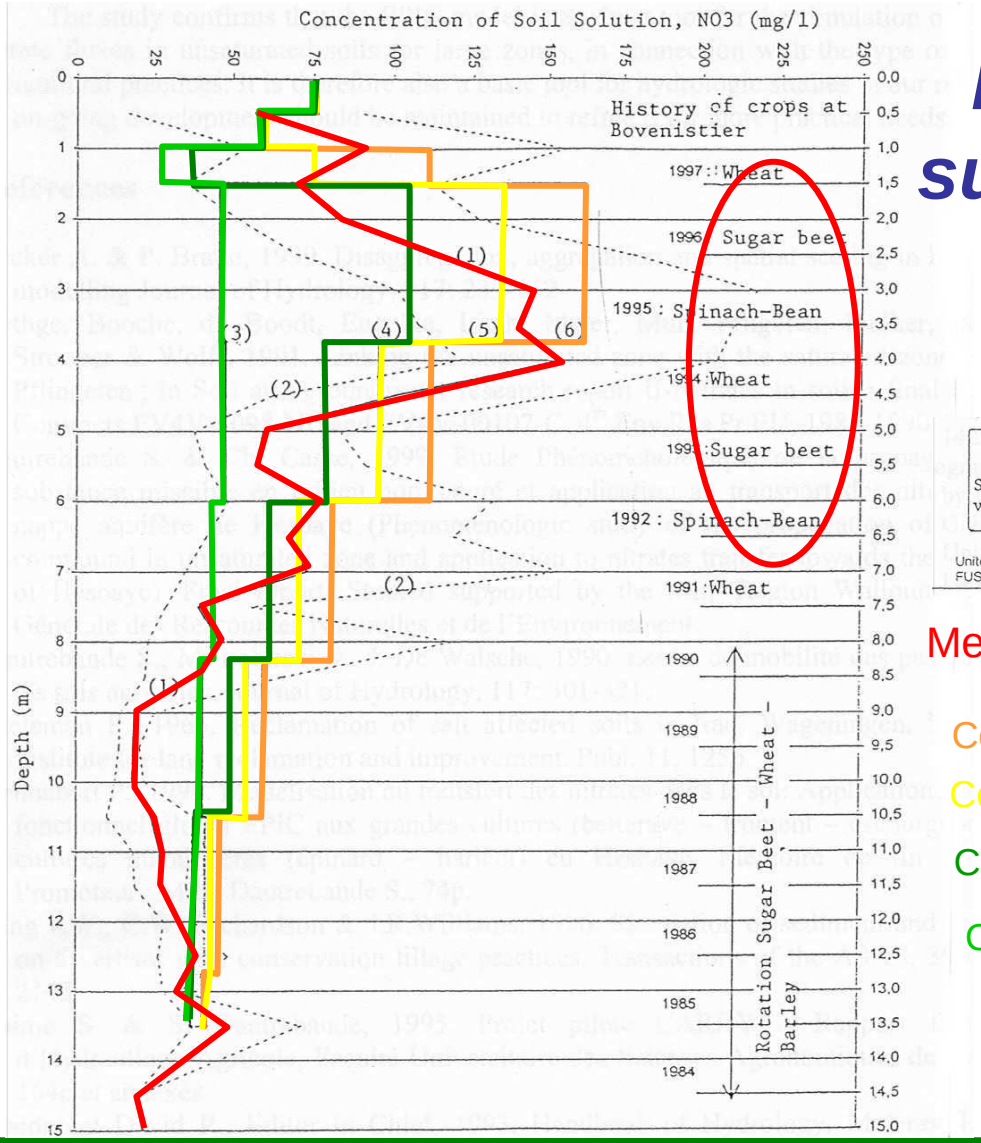


Ex : Ry de Soumoy catchment at Soumoy (15 sq. km.)

Plant Growth



Nitrate transfer from surface to groundwater table



Measured mean concentration NO_3[mg/l]

Considering 600 kg tot N/ha.an (spinash-bean)

Considering 500 kg tot N/ha.an (spinash-bean)

Considering 400 kg tot N/ha.an (spinash-bean)

Considering 200 kg tot N/ha.an (wheat)

Validation : quality

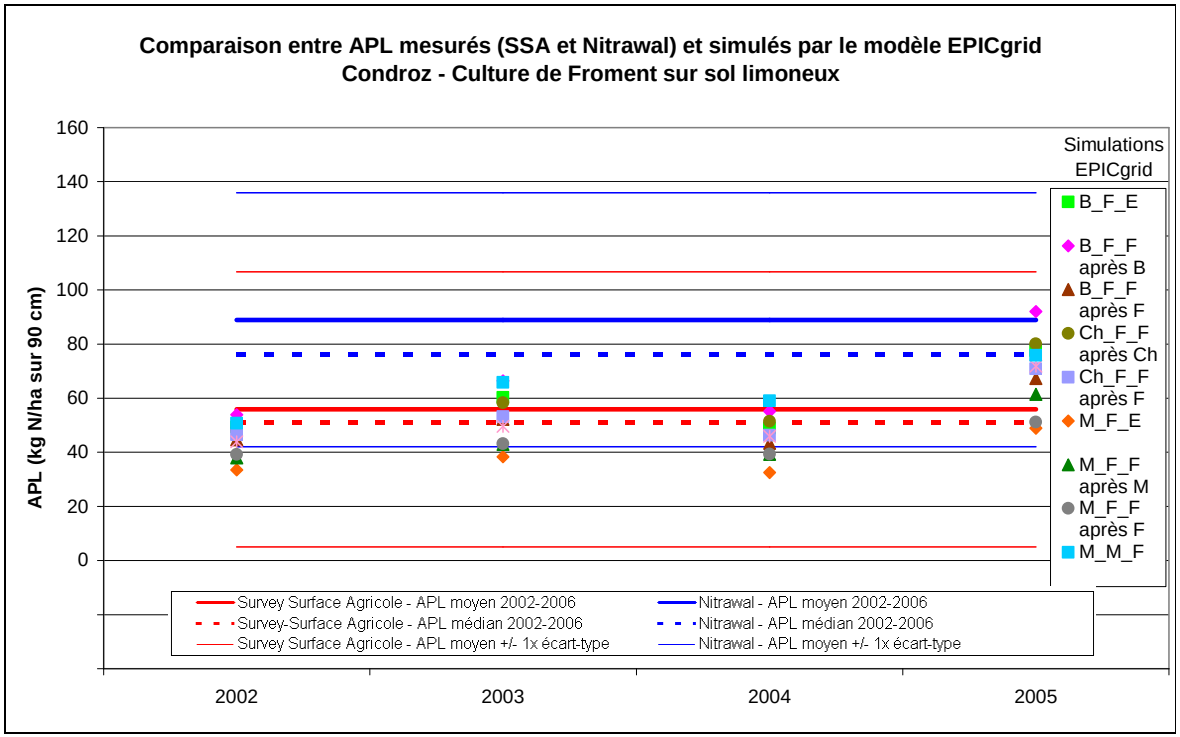
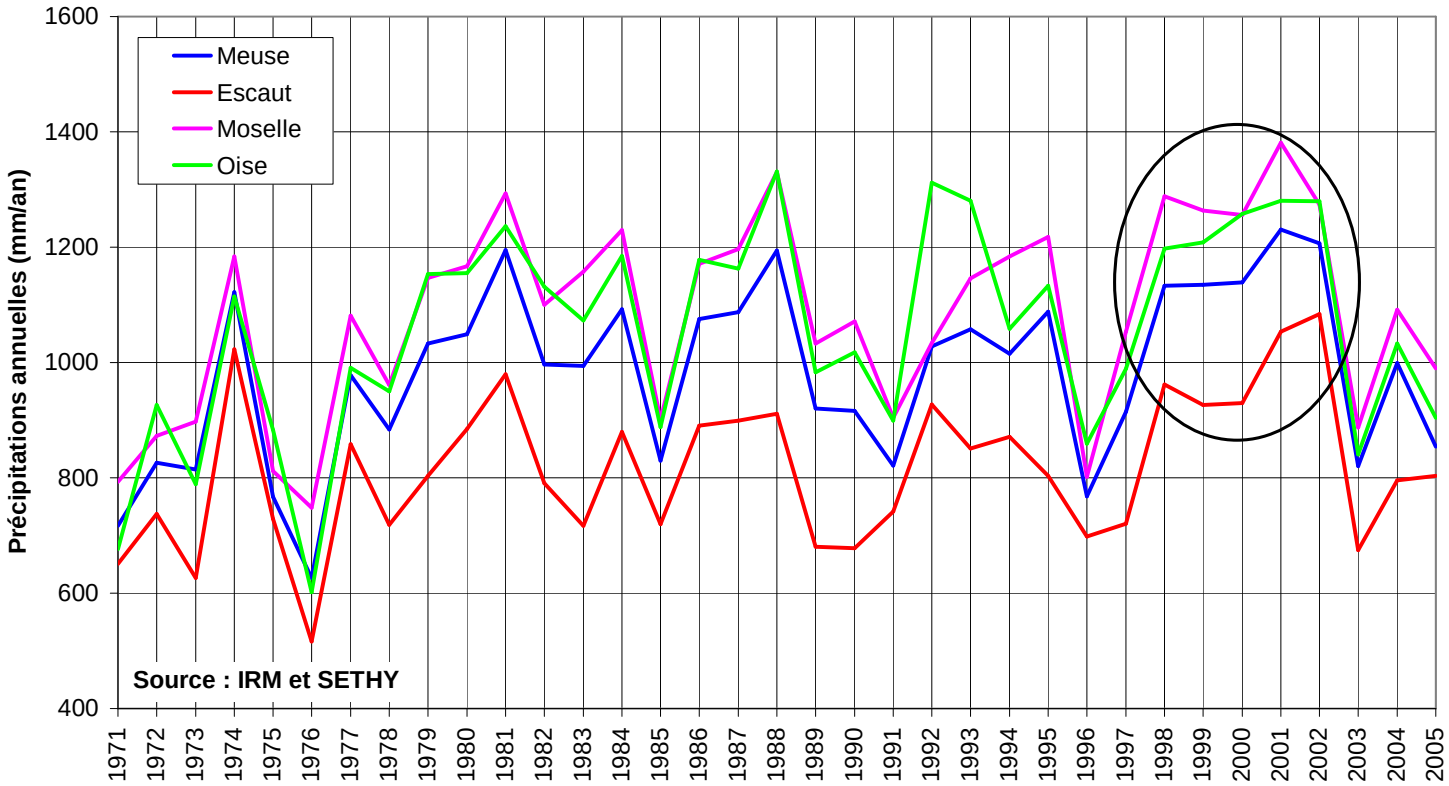


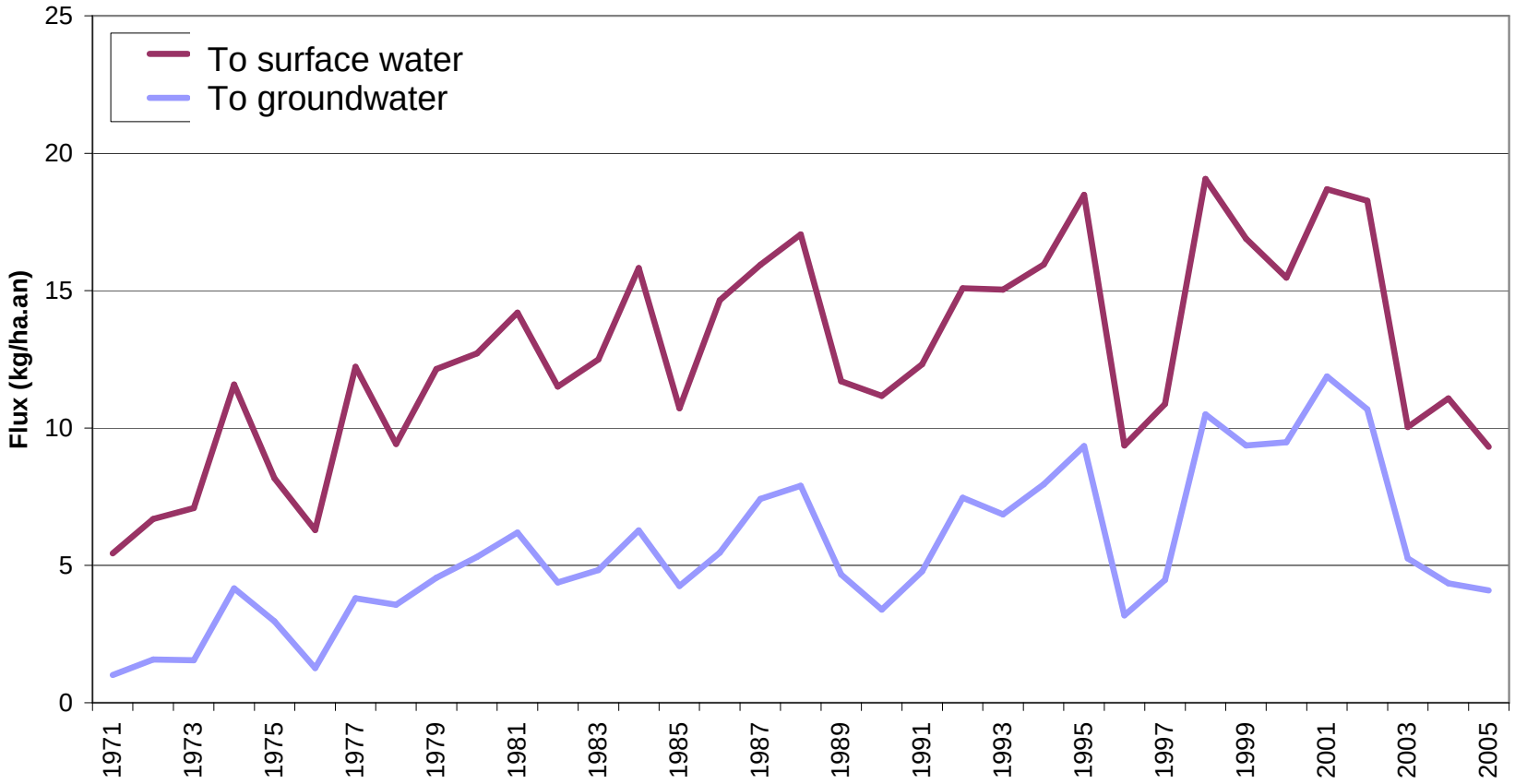
Figure 1 : Comparaison entre APL mesurés (SSA (34 observations) et Nitrawal (21 observations)) et simulés par le modèle EPICgrid – Condroz – Culture de Froment sur sol limoneux

Actual modelling results

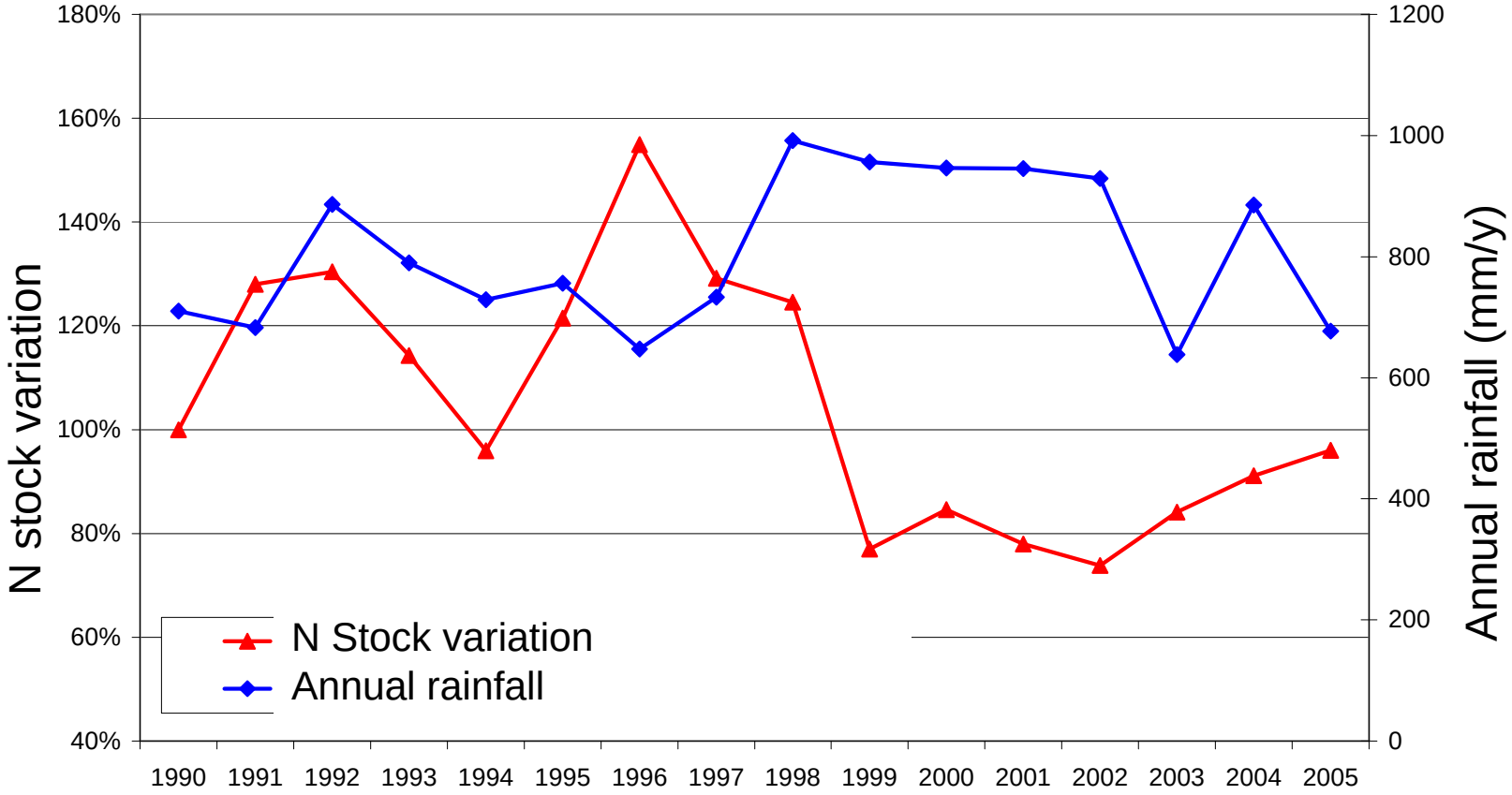
Annual rainfall (walloon Region) – 1971-2005



Annual nitrogen transfer in surface water and groundwater in walloon Region – EPICgrid model – 1971-2005

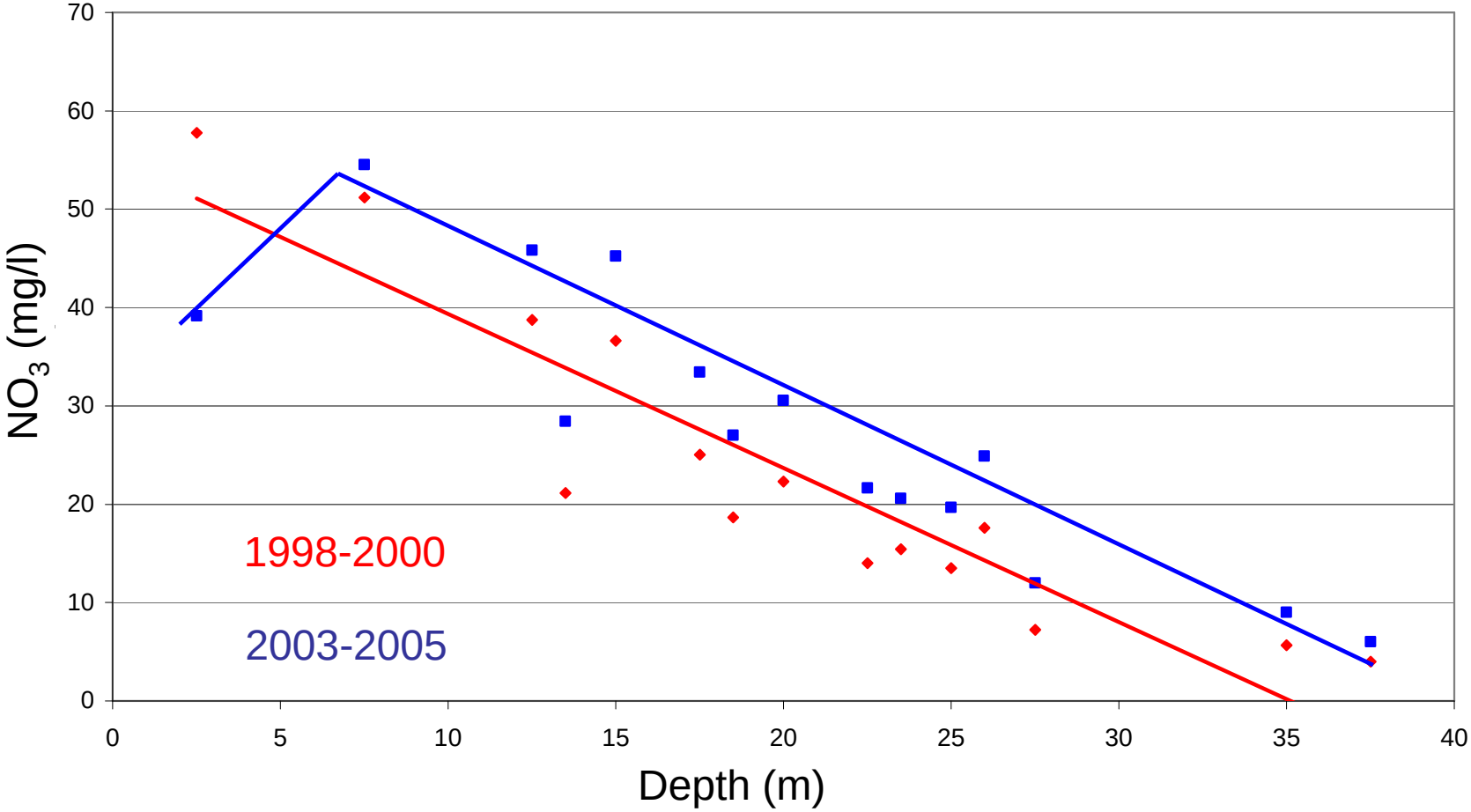


Annual rainfall and N stock variation in root zone – Geer Watershed – EPICgrid model

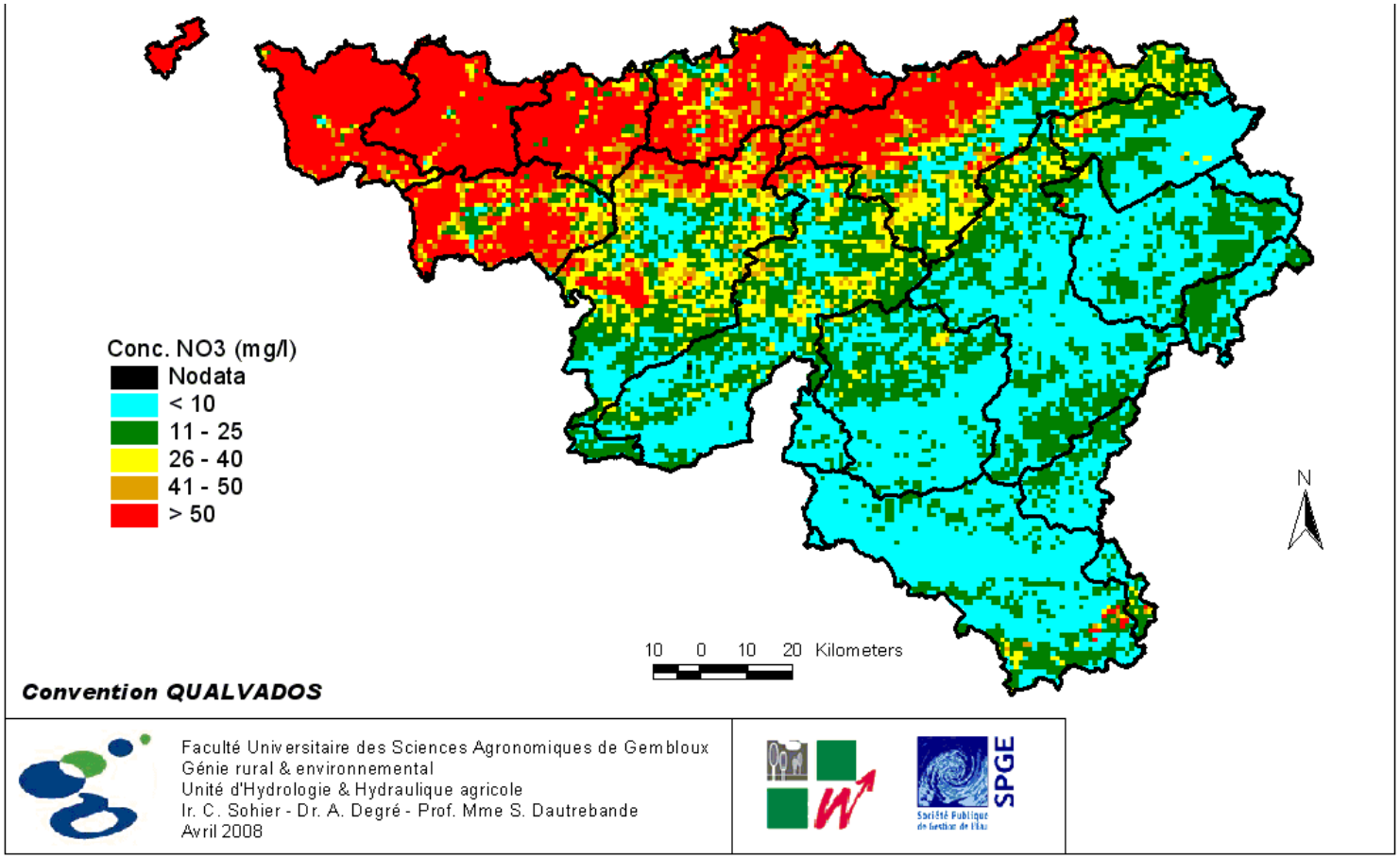


EPICgrid – NO_3 concentration in soil solution

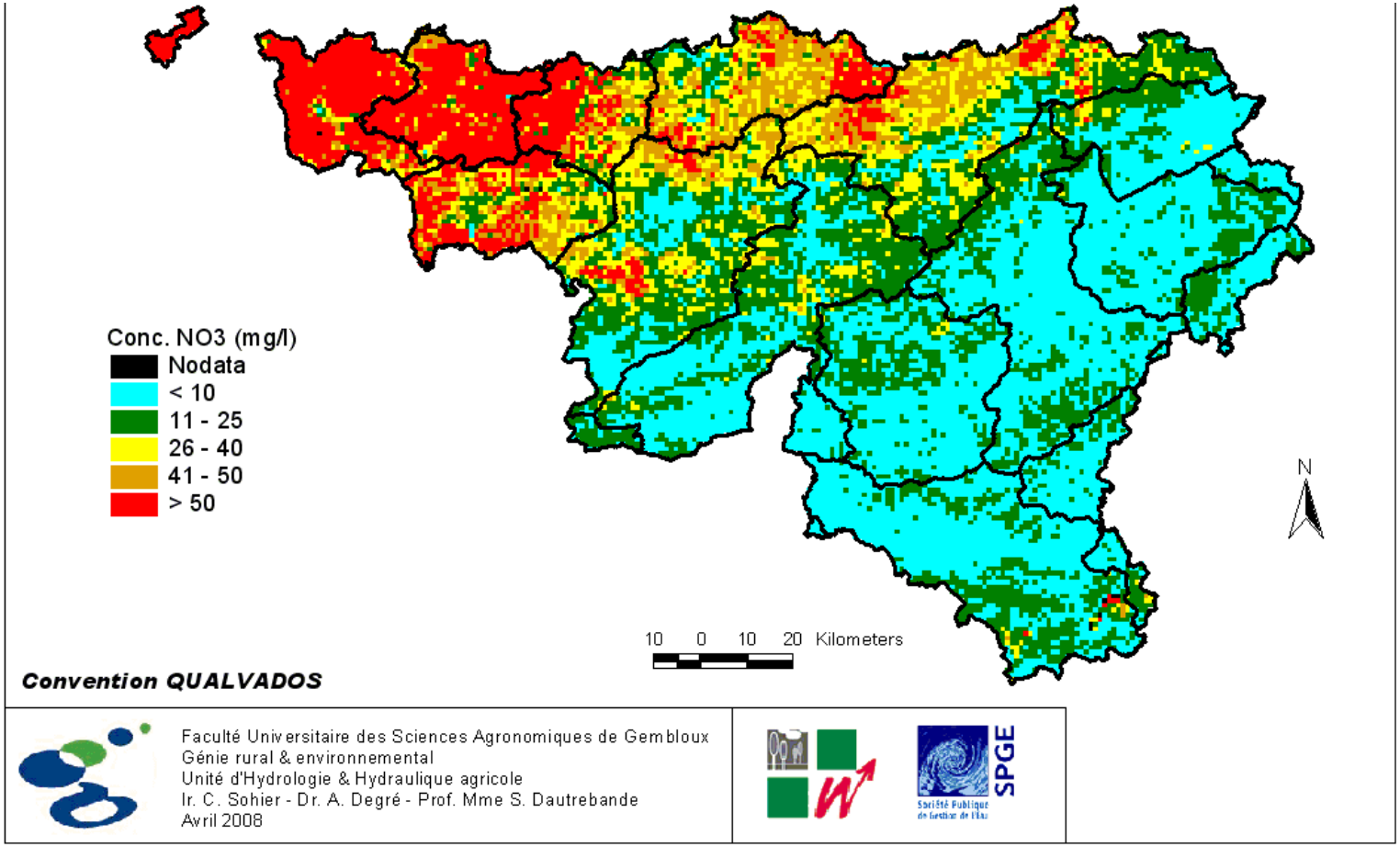
Vulnerable zone « crétacé de Hesbaye »



Nitrate concentration under the root zone (1.5m) – Mean value 1994-1999 – EPICgrid model

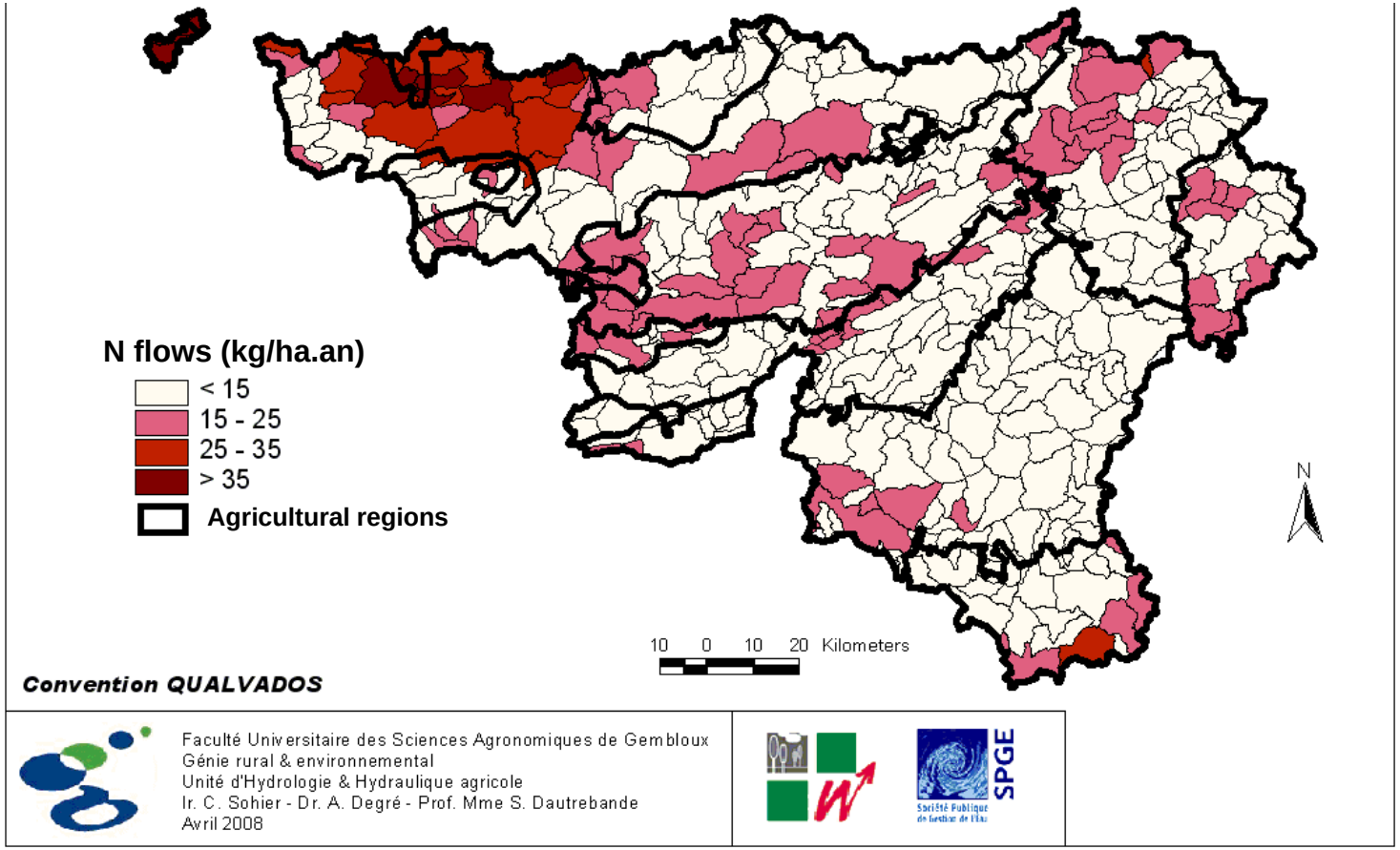


Nitrate concentration under the root zone (1.5m) – Mean value 2000-2005 – EPICgrid model



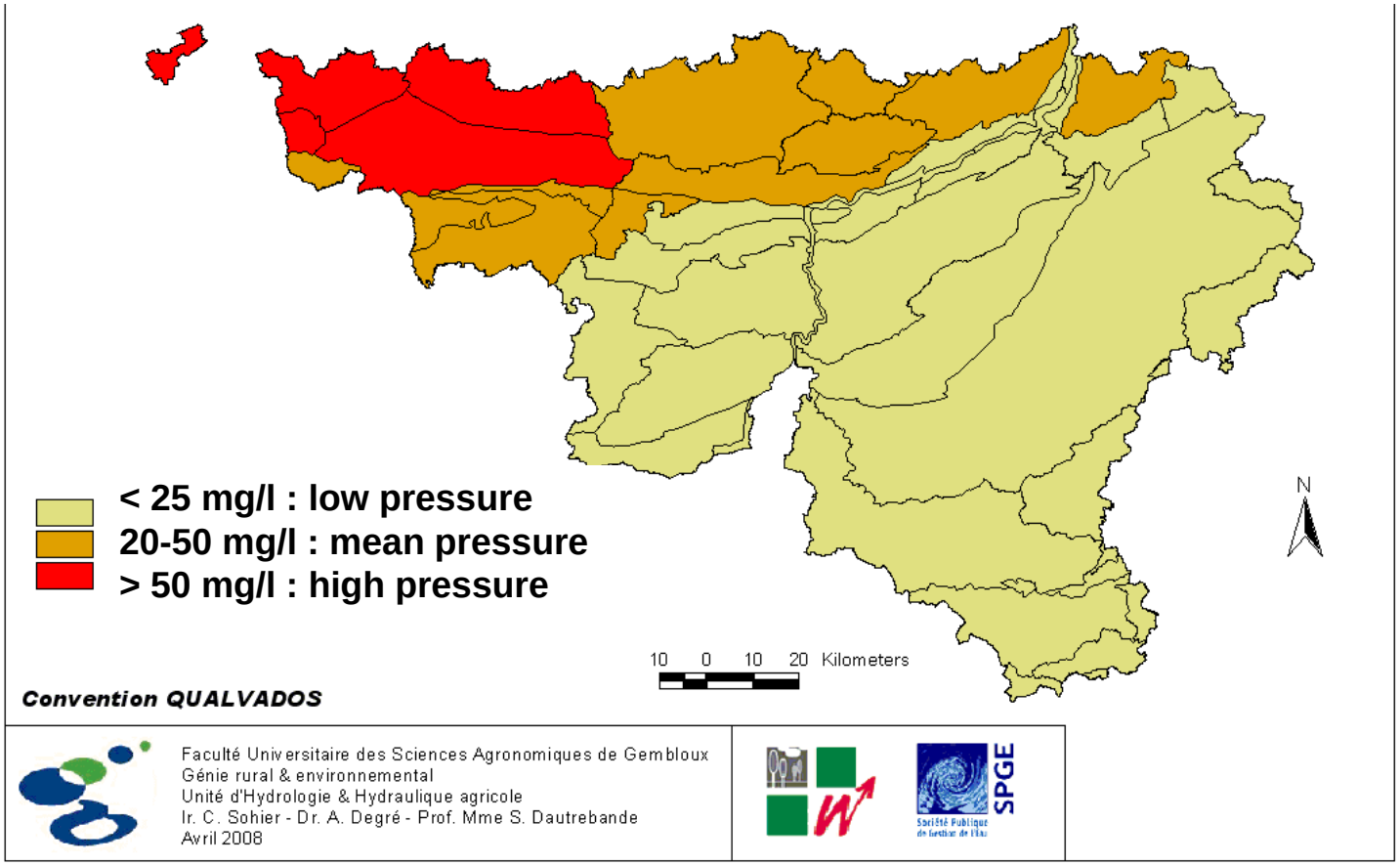
N in direct runoff and interflow to surface water masses

Mean value 2000-2005 – EPICgrid model



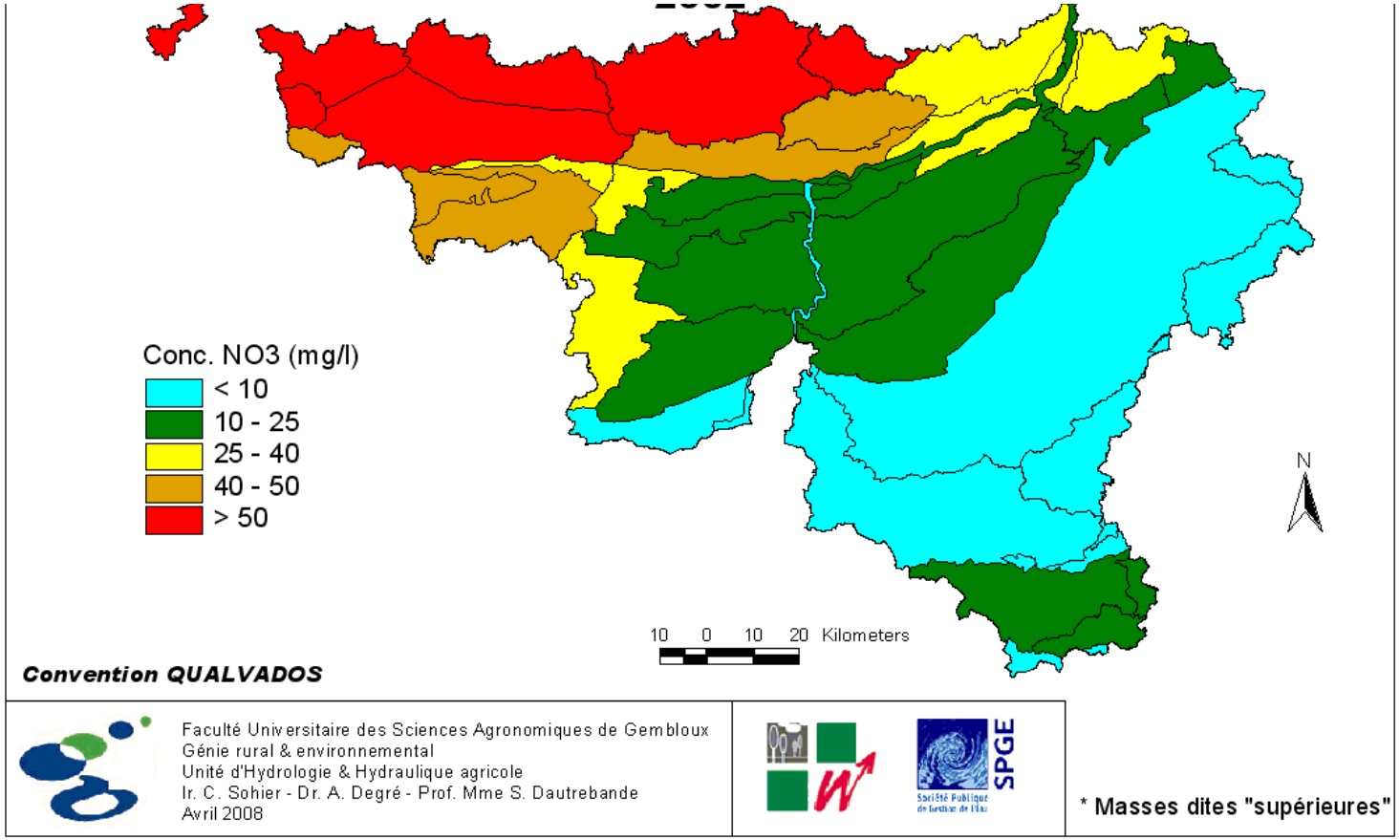
NO_3 pressure at 1.5 m depth – mean by groundwater masses

EPICgrid model – 2000-2005



NO_3 concentration in recharge water - groundwater masses

EPICgrid model - 2002



PGDA2 : Pre-normative modelling

- Aside modelling
  - Spreading standards
  - Intercrop
  - Intercrop's date of ploughing

NO_3 (mg/l) under the root zone example for 3 fertilization scenarios Loamy region – Interannual mean (1971-2000) – EPICgrid model

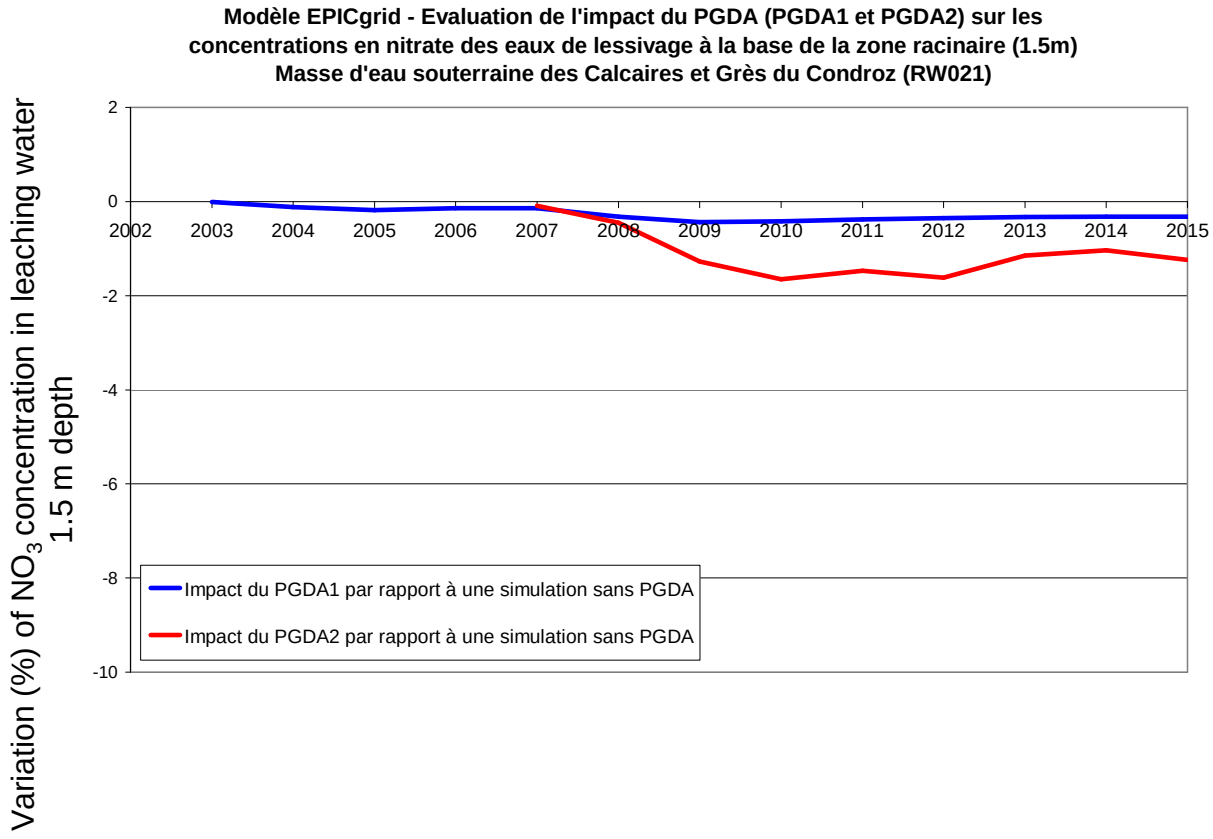
Rotation	Scénario « 80N » Nmin constant	Scénario « 120N » Nmin Constant	Scénario PIRENE
Sugar beet – wheat - cereal	76		42
Sugar beet - wheat – corn - wheat	41	81	47
Sugar beet – wheat – potatoes - wheat	69	109	77

3 scénarios de fertilisation organique et 3 rotations (Nmin constant) – Région limoneuse - Moyenne période climatique 1971-2000

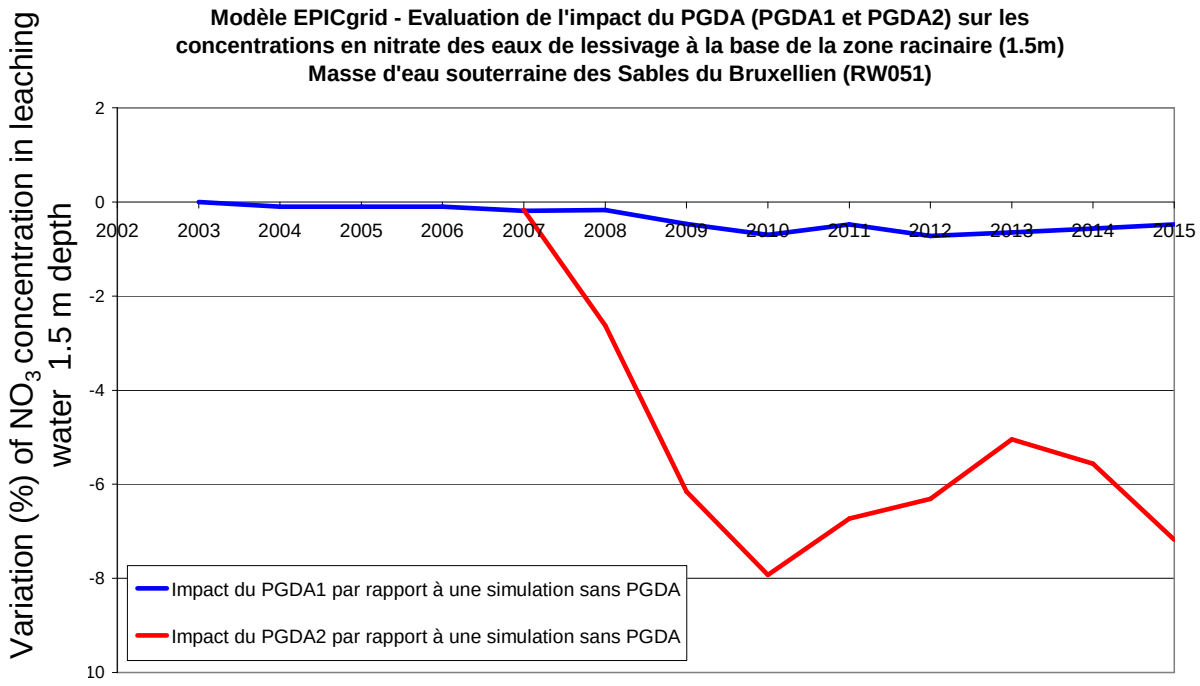
Intercrop's date of ploughing - N losses and soil losses sugar beet wheat potatoes wheat Loamy region – annual mean value (1971-2000) EPICgrid model

Intercrop's date of ploughing	Soil losses (t/ha.an)	N losses at 1.5 m depth (kg N/ha.an)	NO3 concentration of leaching water at 1.5 m depth (mg NO3/l)
Ray-Grass			
30/11	8.6	19.5	46.9
31/12	8.6	19.3	46.5
15/01	8.4	19.3	46.4
01/02	8.2	19.3	46.4
Moutarde			
30/11 (ou gel)	8.7	19.9	47.7
31/12 (ou gel)	8.7	19.9	47.7
01/02 (fixe)	8.6	20.0	47.8

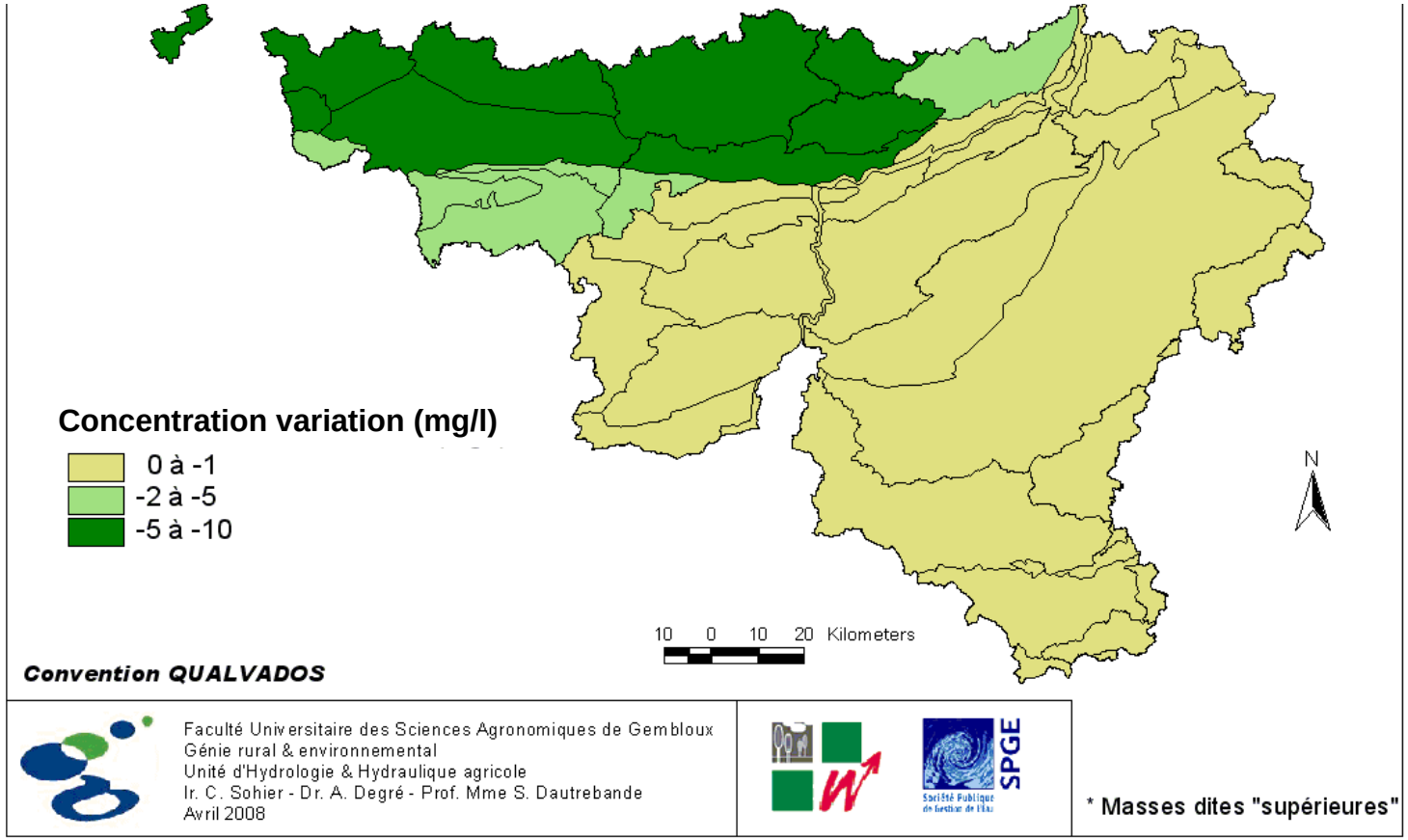
PGDA2's effects forecasting



PGDA2's effects forecasting

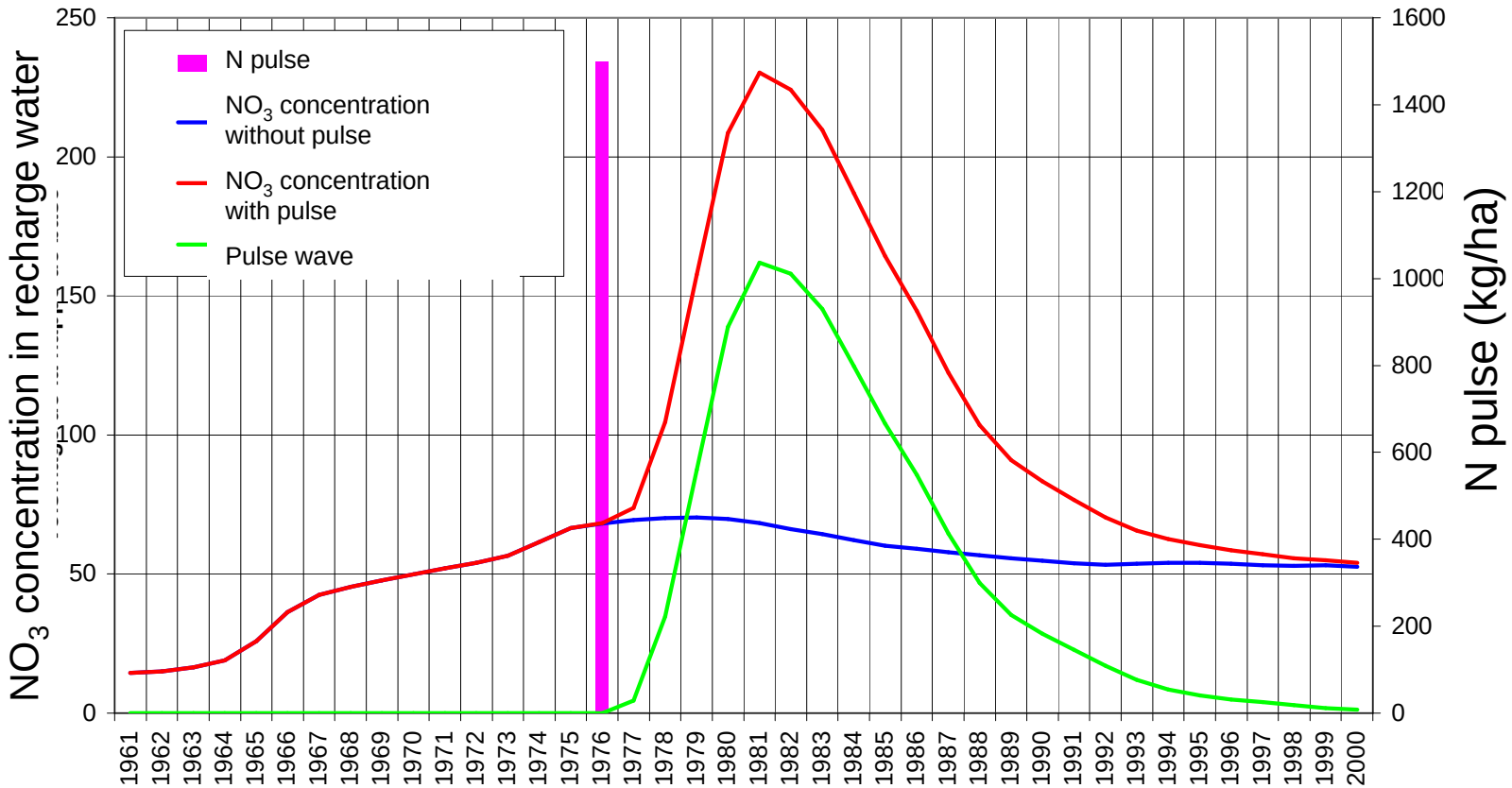


PGDA2 's effect on NO_3 concentration in leaching water under the root zone (1.5 m depth) EPICgrid model

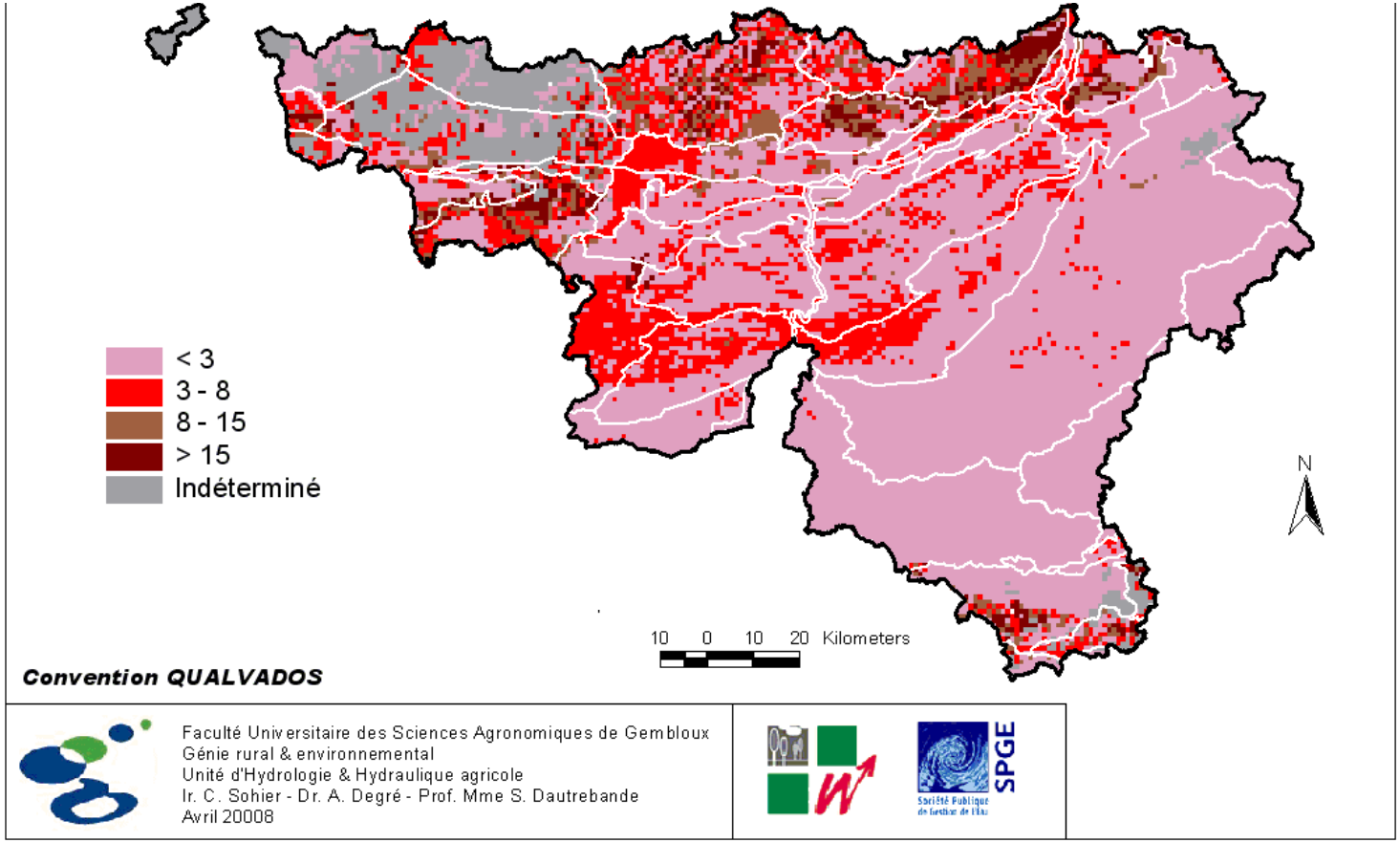


Lag time

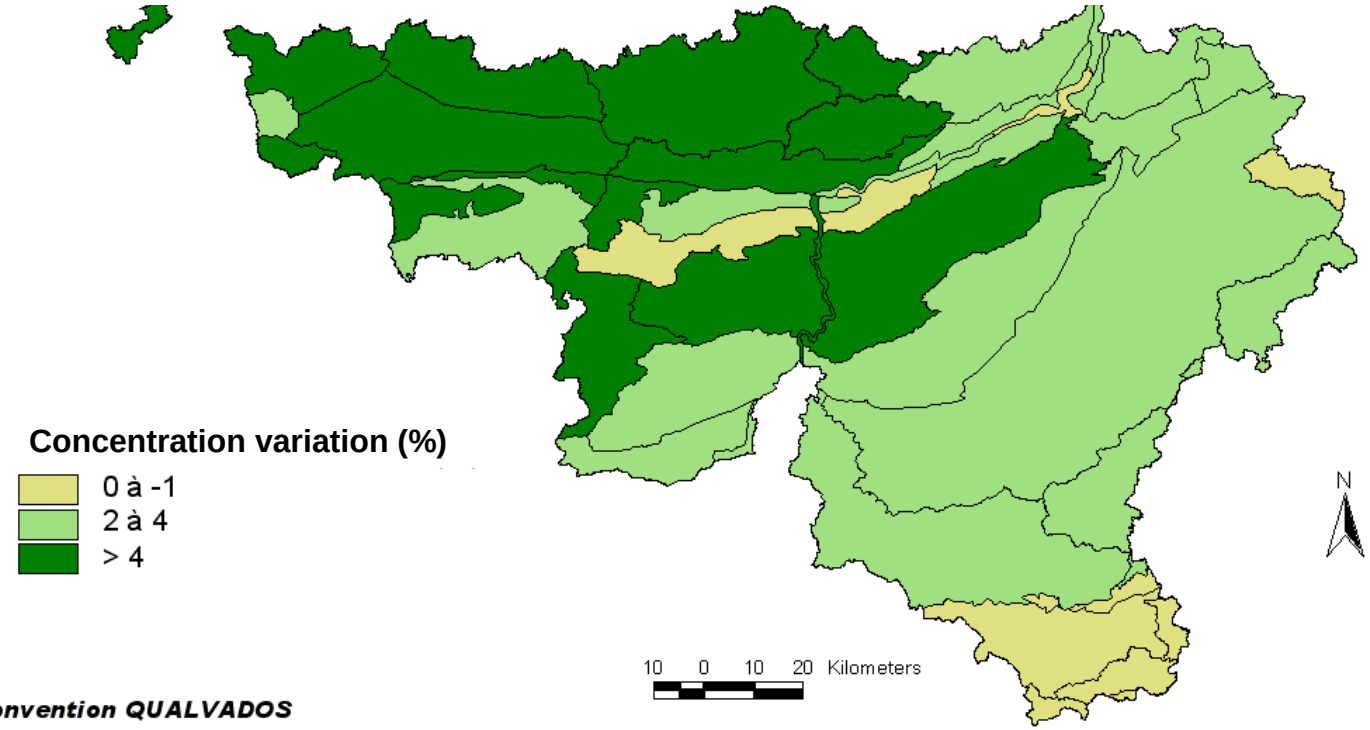
Time for NO_3 transfer to groundwater – vulnerable zone « sables du bruxellien » - EPICgrid model



Lag time (years) for NO_3 transfer to groundwater



PGDA2's effect in 2015 on NO_3 concentration in recharge water – mean value / groundwater mass – EPICgrid model



Convention QUALVADOS

Faculté Universitaire des Sciences Agronomiques de Gembloux
Génie rural & environnemental
Unité d'Hydrologie & Hydraulique agricole
Ir. C. Sohier - Dr. A. Degré - Prof. Mme S. Dautrebande
Avril 2008

SPGE

* Masses dites "supérieures"

Conclusion

- The model fits well all available mesures in water quantities and quality
- The model permits
  - Aside modelling as a decision help
  - New scenarios modelling
  - Leaching forecasting in whole walloon region
  - Climate effect comprehension and forecasting
- PGDA2
  - Is a usefull transposition of nitrate Directive
  - Demands time (transfer, mixing in groundwater masses, …) to produce its whole effect
  - Has to be completed in some areas

Done with the financial support of

Walloon Region www.environnement.wallonie.be

SPGE (public society of water management) www.spge.be

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