BIOMATH

Department of Applied Mathematics, Biometrics and Process Control

Use of Catchment Models for Pesticide Risk Assessment: Application of SWAT in the Nil Catchment.

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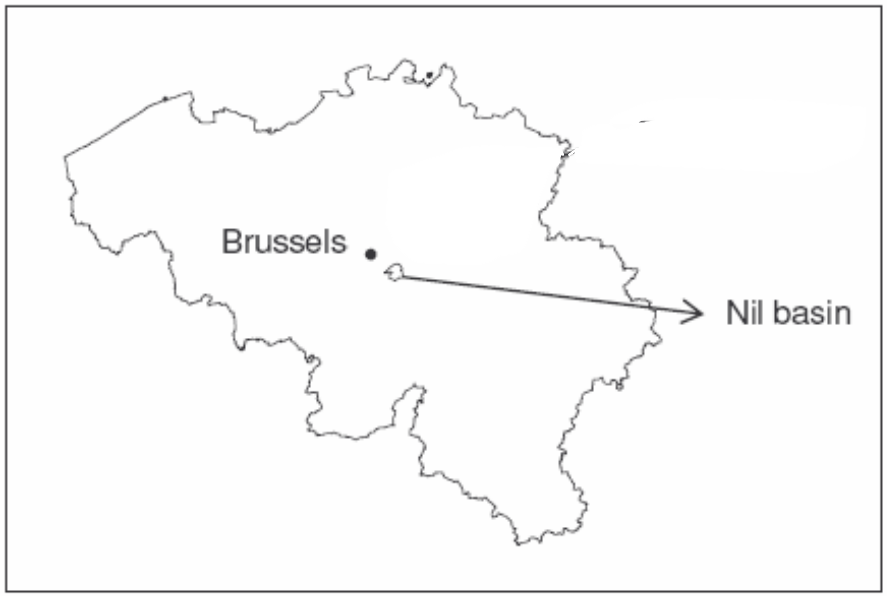
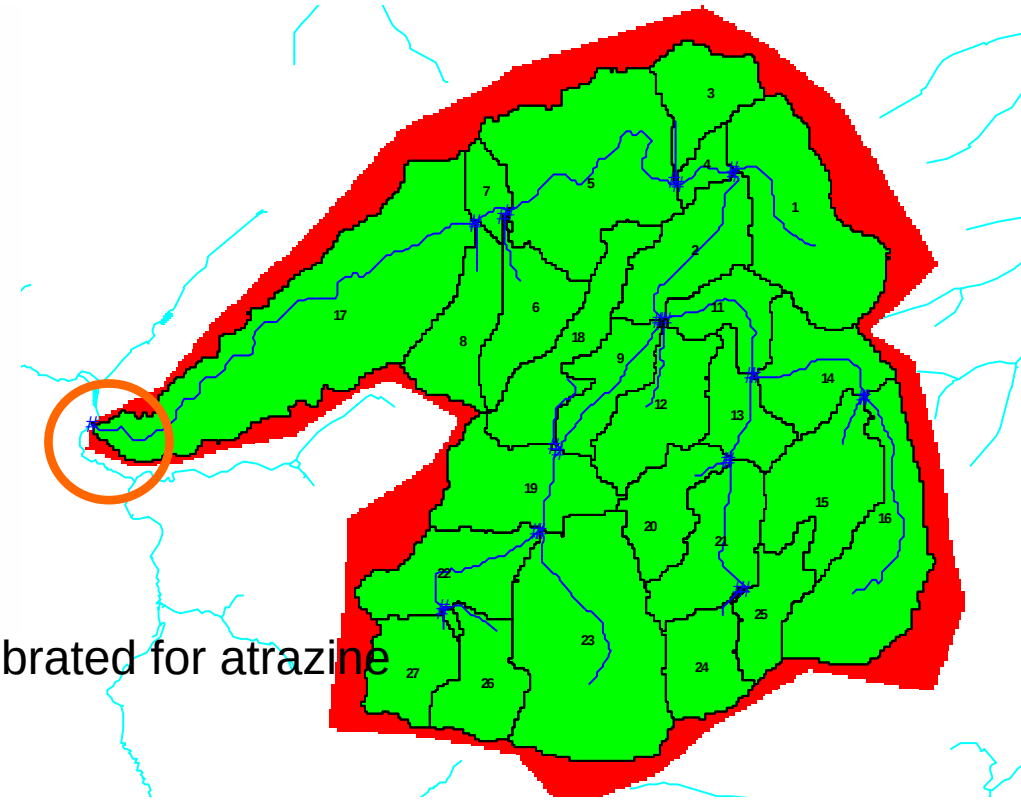
Introduction

- Pesticides applied on crops
  - Pos: controlling weeds, insects and pests
  - Neg: ecotoxicity, bioaccumulating properties and hormone disrupting effects
- Public authorities and industry try to minimise harmful effects: for pesticide risk assessment: FOCUS calculations for registration purposes of pesticides
  - SWAT model for Isoproturon (IPU) on catchment scale and test if it can be used for other pesticides in the future
  - SWAT model used to see what fraction of the measured concentrations of IPU in the river is due to direct losses towards the river

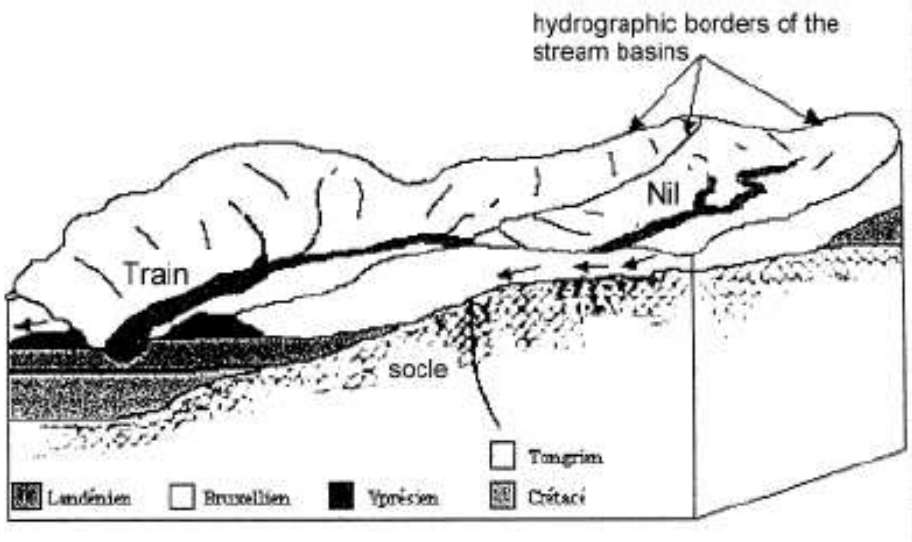
Case study: The Nil watershed





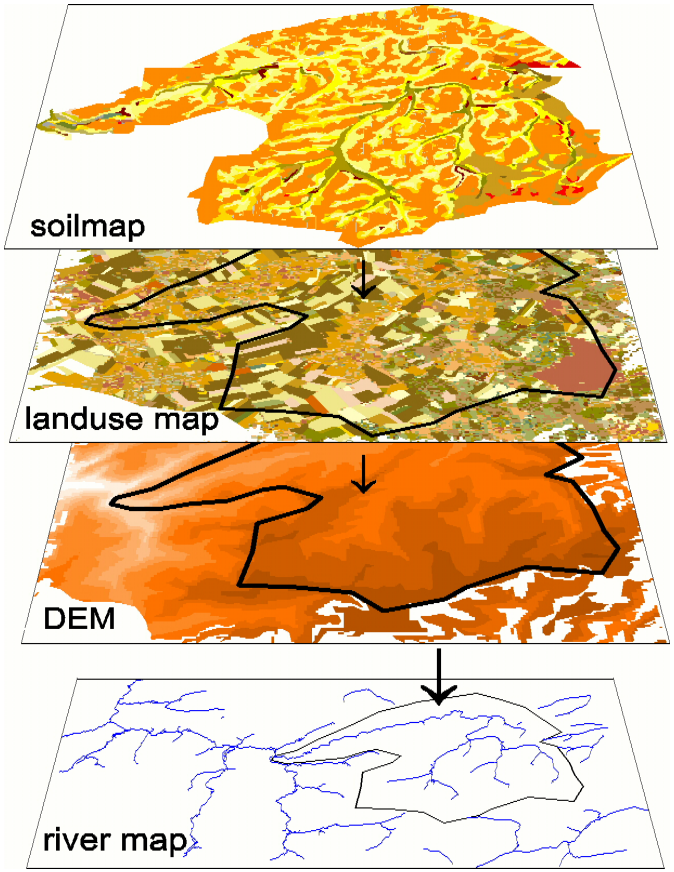
- Well documented and studied and calibrated for atrazine
- 32 km²
- Average flow 0.148 m³/s
- Soil type is loam. 7 % inhabited. Main crops: winter wheat (22%), corn (15%) and sugar beet (10%)

The Nil watershed



The nil basin has groundwater loss through sand layers towards the catchment of the Train. The base flow is very low.

Inputs

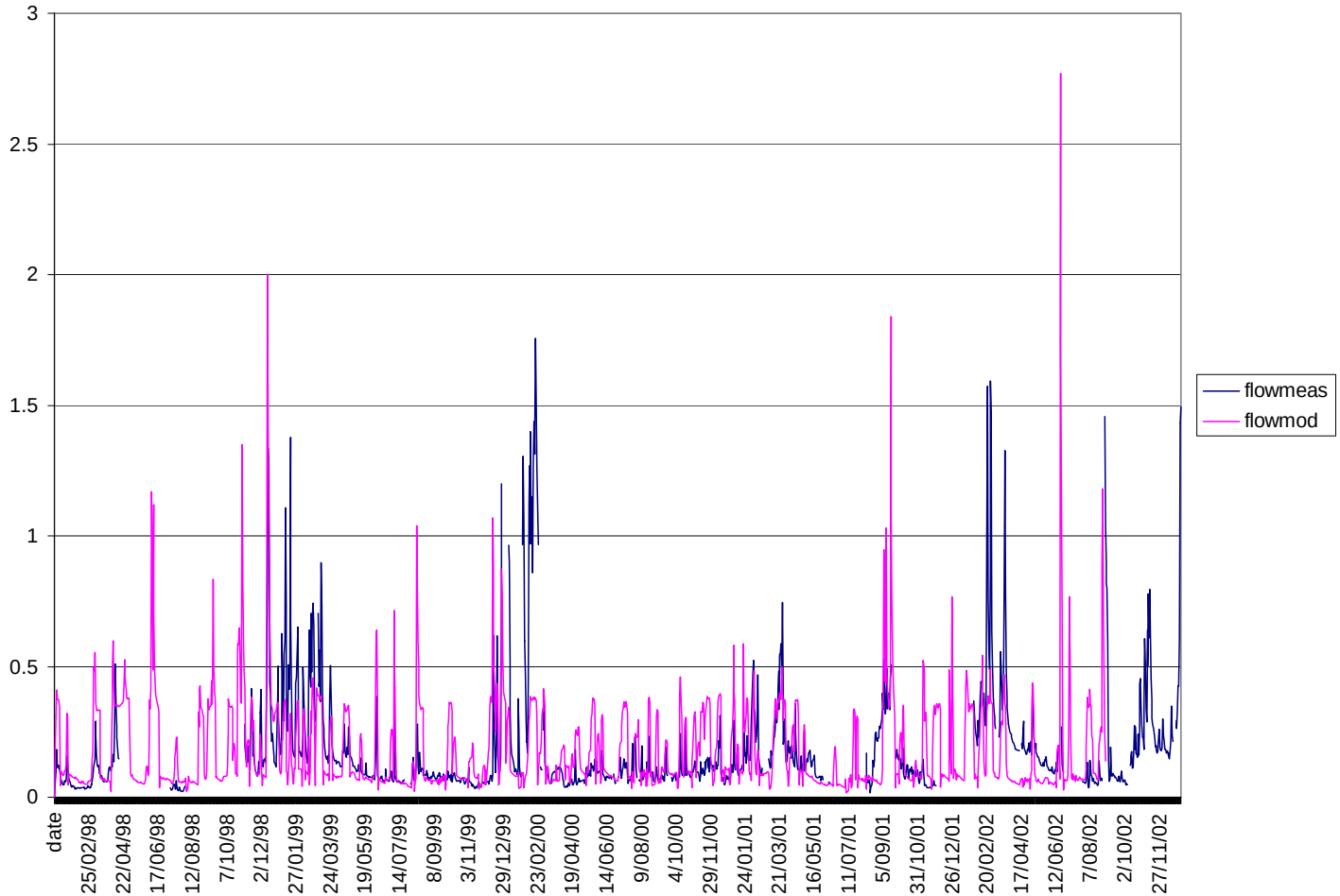


- Climate from the Belgian Royal Meteorologique Institute
- Landscape, soil, landuses, DEM: government authorities
- Use data for isoproturon: questionnaire for 1998-2002
- For calibration: IPU concentrations data for 1998-2002
- For calibration: surface water samples every 15 min for a 3-month period in 2004

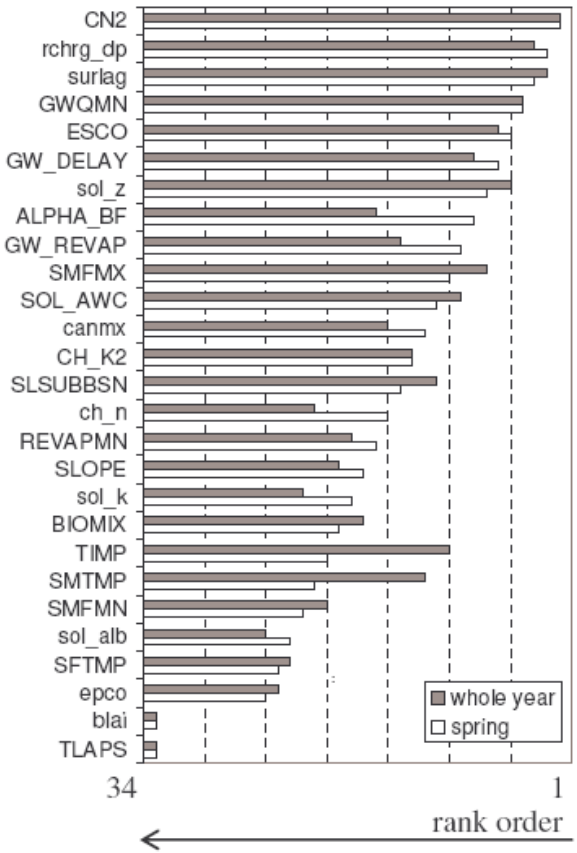
Flow calibration (spring)

- For years 1998 - 2002
- At mouth of the watershed
- Curve numbers, GW parameters adjusted
- Difficulties to calibrate hydrology well while at the same time calibrating for pesticides. At the end big rain events are overestimated because CN2 needed to stay high enough to have enough isoproturon in the runoff.
    - lumping of different fields within a SWAT subbasin, losing spatial detail of application of IPU on fields closely connected to the surface water

Flow calibration



Calibration with most sensitive parameters

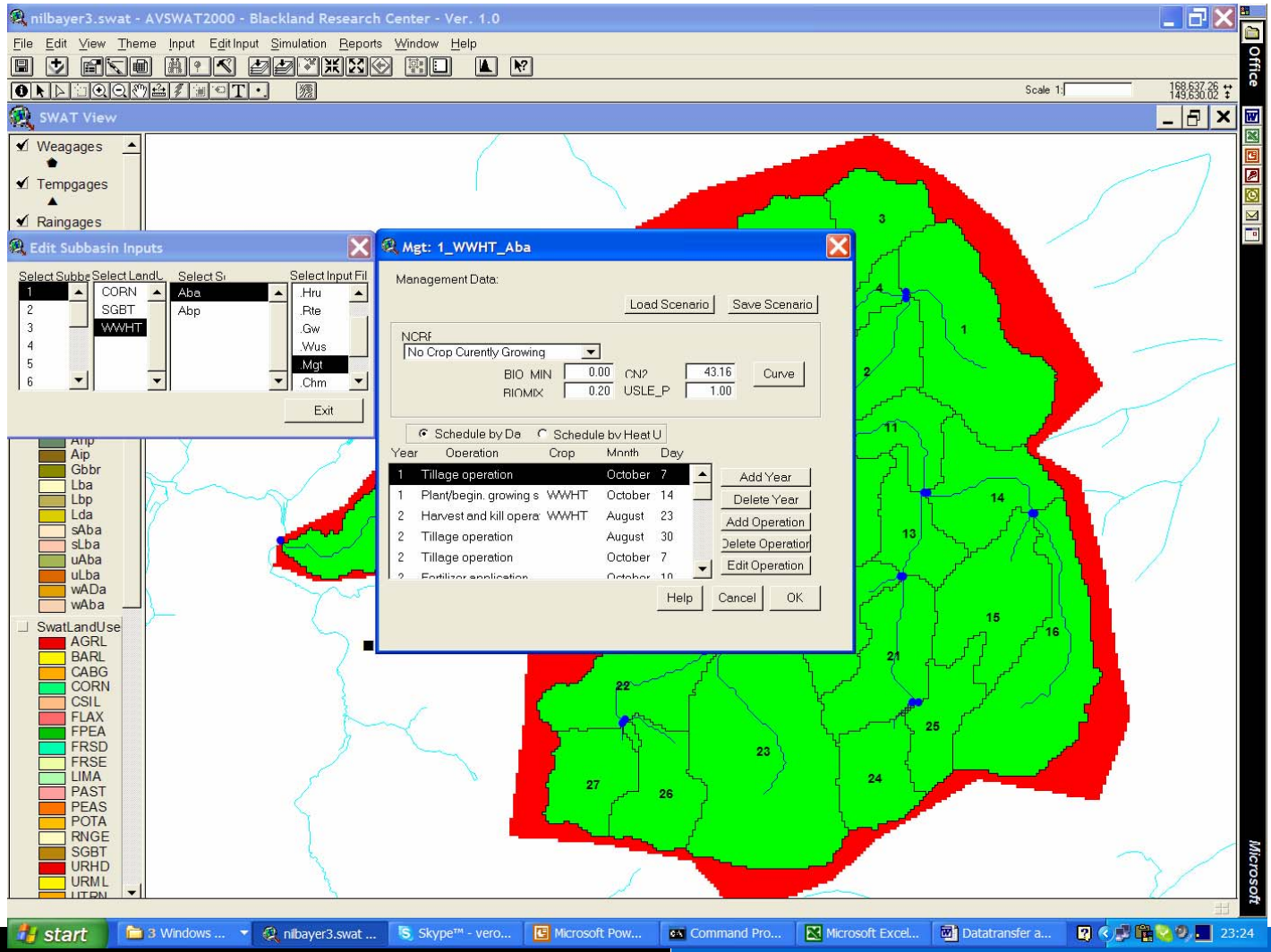


Curve number, groundwater recharge, groundwater delay, surface runoff lag coefficient, threshold depth for return flow

Parameters for isoproturon

- Soil adsorption coefficient: 80 (mg/kg)/(mg/l)
- Wash off fraction: 0,1
- Half life foliage: 10 days
- Half life soil: 11 days
- Application efficiency: 0.25
- Solubility in water: 65 mg/l

Management data



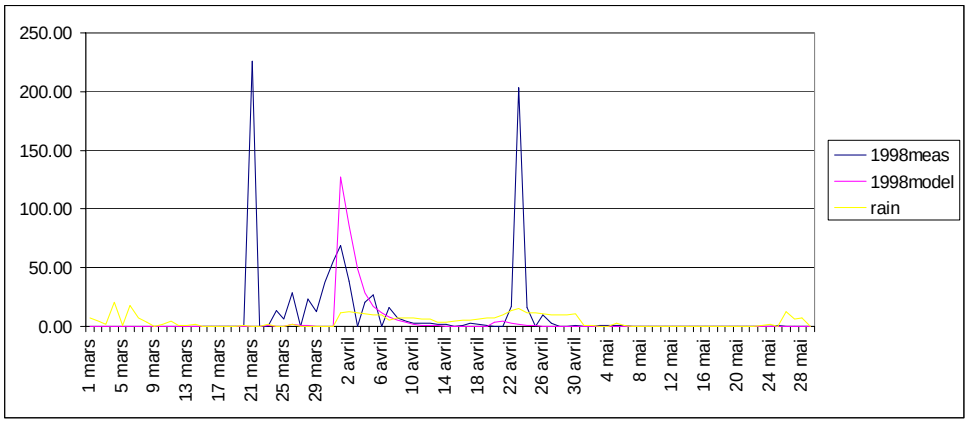
Management data

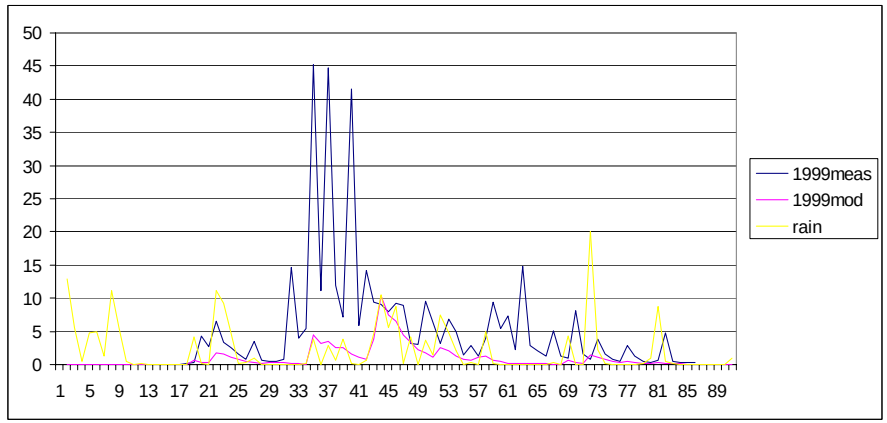
- Assumptions:
  - All fields same amount of IPU
  - Amounts proportional to the percentage of fields that were treated
  - Days of tillage, start of the growing season and harvesting from literature about winter wheat

Operation on the field	Date
Tillage (roller harrow)	7 October
Beginning of growing season	14 October
Harvest and kill	23 August
Tillage (disk plow)	30 August

Simulations 1998 – 2002

isoproturon (microgram/l)

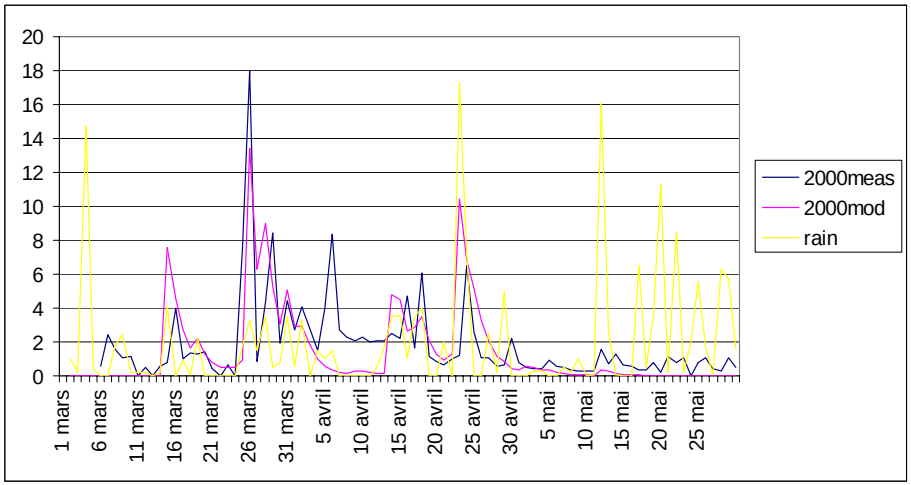


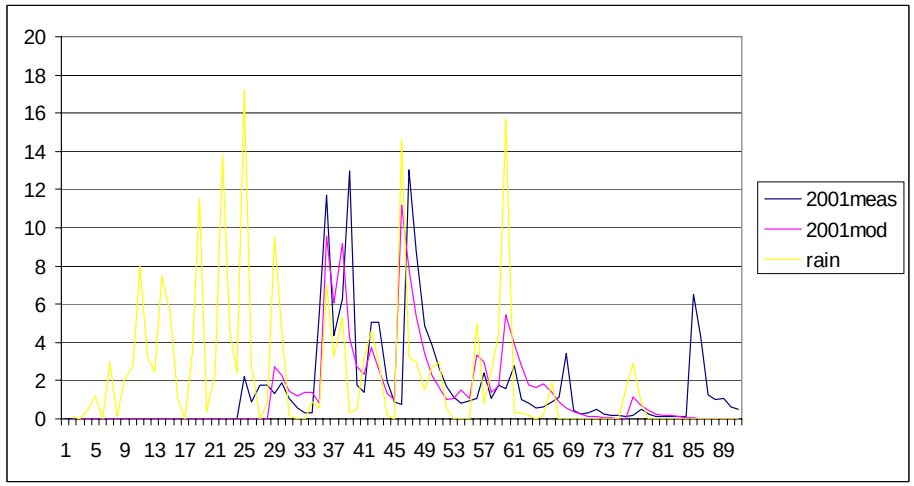


No campaigns against direct losses towards the river

Simulations 1998 – 2002

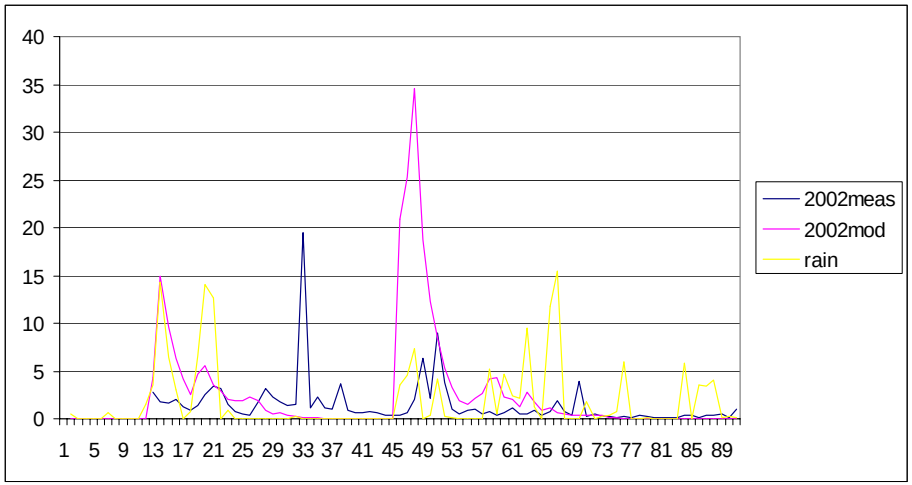
isoproturon (microgram/l)





Simulations 1998 – 2002

isoproturon (microgram/l)

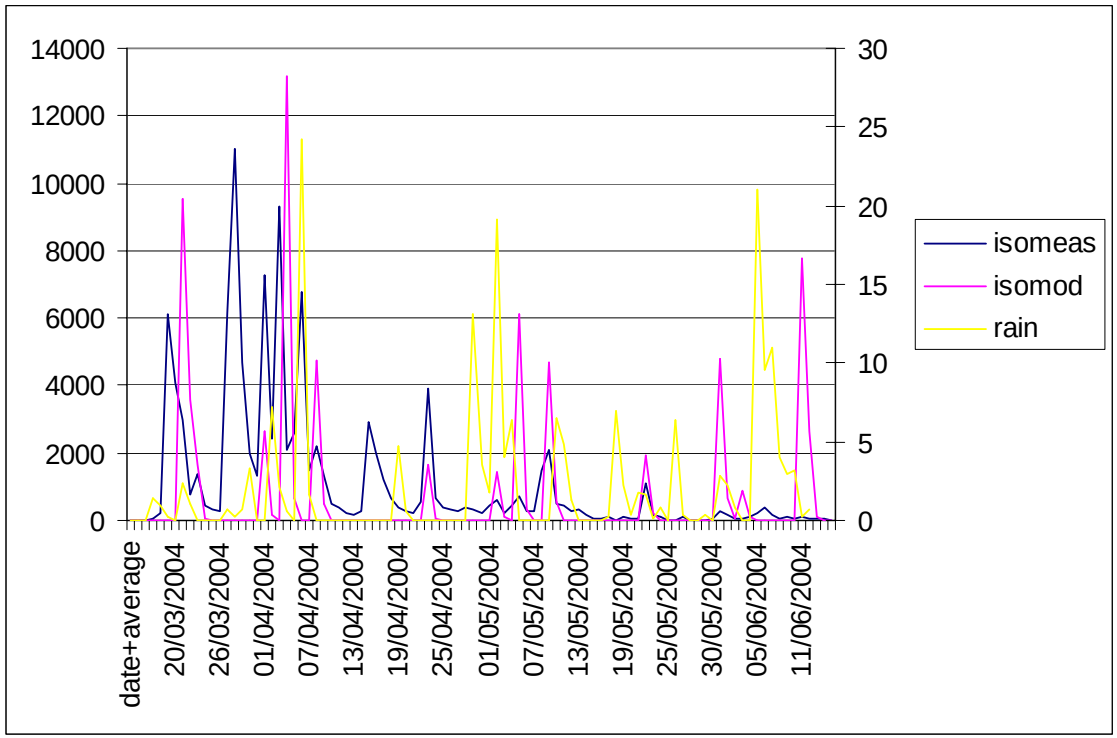


Input data for management 2004

- Date, amount (kg/ha)
- 14.03 0,02
- 15.03 0,03
- 17.03 0,02
- 27.03 0,01
- 28.03 0,01
- 29.03 0,02
- 01.04 0,02
- 02.04 0,02
- 09.04 0,07
- 10.04 0,07
- 11.04 0,09
- 14.04 0,08
- 15.04 0,09
- 20.04 0,04
- 05.05 0,04
- 20.05 0,02
- 25.05 0,02
- 06.06 0,02
- 09.06 0,01
- 13.06 0,01
- Totaal: 0,72

Simulations 2004

isoproturon (nanogram/l)



Application dates and amounts, trial and error, very sensitive

Discussion and Conclusions

- In the Nil catchment isoproturon towards the river is runoff based
- A SWAT model for IPU in the Nil Catchment could be made, however it is case specific.
- 1998 and 1999: underestimation in model: direct losses
  - Peaks in dry periods are not shown by model results -> direct losses caused by bad management practices (peaks 1998: 200 µg/l; peaks 1999: 45 µg/l; peaks 2000: 20 µg/l)
- 2000-2001: measurements and model results fit well:
  - Effect of information campaign towards farmers to reduce direct losses
- 2002: model is overestimating:
  - More dry period than previous year, 20 days no rain, then sudden peak towards the river. Some degradation and removal is not included in this model

Conclusions

- 2004 also high peaks, high simulation results (also dry year)
- Results are very sensitive towards the amount and day of application: uncertainty in application dates and amounts gives uncertainty in end results.

Acknowledgement

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