Monitoring and modelling the dynamic fate and behaviour of pesticides in river systems at catchment scale

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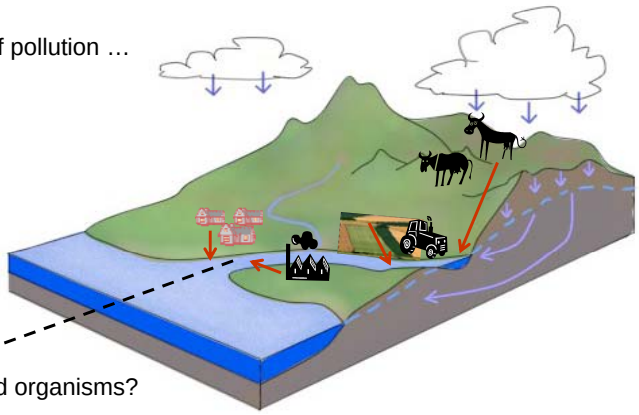
- Intensive monitoring campaigns
- Preliminary risk assessment
- Model developments
- Results
- Conclusions

# Problem statement

## River water quality

Different sources of pollution …



Effect on plants and organisms?

Can we calculate a risk?

# Problem statement

## Pesticides

| ADVANTAGES | DISADVANTAGES |
|---|---|
|  |  |
| - destroy deseases | - ecotoxicity |
| - control insects, weeds, … | - bio-accumulation |
| - economic impact | - hormone disrupting |

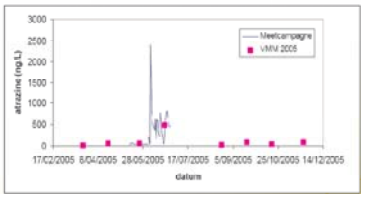
# Problem statement

Gaining insight in processes determining fate of pesticides

MEASURING

but …

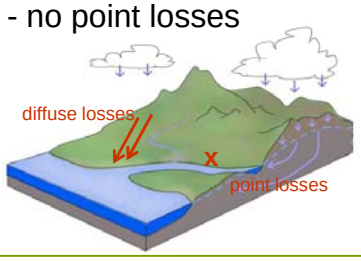
- expensive
- grab samples




MODELLING

but …

- only few well validated
- no point losses




# Problem statement

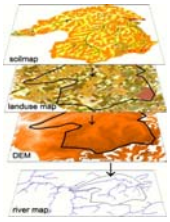
Objectives of the study

→ intensive monitoring campaigns

→ preliminary risk assessment

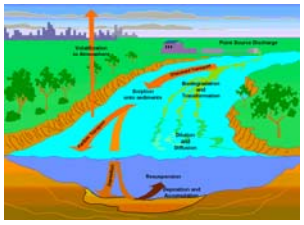
→ modelling

Fluxes towards the river



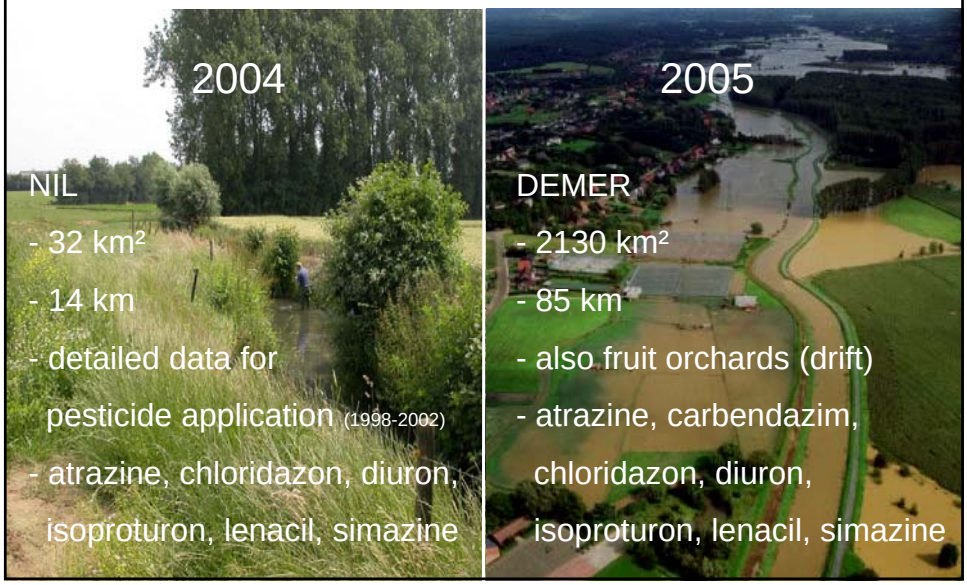

SWAT-model

Processes in the river



RWQM-model

# Intensive monitoring campaigns

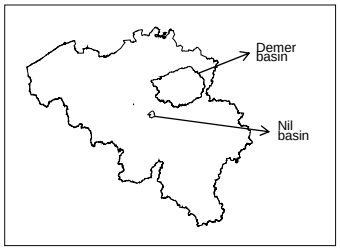


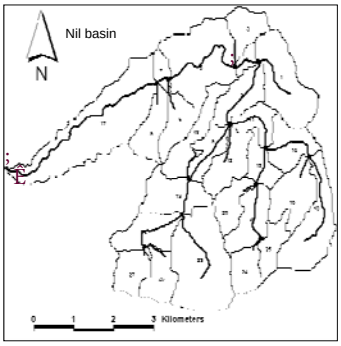
## 2004

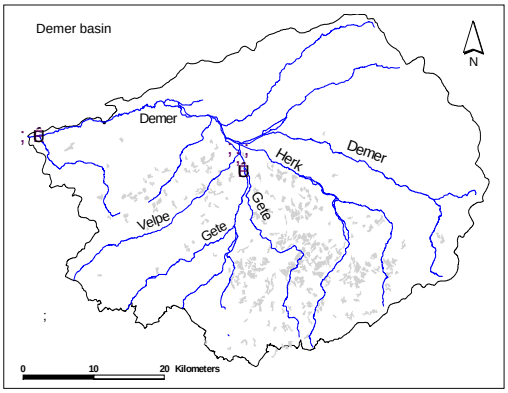
NIL
- 32 km²
- 14 km
- detailed data for pesticide application (1998-2002)
- atrazine, chloridazon, diuron, isoproturon, lenacil, simazine

## 2005

DEMER
- 2130 km²
- 85 km
- also fruit orchards (drift)
- atrazine, carbendazim, chloridazon, diuron, isoproturon, lenacil, simazine




| Catchment | Area (km²) |
|---|---|
| Nil | 32 |
| Demer | 2130 |
| Velpe | 140 |
| Herk | 300 |
| Gete | 450 |

## Monitoring campaigns

- 8 hr composite samples of water → pesticides in solution
  → pesticides on suspended solids

## Monitoring campaigns

- general water quality parameters

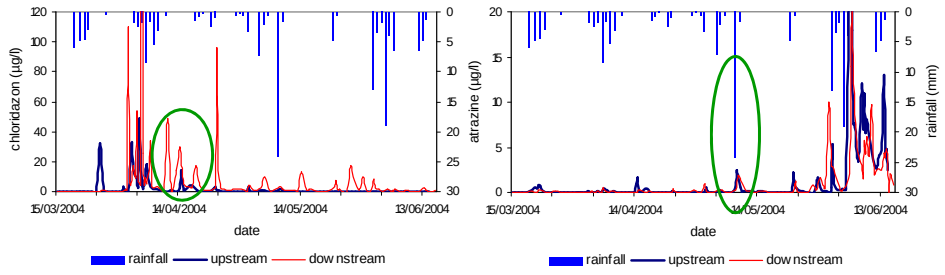
# Monitoring campaigns

- undisturbed sediment samples → sliced
  ⇓
  depth distribution → in pore water
  depth distribution → on the sediment



# Monitoring campaigns

Results in the water column: river Nil




→ highly dynamic system with hourly variations

→ due to runoff but also to direct losses

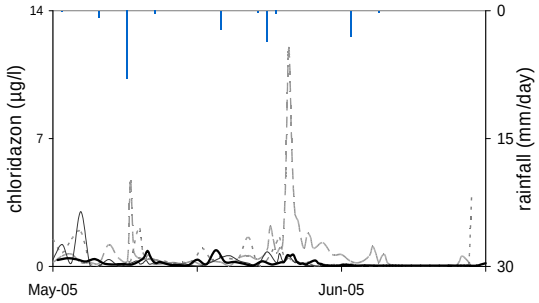
# Monitoring campaigns

## Results in the water column: river Nil

→ point losses: 30 to 90 % of the total pesticide load in the river Nil

# Monitoring campaigns

## Results in the water column: Demer catchment

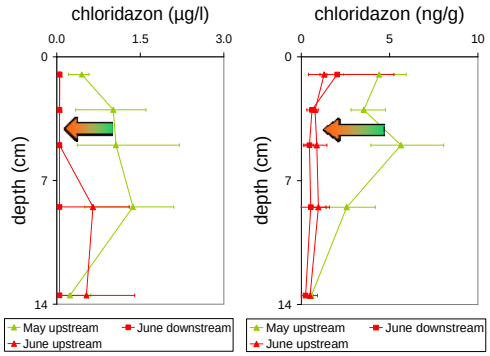



→ higher concentrations in smaller rivers

→ related to land use and flow

# Monitoring campaigns

in porewater on sediment




- in agreement with application sheme
- concentrations in pore water << in water compartment (2 orders of magnitude)
- decrease with depth

# Preliminary risk assessment

Risk assessment

- for each pesticide: lab experiments: → effect concentration
- comparison: measured ↔ effect concentration
- <u>for mixtures</u> of pesticides assuming additive effect:

<u>total hazard</u>: $= \sum_{i=1}^{n} \frac{MEC_i}{EC_{50} \text{ or } NOEC} < 1$

$MEC_i$ : measured environmental concentration

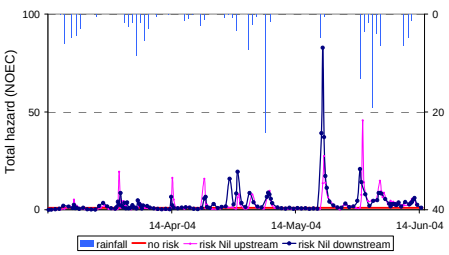
$EC_{50}$ : concentration expected to produce a certain effect in 50% of test organisms in a given population under defined conditions (acute)

*NOEC* : no observed effect concentration (chronic)

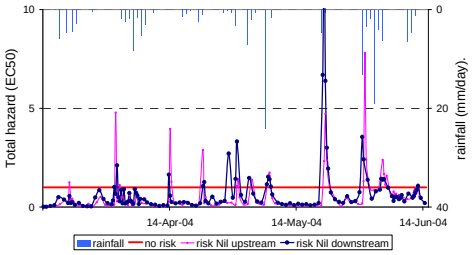
# Preliminary risk assessment

## Results: Nil

chronic




acute

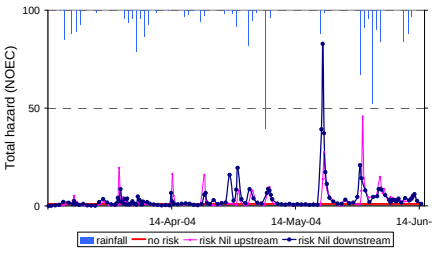



→ the Nil basin is almost permanently at risk

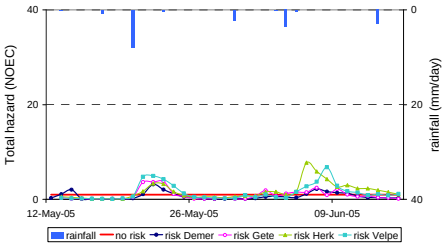
# Preliminary risk assessment

## Results: Nil ↔ Demer

Nil basin




Demer basin

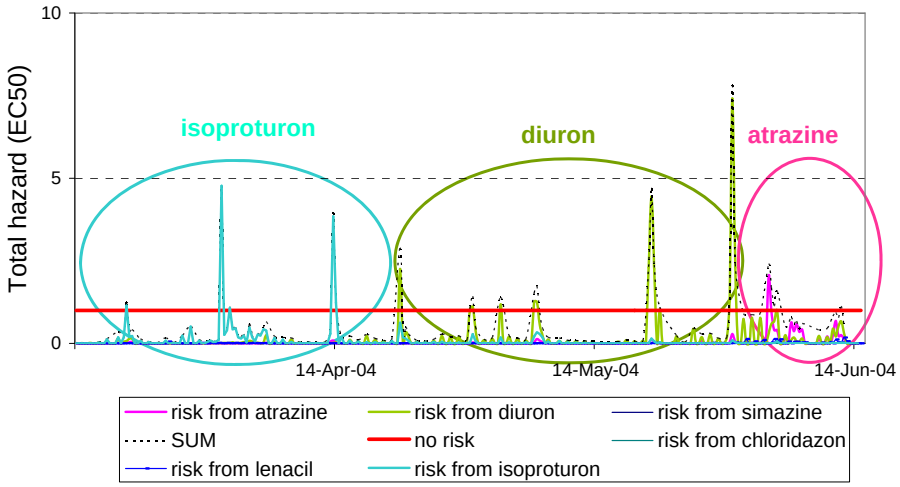



→ in the Demer basin: risk upstream > downstream

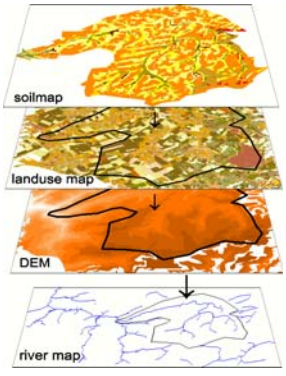
→ longer periods of no risk Demer > Nil catchment

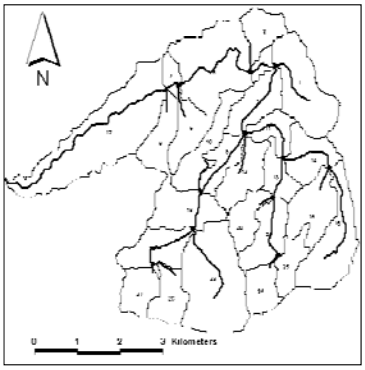
# Preliminary risk assessment

Results: Nil → not always agriculture which is contributing most!




# SWAT model



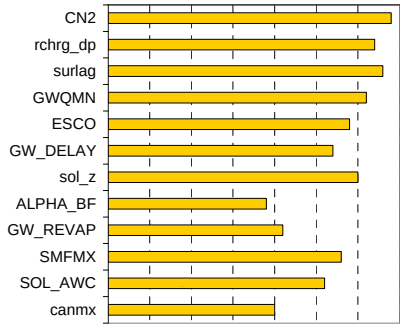




→ modelling hydrology, sediments, nutrients and pesticides

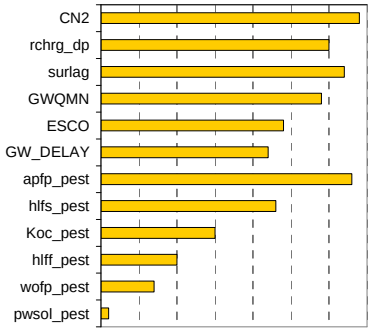
# SWAT model

## Sensitivity analysis

### hydrology

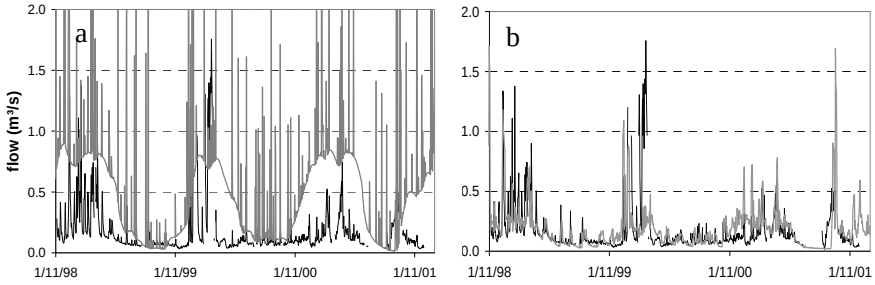



### pesticide supply



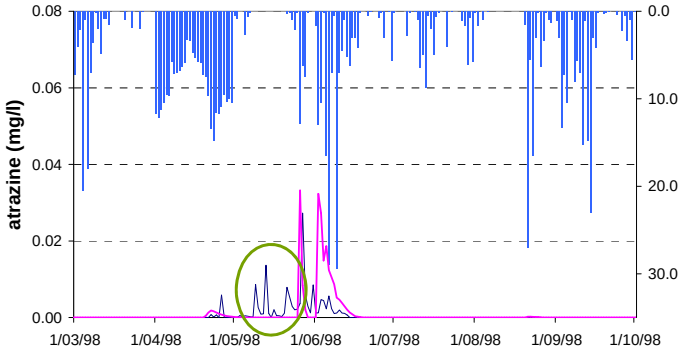

# SWAT model

## Calibrating hydrology



# SWAT model

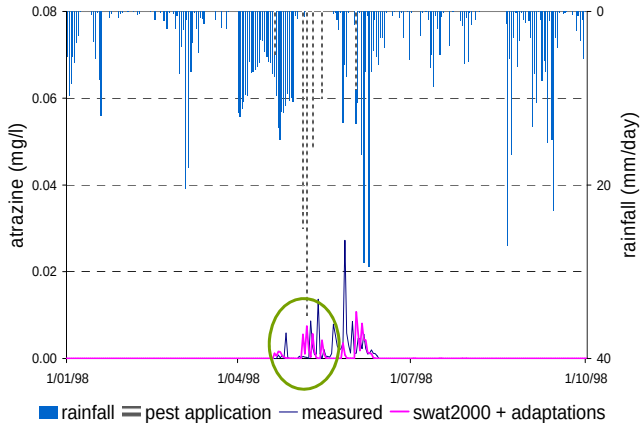
## Adding pesticides and management practices



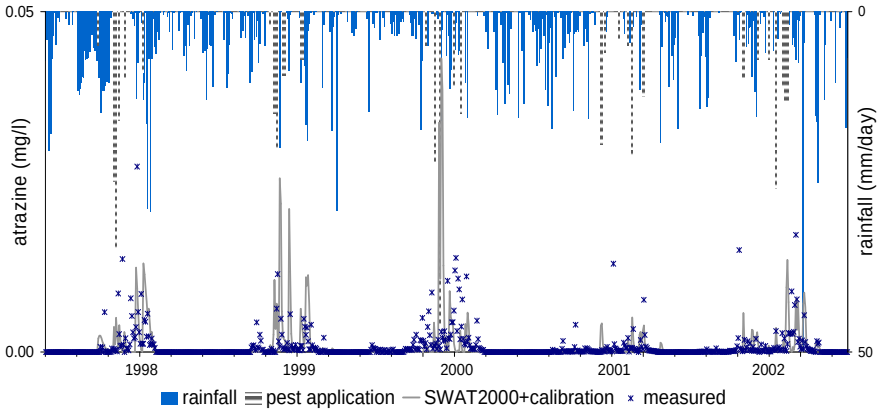

⇒ adjustments to SWAT code for losses on day of application

# SWAT model

## After model adaptations

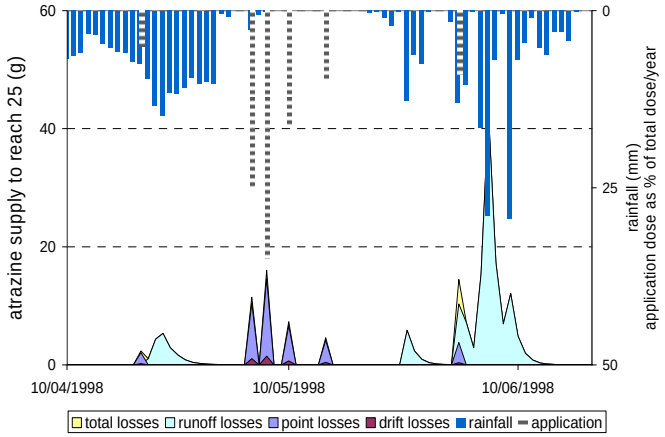


# SWAT model




# SWAT model

## Contribution of point/drift/runoff losses?



# SWAT model

a.

b.

⇒ SWAT allows for comparison of BMP's

# SWAT model

Which measure most effective?

| BMP | | increase(+)/decrease(-) atrazine load to river (%) |
|---|---|---|
| - conservation agriculture | - mb plough | + 0.9 |
| | - direct sowing | - 1.4 |
| - sowing cover crops | - mb plough | - 31.4 |
| | - direct sowing | - 32.7 |
| - contour ploughing | | - 26.9 |
| - strip cropping | | - 38.7 |
| - buffer strips (5m width) | | - 11.4 |

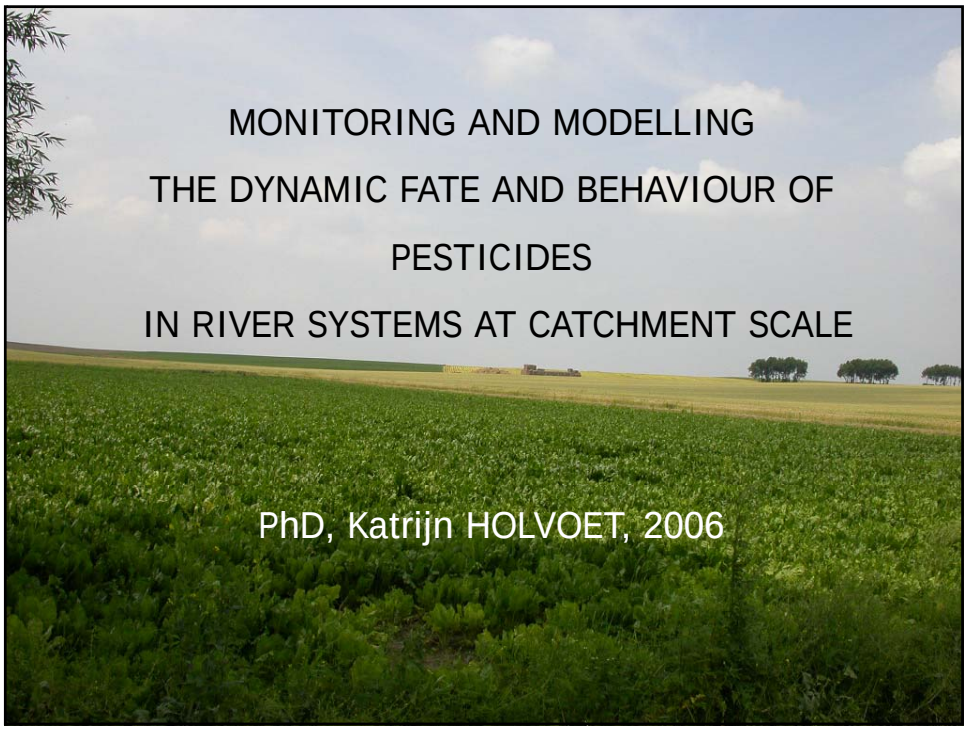
# Conclusions

- monitoring campaigns:
  - a highly dynamic system
  - upstream rivers in agricultural areas > downstream
    → but are ecologically very important
  - advise for set up of monitoring campaigns
    → measure in relevant periods
    → adapt use of mobile sampling teams
    → use Optimal Experimental Design
    → passive sampling can be an alternative
  - risk assessment:
    → upstream rivers: chronic risk is expected
    → it is not always agriculture that is contributing most!

# Conclusions

- modelling pesticides: SWAT
  - important to have hydrology modelled well
  - for detailed pesticide predictions: correct estimation of losses at day of application are important: inquiries
  - extention for losses at day of application
    → runoff + point losses >> drift losses
    → for fruit orchards: contribution of drift will ↑
    → BMP's can be compared


Thank you for your attention!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