Modelling the fate of pesticides in a highly dynamic water-sediment system

K. Holvoet, V. De Schepper, L. Benedetti, P. Seuntjens, P.A. Vanrolleghem

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Problem statement

Current risk assessment → worst case scenario’s
- simple partitioning
- unit world assumptions
- FOCUS surface stream

Is it possible to develop a more realistic model
- taking into account spatio temporal variability
- both indirect and direct pesticide losses
- at catchment scale

Problem statement

Fluxes towards the river
- SWAT-model

Processes in the river
- RWQM-model

Land scape level approach

Today’s talk …
Monitoring campaign

- intensive monitoring campaign spring 2005

<table>
<thead>
<tr>
<th>crop</th>
<th>% area</th>
<th>pesticide</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGBT</td>
<td>10.34</td>
<td>→ chloridazon</td>
</tr>
<tr>
<td>CORN</td>
<td>15.09</td>
<td>→ atrazine</td>
</tr>
<tr>
<td>WATR</td>
<td>0.03</td>
<td>→ isoproturon</td>
</tr>
<tr>
<td>WWHT</td>
<td>21.53</td>
<td></td>
</tr>
</tbody>
</table>

• composite samples of water

pesticides in solution
pesticides on suspended solids
Monitoring campaign

- general water quality parameters

Monitoring campaign

- undisturbed sediment samples → sliced
  ↓
  depth distribution
  in pore water
  on the sediment
• in the water column

→ highly dynamic system with hourly variations

Monitoring campaign

• in porewater
• on sediment

- in agreement with application scheme
- concentrations in pore water <<< water compartment (factor 2)
- irregularities due to stones
- decrease with depth
- explanation observations: combined
  → diffusion
  → biodegradation
  → chemical processes
  → sedimentation – resuspension

**dynamic model:**
- gain insight in the importance of each of these processes
- realistic predictions

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**Model development**

\[ Q_{d-1} C_{d-1} \quad Q_d C_d \]

\[ +1 V_i \]
Model development: extension of RWQM

Bulk Water

DOC sorption TD sorption POC

Sorption

Diffusion

Resuspension

Sedimentation

Biodegradation

Inflow

DOC sorption TD sorption POC

Sorption

Diffusion

Resuspension

Sedimentation

Biodegradation

Outflow

Model development

Bulk Water

Conversion Processes

Resuspension: $k_{res} C_{bed} V_{bed}$
Diffusion: $K_{L,CI} C_{bed}/A$

Sediment

Conversion Processes

Burial: $k_{burial} X_{bed} V_{bed}$

Diffusion: $K_{L,CI} C_{l,A}$

splitter

$Q, C_{l-1}$

$Q, C_l$
Results: model validation

- in the water compartment
  - good agreement
  - should be validated for other pesticides
Results

- in the pore water

![Graph showing chloridazon and diuron levels over time](image)

<table>
<thead>
<tr>
<th>compartment</th>
<th>pesticide</th>
<th>downstream</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>measured</td>
</tr>
<tr>
<td>Pore water (ng/l)</td>
<td>chloridazon</td>
<td>910</td>
</tr>
<tr>
<td></td>
<td>diuron</td>
<td>1540</td>
</tr>
<tr>
<td>Sediment (ng/g)</td>
<td>chloridazon</td>
<td>1,2</td>
</tr>
<tr>
<td></td>
<td>diuron</td>
<td>4,9</td>
</tr>
</tbody>
</table>
Results

- on the sediment

- after the application period: decrease
- upstream sediment is transported towards mouth

Conclusions

- the water-sediment is a dynamic system → dynamic model is necessary for realistic predictions
- extension of the RWQM1-model with pesticide behaviour
- model validation:
  - bulk water: reliable results
  - pore water: underestimated → needs further research
  - on sediment: same order of magnitude
- tool for risk assessment: more realistic pesticide concentrations
QUESTIONS?

Contact:
Katrijn.holvoet@vito.be