Modeling of nitrate leaching from the unsaturated zone at the research site Wagna

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Motivation and goals

- Physically based modeling of nitrate leaching from the unsaturated zone considering soil heterogeneity and authentic crop growing patterns over a 17 year period (meteorological conditions)
- Identification and understanding of the most important factors
- Simulation of scenarios to assess crop growing patterns and define sustainable variants
- Computing of recharge and non-point pollution time series as input data for regional 2d saturated groundwater and transport flow model
### Soil type database

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>gravel</th>
<th>sand</th>
<th>silt</th>
<th>clay</th>
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</thead>
<tbody>
<tr>
<td>UtsG2H3</td>
<td>8</td>
<td>28</td>
<td>53</td>
<td>11</td>
</tr>
<tr>
<td>Ls2G2H2</td>
<td>9</td>
<td>31</td>
<td>41</td>
<td>19</td>
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<td>Sl4G3H0</td>
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<td>55</td>
<td>23</td>
<td>14</td>
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<tr>
<td>gSG6H025</td>
<td>73</td>
<td>25</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Crop growing patterns

- 32 lots with 8 different crop growing patterns; comparison between corn monoculture and crop rotation patterns (including wheat, rape, barley and pumpkin)

- Usage of mineral fertilizer and pig liquid manure

- Fertilization scheme:
  - Until 1992 usage of about 200 kgN/ha
  - Between 1993 and 1997 about 150 kgN/ha
  - From 1998 between 107 and 145 kgN/ha
    - No liquid pig manure in autumn
    - Interim green seeds
    - Ploughing only in springtime
Concept of model SIMWASER
(Stenitzer, 1988)

W1 (1)
W2 (2)
W3 (3)
W (N)

Bodenoberfläche
Profile bottom

Precipitation N
Evaporation from soil E₁ₑₑ

Infiltration or uptake of water

Boundary Conditions at the profile bottom

W1 = root uptake
W = water content

STOTRASIM principle
(Feichtinger, 1998)

NO₃⁻-N in der Bodenlösung

Nährstoff-Wechselschichten in der Luft (Legenden)
Nitrate leachate of fields representative for a given soil and crop growing

Nitrate leachate at field 5 with thickness of A-horizon between 55 and 75 cm for the fertilizing periods
Cumulative, area weighted nitrate leachate of all fields with the same crop growing

Influence of top soil thickness - nitrate leachate for a given soil and crop rotation pattern
Conclusions I

- Strong variation of top soil thickness and soil type within small area
- Typically, far less information on soil is available
- Strong variation of cumulative nitrate leaching between single lots
- Pig liquid manure with less nitrate leachate than mineral fertilizer
- Corn monoculture with less nitrate leachate than crop rotation pattern
- Thickness of top soil of minor importance
- Amount of fertilizer still most important factor
Conclusions II

- Lysimeter important tool for site specific calibration of numerical models that allow for simulation and assessment of agricultural land use
- Sustainable groundwater leachate can be reached
- Resulting groundwater nitrate concentration predominantly depends on subsurface inflow concentration
- Water limiting component for crop yields rather than nutrients