Combination of PELMO with GIS as a strategy for higher tier assessment

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Introduction
Digitised Maps used for the study
Methodology
Results
Conclusions and Recommendations

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Nine realistic worst-case groundwater scenarios, which collectively represent agriculture in the EU, for the purposes of a Tier 1 EU-level assessment of the leaching potential of active substances.

The scenarios should describe an overall vulnerability approximating the 90th percentile of all possible situations.
Introduction: Open questions

Do the 9 groundwater scenarios really represent something like a “90th percentile of all possible situations“?

What can be done as the next step if a decision cannot be made based on the results of the tier 1 simulations?

Spatial modelling using thematic maps as input parameter for the leaching models
Maps: Annual precipitation and Annual temperature

GISCO-data base (Geographic Information System of the Commission of the European Communities)
Point information converted by to grid maps with a resolution of 5 km x 5 km
(Knoche et al., 1998)
The European soil map is based on the FAO-UNESCO map (Fraters 1996) converted to a 5 km x 5 km - raster map (Knoche et al. 1998)
Maps: Organic matter content

The European organic matter map is based on the Soil Organic Matter Map of the European Communities (Fraters and Bouwman, 1993)

Converted to a 5 km x 5 km - raster map (Knoche et al. 1998)
The European land cover maps were developed by the U.S. Geological Survey (USGS), University of Nebraska-Lincoln (UNL) and European Commission's Joint Research Centre (USGS 1997).
Maps: Climatic regions (FOCUS regions)

The map was created based on the climatic maps and the FOCUS scenario descriptions.
Methodology:

- No spatial dependent soil types (use of the FOCUS scenarios)
- Daily weather data based on the FOCUS-Tier 1 scenarios
- Scaling of air temperature and precipitation based on the map information
- Soil type based on the map information
- Organic matter content based on the map information
- No use of a meta model or simplified leaching model
- All simulations pixel by pixel with the real model (resolution 5 km x 5 km)
- For all cells the 80th percentile of the annual concentration was calculated
- Data-aggregation after the simulations (80th percentile)
Methodology: Selection of FOCUS weather series

Based on the maps on annual temperature, rainfall and land use the most suitable FOCUS weather series was selected for each pixel.
Methodology: Scaling of the rainfall data

Based on the annual rainfall map the FOCUS-rainfall series were linearly scaled in order to consider the actual rainfall for each cell.
**Methodology: Scaling of the temperature data**

Annual temperature

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Based on the temperature map the FOCUS-temperature series were linearly corrected in order to consider the actual temperature for each cell.

\[ T = T_0 + T_{map} - T_{scen} \]

- \( T \): corrected daily temperature
- \( T_0 \): original daily temperature
- \( T_{map} \): annual temperature in the map
- \( T_{scen} \): annual temperature of the scenario
Methodology: Organic matter content

Based on the organic matter map the OC-contents of the FOCUS-soil profiles were corrected to consider the actual organic carbon content for each cell.
Results: Pesticides used for the study

FOCUS A: Kom = 60 L/kg, DT50 = 60 d
FOCUS D: Kom = 35 L/kg, DT50 = 20 d
Application: 1 kg/ha 1 day before emergence in winter cereals
Results: Distribution of concentration for FOCUS A

Concentration in the leachate (µg/L) at 1 m depth

- 0.00 to 0.01 µg/L: 3.3%
- 0.01 to 0.03 µg/L: 2.0%
- 0.03 to 0.1 µg/L: 1.8%
- 0.1 to 0.3 µg/L: 4.8%
- 0.3 to 1.0 µg/L: 15.1%
- 1.0 to 3.0 µg/L: 34.2%
- 3.0 to 10 µg/L: 30.3%
- 10 to 30 µg/L: 8.0%
- > 30 µg/L: 0.9%

Mean: 4.0 µg/L
Results: Distribution of concentration for FOCUS D

Concentration in the leachate (µg/L) at 1 m depth
Results: Distribution of concentration within a FOCUS region I

FOCUS A  FOCUS D

600 – 800 mm
5 °C to 12.5 °C
Results: Distribution of concentration within a FOCUS region II

600 – 800 mm
> 12.5 °C
Results: Comparison with FOCUS Tier 1 simulations I
Results: Comparison with FOCUS Tier 1 simulations II

![Graph showing comparison between FOCUSPELMO and GISPELMO simulations for different categories (J, C, H, K, N, S, P, O, T)].
In both studies the biggest deviation between the FOCUS tier 1 scenarios and the GIS-analysis were found for Piacenza (FOCUS too high) and Porto (FOCUS too less).

Additionally, GISPELMO calculated significantly higher leaching for the cold scenario (J).

Respective simulations with EUROPEAR for Jokioninnen were not performed.
Results: Comparison with EUROPEARL analysis (FOCUS D)

Also for FOCUS D, the biggest deviation between FOCUS tier 1 scenario and the GIS-analysis were found for Piacenza (FOCUS too high) and Porto (FOCUS too less).

In opposite to EUROPEARL, GIS-Pelmo calculated significantly lower concentration also for Hamburg.
Discussion: Advantages of higher tier GIS studies

The same models or model packages can be used

- on different scales
  (total EU, EU-zones, member states, region within member states)
- for different purposes
  (EU registration, national registration, regional registration)

Generally, detailed information on the spatial distribution of concentrations dependent on the environmental concentration is given to focus on

- safe uses
- vulnerable situations
Discussion: Weaknesses of the present GIS-PELMO study

Soil information:
The soil maps used for the study were based on topsoil information only. By considering full soil profile information the results would have been improved significantly.

Weather series:
Scaling of temperature and precipitation based on annual data only, may lead to wrong description of seasonal differences. This is important especially for South Europe where rainfall is not distributed equally over the seasons.
Discussion: Representativeness of FOCUS tier 1 scenarios I

The main results of the EUROPEARL study were confirmed by the GIS analysis performed with PELMO:

• Most of the FOCUS-scenarios the results are in line with the extended GIS-analysis

• The Porto scenario seems to be not representative for the respective FOCUS-area (tier 1 scenario too low)

• The Piacenza seems to be not representative for the respective FOCUS-area (tier 1 scenario too high)

Further results of the GIS-PELMO study:

• The Jokioninen scenario seems to be not representative for the respective FOCUS-area (tier 1 scenario too low)

• For FOCUS D the GIS-based analysis show lower leaching than the respective tier 1 simulation for Hamburg.
Discussion: Representativeness of FOCUS tier 1 scenarios II

- The tier 1 scenarios may be inadequately defined
- The quality of the digitised map (especially soil map) was not sufficient

- Better spatial information should be made available in order to reduce misinterpretation of higher tier GIS-studies.
- More studies are needed to analyse discrepancies between the results of tier 1 simulations and higher tier GIS-modelling
- As the results of 2 GIS-analyses performed with 2 different leaching models (PELMO and PEARL) and 2 different spatial data sets show the same deviations for Piacenza and Porto there seems to be significant evidence that these tier 1 scenarios are not representative and redefinition of these scenarios for Piacenza and Porto should be discussed.
Recommendations for the use of GIS techniques for higher tier assessment

• The results of GIS-study may be highly influenced by the map information used for the study. Therefore, the selection of spatial data should be done based on generally accepted and validated maps.

• Standard tools should be made available for a meaningful use of GIS-techniques including:
  • FOCUS leaching shells and models
  • „Standard-FOCUS“ European maps
  • „Standard-FOCUS“ aggregation tools

• Detailed recommendations should be given how to
  • work with the package on different scales (EU, zones, member states)
  • interpret the results of the tools