Spatially Distributed Models: A Step Forward in Higher Tier Leaching Studies

Aaldrik Tiktak

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Outline of presentation

The role of spatially distributed models
The GeoPEARL model
Three Cases

Conclusions & perspectives
References

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The PEARL team

Starring:

Jos Boesten
Daniel van Kraalingen
Joop Kroes
Aaldrik Tiktak
Roel Kruijne
Ton van der Linden
Minze Leistra
Erik van den Berg

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Pesticide registration follows a tiered approach

Strict  Lower (model) tiers  Cheap

Less strict  Expensive
The present “model tiers” in EU and national registration procedures...

... use a limited number of standard scenario's:

- Realistic worst cases on large areas of land
- Expert judgement

Questions with respect to

- the representativeness of standard scenario's
- the possibility to derive a single standard scenario for different substances
Does a single standard scenario exist?

Position of Dutch standard scenario

Scenario is not a realistic worst case for this substance

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What is the effect of variability?

Area of use

Drinking water abstraction areas

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The advantage of spatially distributed models:

- **Percentiles** of the leaching concentration can be obtained directly from maps
  ...no subjective choice of standard scenarios

- **Variability** can be dealt with
  ... leaching in drinking water abstraction areas
  ... leaching in the area of usage
The GeoPEARL model

• GeoPEARL is a spatially-distributed model of pesticide leaching to the groundwater

• The model can be used at different scales:
  • catchment scale (local studies)
  • national scale (national registration)
  • Pan-European scale (EU registration)

• If combined with a regional-scale groundwater model, the model can be used to assess drainage to surface waters as well

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Possible scales...

Catchment

Vulnerability index (%)
- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- Non arable

μg/L
- < 0.001
- 0.001 - 0.01
- 0.01 - 0.1
- 0.1 - 1
- > 1

EU

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GeoPEARL is ran for unique combinations:

- The core of the model consists of a 1D-model, i.e. FOCUS PEARL 2.2.2.
- PEARL is run in a GIS context for a large number of unique combinations (plots) of soil, climate, land-use and hydrogeological units.
- The model is combined with a regional-scale groundwater model (NL)
A user interface facilitates the use of GeoPEARL

User interface has much in common with FOCUS PEARL user interface
Example of GeoPEARL use: New Dutch national registration procedure

- The model will be used in the second tier (after the use of a single - strict - standard scenario)

- For each plot the median leaching concentration in time is calculated and put into a map

- The target value derived from the map is the 90th percentile of the leaching concentration at the area of usage
Case I: Effect of substance properties on the spatial pattern (1):

- PEARL can simulate substances with different properties
  - ordinary substances
  - pH-dependent sorption
  - degradation dependent on pH
  - volatile substances
Case I: Effect of substance properties (2)

Ordinary substance

pH-dependent sorption

Soils with high pH

Vulnerable sandy soils

Opposite spatial patterns!

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Case II: Effect of area of usage (1):

- Registration is requested for specific crops;
- The new decision tree therefore considers the **area of potential usage**, approximated by the area of crops for which a registration is requested;
- GeoPEARL is distributed with a database of areas for 24 major crops.
Case II: Effect of area of usage (2)

Maize
Maize is grown on slightly acidic sandy soils

Potatoes
Potatoes are grown on light sandy clay soils and in 'the Veenkolonien'

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Case II: Effect of area of usage (3)

NLE is a substance with pH-dependent sorption behaviour

Slightly acidic sandy soils

Light sandy clay soils and ‘the Veenkolonien’
Case II: Effect of area of usage (4)

Unsafe in potatoes

Safe in maize

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Case III: Leaching in drinking water abstraction areas (1)

- The aim is to protect groundwater as a source of drinking water;

- The question is whether drinking water areas are sufficiently protected;

- GeoPEARL can be used to answer this question
Case III: Leaching in drinking water abstraction areas (2)

Leaching concentration of NLC

(μg L⁻¹)

- No usage
- < 0.01
- 0.01 - 0.1
- 0.1 - 1
- > 1
- Non arable

Leaching concentration of NLC

(μg L⁻¹)

- < 0.01
- 0.01 - 0.1
- 0.1 - 1
- > 1

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Case III: Leaching in drinking water abstraction areas (3)

![Graph showing the concentration of a substance in potatoes, with areas marked as unsafe in DW and safe in NL.](http://www.pearl.alterra.nl)
Conclusions from cases:

• The predicted spatial pattern of leaching depends on pesticide properties (opposite patterns may occur between pesticides)

• Consideration of spatial variability can affect the final decision:
  • The area of usage may have a strong effect on the authorisation decision
  • Results from GeoPEARL showed that the 90\textsuperscript{th} percentile of the leaching concentration in drinking water abstraction areas is higher
Perspectives:

- A spatially distributed model of pesticide leaching referred to as GeoPEARL is now available.

- The model can be used for:
  - National registration procedures (operational)
  - Registration at the EU level (beta version)

- Based on common knowledge, the predicted spatial pattern is plausible, but there is need for additional validation:
  - catchment studies (Dyle study in Belgium)
  - observations in DW abstraction wells

- FOCUS groundwater working group III


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