Further development of national groundwater scenarios in the Netherlands

Contributors

RIVM: Aaldrik Tiktak, Ton van der Linden

Alterra: Roel Kruijne, Jos Boesten

With co-operation of other members of the PEARL development team

Outline of presentation

- Introduction
- Development of GeoPEARL
- Results from the prototype
- Use of GeoPEARL in the decision tree
- Conclusions

Introduction

Decision Tree Leaching

1

Simple calculation procedure
(on basis of standard dossier)

2

- Additional laboratory lab experiments
- Field/lysimeter experiments
- More advanced calculations
- Monitoring uppermost groundwater

1 m

3

- Behaviour in water-saturated zone
- Monitoring deep groundwater

Introduction

Aim:

X^{th} percentile of concentration (long term median or mean) at 10 m depth in area of use below or above 0.1 µg/L ?

Concepts (in part):

- Preferable to protect a larger surface area on long term than a smaller area against too high peak concentrations
- X^{th} percentile in area of use considering:
  - –variability in soil profile properties
  - –variability in groundwater levels
  - –variability in climate
  - –area of usage
  - –mean or median pesticide properties

X is subject of political debate

Introduction

Why development of new scenarios?

- Current practice: one standard scenario representing an approximate 80% vulnerable location
- Vulnerability, however, differs for the various plant protection products
- Current procedure gives no percentiles

Development of GeoPEARL

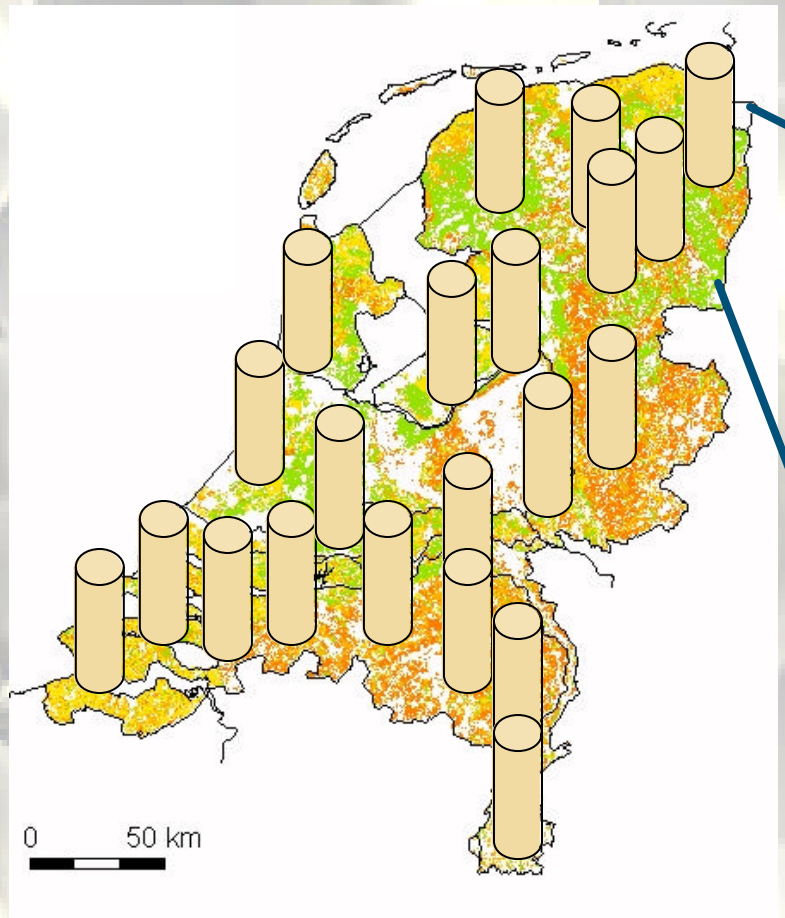
- A model taking regional differences in environmental conditions into account resolves problems of the current procedure; GeoPEARL.

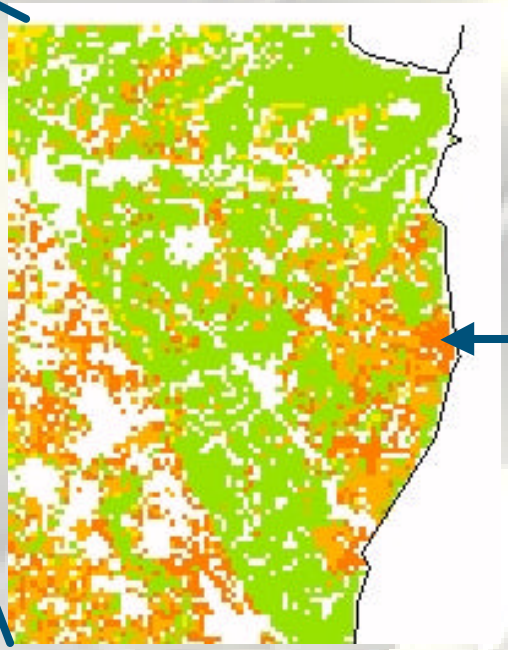
- GeoPEARL will be used in higher tier assessments

- It is envisaged that new standard scenarios for use in lower-tier assessments will be derived from GeoPEARL results.

The plot approach

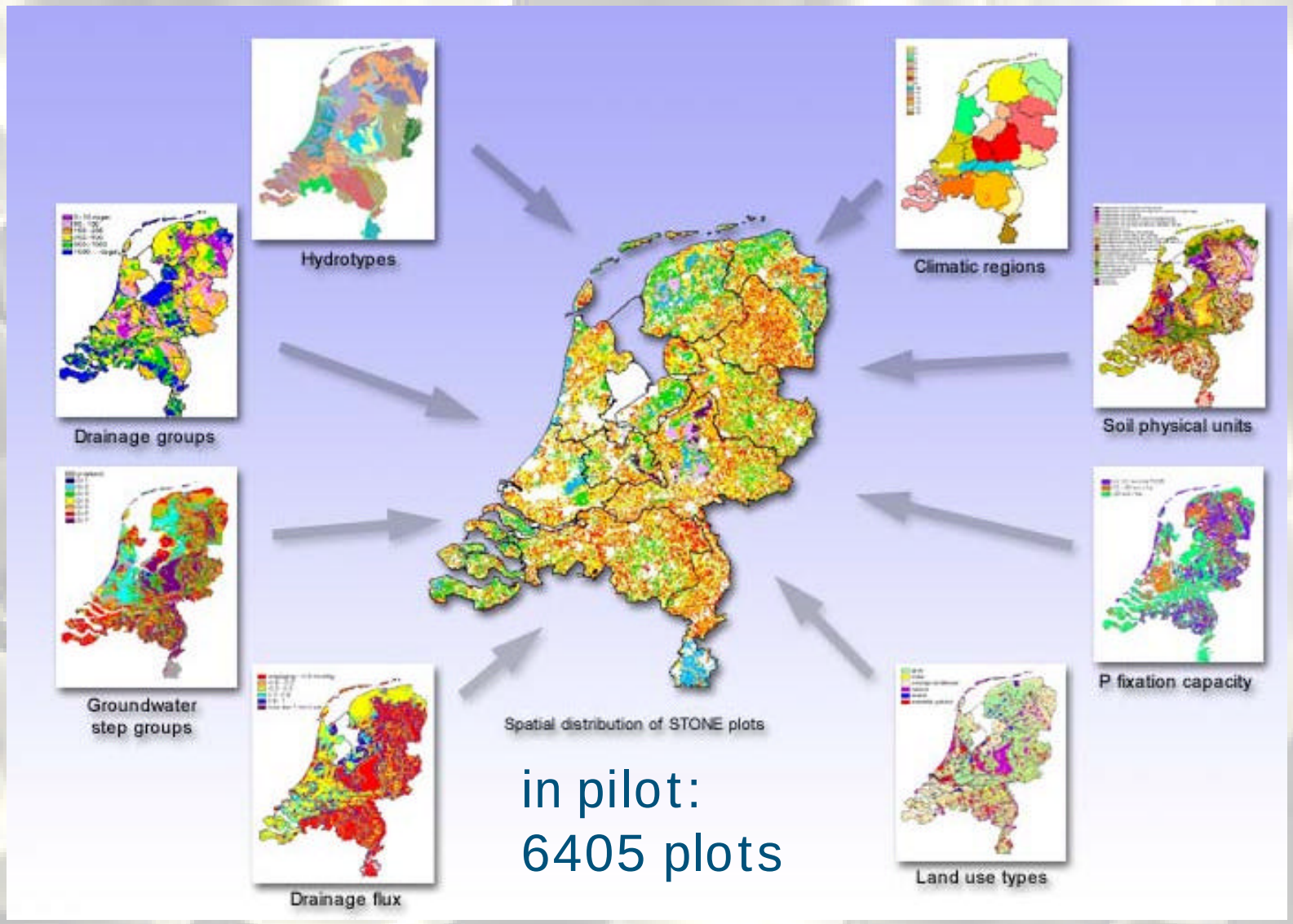
Each column represents a plot





A plot

Plots are unique combinations of:



in pilot:
6405 plots

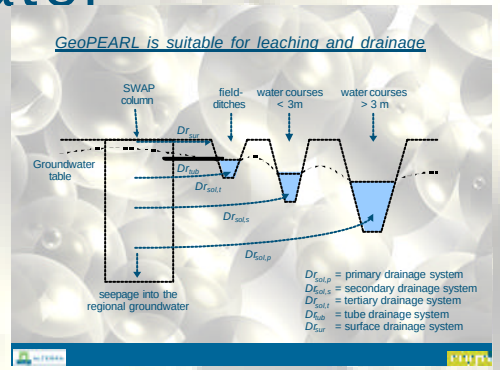
Findings obtained with the pilot version

Discussion will focus upon four pesticides:

- **Atrazine**
  moderately mobile; moderately degradable
- **Bentazone**
  very mobile; fairly degradable
- **Dichloropropene**
  fairly mobile; fairly degradable; volatile
- **Dinoseb**
  mobile under basic conditions; immobile under acidic conditions; moderately degradable

Following results are shown:

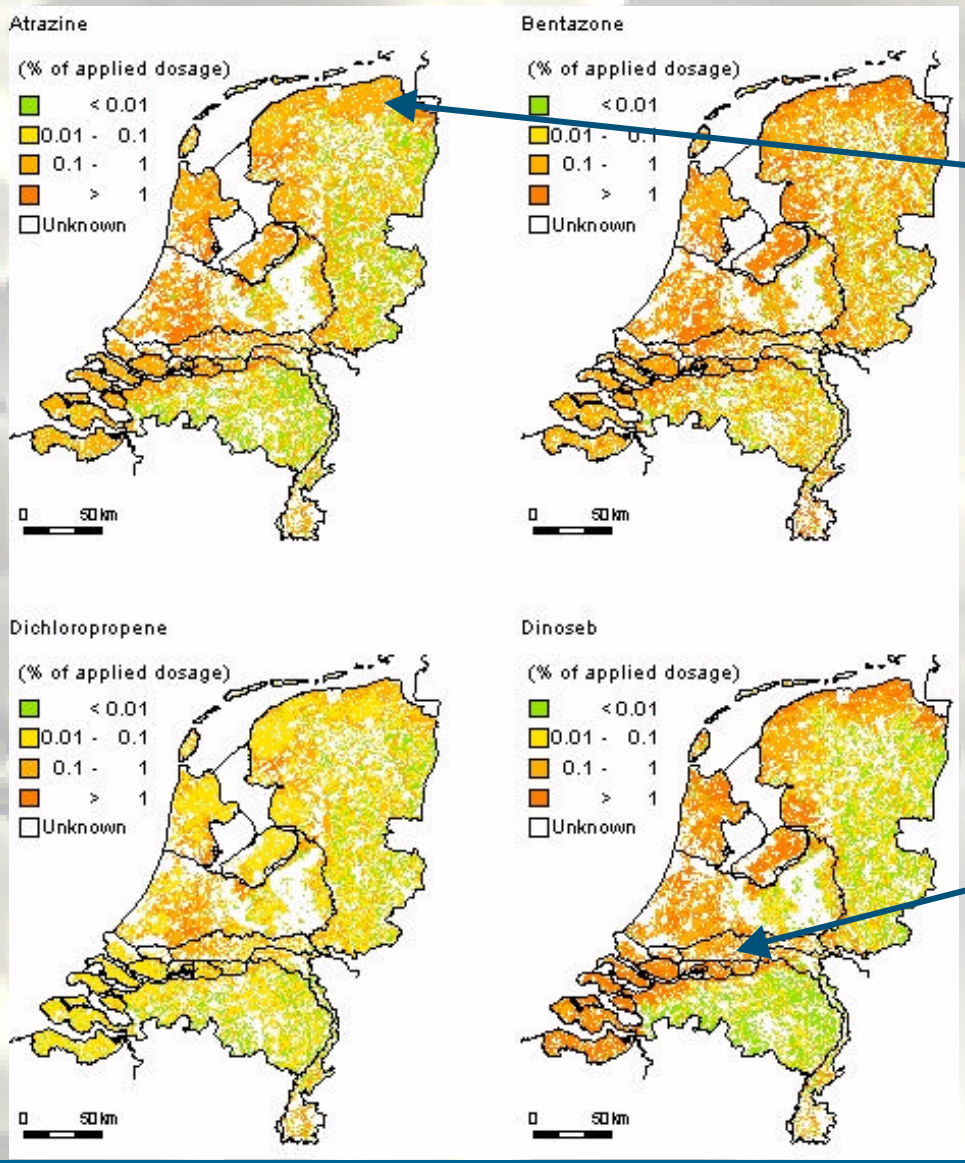
- **Leaching** into the regional groundwater
- **Drainage** into local surface waters (sum of all drainage fluxes)



Simulations were carried out for 20 years (real weather data). In the current version, the long-term **average** substance fluxes are presented.

A dosage of 1 kg ha^{-1} was used **throughout the country** (i.e. *vulnerability assessment*).

Drainage into local surface waters

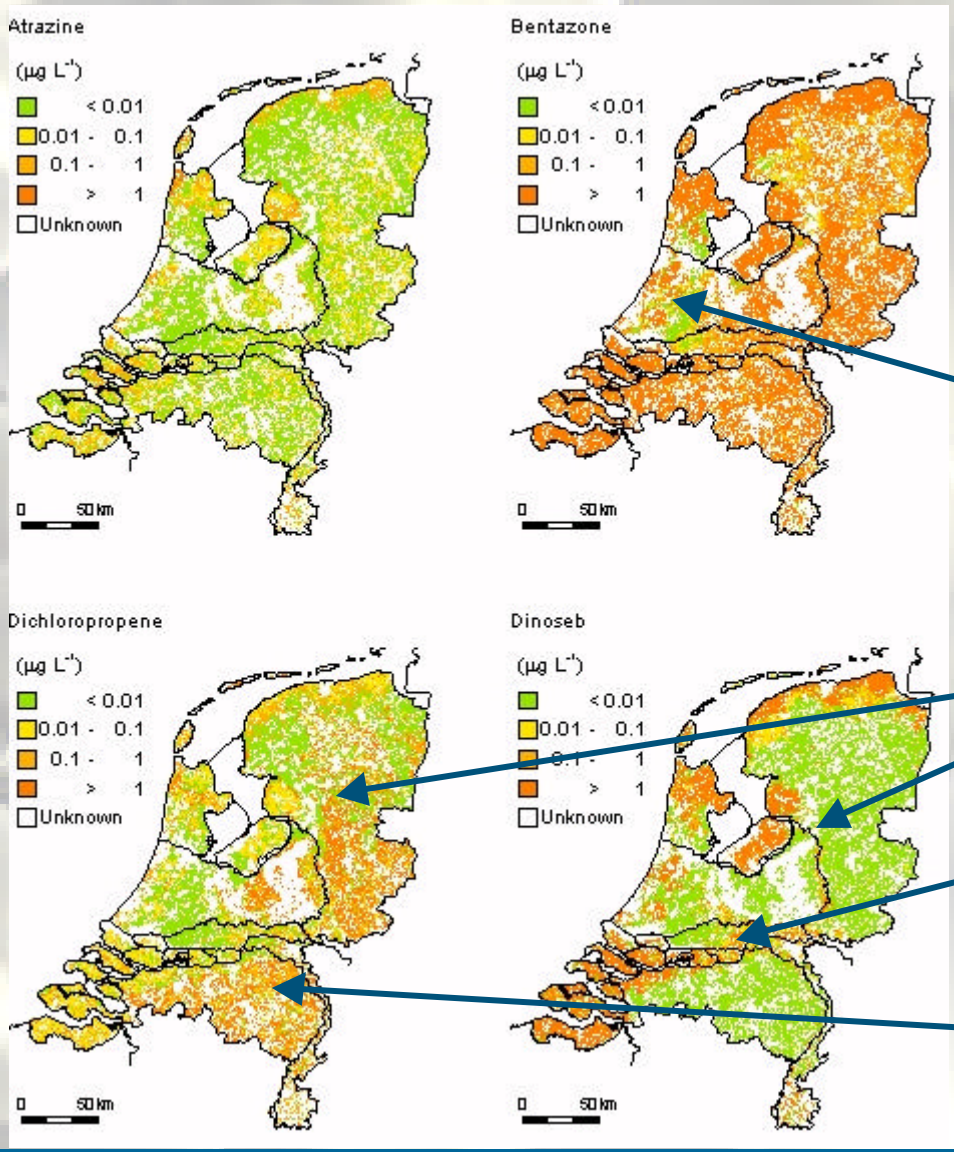


tube-drainage

drainage fluxes are highest in the West

pH effect

Concentration in leaching water



high organic matter content

opposite patterns!

pH effect

transport in gas phase

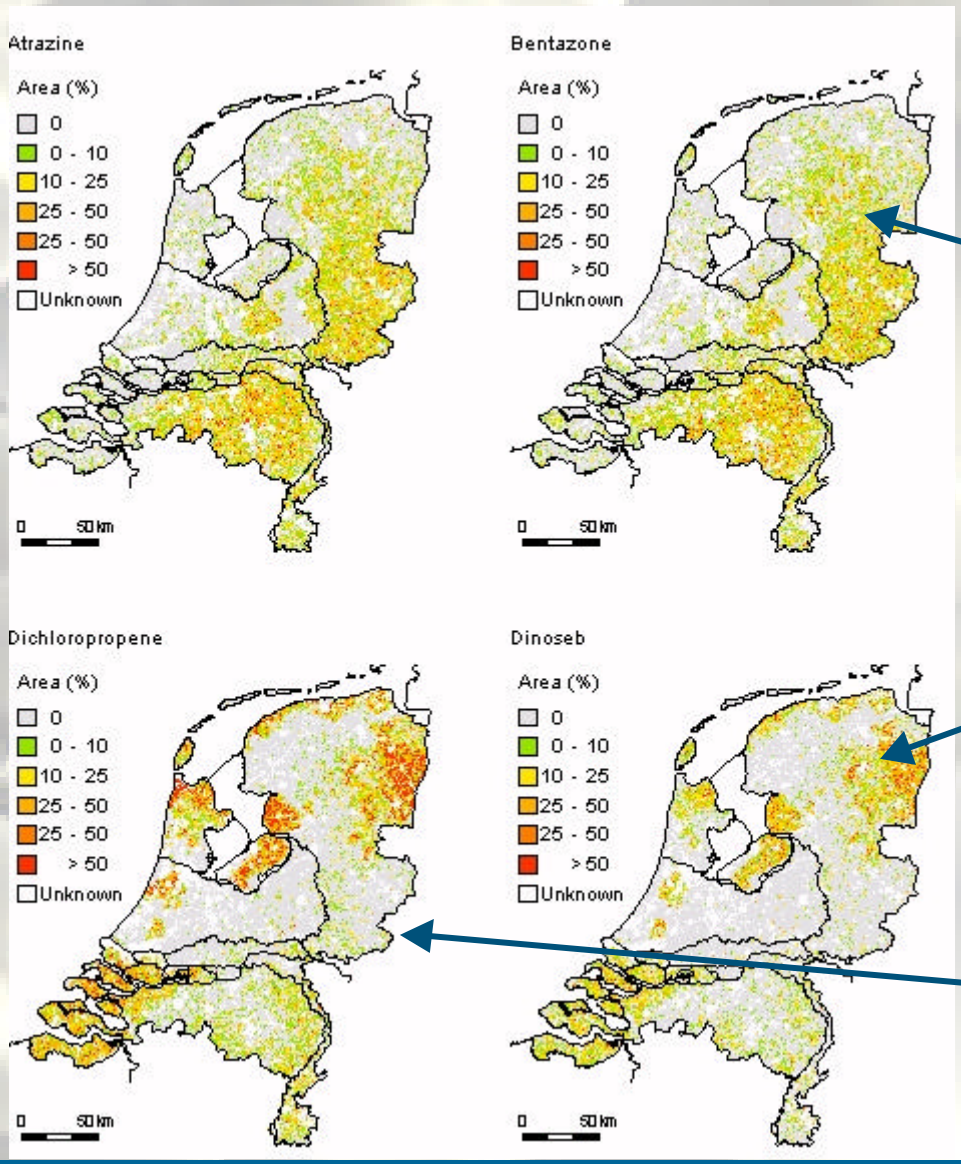
Some observations:

- Drainage fluxes are generally higher than leaching fluxes. Drainage occurs in the West; leaching in the East.
- Leaching and drainage are affected by numerous processes.
- Spatial patterns may be opposite for different pesticides (dinoseb versus dichloropropene)

Incorporation of area of usage:

- Vulnerability assessments were carried out for the Netherlands as a whole.
- Dutch registration procedure focuses upon the area of usage:
- The leaching concentration should not exceed the standard (0.1 $\mu g\ L^{-1}$) at 90% of the total area of usage (and in 50% of the time).
- This implies that GeoPEARL results must be presented for the area of usage

Area of usage



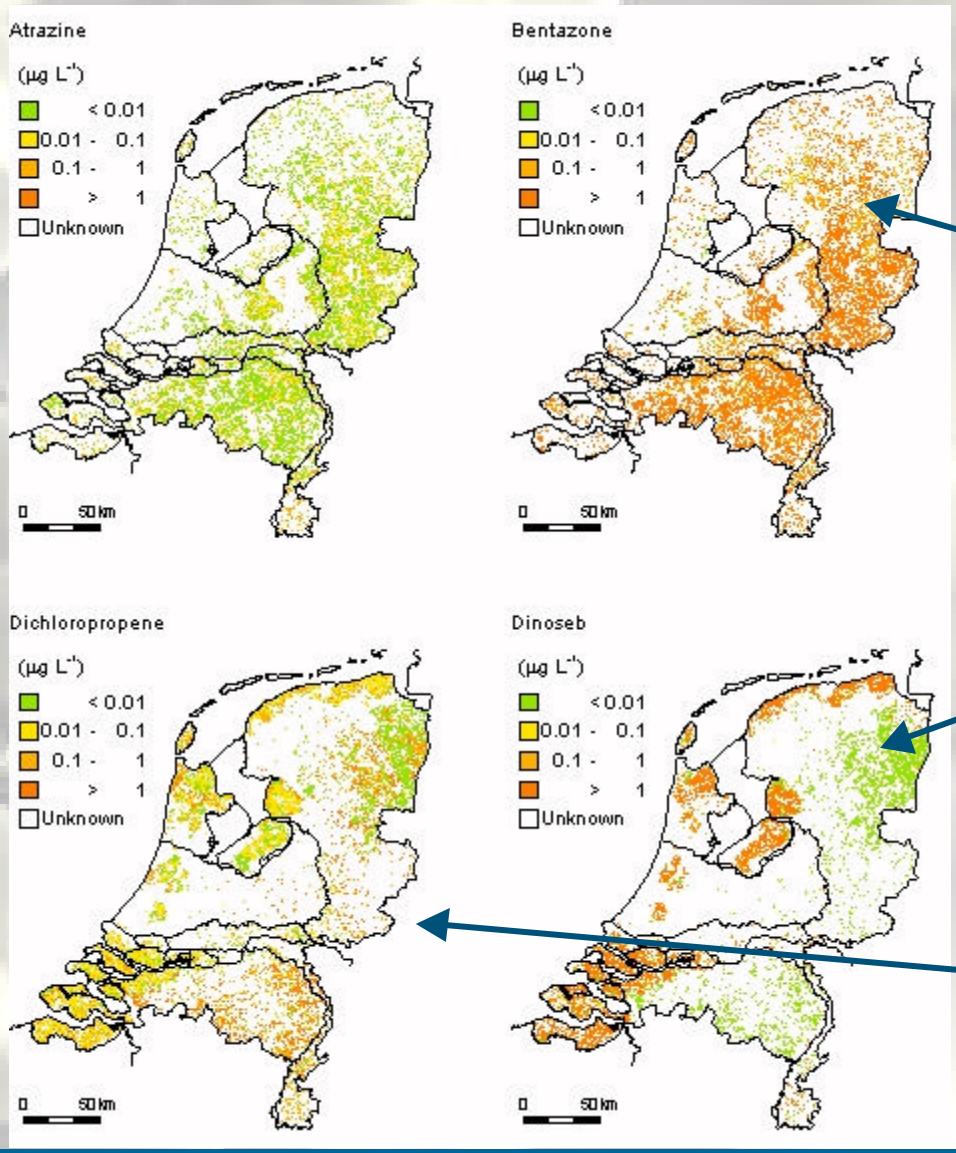
Areas were inferred from satellite images

mais

potatoes

Sum of potatoes, beets and flower bulbs

Concentration in leaching water



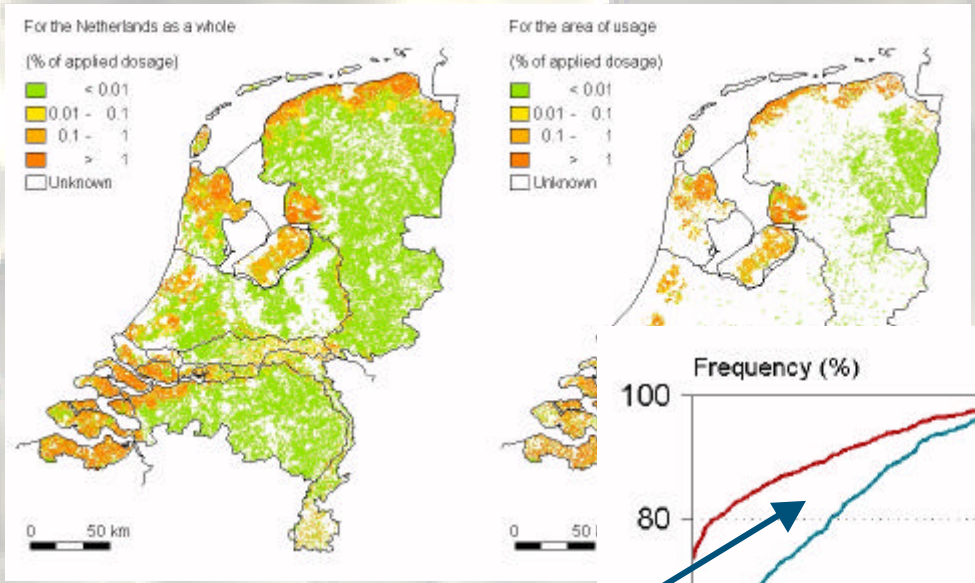
mais

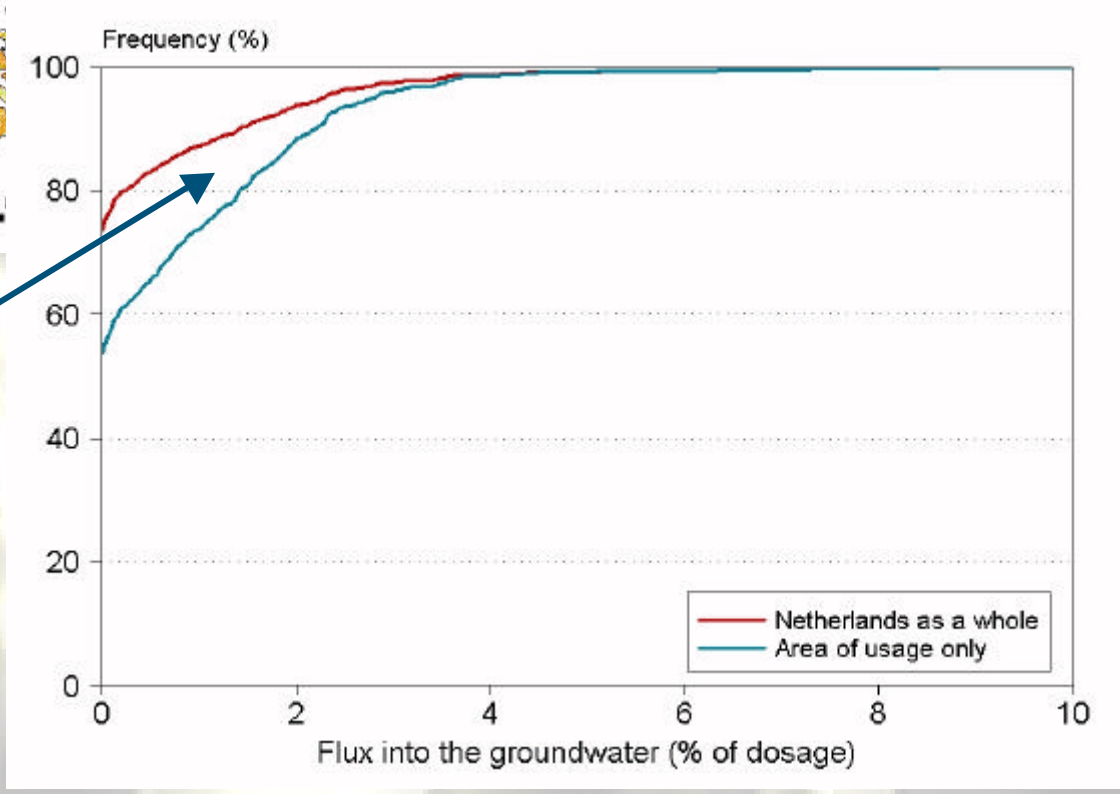
potatoes

potatoes, beets and flower bulbs

Effect of area of usage on frequency distribution

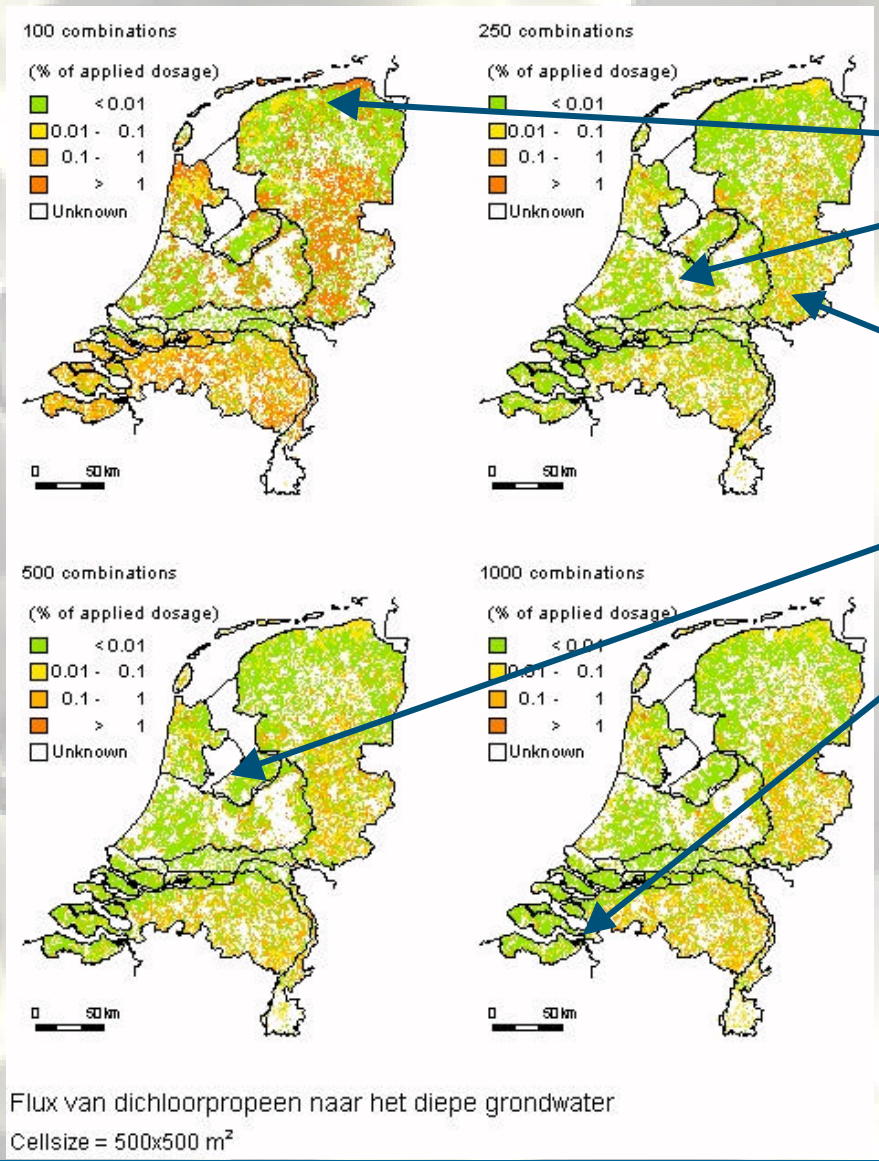
dinoseb





effect is large

How many plots do we need?



Flux van dichloorpropeen naar het diepe grondwater

Cellsize = 500x500 m²

these two are different!

almost no difference

More plots = more detail,

but

250 plots is enough...

Is a single standard scenario sufficient?

- Dutch standard scenario is a well drained sandy soil, low in organic matter and with a pH of 4.6

- Predicted concentration (dosage = 1 kg ha^{-1}):

atrazine	0.03 µg L^{-1}
bentazone	1.46 µg L^{-1}
dichloropropene	0.002 µg L^{-1}
dinoseb	zero

- Area above 0.1 µg L^{-1} (dosage = 1 kg ha^{-1}):

atrazine	14% of total area
bentazone	92 % of total area
dichloropropene	45 % of total area
dinoseb	32 % of total area

incompatible

Summary

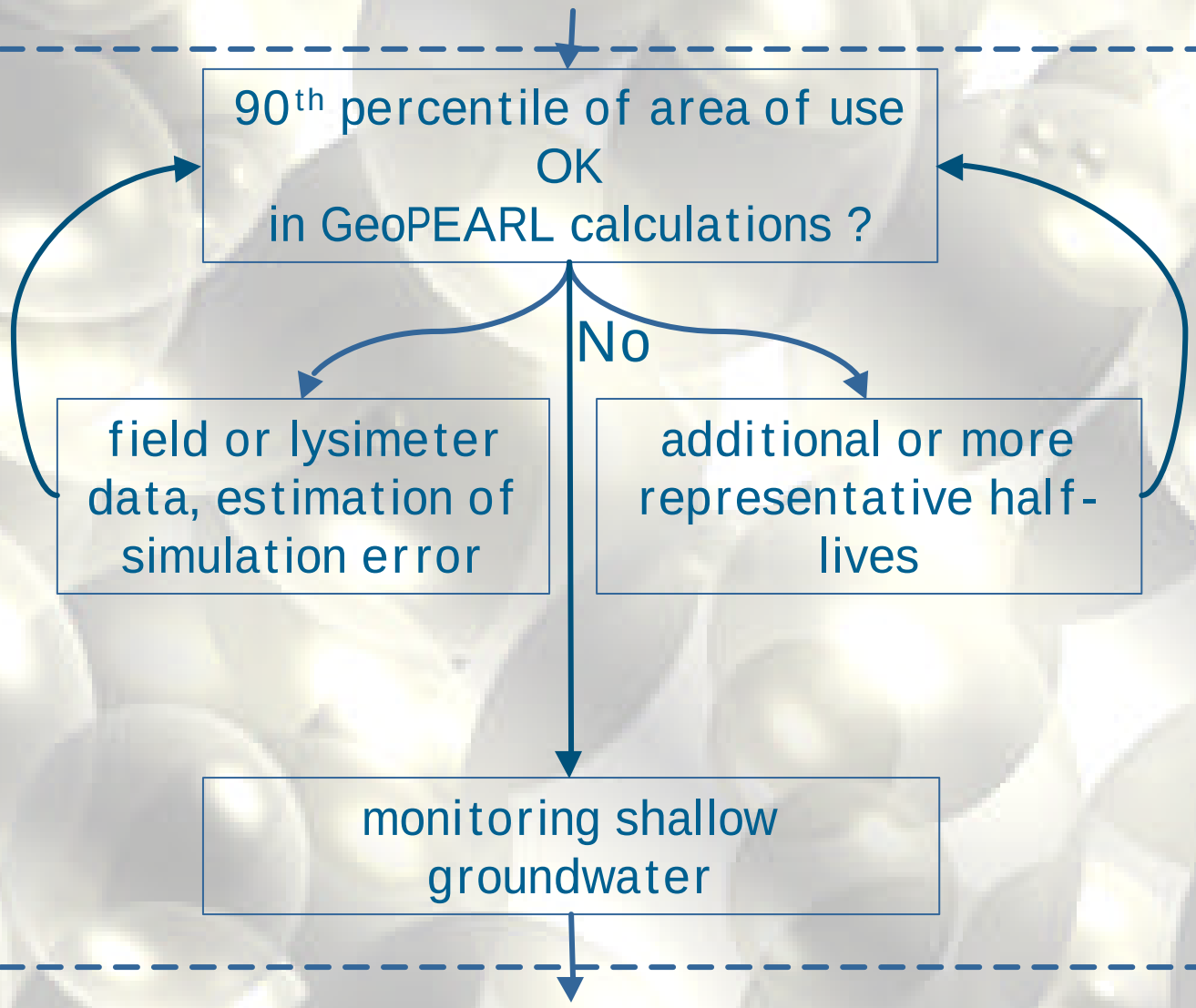
- GeoPEARL can predict both the **leaching** into the groundwater and the **drainage** into surface waters. It is also possible calculate volatilisation (not shown). Maps and frequency distributions can be shown.

- The spatial pattern is affected by numerous processes; frequency distributions may be effected by taking into account the area of use.

- It is not possible to predict the leaching fraction on the basis of the two 'classical' parameters (K_{om} and DT_{50}) and a single scenario.

Use of GeoPEARL in the decision tree

Tier 2



Will Tier 1 still exist after GeoPEARL?

Wait and see:

If there is a need for simplification, then development after development of Tier 2 (GeoPEARL), not earlier than 2003

Is a single standard scenario sufficient?

No, different spatial patterns for the four pesticides:

- atrazine, bentazone & dichloropropene highest on well-drained sandy soils with a low organic matter content
- dinoseb highest on soils with a higher *p*H value (loess and clay soils)

There should be more than one standard scenario,

but

Application of GeoPEARL is more transparent

Concluding remarks (1):

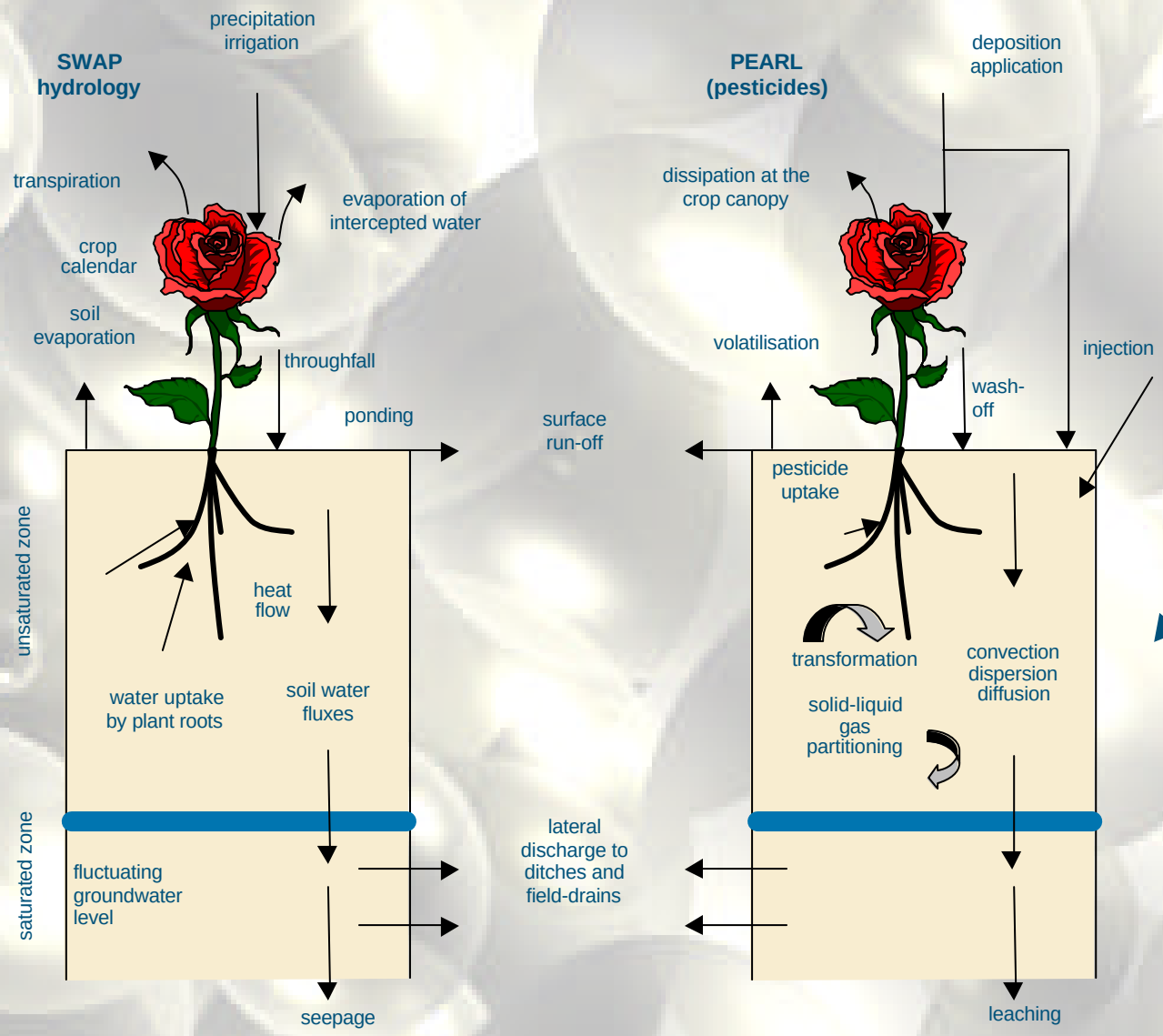
- It was shown that it is not possible to find one single standard scenario, which applies to the full range of registered pesticides.

- The application of GeoPEARL is more transparent than the application of a number of standard scenarios, because:
  - GeoPEARL provides the user with **frequency distributions**
  - GeoPEARL gives information about areas of **safe usage**.

Concluding remarks (2):

- If simplification for the Tier 1 assessments is necessary, one of the possibilities is that new standard scenarios will be derived; one single scenario is not enough.
- If new scenarios are necessary, selection will start not earlier than 2003.

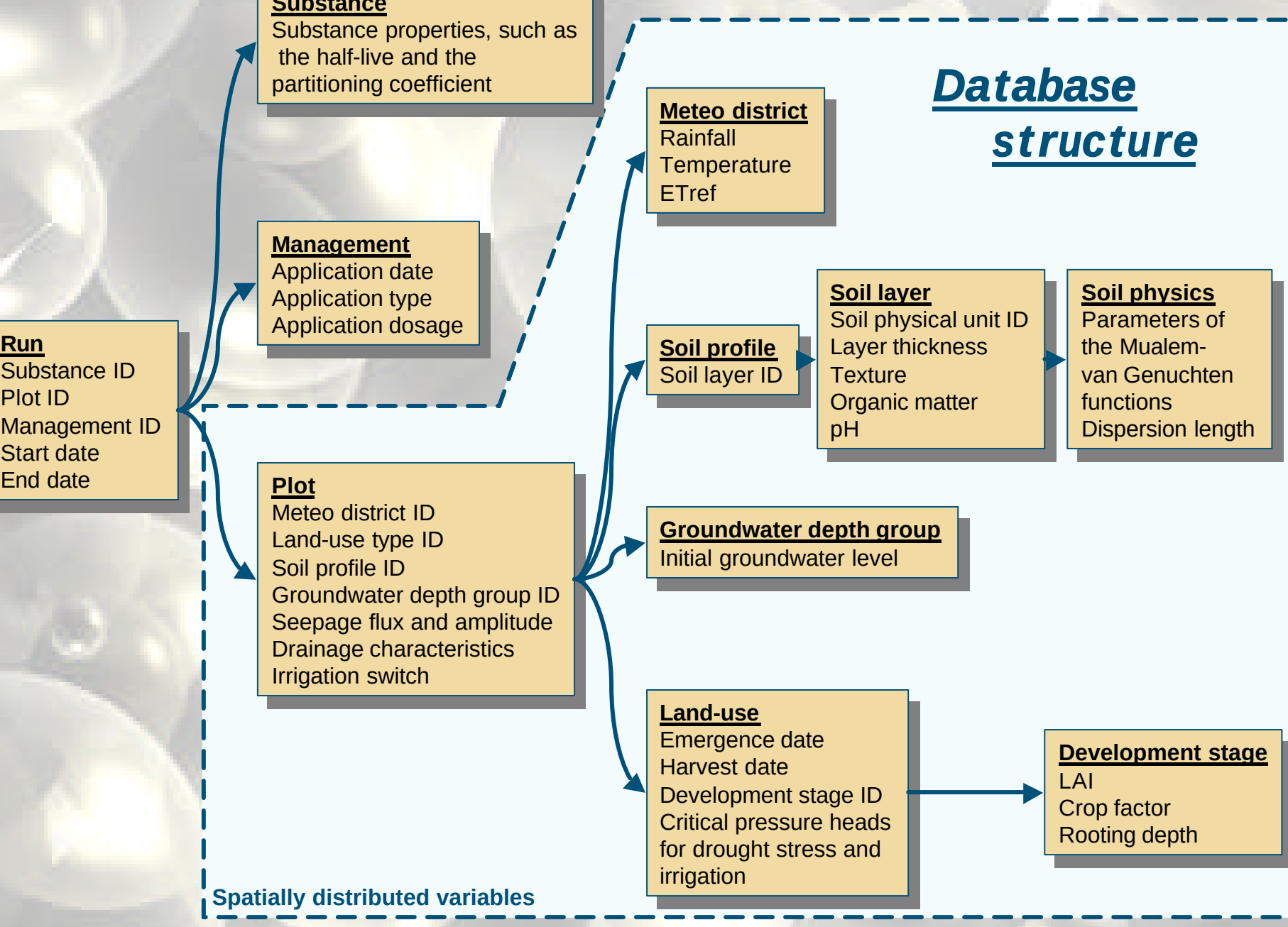
The model: *The core of GeoPEARL is PEARL*



1D columns:

- field
- lysimeters

Database structure



To be specified by the user:

- Substance properties

↓

- Application schedule

↓

- The required spatial detail (discussed later)

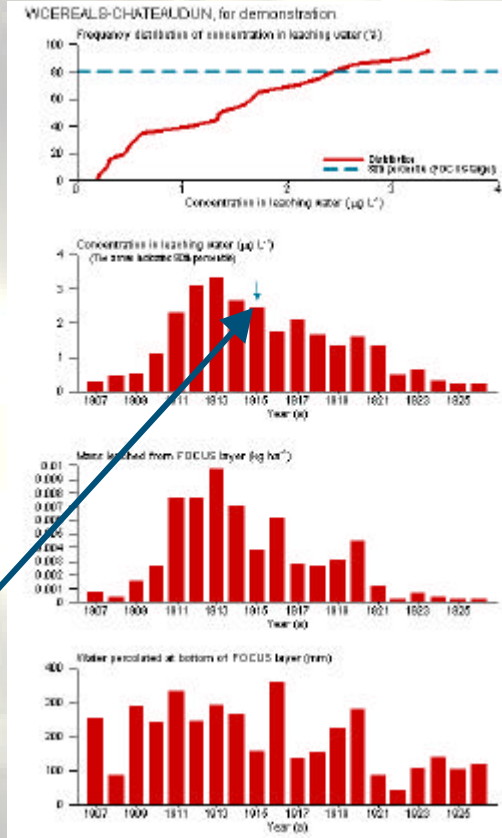
↓

- One or more crops

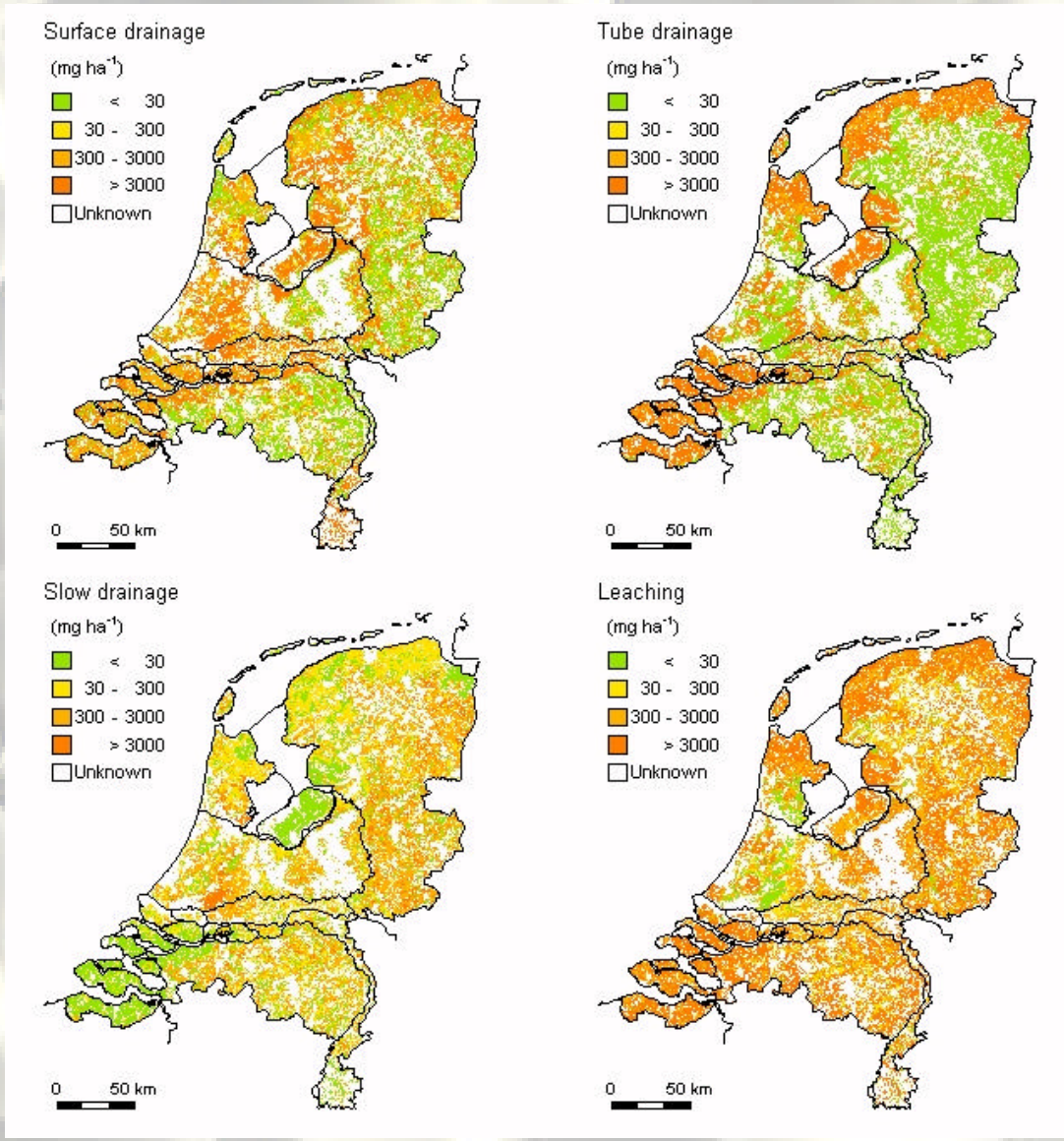
Model outputs include maps of:

- the water balances
- the substance balances, including the leaching, drainage and volatilisation fluxes
- the concentration in leaching water

In the final version, all maps are calculated according to the FOCUS procedure (but here the 50 percentile is used)

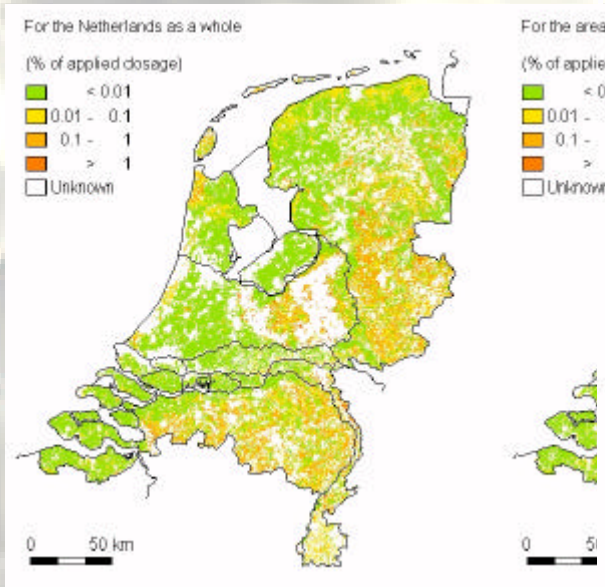


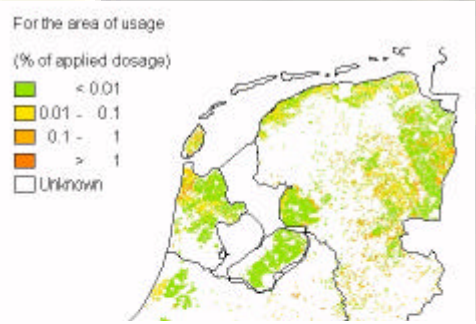
An example:

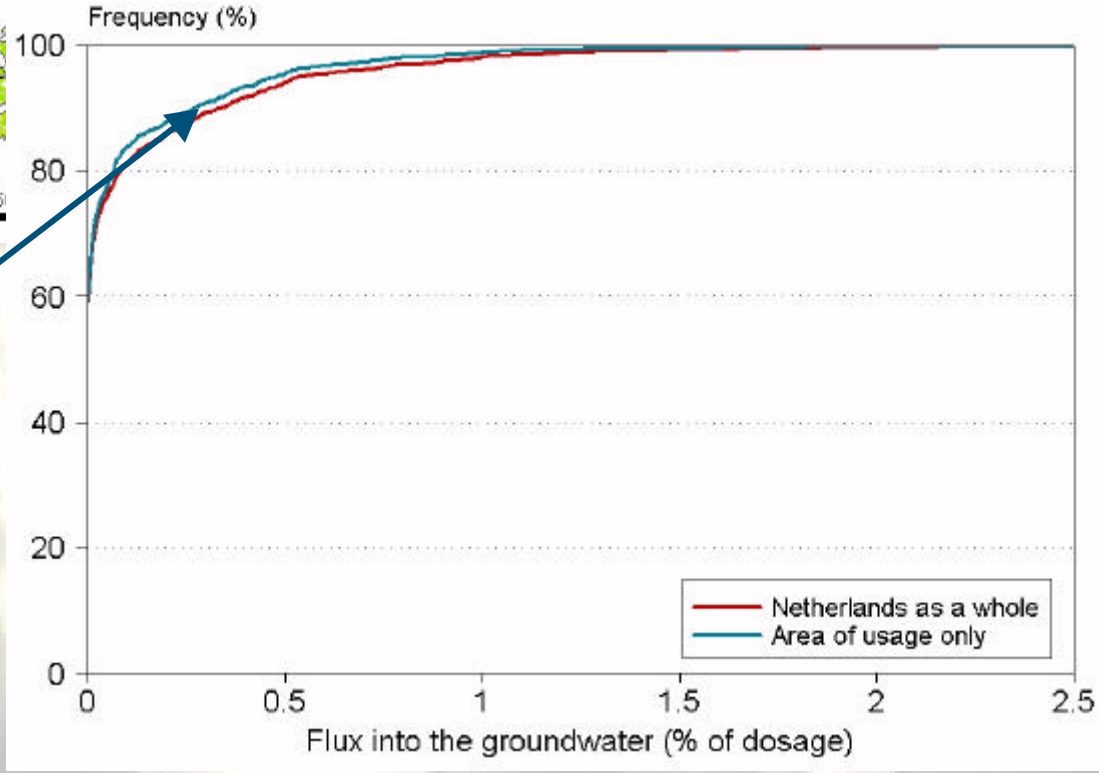

Surface drainage
(mg ha-1)
< 30
30 - 300
300 - 3000
> 3000
Unknown
0 50 km
Tube drainage
(mg ha-1)
< 30
30 - 300
300 - 3000
> 3000
Unknown
0 50 km
Slow drainage
(mg ha-1)
< 30
30 - 300
300 - 3000
> 3000
Unknown
0 50 km
Leaching
(mg ha-1)
< 30
30 - 300
300 - 3000
> 3000
Unknown
0 50 km

Effect of area of usage on frequency distribution

dichloropropene







effect is small

Tier 2: information from higher tier studies

- additional transformation rate (and sorption) studies with e.g. 10 representative Dutch topsoils may lead to parameters more consistent with “area of use”

- information from field or lysimeter studies may be used to calculate a simulation error, which can be used to correct calculations

- Calculate revised 90th percentile with GeoPEARL using best estimates of parameters for relevant soil types or information from field / lysimeters