European Food Safety Authority

European Scenarios for Exposure of Soil Organisms to Plant Protection Products

Aaldrik Tiktak

EU modelling workshop 2010, Capri, Italy

Work done by the Working group Persistence in Soil/fate

Ad-hoc experts
Aaldrik Tiktak (Netherlands Environmental Assessment Agency, NL)
Ciro Gardi (JRC Ispra)
Elena Alonso Prados (INIA, ES)
Jan Vanderborght (Forschungszentrum Jülich, DE)
Richard Bromilow (Rothamsted, UK)

Panel members
Ettore Capri (University of Piacenza, IT)
Jos Boesten (Wageningen UR, NL)
Michael Klein (Fraunhofer Institute, DE)
Ton van der Linden (RIVM, NL)
Walter Steurbaut (University of Gent, BE)

EFSA PPR secretary
Mark Egsmose

Hearing experts
Bernd Gottesbüren (BASF)
Ian Hardy (Batelle)
Ludovic Loiseau (Syngenta)

Background

- Generally excepted European scenarios for exposure of soil organisms not available

- There is a need for such scenarios: ongoing discussion in PRAPer on PEC_{soil}

- Development of tiered exposure assessment approaches for soil organisms in which scenarios play an important role

End points for the assessment: which ERC?

- First step in exposure assessment: identify which type of concentration gives best correlation to effect.

- This is the **E**cotoxicologically **R**elevant **C**oncentration (**ERC**)

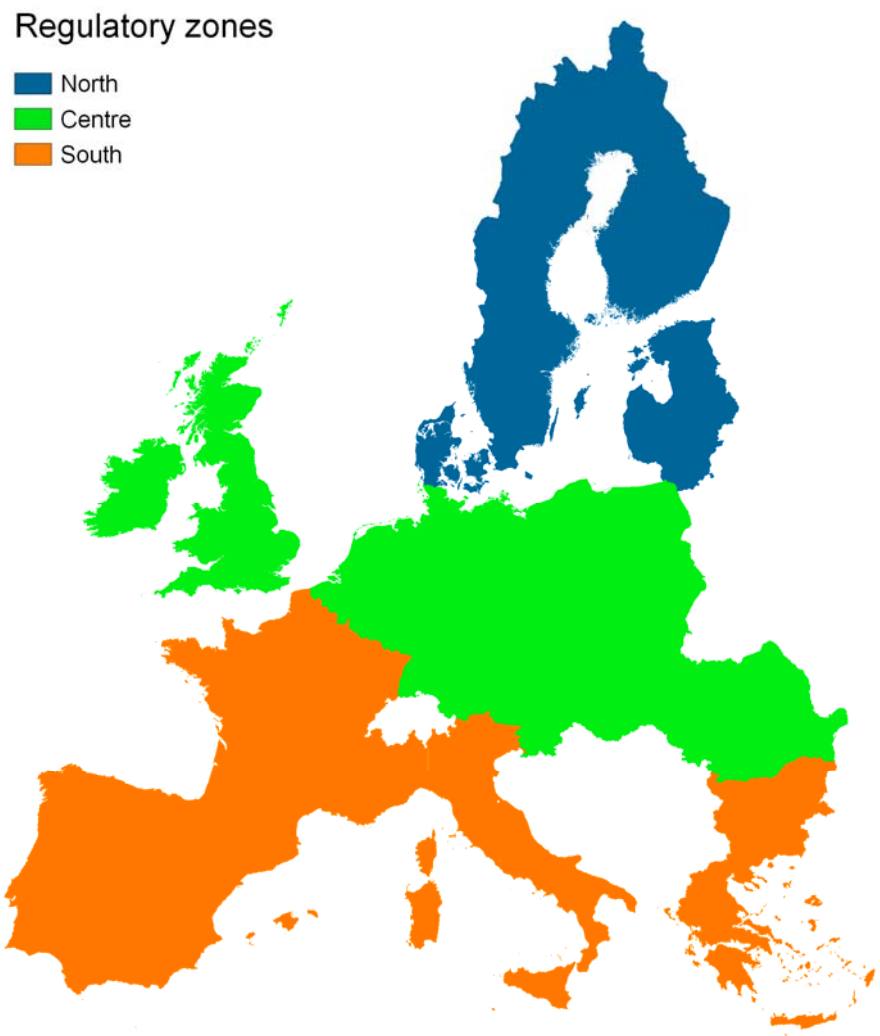
- Ecotox workgroup delivered two types of ERCs:
  - Concentration in total soil (mg kg^{-1})
  - Concentration in the liquid phase (mg l^{-1})
  - Averages over soil layers of different depths

End points for the assessment: which percentile?

- Target defined by risk managers: 90th percentile concentration in a number of climatic zones

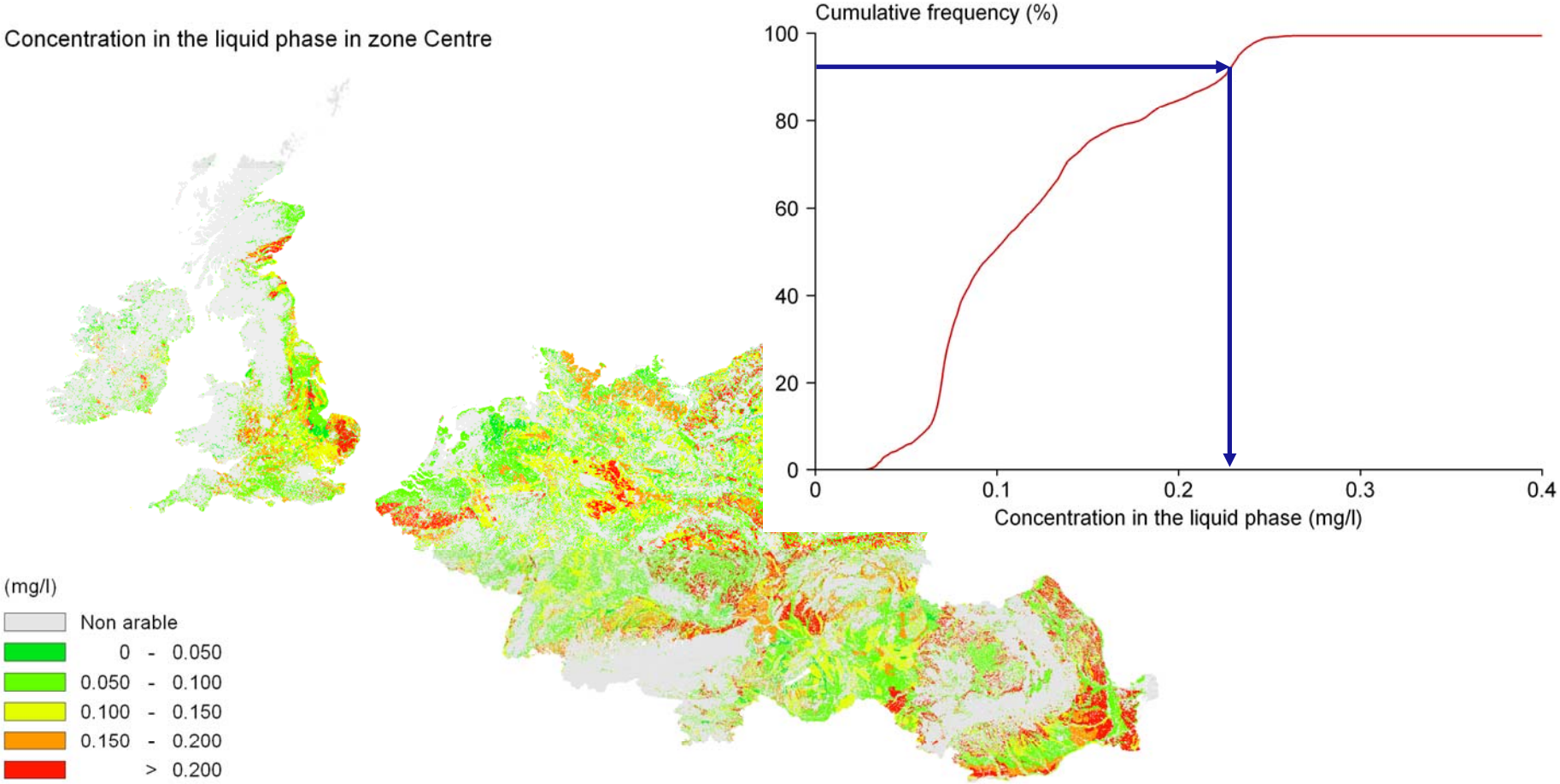
- Practical considerations: The overall 90th percentile concentration within the three regulatory zones proposed in the new Regulation concerning the placing of PPPs on the market

The regulatory zones



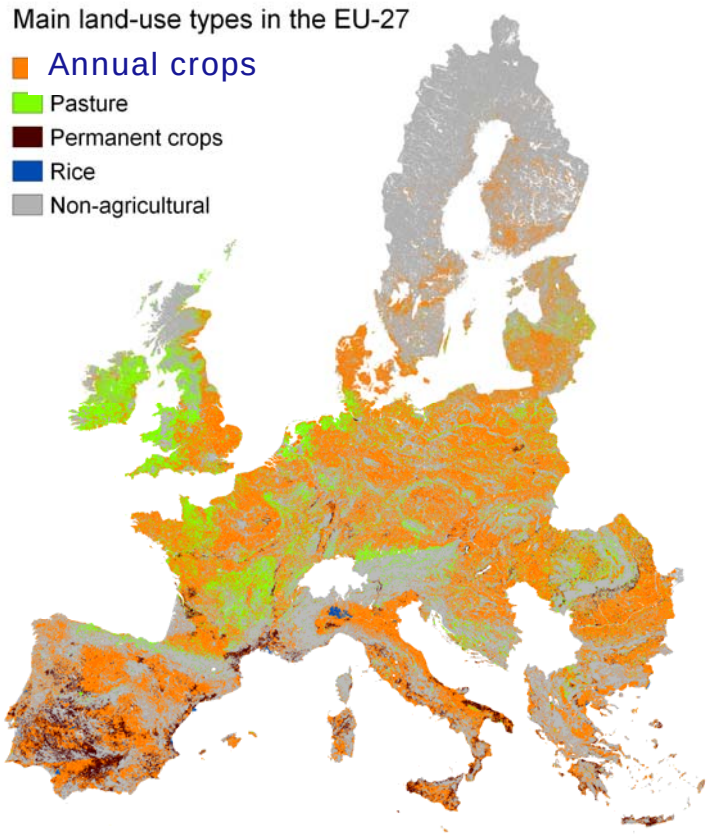
- Good general correspondence with climatic zones
- Only anomaly: Denmark, which has a Central European climate

What is the 90th spatial percentile?



Scenarios for annual crops and conventional tillage

- Largest surface area and most PPP applications, so good starting point
- Ploughing depth: 20 cm
- EFSA ecotox workgroup defined following types of ERC:
  - concentration in total soil (CT) and in pore water (CL)
  - averages over layers 0-1, 0-2.5, 0-5 and 0-20 cm



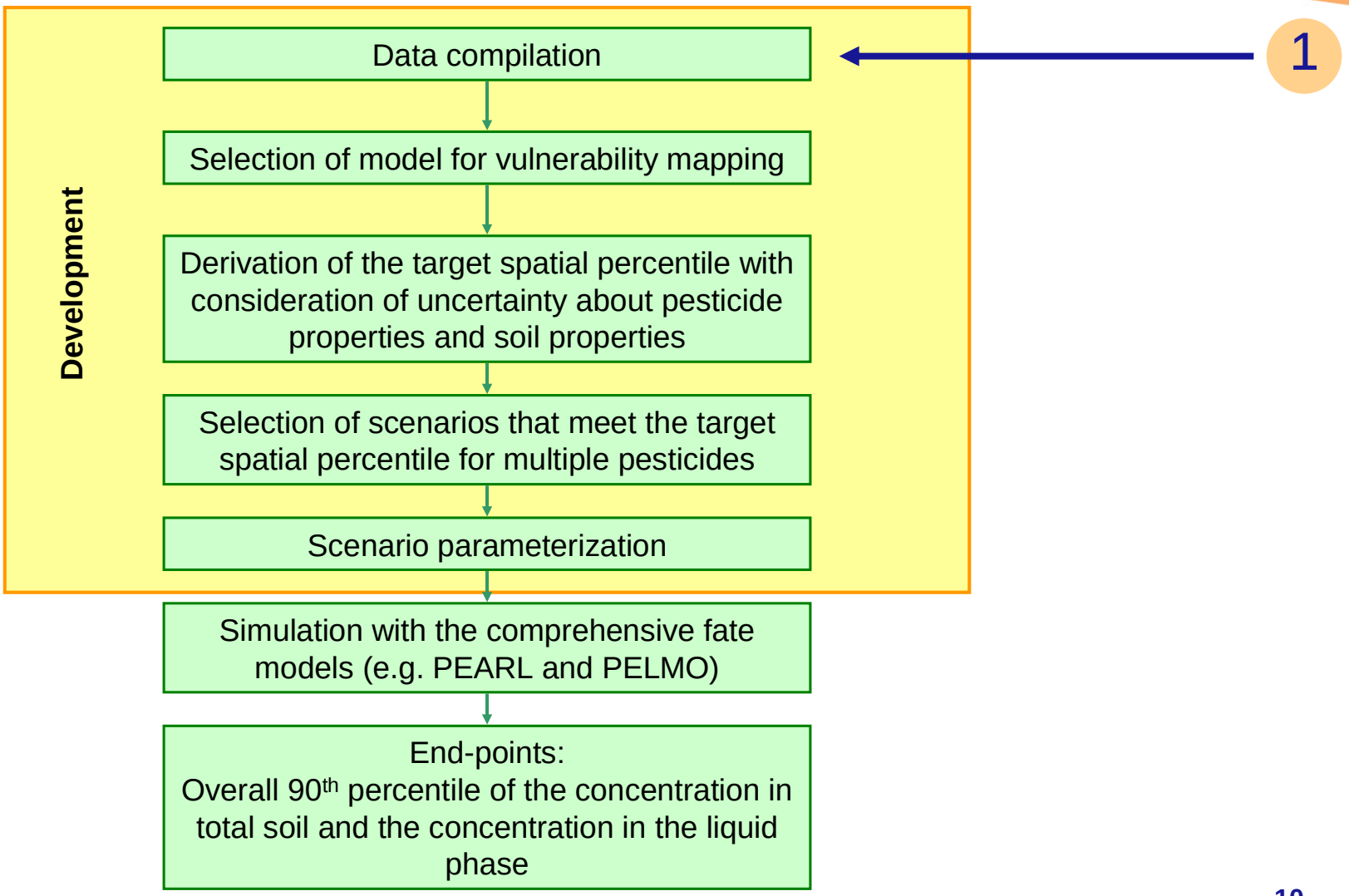
Tiered assessment scheme for annual crops and conventional tillage

1. Conservative scenarios for analytical model (arable land and all substances)
2. Realistic worst-case scenarios for numerical models (arable land and all substances)
3. Crop- and/or substance specific scenarios for analytical model
4. Crop- and/or substance specific scenarios for numerical models

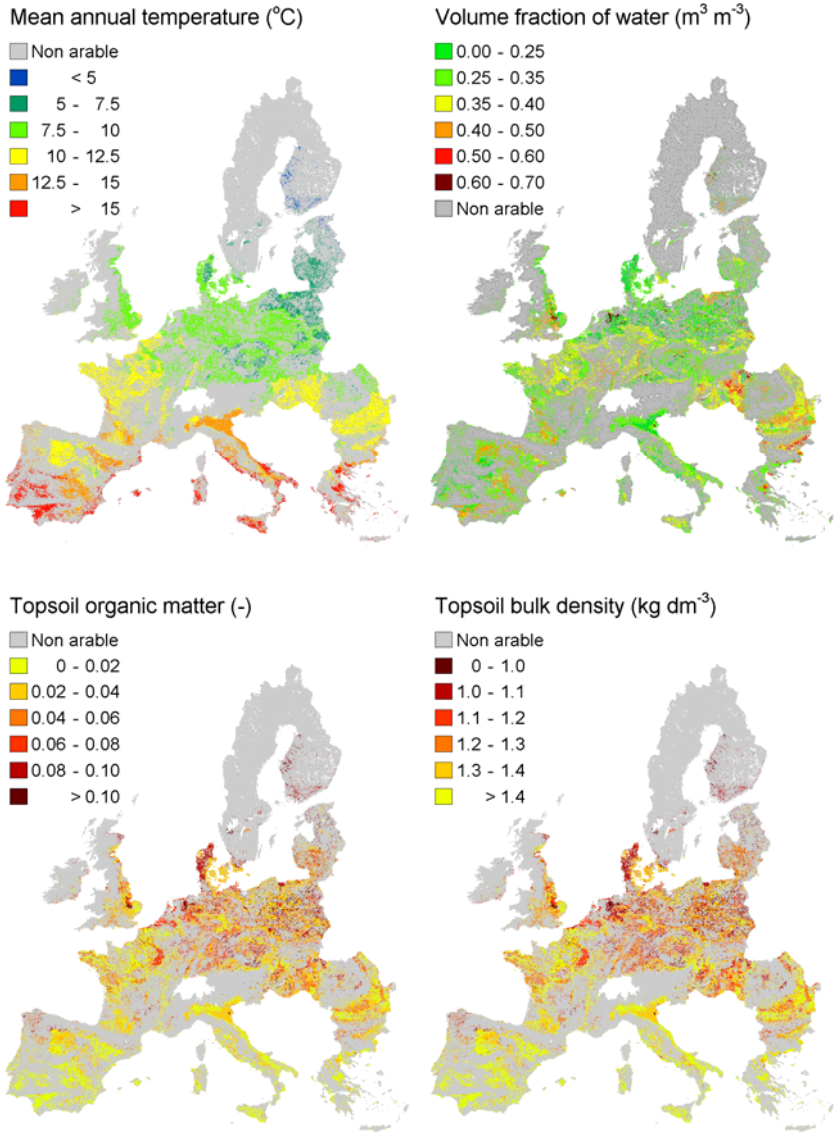
Core of presentation (development of Tier-4 scenarios approximately the same)

Two parallel schemes: One for each ERC

Procedure for deriving Tier-2 scenarios: a systematic approach



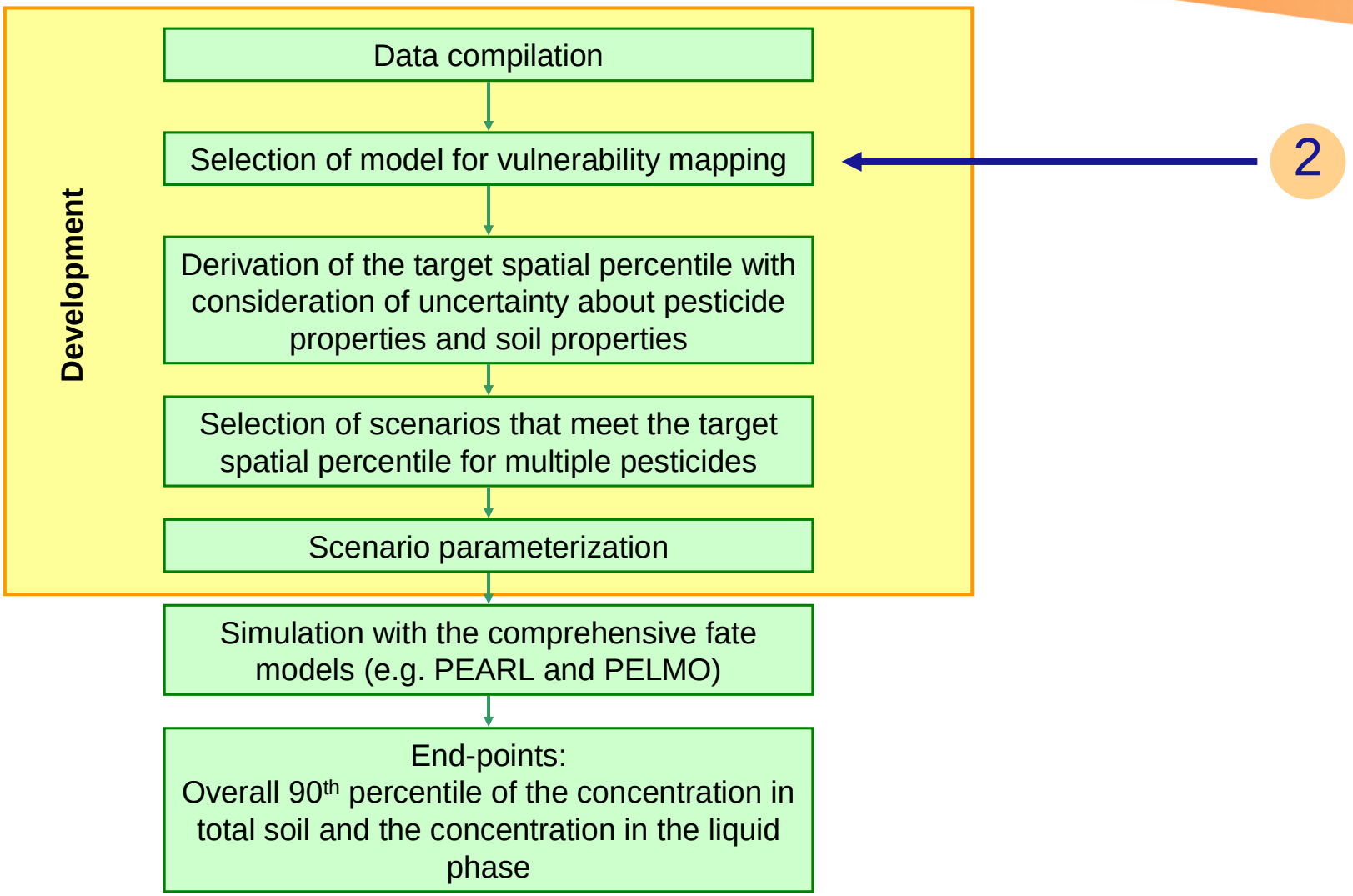
Data compilation



Data made available by JRC at a resolution of 1x1 km^2 :

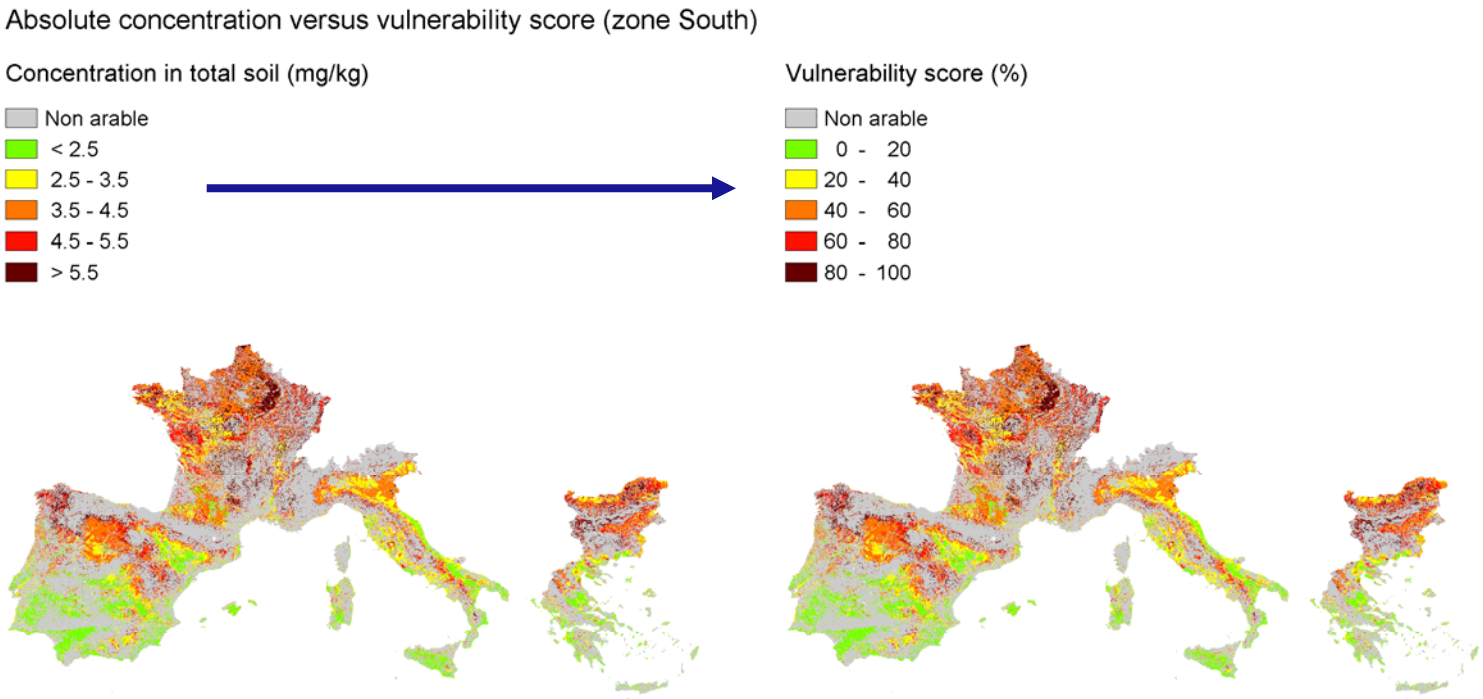
- EU-Soil map
- topsoil organic matter
- climatic data from WorldClim (temperature and precipitation)
- Corine land use data

Selection of model for vulnerability mapping



What is vulnerability mapping?

- Vulnerability maps can be used to find locations where the concentration is equal to a certain spatial percentile



- Grid cell with the highest concentrations score 100% and the grid cell with the lowest concentrations scores 0%

Model requirements

- The model used for scenario selection must:
  - Use data that are available for the entire EU-27
  - Give the same vulnerability score as the Tier-2 model

- We selected an analytical model that simulates degradation and tillage of PPPs in a single soil compartment

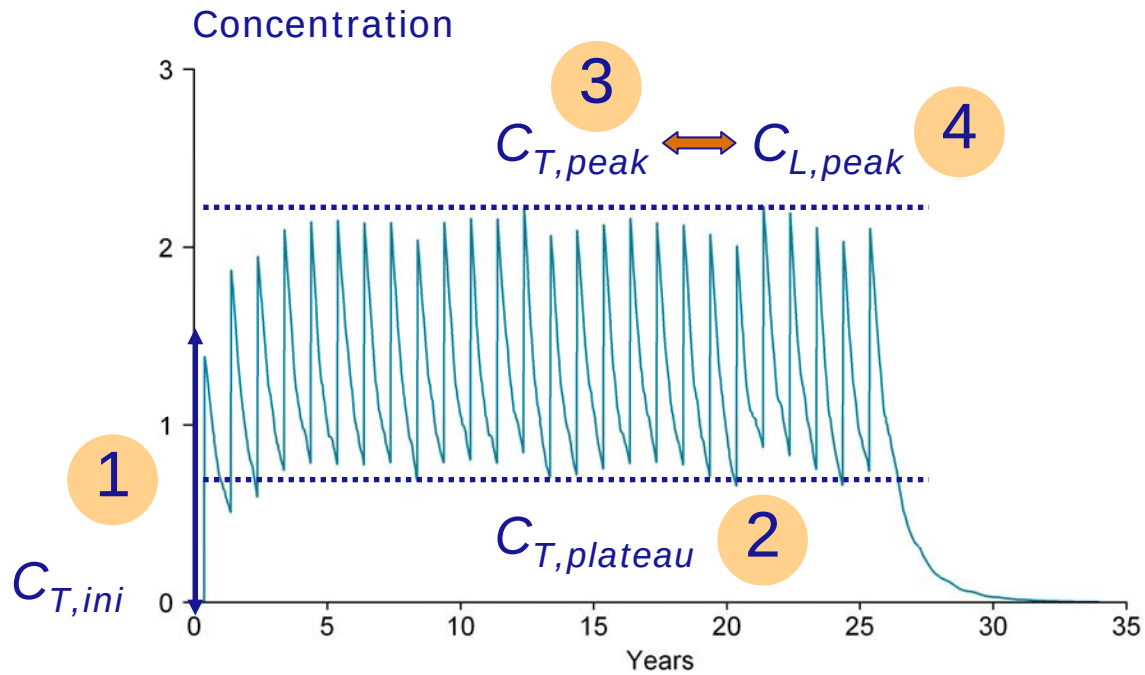
PERsistence in Soil Analytical Model (PERSAM)

$$C_{T,ini} = \frac{DOSE}{\rho z_{rel}}$$

$$C_{T,plateau} = \frac{z_{rel}}{z_{til}} C_{T,ini} \frac{e^{-365 f_T f_\theta f_k k_{ref}}}{1 - e^{-365 f_T f_\theta f_k k_{ref}}}$$

$$C_{T,peak} = C_{T,ini} + C_{T,plateau}$$

$$C_L = \frac{C_T}{\theta / \rho + f_{om} f_{Kom} K_{om,ref}}$$

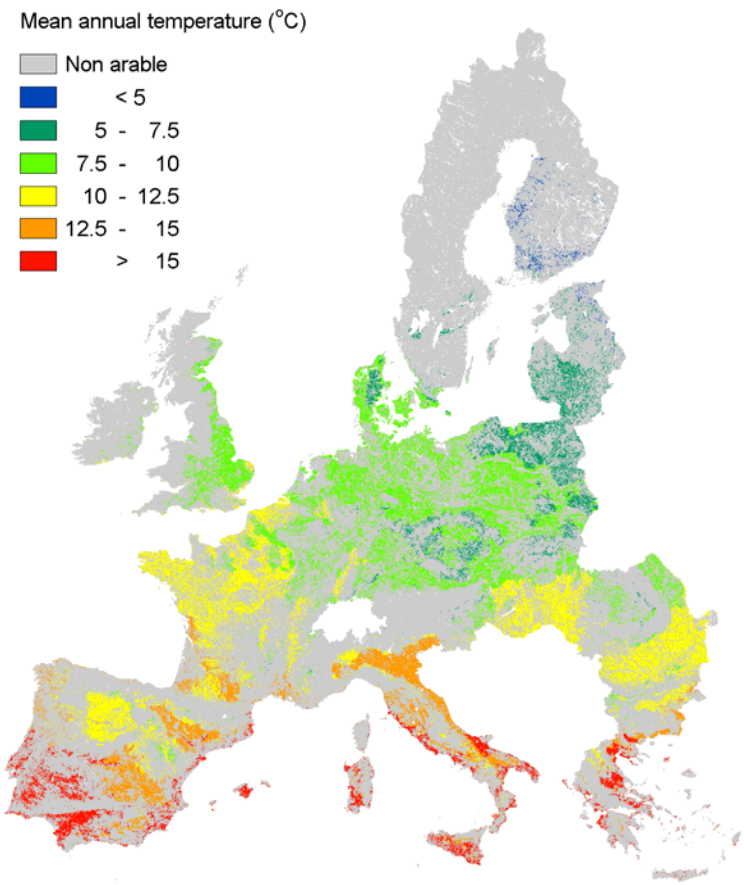


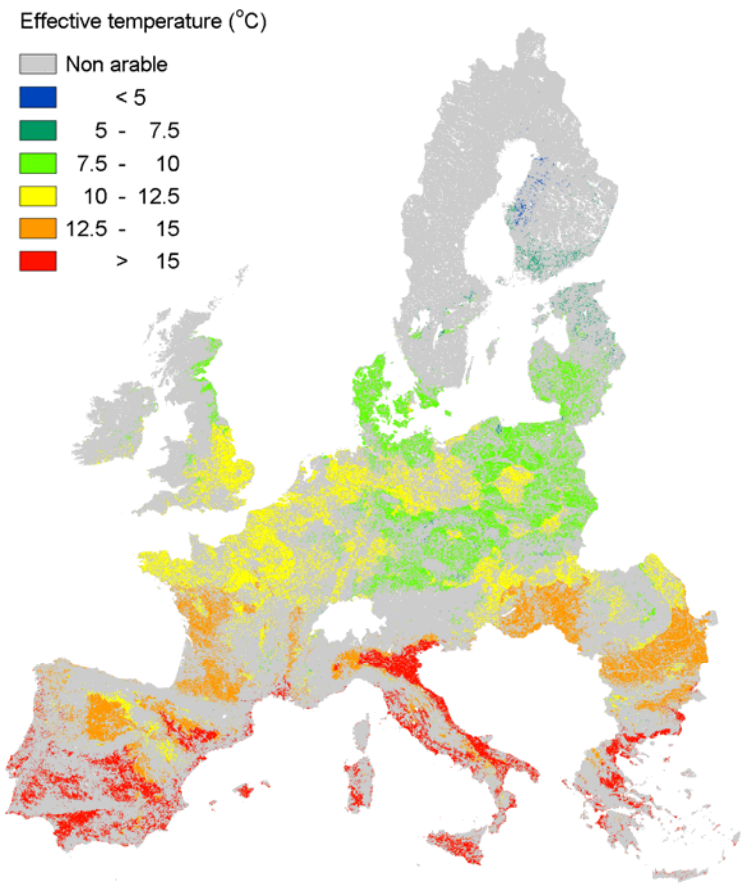
Four spatial parameters:

- Organic matter
- Bulk density
- Mean temperature
- Mean water content

Example for a tillage depth of 20 cm

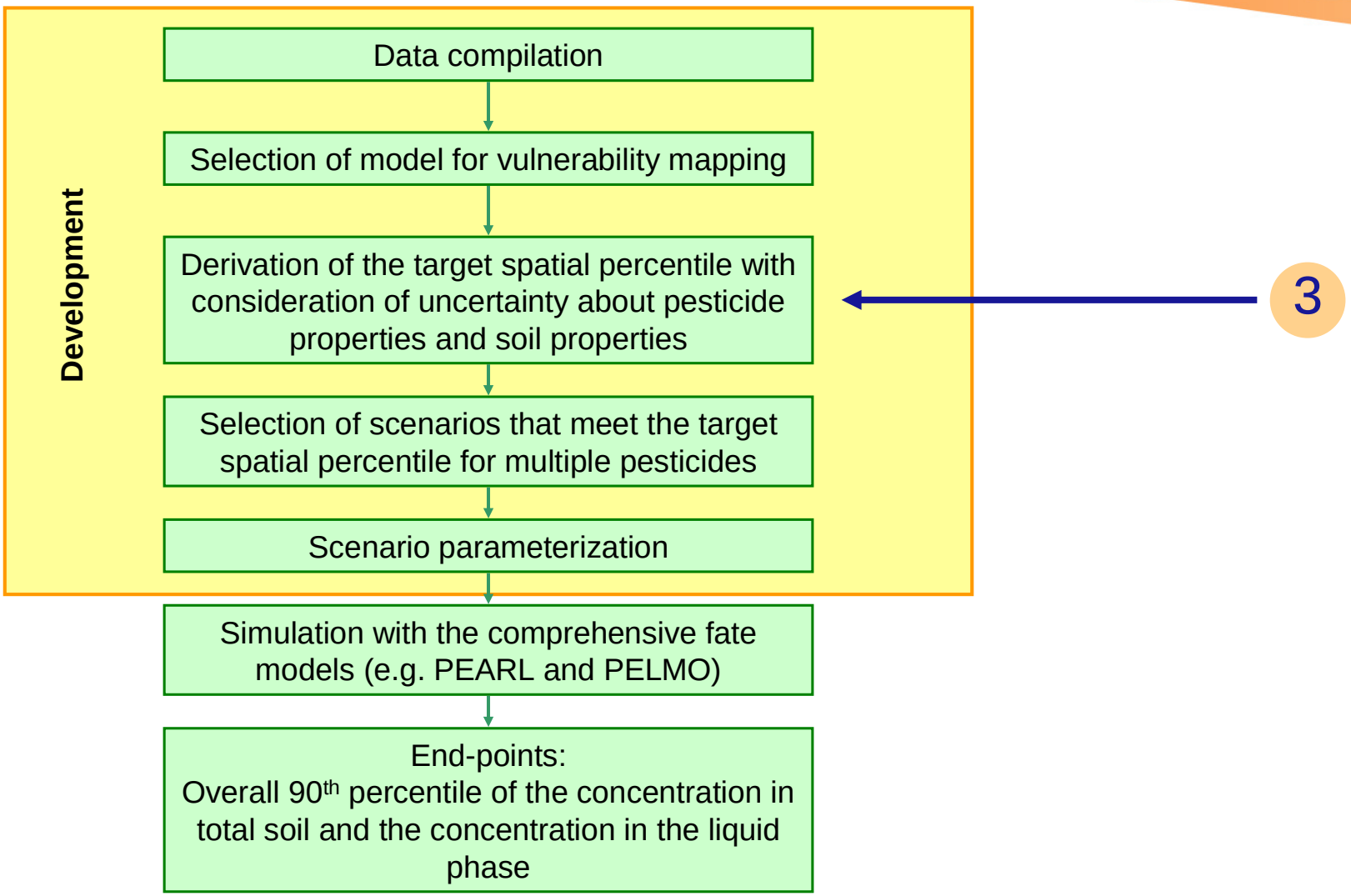
Temperature Arrhenius weighted



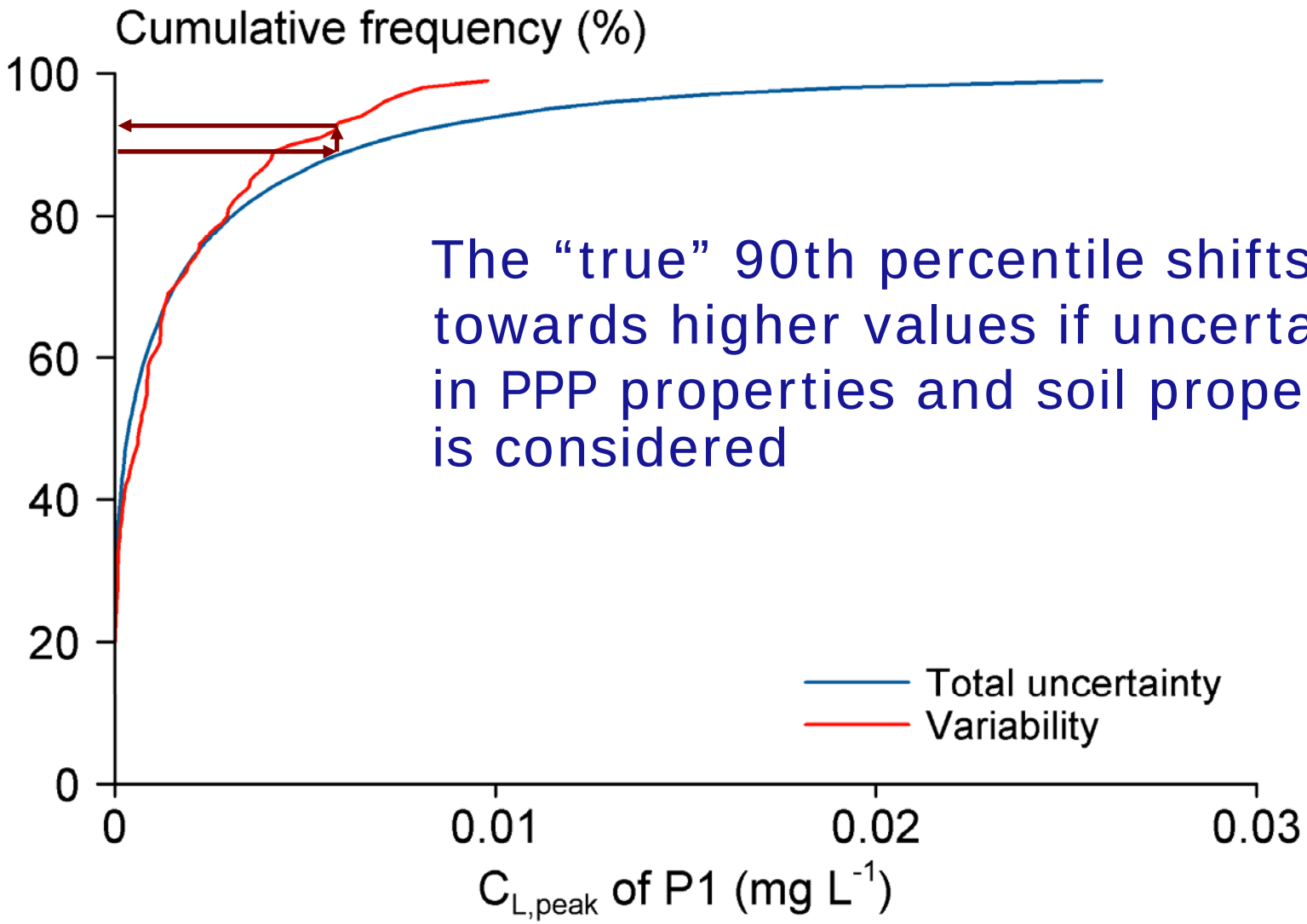


In this way a better estimation of the total degradation is given

Derivation of target spatial percentile



Shift of the 90th percentile due to uncertainty of PPP-properties



The "true" 90th percentile shifts towards higher values if uncertainty in PPP properties and soil properties is considered

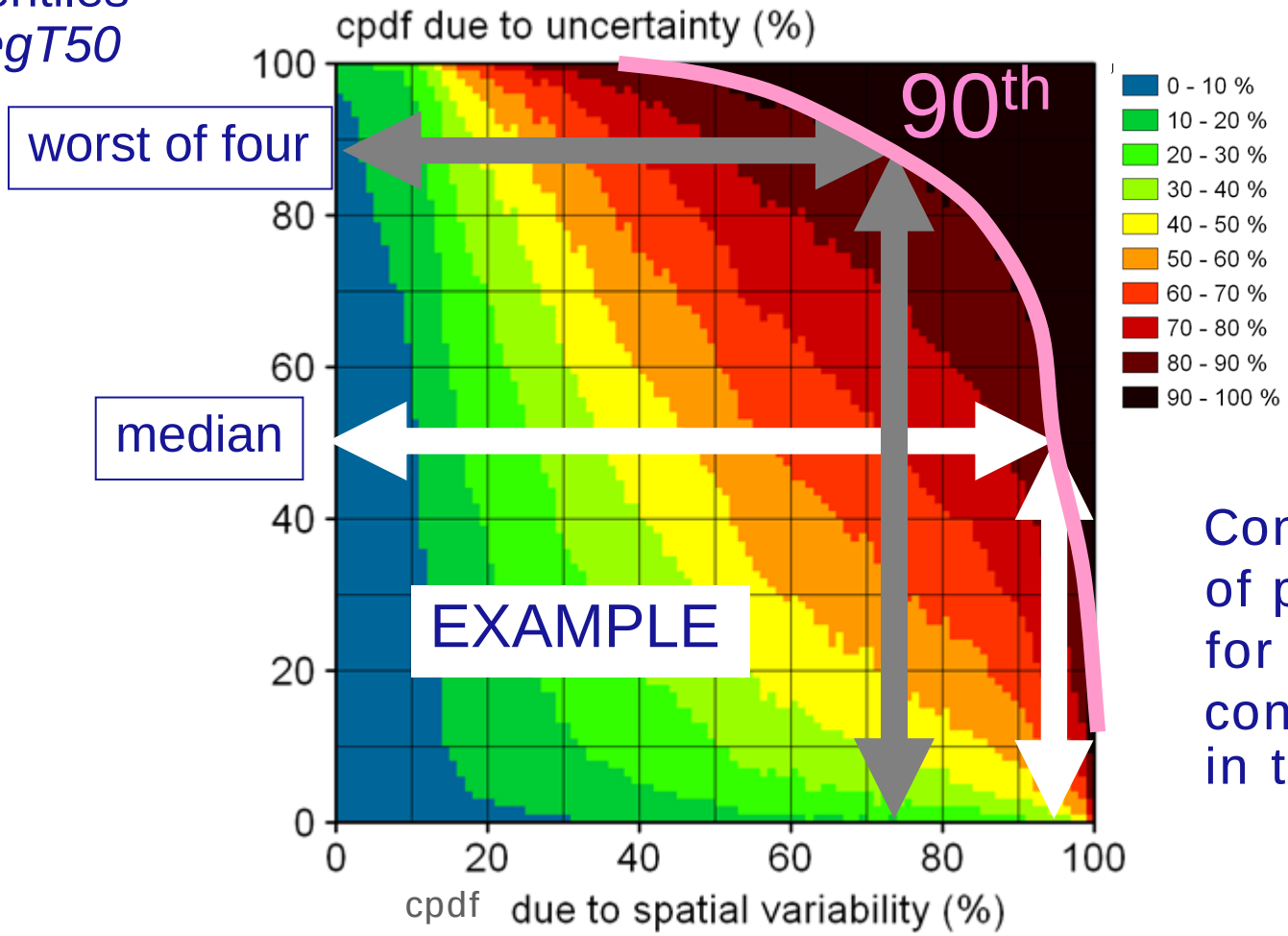
The 95th spatial percentile is used in the remainder of this exercise

- 90th overall percentile corresponds to the 95th percentile of the cumulative probability density function resulting from **median** pesticide properties and **median** soil properties **if a CV of 25% is assumed**

- *See further Vanderborght et al., Pest. Manag. Sci., in press.*

Other choices could have been made – see presentation of Jos

percentiles of *DegT50*

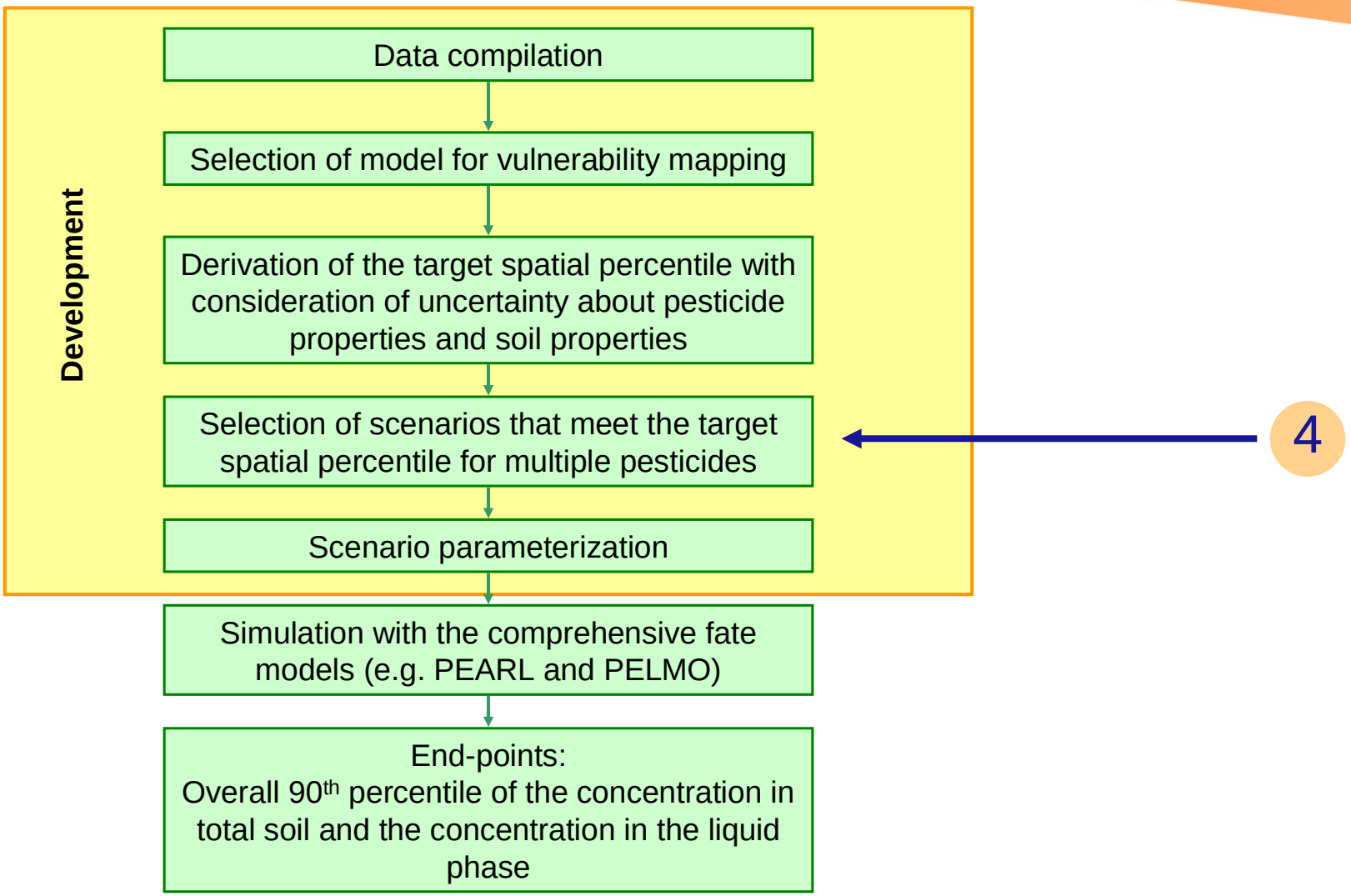


Contour plot of percentiles for concentration in total soil

median *DegT50* → 95th spatial percentile

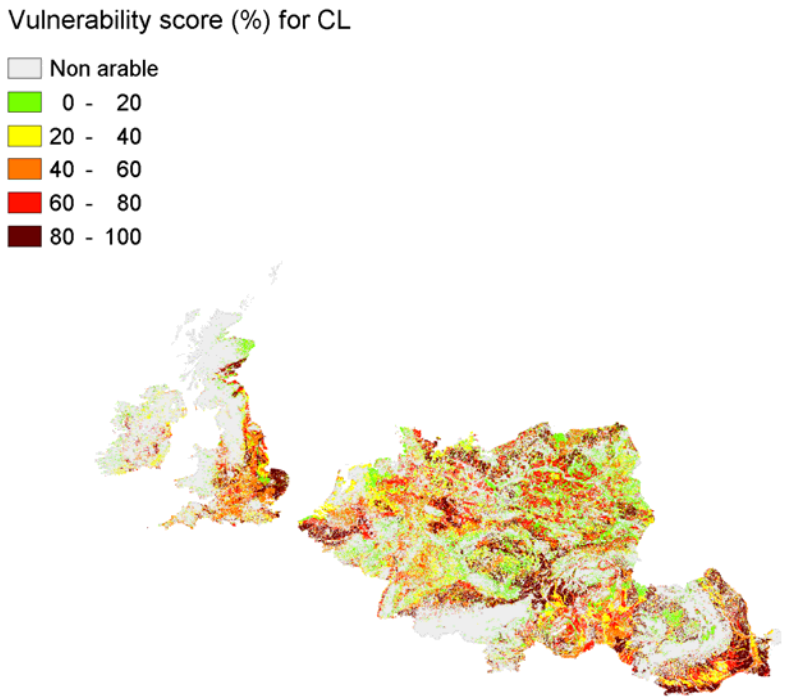
worst of four *DegT50* → 73rd spatial percentile

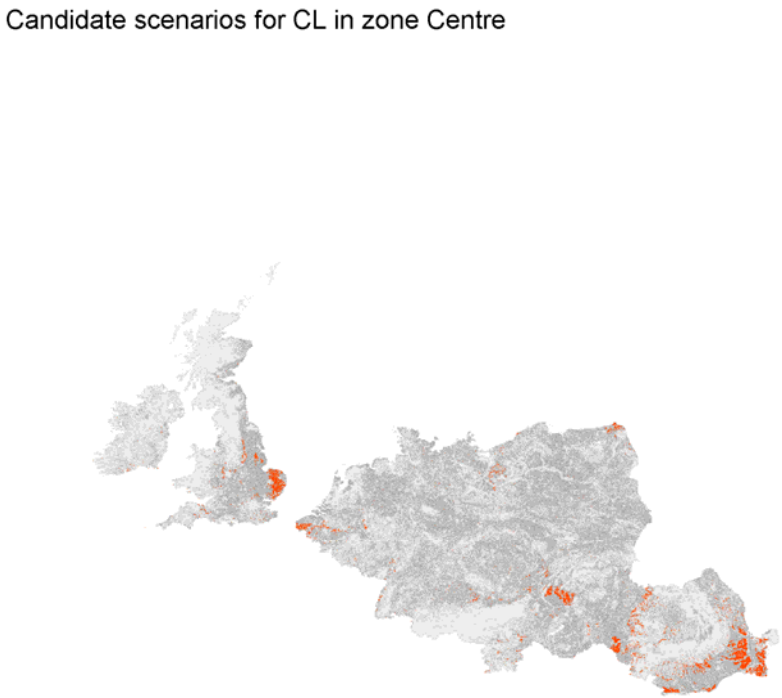
Scenario selection



Select all grid cells with the target vulnerability score

- Target vulnerability = 95 ± 1%





Scenarios must apply to all PPP-depth combinations

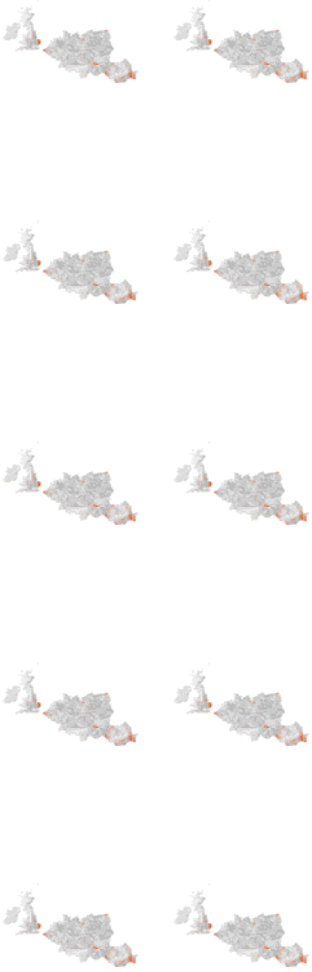
- Different PPPs and evaluation depths may give different rankings and therefore different target scenarios

- But the scenarios must apply to all relevant PPPs and evaluation depths

- To deal with this problem, vulnerability maps are created for 38 PPP-depth combinations and these maps are overlain

Overlay procedure

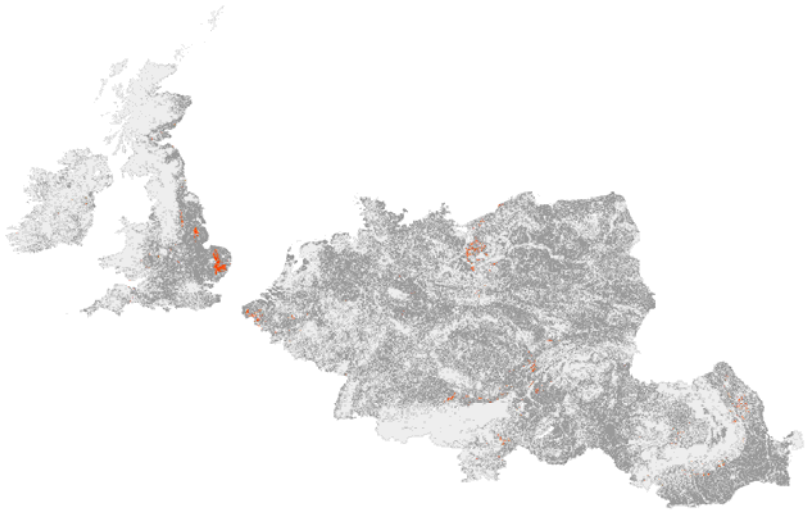
38 vulnerability maps



Overlay →

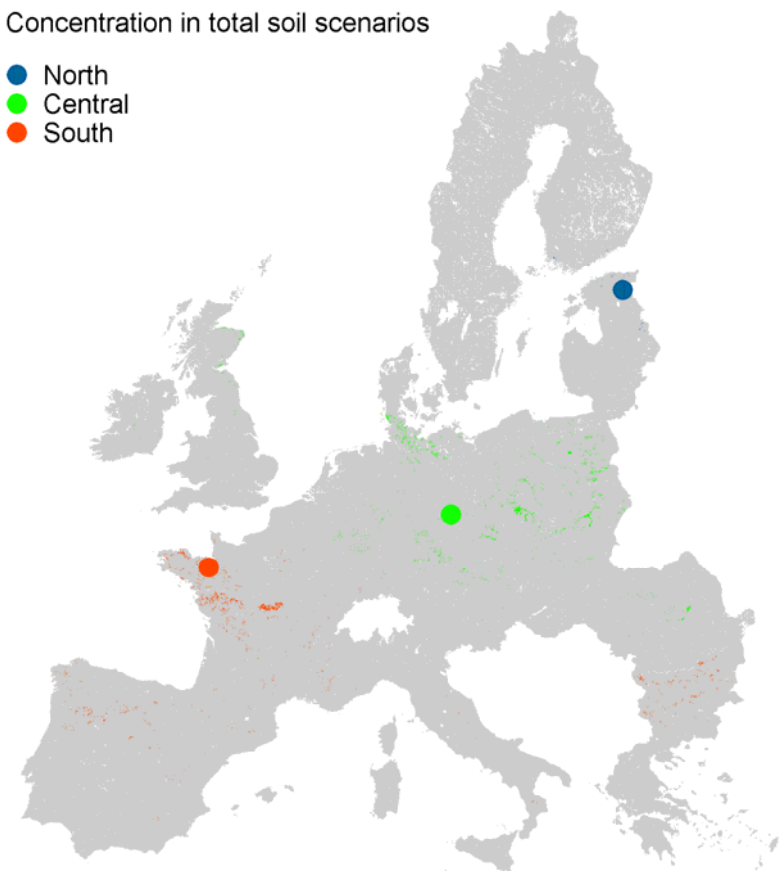
Concentration in liquid phase scenarios

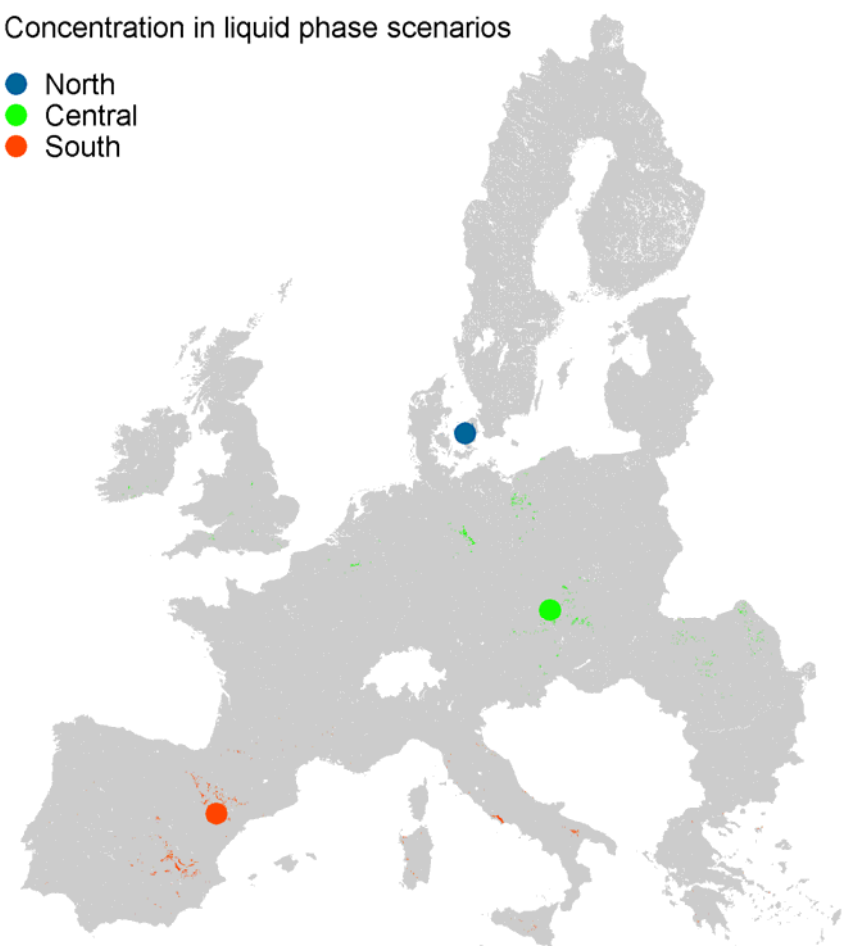
- Non arable
- No candidate scenarios
- Candidate scenarios



Result is a map where all PPP-depth combinations are within the target vulnerability range

Scenarios closest to the scenario with **median properties of all candidates**





Median properties of selected scenarios

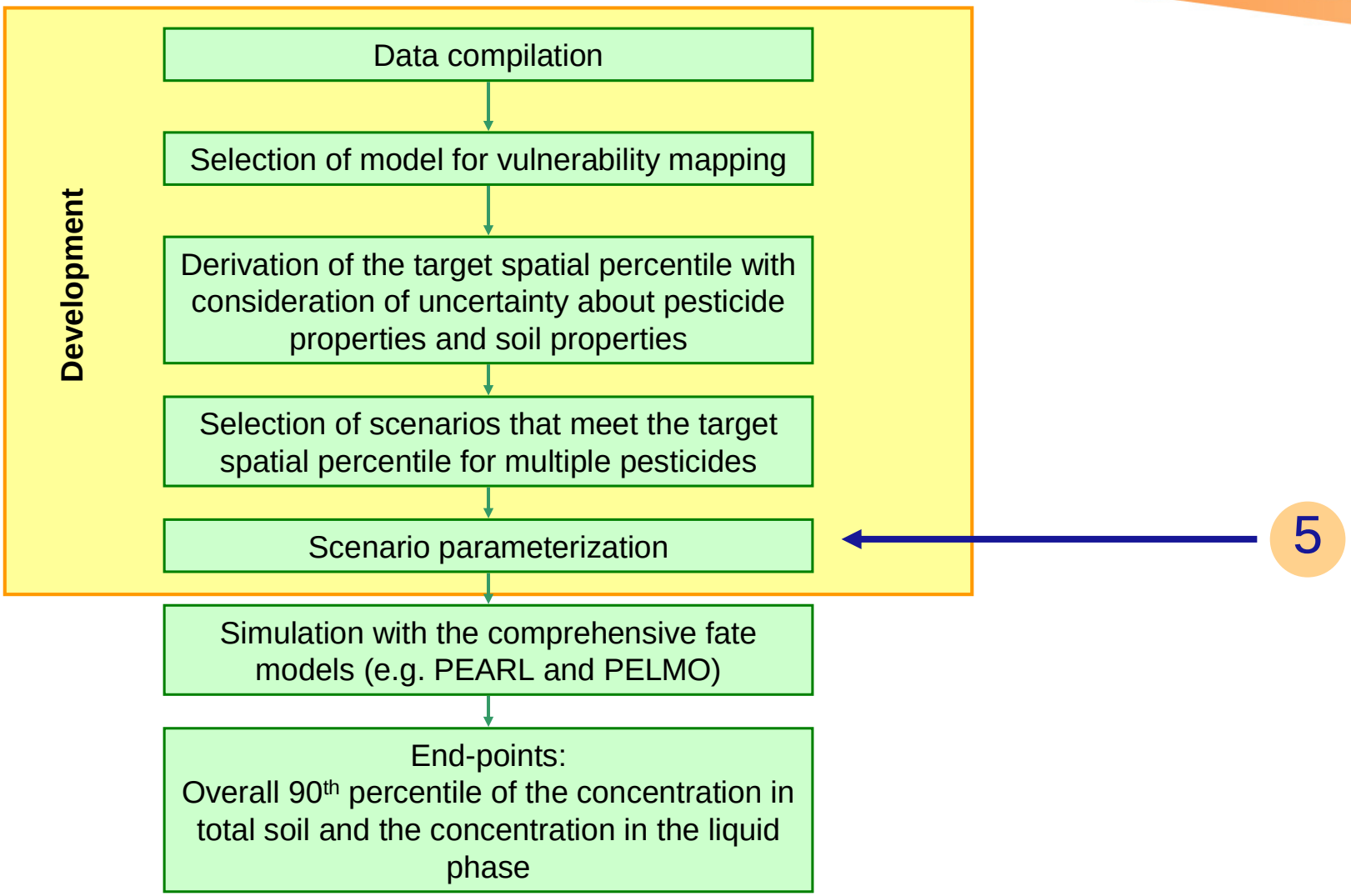
Properties of CT scenarios

	f_{om} (%)	T_{mean} (°C)	Texture
North	11.8	4.7	Coarse
Central	8.6	8.0	Coarse
South	4.8	11.0	Medium fine

Properties of CL scenarios

	f_{om} (%)	T_{mean} (°C)	Texture
North	2.3	8.2	Medium
Central	1.8	9.1	Medium
South	1.1	12.8	Medium

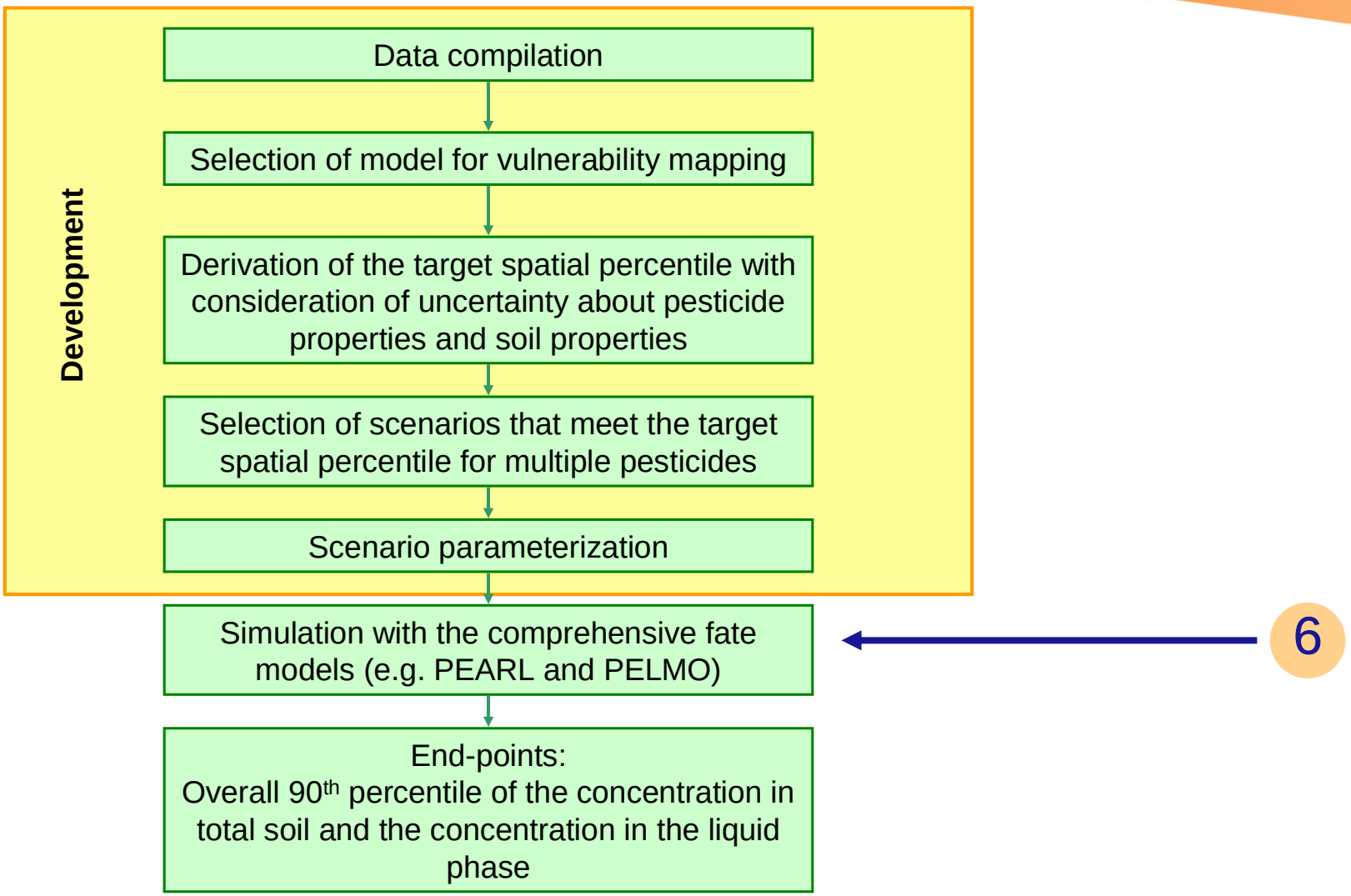
Scenario parameterisation



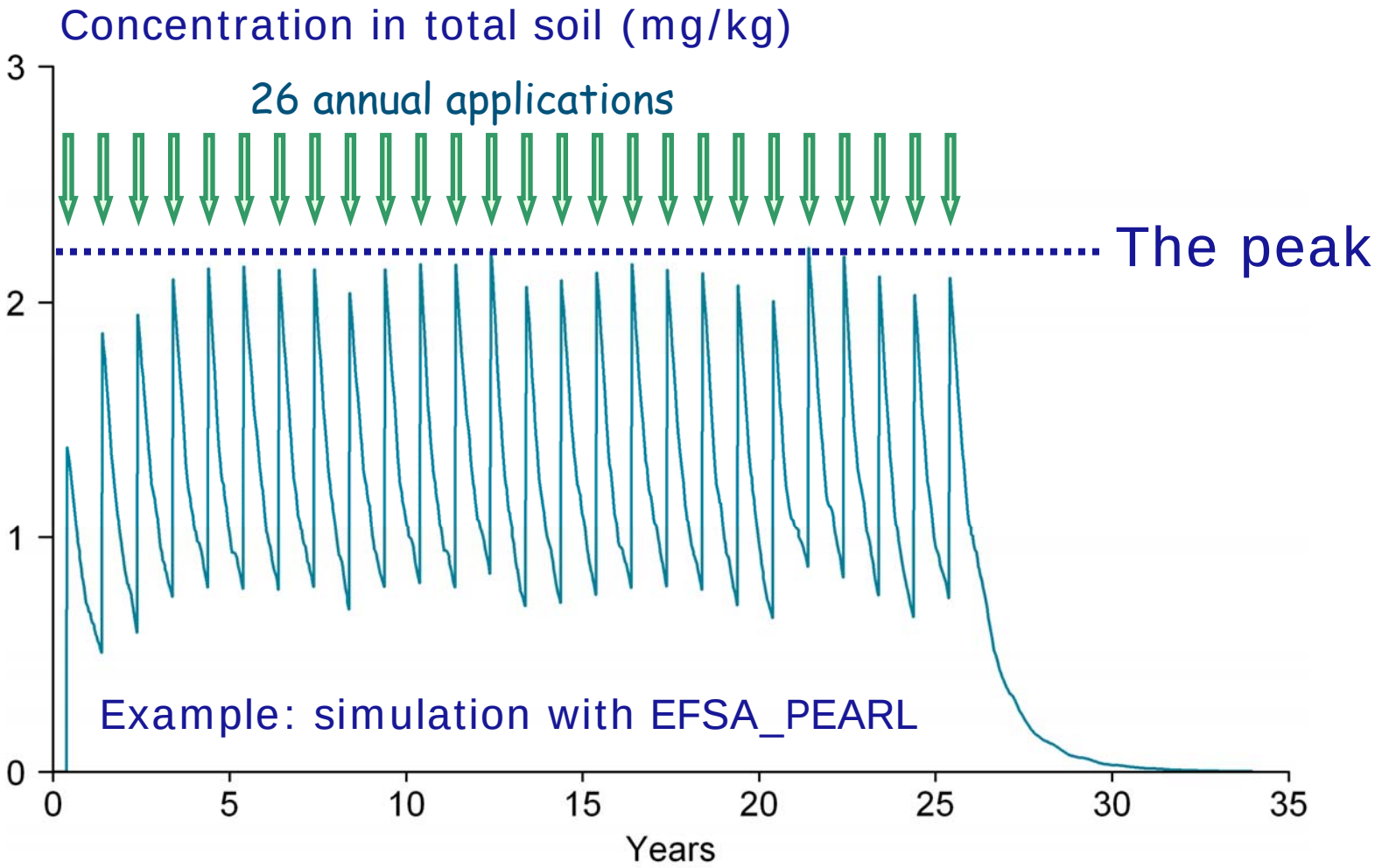
PEARL and PELMO parameters

- Soil profiles and soil parameters: derived by pedotransfer functions
- Dispersion length 2.5 cm
- Crop data from FOCUS
- Daily weather data from MARS and scaled to WorldClim

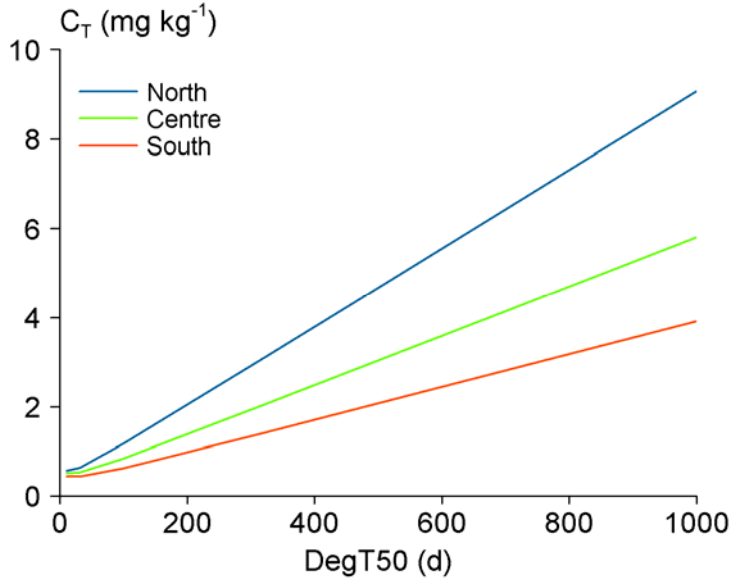
Simulation with PEARL and PELMO

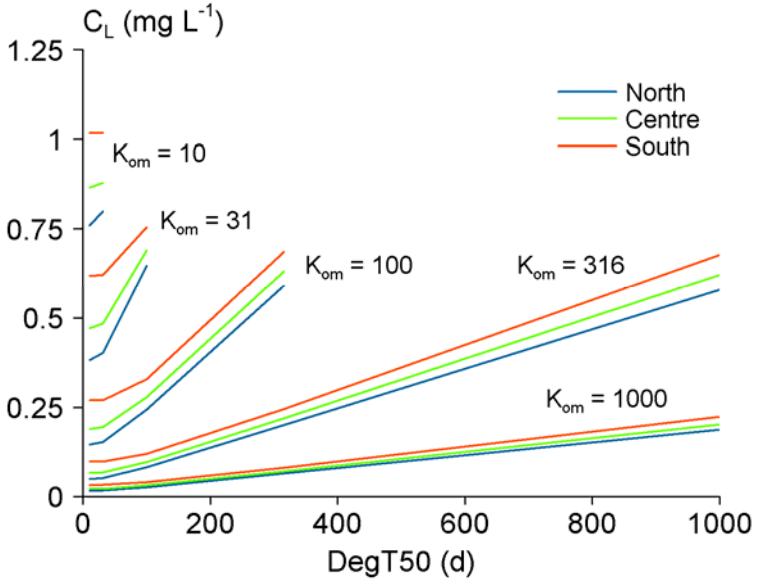


Normal FOCUS procedure: 20 years simulations



Results – the maximum concentration





- Differences between zones small:
  - P90 of CT: factor of 2 – 5
  - P90 of CL: factor of 1 – 1.5
- Small differences due to opposite trend of organic matter and temperature in the EU
  - North: Organic matter high; temperature low
  - South: Organic matter low, temperature high

Tier-2 must apply to all crops

- Scenario selection done for total surface area of annual crops

- End-point is the 90th percentile of the exposure concentration within <u>the intended area of use</u> of a PPP

- Safety factors needed to ensure that Tier 2 is sufficiently conservative

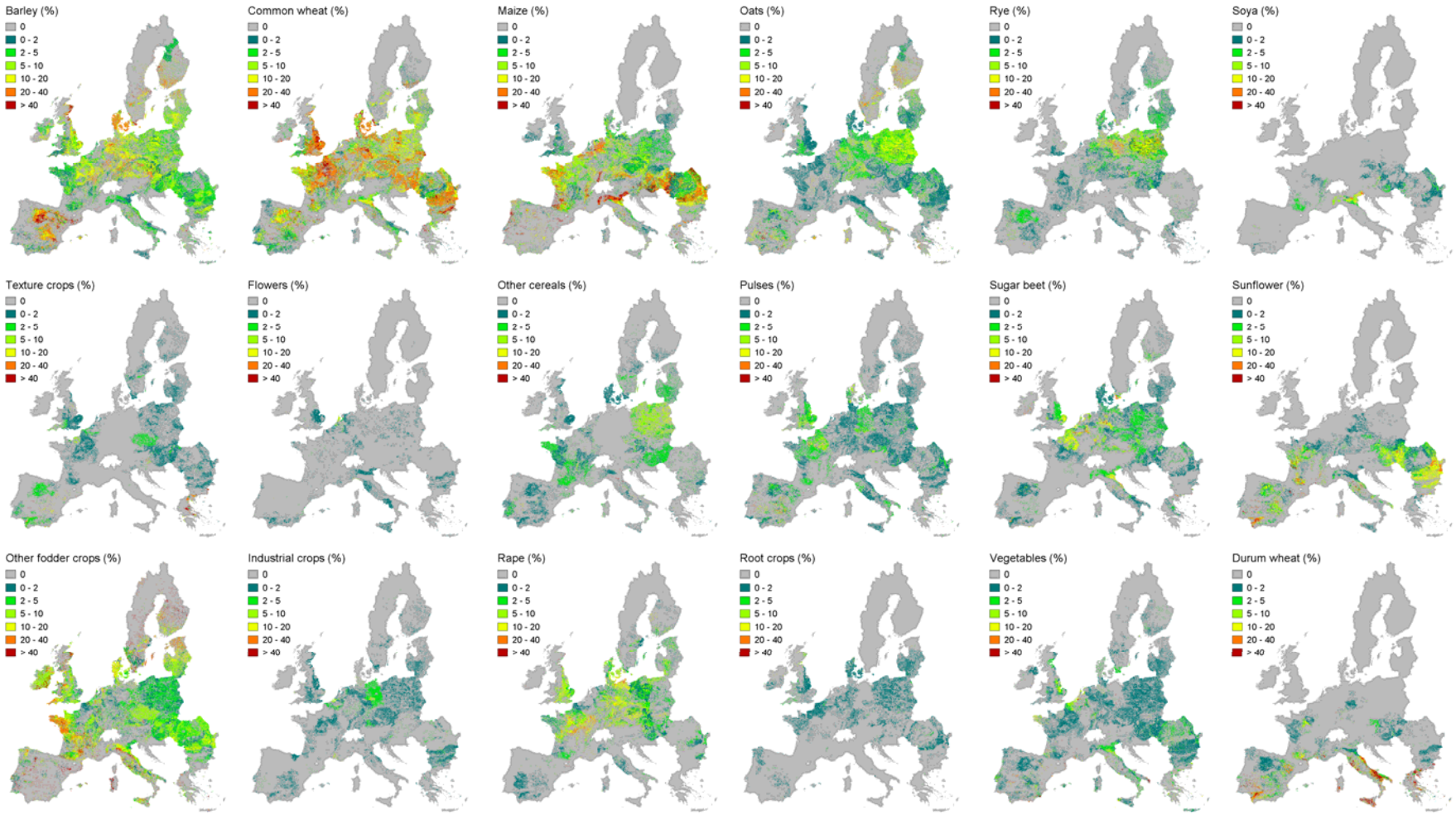
Development of safety factors

- Simulations done for 18 crops or groups of crops as available in the CAPRI crop database provided by JRC

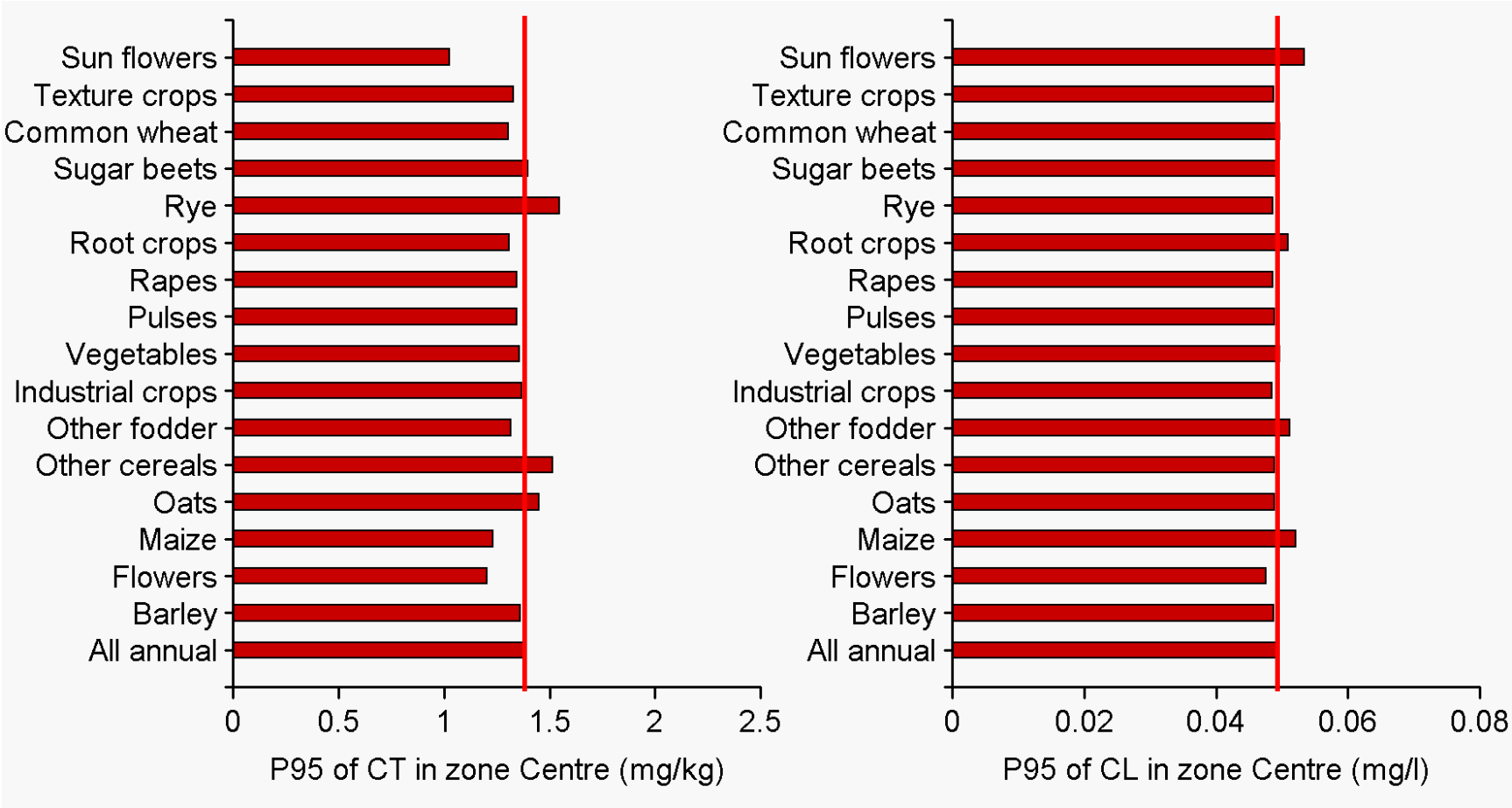
- For each crop $P_{95crop}/P_{95annual}$ is calculated

- The safety factor is the maximum of all these ratios

CAPRI: an extremely valuable resource



Results: P95 for all crops



Safety factors

Safety factor for CT scenario	
North	1.74
Central	1.16
South	1.07

Safety factor for CL scenario	
North	1.02
Central	1.15
South	1.13

Conclusions/relevance for authorisation

- A systematic approach has been developed for the selection of tier 2 and higher tier scenarios. A validation study by an independent contractor showed that the procedure is reproducible

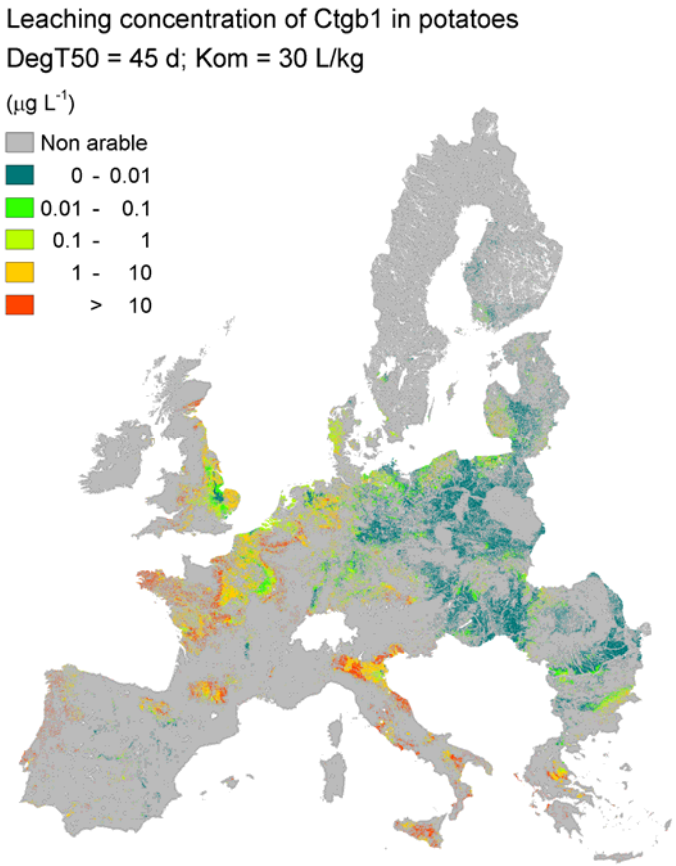
- This procedure explicitly considers the uncertainty of PPP-properties and soil properties by using a higher spatial percentile

- The procedure is generic and can also be applied to e.g. leaching scenarios and the national scale

Final remark

- The full dataset will be made available by JRC, so that notifiers can also do Tier 3 and Tier 4 studies

- This will also make tier 2C of the new FOCUS GW report operational

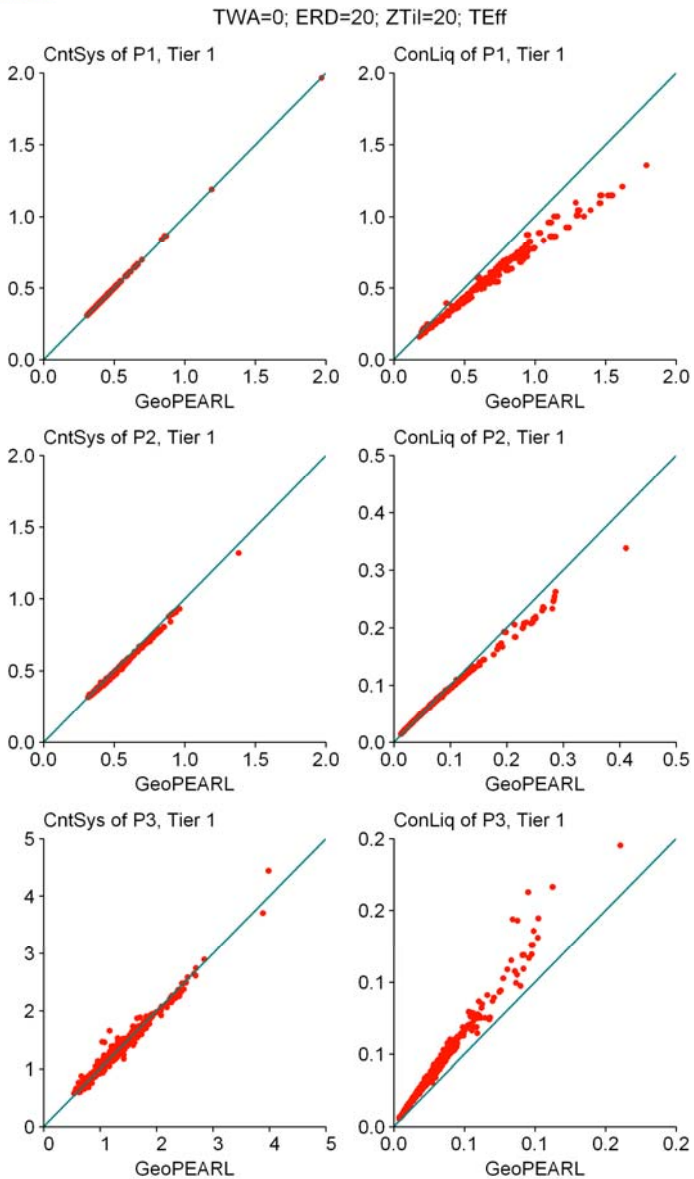


Calculations:
MetaPEARL

European Food Safety Authority

Thanks !

How do PERSAM results compare to (Geo)PEARL results?



- Some differences in liquid phase concentration because of non-linear sorption in PEARL
- But correlation is good
- So PERSAM is defensible for scenario selection

PPPs included

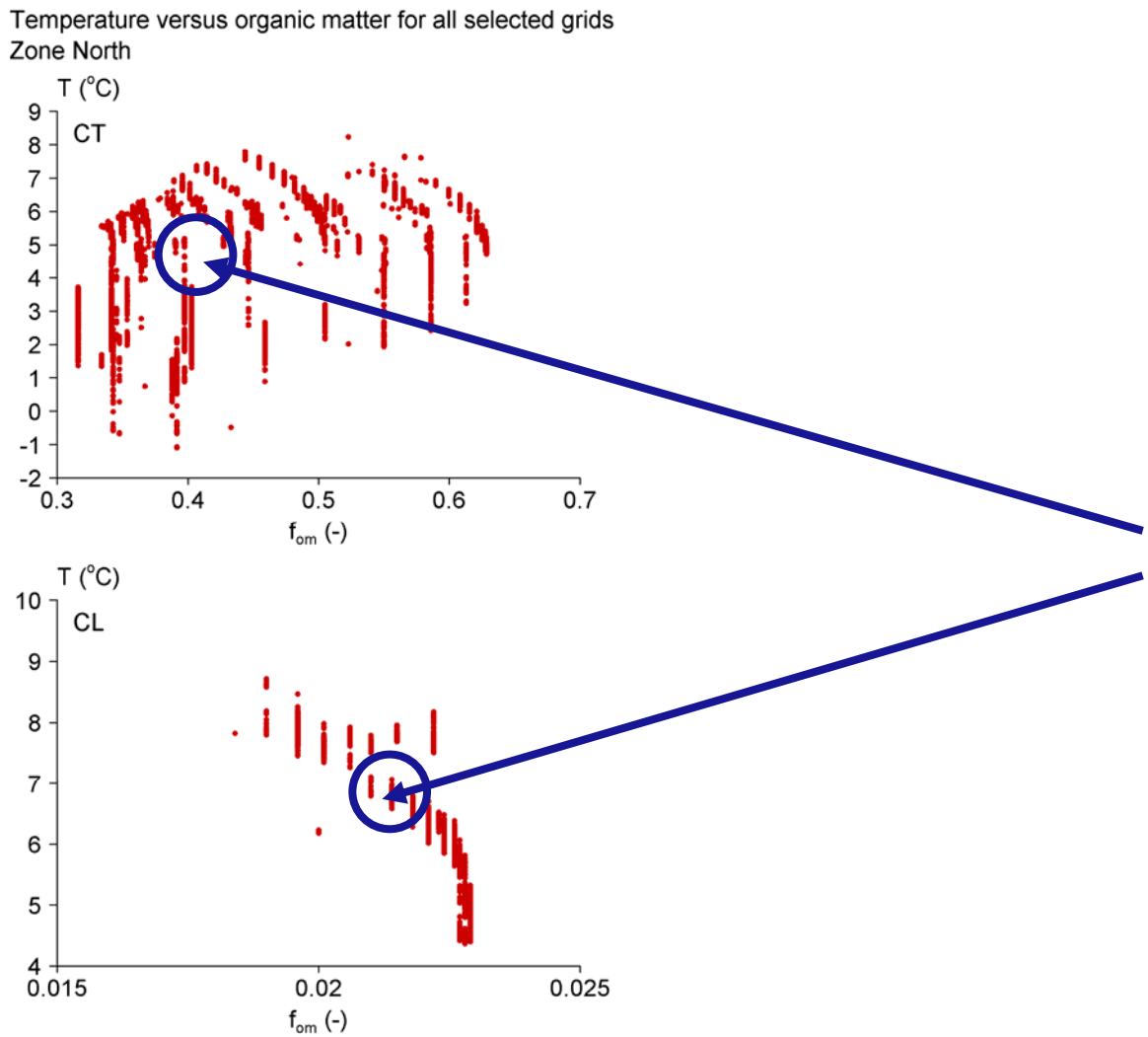
DegT50 →

Kom ↓

	10	31	100	316	1000
10					
31					
100					
316					
1000					

Not relevant, because these PPPs exceed 0.1 µg/l in groundwater

Example: properties of selected scenarios in zone 'North'



Median temperature and organic matter