

Assessments of Leaching to Groundwater in the UK

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Overview

- UK groundwater scenarios
- How were scenarios selected ?
- When Is Macropore flow modelling required?
- The UK tiered approach to leaching assessments
- Future developments ?

UK Groundwater Scenarios

- The UK has 4/5 scenarios which are used as part of a tiered approach to groundwater exposure assessments for product approvals which are:
 - Châteaudun / Châteaudun with MACRO
 - Hamburg
 - Kremsmünster
 - Okehampton

How were scenarios selected ?

- Set out to complete 3 tasks
- Identify those EU groundwater scenarios that have no relevance to the UK
- Quantify the proportion of aquifers in the UK for which calculation of PEC_{gw} using the FOCUS scenarios would be relevant
- Identify any significant agricultural scenarios in the UK not taken into account by the FOCUS scenarios that needed to be defined and developed further

Distribution of the climatic zones defined by FOCUS was defined using Climatic Research Unit data & mapped

Climatic characteristics of the EU groundwater scenarios

Average annual precipitation (mm)	Average mean annual temperature (°C)	Representative location of Scenario
<600	<5	Jokionen
≤600	5 to 12.5	Châteaudun*
601 to 800	5 to 12.5	Hamburg & Châteaudun**
801 to 1000	5 to 12.5	Kremsmunster
1001 to 1400	5 to 12.5	Okehampton
≤600	>12.5	Sevilla* & Thiva*
601 to 800	>12.5	Sevilla** & Thiva**
801 to 1000	>12.5	Piacenza
1001 to 1400	>12.5	Porto

* Where not irrigated

** Most crops in these climatic zones will be irrigated, raising the total amount of water to greater than 600 mm. The location can thus be considered representative of agriculture in this climatic zone.

Distribution of the soil properties defined by FOCUS and land classes associated with the scenarios was defined using Soil Typological Units (STU) within the 1:1,000,000 scale soil geographic database of Europe & mapped

General soil properties of the 1 000 groundwater scenarios and their corresponding STU attributes in the Soil Geographic Database of Europe.

Scenario location	General soil properties	Corresponding STU attributes				
		Soil	Texture class	Parent material	Soil depth	Water regime
Chateaudun	Silty clay loam over soft limestone at 60 cm depth. G/water at around 12 m.	Any	3	210, 212, 213, 214, 215, 216, 218, 219, 220	2,3,5	1
Hamburg	Deep sandy loam over sand. G/water at 2 m.	Not an Arenosol or Podzol	1	Any	1	1
Jokionen	Deep loamy sand with Bs horizon and large organic matter. G/water at 1.5 m.	Arenosol or Podzol	1	Any	1	1 or 2
Kremsmunster	Deep loam with subsoil wetness (Bwg horizon) and G/water at 1.6 m +.	Any	2	Any	1	2

General soil properties of the FOCUS groundwater scenarios and their corresponding STU attributes in the Soil Geographic Database of Europe.

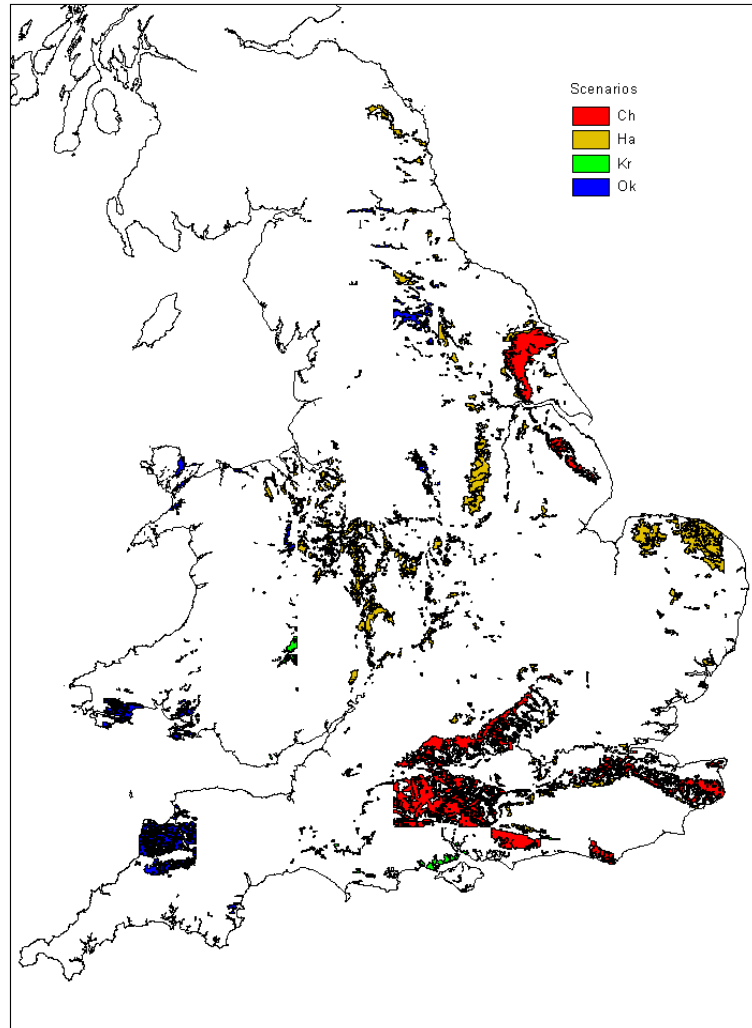
Scenario location	General soil properties	Corresponding STU attributes				
		Soil	Texture class	Parent material	Soil depth	Water regime
Okehampton	Deep loam to sandy loam with no subsoil wetness. G/water at about 20 m.	Any	2	Any	1	1
Piacenza	Deep loam over sand. No subsoil wetness. G/water at 1.3 to 1.7 m.	Fluvisol or Fluvic soil with high base status ('Eutric')	2	110	1	1 or 2
Porto	Deep loam over sandy loam. G/water at 0.7 to >2m depending on season	Fluvisol or Fluvic soil with low base status ('Dystric')	2	110	1	1 or 2
Sevilla	Deep loam. G/water at about 2.4 m.	Any	2	NOT 110, 113, 120	1	1
Thiva	Deep loam. G/water at about 2.4 m.	Any	2	NOT 110, 113, 120	1	1

Specified crops and associated STU land use classes for each FOCUS groundwater scenario in the Soil Geographic Database of Europe.

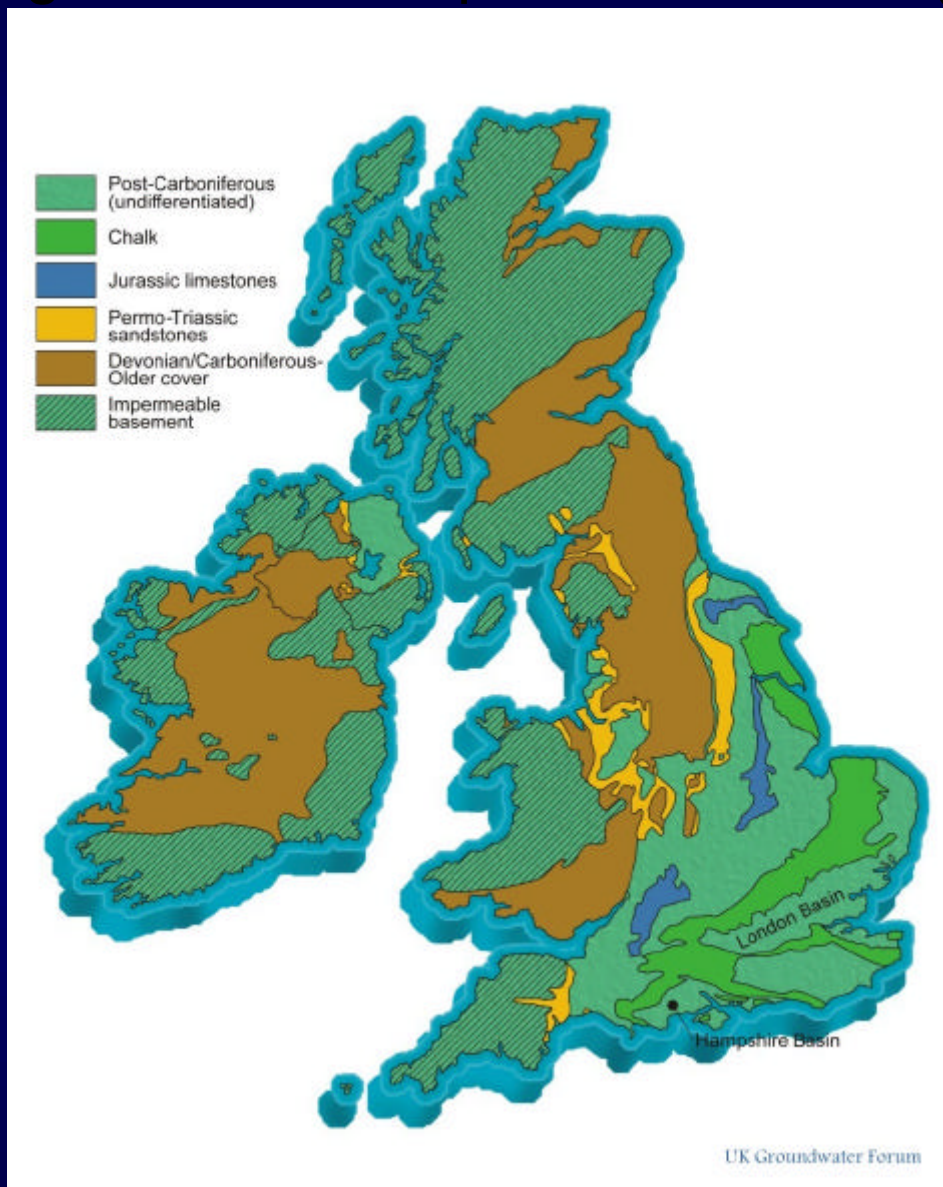
Scenario	Specified crops	STU land use classes
Chateaudun	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; winter oil seed rape; spring cereals; maize; cabbage; carrots; onions; peas (animals); tomatoes; apples; vines.	3; 6; 7; 12; 13; 16
Hamburg	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; winter oil seed rape; spring cereals; maize; cabbage; carrots; onions; beans (field); peas (animals); strawberries; apples; vines.	3; 6; 7; 12; 13; 16
Jokionen	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; spring oil seed rape; spring cereals; cabbage; carrots; onions; peas (animals); bush berries; strawberries; apples.	3; 6; 12; 13; 16
Kremsmunster	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; winter oil seed rape; spring cereals; maize; cabbage; carrots; onions; beans (field); strawberries; apples; vines	3; 6; 7; 12; 13; 16
Okehampton	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; winter oil seed rape; spring cereals; spring oil seed rape; linseed; maize; beans (field); peas (animals); apples;	3; 6; 12; 13; 16
Piacenza	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; winter oil seed rape; maize; soyabean; sunflower; tobacco; tomatoes; apples; citrus; vines	3; 6; 7; 12; 13; 16; 21
Porto	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; winter oil seed rape; spring cereals; spring oil seed rape; maize; beans (veg); cabbage; carrots; onions; tomatoes; apples; citrus; vines	3; 6; 7; 12; 13; 16; 21
Sevilla	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; maize; cabbage; tomatoes; sunflower; strawberries; citrus; apples; vines; cotton.	3; 6; 7; 12; 13; 15; 16; 21
Thiva	Grass (+ alfalfa); potatoes; sugar beet; winter cereals; maize; beans (veg); cabbage; carrots; onions; tomatoes; citrus; apples; vines; tobacco; cotton.	3; 6; 7; 12; 13; 15; 16; 21

Extent of scenarios in the UK

Extent of Scenarios Ch, Ha, Kr and Ok



Location of groundwater aquifers in the UK (and EIRE)



Identifying UK vulnerable groundwater situations not covered by FOCUS

- In UK soils have been classified on the basis of soil leaching potential classes and subclasses
- The FOCUS scenario soil properties were assessed and ascribed to these leaching potential classes
- An assessment of the comparative vulnerability of the 'missing' classes was carried out

The vulnerable groundwater situations covered by FOCUS

- **Châteaudun-H1s** shallow soils that overly rock, rock-rubble or gravel at 40cm or less; overlay 4.4% England and Wales aquifers
- **Hamburg**-intermediate between H2n and H3p sandy soils with moderate topsoil organic carbon content; overlay 4.5% England and Wales aquifers
- **Okehampton-I1c** relatively coarse textured soils with a relatively large drainable pore space ; overlay 1.7% England and Wales aquifers
- **Kremsmünster-I1m** medium textured soils with a moderate drainable pore space; overlay 0.35% England and Wales aquifers

UK vulnerable groundwater situations not covered by FOCUS

H1b	Not directly correlated with FOCUS Scenarios but chromatographic leaching will be less than any of the four correlated Scenarios because of its larger organic carbon and clay contents. Higher clay content may mean preferential flow is of more concern than at Châteaudun. Overlays 4.7 % England and Wales aquifers, but only 2.2% is used for arable or grassland production.
H3s	Not directly correlated with FOCUS Scenarios but very similar characteristics to the Châteaudun Scenario except that H3s is slightly deeper. Leaching is thus likely to be similar to or less than Châteaudun Scenario. Overlays ca. 4.4% England and Wales aquifers
I1g	Not directly correlated with FOCUS Scenarios but chromatographic leaching will be similar to or less that of the Kremsmunster scenario because of its slightly larger clay and organic carbon contents. Potentially slightly worse for preferential flow than Châteaudun but in practice because of the very slowly permeable nature of the deep unsaturated substrates between the upper soil layers and aquifer, less vulnerable than Châteaudun. Overlays 10.2 % England and Wales aquifers
I2o	Not directly correlated with FOCUS Scenarios but no leaching because of their very large organic matter content.
Lnn	Not directly correlated with FOCUS Scenarios but no leaching risk because of their impermeable nature.

Conclusions. What the FOCUS scenarios encompass

- With respect to chromatographic leaching the four correlated scenarios are expected to provide a range of PEC_{gw} values that should be protective of all aquifers in the UK
- With respect to preferential flow leaching (ca. 24% of UK aquifers are overlaid by these soils) the Châteaudun macropore scenario should be protective of almost all these aquifers. (Theoretically 2.2% represented by H1b may be more vulnerable).

When is macropore modelling required?

- It was recognised that for many compounds chromatographic modelling using Hamburg/Okehampton gives significantly higher exposure concentration estimates than using MACRO at Châteaudun
- An assessment of outputs from modelling where compound properties were systematically varied was completed. The aim was to see if it was possible to define the properties of compounds where chromatographic scenarios always gave higher concentrations than MACRO/Châteaudun

80th % concentrations at 1 m from 1 kg/ha application to winter cereals

Pesticide	DT50	Koc	Period	Châteaudun	Hamburg
				MACRO	PELMO
	<i>d</i>	<i>mL/g</i>		<i>mg/L</i>	<i>mg/L</i>
P1	10	10	Spring	0.043	0.22
P2	20	10	Spring	0.98	4.06
P3	10	20	Spring	0.014	0.04
P4	20	20	Spring	0.54	1.47
P5	20	50	Spring	0.048	0.06
P6	50	100	Spring	0.29	0.62
P7	50	200	Spring	0.036	0.004
P8	50	500	Spring	0.0000362	No pest.
P9	20	100	Spring	0.0052	0.001
P1	10	10	Autumn	5.29	21.22
P2	20	10	Autumn	22.60	66.60
P3	10	20	Autumn	2.79	4.56
P4	20	20	Autumn	10.30	22.59
P5	20	50	Autumn	1.28	1.92
P6	50	100	Autumn	3.52	3.48
P7	50	200	Autumn	0.29	0.03
P8	50	500	Autumn	0.00067	No pest.
P9	20	100	Autumn	0.141	0.021

When is macropore modelling required?

- Concluded that MACRO/Châteaudun modelling would only be required for more strongly sorbed compounds ($K_{oc} > 100\text{mg/ml}$)
- For compounds with $K_{oc} < 100\text{mg/ml}$ MACRO/Châteaudun results are not needed as results from chromatographic scenarios/models will be greater

UK tiered approach to groundwater exposure assessment

1. A case may be made that there is no risk to groundwater aquifers based on non association with an aquifer. (Envisaged usually from some non crop uses).
2. First tier FOCUS modelling carried out using FOCUS report pesticide input guidance with PEARL or PELMO or PRZM for the scenarios Châteaudun, Hamburg, Kremismünster and Okehampton, at which the pertinent crops are grown. Also MACRO/Châteaudun where compounds have $K_{oc} > 100 \text{ ml/g}$. Output for decision making is average concentration for the 80th percentile year leaching below 1m as specified in the FOCUS report.

UK tiered approach to groundwater exposure assessment

- 3.If any one of the UK scenarios fails the trigger, the potential for groundwater exposure must be addressed further. The options available are:
- higher tier modelling approaches using the pertinent FOCUS scenarios as discussed in the FOCUS report, with the supporting data to justify deviations from the standard tier 1 FOCUS approach, (e.g. evidence for actual sub soil degradation rates or increased sorption with time etc.). The depth of simulation could be to that which is technically feasible. The depth for which results are presented and their relationship to UK vulnerable groundwater depths as associated with the intended cropping must be considered.

UK tiered approach to groundwater exposure assessment

3. If any one of the UK scenarios fails the trigger, the potential for groundwater exposure must be addressed further. The options available are:

- higher tier modelling using other scenarios more tailored to the intended UK use, probably selected and justified using SEISMIC. The UK Guidance Documents: 'Applicants Wishing to Submit Computer Simulation Data to PSD to Address the Environmental Fate of Agricultural Pesticides' and 'Regulatory Use of the SEISMIC Database' need to be followed.
- Providing lysimeter or field leaching studies, either as the sole information or in combination with a modelling submission.

UK tiered approach to groundwater exposure assessment

- Those making submissions need to be aware that the UK:
- ‘Guidance Document for Applicants Wishing to Submit Computer Simulation Data to PSD to Address the Environmental Fate of Agricultural Pesticides’
- has been updated with significant extra guidance and information particularly on model calibration and parameterisation, some of this guidance is particularly pertinent to the appropriate use of MACRO in regulatory submissions for the UK.
- To access a copy of the UK tiered groundwater approach, computer simulation guidance and SEISMIC guidance VISIT www.pesticides.gov.uk and look under ‘Applicant Advice’ and, ‘Data Requirements Handbook’



Future Developments

- SEISMIC database is to be updated both to ensure it runs correctly in a true windows environment and to add additional functionality that will be of use to higher tier leaching assessments. This will include aquifer mapping, provide additional data on soil moisture release curves and additional (generated) weather data
- Monitoring data from aquifers overlaid by predominantly H1b soils will be scrutinised to see if the theoretical vulnerability of such aquifers has resulted in contamination in practice?

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