Characterising Agricultural Areas in Europe

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Background -1

> Sustainable use of pesticides within European agriculture is a stated goal.

> Requires a clear understanding of the routes by which pesticide residues can reach non-target areas.

> European agricultural conditions are diverse.
- Clearly impractical to measure losses from every field.

> Need other methods – **Numerical modelling**

Background - 2

> Numerical models are difficult to parameterise – 'data hungry'

> Most current European risk assessment procedures use a limited number of 'realistic worse-case scenarios'. (c.f. FOCUS tools)

> Recent suggested refinements include more probabilistic modelling with a broader range of soil and climate conditions (FOCUS L & M 2003).

> BUT, development has been hampered by the lack of harmonised data at the pan-European scale.

> FOOTPRINT has now addressed this issue.

Objectives for creating Agro-Environmental Scenarios

> Develop and apply a methodology for defining generic scenarios for characterising the complete spectrum of European agricultural environments (integrate crop, weather and soil characteristics).

- Scenarios must be capable of being applied anywhere in Europe at European/national/regional, catchment and farm/holding level.

- Each scenario should have a default set of
  - long-term weather data
  - soil property data
  - agronomic data.

Methodology

>Climate: Identify zones in which the critical weather variables are relatively similar.
Define representative long term daily weather data for each zone.

>Crop: Identify and map the different types of agricultural land and the crops grown on them.
Define crop growth characteristics for each crop.

>Soil: Identify the soil properties that are critical for pesticide transport and map their distribution.
Define soil profile characteristics for each soil.

> Integrate all three data layers using GIS intersection to create the scenarios.

Creating the agricultural land & crop data layer

> Use CORINE 2000 to identify and map agricultural land.

> Use corrected European cropping statistics from the FATE Land Cover map (JRC) to quantify range of annual crops grown.

> Use GIS to intersect CORINE agricultural areas with FATE Land Cover data.

CORINE 2000 Agricultural land cover

- **Arable (non-permanently irrigated); 211**
- **Arable (permanently irrigated); 212**
- **Vineyards; 221**
- **Fruit trees & berry plantations; 222**
- **Olives; 223**
- **Pastures; 231**
- **Arable mixed with other uses; 2413**
- **Complex cultivation patterns; 242**
- **Agro-forestry; 244**

All non-agricultural land is grouped together and un-attributed

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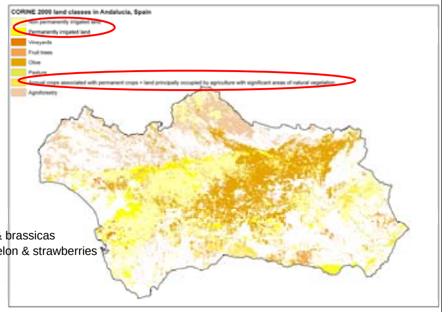
An example from Andalucia

Annual crops used to characterise Arable Land categories

Other cereals
Potato
Pulse
Rape seed
Rye
Soft wheat
Soya
Sugar beet
Sunflower
Tobacco
Barley
Cotton
Durum Wheat
Flax
Fodder roots & brassicas
Fresh veg., melon & strawberries
Green fodder
Maize fodder
Maize grain
Oats



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Identification of FOOTPRINT Soil Types - Objectives

- To identify **a limited number** of soil types suitable for modelling environmental fate of pollutants across Europe.
- To represent the complete range of relevant **pollutant transfer pathways** from the soil surface to water resources.
- To represent the **complete range** of soil sorption potential relevant to 'reactive' pollutants.

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Identifying FOOTPRINT Soil Types

The FST code

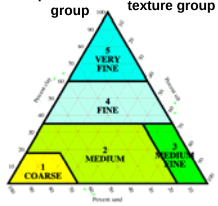
L 4 4 n

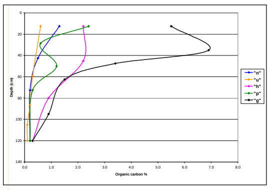
FP Hydrological Group
Based on HOST in Europe, Schneider *et al*, 2007.

Topsoil texture group

Subsoil texture group

Sorption attributes
Organic matter profiles;
Depth to rock
Clay increase in subsoil





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The Hydrological Component

- A combination of the Hydrology Of Soil Types system - **HOST** (Boorman *et al* 1994; Schneider *et al* 2007) and the **CORPEN** system (Groupe "diagnostic" du CORPEN, 1996)
- HOST provides a quantitative link between soil types and stream response to rainfall.
- CORPEN provides seasonal differentiation of pollutant transfer pathways. **(Flow Pathway Categories, FPCs)**.

BOORMAN, D.B., HOLLIS, J.M. & LILLY, A. (1995). *Hydrology of Soil Types: A hydrologically - based classification of the soils or the United Kingdom*. Institute of Hydrology Report No. 126, Wallingford, UK. 137 pp.

SCHNEIDER, M.K., BRUNNER, F., HOLLIS, J.M. & STAMM, C. (2007). Towards a hydrological classification of European soils: Preliminary test of its predictive power for the base flow index using river discharge data. *Hydrol. Earth Syst. Sci.*, **11**, 1–13.

Groupe "diagnostic" du CORPEN (1996). *Qualité des eaux et produits phytosanitaires: Propositions pour une demarche de diagnostic*. Republique Francaise, Ministere de L-Environnement et Ministere de l'Agriculture, de la Peche et de l'Alimentation. 113 pp.

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FOOTPRINT soil hydrological class

FOOTPRINT hydrological code	HOST class	Description	SPR
L	1, 2, 3, 5, 13	Permeable, free draining soils on permeable sandy, gravelly, chalk or limestone substrates with deep groundwater (below 2m depth).	2 – 12%
M	4	Permeable, free draining soils on hard but fissured substrates (including karst) with deep groundwater (below 2m depth).	20%
N	6	Permeable, free draining soils on permeable soft loamy or clayey substrates with deep groundwater (below 2m depth).	34%
O	7	Permeable soils on sandy or gravelly substrates with intermediate groundwater (between 1 & 2 m depth)	20%
P	8	Permeable soils on soft loamy or clayey substrates with intermediate groundwater (between 1 & 2 m depth)	30%
Q	9, 10, 11	All soils with shallow groundwater (within 1m depth) and artificial drainage	25 – 35% (drained peat 2%)
R	17	Permeable, free draining soils with large storage, over hard impermeable substrates below 1 m depth	30%
S	19	Permeable, free draining soils with moderate storage, over hard impermeable substrates at between 0.5 & 1 m depth	45%
T	22	Shallow, permeable, free draining soils with small storage, over hard impermeable substrates within 0.5 m depth	60%
U	20	Soils with slight seasonal waterlogging ('perched' water) over soft impermeable clay substrates	47%
V	23, 25	Soils with prolonged seasonal waterlogging ('perched' water) over soft impermeable clay substrates	50 – 60%
W	16	Free draining soils over slowly permeable substrates	22%
X	18	Slowly permeable sois with slight seasonal waterlogging ('perched' water) over slowly permeable substrates	47%
Y	14, 21, 24	Slowly permeable soil with prolonged seasonal waterlogging ('perched' water) over slowly permeable substrates	40 – 47%
Z	12, 15, 26, 27, 28, 29	All undrained peat or soils with peaty tops	50 – 60%

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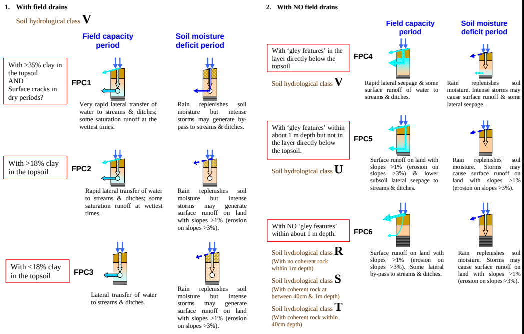
Example of Flow Pathway Categories

Soils on Impermeable Substrates



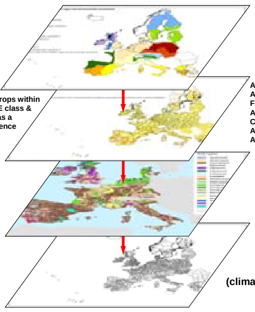
Creating the Soil Data Layer

> Assign a FOOTPRINT Soil Type (FST) to each Soil Typological Unit (STU) in SGDBE using stu.dbf attributes.

- > All STU's in the SGDBE represented by 373 FOOTPRINT soil types.
- > 264 FST's represent soils under arable or permanent crops.
- > 287 FST's represent soils under managed grassland.
- > 33 FST's represent soils **only** under non-agricultural uses.

> Use SPADE-1 and SPADE-2 databases (Approximately 2000 profiles) to derive profile parameters for each FOOTPRINT soil class under arable or permanent crops.

Creation of scenarios by GIS intersection



+ FATE

cropping statistics define the range of crops within each 'arable' CORINE class & the fraction of each as a probability of occurrence

Climate: 16 zones

Each has a representative 20 year daily weather dataset based on analysis of driving variables

CORINE 2000

Arable (non-perm. irrigated); 211. Vineyards; 221.
Arable (perm. Irrigated); 212. Olives; 223.
Fruit trees & berry plantations; 222. Pastures; 231.
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European Soil database 1:1,000,000

Defines the range of FOOTPRINT Soil Types within each climate/ CORINE/NUTS2 area & the fraction of each as a probability of occurrence

25044 scenarios
(climate, CORINE+FATE, SMU)

Approximately 1.7 million polygons representing individual areas with the same type of land use, cropping, climatic zone and soil map unit.

What is a FOOTPRINT Agro-environmental scenario?

> A unique combination of land use, cropping, climatic zone and soil map unit.

> Local soil is defined from a range of FSTs with a specific % probability of occurrence.

> For those scenarios that have a partly or wholly 'arable' land use, a specific range of annual crops with an estimated % probability of occurrence.

Diversity of the Scenarios

Country	Number of unique combinations	Total land area (1,000,000 ha)	Number of unique combinations per 1,000, 000 ha of land	Number of NUTS level 2	Number of FOOTPRINT climatic zones	Number of agricultural FOOTPRINT soil types	Number of FOOTPRINT crops
Italy	1041	30.134	0.345	20	5	86	22
France	967	54.909	0.176	22	5	149	22
Germany	962	35.703	0.269	40	6	116	20
Spain	565	50.537	0.112	17	4	65	23
Hungary	535	9.303	0.575	7	3	100	20
Poland	524	31.268	0.168	16	4	95	16
Greece	451	13.196	0.342	13	3	79	20
Portugal	401	9.191	0.436	5	2	50	17
UK	381	24.382	0.156	36	6	87	13
Czech Rep.	373	7.887	0.473	8	3	80	20
Slovakia	364	4.903	0.742	4	2	82	19
Austria	304	8.387	0.362	9	3	88	20
Slovenia	293	2.027	0.145	1	3	66	15
Lithuania	165	6.530	0.253	1	2	56	15
Ireland	136	7.027	0.194	2	2	37	13
Belgium	125	3.053	0.409	12	1	88	16
Latvia	105	6.459	0.163	1	2	34	15
Netherlands	59	3.736	0.158	12	1	52	12
Estonia	59	4.523	0.130	1	1	24	14
Sweden	52	4.1034	0.127	8	4	15	13
Denmark	40	4.310	0.928	1	2	30	14
Luxembourg	39	0.259	0.151	1	1	39	16
Finland	20	33.815	0.591	6	2	6	13
EU totals	7961	392.573	0.203	243	16	264	23

Data associated with scenarios

> 20 year daily weather data for each climate zone derived from the time series with driving variables closest to the 'average' for the zone.

> Probability fraction of crops occurring in 'arable' polygons.

> Crop growth templates for each crop.

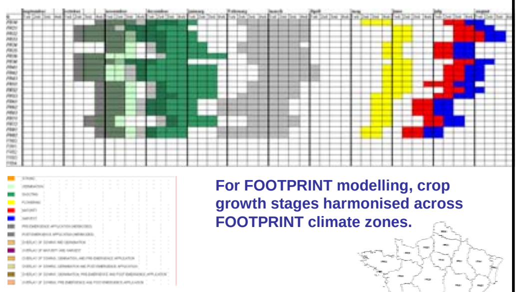
> Probability fraction of FOOTPRINT soil types (FST's) in each polygon.

> Soil horizon property data for each (arable) FST.

> Hydrological data for each FST.

Example crop growth stage template

Winter Soft Wheat



For FOOTPRINT modelling, crop growth stages harmonised across FOOTPRINT climate zones.

Collaborative effort
42 crops, 252 NUTS2 areas (23 countries)

FST Data

Soil hydrology

SMU	STU	PCAREA	HOST	HOST_BFI	LAND_USE	FST	FST_BFI	PRZM_HSG	FOOTPRINT_	FPC_UNDRAINED	FPC_DRAINED
70001	70001	75	5	0.90	Non-agricultural	L11p	0.90	A	L	FPC18	Non-agricultural
70001	70002	25	5	0.90	Non-agricultural	L11i	0.90	A	L	FPC18	Non-agricultural
70002	70003	60	5	0.90	Non-agricultural	L11n	0.95	A	L	FPC18	Non-agricultural
70002	70004	30	6	0.64	Arable	N33i	0.64	B-C	N	FPC24	Drains not needed
70002	70005	10	12	0.17	Non-agricultural	Z61t	0.20	D	Z	FPC22	Non-agricultural
70003	70006	65	5	0.90	Arable	L11n	0.95	A	L	FPC18	Drains not needed
70003	70007	25	12	0.17	Non-agricultural	Z61t	0.20	D	Z	FPC22	Non-agricultural
70003	70008	10	5	0.90	Non-agricultural	L11i	0.90	A	L	FPC18	Non-agricultural
70004	70009	60	6	0.64	Arable	N22n	0.64	B-C	N	FPC24	Drains not needed
70004	70010	25	21	0.34	Arable	Y23i	0.34	B-C	Y	FPC11	FPC8
70004	70011	10	12	0.17	Non-agricultural	Z61t	0.20	D	Z	FPC22	Non-agricultural
70004	70012	5	5	0.90	Non-agricultural	L11i	0.90	A	L	FPC18	Non-agricultural
70005	70013	75	21	0.34	Arable	Y34i	0.33	B-C	Y	FPC11	FPC8
70005	70014	15	6	0.64	Arable	N33i	0.64	B-C	N	FPC24	Drains not needed
70005	70015	10	12	0.17	Non-agricultural	Z63t	0.17	D	Z	FPC22	Non-agricultural
70006	70016	55	6	0.64	Arable	N33i	0.64	B-C	N	FPC24	Drains not needed
70006	70017	30	21	0.34	Arable	Y23i	0.34	B-C	Y	FPC11	FPC8
70006	70018	10	12	0.17	Non-agricultural	Z61t	0.20	D	Z	FPC22	Non-agricultural
70006	70019	5	9	0.73	Grass	Q32a	0.73	A	Q	FPC40	FPC38
70007	70020	90	7	0.79	Non-agricultural	O11n	0.79	A	O	FPC17	Non-agricultural
70007	70021	10	5	0.90	Non-agricultural	L11i	0.90	A	L	FPC18	Non-agricultural
70008	70022	100	7	0.79	Non-agricultural	O11n	0.79	A	O	FPC17	Non-agricultural
70009	70023	80	5	0.90	Arable	L11n	0.95	A	L	FPC18	Drains not needed
70009	70024	20	7	0.79	Non-agricultural	O11i	0.79	A	O	FPC17	Non-agricultural
70010	70025	100	6	0.64	Non-agricultural	N33n	0.64	B-C	N	FPC24	Non-agricultural
70011	70026	100	12	0.17	Non-agricultural	Z66t	0.22	D	Z	FPC22	Non-agricultural
70012	70027	80	11	0.93	Grass	Q66t	0.93	A	Q	FPC40	FPC39
70012	70028	20	9	0.73	Grass	Q33a	0.73	A	Q	FPC40	FPC38
70013	70029	70	9	0.73	vegetables	Q33a	0.73	A	Q	FPC40	FPC38
70013	70030	15	11	0.93	Grass	Q66t	0.93	A	Q	FPC40	FPC39
70013	70031	15	9	0.73	Grassvegetables	Q32a	0.73	A	Q	FPC40	FPC38
70014	70032	85	9	0.73	Grassvegetables	Q32a	0.73	A	Q	FPC40	FPC38
70014	70033	15	9	0.73	Grass	Q32a	0.73	A	Q	FPC40	FPC38
70015	70034	80	24	0.31	Grass	Y12h	0.31	B-C	Y	FPC10	FPC9
70015	70035	20	12	0.17	Non-agricultural	Z66t	0.22	D	Z	FPC22	Non-agricultural
70016	70036	70	24	0.31	Arable	Y44h	0.33	B-C	Y	FPC10	FPC7
70016	70037	15	12	0.17	Non-agricultural	Z66t	0.22	D	Z	FPC22	Non-agricultural
70016	70038	15	12	0.17	Non-agricultural	Z64t	0.17	D	Z	FPC22	Non-agricultural
70017	70039	90	24	0.31	Arable	Y44h	0.33	B-C	Y	FPC10	FPC7
70017	70040	10	12	0.17	Non-agricultural	Z64t	0.17	D	Z	FPC22	Non-agricultural
70018	70041	80	5	0.90	Non-agricultural	L11n	0.95	A	L	FPC18	Non-agricultural
70018	70042	20	5	0.90	Non-agricultural	L11i	0.90	A	L	FPC18	Non-agricultural
70019	70043	50	6	0.64	Arable	N22i	0.64	B-C	N	FPC24	Drains not needed
70019	70044	30	21	0.34	Arable	Y33h	0.34	B-C	Y	FPC11	FPC8
70019	70045	20	6	0.64	Arable	N22n	0.64	B-C	N	FPC24	Drains not needed
70020	70046	100	6	0.64	Arable	N22n	0.64	B-C	N	FPC24	Drains not needed
70021	70047	100	6	0.64	Arable	N22n	0.64	B-C	N	FPC24	Drains not needed
70022	70048	75	21	0.34	Arable	Y33i	0.33	B-C	Y	FPC11	FPC8
70022	70049	15	6	0.64	Arable	N33i	0.64	B-C	N	FPC24	Drains not needed
70022	70050	10	11	0.93	Non-agricultural	Q62t	0.83	A	Q	FPC40	Non-agricultural
70023	70051	80	6	0.64	Arable	N33i	0.64	B-C	N	FPC24	Drains not needed
70023	70052	20	6	0.64	Arable	N33i	0.64	B-C	N	FPC24	Drains not needed
70024	70053	100	5	0.90	Non-agricultural	L11n	0.95	A	L	FPC18	Non-agricultural

Use of the Scenarios in the FOOT tools

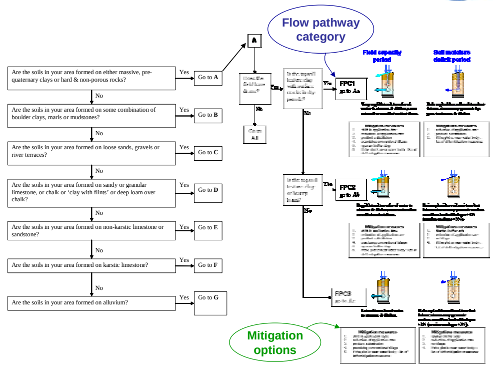
> Option 1: No data:

Use the spatial distribution of agro-environmental scenarios for areas where detailed data are not available (ArcGIS in FOOT-CRS and –NES).

> Option 2: More detailed local/regional data:

Use the Data Management module in FOOT-CRS & FOOT-NES to create your own scenarios from your data. Correlate your local soils (from your own soil map) with FOOTPRINT soil types through a decision tree based on simple questions.

The FST Decision Tree



Conclusions

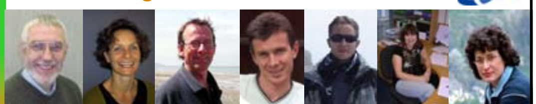
> The 25044 FOOTPRINT scenarios represent the spatial variation and heterogeneity of environmental conditions in the European agricultural landscape.

> The scenarios and their supporting information are used to:
- Identify contamination pathways throughout Europe.
- underpin model parameterization.

> A significant contribution towards harmonization of risk assessment throughout Europe.

> Likely to be applicable to other agricultural contaminants such as nitrate or phosphorus.

Acknowledgements



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