SIXTH FRAMEWORK PROGRAMME

FOOTPRINT

Defining agro-environmental scenarios for the whole of the EU

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Objective of the work

> 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 will have a default set of
  - long-term weather data
  - soil property data
  - agronomic data.

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What is a FOOTPRINT agro-environmental scenario?

Climate zone (1 – 15)

Representative 20 year daily weather based on analysis of driving variables

CORINE land cover code

250m x 250m

Arable (non-perm. irrigated); 211
Arable (perm. Irrigated); 212
Vineyards; 221
Fruit trees & berry plantations; 222
Olives; 223
Pastures; 231
Arable mixed with other uses; 2413
Complex cultivation patterns; 242
Agroforestry; 244

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

NUTS 2 cropping stats.

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

Soil Mapping Unit SMU from SGDBE

Defines the range of FST's within each climate/ CORINE/NUTS2 area & fraction of each as a probability of occurrence

25044 scenarios (climate, CORINE, NUTS2, SMU)

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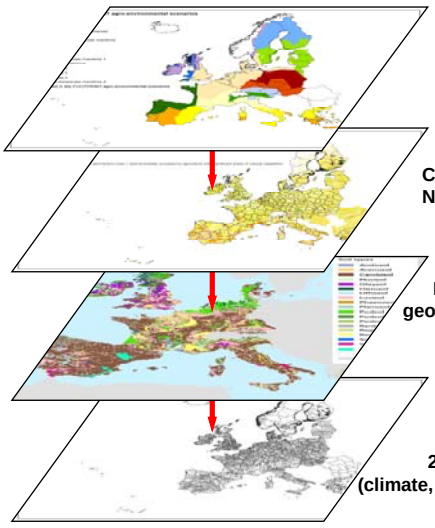
Creation of scenarios by GIS intersection



Climate

CORINE 2000 + NUTS level 2

European Soil geographic database 1:1,000,000

25044 scenarios (climate, CORINE+NUTS2, SMU)

Combined Climate/NUTS2/CORINE 2000/soil type polygons

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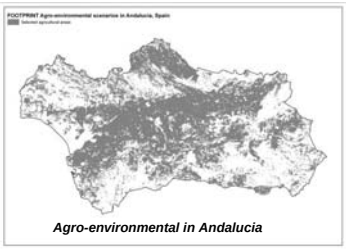
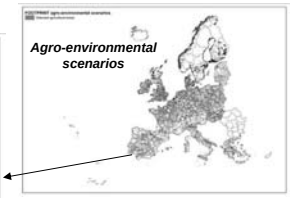
Agro-environmental scenarios

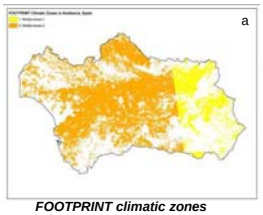
Example of Andalucia, Spain



Agro-environmental in Andalucia

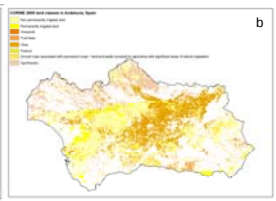


Agro-environmental scenarios



a

FOOTPRINT climatic zones



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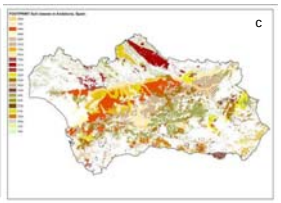
FOOTPRINT agronomic scenarios



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FOOTPRINT soil Scenarios

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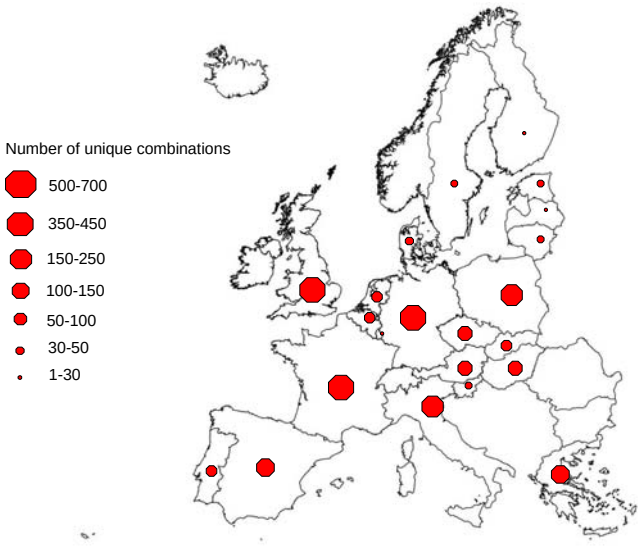
Scenario heterogeneity across Europe



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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.

Eurostat cropping statistics for arable land in NUTS

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

Correction factors for arable crop proportions in NUTS2 areas

> Analysis of areas of CORINE arable categories within NUTS 2 areas showed some significant differences with total arable land statistics from Eurostat.

> Known that allocation of CORINE satellite imagery to specific land cover categories is often uncertain.

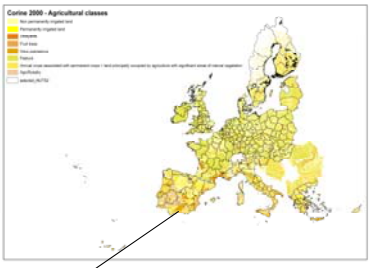
> A correction factor therefore used to calculate crop area fractions in NUTS2 arable areas:

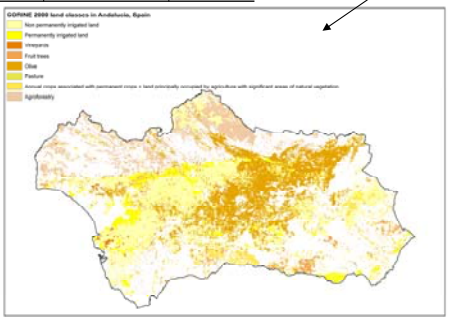
$$CF = \frac{\text{NUTS2 (Eurostat) arable area}}{\text{CORINE (calculated) arable area in NUTS 2}}$$

FOOTPRINT Crop cover and location

Data for NUTS ES61: Andalucia, Spain

Crop Type	EUROSTAT Crop cover area % arable land area	Adjusted crop cover % using correction factor	Crop cover area (1000ha)
Durum wheat	24.86	28.48	475.94
Maize grain	2.45	2.83	47.06
Oil seed	15.47	17.79	296.32
Soft wheat	3.32	3.81	63.59
Sunflower	15.45	17.76	295.81
Olive	-	100	1494.01
Vineyards	-	100	44.31





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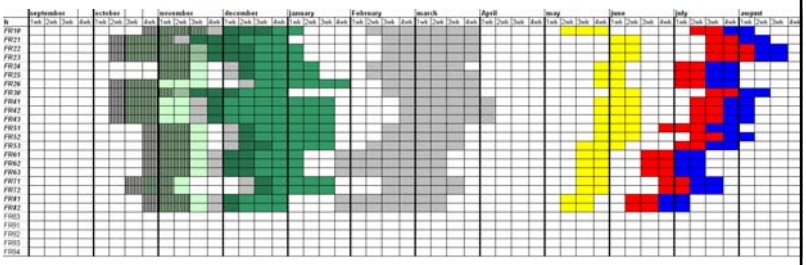
Example crop growth stage template

Winter Soft Wheat



Crop growth stages harmonised across FOOTPRINT climate zones.

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

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Defining Soil Scenarios

> Define soil hydrological characteristics:
HOST attributes; CORPEN soil attributes; Textures.

> Define topsoil and subsoil texture class:
1 – 5 (from TEXT & TD in stu.dbf)

> Define sorption attributes:
Organic matter profiles; (identified by soil class from stu.dbf)
Depth to rock (identified by soil class, IL & ROO from stu.dbf)
Clay increase in subsoil (identified by soil class, TEXT & TD from stu.dbf)

> Combine to define FOOTPRINT soil classes.

> Assign classes to each STU in SGDBE using stu,dbf attributes.

> Use SPADE-1 and SPADE-2 databases (Approximately 2000 profiles) to derive land use-specific profile parameters for each FOOTPRINT soil class.

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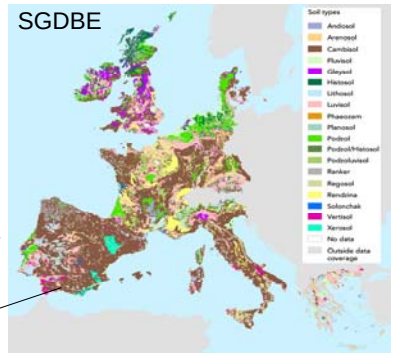
Defining FOOTPRINT Soil codes

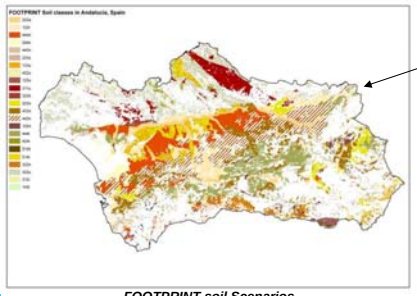
FOOTPRINT Soil class:

L 4 4 n

- L → FOOTPRINT hydrological code
- 4 → Topsoil texture code
- 4 → Subsoil texture code
- n → Organic matter profile code

SGDBE





FOOTPRINT soil Scenarios

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FOOTPRINT Soil Types (FST) in the SGDBE

- All STU's in the SGDBE represented by 373 FOOTPRINT soil types.
- 257 FST's represent soils under arable or permanent crops.
- 221 FST's represent soils under managed grassland.
- 50 FST's represent soils only under non-agricultural uses.

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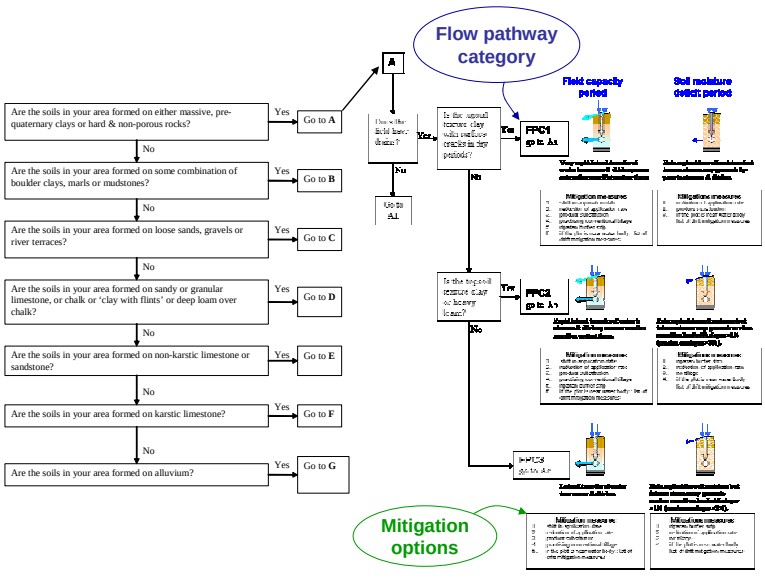
FOOTPRINT agro-environmental scenarios and the FOOT tools

- 13,753 unique combinations of FOOTPRINT climatic zone, FOOTPRINT soil types and crop occurrence have identified.
- When application periods are considered, the number of scenarios is ca. 90,000 scenarios
- Use of the scenarios in the FOOT tools:
  - **Option 1: no data**
    - Use of the spatial distribution of agro-environmental scenarios for areas where detailed data are not available (ArcGIS in FOOT-CRS and -NES, GoogleEarth for FOOT-FS)
  - **Option 2: better data (e.g. soil map)**
    - Relationship drawn between soils on your map and FOOTPRINT soil types through a decision tree based on simple questions

The FST Decision Tree



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FOOTPRINT soil hydrological data

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

Conclusions

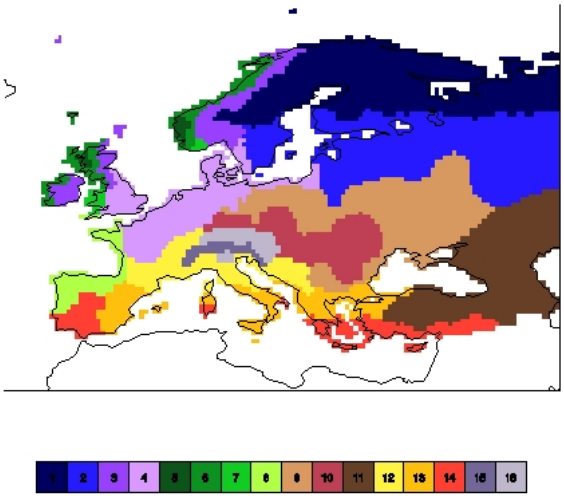
> A large number of unique combinations of FOOTPRINT climatic zone, FOOTPRINT soil types and crop occurrence have been identified.

> The scenarios represent the spatial variation and the heterogeneity of the European landscape

> The scenarios and their supporting information are used to:

- Identify contamination pathways across Europe
- underpin model parameterization.

The 16 FOOTPRINT climatic zones



The 16 FOOTPRINT climatic zones

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FCZs in plain English

Climate Type	FCZ	Description
Northern	1	North European climate, cold and dry.
	2	North European climate, cool and dry.
Temperate	3	Modified temperate maritime climate, cool with moderate precipitation.
	4	Temperate maritime climate, warm with moderate precipitation.
Maritime	5	Very, wet, mountainous maritime climates, with more frequent extremes.
	6	Wet, maritime climates, on exposed western coasts, more frequent extremes.
	7	Modified upland maritime climate, more frequent extremes.
	8	Warmer maritime climate, wetter but fewer wet spring days.
Continental	9	Continental climate, warm and dry.
	10	Continental climate, warm and dry with moderate frequency of extremes.
	11	Continental climate, warm and dry.
Mediterranean	12	North Mediterranean climate, warm and moderate precipitation.
	13	Mediterranean climate with more frequent extreme rainfall.
	14	Mediterranean climate, warmer, lower rainfall with more dry days but higher winter rainfall.
Alpine	15	Alpine climate, cool and wet, relatively more extremes.
	16	Sub-Alpine continental climate, warm, moderate rainfall but low winter rainfall, moderate frequency of extremes.

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Revised CORINE 2000 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

Other work associated with Scenarios

- Identifying FOOTPRINT Soil Types.
  (Module for user-defined inputs in the three FOOT tools)
- Additional data derived for use with SGDBE and FOOTPRINT Soil Types.
  (For use in FOOT_CRS & FOOT-NES)

Acknowledgements

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