



Feasibility of Systematic Forest Soil Monitoring at European Scale



First Results of Biosoil/Soil Survey

R. Hiederer, F. Verheijen, S. Jeffery
European Commission Joint Research Centre
Institute for Environment and Sustainability
TP261
I – 21027 Ispra (VA)
e-mail: roland.hiederer@jrc.ec.europa.eu

Objectives of Evaluation Task

1. Analysis of Data

- Consistency of Biosoil data.
- Spatial variability at country level.
- Temporal variability to previous survey.
- Influence of laboratory methods on observed values.

2. Analysis of Procedures

- QA procedures.
- Sampling and measurement procedures of Manual.
- Relevance.

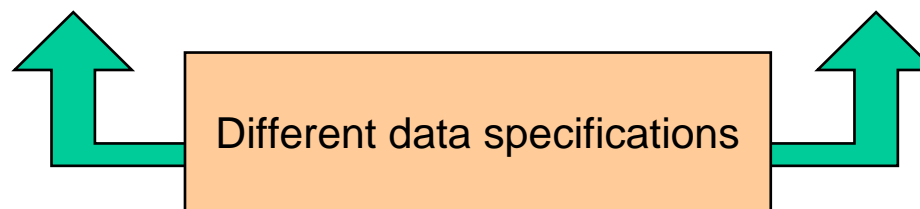
Surveys



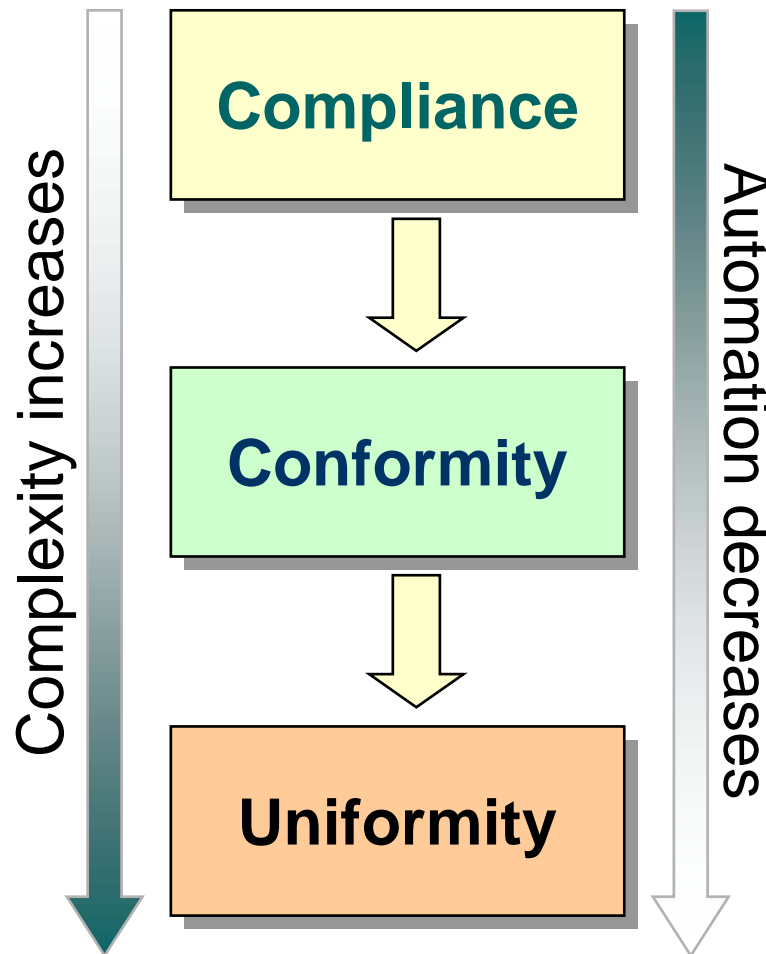
Historic and Current Soil Surveys

Level I/II Parameters and Dictionaries (Manual)

Survey	Forest Focus Monitoring		BioSoil Survey
	Level I/II	Level II	Level I/II
Manual	(EEC) No. 926/93 (EEC) No. 1091/94	Ver. 06/2003 (EC) No. 1737/2006	Ver. 06/2006 Biosoil
Forms	PLS SOM SOO	PLS SOM SOO	PLS SOM SOO PFH PRF
Period	1996 – 2002	2003 - 2006 (incl.)	2006 - ... (ICP Forests)



Validation Procedure



- **Verification of Formal Aspects**

Errors lead to data being rejected, need to be resubmitted.

- **Evaluation of Data Value**

Errors lead to data being re-assessed by NFC.

- **Analysis of Data Comparability**

Warnings on systematic differences lead to message to NFC.

Validation Procedure

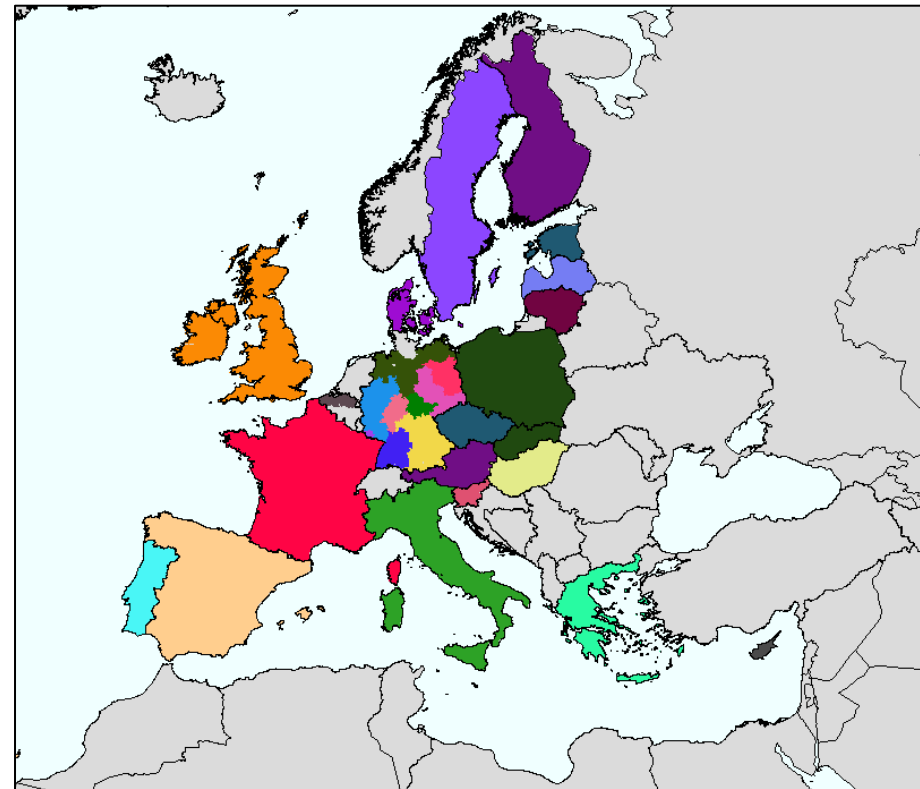
- Compliance and part of Conformity checks are performed on-line when submitting data.
- Part of Conformity and Uniformity checks are performed off-line by manual procedure.
- Data are validated only when they have passed all checks of the procedure.

Separation of Conformity checks into part on-line and part off-line with requests for re-submitting data has confounded validation procedure.

Level 1 Layer Survey

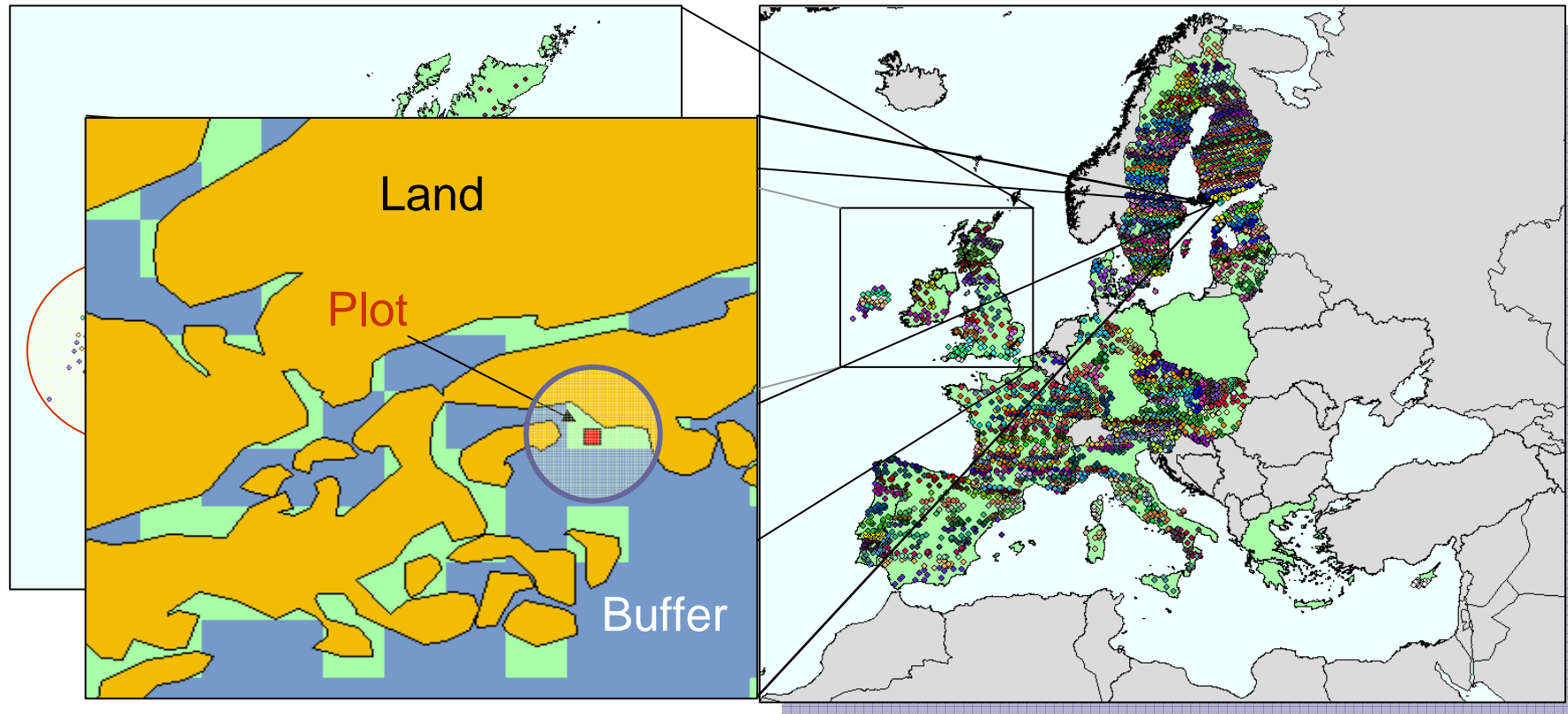
Plot Location

No. of countries:	22
No. of NFCs:	31
No. of Plots:	4,035
with reference	4,024
Plots within NFC area:	
no buffer area	3,544
buffer of 3km	3,557



NFCs of Biosoil/Soil Project

Level 1 Layer Survey Plot Locations



Examples of Coordinate Problems

Biosoil/Soil Level 1 Plots

Soil Organic Carbon

SOC Stock ($t\ ha^{-1}$):

$$SOC_s = SOC_c \times BD \times \left(1 - \frac{CF}{100}\right) \times LD \times 10^2$$

SOC_c : Soil organic carbon content (%)

BD : Dry bulk density ($g\ cm^{-3}$)

CF : Volume of coarse fragments (%)

LD : Depth of layer (m)

Organic Carbon Content

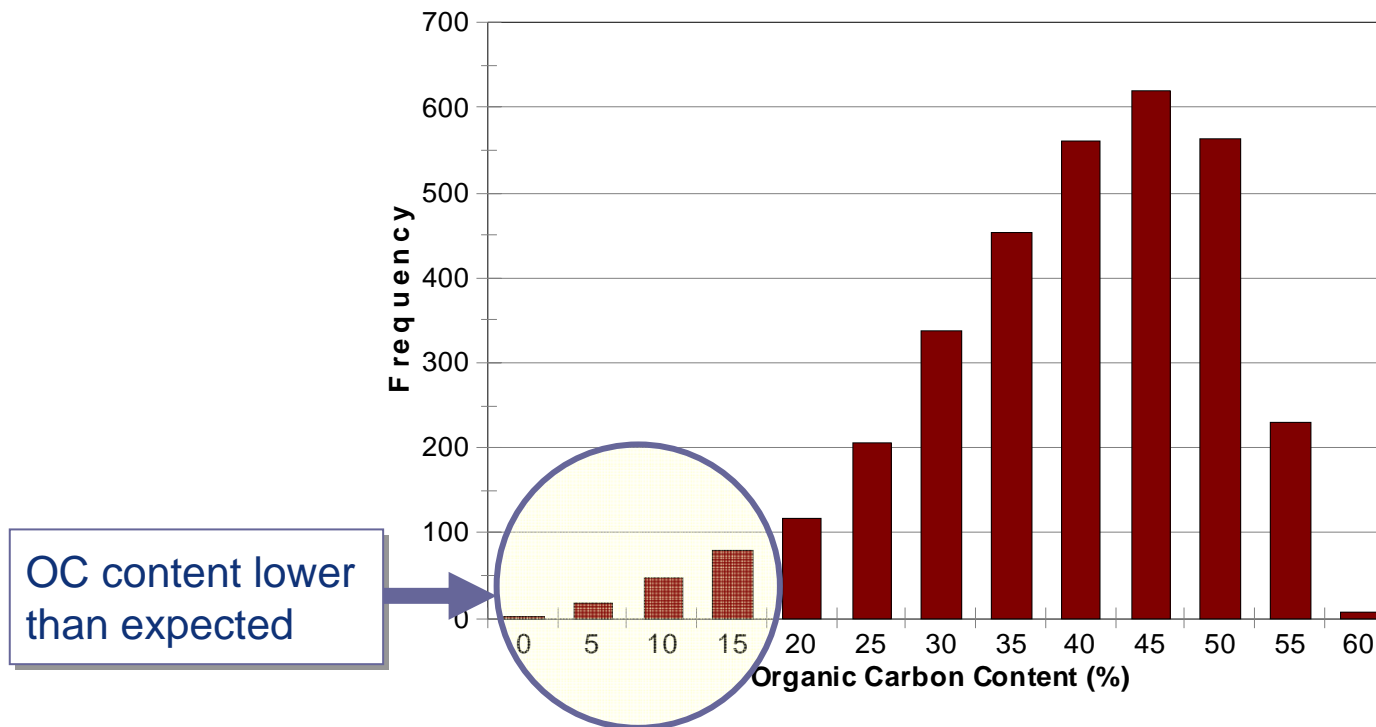
Condition	Occurrence	
	<i>Plots</i>	<i>of Plots (%)</i>
Records	4,027*	
Only organic layer data	73	1.8
No organic layer indicated	884	22.0
Missing data for organic layer	321	8.0
Only soil section data	1,097	27.2
No soil section indicated	181	4.5
Missing data for soil section	327	8.1
No data for 0-10cm soil section	130	3.2
No data for 10-20cm soil section	52	1.3
Data for analysis	2,735**	67.9

* 4,024 Plots with corresponding reference data

** Plot location not considered

Organic Carbon Content in Organic Layer

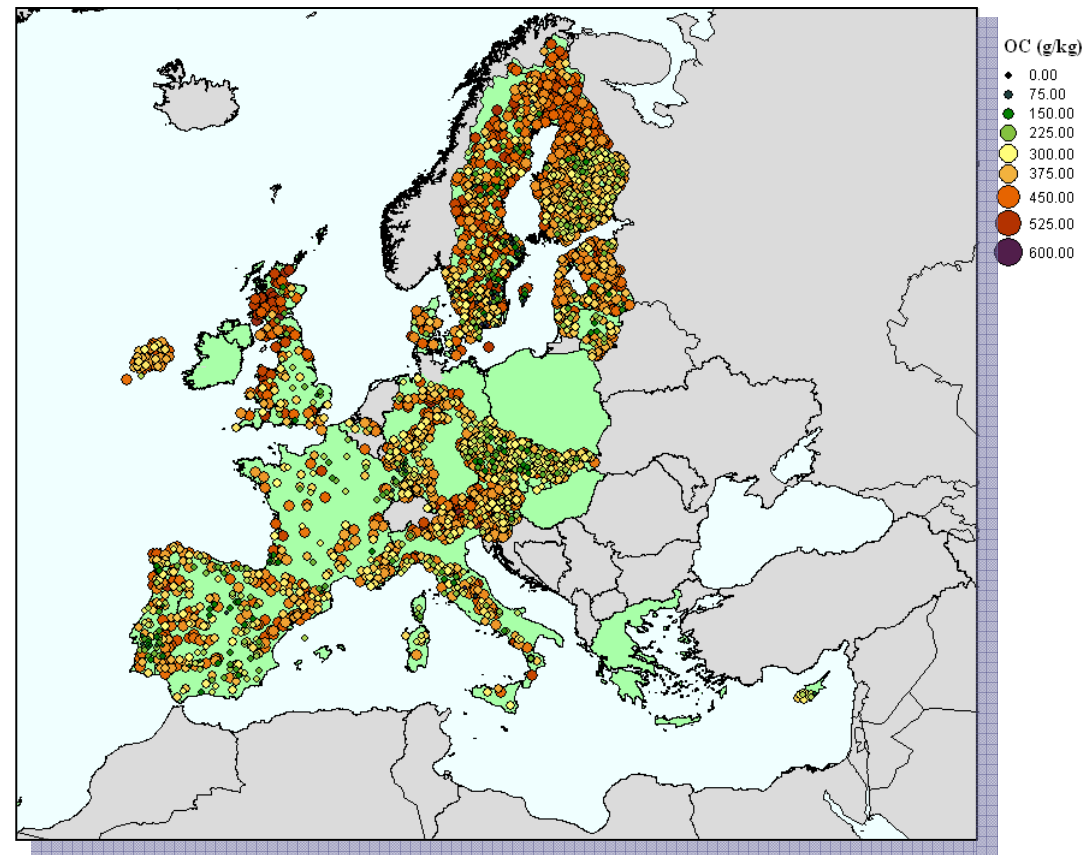
Frequency Distribution



Distribution of Organic Carbon Content in Organic Layer

Organic Carbon Content in Organic Layer

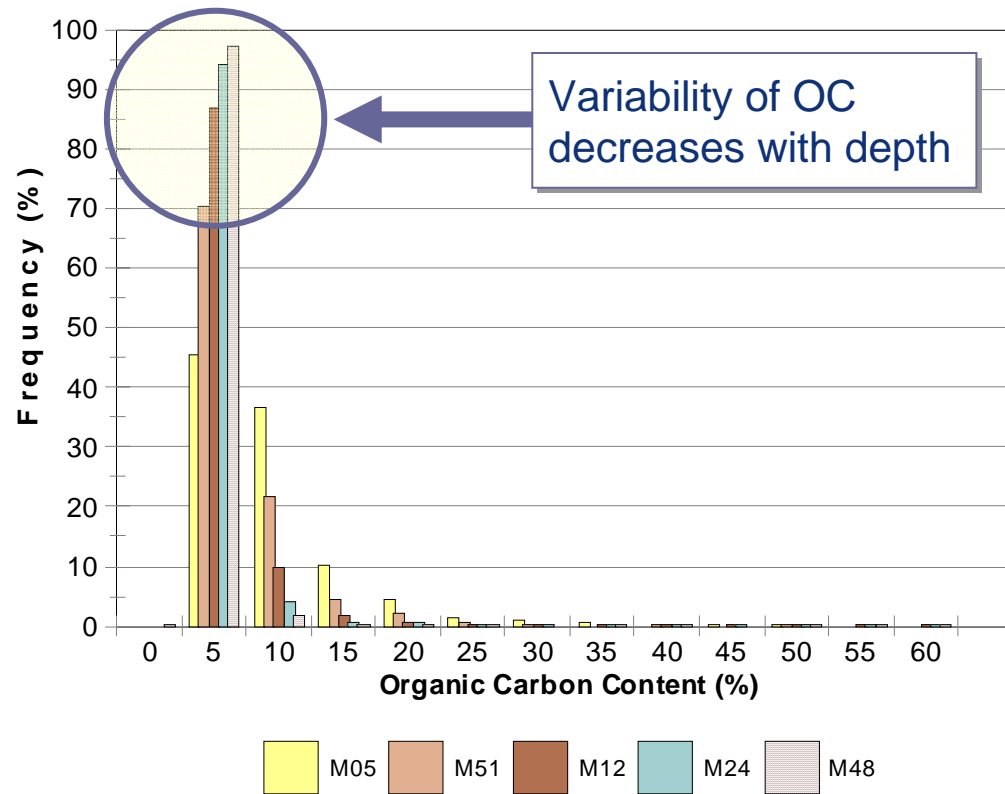
Plot Data



Organic Carbon Content in Organic Layer (g kg^{-1})

Organic Carbon Content in Soil Stratum

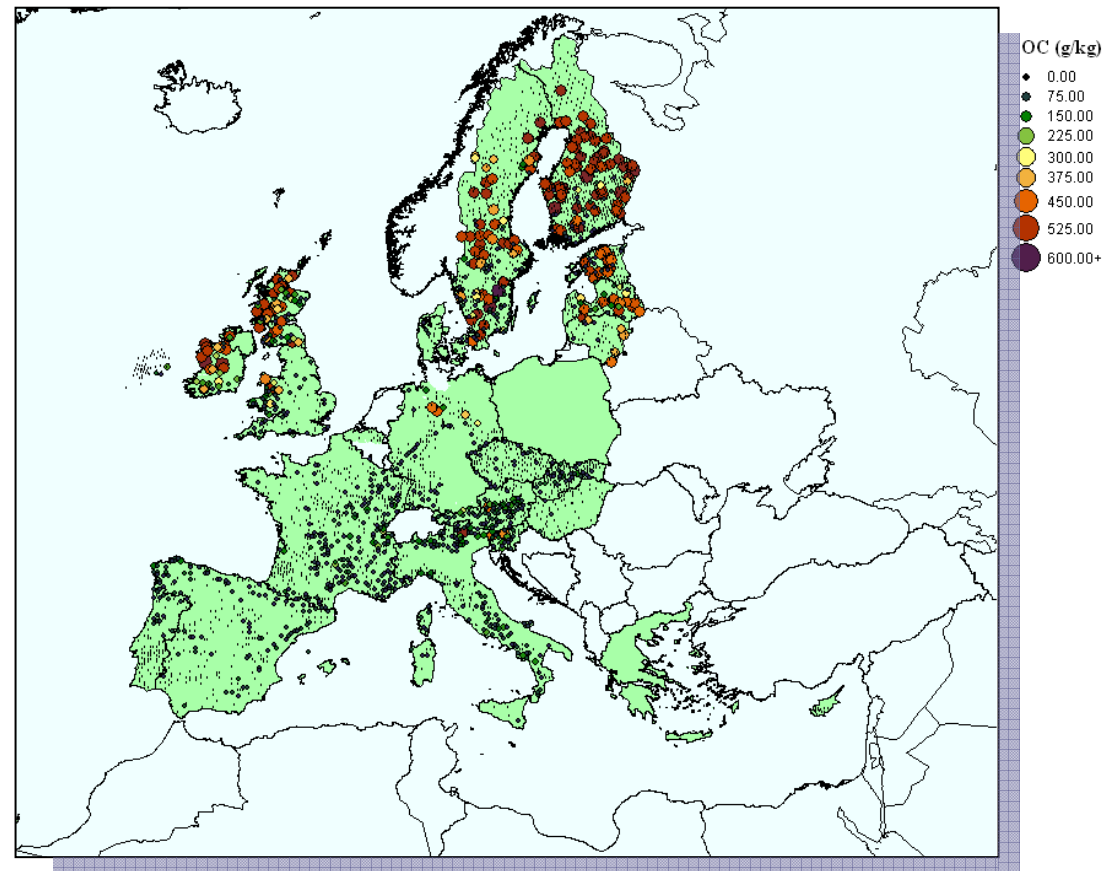
Frequency Distribution



Distribution of Organic Carbon Content in Soil Stratum

Organic Carbon Content in Soil Stratum

Plot Data



Organic Carbon Content in Soil Stratum (g kg^{-1})

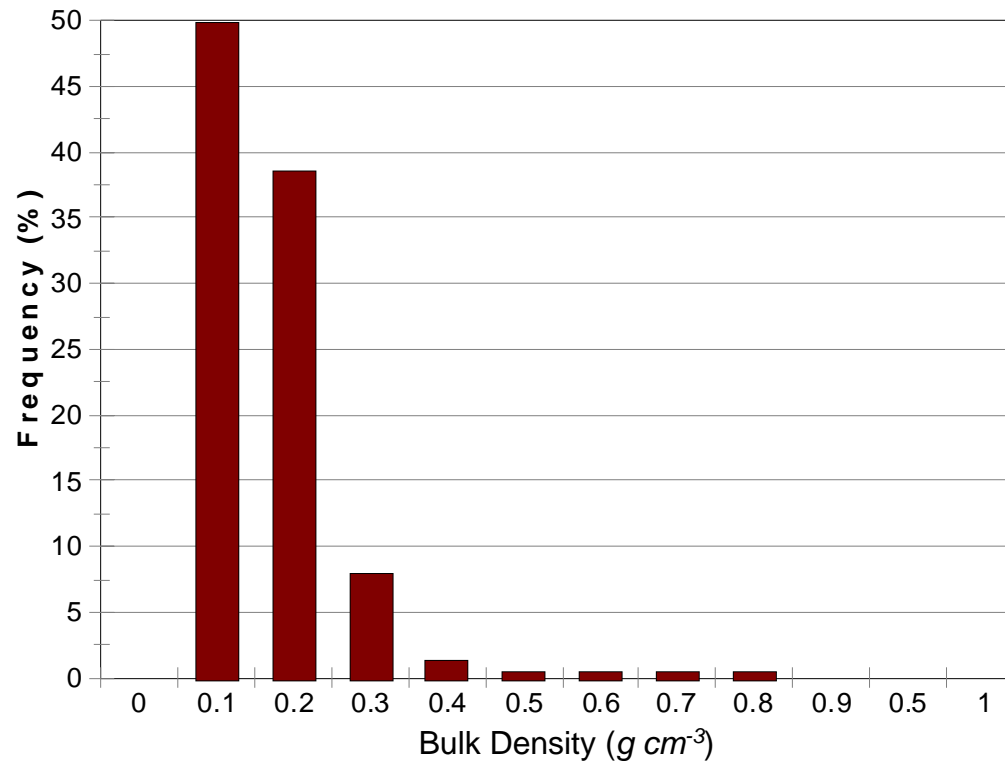
Bulk Density

Method	Code	Comment (shortened)
	Specifications	
Measured	sa04a1	Core method (cylinders)
	sa04b1	Excavation method
Estimated	sa04a3	Core method (cylinders)
	sa04b3	Excavation method
	sa04c3	Adams (1973) PTF
	Reported	
	sa04a3	not applicable
	sa04a3	not available
	sa04a3	not done
	sa04a3	not measured
	sa04a3	not necessary

Content of Database for Method Used to Determine Bulk Density

Bulk Density in Organic Layer

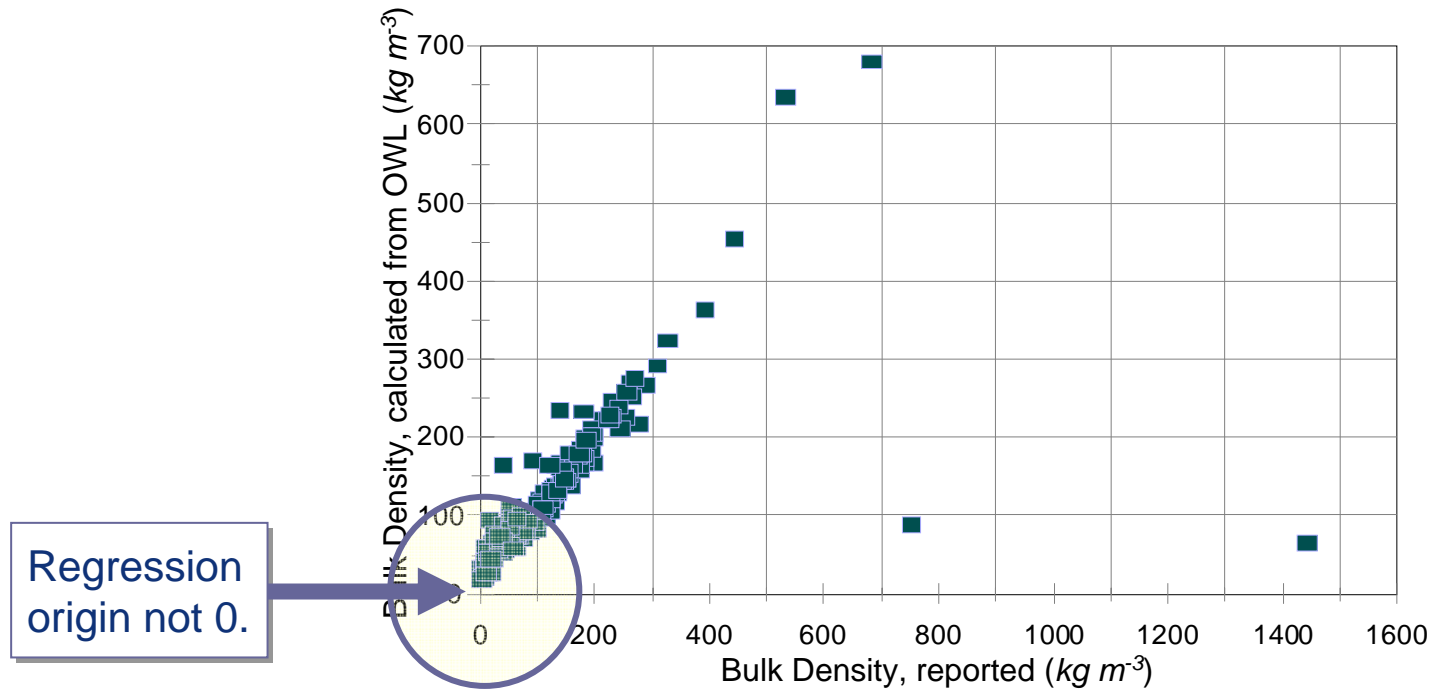
Frequency Distribution



Distribution of Bulk Density in Organic Layer

Bulk Density from Organic Layer Weight

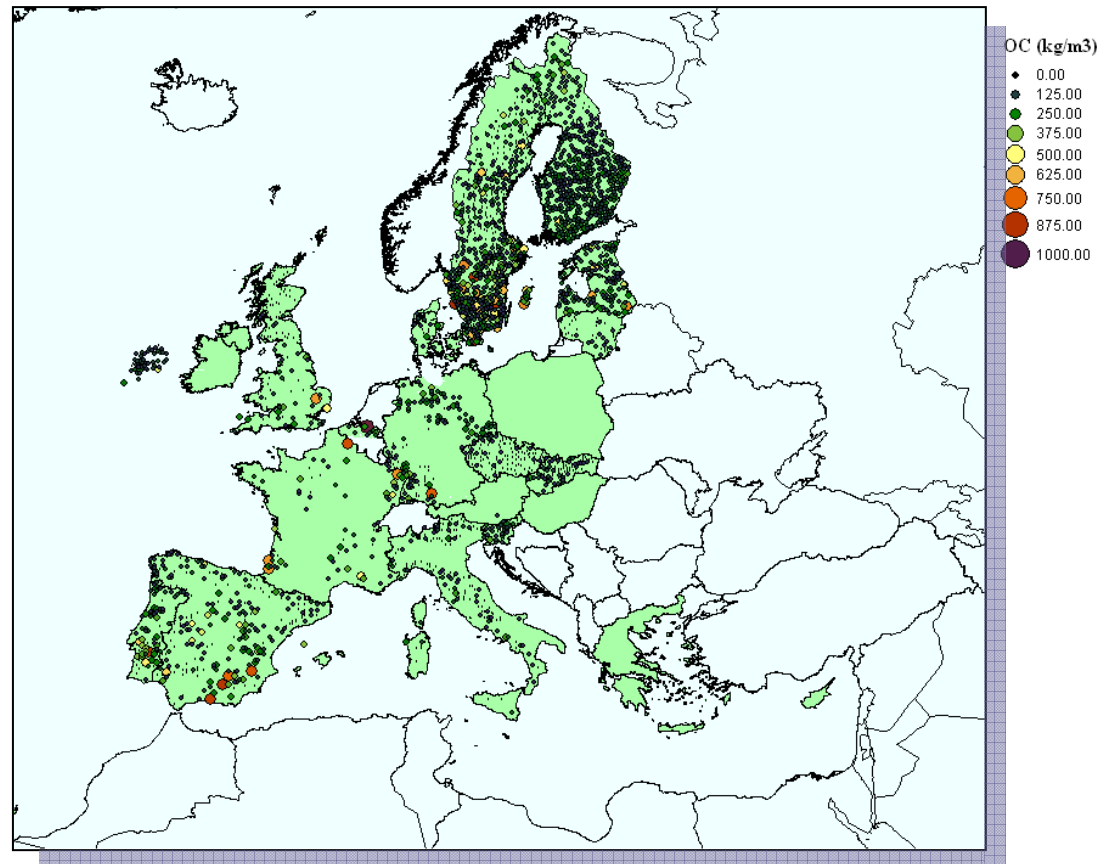
Correlation



Relationship between Reported Bulk Density and Values Derived from OLW

Bulk Density from Organic Layer Weight

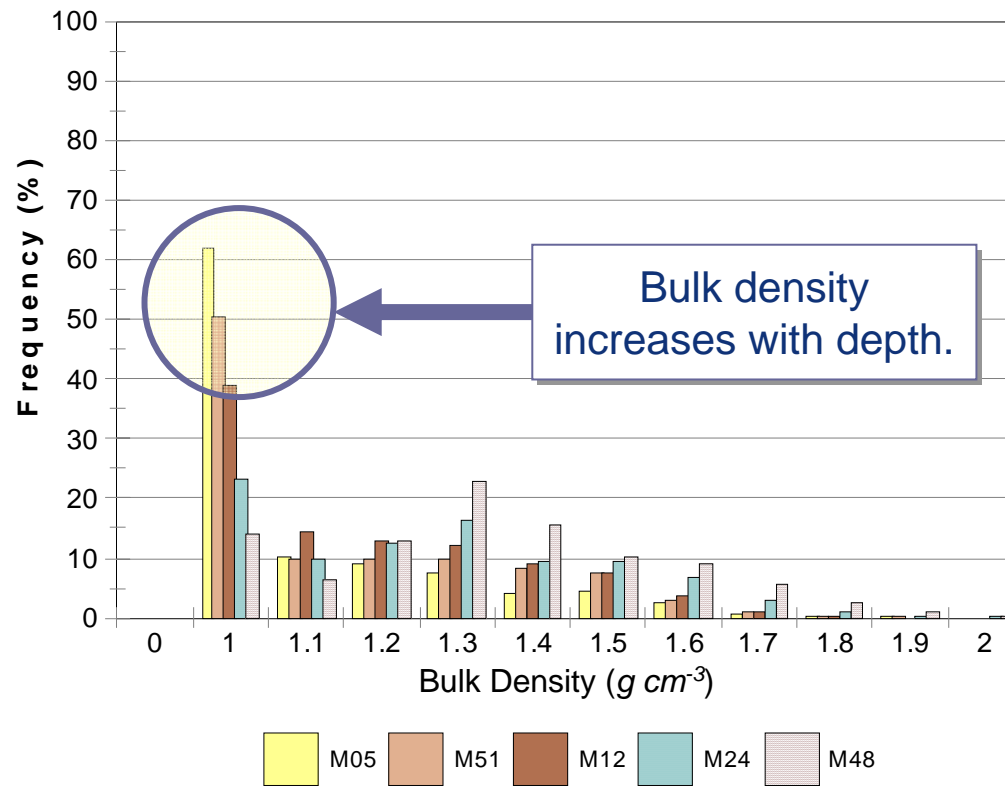
Plot Data



Bulk Density of Organic Layer ($kg\ m^{-3}$)

Bulk Density in Soil

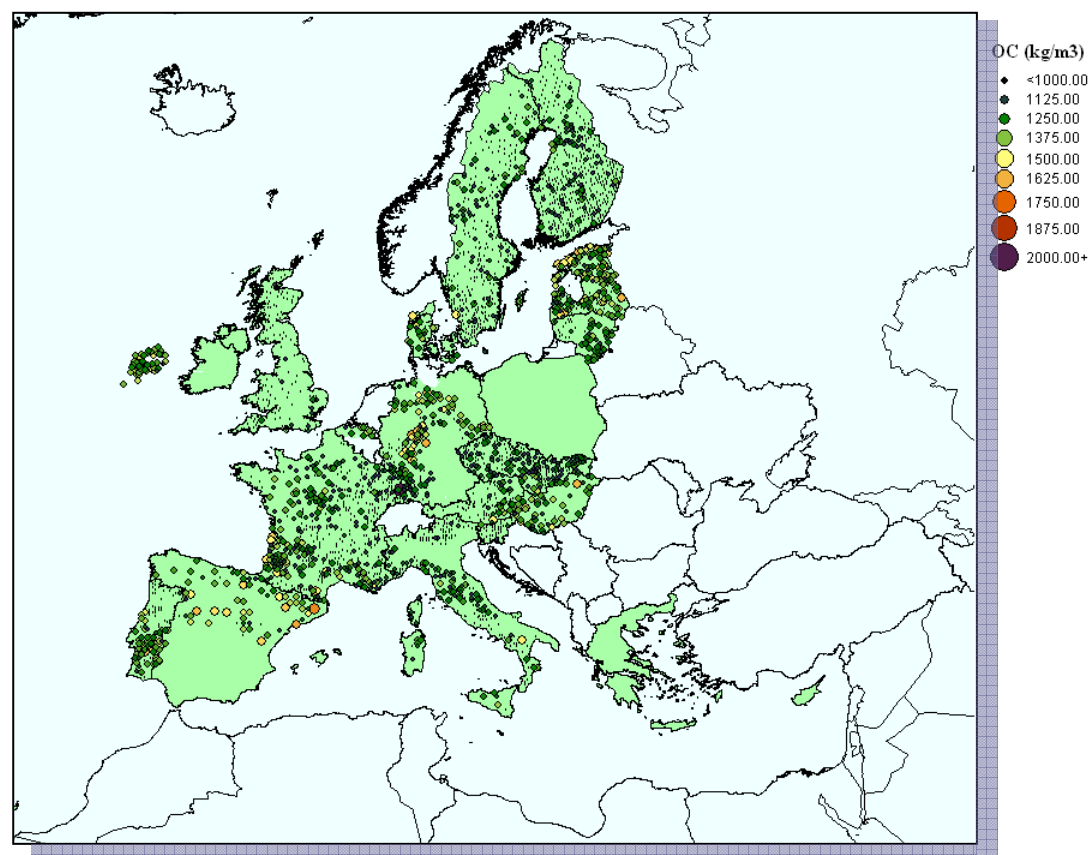
Frequency Distribution



Distribution of Bulk Density in Soil Stratum

Bulk Density in Soil

Plot Data



Bulk Density of Soil Stratum ($kg\ m^{-3}$)

Coarse Fragments

1. Mass of Coarse Fragments

- Organic layers: 147 entries, zero are 144.
- Soil stratum: 6,037 entries, zero are 1,198.

2. Volume of Coarse Fragments

- Organic layers: 165 entries, zero are 96.
- Soil stratum: 9,330 entries, zero are 818.

Inconsistencies between mass and volume of *cf* for soil:

- Mass = 0 AND volume > 0: 121 sections
- Mass > 0 AND volume = 0: 15 sections

Layer Depth

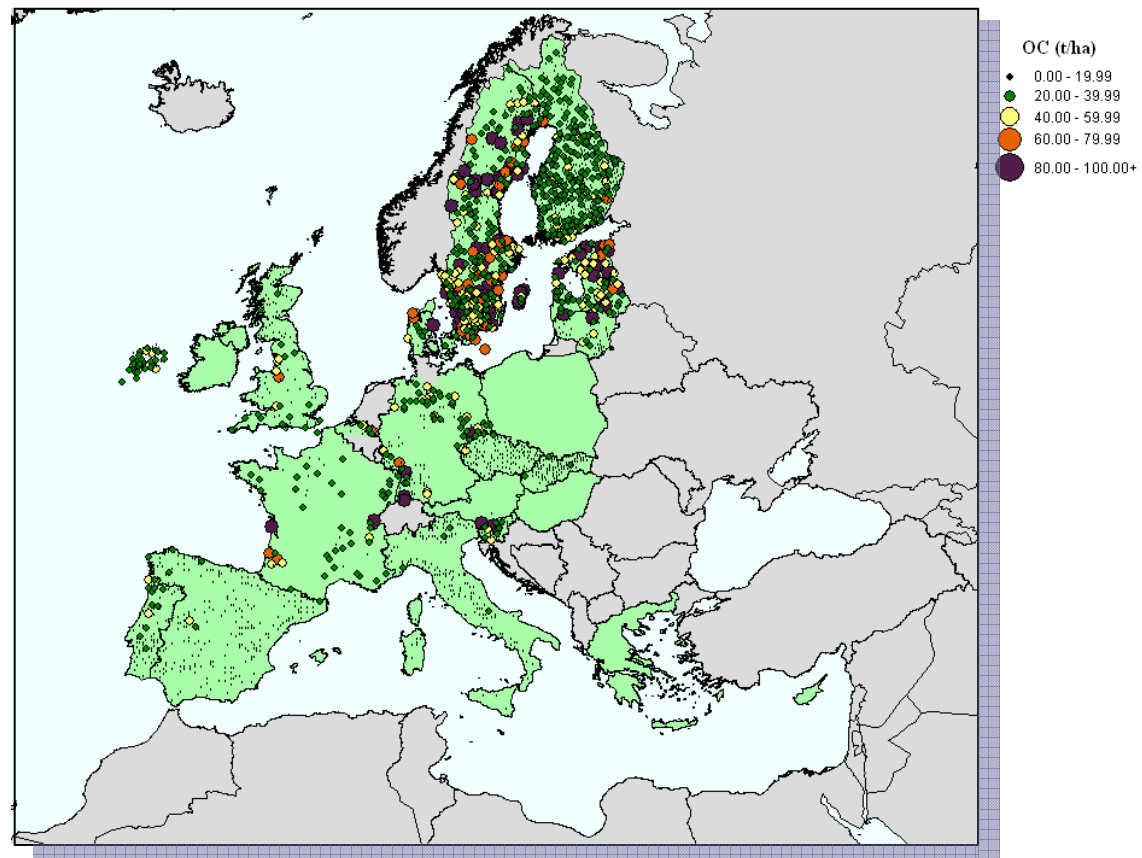


Arrangement of Layers

OC - Spatial Variation in Organic Layer

Organic Layer

- Comparatively high quantities of OC in Sweden and Estonia.
- Relatively homogeneous distribution of OC in organic layer in Finland.

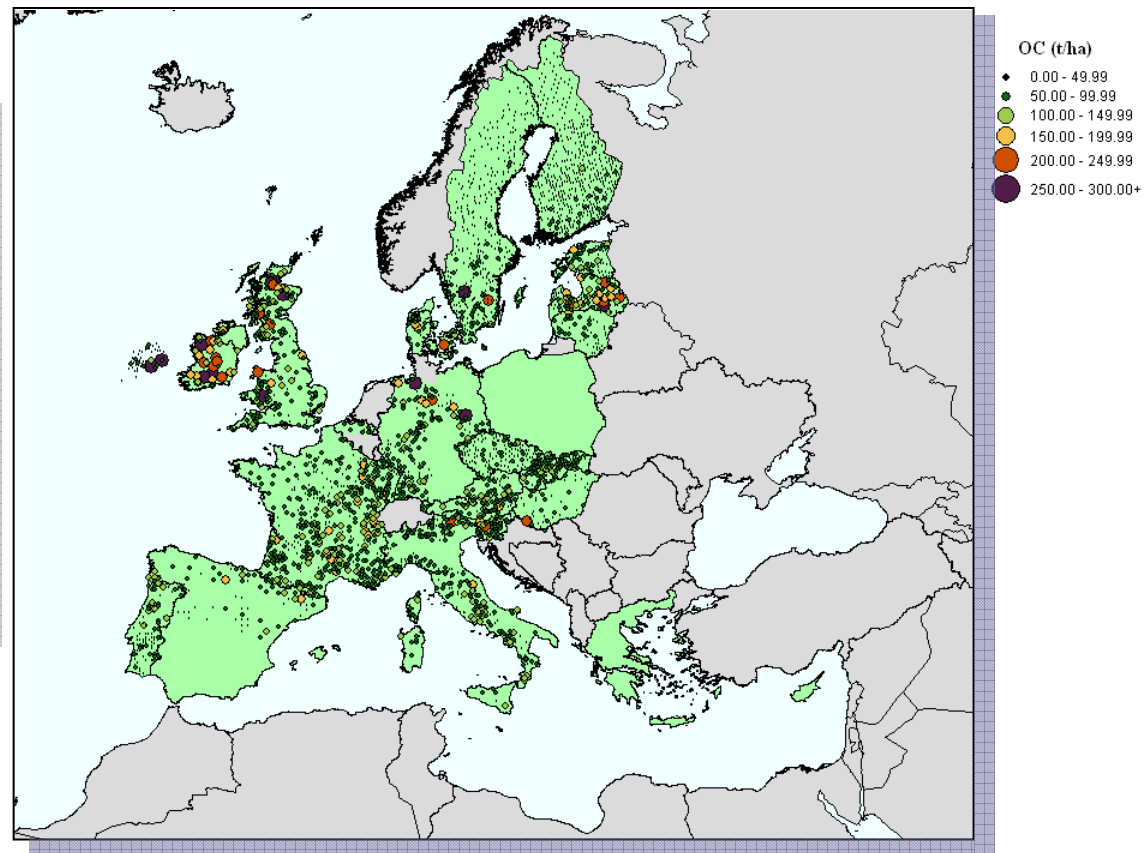


Organic Carbon in Organic Layer ($t\ ha^{-1}$)

OC - Spatial Variation in Soil

Soil Stratum

- High quantities of OC in soil stratum in Ireland, Wales, Scotland and Latvia.
- Low variability and quantity in Sweden and Finland.



Organic Carbon in Soil Stratum ($t\ ha^{-1}$)

Preliminary Results: Data

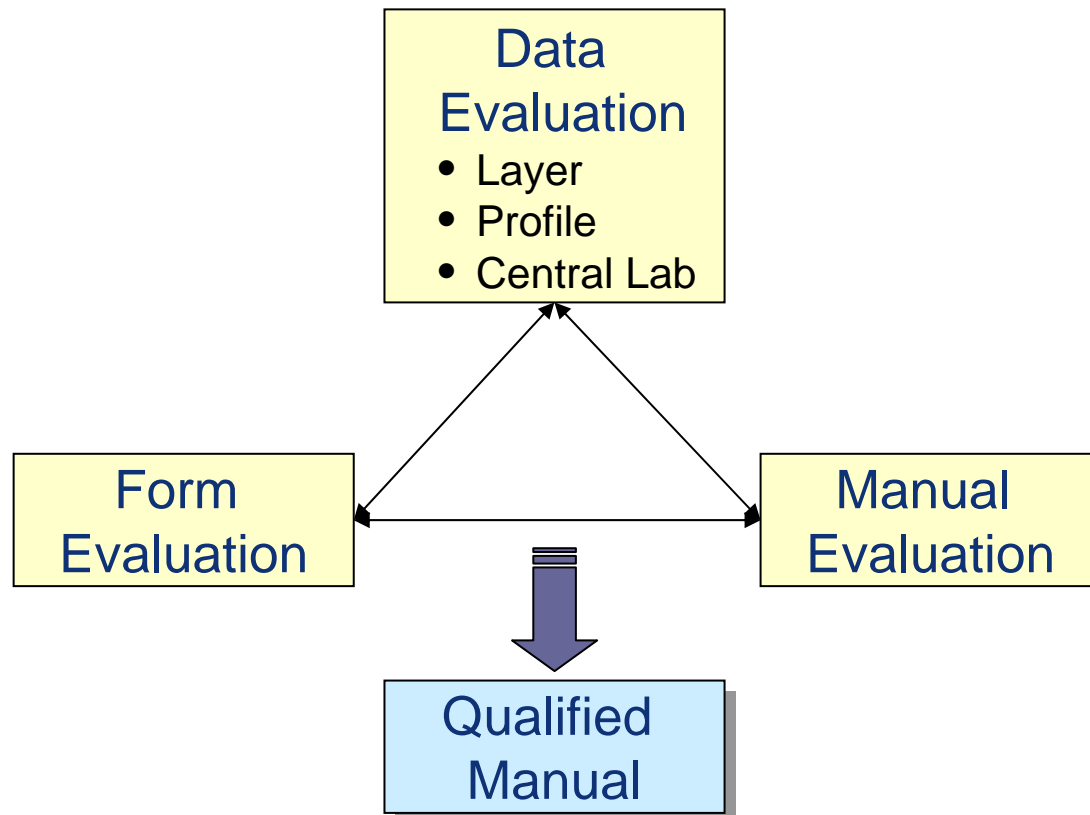
- Substantial quantity of data collected across Europe with temporal equivalence.
- Soil profiles are described using two different procedures.
- Soil organic carbon density computed for 2/3 of plots.
- Different approaches used by NFCs when separating organic layer from soil stratum.
- Completeness of data variable between parameters.
- Treatment of missing data not specified (use of zero).

Preliminary Results: Biosoil Manual

Recommendations

Review of Manual as part of overall evaluation cycle:

- duplication of parameters;
- ambiguous definition of soil horizon;
- inconsistencies in monitoring needs (optional vs. mandatory).



Manual Up-date Depends on Project Evaluation

Conclusions

- Feasibility of sampling soil properties at European scale using common methods has been demonstrated.
- Parameters provide detailed characterization of topsoil.
- Data has potential for large-scale comparative analysis.

- Focus sampling procedure, remove data duplication.
- Adjust specifications for sampling, reporting and storing data.
- Improve transparency and consistency of validation procedure.