Progress Report

Trace Element and Organic Matter Contents of European Soils

First results of the second phase
of the
"Short Term Action"

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1 Introduction

Against the background of the imminent revision of the Sewage Sludge Directive 86/278/EEC, the Joint Research Centre, Unit Soil and Waste, in collaboration with DG Environment, Unit Sustainable Resources: Consumption and Waste, commissioned a feasibility study on trace element and organic matter contents of European soils. In that context, the working group formed from the 15 EU countries and initiated by the European Soil Bureau (ESB) proposed a working program at different time scales to provide meta-information on available data and evaluation approaches for compiling background values of heavy metal and organic matter contents.

Within a first time-step ("Short Term Action"), co-ordinated by the JRC, data actually available in several databases should be evaluated and harmonized to a first, but nonetheless acceptable, approximation of trace element and organic matter contents of soils within the EU 15. A follow-up investigation program ("Long Term Action") should aim to reduce obvious data gaps and to improve our understanding of the inevitable disparities within the data, and further standardize future data collection, both in terms of sampling, analysis and data management.

Faced with the given time-frame the working group, in collaboration with the JRC, carried out the "Short Term Action" in two phases. In the preliminary evaluations only Denmark, France, Germany and England/Wales could be considered. These Member States were able to provide country-wide and, to a certain extent, harmonized data about trace elements and/or cover significant parts of the EU15.

The results (May 2000) clearly reveal that, for the four selected Member States, country-specific evaluations related to different stratification, such as soil texture classes, soil pH classes, land use and soil parent material are possible to a certain extent. However, key aspects identified in order to harmonize data for the purpose of compiling background values on a Europe-wide scale, e.g. measurement procedures for pH-values, digestion procedures for trace element contents, and criteria to compare different sampling strategies, have not been harmonized beyond the level stated. Therefore, the evaluation must be considered as a very preliminary step towards a Europe-wide harmonized data base. Yet, no further information, however, is available for the four selected Member States since the report in May 2000.

In the second phase, based on the experience of the evaluation for the four Member States, a "Europe-wide evaluation of existing databases for trace element (heavy metals) and organic matter contents in soils" started in July 2000 for all 15 Member

States. The country-specific evaluations should follow minimum requirements concerning data harmonization and be related to spatial references which are available and harmonized throughout Europe, such as the European Soil Data Base. The requested information encompassed a so called “Documentation Sheet”, which aimed to document the sampling and analytical procedures, the evaluation approaches and the geographical locations of all sites taken into account.
The documentation sheet was sent out by the JRC Ispra to all 15 Member States asking for existing and elaboratet data for heavy metals and organic matter content of European Soils.

The contract No. 17163-2000-12 F1ED ISP DE was signed by December 28th 2000, between the Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) and the JRC Ispra. The objective was to carry out the evaluation of the Europe-wide existing databases for trace elements and organic matter, which were made available by the JRC Ispra through the above mentioned data request.

A first interim report has been prepared by BGR and sent to the Joint Research Centre in May 2001. The report gave a first overview on the obtained answers to the data request. Meanwhile, an attempt has been made to prepare an exemplary spatial overview of existing trace element data in European agricultural soils.

The present progress report aims at informing about results obtained so far and the lesson learned during the process.

2 Objectives of the study "Trace elements and organic matter contents of European soils"

The general objectives of the study are:

I to make available the best information on heavy metal and organic matter contents in European agricultural soils, and

II to evaluate and provide an overview of heavy metal and organic matter contents in European agricultural soils, and

III to establish a basis for discussion how to evaluate data on heavy metals in agricultural soils (especially against the background of the revision of the European sewage sludge directive).

With respect to pt. III, the evaluation of trace element contents in soils should be related to different bases of reference, such as soil pH, soil texture, land use and soil parent material. The following classes of reference levels should be taken into consideration:

Soil pH ($CaCl_2$):	pH below 4, 4 < pH < 5, 5 < pH < 6, 6 < pH <7, pH higher 7
Soil texture:	*sand, silt/loam, clay* (indication of the nomenclature)
Land use:	arable land, grassland, forest, others (urban etc.)
Soil Parent Material:	Soil Map Units (SMU) of a map of Soil Parent Material.

If available, the results of statistical evaluations should be expressed as quartiles (25, 50, 75), as the 90th percentile, and as minimum and maximum values.

3 Current status of the Europe-wide evaluation

Until June 2001 the BGR has received from the JRC Ispra country-specific evaluations from Austria, Belgium (Flanders only), Finland, the Irish Republic, Italy, Spain, Sweden and Scotland. Additional data was made available for the Czech Republic.

Together with the four EU member countries objected for the first part of the short term action (see report *"Results of Preliminary Evaluations for 4 Member States*" European Soil Bureau – Heavy metal working group, 2000), general information is available for 11 Member States added by data of the Czech Republic.

The "Documentation Sheet" distributed by JRC Ispra in June 2000 among all EU15 Member States in order to collect meta-information of available data was answered by Belgium, Finland and the Irish Republic.

The level of detail of information varies widely. In order to produce a preliminary visualisation of available information, the returned data requests could be divided into four groups with respect to the given information on the geographical references:

I data providing geographical reference according to administrative boundaries,
II data providing geographical reference according to soil units,
III data providing geographical reference according to parent material units, and
IV data providing no geographical reference.

A first set of outline maps has been prepared on the basis of the data providing a geographical reference (see points I – III). The procedure, problems and inaccuracies are described in the next section. It should be stressed that so far neither differences in sampling strategies nor in analytical procedures have been taken into consideration. Aspects of data harmonisation with respect to contaminated samples or of spatial representation have not been considered yet.

4 Towards a geographical coverage of information on heavy metal contents in European agricultural soils – A set of outline maps

In order to provide a visual overview of heavy metal contents in European agricultural soils the results of the data request as a part of the short term action - part II have been evaluated.
As a first result a set of outline maps has been generated, showing the distribution of the copper contents in European agricultural soils on the basis of the 50. percentile values (median). The median as well as the element copper was chosen because this combination was the most complete one (see for example statistical parameter in table 4.1).

Tab. 4.1: Results of the data request - given statistical parameters

country	statistical parameter						
	n	min	max	25 p.	50. p	75 p.	90. p
Italy (pH differentiated tables)	✔	✔	✔		✔		
Austria (3 states)	✔	✔	✔	(✔/2)	✔	(✔/2)	(✔/1)
Belgium (Flanders only)	✔	✔	✔	✔	✔	✔	✔
Finland (4 soil units)	✔	✔	✔	✔	✔	(✔/2)	
Germany	✔	✔	✔	✔	✔	✔	✔
Irish Republic	✔	✔	✔	✔	✔	✔	✔
Czech Republic	✔	(✔)	(✔)	(✔)	✔	(✔)	✔

In order to provide a most differentiated visualisation on the one hand and to guarantee a suitable clearness according to the scale on the other hand, the 50. percentile values of copper were classified into 6 classes as indicated in table 4.2:

Tab. 4.2: Classes of copper contents for the spatial visualisation

Class	50. percentile values of Cu [mg/kg]
1	<10
2	10-20
3	20-30
4	30-40
5	40-50
6	>50

The upper limit (>50 mg/kg Cu) was chosen according to the Eikmann & Kloke (1993) soil value II (BW II)[1].

[1] The Eikmann & Kloke concept evaluates a possible soil contamination focusing on the pathway of contamination under consideration of orientation values directed to land use and the “site and protection group specific land use options”. As far as Cu is concerned, a threshold value of 50 mg/kg can be tolerated for agricultural crops, fruits and vegetables.

4.1 Spatial information according to administrative boundaries

For two countries - Austria and Italy - a spatial reference is given for some administrative units. These two countries are shown in part I of the first set of outline maps – heavy metal contents referred to administrative boundaries (see figure 4.1). For this purpose it was made use of the NUTS[2] – units provided through the GISCo[3] database.

Austria

Austria is subdivided into 9 federal states (Bundesländer). In response to the data request extracts of a study report has been provided, which are related to the Soil Inventories of the Austrian federal states (Bodenzustandsinventuren der Länder).
The extracts of the study report reveal that in Austria about 5977 sampling sites do exist, most of them related to agricultural land use or forests. The sampling sites are related to a regularly grid of 3.9 km^2. Indications of the analytical procedures are missing.

Tables have been provided indicating

- heavy metal contents of all analysed samples (general information for 4 federal states)
- heavy metal contents of all analysed top soil samples (general information for 5 federal states)
- heavy metal contents of all analysed top soil samples of arable land (general information for 3 federal states).

The produced maps refer to top soil samples of arable land (3 federal states). The statistical parameter vary from state to state, median values are given for all three federal states (cf. Table 4.1).

Italy

Italy is subdivided into 20 regions (Regione) which themselves are subdivided into provinces, for a total of 103 provinces. In response to the data request a partly incomplete data set (only arable land) of provinces of mainly northern Italy was provided. The report was written in Italian, therefore, only little information could be gathered. Amongst others, the analytical procedure is described as “hot acid digestion” (presumably aqua regia) and determination with AAS or ICP.
Beside the “number of samples (n)”, minimum, maximum and mean values, all data related to agricultural soils are given as median (= 50. percentile) values.

[2] Nomenclature des unités territoriales statistiques
[3] Geographic Information System of the Commission

General data on heavy metal contents of arable soils was provided for the elements Cd in 24 provinces, Cr in 21 provinces, **Cu** in **38 provinces**, Hg in 15 provinces, Ni in 32 provinces, Pb in 37 provinces, Zn in 36 provinces and As in 6 provinces.
The first part of the set of outline maps is presented in figure 4.1.

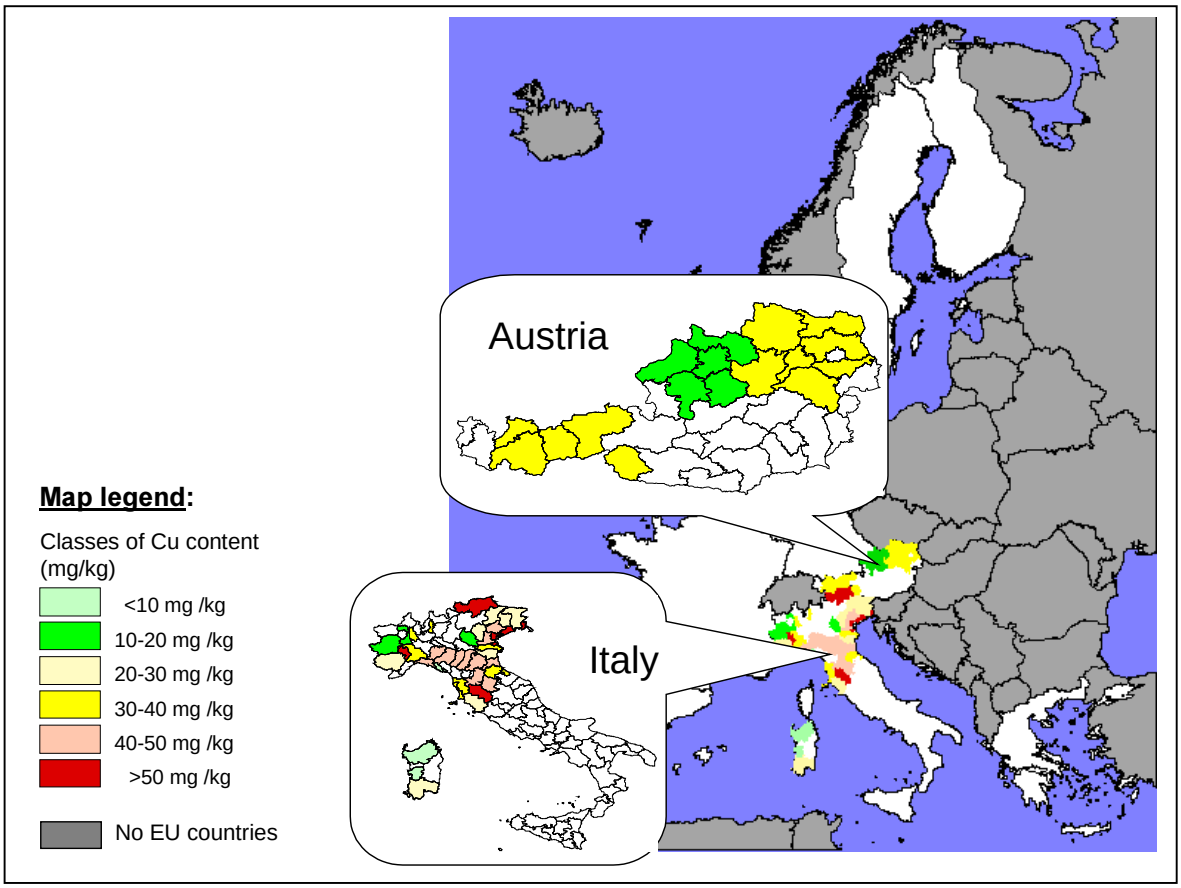

Fig. 4.1 Current status of data on heavy metal contents in agricultural soils – part I: heavy metal contents referred to administrative boundaries (exemplary visualisation of Cu (mg/kg), 50. percentile value (median))

4.2 Spatial information according to soils

The EU Member States Belgium (Flanders), Finland and the Irish Republic answered the data request most consequently. Beside providing meta - information by completing the documentation sheet, heavy metal values were related to soil mapping units of the soil data base (Belgium and the Irish Republic) or other soil units (Finland).

For these three countries the heavy metal contents are referred to the “soil” unit of the European Soil Data Base. The result is shown as part II of set of the outline maps in figure 4.2.

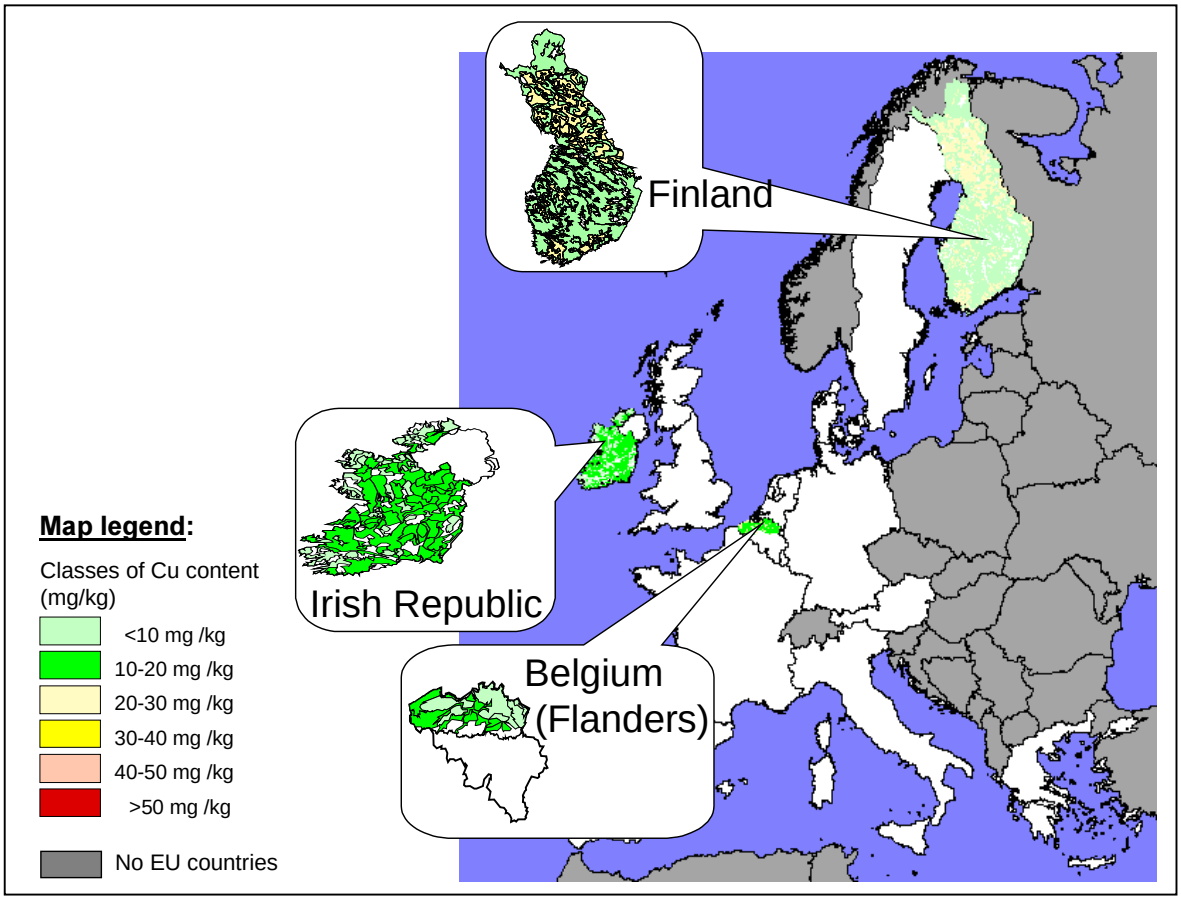

Fig. 4.2 Current status of data on heavy metal contents in agricultural soils – part II: heavy metal contents referred to soil units of the European Soil Data Base (exemplary visualisation of Cu (mg/kg), 50. percentile value (median))

Belgium

The evaluation of the Belgian data refers to the districts of Antwerp, East-Flanders and West-Flanders and is based on a regularly grid sampling strategy by 3.8 km^2. Each sampling location was geo-referenced and the samples were taken as mixed soil cores from the topsoil (0-20 cm). For all sampling locations the soil characteristics and land use classes were recorded.

The heavy metals were extracted with aqua regia and measured with AAS.

Finland

The Geological Survey in Finland provided data of two different programs – the Baltic Soil Survey (BSS) and FOREGS. For the first set of maps the data was taken from the Baltic Soil Survey with 1 profile per 2500 km^2. The Baltic Soil Survey is related to arable land. Abundance of heavy metals were determined by ICP-AES and GAAS methods after aqua regia extraction.

Statistical parameter were given in various quantity, depending from the number of samples, the median was given for all soil units (cf. table 4.1).

The Irish Republic

The Irish data are based on two sets of data. One set is working on soil organic carbon in cultivated soils including the whole country. The other set is restricted to Southeast of the Irish Republic using microwave digestion and AAS for the estimation of heavy metal contents in soils under different land use (McGrath 1998).

Both surveys are based on a regular grid sampling strategy of 10 km^2.

4.3 Spatial information according to the soil parent material

Part III of the set of outline maps shows Germany and the Czech Republic in figure 4.3. For these two countries heavy metal contents were referred to the soil parent material.

Germany

For Germany heavy metal values derived from the BGR by order of a Joint Federal States Working Group for Soil Protection (LABO AK 4) were referred to the “Mat” units at the second level of the European Soil Data Base (“Mat12”).

With respect to the analytical results, different methods are commonly used in Germany, namely i) x-ray-fluorescence or hydrofluoric acid digestion - resulting in a so called “real total content” and ii) aqua regia as a weaker acid extractant. In order to be able to compare both element fractions, comprehensive analytical investigations have been carried out. As a result, a set of regression functions has been derived for transforming element contents between the two fractions with a given statistical certainty (Utermann et al. 1999; 2000). All data used for the Europe-wide visualisation were transformed to the aqua regia extractable fraction.

Czech Republic

General data was provided for two national databases (Sáňka, M. & Němec, P. 2001). Data of the “Register of contaminated sites” are shown exemplary for Cd only. This data set allows an evaluation according to geological substrate and (to a certain

extend) to soil texture. The data for Cd are listed with all required statistical parameter. For generating the outline map, a second database was used – the basal soil monitoring scheme. Only some statistical parameter are given but the paper contains data of all required elements. Amongst other evaluations one table was referenced to the geological substrate. This geological substrate was referred to the "Mat" units at the first level of the European Soil Data Base ("Mat11").

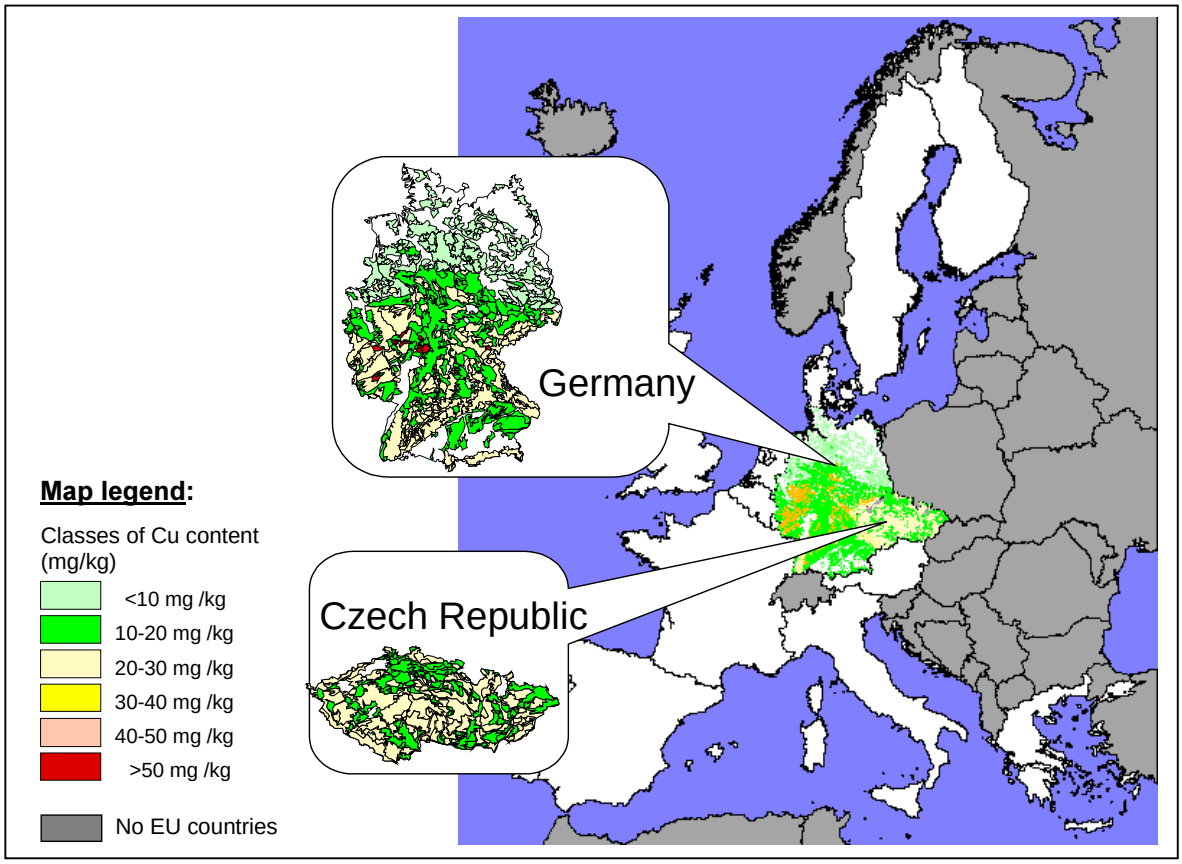

Fig. 4.3: Current status of data on heavy metal contents in agricultural soils – part III: heavy metal contents referred to parent material (Mat units of the European Soil Data Base (exemplary visualisation of Cu (mg/kg), 50. percentile value (median))

4.4 Datasets with currently no geographical reference

Spain

Spain sent a list of publications and site descriptions of sampling locations in Spanish. No further evaluation was carried out. Some of the sampling location seem to be geo-referenced. However, the data set is restricted to selective sampling regions. Based on the information it seems feasible to stratify the data according to land use and soil classification and provide statistical evaluations.

Sweden

The Swedish data set is restricted to a limited number of samples of arable top soils (n=25), and therefore represent mean concentrations for Swedish arable soilsto a very limited extend only. Elemental analysis was done by melting the sample with $LiBO_2$ in a 1:3 w/w ratio which was than dissolved in 5% HNO_3 (modified method according to ASTM D3682), by extracting with aqua regia and 7M HNO_3. Heavy metals contents were determined with ICP-AES, -QMS and AFS.

Scotland

The evaluation of the Scottish data refers to the grid based sampling strategy of the UK Soil Inventory. The soils were described on a 5 km^2 grid and analyzed on a 10 km^2 grid for chemical and physical parameters (n= 720). Heavy metals (Zn, Ni, Co, Pb, Cd) were extracted with aqua regia and soil pH was measured in H_2O and $CaCl_2$. Arable soils with pH-values >5 were evaluated according to UK regulatory limits. More detailed information should be available in the context of the UK Soil Inventory.

England/Wales

In the context of the first phase of the short term action (evaluation for 4 Member States) the data for UK referred exclusively to England and Wales. The data set is based on a grid sampling strategy, with a regularly grid of 5 km^2. Each sampling point was geo-referenced and the samples were taken as mixed soil cores.

The heavy metal contents of the top-soils were determined by digestion with aqua regia. Within the time available, no additional evaluation related to any geo-reference basis could be made.

Denmark

Information on available data of Denmark results also of the first phase of the short term action (evaluation for 4 Member States). The heavy metal contents of the top-soils were determined by digestion with 50% HNO_3. The Danish data set is based on a grid sampling strategy with two different grid sizes, a 7 km^2 grid and a 22 km^2 grid.
For any spatial visualisation a further evaluation with regard to the geo-references is needed.

France

In the feasibility study, France held out the prospect of a country-wide analysis of trace element contents in top-soils by using two different databases. For the preliminary analysis (short term action - evaluation for 4 Member States), only data from one database was used.
For any spatial visualisation a further evaluation with regard to the geo-references is needed.

4.5 Summary maps

The last map, part IV, shown in figure 4.4 contains all parts (I – III) and gives an impression about the current status of the geographical coverage of Cu contents (median values) in agricultural top soils.

Table 4.3 summarises the country specific information currently available.

Tab. 4.3: Current status of geographical coverage of the copper contents (median values) in agricultural used topsoils

Country	Spatial reference	Spatial coverage [%] (Cu, median)
Austria (3 states)	Administrative (NUTS)	52
Belgium (Flanders)	SMU units (soil - first level)	36
Czech Republic	SMU - MAT units (first level)	98
Finland	Soil units	90
Germany	SMU - MAT units (second level)	71
Irish Republic	SMU units (soil - first level)	83
Italy (38 provinces)	Administrative (NUTS)	38
Europe (15)		**25**

This table shows, that for 7 out of the 11 countries providing general information on the statistics of heavy metals in top soils some kind of spatial evaluation is possible.

A spatial visualisation of the 50. percentile value of Cu is possible at a degree of 25 % currently (regarding the EU 15 Member States only). In this context it is important to stress, that all outline maps were generated under the above drafted restrictions (e.g. missing check on pedoregional representation, elimination of contaminated samples, different analyses methods, etc.).

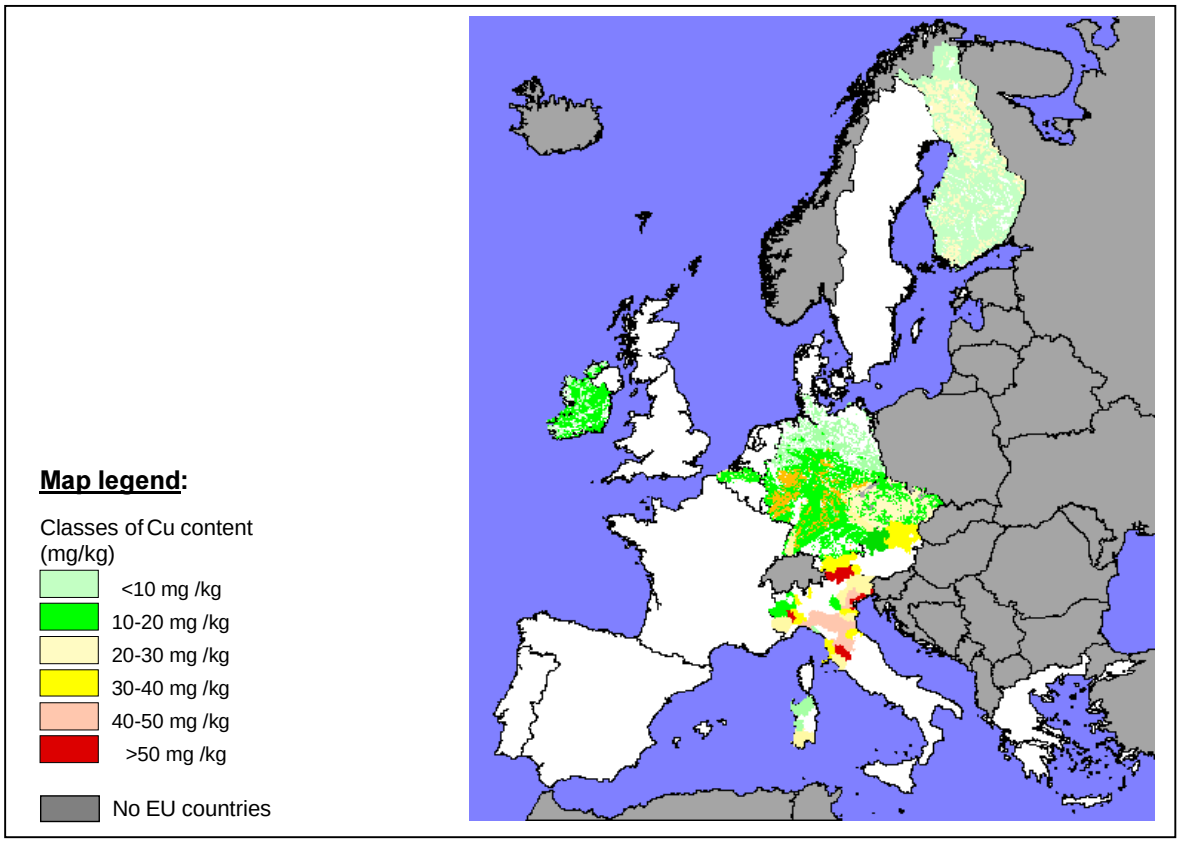

Fig. 4.4 Current status of data on heavy metal contents in agricultural soils – part IV: all data (exemplary visualisation of Cu (mg/kg), 50. percentile value (median))

The visualisation of other elements under consideration shows, that the degree of spatial coverage possibly may decrease to a partially very low level. This is illustrated on the example of the 90. percentile values of Cadmium in figure 4.5 and table 4.4.

The Cd 90. percentile values were classified into five classes as indicated in the map legend in figure 4.5.

The degree of spatial coverage decreases to an amount of almost 5 %.

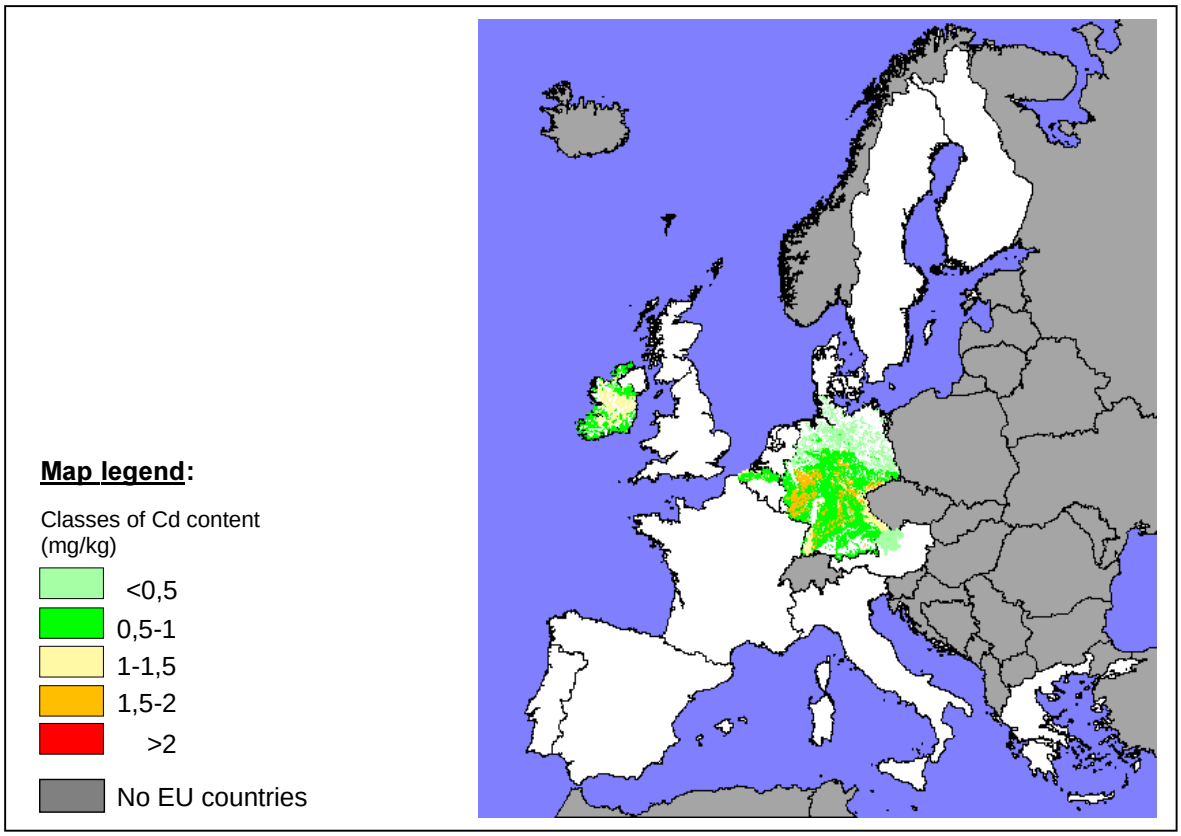

Fig. 4.5: Current status of data on heavy metal contents in agricultural soils – exemplary visualisation of Cd (mg/kg), 90. percentile value

Tab. 4.4: Current status of geographical coverage of the Cd contents (90. percentile values) in agricultural top soils

Country	Spatial reference	Spatial coverage [%] (Cd, 90. percentile value)
Austria (1 state)	Administrative (NUTS)	14
Belgium (Flanders)	SMU units (soil - first level)	36
Finland	Soil units	
Germany	SMU - MAT units (second level)	68
Irish Republic	SMU units (soil - first level)	68
Italy (38 provinces)	Administrative (NUTS)	38
Europe (15)		**5**

5 Summary and conclusions

5.1 Current status of the study

This report summarises the attempt to compile a first Europe wide evaluation of heavy metal contents of agricultural top soils. The evaluation is based on a data request distributed by JRC Ispra in June 2000 among all EU15 Member States.
The results of the data request are not quite satisfactory, because the information provided by the respective countries varies widely both in quality and quantity.

On the example of Cu contents as classified 50. percentile values three maps have been drawn up according to different bases of geo-reference. These three maps are related to at least three groups of countries which have been identified to be suited for a visualisation of heavy metal contents:

- For Austria and Italy a spatial reference is given for some administrative units. The visualisation is based on the NUTS units provided through the GISCO database.
- For Belgium (Flanders only), Finland and the Irish Republic the heavy metal contents are related to the “soil” unit of the European Soil Data Base.
- For Germany and the Czech Republic the visualisation of the heavy metal contents is related to parent material, based on the “Mat” units (“Mat11” and “Mat12”) level of the European Soil Data Base.

Additional exemplary evaluations of the 90. percentile values of Cd underline, that depending on the information provided the degree of spatial coverage varies also widely (the exemplary evaluations reveal a spatial coverage of 25 % (EU 15 states) in the case of Cu, 50. percentile values and 5 % in the case of Cd, 90. percentile values).

With respect to the results of the “Feasibility Study” (European Soil Bureau – Scientific Committee, 1999) and the “Preliminary Evaluations for 4 Member States” (European Soil Bureau – Working Group on Heavy Metals in European Soils, 2000) additional geo-referenced data could be expected from various states, e.g. Austria, France, the United Kingdom, the Netherlands. For example, efforts should be made to check if the data provided by France, the United Kingdom and Denmark could be referenced to the soil parent material or at least to smaller administrative units.
Furthermore, it has to be clarified how far a spatial presentation of heavy metal contents is presently possible in other countries like Portugal, Spain or Greece.

In this context it should be pointed out that any further efforts to evaluate and visualise heavy metal contents in European soils has to take into consideration aspects of harmonisation (e.g. check of contaminated samples).
In figure 5.1 the attempt was made to visualise the current and expected availability of geo-referenced data in the EU 15 Member States.

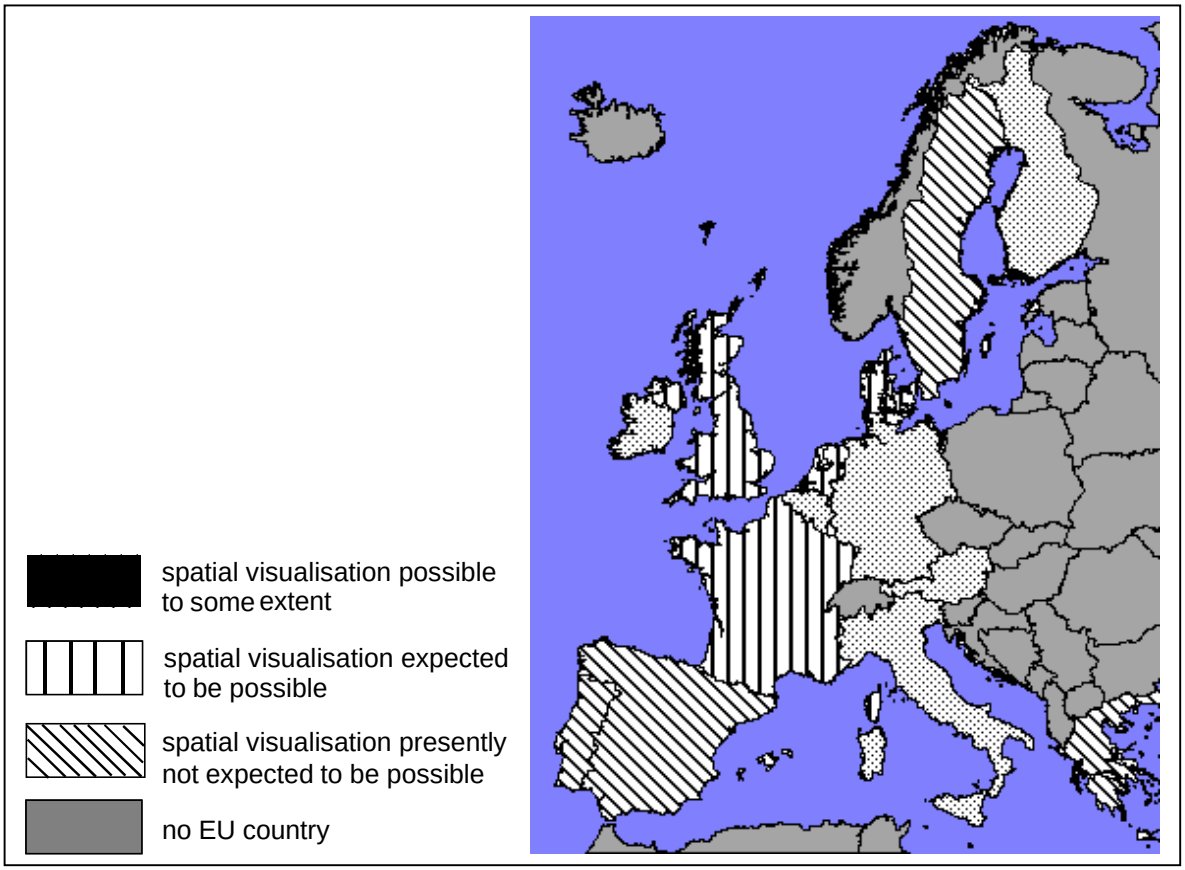

Fig. 5.1: Current situation of the availability of geo-referenced data in the EU 15 Member States

5.2 Further steps

The main part of the work will focus on the evaluation and harmonisation of the returned data in a sort of 'iterative process' that is outlined in figure 5.2. This 'iterative process' should cover the co-ordination of possibly occurring incomprehensibilities and disparities, the compilation of country specific databases / tables and the visualisation of the data through country-wide maps.

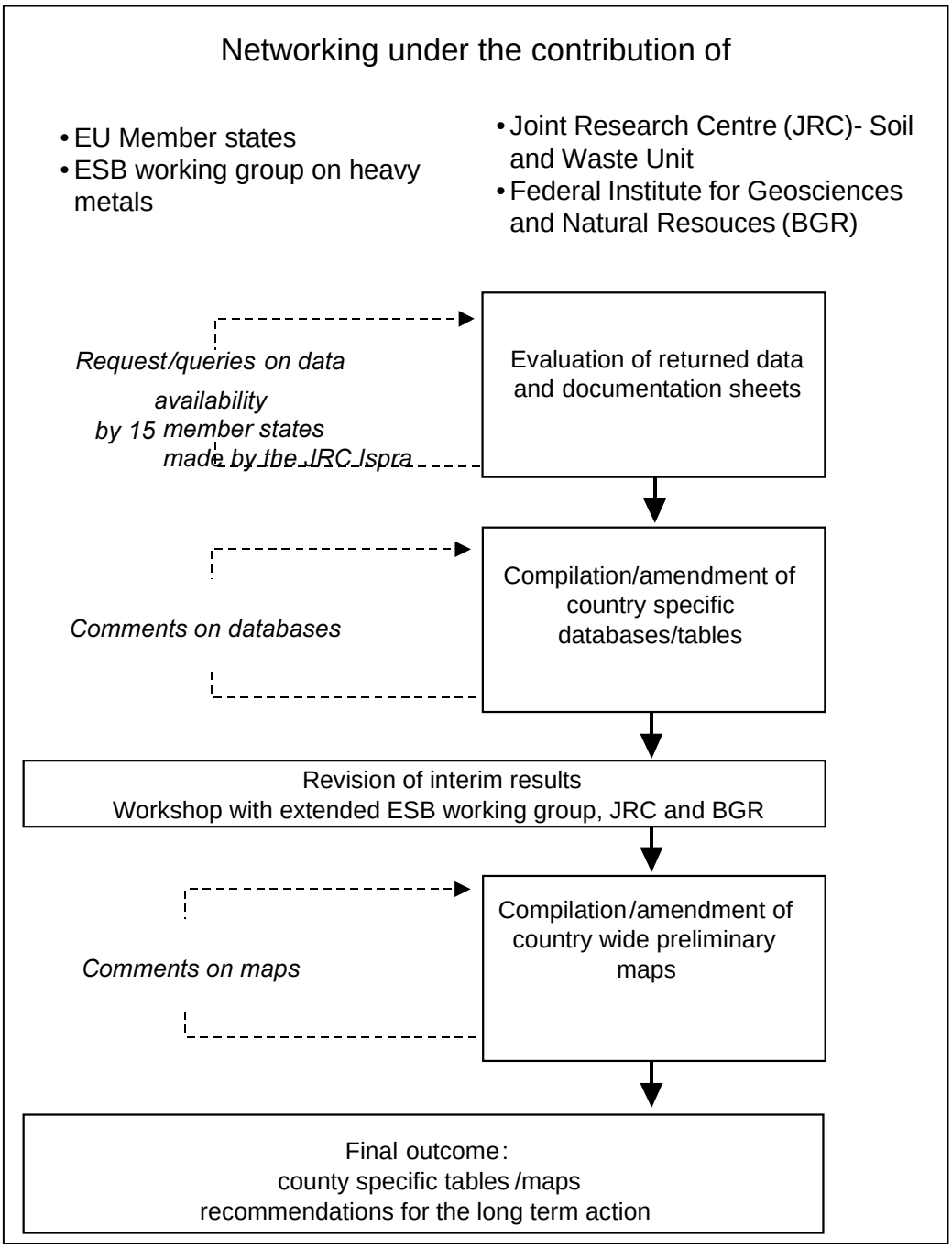

Fig. 5.2: Iterative process for the study

Against this background it is recommended to extend the existing ESB-working group on heavy metals to Member State representatives who are not presently member of the ESB-working group (e.g. Austria) and could provide country-wide databases.

It is recommended to bring together the representatives of the European countries in the near future. An ad-hoc workshop is planned at the JRC Ispra on 15th October.

One of the issues to be discussed by the extended working group is how additional data could be made available.

Against the background of the short-term action plan, countries should be asked to take into consideration the following classes of reference levels:

Soil pH *($CaCl_2$)*:	pH below 5, 5 < pH < 6, 6 < pH < 7, pH higher 7
Soil texture:	sand, silt/loam, clay *(reference to a national or international nomenclature)*
Soil Parent Material:	Parent Material Units ("Mat11" level) of the European Soil Data base.

Precise tables for each country should be attached to the data requests. An exemplary set of tables concerning Italy is attached in annex 1 of this report.
The list of the Soil Parent Material Units ("Mat11" level) has been derived from the European Soil Data Base. In this regard, an extract of the data base should also be prepared for each country. The exemplary map of parent material for Italy is also attached to this report (cf. annex 2).

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Appendices:

Appendix 1: Proposal of a set of tables concerning a substantiated data request (exemplary tables of Soil Parent Material Units (“Mat11” level) for Italy)

Appendix 2: Exemplary map of parent material for Italy (“Mat11” level of the European Soil Data Base)

Appendix 1: Proposal of a set of tables concerning a substantiated data request

Please refer heavy metal values to reference levels mentioned in point 3.b) The short term action plan of the data request.

You are invited to use, as appropriate, one of the following table sets:

- Table set 1 refers to the MAT11 – unit (describing the parent material at an aggregated level) of the European Soil Data Base,
- table set 2 refers to the to the soil pH, and
- table set 3 refers to the to the soil texture.

Table set 1: Heavy metal contents in Italian soils – referred to the parent material according to the European Soil Data Base (MAT11 – unit)

MAT11 unit	**spatial coverage** [% of country area]	**parent material**	**Cd [mg/kg]**						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

MAT11 unit	**spatial coverage** [% of country area]	**parent material**	**Cu [mg/kg]**						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

MAT11 unit	**spatial coverage** [% of country area]	**parent material**	**Cr [mg/kg]**						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

MAT11 unit	spatial coverage [% of country area]	parent material	Hg [mg/kg]						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

MAT11 unit	spatial coverage [% of country area]	parent material	Ni [mg/kg]						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

MAT11 unit	spatial coverage [% of country area]	parent material	Pb [mg/kg]						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

MAT11 unit	spatial coverage [% of country area]	parent material	Zn [mg/kg]						
			n	min	max	25 p	50 p	75 p	90 p
1	23	undifferentiated alluvial deposits (or glacial deposits)							
2	25	calcareous rocks							
3	18	clayey materials							
4	13	sandy materials							
7	14	crystalline rocks and migmatites							
8	6	volcanic rocks							

Table set 2: Heavy metal contents in Italian soils – referred to the soil pH

soil pH	Cd [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

soil pH	Cu [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

soil pH	Cr [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

soil pH	Hg [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

soil pH	Ni [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

soil pH	Pb [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

soil pH	Zn [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
pH<4							
4<pH<5							
5<pH<6							
6<pH<7							
ph>7							

Table set 3: **Heavy metal contents in Italian soils – referred to the soil texture**

soil texture	Cd [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

soil texture	Cu [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

soil texture	Cr [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

soil texture	Hg [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

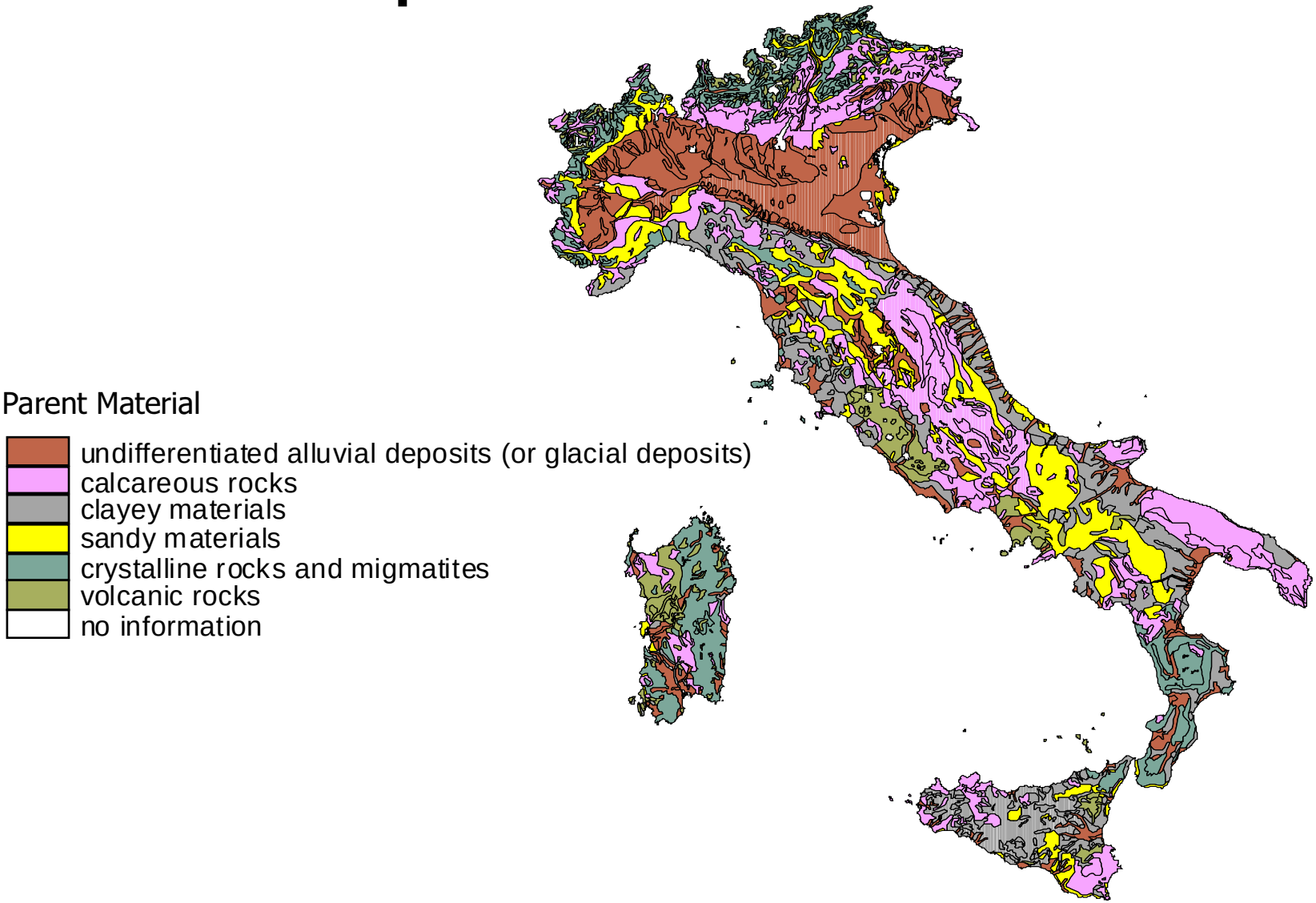
soil texture	Ni [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

soil texture	Pb [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

soil texture	Zn [mg/kg]						
	n	min	max	25 p	50 p	75 p	90 p
sand							
silt/loam							
clay							

Appendix 2

Parent Material of Italian Soils (MAT11 level) source: The European Soil Data base



Annex:- Recommendations by the JRC

The recommendations given by the JRC Ispra, are based on the results obtained from the two reports about heavy metal and organic matter content in European soils and of the overall conclusions of the workshop on harmonization held in Stresa in February 2001.

The heavy metal project will identify the current status of heavy metal concentrations in European soils in the context of the revision of the sewage sludge directive 86/278/CEE and the save protection of the European Soils. The project is coordinated by the JRC Ispra in collaboration with the Member States of the European Union, to collect and evaluate existing data on heavy metal (trace element) and organic matter contents of European Soils.

The first report gives the results of preliminary evaluations for 4 Member States, of France, Denmark, United Kingdom and Germany. The second progress report gives the first results of data collection on heavy metals and organic matter in European soils from all 15 Member States.

The main conclusions taken from these reports is, that there is a urgent need for the harmonization of analytical methods, otherwise it will not be possible to compare analytical data from different counties carried out using different standards and methods.

The main conclusions can be summarised as follows:

- to find an agreement on a common measurement procedure for pH
- to find an agreement on common analytical methods for heavy metal analysis and digestion
- to find an agreement for an Europe-wide sampling strategy
- to find an agreement for the elimination of contaminated soil samples
- to find an agreement on criteria to ensure a minimum level of spatial coverage.

Taking in consideration the conclusions from the two reports, DG Environment and the JRC Ispra organized, in February 2001, a workshop on: “Harmonization of sampling and analysis methods for heavy metals, organic pollutants and pathogens in soil and sludge”. This workshop was held in collaboration with the DG Agriculture, DG Health and Consumer Protection, DG Research, ISO and CEN. The overall conclusions of the workshop were that a horizontal approach in standardization work is urgently required.

During the discussions the workshop agreed that:

- the determination of pH in soil should be carried out in 0.01M calcium chloride solution
- the analytical determination techniques have to conform to the same levels of accuracy (AAS/ICP)
- to use “aqua regia” for the digestion of soil material.

Limits for concentrations of heavy metals in soil

The JRC Ispra has analysed the available data on heavy metal concentration in European soils delivered by the Member States. At this stage, the data collection has not been completed in all countries. The new proposed limits for concentrations of heavy metals are based only on the present knowledge of the heavy metal data supplied to the JRC Ispra. An additional revision of these limits is recommended after the study is completed.

The JRC Ispra proposes the following limit values for concentrations of heavy metals in soil:

Elements	**Limit values (mg/kg dm)**			
	Directive 86/278/EEC 6<pH<7	5≤pH<6	6≤pH<7	pH≥7
Cd	1 – 3	0.5	1	1.5
Cr	-	50	75	100
Cu	50 – 140	30	50	100
Hg	1 – 1.5	0.1	0.5	1
Ni	30 – 75	30	50	70
Pb	50 – 300	70	70	100
Zn	150 – 300	100	150	200

In addition, the JRC Ispra recommends:

- the use of *aqua regia* for the digestion of soil materials;
- the determination of pH in soil in 0.01M calcium chloride solution;
- the use of analytical determination techniques of the same level of accuracy (AAS/ICP).