REPORTS OF THE TECHNICAL WORKING GROUPS

ESTABLISHED UNDER THE THEMATIC STRATEGY FOR SOIL PROTECTION

VOLUME - V

MONITORING

Editors

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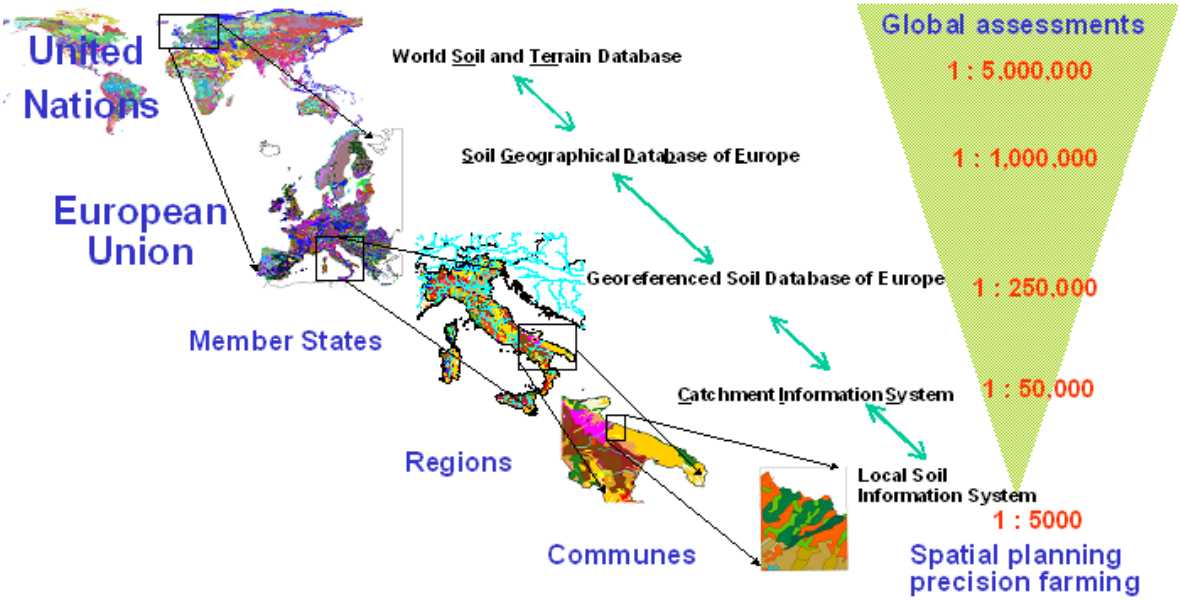

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MONITORING

Task Group 1 on
EXISTING SOIL MONITORING SYSTEMS

Luca Montanarella, Vibeke Ernstsen, Miguel Donezar
Ola Inghe, Patricia Bruneau, Ladislav Kubík
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Executive Summary

A detailed analysis of existing monitoring, survey, GIS inventories and mapping systems in Member States and Accession Countries has allowed us to gain a comprehensive knowledge about existing systems in Europe. A possible way of systematising this very variable and inhomogeneous information is to organise the different sources of information according to three main classes: **Soil maps**, **soil inventories** and **soil monitoring systems**.

Soil maps are available at different scales and used different classification systems and legends in all EU Member States and Accession Countries. They are the results of extensive soil surveys performed in the past 50 years in Europe, mostly for agricultural purposes. There has been no common European approach to soil survey and mapping, with different countries developing different procedures and traditions. Countries with a more structured and developed National soil survey have often developed also a National soil classification system, with measurements and parameters observed that vary greatly between different countries. Detailed soil mapping (1:50,000 or larger) is available only in some countries. Historical developments have strongly influenced the soil survey activities, with Eastern European countries developing very detailed soil maps for centralised planning purposes, but using diverging classification and measurement methods compared to Western Europe. All countries in Europe have a common 1:1,000,000 scale soil map developed jointly in the framework of the European Soil Bureau activities of the European Commission. Most of the existing soil maps are still available only on paper, particularly in Accession Countries.

Soil inventories are often developed starting from digitised existing soil maps. This has been the case of the European Soil Database at 1:1,000,000 scale, but also of many of the National soil inventories. The general adoption of GIS technology and the creation of databases of georeferenced soil information have allowed a number of new type of assessments producing more policy relevant information then the previously available soil maps. Modelling approaches using the existing soil inventories allow to derive information like soil erosion risk, organic matter content, diffuse contamination, soil compaction, salinisation, etc.. Systematic inventories are usually the pre-condition for the establishment of a soil monitoring system. This is the case for the European forest soil inventory with regular observations on a 16 x 16 km grid, but also for many National inventories. The establishment of a common European baseline for the establishment of a European Soil Monitoring System seems mandatory. Some early attempts were made by the European Commission in this sense, with the initiation of a European georeferenced soil database at a scale of 1:250,000.

As regards the monitoring of local soil contamination deriving from point sources such as industrial sites or landfills, or 'hot spots' (where more serious problems occur, and in general need (priority-)actions by the competent authority), the great majority of EU15 countries keeps registers as an instrument to document the extent of contaminated sites problems and to administer the management of these sites. According to the long-term progress in managing the contaminated sites' problem, registers are in continuous progress. Inventories are kept either at national or regional level, content and structure depend on the legal requirements in the Member State concerned. It is common to all of the registers that they refer to "sites" (potentially) posing risks to human health or to the environment. All of the registers include at least information on industrial sites and landfills; due to the country-specific situation additional categories such as mining sites, military sites, accident sites, or stocks of potentially hazardous materials, might also be registered. In any case, the information kept refers to historic contamination; however, there is no common understanding on the term "historic"; some countries also include data on actual soil contamination. Almost all of the Member States keep information on sites with ongoing as well as abandoned industrial activities; just a few countries restrict information on non-active sites.

In addition to problems in the EU15, new Member States face problems *inter alia* with former military bases, oil contamination due to broken pipelines, and pesticide stocks, so that identification and registration also of these sites pose a central task in environmental policy. In a few of the new Member States, registers for contaminated sites already exist; some countries are just setting them up.

There are only very few examples in Europe of fully operational **soil monitoring systems**. Many of the reported systems by Member States have performed only one observation in time, i.e. they are **inventories** and cannot therefore be considered as fully operational systems. The few operational systems allow some conclusions to be drawn:

1. Soil is a fairly stable medium, with detectable changes only over long time spans, depending on parameter considered this could be more then 10 years, especially for heavy metals and some organic pollutants.

2. Heterogeneity in space is often greater then variability in time, making the precise georeferencing of measurements over time a mandatory requirement.

3. Establishing of a well-organised archive of soil samples facilitates backwards comparison of results over time.

4. Variability in sampling and measurements is often larger then variability over time, making stringent standardisation and QA/QC procedures a mandatory requirement.

5. Observed parameters in existing systems are strongly biased by availability of measurement methods, with a strong predominance of observations related to soil contamination (mostly inorganic pollutants) with only little information on the other major threats to European soils.

6. There is a strong need for research in monitoring methods for threats like decline of soil biodiversity and soil physical degradation.

7. Erosion, local contamination and soil sealing, as well as floods and landslides, would need a indicator oriented rather than a classical monitoring approach. Here statistics taken in administrative geographical units (including statistics on agricultural land management) have to be overlaid with soil characteristics (soil risks and potentials) to come to a more aggregated information (e.g. using modelling for the problem of actual erosion risk).

8. Access to information produced by soil monitoring is subject to different legal requirements in Member States, with strong implications of private ownership and confidentiality for georeferenced soil data.

9. Lack of EU coordination in implementing the above recommendations suggests that the creation of an EU Soil Conservation Service (as in par. 2.5.4. "EU soil conservation service" of the Framework Mandate) is needed.

Existing soil monitoring or inventory systems in Member States are organised according to different sampling schemes, with some countries adopting regular grid approaches and others using a stratified approach according to pre-defined representativity criteria. The only EU wide monitoring system (LUCAS) has adopted a regular 18x18 km grid covering all Member States. It includes basic parameters measured in a harmonized way at EU level such as land cover (bio-physical description of the ground) and land use (socio-economic function) relevant to the monitoring of soil erosion, soil organic matter and soil sealing. Two surveys have been already carried out in 2001 and 2003 and the next one should be organised in 2006 in the EU25.

Final conclusions and recommendations are:

1. *Establish a common EU wide soil inventory (baseline) containing general soil parameters and specific parameters (see task group report on parameters) for each threat to soil as identified in COM 179 (2002).*

2. *Select a minimum set of common parameters (see task group report on parameters) to be monitored on a agreed set of sites (see task group on variability of soils) which should be part of the existing soil monitoring systems at National level.*

3. *Promote the adoption of standardized methods and procedures (see task group report on harmonization) for the measurements of the selected common parameters.*

4. *Organize regular quality control/quality assurance procedures including also laboratory ring tests, benchmark sites, training/education in soil classification and sampling, etc.*

5. *Establish a regular reporting procedure (5 years) for the selected parameters from the Member States to the European Commission.*

6. *Explore the possibility of achieving a stronger EU coordination of soil monitoring activities through a EU Soil Conservation Service.*

Introduction

In Europe there are a variety of initiatives that have been developed over the past years aiming at the collection of soil information. These initiatives were developed over a time frame of several decades and were coordinated by actors at different levels: Global (FAO, UNEP, etc.), European (European Community, ECE/ICP Forest, FOREGS), National, Regional and Local.

Collection of soil information in Europe can be broadly classified into three categories:

a) **Soil Mapping**, enabling to identify areas of land for management purposes.

b) **Soil Inventories**, providing a one-off assessment of soil conditions and/or properties at a point in time.

c) **Soil Monitoring**, providing a series of assessments showing how soil conditions and/or properties change over time.

Soil Mapping

Soil mapping has been historically the main activity of National soil survey organizations in Europe. Many of the soil survey organizations of the countries of the EU were initiated post–World War II in response to the perceived need to expand agricultural output at least to the point of self-sufficiency. Most of the early surveys were either general purpose in nature (Table 1) or related to agricultural production in some form, e.g. maps showing the suitability of land for agriculture or for particular crops. Early on, Land Capability Classification (Klingebiel and Montgomery, 1961) was developed and in the UK, Germany and other countries land classification maps for Land Use Planning were also produced in recognition of the need to protect the best agricultural land for the future.

The period 1950-90 was the most productive period for soil survey and the collection of information about the nature, distribution and properties of soils. This period also saw development of an understanding of the main soil processes, information that is now proving so important in helping to find answers to current environmental problems.

In the mid- to late 1980s, a number of EU countries became self-sufficient in staple agricultural products and the EU as a whole built up large surpluses of cereals, wine, olive oil and certain fruit crops. There was a sharp decline in support for soil science because the discipline was inextricably linked to productive agriculture and further research was perceived to lead to even larger surpluses in the future. The importance of soil in the broader environmental debate that was to follow had not yet been appreciated.

Funding for soil surveys declined and many soil survey programmes were curtailed or stopped completely. The result was that only one country in the European Union, namely Belgium, had completed its detailed national soil-mapping programme by the end of the 1980s.

The establishment of an EU Soil Conservation Service in charge also of soil survey, similarly to the Soil Conservation Service of the USA, would allow to complete an European coverage with detailed soil maps.

Table 1: Scales of soil survey and their objectives (after Dent and Young, 1981 and Avery, 1987)

Description	Scale	Ideal inspection density	Kind of map unit	Typical objectives
Large scale	1:2,500	64 per ha.	Simple	Special purpose and
(Detailed)	1:10,000	4 per ha.	Simple	Detailed general purpose
	1:25,000	64 per km^2	Mainly simple	Surveys. Project planning
Medium scale	1:50,000	16 per km^2	Mainly	Regional land use
(Semi-detailed)	1:100,000	4 per km^2	simple	Planning. Project
				Feasibility studies
Small scale	1:200,000	1 per km^2	Compound	Regional or national
(Reconnaissance				Resource inventories.
	1:250,000	<1 per km^2	Compound	National land use
	1:500,000	<1 per km^2		Planning
Exploratory	1:1,000,000 or smaller	<< 1 per km^2	Compound	Display. National Atlases, Continental assessments

The Concept of Soil Mapping

The general aim of soil mapping is to provide a spatial representation of the soils of continents, countries, regions, farms, or in fact any area of land of interest. It involves identifying the different types of soils that occur, collecting data on their nature, properties and potential use, and recording this information on maps and in supporting documents.

Soils can be mapped at a *range of scales* from very detailed at 1:1,250 to 1:5,000, showing soil patterns within individual fields or parcels of land, to broad exploratory surveys at 1:500,000 to 1:5,000,000 providing only a very generalised picture of the soils of a country or continent (Table 1).

In establishing a soil-mapping programme, decisions need to be made on whether surveys are to be general purpose or special purpose. *General-purpose surveys* are expected to provide the basis for interpretations for many different uses, some of which may not yet be known. General-purpose surveys lead to the production of soil maps in which the units are primarily separated on the basis of the morphology of the soil supported by analytical data.

By contrast, *special purpose maps* are prepared for specific uses and the relevant soil characteristics are emphasised in the separation of the different map units. Examples of special purpose maps include those for planning irrigation or sewage sludge disposal, combating salinity or erosion, and identifying contaminated soils. The drawback of special purpose mapping is that when the information base obtained for map is needed for another application it may be incomplete or unsuitable for it.

Most national surveys of soils involving detailed mapping have been general purpose in nature with the expectation that they will provide a broad information base from which to respond to a wide range of demands.

In order to identify and map different soil types, it is necessary to classify the soils. A number of classification schemes have evolved and many of the countries in Europe have produced their own systems suited to local conditions of soil formation and distribution. There are also two main International systems of classification, the IUSS (Working Group RB, 1998, World Soil Resources Reports 74.FAO, Rome) World Reference Base for Soil Resources (WRB) and the US Soil Taxonomy (Soil Survey Staff, 1975, 1994). Most of these systems are hierarchical in structure with a number of divisions representing different degrees of refinement and definition.

The *soil series*, defined as collections of soil profiles showing the same or similar succession of layers in lithologically similar parent materials (Hollis and Avery, 1997) is often the lowest order in a classification and is the one chiefly used to identify map units at scales of 1:65,000 or larger. It is conceived as a grouping of soils that are alike in their characteristics and behaviour in the landscape.

The basic unit of soil sampling and classification is the *soil profile*, a column excavated from the surface through the soil layers or horizons to the rock or other parent material below.

Soils are classified according to selected *profile characteristics* that can be measured or observed such as particle size distribution of different layers, abundance of organic matter in the topsoil, colours representing aerobic or anaerobic conditions, etc.

Soil mapping involves the use of an auger at intervals throughout the landscape to examine the nature of the soil at a point. The intervals between inspections can be according to a pre-determined grid (grid survey) or more commonly are irregularly spaced and chosen to test and refine conceptual models of soil distribution in the landscape.

Auger boreholes are supplemented by excavated profile pits chosen as representative of a particular soil series, and sampled for analysis to provide more details about the nature of the different soil horizons. Profiles are commonly sampled and the samples analysed for their *chemical and physical properties*, and less commonly for their *biological properties.*

Soil Mapping in Europe

Soil maps in Europe have been prepared at a range of scales and there is little consistency between countries in the scale used or in whether the emphasis is on small or large-scale mapping. It is generally accepted that as an absolute minimum each country should have a national map at a scale of 1:250,000. Any scale smaller than this is regarded of little value for in-country management of soil resources.

From a survey of National soil mapping (doc. EUR 18991 EN, *Soil Resources of Europe*), it is clear that only Belgium and the Netherlands have soil maps at detailed scales of 1:50,000 or larger for the whole of their national territories (Figure 1). These data should be taken with care since this inventory did not include the EU Accession Countries.

It is estimated that Austria, Denmark and Portugal have over 60 percent of their territory covered by detailed maps (at scales of 1:50,000 or larger). Finland, Germany, Ireland, Italy, Spain and the UK have 30-60 per cent coverage at detailed scales and the remaining countries have less than 30 per cent (Figure 1). National programmes of detailed soil mapping have ceased in the UK and Ireland with still some provisional maps that have never been published e.g Scotland all covered at 1:50 000 but with 51 maps remaining unpublished (only a black and white outline). Spain has undertaken a pilot project before deciding whether to establish a national detailed mapping project and the results of the assessment of this are awaited.

Italy, The Netherlands, Switzerland and UK are the only countries to have a 1:200,000 or 1:250,000 scale map of the whole of their national territories though Belgium could readily achieve this given its complete detailed mapping cover. Given the amount of detailed mapping that has already been undertaken, Austria, Denmark and possibly Portugal could produce 1:250,000 scale soil maps with moderate effort. France and Germany have active soil mapping programmes, which could produce 1:250,000 scale maps in the medium-term (within 5 years).

Slovakia is covered by detailed digitalised soil maps (at scales of 1:5000 – all agricultural land and 1:10 000 – all forest land). Aside of this general soil map of Slovakia was prepared at the scale 1:400 000 (Soil Science and Conservation Research Institute, Bratislava).

All of the countries have prepared maps at a scale of 1:500,000 or 1:1,000,000, mainly in response to the requirement to develop the 1:1,000,000 European Soil Database.

In addition to major reductions in funding by central Governments, one of the major problems in organising national soil mapping programmes has been the transfer of responsibility from central soil survey and research organisations to regional groups and/or private sector organisations.

This introduces a number of difficulties, particularly a lack of uniformity in approach and methodology used, proliferation of different soil classifications, a lack of availability of the information after surveys have been completed and difficulties in harmonising the information at national and continental levels.

Although several of the EU and EFTA countries have made some progress with mapping of their soil resources,

many countries still lack a coverage that can adequately support the wide range of demands for soil information that will undoubtedly emerge in the next years.

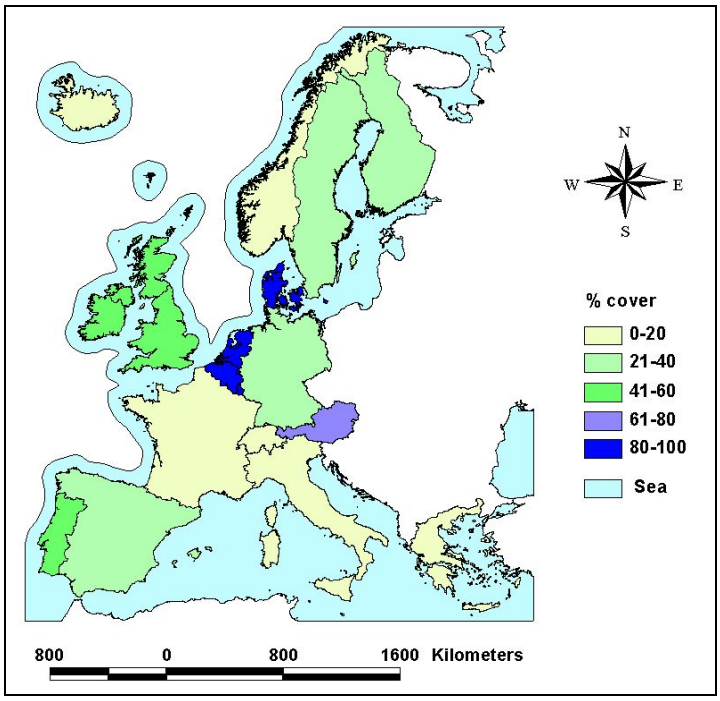

Figure 1: Availability of detailed soil surveys (1:50,000 scale or larger) in the EU and EFTA countries.

The development of a Soil Map of Europe

On the initiative of a number of European soil scientists, a meeting was organized in Gent, Belgium in 1952, with the purpose of harmonising methodologies and classification systems. As a result of this meeting, a request was submitted to the Director-General of the Food and Agriculture Organization of the United Nations (FAO) to sponsor the harmonisation within the framework of the FAO European Working Party on Land Utilisation and Conservation. In response to this request, FAO established a Working Group on Soil Classification and Survey, later affiliated with the Sub-Commission on Land and Water Use of the European Commission.

This work resulted in a first draft of the soil map of Europe at a 1:2.5 million scale presented at the second meeting of the Working Group held in Oxford, United Kingdom in September 1959. From 1959 to 1964 several drafts of the map and text were presented and discussed at successive meetings of the Working Group and at the Seventh and Eighth International Congresses of Soil Science. The map and its explanatory text were published by FAO in 1966.

A further step towards a common European map was the preparation of the 1:5 million Soil Map of the World, jointly undertaken by FAO and UNESCO. The project was initiated in 1961 and publication started in 1971. The two map sheets covering Europe were issued in 1981. The FAO/UNESCO Soil Map of the World incorporated the European systems of soil classification into an internationally recognised legend that enhanced cooperation and enabled a harmonised overview of the soil characteristics, both at continental and global level (FAO, 1995).

The broad composition of the soil associations at scales 1:2.5 million and 1:5 million was considered as a basis for more detailed land resource management and planning. Conscious of its responsibilities with regard to the practical application of soil data, the Working Party on Soil Classification included the preparation at 1:1 million scale in its programme in 1965. This map was published as the EC Soil Map by the Directorate General (DG) of Agriculture in 1985, and was later digitised under the CORINE (Co-ordination of Information on the Environment) project (see below under soil inventories).

Soil inventories

In the past two decades there has been increasing acceptance of the need to organise the soil resource information of a country into a Soil/Land Information System so that it can be more readily available. Such type of digital soil inventories is needed for most of the current computerized models in order to derive environmentally relevant information from basic soil data. Most countries have accepted this need but, as with soil maps, there is a large contrast in terms of development of such systems across Europe.

As can be observed from the available survey (doc. EUR 18991 EN, *Soil Resources of Europe*), soil and land information systems vary across the countries of Europe. They range from essentially simple databases containing soil profile and analytical data to well developed integrated computerised systems containing climatic, land use and cadastral information as well as soil data. The capabilities of these systems range from purely storage and retrieval of data to integrated dynamic modelling using GIS technology for evaluating current and future policy requirements at national and regional scale.

The most advanced systems within European countries seem to be those of Austria, France, Germany, Netherlands and the UK. The Austrian system is a good example of one built from the outset to take in a large variety of data from many different sources. The Dutch system, having the benefit of a digitised set of detailed soil maps for the whole country and associated descriptive and analytical data, is strongly linked with GIS technology and a range of simulation models so as to be able to respond readily to a whole range of topical issues. The England and Wales system (Landis) is a good example of one that from its inception had a very flexible design based on relational database technology and at an early stage in its development combined climatic, land use and topographic data.

Also in Slovakia exists advanced soil information system which includes descriptive and analytical data linked with GIS technology and a range of simulation models for soil cover evaluation in the whole country. This system consists of:

- soil survey database which includes descriptive and analytical data from 220 000 soil profiles of whole country
- land evaluation information system with digitalised soil maps at the scale 1:5000 (agricultural land) and database useful for land management
- geochemical atlas where 36 chemical elements were analysed in 5000 soil profiles (agricultural and forest land) in whole country
- LPIS and remote sensing technologies for subsidies system acceptance
- large variety of data from research activities

The soil information system in Slovakia is active at the Soil Science and Conservation Research Institute in Bratislava which is legislative and standard organisation for soil database development and soil cover evaluation in Slovakia.

Some countries, like Spain, have developed dedicated inventories to specific threats. The National Inventory of Soil Erosion (INES) is aiming at the complete inventory of soil erosion processes in Spain with the specific aim of delineating areas at risk for further action. It includes erosion risk mapping based on RUSLE modelling as well as direct field observations on 20,000 observation points. The first inventory is currently being completed. It is planned that it should form the basis for repeated inventories at 10 years intervals that would then form the future soil erosion monitoring system for Spain. Actual cost of the exercise is estimated at 20 EURO/km^2.

Computerised information systems are now capable of producing sophisticated graphical output but it is important to appreciate that the outputs are only as good as the input data, and for at least half of the European countries this is inadequate for decision making because less than 50 per cent of the area has sufficiently detailed soil maps.

As regards to the monitoring of local soil contamination deriving from point sources like industrial sites or landfills, the majority of EU15 Countries keep registers used as an instrument to inform on the extent of contaminated sites problems and to administrate the management of these sites. The development of these registers is an on-going process. Inventories are kept either at national or regional level; theirs content and structure depend on the legal requirements in the concerned Member States. A common feature to all of the registers is the reference to "sites" (potentially) posing risks to human health or to the environment. All registers include information on industrial sites and landfills, and depending on country circumstances additional categories like mining sites, military sites, accidental sites or stocks may also be added. The information kept refer to historic contamination; however, there is no common understanding on the term "historic". Some countries also include data on actual soil contamination with almost all of the Member States keeping information on sites with ongoing as well as abandoned industrial activities.

Continental scale European Soil Inventories

There are essentially three major European scale initiatives aiming at creating coherent inventories of soil properties in an harmonized way across country borders: **The European Soil Information System (EUSIS)** of the JRC, covering Europe at 1:1,000,000 scale and incorporating more detailed inventories at 1:250,000 and 1:50,000 scales in a nested GIS system, the **EC/ICP Forest level I 16 km X 16 km grid inventory** on forest soils and the **FOREGS Geochemical baseline mapping project**.

The European Soil Information System (EUSIS)

This system is based on the 1:1,000,000 scale “Soil Geographical Database of Europe “ (Jamagne M. et al., 2001) that is currently covering Europe.
The database has been recently extended to cover also the Mediterranean basin countries and the former Soviet Union (Montanarella L., 2001; Stolbovoi V. et al., 2001).

This new coverage is part of the joint Circumpolar Soil Database under development together with Canada and the United States. This extension will serve as a tool for the more accurate estimation of soil organic carbon pools in the boreal areas and for estimates of potential changes in GHG emission in relation to changes of soil temperature regimes in these areas. A first version of this common Euro-Asian Soil database is available (fig. 2).
EUSIS is a multi-scale system integrating data of different level of detail into one single Geographic Information System (GIS) (King, D. et al., 1998; Montanarella L., 1999). It links to global scale systems with the 1:5,000,000 scale World Soil and Terrain database (SOTER) (UNEP/ISSS/ISRIC/FAO, 1995) at one end, while assuring compatibility with the European 1:1,000,000 scale soil database. On more detailed scales (1:250,000 to 1:5,000) it links to National, Regional and local soil information systems within the European Union, assuring a coherent approach from the local to the global scale (fig. 3).

The system incorporates also a number of pedotransfer rules (Van Ranst, E., L. Vanmechelen, A.J. Thomasson, J. Daroussin, J.M. Hollis, R.J.A. Jones, M. Jamagne and D. King, 1995) that allow the preparation of derived products, like soil erosion risk maps, soil organic carbon estimates, and many others. More complex models use the EUSIS for the early forecast of crop production, desertification risk assessments, groundwater vulnerability to agrochemicals, etc… Still the system is far away from being ideal for all applications required; nevertheless it forms currently the only soil information system covering the entire European continent.

The main elements of the European Soil Information System are described below:

Soil Geographical Data Base of Europe at scale 1:1.000.000

This database forms the core of EUSIS. Its history dates back to the mid 80’.

In 1985, the Commission of the European Communities published a soil map of the EC at 1:1,000,000 scale (see above). In 1986, this map was digitised to build a soil database to be included in the CORINE project (Co-ordination of Information on the Environment). This database was called the Soil Geographical Data Base of the EC, version 1. To answer the needs of the DG VI MARS project (Directorate General for Agriculture, Monitoring Agriculture by Remote Sensing), the database was enriched in 1990-1991 from the archive documents of the original EC Soil Map and became version 2. The MARS project then formed the Soil and GIS Support Group with experts to give some advice concerning this database. These experts recommended that new information should be added and each participating country should make updates, leading to the current version 3 of the database.

The aim of the Soil Geographical Database at scale 1:1,000,000 is to provide a harmonised set of soil parameters covering Europe and the Mediterranean countries to be used in agro-meteorological and environmental modelling at regional, state, or continental levels. Its elaboration focuses on these objectives.

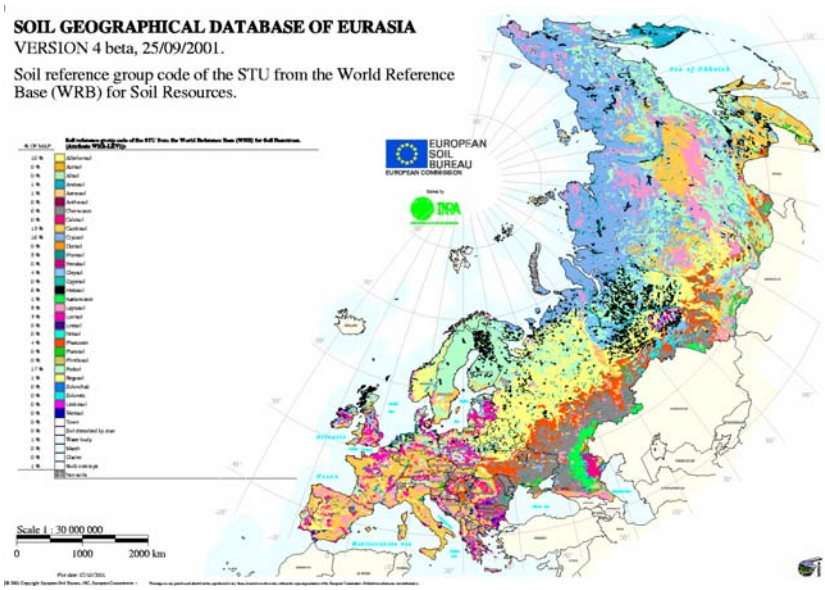

Figure 2: Provisional soil map extracted from the Euroasian Geographical Soil Databases.

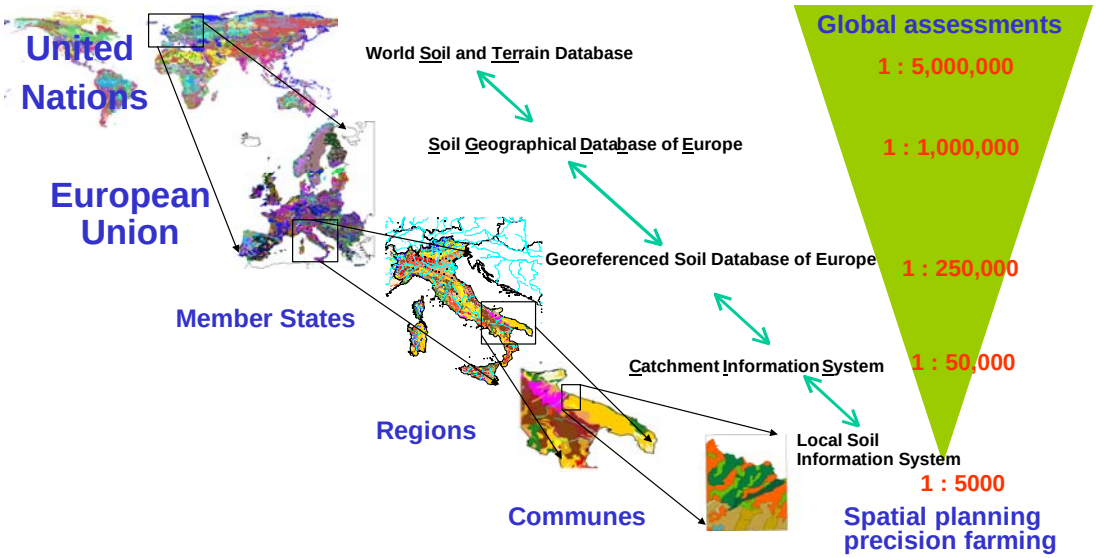

Figure 3: The European Soil Information System, responding to users (in blue) needs at different scales (in red).

Originally covering countries of the European Union, the database has recently been extended to Central European and Scandinavian countries. It currently covers Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, FYROM (Former Yugoslav Republic of Macedonia), Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom and Yugoslavia. The

extension is completed for Iceland and the New Independent States (NIS) covering Belarus, Moldova, Russia and Ukraine. Finally, work is on going to further extend it to other Mediterranean countries: Algeria, Cyprus, Egypt, Jordan, Lebanon, Malta, Morocco, Palestine, Syria, Tunisia and Turkey.

Beside these geographical extensions, the database has also experienced important changes during its lifetime. The latest major changes concern the introduction of a new extended list for parent materials, and, for coding soil types, the use of the new World Reference Base (WRB) for Soil Resources in association with the 1990 FAO-UNESCO revised legend.

The database is currently managed using the ArcInfo® Geographical Information System (GIS) software package.

The database contains a list of Soil Typological Units (STU), characterizing distinct soil types that have been identified and described. The STU are described by attributes (variables) specifying the nature and properties of the soils, for example the texture, the moisture regime, the stoniness, etc. The scale selected for the geographical representation is the 1:1,000,000. At that scale, it is not technically feasible to delineate each STU. Therefore STUs are grouped into Soil Mapping Units (SMU) to form soil associations. The criteria for soil groupings and SMU delineation have taken into account the functioning of pedological systems within the landscape.

The detailed instruction guide of this inventory is available in European Commission publication reference: EUR 20422 EN.

Georeferenced Soil Database for Europe at scale 1:250,000

The scale and the precision of the 1:1,000,000 database do no longer suffice to ensure the harmonisation in methodology between the various soil survey organisations and to meet the needs for specific soil information. The Task Force of the European Environment Agency and DG XI of the European Commission initiated a study on the feasibility of the creation of a soil inventory of Europe at scale 1:250,000 (Dudal et al., 1993). The study concluded that the preparation of such a map was feasible and desirable. Meetings of the heads of soil surveys of the European Union, which took place at Silsoe in 1989 (Hodgson, 1991) and at Orléans in 1994 (Le Bas and Jamagne, 1996), respectively recommended and endorsed the preparation of a georeferenced soil database for Europe at scale 1:250,000. The implementation of these recommendations was ensured by a Soil Information System Development Working Group (SISD) and subsequently entrusted to the European Soils Bureau which was created within the JRC in 1996 (Montanarella, 1996).
A specific working group elaborated the basic concepts underlying the creation of this new database. A Manual of Procedures was therefore published (Doc. EUR 18092 EN), outlining the basic structure and procedures of this new soil inventory. In five selected areas of Europe (fig. 5) detailed pilot studies were implemented, leading to the creation of the first elements of the future complete coverage of Europe with this information layer.

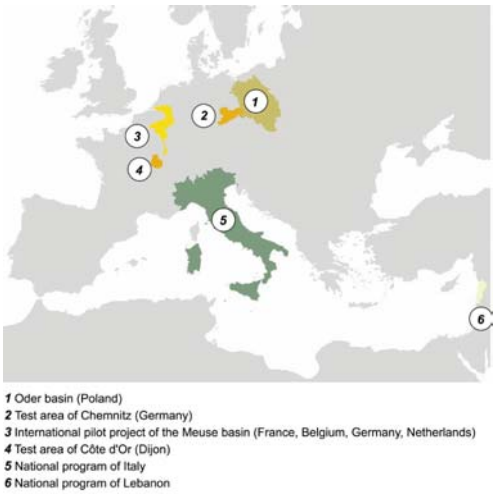

Figure 4: Pilot areas at 1:250.000 scale completed by 2002.

During 2003 a new pilot area covering the complete Danube river basin has been initiated.

EC/ICP Forest level I soil inventory

Public concern for the European forest ecosystems resulted in an extensive forest soil condition-monitoring programme set up by the European Commission (EC) and the International Co-operative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests). The inventory aims to provide basic information on the soil chemical status and on the soil properties which determine its sensitivity to air pollution.

Forest soils were sampled at the intersection points of a transnational 16km x16km grid. General information on the observation points consists of plot number, observation date, plot co-ordinates, altitude code and FAO soil unit.

The organic top layer is sampled separately from the mineral soil which is sampled at two or three fixed depths between 0 and 20 cm. Reference analysis methods are described for pH ($CaCl_2$), Org. C, N and total amounts of P, K, Ca and Mg. Measurement of total amounts of Na, Al, Fe, Cr, Ni, Mn, Zn, Cu, Pb and Cd in the organic layer and of cation exchange properties in the mineral layer are optional. Sampling and analysis were carried out by the national focal centres (NFCs). The analysis results are stored in a common geographical database at the Forest Soil Co-ordinating Centre (FSCC) in Belgium. Of the 31 countries, participating in the European forest soil condition inventory, 23 have completed their national survey activities. To ensure a high quality of the data stored in the database, several screening procedures were performed on the submitted data files. Once loaded, the data are subjected to a number of analysis steps: (1) new parameter values, such as nutrient ratios, are calculated, (2) parameter values are classified for presentation on maps, (3) plots with similar soil properties are grouped for statistical analysis, and (4) statistical analysis is aimed at recognising significant differences in soil condition between groups of plots. A trans-boundary interpretation of the soil condition results is hampered by differences in methods of sampling and analysis.

The soil condition is mainly evaluated in terms of nutrient availability for trees and the capacity to neutralise acids deposited from the atmosphere.

FOREGS Geochemical baseline mapping project

The FOREGS Project (1997- 200x), mapping large parts of Europe, is the result of more than 15 years of discussions among government geochemists from Geological Surveys all around the world. In Europe these discussions are reflected in a series of WEGS (Western European Geological Surveys) reports (e.g., Bølviken et al., 1990; Bølviken et al., 1993). As the main outcome of the discussions Darnley et al. (1995) published a handbook for a worldwide geochemical mapping project. Financing for a worldwide project was never accomplished and in the end the Forum of European Geological Surveys (FOREGS, the successor of WEGS) decided to carry out a European Geochemical Mapping Project. For this project samples were taken in 26 European countries. The size of the survey area is 4,250,000 km^2 and up to 925 sample sites (the exact number varies from sample material to sample material) were visited throughout the area. This gives an average sample density of **1 site per 5,000 km^2**. The sampled materials include: stream water, topsoil (0-25 cm), O- (where available) and C-horizon soil samples, stream sediments and floodplain sediments. All necessary sample equipment for the project was bought in Finland and then distributed to all project participants. All the samples were prepared in only one laboratory in Slovakia. Splits of all samples were analysed in a number of European Survey Laboratories for different parameters or using different methods. A geochemical atlas presenting the results is expected to appear 2004.

Soil monitoring

Monitoring is now a vital component, alongside soil maps and databases, in the quest for information about the soils of a particular region or country. The importance of a monitoring programme is that, if well constructed, it can provide information about how soils are changing with time and can be used to answer questions about whether the quality of a soil is improving, deteriorating or staying about the same under a particular use and management practice.

It is also the chief means of identifying the nature of contaminated land, effects of trans-boundary migration of pollutants and the extent and form of land degradation.

Within the EU and Accession countries monitoring is usually carried out by a number of different organisations, not just those responsible for soil survey. This is because the reasons for establishing monitoring programmes can be very varied, e.g. forest health, land contamination, fertility of agricultural land, environmental risk assessment, effects of acid rain, land degradation.

However, in most cases soil survey organisations are involved in helping to establish monitoring programmes, relating the monitored components to soil type. The latter is particularly important for distinguishing between natural and man-made effects. It is also essential that monitoring programmes be linked to the national land/soil information systems so that the results can be progressively incorporated into these systems.

This will also allow the results of the monitoring programme to be interactive with other data about the soils of the monitored area and also to benefit from being able to interact with ecological, land use, climatic, cadastral and demographic databases in the Information System. It is particularly important that information collected is not isolated from all the other information about soils, their use and management.

National reports confirm that most countries in the EU have established monitoring programmes for soil. Some of these programmes, such as the ECE/ICP Levels I and II Forest Health monitoring scheme, are Europe–wide (van Ranst *et al.*, 1998) but most are national and some are regional. Often regional schemes are carried out without reference or linkage to others in the same country. Unfortunately most of these programmes cannot be strictly considered as monitoring programmes, since only in very few cases more then one observation in time has been performed. They are therefore to be considered for the moment as inventories that could in the future develop into monitoring systems. The uncertainties of these systems are mostly due to the lack of permanent funding and institutions being in charge of the monitoring network and assuring the repetition of observations over time.

In some countries such as Austria, France, Finland, Germany, Netherlands, Sweden and the UK monitoring schemes are both extensive and intensive.

Austria has extensive monitoring schemes for forest soils and also conducts environmental soil surveys, involving monitoring potential problems such as acidification, organic matter depletion and heavy metal contamination at some 6000 sites. An updated review of the soil monitoring activities in Austria is reported by EEA. In Finland a monitoring programme on arable land for nutrients, organic matter, acidity and heavy metals started in 1974 and was repeated in 1987 and 1998. France has two main monitoring networks, one involving long term changes in cultivated land and other land not under forest, the other concerned with monitoring of forested land. Both programmes are integrated into a common 16 x 16 km grid and are linked to the baseline inventory at 1:250,000 scale.

In Germany around 800 sites are installed to monitor trend and development of soil status to be basis for precautionary soil protection. Repeat measurements are to be conducted on all sites. The sites are selected on basis of representativity i.a. according to the criteria: landscape representivity; soil representivity and land use representivity. Special situations with respect to pressures and threats, respectively, are observed at intensive monitoring sites. In addition the forest monitoring is conducted on a grid-based approach with a 4x4 or 8x8 km grid supporting the EU Forest Monitoring.

The monitoring system of Hungary comprises 1236 sites 865 on agricultural lands, 185 in forest areas, 189 in environmentally threatened regions such as degraded lands, hydrogeological recharge zones of drinking watersources, catchments of lakes and reservoirs, severely polluted industrial and agglomeration districts, around landfills and hazardous waste disposal facilities areas affected by transportation, military establishments and other vulnerable environments. The sampling sites were selected in order to represent the soil conditions of smaller geographical regions. The Global Positioning System (GPS) was used to identify the location of the sites with the accuracy of 2.5-3 m, The GPS co-ordinates were converted after correction to geographical co-

ordinates. The sites are sampled between September 15 and October 15 in order to avoid the effect of the fluctuation of certain parameters within a year. One-hundred-fifty cm deep soil profiles were dug out in the first year and a detailed profile description and on-site analyses were carried out before sampling on all the sites. The following years samples were taken by drilling. Samples from each layer and horizon are stored in a sample bank. To get the information on baseline conditions, all the chemical, physical and biological soil parameters were determined for each horizon in the laboratory. Since 1993 the analyses have been repeated in 1, 3, 6 years period depending on the rate of change in the properties. Total costs for baseline condition for 1 sampling points if 3 layers are sampled is 1456 Euros. Total costs for every subsequent year for 1 sampling points if 3 layers are sampled is 211,4 Euros. Additional costs appear in every 3 and 6 years according to the frequency of certain measured parameters.

In the Netherlands, RIVM conducts national programmes to monitor soil quality, shallow groundwater levels, long-term groundwater quality and levels and long-term forest health.

Slovakia has an extensive soil monitoring system covering agricultural soils, forested and alpine areas (e.g. Low and High Tatras are also included)

Sweden has a number of systematic soil monitoring initiatives including the major survey of forest soils and vegetation which started in 1963 and which has been repeated at approximately 10-yearly intervals. The Swedish monitoring programmes also include one for arable land.

In the UK, the National Monitoring Programme has been designed and undertaken by the Soil Survey and Land Research Centre for England and Wales. So far there are data from two periods for comparison. In Scotland only a pilot study to investigate how site can be re-sampled and located was undertaken. The only monitoring system that covers the whole of the UK is the Countryside survey, which is designed more for ecosystem monitoring rather than soil.

Several of the countries of the European Union and EFTA have made soil geochemical surveys, e.g. Austria, France, Germany, Ireland, Netherlands, Sweden, UK. Monitoring of soil erosion is undertaken also in a number of other countries, such as Iceland, Greece, Portugal and Spain. Thus there is a wide range of monitoring initiatives relating to the state of the soils in the countries of the European Union and EFTA. Further information about monitoring programmes and their results are published from time to time by the European Environment Agency (EEA) (see, for example, EEA, 1995; 1998).

An updated inventory of existing national monitoring systems has been recently prepared by EEA and the ETC/TE and a summary of it is represented in table 2.

Together these monitoring programmes represent a considerable body of information about European soils. Given this and the considerable costs involved, it is essential that the information obtained be as widely available as possible. In Sweden, for example, information from monitoring programmes is available on the Internet.

The main problem at present is the lack of harmony in the soil monitoring programmes as noted by the European Environment Agency (EEA, 1998). The EEA quite sensibly calls for harmonised soil monitoring programmes to be established, 'similar to those for air and water, and geared to assessments of the state of the soil over large areas, covering a number of parameters'. The EEA also concludes that monitoring systems have so far been designed mainly for specific research purposes or specific objectives such as heavy metal and sewage sludge control or agricultural nutrition programmes, and are rarely well integrated with other survey activities.

In table 2 a summary of reported National soil monitoring programmes has been compiled, taking into account only operational monitoring programmes that have made at least two observations. Monitoring programmes that did not yet perform at least a second round of measurements should be included under the heading "soil inventories" (see above).

Table 2: Reported soil monitoring programmes in Europe *(source: EEA, 2003, updated inventory of existing systems)*

Country	Nr. of sites	Sampling scheme (regular grid or stratified location)	Periodicity (depending on parameters observed)	Starting year (depending on sites)
Austria	400	stratified/grid	3 years/10 years	!987-1995
Belgium	940	stratified	40 years	1947
Bulgaria	300	not reported	3/10 years	1986/1992
Czech Republic	700	stratified	3/6 years	1992
Finland	750/150	stratified	12/5 years	1974/1992
France	2300	grid	5/10 years	1993/2001
Germany	800/1800	stratified/grid-EU/ICP	5/10 years	1980/1997
Hungary	1236	stratified	1/3/6 years	1993
Netherlands	240	stratified	6/10 years	1983/1993
Norway	13	stratified	1 year	1992
Slovakia	400	grid/stratified	5 years	1992
Spain	41	stratified	1 year	1995
Sweden	26800	grid/stratified	4 month/10 year	1983/1993
United Kingdom	1200	grid	1/5/15 years	1969/1992

European Soil Monitoring Initiatives

Land Use Land Cover Annual Survey (LUCAS)

LUCAS is a pilot project launched by Eurostat in close co-operation with the Directorate General of Agriculture. LUCAS is an area frame statistical survey that aims at obtaining harmonised data at EU level on **land use, land cover and additional environmental features**. The survey consists in the ground visit in **springtime** of about 100 000 points sampled according to a regular grid. The survey has been carried out in 2001 in the EU13, in 2002 in the UK, Ireland, Estonia, Hungary and Slovenia and in 2003, in the EU15 and Hungary. LUCAS could be carried out in 2005 in some Candidate Countries and in 2006, in the EU25.

The LUCAS survey adopts a two-stage sampling design: at the first level, Primary Sampling Units (PSUs) are defined as cells of a regular grid with a size of 18 × 18 km. At the second level, the Secondary Sampling Units (SSUs) are 10 points, distant 300 m apart, regularly distributed in two lines distant as well 300 m apart around the centre of each PSU.

Despite the fact that LUCAS is still in a pilot phase and therefore is not stabilized and needs improvement the survey has proved its reliability in providing for the first time harmonised and comparable data at EU level allowing the assessment of changes occurring in the territory.

Key points:

- Harmonised nomenclature and methods of observation throughout the EU
- Identification of agricultural covers at species level
- Clear separation between Land Cover and Land Use
- Grid of 18 km x 18 km enables many integer divisions for enlargement of the sample for national purposes (2 km, 3km, 6km and 9km)
- The systematic sampling approach is designed to cover with the same probability of observation all the territory and to collect multi-purpose information
- Precise and well documented location of points (orthophotos), geo referenced system
- Regular observation in time (the point is reached each survey with a precision of one to two meters)
- Clear specifications to manage and organize the survey (follow-up and training of surveyors)
- Harmonized quality control of data (common data entry software)
- Project managed by the Commission ensuring coherence of the system
- Full comparability with similar monitoring systems in other OECD countries, like the Natural Resources Inventory (NRI) of the United States.

Obviously LUCAS in observing the Land Use and Land Cover and their changes provides fundamental data for monitoring indirectly threats such as **erosion**, decline in **soil organic matter**, **soil sealing**, and possibly floods and landslides.

Which way LUCAS could be used to gather relevant information on such soil threats?

Even if it is claimed LUCAS is a multipurpose system, it is clear it is not designed to collect all type of data. However, LUCAS offers the possibility to collect harmonised data potentially usable to detect problems occurring on the ground. Such problems would require complementary ground surveys and observations to monitor in an appropriate way the phenomenon. As such LUCAS could be used as a basis to stratify samples for specialised surveys. 2001 and 2003 exercises have shown the kind of additional data that could be provided (traces of erosion, traces of natural hazards, landscape photos). Still the reliability and the relevance of such information are to be further assessed. Eurostat is opened to include any modifications and to improve the observations if feasible.

Estimated Cost of the LUCAS survey phase 1 (Spring time survey) in the EU15 (In Euros)

Year	General costs*	Survey	Orthophotos	**Total**	Cost/PSU	Cost/SSU
2001/2002	1.152.852	1.026.232	479.367	**2.658.451**	271	27
2003	868.267	1.003.525	10.139	**1.881.931**	192	19

**Estimated (Training of surveyors, Meetings, Reporting, Supervision, Quality Assurance, follow-up and documentation)*
Note: orthophotos were not purchased in 2003 in general. Those of 2001 were used in 2003. It can be considered that orthophotos have to be updated at least every 5 years

The statement of the Working Group clearly outlines the conceptual limitations of LUCAS regarding the observation of soil erosion phenomena.

All the critical points mentioned are clear and have been acknowledged already during the design of LUCAS.

The WG mentioned several points for potential improvements of LUCAS, indicating that substantial modification of the current LUCAS survey are necessary to fit in the recommendations of the WG. However, even if the survey period (multiple surveys throughout the year) as well as the reference area (catchment) would be extended and financed, it is questionable how quantitative assessments could be done.

Again, it has to be bear in mind that LUCAS is designed to provide harmonised land cover/land use data at EU level, particularly on cropland for DG Agri (early estimation of crop areas by end of July each year) and thus not replacing a soil monitoring system. Information on soil erosion has to be considered as a "by-product", delivering complementary data about the area affected by soil erosion.

Considering the above, an alternative approach could be envisaged. A first proposal has already been outlined in the framework of the Eurostat funded project "Exploitation of data from the Community's LUCAS survey"[1]. The proposal is based on modelling vulnerability and/or soil loss at plot level. Within such a modelling approach, different data are needed:

- Yearly data on land cover
- Site conditions (e.g. slope, soil texture)
- Rainfall data

LUCAS could provide yearly updated information about land cover, the most important factor in the soil erosion process. About 20.000 observation points (classified as arable land) throughout EU 15 Member States could be considered. Moreover, data from Acceding Countries could be included, since it is foreseen to conduct LUCAS also in these countries.

[1] Available on demand : marcel.ernens@cec.eu.int (Head of Unit Eurostat/E2)

Ancillary information about the site conditions (slope, soil texture etc.) are further needed and could be obtained by exploiting existing data or through a single observation during a LUCAS field campaign. The model could be complemented with actual rainfall intensity data.

The potential advantage of such an approach would be to combine existing and harmonised data at EU level at a minimum financial expense. It is strongly believed that such an approach would complement the planned soil monitoring system, particularly considering the need of harmonised data and common methodology at EU level.

Conclusions and recommendations

This brief survey of existing systems in Europe has demonstrated the need for a common approach to soil monitoring, in order to capitalize on the numerous existing initiatives and to increase the efficiency of the resources already allocated to the various initiatives.

To achieve such a common EU approach to soil monitoring there seems to be the lack of a EU body, such an EU Soil Conservation Service, that could act as an European focal point for soil protection and monitoring.

Establishing a coherent approach to soil monitoring requires first of all to establish a common baseline. Without a basic soil inventory there will be no possibility to detect changes over time in the selected soil properties for monitoring. If this base line inventory is planned to be the "first measurement" in a long-term monitoring, site selection, settings for harmonisation, agreements on soil taxonomy, sampling and analysis have to be identical (even as a subgroup of the whole inventory) with the monitoring, which is planned in the long-term.

A number of initiatives exist at national and at European level aiming at the collection of basic soil data in the form of inventories accessible in electronic formats (soil data bases). It is crucial that a common approach for the collection of georeferenced soil data is adopted at EU level. The possible gains in efficiency and the consequent cost savings have been already documented in many related initiatives. The most recent is the EC INSPIRE initiative (http://www.ec-gis.org/inspire/) that clearly identifies these harmonisation needs and the related cost-benefit analysis.

The common baseline should have an information density corresponding to at least the 1:250,000 scale. Baseline information at this scale is currently collected through National programmes in France, Germany and Italy.

Once a common baseline will be established, soil monitoring could effectively be implemented at European scale.

Existing European initiatives (ICP Forest, FOREGS, LUCAS) show that data collection requires a strong harmonisation effort to allow comparability across country borders. The adoption of common standards (ISO, CEN) should be encouraged as far as possible.

Current existing National initiatives are very fragmentary and difficult to harmonise. Major changes in measurement methods would be required for some of them in order to comply to common ISO or CEN standards.

In conclusion, a cost effective approach seems top be the selection of few common parameters to be monitored regularly by Member States based on adopted standards giving clear responses to the questions raised by the EU Thematic Strategy for Soil Protection.

Given the wealth of existing information on soils in Europe, the future directive on soil monitoring should essentially facilitate the access and the use of existing soil information for the purposes of soil protection and should essentially be oriented towards the creation of the necessary regulatory environment for more effective coordination of existing initiatives rather then the establishment of new soil monitoring systems.

Final recommendations are:

1. *Establish a common EU wide soil inventory (baseline) containing general soil parameters and specific parameters (see task group report on parameters) for each threat to soil as identified in COM 179 (2002).*

2. *Select a minimum set of common parameters (see task group report on parameters) to be monitored on a agreed set of sites (see task group on variability of soils) which should be part of the existing soil monitoring systems at National level.*

3. *Promote the adoption for the measurements of the selected common parameters of standardised methods and procedures (see task group report on harmonisation).*

4. *Organise regular quality control/quality assurance procedures including also laboratory ring tests, benchmark sites, etc.*

5. *Establish a regular reporting procedure (5 years) for the selected parameters from the Member States to the European Commission.*

6. *Explore the possibility of achieving a stronger EU coordination of soil monitoring activities through a EU Soil Conservation Service.*

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MONITORING

Task Group 2 on
PARAMETERS, INDICATORS AND HARMONIZATION

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Recommendations

1. As part of the future strategy for soil monitoring and protection, there should be an evaluation as to whether all the parameters, listed in this report, are equally relevant and necessary for EU-wide monitoring. This is part of the debate as to whether 'one-size-fits-all'. There is agreement that examination of these issues should be part of a 'next-steps' approach to soil monitoring.

2. The monitoring of soil has to be seen as an integrated part of environmental monitoring. This should include classical monitoring of substantial soil contamination as well as of indicators of structural changes in soils.

3. There should be a programme of basic measurements of soil parameters at each monitoring site which forms part of an EU-wide network, in order that the soil at each site can be linked adequately to existing data such as those represented by the 1:1 000 000 European Soil Map. There is also a case for more targeted monitoring at fewer sites to inform specific problems or threats.

4. The monitoring of local soil contamination is a different problem to that of the monitoring of diffuse soil pollution, and should be taken on a case-by-case basis.

5. GMES, LUCAS and other EU environmental programmes should be examined as possible added information by which monitoring of some of the soil threats might be made.

6. The case for the monitoring of those Drivers, Pressures and Impacts that present further threats to soils, should be further examined under a 'next-steps' procedure.

7. Existing data should be harmonised as far as possible, e.g. through expert assessment and a programme of trans-national comparison under a 'next-steps' procedure, so that maximum value can be obtained from past and current soil monitoring activities.

8. There is a need to harmonise future activities, which should include protocols for, but not necessarily restricted to, the selection (taking note of the principle of representativity), location, setting up and maintenance of monitoring sites, site and soil descriptions, sampling strategies, laboratory procedures, data handling and storage, and quality assurance.

9. There is an urgent need to decide the degree of sensitivity to which parameters need to be measured. Thus the WG recommends that, as a 'next steps' exercise, the performance criteria required from a monitoring network should be established.

10. The Commission should support strongly the development of further norms relevant to the aims of the Soil Monitoring Directive.

11. The Commission should undertake, with considerable urgency, a formal cost-benefit analysis of soil monitoring.

12. The Commission should assist in the development of a mechanism whereby all the costs of soil monitoring can be calculated in an open and transparent manner.

Introduction

Parameters are the properties of the soil, or components of the system of which the soil is a part, or surrogates for them, which are measured or otherwise assessed in order to quantify the threat(s) to the soil in space and time. A parameter can be used directly as an indicator of the kind and magnitude of a threat to soil and its functions or it might be used in the development and elaboration of a soil indicator of soil functions, i.e. interpretation is required. It may be useful and valid to examine the usefulness and desirability of parameters in terms of the Drivers, Pressures and Impacts that they might reflect, and in terms of Responses adopted. Not all parameters may be useful across all Member States, so an element of subsidiarity may need to be brought in to obtain maximum value for least cost.

This is reflected in the anthropogenic nature of many of the threats to soil. The potential list of parameters that could be of concern at some time or another is extremely large, especially for chemicals. For this reason, the Working Group believes that considerable local discretion will be needed in selecting parameters that most clearly reflect local problems and concerns. On the other hand, we recommend a basic list of parameters to be measured or assessed that relate to current EU Directives so that overall assessments of the nature of these potential threats to soil can be made at the Community level *sensu lato*. This approach allows Member States and other States to add to the list of parameters in order to address their local concerns. A particular problem is that of local contamination (including 'hot spots'), e.g. industrial sites, in which the parameters of potential interest *and that are amenable to direct measurement* are almost impossible to specify in advance of targeted investigation, site-by-site, without committing organisations to potentially large costs - many of which might prove unnecessary.

The WG also agreed that it would be sensible to integrate soil monitoring parameters with those measured for other soil-related purposes, such as that of ICP-Forests. The WG did not define the precise mechanisms for such integration, but identified it as a task for a 'next-steps' exercise. Further work also needs to be done in relation to the relationship between specific parameters the precise nature of the (perceived) threats to soil, and the frequency and density at which the observations should be made. It is also essential that the lists of parameters (and indicators – see below) are reviewed at regular intervals in order to assess the case for both additions and deletions.

It is axiomatic, in our view, that data sources of all kinds should be taken into account when both designing a soil monitoring network and the ways in which data might be accrued, e.g. we have in mind such things as environmental statistics (see also DPSIR (below), remote sensing, existing inventories, modelling). Further consideration should also be given to the potential linkages of monitoring of air and water with those of soil, and *vice versa*.

General parameters

It is essential that Member States and the Commission obtain maximum value from information collected through either multi-purpose (MP-SM) or action-driven (AD-SM) soil monitoring. In order to do this, site characteristics need to be linked to existing datasets such as the European Soil Map at 1:1 000000 scale. This linking could permit much robust extrapolation, if coupled with a sensible degree of expert assessment and cross-validation. In order to do this effectively, certain basic parameters are required to identify the soil and site characteristics.

The WG has agreed that the basic parameters for the effective characterization of soils at sites to be monitored are (either by measurement or estimation, as appropriate):

- Soil profile description according to an agreed International System. This will include a wide range of observations such as soil structure, evidence of compaction, status of the soil surface, depth the impermeable layers, stoniness etc.;
- Soil classification according to an agreed International System, such as the World Reference Base;
- Identification of soil parent material to an agreed system;
- A sampling design that allows for long-term, robust assessment, i.e. it is essential that the inherent variability of the site can be separated from long-term change;
- Site characteristics, such as slope, aspect, historical and current land use and land management recorded to an agreed system;
- An agreement is required on sampling depth (by horizon, by fixed depth or both; when sampling by depth steps, information on the limits of the relevant horizon is necessary)
- Soil bulk density;
- Stone content and stone size (and their inverse - the solid spatial architecture of the soil);
- Particle size distribution (sand, silt, clay) in an agreed number of classes;
- Soil pH (water, an electrolyte);
- Soil cation exchange capacity
- Soil water holding capacity;

The determination of these basic parameters will form a substantial part of any start-up costs of a soil monitoring network, something which is discussed further below.

Specific Parameters

As one of the next steps, it is essential to differentiate parameters into those that are obligatory and those that are not (facultative parameters). The latter should be monitored on a case-by-case basis in relation to the needs of the Member States depending on special purposes or regional questions. It was generally agreed within the WG that the parameters related to specific threats are as follows, but it is also recognized that several of the general parameters might also be relevant to specific threats, and would need to be brought into any assessment of these.

The WG agreed that there could be a strong case for the stratification of monitoring sites. Thus, for example, the baseline sites could be regarded as Level 1. These would

be the sites at which all the general parameters would be measured. In this way, these sites would offer maximum added value because they would readily link to existing databases such as EUSIS and to similar national databases within Member States.

On the other hand, the WG Monitoring is, like many of the Working Groups, acutely aware that not all desirable parameters can be measured at all sites and that there are many instances such universal measurement would be pointless and not cost-effective. One example would be the determination of the parameters for salinization in regions where such a threat has been absent historically or is never likely to occur within a meaningful time-frame. WG Monitoring is also aware that an element of expert judgment will be involved in the selection of these issues and parameters under the proposed 'next steps' procedures.

We propose, therefore, that consideration should be given to the creation of so-called Level 2 and Level 3 sites. We envisage that the former would relate to the investigation and monitoring of specific parameters and threats, and might well be strongly linked to research activities. Further investigations of, for example, erosion mechanisms or biodiversity might well be addressed properly through such sites. We hesitate to suggest a 'quota' for such sites, but something of the order of 10 per cent of the baseline sites might be adequate to permit a proper investigation, in detail, of a named threat at enough sites to be able to inform the discussion and assessment oif such a threat across al, Member States. Clearly, however, further consideration of this suggestion would be appropriate under a next-steps procedure through the proposed Co-ordination Group.

Level 3 sites could be related to very specific problems, e.g. radio-nuclides, military sites, decontamination of specific industrial residues, 'hot-spots' of anthropogenic or natural processes, or they might be regarded a benchmark sites for very specific research problems or cross-Community issues. Again, we consider that discussion of such an approach would fall naturally into the remit of a Co-ordination Group.

It has not escaped the notice of the Group that the Level 1 sites would also greatly assist the reconsideration of the representativity of any soil monitoring system at some point in the future. A network of this kind requires enough buffering to be able to withstand the loss or relocation of some sites over a long period.

Threats: Soil organic matter and biodiversity

Recommended parameters for soil organic matter and biodiversity:

For general purpose monitoring (Level 1) of the threat to soil organic matter, the Group recommends that the following be measured:

- Total organic carbon
- Total (organic) nitrogen,
- The C:N ratio derived from these.
- Bulk density

Rationale: There is concern that the decline of organic matter (of which organic carbon and nitrogen are measures) in the soils of Member States is leading to irreversible decline in soil fertility and nutrient cycling, structural stability and biological diversity or potential. There is also evidence that organic matter affects the mobility of potentially toxic elements found within, or applied to, soils (see Soil Contamination, below). There is concern that excessive amounts of soil organic matter, either as exogenous material, or in carbon 'hot-spots, i.e. where soil organic carbon is naturally abundant, are equally undesirable, as they can make soils more prone to erosion (especially by wind), may make them more acid, or cause the soil to become nutrient deficient. The concentration of total organic carbon and its quality are also related to the amount of Dissolved Organic Carbon (DOC) in the Soil. Excess of the latter can give rise to unacceptable colour in water supplies, to undesirable nitrogen leaching to ground water, and is involved in the transport of potentially harmful substances such as metals and organic compounds within and through the soil, for example. Total soil organic carbon is an overall measure of the state of the soil, and responds relatively rapidly (<10 years) to changes in pressures and thus is a response variable. The C:N ratio is a measure of the quality of soil organic matter, the higher the ratio the more stabilized the organic matter is.

Organic carbon and nitrogen are widely measured as standard properties in most soil laboratories and thus the determination is made at relatively low cost because of the economies of scale.

Total organic carbon and nitrogen give a broad indication of the soil to host biodiversity. Bulk density allows adequate comparisons of data between different soils. However, there are several parameters that could be monitored at sites targeted at more specialist investigations, many of which have been identified as research tasks (below):

For Level 2 sites, it was agreed that the following parameters might also be measured, depending on the progress in research on methods, standards etc.

- SOM compartments and pools
- with a physical separation + biochemical characterization (FTIR…)
- Top layer description
- Bioavaibility of nutrients and pollutants (toxicity)
- Measurement of fluxes: in water or air (emissions of GHG)
- + test of aggregation
- Forest soil monitoring
- Land occupation and practices
- Exogenous organic matter input
- Carbon hot spot monitoring: soils rich in OM but also depleted and degraded soils (desertification)

For Level 3 (benchmark sites), the following parameters were proposed:

- **Microflora**
- microbial biomass
- measurement of some biological functions (respiration, N and C mineralization..)
- diversity where molecular signature are now widely used (indicator of genetic biodiversity)
- Activity
- Carbon mineralisation (basal respiration)
- Diversity

- **Fauna**

- Nematodes,
- Earthworms or total macrofauna

Research needs: WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to soil organic matter and biodiversity (note that many of these research topics are cross-threat):

1. - research to give a better understanding of the role of SOM in optimising soil functions;
2. - research aimed at understanding why changes in SOM are important for understanding more fully the role and dynamics of the fractions of SOM, the role and dynamics of soil meso-, macro-, and micro-organisms at sub-molecular and higher levels, and the nature of the relationships between SOM fractions and soil organisms;
3. - research aimed at understanding how to upscale information obtained from the sample to the field, regional and global scales;
4. - characterisation of soil biodiversity in selected key, natural and managed ecosystems, including ecosystems currently undergoing change from natural and anthropogenic processes;
5. - research to give a full and clear understanding of the multiple function of SOM and biodiversity in order to be able to present policy guidance confidently into the management of these soil properties;
6. - reversibility and irreversibility of processes linked to the management of carbon in soils by different agricultural and forestry practices.
7. - research for the development of appropriate standardised methods for the characterisation of the nature and function of the SOM pools from a biological and structural perspective in contrasting environments across Europe;
8. - development of appropriate standardised methods to characterise soil biodiversity of micro-organisms;
9. - the identification of organisms as indicators to be monitored, taking into account the ease of measurement, the value as an indicator and the relationship with other organisms;
10. - research to provide a scientific basis for a minimum data set, appropriate for the appropriate monitoring of soil in contrasting natural and managed ecosystems in Europe. These methods will probably be at a range of scales from whole organisms through to characterisation at the functional (mRNA) and the protein level;
11. - research on the spatial and temporal scales at which measurements of SOM pools and biodiversity should be monitored.
12. - research on effects of climate change and associated land cover, land use changes on SOM levels and pools and biodiversity;
13. - research on effects of management practices of farming and other land uses (e.g. additions of EOM to soil; changes in tillage practices such as conventional *vs.* integrated *vs.* organic farming; incorporation of residues from GM-crops; restoration of damaged land) on SOM levels and pools and biodiversity;
14. - research for combinations of those practices which can optimise SOM and soil biodiversity (e.g. combination of reduced tillage and additions of EOM);
15. - different contributions of different agricultural crops and plant covers in influencing SOM levels and pools and soil biodiversity;
16. - effects of the presence of contaminants on the role and functions of the SOM pools and soil biodiversity;
17. - characterisation of the potential of soils to sequester carbon under contrasting environmental conditions; are there broad principles which can be provided across Europe or which specific climate-landscape combinations?
18. - what are the requirements for developing modelling approaches which suggest outcomes with sufficient precision to be incorporated in policy and guidance frameworks.
19. - research for understanding the role of the SOM pools in determining soil functions;
20. - research to understand the relationship between the structural and functional properties of soil biodiversity and soil functioning;
21. - of particular importance to understand the "tolerances" of these relationships, the resilience to change in soil functioning and the extent and rate of recovery.
22. - investigate and evaluate the effects (positive and negative) of SOM pools and functions of different levels of tillage, across a range of environmental conditions;
23. - investigate and evaluate the effects (positive and negative) of the incorporation of a range of exogenous organic materials on SOM pools and functions and soil biodiversity;
24. - investigate whether it is possible to influence the resilience of SOM levels and pools and soil biodiversity to changing environmental conditions.

Threat: Soil erosion

Recommended parameters:
As '*next steps*', the WG Monitoring accepted the advice of the Task Group Erosion that soil monitoring *per se* , i.e. through on-the-ground measurements, should not be done for erosion ***at present***. Assessment of soil erosion should be done by up-dating at regular time intervals the baseline produced through modeling in the status report of the TWG soil erosion (see report from TWG erosion). This will be achieved by the collection of updated land cover/land use information (CORINE, LUCAS, GMES, National data, etc.), improved geomorphological data (DEM's, etc.), more detailed soil information (National data) and improved rainfall data. This modeling approach will allow the land-surface of the EU to be stratified into areas of actual erosion risk, potential erosion risk, and little erosion risk, e.g at the catchment scale. In this way, effort in on-the-ground monitoring will be directed in a cost-effective and focused way. Such an approach does not preclude the future establishment of specific monitoring initiatives for soil erosion in dedicated sites (these would be Level 2 or Level 3 sites depending on the nature of the problem to be investigated, its pan-European component(s), and the degree of research effort required). Within that background, the following topics might have to be considered, many of which are covered by the parameters suggested elsewhere for other threats and thus form part of the whole ethos of added value:

- Land use data and land management data (vegetation cover)
- Meteorological data
- Topographical data
- Soil data
- Surface particle size class, Soil depth, Soil type

MANDATORY physical soil parameters:

- Bulk density
- Solid particledensity
- Pore size distribution
- Saturated hydraulic conductivity (Ks) - laboratory measurements

MANDATORY chemical parameters of the soil solid phase

- Ctot, Corg

OPTIONAL physical soil parameters:

- Unsaturated hydraulic conductivity (Ku) - laboratory measurements
- Hydraulic conductivity (Ks and Ku) - field measurements
- Penetrometric (or cone) resistance
- Aggregate stability
- Soil-water content, volumetric
- Soil-water tension

- Monitoring soil erosion *sensu stricto*

  Measurements at the plot scale

  Measurements at the catchment scale

  - Mapping visible soil erosion features
    - Continuous measurement of sediment loads at the outlet of small catchments
    - Measurement of sediment deposition in ponds, lakes or reservoirs

- Monitoring on site impacts

Rationale: Measuring soil erosion with the same accuracy as soil physical, chemical or biological properties, e.g. soil organic carbon, is not possible, due to the erratic distribution in both space and time of soil erosion events. The modelling approach is suggested to assess the risk or state of soil erosion in Europe because it should be able to simulate scenarios of soil erosion under changing climatic conditions, and, most importantly, under different land cover, land uses and land management practices (agricultural policies and relating subventions), leading to changes in vegetation cover and soil cultivation. Using the same model in all Member States has the advantage that, provided the model is properly tested and validated for the Member State or region, and accurate data are available, model results will be at least comparable and of relative value. Monitoring vegetation cover can be considered both as 'action driven' (evaluating the effect of a policy) and 'multi-purpose' (providing background information). Maximum use should be made of existing sites for validation purposes, which are continuously but independently being set up by different research groups in Europe, but without any co-ordination at a European level. The usefulness or otherwise of linking monitoring of soil erosion to LUCAS (or other EU-programmes) should be considered further as a 'next-steps' exercise (in *Annex 1*), as this kind of system is able to provide at regular time interval for the whole EU fundamental parameters (land cover, land use) for running the above mentioned model.

Research needs:

WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to soil erosion (note that many of these research topics are cross-threat):

1. Research to understand the chain of processes between bio-physical drivers of water and wind erosion and ecological and socio-economic effects, with emphasis on model improvement and scale issues.

2. Extension of existing research facilities to create long-term monitoring sites, to support fundamental research, calibration and validation of models, up-scaling and extrapolation, finding indicators, and risk assessment using soil information and remote sensing.

3. Research to understand the driving forces such as:
   - land use change (climate and policy driven);
   - climate change (frequency, magnitude);
   - land management: land levelling, tillage displacement;
   - spatial impacts: desertification, forest fires, snow melt.

4. Analysis of ecological and socio-economic impacts and definition of sustainable land management;

   - improvement of knowledge on the inter-linkage between soil erosion and biodiversity change.

5. Increase in education and awareness;

   - development of new conservation and remediation methods on agricultural lands;

   - definition of tailored conservation methods.

Threat: Soil Contamination

WG Monitoring broadly accepted that different approaches will need to be taken to the monitoring of widespread (diffuse) pollution and local contamination, including 'hot-spots' where urgent action might be required. Local contamination can present particular problems in that it is often site-specific and might not have a clear spatial relationship to the surrounding diffuse pollution footprint.

Parameters to be monitored for diffuse soil contamination (Level 1 sites):

'Total' element concentrations in soils are commonly measured to give an indication of the total soil resource. 'Total' in this context is often taken to mean that fraction extractable by hot *aqua regia* solution. The aqua regia extractable fraction of heavy metals is a widely used standard method. However, relatively large "total" metal concentrations can be of natural origin, and in many cases these natural concentrations are weakly mobile and not bioavailable. Natural background should be investigated at least from a subset of sampling sites. There is a strong case for linking the elements of interest to those likely to increase from atmospheric deposition, from additions of sewage sludge, or from other wastes, and these relate strongly to various existing Directives. The suggested list at present is as follows, but there may need to be considerable local latitude to allow for particular circumstances in Member States, although we recommend that, in the first instance, this list should not be shortened, i.e. it is a minimum data set:

- Arsenic (As),
- Cadmium (Cd),
- Chromium (Cr),
- Copper (Cu),
- Mercury (Hg),
- Nickel (Ni),
- Lead (Pb),
- Phosphorus (P) and nitrogen (N): nutrients connected with eutrophication,
- Zinc (Zn)

There may also be a need to determine a range of organic compounds, such as persistent organic pollutants (POPs), dioxins, di-benzofurans, PCBs, PAHs, pesticides (e.g. HCH, DDT, DDE). Similar arguments can apply to radio-nuclides such as radio-caesium, radio-iodine etc. However, not all Member States will need to undertake such work, and, certainly, very careful thought needs to be given to the density of observations required to establish meaningful baselines for these parameters in the different regions of the EU25. Thus, we do not recommend that these parameters should be universally determined, or that they should form part of a minimum data set for all Member States.

In addition, application of sewage sludge on agricultural land, base saturation and heavy metal accumulation in topsoil should be included. Total element concentration in soil parent material (same elements listed above) should be measured at selected sites in order to assess the 'natural' background.

<u>Parameters to be monitored for local soil contamination (including 'hot-spots') (Level 2 sites)</u>:

The general conclusion is that the parameters measured at such sites, **which would undoubtedly include many of those mentioned above**, cannot be specified as part of a general monitoring framework, because the requirement depends entirely on the local circumstances. This is particularly true of the very large number of anthropogenic organic compounds. Thus issues of kind, frequency, and appropriateness are still unresolved. However, it was broadly agreed by WG Monitoring that certain *Indicators* should be used to track the nature and magnitude of local soil contamination, as well as some Pressures and Responses:

1. Progress in contaminated site management;
2. The number of contaminated sites at each stage of management;
3. Site specific information
4. Registers of contaminated sites;
5. Area and catchment-specific information;
6. Unused industrial land;

The suggested indicators should be structured as follows:

1. Country level: Progress in contaminated sites' management

   - Number of identified and estimated total number of potentially contaminated sites
   - Number of sites where investigation measures are in progress
   - Estimated total number of sites where investigation measures are necessary
   - Number of identified and estimated total number of contaminated sites
   - Number of sites where remediation activities are in progress
   - Estimated total number of sites where remediation activities are necessary
   - Number of sites where remediation activities are complete

2. Area related level

   Collection of data being of relevance for the total area (e.g. total impact on soil being of relevance for water management at catchment level). Reporting of aggregated data.

3. Site specific level

   Collection of site specific data at national level. Sites can either be large-scale single sites being of EU relevance or "Mega Sites" (agglomeration of individual sites, integrated management required). Reporting obligation for selected data at site specific level.

Level 3 sites would probably encompass both very specific contamination problems, e.g. radio-nuclides, military contamination, major chemical facilities and so on, and could also form a focus for research effort. It was agreed that, due to the complexity of the potential combinations of problems and related parameters, many of these issues will have to be addressed on a case-by-case basis.

<u>Research needs</u>: WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to soil contamination (note that many of these research topics are cross-threat):

1. Identification and quantification of contamination sources (both geogenic and anthropogenic), especially diffuse contamination, the entry route and fate of contaminants into/in the environment and assessment of spatial and temporal variations;
2. Understanding of the capacity-controlling factors in soil that influence long-term behaviour of contaminants in soil;
3. Understanding of the impact of contamination on the soil-water-sediment system.
4. Production, validation, optimisation, and harmonisation of **exhaustive, reliable, and economical measurement methods** for all steps in the characterisation of soil contamination (sampling, analysis, background levels, etc), specifically addressing:

   a. sampling, identification and quantification of "non standard" substances (e.g. VOCs, known and emerging pollutants) in soils;
   b. early warning systems (e.g. sensors) for soil pollution;
   c. characterisation of speciation and short- and long-term fate of pollutants in soils;
   d. passive sampling technologies related to soil pollution;

e. indicators or tracers for the assessment of soil quality and functioning;
f. interdependencies of effects and behaviour of substances in soil under different conditions, in order to better organise site characterisation.

5. Definition of criteria and harmonisation of methodologies to allow the identification of chemicals which may pose potential danger in the future (priority substances for the terrestrial environment).

6. Identification of the socio-economic driving forces (money, education, regulation, administration) and the influence of management actions (e.g. change to different chemicals, change of crop rotation system, livestock units per ha, no-till, soil-protection as a trade-off) influencing soil pollution and quantification of their effects.

7. Improvement and harmonisation of the concepts and the modelling of the transfers of contaminants from and within the soil and of the subsequent risks, specifically addressing:

   - bioavailability for humans (soil ingestion, inhalation, dermal uptake);
   - bioavailability to plant and soil organisms;
   - vapour transfer from soil into outdoor and indoor air;
   - integration of the background exposure for natural substances;
   - (eco)toxicological threshold values and their uncertainty/reliability.

8. Improvement of risk assessment methodologies for:

   - remediation activities on a contaminated site;

   - re-use of waste as soil (ashes from incinerators, foundry sands,…);
   - impact of agricultural practices on soils (sewage sludge, fertilisers,…);
   - impact of diffuse pollution and eutrophication by atmospheric deposition in near-natural ecosystems of Europe.

9. Construction of a" fit-for-use" tool-box for risk modelling for use in (parts of) Europe, including:

   - documentation on the sensitivity of calculated exposures to the input parameters and guidelines on when and how to measure concentrations in contact media;
   - information on the uncertainty and reliability of calculated human and ecological exposure.

10. Comparison of modelled and measured exposures in order to move from assumed conservatism to quantitative data on levels of conservatism, to decrease the conservatism of models and the bias towards overly high safety factors;

11. Development of flexible but harmonised methods for establishing "tolerable loadings" in soil;

12. Development of a conceptual basis for combining different sources of spatial and temporal variability (physical, chemical, biological) for complex soil and ground water systems.

13. Identification of natural attenuation capacities of soil and its preservation;

14. Improvement of the quantification, and the consistency with impact assessment, of natural soil rehabilitation processes;

15. Development of methods for the comparison of alternative management options (evaluation of risk based approaches in decision support systems).

Threat: Soil Sealing

Monitoring of soil sealing can be obtained from appropriate statistics, as is already done by the Member States and collected by EUROSTAT. Effort is needed to find common definitions on the proportion of sealed soils in built-up areas, which also includes private gardens, green areas accompanying transport corridors etc. Harmonization of definitions between member states is needed. WG Monitoring broadly agreed that an approach is needed that both reflects the nature of the amount of soil sealed, the kind of soil being sealed, and the rate (intensity) of soil sealing. The most successful approach is likely to be based on remote sensing. The joint initiative GMES (Global Monitoring of Environment and Security) between the EC and ESA (European Space Agency) aims to develop operational services using remote sensing data by 2008, with the aim of improving the data quality for environmental reporting in relation to the soil thematic strategy and especially on the threat to soils due to sealing.

Research needs:

WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to soil sealing (note that many of these research topics are cross-threat):

1. establish methods to survey sealing in respect of area quality and quantity, analyse ways of flexible use and interaction with sealed areas;
2. investigate the numerous effects and threats from sealing on soil qualities and soil functions, to health and human environment, to quantify them and establish assessment procedures;
3. investigate the threats to social and economic fields;
4. investigate the benefits for soil and nature and develop assessment methods;
5. investigate the economic benefits and develop assessment methods.
6. developing sealing survey and monitoring methods;
7. evaluation of the existing methods of examination of the degree of sealing and developing a standard "sealing degree" assessment procedure;
8. developing standard sealing quality assessment methods with the inclusion of regional demands and specifications such as natural differences;
9. implementing pilot projects on sealing survey, monitoring and assessment; including the other research questions as appropriate, and establishing methods for urban soil and soil substrate survey and monitoring;
10. performing pilot projects for surveying urban, industrial and traffic areas;

11. establishing monitoring and assessment methods for sealing which include the original and current quality, occurrence and rarity of soils, and sensitivity of soils to sealing;
12. developing criteria for the determination of intervals of sealing and urban soil monitoring;
13. developing methods how to monitor soil use, socio-economic and planning parameters, and population development, and their importance for sealed areas.
14. establish parameters for the socio-economic needs for sealing;
15. establish monitoring methods for identifying the land users, land owners and planners and their demands, and the needs for sealing with regard to land use types;
16. establish rules for the determination of the minimum surface and spatial distribution pattern, and the quality of soils in areas which have a high degree of sealing;
17. learn lessons from the implementation of the ESPON (European Spatial Planning Observatory Network) project and integration of land consumption in the analysis of the effects of territorial policies like TEN, structural funds, CAP.
18. investigate the effect of sealing on the mass-, element- and energy flow in urban, suburban and rural areas;
19. analyse kind and degree of impacts from sealing on local, landscape and global level in relation to sealing degree and quality parameters for sealing and soils;
20. establish socio-economic costs of inadequate use (not corresponding with the preferred soil function) of soils by sealing;
21. assess the benefits and negative impacts of land use planning on sealing.

Threat: Soil compaction:

The ecological impact of soil compaction is reduced soil aeration and subsequently reduced rooting density and rooting depth. Soil compaction also has an effect on soil infiltration and on run-off potential. WH Monitoring broadly agreed that the spatial assessment of compaction was difficult to monitor and was strongly affected by land-use. The only parameter put forward was bulk density.

Research needs:
WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to soil compaction (note that many of these research topics are cross-threat):

1. quantification of strengths, deformation and compaction of soils and stress transmission in soils;
2. implementation of new models for prediction of stress transmission and soil deformation.
3. assessment of existing compaction level in European soils.
4. quantification of soil conditions which are sensitive to compaction;
5. assessment of actual trends in the technical-industrial development of agricultural machinery, causing deep reaching compaction.
6. quantification of compaction effects on soil functions;
7. improvement of models predicting and describing effects on soil functions.
8. development and evaluation of tools to reduce sub-soil compaction.

Threat: Floods and Landslides

WG Monitoring was broadly in agreement that this threat was best approached at the trans-national level, with Member States co-operating in the definition of 'flood' and 'landslide', e.g. extent, magnitude, duration, economic aspects. It was also broadly agreed that the initial approach should be indicator-based. Once appropriate definitions of indicators are agreed, it is proposed that there should be development of the following during a 'next steps' period. In the meantime, the suggestions from WG Monitoring are given below for information:

- **European reporting**

  - Occurrence and localisation of events over a certain size (criteria to be specified) and their environmental, social (loss of human life, displacement of people) and economic impacts (damage to buildings, etc.)
  - Localisation and characterisation of areas at risk (limited to areas that have European relevance; criteria to be specified)
  - Costs of remediation and compensation
  - Plans and management systems in place
  - Further information on evolution of soil sealing in risk areas
  - **Development of indicators**
  - Occurrence of landslide and flooding events
  - Impacts of floods and landslides
  - Management of hydrogeological risk
  - Preparation of maps of areas subject to hydrogeological risk.

Research needs:

WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to floods and landslides (note that many of these research topics are cross-threat):

Floods:

1. - Fundamental research on water storage capacity in river basins;

   - soil water storage, soil moisture;
   - influence of vegetation, land cover, and land use changes;
   - influence of soil sealing (cross-cutting).

2. Flood risk assessment across Europe.
3. Research to understand the driving forces:
4. climate (frequency, magnitude);
5. climate change;
   - connectivity in relation to rapid flow.
6. Analysis of ecological and socio-economic impacts of erosion using monitoring and modelling.
7. Development of flood management strategies:
   - o land use planning (giving space to the rivers);
   - o development of legal instruments.

Landslides:

1. Fundamental research for a better understanding of:

   - field strength and stability;
   - effect of vegetation;
   - impact of land cover and land use changes (via hydrology).

2. Land slide risk assessment across Europe, including soil stability research.

3. Research to understand the driving forces:

    - climate and climate change (frequency, magnitude);
    - soil hydrology, ground water systems;

4. geology.

5. Analysis of ecological and socio-economic impacts of landslides, using monitoring and modelling.

6. Development of:

    - early warning systems;
    - prevention measures (technical, land cover and land use change).

Threat: Salinization and sodification

WG Monitoring agreed that salinisation was a problem likely to be of local extent and should be addressed by individual Member States, although there was no agreement as to how the results of such local assessment should be reported. In areas prone to salinization (these would probably be Level 2 sites), the following parameters are suggested (again note how many are already included in 'General Parameters'):

Parameters to be monitored for soil salinisation and sodification:

- Granulometric composition,
- Profile description.
- Catchment scale:
- Soil organic matter,
- Electrical Conductivity,
- Sodium Adsorption Ratio (water and soil extract),
- Bulk density,
- Saturated hydraulic conductivity, aggregate stability*,
- Slope,
- Ground water level,
- Soil water content,
- Soil vegetation cover fraction.
- Plot scale:
- water retention curve,
- unsaturated hydraulic conductivity,
- soil shrinkage characteristic curve,
- Cation Exchange Capacity,
- exchangeable ions,
- sediment production,
- soil loss.

The quality of irrigation water is often a good *surrogate indicator* that soils may be exposed to the threat of salinisation.

Research needs:
WG Monitoring is advised by WG Research that the following topics should be addressed in the longer term with respect to salinisation and sodification (note that many of these research topics are cross-threat):

1. the interrelationships between the physical, chemical, mineralogical and hydraulic properties of soils which make a soil sensitive to salinisation - sodification and determine its response to drivers and pressures;
2. the reversibility of the soil degradation processes caused by salinisation - sodification;
3. how to measure soil resilience and soil renewability;
4. how to translate these concepts into measurable parameters and indicators;
5. how the water flow conditions (Darcian flow, bypass flow) in the saturated and unsaturated zones may influence the processes of salinisation and sodification, as well as strategies for salt-reclamation;
6. pedotransfer functions to be used for predicting soil parameters and up-scaling procedures;
7. inter-relationships between salinisation and sodification and desertification.
8. to agree the selection of indicators to be used for checking the state of and for monitoring the evolution of salinisation and sodification;
9. to monitor the effects of salinity and sodicity on soil structural and hydraulic properties (aggregate stability, water retention and hydraulic conductivity);
10. to harmonise the measurement techniques to be used to measure indicators and soil properties.
11. the influence of the different drivers (i.e. intensive agriculture requiring use of saline water for irrigation and/or waste-waters) on the processes of salinisation and/or sodification under different levels of pressures (i.e. climate with increasing temperature and evapotranspiration, with dry seasons during which irrigation is necessary to keep acceptable levels of crop yield, and erratic rainfall; intensive use of soil and of irrigation);
12. the role of (improper) water and land management as driver or pressure needs to be better quantified;
13. how to integrate actions and policies preventing salinisation or sodification into programmes for the management of water resources (egg. European Framework Directive), environmental and agricultural programmes, and/or desertification programmes (UN Convention for Combating Desertification, UNCCD).
14. how salinity (cation concentration) affects crop productivity and yield, with economic evaluation;
15. how salinisation and sodification affects the structural and hydraulic characteristics of soil, water transport in the vadose zone, water available for crops and evapo-transpiration, bio-diversity;
16. the economic and social impact of salinisation and sodification (e.g. changing crops towards more tolerant ones, sometimes with less economic advantage, additional costs for farmers in order to build drainage systems or to use more water to perform salt-leaching; unemployment and land abandonment, with some extreme consequences such as suicides in some countries;
17. how different levels of salinisation or sodification affect sealing and crusting, water balance, infiltration and runoff, and erosion at different scales.
18. to collect updated and reliable information on the status of salinisation and sodification in Europe, and of other information related to the process of salinisation and sodification (establishing a network in Europe);

19. to identify areas threatened by salinisation and sodification in different countries by measuring the suggested indicators (EC, ESP, SAR);
20. to perform validation/calibration of models predicting transport of water and solutes for selection of management strategies scenarios (i.e. alternative irrigation methods and scheduling, calculation of leaching requirement, conjunctive use of different irrigation waters, amendments, etc) or alternative land uses accounting for the social and economic consequences of land degradation;
21. to increase awareness of the risk of land degradation (desertification) linked to the processes of salinisation and sodification (stakeholders);
22. to integrate actions and policies preventing salinisation and sodification into other European Programmes (Water, Environment, Agriculture, Combating Desertification).

The use of the DPSIR Model

We regard the application of this model to each and every possible parameter as unnecessarily time-consuming **at this stage of development**, but we recommend that this be reviewed by the proposed Coordination Group. Similarly, we were unable to come to an agreed position, within the time available, on what can be achieved with indicators versus parameters, and we thus recommend that this question is visited further by the proposed Coordination Group. However, we clearly recognize that the DPSIR framework could provide useful information on those processes which lead to changes in the pressures on soils and, perhaps, their state, e.g. economic activity (increase in buildings, roads, construction of factories etc.), the drive to increase crop yields and the agronomic advice associated with this, the need to dispose of more waste to land (kind of waste, kind of land to receive it), and so on. This might well include consideration of the monitoring of preventative measures and suggest ways in which the effectiveness of such measures might be assessed.

Task Group on harmonisation

General

The TWG identified two requirements:

1. The need to harmonise existing data so that maximum value can be obtained from past and current soil monitoring activities. We believe that this is best dealt with through assessments by experts coupled, where necessary, by some inter-laboratory comparisons based on Certified Reference Materials (or other agreed materials). We recommend that there should be a next-steps exercise to achieve this.

2. The need to harmonise future activities. The latter should include protocols for, but not necessarily restricted to:

    - the selection (taking note of the principle of representativity), location, setting up and maintenance of monitoring sites
    - site and soil descriptions
    - sampling strategies
    - laboratory procedures
    - data handling and storage

Many of these issues are covered elsewhere in this report. The WG Monitoring recommends strongly that, wherever they exist, use should be made of the normative methods produced under the auspices of ISO and CEN. Such use should be mandatory and backed by legal powers within the Directive. If a Member State requests derogation with respect to a particular norm or norms, then it must produce evidence, acceptable to Commission experts in the relevant field, that the performance of the proposed national or local norm is equivalent to that of the procedure stated in the Directive.

The TWG also recommends that the Commission should support strongly the development of further norms relevant to the aims of the Soil Monitoring Directive. The current norms are listed in Annex 3 of the task group report on Parameters and Harmonization.

Costs of monitoring and harmonisation.

The Task Group was unable to undertake a cost-benefit analysis of soil monitoring as it did not posses the requisite skills in this area of economic science. The TWG recommends that the European Commission should undertake such an analysis with considerable urgency. Similarly, there is no agreed method for deriving the costs of soil monitoring within Member States. It is clear from discussions that there can be considerable hidden costs within such programmes. The WG Monitoring recommends that the costing of soil monitoring should be examined more thoroughly in order to evaluate properly the true costs and the long-term costs, e.g. of sample storage, quality control over decades, data handling and storage etc., few of which are included in the figures below. Figures were supplied for the purposes of comparison by Germany, Hungary, Portugal and the UK. These figures are based on recent monitoring activities adjusted, as far as possible, to current prices. A VAT component has been included only for Portugal. No attempt has been made to harmonise such things as overhead rates. The figures should, therefore, be taken as indicators of costs in representative Member States' economies. It is far from clear to what degree hidden costs are included, especially those of a long-term nature. The WG Monitoring is of the opinion that the costs of soil monitoring are unlikely to be found within standard recurrent programme budgets. Experience suggests strongly that all successful monitoring programmes have been funded by a special programme, set up for that specific purpose, within the relevant Member State.

<u>Costs within Germany</u>: Germany has made a preliminary estimate of the costs for the acquisition of the basic site description parameters (mostly identical with the General Parameters proposed by the respective Task Group), according to internationally agreed standards, of around €6,000 per site and the laboratory costs for the analysis of around 20 of the most relevant parameters at around €4,000 per site. These costs are based on current soil monitoring activities within Germany.

<u>Costs of Soil Monitoring System within Hungary</u>:

The aim of the Hungarian soil Monitoring System (TIM) is describing the soil resources (baseline condition) and keeping track of the changes in soil properties over time. TIM covers the entire territory of Hungary without any limitation as regards land cover, land use, property rights and other considerations. The system was elaborated by an expert team in 1991 and the first observations were carried out in 1992. The Monitoring System comprises 1236 sites 865 on agricultural land, 185 in forest areas, 189 in environmentally threatened regions such as degraded lands, hydro-geological recharge zones of drinking-water sources, catchments of lakes and reservoirs, severely polluted industrial and built-up districts, around landfills and hazardous waste disposal facilities,

areas affected by transportation, military establishments and other vulnerable environments. The sampling sites were selected in order to represent the soil conditions of smaller geographical regions. The Global Positioning System (GPS) was used to identify the location of the sites with the accuracy of 2.5-3 m, The GPS co-ordinates were converted after correction to geographical co-ordinates. The sites are sampled between September 15 and October 15 in order to avoid the effect of the fluctuation of certain parameters within the year. Soil profiles 150 cm deep were dug in the first year and a detailed profile description and on-site analyses were carried out before sampling on all the sites. In the years following, samples were taken by drilling. Samples from each layer and horizon are stored in a sample bank. To get the information on baseline conditions, all the chemical, physical and biological soil parameters were determined for each horizon in the laboratory. Since 1993 the analyses have been repeated at 1, 3, or 6 year intervals depending on the rate of change in the properties. The measured parameters are shown in *Annex 4, Table 1*. TIM is operated by the Plant Protection and Soil Conservation Service. The soil conservation specialists in each county are responsible for sampling, while the laboratories of the Service carry out the analyses. All activities, including data handling, evaluation and distribution, are coordinated by the Department of Soil Protection Development of the Central Service for Plant Protection and Soil Conservation. Costs are broken down in *Annex 4, Table 2*.

- Total cost of the laboratory analyses for baseline condition for 1 sample with laboratory methods according to Hungarian standards: €431,3
- Total cost of the laboratory analyses for every year for 1 sample with laboratory methods according to Hungarian standards €49,3
- Total cost of the laboratory analyses for every 3 years for 1 sample with laboratory methods according to Hungarian standards: €235,7
- Total cost of the laboratory analyses for every 6 years for 1 sample with laboratory methods according to Hungarian standards: €371,8
- Sampling and profile description for 1 sampling point: €147,1
- Costs of data processing and administration: €15
- Total costs for baseline condition for 1 sampling points if 3 layers are sampled: €1456
- Total costs for every year for 1 sampling points if 3 layers are sampled: €211,4
- Additional costs that can not be calculated:
    - storage of the samples in sample bank;
    - maintenance of the database;
    - software development and maintenance.

Costs of soil monitoring in Portugal: These are given in *Annex 4, Table 3*.

Costs within the UK: These are based on the projection from historical costs of four round of monitoring in England and Wales (1978, 1994, 1996, 2001). Baseline costs (site selection, staff training, documentation, quality assurance etc.) are estimated to be between €4000 and €5000 per site, and basic analytical costs (excluding any determination of organic compounds) are estimated at €2500 per site.

Costs of the LUCAS survey: These are given in Annex 4, Table

There was an intensive discussion, but no majority opinion within the Working Group on the question of whether a systematic grid (at whatever level) will be the right approach or if, as a first step, it could be more effective to act at a level of representative sites selected by Member States (cost-benefit analysis).

The Chair wishes to remind people of the fact that according to EUROSTAT statistics,

the EU 25 members cover an area of **3.972.868km^2.** For a **16 x 16** km grid-based sampling this would imply **15.519 measuring points,** for an **8 x 8** km sampling grid this becomes **62.076 measuring points.**

Thus, it becomes very obvious that as long as there is no clear picture of the future soil monitoring needs, a serious over-all cost estimate at this stage of the work is not possible. Therefore, we attempt to give only a picture of the costs of certain elements of soil monitoring.

Germany has made a preliminary estimate of the costs for the acquisition of the basic site description parameters (mostly identical with the General Parameters proposed by the respective Task Group), according to internationally agreed standards, of around €6,000 per site and the laboratory costs for the analysis of around 20 of the most relevant parameters at around €4,000 per site. Note that these costs could be incurred BEFORE a decision is made to accept a site for monitoring because detailed investigation might show it to be unsuitable for the intended purpose. Thus a significant part of the initial costs have a risk element attached, but of course they are only incurred once. In England and Wales, costs are approximately two-thirds of these values, in Portugal they are about half, and in Hungary somewhat less than in Portugal. These differences clearly reflect different staff costs etc., BUT they doubtless fall equally heavily on local budgets, and are substantial when viewed in the light of the number of sites to be monitored.

This picture shows very clearly that because of the different staff costs only cost ranges can be offered.

Germany has calculated the costs for repeat sampling of the basic 18 parameters proposed, with the following result:

Revisiting the sampling site	200€	
Taking soil samples at 2 different depths		45€
Parameters for soil physics		140€
Parameters for inorganic soil chemistry		215€
Parameters for organic chemistry	200€	
Microbial Biomass and basal respiration		60€
Dioxins/Furans	350€	
Earthworm population with differentiation	600€	
Total	1810€	

To repeat: the expected costs per site and per sample for the selected sampling sites and the baseline investigations are calculated to be between 5000€ and 10000€, the repeat sampling of 18 basic parameters will cost between 900€ and 1800€. Costs for each additional indicator/parameter must be calculated separately and added to these sums.

A cost-benefit estimate cannot be provided at this stage.

Reporting

The WG was unable to agree on the precise details of a reporting mechanism for the information collected under a pan-European soil monitoring exercise (although some aspects of this are partly considered under 'Private Ownership', below). However, such a mechanism needs to be developed and should include such fundamental issues as units of measurement, precision of reporting, geo-

referencing, database structure(s), guardianship of, and access to, information, confidentiality, intellectual property rights and so on.

Recommendations

1. Existing data should be harmonized as far as possible, e.g. through expert assessment and a programme of trans-national comparison under a 'next-steps' procedure, so that maximum value can be obtained from past and current soil monitoring activities.

2. There is a need to harmonize future activities, which should include protocols for, but not necessarily restricted to, the selection (taking note of the principle of representativity), location, setting up and maintenance of monitoring sites, site and soil descriptions, sampling strategies, laboratory procedures, data handling and storage, and quality assurance.

3. The Commission should support strongly the development of further norms relevant to the aims of the Soil Monitoring Directive.

4. The Commission should undertake, with considerable urgency, a formal cost-benefit analysis of soil monitoring.

5. The Commission should assist in the development of a mechanism whereby all the costs of soil monitoring can be calculated in an open and transparent manner.

6. Adequate time frame for entering into force must be respected and set before a new method becomes obligatory.

Annex 1. LUCAS as a potential soil monitoring system data provider

Introduction

This paper aims at giving a short overview of the LUCAS data and enabling the reader to make up his mind on their usability in the framework of the soil monitoring system. It is stipulated that this system should be based on existing systems. LUCAS is an ongoing one and could undergo some modifications. However, LUCAS priority is the production of statistics on land cover and land use. Other features were observed during the surveys to show potentialities of LUCAS to be a multiple purpose system. Reliability and validity of data collected on such features is still ongoing and need further assessments. Nevertheless, adaptations could be introduced in the methodology, and it is the right moment to do so, to answer to specific needs in the limits of what a non-specialised surveyor is able to collect.

The LUCAS system

LUCAS is a pilot project launched by Eurostat in close co-operation with the Directorate General of Agriculture. LUCAS is an area frame statistical survey that aims at obtaining harmonised data at EU level on **land use, land cover and additional environmental features**. The survey consists in the ground visit in **springtime** of about 100 000 points sampled according to a regular grid. The survey has been carried out in 2001 in the EU13, in 2002 in the UK, Ireland, Estonia, Hungary and Slovenia and in 2003, in the EU15 and Hungary. LUCAS could be carried out in 2005 in some Candidate Countries and in 2006, in the EU25.

The LUCAS survey adopts a two-stage sampling design: at the first level, Primary Sampling Units (PSUs) are defined as cells of a regular grid with a size of 18 $\times$ 18 km. At the second level, the Secondary Sampling Units (SSUs) are 10 points, distant 300 m apart, regularly distributed in two lines distant as well 300 m apart around the centre of each PSU.

Despite the fact that LUCAS is still in a pilot phase and therefore is not stabilized and needs improvement the survey has proved its reliability in providing for the first time harmonised and comparable data at EU level allowing the assessment of changes occurring in the territory.

Key points:

- Harmonised nomenclature and methods of observation throughout the EU
- Identification of agricultural covers at species level (see annex)
- Clear separation between Land Cover and Land Use
- Grid of 18 km x 18 km enables many integer divisions for enlargement of the sample for national purposes (2 km, 3km, 6km and 9km)
- The systematic sampling approach is designed to cover with the same probability of observation all the territory and to collect multi-purpose information
- Precise and well documented location of points (orthophotos), geo referenced system
- Regular observation in time (the point is reached each survey with a precision of one to two meters)
- Clear specifications to manage and organize the survey (follow-up and training of surveyors)
- Harmonized quality control of data (common data entry software)
- Project managed by the Commission ensuring coherence of the system

Fields of interest in respect to the soil monitoring system

LUCAS is aimed as a priority at providing area estimates on land covers and land uses especially regarding agricultural areas and at assessing changes. It could provide as such basic harmonised data for monitoring soil in the field.

Land cover and land use changes

- The period of observation: points are observed from end of May up to beginning of July. This period has been chosen to easier the recognition of crops in the field
- The observation unit of LUCAS is the point, defined as the basic observation unit with **a 3 m diameter circle (7 m²).** In presence of trees, the circle is enlarged to **40 m (1257 m²)** to assess density and make the distinction between grassland with sparse trees, shrub land and wood land
- For complex situation (e.g. agro forestry, multiple usage), there is the possibility to identify two land covers and two land uses

Some results[1]: *according to LUCAS, artificial areas increased strongly between 2001 and 2003, with a rise of 6% i.e. 8,899 km². The analysis of the matrix of changes shows on what types of area they have encroached. Artificial areas encroached on grasslands for 35.6% of the flows from "non artificial areas" to "artificial areas" (Table 1). The other categories that contributed significantly are woodlands (22.3%), arable crops (16.9%), and bare lands (10.3%).*

[1] Results are to be considered with precaution because of the weak representativeness of LUCAS for small areas. Moreover, data are not completely validated and the period to observe changes is quiet narrow (2001/2003).

Table 1. Flows from "non artificial" towards "artificial"

2001 \ 2003	Built-up Km²	Built-up %	Non built-up Km²	Non built-up %	Artificial Km²	Artificial %
P. grass	3.181	*34,1*	6.158	*65,9*	9.339	*35,6*
Woodl.	744	*12,7*	5.109	*87,3*	5.854	*22,3*
Arable crop	1.320	*29,8*	3.113	*70,2*	4.433	*16,9*
Barel.	541	*20,0*	2.166	*80,0*	2.707	*10,3*
Shrub.	203	*15,4*	1.117	*84,6*	1.320	*5,0*
P. crop	575	*50,0*	575	*50,0*	1.150	*4,4*
FZ	711	*61,8*	440	*38,2*	1.150	*4,4*
Water	0	*0,0*	305	*100,0*	305	*1,2*
Total	7.275	*27,7*	18.982	*72,3*	26.257	*100,0*

The encroachment of artificial areas on non artificial areas was especially to the profit of non built-up areas (72.3%), in particular with regard to woodlands (87.3% of flows from "woodlands" towards "artificial areas") and bare lands (80%). The situation is more contrasted for arable lands and especially grasslands, of which 34.1% passed into built-up areas.

Transect information

In the framework of the LUCAS project, surveyors have to observe features crossed while walking along the straight line that connects the first five SSUs of each PSU, the so-called transects. The information to be registered is the sequence of land cover types along and the presence of linear features such as walls, hedges, roads, railways or irrigation channels etc. intersecting the transect (image 1).

Image 1– Information collected along the transect

The number of intersections counted along the transects makes it possible to estimate by extrapolation the length of the linear elements recorded. Thus in 2001, according to preliminary LUCAS estimates, about 92.000 km of rivers were bordered by green linear features (e.g. grass margin, hedges).

Other environmental features

Beside land cover and land use, the opportunity has been taken in the framework of the pilot survey LUCAS to collect additional data to test the feasibility and the usefulness of their observation**.**

- **Traces of water erosion**: 2 classes of number of rills and gullies (#<5, #>5) and 2 classes of area of accumulation (a<100 m², a>100 m²) are observed in the enlarged circle.
- **Traces of natural hazards:** indicate whether the area is affected by **damage** caused by natural hazards (fire, landslide, gales, avalanches and floods). The presence/absence is observed in the enlarged circle.

Some results[1]*: table 2 reports the distribution of the natural hazards recorded in 2001 within each land cover class; the last column of the table reports the contribution of each land cover class in the total of damaged areas. Most of the disasters affects forests (51,4%), shrubland (18,4%) and permanent grassland (10,8%). Most forest damages are the result of gales, accounting for 65,0%, compared with 20,8% for fire damage. Conversely, 81,2% of natural disasters on shrubland are caused by fire while damaged croplands are due for 59,8% to floods.*

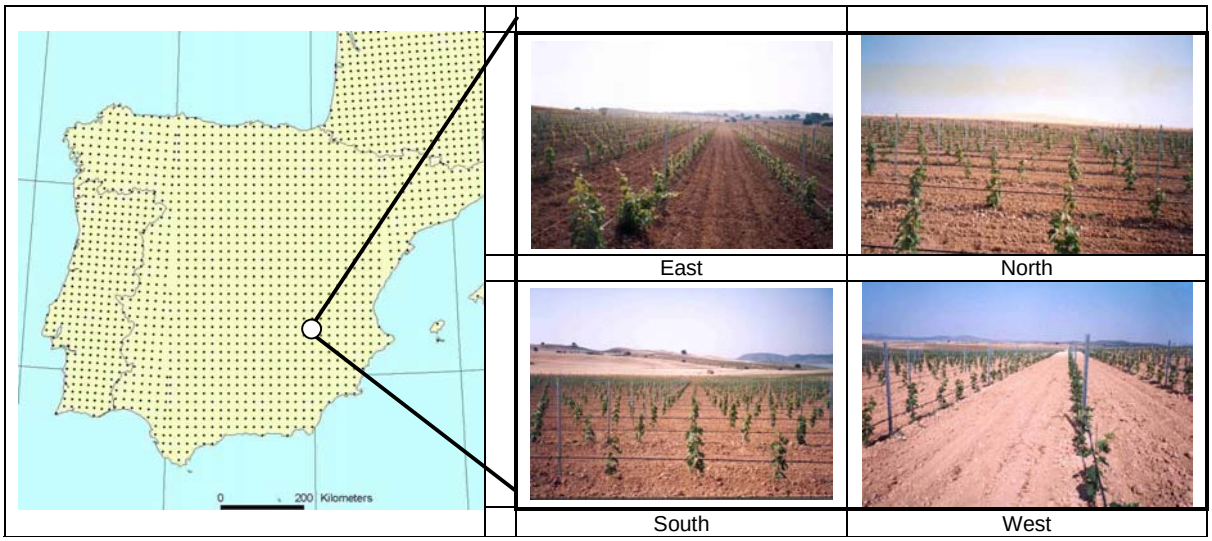
Table 2. Observed traces of natural hazard by land cover (%) in 2001

Land Cover	Gales	Burned	Flooded	Land slide	Ava-lanche		All Hazards
Woodland	65,0	20,8	5,6	7,8	0,8	100	51,4
Shrubland	3,6	81,2	4,5	8,5	2,2	100	18,4
P. grassland	11,5	29,8	39,7	18,3	0,8	100	10,8
Cropland	1,1	25,3	59,8	13,8	0,0	100	7,2
Water/Wetlan	6,0	3,6	88,0	1,2	1,2	100	6,8
Bare land	3,8	39,6	17,0	30,2	9,4	100	4,4
Artificial	38,5	23,1	30,8	7,7	0,0	100	1,1
							100,0

Landscape photos

20.000 photos approximately were taken in the 2001 and the same number in 2003. One photo has been taken in the four cardinal directions for each PSU. Each photo is georeferenced. These photos constitute a unique archive of European landscapes, to be exploited with the aim to open new perspectives of landscape analysis, in particular in combination with other sources of information such as aerial photos or satellite images.

Landscape photos taken at PSU 29-46 in Spain on 06/06/2003



Farm practices (phase2)

*Beside the field survey (May-June), farmer's interviews were carried out (October/November) gathering information on yield, crop rotation system and management practices. Farmers were selected from a sub sample of **5000** LUCAS points located in arable land. Farmers were identified from the points by using registers and cadastres. The survey was carried out in 2001/2002 and 2003 and data were collected for the following items[2]:*

Farm level:

- Farm type
- Type of livestock and number
- Areas and yields of crops cultivated by the farmer
- Crop calendar
- Erosion phenomena observed by crop

Plot level (located where LUCAS point falls)**:**

- Size
- type of Irrigation system and volume of water
- Number of passage of tools
- Quantity of mineral and organic fertilizers
- Number and type of pesticides application
- Traces of Erosion (perceived by the farmer)
- Kind of soil erosion protection measures currently applied on the plot
- Slope of the plot

Could LUCAS be adapted to the soil monitoring needs?

Sampling plan:

LUCAS sampling plan is designed to cover all the territory with the same probability of observation. Therefore, the systematic character of the sampling is to be kept. Changes that can be expected are the densification of the Grid to improve the representativeness of the observations (e.g. from 18 km to 9 km). The Commission expects strong involvement of Member States on that point.

[2] Complete questionnaire available at : http://forum.europa.eu.int/Public/irc/dsis/landstat/library?l=/lucas/reference_documentation/field_questionnaire&vm=detailed&sb=Title

Springtime field survey

As already mentioned, LUCAS is designed to provide harmonized estimates on Land Use and Land cover at EU level. Therefore, nomenclatures, period of observation and observation units (7m² circle and 1257 m² extended circle) will not be modified a part some slight changes for improving quality of results.

Adaptation could be however introduced in the observation of other features: erosion and natural damages. We could imagine (with precaution) that surveyors are asked to assess length and steepness of slope where points are located in arable areas. However, any adaptation will be strongly limited because of surveyors' burden and its lack of expertise in soil sciences. Any adaptation would have to be of the simplest and clearly specified.

Additional surveys

The survey on farm practices was carried out to test its feasibility from a sub sample of points. Results of the survey are still under validation and require further assessments.

If such a survey reveals to answer clearly to user needs, it could be envisaged that the Commission (or other public bodies) organised an additional survey on a regular basis to collect specific data on topics such as land management, erosion, etc. based on the LUCAS sampling scheme. As such LUCAS offers a **common platform**. However, for the time being, Eurostat short term objectives are to strengthen the springtime field survey to build a European statistical system able to provide reliable and early estimates of crops areas and other covers.

Potential uses of LUCAS data for monitoring soil

Obviously LUCAS in observing the Land Use and Land Cover and their changes provides fundamental data for monitoring indirectly threats such as **erosion**, decline in **soil organic matter**, **soil sealing**, and possibly floods and landslides.

Which way LUCAS could be used to gather relevant information on such soil threats?

Detection system

Even if it is claimed LUCAS is a multipurpose system, it is clear it is not designed to collect all type of data. However,

LUCAS offers the possibility to collect harmonised data potentially usable to detect problems occurring on the ground. Such problems would require complementary ground surveys and observations to monitor in an appropriate way the phenomenon. As such LUCAS could be used as a basis to stratify samples for specialised surveys. 2001 and 2003 exercises have shown the kind of additional data that could be provided (traces of erosion, traces of natural hazards, landscape photos). Still the reliability and the relevance of such information are to be further assessed. Eurostat is opened to include any modifications and to improve the observations if feasible.

Model calibrator: the example of erosion

The statement of the Working Group clearly outlines the conceptual limitations of LUCAS regarding the observation of soil erosion phenomena.

All the critical points mentioned are clear and have been acknowledged already during the design of LUCAS.

The WG mentioned several points for potential improvements of LUCAS, indicating that substantial modification of the current LUCAS survey are necessary to fit in the recommendations of the WG. However, even if the survey period (multiple surveys throughout the year) as well as the reference area (catchment) would be extended and financed, it is questionable how quantitative assessments could be done.

Again, it has to be bear in mind that LUCAS is designed to provide harmonised land cover/land use data at EU level, particularly on cropland for DG Agri (early estimation of crop areas by end of July each year) and thus not replacing a soil monitoring system. Information on soil erosion has to be considered as a "by-product", delivering complementary data about the area affected by soil erosion.

Considering the above, an alternative approach could be envisaged. A first proposal has already been outlined in the framework of the Eurostat funded project "Exploitation of data from the Community's LUCAS survey" (Available on demand : marcel.ernens@cec.eu.int (Head of Unit Eurostat/E2)). The proposal is based on modelling vulnerability and/or soil loss at plot level. Within such a modelling approach, different data are needed:

- Yearly data on land cover
- Site conditions (e.g. slope, soil texture)
- Rainfall data

LUCAS could provide yearly updated information about land cover, the most important factor in the soil erosion process. About 20.000 observation points (classified as arable land) throughout EU 15 Member States could be considered. Moreover, data from Acceding Countries could be included, since it is foreseen to conduct LUCAS also in these countries.

Ancillary information about the site conditions (slope, soil texture etc.) are further needed and could be obtained by exploiting existing data or through a single observation during a LUCAS field campaign. The model could be complemented with actual rainfall intensity data.

The potential advantage of such an approach would be to combine existing and harmonised data at EU level at a minimum financial expense. It is strongly believed that such an approach would complement the planned soil monitoring system, particularly considering the need of harmonised data and common methodology at EU level.

Availability of LUCAS data

LUCAS data (springtime field survey) can be transmitted to any organisation as far as they are used for research purposes or in the framework of a contract with a European institution. The transmission of data is submitted to the signature of an agreement between Eurostat and the organisation which engages the latter to protect the confidentiality of data.
Moreover, Eurostat is currently developing a database to store, manage, and exploit LUCAS results (i.e. statistical analysis, display of maps and landscape photos) on an Internet application. Access to individual data will be restricted. The application should be operational last quarter of 2005.

References

Publications on results and complete description of LUCAS methodology are available at: http://forum.europa.eu.int/Public/irc/dsis/landstat/library

Table 3. Land Cover, Land Use and Transect nomenclatures

A	ARTIFICIAL LAND	A1	BUILT-UP AREAS	A11	Buildings with 1 to 3 floors
				A12	Buildings with more than 3 floors
				A13	Greenhouses
		A2	ARTIFICIAL NON BUILT-UP AREAS	A21	Non built-up area features
				A22	Non built-up linear features
B	CROPLAND	B1	CEREALS	B11	Common wheat
				B12	Durum Wheat
				B13	Barley
				B14	Rye
				B15	Oats
				B16	Maize
				B17	Rice
				B18	Other cereals
		B2	ROOT CROPS	B21	Potatoes

Continued…

LAND COVER

				B22	Sugar beet
				B23	Other root crops
		B3	NON PERMANENT INDUSTRIAL CROPS	B31	Sunflower
				B32	Rape and turnip seeds
				B33	Soya
				B34	Cotton
				B35	Other fibre and oleaginous crops
				B36	Tobacco
				B37	Other non permanent industrial crops
		B4	DRY PULSES, VEGETABLES AND FLOWERS	B41	Dry pulses
				B42	Tomatoes
				B43	Other fresh vegetables
				B44	Floriculture and ornamental plants
				B45	Strawberries
		B5	TEMPORARY GRASSLANDS	B50	Temporary grasslands
		B6	FALLOW LAND	B60	Fallow land
		B7	PERMANENT CROPS: FRUIT TREES, BERRIES	B71	Apple fruit
				B72	Pear fruit
				B73	Cherry fruit
				B74	Nuts trees
				B75	Other fruit trees and berries
				B76	Oranges
				B77	Other citrus fruit
		B8	OTHER PERMANENT CROPS	B81	Olive groves
				B82	Vineyards
				B83	Nurseries
				B84	Permanent industrial crops
C	WOODLAND	C1	FOREST AREA	C11	Broadleaved forest
				C12	Coniferous forest
				C13	Mixed forest
		C2	OTHER TREE AREA	C21	Other broadleaved tree area
				C22	Other coniferous tree area
				C23	Other mixed tree area
D	SHRUBLAND			D01	Shrubland with sparse tree cover
				D02	Shrubland without tree cover
E	PERMANENT GRASSLAND			E01	Permanent grassland with sparse tree/shrub cover
				E02	Permanent grassland without tree/shrub cover
F	BARE LAND			F00	Bare land
G	WATER AND WETLAND			G01	Inland water bodies
				G02	Inland running water
				G03	Coastal water bodies
				G04	Wetland
				G05	Glaciers, permanent snow

Table 4. Land use

U1	U11	AGRICULTURE		
	U12	FORESTRY		
			U121	Forestry in natural forests
			U122	Plantations
	U13	FISHING		
	U14	MINING, QUARRYING		
U2	U21	ENERGY PRODUCTION		
	U22	INDUSTRY, MANUFACTURING		
			U221	Manufacturing of food, beverages and tobacco products
			U222	Textile products
			U223	Coal, oil and metal processing
			U224	Production of non-metal mineral goods
			U225	Chemical and allied products
			U226	Machinery and equipment
			U227	Wood based Products
U3	U31	TRANSPORT, COMMUNICATION, STORAGE, PROTECTIVE WORKS		
			U311	Railways
			U312	Roads
			U313	Water transport
			U314	Air transport
			U315	Transport via pipelines
			U316	Telecommunication
			U317	Storage
			U318	Protectiion infrastructure
	U32	WATER, WASTE TREATMENT		
			U321	Water supply and treatment
			U322	Waste treatment
	U33	CONSTRUCTION		
	U34	COMMERCE, FINANCE, BUSINESS		
	U35	COMMUNITY SERVICES		
	U36	RECREATION, LEISURE, SPORT		
			U361	Amenities, museums, leisure
			U362	Sport
			U363	Holiday camps
	U37	RESIDENTIAL		
U4	U40	UNUSED		

Table 5. Linear features (transect)

Linear Feature	Width	code	Definition/Observation
Grass margin	>1 - < 3 m	01	Strip of mainly uncultivated (not agriculturally used) vegetation, dominated by grasses, grass-like plants, forbs or herbs. Often located at the edge of fields, between cropped areas (beetle banks) or bordering roads and tracks (roadside verge) as well as associated with water courses.
	> 3 m	02	
Shrub or wood margin including line of trees	>1 - < 3 m	11	Shrubby or woody vegetation in a continuous linear shape, often managed (hedge) but also without evidence of recent management. This category includes also line of trees. Shrub or wood margins are found as field boundaries within agricultural land or alongside roads or water courses.
	> 3 m	12	
Cultural, man made features	>1 - < 3 m	21	Various man made built structures e.g. walls, dams or terraces etc. of different material such as dry stones or bricks but also mortared walls. All walls are to be recorded, independently from their width.
	> 3 m	22	
Ditches, channels	>1 - < 3 m	31	"Artificial" drainage or irrigation line, usually straight, temporary or permanently wet, often as standing water. Ditches are frequently found in agricultural land for lower the water table or drainage. They are often associated with roadside verges used to drain the runoff from the associated road. Ditches are to be recorded independently from their width. Edges or banks along the small water body are to be recorded separately as grass, shrub or wood margin.
	> 3 m	32	
Rivers and streams	>1 - < 3 m	41	A linear body of water, often flowing in its naturally shaped bed through the land into a body of water such another stream, a lake or the ocean. Banks or edges (riverside vegetation) have to be recorded separately as grass, shrub or wood margin.
	> 3 m	42	
Electric lines		50	Power supply line mounted on pylons used to transport electricity, including telephone lines.
Tracks	>1 - < 3 m	61	Usually rough tracks, mainly used to access agricultural land or forests, in most cases unpaved. They are not part of the public road network thus often closed for public transport. This category includes all type of paths and cycle tracks. Roadside vegetation has to be recorded separately.
	> 3 m	62	
Roads	>1 - < 3 m	71	Mainly part of the official traffic road network composed of roads of different levels (urban streets to highways). Roadside vegetation has to be recorded separately.
	> 3 m	72	
Railways		80	A set of rails on which trains run. Green linear features bordering the railway track are to be recorded separately.
other		90	Anything not specified in other classes. Description is to be given in the "Remarks".

Table 6. Land Cover transitions (transect)

LAND COVER	Code
Artificial	A
Cropland: ▪ Arable Land (B1-B6) ▪ Permanent crops (B7x+B8x)	 Ba Bp
Woodland	C
Shrubland	D
Permanent grass	E
Bareland	F
Water and wetland	G

Annex 2. Example of an Indicators for Local Contamination and other Parameters

Name of the parameter/indicator: Progress in contaminated sites management
Proposed by: Martin Schamann
Justification for selection: Quick, cheap and easy way to monitor progress for handling local soil contamination
Relevance for which EU-policy, -decision or –activity: Landfill directive; mining waste directive, IPPC obligations: Monitoring of effectiveness of existing regulations to avoid new contamination. Ground Water Directive: local contamination as a source for groundwater contamination; EU wide overview of areas/sites exceeding any kind of soil protection level and activities to bring them back into a legal framework
Why should it be done at the EU-level under subsidiarity: MS should be encouraged to monitor point sources and to draw attention to the problems
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Almost all EU countries keep registers of contaminated sites, but including different information in different ways. The EEA tried to compile this information and to harmonise it. As a consequence, there is information available at the EU level; countries are aware of and support data collection; the indicator is well-accepted within EU Member States.
Method/s to be used: (including sampling point density) *there is already experience from the EEA which should be taken into account. Parameters to be monitored*: - number of potentially contaminated sites - number of sites under investigation - number of sites where action is needed - number of contaminated sites - number of sites where action has been undertaken - amount of money spent for activities Builds up on existing monitoring systems in the MS; however needs clear definitions of parameters to be monitored; to a great degree expert estimates will be necessary as a consequence of missing data
Estimated costs and result of the improvement in cost-efficiency Cost-efficient method to get aggregated data in a short time. It is more cost-efficient to avoid or remediate damages at an early stage compared to well-advanced damage on a large scale
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds: 2 Years

Name of the parameter/indicator: Site-specific information-level
Proposed by: Martin Schamann
Justification for selection: As it is not appropriate to deal with all single sites at the EU level, it is proposed to focus on problem areas (areas of large extent with an accumulation of point sources with a large environmental input, needing specific management strategies to remove or mitigate the problems), and selected "mega sites" (e.g. corresponding to IPPC sites) which can pose considerable threats to a great number of people. Their management is therefore of EU-wide interest. As activities for risk reduction involve huge amounts of money, EU-wide comparable approaches for risk assessment should be guaranteed to avoid ignoring of necessary measures for risk reduction.
Relevance for which EU-policy, -decision or –activity: Enforce necessary measures of EU-wide interest to protect human health and quality of soil by the authorities of the EU through responsible bodies at national level. Possibility for the enforcement of activities at national level by EU authorities in case of neglect of necessary measures at national level.
Why should it be done at the EU-level under subsidiarity: Problem areas and IPPC sites are or EU wide interest as regards their tremendous potential for threatening human health and the environment. An EU wide coherent basis for the assessment of risks caused by these sites/areas would be required to guarantee adequate and EU wide comparable risk-estimations. Monitoring of problem areas and mega sites shall guarantee that the management of these sites follows risk priorities rather than local interests.
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Registers for contaminated sites provide the basis for data provision;
Method/s to be used: (including sampling point density) EU-wide comparable methods for data collection and assessment of risks caused by the areas/sites. Stipulation of a frame for measures and remediation goals in case of exceedance of quality levels.
Estimated costs and result of the improvement in cost-efficiency No site-specific investigation (like water or soil sampling) required; however, collection of available information. As a consequence: high degree of cost-effectiveness. In general it is more cost-effective to monitor and avoid contamination or to manage problem areas and specific sites at an early stage of contamination rather than when environmental contamination is far advanced.
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds: 5 years

Name of the parameter/indicator: Area/catchment specific information-level
Proposed by: Martin Schamann
Justification for selection: Protection of the environment for selected areas such as catchments or specifically protected areas (e.g. Natura 2000 areas) is of EU-wide interest. Monitoring of risks caused by point sources located in these areas has therefore to be done at the EU level.
Relevance for which EU-policy, -decision or –activity: Enforce necessary measures of EU-wide interest to protect human health and quality of soil by the authorities of the EU through responsible bodies at national level.
Why should it be done at the EU-level under subsidiarity: Catchment or other specific areas are of EU-wide interest as regards their tremendous potential for threatening human health and the environment. An EU-wide coherent basis for the assessment of risks caused by these sites/areas would be required to guarantee adequate and EU-wide comparable risk-estimates. Monitoring of catchment or other specific areas will guarantee that the management of these sites follows risk priorities rather than local interests.
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Registers for contaminated sites and identification of catchment areas provide the basis for data provision;
Method/s to be used: (including sampling point density) EU-wide comparable methods for the assessment of risks caused by the areas. Stipulation of a framework for measures and remediation goals in case of exceedance of quality levels.
Estimated costs and result of the improvement in cost-efficiency
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds 5 years

Name of the parameter/indicator: Unused industrial land
Proposed by: Martin Schamann
Justification for selection: Currently, there is an intensive trend for using green field sites for locating new industrial enterprises. At the same time wide areas of un- or under-used former industrial land exist and are increasing (brownfield sites). The indicator is informative about the potential to avoid the use of Greenfield sites by supporting the redevelopment of brownfield sites.
Relevance for which EU-policy, -decision or –activity: Information is of use in determining measures for the reuse of brownfield sites instead of the use of greenfield sites.
Why should it be done at the EU-level under subsidiarity: Management of the resource - soil (considering all its functions) has to balanced at the international scale.
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Corine Land Cover Interpretations
Method/s to be used: (including sampling point density) Land use interpretation (GMES) and local data collection
Estimated costs and result of the improvement in cost-efficiency In some countries, measures for desealing are stipulated by law. However, reduction of use of greenfield sites in a precautionary way is more cost-effective than remediation of existing mistakes.
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds 5 years

Name of the parameter/indicator: Application of sewage sludge on agricultural land (first step towards a heavy-metal balance)
Proposed by: Martin Schamann
Justification for selection: For the avoidance of further contamination, which then exceeds tolerable thresholds, it is relevant to know the area of land which is treated with sewage sludge and polluted with which amounts of contaminants due to this application. This negative effect should be compared to the increase of organic matter.
Relevance for which EU-policy, -decision or –activity: Waste Water Treatment Directive; revision of the Sewage Sludge Directive is forthcoming within the STS; measures against decline of organic matter
Why should it be done at the EU-level under subsidiarity: The Sewage Sludge Directive has to be applied in each Member State. There should be no differences in trading and application of this material based on different rules in Member States; only soil susceptibility should be taken into account.
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: National amounts of sewage sludge produced and used in agriculture, detailed data on area treated with sewage sludge and contents of heavy metals only for some countries. In many countries, information on other sources of heavy-metal inputs to agricultural land are available, but only a few data are available for outputs towards a heavy metal balance.
Method/s to be used: (including sampling point density) Collection of national, regional or local statistics and quality investigations related to the NUTS levels, preferably at NUTS level 3.
Estimated costs and result of the improvement in cost-efficiency Data on the amount of sewage sludge are often available due to reporting obligations at EU or national level, but have to be made accessible. Contents of contaminants will need some further investigation, but the knowledge of the load of contaminants before application can avoid negative effects on the environment, in the case of agricultural land in particular on the most important production factor, the soil.
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds 2-3 years

Name of the parameter/indicator: Heavy metal accumulation in topsoils
Proposed by: Martin Schamann
Justification for selection: The definition of tolerable thresholds for certain heavy metals in soils across Europe will not be feasible. Soil variability and also "pedological/geogenic" concentrations differ from country to country. In order to provide information on anthropogenically induced contamination across Europe, the ratio of contents of heavy metals in topsoils versus subsoils is most suitable and easy to calculate.
Relevance for which EU-policy, -decision or –activity: The Directive on Sewage Sludge, currently under revision, regulates the use of sludge and establishes the maximum permitted concentration of heavy metals aiming at preventing their accumulation in soils. This indicator provides information relevant to this process, allowing the identification of hot spots, e.g. in agricultural areas. It is important to be aware not just of sites where maximum permitted values are reached, but sites where combinations of different processes (e.g. atmospheric pollution, sewage sludge) give rise of heavy metal accumulation in relation to natural levels. Furthermore, the Forest Focus Programme can profit from it.
Why should it be done at EU-level under subsidiarity: The Sewage Sludge Directive has to be implemented in each Member State. The methodological approach should be the same across Europe. Different sampling and analytical methods can hinder comparability and give results prone to misinterpretation.
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Various national data sets exist in European countries, based on national or regional soil inventories or monitoring systems. The density of the information differs from country to country, but there are also some harmonised data available (Baltic soil survey, ICP forest database).
Method/s to be used: (including sampling point density) Collection of samples from selected national or regional soil monitoring sites in a harmonised way and determination of total heavy-metal concentrations, pH and humus content using the same analytical methods for each parameter. Bio-available fractions of the contaminants would give added value information related to the risk for the environment.
Estimated costs and result of the improvement in cost-efficiency In many countries, appropriate soil monitoring systems or inventories already exist, but have to be sampled again, preferably all in the same year. The assessment of the accumulation factor gives the possibility of identifying already contaminated areas (and risks), which should be avoided for further input (e.g. by sewage sludge) or need remediation before further negative effects occur.
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds 10 years

Name of the parameter/indicator: Base saturation
Proposed by: Martin Schamann
Justification for selection: This indicator gives information on nutrient supply and also on acidification of soils. The buffering capacity of a soil, one of the main natural soil functions, is described very well by this indicator. This function is very important in relation to leaching and therefore potential contamination and eutrophication of waters.
Relevance for which EU-policy, -decision or –activity: In relation to forest soils, it has a strong link to the UN-ECE Convention on Long-Range Trans-boundary Air Pollution. Furthermore, it is related to some EU regulations against air pollution and has also some relevance for the WFD.
Why should it be done at EU-level under subsidiarity: The methodological approach should be the same across Europe. Different sampling and analytical methods can hinder the comparability and give results prone to misinterpretation.
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Various national data sets exist in European countries based on national or regional soil inventories or monitoring systems. The density of the information differs from country to country, but there are also some harmonised data available (e.g. ICP forest database).
Method/s to be used: (including sampling point density) Collection of samples from selected national or regional soil monitoring sites in a harmonised way and determination of cation and anion concentrations, pH and carbonate content using the same analytical methods for each parameter. This indicator is only relevant for carbonate free soils and for soils without intensive agricultural use (fertilisation, liming).
Estimated costs and result of the improvement in cost-efficiency In many countries, appropriate soil monitoring systems or inventories already exist, but have to be sampled again, preferably all in the same year. The indicator gives the possibility of identifying soils with low buffering capacities, indicating a high risk for nutrient deficiencies and leaching as well as acidification, possible having a risk of root damage. Therefore, it can act as an early warning criterion for damage of forests and (semi-) natural areas.
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds 10 years

Name of the parameter/indicator: Soil sealing intensity
Proposed by: Martin Schamann
Justification for selection: Soil sealing is one of the most important indicators when evaluating the sustainable use of the resource “soil”. Settlements, transport infrastructure, leisure activities and economic growth lead to the sealing of surfaces, thereby reducing the multi-functionality of the soil resource. The associated functions such as water retention capacity, nutrient reservoir or habitat for soil organisms are hampered. Besides the direct effects, soil sealing has an enormous effect on neighbouring areas due to the fragmentation of habitats.
Relevance for which EU-policy, -decision or –activity: The reduction of land consumption is one basic element for sustainable development. Therefore, the problem of soil sealing is included in the 5th and 6th EAP, the ESDP (European Spatial Development Perspective) as well as in the new European Urban Strategy.
Why should it be done at EU-level under subsidiarity: Due to new spatial development, the old theory of concentric development has been replaced by the theory of polycentric urban development. The influence of national borders on the driving forces behind soil sealing has been reduced to the free transfer of goods. Therefore, European wide monitoring is necessary
Kind of monitoring: **A: multi purpose** **B: action driven**
Contribution to **A: strategy** **B: Element for the directive**
Existing available information: Various statistical information derived from EUROSTAT (New Cronos), EEA questionnaire: both data sets show serious differences within the nomenclature defining soil sealing.
Method/s to be used: Point-sources: monitoring of land use and land cover within a dense net; monitoring which kind of changes occur (e.g. from agricultural areas to transport infrastructure); area-sources: remote sensing data (e.g. GMES-project: SAGE) combined with the interpretation of land use
Estimated costs and result of the improvement in cost-efficiency Current costs for data acquisition will be reduced. EU-wide comparable data source for the assessment of soil sealing.
Adequate time frame for repetition taking into account current method/s, method development, biological and seasonal thresholds 2-3 years; no seasonal thresholds; monitoring time-frame can be adjusted according to the rate of change in dynamic and more stable regions

List of indicators 1 (completed by the EEA)

Policy issues/Question	Name of Indicator Used	Short description	Units	Relation to Threat or Threats (EU list)	DPSIR/ Indicator type (optional) 2	Geographical breakdown (referred to NUTS level) 3	Frequency (yearly, 5 years etc.)	Status (Operational, Pilot study, Proposed, etc.)	Link to published reports (optional) 4	Comments
Management and control of contamination. Is the problem of contaminated areas being solved?	Progress in management of contaminated sites	Percentage of sites handled in each management step (preliminary survey, preliminary investigation, main site investigation, remediation) with respect to the estimated total	%	Soil Contamination	R/B	NUTS0	Y	OP	http://themes.eea.eu.int/Specific_media/soil/indicators	Data are available for 15 European countries. Variations in definitions of management steps across Europe make national data not fully comparable. (last updated 2002).
Management and control of contamination. How much is being spent on cleaning up soil contamination?	Expenditures on clean-up of contaminated sites	Private and public expenditures per management step (site investigation, risk assessment, remediation).	Million EUR; EUR per capita	Soil Contamination	R/A	NUTS0	Y	OP	http://themes.eea.eu.int/Specific_media/soil/indicators	Data are available for 14 European countries. Little information on private expenditure. (last updated 2002).
Prevention and control of sources of contamination. What has caused soil pollution?	Soil Polluting activities from localised sources	Contribution of sectors to soil contamination from localised sources expressed as the share of the various soil and groundwater polluting activities (eg. Municipal waste disposal, Losses during transport, etc.) with respect to the total number of contaminated sites	%	Soil Contamination	D-P/A	NUTS0	Y	OP	http://themes.eea.eu.int/Specific_media/soil/indicators	Data are available for 13 European countries. (last updated 2002)
Limitation and control of water pollution. What are the impacts of soil degradation on inland water in Europe?	Risks of contamination of water bodies from contaminated sites	Risks of contamination of surface and groundwater from mines, industrial sites, waste landfills		Soil contamination	I/A	NUTS0	3	P		Data are expected in course of the reporting obligations from the Landfill Directive, the Water Framework Directive, the IPPC Directive and the upcoming Directive on The Management of waste from the extractive industry
Optimal use of municipal land. What is the progress towards the reuse of brownfields?	Redevelopment of brownfields for new urban uses	Redevelopment of derelict and contaminated land (brownfields) for new urban uses (including public urban spaces)		Urban environment	R/B	To be verified	3-5	P	http://www.clarinet.at/library/brownfields.pdf	Data are expect in course of CABERNET Concerted Action

Policy issues/Question	Name of Indicator Used	Short description	Units	Relation to Threat or Threats (EU list)	DPSIR/ Indicator type (optional) 2	Geographical breakdown (referred to NUTS level) 3	Frequency (yearly, 5 years etc.)	Status (Operational, Pilot study, Proposed, etc.)	Link to published reports (optional) 4	Comments
Prevention and control of soil acidification. What is the extent of soil acidification and how is it developing?	Acidification of soils	Deposition of acidifying sulphur and nitrogen compounds is one of the most common diffuse contamination problems in Europe. Because the problem is partly caused by long-range transport of pollutants across country borders, both researchers and policy-makers have started intensive international cooperation.	Exceedance of Critical load for Acidity(eq ha^{-1} a^{-1})	Soil contamination	P	Nuts 0 but possible to plot in Nuts 3	Combining results of different surveys. Some have regular monitoring, some have been performed only once (so far)	Both operational and pilot study.	EEA indicator YIR99AP6. http://themes.eea.eu.int/Specific_media/air/indicators/ecodamage/yir99ap6.pdf Posch, M., de Smet, P.A.M., Hettelingh, J.-P. and Downing, R.J. (Eds.) 2001. Modelling and Mapping of Critical Thresholds in Europe: Status Report 2001. Coordination Center for Effects. National Institute for Public Health and the Environment. Bilthoven, The Netherlands. 188 pp.	The total area of exceedance of critical loads for acidification has decreased considerably since 1985, mainly as a result of reductions in sulphur deposition. Sulphur deposition shall be reduced even further as a result of the second sulphur protocol as well as the National Emissions Ceilings Directive and measures required by national legislations (see EEA indicator YIR99AP6). More recent CL exceedance maps are shown in Posch and others (2001) and the Third assessment report of the Europe's environment (EEA 2003).
Prevention and control of soil eutrophication. What is the extent of soil eutrophication and how is it developing?	Eutrophication of soils	Deposition of nutrient nitrogen is a common diffuse contamination problems in Europe. Because the problem is partly caused by long-range transport of pollutants across country borders, both researchers and policy-makers have started intensive international cooperation.	Exceedance of Critical load for nutrient nitrogen (eq ha^{-1} a^{-1})	Soil contamination	P	Nuts 0 but possible to plot in Nuts 3	Combining results of different surveys. Some have regular monitoring, some have been performed only once (so far)	Both operational and pilot study.	EEA indicator YIR99AP6. http://themes.eea.eu.int/Specific_media/air/indicators/ecodamage/yir99ap6.pdf Posch, M., de Smet, P.A.M., Hettelingh, J.-P. and Downing, R.J. (Eds.) 2001. Modelling and Mapping of Critical Thresholds in Europe: Status Report 2001. Coordination Center for Effects. National Institute for Public Health and the Environment. Bilthoven, The Netherlands. 188 pp.	There has been much less reduction in nitrogen deposition and no reduction in the area of exceedance of critical loads, which has even increased in several countries. In 40% of the EEA countries the percentage of ecosystems exposed to damaging eutrophication has increased since 1990. Looking at the issue in terms of national frontiers, eight countries - the Netherlands, the United Kingdom, France, Ireland, Italy, Portugal, Spain and Greece – saw an increase in the amount of land exposed to eutrophication. (see EEA indicator YIR99AP6). More recent CL exceedance

Policy issues/Question	Name of Indicator Used	Short description	Units	Relation to Threat or Threats (EU list)	DPSIR/ Indicator type (optional) 2	Geographical breakdown (referred to NUTS level) 3	Frequency (yearly, 5 years etc.)	Status (Operational, Pilot study, Proposed, etc.)	Link to published reports (optional) 4	Comments
										maps are shown in Posch and others (2001) and the Third assessment report of the Europe's environment (EEA 2003).
Prevention and control of eutrophication. What is the extent of eutrophication by nutrient losses and how is it developing?	Eutrophication of waters	Nitrogen and phosphor input into waters. Diffuse nutrient (N, P) losses from soils to surface freshwater systems and coastal waters. Soil eutrophication is caused by both airborne polluting components and fertilisers.	t ha^{-1} a^{-1}	Soil contamination	I	NUTS 0		Proposed		Possible input from EUROHARP: study of nutrient balances and losses in selected (17) watersheds of Europe http://www.euroharp.org/
Prevention and control of heavy metal deposition and other harmful elements. What is the extent of heavy metal deposition and other harmful elements and how is it developing?	Deposition of heavy metals and other potentially harmful elements	Aerial deposition is a main source of diffuse contamination and pollution of heavy metals and other harmful chemicals Related EU regulation: Maximum permissible soil levels of heavy metals determined by EU Directive 86/278/EEC and Sludge Use in Agriculture Regulations (1989, 1999)	Mg/kg	Soil contamination	S	NUTS 0	3 years	Operating	Rühling, Åke (ed.); Steinnes, Eiliv (ed.) 1998. Atmospheric heavy metal deposition in Europe 1995-1996. Nord ; 1998 : 16: , 67 s. ISBN 92-893-0254-2. ISSN 0903-7004. http://www.ktbl.de/english/projects/aromis/index.htm).	Moss samples show the deposition over the last 3-year period. Moss samples could be added to the monitoring system to reflect the actual atmospheric deposition in the monitoring site, if no direct deposition measurements are included in the monitoring network. Heavy metal input to agricultural soil is being surveyed by the AROMIS project (Assessment and reduction of heavy-metal input into agro-ecosystems, Results from 21 countries are expected before end of 2003.

Policy issues/Question	Name of Indicator Used	Short description	Units	Relation to Threat or Threats (EU list)	DPSIR/ Indicator type (optional) 2	Geographical breakdown (referred to NUTS level) 3	Frequency (yearly, 5 years etc.)	Status (Operational, Pilot study, Proposed, etc.)	Link to published reports (optional) 4	Comments
Prevention and control of heavy metal accumulation. What is the extent of heavy metal accumulation and how is it developing?	Heavy metal accumulation in agricultural topsoils	Naturally geogenic heavy metals are distributed evenly over the soil profile or the heavy metal content increases with depth in soils that have a high heavy metal content in their parent material. Relatively higher concentrations of heavy metals in the topsoils towards subsoils thus indicate anthropogenic contamination.	Ratio	Soil contamination	P	NUTS 0, plotable in NUTS II	So far only one survey	Pilot	Indicator fact sheet, FOREGS geochemical mapping data set (Rühling, Å (ed.) Atmospheric heavy metal deposition in Europe- estimations based on moss analysis. Nord 1994:9.	The data presented in this fact sheet show the actual situation (1995 – 1999) in almost 20 European countries. The data show the results of two comparable surveys. Various other data sets exist in other European countries. These data sets have to be collected and harmonised to enable pan-European comparison. According to the atmospheric heavy metal deposition study based on moss analysis there has been a general decline of lead deposition since 1985 (about 60% in Denmark, 40% in Norway, 30% in Sweden and Finland). The long-range transport deposition still dominates in Northern Europe.
Determination of heavy metal mobility. What is the extent of heavy metal mobility (and possibly in the future: how is it developing?)	Heavy metal mobility in topsoils in European catchment areas	The relationship between stream sediment and topsoil heavy metal concentrations indicates the mobility of heavy metals. For cadmium and zinc, a general increase in the ratio of stream sediment to topsoil metal concentrations is seen with a decrease in soil pH and soil acidity critical loads in the United Kingdom	Mg/kg and pH	Soil contamination	I	NUTS 0, plotable in NUTS II	So far only one survey	Pilot	FOREGS geochemical mapping data set	Increased mobility to water bodies shows that the buffering mechanism of the soil does not work properly, plants can more easily take up metals in mobile form, and metals can be released to shallow ground waters and small streams. Besides the heavy metal mobility to water bodies, a subindicator could be based on heavy metal mobility to crops when the data will be available from the AROMIS project.

Policy issues/Question	**Name of Indicator Used**	**Short description**	**Units**	**Relation to Threat or Threats (EU list)**	**DPSIR/ Indicator type (optional) 2**	**Geographical breakdown (referred to NUTS level) 3**	**Frequency (yearly, 5 years etc.)**	**Status (Operational, Pilot study, Proposed, etc.)**	**Link to published reports (optional) 4**	**Comments**
Prevention and control of materials applied on the soil. Are the direct sources of soil contamination under sufficient control?	Application of sewage sludge on agricultural land	Area of agricultural land treated with sewage sludge in percentage of total area under agricultural use at regional level	%	Soil contamination	P	Mainly NUTS 2	Mainly every 5 years	Pilot	EEA Technical report No 69 http://reports.eea.eu.int/technical_report_2001_69/en	Data will be available for about 15 countries. In order to make the information more precise, data on the heavy metal content of the sewage sludge is necessary to show the heavy metal input to the soil in the concerned areas.
Limitation and control of soil sealing. How much soil is being sealed?	Soil sealing	Trends on increase of built-up areas as percent of total land	%	Soil Sealing	S/A	NUTS0. Country groups (EU15, AC13, Rest of Europe)	Y	OP	http://reports.eea.eu.int/environmental_assessment_report_2003_10/Chapter9	Proxy indicator. Built-up area is an overestimation of sealed area. Data are available for 28 European countries. Data are derived from national statistics. Variations in definitions and methodologies used across Europe make national data not fully comparable. (last updated 2002)
Prevention and control of soil erosion due to unsustainable agricultural practices. What is the extent of total soil loss due to water erosion?	Soil erosion in agricultural land	Soil loss per year by erosion from agricultural land	t/ha	Soil Erosion	S/A	NUTS0	Y	OP	http://reports.eea.eu.int/environmental_assessment_report_2003_10/Chapter9	Data are available for 24 European countries. Data are derived from national statistics. Variations in methodologies used across Europe make national data not fully comparable. (last updated 2002)
Effective usage of soils. How comparable are different aera based rates for soil sealing	soil sealing per inhabitant	sealed area (m2) per inhabitant/administrative unit	m2/person	soil sealing	D	NUTS 0	5	Prop.	GMES-SAGE-project	
Is there any change in the effectivity of the area used as built-up area	soil sealing intensity	portion of built up area, which is actually sealed (proxy parameter: “areas free of vegetation”)	density classes (% sealed area within category built-up)	soil sealing	R	NUTS 2	5	Prop.	GMES-SAGE-project	

Policy issues/Question	Name of Indicator Used	Short description	Units	Relation to Threat or Threats (EU list)	DPSIR/ Indicator type (optional) 2	Geographical breakdown (referred to NUTS level) 3	Frequency (yearly, 5 years etc.)	Status (Operational, Pilot study, Proposed, etc.)	Link to published reports (optional) 4	Comments
How effective are planning tools to control the built-up area. How much of the land dedicated as built-up area is actually used as built-up area	effectifity of land use zoning plans	proportion of area dedicated for building in land use zoning plans, but not yet used as built-up area	proportion of remaining not used built-up land within prospective built- up area	soil sealing	I	NUTS 2	5	Prop.	GMES-SAGE-project	
distribution of land for functions other than primary production. How much land is consumed for human usages different from biomass production.	land consumption	area measurement of all classes contributing to land consumption (human usage of land for other purposes than biomass) and trend	proportion of total land area	soil sealing	P	NUTS 0	5	Prop.		
What are the consequences of the growing transport infrastructure.	land uptake by transport infrastructure	area measurement and line measuremen of transport infrastructure (sealed and non-sealed areas)	km2 and km of transport network	soil sealing	P	NUTS 2	5	prop.		
How sustainable is the usage of soils. How much land is left for optimal biomass production and protection of rare habitats	soil losses to other land uses	percent of good quality soil lost and specific habitats for agriculture/grassland/forestry/nature protection	% of best quality soil	land consumption	I	NUTS 2	5	prop.	GMES-SAGE-project	
Where are we going in terms of land usage. What are the current trends of land use changes	change of soil usage	percentage and absolute hectares of land cover/ land use changes	absolute and percentage	land use changes	D	NUTS 2	5	Prop.		

NAME OF PERSON COMPLETING THE FORM:
ORGANISATION:
EMAIL ADDRESS:
DATE:

Notes:

1. The list of potential indicators is open-ended.
2. See EEA report: *Environmental Indicators: Typology and Use in Reporting* for a description of DPSIR and Typology of indicators.
3. See Eurostat web site: http://europa.eu.int/comm/eurostat/ramon/nuts/home_regions_en.html for more information on NUTS nomenclature.
4. Do you have protocols for the development and use of soil indicators; if so, please give brief details (a reference to a published report would be useful).

GAPS

The Working Group needs information that is relevant to future research and development. It would be very helpful to have answers to the following questions. Are there any soil indicators that are not in your list, but that you would you like to have ? Why do you not measure or use these missing indicators ? Is this a gap only in your own work, or is it universal ? Are the gaps caused by a lack of technology or a lack of science or both ? Can you identify research areas that could fill these gaps and give any estimate of the time-frame that might be required to do this research ?

Annex 3. Current ISO and CEN norms for Soil Quality

ISO/TC 190 – Soil Quality

List of (draft) standards prepared by ISO/TC 190 - Soil quality

Stages:

- ISO/WI Work Item: the item has been accepted into the work programme.
- ISO/WD Working Document: a document has been prepared. Stage ends when the draft is available as a first CD.
- ISO/CD Committee Draft: principal draft for voting and comments. Stage ends when CD is accepted for circulation as a DIS.
- ISO/DIS Draft International Standard: second draft for voting and comments. Stage ends when DIS is accepted for circulation as a FDIS.
- ISO/FDIS Final Draft International Standard: final draft for voting. Stage ends when FDIS has been approved for circulation as an International Standard.

ISO International Standards

New Work Item ideas:
SC2/SC4/SC7 (combined) Guidance on storage and preservation of soil samples for laboratory determinations.
Sample pre-treatment of large samples. SC 3/WG 9 N 85/092/Revision of N0085.

SC 1 Terminology

ISO 11074-1:1996 Soil quality - Vocabulary - Part 1: Terms and definitions relating to the protection and pollution of the soil.
ISO 11074-2:1998 Soil quality - Vocabulary - Part 2: Terms and definitions relating to sampling.
ISO/CD 11074-3 ? Soil quality - Vocabulary - Part 3: Terms and definitions relating to soil and site assessment.
ISO 11074-4:1999 Soil quality - Vocabulary - Part 4: Terms and definitions related to the rehabilitation of soils and sites.
NWIp 11259:1998 ? Soil quality - Simplified soil description.
ISO/FDIS 15709 ? Soil quality - Soil water and the unsaturated zone - Definitions, symbols and theory.
ISO/ 15903: 2002 Soil quality - Format for recording soil and site information
ISO/CD 11074 2003-05-15 Soil quality - Terms and definitions relating to the protection and pollution of the soil (integration of 4 parts of 11074 into one standard).

SC 2 Sampling

ISO/ 10381-1: 2002 Soil quality - Sampling - Part 1: Guidance on the design of sampling programmes
ISO10381-2: 2002 Soil quality - Sampling - part 2: Guidance on sampling techniques
ISO/DIS 10381-3: 2001 Soil quality - Sampling - Part 3: Guidance on safety
ISO/ISO 10381-4 01-05-2003 Soil quality - Sampling - Part 4: Guidance on the procedure for investigation of natural, near-natural and cultivated sites
ISO/DIS 10381-5 3-2001 Soil quality - Sampling - Part 5: Guidance on investigation of soil contamination of urban and industrial sites
ISO 10381-6:1993 Soil quality - Sampling - Part 6: Guidance on the collection, handling and storage of soil for the assessment of microbial processes in the laboratory
ISO/DIS 10381-7 Soil quality - Sampling - Part 7: Investigation and sampling of soil gas
ISO/CD 10381-8 12-2001 Soil quality - Sampling - Part 8: Sampling of soil material from stockpiles
ISO/WD 15185 Soil quality - Sampling - Specification of soil augering/drilling apparatus
ISO/NWIp N0196 30-06-2003 Soil quality - Guidance on long and short term storage of soil samples

SC 3 Chemical methods

ISO 10382: 2002 Soil quality - Determination of organo-chlorine pesticides and polychlorinated biphenyls - Gas-chromatographic method with electron capture detection
ISO/DIS 10390 5-2002 Soil quality - Determination of pH
ISO 10693:1995 Soil quality - Determination of carbonate content - Volumetric method
ISO 10694:1995 Soil quality - Determination of organic and total carbon in soil after dry combustion (elementary analysis)
ISO/TR 11046:1994 Soil quality - Determination of mineral oil content - Method by infra-red screening and gas-chromatographic method
ISO 11047:1998 Sys Rev (6-2003) Soil quality - Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc - Flame and electrothermal atomic absorption spectrometric methods
ISO 11048:1995 Soil quality - Determination of water soluble and acid soluble sulfate
ISO 11260:1994 Soil quality - Determination of effective cation exchange capacity and base saturation level using barium chloride solution
ISO 11260:1994/Cor Soil quality -- Determination of effective cation exchange capacity and base saturation level using barium chloride 1:1996 solution Technical Corrigendum 1
ISO 11261:1995 Soil quality - Determination of total nitrogen - Modified Kjeldahl method
ISO/FDIS 11262 20-5-2003 Soil quality - Determination of cyanides
ISO 11263:1994 Soil quality - Determination of phosphorus - Spectrometric determination of phosphorus soluble in sodium hydrogen carbonate solution
ISO/DIS 11264 12-2001 Soil quality - Determination of herbicides using HPLC with UV-detection
ISO 11265:1994 Soil quality - Determination of specific electrical conductivity
ISO 11265:1994/Cor1:1996 Soil quality -- Determination of the specific electrical conductivity Technical Corrigendum 1
ISO 11271 2002 Soil quality - Determination of redox potential - Field method
ISO/CD 11464 (revision of ISO:1994) CD: 2003-01-31; DIS 2003-10-31; FDIS 2004-10-31; ISO: 2005-03-31 Soil quality - Pretreatment of samples for physico-chemical analyses
ISO 11465:1993 Soil quality - Determination of dry matter and water content on a mass basis - Gravimetric method
ISO 11465:1993/Cor1:1994 Soil quality -- Determination of dry matter and water content on a mass basis -- Gravimetric method Technical Corrigendum 1
ISO 11466:1995 Soil quality - Extraction of trace metals soluble in aqua regia
ISO 13536:1995 Soil quality - Determination of the potential cation exchange capacity and exchangeable cations using barium
chloride solution buffered at pH = 8

ISO 13877:1998 Sys Rev (6-2003) Soil quality - Determination of polynuclear aromatic hydrocarbons - Method using high-performance liquid chromatography
ISO 13878:1998 Sys Review (6-2003) Soil quality - Determination of total nitrogen content after dry combustion ("elemental analysis")
ISO/ DIS 14154 1-2002 Soil quality - Determination of phenols and chlorophenols – Gas chromatographic method
ISO 14235:1998 Sys Review (6-2003) Soil quality - Determination of organic carbon by sulfochromic oxidation
ISO/ 14254: 2001 Soil quality - Determination of exchangeable acidity of barium chloride extract
ISO 14255:1998 Sys Review (6-2003) Soil quality - Determination of nitrate nitrogen, ammonium nitrogen and total soluble nitrogen in air-dry soils using calcium chloride solution as extractant
ISO/TS 14256-1)_ 2003-03-15 Soil quality- Determination of nitrate, nitrite and ammonium in field moist soils using potassium chloride solution as extractant- Part 1: Manual method
ISO/DIS 14256-2 3-2001 Soil quality - Determination of nitrate, nitrite and ammonium in field moist soils by extraction with potassium chloride solution - Part 2: automated method
ISO 14507 26-03-2003 Soil quality - Pretreatment of samples for the determination of organic contaminants
ISO 14869-1:2001 Soil quality - Determination of the total trace element content - Part 1: Digestion with hydrofluoric and perchloric acids
ISO/FDIS 14869-2 Soil quality – Dissolution for the determination of of total element content - Part 2: Dissolution by alkaline fusion
ISO 14870: 2001 Soil quality - Extraction of trace elements by buffered DTPA solution
ISO 15009 2002 Soil quality - Gas chromatographic determination of the content of volatile aromatic hydrocarbons, naphtalene and volatile halogenated hydrocarbons - Purge and trap method with thermal desorption
ISO 15178:2000 Soil quality - Determination of total sulfur after dry combustion
ISO/DIS 16703 Soil quality - Determination of mineral oil content by gas chromatography
ISO/DIS 16720 2003-10-26 Soil quality – Pre-treatment of samples by freeze-drying for subsequent analysis
ISO/DIS 16772 Soil quality - Determination of mercury in aqua regia soil extracts
ISO/DIS 17380 Soil quality -- Determination of total cyanide and easily released cyanide content -- Continuous flow analysis method
ISO/CD 18287 Soil quality - Determination of polycyclic aromatic hydrocarbons (PAH) - Gas chromatographic method with mass spectrometric detection (GC-MS)
ISO/CD 20280 Soil quality – Determination of arsenic, antimony and selenium in aqua regia soil extracts by atomic absorption spectrometry
ISO/DIS 20279 Soil quality - Extraction of thallium and determination by electrothermal atomic absorption spectrometry
ISO/AWI 22155 Soil quality- Gas chromatographic determination of volatile aromatic and halogenated hydrocarbons – Static headspace method
ISO/WD 22892 Soil quality - Guidance on the identification of organic target compounds using gas chromatography with mass spectrometric determination
ISO/AWI 23161 CD: 06/2003; DIS: Soil quality - Method for the quantification of organotin compounds (N415)
ISO/AWI 23470 Soil quality -- Determination of effective cation exchange capacity (CEC) and exchangeable cations using a cobalthexamine trichloride solution

SC 4 Biological methods

NWIp N0238 Soil quality - Avoidance test for testing the quality of soils and the toxicity of chemicals - test with Earthworms (*Eisenia fetida*)
ISO 11266:1994 Soil quality - Guidance on laboratory tests for biodegradation of organic chemicals in soil under Aerobic conditions
ISO 11267:1999 Soil quality - Inhibition of reproduction of Collembola (*Folsomia candida*) by soil pollutants
ISO 11268-1:1993 Syst. Review Soil quality - Effects of pollutants on earthworms (*Eisenia fetida*) - Part 1: Method for the determination of acute toxicity using artificial soil substrate
ISO 11268-2:1998 Syst. Review Soil quality - Effects of pollutants on earthworms (*Eisenia fetida*) - Part 2: Determination of effects on reproduction
ISO 11268-3:1999 Soil quality - Effects of pollutants on earthworms (Eisenia fetida) - Part 3: Guidance on determination of effects in field situations
ISO 11269-1:1993 Syst. Review Soil quality - Determination of effects of pollutants on soil flora - Part 1: Method for the measurement of inhibition of root growth
ISO/CD 11269-2 Soil quality - Determination of effects of pollutants on soil flora - Part 2: Effects of chemicals on the emergence and growth of higher plants
ISO 14238:1997 Soil quality - Biological methods - Determination of nitrogen mineralization and nitrification in soils and the influence of chemicals on these processes
ISO 14239:1997 Soil quality - Methods for measuring the mineralization of organic chemicals in soil under aerobic conditions using laboratory incubation systems
ISO 14240-1:1997 Soil quality - Determination of soil microbial biomass - Part 1: Respiration method
ISO 14240-2:1997 Soil quality - Determination of soil microbial biomass - Part 2: Fumigation extraction method
ISO 15473: 2002 Soil quality - Guidance on laboratory testing for biodegradation of organic chemicals in soil under anaerobic conditions
ISO/DIS 15685 Soil quality - Rapid method to test the chemical influence on nitrification in soil - Ammonium oxidation
ISO: 9/05 Soil quality – Efects of pollutants on juvenile land snails (*Helix aspersa*) – Determination of the effects on growth by soil contamination. (N217/218)
ISO/16072 2002-12-15 Soil quality - Laboratory methods for determination of microbial soil respiration
ISO/DIS 16387 Soil quality - Effects of pollutants on Enchytraeidae (*Enchytraeus* sp.)- Determination of effects on reproduction and survival
ISO/CD 17126 Soil quality – Determination of the effects of pollutants on soil flora – Seeding emergence, screening test with lettuce (*Lactuca sativa* L.)
ISO/17155 2002 Soil quality – Determination of abundance and activity of soil microflora using respiration curves
ISO/CD 20963 Soil quality – Effects of pollutants on insect larvae (*Oxythyrea funesta*) – Determination of acute toxicity
ISO/CD 22030 Soil quality – Chronic toxicity test in higher plants
ISO : 06/2005 Soil quality – Sampling of soil invertebrates – Part 1: Hand-sorting and formalin extraction of earthworms (N193)
ISO/CD/23611-2 Soil quality – Sampling of soil invertebrates Part 2: Sampling and extraction of mesofauna (Collembola and Acarida) (N196)
ISO/CD/23753-1 Soil Quality – Determination of dehydrogenase activity – Part 1: Method using triphenyltetrazolium chloride (TTC)

ISO/CD 23753-2 Soil Quality – Determination of dehydrogenase activity – Part 2: Method using iodotetrazolium chloride (INT)
NWIp Soil quality – Avoidance test for testing the quality of soils and the toxicity of chemicals – test with Earthworms (*Eisenia fetida*)

SC 5 Physical methods

ISO 10573:1995 Soil quality - Determination of water content in the unsaturated zone - Neutron depth probe method
ISO 11272:1998 Soil quality - Determination of dry bulk density
ISO 11274:1998 Soil quality - Determination of the water retention characteristic - Laboratory methods
ISO/DIS 11275.2 Soil quality - Determination of the unsaturated hydraulic conductivity and water retention characteristic - Wind's evaporation method
ISO 11276:1995 Soil quality - Determination of pressure potential - Tensiometer method
ISO 11277:1998 Soil quality - Determination of particle size distribution in mineral soil material - Method by sieving and sedimentation
ISO 11277: 1998/Cor 1 ISO 11461 Soil quality - Determination of soil water content as a volume fraction using coring sleeves - Gravimetric method
ISO 11508:1998 Soil quality - Determination of particle density
ISO 16586 8-4-2003 Soil quality - Determination of soil water content as a volume fraction on the basis of known dry bulk density - Gravimetric method
ISO/DIS 17312 Soil quality - Determination of saturated hydraulic conductivity of sand and gravel
ISO/DIS 17313 Soil quality - Determination of saturated hydraulic conductivity of clay and silt

SC 7 Soil and site assessment

ISO 15176 2002 Soil quality - Characterization of excavated soil and other soil materials intended for re-use
ISO/FDIS 15799 Soil quality - Guidance on the ecotoxicological characterization of soils and soil materials
ISO/DIS 15800 Soil quality - Characterization of soils with respect to human exposure
ISO/DIS 16133 Soil quality - Guidance on the establishment and maintenance of monitoring programmes
ISO/WD 17924 Soil quality – Determination of bioavailability of metals in contaminated soil – Physiologically based extraction method
ISO/CD 19258 Soil quality – Guidance on the determination of background values
ISO/WD 21268-1 Soil quality – Leaching – Part 1: Batch test using a liquid to solid ratio of 2 l/kg dry matter
ISO/WD 21268-2 Soil quality – Leaching – Part 2: Batch test using a liquid to solid ratio of 10 l/kg dry matter
ISO/WD 21268-3 Soil quality – Leaching – Part 3: Up-flow column test
NWIp N0147 Soil quality - Guidance on the assessment of tests applied in the field of ecotoxicological characterization of soils and soil materials
ISO/pNWI 2003-04 vote Soil quality – Guidance for the development and selection of methods for the assessment of bioavailability in soil and soil-like materials
NWIp N0134; vote 7- 2003 Target date ISO: 12- 2004 Soil Quality – Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil materials – Guidance standard

Annex 4. Costs of soil monitoring

Table 1. Measured parameters in TIM (Hungary)

Measured parameter	**Baseline condition**	**Every year**	**3 years**	**6 years**
Bulk density	*			
Particle size distribution	*			
Sticky point (KA)	*			
Hygroscopy (hy2)	*			
Total water holding capacity (pF0)	*			
Field capacity(pF 2,5)	*			
Non-available water (pF 4,2)	*			
Available water (pF 2,5-pF 4,2)	*			
CaCO3-content ha > 5 %	*			*
ha 1-5 %	*		*	
ha < 1 %	*	*		
pH in distilled water if CaCO3 content > 1 %	*		*	
< 1 %	*	*		
pH in KCl if CaCO3 content > 1 %	*		*	
< 1 %	*	*		
Hydrolytic acidity	*	*		
Exchangeable acidity if no CaCO3 content	*	*		
Total salt content	*			*
Total salt content sodic/salic soils	*	*		
1:5 soil:water extract (CO_2^{3-} HCO^{3-}, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+,K^+) /soils with high salt content	*			*
Reaction with phenolphthalein (salic/sodic soils)	*		*	
Organic matter content	*		*	
Cation exchange capacity	*			*
Exchangeable cations (Ca^{2+}, Mg^{2+}, Na^+, K^+)	*			*
Total-N content	*		*	
Nitrate-nitrite content	*	*		
"Available" nutrients (P, K, Ca, Mg, Cu, Zn, Mn, Na, Fe, B, Mo)[1]	*		*	
"Toxic "(or potentially toxic) elements: (Al, As, B, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn)	*		*	

Biological activity	Cellulose test Dehydrogenase activity CO_2-production	* * *		* * *	
Natural radioactivity		*		*	
Chemical composition of the top layer of the groundwater (pH, EC, Ca^{2+},Mg^{2+},Na^{+}, CO_3^{2-},HCO_2^{3-}, Cl^-, SO_4^{2-}, NO_3^- NO_2^- , PO_4^{3-},)		*	*		

[1]Every year in the top horizon; every 3 years in the lower horizons

Table 2. Estimated costs (€) of the Hungarian soil monitoring system:

Measured parameter		**Baseline condition**	**Price of lab analysis**		
Bulk density		*	3,43		
Particle size distribution		*	32,35		
Sticky point (KA)		*	2,45		
Hygroscopy (hy2)		*	2,94		
Total water holding capacity (pF0)		*	12,75		
Field capacity (pF 2,5)		*			
Non available water (pF 4,2)		*			
Available water (pF 2,5-pF 4,2)		*			
CaCO3-content ha > 5 % ha 1-5 % ha < 1 %		* * *	2,45		
pH in distilled water if CaCO3 content > 1 % < 1 %		* *	2,21		
pH in KCl if CaCO3 content > 1 % < 1 %		* *	2,21		
Hydrolytic acidity		*	2,94		
Exchangeable acidity if no CaCO3 content		*	2,94		
Total salt content		*	2,21		
1:5 soil:water extract (CO_2^{3-} HCO^{3-}, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^{+},K^{+}) /soils with high salt content		*	29		
Reaction with phenolphthalein (salic/sodic soils)		*	2,21		
Organic matter content		*	2,94		
Cation exchange capacity		*	36		
Exchangeable cations (Ca2+, Mg2+, Na+, K+)		*	19,61		
Total-N content		*	10,30		
Nitrate-nitrite content		*	10,30		
"Available" nutrients (P, Ca, Mg, Cu, Zn, Mn, Na, Fe, B, Mo)[1]		*	13		
"Toxic "(or potentially toxic) elements: (Al, As, B, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn)		*	37,75		
Biological activity	Cellulose test Dehydrogenase activity CO_2-production	* * *	167		
Natural radioactivity		*	NA		
Chemical composition of the top layer of groundwater (pH, EC, Ca^{2+},Mg^{2+},Na^{+}, CO_3^{2-},HCO_2^{3-}, Cl^-, SO_4^{2-}, NO_3^- NO_2^- , PO_4^{3-},)		*	34,31		

Table 3. Estimated costs associated with the monitoring of different parameters in Portugal

Estimate presented by Laboratory of Agricultural Chemistry Rebelo da Silva / National Research Institute for Agriculture and Fisheries. Costs are presented for each site. Total costs for the country will depend greatly on the number of monitoring sites chosen to be representative for each threat.

		€/sample	Samples per site	€/site	€/site + VAT
1	**Characterization of the sampling site**				
1.1	Soil profile description, classification and soil sampling			1349	1601
1.2	Analysis				
	Bulk density	12.50	3		
	Particle size distribution	30.00	3		
	pH(H_2O)	5.50	3		
	pH($CaCl_2$)	6.50	3		
	Cation Exchange Capacity	32.00	3		
	Total water holding capacity (pF0) Field capacity (pF2.5) Non available water (pF4.2) Available water (pF2.5 – pF4.2)	50.00	2		
	Hydraulic conductivity (vertical)	100.00	2		
	Mineralogy	50.00	2		
	Cost of analysis	286.50		660	785
			Total (1.1 + 1.2)	**2009**	**2386**
2	**Parameters relevant for monitoring organic matter**				
	Total organic carbon	10.00	2		
	Total (organic) nitrogen	11.50	2		
	Total	21.50		**43**	**51**
3	**Parameters relevant for diffuse contamination**				
3.1	'Total' elements – inorganic contaminants				
	Arsenic (HG-AAS)	35.00	2		
	Cadmium (ET-AAS)	20.00	2		
	Cr, Cu, Ni, Pb, Zn	39.00	2		
	Hg	45.00	2		
	P	10.50	2		
	Cost of 'total' elements	149.50		299	356
3.2	Organic compounds				
	Halogenated compounds (e.g. HCH, DDT/DDE)	100.00			
	PAHs	100.00	1		
	PCBs	100.00	1		
	Dioxins and Furans	400.00	1		
	Cost of organic compounds	700.00		700	833
			Total (3.1 + 3.2)	**999**	**1189**
4	**Parameters relevant for salinisation**				
	pH (already considered above)				
	Electric conductivity (soil:water extract)	5.50	2		
	Soluble salts (Cl^-, HCO_3^-, CO_3^{2-}, SO_4^{2-})	24.00	2		
	Sodium Adsorption Ratio (SAR) and Exchangeable Sodium Percentage (ESP)	35.00	2		
	Total	64.50		**129**	**154**
5	**Estimated costs of the <u>sampling</u> of each site every 5 to 10 years**			€/site	€/site + VAT
				405	421

The costs of sample storage, quality control over decades, data handling and storage are not considered

Table 4. Estimated Costs (€) of the LUCAS survey phase 1 (Springtime survey) in the EU15

Year	General costs*	Survey	Orthophotos	**Total**	Cost/PSU	Cost/SSU
2001/2002	1.152.852	1.026.232	479.367	**2.658.451**	271	27
2003	868.267	1.003.525	10.139	**1.881.931**	192	19

**Estimated (Training of surveyors, Meetings, Reporting, Supervision, Quality Assurance, follow-up and documentation)*

Note: orthophotos were not purchased in 2003 in general. Those of 2001 were used in 2003. It can be considered that orthophotos have to be updated at least every 5 years

MONITORING

Task Group 3 on
PRIVATE OWNERSHIP OF DATA AND LAND

Joachim Woiwode, Marie-Alice Budniok, Stef Hoogveld

Introduction:

The monitoring mandate under 4.5 "Access to information" draws the attention to the fact that we have to take into account that soil is largely privately owned in the EU. Therefore the working group is asked to analyze the difficulties of setting up a soil monitoring system linked to the private ownership of the land. In particular the relationship between

1. Public access to information,
2. Rights on environmental and health protection and
3. Private ownership of the land shall be analyzed.

1 Public access to information

Discussing the public access to information prerequisites the existing of data. There are different kinds of existing data. Some data are published and available for everybody, other data are subject of commercial use and only available by paying, and there also exist data that for several reasons are only available to the (mostly private) data.

Directive 2003/4/EC of the European Parliament and the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC exclusively regulates the public access to environmental information.

Everything becoming part of the monitoring directive must comply with Article 7 of Directive 2003/4/EC. Therefore, every proposal for the monitoring directive must be in line with the spirit and the regulations of Directive 2003/4/EC (see Annex 1).

The way of disseminating existing data is subject to a Community discussion called the INSPIRE project. The Data Policy and Legal Issues Working Group of INSPIRE outlined in a Position Paper the policies and legal framework needed to create an infrastructure for spatial data in Europe. This paper is extracted below.

"In some cases soil data have been gathered, but are not available for common use. To protect commercial, personal or national security interests data can be exempted from information systems or restricted in use. It concerns large amounts of data if there are large interests (for instance mining activities). Within the European Community there are different interpretations of "personal data" and different approaches to managing certain information, which, although possibly not "personal" as such, may be closely related. This leads to situations where similar information will be available in some states and not in others.

To address this issue, it is recommended that data about the state of land or the nature of activities on that land, except to the extent that they give information about how individuals contribute to such activities, should be disclosed and that in any event emissions data must be disclosed. Such a provision would minimise conflict with human rights obligations to provide information necessary to protect health and property."

2 Rights on environmental and health protection

All constitutions guarantee the private ownership of land. Legal restrictions to and obligations derived from the private ownership of land differ from member state to member state and are mostly linked to the respective threats and their possible impacts to the general public.

In cases of acute danger or thread to the environment most of the Member States have legal provisions to force, if necessary, private landowners to tolerate measures to withdraw the danger as long as those measures are unavoidable and in the special interest of the general public. These measures, action driven monitoring included, happen locally in a limited period of time and for a specific purpose, and have to remain exceptional. Therefore this kind of monitoring cannot be used for a survey, large in scale and time and dealing with the Community wide soil status.

3 Private ownership of the land

3.1 Active and passive sampling

The monitoring directive shall indicate if in general there are expected contributions of the landowners and if so, which ones and of which nature. The need of active and/or passive contribution of private landowners to the soil monitoring system could be discerned.

- Active: Data and information to be provided by the landowner e.g. concerning land use, management, kind and amount of fertilizers.
- Passive: Sampling and measuring activities have to be tolerated on the private owned land as a result of the right of certain authorities to act on private land.

The choices witch parameters will be monitored is leading for further investigation at this end.

3.2 Global soil monitoring in Europe

To draw valid conclusions concerning the global soil quality in Europe it is generally accepted to gather the information with a (be it stratified or gridded) randomized method. Because in Europe land is mostly owned by private persons or organizations it is inevitable that monitoring plots will be located on their properties. It will harm the validity of the outcomes if too many sampling plots must be abandoned . As long as there is no acute thread the landowners have the right to refuse the sampling.

So here we encounter a problem. How could we allow access to a certain site, located on privately owned land, and of special concern and necessary from the representativity point of view? A solution could be found to allow access within the mechanisms of the national legal frameworks. Should a solution on the basis of a contract be envisaged, or should the right of sampling for more global purposes be more specific? We have to face this discussion within the STS.

To find the contours of the future EU monitoring system further discussion is needed on the next possible elements:

- From a subsidiarity point of view, is there a need for some Community wide congruence in gathering the necessary information.
- As the monitoring directive aims among others to compare soil aspects between the member states the difference between the national legal frameworks at this point has to be takenadequately into account .
- The kind of storage might be of importance. If

the information gathered on private land can be stored on an anonymous way landowners might be less hesitating to cooperate.

- The way of publication of the information will also influence the willingness of the (land)owners. Recently Europe adopted a Directive on the re-use and commercial exploitation of public sector documents (COM (2002) 207, Directive on Public Sector Information, see annex 2). Is there a possibility to compensate the owner?

- Obligation and time frame for a report on soil status at regular intervals to the public, the parliament and the council might be of importance. If a landowner experiences benefits of the monitoring on her property (e.g. the knowledge having a good soil quality) she might be more cooperating.

- Linking with or integration of other on EU level available databases with relevance to changes in soils and/or of relevance for the right interpretation of monitoring results.

The answers on these questions should not be given by the STS alone because the elements mentioned above are not specific to soil. This is a much bigger issue in other sectors of society, for example medical information about individuals. The Commission has recognized this problem and therefore started INSPIRE.

3.3 Cooperation with INSPIRE

INSPIRE concerns the preparation of Community legislation that aims at making available relevant, harmonised and quality geographic information for the purpose of formulation, implementation, monitoring and evaluation of Community environmental policy-making and for the citizen.

After several years of preparation INSPIRE is now formulating its final proposal to be adopted by the Commission at the second quarter of 2004. This proposal will consist of two elements: The scope and measures, and a strong extended impact assessment.

The soil data theme to be adopted within the scope of INSPIRE is of great concern. The STS will benefit the measures INSPIRE proposes. It is highly recommended to join forces. It might be too late to participate fully at this very moment, since both are going to an interim end soon. At least both proposals must accept their interrelationships and prepare cooperation in the next phases.

It will be very useful to participate in the impact assessment, as also the STS has to formulate the impact of her own proposals. The decision should be taken whether the STS or INSPIRE accounts for the impacts.

The INSPIRE Expert Group has recognized this problem and is drawing up proposals about how to deal with it.

4 Recommendation

Directive 2003/4/EC exclusively regulates the public access to environmental information.

Everything becoming part of the monitoring directive must complain with Article 7 of directive 2003/4/EC. Therefore every proposal for the monitoring directive must be in line with the spirit and the regulations of directive 2003/4/EC.

The use of data being subject of commercial use or privately owned for the future EU monitoring system has to be regulated by contract.

Close cooperation will benefit the activities of INSPIRE and the Soil Thematic Strategy. Initiatives to this end should be taken. The Commission soon will adopt proposals from both. These proposals should refer to each other.

Annex 1:

DIRECTIVE 2003/4/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 January 2003 on and repealing Council Directive 90/313/EEC .

Directive 2003/4/EC exclusively regulates the public access to environmental information.
Everything becoming part of the monitoring directive must comply with Article 7 of Directive 2003/4/EC. Therefore, every proposal for the monitoring directive must be in line with the spirit and the regulations of Directive 2003/4/EC.

The use of data for commercial purposes or being privately owned either for the future EU monitoring system, or deriving from it, has to be regulated by contract.

"The objectives of the Directive are:

> (a) to guarantee the right of access to environmental information held by or for public authorities and to set out the basic terms and conditions of, and practical arrangements for, its exercise; and
>
> (b) to ensure that, as a matter of course, environmental information is progressively made available and disseminated to the public in order to achieve the widest possible systematic availability and dissemination to the public of environmental information. To this end the use, in particular, of computer telecommunication and/or electronic technology, where available, shall be promoted. "

The definitions point out clearly that for all the possible contents of the upcoming monitoring directive directive 2003/4/EC must be applied. The most relevant wording reads as follows:

"1. 'Environmental information' shall mean any information in written, visual, aural, electronic or any other material form on:

> (a) the state of the elements of the environment, such as air and atmosphere, water, soil, land, landscape and natural sites including wetlands, coastal and marine areas, biological diversity and its components, including genetically modified organisms, and the interaction among these elements;
>
> (b) factors, such as substances, energy, noise, radiation or waste, including radioactive waste, emissions, discharges and other releases into the environment, affecting or likely to affect the elements of the environment referred to in (a);
>
> (c) measures (including administrative measures), such as policies, legislation, plans, programs, environmental agreements, and activities affecting or likely to affect the elements and factors referred to in (a) and (b) as well as measures or activities designed to protect those elements;
>
> (d) reports on the implementation of environmental legislation;
>
> (e) cost-benefit and other economic analyses and assumptions used within the framework of the measures and activities referred to in (c); and
>
> (f) the state of human health and safety, including the contamination of the food chain, where relevant, conditions of human life, cultural sites and built structures inasmuch as they are or may be affected by the state of the elements of the environment referred to in (a) or, through those elements, by any of the matters referred to in (b) and (c).

2. 'Public authority' shall mean:

> (a) government or other public administration, including public advisory bodies, at national, regional or local level;
>
> (b) any natural or legal person performing public administrative functions under national law, including specific duties, activities or services in relation to the environment; and
>
> (c) any natural or legal person having public responsibilities or functions, or providing public services, relating to the environment under the control of a body or person falling within (a) or (b).

Member States may provide that this definition shall not include bodies or institutions when acting in a judicial or legislative capacity. If their constitutional provisions at the 14.2.2003 date of adoption of this Directive make no provision for a review procedure within the meaning of Article 6, Member States may exclude those bodies or institutions from that definition.

3. 'Information held by a public authority' shall mean environmental information in its possession which has been produced or received by that authority.

4. 'Information held for a public authority' shall mean environmental information which is physically held by a natural or legal person on behalf of a public authority.

5. 'Applicant' shall mean any natural or legal person requesting environmental information.

6. 'Public' shall mean one or more natural or legal persons, and, in accordance with national legislation or practice, their associations, organizations or groups."

Article 3 regulates the access to environmental information upon request .

> "Member States shall ensure that public authorities are required, in accordance with the provisions of this Directive, to make available environmental information held by or for them to any applicant at his request and without his having to state an interest."

Article 4 more or less regulates the exceptions to limit the free access to the environmental information; it reads as follows:

"1. Member States may provide for a request for environmental information to be refused if:

> (a) the information requested is not held by or for

the public authority to which the request is addressed. In such a case, where that public authority is aware that the information is held by or for another public authority, it shall, as soon as possible, transfer the request to that other authority and inform the applicant accordingly or inform the applicant of the public authority to which it believes it is possible to apply for the information requested;

(b) the request is manifestly unreasonable;

(c) the request is formulated in too general a manner, taking into account Article 3(3);

(d) the request concerns material in the course of completion or unfinished documents or data;

(e) the request concerns internal communications, taking into account the public interest served by disclosure.

Where a request is refused on the basis that it concerns material in the course of completion, the public authority shall state the name of the authority preparing the material and the estimated time needed for completion.

2. Member States may provide for a request for environmental information to be refused if disclosure of the information would adversely affect:

(a) the confidentiality of the proceedings of public authorities, where such confidentiality is provided for by law;

(b) international relations, public security or national defense;

(c) the course of justice, the ability of any person to receive a fair trial or the ability of a public authority to conduct an enquiry of a criminal or disciplinary nature;

(d) the confidentiality of commercial or industrial information where such confidentiality is provided for by national or Community law to protect a legitimate economic interest, including the public interest in maintaining statistical confidentiality and tax secrecy;

(e) intellectual property rights;

(f) the confidentiality of personal data and/or files relating to a natural person where that person has not consented to the disclosure of the information to the public, where such confidentiality is provided for by national or Community law;

(g) the interests or protection of any person who supplied the information requested on a voluntary basis without being under, or capable of being put under, a legal obligation to do so, unless that person has consented to the release of the information concerned;

(h) the protection of the environment to which such information relates, such as the location of rare species.

The grounds for refusal mentioned in paragraphs 1 and 2 shall be interpreted in a restrictive way, taking into account for the particular case the public interest served by disclosure. In every particular case, the public interest served by disclosure shall be weighed against the interest served by the refusal. Member States may not, by virtue of paragraph 2(a), (d), (f), (g) and (h), provide for a request to be refused where the request relates to information on emissions into the environment.

Within this framework, and for the purposes of the application of subparagraph (f), Member States shall ensure that the requirements of Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data are complied with (1).

3. Where a Member State provides for exceptions, it may draw up a publicly accessible list of criteria on the basis of which the authority concerned may decide how to handle requests.

4. Environmental information held by or for public authorities which has been requested by an applicant shall be made available in part where it is possible to separate out any information falling within the scope of paragraphs 1(d) and (e) or 2 from the rest of the information requested."

Article 7 regulates the obligation of active dissemination of environmental information and reads as follows:

"1. Member States shall take the necessary measures to ensure that public authorities organize the environmental information which is relevant to their functions and which is held by or for them, with a view to its active and systematic dissemination to the public, in particular by means of computer telecommunication and/or electronic technology, where available.

The information made available by means of computer telecommunication and/or electronic technology need not include information collected before the entry into force of this Directive unless it is already available in electronic form.
Member States shall ensure that environmental information progressively becomes available in electronic databases which are easily accessible to the public through public telecommunication networks.

2. …..

3. Without prejudice to any specific reporting obligations laid down by Community legislation, Member States shall take the necessary measures to ensure that national, and, where appropriate, regional or local reports on the state of the environment are published at regular intervals not exceeding four years; such reports shall include information on the quality of, and pressures on, the environment.

4. Without prejudice to any specific obligation laid down by Community legislation, Member States shall take the necessary measures to ensure that, in the event of an imminent threat to human health or the environment, whether caused by human activities or due to natural causes, all information held by or for public authorities which could enable the public likely to be affected to take measures to prevent or mitigate harm arising from the threat is disseminated, immediately and without delay.

5. The exceptions in Article 4(1) and (2) may apply in relation to the duties imposed by this Article."

Article 8 sets the requirements for the quality of environmental information:

“1. Member States shall, so far as is within their power, ensure that any information that is compiled by them or on their behalf is up to date, accurate and comparable.

2. Upon request, public authorities shall reply to requests for information pursuant to Article 2(1)b, reporting to the applicant on the place where information, if available, can be found on the measurement procedures, including methods of analysis, sampling, and pre-treatment of samples, used in compiling the information, or referring to a standardised procedure used. “

Fazit:

- Directive 2003/4/EC exclusively regulates the public access to environmental information.
- Everything becoming part of the monitoring directive must complain with Article 7 of directive 2003/4/EC. Therefore every proposal for the monitoring directive must be in line with the spirit and the regulations of directive 2003/4/EC.
- Please remember: The directive entered into force on 14. February 2003. Member States have to comply with the Directive by 14.February 2005 and Directive 90/313/EEC will finally be out of force by that day.
- The use of data being subject of commercial use or privately owned for the future EU monitoring system has to be regulated by contract.

Annex 2:

Outline of the Directive on Public Sector Information (PSI Directive)

(derived from http://wwwlmu.jrc.it/ginie/doc/d293_issues_pse_fv3.pdf)

Aim of the PSI Directive

The Directive on Public Sector Information (PSI Directive) aims to ensure that in relation to the reuse of public sector information the same basic conditions apply to all players in the European information market, that more transparency is achieved on the conditions for reuse and that unjustified market distortions are removed. The PSI Directive offers legal certainty for the market players and establishes deadlines for changes, while leaving the Member States to choose the precise way in which its provisions would be adapted to local circumstance. The terms of access to Public Sector Information are left to the Member States to implement.

Principles behind the PSI Directive

The PSI Directive is guided by compliance with EU competition policy to ensure the existence of a workable single market. Additionally it sets out some basic principles for the establishment of an internal EU market for PSI based on:

1. Availability (Article 4)
2. Principles for charging (Article 6)
3. Transparency (Article 7)
4. Facilitating re-use (Article 8)
5. Non-discrimination (Article 9)
6. Fair trading (Article 9)
7. Prohibition of exclusive arrangements (Article 10)
8. Monitoring (Article 12)

Implementation of the PSI Directive

As a result of the Environment Council on the 27th October 2003 agreeing with the European Parliaments amendments and text the PSI Directive is now set to become law by the end of 2003 with Member States having 18 months to transpose the PSI Directive into their national legal frameworks.

MONITORING

Task Group 4 on
VARIABILITY OF SOILS

Luca Montanarella, Dominique Arrouays
Dieter Wolf, Michele Pisante

Executive summary

Monitoring soils is quite different form monitoring air and water. The spatial variability of soils is very great and requires a customized approach that takes this feature fully into account. It is also important to remember that soils are *relatively* stable, so that their properties, once formed, tend to remain unchanged over space and time.

Soils in Europe are particularly rich and diverse, with many different soil types occurring in different climatic regions, therefore a specific mechanism needs to be developed in order to address this variability. The information available about soil variability can be derived essentially from the 1:1,000,000 scale soil database of Europe located within a European Soil Information System. This data set, together with other information sources, allows for a preliminary representativity analysis for different monitoring strategies.

Thus, different approaches are required for each of the recognised threats to European soils. While some of the threats may require systematic monitoring , other threats need a more focused approach taking into account the fact that they do not occur everywhere in Europe (soil erosion, soil compaction, salinisation, soil sealing, floods and landslides). Stratification of the European soils according to susceptibility to each of the single threats would allow developing targeted monitoring approaches for each of these.

Future soil monitoring at EU level should be based, as far as possible, on existing monitoring systems. A complete inventory of the National monitoring systems sites that Member states and Accession Countries may whish to include and integrate into a future European Soil Monitoring System would allow to perform an in-depth representativity analysis of these systems , both for representativity of the diversity of soil types and of land uses in Europe. Additional analysis of these systems for representativity of the single soil threats should be performed based on a pre-stratification of European soils according to each of the various threats listed in the communication COM 179 (2002). The analysis will allow determining if the existing soil monitoring at the National level covers adequately both soil/landscape diversity for general monitoring purposes and each of the individual threats for action driven monitoring purposes. Eventually the analysis might yield the conclusion that in some parts of the EU additional soil monitoring sites need to be established. Such a conclusion should be submitted to a detailed cost/benefit analysis.

Final recommendations are:

1. Establish a stratification by EU and Accession Countries for each of the eight threats to soils using existing information including a report on the methodology used for risk assessment and reporting procedure in order to determine priority areas for each threat.

2. Acquire from the Member States and Accession Countries the precise coordinates of each existing soil monitoring site[1] that is planned to be included in the future European Soil Monitoring Network[2].

3. Perform a representativity analysis for the monitoring sites that have been reported by Member States and Accession Countries taking into account soil type, land use and the stratification according to threats.

4. Evaluate the opportunity of establishing additional sites on the basis of the representativity analysis and of a separate cost/benefit analysis.

- As already mentioned above also here the recommendations persuade an area concept for soil monitoring (EU network, soil monitoring sites). The use of the word "site" is unclear, moreover it is not possible to base monitoring for several threats in sites (like soil sealing)

- As regards local contamination: Local contamination appears widespread over Europe (in all parts, however with a different importance). To avoid misunderstandings it is suggested to delete "local contamination" in chapter "stratified monitoring site location" (3rd line).

Again, the conclusions and recommendations are focusing on soil sampling and monitoring network.

[1] For the purpose of this report, a monitoring site is defined as a georeferenced data point with data available at least for two different observation dates.

[2] Network is intended as coordinated activity of organisations in Member States responsible for soil monitoring.

Introduction

Soil is a highly variable medium. It is both variable in space as in time. For this reason designing an efficient soil monitoring scheme for Europe requires to take into account this variability. Spatial variability of soils is by far larger then changes over time. This is the reason for the stringent requirements for georeferencing of sampling sites that are mandatory for an efficient and useful soil monitoring system.

Sampling soils at locations different maybe by only a few meters may yield a variability that is by far larger then the changes that are to be detected during the monitoring exercise.

The design of a modern soil monitoring system needs therefore to take into account the spatial variability of soils. In addition the same soils may be subject to different land uses, making the selection of sites even more complex.

Soils of Europe

The distribution of the major soil types over Europe is well represented within the European Soil Information System (EUSIS). In particular the Soil Geographical Database of Europe at scale 1:1,000,000 (fig. 1) allows analysing the distribution of the major soils of Europe.

Table 1 is listing the twelve most frequent soils that account for just a little more the 50% of the total land area. The rest is covered by more then 300 other soil types occurring often only on very limited land areas (less the 2% of total land area covered by the Soil Geographical Database of Europe (SGDE) ver. 3.28).

Table 1: Most frequent soils in Europe (more the 2% of total land area covered by the SGDE ver. 3.28).

Soil Name (FAO 1974)	Area in km^2	Percentage area
Orthic Podzol (Po)	813000	10,1
Dystric Cambisol (Bd)	506000	8,9
Eutric Cambisol (Be)	385000	7,5
Orthic Luvisol (Lo)	307000	5,8
Dystric Histosol (Od)	213000	4,4
Calcic Cambisol (Bk)	206000	4,2
Dystric Regosol (Rd)	203000	4,2
Gleyic Luvisol (Lg)	197000	4,2
Calcaric Fluvisol (Jc)	135000	2,4
Chromic Luvisol (Lc)	110000	2,4
Eutric Fluvisol (Je)	105000	2,4
Dystric Lithosol (Id)	104000	2,1
Total	**3284000**	**58,60**

Source: SGDE ver. 3.28

This large number of relatively rare soil types needs to be taken into account in designing the soil-monitoring scheme. In addition, some of these rare soil types may deserve special attention as unique habitats for a number of organisms, making them potentially eligible for specific protection measures.

Land Use/Land Cover

When choosing the best location of soil monitoring sites, not only soil type information is crucial, but also land use/land cover information is necessary in order to cover all possible soil type/land use combinations.
Several sources of information exist in Europe on current land use/land cover. The most harmonised source is surely the results of the CORINE Land Cover activity of the European Commission, covering Europe with a 1:100,000 scale land cover map derived from satellite remote sensing data.

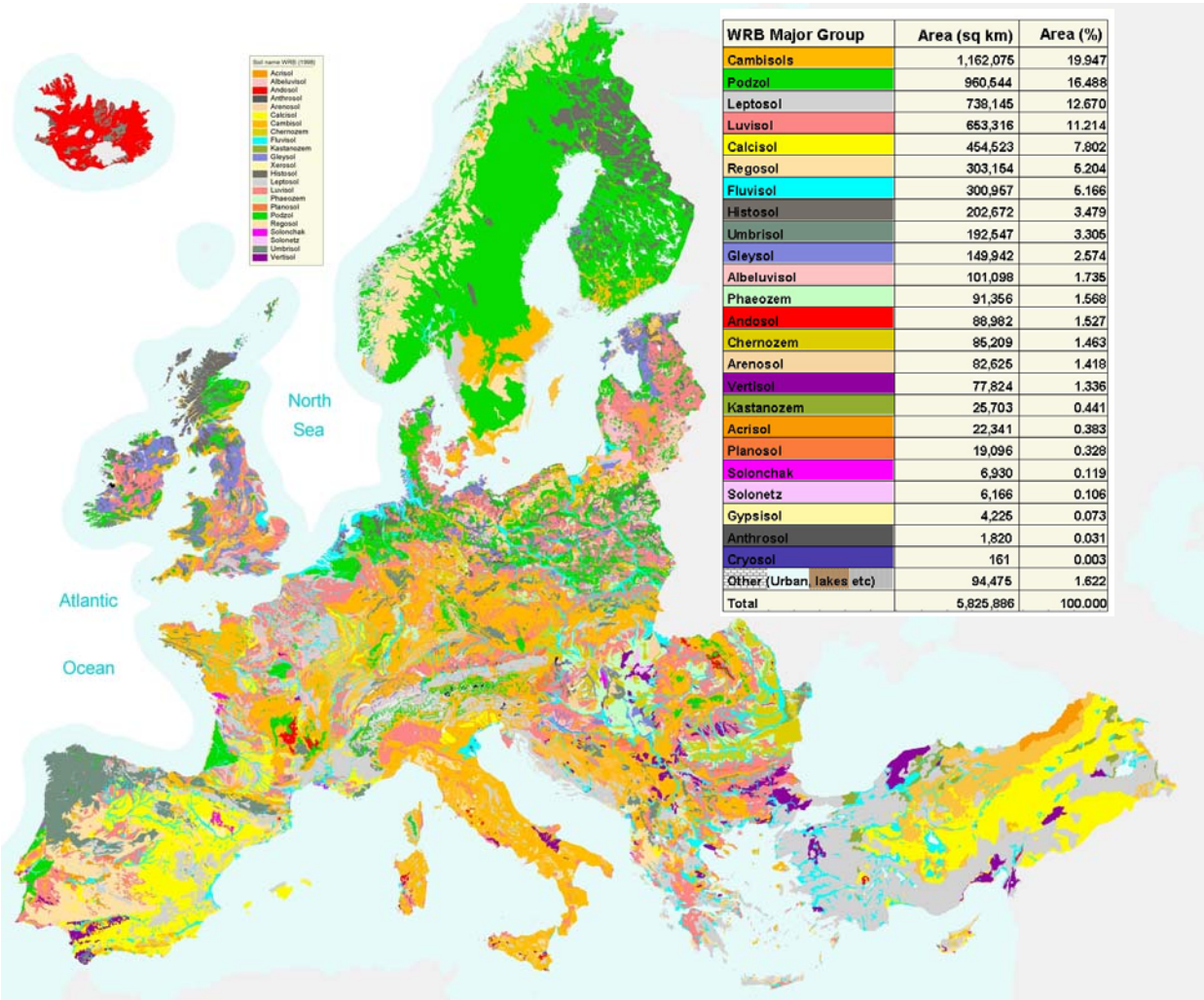
There are 44 land cover classes used by CORINE as a legend to the spatial database.

Details are available at http://terrestrial.eionet.eu.int/CLC2000.

Stratified monitoring site location

Only few of the eight threats to European soils identified in COM 179 (2002) require systematic monitoring all over Europe. Several threats occur only in some parts of Europe, like for example salinisation, floods, landslides, soil compaction, erosion, soil sealing, local soil contamination (contaminated sites). For these threats a stratified sampling strategy using available information on the selected threats would allow site location in the more sensitive areas.

Special attention has to be given to local soil contamination (contaminated sites). Location of monitoring sites in, or close to these “hot spots” should allow for collection of data being of relevance for the total area (e.g. total impact on soil being of relevance for water management at catchment level).



WRB Major Group	Area (sq km)	Area (%)
Cambisols	1,162,075	19.947
Podzol	960,544	16.488
Leptosol	738,145	12.670
Luvisol	653,316	11.214
Calcisol	454,523	7.802
Regosol	303,154	5.204
Fluvisol	300,957	5.166
Histosol	202,672	3.479
Umbrisol	192,547	3.305
Gleysol	149,942	2.574
Albeluvisol	101,098	1.735
Phaeozem	91,356	1.568
Andosol	88,982	1.527
Chernozem	85,209	1.463
Arenosol	82,625	1.418
Vertisol	77,824	1.336
Kastanozem	25,703	0.441
Acrisol	22,341	0.383
Planosol	19,096	0.328
Solonchak	6,930	0.119
Solonetz	6,166	0.106
Gypsisol	4,225	0.073
Anthrosol	1,820	0.031
Cryosol	161	0.003
Other (Urban, lakes etc)	94,475	1.622
Total	5,825,886	100.000

Figure 1: The European Soil Database ver. 1.0. Distribution of major soils groups according to World Reference Base (WRB) is shown in inset (source: European Soil Bureau).

In order to illustrate the concept of stratification few examples are given:

For example, a soil erosion risk map (fig. 2) may be an excellent tool for identifying priority areas where to locate dedicated sites for soil erosion measurements.

In a similar way, a soil salinisation map of Europe (fig: 3), may stratify the European soil according to the occurrence of this specific threat. Monitoring of salinisation outside these areas would be unjustified.

A map of Susceptibility to Subsoil Compaction in Europe (to be validated by Member States) (fig. 4) clearly shows area where dedicated monitoring for this specific soil threat would be desirable.

This maps are only reported as examples of possible outputs of the proposed stratification exercise for the eight threats. They are not definitive and will be subject to validation by more accurate data provided by member states.

Of course such stratification approaches should carefully take into account local information and experiences. The maps reported here are intended to exemplify possible outputs from such a stratification (zonation) exercise.

Determination of the number and distribution of monitoring sites

The debate around the design of the most appropriate soil monitoring scheme in order to be cost-effective and policy relevant is usually restricted to the two options: grid sampling versus stratified sampling. Both approaches have positive and negative sides.

Important for an European soil monitoring system is to be able to cover all major combinations of soil types and land uses in order to take into account the diversity of European landscapes.

Simulations of different grid densities (D. King et al., 2002) have shown that the 16x16km grid is the most representative of all possible soil type/land use combinations (fig. 2 and 3).

This result is in full accordance with similar analyses done at National level (D. Arrouays et al., 2001).

Nevertheless it should be kept in mind that such a systematic approach may be appropriate just for monitoring of the threats to soils that occur in a generalised way all over Europe. This is particularly the case for the monitoring of soil organic matter, decline of soil biodiversity and diffuse contamination. For specific threats occurring only in certain areas in Europe a stratified approach seems more appropriate.

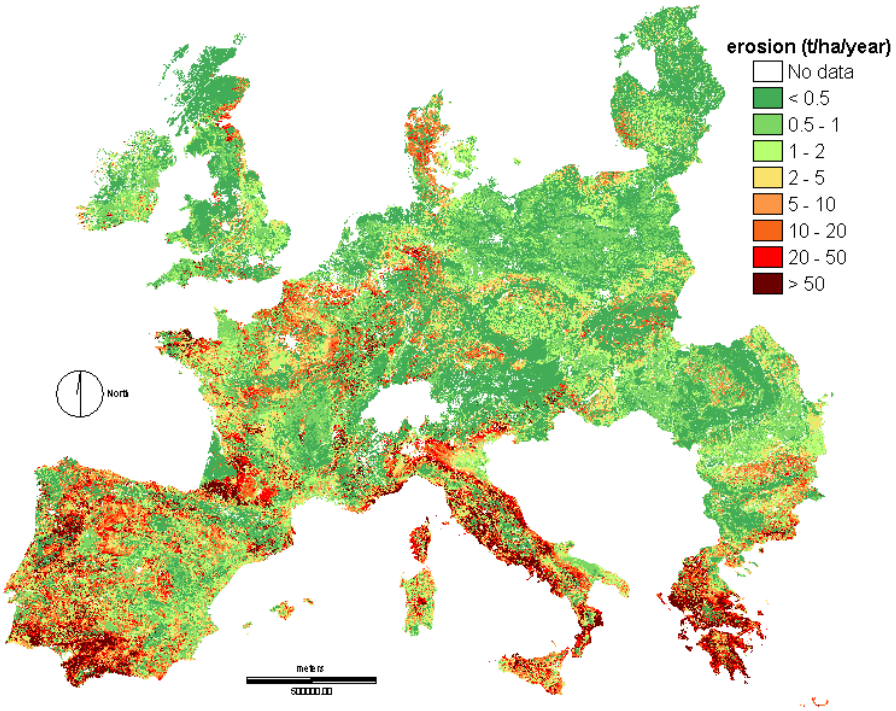


Figure 2: Annual Soil Erosion Risk in Europe (source: final report TWG Soil Erosion).

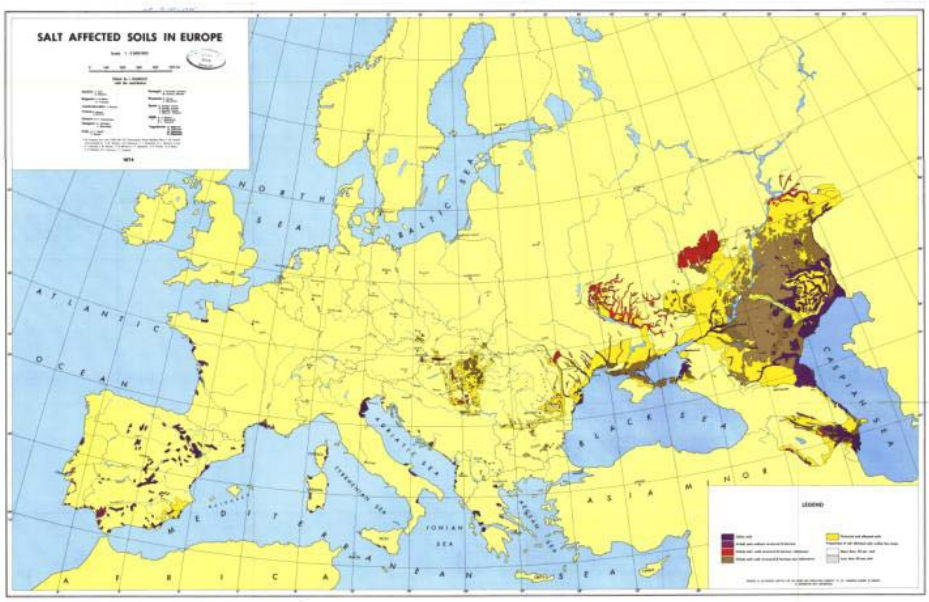


Figure 3: Salt affected soils in Europe (source: I. Szabolcs, 1974)

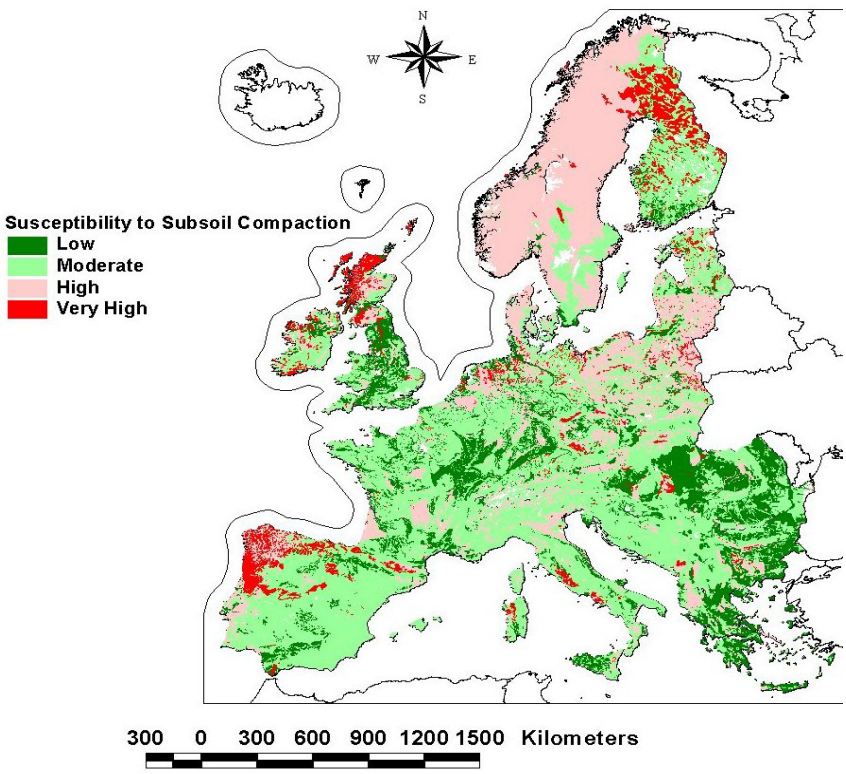


Figure 4: Susceptibility to Subsoil Compaction in Europe (source: Jones, R.J.A. et al., 2004).

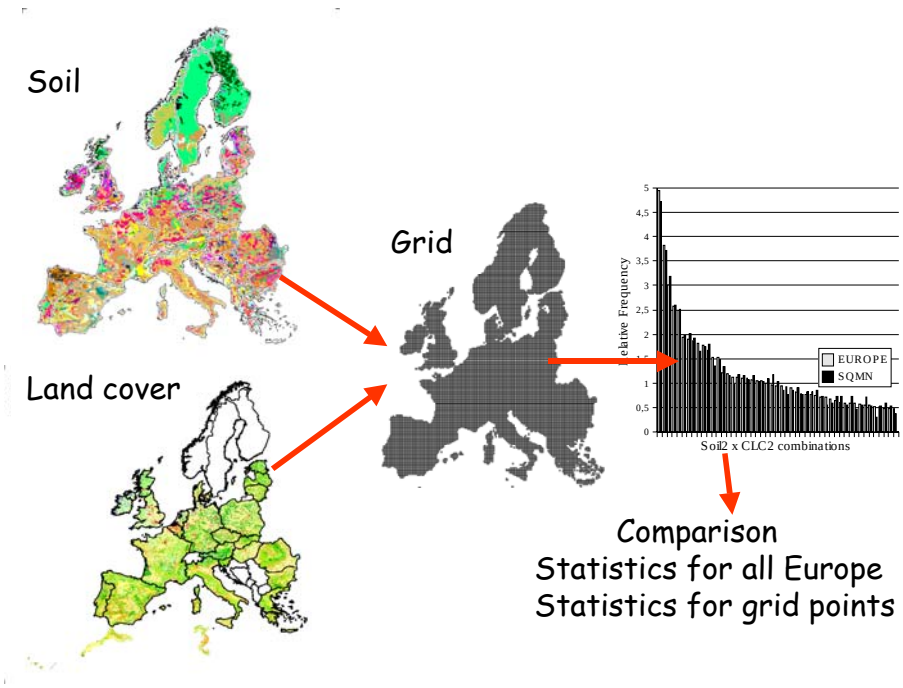


Figure 5: Simulation of representativity of soil variability and land cover classes for a 16km x 16km grid over Europe (source: D. King, 2002).

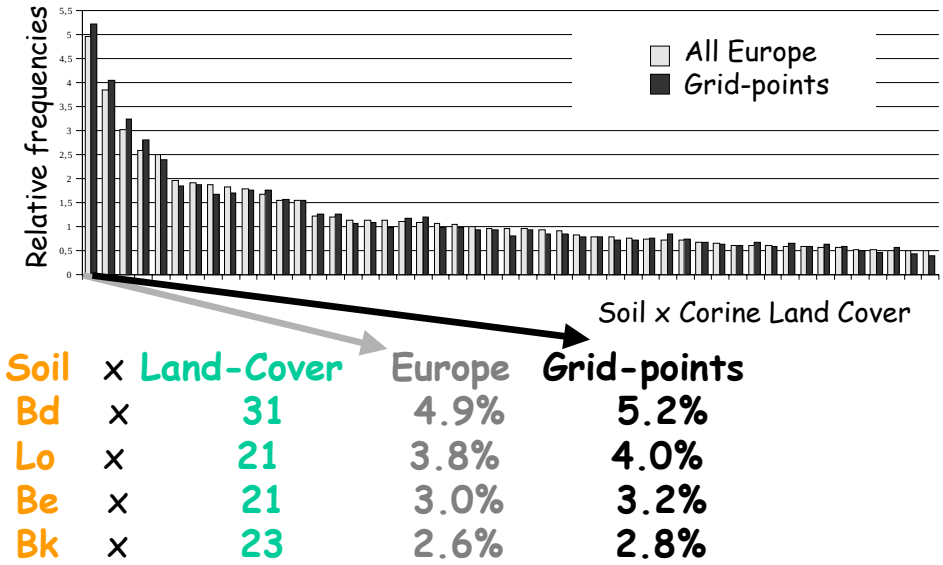


Figure 6: Comparison of the frequencies of distributions of soil type x land cover combinations on a 16 km x 16 km grid, showing that it is well representing the soil and land cover variability of Europe (source: D. King, 2002).

Conclusions and recommendations

The large diversity of soils across Europe requires having representative soil monitoring sites at a minimum density adequately representing the diversity of landscapes, climate, geology, land use and soil type. The choice of a grid sampling design or of stratified sampling designs should allow covering this large diversity. Additionally, sampling density should roughly correspond to the information density of the 1:1,000,000 scale soil database of Europe that could therefore be used as a first baseline for the general purpose monitoring system. This in order to allow for synergies and cost savings by using existing soil information systems, such as the European Soil Information System (EUSIS).

The systematic grid approach seems appropriate for the threats occurring in a generalised way all over the territory of the European Union, like diffuse soil contamination, de. For the other threats, a stratified approach seems more appropriate.

Since the future soil monitoring approach for the EU should be based on existing systems, it is recommended to perform a detailed analysis of the existing monitoring sites at National and Regional level in order to verify their representativity at European scale. Such an analysis requires a detailed inventory of existing sites with precise geographic coordinates of site location. A specific request in this sense should be addressed to the EU Member States. This could be the first step towards the establishment of a common European Soil Monitoring Network that includes all sites that have been submitted by Member States and Accession Countries as sites of Community interest.

Final recommendations therefore are:

1. Establish a stratification of the EU and Accession Countries for each of the eight threats to soils using existing information in order to determine priority areas for each threat.

2. Acquire from the Member States and Accession Countries the precise coordinates of each existing soil monitoring site that is planned to be included in the future European Soil Monitoring Network.

3. Perform a representativity analysis for the monitoring sites that have been reported by Member States and Accession Countries taking into account soil type, land use and the stratification according to threats.

4. Evaluate the opportunity of establishing additional sites on the basis of the representativity analysis and of a separate cost/benefit analysis.

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