European soil monitoring and assessment framework

EIONET workshop proceedings

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Executive summary

Workshop

The first EIONET workshop on soil was organised on behalf of the European Environment Agency (EEA) by the European Topic Centre on Soil (ETC/S), as part of the second EEA multi-annual work programme (MAWP 1999–2003).

The purpose was to present the proposal for a common European monitoring and assessment framework for soil to EIONET partners and Commission services, in order to reach a common understanding and agree on the way to proceed towards implementation. The framework is being designed as a basis for the work needed to support policy developments within the European Community as well as the EEA reporting activities on soil.

The workshop was held in Vienna on 13 and 14 October 1999. It was attended by representatives from 13 EEA countries and the JRC, as well as EEA staff, ETC/S partners and representatives of the EEA Scientific Committee.

The workshop started with an introduction by the EEA, which summarised the major objectives and the results of EEA work on soil, as well as the major elements of the proposal within the wider context of the EEA work programme. ETC/S partners presented the details of the proposal, including the development of policy-relevant indicators, implementation of the framework for contaminated sites and an initial proposal for a European soil monitoring network (EuroSoilNet).

Country representatives were invited to present statements on national soil monitoring and assessment activities. It was clear that countries were at different stages of development and some had not yet established monitoring systems. In some countries, there are problems of data comparability and access, and national data flows need to be streamlined.

The second day was mainly dedicated to the discussion on the proposal and to the presentation of the first results of a consultation on priorities for soil work, which was launched through the distribution of a questionnaire prior to the workshop.

The discussion was constructive and animated. Main points debated included data comparability and availability, specific aspects of EuroSoilNet, the implementation of the proposed framework, as well as funding and institutional issues. In the closing statement the Agency announced that it would develop broader themes to help increase awareness on the cross-cutting nature of environmental issues.

The workshop provided a positive response to the work done. The proposed soil monitoring and assessment framework was seen as an important step to improve soil information at the European level. EEA was invited and encouraged to proceed further in the implementation. Country representatives confirmed their willingness to contribute to the framework, according to their activities on soil issues and their resources.

On the basis of the discussion and the formal consultation, it has been possible to draw a number of recommendations, summarised below.

Recommendations

EEA should develop guidelines on what exactly needs to be measured and monitored. Further consultation with countries and the establishment of a working group elaborating on these issues will help to accomplish the task.

Information should be gathered to enable assessment of the current state of soil in Europe, as well as on the interrelations with the wider environment. An effort should be made to identify trends and changes over time.

Priority should be given to the development of indicators in four main areas: soil sealing, soil erosion, local contamination (contaminated sites) and diffuse contamination, since these are seen as relevant issues both in the short and long-term and data are relatively available.

A twofold approach should be pursued for the development of the indicators: a short-term approach, based on data already available and aimed to provide immediate results; and a long-term approach, based on data gathered through the proposed EuroSoilNet.

EuroSoilNet should be based as far as possible on existing national monitoring activities. Direct contacts with already existing monitoring networks should be established. In the short-term data comparability can be achieved through the use of transformation functions. In the long-term harmonised methods of monitoring and data transfer should be adopted.

The implementation of the framework in general and EuroSoilNet in particular should proceed stepwise. A pilot project, including a limited number of countries and focused on few issues, should be started. Countries will join on a voluntary basis.

EEA should make an official request to enable the countries to start working on the implementation of the framework. This would be particularly relevant in countries where monitoring is undertaken at the regional and local levels.

Work progress in 2000–2001

Since October 1999, the results of this workshop have served as a basis for discussion and reference in the development of the EEA work programme on soil.

The results of the workshop were presented at the first meeting of the European Soil Forum, organised by DG Environment and held in Berlin, in November 1999.

In 2000, the Agency established three working groups on soil indicators. A second EIONET workshop on indicators on soil contamination and two technical workshops on indicators for soil sealing and soil erosion were organised by EEA in early 2001. The results of the work of the working groups are being compiled for publication later in 2001/early 2002.

From July 2001, the follow-up on implementation of the soil framework will be undertaken by the new European Topic Centre on Terrestrial Environment. The choice to integrate soil and land-related issues in one ETC reflects the comprehensive approach to soil and the environment which underpins the framework.

1. Introduction

1.1. Background

The overall objective of the European Environment Agency (EEA) is 'to provide the Community and its Member States with objective, reliable and comparable information at European level enabling them to take the requisite measures to protect the environment, to assess the results of such measures and to ensure that the public is properly informed about the state of the environment'.

EEA main tasks include:

- to report on the state, trends and outlook of Europe's environment;
- to establish, develop and make use of the European Environmental Information and Observation network (EIONET);
- to facilitate access to data and information supplied to, maintained and emanating from, EEA and EIONET, together with access to other relevant environmental information developed by other national and international sources.

The role of EEA, as defined by its mission and mandate, is to provide policy makers and the public with quality information, and to do so through a range of products and services. The Agency works as a facilitator or bridge between member countries, EU institutions and other environmental organisations and programmes to bring together, use, make available and thereby improve the quality of information on the environment relevant at the European level for policy making and assessment.

The European Topic Centre on Soil (ETC/S) was established by EEA in 1996 with the objective to provide and develop information and data on soil aspects, covering all EEA member countries, in order to increase the understanding of soil as a natural resource, document soil degradation processes and improve the level of reliable and comparable information about contaminated sites, thus contributing to the development of the EEA work programme.

ETC/S operated until December 1999. In March 2001, a new topic centre on terrestrial environment (ETC/TE) was designated to carry forward work on soil, land cover and spatial assessment.

1.2. Objectives and follow-up of the workshop

The purpose of the workshop was to present to EIONET partners and Commission services the EEA proposal for a common European monitoring and assessment framework for soil, in order to get to a common understanding and to agree on the way to proceed towards implementation. The framework is being designed as a basis for the work needed to support policy developments within the European Community as well as the EEA reporting activities on soil.

A background report illustrating the proposal in detail (EEA, 2001) was prepared and sent to the participants, together with a workshop questionnaire.

Countries were asked to endorse the proposed framework and to express their willingness to participate in the activities. Countries were also asked to identify priority issues for the development of policy-relevant indicators for soil. The questionnaire is discussed in Appendix II.

Results of the EIONET workshop and the country consultation were presented at the first meeting of the European Soil Forum, organised by DG Environment and held in Berlin, in November 1999.

1.3. Progress of the work in 2000–2001

Since October 1999, the results of this workshop have served as a basis for discussion and reference in the development of the EEA work programme on soil. By the time of the publication of these proceedings, a series of events have happened which have modified the context of the discussion. The major developments are presented below.

1.3.1. Working groups on soil indicators

On the basis of the results of the first EIONET workshop and a wider review of the work on soil (October 1999), implementation of the framework progressed through three working groups in the period 2000–mid 2001 on:

- soil contamination (local and diffuse);
- soil sealing; and
- soil erosion.

A second EIONET workshop on indicators on soil contamination took place in Vienna in January 2001. Two technical workshops on indicators for soil sealing and soil erosion were organised in Copenhagen in March 2001, with the participation of a small number of national experts. The results of the work of the working groups are being compiled at the time of the publication of these proceedings.

1.3.2. The European Topic Centre on Terrestrial Environment

The follow-up on the implementation of the European soil assessment and monitoring framework will be undertaken by ETC/TE.

The choice to integrate soil and land-related issues in one ETC reflects the more comprehensive approach to soil and the environment adopted by the EEA, which underpins the framework.

In this context, the main task of the ETC/TE will be to gradually develop a monitoring and assessment framework for terrestrial environment, extending the framework for soil (to be used as a basis for further developments) to all relevant aspects of terrestrial environment.

In particular, ETC/TE will develop and maintain a core set of indicators (focusing on sustainable land use, soil protection and integrated assessment of coastal areas) in collaboration with EIONET partners, relevant networks and the Commission services. The indicators will reflect pressures from sectors (transport, agriculture, tourism), land cover changes, soil degradation (sealing, local and diffuse contamination) and impacts on land such as habitat fragmentation.

The initial list of policy-relevant indicators included in this report, further extended to all relevant aspects, will be used as a basis for prioritisation.

ETC/TE will also contribute to the shared, multi-purpose European environmental information system with the design, development and implementation of TERRIS, the EEA integrated information system on terrestrial environment. SoilBase will be an integral part of this system.

1.3.3. Collaboration with the Joint Research Centre

In late 1999, EEA and JRC agreed on a joint strategy on soil. The strategy focuses on the adoption of a common framework for the monitoring and assessment of soil in Europe and on the development of a common soil information system.

The shared information system will integrate the relevant parts of TERRIS (EuroSoilBase) and the European soil information system (EUSIS), developed by the JRC/European Soil Bureau. JRC will also contribute to the development of the core set of indicators.

1.3.4. A future common strategy for soil protection

The sixth environmental action programme (6EAP) includes a proposal for a new strategy on soil protection for the European Union. The programme, presented by the European Commission at the beginning of 2001 and to be approved by the European Parliament and the Council, lays down the Community action programme for the period 2001–10 in the field of environment.

The draft 6EAP recognises that '... Little attention has so far been given to soils in terms of data collection and research. Yet, the growing concerns on soil erosion and loss to development as well as soil pollution illustrate the need for a systematic approach to soil protection...'

Moreover, '...Given the complex nature of the pressures weighing on soils and the need to build a soil policy on a sound basis of data and assessment, a thematic strategy for soil protection is proposed...' (European Commission, 2001)

In a long-term perspective, the implementation of the framework for the assessment and monitoring of soil in Europe, presented in this report, would contribute to improve the information basis needed to prepare, implement and monitor a sound European strategy on soil, in line with the priorities set down in the 6EAP.

2. Workshop proceedings

2.1. Presentation of the framework

2.1.1. Introduction

The workshop was held in Vienna on 13 and 14 October 1999. The venue and the organisation were provided by the Austrian Federal Environment Agency (UBA Vienna), partner in the European Topic Centre on Soil (ETC/S).

The workshop was attended by representatives from 13 EEA countries and the JRC (Greece, Iceland, Liechtenstein, Norway and Sweden were not able to participate), as well as EEA staff, ETC/S partners and representatives of the EEA Scientific Committee.

The workshop was introduced by Wolfgang Struwe, manager of UBA Vienna, Prof. Winfried Blum, member of the EEA Scientific Committee with responsibilities on soil and Gordon McInnes, EEA Programme Manager for Monitoring and Thematic Reporting. Prof. Philippe Bourdeau, chairman of the EEA Scientific Committee, also participated in the workshop.

Prof. Blum acted as chairman and facilitator. In his opening speech, he stressed the importance of the first EIONET workshop on soil. He remarked that, after three years, it was the right time to analyse the results of the work done and decide on future activities.

Anna Rita Gentile, EEA Project Manager for Soil and Contaminated Sites, introduced the workshop and summarised the objectives and the results of the work on soil developed by EEA with the support of ETC/S. The major elements of the proposal for a monitoring and assessment framework on soil were presented within the wider context of the EEA work programme. Specific reference was made to the development of policy-relevant indicators.

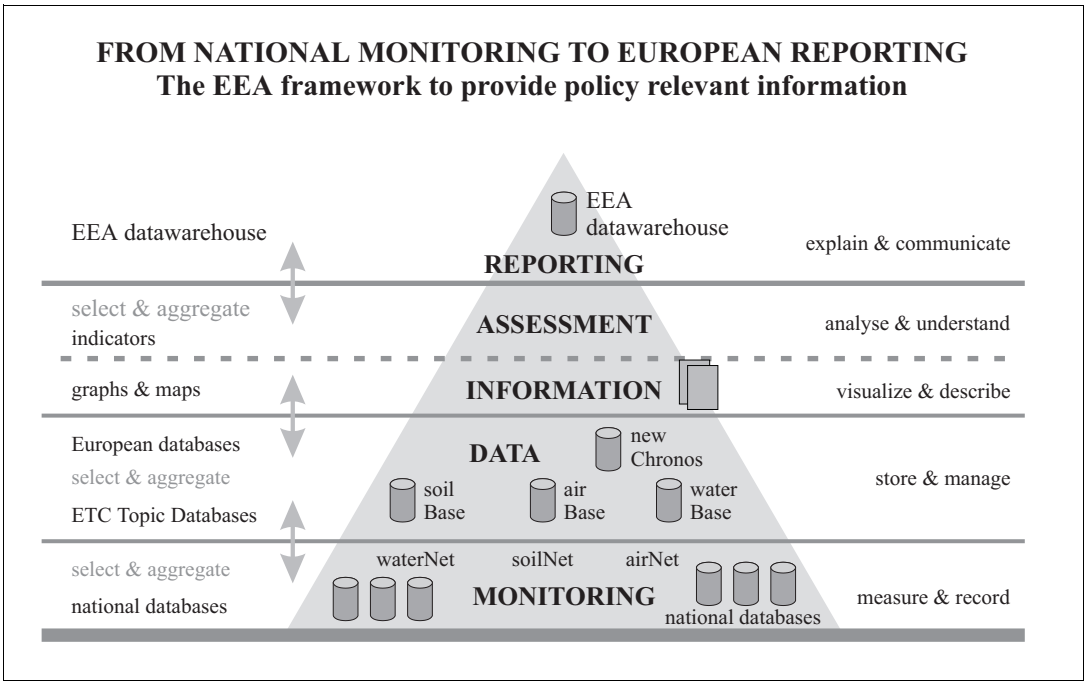
The scope of the soil monitoring and assessment framework is to organise the work needed to support EEA reporting activities on soil and in particular the development of policy-relevant indicators. In this context, a more holistic approach to soil and environment is adopted (EEA, 1999).

The proposed soil framework is both conceptual and operational. It makes use of analytical tools such as the DPSIR assessment framework (driving forces, pressures, state, impact and responses) and the multi/functions-multi/impact approach to carrying out environmental assessments (EEA, 1999).

Operationally, the soil framework is based on the EEA 'national monitoring to European reporting' (MDIAR) pyramid.

It was important to underline that, within the framework, monitoring activities are undertaken at national level. EEA supports the countries in organising their national monitoring systems and has the major responsibility to establish data flows from the national level to the European level. Aggregated national data, rather than raw data, are used for the assessment at the European scale. These aspects are visualised in Figure 1, where the dimensions of the pyramid also indicate the level of aggregation and the quantity of the data involved at each stage.

Figure 1 **From national monitoring to European reporting: the EEA information pyramid**



The introduction of the MDIAR pyramid responds to the need to streamline monitoring and reporting activities, identifying priorities and data needs, and making the best use of existing resources and available data.

The soil framework seeks to extend the scope of existing monitoring activities, mainly based on a classical approach to soil monitoring. It also provides a tool for identifying data needs and avoiding costly data collections.

The term 'assessment' is added to make an explicit reference to the final objective of data collection and monitoring activities, which includes the development of indicators.

Within this context, the operational cycle included in the framework is summarised below:

- identify priorities (agreement on a basic set of indicators) through the identification of the policy requirements and using analytical tools (DPSIR-MF/MI);
- identify data availability and data gaps;
- set up a European soil monitoring network (harmonising national networks towards better data comparability) (EuroSoilNet);
- organise national to European data flow;
- store and organise data (EuroSoilBase);
- use, aggregate and integrate data to make assessments and produce information (development of indicators; integrated assessment; DPSIR, MF/MI);
- communicate the results (soil reporting mechanism).

2.1.2. Technical presentations and country statements

After the introduction, partners of the ETC/S presented the technical details of the proposal.

Presentations included the description of the proposed soil framework, the approaches followed in the development of policy-relevant indicators on soil and the results obtained (with particular reference to soil erosion and soil sealing indicators), the implementation of the framework for contaminated sites (activities were ongoing since 1997) and an initial proposal for a European soil monitoring network (EuroSoilNet). Specific aspects related to monitoring and assessment of boreal soils were also discussed. The latter responds to a request from the EEA Management Board to analyse specific aspects of monitoring and

assessment of soils in northern Europe. Summaries of these presentations are presented in Appendix I.

A discussion on the proposal followed the technical presentations. The proposal to establish a European soil monitoring and assessment framework, based in the first place on identification of main priorities, was well received. Major points of the discussion are summarised in the next section.

The first day of the workshop proceeded with a presentation delivered by Prof. Reijo Salminen on the geo-chemical baseline programme initiated by FOREGS (Forum of the European Geological Surveys directors). The objective of the programme is to provide high-quality environmental geo-chemical baseline data for Europe. Scope of the presentation was to explore the possibility of cooperation. In principle, cooperation is possible since harmonised analytical methods related to ISO standards and a geo-referenced database are used. However, specific aspects must be considered to evaluate feasibility.

Country statements, describing national activities and opinions about the EEA proposal, closed the first day. Brief summaries of the presentations and country statements, including a statement sent by Greece, are reported in Appendix I.

The second day started with a presentation from Prof. Blum, who provided a comprehensive view of perspectives and priorities on soil protection in Europe, followed by a presentation from ETC/S on the first results of the workshop questionnaire and a thorough discussion of the proposal.

In principle, the participants advised to proceed with work on indicators in four priority areas: soil sealing, soil erosion, local and diffuse contamination.

Country representatives agreed to confirm these priorities and complete the questionnaire in writing by the beginning of November 1999, in order to enable EEA to report on the results at the first meeting of the European Soil Forum later that month.

Results of the survey are summarised in Section 3. A full appraisal is reported in Appendix II. The results of the final discussion are included in Section 2.2 below.

2.2. Discussion of the proposal

This section contains a summary of the discussion which took place during the two days of the workshop. The outcomes are grouped by issue, rather than following a strict temporal order, to avoid repetitions and facilitate consultation.

Firstly, relevance of soil monitoring and general points on soil priority problems are presented, followed by technical issues related to data comparability and clarifications on the design of EuroSoilNet. Finally, institutional and funding issues are discussed.

2.2.1. Soil as a multi-functional medium

Soil multi-functionality should be considered in its environmental, social, economic and time dimensions. Some soil functions are mutually exclusive and are often in competition (e.g. soil used for waste treatment in a landfill cannot be used for food production). This competition between functions may lead to an unbalanced use of soil resources and finally to soil degradation (EEA, 1999; EEA, 2000a).

In particular, the major current issue (and in the foreseeable future) in Europe and in most industrialised countries is represented by the continuous increase of built-up areas. This usually leads to irreversible losses of soil resources (soil sealing), which means that the soil cannot perform a wider range of functions.

Moreover, soil issues are complicated by the fact that most soils are under private ownership and that private interests can often conflict with national public interests.

2.2.2. Soil and ecosystems

Soils are closely interrelated with ecosystems, so that changes in these systems affect soils in a very complex way (and vice versa). These processes are rather difficult to quantify. Nevertheless, they are very relevant and should be further investigated.

For instance**,** at present **'boreal soils'** ([1]) act as a sink for several greenhouse gases, since accumulation of organic matter in these areas is currently high. Climate change could have relevant impacts on this function in boreal soils in particular. In fact, higher temperatures could lead to a greater release of the carbon stored in the soil as they provoke an increase of the rate of mineralisation of soil organic matter.

An understanding of ecology related to soils would also demand a distinction between terrestrial and aquatic systems as well as between different land uses, such as agriculture or forests.

The DPSIR assessment framework provides a useful tool to analyse the relationships between soil and the wider environment. In this context, the importance of impact indicators was emphasised in relation to pressure indicators. It was also suggested that more attention should be paid to the state of soils.

2.2.3. Monitoring and assessment of contaminated sites

The inclusion of **contaminated sites** within the wider European soil monitoring and assessment framework, as well as cooperation with existing initiatives, was discussed.

The question arose for several reasons. International cooperation on contaminated land has followed a parallel path in comparison to other soil work, and covered mainly management and research aspects. On the other hand, at the time of the workshop, EEA work on contaminated land was more advanced, consultation with countries had already been initiated and a monitoring and assessment framework was being implemented.

It was recognised that other international initiatives on contaminated land, such as CLARINET ([2]), were focussing on complementary issues, for example research needs. A close cooperation with some of these initiatives is already ongoing.

It was agreed that, as contaminated sites are mainly a soil issue (local contamination), the issue should be treated as a form of soil degradation and included in the wider soil framework.

2.2.4. Development of indicators

In relation to the **indicators** listed in the proposal, the importance of long-term indicators was underlined. It was remarked that the time required to develop indicators labelled as short-term should not be underestimated. Moreover, as building up a monitoring system takes several years, a short-time approach could only be based on existing data. In conclusion, the development of short-term and long-term indicators should proceed in parallel.

Several definitions of the term **soil indicator** were used in the discussion, such as a single soil parameter or a combination of soil parameters and data related to other media. For EEA a **soil environmental indicator** is a well-selected piece of numerical information that describes an aspect of the DPSIR chain applied to soil and that may steer action ([3]).

In relation to indicators for **soil erosion**, it was clearly stressed that measuring soil erosion was rather difficult. In the short-term, it would be hard to collect and compare data. This was demonstrated by the poor results of the joint Eurostat- OECD questionnaire (in relation to

(1) The term 'boreal soils' refers here to the soils of the five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). Much of the region falls within the boreal vegetation zone dominated by spruce and pine forest.
(2) Concerted action on Contaminated land rehabilitation network for environmental technologies in Europe
(3) In general, indicators quantify information by aggregating different and multiple data. Scope of indicators is to simplify information to describe complex phenomena.

the soil erosion tables) and the EEA data request organised to update indicators for the EEA-UNEP joint message on soil in summer 1999 (EEA, 2000a).

2.2.5. Standardisation of terminology

The **standardisation of terminology** in the various European languages would be helpful to establish the framework and facilitate collaboration. In fact, different usage of relevant terms does exist (such as the terms 'indicator', 'data harmonisation', etc.). Specific problems with terminology are discussed later in this section.

2.2.6. Selection of sites for EuroSoilNet

The **design** and **structure** of the proposed **site selection system** was clarified. It was recommended to identify three types of sites. '**Specialist sites'** could be used to monitor sites of special interest (i.e. polluted areas); **'key sites'**, representing background and reference sites in each country, should be set up in regions stratified according to the geology and climate. These should be possibly co-located with already existing national monitoring networks. Finally, **'benchmark sites'** could be located to represent different land uses and for general characterisation (general monitoring). In this way the sites should be applicable to all investigations concerning soils (EEA, 2001).

It was also clarified that the approach for a European soil monitoring network presented at the workshop is based on the results of a survey undertaken in 1995 (GEUS, 1995) and on a survey on existing soil monitoring networks undertaken by ETC/S in 1997 (EEA, 2001; EEA-ETC/S, 1997).

2.2.7. Access to soil monitoring data

It was noted that one main problem of soil networking was that many different organisations were involved. For this reason, it is often difficult for NFPs to identify the actors in order to discuss data ownership and copyright. This complicates access to data and often leads to insufficient or non-existent data flows within a country.

2.2.8. Data comparability and harmonisation of methods for EuroSoilNet

As sampling methods differ from country to country, harmonisation is needed in order to make more comparable data gathered across Europe.

Harmonisation of data is therefore a main priority in the setting up of EuroSoilNet. It would enable the creation of European databases and other applications, such as, for example, the construction of maps at the European scale (and in general enable the use of national data in a European context).

In relation to the term 'data harmonisation', it was noted that it referred to harmonisation of methodologies and methodological approaches for calibrating, collecting and analysing data. The use of alternative terms such as 'data correlation', 'data comparability' and 'harmonisation of methods' was suggested to avoid confusion. In this report the terms **data comparability** and **harmonisation of methods** will be used.

It was also highlighted that the terms 'transformation functions' and 'transfer functions' should be taken as distinct. In particular, transfer functions describe the transfer of a nutrient or pollutant through the soil profile and are not considered here.

To achieve data comparability, two different approaches were mentioned:

- **data transformation** (manipulation of data through transformation functions and expert judgement);
- **harmonisation of methods** (calibration of the monitoring networks through a common reference method).

Agreement with, and full participation of, national experts in choosing the methodologies would be necessary to achieve the best results. A working group should be established to look further at these issues.

Guidelines for harmonisation of methods already in place, for example those used in the integrated ICP forest programme ([4]), could eventually provide a starting basis for the EuroSoilNet. However, it has to be considered that only some countries have a quite comprehensive soil monitoring network already in place.

Funding was identified as a major problem in the establishment of a monitoring network. In order to reduce costs and make EuroSoilNet feasible, co-location with already existing sites in national soil monitoring networks should be a general criterion.

It was also recommended that already existing soil monitoring standards, prepared by ISO (International Organization for Standardization) or IUGS (International Union of Geological Science) should be adopted.

The use of **transformation functions** was proposed as an alternative to harmonisation of methods in the short-term. Participants expressed their preference that the transformation should be done using one methodology proposed by EEA, while the decision on which transformation functions to use should be left to national experts.

As mentioned before, there was a general agreement on the opportunity to use ISO standards. The FAO multilingual soil databases could also be a useful tool to improve data comparability.

For some of the participants the approach of transformation functions seemed to be feasible in the short time, whereas improving comparability through the use of harmonised methods would require a longer period before it could provide good results.

However, other participants remarked that in any case the problem of data comparability can only be solved in the long-term, also if the data transformation approach is adopted. In fact, a correct approach would require, first of all, the countries to set up working groups on specific topics at the national level, with the objective of collecting data and improving data comparability.

It was proposed that EuroSoilNet (and therefore the framework) was first implemented in a few countries on a voluntary basis, and afterwards extended to all the others ([5]). Collaboration with existing monitoring programmes could also speed up the work.

2.2.9. What EuroSoilNet should monitor

During the discussion, it was often emphasized the need to concentrate on the current **state of soil** first, in order to get an overview of the current situation. This would take several years, considering that not all countries have a soil monitoring system in place yet. However, EEA considered that providing information on trends over time, in addition to current status, was most relevant in order to know whether some improvement was taking place.

Taking into account that soil changes are very slow and that the exactness of analyses within 5 or 10 years of repeated measurements can differ in a wider range than the changes, it was suggested to monitor also **pressures on soils** or **fluxes of contaminants in soils**, which could be provided with a higher degree of accuracy. Focusing measurements on pressures or fluxes would enable to report on an annual basis and changes would be more easily detectable. Moreover, measuring the fluxes would provide information on possible contamination of the ground or surface water, as well as information on driving forces and pressures on soils (the 'Ds' and the 'Ps' of the DPSIR assessment framework).

It was underlined that supporting EEA reporting required a more policy-oriented approach to soil problems than the approach followed in classic soil monitoring.

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(4) International cooperative programme on assessment and monitoring of air pollution effects on forests of the United Nations Economic Commission for Europe, Convention on long-range transboundary air pollution

(5) This is also the approach being followed by other European monitoring networks implemented by EEA and EIONET, such as EuroWaterNet (EEA-ETC/IW, 1998a,b).

Country representatives asked EEA to provide a **clear guidance** on what should be measured and monitored, as well as the required level of data aggregation. It was noted that before this request could be answered, priority issues and parameters had to be selected.

EEA clarified that the proposed soil assessment and monitoring framework was a way to organise the necessary activities. But it also provided tools for identifying priority issues, choosing which parameters should be measured and why. This would avoid undertaking long and costly monitoring activities, very broad in scope and still unable to provide information to guide policy action.

2.2.10. Funding and institutional issues

In order to make the best use of the limited resources available at the national and European level, existing data should be used as far as possible. This initial activity would hopefully trigger further actions in countries where soil monitoring is not yet in place.

It must be considered that the implementation of the framework requires additional costs for the countries. Therefore, it would be important to clarify the **funding scheme for the implementation of the framework**, which could be based on three levels: EEA/European, national and regional/local.

It was also stressed that countries need an official statement or request from EEA to be able to start working. This would be particularly relevant in countries where monitoring is undertaken at the regional and local levels.

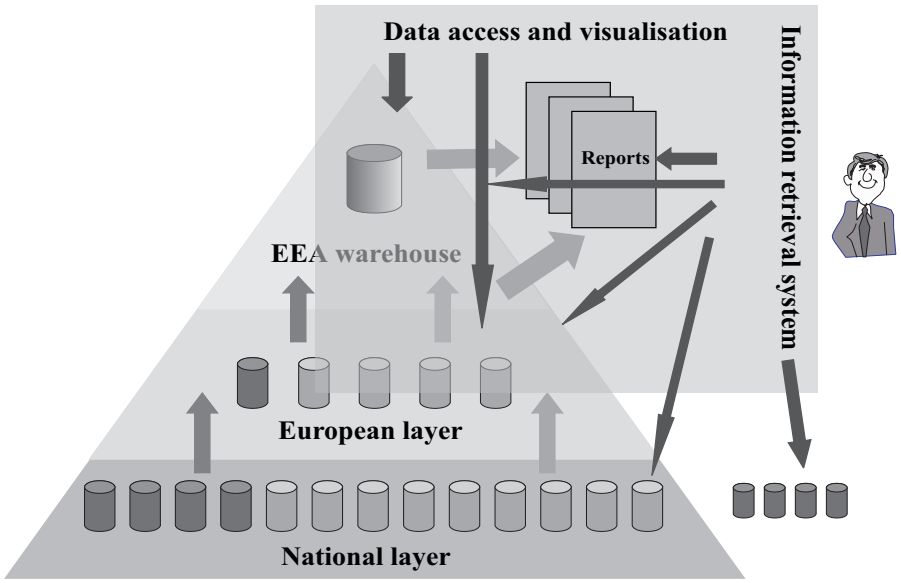
It was recommended that EEA operated in close consultation with national experts. It was also suggested to proceed step-by-step, starting with only one or few issues.

2.2.11. Clarifications from EEA

EEA stressed the **importance of soil** as an emerging issue **at European level** and clarified the EEA approach to environmental monitoring and reporting. The approach is based on the establishment of data flows from the national systems to produce policy indicators and increasingly-integrated environmental assessments (see figure 2). After the assessment, the results (mainly in forms of datasets and reports) go back to the countries and are reviewed.

These activities should also serve national needs for data collection, assessment and reporting.

EEA information pyramid showing the national and European aggregated data levels with links to the different reporting levels and the European Environmental Reference Centre — Figure 2



EEA clarified that it was not proposing to collect all data and produce a comprehensive view of the state on soils across Europe, but rather to select issues and set priorities for data and information collection in some areas where policy action is needed. The main question would be where the priorities should be set up: in monitoring heavy metals or in areas covering more cross-cutting issues, such as nutrients (euthrophication, nitrification).

3. Results of country consultation

This section summarises the outcomes of the formal consultation with EEA member countries on the proposed framework. In particular, country statements and responses to the workshop questionnaire were analysed. Sixteen countries returned questionnaires. A detailed analysis of the responses is reported in Appendix II.

3.1. Acceptance of the framework

Countries were asked to endorse the proposed framework and to express their willingness to participate in the activities identified in the framework itself, such as monitoring. Since the proposed framework is seen as an important step to improve soil information at the European level, countries in general agreed to contribute to it.

However, the proposal should be more specific in certain parts. In particular, the proposed reporting mechanism should be described more in detail. For example, the frequency of the reporting needs to be specified. That would depend on the required parameters or indicators, but it should not be as high as for other environmental media (air, water). The evaluation of the impacts on the soil environment should also be included. Moreover, existing data and national monitoring systems have to be evaluated when developing the framework.

The establishment of a working group to consider these issues was proposed.

3.2. Priorities on soil indicators

Countries were required to express themselves in relation to priorities and data availability for the development of soil indicators. The consultation confirmed that priority should be given to indicators in four soil issues: sealing, erosion, local contamination and diffuse contamination, which are also the issues where data are available in a consistent number of countries.

In particular, in the **short-term**, local contamination, soil sealing and soil erosion have been identified as priorities by most of the countries. Diffuse contamination and soil acidification have been indicated as priorities by about half of the countries. Large-scale movements, salinisation, physical deterioration and eutrophication have been considered as priorities only in a few cases.

In the **long-term**, diffuse contamination, soil erosion and physical deterioration are regarded as priorities by most of the countries. Soil sealing, local contamination and salinisation have been indicated as relevant by about half of the countries. Other issues, such as biological degradation and soil compaction, have been considered as relevant in a few cases together with large-scale movements and soil eutrophication.

Data are available in the field of local contamination in most of the countries, followed by soil acidification, diffuse contamination, soil sealing and soil erosion, where data are available in about half of the responding countries. There are hardly any data available on ‘physical deterioration’, ‘salinisation’ and ‘large-scale land movements’. This analysis does not provide information on to which extent existing data can be used to develop indicators at the European level. However, responses confirm the progress achieved by EEA in the implementation of the framework for local contamination.

On the basis of the answers received, the term ‘diffuse contamination’ needs to be more clearly defined, as the question on data availability could not be clearly answered by all countries.

3.3. Data issues (access, flows and levels of aggregation)

Countries were asked to provide information on access to national data, need for harmonisation at the national level, as well as their opinion on the level of aggregation of data to be provided to EEA, data flows and methodologies for data collection.

In some of the countries data availability is low because they have not yet established a national soil monitoring network. Data have to be made accessible and comparable within the country before they could be provided to EEA. In other countries data availability is high, but access to the data is restricted due to ownership, data protection or financial aspects. Data availability depends on the kind of data required.

Concerning data comparability at European level, a great need for harmonisation was identified. This difficult exercise should be done at least for a minimum set of parameters. Expected problems to be solved are related to definitions, timescales, geographic scales, measured parameters, methods and standards. For this exercise of harmonisation, ISO standards should be considered. Furthermore a glossary of terms will be a helpful tool to reduce problems of definition. In the long-term the establishment of reference sites for monitoring will be of help.

Concerning data flows from the member countries to EEA, it was stated that in some countries national data flows have to be improved first. Then data could be delivered to EEA, preferably directly from PCPs or NFPs to EEA. For improving data collection, a reduced number of questionnaires (low frequency) with a reasonable time-frame for collection and harmonisation is needed. Furthermore official EEA requests sent out in paper format well in advance to the NFPs would facilitate the process. Data requirements should be based on a long-term concept and be focused on the general assessment of soil issues with a transparent and clear documentation of aims.

In general, the aggregation level depends mainly on the type of parameter or indicator. National level is preferred by some countries, while for others the province level (NUTS3 according to Eurostat nomenclature) is regarded as the most suitable, others prefer to provide data aggregated by geographic rather than administrative units. Most of the countries have indicated that data should be aggregated by the countries themselves. Only a few countries suggested that aggregation should be managed by ETCs.

In the short-term, data aggregation on a regional or catchment level and harmonisation of reporting based on national monitoring activities was suggested in order to gather more comparable information across Europe. Nevertheless, the long-term approach has to solve the problem of providing comparable data by using harmonised monitoring methods.

4. Conclusions and recommendations

On the basis of the results of the workshop discussion, country statements and responses to the workshop questionnaire, the following conclusions and recommendations were drawn. These are meant to help EEA in defining how to proceed with further work.

The proposed soil monitoring and assessment framework is seen as an important step to improve soil information at the European level. EEA is invited and encouraged to proceed in the implementation.

Nevertheless, some aspects of the proposal have to be further developed. In particular, the proposed soil-reporting mechanism and the future monitoring scheme should be described in more detail.

EEA should develop guidelines on what exactly needs to be measured and monitored and which data aggregation levels are required. Before this request can be answered, priority issues and indicators have to be selected. Further consultation with countries will help to accomplish this task. The establishment of a working group looking at these issues was proposed.

A twofold approach should be pursued: a short-term approach, based on data already available and aimed to get immediate results; and a long-term approach, based on the establishment of a European soil monitoring network (EuroSoilNet).

In order to identify data gaps and encourage the countries to participate, existing and derived data should be used to develop indicators in the short-term. This would hopefully trigger some action in countries where no soil monitoring network is yet in place.

Soils are closely interrelated with other media and provide important services to the ecosystem, since they perform multiple functions, both ecological and socioeconomic. Soil resources are currently under threat in Europe.

Paradoxically, the major source of soil problems, today and in the foreseeable future, has been identified in the increasing competition between its different functions, induced by human activities. In particular, the intensive growth of urban areas (soil as support basis for human settlements) usually causes irreversible losses of the soil resource (soil sealing) and makes it unavailable to other uses (EEA, 1999).

The nature and the impacts of soil issues are complex. In order to structure these issues and to highlight the main priorities on soil issues, a more comprehensive approach to soil and the environment should be adopted.

Information should be gathered to enable assessment of the current state of soil in Europe, as well as on the interrelations with the wider environment. An effort should be made to identify trends and changes in time. Special attention should be paid to specific soil environments or regional aspects, such as ‘boreal soils’. Within this context, the DPSIR assessment framework, developed by the EEA, provides a useful tool to identify priorities and derive policy-relevant indicators on soil.

Priority should be given to the development of indicators in four main areas: soil sealing, soil erosion, local contamination (contaminated sites) and diffuse contamination, as these are seen as relevant priorities both in the short and long-terms and data are relatively available.

Due to the limited resources available both at the national and at the European levels, the development of EuroSoilNet should be based as far as possible on existing monitoring

activities (co-location of sites). Direct contacts to already existing monitoring networks, such as the ICP forest programme ([6]) should be established.

Since countries are at different stages of development and some do not have monitoring systems established yet, the implementation of the framework in general and the EuroSoilNet in particular should proceed stepwise. It was suggested to start a pilot project, similar to what is being developed for contaminated sites, including a limited number of countries and focused on few issues. Countries would join the project on a voluntary basis.

As the establishment of the framework requires additional resources from the countries, it would be important to clarify funding sources. It was suggested the funding be based on three levels: EEA/European, national and local/regional.

EEA should make an official request to enable the countries to start working on the implementation of the framework. This would be particularly relevant in countries where monitoring is undertaken at the regional and local levels.

Other recommendations of a more technical nature

Development of indicators. Referring to the indicators listed in the proposal, it was remarked that the development of indicators labelled as short- and long-term should proceed in parallel, as approaches and time-frames are clearly different. However, the time required to develop short-term indicators should not be underestimated.

Data access at the national level. As access to existing data is low in many countries, special effort should be spent in establishing data flows at the national level. In some countries, data comparability also needs to be improved.

Data flow. For improving data collection, a reduced number of questionnaires (low frequency) with a reasonable time-frame for collection and harmonisation is needed. NFPs should be involved in order to facilitate the process. Data requirements should be based on a long-term concept and be focused on the general assessment of soil issues with a transparent and clear documentation of aims.

Aggregation levels. For the short-term, data aggregation on a regional or catchment level was suggested. The long-term approach has to solve the problem of providing comparable data by using harmonised monitoring methods.

Terminology. As different usage of relevant terms does exist (such as the terms 'indicator', 'data harmonisation', etc.), standardisation of basic terminology in the various European languages would be helpful to facilitate collaboration. To this purpose, the establishment of a multilingual glossary of all relevant terms is proposed.

Data comparability and harmonisation of methods. Comparability of data gathered across Europe and harmonisations of monitoring methods are considered of the utmost importance.

Harmonisation of methods should be established at least for a minimum set of parameters. In order to accelerate the process, the implementation of national reference (key) sites was suggested.

Existing soil monitoring standards, prepared by ISO ([7]) or IUGS ([8]) should be used as far as possible.

(6) International Cooperative Programme on Assessment And Monitoring of Air Pollution Effects on Forests of the United Nations Economic Commission for Europe, Convention on Long-range Transboundary air pollution
(7) International Organization for Standardization
(8) International Union of Geological Science

In the short-term, transformation functions should be used to make existing data comparable. The transformation should be applied using one methodology defined by the EEA, but it should be the responsibility of national experts to decide which transformation function is used best with their data.

Classification of monitoring sites. Referring to the design and structure of the different site selection systems used in national networks, the different site types should be harmonised and classified, using an approach similar to EuroWaterNet. A specific classification was suggested: specialist sites, key sites, and benchmark sites.

Measurement of fluxes of contaminants in soil. As changes in soil are very slow and the exactness of analyses within 5 or 10 years of repeated measurements can differ in a wider range than the changes, it was suggested to monitor pressures on soils or fluxes of contaminants in soils. Focusing measurements on pressures or fluxes would enable to report on an annual basis and changes would be more easily detectable. Moreover, measuring the fluxes would provide information on possible contamination of the ground or surface water, as well as information on driving forces and pressures on soils (the 'Ds' and the 'Ps' of the DPSIR assessment framework).

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Annex I: Summary of workshop presentations

Presentation of the proposal by ETC/S

Proposal for a European monitoring and assessment framework
Sigbert Huber, Bronwyn Syed, Alexandra Freudenschuβ, Vibeke Ernstsen, Peter Loveland

Introduction
A monitoring and assessment framework for soil is an 'operational model' that outlines necessary measures to enable gauging effectively the current state of soils within Europe. The framework is meant to be a guide or reference aiming to provide consistent measuring and assessment at any site, from the handling of soil samples to the treatment and storage of data. Thus it makes best use of existing soil activities, considering how to best use them to achieve a more harmonised soil monitoring programme at the European scale.

Need for a comprehensive monitoring and assessment framework
The establishment of a European monitoring and assessment framework for soil is necessary to provide policy makers with sound environmental information, to meet the needs of the future, to ensure that soils receive a high level of protection from degradation and that problems are identified as they arise.

The **main soil-related emerging issues** emphasising the need for comprehensive soil information within Europe are for example: climate change, pollution, urban development, desertification, erosion, salinisation or acidification.

Assessment of soil conditions
The term 'soil assessment' stands for the reporting on the state of soil and changes of soil conditions, based on the calculation of defined indicators using comparable, targeted and reliable data sets from harmonised soil monitoring networks and other data sources. Trends could be derived from a comparison of harmonised data with earlier inventories, considering a special time reference and other reference values.

The assessment has to be done according to the politically-relevant concerns over soils based on up-to-date technical knowledge. The **process of soil assessment** comprises:

- identification of relevant indicators and priorities;
- calculation of indicators using data gathered by monitoring or specific investigations;
- validation of the achieved results; and
- comparison with target values, threshold values and background values.

Data needs and gaps
Until now an adequate assessment of the current state or potential risk of soil degradation in Europe is still missing, as well as comparable data on the loss of the resource soil due to erosion and sealing. Basic data, such as detailed European soil maps, are still unavailable for assessment and there has been no progress in the quality and comparability of data available at the European level (EEA, 1999).

There is no European-wide monitoring network for soil, although some progress has been made in some areas, such as the monitoring of forest soils. Statutory soil monitoring is carried out in a number of member countries, but rarely for the purpose of soil protection per se. Consequently, there is a large diversity in the design of soil monitoring schemes, the frequency of sampling, the range of parameters determined, and the methods of analysis used. Another complex problem is the ownership and transfer of data (EEA, 1999).

Monitoring approaches of the EuroSoilNet
The purpose of a soil monitoring network is to provide reliable data in order to report on the state and the changes of environmental issues relating to soil. Depending on the major soil degradation patterns (diffuse contamination, local contamination, sealing and erosion) different parameters, methodologies and monitoring designs are required to provide targeted and effective information. The proposal gives a short overview of these different requirements on soil monitoring networks, which will be considered in the future EuroSoilNet.

Reporting of the results
Soil data feeds into many areas and is required at different **aggregation levels**. It is extremely important that data is supplied to the user at the right aggregation level. The proposed levels for a suitable soil-reporting mechanism are: local, regional, national and European levels.

The aims of a soil-reporting mechanism are to meet the diverse requirements for soil data and information, and to make possible an assessment of the condition of Europe's soils in the light of the complex problems that have to be dealt with on both the national and the European scale.

Conclusions
The proposed European soil monitoring and assessment framework will be the backbone of the EEA system for policy-relevant indicators on soil. **Outputs of the framework** will include:

- an agreed list of policy-relevant indicators on soil;
- a suitable assessment procedure;
- improved data flow between the national and the European level;
- more comparable data and information on the condition of Europe's soils — validation of measured data;
- a European soil monitoring network (EuroSoilNet) to enable an assessment of the state of European soils and effects of anthropogenic activities and of whether the soils are deteriorating as well as of changes in soil quality;
- a standard set of measured parameters and additional parameters where necessary for more specific soil issues;
- the creation of a EuroSoilBase (SoilBase) containing aggregated comparable raw data; an agreed reporting mechanism on soil.

Finally, we hope that the member countries will support this framework with the common aim of providing more relevant information on soil issues to maintain the sustainability of this important environmental medium.

Policy relevant indicators on soil erosion and soil sealing
Olaf Düwel, Jens Utermann

EEA mission is to support sustainable development through the provision of relevant, reliable, targeted and timely information to policy makers and the general public. For this purpose the EEA is establishing a monitoring and reporting system based on indicators. One of the European Topic Centre on Soil's (ETC/S) contribution is to provide information and to report on environmental issues related to soil. The main causes of soil loss and deterioration in Europe are considered to be soil sealing, soil erosion and local and diffuse contamination (EEA, 1999). This paper deals with the development of indicators for assessing the physical soil degradation patterns of **soil erosion** and **soil sealing**.

Table 1 and table 2 summarise the approaches to determine state indicators, both short-term and long-term for soil erosion and soil sealing.

Indicator approaches for soil erosion — state of the art Table 1

	State indicators	Data sources	Data availability	Data reliability
Short-term approach:	• area affected by erosion • soil losses due to erosion	• statistical institutions • questionnaires and data collections	(✓) (✓)	? ?
Long-term approach:	• ground cover from vegetation and other protection measures (e.g. mulching) in areas of high potential soil erosion risk	• map of potential soil erosion risk • periodical monitoring by remote sensing combined with ground validations in test areas	✓ (?)	✓ (?)

Short-term state indicators for soil erosion are included in the latest EEA state of environment report (EEA, 1999). They describe the area affected by erosion and total amounts of soil losses due to erosion in selected European countries, based on questionnaires and data collections carried out by different organisations and institutions (OECD, Eurostat, EEA). Data are only fragmentary as only data from a few countries are available and data reliability has not been assessed.

To handle the soil erosion problem in the long run, the following approach is proposed. It uses information from a map of potential soil-erosion risk combined with periodical monitoring through remote sensing, validated by ground monitoring in selected test areas. With particular reference to agricultural areas, this approach is based on the following principle: in areas with a high potential soil erosion risk, the higher the share of crops which increase the risk of soil erosion ('row crops', e.g. corn, sugar beet, potatoes) with respect to total arable land, the higher the actual soil losses due to soil erosion, unless accompanying protection measures are applied.

The proposed approach requires data on the ground cover in areas of high-erosion risk. An analysis of availability at the European scale of maps of potential soil-erosion risk, data on ground cover by vegetation and other protection measures (e.g. mulching) would reveal data gaps. In order to fill these gaps, a close cooperation with other European institutions, such as the Joint Research Centre — Space Application Institute (JRC-SAI), would be necessary.

Apart from agricultural land use, ground cover is a possible indicator for other land uses potential leading to soil erosion.

Indicator approaches for soil sealing — state of the art Table 2

	State indicators	Data sources	Data availability	Data reliability
Short-term approach:	• built-up areas in Europe • increase of built-up areas road density in Europe	• statistical institutions • questionnaires and data collections	, ,	? ?
Long-term approach:	• built-up areas in Europe and their increase	• periodical monitoring by remote sensing combined with ground validations in test areas	✓ (?)	✓ (?)

Short-term state indicators for soil sealing are included in the latest EEA state of environment report (EEA, 1999). Short-term indicators have been calculated using data on built-up areas in Europe, their increase and road density. These data have been derived from different statistical institutions, questionnaires and data collections. Data are available for some European countries, the data reliability remains to be checked.

For the long-term approach, a periodical monitoring through remote sensing is proposed, combined with ground validations in test areas in order to get a thorough knowledge about the actually-sealed soil surface as compared to the remote sensing results. Data needs include

a map of land cover in Europe and 'sealing factors' (proportion of sealed land in terms of built-up areas and traffic routes in selected test areas). There are data gaps regarding total area of actually-sealed land. Possible data sources might be a periodical monitoring as in the Corine land cover project, statistical institutions in the member countries and European institutions such as Eurostat or the JRC.

Regional aspects — boreal soils
Vibeke Ernstsen

Soil and soil degradation processes in the boreal zone have recently been described in a working paper, which is currently being finalised (EEA, 2000c). A summary of the report, conclusions and recommendations are described below.

The soils of the Nordic countries have ecological functions and are an important resource to mankind. These include biomass production, filtering, buffering and transformation actions, biological habitat and gene reserve, physical medium, source of raw materials, and geogenic and cultural heritages.

The five Nordic countries, Iceland, Norway, Sweden, Finland and Denmark, are located between the 55-71 degrees northern latitude and the 24-32 degrees eastern longitude, with a geographical coverage of 2 000 km from north to south and 2 800 km from east to west. The total area is 1 257 000 km^2, equivalent to approximately 35 % of the area of all EEA Member States. Due to the geographical coverage, large differences in, for example, soil parent materials, land use, population density, and degradation processes occur within the region.

Soils in the Nordic countries are young compared with soils in other parts of Europe, having only developed after the last glaciation, a period of about 12 000 years. Most soils formed under a rather harsh climate characterised by a surplus of precipitation and extended periods with temperatures below freezing point. Low soil temperatures cause periods of highly-reduced or non-existing microbial activity, soil weathering and soil formation are consequently limited.

In Iceland, volcanic soil types are very common. In Norway, Sweden and Finland sandy and loamy soils with low buffer capacity are very common, and these soils have characteristic soil properties as a result of the local conditions. Organic-rich soils and, in the mountainous areas, shallow soils are common also in these countries as well as in Iceland. Extensive areas of fertile clay soils are well-known only in Denmark and in southern and central Sweden. Most soils, except those in Iceland, are acidic by nature and with a low buffer capacity.

Natural soil formation (and degradation) processes, followed by an overall transport of material from the upper to the deeper soil layers, have been active ever since the last ice age. With human settlement the impact on the soil environment was enhanced leading to an aggravation of the soil degradation processes. For example, in Iceland this meant an increased intensity of soil erosion only 1 125 years ago, while in Denmark and southern Sweden the appearance of heath land.

The natural vegetation in the Nordic region is forest, most often of the boreal type with spruce and pine. Until a few hundred years ago most of the land was left unaffected by man, and the environment was shaped mainly by natural factors. Nowadays, forest is still very important in Finland, Sweden and Norway, but exploitation by industry, including a greatly expanded transportation network, has left its marks on the landscape. In Iceland, the original birch and willow woodlands have been reduced from about 25 % when the settlement started to only 1 % now.

Agricultural land is common in Denmark and southern Sweden. In other parts of the Nordic region, the agricultural land share is lower and makes up only a small percentage of the total land area. Manufacturing industry has an increasing importance in the Nordic region and, together with mining, may have a large impact on the soil quality at the local level. In built-up and industrialised areas, the soil quality and soil functionality are also affected.

At present the most severe soil degradation processes in the Nordic countries, in terms of irreversibility, are acidification, pollution (by heavy metals) and erosion (due to wind and water). The dynamics of soil organic matter are extremely sensitive to changes in the global climate (and greenhouse gases) and need more attention as large pools of organic matter are bound in the Nordic soils. Many soils may change status from being sinks to sources of greenhouse gases. Concurrently with changes in the decomposition of organic matter (mineralisation), the mobility of different compounds (e.g. heavy metal) may change and influence the future soil properties. Soil degradation processes by nutrients and pesticides, oxidation of pyrite (acid sulphate soils) and organic matter after drainage and ditching and changes in biodiversity are all soil degradation processes of regional or local interest.

It is recommended, using the DPSIR assessment framework, to carry out the following assessments of soil degradation in the Nordic region:

- assessment of acidification and acid neutralizing capacities of natural- and forest land as most Nordic soils are acidic by nature. In uplifted marine areas around the coast of Gulf of Bothnia the source of acidity comes primarily from the soil itself;
- assessment of background values of heavy metals in different geological deposits related to soil functionality (including ecological and human toxicological reference values) and mobility of heavy metals;
- assessment of changes in the pools of soil organic matter due to increasing concentrations of greenhouse gases and global warming. The role of Nordic soils as sinks or sources as well as changes in the soil quality caused by changes in mineralisation, e.g. leaching of heavy metals, should be considered. Also more than 6.5 million hectares of peatlands have been drained for forestry purpose in Finland and Sweden, and about 0.7 million ha in Iceland (60-70 % of the peatlands) are drained. Ditching of pristine peatlands has nearly ceased today but ditching activity will be replaced by the maintenance of old ditch network. The environmental impacts of ditch maintenance need to be assessed;
- assessment of soil erosion (due to both water and wind) for the whole Nordic region. Currently, the potential risk of erosion has been assessed in Sweden, Finland, Denmark and the surroundings of Oslo, using the universal soil loss equation (USLE). Comprehensive studies have shown severe soil degradation by erosion in Iceland with intensive impact on the environment;
- assessment of soil quality related to nitrogen and phosphorus eutrophication, pesticide pollution and changes in biodiversity;
- assessment of soil sealing and soil loss due to mining, processing industry, waste disposal, service stations, etc. In spite of a generally low population density in most of the Nordic countries compared to other European countries, this particular soil aspect is very important in high-density urban areas.

It is recommended to pay attention to these soil degradation processes when suitable soil indicators/parameters are chosen for the future European soil monitoring network (EuroSoilNet).

Indicators/parameters in the EuroSoilNet could include:

- acidification and mobility of heavy metals;
- pools of soil organic matter related to land use;
- pools of soil organic matter related to climate changes (including greenhouse gases);
- plant nutrients (N and P) in soil and soil biodiversity;
- erosion by wind and water;
- different aspects of surface sealing.

Many data on soil properties have already been collected but even more have to be defined (including soil-related indicators) and monitored in the future.

Towards a European soil monitoring system
Bronwyn Syed, Peter Loveland and Dominique Arrouays

General aspects
A soil monitoring network (SMN), under its 'classic' guise, is the distribution of sites/ areas where changes in soil characteristics can be documented through periodic assessment of a set of soil parameters. Local or regional soil contamination (e.g. accumulation of heavy metals in soils), changes in soil properties e.g. soil eutrophication (higher phosphorus concentrations), or their absence can be monitored effectively using this approach. Existing national and regional SMNs within the EU have largely adopted the 'classic' design. However, soil data derived from this type of network cannot be used (in some instances) to directly address soil issues on a wider geographical (national or European) scale, e.g. land altered through soil sealing or erosion. In such cases, surrogate properties or combinations of measured properties might be used. Disparities between the various networks make comparisons between national datasets difficult, and a lack of integration between SMNs and other environmental networks prevents adequate assessment of impacts of soil degradation on adjacent environmental compartments such as air and water.

Providing relevant harmonised soils data at the national and European level is essential to appraise the current state of Europe's soils and establish adequate soil protection measures. The design and structure of a **European soil monitoring network**, **EuroSoilNet**, is proposed here as a possible solution to obtaining harmonised and comparable national datasets. The emphasis is on utilising existing national SMNs and making use of the wealth of soil data, by employing harmonising techniques to historical databases. EuroSoilNet will not be an SMN just in the 'classic' sense, but will include a range of capabilities — both field and desk-based — for the interpretation of soil issues according to agreed protocols. Implementing EuroSoilNet presents a unique challenge, which can only be met through a firm commitment by European governments, environmental and scientific communities.

Towards EuroSoilNet
Implementing a European-wide soil monitoring network (EuroSoilNet) raises a number of questions such as: what would be the benefits to individual countries, what are the objectives and aims of EuroSoilNet and what would it look like?

Essentially the benefits can be separated into European and national. For the former, EuroSoilNet would be able to support the EEA commitment to ensuring that soil data are representative at the European level, by making national SMNs comparable through harmonisation and utilising other sources of soils data. EuroSoilNet would be able to build upon existing European SMNs (ICP forest and ICP-integrated monitoring) by monitoring and obtaining information from other soil ecosystems, and address wider soil issues by encompassing a larger geographical scale. A wealth of (harmonised) data in the European soils database (EuroSoilBase) would be available for government departments, policy makers and scientists. The data could also be used for modelling at the European dimension, which is especially important for looking at issues such as global climate change or the impacts on the soil regions of Europe due to trans-boundary air pollution.

A pan-European effort would promote better communications and forge stronger links between existing organisations within national SMNs. It would enhance assessment of soil issues within national boundaries by improving our understanding of pollution sources and impacts through a more integrated approach to monitoring. At country borders it would provide more information on trans-boundary soil concerns and 'fill' in gaps in soils data for better interpretation.

Concepts, design and structure
Initially, EuroSoilNet could be developed to look at the main soil degradation patterns (diffuse contamination, local contamination, soil sealing and soil erosion) within Europe, both to save costs and as a trial for expanding the network later on. Factors to take into account include financial considerations (dependent upon funding) and technical considerations from the member countries willing to participate. Aspects of EuroSoilNet would have to be tailored to effectively monitor each of the soil degradation patterns. There

would have to be an agreed minimum list of parameters monitored by each country within the network and the data obtained would have to be meaningful and pertinent to producing useful indicators. International standards for soil analysis should be adopted and agreed protocols must be implemented covering all features of the network, from site and laboratory-related matters to computer-based analysis, data flow and management. Issues such as intellectual property rights (who owns the data) would have to be addressed. However, many aspects of EuroSoilNet would not need to be set up from first principles. As building upon the examples set for ICP forests and ICP-integrated-monitoring networks will reduce a lot of the preparatory work and costs.

EuroSoilNet would act as a reference or control network for harmonisation and quality control between disparate national SMNs. The network would include the classic approach but would also utilise spatial computer tools and techniques (e.g. geographic information systems, geostatistics) to analyse soils' data obtained from other data sources (area statistics, remote sensing data, other soils databases) for interpretation of wider soil issues.

It is important to stress that EuroSoilNet would not be a separate network but would be made up of sites from current national SMNs. In this way existing field, laboratory and computer experience could be used as well as historical datasets. It may be possible to incorporate sites from different environmental networks, and make links to other environmental issues (e.g. the European water quality network, EuroWaterNet).

Monitoring and assessment framework for contaminated sites
Martin Schamann, Gundula Prokop

Progress in establishing a monitoring and assessment framework for local soil contamination
In view of establishing a monitoring and assessment framework for local contamination, several steps have been carried out so far.

In the early stages of the work a review of the state-of-the-art of contaminated sites management in the EEA countries was undertaken (EEA, 2000b), followed by a detailed comparison and analysis of contaminated sites data deriving from two different regions in Austria and Denmark (EEA-ETC/S, 1998). These studies formed the basis for setting up draft indicators to characterise and quantify local contamination problems. A conceptual assessment framework for soil in general and the application of soil issues to the DPSIR approach was published in 1999, linking all soil degradation patterns, soil functions and impacts in one framework (EEA, 1999). The state-of-the-art of contaminated sites management in Eastern Europe was reviewed with the support of the ETC/S, with the same methodology used for the review in Western Europe. The results were included in a report published by the Danish Environment Protection Agency (DANCEE, 2000).

For the time being most emphasis is put on a reduction and revision of the rather comprehensive draft indicators for local contamination. The objective is to focus on a small number of relevant indicators. To meet this objective a data collection in 10 test regions across the EEA countries is currently being carried out (EEA-ETC/S, 1999). The results of this exercise form an important input in the further development of a European data collection and assessment framework. First results of this exercise were presented and discussed at the second contaminated sites workshop of the ETC/S, which was held in Dublin in November 1999.

Proposal for indicators
In order to meet the objectives of EEA DPSIR approach and reporting mission the following draft indicators have been designed as a first proposal:

- **driving forces indicators:** focus on retrospective data from incidents which happened in the past (i.e. waste disposal, consumption of VOC ([9]), metal processing and mineral oil-storage sites between 1950 and 1990);

(9) VOCs = Volatile organic compounds

- **state indicators:** focus on the quantification of the number of contaminated sites and the amount of hazardous substances in the soil;
- **impact indicators:** since only few measurable aspects exist so far, draft indicators are suggested, e.g. the number of known identified incidents of groundwater impairment and the consumption of industrial land in relation to abandoned industrial facilities;
- **response indicators:** responses are evident through remediation measures, quantification is possible via environmental expenditures, extra costs due to groundwater impairment or the number of remediated sites.

Monitoring and assessment frame for local contamination

Table 3 **Preview**

Monitoring units	All European units
Monitoring methodology	(1) Data collection and assessment based on available and reliable data deriving from regional summary reports (2) Modelling of data gaps
Data requirements	Aggregated data on local contamination (per region)
Reporting period	1–2 years

Table 4 **Progress**

Test monitoring	Data collection and assessment of selected European test regions (running)
Implementation of test monitoring	1999
Test monitoring in CEE countries	2000/2001
Up-scaling from test monitoring to European monitoring	Development of methods to make available comparable national data Definition of a reporting format Development of models for data gaps
Output	Data basis for the calculation of contaminated site indicators for the state of local soil contamination

Other presentations

FOREGS geochemical baseline mapping programme 1997–2001

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International background of the programme

The international geological correlation programme (IGCP) project 259 (international geochemical mapping) recommended the collection of a global reference set of materials which should be collected following pre-defined, systematic methods and which should also be consistently analysed in designated laboratories (Darnley et al. 1995). In this way a global geochemical database based on a global reference network (GRN) could be created, to provide a reference against which existing national and regional data sets could be compared.

FOREGS (Forum of European Geological Surveys) directors agreed that there was a need for a European geochemical baseline and decided that the way forward was to integrate this project with the ongoing global geochemical baselines project (IGCP 360), an international project which aimed to realize the recommendations of IGCP 259. The FOREGS geochemistry task force, established in 1996, therefore became the European subcommittee within the IUGS/IAGC working group on global geochemical baselines which was established to continue the work of IGCP 360 project.

FOREGS geochemical baseline programme

This programme has been initiated to provide high-quality environmental geochemical baseline data for Europe. The data will be based on six different sample types collected from all over Europe. High quality and consistency of the obtained data are ensured by using standardised sampling methods and by treating and analysing all samples in the same laboratories.

The choice of **sampling media** has been done in accordance with the recommendations of the IUGS working group on global geochemical baselines (Darnley et al. 1995). The selected sampling media, stream sediment, stream water, flood plain sediment, soil and humus, are considered to be the most representative of the surface environment. Sampling sites are chosen at random, so that the data for each of the chosen media will document the actual situation within Europe.

Stream sediment (<0.15 mm fraction) and **floodplain sediment** (<2 mm fraction) samples are collected because they reflect the average geogenic composition of a catchment basin. Most geological surveys have undertaken national stream sediment studies. The new data are necessary to link these surveys to a baseline level.

Stream water reflects the interplay between geosphere/hydrosphere and pollution. At the same time it is the main source of drinking water. Many surveys have completed local studies, so the GTN data can be used to link results across Europe.

Soil samples (top soil 0-25 cm) and subsoil (a 25 cm layer within a depth range of 50-200 cm) are taken to reflect variations in geogenic composition of the uppermost layers of the earth's crust.

Humus samples can be used to determine the atmospheric (anthropogenic) input of elements to the ecosystem. To reach this aim samples should be collected in forested areas as near as possible to the other sampling sites. To reflect the atmospheric input, the uppermost few centimetres of the organic layer should be collected immediately under the green vegetation and under the litter (max 3 cm).

Methods

Sampling: In the FOREGS programme, the entire land surface of Europe has been divided into 160 km x 160 km global terrestrial network (GTN) cells (Darnley *et al.* 1995). Five small drainage basins of <100 km^2 in area were randomly selected for sampling from each GTN cell. Samples are collected from these small drainage basins except the flood plain sediment sample (upper 25 cm) which is collected from the lowermost point of the larger drainage basin (area 500–6 000 km^2) to which the small catchment is connected. Altogether some 900 sample sites will be sampled during field seasons 1998-99 in 25 European countries. The sampling procedures are described in detail by Salminen *et al.* (1998).

Analysis: All the samples of one sample type will be analysed in one laboratory using standardised or commonly-used methods. Minerogenic soil samples will be analysed by two different methods: 1) total concentrations by XRF and after total dissolution by ICP-MS; 2) the aqua regia soluble element concentrations. The elements to be analysed are Li, Be, B, Na, Mg, Al, Si, P, S, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Rb, Sr, Y, Zr, Nb, Mo, Ag, Cd, Sn, Sb, Cs, Ba, Hf, Ta, Hg, Pb, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Th, and U.

Data management: All collected data are stored in a common Microsoft Access 97 database. GSF (Finland) has prepared field observation databases based on field observation sheets of the field manual. GSF will merge the national field observation databases into European-wide databases and later add the chemical analysis into the databases. The whole database will be sent to each country and is supposed to be an open file to everybody interested in European-wide geochemical information.

Expected results are 1) a common data set available to every country, 2) atlas of geochemical baselines in Europe and 3) publications, including scientific papers and separate manuals for field work, analyses and data management.

Discussion

According to the methodology used in the FOREGS programme, the selection of representative sampling sites is a responsibility of the local geologists, together with its correlation to other national surveys. The programme aims to get information on the geochemical baseline of Europe in the uppermost 25 cm of soils, which is used by humans.

Therefore the samples are not suitable to compare soil conditions linked to soil profiles or soil types across Europe. If a comparison is required, it would again be the responsibility of the local experts. The methods used for analytical response are based on the ISO standards.

There is no charge for accessing the datasets, since the programme is funded by national surveys. At the time of the workshop, the datasets are accessible in Finland and to those responsible for data collection, but common data will be available for every survey. A decision has still to be made by the 25 participating countries, but it can be anticipated that the data would be made publicly available.

In principle, a cooperation with EuroSoilNet is possible, as methods used in FOREGS are based on ISO standards and a geo-referenced database is maintained. However, it must be considered that the grid density established in FOREGS is very low (160 x 160 km) and a link to soil types is not practically feasible.

Soil protection in Europe — perspectives and priorities
Winfried Blum, University of Agricultural Sciences, Austria

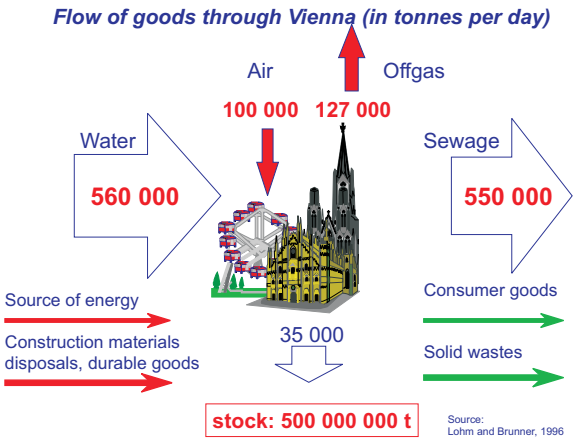
Perspectives
Soils are used by human beings for many purposes, for which the following six main functions of soils can be identified:

- production of agricultural and forest biomass;
- medium for filtering, buffering and transforming;
- gene reserve and protection;
- infrastructure;
- source of raw material;
- protection and preservation of geogenic and cultural heritage, forming landscapes.

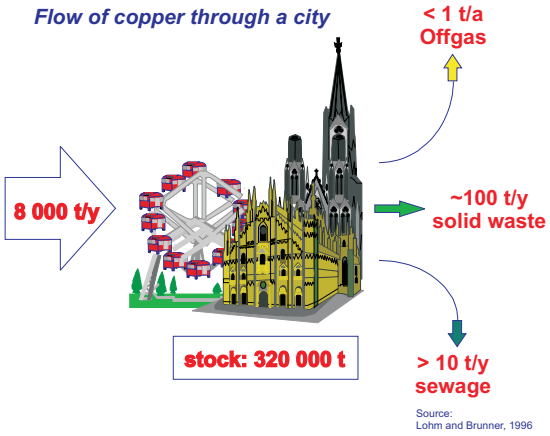
Fierce competition exists among these main uses of land and soil. Competition can be classified into three different types:

- **excluding competition between land uses:**
  land use for infrastructure development excludes the multifunctional use of soils. Soil sealing constitutes the most intriguing problem we have to deal with, as this process is actually not perceived;
- **competition through intensive interactions of different land uses:**
  Cities, villages or roads bring about loads on the adjacent agricultural and forest land. We dig out a lot of material from the earth (oil, coal, etc.). This stuff comes back to the soils through the atmospheric pathway, the waterway and terrestrial transport, produced by traffic, settlement or industry. On the one hand cities are affecting land by soil sealing, on the other hand they cause enormous loads on our soils, as they are agglomerations of energy and goods (see Fig. 3 and Fig. 4). In this sense cities can be seen as 'chemical time bombs';
- **competition between the ecological uses:**
  In addition to the uncontrollable pollutants introduced by overall activities (industry, settlement, transport), waste, sewage sludge, pesticides and fertilisers are used in agriculture. This has consequences for the groundwater, biota, food chain and plant uptake. Therefore, the main targets we have to look at are: food chain, drinking water and biodiversity.

Flow of goods through Vienna (in tonnes per day) Figure 3



Flow of copper through a city (in tonnes per year) Figure 4



The politicians and decision makers have the responsibility to decide which part of the soil can be used in which place and for which purpose. The administration in the sense of EEA, agencies related to agricultural ministries, ministries of economics and social welfare can give advice, but they have to base it on data sets from which scenarios can be derived, leading to indicators that can be used as a basis for political decisions. To steer harmonisation, indicators are needed, which can be indirect or direct ones in the case of sustainable land management. Therefore sustainable land use is the spatial and temporal harmonisation of all the six uses of soil, minimising the irreversible ones such as soil sealing, sedimentation, salinisation, acidification and intensive pollution (e.g. with heavy metals or persistent organic compounds). Here it becomes clear that sustainable land use is not a scientific but a political issue.

Priorities

The priorities have to be seen in minimising irreversible land uses in the sense of severe, long-lasting problems. Activities for the protection of soil and land should be related to irreversible damages and threats, like soil loss and sealing, extraction material, mining and reversible damages, like soil pollution by organic compounds, compacting and other deterioration of topsoil structure and it is important to get indicators on these problems.

Indicators related to the definition of the OECD, should be:

- **policy relevant:** they should indicate the issues, that should be solved and not data that are available for something;
- **analytically sound:** indicators must be based on science and reveal a clear cause-response relationship, that is not always assured, as data are collected under very different aspects;

- **easy to interpret:** they should be understandable for stake holders as well as for politicians and decision makers;
- **measurable:** which means feasible and cost-effective data collections.

The DPSIR approach developed by the EEA is an extension of the DSR approach from the OECD and determines the way on which data have to be collected and decisions have to be made, in order to decide which investigations should be carried out first.

First of all, it is necessary to know about the state of soil. Related to the land use, the state of soil can be very different. For infrastructure development the state is the sealing in percentage of certain soils, for agricultural and forest production the description already gets more complicated and considering biodiversity, groundwater or filtering, buffering and transforming the state is different again. Indicators should characterise the state related to certain land uses. It should be started with something that is feasible. This could be the state of soil related to agricultural practise or diffuse soil contamination. Referring to contaminated sites, work has already been established and has made good progress, also related to the DPSIR approach.

Looking into the overall development in Europe at the moment, in relation to the rest of the world and the WTO negotiations, started in Seattle at the end of 1999, it would be worthwhile for the EEA to contribute to the environmental discussion by providing soil indicators in relation to agricultural land use, in order to help agriculture to define its position in these overall negotiations. Reporting on soil issues should convince the soil users to act in a sustainable way with soils. This is at last our mandate and the Agency has a mandate to report on that in certain time intervals.

The question of soil pollution is very tricky, since very different driving forces occur. Generally, diffuse pollution can come from many sources and, establishing the relationships between driving forces, pressures, state, impact, responses here, is much more difficult. It is easier to start with some impacts for which data already exist (e.g. statistics of used fertilisers, pesticides, use of machinery in agriculture).

It is necessary to discuss if there is a general agreement on what we want to go for, considering which investigations should be started first.

Country statements

Soil monitoring and assessment in Austria
Sigrid Schwarz, Federal Environmental Agency, Vienna

'Soil protection' has been declared a national target with the Federal Constitutional Law on Comprehensive Environmental Protection (Federal Legal Gazette, 1984/491). However, there is no comprehensive federal law on soil protection in Austria. For the assessment of soil quality in Austria, threshold values are only stipulated in provincial soil protection regulations. Soil Protection Acts have been enacted in four provinces; in two other provinces drafts are being prepared. Five provinces have sewage sludge directives and two others have established guidelines.

In Austria three principal systems of soil survey have been set up.

The forest soil survey comprises forest site mapping and forest soil monitoring, which has been implemented by the Federal Forest Research Centre (FFRC) and consists of 514 plots arranged in a grid of 8.7 by 8.7 km.

The soil taxation survey of agricultural land has been carried out by the financial administration in cooperation with the Federal Office of Surveying. Soil assessment data in analogue form exist for approximately 33 % of the total area of Austria and maps are drawn to scales of either 1: 2 000 or 1:2 800.

For the soil-management survey, systematic mapping of agricultural land in Austria has been carried out by the Federal Institute of Soil Survey and Soil Management since 1958. So far, maps of 144 mapping regions, representing an area of 63 % of agricultural land, have been published and about 98 % of the agricultural land has been surveyed.

Additionally, the provincial governments decided to establish an intensive environmental-soil survey programme. To create a basis for comparable soil data all over Austria a recommendation for carrying out an environmental-soil survey was prepared by a working group of the ASSS (Austrian Society of Soil Science). So far, all provinces have finished the surveys and the Tyrol has already carried out a replicated environmental-soil survey.

soil monitoring activities started in Austria about 10 years ago and the initial plan was to repeat the soil surveys. For technical and financial reasons it was considered to establish fewer but more intensively investigated soil monitoring sites. In order to achieve a uniform procedure in implementing soil monitoring sites, a recommendation for soil monitoring has been developed by the Institute of Soil Science at the University of Agricultural Science in Vienna, on behalf of the Federal Environmental Agency and in cooperation with the Austrian Soil Science Society.

Since 1992 a soil information system (BORIS) is being developed by the Austrian Federal Environment Agency. To harmonise data records a 'key for soil data' ('Datenschlüssel Bodenkunde') has been established. At the moment, the database holds more than 500 000 records from over 5 000 sites and contains a soil map of Austria at the scale of 1: 750 000. Two forms of access to the data included in BORIS are provided via Internet: BORIS INFO, which is open to the public and contains meta data for each site and BORIS EXPERT, which includes the complete database and is accessible to those institutions which have already provided relevant soil data for BORIS and which are included in the list of licensed institutions granted access.

Soil policy and legislation in Belgium

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In Belgium the responsibility for environmental policy is with its three regions: Flanders, the Walloon Region and the Brussels-Capital Region. This also includes contaminated land policy.

Until now only Flanders had adopted a full legislative framework for contaminated sites, the 'soil remediation decree' ratified by the Flemish Government on 22 February 1995. The responsible authority is OVAM (Public Waste Agency of Flanders).

Soil is defined as the fixed part of the earth, including the groundwater and the other elements and organisms contained therein.

The Flemish decree contains a number of key ideas which address new ways of handling this issue:

- a register of polluted soils and the opportunity to request a soil certificate, including an extract from the register; the register includes the results of monitoring;
- the difference between historical and new soil pollution;
- the difference between obligation and liability for remediation;
- special rules for transfer of property.

Main issues of concern in the soil-protection policy are to prevent as much as possible soil pollution by chemicals via product regulation and via legislation on environmental permits.

This preventive approach gained extra momentum when the soil remediation decree came into force. The attention paid to the prevention of soil pollution has clearly grown, since new soil pollution has to be remediated immediately.

Another topic in Flanders is groundwater contamination by manure in agricultural areas. Due to the 1995 manure action plan, based on the principles of a limited period in which manure can be spread on the land and a quotation system with taxes, also this problem is decreasing. The Flemish Land Agency (VLM) is the competent authority for the follow up.

The soil monitoring system in Denmark
Vibeke Ernstsen, Geological Survey of Denmark and Greenland, Denmark

In Denmark, soil mapping has taken place for a long time and with very different purposes. In 1972, a national soil survey focused on the upper 25 cm of soil. The survey included texture, organic matter and other basic soil parameters and these data were correlated with information about the sediments in a depth of one meter held by the Geological Survey of Denmark and Greenland.

In the 1980s a soil-survey system was established, arranged in a grid of 8 x 8 km. The obtained data of the different soil horizons and soil analyses are now held in a database that may be used together with other digitised data, such as land-use data.

The square grid is used for nitrate investigations with measurements of mineral nitrogen in soil samples collected to a depth of one meter during the leaching period. A number of the sites from the grid system have also been used for the mapping of eight different heavy metals all over Denmark, and it is planned to repeat the investigation within the next five years. Also, some repeated measurements on the organic matter of the topsoil have already been carried out, but the results are not yet available.

So far, these studies together with ICP-integrated monitoring/ICP-forest monitoring and activities on contaminated land are the main activities related to soil issues in Denmark.

The establishment of a monitoring and assessment framework for Europe seems very interesting for a future work on soil environment-related issues, having in mind that it will be difficult to get an agreement on one methodology used in order to be able to compare soil relevant data.

National soil monitoring programmes in Finland
Michael Starr ([10]), Heli Lehtinen ([11]), Jouko Sippola ([12]) and Timo Tarvainen ([13])

Finland covers an area of 338 144 km^2, making it the fifth largest country in Europe, but the population is only 5.1 million. Water accounts for about 10 % (3.3 Mha) of the country, cultivated land 8 % (3 Mha), and forest 65 % (23 Mha). About one-fourth of the country lies inside the Arctic Circle. Built-up areas and transport routes occupy about 0.8 and 0.4 Mha, respectively. Much of Finland is lowland (average height is 152 m a.s.l.) and there is only minor variation in relief.

The most dominant soil types are podzols and histosols. Concern about soil degradation has mostly been confined to diffuse (air) pollution. Erosion and other forms of soil degradation are not considered important or only constitute a very local problem. For forest soils, and to a lesser extent also agricultural soils, the main concern has been about the effects of long-range transported air pollution, particularly acidifying S and N deposition, on the quality of soil and surface waters and ecosystem response on a regional scale.

The direct contamination of soils through spillage, dumping and disposal of toxic chemicals and waste is a local-scale problem largely confined to urban and industrial centres and primarily seen in terms of human health and ground and drinking-water quality. The atmospheric deposition of heavy metals is limited to a few industrial 'hot spots' and the contamination of ground and surface waters by fertilisers and sludge is primarily confined to agricultural soils.

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Although there is a considerable amount of data and information about soil quality in Finland, much of it is site-specific and not aggregated. There are a number of national systematic programmes specifically dealing with soil quality. The soil monitoring of 1 300 fields was started in 1974 as part of a global FAO soil-fertility project. Another programme monitors cultivated soil concentrations of nutrients, trace elements and heavy metals at 150 farms. Sampling started in 1992 and is repeated every five years. The main forest soil monitoring programmes include the UN-ECE international cooperative programme on forests (ICP forests) and the ICP-integrated monitoring (ICP IM). Since 1995, ICP forests has been carried out jointly with the European Union (EC Regulation 3528/86 and 1398/95). There are some 500 level I (extensive) sites and 31 level II (intensive) sites in the Finnish ICP forest programme. The ICP-integrated-monitoring programme includes 10 soil monitoring plots. The geological survey of Finland has an environmental soil mapping project with 20 sites and a stream sediment-monitoring project.

Some 653 sites and nearly 10 000 sites suspected of having contaminated soil have been registered in Finland. Most of the soil contamination sites are garages, scrap yards, waste-treatment plants (including landfills), sawmills and wood-impregnation plants. In 1989, the SAMASE project dealing with contaminated sites was set up. There is also a network of soil frost-monitoring sites and a network of groundwater-monitoring sites.

Monitoring and assessment framework for soil in France
J. Thorette, IFEN, EEA National Focal Point, jacques.thorette@ifen.fr

A number of public organisations are operating at the national level on soil issues in France dealing with monitoring, mapping and agricultural aspects (A) and with contaminated sites problems (B).

Towards a national framework for the monitoring of soils (A)
The Ministry of the Environment, the Ministry of Agriculture, IFEN (the French Environmental Institute) and INRA (National Institute of Agronomic Research) have proposed to organise a national framework for mapping and monitoring soils at different levels: local, regional, national. Its current name is DINIOS ('Dispositif National d'Inventaire et d'Observation des Sols') and it lies on two major axis:

Soil mapping: the 'pedological map of France' programme (CPF) which led to maps at a 1: 100 000 scale will be re-oriented toward detailed studies in order to formalise soil-distribution laws. The programme 'soil inventory, management and preservation' (IGCS), the most important aim being to prepare a map at a scale of 1:250 000, will be strengthened.

Soil monitoring: RMQS (Réseau de Mesure de la Qualité des sols), a 16 km square-based network will be set-up. It represents 2 360 plots covering all the French territory, on which 514 are already implemented for the forests conditions monitoring network. Sampling and analysis methodology will be defined and each 16 km side cell will be documented on environmental aspects using the available broad national geographic databases: hydrology, road traffic, industrial activities, etc. The list of the elements and parameters to be analysed is under discussion.

All the data will be gathered in a unique database DONESOL, nowadays implemented at INRA/SESCPF. Particular attention will be paid to **communication aspects**.

Contaminated soils (B)
Two main databases are dedicated to the management of the contaminated sites and soils:

- **BASOL**: 'Base des sites et sols pollués': it is a national register under the responsibility of the Ministry of the Environment, which contains a well-documented description of polluted sites and which is continuously updated. It concerns places where clean-up actions are necessary. At the end of 1997, 896 sites were reported as contaminated; 125 of these sites have already been restored with or without restriction for further land use.
- **BASIAS** ('Base des Anciens Sites industriels et Activités de Service'): it is a database on the old industrial sites). The French geological and mining survey (**BRGM)** is working for the

Ministry of the Environment in order to make an inventory of industrial sites (abandoned or not), which are concerned by a specific legislation for the environmental protection and which would present a potentiality of pollution. It is expected that BASIAS will gather 200 000 to 300 000 former industrial sites.

More information is available on the web sites of public bodies involved in soil issues:

- Ministry of the Environment: http://www.environnement.gouv.fr
- IFEN, the French Institute of the Environment: http://www.ifen.fr
- INRA/SESCPF, National Institute for the Agronomic Research/Service for the study of soils and the pedological map of France: http://www.inra.fr/
- BRGM, the French Geological and Mining Survey: http://infoterre.brgm.fr
- ADEME: the National Agency for Environment and Energy: http://www.ademe.fr

Information has been collected from:
D. King, D Arrouays, INRA/SESCPF; D. Darmendrail, BRGM; E. Normant, Ministry of the Environment.

Monitoring and assessing soil status and soil degradation in Germany
Beate Werner, Federal Environment Agency, Germany

There are several monitoring programmes for soil in Germany. Most of them are managed at the Länder level, which implies that the Länder are the owners of the data. Of most interest for EEA cooperation would be the programme on permanent monitoring sites (BDF) as well as the set of data on background values for heavy metals, both on the federal level collected by the Federal Environment Agency (UBA). As a third column of data for soil protection, the Federal Institute for Geosciences and Natural Resources (BGR), collects and assesses on the federal level the geologic and pedogenetic soil data.

The data exchange between the federal Government and the Länder is organized by a regulation. Nevertheless, with respect to the federal structure of administration in Germany ad hoc data requirements are impossible to be answered in a short-term.

The programme of 'permanent soil monitoring sites' implies for the moment 794 sites in 16 Länder. Within this programme agricultural sites, forest sites as well as municipal sites are investigated. The main focus of the programme is the chemical status of soils as well as input/output estimates. Parameters measured are e.g. contents of heavy metals and some organics, data on soil quality and site management. For selected monitoring sites, data on deposition, soil biology, fertiliser input and plant quality are collected. The investigations are repeated periodically. The forest soil analyses are partly supported by the EU.

A monitoring and assessment of soil degradation has to cover more than a monitoring network on chemical soil status can deliver. However, we consider the financing of the pilot/demonstration sites as the main problem of the development of a classical European soil monitoring. Dependent on the agreement with the federal States, Germany could contribute existing monitoring data. However, to enhance the idea of a harmonised European monitoring network there is a need to explicitly raise some additional money to ensure additional and well-organised measurements. With respect to analytical harmonisation the results of ISO TC 190 have to be considered.

Together with harmonised monitoring, in our opinion the discussion about definitions would be much more important. For example, the definition of background values for heavy metals, of the term 'built-up area' or of what is suggested by the terms of 'potential erosion risk' and 'actual erosion risk'.

The data flow between member countries and EEA should be aggregated at the European level, eventually at the national level. But national reports have to remain the responsibility of the member countries alone.

Below are some suggestions made for the follow-up of the cooperation between EEA and member countries:

- data requirements should be based on a long-term concept for a European assessment of soil degradation, as it has started with the indicator framework. The focus should be on the general assessment rather then on a classical soil monitoring network. Both have to be considered, the natural potential of soils and the anthropogenic influence;
- a transparent and clear documentation of aim and background of the assessment would help the **advertisement** in member countries, for example at the 'Länder' level (in Germany) or in other sectors (e.g. agriculture), in order to get more of the required data as well as other data not included in the national monitoring programmes yet;
- the questionnaire should be discussed, updated and improved taking into account the comments from the member countries. An updated version should be sent out to the countries with a sufficient time-frame for responses (suggested: 6-9 months).

Monitoring of forest soils in Greece
G. Nakos, National Agricultural Research Foundation (NAGREF), Forest Research Institute, Athens, Greece

Monitoring of forest soils in Greece is carried out in connection with Council Regulation (EEC) No 3528/86 and the Geneva Convention (LRTAP, Geneva 1979, ICP forests), both dealing with the effects of atmospheric pollution on forest health, at two levels.

Level I. In 1998, approximately 100 plots were established, on a 16 x 16 km grid, in forested areas throughout Greece (Level I plots) to survey annually 'forest conditions' and look for any relations between biotic and abiotic (including atmospheric pollution) parameters and forest health. In connection with this, soil samples were taken from 15 forest plots **with acid soils** and analysed for a number of parameters. To study temporal variation in the properties of these forest soils a repetition of soil sampling, from the same plots, is planned in the near future.

Level II. In 1995, four permanent experimental plots were established in representative forest ecosystems in Greece (Level II plots) where a large number of ecological parameters is intensively monitored with the intention to find relationships between the state of health of the forests and the monitored parameters. In connection with this, soil and soil solution are also monitored.

Soil monitoring and assessment activities in Ireland
J. Lee ([14]), D. McGrath ([14]) and J. Brogan ([15])

Soil quality
There is no statutory framework for the systematic assessment of soil quality parameters. However, as part of its agricultural/environmental research programme, Teagasc has conducted a systematic survey of heavy metals and organic micro-pollutants in the soils of part of the country.

The south-eastern region of Ireland, representing 22 % of the land area of the country, has been systematically sampled. Soils have been analysed for a range of heavy metals and persistent organics. These soils have now been archived and are available for future analyses as required. Analyses conducted to date, are for soil parameters pH and organic matter, for major components, aluminium, iron, and manganese, for trace elements (heavy metals) arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium and zinc and for organics, hexachlorobenzene, hexachloro-cyclohexanes, and for DDT and its metabolites. Other organics, polychlorinated biphenyls and polycyclic aromatic hydrocarbons, were examined in a proportion of soils.

(14) Teagasc, Soils & Environment Research Centre, Johnstown Castle, Wexford
(15) Environment Protection Agency (EPA), Johnstown Castle, Wexford

Results have been statistically analysed and frequency distributions have been calculated. Geographic distributions have also been plotted and localized concentrations have been found for most elements. Geochemical factors are considered to be largely responsible for most of these localized concentrations. Aerial deposition of lead and selenium was also indicated. Historic usage of DDT and γ — HCH was detected in soils with different land uses.

Overall, little serious contamination of soils, especially that caused by man, by toxic elements was evident. However, as many as 21 % of soils breached the provisions of the EU Sewage Sludge Directive for heavy metals in soil.

The propensity for phosphorus run-off from agricultural soils through overland flow is mainly confined to 25 % of the Irish land area, corresponding to impeded soils of reduced permeability. On the well-drained soil areas, losses of P to water are much less serious. However, localised risks may exist.

Research shows that there are soil to soil differences in nitrate leaching and polluting potential. When intensive dairying occurs on a vulnerable aquifer there is a significant chance of groundwater nitrate pollution particularly where dirty water is irrigated on small areas of land. Irish research also shows that there is a strong relationship between arable land use types and nitrate losses from soil to water systems. In this regard it is relevant to note that grassland land-use systems predominate.

Soil erosion/compaction
No statutory framework exists for the systematic assessment of soil erosion. However, it is estimated that 20 % (0.3 Mha) of the uplands may be affected by soil erosion to varying degrees.

Soil compaction and treading damage attributable to grazing livestock and farm machinery is also problematical particularly in the hydromorphic soil areas.

Contribution of polluting activities to local soil contamination
Irelands relatively late arrival into the industrial age means that contaminated land problems are significantly smaller than those of other European countries (Brogan, 1999).

To date no specific national survey has been carried out to identify and register contaminated sites. However, the most common types of facilities likely to give rise to contamination in Ireland have been identified.

It was estimated that between 2 000 and 2 400 sites on which industrial activities have or are currently taking place may pose a risk to soils and/or groundwater. These figures give an indication of the possible scale of the contaminated land situation in Ireland. It should be noted that where the activities mentioned are properly managed, as is the case with many existing activities, the risk to soil and groundwater is greatly reduced.

Technical approach to risk assessment
In line with other European countries, Ireland's approach to contaminated land encompasses pollution prevention, the polluter pays principle, the precautionary principle and the use of risk assessment to identify and prioritise sites requiring remedial action. This approach will initially be applied to the management of sites used for the disposal of hazardous waste and will then be applied to other types of contaminated sites. The EPA is currently preparing a discussion document on environmental quality objectives (EQOs) and standards (EQSs) for soils which is similar to the published discussion document on aquatic environment. EQOs for soil, which will be based on the various uses to which soil can be put, will be met through the application of EQSs. EQSs will take the form of guidance values for chemical contaminants, human and ecotoxological parameters, whereas environmental management plans and programmes can be used to tackle issues of physical degradation and diffuse impacts such as nitrate and phosphate pollution of water.

Soil monitoring and assessment in Italy
Carlo Jacomini, Antonio Pugliese, ANPA and Renzo Barberis, Aldo Panzia Oglietti, ARPA Piemonte

Soil in Italy is a very problematical issue, due to its great variety of types and complex space distribution, and to the number of potential threats, such as: erosion, acidification, salinisation, compaction, desertification, accumulation of toxic substances, loss of biodiversity.

Soil quality data are diffuse and abundant. Current data report 433 pedological maps in Italy (at present, only one third is in digital form). National observation points are about 200 000, while the described and analysed profiles are about 20 000 (almost 85 % geo-referenced). Most useful information comes from regional or local data, often non-homogeneous, hardly comparable, and with poor related meta-information.

The new regulations for local contamination will allow transferring all the information, through regional and local authorities, to the 'national survey of potentially-contaminated sites' and eventually to the 'national inventory of cleaned-up sites'. For these activities, ANPA is defining database requirements and data-transfer protocols at national level.

As for land use, the reference data at national level are those derived from the Corine land cover programme, and those developed through National Statistical Institute (ISTAT), a relevant source for other environmental information, as far as driving forces and pressures are concerned.

The level of knowledge is quickly increasing, and the gaps to European standards in terms of information completeness, data quality and normalisation all over the country, are almost bridged.

Data availability is an issue well known to the national authorities. However, to overcome existing difficulties, the most important actions driven by ANPA are linked to the reorganisation of the national environmental information system network (SINAnet), and to setting up a soil monitoring and assessment network.

The SINAnet network closely resembles the EIONET structure, with a pivotal organisation, ANPA, responsible for coordinating the functional nodes: the regional focal points (PFRs), the national topic centres (CTNs) and main reference institutions (IPRs).

CTNs bring together several regional environmental protection agencies (ARPAs) and IPRs, to carry out activities according to long-term programmes. Each CTN supports ANPA on setting up common rules and homogeneous qualitative standards on major topics: air and climate change; inland, coastal and marine waters; waste; soil and contaminated sites; physical agents, such as IR, NIR and noise.

To streamline soil data flow, ANPA committed to the CTN on soil and contaminated sites (CTN SSC) the following main tasks:

- define reporting obligations on soil, as derived from international conventions, EU legislation, and national laws and norms;
- establish sets of soil indicators necessary to support decision-making and reporting;
- develop guidelines for data collection and validation;
- maintain the catalogue of available data sources;
- support ANPA in performing integrated assessment and reporting;
- identify needs for data integration.

Within SINAnet, CTN SSC is also cooperating in defining environmental quality standards, state-of-the-art on soil analysis methods and design criteria for a national soil monitoring and assessment network.

Soil monitoring and assessment in Luxembourg
Roby Schmit, Administration de l'Environnement, Luxembourg

Luxembourg is the smallest country of the European Union covering a surface of about 2 500 km². Until now soil protection for sustainability was of very little concern and as a consequence no real soil monitoring system has been established in Luxembourg, so far.

Soil-related activities
A number of different institutions deal with soil-related issues at national level, but however, coordination between all these administrations is missing, at the moment. Most of the investigations concerning soil are very specific and in points.

For instance, maps exist on the following areas:

- biophysiological status and activities of the soil;
- pedological characteristics of soil, covering the whole country, prepared by the Ministry of Agriculture.

Moreover, the Environment Protection Agency carried out programmes and initiatives concerning heavy metals in soils.

In fact, soil investigations in Luxembourg are rarely carried out for the purpose of soil protection per se. The main motives can be seen in the control of sewage sludge application and in the analyses of specific local contamination problems.

One major project, which started in September 1999, deals with the establishment of an inventory for contaminated sites. It will probably run until 2002, covering the whole country and providing a comprehensive data set. By building up a database, it should then be possible to connect these data with a geographical reference system.

Legislation
All regulations concerning soil issues are normally covered by other main topics. In the case of contaminated sites legislation is held by the law of waste management. The use of sewage sludge is covered by a specific regulation.

At the moment, one regulation dealing with the characterisation of soil pollution of contaminated soil on a local basis is in preparation. In addition, the government, newly-elected last summer, said it would declare a national law on soil protection.

Conclusions
The establishment of a national law on soil protection is one of the priorities of the new government, but Luxembourg is still at the very beginning of soil monitoring and soil protection. Accordingly, a lot of basic work has to be done and it will take some more years to make it work.

Soil monitoring and assessment in the Netherlands
Hans Bronswijk, National Institute for Public Health and the Environment RIVM Bilthoven, the Netherlands

Soil quality is a subject of major concern in the Netherlands. Attention focuses on chemical pollution of the soil, because other physical and chemical processes (e.g. erosion, salinisation) that are serious threats to soil quality in other countries do not play a significant role in a flat country with a temperate climate. Both the effects of local pollution and diffuse pollution on soil quality are monitored in the Netherlands.

Monitoring and assessment of local soil pollution
The main targets of the Dutch national environmental policy plan with respect to local soil pollution are: to quantify the extension of the soil contamination in 2005, to remediate all urgent contaminated sites and to permanently (active) manage all non-urgent seriously-contaminated sites in 2022. Monitoring of the progress of the clean-up and of the assessment

of the potentially contaminated sites is necessary to be able to evaluate these goals and to manage the soil clean-up operation.

The development of a comprehensive (national) monitoring system is a joint action of the public and local government. The data are collected by the 12 provinces and the four big cities. In the last three years, the parties mentioned above together with the National Institute for Public Health and Environment (RIVM) have worked on the development and implementation of new indicators (resp. comparable data) for a more comprehensive monitoring of the soil clean-up (policy). The data collected by provinces and cities is integrated and used by the RIVM on behalf of the yearly environmental balance report.

Monitoring and assessment of soil pollution by diffuse pollution
In the Netherlands, monitoring of soil quality as affected by diffuse pollution is carried out in the national soil monitoring network, operated by RIVM in cooperation with various other institutes. In addition to the national network, several provinces have started their own soil monitoring networks, in accordance with the methodology of the national network. Data are exchanged continuously, creating a large database on soil quality.

The national soil monitoring network is operational since 1993. Its primary objective is to determine the changes in soil quality in the Netherlands over time. Topsoil (0-10 cm depth), subsoil (30-50 cm) and the uppermost groundwater are repeatedly (every six years) sampled at 200 locations in the Netherlands. The main substances analysed in the solid phase of the soil are heavy metals, polycyclic aromatic hydrocarbons (PAH), and pesticides. In the groundwater, the major compounds analysed are heavy metals and nutrients. At the monitoring locations, the heavy metal balances are also measured.

Between 1993 and 1997 the first round of the monitoring network was executed. In 1999 the second round of the monitoring network was started.

Developing a national framework to manage contaminated soils in Spain. An advance
Antonio Callaba de Roa, Instituto Tecnológico Geominero de España (ITGE), Ministerio de Medio Ambiente, Spain

Summary
The lack of a supporting legal framework in the field of polluted soils has been modified since the approval of the new Waste Act in April 1998 (Ley 10/98 de Residuos). In this new Act there is a title which is completely devoted to aspects related to polluted soils. This law intends to address two very different aspects of soil pollution: on the one hand, environmental assessment and recovery of discovered-registered contaminated soils and, on the other hand, the discovery of those non-initially considered and the prevention of new situations.

Early in 1999, the Spanish Environmental Ministry created a commission for the developing of technical aspects of the abovementioned law, being the ITGE one of the participants. Some of the elements which configure this practical development are:

Selecting activities/facilities to be covered by the law
To bear the monitoring and assessment tasks on those activities which are potentially soil pollutant a reduced number of economic/industrial activities, classified according to the national economic activities census (CNAE) rules, should be selected.

Establishing a priority pollutant list for soils
In order to focus the investigation of potentially-polluted sites, a list of priority pollutants for soils has been prepared, taking into account a limited number of substances, recognised as priorities by the international community or specifically interesting in the national domain.

Setting generic reference levels for soils
For the abovementioned substances, generic levels of concentrations in soils have been calculated on the basis of tolerable human health-risk considerations and establishing different uses for soil (industrial, residential and agricultural). The surpassing of these levels has no legal implications as they are formulated only as a tool for investigation tasks. The next

step should be the development of decision rules for those cases in which the detected levels exceed the generic levels (i.e. formal risk-assessment process).

Soil monitoring in the United Kingdom: the current position

P.J. Loveland and B. Syed, Soil Survey and Land Research Centre, Cranfield University, Silsoe, Bedfordshire MK45 4DT, UK

Historically, soil monitoring in the UK has been undertaken for agricultural or environmental purposes. soil monitoring policy is decided directly within Scotland and Northern Ireland, or by regional consultation between England and Wales. This has resulted in several soil monitoring schemes.

The annual representative soil sampling scheme (England and Wales) survey began in 1969. It gives an estimate of the status of agricultural soils in relation to changes in agricultural practices. The number of farms sampled is currently 180 each year, of which 60 are farms sampled 10 years and 5 years ago, 60 farms first sampled 5 years ago, and 60 new farms, in each sampling year. Once a farm has been sampled three times it is dropped. Total organic matter content, nutrient content (P, K, Mg), and pH are measured in each sample. The total number of sites sampled under this scheme is *c.* 900.

The national soil inventory (England and Wales, Scotland) began in the late-1970s. It gives an estimate of the distribution of soil types and their properties. The inventory is based on an orthogonal 5-km grid. About 5 700 sites were sampled in England and Wales, and *c.* 800 in Scotland. Some or all of Al, Ba, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, P, K, Na, Sr and Zn extractable by *aqua regia*, organic carbon, pH, 'nutrient' P, K and Mg, particle size distribution, and Cd, Cr, Co, Cu, Pb, Mn, Ni and Zn extractable by 0.05M EDTA, were determined. In the mid-1990s, a subset of the NSI sites was re-sampled in order to assess change in soil chemical properties over time.

The soil-geochemical survey of Northern Ireland was carried out between 1988 and 1994 up to the limit of field enclosure (*ca* 200m O.D) and yielded *ca* 6 000 sites. Uplands, bogs, bare rock, and disturbed/urban areas were excluded. *Aqua regia* extractable Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, and Zn were determined.

The countryside survey (England, Wales and Scotland) was carried out in 1978, 1984, 1990, and 1998 in 276, 1-km squares representing the variety of landscapes present. A bulk topsoil sample was taken in each of five squares within each 1-km square. In 1978, 1984 and 1990, the samples were analysed for organic carbon, and pH. In 1998, samples will be analysed for organic carbon, pH, Cd, Cr, Cu, Ni, Pb, Zn and V, PCBs and PAHs. Soil microbiology and soil macrofauna will also be examined.

The environmental change network began in 1994. Soil measurements are made at seven sites in England, one site in Wales, three sites in Scotland and one site in Northern Ireland. Soil samples are taken by soil layer (horizon) and by fixed depth at the start of the programme, then at 5-year and 20-year intervals. Particle size distribution and mineralogy are determined on each soil horizon from the initial sampling. Bulk density and soil water release characteristics are determined on **undisturbed** samples from each soil profile layer at the initial sampling. The following are determined on each bulked sample: pH; N; P; organic carbon; carbonate (pH>6.5); *aqua regia* extractable As, Cd, Co, Cu, Hg, Mo, Pb, Zn, exchangeable Al, Ca, Fe, H^+, K, Mg, Mn, P, Na.

All the data from these different soil monitoring schemes are stored in separate databases.

Annex II: Analysis of questionnaire responses

As agreed at the workshop, member countries were asked to respond officially and complete a questionnaire on the proposed framework. In addition, countries were asked to provide their opinion on priorities for development of policy-relevant indicators on soil, as discussed at the workshop. Conclusions are presented in the following sections.

Sixteen countries returned questionnaires, with the exception of France and Iceland.

Answers to the questionnaire on the framework

a) Is a European monitoring and assessment framework for soil as proposed feasible, and would you participate?

- Framework proposal is seen as an important step to improve soil information at the European level.
- Willingness to contribute to the proposed framework exists among all represented countries.
- The amount of contributions cannot be specified unless the proposal is further discussed and presented in more detail.
- Existing data and national-monitoring systems have to be evaluated and must be taken more into account when developing a European soil monitoring and assessment framework. The setting up of a working group was suggested.
- A few countries consider provision of funding for the monitoring necessary.

b) What is the situation of availability of soil data in your country and the conditions of access to it?

- In some of the countries data availability is low because they have no national soil network established yet. Data have to be made accessible and comparable within the country first.
- In other countries data availability is high but access to the data is restricted due to ownership (in some countries data are owned by provincial authorities), copyright and funding of data collection (no free access to data)
- Data availability depends on the kind of data which is required.

c) What do you think about the need of data harmonisation (data comparability) among the different national soil data and which problems do you expect?

- Need of data harmonisation (data comparability) is high, but will be a difficult exercise. It will not be possible for all parameters, but it should be done at least for a minimum set of parameters.
- Problems: Definitions, timescales, geographic scales, measured parameters, methods and standards differ from country to country. The heterogeneity of soil type, quality and function and ways of describing all three will pose the greatest challenges for harmonisation.
- Establishment of reference sites will be of help for the long-term, ISO standards should be considered and background values have to be agreed on. A glossary will be a helpful tool to reduce problems of definition.
- For the short-term, data aggregation on a regional or catchment level and harmonisation of reporting on monitoring activities is suggested.
- Data harmonisation does not need to be achieved at the European level only but also at the national level.

d) If you want to deliver data for a European soil base, which kind of data flow and aggregation level would you suggest or prefer?

- In some countries national data flows have to be improved first. Then they could deliver the data, preferably from PCPs or NFPs to EEA.
- Aggregation level: depends mainly on the type of parameter or indicator. National level is preferred from some countries, for some the NUT3 level is regarded as the most suitable one, others prefer geographic units.
- Data will mainly be aggregated by the individual countries. A few countries suggested that aggregation should be managed by the ETC/S.
- Prior to aggregation, data harmonisation and clear rules given by the EEA are necessary.

e) What is your opinion on the proposed reporting mechanism for soil?

- The proposed reporting mechanism is regarded as a good initiative, but should be more detailed. Harmonisation of national reporting is necessary. Evaluation of the impacts on the soil environment should be included. The reporting mechanism should be accepted by all member countries.
- The frequency of reporting depends on the parameter/indicator/theme, but should not be as high as for other environmental media (water, air).
- Requirement: the responsibility for national reports will always lie with the member countries.

f) How did you receive the questionnaire (directly, NFP, NRC, other)?

- The questionnaire was mainly received directly from the EEA and/or from the NFP.

g) Do you know how to use CIRCLE and get access to the Interest Group 'Soil at the EEA' and how to download and upload documents?

- In general, the country representatives know how to use the CIRCLE software, although some of them have only little experience with it.

h) What do you think of updates/pre-completed questionnaires?

- Updates are considered helpful; pre-completed questionnaires seem to have some advantages (detection of errors, make updating easier).

i) Do you have any suggestions for improving data collection in the future?

- For improving data collection a reduced number of questionnaires (low frequency) with a reasonable time-frame for collection and harmonisation is needed.
- Data requirements should be based on a long-term concept and be focused on the general assessment of soil issues with a transparent and clear documentation of aims.
- Suggestion: those involved in answering such questionnaires should first be asked to what extent and scale they had been directly involved in soil data collection and evaluation. Official EEA requests sent out in paper format well in advance to the NFPs would facilitate the process.

Answers to the questionnaire on the priorities of policy-relevant indicators for soil

a) Which of the following soil issues do you consider as priorities for the short and medium term?

Countries⇒ Soil issue⇓	AT	BE(1)	DK	FI	GE	GR	IR	IT	LI	LU	NL	NO	PT	SE	SP	UK	Σ
Soil erosion	x		x			x	x	x	x		x	x	x		x	x	11
Soil sealing	x		x	x	x	x	x	x	x	x		x				x	11
Soil acidification	x	x	x	x	x					x				x			7
Physical deterioration						x				x					x		3
Soil eutrophication	x		x		x	x	x										5
Diffuse contamination	x	x	x								x	x	x			x	7
Local contamination	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	15
Salinisation						x							x		x		3
Large-scale land movement									x								1
Others																	-

(1) Response is referred to Flanders

In the **short-term,** local contamination, soil sealing and soil erosion have been identified as priorities by most of the countries. Diffuse contamination and soil acidification have been indicated as priorities by about half of the countries. Large-scale movements, salinisation, physical deterioration and eutrophication have been considered as priorities only in a few cases.

b) Which of the following soil issues do you consider as priorities for the long-term?

Countries⇒ Soil issue⇓	AT	BE(1)	DK	FI	GE	GR	IR	IT	LI	LU	NL	NO	PT	SE	SP	UK	Σ
Soil erosion	x	x		x	x	x	x		x		x	x			x	x	11
Soil sealing	x	x							x	x		x			x	x	7
Soil acidification	x					x				x		x	x	x			6
Physical deterioration	x		x	x	x	x		x		x		x	x		x		10
Soil eutrophication	x			x			x						x				4
Diffuse contamination	x		x	x	x	x		x	x		x	x		x	x	x	12
Local contamination	x					x	x	x		x	x	x		x			8
Salinisation		x				x		x				x			x		5
Large-scale land movement	x								x								2
Others			x(2)		x(3)			x(2)									3

(1) Response is referred to Flanders
(2) biological degradation/deterioration,
(3) compaction

In the **long-term**, diffuse contamination, soil erosion and physical deterioration are regarded as priorities by most of the countries. Soil sealing, local contamination and salinisation have

been indicated as relevant by about half of the countries. Other issues, such as biological degradation and soil compaction, have been considered as relevant in a few cases together with large-scale movements and soil eutrophication.

c) For which of the following soil issues are data available?

Countries⇒ Soil issue⇓	AT	BE(1)	DK	FI	GE	GR	IR	IT	LI	LU	NL	NO	PT	SE	SP	UK	Σ
Soil erosion			x			x	x	x				x			x		6
Soil sealing	x		x		x			x			x	x				x	7
Soil acidification	x			x	x	x					x	x				x	7
Physical deterioration															x		1
Soil eutrophication	x				x		x				x						4
Diffuse contamination	x	(x)	(x)		(x)			x			x	x				x	5(8)
Local contamination	x	x	x	x	x	x	x	x		x	x			x	x		12
Salinisation						x									x		2
Large-scale land movement															x		1
Others																	-

(1) Response is referred to Flanders
(2) biological degradation/deterioration,
(3) compaction
(x) data availability depends on kind of degradation/parameter.

Data are available in the field of local contamination in most of the countries, followed by soil acidification, diffuse contamination, soil sealing and soil erosion, where data are available in about half of the responding countries. There are hardly any data available on 'physical deterioration', 'salinisation' and 'large-scale land movements'.

Conclusions

The proposed framework is seen as an important step to improve soil information at the European level. Countries in general agreed to contribute according to their possibilities. However, the proposal should be more specific in certain parts.

The setting up of a working group was suggested in order to evaluate existing data and national monitoring systems.

The consultation confirmed that priority should be given to indicators in four soil issues: sealing, erosion, local contamination and diffuse contamination, which are also the issues where data are available in a consistent number of countries.

On the basis of the answers received, the term 'diffuse contamination' needs to be more clearly defined, as the question on data availability could not be answered by all countries.

Responses also confirm the progress achieved by EEA in the implementation of the framework for local contamination.

Annex III: Programme

Tuesday, 12 October 1999

1900-2030	*Registration at the venue / Welcome reception*

Wednesday, 13 October 1999

0830-0900	*Registration continues*
0900	Welcome
0915	Introduction/background (A.R. Gentile)
0930	Proposal for a European monitoring and assessment framework for soil (S. Huber)
0950	Discussion
1010	Policy relevant indicators on soil (O. Duewel)
1030	Discussion
1045	*Coffee break*
1105	Special aspects on boreal soils (V. Ernstsen)
1125	Discussion
1140	Towards a European soil monitoring system (B. Syed)
1200	Discussion
1215	Monitoring and assessment framework with regard to contaminated sites (M. Schamann)
1235	Discussion
1250	*Lunch*
1420	FOREGS geochemical mapping programme (R. Salminen)
1435	Country statement — introduction (S. Huber)
1440	Country statement — Austria (S. Schwarz)
1450	Country statement — Belgium (E. Van Dyck)
1500	Country statement — Denmark (V. Ernstsen)
1510	Country statement — Finland (M. Starr)
1520	Country statement — France (J. Thorette)
1530	Country statement — Germany (B. Werner)
1540	Discussion

1600	*Coffee break*
1620	Country statement — Ireland (J. Lee)
1630	Country statement — Italy (C. Jacomini)
1640	Country statement — Luxembourg (R. Schmit)
1650	Country statement — Netherlands (H. Bronswijk)
1700	Country statement — Spain (A. Callaba)
1710	Country statement — United Kingdom (P. Loveland)
1720	Discussion
1800	Close of 1st day
1900	*Invitation to dinner at a 'Heurigen'by the Austrian Federal Environment Agency*

Thursday, 14 October 1999

0900	Conclusions of 1st day/ presentation of a workshop document
0920	Perspectives and priorities for soil protection in Europe (W. Blum)
0940	Discussion
1040	*Coffee break*
1100	Final discussion (further activities)
1200	Close of meeting
1230	*Lunch*

Annex IV: List of participants

Name	First Name	Telephone	Fax	e-mail	Group	Institution	Department	Street	City	Country	Attendance	
											13.10.	14.10.
Bidoglio	Giovanni	(+39) 03 32 78 93 83	(+39) 03 32 78 56 01	giovanni.bidoglio@jrc.it	Other	Joint Research Centre	Environment Institute		I-21020 Ispra	Italy	x	
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Jacomini	Carlo	(+39) 06 5007 2376	(+39) 06 5007 2218	jacomini@unisi.it.or	PCP-S	Agenzia Nazionale per la Protezione dell' Ambiente		Via Vitaliano Brancati 48	I-00144 Roma	Italy	x	x
Lee	John	(+353) 5 342 888	(+353) 5 342 004	jlee@jcastle.teagasc.ie	PCP-S	TEAGASC	Soils and Environment Research Centre	Johnstown Castle	Wexford	Ireland	x	x
Loveland	Peter	(+44) 1525 863 246	(+44) 1525 863 253	p.loveland@cranfield.ac.uk	PCP-S/ ETC-S	Cranfield University	Soil Survey and Land Research Centre	Silsoe Campus, Silsoe	MK45 4DT Bedford	United Kingdom	x	x

Name	First Name	Telephone	Fax	e-mail	Group	Institution	Department	Street	City	Country	Attendance	
											13.10.	14.10.
Lythgo	Malcolm	(+44) 1454 62 44 17	(+44) 1454 62 44 08	malcolm.lythgo@environment-agency.gov.uk	Other	Environment Agency (England Wales)	Land Quality	Rio House, Waterside Drive, Aztec West	UK-BS32 4UD Almondsbury, Bristol	United Kingdom	x	x
Mayer	Johannes	(+43) 1 31304 3240	(+43) 1 31304 5400	mayer@ubavie.gv.at	NFP	Umwelt-bundesamt Wien	Dept. For International Organisations, Information	Spittelauer Lände 5	A-1090 Wien	Austria		x
McInnes	Gordon	(+45) 3336 7137	(+45) 3336 7199	gordon.mcinnes@eua.eu.int	EEA	European Environment Agency		Kongens Nytorv 6	DK-1050 Copenhagen K	Denmark	x	x
Panzia Oglietti	Aldo	(+39) 011 81 53 225	(+39) 011 8153 253	arpa.torino.ricerca@ope.net	NFP	ARPA Piemonte	Area Ricerca e Studi	Via della Rocca 49	10123 TORINO ITALY	Italy	x	x
Prokop	Gundula	(+43) 1 31304 3380	(+43) 1 31304 5400	prokop@ubavie.gv.at	ETC-S	Umwelt-bundesamt Wien	Dept. for Contaminated Sites	Spittelauer Lände 5	A-1090 Wien	Austria	x	x
Salminen	Reijo	(+358) 2055011	(+358)2055 012	reijo.salminen@gsf.fi	Other	Geological Survey of Finland	Head of Geochemistry Department	Betonimiehenkuja 4	SF-02150 Espoo	Finland	x	x
Schamann	Martin	(+43) 1 31304 3370	(+43) 1 31304 5400	schamann@ubavie.gv.at	PCP-CS/ ETC-S	Umwelt-bundesamt Wien	Dept. for Contaminated Sites	Spittelauer Lände 5	A-1090 Wien	Austria	x	x
Schmit	Roby	(+352) 40 56 56 213	(+352) 48 50 78	robert.schmit@aev.etat.lu	PCP-CS	Administration de l'Environnement	Division des Déchets	1 rue Bender	L-1229 Luxembourg	Luxembourg	x	x
Schwarz	Sigrid	(+43) 1 31304 3620	(+43) 1 31304 5400	schwarz@ubavie.gv.at	PCP-S	Umwelt-bundesamt Wien	Dept. for Terrestrial Ecology	Spittelauer Lände 5	A-1090 Wien	Austria	x	x
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Syed	Bronwyn	(+44) 1525 863 267	(+44) 1525 863 253	b.syed@cranfield.ac.uk	ETC-S	Cranfield University	Soil Survey and Land Research Centre	Silsoe Campus, Silsoe	MK45 4DT Bedford	United Kingdom	x	x
Thorette	Jacques	(+33) 2 38 79 78 91	(+33) 2 38 79 78 60	eionet-nfp@nfp-fr.eionet.eu.int	PCP-S	Institut Français de l'Environnement		61 Boulevard Alexandre Martin	F-45058 Orléans Cedex 1	France	x	x
Utermann	Jens	(+49)-511-643-2839	(+49)-511-643-3662	jens.utermann@bgr.de	ETC-S	Bundesanstalt für Geowissenschaften und Rohstoffe		Stilleweg 2	D-30655 Hannover	Germany	x	x
Van Dyck	Eddy	(+32) 15 284 430	(+32) 15 284 407	eddy.van.dyck@ovam.be	PCP-S	OVAM		Kan. de Deckerstraat 22-26	B-2800 Mechelen	Belgium	x	x
Werner	Beate	(+49) 30 8903 2925	(+49) 30 8903 2103	beate.werner@uba.de	PCP-S	Umwelt-bundesamt Berlin	Deutsche Kontaktstelle für Boden/ Kontaminierte Stoffe	Bismarckplatz 1	D-14193 Berlin	Germany	x	x