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Assessment of data needs and data availability for the development of indicators on soil contamination

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Executive summary

This report has been prepared by the Austrian Federal Environment Agency under contract to the EEA and is the final result of a working group on indicators for soil contamination. The working group was established by the EEA in order to progress with the work on soil in the interim period before the new ETC on Terrestrial Environment (ETC/TE) started in July 2001.

As part of this work, an EIONET workshop on indicators for soil contamination was held in Vienna in January 2001 (Vienna workshop 2001) with the objective of discussing the relevance of a preliminary list of indicators on soil contamination from localised and diffuse sources (EEA, 2002a).

As agreed at the workshop, an EIONET consultation was launched with the objective of collecting information on selected indicators. A questionnaire was distributed to the 18 EEA member countries, Switzerland and the 13 candidate countries (only for indicators on soil contamination from diffuse sources)[1].

The responses to the questionnaire provided useful information on national relevance, data availability and data gaps related to the proposed indicators. The analysis of the responses, presented in this report, is an important step in the establishment of a regular data collection and assessment process.

The development of policy-relevant indicators and their update on a regular basis can only be improved when comparable data sets are available. This is precisely the objective of the operational framework 'from national monitoring to European reporting' for soil, under which the work presented in this report has been developed (EEA, 2001a; b).

Indicators for soil contamination from localised sources

So far, the EEA, with the support of the ETC on Soil, has collected information on the management of contaminated sites based on the 'best available' data. However, this approach, although allowing for the provision of timely information, has showed some limitations. For example, it may not help rationalise ongoing data collection and monitoring activities at the national and European levels, possibly covering subjects that are not needed, while resources should be better employed to fill data gaps in other priority areas (BTG, 1998).

In order to help streamline monitoring, assessment and reporting activities, a broader approach is required. In the long term, the objective is to focus on the 'best needed' data. In the area of soil contamination, this shift should be obtained by building stronger links to EU policy needs, by focusing on the assessment of the environmental impacts of soil contamination and by undertaking a more detailed analysis in hot spot areas.

In the past years, a preliminary list of indicators for soil contamination from localised sources was identified and reviewed taking into account comments from the EIONET partners (EEA, 2001a; b). The list needed to be further reviewed, taking into consideration data availability and quality, feasibility and further data requirements, before an agreed preliminary list of indicators proposed for further development could be identified. To this end, the preliminary list was discussed at the Vienna workshop 2001.

From the discussion during the workshop, it emerged that many different approaches regarding data collection exists in the various countries. Each country has established some kind of data collection

1 Since January 2002, EEA membership counts 29 countries, comprising the EU-15, three EFTA countries (Iceland, Liechtenstein, Norway) and 11 of the 13 candidate countries (Poland and Turkey are expected to join shortly).

and monitoring system, but in very different ways, derived from each country's capacity to collect data. Nevertheless, two sets of data seem to be available:

- a basic information or core set (e.g. number of sites);
- a variety of data from various sources, not always available at national level. Data availability often reflects national priorities on environmental matters.

The workshop evaluation of each indicator proposed for development (see Annex I) showed that the following four indicators corresponded to a high degree of environmental and policy relevance, feasibility and data availability:

- soil polluting activities;
- number of sites per impact level;
- progress in contaminated sites management;
- expenditures on remediation activities.

Data availability and the perceived importance of the indicators seemed to be highly correlated (see Table 2.5). For example, the indicator 'incidents of groundwater/drinking water supply impairment deriving from local soil contamination' was ranked medium both in terms of data availability and importance. On the other hand, availability of data for the brownfield indicator was classified as low, whereas its importance was classified as medium. This indicated the need to develop brownfield issues further. The lowest ranking both for importance and data availability was given to the indicator on the 'impact of hazardous substances in soil'.

Following this preliminary evaluation, a questionnaire was distributed and returned by 15 countries after the workshop. The results of this consultation, discussed in this report, are in accordance with the evaluation done at the workshop. This analysis and the results of the data request are at the basis of the pilot EIONET priority data flow on soil contamination carried out by the EEA in 2001.

In general, data availability at the regional level and for selected regions is very patchy. At the national level information is more accessible but nevertheless scarce.

Data availability regarding the impact of hazardous substances on soil is quite low according to the answers to the questionnaire. The importance of this indicator was considered low.

Data on the indicator 'progress in the management of contaminated sites' appears to be easily available. The indicator was valued as very relevant and should be further developed.

For the indicator 'incidents of groundwater/drinking water supply impairment derived from local soil contamination', data availability is medium to low. Although information on this indicator is scarce, it is of major importance. In connection with Annex II of the water framework directive, a description of the impacts and pressures within the water body is required. This description should also include point sources.

About half of the countries responding to the questionnaires could provide estimates of the total costs of remediation activities. Data deriving from previous questionnaires combined with data gained through the most recent data collection form a sound data pool for an updated assessment.

It appears to be very difficult for countries to provide information and data on brownfields, confirming the findings of the Vienna workshop 2001. Since the importance of the related indicator is considered as medium, further development should be considered.

In relation to 'soil polluting activities', prevention of future soil pollution should be investigated together with historic contamination. In particular, the implications of the integrated pollution and prevention control (IPPC) directive should be considered.

Indicators for soil contamination from diffuse sources

The starting point of the work on indicators for diffuse soil contamination was the tentative list of soil indicators included in the proposal for a European soil monitoring and assessment framework

elaborated by the EEA with the support of the ETC on Soil (EEA, 2001a,b). These indicators were evaluated in relation to priority, scientific soundness and policy-relevance criteria, following the principles established in the framework, and complemented with other indicators. A preliminary list of priority indicators, classified according to the DPSIR assessment framework[2], was then discussed at the Vienna workshop 2001.

The following list contains indicators considered of high and upper medium importance during the workshop evaluation and for which data was not available from European databases:

- lead emissions due to exhaust gas by road vehicles;
- sewage sludge application per unit area of agricultural land;
- exceedance of critical limits of heavy metal contents in soils related to different land use;
- heavy metal balance for agricultural land;
- organic carbon or humus content in topsoils related to different land use;
- occurrence of key species in soils;
- exceedance of critical levels of heavy metal contents for food quality in different crops.

A questionnaire on data needs and data availability related to these indicators was distributed to the 18 EEA member countries, Switzerland and 13 candidate countries. Responses were received from 21 countries (14 EEA member countries, Switzerland and six candidate countries). Along with general information on the national relevance and availability of data for the selected indicators, detailed information on the data's temporal and spatial coverage was gathered.

In general, according to the questionnaire responses, data availability is very high for pressure indicators (data are available in at least three quarters of the countries), high for state indicators (data are available in approximately two thirds of the countries), except for parameters concerning deposition rates and outputs of heavy metals, and medium to very low for impact indicators (data are available for approximately half of the countries or less).

A comparison between responses on policy relevance and data availability shows that indicators with (very) high data availability are (maybe temporarily) regarded of low or mainly medium political relevance (see Table 3.2). On the other hand, for indicators which are regarded of high relevance, the data availability is medium to low for some of the required parameters. So further information should be collected, in particular on deposition rates and outputs of heavy metals as well as on contents of heavy metals in crops. Furthermore, it is suggested that more work be done on improving the (very low) availability of data on key species in soils, since this indicator was often regarded as relevant.

The development of the pressure indicators proposed was considered highly feasible, although in relation to the 'sewage sludge application on agricultural land', lack of data would require some estimations about the affected arable land. This is also due to the fact that almost no differentiation is possible in relation to the quality of the sewage sludge (for example, its content in heavy metals.

The feasibility of the state indicators appears to be very differentiated. The 'organic carbon content in topsoil' has a high rate of feasibility, whereas the 'heavy metal balance' has a low one, because little information on the output of heavy metals is available. The 'exceedances of critical limits of heavy metals in soil' is on a medium level of feasibility, as it can be calculated for lead, cadmium and mercury for half of the responding countries.

For the proposed impact indicators, the feasibility is low, mainly due to the lack of relevant data. For the 'impact of contamination with heavy metals to crops', first calculations for some countries could already be made in 2002. For a more comprehensive assessment across Europe, further national (regional) investigations would require a few more years. In relation to impacts on soil biota, no preliminary results can be expected before 2004.

2 DPSIR is an assessment tool used by the EEA. It stands for driving forces, pressures, state, impacts and responses.

These findings provide the basis for the further development of policy-relevant indicators on soil contamination from diffuse sources.

A further step would be to prepare a data request for selected indicators, taking into consideration the policy relevance of the corresponding question or issue and the EEA reporting strategy. The request should be based on the selected priority indicators (see Table 3.1) as well as the assessed data availability and the identified data gaps. After the collection is completed, the comparability of national data should be assessed. Depending on this assessment, indicator fact sheets for selected indicators could be prepared and used in the EEA reporting cycle.

Conclusions and follow-ups

The results achieved by the working group on soil contamination provided important input to the work of the new ETC/ Terrestrial Environment, which started operations in July 2001. In particular, it contributed to ensuring continuity to the EEA work on soil contamination and support to further EEA activities on soil.

The work on soil indicators is now integrated within the broader activity on the development of a core set indicators for the terrestrial environment, carried out with the support of ETC/TE.

Major progress so far has been the establishment of pilot EIONET priority data flows on soil contamination in 2001 and some steps towards the integration of the new EEA member countries in the indicator work.

The priority data flows on soil contamination from localised sources are partly an answer to the requests for a more systematic data collection made by the EIONET partners at the Vienna workshop 2001. Regular annual deliveries are requested on a limited set of national data at this early stage of development.

The integration of the new EEA countries into the process was initiated with the organisation of a technical workshop on contaminated sites for PHARE countries, held in Vienna in December 2001. In spring 2002, the pilot priority data flows on soil contamination were extended to the new countries.

On the basis of the results obtained from the pilot priority data flow exercise, an update of the fact sheets related to three indicators on contaminated sites was produced in May 2002. EIONET experts then reviewed the related assessment and data tables, prior to publication on the EEA web site in late 2002.

Finally, in May 2002, an expert meeting on indicators for soil contamination was held in Seville. The conclusions of this workshop are currently being elaborated by the ETC/ TE and will be available on the ETC/TE web site (http://terrestrial.eionet.eu.int).

1. Introduction

1.1. Background

The overall objective of the European Environment Agency (EEA) is 'to provide the Community and the 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'.

The main tasks of the EEA 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 by and emanating from the EEA and EIONET, together with access to other relevant environmental information developed by other national and international sources.

The role of the 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 the EEA in 1996 with the objective of providing and developing data and information 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.

The ETC/S operated until December 1999. A new Topic Centre on Terrestrial Environment (ETC/TE) started operations in July 2001. ETC/TE is carrying out the work initiated by the ETCs on Soil, Land Cover and the Marine and Coastal Environment (terrestrial part of coastal environment).

On the basis of the results of the first EIONET workshop on soil (EEA, 2001a,b) and a wider review of the EEA work on soil (October 1999), in the period 2000–mid 2001 the implementation of the work programme progressed through three working groups on indicators for:
- soil contamination (from local and diffuse sources);
- soil sealing; and
- soil erosion.

This report is the final result of the working group on soil contamination and a follow-up of the EIONET workshop on indicators for soil contamination organised by the EEA with the support of the Austrian Federal Environment Agency, held in Vienna in January 2001. Based on the results of the EIONET workshop held in Vienna in October 1999 (EEA, 2001a,b), the main objectives of this more technical workshop were to:
- present the results of current work to the EIONET partners;
- discuss the development of a selection of (priority) indicators on soil contamination;
- get information on availability of national data needed to develop the selected indicators (EEA, 2002a).

1.2. Scope of the report and methodology used

The scope of the work summarised in this report is to provide basic information on data availability for the calculation of policy-relevant indicators for soil

contamination and to identify possible data gaps. The overall long-term objective is to establish systematic and regular data flows between national and European levels to serve the EEA reporting on the conditions of Europe's soils.

In particular, the report presents the results of a survey on data needs and data availability for a proposed preliminary set of indicators on soil contamination from local and diffuse sources. The survey comprised the 18 EEA member countries, Switzerland and 13 candidate countries (only for indicators on soil contamination from diffuse sources)[3].

The report contains an evaluation of the national policy relevance and data availability in relation to the proposed indicators, in order to assess the feasibility of their development at the European level. Furthermore, the report summarises the results of previous activities carried out by the EEA, it describes the methodology followed for the selection of indicators and analyses the data needed for their calculation. Finally, the report includes recommendations on how the indicator work should proceed in the future.

In relation to *soil contamination from localised sources,* the objective of the survey was to obtain detailed information on data availability for a preliminary set of indicators at the national and regional levels as well as for selected regions, to be used to establish a future contaminated sites monitoring system. Within this scope, the results of the EIONET workshop on indicators for soil contamination held in Vienna in January 2001 (Vienna workshop 2001) were analysed and an additional data request was prepared.

This report contains a detailed analysis of the responses. This analysis and the results of the data request are at the basis of the pilot EIONET priority data flow on soil contamination carried out in 2001.

In relation to *soil contamination from diffuse sources,* a restricted number of priority indicators were selected from the tentative list included in the proposal for a European soil monitoring and assessment framework (EEA, 2001a,b), to which other policy-relevant indicators were added. This selection of indicators was discussed at the Vienna workshop 2001 on the basis of their priority, scientific soundness and feasibility. As agreed at the workshop, a questionnaire on data needs and data availability for indicators on diffuse soil contamination was distributed, requesting information on the availability of national data needed to calculate the selected indicators as well as detailed information on the data's temporal and spatial coverage. This report analyses the responses received, summarises the results and provides an overview on the feasibility of calculating the selected indicators at a certain spatial and temporal aggregation level. In this respect, the report provides the basis for further steps of the development of suitable and feasible indicators related to diffuse soil contamination.

1.3. Development of indicators at the EEA[4]

The development of indicators in general and indicators on soil contamination in particular, is a core activity for the European Environment Agency (EEA). Its main objective is to provide the basis for the reporting on the state and trends of Europe's environment.

Indicators are increasingly being used at the European and national levels as tools to get across key messages to policy makers and others interested in environmental policy developments (e.g. policy integration, sustainable development, etc.).

The EEA has chosen an indicator-based approach for its environmental reporting since it facilitates the process of transforming data into suitable information. In fact, indicators:

- can support assessment of current policy measures and the identification of future priorities;
- can provide a system of measurement and verification of countries' performance;

3 Since January 2002, EEA membership numbers 29 countries, comprising the EU-15, three EFTA countries (Iceland, Liechtenstein and Norway) and 11 of the 13 candidates countries (Poland and Turkey are expected to join shortly).

4 Main sources: Gentile, 1999; EEA, 2001a

- can be used to link environment, social and economic dimensions of sustainable development in an easily understandable way;
- can be used to focus and prioritise monitoring and reporting activities.

Indicators are needed to inform governments and individuals about the state of the environment and the economy and how they are changing, to measure the extent to which policy objectives for sustainable development are being achieved and to help summarise and analyse the mass of detailed environmental and economic data so that relevant messages are communicated and understood by different audiences. The indicators must be defined on the basis of:

- the needs of the policy-makers who give the strategic direction on type and theme;
- scientifically sound evidence to ensure their recognition and acceptance;
- an understanding of the practical mechanics and problems in compiling credible and timely indicators.

Indicators are also a useful tool to help prioritise data collection activities and in doing so they can help to identify gaps and redundancies in current monitoring activities and statistical collection programmes.

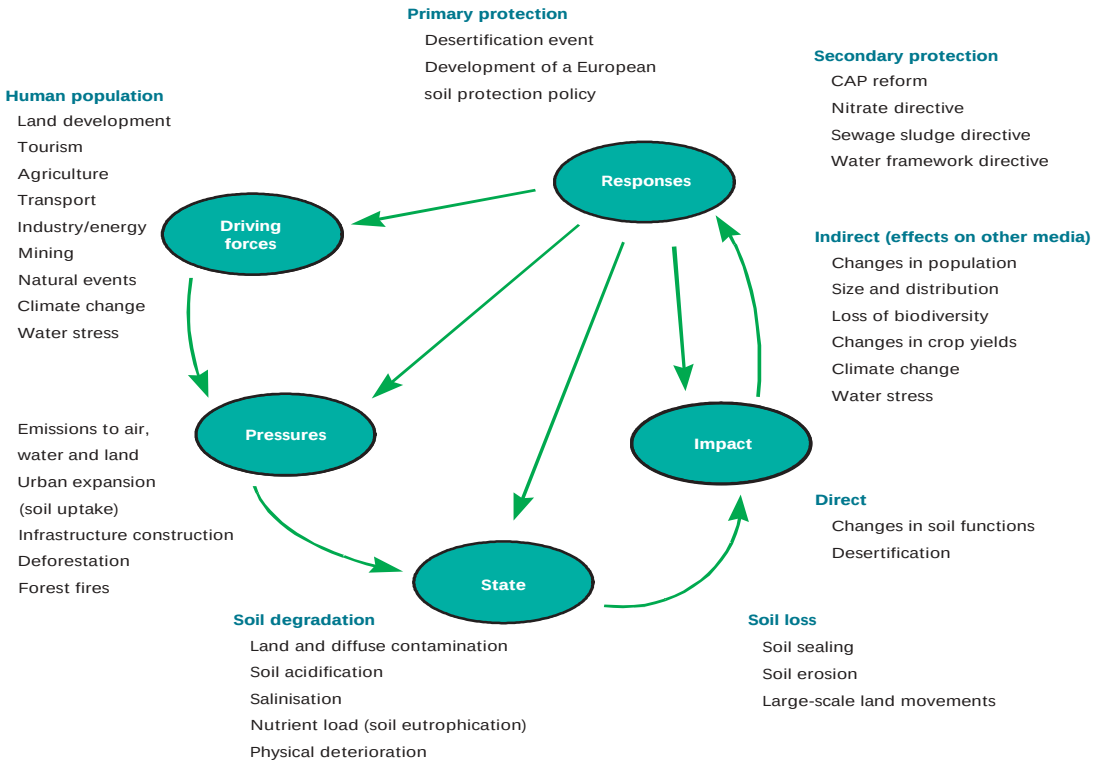
The EEA has defined tools to support the development of indicators, including the DPSIR (driving force, pressure, state, impact and responses) assessment framework and a typology of environmental indicators, which classifies indicators into four simple groups (descriptive, performance, eco-efficiency and overall welfare indicators).

A conceptual framework for the assessment of condition of soils and its multiple effects on the environment has been presented in the report *Environment in the European Union at the turn of the century* (EEA, 1999). This includes the DPSIR framework applied to soil (Figure 1.1) and the multi-function and multi-impact approach, based on the recognition of the role played by the soil multiple functions (ecological and socioeconomical) and the problems arising from the competition between these functions. These assessment tools represent the basis for a quantitative assessment of the condition of soils.

In order to implement these concepts, the EEA, together with its EIONET partners, is building an operational framework ('from national monitoring to European reporting'). The purpose of this framework is to provide policy-relevant information on soil, making use of existing activities and capabilities within member countries, including monitoring, data collection and storage (EEA, 2001a,b).

Figure 1.1. **DPSIR framework applied to soil**

Source: EEA.



The EEA work on soil indicators and the development of the framework started in 1996 with work on indicators on contaminated sites and continued with the preparation of a tentative list of policy-relevant indicators, the assessment of data needs and data gaps and the development of a restricted number of indicators on local contamination, soil erosion and soil sealing.

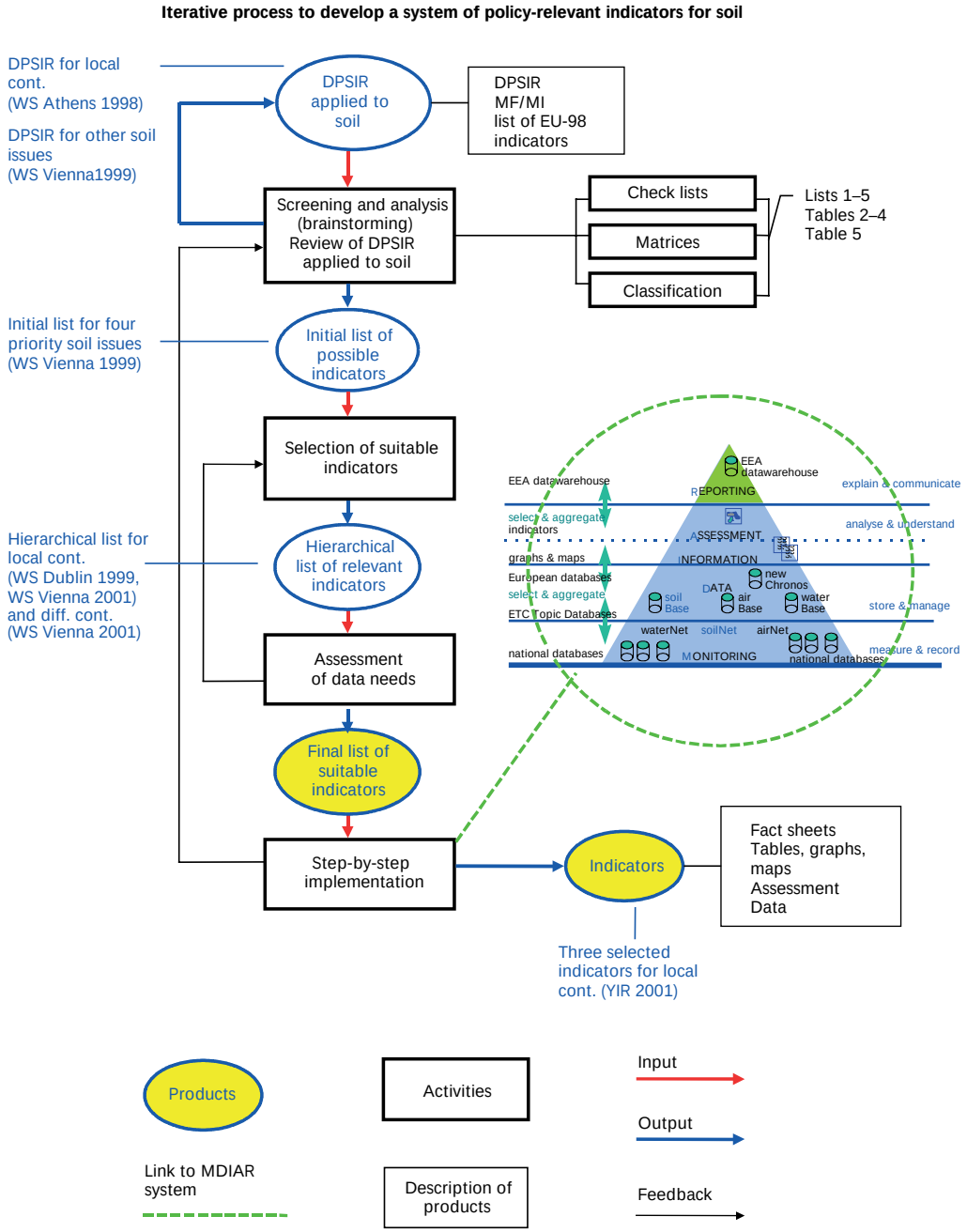
Results of this work have been published in EEA reports (EEA, 1999; EEA, 2000; EEA, 2001c).

The EEA, with the support of the ETC on Soil, organised a workshop in Vienna on 12 to 14 October 1999, where a proposal for a common framework for the assessment and monitoring of soil in Europe was presented. The scope of the workshop was to get to a common understanding and to agree on the way to proceed towards the implementation of the framework.

The proposal contained an initial list of policy-relevant indicators on soil to be used in EEA reporting and to support the development of soil-protection policies. Furthermore, it identified a basic set of soil data that are needed to feed these indicators and that should be considered for soil monitoring at the European level. The initial list of indicators was further developed for local contamination. At the EEA technical workshop on contaminated sites, held in Dublin in November 1999, a draft hierarchical list for local contamination was presented and discussed. Three indicators of the list were selected and included in the 2001 issue of the regular indicator-based report, *Environmentals signals 2001* (EEA, 2001c). Figure 1.2 shows the process devised for the development of soil indicators.

Iterative process to develop a system of policy-relevant indicators for soil Figure 1.2.

Source:
modified from EEA.



2. Indicators for soil contamination from localised sources

2.1. Conclusions of former workshops

The work done so far has been carried out in close collaboration with the member countries. EIONET input to the process of developing policy-relevant indicators for local soil contamination was facilitated by a number of workshops and data collection requests, summarised in table 2.1[5]:

The outcomes of these activities are summarised below.

2.1.1 Common aspects for local soil contamination

Although there is no widely agreed definition for local soil contamination, some common key aspects can be identified.

- It is contamination deriving from point sources, mainly waste disposal, industrial and military activities, and accidents.
- Its major impacts are groundwater contamination due to the leaching of contaminants from the soil and health problems due to direct contact with contaminated soil, which usually results in the necessity to restrict some uses of the land.

2.1.2 Terminology

The definitions of the term 'contamination' adopted across Europe are very generic. Since an agreement on a common definition is unlikely to be reached in the current situation, it has been agreed with the member countries to introduce the concept of 'impact levels'. Table 2.2. describes the four levels proposed.

Table 2.1. **Workshops and questionnaires/data requests on local**

Workshops	Questionnaires/data requests
	'Dobris+3' questionnaire, prepared as input to the EEA report, *Europe's environment: the second assessment,* published in 1998
First contaminated sites workshop, Athens, 29 September 1998	→ 'Athens' questionnaire, 1998
	Data update request prepared as input to the EEA report *Environment in the European Union at the turn of the century,* published in 1999.
	Data update request (by August 1999), prepared as input to the EEA report, *Down to earth: soil degradation and sustainable development in Europe,* published in 2000
Second contaminated sites workshop, Dublin, 10 November 1999	→ 'Test data collection in 11 test regions' questionnaire, 1999
EIONET workshop Vienna, 12 to 14 October 1999	
EIONET technical workshop Vienna, 18 to 19 January 2001	'Vienna workshop 2001' questionnaire on data availability for new indicators and data update request
	Pilot EIONET priority data flows (updated December 2001)

5 The conclusions related to the PHARE workshop held in Vienna in December 2001 and the expert meeting held in Seville in May 2002, organised by the European Topic Centre on Terrestrial Environment (ETC/TE) are not analysed in this report. Further information can be retrieved, when available, from the ETC/TE web site: http://terrestrial.eionet.eu.int/

Impact levels applied to contaminated and uncontaminated sites Table 2.2.

Level	Long description	Brief discription
Level 0	Sites that do not pose any negative effects to human health or the environment; → related environmental media can be used multi-functionally	No impacts; no use restrictions
Level 1	Sites where related environmental media have tolerable contamination levels and which do not pose significant negative effects to human health or the environment; → related environmental media can be used multi-functionally	Minor impacts (tolerable contamination); no use restrictions
Level 2	Sites that pose significant negative effects to human health or the environment if the use of the related environmental media changes to a more sensitive one; → limited use of related environmental media	No significant impacts under current use of environmental media; restricted use only
Level 3	Sites that pose significant negative effects to human health or the environment under current use of the related environmental media; → action is needed	Significant impacts; action needed

The term 'contaminated site' used in the various countries can include sites at different levels of environmental and human health impacts, ranging from minor to relevant adverse effects.

It was proposed to map the impact levels used in the various countries with the proposed four levels and classify the sites on the basis of their impact level. As this is a difficult task, it was agreed that initially the countries would make the classification based on expert judgement. This method will be used until a common solution is agreed.

As an important conclusion of the discussion on these issues, the member countries have recognised that a common data collection and a comparable data baseline are necessary initial steps in the long process of getting to a common acceptable impact level classification.

2.1.3 Field data — expert estimation

Field data about the situation of local contamination is only available in very few cases and therefore the assessment is highly dependant on 'expert estimates'. Two different estimates can be made in the following cases:

- *gaps exist at the site level:* expert estimates are needed to fill data gaps and to produce a comprehensive picture including sites that have not yet been assessed (e.g. to predict the outcome of investigations);
- *geographical coverage of data is 'patchy':* data coverage for a specific parameter in a defined region is in most cases incomplete; as, for example, for the number of contaminated sites ('how many sites at impact level 2 exist in region X?'). Expert estimates are usually a reasonable method of providing missing data. In particular for the development of indicators of progress in the management of the sites ('what have we achieved so far? what is the future target?') expert estimates are very important as data coverage is often incomplete.

2.1.4 Remediation — terminology respecting impact level approach

Remediation of sites can result in a full elimination of the contaminants or in a reduction of their impacts. In order to compare remediation activities across Europe, it has been agreed to classify the remediated sites according to the remaining environmental impacts (see Figure 2.1.).

2.1.5 Tiered approach

The management of local soil contamination is a tiered process. For the monitoring and assessment of progress in the management of the sites, several processing steps have been identified (Table 2.3.).

2.1.6 Test regions (areas)

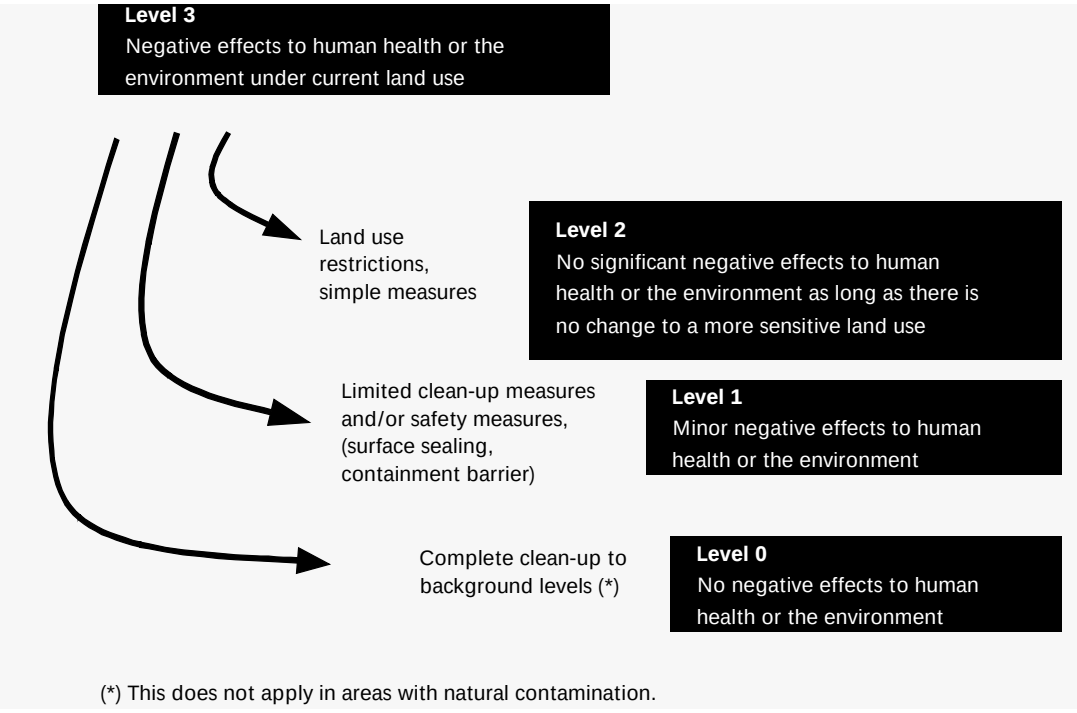
Data at the national scale does not allow a comprehensive assessment of the impacts of local contamination. It was therefore decided to test data availability and indicator development at smaller geographical scales. As a first step, a test data collection was carried out in 11 regions in 11 EEA member countries, using a standard data request and on a voluntary basis. Preliminary results of the test data collection were presented at the second contaminated sites workshop held in Dublin in 1999. A detailed analysis of the results and conclusions were included in the workshop report (EEA, 2002b).

2.1.7 Policy relevance

As mentioned in the introduction, a better analysis of policy needs should be carried out in the selection and the development of the indicators. Some initial considerations in relation to specific European policy instruments are summarised below.

- *Water framework directive.* One of the objectives of the water framework directive is to ensure the progressive reduction of pollution of groundwater and to prevent its further pollution. Point sources can contribute considerably to the direct contamination of rivers, but also through the impact of hazardous substances on groundwater. Reporting on local soil contamination situations at the river basin level is mandatory.
- *Sustainable urban development.* In October 1998, the European Community adopted a framework for action on sustainable urban development. Within this framework the re-use of urban land is seen as having social, economic and environmental benefits. The clean-up of existing contamination at former industrial sites plays an important role in realising this policy objective.
- *Integrated pollution and prevention control (IPPC) directive.* The aim of the 1996 IPPC directive is to reduce the polluting emissions from air, water and land from industrial processes and improve environmental standards for industrial sites related to the handling of hazardous substances. In the future, implementation of this legislative and regulatory framework should result in fewer inputs of contaminants into the soil that might give rise to severe contamination and in a better control of contamination caused by natural or other events.

Figure 2.1. **Possible resulting impact levels in the case of remediation of a site at impact level 3**



- *Landfill directive*. The 1999 landfill directive aims at harmonising controls on the landfilling of waste in the European Union and at reducing the amount of biodegradable municipal waste sent to landfills. It also established the complete ban for the landfilling of certain hazardous waste, liquid wastes and tyres. Separate landfills for hazardous, non-hazardous and inert wastes should be established.

Steps of site investigation Table 2.3.

Preliminary survey	On the basis of available information, a preliminary survey has the aim of assessing whether potentially polluting activities have taken place and whether contamination can be expected. As a result of the preliminary survey, a site will, in most cases, be classified as potentially (suspected to be) contaminated or not contaminated.
Preliminary investigation	Preliminary investigations are carried out to confirm the existence of contamination. In most cases, the results of the preliminary investigation form the basis to definitely classify sites as contaminated. A variety of issues will influence the results of a preliminary investigation, as for example: sampling patterns, number and type of samples, depth of the boreholes, quantity of the samples, transport and storage of samples, selection of substances to be analysed, treatment of samples.
Main site investigation	A main site investigation is carried out to determine the need for remediation or other measures to eliminate or reduce exposure to the contaminants. Major goals are: — to define the extent of the contaminated area and the degree of contamination; — to assess the risks of the involved impacts.
Implementation of remediation activities	Suggested definition: Measures for reduction of environmental impacts have already started.
Remediation activities completed	Suggested definition: Monitoring of environmental media has proven that agreed remediation targets have been meet.

2.2. Selection of suitable indicators

As mentioned in Chapter 1 and Section 2.1, a preliminary list of policy-relevant indicators on local soil contamination was presented at the Vienna workshop in October 1999. A questionnaire was distributed to the member countries, where more information on the indicators was asked for, along with a data update request.

This initial list of policy-relevant indicators was further reviewed and a preliminary hierarchical list was discussed at the Dublin workshop in November 1999. This list contained additional indicators, classified according the DPSIR elements (see Table 2.4)[6].

These preliminary indicators were further discussed at the Vienna workshop in January 2001. The discussion focused on the following points:

- agreement on suggested reviewed preliminary indicators for further development;
- data availability/data quality at national level;
- feasibility of development of the proposed indicators;
- further data requirements/data gaps;
- recommendations.

Three indicators from this list were selected for the *Environmental signals 2001 Report* (EEA, 2001c). Data used in these fact sheets was obtained from a data request carried out in October 1999. Indicator fact sheets were published on the EEA web site[7].

So far, the EEA, with the support of the ETC on Soil, has collected information on the management of contaminated sites based on the 'best available' data. However, this approach, although allowing for the provision of timely information, has showed some limitations. For example, it may not help rationalise ongoing data collection and monitoring activities at the national and European levels, possibly covering subjects that are not needed, while resources should be better employed to fill data gaps in other priority areas (BTG, 1998).

In order to help streamline monitoring, assessment and reporting activities, a broader approach is required. In the long term, the objective is to focus on the 'best needed' data.

The concept is explained in Figure 2.2.

In the area of soil contamination, this shift should be obtained by building stronger links to policy needs, by focusing on the assessment of the environmental impacts of soil contamination and by undertaking a more detailed analysis in hot spot areas.

Table 2.4. **Preliminary hierarchical list of indicators**

DPSIR element	Indicator description
Driving forces / pressure	Soil polluting activities
State	Number of sites per impact level Impact of hazardous substances in soil
Impact	Incidents of groundwater impairment deriving from local soil contamination Impairment of drinking water supply in river basin districts
Response	Expenditures on remediation activities Progress in the management of contaminated sites Reused (reclaimed) contaminated land in relation to the consumption of green land

As a further step in the development of sound policy-relevant indicators for local soil contamination, a questionnaire was elaborated for the Vienna workshop 2001. The aims were to get information on data availability at national and regional levels and carry out a data collection at the national level. The analysis of the results of this questionnaire is presented below. This analysis is essential in the process of regular data collection and assessment and should generate specifications for the further development of the indicators.

6 DPSIR is an assessment tool used by the EEA. It stands for driving forces, pressures, state, impacts and responses.
7 http://themes.eea.eu.int/specific_media/soil/indicators

The questionnaire included a data request for the calculation of three indicators:

- soil polluting activities from localised sources;
- expenditures for remediation of sites;
- progress in management of contaminated sites.

Furthermore, several additional indicators were proposed and for which metadata information were requested:

- number of sites per impact level;
- impact of hazardous substances in soil;
- incidents of groundwater/drinking water impairment; and
- reuse of brownfields in relation to consumed green land.

The questionnaire was distributed to the EEA member countries and Switzerland before the workshop. By January 2002, 15 countries had replied: Austria, Belgium (Flanders), Denmark, Finland, France, Germany, Greece, Ireland, Iceland, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom.

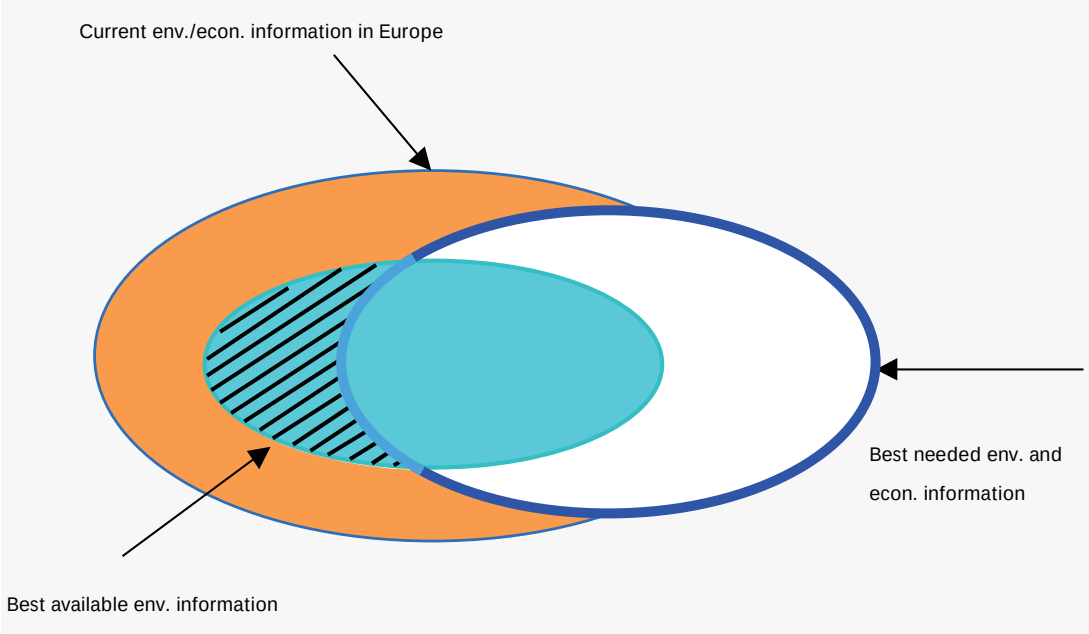
During the Vienna workshop 2001, the participants were asked to evaluate the indicators regarding their importance and data availability. The results are summarised in Annex I. A comparison with the questionnaire responses is provided in Table 2.5. A data request update was also included[8].

2.3. Data needs

The questionnaire distributed at the Vienna workshop 2001 was designed with the objective of obtaining an overview of the data availability at the national and regional levels and in selected regions. The analysis of the responses has provided information on data gaps and input for a regular data collection and assessment. On this basis, recommendations for future data collections have been proposed.

In the following sections, a background for the specific requirements of the questionnaire is provided for each of the proposed indicators.

MDIAR chain — getting from the best available information to the best needed information Figure 2.2.



Source: EEA.

8 On the basis of this data request, an EIONET pilot priority data flow was carried out in 2001 and extended to the new EEA countries in early 2002. The results are being reviewed by EIONET experts and are expected to be published in autumn 2002.

2.3.1 Impact of hazardous substances in soil

Information on the impact of hazardous substances on soil can be obtained through estimates on the total amount of the soil impacts and the potential of soil contamination. There is a wide spectrum of hazardous substances. However, the questionnaire focused on two main pollutants: chlorinated hydrocarbons (CHC) and mineral oil.

For these pollutants, the following parameters were investigated:

- estimation of the number of sites where local CHC and mineral oil contamination is expected;
- average extent of CHC/mineral oil impacts on soil per site due to industrial discharges.

2.3.2 Progress in the management of contaminated sites

The management of contaminated sites is a long process. The first step (inventory of potentially contaminating sources) is far advanced in most EEA countries. Further activities, such as detailed investigations and planning of remediation activities are slowly progressing and are at different levels of completion (see Table 2.3). So far, there is no information available on the progress of remediation activities with respect to total remediation needs (targets).

The progress in contaminated site management can be shown through a data collection updated on a yearly basis.

Data and estimates on the total number of sites were asked for according to the various investigation steps, respectively: total number of sites to be included in a preliminary survey, sites where preliminary investigation has to be carried out, where the main site investigation has to be performed and where remediation activities are necessary.

Furthermore, data on the current state of local contamination management corresponding to the defined process step were required:

- the number of sites currently included in preliminary surveys;
- the number of sites where preliminary and main site investigations have been completed;
- the number of sites where remediation activities are under progress; and
- the number of sites where remediation activities have been completed.

2.3.3 Incidents of groundwater/drinking water impairment deriving from local soil contamination

The leaching of hazardous substances to groundwater through the soil from point sources is a severe threat to the maintenance of drinking water supplies. In cases where drinking water supply systems are already affected, some measures should be taken to meet national and international water quality criteria. A progressive reduction of groundwater pollution has to be ensured and future pollution prevented (see: the water framework directive).

Information on the impacts of local soil contamination on public or private drinking water supply facilities can be assessed by knowing, for instance, the number of closed-down drinking water supply facilities or the costs of the installation of water treatment facilities as a consequence of local soil contamination.

2.3.4 Expenditures on remediation activities

Remediation costs largely depend on the legal background and local land regimes. Remediation activities usually require consistent amounts of money (public and private). However, country data cannot be compared directly because very often private expenditures for remediation activities are not known. Rather, country data gives an indication of the public awareness of the problem.

So far, several countries have already estimated the total amount of the annual expenditures for investigation and remediation of local soil contamination. In the questionnaire, an update of the estimated yearly expenditures was requested.

2.3.5 Reused (reclaimed) contaminated land (brownfields) in relation to the consumption of green land

At present, the pressure to build on 'green land' is relatively high. However, the intention to establish industrial or commercial enterprises on 'green land' is beginning to be more or less intensely counteracted through the implementation of national measures for the re-use of former industrial areas (brownfields). It is being recognised that, in order to achieve sustainable development, the re-use of former industrial sites should be supported against the further consumption of 'green land'. Therefore, information on the extent of brownfield areas and the potential for their re-use is of extreme interest.

In this context, brownfields can have the following characteristics:

- affected by former uses of the site and the surrounding land;
- derelict land or lack of usage;
- real or perceived contamination problems;
- situated in mainly or partly developed urban areas;
- intervention is required to re-establish the site for beneficial use.

Information on abandoned sites and consumption of 'green land' would be required to develop the proposed brownfield indicator:

- yearly amount of green land consumption due to construction purposes;
- total area of brownfields;
- annual increase of brownfields;
- number of houses built on brownfields; and
- other available characteristics.

2.4. Data availability — conclusions of the questionnaire on local soil contamination

The questionnaire distributed at the Vienna workshop 2001 was returned by Austria, Belgium (Flanders), Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom. A summary of the results is provided in the following sections, while a detailed analysis is included in Annex I.

2.4.1 Data availability of the required parameters

Table 2.5. provides an overview of the general availability of national data for the proposed indicators. The answers to the questionnaire are compared with the results of the workshop evaluation.

National data availability: results of the questionnaire and the workshop evaluation Table 2.5.

Draft indicator	Data availability	Importance	
	Questionnaire	Workshop evaluation	Workshop evaluation
Driving forces/pressures			
Soil polluting activities	–	high	high
State			
Impact of hazardous substances on soil	low	low	low
Number of sites by impact level	high to medium	high	high
Impacts			
Incidents of groundwater impairment deriving from local soil contamination	medium to low	medium	medium
Responses			
Expenditures on remediation activities	medium	medium	high
Progress in the management of contaminated sites	medium	high	high
Reclaimed contaminated land (brownfields)	low	low	medium

2.4.2 Impact of hazardous substances on soil

Data availability on the amount of hazardous substances in soil is generally low. Only five countries are able to estimate the number of sites where local CHC and mineral oil contamination are expected. At regional level and for selected regions, data availability is even lower (data is available in two and three countries respectively). Data on the average extent of CHC and mineral oil is only available for two countries.

2.4.3 Progress in the management of contaminated sites

Two categories of data were asked for in relation to the progress in the management of contaminated sites.

The first category comprises the total number of sites included in a systematic national register after a preliminary survey. In the questionnaire an update of this data was requested (see Table 2.6).

Data is available in almost all EEA member countries. In four countries (Austria, Denmark, Finland and Switzerland) no increase in the number of sites occurred in two different reference years. A significant increase in the estimated number can be observed in Belgium, in the region of Flanders. For the rest of the countries, no comparison is possible. But a consistent baseline for further data collection has been obtained.

In Table 2.7, the number of sites is compared with the number of inhabitants in each country. The ratio between the number of inhabitants and the number of sites shows that there is a correlation between these two parameters, with the exception of two countries, (Ireland and Spain).

In relation to the number of sites for which a preliminary survey was carried out, data availability is only medium to low at the regional level and for selected regions (see Annex I). The same applies to preliminary investigation, main site investigation and remediation activities where medium data availability is given at national level and low availability at regional level and for selected regions.

The second category of data requested comprises the number of sites per processing step. Availability of data on the current state of management of local soil contamination was investigated. Data availability is, in general, medium at national level. Data availability at regional level and selected regions is low.

Table 2.6. **Management of contaminated sites — number of sites included in national registers after a preliminary survey**

Country	Number of sites	Update	Reference year	Update
Austria	80 000	80 000	1999	2001
Belgium (Fl)	9 000	53 000	1999	2000
Denmark	30 000	30 000	1999	
Finland	25 000	25 000		1999
France		300 000–400 000		2000
Germany		362 000		2000
Greece		no data		–
Iceland		no data		–
Ireland		2 500		
Italy				
Liechtenstein	100	100 000	1999	
Netherlands	175 000	update available in 2004	1997	
Spain	18 142	data under consideration	1991	–
Sweden	22 000		2000	
Switzerland	50 000	50 000	1997	2000
UK		100 000		1996

Table 2.7. **Management of contaminated sites — number of sites included in national registers after a preliminary survey, compared to inhabitants**

Country	Number of sites	Inhabitants (million)	Inhabitants/ number of sites (1 000 inhabitants/ site)
Austria	80 000	8 083	101
Belgium (Fl)	53 000	5 927	112
Denmark	30 000	5 314	177
Finland	25 000	5 160	206
France	300 000–400 000	58 973	168
Germany	362 000	82 037	227
Greece		10 522	
Iceland		276	
Ireland	2 500	3 735	1 494
Italy	100 000	57 613	576
Liechtenstein	100	32	320
Netherlands	175 000	15 760	90
Spain	18 142	39 394	2 171
Sweden	22 000	8 854	402
Switzerland	50 000	7 124	142
UK	100 000	59 280	593

Table 2.8. **Number of sites where remediation activities have been completed**

Country	Number of remediated sites	Update	Reference year	Update
Austria	16	29	1999	2001
Belgium (Fl)		60		2000
Denmark	1 404	4 800	1999	2000
Finland	500	1 000		2000
France		466		2000
Germany	(3 000)		1998	
Greece		–		–
Iceland		1		2000
Ireland		–		–
Italy		500		2001
Liechtenstein	9		1999	
Netherlands	5 000	7 100	1997	2000
Spain	23	–		–
Sweden		200		2000
Switzerland		–		–
UK		–		–

Table 2.8. shows an update of the number of sites where remediation activities were completed.

Data on remediated sites is available in 11 countries. In four countries, data from two different years shows a significant increase of remediation activities and indicates a rapid progress in these countries. Austria achieved an 80 % increase, Denmark about 340 %, Finland 100 % and the Netherlands about 40 %. These data constitute a good baseline for further comparisons.

Table 2.9. provides the estimated number of sites where remediation activities are necessary, compared to the number of sites where remediation activities are already completed.

Data for the comparison of the number of sites where remediation activities are necessary, with the number of sites where remediation has been completed, is only available for five countries. A full assessment is therefore not possible; however, an analysis of the data available shows that only a small percentage of remediation activities is completed so far.

2.4.4 Incidents of groundwater/drinking water impairment deriving from local soil contamination

Information on events where impairment of drinking water supply facilities due to local soil contamination occurred, with the consequences of closing down the facilities or other adverse effects, was asked for public and private drinking water supply facilities. Data availability was in general low; only at national level is data available for public facilities in six countries. Also, the costs caused by the installation of water treatment facilities, as a consequence of local soil contamination, could not be indicated. Data is available only for two countries in selected regions.

Table 2.9. **Management of contaminated sites — estimated number of sites where remediation activities are necessary in comparison to remediated sites**

Country	Number of sites included in inventories where remediation is necessary	Number of remediated sites	Progress in remediation activities (%)
Austria	2 500	29	1.16
Belgium (Fl)	9 000	60	0.67
Denmark		4 800	
Finland		1 000	
France (*)	164	466	N/A
Germany		3 000	
Greece			
Iceland	2	1	N/A
Ireland			
Italy		500	
Liechtenstein			
Netherlands	60 000	7 100	12
Spain			
Sweden		200	
Switzerland			
UK			

N/A = not applicable.
(*) France: data collection has not been completed.

2.4.5 Expenditures on remediation of sites

An update of the estimation regarding annual expenditures for investigation and remediation of local soil contamination was asked for (see Table 2.10).

The data obtained was a good baseline for further comparison. At the regional level only four countries are able to give data on the expenditures and only one country holds data for selected regions.

National expenditures per inhabitant are provided in Table 2.11.

Yearly expenditures per inhabitant vary from EUR 0.4 to 35 across the surveyed countries. This wide range could indicate the different remediation efforts, but it might also be due to the fact that remediation expenditures in the private sector are unknown in most countries

Total expenditures for investigation and remediation per year at national level Table 2.10.

Country	Total expenditures (million euro)	Update (million euro)	Reference year	Update
Austria	67	75		2000
Belgium (Fl)	78.6	81		2000
Denmark		80		2000
Finland		30		2000
France		402		2001
Germany (*)	(57)			
Greece		–		–
Iceland		–		–
Ireland		–		–
Liechtenstein	0.33			
Netherlands (**)	550	550		2000
Spain	14	–		–
Sweden	23	25		2000
Switzerland		–		–
UK		1 450		1999

Total national expenditures for investigation and remediation per year and per inhabitant Table 2.11.

Country	Total expenditures (million euro)	Inhabitants (million)	Expenditures per inhabitant and year (euro)
Austria	75	8 083	9.3
Belgium (Fl)	81	5 927	13.7
Denmark	80	5 314	15.1
Finland	30	5 160	5.8
France	402	58 973	6.8
Germany (*)	57	82 037	0.7
Greece		10 522	
Iceland		276	
Ireland		3 735	
Liechtenstein	0.33	32	10.3
Netherlands (**)	550	15 760	34.9
Spain	14	39 394	0.4
Sweden	25	8 854	2.8
Switzerland		7 124	
UK	1 450	59 280	24.5

(*) Total expenditures for Germany are projections from data from some *Länder*.
(**) Expenditures in the Netherlands are partly estimated.

2.4.6 .Reused (reclaimed) contaminated land (brownfields) in relation to the consumption of green land

Data availability on brownfields is, in general, very low in all countries. Two countries are able to give information on the yearly consumption of 'green land' for construction purposes. The total area of brownfields is only known in one country. Two countries indicated other characteristics for brownfield problems. On the other hand, there is no data available on any of the other questions such as the annual increase of brownfield areas, data characterising the amount of brownfield problems or the number houses built on brownfields per year.

2.5. Analysis of details regarding indicator feasibility

At the Vienna workshop 2001, most of the country representatives commented on the proposed indicators for local soil contamination and on the national availability of data. It was concluded that different approaches are used for national data collections. Each country has established some kind of data collection and monitoring system according to country capacity. There seem to be two sets of data available:

- core set (e.g. number of sites);
- a variety of data from various other data sources which are not always available at the national level; availability often reflects national priorities on environmental matters.

The participating countries evaluated each proposed indicator in relation to its importance and data availability (see Annex I). The evaluation on the proposed indicators resulted in the identification of a short list of four indicators linking a high degree of environmental and policy relevance with feasibility for providing data:

- soil polluting activities;
- number of sites by impact level;
- progress in the management of contaminated sites;
- expenditures on remediation activities.

The data availability which has been indicated corresponds quite well with the perceived importance of the indicators (see Table 2.5). The indicator 'incidents of ground wate/drinking water supply impairment deriving from local soil contamination' was ranked medium both in availability and importance. Data availability for the brownfield indicator was classified as low whereas the importance of this indicator was considered medium. This indicates the need for further development in brownfield issues. The lowest ranking both for importance and data availability was given to the indicator on the 'impact of hazardous substances in soil'.

Specific comments on the various indicators were made in the country statements provided at the Vienna workshop 2001. Additionally, some countries provided comments in the responses to the questionnaire. The UK and the Netherlands, for example, recommended further development of indicators on the 'number of sites', the 'progress in the management of contaminated sites' and the 'expenditures on remediation activities'. A summary of the country statements is provided in the following sections.

2.5.1 Impact of hazardous substances on soil

The UK stated that the 'impact of hazardous substances on soil' is not an indicator of impact but a measure of the load on the soil (i.e. pressure indicator). Since only two classes of contaminants are covered (CHC and mineral oil) the total pressure is not indicated. Furthermore, no account is taken of the size of the site. It is also not clear whether only existing contamination or already remediated sites too should be included .

Several countries do not distinguish between CHC and mineral oil, so estimations on hydrocarbons are done as a whole. In Denmark, for example, reporting does not distinguish between petrol and oil products. Finland could only provide rough estimates and it would take time to collect background data. Some countries can deliver data only for selected regions.

2.5.2 Progress in the management of contaminated sites

Denmark remarked that the kind of sites to be included is not clear. For example, it is unclear whether or not petrol stations are also included. The terms 'has to' and 'necessary' must be specified more precisely

(the number included in public investigation programmes or also other sites; what kind of activities — according to present use or potential future use?).

The UK suggests an overall indicator that somehow assesses the number of sites that had been remediated to an acceptable standard for their use. More detailed stages of the process could introduce double counting of sites, depending on how often information was collected and updated.

2.5.3 Incidents of groundwater/drinking water impairment deriving from local soil contamination

The UK stated that this indicator is probably good for drinking water quality, but it is not comprehensive for contaminated sites. Risk to human health or to terrestrial ecosystems could arise from the contamination of other receptors, not only through the impairment of drinking water quality.

Denmark recommended clarification of the definition of the size of supply facility, the reason for the differentiation between private and public wells and why, for example, the costs of moving the water supply facilities to another area are not considered. The Netherlands supports the idea of covering private and public water supply facilities.

In general, it is apparently quite difficult to collect data on this issue, especially for private drinking water supply facilities.

Ireland stated that in some areas natural background levels of some heavy metals will cause drinking water quality standards to be exceeded. In these cases it is not possible to distinguish between natural and anthropogenic contamination.

2.5.4 Expenditures on remediation of sites

In several countries, estimates of expenditures on remediation activities are based on data for the public sector and public/private partnership investment (e.g. Finland, Germany and the UK). Estimates of private expenditures are often not included since the 'polluter-pays' principle is applied. On the other hand, in some countries (e.g. Belgium (Flanders) and Denmark) data on private expenditures is also available. As a consequence, the total expenditures can vary considerably from one country to another.

2.5.5 Reused (reclaimed) contaminated land (brownfields) in relation to the consumption of green land

Very little data is available on brownfields. In some countries, data collection on brownfields is ongoing (e.g. Belgium (Flanders)). In particular, Germany emphasised the need to further develop this indicator.

2.5.6 Soil polluting activities from localised sources

Importance and data availability of this indicator were considered high. Some work has already been carried out in many countries. Finland would appreciate a more detailed classification of industrial branches if 'key pollutants' of the various activities were to be investigated. In Denmark, no clear distinction between municipal and industrial waste disposal is possible.

2.6. Follow-up

Data availability on the 'impact of hazardous substances on soil' is quite low according to the answers to the questionnaire. Estimates on the amount of CHC and mineral oil contamination is not possible in two thirds of the countries. Moreover, the importance of this indicator was considered low.

Data for the indicator 'progress in the management of contaminated sites' seems to be easily available. The indicator was valued as very interesting and should be further developed. Good data availability has been stated mainly for the investigation steps. An estimate of the number of sites can be figured out in most of the countries. On the other hand, the current state of contaminated site management confirmed only medium data availability. However, a projection from data of selected regions should be possible if no data are available at the national level.

For the indicator 'incidents of groundwater/drinking water impairment derived from local soil contamination' only medium to low data availability can be observed. Only one or two countries can provide comprehensive information.

Although information on this indicator is scarce, it is of prior importance. In connection with Annex II of the water framework directive, a description of the impacts and pressures on the water bodies, also including point sources, is required.

About half of the 15 countries could estimate the total costs for remediation activities. Data deriving from previous questionnaires combined with data gained through the most recent data collection form a sound data pool for further assessment. For some countries it is difficult to collect data on clean-up costs for the private sector.

Concerning the brownfield issue, it is apparently very difficult for the countries to provide data. This was also confirmed during the Vienna workshop 2001. As the importance of the indicator was considered as medium, further development should be considered in the future.

In relation to the indicator 'soil pollution activities', the prevention of soil pollution from current activities should be included in addition to historic contamination. In this regard, the IPPC directive should be considered in the development of indicators, since its implementation could have direct effects on soil pollution sources.

Priority data flows

The work on soil indicators is now integrated within the broader activity of development of indicators for the terrestrial environment carried out with the support of the ETC/TE. Major progress so far has been the establishment of pilot priority data flows on soil contamination in 2001, extended to the new EEA countries in spring 2002. The results were encouraging: 23 countries responded.

The priority data flows on soil contamination from localised sources are partly an answer to the requests for a more systematic data collection made by the EIONET partners at the Vienna workshop 2001. Regular annual deliveries are requested on a limited set of national data at this early stage of development and in particular on:

- percent contribution of localised sources to soil contamination (soil polluting activities);
- annual public expenditure on remediation of contaminated sites;
- progress in the management of contaminated sites.

On the basis of the results of the pilot data flows, updated fact sheets for the related indicators were produced. The fact sheets are currently under review by EIONET and will be used, among other reports, for the preparation of the pan-European state-of-environment report being prepared by the EEA for the pan-European conference of the environment ministers, to be held in Kiev in 2003.

3. Indicators for soil contamination from diffuse sources

3.1. Background information

Soil contamination from diffuse sources or 'diffuse soil contamination' was considered by the EEA and EIONET as one of the four main soil degradation patterns to be covered by the European soil monitoring and assessment framework (EEA, 2001a,b)[9].

The range of processes summarised by the term 'diffuse soil contamination' often varies. In order to avoid misunderstandings, the term 'diffuse contamination' should be clearly defined.

'Diffuse soil contamination' is, in general, considered as contamination of the soil by substances in a diffuse spatial distribution, originating from sources such as deposition of emissions from the air produced by industry, transport, households or agriculture or from direct applications of those substances on to the soil, as, for example, in agricultural management (fertilisers, pesticides, compost and sewage sludge). The sources of diffuse soil contamination cannot be clearly identified and, in most cases, soil contamination originates from several sources.

Within the European soil monitoring and assessment framework, the term 'diffuse soil contamination' is used for a relatively wide range of processes including contamination by inorganic trace elements, organic compounds or radioactive substances, nutrient load (eutrophication) and acidification.

Work on diffuse soil contamination is at an early stage and just a few results have been achieved so far. In the last EEA state-of-environment report (EEA, 1999a), an assessment of the sensitivity to acidification and lead availability of European forest soils was included, together with an assessment of nutrient load on agricultural soil, which used the indicator 'phosphorus surplus per administrative region'.

In the report *Down to earth: soil degradation and sustainable development in Europe* (EEA, 2000), the results of a preliminary study of hot spots of soil degradation in Europe were analysed. This study included two maps on probable problem areas of diffuse contamination and exceedences of critical loads for acidification and eutrophication. For the EU-15, the first map uses data on the intensity of agricultural chemical use indicated by fertilisers, pesticides and nitrogen production. For central and eastern Europe, approximate locations and areas of diffuse contamination including hydrocarbons and radioactive contamination are identified. The second map shows the number of exceedances of acidifying and eutrophying depositions from the air.

Acidification through deposition from the air is an ongoing problem, but it is not expected to increase further in western Europe due to the success of policies developed over the past 30 years. However, soils under severely acidified conditions are difficult, if not impossible, to rehabilitate. In central and eastern European countries, the problem may still worsen before improving. Acidification is mainly occurring in north-western and central Europe (EEA, 2000).

A few environmental indicators relevant to soil are also available in indicator-based reports from other international organisations (e.g. Eurostat, OECD). These indicators, however, mainly address driving forces (e.g. road network density, area with organic farming as percentage of the total agricultural area) and pressures (e.g. livestock units per unit area of agricultural land, average pesticide consumption per unit area of agricultural land) affecting soil contamination or other soil degradation

9 The recent European Commission communication on soil protection includes diffuse soil contamination as one of the major threats to Europe's soils (European Commission, 2002).

patterns. Hence, more efforts are necessary to develop indicators to cover the state, impacts and responses related to diffuse soil contamination.

According to the EEA reporting strategy, the assessment of soil degradation should be mainly based on the development of indicators using comparable, targeted and reliable data sets from harmonised soil monitoring networks and other data sources. Trends can be identified through the comparison of harmonised data contained in earlier inventories, considering a special time reference and other reference values. In particular, for the assessment of diffuse soil contamination, the data used should be representative of the monitoring sites, the soil group or the land use, depending on the individual issue. The assessment should be done according to policy-relevant concerns and should be based on up-to-date technical knowledge.

The development of indicators is a long-term, iterative, learning-based and participatory process (see Figure 1.2), which takes stock, at each iteration, of the experience gained in the previous steps. On the basis of identified requirements for the indicators, indicator feasibility in terms of data availability and data quality is evaluated in collaboration with EEA member countries.

As the EEA is required to report on the state of the environment on a regular basis, for which timely information is needed, a short-term approach for the development of indicators is also necessary.

Concerning diffuse contamination, the EEA has elaborated some indicators on a short-term basis in order to fulfil its reporting requirements (see results mentioned above). For the long-term approach, a first step was taken by drafting a proposal for a European soil monitoring and assessment framework. This approach seems to be suitable for providing the necessary information for soil indicator development. In the long term, the frame conditions described in Figure 3.1 should be taken into account.

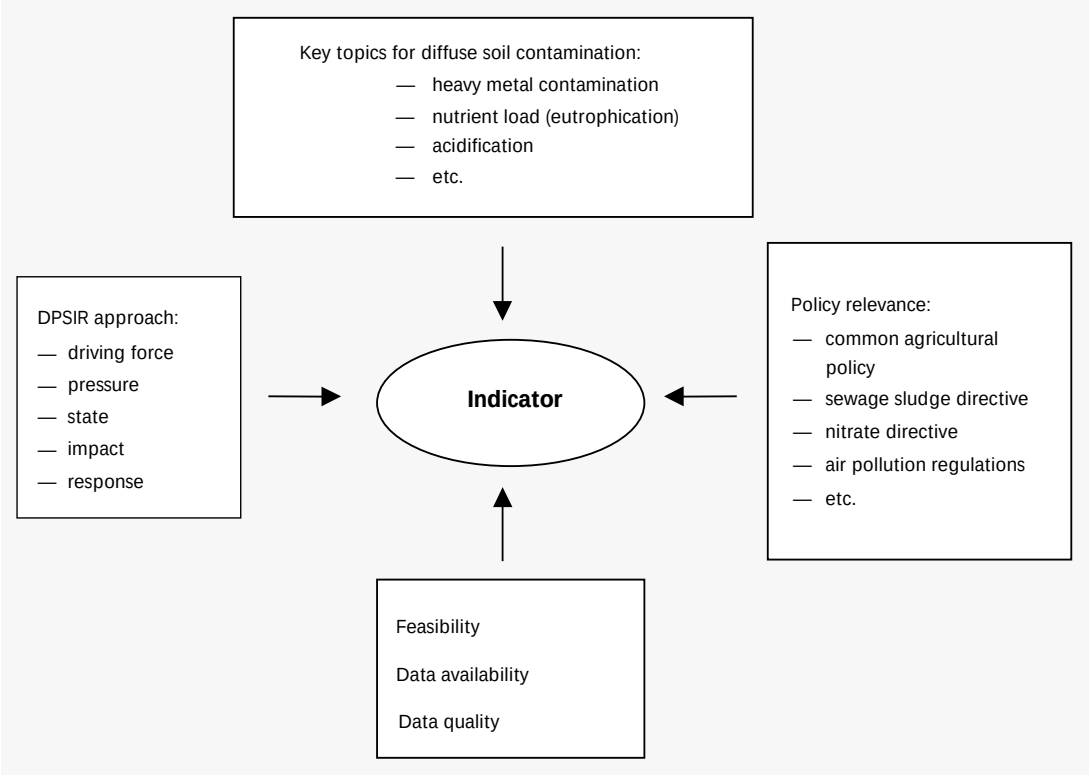
For the identification and development of indicators, the DPSIR approach is a very useful tool[10]. The DPSIR framework applied to diffuse soil contamination is shown in Figure 3.2.

3.2. Selection of suitable indicators

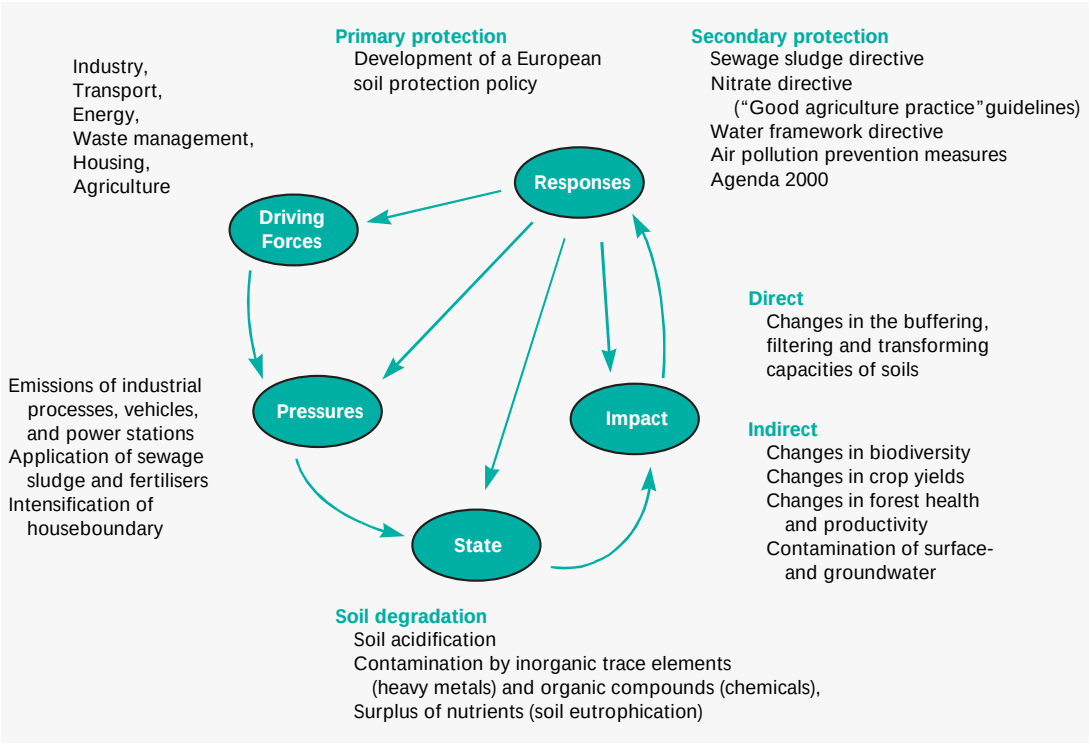
As mentioned above, the process of selecting suitable indicators developed by the EEA is an iterative process (Figures 1.2 and 3.3). It starts with the definition of an initial list of possible indicators. For diffuse soil contamination, a first tentative list was included in the proposal for a European soil monitoring and assessment framework (EEA, 2001a). On the basis of the frame conditions for developing indicators (see Figure 3.1.), this list has been reviewed and an additional list of possible indicators has been elaborated. The result is a comprehensive list of possible indicators, as shown in Annex III. This list contains indicators which could be calculated using data held in European databases (e.g. held by Eurostat or the OECD) and 'new' indicators for which national data should be collected. These indicators were screened to identify priority indicators (in bold letters, in Annex III), classified according to the DPSIR scheme. A hierarchical list of relevant indicators proposed for further development was the final result.

10 DPSIR is an assessment tool used by EEA. It stands for driving forces, pressures, state, impacts and responses.

Important impacts on the selection and development indicators for diffuse soil contamination Figure 3.1.



DPSIR framework applied to diffuse soil contamination Figure 3.2.



At the Vienna workshop 2001, the proposed 'new' priority indicators (not available from European databases) were introduced to the participants.

In order to get a clearer picture on the importance and feasibility of the proposed indicators for diffuse soil contamination, the participants were asked to evaluate the

feasibility and the relevance of the indicators included in the list during the workshop.

Based on the result of the workshop evaluation, the indicators considered to be of high and upper medium priority were selected for further development (in bold letters in Table 3.1).

A questionnaire on data availability was distributed to the EIONET partners. The following sections describe in more detail the content of the questionnaire and summarise the results obtained.

3.3. Data needs

In the following sections, background information is provided for each of the proposed indicators, together with the description of the specific data needs.

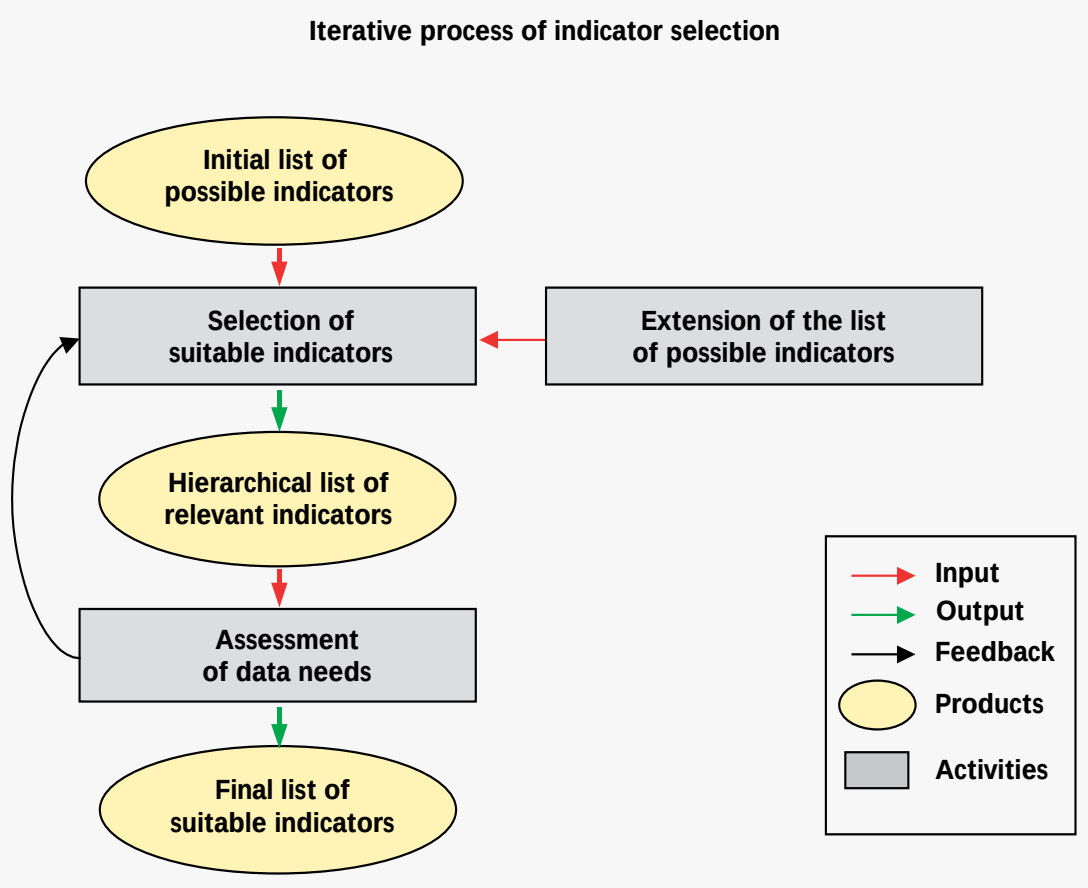
3.3.1 Lead emission due to exhaust gas by road vehicles

Vehicle exhaust emission is one of the main sources of airborne lead. As a consequence of dry and wet deposition, contamination of lead in topsoil is very high in areas with high traffic densities.

In the last decade, increasing environmental awareness and knowledge about the presence of lead causing potential health damages induced consumers and the economy to change to unleaded fuel. So far, the number of cars using leaded fuel has decreased significantly in most European countries. Leaded petrol is expected to be completely phased out in the EU by 2005.

However, in some countries leaded petrol still causes environmental problems and considering that lead is a less mobile heavy metal in soils, this indicator can be used to highlight areas being affected from traffic pollution, particularly in the past.

Figure 3.3. **Iterative process of indicator selection**



The parameters required to calculate this indicator are the consumption of petrol containing lead and the lead content of the petrol. In order to calculate past trends, data time series are needed. The calculation by direct multiplication of both parameters assumes that all lead contained in the used petrol is emitted and deposited in the soil

3.3.2 Sewage sludge application per unit area of agricultural land

Sewage sludge is the residual product of wastewater treatment plants. It is used in agriculture as a fertiliser, but it can contain heavy metals, micro-organisms and a range of hazardous organic substances. The amount of sewage sludge which is not used in agriculture is disposed of in landfills or incinerated.

Table 3.1. **Selected indicators for diffuse soil contamination ('new indicators' are in bold)**

Issue or question	Proposed indicator	Priority class	Importance of indicator (No of preferences)	Feasibility class	Feasibility of indicator (No of preferences)
	Driving forces				
Development of agriculture	Percentage of the utilised agricultural area under agri-environmental measures following Regulation No 2078/92	M	4	M	3
	Pressures				
Influence of infrastructure, traffic and transport	Lead emission due to exhaust gas by road vehicles	M	4	M	3
	Average pesticide consumption per unit area of agricultural land	H	8	L	2
	Fertiliser consumption per unit area of agricultural land	M	4	M	5
Intensity of agriculture	Sewage sludge application per unit area of agricultural land	H	8	H	11
	State				
How many sites show trace element contents over nationally used thresholds (geogenic or anthropogenic enrichment)?	Exceedances of critical limits (thresholds) of heavy metal contents in soils by land use (agricultural land, grassland, forests)	H	5	M	4
Heavy metal contamination of agricultural land	Heavy metal balance (e.g. Pb, Cd, Cu) in agricultural land	H	10	M	3
Nutrient loads (eutrophication) on agricultural soils	N-balance for agricultural land	M	4	M	3
Depletion of humus in soils	Organic carbon (humus) content in topsoil by land use	H	8	M	3
	Impacts				
Changes in biodiversity	Occurrence of key species in soils	H	6	L	2
Changes in forest health	Assessment of forest crown conditions	M	4	M	5
Changes in crop quality	Crop quality (Exceedance of critical levels of heavy metal content for food quality in crops)	M	4	L	2

Note: The scoring criteria are explained in the Vienna workshop proceedings (EEA, 2002a).

Data on the amount of sewage sludge used in agriculture and its average content of heavy metals provides an indication of the extent of arable land potentially contaminated with heavy metals due to sewage sludge application. In the last decades, the production of sewage sludge has shown a steady increase. Meanwhile, several countries have already undertaken successful efforts to improve the quality of sewage sludge. In relation to the assessment of diffuse soil contamination in agricultural land, this indicator complements the proposed indicators on 'the average amount of pesticides and fertilisers used per unit area of agricultural land'.

The datasets necessary for the calculation of this indicator are the area of arable land treated with sewage sludge and the amount of sewage sludge used in agriculture (classified according to different sewage sludge quality classes). In order to make this indicator more precise, data on the average heavy metal content of the sewage sludge used in agriculture is necessary, preferably for each quality class separately. As a further step it would also be important to consider the content of organic pollutants in sewage sludge.

In relation to the amount of sewage sludge spread on agricultural land, an estimate could be made by calculating the total amount of sewage sludge produced minus the amount being incinerated, landfilled and disposed of in other ways.

3.3.3 Exceedances of critical limits of heavy metal content in soils by land use; alternative: ratio of heavy metal content in topsoil and subsoil

The content of heavy metals in soils is an important aspect to consider in the assessment of soil quality. In this respect, land use has a great influence on the dynamic of soil processes and the sensibility of soils to heavy metal contamination. Therefore, this indicator should be disaggregated by land use (arable land, grassland and forest). The content of heavy metals will provide key information on to what extent topsoil exceeds national reference or threshold values, without considering whether this is due to geogenic or anthropogenic enrichment.

Some countries have high background (natural) levels of heavy metals (e.g. the Scandinavian countries) and therefore a high content of heavy metals in topsoil does not necessarily indicate a contamination of anthropogenic origin. An alternative method is therefore suggested, considering the ratio of heavy metal contents in topsoil and subsoil. Sites with a ratio below 1 show a geogenic enrichment, whereas sites with a ratio clearly above 1 point out influences from anthropogenic sources[11].

The datasets necessary to calculate this indicator are the content of heavy metals in topsoil and subsoil as well as information on the national reference or threshold values. Furthermore, information on the analytical methods used would provide a basis for a better interpretation of the results obtained.

3.3.4 Heavy metal balance in agricultural land

The key dataset for this indicator is the heavy metal surplus in agricultural soils. Taking into account that soil changes are very slow over time, the proposed indicator would provide a much easier way, with possibly a much higher degree of accuracy, to highlight agricultural areas with a potential risk of heavy metal pollution.

In order to calculate the inputs of heavy metals on agricultural soils, data on the heavy metal loads by airborne deposition, the amount of sewage sludge, fertiliser or solid organic waste applied to agricultural soil and their average heavy metal contents have to be considered. The deposition of heavy metals can either be estimated by direct measurements of wet and dry deposition or indirectly by analysing the heavy metal content in mosses and drawing a conclusion on the occurring deposition rates. To calculate the removals, data on the average heavy metal contents in the harvested crop or grass and the rates of leaching would be needed.

11 A lower content of heavy metals in the topsoil as compared to the subsoil (ratio below 1) indicates that the origin of the 'contamination' is generally in the parent material. But this does not exclude the fact that diffuse contamination can happen to some extent (e.g. if leaching of heavy metals in acid soils occurs).

3.3.5 Organic carbon (humus) content in topsoil by land use

Since soil quality is largely dominated by its humus content, this indicator is considered to be of high relevance for sustainable soil management. The content of humus is dynamic and responds rapidly to changes in soil management. A decline in humus content will affect soil structure and soil stability, water holding capacity and buffering capacity of soils, biological activity and the retention and exchange of nutrients and contaminants. In the medium and long term, the humus depletion may be responsible for a higher vulnerability of soils to erosion, compaction, acidification, nutrient deficiency, release of contaminants and drought.

Moreover, soil organic carbon has an important role in combating climate change (EEA, 2000).

Therefore, this indicator is not only useful in assessing diffuse soil contamination, it is also relevant for the assessment of soil quality in general.

The calculation of this indicator requires data on the content of organic carbon or humus content in topsoil with detailed information on the analysed soil depth and the analytical method used.

3.3.6 Occurrence of key species in soils

This indicator is based on a biological classification concept for the assessment of soil quality. The concept uses the potential soil fauna community of certain ecotypes for the assessment. Changes in the natural soil conditions, due for example to soil contamination, are expected to have an effect on the occurrence of key species in soils depending on their specific sensitivity to certain soil parameters.

This indicator requires the identification of the key species related to different ecotypes under natural conditions and the ecotype classification of the area. If the actual soil fauna community is investigated, the deviation from the potential soil fauna community can be assessed. The degree of deviation can be used as an indicator for changes in soil conditions.

At the moment, the process of identification of the key species of the potential soil fauna communities is at the status of research going on in selected sites in some countries. Earthworms and macropodes can be initially used as characterising communities, but other fauna groups are more sensitive to changes in soil conditions. First results of cluster analysis in Germany showed that changes of pH value and carbon/nitrogen (C/N) ratio are important parameters related to the occurrence of key species. In the long term, this indicator can provide a very useful tool for the assessment of soil degradation.

3.3.7 Exceedances of critical levels of heavy metal content for food quality in crops

Diffuse soil contamination affects food quality of crops. Several studies showed that mobile heavy metals (e.g. cadmium) are taken up by plants from the soil solution and are stored in different parts of the plants (roots, leaves, seeds). Additionally, heavy metals can be incorporated into plants by surface deposition.

For the calculation of the exceedances of established (national) thresholds, information on the content of certain heavy metals in different kinds of crops is needed. In order to use this indicator for the assessment of diffuse soil contamination in a certain area, it is necessary that crop samples are taken directly from the field, so that no further contamination by transport or other production processes is possible.

3.4. Data availability — conclusions of the questionnaire on diffuse soil contamination

The questionnaire related to indicators for diffuse soil contamination was distributed to all principal contact points for soil of the 18 EEA member countries, the national focal points of the candidate countries and Switzerland. Completed questionnaires have been received from 19 countries (12 EEA member countries, Switzerland and six candidate countries). A detailed analysis of the responses is provided in Annex II.

The country positions of Portugal and the United Kingdom on the selected indicators were derived from the statements given at the workshop.

Table 3.2. **National data availability, policy relevance and indicator feasibility**

Selected indicator	Policy relevance	Data availability	Feasibility
Pressure			
Lead emissions due to exhaust gas by road vehicles	low	very high	high
Sewage sludge application per unit area of agricultural land	medium to high	high	medium to high
State			
Exceedances of critical limits of heavy metal content in soils by land use	high to medium	high	Medium
Heavy metal balance in agricultural land	high	high to low	Low
Organic carbon in topsoil by land use	low to high	very high	High
Impact			
Occurrence of key species in soils	medium	very low	very low
Exceedances of critical levels of heavy metal content for food quality in crops	high	medium to low	low to medium

In order to provide an overview of the results of this consultation, the answers to the questionnaire are summarised in Table 3.2.

3.4.1 Policy relevance of the proposed indicators

Table 3.3 provides an overview on the policy relevance of the selected indicators derived from the responses to the questionnaires. More than half of the countries responding on the subject considered that the following two indicators are highly relevant:

- heavy metal balance in agricultural land;
- exceedances of critical levels of heavy metal content for food quality in crops.

The indicators 'sewage sludge application per unit area of agricultural land' and 'exceedances of critical limits of heavy metal contents in soil by land use' or alternatively the 'ratio of heavy metal content in topsoil versus subsoil' were almost equally regarded as highly or medium relevant.

Country opinions on the relevance of the indicators 'organic carbon content in topsoil by land use' and 'occurrence of key species in soils' are different and the preferences are more or less balanced between low, medium and high.

Since the selling of petrol containing lead will be forbidden in the whole EU soon and many European countries have already changed to unleaded petrol several years ago, the pressure indicator on 'lead emission due to exhaust gas by road vehicles' was considered of low importance for the countries.

Compared with the workshop evaluation (Table 3.1) the results of the questionnaires are quite different, although it must be considered that the questionnaire consultation included more countries.

As a result of the comparison, it can be stated that four indicators ('lead emission due to exhaust gas by road vehicles', 'sewage sludge application per unit area of agricultural land', 'organic carbon content in topsoil by land use' and the 'occurrence of key species') have now been assessed as less relevant[12]. The impact indicator on crop quality, which was suggested at the workshop the first time, was considered more important than it was at the workshop. The evaluation of the relevance of the two other indicators, focused on the state related to contamination by heavy metals, remained the same.

3.4.2 National data availability related to the selected indicators

A general overview of the national data availability of the required parameter for the selected pressure, state and impact indicators is shown in Tables 3.4. to 3.6. The temporal and spatial coverage of the data and the reporting frequency are considered in Chapter 3.4.3.

Pressure indicators

The required parameters of the two pressure indicators are available in most of the countries, but for some countries the area of arable land treated with sewage sludge can only be estimated by considering the maximum amount of sewage sludge allowed for application.

State indicators

More than half of the countries have established critical limits of heavy metal content in soil. In at least 11 countries (eight EEA member countries and three candidate countries) the content in soil of lead, cadmium, mercury (Pb, Cd, Hg) and other heavy metals, mostly copper, nickel and zinc (Cu, Ni, Zn), would be available to calculate the exceedances of critical limits of heavy metals in soils.

Although the heavy metal balance was most frequently classified as an important indicator, the national data availability for all the required parameters shows several gaps. Only the Czech Republic, Latvia, the Netherlands, Norway and Poland have data available for all the required parameters on the heavy metal balance for at least one heavy metal. Data gaps mainly exist for the outputs of heavy metals from soils and less frequently for the deposition rates of heavy

12 This evaluation does not seem to be in accordance with the recent Commission communication on soil protection, which identifies the loss of organic matter as an important threat to Europe's soils and a priority for action (European Commission, 2002). The development of indicators on content of soil organic carbon and on sewage sludge use in agricultural land would be very relevant in policy terms.

metals on soils. Besides, data on the input of heavy metals on soils are rather scarce and scattered in a few countries.

As for the third selected state indicator on the 'organic carbon content in topsoil by land use', it can be summarised that almost all countries reported a national availability of data to some extent.

Impact indicators
The national data availability of the parameters for the selected impact indicators is generally medium or low. In case of the 'occurrence of key species in soils' only Latvia and the Netherlands could provide data at the country level. A few other countries have some data available on this issue, but most have no data available.

For the second impact indicator 'exceedances of critical levels of heavy metal content for food quality in crops' the data availability is higher. The exceedances for lead and cadmium could be calculated for half of the countries which provided information on that indicator, whereas more than half of the countries did not provide any information for mercury or other heavy metals. It can be stated that in most of the candidate countries which responded to the questionnaire, data is available for the required parameters.

3.4.3 Analysis of data spatial and temporal coverage and other data aspects regarding indicator feasibility

Responses on temporal and spatial coverage of the data, reporting frequency and the expected date of data delivery were also provided, as well as some information on availability in international data sources (see Annex II for more detail).

In order to estimate the feasibility of the indicators, the responses were analysed and compared with the evaluation given by the country representatives at the Vienna workshop 2001 (see Table 3.3). It has to be considered that the responses cover a higher number of countries than those present at the workshop.

Lead emission due to exhaust gas by road vehicles
According to the questionnaire responses, it seems feasible to calculate the indicator for most of the countries (with available data) for the last decade on a yearly basis, but only at the national level. For a few countries, data are available just for the last few years. The calculation of the indicator, which seems more feasible than expected by the country representatives present at the workshop, could be already done in 2002.

Table 3.3. **Policy relevance of indicators**

	Pressure indicators		State indicators			Impact indicators	
Indicator ⇒			**Exceedance of critical limits (thresholds) of heavy metal contents in soils related to different land use (agricultural land, grassland, forests); alternative: ratio of heavy metal content in topsoil versus subsoil**	**Heavy metal balance (e.g. Pb, Cd, Cu) for agricultural land**	**Organic carbon or humus content in topsoils related to different land use**		**Exceedance of critical levels of heavy metal contents for food quality in different crops**
Country ⇩	**Lead emission due to exhaust gas by road vehicles**	**Sewage sludge application per unit area of agricultural land**				**Occurrence of key species in soils**	
Austria	low	high	medium	high	medium–low	medium	high
Belgium (Flanders)	low	medium	–	high	–	–	high
Denmark	low	low	medium	medium–high	low	medium	medium
Finland	low	high	medium	high	medium	low	medium
France	medium	high	medium	medium	high	low	low
Germany	no national relevance	–	high	medium	medium	medium	medium
Greece	medium	medium	high	high	low	high	high
Ireland	low	–	–	–	–	–	–
Italy	high	medium	medium	high	high	low	–
Netherlands	low	low	medium	high	medium	high	high
Norway	low	medium	low	medium	medium	medium	medium
Portugal (*)	–	–	–	–	–	–	–
Spain	low	medium	high	high	low	high	high
Switzerland	low	–	high	high	low	–	–
United Kingdom (*)	–	–	–	–	–	–	–
Albania	–	low	–	–	high	–	–
Bulgaria	high	high	high	high	medium	high	high
Czech Republic	high	medium	–	high	low	–	–
Latvia	high	high	high	high	high	medium	high
Poland	medium	high	low	low	low	–	low
Slovak Republic	medium	medium	high	medium	high	–	high

(*) Information is derived from the statements given at the Vienna workshop 2001.

Table 3.4. **National data availability — pressure indicators**

Required parameter ⇒ Country ⇓	Consumption of petrol containing lead	Lead content in petrol	Amount of sewage sludge used in agriculture (by sewage sludge quality classes)	Area of arable land treated with sewage sludge
Austria	yes	yes	yes	yes (can be estimated)
Belgium (Flanders)	yes	yes	yes	yes
Denmark	yes	yes	yes	yes
Finland	yes	yes	yes (not according to qualities)	–
France	yes	yes	yes	yes
Germany	yes	–	only data in the framework of existing EU reporting	–
Greece	yes	yes	no	no
Ireland	yes	yes	yes	yes
Italy	yes	yes	no	no
Netherlands	yes	yes	no (s. sl. is not applied)	no (s. sl. is not applied)
Norway	yes	yes	yes	can be estimated
Portugal (*)	(yes)	(possibly available)	(possibly available)	(possibly available)
Spain	no	–	yes	yes
Switzerland	yes	yes	yes	yes
United Kingdom (*)	(no)	(no)	(yes)	(yes?)
Albania	–	–	no	no
Bulgaria	yes	yes	yes	yes
Czech Republic	yes	yes	yes (assessment)	not complete
Latvia	yes	yes	yes	yes
Poland	yes	yes	yes	yes
Slovak Republic	yes	yes	yes	yes

(*) Information is derived from the statements given at the Vienna workshop 2001.

Table 3.5. **National data availability — state indicators**

Indicator	Exceedances of critical limits of heavy metal content in soils by land use (agricultural land, grassland, forests); or ratio of heavy metal content in topsoil versus subsoil	Heavy metal balance (e.g. Pb, Cd, Cu) for agricultural land	Organic carbon or humus content in topsoil by land use

Required parameter ⇒ Country ⇓	Critical limits of heavy metal content in soils by land use (agricultural land, grassland, forests)	Content of Pb in soils by land use (topsoil and subsoil)	Content of Cd in soils by land use (topsoil and subsoil)	Content of Hg in soils by land use (topsoil and subsoil)	Content of other heavy metals in soils by land use (topsoil and subsoil)	Amounts of heavy metal in materials applied to soils (e.g. sewage sludge, fertilisers, composts)	Average heavy metal content in materials applied to soils (e.g. sewage sludge, fertilisers, composts)	Deposition rates of heavy metals on soils	Outputs of heavy metals from soils	Content of organic carbon in topsoil
Austria	yes	yes	yes	yes	yes	s.s.: yes; fertil. yes; comp: rough estimations	s.s.: yes; fertil: yes; comp: difficult access	yes	no	yes
Belgium (Flanders)	yes	no	no	no	no	yes	yes	yes	no	yes
Denmark	yes	yes	yes	yes	yes (As, Cu, Cr, Ni, Zn)	–	yes	yes	no	yes
Finland	–	yes	agric.: soon; forest: yes	yes	agric.: soon; forest: yes	–	–	–	–	yes
France	probably	probably	probably	probably	probably	yes	yes	yes	no	yes
Germany	yes (generic soil values)	yes	yes	yes	yes	some data	yes	no	some sites	some data
Greece	no	no	no	no	no	scarce and scattered data	–	no	no	data from the soil maps (forestry and agri. land)
Ireland	yes	yes	yes	yes	yes (Cu, Ni, Zn)	s.s.: yes; fertil. yes; comp: no	no	no	no	yes
Italy	yes	yes (not complete)	yes (not complete)	yes (not complete)	yes (not complete)	no (only averages for fertilisers)	no	no	no	yes

Table 3.5. **National data availability — state indicators**

Indicator	**Exceedances of critical limits of heavy metal content in soils by land use (agricultural land, grassland, forests); or ratio of heavy metal content in topsoil versus subsoil**					**Heavy metal balance (e.g. Pb, Cd, Cu) for agricultural land**				**Organic carbon or humus content in topsoil by land use**
Required parameter ⇒ **Country ⇓**	**Critical limits of heavy metal content in soils by land use (agricultural land, grassland, forests)**	**Content of Pb in soils by land use (topsoil and subsoil)**	**Content of Cd in soils by land use (topsoil and subsoil)**	**Content of Hg in soils by land use (topsoil and subsoil)**	**Content of other heavy metals in soils by land use (topsoil and subsoil)**	**Amounts of heavy metal in materials applied to soils (e.g. sewage sludge, fertilisers, composts)**	**Average heavy metal content in materials applied to soils (e.g. sewage sludge, fertilisers, composts)**	**Deposition rates of heavy metals on soils**	**Outputs of heavy metals from soils**	**Content of organic carbon in topsoil**
Norway	no	no	no	no	no	yes	yes	yes	yes	yes
Netherlands	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Portugal (*)	–	–	–	–	–	–	–	–	–	(possibly available)
Spain	no	no	no	no	no	no	scarce and scattered data	no	no	no
Switzerland	yes	yes	yes	yes	yes	yes	yes	yes	no	no
United Kingdom (*)	(no)	(no)	(no)	(no)	(no)	(no)	(no)	(no)	(no)	(yes, for agric. topsoils)
Albania	no	no	no	no	no	no	no	no	no	yes
Bulgaria	yes	yes	yes	no	yes	yes	yes	no	no	yes
Czech Republic	–	–	–	–	–	yes	yes	yes	yes	yes
Latvia	yes	yes	yes	yes	yes (Cu,Ni,Zn)	Cd balance	Cd balance	Cd balance	Cd balance	yes
Poland	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Slovak Republic	yes	yes	yes	yes	yes	yes	no	no	no	yes

(*) Information is derived from the statements given at the Vienna workshop 2001.

Table 3.6. **National data availability — impact indicators**

Indicator	Occurrence of key species in soils	Exceedances of critical levels of heavy metal contents for food quality in crops				
Required parameter ⇒ Country ⇓	**Occurrence of key species in soils**	**Critical levels of heavy metal content for food quality in crops**	**Content of Pb in different kinds of crops**	**Content of Cd in different kinds of crops**	**Content of Hg in different kinds of crops**	**Content of other heavy metals in different kinds of crops**
Austria	no representative data	yes for Cd, Pb and Hg	no	no	no	no
Belgium (Flanders)	no	yes	yes	yes	yes	yes
Denmark	no	no	no	no	no	no
Finland	no	no	yes	yes	–	yes
France	no	–	–	–	–	–
Germany	some data	yes	maybe – further enquiry nec.	maybe – further enquiry nec.	maybe – further enquiry nec.	maybe – further enquiry nec.
Greece	no	no	no	no	no	no
Ireland	no	no	no	no	no	no
Italy	no	no	no	no	no	no
Netherlands	yes	yes	yes	yes	yes	yes
Norway	no	yes	yes	yes	no	no
Portugal (*)	–	–	–	–	–	–
Spain	no	no	no	no	no	no
Switzerland	no	no	yes	yes	yes	no
United Kingdom (*)	(no)	–	–	–	–	–
Albania	no	no	no	no	no	no
Bulgaria	few data	yes	yes	yes	no	yes (Zn,Cu,Ni,Co,Cr)
Czech Republic	–	–	–	–	–	–
Latvia	yes	yes	yes	yes	yes	yes (Cu, Zn)
Poland	no	yes	yes	yes	yes	yes
Slovak Republic	–	yes	yes	yes	yes	yes

(*) Information is derived from the statements given at the Vienna workshop 2001.

Sewage sludge application per unit area of agricultural land
Information on the application of sewage sludge on agricultural land is mainly available starting from 1999. For some countries a trend can be calculated as data is available on a yearly basis since 1990. The most common aggregation level is NUTS 2 (regions)[13]. For four countries no regional differentiation is available.

For countries where data on the area of arable land treated with sewage sludge is not available, an estimate can be produced by dividing the amount of the used sewage sludge and the allowed maximum amount of sewage sludge, if a regulation exists.

For an assessment covering all countries having data on sewage sludge application (the majority of the responding countries) a national estimate can be produced only every three years. Maybe the revision of the EU sewage sludge directive will help gather more detailed information on this matter, in particular in relation to the quality of sewage sludge.

Almost no information was provided on different qualities of sewage sludge, especially on the content of heavy metals. When a data request is formulated, data on the quality of sewage sludge should be explicitly asked from the countries. If no measured data is available, the maximum thresholds for specific contaminants established by relevant regulations can be used as an estimated value.

Exceedances of critical limits of heavy metal content in soils by land use; alternative: ratio of heavy metal content in topsoil versus subsoil
National thresholds of heavy metal content in soils were established in the 1990s, with the exception of one country. Unfortunately the thresholds refer to different NUTS levels and are, in general, not disaggregated by land use.

Data on heavy metal contents is mainly available from the 1990s, but the data gathering often lasted many years. In some of the countries, mainly in the candidate countries, an update is foreseen every five to 10 years. A collection of existing monitoring data, which seem to be relatively homogeneous concerning the analytical method, but heterogeneous concerning the aggregation level, could be launched by mid-2003. The feasibility of this indicator can be regarded as medium.

Due to the different levels of spatial reference and the heterogeneity of parent material, which have a strong influence on the content of heavy metals in soils, it is recommended to calculate the ratio of heavy metal in topsoil versus subsoil in addition to the exceedances. This would enable an evaluation of the source (anthropogenic or natural enrichment) of an occurring exceedance.

Heavy metal balance for agricultural land
In relation to the input of heavy metals into the soil, the part originating from materials directly applied to the soil can be calculated for at least eight countries with reference to the year 2000, and for three further countries with reference to the late 1990s. For some of the countries, trends since 1990 can be shown. First calculations could start already in 2002. Updates can be expected every five to 10 years, for some countries and for certain materials even on a yearly basis. Data at NUTS 2 level can be provided only by a few countries. Data at the national level have to be used in order to cover all countries.

Data on heavy metal input by airborne deposition will be available for almost half of the countries by mid-2003.

Due to the fact that data on the output of heavy metals is only available for six countries, the development of the indicators should wait a few more years, while first calculations covering a limited number of countries could be done already in 2002. Therefore, the feasibility of this indicator can be evaluated as moderate, as already indicated at the workshop.

Organic carbon content in topsoil by land use
This more general indicator for soil quality can be delivered for most of the countries with available data for the last decade. Trends can be calculated on five to 10-year intervals at national level, for some coun-

13 NUTS stands for nomenclature of territorial units for statistics. It refers to a regional division used by Eurostat for regional statistics.

tries also at regional level (NUTS 3 or provinces) and on a yearly basis. Most of the countries could deliver their data already in 2001. Hence, the feasibility of this indicator seems relatively high, higher than estimated at the workshop.

Occurrence of key species in soils
Due to the fact that the identification of key species of certain ecotypes and their sensitivity to specific soil parameters is a relatively new area of research, first results can not be expected before 2004 (except for the Netherlands) and only for a few countries or regions. As the result of the workshop evaluation showed, this indicator has a low degree of feasibility in the next few years.

Exceedances of critical levels of heavy metal content for food quality in crops
The available detailed information related to this indicator is heterogeneous. The reporting frequency, for example, varies from one to 10 years. Data on more common heavy metals (Pb, Cd, Hg, Cu, Zn) are mostly available since 1995, mainly at national level only and can be provided in 2002. From this information it can be concluded that first calculations on exceedances concerning Pb and Cd can be made for six countries in 2002. A more comprehensive assessment across Europe at the national and regional level should wait a few more years. This low degree of feasibility was already expressed by the country representatives at the workshop.

Concerning *availability of international data sources* only a little information was provided in the questionnaire responses. Some countries mentioned the OECD and the ICP forest programme as data holders for several parameters. Additionally the Baltic soil survey, Eurostat, EMEP and the UN-ECE Convention on Long-Range Transboundary Air Pollution were named for one or a few parameters. Before compiling a data request, the mentioned international data sources should be further analysed.

3.5. Follow-up

A further step would be to prepare a data request, considering the policy relevance of the corresponding question or issue and the EEA reporting strategy. The request should be based on the selected priority indicators (see Table 3.1.1) as well as the assessed data availability and the identified data gaps.

The data request should contain specifications for data quality, data format and data aggregation level as well as appropriate data exchange modules to facilitate the collection of data (e.g. templates in Excel format).

After the collection, the comparability of national data should be assessed. Fulfilment of requirements on data quality and format should be checked. For soil monitoring data, a comparison of methods of sampling design and chemical analysis is recommended. For 'non-soil' or other data (e.g. air emission data), a comparison of investigation and calculation methods would be necessary. Moreover, a comparison of the measurement units and scales used and assessment of their comparability has to be carried out.

Based on the results of this assessment, indicator fact sheets for selected indicators could be prepared and used in the EEA reporting cycle.

The continuation of the development of indicators on diffuse soil contamination is now carried out by the new ETC on Terrestrial Environment. In May 2002, an expert meeting on indicators for soil contamination was held in Seville. The conclusions of this workshop are currently being elaborated by the ETC/TE and will be made available on the ETC/TE web site (http://terrestrial.eionet.eu.int).

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Annex I: Availability of national data for indicators on soil contamination from local sources

1. Impact of hazardous substances on soil (CHC, mineral oil)

Table 1.1.

Number of sites where local CHC and mineral oil contamination is to be expected

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	1 000/–	yes	–
Belgium (Flanders)	no		no	no
Denmark	yes	703/2 451	yes	no
Finland	no		no	no
France	yes	884	–	–
Germany	no		no	(yes)
Greece	no		no	no
Iceland	yes	3/–	no	no
Ireland	no		–	–
Italy	no		–	yes
Netherlands	no		no	no
Spain	yes	21/11	no	yes
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	no		no	no

Finland: only rough estimates and it takes time to collect background data.
France: no differentiation between mineral oil and CHC.
Germany: names of the selected regions — to be identified.
Italy: Basilicata, Lombardia.
Spain: Andalucia, Asturias, Aragó, Baleares, Cantabria, Canarias, Castilla la Mancha, Castilla y León, Cataluna, Extremadura, Galicia, Madrid, Murcia, Navarra, Pais Vasco, La Rioja, Valencia.

Table 1.2. **Average extent of CHC (mineral oil) impact on soil per site**

Country	National level	Regional level	Selected regions	Country
Austria	yes	–	–	Austria
Belgium (Flanders)	no	no	no	Belgium (Flanders)
Denmark	no	no	no	Denmark
Finland	no	no	no	Finland
France	yes	–	–	France
Germany	no	no	no	Germany
Greece	no	no	no	Greece
Iceland	no	no	no	Iceland
Ireland	no	–	–	Ireland
Italy	no	no	no	Italy
Netherlands	no	no	no	Netherlands
Spain	no	no	no	Spain
Sweden	no	no	no	Sweden
Switzerland	no	no	no	Switzerland
United Kingdom	no	no	no	United Kingdom

Spain: data might be available in several regions, but there is no reliable information about their investigation status at the moment.

2. Progress in the management of contaminated sites

Table 2.1. **Estimation of the number of sites to be included in national registers after a preliminary survey**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	80 000	yes	–
Belgium (Flanders)	yes	53 000	yes	–
Denmark	yes	30 000	no	no
Finland	yes	25 000	yes	–
France	yes	300 000–400 000	–	–
Germany	yes	362 000	yes	–
Greece	no		–	yes
Iceland	no		no	no
Ireland	yes	2 500	–	–
Italy	yes	100 000	no	no
Netherlands	yes	175 000	no	no
Spain	yes	18 142	no	yes
Sweden	yes	22 000	yes	–
Switzerland	yes	50 000	no	yes
United Kingdom	yes	100 000	no	no

Finland: based on current and former land use of sites.
Greece: Thessalonica flat area, approximately 3 000 uncontrolled waste disposal sites.
Ireland: preliminary survey on national basis only.
Netherlands: a better estimation can be given in 2004.
Spain: methods to estimate the total number have been revised, therefore data are under consideration.
Switzerland: Berne — test region.

Estimation of the number of sites where preliminary investigation has to be carried out Table 2.2.

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	25 000	–	–
Belgium (Flanders)	yes	53 000	yes	–
Denmark	yes	14 000	no	no
Finland	yes	25 000	yes	–
France	yes	3 062	–	–
Germany	no		–	(yes)
Greece	no		–	yes
Iceland	no		no	no
Ireland	no		no	no
Italy	no		no	no
Netherlands	no		no	no
Spain	yes	362	no	yes
Sweden	yes	7 000	–	–
Switzerland	no		no	no
United Kingdom	no		no	no

Finland: at the moment there are about 18 000 potential sites registered.
Germany: to be identified.
Greece: Thessalonica area and selected sites of Attica, mining regions.
Spain: Andalucia, Asturias, Aragón, Baleares, Cantabria, Canarias, Castilla la Mancha, Castilla y León, Cataluna, Extremadura, Galicia, Madrid, Murcia, Navarra, PaisVasco, La Rioja, Valencia.
Switzerland: this information should be abailable from 2004 onwards.
United Kingdom: data might be available in a year for level 3 sites.

Estimation of the number of sites where main site investigation has to be carried out Table 2.3.

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	5 000	yes	–
Belgium (Flanders)	yes	20 000	yes	–
Denmark	no		no	no
Finland	no		no	–
France	yes	308	–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	no		no	no
Ireland	no		–	–
Italy	no		no	no
Netherlands	no		no	no
Spain	no		no	yes
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	no		no	no

Finland: very rough estimation could be 1/3 of potential sites.
France: first step (called ESR) = 901 sites; second step (called ADE) = 61 sites.
Germany: to be identified.
United Kingdom: data might be available in a year for level 3 sites.

Table 2.4. **Estimation of the number of sites where remediation activities are necessary**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	2 500	yes	–
Belgium (Flanders)	yes	9 000	yes	–
Denmark	no		no	no
Finland	no		no	–
France	yes	164	–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	yes	2	–	–
Ireland	no		–	–
Italy	no		no	no
Netherlands	yes	60 000	no	no
Spain	no		no	yes
Sweden	no		no	no
Switzerland	no		no	yes
United Kingdom	no		no	no

Germany: to be identified.
Spain: at this moment it is not possible to determine the extent of remediation activities carried out by regional environment authorities.
Switzerland: Berne — test region..
United Kingdom: data might be available in a year for level 3 sites.

Table 2.5. **Indication of number of sites currently included in preliminary survey**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	36 000	yes	–
Belgium (Flanders)	yes	14 600	yes	–
Denmark	yes	1 770	yes	no
Finland	yes	18 000	yes	–
France	yes	58 000	–	–
Germany	no		–	(yes)
Greece	no		no	yes
Iceland	no		no	no
Ireland	no		–	–
Italy	yes	10 000	no	yes
Netherlands	no		no	no
Spain	yes		no	yes
Sweden	yes	15 000	yes	–
Switzerland	no		no	yes
United Kingdom	no		no	no

Germany: to be identified.
Greece: Thessalonica flat area, Thriassion pedion (Attica), Schimatari-Inofyta industrial zone (Viotia). Only big projects are included.
Italy: all regions except Lazio.
Spain: employed methods in 1991 to estimate the total number of sites included in the preliminary survey have been revised. Therefore data are under consideration.
Switzerland: Berne — test region.

Table 2.6. **Indication of number of sites where preliminary investigation has been completed**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	2 430	yes	–
Belgium (Flanders)	yes	10 500	yes	–
Denmark	yes	5 293 + 528	yes	no
Finland	no		no	yes
France	yes	493	–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	yes	3	–	–
Ireland	no		–	–
Italy	yes	7 000	no	no
Netherlands	no		no	no
Spain	yes	362	no	yes
Sweden	no		yes	–
Switzerland	no		no	yes
United Kingdom	no		no	no

Denmark: 5 293 (included in register 31 December 2000) + 528 (previously included in register – taken out because of remediation to multifunctional use.
Finland: some regional centres.
Germany: to be identified.
Spain: Andalucia, Asturias, Aragón, Baleares, Cantabria, Canarias, Castilla la Mancha, Castilla y León, Cataluna, Extremadura, Galicia, Madrid, Murcia, Navarra, Pais Vasco, La Rioja, Valencia.
Switzerland: Berne — test region.

Table 2.7. **Indication of number of sites where main site investigation has been completed**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	248	yes	–
Belgium (Flanders)	yes	2 000	yes	–
Denmark	no		no	no
Finland	no		no	yes
France	yes	52	–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	yes	3	–	–
Ireland	no		–	–
Italy	yes	3 000	–	yes
Netherlands	yes	18 000	–	–
Spain	no		no	yes
Sweden	no		yes	–
Switzerland	no		no	no
United Kingdom	no		no	no

Finland: some regional centres.
France: observation: ESR step = 493 sites; EDR step = 52 sites.
Germany: to be identified.
Italy: all regions except Lazio.
Spain: possible in selected regions.

Table 2.8. **Indication of number of sites where remediation activities are in progress**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	33	Yes	-
Belgium (Flanders)	yes	500	Yes	-
Denmark	no		No	no
Finland	yes	150-200	Yes	-
France	yes	177	-	-
Germany	no		-	(yes)
Greece	no		No	yes
Iceland	yes	2	-	-
Ireland	no		-	-
Italy	yes	1 200	No	yes
The Netherlands	no		-	-
Spain	no		No	yes
Sweden	yes	25	Yes	-
Switzerland	no		No	no
United Kingdom	no		No	no

Finland: estimation
Germany: to be identified
Greece: Lavreotiki Peninsula (Attica), Kassandra Mines area (Chalkidiki), 3 waste disposal Sites: Skafidaras (Iraklio), Serres, Messini. Only big projects are included.
Italy: all regions but Lazio
Spain: at the moment it is not possible to determine the extent of remediation activities carried out by regional environmental authorities.

Table 2.9. **Indication of number of sites where remediation activities have been completed**

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	29	yes	-
Belgium (Flanders)	yes	60	yes	-
Denmark	yes	4 800	no	no
Finland	yes	1 000	yes	-
France	yes	466	-	-
Germany	no		-	(yes)
Greece	no		no	yes
Iceland	yes	1	-	-
Ireland	no		-	-
Italy	yes	500	-	yes
The Netherlands	yes	7 100	-	-
Spain	no		no	no
Sweden	yes	200	yes	-
Switzerland	no		no	no
United Kingdom	no		no	no

Finland: estimationFrance: limited use: 48, multifunctional use: 203, under surveillance: 215 sites
Germany: to be identified
Greece: the following waste disposal sites: Schistos (Attica), Ano Liossia (Attica), Thermi (Thessalonica), Tagarades (Thessalonica), Derveni (Thessalonica), Zakynthos (only big projects are included)Italy: Campania, Prov. Bolzano, Emilia Romagna, Lombardia, Liguria, Piemonte. Toscana, Valle d'Aosta, Veneto
Switzerland: information will be available in the future (2002 onwards)

3. Incidents of groundwater/drinking water supply affected by local contamination

Number of closed down or affected public drinking water supply facilities due to local soil contamination Table 3.3.

Country	National level	No of sites	Regional level	Selected regions
Austria	yes	20	no	–
Belgium (Flanders)	yes	1	yes	–
Denmark	yes	119	yes	no
Finland	no		no	–
France	yes	41	–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	yes	1	–	–
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	yes		no	yes
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	no		no	no

Number of closed down or affected private drinking water supply facilities due to local soil contamination Table 3.2.

Country	National level	No of facilities	Regional level	Selected regions
Austria	no		no	no
Belgium (Flanders)	no		–	–
Denmark	yes	119	yes	no
Finland	no		no	–
France	no		–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	yes	0	–	–
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	no		no	no

Germany: to be identified.

Table 3.3. **Costs caused by the installation of water treatment facilities due to local soil contamination**

Country	National level	Million euro	Regional level	Selected regions
Austria	no		no	no
Belgium (Flanders)	no		–	–
Denmark	no		no	no
Finland	no		no	–
France	no		–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	no		–	–
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	no		no	no

Finland: case by case some public drinking water supply facilities.
Germany: to be identified.

4. Expenditures for remediation of sites

Table 4.1. **Estimation of the annual expenditures for investigation and remediation of local soil contamination**

Country	National level	Million euro	Regional level	Selected regions
Austria	yes	75	yes	–
Belgium (Flanders)	yes	81	yes	–
Denmark	yes	80	no	–
Finland	yes	30	yes	–
France	yes	402	–	–
Germany	no		–	(yes)
Greece	no		no	no
Iceland	no		–	–
Ireland	no		–	–
Italy	no		no	–
Netherlands	yes	550	–	–
Spain	yes	14	no	yes
Sweden	yes	25	yes	–
Switzerland	no		no	no
United Kingdom	yes	1 450	no	no

Netherlands: expenditures are partly estimated.
Spain: currently economic expenditures on remediation take place through a memorandum of understanding between national and regional governments, so it is possible to do an estimation of expenditures.
United Kingdom: estimation for public sector investment and public/private partnership investment. It does not include any estimate of expenditure purely by the private sector.

5. Reused brownfields in relation to the consumption of 'green land'

Data availability on the yearly consumption of green land for construction purposes Table 5.1.

Country	National level	m²/reference year	Regional level	Selected regions
Austria	no		–	–
Belgium (Flanders)	no		–	–
Denmark	no		no	no
Finland	no		no	–
France	no		–	–
Germany	yes	1 290 000/1999	–	–
Greece	no		no	no
Iceland	no		no	no
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	yes	1 m²/sec	no	no
United Kingdom	–		–	–

Spain: there are currently no data available about the consumption of green land for this purpose.

Data availability on the total area of brownfields Table 5.2.

Country	National level	km²/reference year	Regional level	Selected regions
Austria	no		no	no
Belgium (Flanders)	no		–	–
Denmark	no		no	no
Finland	no		no	–
France	no		–	–
Germany	yes	1 280/1999	–	–
Greece	no		no	no
Iceland	no		no	no
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	–		–	–

Finland: only few sites.

Table 5.3. **Data availability on the annual increase of brownfields**

Country	National level	km²/reference year	Regional level	Selected regions
Austria	no		no	no
Belgium (Flanders)	no		–	–
Denmark	no		no	no
Finland	no		no	–
France	no		–	–
Germany	no		–	–
Greece	no		no	no
Iceland	no		no	no
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	–		–	–

Spain: a project financed by the Spanish Ministry of Environment is under development to define and identify potential brownfields.

Table 5.4. **Characterisation of the brownfield problem — data availability on the total number of houses built on brownfields**

Country	National level	No of houses	Regional level	Selected regions
Austria	no		–	–
Belgium (Flanders)	no		–	–
Denmark	no		no	no
Finland	no		no	–
France	no		–	–
Germany	no		no	–
Greece	no		no	no
Iceland	no		no	no
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	–		–	–

Table 5.5. **Characterisation of the brownfield problem – data availability on the number of houses built on brownfields per year**

Country	National level	No of houses	Regional level	Selected regions
Austria	no		no	no
Belgium (Flanders)	no		–	–
Denmark	no		no	no
Finland	no		no	–
France	no		–	–
Germany	no		no	–
Greece	no		no	no
Iceland	no		no	no
Ireland	no		–	–
Italy	no		no	–
Netherlands	no		no	no
Spain	no		no	no
Sweden	no		no	no
Switzerland	no		no	no
United Kingdom	–		–	–

Table 5.6. **Characterisation of the brownfield problem – data availability on other characteristics**

Country	Info available	Information
Austria	yes	Soil loss due to soil sealing is assumed with 20 ha/day
Belgium (Flanders)	no	
Denmark	no	
Finland	yes	Distances to surface, groundwater and residential area, current use of land but only from potential sites
France	–	
Germany	no	
Greece	no	
Iceland	no	
Ireland	–	
Italy	no	
Netherlands	no	
Spain	no	
Sweden	no	
Switzerland	no	
United Kingdom	–	

Annex II: Availability of data for indicators on soil contamination from diffuse sources

1. Pressure indicators

1.1 Lead emission due to exhaust gas by road vehicles

Table 1.1. **Consumption of petrol containing lead (l.yr–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	–	1985–2000	Yearly	national level	when required
Belgium (Flanders)	–	1980–2000	Yearly	regional level	03/200x
Denmark	–	–	Yearly	national level	when required
Finland	–	?	Yearly	regional level	end 2001
France	–	1980–99	since 1999	national level	–
Germany	connect ETC and NRCs AIR or Trend	1988–95	no more published reporting	no regional differentiation	–
Greece	–	1985–2001	yearly	–	available immediately
Ireland	–	1988–98	–	–	–
Italy	–	–	–	–	–
Netherlands	–	1960s–2001	?	?	?
Norway	–	1973–99	yearly	NUTS 1	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	OECD	1987+	yearly	national level	09/200x
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	OECD?	1992+	yearly	–	–
Czech Republic	no	1995–2000	yearly	no	05/2002
Latvia	OECD	1998–2000	yearly	country level	07/2002
Poland	yes	1990–99	yearly	country level	12/2001
Slovak Republic	–	?–2000	yearly	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: total consumption of fuel by the transport sector (according to different petrol types).
Finland: lead emissions from traffic are available from the 1990s.
Germany: after 1988 no more leaded fuel. Percentage of leaded fuel reduced to 1.4 %.
Netherlands: since the introduction of unleaded fuel, the policy relevance of this indicator has decreased.
Norway: there is no consumption of petrol containing lead in Norway.
Spain: petrol containing lead will be forbidden in the whole EU from 1 January 2002.
Switzerland: NABEL.
United Kingdom: the proposed indicator relates lead consumption and content to emission, but it is not clear how this would be done, or how it would be mapped to the spatial distribution of emissions. In any case, the UK has now largely phased out lead in petrol, so the lifetime of this indicator is limited.

Lead content of petrol (mg.l–1) Table 1.2.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	–	1970–2000	yearly	national level	when required
Belgium (Flanders)	–	1980–2000	yearly	regional level	03/200x
Denmark	–	–	–	–	when required
Finland	–	–	–	–	end 2001
France	–	1980–99	since 1999	national level	–
Germany	connect ETC and NRCs AIR or TREND	–	–	–	–
Greece	–	1985–2001	yearly	–	available immediately
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	1960s–2001	?	?	?
Norway	–	1980–99	yearly	NUTS 1	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	OECD	1987+	yearly	national level	09/200x
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no	–	yearly	–	–
Czech Republic	no	–	–	–	05/2002
Latvia	OECD	1998–2000	yearly	country level	07/2002
Poland	no	1990–99	yearly	not available	12/2001
Slovak Republic	–	?–2000	yearly	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: since 2000 only leadfree (<0.005 g/l) fuel sold; lead content determined in fuel quality measurements.
Netherlands: since the introduction of unleaded fuel, the policy relevance of this indicator has decreased.
Spain: threshold value is established in Ordinance 1728/1999 (November 12) according to the method EN 237
Switzerland: NABEL

1.2. Sewage sludge application per unit area of agricultural land

Table 1.3. **Amount of sewage sludge used in agriculture (according to different sewage sludge qualities) (kg.yr–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	no	1990–2000	yearly	NUTS 2 (federal provinces) / regional	when required
Belgium (Flanders)	–	1990–2000	yearly	regional level	03/200x
Denmark	–	–	yearly	national level	when required
Finland	–	from 1980s	yearly	municipal level	end 2001
France	–	1999–2001	2–3 years	NUTS 3	national: 07/ 2001 NUTS 3: 07/2001
Germany	reporting for Council Directive 86/278/EEC	1994–97, 1997–2001	every 3 years	no regional differentiation	next new data in 2002
Greece	–	–	every 3 years	–	–
Ireland	–	1995–2001	yearly	county level	–
Italy	–	–	–	partly for NUTS 3	–
Netherlands	–	–	–	–	–
Norway	–	1993–2000	yearly	NUTS 3	–
Portugal (*)	(reporting for Council Directive 86/278/EEC)	–	(every 3 years)	(NUTS 1)	–
Spain	–	–	yearly	NUTS 2	data for 2000 are expected at the end of 2001
Switzerland	–	1970+	yearly	NUTS 3	end of each year
United Kingdom (*)	–	–	–	(national level)	–
Albania	–	–	–	–	–
Bulgaria	no	2000+	yearly	–	–
Czech Republic	no	1990–2000	yearly	in localities	10/2001
Latvia	Eurostat	1999–2000	yearly	country level	07/2002
Poland	yes	1990–2000	yearly	regional level	12/2001
Slovak Republic	–	1998–2000	yearly	–	09/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: related to the quality of sewage sludge, it must be assumed that it meets the thresholds of heavy metals recorded in the sewage sludge ordinances of the federal provinces.
Denmark: the amount is related to the quality of the sewage sludge.
France: see also document from Arthur Andersen and ADEME: *Situation du recyclage agricole des boues d'épuration urbaines en Europe*; 1999, ADEME. Available at: ADEME; 2, Square La Fayette BP 406; 49004 Angers Cedex 01; or at http://www.ademe.fr (extract sent by post).
Greece: the Ministry of Agriculture is working to produce guidelines for sewage sludge applications on agricultural land; scarce and scattered data are available and most of them at experimental level.
Ireland: the quantity of sewage sludge applied per hectare will vary significantly over the entire area farmed in each county.
Italy: draft technical annex to Legislative Decree 152/99 expected by the end of 2001.
Netherlands: in the Netherlands, no sewage sludge is applied to agricultural soils.
Switzerland: according to federal ordinance and guidelines.
Albania: sewage sludge is not treated in Albania and the sludge of these waters is not separated or calculated. Part of the rivers, as catchwaters, are used for irrigation. There are no data on the content of sewage sludge, nor on the area of arable land treated with sewage sludge.
Bulgaria: according to Regulation 86/278/EEC; until 2000 the usage of sewage sludge was forbidden in Bulgaria.

Area of arable land treated with sewage sludge application (ha.yr-1)) Table 1.4.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	no	1990-2000	yearly	NUTS 2 (federal provinces)/ regional	when required
Belgium (Flanders)	-	1990-2000	yearly	regional level	03/200x
Denmark	-	-	yearly	national level	when required
Finland	-	-	-	-	-
France	-	1999-2001	2-3 years	NUTS 3	national: 07/ 2001 NUTS 3: 07/
Germany	-	-	-	-	-
Greece	-	-	-	-	-
Ireland	-	1995-2001	yearly	-	-
Italy	-	-	-	NUTS 3	-
The Netherlands	-	-	-	-	-
Norway	-	-	-	-	-
Portugal*	-	-	(every 3 years)	(NUTS1)	(possible available)
Spain	-	-	yearly	NUTS 2	Data for 2000 are expected at the end of 2001
Switzerland	-	1970+	yearly	NUTS 3	end of each year
United Kingdom*	-	-	-	(national level)	-
Albania	-	-	-	-	-
Bulgaria	no	2000+	yearly	-	-
Czech Republic	no	1990-2000	-	in localities	10/2001
Latvia	EUROSTAT	1999-2000	yearly	country level	07/2002
Poland	yes	1990-2000	yearly	regional level	12/2001
Slovak Republic	-	1998-2000	yearly	-	09/2001

* Information is derived from the statements given at the indicator workshop in Vienna, 2001
Austria: The area of arable land treated with sewage sludge can be estimated by the amount of sewage sludge used in agriculture and the maximum amount of sewage sludge that is allowed to apply on 1 ha. This is recorded in the sewage sludge ordinances of the federal provinces.
Denmark: About 3% of the arable land areas of Denmark are treated with sewage sludge.
Finland: can be estimated based on total use of sewage sludge in agric. and restricting guidelines
France: See also document from Arthur Adersen and ADEME: "Situation du recyclage agricole des boues d'épuration urbaines en Europe"; 1999, ADEME. Available at: ADEME; 2, Square La Fayette BP 406; 49004 ANGERS Cedex 01; or at http://www.ademe.fr (extract sent by post)
taly: Draft Technical Annex to Legislative Decree 152/99 expected within end of 2001.
The Netherlands: no sewage sludge is applied to agricultural soils.
Norway: Can be estimated by assumed maximum application rate (20 T/ha/10years)
Switzerland: According to federal ordinance and guidelines

2. State indicators

2.1. Exceedances of critical limits (thresholds) of heavy metal contents in soils by land use; alternative: ratio of heavy metal content in topsoil versus subsoil

Table 2.1. **Critical limits of heavy metal content in soil related by land use (agricultural land, grassland, forests) (mg.kg-1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	–	date of issue June 1993	–	NUTS 0	–
Belgium (Flanders)	–	–	–	local	–
Denmark	–	–	–	–	when required
Finland	EMEP/EC (****)	–	–	–	–
France	–	–	–	NUTS 3 probably	1st trimester 2003
Germany	–	no	no	NUTS 2	–
Greece	–	–	–	–	–
Ireland	–	1998	–	national level	–
Italy	–	–	–	NUTS 3	–
Netherlands	–	1991–2001	irregularly partly updated	not relevant	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1998	–	national level	–
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no (forest–ICP forest I/II level)	1979+	–	–	expected data of critical loads – 2003
Czech Republic	–	–	–	–	–
Latvia	OECD	1997–2001	3 years	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	1994–2000	–	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: ÖNORM L 1075 for agricultural land and grassland; extraction with aqua regia (HCl:HNO3 = 3:1) or HClO4 for samples with more than 5 % organic matter.
Finland: (****) cooperative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe.
France: the GIS Sol (Groupement d'Intérêt Sceintifique sur les sols) built up by IFEN, INRA and ADEME) will provide such information. Probably at the NUTS III level.
Greece: scattered studies have been made around industrial regions and along national roads (1980, 1985, 1991), but the heavy metal content is not monitored systematically. The ministerial ordinance 80568/4225 published in no 641/7-8–91 of the government's newspaper sets the methodology of heavy metal soil analysis. There is no national project to identify, map and report temporally the sites that exceed critical levels of heavy metal concentrations.
Ireland: SI No 148 of 1998 Waste Management (Use of sewage sludge in agriculture) Regulations 1998.
Spain: several scattered studies have been done, but there is no national approach to this issue.
United Kingdom: this appears to be an approach based on national threshold concentrations, rather than a critical loads approach. There are currently no UK thresholds for heavy metals, apart from those in the sewage sludge directive.
Albania: there are no indicators on the loads of heavy metals in soils, as well as on the content of Pb, Cd, Hg and other heavy metals related to different land use (topsoil and subsoil). A study of a pilot area consisting of 20000 ha and a monitoring programme for six zones have been made, which indicate the first data on the content of some heavy metals in soils (not related to different land use and the depth: topsoil and subsoil).

Table 2.2.

Content of lead in soil by land use (topsoil and subsoil) (mg.kg–1)

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	forest sites: ICP forest programme	between 1988 and 1999	once (in Tyrol twice)	punctual information, which can be aggregated at regional level (NUTS3)	when agreed by the provincial governments
Belgium (Flanders)	–	–	–	local	–
Denmark	forest sites: ICP forest programme	–	–	national level – grid	When required
Finland	agricultural soils: Baltic soil survey (***)	agricultural 1996/1997; forest 1989	once	agric:50x50 km grid cells; forest:16X16 km /24X32 km	agr:2001/5 Forest: autumn 2001
France	–	–	–	NUTS 3 probably	1st trimester 2003
Germany	–	depends on federal state, 1990–2000	5–10 years	point data, no aggregation yet	2003 available on a national evaluation level
Greece	–	–	–	–	–
Ireland	–	1995–96	once	national level	–
Italy	–	–	–	NUTS 3	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1985/91 1992/97	5–10 years	national level	published
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no (forest–ICP forest I/II level)	1986+	5–10 years depending on land use	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998	3 years	district level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, region	12/2001
Slovak Republic	–	1994–2000	5 years	–	06/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: analytical methods: extraction with aqua regia in most cases, but detected with different methods; analysed soil depths vary according to land use and provincial investigation.
Belgium: only local examinations for soil sanitation.
Denmark: systematic sampling (grid) from 413 sites in Denmark, only data for topsoils.
Finland: agr: BSS: XRF; forest: dry ashing and uptake in conc. HCl acid (humus, 0-5, 5–20, 20-40 cm layers).
Germany: work has to be done for harmonisation between results of the several federal states, 790 national monitoring sites.
Greece: scattered studies have been made around industrial regions and along national roads (1980, 1985, 1991), but the heavy metal content is not monitored systematically. The ministerial ordinance 80568/4225, published in No 641/7-8–91 of the government's newspaper, sets out the methodology for heavy metal soil analysis. There is no national project to identify, map and report temporally the sites that exceed critical levels of heavy metal concentrations.
Ireland: national geochemical soil survey, 295 samples covering 22 % of the land. The soil samples were analysed using a strong acid mixture including hydrofluoric acid.
Italy: see ADA 2001 (Environmental data yearbook), in prep.
Norway: data from natural (uncultivated) soil is available.
Spain: several scattered studies have been done, but there is no national approach to this issue.
Switzerland: NABO, 105 sites, analysis according to federal ordinance method.
Bulgaria**:** BStandard, since 1996–ISO methods.
Latvia: analytical methods.
Poland: aqua regia soluble, data vs. ref. mat.

Table 2.3. **Content of cadmium in soil related by land use (topsoil and subsoil) (mg.kg-1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	forest sites: ICP forest programme	between 1988 and 1999	once (in Tyrol twice)	punctual information, which can be aggregated at regional level (NUTS 3)	when agreed by the provincial governments
Belgium (Flanders)	–	–	–	local	–
Denmark	–	–	–	national level – grid	when required
Finland	agricultural soils: Baltic soil survey (***)	agricultural 1996/1997	once	50 km x 50 km grid cells –> most detailed level	2002/12
France	–	–	–	NUTS 3 probably	1st trimester 2003
Germany	–	depends on federal state, 1990–2000	5–10 years	point data, no aggregation yet	2003 available on a national evaluation level
Greece	–	–	–	–	–
Ireland	–	1995–96	once	national level	–
Italy	–	–	–	NUTS 3	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1985/91 1992/97	5–10 years	national level	–
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no (forest–ICP forest I/II level)	1986+	5–10 years depending on land use	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998	3 years	district level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, region	12/2001
Slovak Republic	–	1994–2000	5 years	–	06/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: analytical methods: extraction with aqua regia in most cases, but detected with different methods; analysed soil depths vary according to land use and provincial investigation.
Belgium: only local examinations for soil sanitation.
Denmark: Systematic sampling (grid) from 413 sites in Denmark, only data for topsoils.
Finland: (***) Baltic soil survey: top and subsoils from Belarus, Estonia, Finland, North Germany; BSS: aqua regia extraction, GFAAS, also amm. acetate extr.
Germany: work has to be done for harmonisation between results of the several federal states, 790 national monitoring sites.
Ireland: national geochemical soil survey, 295 samples covering 22 % of the land. The soil samples were analysed using a strong acid mixture including hydrofluoric acid.
Norway: data from natural (uncultivated) soil is available.
Bulgaria: BStandard, since 1996–ISO methods.
Latvia: analytical methods
Poland: aqua regia soluble, data vs. ref. mat.
Switzerland: NABO, 105 sites, analysis according to federal ordinance method.

Content of mercury in soil by land use (topsoil and subsoil) (mg.kg–1) Table 2.4.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	forest sites: ICP forest programme	between 1988 and 1999	once	punctual information, which can be aggregated at regional level (NUTS 3)	when agreed by the provincial governments
Belgium (Flanders)	–	–	–	local	–
Denmark	–	–	–	national level – grid	when required
Finland	–	–	–	–	–
France	–	–	–	NUTS 3 probably	1st trimester 2003
Germany	–	depends on federal state, 1990–2000	5–10 years	point data, no aggregation yet	2003 available on a national evaluation level
Greece	–	–	–	–	–
Ireland	–	1995–96	once	national level	–
Italy	–	–	–	NUTS 3	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1985/91 1992/97	5–10 years	national level	–
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no (forest–ICP forest I/II level)	–	–	–	2003
Czech Republic	–	–	–	–	–
Latvia	–	1998	3 years	district level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	1994–2000	5 years	–	06/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: analytical methods: extraction with aqua regia in most cases, but detected with different methods; analysed soil depths vary according to land use and provincial investigation.
Belgium: only local examinations for soil sanitation.
Denmark: systematic sampling (grid) from 413 sites in Denmark, only data for topsoils.
Germany: work has to be done for harmonisation between results of the several federal states, 790 national monitoring sites.
Ireland: national geochemical soil survey, 295 samples covering 22 % of the land. The soil samples were analysed using a strong acid mixture including hydrofluoric acid.
Norway: data from natural (uncultivated) soil is available.
Latvia: analytical methods.
Poland: aqua regia soluble, data vs. ref. mat
Switzerland: NABO, 105 sites, analysis according to federal ordinance method.

Table 2.5. **Content of other heavy metals in soil by land use (topsoil and subsoil) (mg.kg–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	forest sites: ICP forest programme	between 1988 and 1999	once (Cu and Zn twice in Tyrol)	punctual information, which can be aggregated at regional level (NUTS 3)	when agreed by the provincial governments
Belgium (Flanders)	–	–	–	local	–
Denmark	–	–	–	national level grid	when required
Finland	agricultural soils: Baltic soil survey	agricultural 1996/1997	once	50 km x 50 km grid cells most detailed level	2002/12
France	–	–	–	NUTS 3 probably	1st trimester 2003
Germany	–	depends on federal state, 1990–2000	5–10 years	point data, no aggregation yet	2003 available on a national evaluation level
Greece	–	–	–	–	–
Ireland	–	1995–96	once	national level	–
Italy	–	–	–	NUTS 3	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1985/91 1992/97	5–10 years	national level	–
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no (forest–ICP forest I/II level)	1986+	5–10 yrs according to land use	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998	3 years	district level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, regional level	12/2001
Slovak Republic	–	1994–2000	5 years	–	06/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: analytical methods: extraction with aqua regia in most cases, but determined with different methods; analysed soil depths vary according to land use and provincial investigation.
Belgium: only local examinations for soil sanitation.
Denmark: systematic sampling (grid) from 413 sites in Denmark, only data for topsoils.
Finland: BSS: total (XRF or total extraction), aqua regia and amm. acet., total ca. 50 elements.
Germany: work has to be done for harmonisation between results of the several federal states, 790 national monitoring sites.
Ireland: national geochemical soil survey, 295 samples covering 22 % of the land. The soil samples were analysed using a strong acid mixture including hydrofluoric acid.
Italy: As, Cr, Cu, Ni, Zn.
Norway: data from natural (uncultivated) soil is available.
Bulgaria: BStandard, since 1996, ISO methods.
Latvia: analytical methods.
Poland: aqua regia soluble, data vs. ref. mat.
Switzerland: NABO, 105 sites, analysis according to federal ordinance method.

Amount of material applied to soils containing heavy metals (fertilisers, composts, sewage sludge) (kg.ha–1.yr–1)

Table 2.6.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	no	sewage sludge: since 1990 fertilisers: since 1950 compost= ?	sewage sludge: yearly fertilisers: yearly compost= ?	sewage sludge: NUTS 2 (federal provinces)/ regional fertilisers: national sales figures composts: NUTS 2 (federal provinces)	sewage sludge and fertilisers: when required compost= ?
Belgium (Flanders)	–	1990–2000	yearly	regional level	–
Denmark	–	–	–	–	–
Finland	–	–	–	–	2002?
France	–	1998–2001	2 years	NUTS 3	12/2001
Germany	–	–	yearly	NUTS 3 or 4	–
Greece	–	–	–	–	–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	1995–2001	6 years	regional level per combination of land use and soil type)	–
Norway	–	1996	–	NUTS 3	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1990–2000	10 years	national level	at random reports
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no	2000	yearly	No	–
Czech Republic	no	1990–2000	yearly	inputs per districts	06/2001
Latvia	Eurostat	1998	yearly	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	1994–2000	5 years	–	06/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
? = no information available.
Denmark: at the moment only a few data are available.
France: these data will be produced by the GIS sol (scientific interest group on soil), which has just started this year and which is gathering resources from IFEN, INRA and ADEME.
Finland: mass balances of Cd, Pb, Cu and Zn of agricultural land have been estimated.
Switzerland: rough estimates from statistical data.
United Kingdom: this indicator is rather complicated and requires a considerable amount of data to calculate it. It is difficult to see how it could account for the high level of local spatial variation.
Albania: no calculations have been made on the heavy metals that go to or accumulate in soils due to the use of materials applied to soils (fertilisers, composts, sewage sludge). There is no deposition rate of heavy metals on soils and no data on the outputs of heavy metals from soils.
Czech Republic: HM balance for agricultural soils is included in the maps of critical loads based on soil solution criteria (Cd, Pb, Cu limits for drinking waters); methods: semi-dynamic modelling. For sending of national data we need more detailed information such as data format, period of interest, resolution of mapping etc.
Latvia: calculation method.
Poland: analytical data.

Table 2.7. **Average heavy metal content in material applied to soil (mg.kg–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	no	sewage sludge: only recorded thresholds in the sewage sludge ordinances of the federal provinces (1991–2000); fertilisers: since 1985 compost= ?	sewage sludge: once fertilisers: yearly composts: ?	sewage sludge: NUTS 2 (federal provinces)/ regional fertilisers: nationwide investigations, data can be aggregated at NUTS 1 or NUTS 2 composts: NUTS 2 (federal provinces)	sewage sludge: when required fertilisers and composts: ?
Belgium (Flanders)	–	1990–2000	yearly	regional level	–
Denmark	–	–	–	national level	–
Finland	–	–	–	–	–
France	–	–	5 years	–	07/2001
Germany	–	–	–	NUTS 2	–
Greece	–	There are data (1991) of heavy metal content in sewage sludge of nine municipalities with waste water treatment plants and probably more today, but these data are kept from the labs where they produced the s. sl. and are not gathered and published at national level.			
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	1996	–	NUTS 3	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1990–2000	10 years	national level	at random reports
United Kingdom	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no	2000	yearly	–	–
Czech Republic	no	1990–2000	occasional reporting	–	06/2001
Latvia	Eurostat	1998	once a year	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	–	–	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
? = no information available.
Austria: data on the average heavy metal content of sewage sludge are hold by the federal provinces mostly since 1990, but it is likely that they cover a wide range of standard deviation and access to the data is difficult.
Denmark: at the moment only few data are available.
Finland: mass balances of Cd, Pb, Cu and Zn of agricultural land have been estimated.
France: mean values from various studies.
Greece: the Ministerial Ordinance 80568/4225 (Appendix 1B) published in No 641/7–8–91 of the government's newspaper sets the threshold values of heavy metal concentrations in sewage sludge that can be applied to the cultivated soils (mg/kg dry matter).
Spain: Ordinance 1310/1990 (from 29 October) sets heavy metal threshold values (Cd, Cu, Ni, Pb, Zn, Hg and Cr) for sewage sludge to be applied in agricultural land, also analytical reference method to determine their concentration is settled.
Switzerland: rough estimates from statistical data.
Czech Republic: for the sending of national data we need more detailed information such as data format, period of interest, resolution of mapping etc.
Latvia: analytical method.
Poland: calculation methods.

Table 2.8. **Deposition rates of heavy metals on soil (g.ha–1.yr–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	UN–ECE Convention on Long-range Transboundary Air Pollution	1991: pilot programme on selected sites; 1995: nationwide	every 5 years	NUTS 2	when required
Belgium (Flanders)	–	1990–2000	yearly	regional level	–
Denmark	–	–	yearly	national level	when required
Finland	–	–	–	–	–
France	–	–	–	to be studied	12/2001
Germany	–	–	–	–	–
Greece	–	–	–	–	–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	1996	–	NUTS 3	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1988–2000	yearly	from local level to national level	mid-year
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no	–	–	–	2003?
Czech Republic	no	1994–2000	yearly	–	06/2001
Latvia	Eurostat	1998	yearly	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	–	–	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: estimations for heavy metal deposition calculated with the moss technique; analysed heavy metals: As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, V, Zn (additionally Fe), a big advantage of this method is that the deposition can be determined for the last three years.
Denmark: at the moment only a few data are available.
Finland: mass balances of Cd, Pb, Cu and Zn of agricultural land have been estimated.
France: atmospheric method.
Switzerland: VDI.2119 Bl.2.
Czech Republic: for the sending of national data we need more detailed information such as data format, period of interest, resolution of mapping etc.
Latvia: analytical and calculation method.
Poland: calculation methods.

Table 2.9. **Outputs of heavy metals from soil (g.ha–1.yr–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	no	–	–	–	–
Belgium (Flanders)	–	1990–2000	yearly	regional level	–
Denmark	–	–	–	–	–
Finland	–	–	–	–	–
France	–	–	–	–	–
Germany	–	–	–	–	–
Greece	–	–	–	–	–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	1996	–	NUTS 3	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	–	–	–	–
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	no	–	–	–	2003 ?
Czech Republic	no	1994–2000	yearly (amounts of crops)	outputs per district (in the case of crops)	06/2001
Latvia	Eurostat	1998	yearly	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	–	–	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Finland: mass balances of Cd, Pb, Cu and Zn of agric. land have been estimated.
Czech Republic: for the sending of national data we need more detailed informations such as data format, period of interest, resolution of mapping etc.
Latvia: analytical and calculation method.
Poland: calculation methods.

2.3 *Organic carbon or humus content in topsoil by land use*

Table 2.10.

Content of organic carbon or humus in topsoil

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	forest sites: ICP forest programme	between 1988 and 1999	once (in Tyrol twice)	punctual information, which can be aggregated at regional level (NUTS 3)	when agreed by the provincial governments
Belgium (Flanders)	–	1990–2000	yearly	regional level	–
Denmark	–	–	–	national level grid	when required
Finland	–	agric: –74,–87,–98; forest:1989	as temporal coverage	NUTS 3?	autumn 2001
France	–	1970–2000	10 years	NUTS 3	12/2001
Germany	–	–	–	–	–
Greece	–	–	–	–	–
Ireland	–	1964	once	national level grid	–
Italy	–	–	–	–	–
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	2000	–	NUTS 3 (only for agricultural land)	–
Portugal (*)	–	–	–	(NUTS 1)	–
Spain	–	–	–	–	–
Switzerland	–	at random (specific reports)	at random	local	long-term local project pursued (DOK–trial)
United Kingdom (*)	–	–	–	–	–
Albania	–	1971–90	every 5 years	sampling every 5–7 ha	to be decided
Bulgaria	yes – for forest soils–ICP forest programme	1986–2000 (ICP forest programme)	10 years	no	–
Czech Republic	FAO?	1967–75	no regular reporting	–	10/2001
Latvia	Eurostat	1992–2000	yearly	district level, country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	1994–2000	yearly	–	06/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: depending on the investigation carbon is analysed as TOC, TC, TIC, organic matter or $CaCO_3$ by using different analytical methods. Nevertheless the content of humus can be calculated out of these data.
Denmark: systematic sampling (grid) from 820 sites in Denmark.
Finland: forest: combination of loss of ignition and LECO C analyser (humus layer, 0–5 cm layer, 5–20 cm layer, 20–40 cm layer).
Germany: see comment on ESB study under State 1.
Ireland: surveys was confined to pasture soils; gravimetric wet combustion method was used.
Netherlands: no information on changes.
Spain: considering agricultural practices which turn over land periodically, it makes no sense to consider org. C content as an indicator.
United Kingdom: it is not clear how directly this indicator links to diffuse soil contamination, although it will affect the ability of a soil to filter, buffer and transform pollutants. It may be a better indicator of soil fertility. This indicator is widely used, but it is still not clear what it actually tells us about the quality of soil.
Albania: laboratory analysis of the samples for humus and other elements.
Bulgaria: humus contents related to soil types, and organic carbon for forest soil; analytical methods according to guidance of ICP forest programme
Czech Republic: soil humus content is observed recently by institutions of research and soil protection (in the framework of monitoring or research studies).
Latvia: analytical method.

3. Impact indicators

3.1. Occurrence of key species in soils

Table 3.1. **Occurrence of key species in soil (%)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	no	only singular investi-gations	?	'only for local areas	?
Belgium (Flanders)	–	–	–	–	–
Denmark	–	–	–	–	–
Finland	–	–	–	–	–
France	no	no	–	–	–
Germany	no	depending on federal states responsible for the data evaluation	>5 years	no aggregation, point data	for a national summary 2003
Greece	–	–	–	–	–
Ireland	–	–	–	–	–
Italy	–	2001–	year season	NUTS 3	11/01 (see remarks)
Netherlands	–	1995–2001	6 years	regional level (per combination of land use and soil type)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	–	at random	scientific reports (individual)	periodically, at random
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	–	–	–	–	2004, from monitoring programme
Czech Republic	–	–	–	–	–
Latvia	OECD	1999–2001	2 years	country level	07/2003
Poland	no	–	–	–	–
Slovak Republic	–	–	–	–	–

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: investigation on population growth and population dynamic of Collembola (Folsomia candida) on 60 sites; biological investigations of macro-, meso- and microfauna in an industrial area with heavy metal pollution (Brixlegg/Tyrol); investigation of Anneliden (Lumbricidae and Enchytraeidae) on permanent monitoring sites in Salzburg; investigation of macrofauna in alpine soils (10 sites at Neustift/Stubaital).
Denmark: at the moment no systematic data are available on this issue in Denmark.
Germany: work has to be done for harmonisation between results of the several federal states.
France: because of high variability, these indicators are of little interest.
Italy: ANPA is preparing guidelines for soil biomonitoring in agro-ecosystems.
Netherlands: the change is very relevant, but difficult to determine.
Switzerland: analytical methods specific to each project.
United Kingdom: this is excellent in theory. At the moment little is known about which species indicate anything meaningful. A great deal of development is needed for this.

3.2. Exceedances of critical levels of heavy metal content for food quality in crops

Critical levels of heavy metal content for food quality in crops (mg.kg–1) Table 3.2.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	Commission Regulation (EC) No 466/2001 (8 March 2001) setting maximum levels for certain contaminants in foodstuff	Austrian ordinance: 1997 EC regulation will be in force by 5 April 2002	–	–	–
Belgium (Flanders)	–	–	–	–	–
Denmark	–	–	–	–	–
Finland	–	–	–	–	–
France	–	–	–	–	–
Germany	no	no	no	NUTS 3 (on *Länder* level) or 2 (German wide)	–
Greece	–	scattered studies, but no systematic monitoring			–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	not relevant	–	–	–
Norway	–	1989–2000	occasionally	NUTS 1	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	–	at random	individual research projects	periodically, at random
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	–	1986+	–	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1999–2001	2 years	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country level	12/2001
Slovak Republic	–	1995–99	yearly	–	09/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Bulgaria: dry-ashing procedure
Denmark: at the moment, no systematic data are available on this issue in Denmark.
Latvia: analytical methods.
Poland: analytical data.
Switzerland: analytical methods specific to each project.

Table 3.3. **Content of lead in crops for different kinds of crops (mg.kg–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data deliveryv
Austria	–	–	–	–	2003?
Belgium (Flanders)	–	1990–2000	yearly	national level	–
Denmark	–	–	–	–	–
Finland	–	–	–	–	–
France	–	–	–	–	–
Germany	–	–	–	–	–
Greece	–	Scattered studies but not monitoring systematically			–
Irelanvd	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	? (present)	–	? (country)	–
Norway	–	1989–2000	occasionally	NUTS 1	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	1970+?	yearly	NUTS 3	periodically
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	–	1986+	5/10 years	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998	2 years	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, regions	12/2001
Slovak Republic	–	1995–99	yearly	–	09/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Austria: no systematic data are currently available on this issue in Austria, only singular investigations have been carried out so far. But a scientific study will be started within this year by the Federal Office and Research Centre for Agriculture in cooperation with the Federal Office for Agrobiology and the Federal Research Institute for Agriculture in Alpine Regions including nationwide chemical analyses in different kind of crops. Alternatively, investigations on food products of the consumers could be used, which are carried out every two or three years, although it must be considered that a possible contamination can result from many sources and can therefore not directly be seen as an indicator for diffuse soil contamination.
Denmark: at the moment no systematic data are available for this issue in Denmark.
France: because of high variability, these indicators are of few interest.
Netherlands: the metal contents related to the critical levels and the accumulation rate is particularly relevant.
Bulgaria: dry-ashing procedure.
Latvia: analytical methods.
Poland: analytical data.
Switzerland: analytical methods specific to each project.

Content of cadmium in crops for different kinds of crops (mg.kg–1) Table 3.4.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	–	–	–	–	2003?
Belgium (Flanders)	–	1990–2000	yearly	national level	–
Denmark	–	–	–	–	–
Finland	–	2001	once	6–9 areas in south-western and western Finland	Oats 2001 autumn; rye 2002
France	–	–	–	–	–
Germany	–	–	–	–	–
Greece	–	scattered studies but no systematically monitoring			–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	? (present)	–	? (country)	–
Norway	–	1989–2000	occasionally	NUTS 1	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	–	yearly	NUTS 3	Periodically
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	–	1986+	5/10 years	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998	2 years	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, regions	12/2001
Slovak Republic	–	1995–99	yearly	–	09/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Remarks: see Table AII.3.2.2 for lead.

Table 3.5. **Content of mercury in crops for different kinds of crops (mg.kg–1)**

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	–	–	–	–	2003?
Belgium (Flanders)	–	1990–2000	yearly	national	–
Denmark	–	–	–	(few investigations)	–
Finland	–	–	–	–	–
France	–	–	–	–	–
Germany	–	–	–	–	–
Greece	–	scattered studies but no systematically monitoring			–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Nethevlands	–	? (present)	–	? (country)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	–	yearly	NUTS 3	periodically
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	–	–	–	–	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998	2 years	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, regions	12/2001
Slovak Republic	–	1995–99	yearly	–	09/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001
Remarks: see Table AII.3.2.2 for lead.

Content of other heavy metals in crops for different kinds of crops (mg.kg-1) Table 3.6.

Country	International data sources	Temporal coverage	Reporting frequency	Most detailed national aggregation level (NUTS)	Expected date for data delivery
Austria	–	–	–	–	2003?
Belgium (Flanders)	–	1990–2000	yearly	national level	–
Denmark	–	–	–	–	–
Finland	–	–	–	–	Cu, Zn
France	–	–	–	–	–
Germany	–	–	–	–	–
Greece	–	scattered studies but no systematically monitoring			–
Ireland	–	–	–	–	–
Italy	–	–	–	–	–
Netherlands	–	? (present)	–	? (country)	–
Norway	–	–	–	–	–
Portugal (*)	–	–	–	–	–
Spain	–	–	–	–	–
Switzerland	–	–	at random	individual research projects	periodically, at random
United Kingdom (*)	–	–	–	–	–
Albania	–	–	–	–	–
Bulgaria	–	1986+ (Zn, Cu, Ni, Co, Cr)	5/10 years	no	–
Czech Republic	–	–	–	–	–
Latvia	OECD	1998 (Cu, Zn)	2 years	country level	07/2003
Poland	yes	1992–2000	5 or 10 years	country, regions	12/2001
Slovak Republic	–	1995–99	yearly	–	09/2001

(*) Information is derived from the statements given at the indicator workshop in Vienna, 2001.
Remarks: see Table AII.3.2.2 for lead.

Issues or questions	Proposed indicators[+]	Dimension	Type	Required data	International data sources/ data gaps	Spatial coverage	Time frame for indicator development[#]	National data availability	Temporal coverage and reporting frequency	Most detailed national aggregation level (NUTS)	Remarks
	State										
How many sites show trace element contents over nationally used thresholds? (geogenic or anthropological enrichment)	Exceedance of critical loads of heavy metal contents in soils related to different land use (agricultural land, grassland, forests)	no	B	Content of heavy metals (e.g. [1] Pb, [2] Cd, [3] Cu,...) in soils related to different land use, [4] definition of critical loads/limits	Forthcoming ESB/JRC study		medium	[1] [2] [3] [4]	[1] [2] [3] [4]	[1] [2] [3] [4]	
Which areas show exceedance of critical load of heavy metal deposition ?	Exceedance of critical loads of heavy metal deposition on soils related to different land use (agricultural land, grassland, forests)	no	B	Deposition of heavy metals (e.g. [1] Pb, [2] Cd, [3] Cu,...) in soils related to different land use, [4] definition of critical loads/limits	Critical loads: forthcoming by UN-ECE Convention on Long-range Transboundary Air Pollution		medium	[1] [2] [3] [4]	[1] [2] [3] [4]	[1] [2] [3] [4]	
Input of heavy metals due to wet and dry deposition	Deposition rates of heavy metals	g/ha	A	Content of heavy metals (e.g. [1] Pb, [2] Cd, [3] Cu,...) in dry and wet deposition			medium	[1] [2] [3]	[1] [2] [3]	[1] [2] [3]	
	Long-term deposition rates of heavy metals estimated by the moss technique	**mg/kg**	**A**	**Content of heavy metals in mosses**	**ICP vegetation**	**EU-10 and others**	**short**	**--**	**every five years**	**--**	
Heavy metal contamination of agricultural land	**Heavy metal balance (e.g. Pb, Cd, Cu) for agricultural land**	**kg/ha**	**A**	**[1] Amounts and average heavy metal content in material applied to soils (e.g. fertilisers, composts, sewage sludge), [2] deposition rates of heavy metals, [3] outputs of heavy metals**			**medium**	**[1] [2] [3]**	**[1] [2] [3]**	**[1] [2] [3]**	
Nutrient loads (eutrophication) on agricultural soils	**N-balance for agricultural land**	**kg/ha**	**A**	**--**	**OECD, Eurostat**	**OECD, EU-15**	**--**	**--**	**--**	**--**	
	P-balance in agricultural land	**kg/ha**	**A**	**--**	**Eurostat (EEA, 1999)**	**EU-10**	**--**	**--**	**--**	**--**	
To what extent does soil eutrophication occur?	**Soil eutrophication (C/N, C/P) related to different land use**	**--**	**A**	**[1] C/N, [2] C/P related to different land use**	**Forests: UN-ECE ICP Forest**	***EU-14 and others***	**medium**	**[1] [2]**	**[1] [2]**	**[1] [2]**	
To what extent does soil acidification occur?	Base saturation related to different land use	%	A	Exchangeable Ca, Mg, Na, K, Al, Fe, Mn and H^+			long				
	pH CaCl2 distribution (to what extent pH-values less than three occur in a region) related to different land use	%	A	pH $CaCl_2$ values			medium				
Depletion of humus in soils	**Organic carbon or humus content in sop soils related to different land use**	**g/kg**	**A**	**Content of organic carbon or humus in soils**	**Forthcoming ESB/JRC study**		**short**				
	Impacts										
Changes in biodiversity	**Occurrence of key species in soils**	**%**	**A**	**Occurrence of key species in soils**			**(medium) long**				
Changes in forest health	**Assessment of forest crown conditions**	**%**	**A**	**--**	**UN-ECE ICP Forest**	***EU-15 and others***	**--**	**--**	**annual reporting**	**--**	
Nutrient supply of forests	Content of nutrients in tree foliage	mg/kg	A	--	UN-ECE ICP Forest	EU-15 and others	--	--	annual reporting	--	
	Responses										
What is done to reduce emissions?	Statutory regulations on emission standards	**--**	B								
How much on support is spent for 'environmentally beneficial' farming?	**Expenditures for 'organic farming'**	**euro**	**A**	**Expenditures for 'organic farming'**			**short**				
	Expenditures for agri-environmental measures under Regulation 2078/92	euro	A	--	CEC Agriculture DG	EU-15	--	--	1994–2006	--	

Draft assessment of data needs and availability for diffuse soil contamination

-- no further national information is needed

expected time frame: short: <3 years, medium: 3–5 years, long: >5 years

+ indicators in bold are selected to be of high priority

Issues or questions	Proposed indicators+	Dimension	Type	Required data	International data sources/data gaps	Spatial coverage	Time frame for indicator development#	National data availability	Temporal coverage and reporting frequency	Most detailed national aggregation level (NUTS)	Remarks
	Driving forces										
Development of infrastructure, traffic and transport	**Consumption of petrol and diesel oil by road vehicles**	**kg/capita**	**A**	**--**	**Eurostat**	**EU-15**	**--**	**--**	**--**	**--**	
	Road network density	km/100km^2	A	--	OECD	OECD	--	--	--	--	
Development of agriculture	**Area with organic farming (according to Reg. EEC No 2092/91) as percentage of the total agricultural area**	**%**	**A**	**--**	**FAO, Eurostat and Lampkin, SÖL survey, Willer & Yussefi, 2000**	**EEA-18, Eurostat data, EU15**	**--**	**--**	**Arable area: Eurostat: yearly 1961-97 FAO: yearly 1961-98 organic farming yearly 1985-99**	**--**	
	Percentage of the utilised agricultural area under agri-environmental measures following Regulation No 2078/92	%	A	--	CEC Agriculture DG 1998	EU-15	--	--	1998	--	
Development of human population	**No of households per region (NUTS 3 level)**	**no/km^2**	**A**	**No of households per region**			**short**				
	Pressures										
Influence of infrastructure, traffic and transport	Lead emission due to exhaust gas by road vehicles	g/year	A	[1] Consumption of petrol and diesel oil containing lead, [2] lead content in the fuels or [3] lead emission factors of road vehicles	[1] Eurostat, OECD [2] Eurostat, OECD (?) [3] Eurostat, OECD (?)	[1] EU-15 [2] [3]	short	[1] [2] [3]	[1] [2] [3]	[1] [2] [3]	
Intensity of agriculture	**Livestock units per unit area of agricultural land**	**no/ha**	**A**	**--**	**Eurostat**	**EU-15**	**--**	**--**	**--**	**NUTS2/NUTS1**	
	Average pesticide consumption per unit area of agriculutral land	**kg/ha**	**A**	**--**	**Eurostat: FAO; ECPA;OECD (EEA, 2000)**	**EU-15 plus Iceland, Liechtenstein and Norway**	**--**	**--**	**--**	**--**	
	Use of pesticides (active ingredients) in special crops (e.g. permanent crops, sugar beet, vegetable)	**kg/ha**	**A**	**Amount of pesticides (active ingredients) used in special crops (e.g. [1] permanent crops, [2] sugar beet, [3] vegetables)**			**short**	**[1] [2] [3]**	**[1] [2] [3]**	**[1] [2] [3]**	
	Fertiliser consumption per unit area of agriculutral land	**kg/ha**	**A**	**--**	**FAO (EEA, 2000)**	**EU-15 plus Iceland and Norway**	**--**	**--**	**--**	**--**	
	Sewage sludge application per unit area of agricultural land	**kg/ha**	**A**	**[1] Amount of sewage sludge used in agriculutre (according to different sewage sludge qualities [1a, 1b,..]), [2] area of arable land treated with sewage sludge application**			**short**	**[1] [1a] [1b] [2]**	**[1] [1a] [1b] [2]**	**[1] [1a] [1b] [2]**	
	Solid waste disposal per unit area of agricultural land	**kg/ha**	**A**	**[1] Amount of compost used in agriculture (according to different compost qualities [1a, 1b,..]), [2] area of arable land treated with sewage sludge application**			**short**	**[1] [1a] [1b] [2]**	**[1] [1a] [1b] [2]**	**[1] [1a] [1b] [2]**	
Influences of housing	Consumption on fuel oil and gas for domestic use	t/year	A	Sale on [1] fuel oil and [2]-gas for domestic use per region			short	[1] [2]	[1] [2]	[1] [2]	
Influences of industry and waste management	Emission records due to industrial and waste-burning activities	kg/year	A	Emission records on [1] sulphur, [2] lead, [3] cadmium, [4] copper and [5] zinc due to industrial and waste-burning activities			short (Pb, S), medium (others)	[1] [2] [3] [4] [5]	[1] [2] [3] [4] [5]	[1] [2] [3] [4] [5]	