Technical report No 76

Second technical workshop on contaminated sites

Workshop proceedings and follow-up

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Abbreviations

CS	contaminated sites
EEA	European Environment Agency
EIONET	European environmental information and observation network
ETC/S	European Topic Centre on Soil
ETC/TE	European Topic Centre on Terrestrial Environment
IL	impact level
PCS	potentially contaminated sites

Acknowledgements

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Executive summary

On 10 November 1999, the European Topic Centre on Soil organised a workshop in Dublin, on behalf of the EEA, with the objective of making some progress towards the establishment of a European framework for monitoring and assessment of contaminated sites, based on the development of policy-relevant indicators. The development of such a framework is an integral part of the wider European framework for the monitoring and assessment of soil.

A test data collection for contaminated sites was carried out before the workshop by a selection of countries on a voluntary basis. The objective of the exercise was to explore the possibility of defining regional indicators on contaminated sites, based on regional data. Participation agreements were given one year before at the first EEA technical workshop on contaminated sites, held in Athens in September 1998.

The test data collection had been completed in eight regions at the time of the workshop and was later on carried out in three more regions. The data collection was carried out based on a standard data request form and a guideline (Annex B).

Specific objectives of the data collection were to:
— assess the data availability from national contaminated sites inventories;
— test the comparability of obtained data;
— define key datasets for future data collections;
— check whether obtained data could be used to set up models or estimation schemes;
— find out if contaminated sites data from different European countries could be harmonised;
— check the possibility of drawing general conclusions to be applied to all member countries.

The data request was divided into four major categories. It was intended to ask questions which not only referred to inventory data but also to generic background information such as water supply, industrialisation, expenditures and other.

1. **General information:** general background information.
2. **Number of sites:** summarised data from the individual national inventories.
3. **Costs:** information on cost ranges for investigations and remediation and frequently applied remediation technologies.
4. **Industrial branches** (relevant polluting activities): aiming at elaborating a list of relevant branches by asking for major polluting activities according to relevant national or regional priorities.

Results from the test data collection can be summarised as follows:

Data availability
The data availability was in general very high, in particular for general background aspects, potentially contaminated sites, the specification of impact levels for contaminated sites and the prioritisation of industrial branches. Data availability was low with regard to the specification of remediation costs, the size of sites, the type of contaminated sites and the specification of impact level changes after clean-ups (see Table 26).

Expert estimates
Expert estimates were carried out by all test regions and proved to be very useful to assess the level of progress related to the identification of potentially contaminated sites and contaminated sites. Based on expert estimates, the expected total number of sites per region could be extrapolated (see also Tables 27–29).

Data comparability
Correlation of obtained data with the following comparable units was carried out:
— total population of the region;
— total artificial surface area of the region;
— regional population density;
— density of artificial surface.

The results showed clearly that:
— data on potentially contaminated sites are not comparable across the tested regions,
— data related to contaminated sites with a specified impact level ([1]) have a strong positive correlation to the total artificial surface, the population density and the density of artificial surface and are hence comparable among the tested regions.

A broader range of samples and hence more test regions would clearly improve the quality of the above statements.

Benchmarking
Benchmarks are orientation values, which allow to roughly define orders of magnitude. Two benchmarks are proposed for further assessments. These are described below.

- Benchmark 1, corresponds to contaminated surface area at impact levels 2 and 3 per total artificial surface:

$$Benchmark1 = \frac{contaminated\ surface\ at\ impact\ levels\ 2\ and\ 3\ [km^2]}{artificial\ surface\ [km^2]}$$

  Based on data from five test regions the proposed benchmark amounts to 1–5 %. Further work would be needed to derive a more solid benchmark.

- Benchmark 2, corresponds to expenditures for remediation for contaminated sites at impact levels 2 or 3 to achieve impact level 1 (and lower) related to m² of remediated surface:

$$Benchmark\ 2 = \frac{remediation\ expenditures\ to\ achieve\ impact\ level\ 1\ [EUR]}{remediated\ surface\ [m^2]}$$

  For the above benchmark, no suitable data were obtained.

Benchmark 1 would allow projections of the extent of local soil contamination for each European region. For future data collections, it could be useful to consider only those regions which are most affected.

[1] ( ) Impact levels are described in Table 36 and Annex B.

Definitions
It can be concluded that data related to **contaminated sites** should comprise quantitative as well as qualitative information in order to allow comparison among different countries and regions.

The results clearly showed that data on contaminated sites together with the specification of impact levels are much more reliable and better comparable than data on contaminated sites in general without specification of an impact level. The impact level approach proved to be very practical and easy to implement. The data quality is also highly improved if the size of the sites can be specified. The specification of impact levels can also be applied to remediated sites.

In relation to potentially contaminated sites, it can be concluded that this term is too vague and interpreted in significantly different ways in the member countries. Management of contaminated sites is a tiered process and the identification of potentially contaminated sites represents only the first step (see Table 37). For future data collections, it is proposed to abandon this term. It is recommended to focus on specific polluting activities or polluting sources instead of using one generic term. A workable solution could be to use the results of the prioritisation of industrial branches (see also Table 25) for future data collections. Furthermore, it is recommended to apply quantitative information to each polluting activity; i.e. annual turnover, number of employees, etc.

Development of policy-relevant indicators
A proposal for the derivation of policy-relevant indicators based on data collections at the regional level is presented at the end of the report. A list of indicators and possible data sources is included (Figure 25, Table 38). Data sources are mainly:

— European databases (i.e. GISCO, Corine land cover, Eurostat statistical databases, UNECE databases);
— regional data to be obtained from the countries.

Conclusions

The results of the analysis presented in this report show that the monitoring of local soil contamination should be carried out at a **regional level**. The geographical level of the test data collection corresponds in most cases to the NUTS 3 level of the Eurostat classification. This level seems to be reasonable for future data collections. A lower geographical level, corresponding to the municipality level, would result in enormous data amounts and collection efforts. A larger geographical level would result in too generic results.

It can be concluded that the above analysis clearly reveals that data from contaminated sites inventories need a **minimum specification in terms of quality and quantity**. For contaminated sites, the specification of impact levels and the size of sites proved to be very practical and should be maintained in future data collections. For potentially contaminated sites, it is evident that better specifications are needed (i.e. only selected activities plus quantitative information).

It was possible to derive representative minimum and maximum values for specific parameters, such as:
— the total surface of contaminated sites at impact levels 2 and 3 related to comparable units;
— the total expenditures for main site investigations per m^2 of investigated area.

The first value could be used as an orientation value or **benchmark** to project the level of local soil contamination for each region and to derive those regions in Europe which are highly affected by local soil contamination. The results could be categorised according to classes based on comparisons with average contamination levels. Average contamination levels should be defined on the basis of mean values from representative European samples (e.g. 20 European test regions). The classes could be defined as follows:

— regions with average contamination level;
— regions with contamination level significantly lower European average;
— regions with contamination level significantly above European average.

For future data collections, it could be useful to consider only those regions where the projection shows a high contamination level. This would greatly reduce the effort for future data collections.

Development of policy-relevant indicators

A proposal for policy-relevant indicators based on data collected at the regional level is presented at the end of the report (Figure 25, Table 38).

Follow-up activities

Major developments and progress in the work took place after November 1999.

A working group on soil contamination was established and work on indicators for soil contamination continued during 2000 and early 2001. One major outcome of the working group was the organisation of an EIONET workshop on indicators for soil contamination, held in Vienna in January 2001.

Work on the development of indicators continued and further assessment was carried out, including an analysis of the location of 'hot-spots' of local contamination in Europe. Results were included in the *Down to earth* report (EEA, 2000b) and *Environmental signals 2001* (EEA, 2001b).

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

A new European Topic Centre on Terrestrial Environment (ETC/TE) started operations in July 2001. In particular, the ETC/TE will carry out the follow-up work on indicators for contaminated sites and extend the work to the new EEA countries. To this purpose, a technical workshop addressed to Phare countries took place in Vienna in December 2001, with the objective to integrate the new member countries into the development process of indicators on contaminated sites. As a result, a data collection was launched soon after the workshop. The results will be available by mid-2002.

A follow-up workshop on indicators for soil contamination is foreseen at the end of May 2002 in Seville.

Introduction

Background

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

The EEA's main tasks are:

- to report on the state and trends of the environment;
- to establish, develop and make use of the EIONET;
- to facilitate access to data and information supplied to, maintained 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 therefore 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-15 plus Norway, Iceland and Liechtenstein), EU institutions (in particular the Commission, Parliament and Council) 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 to provide and develop information and data on soil aspects, covering all EEA member countries, in order to increase the understanding of soil as a natural resource, document soil degradation processes and improve the level of reliable and comparable information about contaminated sites, and thus to contribute 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 in July 2001. The ETC/TE is carrying out the work initiated by the ETCs on Soil, Land Cover and Marine and Coastal Environment (terrestrial part of coastal environment).

Past achievements of work on contaminated sites

This second technical workshop was preceded by a number of activities related to soil and contaminated land. The results of these activities were used as a basis for the EEA work on soil and for this workshop in particular. Details are provided below.

1. A survey of contaminated sites management in EU and EFTA member countries, describing legal issues, liability and funding aspects, the existence of databases and inventories (EEA, 2000a).
2. A survey of contaminated sites management in central and eastern Europe. This work was carried out in cooperation with the ad hoc working group on contaminated land. The resulting report uses a similar framework and structure defined in the previous report (Dancee, 2000).

3. Assessments of contaminated land prepared for the EEA state of the environment reports (EEA, 1998a; EEA, 1999).
4. The first contaminated sites workshop in Athens with representatives from all EEA member countries and Switzerland (EEA, 1998b). The workshop addressed the establishment of a European data-collection and assessment framework for contaminated sites.
5. Preparation of a proposal for a European soil-monitoring and assessment framework, based on the development of policy-relevant indicators for soil (EEA, 2001a,b).

Objectives and follow-up of the workshop

The workshop was organised by the ETC/S on behalf of the EEA, under the second EEA multi-annual work programme (MAWP 1999–2003).

The scope of the workshop was to discuss the technical details and make progress in the work on indicators for contaminated sites.

The indicators are developed in the context of a wider European framework for the monitoring and assessment of soil. The objective of the framework is to organise the work needed to support EEA reporting activities on soil, including contaminated sites (EEA, 2001a,b).

A test data collection was carried out before the workshop with the major objective of exploring the possibility of defining indicators on contaminated sites based on regional data.

The expected outcomes of the test data collection were to find out to what extent data from national contaminated sites inventories are available, to test the comparability of obtained data, to define key datasets for future data collections and to check whether these data can be used to set up models or estimation schemes.

Invitations were sent to Commission services, EEA national focal points (NFPs), principal contact points (PCPs) for contaminated sites and other national experts.

A background paper describing in detail the objective and guidelines for the test data collection was prepared and sent to the participants, together with a standard data request form (see Annex B).

Countries were asked to participate in the test data collection on a voluntary basis, to propose a region to this purpose and to compile the data request form with data from this region as well as national data.

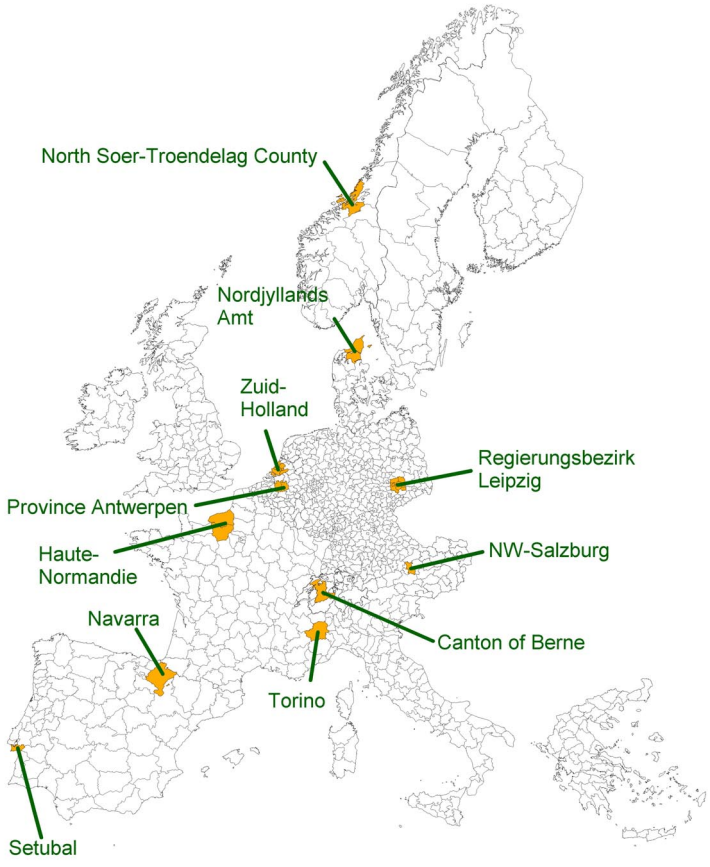
Workshop minutes

On 10 November 1999, the European Topic Centre on Soil organised a workshop in Dublin, on behalf of the EEA, with the objective of proceeding with the work on indicators on contaminated land. This work is an integral part of the implementation of the wider European framework for the monitoring and assessment of soil.

The workshop was preceded by a test data collection for contaminated sites, which was carried out by a selection of countries on a voluntary basis. Participation agreements were given a year before at the first EEA technical workshop on contaminated sites (EEA-ETC/S, 1998).

The test data collection had been completed in eight regions at the time of the workshop and was later carried out in three more regions. The data collection was carried out based on a standard data request form and a guideline (see Annex B), both of which were submitted to the data collectors and all relevant EIONET members by the end of July 1999, namely the EEA national focal points, all EEA principal contact points for contaminated sites (nominated national experts) and the participants of the previous contaminated sites workshop.

Figure 1: Participating test regions



Presentations

The morning session was dedicated to presentations whereas the afternoon session focused on the response of the member countries.

The first presentation was given by Anna Rita Gentile explaining the EEA approach to indicator-based reporting (Annex C), in particular addressing the following issues:

— the EEA mandate;
— the EEA monitoring and assessment framework for soil;
— the EEA reporting context and EEA reporting activities;
— the DPSIR assessment framework applied to soil and the soil multi-function/multi-impact approach;
— required indicators for contaminated sites;
— the problems related to the development of contaminated sites indicators.

The second presentation was given by Martin Schamann, who made special reference to the EIONET workshop on a proposal for a soil-monitoring and assessment framework, held in Vienna in October 1999. (Annex D). The following topics were presented:

— the thematic context between the soil-monitoring and assessment framework and contaminated sites;
— the EEA DPSIR indicator approach applied to contaminated sites; namely the DPSIR approach referring to the driving forces, pressures, state, impacts, and responses related to contaminated sites. Furthermore, the EEA indicator typology, which is based on descriptive indicators (Type A), performance indicators (Type B), efficiency indicators (Type C), and total welfare indicators (Type C);
— a first tentative list of draft indicators. For each indicator a reference to the addressed DPSIR element and to the type of indicator was given;
— the lack of a legal framework addressing contaminated sites problems at EU level and the resulting conflict to establish a framework for data collection and assessment;
— a proposal for continuation, on the basis of data collection on a voluntary basis, by making use of aggregated data at the regional level, and by making use of models or estimation schemes wherever data are not available.

The third presentation was given by Gundula Prokop, who presented the results of the test data collection (Annex E). The presentation started with an overview of already performed activities with regard to developing policy-relevant indicators for contaminated sites. In general, it is foreseen to follow a short-term approach based on collecting national data and by making use of pre-filled questionnaires and a long-term approach based on achieving a minimum of data harmonisation, by collecting data at regional level, and by developing models or estimation schemes wherever data are missing. Expectations of the test data collection were to find out to what extent data from contaminated sites inventories are available, to test the comparability of obtained data, to define key data for future data collections and to check whether these data can be used to set up models or estimation schemes.

At the time the workshop took place, eight regions had submitted their data, namely Northern Jutland Amt (Denmark), the Province of Torino (Italy), North-west Salzburg (Austria), the Region of Navarra (Spain), the Province of Antwerp

(Belgium), Zuid Holland (the Netherlands), Regierungsbezirk Leipzig (Germany) and the Canton of Bern (Switzerland).

The returned data and their assessment are specified in detail in the next section. The outcomes of the exercise are summarised below:

— general data availability was very high;
— the application of the impact level approach was feasible and well received;
— detailed data from the different inventories need a lot of qualitative information and cannot be directly compared.

Comments from the data collectors

The afternoon session continued with feedback from the data collectors to the test data collection.

Belgium: Province of Antwerp
Represented by Eddy van Dyck, Public Waste Agency of Flanders.

The Province of Antwerp is one of the five Flemish provinces. The data situation in the Province of Antwerp is representative for the whole of Flanders. A general contaminated sites survey started in 1987. Before then legislation on contaminated sites was non-existent. In 1995, specific contaminated sites legislation came into force and preliminary investigations were carried out according to the new legislation. The number of sites deriving from these two different surveys do not necessarily overlap due to the different requirements at different points in time.

In 1987, the number of potentially contaminated sites was estimated at 9 000 sites. Many more sites have been identified up to now, and tentative estimates according to current knowledge would raise the estimated total for potentially contaminated sites to 15 000 sites.

Other comments:
— Type of sites. The category 'others' refers to tank storage sites.
— Size of sites. In the Flemish region, cadastral lots are registered. It is possible that one site consists of several cadastral lots. This is a reason why numbers deriving from the Flemish region are in general very high.
— Sub-regions. Data can be provided at provincial level, at municipality level and at cadastral lot level.

Germany: Regierungsbezirk Leipzig
Represented by Detlef Grimski, German Federal Environment Agency.

The German Federal Environment Agency (UBA) does not have direct access to the individual databases of the federal states. A central national database does not exist.

The completion of the data request took about 20 hours.

The data situation of the selected region is representative for Germany.

Specific problems encountered were providing information on the size of sites and costs of investigations and remediation activities.

Spain: Region of Navarra
Represented by José Lopez de Velasco, Ministry of the Environment.

Spain has 16 regions in total with different political structures. Navarra is one of the richest regions in Spain and has outstanding rights of autonomy, such as its own tax system.

Areas of major concern are around the city of Pamplona.

Landfills are a key issue.

The data provided have been obtained from a regional ministry.

An extension of data collection to all Spanish regions implies a number of difficulties.

Specific parts of the data assessment are judged as very problematic, such as the average number of persons per site or costs per square metre (it would be better per cubic metre).

Austria: North-west Salzburg
Represented by Martin Schamann; Federal Environment Agency (UBA) — Austria.

The Austrian UBA is managing a national contaminated sites database and has therefore direct access to Austrian contaminated sites data. Most questions were easy to answer.

The data situation of the test region is above average compared to most Austrian regions. The data situation is dependant on the performance and completion of detailed regional surveys on potentially polluting industrial sites. Among the Austrian federal states, data quality might vary.

Other comments:
— Extension to the national level. At this level of detail, it is possible to provide information for the entire country. Eventual data gaps could be overcome by estimates.
— Impact level approach. This is regarded as good experience. It is possible to assign national definitions for different contamination levels to the proposed impact levels.
— Industrial sectors. This is seen as an important step to find a common base for relevant 'sectors'. Austria has a lot of experience with relevant branches. On the other hand, prioritising of branches on a scientific basis is not very advanced.
— Suggestions. Current and past activities of the former ETC/S focused on the management of contaminated sites. Objective methods to assess the actual state of the environment should be defined and further work should focus on retrieving data on the actual state of the environment.

Italy: Province of Torino
Represented by Aldo Panzia Oglietti, regional Environment Protection Agency of Piemonte.

The Province of Torino is highly industrialised. The data provided includes only a few sites, since a lot of types (as specified in the data request) are not included in the regional inventory. Furthermore, the number of abandoned industrial sites is incomplete.

Other comments:
— Impact levels ([2]). Impact level 1 is assigned to sites where contamination is below the limits specified for specific industrial activities. Impact level 2 is assigned to sites where the limits for specific industrial activities are exceeded.
— Costs. It is not possible to retrieve information from private companies (i.e. investigation costs, remediation costs).
— Size categories. The specified size categories do not match those defined in the regional inventory. The current inventory includes only a few but very large sites, usually in the range of several square kilometres. It is also possible that several contaminating activities are grouped and reported as one site.
— National situation. About half of the Italian regions provided inventory data for a national survey, which was carried out in 1991 and managed by the Ministry of the Environment. No updates have been performed since.

Switzerland: Canton of Bern
Represented by Urs Ziegler, Swiss Agency for the Environment, Forest and Landscape.

The Swiss Agency does not operate at enforcement level. Military sites are included in a separate inventory. In general, data at municipality level are difficult to retrieve.

Information on frequently applied remediation technologies will be available in the future.

The data situation of the Canton of Bern is above average compared to other regions of the country.

It is suggested that qualitative information should be linked with quantitative information (i.e. number of sites).

The Netherlands: Zuid Holland
Represented by Esther Soczó, National Institute of Public Health and the Environment (a detailed written response was provided, see Annex G).

The data collection lacks a reference year or starting year. The identification of potentially contaminated sites includes different stages: the specification of the number of potentially contaminated sites is therefore rather difficult. Information on the size of sites is currently missing; this might change in the future.

The contaminated site situation of Zuid Holland is more or less representative for the rest of the country. With regard to the data situation there are, of course, differences in the level of completion among the Dutch provinces.

Other comments:
— Impact levels ([3]). Impact levels 0 and 1 are the same in the Netherlands.
— Industrial branches. The Netherlands do not have any national priority list based on experience.
— Suggestions. Cost ranges can change. It is therefore suggested to work with percentages; better definitions are needed. A scheme, explaining the relationship between potentially contaminated sites, contaminated sites, remediated sites and involved costs, would be important.

([2]) Impact levels are defined in Table 36 and Annex B.
([3]) Impact levels are defined in Table 36 and Annex B.

Denmark: Northern Jutland Amt
Represented by Sören Bagger, Environment Agency of Northern Jutland (detailed written response was provided, see Annex F).

The data situation in Denmark is in general very good. Information on potentially contaminated sites is above average in Northern Jutland. Most of the requested data already existed in a database.

A special case in Denmark is the fact that about half of the sites are administered by municipalities and the other half by the counties. The data provided for the test data collection represent only those sites which are administered by the counties. A new act came into force on 1 January 2000, requiring that 95 % of the sites be administered by the counties.

— Impact levels ([4]). The method, in general, is regarded as a suitable methodology to proceed with collecting data at the European level. However, better specifications of the impact levels are required, especially for impact level 3. In the case of Northern Jutland, only impact levels 0 and 3 are applied. The other levels could be deduced by further analysing existing data.
— Extension to the national level. The extension of the test data collection to the total country is possible with minor efforts.
— Costs. Remediation measures are usually partly paid by private parties and by public authorities. Public authorities have fragmentary information on remediation costs paid by private parties.

The data of two more regions were not completely received at the time the workshop took place. However, the data were submitted after the workshop. Feedback from the data collectors are described below.

France: Haute-Normandie
Represented by Jean Pierre Gerard, National Geological Survey, France.

The data were collected and submitted on time. Due to an e-mail defect, they were not received before the workshop.

The region of Haute-Normandie has about 6 000 potentially contaminated sites. The data situation of the region is not comparable with other French regions.

Portugal: Peninsula de Setùbal
Represented by Barbara Dias, Waste Institute.

Little information on impact levels and on costs can be provided for the selected region. Besides that, a regular contaminated sites inventory does not exist.

Discussion

The discussion focussed on key aspects for the follow-up of a European data collection for contaminated sites.

Malcolm Lowe (United Kingdom, Department of the Environment, Transport and the Regions) started the discussion with the statement that information on the number of potentially contaminated sites per country or per region would not result in any useful information about the actual extent of the contaminated sites problem. For the definition of policy-relevant indicators, a baseline would need to

([4]) Impact levels are defined in Table 36 and Annex B.

be defined. The definition of such a baseline should be the basis of an international research project.

Andreas Bieber (Germany, Federal Environment Ministry) raised the question as to which consequences the proposed data collection would finally lead to in the future; in particular, the change of data over a certain time period. He made the point that referring to blank figures would lead to a wrong impression on the actual contaminated sites situation.

Urs Ziegler (Swiss Agency for the Environment, Forest and Landscape) stated that there is a need to add value to mere blank figures, further interpretation of data is needed and additional assessment. He is also in favour of performing a research project on a European baseline scenario.

Martin Schamann (Austria, Federal Environment Agency) doubted that additional information would lead to higher data comparability.

Malcolm Lowe (United Kingdom) mentioned that additional information is usually ignored.

Eddy van Dyck (Belgium, Public Waste Agency of Flanders) made the point that the number of sites plus additional information would provide a good overview on how far advanced the contaminated sites management of a specific country is.

Malcolm Lowe (United Kingdom) replied that the measurement of different national progress levels would not be a European question.

Jaqueline Miller (Belgium, Brussels University for the Walloon Region, Institut de sociologie) is of the opinion that the work with the test regions should be considered as a first step towards a European framework. A larger sample, for regions with different features, would be required to achieve a broader data pool.

In the second part of the discussion, those countries which did not participate in the test data collection were asked if a future contribution was possible. The following answers were provided.

Harald Solberg (Norway). The participation of Norway is, in general, possible (detailed comments were provided, see Annex H). The EEA proposal to set up a data-collection and assessment framework for contaminated sites is, in general, welcomed.

Jacqueline Miller (Belgium — Walloon Region). It is possible to perform the exercise for industrial sites.

Gerry Carty (Ireland). Available information is not very detailed. Some basic information could be provided.

Fotini Boura (Greece). Only a little information is available — mostly on waste sites. Support from the regions is doubtful. The Greek Ministry of the Environment will, in the near future, establish a soil department, which will also tackle contaminated sites issues.

Outi Pyy, Teija Haavisto (Finland). Finland will participate if a new or complementary data collection is to be carried out.

Malcolm Lowe (United Kingdom). It is not possible to provide detailed information. For the moment, metadata could be provided.

Results of the test data collection

The data request was completed by 11 regions in total. The minimum criteria for the selection of the region was the existence of at least one major city with more than 100 000 inhabitants, and the co-existence of rural areas next to urban areas. In order to avoid the selection of very large regions, it was recommended not to exceed 10 000 km² for the total area and 3 million inhabitants for the total population.

The data request was divided into four major categories. It was intended to ask questions, which not only refer to inventory data but also to generic background information such as water supply, industrialisation, expenditures and other.

1. **General information:** general background information.
2. **Number of sites:** summarised data from the individual national inventories.
3. **Costs:** information on cost ranges for investigations and remediations and frequently applied remediation technologies.
4. **Industrial branches** (relevant polluting activities): aiming at elaborating a list of relevant branches by asking for major polluting activities according to relevant national or regional priorities.

The selected regions are distributed all over Europe (see Figure 1). In all cases, except Norway, administrative units at the NUTS 3 (province) level could be identified, thus facilitating the derivation of secondary data from European statistical databases (i.e. Eurostat).

General information

The regions chosen matched very well with the minimum criteria; only in a few cases did the regions slightly exceed the criteria. Navarra and Haute-Normandie exceeded the recommended total area and Zuid Holland slightly exceeded the recommended total population. Details are provided in Table 1.

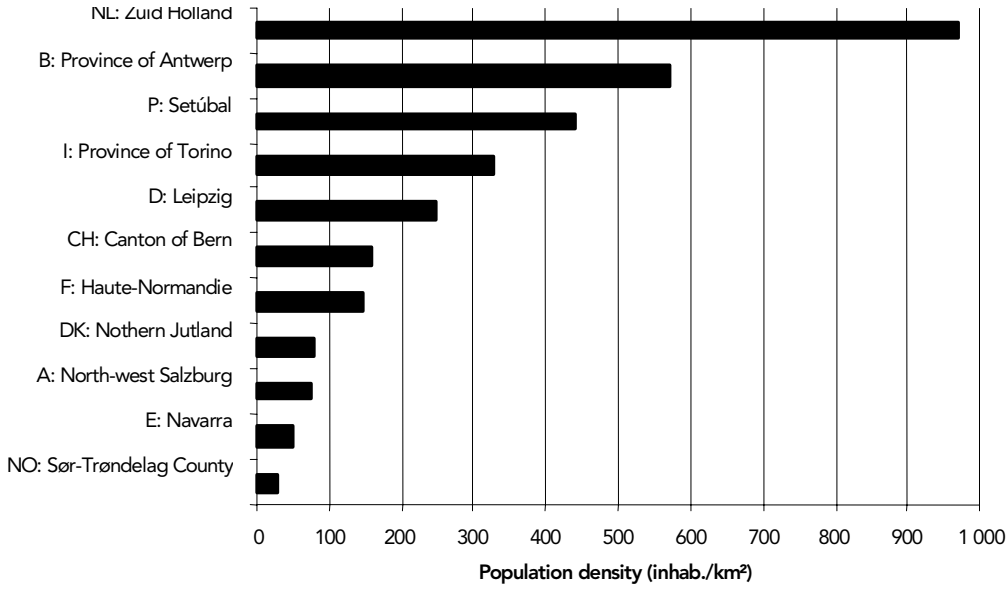
Table 1: Overview of participating test regions

Country	Test region	Surface (km²)	Population	Major cities
A	North-west Salzburg	1 738	312 500	Salzburg
B	Province of Antwerp	2 868	1 640 966	Antwerp
CH	Canton of Bern	5 959	942 000	Bern
D	Regierungsbezirk Leipzig	4 386	1 090 658	Leipzig
DK	Northern Jutland	6 173	490 000	Aalborg
E	Navarra	10 391	532 836	Pamplona
F	Haute-Normandie	12 318	1 780 127	Rouen
I	Province of Torino	6 830	2 222 265	Torino
NL	Zuid Holland	3 446	3 350 000	Rotterdam, The Hague, Dordrecht, Leiden, Zoetermeer
NO	Parts of Sør-Trøndelag County	8 155	233 000	Trondheim
P	Setúbal	1 519	667 150	Almada, Seixal, Setúbal

The **size of the regions** ranged from 1 519 km² (Portugal/Setúbal) to 12 318 km² (France/Haute-Normandie).
The **population in the regions** ranged from 233 000 inhab. (Norway/Parts of Sør-Trøndelag County) to 3 350 000 inhab. (The Netherlands/Zuid Holland).

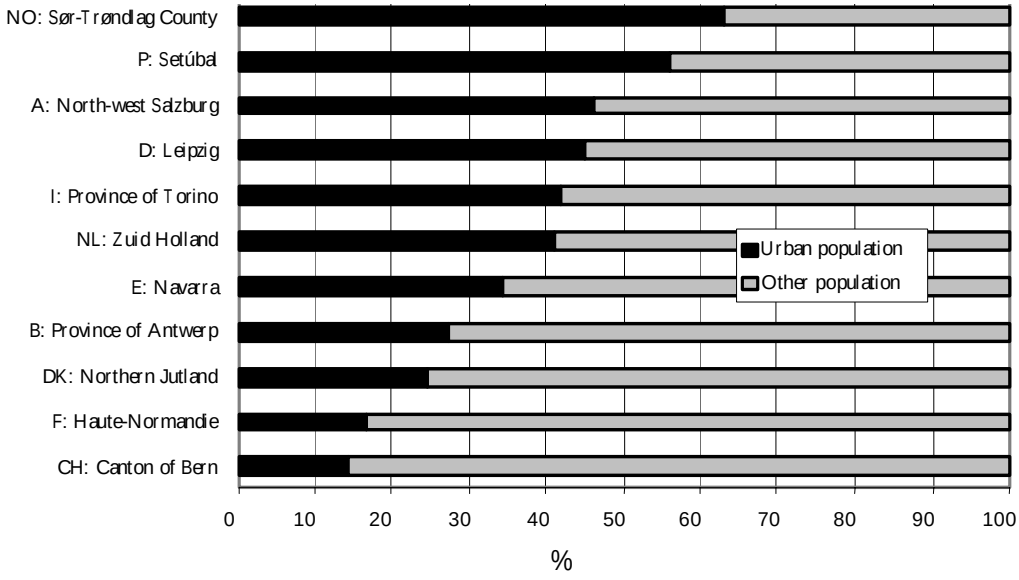
The **population density** ranged from 51 (inhab./km²) in Navarra to 972 (inhab./km²) in Zuid Holland. Details are provided in Figure 2.

Figure 2: Average population density in test regions



The **share of urban population,** defined as the percentage of people living in towns with a population greater than 100 000 inhabitants, ranged from 14 % in Bern (Switzerland) to 63 % in the County of Sør-Trøndelag (Norway). Details are provided in Figure 3.

Figure 3: Share of urban population in test regions



Descriptive information on topography, drinking water supply and industrialisation was required without specifying any criteria.

With regard to the **general drinking water** supply, most regions referred to groundwater or riverbank filtrate to be the most important drinking water source (Table 2). The Norwegian region is the only region with surface water as major drinking water supply.

Table 2: Drinking water supply in test regions

		Groundwater, including river filtrate (%)	Surface water (%)	Spring water (%)
A	**North-west Salzburg**	~ 100		
B	**Province of Antwerp**	Partly	Partly	
CH	**Canton of Bern**	80	< 20	Minor
D	**Regierungsbezirk Leipzig**	100		
DK	**Northern Jutland**	100		
E	**Navarra**	80		20
F	**Haute-Normandie**	Partly	Partly	
I	**Province of Torino**	72	21	7
NL	**Zuid Holland**	Major source		
NO	**Parts of Sør-Trøndelag County**		Major source	
P	**Setúbal**			

Topographic features of the test regions were summarised, according to the existence of mountains, hills, plains and coastlines (Table 3). The following main classes can be identified:

— regions with high elevations, where major settlements are located in river valleys: North-west Salzburg (A), Canton of Bern (CH), Navarra (E), Province of Torino (I), North of Sør-Trøndelag County (NO));
— regions with coastlines, and generally flat topography: Province of Antwerp (B), Zuid Holland (NL), Setúbal (P), Northern Jutland (DK) and Haute-Normandie (F);
— regions with a mixture of the above patterns: Leipzig (D), Navarra (E).

Table 3: Dominating landscapes and major topographic features in test regions

		Dominating landscapes					
		Mountains	**Hills**	**Plains**	**Coast-line**	**Major rivers**	**Highest elevation**
A	North-west Salzburg	•	•			Salzach	2 500
B	Province of Antwerp			•	•	Schelde	< 100
CH	Canton of Bern	•	•			Aare	4 274
D	Regierungsbezirk Leipzig		•	•		Elbe	
DK	Northern Jutland			•	•		135
E	Navarra	•	•			Ebro	< 1 500
F	Haute-Normandie			•	•	Seine, Eure	239
I	Province of Torino	•	•			Po, Dora,Baltea	> 2 000
NL	Zuid Holland			•	•	Rhine, Meuse	< 100
NO	Northern Sør-Trøndelag County	•			•	Orkla, Gaula	~ 1 500
P	Setúbal			•	•		< 100

Industrial history
In this section, test regions were asked to provide information on the industrialisation level of their region. No specific format was predefined, in order to avoid too detailed efforts at this level of data comparison.

All regions have areas with a mixed pattern of commercial and industrial activities. A lesson to be kept in mind for future data collections is to ask for more specific information which can later be better assessed, such as:

— percentage of employees in industry/agriculture/service sector;
— regional domestic product per capita;
— waste production per capita;
— waste-management approaches in the region;
— information on the size and type of companies.

Additional background information

Information on land-use patterns and on the EU Structural Funds are indicated in the following two sections. This type of information was not part of the test data collection. The appropriate information was extracted from the Corine land cover database and the Eurostat GISCO databases.

Land-use patterns

Land use categories of the Corine land cover database were generalised and merged into five main land-use patterns (see Table 4).

Table 4: Generalisation of the Corine land cover classes

Generalised pattern	Classification according to the Corine land cover database
Artificial surface	11. Urban fabric
	12. Industrial, commercial and transport units
	13. Mine, dump and construction sites
Agricultural patterns	21. Arable land
	22. Permanent crops
	23. Pastures
	24. Heterogeneous agricultural areas
Forests	31. Forests
	32. Shrubs and/or herbaceous vegetation associations
	33. Open spaces with little or no vegetation
Wetlands	44. Inland wetlands
Inland waters	51. Inland waters
Other	Other

Distribution of main **land-use patterns** according to Corine land cover are summarised in Table 5.

Table 5: Distribution of main land-use patterns in the test regions (%)

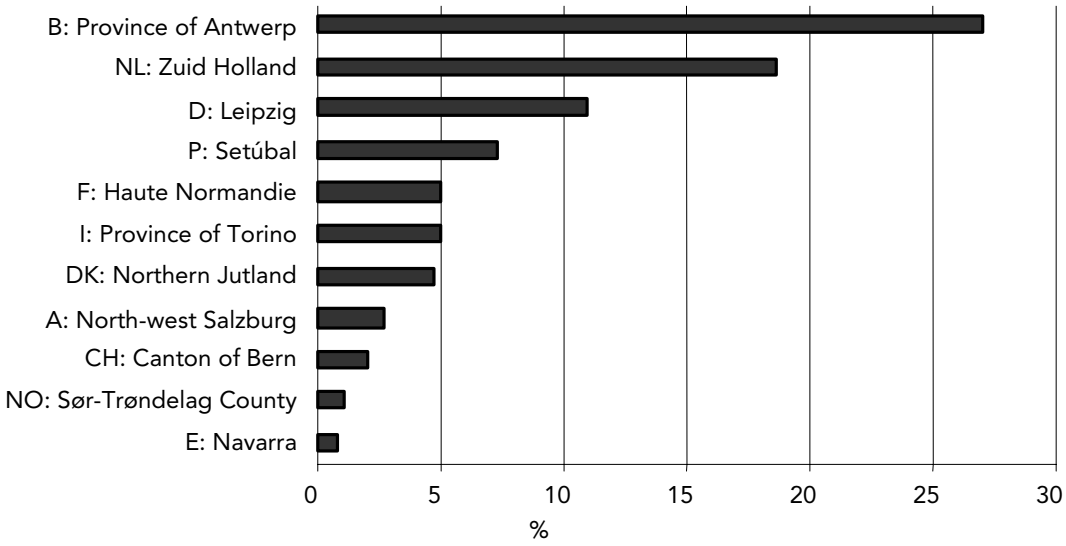
		Artificial surface	Agricultural patterns	Forests	Wetlands	Inland waters	Others
A	North-west Salzburg	2.7	38.6	56.5	0.2	2.0	0.0
B	Province of Antwerp	27.1	54.8	15.4	0.4	2.3	0.0
CH	Canton of Bern	2.0	33.0	63.0	0.0	0.6	1.3
D	Regierungsbezirk Leipzig	10.9	73.9	14.6	0.1	0.5	0.0
DK	Northern Jutland	4.7	80.2	11.9	2.4	0.8	0.0
E	Navarra	0.7	48.5	50.2	0.4	0.3	0.0
F	Haute-Normandie	5.0	76.2	17.7	0.1	0.8	0.2
I	Province of Torino	4.9	38.0	54.3	0.0	0.2	0.0
NL	Zuid Holland	18.7	70.0	2.6	1.9	6.6	0.0
NO	N. Sør-Trøndelag C.	1.0	7.0	39.0	10.0	5.0	62.0
P	Setúbal	7.2	46.7	41.6	1.7	2.4	0.4

Data sources: Data elaboration from Corine land cover. Data for Norway were provided by NIJOS, Norsk institutt for jord- og skogkartlegging

Artificial surface includes buildings, industrial and commercial areas, and transport infrastructure, and is considered to be most relevant for the assessment of local soil contamination. The percentage of artificial surface (with respect to the total surface) is presented in Figure 4. The regions can be grouped in two classes:

Very high share of artificial surface (> 20 %)
— Province of Antwerp (B)
— Zuid Holland (NL).
Very low share of artificial surface (< 5 %)
— North-west Salzburg (A)
— Canton of Bern (CH)
— Navarra (E)
— Northern Jutland (DK)
— Northern Sør-Trøndelag County (N)

Figure 4: Percentage of artificial surface in test regions



EU Structural Funds

A comparison of the economic situation of the different regions was considered to be valuable. Economic classification according to the EU Structural Funds ([5]) was chosen for this assessment. Switzerland and Norway are not part of this classification system and are therefore not included. The European regions are classified in different levels of eligibility for the EU Structural Funds, namely classes according to different funding objectives (Tables 6 and 7).

Table 6: Eligibility classes of the EU Structural Funds

Class	Description
OB1-T	Objective1 — Areas lagging behind/totally eligible
OB2-T	Objective 2 — Declining industrial areas/partly eligible
OB2-P	Objective 2 — Declining industrial areas/totally eligible
OB5b-T	Objective 5b — Rural areas to be developed areas/partly eligible
OB5b-P	Objective 5b — Rural areas to be developed areas/totally eligible
Not eligible	Not eligible

([5]) One of the main European policies concerns the regional policy. With a budget of ECU 141 billion for the six-year period of 1994 to 1999 (one third of the total Union budget), the Structural Funds are the preferred instrument of the economic and social cohesion policy that gives expression to intra-Community solidarity. The effectiveness of the Funds depends mainly on the quality and relevance of the measures undertaken, as well as the capacity of the Member States, regions and other potential beneficiaries to implement them.

Table 7: Eligibility for the EU Structural Funds in test regions

		OB1-T (%)	OB2-T (%)	OB2-P (%)	OB5b-T (%)	OB5b-P (%)	Not eligible (%)
A	North-west Salzburg				17		83
B	Province of Antwerp		24				76
D	Regierungsbezirk Leipzig	100					
DK	Northern Jutland		61		29		11
E	Navarra		17		73		10
F	Haute-Normandie		48		8		44
I	Province of Torino		92	4			
NL	Zuid Holland						100
P	Setúbal	100					

The economic situation of the test regions can be summarised as follows.

— **Regions socially and economically lagging behind** and totally eligible for funding according to the EU Structural Funds:
Regierungsbezirk Leipzig (D) and the Peninsula of Setúbal (P).

— **Regions with a large share of declining industrial areas**, being totally eligible for funding according to the EU Structural Funds:
Province of Torino (I), Northern Jutland Amt (DK) and Haute-Normandie (F).

— **Regions with a large share of rural areas to be developed**, being totally eligible for funding according to the EU Structural Funds:
mainly the region of Navarra (E).

— **Regions with a small share of either declining industrial areas or rural areas to be developed**, being totally eligible for funding according to the EU Structural Funds:
Province of Antwerp (B) and North-west Salzburg (A).

— **Regions which are not eligible**:
Zuid Holland (NL).

Number of sites

Sub-regions

In this section, data from inventories were requested. Test regions were asked to assign data to smaller units than the entire test region and to define sub-regions. About half of the regions selected the municipality level, the other half distinguished between urban and extra-urban areas (Table 8).

Table 8: Selected sub-regions for the aggregation of inventory data

		Potentially contaminated sites	Sites at impact levels 1–3
A	**North-west Salzburg**	Urban and extra urban areas	Urban and extra urban areas
B	**Province of Antwerp**	Municipalities	Municipalities
CH	**Canton of Bern**	Urban and extra urban areas	Urban and extra urban areas
D	**Regierungsbezirk Leipzig**	Counties	Counties
DK	**Northern Jutland**	Municipalities	Municipalities
E	**Navarra**	Municipalities	Municipalities
F	**Haute-Normandie**	Municipalities	—
I	**Province of Torino**	Urban and extra urban areas	Urban and extra urban areas
NL	**Zuid Holland**	Urban and extra urban areas	Urban and extra urban areas
NO	**N Sør-Trøndelag C.**	Municipalities	Municipalities
P	**Setúbal**	Municipalities	—

Type of sites

In order better to compare inventory data from the different regions, participants were asked to specify which type of sites would be regarded by the inventory (see Table 9).

All participants referred to abandoned waste sites and abandoned industrial sites. None of the participants referred to nuclear waste sites. Military sites and natural contamination are considered by a minority of regions.

Table 9: Type of sites included in the inventories of the test regions

		Abandoned waste sites	Operating waste sites	Abandoned industrial sites	Operating industrial sites	Nuclear waste sites	Diffuse contamination	Accidents	Natural contamination	Abandoned military sites	Operating military sites	Other
A	North-west Salzburg	●	●	●	●					●	●	
B	Province of Antwerp	●	●	●	●							●
CH	Canton of Bern	●		●	●			●				
D	Regierungsbezirk Leipzig	●	●	●					●	●		
DK	Northern Jutland	●	●	●	●							
E	Navarra	●	●	●	●		●	●				●
F	Haute-Normandie	●	●	●	●			●				●
I	Province of Torino	●		●	●			●	●			
NL	Zuid Holland	●		●			●				●	
NO	N Sør-Trøndelag C.	●		●						●	●	
P	Setúbal	●	●	●	●		●					●

Completion of surveys

A second step towards improvement of data comparability was the specification of the completion of site investigations in the test region. Firstly, participants were asked to specify the percentage of completion for three different types of site

investigations. Secondly, participants were asked to specify the corresponding investigation name in the original language.

With regard to preliminary surveys, all regions reported a high level of completion. Regarding preliminary investigations and main site investigations, completion levels vary in the test regions (Table 10).

Table 10: Completion of surveys and site investigations in the test regions

		Preliminary surveys		Preliminary investigations		Main site investigations	
		Com-pletion (%)	Corresponding name	Com-pletion (%)	Corresponding name	Com-pletion (%)	Corresponding name
A	**North-west Salzburg**	95	Erfassung, Erhebung	20	Voruntersuchung	5	Detail-Untersuchung
B	**Province of Antwerp**	90	Inventaris	35	oriënterend bodemonderzoek	10	Beschrijvend bodemonderzoek
CH	**Canton of Bern**	90		8		5	
D	**Regieurungsbezirk Leipzig**	95	Historische Erkundung	25	Orientierende Untersuchung	5	Detail-untersuchung
DK	**Northern Jutland**	90	Kortlægning, Opfølgning, Tilsyn	66	Orienterende forureningsundersøgelse	5	Udvidede undersøgelser
E	**Navarra**	100	Inventario Nacional de Espacios contaminados Fase I	29	Inventario Nacional de Espacios contaminados Fase II	1	Inventario Nacional de Espacios contaminados Fase II
F	**Haute-Normandie**						
I	**Province of Torino**	100	Censimento	80	Questionario	40	Piano della caratterizzazione
NL	**Zuid Holland**	80	Inventories of potentially polluting activities	30	Verkennend onderzoek, Oriënterend onderzoek	20	Nader onderzoek
NO	**Part of Sør-Trøndelag County**	100	Problembeskrivelse: desk study	20	Avklarende undersøkelse: limited technical investigation	5	Utvidet undersøkelse: detailed technical investigation
P	**Setúbal**	100	Amostragem preliminary	—	Investigações preliminares	—	

Potentially contaminated sites

Participants were asked to specify the number of potentially contaminated sites which have been identified and to indicate the percentage distribution according to predefined site types or sources of contamination (e.g. 5 000 potentially contaminated sites, of which 41 % abandoned waste sites and 59 % abandoned industrial sites) (Table 11).

Waste sites and industrial sites are, in general, reported as the most frequently occurring types of sites. The share of waste sites and industrial sites out of the total potentially contaminated sites varies remarkably (see Figure 5).

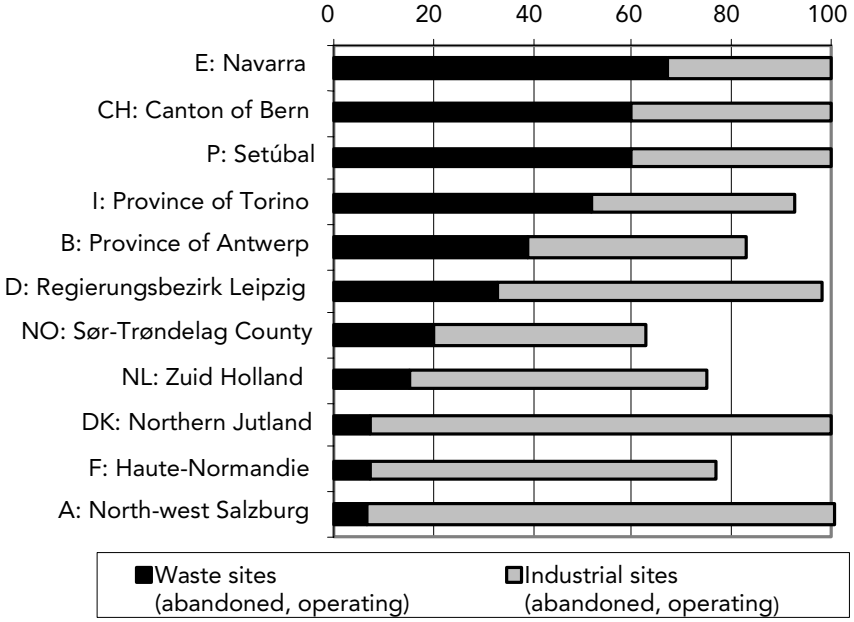
Regions with a high share of potentially contaminated waste sites are Navarra (E), the Canton of Bern (CH) and the Peninsula of Setúbal (P).

Regions with a high share of potentially contaminated industrial sites are North-west Salzburg (A), Haute-Normandie (F) and Northern Jutland (DK).

Table 11: Number of identified potentially contaminated sites and distribution according to sources of contamination (%)

		Potentially contaminated sites	Abandoned waste sites	Operating waste sites	Abandoned industrial sites	Operating industrial sites	Accidents	Diffuse contamination	Nuclear waste sites	Natural contamination	Abandoned military sites	Operating military sites	Other
A	North-west Salzburg	4 170	6	< 1	44	50							
B	Province of Antwerp	1 494	37	2	41	3							18
CH	Canton of Bern	2 452	60		40								
D	Regierungsbezirk Leipzig	4 354	33		65								
DK	Northern Jutland	6 265	6	1	23	70							
E	Navarra	58	67		33								
F	Haute-Normandie	6 206	5	2	37	33	1						18
I	Province of Torino	73		52	29	12	6			1			
NL	Zuid Holland	110 000	15		35	25							25
NO	N Sør-Trøndelag C.	126	20		43						12	25	
P	Setúbal	56	60		40								

Figure 5: Distribution of waste sites and industrial sites within potentially contaminated sites (%)



Contaminated sites

The test data collection required the implementation of different impact levels for contaminated sites. The impact levels are described in the guideline to the data collection (Annex B). Test regions were asked which impact levels are, in general, included in the inventories, and what the corresponding national definitions would be (see Table 12).

Most test regions were able to identify a correspondence between their own terminology and the four impact levels of the data request.

Table 12: Specification of applied impact levels in test regions and specification of corresponding national definitions

			Impact level 3		Impact level 2		Impact level 1
A	**North-west Salzburg**	●	Altlast/Gefahr im Verzug (emergency case)	●	Altlast (contaminated site)	●	Beobachtungsfläche (site under monitoring)
B	**Province of Antwerp**	●	R: opname in register, verdere maatregelen noodzakelijk (registered, further measures necessary)	●	Y: opname in register, geen verdere maatregelen noodzakelijk (registered, no further measures necessary)	●	Geen opname in register, enkel verhoogde concentraties t.o.v. achtergrondwaarden (no registration necessary, only increased concentrations compared with background values)
CH	**Canton of Bern**	●	Sites in need of remediation = polluted sites which lead to harmful effects or nuisances or if there is a substantial danger of such effects arising = contaminated sites	—		●	Polluted sites from which no harmful effects or nuisances are to be expected
D	**Regierungsbezirk Leipzig**	●	Based on current use, there is a significant risk for human beings and the environment	●	Sites posing a significant risk in case of other than current use	●	Sites from which no significant risks are to be expected
DK	**Northern Jutland**	●	Konstateret væsentligt forurenet, risiko for grundvand eller arealanvendelse (considerable contamination detected, risk of groundwater or land use (housing, childcare))	●	Konstateret væsentligt forurenet, lav risiko for grundvand og arealanvendelse (considerable contamination detected, low risk of groundwater and land use)	●	Forurening over vejledende kvalitetskrav (minor contamination detected)
E	**Navarra**	●		●		●	
F	**Haute-Normandie**	●	Secon level of 'classe II ESR (évaluation simplifiée des risques)' (site without remediation plan in accordance with future use)	—		●	'Classe III DR (évaluation détaillée des risques)' (action needed to be in accordance with the future use of the site)
I	**Province of Torino**	●	'Siti contaminati' or 'Siti effettivamente contaminati' (contaminated or effectively contaminated sites)	●	'Siti messi in sicurezza' or 'Siti bonificati con misure di sicurezza' (sites put under or remediated by safety measures)	●	'Siti bonificati' (remediated sites)
NL	**Zuid Holland**	●	(A) After main site investigation 'ernstig verontreinigd, urgent te saneren' seriously contaminated, urgent need for remediation (several urgency categories) safety measures not (yet) effective	●	(A) After main site investigation 'ernstig verontreinigd, niet urgent te saneren', seriously contaminated, no urgent need for remediation (in the short term)(restrictions in use of environmental media, in principle, remediation has to take place in the long term)	●	(A) After main site investigation 'niet ernstig verontreinigd', not seriously contaminated (in principle, enforced restrictions in relation to use of environmental media are not excluded, but not usual) (B) After remediation 'multifunctioneel gesaneerd' (multifunctional remediation completed, level 1 or 0)
NO	**N Sør-Trøndelag C.**	●	Rank 1 or 2 and status 'ikke avsluttet' (investigation/remediation not completed)	●	Rank 3 and status 'ikke avsluttet' (investigation/remediation not completed) Rank 1, 2, or 3 and status 'avsluttet med restriksjoner' (investigation/remediation is completed — restricted use)	●	Rank 1, 2, or 3 and status 'avsluttet' (investigation/remediation is completed — no use restriction)
P	**Setúbal**	●		●		●	

Contaminated sites per sub-region

Test regions were asked to specify the number of contaminated sites, according to impact levels and sub-regions. The results are summarised below (Table 13).

Table 13: Number of sites at impact levels 1–3 in test regions and specification of sub-regions

		Number of sub-regions	Sub-region type	Impact level 1	Impact level 2	Impact level 3
A	North-west Salzburg	3	Urban and extra urban areas	3	4	0
B	Province of Antwerp	70	Municipalities	515	1 167	1 100
CH	Canton of Bern	1	Total test region	671		
D	Regierungsbezirk Leipzig	6	Counties	72	361	327
DK	Northern Jutland	27	Municipalities	223	153	322
E	Navarra	37	Municipalities	3	26	28
F	Haute-Normandie	35	Municipalities		48	
I	Province of Torino	2	Urban and extra urban areas	—	9	15
NL	Zuid Holland	3	Urban and extra urban areas	~ 1 599	~ 836	~ 786
NO	N Sør-Trøndelag C.	18	Municipalities	8	19	13
P	Setúbal	—	—	—	—	—

Test regions were also asked to report the source of contamination by specifying the type of site (i.e. the percentage of abandoned waste sites out of the total number of sites at impact level 1) (Table 14).

This type of information was provided by only 50 % of the test regions. France and Spain submitted generalised data (i.e. impact levels 1 to 3 were aggregated as well as abandoned and operating sites).

Remediated sites

In relation to remediation of contaminated sites, test regions were asked to provide the number of completed clean-ups and the remediation target achieved. Furthermore, information on frequently applied remediation technologies and the average surface size of contaminated sites was requested.

Very heterogeneous information was obtained in this section (see Table 15). No information was obtained from France, Portugal and Switzerland; only Germany provided qualitative information.

However, it is evident that remediation from impact level 3 to impact level 2 is the type of remediation most frequently applied. Remediation to complete functionality (impact level 0) was not mentioned by any of the test regions. Furthermore, remediations from impact level 2 to a lower impact level are rare.

Table 14: Number of sites at impact levels 1–3 in test regions and specification of the type of sites (sources of contamination)

Test region	Type of sites	Impact level 1 (%)	Impact level 2 (%)	Impact level 3 (%)	(Remediation started) (%)
A —North-west Salzburg	Abandoned waste sites	33		50	
	Operating waste sites	0		25	
	Abandoned industrial sites	33		0	
	Operating industrial sites	34		25	
DK — Northern Jutland	Abandoned waste sites	4	44	14	
	Operating waste sites	< 1	2	1	
	Abandoned industrial sites	66	35	53	
	Operating industrial sites	30	19	32	
E — Navarra	Waste sites	100	31	100	
	Industrial sites	0	69	0	
F — Haute-Normandie	Abandoned waste sites	39			5
	Operating waste sites	4			
	Abandoned industrial sites	34			18
	Operating industrial sites	21			5
	Accidents on operating sites	2			2
I — Province of Torino	Abandoned industrial sites		11	27	
	Abandoned waste sites		67	40	
	Natural contamination			6	
	Operating industrial sites		22	27	
NO— N Sør-Trøndelag C.	Abandoned waste sites	77	65	6	
	Operating waste sites				
	Abandoned industrial sites	0	35	47	
	Operating industrial sites				
	Abandoned military sites	8	0	12	
	Operating military sites	15	0	35	

Table 15: Achieved impact levels of remediations applied in test regions

		Remediation level					
		3→2	3→1	3→0	2→1	2→0	1→0
A	**North-west Salzburg**				1		
B	**Province of Antwerp ([1])**	5(22)			n.a.	n.a.	n.a.
CH	**Canton of Bern**						
D	**Regierungsbezirk Leipzig**	Mostly	Rarely	Never	Often	Rarely	Never
DK	**Northern Jutland**	20	67	n.a.	n.a.	n.a.	n.a.
E	**Navarra**				1		
F	**Haute-Normandie**						
I	**Province of Torino**	1	13	n.a.	10	n.a.	n.a.
NL	**Zuid Holland**	160	1 292	n.a.	n.a.	n.a.	n.a.
NO	**N Sør-Trøndelag C.**	0	3		8		
P	**Setúbal**						

([1]) In the case of the Province of Antwerp, remediation was completed for five sites and was in progress in 22 sites.

Frequently applied remediation technologies
Test regions were asked to provide information on the most frequently applied remediation technologies and to specify which technologies would most likely be applied for which remediation target.

Seven countries responded to the request, 50 % of which provided national data, and 50 % regional data.

A simple scoring system was applied, in order to assess information provided:

Never applied = 0 points	Often applied = 10 points
Rarely applied = 5 points	Mostly applied = 15 points

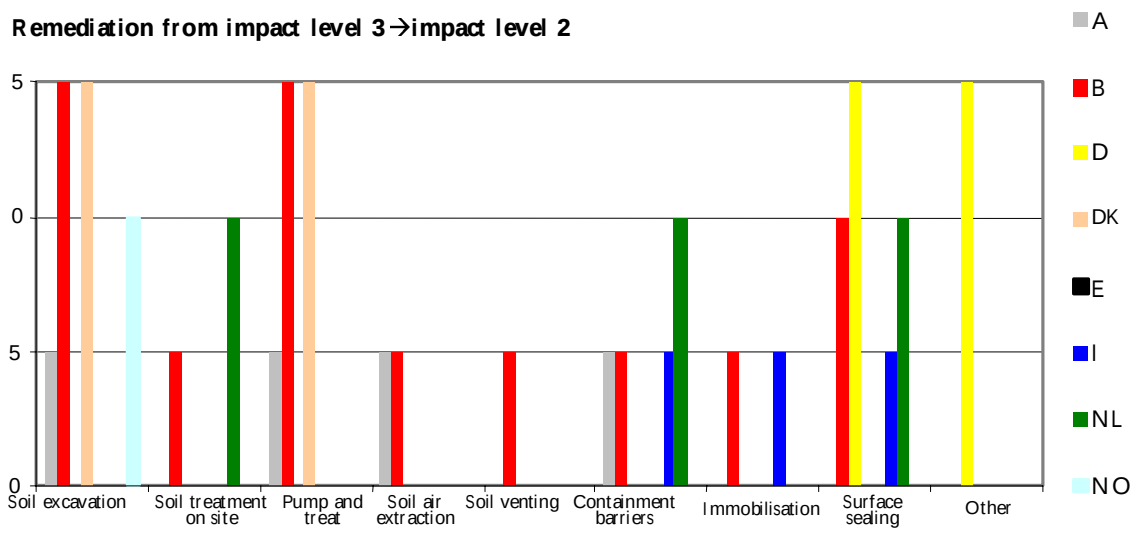
Remediation from impact levels 3 to 2
The results show clear national preferences (see Table 16 and Figure 6):

Denmark:	Soil excavation and pump and treat
Belgium:	Pump and treat, soil treatment on site
Netherlands:	Containment barriers and surface sealing
Germany:	Surface sealing
Norway:	Soil excavation and surface sealing
Italy, Austria, Spain:	Rare application of any of the listed technologies at this level of remediation

Table 16: Frequently applied remediation technologies for remediations from impact levels 3 to 2

Remediation levels 3→2	A	B	D	DK	E	I	NL	NO
Information source	National	National	Regional	Regional	Regional	Regional	National	National
Soil excavation	5	15		15				10
Soil treatment on site		5					10	
Pump and treat	5	15		15				
Soil air extraction	5	5						
Soil venting		5						
Containment barriers	5	5				5	10	
Immobilisation		5				5		
Surface sealing		10	15			5	10	
Other			15					

Figure 6: Frequently applied remediation technologies for remediation measures from impact levels 3 to 2



Remediation measures from impact levels 3 to 1
Results clearly show a higher frequency of application in comparison to the previous remediation type (see Table 17 and Figure 7).

National preferences are not as significant as in the case showed above.

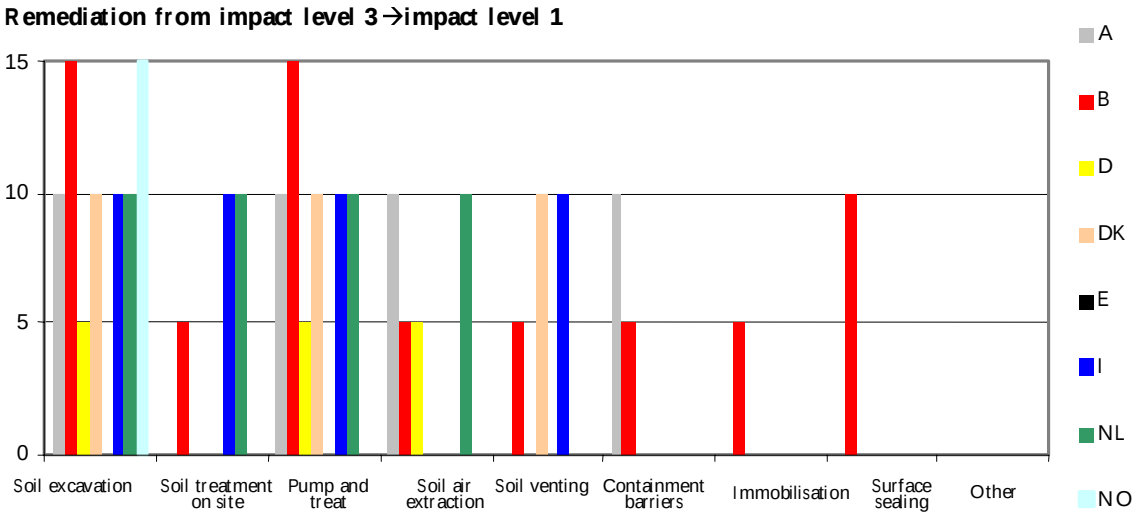
Spain and Germany rarely apply any of the listed technologies at this level of remediation.

Austria, Denmark, Belgium, the Netherlands and Italy often apply several of the listed technologies.

Table 17: Frequently applied remediation technologies for remediations from impact levels 3 to 1

Remediation levels 3→1	A	B	D	DK	E	I	NL	NO
Information source	National	National	Regional	Regional	Regional	Regional	National	National
Soil excavation	10	15	5	10		10	10	15
Soil treatment on site		5				10	10	
Pump and treat	10	15	5	10		10	10	
Soil air extraction	10	5	5				10	
Soil venting		5		10		10		
Containment barriers	10	5						
Immobilisation		5						
Surface sealing		1						
Other								

Figure 7: Frequently applied remediation technologies for remediation measures from impact levels 3 to 1



Remediation measures from impact levels 3 to 0

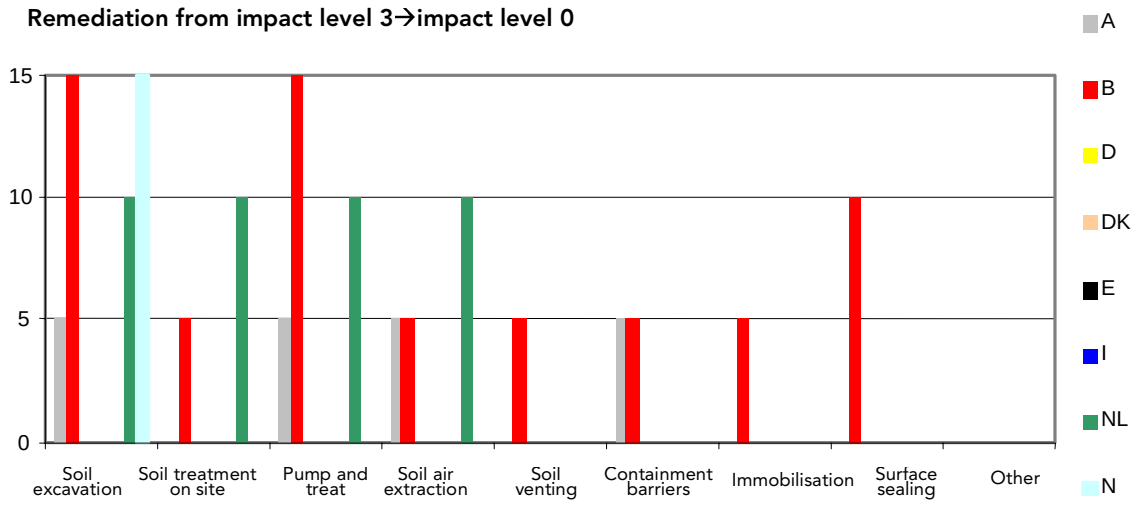
Results prove a clearly rare application of remediation measures at this remediation level (see Table 18 and Figure 8). Only four countries apply this remediation level.

Austria and Spain rarely apply some of the listed remediation technologies. The Netherlands and Belgium (Flanders) often apply several of the listed remediation technologies.

Table 18: Frequently applied remediation technologies for remediations from impact levels 3 to 0

Remediation levels 3→0	A	B	D	DK	E	I	NL	NO
Information source	National	National		Regional	Regional	Regional	National	National
Soil excavation	5	15					10	15
Soil treatment on site		5					10	
Pump and treat	5	15					10	
Soil air extraction	5	5					10	
Soil venting	5	5						
Containment barriers		5						
Immobilisation		5						
Surface sealing		1						
Other								

Figure 8: Frequently applied remediation technologies for remediation measures from impact levels 3 to 0



Remediation measures from impact levels 2 to 1

Results prove a clearly different picture in comparison to the cases analysed above (see Table 19 and Figure 9).

Belgium, Denmark and Spain rarely apply any measures at this level.

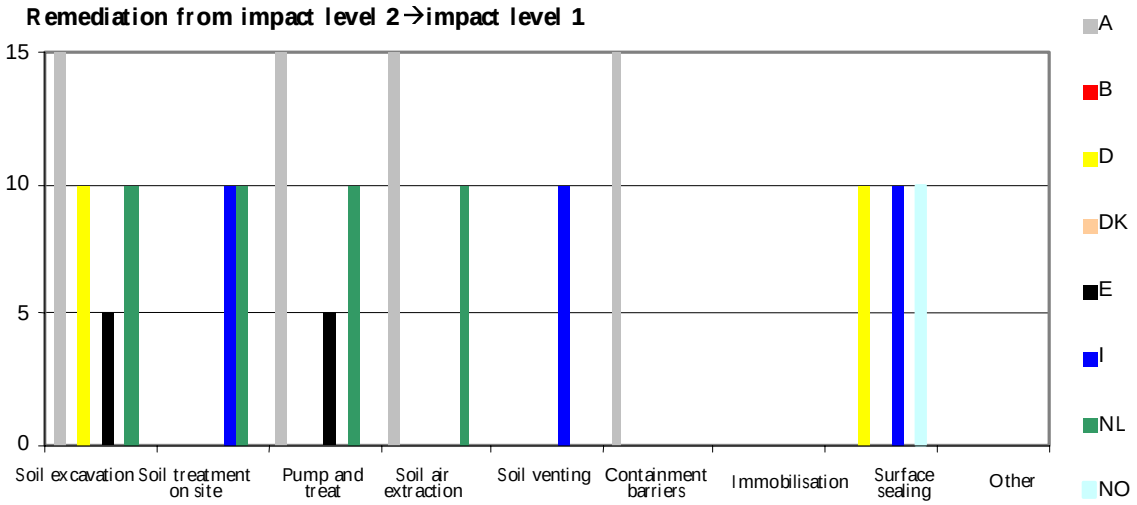
Germany, the Netherlands, Italy and Austria often apply several of the listed technologies.

Austria applies a variety of the listed measures very often.

Table 19: Frequently applied remediation technologies for remediations from impact levels 2 to 1

Remediation levels 2→1	A	B	D	DK	E	I	NL	NO
Information source	National	National	Regional	Regional	Regional	Regional	National	National
Soil excavation	15		10		5		10	
Soil treatment on site						10	10	
Pump and treat	15				5		10	
Soil air extraction	15						10	
Soil venting						10		
Containment barriers	15							
Immobilisation								
Surface sealing			10			10		10
Other								

Figure 9: Frequently applied remediation technologies for remediation measures from impact levels 2 to 1

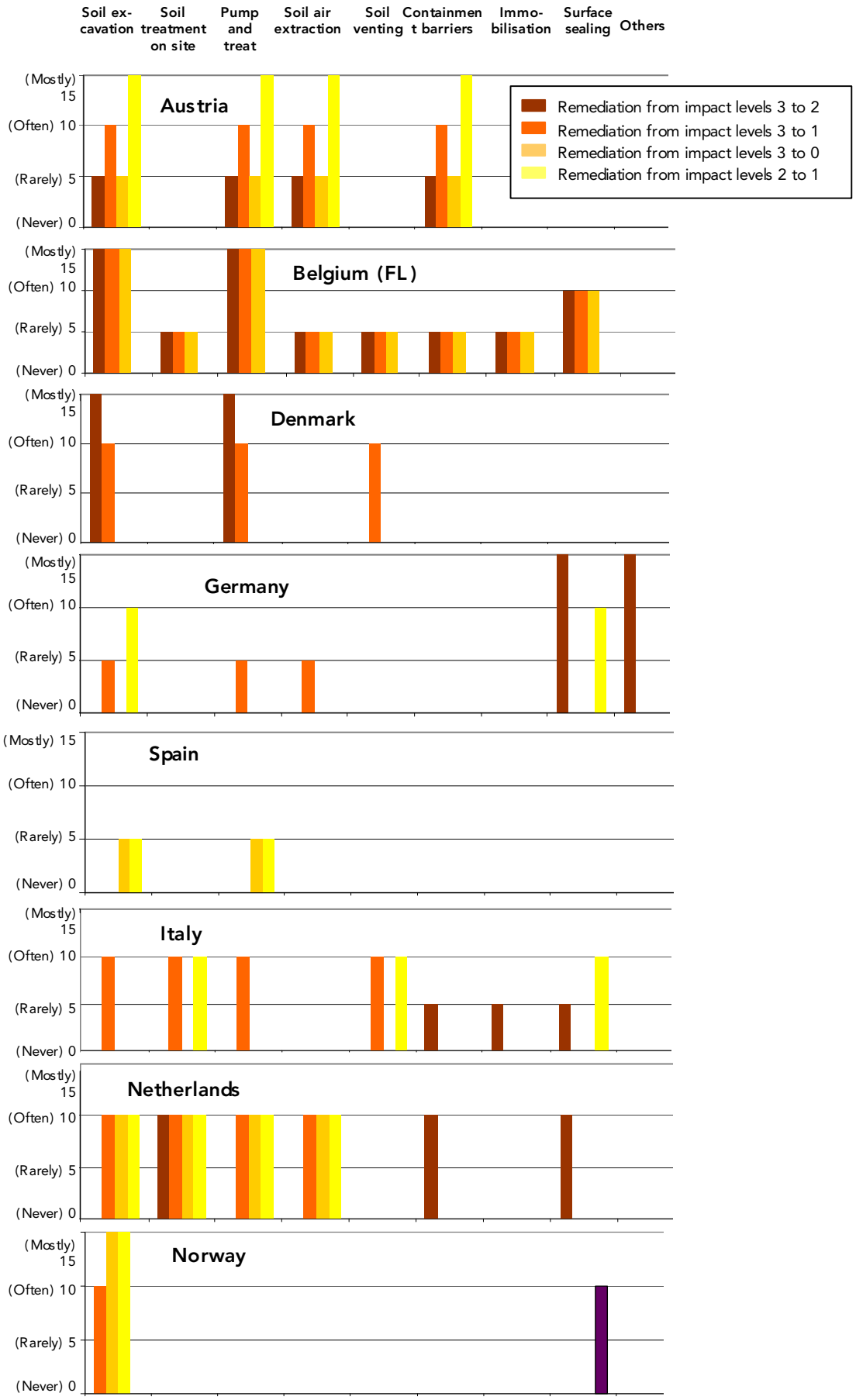


The overview of responses received reveals that specific types of remediation are not applied at all or only rarely applied. Furthermore, it is evident that different types of remediation technologies are applied in the test regions analysed. Results are summarised in Table 20 and Figure 10.

Table 20: Remediation types which are either never or only rarely applied

	3→2	3→1	3→0	2→1
A	X		x	
B (FL)				x
D			x	x
DK			x	x
E	X	x		
I	X		x	

Figure 10: Frequently applied remediation technologies and remediation Types in test regions



Size of sites

Would the size of a site refer only to the size of the contaminated area or to the size of the entire real estate? In order to get more detailed information, test regions were asked to answer specifically on this issue.

In all, 10 countries provided information. With regard to the size of potentially contaminated sites, five countries consider the size of the real estate, three consider the size of the contaminated area and two countries consider both.

With regard to contaminated sites, only two countries consider the real estate size, three countries refer to the size of the contaminated area and four countries consider both. Results are summarised in Table 21.

Table 21: Understanding of the size of sites in test regions, being either the size of the real estate or the size of the contaminated area

	Potentially contaminated sites		Sites at impact levels 1–3	
	Real estate	Contaminated area	Real estate	Contaminated area
A	Y		Y	
B		Y		Y
CH		Y		Y
D	Y		Y	
DK	Y		Y	Y
E	Y	Y	Y	Y
F	Y			
I	Y		Y	Y
NL		(Y)([1])	(Y)([2])	Y
NO		Y		Y

([1]) This information is usually lacking.
([2]) This information is considered of minor importance.

To get an idea of how large contaminated sites are, test regions were asked to provide information on the size of their contaminated sites in terms of size categories.

All countries provided at least some information on this issue. However, the obtained information includes a lot of gaps and data which were not comparable.

Table 22: Size classes of potentially contaminated sites in test regions (%)

	No information	< 100 m²	100–500 m²	501–1 000 m²	1 001–5 000 m²	5 001–10 000 m²	> 10 000 m²
A	10	3	26	19	29	7	6
B ([1])	11.4	0.5	9.2	8.7	19.2	13.2	37.8
D	58.5	2.5	4.8	4.1	11.9	6	12.2
DK		1	10	16	35	11	27
E	84			2		2	12
F	82	0.2	1.6	2	5.2	2.5	6.5
NL	100						
NO	17	2	13	13	20	11	24
P	45	5	11	5	16	4	14

([1]) Information refers to Flanders.

In relation to potentially contaminated sites, results are shown in Table 22 and Figure 11. Some countries reported not to have the required information for the majority of sites (i.e. Spain 84 %, France 82 %, the Netherlands 100 %). Belgium (Flanders) reported a remarkably high share of large sites (>10 000 m²) for potentially contaminated sites.

Figure 11: Size classes of potentially contaminated sites in test regions (%)

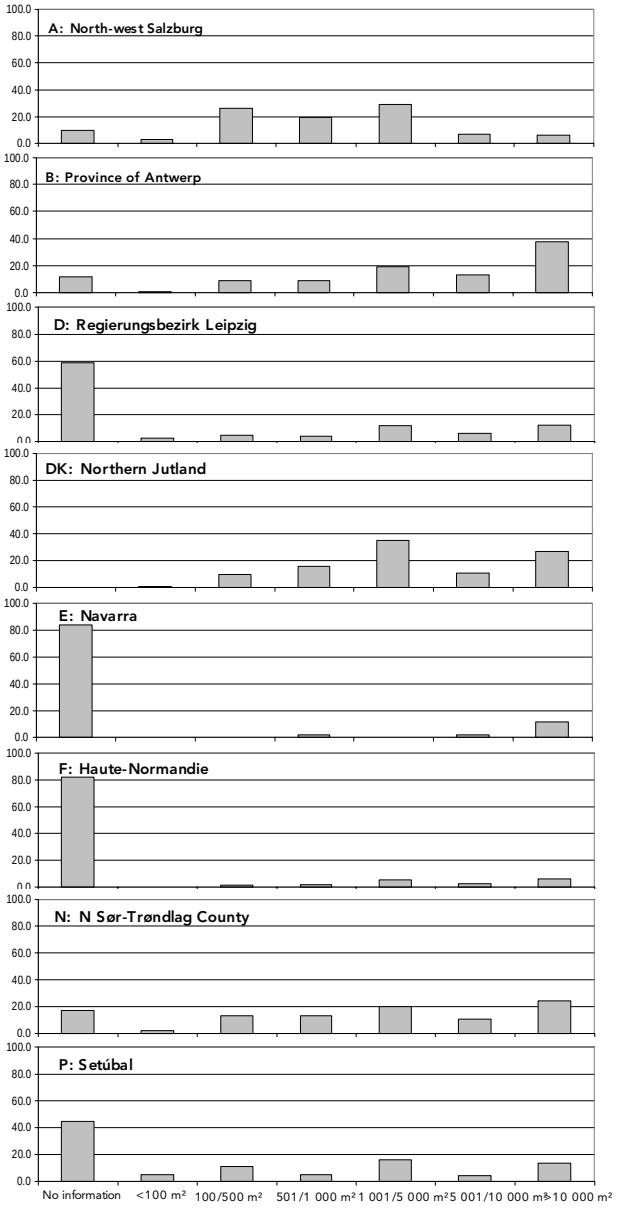
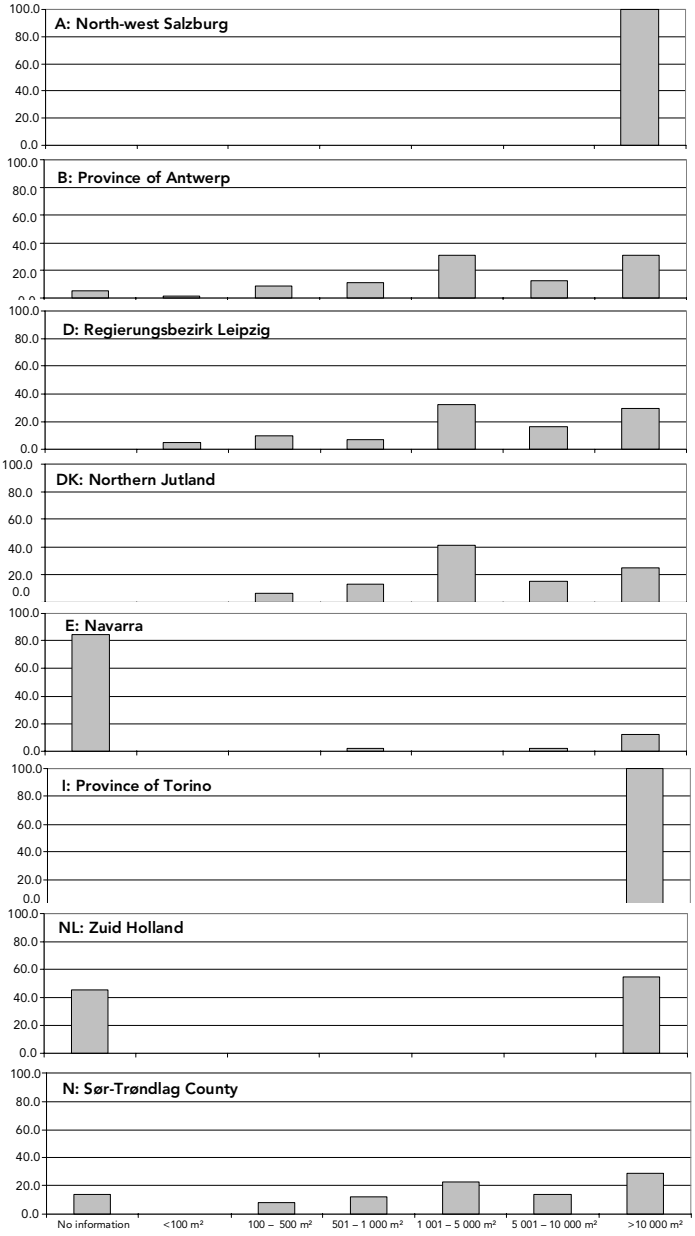


Table 23: Size classes of sites at impact levels 1–3 in test regions (%)

	No information	< 100 m²	100–500 m²	501–1 000 m²	1 001–5 000 m²	5 001–10 000 m²	> 10 000 m²
A							100
B	5.5	1.1	8.9	10.8	30.5	12.5	30.7
D		5.1	9.6	7.1	31.9	16.6	29.7
DK	0	0.5	6	13	41	15	25
E	84.0	0.0	0	2	0	2	12
I							100
NL	45						55
NO	14	0	8	12	23	14	29

Less information was obtained for sites at impact levels 1–3. Austria and Italy refer to large sites only, whereas Germany, Denmark and Belgium refer to a more even distribution of sites in all size categories (see Table 23 and Figure 12).

Figure 12: Size classes of sites at impact levels 1–3 in test regions (%)



Expenditures

Investigation costs

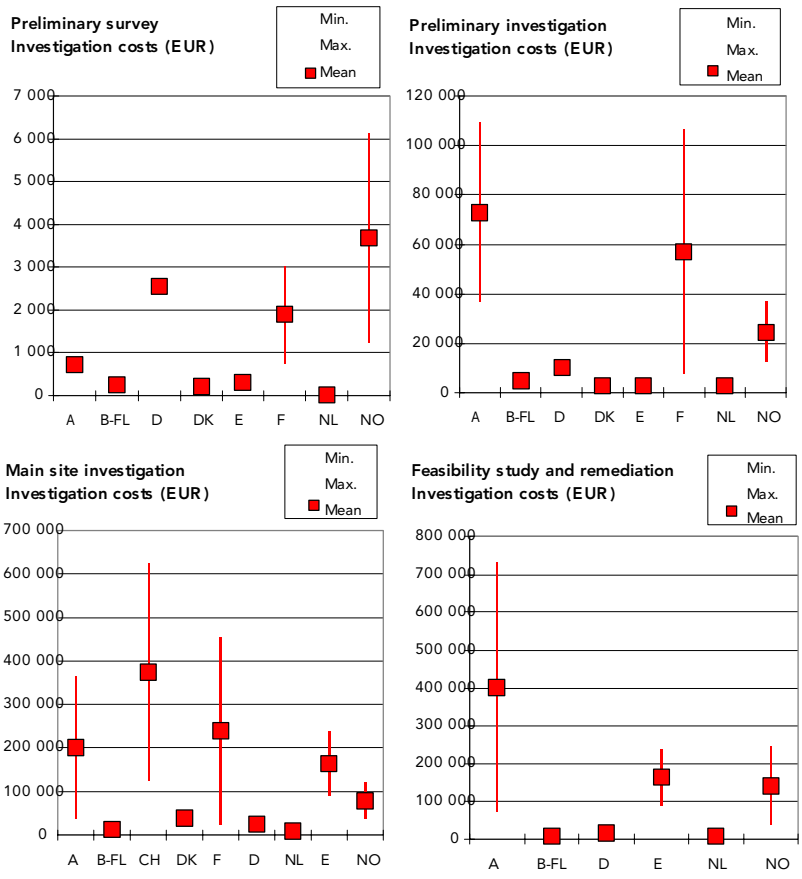
Countries were asked to specify expenditures for different investigation stages, such as preliminary survey, preliminary investigation, and main site investigation. Nine test regions provided information on this issue. Results are listed in Table 24.

Table 24: Investigation costs in test regions

	Cost range per site (EUR)				Cost range per m² (EUR)
	Preliminary survey	Preliminary investigation	Main site investigation	Feasibility study and remediation investigation	Main site investigation
Austria	730	36 500–109 500	36 500–365 000	73 000–730 000	40–150
Belgium	250	2 500–7 500	2 500–25 000	3 750–12 500	Not possible
Denmark	200	3 000	38 200		
France	760–3040	7 600–106 400	22 800–456 000		
Germany	2.570	10 280	25 700	15 420	
Netherlands	30	2 500–3 500	10 000	7 500–10 000	
Norway	1 230–6 140	12 280–36 850	36 850–120 850	36 850–245 690	
Spain	300	3 000	90 000–240 000	90 000–240 000	
Switzerland			12 500–62 500 ([1])		3 (industrial sites)

([1]) EUR 12 500 per landfill site < 10 000m³, EUR 31 250 per landfill site between 10 000 and100 000 m³ and EUR 62 500 per landfill site > 100 000 m³.

Figure 13: Costs for different investigation types in test regions



A graphic representation of investigation costs reveals remarkable differences in cost ranges among the countries (Figure 13).

General trends could be identified:

- Belgium (Flanders), the Netherlands, Germany and Denmark refer to relatively low investigation costs.

— France, Norway and Austria refer to relatively high investigation costs, in particular for preliminary investigations and main site investigations.

Remediation costs

In this section, countries were asked to provide information on remediation costs by specifying remediation types.

Only six countries were able to provide information on this issue. In all cases, remediation costs refer to the general national situation. The little data provided are difficult to interpret. However, most information was obtained for remediation measures from impact level 3 to impact level 1.

Austria has significantly high remediation costs for all remediation targets; on the other hand, remediation actions are rare in comparison to other regions and sites are larger in general.

Figure 14 gives an overview of cost ranges (minimum and maximum costs) for different impact levels. This presentation does not consider the size of the remediated sites. A more detailed analysis is included in the section 'Final assessment', combining information on the size of sites at impact levels 1, 2 or 3 and their average remediation costs.

Industrial branches

A list of 41 industrial activities (nine major groups) was distributed to the test regions. For each single activity, they were asked whether or not the activity was included in contaminated sites management at a national level and which priority the activity would be given based on expert judgment. Countries completed this data request.

Data provided were evaluated by applying a scoring system:
— **priority 1**: very important for contaminated sites management (30 points);
— **priority 2:** important for contaminated sites management (20 points);
— **priority 3**: not very important for contaminated sites management (10 points);
— **not included** in the national system (– 10 points).
Results for the various groups of activities are shown in Figures 15 to 19.

Figure 14: Cost ranges for different remediation types

NB: Figure refers to national data.

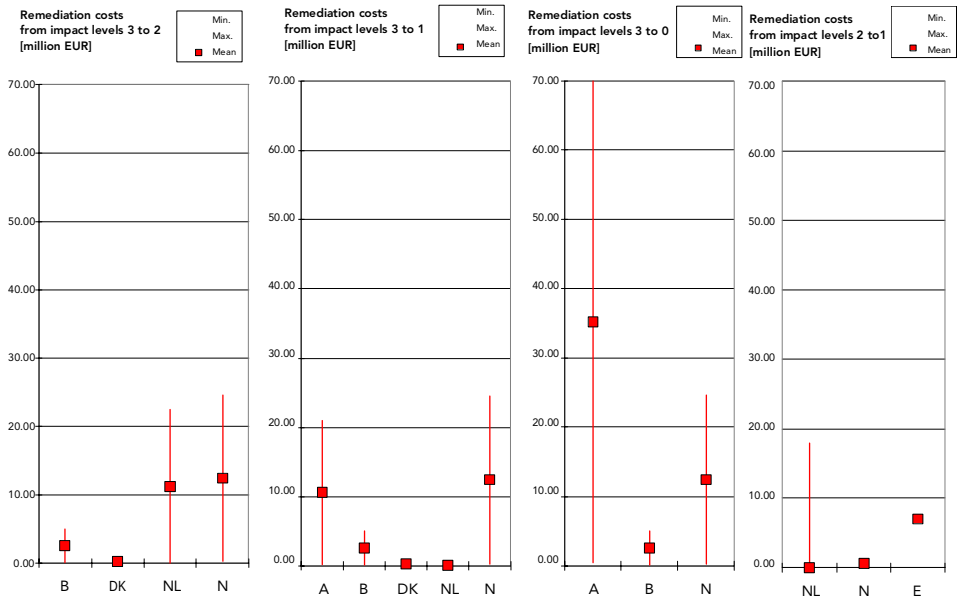
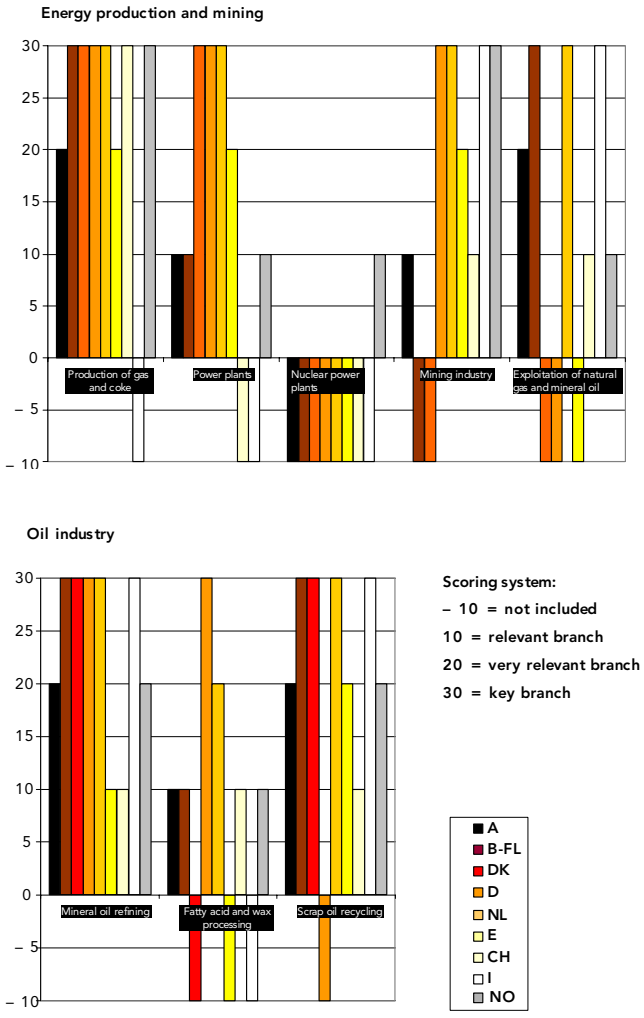


Figure 15: Priorities assigned to industrial activities of the energy production and mining sector and the oil industry



Energy production and mining
Nuclear power plants are not included in contaminated sites management in any of the test regions and are obviously handled under different provisions. Production of oil, gas and coke is generally prioritised with a high score (Figure 15).

Oil industry
Fatty acid and wax processing are generally rated very low, whereas mineral oil refining is rated very high. Scrap oil recycling is rated very differently among the countries (Figure 15).

Chemical industry
All activities of the chemical industry are generally rated very high, except the rubber industry (Figure 16).

Figure 16: Priorities assigned to industrial activities of the chemical industry

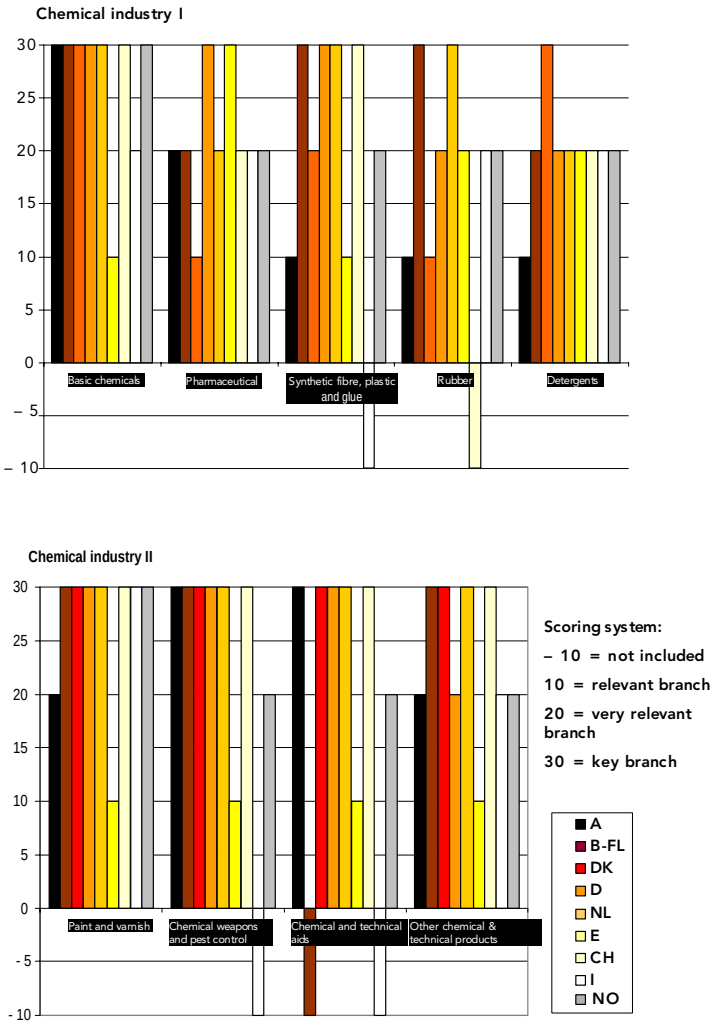
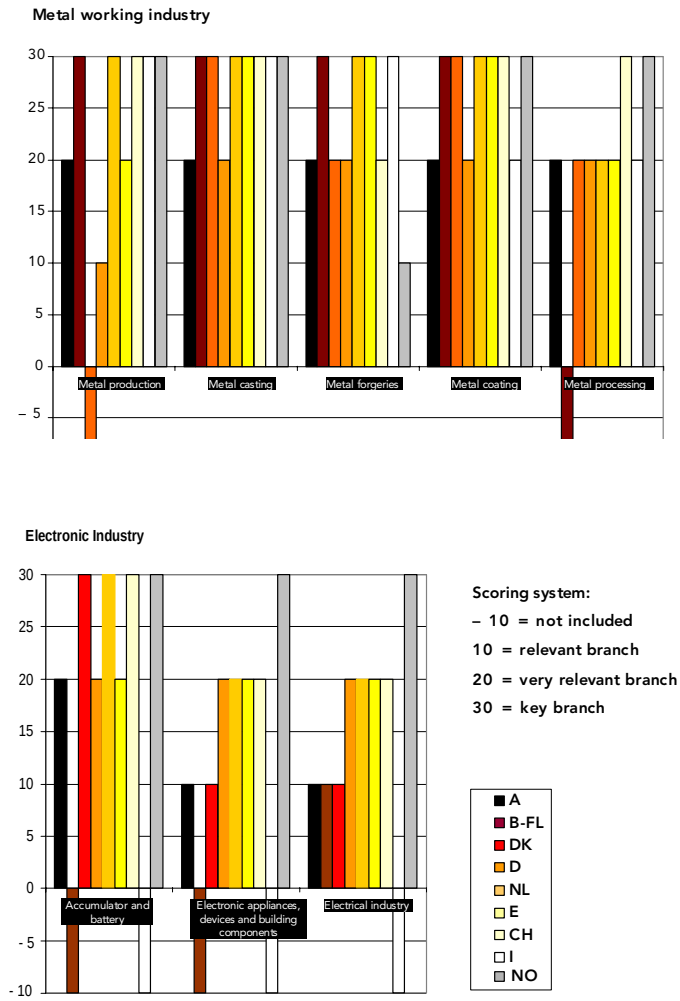


Figure 17: Priorities assigned to branches of the metal working and the electronic industry

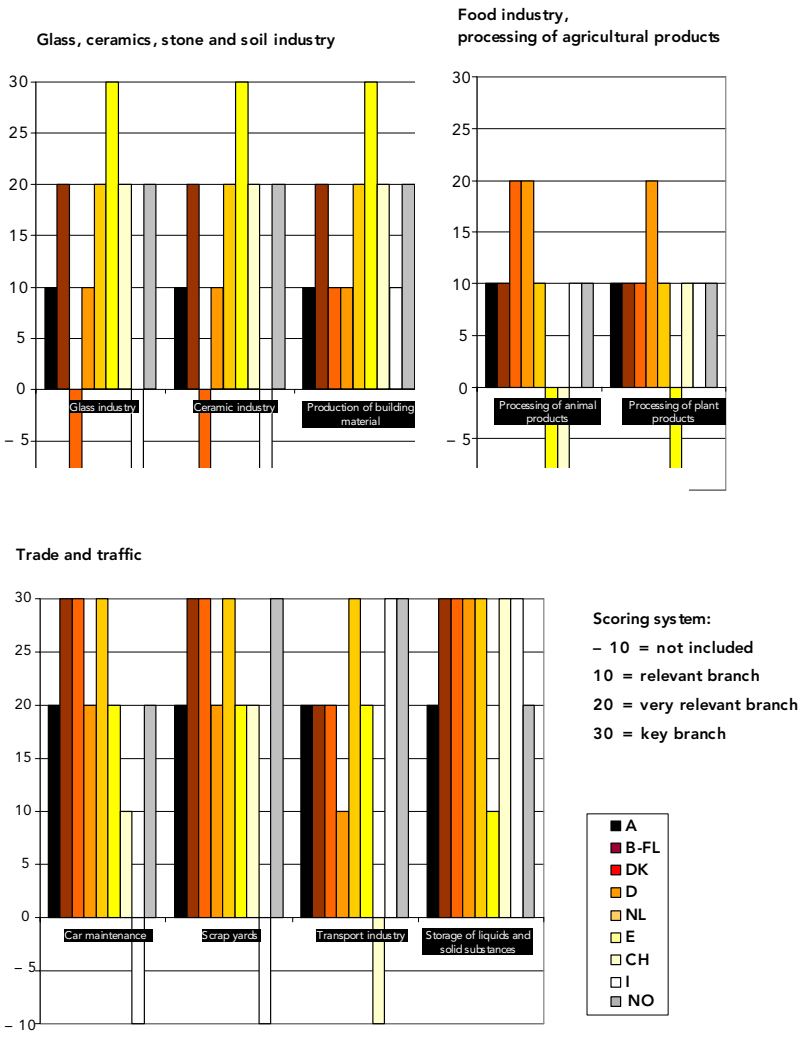


Metal working industry
All activities related to the metal working industry are in general rated very high (Figure 17).

Electronic industry
Production of accumulators and batteries is generally rated high, other activities related to this group are rated low (Figure 17).

Figure 18: Priorities assigned to industrial activities related to the glass, ceramics, stone and soil industry, the food industry and the trade and traffic industry

Glass, ceramics, glass and soil industry

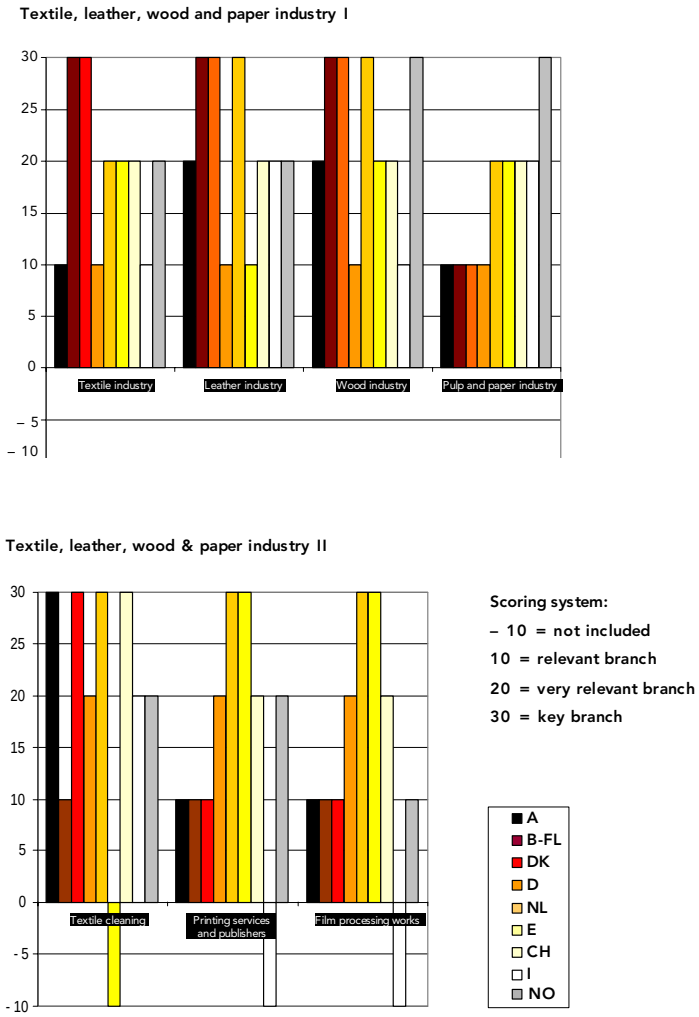


Activities related to this group are generally rated low (Figure 18).

Food industry
Activities related to this group are generally rated low (Figure 18).

Trade and traffic
Activities related to this group are generally rated high, in particular storage of liquids and solid substances (Figure 18).

Figure 19: Priorities assigned to branches of the textile, leather, wood and paper industry



Textile, leather, wood and paper industry
Activities related to this group are generally rated with medium scores (Figure 19).

Table 25 represents a ranking list, indicating average scores for each activity, the highest average scores being at the top of the list and the lowest average scores at the bottom. Activities of the metal working industry and of the chemical industry received the highest scores.

Table 25: Assessment of relevance to soil and groundwater contamination of 41 industrial activities based on expert judgment

Industrial activity	Industrial sector	Average score
Metal casting	Metal working industry	27.8
Basic chemicals	Chemical industry	26.7
Paint and varnish	Chemical industry	26.7
Metal coating	Metal working industry	26.7
Storage of liquids and solid substances	Trade and traffic	25.6
Production of gas and coke	Energy production and mining	23.3
Mineral oil refining	Oil industry	23.3
Other chemical and technical products	Chemical industry	23.3
Metal forgeries	Metal working industry	23.3
Chemical weapons and pest control	Chemical industry	22.2
Wood industry	Textile, leather, wood and paper industry	22.2
Pharmaceutical industry	Chemical industry	21.1
Metal production	Metal working industry	21.1
Leather industry	Textile, leather, wood and paper industry	21.1
Scrap yards	Trade and traffic	21.1
Scrap oil recycling	Oil industry	20.0
Detergents	Chemical industry	20.0
Textile cleaning	Textile, leather, wood and paper industry	20.0
Synthetic fibre, plastic and glue	Chemical industry	18.9
Metal processing	Metal working industry	18.9
Textile industry	Textile, leather, wood and paper industry	18.9
Car maintenance	Trade and traffic	18.9
Transport industry	Trade and traffic	18.9
Chemical and technical aids	Chemical industry	17.8
Accumulator and battery	Electronic industry	17.8
Rubber	Chemical industry	16.7
Production of building material	Glass, ceramics, stone and soil industry	16.7
Pulp and paper industry	Textile, leather, wood and paper industry	16.7
Mining industry	Energy production and mining	15.6
Printing services and publishers	Textile, leather, wood and paper industry	15.6
Electrical industry	Electronic industry	14.4
Film-processing works	Textile, leather, wood and paper industry	14.4
Power plants	Energy production and mining	13.3
Electronic appliances devices and building components	Electronic industry	12.2
Glass industry	Glass, ceramics, stone and soil industry	12.2
Ceramic industry	Glass, ceramics, stone and soil industry	12.2
Exploitation of natural gas and mineral oil	Energy production and mining	11.1
Processing of plant products	Food industry, processing of agricultural products	8.9
Processing of animal products	Food industry, processing of agricultural products	7.8
Fatty acid and wax processing	Oil industry	6.7
Nuclear power plants	Energy production and mining	-7.8

Average scores deriving from eight test regions, scoring system: 30 = very relevant;
– 10 = currently not regarded or included.

General assessment

Contaminated sites exert pressures on soil and groundwater resources. To assess these pressures and their impacts at European level, it is necessary to identify where and to what extent they exist. To monitor this phenomenon, it is necessary to collect specific data on a regular basis.

The test data collection represents a first step towards finding out what data are most relevant for the monitoring of soil and groundwater pressures and hence suitable for regular data collections.

Previous surveys related to contaminated sites have revealed that available data at national level are not directly comparable. It was therefore suggested to go into more detail and analyse the reasons why national data are not comparable.

Data availability

Table 26 gives an overview of data availability. The data availability was in general very high, in particular for general background aspects, for potentially contaminated sites and for the prioritisation of industrial branches.

Table 26: Available data of participating test regions with regard to requested data

Complete data available
Data partly available
No data (not available, missing, etc.)
Submitted data difficult to assess (data do not match with requested format)

No	Type of requested data	A	B	CH	D	DK	E	F	I	NL	P	NO
1.	General information	■	■	■	■	■	■	■	■	■	■	■
1.1.	Population density at municipality level	▒	■	▒	■	■	■	■	■	■	■	■
1.2.	Type of sites included in submitted data	■	■	■	■	■	■	■	■	■	■	■
1.3.	Definition of sub-regions	■	■	■	■	■	■	■	■	■	■	■
1.4.	Progress in contaminated sites management	■	■	■	■	■	■		■	■	▒	■
1.5.	Type of PCS identification	■	■	■	■	■	■	■	■	■	■	■
2.1.a.	No of PCS per sub-region	■	■	▒	■	■	■	■	■	▒	■	■
2.1.b.	PCS specified by type of sites	■	■	▨	■	■	▨	▨	■	■		■
2.2.a.	Included impact levels and definitions	■	■	■	■	■	■	■	■	■	▒	■
2.2.b.	No of sites per impact level and sub-region	■	■	▒	■	■	■	▒	■	▒		■
2.2.c.	Type of sites per impact level	■			■	■	▨	▨	■			■
2.3.a.	Remediated sites; change of impact levels	■	■		▒	■	■		■	▒		■
2.3.b.	Remediated sites; applied technologies	■	■	■		■	■		■	■		■
2.4.a.	Size of sites; real estate or contaminated area	■	■	■	■	■	▨	▒	■	▨		■
2.4.b.	Size of sites; size categories for PCS and CS	■	■	▨	■	■	▒	▒		▒	▒	■
3.1.a.	Costs; investigation	■	■	■	■	■	■	■		■		■
3.2.b.	Costs; remediation	■	■			■	■			■		■
4.	Industrial branches; prioritisation	■	■	■	■	■	■		■	■		■

It is evident that some of the requested data are not collected in some of the regions. This is particularly the case in regions where public authorities have only recently started with a systematic survey of contaminated sites. The following requests received the lowest response:

— **2.4.b. The size of sites according to size categories**
This type of data request is apparently not easily available for many test regions. Italy reported sites much larger than the pre-defined size categories of the data request.

— **2.2.c. Type of sites per impact level**
This type of request was correctly answered by four test regions only. The type of request was apparently either too complicated or not clearly explained.

— **2.3.a. Remediated sites; change of impact levels**
Three regions have apparently no information on this issue; two regions provided qualitative information only.

— **3.2.b. Remediation costs**
Half of the regions cannot provide information on remediation costs, in particular if remediation measures are privately funded.

Can the data be compared?

General considerations

A key expectation of the data collection was to find out if contaminated sites data from different European regions can be harmonised and made fit for comparability.

Example:
Considering two regions of the same size, Region A with a high population density and a variety of industrial activities and Region B with medium population density and with service industries dominating. It is expected that Region A has a higher number of contaminated sites than Region B.

In order to compare contaminated sites data from Region A with Region B in a sound way, it would make sense to relate quantitative information on contaminated sites to other quantitative information with a direct link to polluting activities or sources of pollution; for example contaminated land versus industrially used land or number of employees in industry.

$$\frac{\textit{contaminated land [km²]}}{\textit{industrially used land [km²]}} = X\ [\%]$$

$$\frac{\textit{contaminated land [km²]}}{\textit{employees in industry [inhab.]}} = X\ [km^2/km^2]$$

Quantitative information on the sources of pollution or actual polluting activities were not available when this exercise was carried out. For this reason, the best available data were used. For each region, the total population, the total surface area, the total artificial surface area, the population density and the density of artificial surface were used to find out some sort of direct correlation with the available data.

Data analysis

The following data sets were used for a more detailed analysis:

— the number of potentially contaminated sites per region;
— the number of contaminated sites at impact levels 2 and 3;
— the surface of contaminated sites at impact levels 2 and 3;
— expenditures on preliminary surveys;
— expenditures on main site investigations.

The obtained data sets corresponded to different levels of completion; i.e. the identification of potentially contaminated sites was reported to be complete in some regions whereas in other regions the identification process was still ongoing. In order to make the obtained data sets more comparable, they were extrapolated to 100 % completion of preliminary surveys and main site investigations. The extrapolated data were then correlated with regional data, which were considered to have a direct link to soil pollution. For this exercise, regional industrialisation parameters would have been most suitable but were not available. The following regional urbanisation parameters were used instead:

— total population of the region;
— total artificial surface area of the region;
— regional population density;
— density of artificial surface.

The results of the correlation were classified according to:
☺ = Strong positive correlation ..... Correlation factor > 0.85
😐 = Medium correlation..... Correlation factor 0.65–0.85
☹ = Weak correlation..... Correlation factor < 0.65

Extrapolation

The already identified number of potentially contaminated sites and contaminated sites for each region were extrapolated to 100 %. For both categories, the level of completion of the appropriate surveys (i.e. preliminary survey and main site investigations) was available as percentages (Tables 27 and 28).

Example:
— Number of identified PCS in Region A: 550 sites
— Completion of preliminary survey in Region A: 60 %
— Total number of PCS in Region A (extrapolated): 917 sites

Table 27: Extrapolation of identified potentially contaminated sites (PCS) for each region

	Region	Identified PCS per region	Completion of PCS survey (%)	Extrapolated total PCS
A	NW-Salzburg	4 170	95	**4 389**
B	Province of Antwerp	1 494	90	**1 660**
CH	Canton of Berne	2 452	90	**2 724**
D	Regierungsb. Leipzig	4 354	95	**4 583**
DK	Nordjyllands Amt	6 265	90	**6 961**
E	Navarra	58	100	**58**
F	Haute Normandie	6 206	[1]100 ([1])	**6 206**
I	Provincia di Torino	73	100	**73**
NL	Zuid Holland	110 000	80	**137 500**
NO	Sør-Trøndelag County	126	100	**126**
P	Península de Setúbal	56	100	**56**

([1]) In the case of France, the level of completion for the PCS survey was only assumed, based on available background information.

Table 28: Extrapolation of identified contaminated sites at impact levels 2 and 3 (CSIL2 + CSIL3)

	Region	Identified IL2 + IL3 sites	Completion of survey (%)	Extrapolated total IL2 + IL3 sites
A	NW-Salzburg	4	20	**20**
B	Province of Antwerp	2 267	35	**6 477**
D	Regierungsb. Leipzig	688	25	**2 752**
DK	Nordjyllands Amt	475	66	**720**
E	Navarra	54	29	**186**
I	Provincia di Torino	24	40	**60**
NL	Zuid Holland	1 622	30	**5 407**
NO	Sør-Trøndelag County	32	20	**160**

A few regions specified percentages for size categories for their contaminated sites. For these region, the total surface of contaminated sites at impact levels 2 and 3 was extrapolated (Table 29).

Table 29: Extrapolation of the surface of identified contaminated sites at impact levels 2 and 3 (CSIL2 + CSIL3)

	Region	Surface area of identified IL2 + IL3 sites (km²)	Completion of survey (%)	Extrapolated total surface area of identified IL2 + IL3 sites (km²)
A	NW-Salzburg	0.1	20	**0.4**
NO	Sør-Trøndelag County	0.2	20	**1.1**
DK	Nordjyllands Amt	3.2	66	**4.9**
D	Regierungsb. Leipzig	3.7	25	**14.8**
B	Province of Antwerp	14.3	35	**40.9**

The extrapolated total number of sites was used in further data analysis.

Correlation analysis

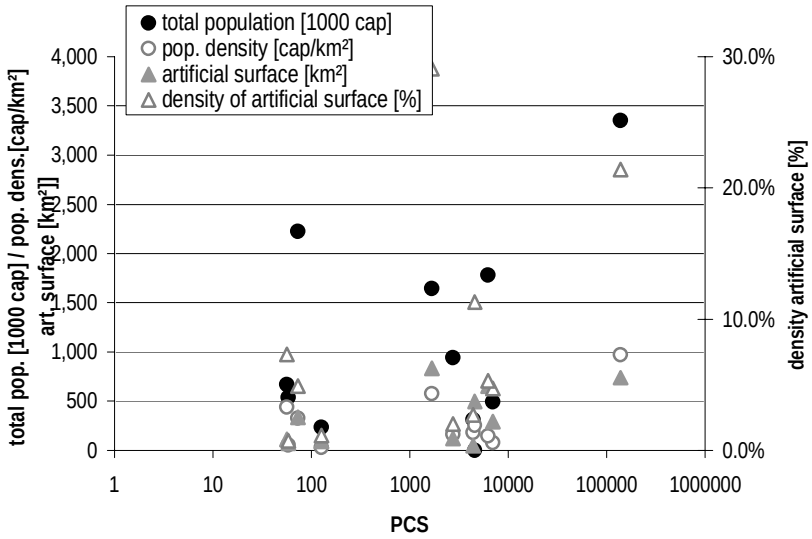
Number of potentially contaminated sites (PCS)
For each region, the extrapolated total number of PCS was correlated with the population, the surface area, the artificial surface, the population density and the density of artificial surface (Table 30, Figure 20).

☹ Results reveal a medium positive correlation with the total population and the regional population density. From previous surveys, it was established that the participating countries use different methodologies to identify PCS. Some regions follow a systematic regional screening for 'potentially polluting sources' (e.g. according to key branches or according to questionnaires on historic industrial activities etc.), whereas others identify such sources on a case-by-case basis. The term PCS is evidently too vaguely defined and cannot be compared in the test regions.

Table 30: Correlation of total number of potentially contaminated sites (PCS) with the total population, the population density, the total artificial surface area and the density of artificial surface

		Total PCS (extrap.)	Total population (inhab.)	Artificial surface (km²)	Pop. Density	AS density (%)
A	NW-Salzburg	4 389	312,500	47	180	2.7
BE	Prov. of Antwerp	1 660	1 640 966	835	572	29.1
CH	Canton of Berne	2 724	942 000	119	158	2.0
D	Reg. Leipzig	4 583	1 090 658	496	249	11.3
DK	Nordjyllands Amt	6 961	490 000	290	79	4.7
E	Navarra	58	532 836	73	51	0.7
F	Haute Normandie	6 206	1 780 127	653	144	5.3
I	Provincia di Torino	73	2 222 265	335	325	4.9
NL	Zuid Holland	137 500	3 350 000	737	972	21.4
NO	Sør-Trøndelag C.	126	233 000	92	29	1.1
P	Penín. de Setúbal	56	667 150	111	439	7.3
	Correlation factor		**0.74**	**0.47**	**0.79**	**0.48**

Figure 20: Correlation of total number of potentially contaminated sites (PCS) with the total population, the regional population density, the total artificial surface area, and the density of artificial surface



Number of contaminated sites at impact level 2 and 3

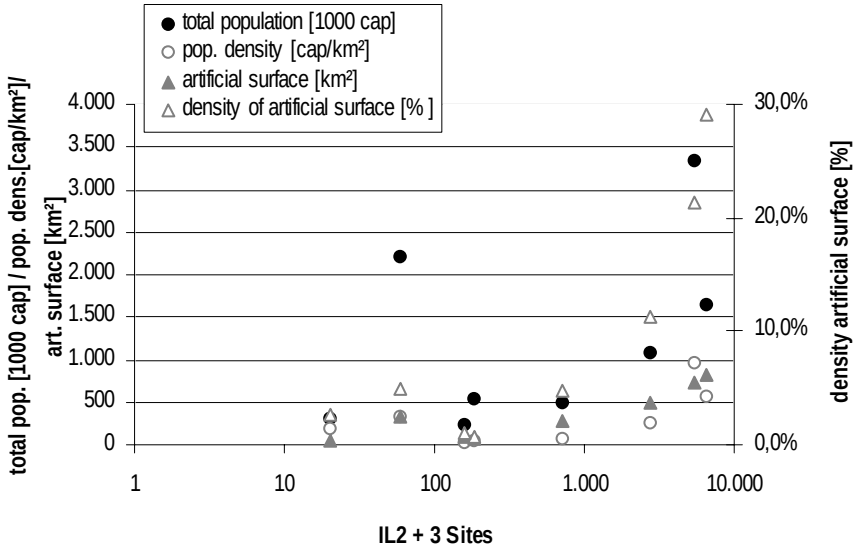
For each region, the extrapolated total number of contaminated sites at impact levels 2 and 3 was correlated with the population, the surface area, the artificial surface, the population density and the density of artificial surface (Table 31).

☺ Results reveal a strong positive correlation with the total artificial surface and the density of artificial surface, and a medium correlation with the population density (Figure 21). The parameter artificial surface shows a better correlation to the number of contaminated sites than other parameters. The distinction between different impact levels for contaminated sites has proved to be useful. Among the tested regions the parameter 'number of contaminated sites' with a specified impact level shows some correlation with other urban parameters.

Table 31: Correlation of total contaminated sites at impact levels 2 and 3 with the total population, the population density, the total artificial surface area, and the density of artificial surface

		Total IL2 +3 sites (extrap.)	Total population (cap)	Artificial surface (km²)	Pop. density	AS density (%)
A	NW-Salzburg	20	312 500	47	180	2.7
B	Prov. of Antwerp	6 477	1 640 966	835	572	29.1
D	Reg. Leipzig	2 752	1 090 658	496	249	11.3
DK	Nordjyllands Amt	720	490 000	290	79	4.7
E	Navarra	186	532 836	73	51	0.7
I	Provincia di Torino	60	2 222 265	335	325	4.9
NL	Zuid Holland	5 407	3 350 000	737	972	21.4
NO	Sør-Trøndelag C.	160	233 000	92	29	1.1
	Correlation factor		**0.64**	**0.95**	**0.83**	**0.99**

Figure 21: Correlation of total contaminated sites at impact levels 2 and 3 with the total population, the population density, the total artificial surface area and the density of artificial surface



Surface occupation of contaminated sites at impact levels 2 and 3

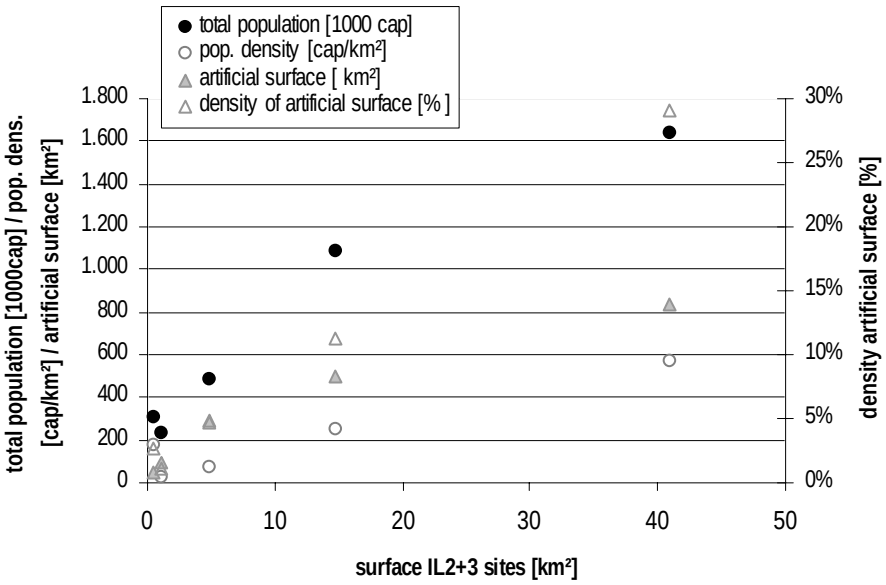
For each region, the extrapolated total surface occupation of contaminated sites at impact levels 2 and 3 was correlated with the population, the surface area, the artificial surface, the population density and the density of the artificial surface (Table 32).

☺ Results reveal a strong positive correlation with the total population, the total artificial surface, population density, and density of artificial surface (Figure 21). The use of the parameter surface occupation of contaminated sites leads to more comparable results than the use of the parameter number of sites only.

Table 32: Correlation of the total surface of contaminated sites at impact levels 2 and 3 with the total population, the population density, the total artificial surface area and the density of artificial surface

		Total surface area IL2 + IL3 sites (extrapol.) (km²)	Total population (cap)	Artificial surface (km²)	Pop. Density (cap/km²)	AS density (%)
A	NW-Salzburg	0.42	312 500	47	180	2.7
B	Prov. of Antwerp	40.86	1 640 966	835	572	29.1
D	Reg. Leipzig	14.80	1 090 658	496	249	11.3
DK	Nordjyllands Amt	4.85	490 000	290	79	4.7
NO	Sør-Trøndelag Co.	1.05	233 000	92	29	1.1
Correlation factor			**0.97**	**0.97**	**0.95**	**1.00**

Figure 22: Correlation of the total surface of contaminated sites at impact levels 2 and 3 with the total population, the population density, the total artificial surface area and the density of artificial surface



Expenditures on preliminary surveys

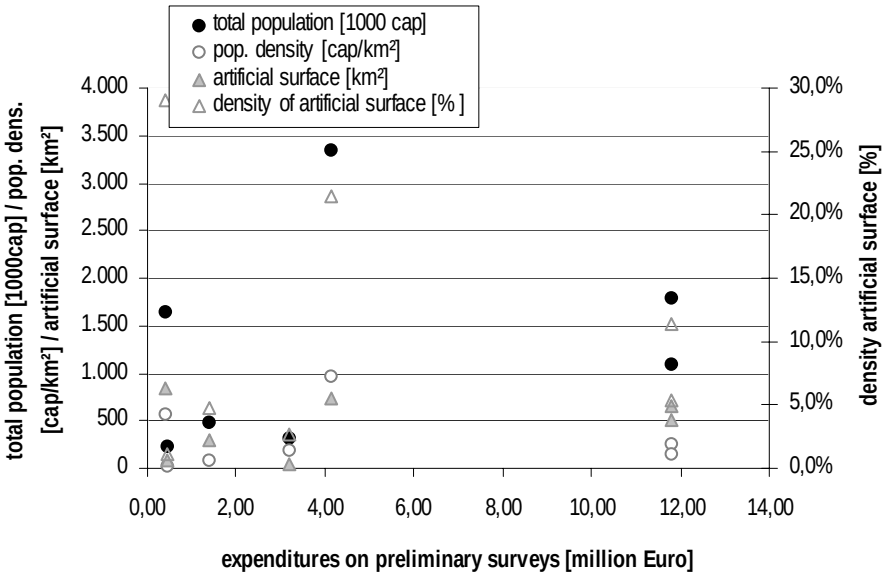
Expenditures on preliminary survey were specified by seven regions. This information was extrapolated to derive total regional expenditures on preliminary surveys. For each region, the extrapolated total expenditures on preliminary surveys were correlated to the population, the surface area, the artificial surface, the population density and the density of artificial surface (Table 33 and Figure 23).

☹ Results reveal no clear positive correlation with any of the tested parameters (Figure 23). Preliminary surveys and the identification of PCS are hence interpreted in different ways throughout the tested regions. Again, it can be observed that the term PCS is evidently too vaguely defined and cannot be compared among the test regions.

Table 33: Correlation of the total expenditures on preliminary surveys with the total population, the population density, the total artificial surface area and the density of artificial surface

		Total expenditures on preliminary surveys (extrapolated)	Total population (cap)	Artificial surface (km²)	Population density (cap/km²)	AS density (%)
A	NW Salzburg	3 204 316	312 500	47	180	2.7
B	P. Antw.	415 000	1 640 966	835	572	29.1
D	R. Leipzig	11 778 716	1 090 658	496	249	11.3
DK	N-Jyllands	1 392 222	490 000	290	79	4.7
F	Haute Normandie	11 791 400	1 780 127	653	145	5.3
NL	Zuid-Holland	4 125 000	3 350 000	737	972	21.4
NO	N Sør-Trøndelag C.	464 310	233 000	92	29	1.1
Correlation factor			**0.24**	**0.28**	**– 0.09**	**– 0.15**

Figure 23: Correlation of the total expenditures on preliminary surveys with the total population, the population density, the total artificial



surface area and the density of artificial surface

Expenditures on main site investigations

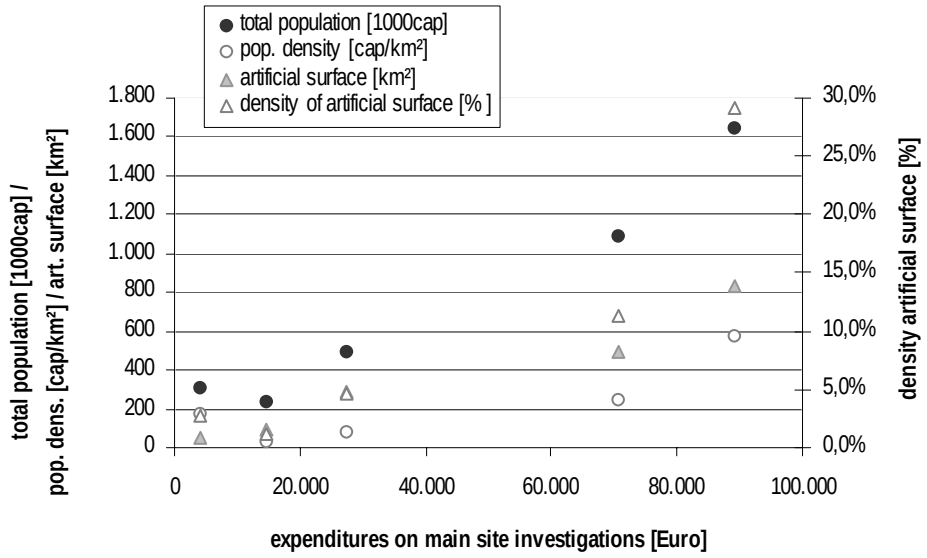
Expenditures on main site investigations were specified by five regions only. This information was extrapolated to derive total regional expenditures on main site investigations. For each region, the extrapolated total expenditures on main site investigations were correlated to the population, the surface area, the artificial surface, the population density and the regional density of artificial surface (Table 34).

☺ Results reveal clear positive correlation with all parameters except the total surface area. Expenditures on main site investigations are hence comparable in the tested regions (Figure 24).

Table 34: Correlation of the total expenditures on main site investigations with the total population, the population density, the total artificial surface area and the density of artificial surface

		Total expenditures on main site investigations (extrapolated)	Total population (cap)	Artificial surface (km²)	Population density (cap/km²)	AS density (%)
A	NW Salzburg	4 015	312 500	47	180	2.7
B	P. Antw.	89 059	1 640 966	835	572	29.1
D	R. Leipzig	70 726	1 090 658	496	249	11.3
DK	N-Jyllands	27 504	490 000	290	79	4.7
NO	N Sør-Trøndelag C.	14 666	233 000	92	29	1.1
Correlation factor			**0.98**	**0.97**	**0.83**	**0.91**

Figure 24: Correlation of the total expenditures on main site investigations with the total population, the population density, the total artificial surface area and the density of artificial surface



Conclusions

Results of the assessment

The test data collection provided insight and clarification of the large differences in contaminated sites data from different countries in Europe.

Data availability
The data availability was in general very high, in particular for general background aspects, potentially contaminated sites, the specification of impact levels for contaminated sites and the prioritisation of industrial branches. Data availability was low with regard to the specification of remediation costs, the size of sites, the type of contaminated sites and the specification of impact level changes after remediation.

Expert estimates
Expert estimates were carried out by all test regions and proved to be very useful to assess the level of progress related to the identification of potentially contaminated sites and contaminated sites. Based on expert estimates, the expected total number of sites per region could be calculated (see Tables 27–29).

Correlation of obtained data with comparable units
Results of the test data collection were correlated with the following parameters:

— total population of the region;
— total artificial surface area of the region;
— regional population density;
— density of artificial surface.

The results of the correlation were classified according to:
☺ = Correlation factor > 0.85
😐 = Correlation factor 0.65 – 0.85
☹ = Correlation factor < 0.65

Table 35: Results of the correlation analysis

	Total pop.	Total artificial surface	Pop. dens	AS dens.	Tested regions
No PCS	😐	☹	😐	☹	11
No CS IL2+3	☹	☺	😐	☺	8
Surface CS IL2+3	☺	☺	☺	☺	5
Expend. prelim. surveys	☹	☹	☹	☹	7
Expend. main site investigations	☺	☺	☺	😐	5

Results show clearly that:

- data related to potentially contaminated sites are not comparable among the tested regions;
- data related to contaminated sites with a specified impact level have a strong positive correlation with the total artificial surface, the population density, and the density of artificial surface, and are hence comparable among the tested regions.

A broader range of samples (more test regions) would clearly improve the quality of the above assessment.

Benchmarking

Benchmarks are orientation values, which allow to roughly define orders of magnitude. The order of magnitude is an important issue and often addressed when contaminated sites problems are discussed. This is particularly true for parameters/indicators such as 'the extent of contaminated land' and 'the costs of remediation'. Benchmarking allows to roughly define such orders of magnitude. First attempts to apply this approach have been made. The results are summarised below.

Example 1:

- Benchmarking: Based on the results from the test regions, the relation between the total artificial surface area per region and the total surface area of contaminated sites at impact levels 2 and 3 ranges between 1 % and 5 %.

- Projections: The above statement would allow to roughly project the total surface of contaminated sites at impact levels 2 and 3 per region or for the whole EU and EFTA coverage based on the artificial surface area.

	Artificial surface (km²)	Projected contaminated surface (impact levels 2 + 3) (km²)
Austria	1 457	15–73
Belgium	5 608	56–280

Example 2.

- Benchmarking: Based on the results from the test regions, expenditures for main site investigations range between EUR 5 and 14 per investigated m².

- Projections: Together with the results of example 1 the expenditures for investigations of contaminated sites at impact levels 2 and 3 can roughly be projected.

	Projected contaminated surface (impact levels 2+ 3) (km²)	Projected expenditures for main site investigations (million EUR)
Austria	15–73	72–1 020
Belgium	56–280	280–3 926

- Benchmark 1, corresponds to contaminated surface area at impact levels 2 and 3 per total artificial surface.

$$Benchmark1 = \frac{contaminated\ surface\ at\ impact\ levels\ 2\ and\ 3\ [km^2]}{artificial\ surface\ [km^2]}$$

Based on data from five test regions, the proposed benchmark amounts to 1–5 %. Further results would be needed to derive a more solid benchmark.

- Benchmark 2, corresponds to expenditures for remediation for contaminated sites at impact levels 2 or 3 to achieve impact level 1 (and lower) related to the area of remediated surface.

$$\text{Benchmark 2} = \frac{\text{remediation expenditures to achieve impact level 1 [EUR]}}{\text{remediated surface [m}^2\text{]}}$$

For the above benchmark no suitable data were obtained.

Benchmark 1 would allow to project the extent of local soil contamination for each European region. For future data collections, it could be useful to consider only the regions which are most affected.

Definitions
It can be concluded that data related to contaminated sites need quantitative as well as qualitative information in order to allow comparison among different countries and regions.

The term 'contaminated site' can include sites with different levels of environmental and human health impacts, ranging from minor to relevant negative effects. The remediation of contaminated sites can result in a full elimination or in a reduction of these impacts. At the first EEA technical workshop on contaminated sites (EEA, 1998b), it was proposed to define sites at different impact levels instead of using the generic term 'contaminated sites'. The objective was to apply quality criteria for contaminated sites, which are flexible enough to co-exist with national terms and definitions. Table 36 summarises possible impact levels in this context.

The results showed clearly that data on contaminated sites together with the specification of impact levels are much more reasonable and better comparable than data on contaminated sites in general without specification of an impact level. The impact level approach proved to be very practical and easy to implement.

Table 36: Impact levels applied to contaminated sites and remediated sites

Level	Brief definition
Level 0	No impacts; no use restrictions (mostly applied at remediated sites)
Level 1	Minor impacts (tolerable contamination); no use restrictions
Level 2	No significant impacts under current use of environmental media, restricted use only
Level 3	Significant impacts, action needed

The data quality would be also improved if the size of the sites could be specified. The specification of impact levels can also be applied to remediated sites.

In relation to potentially contaminated sites (PCS), it can be concluded that this term is too vague and definitely interpreted in significantly different ways in the member countries. Management of contaminated sites is a tiered process and the identification of potentially contaminated sites represents only the first step (Table 37).

Quantitative data about PCS for a defined region or area provide information which is valuable for two reasons:

— the number of PCS for a defined region or area is an important indicator for the extent of industrialisation in this area (pressures and driving forces);
— the progress made in the identification of PCS is an important indicator for the management of contaminated sites (responses).

However, for future data collections, it is proposed to abandon this term. It is recommended to focus on specific polluting activities or polluting sources instead of using one generic term. A reasonable solution could be the use of the results of the prioritisation of industrial branches (see also Table 25) for future data collections. Furthermore, it is recommended to gather quantitative information for each polluting activity, such as annual turnover, number of employees, etc.

Table 37: The key steps of contaminated sites management

Step	Activity	Result
Preliminary survey	Negative effects to human health and the environment suspected	Existence of potential contamination detected
Preliminary investigation	Verification of negative effects to human health or the environment	Existence of contamination verified (definition of impact level eventually possible)
Main site investigation	Quantification of negative effects to human health or the environment	Extent of contamination determined (definition of impact level)
Feasibility study and remediation investigation	Detailed planning of measures to reduce the degree of negative effects to human health or the environment	Detailed remediation plan

Conclusions

Results show that the monitoring of local soil contamination should be carried out at a **regional level**. The geographical level of the test data collection corresponds in most cases to the NUTS 3 level of the Eurostat classification. This level seems to be reasonable for future data collections. A lower geographical level would correspond to the municipality level and would result in enormous data amounts and collection efforts. A larger geographical level would result in too generic results.

The above analysis clearly reveals that data from contaminated sites inventories need a **minimum specification in terms of quality and quantity**. For contaminated sites, the specification of impact levels and the size of sites proved to be very practical and should be maintained in future data collections. For potentially contaminated sites, it is evident that better specifications are needed (i.e. only selected activities plus quantitative information).

It was possible to derive representative minimum and maximum values for specific parameters:
— the total surface of contaminated sites at impact levels 2 and 3 related to comparable units and comparable units;
— the total expenditures for main site investigations per m^2 investigated area.

The first value could be used as an orientation value or **benchmark** to project the level of local soil contamination for each European region and to derive those regions in Europe which are highly affected by local soil contamination.

The results could be categorised according to classes based on comparisons with average contamination levels. Average contamination levels should be defined on the basis of mean values from representative European samples (e.g. 20 European test regions). The classes could be defined as follows:
— regions with average contamination level;
— regions with contamination level significantly lower European average;
— regions with contamination level significantly above European average.

For future data collections, it could be useful to consider only those regions where the projections reveal a high contamination level. This would reduce the effort for future data collections to a great extent.

Development of policy-relevant indicators
Figure 25 shows a tentative proposal for the presentation of policy-relevant indicators based on data collected at the regional level.

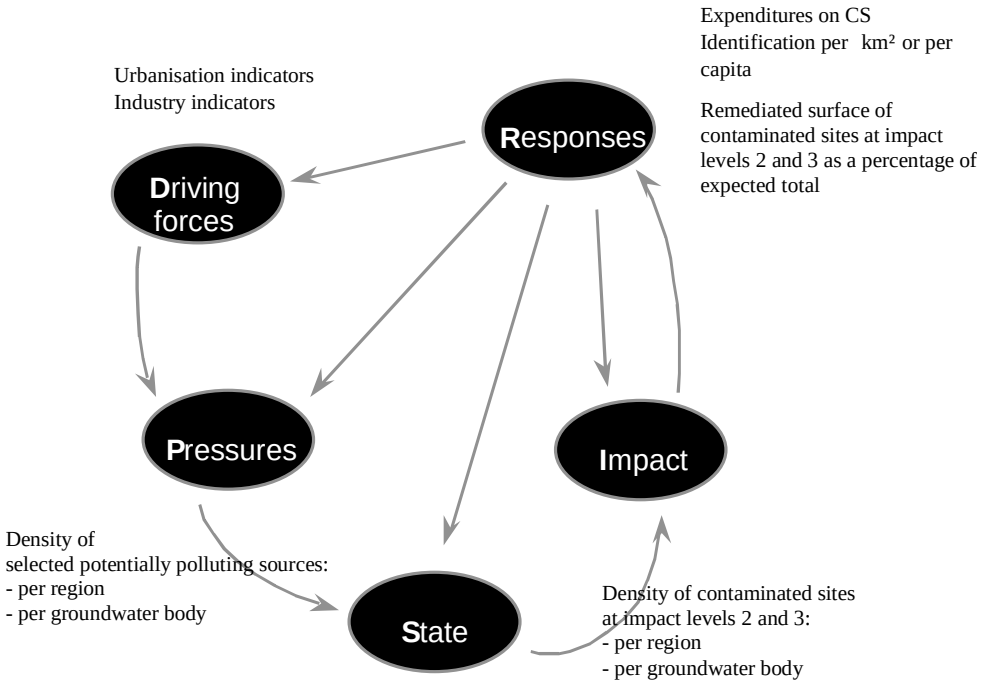
Table 38 provides a tentative list of indicators and a tentative list of possible data sources. Possible data sources are European statistical databases (e.g. GISCO, Corine Land Cover, other Eurostat databases, UNECE databases) as well as specific regional data.

It can be anticipated that only some regions will be able to provide complete data sets, whereas others will only be able to provide fragmentary data sets. It has to be discussed whether missing data could be subject to estimates or projections.

Table 38: Tentative list of feasible indicators on a regional basis according to the DPSIR framework

DPSIR element	Indicator description	Data sources
Driving forces	Urbanisation Indicators (population density, density of artificial surface)	Existing information from European statistical databases
	Industry Indicators	
	Density of relevant industrial branches	
Pressures	Number and quantity of defined potentially polluting sources (industrial or commercial activities) per km² or per capita	Data requests on regional basis Eventually, use of estimates and modelled data for data gaps
	Density of defined potentially polluting sources per groundwater body	
State/impacts	Number and size of contaminated sites at different impact levels per km² or per capita	
	Number and size of contaminated sites at impact levels 2 and 3 per groundwater body	
Responses	Remediated area per region and year (with specification of new impact levels) in relation to total area needing remediation	
	Reused (reclaimed) contaminated land in relation to consumed green land	
	Expenditures on remediation per year in relation to estimated total	
	Expenditures on CS identification in relation to estimated total	

Figure 25: Proposal for indicators based on regional data collections



Recommendations and follow-up activities

Recommendations

Based on the outcome of the workshop, the following activities are proposed for further continuation:

1. To repeat the test data collection in other volunteering countries in order to have more representative samples and hence a broader data pool to derive reasonable benchmarks.

2. For future data collections, to be carried out on a regular basis, the following points should be considered more in detail:

   2.1. Collection of data only in highly affected European regions or in all regions.

   2.2. Definition of a core data set for:

   — **contaminated sites:**
   - specification of impact levels
   - specification of the size of the sites

   — **remediated sites:**
- specification of achieved impact levels
- specification of the size of the sites

   2.3. Abandon the term 'potentially contaminated sites' and instead promote the inventarisation of potentially polluting activities (or sources) according to selected relevant industrial branches as specified in Table 25, with
   specification of the size of the activities, i.e. in terms of employees or production.

3. Find an agreement on policy relevant issues and their monitoring by making use of policy relevant indicators, in particular related to:

   3.1. The water frame work directive; i.e. monitoring of local soil contamination in relation to major groundwater bodies

   3.2. **The biodiversity action plan for the conservation of natural resources**, i.e. monitoring of the reuse of contaminated or derelict land in urban areas.

Follow-up activities on contaminated sites

Major developments and advancements in the work which took place after November 1999 are presented below.

After the ETC/S ended in December 1999, the EEA management board decided to proceed with the work on soil through the establishment of working groups, before a new generation of ETCs was agreed and put in place.

In particular, a working group on soil contamination was established, and work on indicators for soil contamination continued during 2000 and early 2001. A major

outcome of the working group was the organisation of an EIONET workshop on indicators for soil contamination, held in Vienna in January 2001. The results from the second EEA technical workshop on contaminated sites and an additional ad hoc survey were used as background material.

Work on the development of indicators continued and further assessment was carried out, including an analysis of the location of 'hot-spots' of local contamination in Europe. Results were included in the 'Down to earth' report (EEA, 2000b) and *Environmental signals 2001* (EEA, 2001b). First attempts with regard to benchmarking local soil contamination in Europe were presented and published along the seventh International FZK/TNO Conference on Contaminated Soil (UBA, EEA, 2000c).

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

— percentage contribution of localised sources to soil
— contamination;annual public expenditure on remediation of contaminated sites;
— progress in the management of contaminated sites.

A new European Topic Centre on Terrestrial Environment (ETC/TE) started operations in July 2001. In particular, the ETC/TE will carry out the follow-up work on indicators for contaminated sites and extend the work to the new EEA countries. To this purpose, a technical workshop addressed to Phare countries took place in Vienna in December 2001, with the objective of integrating the new member countries into the development process of indicators on contaminated sites. As a result, a data collection was launched soon after the workshop. The results will be available by mid-2002.

A follow-up workshop on indicators for soil contamination is foreseen for the end of May 2002 in Seville.

Policy developments

Important progress took place at the policy level. In fact, in 2001 the European Commission prepared a proposal for the sixth environmental action programme (6EAP). The programme introduces a new strategy on soil protection for the European Union. The programme lays down the Community action programme for the period 2001–10 in the field of environment.

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

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

The Commission is currently preparing a communication on soil protection which is expected to be approved by June 2002.

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