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Task Group 4 on
WORKING TOGETHER TOWARDS A RISK BASED LAND MANAGEMENT

Victor Dries

REPORTS OF THE TECHNICAL WORKING GROUPS

ESTABLISHED UNDER THE THEMATIC STRATEGY FOR SOIL PROTECTION

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CONTAMINATION AND LAND MANAGEMENT

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CONTAMINATION AND LAND MANAGEMENT

Task Group 1 on
STRATEGIC OVERVIEW AND STATUS OF CONTAMINATION

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want information on it in advance. It is recommended that a report on land status should be drawn by the landowner (or his expert consultant) for the new owner and the competent public authority upon any transaction of land property according to requirements and instructions of the competent authority. According to the Aarhus Convention the public should have the right to have access to environmental data. Therefore data should be available to the public if a contamination becomes public interest (e.g. contamination of playing grounds, groundwater). Accessibility of data owned by the private sector should be regulated at the national or regional level.
Another fact that affects data accessibility in practise is costs that have been spent to gather data and the administration of soil data in Member States depending on their structure (responsibility for soil issues at national, regional or local level). Nevertheless data owned by public administrations has to be made publicly available (Directive 2003/4/EC). Soil information systems accessible by internet can provide such services.

Conclusions: Data owned by public administrations has to be made publicly available, but also private data in case they are getting of public interest due to risk of damage to the environment.

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contaminated land management has been intensively discussed during the CLARINET project. The CLARINET report contains many suggestions for improving the synergy between land use planning and environmental concerns.

Conclusions: Land use planning should consider soil contamination, in particular in urban areas which show the need for consideration of soil degradation in the urban thematic strategy.

5.6 Role of agriculture and forestry in revitalising soil

As regards soil contamination different measure for revitalising soils will have influence on the level of contamination in the soil. Application of different pesticides, soil improvers and fertilisers can cause accumulation of pollutants in the soil if no proper application is carried out. Guidelines and regulations are useful and further needed in order to avoid mismanagement with these materials (e.g. regulations and directives concerning pesticides, fertilisers, sewage sludge and biowastes). More general rules on agricultural management for the conservation of a good agricultural and environmental condition are given in EC Regulation 1782/2003 in order to receive direct financial support under the common agricultural policy. These rules should also consider best practices for avoiding soil contamination apart from the basic requirement to comply with the Sewage sludge and the Nitrate Directive (e.g. suitable application of manure and reduction of feed additives).

Beside regulations and directives there are other instruments like agri-environmental programmes in place which give incentives for certain soil conservation practices (e.g. promotion of organic farming, reduction of fertilisation, renunciation of pesticides). The acceptance of certain measures to avoid soil contamination could be promoted.

Conclusions: Guidelines and regulations for materials applied to agricultural are useful and further needed in order to avoid contamination, but also incentives are suitable to enhance soil protection, e.g. by reducing input of pollutants into soils.

5.7 Co-ordination of the world-wide dimension

Due to the fact that contamination is mainly caused by localised input of contaminants into soils, there is no big need for co-ordination of the world-wide dimension, except for large-scale diffuse contamination due to atmospheric deposition. In relation to the latter there exists the Convention on Long-Range Transboundary Air Pollution (UN-ECE CLRTAP). According to its protocols for heavy metals and persistent organic pollutants the member states have committed themselves to reduce emissions of these pollutants in order to protect ecosystems. Relevant data have to be provided on a regular basis. Currently the discussion on which organic pollutants should be included in the reporting obligations is ongoing. The evaluation is based on a comparison of calculated depositions and critical loads which would protect certain ecosystems by 95% of the area. It is strongly recommended to develop synergies between the soil strategy and this convention. This can help to reduce diffuse inputs, but also to avoid repetitions and double national reporting (i.e. ask countries to provide same information twice or more).

Conclusions: Regarding large-scale diffuse contamination it is strongly recommended to develop synergies between the soil strategy and the Convention on Long-Range Transboundary Air Pollution.

5.8 Awareness, communication and participation

Awareness raising on soil issues is very important in order to avoid soil contamination. Often there is a big delay between occurrence of contamination and perception of it. Awareness helps to implement regulations and encourage landowners to protect their soils. In case of historical contamination awareness and information by local authorities can be very helpful, in particular if buildings for living are erected on contaminated land. Mediation processes can help people to cope with the situation and their fears. Furthermore consideration of soil issues in processes of the local agenda 21 would give citizens the possibility to actively participate in soil protection.

Due to the fact that all people are in contact with soils in some way (e.g. landowners, recreation areas) and many of them can cause contamination, education in soil issues is needed. Education can be achieved by integration in lessons at school or adult education, by internet platforms or more specific by training courses for entrepreneurs and its employees.

In urban areas there is a high competition for the available land and also a lot of contaminants are produced or imported from other areas. Sustainable and efficient use of soils is therefore necessary. Urban administrations should perceive this and set some supporting measures (e.g. sealing tax, guidance for proper treatment of private gardens) and incentives (e.g. reuse of derelict land). At European level an initiative called European Land and Soil Alliance has been founded already with the aim of making an active contribution to sustainable soil use in communes.

In order to derive the information for dissemination a lot of detailed data are needed, in particular concerning soil contamination. Often the data gathering is time consuming and costly. So the data should be available for multi-purpose use, but the dissemination has to be carried out in a differentiated way according to the audience. Meta information and aggregated information should be made accessible for a wider audience, but site-specific information (raw data) should be restricted to experts because otherwise there is a high risk of misinterpretations. Furthermore the problem of data comparability from different data sources has to be taken into account and tried to be solved as much as feasible. In this context the requirements for INSPIRE need to be defined.

Conclusions: Awareness raising on soil issues is very important in order to avoid soil contamination. Therefore provision of information is recommended using different tools adapted to the audience to be addressed.

5.9 Property rights related to soil and soil data

Data on soil contamination are mainly sensitive information and can have negative implications on landowners and are therefore often under restrictive accessibility. On the other hand potential buyers of land or even into nearby surface water. This movement can contribute to or cause eutrophication and contamination of soils and also water courses. It can be expected that distribution of precipitation will change spatially and temporally. This could affect the water flow through soils and change leaching conditions of pollutants.

Furthermore climate change will cause changes of land use which will have influence on the situation of soil contamination. Forests are filtering more airborne pollutants than agricultural vegetation does which are deposited on the soil. Agriculture requires fertilisation which can be achieved by application of different materials (mineral fertilisers, manure, slurry, compost, sewage sludge) containing certain amounts of contaminants. Their accumulation in the soil depend from various factors, among them the content of organic matter. This factor has a relationship to climate change because soils have a potential as a carbon sink and can therefore reduce the concentration of carbon dioxide in the atmosphere which contributes to the climate change.

Conclusions: Effects of climate change on the impacts of soil contamination will be caused by changes in the water flow and organic matter status of soils. This will in turn influence the fluxes and the bioavailability of contaminants. The conclusions from the EU funded Chemical time bomb project (1991) are still relevant in this respect and need to be further explored to yield reliable scenarios in view of decision making.

5.3 Environment and health

It is estimated that around 25-33% of the total burden of the diseases in industrialised countries can be attributed to environmental factors (WHO, 2002).

Health impacts derived from soil issues may occur in different ways. Exposure pathways are either directly through the ingestion of soil or indirectly via leaching through the soil into groundwater or surface water, release into the atmosphere or uptake by plants and animals causing an accumulation in the food chain. Especially children and vulnerable groups, such as poor and women in reproductive age are the critical population for environmental pollutant exposure.

Exposures to substances like lead, mercury can lead to mental or physical disabilities of infants. Chemicals like endocrine disruptors, can also act like hormones and disrupt the way of body functions with adverse effects a reproductive capacity.

Most examples of ill health associated with the soil are caused by concentrations of elements in food or water that are either deficient or toxic. Their concentrations might reflect the natural condition of the soil, or the effects of people's activities, such as pollution. In isolated subsistence communities distinct relations between elements and the aetiology of diseases can be identified. Examples include Keshan disease caused by selenium deficiency, and itai-itai disease caused by excess cadmium.

Even if people do not come in direct contact with soils dust particles due to wind erosion can also affected human health. The suspended particulate matter involved in dust contamination ends up making its way into the ambient air and other environmental media causing negative impacts to human health.

Some of the relations between soil and health are uncertain and the causes assumed, and they require further research to validate them. Currently a European Environment and Health Strategy is under development which aims to achieve a better understanding of the environmental threats to human health to identify the disease burden caused by environmental factors in the EU and to plan policy responses to the challenges that emerge. Although the cause-effect relationships are not all known a strong link between the two strategies is recommended, also concerning monitoring and information systems.

Conclusions: Apart from the clear human health risks associated with heavily contaminated areas the relation between soil contamination and human health is rather vague. In view of the uncertainties of the cause-effect relationships between soil health and human health a strong link between the Soil Thematic Strategy and the Strategy on Health and Environment is recommended.

5.4 Biodiversity

The biodiversity issue is mainly dealt with by the TWG Organic matter. As regards soil contamination this threat can have a significant influence on biodiversity, in particular soil biota. According to ecotoxicity tests specific species of micro-organisms and also plants show negative effects above a certain concentration of heavy metals in soil, especially in the soil solution. This NOEC toxicity data is used in eological risk assessment of soil contamination and in defining critical limits used for calculation of critical loads of heavy metals in order to protect the most of the ecosystems (Hettelingh et al., 2002). Also eutrophication and acidification can be assessed by a quite similar approach. Enhanced concentration of nitrogen and hydrogen protons respectively can change occurrence and abundance of plants and microbiota. This can have further implications on plant uptake of nutrients and pollutants as well as soil processes like mineralisation.

Conclusions: There is clear evidence of adverse effects of soil contamination on soil biota and plants. Methods for ecological risk assessment should be further developed and further research is needed for implementation of specific indicators concerning the protection of biodiversity.

5.5 Role of land use planning policy

As mention already before land use planning has an important influence on the soil status and consequently on the content of contaminants. For certain kinds of land (arable land, grassland, pastures, forest) suitable assessment methods on the status of soils have been developed and can be used to identify the suitability and capability of soils for these land uses. As regards urban areas and its specific land uses (e.g. infrastructure, trade and industry, playing grounds, recreation areas) and soil forming processes (e.g. refilling of excavated soils) such evaluation methods have been developed within the contaminated land risk assessment framework (See CLARINET and CARACAS reports, www.clarinet.at). Specific soil characteristics and functions (e.g. water retention capacity, compaction, stability, filtering capacity, soil biological processes) are relevant for these assessments and drive the suitability for certain soil uses. The need for land in urban areas is high and causes a high degree of competition. This situation requires a carefully land use planning based on appropriate methods. Synergies with the urban thematic strategy are needed in this respect. The role of land use planning in and transport of substances in soils and sediments. Soil Organic Matter (stable and dissolved), pH, CEC, soil texture and redox-potential are the most important ones.

As soil monitoring pertains to repeated measurements in time it is necessary to specify the frequency of the measurements. Concerning the metals and organic contaminants listed above most changes are likely to be slow. A sampling interval of 10 years and more seems adequate. On the other hand substances like N and P and the inputs or outputs of contaminants to the soil system may change faster. A sampling interval of 5 to 10 years may be a good compromise if all parameters need to be measured simultaneously. If more knowledge of the dynamics of the various parameters is available, the sampling frequency could be adjusted accordingly for each group of substance.

The extrapolation of observations at a single point to a larger area is an additional problem to consider. To be representative for EU soils, a monitoring network should cover the major forms of land use, climate, hydrological regime and soil type, as strata in a stratified sampling design. Although monitoring could be done on an arbitrary grid basis, it is not very efficient to consider soil as a black box system and ignore that land uses, soil types, climate and hydrological regimes are major factors determining the influence of diffuse inputs on the state of soils. Stratified sampling is much more powerful in this case because it addresses these factors explicitly and will make interpretation of data much easier.

Since several soil monitoring networks already exist within different countries, harmonisation of *what* and *how* is being measured seems a good start to use existing information at the EU levels. However the limitation of such a network is that the designated sites might diverge from the rest of the country.

4.5 Concluding remarks

Methods for measuring concentration of contaminants in soil and a number of important soil characteristics like CEC, organic matter content and pH are available and even standardized by ISO. CEN is in the process of adopting ISO standards for soil as European standards. However it should be noted the difficulty that in many cases there is more than one standard method for measuring a parameter. The interpretation of the results of this type of measurements in a monitoring program is less straightforward however. A large amount of additional information must be available to interpret the results in a meaningful way for policy making and policy evaluation. On the other hand, performance indicators used in “action-driven monitoring” or reporting (in the sense described in this paper) are less well standardized and may have different meanings in different countries. They are of interest since they reflect the political perception of certain soil problems by member states. They also have one big advantage over classical monitoring data: their ease of interpretation.

Monitoring and reporting approaches need to evolve into a more harmonised EU information management framework. EU Monitoring has to start with aggregating the already existing monitoring schemes as much as possible and will identify the need for harmonisation and additional monitoring information for the interpretation of the results. Reporting has to start by using already defined program performance indicators and will have to accept some differences between member states. As policy will become more uniform due to the EU soil strategy, policy implementation differences between member states will gradually disappear and policy performance indicators will become more comparable.

So, both for monitoring and for reporting, we need to accept that the first results will give a rather blurred image of the DPSIR for soil contamination. But the quality of the information will improve gradually if information exchange and harmonisation of approaches is stimulated.

5 CROSS-CUTTING ISSUES

According to the mandates cross-cutting issues are to be dealt with by all technical working groups. Due to this fact there may be some overlaps of the following with text of other working group reports, although here it was tried to focus only on issues linked to soil contamination.

5.1 Basic definitions

The TWG Contamination considers soils as a part of the soil-water-sediment system which requires an integrated approach concerning protection against the threat of contamination, towards a sustainable use of its resources and ecological services. There exist direct relationships between the compartments soil, water and sediment because of several fluxes of substances and energy. Processes like leaching and weathering are involving the whole system. Contaminants (heavy metals, POPs) deposited on soils are often accumulated, but under specific conditions they can be transferred through the whole soil-water-sediment system. On the other hand heavy metals naturally inherited in bedrock can be transferred into the soil compartment and released by leaching. Furthermore the process of erosion can contribute to contamination of water-sediment systems (e.g. in alluvial areas).

Soil contamination can occur under all land uses (due to atmospheric deposition), but most likely in soils under urban and industrial use. The timeframe of the process of contamination is very different depending on the land use (industrial accident vs. low atmospheric deposition in natural areas) and also its perception. Therefore all kinds of (past and present) land use have to be addressed when assessing soil contamination and defining appropriate measures to remediate or prevent contamination. Land use planning should take into account the status of soils and consider a suitable land use distribution at the local and regional level to avoid soil contamination in sensitive areas (e.g. no placement of potentially polluting industrial facilities near playing grounds or arable land). Already contaminated land should be used for specific land use for which contamination does not matter (e.g. reuse of brownfields for trade and industry areas) under the precondition that harm to the wider environment (e.g. groundwater) is not expected, or should be restored for intended uses and functions

Conclusions: Protection against the threat of contamination has to consider the whole soil-water-sediment system and all kinds of (past and present) land use have to be addressed for the definition of appropriate measures.

5.2 Climate change

Climate change will result in significant change of weather conditions (e.g. more often heavy rainfalls) which will have influence on run-off and consequently on soil erosion. Due to erosion of soil particles adhering nutrients and pollutants will be transported from one field to another

Mercury

Mercury is very toxic, mainly accumulates in soils and sediments, but can be transformed into mobile fractions (e.g. methyl mercury). Hg is prioritised in many environmental programmes at EU level (Heavy metal protocol of CLRTAP, Sewage sludge directive, proposal for biowaste directive, strategy for health and environment) and also national level. Unfortunately it is difficult and expensive to measure.

Arsenic

In many areas in the EU natural high concentrations of arsenic exist in soils. Arsenic accumulates in soils (mainly linked to iron oxides). The risk of leaching to groundwater is usually low, as is bioavailability. This may change however after a change in soil conditions or after ingestion by humans (especially children) [8] and grazing animal. Arsenic is to be considered as a priority element within the strategy for health and environment.

Nickel and Chromium

Although these metals are less “critical”, they can be included in routine monitoring since they can be measured together with the metals mentioned above in an ICP scan.

PAH

This group contains a number of known carcinogens. PAH concentrations do show a long term upward trend in soils since the beginning of the previous century according to results obtained at Rothamsted in UK. Human health risks associated with soil ingestion already occur at moderate contamination levels (above 40 mg/kg for the sum of 10 PAH in the NL).

Dioxins, PCB and other substances with dioxine-like behaviour

Dioxins are considered the most dangerous substances. Many other substances like some PCB’s have a similar mode of action. PCB’s are a burden of the past and especially of concern in sediments. Measuring dioxins (including furans) in soil is expensive but individual substances relevant according to WHO guidelines should be considered.

Other PCBs

PCBs related to certain products should also be considered. Combustion of these products may cause emissions of PCB’s, which can accumulate in the environment. Usually the 6 congeners of Ballschmiter are analysed. However they should be given less priority than the PCB’s with dioxin-like mode or action.

HCH, DDT/DDE

These banned pesticides are very persistent and are now ubiquitous in soils. Monitoring will indicate whether biodegradation is occurring and whether further dilution of these substances does occur. DDT and DDE are also of concern since they are slowly transported by air and bioaccumulate in polar animals. Monitoring will also point out how much of these persistent substances have to be accepted as “background levels” for the next century.

The Nitrogen cycle

Various forms of nitrogen should be measured as input to soils and as concentrations in soil in view of prevention of eutrophication of surface water, prevention contamination of groundwater, acidification of soils. There is some concern about long-term health effect associated with changes in the global nitrogen cycle.[9]

Phosphate

In view of leaching of phosphate to groundwater and the risk of eutrophication of surface waters, it would be useful to monitor the degree of phosphate saturation and the water soluble fraction of phosphate which gives information on actual P availability in case of high P supply in soils used in agriculture. Because the impacts of high P supply are restricted to agriculture this monitoring can also be considered as “action driven”.

4.4.2.6 Putting monitoring of substances of soil into practice

Results from a monitoring programme should enable the user to:

1. Evaluate the impact (= quantity and quality) of diffuse inputs in relation to other inputs (e. g. what is the contribution of atmospheric inputs compared to inputs by manure?). This will, later on, steer the measures to be taken to reduce inputs according to relevance.

2. Evaluate the future state of the system, i.e. how does the current land use (or changes thereof) affect soil quality. Again, soil quality in relation to crop growth, water quality, ecosystem etc. This means that input output (balance) approaches are needed that are able to calculate fluxes into (inputs), within (processes) and out (outputs) of the system. Based on the outcome of these balance approaches, inputs can be reduced or effects can be reduced (accept a certain input but make sure effects are negligible, e.g. by additional liming).

This calls for integrated monitoring where not only soil aspects are important but even more so, accurate measurements of quantity and quality of in- and outputs and processes in the soil system itself that affect the behaviour of substances. This is important because an increase or decrease of a concentration of a substance over time will not tell us much about the reasons behind this change. It will be clear that the interpretation of trends in the concentration of substances in soil indeed requires additional information.

It may be worthwhile then to measure total concentrations and bioavailable concentrations, and to measure concentrations in pore space water to assess the mobility of the identified substances. In addition a number of soil parameters should be measured which control the fate farm scale, some information on the concentrations of contaminants in soil and the nutrient status of soil is useful for managing purposes. Sometimes a soil investigation is required before the application of organic waste as fertilizer, like sewage sludge. Collecting these data may also be useful for scientific purposes, to improve conceptual models of substance flows in agricultural systems. A number of farming systems maybe monitored through EU and such a monitoring system may help to improve GAP (good agricultural practice).

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[9] Townsend, A.R, et al. (2003). Human health effects of a changing global nitrogen cycle. Front Ecol Environ 2003 1(5): 240-246.

Given the large number of farms in EU it will be expedient to aggregate all information in policy performance indicators or sustainability indicators for reporting to EU.

It should be noted that plant protection products although applied to plants or soil are more often monitored in plants and groundwater than soil, as required by the Pesticide (91/414/EEC), Drinking water and Water Framework Directives. In some cases (risk areas) monitoring the amount applied to soil may be useful but additional information is required to relate this to potential environmental impacts, such as described in Directive 91/414/EEC. Hence it would be relevant to monitor certain of these products in soil solution as well.

4.4.2.4 Large-scale diffuse pollution

This is the policy area where monitoring is of utmost importance and relevant at EU level because of the transboundary nature of large scale diffuse pollution. Monitoring the fate and transport of potential contaminants through environmental media will help us to find the best national and regional abatement strategies. These integrated environmental assessments will also indicate our success. Because all environmental compartments are involved, soil and sediment monitoring should be linked to monitoring of surface water as required in the Water Framework Directive, monitoring of groundwater, as required in the Groundwater directive and also linked to air pollution monitoring. A number of soil monitoring networks already exist in member states. The EU monitoring system could use already existing networks as a starting point. Even if the methods used differ between networks, the conclusions may still be consistent.

4.4.2.5 Which substances should be monitored?

In order to specify the requirements of monitoring in relation to diffuse inputs the task group on Diffuse Inputs of the TWG contamination defined monitoring as follows:

Monitoring should focus on the abatement of (current and future) effects due to diffuse inputs, but should include effects of measures to reduce inputs as well.

It will be clear that monitoring a few thousands of substances that may enter the soil system by diffuse contamination is not feasible. Even the selection of high production volume chemicals by OECD covers 4000 substances. We need to set priorities and consider only those substances which may reach critical limits in soil in view of human heath, food safety, soil fertility, ecological risks especially concerning biodiversity in soil, groundwater and surface waters. Monitoring should only be done where there are real concerns (risk areas) rather than a routine grid sampling. The following paragraph will list the choice of high priority substances for monitoring diffuse soil contamination and will give some justification for their choice. The substances listed are minimum requirements for consideration. More substances may be added if they are of general interest but these will increase the costs of the monitoring. Furthermore parameters related to acidification, like pH, cation exchange capacity and base saturation should be considered. These parameters are also relevant for other threats and give some information on bioavailability of substances.

Cadmium

This contaminant is often discussed in relation with food safety issues. It readily accumulates in crops especially in acidic soils with low binding capacity. Exposure risk due to soil ingestion is less critical although recent investigations in the Kempen area (NL and Flemish region) indicate that exposure through indoor dust (soil related) is as high as exposure due to consumption of homegrown vegetables. In slightly acidic soils with low binding capacity there is a high risk of leaching to the subsoil and the groundwater.

Copper

Copper is an essential element for life but it is also very toxic. Ecological risk assessment is difficult for this element since generic safe levels derived from toxicity tests are below the levels necessary to sustain life in less sensitive organisms. Experience with the assessment of ecological impacts may improve if copper is monitored in soil in conjunction with biodiversity indicators. There is some concern of acute toxicity in children due to ingestion of soils containing only moderate levels of copper contamination[8].

Lead

Although emissions from lead to soil are decreasing, it is still a substance of concern given the amounts of lead stored especially in organic layers of topsoils. Effects associated with soil ingestion by children are well known. Critical levels in soil (based on total concentrations) for long-term exposure are often exceeded in urban areas, although bioavailability may be low. There is some concern of acute toxicity in children due to ingestion of soils containing only low levels of lead contamination [4].

Zinc

Zinc is an essential element for life but it is also very toxic for micro-organisms leading to a decreased decomposition of organic matter. Ecological risk assessment is difficult for this element since generic safe levels derived from toxicity tests are below the levels to sustain life in less sensitive organisms and even lower than background levels. Experience with the assessment of ecological impacts may improve if zinc is monitored in soil in conjunction with biodiversity indicators and assessments of soil decomposition processes. Also zinc deficiencies related to crop production could be identified.

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[8] Calabrese, E.D., Stanek, E.J., James, R.C. & Roberst, S.M. (1997). Soil Ingestion: A Concern for Acute Toxicity in Children. Environmental Health Perspectives, 105, 1354-1358.

quantity of information collected. The system architecture and individual data collection items will be updated along with the improvement of the information basis that will be available with the enforcement of a harmonized EU Soil Protection Policy.

2. The system should be built on systems already in place both at the European and national level.

3. The system design should be implemented following a dynamic and flexible nature and devised to fulfil short-term requirements, mainly based on a number of already available and comparable indicators and parameters at the different spatial scales. Long-term needs should also be identified.

4. The monitoring and assessment system of soil contamination should be based on the following elements:

   a. Action-driven monitoring

   b. Identification of relevant indicators and related data needs

   c. Integration with existing European monitoring and reporting activities

   d. Integration of local and diffuse contamination

   e. Streamlining (not extensive multi-purpose monitoring but based on specific policy needs)

   f. Tiered approach, according to the following geographical levels:

      i. Country
      ii. Catchment (regions of natural boundaries)
      iii. Site-specific-European Level (full EU coverage limited to pressures; detailed monitoring limited to problem areas)
      iv. Site-specific- national Level (limited to guidelines for national inventories))

   g. Step-by-step implementation and harmonisation (gradual implementation and learning by doing)
      h. Guidelines for national monitoring (data collections activities, national inventories, etc.).

5. The Driving Forces-Pressures-State-Impacts-Responses (DPSIR) assessment framework should be used to identify and prioritise the policy-relevant indicators to include in the system.

4.4.2 Classical monitoring

The present section will provide some recommendations for classical monitoring and give further details on the choice of substances to be monitored. So in this section the term “monitoring” will refer to measurements of concentrations of substances in soils at regular intervals . If soil measurements are not intended to be repeated, we may use the terms ‘Inventory’ or ‘Survey’. Other policy relevant information which has to be provided at regular time will be denoted as “reporting”. In this terminology, “action driven monitoring of policy performance indicators” will be labelled as reporting. There is a strong relation between monitoring and reporting, because policy performance indicators may use information from local monitoring schemes. Indicators can also be used to combine and evaluate the data deriving from classical monitoring schemes and provide conclusions in a format more accessible to policy makers. To make this relation clearer, the use of monitoring in the basic soil protection strategies for soil contamination, which were introduced by the TWG contamination, as well as the needs for aggregated information, will be briefly described. This will lead to the conclusion that monitoring as defined above is only useful at the EU level for large scale diffuse inputs and contaminated regions (megasites).

4.4.2.1 Local sources

The preventive strategy aims at the application of technical measures that prevent contaminants from entering the soil system at sites where activities entail such a risk (like industrial facilities, underground storage, waste disposal sites, etc). Monitoring systems (measuring concentrations of substances that are relevant in view of the risk activity, in soil and groundwater) are designed to detect failure of the technical preventive measures as fast as possible. Results of this type of monitoring are very specific and less relevant for a general impression of the state of the soil (or groundwater) with respect to contamination. The data may be useful for some exploratory data analysis but not for reporting to EU and even national authorities. Reporting about local sources will make use of more aggregated information like failure frequency of specific preventive technologies or general policy performance indicators.

4.4.2.2 Contaminated land management

Measurements of contaminant concentrations in soils are needed to assess the risks of contamination. These measurements are not intended to be repeated in most cases, so they should be considered as local inventories. These local inventories may be used to draw soil contamination maps, which may be useful for local spatial planning in view of land use restrictions due to contamination. Sometimes it is not possible to restore a contaminated site for some intended use. Risk management plans will promote measures and actions suitable for improving the situation gradually and for avoiding unacceptable human health and ecological risks. Long-term risk management plans often require monitoring. The monitoring will be specific for the site and of limited representativity, unless there are a larger number of similar sites. Only for very large sites (megasites), where risk management plans are at the regional scale (like for instance “the Kempen” in NL and the Flemish region, the old coal and steel region in the North of France, or the Bitterfeld area in Germany), reporting of monitoring data may be of EU interest. EU relevant information about contaminated land problems and solutions will be reported in the form of policy performance indicators. Data on concentrations of contaminants at individual sites (there may be more than 1.000.000 sites in EU) make little sense for EU policy discussions.

4.4.2.3 Sources of contamination resulting from agricultural practices

The preventive strategy for contamination from agricultural land use should be based on a long-term balance approach. To balance inputs and outputs at a these measurements, deposition rates will be modelled using transfer functions based on emissions of contaminants.

4.3.2 Comparability of existing data

For soil contamination, work on development and population of indicators at the EU level has generally been limited to the collection of 'country level' information for local contamination. Several exercises have been carried out to define indicators and to collect data at 'regional' and 'province levels' (NUTS 3 level[6]), with the purpose to reach a higher detail, trace variations within countries and regional areas and to identify 'hot spots'.
Concerning data quality and comparability the results obtained so far show large heterogeneity (lack of comparability) in the gathered data at country level as well as at higher spatial detail. The major reasons are the following:

- Progress in the management of soil contamination, and the knowledge base, is very different among countries and, in some countries, among regions. This is mainly caused by the different start of relevant policies in the different countries: some countries have enforced relevant legislation one or two decades earlier than others. At a regional/provincial level larger variability is due to non homogeneous administrative procedures in place that may be highlighted whenever planning/remediation/and licensing rests on local authorities responsibilities.

- Different legal frameworks are adopted in the different countries. This means that policies may differ in many aspects, first of all by setting different political and environmental targets and as a consequence in different definitions of 'contaminated ' and 'cleaned-up or remediated site'. Different technical criteria used in site investigation and application of management solutions may also vary from country to country.

For these reasons indicators, even when derived by aggregated data, may give responses that are difficult to compare and perhaps of questionable use in policy making decisions.
There is then a general need to achieve a higher harmonization in the quality of the information provided by the indicators, and in the data collected behind. This can be achieved by using standardised definitions, specifying the data that are required and the standardised methods of sampling and analysis to be used for acquiring them. The following tools are recommended:

- provide guidance and relevant technical guidelines

- establishing an EU information and monitoring system able to trace soil contamination state and trends at different spatial levels.

Concerning monitoring of diffuse soil contamination we see that different sampling designs and methods as well as different analytical methods for the same parameters are used, even within a country (with regional inventories). Furthermore the monitoring frequency varies very much between the countries, but also within countries (different levels of monitoring or regional decisions). Further standardisation of methods would help to improve comparability but this is not so essential if monitoring schemes are designed to answer the same policy question. The methods used may be different but the conclusions reached on the basis of results from different monitoring schemes may still be consistent. It should be investigated whether the current national monitoring approaches can already lead to harmonised conclusion without complete harmonisation of the methods used.

4.4 Monitoring proposals from TWG contamination

4.4.1 Action-driven monitoring - a general approach to monitoring and reporting of soil contamination

Use of indicators as aggregated information

Indicators simplify information that can help to reveal complex phenomena.” Indicators should be related to policy-relevant questions and help evaluate specific measures by describing the situation at certain time intervals and showing changes over time. Indicators are usually based on a number of single parameters which are combined according to a specific methodology. [7]

The use of indicators at EU level for monitoring the state of the environment and temporal trends is a consolidated practice. It is used to assess the state and the trends in the environment, analyse the impacts of economic activities and provide information to help framing, implement and evaluate policies. Indicators are developed and data collected and updated on a regular basis for the major environmental areas or topics.

The design of a system of indicators should be implemented through a dynamic and flexible cycle. The system could be built on systems already in place both at the European and national level. It should fulfil known requirements, mainly based on a number of already available and comparable data at the different spatial scales. Long-term needs should also be identified to plan activities over a wider time scale. The use of the DPSIR assessment framework will be of great help to integrate information on all related soil threats and environmental media. It can be used not only to identify linkages between degradation of soil and its impacts on other media, but also identify the connections between different soil threats (e.g linkages between soil sealing, soil erosion and hydro-geological risk).

The main elements of a proposal on a general approach to the monitoring and reporting of soil in the EU, as applied to soil contamination in particular, are listed below.

1. The implementation of the soil information and monitoring system on soil contamination should follow a progressive upgrade in terms of quality and

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[6] NUTS is the Eurostat nomenclature for the territorial unit

[7] Example for an aggregated indicator: heavy metal load in agricultural areas due to application of sewage sludge application.
Policy question: How big is the extent of agricultural land treated with sewage sludge and how high is the heavy metal input in these areas. Necessary input parameters are:

- amount of sewage sludge used in agriculture
- amount of sewage sludge applied per ha
- heavy metal content in sewage sludge.

It may have consequences for the adjustment or improvement of policies but it has never been used in the first stage of the policy life cycle, to convince politicians of the need for soil protection. The change of the state of soil over time is too slow, apart from changes resulting from changes in the use of the land or from sudden events like flooding. Significant and politically convincing changes may take half a century. Because many changes in soil due to contamination are very hard to reverse, we will have to conclude that prevention should have started 50 years ago. This is not a very effective way to raise the right awareness for the need of soil protection.

4.3 The need for information and monitoring in the EU thematic strategy for soil

In discussions about the Soil communication and the EU thematic strategy for soil the members of the European parliament stressed the need for general and policy relevant information on European soils. They asked for a catalogue of soil status, vulnerability, threats and pressures as a basis for future policy and decision-making. They also asked for a policy that prevents further loss of soil information for instance present in national institutes. Existing national soil maps should be harmonized and the use soil information for spatial planning and sustainable land use should be intensified. These are indeed the questions that are raised during the first stage of the policy life cycle.

The need of monitoring the state of soil has been mentioned in the TWG contamination report in relation with the management of large-scale diffuse pollution, as an element of the management and control stage of the policy life cycle, comparable to the national approaches. For such a management approach, which should address the soil-sediment-surface water and groundwater system, it is absolutely necessary that the fate and transport of the most important contaminants are known, and are followed in time. On the basis of this information models can be designed that permit the optimization of abatement scenarios for diffuse sources.

In contrast to national soil protection approaches that developed gradually and where the various stages in the policy life cycle do show a nice sequence, the development of EU soil policy appears to be a mixture of stages. There is a need for information from inventories and surveys to justify further actions at EU level (first stage in the policy life cycle). There is an existing body of EU legislation already addressing soils which may need fine-tuning (last stage) and new legislation is being formulated (intermediate stage in the policy life cycle). Because we have to address all stages simultaneously in the soil thematic strategy, there is a very large demand for all sorts of information, but this should not imply that the tools for the collection and management of information loose their original policy life cycle dependent purpose. Monitoring in the classical sense will always remain a tool for answering policy questions from the last stage almost exclusively.

Given the large demand for information to support an EU policy one may have different views on a monitoring directive:

1] A directive that forces the member states to monitor concentrations of contaminants at regular intervals in soil (monitoring in the classical, narrow sense of the word). This will be a technical directive.

2] A directive organizing the flow of all policy relevant information for an EU soil policy. This is a directive which sets rules for data ownership, describes competences for organizations involved in collecting, analysing and reporting information and provides a framework for further harmonization of national reporting of DPSIR for soils. It may (of course) also contain instructions for classical monitoring but the emphasis of the directive is on information management procedures.

A technical directive has the possible advantage of being very concrete in the sense that methods of measuring contaminants in soils are available and standardized. But the big disadvantage is that other DPSIR information on soils, which is needed for EU policy purposes, is not addressed and may be labelled as “less relevant” because it is not included in THE directive.

4.3.1 National inventories

The completion of national inventories follows today different approaches according to criteria and definitions established in national policies and to resource allocation strategies. As an example some legislative frameworks addressing soil contamination do not include sites used for agricultural use. In some Member states soil inventories are not explicitly focused on contamination, but e.g. on soil fertility or environmental status of soils due to different national priorities. Some soil inventories are established only at the regional level which is the effect of legal responsibilities.

In order to register suspected contaminated sites, affected by local contamination, it is a general policy to conduct a preliminary survey on existing soil polluting activities and activities that have taken place in the past, including an historical investigation on the site use. This activity may be performed at the regional scale and collected in the national register. The following step envisages the setting of priorities for selecting sites where a preliminary site investigation is needed. This investigation may lead to the definition of the site as contaminated. According to other policies only the following main site investigation and site-specific risk assessment decides upon the status of the site and its remediation requirements.
These two levels of inventories, suspected contaminated sites and confirmed contaminated sites, should generally be kept at the national level. More detailed inventories may record the different activities carried out on the sites and their abandoned/active state in the case of industrial or waste disposal sites.
Inventories of contaminated sites, generally do not include sites where naturally occurring substances are present at anomalous levels, except if they are concentrated by industrial activities, e.g. mining exploitation.

In order to get national information on soils affected by diffuse contamination, several approaches are used, direct and indirect ones.
Direct approaches are soil inventories based on systematic grids or representative site selection carried out once, often intended to be done more frequently in order to monitor the changes of soil conditions over time. Regarding diffuse soil contamination national or regional soil inventories across Europe are often focussing on soil properties like pH or base saturation and total contents of heavy metals, but less on organic compounds and bio-availability of these contaminants. Apart from these common objectives on the measured parameters, there are a lot of differences in the methodology. Indirect approaches to identify diffuse inputs to soil are necessary are to measure atmospheric deposition, e.g. with air monitoring or with moss monitoring technique. If lacking of

SOILPROTECTION STRATEGY
protect soil in its own right and maintain soil functions)

IMPLEMENTATION OF PROTECTION:
Good agricultural practices
Policies on chemicals and pesticides
Waste legislation (landfill, sewage sludge, mining waste directives)
Water legislation (framework, groundwater, nitrate directives)
Prevention of industrial accidents
Air pollution prevention measures
Integrated pollution and prevention control
Directive on biological treatment of biodegradable waste (compost)

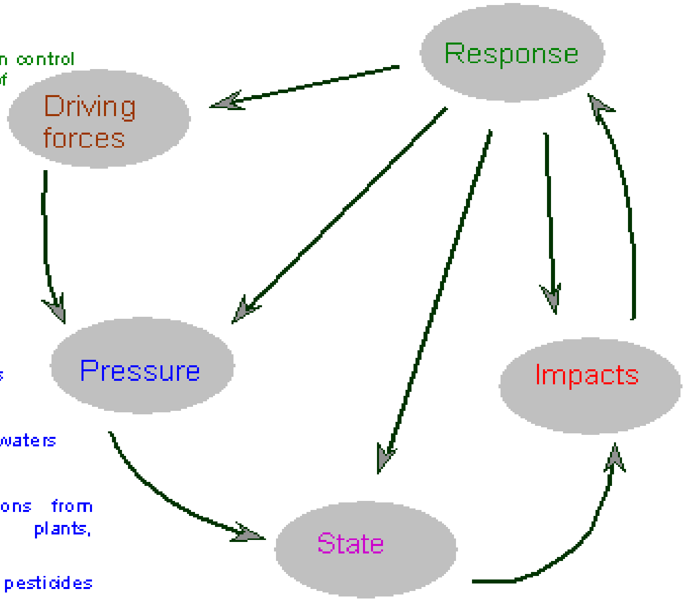
RESTORATION OF SOIL QUALITY & RISK BASED LAND MANAGEMENT:
Activities for risk reduction

Restrictions on:
- land use
- water use

Clean-up programmes

Fund raising/Taxes

Best practices of RM



Waste management
Industrial processes
Transport
Energy production
Mining
Households
Agriculture
Military sector

Leakage of hazardous substances

Accidents

Emissions to ground and surface waters

Development of explosive gases

Deposition of airborne emissions from industrial processes, power plants, transport, etc.

Application of sewage sludge, pesticides and fertilisers on agricultural land

Mining waste

Hazardous waste

Use of hazardous substances in industry and the military

Soil contamination by hazardous substances, including inorganic trace elements (heavy metals), organic compounds and explosive gases

Soil acidification

Nutrient surplus (soil eutrophication)

Brownfields and derelict land in urban areas

INDIRECT:
(on other media, ecosystems, human health and activities)

Threats to human health through:
- contaminated drinking water
- direct contact with contaminants
- explosion of landfill gases
- uptake of pollutants through the food chain

Threats to ecosystems:
- Changes in biodiversity
- Changes in crop yields
- Changes in forest health and productivity

Ground and surface water pollution

Impacts on current and future use of land by sectors

DIRECT:
(on soil functions)

Changes in the buffering, filtering and transforming functions of soil

DPSIR applied to soil contamination

quality for uses and functions), the impacts on man and environment and the policy responses. Monitoring of responses should highlight the success of protection and restoration policies in avoiding pressures and negative impacts. This is not an easy task. Soil is a very slow reacting environmental compartment. But once the state of the soil has been changed and impacts become noticeable it is often too late to react. Many changes tend to become irreversible especially is they occur at larger spatial scales, as the many contaminated land problems in EU have shown. For soil the sequence in DPSIR may easily lead to the wrong perception that action (response) should only start if there is a clear impact or if a negative trend in soil quality has been demonstrated.

This approach may be adequate for faster reacting environmental compartments like air and surface water, but it is inadequate for soil protection. Emphasis of preventive policies and monitoring should be put on earlier stages in the DPSIR scheme like drivers and pressures. This is the reason why the TWG contamination has proposed various forms of action-driven monitoring (see the monitoring recommendations in the executive summary). These proposals are related to policy programmes for agriculture, for local sources and for contaminated land management.

This type of monitoring boils down to the reporting of programme performance indicators[3] on a regular basis by member states. Some people seem to prefer to label these activities as "reporting" and want to reserve the term monitoring for the measurement at regular time intervals of concentrations of chemical substances in soils and their impacts on man and the environment. One should realize however that this narrower view on monitoring seems to reduce a soil protection policy on soil contamination to a policy on chemicals. As monitoring of many substances will be required by the new EU policy on chemicals under the upcoming REACH program, there is no added value for a special soil monitoring program which only measures contaminants in soil. The added value of a soil monitoring program has to be found in it's relevance for soil protection, where soil is considered as a system where effects of many contaminants and pressures from other soil threats come together.

In addition, from a broader soil protection perspective, soil should be characterized by its functions as related to human land uses and its functions in ecological cycles that relate soil to air and water. Concepts like "Soil Quality" or "Soil Health" are providing an intellectual framework for discussion about this holistic and system-oriented view on the state of the soil (the S in DPSIR) and it's impact (I) on the three dimensions of sustainability (people, prosperity and environment) (see also the discussion on "soil health" and "soil quality" in the TWG research and on "soil as ecological capital" in the TWG organic matter). Unfortunately a fully operational set of indicators for Soil Health and Soil Quality is presently lacking, especially for the description of the state of the soil.

Concerning contamination and the evaluation or monitoring of the state of soil in terms of soil functions, measuring concentrations of contaminants in soil can only be a starting point. These measurements should at least be accompanied by measurement of the fluxes of the substances through the soil system in view of the system-oriented approach needed in soil protection. This means that inputs from atmospheric deposition, inputs from surface waters (sedimentation, flooding), inputs from land uses (agriculture) and outputs like leaching to groundwater, uptake by crop plants and if possible biodegradation should be measured. These accompanying measurements are also needed for practical reasons if we want to interpret the soil monitoring results. This will be described later. The approach should also be flexible enough to accommodate newer indicators based on the further development of soil heath or soil quality concepts.

4.2 Monitoring as perceived by the TWG contamination

TWG contamination has a broad view on monitoring as already expressed in their previous reports for the Advisory forum. The term "monitoring" is used in all reports as general term covering classical soil monitoring, multi-purpose monitoring, action-driven monitoring and regular reporting using various indicators or other type of information across the whole DPSIR chain.

"Classical monitoring" is the measurement of concentrations of substances in soil (monitoring of state). Multi-purpose monitoring and action-driven monitoring are defined in the Monitoring mandate. We consider multi-purpose monitoring as the monitoring of the state of soil for all threats to fulfil different needs, whereas action-driven monitoring is focused on the evaluation of policy measures against soil degradation. "Regular reporting" is the periodic communication of aggregated information resulting from national monitoring programmes, according to an agreed format.

The broader view on monitoring of the working group is not necessarily linked to the preparation of a directive but stems from the perception of the group about what a thematic strategy on soil protection should mean[4].

The development of a EU soil protection policy should be based on information about soils, about the impacts of human activities on soils and the success of policies to improve the situation. Some member states have soil protection policies in place and even specific soil protection acts are in force in Germany and the Netherlands. Experience in these states has shown that monitoring in the classical sense - the measurement at regular time intervals of concentrations of chemical substances in soils and their impacts on man and the environment - can be useful in the last stage of the policy life cycle[5].

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[3] This term is used in a general sense in this document. Programme effiency and cost benefit analyses and other indicators like the ones described in the EEA report "Environmental indicators, Typology and use in reporting" are considered to be covered by this term in the present document.

[4] According to this view the current discussion in the thematic strategy should result in a politically endorsed policy document describing the basic principles of EU soil protection in relation to the identified main soil threats. The main functions of such a document are:

- It serves as check for existing EU legislation to see whether it is protective enough for soil (and sediments) and may indicate the need for changes in this legislation
- It may indicate the need for new EU legislation in certain areas
- It provides a common basis for the development of national soil protection policies
- It provides guidance for setting priorities in policy related research
- It provides guidance for collecting and reporting and exchanging policy relevant soil information (inventories, monitoring, reports on policy performance indicators)

[5] The policy life-cycle. Generally the following stages can be distinguished:

1. Problem recognition
2. Policy formulation and implementation
3. Management and control

associated with certain activities and technological failures. The probability of a spill or leakage of a hazardous substance in soil and groundwater is the central question in the assessment. For agriculture the risk should be related to accumulation of persistent contaminants and to leaching rates of nutrients and pollutants to groundwater and surface water. In contaminated land management risk assessment is related to exposure of man and the ecosystem, in other words the impact of the contamination is assessed.

Contaminated land risk assessment should therefore not be confounded with other forms of risk assessment like Environmental impact assessment, risk assessment before introducing new chemicals on the market and assessments of the risk of failure of certain technologies. The different approaches in risk assessment of chemical substances and contaminated land risk assessment may illustrate this. Risk assessment for new chemicals applies the so-called EUSES model, which predicts the distribution of a substance over the different environmental compartments after a release. The main exposure routes to soil contamination (ingestion of soil, consumption of home grown crops and inhalation of indoor air) are not taken into account in EUSES. For the purpose of the assessment of new chemicals this is justified, because we take into account that dumping of the chemical in soil will be prevented by regulations. But one should never apply EUSES in risk assessment of soil contamination, because we have to answer a different question: What is the risk of this contaminant in soil even if it is not expected to be there according to the EUSES model.

Another important difference between risk assessment in a policy on chemicals and contaminated land risk assessment is the level of precaution in the assessment. It will be obvious that one should be more precautionary before allowing a new chemical on the market than one should be in a decision to remediate soil and groundwater at a certain site. In the latter case the risks can be evaluated on the basis of real site specific impacts. On the other hand, the decision to allow a new chemical on the market can only be made on the basis of predicted adverse effects. These predictions involve more uncertainties than site specific contaminated land risk assessment, which can be based on empirical data.

3.2 What type of soil policy do we need at the EU level

In the previous sections we related the strategies to various stages in the DPSIR framework. For policies focussing on the long-term socio-economic drivers a large EU wide effort will be needed. After all the EU is a socio-economic union of states. At the other side of the range are historically contaminated sites. These burdens from the past require very site-specific solutions, which have to fit in a local socio-economic context. If the subsidiarity principle applies in soil protection, it applies there. One must be aware that subsidiarity concerns decision-making. It should not become a barrier to international exchange of experiences in research, policy and practice. We should aim at combining international expertise with local decision-making.

Contaminated land management is primarily operating at the “Impact” level in the DPSIR framework. But it is also noted that there are some longer-term consequences that may remain a burden for future socio-economic development, especially in areas that are still being contaminated. These wider and longer-term issues are at the “Driver” level in the DPSIR framework. Moreover these areas are quite large, and are affected by transboundary air and water pollution. In the case of sediments one has to consider the international transport of sediments as well. It will be obvious that a strong commitment at the EU level is needed to tackle these large and long-term problems.

For source-oriented soil protection there seems to be an intermediate position between ‘subsidiarity’ and ‘EU driven’. The higher we are in the DPSIR framework, the more important EU will be. For agriculture for instance, for which soil protection is strongly related to the “State” level in DPSIR, there is a EU driven Good agricultural practice but there are also many local considerations (soil types are different throughout Europe, differences in climate, crops and culture).

For local sources, where the focal point of the strategy is at the ‘Pressure’ level, much can be done at EU in the IPPC context. This strategy is less dependent on soil type and climate and more dependent on state of the art techniques for prevention. Moreover the application of preventive techniques for industrial activities in EU may distort the balance in competition if the requirements in member state are very different

There has been some discussion about the nature of an EU policy strategy for soil. We will make a distinction between a “light strategy” and a “heavy strategy”. Both strategies should derive from some legal obligation to address soil as a target of concern in environmental policy. Although not mentioned explicitly such a “duty of care” for soil (and sediment) already exists in the EU (see for instance EU treaties and the liability directive) but the implementation is lagging behind.

The light strategy will correct this by screening relevant EU directives and add soil protection issues when appropriate. A politically endorsed strategic document is needed as a yardstick for this assessment. The light strategy will also stimulate member states to make a national contaminated land management program. In short the light strategy is only strengthening approaches that are already there.

One can also think about a heavy strategy. That is for instance drafting a Soil framework directive to achieve sustainable soil use and putting all measures related to soil protection which are already in force under this single legal umbrella. This will be a very long process and require tedious negotiations with stakeholders and member states. Moreover the problem of overlap with the WFD should be solved and the relation with spatial planning and water management should be clarified. For the short term the light strategy is clearly the best option and may, at least for local sources, lead to good results already. For agricultural land uses current discussions about Good Agricultural Practice are a good opportunity to implement measures against soil contamination.

A stronger legal basis for environmental protection (not necessarily in the form of a soil framework directive) may be needed to tackle problems with transboundary air and water pollution that leads to accumulation of contaminants in soil sediments and groundwater. Also the ultimate goal of achieving sustainable development by influencing the socio-economic drivers may need new legal instruments in the longer term.

4 MONITORING SOIL AND SOIL PROTECTION

4.1 Introduction

Monitoring schemes for soil contamination should keep track of the changes in drivers, pressures, state (soil

Contamination with radioactivity is also important as a result of nuclear weapons tests, improper radioactive waste disposal and the Chernobyl accident (UNEP, 1998).

Further information on the status of soil contamination in Europe is given in Part 2 (see separate document).

DPSIR as basis for the design of solutions

Up till now the two strategies for source-oriented soil protection, a contaminated land management strategy and an approach for indirect contamination have been discussed separately. Since they should be part of a general soil protection strategy they should be interlinked. The Driver – Pressure - State – Impact - Response framework may be used to achieve this. The diagram one the next page will show the DPSIR for soil contamination. We may start our discussion by looking at the response to impacts of soil contamination.

The need for an environmental protection policy for soil is only recently perceived in most countries. Soil and sediments are really slow reacting media, which means that there can be a long delay between the contaminating activity and the adverse effects on land uses and functions. Translated in DPSIR language: There is a long delay between pressures, changes in state (soils and sediment systems have a large buffering capacity and are - ecologically speaking - very resilient) and impacts. Response to impacts is always too late and very costly, as clean-up programmes in a number of member states have shown. Therefore prevention needs to move “upwards” in the DPSIR approach. In the ideal situation we should change the socio-economic drivers that lead to pressures on the environment. This process, which must lead to sustainable development, is slow due to many international aspects and the need of proactive planning of uses and functions of land and water resources. It should be the long-term goal in soil protection and indeed for general environmental policies as well.

In the meantime much progress can however be made if we could prevent pressures from ongoing activities altogether as described for the local sources strategy. In this strategy the pressure -for instance hazardous material handling at an industrial site- is prevented from affecting the state of the soil if leaking is prevented by appropriate techniques, safety plans and other measures. The focal point of this strategy is at the “pressure” level in the DPSIR framework.

This approach is not feasible for all land uses. Moreover sealing of large areas of soil has been identified as an adverse effect on its own. For land uses that require ecological interactions with the soil system like agriculture (input of nutrients, output of crops) it is not possible to avoid all pressures on the system. Even without contamination cropped soils can be demonstrated to be under some pressure[2]. For this type of land use it is important to address the state of the soil. The state under agricultural pressure should be reversible within reasonable time. From the ‘problem of contamination’ point of view a balance approach (input = output) is the best option under the condition that the output does not affect other targets, like food quality or water. On the DPSIR scale the balance approach is on step lower than the local sources approach, the focal point is “state”.

For historically contaminated land (sources no longer present) the strategy is to reduce impacts by risk reduction, as described by the Risk based land management (RBLM) approach. Sometimes it is feasible to restore the multifunctional state of the soil and even in a risk based approach this could be cost effective since multifunctional soil does not require structural long-term care (administration and control of use restrictions, monitoring of residual contamination). On the DPSIR scale the focal point is “Impact”. However RBLM also addresses issues related to the long term. For instance risk reduction by natural attenuation, which requires adjustments in spatial planning (no changes in land use) and in water management. But also long-term care, which is necessary if land is not “multifunctional” anymore, will reduce the flexibility in land use planning and water management and indirectly socio- economic development. The lesson to be learned is that soil and sediment contamination, even if today estimated to be harmless given the current use of soil and water resources, becomes a “driver” (actually a negative one, a “restrictor”) for future developments.

Large areas of soil and sediments are still being contaminated. The strategic approach for these situations can be based on Risk based land management. Because the sources are still active management solutions for the short term may be different from historical pollution. Although it may be worthwhile to clean-up the soil to a certain extent, one has to anticipate on future pollution, because for some sources the source-oriented approach will only be effective in the long run. Optimisation of the overall approach becomes attractive then. We may clean the soil now to be fit for a certain land use taking into account that accumulation of contaminants will diminish only gradually. This means that we clean-up to a more stringent level than is strictly necessary, to accommodate some ongoing contamination for a limited amount of time.

This approach will only be sustainable if in the long run all pressures on the soil system can either be eliminated as proposed for the local source approach, or balanced with the regenerative capacities of the soil system, as proposed for land uses that do require an interaction with soil ecosystem processes. In addition contamination of air and water should decrease to reduce the pressure of indirect sources of soil contamination. This underlines the need for a long-term strategy for sustainable land use and water management, which can only be effective at the “driver” level of the DPSIR framework.

In view of the many pressures on soil and the long recovery time or very expensive remediations of affected soils, soil protection policies need to be more proactive than traditional water and air policies. A sound strategic management of soil requires the combination of a long-term vision and shorter-term actions. The balance approach for diffuse inputs to soil can be considered as long-term a strategic goal. Priority setting of short-term actions is based on already existing regulatory obligations and liabilities or on an assessment of the risks associated with contaminants entering or being present in the soil system.

3.1 Risk assessment

In our analyses of approaches to prevent or remediate soil contamination we may observe an important common question: How to assess the risk of a local activity, an agricultural practice, or a contaminated site? Although these questions can be labelled as ‘risk assessment’, the way these questions should be answered can be very different. There is no such a thing as ‘universal risk assessment’. For local sources the risk to be assessed is

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[2] soil compaction, less organic matter, less biological activity, less soil fungi and so on, see for instance recent publications of Sparling and Schipper, Performance of soil condition indicators across taxonomic groups and land uses, Soil Sci. Soc. Am 64, 1,(2000)

We may observe that many incentives are expected to come from policy. Although in many cases contaminated land can be turned “from a threat into an asset” locally because private investors may make profits by decontaminating and redeveloping the land, there is still much contaminated land “that nobody wants unless……..there are some subsidies or legal obligations or…..”

2.5 Soil contamination by atmospheric deposition and by surface water

To curb the ongoing “diffuse contamination” of soil and sediments through water and air is beyond the scope of most private parties interests. This is a task for governments which need to formulate policies, for the short term aiming at the implementation of better preventive technologies and for the long term aiming changing our socio economic environment (the drivers in the DPSIR framework which will be discussed in the next section) towards ‘sustainable development’. Soil contamination by atmospheric deposition and water pollution should be reduced to acceptable limits which protect the soil functions, especially the ecological ones (including life support functions and soil fertility) , in the long term.

The tools to achieve this are:

- Quality control of emissions to air and surface water from industry and energy facilities, traffic, households and agriculture
- Definition of acceptable deposition limits (e.g. critical loads) for soil and water resources
- Adjustment of water quality targets to improve sediment quality
- Monitoring of atmospheric deposition and surface water quality
- Land use planning and water management

What are the incentives:

Atmospheric deposition does not only affect the soil, but also plants and biota and finally the whole ecosystem. Precautionary measures are necessary because restoration of soils needs long time (many decades to centuries). The need to protect different ecosystems, biodiversity, food production and nature reserve should lead to incentives to control and implement the tools. International conventions (e.g. Convention on Long-Range Transboundary Air Pollution - CLRTAP, Alpine Convention) could help to promote the formulation of policies to improve the situation and meet the goal in the long run. In order to encourage polluters to take measures now incentives should be created by governments in the form of funds or direct subventions or with legal obligations (e.g. Environmental Impact Assessment, Environmental Liability Directive). For diffuse contamination related to surface water the Water Framework Directive may become an important vehicle for quality improvement of soils and sediments.

3 THE STATUS OF SOIL CONTAMINATION IN EUROPE

In many areas of Europe, soil is being irreversibly lost and degraded as a result of increasing and often conflicting demands from nearly all economic sectors.

In Western Europe (WE), pressures result from the concentration of population and activities in localised areas, economic activities and changes in climate and land use. Air depositions and cultivation systems are among the most important influences on the quality of soils in agricultural and natural areas. Consumer behaviour and the industrial sector are contributing to the increase in the number of potential sources of contamination such as municipal waste disposal, energy production and transport, mainly in urban areas.

In Central and Eastern Europe (CEE), many of the problems stem from past activities and poor management practices.

The combined action of these activities affects quality and limits many soil functions including the capacity to remove contaminants from the environment by filtration and adsorption. This capacity and the resilience of soil mean that damage is not perceived until it is far advanced.
This partly explains the low priority given to soil protection in Europe until recently. Moreover, since soil is a limited and non-renewable resource, when it is damaged, unlike air and water, it is not easily recoverable.

The geographical distribution of soil degradation depends on several factors. Soil problems are influenced by the diversity, distribution and specific vulnerability of soils across Europe. They also depend on geology, topography and climate and on the distribution of driving forces. Better integration of soil protection into sectoral policies and better harmonisation of information across Europe are needed to move to more sustainable use of soil resources and promotion of sustainable models of its use. In particular, soil contamination from diffuse inputs and local sources can result in the damage of several soil functions and the contamination of surface water and groundwater.

In WE, soils in agricultural and natural areas are still in an acceptable state with respect to contamination but are under pressure. If pressures continue at the current level, as it is already evident in some problem areas, impacts will start to occur on a larger scale. Because the negative effects on the quality of soils are hard to remediate, these pressures should be addressed in time. On the other hand many urban soils and sediments are already heavily affected. Prevention should stop further deterioration and the risks of the currently contaminated land should be adequately managed.

Soil degradation problems in the CEE countries are quite similar to those in WE. Most of the problems are inherited from the time of the former USSR, when environmental issues were of minor concern.
Past agricultural policies that focused on increasing productivity led to often unsuitable use of mineral fertilisers and pesticides.
The combined effects of these resulted in pollution of groundwater and reduction of soil fertility. Increased awareness of environmental issues, the obligation to implement EU legislation upon accession and declining economies are reducing the pressures from agriculture (decreases in fertiliser and pesticide consumption).

In CEE soil contamination is, to a great extent, a result of the legacy of inefficient technologies and uncontrolled emissions.

Problem areas include some 3 000 former military sites, abandoned industrial facilities and storage sites which may still be releasing pollutants to the environment (DANCEE, 2000). One of the major impacts is groundwater contamination and related health problems. Major concerns are the long time needed to regenerate contaminated soil and the considerable investment required for remedial measures.

2.4 Contaminated land management

European soils contain many legacies from a less sustainable industrial past. Whereas water and air have much improved due to source-oriented measures, the soil does not (or very slowly) improve by itself after reducing or closing the sources. Soils and sediments are sinks for many contaminating substances and can only improve in a reasonable time if an active clean-up operation is performed. Active clean-ups are very expensive especially if the area to be decontaminated is large and the contamination is persistent. With the development of techniques that make use of the biodegradation potential of the soil decontamination of larger areas becomes feasible but the costs are still high, especially when spatial planning consequences and aftercare are considered: The land use must remain compatible with the biodegradation and the monitoring and management of this process for a few decades. Similar considerations apply for other extensive techniques like phytoremediation (for further discussions see CLARINET reports). If an area cannot be cleaned, one has to restrict the use of the land or adjust land use to the contamination. Sometimes immobilisation techniques can help to achieve this.

It is important to note that clean-up as a once and for all solution is only expedient if the sources of the contamination are no longer in operation. This situation is often referred to as “historical contamination” or “Altlasten”. However due to inadequate environmental controls in water and air land is still being contaminated. A clean-up, even using a long-term “ natural attenuation” technique, is only expedient if the situation really improves. If there is still a substantial input to the soil from atmospheric deposition or especially in the case of sediments, from water pollution a clean-up of soil or sediment will not be a long lasting solution. Air and water pollution should be addressed first.

Because soils and sediments (also groundwater) are sinks for many pollutants it is quite common to discuss polluted surface waters and air as “sources”. From an environmental policy perspective however we should go to the ultimate sources of the pollution, the human activities that give rise to the emissions. Air and surface waters are in fact contaminated pathways to soil and sediment. It is not easy to quantify the area of Europe of soil under “pressure” from the water and air pollution pathways. Some basic results regarding air pollution have been achieved by ICP Mapping and Modelling (critical load maps) and ICP Vegetation (moss monitoring) under the CLRTAP. In general the loading of soil and sediments with persistent pollutants is more intensive in areas with high air and water pollution. In order to set priorities it is also important to know the accumulation rates of the pollution (e.g. by monitoring of atmospheric deposition) and the risks associated with this (e.g. by ecological and human health risk assessment models, trend analyses, ecotoxicological tests). Moreover an analysis should be made of the ultimate sources of the pollution. Some sources may contribute more significantly to ‘diffuse’ water and air pollution than others, and pollution by some sources may be more avoidable than others in view of technical and socio-economic considerations. An efficient and effective policy should be based on the relative contribution of the source (or group or type of sources) and the “avoidability” of the pollution.

Estimates of the number of contaminated sites that could in principle be cleaned (historic pollution, sources no longer present, not too large) in the EU range from 300 000 to 1.5 million. The European Environment Agency has estimated the total costs for the clean-up of these sites in Europe to be between EUR 59 and 109 billion. Not included are the costs of not being able to use the soil as intended (planning damage), and all costs associated with the land that is still being contaminated. Contaminated sediments lead to considerable additional cost for dredging, to keep important harbours accessible and to maintain the flow in water systems.

There is a growing consensus among the EU member states how to manage contaminated land problems, as a result of networks like Common Forum and the concerted actions CARACAS, CLARINET and NICOLE. Co-operation with countries outside EU has also a long tradition in the adHoc Working group on Contaminated land and the NATO/CCCMS pilot studies concerning remediation technologies. Although most remediation technologies are only cost-effective at a local scale, the recent interest in Monitored Natural Attenuation and Risk Based Land Management opens possibilities for sustainable management of larger contaminated areas and regions. For the management of contaminated land in general managers have to take into account that the so-called “diffuse sources (pathways)” may still be present. Risk based land management as described in the CLARINET reports can be easily extended to cover also the diffuse pathways, if applied at a regional or river basin scale. River basin management as initiated by the EU Water Framework Directive could become a major vehicle for the abatement of these so-called diffuse sources, related to water pollution. The river basin scale may also be the right scale to bring sources of large scale diffuse air pollution under control. It needs further discussion whether the river basin is indeed the scale for the integrated management of all environmental compartments. Would emission trade of air pollution be acceptable at this scale? The EU funded project AgriBMPwater[1] has recently explored a system approach to environmentally acceptable farming based on emission trades for nitrate and phosphate between farmers affecting the same watershed.

If we state that contaminated land needs to be managed properly we may also mention the most important tools and incentives.
The tools:

- Contaminated land risk assessment.
- Clean up and risk control techniques (site specific decision making)
- Planning (spatial planning, water management)
- Adapted agricultural land uses

The incentives:

- Avoiding risk for human health
- Spatial planning, urban redevelopment need soils that are fit for their use (human health and ecological requirements)
- Policies favouring brownfield redevelopment and site recycling instead of the use of greenfields
- Policies concerning protection of biodiversity and the soil as a life support system (ecological services)
- Policies concerning the protection of soil as a production factor (agricultural needs)
- Policies concerning the protection of water resources.

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[1] AgriBMPwater. http://alpha.bordeaux.cemagref.fr/adbx/agribmpwater/

Apart from the direct toxic effects of certain substances, diffuse soil contamination may also eventually result in significant reduction of the buffering capacity of soil, which reduces soil fertility and soil biodiversity and results in additional costs for water treatment due to organic compounds, pesticides, plant nutrients and heavy metals released form soils to waters.

Although the traditional distinction between local and diffuse pollution seem to imply a difference in spatial scale, the main difference is the way the input of contaminating substances is related to the use of the land. Contamination from local sources corresponds to activities where it is not necessary to put (contaminating) substances into the soil. Oil tanks do not necessarily leak, properly designed waste dumps do not need to have substantial emissions to groundwater and leaching in construction materials can be reduced without affecting their functionality. Soil is only used for support or to provide space for these activities. On the other hand activities like agriculture do address the soil as an ecosystem. Agriculture takes space but in addition modifies the ecological cycles of energy and matter to adjust them to agricultural use. Sustainable agriculture is not possible without some input of fertilisers. However, to keep the soil in good shape we must avoid accumulation and balance the inputs to the soil system with its normal outputs without adversely affecting other parts of the environment. To stick with the agriculture example: in the long term input of heavy metals resulting from applications of manure and fertilisers must be balanced by the output, which is the amount leaving the system via crops and leaching to groundwater. The balance must be set in such a way that the ecological health of soil is maintained, concentrations of substances in crop or animal products do meet standards for food safety and the flux to groundwater does not lead to pollution of ground- and surface water. For pesticides the balance will also include biodegradation.

Discussions about local and diffuse sources easily lead to confusion. This can be avoided if we put more emphasis on the relation between soil protection and soil (or land) use. In line with the polluter pays principle and the principle that pollution should be preferably controlled at the source, it is obvious to state that the soil (land) user is responsible for protecting the soil that he uses (or actually rents from the next generations if we want to underline that uses should be sustainable). To put this into practice we must provide the users with the right tools and with some incentives to take care of the soil.

In the previous paragraphs discussing local and diffuse pollution two types of soil uses were introduced. Uses which use the soil as physical support only, and agricultural uses in which the ecological capacities of the soil are exploited. Although this distinction may ask for a new terminology, we may for the moment use ‘local soil uses’(local scale) to denote the use of soil as physical support and ‘agricultural soil uses’(farmland scale) to denote soil ecosystem uses.

Source-oriented soil protection related to the way the soil is used will contribute to the reduction of water and air pollution, by controlling the direct contamination of soil by the land-user. But the source-oriented soil protection will not be enough to prevent the contamination of soils and sediments and flooding areas coming from non-soil sources, by atmospheric deposition and by sedimentation in surface water. We may need a third group reflecting ‘indirect soil contamination by atmospheric deposition and surface water’. Industry and energy facilities, traffic, households and agriculture affect soils by diffuse contamination also in far distances from the source. Air and water are actually to be considered as important contaminated pathways leading to soil and sediment contamination at a large scale, way beyond the scale of individual land uses. We will discuss this later on, after the discussions about contaminated land management. This seems logical since we will need to consider the management of the contaminated environment in general, not only in relation with the use of the soil as we do for those sources that affect soils directly.

Local soil uses.

A typical characteristic of local sources is that the source is close to the target (soil). These sources are related to activities that do not involve soil as an ecosystem but only use the support function.

The goal here is to prevent the contamination entering the soil system, for example through barriers between source and target.

The tools to achieve this are:

- Appropriate techniques that prevent leakages and spills. If the techniques fail the resulting soil pollution should be removed as soon, and as entirely as possible.
- Monitoring systems for early warning.
- Necessity of additional barriers.
- Quality control of materials used in the built environment. As more waste materials containing contaminating substances are recycled into construction material some quality requirements are necessary concerning leaching and reuse after demolishing.

What are the incentives:

Soil clean-up is generally known to be very expensive. Since the polluter has to pay there is a big incentive for preventive measures. Adequate prevention costs orders of magnitude less than a clean-up. It is important that some legal obligation /liability exists to remediate the damage caused by spills and leakages *or* to restore the previous condition.

Agricultural soil uses.

The long-term goal is to balance inputs of substances (nutrients, metals, pesticides) with natural outputs to prevent accumulation of hazardous substances and irreversible depletion of buffering capacity of soils.

The tools to achieve this are:

- Quality control of manure, fertilizers, sewage sludge, composts and plant (and animal) protection products
- Methods to keep track of the balance.

What are the incentives:

Soil contamination in agriculture will affect soil fertility. For adverse effects that show up within a few years there is a big incentive to change agricultural practice and avoid contamination. To take measures now to avoid adverse effects after a few generations is more difficult and some incentives should be created by governments in the form rewarding more sustainable and therefore soil protecting farming, or with legal obligations.

environmental policy with land use planning often propagate “Land use planners should take soil properties into account in land use planning”.

Soil environmental problems: Soil is considered as a collection of problems like acidification, eutrofication, erosion, contamination, salinisation, desertification.

Soil policy: The response of society and its public administration to soil problems. It is often a reactive response, although ‘sustainable development’ implies a proactive approach.

Soil (=land) management: This perspective puts the soil in a wide sense, or land, upfront as a valuable and limited resource to be managed for the current and future generations. Often related to the wish to achieve sustainable land use. It is proactive and sees the need for integration with water management and spatial planning.

Ethical considerations/ cultural values: Environmental stewardship, opinions about the relation of man to nature: protect it, use it or restore it. Precautionary principle, how to deal with the many uncertainties in risk assessment.

Economy: Soil has great value (living space, agriculture), is owned and traded but cannot be produced. Contaminated and degraded land looses economical value.

Juridical aspects: Linked to economical and land use perspectives. The right to own and use the land. Problems with liabilities in case of land contamination or degradation. Is the right to use the land a permit to contaminate the land to a certain extent? Can landowners prevent public authorities to investigate the quality of their land?

The diversity of perceptions described above is not intended as a complete catalogue of opinions but to raise awareness of the complexity of the soil protection discussion. As the European commission aims at a holistic approach we need to take this complexity into account, without loosing ourselves in too much detail. There is probably not a single definition that will satisfy everybody so it is better not to waste too much time on the definition of soil and instead concentrate on soil protection.

2.2 The “soil system” approach

. . In developing soil protection we need to consider soil as a system that interacts with other parts of the environment and is therefore a sink and a resource of substances. If we take a narrow view of soil, for instance only the upper part as used in agriculture, we need to address many relations with other parts of the environment. If we take soil in a very broad sense like the ISO definition, including groundwater, sediments, subsoil and go as deep as human activities go, we have to address more internal complexity and less external relations. The system approach has the advantage that all important aspects will be addressed, either as internal to the system or as external relations to other systems, independent of the definition of soil.

The scope of the EU soil protection strategy is similar to soil as defined in ISO with one important difference. Groundwater is NOT part of the strategy, but soil water (percolation water) is part of the soil. The groundwater surface is the border. That means that we have to see groundwater as a target of concern, outside the soil system. It is also important to note that sediments (excluding the marine ones) are part of the Soil strategy.

We must realise that including or excluding certain parts of the environment from the soil strategy has administrative reasons, in the real world it is hard to separate groundwater from the soil. In the same way the separation of sediments from surface water seems to violate the aquatic ecosystem approach. But on the other hand, sediments share a number of characteristics with soil, especially when they are used as soil material in the terrestrial environment. They act as sinks for contaminating substances and can behave like ‘chemical time bombs’, which means releasing accumulated contaminants after a change in environmental conditions. Considering sediments as soil material may also help to solve administrative problems with reuse or disposal of dredged materials. At present, dredged material is not considered as contaminated soil, but as waste. Once a material has been labelled as waste it becomes very difficult to reuse it as soil material. Finally it is worth noticing that often the most productive agricultural soils are former sediments.

As the focus of the present TWG is on contamination a further distinction is useful between the sources of contamination on the one hand and the problems of already contaminated land on the other hand. Contamination refers to the present or past introduction of chemical substances in the soil system by human activities that may lead to adverse effects on soil uses and functions and/or adverse effects in other parts of the environment. Older publications used to make distinctions between contamination (concentration above background value) and pollution (concentration above background value with adverse effects on soil uses and functions or on other parts of the environment). Contamination and pollution are nowadays used more or less as synonyms. The discussions on contaminated land by networks like CARACAS, CLARINET and NICOLE were based on a risk based perspective and did not make a distinction between pollution and contamination.

2.3 Source-oriented soil protection

Source-oriented environmental protection usually makes a distinction between local (or point source) contamination and diffuse contamination. Local sources are generally associated with industrial facilities, waste landfills and other facilities both in operation and after closure. In addition leaching from materials used in constructions (especially in view of mineral wastes which are more and more recycled as construction products) is considered a local source. Other examples are improperly designed septic tanks and underground oil storage tanks in residential areas.

Diffuse sources are generally associated with atmospheric deposition, certain farming practices and inadequate waste and wastewater recycling and treatment. Atmospheric deposition is due to emissions from industry, energy production, traffic, households and agriculture. Farming production systems may result in the contamination of ground- and surface water. Additional problems relate to heavy metals (e.g. cadmium, copper) in fertilisers, manure and animal feed, to antibiotics and to pesticides.

Sewage sludge often contains a range of pollutants, poorly biodegradable trace organic compounds and eventually pathogenic organisms. The use of compost from recycled organic waste – if quality is bad and applied in large quantities- may result in diffuse contamination.

compost and sludge). Existing mid and long-term field trials must be integrated in order to profit from the already existing data pool. Harmonisation of *what* is being measured and *with which methods* is needed as well as completion with missing soil, management and climate variations. Parameters identified as effective indicators for soil quality and function can easily be integrated in such a co-operative research/monitoring network.

Key parameters related to soil contamination would be:

1. Various forms of *nitrogen* (nitrogen pools)
2. the *emission of greenhouse gasses* (N_2O)
3. the impact of spreading EOMs on *phosphorus-fractions* and their mobilisation potentials
4. The long-term effects of increasing the *sorption or fixation capacity for heavy metals* in soil by humified organic matter and dynamics are not fully understood in the view of precaution.
5. Accumulation, decay and solubility of *persistent organic pollutants* (POPs).
6. Potential hygienic problems resulting from the use of "*fresh compost*"
7. Impacts of the one-time use of higher amounts of composts (100 to 400 t/ha) in *land reclamation*.
8. The above mentioned effects (point 1 to 9) of *digestate* as compared to compost.

1.4.3.3 CONTAMINATED LAND MANAGEMENT

Many issues related to risk assessment management have been identified in the CARACAS and CLARINET concerted actions and by the NICOLE industry network.

In view of the need to integrate water protection, soil protection and prevention of air pollution a system-oriented approach is required in contrast to approaches focussing on individual substances. Feasibility of a river basin scale system-oriented approach should be scientifically explored, including demonstration projects. The system approach will require the development of conceptual models of the system we need to manage. The conceptual model will suggest (among others):

- What to monitor and where,
- The most promising measures to improve the environmental quality of the system
- The best way to conserve the quality (e.g. protection of non-contaminated ecosystems)

In addition the Task group on Contaminated land management identified the following research needs:

1. There is a strong need for harmonised analysis and sampling procedures. If not enough political agreement can be found to achieve this in a short term, effort should be put in attaining common performance standards such as accuracy and precision of the processes. Sampling and analysing have to be oriented as much as possible to the objective of the monitoring: whether one is interested in concentrations or in possible effects may have a strong influence on the kind of analyses that have to be carried out. There is a strong wish for risk-oriented sampling/analyses to get a better understanding of the possible effects of a contamination, rather than getting an idea about concentrations of a certain substance, without any notion of possible risks and without any notion of the potential effect of a cocktail of hazardous substances.
2. Focus research on giving better estimations of transfer of contaminants to possible receptors via the different transfer routes.
3. Sustainability of remediation concepts: most remediation concepts have an environmental impact themselves: emissions of volatile compounds, traffic, energy consumption, while on the other hand some concepts require long-term (sometimes even eternal) management. Most often, information about those environmental impacts and impact of this long term care is very scarce.
4. Easy-entry decision support tools for BAT: a lot of research has been carried out already on remediation techniques, but the information is not easily accessible for the end-users. There is a strong need for a good instrument for information exchange on remediation technologies. Such an instrument should be created at an EU-wide level. Projects like Eugris offer a help, but have the disadvantage that they stop at a certain moment.

2 REFLECTIONS ON SOIL, SOIL PROTECTION AND SOIL CONTAMINATION

2.1 A definition of soil

The first question that is often raised in discussions about Soil protection is "the definition of soil". Soil is a complex issue. The soil environment is very heterogeneous, and may show delayed reactions on human impact. It is important for its support of many needs of society, it has a huge biodiversity, it's biological activity is essential for maintaining the conditions for life on earth and it has many relations with other environmental compartments like water and air. Complexity of soil and its relations with other parts of the environment tend to manifest themselves differently at different spatial scales from individual soil particles to regional landscapes.

The complexity of soil, which is briefly outlined above, is the complexity as perceived by scientists. But there are also many different perceptions of the "soil issue" in the policymakers community:

Soil as a part of "system earth": This is mainly the scientist's perception, soil as the upper part of the earth, with the geosphere below and intensive interactions with hydrosphere and atmosphere.

Soil functions: Soil is seen as a multifunctional unit. Ecological functions like buffering, filtering, decomposition, and gene reservoir. Human related functions like crop production, support of buildings, archaeological archive and so on.

Soil (=land) uses: This is the spatial planners perspective: agricultural land, industrial, residential, nature area and so on. Proponents of integration of

3. From 1 and 2 it is obvious that some degree of consensus on the concept of bioavailability is needed since it forms a crucial aspect. If bioavailability in some form or another is to be implemented in EU policy, there should be some agreement amongst scientists what is meant by bio-availability. Further on it is an important to take scientifically based steps for the definition of critical soil threshold concentrations. This cannot be done by setting one value of a contaminant for all soils, land uses and climates. But without such an orientation all technical debates on risk-based assessments and precautionary principles etc. become obsolete

4. Field based process studies that establish process information at the desired level. Often process knowledge obtained in laboratories is insufficient to explain the behaviour of substances under field conditions. Especially retention and transport of substances like P, metals and organics have to be addressed in order to be able to link levels in soils to those in ground- and surface waters.

5. Investigate feasibility of development of true Farm and Field gate balances that take into account all in- and outputs. Currently various outputs (crop uptake, leaching, gaseous emissions) are not properly quantified or even neglected.

6. Knowledge on long-term changes in soil in relation to changes in land use (conversion of arable land to forest or wetland, extensivation, changing groundwater tables, changes in salinity due to irrigation or intrusion of sea water)

7. An overview of effects of available and new management strategies on environmental impact. For example the change from low to high inputs systems of organic manure may result in higher nitrate losses to the groundwater.

8. The economic impact (both form farmers and governments) of changing regulations on the allowed content of unwanted substances. For example reducing the amount of cadmium in P-fertiliser will result in higher prices for fertiliser. What are economic consequences for this?

9. Organic matter decline can be compensated by organic fertilisers, like animal manure, sewage sludge or compost. How do these potential sources for soil organic matter compare to the real natural input (decomposition of the local vegetation)and what are the long-term consequences for the soil and the surrounding ecosystem?. How is the life support system and biodiversity affected by current "high input- high output" agriculture?

10. Establish long-term field scale experimental sites across the EU where EOM is used at controlled rates that approximate to GAP. The sites should span the breadth of climatic and soil types found in the EU. The sites can be a resource to experimenters wanting to research the long-term effects of EOM.

Specific recommendations for manure and slurry

1. Digestibility of diets of animals and more efficient use of Cu and Zn in the diet, according to the real needs of animals

2. Regarding management, plant nutrition and soil protection:

   - Mineralization kinetics of organic matter and organic N
   - Availability to crops and leaching to groundwater of N, P at field scales
   - Characterization of organic matter (easily degradable or stable fractions)
   - Effects of organic matter on soil (increase of microflora, stabilisation of soil structure…)
   - Development of models and software predicting the mineralization and availability of nutrients
   - Development of models predicting and quantifying the effects of organic matter on soil

3. Regarding the prevention of soil pollution and the protection of soil ecosystems:

   - Effect on soil ecosystems of N and P accumulation
   - Speciation of trace elements and links with bioavailability
   - Extraction, analysis, transfers and impacts of veterinary drugs
   - Characterization and behaviour of pathogens in manures and slurry

4. Regarding the socio economical aspects

   - How to change the regional distribution of animal production in EU?
   - How to de-concentrate animal breeding in EU countries?
   - How to incite such changes?
   - What will be the socio-economical and technical impacts of such changes?

Specific recommendations for EOM

The regular use of EOM on Agricultural land imposes 2 main challenges to be covered:

1. optimisation of OM and nutrient supply (=soil improvement)
2. diminishing potential adverse effects due to load with accompanying contaminants.

A lot of applied research has been conducted for a number of materials such as animal manure, sewage sludge and, recently since 10 to 15 years also for compost.
Especially for compost from source separated organic waste long-term impacts on the soil-plant-groundwater system (agro-ecosystem) are still missing and do not reflect all typical ranges of soil, climate and land management conditions. Therefore in order improve GAP (good agricultural practice) for the organic fertilisation systems specific networks should be established covering the use of exogenous organic matter (EOM, such as

1.4.2.5 MONITORING OF CONTAMINATED LAND

Measurements of contaminant concentrations in soils are needed to assess the risks of contamination on a one-off basis or in relation to long-term management plans. In both cases monitoring will be specific for the site and of limited representativity, unless there is a larger number of similar sites. For these reasons, only for very large sites (megasites), where risk management plans are at the regional scale (like for instance "the Kempen" in the Netherlands and the Flemish region, the old coal and steel region in the North of France, or the Bitterfeld area in Germany), reporting of monitoring data may be of EU interest.

Data on concentrations of contaminants at individual sites (there may be 1.000.000 sites in EU) make little sense for EU policy discussions. Therefore, EU relevant information about contaminated land problems and solutions should be reported in the form of policy performance indicators.

The monitoring of contaminated land should have the following objectives:

1. gather data on the quality of soil according to risk-based principles, i.e. land use fitness and protection of resources
2. identify where action is needed
3. assess the efficiency of the actions undertaken and of the effectiveness of policy in place.

There is a strong need for tiered monitoring: at national or regional/catchment level a monitoring strategy is desirable to know where action is required, at EU-level it may be interesting to aggregate the collected data to give an idea about the effectiveness of the policy in place. The monitoring objectives are also linked to the discussion under "definition"; following that item, "aggregated parameters" or "indicators" might be:

1. Number of potentially contaminated sites
2. Number of sites that have been investigated
3. Number of sites where action is needed
4. Estimated amount of money needed to undertake action
5. Number of sites where action has been undertaken
6. Amount of money spent in action

Other interesting parameters/indicators (giving a broader view) might be:

1. Technologies used for remediation: this parameter gives an idea about the "sustainability" of remediation concept and may serve as a driver to initiate use of new technologies in other Member States.

2. Surface of brownfields known and dealt with: those parameters/indicators may serve as a signal for site remediation as driver for sustainable land use

3. Some sites may have such a serious impact on other relevant fields (so called megasites or problem areas), that reporting at EU-level on specific parameters for this site could be interesting. A definition of a megasite could be: "site where pollution is so bad that is has EU dimension (meaning that the site is relevant for existing EU-policy). Examples may be sites where the quality of a (ground or surface) water bodies is endangered, where food safety is endangered or a site that has a big social impact. A report on such a site could comprise parameters such as the location, kind of hazard (what EU dimension is "close") and the management concept for the site.

4. The main principles on monitoring could be in a directive, details on the monitoring scheme and on the reporting should be in a technical guideline.

1.4.2.6 EU INFORMATION MANAGEMENT FRAMEWORK: A STEP-BY STEP APPROACH

Monitoring and reporting approaches need to evolve into a more harmonised EU information management framework. EU Monitoring has to start with aggregating the already existing monitoring schemes and will identify the need for harmonisation and additional monitoring information for the interpretation of the results. Reporting has to start by using already defined program performance indicators and will have to accept some differences between Member States. As policy will become more uniform due to the EU soil strategy, policy implementation differences between Member States will gradually disappear and policy performance indicators will become more comparable.

So, both for monitoring and for reporting, we need to accept that the first results will give a rather blurred image of the DPSIR for soil contamination. But the quality of the information will improve gradually if information exchange and harmonisation of approaches is stimulated. There is a need to report aggregated information on agreed formats.

1.4.3 Recommendations for Research

1.4.3.1 LOCAL SOURCES

1. Further development of containment devices and techniques for safe storage, handling and transport of substances that may contaminate soil and groundwater.

2. Passive sampling technologies work contaminant specific and are a promising technology for early warning of soil pollution. However, absence of performance data from lengthy use and other uncertainties prevents their availability on the market. Further improvement on product development is needed to improve economy and reliability of such devices.

1.4.3.2 DIFFUSE INPUTS

General recommendations

1. The availability of substances (to plants, animals and soil micro-organisms) that reach the soil from either atmospheric deposition or agricultural activities, both chemical and biological, and changes therein with time. Specific issues that need to be addressed include P-availability in soils, change in heavy metal availability with time, effects of organic matter and pH on availability of metals and organic micropollutants in soils (link with organic matter group; specifically in relation to compost addition, see additional remarks on compost discussion)

2. Practical tools (i.e. measurement techniques) to assess the degree of biological availability of substances in the soil that can be used to assess the internal levels. Here especially crop uptake and exposure of toxic substances for soil organisms have to be addressed.

91/414/EEC. Hence it would be relevant to monitor certain of these products in soil solution as well.

Large scale diffuse pollution

This is the policy area where monitoring is of most importance and relevant at EU level because of the transboundary nature of large-scale diffuse pollution. Monitoring the fate and transport of contaminants through environmental media will help the choice of the best national and regional abatement strategies and their effectiveness. Because all environmental compartments are involved, soil and sediment monitoring should be linked to the monitoring of surface water, as required in the Water Framework Directive, to the monitoring of groundwater, as required in the Groundwater directive, and also linked to the monitoring of air pollution. The EU monitoring system could use already existing networks as a starting point. Even if the methods used differ between networks, the conclusions may still be consistent.

Substances to measure

Measurement of concentration of contaminants in soil should focus on the abatement of (current and future) effects due to diffuse inputs. It should also include the effects of measures to reduce inputs. Monitoring should only be done where there are real concerns (risk areas) rather than a routine grid sampling. The choice of substances should consider only those substances which may reach critical limits in soil in view of human health, food safety, soil fertility, ecological risks especially concerning biodiversity in soil, groundwater and surface waters. Those include the following:

- Heavy metals (Cadmium, Copper, Lead, Zinc, Mercury, Arsenic, Nickel and Chromium)
- Polycyclic aromatic hydrocarbons (PAHs)
- Dioxins, polychlorinated biphenyls (PCBs) and other dioxin-like substances
- Banned, persistent pesticides, such as hexachlorocyclohexane (HCH), dichlorodiphenyltrichloroethane (DDT) or DDE
- Nutrients (nitrogen and phosphates).

Use of the results of measurement of substances in soil

Results from a monitoring programme should enable the user to:

- Evaluate the impact (= quantity and quality) of diffuse inputs in relation to other inputs (e. g. what is the contribution of atmospheric inputs compared to inputs by manure?). This will, later on, steer the measures to be taken to reduce inputs according to relevance.
- Evaluate the future state of the system, i.e. how does the current land use (or changes thereof) affect soil quality. Again, soil quality in relation to crop growth, water quality, ecosystem etc. This means that input-output (balance) approaches are needed that are able to calculate fluxes into (inputs), within (processes) and out (outputs) of the system. Based on the outcome of these balance approaches, inputs can be reduced or effects can be reduced (accept a certain input but make sure effects are negligible, e.g. by additional liming).

Frequency

An average sampling interval of 5 to 10 years seems to be an adequate compromise to measure changes in the metals and organic contaminants listed above, which are likely to be slow as well as nitrogen, phosphorus and the inputs/outputs of contaminants to/of the soil system, which may change faster. If more knowledge of the dynamics of the various parameters is available, the sampling frequency could be adjusted accordingly for each parameter.

Representativity and spatial resolution

To be representative for EU soils, a monitoring network should cover the major forms of land use, climate, hydrological regime and soil type, as strata in a stratified sampling design. Although monitoring could be done on an arbitrary grid basis, it is not very efficient to consider soil as a black box system and ignore that land uses, soil types, climate and hydrological regimes are major factors determining the influence of diffuse inputs on the state of soils. Stratified sampling is much more powerful in this case because it addresses these factors explicitly and will make interpretation of data much easier. We need to take into consideration the distribution of driving forces/pressures and the receptors of contamination (not just the distribution of physical parameters).

Specific recommendations for (action-driven) monitoring of exogenous organic matter (EOM)

Due to the usually low quantity of pollutants and limited amount of material applied to land (following GAP) accumulation rates are generally low. If source materials as well as the gained exogenous organic materials (including manure) are of well defined quality (limit values) it would be fairly enough to monitor changes on pilot scale where pure modelling would still leave considerable uncertainties. In this way (as mentioned below) basic data taking into account the most important management and site conditions can be considered.

Collecting these data may be useful also for scientific purposes, to improve conceptual models of substance flows in agricultural systems. A number of farming systems maybe monitored through EU and such a monitoring system may help to improve GAP (good agricultural practice)

There exists research based evidence that the input of humified organic matter (compost) increases the sorption or fixation capacity for heavy metals in soil. So monitoring of heavy metal availability/solubility/mobilisation within *pilot schemes* with plots fertilised with EOMs would be an important tool for further evaluation of potential impacts due to the input of contaminants by fertilisation systems. Also persistent organic pollutants (POPs) and their breakdown/solubility behaviour which may be found in those EOMs could be considered to be monitored in this way. But currently this may rather be a matter of research than of regular monitoring system.

be updated along with the improvement of the information basis that will be available with the enforcement of a harmonized EU Soil Protection Policy.

2. The system should be built on systems already in place both at the European and national level.

3. The system design should be implemented following a dynamic and flexible nature and devised to fulfil short-term requirements, mainly based on a number of already available and comparable indicators and parameters at the different spatial scales. Long-term needs should also be identified.

4. The monitoring and assessment system of soil contamination should be based on the following elements:

    a. Action-driven monitoring
    b. Identification of relevant indicators and related data needs
    c. Integration with existing European monitoring and reporting activities
    d. Integration of local and diffuse contamination
    e. Streamlining (not extensive multi-purpose monitoring but based on specific policy needs)
    f. Tiered approach, according to the following geographical levels:
        i. Country
        ii. Catchment (regions of natural boundaries)
        iii. Site-specific-European Level (full EU coverage limited to pressures; detailed monitoring limited to problem areas)
        iv. Site-specific- national Level (limited to guidelines for national inventories))
    g. Step-by-step implementation and harmonisation (gradual implementation and learning by doing)
    h. Guidelines for national monitoring (data collections activities, national inventories, etc.).

5. The Driving Forces-Pressures-State-Impacts-Responses (DPSIR) assessment framework should be used to identify and prioritise the policy-relevant indicators to include in the system.

1.4.2.3 MONITORING OF LOCAL SOURCES

The measurement of concentrations of substances in soil and groundwater are planned to detect failure of the technical preventive measures as fast as possible. Therefore they are of little relevance in terms of providing an overview of the state of the soil (or groundwater) with respect to contamination.
For this reason, monitoring of local sources should make use of more aggregated information like failure frequency of specific preventive technologies or general policy performance indicators (see also monitoring recommendations from task group contaminated land management).

Main recommendations of the task group are:

1. Establishment of a European Point Source Assessment System (EPSAS). Safety conditions at defined point sources should be monitored on a regular basis. The system should cover activities included in an agreed common list of potential soil polluting activities. A distinction should be made between activities subjected to EU policies and activities subjected to national regimes. The system should be based as far as possible on existing activities.

2. At the European level, EPSAS should cover those installations that are currently obliged to report their environmental standards on a regular basis. These are industrial installations as defined by the IPPC directive, installations addressed by the regime of the Seveso II directive, exploratory industries addressed by the new BAT document of the IPPC directive, and landfills that come under the regime of the landfill directive.

3. At the national level, on the basis of an agreed list of potential soil polluting activities, Member States should be encouraged to monitor point source safety at other installations or activities which are currently not covered by EU legislation (i.e. small enterprises with relevance for soil pollution).

4. Existing information should be improved and expanded:

    - **Industry:** in the long term the European Pollutant Emission Register (EPER) should be extended to provide information on the efficiency of soil protection at IPPC sites

    - **Mining:** Member States should compile and report national overviews of sites which need to comply with new standards and progress in standard implementation.

    - **Waste management:** further development of the EEA electronic waste catalogue and integration in EPSAS of reporting under the hazardous waste directive and the landfill directive.

5. The EPER register should be extended to include emissions to soil.

6. The status of strategic industries (i.e. Seveso II) should be reviewed, including any installation and waste sites of the military sector

1.4.2.4 MONITORING OF DIFFUSE INPUTS

Sources of contamination from agricultural practices

The monitoring in farm systems of input-output balances of the concentration in soil of selected contaminants and nutrients may help the improvement of GAP (good agricultural practice). Given the large number of farms in the EU, information to be reported to the EU should be aggregated in policy-performance indicators or sustainability indicators.

It should be noted that plant protection products although applied to plants or soil are more often monitored in plants and groundwater than soil, as required by the Pesticide (91/414/EEC), Drinking water and Water Framework Directives. In some cases (risk areas) monitoring the amount applied to soil may be useful but additional information is required to relate this to potential environmental impacts, such as described in Directive

2. It would be desirable to improve the definition of treatment and preferably to move to the protocol that has been adopted buy the food industry and that is progressively being required of farmers, i.e. Hazard Analysis and Critical Control Point (Codex, 1997; Evans, 2003). HACCP is equally applicable to chemical as well as to microbiological hazards.

Specific recommendations for compost

1. A positive list of high quality source materials for composting and anaerobic digestion intended for the processing of organic soil amendments would be essential to guarantee high quality compost. This should include source separated household waste and green waste as well as organic industrial waste (e.g. from food industries).

2. In order to bridge the gap between targets for the reduction of biodegradable municipal waste to landfill and a sustainable use of the biodegradable waste fraction incentives for the recycling of source separated biowaste are essential. Member States are encouraged to explore the best solution for implementation considering local conditions.

1.4.1.3 CONTAMINATED LAND MANAGEMENT

1. As a starting point for individual monitoring at risk activities, it is interesting to start with a soil quality monitoring duty for operators who already have an existing monitoring and reporting duty, such as IPPC. An amendment to the directive should be made to specifically reference soil monitoring activities in the duties for operators. To make sure that the activities with higher risks for soil contamination are covered, an investigation should be carried to define the main contaminating activities which are not yet covered by the IPPC-list.

2. It seems necessary to clarify “satisfactory state” in IPPC, as interpretations differ at the moment throughout MSs.

3. Every MS should work out national or regional action plans for contaminated land management.

4. Contaminated land policy comprises both soil and groundwater contamination. We need an integrated approach to soil and water.

5. Water-soil interaction is very important for dealing with sediment problems. Sediments should be included in soil strategy.

6. Create an incentive to the harmonisation process for risk assessment.

7. Promote the use of the RBLM concept to manage historically contaminated sites in an efficient and sustainable way.

8. Soil should be protected at the same level as other environmental compartments in the coming Directive on environmental damage.

9. The text of the “state aid” regulation should be amended or at least clarified to reduce uncertainties about possible public incentives which for instance aim to bring brownfield sites/regions back into the economic cycle, to solve urgent problems which pose a high risk, etc.

10. Create a legal basis for the public availability of aggregated data on soil quality of contaminated sites.

11. Create incentives for the redevelopment of brownfield areas; this implies often creating extra protection against greenfield development.

1.4.2 Recommendations for Monitoring

1.4.2.1 DEFINITIONS

The term “monitoring” is used in this report as general term covering classical soil monitoring, multi-purpose monitoring, action-driven monitoring and regular reporting using various indicators or other type of information across the whole DPSIR chain.

“Classical monitoring” is the measurement of concentrations of substances in soil (monitoring of state). Multi-purpose monitoring and action-driven monitoring are defined in the Monitoring mandate. We consider multi-purpose monitoring as the monitoring of the state of soil for all threats to fulfil different needs, whereas action-driven monitoring is focused on the evaluation of policy measures against soil degradation.

”Regular reporting” is the periodic communication of aggregated information resulting from national monitoring programmes, according to an agreed format.

1.4.2.2 GENERAL RECOMMENDATIONS

Classical monitoring is only useful in well-defined stratified approaches. The group recommends that detailed monitoring is carried out only in problem areas. Many parameters have to be measured in order to interpret the observed changes in the state of soil with respect to contaminants. There should be a recommendation for reference standard methods for sampling and analysis and for standard specification of what to report and how to report it. Monitoring of soil should be integrated with monitoring of sediments, groundwater and surface waters. A European approach should be based on information provided by the national monitoring programmes. Related to the different threats an explicit identification of problem areas or risk zones is needed. Criteria for identification of risk zones should be agreed with the Member States.

The following recommendations are mainly referred to ‘action-driven’ monitoring which is considered the most appropriate approach to monitoring and assessment of soil contamination. For this reason particular relevance is given to action and policy-relevant indicators, which are usually collected at a relatively high – i.e. by country - aggregation level. However a number of indicators and parameters might be considered in order to get less aggregated information needed to carry out a more detailed, and still action-driven, monitoring down to specific problem areas. Details on the choice of contaminants to be monitored are also provided.

1. The implementation of the soil information and monitoring system on soil contamination should follow a progressive upgrade in terms of quality and quantity of information collected. The system architecture and individual data collection items will

reclamation, landscaping and building activities. This policy has to achieve the following:

1. Specification of (ultimate) long-term goals and (proximate) short-term goals.

   The long-term goal is related to sustainable land use and protection of natural resources. Balancing diffuse inputs with acceptable outputs of the soil and groundwater system in order to prevent a decline of soil functions seems to be the most appropriate long-term goal, whereas short-term goals can be based on the current risks of the contamination as related to land uses and functions and the bioavailability of the contaminants. Moderate surplus of diffuse inputs could be acceptable if the long-term goal is not endangered. The interaction between short-term and long-term goals need a thorough consideration, especially in relation to land use changes and cross-cutting issues like sustainable agriculture, mid-term beneficial aspects of certain soil management practices and climate change.

   Therefore function related soil quality definitions and investigations on critical concentrations of (potential) contaminants are an important pre-requisite and reference for addressing GAP related to land management.

2. Specification of the responsibilities of the users of the land.

   The user of the land should be addressed while taking into account that the user cannot be held responsible for all diffuse inputs. In the light of a “Good agricultural practice” a farmer should have the duty to be as eco-efficient as possible by minimising the flux of contaminating substances like heavy metals and organic pollutants coming from agricultural inputs and the flux of unused nutrients to groundwater and air. Suppliers and manufactures of products that are used on land and may impact on soil also have responsibilities to support the farmer in proper use of these products (quality assurance, guidelines for application).

   Abatement of air and water pollution contributing to non agricultural diffuse inputs is a task for society as a whole. The long-term goal is to achieve a balance between inputs and outputs to groundwater into balance without compromising the quality of soil and water resources for future uses and functions taking into account the requirements of the water framework directive.

3. Ensure a linkage between soil protection policies and other related policy areas

   Policy areas of relevance are policies approving chemical substances (including pesticides) for the market, policies concerning the quality of products applied on soils (fertiliser, compost) that may contain “unwanted” contaminating substances, policies for Good agricultural practices and policies concerning the use of organic waste on soil. Soil protection aspects should be taken into account, or enhanced where necessary, to ensure that there are no long- or short-terms threats.

   There should be a more direct feedback loop from diffuse contamination and agricultural practice to the approval policies for chemicals and pesticides so that sustainable use in agricultural practice and prevention from entering the large-scale diffuse pollution pathways (deposition and sedimentation) can be improved. A stronger emphasis on persistence of chemical substances and pesticides in soil may be necessary in view of soil protection. The EU regulations on chemical substances and on pesticides should solve that problem. Further discussion about this issue for pesticides should take place in the Thematic strategy on pesticides and the current revision of 91/414/EEC Regulation on pesticides.

Concerning waste the policy should specify whether recycled waste can be used as a product or if it should be recycled in the framework of waste regulations.

If an application regime under waste regulations controls is chosen possibilities of a proper use of products are limited. Therefore for products high level of quality assurance, product declaration and quality requirements must be applied together with more and more emphasising GAP.

Specific recommendations for manure and slurries

1. In the long term, sustainable land use planning could encourage a better distribution of animal breeding and production in EU countries. One possibility to reduce unwanted inputs to soils would be to adapt the husbandry density (livestock unit per hectare) according to the environmental sensitivity of each area. Further recommendations are the following:

- Substitute manures and slurries for mineral fertilizer according to the needs of crops (good agricultural practices) in intensive breeding regions

- Develop treatments like biogas production that, on the one hand, improves the fertilization capacities of manures and slurries and, on the other hand, makes it easier to store and to handle. Appropriate land use planning policies are needed to ensure its development.

- Compost manures and slurries, which increases the percentage of stable organic matter in these materials and sanitises the manure but loses nitrogen. The benefits have to be compared with negative impacts like emissions of ammonia to the air which needs more research work.

- Decrease (if feasible) the amount of Zinc and Copper in the feeding of animals to a necessary level taking animal welfare implications into consideration as well as increasing the digestibility of diets to limit excretion in excess of N and P in the faeces after evaluation of potential benefit.

Specific recommendations for sludges

1. It would be desirable to refine the current EU sludge directive to achieve a holistic approach to all organic resources that are applied to all types of land in order to have soil protection based, harmonized requirements for all of them.

9. A need exists for a better harmonisation of risk assessment concepts. Much research has been carried out on the issue, and within the Caracas project an effort has been made to bring together all information within MSs, but little has been done to really co-ordinate the concepts. Some scientific elements relevant to risk assessment should be harmonized (e.g. stepwise and scientifically coherent decisional procedure, tox/ecotox/chem. contaminant properties) while others should be optionally selected from jointly developed “toolboxes” (e.g. sampling/analytical procedures, fate and transport models), in order to allow for site-specific and regional variability. MSs should be encouraged to harmonize their acceptable human health risk level e.g. excess lifetime tolerable cancer risk because differences are hard to explain to the public.

10. The “Best Available Technology” (BAT)-principle is relevant to make sure that best technologies are being used for soil remediation, while taking into account also secondary effects and costs of a technology. Guidance documents on proven technology may be helpful, while a strict list is likely to stifle innovation and development of new technologies. Implementing “BAT” should more be about procedures to come to site specific BAT rather than a strict list of what technology should be used for what type of contaminant. Examples of guidance documents already exist in several MSs, while also Clarinet- and NATO/CCMS Pilot Study reports provide useful information. When EU-funds include soil remediation in certain projects (like in funds for regional development, Interreg, Life, etc.) building in the necessity to use site specific BAT could trigger technology development and knowledge dissemination.

11. Some MSs have got mechanisms to co-finance the remediation by the present owner of contaminated sites where responsible parties have failed. Some EC-funding mechanisms (such as Interreg or European Fund for Regional Development) may fund soil remediation; they are limited though to certain regions. Yet, the application of the “state aid” regulation on soil remediation is not always very clear and should be amended.

12. The rights of an owner can interfere with “public interest”, where e.g. soil contamination poses a threat to human health, groundwater quality, ecosystems, etc. The rights of an owner should be of minor importance to the public interest. Anyhow, an owner is an interested party in the soil quality, so he should take part in the decision making process of a remediation plan. To make the market “work” on remediation, the responsibility for the remediation could be put with the owner of the land, as this will make a remediation most effective; this can be “softened” with co-financing when the owner is not the liable party. Financial guarantees could also be required to ensure that industrial operators have the necessary funds to rehabilitate their sites when the activities cease.

13. Generally, greenfield development is too easy, thus hindering brownfield redevelopment.

14. A report on land status is desirable when a “risk activity” has been carried out on a piece of land to inform a potential buyer about the risks. One might even think of creating a “financial guarantee” at the moment of transfer to avoid constructions in which a liable party “sells” the badly contaminated land to an insolvent third party. Such a land status report should also be required in case of land use change toward a more sensitive use.

1.4 Recommendations

1.4.1 Recommendations for Policy

1.4.1.1 LOCAL SOURCES

Main recommendations of the task group are:

1. A commonly recognised list of potentially soil polluting activities from industry, waste deposits, and extractive industries needs to be drawn up and a distinction shall be drawn between those activities that shall be subject to EU policy and those that shall be subject to national policy regimes. A list of major sources was set-up by the Task Group (see p. **Error! Bookmark not defined.**), which needs more detailed specifications.

2. In view of the enormous costs generated in the case of soil remediation, environmental liability needs to be strengthened. The Task Group recommends a regime of obligatory financial security, or insurances depending on the size and type of activity and the efficiency of implemented preventive measures.

3. Implementation of an obligatory soil assessment at the start and closure of potentially soil polluting activities.

4. Prevention of soil pollution from potentially soil polluting activities needs “tailor made” prescriptions and should be based on sector-specific or activity-specific precautionary measures. At EU level the Task Group considers IPPC BREF documents as the most suitable level to integrate soil protection measures in a sensitive way.

5. Consideration of early warning systems in landfills.

6. Consideration of soil pollution in mine waste management and reclamation of mining areas.

7. Incentives for operators → better insurance and liability conditions for proactive soil protection measures.

8. Improvement of point source safety at sites that are currently not covered by EU legislation, in particular small and medium sized enterprises (SMEs). Development of short guidance documents for prevention of soil pollution at potentially soil polluting SMEs.

9. Awareness raising at sites where potentially polluting activities are carried out.

10. Monitoring of point source safety with regard to soil pollution at EU level and Member State level.

1.4.1.2 DIFFUSE INPUTS

A general policy framework should be developed to address diffuse soil contamination resulting from atmospheric deposition, water pollution in the case of sediments, from agriculture and other activities like concerning soil. Sewage sludge is produced locally and should be dealt with close to the source (it is not an example of transboundary pollution). Generally sludge is not exported as a recycled product to other countries (though it is sometimes transported over long distances), and whether sludge is burnt, landfilled or applied as organic fertilizer does not affect the performance of the internal market in EU or the balance of competition between Member States. However, organic waste recycling to the benefits of the environment must go hand in hand with the needs of agriculture and more specifically the demands of soil protection.

1.3.4 Task group Contaminated Land Management

The **task group Contaminated Land Management** focuses on a risk based and sustainable management of land that has already been contaminated (= "historical pollution"). This accounts for diffuse contamination as well as for contamination coming from point sources. It also covers what has been termed recently as "proximity pollution", wide-spread diffuse pollution originating from a single industrial source, outside the property boundaries of the industry.

The **main results** of the discussions in the task group are:

1. The following definitions are proposed:
    a. A *"potentially contaminated site"* is a "site where an activity is or has been operated that may have caused soil contamination".
    b. *"Land"* represents a geographical area (could be a single site, or it could be a region such as a municipality or larger area). However, it also includes the physical components of this spatial area, such as soil and groundwater beneath the surface of the land.
    c. *"Site"*: A particular area of land, usually related to a specific area of ownership or activity.
    d. *"Contaminated land"*: a geographical area with confirmed presence of "dangerous substances" caused by man in such a level that they may pose a significant risk to a receptor in such a way that action is needed to manage the risks. The risk is evaluated taking into account current and expected uses of the land."
    e. *"Contaminated site"*: a site with confirmed presence of "dangerous substances" caused by man in such a level that they may pose a significant risk to a receptor in such a way that action is needed to manage the risks. The risk is evaluated on a site-specific base taking into account current and expected uses of the site.
2. The management of contaminated land must follow the concept of Risk Based Land Management (as studied in the Clarinet-report) applied on a case by case approach. When a problem of new soil contamination is found immediate action is required.
3. Every MS should work out an action plan for contaminated land management.
4. Today, an EU-wide inventory has little relevance, because many Member States (MS) have a different understanding of what "contaminated site" means, and because the way and speed of building up inventories throughout the MSs differ greatly. That being said however, every MS (or county or region) needs information on potentially contaminated sites to be able to plan necessary management actions. This information can be grouped in an inventory. As decision for action can take into account other factors than contamination, it should be up to MS to fill it in depending on its own needs. EU-wide guidelines on how to build up an inventory of potentially contaminated sites as well as contaminated sites can be useful to exchange good practice in particular for MS not having such inventories.
5. Several Member States have carried out national action plans. Key principles and recommendations concerning such action plans are the following:
    a. A strategic approach at national level is very useful in particular to define priorities for action based on the risks and the impacts of the contaminated sites.
    b. An approach requiring a strong harmonisation of such plans at EU level is not appropriate. In particular MSs should have the freedom to decide whether the inventory or the plan should be carried out at national or regional level. MSs should also decide the type of inventory necessary to cover their territory (in particular a number of MSs have already developed such tools).
    c. An information exchange on strategic approach between MS would be highly beneficial and should be developed to define best practices; the already established EU Common Forum may serve as a useful starting point here.
6. Information on soil contamination is often owned by private parties (e.g. land owner or operator); this information should be made publicly available, at least when contamination has been proven. MSs should be able to decide that they want all information on possible soil contamination to be made publicly available.
7. Application of the "polluter pays"-principle is not always possible for historical contamination, as the polluter may not be liable for historical contamination, may not be able to pay for remediation or does not exist any more. The recent Directive on environmental liability deals differently w ith soil damage versus water and biodiversity damage. The liability directive might have been an opportunity to protect/restore soil and land to the same standards as water and biodiversity.
8. The Proposal of the Commission for a Directive on Groundwater gives no solution for large zones of contaminated groundwater (for instance compliance with certain limit values is required in all points of the water body regardless the technical and economical difficulties to manage historical contamination). The Proposal should be amended to ensure an appropriate management of historical contaminated sites. In particular, the preventive and limit clause in the Water Framework Directive (WFD) may hinder remediation activities and should be clarified.

2. Soil pollution deriving from point sources shall be avoided as far as reasonably achievable whatever the state of soil might be at the beginning of an operation (“no added/increasing contamination”).

3. Prevention of soil pollution from point sources is not sufficiently addressed in current EU policy (in contrast to emissions to air and water). Environmental liability in the case of pollution is weak and legally binding financial security of potential polluters is entirely lacking.

4. Point source safety for potentially soil polluting activities from industry, waste deposits, buildings, and extractive industries needs to be reviewed. In this respect special provisions to prevent emissions to soil need to be defined and the progress of their implementation needs to be surveyed.

5. Monitoring of soil pollution from point sources can only be based on assessing policy efficiency in the sense of surveying the progress and efficiency of implementing measures intended to increase point source safety related to soil protection. Appropriate “policy monitoring” can only be implemented after implementation of appropriate policy adjustments at EU level and at Member State level.

1.3.3 Task group Diffuse Inputs

The **task group diffuse inputs** discussed two classes of soil contamination which are generally labelled as diffuse contamination:

1] Contamination that may arise from current agricultural practices and related soil uses such as forestry, managed nature reserves, reclamation areas, landscaping, gardens and parks where the user of the land modifies ecological processes in soil with additions of nutrients, exogenous organic matter and pesticides to increase productivity or to protect the current state of the land.

2] Contamination that enters the soil system by natural pathways like atmospheric deposition and sedimentation from surface waters (in the case of sediments).

These two classes have in common that the input from contaminants cannot be avoided like for local sources that only use the soil for support. In order to formulate adequate soil protection policies for diffuse contamination one has to address the interaction of the contaminants with the complex living soil system and its heterogeneity in space and time. Moreover contaminants enter the soil system by multiple pathways. Agricultural land may become contaminated through atmospheric deposition, through certain trace elements in fertilisers, through the application of pesticides, manure, slurries, sludges and compost or applied soil material. Another complication is the fact that many substances may contaminate the soil simultaneously and can interact, which may lead to additional adverse effects on some receptors.

The **main conclusions** from the task group are:

1. Given the complexity of the diffuse input problem a strategic approach is needed that gives some indication how to consider the different inputs and their relations and how to pave the way to sustainable land use and soil conservation as a resource for future generations. European Parliament stressed the importance of preventing the accumulation of hazardous substances in soils, but the task group could not agree on the basic principles to turn this EP statement into a policy.

2. Preventing accumulation of harmful substances by balancing inputs and outputs was considered a too simple “arithmetic” approach by some. According to them it is not the accumulation of the substance as such but the accumulation of risk for human health or ecosystems that should be the key issue. Others considered that focussing on (short-term) risk and current land uses is not preventive enough, in particular in relation to the Water Framework Directive. Risk assessments must be sufficiently knowledge-based and detailed to take into account future land uses and potential impacts in the long term in order not to be in conflict with sustainability. We should not want to endow future generations with risky soils and limit their freedom of choice to use the land differently.

3. In view of the lack of consensus for a strategic approach, the group decided to use a bottom up approach, because they felt that was the most practical when discussing inputs of contaminants in agriculture. Materials like composts, manures, lime, fertilizers, sludges and pesticides can be assessed according to agronomic value, the impurities and potential pollutants can be identified, the pathways of exposure can be tracked and the risks for soil functions, water resources, plants animals and man can be assessed. This discussion automatically led to the question whether we should protect the multifunctionality of soils together with applying the precautionary principle, or whether we should make a differentiation between different types of land uses according to their sensitivity for pollution. Some favoured the long-term goal of preserving soil as a multifunctional resource for future generations, others favoured the more short-term risk based point of view related to the current use of the land.

4. The weighing of agricultural benefits versus environmental impacts of each product proved also to be a controversial issue. This weighing is dependent on several political value judgements. Moreover the merger of the discussion about the sludge and biowaste from a waste management point of view with the discussion about soil protection did not contribute to the consensus in the group. One option is to define treated (e.g. composted) waste materials as product which is put on the EU market to be used for the improvement of nutrient status or organic matter content of soils. This strategy is applied in a number of Member States for composted biowaste (Austria, Italy, The Netherlands etc.). Another option as known from the Sewage Sludge Directive and national regulations is the strategy of waste recycling with the possibility to follow and control the recycling path until the application on a specific plot. In both cases agriculture must not be urged to serve as principle receptor of certain waste streams, but a distinct and comprehensive material and quality definition of waste derived soil amendments must ensure an environmentally sound beneficial use. In addition it has to be noted that, by definition, if a material is a waste does only depend on the fact, if someone wants to discard a material. On the first hand this is no matter of quality definition. The answers to these questions seem to require some general policy guidance. The more so because the added value of intervention at the EU level in regulations concerning waste, especially sewage sludge seems to be based on different arguments than for regulations

d) Define what should be monitored;
e) Make a research agenda.

The following sections will summarise the policy recommendations (based on objectives a, b and c), the monitoring recommendations (d) and the research recommendations (e) based on the work done by the task groups.

1.3 Main conclusions

1.3.1 Mandates and cross-cutting issues

The working group analysed all relevant mandates, identified the issues that are to be covered by the group and divided the work into work packages (see chapter 2). Most of the issues have been covered (see this report and task group reports), but a few have not been addressed due to time constraints, lack of expertise or low relationship with soil contamination.

The issue that could not be addressed in a quantitative way from the specific mandate was to assess the consequences of soil contamination hindering the achievement of sustainable development by addressing the impacts on economy, employment and social welfare.

Concerning the general mandate for all working groups, the basic principles (like polluters pay and precautionary principle) have been addressed by the working group and are reflected in the task group reports. Regarding policy needs a European soil policy should not replace current regulations, which already contribute to soil protection or duplicate these efforts but amend and complement these where required and act as a coordinating umbrella. The main philosophy of the working group is to stress the responsibility for soil protection and liability for soil contamination of the owner and/or user of the land. If soil users need to contribute to the improvement of soils contaminated by others, it will be obvious that some additional incentives will be needed. The role of agriculture and forestry in revitalising soils has to be seen in this light.

Concerning cross-cutting issues the following rough conclusions have been drawn in relation to soil contamination:

- Basic definitions: Protection against the threat of contamination has to consider the whole soil-water-sediment system and all kinds of (past and present) land use have to be addressed for the definition of appropriate measures.

- Climate change: Effects of climate change on the impacts of soil contamination, will be caused by changes in the water flow and organic matter status of soils. This will in turn influence the fluxes and the bioavailability of contaminants. The conclusions from the EU funded Chemical time bomb project (1991) are still relevant in this respect and need to be further explored to yield reliable scenarios in view of decision making.

- Environment and health: Apart from the clear human health risks associated with heavily contaminated areas the relation between soil contamination and human health is rather vague. In view of the uncertainties of the cause-effect relationships between soil health and human health a strong link between the Soil Thematic Strategy and the Strategy on Health and Environment is recommended.

- Biodiversity: There is clear evidence of adverse effects of soil contamination on soil biota and plants. Methods for ecological risk assessment should be further developed and further research is needed for implementation of specific indicators concerning the protection of biodiversity.

- Role of land use planning policy: Land use planning should consider soil contamination, in particular in urban areas showing the need for consideration of soil degradation in the urban thematic strategy.

- Role of agriculture and forestry in revitalising soils: Guidelines and regulations for materials applied to agricultural are useful and further needed in order to avoid contamination, but also incentives are suitable to enhance soil protection, e.g. by reducing input of pollutants into soils.

- Co-ordination of the world-wide dimension: Regarding large-scale diffuse contamination it is strongly recommended to develop synergies between the soil strategy and the Convention on Long-Range Transboundary Air Pollution.

- Awareness, communication and participation: Awareness raising on soil issues is very important in order to avoid soil contamination. Therefore provision of information is recommended using different tools adapted to the audience to be addressed.

- Property rights related to soil and soil data: Data owned by public administrations has to be made publicly available, but also private data in case they are getting of public interest due to risk of damage to the environment.

Issues that have not been addressed from the general framework:

- Impact Assessment
- Socio-economic aspects
- Gender mainstreaming
- Basic typology and characterisation across European soils
- EU soil conservation service

1.3.2 Task group Local Sources

The **task group Local Sources** focussed on recommendations for preventing soil pollution from point sources. These sources only need the soil for support. Introduction of contaminants in the soil system can be avoided so the phrase “no added pollution” can be used to describe the strategic policy objective. The task group also provided an overview of major point sources contributing to local soil contamination.

The **main conclusions** of the task group are:

1. In most cases soil pollution from point sources is unintended and happens due to handling spills or accidents or insignificant but continual losses/emissions. In contrast to air emissions and wastewater discharges, the principle of “controlled emissions” can not be applied and appropriate measures need to focus on pollution prevention.

Executive Summary

1.1 General introduction

Contamination is one of the main threats to soil identified in the EU soil communication (COM(2002) 179 final). Prevention of soil contamination has strong links with policies on chemical substances and with environmental protection policies for water and air. It has also strong links with policies concerning certain land uses, for instance agriculture.

The relation between soil contamination and waste management is obvious as well. Bad waste management has led to a large number of contaminated sites. Better waste management has led to recycling of waste as construction products, or as composts and sludges that can be used as fertilisers. Both ways of recycling may positively or negatively affect the quality of the soil. Waste disposal by landfilling is now subject to environmental regulations which protect soil and groundwater.

In fact many policies have significantly contributed to the protection of soil. However soils are still subject to many pressures leading to soil degradation, which calls for a policy which addresses soil in it's own right. Such a policy should not replace current regulations which already contribute to soil protection but act as an umbrella. It may be described in a policy document aiming at the coordination of the implementation of regulations already in place and at improving current regulations if soil is not addressed sufficiently. The legal basis for such a strategy document is implicit in EU treaties and the proposed directive on environmental liability (COM(2002) 17 final). There is also political commitment from the European council (CO-DBP (2003) 10) and European parliament (2002/2172(COS)).

The discussions in the TWG contamination have strengthened the above point of view. Specific policy strategies have been designed for local sources of contamination, for agricultural soil uses, for management of contaminated land and for large scale diffuse pollution. The strategies, which form the basis of the policy recommendations of the working group, are tightly linked to the way the land is used and identifies the owner/user of the land as the primarily responsible party for soil protection. For agricultural land the farmer has to treat the soil in a balanced way in order to save the soil quality for future generations. This should be supported by production of high quality products and proper information on usage. For land of local sources the owner has to prevent soil contamination by safeguarding avoidance of release of substances to soil as much as possible. For contaminated land the owner of the land is responsible for managing and improving the situation only if the polluter cannot be legally addressed. A policy approach for large-scale diffuse pollution however requires large-scale integration of soil protection, air and water policies and land use policies. The water framework directive provides opportunities for management of water quality and quantity at the river basin scale and will become an important vehicle for soil and sediment protection and further integration of environmental management. The abatement of large-scale diffuse contamination problems will for long be the task of public authorities and EU wide coordination is necessary due to the transboundary nature of the environmental problem and its economic repercussions. It is also clear that the classical generic tools in environmental policies for contaminating substances like state-of–the-art emission reduction techniques and the setting of (eco)toxicological quality standards fall short in view of the large-scale diffuse soil contamination. For soil protection we need to put the uses and functions of the soil-(ground)water-sediment system upfront and not the individual contaminating substances. The generic tools have to be adapted to fulfil their role as decision-making tools within a system-oriented management framework.

The analysis of regulations already in place that can contribute to soil protection against contamination has been the starting point for the working group and its task groups. Before any additional regulations or measures are proposed better implementation of existing ones or amendments concerning soil contamination are recommended. The reporting obligations at the EU level associated with these regulations already provide information that can be used for “action-driven” soil monitoring, but may have to be extended if necessary. For the further development of action-driven monitoring a scheme has been proposed for monitoring and assessment, based on indicators and a tiered approach. The working group discussed in depth the usefulness of classical soil monitoring to improve our insights in diffuse contamination. It proposed to start with an aggregation of the results of national monitoring approaches for heavy metals and POP's as listed by the Stockholm convention on POP's. However the need for new monitoring schemes is obvious in view of the large-scale diffuse pollution problem, in relation with monitoring requirements of the water framework directive and the groundwater directive.

A large input of the working group to the TWG Research was based on the RTD needs identified by the concerted actions CARACAS and CLARINET and the networks SEDNET and NICOLE. Concerning agricultural land uses many research questions are inspired by the lively discussions on compost, sewage sludge and fertiliser applications and more generally by discussions about Good Agricultural Practice, sustainable agriculture and the reform of the EU Common Agricultural Policy.

1.2 Organisation of the work

The general approach for discussion of soil contamination makes a distinction between source-oriented soil protection and contaminated land management. Source-oriented soil protection is aimed to prevent (further) contamination of the soil, while contaminated land management deals with the clean-up, remediation and reuse of soil which is already contaminated, often as a result of past activities.

Within this strategy framework, four workpackages and related task groups were established:

1) Policy, strategy and integration of issues (PSI), providing the common ground for the task groups and covering general policy requirements and cross-cutting issues;

2) Local sources (LS), dealing with prevention of contamination at the single site scale;

3) Diffuse inputs (DI), including agricultural sources, dealing with prevention of contamination due to diffuse inputs at the large and farmland scale;

4) Contaminated land management (CLM), dealing with remedial actions.

Common objectives of the task groups were the following:

a) Draw a general picture of the extent of soil contamination in the enlarged EU;
b) Describe strategies and technologies solutions;
c) Identify the added value of action at the EU level;

ANNEX III BACKGROUND VALUES OF HEAVY METALS IN EUROPE'S SOIL

Heavy metal contents in European soils are varying according to soil parent material and land use (arable land, grassland, forest, other land use) and also due to heavy metal inputs. In order to assess soil contamination and its development it is essential to know the background level of trace elements in soils. Based on a study commissioned by the Joint Research Centre and DG Environment (JRC, 2004), ranges of background values of trace elements in European top soils in relation to parent material (including all land uses) are given in Table 1.

Table 1: Range of heavy metal contents (median) within the units of soil parent material considering all land use types [mg*kg-1], 11 countries included

Soil parent material*	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**
Undifferentiated alluvial or glacial deposits	0.07 - 0.76	7 – 40	4 - 30	0.02 - 0.24	4 - 34	6 – 64	13 - 128
Calcareous rocks	0.26 - 1.23	10 – 56	12 - 24	0.06 - 0.23	13 - 39	16 – 63	49 - 100
Clayey materials	0.14 - 0.90	9 – 50	7 - 22	0.05 - 0.13	7 - 36	9 – 37	25 - 78
Sandy materials	0.09 - 0.30	5 – 37	2 - 21	0.04 - 0.18	3 - 22	9 – 39	6 - 62
Loamy materials	0.10 - 0.85	10 – 62	8 - 21	0.04 - 0.18	9 - 29	11 – 54	35 - 86
Detrital formations	0.18 - 1.23	16 – 49	12 - 24	0.10 - 0.13	21 - 32	17 – 46	52 - 107
Crystalline rocks and migmatites	0.11 - 0.94	8 – 43	11 - 31	0.04 - 0.20	10 - 38	15 – 73	40 - 101
Volcanic rocks	0.25 - 1.48	10 – 68	10 - 32	0.11 - 0.29	8 - 48	26 – 58	55 - 130
Other rocks	0.10 - 1.00	5 – 40	4 - 32	0.07 - 0.24	3 - 37	14 – 88	19 - 125

Note: * Mapping units of the European Soil Data Base
Sourcs: JRC, 2004

Maximum median values exceed the respective lowest median values 1.3 to 12.3 times. The highest median values can be found in the units "Volcanic rocks" and "Other rocks". They occur under grassland, forest or other land use but not under arable land. The lowest values are distributed to the units "Undifferentiated alluvial or glacial deposits", "Sandy material" and "Other rocks". They emerge either under forest or arable land. With regard to the limited data availability and comparability it must be pointed out that the given ranges of heavy metal contents are only in parts representative for the whole of Europe.

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ANNEX II HEAVY METAL LOADS IN EUROPE’S AGRICULTURAL AREAS DUE TO APPLICATION OF SEWAGE SLUDGE

Table 1: Loads of heavy metals in selected countries due to application of sewage sludge (mainly based on the national maximum permitted application rate)

Country	Year	Cd g/ha/a	Cr g/ha/a	Cu g/ha/a	Hg g/ha/a	Ni g/ha/a	Pb g/ha/a	Zn g/ha/a
AT	1995	3.20	143.93	639.71	5.60	93.29	266.54	3,331.80
AT	1998	3.18	143.24	636.64	5.57	92.84	265.27	3,315.84
AT	2001	3.29	147.86	657.14	5.75	95.83	273.81	3,422.62
DK	1995	1.77	31.37	269.75	2.14	26.84	68.02	957.16
DK	1996	1.33	26.86	262.54	1.23	21.59	51.86	712.51
DK	1997	1.32	25.11	244.51	1.11	18.16	49.45	664.18
DK	1998	1.37	25.47	246.35	1.00	20.54	50.64	697.94
DK	1999	1.45	25.61	229.62	0.95	21.34	49.25	678.00
DK	2000	1.15	23.87	214.76	0.94	21.46	49.87	649.31
DK	2001	1.29	23.18	221.62	0.94	26.23	46.83	702.34
GE	1998	2.34	81.83	482.63	1.67	45.09	105.21	1,394.45
GE	1999	2.17	78.49	490.98	1.50	46.76	101.87	1,369.40
GE	2000	2.17	68.47	504.34	1.50	46.76	100.20	1,379.42
HU	2002	9.65	330.13	-	7.11	154.34	256.18	4,744.33
IE	1999	5.20	330.00	666.00	1.20	66.00	212.00	1,136.00
IT	1998	16.94	486.96	1,472.41	8.37	315.88	560.92	4,347.04
IT	1999	16.60	437.17	1,609.62	7.66	226.25	515.38	4,471.79
IT	2000	14.82	611.08	1,424.88	5.67	318.66	503.73	4,312.49
LU	1999	5.10	189.00	900.00	5.70	153.00	387.00	5,004.00
NO	2001	2.00	49.60	488.20	1.80	29.00	41.20	634.00
PT	2000	20.40	660.00	3,072.00	31.20	276.00	630.00	10,020.00
ES	1999	47.30	2,992.22	6,782.38	30.58	1,096.70	2,575.98	21,098.44
ES	2000	49.60	2,888.20	6,051.00	42.60	916.20	2,058.00	18,034.60
ES	2001	76.50	3,001.80	7,994.70	33.90	1,236.00	3,747.00	21,995.10

Source: EIONET data flow, September 2003 (data not yet published)
Note: The table shows a worst case scenario, as for most countries data are based on maximum permitted application rather than actual application.

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Table 2 Heavy metal concentration in arable and grassland soils of Austria as compared to public greens and parks in Vienna

Cadmium in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	2066	0,11	0,15	0,21	0,28	0,38
grass land [1]	0 - 20 cm	1172	0,14	0,18	0,24	0,35	0,59
grass land [1]	0 - 5 cm	1425	0,18	0,23	0,31	0,43	0,68
Vienna: public greens [2]	0 - 10 cm	28	0,30	0,37	0,50	0,62	0,78
Vienna: parks [2; 3]	0 - 10 cm	38	0,39	0,47	0,57	0,83	0,99

Chromium in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	2045	22,56	30,50	38,00	48,00	61,20
grass land [1]	0 - 20 cm	1106	19,78	27,80	36,16	47,23	66,64
grass land [1]	0 - 5 cm	1395	19,20	27,60	36,80	47,40	64,30
Vienna: public greens [2]	0 - 10 cm	28	15,54	19,58	26,39	38,89	46,16
Vienna: parks [2; 3]	0 - 10 cm	38	19,09	21,34	25,93	28,62	32,88

Copper in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	2066	12,30	16,30	21,20	27,62	37,90
grass land [1]	0 - 20 cm	1172	11,22	15,34	22,70	33,00	43,22
grass land [1]	0 - 5 cm	1425	11,60	15,70	22,40	31,50	40,90
Vienna: public greens [2]	0 - 10 cm	28	18,07	24,05	27,21	37,80	56,36
Vienna: parks [2; 3]	0 - 10 cm	38	29,29	35,17	46,28	59,40	96,37

Mercury in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	1728	< d.l.**	0,10	0,16	0,22	0,29
grass land [1]	0 - 20 cm	906	< d.l.**	0,07	0,14	0,23	0,33
grass land [1; *]	0 - 5 cm	1073	< d.l.**	0,09	0,13	0,20	0,30
Vienna: public greens [2]	0 - 10 cm	28	0,11	0,15	0,17	0,26	0,48
Vienna: parks [2; 3]	0 - 10 cm	38	0,27	0,33	0,55	0,75	1,06

Nickel in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	2045	10,40	18,40	23,70	30,00	38,20
grass land [1]	0 - 20 cm	753	9,09	16,45	24,10	32,88	46,17
grass land [1; *]	0 - 5 cm	1395	8,80	16,30	24,30	33,60	45,20
Vienna: public greens [2]	0 - 10 cm	28	18,81	23,80	27,38	31,38	34,52
Vienna: parks [2; 3]	0 - 10 cm	38	23,63	26,02	28,89	31,70	33,66

Lead in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	2066	5,48	11,60	17,20	23,20	32,13
grass land [1]	0 - 20 cm	1172	12,32	18,50	26,69	39,30	55,68
grass land [1]	0 - 5 cm	1425	15,82	21,50	28,40	42,70	67,04
Vienna: public greens [2]	0 - 10 cm	28	29,94	39,66	57,41	72,10	82,15
Vienna: parks [2; 3]	0 - 10 cm	38	47,84	73,97	85,70	123,11	185,26

Zinc in soils [mg/kg]

soil use	horizon	N	Percentile				
			10	25	50	75	90
arable land [1]	0 - 20 cm	2066	54,17	63,10	73,89	92,00	112,87
grass land [1]	0 - 20 cm	1172	52,57	69,02	90,59	114,60	144,99
grass land [1]	0 - 5 cm	1425	56,46	73,20	96,00	119,43	144,42
Vienna: public greens [2]	0 - 10 cm	28	66,08	85,94	109,08	131,89	188,52
Vienna: parks [2; 3]	0 - 10 cm	38	96,19	123,04	155,85	213,51	304,10

Notes:

* without province Tyrol

** below detection limit

[1] Amlinger, F., Peyr, S., 2001.; soil data extracted from the soil information system BORIS of the Austrian Federal Environment Agency, based on provincial soil inventories of Burgenland, Carinthia, Lower and Upper Austria, Styria and Tyrol.

[2] Kreiner, 2001

[3] all parks with playgrounds