JRC Scientific and Technical Reports

Soil Country Analyses
Germany

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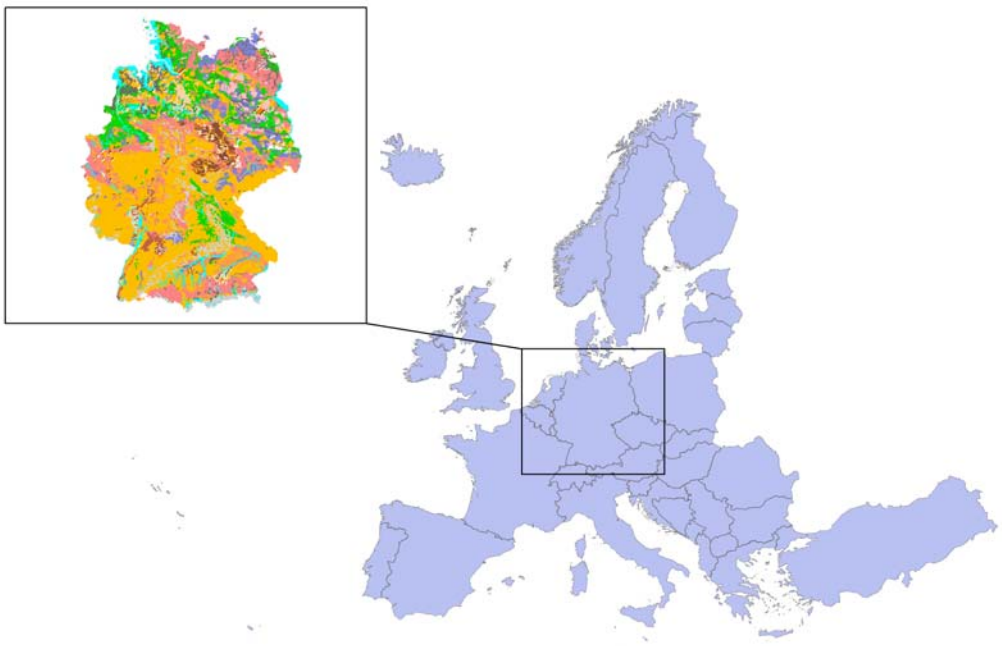

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Soil Country Analyses
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Introduction

The state of soil in Europe is influenced by its diversity, distribution and specific vulnerabilities across the region, as well as the diversity of geology, climate, topography and the availability of other natural resources. Soil conditions are also determined by the spatial distribution and intensity of the economic activities, together with the underlying social political, legislative, financial, scientific and institutional frameworks within individual countries. Given the cross-cutting nature of the soil environment and the many users and sectors exploiting soil resources, providing comprehensive assessments on soil in Europe or at the national level is a difficult task.

The DPSIR (Driving forces-Pressures-State-Impacts-Responses) approach has been widely used to carry out integrated environmental assessments. This approach requires the integration of socio-economic information on driving forces and pressures with: media-specific information on state and impacts; information on the impacts of environmental degradation on society and information on responses and their effects.

On the other hand, data on the different aspects of soil at the pan-European scale are scarce and patchy. In particular, the information currently available is not sufficient to cover all the soil threats nominated in the EU Thematic Strategy for Soil Protection[1] and socio-economic aspects are in general not taken into account. This scarcity of the policy-relevant information has prevented so far the production of a comprehensive assessment on soil in Europe.

In order to approach this challenge, in early 2007, the European Environment Agency (EEA) initiated the preparation of soil country analyses in close collaboration with the EIONET.

The EEA started the process by putting together available information on the different soil aspects. This information was loaded into a customised questionnaire for each country. The countries were then asked to review the information and provide additional data where possible.

The so-called “Soil Country Analyses” reports are the final outcome of this process. Each report offers an overview of the status of soil resources at the national level and touches the aspects presented in the Soil Thematic Strategy. These include the main soil threats, the different soil policy instruments (also economic instruments) in force, and the specific soil management programmes and monitoring activities implemented or planned in each country.

Putting together this wide range of information from diverse sources has not been an easy exercise, and the EIONET countries have made considerable efforts over a period of two years.

The completeness and quality of the information which underpins the analyses is variable, reflecting the range of resources and information available at the national level. The positive outcomes of the exercise are many:

- The information provided by the countries filled many of the existing data gaps and provided the basis for preparing the soil country reports;
- For the first time, soil information spanning across the aspects of the EU Soil Thematic Strategy is available from one place, thus facilitating analysis and further use;
- The completed questionnaires plus the country reports are available as input to national activities (e.g. preparation of national State of the Environment Reports);

[1] COM(2006) 231. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions – Thematic Strategy for Soil Protection. Commission of the European Communities. Brussels, 22.9.2006

- Comprehensive lists of national data sources have been collected and can be used for further processing in European and national projects;
- The Information provided by the countries helped the validation of the data already available and has in some countries led to improvements in data reporting processes, in particular by enhancing the contacts between national institutions;
- Information is now available to support the European State of the Environment Report.

In parallel to this exercise, the European Commission's DG Environment (ENV), DG Joint Research Centre (JRC) and Eurostat, together with the European Environment Agency (EEA) decided at the end of 2005 to establish "Environmental Data Centres" to ensure the provision of robust data and information on the state of the environment for the development of environmental policies at European Union level. In that context, the European Soil Data Centre (ESDAC) was established at the JRC.

In the "EIONET Workshop on Soil" held on 18 September 2007[2] with representatives from DG ENV, the EEA and the JRC, together with representatives from the EIONET 'National Reference Centres for Soil' and members of the Steering Committee of the 'European Soil Bureau Network', the EEA and the JRC jointly decided that all soil data management activities carried out by the EEA in collaboration with EIONET were to be transferred to the JRC.

Following that decision, in the "EIONET workshop on Soil" organized by the JRC IES on the 4-5 of March, 2009[3], the representatives of the EIONET National Reference Centres for Soil agreed on the joint JRC-EEA publication of the Soil Country Analyses under the "Scientific and Technical Reports" series of the JRC. The final edition of the reports and the inclusion, where relevant, of additional soil information available at the SOIL Action was the contribution of the JRC to the publication of the Soil Country Analyses. They are also made available online at the European Soil Portal (http://eusoils.jrc.ec.europa.eu/).

[2] All the material from the workshop can be found at http://eusoils.jrc.ec.europa.eu/library/data/eionet/Workshop2007.htm
[3] All the material of the workshop can be found at http://eusoils.jrc.ec.europa.eu/library/data/eionet/Workshop2009.htm

Organization of the report

Section 1 presents a brief description of the general situation in the country. It is aimed at capturing the main context features which have an influence on the environment, with specific reference to the status of soil resources.

Section 2 contains a summary of the status of soil resources, including priorities, challenges, problems, and success stories. It presents information on the following specific issues:

- the eight threats identified in the Soil Thematic Strategy (compaction, contamination, erosion, depletion of soil organic matter, loss of soil biodiversity, salinisation, floods and landslides, and soil sealing)
- cross-cutting and complex issues such as desertification (where relevant)
- impacts of sectors of activity that are relevant in the country
- case studies/success stories. Specific documentation that is related to issues of particular interest or that describes an emergent or underestimated issue that is worth telling (e.g. surface mining in Germany)

Section 3 provides a brief overview on legislation, market-based and in general economic instruments to protect soils (e.g. remediation funds, subsidies, etc.), as well as international activities.

Section 4 contains information on management and monitoring programmes with particular reference to programmes aimed at soil resources (e.g. the water basin management programmes, national inventories of contaminated sites) and major factors that hinder the access to relevant information (e.g. confidentiality issues).

Section 5 presents information on the status of the main environmental issues in the country, including priorities, challenges, problems, success stories.

Section 6 presents brief overviews and relevant statistics of main sectors of activity and main industries and a snapshot of the social features, including characteristics of the population such as lifestyles and consumption patterns. The sectors that are likely to be relevant to soil are agriculture, energy production, transport, tourism, households, chemical industry, etc. It includes information on industrial development and economic evolution (historical).

Section 7 presents information on land use changes.

The report has four appendices. The first one details information on local soil contamination, since a reporting process has been going on in the EEA since 2000 and more detailed information is available. The second appendix provides a detailed factsheet on the different Market Based Instruments presented in section 3, when this information is available. Finally, the third and fourth appendices offer some comments provided by the country experts on different datasets available at European level: on soil threats in appendix 3 and on socio-economic information in appendix 4.

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This report was prepared by Anna Rita Gentile, European Environment Agency, on the basis of the information available in December 2006. Comments and additional and recent information were provided by Germany through an ad-hoc questionnaire.

Sara Barceló-Cordón and Marc Van Liedekerke, Joint Research Centre, completed and revised the report for its publication.

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1. THE GENERAL CONTEXT

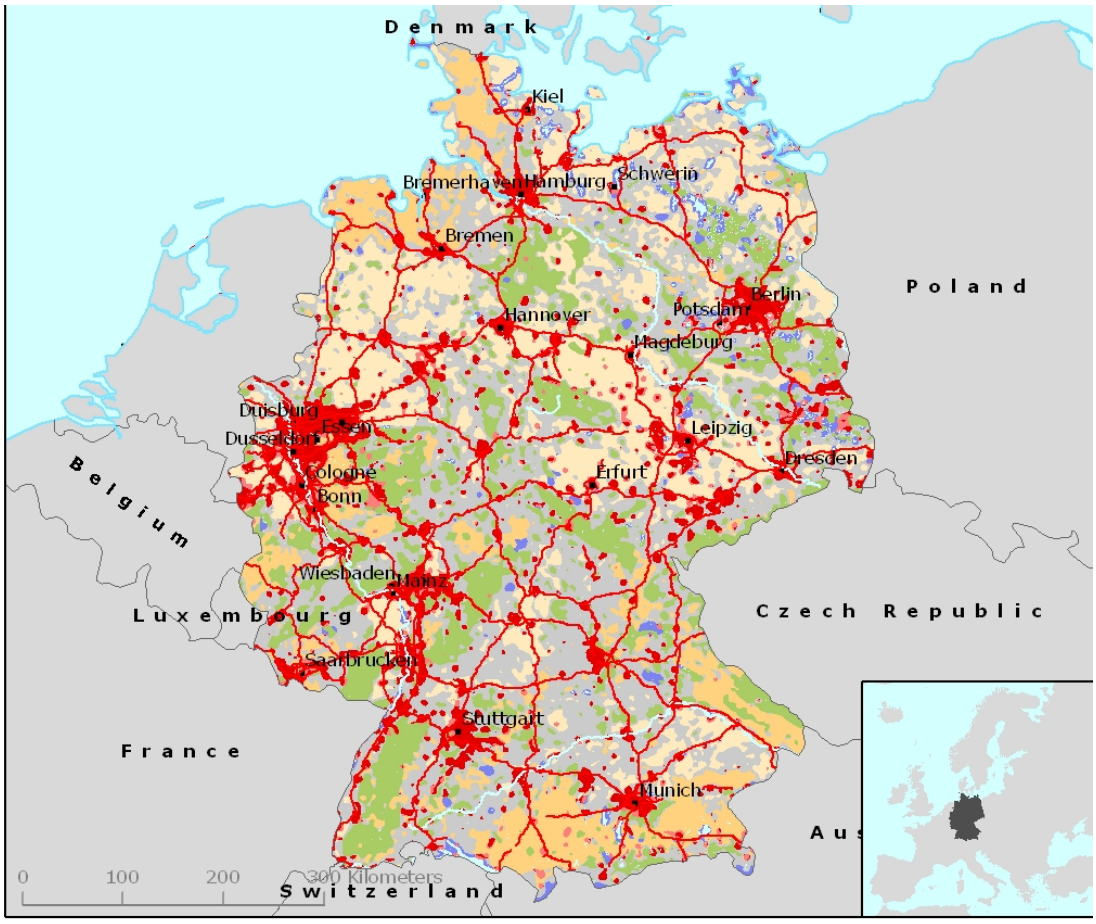
Germany is located in the centre of Europe and shares its borders with nine countries. Its coastline stretches from the North Sea to the Baltic Sea. Topographically, it can be divided in three major zones: the north flatlands, south of the North and Baltic Sea coastline, with many lakes and wetlands; the central uplands, with hills and mountains rising to 1 000 metres; and a mountainous southern area with hills, large lakes and the German Alps, where elevations reach 3 000 metres. Within these zones, nine major landscape units, showing very different conditions in terms of natural features and anthropogenic pressures on soil resources, can be identified[4].

Germany's climate is moderate, with frequent changes in weather conditions. It varies greatly proceeding from the north-west to the south-east. In particular, precipitations as well as the frequency and the severity of thunderstorms decrease along this gradient.

Major land uses include agriculture (half the total area), forests (about 30 %) and artificial surfaces (nearly 13 %)[5]. Germany is also one of the most densely populated countries in Europe. Its population is especially concentrated in some areas, including the Berlin region (over 4 million inhabitants), the Rhine-Ruhr industrial district (more than 11 million people or about 1 100 per km^2) and other major industrial areas and urban agglomerations. In contrast, other regions, such as the Bavarian forest, are very sparsely populated.

Germany is rich in groundwater resources, which provide over 85 % of the drinking water. Overall, the country is not abounding in non-renewable natural resources. Resources of importance include reserves of brown coal and hard coal, iron ore, petroleum, natural gas and mineral salts. (Description compiled from OECD, 2001 and Boardman and Poesen, 2006).

[4] Further details on landscapes can be found in (Boardman and Poesen, 2006).



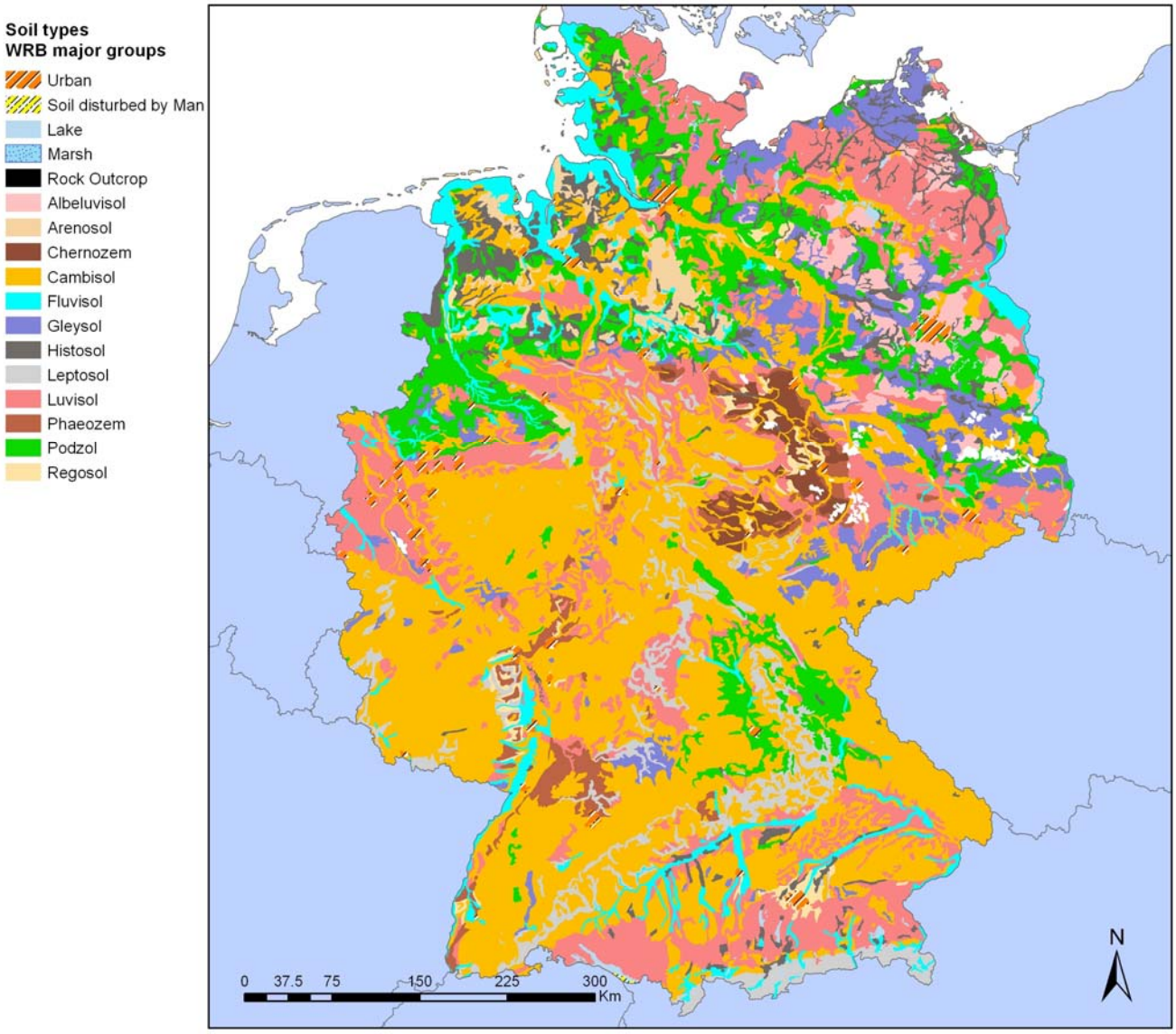
Map 1. Dominant landscape types of Germany. ***Source: EEA (Year: 2007)***

1.1. Soil description[6]

Soil in Germany is formed by a temperate sub-oceanic to temperate sub-continental climate. Germany can be grouped into six main areas with different soil forming factors. The coastal Holocene is characterised by tidal-flats ands marshy soil giving rise to Thionic Gelysols and Fluvisols. Pleistocene deposits mark the north German lowlands and the Alpine forelands where Luvisols or Gleysols are predominant on loamy substrate whereas Cambisols and

[5] Data source: Eurostat, reference year 2000.

Podzols prevail on sandy sites. Podzols are found in the more humid northwest where they are often associated with Dystric Histosols. The transition from lowland to mountainous areas is indicated by a loess belt containing Luvisols, Albeluvisols and Gleysols. A dry landscape on the lee side of the mountains where Chernozems and Phaeozems have developed instead of Luvisols also belongs to this zone. In hilly and mountainous country, loess soils are very common but the predominant soil associations are those derived from a periglacial origin consisting of weathering and solifluxion material of the underlying parent rock.



Map 2. Soil Map of Germany. *Source: elaborated from European Soil Database v.2*

[6] Extracted from Soil Atlas of Europe (2005).

Rendzic Leptosols, Calcareous Regosols, Chromic Cambisols and sometimes Luvisols are formed on limestone and marlstone. Sandstone and igneous and metamorphic rocks tend to develop Cambisols, mostly Dystric, and Podzols but in some higher parts of mountains, Umbric Leptosols and Endoskeletic Umbrisols are found. Cambisols, usually Eutric or Vertic, also occur on mudstones and on argillaceous and silty slates, often associated with Gleysols. In the Alps, soil formation is mainly influenced by the relief where immature soil, as Lithic Leptosols, or rock exposures without soil cover is much higher than in other parts of the country. In the German Alps limestone is dominant and therefore Rendzic and Calcaric Leptosols are quite common.

The coverage of the main soil types in the country is reported in Table 1.

Table 1. Facts and figures

Item	Data and information			Sources
Population (inh) [1]			82 266 372	*2*
Population density (inh/km2) [1]			230.4	*2*
GDP (Million EUR) [2]			2 422 900.0	*2*
GDP (EUR per capita) [2]			29 500	*2*
Administration	Federal Republic with13 states (Laender, singular - Land) and 3 free states* (Freistaaten, singular - Freistaat); Baden-Wuerttemberg, Bayern*, Berlin, Brandenburg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Niedersachsen, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland, Sachsen*, Sachsen-Anhalt, Schleswig-Holstein, Thueringen*			*3*
Geography	Strategic location on North European Plain and along the entrance to the Baltic Sea			*3*
Borders	*Land:*	Total: 3 621 km Border countries: Austria 784 km, Belgium 167 km, Czech Republic 646 km, Denmark 68 km, France 451 km, Luxembourg 138 km, Netherlands 577 km, Poland 456 km, Switzerland 334 km		*3*
	Coastline:	2 389 km		*3*
Climate	Temperate and marine; cool, cloudy, wet winters and summers; occasional warm mountain (foehn) wind			*3*
Land use [3]	*Land use type*		*Km²*	*Reference year* *2*
	Total agricultural land		191 028	2000
	Arable land		N/A	
	Total land under forest and other wooded land		105 314	2000
	Built-up and related land		45 735	2000
	Land used for transport and communication		17 118	2000
	Wet open lands		948	1990
	Total dry open lands		2 666	2000
	Waters [8]		8 085	2000
	Land area		348 946	2000
	Total area		357 031	2000
Dominant landscape types [4]	*Landscape type*		*% of total area*	*1*
	A1 - Urban dense areas		10	
	A2 - Dispersed urban areas		3	
	B1 - Broad pattern intensive agriculture		20	
	B2 - Rural mosaic and pasture landscape		11	
	C1 - Forested landscape		16	
	C2 - Open semi-natural or natural landscape		4	
	D1 - Composite landscape		37	

Table 1. Facts and figures

Item	Data and information		Sources
Elevation	Lowlands in the north, uplands in the center, Bavarian Alps in the south. Lowest point: Neuendorf bei Wilster -3.54 m. Highest point: Zugspitze 2 963 m.		*3*
Elevation Breakdown (%total area) [5]	*Elevation class*	*% total area*	*1*
	1 - Low coast	5	
	2 - High coast	0	
	3 - Inlands	46	
	4 - Uplands	44	
	5 - Mountains	6	
Soil resources [6]	*Major soil type or ground cover type*	*% total area*	*4*
	Cambisol	32	
	Luvisol	17	
	Gleysol	12	
	Podsol	11	
	Leptosol	6	
	Albeluvisol	5	
	Histosol	4	
	Fluvisol	4	
	Arenosol	3	
	Chernozem	2	
	Regosol	2	
	Phaeozem	2	
	Other soil and ground types	2	
Hydrology			*5*
Seas	Baltic Sea and North Sea. Territorial sea: 12 nautical miles Exclusive economic zone: 200 nautical miles Continental shelf: 200-m depth or to the depth of exploitation.		*6*
Water resources			*5*
Natural resources	Lignite, petroleum, iron ore, bauxite, lead, zinc, nickel, magnetite, marble, salt, hydropower potential		*3*
Natural risks	Flooding		*3*
Protected areas			*5*
Products	*Agriculture:*	Potatoes, wheat, barley, sugar beets, fruit, cabbages; cattle, pigs, poultry	*3*
	Industry:	Among the world's largest and most technologically advanced producers of iron, steel, coal, cement, chemicals, machinery, vehicles, machine tools, electronics, food and beverages, shipbuilding, textiles	*3*

Notes	
	[1] Source: ESTAT; Reference year: 2007 [2] At current prices. Source: ESTAT; Reference year: 2007 [3] Source: ESTAT. Reference year varies. [4] EEA Major landscape types (EEA, 2006ab) [5] EEA Elevation classes (EEA, 2006ab) [6] Soil classification based on the reference soil groups of the World Reference Base for Soil Resources-WRB (FAO AGL, 2003). EEA elaboration based on European Soil Database v. 2. Only soil and ground cover types covering at least 2% of total area are explicitly included.

	[8] Comprises inland waters only

Sources:

1 EEA
2 ESTAT
3 CIA world factbook web. Updated 7 September 2006
4 European soil map 1:1 000 000
5 No information available
6 Eionet questionnaire

2. THE STATUS OF SOIL RESOURCES

2.1. A snapshot of the status of soil in the country

As Germany is a highly industrialised and densely populated country, its soil resources are put under pressure mainly through the input of hazardous compounds in industrial and rural areas, as well as the sealing of the soil due to the expansion of urban areas and transport infrastructures.

Following the implementation of the air pollution legislation (i.e. the Federal Input Control Act and related ordinances), the deposition of airborne pollutants has been reduced in the past two decades, thus releasing some of the pressures on the soil. However, forest soils are still under risk of acidification and eutrophication. In agricultural areas, the input of hazardous compounds from agricultural sources (agro-chemicals, sewage sludge and other materials) is still high.

Germany has also a heavy legacy of contamination from local sources (in particular former waste disposal sites and industrial sites). On the other hand, a steady progress in investigation and remediation of contaminated sites has been registered in the past thirty years (EEA, 2007a; BMU, 2002).

The use of new land for human settlements has been decoupled from economic growth, but its extent is still high while the demand for residential space is increasing (BMU, 2002; Destatis, 2009). A national target establishes a reduction of the increase of the area of land used for settlements and transport infrastructures to 30 ha/day by 2020. Nevertheless, the sealed areas have increased by over 5 % in the period 2000-2006. On the other hand, in eastern Germany, the demolition of surplus housing has resulted in the reduction of sealed soil and further reductions are expected due to projected population decreases.

A country review of European datasets relevant to the soil threats is provided in Appendix 3.

2.2. The threats to soil

2.2.1. Contamination

2.2.1.1. Diffuse contamination

Information on background values for several hazardous compounds can be found on the Internet at:

http://www.stoffdaten-stars.de

http://www.labo-deutschland.de/pdf/LABO-HGW-Text.pdf

http://www.labo-deutschland.de/pdf/LABO-HGW-Anhang.pdf.

Information on selected issues, e.g. soil-plant transfer, is also available. Most publications are in German and can be found at:

http://www.umweltbundesamt.de/uba-info-medien/publikationsliste-drucken.php

Acidification and euthrophication[7]

The deposition of acidifying and eutrophying compounds puts soil and vegetation ecosystems under risk for acidification and eutrophication in most of the forest areas in Germany, which cover over 100 km^2 (nearly 30 % of the total country area; see Table 1).

The sensitivity of these ecosystems is measured in terms of exceedances of critical loads[8]. The critical loads of acidity for most of the German forest soils are in the range of 200 to 700 eq ha^{-1} a^{-1} (5^{th} percentiles; Hettelingh et al. 2005). The critical loads of nutrient nitrogen are in the same range. The average accumulated exceedance of the critical loads of acidity in Germany is highest in north-western Germany, along the Dutch border[9].

According to recent projections[10], based on a 'current legislation' scenario, approximately two thirds of the forest area in Germany will still receive nitrogen depositions exceeding the critical loads by more than 800 eq ha^{-1} a^{-1} in 2010, with peaks along the North Sea coast.

Some progress has been noticed in the past two decades. According to EEA estimates, in Germany the area where ecosystems are not protected from acidification decreased from 84 % in 1995 to about 55 % in 2004, and it is expected to further decrease to 45 % in 2010. On the other hand, the area not protected from eutrophication only slightly decreased from 97.4 % to 96.8 % in the period 1995-2004, and it is expected to further decrease to 95.4 % of the country area in 2010.

Further information on acidification is provided in Appendix 5.

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[7] Source for this section: EEA core-set indicator "Exposure of ecosystems to acidification, eutrophication and ozone": CSI 005, Figure 6: Country-wise ecosystem damage area for eutrophication in Europe, 1995-2010. Data source: UNECE (Coordination Center for Effects). Data source of deposition data used to calculate exceedances: EMEP/MSC-W. NOTE: In 2009 this indicator has changed to version 2 (http://themes.eea.europa.eu/IMS/ISpecs/ISpecification20091007131526/full_spec).

[8] Germany reports data on critical loads of acidity and nutrient nitrogen for the most sensitive ecosystems (forest soils and semi-natural vegetation) to the Coordination Center for Effects (CCE) at the Netherlands Environmental Assessment Agency (MNP), in the framework of the UN ECE Convention for Long-range Trans-boundary Air Pollution (LRTAP). In order to estimate critical loads exceedances, e.g. for forest soils, the critical load values are compared to the modeled deposition of acidifying and eutrophying sulphur or nitrogen equivalents.

[9] 2005 estimates.

[10] CCE projections.

2.2.1.2. Contamination from local sources

In Germany, it is estimated that potentially polluting activities have occurred at 289 500 sites and further information or investigations are needed to establish whether remediation is required. National estimates expect that around 10 % (or 29 000 sites) are contaminated and need to be remediated[11]. About 12 500 confirmed contaminated sites are currently registered in the *Länder* registers, while it is estimated that more than 21 300 sites have been cleaned up in the past 30 years[12].

Most cases of contamination are a heritage from the past. However, current activities may still cause soil contamination. Information on the contribution of new contamination from ongoing activities is not included in the *Länder* registers as long as the contamination is not identified[13].

Information on the main sectoral activities causing soil contamination is scarce. According to the German legislation, *contaminated sites* may only include former waste disposal sites and former industrial sites (BMU, 2002).

Germany spends each year about 500 million EUR from the public budget for the investigation and remediation for ownerless sites (coming from the *Länder* budgets), in addition to the expenditures of responsible polluters, and the costs of remediation and research programmes.

Further information is included in Appendix 1.

2.2.2. Erosion

According to the results of a national study, in 1999 over 20 % or about 3 million ha of agricultural land in Germany was under moderate to very high risk of erosion (see Table 2)[14]. Further information, including a map of soil erosion risk in arable land by county, can be found in Appendix 5.

[11] According to the German Soil Protection Act, contaminated sites are shut-down waste recycling and disposal facilities (abandoned waste disposal sites) and sites of shut-down facilities and areas where environmentally hazardous substances have been handled (abandoned industrial sites), and which cause harmful changes to the soil or other hazards for individuals or the general public.
[12] These numbers derive from a summation of measures implemented to date, calculated on the basis of accounting records related to the implementation of the *Länder* registers, generally starting in the 1980s. Reported statistical information shows the most recent data available. Data are updated at least once a year by a joint *Länder* working group.
[13] In Germany there is a clear separation between sites with ongoing commercial activities under the responsibility of the trade supervisory centre and abandoned sites under the responsibility of the soil protection authorities. This means there is no common data source for contamination.
[14] Agricultural land in Germany amounted to 138 000 km^2 in 1999.

Table 2. Actual soil erosion risk in Germany		
Soil erosion classes (soil loss)	**Area under risk (%)**	**Area under risk (km^2)**
< 5 t/ha*y	79	108 615
5 - 10 t/ha*y	9	12 750
10 - 20 t/ha*y	7	9 507
> 20 t/ha*y	5	7 129

Source: EEA data elaboration, based on the latest results of the work of the Institut für Atmosphärische Umweltforschung (IMK-IFU), the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) and the Umweltbundesamt (UBA). Time reference for the assessment: 2005. Detailed references are provided in Appendix 5.

2.2.3. Decline in soil organic matter

National estimates of the content and spatial distribution of soil organic matter (SOM) in topsoil are available for nearly 90 % of the country. According to these estimates, land use, soil formation and climatic conditions are the main governing factors for the level of SOM in top-soils. SOM increases from soils in arable land to forest soils to soils in grassland. Dryer regions, such as in eastern Germany, show a significantly lower SOM content compared to the wetter regions in the north-west. Further information on the assessment framework can be found in Appendix 5.

2.2.4. Sealing

The consumption of new or undeveloped land for human settlements and transport infrastructures is a major environmental concern in Germany. The use of new land for settlements has been decoupled from economic growth in recent years[15] but its extent is still high, while the demand for residential space is increasing[16] (BMU, 2002; Press Office of the German Federal Government, 2008; Destatis, 2009).

Overall, in Germany, the total area covered by settlements and transport infrastructures (built-up area) increased by about 6 % between 2000 and 2006, while the sealed area increased by over 5 % in the same period (see Table 3). On the other hand, regional differences can be observed. In eastern Germany, for example, the demolition of surplus housing has resulted in

[15] This means that the area intensity (the ratio between the settlement area used for economic activities and the gross added value achieved through these activities, adjusted for price) has decreased. However, this is due to a shift of the economic structure towards less land-intensive activities, such as the expanding service sector, rather than to a more economical use of land by the individual sectors (Destatis, 2009).

[16] In the period 1992-2004, the area of settlements used by private households increased considerably more than the number of residents (respectively about 22 % and nearly 2 %). This was mainly due to the increase of the demand for living space, which rose from 36 to 42 m2 per capita in the same period (Destatis, 2009).

the reduction of sealed soil. Further reductions are expected due to projected population decreases (BMU, 2002).

A national target has been established, aiming at the reduction of the daily increase, or consumption, of land used for settlements and transport infrastructures to 30 ha/day by 2020. In the period 1998-2003, land consumption decreased from 131 ha/day to 93 ha/day, but this improvement would not be sufficient to reach the target (see Figure 1).

Table 3. Built-up areas and soil sealing in Germany

Year		**2000**	**2004**	**2005**	**2006**
Total country area (ha)		35 703 098	35 704 964	35 709 286	35 711 513
Settlements and transport infrastructures (area in ha)		4 393 904	4 562 075	4 605 043	4 643 777
Thereof:	**Buildings and open spaces**	2 308 077	2 393 840	2 404 699	2 415 631
	Assets without mining land	73 241	75 392	77 473	77 386
	Recreational areas	265 855	313 090	333 847	352 622
	Transport infrastructures	1 711 768	1 744 589	1 753 766	1 762 701
	Cemeteries	34 963	35 167	35 257	35 438
Thereof sealed areas		2 021 298	2 092 881	2 111 260	2 129 015

Note: Time reference: 31 December of each year

Sources: Settlements and traffic infrastructures: Federal Statistical Office; Soil Sealing: Federal Environmental Protection Agency (based on LABO procedure, Saxony-Anhalt estimated)

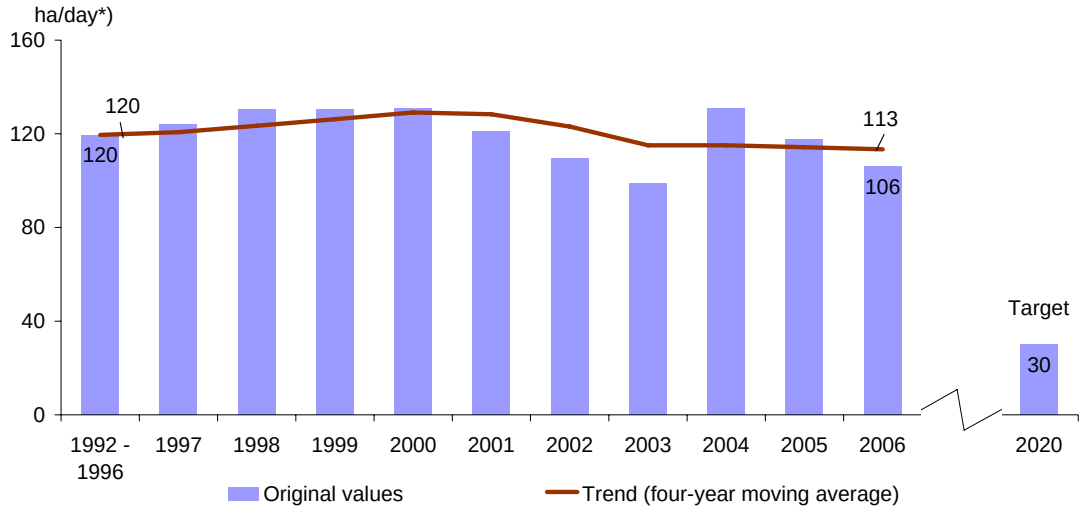

Figure 1. Increase in the area of land used for settlements and transport in Germany

Notes:

**) This assessment is based on the analysis of the* Länder *land surveys, which document the actual land use. Due to the reorganisation of the official land registers (reclassification of uses during digitalization), the representation of the area increase is distorted at the edges.*

The graph shows the average daily increase in land use for settlements and transport. The averages are calculated by dividing the increase of the area of land used for settlements and transport (in hectares) over a specific period of time (one year or four years) by the number of days in the period (365/366 or 1461). The moving four-year average for a particular year is calculated by taking into account a period including the relevant year and the previous three.

As the data for a single year are currently influenced by external effects (such as the reorganisation of the land registries), the moving four-year average provides a better picture of the long-term developments.

Sources: Federal Statistical Office, Federal Office for Building and Regional Planning. Reference year: 2007 (published in Destatis, 2009.)

2.2.5. Hydro-geological risks

Information on this threat was not available to the Eionet National Reference Centre [17].

2.2.6. Compaction

To date, little information is available on soil compaction in Germany. In 2004, the Federal Environment Agency financed a research project for the identification of soil compaction criteria. The aim was to support the establishment of regulations to prevent the risk for soil-damaging compaction, according to § 8 of the Federal Soil Protection Act. Harmful changes to the soil through compaction are identified through soil physical investigations and the estimation of the soil structure in the soil profile. The assessment framework should include indicators in four areas (vehicle, soil pressure, soil bearing capacity and soil moisture). Four concepts regarding subsoil compaction were analysed. The project concluded that, in the current formulation, this information alone is not suitable for characterising soil-damaging compaction to support the establishment of policy measures to avert risk. A new project is expected to develop a stepwise concept for the identification of compaction risk.

Further information can be found in the publication: “Ableitung von Kriterien zur Charakterisierung einer schädlichen Bodenveränderung, entstanden durch nutzungsbedingte Verdichtung von Böden / Regelungen zur Gefahrenabwehr“ (UBA – Texte 46/2004) http://www.umweltdaten.de/publikationen/fpdf-l/2831.pdf

[17] The Federal Institution of Geosciences and Natural Resources is the responsible institution for this area.

3. POLICY INSTRUMENTS AND INTERNATIONAL COOPERATION

3.1. Environmental policy

In Germany, the environment is a major policy area. The current policy priorities include:

- climate change;
- renewable energy;
- resource efficiency;
- protection of biodiversity.

The responsibility for environmental policy is shared between the Federal government and the *Länder*. In principle, the government regulates precautionary-, trigger- and action-values or limits for hazardous compounds in the environmental media, while the *Länder* implement protection measures.

The Federal Ministry of Environment, Nature Protection and Nuclear Safety was established in 1986, in the aftermath of the Chernobyl catastrophe. Before 1986, the environment policy was under the responsibility of the Ministry of Internal Affairs, supported by the Federal Environment Agency (created in 1976).

3.2. Soil policy instruments

The Federal Government has the responsibility to set legislation in the field of soil conservation, while the *Länder* are responsible for its enforcement and can add complementary procedural rules.

Before the entry into force of specific soil legislation, soils were indirectly protected through policy measures on air pollution control, waste disposal and the agricultural use of fertilizers and pesticides. The Federal Government firstly adopted a soil conservation framework in 1985 and placed this issue in the focus of environmental policy. At the beginning of 1998, the Bundestag adopted the Federal Soil Protection Act, followed in mid-1999 by the Federal Soil Protection and Contaminated Sites Ordinance, with the aim to create a harmonised legislative basis for soil conservation at the national level.

In 2002, the Federal Government presented its first Soil Protection Report: (http://www.bmu.de/english/soil_conservation/doc/3388.php)[18].

[18] A second report has been announced but in August 2009 was not yet available.

3.2.1. Soil legislation

In Germany, soil protection is regulated by the Federal Soil Protection Act (Soil Act, BBodSchG) and the Federal Soil Protection and Contaminated Sites Ordinance (Contaminated Sites Ordinance, BBodSchV), which entered into force in 1999. This legislation has established a national assessment framework for the evaluation of soil quality in relation to the "Soil-Man", "Soil-Plant" and "Soil-Groundwater" paths of action[19].

The purpose of the Soil Act is to protect and restore soil functions on a permanent and sustainable basis. The actions aim at the prevention of soil changes which are harmful to the soil, the rehabilitation of the soil and water resources at contaminated sites, and at preventing negative soil impacts, such as the disruption of its natural functions and its function as an archive of natural and cultural history.

Based on the subsidiarity rule, the Soil Act has effects where sectoral legislation does not cover impacts on soil. Relevant sectoral legislation includes:

- Certain provisions of the Closed Substance Cycle and Waste Management Act;
- Transport of hazardous materials;
- Fertilizer and plant-protection law;
- Genetic Engineering Act (Gentechnikgesetz);
- Federal Forest Act and the *Länder* forest law;
- Land Consolidation Act (Flurbereinigungsgesetz);
- Construction, modification, maintenance and operation of transport routes and provisions governing traffic and transport;
- Construction-planning law and building regulations;
- Federal Mining Act (Bundesberggesetz);
- Federal Pollution Control Act.

The Soil Act does not apply to installations, activities, devices or equipment, nuclear fuels and other radioactive substances and to investigations for the recovery, transport, storage, treatment and destruction of warfare agents.

3.2.2. Soil policy targets

National targets were established by the Soil Protection Strategy (1986) and reinforced in the Soil Protection Act. These include:

- minimising the inputs of hazardous compounds to the soil;
- limiting soil sealing and extensive soil use;
- implementing good agricultural practices.

A political target derived from the Strategy on Sustainable Development is the decrease of the daily consumption of land to 30 ha/day by 2020.

[19] Further information on the framework can be found in Appendix 5.

Soil Protection Values

The Federal Soil Protection Ordinance[20] includes precautionary-, trigger-, and action-values as well as "Permissible additional annual pollutant loads through all pathways". The ordinance defines:

1) values which, if exceeded, require site-specific investigations to determine whether a harmful soil change or site contamination exists (*trigger value*s), taking into account the relevant soil use;
2) values for impacts or pollution which, if exceeded, generally indicate the presence of a harmful soil change or site contamination, and which require the application of specific measures, taking into account the relevant soil use (*action values*),
3) requirements for:
    a) prevention of harmful soil changes; these shall include requirements relative to the handling of excavated and treated soil material,
    b) remediation of the soil and of contaminated sites, especially with regard to:
        - determination of the rehabilitation objective,
        - the extent of decontamination measures and safeguarding measures that prevent spreading of pollutants in the long term, and
        - protection and restriction measures.

Cooperation with the Länder

A permanent cooperation between the Federal Government and the *Länder* on soil policy has been established since 1983, with the Special Working Group on Soil Information Resources. Since 1991, the Federal-*Länder* Working group on Soil Protection (LABO) serves as a forum for the exchange of information, discussion on relevant policy areas, finding solutions and making recommendations (BMU, 2002).

Soil advisory bodies

A Soil Protection Commission was appointed in 2004 to support the Federal Environment Agency (UBA) in the area of soil protection. Its objective is to raise public awareness on soil protection and to provide impulses for future soil protection strategies in environmental policy (http://www.umweltbundesamt.de/fwbs-e/kbu/index.htm).

According to Annex 1 of the Soil Act, the Minister for Environment, Nature Protection and Nuclear Safety established in 2000 a Commission for Soil Analysis (FBU) with the mandate to take care of the State of the Art of Soil Analytical Methods (http://www.umweltbundesamt.de/fbu/index.htm).

[20] http://www.bmu.de/files/pdfs/allgemein/application/pdf/bbodschv_uk.pdf

3.2.3. Market based instruments for soil protection

Available information on marked-based instruments relevant to soil protection in Germany is summarised in Table 4.

Table 4. MBI overview

Marked-based Instrument (MBI)				Soil threats covered by the MBI									Type of instrument [2]	References [3]	Sources [4]	Detailed information available [5]
Country/Region	Country code	ID	Name of instrument	Short description	1. General	2. Erosion and Hydro-geological risk	3. Decline in organic matter	4. Contamination	5. Sealing [1]	6. Compaction	7. Decline in soil biodiversity [1]	8. Salinisation [1]				
Germany	DE	1	Penalties for off-site damage due to wind erosion	Under the Soil Protection Act (Bundesbodenschutzgesetz 1998) farmers can be penalised if they do not adhere to Good Agricultural Practice		x							1	Riksen et al. (2003)	1	N
Germany	DE	2	Promotional Loans	Low-interest loans from the German Equalisation Bank (DtA) for (a.o.) remediation of contaminated sites				x					2	OECD (2001), p. 119, Table 5.3.	1	N
Germany (Baden-Württemberg)	DE	3	Charge on soil extraction		x								1	OECD (2001), p. 112	1	N
Germany (*Länder* level)	DE	4	Support for clean-up of orphan sites					x					2	EEA (2000)	1	N
Germany (various *Länder*)	DE	5	Subsidies for erosion control	Regional support schemes for soil conservation practices in arable land-use		x							2	Olmeda-Hodge et al. (2004)	1	N

NOTES

[1] No information available

[2] Type of instrument:

1 Taxes and charges

2 Subsidies

3 Tradable permits

4 Voluntary agreements

5 Other

[3] Relevant literature referring to the specific instrument

[4] Sources of the information contained in this table:

1 DGENV, 2005

[5] Y/N. If yes a detailed table is available for the specific instrument

3.3. International co-operation

Germany is engaged in several activities aimed at sharing knowledge and experience with Eastern European countries in the framework of the EU twinning programmes. The programme includes new Members States, Accession Countries and the EU new neighbours in the Western Balkan, Mediterranean and Southern Caucasus. Germany has set up twinning partnerships with Ukraine and Serbia.

In the period 1992-2000, the Federal government supported environmental protection projects within the context of TRANSFORM, a programme mainly aimed at funding projects in Eastern Europe, with a total budget of about 15 million EUR. On the basis of this experience, the Federal Environment Ministry created a separate advisory aid programme in 2000. The programme initially received a budget of 2 million EUR per year, which increased to 2.24 million EUR after two years. The Federal Environment Ministry has also created an investment programme to support environmental projects which also bring benefits to Germany. Examples include trans-boundary initiatives to tackle contamination of the River Elbe and the Baltic Sea, or air pollution in the Erz Mountain Range.

Co-operation in the field of contaminated sites

The Federal Ministry of Education and Research funded some multilateral know-how transfer projects, such the International Centre for Soil and Contaminated sites (ICSS) hosted by the Federal Environment Agency. ICSS has the aim is to promote knowledge transfer in the field of contaminated sites and soil protection. The ICSS advises authorities and relevant institutions in partner countries and seeks to help eliminate soil contamination with the aid of German environmental technologies.

Germany has also been actively participating in European initiatives funded under the EU Research Framework Programmes (FPs), especially in the field of contaminated soil management (projects, concerted or coordination actions and accompanying measures).

In particular, in the period 1991-2006, the German Federal Environmental Agency (UBA) carried out several soil protection projects with former EU candidate countries and new independent states on soil protection, also known as “twinning projects” (Poland, Russian Federation, Bulgaria, Hungary, Czech Republic, Slovakia). Cooperation with Netherlands on organic hazardous compounds was carried out in 1995. UBA participated, among others, in the following EU-funded projects:

- Co-ordinator of CARACAS (Concerted Action on Contaminated land Rehabilitation Network for Environmental Technologies),1996-1998
- Partner in CLARINET (Concerted Action on Contaminated land Rehabilitation Network for Environmental Technologies), 1999-2001

- Co-ordinator together with University of Nottingham in CABERNET (Concerted Action on Brownfield and Economic Regeneration Network), since 2002
- Partner in RESCUE (Regeneration of European Sites in Cities and Urban Environments), 2002-2005
- Co-ordinator of EUGRIS (European groundwater and contaminated land remediation information system), 2003-2005
- Partner and secretariat of ERA-NET SNOWMAN (Sustainable management of soil and groundwater under the pressure of soil pollution and soil contamination), since 2005.

Germany is also taking part in the Common Forum, a network of contaminated land policy makers and advisors from national ministries in EU Member states and EFTA countries.

Further co-operation in the field of soil protection

The Federal Institute for Geosciences and Natural Resources (BGR) has been involved in several soil-related initiatives at the international level. The Institute is a member of the European Soil Bureau Network (ESBN) and is chairing a soil working group established by the European Geological Surveys Association (EuroGeoSurveys). BGR coordinated the preparation of the report "Common Criteria for Risk Area Identification according to Soil Threats", in support to the development of the EU Soil Framework Directive, and is contributing to the development of the Soil Database of Europe.

BGR also participated in relevant EU research projects such as the recent Integrated Sink Enhanced Assessment (INSEA) and the Environmental Assessment of Soil Monitoring (ENVASSO, described below).

ENVASSO was a policy-oriented research project, funded under FP7 for the period Jan. 2006 - Dec. 2007. Its objective was to design and test a single, integrated, EU-wide operational set of measurable indicators to assess the extent of the eight soil threats identified in the EU Soil Thematic Strategy. The choice of indicators within ENVASSO builds on the results of the work of the former Technical Working Groups of the Soil Thematic Strategy and other sources. Formal protocols, procedures, tools and implementation recommendations were proposed for the future collection, collation and reporting of harmonised soil information in Europe. BGR was responsible for the work package “Data Base Design and Selection”, and led the contributions on indicators of diffuse contamination.

4. SOIL MANAGEMENT, MONITORING AND ACCESS TO ENVIRONMENTAL INFORMATION

4.1. Soil management

4.1.1. Management of contaminated sites

Since 1999, contaminated land management in Germany is regulated by the Federal Soil Protection Act and the Federal Soil Protection and Contaminated Sites Ordinance. The latter provides technical guidance on: sampling, analysis and quality assurance procedures to use in site investigations; calculation of pathway values for measures, tests and prevention; and the requirements for remediation, monitoring and planning.

In the national legislation, *contaminated sites* are defined as shut-down waste recycling and disposal facilities (old deposits), and former industrial facilities or areas where environmentally hazardous substances were handled in former (abandoned) industrial sites which can still cause harmful changes to the soil or hold other risks for individuals or communities in general.

Old deposits and former industrial sites are considered *potentially contaminated* when there are concrete reasons to suspect harmful changes in the soil or other hazards for individuals or the community at large. Locations which were formerly used by the military or for armament production are also classified as potentially contaminated sites. However, a site is declared as "contaminated" only when a specific site assessment has shown that there is a risk for humans and the environment.

In terms of liabilities, the polluter-pays principle is applied. Besides the polluter, the owner or the users of the contaminated sites are liable. Identification, risk assessment and clean-up of contaminated sites are carried out by the *Länder*.

Due to the high number of sites to be managed (see Section 2), remediation activities need to be prioritised. This is done through a stepwise risk assessment procedure which has the aim to identify the sites where there is an urgent need for remediation because of their risks for humans and the environment.

Additional information on the management of contaminated sites in Germany is provided in Appendix 1, while details on the risk assessment procedure are provided in Appendix 5.

4.2. Soil monitoring

In Germany, permanent soil monitoring has been introduced and is carried out by the Federal States. Since 1986, about 800 monitoring sites have been established across the country.

Two different types of monitoring sites are used, differing in the parameters and frequency of the investigations: *basic monitoring sites* are used for measuring classical soil properties, while *intensive monitoring sites* also focus on dynamic processes (substance input and output).

In order to achieve the standardisation across the country of the procedures used in the selection and installation of soil monitoring sites and in collection, sampling and storage, analysis and data management, the Federal-Land Working Group Soil Protection (LABO) published the "Concept for the installation of soil monitoring sites" of the special working group 'Basic Information for Soil Protection' (SAG) in 1991. In addition, in order to ensure uniform and comparable methods, the concept was supplemented by further recommendations of LABO, included in the "Soil monitoring in Germany - Installation and Operation of Soil Monitoring Sites (Barth et al. 2001). A map of the location of the national soil monitoring network and the national framework for the assessment of soil quality are shown in Appendix 5.

4.3. Information, education and data access

4.3.1. Data access

The Federal Environmental Agency has the mandate to report on the state of the environment in Germany. A national environmental data summary is published every two years. In relation to soil, the Agency must report on "…the progress achieved concerning soil protection" (German Bundestag, Drucksache 14/2567) every four years (medium-term reporting, once for each legislation period). Basic information for this report includes, *inter alia*, the data of the permanent soil monitoring sites from the Federal States (*Länder)*.

The Federal Statistical Office publishes environmental statistics and indicators on a regular basis. Data and information, such as the indicators defined in the context of the National Sustainable Development Strategy, are made available to the public through its web portal.

The availability and exchange of soil monitoring data are regulated by a so-called "Administrative agreement on the exchange of environmental data between the Federal Government and the Federal States" (Verwaltungvereinbarung Datenaustausch, 1994). Data from soil monitoring are partly subjected to privacy restrictions.

4.3.2. Information and education

The *Länder* are the promoters of several campaigns to increase soil awareness and produce information material for schools, children and the general public.

The Federal Government's Scientific Advisory Committee on Soil Conservation (WBB), in conjunction with representatives of the Federal Government's Scientific Advisory Council

called Global Changes to the Environment (WBGU), has published the report "Without Soil – Soil less" (http://www.umweltbundesamt.de/fwbs/publikat/download/Denkschrift.pdf) addressed to the general public.

5. STATE OF THE ENVIRONMENT

"One of the most densely populated countries in Europe, Germany shows above-average progress in reducing per capita emissions and municipal waste and has relatively high levels of eco-efficiency but its per capita performance could be improved. Progressive waste management policies are in place but there is still room to improve performance. Legislation and ecological reforms encourage energy savings and development of profitable renewable energy."(extract from EEA, 2005). Details on the German environmental performance are provided in Table 5 (selected EEA core-set indicators, published in EEA, 2005 and revised by national experts for this report).

According to the OECD:

> "In Germany, environmental protection continues to be a major public concern and a high policy priority. This is largely due to pressures on the environment resulting from its high population density, level of industrialisation and strong dependence on fossil fuels. Transport and agriculture also continue to generate diffuse pressures on the environment. Economic and social changes in the New *Länder* (representing 30 % of Germany's land, 20 % of its population and 10 % of GDP) have led to the alleviation of some environmental pressures, but they also present new sustainable development challenges.
>
> The decoupling of economic growth from emissions of several major pollutants during the 1990s is indicative of Germany's achievement and its continuing efforts to reconcile economic growth and environmental objectives. However, important environment related challenges remain (e.g. waste treatment and disposal, strengthening of the waste water infrastructure, combating nitrate pollution and transport pollution, nature conservation, progressive phasing out of nuclear energy, further implementation and development of the eco-tax reform and climate change related commitments)." (Extract from OECD, 2001.)

Table 5. Environmental indicators[21]	
Environmental issue	**Description**
Greenhouse gas emissions	Total greenhouse gas emissions (in GHG eq.) were reduced by almost 19 % compared to the base-year (1990). Reasons for this trend include: an improvement in energy efficiency, a switch in the types of fuel used (to gaseous and liquid fuels instead of solid fuels) and a replacement of 'old technologies' following German reunification in the early 1990s; new policies and measures resulting from climate protection programmes; and a decoupling of economic growth and energy consumption which relates to greenhouse gas emissions (especially carbon dioxide). This trend is also influenced by changing personal energy consumption habits and the implementation of eco-taxes. Reaching the burden-sharing reduction target (– 21 %) does not seem possible solely by using domestic actions. This will result in additional emission reductions by using the flexible mechanisms of the Kyoto Protocol and the EU emission trading scheme.
Energy consumption	As a highly industrialised country, energy consumption per capita is rather high compared to other European countries and energy intensity per GDP better reflects the energy efficiency in the energy and industry sector. In recent years energy consumption has decoupled from economic growth. Energy conversion efficiency has improved as highly efficient units replace older generating plants. Although additional measures to improve efficiency and reduce energy consumption in the industry sector have led to lower energy consumption per production unit, progress has slowed significantly in recent years.
Renewable electricity	The production of renewable energy in Germany is increasing, accounting for 3 % of the primary energy supply in 2002. The contribution of renewables to electricity production more than doubled between1992 and 2002. Electricity production by renewable sources is promoted by the German renewable energy sources act from 2000, which gives priority to feeding electricity from renewable energies into the grid at fixed price levels. It has triggered a boom in the construction of wind and biomass installations. Further measures to promote the use of renewable energy include the Act on the Further Development of the Ecological Tax Reform (2003), which provides incentives for saving energy and improving energy efficiency.
Emissions of acidifying substances	Emissions of acidifying substances have been reduced by more than two-thirds. This was mainly influenced by reductions in SO_2 emissions (– 88 % compared with 1990) and NO_X (– 48 %). To a large extent both compounds come from energy related processes so that the basic drivers for these trends could be summarised as: fuel switching; improved energy efficiency; replacement of 'old technologies'; and implementation of abatement technologies (e.g. De-NO_X, De-SO_X, car catalysts). More than 90 % of NH_3 emissions come from agricultural activities. After German reunification, there was a reduction in livestock numbers in former eastern Germany. This meant that emissions were reduced by almost 20 % up to 1994, but that since then emissions have more or less stabilised. Germany is working on additional policies and measures for further reducing acidifying substances (especially NO_X and NH_3).

[21] NB: These indicators were published in part C on the report "The European Environment. State and outlook 2005" (EEA, 2005). An update is foreseen for the next edition of the report, to be published in 2010.

Table 5. Environmental indicators[21]	
Environmental issue	**Description**
Emissions of ozone precursors	Emissions of ozone precursors were reduced by approximately 54 % in the period 1990–2002. This trend is based on similar developments for all substances included (2002 compared to 1990: NO_X – 48 %, NMVOC – 58 %, CO – 62 % and CH_4 – 42 %). Germany has reached one of the best European emission ratios per GDP. The emission reductions are based on activities to improve energy efficiency, fuel switching, economic reconstruction, implementation of new technologies in the road transport sector, the replacement of natural gas distribution systems in the former GDR and the gasoline distribution systems in total. Similarly, livestock reduction in the early 1990s led to emission reductions for CH_4. Germany is working on further measures to reduce emissions from solvent use which dominate the NMVOCs.
Freight transport demand	Freight transport in Germany has been increasing but during the past three years development has leveled off and is in line with economic development. The increase mainly relates to road transport while the share of rail and inland shipping has decreased.
Share of organic farming	The share of organic farming in Germany was just 1 % in 1992 but increased to 4.1 % in 2002. The number of organic farms also rose from below 1 % to 4 % in the same time period. The market share for organically produced food amounted to 2.3 % (= 3 billion euro) in 2002. The yearly increase in share of organic farming and number of farms reached 22 % in 2000 and has been declining since then (2001: 15.6 %, 2002: 6 %). In a European comparison of the share of organic farming, Germany with 4.1 %, is in middle-place. However, comparing the actual area used for organic farming, Germany ranks in third place.
Municipal waste	In Germany, the amount of municipal waste collected from households and small- and medium-sized enterprises has been relatively stable during recent years and has even decreased slightly. This has been influenced by an advanced waste management policy. Elements of this policy include the phasing-out of landfilling for municipal waste, and introducing both the concept of total recycling of municipal waste by 2020 (Strategy 2020), and mandatory take-back obligations for packaging waste. These elements have encouraged both recycling and avoidance of waste.
Use of freshwater resources	In Germany, the private and economic sectors use only 22 % of naturally available water. The volume of water consumption in the main sectors is continually decreasing. In fact, the demand for private households is 15 % below the 1991 level; water abstraction for cooling purposes in thermal power stations also decreased 15 % from the 1991 level, and the abstraction for manufacturing and quarrying industries decreased about 29 % over the same period. Water use for agricultural irrigation is not significant and has stabilised at a low level.

6. ECONOMY AND SOCIETY

A discussion on socio-demographic changes in cities and regions from an environmental perspective is included in Appendix 5.

7. LAND USE

7.1. Land use changes

According to Corine Land Cover 2000 data, most of the German territory is covered by arable land and permanent crops (nearly 40 %), followed by forests (about 30 %), pastures and mosaics (more than 20 %), and artificial areas (8 %). The rest of the territory is covered by water bodies, wetlands and semi-natural areas.

In the period 1990-2000, the decline of arable land and permanent crops was the most significant land cover change in absolute terms (nearly 3000 km^2 or over – 2 %). Most of this land was taken up by expanding urban areas and infrastructures (more than 50 %), pastures and mosaics (30 %) and forested land (less than 20 %). Other significant changes in relative terms occurred in the urban and infrastructure areas (nearly + 6 %), in areas with 'semi-natural' land cover (about – 9 %) and open spaces/bare soils (+ 4 %).

About half of the increase in built-up areas was due to the expansion of housing, recreation and service areas. Industrial and commercial sites, mines, quarries and waste dumpsites also contributed. New transport networks and infrastructures made up a relatively small part of the change, since infrastructures are already highly developed. Most of the urbanisation seems to have occurred in densely populated areas and around major settlements.

Urban expansion in Germany is also characterised by changes in the household structure. A combination of ageing population, fall in overall population and increasing number of single-households has one of the biggest impacts on the changes of urban patterns.

The conversion of other land uses to urban is perceived as a very important issue in Germany, especially as most of the changes occur in parts of the country were the population is decreasing. As a consequence, the protection of 'green spaces' is becoming a national priority.

Forests expanded during the 1990s, particularly in the east of the country where increases of more than 10 % were observed in some locations. The afforestation took place mainly in areas where farming was withdrawn and former military zones (EEA, 2006a).

Table 6. Relevant statistics 1990-2000 by land cover class in ha						
	Land cover flows					
Corine land cover types	Total land cover, 1990 (ha)	Total Consumption of 1990 land cover (ha)	Total Formation of 2000 land cover (ha)	Net Formation of Land Cover (formation-consumption)	Net formation as % of initial year	Total land cover, 2000 (ha)
1 Artificial areas	2 738 368	58 000	216 843	158 843	5.8	2 897 211
2A Arable land & permanent crops	14 227 290	416 419	122 013	-294 406	-2.1	13 932 884
2B Pastures & mosaics	7 379 985	195 305	284 041	88 736	1.2	7 468 721
3A Forested land	10 551 787	127 146	176 319	49 173	0.5	10 600 960
3B Semi-natural vegetation	255 265	35 515	13 682	-21 833	-8.6	233 432
3C Open spaces/ bare soils	77 328	17 370	20 483	3 113	4.0	80 441
4 Wetlands	434 927	11 441	13 904	2 463	0.6	437 390
5 Water bodies	514 166	11 207	25 118	13 911	2.7	528 077
Total (ha)	36 179 116	872 403	872 403	0	0.0	36 179 116

Source: EEA, 2006bc

7.2. Land ownership

This information is not available for Germany.

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http://www.cabernet.org.uk

http://www.rescue-europe.com,

http://www.eugris.info

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APPENDIX 1. Soil contamination from local sources

In Germany, it is estimated that potentially polluting activities have occurred at 289 500 sites and further information or investigations are needed to establish whether remediation is required. National estimates expect that around 10 % (or 29 000 sites) are contaminated and need to be remediated[22]. A total of 55 800 risk assessments were completed by 2007, which resulted in the identification of contaminated sites requiring the application of remediation measures. About 12 500 confirmed contaminated sites are currently registered in the *Länder* registers, while more than 21 300 sites have been cleaned up[23]. Table A1.1 provides an overview of progress in management of contaminated sites by *Länder*.

Most cases of contamination are a heritage from the past. However, current activities may still cause soil contamination. Information on the contribution of new contamination from ongoing activities is not included in the *Länder* registers as long as the contamination is not identified[24].

Information on the main sectoral activities causing soil contamination is scarce. According to the German legislation, contaminated sites include former waste disposal sites and former industrial sites (BMU, 2002). In the mid-1990s, a survey identified 3 240 sites potentially contaminated as a result of the production of military goods[25]. Most of the contamination in these sites dates back to the period between the two World Wars, while a few sites were contaminated after the Second World War (BMU, 2006).

The situation for mining sites is comparable to other types of sites. While a mining site is still in operation, its management falls under the mining law. With the end of the supervision of the mining authority, the site will be registered as abandoned. In case of any suspicion of contamination, the site will be registered. The same applies to ownerless old mining sites not covered by the mining law[26].

[22] According to the German Soil Protection Act, contaminated sites are shut-down waste recycling and disposal facilities (abandoned waste disposal sites) and sites of shut-down facilities and areas where environmentally hazardous substances have been handled (abandoned industrial sites) that cause harmful changes to the soil or other hazards for individuals or the general public.

[23] These numbers derive from a summation of measures implemented to date, calculated on the basis of accounting records related to the implementation of registers, generally starting in the 1980s.

[24] In Germany there is a clear separation between sites with ongoing commercial activities under the responsibility of the trade supervisory centre and abandoned sites under the responsibility of the soil protection authorities. This means there is no common data source for contamination.

[25] This special group of sites comprises the categories mentioned before and therefore is included in the total numbers provided in the assessment.

[26] Mining rehabilitation goes beyond the scope of the Federal Soil Protection Act. Most of the former mining sites and suspected contaminated sites are subject to the Federal Mining Act, which came into force in the New States in 1990. Article 55 of the Federal Mining Act requires mine-owners to rehabilitate abandoned mining sites. It has to be ensured that no risks arise from land formerly used for mining purposes and takes the public interest into account. According to an Administrative Agreement

To handle the large number of sites, a stepwise risk assessment procedure is used to select the sites where there is urgent call for action because of their risks to humans and the environment[27].

In the past 20 years, considerable efforts have been made to clean up and redevelop contaminated sites. This was facilitated by the development of specific soil treatment technologies, with particular reference to technologies for the treatment of typical industry-originated substances. In Germany, there are more than 100 soil treatment plants in operation, providing a total treatment capacity of almost 4 million tonnes per year.

According to the data reported by the *Länder*, the country spends each year about 500 million EUR from the public budget for investigation and remediation for ownerless sites (coming from *Länder* budgets) on top of the expenditures of the responsible polluters, and the costs of remediation and research programmes.

A national inventory or register of contaminated sites is not provided for by the Federal Soil Protection Act. However, registers are kept at the regional and local levels under the responsibility of the Federal Sates (*Länder)*. In line with the legal framework, inventories distinguish two main groups, namely industrial sites and waste disposal sites. Sector and branch related information and site-type classification (e.g. into harbours, pipelines, airports, nuclear operations, commercial sites, accidents) are not systematically recorded. For each site, the registers provide at least information on the exact location, site characteristics, local conditions, environmental impacts (in terms of risks to environmental media) and progress in the management of the site. In general, data are not available on investigated media, priorities for remediation and most frequently applied technologies.

Public funding to research and to industry has contributed significantly to the development of soil treatment technologies at a high standard in the past. Current research and development efforts are rather concentrated on the setting up of cost-efficient clean-up techniques and strategies. Initially remediation strategies focussed on soil decontamination, but nowadays a broader approach is applied. Today, site remediation not only involves the clean-up of soil and groundwater but also encompasses the entire land redevelopment process aimed at making the site fit for future uses. As remediation is becoming more complex and interdisciplinary, technological developments must contribute by making available effective technologies at reasonable prices.

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the ownership of the mines passed into the hands of the Federal Government, which became responsible for mining site remediation in the eastern part of Germany.
By the end of 2007, a total budget of approximately 7.8 billion EUR was spent for the lignite remediation programme only. Another focus in mining rehabilitation lies on former uranium mining. The financial responsibility belongs to the Federal Government. The remediation programme will continue until 2015 with an expected budget of over 6 billion EUR.

[27] Further information on the risk assessment procedure is provided in Appendix 5.

Table A1. Progress in the management of contaminated sites in Germany by *Länder*

category [1]	survey	Suspected Contaminated Sites	Abandoned Waste Disposal Sites	Abandoned Industrial Sites	Contaminated Sites	Remediation (finalised)	Risk Assessment (finalised)	Remediation (ongoing)	Supervision / Monitoring (ongoing)
lfd. Nummer		1	1.1	1.2	2	3	4	5	6
Baden-Wuerttemberg	12/2005	11.572	2.285	9.287	9.452	1.456	623	1.502	74
Bavaria	03/2006	16.035	11.166	4.869	3.471	1.450	1.398	1.032	52
Berlin	07/2006	3.849	1.056	3.379	k.A.	681	62	122	67
Brandenburg	03/2006	21.165	7.498	13.667	3.756	1.431	86	3.328	38
Bremen	06/2006	3.333	40	3.293	552	367	41	467	149
Hamburg	6/2006	1.925	306	1.644	2.833	423	135	424	118
Hesse	07/2006	740	315	425	837	468	287	546	158
Mecklenburg-Western Pomerania	12/2005	6.652	2.799	3.853	385	1.130	374	849	530
Lower Saxony	06/2005	69.071	9.311	59.760	1.559	1.169	277	1.015	95
North Rhine-Westphalia	01/2004	48.459	19.163	29.568	10.701	2.186	2.090 919	3.774	1.669
Rhineland-Palatinate	06/2005	13.415	10.563	2.852	1.365	405	167	712	206
Saarland	08/2005	1.941	1.668	289	740	461	33	42	156
Saxony	03/2006	22.125	7.139	14.986	5.624	1.016	724	2.146	1.204
Saxony-Anhalt	05/2006	18.901	5.581	13.320	2.141	127	55	1.117	11
Schleswig-Holstein	12/2005	17.498	2.395	15.103	2.233	257	104	874	k.A.
Thuringia	03/2006	15.559	4.826	10.733	2.321	604	604	722	39

Source: Last update provided by the Joint working group (LABO) in October 2007

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BMU, 2006: Soil conservation web site of the German Federal Environment Ministry, Contaminated sites-General information (Altlasten) INTERNET: http://www.bmu.de/english/soil_conservation_contamined_sites/general_information/doc/4970.php. Last accessed June 2007. Information is dated January 2006.

APPENDIX 2. Market Based Instruments (MBI) Fact sheets

Information not available for Germany.

APPENDIX 3. Country review of European datasets for soil erosion, decline in organic matter and hydrogeological risks

At the time of drafting these reports, there are few data at European scale on soil threats. Three European datasets that were identified as significant are: the data of the Pan-European Soil Erosion Risk Assessment (PESERA), the Map of Organic Carbon Content in Topsoils in Europe (OCTOP) and the Emergency Disasters Data Base (EM-DAT). The PESERA and the OCTOP data are both available at the JRC web site(http://eusoils.jrc.ec.europa.eu/ESDB_Archive/pesera/pesera_data.html and http://eusoils.jrc.ec.europa.eu/ESDB_Archive/pesera/pesera_data.html), while data on natural and technological accidents are available at the EM-DAT web site (http://www.em-dat.net/).

For this appendix, the national experts were asked to provide:

1) Comments on the results of PESERA for their country.
2) Reference to national data sources on erosion, if available.
3) Comments on the OCTOP data for their country.
4) Reference to national data sources on topsoil organic carbon, if available.
5) Comments on the quality and coverage of data stored in the EM-DAT for their country.
6) Reference to national data sources on natural and technological accidents, if available.

1) Information not available.

2) A map showing land use-driven erosion risk in arable land (reference year 1999) has been prepared by the Federal Institute for Geosciences and Natural Resources (BGR)[28]. The erosion risk is expressed as average soil loss per year (t/ha*a) aggregated by county (for a total of 430 counties). See Appendix 5 for further information.

3) Information not available.

[28] Data are not available through the Eionet National Reference Centre.

4) Statistics (stratified according to climate, land use and soil properties) on soil organic matter contents in top soils are available at the national scale. An appropriate methodology to evaluate the current or future extend of organic matter decline is still to be developed. See Appendix 5 for further information.

A comparison between national soil organic carbon data and European data would be interesting, if JRC provides relevant spatial information for Germany.

5) Information not available.

6) No nationally aggregated data are available. The regional Geological Surveys of the federal states (*Länder*) are responsible in this area.

APPENDIX 4. Socio-economic indicators

This section was not developed for Germany.

APPENDIX 5. Additional information[29]

Section 2

Critical loads

Text prepared by Anke Lükewille, EEA

Under the UN ECE Convention for Long-range Transboundary Air Pollution (LRTAP) Parties report data on critical loads of acidity and nutrient nitrogen to the Coordination Centre for Effects (CCE) at the Netherlands Environmental Assessment Agency (MNP). Depending on the most sensitive ecosystems in a respective country, critical loads are reported for: forest soils, semi-natural vegetation and/or surface waters. Germany provides data for the first two receptors listed above (Hettelingh et al. 2005).

Forests cover over 100 km^2 of the Germany territory (approximately 30 % of the total country area). Soils and forest ecosystems in most of those areas are sensitive to acidification and eutrophication. The CCE compiles European-wide maps of critical loads for ecosystems within the so-called 50x50 km^2 EMEP grid cells. The maps are based on regularly updated national contributions (including information from several non-EU countries). The critical loads of acidity for most German forest soils are in the range of 200 to 700 eq ha^{-1} a^{-1} (5^{th} percentiles; Hettelingh et al. 2005). The critical loads of nutrient nitrogen are in the same range.

In order to estimate critical loads exceedances, e.g. for German forest soils, the critical load values are compared to the modeled deposition of acidifying and eutrophying sulphur or nitrogen equivalents. To model average deposition for a certain year on a 50x50 km^2 scale the regional EMEP atmospheric dispersion model is used by the Meteorological Synthesizing Centre-West under the LRTAP Convention (EMEP MSC-West in Norway). 'Exceedance' refers to the 'average accumulated exceedance' (AAE). The AAE is the area-weighted average of exceedances (averaged over all ecosystem points) in a grid cell, and not only the exceedance for the most sensitive ecosystems (for details see Hettelingh et al. 2005 and UBA 2004).

The average accumulated exceedance of the critical loads of acidity in Germany is highest in north-western Germany along the Dutch border. Using dynamic critical loads modeling approaches and the development deposition based on a 'current legislation' scenario, CCE has estimated that the exceedances in 2010 will still be 600 - 800 or even > 800 eq ha^{-1} a^{-1}.

[29] This section was developed by Germany, except the parts where contributors are explicitly indicated.

Concerning critical loads of nitrogen the situation is believed to be even worse in 2010 (Hettelingh et al. 2005). According to CCE projections approximately two thirds of the forest area in Germany will receive nitrogen deposition exceeding the critical loads by more than 800 eq ha^{-1} a^{-1} in 2010. Peaks can be found along the North Sea coast.

References

Hettelingh, J-P, J Slootweg, and M Posch (2005). *Critical Loads and Dynamic Modelling, CCE Progress Report 2004*.- Working Group on Effects of the Convention on Long-range Transboundary Air Pollution, ICP M&M Coordination Centre for Effects, RIVM report 259101014/2004, ISBN: 90-6960-113-3. http://www.mnp.nl/cce/publ/SR2005.jsp

UBA (2004). Manual on methodologies and criteria for modelling and mapping critical loads & levels and air pollution effects, risks and trends. UNECE Convention on Long-range Transboundary Air Pollution, Federal Environmental Agency (Umweltbundesamt) Germany, http://www.icpmapping.org/

Soil Organic Matter Content in top-soils of Germany

Text extracted from: Utermann, J. & Düwel, O., Federal Institute for Geosciences and Natural Resources. Soil Organic Matter Content in top-soils of Germany[30]

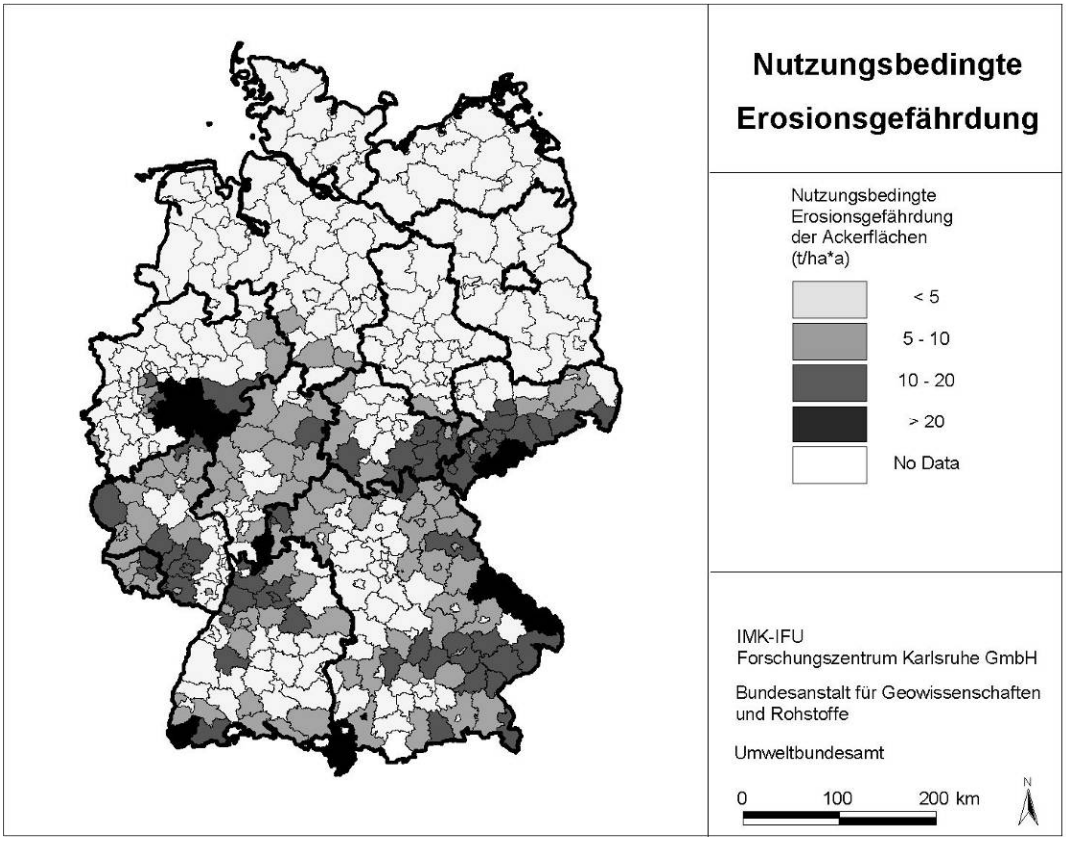
The importance of soil organic matter (SOM) in supporting basic soil functions has been stressed in the context of several legislative activities which have recently been initiated both at the European and the national levels. At the European level, the proposal for a Soil Framework Directive, presented in September 2006, provides for the identification of regions vulnerable to various soil threats, including the decline of SOM. At the national level, the revision of the German soil protection ordinance and the regulations for direct payments under the Common Agricultural Policy (CAP) require sound data on SOM.

In this context, a comprehensive evaluation was carried out in order to provide a national baseline on typical SOM contents in top-soils under different land uses. The evaluation was based on analytical data for SOM of about 9 000 soil pits provided by the national and the regional soil surveys. The data on SOM were harmonised and stratified according to three climatic regions, 15 groups of soils parent material and three main land uses, using a step-wise procedure. The data were linked to a map of soil parent material at the scale of 1:1 million, differentiated according to climatic regions and land use. The SOM contents were grouped in six classes according to the national soil taxonomy and subsequently analysed statistically.

[30] See also: Düwel, O., Utermann, J., 2007. 'Repräsentative Humusgehalte in den Oberböden Deutschlands' *Mitteilgn. Dtsch. Bodenkdl. Ges.* 110 (2): 677-678 and http://www.bgr.bund.de/cln_011/nn_322846/DE/Themen/Boden/Aktuelles/Humusversorgung__Oberboeden__D.html?__nnn=true

For the first time, country-wide information on SOM contents in top-soils could be compiled both in terms of statistical characteristics (e.g. percentile values) and a map of SOM referring to the mean values of the sample distributions. Based on the available data, a total of 79 stratification units covering 88 % of the national area were evaluated. Land use, soil formation and climatic conditions were clearly identified as governing factors for the level of SOM in top-soils. In fact, SOM increases from soils under arable land to forest soils to soils under grassland. In addition, dryer regions such as eastern Germany show significantly lower SOM contents compared to the wetter regions in the north-west.

Land use-driven water erosion risk in arable land per county



The map shows the land use-driven erosion risk in arable land in 1999 as average soil loss per year (t/ha*a), aggregated by county (430 counties). The availability of detailed information on the actual land use and the agricultural crops is the precondition for the assessment of the environmental impacts of water erosion. The assessment of the water erosion risk was done through a model which links agro-statistics, data on actual land cover and soil properties. The calculations were done using a 250x250m raster format. Data used in the assessment: CORINE land cover map at the 500mx500m resolution soil map of Germany at the 1 million scale (BÜK1000) data on slope derived from a 50x50 m elevation model, detailed statistical information from the ‘main survey on land use’ (as of 01.01.1999). The statistics provide data

on area under crops and yields for the most important crops in Germany. This information is updated every 4 years[31].

References

Erhard M., Hennings V., Werner B., 2005. 'Großräumige Darstellung der nutzungsbedingten Erosionsgefährdung durch Wasser – ein Bodenschutz bezogener Indikator'. *Zeitschrift für Bodenschutz*: 10(2): 53-57. (Latest results in German with English summary using 50m x 50m resolution)

Erhard M., Böken H., Glante F., 2003. ,'The Assessment of the Actual Soil Erosion Risk in Germany, Based on CORINE Land-Cover and Statistical Data from the Main Representative Survey of Land Use'. In: Francaviglia R. (Ed.). *Agricultural Impacts on Soil Erosion and Soil Biodiversity: Developing Indicators for Policy Analysis*. Proceedings from an OECD Expert Meeting - Rome, Italy, March 2003, 654 pp. www.oecd.org/agr/env/indicators.htm (English publication using older data (250 x 250m resolution)

Erhard M., Everink C., Julius C., Kreins P., Sietz D., Meyer J. (2002): *Bundesweite Betrachtung der Zusammenhänge zwischen Agrarstatistikdaten und aktuellen Daten zur Bodennutzung*. UBA Texte 71/02. Umweltbundesamt, Förderkennzeichen (UFOPLAN) 200 71 247; UBA-FB 000341; 125 S. (Original report in German with English summary)

Section 4

Risk assessment at contaminated sites

The obligations for the general management of contaminated sites are defined in the Federal Soil Protection Act and the Soil Protection and Contaminated Sites Ordinance. According to these instruments, site investigations should be carried out step by step, in order to ensure a cost-effective and comparable evaluation of the sites.

This stepwise risk assessment procedure leads to a higher level of knowledge at each step. Sites with low or no risks can be excluded from further investigations at an early stage, whereas acute hazards demanding immediate measures can be promptly identified.

The first step consists of a historical investigation of a suspected contaminated site,. where available data are collected on the former industrial activity, the technologies implemented or the waste released through the manufacturing processes. This information may be found, for example, in manufacturing files, archives, documents of environmental authorities, state land registers and local chronicles or by interviewing contemporaries. The historical investigation includes a site visit but no technical or chemical investigations.

If the historical investigation leads to suspect contamination at the site, an exploratory investigation is carried out. First measurements and soil samples are taken to assess the hazard for the relevant transport pathways and the resources to be protected.

[31] Data are not available through the EIONET NRC.

Trigger values assist in indicating if there is a concrete suspicion of contamination. This helps the responsible authorities to cope with the huge numbers of suspected contaminated sites. If a trigger value is exceeded, further investigations are required to determine whether the site is contaminated and whether specific measures are necessary. If the measured contaminants are lower than the trigger values, a risk for human health and the environment can be excluded.

The trigger values are based on toxicological data, exposure models and substance-specific considerations.

The exploratory investigation leads to an expert opinion including a hazard assessment and recommendations for further action.

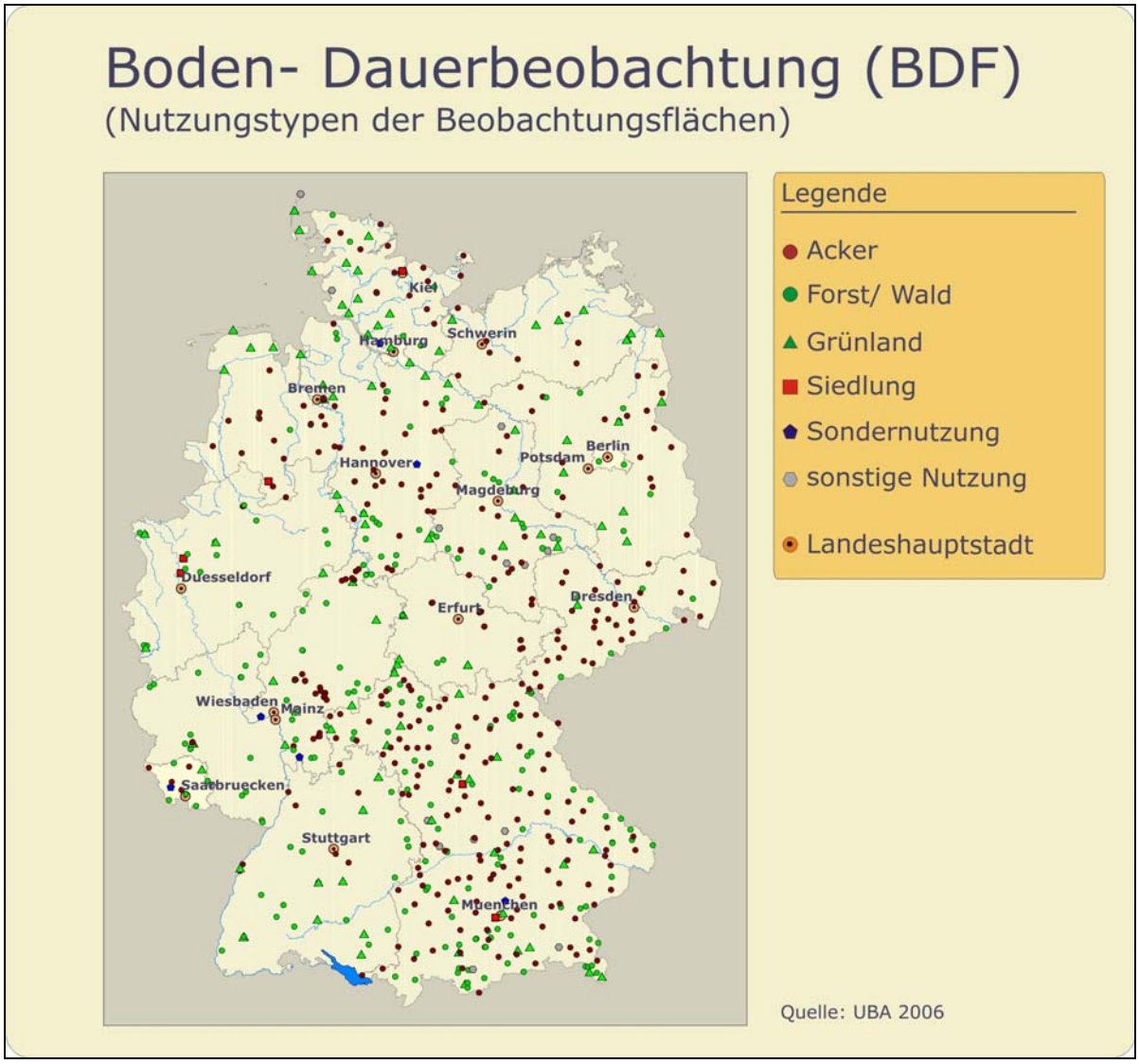
If the exploratory investigation has confirmed the suspected contamination, a detailed investigation is required. Its objectives are a final hazard assessment and the setting of criteria for further treatment. In general, data are required on the contamination source and the pathways of the harmful substances to the sensitive receptors (the resources to be protected).

As a result of the detailed investigation, a remediation proposal is compiled, working out the optimum remediation technology for the individual sites and the target values for the remediation. It may also include different alternatives for the remediation or a combination of several remediation technologies.

Three major options for the elimination/reduction of hazards are available:

- Decontamination measures: the source of contamination or the contaminated material is eliminated or reduced;
- Securing/containment measures: prevention/reduction of spreading of the contaminants;
- Protection and restriction measures: other measures to prevent or reduce hazards.

Location of soil permanent monitoring stations in Germany



Source: UBA, 2006

Legend (Land use at the site): Red dots = cropland; Green dots = forest; Green triangle = grassland; Red square = settlements; Dark blue pentagon = used for special purpose; Gray pentagon = other use; Orange circle with dot = *Länder* capital

National framework for the assessment of soil quality

The Federal Soil Protection Act (BBodSchG) and the Federal Soil Protection and Contaminated-sites Ordinance (BBodSchV) have created a nation-wide assessment framework for assessing soil quality for the “Soil-Man”, “Soil-Plant” and “Soil-Ground Water” paths of action.

In a research project one particular focus was on CMT substances, i.e. substances with a carcinogenic, mutagenic or teratogenic potential. An eco-toxicological risk assessment for cobalt, chromium (VI), benzene and ethyl benzene as substances relevant for soils and contaminated sites has been developed. A draft trigger value document for the “Soil-Man” path (direct path) has been submitted. This document distinguishes between different uses of suspect areas in terms of children’s playgrounds, residential areas, parks and leisure areas, as well as industrial and commercial properties. In order to protect the soil’s function as a biosphere for soil organisms, trigger values should also be identified for individual pollutants, so that they can be considered in a future revised version of the Federal Soil Protection and Contaminated-sites Ordinance. Since a pollutant has a specific effect on different soil functions, the question arises as to which reactions are to be used in order to determine these effects.

In order to ensure the production of healthy food and to protect natural soil functions on a long-term basis, inputs of pollutants into soils must be avoided as far as possible. Food is produced with the help of fertilizers, such as sewage sludge, manure, mineral fertilizers and compost. However, the use of fertilizers means that not just nutrients, but also pollutants access soils. In order to prevent the long-term accumulation of pollutants in soils, the pollutant content of fertilizers should be generally limited as a preventive, permanent measure. The prevention values contemplated in the Federal Soil Protection and Contaminated- sites Ordinance can serve as a yardstick. The aim of preventive soil protection is to pursue agricultural methods and processes which avoid pollutant levels at which negative changes in soil functions would have to be expected. This new concept for the use of fertilizers in agriculture is based on four options which reflect the needs of soil as an asset deserving protection:

Option 1: Avoidance of pollutant inputs.

Option 2: Limiting pollutant inputs to a level that corresponds to that of the place where fertilizers are used (“equal to equal”).

Option 3: Limiting pollutant inputs to a tolerable, balanced state of inputs and emissions into and from ground water, surface water or foodstuffs (“input equals emission”).

Option 4: Development of conventions on temporarily tolerable accumulation levels and pollutant inputs under defined boundary conditions.

The concept was presented to the expert public at a two-day symposium on “Agricultural use of sewage sludge, manure and other fertilizers, taking environmental and consumer protection interests into consideration” organized by the Federal Ministry for the Environment and the Federal Ministry for Consumer Protection (BMVEL) in October 2001 in Bonn. The implementation of the first three options hence requires prompt action. The aim is thus clear.

Current pollutant concentrations in soils may not rise further. This option is already set forth in the EC Regulation on Organic Production of Agricultural Products (Regulation 2092/91/EEC, as amended by Regulation 2381/94/EEC on compost) as well as in the Federal Soil Protection and Contaminated-sites Ordinance.

Further references

Printfassung, Download-Langfassung [4,23MB]
Assessing the bioavailability of contaminants in soils: a review on recent concepts
T. Frische, K.-H. Mebes, J. Filser
Texte
Nr. 66/2003
UBAFBNr 000405
Förderkennzeichen 201 64 214
Umweltbundesamt

Printfassung, Download-Langfassung [0,466MB], Download-Kurzfassung [0,15MB]
Bodenschutz und Landschaftsverbrauch
Texte
Nr. 15/1999
Umweltbundesamt

CD-Rom, Download-Kurzfassung [0,03MB]
Bundesweite Betrachtung der Zusammenhänge zwischen Agrarstatistikdaten und aktuellen Daten zur Bodennutzung
Achtung! Nur als CD-ROM erhältlich.
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Information for Investors, Builder- Owner and Real Estate Owners; Auch in Deutsch vorhanden!
Broschüren
Umweltbundesamt
Printfassung, Download-Langfassung [1,67MB]

In the publication list of www.uba.de some relevant publications are listed under the soil section (Boden)

Section 6

Socio-demographic change in cities and regions – development strategies from an environmental perspective

Abstract from: Soziodemographischer Wandel in Städten und Regionen – Entwicklungsstrategien aus Umweltsicht (UBA-Texte 18/2007)

Subject and Goals of the Project

Numerous cities and regions are already affected by massive socio-demographic change, such as an absolute drop in population, transformation of age patterns as well as changes to the social and cultural composition of communities. Many more will feel such effects in the future.

This socio-demographic transformation presents considerable structural challenges to almost all areas in the provision of public goods and services. To what extent this will positively or negatively influence the realisation of environmental goals and which specific actions may become necessary has only been clarified for specific questions in a somewhat tentative fashion. So far there has been no new strategic orientation.

The aim of this research and development project is therefore to determine the direct and indirect impacts of this socio-demographic change on the condition of the environment in terms of type and relevance, to evaluate these impacts and also develop options for action in terms of environmental policy on several levels. Here the national level is of particular importance.

The work does not incorporate any new empirical investigations. Instead a comprehensive analysis of relevant literature was carried out to evaluate and structure existing data.

Where no empirical data was available the project team members formulated assumptions mainly based on generally accepted notions of ecological and spatial-functional connections, as well as on hypotheses derived from these.

Demographic Typology

Socio-demographic change and its impacts do not conform to one unique pattern. Therefore it is impossible, from an environmental perspective, to develop one generally applicable development strategy for such change in cities and regions. Differences in the development of birth/death rates, as well as population migrations and associated transformation of population figures or structures in affected regions ensure that the intensity and form of social-demographic change is highly diverse among affected cities and regions.

When such factors as centrality, population density, settlement type and ecological framework conditions are incorporated one is able to observe diverse developments in adjacent small-scale areas down to level of individual city districts. It is necessary to develop a practical and simple spatial typology to help answer general questions and aid in the development of national strategies. This project contributed one important step by evaluating currently used typologies (and those still under development) of (socio)- demographic change to develop eight demographic types which reflect various environmental and politico-spatial aspects and which enable a comparison of spatial patterns of demographic change.

Impacts on the Environment and Provision of Public Services

Following a wide-ranging analysis of the relevant literature, some assumptions were formulated regarding the interconnections between socio-demographic change in cities and regions, its effect on national and municipal tasks of providing public goods and services, and the associated environmental impacts. Examination of specialist literature in the framework of this project, in particular regarding current or recently completed research, concluded that results on specific interactions were often lacking. This was particularly true of quantitative data.

The authors therefore formulated some assumptions to ensure that relevant results could still be realised within the project framework. These assumptions are based on sectoral data and theories taken from literature, as well as current thinking in specialist discussions. This implies that presented statements should be understood with some reservations regarding their reliability. It cannot be discounted that in reality other developments, even contradictory ones, are to be found. Although not recognised these may in fact already exist. One main result of this investigation is therefore also a realisation of the considerable need for further research regarding the environmental effects of socio-demographic change.

Opportunities and Risks

A sizeable drop in population in large areas of Germany will lead, at least on the long term, to a reduction in the numbers of households and thus the **demand for housing**. In theory this offers such regions the opportunity to reduce the **land consumption** to zero, avoiding further environmental loads. However this presupposes a consistent application of the spatial principle stressing the priority of the re-use of abandoned land. The widespread renaturization of abandoned housing and disused commercial plots in areas suffering population loss could provide opportunities for **land-resource policy**.

The loosening of urban structures and planned improvements in the quality of urban design and systems of green space brings about structural and ecological improvement of central city areas, so that in theory living conditions can approach those in suburban areas. The creation of high-quality “slimmer“ urban districts in central city areas can slow down the

processes of migration and suburbanisation with their associated negative consequences for the environment, sustainability and provision of public goods and services. The aging population can also make a contribution here, as older inhabitants with decreased mobility favour short distances for shopping and to carry out leisure activities. A dense settlement structure favours this requirement.

The land freed by the renaturization of settlements offers an opportunity to improve the **natural resource capacity** in terms of biodiversity, biotope networks, landscape and leisure value, new creation of groundwater, condition of surface water, flood protection and microclimates. In areas with a clearly declining population the local **traffic volume** (starting point and destination within the region) will decrease, for both passenger and goods transportation, as the lower population more than offsets the increasing transport performance per person.

Thus in such areas socio-demographic change can help reduce the noise and pollution burdens from local traffic. On the other hand growth in the national traffic volume will lead to increased loads. Generally it can be assumed that the extra load will be concentrated throughout the national transport network. The total load will probably decrease in some parts of Germany. A reduction in population should also be seen as aiding efforts to lower **the consumption of raw materials and primary energy** as well as supporting the reduction in emissions of pollutants and greenhouse gases.

However it should be noted that the decline in settlement density in areas undergoing contraction, the number of unoccupied houses and the general reduction in household size will bring lower efficiencies in the consumption of energy and resources. It is as yet unclear how the continued growth of **information and communication technologies** and related technical innovations will influence settlement structures in the future, and thus indirectly affect transport-related environmental loads.

The main risk is that **network infrastructures** will face pressures in terms of affordability and proper functioning. Infrastructures where fixed construction costs make up a large proportion of total costs, e.g. water supply and sewage removal as well as community heating are particularly subject to such pressures. In a growing number of areas **water supply and sewage disposal** currently face the dilemma of trying to maintain strict quality and environmental regulations at a time of shrinking populations. The lower profits from fewer and fewer customers have a negative impact on the financing of maintenance, renovation and renaturization measures.

Unlike the supply of drinking water or sewage disposal, the supply of **community heating** is not mandatory. If this form of heating is no longer profitable then other technologies, e.g. gas central heating systems, can be adopted. Apart from the financial consequences of writing off valuable assets and the necessity of making new investments, a further impact for the

environment is the considerable drop in efficiency in the use of primary energy, as the advantage of combined heat and power is not realised. In areas with a shrinking population one can expect, in addition to inefficiencies in primary energy production, a drop in the **efficiency of energy and resource consumption**.

In general, improvements in pollution emissions and quality of green spaces in areas with shrinking populations have to be weighed against worsening energy and resource efficiency of buildings and settlement structures. This is particularly important when attempting to achieve goals in sustainability.

In **areas showing stable development or growth** the goals of sustainability in energy, resource and land consumption will generally not be achieved. The positive effects in terms of reduced loads seen in areas with a shrinking population can only compensate in a very limited way for these negative factors. Socio-demographic change will certainly offer **opportunities** for the environment, whether in the recultivation of derelict land or the reduction of pollution emissions. However there also exists the not inconsiderable **risk** that such opportunities will be missed if specific measures for their realisation are not introduced.

Recommendations for Action

The recommendations for action drawn up by the German Federal Agency for the Environment and the Ministry for the Environment, Nature Protection and Nuclear Safety can be classified in terms of importance and urgency (cf. Heiland 2006, and elsewhere). Here the term importance describes the extent of the determined requirements for action, while urgency describes the timeframe within which action appears necessary. Measures of high urgency should be started immediately. A timeframe of around two years is sufficient for the realisation of initial results. Measures with lower urgency should realise some initial results within a timeframe of around five years.

Measures of special importance and high urgency include the development of interagency communication and consultation structures in the Federal Government as well as the creation of a structured knowledge base. Other important and urgent measures include more consideration of environmental and sustainability issues in current programmes which deal with socio-demographic change, as well as inclusion of this subject in the upcoming development of strategies at national and European levels. **Measures of special importance and lower urgency** are the strengthening of efforts to implement sustainability goals, the introduction of process monitoring and control, the permanent adoption of new regulations as well as securing long-term financial support for adaption measures. The continued development of models and strategies for action in spatial development and improvements in public relations are examples of **measures with lower importance and high urgency**. The organisation of a national and international forum for the exchange of experiences is a **measure with lower importance and lower urgency**.

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Abstract

The ‘Soil Country Analyses’ series is the outcome of a collaboration between the European Environment Agency (EEA), the EIONET countries and the European Soil Data Centre from the IES-JRC.

In order to overcome the general scarceness of information on soil at European scale and to include socioeconomic aspects in the assessment of soils in Europe, the EEA initiated in 2007 the preparation of the soil country analyses, by putting together available information on the different soil aspects. This information was loaded into a questionnaire customised for each country. The countries were then asked to review the information and provide additional data where possible.

The country reports presented here are the final outcome of this process. The reports offer an overview of the status of soil resources at the national level and touch on the aspects presented in the Soil Thematic Strategy. These include the main soil threats, the different soil policy instruments (also economic instruments) in force, and the specific soil management programmes and monitoring activities implemented or planned in each country.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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