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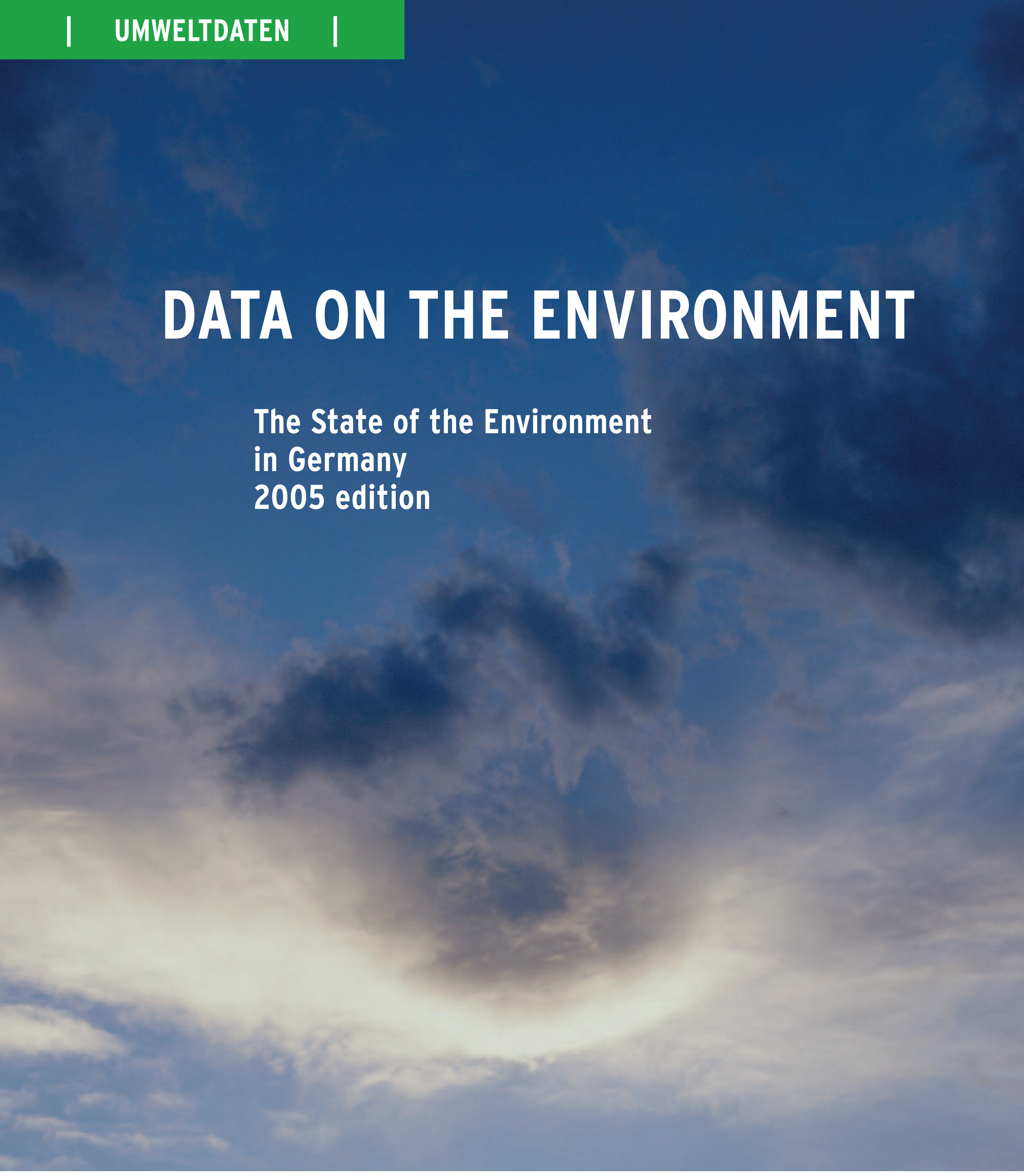

DATA ON THE ENVIRONMENT

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V AIR QUALITY MANAGEMENT

Air quality in Germany

Article 44 of the Federal Immission Control Act prescribes regular assessments for monitoring of air quality. Area-wide air quality monitoring is the responsibility of the *Länder*, which have established air monitoring networks to meet legal objectives. In addition to this, the Federal Environment Agency (UBA) collects immissions data at measurement stations in rural regions in order to monitor the background air pollution. This data also forms the basis for the fulfilment of international reporting duties according to conventions signed by the Federal State.

The assessment of the air quality in Germany is carried out on the basis of data collected from the 16 ambient air monitoring networks operated by the *Länder* and that of the UBA.

Emission of air pollutants

Emissions data is provided on an annual basis and follows the principle of territoriality. This means, for example, that emissions caused by international traffic outside German borders are not considered. In addition, emissions are calculated according to the “principle of origin”, i.e., the emissions are reported according to the location at which they are produced. For example, emissions from heating plants are allocated to the relevant power station or district heating station, although the heat is actually used in the domestic sector, which is therefore the indirect source of the emissions. Emissions relating to traffic that result from the exploitation, transportation, and processing of crude oil and the distribution of fuel components are not considered.

The mechanisms by which harmful substances are emitted can be divided into two main groups: combustion processes in industrial plants or motor vehicles, and a broad range of other processes.

In general, energy conversion processes are the predominant source of emissions with regard to the individual components/substance groups considered; for example, these contribute approximately 98 % of carbon dioxide emissions. There are, however, examples of emissions that originate predominantly from non-energetic processes; for example, these cause 98 % of ammonia and methane emissions.

In order to provide a comparison for evaluation, emissions are categorised according to the emission source that caused them, and grouped according to the general structure proposed by the IPCC [1] (Table V-1).

V 1 Airborne pollutants

Large-scale trends in concentrations of airborne pollutants

Air pollution in the old *Länder*, due to the traditional pollutants sulphur dioxide and airborne particulates, was considerably higher between the 1950s and 1970s than today. The reduction in the concentration of pollutants has been forced by regulations that caused the change over from solid fuels like coal and lignite to oil and gas, the increased use of low-sulphur heating oil, and, later, the desulphurisation of flue gases in large combustion plants (LCP).

Air pollution control measures, regulated by law from 1983 onwards, have led to a further major pollutant reduction of average annual levels – to below 25 $\mu g/m^3$ in the case of SO_2 concentrations. In the new *Länder*, decreases in SO_2 and particulate emissions associated with economic restructuring, redevelopment of smokestack industrial areas, and the construction of advanced, state-of-the-art industrial plants are also reflected in the immission concentrations measured. For example, the annual mean SO_2 pollution levels in the industrial and urban conurbations of West Saxony, southern Saxony-Anhalt, and eastern Thuringia fell by about 150–175 $\mu g/m^3$ to 8–15 $\mu g/m^3$ between 1990/1991 and 2003. As a result of the reductions achieved, the winter smog alarms that were previously caused by sulphur dioxide emissions have been effectively eliminated. This applies to both old and new *Länder*, even in topographically unfavourable locations such as valleys and geological basins. Consequently, all *Länder* have now repealed their winter smog regulations.

Developments relating to motor vehicle traffic have played a key role in the situation change with regard to immissions of nitrogen oxides in both the old and new *Länder*. The reduction of NO_x emissions stated has only started to be reflected to a limited extent in trends in immission levels. Traffic-related emissions of NO_x in large cities in the new *Länder* have increased, and as a result, there is a tendency towards higher NO_x immission values with levels approaching those seen in comparable regions in the old *Länder*.

Because of the fact that air pollution is not being kept within national borders, this is an issue that

Tab. V-1: *Source groups for emission of air pollutants*

Source Group (CRF)	CRF category	Sources of emissions
Energy industries	1.A.1	Public electricity and heat suppliers, district heating stations, industrial furnaces, industrial power plants for mineral oil processing, extraction and manufacture of solid fuels, and other energy industries
Manufacturing industries and construction	1.A.2	Industrial furnaces and industrial power plants in the stone and earth extraction sectors, all other mining and processing industries, construction industry
Transport	1.A.3	Road transport and other transport (not agricultural and forestry transport)
Road transport	1.A.3b	Private cars, busses, light and heavy goods vehicles, motorcycles
Other transport	Remainder of 1.A.3	Rail transport, coastal and inland navigation, national civil air traffic, mobile sources related to the construction industry (not road transport), fishing (part of 1.A.4c not open sea), natural gas compressing stations
Other sectors Other: Military	1.A.4. 1.A.5.	Furnaces in the trade, commercial, and service sectors, agricultural and forestry traffic, military
Residential	1.A.4b	Furnaces and mobile sources related to private households (not road transport)
Fugitive emissions from fuels	1.B	Fugitive emissions from the extraction of coal, crude oil, and natural gas, the energy conversion sector, gas distribution networks, distribution of petrol
Industrial processes	2	Industrial production processes that cause non-energy related emissions (e.g., product emissions)
Solvent and other product use	3	Use of solvents by trade, industry, and private households use of nitrous oxide for anaesthesia
Agriculture	4	Fermentation during digestion storage and application of commercial and inorganic fertilisers, emissions from agricultural soils
Land use change and forestry	5	Changes to forest resources and other biomass resources, CO_2 emissions, carbon-fixation in soil
Waste	6	Waste landfill and waste water treatment
Other	7	Handling of bulk goods

Categories established under the terms of the Federal Environmental Agency and according to the report format stipulated by the CRF (Common Reporting Format) of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

Source: *Federal Environment Agency 2004*

has been tackled by the European Union for a long time, resulting in increasingly strict regulations for air quality management, as new knowledge and concepts are taken into consideration. The framework for these regulations is the Council "Framework" Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management, the objectives and principles of which are set out in concrete terms in so-called daughter directives. The framework directive and the first two daughter directives were adopted in German law through the 22nd Federal Immission Control Ordinance (22nd BImSchV). The third daughter directive was subsequently adopted through the 33rd Federal Immission Control Ordinance

(33rd BImSchV), whilst the fourth daughter directive is currently passing through the legislative process. The limit values specified in the daughter directives are based on the work of the World Health Organisation (WHO) and, in general, are considerably lower than the limits specified in previous regulations. Where particle emissions are considered, new limit values for fine dust (PM_{10}) have replaced the previous limit values for total suspended particulate matter. Another new feature compared to the previous EC directives is that the first daughter directive makes it compulsory to make up-to-date information on ambient air quality and air pollution situation routinely available to the public.

In addition to the air quality directives, the European Commission has also issued Directive 2001/81/EC on national emission ceilings (NEC) for certain atmospheric pollutants, restricting maximum national emission levels for the first time. This directive covers sulphur dioxide, nitrogen oxides, ammonia, and volatile organic compounds (VOCs), and was adopted into German law through the 33rd BImschV.

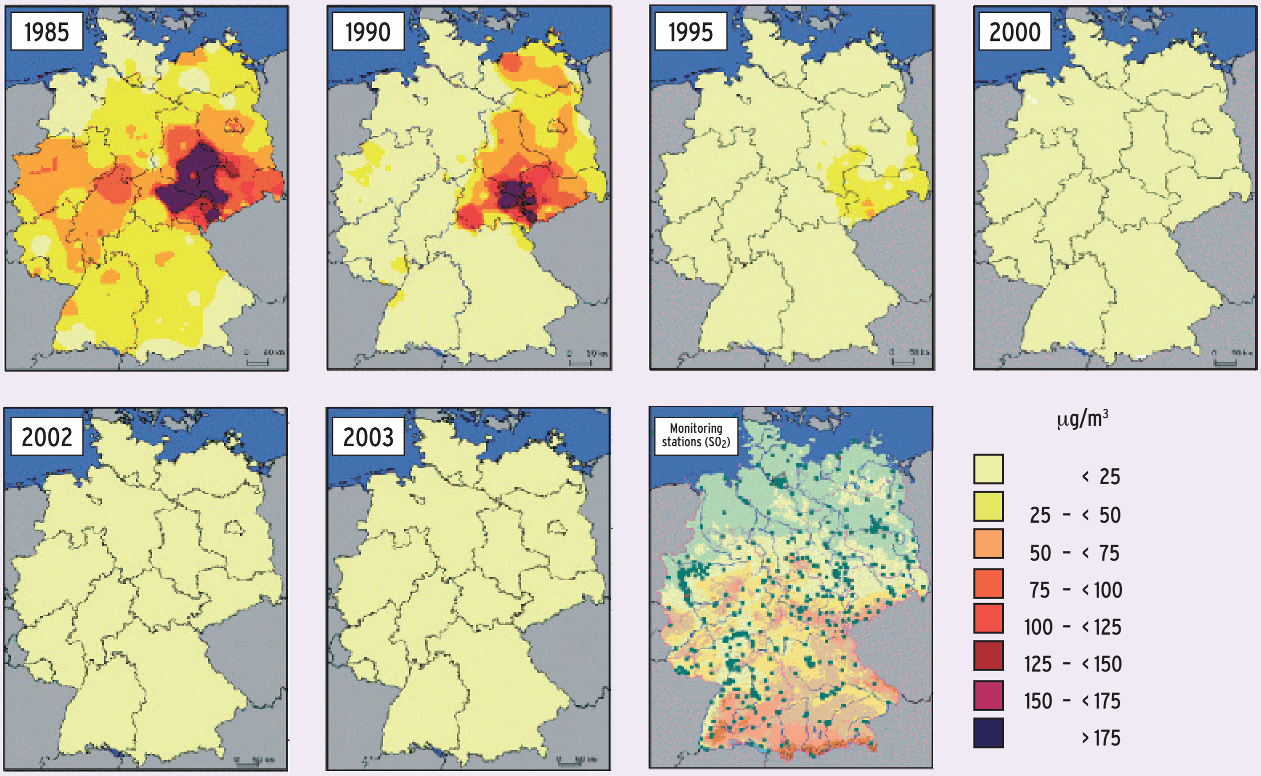
V 1.1 Sulphur dioxide (SO_2)

Trends in SO_2 immission concentrations

The nationwide representation and evaluation of SO_2 immission levels is based on the measurement results from approximately 500 ambient air monitoring stations belonging to the networks of the *Länder*, and approximately 30 stations operated by the UBA.

The annual mean SO_2 concentrations clearly show a downward trend in SO_2 pollution in the period 1985

Fig. V 1.1-1: *Annual mean SO_2 levels*



Data: Monitoring networks operated by the German *Länder* and the Federal Environment Agency
A small-scale interpretation is not feasible because of the interpolation method used

Source: *German Länder, Federal Environment Agency 2004*

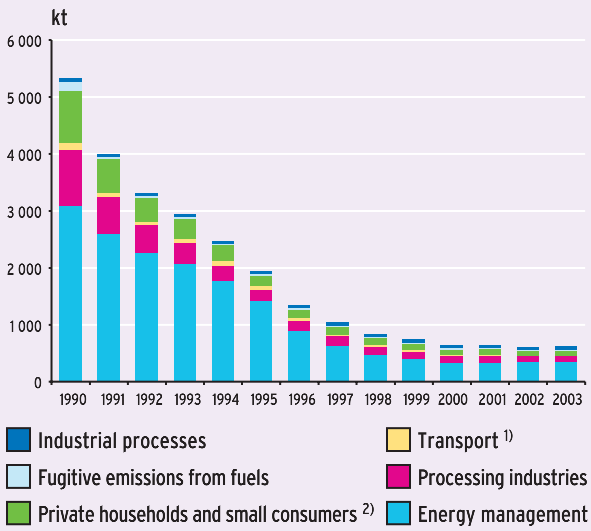
to 2003 (Fig. V 1.1-1). Taking as a basis the large-scale concentration levels between 1985 and 1987 of approximately 25–50 µg/m³, and levels of 50–75 µg/m³ in certain regions (Ruhr area, Rhein-Main area, North Hesse), reductions in levels to below 25 µg/m³ were achieved almost everywhere in the old *Länder* at the end of the 1980s and in the early 1990s.

In the years leading up to 1990, SO_2 pollution in the new *Länder* regions reached extremely high levels, particularly in the industrial regions of Saxony, Saxony-Anhalt, and Thuringia. The annual mean value was found, in places, to be above 150 µg/m³ across large areas. An appreciable reduction in levels started in 1990, and this trend has continued every year since. In the period up to 1994, the large-scale annual mean levels in Mecklenburg-Western Pomerania and Brandenburg showed low levels of SO_2 pollution, similar to the levels in the old *Länder*. During this time, the values remained between 25 and 50 µg/m³ only in Saxony, Saxony-Anhalt, and Thuringia, with a few places recording levels above 50 µg/m³. Today, differences in the levels of SO_2 pollution between the new and old *Länder* are no longer identifiable. The annual mean limit value of 20 µg/m³ defined for the protection of ecosystems is achieved everywhere in Germany.

Trends in SO_2 emissions

The reduction in emissions from 1990 to 2003 has been shown to be more than 4.7 Mt (−88 %) (Fig. V 1.1-2). The main reason for this in the new *Länder*

Fig. V 1.1-2: *SO_2 emissions in Germany by source group*



1) Not including agricultural and forestry transport
2) Including agricultural, forestry, and military transport

Source: *Federal Environment Agency 2005*

regions is the enforcement of the 13th Federal Immission Control Ordinance concerning large combustion plants (LCP; in German: 13th BImSchV – 'Großfeuerungsanlagenverordnung'), which lays down technical regulations for the limitation of emissions, the introduction of low emission fuels, and major reductions in energy demand through decommissioning of operations and economic restructuring. In 2003, the main producers of SO_2 emissions were still non-vehicular sources in the energy conversion sector (combustion plants in power stations and district heating plants –55.2 %) and the manufacturing sector (industrial furnaces –17.8 %) Nonetheless, it was still possible to reduce emissions in these areas by 3.6 Mt in the period from 1990.

Polluters

By far the largest proportion of SO_2 is produced by the oxidation of the sulphur contained in the fuels used in combustion processes. Emissions from processing industries remain almost constant, however they are relatively minor. The main emission sources in this sector are: industrial production processes in the chemical industry, metal production, stone and earth processing, and refining of crude oil and natural gas.

Fulfilling of international conventions by Germany

Under the terms of the UN ECE Geneva Convention on Long-range Transboundary Air Pollution Control (CLTRAP, 1979) , the Federal Republic of Germany was obliged by the UN ECE Helsinki Protocol (First Sulphur Protocol, 1985) to reduce its annual sulphur emissions by at least 30 % by 1993, as compared to 1980 levels. In 1993, the SO_2 emissions were 2 945 kt, compared to approximately 7.5 Mt in 1980. This represents a reduction of 61 %. The second UN ECE protocol on the reduction of sulphur emissions obliged Germany to reduce SO_2 emissions to 1,300 kt by 2000, and to 990 kt by 2005. The target set for 2005 had already been achieved by 1998.

The latest UN ECE protocol aims to minimise the damage caused by acidification, eutrophication, and ground level ozone (known as "Göteborg multi-component protocol", s. NEC Directive of the EC, adopted in German law through the 33rd Ordinance – 33. BImschV) and obliges the Federal Republic of Germany to reduce SO_2 emissions to 550 kt by 2010. In order to achieve this target, the emissions recorded in 2003 will need to be reduced by a further 10 %. It should be noted that between 2000 and 2003 emissions remained roughly constant, so further measures will be required in order to achieve this target.

V 1.2 Nitrogen Oxides (NO_x)

Trends in NO_x immission concentrations

The majority of emissions of nitrogen oxides (NO, NO_2) are emitted as nitrogen monoxide (NO). NO does not occur on a wide scale however, since this gas oxidises relatively quickly with atmospheric oxygen and ozone to form NO_2. In the summer months, nitrogen dioxide degrades due to the action of UV(B) radiation. As a result, in rural regions away from metropolitan areas, the concentrations rarely exceed a value of 30 $\mu g/m^3$, and generally lie below 10 $\mu g/m^3$ except in areas with heavy traffic. Depending on the location of the monitoring station, annual mean values of between 30 and 60 $\mu g/m^3$ may be measured in a few metropolitan areas. The first EC daughter directive on ambient air quality (1999/30/EC) specifies an annual limit value of 40 $\mu g/m^3$ for the protection of human health, which must not be exceeded after 2010. This limit value is currently not complied with in all parts of Germany.

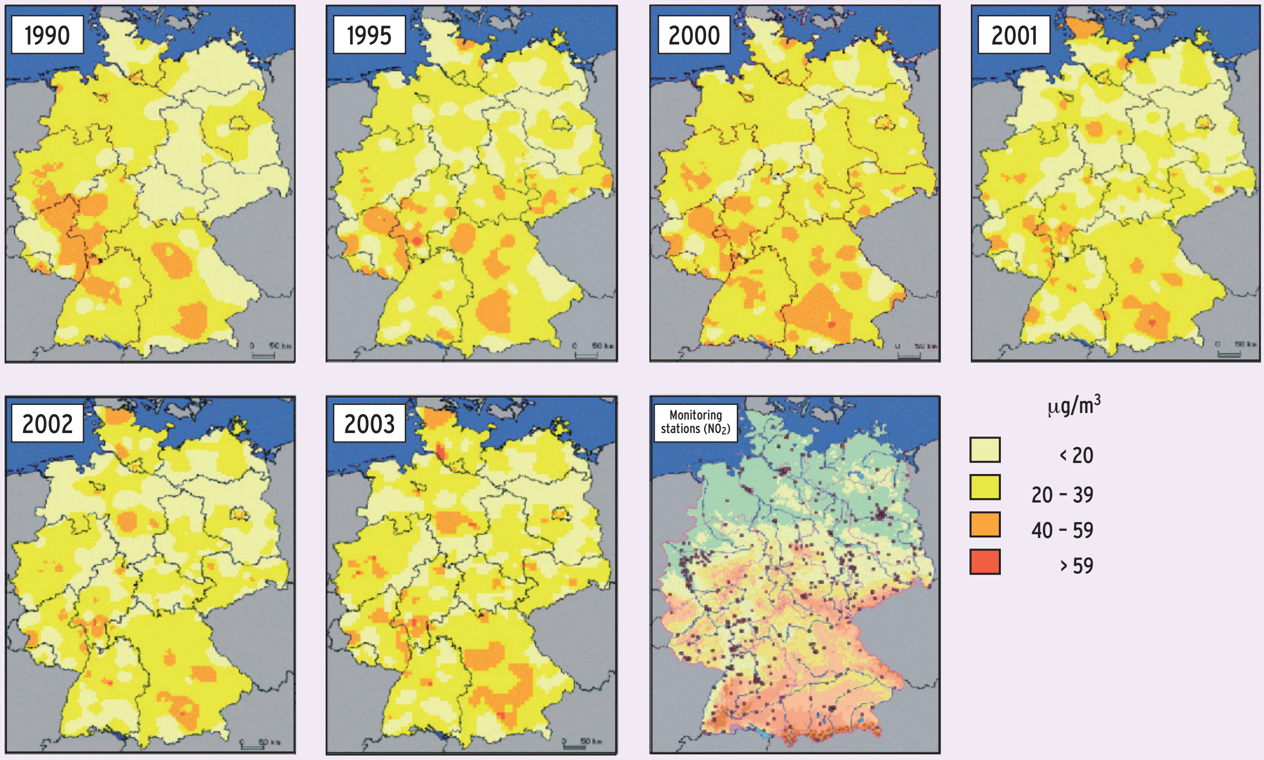
In the former German Democratic Republic NO_2 levels were only recorded in exceptional cases, with the result that very few measurements from the years before 1988 are available. As such, the area-wide figures only go back as far as this year. Across Germany as a whole, NO_2 measurements are taken at about 450 stations (Fig. V 1.2-1).

Trends in NO_x emissions

Emissions data for nitrogen oxides (NO_x) are counted in terms of NO_2. The reduction in emissions from 1990 to 2003 has been shown to be 1 418 kt (–50 %) (Fig. V 1.2-2). This reduction comes from all categories of emissions sources – the most significant reduction in terms of volume being the transportation sector, which contributed over 700 kt (–49 %). Despite this reduction, the transportation sector still produces by far the largest proportion of emissions, contributing almost 50 % of NO_x emissions. Emissions reductions in other sectors come as a result of the introduction of low-emission fuels/burners and more efficient use of energy, as well as from the benefits of economic restructuring, mainly in the new *Länder*.

Nitrogen oxides are produced almost exclusively by industrial and vehicular combustion processes as the result of oxidisation of the nitrogen content of the fuel and the combustion air. The majority of these 'nitrous' gases are emitted as nitrogen monoxide (NO) and subsequently oxidised in the atmosphere to form NO_2. The proportion attributed to non-combusting processing operations is only in the parts per thousand range, and can be chiefly attributed to the chemical industry (e.g., manufacturers of nitric acid)

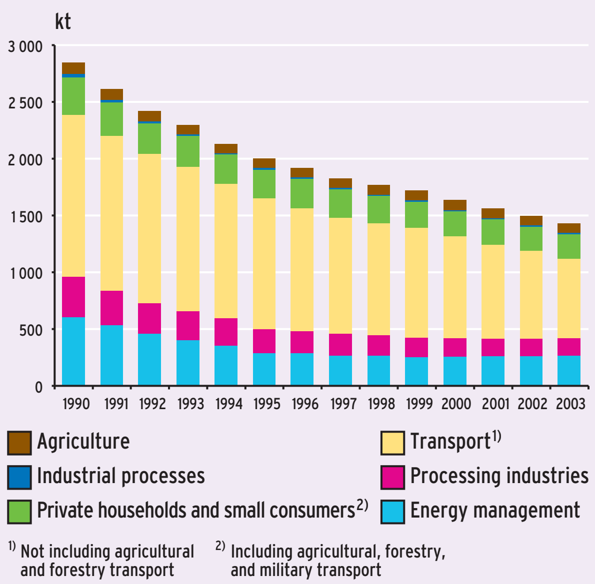
Fig. V 1.2-1: *Annual mean NO_2 levels*



Data: Monitoring networks operated by the German *Länder* and the Federal Environment Agency
A small-scale interpretation is not feasible because of the interpolation method used

Source: *German Länder, Federal Environment Agency 2004*

Fig. V 1.2-2: *NO_x emissions in Germany by source group*



Source: *Federal Environment Agency 2005*

and the stone and earth processing sectors (except clinker & clay brickstone furnaces, etc.).

The decisive factors in determining the extent of NO_x formation are the thermodynamic combustion conditions such as pressure, temperature, residence time, and excess air. These vary considerably between furnace plants depending on the technology used. The amount of NO_x released can be substantially reduced using aftertreatment systems (catalytic converters in vehicles, $DeNO_X$ systems at large-scale combustion plants, etc.). The highest emissions per unit of energy used come from the transport sector, followed by power stations and industrial furnaces. The lowest specific emissions are produced by small household heating facilities, especially those with low-NO_x burners.

Within the scope of the UN ECE Göteborg protocol on the reduction of NO_x emissions, the Federal Republic of Germany was obliged to reduce emissions to the 1987 level of 3 177 kt by 1994. However, this value is inconsistent with the time series data after 1990 because, for example, it does not include any emissions from the agricultural sector. Emissions were successfully reduced by over 30 % to 2 130 kt in this period, exceeding the obligatory requirements of the protocol and also meeting the additional voluntary commitment that was entered into by Germany and 11 other ECE countries (reduction of NO_x emissions before 1998 by 30 % compared to 1986 levels).

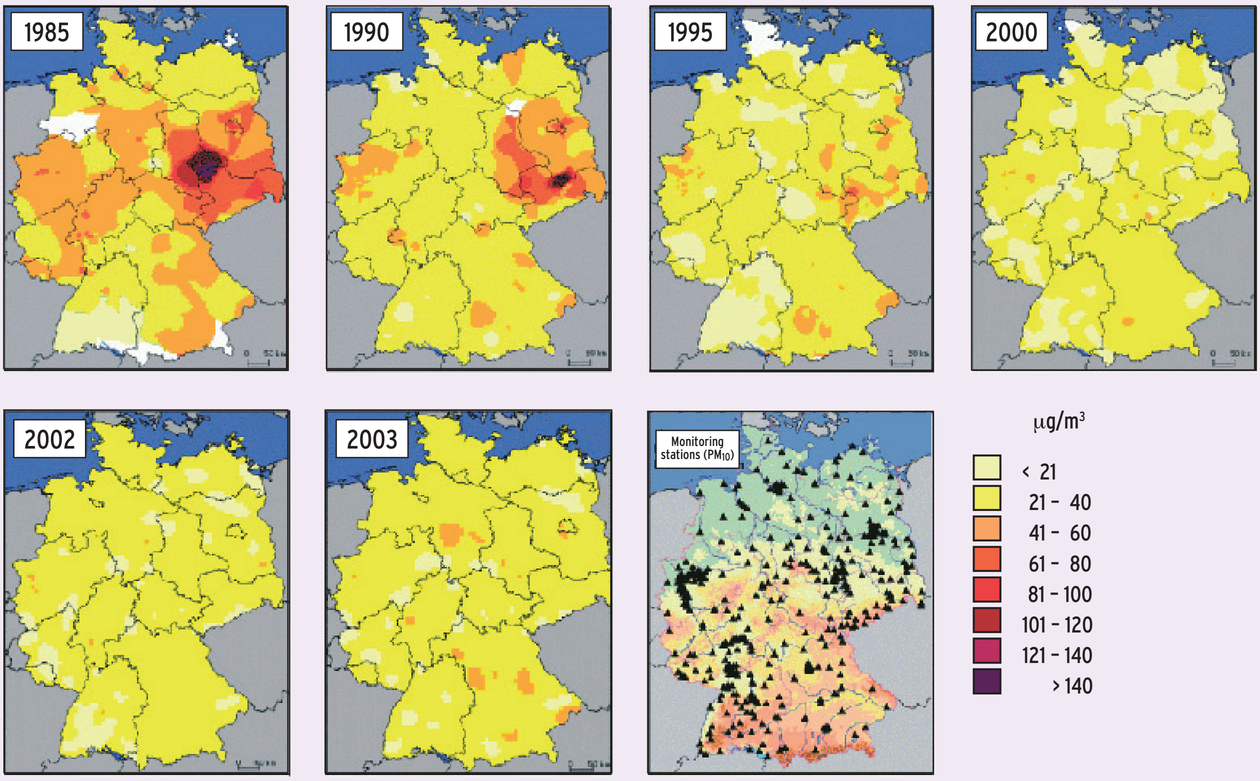
Germany has made a commitment under the multi-component protocol to minimise emissions, as it has with SO_2. By 2010, it will no longer be permissible to exceed a National Emission Ceiling of 1 081 kt NO_x for Germany as whole. In order to achieve this target, the emissions recorded in 2003 will need to be reduced by a further 24 %.

V 1.3 Airborne particulates (particulate matter, PM)

Trends in ambient air concentrations of airborne particulate matter ('dust')

Discussions relating to public health policy no longer tend to consider overall concentrations of airborne particulates, rather, they give increasing attention to the PM_{10} and $PM_{2.5}$ components of suspended dust (PM = particulate matter). This takes into account the limit values for PM_{10} specified in the first EC daughter directive (1999/30/EC) across the whole of Europe. The terms PM_{10} and $PM_{2.5}$ refer to the mass concentrations of all airborne particles with diameters less than 10 µm and 2.5 µm, respectively. Of all the dispersed particulate matter in the atmosphere, these PM fractions come mainly from combustion processes of stationary (industrial and household) and mobile (traffic related) sources; significant industrial processes include cement clinker manufacture and the handling (including transportation) of dustproducing goods. Airborne PM can also be formed from gases (SO_2, ammonia, hydrocarbons), and natural sources exist as well. Scientific investigations on the particle distribution of total suspended particles (TSP) in the atmosphere have shown that on average 83 % of the TSP falls into the PM_{10} category. Several *Länder* monitoring networks began individually with measurements for the PM_{10} fraction in the mid-1990s. Since 2000, PM_{10} has been measured throughout Germany. In order to produce a complete picture of PM_{10} pollution across Germany in the years for which only incomplete measurements are available, the PM_{10} concentrations have been calculated from the data relating to TSP concentrations. The results from this calculation process do not necessarily correspond to actual PM_{10} levels in every individual case; it does however provide a reasonably good guide to current and previous pollution levels. The first year in which both measured PM_{10} values and those calculated from TSP concentrations were used as the base data for the nationwide figures was 1998. The proportion of measured PM_{10} data increased in subsequent years, and since 2001 the pollution maps have been produced based exclusively on measured PM_{10} data (Fig. V 1.3-1).

Fig. V 1.3-1: *Annual mean PM_{10} levels*



Data: Monitoring networks operated by the German *Länder* and the Federal Environment Agency

For 1985 to 1998, suspended dust data (TSP) was converted to PM_{10} values (factor 0.83). From 1999 onwards over half of all PM_{10} data was based on measurements. The remainder was converted as previously.

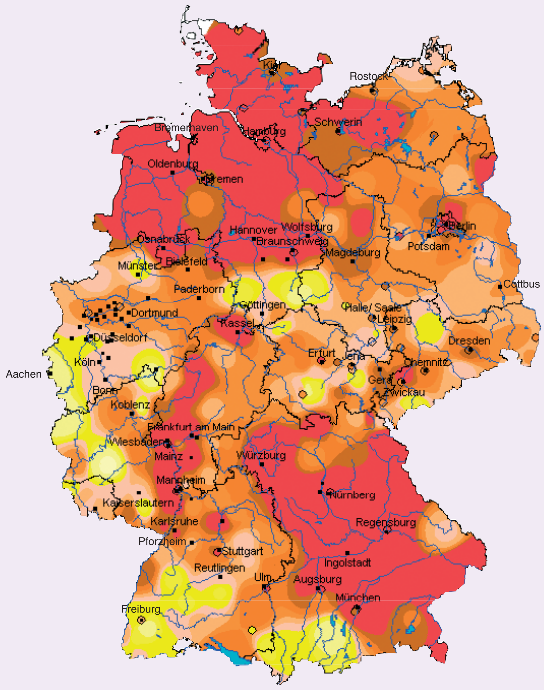
A small-scale interpretation is not feasible because of the interpolation method used

Source: *German Länder, Federal Environment Agency 2004*

Since about 1989, and particularly since 1993/1994, it has been possible to identify a downward trend in the airborne PM pollution in the new *Länder* regions, whereby pollution is calculated using annual average PM_{10} concentrations. Marked differences in the levels of PM_{10} pollution between the old and new *Länder* were not present, as was the case for SO_2. The trends show that PM_{10} concentrations in the old *Länder* since the late 1980s and early 1990s have tended towards low values of around 50 µg/m³. At the end of the 1980s, PM_{10} concentrations in Thuringia, Saxony, Saxony-Anhalt could still be shown to be over 100 µg/m³ (annual mean), whereas in 1998 the levels in the same areas were between 25 and 50 µg/m³ in only a few locations. Across Germany as whole, the current wide-scale annual mean PM_{10} levels are between 25 und 35 µg/m³. In 2003, the annual mean levels that approached 50 µg/m³ were seen predominantly at measuring stations affected by traffic.

The Ordinance on Immissions Values for Airborne Pollutants (22nd BImSchV) specifies a limit value for annual mean PM_{10} of 40 µg/m³, which must be complied with by 2005. This limit value is currently not complied with in all parts of Germany. As a result of the drastic reductions in TSP and fine PM emissions in Germany in the last decade, it is to be expected that concentrations of airborne PM will only be reduced gradually in future. This is because the contribution of long-distance transport and natural emissions will be increasingly significant. Further measures for the reduction of PM_{10} emissions will therefore be required.

Fig. V 1.3-2: *Daily average values of particle concentrations from 27.02.2003*



> 0 - 10 µg/m³
> 10 - 20 µg/m³
> 20 - 30 µg/m³
> 30 - 40 µg/m³
> 40 - 50 µg/m³
> 50 - 60 µg/m³
> 60 - 70 µg/m³
> 70 - 80 µg/m³
> 80 - 90 µg/m³
> 90 - 100 µg/m³
> 100 µg/m³
No data available

The maps and data compiled by the Federal Environment Agency relating to the current immissions situation are intended as guideline information for the general public.

Source: *German Länder, Federal Environment Agency 2004*

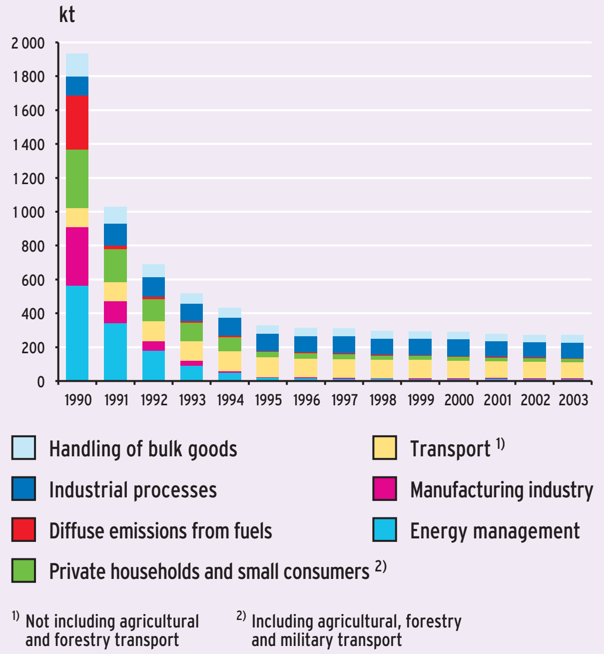
In order to comply with the 22nd Ordinance (22nd BImSchV), from 2005 onwards daily mean PM_{10} concentrations may exceed the short-term limit value of 50 µg/m³ only on 35 days in one calendar year. Particularly in dry winters, but also in hot summers, there are still days when high PM_{10} concentrations occur across the whole of Germany. On such days, the value of 50 µg/m³ may be exceeded almost everywhere in Germany. Figure V 1.3-2 shows an example of this type of pollution situation. On the day illustrated, PM_{10} levels of 120 µg/m³ or greater were measured at 65 stations. The highest values (around 180 µg/m³) were measured at roads carrying heavy traffic. Values under 50 µg/m³ were almost exclusively detected at sites at altitudes of 1 000 m a.s.l.

The height of the PM_{10} pollution level during such periods is mainly dependent on the meteorological conditions. The deciding factors are the speed at which fine PM is distributed in the air, and how quickly it dissipates. Similar to the situation in the past with winter smog, high-pressure, low-wind weather patterns in winter create conditions in which pollutants are not transported away, but rather collect in the lower layers of the atmosphere (up to about 1 000 m) in a bell-shaped formation. A significant improvement in the level of air pollution occurs when the weather conditions change and stronger winds can dilute the polluted air mass. This results in a considerable decrease in PM_{10} values.

Trends in suspended particulate matter [SPM] emissions

From 1990 to 2002, an overall reduction in SPM emissions from over 1.6 Mt to only 0.3 Mt has been seen (Fig. V 1.3-3). This reduction was possible to a large extent due to the change in emissions in the new *Länder*. As part of this change, numerous aging combustion plants and other industrial facilities have been decommissioned, and the efficiency of existing dust extraction facilities in power stations and district heating stations has been considerably improved in a short time. The conversion from solid

Fig. V 1.3-3: *Dust emissions in Germany by source group*



Source: *Federal Environment Agency 2005*

fuels to low-emission liquid and gaseous fuels, especially in smaller furnaces, has also had an effect.

The data does not currently include emissions from the transportation sector that are not produced as a result of combustion processes. The current state of knowledge suggests that emissions caused as a result of abrasive processes are certainly not insignificant (sources include: tyres, which contribute approximately 70 kt per year; road surfaces, which contain a substantial proportion of fine PM; and brake linings, which produce fine PM almost exclusively). As such, the low overall levels already achieved will be considerably affected in terms of the proportional results when this data is included.

Pollutants

Within the sectors already considered, all combustion processes and other sources of emissions are considered to be emissions-relevant. The other sources of emissions are predominantly attributable to the iron and steel industries, stone and earth processing sectors, and the handling of solid bulk goods.

If the handling of bulk goods is not considered, then the main producers after the transportation sector – with 43 % – are industrial processes – with 40 %. Since the mid 1990s, combustion processes have only contributed about half of overall emissions.

V 1.4 Ground level ozone and photochemical smog ('summer smog')

The lower levels of the atmosphere, up to 10 km altitude (e.g., troposphere), contain a base level of naturally occurring ozone. Additional ozone forms under intensive sunlight, i.e. solar irradiation, as a result of complex photochemical reactions between oxygen and pollutants in the air – particularly volatile organic compounds (VOC) and nitrogen oxides (NO_x), but carbon monoxide (CO) and methane (CH_4), too. These airborne pollutants as ozone precursor substances mainly originate as a result of human activity. Ozone is not produced and not emitted directly, and is, therefore, referred to as a secondary pollutant.

Photochemical smog (also known as 'summer smog') is a mixture of pollutants in the atmosphere that is created from a number of precursor substances under the influence of sunlight. Ozone is the primary substance in summer smog, as it dominates photochemical smog in terms of pollutant concentration and its effects..

The values for ozone in ambient air, specified in Directive 2002/3/EC of the European Parliament and of the Council have been adopted in German law as part of the Ordinance on the reduction of summer smog, acidification, and inputs of nutrients (33rd BImSchV). The 33rd BImSchV includes target values, long-term goals, and threshold values for ground level ozone.

Target values for the protection of human health and vegetation:

120 µg/m^3 over 8 hours may only be exceeded on 25 days in one calendar year, averaged over 3 years.

Long-term objective for the protection of health:
120 µg/m^3 should be the highest 8-hour mean value in any calendar year, and never exceeded.

Target value for the protection of vegetation:
18 000 µg/m^3 per hour, averaged over 5 years (AOT40, calculated as 1-hour values from May to July).

Long-term goal for the protection of vegetation:
6 000 µg/m^3 per hour (AOT40, calculated as 1-hour values from May to July).

Alert threshold value for the protection of health:
240 µg/m^3 1-hour average value measured over 3 successive 1-hour periods.

Information threshold value for the protection of health:
180 µg/m^3 1-hour average value.

Because the emissions do not come directly from man-made equipment, pollutant emission levels do not exist for ozone in the same way like for sulphur dioxide, particulate matter, and nitrogen dioxide e.g., in the "*TI Air*" Technical Instructions on Air Quality Control.

In 2003, in Germany, 340 monitoring stations operated by the government and the individual *Länder* were used to monitor concentrations of ground level ozone (Fig. V 1.4-1 and Fig. V 1.4-2).

Annual average values

Annual average values for ozone concentrations (Fig. V 1.4-3) play a minor role in the evaluation of the of summer smog levels. They can however still be useful in assessing the immission situation. The annual mean values are of more importance when it comes to discussions on long-term ozone pollution trends, insofar as ozone measurement values already go as far back as the turn of the last century. The following average values are included in the records:

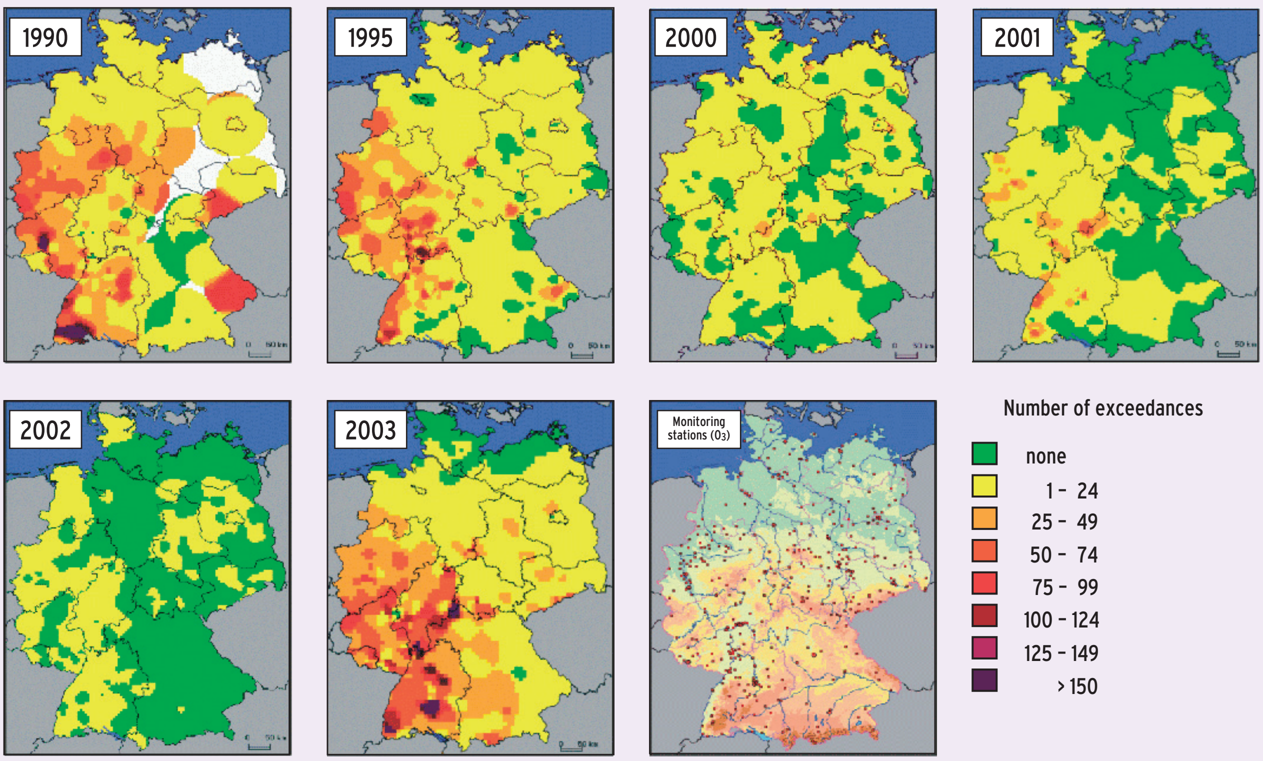
At Montsouris (near Paris), approximately 20 µg/m^3 (ca. 1875–1900), according to the Encyclopaedia of Technical Chemistry (ca. 1915–1920), for valley locations approximately 40 µg/m^3, and for higher altitude locations approximately 95 µg/m^3.

This historical data is only comparable with the ozone concentrations measured today to a certain extent, due to modified measuring techniques, the locations of the monitoring stations, and the conditions under which samples were taken. The annual average ozone concentrations from 1984 to 2003 show an upward trend (Fig. V 1.4-4). It is highly probable that this can be attributed to the growing contribution from background levels in the northern hemisphere, as well as to the reduction of NO_x emissions in Germany (the main source of NO_x pollution is nitrogen monoxide (NO) generated by road traffic). A further reduction in NO emissions (from use of catalytic converters in automotive exhaust equipment) can lead to an increase in ozone levels close to heavily used roads, since ozone is normally absorbed by the so-called titration reaction with NO to form NO_2.

Exceedance of threshold values

The frequency with which threshold values are exceeded is a parameter that is regularly discussed in the ozone data debate. The data relating to absolute exceedance (e.g., hours during which values are exceeded) is dependent on both the number of moni-

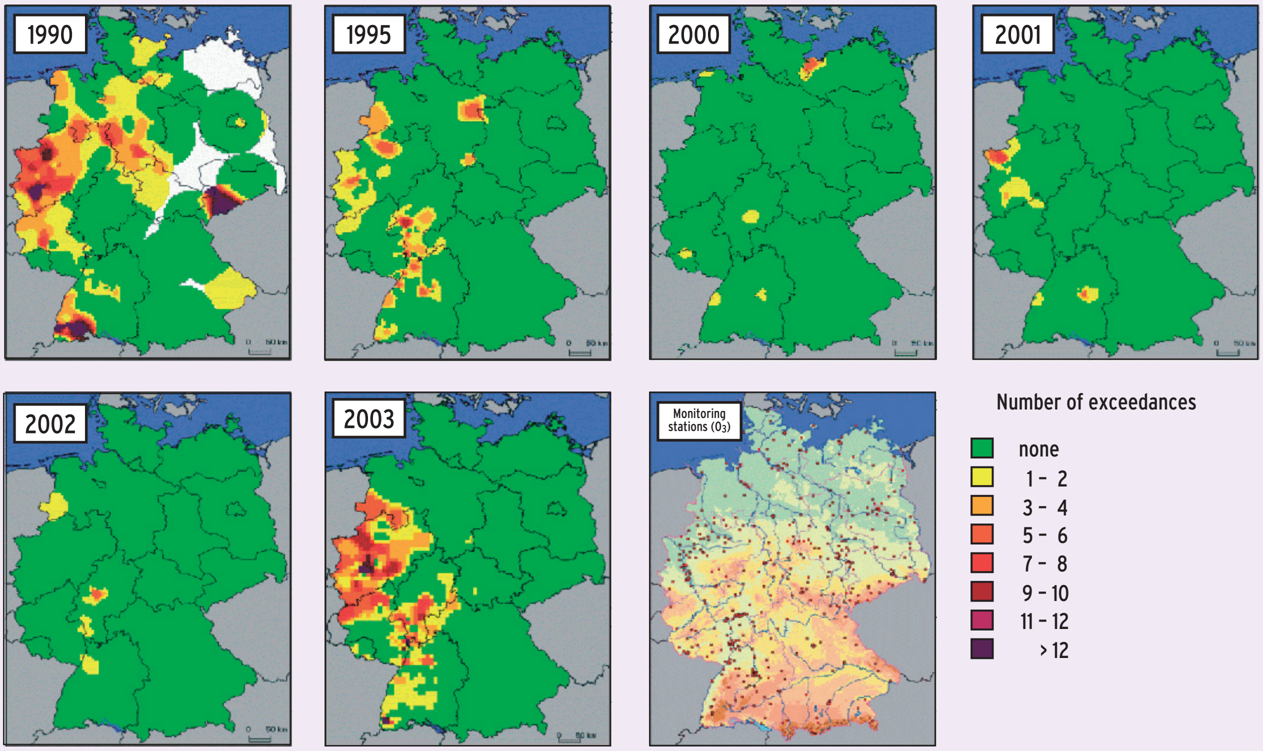
Fig. V 1.4-1: *Exceedance of ozone levels of 180 µg/m^3*



Data: Monitoring networks operated by the German *Länder* and the Federal Environment Agency
A small-scale interpretation is not feasible because of the interpolation method used

Source: *German Länder, Federal Environment Agency 2004*

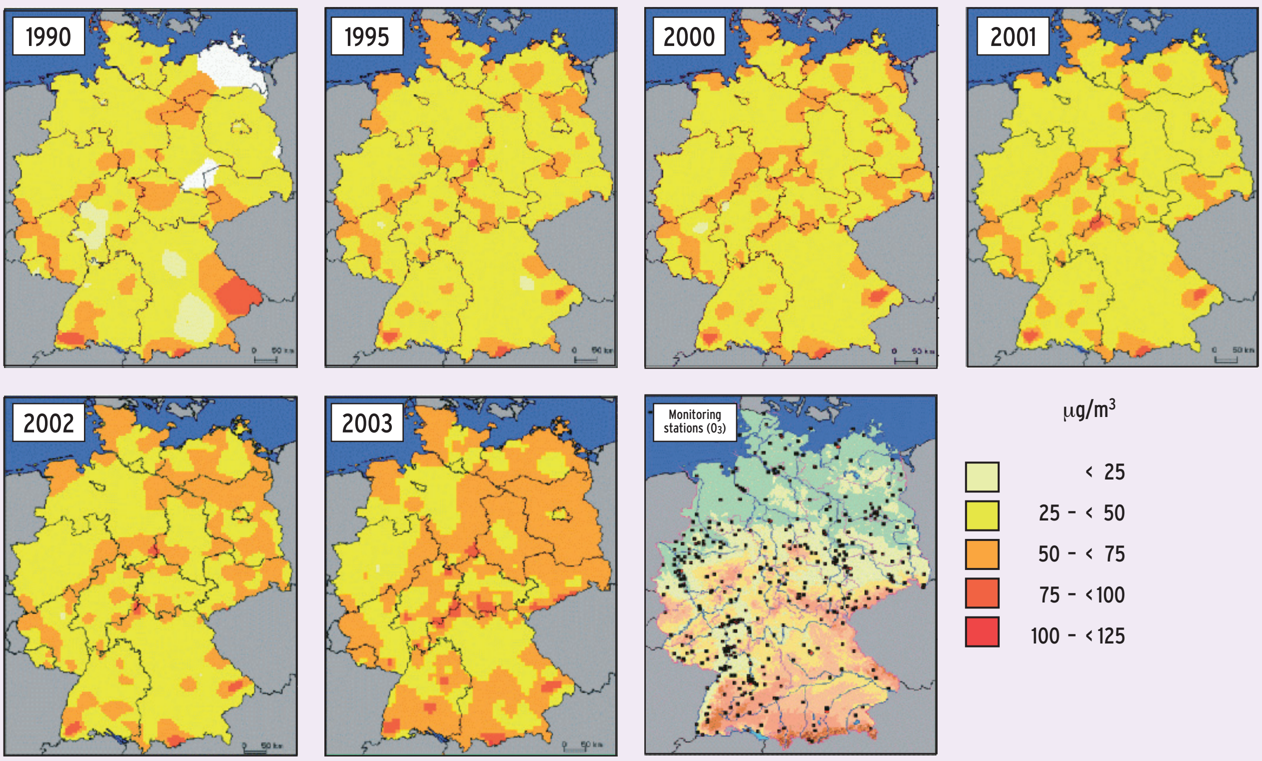
Fig. V 1.4-2: *Exceedance of ozone levels of 240 µg/m³*



Data: Monitoring networks operated by the German *Länder* and the Federal Environment Agency
A small-scale interpretation is not feasible because of the interpolation method used

Source: *German Länder, Federal Environment Agency 2004*

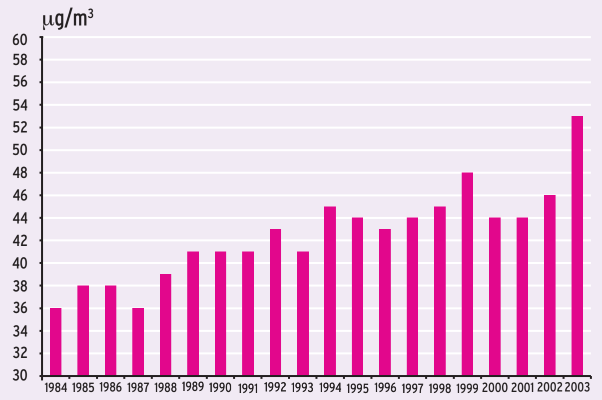
Fig. V 1.4-3: *Annual mean ozone levels*



Data: Monitoring networks operated by the German *Länder* and the Federal Environment Agency
A small-scale interpretation is not feasible because of the interpolation method used

Source: *German Länder, Federal Environment Agency 2004*

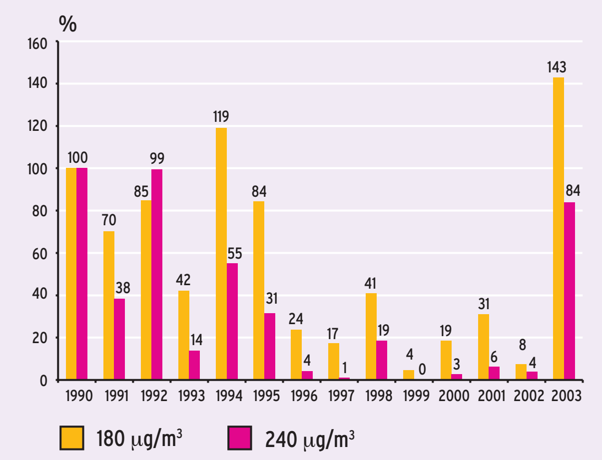
Fig. V 1.4-4: *Annual average values for ozone concentration averaged across all measuring stations*



Source: *Federal Environment Agency 2004*

toring stations installed and the number of periods of increased ozone concentration. It is also dependent on the type and location of the monitoring stations (i.e., proximity to traffic, large town site, rural site, mountainous site). For example, in recent years a number of monitoring stations have been installed at rural sites, and the ozone measurements from these have a significant influence on the overall nature and structure of the nationwide ozone database (Fig. V 1.4-5).

Fig. V 1.4-5: *Exceedance hours (relative to 1990 and to the number of measuring stations in operation each case)*



Source: *Federal Environment Agency 2004*

If average values for the number of hours during which ozone levels of 180 and 240 µg/m³ were exceeded are normalised for the measuring stations in operation in 1990, then it can be seen that the incidence of values over 180 and 240 µg/m³ fluctuated from year-to-year between 1990 and 2003. It is very difficult to identify any particular trend in this representation of the data due the similarly fluctuating meteorological conditions each year. In the summer of 2003, the conditions for the formation and accumulation of ozone (and ozone precursor substances) were very favourable over a sustained period (two weeks), with the result that a high base level of ozone was able to accumulate, with peaks in excess of the threshold values. This type of unusual weather situation was only observed for the first time in 2003, so the "ozone summer" of 2003 is regarded with particular significance in this context. Compared to 1990 levels, emissions of ozone precursor substances (nitrogen oxides and volatile organic substances) have been reduced by between 42 % and 50 % to date in Germany. If the same quantity of ozone precursor substances had been released to the atmosphere in 2003 as were in 1997, even higher levels of ozone pollution would have occurred, with 10 % more incidences of exceedance.

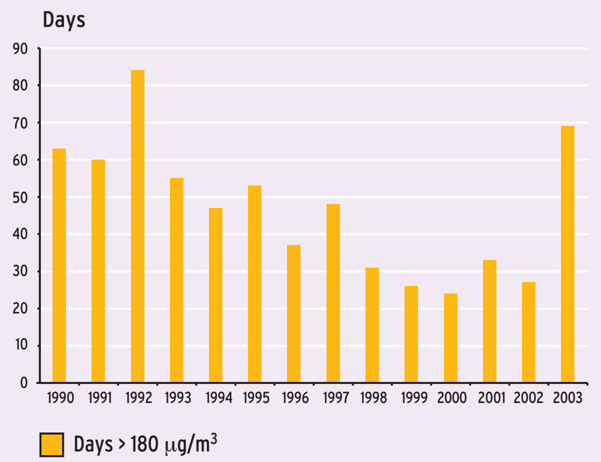
Summer smog (photochemical smog)

The following are prerequisite conditions for the occurrence of summer smog: presence of both precursor substances, NO_x and NMVOC; intense solar radiation; a continuous and a stable period of dry, sunny weather over several days, leading to accumulation of ozone within the troposphere.

The altitude and frequency of periods of summer smog is largely dependent on the characteristics of a particular summer. Periods of summer smog are defined as occurring when ozone levels exceed the information threshold value of 180 µg/m³ for at least two days over a wide area. Figure V 1.4-6 and Figure V 1.4-7 show the number of hours in which levels exceeded 180 µg/m³ and 240 µg/m³,respectively, with values averaged across all relevant monitoring stations.

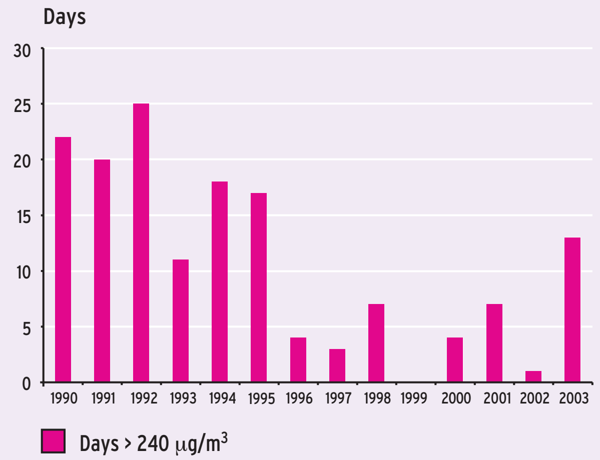
During the longest lasting incident of high ozone levels since 1990 (from 1st to 14th August 2003), the

Fig. V 1.4-6: *Number of days when the 180 µg/m³ level was exceeded*



Source: *Federal Environment Agency 2004*

Fig. V 1.4-7: *Number of days when the 240 μg/m³ level was exceeded*



Source: *Federal Environment Agency 2004*

meteorological conditions were favourable to the formation and accumulation of ozone (and ozone precursors) for a very long period. By way of illustration, the maps shown in Figure V 1.4-8 give the daily maximum ozone concentrations at the peak of the occurrence between 5th and 13th August 2003.

Trends in traffic-specific emissions of ozone precursor substances

The 33rd Ordinance (BImSchV) defines controls on the emissions of ozone precursor substances, which must be reduced to the national maximum emissions limits by 2010 (NO_x to 1 051 kt and VOC to 995 kt).

Motor vehicle traffic is a major source of ozone precursor substance emissions. In addition to this, emissions of volatile organic compounds are largely attributable to nitrogen oxides from the power generation sector and from the use of paints and solvents. There are also some emissions from natural sources.

In view of the considerable reductions in emissions of ozone precursors since 1990 (Fig. V 1.4-9) and the emissions reduction targets for 2010 across Germany and Europe, it is of particular interest to know how ozone concentrations have changed in response to the reductions, and when it can be expected that the ozone emissions levels specified in the 33rd BImSchV will be complied with. Investigations have shown that peak ozone concentrations in Germany between 1990 and 2002 have decreased significantly. This decrease is mainly attributable to the considerable reductions in precursors, and not to the effects of meteorological conditions. Peak ozone levels will decrease further in coming years, albeit not to the same degree as in the period 1990 to 2002. In contrast to the pleasing trends and prognosis with regard to peak ozone levels, the average ozone concentrations in Germany are not set to decrease significantly in the next decade. This means that the new target values for the protection of vegetation are unlikely to be met in this period.

The following measures should be introduced in order to achieve further reductions in pollutant emissions:

- Enforcement of three-way catalytic converter regulations for existing cars with petrol engines
- Continued tightening of permissible automotive exhaust limit values
- Diesel particle filters
- Further development of environmentally-friendly alternative propulsion technologies
- Training for motorists in driving techniques that use less fuel and reduce emissions
- Measures to increase occupancy and load levels (freight exchanges, car sharing, etc.)
- Measures to reduce traffic levels and transfer road traffic to less environmentally damaging forms of transport (changing the 'modal split').

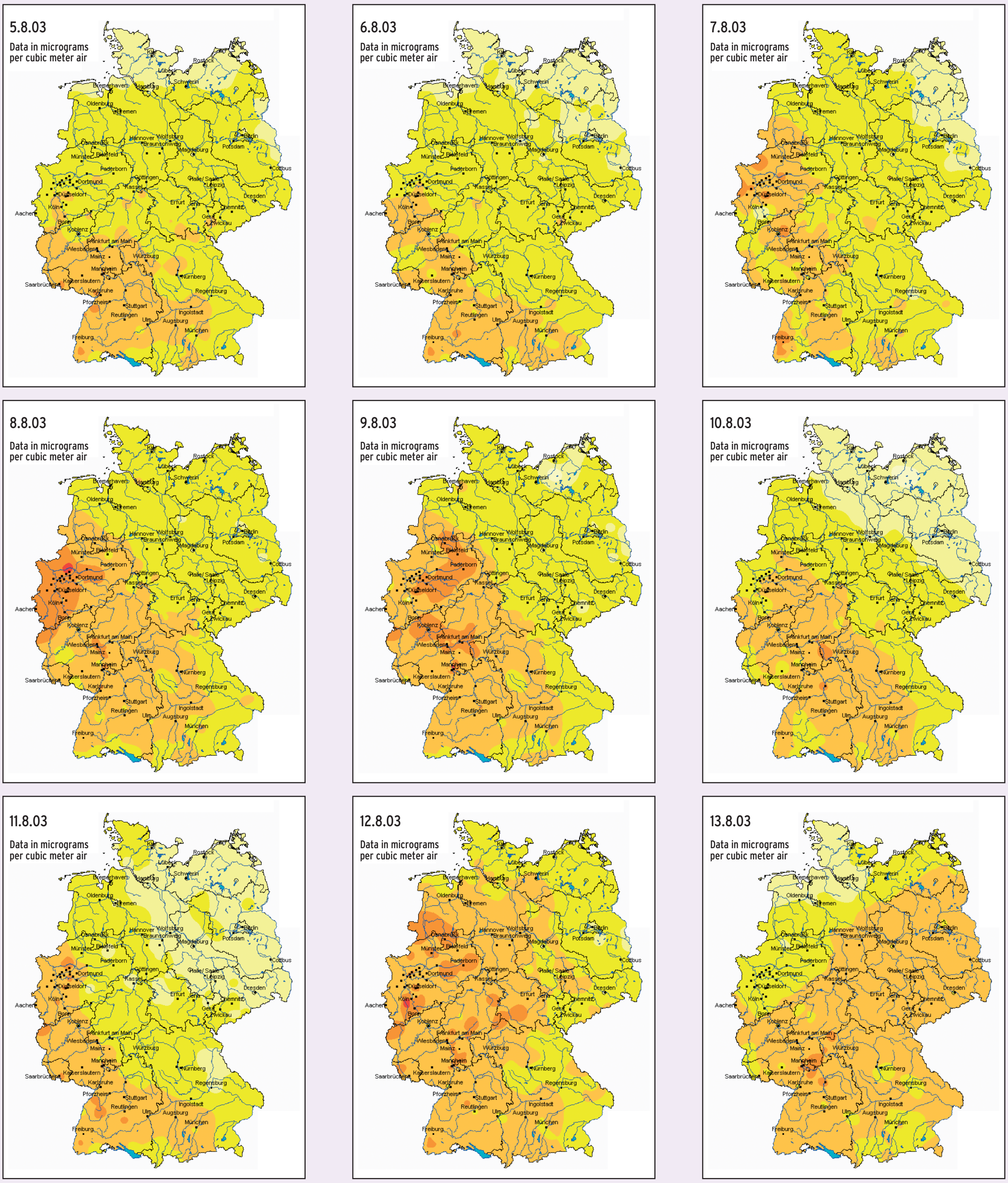
V 1.5 Pollution in urban agglomerations

The Ruhr area was, for a long time, one of the worst affected parts of the old Federal Territory in terms of air pollution. The trends in SO_2 pollution seen here represent one of the main components in the evaluation of air pollution. In the mid-1960s in Gelsenkirchen, the annual mean sulphur dioxide levels were measured at between 180 and 270 μg/m³. Since then, SO_2 concentrations have continuously decreased, with levels in the mid-1980s falling below 100 μg/m³. Further reductions were seen up to 2002, with levels falling to 8 μg/m³ as a result of emission reduction measures undertaken at power stations and industrial plants.

The situation in Leipzig is representative of the trends seen for urban agglomerations in the new *Länder*. The annual mean SO_2 concentrations measured in the 1980s were about 200 μg/m³, but between 1984 and 1987, when the winters were very severe, concentrations in some places exceeded 300 μg/m³. In the years following 1988 that experienced mild winters, mean values of up to 200 μg/m³ were achieved. Marked reductions related to emissions have been seen since 1990. At the same monitoring stations in 2002, annual mean SO_2 immission concentrations of 4 μg/m³ were achieved (Fig. V 1.5-1).

Following these reductions in SO_2 pollution, achieved primarily through the successful introduction of

Fig. V 1.4-8: *Maximum hourly average values for ozone concentrations from 5th to 13th August 2003*



- > 0 – 60 µg/m³
- > 60 – 120 µg/m³
- > 120 – 180 µg/m³
- > 180 – 240 µg/m³
- > 240 – 300 µg/m³
- > 300 – 360 µg/m³
- > 360 µg/m³
- No data available

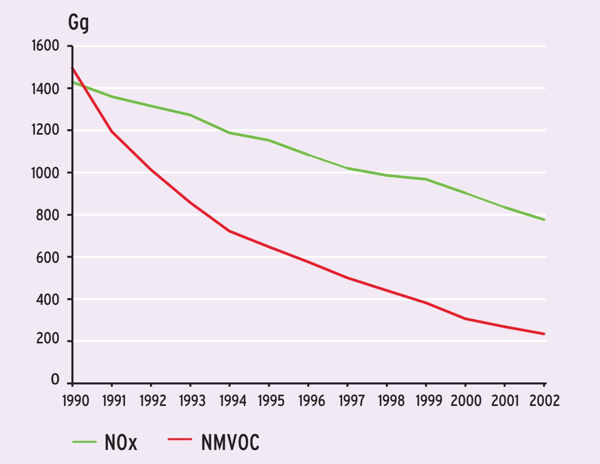
The data and maps prepared by the Federal Environment Agency relating to the current immissions situation are intended to provide reference information for the general population. Because observations are made over wide areas, a small-scale interpretation is not feasible.

Produced by the Federal Environment Agency using data from the monitoring networks operated by individual German *Länder* and the federal government.

Source: *German Länder, Federal Environment Agency 2004*

emission reduction measures in the electricity generation sector and at industrial plants, air pollution has started to become an issue of increasing concern, mainly due to emissions from the transportation sector. Diesel soot and benzene are the most important factors to consider here, because they have properties that present a risk to health. The trend in frequent years has, in many cases, been towards a reduction in benzene pollution. During the 1990s, annual mean benzene levels above 5 µg/m³ were still being recorded at roughly 20 % to 30 % of monitoring stations, however, since 2000, these lev-

Fig. V 1.4-9: *Transport related emissions*



Source: *Federal Environment Agency 2004*

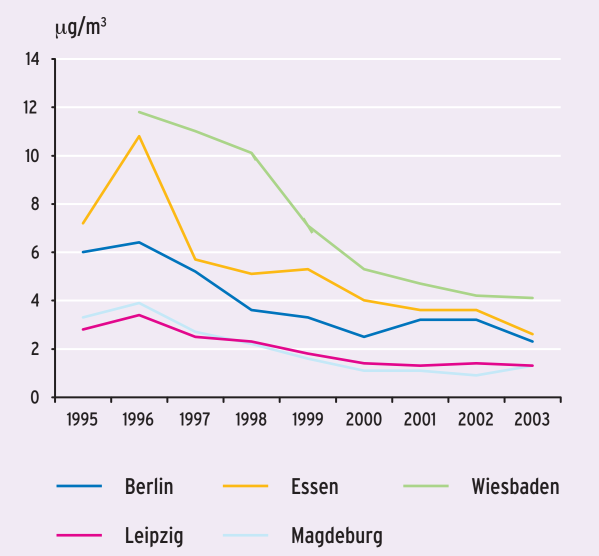
els have only been seen at less than 10 % of measuring stations. A decline in the maximum average values measured anywhere in Germany can also be seen. Between 1995 and 1998, the places in Germany that were most seriously affected by benzene pollution had annual mean values as high as 15 µg/m³, whereas current maximum annual mean levels are approximately 8.5 to 9 µg/m³. Currently, the annual benzene levels at around 90 % to 95 % of all measuring locations lie between 0.5 and 5 µg/m³, with levels in rural areas only reaching 0.5 µg/m³. The highest levels of benzene pollution occur in areas close to heavily used roads, particularly in street canyon environments. The annual average benzene levels for the period 1995 to 2002 for five agglomeration areas/ towns are summarised in Figure V 1.5-2. Benzene pollution levels fluctuate between 1 µg/m³ and almost 12 µg/m³.

The EC Directive 2000/69/EC on benzene and carbon monoxide limit values, which is implemented in German law through the 22nd Federal Immission Control Ordinance specifies a threshold value for annual mean benzene pollution levels of 5 µg/m³, which must be complied with by 2010. This value is currently exceeded in some areas.

In addition to benzene, airborne particle pollution plays a significant role in urban agglomerations and cities.

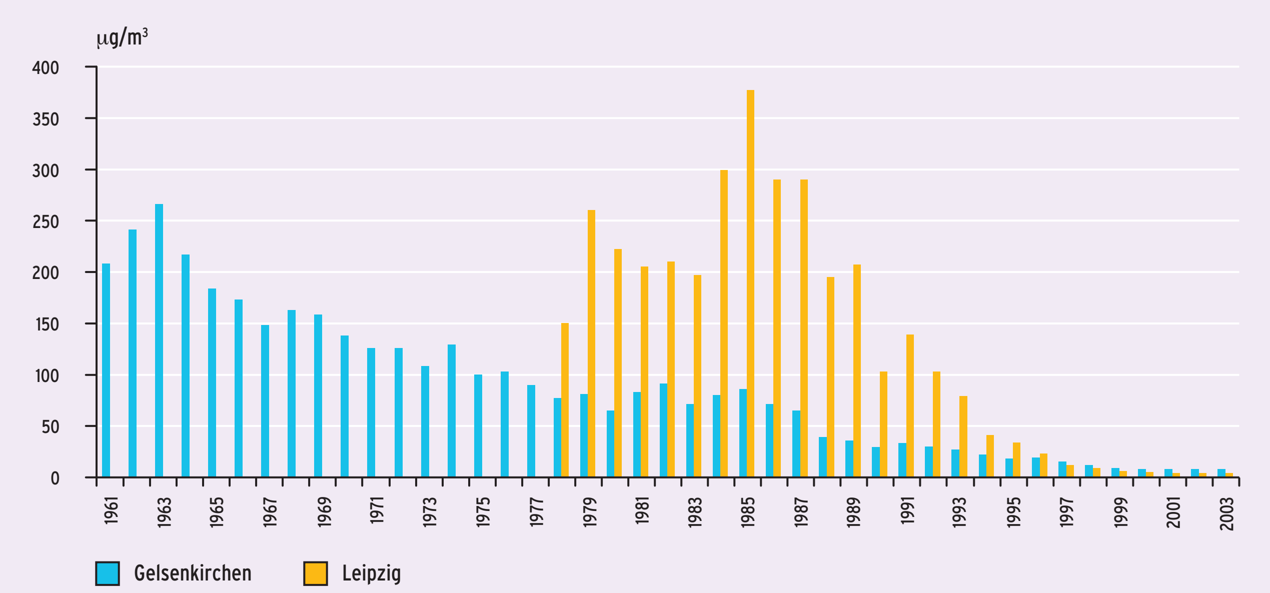
Since mid-1997, the UBA has been carrying out measurements for the PM_{10} and $PM_{2.5}$ components of dispersed particulate matter and soot ("environ-

Fig. V 1.5-2: *Benzene concentrations at selected measuring stations in urban agglomerations/cities*



Source: *Federal Environment Agency 2004*

Fig. V 1.5-1: *Comparison of annual mean SO_2 levels, Gelsenkirchen – Leipzig*



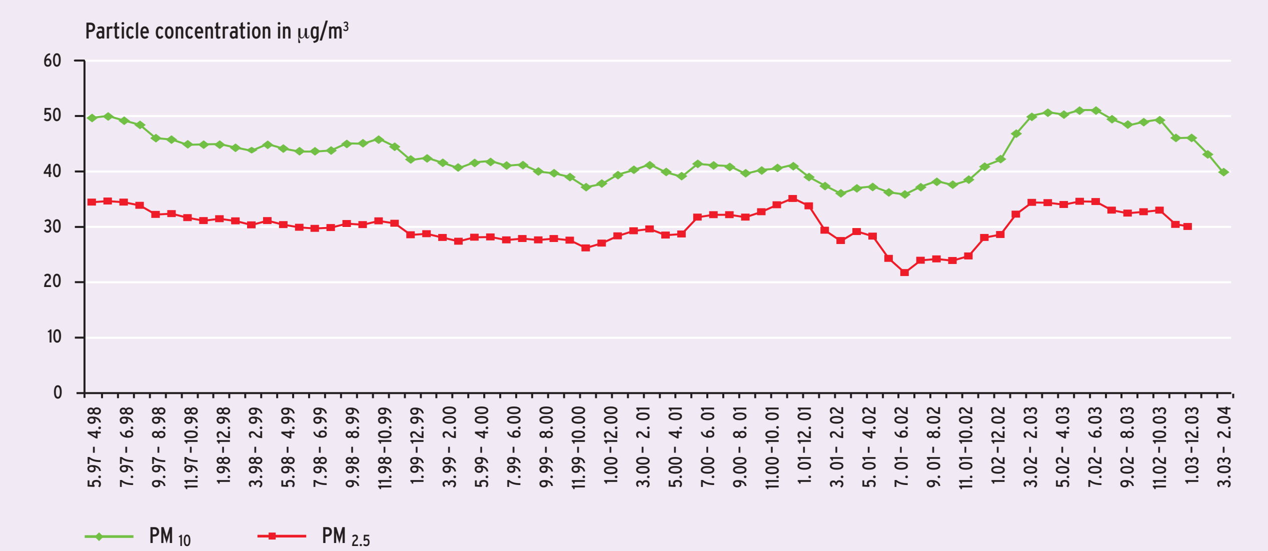
Source: *Federal Environment Agency 2004 a* mental carbon", EC) concentrations at a monitoring station in Berlin, which is located in a heavily built-up part of the city in the immediate vicinity of the urban motorway.

This monitoring station is located at one of the most heavily polluted sites in Germany, due to the high levels of emissions from traffic, including (diesel) soot, tyre particles, and dust raised up by vehicles, as well as emissions from the city, including particulate matter produced by domestic heating & furnace systems, small businesses, and industrial plants.

The suspended particles concentrations show a gradual decrease between May 1997 and December 2002, as illustrated by the example in Figure V 1.5-3, which shows the moving-average annual mean PM_{10} and $PM_{2.5}$ levels at the Berlin urban motorway. The increase in 2003 can be attributed to the periods of increased PM_{10} pollution seen across the whole of Germany. The curve can be seen to decrease again at the start of 2004 to the concentration levels recorded prior to the 2003 increase.

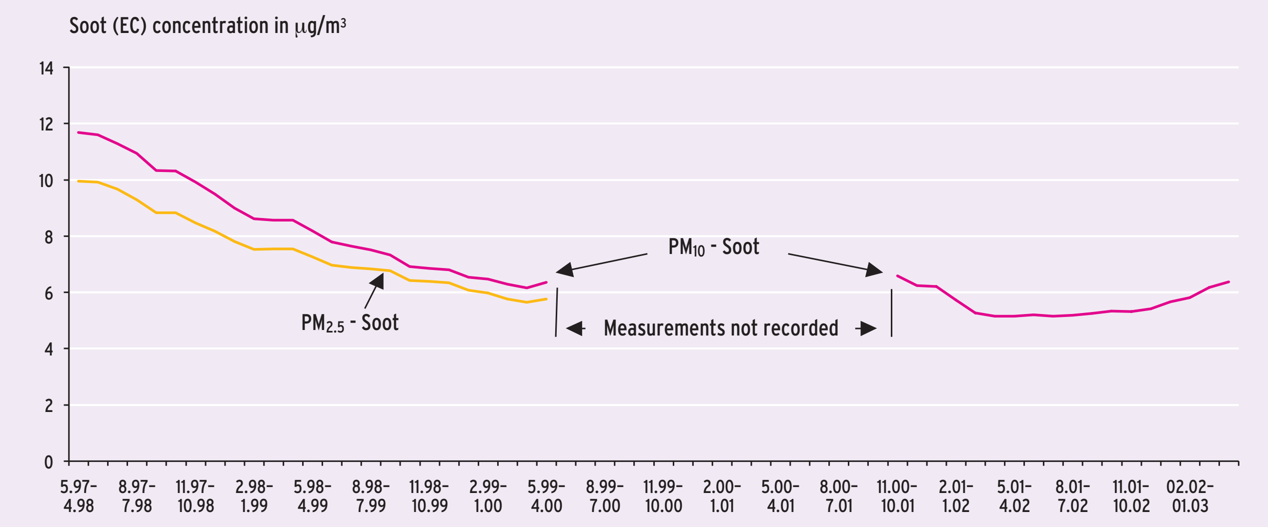
With the exception of the periods of high PM_{10} concentrations during 2003, it can be seen from Figure V 1.5-4, that, during the measurement period, reductions in mean EC (diesel soot) concentrations were achieved at these monitoring locations (around 6 µg/m³ for PM_{10} and 4 µg/m³ for $PM_{2.5}$) while traffic volume density remained constant. This reduction in soot concentrations also corresponds to the reduction in concentrations of PM_{10}

Fig. V 1.5-3: *Moving-average annual mean PM_{10} and $PM_{2.5}$ levels at the urban motorway measuring station, Berlin*



Source: *Federal Environment Agency 2004*

Fig. V 1.5-4: *Moving-average annual mean soot (EC) concentrations at a traffic monitoring station, Berlin*



Source: *Federal Environment Agency 2004*

and $PM_{2.5}$ in the same period. Both figures show that the difference in concentrations between PM_{10} soot and $PM_{2.5}$ soot has been significantly reduced during the measurement period.

It can be deduced from the pattern of the curves that modern diesel vehicles produce less soot, measured in grams of soot emitted per kilometre, than they did in the past. The reduction in the differences between PM_{10} soot and $PM_{2.5}$ soot levels suggests the further conclusion that modern HDV (high-duty vehicle) engines do not produce such a high proportion of coarse soot particles (larger than 2.5 μm) as previously.

V 2 Expenditure by manufacturing industries, the State, and privatised public sector companies on environmental protection measures related to air quality management

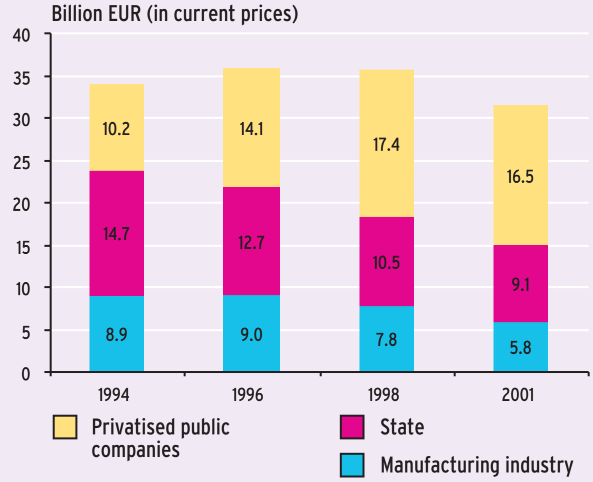
"Expenditure on environmental protection" describes investments in environmentally friendly facilities and ongoing expenditure for the operation of these (Fig. V 2-1). Due to statistical limitations on the acquisition of data, the items of expenditure described below should be considered as lower limits for the overall financial expenditure on environmental protection. The absence of data relating to parts of the service sector and integrated environmental protection investments by manufacturing industries should be noted in particular.

Investments in environmental protection take into account the value of long-lasting, reproducible resources that are procured by domestic business entities with the aim of protecting the environment. This includes both equipment (e.g., machines and mechanical installations, vehicles) and structures (e.g., buildings, sewage facilities, waste disposal).

Ongoing expenditure on environmental protection by manufacturing industries includes personnel costs (including maintenance and repair), spare parts, and the cost of raw materials, operating materials, and auxiliary supplies. State expenditure includes personnel costs (gross wages/salaries, effective social security contributions) and functional expenditure (commercial requirements, fuel, rent, etc.).

As time progresses, the ongoing expenditure gains in significance in comparison to initial investments in environmental protection (Table V 2-1). The reason for this is the significant number of environmental protection facilities that have already been installed, primarily in the last two decades.

Fig. V 2-1: *Trends in expenditure on environmental protection[1)]*



1) Excludes data for integrated environmental protection

Source: *Federal Statistical Office 2004*

In 2002, the combined expenditure on environmental protection by commercial enterprises, the state, and privatised public companies totalled around €31.4 billion (current prices). This amount corresponds to approximately 1.5 % of gross domestic product. The expenditure was distributed as follows: manufacturing industries, €5.8 billion; public funds (state), €9.1 billion; privatised public companies, €16.5 billion.

Around €2.3 billion, or 7 %, of the overall expenditure on environmental protection was spent on air quality management. Investments in 2001 constituted approximately one-third of this expenditure (Fig. V 2-2).

V 3 Overview of pollutant-specific emissions

The calculation of emissions is carried out mainly on the basis of the energy balance that is published each year. Statistical data, and any additional detailed data from individual associations that is necessary, are used in addition to the emissions calculation.

This data makes it possible to calculate the energy used by individual categories of emission sources according to the type of fuel burnt. It is possible to draw conclusions about emissions in relation the sectors that cause them by linking them with emissions factors for the energy consumed and other processes that produce emissions – this can be carried out according to the required boundary conditions. The IPCC structure [1], for example, is used for greenhouse gases.

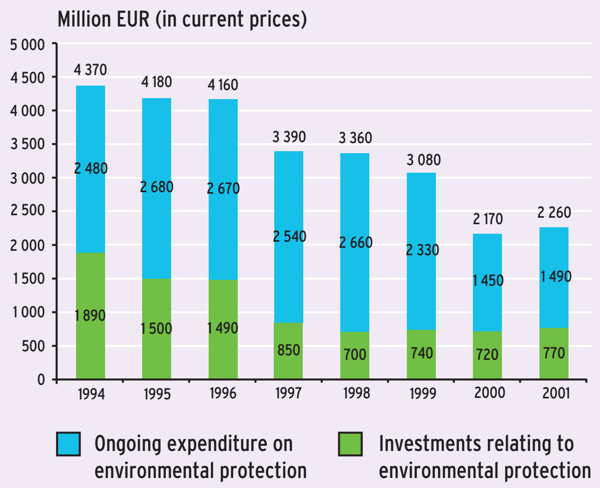
Tab. V 2-1: *Expenditure on environmental protection in millions of EUR (in current prices)*

Category	1994	1996	1998	2000[*)]	2001[*)]
Total expenditure on environmental protection	33 870	35 770	35 640	31 400	31 380
Of which:					
Manufacturing industries[1) 2)]	8 910	9 000	7 780	5 760	5 840
State	14 730	12 700	10 460	9 550	9 070
Privatised public companies[4)]	10 230	14 070	17 400	16 080	16 470
Investments relating to environmental protection	15 180	12 780	12 050	9 360	8 670
Of which:					
Manufacturing industries[1)]	3 030	2 550	1 630	1 560	1 580
State	6 840	4 970	3 740	3 010	2 630
Privatised public companies[4)]	5 310	5 260	6 680	4 790	4 470
Ongoing expenditure on environmental protection	18 690	22 990	23 600	22 040	22 710
Of which:					
Manufacturing industries[1) 2) 3)]	5 880	6 460	6 140	4 200	4 270
State	7 890	7 720	6 730	6 540	6 440
Privatised public companies[4)]	4 920	8 810	10 730	11 300	12 000

1) Excludes construction industry and expenditure for integrated environmental protection measures
2) From 2000, excludes ongoing expenditure for energy and water supply
3) Excludes fees and charges for supply of services by third parties
4) Enterprises run outside the scope of public funding, particularly owner-operated municipal enterprises for waste disposal and prevention of water pollution
*) Provisional figures

Source: *Federal Statistical Office 2004*

Fig. V 2-2: *Expenditure on environmental protection for air quality management*



Source: *Federal Statistical Office 2004*

This takes into consideration direct greenhouse gases (CO_2, CH_4, and N_2O) and indirect greenhouse gases (NO_x, NMVOC, and CO), as well as SO_2 and overall dust concentrations.

Trends in emissions since 1990 demonstrate considerable success in the reduction of these pollutants (Tab. V 3-1).

The main reasons for this positive trend are given below; all of these are relevant to the components considered here, to a greater or lesser extent:

- Because of the German Reunification in 1990, the initial levels for emissions were very high due to the emissions contributed by the states in former German Democratic Republic.
- Aging and inefficient industrial facilities in Eastern Germany were decommissioned in subsequent years. These were replaced to by new facilities that, as far as possible, met the most up-to-date requirements.
- In addition to this, and especially in Eastern Germany, facilities were converted to use energy sources associated with lower emissions, such as natural gas and petroleum, instead of the locally available lignite.
- The transportation sector saw the introduction of vehicles equipped with technology aimed at reducing pollution.
- Following the expiration of time-limited intermediate regulations in the years after 1990, the immission control regulations that had applied in the former West Germany also gained full legal applicability in Eastern Germany. In many instances, the applicable law was also changed to conform to further developments in the state-of-the-art.
- Legal regulations and the demands of the market economy also led to more economical use of energy and raw materials.
- International legislation, particularly that of the European Community, has also had an effect in reducing emissions (e.g. the NEC Directive).

[1] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

Tab. V 3-1: *Emissions of selected airborne pollutants by source group*

	1990	1995	2000	2001	2002	2003
Carbon dioxide (CO_2) in Mt[1)]						
Energy management	414	355	344	349	357	363
Processing industries	196	150	136	133	132	129
Transport[2)]	162	177	182	178	176	170
Private households and small consumers[3)]	216	194	173	190	176	180
Industrial processes	26	26	25	24	23	24
All	**1 015**	**902**	**860**	**874**	**864**	**865**
Nitrogen oxide (NOx, calculated as NO2) in kt						
Energy management	603	288	254	258	262	266
Processing industries	355	210	165	156	152	154
Transport[2)]	1 429	1 152	896	828	771	700
Private households and small consumers[3)]	328	252	220	224	216	214
Industrial processes	31	14	12	10	10	12
Agriculture	101	84	88	85	82	82
All	**2 846**	**2 000**	**1 634**	**1 560**	**1 493**	**1 428**
Sulphur dioxide (SO_2) in kt						
Energy management	3 078	1 418	325	329	337	340
Processing industries	994	188	119	119	109	113
Transport[2)]	106	76	21	18	4	2
Private households and small consumers[3)]	923	171	96	105	88	87
Fugitive emissions from fuels	169	27	20	20	20	20
Industrial processes	57	57	54	53	53	55
All	**5 326**	**1 937**	**636**	**643**	**611**	**616**
Carbon monoxide (CO) in kt						
Energy management	179	122	112	115	119	119
Processing industries	828	676	687	640	605	638
Transport[2)]	6 765	3 937	2 434	2 145	1 960	1 756
Private households and small consumers[3)]	2 711	1 210	1 062	1 065	1 020	1 049
Fugitive emissions from fuels	47	11	9	7	7	8
Industrial processes	682	624	608	589	588	584
All	**11 212**	**6 581**	**4 913**	**4 561**	**4 300**	**4 155**
Nitrous oxide (N_2O) in kt						
Energy management	14	12	12	12	12	12
Processing industries	6	4	3	3	3	3
Transport[2)]	10	18	17	16	15	14
Private households and small consumers[3)]	4	2	2	2	2	2
Industrial processes	76	81	18	24	25	33
Solvent and other product usage	6	6	6	6	6	6
Agriculture	156	131	136	132	129	128
Waste	7	7	7	7	7	7
All	**279**	**261**	**201**	**202**	**199**	**205**
Ammonia (NH_3) in kt						
Energy management	4	3	3	3	3	3
Processing industries	3	2	1	1	1	1
Transport[2)]	5	9	9	9	8	7
Private households and small consumers[3)]	4	4	4	4	3	3
Fugitive emissions from fuels	1	0	0	0	0	0
Industrial processes	15	10	10	9	10	10
Solvent and other product usage	1	2	2	2	2	2
Agriculture	704	582	578	588	578	573
All	**736**	**611**	**607**	**616**	**606**	**601**
Dust in kt						
Energy management	565	18	11	11	12	12
Processing industries	343	5	3	3	3	3
Transport[2)]	113	116	106	102	98	95
Private households and small consumers[3)]	347	32	22	22	21	21
Fugitive emissions from fuels	317	7	4	4	4	4
Industrial processes	114	103	99	93	91	92
Handling of bulk goods	136	49	44	44	44	44
All	**1 934**	**329**	**289**	**279**	**273**	**271**
NMVOC in kt						
Energy management	8	9	8	8	8	9
Processing industries	12	8	7	6	6	6
Transport[2)]	1 495	647	304	267	233	199
Private households and small consumers[3)]	182	91	88	88	87	89
Fugitive emissions from fuels	283	110	66	62	57	55
Industrial processes	90	96	118	115	123	124
Solvent and other product usage	1 160	1 050	875	812	750	750
Agriculture	304	237	231	233	229	228
All	**3 534**	**2 248**	**1 697**	**1 592**	**1 494**	**1 460**
Methane (CH_4) in kt						
Energy management	8	6	5	5	6	6
Processing industries	12	6	6	6	5	6
Transport[2)]	64	30	17	15	13	11
Private households and small consumers[3)]	133	38	32	32	31	32
Fugitive emissions from fuels	1 561	1 197	835	722	697	678
Industrial processes	16	16	18	18	17	19
Agriculture	2 891	2 458	2 342	2 361	2 298	2 269
Waste	1 605	1 245	693	617	574	560
All	**6 290**	**4 996**	**3 948**	**3 777**	**3 642**	**3 582**

[1)] Not including land use change and forestry
[2)] Not including agricultural and forestry transport
[3)] Including agricultural, forestry, and military transport

Source: *Federal Environment Agency 2005*

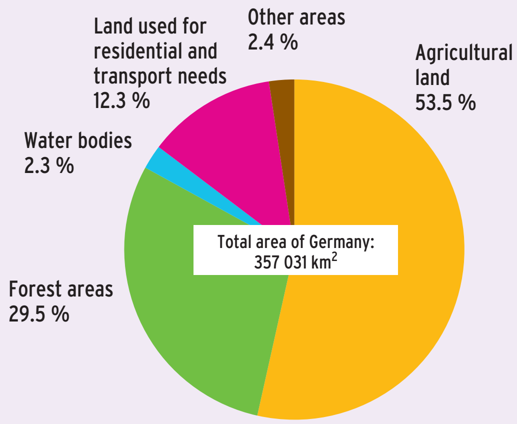
VII SOIL CONSERVATION

VII 1 Land use/residential structure

VII 1.1 Land use structure

The total area of Germany in 2001 (i.e., on 31 December 2000) was 35,703,099 ha, excluding jointly held German-Luxembourgian territory (Fig. VII 1.1-1).

Fig. VII 1.1-1: *Land use 2001*[1)]



1) i.e., on 31 December 2000

Source: *Federal Statistical Office 2003*

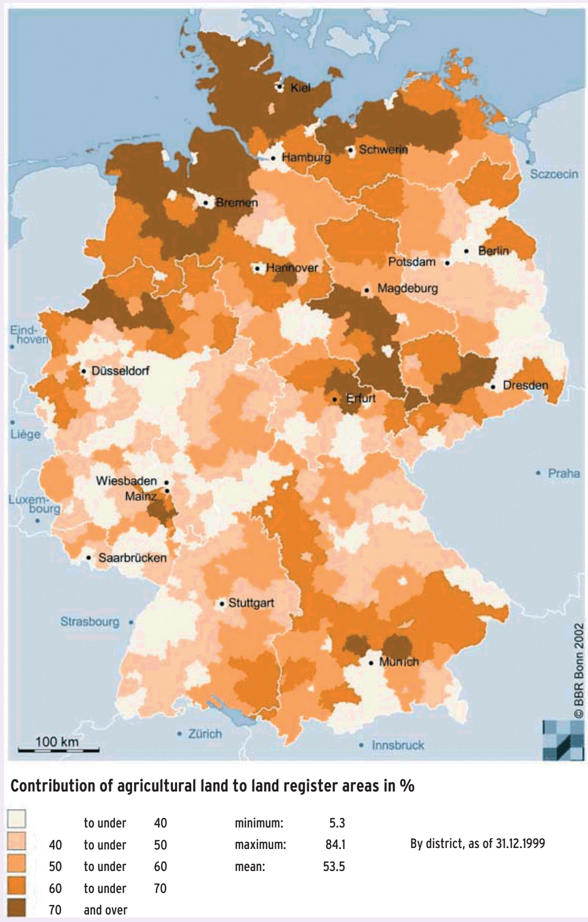
The proportion of agricultural land (including moors and heaths) in Germany in 2001 was 53.5 % (19 102 791 ha), 0.6 % lower than in 1997 (i.e., on 31 December 1996) with 54.1 %; this remains the main land use (see Fig. VII 1.1-2).

There has been a steady reduction in agricultural land use, particularly around large urban population centres, primarily due to continuous growth in land used for residential and transport needs.

Although many animal and plant species depend directly on agricultural management – often forms of extensive pastoral management – intensive forms of agricultural land use can place great burdens on the balance of nature: disrupt valuable habitats, eutrophy waters, and burden soils and groundwater in other ways. Structural changes (the use of large-scale agricultural machinery) to agricultural land also frequently leads to ecologically valuable landscape features being cleared, as hedges, embankments and copses are removed, rivers and streams are straightened, or networks of paths are constructed for agricultural use.

Forest areas covered 29.5 % (10 531 415 ha) of Germany's land in 2001, 0.1 % more than in 1997. In the centres of large population centres and on in-

Fig. VII 1.1-2: *Agricultural areas 2000*



Source: *Federal Statistical Office 2000*

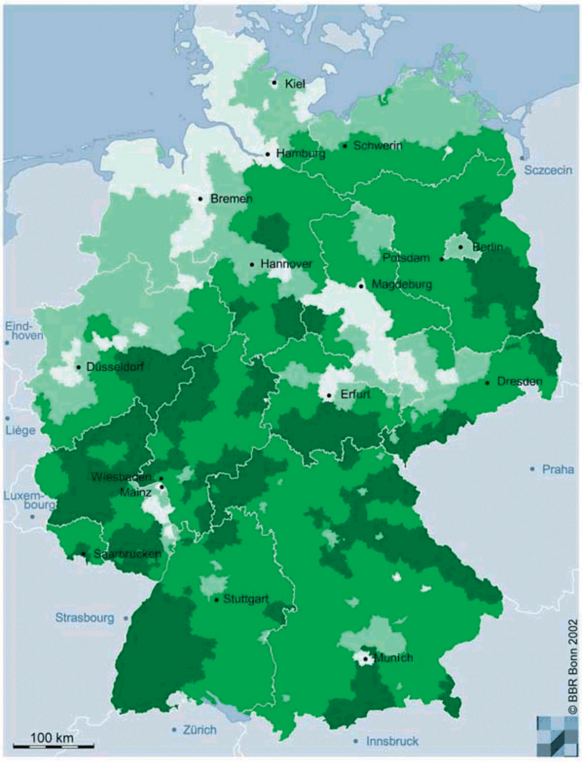
tensively farmed land, forest covers less than 20 % of the total area. Above-average shares of forest land (over 60 %) are found in sparsely settled low and high mountain regions poorly suited to agriculture, for example the Harz, the Thuringian Forest, the Sauerland, the Eiffel, the Black Forest, the Bavarian Forest, and the Alps (Fig. VII 1.1-3).

Besides water bodies, moors, and heaths, forests hold a special ecological value (including renewing groundwater, filtering air, preventing erosion). They are also a principal leisure resource for the population.

Water bodies in Germany cover only 808 462 ha (2.3 %) and make up the smallest share.

The principal reason for the 1.8 % or 14 448 ha increase in water bodies is the mining of raw materials such as gravel, sand, and lignite. The worked areas, upon closing, are then flooded, which gives rise to the formation of new lakes in post-mining landscapes.

Fig. VII 1.1-3: *Forest areas in 2000*



Contribution of wood land to land register areas in %

	to under	10	minimum:	0.8	
10	to under	20	maximum:	64.8	By district, as of 31.12.1999
20	to under	30	mean:	29.5	
30	to under	40			
40	and over				

Source: *Federal Statistical Office 2000*

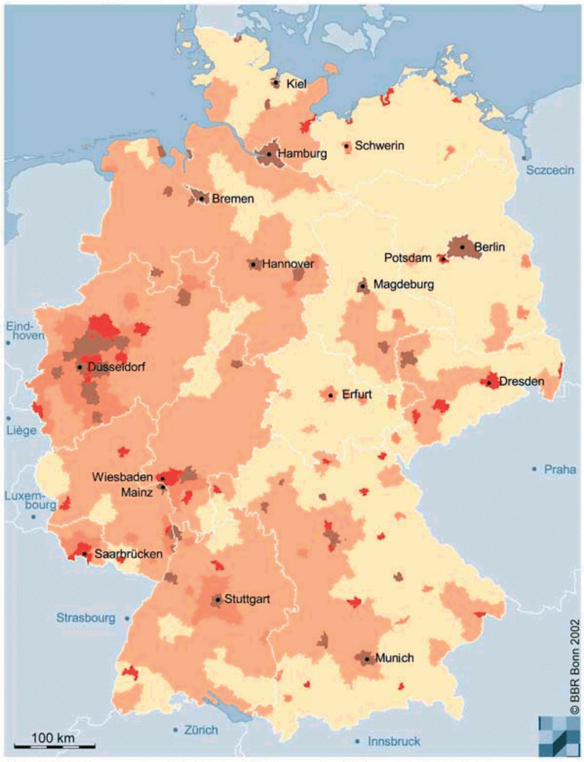
The share of land used for residential and transport needs (SuV) in 2001 (i.e., on 31 December 2000) rose by 0.5 % (4 393 895 ha, 12.3 %) compared to 1997, and is the third largest land use type in Germany. Regional distribution varies widely across the country, exceeding 50 % in the core urban regions of population centres.

Despite a weak economy, the share of land used for residential and transport needs rose by 115 194 ha between 31 December 2000 and 31 December 2003.

In 2003, buildings and their associated plots made up 6.6 %, transport 4.9 %, and recreational land 0.8 % of land used for residential and transport needs in Germany. Only roughly half of this land is actually sealed [1]; amounting to approximately 2.3 million ha or 6.3 % of the country.

The city states (Berlin, Hamburg, and Bremen) aside, North Rhine-Westphalia (with 20 %) and the Saarland (with approx. 19 %) reveal particularly high shares of residential land (Fig. VII 1.1-4). Environmental impacts caused by increasing land consumption for residential and transport needs go beyond the direct loss of agricultural land mentioned earlier; they also include, for example, increased material and energy consumption for new buildings, a continued rise in fuel consumption and emission of pollutants due to increased traffic levels, noise pollution, and the isolation and shrinking of natural habitats for wild flora and fauna.

Fig. VII 1.1-4: *Land used for residential and transport needs in 2000*



Contribution of agricultural land to land register areas in %

	to under	10	minimum:	4.3	
10	to under	20	maximum:	74.6	By district, as of 31.12.1999
20	to under	30	mean:	12.3	
30	to under	40			
40	and over				

Source: *Federal Statistical Office 2000*

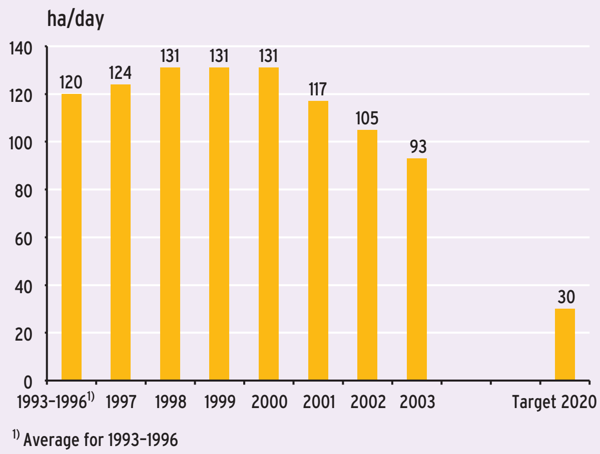
[1] Information on the extent of Residential and Traffic Area (SuV) sealing is not derivable from official land statistics. According to research carried out in 1996 based on national results from the land survey and on studies on sealing carried out in Bavaria and North Rhine-Westphalia, approximately 41 % to 59 % of Germany's SuVs are sealed.

VII 1.2 Daily rise in land used for residential and transport needs

In 2003, the sharp growth in land used for residential and transport needs [1] continued in Germany (93 ha per day) to the considerable detriment of agricultural land (Fig. VII 1.2-1).

According to the partial survey carried out in 2003, additional nation-wide consumption has dropped to the current 93 ha a day for the third consecutive

Fig. VII 1.2-1: *Average daily redesignation of open landscape in land used for residential and transport needs*



Source: *Federal Office for Building and Regional Planning 2003*

time. It had already fallen from 129 ha (1997–2000) to 117 ha by 2001 [1].

The highest increases in land used for residential and transport needs are, as in previous years, in the old *Länder* of Baden-Württemberg, Bavaria, and Lower Saxony. Saxony-Anhalt, Mecklenburg-West Pomerania, and Brandenburg show similar figures. It should be noted that the increases were partly overestimated in the new *Länder* due to statistical amendments regarding recreational space and farmland.

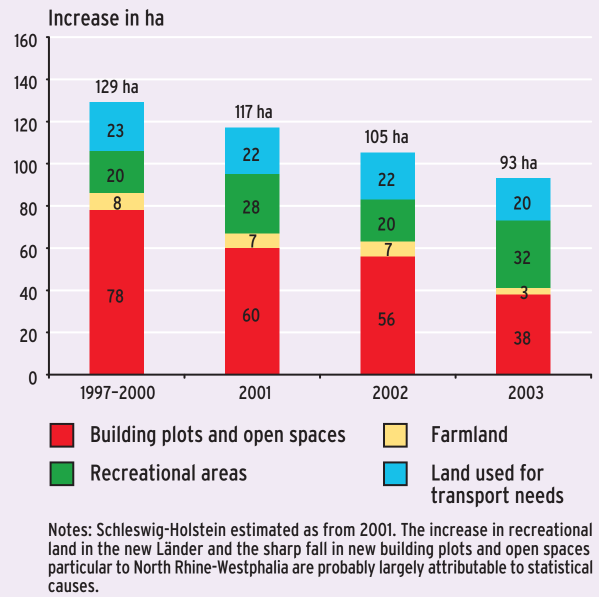
The nation-wide increase of 93 % a day is split between the old *Länder* with around 62 ha a day and the new *Länder* with around 32 ha a day.

The old *Länder* have experienced the slowest growth in land used for residential and transport needs in 50 years. However, this encompasses a sharp decline in designations of new building plots and open spaces, especially in North Rhine-Westphalia, attributable to statistical recoding. The actual decrease, measured against the mean over many years, is therefore overestimated.

In the new *Länder*, 2003 growth was only 2 ha lower than that for 2002. There was a regressive increase in building plots and open spaces. Two-thirds of the increase is attributable to recreational land. However, it must be assumed that this is largely due to statistical amendments rather than to actual changes in utilisation [2], [3].

In comparison, the increase in building plots and open spaces contributing to over half of the increase in SuVs is clearly regressive (Fig. VII 1.2-2). The increase of only approximately 20 % in land for transport needs is disproportionately low. However, this is associated with adverse environmental impacts, in particular the continued isolation of open spaces and noise pollution [4] (Chapter III and Chapter VIII).

Fig. VII 1.2-2: *Daily shift in land used for residential and transport needs*



Notes: Schleswig-Holstein estimated as from 2001. The increase in recreational land in the new Länder and the sharp fall in new building plots and open spaces particular to North Rhine-Westphalia are probably largely attributable to statistical causes.

Source: *Federal Statistical Office 2004*

The strongest growth in building plots and open spaces is in the south of Germany and around metropolitan areas. Yet development revealed significant regional variation in 2003. Comparatively high growth rates were recorded in Rhineland-Palatinate and Brandenburg (1.1 % each), Bavaria, Hamburg, and Lower Saxony (1.0 % each), Baden-Württemberg, and Bremen (0.9 % each). In contrast, low growth rates were reported for Hessen (0.5 %), Saxony (0.3 %), North Rhine-Westphalia (only 0.2 % due to statistical recoding), and Berlin and Thuringia (0.1 % each) [2].

For this reason, the increase in land used for residential and transport needs (SuV) is to be reduced to 30 ha a day by 2020 [5]. We are still a long way from achieving this national sustainability strategy goal.

The regression over recent years is essentially influenced by economic factors. Renewed growth is expected in the case of an economic upswing, especially within the construction industry. Considerable efforts will be required to prevent another rise in land consumption in the case of economic revival. Continued resolute development of planning, legal, and economic instruments and their practical utilisation is, therefore, required. The utilisation of the potential of brownfield sites in many areas is also being carefully targeted. Increased public awareness of the problems must also be developed.

In view of the considerable regional variation in demographic development trends, economical land consumption also contributes to a sustainable economic and financial policy in terms of avoiding expensive future developments of ill-adapted false investments (Chapter VII 1.5).

[1] Federal Statistical Office 2003, 2004
[2] www.bbr.bund.de/raumordnung/siedlung/Flaechenerhebung_2004.htm
[3] Federal Environment Agency (UBA) Texts 90/03: Reduzierung der Flächeninanspruchnahme durch Siedlung und Verkehr – materials handbook, footnote page 67
[4] Bergmann, Eckhard; Dosch, Fabian: Von Siedlungsexpansion zum Flächenkreislauf, Trendwende zum haushälterischen Umgang In: Planerin, Fachzeitschrift für Stadt-, Regional- und Landesplanung, Book 1_04, March 2004
[5] The Press and Information Office of the Federal Government (Ed.): Fortschrittsbericht 2004: Perspektiven für Deutschland: Unsere Strategie für eine nachhaltige Entwicklung. Berlin 2004

VII 1.3 Regional planning in the Exclusive Economic Zone

Traditional exploitation of the seas (including shipping, fishing, ocean dumping and tipping, mining, military exercises among others) was regulated in previous decades by sectoral technical planning laws and ordinances. However, the advent of new forms of exploitation such as offshore windfarms and aquacultures have created a situation where exploitation demands clash with protection demands such as nature conservation sites at sea under the European ecological network “Natura 2000”. This gives rise to conflicts. These can be coordinated and, guided by sustainability criteria, solved through comprehensive, balanced, and forward-looking regional planning. The scope of validity of the Federal Regional Planning Act which already covers territorial coastal waters (12 sea miles zone) has been extended to the Exclusive Economic Zone (EEZ, 200 sea miles zone). The Federal Ministry of Transport, Building and Housing (BMVBW) was authorised to set regional planning goals and basic principles in the German EEZ (Regional Planning Act – 24 July 2004, German Civil Code (BGB, Bundesgesetzbuch)l I page 1359) in a joint venture with the technically affected federal ministries including the Environmental Ministry. The EEZ itself does not belong to the territory of the Federal Republic of Germany. Under the 1982 United Nations Convention on the Law of the Sea (SRÜ, Seerechtsübereinkommen – BGBl 1994 II page 1799), restricted forms of exploitation are permitted. These include:

- the sovereign right to the conservation of living marine resources (Article 56 and 61),
- the sovereign right to the utilisation of living marine resources (Article 56 and 62),
- the exclusive right to continental shelf research and the exploitation of its non-living and living resources (Article 56 and 77),
- the sovereign right to economic research and exploitation of the EEZ with regard to other activities such as the production of energy from water, currents, and winds (Article 56),
- territorial jurisdiction with regard to protection and preservation of the marine environment (Article 56).

Regional planning on the seas aims to set up offshore regional planning using instruments developed for onshore use. The specific features of the marine landscape must be taken into account and require that existing regional planning instruments be adapted. EEZ regional planning strategies, including the designation of areas suitable for wind farms are to be developed in agreement with neighbouring countries and German coastal regions. The coastal regions of Lower Saxony, Schleswig-Holstein and Mecklenburg-West Pomerania have extended the scope of their regional planning schemes to coastal waters (12 sea miles zone).

In terms of the Exclusive Economic Zone (EEZ) scope of validity, amendments were made to the Federal Nature Conservation Act (BnatSchG) and Marine Facilities Ordinance (SeeAnlV, Seeanlagenverordnung) in 2002 and to the Regional Planning Act in June 2004, adapting them to existing and future planning purposes.

Marine Facilities Ordinance approval

The Federal Maritime and Hydrographic Agency (BSH) approved the erection, operation, and utilisation of facilities (constructions and artificial islands) in the North and Baltic Seas used for the production of energy from water, currents, and winds or other economic purposes in the Exclusive Economic Zone (EEZ) of the Federal Republic of Germany, in accordance with the Marine Facilities Ordinance. Since 1997, numerous large-scale projects have been planned for this area, including many large offshore wind farms, since offshore wind power gained the support of the legislative authorities under paragraph 7 of the Act on Granting Priority to Renewable Energy Sources (EEG). The facilities must be located in the designated areas. At that time (January 2005) 33 applications (27 North Sea/6 Baltic Sea) were submitted to BSH, partially representing several hundred individual wind power stations. The Federal Environment Agency (UBA) is involved in the procedure as public body.

By 2030 25 000 wind power stations with an approximate total of 20 000 to 25 000 MW of installed capacity are to be erected in the North and Baltic Seas in the German Exclusive Economic Zone. Together with the existing onshore wind farms, these facilities could generate around a quarter of Germany's power requirements from wind power (Chapter I 4.4).

Integrated Coastal Zone Management (IKZM)

The "Recommendation of the European Parliament and of the Council of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe" (2002/413/EC) encourages Member States to develop a national strategy for the implementation of IKZM basic principles. The European Commission will report on this by February 2006.

The Recommendation is supported by the Agenda 21 declaration at the 1992 "UN Conference on Environment and Development" (UNCED) in Rio de Janeiro, which states that use and development of marine and coastal areas should follow new approaches "that are integrated in content and are precautionary and anticipatory in ambit". The EU is providing co-financial support under the INTERREG III B support programme. The Federal Ministry of Education and Research (BMBF) set up the research programme "Research for a sustainable coastal management" in August 2002. Two cooperative projects for the Oder estuary region and the west coast of Schleswig-Holstein have already been allocated funds. Together with the Federal Office for Building and Regional Planning (BBR), the Federal Ministry of Transport, Building and Housing allocated funds to the research project "Towards a national strategy for an integrated coastal zone management – regional planning perspectives" in March 2003 which is expected to develop proposals for a national IKZM strategy from a regional planning perspective.

UBA is developing implementation strategies for an integrated coastal zone management with particular emphasis on Germany's environmental issues, in cooperation with the Federal Ministry for the Environment (BMU). The foundation for this is EU Recommendation 2002/413/EC. The national strategy for the implementation of an integrated coastal zone management is to be drawn up by autumn 2005. The Federal Government is currently working on a national strategy for the integrated management of marine and coastal areas. Within the Federal Government, BMU is coordinating the development of the strategy in close cooperation with the coastal *Länder* with involvement from the public and all parties concerned. A national IKZM internet platform has been set up at

www.ikzm-strategie.de in order to promote information exchange.

VII 1.4 Regional planning progress

Regional planning carried out by the *Länder* provides considerable influential guidance in terms of environmental issues at the *Länder* and regional level in Germany by way of the established binding central ideas under the Regional Planning Act (24 July 2004, BGBl I 3.1359). National planning should therefore take into account all issues in order to achieve sustainable regional development.

These include:

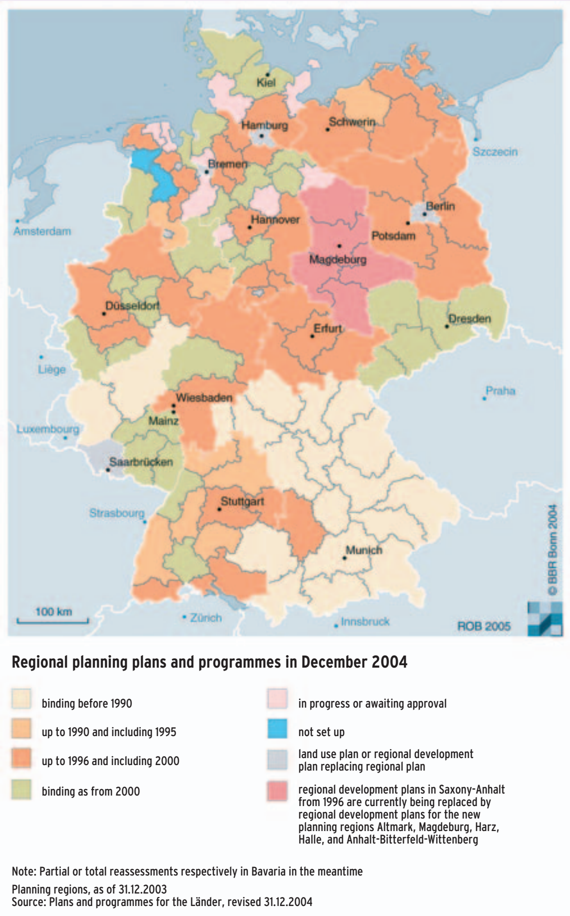
- guaranteeing the free expression of identity in the community and in responsibility for future generations,
- protecting and developing the natural prerequisites for life,
- strengthening regional characteristic diversity,
- creating local prerequisites for economic development and
- establishing equal living conditions in all participating regions.

Progress and quality in regional and national planning have now reached a high level in Germany. At the end of 2004 binding regional plans were in place in almost all regions (Fig. VII 1.4-1).

In recent years, the Federal Environment Agency has been compiling opinions on many regional and national plans concerning the particular demands in view of flood protection, utilisation of renewable forms of energy and other issues. Commendable examples given for 2004 are:

- 35th amendment of the regional development plan (GEP) for the Düsseldorf administrative region, relevant section *vorbeugender Hochwasserschutz* (Preventative flood protection), 2004,
- Schwarzwald-Baar-Heuberg regional plan: continuation of the *Regionales Gewerbegebiet*, (Regional industrial park) *Rohstoff-Sicherung* (Safeguarding raw materials) and *Windenergie* (Wind power) chapters, 2004,
- GEP for the Cologne administrative region – relevant section *Vorbeugender Hochwasserschutz* (Preventative flood protection) – Part 1: *Regionen*

Fig. VII 1.4-1: *Regional planning progress*



Source: *Federal Office for Building and Regional Planning 2005*

Köln, Bonn/Rhein-Sieg und Wassereinzugsgebiet der Erft (Regions Cologne, Bonn/Rhine-Sieg, and Erft catchment area), 2004,

- 1998 alterations to the 1995 Braunschweig area municipal association Regional Planning Programme (RROP): *Vorrangstandorte für Windenergienutzung* (Priority locations for wind power utilisation), 2004,
- draft for alteration to the Saxony-Anhalt *Eignungsgebiete zur Nutzung von Windenergie* (Suitable areas for utilisation of wind power) GEP, 2004,
- re-establishing the Mecklenburg-West Pomerania regional development plan, map chart detailing expected designated sites for wind power installations in Mecklenburg-West Pomerania coastal waters under the GEP and LED (Regional Development Programme), 2004,
- Lower Saxony regional development plan: draft for an alteration to the coastal waters' 12 sea miles zone, *Empfehlungen zur Festlegung von Vorrang- oder Eignungsgebieten für die Windenergienutzung* (Recommendations for establishment of priority or suitable areas for utilisation of wind power), 2004,
- partial alteration to the Verden district Regional Planning Programme (priority location for wind power), 2004.

Since July 2004, the Regional Planning Act has required all new or fundamentally altered Regional Development Plans to undergo an environmental audit (SUP, Strategische Umweltprüfung in accordance with EU Directive 2001/42/EC). The expected main environmental impacts of the plans will be ascertained, described, and evaluated in an environmental report. This will involve the public and neighbouring states. Significant environmental impacts will be monitored. The Federal Ministry of Transport, Building and Housing (BMVBW) was authorised to set regional planning goals and basic principles in the German EEZ, in a joint venture with the technically affected federal ministries including the Environmental Ministry, with regard to economic and scientific utilisation, guaranteeing the security and importance of maritime navigation and protecting the marine environment.

In terms of environmental protection, the improvement of the information base and its availability in the participatory procedure can improve the decision-making process and raise the level of acceptance.

VII 1.5 Demographic shift and residential structure

Many aspects contribute to Germany's demographic shift. The population is set to rise sharply in coming decades. According to the Federal Statistical Office's 10th coordinated population projection, the population is set to decrease, given certain conditions, from its present level of over 82 million to as low as 67 million by 2050 (Tab. VII 1.5-1 and Fig. VII 1.5-1). The number of old persons will also increase sharply within this timeframe. Between 2001 and 2050, the group of persons aged 60 and over will have risen from a quarter to a third of the total population, the group of persons aged 80 and over will almost triple. At the same time, there will be a sharp decline in the group of persons aged 20 and under.

These assumptions are based on:

- a constantly low birth rate,
- a death rate higher than the birth rate,
- a continued increase in life expectancy.

Germany already has one of the lowest birth rates in the world: 1.38 (Tab. VII 1.5-2). Among the 15 European Union Member States, only Italy (1.24), Spain (1.23), Greece (1.29), and Austria (1.34) had lower birth rates in 2000. Comparable or still lower birth

Tab. VII 1.5-1: *Area and population*

	Area km²	Population[1)] in 1000 total	male	female	Inhabitants per km²
Year/month/day			31.12.2003		
Baden-Württemberg	35 751.65	10 693	5 247	5 445	299
Bavaria	70 549.19	12 423	6 079	6 344	176
Berlin	891.75	3 388	1 651	1 737	3 800
Brandenburg	29 477.16	2 575	1 273	1 302	87
Bremen	404.23	663	321	342	1 640
Hamburg	755.16	1 734	843	891	2 296
Hesse	21 114.72	6 089	2 982	3 108	288
Mecklenburg-Western Pomerania	23 174.17	1 732	858	874	75
Lower-Saxony	47 618.24	7 993	3 915	4 078	168
North Rhine-Westphalia	34 083.52	18 080	8 803	9 277	530
Rheinland-Palatinate	19 847.39	4 059	1 989	2 070	204
Saarland	2 568.65	1 061	516	546	413
Saxony	18 413.91	4 321	2 103	2 219	235
Saxony-Anhalt	20 445.26	2 523	1 231	1 292	123
Schleswig-Holstein	15 763.18	2 823	1 380	1 443	179
Thuringia	16 172.14	2 373	1 166	1 207	147
Germany	**357 030.32**	**82 532**	**40 356**	**42 176**	**231**

1) Results of Population extrapolation

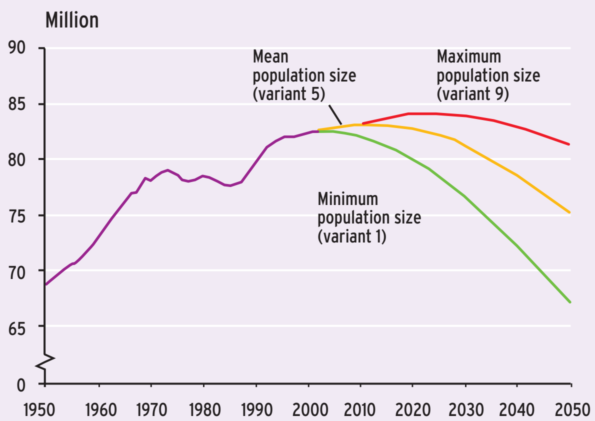
Source: *Statistical Offices of the Federal Government and the Länder 2004*

rates were recorded in a further eight states in economic and social turmoil: the Czech Republic (1.18), Estonia (1.28), Hungary, (1.38), Latvia (1.17), Lithuania (1.38), Romania (1.32), the Russian Federation (1.25), and the Ukraine (1.25). In the mid-1970s in the USA a minimum birth rate was reached which subsequently rose steadily and has been fluctuating since 1989 between 2.0 and 2.1. Measures orientated towards a basic reconsideration of the social and individual value of children is a lengthy process and it is decades before they will have any effect on population development.

Migration patterns play a central role in demographic shifts. Since reunification, population growth has rested for the most part on a fairly constant high net immigration from abroad. Without it, a sharp fall in population would have been recorded in Germany in recent years. Effectively, population increases are principally recorded in regions with thriving economies [1].

This demographic shift is characterised by regional diversity. An ever-increasing group of shrinking districts is confronted with an ever-decreasing group with constantly high growth rates. As Figure

Fig. VII 1.5-1: *Trends in population size in Germany*



Variant 9: Large increase in immigration, Large increase in life expectancy
Variant 5: Moderate increase in immigration, moderate increase in life expectancy
Variant 1: Low increase in immigration, low increase in life expectancy

Source: *Federal Statistical Office 2003 a*

Tab. VII 1.5-2: *Birth figures for selected countries*

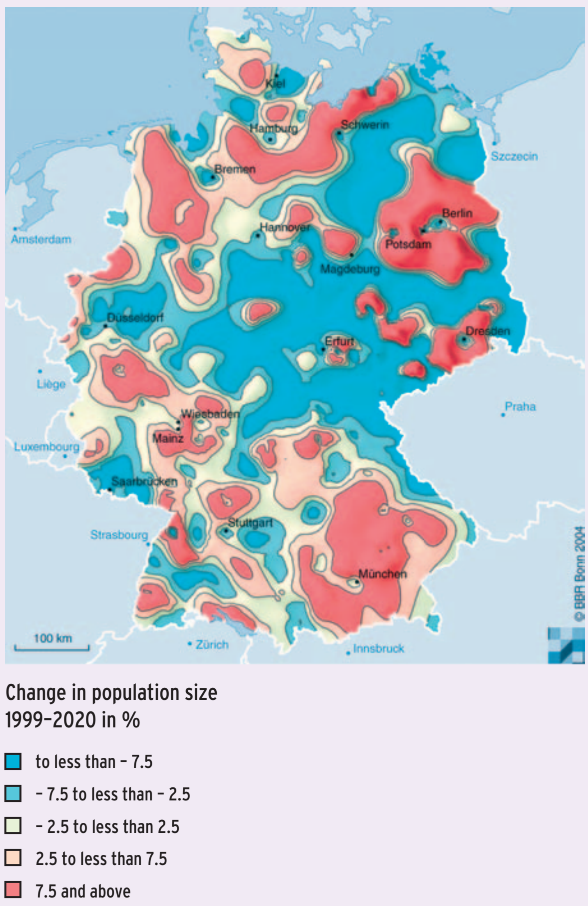
	1990	1995	2000
European Union (15 states)	1.57	1.42	1.48
Belgium	1.62	1.55	1.66
Denmark	1.67	1.80	1.77
Germany	1.45	1.25	1.38
Finland	1.78	1.81	1.73
France	1.78	1.70	1.88
Greece	1.39	1.32	1.29
Ireland	2.11	1.84	1.89
Italy	1.33	1.18	1.24
Luxembourg	1.61	1.69	1.8
Netherlands	1.62	1.53	1.72
Austria	1.45	1.40	1.34
Portugal	1.57	1.40	1.52
Sweden	2.13	1.73	1.54
Spain	1.36	1.18	1.23
United Kingdom	1.83	1.71	1.64
Iceland	2.30	2.08	2.10
Japan	1.54	1.42	1.41
Norway	1.93	1.87	1.85
Switzerland	1.59	1.48	1.50
USA	2.08	2.02	2.06

1) Information not available

Source: *Eurostat 2003*

VII 1.5-2 illustrates, a forecast carried out by the Federal Office for Building and Regional Planning (BBR) shows that population increases occur principally in regions in the vicinity of urban areas with higher population densities ("islands of growth"), above all in the old *Länder*. The new *Länder*, mostly sparsely populated rural regions, are losing increasing numbers of young qualified persons as they migrate to economically strong regions. This means that the average age in sparsely populated regions is well over the national average. The population is therefore decreasing both in the East as well as in the West, yet with varying degrees of intensity.

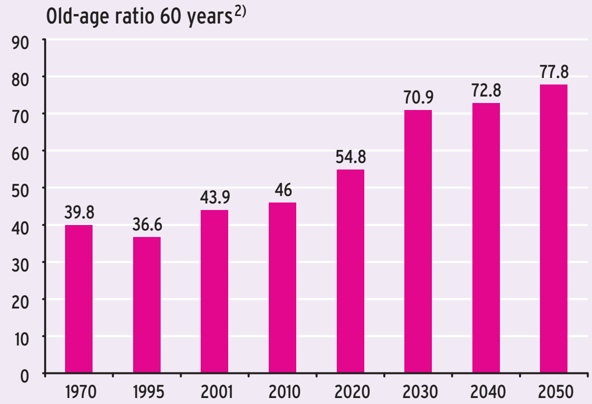
Fig. VII 1.5-2: *Change in population size 1999–2020 in %*



Source: *Federal Office for Building and Regional Planning 2004*

A significant indicator of an ageing society is the so-called old-age ratio. This measures the relation between the population cohort of working age and that of retirement age. In Germany the old-age ratio is currently 44 persons of retirement age to every 100 persons of working age, a figure set to rise to 78 to every 100 by 2050 (Fig. VII 1.5-3). The number of persons of working age is set to drop to 53.6 million by 2020 according to a BBR forecast (Fig. VII 1.5-4) [2].

Fig. VII 1.5-3: *Old-age ratio with retirement age of 60*[1)]



1) Estimated values as from 2002 of 10th coordinated population projection, variant 5 "mean" population: Mean increase in migration W2 (annual balance of at least 200,000) and mean increase in life expectancy L2 (average life expectancy for 2050 at 81 or 87 years of age).

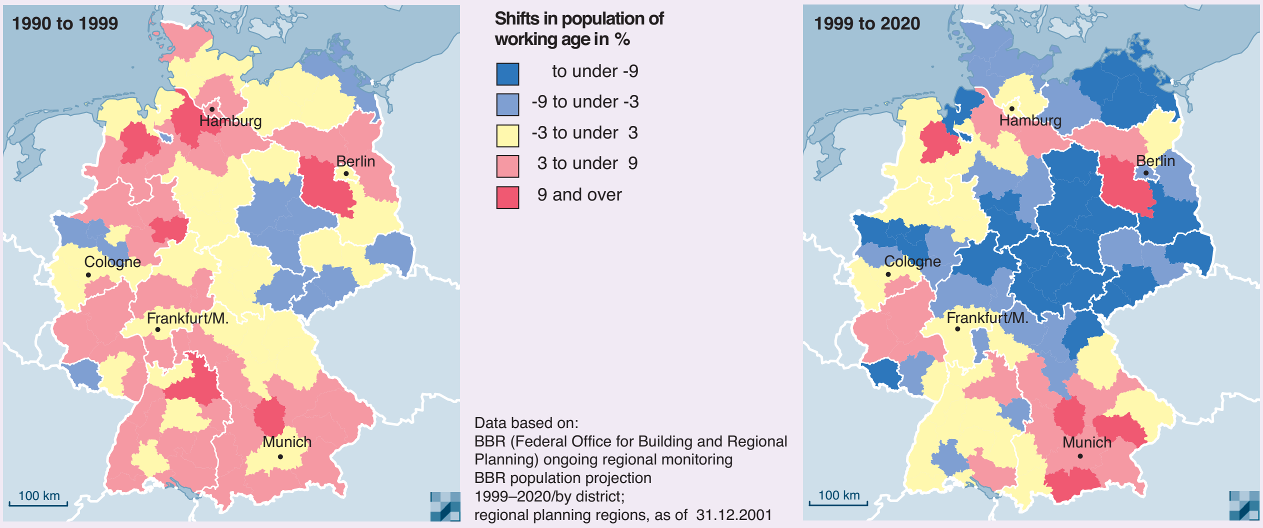
2) 60-year-olds and above per 100 persons between 20 and 59 years of age.

Source: *Federal Statistical Office 2003 a*

Despite a decreasing population, the number of households is also set to rise in the future. Modified ways of life and family structures and particularly an ageing population are leading to a sharp increase in smaller households. Although characterised by regional variation, this is a nation-wide tendency. According to a BBR forecast, there will be a 2.9 % increase in the number of households by 2020, corresponding to approx. 1.1 million new households. In 2020 almost three quarters of all households will consist of only one or two persons. Between 1970 and 2000 the average household size in the old *Länder* had already fallen from 2.74 to 2.17 persons and a further decrease is expected in the future: 2.1 persons per household by 2020 and 1.95 by 2050. Available per capita living space has tripled – pertaining to the former federal territory – from 15 m^2/house in 1950 to 41.1 m^2/house in 2003. 2 % of all households have second or holiday homes. If incomes continue to increase, so will per-household living space demands. Increasing living space consumption will be supplemented by increasing qualitative housing demands, whereby replacement demand could play an ever-increasing role alongside primary demand. These trends suggest that despite the fall in population, living space demand will increase generally. At the same time, both small- and large-scale differentiations in demand are expected [3] (Fig. VII 1.5-5).

The shifts in settlement structure are primarily attributable to progressive suburbanisation. Emigration from the cities to the surrounding countryside means that metropolitan areas have spread to penetrate well into rural infrastructures. In most conur-

Fig. VII 1.5-4: *Shifts in population of working age 1990–2020 in %*

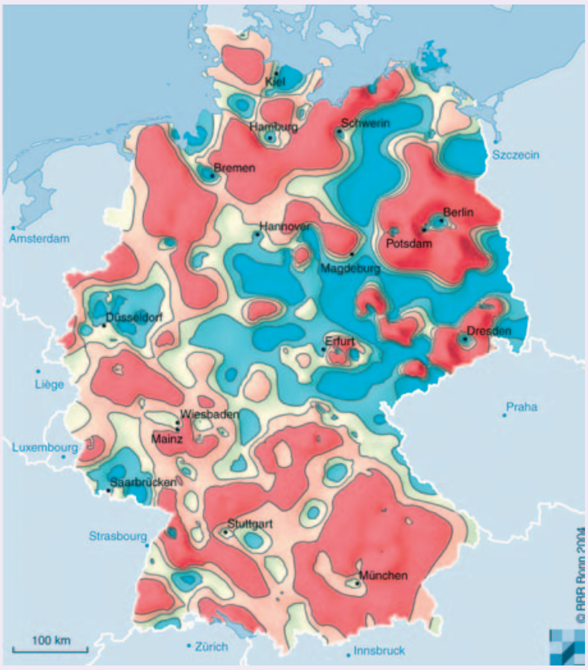


Source: *Federal Office for Building and Regional Planning 2004*

bations, more people now live in the surrounding countryside than in the core urban regions.

Figure VII 1.5-6 illustrates this phenomenon. The most significant increases in population and the

Fig. VII 1.5-5: *Shifts in number of households 1999–2020 in %*



Shifts in number of households 1999–2020 in %

- to under – 10
- – 10 to under – 3
- – 3 to under 3
- 3 to under 10
- 10 and over

Source: *Federal Office for Building and Regional Planning 2004*

consequent highest rises in land for residential and transport needs in both the old and the new *Länder* were recorded in the 1990s in rural districts situated a long distance from core urban regions. It is precisely in these regions that residential development competes with the conservation of large contiguous expanses (Chapter VIII).

In the new *Länder* there was no suburbanisation before reunification. This began to change in the early 1990s. Although residential suburbanisation in some areas of the new *Länder* is currently declining, migratory processes from the cities and towns to the surrounding countryside continue, which also limits development opportunities in the core urban regions of the New *Laender*. Population losses as a result of East-West migration are eclipsed by drops in population levels and worker numbers, an effect of migration from cities and towns to the surrounding countryside. One visible sign of this development is a severe vacant housing phenomenon. Regions of West Germany are also increasingly affected by population decreases, particularly derelict industrialised regions [4].

The shifts in Germany's basic socio-demographic framework present our cities and regions with new challenges. In view of the different patterns of demand and scales of requirement, greater emphasis will in the future be placed on adapting present residential, open space, transport, and provision systems to the new conditions. The aims should be the maintenance, strengthening, and continued development of the functional capacity and potential of cities and regions, in line with the "sustainability" model. A central task in the coming years will therefore be "urban restructuring" in East and West.

VII 1.5-6: *Population shifts in German metropolitan areas*

Source: *Federal Office for Building and Regional Planning 2003*

[1] Federal Statistical Office, 10th coordinated population projection, Wiesbaden, Germany 2003

[2] Old-age ratio: Börsch-Supan, Axel: Kann die Finanz- und Sozialpolitik die Auswirkungen der Bevölkerungsalterung auf den Arbeitsmarkt lindern? Paper for the 2001 financial sciences committee's annual conference in Cottbus, Germany. Cottbus 2001. Zahl der Erwerbsfähigen: Federal Office for Building and Regional Planning Information zur Raumordnung 3/4 2004, page 159

[3] Federal Office for Building and Regional Planning (Ed.): Raumordnungsprognose 2020, Informationen zur Raumentwicklung, Book 3/4, 2004

[4] www.bbr.bund.de/raumordnung/stadtregionen/umland.htm

VII 2 Chemical soil contamination

VII 2.1 Background levels of inorganic pollutants in Germany's soils

The background content of a soil is determined by the geogenic basic content of a pollutant in the soil and the ubiquitous loading resulting from diffuse deposition into soil. The geogenic (natural) basic content of inorganic pollutants, particularly metal ores, are characterised by the balance of parent rock in the soil formation and in some cases by mineralisation and redistribution during the formation of the soil (accumulation or depletion). Major influences on the ubiquitous dispersion of hazardous substances are a variety of input pathways. Ubiquitous/diffuse background soil levels are distinguished from those which result from large point chemical content (emissions or contamination).

Under the direction of the Federal Environment Agency, a working group on soil protection – Federal/Länder Working Group on Soil Conservation (LABO) – in cooperation with the Federal Institute for Geosciences and Natural Resources (BGR) and regional environmental agencies has evaluated the available federal and *Länder* data on the parent material of soil formation, soil horizons, main types of utilisation and residential areas. It has also deduced federal as well as *Länder*-specific background levels for upper and lower soils and underground. These levels are representative for generally distributed background levels of a chemical or chemical group in soils.

Table VII 2.1-1 contains the nation-wide background levels for inorganic chemicals in soils (90th percentile) for Germany's predominant soil parent stones. These background levels provide a broad basis for formulating conclusions on background levels in soils in rural areas. The LABO (2003) [1] report also contains information on the 50th percentile and *Länder*-specific background values for inorganic as well as organic chemicals in soils reported via monitoring programmes in the individual *Länder* (www.labo-deutschland.de).

The representatively derived background levels of inorganic pollutants in soils are detailed on map charts based on widely available information on land use and soil parent stone. Figures VII 2.1-1 and VII 2.1-2 illustrate, for example, the background levels for lead in upper and lower soils. Small-scale differentiations such as small-scale socialised lithological bodies, soil units, and depth differentiation are not represented due to limitations of scale. In lower soils, the average lead contents are calculated across the entire depth of each lower soil.

In order to guarantee an overview true to scale, the 90th percentile of the lead contents in upper soils is grouped into six classes. This classification was adopted for the direct comparison with lower soils.

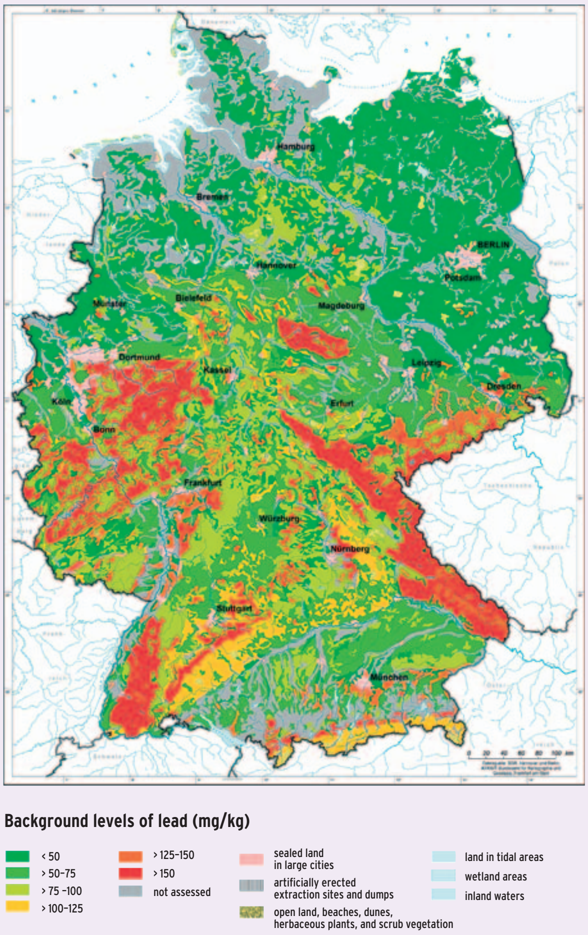
Tab. VII 2.1-1: *Nation-wide background levels for inorganic chemicals in soils (90th procentiles)*

	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Hg (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
River and gravel deposits							
Arable upper soil	0.69	33	31	0.22	29	47	75
Forest upper soil	0.48	28	28	0.22	23	130	69
Lower soil	(0.14)	38	21	–	40	22	64
Sand							
Arable upper soil – NW	0.3	20	13	0.06	7.6	23	41
Arable upper soil – NE	0.42	13	11	0.13	9.3	38	39
Grassland upper soil – NW	0.36	16	14	–	(7.5)	29	35
Grassland upper soil – NE	0.35	17	15	(0.2)	12	48	44
Forest upper soil – NW	0.74	17	13	0.26	10	86	32
Forest upper soil – NE	0.32	7	8.5	0.17	6.9	41	25
Lower soil	(0.24)	15	7	0.05	9.4	12	24
Alternating marl deposits/boulder clay with shallow sandy surface layers							
Arable upper soil	(0.26)	13	13	0.16	10	44	41
Forest upper soil	(0.28)	9.1	7.2	–	5.9	33	32
Peats							
Grassland org. upper soil – NE	0.4	27	26	–	10	48	50
Lower soil/underground	0.49	10	18	0.14	22	22	33
Alternating marl deposits/boulder clay							
Arable upper soil – NE	0.25	16	13	0.13	18	29	45
Grassland upper soil – NE	–	23	16	–	17	26	49
Forest upper soil – S	0.49	26	17	–	–	54	68
Lower soil – N	(0.31)	22	15	0.11	22	31	47
Lower soil – S	0.31	40	29	019	48	28	79
Loess							
Arable upper soil	0.7	43	24	0.19	33	60	75
Grassland upper soil	0.7	32	25	0.22	34	61	100
Forest upper soil	0.55	37	19	0.25	24	99	65
Unterboden	(0.23)	46	21	0.11	38	26	63
Sand loess							
Arable upper soil	0.45	25	20	0.17	15	41	49
Forest upper soil	–	29	18	–	10	151	41
Lower soil	(0.18)	25	11	0.06	14	17	32
Periglazial surface layers over calcareous gravel							
Arable upper soil	0.59	56	45	0.23	59	60	102
Grassland upper soil	1.19	60	34	0.16	54	63	130
Forest upper soil	1.6	48	32	0.26	43	115	172
Lower soil – rich in loess clay	0.55	45	25	0.19	44	52	84
weak in loess clay	0.67	65	39	0.19	70	68	137
Periglazial surface layers over argillaceous gravel							
Arable upper soil	0.94	57	45	0.17	70	85	158
Grassland upper soil	0.67	57	33	0.2	68	99	141
Forest upper soil	0.6	54	31	0.32	56	205	129
Lower soil – rich in loess clay	0.31	52	25	0.14	58	48	107
weak in loess clay	0.34	59	40	0.15	66	53	124
Periglazial surface layers over sandstone							
Arable upper soil	0.37	40	23	0.17	26	48	82
Grassland upper soil	0.33	33	13	0.13	22	33	63
Forest upper soil	0.34	27	12	0.23	20	94	60
Lower soil – rich in loess clay	(0.34)	35	19	0.14	28	42	70
weak in loess clay	(0.33)	27	10	0.12	22	25	51
Periglazial surface layers over intermediary and basic igneous and metamorphic rock							
Arable upper soil	0.77	355	69	0.15	248	59	158
Grassland upper soil	0.92	228	64	–	222	79	179
Forest upper soil	1.04	278	71	0.38	221	129	171
Basic igneous and metamorphic rock							
Lower soil – rich in loess clay	0.53	145	63	0.1	208	42	139
weak in loess clay	0.59	240	79	0.13	332	40	173
Periglazial surface layers over acidic igneous and metamorphic rock							
Arable upper soil	0.94	40	40	0.25	34	143	151
Grassland upper soil	1.15	51	52	0.23	34	131	146
Forest upper soil	0.91	40	31	0.27	33	189	104
Granite and rhyolites							
Lower soil – rich in loess clay	–	–	28	–	–	–	79
weak in loess clay	0.39	28	30	0.14	28	59	93
Gneiss							
Lower soil – rich in loess clay	0.25	65	45	0.59	52	41	121
Mica-schist							
Lower soil – rich in loess clay	–	67	45	–	67	56	190

Comments on table:
1. The background levels apply to the 90th percentile.
2. The background levels for upper soils apply to the following use-specific upper soil horizons: Arable land – Ap-horizon (approx. 0–30cm); Grassland – Ah-horizon (approx. 0–10cm); Forest – Ah-horizon (approx. 0–10cm).
3. Share of loess clay periglazial surface layer: rich in loess > 25–100 %; weak in loess 0–25 %
4. The background levels apply to aqua regia extractable nitrogen contents.
5. (...) if the 50th percentiles are within the analytic limit of quantification, the 90th percentiles are not statistically guaranteed and therefore appear in brackets.

Source: *Federal/Länder Working Group on Soil Conservation 2003*

Fig. VII 2.1-1: *Nation-wide background levels of lead in upper soils (90th percentile)*



Source: *Federal Institute for Geosciences and Natural Resources 2004*

Fig. VII 2.1-2: *Nation-wide background levels of lead in lower soils (90th percentile)*

Source: *Federal Institute for Geosciences and Natural Resources 2004*

The comparison between the map charts shows the anthropogenic influence on the background levels of lead.

[1] Federal/Laender Working Group on Soil Conservation (LABO), Hintergrundwerte für anorganische und organische Stoffe in Böden. Appendix 3, revised and amended edition, 2003

VII 2.2 Soil contamination caused by dioxins

Polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs) have never been selectively produced. Rather, they come into being via the production of chlorinated organic compounds such as polychlorinated biphenyls (PCBs) and pentachlorophenol. These chemicals are inadvertently formed as part of the pulping process and during all thermal processes such as metal extraction and recycling, domestic fuel burning, and waste incineration. Due to their high chemical, physical, and biological stability, they belong to the Persistent Organic Pollutant (POP) group.

Since the early 1990s, levels of polychlorinated dibenzodioxins and furans (PCDD/F) from over 2 500 soil samples from various measurement programmes have been recorded in the Federal/Laender Working Group on Dioxins DIOXINE database [1]. The average background soil contamination was ascertained by selecting from the total data inventory those measurement results of soil samples with no marked contamination. Analysis of the soil samples was carried out according to horizon, region type following the former Federal Regional Studies and Planning Research Institute's classification system (BFLR) and use type. The homologous profile (each of the sums of the tetra to octachlorodioxins) were ascertained from the median values of the profiles for the three use types (forest, grassland, and arable land).

The toxicity equivalents (TEQs) were calculated using the measured concentrations of the PCDD/F congeners (Tab. VII 2.2-1). The PCDD/F congeners with a lesser or equal concentration to that of the limit of detection were not taken into account (set at absolute zero).

Tab. VII 2.2-1: *International toxic equivalence factors in accordance with NATO-CCMS1) (I-TEF, 1988) and the World Health Organization (WHO-TEF, 1998)*

polychlorinated dibenzodioxins (PCDDs)	I-TEF	WHO-TEF	Polychlorinated dibenzofuranes (PCDFs)	I-TEF	WHO-TEF
2,3,7,8-TCDD	1	1	2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PeCDD	**0.5**	**1**	1,2,3,7,8-PeCDF	0.05	0.05
1,2,3,4,7,8-HxCDD	0.1	0.1	2,3,4,7,8-PeCDF	0.5	0.5
1,2,3,6,7,8-HxCDD	0.1	0.1	1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1	1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01	1,2,3,7,8,9-HxCDF	0.1	0.1
OCDD	**0.001**	**0.0001**	2,3,4,6,7,8-HxCDF	0.1	0.1
			1,2,3,4,6,7,8-HpCDF	0.01	0.01
			1,2,3,4,7,8,9-HpCDF	0.01	0.01
			OCDF	**0.001**	**0.0001**

[1)] North Atlantic Treaty Organization, Committee on Challenges of modern Society
Toxicity equivalent factors (TEFs) indicate the relative effect in relation to 2,3,7,8, TCDD. The concentration of a congener is multiplied by this factor. The values are added to a toxicity equivalent concentration (TEQ). This is a measure for the toxic effect concentration. The factors are published in papers and updated by technical committees. The last update was carried out by WHO in 1998. The various factors from NATO-CCMS and WHO appear in bold in the tables.

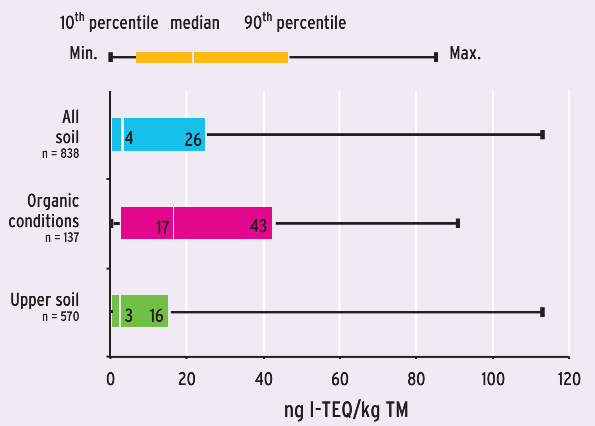
Source: *North Atlantic Treaty Organization 1998*

Evaluation

Analysis of the soil samples from the dioxin database of soils with no marked contamination obtained the following results: the median of all assessed horizons amounts to 4 ng I-TEQ/kg TM, the 90th percentile was 26, the maximum level 112. Most measurement results are for upper soils (A horizons), with a median of 3 ng/kg I-TEQ/kg TM and the 90th percentile of 16 ng/kg I-TEQ/kg TM (Fig. VII 2.2-1). Forest organic conditions reveal the highest levels with a median of 17 ng I-TEQ/kg TM and a 90th percentile of 43. Analysis of mineral upper soil according to region type (BBR type: metropolitan, urban, rural) did not reveal any significant difference. The median levels were between 1 und 3 ng/kg I-TEQ/kg TM and the 90th percentile between 8 and 16 ng/kg I-TEQ/kg TM (Fig. VII 2.2-2). The measured PCDD/F concentrations from agricultural arable soils are predominantly below the target values for the unrestricted agricultural use of 5 ng I-TEQ/kg TM, as recommended by the Federal/ *Länder* DIOXINE working group (Fig. VII 2.2-3).

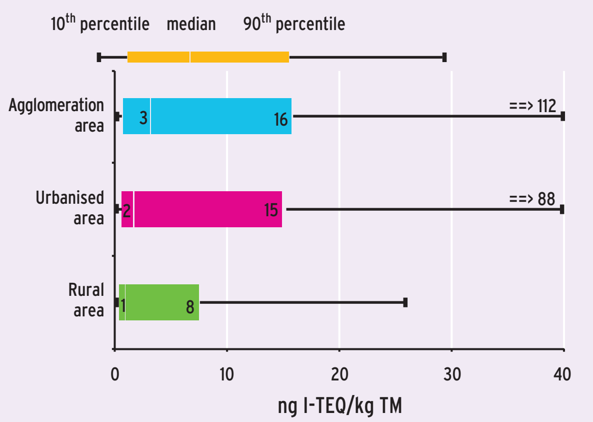
The homologous profiles reveal an increase in concentration from tetrachlorodibenzo-p-dioxins (TeCDDs) to octachlorodioxins (OCDDs) homologenes. OCDDs dominate with a share of almost 30 % for arable land and grasslands. In forest soil the 19.7 %, share of tetrachlorodibenzofurans (TCDFs) and pentachlorodibenzofurans (PeCDFs) is well over the OCDD concentration share of 14.5 % (Fig. VII 2.2-4).

Fig. VII 2.2-1: *PCDD/PCDF content (ng I-TEq/kg TM) in uncontaminated soils disregarding the detection limits (modified box-whisker plot, figures in the chart = median, 90th percentile)*



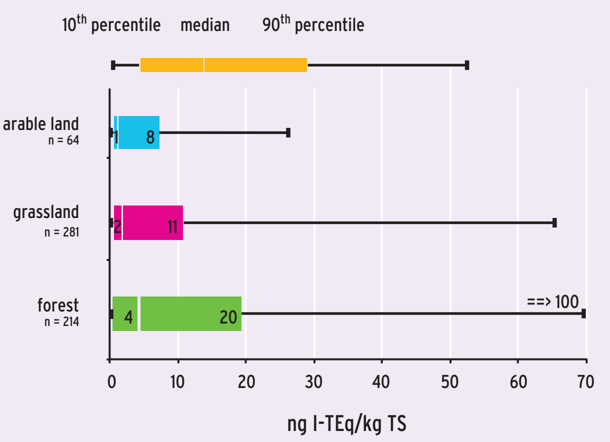
Source: *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2002*

Fig. VII 2.2-2: *PCDD/PCDF content (ng I-TEq/kg TM) in mineral, uncontaminated upper soils in various types of area disregarding the detection limits (modified box-whisker plot, figures in the chart = median, 90th percentile)*



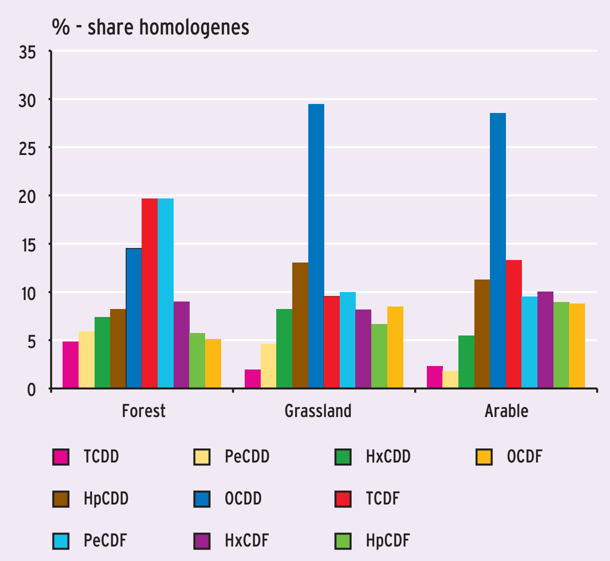
Source: *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2002*

Fig. VII 2.2-3: *PCDD/PCDFcontents (ng-Teq/kg TM) in uncontaminated upper soils in relation to various use types without any particular contamination (modified box-whisker-plot, numbers in figure = mean, 90th percentile)*



Source: *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2002*

Fig. VII 2.2-4: *Homologous profiles of PCDD/F concentrations in forests and on grassland and arable land*



Source: *Federal Environment Agency 2002*

Hardly any dioxin decomposition occurs in soils and tillage simply disperses the dioxins throughout the soil (distribution effect). This also explains high dioxin concentrations in forests, increased by the trees combing out dioxins from the air and the soil not being worked. The dioxins make their way into the food chain via the soil. However, direct intake into plants, except courgettes, is minimal. Contamination usually occurs via soil particles attached to plants. Therefore, it is recommended that pastoral utilisation be avoided where there are increased dioxin concentrations. The plant – animal foodstuff – cow path leads to the contamination of milk which contributes 30 to 50 % of Germany's human dioxin intake. Children may be exposed to high levels of dioxins stored in female fat. These travel via the placenta into the breast milk. Future measures must therefore be taken to further reduce environmental dioxin contamination.

Measures

Legal regulations for soil protection have been drawn up which reduce inputs into the soil, for example dioxin emissions from incinerators must comply with the limit value of 0.1 ng I-TEQ/m^3 air (17th Federal Immision Control Ordinance 1990 – BimSchV). Sewage sludge may only be applied to soil if the dioxin content is less than 100 ng I-TEQ/kg dry solids (waste sewage sludge ordinance 1997). Federal/*Länder* Working Group on Dioxins recommendations apply to agricultural and horticultural land, and various action values are set out in the land utilisation regulation (Tab. VII 2.2-2).

Tab. VII 2.2-2: *Legal regulations and recommendations for the evaluation of dioxins and furans in soil*

Federal Soil Conservation Ordinance, 12 July 1999: Action values	
Play park areas	100 ng I-TEQ/kg TM
Residential areas	1 000 ng I-TEQ/kg TM
Industry, trade	10 000 ng I-TEQ/kg TM
Federal Government/Länder AG recommendations Dioxins in agricultural and horticultural soil	
No limitations on use	< 5 ng I-TEQ/kg TM
Limitations for pastures[1]	5 bis 40 ng I-TEQ/kg TM
Limited use	> 40 ng I-TEQ/kg TM

[1] If contamination level above 5 ng I-TEQ/kg TM, cause to be notified.

Source: *Federal Environment Agency 2005*

[1] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): Dioxine-Daten aus Deutschland. Daten zur Dioxinbelastung der Umwelt, 3rd Federal Government/Länder Working Group on Dioxins report; Dioxin-Referenzmessprogramm 4th Federal Government/Länder Working Group on Dioxins. The reports are available in German and English from the UBA portal Persistente organische Stoffe, Dioxine at http://www.umweltbundesamt.de/uba-info-daten/daten/dioxine-dbla.htm.

VII 3 Inputs of harmful substances

VII 3.1 Inputs of air pollutants

The major pathway for air pollutants into soil, vegetation, and surface waters is atmospheric deposition. In the absence of precipitation, direct or "dry" deposition occurs, e.g., sedimentation, adsorption, or turbulent diffusion. Washout of atmospheric pollutants during precipitation (rain and snow) causes "wet" deposition. "Damp" deposition through fog, dew, and frost is also especially important in interaction with vegetation.

The different physical and chemical properties of airborne impurities mean that they spread to differing extents due to the transport processes and chemical reactions in the atmosphere. Reactive air pollutants such as SO_2, NO_X, and NH_3 typically remain in the atmosphere for a matter of hours or days, during which time they can spread throughout Europe before deposition. The point of deposition can therefore be far distant from the point of emission.

In Central Europe, wet deposition (here rain and fog) is a key process in purifying the atmosphere of air pollutants. The chemical composition of the predominantly acidic precipitation in this region is determined by a large number of gases and particulate matter in the atmosphere (such as SO_2, NO_X and NH_3 and their products).

For some years inputs of acid have been dominant in Germany and in large areas of Europe via inputs of nitrogen. Based on the national average, reduced nitrogen compounds (ammonia/ammonium) alone currently contribute more to the acidification of the ecosystem than sulphur, and ammonia/ammonium especially dominates inputs of acid in heavily contaminated areas. Ammonia/ammonium from agriculture (e.g., intensive animal husbandry) is effectively the most significant acidifying and eutrophying air pollutant in Germany and across large regions of Europe. This trend is set to continue in view of current developments.

Europe-wide emissions and international cooperation (EMEP)

Since air pollution does not cease at national borders, effective environmental protection must also straddle these boundaries. This is especially the case with atmospheric transport of pollutants and the resulting Europe-wide contamination of terrestrial, limnetic, and marine ecosystems. The Geneva Convention on Long-range Transboundary Air Pollution (13 November 1979) established a framework for measuring transboundary air pollution and, through protocols to the convention for setting commitments to reduce emissions (the SO_2, NO_X, VOC, Heavy Metals, POP, 2^{nd} Sulphur, and Multipollutant Protocols). The spread of pollutants within Europe is calculated by the European Monitoring and Evaluation Programme (EMEP).

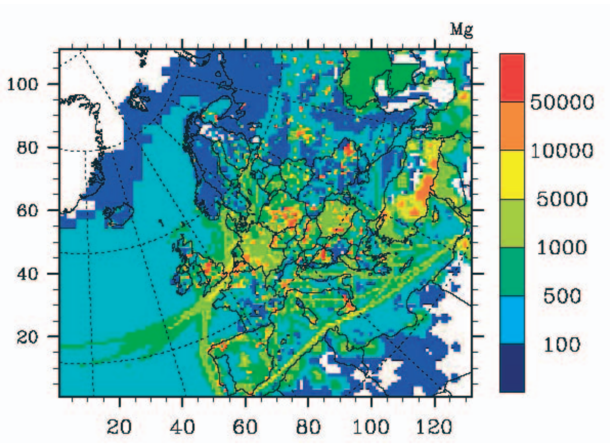
Measuring concentrations and depositions of air pollutants (including collecting, processing, evaluating, and exchanging data), and modelling transboundary transport and deposition of atmospheric pollutants on the basis of emissions and meteorological data provide a scientific foundation for measures to reduce emissions as well as a tool for assessing their effectiveness.

Research concentrates on acidifying components (e.g., sulphur and nitrogen compounds), photochemical oxidants (e.g., ozone), heavy metals, persistent organic pollutants (POPs), and fine dust (Figures VII 3.1-1 to VII 3.1-9).

Long-range transport and deposition of air pollutants

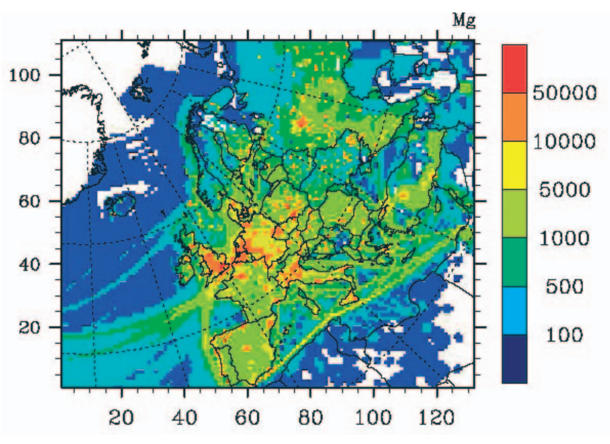
Calculating the spread of air pollutants requires complex atmospheric models, high quality input data, and considerable technical effort. For the first time, EMEP calculated the 2000 transboundary fluxes of oxidised sulphur and nitrogen (S_{ox}, N_{ox}) and reduced nitrogen (N_{red}) using trajectory models which take into account the vertical structure of the atmosphere. Transboundary fluxes of the heavy metals lead (Pb), cadmium (Cd), and mercury (Hg) were modelled for 2001.

Fig. VII 3.1-1: *Europe-wide 2001 sulphur dioxide emissions*



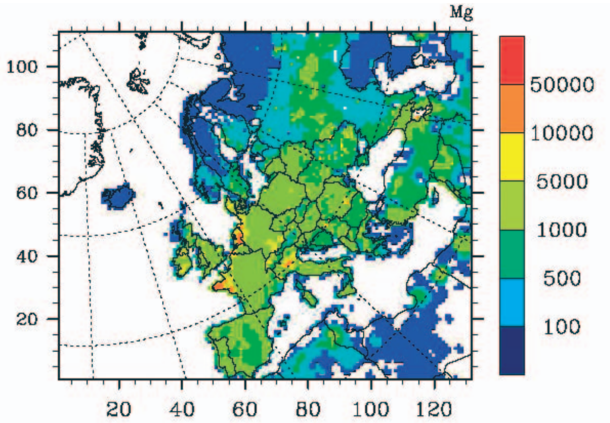
Source: *EMEP 2003*

Fig. VII 3.1-2: *Europe-wide 2001 nitrogen oxide emissions (as NO_2)*



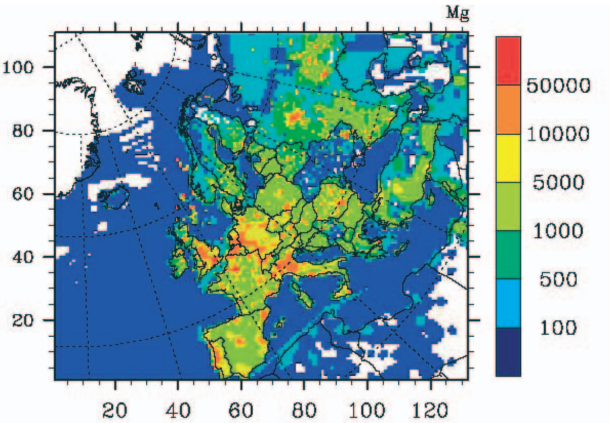
Source: *EMEP 2003*

Fig. VII 3.1-3: *Europe-wide 2001 ammonia emissions*



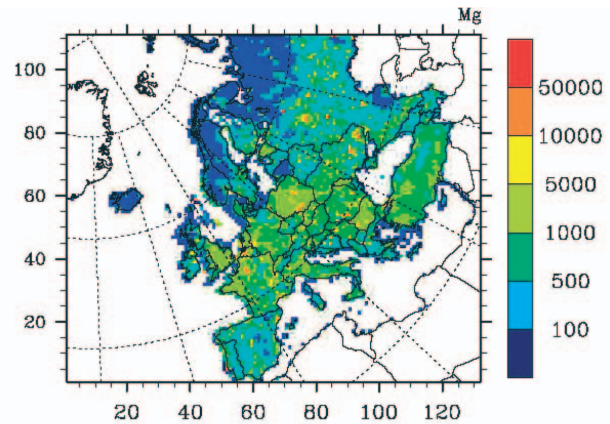
Source: *EMEP 2003*

Fig. VII 3.1-4*: Europe-wide 2001 volatile organic air pollutant emissions (excluding methane, NMVOC)*



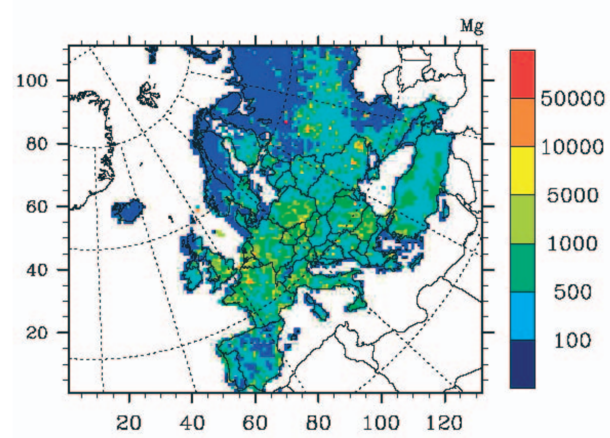
Source: *EMEP 2003*

Fig. VII 3.1-5: *Europe-wide 2001 fine dust emissions (PM_{10})*



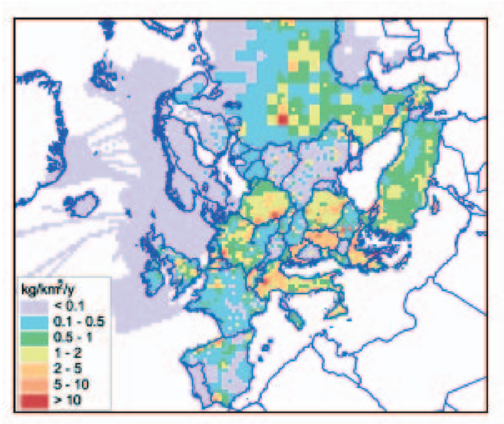
Source: *EMEP 2003*

VII 3.1-6: *Europe-wide 2001 fine dust emissions ($PM_{2,5}$)*



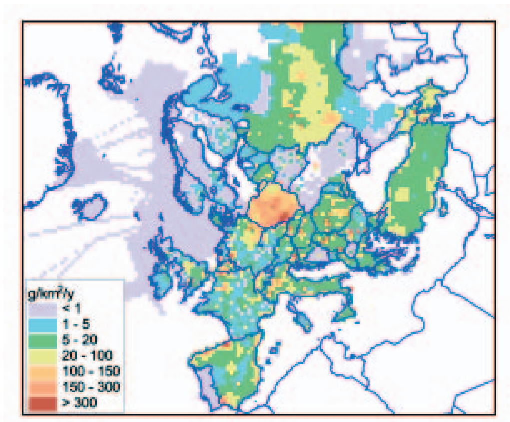
Source: *EMEP 2003*

Fig. VII 3.1-7: *Europe-wide 2002 lead emissions*



Source: *EMEP 2003*

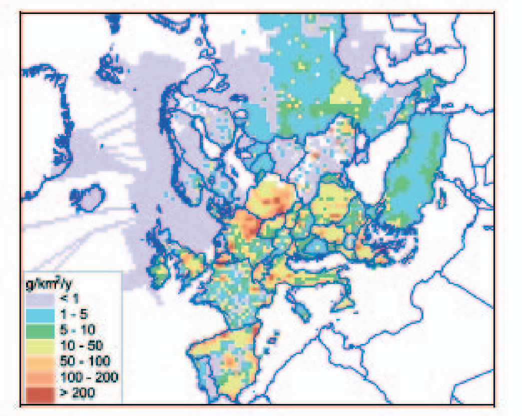
Fig. VII 3.1-8: *Europe-wide 2002 cadmium emissions*



Source: *EMEP 2003*

The calculations are based on depositions of SO_2, NO_x, and NH_3, and of Pb, Cd, and Hg, and on meteorological data. Depositions arising from emissions of SO_2, NO_x, NH_3, Pb, Cd, and Hg in each country are calculated, the data being presented in annual source receptor matrices. Figures VII 3.1-10 to VII 3.1-12 show the import-export budgets for sulphur and oxidised and reduced nitrogen in Germany for 2000.

Fig. VII 3.1-9: *Europe-wide 2002 mercury emissions*



Source: *EMEP 2003*

The continuing development of the EMEP model and improvements in the meteorological and emissions input data mean that more recent calculations of deposition may deviate from earlier results. The figures discussed here cannot therefore be compared directly with previously published data.

According to the preliminary results from the EMEP model, the situation in Germany for 2000 is presented below:

Of the total calculated 346 200 tonnes of sulphur (S) for 2000 (t/a S) deposition, 162 000 t/a S originated from emissions in Germany itself, 184 200 t/a S originated in the rest of Europe (152 300 of which originated in mainland Europe). This represents a mean annual rate of deposition of 0.97 t/km^2/a S. Germany exported 246 800 t/a S to the rest of Europe (168 900 t/a S of which to mainland Europe) (Fig. VII 3.1-10).

Of the total calculated 321 700 t/a oxidised nitrogen (N_{OX}) deposition, 84 200 t/a N_{OX} originated from emissions in Germany itself, 171 600 t/a N_{OX} originated in the rest of Europe (147 700 of which originated in mainland Europe) and a further 65 900 N_{OX} from sources outside Europe. This represents a mean annual rate of deposition of 0.90 t/km^2/a N_{OX}. Germany exported 370 200 t/a N_{OX} to the rest of Europe (259 000 t/a N_{OX} of which to mainland Europe) (Fig. VII 3.1-11).

Of the total calculated 371 500 t/a reduced nitrogen (N_{red}) deposition, 234 600 t/a N_{red} originated from emissions in Germany itself, 136 900 t/a N_{red} originated in the rest of Europe. This represents a mean annual rate of deposition of 1.04 t/km^2/a N_{red}. Germany exported 273 400 t/a N_{red} to the rest of Europe (184 400 t/a N_{red} of which to mainland Europe) (Fig. VII 3.1-12).

Figures VII 3.1-13 to 3.1-15 show the 2001 heavy metal levels for lead, cadmium, and mercury.

Model for total Europe-wide deposition of oxidised sulphur and nitrogen and reduced nitrogen

The EMEP programme calculates the total (wet and dry) deposition over Europe, using atmospheric transport models. Emissions inventories, expressed in the EMEP grid (currently 50 x 50 km^2), are combined with meteorological transport models and parameterised chemical and deposition processes. The MSC-W (Meteorological Synthesis Centre West) in Oslo calculates deposition rates as the averages for elements in the grid used for emissions. The figures show the interpolated results.

Such a model not only calculates the overall deposition but also assigns depositions to specific emissions.

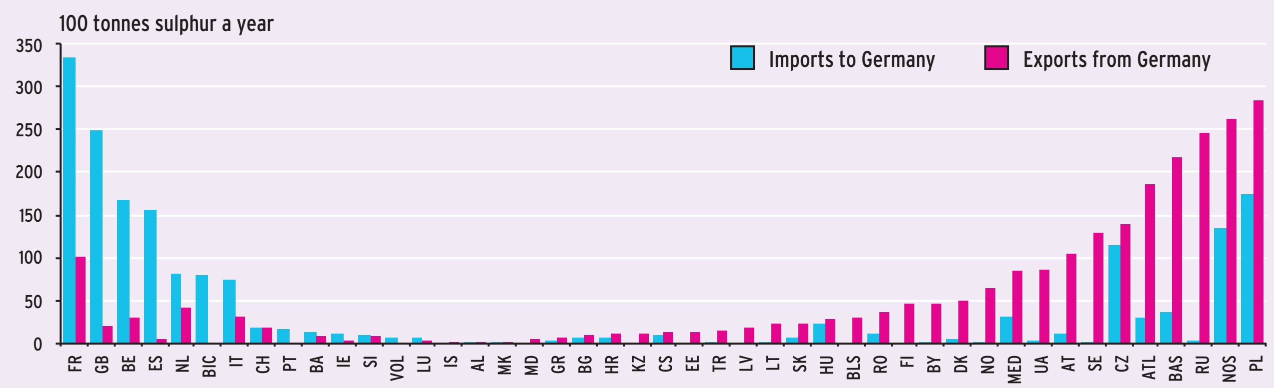
This makes it possible to test the effects of emissions reductions on deposition, for example, in especially sensitive areas.

The model's 2002 calculations for the total deposition of oxidised sulphur were 1–2 g/m^2·a S in large areas of east and southeast Europe and the Benelux countries, and also for parts of Great Britain, northern Spain, and northern Italy. For Germany, the EMEP model produced depositions of mostly 0.5–1 g/m^2/a S (and 1–2 g/m^2/a S for parts of west Germany). The calculated oxidised sulphur depositions for northern and southwestern Europe were well below this level (0.1–0.5 g/m^2/a). The highest depositions in Europe (above 2 g/m^2/a S) occurred in southeast Europe (e.g., the Balkan Peninsula, Romania, Bulgaria). High depositions of oxidised sulphur were also found on Sicily in 2002, as a consequence of local volcanic activity (Etna) (Fig. VII 3.1-16).

According to the 2002 EMEP calculations total depositions of oxidised sulphur of 0.5–1 g/m^2/a N_{ox} occur in, among other places, Great Britain, the Benelux countries, northern France, Germany, Poland, the Czech Republic, Slovakia, Austria, the west Balkan Peninsula, and Italy. Depositions of oxidised sulphur with values under 0.5 g/m^2/a N_{ox} were however calculated for large parts of western and eastern Europe (for Northern Scandinavia: below 0.1 g/m^2/a N_{ox}) (Fig. II 3.1-17).

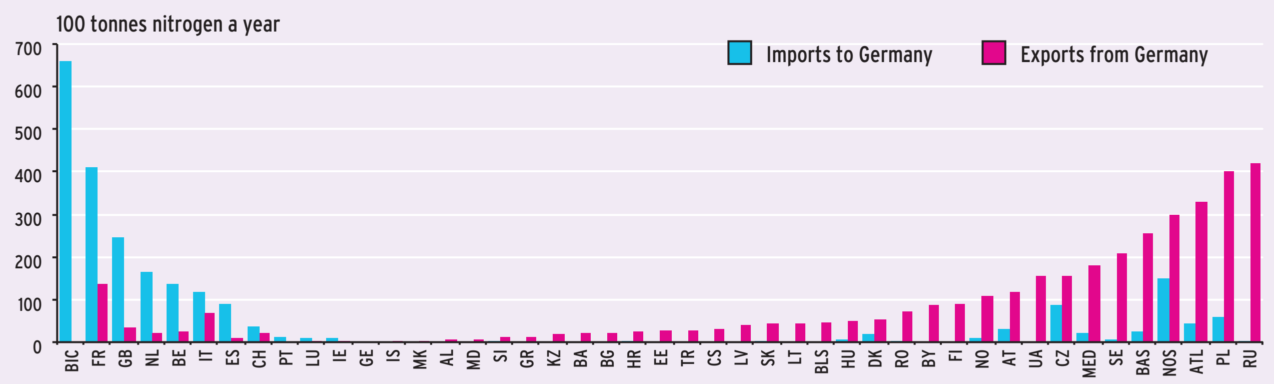
The highest depositions of reduced nitrogen (ammonia and ammonium) for 2002 occurred in the Netherlands, northwest and south Germany, Switzerland, northern Italy, and in parts of France (levels above 1 g/m^2/a N_{red}). The lowest deposition levels of reduced nitrogen were calculated for, among others, northern and southwest Europe (lev-

Fig. VII 3.1-10: *Balance of oxidised sulphur for Germany according to EMAP for 2000*



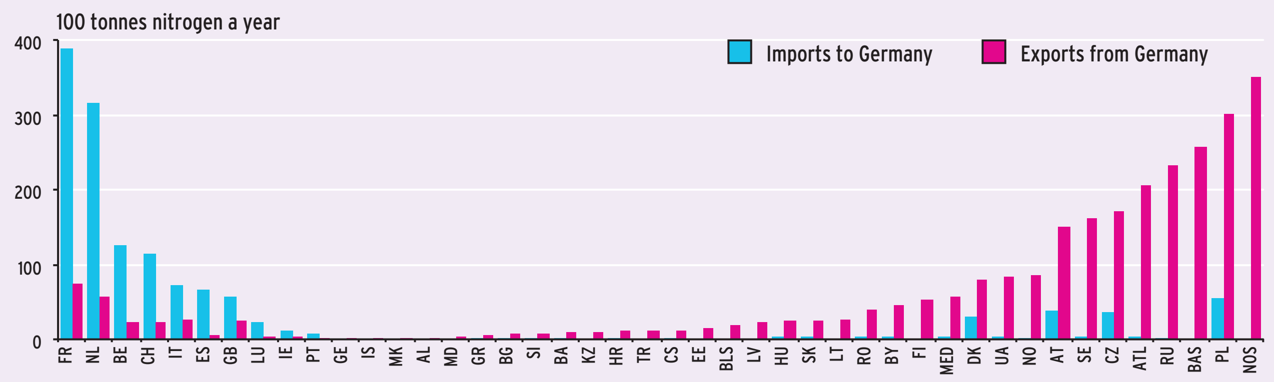
Source: *EMEP 2003 a*

Fig. VII 3.1-11: *Balance of oxidised nitrogen for Germany according to EMAP for 2000*



Source: *EMEP 2003 a*

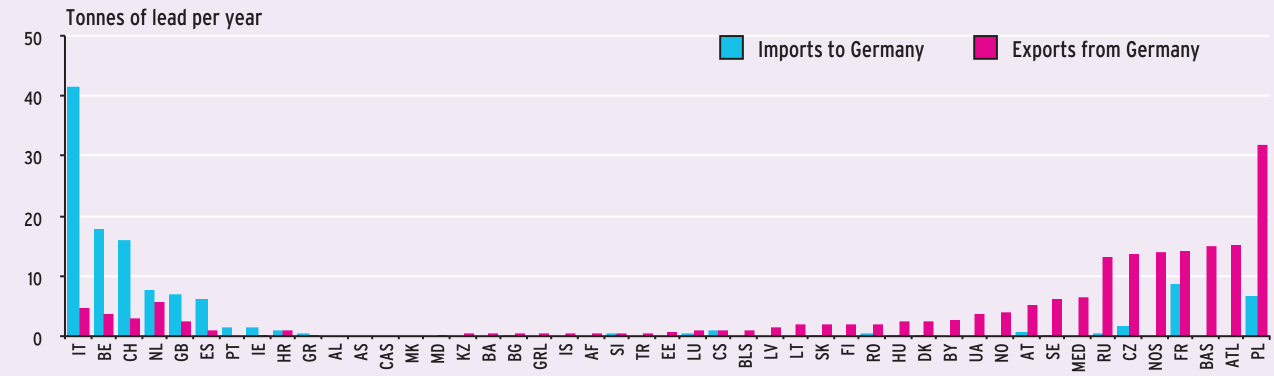
Fig. VII 3.1-12: *Balance of reduced nitrogen for Germany according to EMAP for 2000*



Source: *EMEP 2003 a*

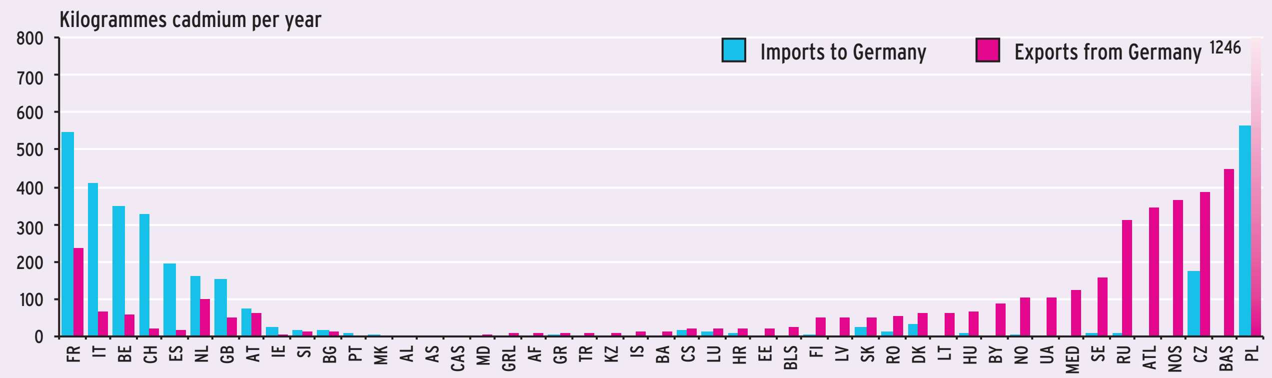
AF	Africa
AL	Albania
AM	Armenia
AS	Asia
AT	Austria
ATL	Atlantic
AZ	Azerbaijan
BA	Bosnia Herzegovina
BAS	Baltic Sea
BE	Belgium
BG	Bulgaria
BIC	non-European sources
BLS	Black Sea
BY	Belarus
CAS	Caspian Sea
CH	Switzerland
CS	Serbia and Montenegro
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
EU	EU
FI	Finland
FR	France
GB	Great Britain and Northern Ireland
GE	Georgia
GR	Greece
GRL	Greenland
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
KZ	Kazakstan
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Moldavia
MED	Mediterranean
MK	Macedonia
MT	Malta
NL	Netherlands
NO	Norway
NOS	North Sea
PL	Poland
PT	Portugal
RO	Romania
RU	Russia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UA	Ukraine
VOL	volcanic emissions

Fig. VII 3.1-13: *Lead – 2001 figures for Germany according to EMEP*



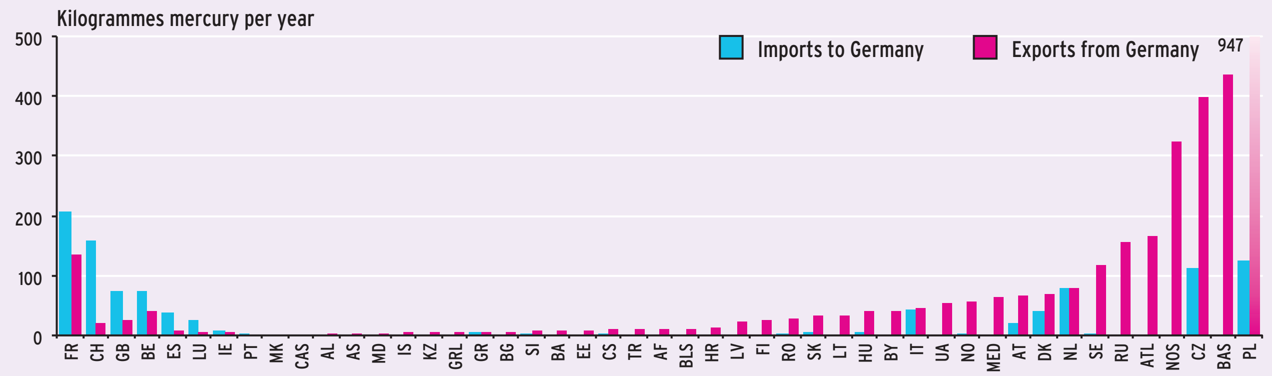
Source: *EMEP 2004*

Fig. VII 3.1-14: *Cadmium – 2001 figures for Germany according to EMEP*



Source: *EMEP 2004*

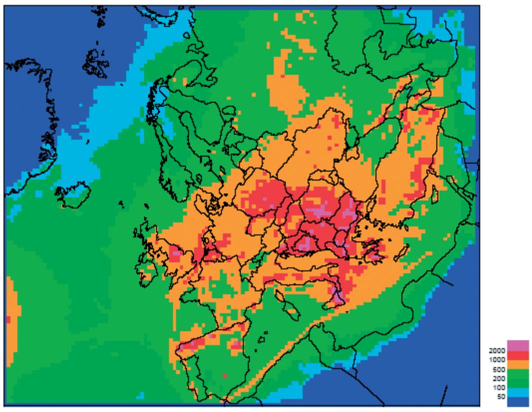
Fig. VII 3.1-15: *Mercury – 2001 figures for Germany according to EMEP*



Source: *EMEP 2004*

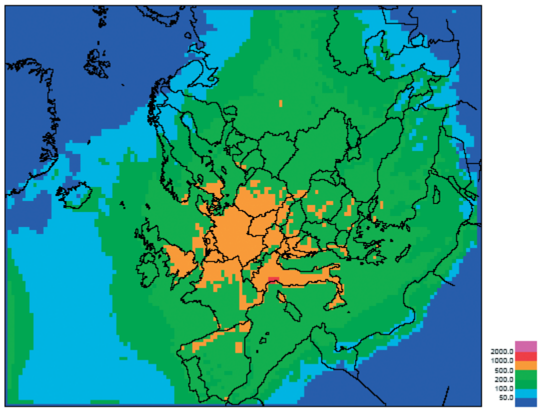
AF	Africa
AL	Albania
AM	Armenia
AS	Asia
AT	Austria
ATL	Atlantic
AZ	Azerbaijan
BA	Bosnia Herzegovina
BAS	Baltic Sea
BE	Belgium
BG	Bulgaria
BIC	non-European sources
BLS	Black Sea
BY	Belarus
CAS	Caspian Sea
CH	Switzerland
CS	Serbia and Montenegro
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
EU	EU
FI	Finland
FR	France
GB	Great Britain and Northern Ireland
GE	Georgia
GR	Greece
GRL	Greenland
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
KZ	Kazakstan
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Moldavia
MED	Mediterranean
MK	Macedonia
MT	Malta
NL	Netherlands
NO	Norway
NOS	North Sea
PL	Poland
PT	Portugal
RO	Romania
RU	Russia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UA	Ukraine

Fig. VII 3.1-16: *Sulphur depositions model for 2002 (in mg/m² S)*



Source: *EMEP 2004 a*

Fig. VII 3.1-17: *Oxidised nitrogen depositions model for 2002 (in mg/m² N)*



Source: *EMEP 2004 a*

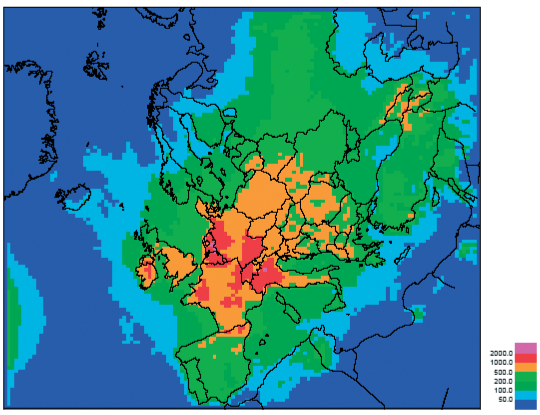
els above 0.1–0.5 g/m²/a N_{red} – for northern Scandinavia below 0.1 g/m²/a N_{red}) (Fig. VII 3.1-18).

Wet deposition of acids and acidifying compounds at UBA measuring stations

Long-term measurements of daily samples in the FEUBA network of measuring stations (Fig. VII 3.1-19) have shown that the concentrations and deposition of a number of ions in precipitation fell significantly between 1982 and 2003.

At the five stations in the old *Länder* (Westerland, Waldhof, Deuselbach, Schauinsland, and Brotjacklriegel), pH values in precipitation rose from approx. 4.3–4.4 to 4.8–5.0 (Fig. VII 3.1-20). A rise in pH corresponds to a fall in the concentration of hydrogen ions (H^+), and rain is therefore less acidic now than in the early 1980s. Although monitoring at the three stations in the new *Länder* (Zingst, Neuglobsow, Schmücke) has only been conducted for 10 years, a fall in pH has also been observed there.

Fig. VII 3.1-18: *Reduced nitrogen depositions model for 2002 (in mg/m² N)*

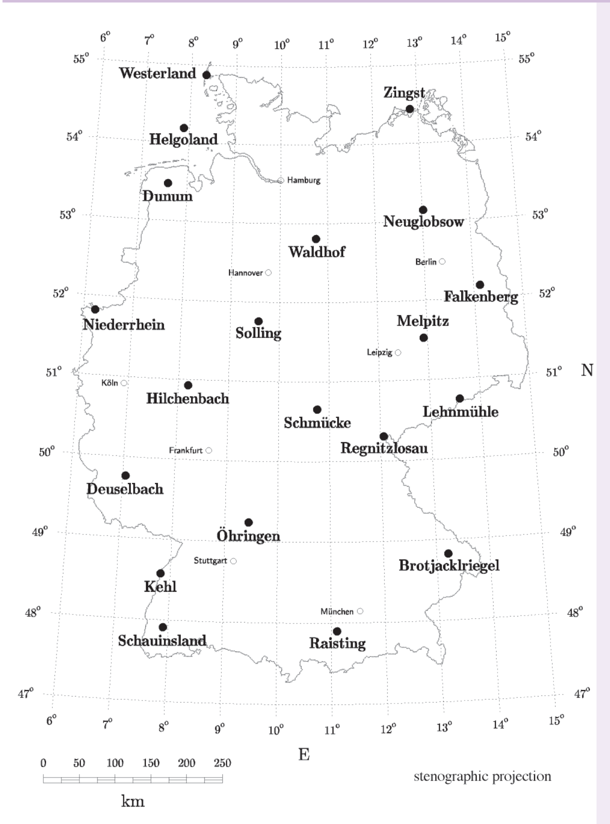


Source: *EMEP 2004 a*

Today's pH values are within a natural range, i.e., that which might be expected in central Europe without the influence of human activity, between 4.6 and 5.6. On the other hand, concentrations of some substances in large areas of central Europe are well above natural levels.

In parallel to the rise in pH values, the total ion content in precipitation, and thereby its specific conductivity, fell significantly at the stations in the old *Länder* between 1982 and 2003, except for West-

Fig. VII 3.1-19: *UBA measuring network deposition measuring points*



Source: *Federal Environment Agency 2004*

erland, where the total ion content of precipitation is more or less due to sea salt, and the fall was therefore only slight. A fall was also observed between 1993 and 2003 at the three stations (Zingst, Neuglobsow, Schmücke) and in the New *Länder* (Fig. VII 3.1-21).

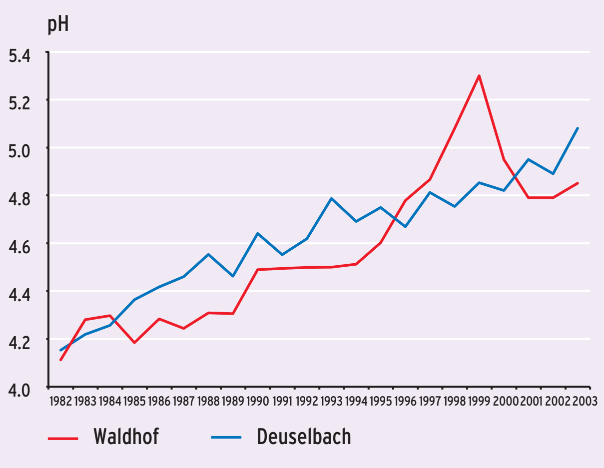
The drop in total ion content of rain water over the past two decades has been accompanied by a change in the regional distribution of different ions. At continental stations (Waldhof, Deuselbach, Schauinsland, and Brotjacklriegel), the percentage shares of H^+ and SO_4^- ions observed in 2003 were lower than those in 1984, while those of NO_3^- and NH_4^+ were higher (although absolute concentrations had fallen). The lower total ion concentrations and the shift in the distribution of ions are essentially due to greater reductions in SO_2 emissions than in NO_x and NH_3.

Concentrations of H^+ and SO_4^- fell most sharply, by 80 % and 70 % respectively, between 1982 and 2003. There was a fall of approximately 20–40 % in nitrate and ammonium concentrations. Figures VII 3.1-22 and VII 3.1-23 show concentrations and depositions between 1982 and 2003 as rainfall-weighted averages of five stations (Westerland, Waldhof, Deuselbach, Schauinsland, and Brotjacklriegel), normalised relative to 1982.

VII 3.2 Agricultural and horticultural soil contamination caused by fertilisers

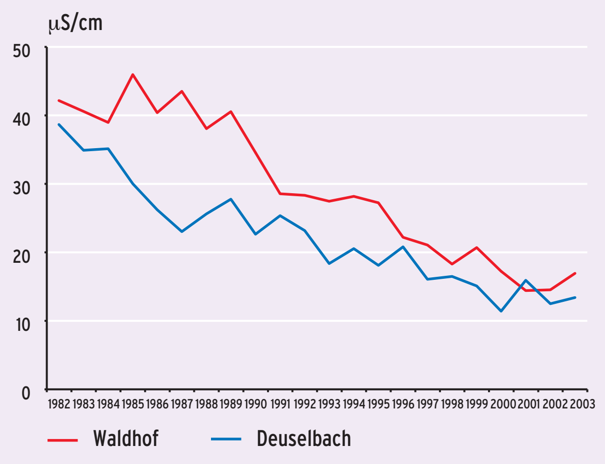
On the basis of decisions reached at the joint Agriculture and Environment Ministers' Conference on 13 June 2001 in Potsdam which states "it must be guaranteed on grounds of precaution, that cultivation practices do not give rise to an accumulation of

VII 3.1-20: *pH value development in precipitation*



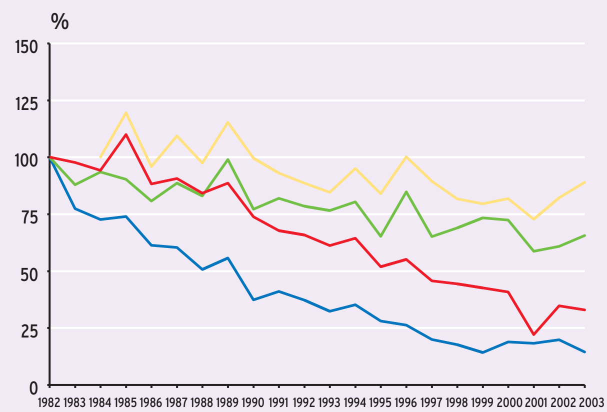
Source: *Federal Environment Agency 2004*

Fig. VII 3.1-21: *Conductivity development in precipitation*



Source: *Federal Environment Agency 2004*

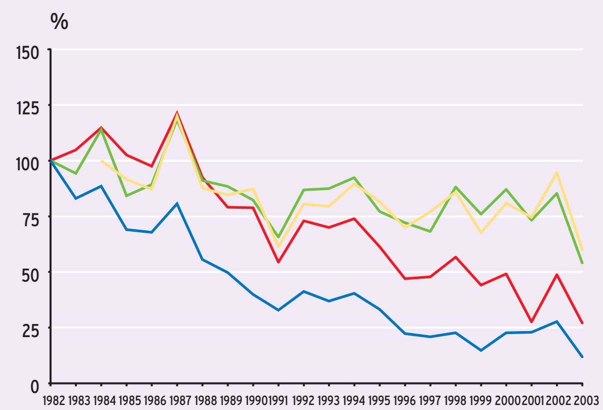
VII 3.1-22: *Development of ion concentrations*



Note: With the weighted annual mean precipitation values from the UBA measuring stations Westerland, Waldhof, Deuselbach, Brotjacklriegel and Schauinsland, normalised relative to 1982

Source: *Federal Environment Agency 2004*

VII 3.1-23: *Wet deposition development*



Note: With the weighted annual mean precipitation values from the UBA measuring stations Westerland, Waldhof, Deuselbach, Brotjacklriegel and Schauinsland, normalised relative to 1982

Source: *Federal Environment Agency 2004*

contaminants in the soil" and the new requirements of the Federal Soil Protection Act, the Federal Environment Ministry (BMU) and the Federal Ministry of Food, Agriculture and Consumer Protection (BMVEL) produced a concept for a uniform assessment of fertilisers on 3 June 2002 – "high quality and safe yields". The calculations for permissible heavy metal levels in the affected materials are based on the soil precautionary values for the individual soil types as a standard for high soil quality. The values of the following control mediums were determining factors, following the "part for part" and "input equals output" principles:

- share remaining in the soil over the long-term,
- plant degradation,
- nutrient content,
- research errors.

Contamination of agricultural and horticultural soil caused by biowaste

Levels of biowaste have risen sharply since the Technical Instructions on Municipal Waste came into effect on 1 June 1993 (Chapter X 2.2). In Germany, approx. 900 biowaste treatment plants process around 12 million t of biowaste a year (including biodegradable agricultural material [1]). The Compost Quality Assurance Organisation (BGK) inspected 436 plants from 2004 using RAL quality controls, (set forth by the Deutsches Institut für Gütesicherung und Kennzeichnung e.V.). The secondary recycled fertilisers produced by these plants are potentially available for agricultural and horticultural organic fertilisation.

Every year, 4.8 million t of biowaste compost and 2.6 million t of biowaste fermentation products are produced. The five most significant sales areas are listed in Table VII 3.2-1 [2].

Tab. VII 3.2-1: *Sales areas for compost*

Sales areas in percent	
Agriculture	39
Horticulture and landscaping	17
Leisure gardens	9
Earthworks	10
Specialized crops	13

Source: *Bergs, C. G. 2000*

Since 1998, compost use in agriculture, forestry and horticulture has been regulated by the Ordinance on Biowastes (BioAbfV), which sets limit values on the heavy metal contents of recycled biowaste, based on quantities applied within a specific period (Tab. VII 3.2-2). If no more than 20 t biowaste per hectare (dry weight) are applied within three years, the limit values in column A apply. These limits correspond to the RAL quality seal for compost (RAL-GZ 251) reference values. If the quantities spread are up to 30 t dry weight per hectare over three years, the limit values in column B apply.

Tab. VII 3.2-2: *Limit values for heavy metals in bio-waste*

in mg/kg TS	A	B
Lead	150.0	100.0
Cadmium	1.5	1.0
Chrome	100.0	70.0
Copper	100.0	70.0
Nickel	50.0	35.0
Mercury	1.0	0.7
Zinc	400.0	300.0

DS = Dry solid

Source: *Ordinance of Biowaste (BioAbfV), 1998*

A study initiated by the Federal Environment Agency (UBA) on compost quality in the plants merged under BGK for 1998 to 2002 [3] obtained the following results: in comparison to levels before the Ordinance on Biowastes came into effect, an increase in quality of over 10 % was established. This is a result of the increase in nutrients and a reduction in lead, mercury, and cadmium. Higher organic matter contents were most often connected to decreasing concentrations of heavy metals. Around 18 % of all plants taking part in the study did not remain within the limit values stated in BioAbfV Article 4 (3), clause 2. In terms of the value recommendations revised by the UBA for an article regulation, 95 % of all plants are anticipated to fulfil the expected quality demands for material recycling (Tab. VII 3.2-3).

Contamination of agricultural and horticultural soil caused by semi-liquid manure

Semi-liquid manure is produced in strawless housing used in modern animal husbandry. Improper application, i.e., application under inappropriate weather conditions and incorrect application amounts can lead to the leaching of easily soluble nutrients in the soil. Table VII 3.2-4 shows the nutrient contents of the different semi-liquid manure types.

Besides nutrients, semi-liquid manure also contains inorganic and organic contaminants. Table VII 3.2-5 shows the heavy metal contents of cow and pig semi-liquid manure. Particularly problematic are high levels of copper and zinc originating in foodstuffs.

Besides heavy metals, semi-liquid manure contains a variety of organic contaminants, originating in animal foodstuffs or housing hygiene.

Under the UBA research programme "Characterisation and evaluation of waste from intensive live-

Tab. VII 3.2-3: *Development of compost quality*

Analysis-Parameter		1991 Average n = 153	1995 Average n = 488	2002 Average n = 376
Germinating seeds	per l FM	0.09	0.19	0.08
Impurities	% TM	0.23	0.16	0.20
Stone	% TM	2.53	1.94	1.74
Heat loss	% TM	36.30	36.50	37.30
Nges	% TM	1.03	1.25	1.52
P_2O_5ges	% TM	0.52	0.63	0.83
K_2Oges	% TM	0.85	1.04	1.26
Mgges	% TM	0.50	0.74	0.84
CaOges	% TM	3.55	4.35	4.79
Nloes	mg/l FM	114.49	235.89	402.10
Ammonium	mg/l FM	505.00	125.41	295.40
Nitrate	mg/l FM	64.00	66.95	92.40
P_2O_5loes	mg/l FM	815.94	942.09	1 068.00
K_2Oloes	mg/l FM	1 952.15	3 149.81	4 101.00
Mgloes	mg/l FM	433.62	243.45	227.00
Lead	mg/kg TM	63.21	59.32	46.40
Cadmium	mg/kg TM	0.79	0.60	0.47
Chrome	mg/kg TM	33.02	26.37	25.30
Copper	mg/kg TM	39.32	45.53	57.70
Nickel	mg/kg TM	18.58	16.28	16.30
Mercury	mg/kg TM	0.25	0.19	0.16
Zinc	mg/kg TM	182.93	196.68	203.70

FM = Fresh weight; TM = Dry weight; n = number of assessments; ges: Total; loes: soluble

Source: *Compost Quality Assurance Organisation 2002*

Tab. VII 3.2-4: *Nutrient contents for different fertilisers[1] in g/kg m_T*

Fertiliser given as:	Nitrogen N	Phosphate P_2O_5	Potassium K_2O
Cow semi-liquid manure	50	23.0	65.9
Pig semi-liquid manure	105	57.7	69.4

[1] According to bibliographical references and Länder surveys; an average content for organic fertiliser derived from these references is given. Please note that the underlying data sometimes obtains quite considerable fluctuations. These are not presented here since they are are negligible with regard to the model differentiations.

Source: *Federal/Länder Working Group on Soil Conservation 2000*

stock farming in various soil types" [4], statistics were recorded for veterinary medical products and substances with pharmacological effects used in the Weser-Ems region. The aim of the project was to assess the extent to which these preparations can lead to harmful changes in the soil and groundwater pollution. The study focused on the quantification of inputs of contaminants into the soil via veterinary medical products and animal feed chemical additives with so-called pharmacological effects.

Tetracycline represents the most significant class of substances, with a 58 % antibiotic level. Sulfanamide (21 %), aminoglycoside (10 %), b-lactam (5 %), and polymixin (3 %) are also noteworthy. 78 % of the tetracycline use is attributable to pig farming.

Exposure assessments under worst-case scenarios for excretion and persistence following EMEA/CVMP revealed final concentrations of approximately 20 ppm in semi-liquid manure (fattening pigs) and 90 ppm in solid manure (fattening turkeys) for once only stand treatment under average dosage. Administration of permitted levels in line with the Use of Fertilisers Ordinance (Dünge VO) obtained PECs (predicted environmental concentrations) in the soil at 0.45 and 0.9 ppm. These are well over the trigger values. Further ecotoxicological studies are being planned in response to such contraventions, in accordance with approval guidelines in effect since 1998 (EMEA/CVMP Guideline).

Tab. VII 3.2-5: *Heavy metal contents for different fertilisers[1]*

Fertiliser	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Cow semi-liquid manure	0.28	7.3	44.5	0.06	5.9	7.7	270
Pig semi-liquid manure	0.40	9.4	309.0	0.02	10.3	6.2	858

[1] According to bibliographical references and Länder surveys; an average content for organic fertiliser derived from these references is given in mg/kg m_T.

Source: *Federal/Länder Working Group on Soil Conservation 2000*

Tetracycline in excrement and urine is characterised by a significant increase up to the last day of administration and then falls back again sharply. Some animals are however still able to excrete significant levels of TC over longer periods. Up to 70 % of the administered active substances were found on the seventh day after administration.

Contrary to the results of other studies [5], tetracycline displayed a high stability in pig semi-liquid manures. The maximum reduction was 50 % over a period of 7 weeks. Chemical concentration, ambient temperature or air entry through occasional agitation had little influence on storage behaviour. In test container sediments rich in solids, the TC concentrations were 3 to 5 factors higher than in the liquid phase.

The Federal Environment Agency research project on "inputs of substances in soils – an assessment of hazard potential", cleaning and disinfecting agents used in agriculture were also examined. In terms of quantity, these use-specific synthetic chemicals occupy third place after commercial fertilisers and plant protection products.

Table VII 3.2-6 presents the results of a poll answered by associations, research institutions, dealers, and manufacturing companies on the quantitative use of cleaning and disinfecting agents in 1997.

- *Cleaning and disinfecting agents:* the most significant group in terms of quantity is cleaning and disinfecting agents for milking plants. It deals with concentrates or powders used in diluted solutions. Sodium chloride and dichlorisocyanurate from milking plant cleaners can lead to additional AOX-contamination in sewage sludge and semi-liquid manure.
- *Teat dip preparations containing iodine:* iodine-based teat dip preparations follow in second place. These are not usually diluted down. Nonylphenolethoxylate from teat dip preparations can lead to maximum nonylphenol levels of 0.9 mg/kg TS in cow semi-liquid manure and nonylphenol concentrations of around 3–4 mg/kg can occur in sewage sludge. This represents a nonylphenol content of around 15 % in sewage sludge.
- *Copper sulphate in hoof disinfection:* the use of copper sulphate powder is estimated at 1000 t/a where a 5–10 % aqueous solution is used in preventative disinfection and hardening of cow hooves. Copper sulphate solution leads to heavy metal contamination of semi-liquid manure and thereby of the soil. 1000 t copper sulphate contains (approximately) 250 t copper which amounts to 7 % (approx. 3500 t) of annual total copper inputs in agricultural soil. Local peak contents can be well over this mean value, in some cases over the alternative sewage sludge limit value of 800 mg/kg TS.
- *Disinfection of livestock housing:* between 800 and 900 t/a livestock housing disinfectants (commercial ready-preparations) are in use. Their commercial concentrations are between 1 and 4 percent volume. Quarternary ammonium compounds (QAC) disinfectants, except those originating in milk plant cleaners and livestock housing, do not lead to toxic risks in cow and pig semi-liquid manure. Poultry semi-liquid manure however can attain QAC concentrations of 100 mg/kg TS.
- *Cyanamide solution for semi-liquid manure disinfection:* in incidents of disease which must be reported, the semi-liquid manure is disinfected using organic chemicals such as formaldehyde, peracetic acid, formic acid, and calcium cyanamide. Moreover, inorganic preparations containing calcium and sodium hydroxide are employed but which are not referred to again in this connection. There are only rough estimates on usage amounts for the substances mentioned above due to irregular utilisation requirements. Permissible annual consumption levels of formaldehyde and calcium cyanamide in semi-liquid manure decontamination are around the 1000 t mark. Approx. 250 t cyanamide is routinely employed for killing pathogenic germs and fly eggs in the semi-liquid manure channel of livestock housing.

Contamination of agricultural and horticultural soil caused by sewage sludge

In 2003 2172 million t of dry solids were accumulated.

Tab. VII 3.2-6: *Cleaning and disinfecting agent groups in agricultural animal husbandry*

Application	t/a	Information sources
Cleaning and disinfecting agents for milking plants	22 000	Milk plant cleaning agent manufacturers
Teat dip preparations containing iodine	3 500	Teat dip preparation manufacturers
Copper sulfate for hoof disinfection	1 000	Primarily chemical dealers
Disinfection of livestock housing	860	Manufacturers of livestock housing disinfecting agents
Organic semi-liquid manure disinfectants	< 1 000	Primarily Hohenheim University
Cyanamide solution for semi-liquid manure disinfection	250	Primarily Hohenheim University

Source: *Kaiser et al. 1998*

These amounts were evaluated as follows:
- agricultural use 44 %
- landscaping 12 %
- composting 10 %
- incineration 23 %
- landfilling 11 %

The sewage sludge regulation [6] stipulates limit values for contaminants in sewage sludge for application on agricultural or horticultural land.

Contaminants:
- heavy metals (lead, cadmium, chromium, copper, nickel, mercury, and zinc),
- polychlorinated dibenzodioxins and dibenzofuranes (PCDD/Fs),
- polychlorinated biphenyls (PCBs),
- total parameters of adsorbable organic halogens (AOXs).

Tables VII 3.2-7 and VII 3.2-8 show the average concentrations of heavy metals and organic compounds in sewage sludge for agricultural use from 1991 to 2003, as well as the corresponding limit values set by the sewage sludge regulation (AbfklärV).

Tab. VII 3.2-7: *Average heavy metal concentrations in agriculturally employed sewage sludge (mg/kg TM)*

	1991–1994	1995	2001	2003	Limit value in accordance with sewage sludge ordinance (AbfklärV)
Lead	93.0	73.0	48.5	48.0	900.0
Cadmium	2.1	1.5	1.1	1.1	10[1)]
Chrome	59.0	52.0	37.4	42.0	900.0
Copper	286.0	277.0	300.6	305.0	800.0
Nickel	31.0	24.0	26.0	27.0	200.0
Mercury	2.1	1.3	0.8	0.7	8.0
Zinc	1076.0	863.0	774.0	746.0	2 500[1)]

[1)] In accordance with AbfkläV, the limit value for light soils with a clay content < 5 % or a pH-Value 5–6 is Cd = 5 and Zn = 2000.

Source: *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2004*

Compared to the 1991 to 1994 period, average heavy metal contents exhibit a downwards trend (except copper) up to 2003, as do average organic chemical contents in sewage sludge.

Contamination of agricultural and horticultural soil caused by mineral fertilisers

Besides actual nutrients, mineral fertilisers contain variously high levels of contaminants (particularly heavy metals) depending on raw materials and production process.

Tab. VII 3.2-8: *Average concentrations of organic compounds in sewage sludge for agricultural use (mg/kg TM)*

Parameter	1994	2000	2003	Limit value in accordance with sewage sludge ordinance (AbfklärV)
PCDD/F (ng TE/kg TM)	22	9.6	9.5	100
PCB 28	0.015	0.0059	0.0077	0.2
PCB 52	0.015	0.0062	0.0085	0.2
PCB 101	0.024	0.0113	0.0200	0.2
PCB 138	0.039	0.0187	0.0187	0.2
PCB 153	0.039	0.0206	0.0195	0.2
PCB 180	0.026	0.0141	0.0138	0.2
Total PCB		0.0748	0.0835	
AOX	206	175.6	171.9	500

Source: *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 2004*

Various independent studies have been carried out on chemical contamination. The Federal Environment Agency first provided an overview of the different fertilisers in its 1992 study "Heavy metals and other contaminants in fertilisers" [7]. There are no new studies to date. More recent papers dealing with heavy metals in agriculture cite the results of the UBA study [8], [9].

Subsequently, only fertilisers for the main nutrients have been considered.

Nitrogen fertilisers

Pure N fertilisers reveal only low levels of heavy metal contamination. In contrast, high heavy metal contents are expected where P components are mixed into NP and NPK fertilisers, particularly with regard to cadmium, chromium, copper, nickel, and zinc. Heavy metal content is on average lower in NPK fertilisers as the mixed in potash components reveal lower levels of heavy metal contamination, resulting in lower levels of total heavy metal contamination [10].

Heavy metal contents of the main nitrogen fertilisers are listed in Table VII 3.2-9.

Phosphate fertilisers

In view of their impact on soil, differentiation must be drawn between soluble phosphates (for example

Tab. VII 3.2-9: *Heavy metal contents for different nitrogen fertilisers[1)] in g/kg m_T*

Fertiliser	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Calcium ammonium nitrate	0.25	8.70	4.00	0.02	3.80	21.40	38.30
Ammonium nitrate – urea solution	0.03	1.30	6.30	0.30	0.20	2.30	
Urea	0.13	0.50	0.50		0.70	0.60	1.90
Mineral. NPK-fertiliser, 15/15/15 and others	3.78	45.80	11.30	0.06	10.90	14.80	116.00
Mineral. NP-fertiliser, 20/20/0 and others	9.15	91.40	21.50	0.02	18.00	5.50	151.00
Limit value in accordance with fertiliser ordinance (DüMV)	**1.5**	**2.0[2)]**	**70**	**1**	**80**	**150**	**1 000**

[1)] According to bibliographical references and Länder surveys; an average content derived from these references is given. Please note that the underlying data sometimes obtains quite considerable fluctuations. These are not presented here since they are negligible with regard to the model differentiations.
[2)] Only applies to fertilisers originating in combustion processes. As Cr(VI).

Source: *Federal/Länder Working Group on Soil Conservation 2000*

superphosphates) and non-soluble phosphates (for example rock phosphates). The various rock phosphates display wide ranges of fluctuation in their heavy metal contents, depending on their rock phosphate deposits. Heavy metal contents in primary deposits (from magma) are lower than those of secondary phosphate deposits (from organic deposits) [11]. Besides high chromium contents in basic slag, a by-product of iron ore smelting with limited uses, P fertilisers can have significantly high cadmium contents.

Two studies were commissioned by the EU Commission to test the health risks and environmental impacts of cadmium in fertilisers, principally P fertilisers in EU Member States. Nine Member States carried out independent studies.

The Scientific Committee for Toxicity, Ecotoxicity and the Environment (SCTEE) study, commissioned by some of the Member States, obtained the following results:

- Only relatively slow accumulation tendencies in soil is anticipated for weak concentrations of cadmium in fertilisers (1...20 mg Cd/kg P_2O_5) or at best a reduction through higher output than input levels over a period of 100 years.
- In contrast, a relatively high accumulation on arable land is estimated for high cadmium concentrations in fertilisers (> = 60 mg Cd/kg P_2O_5) over a period of 100 years.

The results of the EU Member States' independent study on the risk assessments led to the adoption of the SCTEE recommendations. Fertilisers with < = 20 mg Cd/kg P_2O_5 cadmium concentrations do not cause long-term accumulation of cadmium in soil, as long as no other significant input paths exist. Fertilisers with cadmium concentrations of > = 60 mg Cd/kg P_2O_5 result in a greater likelihood of long-term accumulation of cadmium in soil.

Heavy metal levels of the main phosphate fertilisers are listed in Table VII 3.2-10. In accordance with the

Tab. VII 3.2-10: *Heavy metal contents for different phosphate fertilisers[1)] in g/kg m_T*

Fertiliser	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Superphosphate	10.8	114	17.2	n. b.	28.8	18.5	236
Triple superphosphate	26.8	288	27.3	0.04	36.3	12	489
various rock phosphates[2)]	7.8	168	15.6	n. b.	15.6	1.3	199
Mineral. NPK-fertiliser, 15/15/15 and others	3.78	45.8	11.3	0.06	10.9	14.8	116
Mineral. NP-fertiliser, 20/20/0 and others	9.15	91.4	21.5	0.02	18	5.5	151
Mineral. PK-fertiliser, 0/15/20 and others	7.98	191	19.3	0.08	19.9	14.4	152
Limit value in accordance with fertiliser ordinance (DüMV)	**1.5**	**2 [3)]**	**70**	**1**	**80**	**150**	**1 000**

[1)] According to bibliographical references and Länder surveys; an average content derived from these references is given.
[2)] Depending on origin, there are quite significant cadmium content widths of spread for rock phosphates: 2–80 mg P_2O_5/kg m_T. Only those phosphates with a content below 40 mg P_2O_5/kg m_T are presently used in the fertilser manufacturing process.
[3)] Only applies to fertilisers originating in combustion processes. As $Cr^{(VI)}$.

Source: *Federal/Länder Working Group on Soil Conservation 2000*

September 2004 Fertiliser Ordinance, a cadmium limit value of 50 mg Cd/kg P_2O_5 applies in Germany for fertilisers with 5 % P_2O_5 and above.

Potassium fertilisers

Potash ores contain very low heavy metal contents. The problems outlined above regarding high chromium contents in P fertilisers apply to potassic basic slag. Pure potassium fertilisers however only have limited application uses.

Heavy metal levels of the main potassium fertilisers are shown in Table VII 3.2-11.

[1] Körschens, M., Reinhold, J.: Einordnung von Komposten in die „Gute fachliche Düngungspraxis" unter besonderer Berücksichtigung der Humusversorgung landwirtschaftlicher Böden. Unpublished 2004
[2] Bergs C. G. (2000): Rechtliche Grundlagen für die Verwertung von Komposten und anderen Bioabfällen im Landbau, Müllhandbuch, code 6502
[3] Reinhold, J. (2004): Neubewertung von Kompostqualitäten. UBA Texts 15/04
[4] Winkler, C., Grafe, A. (2000): Charakterisierung und Verwertung von Abfällen aus der Massentierhaltung. UBA Texts 44/2000
[5] Kühne und Aghte (1998): Personal communication in Charakterisierung und Verwertung von Abfällen aus der Massentierhaltung, UBA Texts 44/2000
[6] Sewage sludge ordinance (AbfKlärV), 15 April 1992 (BGBl I 1992 page 912; 1997 page 446)
[7] Boysen, P. (1992): Schwermetalle und andere Schadstoffe in Düngemitteln. UBA Texts 55/92
[8] KTBL (1995): Schwermetalle in der Landwirtschaft. Working paper 217
[9], [10], [11],LABO (2000): Kadmiumanreicherung in Böden/einheitliche Bewertung von Düngemitteln. UMK-AMK-LABO-AG report, presented by 26th ACK.

VII 3.3 Contaminated sites

The Federal Soil Protection Act (BBodSchG) introduced legal definitions for a number of terms connected with contaminated sites:

- suspected sites are lands suspected to contain harmful soil changes.
- sites suspected of being contaminated are former waste disposal sites and former industrial sites that are suspected to contain harmful soil changes or other hazards for individuals or the general public.
- contaminated sites, for example
  - closed-down waste management installations, and other real properties, in/on which waste has been treated, stored or landfilled (old landfill sites), and
  - properties that house closed-down installations, and other properties, on which environmental pollutants have been handled, except for installations that can be closed down only under a license pursuant to the Atomic Energy Act (former industrial sites), that cause harmful soil changes or other hazards for individuals or the general public.
- protection and restriction measures are other measures that prevent or reduce hazards, considerable disadvantages or considerable nuisances for individuals or the general public, especially usage restrictions.
- remediation refers to measures
  - that eliminate or reduce pollutants (decontamination measures),
  - that prevent or reduce spreading of pollutants in a lasting way, without eliminating the pollutants themselves (securing containment measures),
- that eliminate or reduce harmful changes in the soil's physical, chemical, or biological characteristics.

VII 3.4 Registration of contaminated land, risk assessment, site decontamination

Table VII 3.4-1 shows progress made in discovering and processing sites suspected of being contaminated and contaminated sites in Germany.

To facilitate comparison, nation-wide statistics on contaminated sites are being published in line with the following agreed classifications:

Tab. VII 3.2-11: *Heavy metal contents for different potash fertilisers[1] in g/kg m_T*

Fertiliser	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Min. NPK fertiliser, 15/15/15 and others	3.78	45.8	11.3	0.06	10.9	14.8	116.0
Min. PK fertiliser, 0/15/20 and others	7.98	191.0	19.3	0.08	19.9	14.4	152.0
Potassic basic slag	0.30	928.0	19.0	n. b.	3.0	4.0	9.0
Potassium chloride, 40+6	0.08	3.5	2.9	0.02	1.5	0.5	3.7
Potassium sulphate with Mg, potassium magnesium sulphate	0.11	5.2	3.6	n. b.	4.1	2.5	17.4
Limit value in accordance with fertiliser ordinance (DüMV)	**1.5**	**2.0[2]**	**70**	**1**	**80**	**150**	**1 000**

[1] According to bibliographical references and Länder surveys; an average content derived from these references is given. Please note that the underlying data sometimes obtains quite considerable fluctuations. These are not presented here since they are negligible with regard to the model differentiations.
[2] Only applies to fertilisers originating in combustion processes. As Cr(VI).

Source: *Federal/Länder Working Group on Soil Conservation 2000*

Tab. VII 3.4-1: *Nation-wide overview of contaminated sites statistics*

	As on	Suspected contaminated sites	Old landfill sites (AA)	Abandoned industrial sites (AS)	Contaminated sites	Decontamination complete	Risk assessment complete	Decontamination in progressg	Monitoring
serial number		1	1.1	1.2	2	3	4	5	6
Baden-Württemberg	12/2003	10 118	2 644	7 474	758	878	6 278	562	71
Bavaria	03/2003	13 930	10 193	3 737	1 449	727	3 042	1 427	22
Berlin	02/2004	2 711	857	2 322	439	49	k. A.	69	54
Brandenburg	12/2003	20 080	6 703	13 377	959	2 244	k. A.	59	309
Bremen	06/2003	2 965	55	2 910	101	307	499	56	62
Hamburg	1/2004	2 317	420	1 933	236	347	3 070	54	34
Hesse	03/2004	666	316	350	444	228	582	659	125
Mecklenburg-Western Pomerania	12/2003	8 546	3 648	4 898	642	742	596	256	355
Lower Saxony	02/2004	39 876	8 976	30 900	884	582	965	222	80
North Rhine-Westphalia	12/2001	42 868	18 337	24 642	1 917	2 901	8 915	1 843 675	1 575
Rheinland-Palatinate	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.	k.A.
Saarland	03/2004	1 807	1 671	136	412	26	588	28	139
Saxony	04/2003	30 073	7 655	22 418	1 630	2 837	7 828	1 151	1 538
Saxony-Anhalt	11/2003	19 443	5 985	13 958	104	617	1 470	44	4
Schleswig-Holstein	12/2002	18 508	2 412	16 096	162	624	1 726	86	k.A.
Thuringia	11/2003	16 650	5 556	11 094	458	489	1 612	109	9

Notes on figures for individual Länder:
(serial numbers relate to tables above.)
Baden-Württemberg: serial no. 6: monitoring figures apply only to decontaminated site aftercare measures.
Bavaria: no footnotes for ID codes. Additional information on agreed official descriptions in accordance with paragraph 9, clause 1 BBodSchG: 4565 (AA 2 032/AS 2 533).
Berlin: serial nos. 1, 2 and 6: Evaluation possible as information in Berlin soil land register but many districts have not yet contributed to this. 5152 of 7894 land register sites are currently classified according to BBodSchG.
Serial nos. 1.1 and 1.2: limited evaluation possible as corresponds to a link between “suspected contaminated sites” and “case category”. Duplicate terms cannot be ruled out. Reason: several case categories can apply to one site. The total number of “industrial site” and “old landfill site” case categories is therefore larger than the number of “suspected contaminated sites”.
Serial no. 3: Serial no. 3: this information relates to contaminated sites which have been completely decontaminated and cleaned up. The Land of Berlin does not regard this information as discriminatory. Many decontamination measures are carried out path-specifically, on sub-plots and/or accompanied by building work. It is not clear whether the measure, i.e. partial or complete clearance of a site, is superficially responsible for harmful soil changes or contamination. In such cases the figures would rise: partial decontamination: 110, clearance via GW path: 7, clearance of sub-plots: 29.
Serial no. 4: problematic information as current processing progress is being queried. The Land of Berlin regards the information required as unusable and reappears in other information considered more useful in accordance with BBodSchG and BBodSchV: a) cleared of suspicion after suspected harmful soil changes ascertained, b) sites with proven harmful soil changes or contamination.
Information on completed risk assessments of suspected contaminated sites with regard to clearance: a) total area cleared from suspicion: 187, b) clearance with regard to GW path: 42, c) clearance of sub-plots: 48.
Serial no. 5: problematic information as current processing progress being queried. Constant care and updating of the “processing phase” field required.
Brandenburg: serial no. 4: no information as yet due to current ISAL package of questions. No information available on sites cleared of suspicion following risk assessment. Will be possible to publish the missing ID nos. with new software by end of 2004. Additional information on “sites without classification”: 1555.
Bremen: figures referring to the current definitions are presently only estimated values. Bremen’s contaminated sites land register is currently being reprocessed and restructured.
Hamburg: figures again provisional as the contaminated sites land register database in Hamburg is currently being technically revised. Serial no. 3: excluding protection or restriction measures, including some ongoing decontamination operations; serial no. 4: excluding contaminated sites upon close inspection; serial no. 5: excluding decontamination inspection or planning; not including private measures; serial no. 6: monitoring as completed post-risk assessment or decontamination measure.
Hesse: serial no. 1: sufficient suspicion for site in accordance with paragraph 9, clause 2 BBodSchG. Ascertained by notification. On the stated qualifying date in Hesse, a total of 6.800 old landfill sites were declared and recorded (212 of which with very high risk potential according to previous use or landfill site rating) and 101.682 abandoned industrial sites (20.005 of which with very high degree of risk according to previous use or industrial rating). Risk assessment not yet carried out on all sites. Serial no. 6: monitoring operations figures apply only to decontaminated site aftercare measures..
Mecklenburg-Western Pomerania: serial no. 1: The stated number only covers normal suspected contaminated sites. Serial no.s 2,3,5: figures only recorded since final quarter of 2003, not yet complete due in particular to changes to recording programme contents. Serial no. 6: the stated figure comprises not only the monitoring of contaminated sites but also the monitoring of suspected contaminated sites.
Lower Saxony: serial no. 1.2: the number of suspected contaminated sites to rise because recording has not yet been carried out. Serial no. 3: given figure comprises successfully completed decontamination operations (451) and partially completed decontamination operations (decontaminated sub-plots, 131).
North Rhine-Westphalia: serial no. 1 and 2: figures provided indirectly because NRW does not as yet differentiate between suspected contaminated sites and contaminated sites. The contaminated sites and harmful soil changes technical information system (FIS AlBo) is currently under construction. This will encompass the above differentiation. As part of the annual statistics inspection presently being carried out by the responsible local authorities for soil conservation, discrimination between suspected contaminated sites, contaminated sites and land cleared of suspicion will first be examined. Serial no. 4: figures apply to all completed risk assessments, including sites which have been cleared of suspicion. Serial no. 5: separate information only on either ongoing and completed decontamination inspections or ongoing decontamination because these figures are called up separately and duplicate records caused by summation cannot be ruled out. The current state of progress for each site is in FIS AlBo, enabling definite figures. Serial no. 6: figures represent the sum of the ongoing monitoring operations following risk assessment and following decontamination.
Saarland: no footnotes on the ID codes.
Saxony: all information refers to sub-plots. Serial no. 4: incl. sites cleared of suspicion of contamination on basis of present use. Serial no. 5: completed decontamination inspections. Not possible to state whether decontamination initiated or not. Serial no. 6: figures comprise monitoring operations following guided inspection, close examination and decontamination inspection as well as aftercare for decontaminated sites.
Saxony-Anhalt: no footnotes on the ID codes.
Schleswig-Holstein: serial no. 1: estimated figures for abandoned industrial sites; number of old landfill sites in some cases excluding decontaminated sites. Serial no. 2: figures do not include contaminated sites for which protection and limitation measures only have been arranged. Serial no. 4: no definite figures for completed risk assessments. Monitoring reported for 292 old landfill sites and 112 abandoned industrial sites. This may be a question of when the monitoring was carried out, either during or following decontamination. Serial no. 6: number of monitoring operations following risk assessment cannot be reported separately because the responsible local authorities for soil conservation also report many monitoring operations taking place during risk assessment.
Thuringia: no footnotes on the ID codes.

Source: *Federal Environmental Agency 2004 a*

- sites suspected of being contaminated/former waste disposal sites/former industrial sites,
- risk assessment completed,
- contaminated sites,
- decontamination in progress,
- decontamination complete,
- number of sites being monitored.

The data provided by the *Länder* contains numerous explanations (e.g., references to duplicate terms, data validity limitations, information on estimates ascertained according to land registers for each contaminated site).

Large-scale projects for site decontamination in the new Länder

In order to encourage funding for remediation in transitionally state-owned contaminated industrial sites (Treuhand) and to preserve and create jobs, the Federal Government and the Treuhandanstalt (THA – institution responsible for privatising former east German industry) concluded an administrative agreement in 1992 with the *Länder* of Berlin, Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, and Thuringia joint funding of this project. The administrative agreement on the regulation of funding of ecologically hazardous sites was concluded for this purpose.

This regulates proportionate funding of Federal Government/*Länder* measures with the prerequisite that the competent *Land* authorities exonerate investors from the responsibility and costs of any environmental damage caused prior to 1 July 1990, in accordance with the Environmental Framework Act/obstruction siting law. Exoneration granted, the demands enforced on the *Länder* are split 60 (Federal Government) to 40 *(Länder)*. A costs ratio of 75 (Federal Government) to 25 *(Länder)* was set for large-scale ecological projects. These costs are reduced by the sum paid by the purchaser of a THA business.

Under the direction of the Federal Ministry of Finance and the Federal Environment Ministry, a joint Federal Government/THA working group (since January 1995 BvS)/*Länder* was set up which unanimously determined 21 large-scale industrial projects in accordance with the criteria set out in the administrative agreement. The measures and the funding thereof form the basis of the THA obligations towards the investors in accordance with the contaminated site clauses in the respective privatisation agreements.

In order to extend its sphere of application and speed up its implementation, the federal and *Länder* governments agreed in January 1996 that, given certain conditions, the level of federal funding for large-scale remediation projects could be set in advance (as a lump sum), passing the entire responsibility for further treatment of contaminated sites under the large-scale projects, to the respective *Länder*.

Between 1996 and 2000, agreements between the respective *Länder* and BvS for federal funding obligations were concluded for eight large-scale remediation projects (the shipyards in Rostock, Stralsund, and Wismar in Mecklenburg-West Pomerania, TVW project in Rositz and potash mines in the southern Harz and Werra in Thuringia, as well as projects in Mansfeld and Magdeburg-Rothensee in Saxony-Anhalt and Saxonia Freiberg). The large-scale Dresden-Coschütz project came to an end in 2001.

In 1999 the free state of Thuringia was the first *Land* to conclude a general treaty with BvS on definitive funding of old ecologically hazardous sites. The consent principle was annulled upon fulfilment of all federal and BvS funding obligations under the administrative agreement. Responsibility for further implementation is passed to all projects under the administrative agreement, including the use of the substance on the land, without the need for a further agreement with the Federal Government and BvS. Further general treaties were concluded with Saxony-Anhalt and Mecklenburg-West Pomerania in 2003.

Other large-scale projects are underway in line with the present regulation in the Spree industrial area, the *Land* of Brandenburg, the Oranienburg region, the city of Brandenburg, BASF Schwarzheide, PCK Schwedt and the SOW Böhlen and Lauta projects in Saxony.

Decontamination of open-cast lignite coal mines

A further large-scale project "lignite mine decontamination" aims to decontaminate and find other uses for abandoned open-cast mines and industrial lignite refinement sites. This largest single environmental project is being implemented and represented at federal and *Land* level by LMBV (Lausitzer und Mitteldeutsche Bergbauverwaltungsgesellschaft mbH – company regulating reclamation measures in post-mining landscapes).

Since decontamination of open-cast lignite mines began, 7.5 billion EUR has already been made available by the Federal Government and lignite mine *Länder* Brandenburg, Saxony, Saxony-Anhalt und Thuringia, based on an administrative agreement. A total financial framework of 1.7 billion euros has been set for 2003 to 2007, split 75:25 between the Federal Government and the *Länder*. Approximately 50 % of the original total decontamination area (1200 km^2) is to be converted into agricultural and forestry areas, 27 % into water surface, 18 % into conservation areas, and 3 % into commercial and industrial areas. The impressive lakeland areas emerging in Lusatia and central Germany are attractive leisure and recreational areas.

VII 4 Non-chemical soil conservation

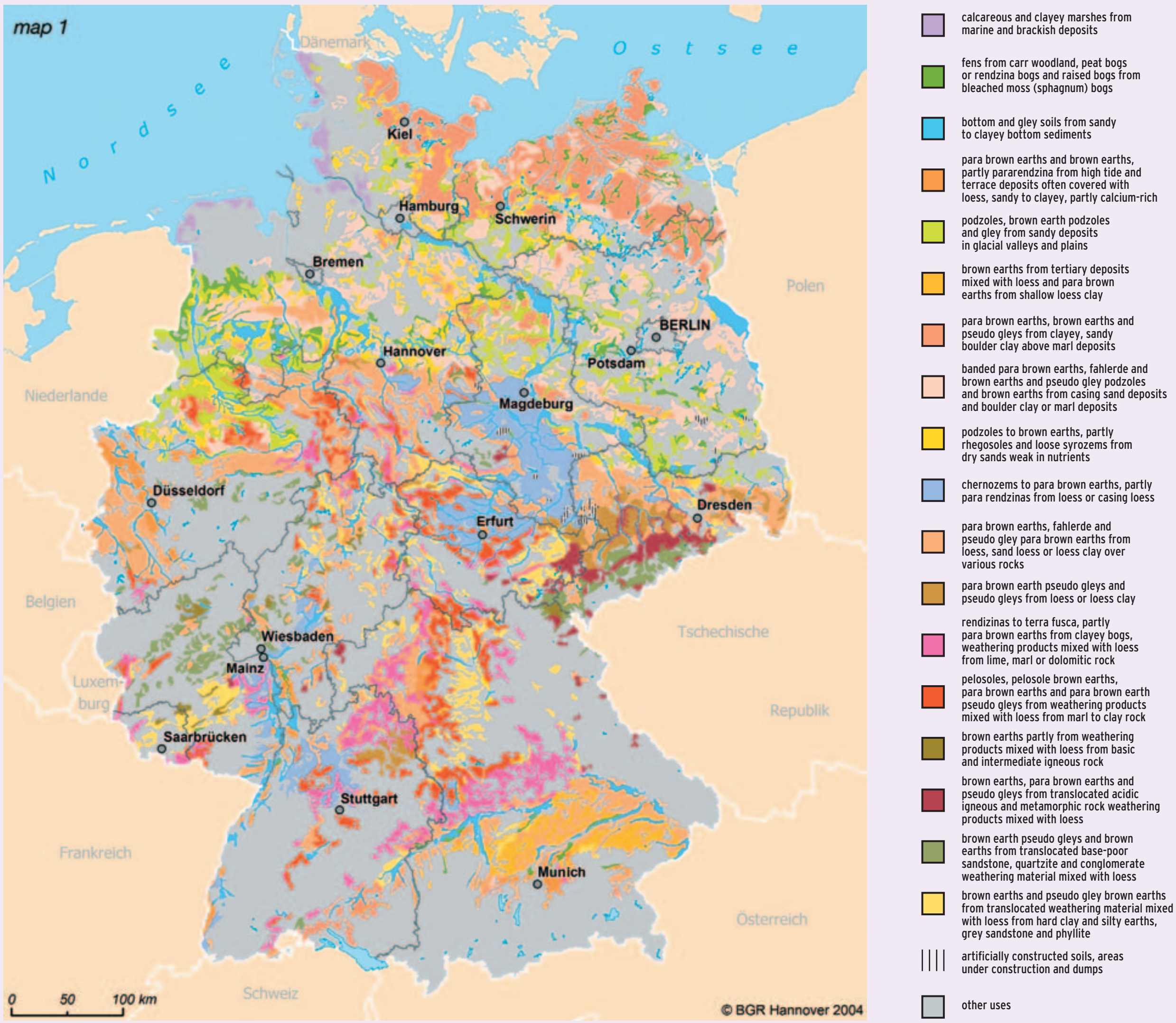
VII 4.1 Erosion risk

The process of soil erosion caused by water is governed by the rain and soil properties, length and inclination of slopes, soil coverage and tillage and the type of erosion control measures. The share of threat exclusively attributable to natural local factors without anthropogenic influence is described as natural erosion disposition or erosion susceptibility.

Soil erosion caused by water on grassland and in forest areas under central European climatic conditions is negligible. Therefore, only areas utilised predominantly for arable farming identified under the CORINE land use model will be taken into account here. In order to ascertain erosion susceptibility caused by water, relief and climate information is invoked alongside soil and land use data. Relief impact is assessed using grid data on degrees of inclination in spatial divisions of 50m. An isoerodent map is used to record erosivity of precipitation on a nation-wide scale, based on long-term precipitation data collected from 139 climate stations.

Figure VII 4.1-1 presents a nation-wide overview of the chief arable soils utilised for farming.

Fig. VII 4.1-1: *Use-specific soil overview map for the Federal Republic of Germany arable land excerpt*

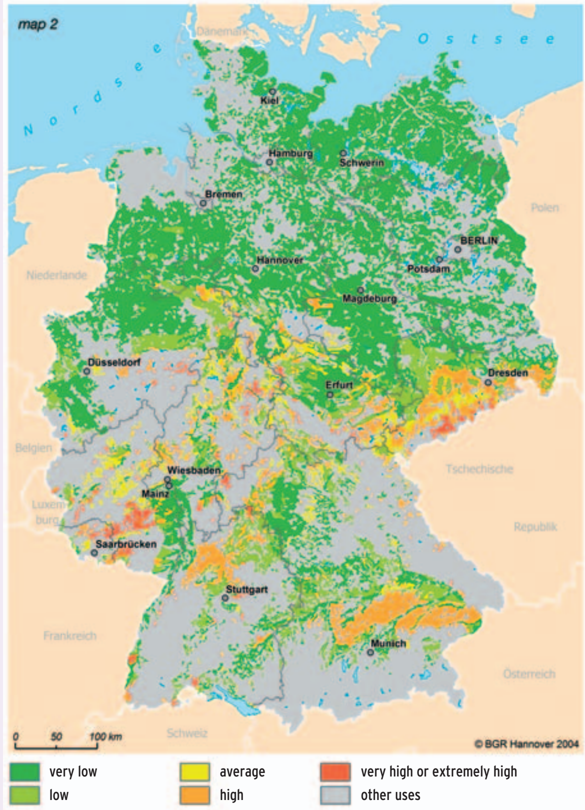


Source: *Federal Institute for Geosciences and Natural Resources 2004*

The data is based on the soil overview map of Germany on a scale of 1:1,000,000 (BÜK 1000), scaled down here to 1:5,000,000 from the Federal Institute for Geosciences and Natural Resources' specialists soil science information system data inventory (FIS-Bo BGR).

As shown in Figure VII 4.1-2, more than 50 % of the assessed areas of the country fall under the very low and low erosion susceptibility classifications. A classification system designed to provide a nation-wide overview portrays northern Germany as comparably undifferentiated and offers no spatial separation between old and young moraine areas, despite variations in morphogenesis. Even in loess dissemination regions, large areas of the Magdeburg Boerde or the Thuringia Basin fall under very low erosion susceptibility because chernozems with favourable structural development and low slope inclinations prevent a higher classification. Soils in sand loess areas reveal slightly higher hazard levels. Focal areas susceptible to water erosion are in the Bavarian tertiary hills, the Erzgebirge and the Erzgebirge foreland, the Kraichgau, the Palatine-Saarland cuesta and the Saar-Nahe hills. It should however be taken into account that viticultural areas are included in the combined classification of arable areas and permanent crops in some areas of southwestern Germany [1].

Fig. VII 4.1-2: *Land threatened with erosion in Germany*



Source: *Federal Institute for Geosciences and Natural Resources 2004*

VII 4.2 Measures

Adaptation in agriculture

Erosion control measures for soil tillage such as ploughing against the slope on hills (contour ploughing), minimal soil tillage, mulch seeding, undersowing of crops or intercropping contribute significantly to the reduction of loss rates. Ways of reduced land management (eg., contour ploughing) and erosion limitation measures can reduce Germany's ascertained potential loss risk by up to a half. Actual annual soil loss varies greatly between different regions and depends on the soil tillage methods of the individual enterprises and possibly on any erosion control measures already implemented. The use-dependent erosion threat calculated using the universal soil loss equation (USLE) must be examined against the background of the respective regional local conditions and the prevailing soil management type. In view of actual threats to soil and a possible need for action, a differentiated on-site examination of the risk of loss is therefore required. Although spatial variability of the erosion risk chiefly depends on local conditions, the amount of soil loss is conclusively determined by type of land cover and implementation of erosion control measures.

[1] Federal Institute for Geosciences and Natural Resources (BGR) 2004