



# Environmental Data Germany 2002

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For Humanity and Environment

## Important indicators

|                                                                    |                                                                 |           | page |
|--------------------------------------------------------------------|-----------------------------------------------------------------|-----------|------|
| Population                                                         | 1991 – 2000                                                     | +2.8%     | 9    |
| Households (number)                                                | 1991 – 1999                                                     | +7.1%     | 5    |
| – Household waste                                                  | 1996 – 2000                                                     | –0.7%     | 7    |
| – Drinking water consumption                                       | 1991 – 1998                                                     | –10.4%    | 7    |
| – Consumption of detergents                                        | 1991 – 1998                                                     | –5.1%     | 7    |
| Area – Residential and transport                                   | 1993 – 2000                                                     | +7.8%     | 9    |
| – Agriculture                                                      | 1991 – 2000                                                     | –0.4%     | 18   |
| Gross Domestic Product                                             | 1991 – 2000                                                     | +15.1%    | 9    |
| – Energy productivity                                              | 1991 – 2000                                                     | +18.6%    | 10   |
| – Raw materials productivity                                       | 1991 – 2000                                                     | +17.3%    | 10   |
| Primary Energy Consumption                                         | 1990 – 2000                                                     | –4.9%     | 14   |
| – Proportion of renewable energy in the primary energy consumption | 1990: 0.9% 2000: 2.1%                                           |           | 14   |
| Volume of traffic                                                  |                                                                 |           |      |
| – Motorised individual transport                                   | 1991 – 2000                                                     | +3.7%     | 17   |
| – Road freight transport                                           | 1991 – 2000                                                     | +41.3%    | 17   |
| Livestock population (adult bovine units)                          | 1990 – 1999                                                     | –19.4%    | 19   |
| Agriculture area with organic farming                              | 1994: 1.6% 2000: 3.2%                                           |           | 18   |
| Organic farming businesses                                         | 1995 – 1999                                                     | +57.0%    | 18   |
| Total nitrogen surplus                                             | 1990 – 2000                                                     | –4.3%     | 20   |
| Recovery rate of packaging                                         | 1991: 37% 2000: 77%                                             |           | 23   |
| Recycling rate                                                     |                                                                 |           |      |
| – Paper                                                            | 1995: 67% 2000: 71%                                             |           | 23   |
| – Glass containers                                                 | 1995: 75% 2000: 83%                                             |           | 24   |
| Greenhouse gas emissions (Kyoto)                                   | 1990 – 2000                                                     | –19.1%    | 27   |
| CO <sub>2</sub> emissions                                          | 1990 – 2000                                                     | –15.4%    | 31   |
| SO <sub>2</sub> emissions                                          | 1990 – 2000                                                     | –85.1%    | 31   |
| NO <sub>x</sub> emissions                                          | 1990 – 2000                                                     | –41.4%    | 32   |
| NM/OC emissions                                                    | 1990 – 2000                                                     | –50.3%    | 32   |
| NH <sub>3</sub> emissions                                          | 1990 – 1999                                                     | –18.4%    | 33   |
| Air pollution through particulate matter (PM <sub>10</sub> )       | 1990: 25–85 µg/m <sup>3</sup> 2000: 20–45 µg/m <sup>3</sup>     |           | 35   |
| Benzene concentrations in cities                                   | 1995: 2.8–7.2 µg/m <sup>3</sup> 2000: 1.1–5.3 µg/m <sup>3</sup> |           | 37   |
| Water abstraction                                                  | 1991 – 1998                                                     | –12.5%    | 42   |
| Public water supply                                                | 1991 – 1998                                                     | –13.8%    | 42   |
| Public waste water treatment with nutrient elimination             | 1991: 54% 1998: 92%                                             |           | 42   |
| Population connected to public waste water treatment plants        | 1991: 86% 1998: 91%                                             |           | 42   |
| Nutrient inputs in rivers                                          |                                                                 |           |      |
| – Phosphorus                                                       | 1993 – 1997                                                     | –80%      | 43   |
| – Nitrogen                                                         | 1993 – 1997                                                     | –25%      | 43   |
| Chemical water quality                                             | Proportion of Class II rivers                                   |           |      |
| – AO <sub>x</sub>                                                  |                                                                 | 1999: 40% | 45   |
| – Total nitrogen                                                   |                                                                 | 1999: 12% | 45   |
| Biological water quality                                           | Proportion of Class II rivers                                   | 1995: 48% | 45   |
| Forest damage                                                      |                                                                 |           |      |
| Level of significant damage                                        | 1990: 23% 2001: 22%                                             |           | 49   |

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## **Foreword**

“Environmental Data Germany 2002” is published jointly by the Federal Environmental Agency and the Federal Statistical Office.

Decisions are made each day which have a direct or indirect influence on the environment. “Environmental Data Germany 2002” is intended to be a compact reference booklet for the environmental community and members of the public with a general interest in environmental issues. 150,000 copies were distributed of the previous edition of “Environmental Data Germany”, confirming the usefulness of environmental information for the public.

It remains our intention to take up environmental topics which characterise the environmental situation in Germany. Environmental issues are described and assessed with the help of appropriate indicators. Germany’s contribution to the sustainable solution of global environmental problems is also portrayed.

Indicators have been included from the Federal Environmental Agency’s “Environmental Barometer”, from the government’s national sustainability strategy and from the European Union’s 6th Environmental Action Programme (2001 to 2010).

The selected environmental topics have been sorted according to the internationally accepted reporting structure:

- Driving forces (information on economic issues, consumer behaviour, energy, transport, agriculture, etc.)
- Pressures (emissions and inputs)
- State of the environment (pollution, biodiversity, etc.)
- Impact (effects on public health and ecological status)
- Responses (policy and societal targets and reactions)

The environmental situation for the whole of Germany has been described, as there are no longer any significant differences between the old and new Länder.

Further information is available from the organisations named in the sources and via the internet.

The Federal Environmental Agency’s homepage can be found under [www.umweltbundesamt.de](http://www.umweltbundesamt.de) and the Federal Statistical Office under [www.destatis.de](http://www.destatis.de).

We would like to thank all participating agencies and institutions for their constructive co-operation, without which the production of this brochure would not have been possible.

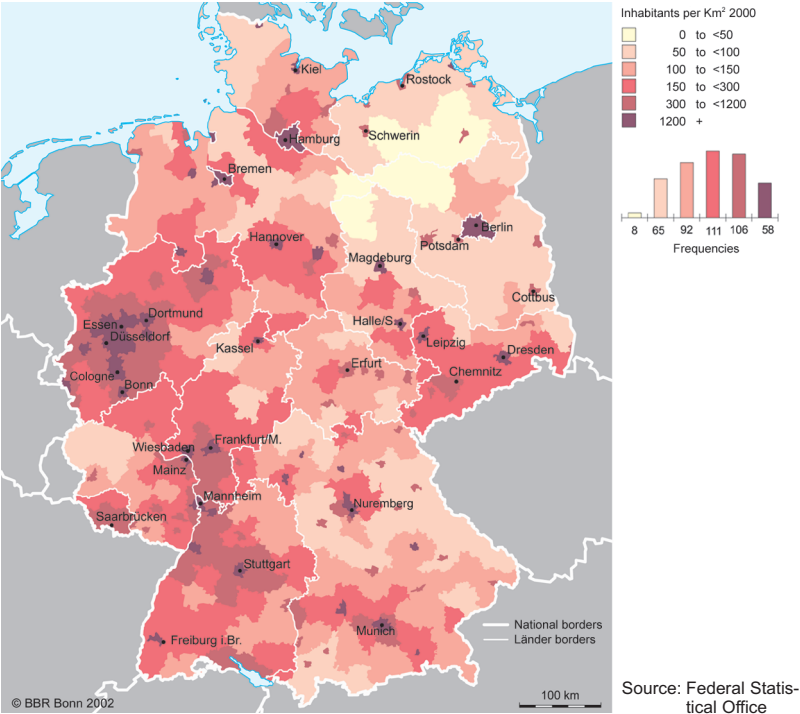
**President of the  
Federal Environmental Agency**

**Prof. Dr. Andreas Troge**

**President of the  
Federal Statistical Office**

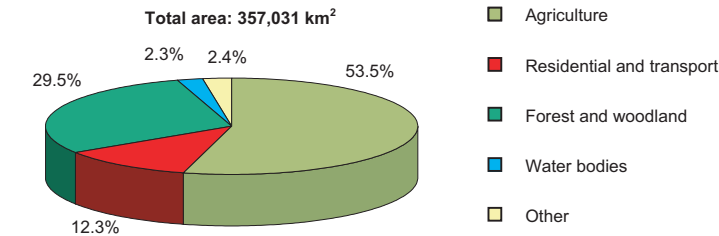
**Johann Hahlen**

Population density 2000



Germany is a densely populated country with more than 82 million inhabitants. Population density is 230 inhabitants per km<sup>2</sup> compared to 116 on average for the European Union.

Land use 2001



Source: Federal Statistical Office

Despite the constant reduction of agricultural land, it still covers an area of 19.1 million ha and therefore more than half the total area of Germany. Over the years there has been an increase in land used for residential and transport facilities (4.4 million ha) and in forest and woodland areas (10.5 million ha). This has mainly occurred at the expense of agricultural land.

# Human Activities and the Environment

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## Direct use of natural resources by household consumption

|                                                               |                      | 1991    | 1993     | 1995    | 1997     | 1998    | 1999    | Change<br>between<br>1991 and<br>1999 |
|---------------------------------------------------------------|----------------------|---------|----------|---------|----------|---------|---------|---------------------------------------|
| Number of households                                          | mill.                | 35.3    | 36.2     | 36.9    | 37.5     | 37.5    | 37.8    | +7.1%                                 |
| Private expenditure for consumer articles<br>(at 1995 prices) | bill. Euro           | 942     | 967      | 996     | 1 010    | 1 028   | 1 058   | +12.3%                                |
| Direct energy consumption                                     | Petajoule            | 3 767.1 | 3 869.5  | 3 945.6 | 4 146.8  | 4 084.0 | 4 227.0 | +12.2%                                |
| Material consumption                                          | mill. t              | —       | —        | 193.3   | —        | —       | —       | —                                     |
| Carbon dioxide emissions                                      | mill. t              | 219.2   | 223.6    | 216.1   | 227.5    | 223.4   | 210.7   | -3.9%                                 |
| Water consumption                                             | mill. m <sup>3</sup> | 3 551.0 | —        | 3 313.0 | —        | 3 250.0 | —       | -8.5% <sup>1)</sup>                   |
| Waste water                                                   | mill. m <sup>3</sup> | 3 409.0 | —        | 3 180.0 | —        | 3 254.0 | —       | -4.5% <sup>1)</sup>                   |
| Residential and<br>transport area                             | km <sup>2</sup>      | —       | 23 120.0 | —       | 24 080.0 | —       | —       | +4.2% <sup>2)</sup>                   |

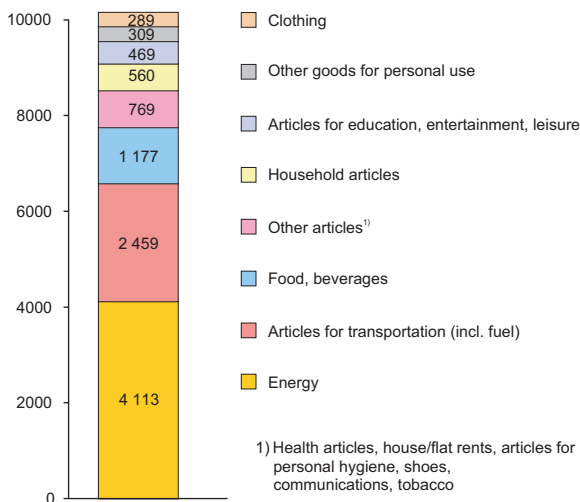
1) Change between 1991 and 1998

2) Change between 1993 and 1997

Source: Federal Statistical Office

The social-structural and social-economic trends in households (not including small businesses) can be used as indicators for assessing the environmental impact caused by areas of private consumption. An uneven picture presents itself: increasing environmental pressures stand in contrast to decreasing impacts in other areas. Despite increasing energy consumption (+12%), CO<sub>2</sub> emissions fell by almost 4%. Household waste and land use are increasing (approx. +4%). Water utilisation, on the other hand, is decreasing (-8.5%), although it must be taken into account that these figures do not cover the whole period. It can be observed that trends in the utilization of natural resources are partly more moderate than the growth in the number of households (+7%) and the increase in expenditure for consumer goods (+12%). There are however many other environmental pressures which can be pointed out.

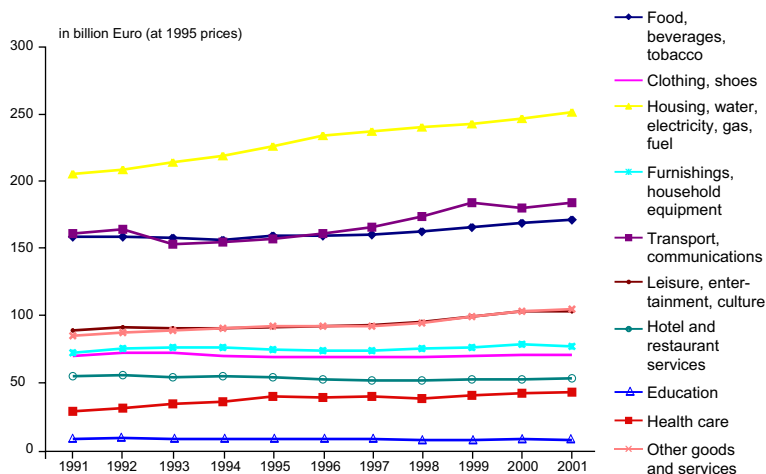
## Household energy consumption for 1995 in PJ



Source: Federal Statistical Office

The categories energy (heating of buildings, warm water, cooking, etc.) and goods for transportation take up almost two-thirds of the total energy consumption and occupy a dominating role in direct and indirect energy consumption.

## Domestic household consumer expenditure according to use



Source: Federal Statistical Office

The consumer activities of households put pressure on the environment in many different ways, e.g. by causing energy, materials and water consumption and by causing increasing land use. Consumer expenditure (at 1995 prices) has only increased slightly in many areas of private consume in the past ten years. A distinct increase in consumer expenditure can be observed in the areas housing, water, electricity, gas, fuel (+23%), transport and communications (+15%) and leisure, entertainment, culture (+16%). The 45% increase in expenditure for health care is quite remarkable. However, a slight decrease in expenditure for education (-5%) and hotel and restaurant services (-2%) can be seen.

## Environmental awareness and behaviour

| Percentage of respondents who considered the state of the environment to be very good or fairly good | 1991 | 1992 | 1993 | 1994 | 1996 | 1998 | 2000 |
|------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|
| <b>Perception of the state of the environment in the new Länder</b>                                  |      |      |      |      |      |      |      |
| all respondents                                                                                      | 2    | 6    | 10   | 11   | 19   | 24   | 35   |
| respondents from the new Länder                                                                      | 4    | 13   | 27   | 25   | 51   | 53   | 58   |
| respondents from the old Länder                                                                      | 2    | 5    | 5    | 7    | 11   | 17   | 28   |
| <b>Perception of the state of the environment in the old Länder</b>                                  |      |      |      |      |      |      |      |
| all respondents                                                                                      | 55   | 49   | 52   | 55   | 52   | 60   | 77   |
| respondents from the new Länder                                                                      | 80   | 66   | 73   | 67   | 53   | 56   | 76   |
| respondents from the old Länder                                                                      | 48   | 45   | 47   | 51   | 52   | 61   | 78   |

Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety / Federal Environmental Agency

While there has been a drop in the day-to-day significance of the environment, as newer issues have tended to gain greater public attention, environmental protection has retained a relatively high profile with a large majority of the population. Only 6% regard environmental issues as not so important or wholly unimportant.

## Household waste

|                                  | 1996 | 1997 | 1998 | 1999 <sup>*)</sup> | 2000 <sup>*)</sup> |
|----------------------------------|------|------|------|--------------------|--------------------|
| Household waste in kg per capita | 428  | 441  | 438  | 431                | 425                |
| Recovered waste                  | 35%  | 40%  | 43%  | 46%                | 50%                |

\*) estimate

Source: Federal Statistical Office

Waste generation from private households (incl. similar waste from trade and commerce) collected by municipalities has remained virtually constant. However waste volumes collected for disposal have been falling continually for years, whereas waste volumes being recovered have increased.

## Drinking water consumption<sup>1)</sup> by households and small businesses

|                              | 1991 | 1995 | 1998 |
|------------------------------|------|------|------|
| In litres per capita per day | 144  | 132  | 129  |

1) From the public water supply

Source: Federal Statistical Office

From 1991 to 1998 the per capita consumption of drinking water fell by 10%. This reduction can be attributed to altered consumer behaviour and the use of water-saving household and sanitary equipment. 99% of the population is connected to the public water supply.

## Use of detergents

| Consumption of detergents            |         |         |         |         |         |         |         |         |
|--------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
|                                      | 1991    | 1992    | 1993    | 1994    | 1995    | 1996    | 1997    | 1998    |
| Consumption in kg per capita         | 8.7     | 7.9     | 8.0     | 8.0     | 7.7     | 7.7     | 7.9     | 8.1     |
| Total amount of detergents in tonnes | 700 800 | 638 500 | 648 300 | 653 200 | 633 000 | 633 000 | 647 000 | 665 000 |

Source: Industry Association for Toiletry and Washing Products (IKW)

Detergents constitute the largest share of inputs into household waste water. The transition to phosphate-free detergents meant that by 1993 the amount of phosphate used in households was drastically reduced. However, since 1994 phosphate consumption has risen again due to the use of phosphates in dishwasher detergents.

### Consumption of detergents in 1998 in tonnes

|                               |                |
|-------------------------------|----------------|
| Conditioners                  | 174 000        |
| Hand dishwashing detergents   | 115 000        |
| Dishwasher detergents         | 58 000         |
| Rinsing agents                | 10 000         |
| Water softeners               | 64 000         |
| All-purpose cleaning products | 78 000         |
| Scouring agents               | 29 000         |
| <b>Total</b>                  | <b>528 000</b> |

Source: Industry Association for Toiletry and Washing Products (IKW)

## Leisure and tourism behaviour 1999

| Overnight tourism                     | Units         | All<br>travel | Private<br>travel total | of which:         |                         |
|---------------------------------------|---------------|---------------|-------------------------|-------------------|-------------------------|
|                                       |               |               |                         | Holiday<br>travel | Other<br>private travel |
| <b>Travel in Germany<sup>1)</sup></b> | mill.         | <b>145.2</b>  | <b>109.5</b>            | <b>68.0</b>       | <b>41.5</b>             |
| short holidays (1–3 nights)           | mill.         | 85.6          | 60.2                    | 31.9              | 28.3                    |
| longer holidays (at least 4 nights)   | mill.         | 59.7          | 49.2                    | 36.1              | 13.1                    |
| <b>Length of holiday</b>              | <b>nights</b> | <b>4.9</b>    | <b>5.3</b>              | <b>5.7</b>        | <b>4.7</b>              |
| <b>Overnight stays</b>                | mill.         | <b>711</b>    | <b>584</b>              | <b>387</b>        | <b>197</b>              |
| <b>Type of accommodation</b>          |               |               |                         |                   |                         |
| (related to number of trips)          |               |               |                         |                   |                         |
| hotels                                | share         | 40%           | 29%                     | 31%               | 25%                     |
| other commercial accommodation        | share         | 21%           | 23%                     | 35%               | 3%                      |
| with relatives/friends                | share         | 39%           | 48%                     | 34%               | 71%                     |
| <b>Main means of transport</b>        |               |               |                         |                   |                         |
| (related to number of trips)          |               |               |                         |                   |                         |
| car                                   | share         | 69%           | 74%                     | –                 | –                       |
| rail                                  | share         | 15%           | 15%                     | –                 | –                       |
| bus                                   | share         | 6%            | 7%                      | –                 | –                       |
| aeroplane                             | share         | 8%            | 3%                      | –                 | –                       |
| other                                 | share         | 2%            | 2%                      | –                 | –                       |
| <b>Proportion of foreign guests</b>   |               |               |                         |                   |                         |
| (related to number of trips)          | share         | 21%           | 18%                     | 19%               | 16%                     |
| 1) with at least one overnight stay   |               |               |                         |                   |                         |

Source: Öko Institute

Over the last three decades, the tourist sector has become a significant factor in the domestic economy.

In 1999, around 60 million holiday trips (at least 4 overnight stays) were made, which means that 75.3% of all Germans over 14 years took one or more holiday trips. By 2010 there will probably be an 80% increase. In 1999, 13% took a second holiday trip and 4% took a third. In 2010, these figures could increase to 20% and 10% respectively.

Germans are travelling increasingly farther afield for their holidays. The choice of destination also determines the choice of transportation, so that the faster, but more heavily polluting aeroplane is being used more frequently for holiday travel. The share of the former market leader, the railways, has fallen to only 5.9% (Ökō Institute) in 1990. By 2010 there will probably be a further 22% decrease.

With 48%, holiday and leisure travel constituted the largest proportion of passenger transport in 1999 amounting to 955.6 billion passenger kilometres. In comparison, travel for work and education came to around 25% and shopping trips 11%.

## Use of resources and emissions

|                                                      |                      | 1991   | 1993   | 1995   | 1997 <sup>1)</sup> | 1999 <sup>1)</sup> | 2000 <sup>1)</sup> |
|------------------------------------------------------|----------------------|--------|--------|--------|--------------------|--------------------|--------------------|
| Gross domestic product at 1995 prices                | bill. Euro           | 1 711  | 1 730  | 1 801  | 1 840              | 1 911              | 1 969              |
| Population                                           | mill.                | 80.0   | 81.2   | 81.7   | 82.1               | 82.1               | 82.2               |
| Hours worked                                         | mill. Std.           | 60 004 | 58 132 | 57 393 | 56 303             | 56 977             | 57 351             |
| Consumption of fixed capital                         | bill. Euro           | 229    | 251    | 266    | 280                | 296                | 305                |
| Primary energy consumption                           | Petajoule            | 14 611 | 14 310 | 14 629 | 14 614             | 14 193             | 14 180             |
| Carbon dioxide emissions                             | mill. t              | 976    | 918    | 904    | 894                | 859                | 859                |
| Raw material withdrawal and imports <sup>2)</sup>    | mill. t              | 1 460  | 1 413  | 1 485  | 1 440              | 1 439              | 1 432              |
| Water abstraction from natural sources <sup>3)</sup> | mill. m <sup>3</sup> | 51 344 | 48 150 | 48 909 | 47 334             | —                  | —                  |
| Residential and transport area                       | km <sup>2</sup>      | —      | 40 305 | —      | 42 052             | 42 976             | 43 447             |

1) partly estimated

2) extracted inorganic raw material inputs and imported inorganic goods

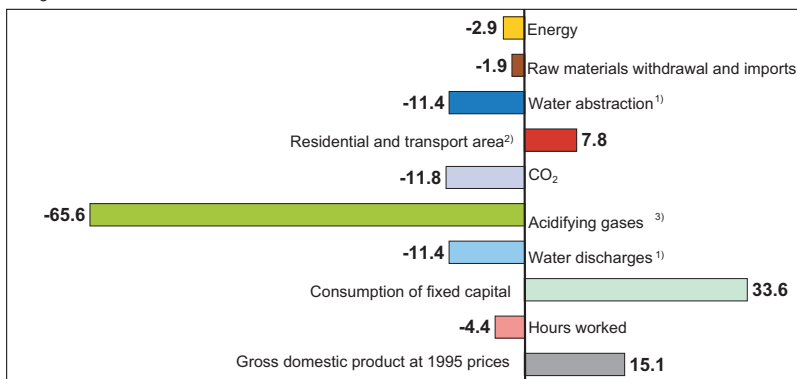
3) including extraneous and rain water, etc.

Source: Federal Statistical Office; Working Group on Energy Balances

Utilisation of nature can be measured against the amount of natural input factors such as the consumption of raw materials, energy consumption and the intensity of land use. Using the environment as a sink for harmful substances can only be indirectly measured against the amount of harmful substances discharged. If the volumes measured are regarded in relationship to the economic performance, productivity can be calculated as an indicator for the efficiency of the consumption of natural input factors.

## Application of resources for economic purposes

Change 1991 - 2000 in %



1) Change 1991 - 1998

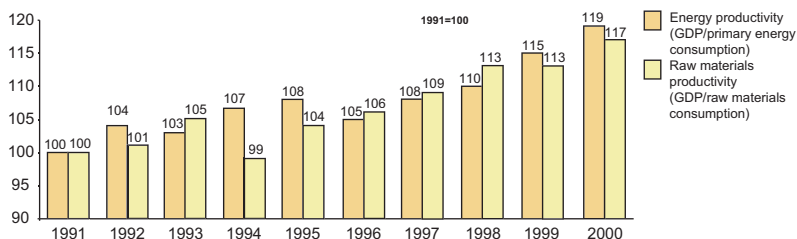
2) Change 1993 - 2000

3) Change 1991 - 1999

Source: Federal Statistical Office

Productivity of the individual natural resources developed in various ways during the 1990s. The consumption of natural and energy resources decreased slightly between 1991 and 2000 (−2.0% and −1.9%). The use of natural resources as a sink for CO<sub>2</sub> emissions (1991–2000: −11.8%) and the abstraction of water (1991–1998: −11.4%) has fallen considerably. On the other hand, land use for residential and transport purposes has increased continuously between 1993 and 2000 by 7.8% (1998 to 2000 estimated by Federal Office for Building and Regional Planning). GDP increased by 15.1% between 1991 and 2000.

## Resource conservation



1) abiotic raw materials and imported abiotic goods

Sources: Federal Statistical Office; Working Group on Energy Balances

The efficient use of energy and raw materials is depicted by the indicators energy productivity and raw materials productivity. The production indicators for energy and raw materials consumption have increased by 18.6% and 17.3% respectively between 1991 and 2000. During this period, primary energy consumption fell by 2.9% and raw materials consumption by 1.9%. Within the framework of the national sustainability strategy the Federal government aims to double energy productivity (base year 1990) and raw materials productivity (base year 1994) by 2020.

## Extractions and discharges of materials in million tonnes

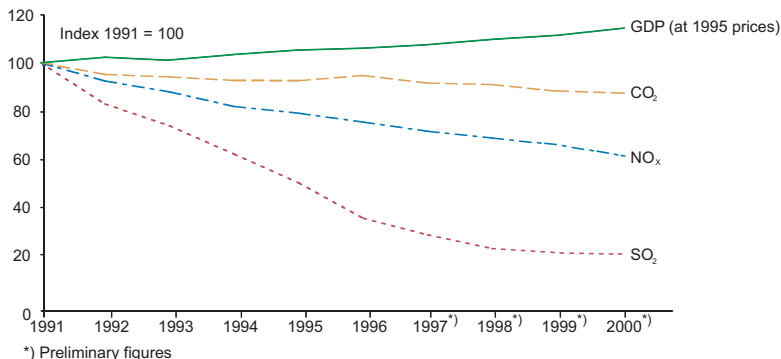
|                                           | 1991   | 1992   | 1993   | 1994   | 1995   | 1996   | 1997   | 1998   | 1999  |
|-------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| <b>Solid materials and gases</b>          |        |        |        |        |        |        |        |        |       |
| <b>Extractions</b>                        | 5 121  | 4 697  | 4 779  | 4 717  | 4 508  | 4 438  | 4 276  | 4 151  | 4 098 |
| Raw materials extraction (domestic)       | 3 968  | 3 559  | 3 681  | 3 589  | 3 380  | 3 285  | 3 139  | 2 996  | 2 981 |
| Non-recovered extractions                 | 2 686  | 2 336  | 2 422  | 2 259  | 2 089  | 2 021  | 1 897  | 1 791  | 1 741 |
| Recovered extractions                     | 1 282  | 1 223  | 1 260  | 1 330  | 1 291  | 1 263  | 1 242  | 1 205  | 1 240 |
| Import                                    | 433    | 456    | 423    | 463    | 464    | 475    | 482    | 505    | 489   |
| Oxygen extraction                         | 719    | 683    | 675    | 664    | 664    | 678    | 655    | 651    | 629   |
| <b>Discharges</b>                         | 4 390  | 3 988  | 4 044  | 3 901  | 3 729  | —      | —      | —      | —     |
| Materials input                           | 295    | 284    | 283    | 284    | 283    | 283    | 278    | 277    | 274   |
| Non-recovered input                       | 2 527  | 2 167  | 2 258  | 2 091  | 1 934  | 1 875  | 1 751  | 1 638  | 1 588 |
| Export                                    | 211    | 216    | 202    | 223    | 225    | 238    | 249    | 260    | 265   |
| Total waste                               | 354    | 371    | 363    | 379    | 365    | —      | —      | —      | —     |
| Atmospheric emissions                     | 1 002  | 950    | 938    | 923    | 922    | 941    | 909    | 902    | 872   |
| <b>Balance: solid materials and gases</b> | 731    | 709    | 735    | 816    | 779    | —      | —      | —      | —     |
| <b>Water<sup>1)</sup></b>                 |        |        |        |        |        |        |        |        |       |
| Water abstractions from natural sources   | 51 344 | 49 852 | 48 150 | 48 972 | 48 909 | 47 786 | 47 334 | 45 502 | —     |
| Water discharges to natural sources       | 51 148 | 49 665 | 47 966 | 48 787 | 48 724 | 47 601 | 47 159 | 45 331 | —     |
| Balance: export and import of water       | 8      | 8      | 8      | 8      | 8      | 7      | 7      | 7      | —     |
| <b>Balance: water</b>                     | 189    | 179    | 176    | 177    | 177    | 178    | 168    | 164    | —     |
| <b>Total</b>                              |        |        |        |        |        |        |        |        |       |
| <b>Consumption of materials</b>           | 920    | 888    | 911    | 993    | 956    | —      | —      | —      | —     |

1) including extraneous and rain water

Source: Federal Statistical Office

A comparison of material flows from 1991 to 1999 shows that total materials extraction has fallen in the German economy during the 1990s. Materials yield (domestic raw materials extraction plus materials imported from the rest of the world) fell by 1,022 million tonnes (20%) to 4,098 million tonnes. This is primarily due to the significant reduction in open-cast lignite mining in the new Länder. In 1999, 50 tonnes of material per capita were extracted for economic purposes.

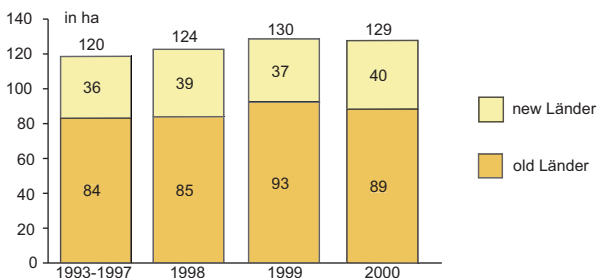
## Economic growth and pollutant emissions



Sources: Federal Statistical Office; Federal Environmental Agency

The care and efficiency of economic use of the environment cannot be judged solely in terms of pollutant emissions. Economic output must also be considered. The growth of the economy in terms of GDP, 15.1% between 1991 and 2000, shows that emissions of atmospheric pollutants have been clearly decoupled from economic growth.

## Daily growth in residential and transport-related land use



Sources: Federal Statistical Office; Federal Office for Building and Regional Planning

Land use for residential and transport needs has increased continuously since the start of the industrial revolution. This irreversible land use still continues despite almost constant population figures, mainly at the expense of agricultural land. Land area is scarce and cannot be increased. It has to be used economically and carefully in order to ensure a sustainable settlement development. More than half (52.2%) of the residential and transport area is covered by buildings and open spaces. Land use for transport facilities takes up 39%. At least half of the residential and transport area is built upon or sealed.

The target of the Federal Environment Ministry is to reduce land use consumption to 30 hectares per day by 2020.

## Environmental expenditure

in million Euro

|                                             | 1991          | 1992          | 1993          | 1994          | 1995          | 1996          | 1997          | 1998 <sup>*)</sup> |
|---------------------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| <b>Manufacturing industry <sup>1)</sup></b> | <b>8 110</b>  | <b>8 660</b>  | <b>8 890</b>  | <b>8 910</b>  | <b>8 950</b>  | <b>9 000</b>  | <b>7 900</b>  | <b>6 220</b>       |
| of which:                                   |               |               |               |               |               |               |               |                    |
| waste disposal                              | 1 430         | 1 510         | 1 700         | 1 650         | 1 680         | 1 800         | 1 640         | 1 360              |
| water protection                            | 2 650         | 2 860         | 2 820         | 2 780         | 2 950         | 2 900         | 2 730         | 2 450              |
| noise abatement                             | 170           | 190           | 160           | 160           | 190           | 190           | 190           | 180                |
| air pollution control                       | 3 860         | 4 100         | 4 200         | 4 320         | 4 130         | 4 110         | 3 340         | 2 230              |
| <b>Public sector</b>                        | <b>13 030</b> | <b>15 240</b> | <b>14 720</b> | <b>14 640</b> | <b>14 030</b> | <b>12 700</b> | <b>11 270</b> | <b>10 470</b>      |
| of which:                                   |               |               |               |               |               |               |               |                    |
| waste disposal                              | 4 770         | 5 740         | 5 240         | 5 230         | 5 510         | 5 430         | 4 720         | 4 490              |
| water protection                            | 8 040         | 9 280         | 9 230         | 9 170         | 8 320         | 7 070         | 6 340         | 5 720              |
| noise abatement                             | 180           | 170           | 200           | 200           | 150           | 150           | 170           | 220                |
| air pollution control                       | 40            | 40            | 40            | 40            | 50            | 40            | 40            | 40                 |
| <b>Privatised public ventures</b>           | <b>–</b>      | <b>–</b>      | <b>–</b>      | <b>10 230</b> | <b>12 460</b> | <b>14 130</b> | <b>14 860</b> | <b>–</b>           |
| of which:                                   |               |               |               |               |               |               |               |                    |
| waste disposal                              | –             | –             | –             | 5 060         | 6 040         | 6 720         | 7 550         | –                  |
| water protection                            | –             | –             | –             | 5 170         | 6 420         | 7 410         | 7 310         | –                  |

\*) preliminary figures

1) excluding construction, running costs and investment in integrated environmental protection

Source: Federal Statistical Office

In 1998, the public sector, manufacturing industry and privatised public companies spent 39.9 billion Euro on environmental protection measures. This was 1.8% of gross domestic product.

## Employment in the environmental sector 1998

| Environmental employment                                           | Jobs             |
|--------------------------------------------------------------------|------------------|
| <b>Production of environmental protection goods</b>                | <b>370 000</b>   |
| Environmental protection investments                               | 135 000          |
| Environmental protection expenditure                               | 165 000          |
| Environmental protection-related foreign demand                    | 69 800           |
| <b>Environmentally relevant services</b>                           | <b>906 500</b>   |
| Agriculture and forestry                                           | 55 700           |
| Manufacturing industry                                             | 253 900          |
| Commerce, hotel trade, transport                                   | 166 500          |
| Real estate and housing, finance, rentals, services for businesses | 168 800          |
| Public and other private services                                  | 261 600          |
| <b>Job creation schemes in the environment sector</b>              | <b>93 500</b>    |
| <b>Total surveyed</b>                                              | <b>1 370 000</b> |

Sources: IFO-Institut (2001), Projektgemeinschaft IFO, DIW, ISI Karlsruhe (2001)

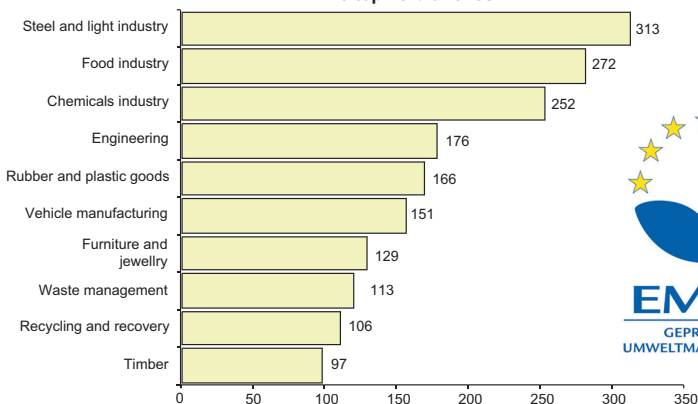
In 1998, more than 1.3 million jobs were dependent on environmental protection, around 3.6% of total employment in Germany. More people were employed in the environmental protection sector than, for example, in mechanical engineering, vehicle manufacturing or in the food industry. Around two thirds of jobs are situated in the service sector, indicating that environmental protection is following the general trend towards a service-orientated society. In 1994, almost 1 million people were employed in the environment sector. However, a direct comparison to 1998 is not possible because of the methodology used.

## European Eco-Management and Audit Scheme (EMAS)

Organisations registered with the European Eco-Management and Audit Scheme (EMAS)

Total: 2896 (4 April 2002)

### The top 10 branches



Source: German Chambers of Industry and Commerce

Almost 3,000 businesses and organisations have voluntarily agreed to establish an environmental management system and can advertise their participation with a European EMAS label. The purpose of this label is to signal that they are voluntarily fulfilling the strict EMAS conditions.

## Energy taxes

### Mineral oil and electricity taxes within the framework of the environmental tax reform (ETR)

| Energy source <sup>1)</sup> |             | Without ETR<br>31.03.99 | from<br>01.04.1999   | from<br>01.01.2000   | from<br>01.01.2001   | from<br>01.01.2002   | from<br>01.01.2003   |
|-----------------------------|-------------|-------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Petrol (unleaded)           | €/DM/1 000l | 501.07<br>(980.00)      | 531.74<br>(1 040.00) | 562.42<br>(1 100.00) | 593.10<br>(1 160.00) | 623.80<br>(1 220.05) | 654.50<br>(1 280.09) |
| Diesel                      | €/DM/1 000l | 317.00<br>(620.00)      | 347.68<br>(680.00)   | 378.36<br>(740.00)   | 409.03<br>(800.00)   | 439.70<br>(859.98)   | 470.40<br>(920.02)   |
| Light heating oil           | €/DM/1 000l | 40.90<br>(80.00)        | 61.35<br>(120.00)    | 61.35<br>(120.00)    | 61.35<br>(120.00)    | 61.35<br>(199.99)    | 61.35<br>(199.99)    |
| Natural gas                 | €/DM/MWh    | 1.841<br>(3.60)         | 3.476<br>(6.80)      | 3.476<br>(6.80)      | 3.476<br>(6.80)      | 3.476<br>(6.80)      | 3.476<br>(6.80)      |
| Electricity                 | €/DM/MWh    | 0                       | 10.22<br>(20.00)     | 12.78<br>(25.00)     | 15.34<br>(30.00)     | 17.90<br>(35.01)     | 20.50<br>(40.09)     |

1) Energy and mineral oil taxes for major fuels (with exceptional regulations)

Source: Federal Ministry of Finance; Euro figures before 2002 calculated by the Federal Environmental Agency

Energy taxes are primarily levied through a mineral oil tax and the electricity tax. Since April 1999, an additional tax of 20 DM/MWh (2 Pf/kWh) is levied on electricity through the environmental tax reform. Further planned yearly tax increases between 2000 and 2003 of 5 DM/MWh (0.5 Pf/kWh or 0.26 cent/kWh) on electricity and 60 DM/1,000 l (6 Pf/l or 3.07 cent/l) on fuel allows energy users to plan for the future and creates economic incentives for thrifty energy use. The mineral oil tax applies to motor and heating fuels. The revenue from the environmental tax reform is used to reduce state pension contributions and to promote environmentally sound energy technology.

## Primary energy consumption by sector<sup>1)</sup> in PJ

|                                                 | 1990          | 1992          | 1994          | 1996          | 1998          | 1999 <sup>1)</sup> | 2000 <sup>1)</sup> |
|-------------------------------------------------|---------------|---------------|---------------|---------------|---------------|--------------------|--------------------|
| Transport                                       | 2 379         | 2 522         | 2 554         | 2 625         | 2 692         | 2 779              | 2 745              |
| Households                                      | 2 383         | 2 436         | 2 558         | 2 890         | 2 779         | 2 637              | 2 550              |
| Trade, commerce, services <sup>2)</sup>         | 1 702         | 1 556         | 1 468         | 1 749         | 1 576         | 1 514              | 1 472              |
| Industry <sup>3)</sup>                          | 2 977         | 2 560         | 2 463         | 2 424         | 2 397         | 2 380              | 2 430              |
| Total final energy consumption                  | 9 441         | 9 074         | 9 043         | 9 688         | 9 444         | 9 310              | 9 197              |
| Losses and in-process consumption <sup>4)</sup> | 4 513         | 4 329         | 4 175         | 4 105         | 3 925         | 3 832              | 3 886              |
| Non-energy consumption                          | 958           | 911           | 964           | 953           | 1 046         | 1 052              | 1 096              |
| <b>Primary energy consumption</b>               | <b>14 916</b> | <b>14 319</b> | <b>14 184</b> | <b>14 746</b> | <b>14 521</b> | <b>14 193</b>      | <b>14 180</b>      |

1) Calculations based on efficiency aspects (differences in totals due to rounding off)

2) Including military offices

3) Including other mining and manufacturing industry

4) In power plants, refineries, briquetting plants, including transmission losses

\*) Preliminary figures (20.07.2001)

Source: Working Group on Energy Balances

The importance of industry in final energy consumption has fallen significantly, from a share of over 40% in 1970 to only 26.5% in 2000. On the other hand, household consumption has risen (from 25% in 1970 to almost 28% in 2000) and the transport sector (from 12% in 1970 to almost 30% in 2000). Losses and energy used for energy conversion account for 27.5% of primary energy consumption.

## Primary energy consumption by fuel<sup>1)</sup> in PJ

|                                       | 1990          | 1992          | 1994          | 1996          | 1998          | 1999 <sup>1)</sup> | 2000 <sup>1)</sup> |
|---------------------------------------|---------------|---------------|---------------|---------------|---------------|--------------------|--------------------|
| Coal                                  | 2 306         | 2 196         | 2 139         | 2 090         | 2 059         | 1 890              | 1 920              |
| Lignite                               | 3 201         | 2 176         | 1 861         | 1 688         | 1 514         | 1 468              | 1 547              |
| Mineral oil                           | 5 238         | 5 628         | 5 693         | 5 808         | 5 775         | 5 598              | 5 478              |
| Natural gas                           | 2 316         | 2 408         | 2 592         | 3 161         | 3 048         | 3 057              | 3 025              |
| Water and wind energy                 | 58            | 62            | 67            | 73            | 80            | 88                 | 106                |
| Foreign trade balance for electricity | 3             | -19           | 8             | -19           | -2            | 3                  | 9                  |
| Nuclear energy                        | 1 668         | 1 733         | 1 650         | 1 764         | 1 764         | 1 852              | 1 849              |
| Other energy sources <sup>2)</sup>    | 126           | 135           | 174           | 181           | 283           | 237                | 246                |
| <b>Primary energy consumption</b>     | <b>14 916</b> | <b>14 319</b> | <b>14 184</b> | <b>14 746</b> | <b>14 521</b> | <b>14 193</b>      | <b>14 180</b>      |

1) Calculations based on efficiency aspects (differences in totals due to rounding off)

2) Firewood and waste timber, peat, waste sewage sludge, other gases and waste heat from power and district heating stations

\*) Preliminary figures (20.07.2001)

Source: Working Group on Energy Balances

Primary energy consumption is increasingly being supplied by fuels with favourable emissions properties. Energy needs in 2000 were met using about 39% mineral oil, 21% natural gas, 14% coal and 11% lignite. 13% of primary energy consumption was provided by nuclear energy. The proportion contributed by renewable energy sources such as water, wind, biomass and solar, is still very low at just over 2%.

## Electricity generation from renewable energy sources in million kWh

|              | 1990          | 1992          | 1994          | 1996          | 1998          | 1999          | 2000 <sup>*)</sup> |
|--------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Water        | 15 580        | 16 153        | 17 499        | 16 152        | 17 264        | 19 708        | 20 500             |
| Wind         | 40            | 230           | 940           | 2 200         | 4 489         | 5 528         | 9 200              |
| Biomass      | 222           | 295           | 570           | 804           | 1 050         | 1 170         | 1 625              |
| Photovoltaic | 1             | 4             | 10            | 21            | 42            | 54            | 89                 |
| <b>Total</b> | <b>15 843</b> | <b>16 682</b> | <b>19 019</b> | <b>19 177</b> | <b>22 845</b> | <b>26 460</b> | <b>31 414</b>      |

\*) Preliminary figures

Source: Yearbook of renewable energy 2001

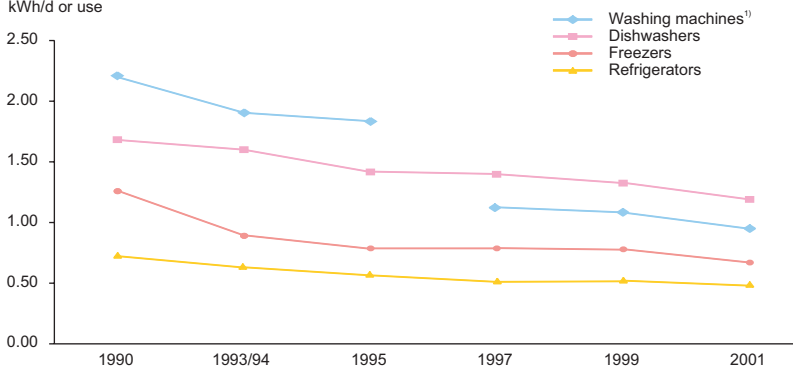
In 2000, 6.2% of electricity consumed came from renewable sources. Taking the year 2000 as a baseline, the government aims to increase the share of energy from renewable sources to 4.2% and the share of electricity consumption from renewable sources to 12.5% by 2010. Wind power is becoming increasingly important. Since 1990, electricity generation from wind has increased more than two hundred-fold. During this period, wind power generators have grown in size and become more reliable and more efficient, many already in the megawatt category. A 1.5 mW installation is capable of generating up to 3.5 million kWh electricity per year, depending on the amount of wind. This is enough to meet the annual energy needs of 1,000 households. Every KWh of electricity generated with wind power can save about a kilogram of CO<sub>2</sub> emissions from coal-fired power generation.

## Energy conservation / energy efficiency

The environment can only benefit from the use of renewable energy sources if electricity consumption does not increase. Therefore energy conservation is very important. Energy can also be efficiently employed in combined heat and power plants. The discharged heat of conventional power plants is used for heating and cooling by nearby end users. The fuel efficiency of the power plants therefore increases from 30–45% to 80–90%. In the old Länder, some 9% of all households are warmed with district heating, in the new Länder 27%.

### Average energy consumption of selected household appliances

kWh/d or use



1) Up to 1995: boil wash, from 1997 onwards: 60° C wash

Source: Niedrig-Energie-Institut

The improvement of technology used in large household appliances has led to a decrease in energy consumption. This decrease is offset by increases caused by, for example, stand-by wastage.

## Distribution of road traffic

|                                           |          | 1991   | 1993   | 1995   | 1997   | 1999   | 2000   |
|-------------------------------------------|----------|--------|--------|--------|--------|--------|--------|
| <b>Passenger road transport</b>           |          |        |        |        |        |        |        |
| Motor vehicles and motorised two-wheelers | mill.    | 40.5   | 42.8   | 44.3   | 45.8   | 47.2   | 48.0   |
| Vehicle mileage                           | bill. km | 542.7  | 555.5  | 535.4  | 539.2  | 550.8  | 539.8  |
| Buses                                     | thousand | 90     | 89     | 86     | 84     | 85     | 86     |
| Vehicle mileage                           | bill. km | 3.9    | 3.8    | 3.7    | 3.7    | 3.7    | 3.7    |
| Fuel consumption (passenger transport)    | mill. l  | 47 407 | 49 337 | 48 151 | 48 143 | 48 317 | 46 403 |
| <b>Road freight transport</b>             |          |        |        |        |        |        |        |
| HGVs                                      | mill.    | 1.8    | 2.1    | 2.3    | 2.5    | 2.6    | 2.7    |
| Vehicle mileage                           | bill. km | 60.5   | 64.3   | 75.2   | 78.7   | 89.2   | 93.7   |
| Fuel consumption (freight transport)      | mill. l  | 15 927 | 17 864 | 19 057 | 19 450 | 22 676 | 23 137 |

Source: Federal Environmental Agency

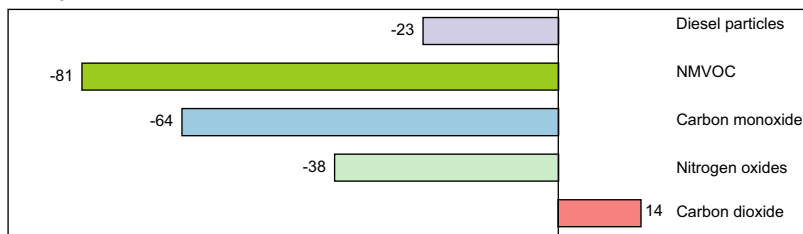
Motor vehicle stocks continue to rise. Car ownership in Germany increased from 460 per 1,000 residents in 1991 to 515 in 2000, one of the highest rates in the world.

Fuel consumption increased between 1991 and 2000 by 9.8%. While consumption in passenger transport fell by 2%, fuel consumption for freight transport rose by more than 45%. The share of road haulage in total fuel consumption for road transport therefore increased from 25% in 1991 to 33% in 2000. Despite improved technology in reducing the fuel consumption of cars, the trend towards more powerful, heavier cars has meant that average fuel consumption fell only by 0.4 l per 100 km.

A far more serious trend in environmental terms is the sharp increase in vehicle mileage for HGVs, as they produce significantly more atmospheric emissions and noise per kilometre travelled. Between 1991 and 2000, the total distance travelled by HGVs rose by 55%.

## Emissions from road transport

Changes between 1990 and 2000 in %

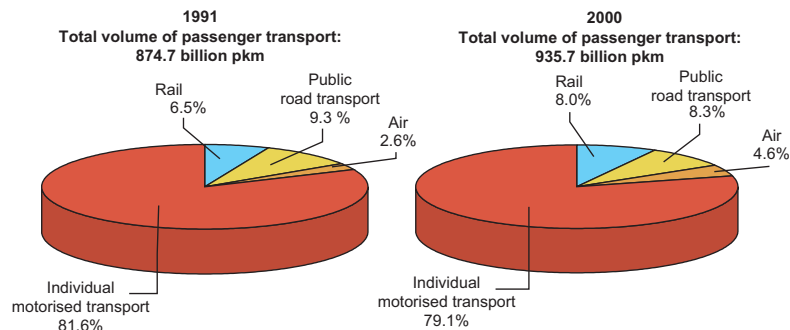


Source: Federal Environmental Agency

From 1990 to 2000, there was a fall in emissions of particles (-19%), carbon monoxide (-49%) and NMVOCs (-33%) from road freight transport due to improved technology. However, the effects of technical improvements to reduce nitrogen oxide emissions were more than offset by the increased distances travelled (NOx: +15%).

Between 1990 and 2000 there was a significant fall in emissions from passenger transport (CO: -65%, NOx: -64%, NMVOCs: -84%) although the distances travelled by cars increased by 2%. This was due to the gradual tightening up of exhaust emission standards for newly registered cars and to retrofitting older cars.

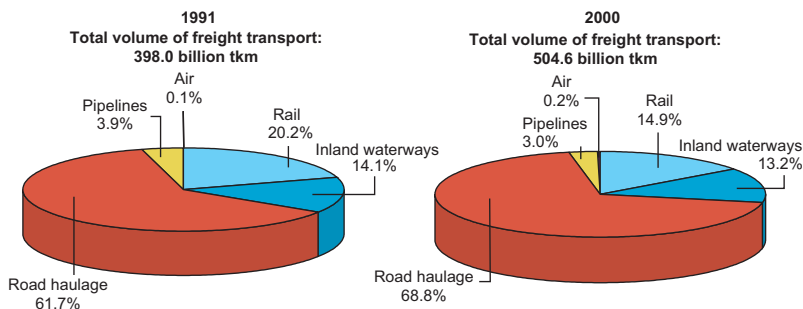
## Modal split in passenger transport



Source: Federal Ministry for Transport

The rise in passenger transport between 1991 and 2000 was 7%, with individual motorised transport increasing by 3.7%. During the same period, its share in the total volume of passenger transport fell by 2.5% from 81.6%. By far the sharpest rise among modes of passenger transport was the almost 90% rise in air transport. The transport performance of public road and rail transport increased by 10.3%. These less environmentally harmful transport modes have thus maintained their relatively low share of around 16% of total transport performance. If non-motorised modes (pedestrians, cycling) are included in total transport performance, passenger transport is still dominated by individual motorised transport (75% share), some way ahead of all environmentally friendly forms of transport together (pedestrians, cycling, rail and public road transport) with only 21% share.

## Modal split in freight transport



Source: Federal Ministry for Transport

Freight transport performance rose between 1991 and 2000 by 26.8%. The highest growth was in road transport (+41.3%) and, although starting from a very low level, air transport (+78%). The share of freight transport by road rose from 61.7% to 68.8%, primarily at the expense of the railways, whose share fell in the same period from 20.2% to only 14.9%. The total share accounted for by environmentally less harmful forms of transport (rail and ship) fell from 34.2% to around 28%.

## Agricultural land use and organic farming in thousand ha

| in thousand ha                         | 1991          | 1992          | 1993          | 1994          | 1995          | 1996          | 1997          | 1998          | 1999          | 2000          |
|----------------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Crops                                  | 11 559        | 11 467        | 11 676        | 11 805        | 11 835        | 11 832        | 11 832        | 11 879        | 11 821        | 11 804        |
| Pasture                                | 5 330         | 5 234         | 5 251         | 5 271         | 5 282         | 5 273         | 5 268         | 5 265         | 5 114         | 5 048         |
| Other <sup>1)</sup>                    | 248           | 240           | 235           | 232           | 228           | 230           | 227           | 228           | 216           | 216           |
| <b>Total</b>                           | <b>17 136</b> | <b>16 950</b> | <b>17 162</b> | <b>17 308</b> | <b>17 344</b> | <b>17 335</b> | <b>17 327</b> | <b>17 373</b> | <b>17 152</b> | <b>17 067</b> |
| Share of area used for organic farming | —             | —             | —             | 1.6%          | 1.8%          | 2.1%          | 2.3%          | 2.4%          | 2.7%          | 3.2%          |

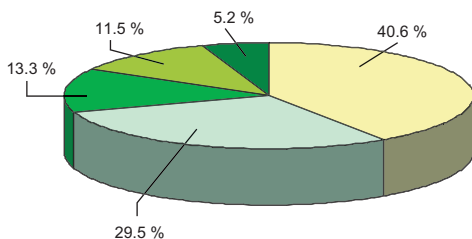
1) e.g. private gardens, nurseries, vineyards, etc.

Sources: Federal Statistical Office, Federal Ministry of Consumer Protection, Food and Agriculture

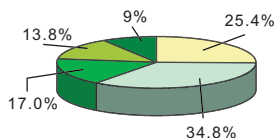
Intensive agricultural land use leads to loss of natural habitats and endangers species. Fertilisers, pesticides and intensive animal husbandry cause pressures on soil, water and air. Extensive farming, on the other hand, can have various positive effects on the environment. It can provide habitats for certain species, help prevent flooding and protect the soil. Organic farming, which conserves natural resources, is becoming increasingly significant. Despite the growth of this sector, the share of organic farming is still very low. The target introduced by the federal government is to increase the share to 20% by 2010.

## Structure of agricultural holdings 1999

**Total number of agricultural holdings (472,960)**



**Organic farming businesses (10,425)**



less than 10 ha    10 - < 30 ha    30 - < 50 ha    50 - < 100 ha    100 ha and over

Source: Federal Statistical Office

Between 1995 and 1999, the number of registered organic farming businesses increased steadily by 57%, reaching a total of 10,425, and doubling the share of agricultural land being farmed organically to 2.2%. Organic farms are 51.1 ha on average and are significantly larger than the average of all agricultural holdings at 36.3 ha. A lot of conventional agricultural holdings are run as secondary businesses.

## Use of renewable raw materials

The main industrial crop cultivated was the oil plant. In 1999, so-called non-food rape was cultivated on 6.5% of farmed arable land and on 363,000 ha of set-aside land (Annual Agricultural Statistics). In the forestry area, only about two thirds of the annual increased growth of wood is put to use (AG Ökologischer Landbau).

## Livestock population in thousands

|                                                 | 1990          | 1996          | 1999          | 2000     | 2001 <sup>*)</sup> |
|-------------------------------------------------|---------------|---------------|---------------|----------|--------------------|
| Cattle                                          | 19 488        | 15 760        | 14 896        | 14 538   | 14 536             |
| Pigs                                            | 30 819        | 24 283        | 26 101        | 25 633   | 25 893             |
| Sheep                                           | 3 239         | 2 324         | 2 724         | 2 743    | 2 674              |
| Horses                                          | 491           | 652           | 476           | –        | –                  |
| Poultry                                         | 113 879       | 112 508       | 118 303       | –        | –                  |
| <b>Total (thousand adult bovine units, ABU)</b> | <b>18 051</b> | <b>15 103</b> | <b>14 549</b> | <b>–</b> | <b>–</b>           |

\*) preliminary figures

Source: Federal Statistical Office

The livestock population, measured in adult bovine units, fell by 19% between 1990 and 1999. This is mainly due to changing eating habits, continuing productivity increases from livestock and structural changes in agriculture in the new Länder.

Both ruminants themselves and the decomposition of animal excrement produce the greenhouse gases methane (CH<sub>4</sub>) and laughing gas (N<sub>2</sub>O). Livestock farming also releases ammonium (NH<sub>3</sub>), which should be taken particularly seriously, as it contributes considerably to acidification and eutrophication. Animal excrement used as fertiliser can, under certain circumstances, lead to groundwater pollution.

Methane emissions from agriculture fell by 22% between 1990 and 1999.

## Turnover of fertiliser in ktonnes nutrient

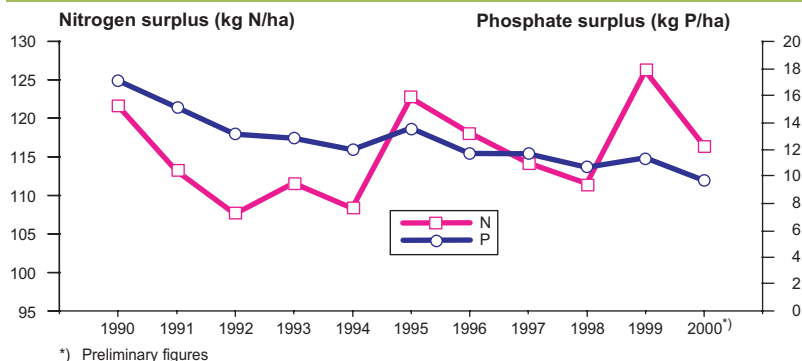
|                                            | 1990/91 | 1994/95 | 1995/96 | 1996/97 | 1997/98 | 1998/99 | 1999/00 | 2000/01 |
|--------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Nitrogen (N)                               | 1 885.3 | 1 786.1 | 1 769.2 | 1 758.0 | 1 788.4 | 1 903.0 | 2 014.4 | 1 847.6 |
| Phosphate (P <sub>2</sub> O <sub>5</sub> ) | 672.2   | 449.6   | 401.7   | 415.1   | 409.6   | 406.8   | 420.3   | 351.3   |
| Potash (K <sub>2</sub> O)                  | 1 031.7 | 667.1   | 652.2   | 645.8   | 658.9   | 628.7   | 599.2   | 544.0   |
| Lime (CaO)                                 | 2 407.6 | 1 766.6 | 1 886.5 | 1 979.1 | 2 248.5 | 2 269.8 | 2 508.3 | 2 171.1 |

Source: Federal Ministry of Consumer Protection, Food and Agriculture

Fertilisers and livestock farming are significant sources of greenhouse gas emissions. Nitrogen fertilisers release some of the nitrogen applied (1.25% on average) in the form of nitrous dioxide (N<sub>2</sub>O).

The aim of the Use of Fertilisers Ordinance, which came into force in 1996, is to permanently reduce nitrogen inputs to water bodies and other ecosystems by using fertilisers more carefully and avoiding losses of nutrients. However, turnover of commercial fertilisers in the medium-term is influenced by economic conditions and agricultural or environmental policy (for example the amount of set-aside land and the structure of agricultural/environmental programmes).

## Nutrient surplus (total balances)

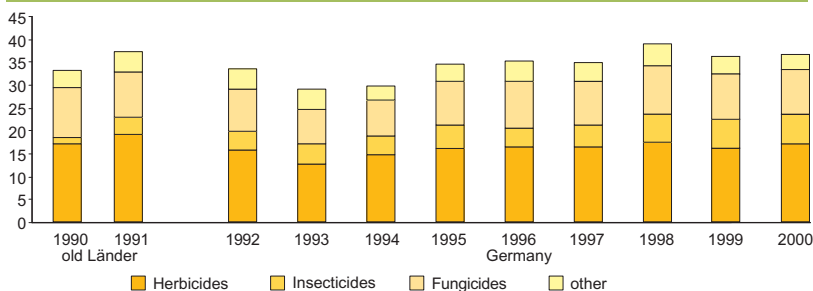


Source: Federal Environmental Agency

The total nitrogen surplus has decreased from the highest level in 1987 to 2000 by almost 40% (since 1990 by around 4%). The main reason for this decrease is the fall in livestock numbers in the new Länder. Phosphate surplus has fallen by almost 80% since 1980 (since 1990 by around 43%) to a very low level. Despite low inputs, the phosphate contents of the soil can still increase regionally.

The government aims to reduce the nitrogen surplus in the total balance to 80kg/ha by 2010.

## Turnover of pesticides in ktonnes



Source: Federal Ministry of Consumer Protection, Food and Agriculture

European and German legislation on pesticides ensures that only products whose environmental impact has been tested can be put on sale. Since 1987, well over 200 active ingredients and more than 1,200 products have been tested during the licensing applications procedure. On this basis 1,156 plant protection products are currently being manufactured. There has been a rise in herbicide sales since 1994, due essentially to recultivation of fallow land, agricultural restructuring in the new Länder and weather-related fluctuations. Assessing the environmental impact of plant protection is less a question of quantities than of the actual effects.

## Waste generation in ktonnes

|                                                                                                     | 1996           | 1997           | 1998 <sup>1)</sup> |
|-----------------------------------------------------------------------------------------------------|----------------|----------------|--------------------|
| Municipal waste                                                                                     | 44 390         | 45 593         | 44 094             |
| Mining waste                                                                                        | 54 308         | 57 590         | 56 155             |
| Manufacturing waste                                                                                 | 43 012         | 48 088         | 47 975             |
| Construction/demolition waste<br>(incl. road construction and building site waste), soil excavation | 231 480        | 229 338        | 230 984            |
| Hazardous waste                                                                                     | 18 281         | 18 860         | 19 102             |
| <b>Total</b> (Fluctuations caused by rounding off figures)                                          | <b>391 472</b> | <b>399 469</b> | <b>398 311</b>     |

1) Excluding Hamburg

Source: Federal Statistical Office

Waste generation overall has remained more or less constant. Construction and demolition waste, including road construction, building site waste and soil excavation accounted for the majority of waste generated with almost 60%. Soil excavation and construction waste are mainly recovered.

## Municipal waste generation in ktonnes

|                                                                                    | 1996          | 1997          | 1998 <sup>1)</sup> |
|------------------------------------------------------------------------------------|---------------|---------------|--------------------|
| <b>Total household waste</b>                                                       | <b>35 129</b> | <b>36 211</b> | <b>35 177</b>      |
| Household and similar waste from trade, commerce, etc. collected by municipalities | 19 875        | 18 476        | 16 806             |
| Bulky household waste                                                              | 3 003         | 3 170         | 3 174              |
| Compostable waste from bio-waste containers                                        | 2 413         | 2 935         | 3 308              |
| Other separate collections (glass, paper, plastic, electronic components)          | 9 838         | 11 629        | 11 889             |
| <b>Total other municipal waste</b>                                                 | <b>9 261</b>  | <b>9 382</b>  | <b>8 917</b>       |
| Similar waste from trade, commerce, etc. not collected by municipalities           | 5 317         | 5 305         | 5 078              |
| Parks and garden waste (incl. cemetery waste)                                      | 3 069         | 3 216         | 3 133              |
| Street cleansing, market waste                                                     | 876           | 861           | 706                |
| <b>Total</b> (Fluctuations caused by rounding off figures)                         | <b>44 390</b> | <b>45 593</b> | <b>44 094</b>      |

1) Excluding Hamburg

Source: Federal Statistical Office

Municipal waste differentiates between waste from private households and other municipal waste. Municipal waste generation has remained virtually constant during the past few years.

## Generation of hazardous waste in ktonnes

|                                                  | 1996          | 1997          | 1998 <sup>1)</sup> |
|--------------------------------------------------|---------------|---------------|--------------------|
| consignment note procedure (off site management) | 9 686         | 10 837        | 11 372             |
| on site management                               | 8 595         | 8 023         | 7 730              |
| <b>Total</b>                                     | <b>18 281</b> | <b>18 860</b> | <b>19 102</b>      |

1) Excluding Hamburg

Source: Federal Statistical Office

Wastes which are particularly harmful to health, air or water require special supervision by the authorities. The share of waste requiring special supervision was around 5% of total waste generated between 1996 and 1998.

## Disposal in waste disposal facilities<sup>1)</sup> in million tonnes

| Facility type             | 1996        | 1997        | 1998 <sup>2)</sup> |
|---------------------------|-------------|-------------|--------------------|
| Landfills                 | 55.6        | 49.4        | 47.2               |
| Waste incineration plants | 9.0         | 10.0        | 10.7               |
| Composting                | 6.6         | 7.2         | 7.7                |
| Other                     | 9.1         | 14.1        | 16.6               |
| <b>Total</b>              | <b>80.3</b> | <b>80.7</b> | <b>82.2</b>        |

1) Excluding hazardous waste

2) Excluding Hamburg

Source: Federal Statistical Office

Waste disposal facilities are supplied by waste collection services, trade, business and industry, as well as by private persons. Production waste is also disposed of by the companies themselves. The other facilities comprise chemical/physical treatment plants, shredder plants, soil treatment plants and mechanical-biological treatment plants. Deliveries of waste to landfills continues to fall. However, waste treatment and recovery is increasing.

## Import and export of waste in ktonnes

| Amounts transported to and from Germany | 1999         |              | 2000         |              |
|-----------------------------------------|--------------|--------------|--------------|--------------|
|                                         | Export       | Import       | Export       | Import       |
| Waste not subject to approval           |              |              |              |              |
| non-hazardous waste for recovery        | 15 560       | 7 420        | 16 030       | 8 500        |
| Waste subject to approval               |              |              |              |              |
| waste for disposal                      | 100          | 290          | 90           | 430          |
| hazardous waste for recovery            | 1 060        | 750          | 1 330        | 1 550        |
| other waste                             | 130          | 0            | 200          | 0            |
| <b>total waste subject to approval</b>  | <b>1 290</b> | <b>1 040</b> | <b>1 620</b> | <b>1 980</b> |

Source: Federal Environmental Agency

Making illegal waste transport a criminal offence and creating a fine-meshed control network (the Federal Agency for Goods Transport checks about 600,000 HGVs per year), has meant that Germany has had no serious cases of illegal waste transport for quite a while. In addition, the solidarity fund for the return of waste ensures that the costs of returning waste that has been transported illegally are covered. Since the funds were founded in 1996, they have only been claimed five times.

German and European law requires waste disposal to occur close to the point of origin. The average distance (as the crow flies) between the point of origin and disposal location when exporting waste from Germany in 1999 was around 150 km. The average distance for the export of waste, which is not subject to this condition, was about 390 km.

## Recycling of sales packaging in ktonnes

|                                     | 1991   | 1994   | 1996   | 1997   | 1998 <sup>a</sup> | 1999   | 2000 <sup>a</sup> |
|-------------------------------------|--------|--------|--------|--------|-------------------|--------|-------------------|
| Glass consumption                   | 3817.3 | 3504.4 | 3308.1 | 3266.0 | 3285.6            | 3342.4 | 3287.9            |
| Recycling by weight                 | 2049.7 | 2457.6 | 2671.5 | 2721.3 | 2742.1            | 2756.5 | 2709.2            |
| Recycling rate (%)                  | 53.7   | 70.1   | 80.8   | 83.3   | 83.5              | 82.5   | 82.4              |
| Tinplate consumption <sup>1)</sup>  | 740.8  | 648.0  | 649.0  | 641.5  | 637.6             | 639.1  | 641.0             |
| Recycling by weight                 | 250.6  | 372.8  | 517.0  | 531.7  | 527.1             | 525.8  | 514.9             |
| Recycling rate (%)                  | 33.8   | 57.5   | 79.7   | 82.9   | 82.7              | 82.3   | 80.3              |
| Aluminium consumption <sup>1)</sup> | 84.5   | 70.4   | 69.4   | 68.8   | 68.4              | 71.0   | 73.1              |
| Recycling by weight                 | 4.3    | 21.4   | 49.8   | 53.9   | 54.4              | 56.6   | 60.3              |
| Recycling rate (%)                  | 5.1    | 30.4   | 71.8   | 78.4   | 79.6              | 79.7   | 82.5              |
| Plastics consumption <sup>1)</sup>  | 976.9  | 929.7  | 919.9  | 937.2  | 971.3             | 1002.8 | 1049.9            |
| Recycling by weight                 | (30.0) | 461.0  | 541.2  | 596.3  | 637.3             | 651.2  | 638.1             |
| Recycling rate (%)                  | 3.1    | 49.6   | 58.8   | 63.6   | 65.6              | 64.9   | 60.8              |
| Paper consumption <sup>1) 2)</sup>  | 1834.2 | 1664.2 | 1716.8 | 1722.3 | 1839.3            | 1878.9 | 1916.6            |
| Recycling by weight                 | 514.0  | 948.0  | 1216.5 | 1313.9 | 1392.7            | 1501.4 | 1476.0            |
| Recycling rate (%)                  | 28.0   | 57.0   | 70.9   | 76.3   | 75.7              | 79.9   | 77.0              |
| Liquids carton consumption          | 193.0  | 201.5  | 204.6  | 209.7  | 217.1             | 224.8  | 241.0             |
| Recycling by weight                 | –      | 81.8   | 118.8  | 129.2  | 141.6             | 138.7  | 134.3             |
| Recycling rate (%)                  | –      | 40.6   | 58.0   | 61.6   | 65.2              | 61.7   | 55.7              |
| Total consumption <sup>3)</sup>     | 7646.7 | 7018.2 | 6867.8 | 6845.5 | 7019.3            | 7159.0 | 7209.5            |
| Recycling by weight                 | 2848.7 | 4342.6 | 5114.7 | 5346.3 | 5495.3            | 5630.2 | 5532.7            |
| Recycling rate (%)                  | 37.3   | 61.9   | 74.5   | 78.1   | 78.3              | 78.6   | 76.7              |

1) Including composites

2) Excluding liquids cartons

3) Excluding consumption of packaging from other materials (30 ktonnes)

4) As of 1998 on the basis of definitions in the revised Packaging Ordinance

<sup>a</sup>) Provisional estimate (August 2001)

Source: Society for Packaging Market Research

The yearly packaging consumption of private end users fell by about 11% between 1991 and 1997. Around 12 kg less sales packaging was consumed per capita in 1997 than in 1991. Since 1998, there has been a rise in consumption.

The yearly recovery volumes of packaging waste have been increasing since 1991. The recovery quota has doubled from 1991 to 1996. The Dual System (DSD) has recovered 40.72 million tonnes of sales packaging between 1993 and 2000.

## Waste paper input in %

|                                            | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|--------------------------------------------|------|------|------|------|------|------|
| Waste paper utilisation rate <sup>1)</sup> | 58   | 60   | 60   | 61   | 61   | 60   |
| Waste paper recovery rate <sup>2)</sup>    | 67   | 71   | 71   | 71   | 73   | 71   |

1) Waste paper consumption as % of paper and board production (minus waste paper consumption for export)

2) Waste paper volume as % of paper and board consumption

Source: German Pulp and Paper Association

In 2000, paper consumption per capita was 232.7 kg. This corresponds to a total consumption of 19.11 million tonnes. Waste paper supplies, i.e. the quantities of waste paper collected by the waste paper industry and private or local authority waste management and then returned to the paper industry or exported, rose to 13,57 million tonnes in 2000, a recovery rate of 71%. The German paper industry recovered 11 million tonnes of waste paper. The share of waste paper inputs to total domestic paper production was 60%, or 18.2 million tonnes in 2000.

## Recycling of glass containers in ktonnes

|                                                                                      | 1995     | 1997     | 1999     | 2000     |
|--------------------------------------------------------------------------------------|----------|----------|----------|----------|
| Total domestic turnover by glass container industry<br>(incl. returnable containers) | 3 705.21 | 3 470.00 | 3 530.50 | 3 414.33 |
| Domestic recycling organised and conducted by<br>the German glass container industry | 2 785.77 | 2 737.00 | 2 844.63 | 2 837.99 |
| Rate of recycling for glass containers in Germany                                    | 75.20%   | 78.90%   | 80.57%   | 83.12%   |

Source: Gesellschaft für Glasrecycling und Abfallvermeidung mbH, Ravensburg

In 2000, a total of 3,414 ktonnes glass was used in the production of returnable and non-returnable containers. The waste glass recycling quota reached 83.12% in 2000, showing a significant increase to 1999 (80.57%). This fulfils the requirements of the Packaging Ordinance regarding glass container recovery. In the next few years there will be a sharp decrease in glass container production and therefore a smaller amount of waste glass. This is due to the increasing use of PET containers, especially in the non-returnable packaging sector.

## Share of returnable packaging of beverages in %

|                                    | 1991         | 1993         | 1995         | 1997         | 1998         | 1999         | 2000         |
|------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| <b>Total drinks (excl. milk)</b>   | <b>71.69</b> | <b>73.55</b> | <b>72.27</b> | <b>71.33</b> | <b>70.13</b> | <b>68.68</b> | <b>65.46</b> |
| Mineral water                      | 91.33        | 90.89        | 89.03        | 88.31        | 87.44        | 84.94        | 80.96        |
| Fruit juice and other still drinks | 34.56        | 39.57        | 38.24        | 36.81        | 35.66        | 34.75        | 33.35        |
| Carbonated drinks                  | 73.72        | 76.67        | 75.31        | 77.76        | 77.02        | 74.90        | 68.45        |
| Beer                               | 82.16        | 82.25        | 79.07        | 77.88        | 76.14        | 74.83        | 73.07        |
| Wine                               | 28.63        | 28.90        | 30.42        | 28.10        | 26.20        | 26.75        | 25.76        |

Source: Society for Packaging Market Research

## Share of environmentally preferable packaging of pasteurised milk

|                               | 1991         | 1993         | 1995         | 1997         | 1998                     | 1999        | 2000        |
|-------------------------------|--------------|--------------|--------------|--------------|--------------------------|-------------|-------------|
| <b>Total pasteurised milk</b> | <b>26.27</b> | <b>27.97</b> | <b>28.44</b> | <b>30.21</b> | <b>25.0<sup>1)</sup></b> | <b>21.9</b> | <b>18.9</b> |
| Returnable packaging          | 24.17        | 26.56        | 22.54        | 17.99        | 15.2                     | 13.2        | 11.8        |
| Tubular bags                  | 2.10         | 1.41         | 5.90         | 12.22        | 9.7                      | 8.7         | 7.1         |

1) rounded figures

Source: Pack Marketing GmbH, from 1998 Federal Institute for Milk Research

The Packaging Ordinance prescribes a share of returnable packaging of drinks (excluding milk) of 72% and a share of environmentally preferable packaging of pasteurised milk of 20%. The returnable quota for drinks rose in 1992 and 1993, but the trend has been downwards since 1994 and in 1997, the returnable quota failed to meet the prescribed 72%. The quota is continuing to fall. The quota for pasteurised milk has been falling since 1998 and in 2000 the legally required quota was not fulfilled. If the required quotas are not maintained, the ordinance provides for a mandatory deposit on non-returnable drinks containers to come into effect (except for tubular bags for milk).

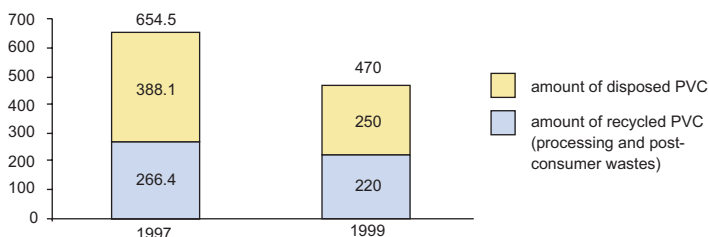
## Production and recycling of PVC in ktonnes

|      | Production | Processing | Packaging | Construction | of which for<br>Vehicles | Electrical<br>engineering | Other |
|------|------------|------------|-----------|--------------|--------------------------|---------------------------|-------|
| 1997 | 1 450      | 1 460      | 143       | 883          | 57                       | 63                        | 314   |
| 1999 | 1 550      | 1 520      | 140       | 1 076        | 62                       | 99                        | 143   |

Source: Consultic Marketing- und Industrieberatung GmbH

The quantity of polyvinyl chloride (PVC) makes it the most significant organo-chlorinated plastic. PVC production and processing are continuously increasing in comparison to the production volume at the beginning of the 1990s of just under 1,000 ktonnes. PVC is mainly used in areas where it has a long useful life, e.g. in construction in windows and pipes. Despite the increase in PVC production, the waste volume has fallen.

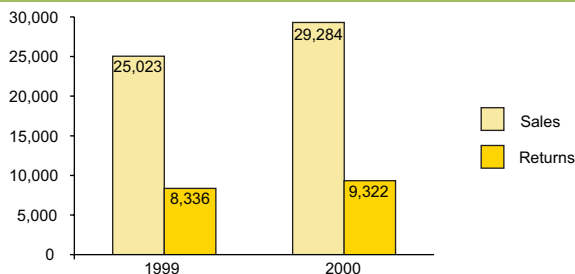
Recovery of PVC waste in kt



Source: Consultic Marketing- und Industrieberatung GmbH

The fall in the amount of PVC waste, despite the increase in production and processing, can be accounted for by a move away from short-lived products to ones which last longer. The recovered PVC wastes are accounted for mainly by commercial recycling of production and processing wastes. According to estimates of the Federal/Länder Committee for Chemicals Safety (BLAC) on amounts of recycled PVC from the post-consumer sector, there is a very small volume (less than 20 ktonnes per year) stemming from products such as floor coverings, roofing materials, windows and pipes.

## Sales and returns of batteries in tonnes



Source: Federal Environmental Agency

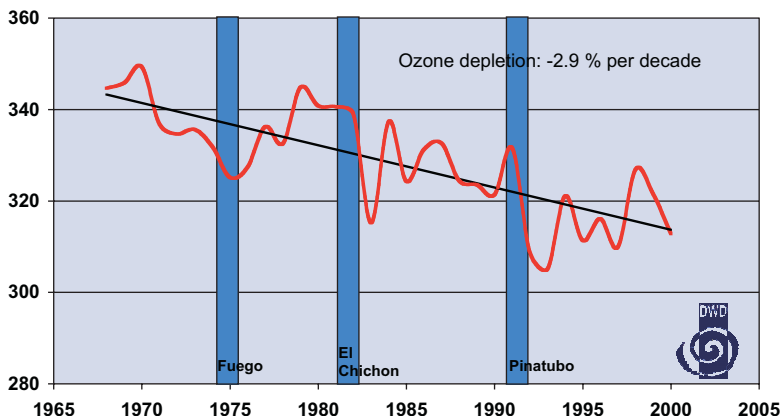
Each year around 800 million batteries and accumulators are brought into circulation. Due to their harmful contents, batteries and accumulators are not allowed to be disposed of with household and industrial waste in Germany. According to the Battery Ordinance, all used batteries and accumulators have to be returned to the retailers or to special collection points.

## Production and consumption of ozone depleting substances (CFCs)

Germany has fulfilled its commitment to the Montreal Protocol to cease production and use of fully halogenated CFCs ahead of time (1994). The permission to use R22 (partially halogenated substitutes), which has less harmful effects, expired in 2000.

## Column ozone levels at Hohenpeißenberg

Dobson units



Source: German Meteorological Service

Total levels of substances in the lower atmosphere harmful to the ozone layer peaked in 1994 and have slowly been falling since, although trends for substances containing chlorine and bromine vary. Total bromine content is still rising, unlike total chlorine content. There is still a significant rise in the increasingly used CFC substitutes, HFCs and PFCs. Although neither are ozone depleting substances, they have a great global warming potential, as do CFCs and HFCs. Stratospheric concentrations of ozone depleting substances are expected to have peaked now and to start falling. Over the past 30 years, the ozone column over northern mid-latitudes has fallen by some 10%. Although depletion of stratospheric ozone over mid-latitudes has slowed down, the downwards trend continues. Since 1967, column ozone levels have decreased by about 3% per decade in our latitudes. The hole in the ozone layer over the Antarctic is as severe today as it ever was. Destruction of the ozone layer is expected to peak within the next ten to twenty years.

## UV radiation

The ozone layer absorbs a large proportion of incoming ultra-violet solar radiation. Ozone depletion reduces the amounts absorbed, exposing humans, as well as terrestrial and aquatic ecosystems, to harmful UV radiation.

## Greenhouse gas emissions in CO<sub>2</sub> equivalents according to source category in ktonnes

| Source category                        | Substance                     | 1990             | 1995             | 1998 <sup>1)</sup> | 1999 <sup>1)</sup> | 2000 <sup>1)</sup> |
|----------------------------------------|-------------------------------|------------------|------------------|--------------------|--------------------|--------------------|
| <b>Energy-related emissions</b>        | CO <sub>2</sub>               | 986 832          | 877 353          | 860 315            | 833 225            | 831 759            |
|                                        | CH <sub>4</sub>               | 37 273           | 26 827           | 22 390             | 21 185             | 18 594             |
|                                        | N <sub>2</sub> O              | 11 375           | 11 400           | 11 284             | 11 022             | 10 702             |
| <b>Total</b>                           |                               | <b>1 035 481</b> | <b>915 580</b>   | <b>893 989</b>     | <b>865 432</b>     | <b>861 055</b>     |
| Share of total emissions               |                               | 84.7%            | 85.5%            | 87.1%              | 87.1%              | 86.9%              |
| <b>Industrial processes</b>            | CO <sub>2</sub>               | 27 668           | 26 312           | 25 648             | 26 021             | 26 149             |
|                                        | CH <sub>4</sub>               | 0                | 0                | 0                  | 0                  | 0                  |
|                                        | N <sub>2</sub> O              | 25 420           | 25 517           | 9 271              | 5 141              | 5 089              |
|                                        | H-FKW                         | 2 340            | 3 130            | 4 278              | 5 250              | 7 700              |
|                                        | CF <sub>4</sub>               | 2 308            | 1 456            | 1 209              | 1 209              | 1 209              |
|                                        | C <sub>2</sub> F <sub>6</sub> | 386              | 294              | 423                | 423                | 423                |
|                                        | C <sub>3</sub> F <sub>8</sub> | 0                | 14               | 77                 | 77                 | 77                 |
|                                        | SF <sub>6</sub>               | 3 896            | 6 238            | 5 473              | 3 537              | 3 442              |
| <b>Total</b>                           |                               | <b>62 018</b>    | <b>62 961</b>    | <b>46 379</b>      | <b>41 658</b>      | <b>44 089</b>      |
| Share of total emissions               |                               | 5.1%             | 5.9%             | 4.5%               | 4.2%               | 4.4%               |
| <b>Product use</b>                     | CO <sub>2</sub>               | –                | –                | –                  | –                  | –                  |
|                                        | CH <sub>4</sub>               | –                | –                | –                  | –                  | –                  |
|                                        | N <sub>2</sub> O              | 1 860            | 1 860            | 1 860              | 1 860              | 1 860              |
| <b>Total</b>                           |                               | <b>1 860</b>     | <b>1 860</b>     | <b>1 860</b>       | <b>1 860</b>       | <b>1 860</b>       |
| Share of total emissions               |                               | 0.2%             | 0.2%             | 0.2%               | 0.2%               | 0.2%               |
| <b>Agriculture</b>                     | CO <sub>2</sub>               | –                | –                | –                  | –                  | –                  |
|                                        | CH <sub>4</sub>               | 33 700           | 27 499           | 26 179             | 26 009             | 25 315             |
|                                        | N <sub>2</sub> O              | 48 698           | 40 429           | 40 153             | 40 946             | 41 189             |
| <b>Total</b>                           |                               | <b>82 398</b>    | <b>67 927</b>    | <b>66 333</b>      | <b>66 955</b>      | <b>66 503</b>      |
| Share of total emissions               |                               | 6.7%             | 6.3%             | 6.5%               | 6.7%               | 6.7%               |
| <b>Waste management</b>                | CO <sub>2</sub>               | –                | –                | –                  | –                  | –                  |
|                                        | CH <sub>4</sub>               | 39 768           | 21 609           | 16 674             | 16 674             | 16 674             |
|                                        | N <sub>2</sub> O              | 1 240            | 1 240            | 1 240              | 1 240              | 1 240              |
| <b>Total</b>                           |                               | <b>41 008</b>    | <b>22 849</b>    | <b>17 914</b>      | <b>17 914</b>      | <b>17 914</b>      |
| Share of total emissions               |                               | 3.4%             | 2.1%             | 1.7%               | 1.8%               | 1.8%               |
| <b>Total emissions</b>                 |                               | <b>1 222 765</b> | <b>1 071 177</b> | <b>1 026 475</b>   | <b>993 819</b>     | <b>991 421</b>     |
| Share of substances in total emissions | CO <sub>2</sub>               | 83.0%            | 84.4%            | 86.3%              | 86.5%              | 86.5%              |
|                                        | CH <sub>4</sub>               | 9.1%             | 7.1%             | 6.4%               | 6.4%               | 6.1%               |
|                                        | N <sub>2</sub> O              | 7.2%             | 7.5%             | 6.2%               | 6.1%               | 6.1%               |
|                                        | H-FKW                         | 0.19%            | 0.29%            | 0.42%              | 0.53%              | 0.78%              |
|                                        | CF <sub>4</sub>               | 0.19%            | 0.14%            | 0.12%              | 0.12%              | 0.12%              |
|                                        | C <sub>2</sub> F <sub>6</sub> | 0.03%            | 0.03%            | 0.04%              | 0.04%              | 0.04%              |
|                                        | C <sub>3</sub> F <sub>8</sub> | 0.00%            | 0.00%            | 0.01%              | 0.01%              | 0.01%              |
|                                        | SF <sub>6</sub>               | 0.32%            | 0.58%            | 0.53%              | 0.36%              | 0.35%              |

\*) Preliminary figures 1) CO<sub>2</sub> = excluding sinks

Source: Federal Environmental Agency

With the help of CO<sub>2</sub> equivalents, which take into account the specific greenhouse potential of each gas, the effect on the climate of emitted greenhouse gases can be estimated in a comparable way. In Germany, CO<sub>2</sub> released during energy production alone contributes to 80% of greenhouse gas emissions, followed by methane from waste management, agriculture and natural gas supply, as well as N<sub>2</sub>O from agriculture and the chemicals industry. Under the obligations of the Framework Climate Convention and the Kyoto Protocol, emissions of greenhouse gases must be reduced. Regulations such as the Energy Conservation Ordinance, the Renewable Energy Sources Act, the climate protection agreement between the government and the private sector all play their part, as do measures such as integrated transport plans and energy conservation technologies. Emissions of the greenhouse gases listed above have been reduced 19% since the baseline year 1990 (1995 for fluorinated gases). However, the share of CO<sub>2</sub> as a percentage of emissions has increased.

## Global energy-related CO<sub>2</sub> emissions

|                                          | 1999          | Change<br>between<br>1990 and<br>1999 | Share<br>in<br>global<br>emissions<br>1999 | Per capita<br>emissions<br>for 1999 | Emissions<br>from primary<br>energy<br>consumption<br>1999 |
|------------------------------------------|---------------|---------------------------------------|--------------------------------------------|-------------------------------------|------------------------------------------------------------|
|                                          | mill.t        | in %                                  | in %                                       | in t/pc                             | in t/TJ                                                    |
| OECD                                     | 12 152        | + 10.4                                | 55.1                                       | 11.0                                | 55.9                                                       |
| Canada                                   | 504           | + 17.1                                | 2.3                                        | 16.0                                | 48.3                                                       |
| Mexico                                   | 348           | + 19.3                                | 1.6                                        | 3.7                                 | 57.4                                                       |
| USA                                      | 5 522         | + 14.3                                | 25.0                                       | 20.5                                | 58.8                                                       |
| Japan                                    | 1 127         | + 10.7                                | 5.1                                        | 9.1                                 | 53.7                                                       |
| Korea                                    | 401           | + 74.6                                | 1.8                                        | 8.8                                 | 54.1                                                       |
| Australia                                | 327           | + 26.1                                | 1.5                                        | 17.0                                | 71.2                                                       |
| New Zealand                              | 30            | + 36.1                                | 0.1                                        | 8.0                                 | 40.2                                                       |
| Austria                                  | 62            | + 8.6                                 | 0.3                                        | 7.5                                 | 50.9                                                       |
| Belgium                                  | 116           | + 9.3                                 | 0.5                                        | 11.6                                | 48.4                                                       |
| Czech Republic                           | 110           | -28.5                                 | 0.5                                        | 10.8                                | 68.5                                                       |
| Denmark                                  | 54            | + 5.3                                 | 0.2                                        | 10.0                                | 63.4                                                       |
| Finland                                  | 56            | + 1.5                                 | 0.3                                        | 11.2                                | 41.4                                                       |
| France                                   | 381           | + 7.9                                 | 1.7                                        | 6.0                                 | 33.8                                                       |
| Germany <sup>1)</sup>                    | 825           | -14.2                                 | 3.7                                        | 10.0                                | 58.2                                                       |
| Greece                                   | 84            | + 19.3                                | 0.4                                        | 7.7                                 | 72.4                                                       |
| Hungary                                  | 61            | -14.2                                 | 0.3                                        | 5.8                                 | 54.6                                                       |
| Iceland                                  | 2             | + 10.5                                | 0.0                                        | 7.5                                 | 15.5                                                       |
| Ireland                                  | 40            | + 31.7                                | 0.2                                        | 10.7                                | 68.2                                                       |
| Italy                                    | 422           | + 5.8                                 | 1.9                                        | 7.3                                 | 59.4                                                       |
| Luxembourg                               | 8             | -28.6                                 | 0.0                                        | 17.2                                | 51.3                                                       |
| Netherlands                              | 171           | + 6.8                                 | 0.8                                        | 10.5                                | 53.7                                                       |
| Norway                                   | 38            | + 34.0                                | 0.2                                        | 8.3                                 | 33.3                                                       |
| Poland                                   | 304           | -10.7                                 | 1.4                                        | 8.0                                 | 79.3                                                       |
| Portugal                                 | 60            | + 52.5                                | 0.3                                        | 6.1                                 | 61.8                                                       |
| Slovakia                                 | 40            | -27.6                                 | 0.2                                        | 7.3                                 | 52.3                                                       |
| Spain                                    | 267           | + 29.3                                | 1.2                                        | 6.9                                 | 54.8                                                       |
| Sweden                                   | 52            | + 1.2                                 | 0.2                                        | 5.4                                 | 22.5                                                       |
| Switzerland                              | 41            | + 3.0                                 | 0.2                                        | 5.6                                 | 35.7                                                       |
| Turkey                                   | 181           | + 40.7                                | 0.8                                        | 2.8                                 | 62.1                                                       |
| United Kingdom                           | 519           | -7.3                                  | 2.4                                        | 9.0                                 | 55.5                                                       |
| Europe (non-OECD)                        | 225           | -41.9                                 | 1.0                                        | 4.0                                 | 54.3                                                       |
| Africa                                   | 660           | + 21.9                                | 3.0                                        | 0.9                                 | 35.6                                                       |
| Asia                                     | 2 070         | + 56.9                                | 9.4                                        | 1.1                                 | 47.1                                                       |
| People's Republic of China <sup>2)</sup> | 2 974         | + 29.8                                | 13.5                                       | 2.4                                 | 65.9                                                       |
| Former USSR                              | 2 201         | -34.2                                 | 10.0                                       | 7.9                                 | 59.5                                                       |
| Latin America                            | 836           | + 39.3                                | 3.8                                        | 2.1                                 | 46.3                                                       |
| Middle East                              | 942           | + 63.4                                | 4.3                                        | 5.5                                 | 61.7                                                       |
| <b>World <sup>3)</sup></b>               | <b>22 060</b> | <b>+ 9.9</b>                          | <b>100.0</b>                               | <b>3.9</b>                          | <b>56.3</b>                                                |

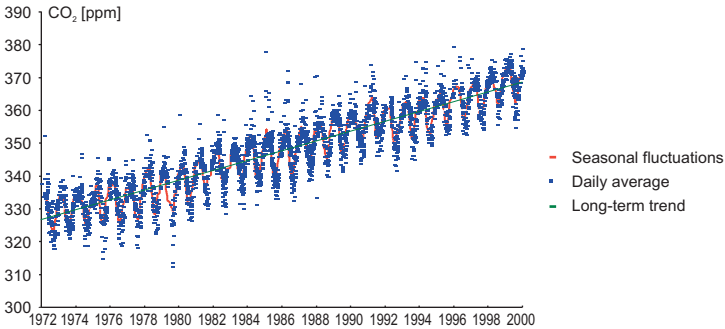
1) Deviations from German government figures are due to differences from OECD calculation methods

2) Including Hong Kong

3) Excluding international transport (758.2 million t)

Source: Organisation for Economic Cooperation and Development (OECD)

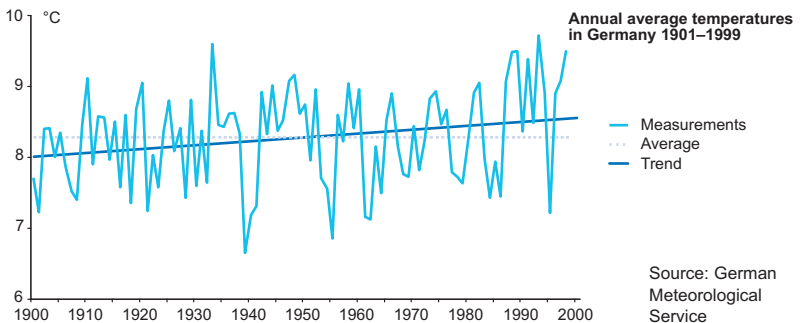
In 1999, the OECD countries were responsible for over 55% of energy-related CO<sub>2</sub> emissions worldwide. In most countries, CO<sub>2</sub> emissions increased significantly between 1990 and 1999 (globally by almost 10% on average). There were noticeable reductions in Germany, Luxembourg and the United Kingdom, although they belong to the highly industrialised countries with a very high per capita CO<sub>2</sub> emissions level. In the wake of the economic slump, emissions in the former Soviet Union (–34%) and Eastern Europe (non-OECD Europe: –42%) fell particularly sharply.

Trends in atmospheric concentrations of CO<sub>2</sub>

Source: Federal Environmental Agency (Schauinsland monitoring station)

Since the start of industrialisation around 1750, the atmospheric concentration of CO<sub>2</sub> has risen by 31%, from 280 ppm to more than 360 ppm, and has probably now reached the highest level of the last 20 million years. The annual increase in the last decades has been 1.5 ppm (0.4%). If anthropogenic emissions continue at current levels, further increasing climate changes can be expected.

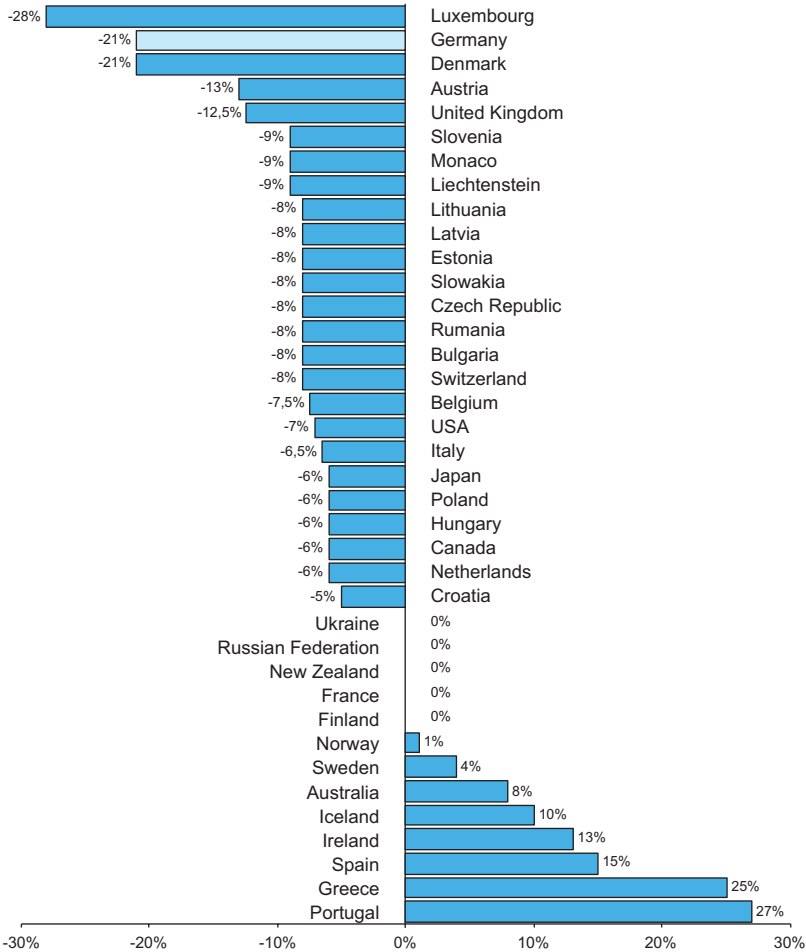
## Climate trends



The last decade of the 20th century was not only the warmest decade of the century but even the warmest of the millennium. Nine out of ten years were hotter than the long-term annual average temperature (8.3° C). Five of the ten hottest years of the century were in the 1990s. 2000 was the hottest year of all. The annual average temperature increased by 0.6° C during the century. Climate change in Europe has become so significant that the first effects on flora and fauna can be observed. For example, forsythia and snowdrops are blossoming earlier (approx. 5 days/decade), trees are bursting into bud earlier (approx. 5 days/decade) and their foliage is also turning brown later. Many songbirds are staying almost a month longer in northern regions than in the 1970s. Spring comes earlier and autumn later.

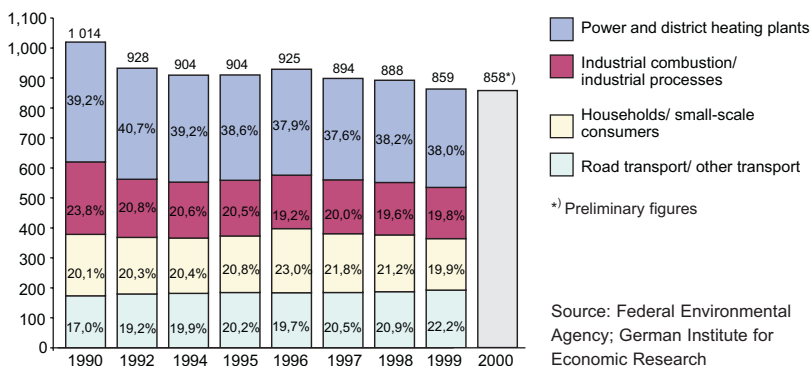
On a global level, climate change not only leads to a shift of vegetation zones but also to a distinct increase in extreme weather events (storms and floods) and to a gradual rise in sea level, which, in turn, poses a threat to small groups of islands and coastal areas.

Commitments for reducing greenhouse gas emissions between 2008–2012 in relation to given baseline years

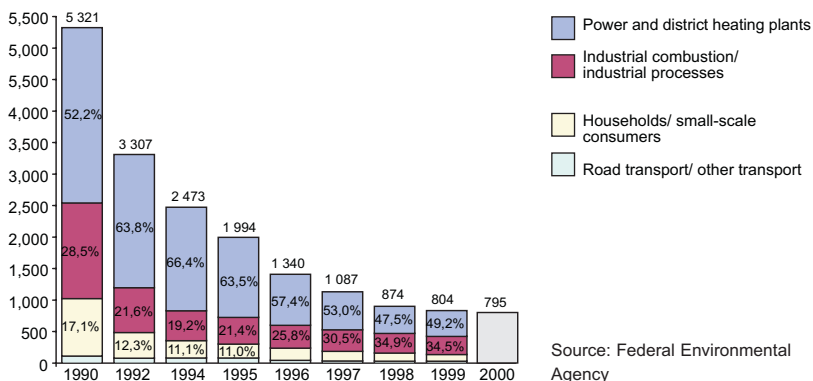


Source: Federal Environmental Agency

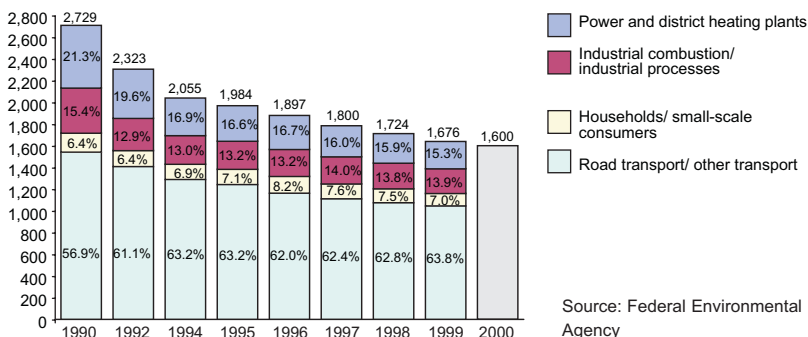
The Kyoto Protocol of the Framework Convention on Climate Change commits industrialised countries to reducing their emissions of the greenhouse gases CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O (baseline year 1990), HFCs, PFCs and SF<sub>6</sub> (baseline year either 1990 or 1995) by at least 5% by 2008–2012. The EU has committed itself to an 8% reduction in emissions. Within the EU these reduction commitments have been distributed in the framework of the so-called burden sharing scheme, taking account of special national features.

Carbon dioxide (CO<sub>2</sub>) emissions in million tonnes

Germany has committed itself to reducing CO<sub>2</sub> emissions by 25% by 2005 compared to the baseline year 1990. The fall in emissions from 1,014 million tonnes in 1990 to 858 million tonnes in 2000 represents a reduction of 15%. The continuous fall from 1990 to 1995 was interrupted by unusually cold winters in 1995/96 and 1996/97, which led to a rise in CO<sub>2</sub> emissions. The recent reductions in emissions are due both to economic restructuring and reduced use of lignite in the new Länder and to the active climate policy of the government. In contrast, emissions from private households and in particular from road transport rose sharply.

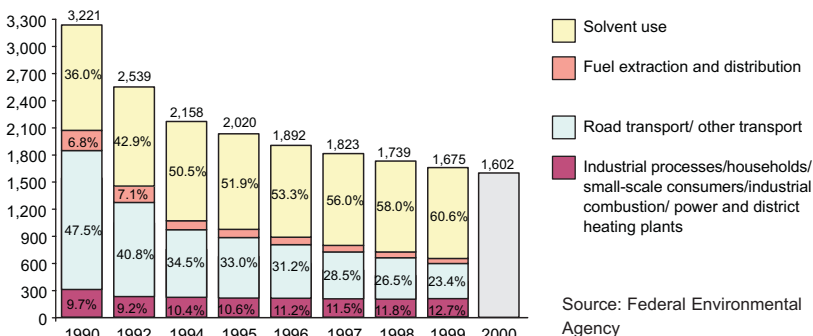
Sulphur dioxide (SO<sub>2</sub>) emissions in ktonnes

Under the Helsinki Protocol (1st Sulphur Protocol), Germany committed itself to a reduction of at least 30% in its annual sulphur dioxide emissions (relative to 1980 levels) by 1993. In 1993, emissions were 2,945 ktonnes compared with 7,514 ktonnes in 1980, a fall of 61%. The target of the 2nd Sulphur Protocol (reduction to 990 ktonnes by 2005) has already been fulfilled. Under the EU Directive on National Emissions Ceilings, Germany is committed to a reduction of SO<sub>2</sub> emissions by 520 ktonnes by 2010.

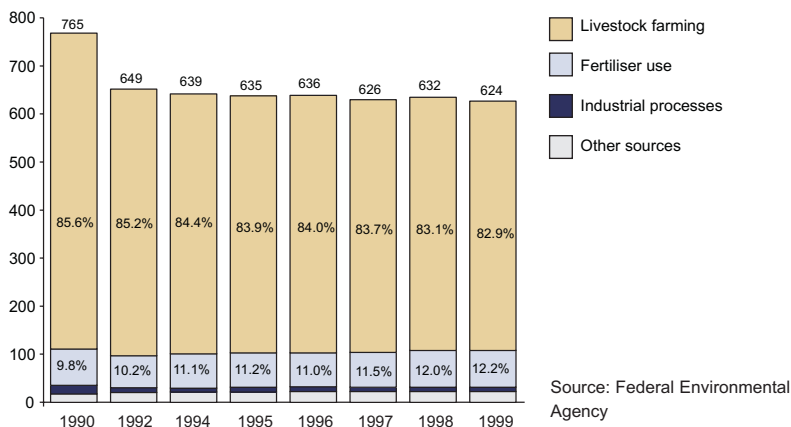
Nitrogen oxide (NO<sub>x</sub> calculated as NO<sub>2</sub>) emissions in ktonnes

Under the UNECE protocol on the reduction of NO<sub>x</sub> emissions, Germany committed itself to reducing emissions to 1987 levels (3,177 ktonnes) by 1994. During this period, emissions were reduced by over 30% to 2,055 ktonnes, more than meeting this obligation. The additional voluntary commitment, undertaken by Germany and 11 other ECE countries (a 30% reduction by 1998, relative to 1986) was also more than fulfilled (-48%). Under the EU Directive on National Emissions Ceilings, there is a commitment to reduce NO<sub>x</sub> emissions to 1,051 ktonnes by 2010.

## Emissions of non-methane volatile organic compounds (NMVOCs) in ktonnes

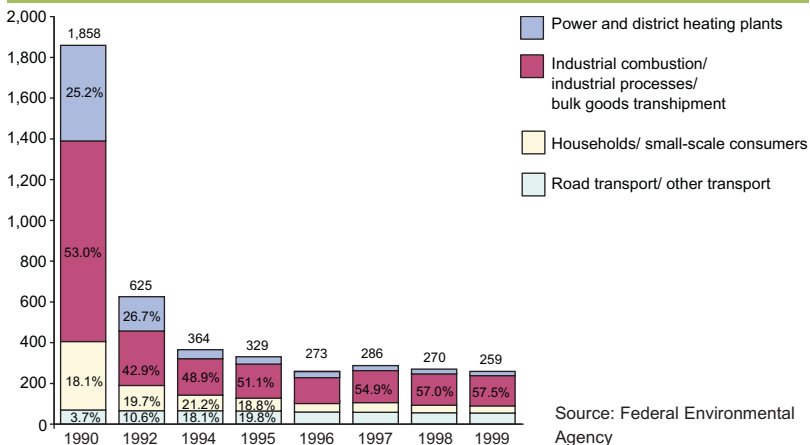


The obligation undertaken by signatories to the UNECE protocol to reduce emissions of non-methane volatile organic compounds by 30% relative to 1988 levels (3,188 ktonnes) by the year 1999 was fulfilled by Germany. The 50% reduction between 1990 and 2000 was mainly due to legal regulations on exhaust gas, which brought reductions in emissions from road transport. Regulations on reducing emissions during the distribution of motor fuel also had an effect. The main source of NMVOC emissions (60%) is solvent use in industry, business and private households. Under the EU Directive on National Emissions Ceilings, there is a commitment to reduce NMVOC emissions to 995 ktonnes by 2010.

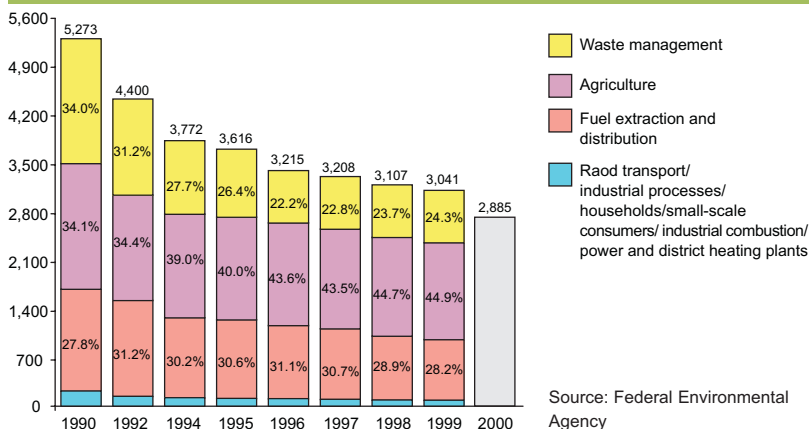
Ammonia (NH<sub>3</sub>) emissions in ktonnes

The approximately 120 ktonnes drop in emissions of ammonia between 1990 and 1999 was due primarily to the fall in livestock numbers and the decreasing use of mineral nitrogen fertilisers in the new Länder. Under the EU Directive on National Emissions Ceilings, there is a commitment to reduce NH<sub>3</sub> emissions to 550 ktonnes by 2010.

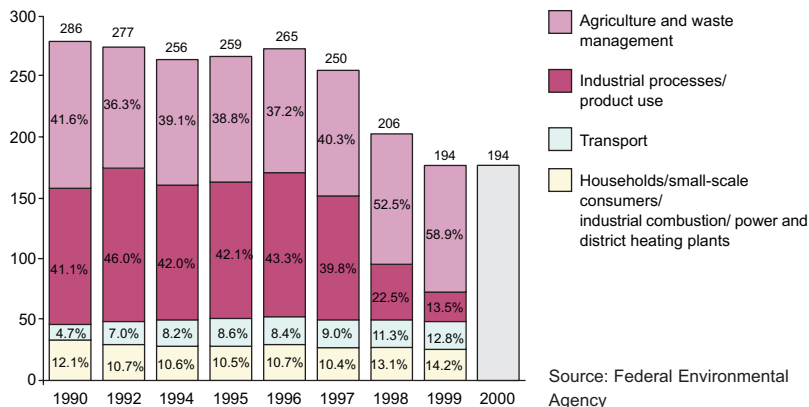
## Particulate emissions in ktonnes



Particulate emissions fell by 1.6 million tonnes between 1990 and 1999, due primarily to reductions in the new Länder, where many obsolete combustion plants and other industrial facilities were decommissioned. The shift away from solid fuels towards low-emission liquid and gaseous fuels, especially in smaller combustion plants, was another factor. Industrial processes are currently the main source category of particulate emissions, contributing to almost 40%.

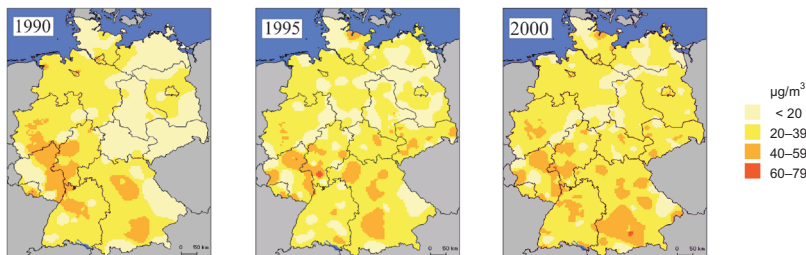
Methane (CH<sub>4</sub>) emissions in ktonnes

Methane emissions fell by around 2.4 million tonnes (–45%) between 1990 and 2000. This reduction was caused by a decline in coal mining, reduced numbers of livestock and a sharp decrease in waste volumes due to increased recycling activities. A further reduction was brought about by upgrading the gas distribution network and by shifts in fuel use towards liquid and gaseous fuels for small combustion plants.

Dinitrogen oxide (N<sub>2</sub>O) emissions in ktonnes

Dinitrogen oxide emissions fell by about 32% between 1990 and 2000. Reductions in the agricultural sector (drop in livestock holdings) were offset by increases in emissions from road transport. Since 1997, technological reduction measures taken by producers of adipic acid have brought about significant reductions in emissions from industrial processes.

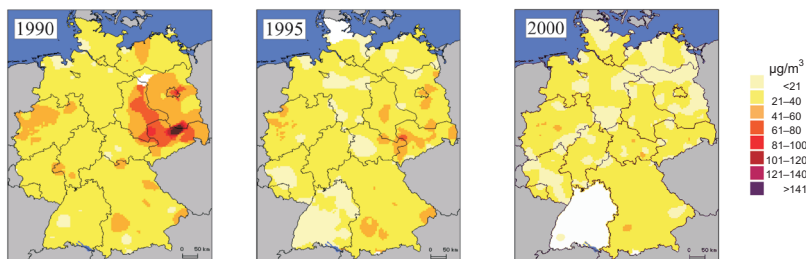
## Nitrogen dioxide (NO<sub>2</sub>) concentrations



Source: Federal Environmental Agency

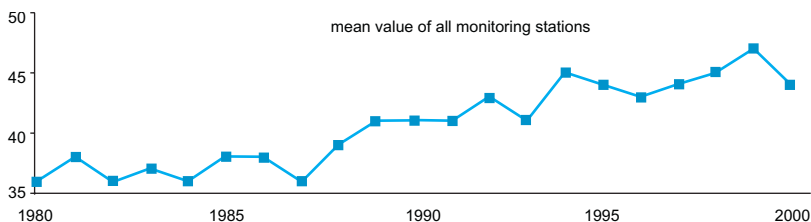
Despite the increasing use of catalytic converters, road transport still accounts for around 50% of all NO<sub>x</sub> emissions, due to the continuously increasing volume of motor vehicles. There are considerable differences in NO<sub>2</sub> concentrations between rural areas and urban agglomerations. No distinct trend towards increased or reduced NO<sub>2</sub> concentrations could be observed in the past decade. While annual mean NO<sub>2</sub> concentrations of 30 to 60  $\mu\text{g}/\text{m}^3$  have been recorded in urban agglomerations, some measuring stations located near major traffic routes have registered up to 80  $\mu\text{g}/\text{m}^3$ . NO<sub>2</sub> pollution in rural areas has a yearly average of not even 10  $\mu\text{g}/\text{m}^3$ .

## Concentrations of particulate matter components PM<sub>10</sub>



Source: Federal Environmental Agency

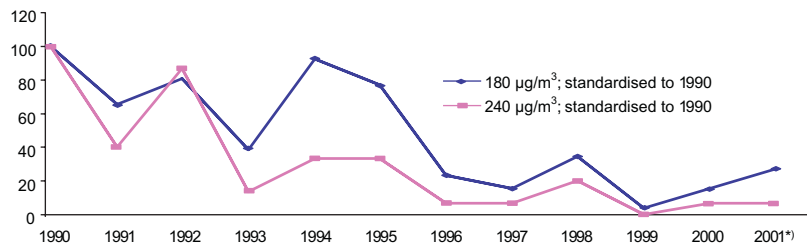
The particulate matter components PM<sub>10</sub> and PM<sub>2.5</sub> are becoming more important in the debate on public health policy. Particulate matter is mainly produced during incineration at stationary and mobile sources, during industrial processes such as cement manufacture and during the handling and transport of dusty goods, but it can also be formed from gases as well as occurring naturally. Overall levels in Germany are now between 25 and 50  $\mu\text{g}/\text{m}^3$ . The EU directive 1999/30/EC sets a limit of 40  $\mu\text{g}/\text{m}^3$  for annual mean levels of PM<sub>10</sub>, to be complied with as of 2005. This limit is not currently being complied with all over Germany.

Concentrations of ground level ozone in  $\mu\text{g}/\text{m}^3$  (annual mean levels)

Source: Federal Environmental Agency

Annual mean ozone levels of all measuring stations can be used to determine the overall situation in Germany which is greatly influenced by background pollution from the rest of Europe. Apart from some slight fluctuations, there has been an increase in ozone concentrations between 1980 and 1999.

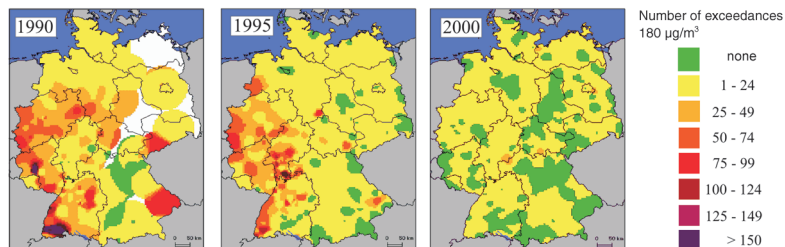
## Frequency of ozone thresholds being exceeded



Source: Federal Environmental Agency

\*) Preliminary figures

Hourly threshold levels are aimed at ensuring there is no risk to human health – above 18  $\mu\text{g}/\text{m}^3$  the public has to be informed, and above 240  $\mu\text{g}/\text{m}^3$  a public alert must be issued. In contrast to the overall average ozone concentrations, ozone exceedances have been decreasing since the mid 1990s, due to measures undertaken to reduce emissions of the ozone precursors  $\text{NO}_x$  and VOCs. The number of stations registering at least one exceedance of 240  $\mu\text{g}/\text{m}^3$  per year has fallen by almost 90% since 1990. The average number of exceedances per station fell between 1990 and 2000 by around 85% for 180  $\mu\text{g}/\text{m}^3$  exceedances and by 93% for 240  $\mu\text{g}/\text{m}^3$  exceedances.



Source: Federal Environmental Agency

## Ambient air quality in urban agglomerations

With the reductions in SO<sub>2</sub> levels in cities and urban agglomerations, attention is turning to atmospheric pollution from transport, especially to nitrogen oxides, benzene and soot which are all harmful to human health.

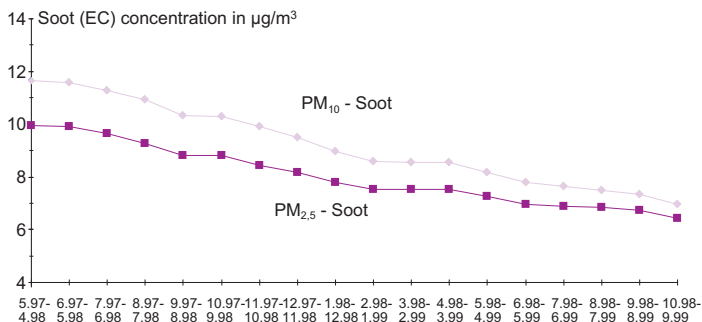
### Benzene concentrations in µg/m<sup>3</sup> (annual mean values)

|           | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|-----------|------|------|------|------|------|------|
| Berlin    | 6.0  | 6.4  | 5.2  | 3.6  | 3.3  | 2.5  |
| Leipzig   | 2.8  | 3.4  | 3.0  | 2.0  | 1.8  | 1.4  |
| Essen     | 7.2  | 10.8 | 5.7  | 5.1  | 5.3  | 4.0  |
| Magdeburg | 3.3  | 3.9  | 2.7  | 2.0  | 1.6  | 1.1  |
| Wiesbaden | –    | 11.8 | 11.0 | 10.0 | 7.1  | 5.3  |

Source: Federal Environmental Agency

The highest benzene concentrations were found near heavily used roads, especially in roads running through ravines. Annual mean benzene concentrations are falling slightly and around 75% of all benzene measuring stations record annual levels between 1 and <5 µg/m<sup>3</sup>. 25% of measuring stations still register values of ≥5 µg/m<sup>3</sup>. From 1 January 2010 onwards, the EU directive on air quality sets a threshold of 5 µg/m<sup>3</sup>.

### Soot levels in PM<sub>10</sub> and PM<sub>2.5</sub> fractions<sup>1)</sup>



1) at a heavily polluted traffic monitoring station in Berlin

Source: Federal Environmental Agency

The graph indicates that diesel engines emit less soot today than previously and the narrowing gap between PM<sub>10</sub> and PM<sub>2.5</sub> levels also indicates that HGV engines no longer emit that much more coarser-grained soot than PM<sub>2.5</sub>.

## Deposition of atmospheric pollutants 1998 in 100 tonnes

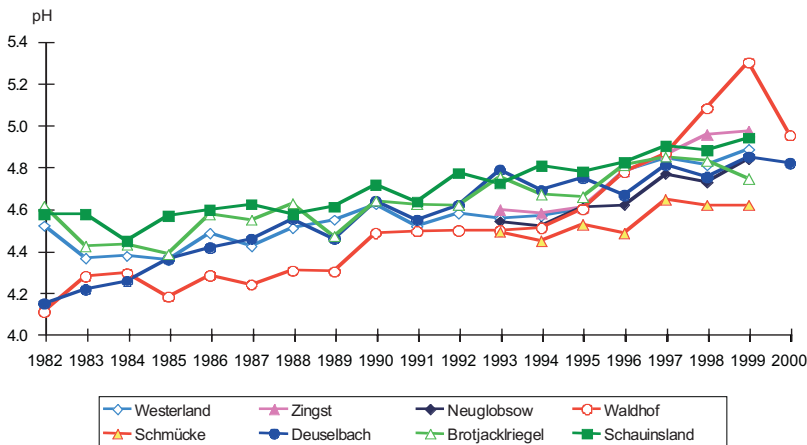
|                                                 | Oxidised sulphur |        | Oxidised nitrogen |        | Reduced nitrogen |        |
|-------------------------------------------------|------------------|--------|-------------------|--------|------------------|--------|
|                                                 | Import           | Export | Import            | Export | Import           | Export |
| Albania                                         | 0                | 3      | 0                 | 2      | 0                | 0      |
| Austria                                         | 19               | 96     | 38                | 105    | 59               | 188    |
| Belgium                                         | 234              | 23     | 200               | 33     | 142              | 26     |
| Belorussia                                      | 2                | 141    | 2                 | 70     | 1                | 26     |
| Bosnia-Herzegovina                              | 15               | 16     | 1                 | 14     | 2                | 4      |
| Bulgaria                                        | 5                | 12     | 0                 | 10     | 0                | 3      |
| Croatia                                         | 5                | 19     | 2                 | 19     | 1                | 6      |
| Czech Republic                                  | 206              | 313    | 107               | 184    | 50               | 223    |
| Denmark                                         | 17               | 56     | 24                | 40     | 33               | 73     |
| Estonia                                         | 0                | 24     | 0                 | 13     | 0                | 7      |
| Finland                                         | 0                | 63     | 2                 | 36     | 0                | 19     |
| France                                          | 425              | 111    | 387               | 173    | 270              | 82     |
| Greece                                          | 3                | 6      | 0                 | 7      | 0                | 1      |
| Hungary                                         | 34               | 53     | 7                 | 48     | 4                | 19     |
| Iceland                                         | 0                | 1      | 0                 | 1      | 0                | 0      |
| Ireland                                         | 10               | 5      | 8                 | 5      | 5                | 2      |
| Italy                                           | 68               | 38     | 87                | 55     | 35               | 15     |
| Jugoslavia                                      | 14               | 23     | 0                 | 22     | 2                | 7      |
| Latvia                                          | 0                | 42     | 0                 | 28     | 0                | 15     |
| Lithuania                                       | 2                | 69     | 1                 | 43     | 0                | 24     |
| Luxembourg                                      | 7                | 3      | 14                | 4      | 24               | 6      |
| Macedonia                                       | 0                | 2      | 0                 | 1      | 0                | 0      |
| Moldovia                                        | 0                | 6      | 0                 | 3      | 0                | 0      |
| Netherlands                                     | 112              | 42     | 251               | 57     | 410              | 115    |
| Norway                                          | 2                | 78     | 8                 | 42     | 1                | 27     |
| Poland                                          | 277              | 1094   | 80                | 502    | 68               | 300    |
| Portugal                                        | 4                | 2      | 4                 | 2      | 1                | 1      |
| Rumania                                         | 10               | 61     | 2                 | 43     | 1                | 16     |
| Russia                                          | 1                | 343    | 8                 | 185    | 0                | 64     |
| Slovakia                                        | 13               | 57     | 5                 | 38     | 3                | 21     |
| Slovenia                                        | 14               | 8      | 5                 | 9      | 2                | 4      |
| Spain                                           | 141              | 15     | 43                | 18     | 29               | 6      |
| Sweden                                          | 2                | 150    | 8                 | 93     | 3                | 66     |
| Switzerland                                     | 29               | 18     | 67                | 27     | 125              | 37     |
| Turkey                                          | 1                | 15     | 0                 | 17     | 0                | 2      |
| Ukraine                                         | 7                | 187    | 2                 | 107    | 2                | 31     |
| United Kingdom                                  | 398              | 52     | 275               | 51     | 58               | 29     |
| <b>Deposited in Germany</b>                     |                  |        |                   |        |                  |        |
| Imports from Europe                             | 2 077            |        | 1 638             |        | 1 331            |        |
| Depositions from German emissions               | 2 012            |        | 1 568             |        | 3 038            |        |
| Natural and not directly attributable emissions | 435              |        | 447               |        | 1                |        |
| <b>Amount deposited</b>                         | <b>4 524</b>     |        | <b>3 653</b>      |        | <b>4 370</b>     |        |

Source: European Monitoring and Evaluation Programme (EMEP)

The Geneva Convention on Long-range Transboundary Air Pollution of 13.11.1979 laid the groundwork for recording transboundary atmospheric pollution and determining Europe-wide measures to reduce it. The emissions reductions achieved in Europe led to reductions in depositions of sulphur ( $\text{SO}_x$ ), nitrogen oxides ( $\text{NO}_x$ ) and ammonia ( $\text{NH}_3$ ) in Germany between 1991 and 1998. In some regions, and particularly where the recipient soil is especially sensitive, depositions still exceed thresholds (critical loads) for causing acidification or eutrophication to certain ecosystems, above all forests.

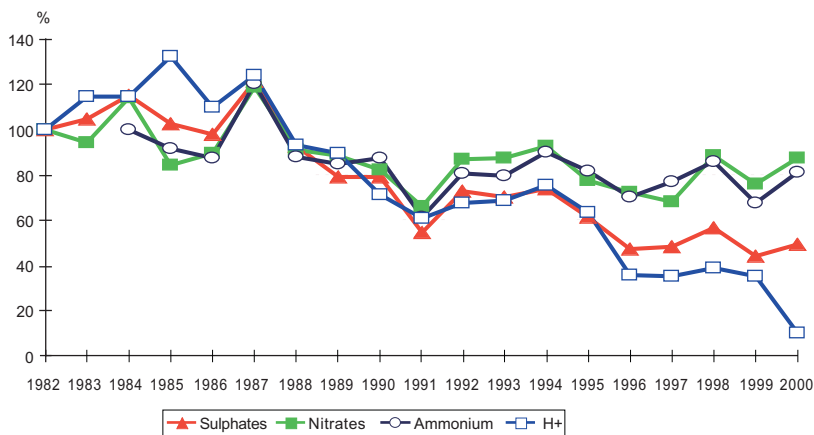
## Wet deposition (annual mean at UBA monitoring stations)

Trends in the pH values in precipitation



Source: Federal Environmental Agency

Trends in the wet deposition of  $H^+$ ,  $SO_4^{2-}$ ,  $NO_3^-$  and  $NH_4^+$



Source: Federal Environmental Agency

The downward trend in pollutant deposition is reflected in trends for the pH value of precipitation. This has been rising continually during the past ten years, a change which can be explained by the drastic fall in  $SO_2$  emissions. The extremely high nitrogen and sulphate ion inputs from the beginning of the 1980s have fallen sharply. Decrease in wet depositions of nitrate and ammonium ions is much less and prone to strong fluctuations.

## Heavy metals in precipitation in g/ha

| Messstationen  | Lead |      | Cadmium |      | Copper |      | Zinc |      |
|----------------|------|------|---------|------|--------|------|------|------|
|                | 1996 | 2000 | 1996    | 2000 | 1996   | 2000 | 1996 | 2000 |
| Angermünde     | 14.2 | –    | 2.1     | –    | 10.3   | –    | 64   | –    |
| Ansbach        | 11.3 | 6.6  | 1.1     | 0.33 | 10.6   | 9.2  | 68   | 66   |
| Bassum         | 7.3  | 5.4  | 0.7     | 0.38 | 11.8   | 12.2 | 65   | 84   |
| Bornhöved      | –    | 7.8  | –       | 0.49 | –      | 7.7  | –    | 86   |
| Brojtackriegel | 14.6 | 14.5 | 1.4     | 0.78 | –      | 17.6 | –    | –    |
| Deuselbach     | 10.2 | 13.8 | 0.8     | 0.43 | 8.4    | 9.5  | 56   | 123  |
| Doberlug       | 12.3 | 5.8  | 0.6     | 0.42 | 20.5   | 5.2  | 139  | 119  |
| Dunum          | –    | 6.6  | –       | 0.31 | –      | 4.7  | –    | 81   |
| Eining         | 10.2 | 6.4  | 1.0     | 0.29 | 8.1    | 5.4  | 53   | 73   |
| Falkenberg     | –    | 11.8 | –       | 0.41 | –      | –    | –    | 90   |
| Hilchenbach    | 20.4 | 30.3 | 2.1     | 0.92 | 14.0   | 11.2 | 127  | 238  |
| Hohenwestedt   | 6.8  | –    | 0.7     | –    | 6.7    | –    | 41   | –    |
| Kehl           | –    | 12.1 | –       | 0.61 | –      | 7.6  | –    | 125  |
| Lehnmühle      | 15.2 | 17.1 | 1.0     | 0.87 | 10.7   | 11.8 | 70   | 105  |
| Leinefelde     | 19.1 | 11.6 | 1.2     | 0.81 | 13.4   | 8.3  | 136  | 193  |
| Lückendorf     | 22.0 | 19.7 | 2.7     | 0.84 | 63.7   | 10.4 | 142  | 113  |
| Melpitz        | 10.8 | 4.4  | 1.1     | 0.38 | 9.8    | 3.7  | 45   | 44   |
| Murnau         | 17.0 | –    | 2.0     | –    | 11.8   | –    | 79   | –    |
| Neuglobsow     | 7.3  | 12.0 | 0.6     | 0.48 | –      | –    | –    | –    |
| Regnitzlosau   | 9.8  | 7.7  | 0.8     | 1.61 | –      | 5.2  | –    | –    |
| Schauinland    | 20.4 | 16.9 | 2.4     | 0.68 | 15.6   | 13.4 | 124  | 128  |
| Schmücke       | 21.4 | 24.4 | 1.8     | 0.84 | 13.7   | 9.7  | 108  | 166  |
| Schwerin       | 9.6  | –    | 0.6     | –    | 9.9    | –    | 82   | –    |
| Solling        | 16.0 | 18.9 | 1.3     | 0.68 | 20.3   | 20.1 | 144  | 220  |
| Teterow        | 5.7  | 7.4  | 0.5     | 0.36 | 7.6    | 8.4  | 58   | 78   |
| Twixlum        | 7.5  | –    | 0.7     | –    | 12.1   | –    | 51   | –    |
| Ueckermünde    | 8.2  | 11.1 | 0.7     | 0.45 | 9.6    | 9.9  | 116  | 93   |
| Waldhof        | 8.3  | 8.4  | 0.7     | 0.44 | 8.6    | 5.1  | 48   | 75   |
| Westerland     | 7.3  | 8.5  | 0.5     | 0.39 | 11.2   | –    | 50   | 96   |
| Wiesenburg     | 6.6  | 9.1  | 0.5     | 0.36 | 7.1    | 4.3  | 102  | 94   |
| Wurmberg       | –    | 14.3 | –       | 0.89 | –      | 23.4 | –    | 158  |
| Zingst         | 10.1 | 12.3 | 0.6     | 0.43 | 19.7   | 17.2 | 47   | 94   |

Source: Federal Environmental Agency

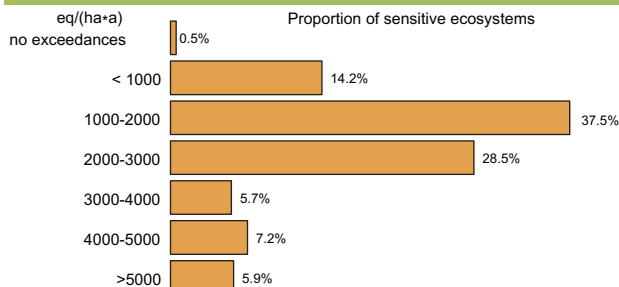
The increasing accumulation of heavy metals, caused by transboundary atmospheric depositions, especially those due to human activity, has become a significant stress factor for ecosystems, comparable to acid rain. The annual deposition of selected heavy metals is monitored in a heavy metals screening programme at 25 UBA measuring stations. This long-term programme to estimate heavy metal deposition in precipitation (wet only) across Germany follows the Heavy Metals Protocol of the UNECE Convention on Long-range Transboundary Air Pollution.

Increased depositions of lead, cadmium, copper and zinc are found above all at Lückendorf and Lehnmühle on the Czech border and in mountainous regions (e.g. Schmücke/Thuringian Forest, Schauinsland/Black Forest, Solling/Lower Saxony), where annual precipitation is relatively high.

## Critical loads

Critical loads for acidification and eutrophication express the potential risk of harmful effects from pollutant inputs on ecosystems such as forests. The aim of the critical loads approach is to compare the varying levels at which ecosystems are burdened by current airborne pollutants as the basis for air quality planning, for example within the Geneva Convention on Air Quality or the EU strategy against acidification.

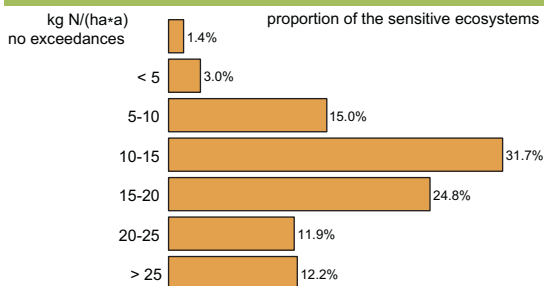
### Exceedances of critical loads for acidification 1995



Source: Federal Environmental Agency (Figures for September 2001)

In the forest areas of Thuringia and Saxony, which are near to emitters, the inputs of acidifying substances and incidences of exceeded critical loads are especially high. Critical loads are also exceeded on vulnerable soil in the North German lowlands as a result of high ammonium/nitrogen inputs from agricultural sources. Inputs of acidifying substances have fallen in the last few years, but critical loads are still exceeded on a large scale.

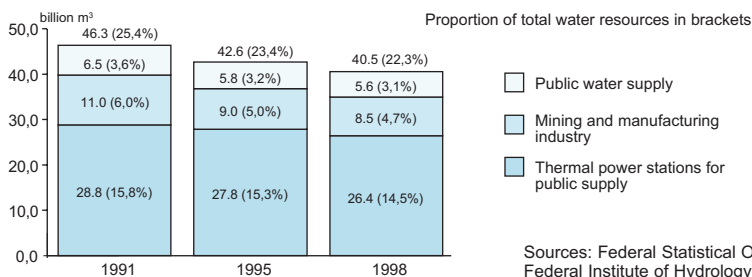
### Exceedances of critical loads for eutrophication 1995



Source: Federal Environmental Agency (Figures for September 2001)

Eutrophying pollutants not only cause acute or chronic damage to plants, but also lead to loss of biological diversity. Critical loads for eutrophying nitrogen are being exceeded on over 90% of areas of sensitive ecosystems. The agricultural areas of North-West Germany, where intensive livestock farming takes place on vulnerable soil, are particularly hard hit by nitrogen deposition from ammonium and exceedances of critical loads. Inputs of atmospheric nitrogen compounds have either fallen in the last few years (nitrogen oxide from industry and transport) or remained on a too high level (ammonia/ammonium from livestock farming).

## Water abstraction by sector in billion m<sup>3</sup>



On average, water resources available in Germany total 182 billion m<sup>3</sup> yearly. The 12.5% fall in water abstraction is due to a more economic use of water in households and the introduction of water-conserving production technologies.

## Waste water treatment in billion m<sup>3</sup>

|                                                                     | 1991       | 1995       | 1998                    |
|---------------------------------------------------------------------|------------|------------|-------------------------|
| <b>Public waste water treatment plants</b>                          | <b>8.5</b> | <b>9.8</b> | <b>9.6</b>              |
| Mechanical waste water treatment                                    | 0.6        | 0.3        | 0.1                     |
| Biological waste water treatment with specific nutrient elimination | 4.6        | 8.1        | 8.9                     |
| without specific nutrient elimination                               | 3.3        | 1.5        | 0.7                     |
| <b>Private (company) waste water treatment plants<sup>1)</sup></b>  | <b>2.2</b> | <b>1.7</b> | <b>1.4<sup>2)</sup></b> |
| Mechanical waste water treatment                                    | 0.7        | 0.4        | 0.1                     |
| Biological waste water treatment with specific nutrient elimination | 0.5        | 0.4        | 0.6                     |
| without specific nutrient elimination                               | 0.3        | 0.4        | 0.2                     |

1) including chemical and advanced waste water treatment; waste water treated more than once is included more than once  
2) including thermal power stations for public supply

Source: Federal Statistical Office

The volume of waste water arising in both industry and private households connected to public waste water treatment plants has been falling since 1995. In 1998, 92% of waste water was treated in biological plants with specific nutrient elimination. In 1991, these modern treatment methods accounted for only 54%.

## Population connected to waste water treatment plants

|                                                   | 1991 | 1995 | 1998 |
|---------------------------------------------------|------|------|------|
| Connection to public sewerage systems             | 90%  | 92%  | 93%  |
| Connection to public waste water treatment plants | 86%  | 89%  | 91%  |
| biological                                        | 79%  | 85%  | 89%  |
| mechanical                                        | 7%   | 4%   | 2%   |

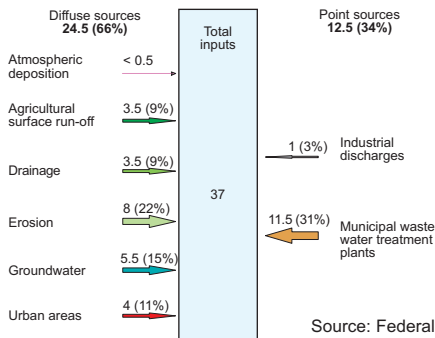
Source: Federal Statistical Office

Connection levels of the population to public waste water treatment plants are continually increasing, especially to biological treatment plants. There are, however, significant differences in connection rates between the old and the new Länder.

## Nutrient inputs

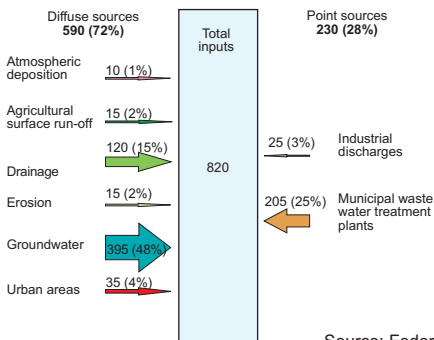
Nutrient inputs cause increased growth of algae, which can in turn lead to fish dying off, to problems in drinking water treatment and to allergic reactions in people bathing in the water. Progress in waste water treatment has improved water quality, but nutrient inputs from diffuse agricultural sources still remain a problem.

### Phosphorus pollution (estimates for 1993–1997) in ktonnes



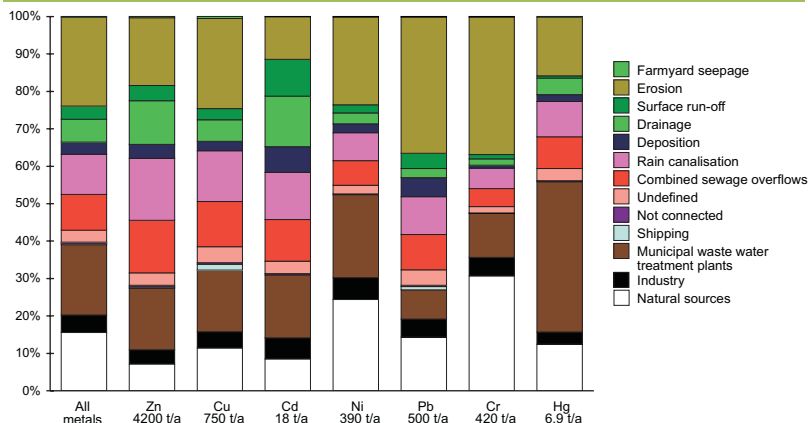
The use of phosphate free washing products and phosphate precipitation has reduced inputs to municipal waste water treatment plants by 80%. Today, this path amounts to only 31% of phosphorus pollution and has contributed most to the reductions. The internationally agreed 50% reduction target (between 1985 and 1995) of phosphorus riverine inputs to marine waters has been achieved.

### Nitrogen pollution (estimates for 1993–1997) in ktonnes



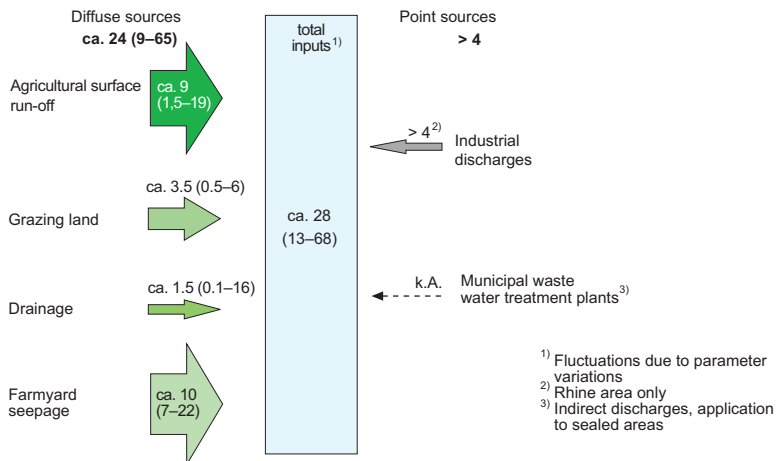
The greatest contribution to nitrogen inputs comes via groundwater from nitrogen lost in agriculture. Discharges and losses of total nitrogen to surface waters were 820 kt/a during 1993–1997, 25% lower than a decade previously. The internationally agreed target of a 50% reduction in riverine inputs of nitrogen to marine waters (between 1985 and 1995) was therefore not met.

## Heavy metal pollution (annual inputs 1993–1997) in ktonnes



Reductions can be achieved, especially in the agricultural sector, by erosion control, the use of phosphate fertilisers with a low cadmium content and by improving the treatment of urban storm water.

## Pesticide pollution (estimates for 1993–1994) in tonnes



Source: Federal Environmental Agency

Pesticide discharges/losses to water bodies are about 30 t/a, with an uncertainty range of 10–70 t/a, corresponding to about 0.1% of the quantities applied. The paths modelled – surface run-off, spraydrift and drainage – account for 15 t/a (uncertainty range 2–40 t/a), with surface run-off probably the most important path. Farmyard seepage accounts for an estimated share of 90% of inputs in southern and western Germany.

## Chemical water quality

### Ammonium nitrogen load in mg/l, 50th %ile

|        | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|--------|------|------|------|------|------|------|------|------|------|------|------|
| Danube | 0.17 | 0.20 | 0.13 | 0.09 | 0.08 | 0.09 | 0.06 | 0.05 | 0.06 | 0.07 | 0.06 |
| Oder   | 0.31 | 0.21 | 0.12 | 0.34 | 0.06 | 0.03 | 0.14 | 0.05 | 0.04 | 0.08 | 0.06 |
| Weser  | 0.18 | 0.14 | 0.14 | 0.10 | 0.13 | 0.14 | 0.25 | 0.15 | 0.08 | 0.10 | 0.07 |
| Rhine  | 0.24 | 0.25 | 0.17 | 0.16 | 0.14 | 0.12 | 0.09 | 0.08 | 0.08 | 0.05 | 0.04 |
| Elbe   | 1.60 | 0.25 | 0.40 | 0.05 | 0.07 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |

### Total phosphorus load in mg/l, 50th %ile

|        | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|--------|------|------|------|------|------|------|------|------|------|------|------|
| Danube | 0.10 | 0.11 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.07 | 0.06 | 0.07 | 0.07 |
| Oder   | 0.49 | 0.48 | 0.36 | 0.30 | 0.17 | 0.18 | 0.17 | 0.17 | 0.12 | 0.13 | 0.14 |
| Weser  | 0.35 | 0.28 | 0.22 | 0.20 | 0.19 | 0.17 | 0.22 | 0.18 | 0.22 | 0.16 | 0.16 |
| Rhine  | 0.22 | 0.17 | 0.16 | 0.14 | 0.12 | 0.09 | 0.15 | 0.14 | 0.15 | 0.13 | 0.14 |
| Elbe   | 0.53 | 0.42 | 0.35 | 0.32 | 0.23 | 0.22 | 0.24 | 0.23 | 0.22 | 0.23 | 0.22 |

### Nitrogen (nitrate) load in mg/l, 50th %ile

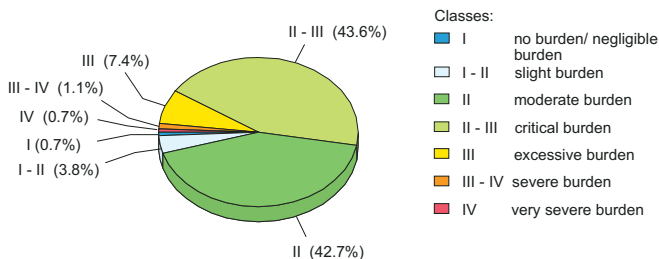
|        | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|--------|------|------|------|------|------|------|------|------|------|------|------|
| Danube | 2.10 | 2.40 | 1.70 | 2.20 | 2.30 | 2.25 | 2.00 | 2.10 | 1.90 | 1.80 | 1.50 |
| Oder   | 2.32 | 2.62 | 2.16 | 2.37 | 2.41 | 2.41 | 2.60 | 2.08 | 2.54 | 2.10 | 1.97 |
| Weser  | 5.00 | 4.90 | 5.00 | 5.40 | 4.60 | 4.65 | 4.30 | 3.90 | 4.40 | 4.40 | 3.50 |
| Rhine  | 3.87 | 3.78 | 3.73 | 3.21 | 3.31 | 3.20 | 3.40 | 3.19 | 3.11 | 2.50 | 2.68 |
| Elbe   | 4.70 | 4.90 | 4.90 | 4.20 | 4.60 | 4.90 | 4.60 | 4.30 | 4.10 | 4.00 | 3.40 |

Monitoring Stations: Jochenstein (Danube), Hohenwutzen (Oder), Bremen (Weser), Kleve-Bimmen (Rhine), Schnackenburg (Elbe)

Source: Länder working group on water quality (LAWA)

When water quality is monitored, concentrations of chemicals such as nutrients, heavy metals and organic compounds are measured, as well as biological properties. The network of measuring stations, run by the Länder working group on water quality (LAWA), comprises 152 selected stations. The quality of rivers in Germany has come closer to the target set, which is Class II (moderately polluted). Measurements for AOX (Class <25 mg/l) show slight improvements in water quality, and in 2000, measurements made at 46% of river stations qualified as Class II. Total nitrogen loads are comparatively higher, only achieving Class II (< 3mg/l) at 13% of the measuring stations in 2000. This shows that water pollution control measures are necessary in future in the area of diffuse inputs, e.g. from agriculture.

## Biological water quality 1995



Source: Federal Environmental Agency

In terms of biological quality, 48% of the water system had reached quality Class II or better in 1995.

## Water quality of selected lakes 1999 (annual mean values)

| Name of lake                 | Area,<br>km <sup>2</sup> | Maximum<br>depth,<br>m | Average<br>depth,<br>m | Lake<br>volume,<br>bill.m <sup>3</sup> | Environ-<br>mental<br>factor | Total<br>phosphorus,<br>µg/l | Chlorophyll, µg/l | Nitrate-N,<br>mg/l |
|------------------------------|--------------------------|------------------------|------------------------|----------------------------------------|------------------------------|------------------------------|-------------------|--------------------|
| Ammersee                     | 46.6                     | 81.1                   | 37.6                   | 1.75                                   | 20.3                         | 12.1                         | 7.4               | 1.03               |
| Arendsee                     | 5.14                     | 48.7                   | 28.6                   | 0.147                                  | –                            | –                            | 22.4              | 0.11               |
| Lake Constance               | 571.5                    | 254                    | 85                     | 48.5                                   | 22                           | 11.6                         | 3.4               | 0.76               |
| Chiemsee                     | 79.9                     | 73.4                   | 25.6                   | 2.048                                  | 16.5                         | 21.1                         | 4.6               | 0.51               |
| Dobersdorfer See             | 3.12                     | 18.8                   | 5.4                    | 0.0169                                 | 6.5                          | 75.9                         | 38.7              | 0.41               |
| Großer Müggelsee             | 7.2                      | 7.5                    | 4.85                   | 0.035                                  | 943                          | 144.1                        | 36.5              | 0.68               |
| Großer Plöner See            | 29.97                    | 58                     | 12.4                   | 0.372                                  | 11.7                         | 66.8                         | 10.3              | 0.16               |
| Kummerower See               | 32.6                     | 23.3                   | 8.1                    | 0.263                                  | 35                           | 113                          | 12.8              | 0.98               |
| Laacher See                  | 3.31                     | 51                     | 31.1                   | 0.103                                  | 2.7                          | –                            | –                 | 0.07 <sup>1)</sup> |
| Müritz (Außenmüritz)         | 103.85                   | 29                     | 6.5                    | 0.673                                  | –                            | 100                          | 4.9               | 0.03               |
| Müritz (Binnenmüritz)        | 4.07                     | 31                     | 10.5                   | 0.043                                  | 187                          | 60                           | 4.7               | 0.06               |
| Plauer See                   | 37.8                     | 23.8                   | 8                      | 0.3                                    | 33                           | 72.5                         | 7.3               | 0.07               |
| Sacrower See                 | 1.021                    | 36                     | 18                     | 0.0151                                 | –                            | 103.8                        | 9.3               | 0.22               |
| Schweriner See<br>(Außensee) | 34.1                     | 56                     | 11.6                   | 0.396                                  | 1.2                          | 405                          | 10.7              | 0.09               |
| Schweriner See<br>(Innensee) | 29.1                     | 42                     | 12.6                   | 0.367                                  | 8.5                          | 572.5                        | 7.9               | 0.08               |
| Starnberger See              | 56.4                     | 127.8                  | 53.2                   | 2.999                                  | 5.85                         | 8.6                          | 5                 | 0.25               |
| Stechlinsee                  | 4.25                     | 68.5                   | 22.8                   | 0.097                                  | 2.91                         | –                            | –                 | –                  |
| Steinhuder Meer              | 29.1                     | 2.9                    | 1.4                    | 0.042                                  | 1.8                          | 46.7                         | 42.2              | 0.17               |
| Unterbacher See              | 0.878                    | 11                     | 4                      | 0.0035                                 | –                            | 23.3                         | 6                 | 0.27               |

1) single value

Source: Federal Environmental Agency according to LAWA data

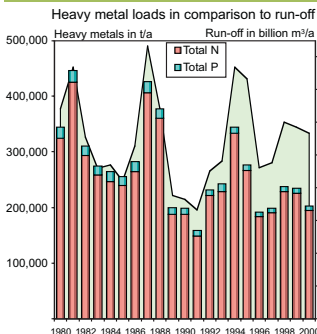
The greatest problems faced by lakes remain excessive nutrient inputs and the resulting eutrophication. Since nutrients are stored in the sediments of stagnant water systems and can, under certain circumstances, be released again, algal growth in lakes reacts very slowly to a reduction in nutrient inputs.

There was an increasing eutrophication caused by agriculture and waste water discharge in the old Länder from the 1950s to the 1970s. Since the mid 1970s, a drop in nutrient inputs, caused by keeping waste water away, can be observed. The deep lakes of the Alpine foothills reacted relatively quickly with a distinct reduction of the trophic level. In the shallow Steinhuder Meer, however, which is surrounded by intensive agricultural areas, a reduction of algae was not evident until 1999.

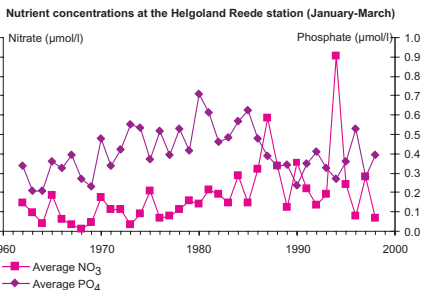
In the new Länder nutrient inputs were reduced at the beginning of the 1990s through improved waste water treatment. The relatively shallow lakes of Mecklenburg-West Pomerania have large catchment areas, most used for agriculture. Therefore a quick reaction to reduced nutrient inputs solely from point sources can not be expected. The Müritz is an exception; there is little agriculture in the catchment area and measures to keep waste water at a distance are already showing positive effects.

Only a reduction of nutrient inputs from agriculture can lead to a further reduction of lake eutrophication.

## Nutrient pollution in the North Sea



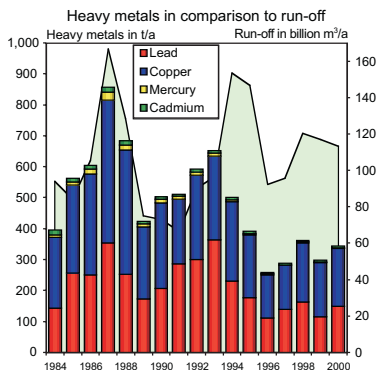
Source: Länder data (OSPAR)



Source: Biological Institute on Helgoland

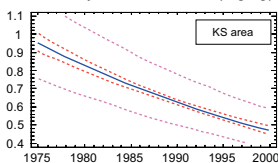
Phosphate concentrations in the German Bight (long-term measuring station is Helgoland Reede) have decreased significantly since the mid 1990s. This is due to the sharp decrease in riverine inputs of phosphate caused by effective reduction measures in the catchment area (phosphate free detergents and elimination of phosphates in waste water treatment plants). No comparable trend can be observed in the case of inorganic nitrogen compounds, neither with inputs nor with concentrations in the coastal area. There is still a considerable deficit concerning effective reduction measures for nitrogen inputs, especially from agriculture.

## Heavy metal pollution in the North Sea

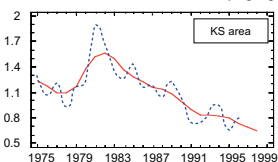


Source: Länder data (OSPAR)

Mercury in the sediment (mg/kg)



Cadmium in the sediment (mg/kg)



Source: Federal Maritime and Hydrographic Agency

Heavy metal concentrations in the North Sea are determined by riverine inputs and are therefore higher in river estuaries and coastal areas than in areas at a distance from the coast. Long-term monitoring in the mud by Helgoland have shown that concentrations of mercury, cadmium and other heavy metals in the fine grain fraction of the sediment have gradually been falling since the mid 1980s. The heavy metal loads of the North Sea tributaries have also fallen, although this is more difficult to identify due to the fact that the volume of pollutant input varies from year to year an account of the various flow rates.

Groundwater pollution through pesticides 1999

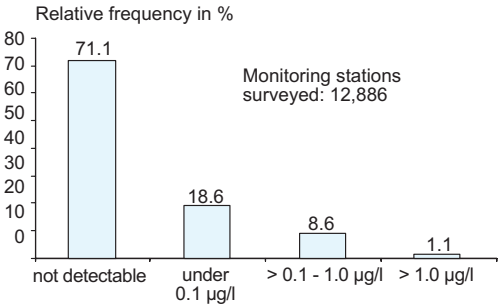
| Active ingredient/<br>metabolite | Number of<br>Länder<br>doing<br>investigation | Total<br>invest-<br>igated | Number of measuring stations <sup>1)</sup><br>Highest measurement per station |                         |                        | Relative<br>frequency |
|----------------------------------|-----------------------------------------------|----------------------------|-------------------------------------------------------------------------------|-------------------------|------------------------|-----------------------|
|                                  |                                               |                            | No<br>evidence                                                                | Evidence<br><= 0,1 µg/l | Evidence<br>> 0,1 µg/l |                       |
| Desethylatrazine                 | 14                                            | 4 678                      | 3 598                                                                         | 829                     | 251                    | 5.4%                  |
| Atrazine                         | 14                                            | 4 711                      | 3 934                                                                         | 667                     | 110                    | 2.3%                  |
| Bromacil                         | 13                                            | 3 310                      | 3 209                                                                         | 38                      | 64                     | 1.9%                  |
| Mecoprop                         | 15                                            | 2 400                      | 2 327                                                                         | 36                      | 37                     | 1.5%                  |
| Diuron                           | 14                                            | 2 615                      | 2 563                                                                         | 27                      | 25                     | 1.0%                  |
| Desisopropylatrazine             | 13                                            | 4 103                      | 3 977                                                                         | 105                     | 21                     | 0.5%                  |
| 2.6-Dichlorbenzamide             | 2                                             | 753                        | 683                                                                           | 50                      | 20                     | 2.7%                  |
| Bentazone                        | 13                                            | 2 259                      | 2 219                                                                         | 22                      | 18                     | 0.8%                  |
| Simazine                         | 14                                            | 4 579                      | 4 393                                                                         | 168                     | 18                     | 0.4%                  |
| 1.2-Dichlorpropane               | 4                                             | 356                        | 340                                                                           | 4                       | 12                     | 3.4%                  |
| Isoproturon                      | 14                                            | 2 803                      | 2 765                                                                         | 32                      | 6                      | 0.2%                  |
| Propazine                        | 14                                            | 4 087                      | 4 047                                                                         | 34                      | 6                      | 0.2%                  |
| Chloridazon                      | 7                                             | 1 406                      | 1 393                                                                         | 8                       | 5                      | 0.4%                  |
| Chlortoluron                     | 13                                            | 2 388                      | 2 376                                                                         | 7                       | 5                      | 0.2%                  |
| Dichlorprop                      | 15                                            | 2 373                      | 2 358                                                                         | 10                      | 5                      | 0.2%                  |
| Hexazinon                        | 12                                            | 3 090                      | 3 058                                                                         | 27                      | 5                      | 0.2%                  |
| Terbutylazine                    | 14                                            | 4 565                      | 4 537                                                                         | 23                      | 5                      | 0.1%                  |
| Metalaxyl                        | 6                                             | 1 261                      | 1 251                                                                         | 6                       | 4                      | 0.3%                  |
| MCPA                             | 13                                            | 1 971                      | 1 964                                                                         | 4                       | 3                      | 0.2%                  |
| Metolachlor                      | 14                                            | 3 617                      | 3 605                                                                         | 9                       | 3                      | 0.1%                  |

1) Rank according to number of stations with evidence of > 0.1 µg/l

Source: Federal Environmental Agency

Since 1989, pesticide findings in groundwater have been registered and annually compiled by the Federal Environmental Agency. The active ingredients and metabolites which occur most frequently in groundwater are determined and this information is taken into account during the licensing procedure.

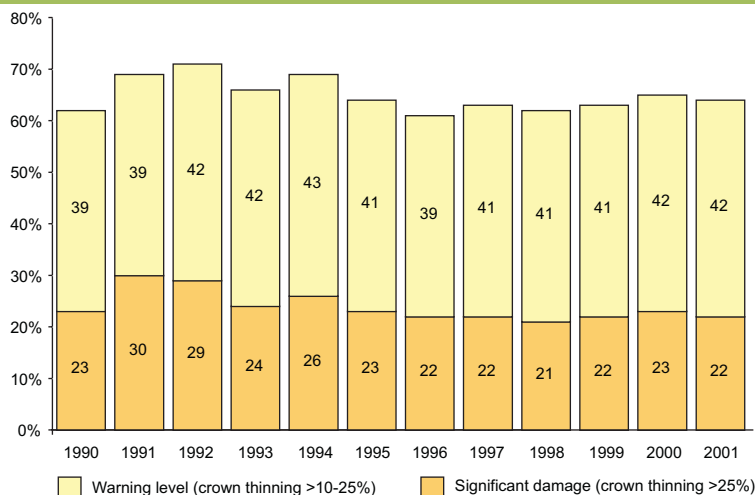
Occurrence of pesticides in groundwater at the water table (1990-1995)



Source: Länder working group on water quality (LAWA)

Of the 12,886 monitoring stations evaluated, 71.7% found no pesticide contamination, but more than one in four (28.3%) found evidence of pesticides in groundwater. The Drinking Water Ordinance sets a limit of 0.1 µg/l for pesticides and this was exceeded at almost every tenth (9.7%) monitoring station.

## Trends in forest damage (all species)



Source: Federal Ministry of Consumer Production, Food and Agriculture

The condition of many forest ecosystems is still of great concern. The extent of significant damage to the crowns of the trees has stabilised, but is still far too large. In addition, the extensive changes in forest soils, caused by atmospheric pollution, and the subsequent long-term effects are becoming more and more evident. Every fourth tree still has signs of significant damage. Successes achieved so far in air pollution control are still not sufficient. In particular the nitrogen inputs from agriculture and transport have to be reduced further.

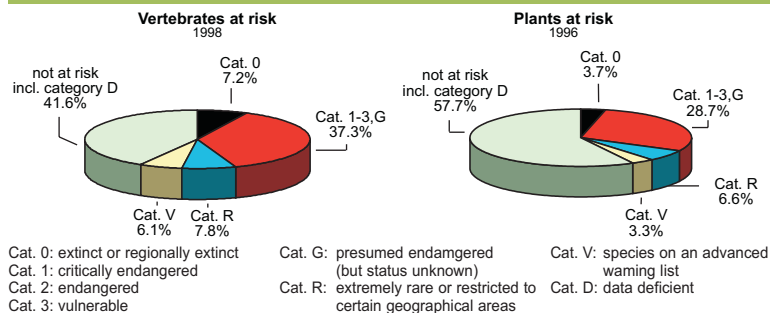
Trends in the condition of tree crowns by species  
(level of significant damage) in %

| Species | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---------|------|------|------|------|------|------|------|------|------|------|------|
| Spruce  | 29   | 30   | 26   | 29   | 24   | 22   | 23   | 26   | 25   | 25   | 26   |
| Pine    | 33   | 23   | 16   | 19   | 14   | 13   | 13   | 10   | 13   | 13   | 14   |
| Beech   | 26   | 38   | 32   | 27   | 36   | 30   | 30   | 29   | 32   | 40   | 32   |
| Oak     | 35   | 33   | 42   | 44   | 39   | 47   | 47   | 37   | 44   | 35   | 33   |

Source: Federal Ministry of Consumer Production, Food and Agriculture

Since the beginning of the 1980s, 'new' forms of forest damage have increasingly been observed. The vitality of the forest has been impaired on a large scale independent of species and location. Many individual factors are responsible, depending on location and air pollutants playing a key role, especially  $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{NH}_3$  and ozone.

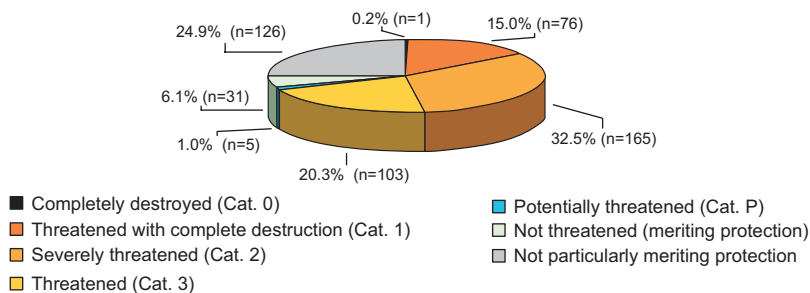
## Endangered wild animal and plant species



Source: Federal Agency for Nature Conservation

Central Europe in particular has a large proportion of endangered species. This is due above all to the high population density, the close-meshed transport infrastructure and widespread intensive forestry and agriculture. Predicted increases in traffic volumes and growth in land use for settlements, transport and industry indicate that the situation will intensify further.

## Endangered biotope types 1994<sup>1)</sup>

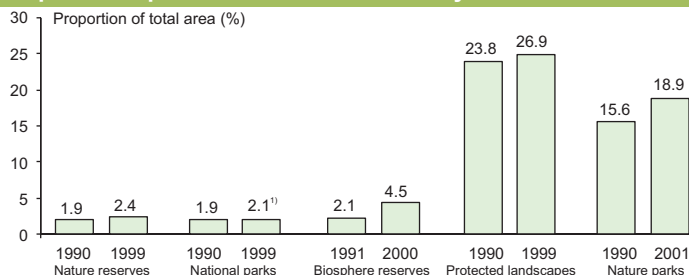


1) n=507 (not including "technical biotope types" such as roads, buildings, landfills, etc.)

Source: Federal Agency for Nature Conservation

The extent to which a biotope type is at risk is determined by three criteria: firstly, the loss of area (LA) and qualitative change (QU) describe the level of the threat to the biotope, while a third criterion, regenerative capacity (RE), describes how easily a biotope can recover. The average of the regional values then provides a measure of how endangered a biotope type is throughout Germany. A survey of Germany's biotopes shows that over two thirds (69%) of all biotope types are endangered. The distribution of biotopes over all the categories is not evidence of a favourable overall situation, for example, types which may have existed 100 or 150 years ago have not been taken into account. Under Art. 3 (1) of the revised Federal Nature Conservation Act, the Länder are to establish a biotope network, covering at least 10% of the area of each Land.

## Development of protected areas in Germany



1) Excluding Wadden Sea

Sources: Federal Agency for Nature Conservation; UNESCO

Placing areas of land under protection is a key instrument in nature conservation. Protected areas are defined according to national and international criteria.

## Protected areas according to the EU Habitats Directive

Reports by BMU to EU Commission under Art 4(1) Habitats Directive (23.10.2001)

|                               | Number of areas   | Area (ha)                                    | % of area of Land |
|-------------------------------|-------------------|----------------------------------------------|-------------------|
| Baden-Württemberg             | 363               | 230 870<br>(+3 582) <sup>1)</sup>            | 6.5               |
| Bavaria                       | 514               | 470 533                                      | 6.7               |
| Berlin                        | 14                | 4 194                                        | 4.7               |
| Brandenburg                   | 477               | 304 464                                      | 10.3              |
| Bremen                        | 6                 | 1 471                                        | 3.6               |
| Hamburg                       | 12                | 4 341<br>(+11 350) <sup>1)</sup>             | 5.7               |
| Hesse                         | 408               | 133 693                                      | 6.3               |
| Mecklenburg-Western Pomerania | 136               | 107 904<br>(+73 900) <sup>1)</sup>           | 4.7               |
| Lower Saxony                  | 172               | ca. 285 000<br>(+248 000) <sup>1)</sup>      | 6.0               |
| North Rhine-Westphalia        | 491               | 180 808                                      | 5.3               |
| Rhineland-Palatinate          | 74                | 135 831                                      | 6.8               |
| Schleswig-Holstein            | 123               | 59 196<br>(+477 622) <sup>1)</sup>           | 3.7               |
| Saarland                      | 109 <sup>2)</sup> | 189 552                                      | 7.4               |
| Saxony                        | 89                | 64 485                                       | 3.5               |
| Saxony-Anhalt                 | 193               | 147 266                                      | 7.2               |
| Thuringia                     | 172               | 134 002                                      | 8.3               |
| <b>Total</b>                  | <b>3 352</b>      | <b>2 283 013</b><br>(+814 454) <sup>1)</sup> | <b>6.4</b>        |

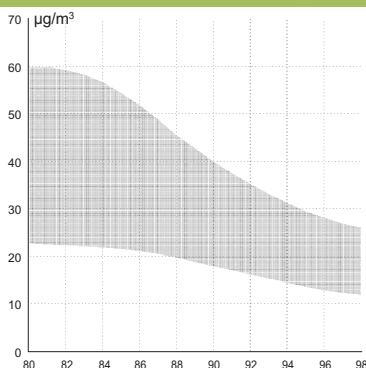
1) Wadden Sea, Bodden, Lake Constance and marine areas

2) 12 sites are underground bat caves, which are not counted in the total land area

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

The Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) obliges the Member States to establish a coherent European ecological network of protected areas called NATURA 2000. The network also includes areas classified as Special Protected Areas under the EU Birds Directive (Council Directive 79/409/EEC on the conservation of wild birds). The areas protected under the two directives partially overlap.

## Atmospheric pollution through airborne dust

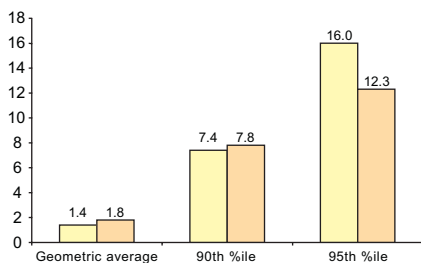


Range of variation of annual mean atmospheric concentration of particulate matter from the UBA air monitoring network

Source: Federal Environmental Agency

The particulate matter fractions  $PM_{10}$  and  $PM_{2.5}$  account on average for around 80% and 50% of all particulate matter. With regard to the effect of particulate matter on human health, it is possible that the extremely fine particles (under  $0.1 \mu m$ ) mainly affect the circulatory system and that the larger particles of over  $1 \mu m$  and especially those larger than  $2.5 \mu m$  affect the respiratory system. The dramatic reduction in particulate emissions during the past decade indicates that levels will only fall slowly in future, as much of the remaining airborne particulate matter is accounted for by transboundary pollution and natural emission sources (see also the air chapter).

## Drinking water quality

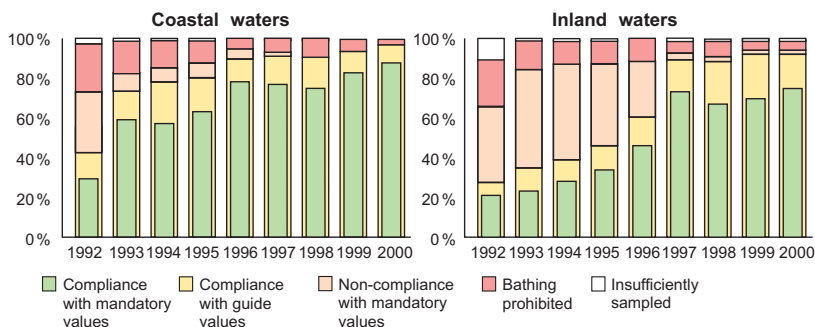


Lead contents in stagnant samples of domestic drinking water in µg/l

Source: Federal Environmental Agency

Drinking water in Germany is good to very good. The quality is regularly controlled and corresponds to the strict requirements of the Drinking Water Ordinance. The exception is nitrate, where 2.2% of samples exceeded the limit value of 50 mg/l in 1996, and less than 1% in 1998. The environmental survey undertaken by UBA has shown that the quality of domestic drinking water is also dependent on pipes, fixtures and other installations in buildings and that it sometimes differs from the quality found in water supplies. Due to the use of lead in water pipes in residential buildings, there is still a higher lead concentration in the drinking water supply of some households, caused by a build up of lead in the pipes during the night when no water is used. This means that the limit value of 10 µg/l, which will be valid for drinking water in the future, can not be adhered to. Some sort of remedial measures, e.g. replacement of lead pipes, are necessary.

## Bathing water quality



Source: European Commission

The presence of pathogens in bathing waters can cause illness, with fever, diarrhoea and vomiting. In order to avoid or minimise health problems, official bathing areas are monitored by the Länder authorities. In the EU directive 76/116/EEC, limits and strict guide values for microbiological, biological and chemical parameters are set down, in order to assess health risks. The annual monitoring programme before and during the bathing season has led to a continual improvement of the water quality both in inland as well as coastal waters.

## Food monitoring

|                                                               | 1995  | 1996  | 1997  | 1998  | 1999  |
|---------------------------------------------------------------|-------|-------|-------|-------|-------|
| <b>Vegetable foodstuffs: pesticide residues</b>               |       |       |       |       |       |
| Number of samples                                             | 2 613 | 2 235 | 2 502 | 3 061 | 2 026 |
| Proportion (%) without residues                               | 65.8% | 49.0% | 42.1% | 55.4% | 73.1% |
| Proportion (%) with residues ≤ maximum amount allowed         | 31.8% | 49.1% | 52.0% | 40.7% | 23.3% |
| <b>Animal foodstuffs: persistent organochlorine compounds</b> |       |       |       |       |       |
| Number of samples                                             | 1 405 | 1 923 | 1 437 | 995   | 1 354 |
| Proportion (%) without traces                                 | 15.2% | 22.7% | 26.4% | 12.6% | 42.8% |
| Proportion (%) with traces ≤ maximum amount allowed           | 83.1% | 75.8% | 71.3% | 84.6% | 56.9% |

Source: Federal Institute for Consumer Health Protection and Veterinary Medicine

Since 1995, food monitoring has been carried out on a yearly basis as a supplement to legally required monitoring. Samples are tested for residues of pesticides, organochlorine compounds, toxic heavy metals, nitrate and mycotoxins. The range of foodstuffs and substances examined varies from year to year. Baby food, which is subject to particularly strict regulations, was largely free of contamination and residues. There may, however, be a cause for concern regarding pesticide residues in some vegetable foodstuffs such as grapes, stone fruits and lettuce.

Milk products and fatty tissue in livestock exhibit little contamination, a result of successful controls on animal feeds, while contamination of some animals in the wild, such as wild boars or herrings, remains high.

# Human biomonitoring

As part of the Environmental Survey, representative data are compiled in order to gain an indication of which substances possibly lead to health damages when present in higher concentrations in humans (human biomonitoring) and in living quarters (drinking water, indoor air, house dust). Blood and urine are examined for heavy metals, organochlorine compounds and polycyclic aromatic hydrocarbons (PAH).

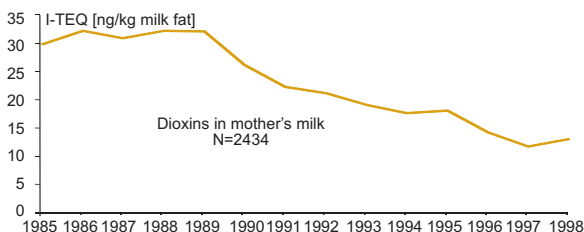
| Heavy metals in the urine of adults    |                | 1990/92               | 1998           |                       |
|----------------------------------------|----------------|-----------------------|----------------|-----------------------|
|                                        | Number sampled | Geometric mean (µg/l) | Number sampled | Geometric mean (µg/l) |
| Cadmium in urine                       | 4 002          | 0.29                  | 4 052          | 0.24                  |
| Mercury in urine                       | 4 002          | 0.53                  | 4 043          | 0.4                   |
| Precious metals in the urine of adults |                |                       |                |                       |
| Platinum in urine                      |                |                       | 1 080          | 2.18                  |
| Gold in urine                          |                |                       | 1 080          | 45.5                  |

Source: Federal Environmental Agency

The level of mercury in urine has fallen, whereas the cadmium level, which is fairly low, has remained almost unchanged. The individual sources of these two heavy metals are important to note: mercury comes from amalgam dental fillings and cadmium presents a problem for smokers.

Since the introduction of catalytic converters for motor vehicles, there is evidence of platinum in dust along roads and in some plants. Platinum contamination of humans, however, stems mainly from the use of this metal in alloys used for dental purposes, e.g. for crowns and bridges. The same is valid for gold.

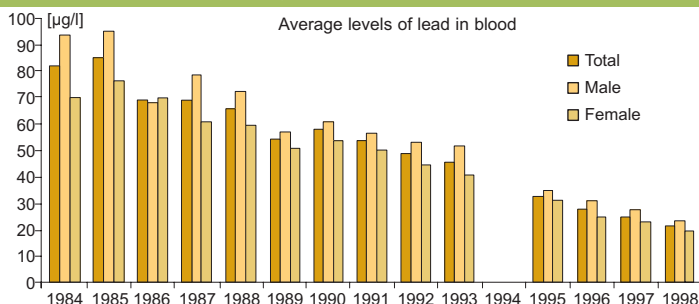
# Dioxins in mother's milk



Source: Federal Institute for Consumer Health Protection and Veterinary Medicine

Mother's milk is considered an appropriate indicator to track contaminants stored in human body fat. Since 1990, a significant fall of around 60% in the concentration of dioxins in mother's milk can be observed. This is due to measures which have succeeded in reducing the discharge of dioxins into the environment. These measures include limiting dioxin emissions from incineration plants and shutting down cable pyrolysis plants. However, the estimated average daily dioxin intake by a breastfed infant is around 60 pg I-TEQ/kg body weight. The daily intake of dioxins therefore exceeds the tolerable daily intake prescribed by the WHO during the short period of breast-feeding. However, according to the WHO, the German pharmacological and toxicological association and the national breast-feeding association, the advantages of breast-feeding still outweigh the risks and they continue to recommend it.

## Effect of pollution on young adults



Source: Federal Environmental Agency

The environmental sample bank archives frozen environmental and human tissue samples which are tested for organic and inorganic substances before freezing. The samples of human tissue are taken yearly from groups of students from four universities and examined for harmful substances in blood, plasma, a 24-hour urine sample, saliva and hair. Since 1984, there has been a significant fall in the levels of lead in the blood. Lead concentrations in the blood fell by around 75% between 1984 and 1998.

The Leaded Petrol Act from 1971 (last amended in 1994), which was a prerequisite for the introduction of the catalytic converter, led to a fall in lead emissions from motor vehicles, leading in turn to reduced lead contamination of the population.

## Public annoyance from noise

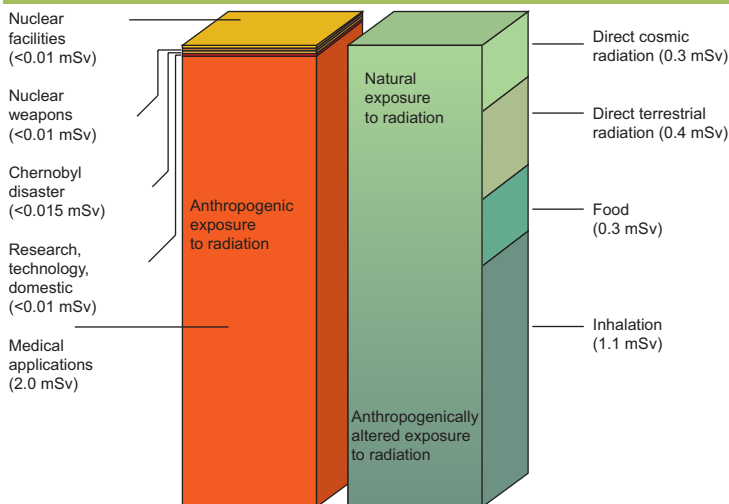
| Average-noise levels<br>[dB(A)] | Proportion (in %) of population exposed to |       |                      |       |
|---------------------------------|--------------------------------------------|-------|----------------------|-------|
|                                 | Road traffic<br>1999                       |       | Rail traffic<br>1997 |       |
|                                 | day                                        | night | day                  | night |
| > 45 - 50                       | 16.4                                       | 17.6  | 12.4                 | 15.5  |
| > 50 - 55                       | 15.8                                       | 14.3  | 14.9                 | 10.8  |
| > 55 - 60                       | 18.0                                       | 9.3   | 10.4                 | 6.2   |
| > 60 - 65                       | 15.3                                       | 4.2   | 6.2                  | 2.7   |
| > 65 - 70                       | 9.0                                        | 2.9   | 2.3                  | 0.9   |
| > 70 - 75                       | 5.1                                        | 0.2   | 0.7                  | 0.4   |
| > 75                            | 1.5                                        | 0.0   | 0.1                  | 0.1   |

Source: Federal Environmental Agency

The predominant source of noise in the environment is road traffic, which remains a nuisance for almost half the population and a cause for disturbance of people's physical and social well-being (noise exceeding 55 dB(A) during the day). Rail traffic affects around 20% of the population.

15.6% of the population is exposed to noise levels in excess of 65 dB(A) by day from road traffic and 3.1% from rail traffic. Such levels may increase the risk of cardiovascular problems. Noise pollution is also too high at night. Noise levels in excess of 45 dB(A) can lead to sleep being disrupted.

## Public exposure to radiation 2000



Source: Federal Office for Radiation Protection

The largest share of exposure to natural radiation is accounted for by radon inhalation. In regions where the bedrock is rich in radon and in uranium mining areas, increased levels have been measured. A study of the health effects of residential radon pollution is currently in progress. Almost all anthropogenic radiation (2 mSv) is generated during medical use of radioactive substances and ionising radiation, in particular in radiology. Radiation exposure from nuclear facilities accounts for less than 1% of anthropogenic radiation (<0.01 mSv).

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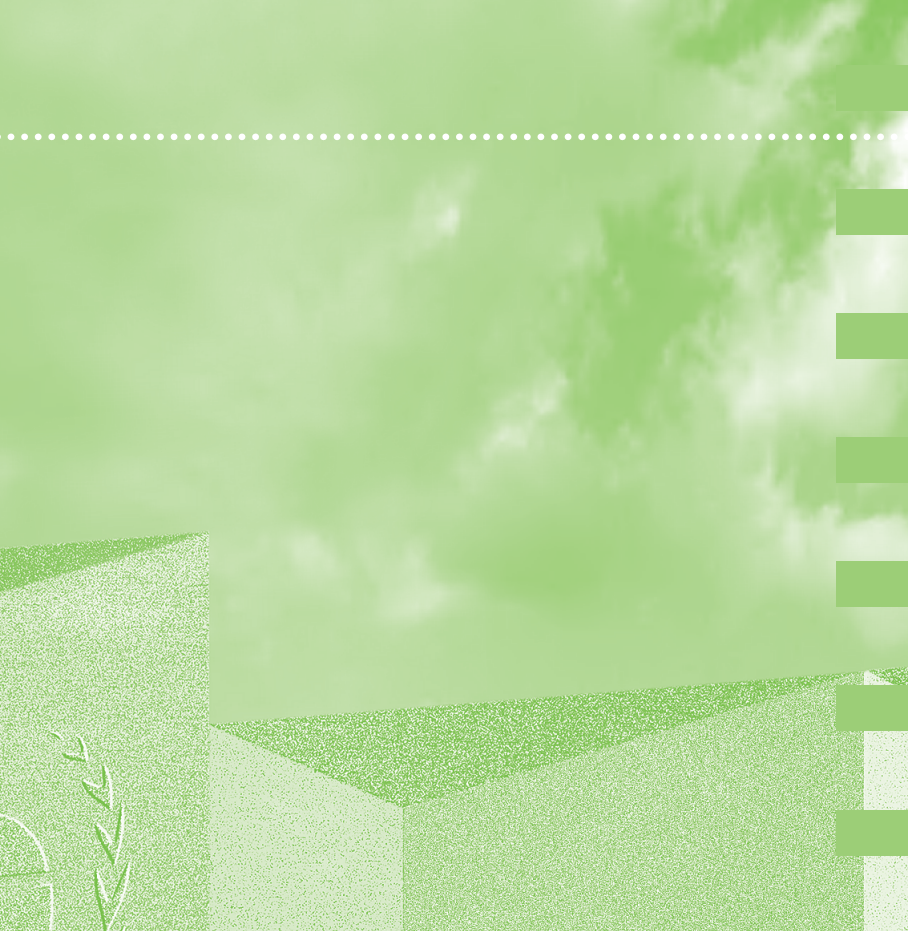
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## List of abbreviations

|                                      |                                                        |
|--------------------------------------|--------------------------------------------------------|
| a                                    | year (annum)                                           |
| C <sub>2</sub> F <sub>6</sub>        | perfluoroethane                                        |
| CF <sub>4</sub>                      | perfluoromethane                                       |
| CFCs                                 | chlorofluorocarbons                                    |
| CH <sub>4</sub>                      | methane                                                |
| CO                                   | carbon monoxide                                        |
| CO <sub>2</sub>                      | carbon dioxide                                         |
| dB                                   | decibel (logarithmic scale)                            |
| eq                                   | acid equivalent                                        |
| EU                                   | European Union                                         |
| GDP                                  | gross domestic product                                 |
| I-TEQ                                | international toxicity equivalent                      |
| kt                                   | kilotonne                                              |
| kWh                                  | kilowatt hour                                          |
| mW                                   | megawatt                                               |
| µg                                   | microgramme                                            |
| N                                    | nitrogen                                               |
| ng                                   | nanogramme                                             |
| NH <sub>3</sub>                      | ammonia                                                |
| NM VOC                               | non-methane volatile organic compound                  |
| N <sub>2</sub> O                     | dinitrogen oxide                                       |
| NO <sub>x</sub>                      | nitrogen oxide                                         |
| OECD                                 | Organisation for Economic Co-operation and Development |
| OSPAR                                | Oslo and Paris Commission                              |
| P                                    | phosphorous                                            |
| PET                                  | polyethylene terephthalate                             |
| PJ                                   | petajoule                                              |
| PM <sub>2.5</sub> , PM <sub>10</sub> | particulate matter                                     |
| Pkm                                  | passenger kilometres                                   |
| P <sub>2</sub> O <sub>5</sub>        | phosphate                                              |
| ppm                                  | parts per million                                      |
| PVC                                  | polyvinyl chloride                                     |
| SF <sub>6</sub>                      | sulphur hexafluoride                                   |
| SO <sub>2</sub>                      | sulphur dioxide                                        |
| Sv                                   | Sievert (1 Sv = 1 J/kg)                                |
| TJ                                   | terajoule                                              |
| tkm                                  | tonnes kilometres, a unit of goods transportation      |
| UV radiation                         | ultraviolet radiation                                  |
| VOC                                  | volatile organic compound                              |
| WHO                                  | World Health Organisation                              |



## ***Human Activities and the Environment***

Environment and the Consumer  
Environment and the Economy  
Environment and Energy  
Environment and Transport  
Environment and Agriculture  
Environment and Waste  
Management

## ***Pressure, State and Responses***

The Earth's Atmosphere  
Air  
Soil  
Water  
Biodiversity and Selected  
Ecological Systems  
Environment and Health