Magazine of the German
Environment Agency
2/2020

WHAT MATTERS

Umwelt Bundesamt

For our Environment

FOREWORD

COVER PICTURE
Large-scale protest by tens of thousands of GDR citizens at the Palace of the Republic in Berlin on 04/11/1989.

Dirk Messner, President,
German Environment Agency

Hardly any scene in recent German history has been more strongly etched in the collective memory: on a cold, grey night in November 1989, thousands of people are suddenly streaming across the border crossings that had opened as if by magic. The first Trabis rattling along with the cheering people are also heading west. And even if the two-strokers have long since disappeared from the cityscape – we probably all still remember their clouds of blue haze.

Less than a year later, on 3rd October 1990, German unification was completed which marks the beginning of an important chapter in German environmental policy. There was a lot to do according to the Environmental Report of May 1990, which was still published in the Federal Republic of Germany. The report states that the air, water and soil in eastern Germany were largely ‘catastrophically polluted’. As a result, a major remediation programme began, during which wild rubbish dumps were cleared away, many new wastewater treatment plants were built, and the chemical industry’s contaminated sites were extensively remediated.

Ten years later, by 2000, hardly any east-west differences could be detected on Germany’s air quality maps. The reduction in sulphur dioxide in particular was tremendous. Eastern Germany had fallen from having the world’s highest level of pollution in the mid-1980s, at record speed. The truth is also, that a large part of the decline was simply due to the fact that around 80 percent of the GDR power plants and many factories were shut down soon after reunification while the remaining have been extensively modernised.

Big changes are now imminent following the he fall of the Berlin Wall and the transition to a market economy and democracy. We must create future-proofmarket economies in order to avoid dangerous environmental change, i.e. climate change. We need energy transition, mobility transition, more sustainable cities, agriculture that is fit for the future, and we must move even further away from linear to circular industry. The magnitude of this change can certainly be compared with the efforts of reunification. But we have already shown that together we can achieve great things.

In this magazine we want to trace the milestones in the history of environmental protection in East and West. Peter Wensierski, who reported from the GDR as a west german correspondent between 1979 and 1985, has written down his impressions on site for us. We will speak of the many courageous people of the numerous GDR environmental groups who, since the 1980s, even undercut the central media censorship with their underground films And we talked to UBA colleagues who grew up in the GDR and started their careers at the German Environment Agency in the early 1990s.

I wish you an inspiring read and some interesting insights! Yours

Dirk Messner

PS: If you prefer a virtual journey through time, you can do so at https://stories.umweltbundesamt.de/chronik-einheit-umwelt where exciting film, image and sound documents from 30 years of environmental protection in East and West await you!

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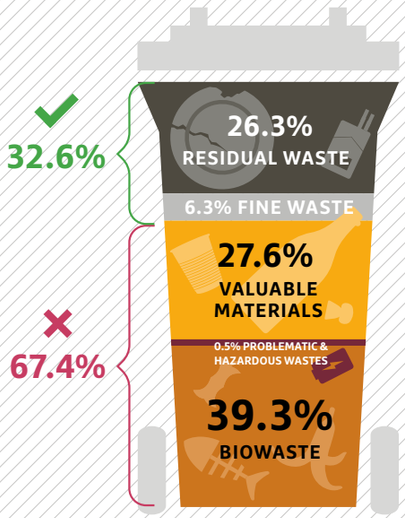
UBA INSIGHTS



ANALYSIS

Too much biowaste in the residual waste bin

Almost 40 percent of the residual waste is biowaste, which is better disposed of in the organic waste bin because biowaste is 100% recycable. This is shown by a current representative analysis of municipal solid waste in Germany. 27 percent are valuable materials such as waste paper, waste glass and plastics, textiles, wood, cork and waste electrical and electronic equipment. Some of these materials could be recycled. Only 32 percent of what actually ends up in the residual waste bin actually belongs there. So there is still a lot of potential for better waste separation. A first start would be to make organic waste bins mandatory in Germany. After all, when an analysis was last carried out more than 35 years ago, there was twice as much waste in the residual waste bin

www.umweltbundesamt.de/restmuell

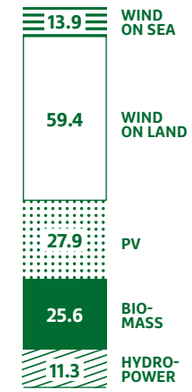
LATEST STATISTICS FROM AGEE-STAT

Renewable energy continues to grow

Renewable energy sources significantly expanded their share in the German electricity mix in the first half of 2020 compared to the same period of the previous year. In total, around 138 billion kilowatthours of renewable electricity were generated in the first six months of 2020, about eight percent more than in the first half of 2019 (plus about 10 billion kWh).

This continuation of the previous years' increase is shown by the Working Group on Renewable Energy Statistics (AGEE-Stat) data. Because overall electricity consumption fell in the wake of the corona crisis, the share of renewable energy in gross electricity consumption grew significantly, reaching around 50 percent for the first time over a six month period. This is an increase of around six percentage points, compared to the 44 percent reached in the first half of 2019.

More information at www.uba.de/agee-1-2020



SARS-CoV-2

Let's air schools properly

Aerosols are a possible transmission route for the novel corona virus. Aerosols spread quickly throughout the rooms, especially in closed interiors. Regular ventilation by pump and cross airing or via ventilation systems in the rooms can significantly reduce the risk of SARS-CoV-2 infection. This is explained in a recent announcement by the Indoor Air Hygiene Commission (IRK) at the German Environment Agency. IRK recommends intensive airing for schools with the windows wide open at every breaktime, or even during lessons if they are longer than 45 minutes. IRK suggests that CO_2 'traffic lights' may provide indication for good or bad air. Under normal conditions, a CO_2 concentration of less than 1000 ppm (0.1 % by volume) in the interior indicates hygienically good air exchange.

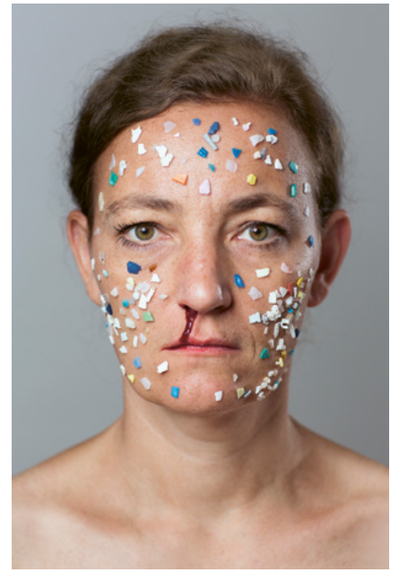
More information at www.uba.de/lueften-corona

ART & ENVIRONMENT

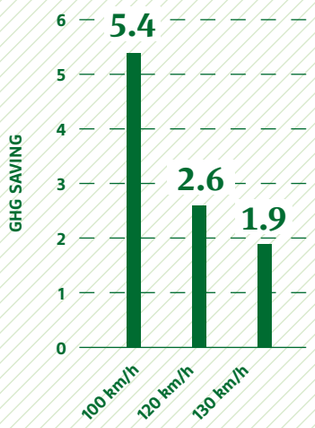
'ZERO WASTE' exhibition in Leipzig

Waste is everywhere: as a gigantic vortex in the Pacific, particulate matter in the air and microplastics in the food chain. The 'Zero Waste' group exhibition displays international contemporary art that points to the urgency of conserving resources, consuming less and living more sustainably. The participating artists use installations, videos, sculptures and photographs to investigate the global consequences of plastic packaging, tyre wear, toxic chemicals and overproduction. 'Zero Waste' has been organised by the German Environment Agency in cooperation with the Leipzig Museum of Fine Arts and curated by Hannah Beck-Mannagetta and Lena Fließbach. The exhibition will be open until 8 November 2020.

More information at www.uba.de/zero-waste



Climate protection effect
Motorway speed limit
in Mt CO_2 equivalents



CLIMATE PROTECTION

Speed limit on motorways can reduce CO_2 emissions considerably

A general speed limit on federal motorways could reduce greenhouse gas emissions by 1.9 to 5.4 million tonnes of carbon dioxide equivalents per year, depending on the value of the limit. With a general speed limit of 120 km/h, the savings are 2.6 million tonnes per year. Even a speed limit of 130 km/h reduces emissions by 1.9 million tonnes – immediately and at practically no extra cost. A speed limit of 100 km/h would result in annual greenhouse gas reductions of 5.4 million tonnes of carbon dioxide equivalents. UBA's calculations are based on real consumption data for cars and light commercial vehicles and Federal Highway Research Institute data on speeds on motorways.

More information at www.uba.de/tempolimit-mindert

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As of September 2020

Responsible editors:
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Design: Studio GOOD, Berlin
www.studio-good.de
Print: Bonitasprint GmbH, Würzburg
Printed as per Blue Angel criteria
English by Nigel Pye, npservices4u@gmail.com
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CONSEQUENCES OF CLIMATE CHANGE

Drought in the middle of Germany

This year, too, many regions of Germany experienced an exceptional drought, extending into the deeper soil layers. This is also due to the fact that there was already far too little rain in 2018 and 2019. Rainfall in both winters was not sufficient to replenish groundwater everywhere. The danger of wild fires is increasing, plants are suffering and the soil is drying out and in some areas there is even too little drinking water.

Water stress, as experts call it when more than 20 percent of the available groundwater and surface water is extracted each year, does not exist in Germany. But prolonged drought can have a negative impact on groundwater levels. This year, as in previous summers, extreme drought even led to bottlenecks in the drinking water supply in some regions and in very hot weather – for example in the Hochtaunuskreis, where an appeal was made to save water, or in Lauenau in Lower Saxony, where the drinking water supply came to a partial and temporary standstill. So far, however, the drought has not had a negative impact on the drinking water supply across the country as a whole, and there is (still) no shortage of drinking water in Germany. Nevertheless, drinking water is valuable and we should handle it carefully in all seasons of the year.

Of course, prolonged drought has consequences – it reduces plant growth and agricultural yields and can also lead to high nutrient surpluses of nitrogen etc. In drought conditions, the conversion and transport of fertilisers to the plant roots is delayed. As a result, plants have difficulty absorbing the fertiliser offered. The danger of wind erosion is also higher during drought: fine material rich in humus can be blown away and soil fertility and plant growth suffer as a result. Drought also exacerbates the already existing problem of inadequate water supply to tree roots in the streets due to sealing and compaction. Young trees are particularly affected. Forests can also be severely damaged by drought.

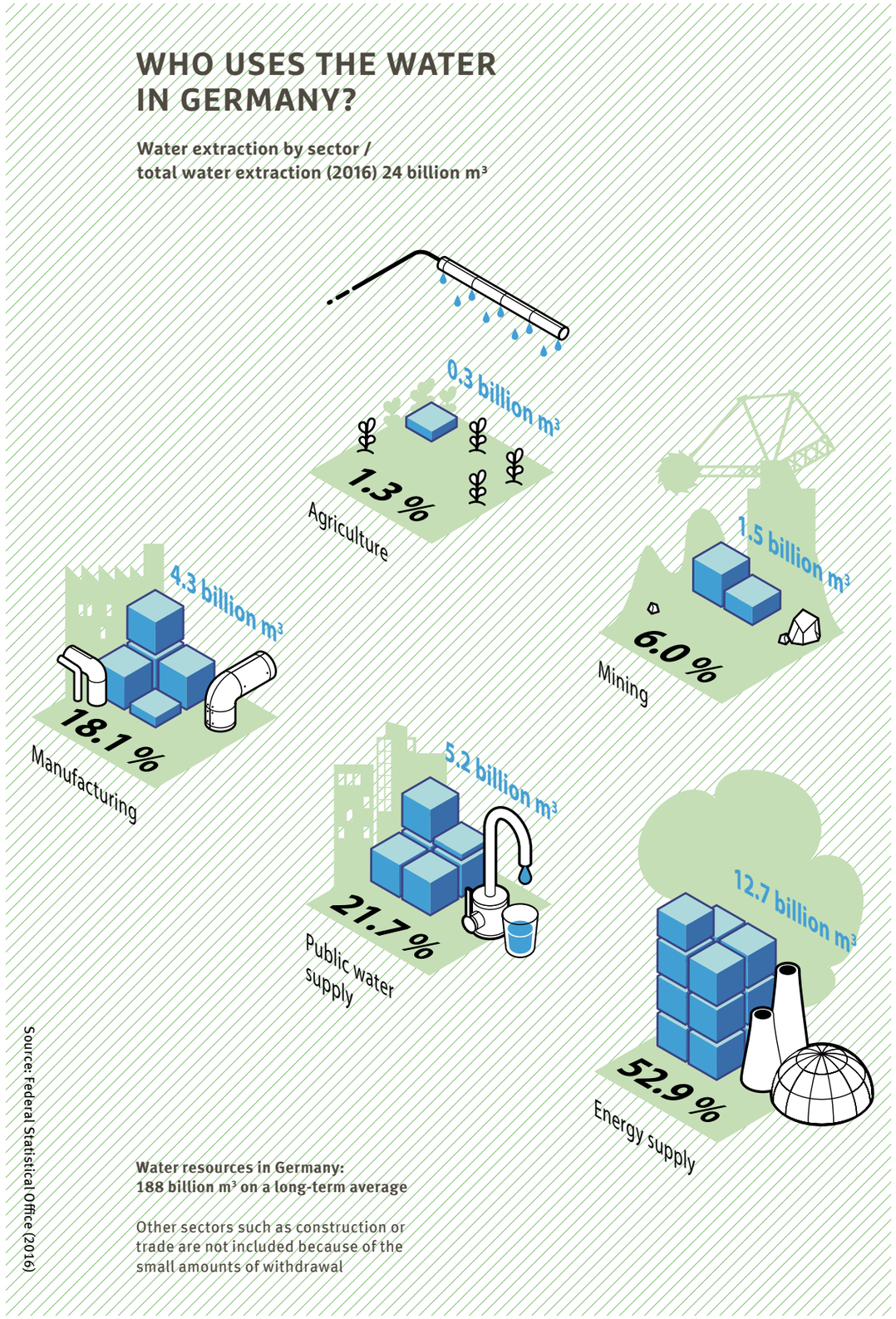
The decrease in soil moisture due to permanently low precipitation is a long-term process and not a short-term weather phenomenon – i.e. a consequence of climate change. Regions of Germany with light, sandy soils, e.g. parts of eastern Germany and the Rhine-Main region, are particularly affected. But other extreme events such as heavy rainfalls, have also increased in recent years and are indications of climate change.

The fact is if these developments – heat waves and hardly any summer rain – continue, the number of regions in Germany that have a problem with drought and water shortages in summer will increase in the future. Agriculture, drinking water supply, ecosystems such as wetlands and forests and also sectors of industry such as shipping can be affected. We must prepare ourselves for this.

The last few months, especially April, were very dry in Germany. The German Weather Service (DWD) says that 2020 was the sunniest and third driest April since the beginning of records in 1881. Instead of the usual 58 litres, the rainfall was only 17 litres per square metre. There was too little rain in May and July too: with around 40 litres per square metre (l/m²), May 2020 clearly missed its climate value of 71 l/m² according to the DWD. July also only reached 65 percent of its target of 78 l/m² with around 50 (l/m²). June alone, at 90 l/m², reached the normal value of 85 l/m². At the beginning of August 2020, the ‘German Drought Monitor’ of the Helmholtz Centre for Environmental Research (UFZ) showed an extreme to exceptional drought for the entire soil (down to a depth of approx. 1.8 metres) for large parts of eastern and central Germany and in some areas of southern and western Germany.

Questions and answers about drought on the web:
www.umweltbundesamt.de/themen/trockenheit- in-deutschland-fragen-antworten

The 2019 monitoring report shows the consequences of climate change in Germany:
www.umweltbundesamt.de/publikationen/monitoringbericht-2019



ENVIRONMENTAL PROTECTION
IN THE GDR

From Grey Skies to Green Belt

BY PETER WENSIERSKI

SUNRISE AT THE ESPENHAIN LIGNITE COMBINE 1990

“In the interest of the welfare of its citizens, the state and society provide for the protection of nature” – this was written in 1968 in the constitution of the GDR. Environmental protection was thereby incorporated as a national objective earlier than in the Federal Republic of Germany, but the reality looked quite different.

Environmental problems in all regions within the GDR could clearly be seen, smelled and noticed by the population. East Germany had per capita the highest pollutant emissions of Europe in sulphur dioxide, dust, heavy metals and climate-damaging carbon dioxide. This was a problem not only for the GDR. Environmental problems haven’t stopped and do not stop today at the borders, and they compel collaboration.

Germany was divided for 40 years, but rivers do not end at the border, and in Berlin in winter smog prevailed constantly on both sides of the wall. There were driving bans only in the western part of the city, where however lignite was also used for heating. Both parts of Germany stayed connected to each other not only because of their shared history, but also through their shared responsibility for the growing environmental problems.

This came to the attention of the players on both sides of the inner German border since the beginning of the 1970s at the latest. To prevent ‘damage and dangers for the respective other side’, an environmental protection-framework agreement between East and West Germany was already being considered in 1972. However, already by the following year the GDR stopped the negotiations. Of all things, the reason given was the establishment of the ‘German Environment Agency’ in West Berlin in July 1974 – which East Berlin considered to be a violation of the recently concluded Four-Power Agreement.

Despite much effort from Bonn, for many years joint work on environmental issues fell by the wayside. Only in 1980 did at least expert discussion commence. The concern thereby was Berlin’s waters and the Werra, which was heavily contaminated by the potash extraction industry. Only after two years of negotiations a minor agreement was reached. The Federal Republic of Germany made a contribution for one of the till then non-existing chemical purification stages to three wastewater treatment plants in the surroundings of Berlin at a cost of 68 million marks. This was celebrated as a major advance, as the Spree, the Havel and Berlin’s chain of lakes were by then extremely polluted, heavily covered in algae and contaminated through eutrophication from the phosphate-laden wastewater from Brandenburg.

The second outcome of the negotiation concerned the Bavarian-Thuringian border region near Sonneberg. The Federal Republic of Germany financed the construction of a wastewater treatment plant with 18 million marks to improve, in the interest of the people in the Coburg area, the small river called Röden polluted by untreated wastewater from the GDR. One river treatment plant already constructed in the West in 1974 had not managed to prevent damage by the GDR wastewater.

from left:
OPEN CAST MINING NEAR BITTERFELD, 1955

GRAIN HARVEST NEAR ESPENHAIN, 1957

THE 10TH INTERNATIONAL PEACE RACE THROUGH BITTERFELD, 1957

ESPENHAIN, 1990

One wastewater treatment plant in Sonneberg and three new stages in existing wastewater treatment plants in Brandenburg were far from being major successes in environmental protection matters, even while expert discussion continued on the issues of a reduction of Werra salinisation, flue gas desulphurisation, pollution of the Elbe, reactor safety, waste management and emergency planning and preparedness. While the western delegation members kept looking at it from the polluter pays principle, the GDR delegates argued based on the cost-benefit principle and the comparative advantage principle. Furthermore, the inclusion of West Berlin continued to be a sensitive issue for the GDR because for them the half city was 'no part of the FRG'. As for the rivers, the polluter was clear: Whether the Elbe, the Spree, the Werra, the Leine, the Jeetze, the Röden or the Saale, they all transported pollutants towards the West. As for pollution by sulphur dioxide, dust and fly ash, it could also appear to be the other way around, depending on wind direction. For example, air pollution near Helmstedt alternated between the lignite power stations lying directly on the border, Harbke (in the East) and Buschhaus (in the West).

All these inner German talks and agreements were better than standstill, but were ultimately only a drop in the bucket. The major environmental problems remained the air pollution in industrial metropolitan areas, the contamination of surface waters and groundwater through industrialised agriculture, the large-area forest dieback in the south of the GDR and the massive landscape destruction through open cast lignite mines. Nuclear plants and the uranium mining of the Wismut (Bismuth) company also posed incalculable risks.

Many industrial plants, for example near Bitterfeld, Leuna or Wolfen, were still operating at pre-war standards. The large lignite-fuelled power stations, such as in Cottbus, either had no filter or, in case old ones were available, the filters were disconnected for the 'attainment of the planned production target'. Highly toxic wastewater from the chemical industry was discharged practically untreated into receiving pits and tailings ponds. Throughout the country there were 13,000 small and large landfill sites, which were operated mostly without liners towards waters and soil. For decades, household waste and toxic waste was dumped there and on top of that even hazardous waste from the West in exchange for foreign currencies. In some places – as in the eighties near Bernau – highly toxic circuit board scrap from the electronics industry was burned in the open air. This practice was not stopped, even as serious damage to health arose among people in the neighbourhood from the released dioxin.

"Considering that the GDR constantly declared that its people were at the focus of its politics, it cared little for their health"

from left:
THE WASTEWATER LAKE OF THE WOLFEN FILM FACTORY NEAR BITTERFELD, 1991

THE SO-CALLED 'SILVER LAKE' IN BITTERFELD, 1990

SODA WORKS STRASSFURT, 1990

Sometimes the environmental 'sins' in both East and West were also similar: close to the border near Helmstedt and Salzgitter both states stored radioactive waste underground, practically in a gigantic subterranean salt dome spanning the border between Morsleben in the East and the 'Asse' in the West. The problem remains to this day a cause for great concern.

The list of GDR environmental 'sins' is long and considering that the GDR constantly declared that its people were at the focus of its politics, it cared little for their health. As an example, while the carcinogenic and mutagenic toxin DDT was already long since shunned and banned worldwide, it was used continuously in large areas in the GDR to combat the bark beetle. Small agricultural aircraft sprayed the 'chemical weapon' over wide parts of the GDR and thereby also continually flew over residential areas at the edges of forests and fields.

None of these problems, however, could be discussed publically. The GDR media broadcasted only success articles on the government's politics. Citizens could only appeal to the authorities with inputs, i.e. grievances. And they did this quite often, although seldom with success. The SED (Socialist Unity Party of Germany) and the Stasi (State Security Police) strived to keep word of environmental damage or disasters from the public. All environmental data were subject to secrecy, and the law of secrecy of environmental data was itself, in turn, secret. Even though especially in the seventies it came to major environmental damage in the Federal Republic of Germany, the problems there were not subject to state secrecy and were tackled – even if sometimes later than environmentalists would have wished. Thus in 1971 the lead-in-petrol law was adopted, and in 1983 emission limit values for sulphur dioxide were specified, which combated acid rain, and desulphurisation plants were installed. Even the Rhine, which in the seventies was still all but uninhabitable for fish, was brought back little by little to a better environmental condition (see also the Mountains of foam and colourful rivers chapter).

As the GDR according to its name was a democratic republic, on paper it was also an environmentally friendly republic. Even before the Federal Republic of Germany there was in 1972 in East Berlin, with Hans Reichelt as environment minister, a Ministry for Environmental Protection and Water resources Management as central authority. The GDR had already enacted in 1970 a on paper comprehensive Landeskulturgesetz (state culture law). It was concerned about its international reputation – after all, it could participate, at a time when it was recognised only by a few states, on an equal footing next to the Federal Republic of Germany at the first international environmental conference in Stockholm in 1972. The Federal Environment Ministry was founded in 1986 in the Federal Republic of Germany.

The Landeskulturgesetz was supposed to preserve the natural foundations of life and production but also ensure that it would "use them effectively". The latter meant that in principle environmental protection remained subordinate to economic targets. The GDR however gladly pointed to more than 400 declared scenic and conservation areas, which covered about 18 percent of the total area of the GDR.

Many citizens in the GDR experienced a constant waste of energy in everyday life: open windows

from top:
WATERS NEAR EISLEBEN, 1982

APPLICATION OF CHEMICALS IN FRUIT PRODUCTION IN BORTHEN NEAR DRESDEN, 1974

DEAD TREES ON THE FICHTELBERG IN THE ORE MOUNTAINS, 1983

even in winter in offices with poorly adjustable district heating, permanently lit street lamps, damaged sanitary facilities through which for months fresh water disappeared directly into the outflow, not to mention obsolescent, power-hungry installations in plants.

The GDR was not however a throwaway society, as furniture and clothing were kept longer, and anything and everything was repaired, which many people between Rügen and the Ore Mountains are still rightly proud of today. Many former GDR citizens still gladly recall the SERO[1] collection system for the recycling of valuable waste materials, in which entire school classes, 'Free German Youth' groups and brigades participated. With waste paper, bottles, glassware's, rags, plastic or scrap metal, people's pocket money and many class funds were in better shape. A kilo of Plaste (plastics) brought one GDR mark, copper 2 marks 50 pfennigs. This resulted in a high recycling share. In comparison, in the Federal Republic of Germany recycling fared poorly. According to statistics, on average just under 240 kilograms of household waste per resident per year in 1985. A waste sorting system had not yet been established.

“The GDR was not, however, a throw-away society”

There was also less road traffic than in the West, but the Trabant, the GDR citizens' favourite car and a cult object today, was a sickening polluter. It was above all the hydrocarbons that were harmful to health, such as highly carcinogenic benzapyrene, which together with the fuel/oil mixture formed the typical smell of the Trabi, whose emissions were 90 times higher, except for oxides of nitrogen, than those of a VW Golf of the same period with catalytic converter.

After the fall of the Berlin Wall, the true extent of the environmental situation in the GDR came to light. Already since 1979 a growing number of non-governmental environmental action groups, mostly under the umbrella of the Protestant Church, had criticized the heavy environmental pollution. They were monitored by the GDR secret service and 'subverted' when possible. This did not change the fact that the visibly dirty environment disgusted more and more people and also served as an argument for justifying applications for emigration. Environmental protection became an ongoing issue of the opposition movement. The GDR expressly established in response in 1980 a 'Society for Nature and Environmental Protection' (GNU), which however could not make any notable impact.

Independent environmental groups on the other hand played an important role in the autumn of 1989. A number of activists found themselves together in the – however short-lived – 'New Forum' mass movement, took part at the round tables and made an impact in this way on environmental objectives in the environmental conversion of East Germany. A Joint Environment Commission assessed the situation already in February 1990 as alarming. Little by little, expertise and reports that were kept secret became public. So for example, for years already the area around Bitterfeld was classified internally as uninhabitable for children, without this being communicated to the general public.

Thus it came rather quickly to shutdowns especially of obsolete installations of the coal industry, a gradual exit from lignite and the decommissioning of nuclear plants. Moreover, uranium mining in the south of the GDR was completely abandoned. After secrecy ended it became clear: the resultant damage could be remedied only with a recovery programme running into the billions. After the reunification, the environmental laws of the Federal Republic of Germany were carried over to the former area of the GDR, which led to considerable improvements for the environment, not least for sulphur dioxide and carbon dioxide emissions and for the entry of pollutants into rivers and waters. New problems were added through more traffic, more waste generation and more urban sprawl. All told however, the GDR had vast, indeed polluted but valuable stretches of land that could be successfully recovered environmentally. 4.5 percent of the GDR territory became environmentally protected area.

Even the 'Death Strip', the nearly 1,400 kilometre long inner German border, has today transformed itself as a green belt into a valuable biotope and was even declared a national natural heritage by the German government. A development that surely nobody had predicted 30 years ago – from mines, automatic firing devices and watchtowers to a green protected area for nature and biodiversity. Also a symbol of the peaceful reunification and merging of two states.

THE GREEN BELT BETWEEN SONNEBERG AND COBURG

1 SERO is the VEB (state-owned business) Sekundär-Rohstofferfassung (secondary collection of raw materials) combine

German Unity and the Environment

EXPERIENCE THE CHRONICLE ONLINE:

stories.umweltbundesamt.de/chronik-einheit-umwelt

1910

1913
First International Conference on Nature Conservation in Bern

1940

1941
In 'Human activity as a climate factor', Hermann Flohn postulates that climate change is not just determined by nature and is not predictable

5 June 1945
Germany is divided into four occupation zones (France, USA, Great Britain, USSR)

23 May 1949
Founding of the Federal Republic of Germany

7 October 1949
Founding of the German Democratic Republic

1960

28 April 1961
Willy Brandt demands "Blue skies over the Ruhr" and makes environmental pollution an election campaign topic for the first time

13 August 1961
Start of building the Berlin Wall

RACHEL CARSON, 1963

1962
'The Silent Spring' is published by Rachel Carson to mark the one of the starting points of the global environmental movement

1967
Founding of the world's first environment agency in Sweden

1970

1972
In 'The Limits to Growth', the Club of Rome criticises the environmental consequences of economic growth for the first time

1972
GDR establishes the Ministry for Environmental Protection and Water Management

June 1972
1st UN Conference on the Human Environment in Stockholm, considered the beginning of international environmental policy

STOCKHOLM, 1972

22 July 1974
Founding of the German Environment Agency in West Berlin

CLEAN-UP IN SEVESO, 1977

10 July 1976
Large quantities of the highly toxic dioxin TCDD released in Seveso, Italy in Europe's biggest chemical accident so far

February 1979
First World Climate Conference in Geneva

1980

November 1981
DER SPIEGEL predicts that forests will die – sulphur dioxide from industry damages the trees as acid rain

May 1985
British polar explorers discover an ozone hole above the Antarctic

CHERNOBYL, 1986

26 April 1986
Nuclear meltdown and explosion at the Chernobyl reactor in Ukraine (then Soviet Union) – one of the biggest environmental disasters ever

6 June 1986
Establishing the Federal Ministry of the Environment in the FRG

16 October 1989
Leipzig Monday Demonstration with 120,000 participants ("We are the majority! We are the people!")

9 November 1989
The Berlin Wall falls

1990

3 October 1990
Accession of the five eastern German Länder to the Federal Republic

1992
UN Conference on Environment and Development – starting signal for global climate politics

UN CONFERENCE 1992

1995
COP 1: First UN Climate Change Conference in Berlin

1997
Kyoto Protocol at COP 3 in Japan: binding greenhouse gas limits set for the first time

2010

2011
Nuclear disaster in Fukushima, Japan, following which Germany decides to phase out nuclear power by 2022

FUKUSHIMA 2011

2015
COP 21 and the Paris Climate Agreement: global warming to be limited to well below two degrees

2020

2020
Germany decides to phase out the coal industry completely by 2038 at the latest

AIR POLLUTANTS

Industrial fog and smog Alerts

Pollutants in the air, one could see, smell and even taste them! Air pollution in the GDR was extremely high. The industrial region around Leipzig / Halle / Weißenfels / Bitterfeld was particularly badly affected. Unlike today, people living there had no information about the extent of the pollution as the air quality data collected was kept secret.

Pollution situation in the GDR

Extremely high sulphur dioxide (SO_2) concentrations were measured in the 1980s, particularly in the industrial area around Leipzig / Halle / Weißenfels / Bitterfeld. At annual average values of over 400 micrograms per cubic metre (µg/ m³), pollution here was about four times higher than in the West German Ruhr District. For comparison: the highest values are around 10 µg / m³ today. Even in what is now Mecklenburg-Western Pomerania, which is less industrialised, SO_2 concentrations reached roughly the same level as in the Ruhr District.

In the central German region, the level of particulate matter was also about twice as high as in the Ruhr District reaching annual average values of 150 to 200 µg/m³. It was only when power stations and industrial plants were shut down or refurbished at the beginning of the 1990s that sulphur dioxide and suspended particulate matter pollution in the GDR fell drastically. By the end of the 1990s, there was no longer any difference between concentrations in East and West German industrial areas.

Winter smog

In the 1980s, high levels of air pollution, known as winter smog – somewhat trivialised as 'industrial fog' in the GDR – occurred in large industrial conurbations or cities in both East and West during the winter months. In inversion weather conditions during such smog situations the exchange of air was severely restricted so that the pollutants could accumulate over several days. The air was particularly dirty in winter in the region around Halle / Leipzig. Here, lignite with a particularly high sulphur content was used in power stations, processed in industry and used for heating the flats. In a smog period in January 1985, which affected all Germany, SO_2 concentrations in Leipzig peaked at up to 4,999 µg/m³ – the measuring instruments were not able measure any higher values. Even the notorious London smog of 1952, which caused many deaths, was reported as having 'only' 3,580 µg/m³ [2]. Unfortunately, no records of health effects have been obtained from the GDR.

Measurement network and data quality

At about 300 sites, air quality was monitored mainly by District Hygiene Institutes (BHI) and the GDR Meteorological Service (MD) but also by 40 other operators in the GDR. Since exhaust gases from power plants, industry and households were the main sources of air pollutants, the focus was on measuring sulphur dioxide and suspended particulate matter in the air. The first air quality measurements in the GDR date back to 1969.

Measuring instruments and IT technology were developed and built by the GDR itself, partly because imports from Western countries were not possible. The accuracy of air quality data collected before the end of the 1990s is not comparable with today's, and little is known about the structure and surroundings of the measuring stations at that time. Nevertheless, basic conclusions can be drawn from the old data.

Figure 1

Sulphur dioxide concentrations
on an annual average

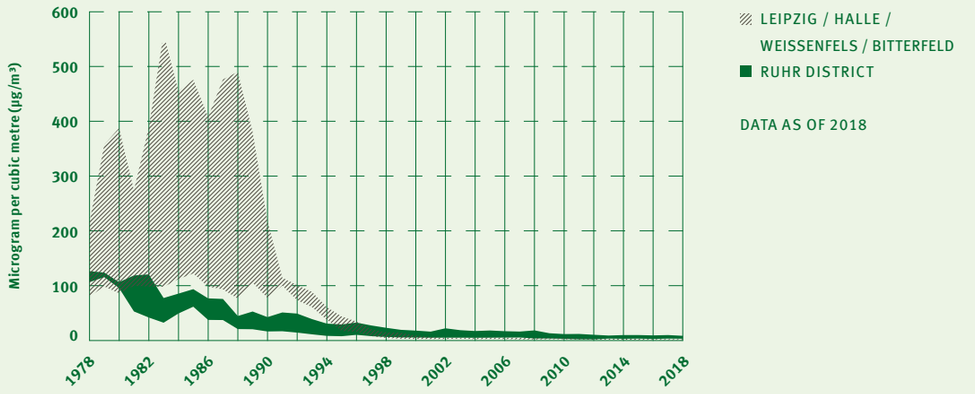


Figure 2

Sulphur dioxide emissions in Germany
1970 to 1990: GDR and Federal Republic separated, 1991 to 2017: together

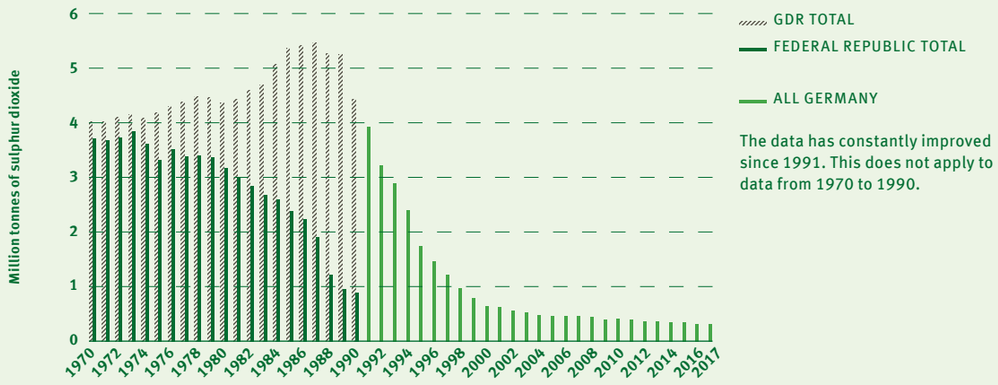
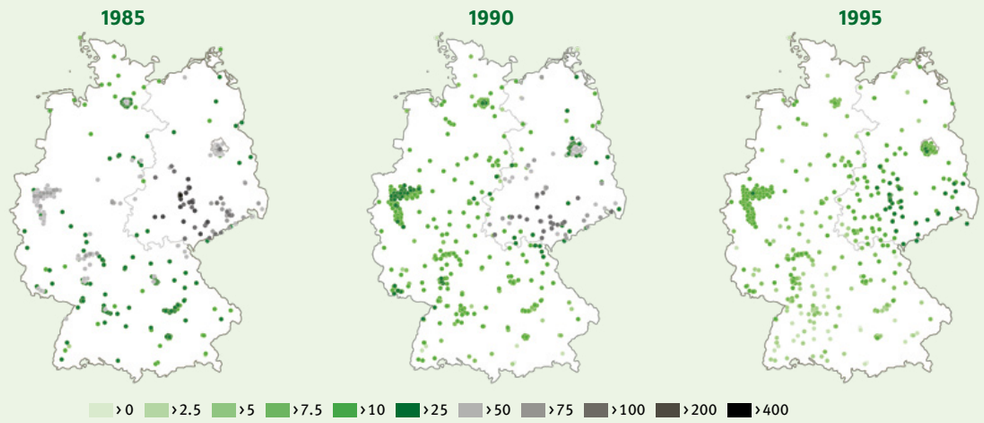


Figure 3

Sulphur dioxide concentrations in microgram per cubic metre (µg/m³)
Annual averages per station



But SO_2 concentrations also climbed to over 1,000 µg/m³ in some places of the FDR. In this situation, some authorities declared a smog alert and warned the population. Industrial companies had to cut back their production and driving bans were imposed. In the GDR, however, where pollution levels were more than four times as high in some places, power stations and industry continued to operate. People were neither warned nor informed.

Causes of air pollution

The main sources of sulphur dioxide emissions in the GDR and the FRG were power and heating plants, industrial combustion plants and households. In the Federal Republic the Large Combustion Plants Ordinance of 1983 effectively limited SO_2 emissions from power plants and industrial plants thus air pollution fell rapidly and significantly. In the GDR, however, emissions from power plants continued to rise in the 1980s. Power plants in the GDR, often built at the beginning of the 20th century and lacking filter systems, were generally operated at maximum load to cover energy demand.

“People were neither warned nor informed”

Lignite was used as an energy source. As opposed to hard coal, lignite has higher water and sulphur content and only about one third of its calorific value. However, lignite was the only energy source that was sufficiently available in the GDR and did not have to be imported. Lignite from the central German district near Halle / Leipzig has a higher calorific value than most other districts[3], but its sulphur content is comparatively high at up to three percent. The sulphur-containing lignite from the domestic mining areas thus contributed significantly to the high sulphur dioxide emissions from power plants and private households which explains the high sulphur dioxide concentrations in the GDR.

Pollution today

Flue gas desulphurisation in power plants and the use of low-sulphur fuels have drastically reduced sulphur dioxide emissions in Germany, and, as a consequence, health-endangering SO_2 concentrations do not occur today. The same applies to exposure to suspended particulate matter (coarse dust). Winter smog as in the 1980s is something of the past in Germany. The last country-wide smog ordinance was repealed in 2000. The annual average SO_2 concentrations are between 1 and 5 µg/m³ across Germany today and only a few industrial sites exhibit values of up to 10 µg/m³. There are no regional concentration differences between the former FRG and the former GDR any longer. Unlike in the 1980s, up-to-date air quality information is now available. State (Land) environmental agencies and the German Environment Agency keep updating their data on an hourly basis and publish them on their websites. The UBA *Air Quality* app provides a quick overview of current air quality for those travelling.

2 Berthold Seewald, ‘Nebel des Grauens: Als Londons Smog 12.000 Menschen tötete’ (The horror fog: When the London smog killed 12,000 people), www.welt.de, 2018

3 Lignite has been widely mined in open cast mines and used in Germany. There are four main lignite deposits: the Rhineland District in the Ruhr area, the Central German District near Halle / Leipzig, the Helmstedt District near Braunschweig and the Lusatian District near Cottbus, which extends into Poland.

WATER STATUS

Mountains of foam and colourful rivers

When in 1990 the first all-German water quality map was to be created, it was necessary to create an additional quality class for describing the water quality of many East German rivers: ‘ecologically devastated’.

Otherwise, the condition of the Elbe, the Mulde and many smaller rivers could not be described. Migratory fish such as sturgeon and salmon disappeared. Before 1990, the East German rivers counted among the waters most heavily polluted with wastewater in Europe – mountains of foam at dams and rivers coloured with chemicals were not the exception, but rather the rule.

Many small waterways were polluted almost everywhere: on the one hand, from untreated wastewater which requires oxygen to break it down and which the river ecosystem lacks. With an oxygen content of less than five milligrams per litre (mg/l), only few plants and animals can survive. On the other hand, they were polluted with agricultural and industrial releases of nitrate and phosphorus as well as chemicals such as the pesticides DDT and lindane. In addition, there were acidification phenomena caused by acid rain even in the smallest streams of the East German highlands.

“Before 1990, the East German rivers counted among the waters most heavily polluted with wastewater in Europe”

What has changed since reunification?

Much has happened to the rivers since 1990. Obsolete industrial enterprises were shut down or refurbished, modern and more efficient wastewater treatment plants were built and environmental legislation improved. As a result, the water quality in many rivers has visibly and measurably improved. Even in the waters of the western German states (Länder), there were environmental problems, but these had been addressed prior to 1990.

Contamination with **heavy metals** such as mercury and **persistent organic pollutants** has decreased by more than 95 percent in many of the bigger East German rivers since the early nineties. Many heavy metals and persistent organic pollutants accumulate in the food web, often with adverse consequences for living organisms – for example lower vitality, a decline in reproductive success, mortality or the total extinction of particularly sensitive species.

Meanwhile, it can be demonstrated that the waters and the organisms living in them are less polluted with such substances than before. The concentrations of heavy metals and persistent organic pollutants in the Elbe declined quickly after the abatement of industrial discharges through plant closures after reunification. By 1992 the mean mercury concentrations in suspended matter at the Schnackenburg / Elbe monitoring station (former inner German border) had been halved and have now decreased to ten percent of their 1991 value. Even contamination with persistent organic pollutants has declined since the early nineties.

As an example, at sampling locations in the Bitterfeld area along the Elbe, there is a decline of **lindane** (gamma HCH) insecticide, produced before reunification, in the muscles of fish (bream).

Even contamination with **phosphate** (phosphorus) has demonstrably fallen sharply since reunification – wastewater treatment plants have been modernised so that nitrogen compounds could biodegrade and phosphate could be better eliminated, phosphate-free detergents introduced and industrial enterprises shut down. The phosphorus concentrations in the Elbe have thereby decreased as measured by the Schnackenburg monitoring station.

Moreover, **nitrogen releases** into the Elbe have decreased. Industrial plants were closed, and as a consequence direct industrial discharges of nitrogen were eliminated – and the nitrogen introduced from industry has reduced by about 80 percent since the mid-eighties. As more and more municipalities were connected to the modernised waste-water treatment plants, the releases from drainage systems and wastewater treatment plants also decreased by about 50 percent. At the same time, livestock was significantly reduced following reunification and thus the nitrogen surplus on agricultural lands. The structural change of agriculture

in the former GDR can be illustrated by the reduction of nitrogen introduced by drainage channels set up for draining wet soils. These nitrogen releases have fallen by about 60 percent.

Ecosystems in the Elbe recovered very quickly after 1990 thanks to better oxygen conditions and declining pollution from nutrients and chemicals as well as the first renaturalisations. Despite the many improvements, however, all is still not good: Although the annual mean value of the oxygen content in the Lower Elbe between Hamburg and the North Sea has significantly improved from six to nine milligrams per litre, there is still a massive oxygen deficiency in summer. The substances that consume oxygen used to come from wastewater treatment plants. Today it is algae growing in rivers that consume the oxygen. The cause is still excessive phosphorus runoff from agriculture and small obsolete wastewater treatment plants.

The western German states took care of the waters earlier

In the western German states (Länder) the recovery of the waters had already begun before reunification. The Rhine is a good example of this. Its recovery began around 1970 and was slower because wastewater treatment plants were gradually being built and acidification caused by air pollutants such as sulphur dioxide diminished sharply. All measures were followed by a slow recovery of the biocoenosis of the streams and rivers that continues to this day. Sensitive aquatic organisms are returning to the waters. Migratory fish species, such as salmon, are gradually moving back into the rivers thanks to appropriate reintroduction initiatives and the construction of fish locks.

As one can see in the positive environmental trends of some waters, the social changes, the technological innovations and the implementation of environmental protection measures have already shown themselves to be worthwhile. In order to achieve a good water status, these must now be pursued comprehensively.

Figure 4

Mean mercury concentrations at the monitoring station Schnackenburg / Elbe

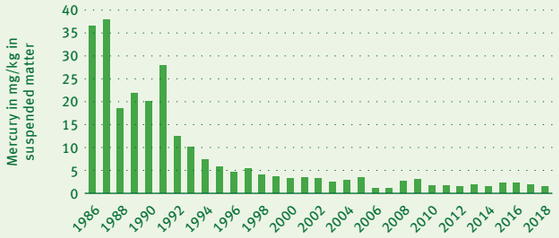


Figure 5

Annual mean values of lindane concentrations in the muscles of bream along the Elbe

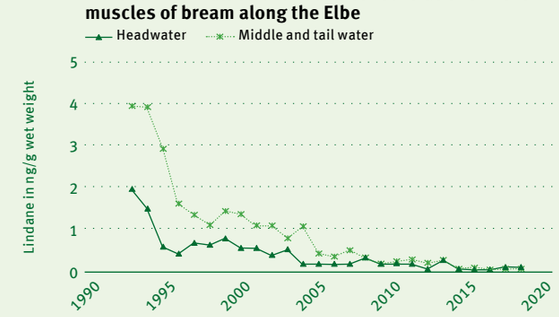


Figure 6

Annual mean concentrations* of phosphorus at the monitoring station Schnackenburg / Elbe

* 1982–1987 median

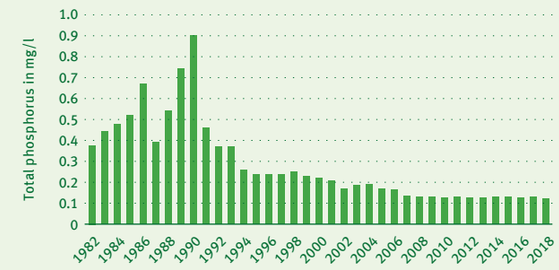
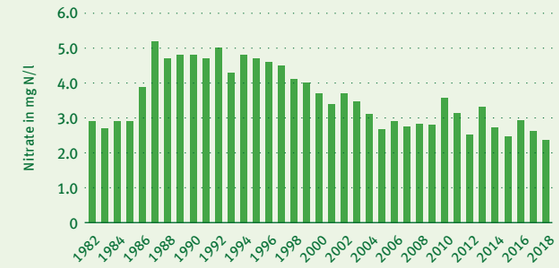


Figure 7

Annual mean concentrations* of nitrate at the monitoring station Schnackenburg / Elbe

* 1982–1987 median



Waters protection today and tomorrow

Biocoenoses are at the core of environmental assessment today. Selected sensitive organisms serve as indicators for intact aquatic ecosystems: if the waters are not in a good condition, they die or no longer reproduce, the biotic community becomes impoverished and the self-cleaning ability of the waters decreases. Aquatic biologists use four groups of living organisms for this: bottom-dwelling invertebrate animals; aquatic plants and algae adhering to the bottom; floating algae; and fish.

Despite the positive trends in recent years, currently only seven percent of the rivers in Germany have attained a good ecological status, as should be achieved by 2027 according to the EU Water Framework Directive. In order to achieve a **good ecological status** in all German waters, the nutrient and pollutant inputs from agriculture, rainwater runoff and leachates must be further reduced and the wastewater treatment plants optimised. In order to create habitats for the former biodiversity, the waters require more area for renaturalisation. In order to facilitate fish passage for migratory species (e.g. salmon on route from the sea to the spawning grounds in small streams), transverse structures such as weirs must be passable.

According to the criteria of the EU Water Framework Directive, no rivers in Germany reach the **good chemical status.** This also applies to the East German rivers such as the Elbe, the Mulde and the Saale where high mercury concentrations still can be detected and where long-lived and toxic chemicals are found in suspended matter and in the sediment.

The waters in Germany and in the EU will only achieve a good status if the federal government, states, municipalities, industry and agriculture, as well as citizens adequately invest in and cooperate in the required improvements. At the same time, the few waters that are at least currently in good ecological status must be preserved and strictly protected because the of the past will still accompany us over decades on our way to clean water.

The EU Water Framework Directive

The European Water Framework Directive came into force on 22 December 2000. According to it, rivers, lakes, transitional waters, coastal waters and groundwater should be in a ‘good status’ by 2027 at the latest. To get there, the European Commission has given the Member States a clear timetable and three six-year management cycles. Central control instruments are the river basin management plans, which contain among other things declarations of condition, pollution, target achievement and measures. At the same time, the plans represent a control instrument for the European Commission.

More information can be found on the Internet: www.umweltbundesamt.de/wasserrahmenrichtlinie

SOILS AND LAND

The long memory of soils

When digging up the soil, one sees into the past. Soils are the reflection of our geological history and human activities.

Germany's soils are comparatively young. After the end of the last ice age 12,000 years ago, they developed from the weathering of rocks, the decomposition of plants and other soil-forming processes as well as human activities such as agriculture, livestock breeding and forest use. The parent rock of soil formation has a major impact on the natural concentrations of cadmium, lead and other elements. For example, soils that have developed from solid rock contain more arsenic than soils that developed from sand.

With the beginning of industrialisation in Europe, increasingly more naturally occurring and manufactured chemicals have entered the environment. Soils have become a sink for these substances where they can accumulate – whether through deposition from the air, from handling losses, leaks and disasters, through unprotected waste dumping or the agricultural use of municipal waste (compost) and sewage sludge produced by the treatment of wastewater. Chemicals also were and are carried into soils through a vast number of other activities, for example mining, coal combustion, traffic or the use of mineral fertilisers and farmyard manure.

Soils 'forget' nothing. In particular if it concerns chemical compounds that are poorly or not degradable by soil organisms. The 40 years of the GDR were only a short period of time for the soil. That is why the environmental footprint of the GDR history is only a short episode for soils that, unlike air and waters, remains largely hidden. Exceptions are the contamination hot spots such as the Bitterfeld-Wolfen chemical site (see the 'Challenges up to the Present' chapter).

The many diffuse inputs leave their traces in the soils over a wide area. Indeed, far fewer environmentally harmful chemicals enter the soil now via the air. Moreover, composts, sewage sludge and other organic fertilisers have become 'cleaner', at least as concerns heavy metals and some organic chemicals.

Figure 8

Distribution of the PCB 6 concentrations in Germany's topsoil

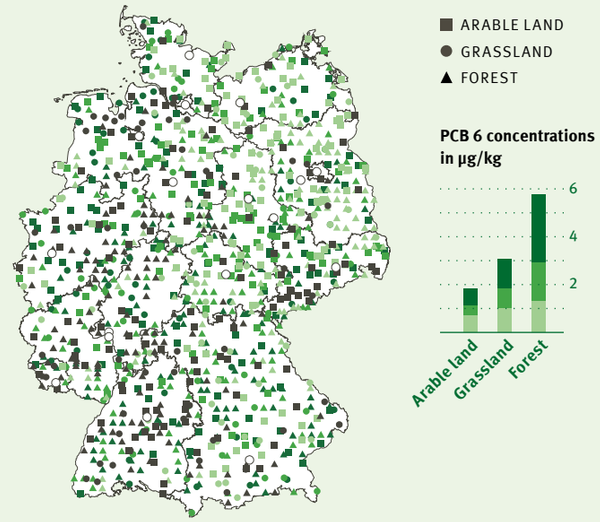
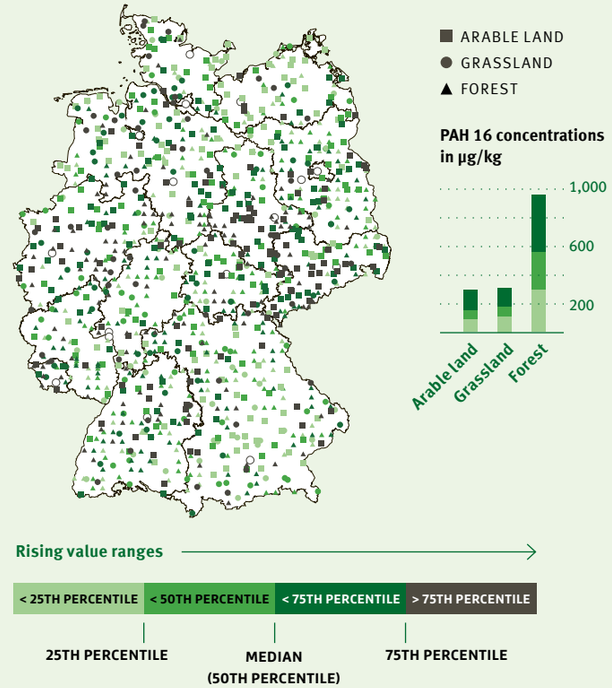


Figure 9

Distribution of PAH 16 concentrations in Germany's topsoil



Persistent chemicals however remain in the soil. Heavy metals and other chemicals can reach the groundwater from the soil or can be absorbed by the plants under unfavourable circumstances that depend on pH value, carbon content and other soil parameters.

With few exceptions, organic chemicals do not occur naturally in soils. For instance, polycyclic aromatic hydrocarbons (PAH) are produced by the incomplete combustion of wood, coal or oil. Polychlorinated biphenyls (PCB) are industrial products whose manufacture and use was first prohibited in open environment systems in 1978 and then in general in 1989.

The distribution of organic substances in soils throughout Germany is largely a reflection of human impact: for example, where they were produced and how the pollutants have spread through the air, and it depends on the density of industry and of the population (Figures 8/9).

The permanent soil monitoring programmes of the states (Länder) and the survey of soil status throughout Germany are suitable instruments for recording the condition of our soils and its trends. The goal must therefore continue to be to minimise the input of substances into soils and to preserve their functions because the soil is also our livelihood and forgets nothing.

Land-take – the East has caught up

Pollutants that are buried underground cannot generally be seen. On the other hand, what happens on the ground and potentially damages the soil can most certainly be seen. This also includes land-take – sometimes also referred to as soil consumption. By that is meant the first-time use of open spaces such as fields, forest and meadows for residential and transport purposes. These include building spaces and open spaces, operating areas without mining land, recreational land, traffic areas and cemeteries. About half of the residential and transport areas are sealed, which means with buildings or installations built on them or for roadways, parking spaces and pavements asphalted, concreted, paved or compacted and otherwise sealed. Sealing causes soils to lose their ability to to seep or store water. This increases the risk of flooding by heavy rains. In addition, the sealing of soils destroys the natural soil fertility and deprives soil organisms of their habitat. Recoverery therefore takes a very long

time. Furthermore, land-take leads to a loss of biodiversity and impairs or reduces the habitat of plants and animals.

Meanwhile, land-take is an all-German problem

As for land-take, the east of the country has unfortunately caught up tremendously in the past 30 years and approached the high level of the western German states. All told, the residential and transport land-use in the new German states increased on average about 17 percent between 1989 and 2001, whereby the population in the same period decreased by around 10 percent (for comparison, in the same period the resident-ial and transport land-use in the former West German states grew by 12.1 percent with a population growth of approximately 9 percent). From 1993 to 2000, each resident in the new German states has made use on average of approximately four times as much residential and transport land-use as in the western German states.

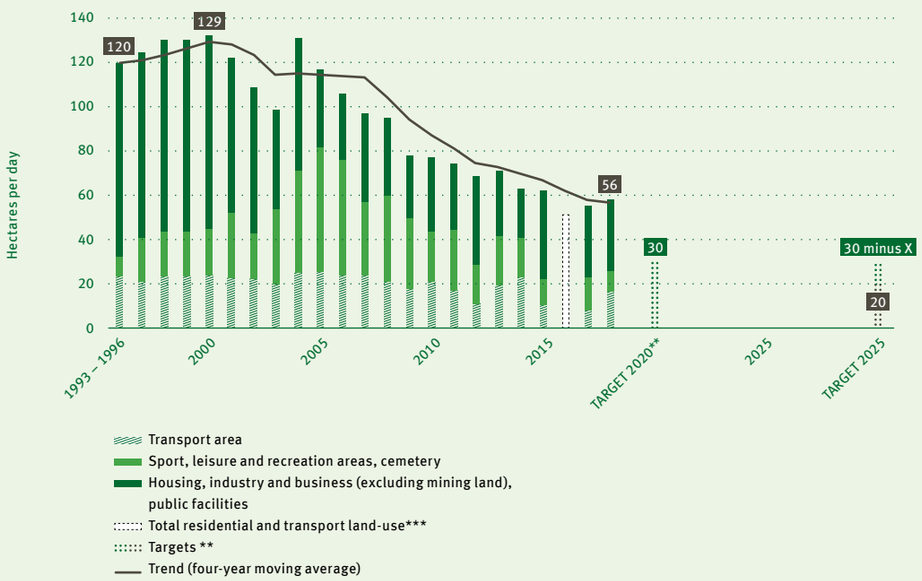
The reason for this was on the one hand the many new commercial areas that were established in large measure in the open countryside. Access roads were also part of the additional land-use. In principle, the brownfield sites that arose in the course of economic structural change would also have been an option. Based on estimates in the nineties, this included just roughly 6,000 hectares of previously used brownfield sites, approximately 38,800 ha of real estate with high release potential of the Treuhand-Liegenschaftsgesellschaft commercial (Privatisation Agency) plus brownfield sites of the Deutsche Bahn AG (German Rail) and the conversion of about 250,000 hectares of real estate earmarked for release in the new German states. A majority of this brownfield however was classified as barely marketable or un-marketable due to mobilisation obstacles (e.g. soil and groundwater contamination, liability issues). Agricultural land was preferred as it offered freedom of planning and could be acquired cost-effectively.

On the other hand, the desire for better housing conditions also created a surge in demand for land in the new German states. There the growth of housing development areas increased – from a very low value in the beginning of the nineties – to 7 hectares per day in the middle of the decade and increased again by almost double, i.e. by 12 hectares per day up to the turn of the millennium. In particular, many new single-family houses were also constructed in open countryside in the outskirts. Homeownership in 1989 in the East was only around 25 percent. Meanwhile the rate is approximately the same as in West at about 46 percent, to which newly built family homes in the cities outskirts contributed greatly. In the town centres on the other hand, widespread housing vacancy occurred and despair was not uncommon in the lower income communities.

Meanwhile, land-take (i. e. the increase of settlement and traffic areas) is an all-German problem, which no longer needs to be differentiated according to east and west, but rather according to spatial structures and economic areas. In the German Sustainable Development Strategy, the German government aims to reduce land-take in Germany by 2030 to less than 30 hectares per day. It was originally planned that the land-take should not amount to more than 30 hectares per day by 2020. According to the latest figures of the Federal Statistical Office, the four-year average land-take from 2015 to 2018 lies at around 56 hectares per day. Although no data is available yet for the current year 2020, it can nevertheless be determined with reasonable certainty that the original land policy target of 30 hectares will not be achieved within this year. In the coming ten years it will therefore require considerable efforts (e.g. setting binding targets for land-take and strict inner development) in order to further reduce land-take as well as preserve valuable soil resource for future generations.

Figure 10

Daily increase of settlement and traffic area (in hectares)



CLIMATE PROTECTION

Greenhouse gas emissions in East and West

Climate change was indeed a topic of discussion among experts in the seventies and eighties, but hardly in politics.

This was true for the Federal Republic of Germany, and all the more for the GDR. Electricity and heat were largely generated by coal and oil. Carbon dioxide emissions from the combustion of fossil fuels contributed to over 80 percent of greenhouse gas emissions, both in the East and West. Emission data between 1970 and 1989 indicated little change apart from economic activity and weather effects.

The total emissions of reunified Germany have fallen by over 35 percent since 1990

This changed abruptly with the German Unity. The collapse of the economy and the optimisation of the mode of operation of power stations and industrial instalaltions from 1990 in the new German states are clearly evident in the emission data. Between 1989 and 1994 carbon dioxide emissions fell by almost half. Unlike in the Federal Republic of Germany, where emissions initially remained unwaveringly high.

The main reasons for the lower emissions was less lignite being burned in power stations and heating systems which were being speedily modernised.

The total emissions from reunified Germany have fallen by over 35 percent since 1990. Above all, major successes were achieved in the energy sector even though the economy grew remarkably right after reunification. Meanwhile, the energy-related emissions are on a strong abatement path, although the problem child continues to be the transport sector.

Lignite – the East German energy supplier

The GDR economy was essentially based on lignite as the most important domestic source of energy. Lignite has the highest specific CO_2 emissions of all commonly used fossil fuels found in quantity. In the new German states after reunification, much less coal was mined and also less was burned. The sharpest decline was recorded between 1990 and 1998. By 2002, emissions from lignite combustion rose again slightly as some power plants that were previously shut down were replaced by new ones.

Lignite was the only source of energy that was adequately available in the GDR and did not need to be imported. Lignite from the Central German lignite mining district near Leipzig/ Halle had a higher heat value than most of the other coal-mining districts[4], although its sulphur content of up to three percent is comparatively high. Sulphurous lignite from domestic coal-mining districts also contributed substantially to the high sulphur dioxide emissions from power stations and private households and explains the high sulphur dioxide concentrations in the GDR (see also the ‘Industrial fog and smog alerts’ chapter).

In the only remaining West German mining district (Rhineland), the amount of coal mined has decreased only in recent years. The phasing-out of coal recently agreed upon will cover all coal-mining districts as a joint German project. Hard coal, with specific CO_2 emissions lower than that of lignite, was only mined in West Germany. Its mining was completely discontinued in 2019.

4 Lignite was and still is excavated in open cast mines today and used extensively in Germany. There are still three active lignite districts: the Rhenish coal-mining district, the Central German coal-mining district near Halle / Leipzig and the Lusatian mining region near Cottbus.

EINE FRAU SCHAUFELT BRAUNKOHLEBRIKETTS IN DEN KELLER, BITTERFELD 1989

The coal stove as a heat source

In the year of reunification, the heating of buildings in both East and West, and hence also the greenhouse gas emissions in these areas, were very different. In the new German states, lignite briquettes were burned in individual coal stoves on a large scale. There were also extensive district heating networks. On the other hand, oil and gas central heating systems dominated in the western German states. In the GDR, the large-scale use of briquettes also led to heavy air pollution (see the 'Industrial fog and smog alerts' chapter) as well as to particularly high CO_2 emissions.

In the course of reunification, most small-scale combustion installations in the new German states were quickly modernised so that air quality improved significantly and greenhouse gas emissions also fell. Changes in the fuel mix were already clearly apparent in 1994 as a reduction in emissions. In reunified Germany there was a move from oil to gas, which also led to a reduction in CO_2 emissions.

The gas supply in the GDR was based on town gas in many places. This was essentially manufactured from lignite. In the early nineties, the gas supply in the new German states was converted to natural gas, but natural gas is significantly richer in methane. Since the gas distribution network from Plauen to Rostock was partially in disrepair, methane emissions increased. The pipes were however quickly modernised, and thus gas emissions more than halved in the past 30 years despite a simultaneous massive network expansion (over 70 percent growth).

En route on two wheels

There is unfortunately no accurate emission data on transport divided up between East and West. The differences in the vehicles used were however enormous. In 1989 there were in the GDR only about half as many cars per 1,000 residents as in the FRG (235 compared to 479). No wonder, since the waiting periods for Trabant and Co. were legendarily long. This is why many GDR citizens switched to mopeds and motorcycles. Compared to the FRG, there were 163 Schwalbe and other two-wheelers per 1,000 residents, and thereby more than seven times as many as in the FRG. Above all, the two-wheelers were popular among young adults and commuters. After 1990, access to owning a car for citizens of the former GDR was then, above all, a question of disposable income, which is why that even today in the east of Germany, there are on average still fewer cars on the road than in the west. Transport with respect to all of Germany is the problem child in climate protection. Emissions lie at roughly the level of 1990. More cars overall and significantly increased performance have all but eroded the gains in engine efficiency.

CARS / 1000 RESIDENTS (1989)

GDR **235**

FEDERAL REPUBLIC OF GERMANY **479**

MOTORISED TWO-WHEELERS

GDR **163**

FEDERAL REPUBLIC OF GERMANY **22**

Significantly more travel by rail was happening in the East up to 1989: in proportion to the number of inhabitants, twice as many people travelled by train in the GDR.

Figure 11

Overview of the lignite coal-mining districts

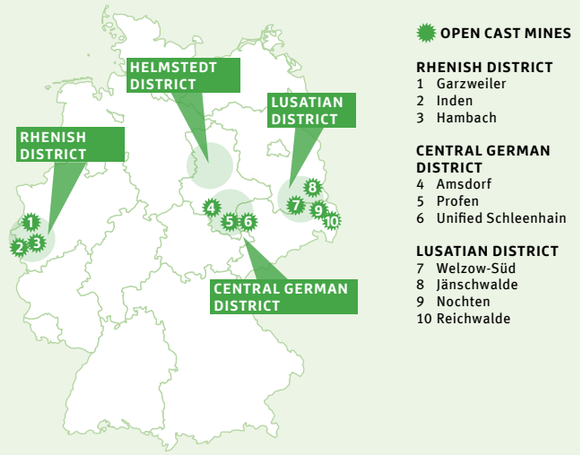


Figure 12

Greenhouse gas emissions from Germany (excluding F-gases)
Historical data for the new German states and the western German states as well as inventory data for Germany as a whole

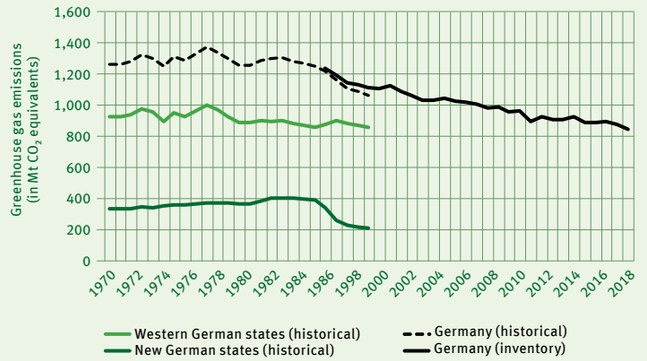
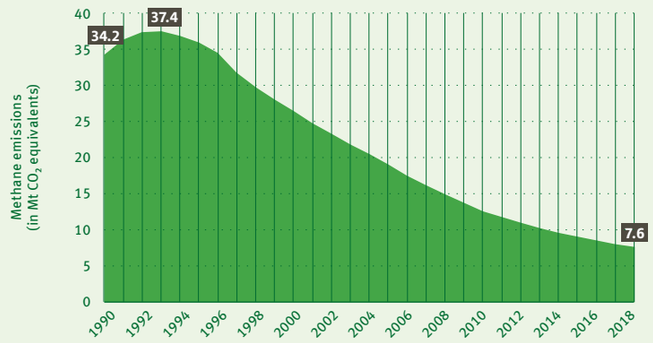


Figure 13

Methane emissions from landfill disposal in Germany
annual emissions, 1990 to 2018



ILLEGAL DUMPING SITE ON RÜGEN, 1977

Waste and wastewater

There were several thousand landfills and waste dumps in the GDR. Most of these would be considered illegal dump sites as they usually didn't even have a base liner. A wide variety of waste was deposited here such as demolition waste, household waste, ash, and also toxic industrial waste. The waste dumps polluted the soil, surface water and groundwater through polluted leachates. Methane-containing landfill gases escaped into the atmosphere in an uncontrolled way and contributed to climate change.

This situation has changed fundamentally since reunification. In the seventies, a large number of the old landfills in the FRG were closed, reclaimed or completely modernised. After German reunification, this also happened in the former GDR. Landfills that continued to be operated and newly constructed ones were equipped with base liners and systems for collecting and treating leachate and landfill gas.

Today, strict requirements apply to waste that is landfilled, and as a result, hardly any pollutants are released. Biodegradable waste is no longer allowed to be disposed of in landfills so that such waste no longer contributes to landfill gas production. As a result of these measures, methane emissions from landfills have been reduced by more than 75 % compared to 1990. Today, landfill disposal is one of the most successful sectors in reducing greenhouse gas emissions in Germany.

FORMER MINING AREA AROUND BITTERFELD BEFORE ITS REHABILITATION

THE BITTERFELD-WOLFEN INDUSTRIAL SITE

Challenges up to the present

LAKE GOITZSCHE 2018

Environmental agencies and environmentalists are still busy today with the contaminated sites of East German industry. Many large-scale industrial sites go back in their contamination history to even before the GDR existed – worldwide, contaminated sites represent a ‘dark’ legacy of industrialisation.

Today’s city of Bitterfeld-Wolfen in the administrative district of Anhalt-Bitterfeld counts among the oldest industrial sites in Germany. Sponsored by lignite mining since the beginning of the 19th century, the chemical industry started in 1893. Two large industrial sites originated on 13 km² land: the Bitterfeld chemical plant and the Wolfen film factory.

In 1989/1990, 32,000 people worked in what was then the VEB (state-owned business) Bitterfeld chemical combine and the VEB Wolfen Photochemical combine. From basic chemicals to pesticides, disinfectants, plastics, dyes, ion exchangers to technical and photographic films, around 5,000 different products were manufactured. Most installations at the time of reunification no longer conformed to the state of the art, and the susceptibility to failure constantly increased due to poor plant maintenance and a scarce supply of spare parts. Pollutants entered the soil and groundwater through leaks and disasters from installations in disrepair and landfills without liners.

Hazardous waste, chemical mixtures and industrial waste, was disposed of in surrounding depleted open cast lignite mines. Here too, soil and groundwater were contaminated in numerous places, for example through missing or inadequate liners in landfills or leaks at transfer points, leaking plant components and from pipeline networks in disrepair. When the landfills were constructed, no safety devices were provided that meet today’s requirements. Toxic wastewater was disposed of for decades together with rainwater through central combined wastewater systems and discharged largely untreated into the Mulde river through wastewater pipes, channels and ditches. There, persistent pollutants accumulated in aquatic sediments or found their way into the Elbe and the North Sea.

A sobering bottom line

Numerous investigations, expert reports and research projects point to a sobering bottom line: the soil in 1990 was contaminated on 1,300 hectares with various pollutants, and 100 million cubic metres of groundwater were contaminated. During the heyday of lignite mining in the Bitterfeld District alone, 80 million cubic metres of groundwater were pumped out in 1985 to allow open cast mining to be able to operate securely. This peak value marks the mean flow of the Elbe at the Wittenberg gauge over a time period of 60 hours – one can only imagine that decades of lignite mining that led to a serious dropping of the water table in the region.

Mining had also led to comprehensive changes in the surface waters. The river was rerouted, abandoned open-cast mining holes were left behind and new mining lakes were created. After the groundwater pumping was phased out, the remaining pits were refilled by local flooding from rising groundwater and river water.

Numerous investigations at the Bitterfeld-Wolfen site account for an enormous abundance of different pollutants in soil and groundwater. Almost all chemicals commonly used in the chemical industry were found.

Discovered in Bitterfeld-Wolfen (1990)

- phosphorus (yellow), phosphorus chlorides, phosphorus pentasulphide,
- tricresyl phosphate, triphenyl phosphate,
- dioxins / furans,
- organotin compounds (wood preservatives), tin tetrachloride,
- molten chlorophenols,
- CVOC (carbon tetrachloride, tri- and perchloroethylene, tetra-, penta- and hexachloroethane),
- chlorinated aromatic compounds (mono- and dichlorobenzene),
- HCH isomers, HCH defective batches,
- pesticides (lindane, chloral, Bi 58),
- cyanide compounds,
- carbon disulphide,
- acid resins, sulphuric acid, inorganic acids and alkalis.

SILVER LAKE, 1996

GOITZSCHE OPEN CAST LIGNITE MINING AREA, 1993

This is exceptional in this form, even in comparison to other industrial sites, and makes restoration much more difficult. Cleaning that volume of groundwater is therefore almost impossible due to the disproportionate effort involved. For this reason, the contaminated groundwater must be secured by technical measures on site.

Megaprojects for an environmental change

The democratic movement and the fall of the Berlin Wall put the debate about 'environmental sins' and their rapid clean-up in the Bitterfeld-Wolfen area on the agenda. Following German reunification the Federal Republic of Germany, together with the new states (Länder), became the legal successor to the GDR and was therefore obliged to remediate the contaminated sites. This was an enormous environmental and economic task, which initially was a tremendous hinderance to economic development in the region. In order to promote investment on contaminated industrial sites in the region covered by the Treuhandanstalt (Privatisation Agency) and to maintain or create new jobs. The Federal Government and the new Länder agreed in 1992 on jointly financing these tasks. 21 so called mega projects were initiated, including 'Bitterfeld-Wolfen Chemistry AG' and 'Wolfen film factory'. This marked the launch of an unprecedented environmental remediation programme for the new states (Länder), which also introduced environmental change for Bitterfeld-Wolfen.

Intensive, expensive and lengthy investigations of the contaminated site situation determined the extent of and danger posed by soil and groundwater pollution in the Bitterfeld area. The remediation concept then had to be based on technically feasible remediation methods and financial framework conditions. This, and complying with the risk-based approach of the soil protection laws concerning remediation of contaminated sites, prevented the original condition of the soil and groundwater from being restored. The area affected covered about 48 square kilometres including a wide range of pollutants down to a depth of 30 metres. The aim set was therefore to limit the spread of the pollutants and to effectively protect the Mulde floodplain and the adjacent water bodies, the residents of Bitterfeld-Wolfen and the groundwater needed for drinking water production. Another goal was to protect previously clean groundwater from being contaminated and prevent contaminated groundwater from entering the Mulde, other water bodies or wells in adjacent municipalities. Even today, a number of technical measures still need to be maintained to meet these requirements.

The most important measure is the prevention of groundwater damage. Any change in water levels of water bodies and groundwater can endanger this status. Therefore, a comprehensive monitoring system and a regulatory option are required. The latter can be achieved by using groundwater wells arranged in a line and equipped with powerful groundwater pumps. The wells act as a barrier: they stop the spread of pollutants and ensure vulnerable areas are safeguarded. A further component in this system is groundwater rise following mining which, over decades, has massively influenced the regional groundwater system in the immediate vicinity regarding groundwater flow direction, velocity and quality. Changes in groundwater status and altered reaction conditions in the subsoil can also unbalance the contaminated site situation in Bitterfeld-Wolfen, transfer pollutants and exacerbate groundwater damage.

From Silver Lake to a swimming beach

Every year, around 2 to 2.7 million cubic metres of contaminated groundwater are pumped to the surface in Bitterfeld. They are treated by various reactive and extractive procedures, modules and filters and then cleaned before being discharged into the Mulde. Since 1994, this amounts to 39 million cubic metres of water. In addition, 1.1 million cubic metres of soil, mostly from polluted sources, have been remediated or disposed of and thus an area of 300,000 square metres made available for a predominantly industrial and commercial use in the 'Chemistry Park'. To date, 332 million euros have been spent on remediation measures and accompanying research projects in Bitterfeld-Wolfen.

A large number of facilities and plots of land have been privatised at the site since 1990. Today's Bitterfeld-Wolfen Chemistry Park Ltd., as the company responsible for the site, provides central services such as water supply and disposal or the provision of the pipe bridge network. More than 300 companies from small and medium-sized enterprises to large corporations are working in the Chemistry Park. This is how Bitterfeld-Wolfen has developed from an environmental disaster to a showpiece site: a shining example of complex remediation at a mega-site and successful land recycling for the resettlement of industry. The black image of Bitterfeld has transformed despite remaining but manageable residual pollution in soil and groundwater. After the environmental transition, Bitterfeld today stands for a modern, future-focussed chemical site – with Lake Goitzsche providing an attractive local recreation area right on its doorstep.

LAKE GOITZSCHE 2018

ENVIRONMENTAL GROUPS
IN THE GDR

From an environmental to a democratic movement

Schwerin 1980: two dozen young people from the town and surrounding villages sit in a meeting room in the church. Jörn Mothes, an 18-year-old with a full beard, leads the discussion. It is about an action next morning. He talks about air pollution, industrial agriculture, acid rain and the consequences of lignite mining in the GDR.

In a dreary prefabricated concrete slab district of Schwerin, they just want to plant trees after the information evening. This alone is a subversive action in the GDR – there is something conspiratorial about the meeting in the parish hall cellar. The people involved are certainly taking a risk, they are being monitored by the secret service (as the files will show ten years later), even if they cooperate well with the state-owned company 'VEB Green Spaces'.

The idea is spreading and soon there are tree planting campaigns in many places throughout the GDR. On the occasion of the annual UN Environment Day in June, some of them dare to stage bicycle demonstrations– initially without banners or posters – under the motto: 'Mobile without a car'. In 1982, Carlo Jordan of Berlin organised a ride through East Berlin's city centre, even along the Unter den Linden (Under the lime trees) boulevard. This unsettled the Stasi secret police, which reported to the SED (communist party): 'This may be a demonstrative act by so-called environmentalists. Many people had an unkempt appearance. They were most likely GDR citizens because their bicycles were GDR products'.

The GDR secret service quickly classified the bearded men with long hair and green parkas and the women with self-dyed scarfs around their necks as 'hostile-negative persons'. But such successful actions enabled the environmental groups to grow astonishingly fast, establishing solid structures and developing into a political youth movement across the republic. The number of participants in the bicycle demonstrations rose steadily, people soon openly wore breathing masks or mouth coverings, carried posters and balloons and were barely intimidated by controls and interrogations. The main demand was: a public environmental discussion and the disclosure of measured values and facts.

Soon uranium mining, nuclear power, agriculture or toxic waste dumps came under criticism, including the Schönberg landfill where the West dumped its waste against payments in hard deutschmark. From 1986 onwards, environmental libraries were founded in a number of places providing access to prohibited specialist literature from the West and to their own underground publications. This led to a new political quality of the environmental groups' work and their events and exhibitions became important venues. There were uncontrolled cafés and meeting rooms for seminars, presentations, film screenings or concerts in East Berlin and Leipzig. Secret printing facilities without censorship became very important. The 'Umweltblätter' (Environmental Pages) from East Berlin, 'Streiflichter' (Spotlights) from Leipzig or 'Briefe' (Letters) from Wittenberg went from hand to hand, worn out by reading. Environmental libraries increasingly became a central information and meeting place for opposition members throughout the country. In this way independent environmental, peace, women's, gay, artist and political groups were able to exchange experiences, connect with

THREE QUESTIONS TO ULRICH NEUMANN, ONE OF THE FOUNDERS OF THE GREEN GDR NETWORK 'ARCHE' (ARK)

Environmental groups have existed in the GDR for a long time. Why do you now need the 'Arche' green network?
Previous groups have mostly worked only locally but in recent years the environmental problems in the GDR have become more acute. Dying forests in the south, pollution of rivers such as the Elbe, Werra, Saale and Mulde. The environmental groups have worked on their local problems in isolation. However, the idea of creating a common platform or a common umbrella has long existed in the GDR environmental movement. This is what the 'Arche' tries to do by bringing the groups together to exchange information, organise joint seminars and training courses and to undertake joint actions.

How does this work in practice?
Everyone realises the environmental problems in their region, but reliable data has been in short supply until now. All groups have constantly been trying to find sources, whether experts, scientists or local authorities, to publish the facts, e.g. using opportunities at events, which has previously only been possible in church rooms.

What other possibilities does 'Arche' have to reach people in the GDR?
The publication of a hectographed information leaflet, the 'Arche Nova' (New Ark). This is a forum for ecological design in environment and society. It deals with the GDR's environmental problems. The 'Arche Nova' is distributed by us through the various contact points of the green network and church environmental libraries.

The questions were asked by Peter Wensierski (in February 1988)

Source: “Nothing grows from top to bottom – environmental destruction and protest in the GDR”, Fischer 1986

A GDR resident describes his life in an industrial region of the GDR in 1975. The man had come with his family to Mölbis, a town of 500 inhabitants south of Leipzig, in the middle of the lignite mining area in the immediate vicinity of coal-processing industrial plants in Espenhain:

“The future has already begun in Mölbis: this year the apple trees lost their leaves around 26 May. There is no parsley anymore, it is all white and most leafy plants only have rolled up leaves. There are hardly any trees left in Mölbis, and if one goes out in the morning and opens the front door, one gets dirty hands if they hadn’t already got dirty inside the flat because the air is dirty.

The air is so dirty that if one removes a piece of paper from a desk, a black border all around where it was laying remains. This does not happen just occasionally! If one walks in front of the front door, one leaves traces on the doorstep some days because one walked through soot which is very thick. People from Mölbis say: It has ‘dirted’. One can sweep the dirt away. Some people say: water helps against dirt. But if there are flowers and one has to wash them before putting them in a vase and then they collapse, that’s really bad. The dirt sometimes is so dense in the air that one must drive with one’s headlights on during the day and one can’t see next door.

But the worst thing is the gas, not the dirt. When one goes to bed in the evening on a hot day and thinks, I can now relax and it’ll be nice, and one opens the windows to let in fresh air – one can’t do that in Mölbis because the gas comes in. Heat and gas – it’s hard to sleep. Often people who come visiting must leave prematurely. Some throw up, some have terrible headaches. The best thing to do is to get drunk in the evening and then one will definitely fall asleep. This is what Mölbisians do.”

each other and try out a new liberal culture in society even before the GDR collapsed. Infiltrated informers and harassment by the Stasi (secret police) were unable to prevent this.

In 1988, after three days of discussion, grassroots groups joined together nationwide in a green network called ‘Arche’ (Ark). More illegal printing presses and even video technology were (laboriously) acquired. This enabled the production of films about the worst environmental damage in the GDR, e.g. in the Bitterfeld area. The overcrowded pig-fattening facilities in Haßleben, the radioactive waste heaps of the uranium mining area in the south of the GDR and the nuclear power station under construction in Stendal were also filmed.

Underground films managed to break media censorship. Thematically, the TV footage of West German television watched in East and West shows a development from purely environmental topics (e.g. ‘Bitter things from Bitterfeld’, ‘Uranium mining’) to political-oppositional themes (‘Elections in the GDR’, ‘Press censorship’, ‘What does the opposition want?’, ‘Old towns’ collapse’, ‘Democracy now’). The debates in the environmental groups developed in a similar way, their members were increasingly working in political groups. Video film makers from the Berlin Environmental Library eventually managed to publish films about the largest and most decisive demonstration in Leipzig on 9 October 1989 worldwide thus contributing to the GDR’s final collapse.

The ‘Arche Nova’ (New Ark) underground leaflet became a competent specialist information medium. The activists realised that the GDR’s environmental problems could only be solved through democratisation and by opening up, with freedom of the press, information and opinion, with international exchange across the borders. Thus, many members of the environmental groups joined the ranks of the democratic movement, e.g. the ‘New Forum’ or ‘Democracy Now’ which later became the ‘Bündnis 90 / Die Grünen’ (Alliance 90 / The Greens) political party.

Many activists of the early eco-movement are still active in politics, parliaments, committees and democratic institutions

In autumn 1989, the activities of the GDR’s independent environmentalists led to the founding of a separate ‘Green Party’, whose representative Carlo Jordan finally sat at the GDR Round Table after the fall of the Berlin Wall and, after a decade of grassroots effort, was finally able to influence environmental policy ‘from the top’.

Many activists of the early eco-movement are still active in politics, parliaments, committees and democratic institutions. Nico Voss, for example, once co-founder of the Leipzig Environmental Group at the age of 18, is now state secretary in Mecklenburg-Western Pomerania. Or Jörn Mothes, the Schwerin tree planter. He too sat at the Round Table of the Volkskammer (GDR legislature) – today he is the chairman of the advisory board of the Federal Commissioner for Stasi Files.

The German Environment Agency

The German Environment Agency's site used to be a busy industrial park at the beginning of the 20th century.

LAND RECLAMATION IN DESSAU

From Gas Quarter to Green Showpiece Architecture

Following reunification, the Federal Government decided to move federal institutions to the new states (Länder).

In 1992 the Federalism Commission of the German Bundestag (Parliament) proposed to move the German Environment Agency to Saxony-Anhalt. When Dessau was chosen as the location in 1996, it was clear that a large area of urban industrial brownfield was to be ‘recycled’ to keep land-take and thus the building’s environmental footprint as small as possible. In 1997 the decision was made in favour of the former Gas Quarter, located directly next to the main railway station and close to the rails.

The first German technology park was opened here in 1855. Later, the products of Hugo Junkers were manufactured on the site which is commemorated today by a monument at the entrance to Dessau. Junkers produced gas engines, bath stoves and later also aircraft. Dessau was an ultra-modern industrial town – before it was largely destroyed in World War Two.

The district by the railway was rebuilt after 1945. But the last operating facilities were closed down in 1991. Weeds overgrew the area, under which enormous contaminated sites lay: tar oils, volatile hydrocarbons, heavy metals.

“The whole area is a single contaminated site” said Kurt Schmidt, the then Vice-President of the German Environment Agency, to the SPIEGEL magazine. A lot had already been done before UBA was built on the site. The Association for the Promotion of the Dessau-Wörlitz Museum Railway took care of the brownfield. An old engine shed had been torn down and underground waste oil storage facilities were disposed of. The town demolished almost all old buildings in 1995.

Before the start of construction work, a further ‘major clean-up’ was necessary. The analyses and expert reports from 1996 and 1997 had revealed a profound need for action. Extensive earthworks were carried out and the construction site had to be dug up to 3.50 metres deep in some places. In other areas the soil had to be disposed of as hazardous waste. The groundwater was also contaminated and was cleaned using natural processes by 2008. In 2001, costs of around €2,425,000 incurred for the preparation of the 27,373 square metres of industrial brownfield, with disposal costs accounting for around €443,000.

But earth replacements also offered an opportunity. One of the world’s largest geothermal heat exchangers was built in four fields around the new building. The pipe system is five kilometres long in total and is used regeneratively and sustainably to pre-condition the outside air for the building’s ventilation systems. The building is modern and aesthetic but ecological and energy-saving at the same time. The building materials used are environmentally friendly and safe for health. They have been selected according to strict criteria and tested for the release of harmful substances. Additional energy is generated via photovoltaic and solar thermal systems. Energy requirements and energy consumption have been significantly reduced through an air-tight and highly heat-insulated façade and efficient heat recovery. Energy consumption values in practical operation turned out to be below the target.

The ecological model construction on contaminated land has proved an exemplary recultivation of an industrial brownfield. In Dessau-Roßlau, UBA has set new standards for environmentally friendly and energy-saving construction and proved that these are not only applicable in theory but also feasible in practice. A certification system (BNB) developed also based on this building now recommends the application of the basic principles of sustainable construction for other federal buildings.

Thomas Voigt, how long have you been employed by UBA?
Since 14 February 1991, when UBA became the legal successor to the Institute for Water Management / Centre for Environmental Design after reunification.

What was your experience of this?
I personally have fond memories of this. I became a staff member of the then newly founded 'Protection of the Earth's Atmosphere' section in the Air and Climate Department. I and other colleagues were welcomed there very openly. Everyone was interested in our experience, our training, and also in our way of life. We quickly became fully fledged colleagues. Soon we organised private trips to states (Länder) unknown to our old UBA colleagues including our families. We jokingly called these brigade trips.

But you were also able to help with your professional competence?
Of course, and that was very exciting. I had worked on remote sensing at the Institute of Water Management. In other words, I evaluated aerial photographs of the Baltic Sea and analysed the sand movements that changed due to structures such as breakwaters off the coast. That was a great job, not least because one could go on business trips to the Baltic Sea, and unlike other colleagues in environmental science, the topic was less subject to secrecy. Others had a much harder time with their investigations.

How were you then able to convey this knowledge to UBA?
When I started working at UBA, I basically changed the theme. Previously water management, now climate protection. The reason was my participation in a study course run by the United Nations Environment Programme (UNEP) in 1991 where I first met this topic. It became clear to me that this topic would become one of the biggest challenges of the future. This was what I wanted to work on. In concrete terms, I continued with remote sensing right from the start and analysed satellite images of burning oil wells in Kuwait. This is how I ended up in the USA for the first time. There was a conference on these oil fields in Boulder / Colorado. Even later I travelled an incredible amount around the world – there were no video conferences yet, so one had to travel everywhere. Unfortunately, mostly by plane, I must admit.

And what happened to your work on climate change?
I was first appointed reporter for UBA in the Enquete Commission on 'Protecting the Earth's Atmosphere' of the 12th German Bundestag. It was a novelty that a parliament was already dealing with the climate issue for years at that time. I attended at least 200 sessions to which federal ministers were invited, including Waigel, Kiechle and Töpfer. The latter was always very well informed, by the way. In general, it was a great experience to work in the Commission, the interaction between ministers, scientists and members of the Bundestag was open and collegial. And the open and direct questioning of ministers by members of the Bundestag was of course an experience for the colleagues who joined the Commission, especially at the beginning. Later, I mainly dealt with the scientific fundamentals of climate change. Especially exciting was the period from 2000 to 2010, when I worked in the European Topic Centre on Air and Climate Change for the European Environment Agency in Copenhagen.

Dr. Thomas Voigt studied physics at the Dresden Technical University. He earned his PhD for his work on the use of remote sensing in the observation of coastal dynamic processes in 1991. Thomas Voigt is a staff member of the 'International Climate Protection' section and will retire in 2021.

Ute Dauert, to you home tastes like sulphuric acid. Why?
That's because of the chemical plant where I grew up and because of our coal-fired heating systems at the time. I grew up in Coswig / Anhalt, about 20 kilometres from Dessau where the German Environment Agency is situated today. Concrete and fertiliser were produced on the western edge of the town and the smell of the industrial plant was often all over the place.

"I associate the warm summers at our beautiful swimming lake with the smell of rotten eggs."

This does not sound appealing.
No, objectively speaking, it certainly does not. But that's the way it is with smells, they revive old memories. I went to the kindergarten run by the chemical plant at that time. I associate the warm summers on our beautiful swimming lake with the smell of rotten eggs and an often slightly furry tongue. Still, it was a great time for me.

What other effects did the chemical plant have?
It was the biggest employer in the town. About 2,000 people worked there. But many people from Coswig also went to Piesteritz, the next, even bigger chemical plant, or to Dessau and even Bitterfeld and Wolfen. That was of course a bit further, but there were many jobs there. Whenever we went there by train – my family didn't have a car – we always closed the windows in the carriage. What came in was really biting, it smelled terrible. But not only did the air smell, you actually saw how dirty it was. My mother wiped the windowsills every day, they were really black. It was particularly bad in winter when smoke and ash from coal-fired heating was added to the industrial fumes. The stove of the coal-fired central heating for the four-party house where we lived stood in our flat in the hallway. My father used to burn lignite and coke. He removed the slag from the ash pan every morning. That was certainly not healthy.

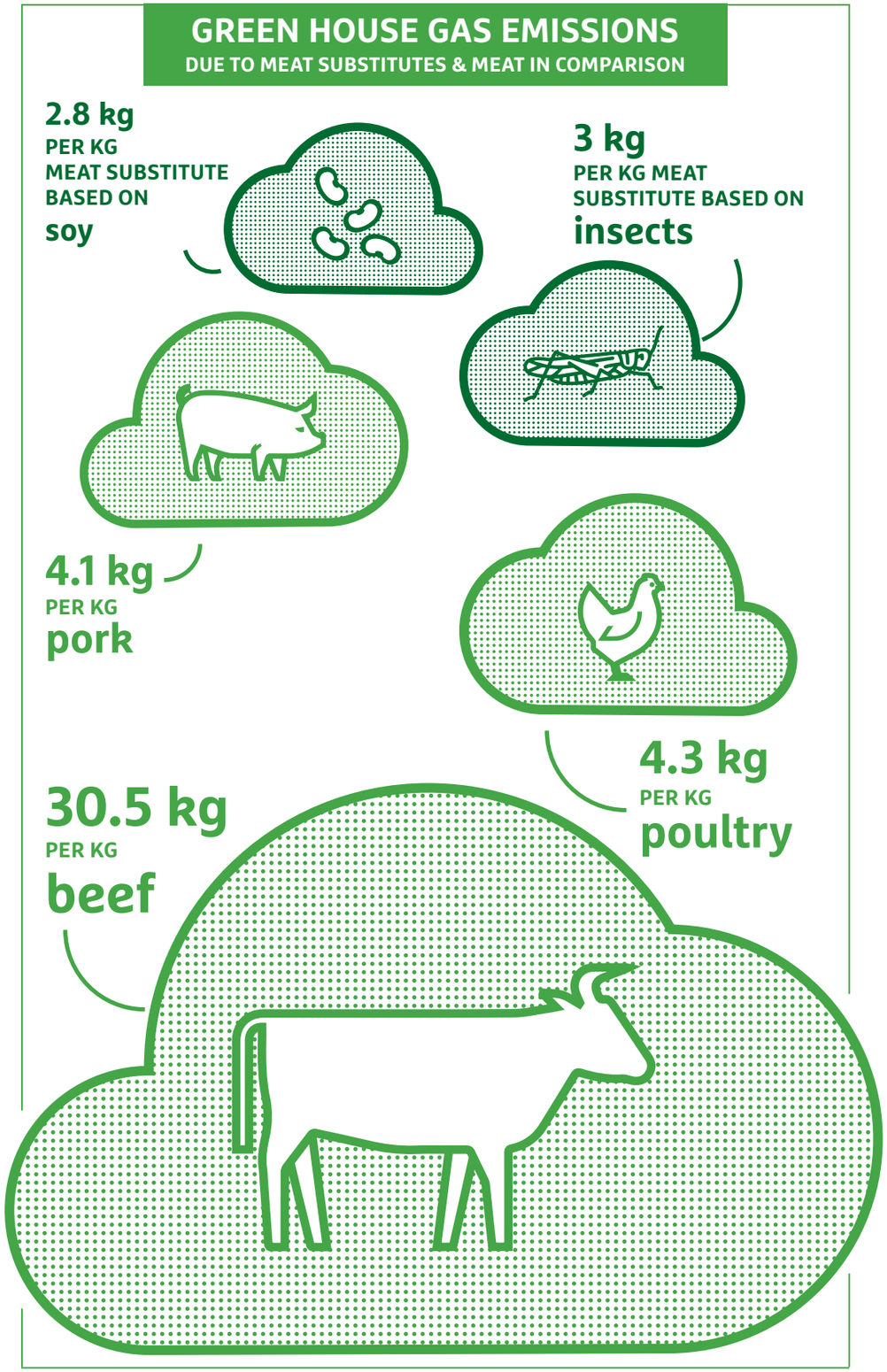
You are still dealing with air quality today.
Yes, I started it at university. I studied meteorology in Berlin. We planned an event on air and climate on the fringes of the Pentecost Meeting. We wanted to have measurement data for this. But we were unable to get it, not even our professor. The data was top secret and locked away.

But now you have it.
We have finally processed it. That needed quite an effort, the data was available in a coding unknown to us and also the description to the stations and their coordinates could not be used 1:1. A colleague of ours did a lot of research and programming to make the data usable for us. Now we finally have the measurement data of the GDR air measurement stations in our database. But the work does not stop there, we are still checking the quality of the data. The highest values, for example, show 4,999 micrograms per cubic metre ($\mu g/m^3$), for sulphur dioxide for example: an incredibly high value. Maybe that's when the measuring device stopped measuring or that was actually the maximum, we don't yet know. Today it is below 10 $\mu g/m^3$.

Ute Dauert graduated as a meteorologist in Berlin. After her studies she first worked at the aviation weather station at the Berlin Schönefeld Airport. She joined UBA after German reunification and she is head of the 'Air Quality Assessment' section today.

ENVIRONMENTAL DATA

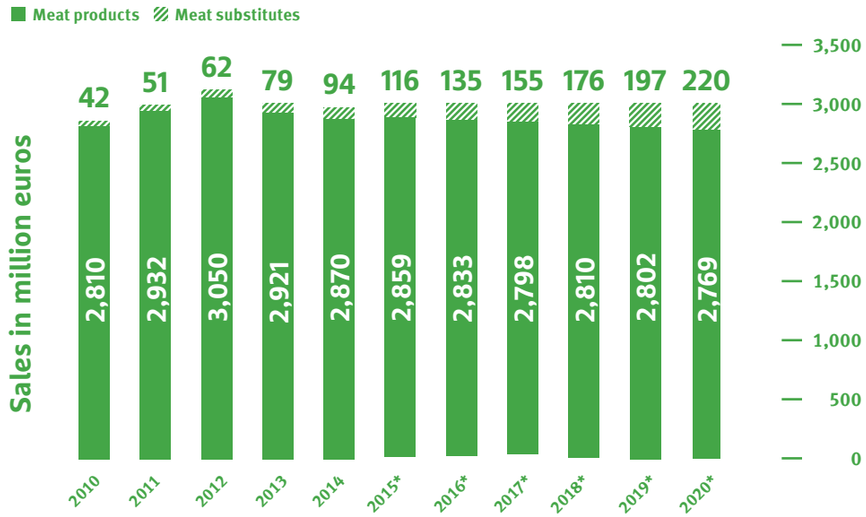
GREEN HOUSE GAS EMISSIONS
DUE TO MEAT SUBSTITUTES & MEAT IN COMPARISON



60 kg
meat consumption
in Germany
per capita and year

EAT Lancet Commission:
a maximum of
15 kg
would be healthy
and sustainable

Meat products and substitutes sales trend in Germany



*Forecast from 2015

0.5 – 0.6 %
was the estimated market
share of meat substitutes
on the world's overall meat
market in 2017

Germany's share
is about
6%

Publications as PDF:
https://www.umweltbundesamt.de/en/publikationen/what-matters-2-2020-30-years-german-unity

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