AIR QUALITY 2012

- Preliminary Analysis -

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Amt
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Imprint

Published by:	German Federal Environment Agency (UBA) Press Office Wörlitzer Platz 1 06844 Dessau-Roßlau Germany
E-Mail:	pressestelle@uba.de
Internet:	www.umweltbundesamt.de
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Issue date:	17/01/2013
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Cover photo:	© Bruno Neininger / www.metair.ch

CONTENT

I Preliminary analysis of the air pollution situation in Germany

The Federal Environment Agency is presenting a first analysis of the air pollution situation in Germany of the year 2012 (as per 17/01/2013) compared to previous years. The analysis is based on preliminary, not finally validated data from the monitoring networks of the Länder (German federal states) and the Federal Environment Agency. Due to comprehensive quality assurance activities in the monitoring networks of the Länder and the Federal Environment Agency, finally validated data will only be available in the first half of the current year. It may therefore be that the numbers will change. A comparison of the previous years' preliminary analysis with the respective final analysis shows that the pollution situation is at least not overrated and that the preliminary data thus enable a general evaluation of the situation in the past year. The analysis focuses on the assessment of the pollution situation of particulate matter (PM_{10}), nitrogen dioxide (NO_2) and ozone, which still show exceedances of the applicable limit and target values for the protection of human health.

II Abstract

The limit values for nitrogen dioxide (NO_2) adopted as early as in 1999 had to be met since 1/1/2010: Annual mean concentrations must not exceed 40 µg/m^3, and hourly values over 200 µg/m^3 are not allowed more than 18 times in a calendar year. In 2012, the annual mean concentrations of NO_2 were above 40 µg/m^3 at about 52 percent of the measuring stations classified as "urban traffic". If the still missing data from measurements using the diffusive sampling method are included, this percentage will increase to about 65 percent based on the experience from previous years. At some measuring stations of type urban traffic (about 3 percent), hourly NO_2 values over 200 µg/m^3 occurred more often than 18 times. Nitrogen dioxide pollution in 2012 was generally similar to that in previous years.

Daily mean concentrations of PM_{10} above 50 µg/m^3 were measured on more than 35 days at about 4 percent of all measuring stations, i.e. exceedances of the PM_{10} limit value still occur.

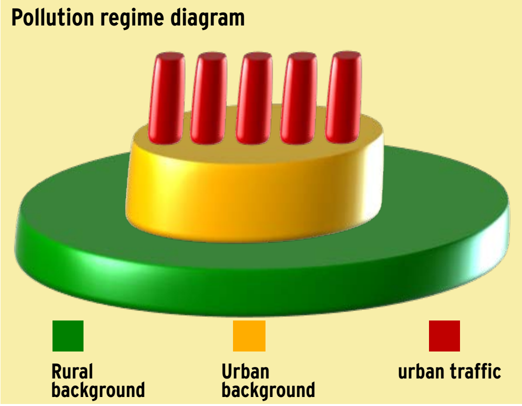
PM_{10} concentrations in 2012 were on average clearly below the levels of the past three years.

There were no pronounced episodes of high ozone pollution peaks in the summer of 2012. However, ozone concentrations did exceed the target value for the protection of human health at about 10 percent of the measuring stations. The maximum daily eight-hour mean may not exceed 120 µg/m^3 on more than 25 days per calendar year, averaged over three years.

III Causes of air pollution

The causes of air pollution are, first of all, emissions from road traffic and from combustion processes in industrial plants, power generation and households, but these vary from year to year depending amongst others on the economic situation. In addition, emissions from agriculture contribute to the concentration of particulate matter. The level of pollution is also influenced by weather conditions in the respective year. For example, high pressure weather conditions in the winter at very low air temperatures result in increased emissions due to heating. If these conditions are also characterized by low wind speeds and limited vertical air mass exchange, pollutants accumulate in the lowest layer of the atmosphere. On the other hand, weather conditions with high wind speeds and good mixing reduce air pollution. It is primarily these various meteorological conditions that cause inter-annual variation in air pollution.

IV Pollution regimes



The following sections pool the concentration values collected at each air quality measuring station in such a way that they characterize specific pollution regimes. The "rural background" regime represents regions in which air quality is largely uninfluenced by local emissions. Stations in this regime thus represent pollution at a regional level, also termed regional background. The "urban background" regime is characteristic for areas in which measured pollutant concentrations can be regarded as typical of air quality in cities. It characterizes the pollution that arises from urban emissions (road traffic, domestic heating, etc.) and the regional background. "Urban traffic" regime stations are typically found on roads with heavy traffic. The result is a cumulative contribution to urban background pollution that arises from direct emissions of road traffic. The graph gives a schematic view of the contributions made by each pollution regime.

V Particulate matter (PM_{10})

1. Daily mean PM_{10} concentrations

Daily mean concentrations over 50 µg/m³, thus exceeding the limit value, were measured at about 4 percent of all measuring stations on more than 35 days. Except for two stations near industrial processes, those measuring stations are located near road traffic. The front runner with the highest number of days on which values are exceeded is once again the Stuttgart-Neckartor measuring station. It is apparent from Figure 1 that non-compliance with this limit value was and is almost exclusively a problem at urban traffic measuring stations (red bars).

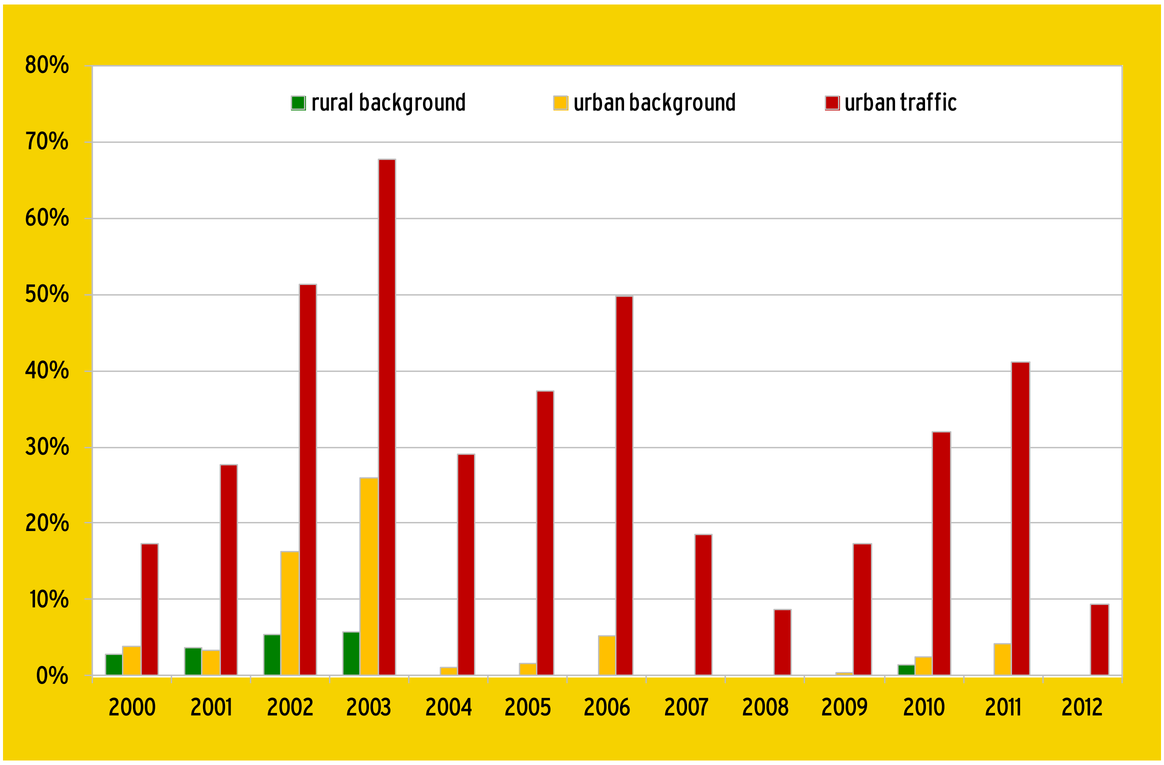


Figure 1: Percentage of stations in the respective categories "rural background", "urban background", and "urban traffic" that exceeded daily mean PM_{10} concentrations in the period from 2000 to 2012.

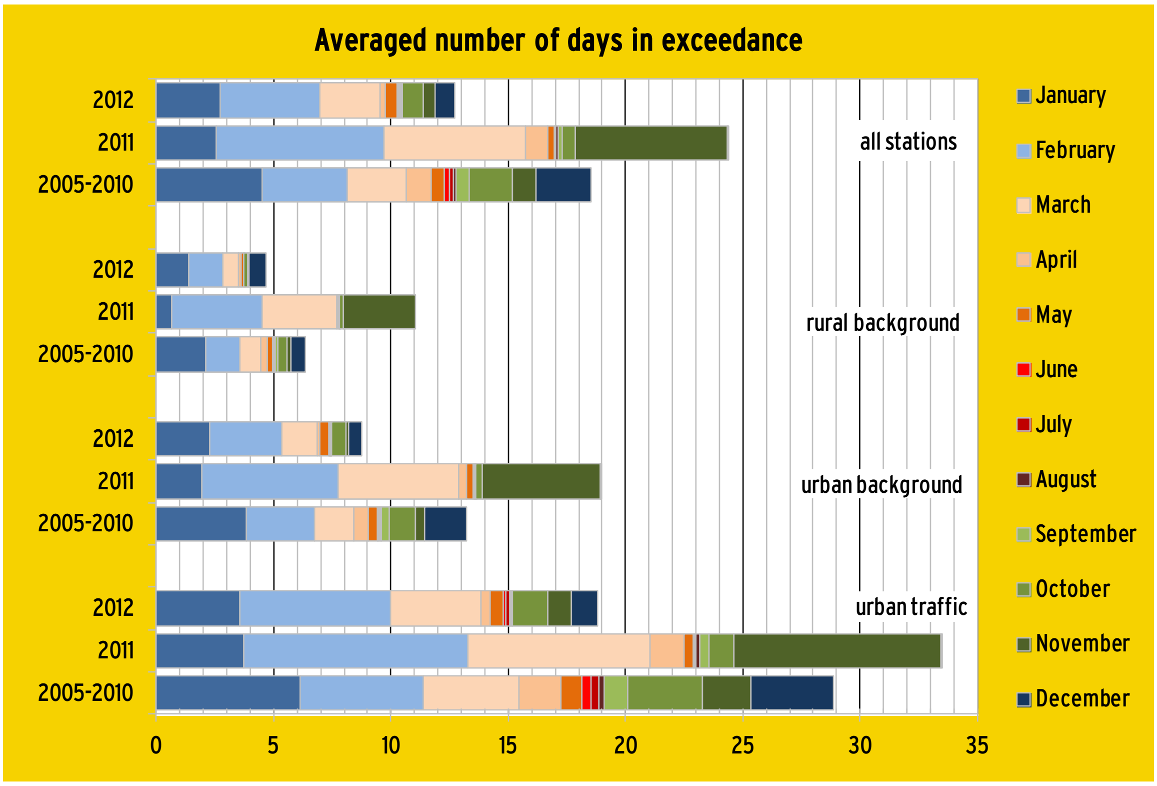


Figure 2: Average number of daily mean PM_{10} concentrations > 50 µg/m³

Figure 2 shows how many days in exceedance were registered on average per month. Since the occurrence of exceedances was particularly high in the previous year due to frequent cold, stable high pressure weather conditions, the years 2011 and 2012 were individually compared to a comparison period (2005 to 2010). It is apparent that more days in exceedance were counted as early as in March of high-pollution year 2011 than occurred in the entire year 2012.

2. Annual mean PM_{10} concentrations

The PM_{10} annual mean limit value of 40 µg/m³ was met all over Germany in 2012. Values were exceeded sporadically at urban traffic measuring stations in the past few years. Extreme weather conditions, like those that were observed in the spring and autumn of 2011, did not occur this year. Therefore the annual mean PM_{10} concentrations are clearly below the level of the past three years. Overall, air pollution by particulate matter was among the lowest of all in 2012 (Figure 3).

The large-scale reductions in PM_{10} emissions are accompanied by a slight drop in annual mean PM_{10} concentrations in all pollution regimes over the entire period under review from 2000 to 2012. But the curve is characterized by strong inter-annual fluctuations, primarily caused by varying weather conditions.

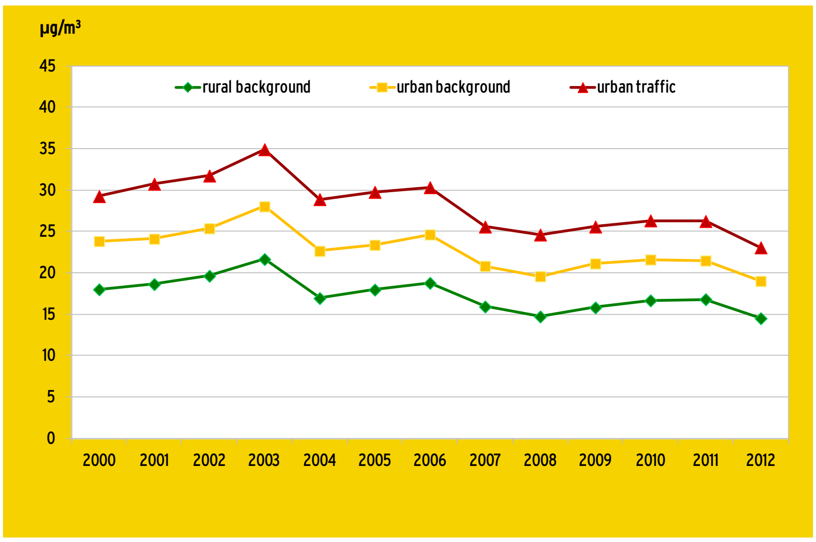


Figure 3: Trend in annual mean PM_{10} concentrations based on the average of measuring stations in the pollution regimes “rural background“, “urban background“ and “urban traffic“ in the period from 2000 to 2012 (stations that have measured for at least 9 years).

VI Nitrogen dioxide (NO_2)

1. Annual mean NO_2 concentrations

NO_2 concentration levels are to a large extent determined by local sources – in particular by traffic in agglomerations. Inter-annual fluctuations of annual mean NO_2 concentrations are low. In rural regions remote from emission sources, measuring stations registered annual mean NO_2 concentrations at about the same level around 10 µg/m³ for the entire period under review of 2000 to 2012 (Figure 4, green curve).

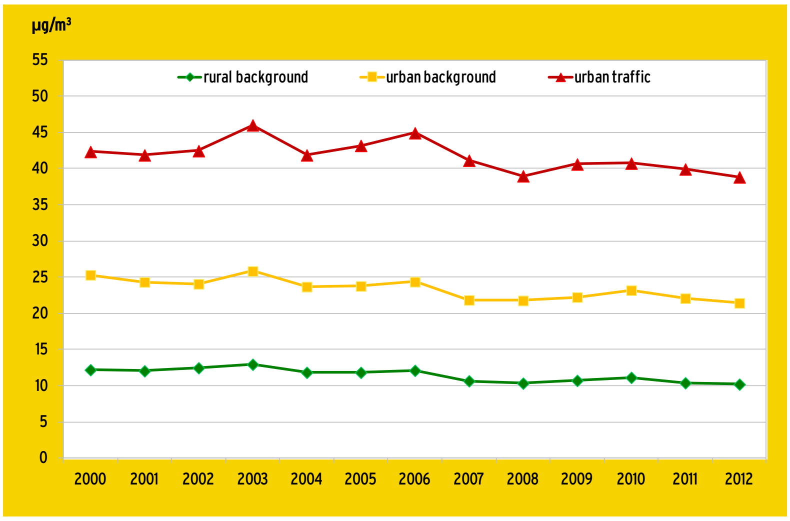


Figure 4: Trend in annual mean NO_2 concentrations based on the average of measuring stations in the pollution regimes “rural background“, “urban background“, and “urban traffic“ in the period from 2000 to 2012 (stations that have measured for at least 9 years).

Values are far below the limit value in urban background regions as well (Figure 4, yellow curve). The annual mean NO_2 concentration at urban traffic stations (Figure 4, red curve) is around 40 µg/m³ and thus in the range of the limit value to be met since 1/1/2010. This reflects that annual mean concentrations above 40 µg/m³ were measured at many stations, so that exceedances of the limit value were registered.

Since the NO_2 concentrations measured primarily at highly polluted traffic-oriented stations using the diffusive sampling method were not yet available for this preliminary analysis, the annual mean value in this pollution regime is lower than in the previous years. Including data from diffusive sampling, a mean value around 40 µg/m³ is expected similar as in 2011.

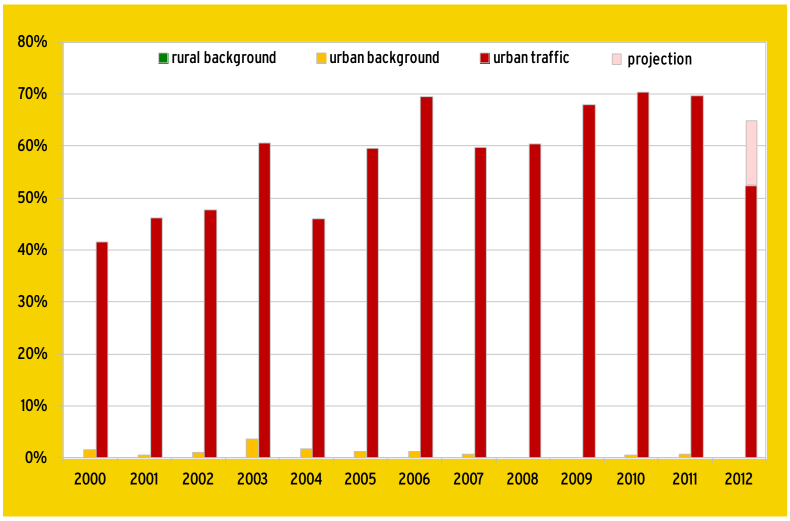


Figure 5: Percentage of stations in the respective categories “rural background“, “urban background“, and “urban traffic“ that exceeded annual mean NO_2 concentrations of 40 µg/m³ in the period from 2000 to 2012.

The annual mean NO_2 concentrations exceeded the limit value to be met at about 52 percent of traffic-oriented measuring stations in 2012 (Figure 5, red bars). In 2011, the percentage of stations where values were exceeded was reported here to be 57 percent, a percentage that was later replaced by 70 percent based on finally validated and supplemented data. It can be expected for this year as well that the percentage of stations near traffic that have exceeded the limit is underestimated again and will later have to be corrected to a higher value of around 65 percent.

2. Hourly mean NO_2 concentrations

Hourly mean NO_2 concentrations above 200 µg/m³ have been allowed no more than 18 times a year since 2010. About 3 percent of all traffic-oriented stations exceeded this value in 2012. The situation was similar in previous years.

VII Ozone

There were no sustained episodes of higher ozone pollution in the summer of 2012, which was rather average according to Deutscher Wetterdienst (Germany's National Meteorological Service). The information threshold of 180 µg/m³ was exceeded on a total of seven days during the two heat waves at the end of July and in mid-August only. While the total number of hours in which the value was exceeded (629) was clearly higher than in the year before (35), yet it still reflects low ozone pollution compared to the past two decades. The alarm threshold of 240 µg/m³ was exceeded for two hours at just one station in Hesse on 26/07/2012.

The assessment with respect to the ozone target value for the protection of human health (number of calendar days with 8-hourly mean values above 120 µg/m³ over an average period of three years may not exceed 25) shows: In the most recent averaging period reflecting the years of 2010, 2011, and 2012 that were characterized by low ozone pollution, 10 percent of the stations still exceed the target value for the protection of human health (Figure 6).

Compared to the past 15 years, ozone pollution in the summer of 2012 was about level with the average over the past decade, during which – except for the high-pollution year of 2003 – there were no pronounced episodes as they used to occur until the first half of the 1990s.

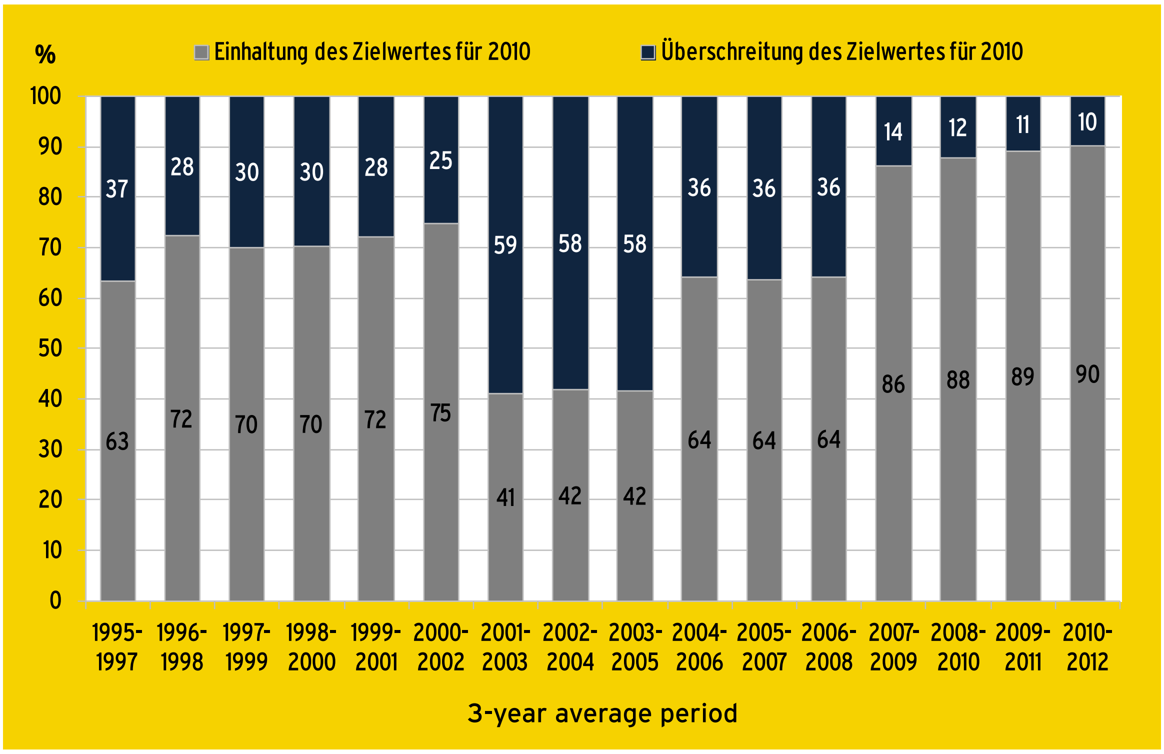


Figure 6: Percentage of ozone measuring stations that have exceeded or met the target value since 1995 (3-year averages)

VIII Development of air quality in Germany since 1990 – an interim account on the occasion of the European "Year of Air" in 2013

The preliminary assessment of air quality in 2012 proves that – like in the years before – many exceedances of limit values for particulate matter (PM_{10}) and nitrogen dioxide (NO_2) occur. Hence, further efforts to reduce emissions of air pollutants are required. This is also in line with the European Commission's objective to attain "levels of air quality that do not give rise to significant negative impacts on, and risks to human health and the environment" and which has been expressed in the thematic strategy on air pollution.

This objective, to which the Federal Republic of Germany is committed as well, is accompanied by a success story of air pollution control: Winter and summer smog are phenomena of the past. Air pollution levels as they were reported from China in January 2013 have not been found anymore in Germany since long.

The emissions of air pollutants in Germany partially have declined drastically since 1990. Figure 7, which illustrates the emission reduction in percent for each air pollutant relative to the year 1990, gives impressive proof of this: Sulphur compounds (SO_2) showed a decline by almost 92 percent compared to 1990, Total suspended particulate matter (TSP) by 85 percent, carbon monoxide (CO) by 74 percent (in the same period, respectively). Still, harmful particulate matter and other "problem pollutants" still tarnish the overall positive picture. While particulate matter emissions (PM_{10}) are dropping all over Germany, the decline of just 30 percent compared to 1995 is clearly less than for the other air pollutants. Emissions of nitrogen oxides (NO_x) and ammonia (NH_3) are still too high; minus 55 percent or minus 20 percent, respectively. Ammonia emissions in particular play an important part in the pollution of our ecosystems, and they show the least declines since 1990.

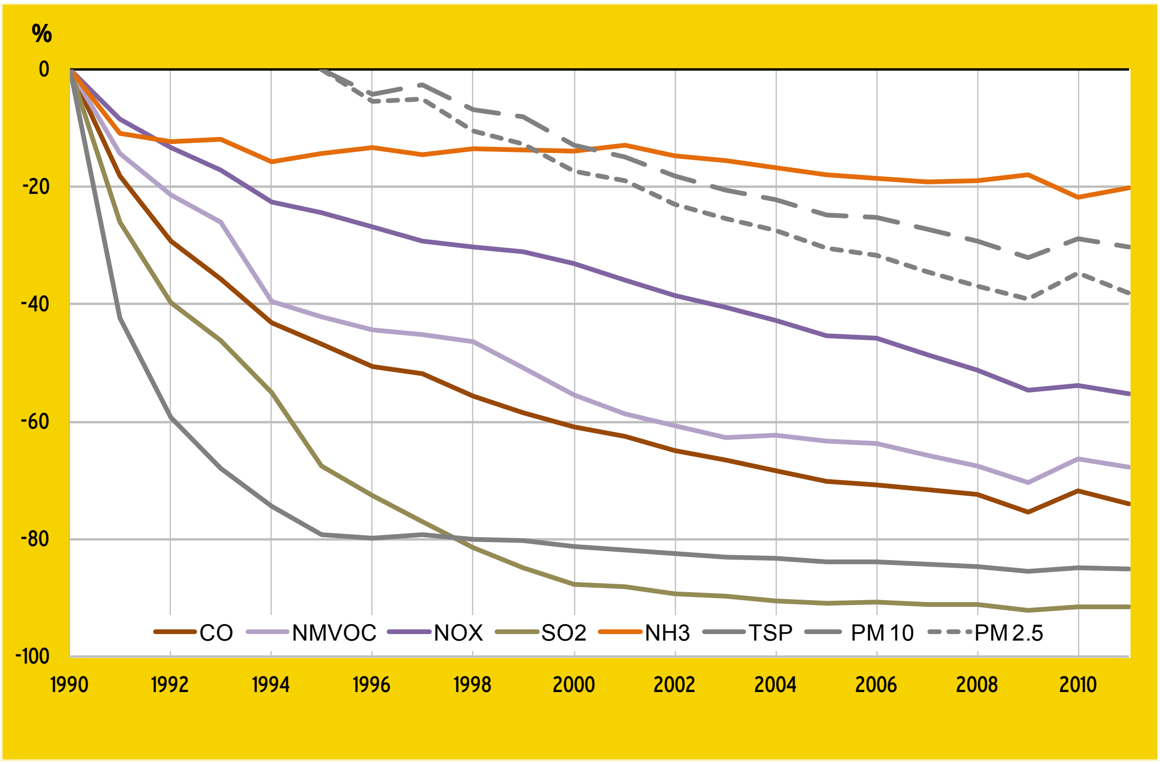


Figure 7: Percentage change of emissions of air pollutants in the period from 1990 to 2011 compared to the baseline year of 1990.

The connection between emissions and air pollution is mainly non-linear due to complex atmospheric processes, including air chemistry reactions. However, the success of steps taken to reduce emissions is apparent even when looking at air pollution. Figures 8 and 9 below, which show the curves over time for NO_2 and PM_{10} since 1990, document this.

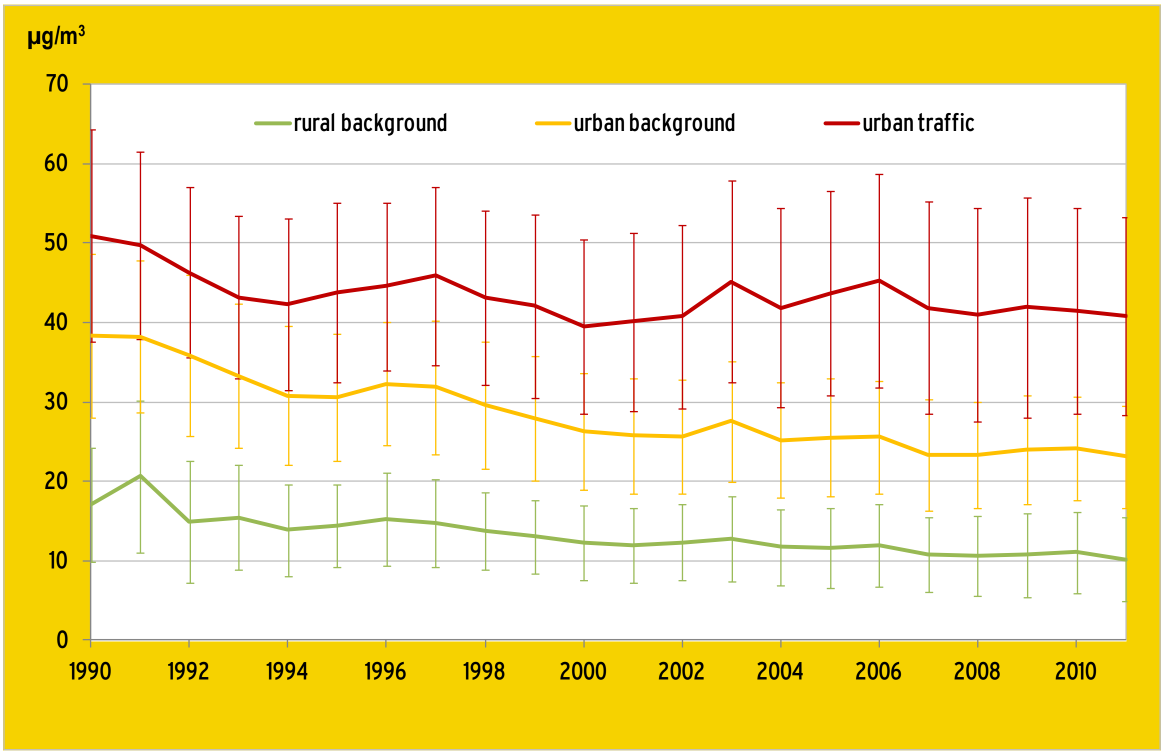


Figure 8: Trend in annual mean NO_2 concentrations based on the average of measuring stations in the pollution regimes "rural background", "urban background", and "urban traffic" in the period from 1990 to 2011 (only includes stations that were selected as a result of a statistical analysis).

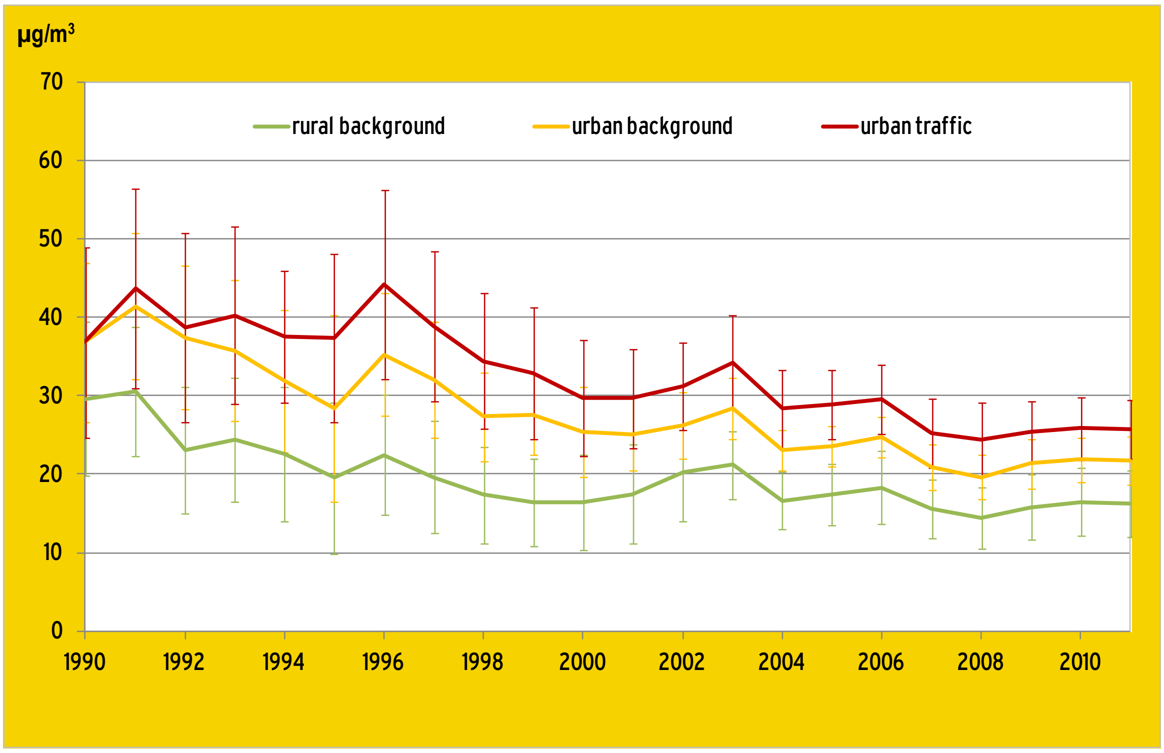


Figure 9: Trend in annual mean PM_{10} concentrations based on the average of measuring stations in the pollution regimes "rural background", "urban background", and "urban traffic" in the period from 1990 to 2011 (only includes stations that were selected as a result of a statistical analysis).

Unlike the curves in Figures 3 and 4, determining long-term trends requires statistical methods that are based on final and fully quality-assured data. Since such quality-assured data is not yet available for 2012, the trend curves 8 and 9 still lack the result of the calculations for 2012. Still, the curves in the respective graphs show little variation since 2000.

Peak ozone concentrations have dropped considerably due to emission reduction of the ozone precursors – nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC). As a result, the summer smog that became known in the 1990s has gone. However, the fact that the target value for the protection of human health, as Figure 6 shows, is currently still at about 10 percent exceeded indicates that the efforts to reduce NO_x and NMVOC emissions must continue. Unlike the drop in peak ozone concentrations, the mean annual ozone concentrations have increased over the entire period from 1990 to 2011 (Figure 10); in the past decade, there has been no significant trend any more, and the picture is characterized by inter-annual fluctuations.

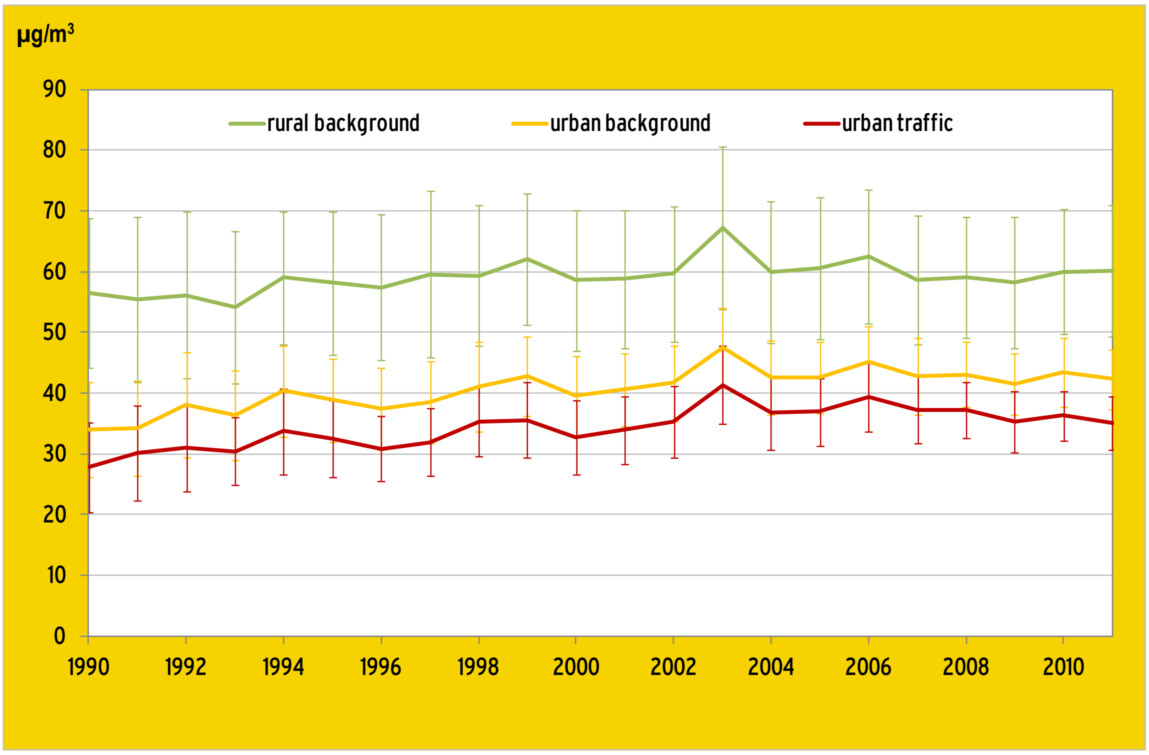


Figure 10: Trend in annual mean ozone concentrations based on the average of measuring stations in the pollution regimes "rural background", "urban background", and "urban traffic" in the period from 1990 to 2011 (only includes stations that were selected as a result of a statistical analysis).

The basis for clean air in Europe was laid by the Geneva Convention on Long-Range Transboundary Air Pollution, an international agreement that addressed transboundary air pollution as early as in 1979 across the "Iron Curtain". Other milestones were the EU-wide stipulation of national emission ceilings and the transformation of the economic system in Eastern Europe after 1990. Sulphur-containing lignite coal was increasingly substituted by lower-emission fuels such as hard coal and natural gas, and power plants were equipped with emission control systems. Stricter limits were also set for emissions from industrial plants.

The emission of exhaust gases from motor vehicles in road traffic was clearly reduced by introducing socalled EURO standards (1 to 5 for passenger cars and I to V for heavy duty vehicles). More measures are planned for the future, e.g. the EURO 6/VI standard for passenger and heavy duty vehicles, which will further reduce nitrogen oxide emissions. Road traffic was also critical in reducing heavy metal emissions. While leaded petrol was available at every filling station in 1990, the ban of its sale in 1998 has resulted in a significant reduction of emission volumes. Lead emissions in Germany dropped by almost 91 percent between 1990 and 2010.

Codes of good agricultural practice, including the application regulations for fertilizers and the storage of farmyard manure, must be complied with consistently to reduce ammonia emissions, which mostly originate from agriculture. Consumers can also help by consuming less meat.

Emissions from what used to be marginal sectors, such as heating with individual furnaces like fireplaces or wood stoves are gaining importance in conjunction with climate policy. Ambitious regulations such as in the 1st Federal ordinance for small-scale furnaces and their fuels are measures that effectively limit emissions of particulate matter, for example.

At the same time, efforts to reduce industrial emissions must continue. Larger stationary sources have to be upgraded continuously to the state of the art in order to minimize emissions of nitrogen oxides as well as ozone and particulate precursors. Apart from road traffic, air and sea traffic must be included in emission reduction concepts. Laying down national emission ceilings through international agreements has proven of value to balance available measures and make cost-optimized decisions. The values stipulated for 2010 have to be urgently revised and supplemented with a regulation for particulate emissions.

Conclusion

Although limit and target values for some air pollutants are still exceeded, air pollution control over the past 30 years in Germany has also recorded a number of successes. The Federal Immission Control Act (Bundes-Immissionsschutzgesetz) of 1974 was the first systematic regulation that addressed, first of all, state of the art emission control of new installations and existing plants in polluted areas. The 1980s were marked by extensive remediation programmes for all power plants and major industrial plants. In the 1990s, sources of emission in the new Länder were extensively refurbished or shut down and replaced with modern plants featuring state of the art emission control facilities. Therefore, pollutants such as soot and coarse particulate matter, sulphur dioxide and summer smog with ozone as the lead compound are no longer a problem.

Protection of human health and the environment from harmful environmental impacts as well as preventive action still remain an important responsibility for German and international air pollution control policy on the way towards cleaner air in Germany and Europe.

For more information, please visit:

- UBA web page on the “Year of Air 2013“
- Air and pollution control portal
- UBA map service on air pollutants
- Development of air quality in Germany
- Current air quality data
- PM_{10} pollutant information
- NO_2 pollutant information
- Ozone pollutant information
- List of air pollution control and action plan links