03.11.2 Traffic-Related Air Pollution Along Streets 2015 and 2020 (Edition 2016)

Overview

Original situation

In the past, the reduction of emissions from industrial and domestic heating was the main focus of air quality planning. In these segments, sizeable reductions of airborne pollutant emissions could be achieved through extensive rehabilitation programmes and plant closures. Improvements were also achieved in the area of traffic, but nonetheless, **traffic is the largest single source** of both current and future air pollutants – not only in Berlin – and is the determining factor for the course of future action in air quality planning.

Due to historical development conditions, the spatial residential structure of Berlin and Brandenburg is “traffic-efficient”. No other region in Germany has anywhere near such favourable conditions. Especially characteristic of Berlin are the clearly polycentric structures and the intensive utilization of limited space in the inner city, as well as in the centres on the periphery, with intensive large and small scale multiple uses resulting in a lower degree of suburbanization than in other large cities. Only 20% of the population lives in the surrounding suburbs, whereas for example around 2.5 million inhabitants live in the city region of Frankfurt am Main, of which only slightly more than 710,000 inhabitants are registered within the city limits. However, also in and around Berlin the development of the relations between the city and its surroundings has led to the developments typical for metropolitan areas. Whereas in 2002 only around 123,000 commuters were coming to Berlin daily from the surroundings (= about 10 % of employed persons with mandatory social insurance payments), in mid-2014 there were already 266,000 commuters (= 21 % of employed persons with mandatory social insurance payments). An additional 160,000 Berliners were commuting to the surroundings (AfS 2016). However, compared with other metropolitan areas, this proportion is still relatively low (e.g. in Frankfurt/Main it amounts to around 60% of inbound commuters).

Since reunification, the city of Berlin has been confronted with a considerable **increase in traffic**. The number of the motor vehicles registered in Berlin increased by 23% between 1989 and 2002, when a high point of 1,440,000 was achieved. This figure has since dropped continuously over the course of several years and is now at 1,387,733 motor vehicles (as of Jan. 1, 2016, cf. Table 1), after a recent upturn.

Table 1: Number of motor vehicles and trailers in the State of Berlin (each reference date Jan. 1)

Vehicle	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Motorcycles and 3-wheeled motor vehicles	94.307	96.000	88.280	90.292	93.478	94.985	97.103	98.837	100.327	100.327	103.150
Automobiles	1.225.967	1.228.621	1.091.164	1.088.221	1.105.732	1.120.360	1.135.704	1.149.520	1.154.106	1.165.215	1.178.417
Buses	2.394	2.376	2.170	2.078	2.276	2.130	2.133	2.133	2.133	2.195	2.274
Trucks/Lorries	80.812	81.925	75.580	73.929	73.655	74.545	78.367	81.085	82.771	85.664	89.879
Tractor trucks	4.450	4.389	4.481	4.734	4.341	4.853	5.883	5.254	5.080	5.475	5.787
Other motor vehicles	8.449	8.376	7.784	7.625	7.711	7.677	7.825	8.047	8.144	8.190	8.226
Motor vehicles, total	**1.416.379**	**1.421.687**	**1.269.459**	**1.266.879**	**1.287.193**	**1.304.550**	**1.327.015**	**1.344.876**	**1.352.561**	**1.368.868**	**1.387.733**
Trailers, total	**74.376**	**74.958**	**73.336**	**74.258**	**75.522**	**76.614**	**78.186**	**79.798**	**80.932**	**82.410**	**84.492**

Table 1: Number of motor vehicles and trailers in the State of Berlin 2006 - 2016 (each reference date: Jan. 1) (according to Statistical Office of Berlin-Brandenburg, Statistical Yearbooks)

The traffic volume on the Berlin road network has, however, according to the currently still applicable Emissions Register, decreased only slightly, from 12,641,300,000 vehicle-km in 2005 to 12,055,700,000 vehicle-km in 2009 (see Tab. 4). In future too, moreover, traffic growth is to be expected in road freight transport, which is very impact-intensive; even just the steady increase in the number of registered vehicles of this category suggests this (cf. Tab. 1).

These far-reaching changes have not ended yet. The increase in non-local traffic is caused, among other things, by the continuing expansion of the combined Berlin-Brandenburg residential and commercial area; the intensification of international economic interdependence; and, especially in Berlin, increasing interdependence with Eastern Europe.

The contribution of motor vehicle traffic to air pollutant concentrations: Origins and trends

Berlin's motor vehicle traffic has for years now been **the cause not only of considerable noise immissions** in significant problem areas (see also Maps 07.05.1 and 2, Strategic Noise Maps, Road Traffic; 2013 Edition), **but also of air pollution**, especially since other categories that originally contributed to air pollution have been substantially reduced. Table 2 shows the combined emissions of all of Berlin's sources of major pollutants since 1989 according to the current state of knowledge.

Since the fall of the Berlin Wall in 1989, many **industrial enterprises** have been rehabilitated or shut down, and the use of coal for fuel for home furnaces in Berlin's residential areas has been replaced with heating oil, natural gas, or district heating (cf. Map 08.02.1 Predominant Heating Types, Supply Shares of Individual Energy Carriers; 2010 Edition). In 1989, **domestic heating** and industry were significant sources of sulphur dioxide and particulate pollutants, but these have been reduced substantially. Between 2000 and 2009, total emissions of nitrogen oxides were reduced by almost 30 %, and of particulate matter by over 20 %.

Tab. 2: Emissions in Berlin by emission category, 1989 - 2020 (trend)

	Figures in tonnes per year (t/a)								
	1989	**1994**	**2000**	**2002**	**2005**	**2008**	**2009**	**Trend 2015**	**Trend 2020**
Sulphur dioxide	**70,801**	**17,590**	**8868**	**7158**	**4666**	**3861**	**3838**	**3666**	**3153**
Facilities requiring authorization	60,470	10,870	5683	4433	2899	2319	2319	2310	2300
Home furnaces	8526	4890	2500	2400	1513	1305	1294	1150	663
Small business	75	70	60	60	50	45	45	43	41
Traffic (vehicles only)	1440	1400	400	55	16	15	13	10	6
Traffic (other)	140	140	75	75	68	62	54	51	45
Other sources	150	220	150	135	120	115	113	102	98
Nitrogen oxides	**69,971**	**42,417**	**25,981**	**21,913**	**20,292**	**20,744**	**18,619**	**16,620**	**13,006**
Facilities requiring authorization	41,757	16,172	8331	6499	6034	6594	6594	6400	6300
Home furnaces	2704	3120	2860	2860	2945	2900	2807	2739	1595
Small business	1200	700	190	185	160	150	127	124	120
Traffic (vehicles only)	21,410	19,025	12,400	10,455	9538	9500	7510	5822	3491
Traffic (other)	1400	1300	1000	900	652	650	641	635	630
Other sources	1500	2100	1200	1014	963	950	940	900	870
Carbon monoxide	**293,705**	**203,948**	**94,928**	**76,133**	**69,701**	**66,557**	**57,463**	**48,897**	**37,481**
Facilities requiring authorization	32,443	3888	2028	1581	1521	1637	1637	1630	1620

Home furnaces	68,712	41,560	8000	8000	5900	5800	5673	5100	3100
Small business	1500	800	200	193	168	150	150	140	135
Traffic (vehicles only)	182,050	144,200	76,500	51,259	47,767	45,000	36,053	28,607	19,426
Traffic (other)	4000	3500	3100	3100	2945	2970	2950	2920	2900
Other sources	5000	10,000	5100	12,000	11,400	11,000	11,000	10,500	10,300
Particulate matter (PM10)	**17,580**	**8804**	**4729**	**4199**	**3854**	**3623**	**3125**	**2993**	**2778**
Facilities requiring authorization	9563	3161	960	650	384	153	153	150	145
Home furnaces	2693	1148	131	132	96	96	95	90	84
Small business	250	220	160	153	149	258	258	250	240
Traffic (vehicles only, exhaust)	1736	1135	667	394	355	300	225	124	60
Abrasion and resuspension by motor vehicle traffic	1200	1150	997	1050	1099	1090	669	692	631
Traffic (other)	238	190	124	130	123	120	119	119	118
Other sources	1900	1800	1690	1690	1648	1606	1606	1568	1500
Particulate matter (PM2.5)					**2363**	**2239**	**1829**	**1708**	**1563**
Facilities requiring authorization					211	89	89	87	84
Home furnaces					87	86	86	81	76
Small business					119	197	197	190	185
Traffic (vehicles only, exhaust)					337	285	225	124	60
Abrasion and resuspension by motor vehicle traffic					714	709	360	374	341
Traffic (other)					71	70	69	68	67
Other sources					824	803	803	784	750
Organic gases	**103,351**	**73,703**	**32,814**	**26,590**	**24,033**	**22,924**	**22,427**	**20,216**	**17,951**
Facilities requiring authorization	11,801	3473	2554	1966	1596	824	824	840	860
Home furnaces	5250	2340	550	550	550	500	478	450	400
Small business	15,500	15,000	6500	6484	5511	5600	5500	5300	5200
Traffic (vehicles only)	49,800	33,890	12,500	8000	7300	7100	6925	5326	3491
Traffic (other)	3000	2000	1710	1710	1590	1400	1200	1100	1000
Other sources and households	18,000	17,000	9000	7880	7486	7500	7500	7200	7000

Table 2: Emissions in Berlin by emission category, 1989 to 2020 (trend)

The particulate emissions from motor vehicle exhausts, which are an especially great health threat, also decreased by more than 80 % between 1989 and 2002. The trend calculations indicate further reductions up to the end of the decade. This finding agrees substantially with the measurements of diesel soot detected in so-called “canyon streets” – the major component of motor vehicle exhaust emissions. However, since the particulate matter emissions from abrasion and resuspension of road transport decreased by only 43 % during these 20 years and only slight reductions are predicted for the near future, **road traffic is the second greatest source of particulate matter in Berlin, after “other sources”**. The calculated decline was based on the use of new, significantly lower emissions factors; in actual fact, the emissions probably declined only commensurately with the decrease in traffic, or by about 10 %. Road traffic, including abrasion and resuspension, in 2009 accounted for 29 % of the particulate emissions of PM_{10} in Berlin, while “other sources” a counted for 51 % (for $PM_{2.5}$ particulate matter, the ratio was 32 % to 44 %).

By the beginning of the 1990s, road traffic had replaced industrial plants as the main source of nitrogen oxides in Berlin. As of 2009, street traffic produced 40 % of the nitrogen oxides in Berlin, whereas industrial plants accounted for 35.2 % of total emissions.

Especially high in relative terms is the pollution from motor vehicle traffic in the inner city, where over one million people live in an area of 100 sq km. If current trends for use of and competition for space continue, motor vehicle traffic will increase especially strongly here. If current conditions continue, freight transport will encounter a particularly major increase in bottlenecks in the streets.

In order to counteract these developments, which are to some extent incompatible with urban living and threatening to public health, two mutually complementary planning strategies have been developed for Berlin:

- Urban Development Plan for Traffic
- Berlin Air Quality Plan 2011-2017.

With the revised **Urban Development Plan for Traffic**, the Berlin Senate in a resolution of March 29, 2011 presented an updated action plan which combines the possible and necessary steps for the further development of the Berlin traffic system for the coming years with a long term strategic orientation. The core of the action plan is a catalogue of measures that were previously analyzed in detail and coordinated for effectiveness, acceptability and fundability. With regard to the future development of traffic in Berlin and the surrounding area, the investigations for the Berlin Air Quality Plan are based on this long term action concept.

“Health and Safety”, one of the key strategic components of the Urban Development Plan for Traffic, includes a number of important strategies to limit the increase of motor vehicle traffic and its associated effects, with the goal of a reduction of air and noise pollution in the primary road network. The implementation of the measures of the Urban Development Plan for Traffic is expected to be completed by 2015.

The target date for the Urban Development Plan for Traffic is 2025, which is rather long-term; however, with its “Mobility Programme 2016”, it also takes short- and medium-term requirements into account (more information under: Urban Development Plan for Traffic (SenStadtUm 2016b)).

The standardized Air Quality Plan mandated by the EU, titled “Air Quality Plan 2011-2017”, was adopted by the Berlin Senate on June 18, 2013.

Under Europe-wide standards, the Air Quality Plan data must include information on:

- pollution measurements,
- the causes of high air pollution levels,
- the frequency and degree of instances in which the limits are exceeded,
- pollution immission and the proportions of the immission for each causative factor (e.g. industry, commercial activity, home heating, traffic),
- planned measures, and a schedule for implementation; and
- a prognosis of the goals to be achieved by such measures.

The present Air Quality Plan provides information about the legal framework and the prevailing situation, and describes the causes of air pollution. The measures take into account the developments to date of the condition of the air (through 2010), and future trends through 2020. The focal point is the presentation of a range of potential measures and their evaluation. Based on the effectiveness of these measures, a strategy will be developed for the Berlin Air Quality Plan. The Air Quality Plan documents that Berlin, like many other large German and European cities, faces a major challenge to meet the new EU limits.

The essential results can be summarized as follows: the locally generated segment of the pollution, the share which can only be reduced by Berlin measures, accounts for about 36 % of the particulate pollution measured at a main traffic street; it is caused by the urban background (approx. 17 %) and by the local sources from road traffic (approx. 19 %). The urban background pollution share is caused mostly by road traffic (7.5 % of total PM_{10} pollution). The remainder (9.5 %) is mainly from other sources (approx. 7.5 %, including construction activity with transport, wood burning as additional heating in private households, resuspension through strong wind and the like) as well as from Berlin residential heating and industry and power plants.

The results of the measurements of recent year and the comprehensive model calculations carried out for 2015 lead, among other things, to the following conclusions:

- The measured NO_2 pollution both in the Berlin suburbs and in residential areas and along primary roads has been consistently high since 2002, and in canyon streets it almost always exceeds the limit of 40 µg/m³ for protecting human health. Annual mean values of 52 µg/m³ along primary roads, 27 µg/m³ in inner-city residential areas and 14 µg/m³ on the outskirts were measured in 2014. Very similar values had already been observed in 2002. Despite improvements in exhaust gas technology and despite a slight reduction in motor vehicle traffic in Berlin, the expected reduction in NO_2 immissions has not occurred.
- One of the reasons for this is the strong increase in the number of diesel vehicles in Berlin. Whereas in 2002 approx. 14 % of all cars and light commercial vehicles had diesel engines, this proportion increased to approx. 35 % in 2014. Diesel vehicles emit significantly more nitrogen oxides than gasoline-powered vehicles. The share of NO_2 in the exhaust has also increased in the last 10 years from less than 10 % to more than 40 %. Thus diesel vehicles contribute disproportionately to the NO_2 pollution along primary roads. It has also turned out that diesel vehicles with the newer exhaust emissions standard Euro 5 sometimes produce higher NOx emissions than diesel vehicles with the older Euro 3 and 4 standards.
- In contrast to the measurements of the pollution along primary roads, the NO_2 prognoses for 2015 calculated in 2009 indicated an average decrease of 17 %. The NO_2 pollution of the inner-city residential areas was also supposed to decrease by more than 20 % by 2015 according to the predictive calculations of 2009. The calculations of 2009 were based on efficient exhaust gas treatment systems in diesel vehicles, mainly with the newer emission standards (Euro 5 and Euro 6). The Euro 5 standard only became mandatory for cars with diesel engines on January 1, 2011, so that the emission factors of these vehicles were still very uncertain at the time the prognoses were made.

More detailed notes on the effects of air pollutants, the applicable legal regulations and further background information can be found in the accompanying text of the 2011 edition of the Environmental Atlas (SenStadtUm 2011).

Statistical Base

Motor Vehicle Traffic Emissions Registry

The current Motor Vehicle Traffic Emissions Registry was compiled anew on the basis of traffic counts for 2009, because according to experience to date, this category of polluters contributes significantly to particulate and nitrogen oxide pollution. Traffic counters have been installed at many locations on the primary roads of Berlin since 2001. These data serve to make the current traffic patterns in Berlin accessible, and to incorporate them into traffic management. This information is evaluated in the Office of Traffic Management (VKRZ), and is used to inform the populace (especially drivers) of traffic conditions and provide routing recommendations to avoid traffic jams via radio broadcasts, the internet, and centrally located sign boards. The enhancement of the VKRZ serves the goal of dynamically controlling traffic according to the current traffic situation and volume.

Ascertainment of traffic volume

Since 2002, the data from approx. 400 detectors at about 300 locations within the Berlin primary road network have been available at the Traffic Control Office (VLB). Many of these detectors distinguish between cars and lorries, and can be used for approximate annual traffic counts.

In addition for 2009, traffic count figures for car, lorries, buses and motorcycles from an official count by trained persons at many intersections ordered approximately every 5 years by the Senate Department for Urban Development and the Environment were available. Compared with counts by detectors, this official traffic count has the advantage of being better able to distinguish between lorries of more or less than 3.5 t, respectively, and other motor vehicles. For 2009 therefore, this traffic count was selected as the basis for an "**Emissions Survey for Motor Vehicle Traffic 2009 in the framework of the Air Quality Plan 2011-2017**", as had been the case for the previous Emissions Registers for Motor Vehicle Traffic in 1994, 1999 and 2005. The exhaust emissions were then ascertained as follows:

- The extrapolation of the point-related intersection counts to the entire Berlin primary road network with a traffic-flow computational model (VISA) by the Senate Department for Urban Development provided the results showing the mean daily traffic figures (DTV) and the proportions of lorries for all major streets.
- The ascertainment of the segment-related pollution of the primary road network with regular bus traffic of the Berlin Transit Company (BVG) was calculated on the basis of the bus schedule data for 2009.
- The calculation of the emissions with the emission factors from the UBA manual for emissions factors with consideration for the type of road and its function, was ascertained with the aid of the program $IMMIS^{em/luft}$.

Detailed information on the ascertainment of motor vehicle emissions, the emission models for the primary and secondary road networks as well as the ascertainment of exhaust, abrasion and resuspension emissions has already been provided in the 2011 Edition (SenStadtUm 2011).

The new method of calculating emissions developed for this registry is also a suitable basis for dispersion calculations to determine the extent of pollution along streets and was also used for the illustrations in the map "03.11.2 Traffic related Air Pollution - Index of air pollution for PM_{10} and NO_2" (Edition 2011) (SenStadtUm 2011). The extensive reorganisation of the calculation methods used for this purpose permits only very limited comparisons with previous emissions surveys, because these were based on a much simpler method of calculation.

In the meantime, it has turned out that particularly in actual urban traffic situations newer diesel vehicles exhibit far higher specific NOx emissions than predicted in 2009. This led to a significant overestimation of the NO_2 reduction along primary roads, but as a consequence also in residential areas.

In the meantime, the NO_x emission factors for Euro 5 vehicles and also for the Euro 6 vehicles mandated beginning on September 1, 2015 have been corrected upwards, in particular for diesel cars and light commercial vehicles. These emission factors were first published in the summer of 2014 in the UBA manual Emission Factors of Road Traffic (Version 3.2) (INFRAS 2014).

Moreover, new counts of the Berlin fleet composition were available for 2012, which allowed the NO_2 pollution in Berlin to be recalculated for 2015 and for the prognosis year 2020.

The aim of the calculation was to allow a more reliable statement about the number of residents affected by excessive NO_2 values to be made. A further aim was to check the hypothesis, based on the old calculations, that in 2020 no-one will be exposed to NO_2 concentrations above 40 µg/m³ in Berlin anymore.

Methodology

Use of the model

The results of existing street measurements show that the concentration levels set forth in Directive 2008/50/EC and the 39th BImSchV were exceeded at a large number of primary roads – continually, in the case of nitrogen dioxide. Since measurement-based investigations are, for cost reasons, not possible on all streets in the city, the pollution immission from all the primary roads networks in Berlin were ascertained using emission and dispersion calculations. Under this process, those streets are ascertained where the legal limit values are almost certain to be exceeded, or where they will be met.

To achieve this, these measurements are supplemented with model calculations in all traffic-filled streets in which limits are potentially exceeded. However, even in a traffic-filled canyon street, the background pollution produced by other sources in the city, and introduced by the long distance transportation of pollution, is an important factor. Therefore, to plan the improvement of air quality in Berlin, a system of models is applied that can calculate both the large scale influence of distant sources and the contribution of all emitters in the city, even in traffic-filled canyon streets. For such an estimation of all primary roads ("**screening**"), the aptly designed modular program system IMMIS■■■ is suitable.

IMMIS-Luft■■■ (air) is a screening program system for the evaluation of pollution caused by road traffic. It was developed specifically for application in the context of traffic-related assessments. Provided the necessary input data is known, a rapid calculation of pollution immissions is possible with the aid of this program, both for particular streets and for comprehensive street systems.

In this process, the pollution immission is calculated on both sides of the street for one point on each side, at an elevation of 1.5 m, and at a distance of 0.5 m from the edge of the building (cf. Figure 1). The mean of the calculated immission at these two points is considered the characteristic estimate of the immission pollution in this section.

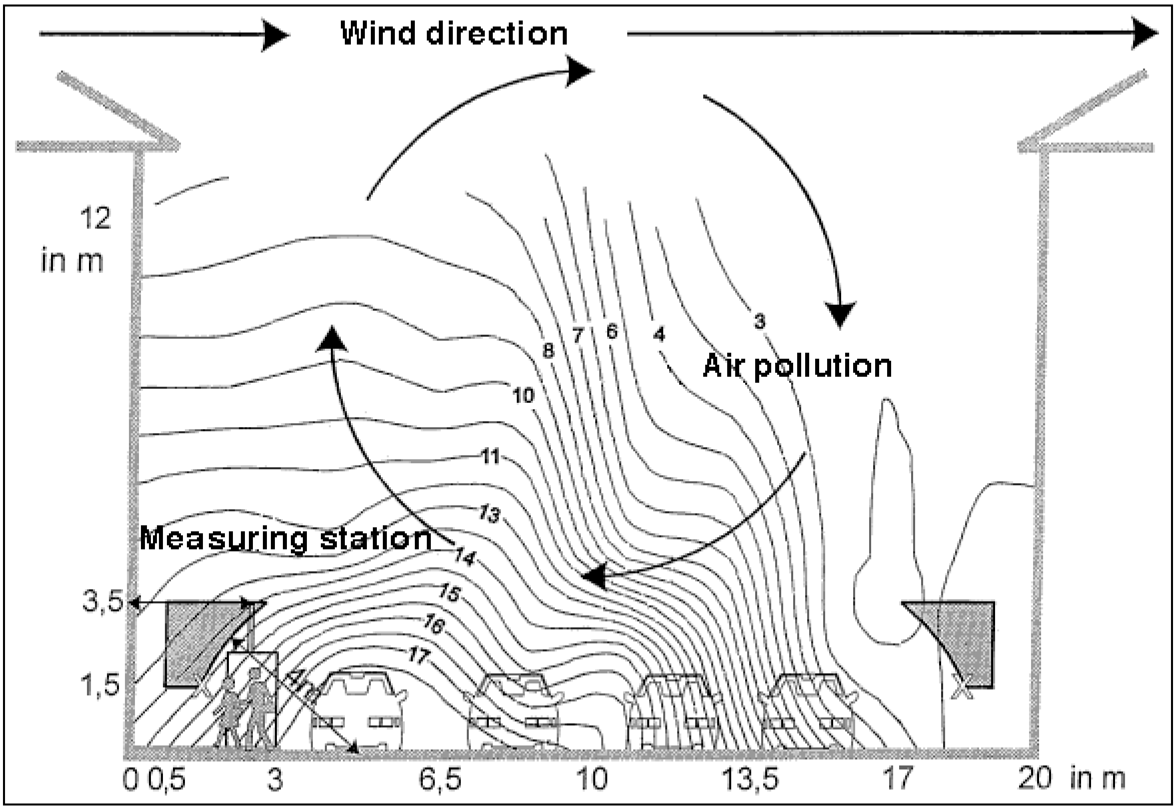

Fig. 1: Pollution distribution on a canyon street, with the measurement range as per 39th BImSchV, and the receptors used for calculation with the IMMIS■■■ canyon street model

Traffic-caused air pollution immission in canyon streets is modelled with the program segment IMMIS^{cpb}. It enables the calculation of hourly values of pollutant immissions produced by local traffic at any receptor in a canyon street with varying building heights and with spaces between buildings which allow the passage of wind, on the basis of easily accessible meteorological quantities. An additional required input quantity is the emission level for each section of the street. The emissions were calculated from the current traffic data using the program segment IMMIS^{em}. The pollution produced by the city is derived from the sum of the additional pollution measured using the canyon street model, the local street traffic, and the urban background pollution calculated using the IMMIS^{net} program.

Update of the calculational basis for applying the model to the prognosis year 2015

Information on the actual motor vehicle fleet composition in Berlin was available from license-plate observations for the reference year 2012. In addition, information on the current and future fleet composition of the regular buses of the BVG was available. This information for 2012 was transferred to the reference years 2015 and 2020 using extrapolation factors.

The traffic volumes on Berlin's primary roads were taken from the calculations for 2015 for the Air Quality Plan 2011-2017, as no newer values were available.

Moreover, background pollution values in the urban background were adapted for the recalculation. Thus, the decreasing trend of the urban NO_2 background pollution that had had been assumed in 2009 in the prognosis up to 2015 is not discernible in the measurement data between 2009 and 2014. For 2015, the NO_2 background value was derived from measurements and extrapolated up to 2020 using supraregional models from the UBA project "LUFT 2030" (UBA 2014).

The calculation of the motor vehicle emissions was carried out with the new emission factors based on the current UBA manual (Version 3.2).

Evaluation of the calculation results based on an index

The map drafted using this process shows the spatial distribution of traffic caused air pollution for NO_2 and PM10. A **summary assessment** was conducted for both substances. The index developed weighs the calculated concentrations of both pollutants according to their limit values throughout the network of road sections of the primary roads network for 2015, which has been expanded to some 10,000 for this purpose, and adds the quotients. For example, if the two components both reach 50% of the limit, an index of 1.00 will result. All sections that show a reading in excess of 1.8 (90% or more of the limit value) will require special attention in future (cf. Effects on Human Health).

The approach used to calculate the number of residents affected by limit value exceedances was taken from the noise mapping procedure (see also Maps 07.05 Strategic Noise Maps (SenStadtUm 2013)). The number of residents in the flats facing the street front is counted. The number of citizens affected by limit value exceedances thus ascertained represents a rather conservative estimate, because the pollutants spread everywhere, so that increased concentrations can also occur outside highly polluted canyon streets.

Data display for the map Traffic-related Air Pollution

The data display in the Geoportal FIS Broker includes the following detailed information on the selected road section:

- Section Number
- Name of the road section
- Length of the road section [m]
- Average daily traffic volume (DTV) motor vehicles prognosis 2015
- Number of heavy trucks (> 3.5 t) per day prognosis 2015
- Number of light trucks (<3.5 t) per day prognosis 2015
- Number of public transport buses per day prognosis 2015
- Number of motorcycles per day prognosis 2015
- Affected residents on the road section
- NO_2 pollution (annual mean in µg/m³) prognosis 2015
- PM10 pollution (annual mean in µg/m³) prognosis 2015
- PM2.5 pollution (annual mean in µg/m³) prognosis 2015
- NO_2 pollution (annual mean in µg/m³) prognosis 2020
- PM10 pollution (annual mean in µg/m³) prognosis 2020
- PM2.5 pollution (annual mean in µg/m³) prognosis 2020
- Air pollution index for NO_2 referred to 2015

- Air pollution index for PM10 referred to 2015
- Overall air pollution index for NO_2 and PM10 referred to 2015

Map Description

Table 3 shows the development of the number of persons affected by limit value exceedances and the sum of the corresponding section lengths for the years 2015 and 2020.

Table 3: Section lengths and residents affected by limit value exceedance in the primary road network, Calculation for 2015 and 2020				
Substances examined: PM10 and NO_2	**Trend calculation of limit exceedance for 2015**		**Trend calculation of limit exceedance for 2020**	
	km Road length	**Residents affected**	**km Road length**	**Residents affected**
NO_2 [exceedance of annual limit value]	30.00	26,400	1.8	1,718
PM10 [exceedance of daily limit value]	15.90	14,000	2.70	2,700

Table 3: Section lengths and residents affected by limit value exceedances in the primary road network, calculation for 2015 and 2020

For the year 2015, NO_2 values above 40 µg/m³ were calculated along 215 road sections with a total length of approx. 30 km. Nearly 26,400 people live along these road sections.

By 2020, NO_2 annual mean values above 40 µg/m³ are predicted for 13 sections with 1,718 affected persons and a total length of 1,800 metres.

The most severely polluted road sections lie along Potsdamer Straße between Lützowstraße and Kleistpark as well as along Schillstraße in Tiergarten and Schöneberg, along Leipziger Straße between Mauerstraße and Charlottenstraße, along Friedrichstraße between Dorotheenstraße and Mittelstraße as well as along Dorotheenstraße and Wilhelmstraße from the Reichstag up to Unter den Linden in Mitte.

Especially in Dorotheenstraße and Wilhelmstraße, many buses contribute significantly to the increased NO_2 values. Whereas the diesel soot emissions of the Berlin buses were reduced by more than 90 % by fitting them with particulate filters, there is still potential for reducing the nitrogen oxide emissions. Retrofitting with systems for nitrogen oxide reduction of regular buses with the exhaust emission standards EURO IV and EURO V is already being carried out. Moreover, for new acquisitions, the exhaust emission standard EURO VI is mandated. It also has to be demonstrated that the intended reduction in emissions is also effective in urban traffic. First successes have already manifested at Hardenbergplatz. In 2015, the measurement station installed there measured NO_2 concentrations lower than in the previous years by approx. 15 %.

Along Potsdamer Straße as well as along Schillstraße and Leipziger Straße, the motor vehicle traffic and the still rising share of diesel vehicles as well as the insufficient effectiveness of the NO_2 reduction systems are mainly responsible for the increased values. It is assumed that without a change in legislation or tax subsidies, the proportion of diesel vehicles in Berlin will be above 50% in 2020. In that case, only a decrease in traffic volume and a significant reduction of the proportion of trucks would lead to compliance with the NO_2 limits in 2020.

The current discussion about the exhaust values during the actual operation of the newest diesel vehicles also shows that these modelling results are still associated with a significant uncertainty. The Federal Environment Agency is therefore working on a further update of the manual for motor vehicle emission factors, which draws on considerably more information on the emission behaviour during actual operation particularly of diesel cars and light trucks.

Summary

It has turned out that the Berlin NO_2 pollution in residential areas and along primary roads did not decrease as much as had been predicted with model calculations. The reasons for this include the significantly higher emissions of new diesel vehicles with the Euro 5 and 6 norms during actual operation. They not only lie far above the limit of the respective Euro norm to be adhered to in the laboratory but also significantly exceed the emission factors of Version 3.1 of the UBA manual that the calculations in 2009 were based on. In the meantime, the manual has been updated based on new information about the actual emissions particularly of vehicles with the exhaust emission standards Euro 5 and Euro 6, which are significantly higher than predicted in 2009. Based on these improved emission factors and newer insights into Berlin's fleet composition, the calculation of the NO_2 pollution along Berlin's primary roads was repeated for the years 2015 and 2020. Moreover, the NO_2 background values predicted for 2009 and 2015 were adapted to the actually measured values and extrapolated to 2020.

The numbers of residents affected by NO_2 limit value exceedances in 2015 and 2020 have also been corrected based on the new calculations. Whereas in 2009 it was predicted that in 2015 approx. 11,400 Berlin residents would be affected by NO_2 limit value exceedances and that in 2020 no more residents would be affected, the newer calculations have shown that in 2015 approx. 26,400 and in 2020 approx. 1,700 Berliners will still be exposed to excessive NO_2 pollution.

Literature

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