03.11.2 Traffic-Related Air Pollution Along Streets 2015 (Edition 2017)

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 space in the inner city, as well as in the centres on the periphery, with intensive large- and small-scale multiple uses, as well as a lower degree of suburbanization compared to 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 84,000 Berliners were commuting to the surroundings (AfS 2017). 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 1,409,642 motor vehicles (as of January 1, 2017, 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**	**2017**
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	104.530
Passenger cars	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	1.195.149
Buses	2.394	2.376	2.170	2.078	2.276	2.130	2.133	2.133	2.133	2.195	2.274	2.249
Trucks/Lorries	80.812	81.925	75.580	73.929	73.655	74.545	78.367	81.085	82.771	85.664	89.879	93.141
Tractor trucks	4.450	4.389	4.481	4.734	4.341	4.853	5.883	5.254	5.080	5.475	5.787	6.246
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	8.327
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**	**1.409.642**
Trailers, total	**74.376**	**74.958**	**73.336**	**74.258**	**75.522**	**76.614**	**78.186**	**79.798**	**80.932**	**82.410**	**84.492**	**86.822**

Table 1: Number of motor vehicles and trailers in the State of Berlin 2006 - 2017 (each reference date: Jan. 1) (according to [Statistical Office for Berlin-Brandenburg, Statistical Yearbooks](), only in German)

The traffic volume on the Berlin road network has, according to the Emissions Register, decreased only slightly, from 12,641,300,000 vehicle-km in 2005 to 11,651,900,000 vehicle-km in 2014. In future, however, traffic growth is to be expected in road freight transport, which is very impactintensive; even just the steady increase in the number of registered vehicles of this category suggests this (cf. Table 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; 2017 Edition), **but also of air pollution**, especially since other categories that originally contributed to air pollution in Berlin 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 brown 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 2002 and 2015, total emissions of nitrogen oxides were reduced by approx. 17 %, and of particulate matter by almost 40 %. During emissions calculations in 2015, the analysis of relevant polluters was extended significantly. This limits the comparability of emissions by heating systems with those measured in previous years. A new emissions report was drawn up to calculate emissions in 2015. In addition to the previous analysis of statistical parameters, this report includes a survey and considers a multitude of stakeholders. The final report (only in German) is available on the website of the Senate Department for the Environment, Transport and Climate Protection.

Table 2: Emissions in Berlin by polluter groups, 1989 to 2015						
	Data in tonnes per year (t/a)					
	1989	1994	2002	2005	2009	2015
Sulphur dioxide	**70801**	**17590**	**7158**	**4666**	**3838**	**2997**
Plants requiring a permit	60470	10870	4433	2899	2319	2372
Domestic heating, commerce, trade, services	8601	4960	2460	1563	1339	590
Traffic (only motor vehicles)	1440	1400	55	16	13	13
Traffic (other)	140	140	75	68	54	17
Other sources	150	220	135	120	113	5
Nitrogen oxides	**70369**	**42333**	**22043**	**19787**	**18718**	**18929**
Plants requiring a permit	43531	16169	6494	6035	6590	6794
Domestic heating, commerce, trade, services	3904	3820	3045	3105	2934	1994
Traffic (only motor vehicles)	20034	18944	10590	9032	7613	7077
Traffic (other)	1400	1300	900	652	641	1596
Other sources	1500	2100	1014	963	940	1468
Carbon monoxide	**293705**	**203948**	**76133**	**69701**	**57463**	**36510**
Plants requiring a permit	32443	3888	1581	1521	1637	1726
Domestic heating, commerce, trade, services	70212	42360	8193	6068	5823	11276
Traffic (only motor vehicles)	182050	144200	51259	47767	36053	19433
Traffic (other)	4000	3500	3100	2945	2950	861
Other sources	5000	10000	12000	11400	11000	3214

Particulate matter (PM_{10})	**17580**	**8804**	**4199**	**3854**	**3135**	**2526**
Plants requiring a permit	9563	3161	650	384	152	142
Domestic heating, commerce, trade, services	2943	1368	285	245	353	241
Traffic (only motor vehicles, exhaust)	1736	1135	394	355	225	110
Abrasion and resuspension caused by traffic	1200	1150	1050	1099	680	516
Traffic (other)	238	190	130	123	119	250
Other sources	1900	1800	1690	1648	1606	1267
Particulate matter ($PM_{2.5}$)				**2363**	**1834**	**1216**
Plants requiring a permit				211	88	78
Domestic heating, commerce, trade, services				206	283	228
Traffic (only motor vehicles, exhaust)				337	225	110
Abrasion and resuspension caused by traffic				714	366	203
Traffic (other)				71	69	51
Other sources				824	803	546
Organic gases	**103351**	**73703**	**26590**	**24033**	**22427**	**25620**
Plants requiring a permit	11801	3473	1966	1596	824	576
Small business, domestic heating, households, other sources	38750	34340	14914	13547	13478	21058
Traffic (only motor vehicles)	49800	33890	8000	7300	6925	3760
Traffic (other)	3000	2000	1710	1590	1200	226

Table 2: Emissions in Berlin by polluter groups, 1989 to 2015

The particulate emissions from motor vehicle exhausts, which are an especially great health threat, also decreased by more than 90 % between 1989 and 2015. This finding agrees substantially with the measurements of diesel soot detected in urban canyons – the major component of motor vehicle exhaust emissions. The measured concentration of diesel exhaust particulates at Measurement Station 174 of the Berlin Clean Air Measurement Network (BLUME) on Frankfurter Allee in the borough of Friedrichshain dropped by 50 % during the period 2000 - 2015 (cf. also the evaluation of Map 03.12.1, Station 174). However, since the particulate matter emissions from abrasion and resuspension of road transport decreased far less and, **road traffic is the second greatest source of particulate matter in Berlin, after "other sources"**. Road traffic, including abrasion and resuspension, in 2015 accounted for 25 % of the particulate emissions of PM_{10} in Berlin, while other sources accounted for 50 %.

By the beginning of the 1990s, road traffic had replaced industrial plants as the main source of nitrogen oxides in Berlin. As of 2015, street traffic produced 39 % of the nitrogen oxides in Berlin, whereas industrial plants accounted for 33 % 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 km^2. 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 (only in German)
- 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 plan.

The “Health and Safety” section, 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 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 (SenUVK 2016b, only in German)).

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, commerce, domestic 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 primary road; 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 %) stems 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 domestic heating and industry and power plants.

The results of the measurements of recent years 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 urban canyons it almost always exceeds the limit of 40 µg/m³ for protecting human health. Annual mean values of 48 µg/m³ along primary roads, 27 µg/m³ in inner-city residential areas and 14 µg/m³ on the outskirts were measured in 2016. Very similar values had already been observed in 2001. 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 NO_x 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 2014, because according to experience to date, this category of polluters contributes significantly to particulate and nitrogen oxide pollution. Detectors to count the number of passing motor vehicles have been installed at many locations on the primary roads of Berlin since 2001. This data serves to make the current traffic patterns in Berlin accessible, and to incorporate them into traffic management. This information is evaluated in the Traffic Control Centre (VKRZ), and is used to inform the population, especially drivers, of current 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. With its further development, the VKRZ aims at achieving dynamic traffic management based on current traffic conditions and volumes.

Ascertainment of traffic volume

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

In addition, for 2014, 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 the Environment, Transport and Climate Protection were available (cf. Environmental Atlas Map Traffic Volumes 07.01, Edition 2017). 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 2014 therefore, this traffic count was selected as the basis for an **“Emissions Survey for Motor Vehicle Traffic 2015,as part of the update of the 2011-2017 Air Quality Plan”**, as had been the case for the previous Emissions Registers for Motor Vehicle Traffic in 1994, 1999, 2005 and 2009. 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 (VISUM) by the Senate Department for the Environment, Transport and Climate Protection 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 Berliner Verkehrsbetriebe (BVG, Berlin Transport Services) was calculated on the basis of the bus schedule data for 2014.
- the calculation of the emissions with the emission factors from the UBA manual for emissions factors (Edition 3.3, UBA 2017) with consideration for the type of road and its function, is ascertained with the aid of the program $\text{IMMIS}^{\text{em/luft}}$. Furthermore, additional corrections have been made regarding the emission factors for light commercial vehicles (< 3.5 t), as they produce higher emissions in actual operation, much like diesel cars.

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 Environmental Atlas map Traffic-Related Air Pollution - NO_2 and PM_{10}, 03.11.2, 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 NO_x 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 spring of 2017 in the UBA manual Emission Factors of Road Traffic (Version 3.3, UBA 2017).

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

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.

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 a measurement-based survey is not possible on all streets of the city, for cost reasons, the pollution immission for the complete primary road network in Berlin was estimated 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 urban canyon, 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 wide-ranging influence of distant sources and the contribution of all emitters in the city, even in traffic-filled urban canyon. For such an estimation of all primary roads (“**screening**”), the modular program system IMMIS■■■ developed for this purpose 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 individual streets and for comprehensive road networks.

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.

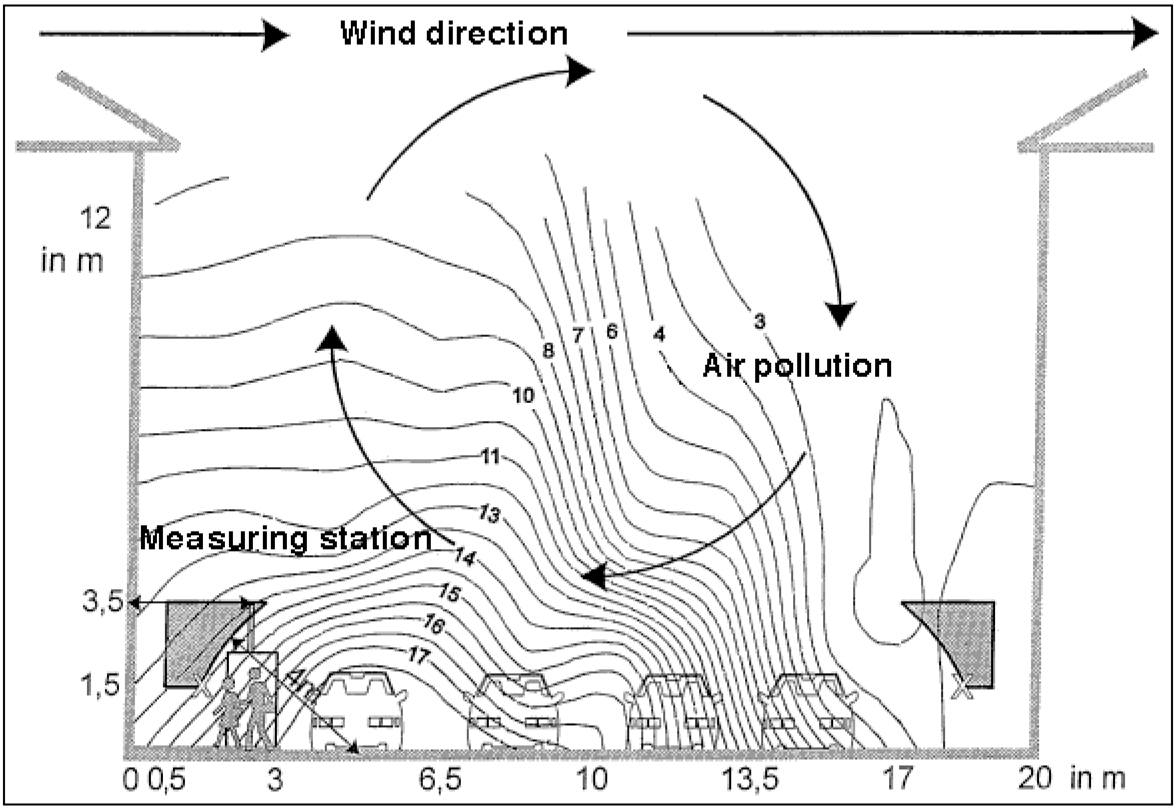

Fig. 1: Pollution distribution on an urban canyon, with the measurement range as per 39th BImSchV, and the receptors used for calculation with the IMMIS■■■ urban canyon model

Traffic-caused air pollution immission in urban canyons is modelled with the programme segment IMMIS^{cpb}. It enables the calculation of hourly values of pollutant immissions produced by local traffic at any receptor in an urban canyon 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 programme segment IMMIS^{em}. The pollution produced by the city is derived from the sum of the additional pollution measured using the urban canyon 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 reference year 2015

Information on the actual motor vehicle fleet composition in Berlin was available from license-plate observations for the reference year 2015. In addition, information on the current and future fleet composition of the regular buses of the BVG was available.

The traffic volumes on Berlin's primary roads were taken from the calculations for 2015 for the update of the 2011-2017 Air Quality Plan (cf. Environmental Atlas Map Traffic Volumes, 07.01, Edition 2017).

Moreover, the background pollution values in the urban background were adapted for the recalculation. For this, the newest emissions surveys were used for the reference year 2015 (cf. Environmental Atlas Map Long-Term Development of Air Quality, 03.12, Edition 2018).

The calculation of the motor vehicle emissions was carried out with the new emission factors based on the current UBA manual (Version 3.3).

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 particulate matters (PM_{10} and $PM_{2.5}$). A **summary assessment** was conducted for NO_2 and PM_{10}. 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 12,000 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.

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, reference year 2015
- NO_2 pollution (annual mean in µg/m³), reference year 2015
- PM_{10} pollution (annual mean in µg/m³), reference year 2015
- $PM_{2.5}$ pollution (annual mean in µg/m³), reference year 2015
- Air pollution index for NO_2, reference year 2015
- Air pollution index for PM_{10}, reference year 2015
- Overall air pollution index for NO_2 and PM_{10}, reference year 2015

Map Description

For the year 2015, NO_2 values above 40 µg/m³ were calculated along 492 road sections with a total length of approx. 60 km.

The most severely polluted road sections are located along Leipziger Straße across Potsdamer Straße and Hauptstraße, along Reinhardstraße and Wilhelmstraße, along Brückenstraße and Friedrichstraße in Mitte, Tiergarten and Schöneberg. Hermannstraße in Neukölln, too, lies well above 50 µg/m³, as do many other road sections. Measuring more than 70 µg/m³ and in some sections even more than 90 µg/m³, Leipziger Straße is Berlin's most heavily polluted street. The annual average limit to protect human health is 40 µg/m³.

The large number of 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 retrofitting 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 2016, the measurement station installed there measured NO_2 concentrations lower than in the previous years.

Along Leipziger Straße and Potsdamer 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.

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 between 2009 and 2015. The reasons for this include the significantly higher emissions of newer 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 year 2015.

The numbers of residents affected by NO_2 limit value exceedance in 2015 are being corrected based on the new calculations. Whereas in 2009 it was predicted that in 2015 approx. 30 km of primary roads and that in 2020 no road sections would exceed the NO_2 limits, the newer calculations have shown that in 2015 Berliners were still exposed to excessive NO_2 pollution along 60 km of road sections.

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