07.03 Traffic Noise in Green and Open Spaces (Edition 1994)

Overview

The background noise in major German cities today is determined predominantly by **traffic noise**. Accordingly, when surveyed on noise pollution from different noise sources, German citizens frequently identify street noise as the primary irritant.

Pollution due to noise in residential and work areas is extreme. However, even during free time, when people want to recuperate, noise harms their well-being. Many parks and meadows, but also large parts of the urban recreational areas are so noise-polluted that their usefulness for peaceful recreation is greatly limited.

In recent years, the driving noise caused by individually-owned motor vehicles has of course receded slightly due to technical innovations; however, due to the increasing numbers and greater speed of cars, the total noise level has climbed.

In addition to the noise of motor vehicles, railways and airplanes, noise pollution also occurs due to industry, trade and building activity. In addition, there is neighborhood noise (i.e., noise from household appliances, musical instruments and lawn mowers, etc.) as well as noise from sports and other leisure activities and events. The intensity of the annoyance from the different noise sources was investigated by the Federal Environmental Agency (cf. Fig. 1).

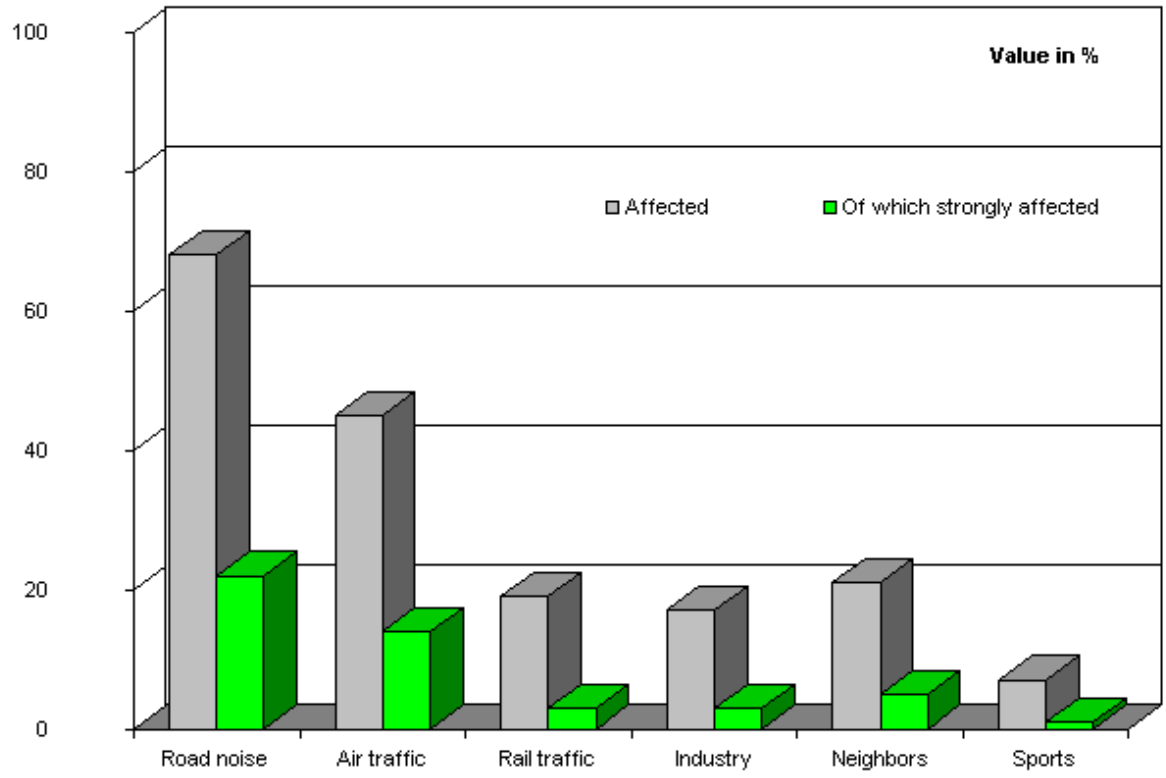

Fig. 1: Noise Pollution of the Population 1992 (Federal Environmental Agency, 1993)

Noise can be defined as a **sound-producing event** which would be considered disturbing by the majority of persons.

Sound events are air pressure oscillations with an alternation of 20 to 20,000 Hz, which can be perceived by the human ear. The perceptibility of sound events by the human ear extend from the audibility threshold, with an effective value of the air pressure oscillation of 0.00002 Pascal (0.0002 µbar), up to the pain threshold, with an effective value of 20 Pascal (= 200 µbar).

To obtain a graduation scale conceivable to the human mind, the sound pressure is indicated in a logarithmic scale of sound pressure levels, by means of the unit "decibels" (dB). In this scale of values, the above-mentioned perceptibility range of the human ear extends from 0 to 120 dB. The sound volume perception of the person is determined by the interaction of the physical sound pressure level (0 to 120 dB) and the frequency (20 to 20,000 Hz). The greatest sensitivity of human ear is in the medium range, between 1,000 and 4,000 Hz. The frequency rating known as the A-rating is oriented toward this circumstance. Noises of low (20 to 1,000 Hz) or high (4,000 to 20,000 Hz) frequency positions are considered with a slighter weighting than medium frequencies when ascertaining the so-called A-sound level. A-sound-pressure levels are indicated in decibels (A) [dB(A)].

The typical A-sound levels occurring from different noise sources are shown in Figure 2.

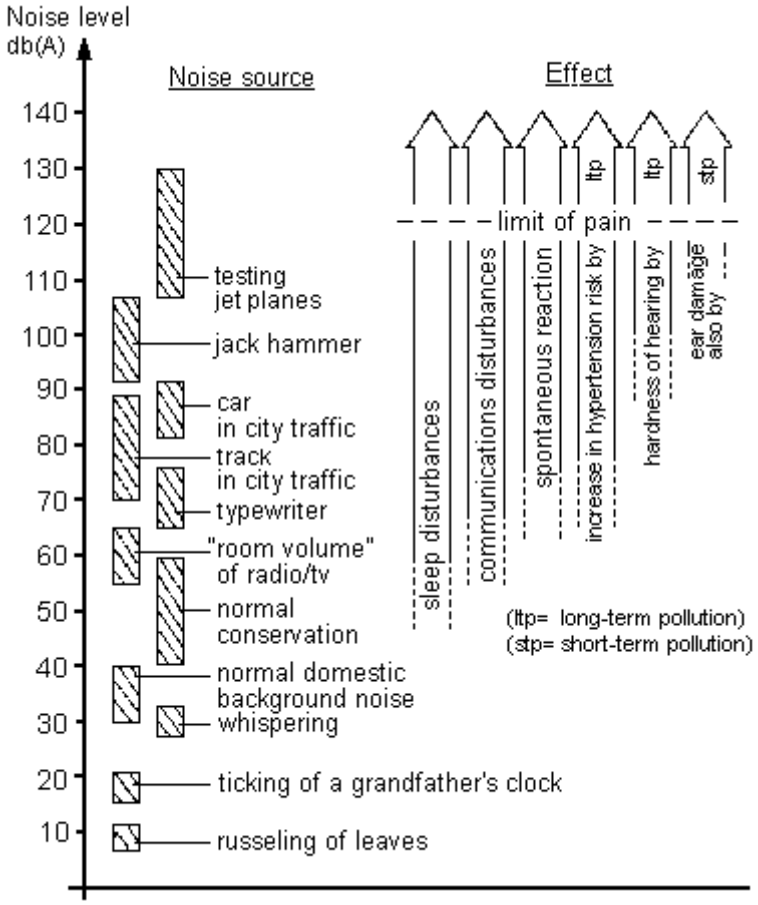

Fig. 2: Noises and the Accompanying Typical A-sound Levels, with Possible Effects

The disturbance effect of noise is rated subjectively very differently. Thus, an open-air pop concert can be perceived by a concert-goer in the first row as pleasant at a sound pressure level of 100 dB(A), and, 1,000 m away and at a sound pressure level of 60 dB(A), be considered disturbing by a resident. Disturbing sounds heard involuntarily are noise.

Traffic-caused sounds are classified by the majority of the population as disturbing, and hence as noise. **Noise** is considered, according to the present state of knowledge, as a risk element which can effect the physical, psychic and social well-being of a person adversely. Alone and/or together with other pollution factors, noise can cause health impairments. The following effects can be distinguished:

- a decrease in the attention span and the power of concentration;

- a reduction of the ability to observe;
- impairment of sleep and relaxation;
- overexcitement of the nervous system;
- high blood pressure;
- cardiovascular comareats;
- damage to the sense of hearing.

The noises occurring in everyday life are frequently exposed to major fluctuations. Their annoyance intensity is described by the **evaluation level**. The evaluation level is determined by a median value, the mean level. This is calculated by means of a somewhat complicated conversion process, in which the sound volume (sound-pressure level) of the occurring noises and the respective duration of their effects are set in a relationship with the duration of the evaluation period, e.g. the 16 hours of daytime, from 6 AM to 10 PM, and the nighttime, from 10 PM to 6 AM.

For traffic noise, the mean level is usually identical with the evaluation level. At traffic-light regulated crossings and junctions, the evaluation level is obtained by an additional factor added to the mean level, in order to take into consideration the particular inconvenience of the braking and start-up noises.

The evaluation level is a measure for average long-term noise pollution. It describes a (theoretical) continual noise of constant volume, which - if it were actually to occur - would calls forth a measure of annoyance equal to that which is actually caused by the different real noises, with their distribution over time, during an equal period. Goal values in urban development planning or fixed limits set by legislation can be compared with this value.

Changes in the traffic volume lead to changes in the evaluation levels. The influence upon this as well as the evaluation of this change by humans are shown in Table 1.

Tab. 1: Influence of the Traffic Volume on the Evaluation

Change of the Traffic Intensity	Change of the Evaluation Level	Level Evaluation of the Change of the Annoyance Intensity
doubling	+ 3 dB(A)	significant increase
halving	- 3 dB(A)	significant decrease
tenfold increase	+ 10 dB(A)	very significant increase
decrease by 10%	- 10 dB(A)	very significant decrease

Tab. 1: Influence of the Traffic Volume on the Evaluation

For urban development planning, acoustical **orientation values** are specified by German Industrial Standard (DIN) 18005, of May 1987, for noise pollution.

The indicated value for green and open spaces sound levels (during the day and at night) is:

- Orientation value: 55 dB(A)

and is to be compared with the evaluation level shown on the map.

In the expert opinion "Study of the Ecological and Urban-compatible Load Capacity due to Motor-vehicle Traffic for the Berlin Inner City“, the following values for recreational zones were recommended in 1991:

- Orientation value 55 dB(A)
- Recommended limit 60 dB(A)

The noise prevention ordinance of Switzerland provides the following values for recreational zones:

- Planning value 50 dB(A)
- Emission limit value 55 dB(A)
- Alarm value 65 dB(A)

The orientation value of 55 dB(A), the target value for green and open spaces according to DIN 18005, is based on results of noise-effect research. According to that, hardly any vegetative reactions and no bodily damage occurs up to this sound pressure level. Also, the psychic and social impairment lies within an acceptable range. With normal diction, a satisfactory conversation is possible for persons conversing at a distance of 2 m.

Statistical Base

The noise pollution caused by Berlin's main traffic arteries was calculated for the forests and approx. 120 parks, allotment gardens and cemeteries.

For the calculation of the traffic noise pollution in the green and open spaces, the average daily traffic volumes (DTV) were taken as a basis on the main traffic arteries. As the statistical base, counts carried out by the Berlin Department of Transportation and Utilities of traffic volumes and proportions of truck traffic through 1992 were used.

In addition to the traffic figures, the following factors have entered in the calculation of the noise pollution:

- permissible maximum speed;
- surface and condition of the roadway;
- mean distance of the roadway from roadside developments;
- kind and mean amount of roadside development (open/closed development);
- traffic lights located at traffic crossings.

These data were ascertained in 1992 by on-the-spot investigations and evaluation of maps. In the eastern part of the city, streetcars were included in the calculation of the traffic noise pollution. The speed of the streetcars was assumed to average 50 km/h; for the frequency (streetcars per hour), schedules were consulted, and condition, composition and situation of the rail beds in the street area were determined by on-the-spot investigations and maps.

The data relevant likewise for the expansion conduct of noise over terrain elevations or molds and noise prevention walls were raised likewise by on-the-spot investigations and map evaluations.

No significant changes in the statistical base used for the map in 1992 are to be expected with regard to the noise pollution of the green and open spaces as a result of the new traffic count of 1993, although the traffic volume has increased. This is because only a considerable increase or decrease would change the pollution picture significantly. An increase or decrease of the traffic volume of 20%, for instance, would shift the isophones (lines of equal evaluation level) by only a few meters.

Methodology

The evaluation level was calculated for the selected areas and shown on the map in color, with a 5 dB(A)-graduation. The only source used for the noise pollution was the data on the motor vehicle and streetcar traffic of the main traffic arteries. Other noise sources, such as the traffic of the side-street network, the rail traffic of the city rail system, the subway and the Federal Railway, air traffic, and industrial and commercial noise, were not considered.

The evaluation level shown on the map was ascertained for the motor vehicle traffic on the basis of the "Guidelines for Noise Prevention on Streets" (RLS-90) and for the streetcar traffic on the basis of the "Guidelines for the Calculation of the Noise Pollution of Rail Traffic" (Schall 03).

For the calculation of the evaluation level, the mean levels were added for motor vehicles and streetcars. Thus, the streetcar noise was fully integrated into the calculation. The allowance of 5 dB(A) for rail traffic ("rail bonus"), which is contained in some guidelines and norms, is not utilized on streetcar noises in the inner-city area. Start-up and braking processes of vehicles at traffic-light-regulated intersections were arrived at by a distance-dependent addition of up to 3 dB(A) into the calculation of the evaluation level.

The calculations were undertaken for the mean ear height of a standing person (about 1.6 m), taking into consideration such large-scale screens as roadside developments, noise-prevention walls or

extended mounds. For a lying person small-scale screening and increased floor insulation can result in up to 10 dB(A) less noise pollution.

The basis of the calculation is the average daily traffic volume mean for all days of a year. In addition to that, a day-time mean is calculated for the time from 6 AM – 10 PM, in order to determine the evaluation of the level per day. The evaluation level thus provides a year-round median value for the time between 6 AM and 10 PM. Particularly on Sundays and holidays, lower levels of noise pollution can occur, because of generally decreased flows of traffic, as is shown on the map. Streets which serve predominantly weekend traffic can, however, show higher noise pollution levels on Sundays and on holidays.

Because of the non-consideration of the side-street network (for this, no data exist from traffic counts), significant deviations of the calculated evaluation level from the actual noise pollution level may occur, particularly in the areas shown as having slight noise pollution (less than 45dB(A)).

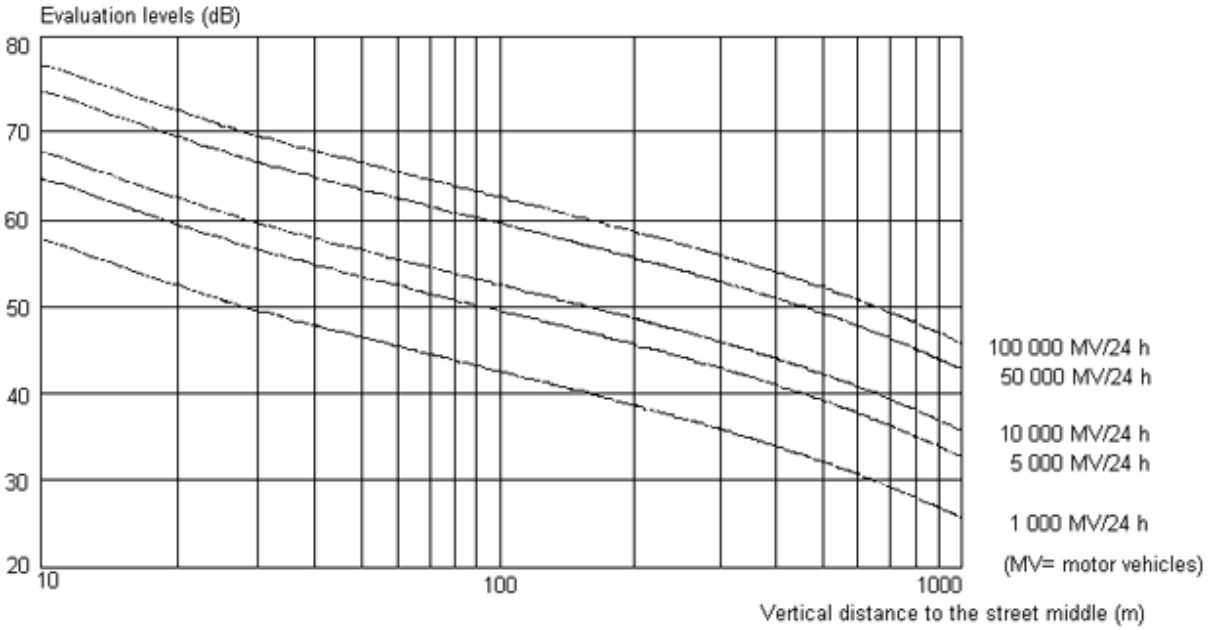

Fig. 3: Evaluation Levels Depending on the Distance from the Street Axis, for Various Traffic Volumes (DTV), Given Free Sound Propagation and a Truck Proportion of 5%. (The hourly traffic volume decisive for the calculation amounts to 6% of the DTV.)

By way of elucidation, the distance-dependent evaluation level is shown in Figure 3 for ear-level on a long, straight street at free sound propagation, for various average daily traffic volumes. The display also covers very lightly traveled (DTV = 1,000 motor vehicles/24 h) and heavily traveled (DTV = 10,000 motor vehicles/24 h) streets of the side-street network, which were considered for the map.

At a traffic volume of 1,000 motor vehicles/24h, the evaluation level at 10 m distance is approx. 57 dB(A), and at 50-plus m distance, it is approx. 46 dB(A). This means that, due to the generalization undertaken for the map, even consideration of side-streets with a DTV of less than 1,000 motor vehicles/24h no would yield no other rating for the park. This is different, however, in the case of more typical side-streets, which are on as a rule traveled more heavily. Even at a traffic volume of 10,000 motor vehicles/24h, far-reaching noise pollution occurs on adjacent green spaces. Here, the evaluation level totals at a 50 m distance are still 56 dB(A); an inclusion of this side-street would thus yield a changed display of the affected areas of the adjacent green spaces on the map.

As a rule one can proceed on the assumption that the noise of these side-streets effects the green spaces to a depth of about 50 – 250 m, and causes a evaluation level of approx. 45-50 dB(A).

Small-area effective screenings (e.g. behind rotundas or small embankments) can cause lower evaluation levels in some cases than those indicated on the map. These lower evaluation levels, like higher evaluation levels in direct street proximity, cannot be shown at the present scale. The scale allows for a color-resolution of at least 50 m. Therefore, the color value indicated on the maps directly at the street describes the evaluation level at 50 m distance from the street. In the pedestrian area of the street, the evaluation levels can therefore be up to 10 dB(A) above the value indicated on the map.

The main traffic arteries, which provides the basis for the calculation of the noise in the open spaces, is shown on the map separately, with the calculated evaluation levels. The mean evaluation level of the streets is the averaged evaluation level of both sides of the street at the building edge. For street segments without development on both sides, the level at the roadside has been given. The values serve here solely for the orientation of the street segments and their sound levels which are the basis for the calculation of the noise in the open spaces. A more differentiated and more current representation of noise in built-up areas is found on Map 07.02 (SenStadtUm).

In addition, the noise prevention areas of the airports are marked on the map. In addition to the noise pollution of the open spaces due to the motor vehicle -traffic, which is shown, there is also noise pollution in the affected areas due to air traffic. A simple addition of the both sources of the noise is not permissible, however. For the Gatow and Tempelhof airports, no aircraft noise protection zones have up to now been ascertained. The presented protection zones of the Schönefeld Airport are of preliminary character and have not yet finally established (cf. State Development Corporation for Urban Development, Housing and Transportation of the State of Brandenburg 1994). By contrast, the noise prevention area of the Tegel Airport is legally defined and mandated by means ordinance.

Map Description

Especially strong and large-scale infringements of the target value of 55 dB(A) specified by the German Industrial Standard (DIN) 18005 occur in the area of the Avus freeway. In this case, the noise pollution results significantly from a rush-hour corridor. Due to a network of main traffic arteries, the Tiergarten is affected by noise pollution, especially in the area of the Grosser Stern. In both cases, free sound propagation exists without significant decreases in level due to screening. The Treptow Park, too, is extensively affected by traffic noise, which is associated with a considerable decrease of the recreational value.

Because of the physically entailed characteristics of sound propagation, courses of isophonic lines which are difficult to understand can occur, particularly behind screening facilities. For the consideration and interpretation of this, the following points are to be primarily considered:

- **Screening arrangements** (noise prevention walls, closed rows of houses etc.) are especially effective in the proximity zone. In some few areas, the green and open spaces are protected by buildings located in front, toward the traffic noise. Although a closed roadside development with high houses on both sides means major noise pollution for the street area and/or for the roadside developments themselves, the acoustical advantage of a closed roadside development facing an open development for the behind it lying green and open spaces shows itself here. Due to the closed roadside development with four-story apartment houses (that corresponds to an amount of 15 to 20 m) can be decreased the noise pollution of the behind it lying areas large-area around up to 20 dB(A) (e.g. in the Hasenheide park).

  Noise prevention wound display against it relatively slight wall amounts of up to 5 m. Still level decreases can be reached with these noise prevention arrangements in the distance up to 300 m of the street middle still by 10 – 15 dB(A).

- The **distance-conditional level decrease** in the distance radius of 50 – 1,000 m of the axis of a long street totals about 4 dB(A) per distance doubling. If one departs for instance at an excursion through the Grunewald of 50 on 100 m distance from the middle of the Avus freeway, to reach so sinks the perceived noise level around approx. 4 dB(A). Around a further decrease of the noise level by 4 dB(A), the hiker must depart around in addition 100 m of the Avus freeway up to a distance from 200 m. An approximating or removing from the highway around 100 m in the distance radius of 800 m leads against it for a lifting and/or layering of the noise level around approx. 1 dB(A), which as volume change with the human ear hardly is to be perceived. Because of these expansion conditions the calculated isophone lie nearby from streets more densely together, and in larger distances prevail uniform noise pollution, which are marked by a constant color on the map.

Altogether becomes clear, that the **majority of the inner-city recreational areas** and large parts of the forests serving as urban recreation areas are **hurt** in the outside area **considerably by the motor vehicle noise**. If one compares the noise values with the orientation value the German Industrial Standard (DIN) 18005 from 55 dB(A), shows itself, that this value is overstepped in all green spaces in the area of the internal city rail circle line partly considerably. With it the there anyhow bad quantitative provision is hurt with green and open spaces in addition in their quality clearly.

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