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# TRAFFIC NOISE MEASUREMENTS IN ANTWERP AND BRUSSELS AND THEIR RELATION WITH ANNOYANCE

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This work is a part of a large scale traffic noise survey in two Belgian cities: Antwerp and Brussels.

A social survey (interviews of 1800 persons) was coupled with intensive acoustical measurements (40 places in Antwerp and 25 in Brussels, covering 1100 hours of measurements). Part I concerns the physical measurements, analysis and synthesis of the data. A prediction method based on these measurements is also included. Part II concerns the results of the enquiry about annoyance and its correlation with physical quantities.

## PART I: PHYSICAL MEASUREMENTS

### 1. Measurement facilities

A technical team of 3 persons disposed of an autonomous measuring car equiped with two independant measuring systems composed out of:

– a microphone with special protection against humidity;

– a measuring amplifier;

– a level recorder giving continous registration of the sound level as a function of time;

– statistical analyzers with a resolution of 2 dB($A$) and a sampling rate of 10 times per second;

– an automatic photo unit for the registration of the state of the statistical counters each 10 minutes;

At least one operator was always present during the measurements.

### 2. Measurements

Contin uous 24-hours measurements were done at 40 places in Antwerp while the total observation periods at 25 places in Brussels were reduced to 12 hours.

The microphone was placed at the edge of the kerbside at a height of 1.2 m.

The measurement sites covered the whole range from very quite places to very noisy and they presented mainly free flowing traffic conditions.

During the acoustical measurements the traffic intensity was automatically counted.

In order to study the effect of parameters which influence the sound level, series of additional measurements were done simultaneously, e.g. in respect with streetwidth, streetheight, ground cover, traffic lights etc.

In this context a study was also made on the reverberation phenomena in town streets, the results of which are published in Acustica [1].

For each measurement site data are presented as follows:

— exact location and description;

— statistical distribution histograms per hour;

— $L_{eq}$, $L_{10}$, $L_{90}$ levels as a function of time (hourly values);

— For three periods namely: day (7-19h), evening (19-23h) and night (23-7h), mean values were calculated of the following quantities: $L_1$, $L_5$, $L_{10}$, $L_{50}$, $L_{90}$, $L_{95}$, $L_{99}$, $L_{eq}$, *TNI*, *NPL*, the standard deviation and $L_{dn}$ over 24 hours.

### 3. Analysis of the measurement results

The most important information is given by the statistical noise distribution as a function of time. All these distributions are given in the final report.

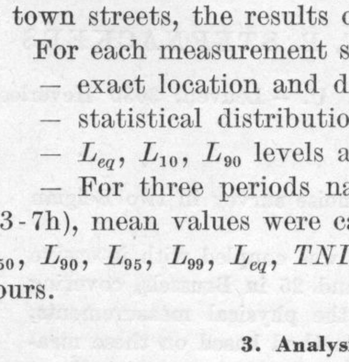


Fig. 1. Evaluation of the noise distribution with increasing traffic flow

In this paper only one typical noise distribution is given, e.g. the evaluation of the noise distribution with increasing traffic intensity in Fig. 1.

To have a good overall picture of the traffic noise the $L_{eq}$, the $L_{10}$ and $L_{90}$ sound levels are presented as a function of time. In Fig. 2 and 3 those values are given for a street with respectively low and dense traffic flow. The $L_{eq}$-values are nearly constant during the day period (7-19h) for streets with dense traffic flow.

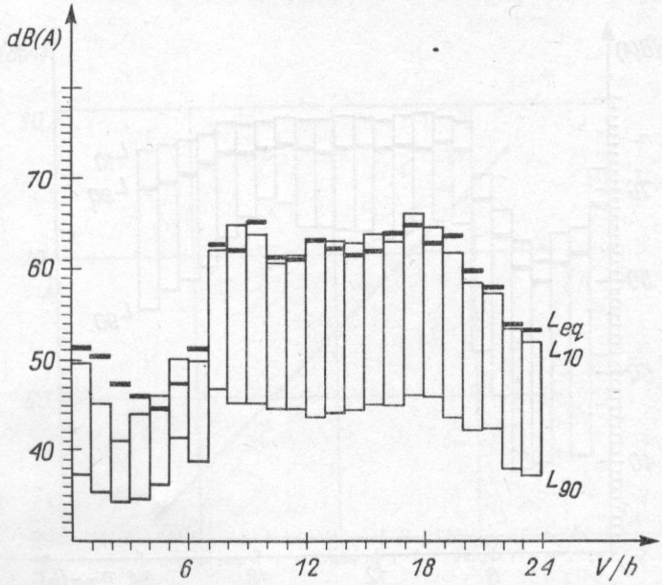


Fig. 2. Werkstraat – low traffic flow $L_{eq}$ and the noise climate ($L_{10}$ - $L_{90}$) as a function of time

For streets with relative low traffic flow there can be some greater variation. The mean $L_{eq}$-value over this period gives the best correlation with the enquiry about annoyance (cf. Part II).

For the evening and night periods the variation is much higher. This is also the case for the $L_{10}$ and $L_{90}$ values. It is less significant to speak about mean values for these both periods.

The $L_{10}$-values are comparable with $L_{eq}$-values in the case of dense traffic flow. They give values which are appr. 3 dB higher than the $L_{eq}$-values (see Fig. 3).

In streets with low traffic flow, the $L_{10}$-values even can give smaller levels than the $L_{eq}$-values. For normal (Gaussian) distributions this can be explained by the equation $L_{eq} = L_{50} + 0.115\sigma^2$. As traffic noise is not normally distributed, the relationship of $L_{eq}$ with other percentiles of distribution can even be determined experimentally. $L_{eq}$ will always be greater than $L_{50}$.

In order to make correlations with the enquiry about annoyance mean values of $L_1$, $L_{10}$, $L_{50}$, $L_{90}$, $L_{eq}$, $TNI$, $NPL$, vehicles/hour and $L_{dn}$ were calculated during the three above mentioned periods [2].

#### 4. Synthesis and prognosis

*The $L_{eq}$-levels.* $L_{eq}$-levels roughly give a 3 dB($A$) increase per doubling of the amount of vehicles per hour. This is shown in Fig. 4, where the $L_{eq}$-levels per hour are given as a function of traffic intensity. All the measuring points fall nearly within the $\pm 5$ dB($A$) region.

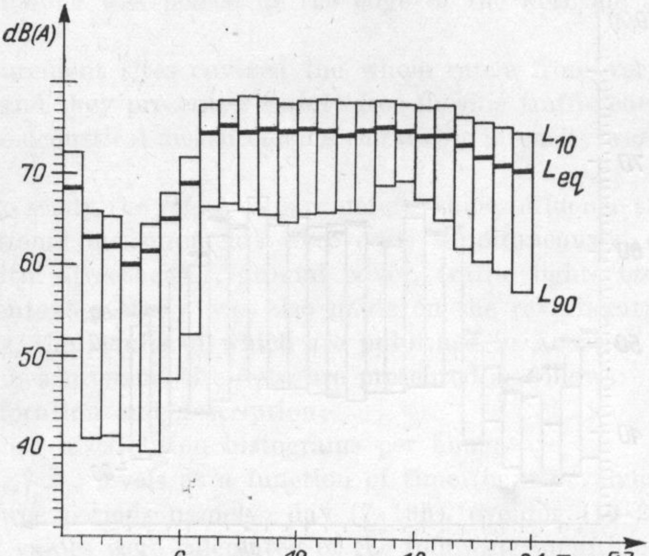


Fig. 3. Plantin en Moretusleki – dense traffic flow $L_{eq}$ and the noise climate ($L_{10}$-$L_{90}$) a a function of time

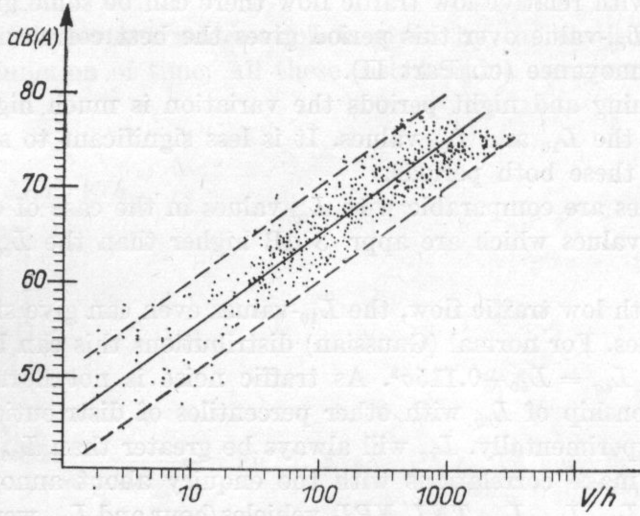


Fig. 4. $L_{eq}$ levels per hour as a function of traffic intensities (Antwerp)
The measuring points are nearly completely within the ±5 dB($A$) region

The spread of these points around the theoretical straight line is caused by:

– errors of measurement due to foreign noise sources. The influence of these noises can be statistically smoothed out by taking mean values over larger observation periods. Fig. 4 turns then over to Fig. 5.

– a systematic influence of the ground cover. Fig. 6 shows mean lines for respectively stone cover and asphalt (difference appr. 2.4 dB($A$)).

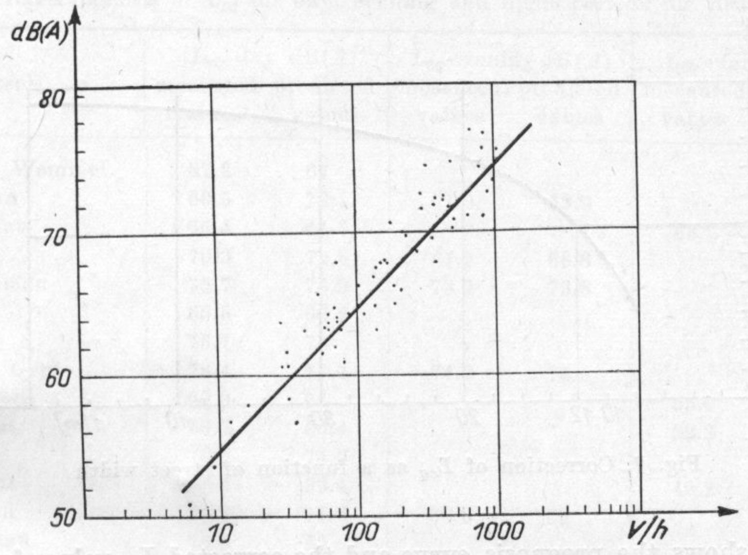


Fig. 5. Mean values for $L_{eq}$ as a function of traffic intensities. Day – Evening – Night

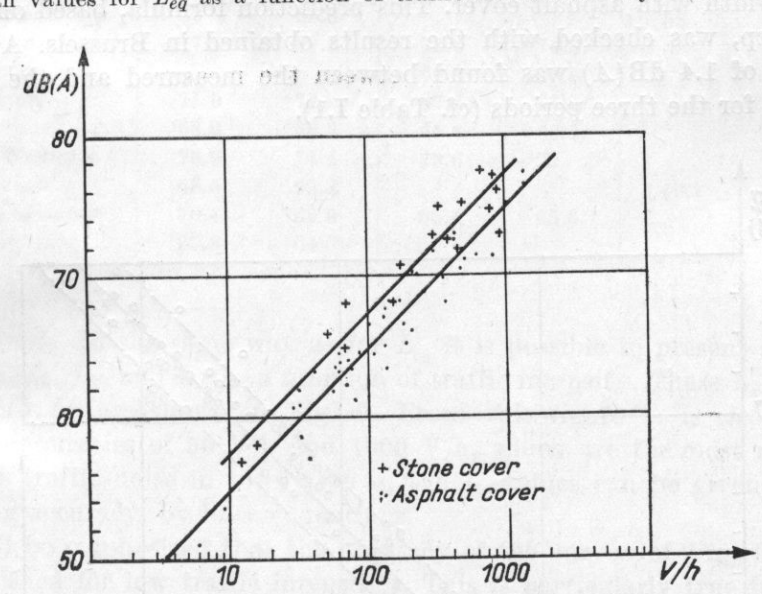


Fig. 6. Mean values for $L_{eq}$ as a function of traffic intensities

– a systematic influence of the streetwidth. This influence was determined partly on a theoretical and partly on an experimental basis. Fig. 7 gives the proposed correction factor.

Summarised the following prediction formula can be used

$$L_{eq} = 10 \log I + 44.8 + C_1 + C_2,$$

where $I$ is the traffic intensity (vehicles/hour). $C_1$ is the correction for ground cover, $C_2$ is the correction for streetwidth.

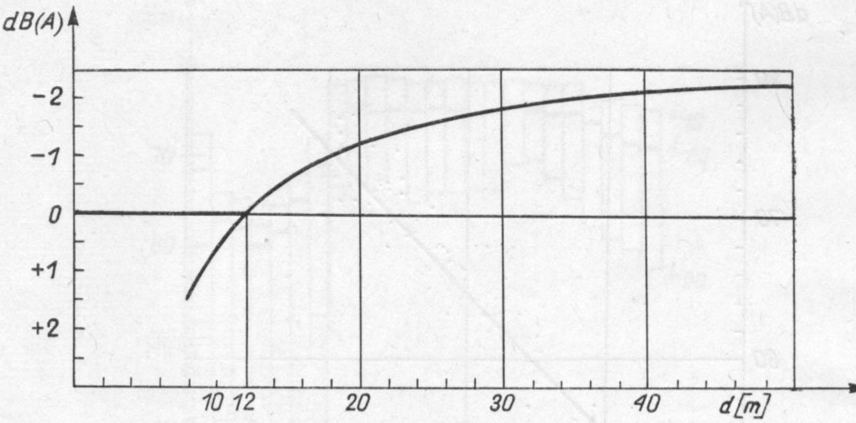


Fig. 7. Correction of $L_{eq}$ as a function of street width

Fig. 8 shows the prognosis curve and the corrected $L_{eq}$-values for a street of 12 m width with asphalt cover. This prediction formula, based on the data of Antwerp, was checked with the results obtained in Brussels. A standard deviation of 1.4 dB($A$) was found between the measured and the predicted $L_{eq}$-values for the three periods (cf. Table I.1).

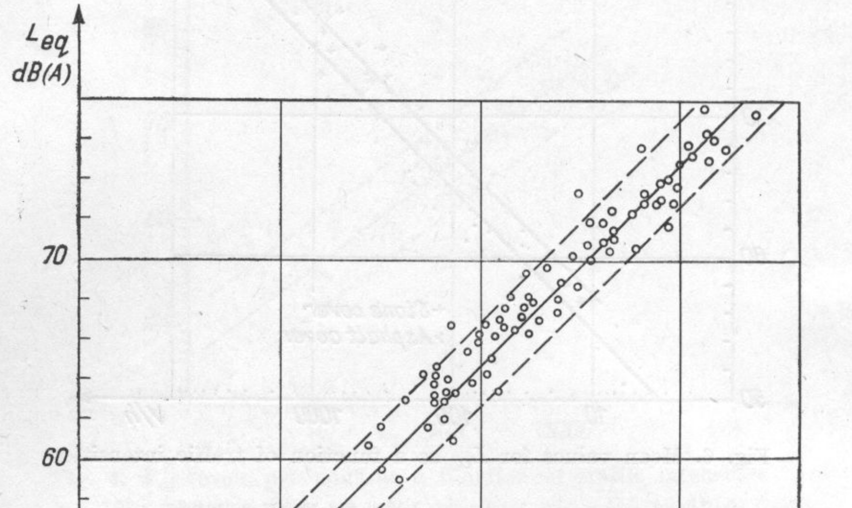


Fig. 8. Prognosis and measuring results for a 12 m street width an asphalt cover

**Table I.1.** Prognosis of $L_{eq}$ for day, evening and night periods for Brussels

| Brussels | $L_{eq}$ day dB($A$) measured values | $L_{eq}$ day dB($A$) predicted values | $L_{eq}$ evening dB($A$) measured values | $L_{eq}$ evening dB($A$) predicted values | $L_{eq}$ night dB($A$) measured values | $L_{eq}$ night dB($A$) predicted values |
|---|---|---|---|---|---|---|
| Steenweg op Wemmel | 67.2 | 67 | | | | |
| C. Woestelaan | 69.5 | 72.1 | 67.9 | 68.9 | | |
| Heidekenstraat | 65.4 | 64.7 | | | 55.8 | 55.3 |
| Vriheidslaan | 70.3 | 72.6 | 67.7 | 68.8 | | |
| Keizer Karellaan | 75.7 | 76.9 | 73.7 | 73.8 | | |
| Basilieklaan | 65.6 | 66.2 | | | | |
| Piersstraat | 75.1 | 74 | | | | |
| Steenweg op Gent | 78.4 | 77.4 | 74.2 | 73.5 | | |
| Koekelberglaan | 65.9 | 64 | | | 55.0 | 54.4 |
| Begijnenstraat | 66.2 | 66.4 | | | 52.2 | 53.5 |
| Parklaan | 72.3 | 74.6 | | | | |
| J. Robiestraat | 62.5 | 59.4 | | | 49.2 | 48 |
| P. Jansonlaan | 71.6 | 71.6 | 68.6 | 69 | | |
| Clemenceaulaan | 75.3 | 76 | | | | |
| Demolderlaan | 70.3 | 69 | | | 58 | 59 |
| P. Deshanellaan | 69 | 68.8 | | | 58 | 55.8 |
| Lambermontlaan | 77.1 | 77.5 | 73.6 | 74.3 | | |
| Plaskylaan | | | 69.2 | 68.5 | | |
| F. Guillaumelaan | 71.9 | 72 | 67.9 | 67.2 | | |
| Slegerslaan | 68.9 | 69.3 | 64.4 | 66.4 | | |
| Steenweg op Wemmel | 76.9 | 74.4 | 73.6 | 72 | | |
| Hertogendalstraat | 63.5 | 63.2 | | | 49.1 | 49.8 |
| T. Van Der Elststraat | 70.4 | 69.9 | 65.4 | 65.5 | | |
| Gem. Godshuisstraat | 63.8 | 64 | | | | |

*The $L_x$-levels.* In the same way as for $L_{eq}$ it is possible to present a mean value for $L_1$, $L_{10}$, $L_{50}$ and $L_{eq}$ as a function of traffic intensity. These $L_x$-indices compared with $L_{eq}$ are shown in Fig. 9. From this figure it is clear that, between the intensities of 50 V/h and 1000 V/h, which are the most realistic situations for traffic noise in town streets, the $L_x$-values can be given within the measuring accuracy, by linear equations.

It should be emphasized that the accuracy of the curves of Fig. 9 is severely diminished for low traffic intensities. This is particularly true for high $x$-indices.

## PART II: ENQUIRY CONCERNING ANNOYANCE

In part I the physical aspects of the research program were explained. Another major aim of this research work consisted in determining the relation between objective characteristics of noise and the annoyance.

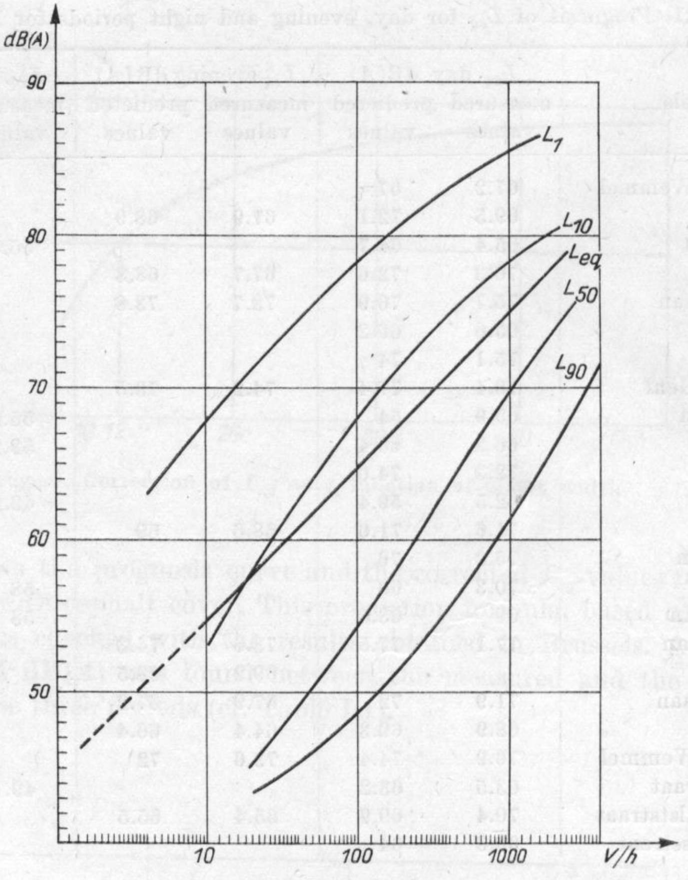


Fig. 9. Mean values for 40 streets

### II.1. General information about the survey

A large-scale survey was carried out in two cities: Antwerp (1975) and Brussels (1976). In Table II.1 more details of these investigations are shown.

The subjects were invited to cooperate by letter. A second letter was mailed if the first one was not replied positively by at least 25 subjects. If this number

**Table II.1.** Extent of the surveys in Antwerp and Brussels

| Town | Number of streets | Number of interrogated subjects |
|---|---|---|
| Antwerp | 40 | 1279 |
| Brussels | 25 | 496 |
| Totals | 65 | 1775 |

was not yet reached after two written invitations, the collaborators ringed the bell of every house until they had interrogated 25 inhabitants.

The subjects who replied positively to our invitation, were interrogated at home by one of our collaborators. During this interview a questionnaire was presented to the subjects, who marked themselves the answers.

The questionnaire was composed of about 70 questions. The subjects gave an answer by putting a stripe on a full-linescale of 155 millimetres long. For example:

5. We would like to know your opinion on the traffic noise you hear during the day

Not disturbing at all ______________________________ Very disturbing

After each investigation (Antwerp, Brussels) a factor analysis was performed on the data. The results of this method enabled us to purify the questionnaire: questions with a loading lower than 0.500 were discarded for the following investigation, since they were of little use.

However, the factorial structure of the investigations was remarkably stable through the three investigations, and the high-loading items did not switch from one factor to another.

The results of the factor analysis further show that we can compute scores on five factors:

1. Disturbance of diurnal activities by traffic noise.
2. Nocturnal disturbance.
3. General statements on traffic noise.
4. Supposed physical (physiological) effects of traffic noise.
5. Satisfaction with the environment.

### II.2. Some remarks upon the research method

Results of a survey can be influenced by the method. In fact, our survey was carried out with subjects who cooperated of their own free will, without any reward. In this circumstances it is possible that only highly annoyed inhabitants of a town make an appointment with our collaborators to express their displeasure.

However, there are different reasons why we can contradict this supposition:

(a) All letters to the inhabitants contained the following sentence: "Even if your quarter is quiet, or if you are not annoyed by traffic noise, your cooperation is very important, since we have to investigate quiet as well as noisy streets in order to obtained clear and useful results."

(b) In two streets the survey was carried out while the inhabitants were not previously notified or invited to cooperate: the collaborators ringed from door to door. In these two streets higher mean annoyance scores were computed than in streets with a comparable traffic noise level.

(c) The correlation between the percentage replied letters and the $L_{eq}$ is not significant (see Table II.2).

The negative correlations in Brussels even suggest that more inhabitants of quiet streets are willing to cooperate.

**Table II.2.** Correlations between the percentage replied letters and the $L_{eq}$

| % replied | Antwerp | Brussels |
|---|---|---|
| 1st letter – $L_{eq}$ (day) | 0.05 | −0.12 |
| 1st letter – $L_{eq}$ (night) | 0.02 | −0.60 |
| 2nd letter – $L_{eq}$ (day) | 0.02 | −0.14 |
| 2nd letter – $L_{eq}$ (night) | 0.02 | −0.06 |

(d) There should be no correlation at all between the annoyance and noise in the case that only highly annoyed people cooperate.

(e) The representativity of the sample is good.

We determined the relation between annoyance and noise by measuring the traffic noise outside, and by comparing the results of these measurements with the annoyance the inhabitants claimed to support. These people of course live inside their appartment. This is a kind of contradiction, and our method has been criticized for this reason: we should measure the traffic noise inside the appartment where we interview an inhabitant.

We could refute this argument by pointing out that by our knowledge, this method has not been used until now. But of course, this is not a valid refutation of the fundamental objections to the reliability of the method.

However, there is a second argument in favour of our method. In all the investigations we know, the correlation between the individual annoyance and the noise level is poor. Research workers usually explain this lack of correlation by pointing out that the reaction of an inhabitant to traffic noise is not only determined by the intensity. They state that physiological, psychological, sociological and environmental factors are at least as important as the intensity of the traffic noise. In Table II.3 we give a clear example of this lack of correlation between individual annoyance scores and the noise intensity ($r$ = correlation coefficient).

**Table II.3.** Correlation between the annoyance scores on the first factor (disturbance of diurnal activities) and the noise indices (investigated town : Antwerp)

| | Individual annoyance scores | | Mean annoyance scores | |
|---|---|---|---|---|
| | $r$ | $r^2$ | $\bar{r}$ | $\bar{r}^2$ |
| $L_1$ day | 0.40 | 0.16 | 0.83 | 0.69 |
| $L_{10}$ day | 0.42 | 0.18 | 0.85 | 0.72 |
| $L_{50}$ day | 0.42 | 0.18 | 0.86 | 0.74 |
| $L_{90}$ day | 0.38 | 0.14 | 0.78 | 0.61 |
| $L_{eq}$ day | 0.42 | 0.18 | 0.86 | 0.74 |

This table shows that our investigation in Antwerp is no exception to the rule that has been described by other research workers: the intensity of noise determines maximally 18 % of the variance of the individual annoyance. The mean annoyance on the contrary is determined for maximally 74 % by the same intensity.

This large difference between 74 % and 18 % enables us to suppose that we will be more lucky in computing the relation between individual annoyance and noise, if we pay attention to the causes of individual differences in annoyance, rather than by measuring the traffic noise in every appartment or dwelling. Indeed, when mean annoyance scores are computed, we minimize approximatively the influence of physiological, psychological, sociological and environmental factors.

## II.3. The relation between noise and annoyance

In Table II.4 we can see that the correlation between the disturbance of diurnal activities and the diurnal traffic noise is good and highly significant. The other variables (nocturnal disturbance, general statements on traffic noise, supposed physiological effects, and satisfaction with the environment), correlate rather poorly.

**Table II.4.** Correlation between the mean factorscores and the noise indices (day)

| | | Antwerp | | | | | Brussels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FS1 | FS2 | FS3 | FS4 | FS5 | FS1 | FS2 | FS3 | FS4 | FS5 |
| $L_1$ | $r =$ | 0.83 | 0.15 | −0.04 | 0.32 | 0.11 | 0.82 | 0.55 | −0.35 | −0.15 | 0.52 |
| | $p =$ | 0.001 | 0.184 | 0.415 | 0.021 | 0.241 | 0.001 | 0.003 | 0.047 | 0.236 | 0.004 |
| $L_{10}$ | $r =$ | 0.85 | 0.11 | 0.00 | 0.32 | −0.20 | 0.86 | 0.36 | −0.40 | −0.18 | 0.51 |
| | $p =$ | 0.001 | 0.250 | 0.496 | 0.023 | 0.115 | 0.001 | 0.043 | 0.027 | 0.195 | 0.005 |
| $L_{50}$ | $r =$ | 0.86 | 0.13 | −0.04 | 0.38 | −0.21 | 0.83 | 0.29 | −0.25 | −0.17 | 0.51 |
| | $p =$ | 0.001 | 0.220 | 0.393 | 0.007 | 0.094 | 0.001 | 0.086 | 0.117 | 0.220 | 0.005 |
| $L_{90}$ | $r =$ | 0.78 | 0.11 | −0.09 | 0.42 | −0.14 | 0.78 | 0.27 | −0.14 | −0.13 | 0.47 |
| | $p =$ | 0.001 | 0.241 | 0.292 | 0.003 | 0.189 | 0.001 | 0.101 | 0.259 | 0.266 | 0.010 |
| $L_{eq}$ | $r =$ | 0.86 | 0.14 | −0.03 | 0.33 | −0.18 | 0.86 | 0.41 | −0.32 | −0.15 | 0.56 |
| | $p =$ | 0.001 | 0.199 | 0.419 | 0.019 | 0.139 | 0.001 | 0.023 | 0.062 | 0.239 | 0.002 |
| $TNI$ | $r =$ | 0.47 | 0.04 | 0.13 | −0.02 | −0.16 | 0.51 | 0.38 | −0.53 | −0.14 | 0.20 |
| | $p =$ | 0.001 | 0.405 | 0.220 | 0.450 | 0.168 | 0.005 | 0.034 | 0.004 | 0.255 | 0.121 |
| $NPL$ | $r =$ | 0.70 | 0.12 | 0.05 | 0.16 | −0.16 | 0.76 | 0.50 | −0.48 | −0.16 | 0.43 |
| | $p =$ | 0.001 | 0.239 | 0.391 | 0.163 | 0.160 | 0.001 | 0.007 | 0.009 | 0.235 | 0.019 |
| $\log_{10} V/h$ | $r =$ | 0.83 | 0.04 | −0.06 | 0.31 | −0.18 | 0.85 | 0.18 | −0.24 | −0.19 | 0.44 |
| | $p =$ | 0.001 | 0.417 | 0.365 | 0.031 | 0.146 | 0.001 | 0.209 | 0.135 | 0.200 | 0.018 |

FS1: Disturbance of diurnal activities by traffic noise
FS2: Nocturnal disturbance
FS3: General statements on traffic noise;
FS4: Supposed physical (physiological) effects of traffic noise
FS5: Satisfaction with the environment

When we compare the results in Table II.4 with those of Table II.5, where the correlation between the different annoyance variables with the nocturnal traffic noise is given, it is quite surprising that we cannot find large differences. In fact, the disturbance of diurnal activities correlates as well with the measurements of nocturnal traffic noise as with the measurements of diurnal traffic

**Table II.5.** Correlation between the mean factorscores and the noise indices (night)

| | | Antwerp | | | | | Brussels | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FS1 | FS2 | FS3 | FS4 | FS5 | FS1 | FS2 | FS3 | FS4 | FS5 |
| $L_1$ | $r =$ | 0.82 | 0.12 | 0.05 | 0.40 | −0.22 | 0.50 | 0.46 | −0.21 | −0.05 | 0.54 |
| | $p =$ | 0.001 | 0.229 | 0.392 | 0.007 | 0.093 | 0.069 | 0.091 | 0.284 | 0.449 | 0.055 |
| $L_{10}$ | $r =$ | 0.80 | 0.15 | −0.08 | 0.41 | −0.23 | 0.48 | 0.54 | −0.01 | 0.02 | 0.61 |
| | $p =$ | 0.001 | 0.187 | 0.317 | 0.005 | 0.084 | 0.079 | 0.053 | 0.485 | 0.478 | 0.029 |
| $L_{50}$ | $r =$ | 0.68 | 0.21 | −0.17 | 0.29 | −0.13 | 0.40 | 0.39 | 0.44 | 0.21 | 0.10 |
| | $p =$ | 0.001 | 0.103 | 0.160 | 0.038 | 0.226 | 0.125 | 0.132 | 0.104 | 0.277 | 0.391 |
| $L_{90}$ | $r =$ | 0.22 | −0.04 | −0.10 | 0.16 | 0.02 | 0.50 | 0.01 | 0.41 | 0.12 | −0.26 |
| | $p =$ | 0.089 | 0.418 | 0.278 | 0.164 | 0.446 | 0.069 | 0.492 | 0.120 | 0.370 | 0.235 |
| $L_{eq}$ | $r =$ | 0.82 | 0.14 | −0.02 | 0.41 | −0.18 | 0.47 | 0.52 | −0.16 | −0.01 | 0.58 |
| | $p =$ | 0.001 | 0.201 | 0.456 | 0.005 | 0.142 | 0.085 | 0.062 | 0.333 | 0.490 | 0.039 |
| *TNI* | $r =$ | 0.80 | 0.17 | −0.06 | 0.39 | −0.26 | 0.25 | 0.52 | −0.19 | −0.03 | 0.71 |
| | $p =$ | 0.001 | 0.147 | 0.373 | 0.007 | 0.059 | 0.240 | 0.06 | 0.300 | 0.465 | 0.011 |
| *NPL* | $r =$ | 0.81 | 0.14 | 0.00 | 0.41 | −0.25 | 0.35 | 0.56 | −0.19 | 0.01 | 0.71 |
| | $p =$ | 0.001 | 0.202 | 0.497 | 0.005 | 0.064 | 0.163 | 0.047 | 0.302 | 0.487 | 0.011 |
| $\log_{10} V/h$ | $r =$ | 0.82 | 0.07 | −0.09 | 0.25 | −0.13 | 0.66 | 0.37 | 0.35 | 0.38 | −0.49 |
| | $p =$ | 0.001 | 0.352 | 0.316 | 0.094 | 0.251 | 0.052 | 0.206 | 0.220 | 0.202 | 0.135 |

FS1: Disturbance of diurnal activities by traffic noise
FS2: Nocturnal disturbance
FS3: General statements on traffic noise
FS4: Supposed physical (physiological) effects of traffic noise
FS5: Satisfaction with the environment

noise, while the nocturnal disturbance correlates as poorly with the nocturnal traffic noise as with the diurnal traffic noise! In our investigation in Brussels the correlation between nocturnal disturbance and nocturnal traffic noise is better, but not convincing!

There are several reasons why nocturnal disturbance correlates poorly:

1. During the survey the research workers observed that some inhabitants of quiet streets declared themselves highly disturbed by the few passing cars at night, while in noisy streets some inhabitants declared that they were never disturbed by nocturnal traffic noise. Presumedly, this is a kind of "natural selection": people who cannot sleep in a noisy environment, will not move into a noisy quarter, or will not stay there for a long time.

2. In Antwerp and Brussels, the noise levels at night are proportionally lower to the diurnal noise levels. This means that noisy streets are also noisy at night, and quiet streets will also be quiet during the night period. This is very clear when we compute the correlation between the diurnal noise measu-

rements and the nocturnal measurements. The correlation between $L_1$ (Day) and $L_1$ (night) is 0.93; between $L_{10}$ (Day) and $L_{10}$ (night): 0.86. Reasoning in statistical terms: the correlation between diurnal noise levels ($A$) and nocturnal noise levels ($B$) is high.

Since the correlation between diurnal noise levels ($A$) and nocturnal disturbance ($C$) is low, the correlation between nocturnal noise levels ($B$) and nocturnal disturbance ($C$) will also be low: $ArB = +++$, $ArC = ---$, thus $BrC = ---$.

Fig. 10 shows the relation between the different noise indices and the variable (factor) 1: disturbance of diurnal activities. These figures

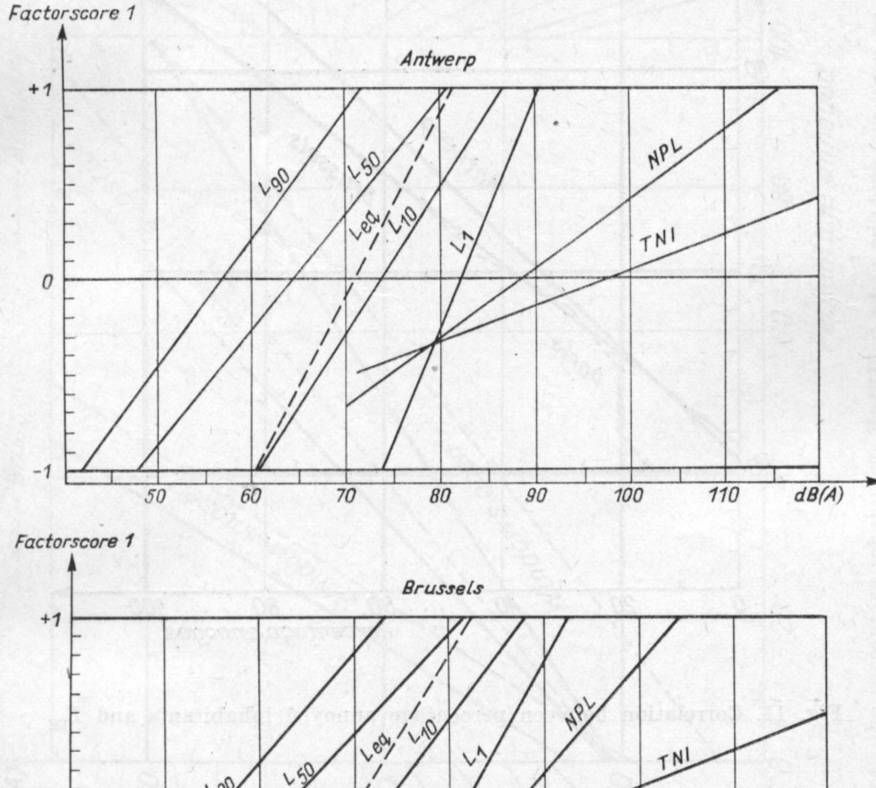


Fig. 10. Correlation between different noise indices and disturbance of diurnal activities (Faktorscore 1)

show clearly the different slopes and positions of $L_1$, $L_{10}$, $L_{50}$ $L_{eq}$, $NPL$ and $TNI$ (Day period).

In every street where the survey was carried out, the percentage of inhabitants who declared themselves annoyed, was calculated. The following Fig. 11 shows the relation between the percentage of inhabitants who declare

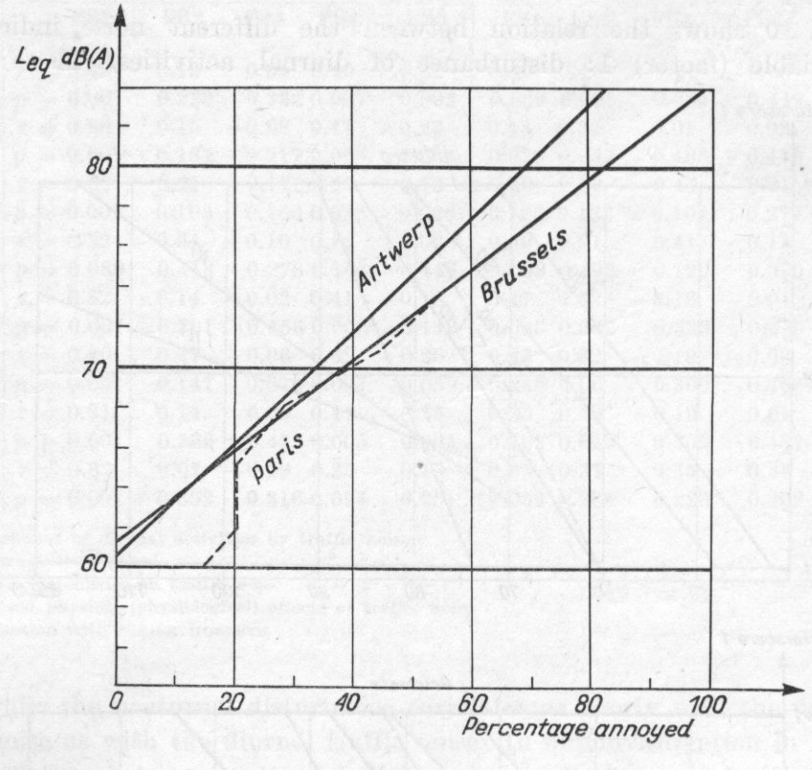


Fig. 11. Correlation between percentage annoyed inhabitants and $L_{eq}$

that the diurnal traffic noise they hear in their appartment is annoying. At $\pm 72$ dB$(A)$ 50 % of the inhabitants are annoyed. In this same figure the results of a French survey [3] are given. We can see that there is good agreement between the two studies.

Fig. 12 shows the relation between the percentage of people who declare their diurnal activities disturbed by traffic noise when the windows are open or closed. The regression line on the general question (Fig. 11): "What is your opinion on the traffic noise you hear during the day?" is also repeated in this Fig. 12.

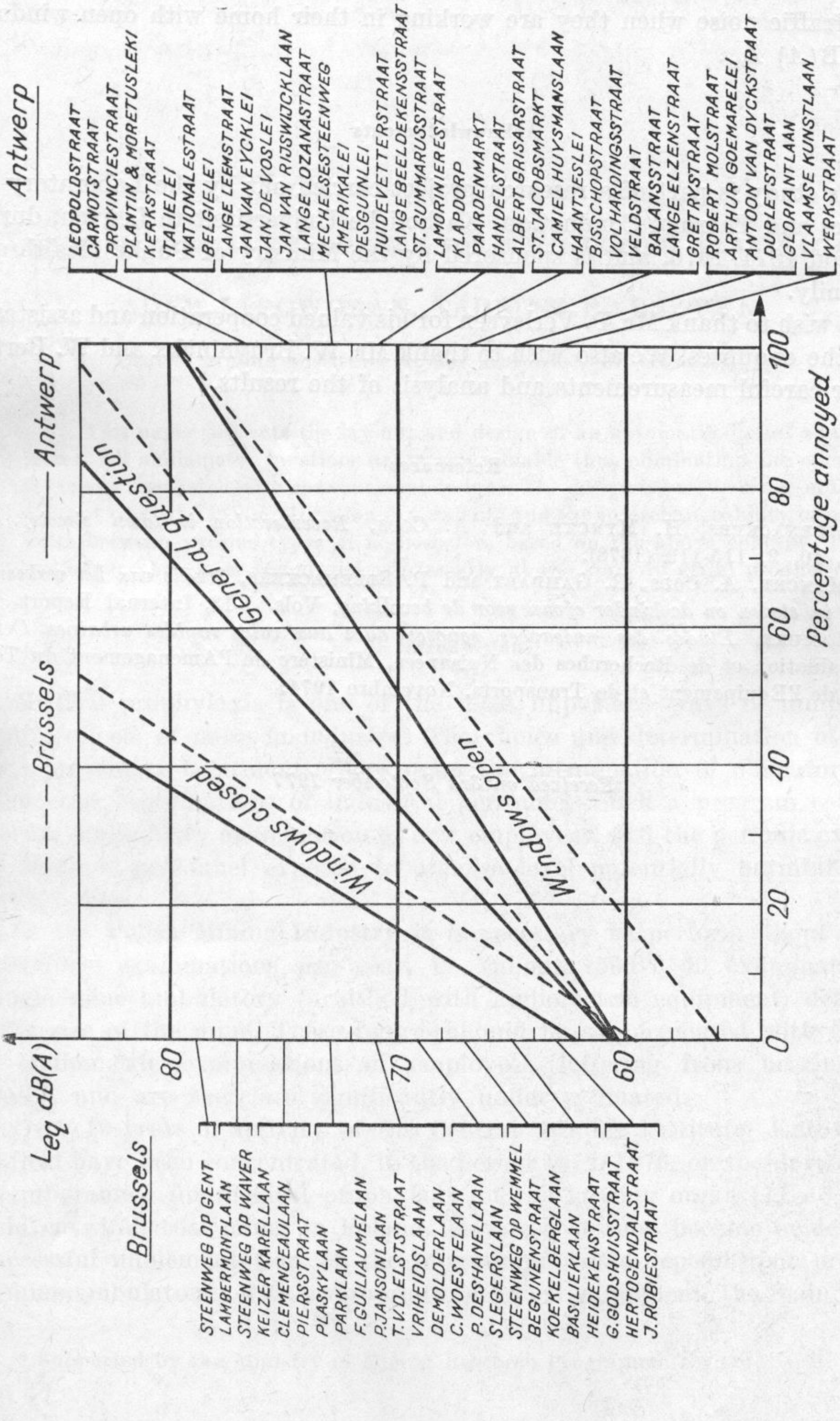


Fig. 12. Correlation between the percentage inhabitants disturbed when windows are open or closed, the general question and $L_{eq}$

We can see that approximatively 50 % of the inhabitants are disturbed by the traffic noise when they are working in their home with open windows at 70 dB($A$) $L_{eq}$.

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