ICSV13 - Vienna
The Thirteenth International Congress on Sound and Vibration
Vienna, Austria, July 2-6, 2006

COMPARISON BETWEEN EU DIRECTIVE NOISE EXPOSURE AND ANNOYANCE

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Abstract

In the EU-Directive 2002/49/EC the noise exposure of the population is assessed by taking the noise level on the most exposed façade on the building and calculating the number of inhabitants exposed to this level. On the other hand the noise exposure of the population can also be calculated on basis of annoyance using known relations between Ldn and annoyance. In combination with the population distribution this can give a different result. Since the main goal of the assessment of noise exposure is to set up an action plan in order to reduce the noise exposure. Depending on the assessment method the action plans can be different. In this paper the two methods – façade exposure according to the EU directive and annoyance – shall be compared for an example of a medium sized city in Germany. Furthermore a comparison of different façade noise exposure method will be given.

INTRODUCTION

In 2002 the directive 2002/49/EC (END) [1] was enforced. According to this directive all member states have to produce strategic noise maps for the main noise sources and for large populated area by 2007. Based on these noise maps action plans for noise reduction measures shall be set up. There are still some aspects in this procedure which have to be discussed. The first aspect is the database for the calculation of the noise maps. Since the END uses noise indicators Lden and Ln which are based on hourly noise levels during the day, such data must be available. The second aspect is the availability of the distribution of the inhabitants and the identification of dwellings which is in most cases not available in sufficient detail. Even having access to this data the there is still the question if the noise levels at 4 m height are representative for the dwelling, especially in inner city where the building height is much above 4 m. What ever procedure is applied to calculate the number of people exposed to façade levels between 55 dB(A) and > 75 dB(A) Lden, action plans

for noise reduction measures must somehow specify noise or better annoyance hot spots were noise reduction measures do have priority. Since it is known [2] that different noise sources (road, railway, aircraft) have different annoyance potentials, the classification of noise/annoyance hot spots based on the END façade exposure can lead to a noise reduction measures which are not reflecting the real annoyance. In the following paper these aspect will be discussed in some detail.

Calculation noise maps

The first step in producing noise maps is to collect the data e.g. buildings, data for the noise sources, etc. Especially for road traffic most data is not available on a hourly basis, but only for daytime and night-time. For the calculation of Lden (day-evening-night level) more detailed information is necessary, since during the evening hours the traffic flow is different from the daily average. In case there is no such data available, a standard hourly change in levels, based on measurements, can be assumed (see. Fig. 1).

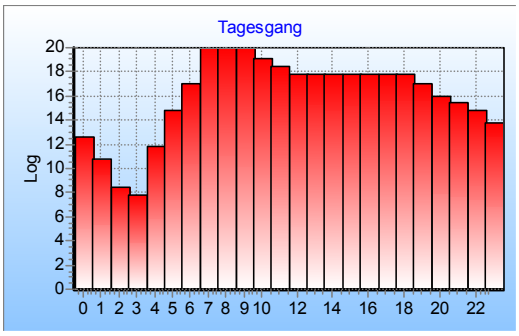

Figure 1 – 24h level variations for road traffic

Calculation for example, the Lden using this level variation instead of only day and night-time levels can lead to an increase of about **10%** of people exposed to Lden levels of > 55 dB(A). For the single level classes of the END classes this error can be much large. Difference of up to **90%** could be found in a recent noise mapping project [3]. For railway and aircraft noise similar errors can be expected.

Following the END, the noise levels have to be calculated for a height of 4 m above ground. For one or two storage buildings the variation of noise levels due to the change of height may have only a small impact on the number of people exposed to noise. For tower buildings, on the other hand, a change in numbers of exposed people of up to **20%** was found [4].

Thus even in the first step of calculating simple noise levels a large uncertainties in façade levels can occur. On other source of uncertainty in assessing the number of people exposed to noise is the distribution of the population.

DISTRIBUTION OF THE POPULATION

The major problem of assessing the no. of exposed people is to find or create a 'correct' distribution of people for dwellings. In some cases the number of persons per dwelling will not be available, but only the number of inhabitants per areas or per road address as shown in Fig. 2. In such a case a decent distribution procedure has to be applied.

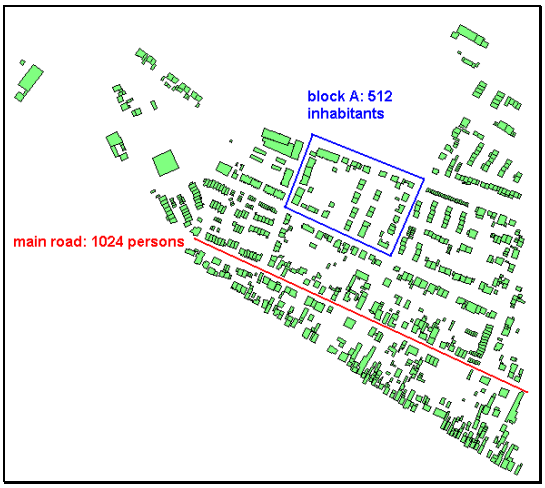

Figure 2 – data of no. of inhabitants

At the end of the different methods for each building/dwelling the number of people have to be defined. Fig. 3 gives an example of distributing the population. In this example the available data was given as no. of people per address/co-ordinates. As can be seen from Fig. 3 there is no necessary relation between the surface/volume of the building and no. of inhabitants. This means that distributing the population evenly to buildings/dwellings according either to the surface of the volume of a building can result in large errors for certain areas, even if in total the errors might be cancelled out.

On other aspect in distributing the population is, how to distribute the people within a dwelling. For assessing the noise exposure people can, for example, either be distributed on the whole façade or they can be concentrated of one side of the building, e.g. the most exposed façade. Since in reality buildings do have more than 4 facades (see Fig. 4) this make the distribution even more complicated, since the most exposed façade can have only a small length with high levels. To estimate the influence of the distribution of people along a façade, three different methods have been uses:

1) Distributing people evenly on the façade and taking the average the levels on the different parts of façade
2) Distributing people evenly on the façade and classifying the façade according to directions of the facade (no level averaging)

3) concentrating the inhabitants on the noisiest part of the façade (no level averaging)

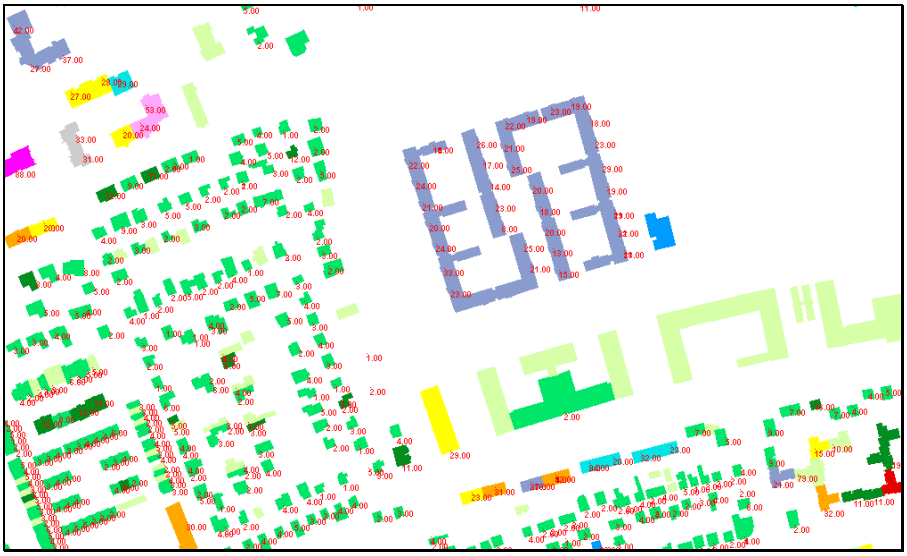

Figure 3 – distribution of the population

Figure 4 – shape of buildings

Table 1 is giving a comparison between the three methods. The numbers are the percentage of the total number of people. Method 2 and 3 are giving similar results for the different level classes. Since for method 2 and 3 no level averaging was employed, the lower level classes are empty.

Lden dB(A)	< 55	55-59	60-64	65-69	70-74	> 75
Method 1	51.2	22.3	13.1	8.4	4.5	0.5
Method 2	0.0	0.0	6.0	52.6	37.6	3.8
Method 3	0.0	0.0	6.7	51.8	37.5	4.0

Table 1 – comparison between different methods of assessing no. of exposed people ***(number in %)***

ANNOYANCE VS END FAÇADE EXPOSURE

Setting up action plans one major aspect is to make a priority list where to start reduction measures. The highest priority is a combination of high noise levels and large number of people exposed to noise. Here not only the simple levels like Lden or Ln should be used, but also the different annoyance potential of the different noise sources must be taken into account. Fig. 5 shows an example of the relation between noise levels and the annoyance for different noise sources.

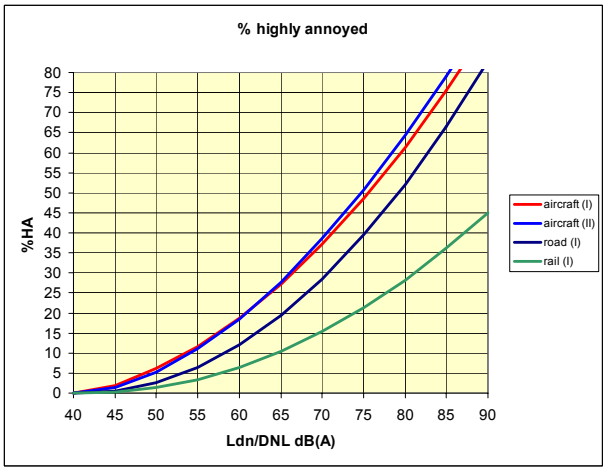

Figure 5 – level annoyance relation [2]

In Table 2 an example of calculating the no. of exposed people for different noise sources is given. Estimating the noise exposure according to END for different noise sources taking all people exposed to levels above 60 dB(A) will give 9% of the total population. Taking everyone above 55 dB(A) will result in a percentage of exposed people of about 17%.

Noise sources	55-59 dB(A)	60-64 dB(A)	65-69 dB(A)	70-74 dB(A)	> 75 dB(A)
Road	9400	6700	3200	900	100
Railway	1600	900	500	300	200
Aircraft	12200	600	-	-	-
sum	17300	11200	4300	1400	300

Table2 - : no of exposed people according to END (method 1)

On the other hand, following the concept of annoyance with a slightly different population distribution will give 12% of highly annoyed people. Taking the different noise limits and the slightly different distribution, the numbers are not completely different. But looking at the hot spots for action planning gives a different result (Fig.6). In Fig. 6 the small squares are depicting the distribution of annoyed people. For a comparison of annoyance vs END the noise/annoyance hot spots determined from annoyance calculation are marked by large squares where as the noise hot spots determined from END are marked by circles. As it is obvious from Fig. 6, the areas are not identical. For this example this is mainly due to aircraft noise which has a higher annoyance potential than rail and traffic noise. The calculation of the combined annoyance for the different noise sources is based on the dominant noise source model. A description of the method can be found e.g. in [5].

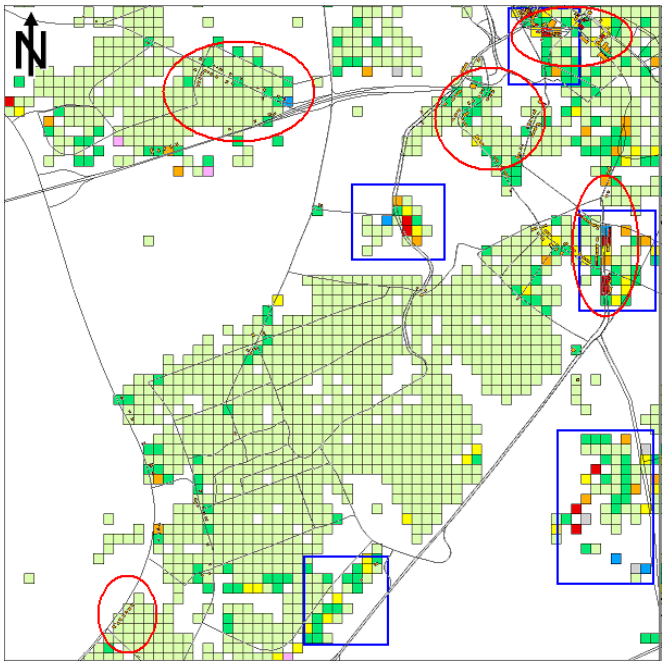

Figure 6 –hot spots: comparison annoyance vs END

CONCLUSION

Determining the noise exposure of people according to the environmental noise directive (END) can result in large errors due to insufficient information on the hourly variations of the noise source as well as the method of distributing the population onto the facades of buildings. Setting up action plans for noise reduction the different annoyance potentials of the noise sources have to be taken into account in order to get a correct description of 'annoyance hot spots'.

REFERENCES

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