inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 5.6

ROAD TRAFFIC NOISE MAPPING ON AN EUROPEAN SCALE

C. Roovers*, G. Van Blokland*, K. Psychas**

* M+P Noise & Vibration Consultants, Bruistensingel 232, NL-5232 AD, 's-Hertogenbosch, Netherlands

** European Environment Agency, Kongens Nytorv 6, DK-1050, Copenhagen, Denmark

Tel.: +31-73-6408851 / Fax: +31-73-6408852 / Email: roovers@db.mp.nl

Keywords:

ABSTRACT

Decision making in the field of road traffic noise issues is based on adequate knowledge of the actual noise problem and insight in the impacts of different noise policies. Various noise mapping strategies are available to supply the desired information to the policy makers. At a city level, street- and grid-based measurement programs and calculation models are used in combination with a Geographic Information System (GIS) to provide accurate visual information. At the European scale these noise mapping techniques cannot be used adequately at present since there is a lack of harmonized input figures. Therefore two straightforward statistical models are developed to achieve an appropriate assessment of the road traffic noise problem in the EU: i) Indicators for the exposed land area are specified, such as "Land area exposed to road traffic noise exceeding 55 dB(A) Ldn". The Land-Area-Noise-Exposure-model (LANE-model) combines available input figures on present and future passenger- and freight-kilometres, traffic volumes, road lengths and road surfaces with a prediction of the evolution of the noise emission to depict the development of the defined indicators; ii) Indicators for the number of exposed inhabitants in the EU are specified, such as "Inhabitants exposed to road traffic noise exceeding 55 dB(A) Ldn". The present situation of these indicators is calculated with the use of an extrapolation method. This method uses accurate noise assessments on a smaller scale, as well as basic knowledge about the surroundings and the noise policies in different EU-countries. The apparent relation between city-size and the relative number of exposed inhabitants is an important aspect of the extrapolation method. References: EEA publication "Transportation Noise in Europe: an overview", to be published late 2000.

1 - INTRODUCTION

Decision making in the field of road traffic noise issues must be based on adequate knowledge of the extend of the noise problem in terms of area involved and the number of people within noise classes.
At a city level, street- and grid-based measurement programs and calculation models are being used in combination with a Geographic Information System (GIS) to provide accurate visual information. Such data is not available, nor feasible on a regional, national or European scale. Still, this type of information is crucial in the set-up of national or European based noise policy.
In this paper we will present a method for determining the impact of noise on a European scale and we will discuss results. The development of this system was part of a project in the European Environmental Agency carried out within the frame work of the *Environment in the European Union at the Turn of the Century* report [1].
Two straightforward statistical models are developed to achieve an appropriate assessment of the road traffic noise situation in the EU. The first model is used to calculate the number of inhabitants exposed within different noise classes. These data can be interpreted in terms of annoyance and health effects due to road traffic noise in the EU. This model uses the relation between city size and noise exposure distributions found in several countries. It continues and broadens the work carried out in earlier inventories on the number of exposed inhabitants ([2] and [3]).

The second model intends to give data on areas along side the EU road system exposed to such noise levels that housing, wild life or nature quality is affected. This model uses data on road lengths, traffic volumes, vehicle-kilometres and road pavements in combination to a noise propagation model to evaluate classification of land areas in the EU.
The noise metric used in the study is the L_{DN} being the 24 hour equivalent level with a 10 dB penalty for hours between 10 p.m. and 7 a.m.

2 - NOISE-EXPOSED INHABITANTS

The basis of the method used here is the strong relation that exists between the size of a city and the distribution of its population over the relevant noise classes. This relation was reported in several countries spread over Europe; Sweden [4], the Netherlands [5], Greece [6], Denmark [7], Spain [8], Portugal [9] and France [10]. People living in the rural areas are the least exposed to road traffic noise.
We also concluded that this relation shows regional influences. In general one can say that north European cities belong to the low exposure type and southern European cities show high exposures. This finding was corroborated by an analysis of the noise situation in three representative cities, Amsterdam, Munich and Madrid. From these cities a detailed GIS noise map was made based on the same calculation method (see Figure 1).

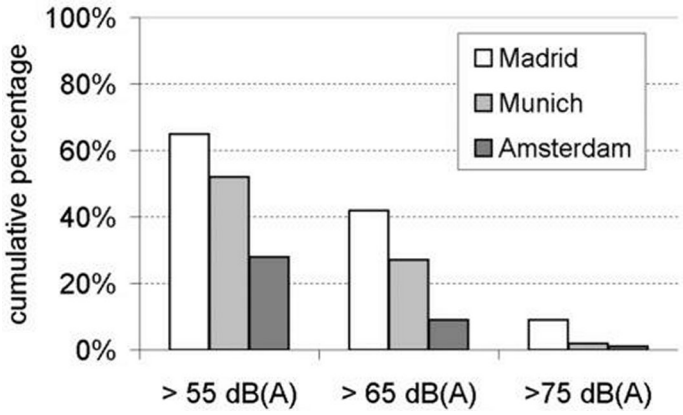

Figure 1: Distribution of exposure of population determined in three major European cities.

We combined the two relations and the underlying data in a classification of cities in five categories ranging from extreme noisy to moderate noisy. We determined for each category a distribution of percentage of the population exposed to L_{DN} levels $>$ 55 dB(A), $>$ 65 dB(A) and $>$75 dB(A). For the rural areas a separate distribution was assessed (see Figure 2).

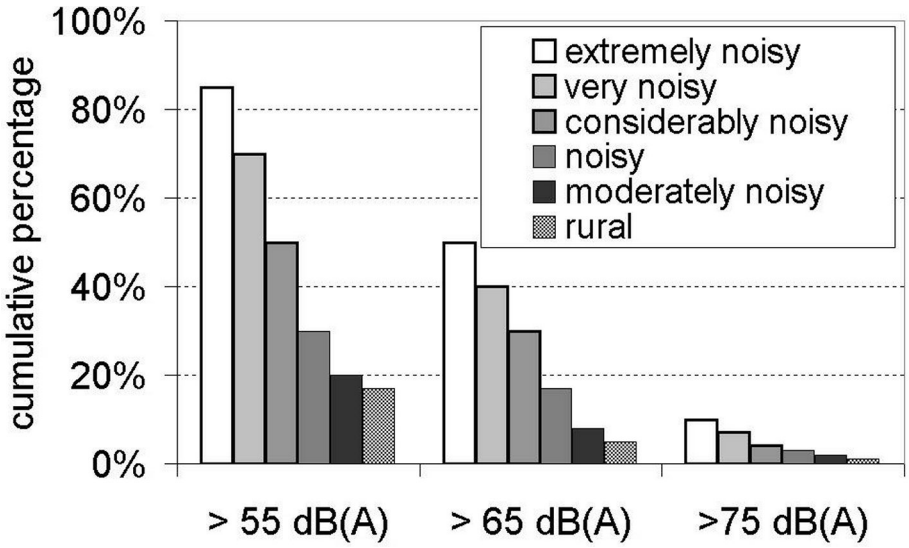

Figure 2: Definition of the distribution of the exposed inhabitants in urban and rural areas.

Next the number of inhabitants of the urban and rural areas of the EU countries, as well as the number of inhabitants of all EU cities were gathered, mostly based on UN and EUROSTAT statistics. These data were combined with the categorisation in noisiness classes, resulting in an assessment of the total number of EU-inhabitants in each of the relevant noise classes, i.e. exceeding 55, exceeding 65 and exceeding 75 dB(A). The results are presented in Table 1.

		<55dB(A)		**55-65dB(A)**		**65-75dB(A)**		**>75dB(A)**	
Country	**Inhabitants:**	**%**	**total (mln)**	**%**	**total (mln)**	**%**	**total (mln)**	**%**	**total (mln)**
EU TOTAL:	**371.602.000**	**68%**	**251,3**	**19%**	**71,2**	**11%**	**41,4**	**2%**	**7,7**

Table 1: Inhabitants of EU exposed to road traffic noise exceeding 55, 65 and 75 dB(A) L_{DN}.

3 - NOISE-EXPOSED LAND AREA

Road traffic noise not only affects the well- being and health of people in their living areas but is more and more considered a problem in rural and nature areas. Table 2 presents criteria for evaluation the quality of land area under noise exposure.

Noise levels	**Impact**
$L_{DN} > 55$ dB(A)	Loss of usage for housing development
$L_{DN} > 47$ dB(A)	Impact on wild life, especially breeding activities of birds [11]
$L_{DN} > 40$ dB(A)	Loss of nature quality by disturbance of natural sounds and of silence areas [12]

Table 2: Criteria for evaluation of land area exposed to transportation noise.

The total land area of the EU exposed to road traffic exceeding L_{DN} levels of 40, 47 and 55 dB(A) is calculated using available input figures on passenger- and freight-kilometres, traffic volumes, road types, road lengths and road surfaces in the EU countries.
Five classes of traffic intensities (very busy to very quiet) are defined with respect to the motorways, national and regional roads for all EU countries separately. The total road length in each country (International Road Federation data) is distributed over these five classes (estimated based on Dutch, German, Spanish, Swedish, Belgium and Austrian data provided by national road authorities). A distribution over three classes of road pavements (-2, 0 en +2 dB(A)) is attributed to every class, as well as the average speed, the day/night distribution of traffic (estimated based on Swedish, Dutch, German and Belgium data provided by national road authorities) and the light/heavy traffic distribution (estimated based on Dutch, Spanish, German and Swedish data provided by national road authorities). Traffic of local roads is estimated from the difference between total transport data in a country and the amount calculated on road length and intensity data on main roads.
Roads in urbanised areas or between barriers do not emit sound under free field conditions. We accounted for this effect by reducing contribution of the busiest roads by about 20% and neglecting most of the local roads, presumably in cities.
The model which is used to compute the distance between a road (motorway, national, regional or local) and its noise contour is based on the Dutch calculation scheme [13]. The resulting figures on exposed land area are presented in Table 3 for the EU and in Figure 3 for the individual EU countries.

Total Area	**> 40 dB(A) L_{DN}**		**> 47 dB(A) L_{DN}**		**> 55 dB(A) L_{DN}**	
3.239.576	**12,7%**	**411.095**	**6,1%**	**198.129**	**2,9%**	**95.427**

Table 3: Total land area (km^2) of the EU and the fractions (in % and in km^2) that are exposed to road traffic noise exceeding 40, 47 and 55 dB(A) L_{DN}.

4 - CONCLUSIONS

A first step is taken towards an accurate assessment of road traffic noise exposure in the EU. Two straightforward methods were developed to compute the number of exposed inhabitants and the exposed land area. It is found that 32% of the EU inhabitants and 3% of the land area are exposed to road traffic

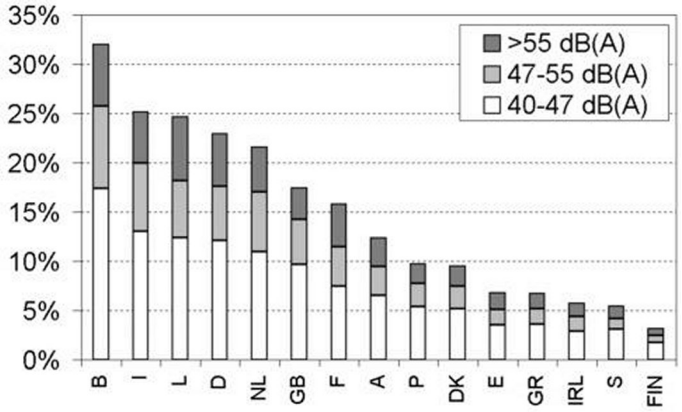

Figure 3: Fractions of the land area of the EU countries (in %) that are exposed to road traffic noise exceeding 40, 47 and 55 dB(A) L_{DN}.

noise levels exceeding 55 dB(A) L_{DN}. The accuracy of these figures will improve when more (harmonised) input figures will become available.

REFERENCES

1. **European Environment Agency** , *Environment in the European Union at the Turn of the Century* , 1999

2. **A. von Meier**, *Europe's Environment 1993: Noise Pollution*, M+P Raadgevende ingenieurs bv report EG.93.1.1 prepared for EC DGXI, 1993

3. **J. Lambert and M. Vallet**, *Study related to the preparation of a communication on a future EC noise policy* , LEN report 9420, 1994

4. **Naturvårdsverket**, Miljöfaktorer som påverkar människors hälsa, *Rapport 4760*, 1996

5. **Dutch Ministry of Housing and Environment** , *Exposure data for 60 Dutch cities*, 1985

6. *Results of noise survey in Greece*, 1987

7. *Results of noise survey in Denmark*, 1991

8. **A. Garcia**, Noise survey in the Community of Valencia, *Acta Acustica*, Vol. 83, pp. 516-521, 1997

9. **Direcção Geral do Ambiente, Portugal**, *Ambiente em Portugal*, 1995

10. **M. Maurin and J. Lambert**, Exposure of the French Population to Transport Noise, *Noise Control Engineering Journal*, Vol. 35(1), 1990

11. **M.J.S.M. Reijnen**, *Disturbance by car traffic as a threat to Breeding Birds in the Netherlands*, PhD thesis, university of Leiden, 1995

12. **Gezondheidsraad: Commissie Uniforme Geluiddosismaat** , *Omgevingslawaai beoordelen*, Rijswijk NL, publicatie nr. 1997/23 (summary in English), 1997

13. *Reken- en Meetvoorschrift Verkeerslawaai* , Regeling als bedoeld in artikel 102, eerste en tweede lid, van de Wet geluidhinder, 1982