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A METHOD OF STRATEGIC TRAFFIC NOISE IMPACT ANALYSIS

R Tonin

Renzo Tonin & Associates Pty Ltd, Level 16, 9 Castlereagh Street, Sydney, NSW 2000, Australia

1. INTRODUCTION

Traffic noise is acknowledged to be one of the most significant environmental impacts of our time. The benefits and adverse impacts which are at issue in any major road project are usually discussed in an Environmental Impact Study which assists with balancing the social needs, impacts and monetary costs of a project. However, there is usually no account taken of people who benefit from an improvement (i.e. reduction) in traffic noise. This paper is therefore a methodology for calculating and reporting traffic noise impact on a community wide basis (a strategic level). The method is independent of any specific algorithm and can be adapted to any country's unique noise descriptors and considerations.

Noise impact from traffic is normally assessed by comparing the predicted noise levels at nearby receptor locations to appropriate noise criteria. In many cases noise contours are prepared to show the extent of the affectation. The number of people exposed to various noise zones can then be counted and decisions made to implement noise amelioration measures.

Whenever a new road project is planned or an existing road is widened or otherwise modified , it is normal to consider noise impact to receptors immediately adjacent the corridor. However, with any important road project, the re-distribution of traffic can extend much wider than this and can in fact produce beneficial results to locations far from the road.

The justification for new road projects is generally to improve traffic conditions for the community as a whole by diverting noisy traffic to roads which are designed to accommodate noise mitigation. It therefore follows that the benefits of a road project should be assessed on the basis of community impact and not just the impact to receptors closest to the road corridor.

The difficulty of calculating noise levels on such a "grand scale" however, can make such an ideal impossible to implement. For this reason, a "strategic" tool is needed, capable of accommodating a large area and which can be quickly and simply applied. Such a tool would be particularly beneficial in the comparison of different road options.

The Method of Strategic Noise Impact Analysis (SNIA) described in this paper is put forward as a technique for the determination of community impact. The rational behind SNIA is the estimation of the change in the number of people moderately or highly affected by a road project on a community wide basis.

2. DESCRIPTION OF THE METHOD

The study area is divided into a number of small zones to which are ascribed population, topographic, traffic and acoustic parameters which are assumed to be common throughout each zone such that the multiplication of these factors will result in an estimation of the change in the number of people moderately or highly annoyed. The following describes the factors taken into consideration[1];

Demographic Characteristics: The balance of the evidence shows that, after allowing for noise level, noise annoyance is not affected to any important extent by age, sex, social status, income, education, home ownership, type of dwelling, length of residence or the receipt of the benefits from the noise source.

Attitude: The balance of the evidence shows that, after allowing for noise level, noise annoyance is strongly related to three attitudes - fear, prevent-ability and sensitivity.

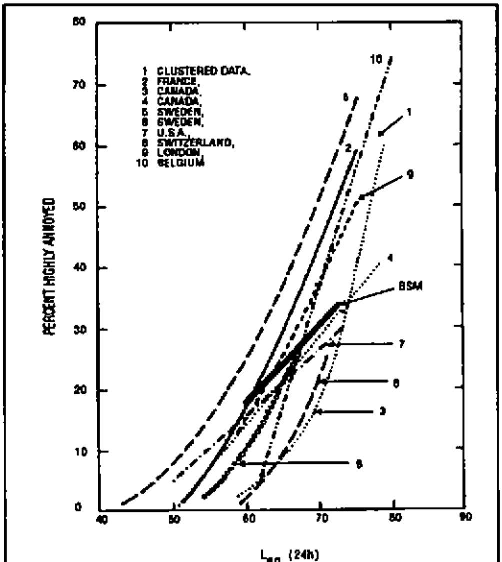

Figure 1: Traffic Noise-Dose Relationship.
BSM = Australian Data (Source: Reference 3).

Ambient Noise Level: The data do not support the hypothesis that ambient noise levels effect sensitivity to environmental noise. The balance of the evidence suggests that there is no important difference between the general sensitivity to noise residents of noisy and quiet areas.

Reaction to a Change in Noise levels: Although it is often noted that new noise sources can provoke strong public reaction, opinions are mixed on whether annoyance experienced by residents is any different to a new noise than it is to a pre-existing noise of the same noise level. In other words, do people "over-react" to an increase or decrease in noise level over and above the established noise-dose curve. In the author's experience, this is considered likely and hence the hypothesis is worthy of adoption.

Truck Noise Impact: In the author's experience, noise from trucks at night ranks highly amongst the list of grievances put forward by residents. Annoyance from this source is not considered to be well accommodated in social syntheses.

Figure 1 (after Hede[2]) shows typical noise-dose relationships for traffic noise ascribed to various countries. Reference to Nelson[9] suggests that

$$\%\ (\text{Moderately and Highly Annoyed}) = 1.59 * L_{eq,24hour} - C2 \quad \ldots(1)$$

where C2 is a constant.. It is assumed that attitude will play a most important role in one case - that is, residential areas for which no motorway exists but for which one is planned.

It is proposed to assess community noise impact according to the following equation;

$$\text{Impact} = 1.59 * ZCF * PF * TF * HVF * \delta dB, \quad \ldots(2)$$

where,

Impact = Change in the proportion of people in a zone moderately or highly annoyed

ZCF = Zone Classification Factor PF = Population Factor

TF = Topographical Factor HVF = Heavy Vehicle Factor

δdB = Change in noise Exposure, L_{eq} 24hr.

Zone Classification: The Zone Classification is one of four categories as shown in Table 1. The study area is classified into zones based on land usage and a factor ascribed to the area according to the table above. The zone classification termed "Residential +" is a residential area in which a new thoroughfare is proposed (people newly exposed to noise).

Population Factor: A population factor of unity accounts for the average density of residences. The factor is scaled according to the population density in the zone concerned.

TABLE 1 - ZONE CLASSIFICATION FACTORS	
ZONE CLASSIFICATION	ZONE CLASSIFICATION FACTORS (ZCF)
Industrial	0
Commercial	0.1
Residential	1.0
Residential +	2.0

Topographical Factor: As one gets further and further from a road, the noise contribution from that road is masked by other urban noise. Therefore, any change in noise level due to the change in flow will at some point become significant. In a study of national exposure to road traffic noise, Stewart[4] assumes residences only 2-3 deep are affected by local traffic noise and Carr & Wilkinson[5] assumes there is a screening effect of 5dB for each row of housing. In this study, we will take a wider "affectation corridor" of 200m from a road on flat land because we are concerned not only with the worst effected but by any affected by a change in noise levels.
In some cases, the topography of the land is such that more or less houses are affected by the road. The Topographical Factor accounts for this - a value of 1.0 is assumed for flat land.
Heavy Vehicle Factor: Experience with new freeways in Australia leaves no doubt that noise impact from individual heavy vehicles causes more annoyance and sleep disturbance than accounted for by bulk flow descriptors alone especially at night. Based on Hede's[6] recommendations,

$$HVF = 1 + 0.0027 * \left| \delta \max HV / hr \right| \quad \ldots(3)$$

where $\delta \max HV / hr$ is the change in maximum number of heavy vehicles in any hour at night between the hours midnight and 6am (the factor 0.19 = 0.11 * 6hrs /35L_{eq}/7). The mod bars indicate that the change is always positive.
Change In Noise Exposure, L_{eq} 24hr: The change in noise exposure may be expressed in any units commensurate with the noise-dose synthesis used. In this paper, the change is measured in terms of L_{eq} 24hr and is determined from any noise traffic model such as CORTN or FHWA. The inputs required are the change in traffic volumes and heavy vehicle content, use of roadside barriers etc.

3. IMPLEMENTATION

The study area is divided into grids or zones. For each zone, the factors described above are ascribed and entered into a computer spreadsheet. The outputs may be in the form of tabulated data as shown in Table 2 or as a series of coloured dots on a map representing in size and colour the change in the number of people moderately or highly affected by the route (increase or decrease) as shown in Figure 2.

TABLE 2 - STRATEGIC NOISE IMPACT FOR FIVE ROAD OPTIONS CHANGE IN No. OF RESIDENCES MODERATELY/HIGHLY ANNOYED					
	Wallgrove Expressway	Wallgrove Arterial	Prospect Expressway	Prospect Arterial	Cumberland Arterial
Residences Near Road (Local Impact)	4000	1856	1492	3180	300
Regional Impact	-1160	-600	-1020	-864	-244
Nett Impact	2848	1256	472	2316	56

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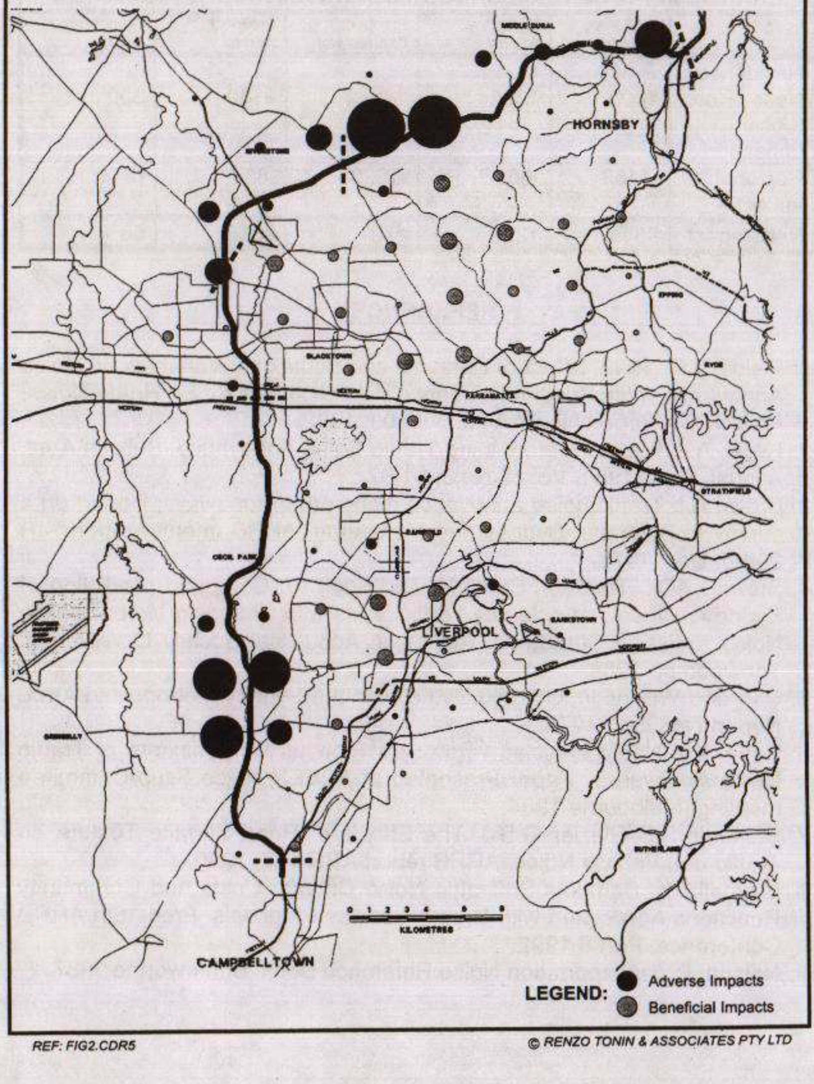
FIGURE 2: REGIONAL NOISE IMPACT OF PROPOSED EXPRESSWAY.



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