STRATEGIC NOISE ASSESSMENT – A POLICY TOOL

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1. INTRODUCTION

It is now three years since the European Commission published its Green Paper on Future Noise Policy. Regardless of our political views on European integration we must all welcome the impetus the Green Paper has created in working towards a quieter environment for everyone in this country. But how far have we got in the UK in working out how to achieve this aim ? We are contributing wholeheartedly to the research activities instigated by the EC and we have several noise mapping activities in progress, but it is time to begin thinking about the Noise Abatement Plans that will actually create improvements in our noise climate. This paper advocates the use of strategic noise assessment for developing National Noise Abatement Plans. It also offers potential solutions to some of the difficulties such studies encounter, drawing on experience from two major projects undertaken this year by Environmental Resources Management on behalf of the UK government.

2. BACKGROUND

The EC's initiative to develop a future Noise Policy is, and will increasingly be, a driving force for National Noise Abatement Plans. The EC's general approach is similar to that being followed for air quality, and can be summarised broadly as follows:

1. Monitor/map noise;
2. Publicise noise maps to inform the public and to empower politicians;
3. Develop and fund Noise Abatement Plans; and
4. Implement Noise Abatement Plans to improve the national noise climate.

Stage 1) is in progress, but how do we as acousticians contribute to stages 2) and 3) ? These are the key stages in progressing our national noise policy, and there is a central question that must be addressed in this process (assuming funding is forthcoming);

- *Where do we prioritise noise abatement, who needs it most ?*

It is widely recognised that transportation noise is the main villain, it is also produced within a sector of our economy over which the government has some authority through the DETR's mandate. There are several current studies aimed at assessing transportation noise over wide geographic areas, these include:

A. Network Classification of Noise Impacts – Highways Agency;
B. Birmingham City Noise Map – DETR and Birmingham City Council;
C. London Underground Network Noise Model - London Underground Ltd; and
D. Retrospective mitigation to deserving truck roads - Highways Agency.

All are major projects with substantial funding, the latter being budgeted at £ 5 million each year to apply remedial mitigation to sections of road built before the CRTN [1] method was adopted in 1988.

3. DEVELOPING NATIONAL NOISE ABATEMENT PLANS

In 1997 ERM completed a project for the DETR entitled *Noise Climate Assessment, A Review of National and European Practice* [2] . The study concluded that there is a wide range of noise mapping activities taking place across Europe, and there is a need for each Member State to somehow draw on all of these to obtain the 'big picture' of population noise exposure across the whole of their region. But this is no simple task.

Of course, many of us in the Institute of Acoustics could contribute population noise exposure information from our own noise assessment work. But it would be an enormous task to assimilate the many thousands of individual pieces of noise data into any overall picture that would help to prioritise where noise abatement is most needed. What is required is a more strategic approach to obtain a coarse view of the overall national noise climate.

As well as the EC initiatives, there is now another major influence on the way in which transportation noise is considered in transport planning. In 1998, following the Review of the Road Programme, the DETR published its Integrated Transport White Paper and the New Approach to Appraisal (NATA). The roads building programme was severely curtailed in favour of a move away from the historic 'Predict and Provide' approach towards appraisal of transport strategies that integrate all forms of surface travel (private car, public road transport and rail modes). The process by which transport strategies are prioritised for implementation is termed Multi-Modal Appraisal, and in accordance with the NATA, considers five key objectives; Economics, Safety, Accessibility, Integration and Environment. Noise as one of the sub-objectives to the Environment objective. (The methodology developed for multi-modal noise assessment is discussed further below.)

The Highways Agency is currently beginning a first batch of multi-modal appraisal studies to consider transport strategies over geographic areas ranging from areas around single towns to regions covering several counties. More similar studies will follow next year. Each requires the comparison of noise impacts from different multi-modal transport strategies as part of the appraisal process. The noise impacts from each strategy must be contrasted against the others and reported in a simple way so that noise can be considered along with all the other factors that determine the optimal transport strategy. So, the government's integrated transport policy has become a driver for multi-modal noise assessment at strategic level.

4. PROBLEMS IN STRATEGIC NOISE ASSESSMENT

Strategic Noise Assessment faces at least four major challenges:

1. It covers large geographic areas.

2. It must yield simple, easy to understand results.

3. Noise impacts from roads and railways (and possibly airports) must be assessed on a common basis.

4. It must assess population noise exposure in terms of both noise level and the size of populations affected.

The first of these challenges could be overcome by constructing an enormous noise model of the area, in full detail using conventional CRTN/CRN [3] methodologies. As the Birmingham experience has shown, this can be done, at least at city level, but it is expensive and very time consuming (Birmingham's noise map has cost about £200,000 do date). Furthermore, the huge volume of information obtained may be too cumbersome to report to a decision maker who is weighing up all the factors that influence the choice of an optimal transport strategy for a region. Such large scale detailed noise modelling studies provide invaluable examples of population exposure in particular areas, but a simpler, quicker, cheaper method is also needed in order to cover even larger areas and to produce easy to understand results.

The third challenge is how to overcome the differentials between the human does-response to noise from different sources; aircraft noise creates bigger impacts than road traffic noise, which creates bigger impacts than railway noise, at the same noise level. A solution to this problem is discussed below.

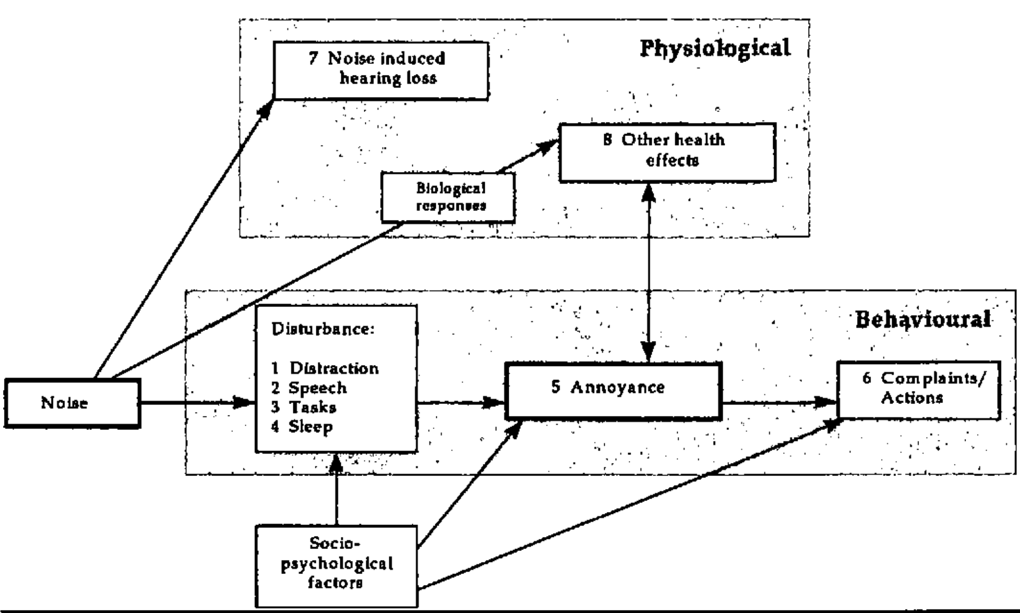
The fourth challenge is common to any situation where we are seeking to compare options for noise abatement for which large numbers of people are affected. It concerns the trade-off between the 'depth' of the impact – how many decibels, and the 'breadth' - how many people are impacted [4]. For example, which is worse, 1000 people exposed to traffic noise at $L_{Aeq, 18 hour}$ 70 dB or 500 people exposed to 73 dB ?

A solution to these challenges is presented in the noise chapter of the DETR's Guidance to Multi-Modal Studies (GOMMS [5]), and is discussed below.

5. STRATEGIC NOISE ASSESSMENT METHODS

Noise has a number of quantified effects including disturbance (such as distraction, speech interference and sleep disturbance), annoyance, hearing loss, and other potential health effects. The relationships between these effects are illustrated in Figure 1 [6].

Figure 1 Cause and Effect Relationships for Noise



Given that different transport modes produce noises of different character, which give rise to different physiological responses, and that behavioural effects are modified by socio-psychological factors, it is clear that any method used to appraise transport noise impacts must take account of the links between all of these factors.

Annoyance, as can be seen in Figure 1, is a key link between the physiological and behavioural responses. A conclusion reached from a large volume of research into the effects of transport noise is that *community annoyance* is the most useful general criterion of overall, long-term noise impact and that it can be correlated with long-term average noise exposure.

In the UK the concept of annoyance is generally recognised as a robust and well established measure for identifying long term noise impact from roads and railways (and airports). The Design Manual for Roads and Bridges (DMRB) Volume 11 [7] gives guidance on the annoyance response relationship for road traffic noise in tabular and graphical form, showing the percentage of a population bothered (annoyed) by road traffic noise as a function of noise level. However, research has shown that railway noise is perceived to be less annoying than road traffic noise at the same level. Given these differing levels of annoyance, a simple summation of noise exposure levels, using a convenient noise metric such as $L_{Aeq,\ period}$, is not, therefore, a reliable indicator of noise impact for a multi-modal study.

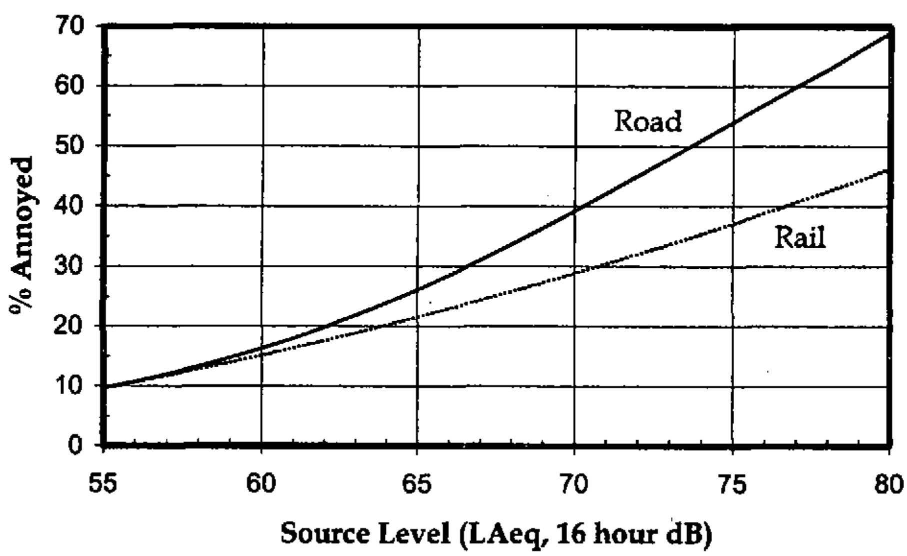
One approach to overcoming the problem of mode-specific community noise response relationships is to apply different impact criteria to noise from each mode. This approach allows estimates of numbers of people exposed to 'unacceptable' noise levels to be made, but there is a residual problem in weighing up the significance of changes in noise level from different sources (which is better, a plan that reduces road traffic noise by 3 dB or one that reduces rail traffic noise by 3 dB ?).

One solution to these problems is to use the annoyance response relationship(s) to estimate the numbers of people likely to be annoyed in each case, ie the *estimated population annoyed*. The best performing option, in terms of noise, is then simply the one that results in the highest change in estimated population annoyed. Given that the community annoyance response relationships for road, rail and aircraft noise have been well researched, as are the relative differentials between them, the population annoyed from each mode of transport can be estimated on a common basis by using calibrated annoyance response functions for each mode of transport.

The EC's Working Group 2 is studying noise dose-response relationships, but their work is not yet finished. So, in order to develop the noise appraisal methodology in GOMMS in time to be used in the DETR's first batch of multi-modal integrated transport studies, past research on annoyance dose-response functions was reviewed. Since the DETR studies are primarily concerned with surface transport, aircraft noise was not considered, but it could be at a future date. Of course different authors give varying results, but this is partly due to different social survey techniques. Some recent researchers have attempted to reconcile these different techniques when reviewing previous surveys. These include a review in 1996 of 60 papers on the subject spanning 20 years of research [8], and a study in 1998 that assimilated data from 45 social surveys and over 58,000 respondents [9].

This international research, and international guidance [10] was judged against UK research (including that summarised by the Mitchell Report in 1991 [11]) and guidance (DMRB and PPG 24 [12]) to yield the calibrated railway and road traffic noise annoyance dose-response functions shown in Figure 2.

Figure 2 **Road and Railway Noise Annoyance Response Functions**



The road traffic noise curve in Figure 2 is derived from the 'steady state' annoyance curve given in the DMRB Volume 11 which is in terms of $L_{A10,\ 18\ hour}$ and is calculated using the CRTN method. This response function has been converted to $L_{Aeq,\ 16\ hour}$ to allow comparison with railway noise calculated in accordance with CRN method, using the approximate 2 dB differential for heavy traffic conditions given in PPG24.

GOMMS goes on to suggest how these annoyance response relationships can be used at different levels of strategic noise assessment. Clearly, at a very small scale detailed noise modelling using a proprietary road and railway noise model is appropriate. Noise contours can be overlaid on population data to estimate population noise exposure in bands of noise level. For each band the relevant % annoyed can be used to estimate population annoyed. Annoyance from road and rail noise are estimated separately but can then be summed to obtain a total *estimated population annoyed*. When estimating population annoyance it is helpful to apply a cut-off noise level below which annoyance can be ignored. Otherwise, if annoyance is considered at low noise levels the distance over which noise modelling must be carried out, and the inaccuracies in the modelling process, can become unmanageably large. A suitable threshold, below which less than about 10% of people are annoyed, is $L_{Aeq,\ 16\ hour}$ 55 dB, which is consistent with PPG24, and WHO [11] guidance.

If noise appraisal is required over larger areas (say covering several counties, or even the whole country) increasing levels of simplifications are required. GOMMS offers guidance on these, in the context of appraising competing transport strategies. The level of simplification depends directly on the source of information available. Transport strategies are developed and tested in transport models and their traffic data can be extracted to allow simplified CTRN/CRN calculations to be made. For example, it may be necessary to ignore inputs to CRTN such as road surface and gradient, but total flow, % heavy vehicles and mean speed can be extracted. This allows *noise emission levels* to be calculated for the various road and rail routes in the study area. These noise emission levels will not be calibrated in absolute terms if simplified calculations are needed, in which case they will not represent real, on the ground noise predictions. They will however, be calibrated with respect to different road and rail routes and between different transport strategies. These noise emission levels can then be used to derive estimates of population annoyed based on population density and distribution across the study area. Population data can conveniently be manipulated within a Geographic Information System (GIS). Whilst these estimates will be similarly uncalibrated when simplifying assumptions have been needed, they will nonetheless provide a means of comparing noise impacts across regions and for different multi-modal transport strategy scenarios.

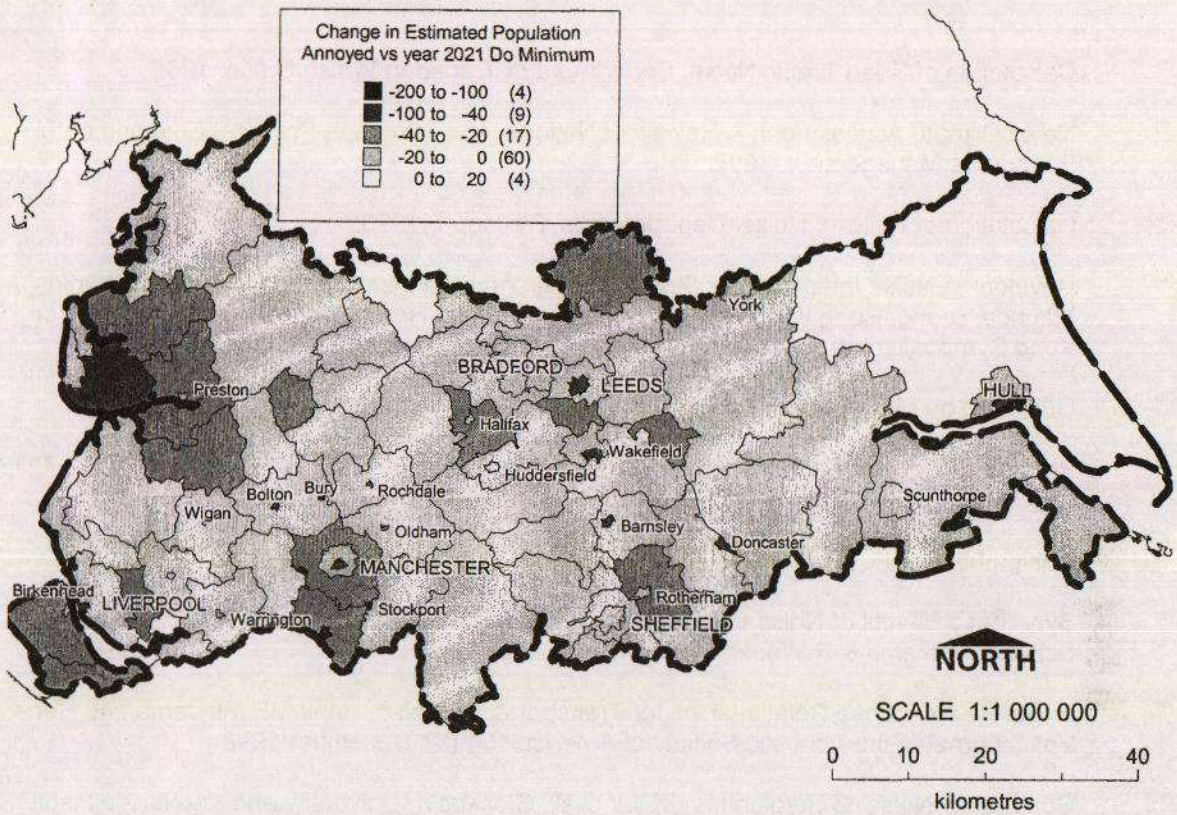
One large-scale study that has followed the GOMMS methodology is the Strategic Environmental Assessment of the Trans-Pennine Corridor [13]. The study appraised 10 transport strategies for a study area covering 14,000 km^2 stretching the width of England from Liverpool to Hull. Estimations of population annoyed by traffic noise were made for the strategic roads in each of 123 zones based on the outputs of MVA's START transport model and zonal population densities. Future transport strategies for the year 2021 were compared against the baseline (or do-minimum case) to assess their relative environmental performance.

In such strategic studies there is a temptation to assess noise impacts solely in terms of the changes in noise levels across the study area. A key finding of this study was that this can be misleading because the size of the impact of a given noise change depends directly on how many people are affected. A strategic study will generally cover rural areas and urban areas; where population densities can differ by a factor of 1000 or more. The approach of estimating population annoyed takes full account of this.

An example of the results obtained in the Trans-Pennine Corridor study is shown graphically in Figure 3. This shows the change in estimated population annoyed for one of the more dramatic road traffic reduction strategies compared to the do-minimum case in the year 2021. It can be seen that this strategy creates the largest benefits in population annoyance in certain urban areas.

The total change in estimated population annoyed by that particular strategy was 2,100 people. The increase in estimated population annoyed between the years 1996 and 2021 (the do-minimum) was 5,300 people, expected due to general traffic growth. It was concluded that this strategy would go some way (about 40%) to offsetting the noise impacts expected from future traffic growth across the study area. Furthermore the areas where the strategy offers the largest benefits were clearly identified, as were the relative performances of the various strategies in terms of noise abatement.

Figure 3 **Trans-Pennine Corridor - Change in Estimated Population Annoyed due to One Transport Strategy Option**



6. CONCLUSIONS

The development of national Noise Abatement Plans, in line with the next stage of the EU Noise Policy, must be informed by a strategic overview of the noise climate of the whole country. The government's integrated transport policy is now requiring multi-modal noise appraisals over broad geographic areas which will utilise simplified noise assessment techniques to make comparative noise appraisals of regional transport strategies. The methodology prescribed in GOMMS offers techniques for such appraisals that allow transportation noise (the major source of environmental noise) to be assessed at a strategic level. Strategic Noise Assessment, using techniques of this type may have an important role to play in showing which parts of the country are worst effected by noise and from which modes of transport. Strategic noise assessment may also be a valuable tool in testing different noise abatement strategies to begin to improve the noise climate in these areas.

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