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THE LONDON ROAD TRAFFIC NOISE MAP - CREATION, FINDINGS AND APPLICATIONS

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1 INTRODUCTION

The London Road Traffic Noise Map was produced by Atkins on behalf of Defra (the UK Government Department of Environment, Food and Rural Affairs) as part of the Government's Ambient Noise Strategy. It was officially launched on 14th September 2004. It is the largest map of its kind produced as yet in the UK, covering an area of 1,650 square kilometres with calculation points placed on a 10-metre square grid. Papers on its method of production have been given both to the IoA and to other conferences, so this paper describes some of the initial findings of the map, how it can be accessed and the uses to which it is already being put. Some suggestions for further work are also made.

2 THE ASPIRATIONS OF THE LONDON ROAD TRAFFIC NOISE MAP

2.1 The Background

The London Road Traffic Noise Map is just one element of the Government's much wider national ambient noise strategy. It has been created to provide information on the levels of road traffic noise across the whole of the Greater London Authority's area. Other types of noise will be covered in projects that are being planned or progressed at present.

Noise maps will help to establish the existing baseline so that we will be able to measure the effectiveness of future initiatives to control noise. They will also let us see in an understandable and visual way how noise spreads from roads and into residential areas. They will help us to see how different types of building layout can affect the spread of noise, the havens of quiet that already exist within the city, and how careful planning could create more of them.

Noise maps will help non-specialists to develop a more intuitive feel for how noise behaves, which will allow more people to appreciate the importance of planning and designing against noise and to let them become involved in the process. They will also give experts the tools to refine designs for maximum benefit at affordable cost.

The London Road Traffic Noise Map is the first detailed noise map of the whole of London and is necessarily limited by the availability of some types of information. But at the same time, it has formed a focus for gathering together some of the huge body of information that already exists. The map is a live resource that can answer many of the questions which will arise as people continue to look for ways of improving our management of the noise that we create.

The project will also assist in the development of policy and will help those bodies who may have obligations as a result of the EU Directive on the Assessment and Management of Environmental Noise[1]. The Directive requires noise mapping to be carried out and prescribes the scope and

methodology to be used. The Directive also requires Member States to designate the competent authorities and bodies responsible for implementing various elements of the Directive. The first round of mapping will have to be complete by 30th June 2007.

2.2 Basic features of the noise map

The map was created by calculation, as distinct from measurement, using computer software operating in accordance with the methodology prescribed in *Calculation of Road Traffic Noise* (CRTN).[2] This calculates noise levels in terms of either the L_{A10} (18-hour) index or the L_{A10} (1-hour) index. The results were modified in accordance with a procedure devised by TRL[3] to produce the noise indexes L_{day}, $L_{evening}$, L_{night} and L_{den} as defined by the EU Environmental Noise Directive. The calculations were made on a square grid covering the whole of the calculation area at 10-metre intervals and at a height of 4 m above local ground level.

2.3 The size of the project datasets

The GLA's area covers about 1,650 square kilometres, much of which is densely urbanised. There is a total population of almost 7.1 million people living within the 33 boroughs (including the City of London). In this area, there are 2.67 million buildings and over 5,200 kilometres of roads considered to be acoustically significant.

These roads are represented by some 120,578 road segments with more than 21,100 different traffic flows distributed over the network. The flows vary from virtually nothing up to 171,800 vehicles per 18 hours, at average speeds varying from 2 km/h to 108 km/h. There are over 2,300 noise barriers (excluding buildings and ground topography) covering a total length of 121 km.

The map contains about 16,575,000 calculation points with 25 values at each point, giving a total of about 415 million results.

3 METHODOLOGY

3.1 Data-centric approach

The project used a data-centric approach, which meant that as far as possible, data was gathered in a form suitable for automatic processing and direct entry into the noise modelling software. Manual intervention was kept to a minimum, as automation not only speeds the processing but also reduces the likelihood of error.

3.2 NoiseMap Server Edition software

Atkins' NoiseMap Server Edition software was used for creating the noise model, undertaking the calculations and producing the noise maps for use in a Web-viewer. This software has been optimised for the calculation of noise maps of large areas, which requires the ability to store large amounts of geographically-referenced data, to allow multiple users to work on it and to allow multiple computers to undertake the calculations. The 6,500 hours of computer time needed to calculate the 415 million results were completed within one month by using a network of about a dozen desktop personal computers.

3.3 GIS Data Processing

Most of the raw data required some pre-processing before it could be used in NoiseMap. This was done by the ESRI ArcView 3.2a Geographical Information System (GIS) programmed to automate the work as far as practicable.

3.4 Data Sources

Given the size, scope and time-scale of the project, it was necessary to use existing data sources as far as possible, although some new data sets also had to be assembled. The data sources are shown in Table 1.

Table 1 Parameters and Datasets used for London Noise Map

Input parameters	Data Set
Building outlines Road widths Side slope location and widths Areas of acoustically-hard ground (paved areas, water bodies, etc)	OS MasterMap
Road Centre Lines	OSCAR Asset Manager
Road traffic flows (linked to OSCAR by GIS processing)	London Atmospheric Emissions Inventory
Traffic flow conversion factors (by year and by time of day)	National Traffic Statistics
Road type (major/other)	Transport for London
Carriageway type (one-way/two-way)	Street maps/ observation
Road surface type Location of purpose-built barriers	Requested from local Boroughs
Natural ground topography	OS Landform Contours
Man-map topography (side-slopes, road heights) Retained cuttings Elevated roads, bridges Railway topography	Photogrammetry (only for major roads)
Building type Number of households	OS Addresspoint
Population density	ONS Census Output Areas

3.4.1 Height data

Height data was the most difficult dataset to obtain, because most digital mapping data is two-dimensional – in other words, it is a digital version of a paper map. Although various digital height data sets were available, none had been co-ordinated to the OS digital maps. Moreover, for noise work, it is the edges of features that are significant, but radar or lidar aerial surveys produce a mesh of points which blur edges and may entirely overlook thin vertical features such as noise barriers.

This is a particular problem for the major road network, much of which has been built since Ordnance Survey completed their height surveys in the 1960s, and much of which is grade-separated. A photogrammetric survey [stereoscopic analysis of aerial photographs] of the major road network was therefore commissioned.

It was not possible to obtain a dataset on building heights within the time-frame and budgetary limitations of the project, so all acoustically-significant buildings were taken to have a height of 8 m above local ground level. Buildings with a floor area of less than 20 square metres were considered not to be acoustically significant and were filtered out.

4 QUALITY AND ACCURACY

Although quality requirements were central to the project, and were subject to audit, including a semi-independent role by Acoustical Investigation and Research Organisation (AIRO)[4], there was no requirement to verify the map against field measurements. Accordingly although the project team did not undertake any such verification, some stakeholders compared existing measurements

within their local areas with the values on the map, with favourable results. AIRO also compared the map with measurements in their own database and concluded that there was excellent correspondence.

Initial indications are that the average error is probably small, and comparable with typical measurement error, based on anecdotal evidence. However, this does not amount to formal verification, and the project team is aware of certain locations where the results are affected by modelling error which results in greater discrepancies. Accordingly, reliance should not be placed on the map when it is important to be certain of the noise level at any particular location. Caution is necessary not only because of possible errors in the map, but also because it omits aircraft, railway, industrial and neighbour noise.

5 STAKEHOLDER LIAISON

The project specification place great emphasis on the involvement of stakeholders – primarily London Boroughs, the GLA, Transport for London and other project participants. An important objective of stakeholder liaison was to disseminate a wide understanding of how noise maps are developed and how they can be used. Stakeholder events were held at intervals throughout the project, and used to inform stakeholders about the progress of the project, to ask for their assistance with supplying datasets and for comments on the draft noise maps. All interested stakeholders received on-line access to the map and training on how they could interact with it.

All but one of the 33 London Boroughs attended stakeholder events and training courses. They were impressed by the utility of the noise map and hoped that they would be allowed to use the map interactively and especially for assessing the impact of future developments. Some participants even brought current planning applications to training courses in order to learn how they could put the information into the noise model and calculate its impact.

Environmental Health Officers were keen to use the map as a tool not only for assessing new planning applications in accordance with PPG 24 'Planning and Noise' guidance, but also for prioritising planning applications by using an image of the map contours divided into PPG 24 Noise Exposure Categories.

Highways and Traffic engineers found that the software gave them an easy method of viewing traffic information, and some EHOs also thought that they would use it to extract traffic information for other projects such as air quality modelling, as they found the user interface so friendly.

A subsidiary objective of the stakeholder involvement was to assess the appropriate degree of involvement of local authorities in the development of noise maps. The report on the Birmingham noise map stated that the exercise would not have been possible without the involvement of noise mapping experts, and this was found to be equally true of the London Noise Map. It was concluded that it would not be appropriate to expect local authority staff to create noise maps from scratch, although once developed the operation of the map is well within the competence of local authorities.

6 WEB-VIEWER

A publicly-accessible web-site[5] has been established to allow anyone to view the finished noise maps. The concept is similar to that of web-based street maps. With an ordinary web-browser such as Netscape, Mozilla or Internet Explorer, users can select any area of the map by post-code, street name, Ordnance Survey co-ordinates or NoiseMap tile reference. Any of the various noise maps can be viewed at small, medium or large scale. In the first seven days of public use, the map attracted visits from 15,000 different sources and its popularity is expected to increase as more people learn about it. The web-viewer should be consulted for coloured examples of the noise map.

There are risks with making such data publicly available, both through misunderstanding or misuse of the data, and because of errors in the map. In addition to the more routine press articles

announcing the noise map, there have already been some articles that have started to look at the significance of the map for property values, albeit in a rather superficial way.

There have also been some queries from the public about the map – mostly complaining that it does not include aircraft noise – but one resident claimed that the map has incorrectly routed traffic past his house. Clearly, the map will need to undergo regular updates, especially as it pre-dates the congestion charge.

7 NOISE EXPOSURE

The principal objective of the project was to derive statistics on the noise exposure of buildings and people in London – visual or printed maps were not part of the original specification.

To calculate building exposure, all buildings in London were identified by relating their OS AddressPoint data to every building in the noise model. AddressPoint identifies the location of every address in London, and indicates the building /organisation name. By overlaying the building onto the noise map, it was possible to identify the noisiest façade of each building and to allocate that noise level to one of three building types – dwelling, hospital or school. Other buildings were ignored. A further step was to estimate the number of people occupying each dwelling. This was done by taking the population of each National Census output area (formerly Enumeration District) and dividing by the number of dwellings in that area. (The Census data do not give the occupancy of each dwelling for reasons of confidentiality).

The results are summarised in Table 2 below for various noise indexes. These results are presented in accordance with the noise exposure bands stipulated in the contract, which corresponds with the Environmental Noise Directive. The lower bounds for reporting noise levels were set on the basis that lower levels would have reduced accuracy.

Table 2 – Population and building exposure

Noise Exposure Band (dB)	**Population Exposure (%) For various noise indexes**				**Lden Building Exposure (%) For various building types**		
	L_{day}	$L_{evening}$	L_{night}	L_{den}	Dwellings	Hospitals	Schools
<50			74.9				
<55	72.8	77.1	84.1	67.3	65.8	41.5	55.4
<60	80.0	84.4	94.5	77.8			
<65	87.8	93.3	99.7	85.8	84.7	64.8	83.0
<70	97.0	99.5	100.0	95.5			
<75	99.9	100.0	100.0	99.8	99.7	98.9	100
<80	100.0	100.0	100.0	100.0	100.0	100.0	100.0

It will be noted that 27.2 % of the London population are exposed to daytime road traffic noise levels in excess of 55 dB L_{day}, and 25.1 % are exposed to night-time road traffic noise levels in excess of 50 dB L_{night}.

This may be contrasted with the findings of the recently-completed study of ambient noise on Merseyside[6], which reported that 48 % of locations had noise levels above 55 dB L_{Aeq}, (16 hour) and 70 % had night-time levels exceeding 45 dB L_{Aeq}, (8 hour).

Although the Merseyside study included all noise sources, the report indicates that road traffic was the predominant noise source, and this would not therefore appear to explain the large differences in the findings of the two studies. It is possible that there was a tendency (conscious or unconscious) in the Merseyside report (which is based on noise measurements) to survey at typically noisy locations, and indeed para 7.18 of the Merseyside report cautions that the measurement locations were not intended to be statistically representative of Merseyside.

The National Noise Incidence Survey 2000 found that the mean noise levels for England and Wales were 57 dB L_{Aeq} (16-hour) for the daytime and 48 dB L_{Aeq} (8-hour) for the night-time. Although a 16-hour index was not calculated for London, the day value would be quite similar to this numerically. It therefore appears that the mean population exposure of London is less than the average indicated by the Noise Incidence Survey.

If these findings are confirmed by further study, it will show the benefit of noise mapping in reaching the parts that other methods cannot reach.

8 THE FUTURE

8.1 Lessons learnt

The overall approach to the project was considered to be very successful. The project has delivered a high-quality noise map on time and to budget; most stakeholders have participated in events with enthusiasm and the understanding of noise mapping by all parties – including the project team – has increased considerably.

8.2 Future work

OS MasterMap, used as the base mapping for the project, has proved to be tremendously useful, although its two-dimensional nature caused some problems. Further work will be needed on resolving the issue of obtaining height data, especially for linear features such as noise barriers, walls and edges of elevated or cut roads.

Many stakeholders expressed reservations about all buildings being given a height of 8m. It will now be possible to undertake sensitivity testing of this assumption.

Noise predictions made close to a noise source are considered to be more reliable than those made further away. The map provides a useful starting point for this to be investigated.

It is interesting that the noise exposure of London seems to be lower than average values given in the Noise Exposure Survey and in the Merseyside study. This needs to be explained.

The map provides a good basis for research into noise action planning.

9 CONCLUSION

The Road Traffic Noise Map of London has been successfully created and released to the public. A number of the aspirations for the noise map these have already been met: a baseline road traffic noise exposure has been derived, and appear to indicate that the proportion of London's population subject to excessive noise levels may be less than formerly supposed.

Stakeholders have seen how noise can be assessed in a scientific and objective manner: the visual nature of the printed maps is already being used to teach experts and non-experts alike how noise spreads, and a few planning authorities are already using it to assist in the assessment of planning applications.

Public access to the map, through the web-viewer, is raising people's awareness of noise as an environmental pollutant, as the EU intended. The map is a valuable resource and is expected to form the basis of much future research.

10 REFERENCES

1 Directive 2002/49/EC of the European Parliament and of the Council (June 2002).
2 Calculation of Road Traffic Noise. Department of Transport and Welsh Office. HMSO 1988.
3 Converting the UK Traffic Noise Index $L_{A10,\,18\,h}$ to EU Noise Indices for noise mapping. Abbot and Nelson. TRL Ltd. Report PR/SE/451/02 (2002).
4 Acoustical Investigation and Research Organisation, Hemel Hempstead, Herts.
5 Web viewer at www.noisemapping.org/frames/map.asp
6 Merseyside Ambient Noise Survey Final Report. Hepworth Acoustics Ltd et al; Report no. 2674.17 June 2004