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AN OVERVIEW OF THE IMPACT OF SOURCE DATA ACCURACY VARIATIONS ON THE OVERALL ACCURACY OF NOISE MAPS

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Abstract

The paper will provide an overview of research carried out by Hepworth Acoustics Ltd and others on the impact on the overall accuracy of noise maps from variations in the level of accuracy of individual data items.

Noise mapping carried out for the European Union Environmental Noise Directive (END) will be used to inform the general public across Europe of the current distribution of noise levels in urban areas and adjacent to main transport noise sources, as well as being used to identify hot spots for future mitigation measures. In order for the general public to maintain confidence in the process, there is a need to be able to explain the level of accuracy of the maps produced, in order to manage public expectations. To be able to explain the level of accuracy, the noise mapping practitioners need to be able to detail the overall level of accuracy of the noise map, and to be able to understand the implications on overall accuracy of using imperfect data for some or all data requirements. This paper reports on a range of work carried out for the Department of Environment, Food and Rural Affairs (Defra) in the United Kingdom that has looked at accuracy implications of variations in source data accuracy. The paper will also discuss whether the type of noise source being modelled affects the accuracy requirements for source data.

1. INTRODUCTION

Within noise mapping, it is considered that there are four key areas of uncertainty to be considered when assessing the overall accuracy of noise maps. These are:

- Input uncertainty.
- Uncertainty propagation.
- Model uncertainty.

- Uncertainty of evaluation data.

This paper looks at work that has been carried out for Defra on uncertainty propagation within the noise mapping process, the second of the four key areas. The aim of the work has been to gain an understanding of the way in which uncertainties are propagated through some of the noise mapping calculation methodologies, to rank the importance of different input data and to use the results to make recommendations on data acquisition strategies. The results of this work can be fed back in to the first key area in order to manage input uncertainty.

2. BACKGROUND

Noise mapping is a very data hungry activity, and a wide range of geometric and non-geometric data is required. It was realised relatively early in the END development that there was a need for guidance to EU Member States and noise mapping practitioners, not only to achieve more consistency in the noise mapping methodologies, but also on strategies to be adopted in the absence of perfect data for the noise maps. This led to the setting up of the EU Working Group Assessment of Exposure to Noise (WG-AEN) in 2001. One of the tasks of the working group was to produce a Good Practice Guide for Strategic Noise Mapping. This was duly published in December 2003[1].

Version 1 of the Good Practice Guide (GPGv1) contained a number of toolkits of solutions relating to specific challenges. Each toolkit contained a number of tools providing guidance on procedures to be adopted depending on the level of data available for each input parameter, including the situation if no data was currently available. Each tool contained an indication of complexity, accuracy and cost for the options listed. This meant that an informed assessment could be made of the options available for each input parameter. However, the indications of complexity, accuracy and cost were only applicable within each tool. The highest accuracy option in one tool could have a different absolute level of accuracy compared with the highest accuracy option in another tool. The GPGv1 provided useful information to mapping practitioners on strategies to adopt in areas where data was lacking or incomplete, but it did not provide guidance in quantifying the level of accuracy achieved by using these recommendations in noise maps.

In order to provide further information on the accuracy implications of the use of the toolkits, Defra, as part of its support for WG-AEN has let two research contracts to provide quantified accuracy statements for some of the items covered in the toolkits. The results from the first contract carried out by Hepworth Acoustics and DGMR, relating to toolkits for road traffic noise, have been incorporated in to Version 2 of the Good Practice Guide (GPGv2) [2]. In a number of the toolkits, decibel accuracy statements are included. This not only enables more informed decisions to be made on the choice of tool within a toolkit, it also enables informed decisions to be made about the relative importance of different toolkits. In 2006, a second contract was let by Defra to Hepworth Acoustics, Acustica, DGMR and DeltaRail to carry out similar research on toolkits for railway noise. This work is currently being finalised and reported to Defra. A summary of the work will be published on the Defra website in due course, and it is hoped that the work may be used in any future revisions of the GPG.

3. ROAD NOISE ACCURACY IMPLICATIONS

The study carried out for Defra on road traffic noise looked at toolkits 1, 2, 3, 6, 7 and 8 in the GPGv1 plus a new toolkit for road surface. The work was carried out using the UK Calculation of Road Traffic Noise (CRTN) method and the EU recommended Interim Method for roads, XPS 31-133. The studies looked at the non-geometric aspects such as traffic volume, speed, composition of flow, road surface type and gradient as well as the geometric aspects of location, height and ground surface type.

The CRTN studies identified that vehicle speed, traffic flow and road gradient gave the highest decibel error for the same level of uncertainty, and the error increased with the input magnitude. Therefore, for high input values, more accurate input data is required. It was also identified that the decibel error due to multiple simultaneous input uncertainties is higher than for an individual input uncertainty. Therefore, where there are a number of input data with uncertainties, the accuracy requirement for each input parameter will need to be higher than those with a single input uncertainty, to obtain the same overall uncertainty. In relation to geometric aspects, the height of an item, whether it be ground, building or barrier height was more critical than the location of an item, although often there is more locational information available for items such as buildings than there is height data. Uncertainty in ground surface type was found to give relatively small variations in noise level.

The XPS 31-133 studies identified a similar trend in the results, although details varied as a result of the different calculation methodologies. Uncertainty in vehicle speed was identified as giving the largest decibel error with the error increasing with the input magnitude. Therefore, greater accuracy is required for higher speed roads. The results again demonstrated that inaccuracies in multiple input parameters led to a higher decibel error than for an individual input uncertainty. The study of geometric aspects confirmed that height data was more important than locational data.

Within the detailed reports, accuracy requirements are specified for the various input data in order to achieve a given level of accuracy. The accuracy implications of the various tools within the toolkits studied are specified. A summary of the study is published on the Defra website [3], and it is possible to obtain the full reports on cd from Defra by request.

4. RAILWAY NOISE ACCURACY IMPLICATIONS

Following on from the publication of the road traffic noise study by Defra, and the incorporation of the accuracy figures for the toolkits within GPGv2 in 2006, a decision was made by Defra to let a second research project to carry out similar work on railway noise. This study looked at the UK Calculation of Railway Noise (CRN) methodology and the EU Interim calculation method RMR 1996. The contract was awarded towards the end of 2006 to a consortium of Hepworth Acoustics, DGMR, Acustica and DeltaRail. The final reports were presented to Defra in April 2007. The project looked specifically at toolkits 8, 9, 12, 13, 15 and 16 when applied to the two methodologies.

The CRN studies identified that uncertainties in train speed yielded the greatest decibel uncertainty in the total emission level. Uncertainties in railhead roughness yield different acoustical uncertainties based on different types of rail vehicles. With diesel locomotive units, the engine exhaust is usually a significant noise source, and this is unaffected by railhead roughness. Therefore, railhead roughness is usually less important for diesel engines than other rail vehicle types. Train flow uncertainties have less of an impact than train speed and railhead roughness.

Within the CRN studies, it was identified that using inappropriate train vehicle types can produce large uncertainties. Within the CRN methodology, there are source noise level variations of around 10 dB for similar types of train vehicle. When carrying out large scale noise mapping, it would be expected that some data would be available on train types from the railway authority. However, if train vehicle types have to be captured by site survey, provision of some training to the technicians can greatly reduce the level of uncertainty.

The geometric testing of CRN produced a similar pattern of results to those produced by CRTN in that vertical height data is required to be more accurate than location data to obtain the same level of uncertainty. An example of this is that in order to produce the same level of uncertainty, a noise barrier height in relation to the railway should be accurate to between 0.25-0.5m whereas the horizontal distance from the railway only needs to be accurate to between 1.5-4m.

Using RMR 1996, the ranking of non-geometric factors is reversed compared with CRN. Train flow uncertainties lead to the greatest acoustical uncertainties for most train types, followed by train speed. The geometric factors follow a similar pattern to the results from CRN. The results from both CRN and RMR 1996 demonstrate that inaccuracies in multiple input parameters lead to a higher decibel error than for an individual input uncertainty.

One factor that came out of comparing the results for the road and railway noise calculations, was that in order to obtain the same level of uncertainty from the geometric factors, a greater level of accuracy was required for the geometric data in the railway calculations. However, it is not considered that this is a factor of the different types of noise sources, but rather a factor of the number of sources being considered. When considering railway noise, most receptors will be affected by one railway line (or rail corridor). Urban receptors in road noise assessments will normally be exposed to a number of different roads. Therefore, variations in geometric data will have less impact where there are multiple sources than where there is one main source. This means that in order to achieve the same level of uncertainty, greater geometric accuracy is required where receptors are exposed to a single source (such as railways and major roads outside agglomerations) than where receptors are exposed to multiple sources such as an urban road network.

5. CONCLUSIONS

This paper has presented a summary of some of the findings on studies carried out for Defra on the accuracy implications of using imperfect data for noise mapping. These studies provide some guidance on understanding uncertainty issues caused by imperfect data, and will help practitioners manage some of the uncertainty issues within the noise mapping process. Successful management of uncertainty issues is vital to ensure that public confidence is maintained in noise maps and that they are not used for roles that are incompatible with their associated uncertainty.

REFERENCES

[1] European Commission Working Group Assessment of Exposure to Noise (WG-AEN), *Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure, Version 1,* 2003

[2] European Commission Working Group Assessment of Exposure to Noise (WG-AEN), *Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure, Version 2,* 2006

[3] http://www.defra.gov.uk/environment/noise/research/wgaen-gpguide/index.htm