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On the creation of noise action plans for urban areas by the use of large noise maps and hot-spot analysis

Åsa Stenman^a and Peter Malm^b

Acoustic Control AB
Tumstocksvägen 1
187 66 Täby
SWEDEN

ABSTRACT

One of the goals for the EC financed Integrated Project Quiet City Transport (QCITY), is to provide European city administrations with validated analysis tools and technical noise control solutions for the efficient production of noise action plans. A part of the QCITY project work is to produce complete noise maps and hot-spot analysis for the entire Gothenburg area.

By examples presented from the Gothenburg noise map, this paper will highlight the applicability of large noise maps in relation to noise action plans, preservation of quiet areas as well as general long term planning. We will especially focus on the new Noise Environmental Rating System (NERS), a tool for performing hot-spot analysis on noise maps, developed within the QCITY project. Examples on how NERS can be used for creating cost efficient noise action plans will also be presented.

1 INTRODUCTION

It is a rather new issue to focus on noise exposure in large scale in Sweden. It was no more than ten years ago that the government decided limiting national exposure levels concerning traffic noise [1]. These exposure levels were to be implemented in construction of new housing areas or when significant changes to existing areas were made. This proposition also outlined when actions should be taken to decrease exposure to noise from government roads in existing housing areas. The actions aimed, in time, to reach the limiting exposure levels set for indoor noise. This gave the national authority in Sweden an overall action plan for working with measures to reduce noise exposure in existing housing areas. The municipals in Sweden are though responsible for their own roads and they were not directly affected by the proposition regarding existing areas. Nevertheless, many of Sweden's 290 municipals have used this proposition for setting their own limiting exposure levels for existing situations on when to react and work further with possible mitigation measures. This work has been optional for the municipals.

According to the EC-directive [2] some of the municipals have to generate their own action plans. In 2007, three Swedish cities have to present their action plans and another ten is due, 2012. There has been a large interest also in other, smaller, municipals to make their own action plans with respect to the EC-directive regarding noise. In our point of view, the EC-directive has in the recent years brought the topic of noise action plans to the surface.

^a Email address: stenman@acoustic.se

^b Email address: peter.malm@acoustic.se

In support for making action plans, the EC partly finances the project QCITY (Quiet City Transport) which is an environmental project within the sixth framework. The project, which will continue until 2009, consists of 27 organisations and companies. One of the goals for the project QCITY is to provide European city administrations with validated analysis tools and technical noise control solutions for the efficient production of noise action plans.

A part of the QCITY project work was to produce complete noise maps for the municipal of Gothenburg and evaluate these maps to find areas where inhabitants are exposed to high noise levels. These areas were then more detailed investigated and discussed with the city authorities.

Present measures for noise reduction are often governed by complaints. The aim in this work is to present a method for analyzing noise maps to use as a complement in prioritizing areas where measures should be considered first.

This paper shows an example of how this method may be used to evaluate different measures to an area detected via hot-spot analysis.

2 ACTION-PLANS

According to the EC-directive, 2002/49/EC, the action plans should be designed to manage noise issues and effects, including noise reduction if needed. The action plan shall also aim to protect quiet areas against an increase in noise. The measures included in the action plan is decided by the competent authorities within each Member State. It shall focus on areas with exceeding limiting values or according to other criteria that the Member State has chosen. In particular it should apply to the most important areas as established by the strategic noise map. This definition gives the Member States a wide possibility to interpret the description and deliver a very thin and general action plan or an extremely detailed plan.

In this paper we focus on the possibility to use the established strategic noise map in defining the existing areas relevant for further analysis and action plan. The paper also shows an example on how different actions will be reflected in the analysis model.

2.1 Noise maps

The common noise map consists of a raster of calculated sound levels. The calculation is made via a 3-dimensional digital model including sources, reflecting objects and other obstacles to take into account when calculating sound propagation. The algorithms used for the calculation are standardized calculation methods. In Sweden the Road Traffic Noise – Nordic Prediction Method [3] is used. The calculated raster points are coloured according to level for better presentation and understanding of the noise map.

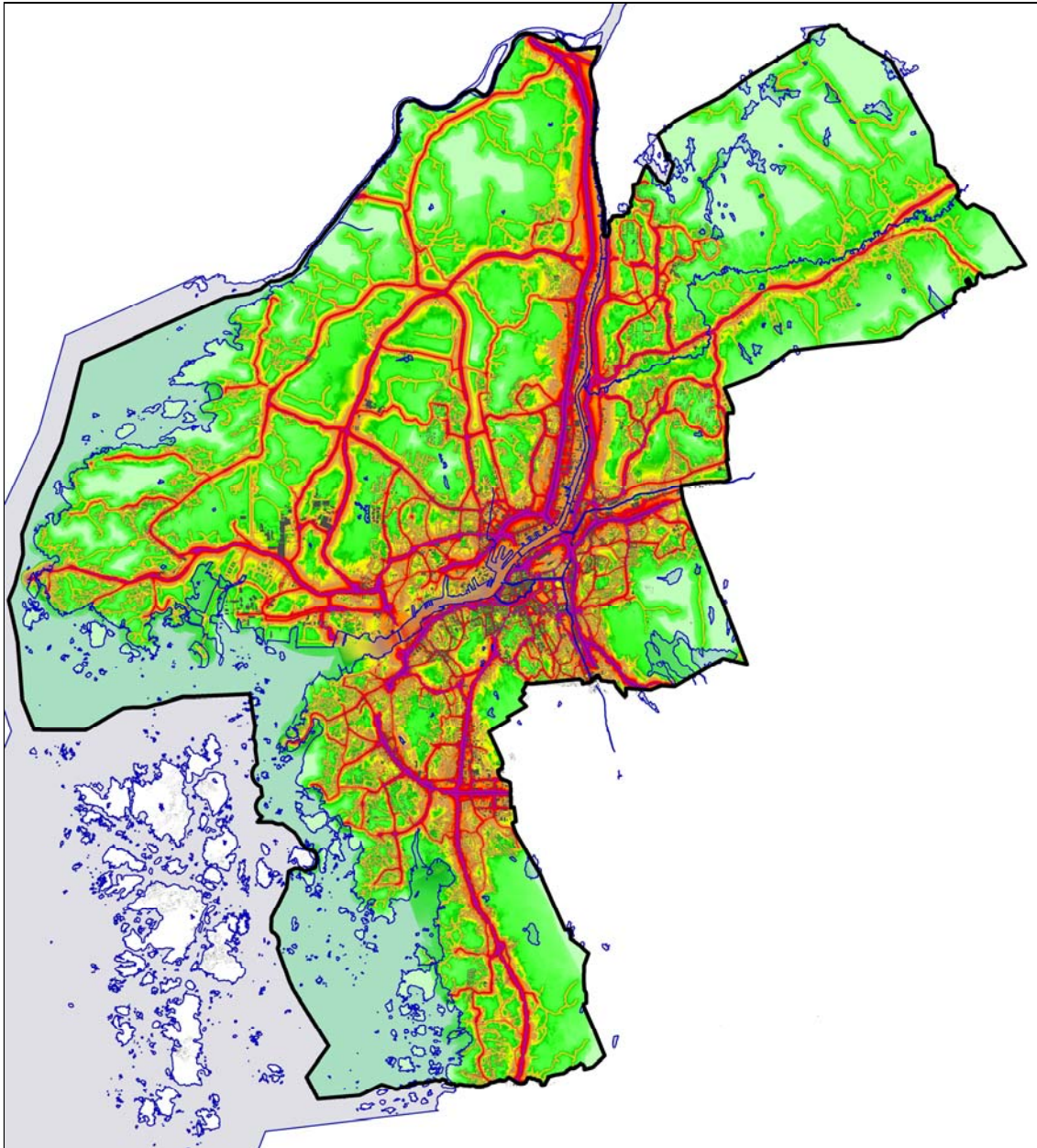


Figure 1: The noise map of the city of Gothenburg.

As an example throughout this paper, the noise mapping of the municipal of Gothenburg, Sweden is used. The noise map includes an area of 520 km² and no less than 5.2 million calculation points. Shown in this paper are the results and derivatives from the road-noise calculation which includes 2 400 km of road sources and more than 120 000 buildings.

Today the noise maps generated in Sweden are mainly used for checking noise at a specific location. If the level is close or exceeding the limit value, further investigation is carried out. Usually the maps are used as a basis for checking values after a complaint has been filed instead of analysing where complaints may arise before they do.

3 FURTHER ANALYSIS OF NOISE-MAPS

A noise map gives focus on locations which are subject to high noise levels. This may be interesting in itself but may also lead the attention away from the locations where measures actually have to be taken to achieve less exposure to a greater part of the population. Another reason to further analysis is that measures resulting only in lower indoor levels are not detected using a noise map.

With the use of today's available GIS-software many parameters can be connected to each object in the digital map. As an example, the number of inhabitants and the façade level can be coupled to place inhabitants in noise level intervals, according to the EC-directive. Applying even more parameters can enhance the results. Information about the location of apartments inside a specific building can give more accurate estimations of inhabitants with access to a quiet side for example. One of the more interesting parameters is probably the sound reduction of the specific facades. Using this parameter allows us to calculate the indoor level.

3.1 NERS

Utilizing the GIS-software, parameters such as façade level, number of inhabitants, window measures and sound reduction of the façade etc. can be given to each building object in a map. From these parameters an evaluation can be made using different algorithms. For the Gothenburg case study, an algorithm developed by Wolfgang Probst [4] is used. Using the façade level, sound reduction of the façade and the number of inhabitants, also taking into account peoples difference in subjective annoyance with a façade level above 65 dB(A), a noise score is calculated. The method is called Hot-Spot analysis using Noise Environmental Rating System, NERS. Hence, the NERS method can be used as a tool for making an action plan.

Using NERS to calculate the noise score, results in a logarithmic value. This helps to distinguish the Hot-Spots in a dense populated area. For example, a small increase in inhabitants gives a large change in noise score.

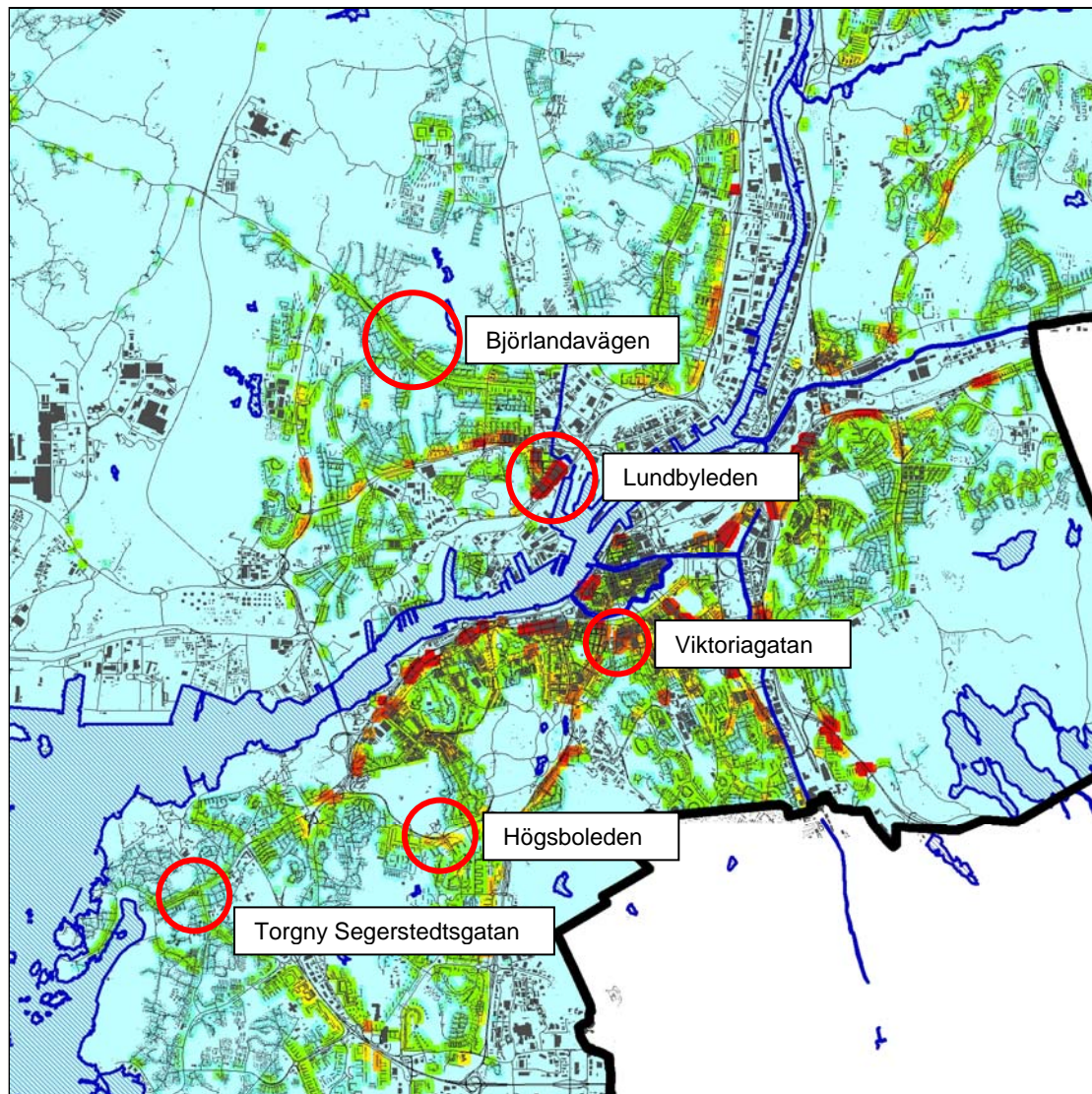


Figure 2: Hot-spot analysis showing the central part of Gothenburg. Five hot-spots were chosen for further analysis.

Five Hot-Spots were selected in cooperation with Gothenburg officials. The hot-spots were to be studied further with respect to the effect achieved by different measures. Most selections were based on the Hot-Spot analysis but the frequency of complaints in different areas was also a part of the selection procedure.

In this paper the results from the study of one of the Hot-Spots regarding the effect of different measures and their resulting noise score using NERS will be shown. The area is located along Högsboleden in the central part of Gothenburg. The investigation was aimed to examine the use of Hot-Spot analysis for the development of noise action plans. Three measures were investigated for the selected Hot-Spot. Window measures, the implementation of a noise barrier along the road and the introduction of sound reducing asphalt.



Figure 3: An analysis is made of the present situation for comparison with the results from the different measures. The black line represents the calculated 55 dB(A)-line.

The first measure to be investigated is one of the more common throughout Sweden. Funding for window measures are in some areas given to residents after investigation of the façade levels. In the case study, all apartments with a façade level above 65 dB(A) is given window measures that result in an increase of the sound reduction of 10 dB.



Figure 4: Hot-spot analysis after implementing substantial window measures to all apartments with a façade level above 65 dB(A).

The Hot-Spot analysis clearly shows the results. Of course the 55 dB(A)-line is not moved since nothing has been made to change the sound attenuation or the source.

To have an effect on the outdoor levels, a measure that reduces the noise close to the source can be introduced. Building a noise barrier along the road is often used to achieve such effect.

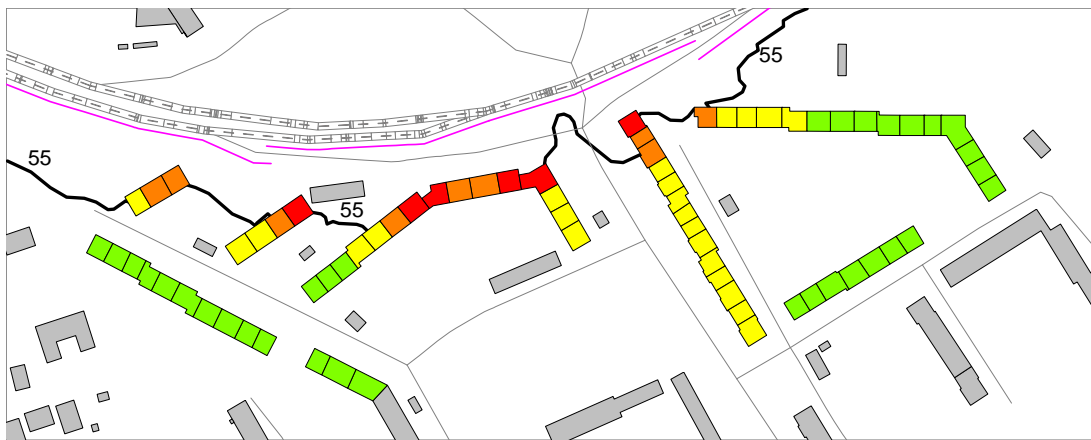


Figure 5: Hot spot analysis after implementing a noise barrier with the height of 3 meters along Högsboleden.

The noise barrier show great results on the 55 dB(A)-line. Due to the height of the exposed buildings, the barrier cannot give the desired effect to all floors. The Hot-Spot analysis is based on all floors of the buildings, thus limiting the barriers effect on the noise score. This result could easily have been overlooked using a standard noise map of the barriers effect due to the fixed height for the noise map calculation.

The third measure to be analysed is the introduction of sound reducing asphalt along the road. The hot spot analysis is made assuming the asphalt is fairly new, resulting in a sound reduction of 6 dB(A) of noise from tire-road interaction.



Figure 6: The results of the sound reducing asphalt shows clearly in the hot-spot analysis.

Changing the road surface to sound reducing asphalt gives results both on the façade levels and the 55 dB-line. The effect of this measure is global, reducing not only the sound level indoors but also the outside façade levels on the highest floors, something that a noise barrier or window measures cannot do.

Part of the road considered in this paper has actually been fitted with a sound reducing road surface as a project part within QCITY for further evaluation.

4 CONCLUSIONS

Making a Hot-Spot analysis of the noise map gives many interesting results. The investigation of different measures and their effect to the people exposed using NERS may yield even more information for the process of making an action plan. As shown in this paper different measures have unique benefits, but using NERS may in many ways help making the choice less difficult.

For future analysis of noise maps, the NERS method as well as other ways to improve or highlight problem areas can incorporate many more factors. For the implementation of more parameters, it is imperative that they are available in digital form. Information about apartment layouts, measurements of sound reduction of the facades as well as the importance of outside factors such as quiet parks is hard to find in today's digital maps in Sweden. The implementation of these parameters would enhance the capabilities of the hot-spot analysis as a tool for active generation of action plans.

5 ACKNOWLEDGEMENTS

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