inter.noise
HAMBURG 2016

Noise mapping of quiet areas

Andreas R. NOVAK[1]

[1] Acoustics department, WSP Sverige AB

ABSTRACT

Quiet areas are becoming increasingly scarce in our society, especially close to populated areas. Residential areas are now being built in places previously deemed not suitable for residential purposes. At the same time, research is showing how harmful noise pollution is to our health.
Identifying quiet areas is the first step in ensuring their protection. A conventional noise map does not show quiet areas, only areas that are not. These maps normally include only road and rail traffic noise, industrial noise and noise from airports. In order to find quiet areas, the noise map also needs to include a large number of smaller noise sources.
In Sweden there are several different models according to which quiet areas can be identified. The official model is so demanding and complicated that no one is using it. The aim of our work is to present a new model that can be used in practice. We hope this new model can be adopted as the official one instead of everyone creating their own model. This would mean that all investigations will be carried out according to the same model, ensuring they are more uniform and with a higher quality.

Keywords: Quiet areas, Noise mapping, Environmental noise, I-INCE Classification of Subjects Number(s): 02.8, 52.9

1. INTRODUCTION

In order to create more dwellings close to our city centers, many green areas are now being converted from recreational use to residential developments. This is therefore increasing the distance from the city center to a field where you can play football, or a wooded area where you can walk your dog.

It is easier to accept a noisy neighborhood if there is a quiet area close by. This fact must be taken into consideration by city planners when they are searching for suitable places to develop. Studies are showing the adverse effects noise has on our health, including links with an increased risk of cardiovascular disease. This would imply that reducing exposure to noise is not only a question of comfort but also plays an important role in health and wellbeing.

Last year in Sweden the noise limits relating to traffic noise and industrial noise were relaxed. From a health standpoint the relaxation of noise criteria may prove to have a detrimental effect.

Since the absence of community noise sources, such as traffic and industrial noise, are an important factor in the design of recreational areas, it is important to know were those quiet areas are located. A noise map is therefore an important tool for the city planners. Unfortunately a common noise map will only show the areas where noise is an issue, and does not show the quiet areas. This fact is often overlooked by the city planners.

A noise map normally includes noise sources such as road and rail traffic, larger industries and air ports. However, our communities contains many more noise sources which, if not included in the noise map, can mean the quiet areas are perceived to be much larger than they really are.

The term “quiet” can be somewhat misleading, but is perhaps a more suitable word than “silent”. In the European Environment Agency report, ‘Good practice guide on quiet areas’ (1), the word “calm” is also used. In our report we use the term “quiet”, by which we mean the absence of, or very low levels of community noise from sources such as road and rail traffic, industry, airports, mechanical services etc. Natural sources such as a waterfall or wind in the trees are not considered as noise sources, even if they emit relatively high levels of noise.

[1] andreas.novak@wspgroup.se

When new noise sources are introduced to the landscape, it is normally only determined that the noise criteria are satisfied at the nearest dwelling and at the nearest designated recreational area. It is almost never taken into consideration that the noise level may increase in other areas and therefore the quiet areas are pushed further and further away from the residential areas. A map of the quiet areas could perhaps facilitate the decision when planning whether a new noise source should be located in the landscape.

2. Noise mapping of quiet areas

An increasing number of municipalities in Sweden are interested in a noise map of the quiet areas to complement the normal noise map. In order to make such a map, a suitable calculation model is needed, as well as a suitable calculation program. It must also be decided which noise sources to include.

2.1 Calculation model

One calculation model for noise mapping of quiet areas has been proposed by the Swedish Environmental Protection Agency (2). This model, however, specifies noise level criteria on a 1 minute basis and is therefore not commonly used. Source data with such precision is not usually available.

Consequently many other models have been developed and there are now almost as many models as there are municipalities that have undertaken noise mapping of the quiet areas. It is therefore difficult to compare the different municipalities' noise maps and to decide which noise levels should be used to classify a quiet area.

If the model from the Environmental Protection Agency is the most demanding, the simplest is GIS based which uses buffer zones around all noise sources.

The new model that we propose uses existing data, or data that is easily available. Normally the municipalities are not prepared to pay as much for an investigation of the quiet areas as they are for a normal noise map. Therefore, the new model must be easy to use and cannot be too complicated or place strict demands on the input data. We believe that it is better to perform a simplified noise mapping project then to undertake no mapping at all. It is also preferable that the same model is used for all noise maps instead of having multiple models in operation.

One difficulty when performing a noise mapping project is that input data, noise levels, or operating hours are often missing. The source strength can of course be measured but there is often no time to perform such measurements on the large number of sources found when calculating an entire town. Therefore, default values must often be used. The new model contains suggested default values for a number of noise sources.

The first step of the noise mapping project is to choose which areas to map. Normally it is not necessary to map an entire town as this is often too time consuming. If a normal noise map is available it can provide clues where to look for the quiet areas.

The second step is to find areas that are often frequented, or areas which have certain qualities making them suitable for recreational purposes i.e. coastal areas, virgin forests etc. For locations close to residential areas, the demands are lower compared to those which are further away. A special reason is needed to travel far to visit a recreational area.

The choice of areas which should be investigated is best made by the municipality or someone with good local knowledge.

The third step is to decide which noise sources to include in the investigation. This work should also be done in collaboration with someone who possesses good local knowledge. Examples of sources to include are listed in chapter 2.3.

2.2 Calculation program

In Sweden it is common practice to use the Nordic prediction model for the calculations in a noise mapping project. There is one model for railway noise and one for road traffic noise. For industry noise we use the Danish model Dal32. All these are implemented in programs such as SoundPlan or CadnaA.

One limitation in the Nordic prediction model is that calculations cannot be performed too far away from the noise source. For road traffic the distance is 300 m. This is far too short for a noise mapping project concerning quiet areas. We therefore propose using the Nord2000 calculation model instead.

2.3 Noise sources

According to this new model, calculations should be done in the normal way for all noise sources where input data can be easily found i.e. road and rail traffic and perhaps some industry sources. For other sources it must be decided if measurements should be undertaken or if default values should be used. Suggested source data can be found in the calculation model for a number of noise sources in the form of point or surface data. These can easily be adapted to the actual sources.

Together with the municipality it must be decided what sources to include. Road and rail traffic and all industry sources are obvious choices. However, it is not certain whether a leisure boat harbor or the lawn mower on a golf course should be included.

The following sources can be considered for inclusion in the calculations:

- Road traffic
- Railway traffic
- Air traffic, including ground based sources at the airports
- Boat traffic, including jet skies
- Off-road driving (car, motocross, snowmobile etc.)
- Civilian shooting ranges
- Military training areas
- Industries
- Race tracks, including radio controlled cars or airplanes
- Aircraft training areas including sky diving areas
- Wind farms
- Beaches, concert areas, stadiums and other areas with large crowds or high noise levels
- Garden equipment, such as lawn mowers, leaf blowers etc.

Industry noise can include a number of different sources such as:

- Farm equipment such as tractors
- Forestry equipment
- Construction activities, if they cannot be considered to be temporary
- Quarry
- Snow cannon, snow groomer etc.
- Ventilation fans, chillers etc.

Calculation of airport noise is not normally carried out in a noise mapping project for a municipality since airports are already noise mapped. However, these calculations are usually only presented to a lower limit of 55 or 50 dBA which is too high when searching for quiet areas. The noise map around an airport therefore has to be extended. Aircraft flight paths further from the airport have to be taken into account. In Figure 1 an example is shown for Arlanda airport. The flight path of approaching aircrafts is shown with the red line. The altitudes of the arriving aircrafts are also indicated in the figure. The aircrafts fly over several nature reserves and bird sanctuaries where the resulting noise levels have to be determined.

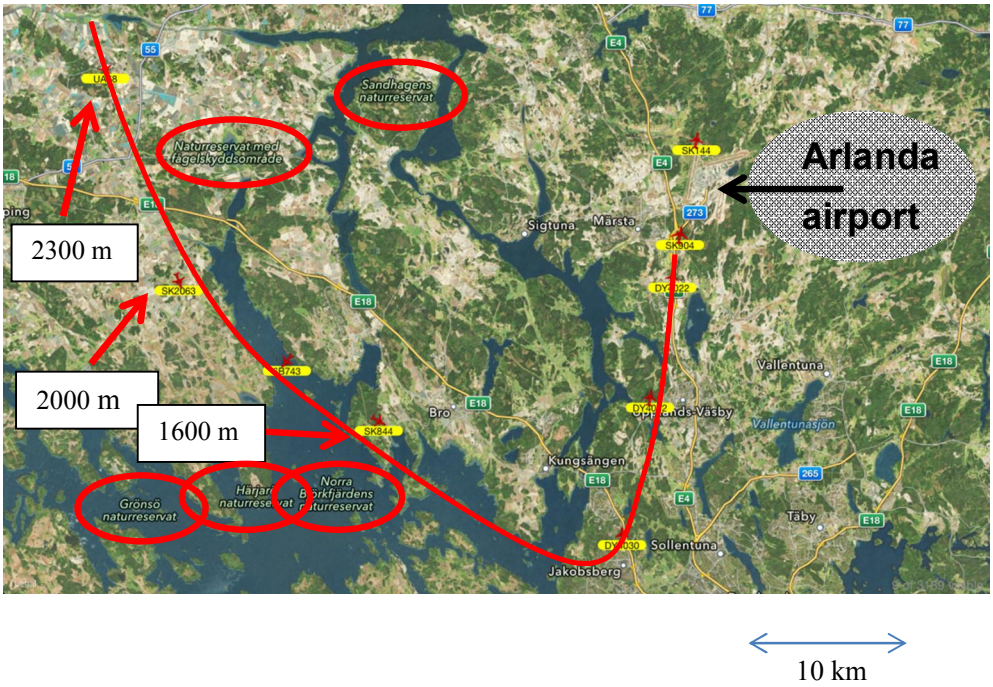

Figure 1 – Flight path for approaching aircrafts to Arlanda airport. The aircrafts altitude and several nature reserves and bird sanctuaries are highlighted in the figure.

2.4 Default values

If the noise levels of the sources are not known and cannot be determined, the following source data is suggested. In Table 1 a number of examples from the new model are shown. The indicated areas are the entire surface occupied by, for instance, an industry.

Table 1 – Examples of default values for sound sources.

Noise sources	*Sound power level (L_{WA})*	*Geometry (surface/line/point)*
Industry		
General industry: manufacturing, heat production etc.	55 dB/m²	Surface
Heavy industry: Steelworks, quarry etc.	65 dB/m²	Surface
Light industry: Farm, garage etc.	95 dB	Point
Shipping		
Port handling containers, ferry terminal etc.	55 dB/m²	Surface
Leisure boats in a shipping lane including jet skies	55 dB/m	Line
Wind farms		
Power: 200-2000 kW, rotor diameter: 25-70 m, hub height: 30-130 m	105 dB	point, h = 130 m

2.5 Quality of the input data

To ensure that the noise map is of high quality, the quality of the input data must also be high. The quality of the data must also be specified in the report. In the new model the quality and format of the terrain maps, buildings, traffic data etc. is specified. Calculation settings and the type of output data is also specified. In Table 2 examples from the new model are shown.

Table 2 – Examples of requested quality of input and output data and suggested calculation settings.

Parameter	***Quality***	***Format***
Input data to the calculations		
Terrain map	GRID 2+/ height curves at 0.5 m distance	ASC/Shp, dwg
Ground absorption	Ground map according to The Swedish mapping, cadastral and land registration authority	Shp, dwg
Buildings	According to The Swedish mapping, cadastral and land registration authority	Shp, dwg
Building heights	Actual heights or default values according to the number of floors, size etc.	Shp, dwg
Noise screens	According to the municipally or road authority	Shp, dwg
Industry input data		
Noise sources	Measured or default value	–
Location	Map or observed	Shp, dwg
Operating hours	According to the industry	-
Input data for road traffic		
Traffic flow	Measured or estimated by the road authority	Shp, table, map
Percentage of heavy vehicles	Measured or estimated by the road authority	Shp, table, map
Speed	Posted speed	Shp, table, map
Calculation results		
Grid	Surfaces in 5 dB steps	Shp
Calculation settings		
Grid height	2 m	
Grid size	10×10 m	
Reflections	1	
Search distance source-receiver	5 000 m	
Search distance source - reflector	100 m	
Search distance receiver - reflector	200 m	

2.6 Criteria

Measurements and calculations yield a sound level for the area in question. That sound level is, however, not directly linked to the perceived disturbance. This problem is not taken into consideration in this new model.

The calculated sound levels should only include community noise sources and no natural sources such as wind, waterfalls etc.

The suggested criteria for quiet areas are listed in Table 3. These criteria are based on L_{Aeq} for day and evening (06.00-22.00).

Table 3 – Suggested criteria for quiet areas

Sound pressure level, L_{Aeq} dB	***Explanation***
20	Very little noise impact
25	Little noise impact
30	Limited noise impact
40	Limited noise impact close to residential areas

3. CONCLUSIONS

A noise map showing the quiet areas in a municipality is an important tool for city planners. It is important that everyone follows the same method of finding these areas as failure to do so make it very hard to interpret the maps and to decide the significance and quality of the indicated noise levels.

A model for mapping the quiet areas cannot be too complicated or too expensive to perform. This will only result in the mapping not being undertaken or being carried out according to an undefined model.

The new model is a good compromise giving a good enough quality of the noise map and at the same time being easy to use.

The first noise mapping project according to this new model is now under way.

ACKNOWLEDGEMENTS

This work has been financed by the Center for Occupational and Environmental Medicine, Stockholm County Council, Sweden.

REFERENCES

1. Good practice guide on quiet areas, European Environment Agency, EEA Technical report No 4/2014
2. *Sound quality in natural and cultural environments. Swedish Environmental Protection Agency. Report 5709. 2007.*