



euronoise

# NERS-analysis extended to include the existence of neighbouring quiet areas

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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 a part of Stockholm.
This paper will focus on the Noise Environmental Rating System (NERS), a tool for performing hot-spot analysis on noise maps, developed within the QCITY project. The input parameters that have been used in previous studies are outdoor noise on all floors, number of inhabitants per building and the facade sound insulation index.
Previous studies, such as the "Stockholm score rating model" show a strong correlation between noise annoyance and the existence of quiet nearby areas. The NERS-analysis in this work has therefore been extended to include quiet areas.

# 1 Introduction

According to the directive 2002/49/EC "relating to the assessment of management of environmental noise" [1] the city of Stockholm finished their noise maps in June 2007. The city is now in the process of approving the noise action plan which will be presented in July 2008. According to the directive 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 and the measures included in the action plan are decided by the authorities within each Member State. In particular the action plan 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 general or more detailed action plan.

In support for making action plans, the EC partly provide financial support to the project QCITY (Quiet City Transport) which is an environmental noise 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.

The Stockholm action plan [2] for the coming five years is mainly a document describing a strategy on how the noise abatement work will be handled. It proposes a strategy to focus on measures at the source combined with direct measures for the most exposed dwellings. This action plan is planned to be followed up every year and evaluated in the end of the five year period to enable improvement for the next action plan, due for 2013. The complete potential represented by the calculated noise maps is not fully exploited in the 2008 action plan. The calculated sound levels together with other parameters in the GIS-software offer a large array of additional options for further analysis.

Within the QCITY project, work has been done developing an algorithm and method called NERS, Noise Environmental Rating System [3]. This method takes the outdoor sound level, sound insulation of the façade and the number of inhabitants into consideration for the analysis. The NERS-analysis, in its current form [3], provides a good indicator to where measures primarily could be of interest.

In a long term perspective there is a need for directing the focus of the action plan work also at the outdoor sound environment. The work with the NERS method was partly developed from a City of Stockholm concept; with its "Stockholm score rating model"[4]. A conclusion from the Stockholm study was that the existences of neighbouring quiet recreational areas influence the residents' general opinion on how they perceived their noise environment situation. This paper therefore will focus on a method to include also the quiet nearby recreational areas in the NERS-analysis. This will enable the use of the established strategic noise maps in defining the existing recreational areas relevant for further analysis and for inclusion in the noise action plan. It will provide indications on where the need for better or developed recreational areas would be most appreciated.

# 2 NERS-analysis

Based on the outdoor sound level, sound insulation at the façade and the number of inhabitants per building a noise score is calculated [3]. This noise score focuses on rating noise scores for different buildings and to identify the potential problem areas.

The access to recreational areas is in this paper included in the equations for determination of the score rating to study the impact of the parks.

# 3 Stockholm

Only just recently Sweden has focused more on noise exposure in large scale. It was no more than eleven years ago that the Swedish government decided to limit national exposure levels concerning traffic noise [5]. These exposure levels were to be implemented in the design and planning of new housing areas or when significant changes to existing areas were made. This proposition also outlined when actions should be taken to decrease noise exposure from government roads in existing housing areas. At the end of the day, the noise actions should aim at reaching the limit for noise exposure for indoor noise, 30 dB(A). Until now, most Swedish municipalities have focused their action plans on economic subsidies for house proprietors doing noise reduction measures on improving the sound insulation, primarily by providing better windows.

## 3.1 Study region

In this paper Stockholm, Södermalm will be used as a study area. The City of Stockholm is shown in the figure below. Södermalm is an island in the city centre, well suited for this study. The number of inhabitants on Södermalm is approximately 100 000.

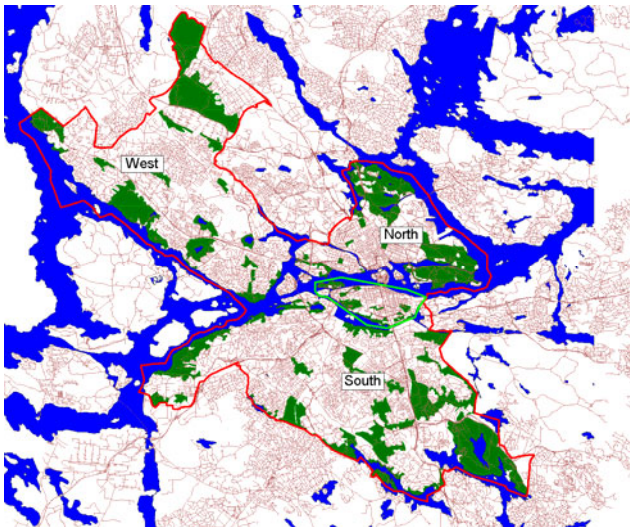


Fig.1 City of Stockholm. Södermalm is indicated with an inner borderline. The defined recreational areas in Stockholm are marked in green.

# 4 Recreational areas

The vast majority of noise investigation has in Sweden been measures to be compliant to the limits on indoor noise levels primarily by improved window insulation as the standard solution. A side effect is that the importance of recreational areas for the well-being has been neglected. This paper could be seen as a first step to use the soundscape of the parks as a positive value for the surrounding dwellings.

To include the soundscape of the recreational areas in the original NERS-analysis, the dwellings need to recieve a parameter describing the accessibility to the neighbouring parks. To create this parameter, two parameters of the park are used; area and quality score. The area defines the catchment area radius and the quality score is defined by the noise factor and size factor. This is done by weighting the size of the park and the sound quality of the park to ensure that a small quiet park receive a score comparable or even higher than a large but noisy park. The score is then coupled to the dwellings in the catchment area and included in the NERS-analysis as a correction of the outdoor noise level.

## 4.1 Studied region

All recreational areas in the vicinity of Södermalm, with an area above one hectare are included in this analysis. Södermalm and its surroundings include 18 recreational areas, listed in Table 1.

| | Recreational area | Area [Hectare] |
|---|---|---|
| 1 | Beckholmen | 1 |
| 2 | Tengdalsparken | 2 |
| 3 | Lilla Blecktornsparken | 2 |
| 4 | Tullgårdsparken | 3 |
| 5 | Stora Blecktornsparken | 4 |
| 6 | Rosenlundsparken | 5 |
| 7 | Vintertullsparken | 5 |
| 8 | Skinnarviksparken | 6 |
| 9 | Högalidsparken | 7 |
| 10 | Vita Bergsparken | 10 |
| 11 | Svensksundsparken | 11 |
| 12 | Eriksdalslunden | 25 |
| 13 | Långholmen | 29 |
| 14 | Drakenbergsparken | 38 |
| 15 | Fågelsångens koloniområde | 56 |
| 16 | Årstaliden | 65 |
| 17 | Björkhagens koloniområde | 72 |
| 18 | Nobelstranden | 453 |

Table 1 Recreational areas included in the analysis.

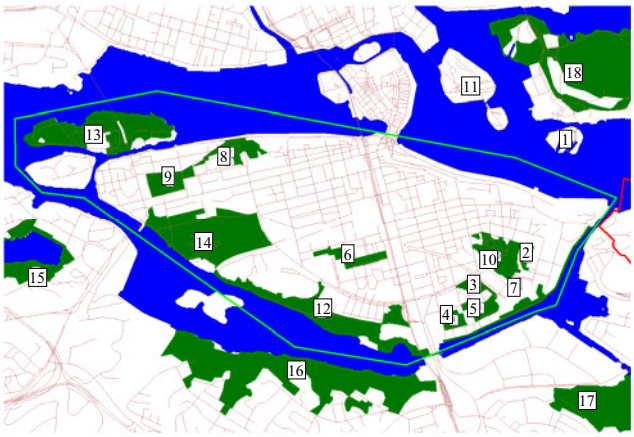


Fig.2 Södermalm with included recreational areas.

## 4.2 Catchment area

The city of Stockholm has a sociotopic map for parks and recreational areas which is described in a report [6]. That work does not include noise levels within parks.

In the document, the catchment region of a recreational area is defined as depending on the size order of the area. Park areas > 50 ha attracts people living within 800 meters from the park boundary. Areas 1- 50 ha, are used within 500 meters and areas < 1 ha, within 300 meters.

Water is here considered to be a barrier obstructing people from reaching the park. Bridges are included maintaining the total search distance for finding dwellings within the catchment area.

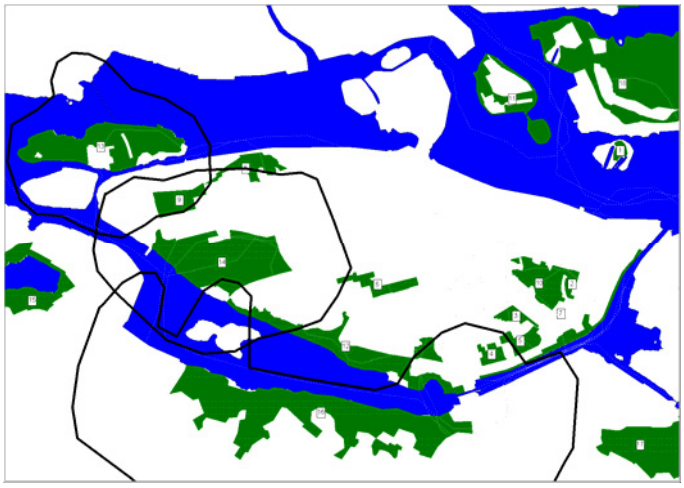

Fig.3 Defined catchment areas for park # 13, #14 and #16 including barrier and bridge effects.

## 4.3 Quality score

The quality score for a specific recreational area is defined by Eq.1.

$$QualityScore = \frac{NoiseFactor \cdot SizeFactor}{3} \qquad (1)$$

### 4.3.1 Noise factor

Three noise level interval classes are defined for the recreational areas;

| | |
|---|---|
| Class A: < 50 dB(A) | good noise environment |
| Class B: 50 – 55 dB(A) | acceptable noise environment |
| Class C: > 55 dB(A) | poor noise environment |

The interval classes above are documented as a rule of thumb for day-time exposure from traffic when defining good soundscape quality [7].

Drakenbergsparken is shown in Figure 4 as an example.

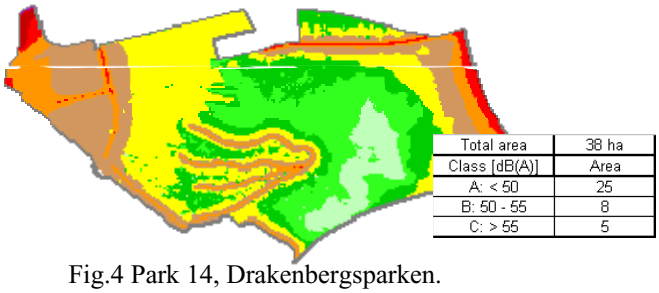


Fig.4 Park 14, Drakenbergsparken.

The value relation between the classes A:B:C are determined to be 12:6:1, in corporation with the Stockholm Environmental Protection Agency. The noise quality factor is then derived as;

$$NoiseFactor = \frac{A_{ClassA} \cdot 12 + A_{ClassB} \cdot 6 + A_{ClassC} \cdot 1}{A_{Total}} \qquad (2)$$

The noise factor can reach a maximum value of 12 for a good noise quality park. Full noise factor score is given to a park where 100 % of the total area is of class A-quality or if the total class A-quality area is more than 100 hectare. The considered total area of the park in this work is 100 hectare.

### 4.3.2 Size factor

The noise factor is the primary input value and also the smallest value the total quality score can get. The size factor can increase the noise quality factor from 1 to 3. This is due to the assumption that a large recreation area with optimal soundscape quality is worth three times more than a small standard city park in Stockholm. The total quality score is then normalized to a maximum of 12. The largest area taken into account is 100 hectare hence a park of 100 hectare or more receives the maximum size factor.

## 4.4 Resulting quality score for buildings

The total quality score is the normalized multiplication of the size factor and the noise quality factor. The results for the parks of interest are listed in Table 2.

All buildings inside the catchment area of a recreational area receive the quality score of the park. Buildings reaching several parks will receive the highest score from the parks in the vicinity, Fig.5.

Fig.5 Buildings coloured from the received quality score.

| no | Recreational area | Part A | Score | Part B | Score | Part C | Score | Noise factor | Area [Hectare] | Size factor | Total quality score |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Beckholmen | 1,00 | 11,9 | 0,00 | 0,0 | 0,00 | 0,0 | **12,0** | 1 | **1,03** | 4,1 |
| 2 | Tengdalsparken | 0,92 | 11,0 | 0,08 | 0,5 | 0,00 | 0,0 | **11,5** | 2 | **1,03** | 4,0 |
| 3 | Lilla Blecktornsparken | 0,02 | 0,3 | 0,39 | 2,4 | 0,58 | 0,6 | **3,2** | 2 | 1,05 | 1,1 |
| 4 | Tullgårdsparken | 0,27 | 3,3 | 0,53 | 3,2 | 0,20 | 0,2 | **6,7** | 3 | 1,05 | 2,3 |
| 5 | Stora Blecktornsparken | 0,75 | 9,0 | 0,13 | 0,8 | 0,12 | 0,1 | **9,9** | 4 | 1,08 | 3,6 |
| 6 | Rosenlundsparken | 0,82 | 9,8 | 0,12 | 0,7 | 0,06 | 0,1 | **10,6** | 5 | 1,10 | 3,9 |
| 7 | Vintertullsparken | 0,62 | 7,4 | 0,23 | 1,4 | 0,15 | 0,2 | **8,9** | 5 | 1,11 | 3,3 |
| 8 | Skinnarviksparken | 0,72 | 8,6 | 0,13 | 0,8 | 0,15 | 0,2 | **9,5** | 6 | 1,12 | 3,6 |
| 9 | Högalidsparken | 0,57 | 6,8 | 0,17 | 1,0 | 0,26 | 0,3 | **8,1** | 7 | 1,13 | 3,1 |
| 10 | Vita Bergsparken | 0,73 | 8,8 | 0,17 | 1,0 | 0,10 | 0,1 | **9,9** | 10 | 1,20 | 4,0 |
| 11 | Svensksundsparken | 0,09 | 1,0 | 0,47 | 2,8 | 0,44 | 0,4 | **4,3** | 11 | 1,22 | 1,8 |
| 12 | Eriksdalslunden | 0,59 | 7,1 | 0,18 | 1,1 | 0,23 | 0,2 | **8,4** | 25 | 1,50 | 4,2 |
| 13 | Långholmen | 0,26 | 3,1 | 0,31 | 1,8 | 0,44 | 0,4 | **5,4** | 29 | 1,58 | 2,8 |
| 14 | Drakenbergsparken | 0,67 | 8,0 | 0,20 | 1,2 | 0,13 | 0,1 | **9,4** | 38 | 1,75 | 5,5 |
| 15 | Fågelsångens koloniområde | 0,64 | 7,7 | 0,19 | 1,1 | 0,17 | 0,2 | **9,0** | 56 | 2,13 | 6,4 |
| 16 | Årstaliden | 0,88 | 10,6 | 0,08 | 0,5 | 0,03 | 0,0 | **11,1** | 65 | 2,30 | 8,5 |
| 17 | Björkhagens koloniområde | 0,81 | 9,7 | 0,10 | 0,6 | 0,09 | 0,1 | **10,4** | 72 | 2,45 | 8,5 |
| 18 | Nobelstranden | 0,86 | 12,0 | 0,09 | 0,5 | 0,05 | 0,1 | **12,0** | 453 | **3,00** | 12,0 |

Table 2 Total quality score.

## 5 NERS analysis extended with the influence of recreational areas

The original NERS method uses the indoor sound level as a parameter in the analysis to find the hot-spots where measures should be given priority. With this new analysis tool, the outdoor sound level is of prime interest. The total quality score from the park is therefore subtracted from the outdoor sound level in the same manner the sound insulation is subtracted from the outdoor sound level in the original analysis. This is made in order to arrive at a single number descriptor for characterization of the positive influence from nearby parks on the perception of the total noise environment, Fig 6.

It should be pointed out that this analysis is not aimed to be used as a tool to find dwellings in need of noise measures. Instead, this is a complementary analysis; to be employed when improvements of the outdoor noise environment has to be made. This is also a way to point out areas where new or more quiet parks would give most positive effect in terms of resident satisfaction.

## 6 Summary

A new method for assessing the influence of nearby green areas or parks has been suggested. The base is a rating system to include the positive effects of recreational parks expressing them as an equivalent increase in facade insulation.

Except from providing a single number descriptor of the noise impact, a clear indication of how important it is to create nearby high quality recreational areas is shown.

The method can be further developed to include and rate easy access to recreational areas also where there are greater distances from residents.

Fig. 6 Buildings coloured from the NERS-analysis including the total quality score for recreational areas.

## Acknowledgments

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