QCITY: providing cities validated mitigation measures for noise action plans

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Abstract

QCITY is an integrated research project sponsored by the EC-sixth research framework – priority: sustainable surface transport. A major directive is to provide municipalities with tools to establish noise maps and action plans for compliance with Directive 2002/49/EC. This paper describes the development of a validated selection guide of mitigation measures fully documented with information such as the expected noise reduction, costs, limitation in applicability. In addition to the selection limit, datasheets with further documentation and references are provided. This guide focuses on practical and validated actions that can be undertaken by municipalities themselves in their search for quiet city transportation. It involves the evaluation of aspects such as traffic planning, noise reduction of road and rail, propagation paths and barriers, economic incentives, …

Introduction

QCITY (Quiet City Transport) is an integrated research project sponsored by the EC-sixth research framework, currently in progress: February 2005 - January 2009. Twenty seven partners are working to develop an integrated technology for the efficient control of road and rail ambient noise in urban areas.

A major objective is to provide municipalities with tools to establish action plans and to provide them with a broad range of validated technical solutions for specific hot-spot problems they may encounter in their specific city.

Following further aspects have to be solved when carrying out action planning: methods and parameters for automated hot spot detections; integration of global and local mitigation measures in noise maps.

Validated approach

A three way approach was used. At one side, a list of complaints made by the citizens of cities (Stockholm, …) has been analysed. It was verified that the list of mitigation measures contained at least one answer to the each of the problems.

At a second side, a technical analysis was made on all existing technologies and mitigation measures. They were evaluated from a technical, acoustical and economic point of view.

Additional studies were carried out on areas where information was missing (such as economic incentives) or on which further application work was needed (in total, 15 topics were evaluated in situ).

A third approach was the development of new rating quantities for annoyance to assist and automate hot spot detection.

Use of supplementary indicators for annoyance and sleep disturbance

In order to get an overview of adverse effects of environmental noise, Miedema & Borst (2006) developed a Noise Rating System. The first two indicators in this noise rating system, *%HA* and *%HSD* are indicators for the health impact of noise:

- *%HA*, the expected percentage of people being highly annoyed due to noise as supplement to L_{den};
- *%HSD*, the expected percentage of people being highly sleep disturbed due to noise as supplement to L_{night};

Based on calculation tables and noise-annoyance maps, the use of those indicators were evaluated for hot spot detection. The method used was a moving average over a certain area (diameter of 50 or 100 m).

On the figures underneath, it can be seen that the % HSD map gives a clearer indication of two hot spot areas.

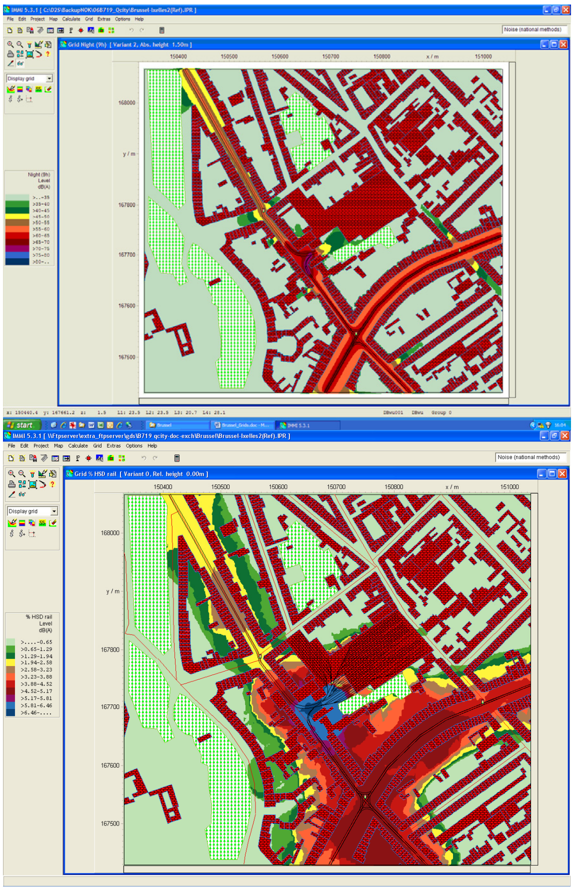

Figure 1. Noise map of L_{night}, versus noise maps %HSD (r = 50 m)

Difference between global mitigation plans and local complaint actions

Difference between global and local complaints is needed because there is not always a relation between hot spots identified in the noise maps and complaints identified by the inhabitants. This can be due to various reasons:

- the complaint is local, affecting a too small number of citizens to yield a high noise score in the hot spot detection methods.
- the L_{den} and L_{night} descriptors as used in global noise maps are not sensitive to noise sources that may locally cause considerable annoyance such as squealing.
- the methods used for the noise mapping do not always correctly include the local high noise generators.

Some of the work reported in this project gives a good illustration of this duality.

This is illustrated underneath for a small part of the city of Brussels: 0,5 km², 6600 inhabitations, 1100 houses. The effect of both a local mitigation method (elimination of squeal noise) as well as a global mitigation method (rail grinding) is evaluated.

Squeal noise (tramways in curve) requires a local complaint handling measure. It modifies the rail noise reception for, e.g., ±100 inhabitants, but no effect can be seen in the global noise maps and tables of annoyed. Only when analysing the rail noise alone, some small differences can be observed.

This measure is being tested in practice (by lubrication device). When the device has been put out of work for one week, the city/operator reported immediate complaints and threats with legal actions.

Although the number of people affected is small and its appearance in global noise maps is nihil, squeal noise mitigation measures are an important contribution to the sustainability of urban transport.

	Inhabitants of a building with a value at the most exposed façades inside the specified range	
	Original	Squeal noise difference
Road & Rail		
... < L_{den} < 55 dB	1092	0
55 ≤ L_{den} < 60 dB	233	0
60 ≤ L_{den} < 65 dB	1572	0
65 ≤ L_{den} < 70 dB	885	0
70 ≤ L_{den} < 75 dB	625	0
75 ≤ L_{den} < ...	1977	0
sum	6381	0
Rail only		
... < L_{den} < 55 dB	4337	0
55 ≤ L_{den} < 60 dB	574	81
60 ≤ L_{den} < 65 dB	526	76
65 ≤ L_{den} < 70 dB	887	-97
70 ≤ L_{den} < 75 dB	39	-39
75 ≤ L_{den} < ...	21	21
sum	6384	0

Table 1. Squeal noise – number of inhabitants exposed

Acoustical modelling of mitigation measures

One of aspects, when evaluating mitigation measures, is the possibility to integrate mitigation measures into noise maps.

Some mitigation measures can be integrated directly into noise maps because the considered items (such as road surface, vehicle speed, ...) are specific input variables in the noise calculation methods.

Other parameters (such as rail quality, rail lubrication, traffic flow fluidity, specially shaped barriers, ...) are not specific input variables and need an indirect input. The possibility to integrate those parameters in actual (and future) calculation aspects is studied hereafter.

Further, the aspect of loosing the effect of smaller and local mitigation measures into a global noise map was studied.

Out of the study, it can be concluded that the actual calculation methods are mostly not designed to take this kind of mitigation measures into account. Some of the mitigation measures, although not foreseen or defined in the actual computation method could be included. But, in general, future calculation methods, being described as 1/3 octave spectral transfer function calculation, yield all the flexibility to add 1/3 spectral correction functions, apt to include all types of mitigation measures.

Consolidation

The consolidation report includes more than 100 mitigation measures for urban noise. The mitigation measures are first summarised in tables (see example below) and then further detailed in adjoined data sheets.

The areas of mitigation measures include:

- traffic planning;
- reduction of emission from road transport;
- reduction of emission from rail transport;
- mitigation through propagation path modification: façade isolation, barriers and physical planning;
- economic incentives.

Each list consists of:

- a table with information on potential noise reduction and a first cost estimate for each mitigation measure;
- for each mitigation measure, a datasheet giving additional information, examples, and links for further information

A few examples are given hereafter.

ref.erence	location	action	noise reduction [dB(A)]	cost [€]	site specific limitation
GM-RAIL-9	vehicle	wheel truing	7 to 10	60,00 per wheelset	Single most important treatment, because wheel flats are most significant cause of impact noise
GM-RAIL-11		slip-side control	7 to 10	5 000,00 to 10 000,00 per vehicle	Reduces flat occurrence by about 50%, and thus reduces wheel truing costs proportionally
GM-RAIL-10	trackwork	rail grinding	7 to 10	4 000,00 per km track	Must be done in conjunction with wheel truing
GM-RAIL-12		defect welding & grinding	0 to 3	200,00 per defect	Noise reductions depend on number of defects. Costs are subject or local labour rates and field conditions
GM-RAIL-13		joint maintenance	2 to 3	200,00 to 400,00 per joint	Primarily relevant to older transit systems with steel elevated structures
GM-RAIL-14		field welding of joints	5	600,00 per joint	Ancillary cost benefits in reduced maintenance
GM-RAIL-15		eliminate rail support looseness	5	250,00 per m	Achieved with resilient direct fixation fasteners or concrete ties with spring clips Primarily relevant to steel elevated aerial structures
	wayside	treatments for normal and excessive rolling noise			

Table 2. Action plans for impact noise due to rail defects

Ref. – GM	Location	Action	Noise reduction at site [dB(A)]	Cost [€]	Site specific limitation
GM-TRAF-1	Link specific road traffic noise	Close off road for car through traffic	Can give substantial noise reduction of 3-14 dB(A) (L_{DAY})	Low implementation cost	Extent of traffic diversion effects
GM-TRAF-2	Link specific road traffic noise	Decrease speed limit	Can give noise a reduction of 3 - 4 dB(A) (L_{DAY})	Low implementation cost	Extent of traffic diversion effects
GM-TRAF-3	Area wide road traffic noise	Create quiet areas by restricting noisy vehicles by charges or road barriers	Has a potential to give substantial noise reduction of 3 - 14 dB(A) (L_{DAY})	High implementation cost	Extent of traffic diversion effects, supply of quiet vehicles and adjacent parking
GM-TRAF-4	Area wide road traffic noise	Increased frequency of public transport services	Generally small noise reductions	High implementation cost	Other effects than noise impacts needs to be considered
GM-TRAF-5a	Area wide road traffic noise	Decreased ticket price for public transport	Generally small noise reductions	High revenue loss	Other effects than noise impacts needs to be considered
GM-TRAF-5b	Area wide road traffic noise	Use of silent busses	0 – 1 dB(A)	Average costs	Small effect
GM-TRAF-6	Area wide road traffic noise	Area wide congestion charging schemes	Generally small noise reductions of 1 - 2 dB(A)	High implementation cost (should be exceeded by revenues)	Other effects than noise impacts needs to be considered
GM-TRAF-7	Road traffic noise	Make people drive less aggressive	About 1 dB(A)	Situation specific	Increased supervision or ISA-systems is necessary
GM-TRAF-8	Truck	truck routing/road restrictions	1 – 3 dB(A)	±400 000	Heavy load has to be significant compared to the overall amount of traffic; bypass roads have to be present

Table 3. Action plans for road traffic noise by traffic management

Conclusions

This paper describes some of the steps towards one objective of the QCITY project: providing a well documented guide for cities of validated mitigation measures to solve all kind of complaints related to urban traffic.

The full consolidated guide of mitigation measures can be found on the website of the QCITY project.

Acknowledgements

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This project involves 26 partners, of which further information can be found on www.qcity.eu.

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