The Sixteenth International Congress on Sound and Vibration
Kraków, 5-9 July 2009

STRATEGIC NOISE MAPPING – CAN IT SERVE AS A TOOL IN CITY PLANNING?

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Strategic Noise Maps have been produced to get an overview about noise levels in residential areas and to derive action plans to reduce unacceptable exposures. In the meantime there is a lot of experience how these data and the relevant models can be used even outside the frame of the directive. The first step is to include little modifications to relate the models to the noise indicators used for legal purposes. In some countries these changes are negligible, in others some new parameters must be taken into account. After this adjustment the 3D-models are a powerful basis for a lot of planning tasks and decisions..

1. Introduction

Noise mapping has become an invaluable tool to predict, control and at the end to reduce environmental noise. In Europe Noise Mapping has become a legal requirement – noise maps have to be produced for all agglomerations (cities) with more than 250.000 inhabitants, for residential areas near main roads, main railway lines and main airports. These maps are the basis for action plans to reduce the noise, that had to be developed and published till mid 2008. Five years later the same has to be done for all cities exceeding 100.000 inhabitants and the existing noise mapping studies have to be updated.

These requirements gave a tremendous push to the development of software-tools to perform these calculations. In the meantime it is state of the art to flank all noise relevant projects with a noise map demonstrating the distribution of sound pressure levels for the existing situation, the planned situation and the improvement or the deterioration by a difference map.

The same is true for all areas where noise may be a severe impact that should be controlled by all future developments. If a 3-D-model of an environment exists, it is easy to communicate an existing noise problem to the relevant decision makers to be able to attack it. This is especially the case if noise relevant facilities like roads, railway tracks, airports or industrial facilities are planned or shall be modified.

The additional value and its usability for these different tasks depend on the flexibility and the features of the software used. There are more old fashioned products available can be used to calculate a noise map by people that are experienced and used to it – but that would never be used by others to perform other tasks or to use the existing model for other decisions.

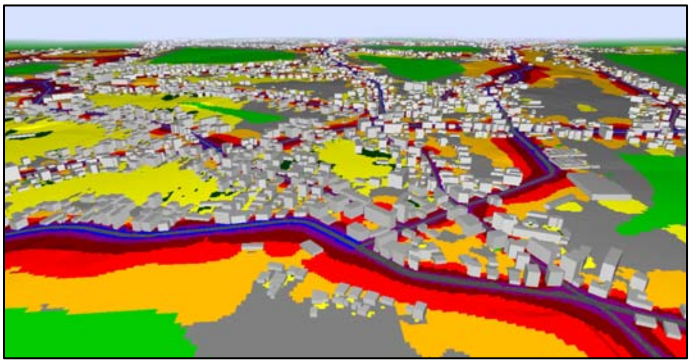

Figure 1. 3D-model of Nicosia (Cyprus) with a noise map covering the surface.

The techniques and some applications of noise mapping for industrial sources, for roads, railways and airports are presented with this short contribution.

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2. The features influencing the quality of a noise map

2.1 Measurement - calculation

In all cases the task is to use the technical parameters of noise relevant facilities as input parameters and to calculate the noise levels that are the reason for the noise exposure of people.

It shall only be mentioned here that noise measurements can never replace calculations, because they are only a spotlight to the noise situation without the necessary link between technical system parameters and levels. This link is necessary because it is the only possibility to check what modifications or mitigation measures give what improvement. Therefore realistic action plans can only be based on calculations. Measurements may be helpful to control the validity of assumptions about input parameters and propagation conditions, but they can never replace these calculations.

2.2 Creation of a model

The software used should support the production of the model at its best, because most of the time and effort in noise mapping is spent for this task. This means that a lot of input formats should be integrated – if digital data are available it should be possible to use these data some way.

An aspect that is often underestimated is the use of real 3D-presentations as it is shown in figure 1. This is not only a nice feature to present the model and the resulting noise distribution, but a very effective tool to control the model and to find or avoid geometrical errors. It is extremely helpful to drive in the virtual model along a road, to walk or to fly and to check all the different objects. If it is possible to click to any object and to get the edit window with all parameters describing its properties it this saves a lot of time to check if the inputs are correct.

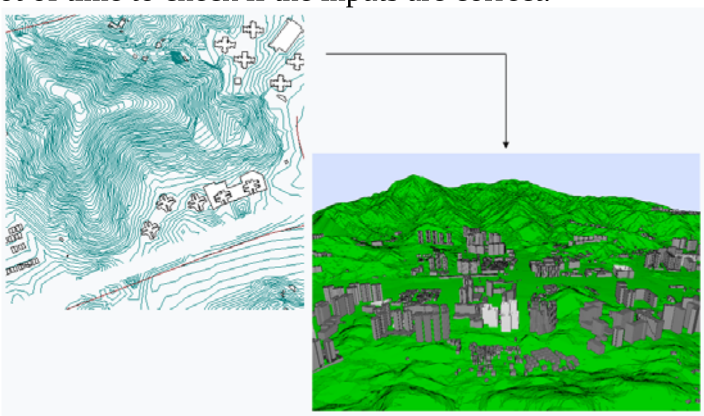

Figure 2. 3D-ground model defined by the contour lines with heights at each point.

There are a lot of supporting features that shorten the development of such a model. An example is the simplification of complex terrain models as shown in figure 2 – in many cases the height information available as height points or contour lines is by far to detailed with respect to noise calculations and calculation times. To reduce these calculation times the software should offer the feature to simplify the ground model with a defined maximal deviation of the simplified from the original model. Some products offer such a feature, but the decision if a height point can be deleted is based only on the ground model in the near vicinity. This method gives no control about the final maximal deviation and therefore it is dangerous to be used.

There are a lot of other software properties that influence the accuracy and precision of the modeling – it can only be recommended to check carefully the different steps to create a model before a decision for a software product is taken.

2.3 Calculation of noise levels

From the technical parameters in a first step the emission levels are calculated, and in a second step the attenuation due to sound propagation and the receiver levels are determined.

If aspects of uncertainty are discussed, one should always take into account the differences that are based on different standards or guidelines used. Figure 3 shows the emission of a piece of road in dependence of the speed of cars if different national standards are The values show a spread of about 5 dB with speeds above 50 km/h – for lower speeds the differences are even larger.

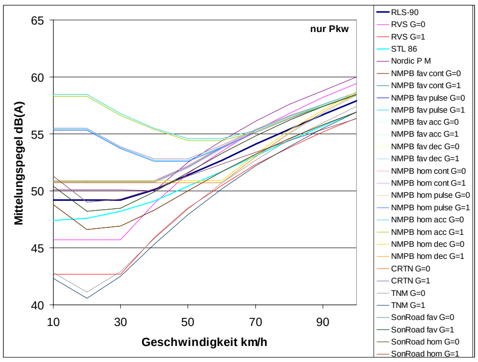

Figure 3. Emission of road piece calculated with different national methods.

The uncertainty of emission levels can be defined by a standard deviation – this is especially important for industrial sources where emission levels are based on measurements according to ISO 3740 series. If measurements have been made with ISO 3744, a standard deviation of 2 dB, with ISO 3746 a standard deviation of 4 dB should be taken into account.

The software used should be able to determine the total uncertainty at the receiver based on the uncertainty of the source emissions and on the uncertainty of the propagation calculation. The applied methods have been published [1,2] and can easily be applied with modern software tools [3].

With large noise mapping projects calculation times can be extremely long and therefore acceleration techniques must be used. These strategies reduce the accuracy even in cases, where intelligent strategies are used. In DIN 45 687 a method has been published, that allows to evaluate the uncertainty in a noise map that is caused by these acceleration techniques [4]. It is an enormous advantage if a software product supports this approach and if it’s possible to print out an analysis of the uncertainty for a calculated noise map without any additional calculations.

2.4 Where to calculate what noise levels

Modern software should allow to calculate different noise levels in one run. The following description is based on the product CadnaA – generally it is recommended to check how these aspects are dealt with by the software that shall be evaluated.

Generally the calculation is performed parallel for the time slices day, evening and night. The user can define up to 4 evaluation parameters that are calculated (and can be presented as coloured map) parallel. These are the L_{eq} levels for these time slices day, evening, night or any mixed value like L_{den}. It is also possible to select the uncertainty of these levels σ or even a level that is not exceeded by a certain confidence (e.g. $L_d + 1.615*\sigma_d$).

These evaluation parameters can be determined at locally defined receiver points, on horizontal grids (noise maps), on vertical grids and around facades (building noise maps).

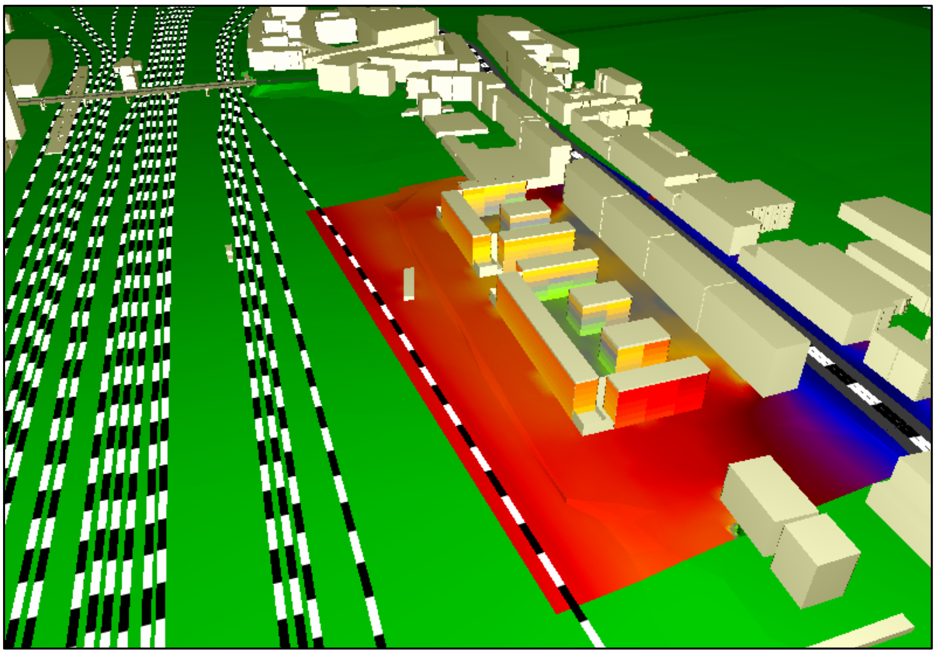

Figure 4. Horizontal noise map and building noise maps.

3. How can these digital models be used?

The main task is clearly to show the distribution of noise and to support the decision where mitigation measures are necessary. It can be evaluated what reduction is possible if measures like speed reduction, modification of road surfaces or screenings are applied.

But the model is also extremely helpful if new industrial facilities are planned. The model for the plant is created, optimized and then imported into the model of the environment. This detailed modelling may be supported by powerful software tools that allow to calculate the noise emission from the technical parameters of devices like motors, gears, pipes, fans or cooling towers. Figure 5 shows such an example. It is clear that such detailed modelling is too complicated for strategic noise mapping, but nevertheless it is a powerful support if the model is used for detailed plannings afterwards.

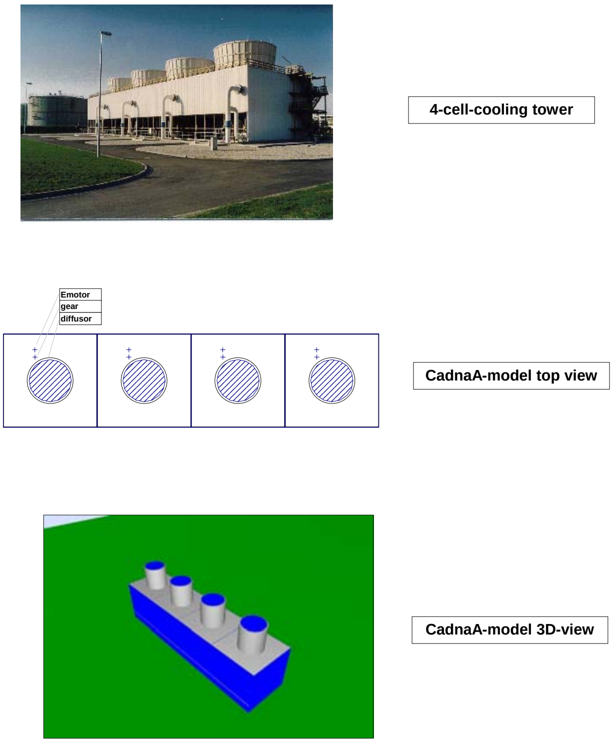

Figure 5. Modelling of a 4 cell cooling tower with CadnaA-SET.

Experience in the last years has shown that software for noise prediction can be a powerful tool in all noise relevant planning. It serves people to improve their environment and helps environmental experts to communicate their ideas to decision makers.

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