# NOISE PREDICTIONS AND THE NEW EUROPEAN HARMONISED PREDICTION MODEL

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**ABSTRACT**
Noise predictions are becoming more popular. An overview of the complete noise situation of a local community or authority is the start for noise policy. In addition, the European noise directive from Brussels creates an obligation to make noise maps.

The HarmoNoise Project started at the end of 2001 and its objective is to develop a European prediction model that can be used all over Europe.

This paper gives the status of the project and the method of working and provides some first impressions of the HarmoNoise models. These first impressions are compared to the existing models, such as the ISO, the Dutch SRM 2, Nordic and the French NMPB.

## INTRODUCTION

The assessment and management of environmental noise has become a hot issue. This has become even more the case since the European Commission issued a draft directive on noise [1].

The first thing to do when developing a noise policy is to investigate the existing situation. Noise annoyance or noise levels need to be quantified. Taking measurements would seem to be a logical way of doing this. Such measurements appear to be more straightforward than calculations in the eyes of the general public. Nevertheless, in most member states the standardised methods state a general preference for calculation as the way to assess environmental noise levels, mainly for three reasons:

- Measurements are a random sample survey. The particular moment when you take the measurements at a given traffic flow, speed, temperature, wind direction and wind speed will affect your results;
- For better correlation with noise annoyance, the long-term (approximately 1-year) average level must generally be assessed, whereas the instantaneous or short-term average level may be subject to strong variations due to differences in weather conditions and operating conditions of the source;
- Environmental noise assessment very often involves the prediction of future situations, be it new infrastructure developments or situations where abatement measures such as noise barriers are to be installed.

The prediction and assessment of noise levels from transport and industrial activities can be achieved either by measurement or by computation or by hybrid methods using measurement results in computations. For reasons of reproducibility the methods to be applied when measuring or calculating noise levels in the framework of legal regulations have been standardised on a national scale or even internationally.

At this moment in Europe there is a lack of harmonised methods of sufficient accuracy for the prediction and assessment of noise from roads, railways and industrial sites. The available national methods have been compared and evaluated. Literature [2, 3, 4, 5] gives some results.

The conclusion of the evaluation of the European Commission's noise steering group was that none of the available methods was quite sufficient to satisfy the requirements of the draft directive.

The conclusion is that new prediction methods should be developed. These new methods will become obligatory for the authorities and specialised consultants in all European Member States. The range of application will be wide: the assessment of environmental noise levels for permit application, for urban planning, for mapping and zoning, for noise abatement action plans and for predicting noise levels in future situations. These application purposes can be summarised by the common term: environmental noise management.

The main objective of the HarmoNoise Project is to provide new prediction methods for environmental noise from roads and railways that can meet the requirements of the EC directive in that they are more accurate, more reliable and, on that basis, enjoy general international acceptance by future users throughout Europe.

## BRIEF DESCRIPTION OF THE HARMONOISE PROJECT

The project is divided into several work packages. Work package 1 relates to the noise sources, with a distinction being made between road vehicles and rail vehicles as sources. In work package 1.1 the noise sources from moving road traffic will be considered. The same will be done in work package 1.2 for railway sources. All the sources should be described as physical noise sources with a total sound power, directivity and a certain position.

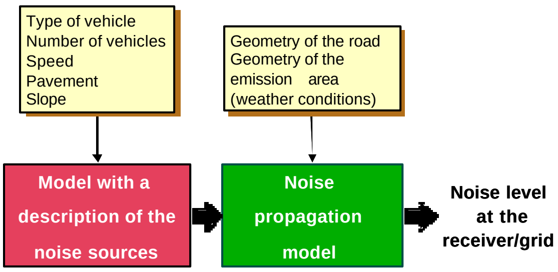


Figure 1. The distinction between noise sources and propagation

An important objective of work package 2 is to develop a "Golden Standard". This standard is a prediction model based on advanced techniques such as the Linearised Euler model, the Parabolic Equation Model, the Fast Field Program, the Boundary Element Method (BEM), Meteo–BEM, a ray model with straight and curved rays and the Gaussian Beam Model. With this reference model a limited number of situations will be calculated to get information on the point to point noise propagation. This noise attenuation from source to receiver must be a function of geographical information in the cross-section between source and receiver, such as the source height, ground surface impedance, ground altitude variations in this cross-section, barriers and buildings. This attenuation must also be a function of meteorological conditions, determined by wind speed and air temperature gradients for each specific direction.

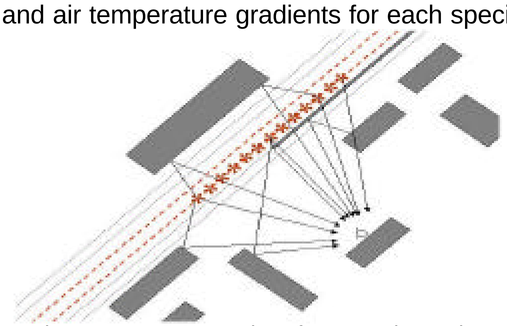

Figure 2. Some examples of propagation paths.

Figure 2 shows some examples of propagation paths. The line from where the noise is emitted is divided into a number of point sources. From all these sources the acoustical energy is transmitted to a receiver. It should be clear that the figure does not give every propagation path. It is along these paths that the sound propagation should be calculated. Defining these sound propagation paths is the only feasible method of predicting noise levels in complex situations. The main task of work package 3 is to combine the acoustical propagation paths with the propagation and the noise sources. The result is an engineering model. Another important point in this task is to simplify the calculation method so that it becomes acceptable for practical use. For example it is impracticable to measure the ground impedance of every single square metre of a city and it is also not realistic to model small variations in asphalt surface.

Compared with the ISO, the Dutch SRM 2, Nordic and the French NMPB, the engineering model will be more dependent on weather effects. Vertical wind speed gradients, mainly caused by wind and temperature, result in refraction of the noise propagation path. Especially with regard to ground reflections and screening by barriers, this is an essential phenomenon. The ISO and SRM 2 models assume certain downwind conditions in every (!) direction. The NMPB allows two different calculations for certain downwind conditions and for homogeneous conditions without refraction. The long-term average noise level is obtained by combining these calculations with meteorological data for each direction. The Nordic model enables calculations to be performed for different wind speeds and with different wind gradients.

Work package 4 deals with the validation of the engineering model and of some of the individual components of the source description and the propagation. The main object of this work package is to collect data from measurements.

The other work packages deal with dissemination, exploitation, co-ordination and project management. More information can be found at [6].

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The partners in the HarmoNoise Project

**NOISE MAPS**

The objective of HarmoNoise is to calculate a noise level at a certain point that can be checked against legal limits or requirements. In addition to this objective, it must be possible to use the HarmoNoise model to produce noise maps.

Noise maps are drawings of (part of) the earth's surface showing the noise levels of different noise sources. The noise levels must be viewed on top of natural features such as rivers and mountains and artificial features such as roads and buildings. Often a noise map will show the noise levels for road traffic noise, railway noise, industrial noise and aircraft noise. An accumulation can be made to give the total noise levels of the different sources together. These accumulations can be made as a summation of the total acoustic energy of the noise levels or as a weighted summation dependent on the degree of annoyance.

The benefits of noise maps are:
- To get a clear view of noisy and quiet areas.
- To preserve quiet and tranquil areas
- To develop strategies for reducing noise.
- To improve urban planning.

Noise maps form the backbone of noise policy because they are used by a wide range of users and decision-makers and they indicate public response to long-term exposure to various sources of noise.

As a principle a level on a noise map is not equal to the incident noise level at a facade. The incident noise levels, in combination with the acoustic facade insulation, give the noise level inside dwellings and are thus an indicator of annoyance. For most of the regulations in Europe the incident noise level will be checked against legal limits.

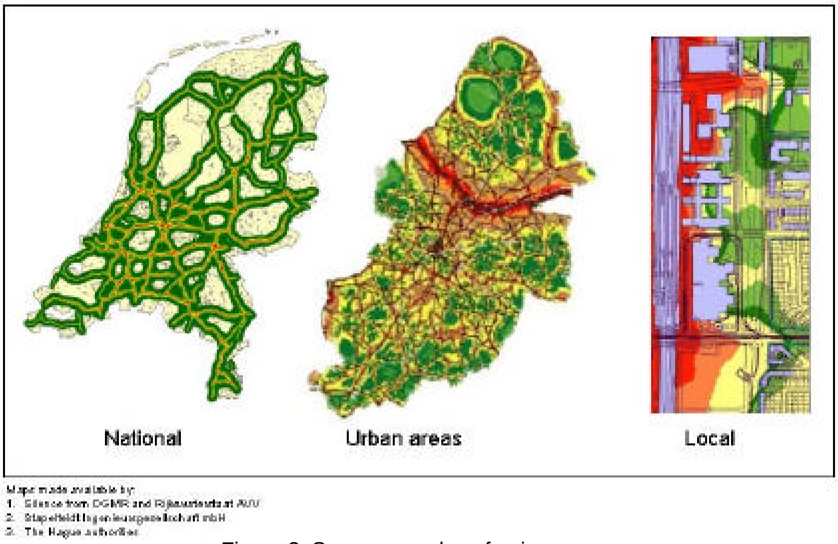


Figure 3. Some examples of noise maps.

For the EU directive noise maps should be made for the purpose of counting the number of inhabitants living between a certain noise contour, i.e. between 55 and 60 dB(A) or between 65 en 70 dB(A). For silent areas such as environmental protection areas it is also possible to calculate the number of square metres exposed to a range of certain noise levels. For the EU directive these noise levels should be calculated at a height of 4 m above ground level. The noise levels must be expressed as the $L_{den}$ or $L_{night}$ in dB(A).

## CONCLUSION

Noise measurements are a random sample survey in relation to a long-term average equivalent noise level. Noise predictions are crucial for determining long-term levels. Predictions are also needed for environmental noise assessment involving future situations and for calculating the effect of measures.

The main objective of the HarmoNoise Project is to provide new prediction methods for environmental noise from roads and railways. The project will deal with physical noise sources and with acoustic propagation. In this project the reference model will be the "Golden Standard". The engineering model will be the model for everyday use.

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