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# A noise mapping system for highways in the Netherlands

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## Abstract

A noise map is a tool for developing a policy about quality of life. Silence 2.0 is a new application for noise calculations on a national or regional scale. The application will calculate noise contours as well as the amount of surface above a certain noise level and the number of people annoyed. The application uses a large number of databases from different origin. Information of hectometre signs, traffic flow, road surface, noise barriers is added to geographical information of roads. Other information as geographical information from residential areas, industrial areas, nature areas and the so-called "silent areas" is also combined to get the complete model for noise calculations. Data collected by the ministry for the complete network, which consists of 3000 km of highways, is combined for the last 10 years. The noise levels will be calculated in discrete points and interpolations between these points will give noise contours. The calculation core is the DGMR GeoNoise with the Dutch calculation method for traffic noise. The noise contours are combined with information on number of inhabitants from different areas so the number of people annoyed by noise will be determined. The presentation will give information about the gathering of data, the calculation method, the method of noise mapping, and some first results about the number of people annoyed around the Dutch network.

## 1. Introduction

A noise map is a tool for developing a policy about the quality of life. Silence 2.0 is a new application for the standardisation of noise mapping around highways on national and regional scale. Silence 2.0 provides a filled database and calculation core in a user friendly GIS environment. It presents noise contours geographically and estimates the surface area, number of houses and inhabitants above a certain noise level.

## 2. Background for the development

There is no standard, user friendly and up to date instrument for noise mapping in use in the Netherlands. It is mostly unclear which data and exact method are suitable and it generally takes a lot of time to collect the information needed and carry out the calculation itself. Moreover, once results are achieved at different locations they are never truly comparable because they are never generated in exactly the same way.

## 3. Data-acquisition

The application uses a large amount of data from different origin, but which is free to use within all sectors of the Ministry of Transport. Information on traffic flow, road surface and noise barriers is added to geographical information of roads. Additional information on residential areas, industrial areas, nature areas and the so-called "silent areas" is combined to establish a complete model for noise calculations. Most data is collected by the ministry for the complete network, which consists of 3000 km of highways. The complete database consists of information on the period 1989-99 with a structure that allows users to choose between years.

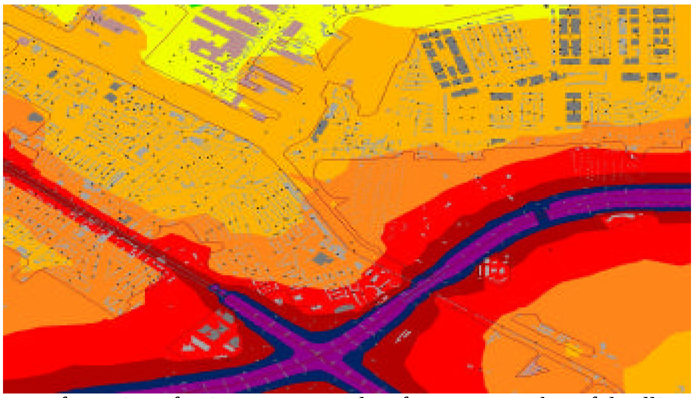

Figure 1: Review of the confrontation of noise contours and surface area, number of dwellings and people involved.

# 4. Noise calculation

Noise levels are calculated in discrete points and interpolations between these points will give noise contours. In the application, an automatic generation of receiver points is generated to calculate the noise levels.

The model uses the most updated calculation method for estimating traffic noise that is lawfully accepted to use in the Netherlands [1]. This method is one of the most realistic models currently in use in Europe. It has been appointed as one of two candidates for European estimations during the interim period in which a new Harmonised European model will be developed. [2]

# 5. The source model

The method estimates noise levels for different octave bands frequencies. The description of the noise source concerns the position of the source and the corresponding sound power level. The most relevant is the acoustic radiated energy of the tyre and the noise produced by the effect of air pumping. For low speed engine noise also is considered relevant.

Estimations are carried out for four traffic vehicles categories. These categories are motor cycles, passenger cars and light vans, light trucks and busses and heavy trucks. For every category the equivalent sound level of the source (related to the sound power level per meter) is equal to:

$$E = a + ß \cdot v + 10 \cdot Lg\left(\frac{Q}{v}\right) + C_{roadsurface} \qquad \text{in dB}$$

With:

| | | |
|---|---|---|
| | E | the sound emission of a noise source defined in the source model in dB |
| | a and ß | constant values for every category of traffic |
| | Q | the number of vehicles per hour |
| | v | the speed in km/h |
| | $C_{roadsurface}$ | a correction (in octaves) for other types of road surface in dB |

The total emission is estimated by summation of the sound power level by every category. The physical height of noise source above the road is 0.80 m. Figures 2a and 2b give the sound power level in dB(A) as a function of the speed and the octave spectrum for a speed of 80 km/h.

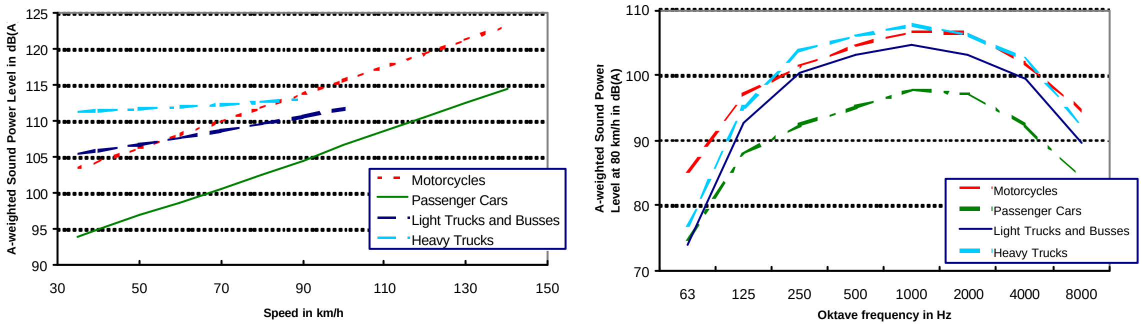


Figure 2: The sound power level in dB(A) as a function of the speed and the octave spectrum for a speed of 80 km/h.

# 5. The noise propagation model

An acoustic propagation model must be (or is supposed to be) very general. Such a model describes the attenuation of noise transmission from source to recipient by assuming that the noise of a vehicle will not propagate in a different way than any other kind of noise. The international standard for this type of prediction is given in ISO 9613 [3]. In the Netherlands the standard for road traffic noise is slightly different from this ISO model [4].

The general principle to predict a sound level is based on empirical algorithms. In order to be able to make the total calculation the following formula can be used:

$$L_{eq} = E - D_d - D_a - D_g - D_b + C_r - C_m \qquad \text{in dB}$$

With:

- $L_{eq}$ the equivalent sound pressure level at a recipient
- $E$ the sound emission of a noise source defined in the source model
- $D_d$ the attenuation due to geometric extension of the noise
- $D_a$ the attenuation due to atmospheric absorption
- $D_g$ the attenuation due to the absorption of the ground
- $D_b$ the attenuation due to a barrier or another obstacle
- $C_r$ a correction for the contribution caused by reflections of the noise
- $C_m$ a correction for meteorological effects

The propagation model describes how to calculate these attenuation and correction terms. This calculation is done for every octave frequency band.

Noise calculations can be made on a very detailed scale. Around buildings and other obstacles it is, in principle, possible to calculate the exact noise level. Therefore it is necessary that the information of, for example, reflection coefficients of the façade or the building itself and all the surrounding buildings is known. Also data about ground impedance and other details should be known. It shall be clear that it is almost impossible to collect all this information. In addition, this amount of data would impose an impractical calculation time. For these reasons calculations are carried out on a “residential area” scale. For every residential area the edges are modelled with a barrier. Within these barriers the average reflection, scattering and diffraction are calculated using a constant attenuation as a function of the density of the buildings.

In addition some data is economized even further, for example to reduce the number of items used in the calculation. The amount of noise sources (roads) is reduced by using the Arcview generalize functions. The result is that the number nodes of the source polyline are reduced; taking into account that the geographical error is set at a maximum of 1 m. The same is done for the number of barriers around building areas, where the maximum geographical error is set at 10 m.

The software allows users to define the level of detail of calculations in a standardised way. Provided are four different default levels of detail. Calculations on a national scale do not need the highest level of accuracy possible (see Figure 3). The acceptable error is related to the scale intended. For a regional scale, or for calculations on a single highway, the level of detail can be increased.

The calculation core is the DGMR GeoNoise/ B&K type 7810 Predictor. This calculation core is fully incorporated into the Arcview software.

Calculations are performed to a grid or receiver point. Interpolations between points result in noise contours. The confrontation of noise contours and geographical information determines the number of surface area, houses and inhabitants in different areas.

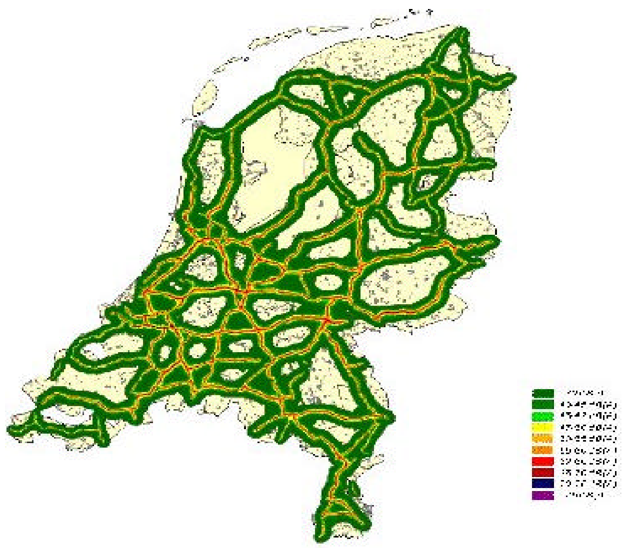

Figure 3: A noise map for the complete highway network of the Netherlands.

# 6. Conclusion

Silence 2.0 is easy to use software that may greatly improve the way in which government officials throughout the country produce and use noise mapping for policy related, strategic and trend studies. The application provides a means of standardisation by enhancing the use of the exact same input (data), software environment (ArcView) and calculation method (GeoNoise) by introducing a new set of default ways to estimate noise levels that is suitable on both national and regional scale. In addition the application facilitates users to modify the level of detail or data used according to their own needs. Silence 2.0 will generate estimations that can be compared even if they are produced by different users.

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