
# INTEGRATED SOLUTIONS NOISE-MAPPING - GIS

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## Abstract

GIS Technologies are widely used to administrate and use large amounts of georeferenced data. It is obvious that these sources should be used in the frame of strategic noise mapping according to the directive 2002749/EC. There are many possibilities to take advantage of the GIS functionalities in Noise Mapping Projects, and some of them are presented as Case Studies carried out or just in progress.

The simplest form is the direct input of GIS data in the noise mapping and calculation program. There are some requirements for this input interface to understand the imported data correctly. An example are patios and otherwise complex building structures, that are part of the polygon surface in the GIS and must be transformed to the polygon-line-logic by the noise mapping software.

In the German DIN 45687 [1] a so called QSI format was standardized that allows – or is intended to allow – the exchange of complete models between different software packages. Advantages and shortcomings of this interface are discussed.

The largest case study using GIS data is the Noise Mapping England Project (NME). For about 15 large project areas these data have been prepared in a uniform way and where supplied to different companies performing the calculations with different noise calculation software. The resulting grid of noise indicator values had to be returned in a uniform way to be imported to the GIS.

If the noise calculation software (NCS) can be configured as a runtime-module it can be hidden completely under the surface of the GIS. The user of the GIS models an urban area with his familiar tools and then starts the noise calculation. The NCS performs all calculations and returns the results to the GIS, where they are presented or processed further.

Such a complete “merging” of GIS and NCS has been applied in the EU Project GipSyNoise and in the Noise-DataBase Swizerland. Experiences with these projects and related case-studies are discussed.

## INTRODUCTION

Noise Mapping according to the European Directive about Environmental Noise is not a stand alone activity of cities and communities, but is more and more embedded in the complete data environment of administrations. Most of the data needed can be used for other purposes, and it would be a waste of time and money to regard Noise Mapping as an isolated issue.
Geographic Information Systems (GIS) are specialised software packages to create, modify and handle large amount of data describing the environment. It is obvious that the use of these systems to supply the Noise Calculation Software (NCS) with necessary data and to use them to evaluate and present the calculated noise maps.
The question arises how the different steps should be shared among NCS and GIS.
Generally there are the following steps necessary

1. data collection and transforming into proper formats
2. control of data and adaption if necessary
3. combining data to a complete model
4. control and validation of the model
5. calculation of strategic noise maps (horizontal distribution)
6. calculation of façade levels and determination of max. and min levels
7. determination of the distribution of inhabitants versus noise-indicator-intervals as indicated in Annex VI of the Directive
8. calculation of conflict maps, detection of hot spots
9. development of alternative possible mitigation measures
10. best choice by applying Noise Scoring techniques
11. information of the public.

Extensive use of GIS means that only with 5 and 6 the NCS is used – all other jobs are performed in GIS. If the NCS can be controlled by the GIS, the user of the GIS starts the noise calculation and has nothing to do with the NCS. It works like a slave in the background, reads data, calculates and returns the results to the GIS.

The other end of the scale is marked by the mostly complete handling of the project in the NCS. This can even be the more straightforward approach, if the NCS offers the necessary functionalities, but this depends on the software product used.

## DATA TRANFER GIS – NCP – GIS

Basically it is an enormous advantage if a NCS offers interfaces to read data in many GIS-Formats. ArcGIS, AtlasGIS, MapInfo and SICAD may be mentioned representative for some others. It is always boaring and time consuming, if data are available in a certain format and the user has first to buy this additional interface before he can use the data.

Generally we have to handle pure geometric data describing points, lines and areas and attribute or parameter data that describe the properties of the objects.
The geometric data are used to create the topography and the objects in the environment as it is shown in figure 1.

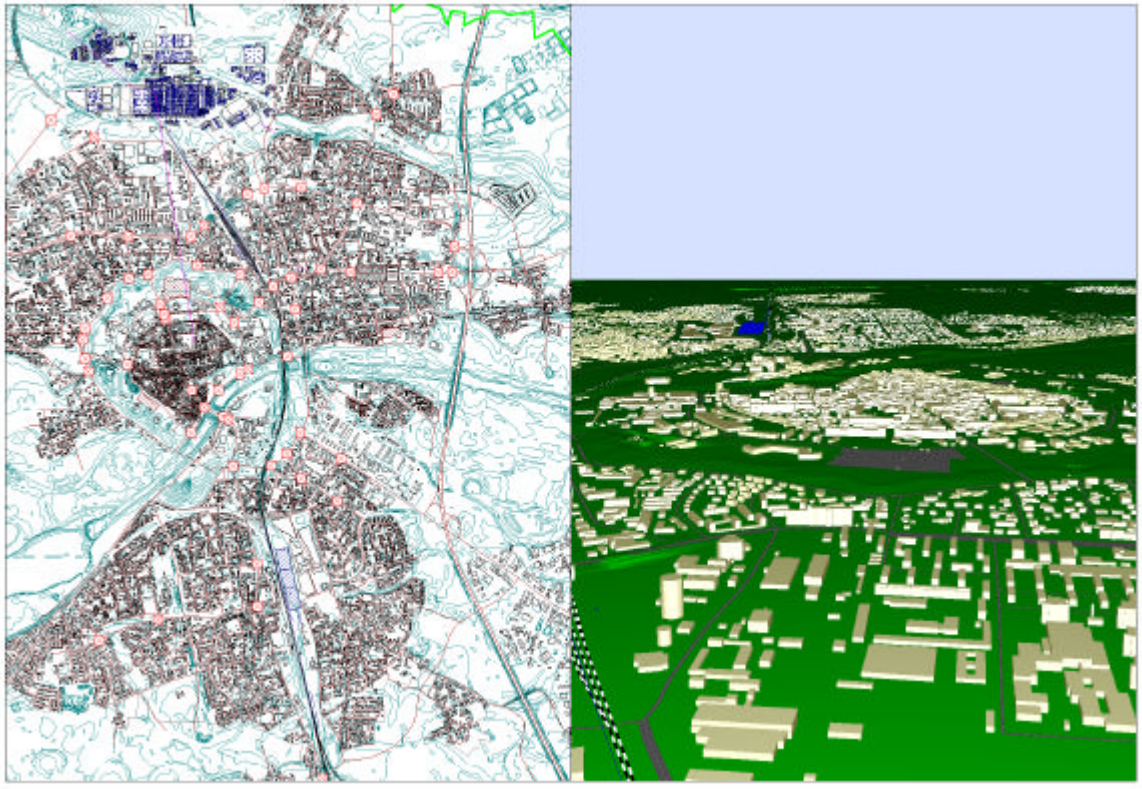

*Figure 1 – Top View and 3D-view of a city created in the NCS*

Attributes are in general organized in databases and it should be possible to import and use them in the NCS.
Presentations as shown in figure 1 are an unvaluable help to control geometric input data and the combined model. If the NCS offers the possibility to walk or fly in the 3D-model, this is helpful to detect errors. This is especially the case if the attributes are linked with the objects and if it is possible to click to objects during such virtual walks or flights and control or even modify the data.

The German standard DIN 45687 defines in "Beiblatt 1" a QSI-format – this format was created to exchange geometric and attribute data among different NCS products. This format is based on ArcGIS and the attribute names to be used are published. There are always special objects that have been created by a developer to fulfill special needs of a customer and that have no equivalent in other products and these are certainly not included in the exchange format.

If a country uses generally a certain data format and wants to handle calculated maps in GIS, it's worth to standardize the input of these data to create the complete model

in one run. An nice example is the Noise Mapping England project (NME), where the data for all project areas have been prepared in the same way. According to the necessary transformation from 18 hour- levels $L_{18h}$ to noise indicators $L_{den}$, two variants are produced with maps for Motorways and Non-Motorways separately. A little input program was developed, that allows to read all the data, to combine them to the complete city model and to have the variants defined as described. The calculated grids are exported and can be imported in the GIS.

## COMBINING DATA TO PRODUCE THE MODEL

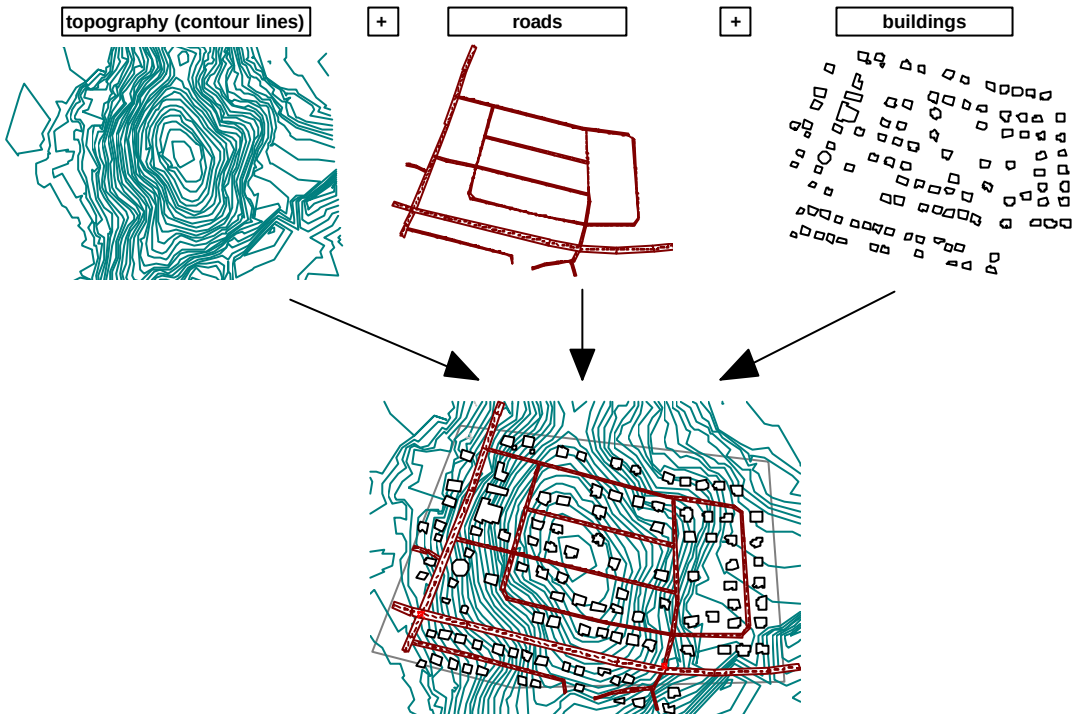


*Figure 2 – Integration of data to create the model*

The integration of data to the complete model is possible inside GIS or NCS. If it is done in the NCS, the program used should offer possibilities to

- combine single lines to building polygons
- attach roads, railways and other objects to the ground model
- fit the ground model to roads, railways and other objects
- connect segments of roads to build one single road

and many others.

Figure 3 shows data that fit not well at the left side – the relative heights of buildings are imported as absolute and the roads are partially buried. Using the features described, the model can be corrected as it is shown at the right side.

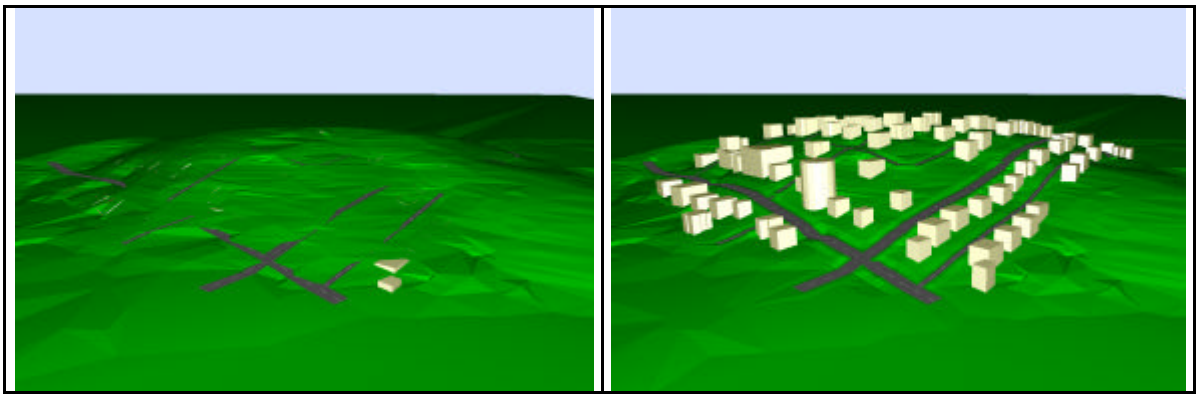

*Figure 3 – correction of data when merging them to an integrated model*

## CALCULATION OF NOISE ON GRID AND AT FACADES

The calculation of noise levels has to be performed in the NCS. Even if all other steps can be done in GIS – the calculation is a core activity optimized with respect to time and precision and this is another approach than used in GIS.
With project Noise Database Switzerland the NCS produces the transmission indices source – receiver and these are saved. Using this technique, it is possible to update the calculated noise levels in the GIS without any activity of the NCS if only source data like traffic flows or road surfaces have changed.

**Horizontal Noise Maps**
Are produced by calculating the noise levels at points distributed on a grid.

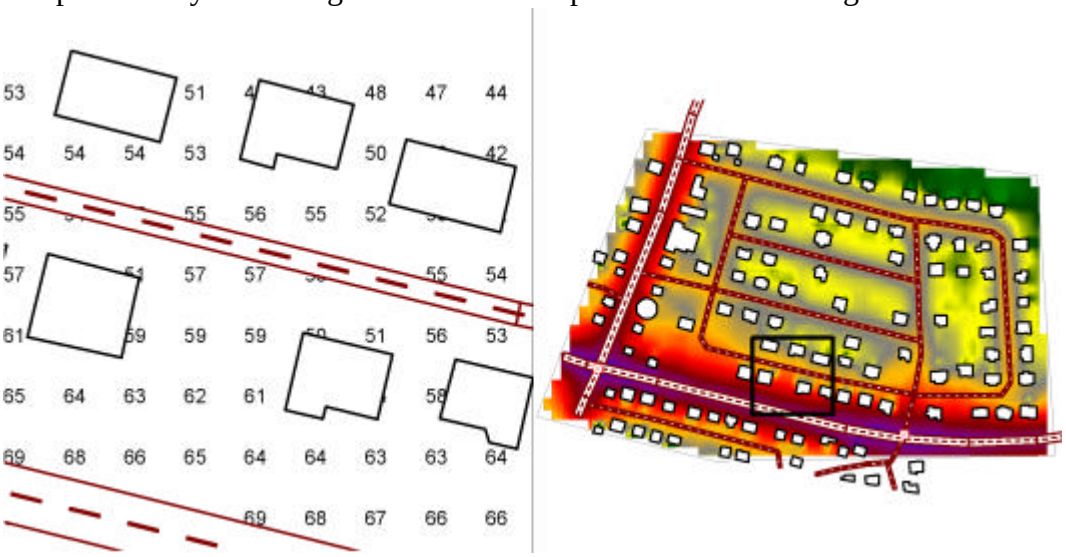


*Figure 4 – Calculation on a grid and presenting as coloured map*

These noise maps present an overview and show the distribution of noise in one glance.

**Façade levels**

To decide about the most exposed façade, the levels can be calculated evenly spaced at the facades.


*Figure 5 – Calculation at façade points*

All information needed to evaluate the exposure of people, to rank noise mitigation measures and to link the result of noise calculations to political decisions can be derived from these façade levels – it is therefore advantageous to export these façade levels to the GIS if a powerful evaluation system shall be created.

It cannot be recommended to calculate façade levels by interpolating them from the levels at the horizontal grid, if these levels are used in sensitive evaluation calculations. If the used Noise Scoring is sensitive to the highest levels (see equation 19 in [3]), these determine the total Noise Score and therefore should be calculated with the best accuracy possible. Recent investigations showed, that interpolation from grid point is too inaccurate in inner cities if the grid spacing is 10 m or even larger.

In some projects we export the transmission indices for all relevant sources and all façade levels to the GIS. This allows to update the façade levels completely in the GIS if emission parameters change.

## INTEGRATION OF THE NOISE CALCULATION PROGRAM IN GIS

As it is mentioned above, it may be advantageous in some cases to integrate all geographic data together with attribute data in one common geographical information system (GIS) and – in case of very large projects – in an additional data base system.

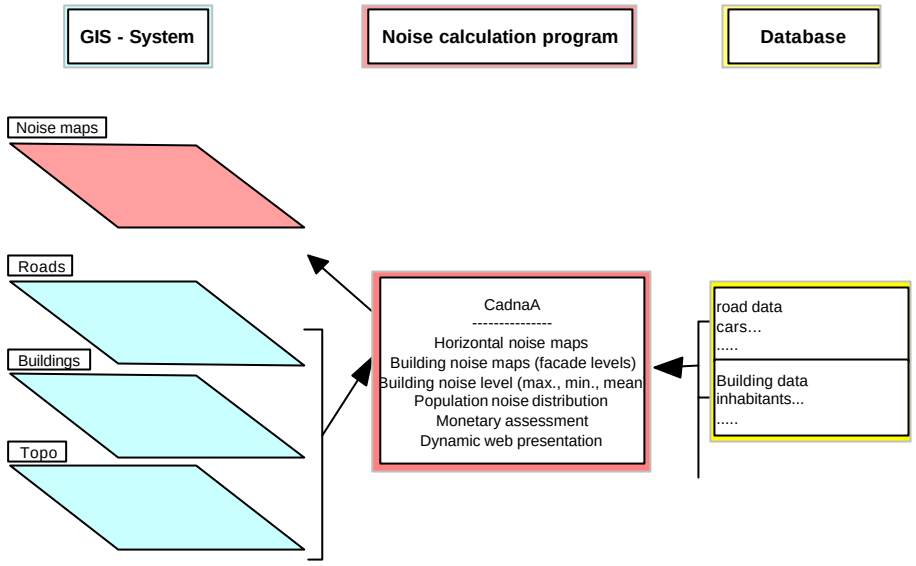


*Figure 2 – Combining GIS, NCS and Database*

This solution is necessary if very large amount of data shall be handled. An example is the ongoing project Noise Database Switzerland, where noise maps of all cities and at communities along roads and railways and around airports are calculated and must be organized.

Another project is GiPsy Noise – a project funded by EC -, where the data of a city are produced inside GIS in a formalized and standardized way. The user of GIS starts the noise calculation at the GIS surface, and the NCS reacts as runtime module without any support by the user.
14 participants of the project are using the system in a test phase – we will report about it after end of the project.

## SUMMARY

Geographic Information Systems (GIS) and Noise Calculation Software (NCS) can be linked to form a highly effective Noise Information System. It even seems to be possible in near future to calculate the transmission for all paths source-receiver in a country, to save these in a powerful database and then to use GIS with DataBase to update the noise information if source data change. The Noise DataBase Switzerland is such an approach using ArcGIS, Oracle-DataBase and CadnaA.
But even in less ambitious applications city administrations and other groups not interested in the acoustical aspects want to use a Noise Information System integrated in their GIS. We have developed such a system and it is now used in the EC-funded GiPsy-Noise-Project by 14 partners.
It is our experience that the calculation, evaluation and presentation of noise exposures is more flexible organized in the NCS if this program is able to handle the

large amount of data. But it is foreseeable that the demands to integrate the noise into the data systems of an administration will increase. With our developments we support these endeavours and I hope the presented examples are able to mediate an impression where we are on that way.

## REFERENCES

[1] DIN 45687 (2006-05) “Akustik - Software-Erzeugnisse zur Berechnung der Geräuschimmission im Freien - Qualitätsanforderungen und Prüfbestimmungen”

[2] DIN 45687 Beiblatt 1 Norm-Entwurf (2006-04) “Akustik - Software-Erzeugnisse zur Berechnung der Geräuschimmission im Freien - QSI-Datenformat und QSI-Modelldatei”

[3] Probst, W (2006) “Noise Perception and scoring of noise exposure”, ICSV 13, Vienna