

# MODELING AND MAPPING OF URBAN NOISE POLLUTION WITH SOUNDPLAN SOFTWARE

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**Abstract:** Noise maps are used to assess and monitor the influence of the noise effects. Thus, the number of citizens who are annoyed can be determined. Noise maps can be helpful in the planning and decision making processes for reducing the noise pollution. In this paper, the noise map for parts of the city Stip, as a small urban area in the centre of the East Macedonia is delivered as a visual information of the acoustic behaviour. For this purpose, the SoundPLAN software is used. The small and medium sized agglomerations (up to 100,000 inhabitants) as well as model generation and data administration are performed by the SoundPLAN as single software. It is of great importance that noise modelling software is flexible in the administration of multiple noise scenarios and to be able quickly and reliably to turn these models into noise maps. Software's like SoundPLAN use advanced filtering algorithms so the model can be reduced with a user defined tolerance. The SoundPLAN software offers many tools for data preparation, consistency checks and reports documentation. Many of the tools go well beyond what could be expected in an acoustical simulation program.

**Keywords:** NOISE, MAPPING, SOUNDPLAN SOFTWARE, MODELLING.

## 1. Introduction

One of the serious issues of environmental pollution is noise. Noise can be defined as unwanted sound, undesirable and unpleasant sound or sound that bothered, irritated and can lead to damage of the human ear. Noise pollution in large urban areas is regarded as a growing problem of communities. There are various factors that contribute to increase of noise levels in urban areas. One of the factors is the increase in urban population, which contributes to high traffic volume combined with increased intensity. In most urban areas, the corridors are developed in a close proximity where people live and work, which led to limited space and thus increase the number of high rise buildings. This type of settlement created a dense environment in urban areas, thus increasing the traffic volume. Numerous countries have implemented new technologies to control noise pollution in urban areas. For example, low noise generating engines, changes in quality of tyres, changes in road material. These technologies have proven to reduce the noise on individual scale. However, the overall noise pollution in urban areas is still increasing because of increasing traffic volume.

In Europe, it is estimated that, more than 90 million people suffer from unacceptable noise levels (European Commission News, 2005). This has become one of the most serious issues of community concerned. In order to have a common mitigation program to controlling noise levels, European Union has formulated the Environmental Noise Directive (END), 2002/49/EC.

## 2. Role of GIS for Noise Mapping

GIS provides a powerful set of tools for storing and retrieving, transforming and displaying spatial data from the real world for a particular set purposes [1]. A cataloguing and metadata management system of GIS could be used to track data manipulation at each stage of process [2]. These include: changes in input data, data simplification, interpolation methods, calculation methods, calculation settings, other factors, which could influence the accuracy of results. GIS facilitates the visual presentation of the noise effects and an additional tool for analysing the results. The integration of GIS with noise prediction models provides fast and accurate assessment of the environmental impact of noise. GIS Database management system facilitates for storing, collecting, controlling and managing the noise data. Noise contours can be generated based on the interpolation techniques available in GIS. It is possible to generate a continuous spatial model of noise levels within GIS.

A GIS based structure for noise mapping process is shown in Figure 1. This map shows the different layers of features of GIS along with the noise maps.

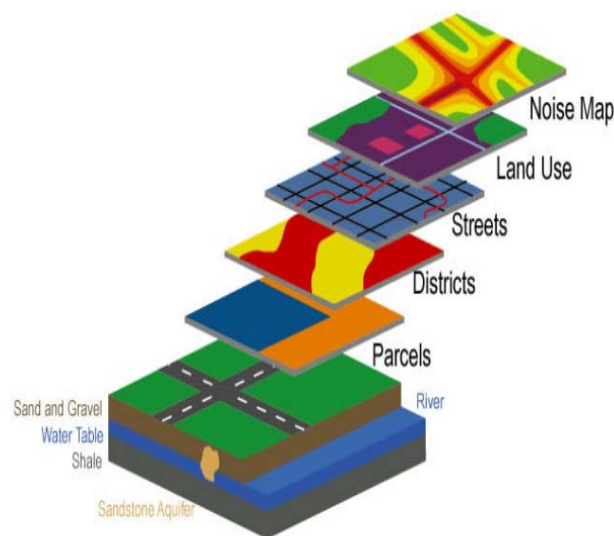


Figure 1: GIS based structure for noise mapping

## 3. SoundPLAN Noise Modelling Software

For making a noise map of the central part of Stip is used SoundPLAN 7.1, Software for Noise and Air Pollution Modeling.

SoundPLAN Software by SoundPLAN International LLC and Braunstein + Berndt GmbH is a software package offering a flexible range of noise and air pollution evaluation modules. It is used by more than 5,000 users, including governments, consultants and researchers in more than 40 countries and is the world's leading environmental prediction software. The speed and accuracy of SoundPLAN has been developed to the point where evaluation of noise and pollution impacts on whole cities can be carried out using computer power available to even the most modest of users. The output can range from noise prediction tables to colour contour maps and 3D animations. SoundPLAN has been a leader in its field for more than 25 years.

According to the Low for noise protection in the environment [3], are used the following indicators for noise to establish standards for noise protection and the noise level in the environment, the limits of the environmental noise levels, assessment and prediction of the state with noise, making the strategic noise maps and planning measures for noise protection:

( $L_d$ ) (Indicator for noise disturbance during the day) or daily noise level which is A-equivalent long-term average sound level defined in ISO 1996-2:1987;

$L_e$  (Indicator for noise disturbance during the evening) or evening noise level which is A-equivalent long-term average sound level defined in ISO 1996-2:1987;

$L_n$  (Indicator for noise disturbance during the night) or night noise level which is A-equivalent long-term average sound level defined in ISO 1996-2:1987;

$L_{eq}$  (Equivalent noise level) is an indicator of the noise calculated from the measured noise levels in an interval.

According to the Regulations for application of noise indicators, additional indicators of noise, method of measuring noise and methods of assessment indicators for noise in the environment [4] the Indicator for noise disturbance during the day ( $L_d$ ) covers the period of 12 hours, from 7 am to 7 pm (7-19), Indicator for noise disturbance during the evening ( $L_e$ ) covers the period of 4 hours, from 7 pm to 11 pm (19- 23) and Indicator for noise disturbance during the night ( $L_n$ ) covers the period of 8 hours, from 11 pm to 7 am (23 - 7). These time slices are defined as a Emission time slices in the SoundPLAN Manager, Figure 2.



Figure 2: SoundPLAN Manager

The basic model for the noise mapping consists of four main components (Figure 3):

1. Making a Digital Ground Model (DGM);
2. Obstacles to the spread of sound (buildings);
3. Roads;
4. Absorption zone.

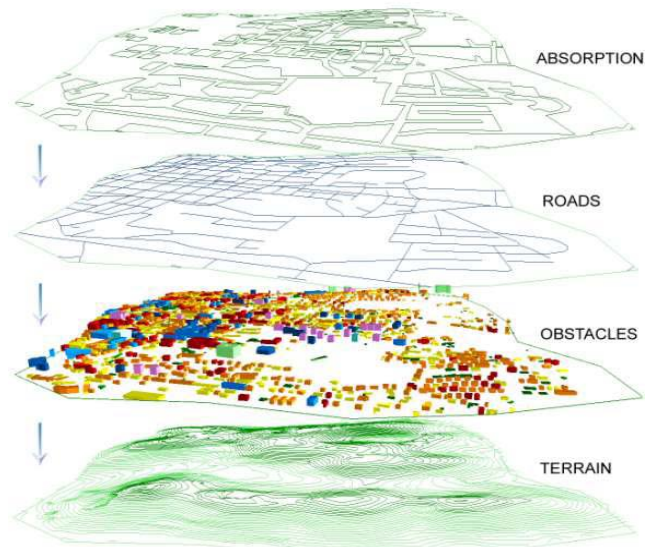


Figure 3: Space modelling

First step during the making DGM for the noise map with the SoundPLAN Software 7.1 [5] is defining of coordinate and reference system. In Republic of Macedonia from the selection list we define the Gauss-Krueger (3 degrees wide strips) as coordinate system and D48 (SI), Hermannskogel, Bessel as reference system (Figure 4).

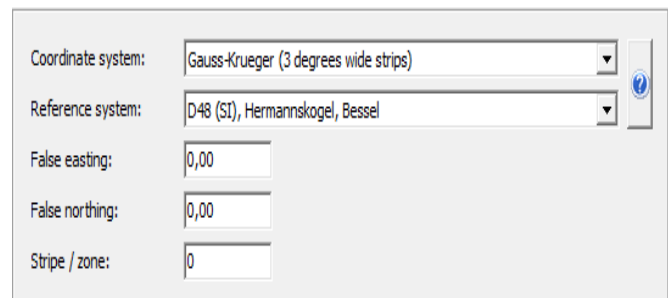


Figure 4: Defining of coordinate and reference system

So defined coordinate systems allow us in connection with Google Earth to use a background bitmap from Google Earth and directly taking the real coordinates (x,y). Thus, we get geo-referenced bitmap for the central part of Stip. (Figure 5).

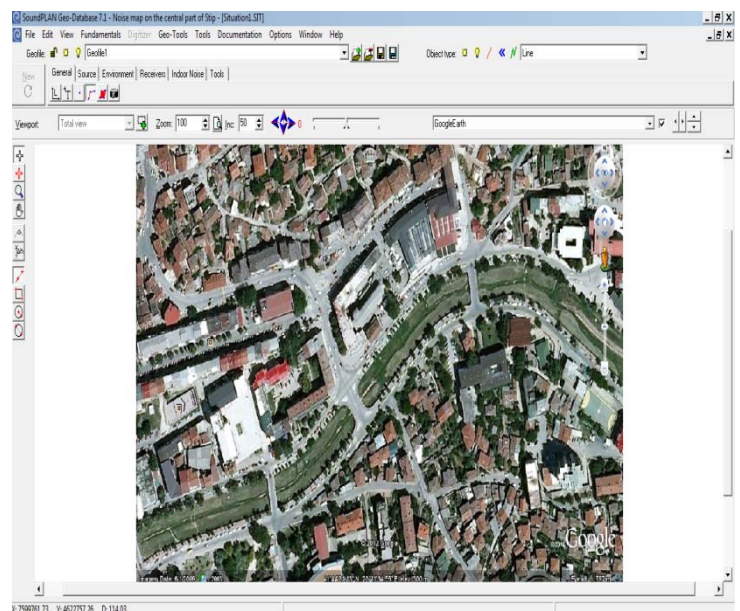
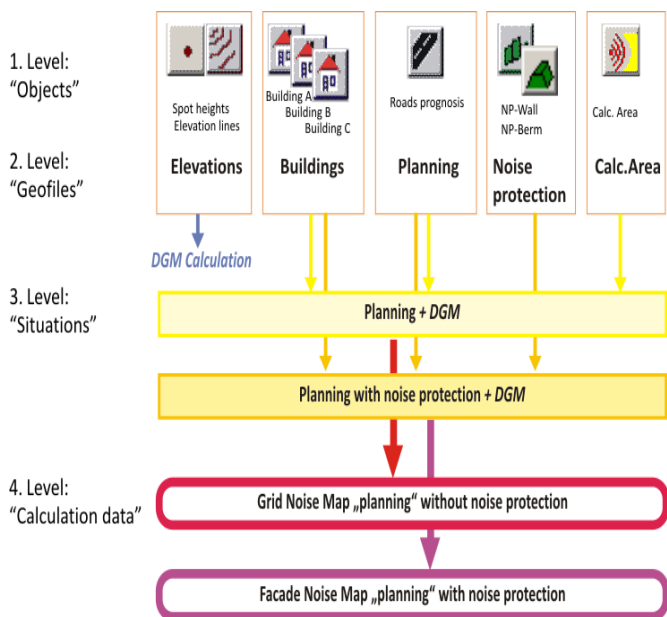


Figure 5: Geo-referenced bitmap for the central part of Stip from Google Earth

In the Geo-database all geometry data and their properties (building height, road width, sound power level, emission level ...) are entered or imported and prepared for the calculation. All objects entered in the Geo-Database are stored in Geo-Files and can be managed in Situations. The Geo-Files are comparable to the layers in AutoCAD. The Geo-Files can be used to group objects in accordance to a user defined logic.



The example above shows the principle possibilities of structuring a small project [5].

The objects "spot elevations" and "elevation lines" were saved to form the Geo-File "elevations". This Geo-File is used to generate the Digital Ground Model from within the Geo-Database. Once the DGM is calculated, it is assigned to all Situations.

All buildings, the road, the noise protection walls and the calculation area are saved in additional Geo-Files. The "road" and the "building" Geo-Files are assigned to both Situations the "noise protection" and the "calc\_area" Geo-Files are only referenced in one of the Situations.

After the importation or digitization of terrain information, the software calculates a DGM. Then, we enter the input data for buildings and roads.

Buildings are an important factor in the outdoor noise propagation. For this reason, the elevations of the building, the building height, number of floors (Figure 6) and the reflection properties are important parameters.

Some of the properties that are assigned to buildings can be inherited to receivers to reduce the effort of the definition of manually assigned and automatically generated receivers (Single point calculations and Façade Noise Maps).

Statistical data such as the number of occupants and the number of dwellings is necessary for the evaluation of occupants affected by noise, for example for the statistics in connection with the EU noise mapping and noise action planning as well as for conflict and annoyance analyses.

A building is described with the ground floor elevation (normally the elevation of the entrance above sea level) and the building height above the ground floor. The positions of receivers are measured from the ground floor elevation.

The ground floor elevation is the same for all building coordinates. The first entered coordinate is defining the ground floor elevation for the whole building. The difference between the ground floor elevation and the terrain defines the building base, which is used as extended reflecting façade area. Then, we assign

receivers to a building. For buildings situated on a hillside can be assigned receivers in basement floors. If receivers are assigned to a building, all relevant data is entered with the building. When referencing the receiver, the parameters are reused for the receivers. On this way parameters such as number of floor or area usage are defined only once per building.

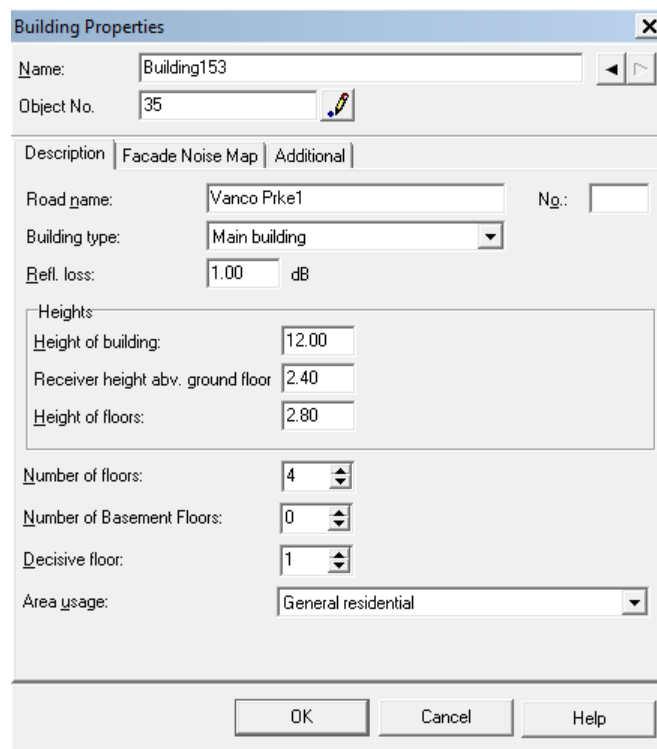


Figure 6: Building properties

Roads are used in the acoustics and air pollution modeling as a line element. The road master alignment is entered with X and Y coordinates and the elevation of the road surface above sea level. The width of the road and the distance of the emission bands are defined in the tab index card **PROFILE**. The elevation of the emission band is computed automatically from the elevation of the road surface according to the used standard and taken into account for the propagation calculation.

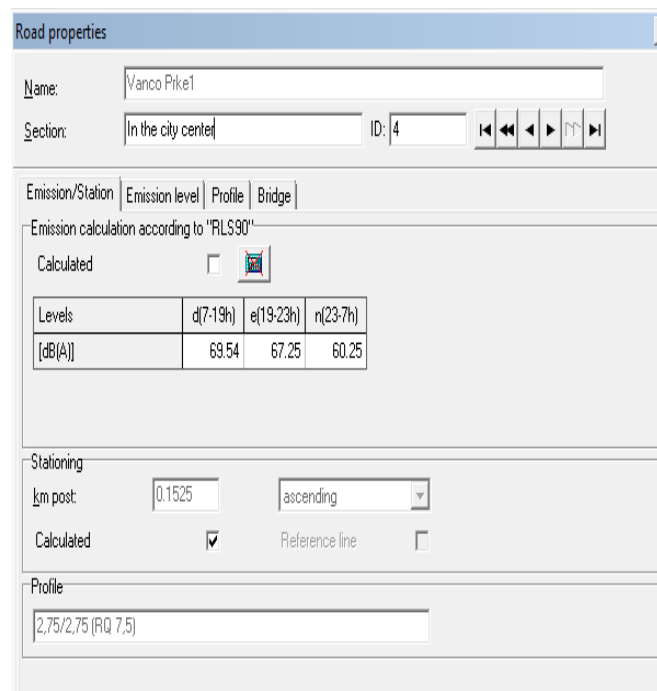


Figure 7: Road properties



The dialog for the entry of the traffic volume is the same for nearly all standards; only the number of vehicle types can vary (Figure 8).

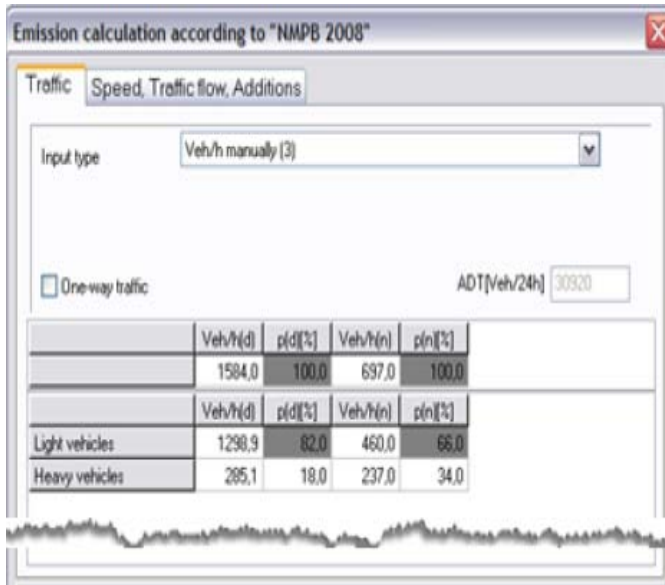


Figure 8: Dialog for the entry of the traffic volume

The following are the assumption of input data for noise mapping model.

Assumption for building data:

- All the buildings have same type of construction material
- The built-up area will be assumed acoustically hard because it is easy to check in the field.
- There is no occurrence of noise due to façade effect from the wall of the buildings.

Assumption for traffic data:

- The road traffic includes all types of vehicles such as light vehicles, small vehicles, heavy vehicles and light trucks
- The noise is emitted from the centreline of roads.
- The type of road surface is same in the entire study area and it is assumed to be asphaltic concrete.
- The road surface of study area is flat without any undulations in ground surface.

Assumption for noise absorbing area like open ground:

- The noise absorbing areas such as road material, trees and water is not considered in the noise calculation model.
- In the noise calculation, only the noise from road traffic is considered not the background noise.
- During noise calculation it is assumed that there is no noise barriers located in the noise map.

SoundPLAN Graphics combines the geometry data and calculation results with supplemental elements such as north arrows, scale bars, legends, color scales and textboxes to form noise map.

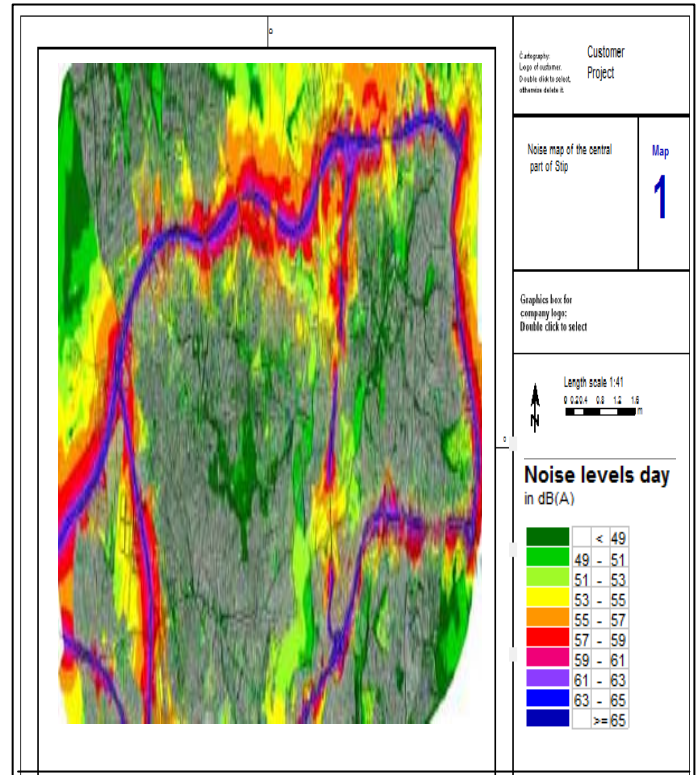


Figure 9: Noise map of the central part of Stip

#### 4. Conclusion

Noise pollution of urban areas is one of serious factors that the local agencies and state authorities have to consider in decision making processes. The spatial analysis and geo statistical methods of GIS can play an important role to control noise pollution. GIS provide framework to integrate noise calculation models with spatial data that can be used for building noise maps. Noise maps can be used to assess and monitor the influence of noise effects. Noise maps within GIS have been developed in most of the European Countries.

The spatial database and spatial analysing tools of GIS can be useful to monitor the effect of noise and its impact. Noise maps can be used for calculating the areas, which are affected by noise. Noise maps can be used for determining the number of sensitive buildings, which are affected by high noise levels [6]. Using noise maps the number of citizens who are annoyed can be determined. Noise maps can be helpful in planning and decision making process to reduce the noise pollution.

#### 5. References

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