

GIpSynoise: a GIS tool adapted to the European Directive on Assessment and Management of Environmental Noise 2002/49/CE

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Abstract [1556]. As a European LIFE Environment project, GIpSynoise^[1] aims at developing an operational decision support tool:

- Compliant with European Directive 2002/49/CE relative to the assessment and management of environmental noise (DAMEN)^[2] in collaboration with European local authorities,
- Including requirements of city decision makers/managers, in charge of defining action plans aiming at improving the quality of life and public information,
- Simple and user-friendly (designed for operators who are not experts in acoustics/computer science), based on a Geographic Information System (GIS).

GIpSynoise functions rely on the calculation of actual acoustic situations from European-wide indicators / models and on their representation as noise maps by type of noise source (road, railway, industry, aircraft). Various simulations of noise source changes, in particular for road noise, can then be achieved. Two acoustic situations are compared to generate a conflict map. Automatic crossing of noise/population data is used to work out the map of exposed population. Statistical data are estimated with respect to area, building and population exposure for the entire city. Eventually, action plans can be validated by local decision makers and maps can be communicated to the public^[3].

As of now, this tool is being tested by all local authorities-partners in this project (15 European cities and experts) on a pilot site located in Greater Lyon (France) and also by a sample of citizens (communication).

1. INTRODUCTION

GIpSynoise is an integrated tool to the ArcView® Geographical Information System 8.3. The acoustics calculations are achieved on the tool, with the help of a CadnaA®^[4] runtime. GIpSynoise enables the user to match with the 2002/49/CE European instruction with the achievement of acoustics mappings and related statistic data.

GIpSynoise is used for road, railway and industrial noise sources. The acoustics mappings generated by the airport managers may also be imported into the tool. The types of calculation of the acoustics propagation are NMPB for the road, SRMII for the rail and ISO96-13 for the industrial sources (European instruction advices).

The data validity has to be checked before their use as the input. For that matter, it is the responsibility of the user to input valid data. The wrong entry data lead to a wrong calculated result “in fine”. The user must enter valid information. The entered data into the tool GIpSynoise have a format complying with the “necessary entry data”.

The GIpSynoise tool is not an expertise tool. The aim of this tool is to get a macroscopic idea of real situations. The standard scales “urban communities”, “communities of cities” and “towns” are the appropriate scales for the use of GIpSynoise.

2. GIPSYNOISE BASIC FUNCTIONS

The logic of the tool is based upon the setting-up of projects in which it is possible to create a set of scenario, an original scenario (corresponding to the initial situation) and various types of this original scenario (corresponding to various simulations).

Current functions of the tool GIpSynoise^[5] are:

<p style="text-align: center;">Project Menu:</p> <ul style="list-style-type: none"> • New: creation of a new project • Open: opening of an existing project • Exit: closing of the application • Delete: suppression of a project • Import: importation of noise project (aircraft) • Export: exportation of map toward others GIS • Create Macro Project: concatenation of individual project 	<p style="text-align: center;">Scenario Menu:</p> <ul style="list-style-type: none"> • Management: creation of a new scenario / opening of an existing scenario • Modify layer road: modification of parameters related to road sources • Calculate: launching of the calculations • Validate: validation of a scenario to be realised on site • Delete: suppression of a scenario
<p style="text-align: center;">Display Menu:</p> <ul style="list-style-type: none"> • Create raster: map creation from the calculation • Noise map: introduction of the noise map • Conflict map single: introduction of the conflict map based upon one value • Conflict map reference: introduction of the conflict map based upon the reference map • Exposed population: introduction of the exposed populations map • Risk map: introduction of the risk map (day annoyance/night sleep disturbance) • Table: number of exposed population, surfaces of exposed areas by 5dB(A) classes. 	<p style="text-align: center;">Comparison Menu:</p> <ul style="list-style-type: none"> • Noise maps: comparison of noise maps calculated (with original and others scenarios) • Tables: comparison of tables calculated.

Table 1: GIpSynoise Menus

3. CREATION OF A PROJECT

3.1 Characteristics of the project data

To create a project, the user clicks on the button « *Project* » in order to enter the running menu and then he clicks on the option “New”, as showed below:

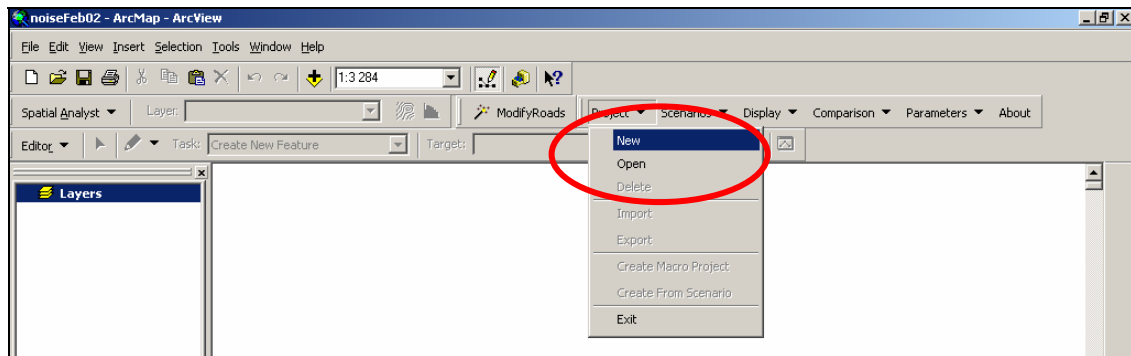


Figure 1: new project creation

A dialog box presents several fields to be filled by him, necessary to the running of the calculation; these are entry data of the tool GIpSynoise.

Field « *Project Name* »: First of all, the user has to give a name to the project.

Field « *Comments* »: This field enables to complete the name of the project by remarks specifying the nature of the calculation.

Field « *Original Data File* »: These fields enable to load different layers, to be used for the calculation. Just click on one of the existing buttons and load the layer of corresponding geographical data, by showing the path of the directory in which it lies. All the layers to be loaded must absolutely be files type 'shapefile' files. Necessary input data concerns:

- Road / Railways / Industry / Aircraft
- Topography (height point and/or height line)
- Building / Barrier / Ground absorption
- Population per block / Reference map (residential, commercial ...) / Calculation zone

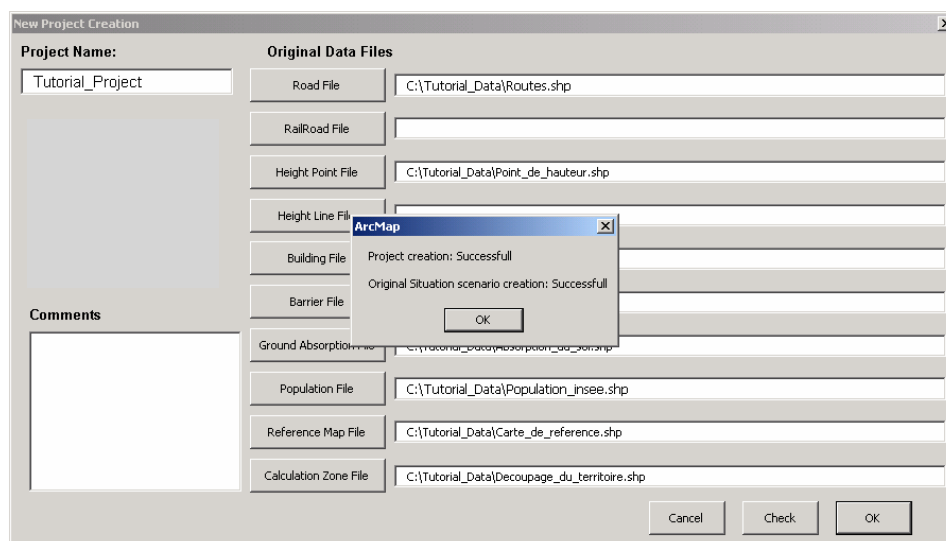


Figure 2: new project creation OK

The user automatically loads the original scenario generated by GIpSynoise, in order to launch the calculation. To that purpose, he selects in the running menu « Scenario » the forecast option « Management ».

3.2 Launching of the calculation

Once everything is checked (executable file folder, ...), the user launches the calculation by means of “Calculate” positioned in the running menu « Scenario ».

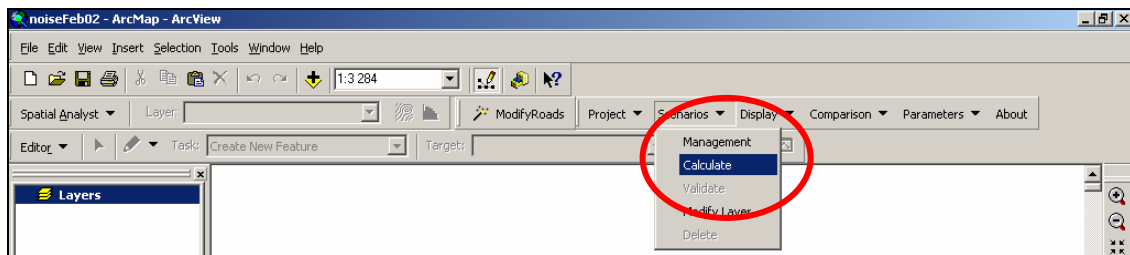


Figure 3: calculate menu

4. MAPS REPRESENTATION

4.1 Display of noise map

To present the noise map corresponding to the initial situation, the user clicks on the button « Noise Map » existing in the menu « Display ». Here is an example of the result which can be obtained by him when he creates such a map during the day:

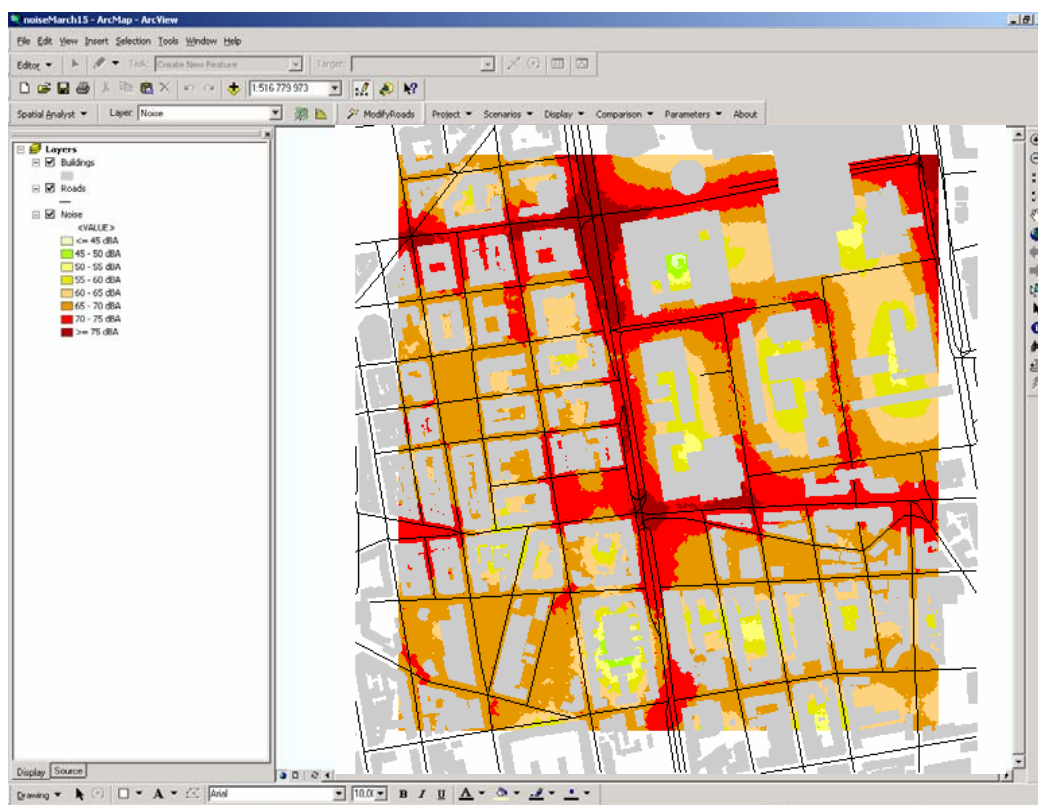


Figure 4: example of noise map for daily period

Levels are mapping by 5dB(A) classes as required by DAMEN from less than 45dB(A) to more than 75dB(A). This map lets appear a classification of the territory from quiet to noisy zones, the daily noise levels, the most important drawn in dark.

4.2 Display of conflict map

The conflict maps consist in making an arithmetical difference in each calculation point between the level calculated and a reference threshold specified by the user. The conflict map adjusts the acoustic level threshold « *Reference Value* (dB(A)) », enabling to display a map presenting zones with an upper value to this threshold value. The map displayed will present various colours with different zones.

The reference threshold can be a single value or a table of values depending on the area categories: Residential zone, Mixed zone (residential/business), Industrial zone, Sensitive zone, Other zone.

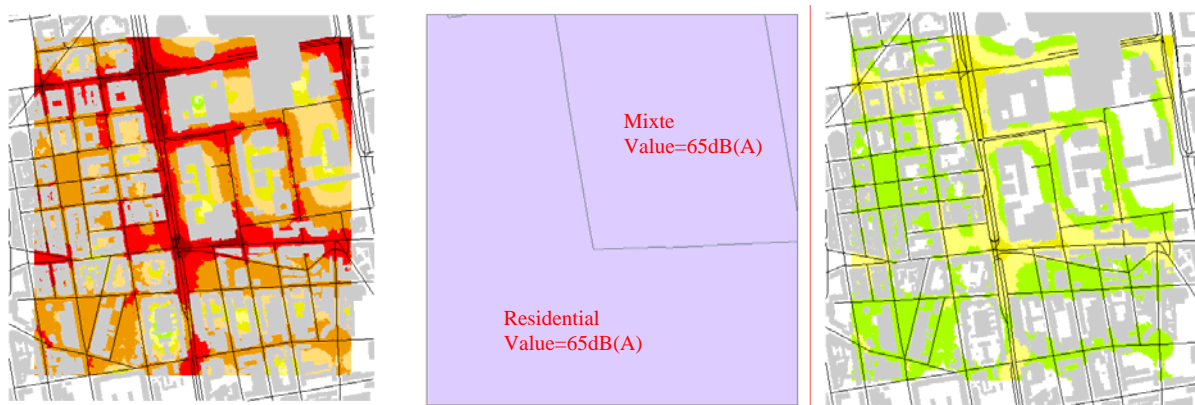


Figure 5: example of conflict map from reference thresholds values

This figure shows the various zones where the daily sound levels calculated over the specified thresholds, by type of zones and sources. It lets appear in 5 categories, without conflicts (no colour), from 0 to 5 dB(A) in light green, from 5 to 10 dB(A) in light yellow, from 10 to 15 dB(A) in yellow and upper 15 dB(A) in light orange.

4.3 Display of exposed population map

The user wants to present the exposed population to this acoustic situation. He launches the presentation of the corresponding day map by actuating «Exposed Population» in the menu « *Display* ».

This presentation comes from the sound levels calculation by building, realised by the runtime CadnaA®. The information drawn here has two meanings: the sound levels on a building façade (colour) and the number of exposed persons (circle). To be homogeneous, the colour slice used is the same as noise maps one. The size of the circle will depend on the number of the exposed persons.

4.4 Display of risk map

This map represents the risk of day annoyance and night sleep perturbation. It integrates the percentage of disturbed persons by type of sound source implied. It is based upon studies published by the European Commission^[6]. These studies have led to two curves concerning:

- Percentage of annoyed people during their day (according to the L_{Den} on building front)
- Percentage of disturbed persons during their sleep (according to the L_{Night} on building front).

Three different categories of risks are outlined:

- Low risk yellow
- Medium risk orange
- High risk red

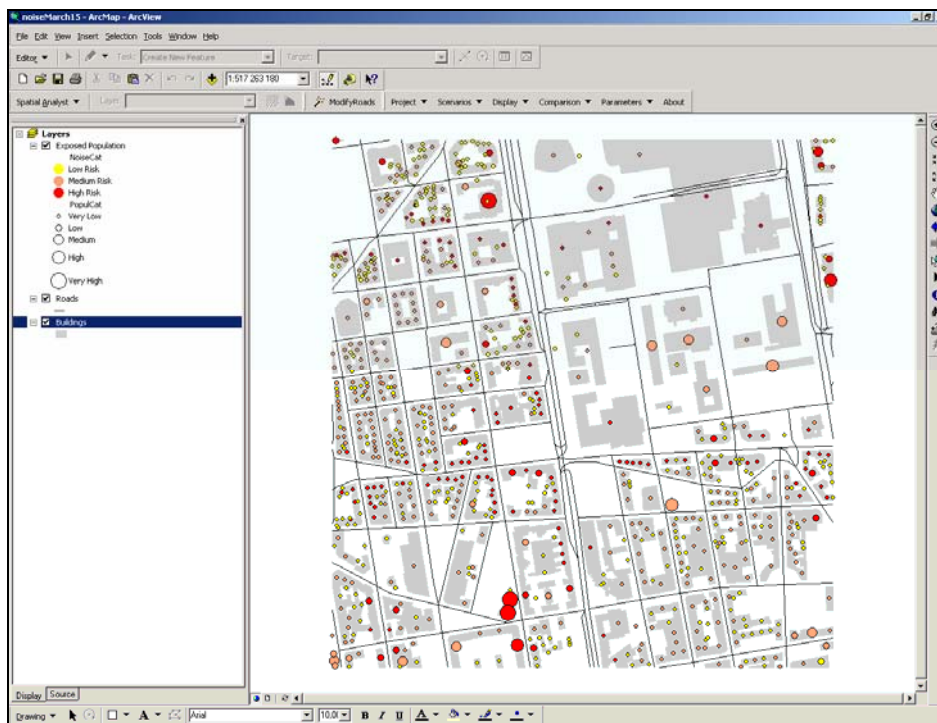


Figure 6: example of risk map for daily period

By means of different colours and size circles, this map shows the daily annoyance risk. The bigger the diameter of the circle is and the darker the used colour is, the more important the risk is.

At this step of display, the user has a good idea of the global noise situation, the exposed population and the risk of annoyance/sleep disturbance on the studied territory. He wants to quantify exposed areas, exposed building and exposed population.

5. TABLES

These tables presented below are calculated automatically by GIpSynoise.

5.1 Exposed areas table

For each noise source, this table lists the area of same-level zones and the percentage of corresponding city area, by classes of 5 dB(A). These values are calculated from horizontal noise maps with all indicators L_{Day} , $L_{Evening}$, L_{Night} , $L_{Global Day}$ and L_{Den} .

Exposed areas (km ²)	< 55		[55-60[		[60-65[		[65-70[		[70-75[		> 75		Total area
	Area	% of city area	Area	% of city area	Area	% of city area	Area	% of city area	Area	% of city area	Area	% of city area	
Road	0.4	6.9	0.7	12.1	1.9	32.8	1.4	24.1	0.9	15.5	0.5	8.6	5.8
Rail	-	-	-	-	-	-	-	-	-	-	-	-	-
Industry	-	-	-	-	-	-	-	-	-	-	-	-	-
Aircraft	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2: example of exposed areas table

5.2 Exposed buildings table

For each type of noise source, this table lists the number of buildings exposed to a noise level, by classes of 5 dB(A). These values are derived from the building maps.

Number of exposed buildings	< 55			[55-60[			[60-65[			[65-70[			[70-75[			> 75			Total		
	Residence	School	Hospital	Residence	School	Hospital	Residence	School	Hospital	Residence	School	Hospital	Residence	School	Hospital	Residence	School	Hospital	Residence	School	Hospital
Road	869	0	0	1367	2	0	2644	3	1	1976	1	0	1210	1	0	836	0	0	8902	6	1
...	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3: example of exposed buildings table

5.3 Exposed population table

This table lists the exposed population and the percentage of total population exposed to a noise level, by classes of 5 dB(A). These values are derived from the building maps.

Exposed residents	< 55		[55-60[		[60-65[		[65-70[		[70-75[		> 75		Total population
	Number	% population	Number	% population	Number	% population	Number	% population	Number	% population	Number	% population	
Road	5741	6.9	13458	16.3	28754	34.8	18896	22.9	8833	10.7	6970	8.4	82652
...	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4: example of exposed population table

At this step of display, the user has a good idea of the global situation with various maps. Moreover, he has tables with data on exposed areas, exposed building and exposed population. So, he chooses different priority sites that have to be improved by the implementation of different solutions on the studied territory.

6. SIMULATION AND COMPARISON OF VARIOUS SOLUTIONS

Playing on one or several entry parameters of road sources, the user can create the wished simulations. As a whole, it is sometimes difficult to make the point, only from a noise map concerning the improvement or the degradation of the urban noise environment. That's why it is interesting to make a comparison of acoustics situations.

Here are maps and tables comparisons based on 3 examples of various scenarios about a pilot site in the city of Lyon.

6.1 Noise maps comparison

Scenario 1: he has reduced the traffic of Garibaldi road and increased both the traffic of Servient road and Duguesclin road.

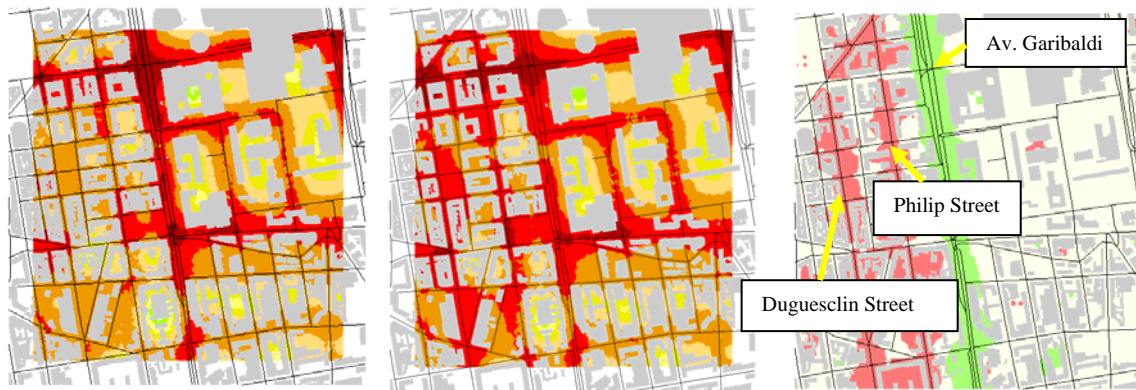


Figure 7: original situation, scenario1 simulation and comparison

The sound levels near the Avenue Garibaldi are lower, those issued from the streets Philip and Duguesclin are higher than before.

In fact, the user will consider a global modification of the traffic plan at the city's scale. So, increased traffic won't be as significant as it is in this example and noise situation won't be as worse as it is on Philip and Duguesclin street above.

Scenario 2: he has changed the asphalt of Garibaldi road for a street with acoustic properties.

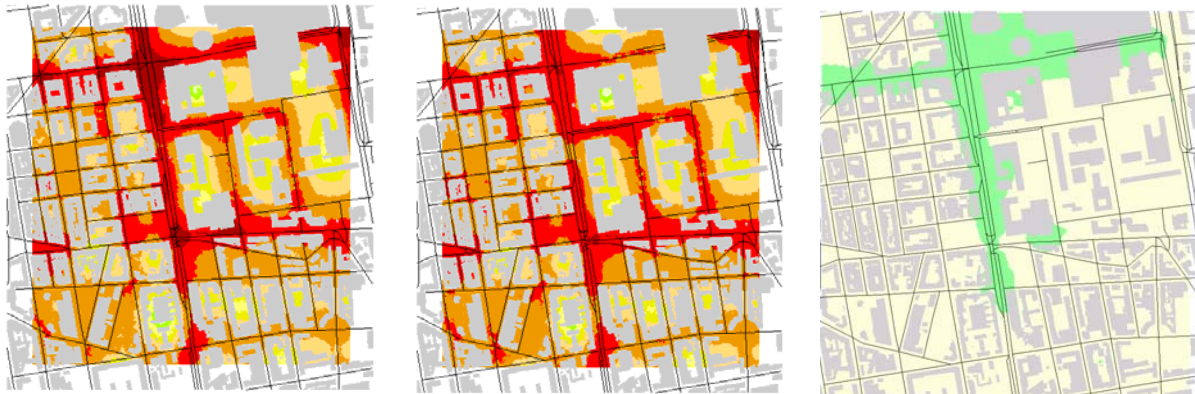


Figure 8: original situation, scenario2 simulation and comparison

The effect of the asphalt with acoustics characteristics is very favourable. This map shows that the modification of the cement embedded on the place with important traffic is an interesting mean to reduce the noise level, about 5dB(A) locally here.

Scenario 3: he has reduced speed of the traffic on Garibaldi road.

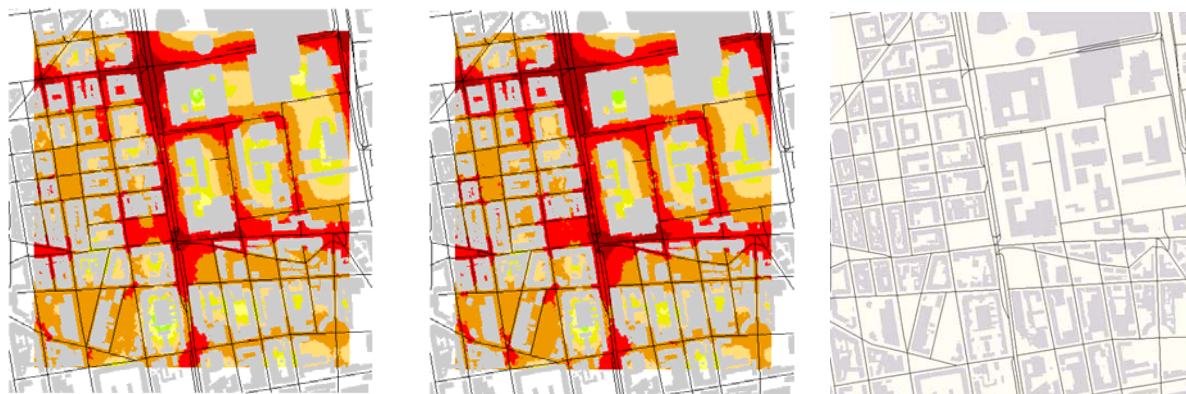


Figure 9: original situation, scenario3 simulation and comparison

The speed modification of the traffic is not sensitive as far as acoustics is concerned on the Garibaldi Avenue. You can clearly display the speed limit carried out to the very noisy zones on the noise map isn't an interesting solution in order to reduce significantly the noise in this precise case.

At this step, the user analyses these results: a global modification of the traffic plan represents a good way to optimize noise situation on specific noisy street. A change of asphalt on street segment with acoustic properties has to be considered in order to improve acoustic environment. If necessary, others complementary scenarios will be created by "playing" on barriers, flow, ... or adding solutions in the same time.

6.2 Tables comparison

The user can also compare the exposed areas, exposed buildings and exposed population between the original situation and scenario 1/2/3 or 4.

Difference of exposed residents	< 55		[55-60[		[60-65[		[65-70[		[70-75[		> 75		Total population
	Number	% population	Number	% population	Number	% population	Number	% population	Number	% population	Number	% population	
Road	0	0	0	0	1387	1.7	10095	12.2	-4547	-5.5	-6935	-8.4	82652
...	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5: example of exposed population comparison

With these various analyses of displays and tables, the user creates his priority to preserve quiet zones and to treat noisy areas. He can elaborate his action plan connected with the consequences induced on areas, building and population. He can plan different deadline for the implementation of various solutions and quantify for each choice benefices in term of noise exposition.

7. COMMUNICATION AND EUROPEAN COMMISSION REPORT

GIpSyNOISE tool integrates various recommendations in order to optimize communication. These advices let the user realise best supports from GIpSynoise tool and develop right arguments to general public. The main aim is to explain with transparency the actual situation, the considered action plans and the resulted situation in 5 years.

With all the outputs (maps, tables) given by GIpSynoise, the user can complete the automatic report integrated to the tool that have to be sent to the European commission.

8. CONCLUSION

GIpSyNOISE tool will be used to perform the noise mapping of an urban area and to issue statistics and maps on the corresponding exposure to noise for the local residents, according to European Directive 2002/49/CE and to the requirements of the partner cities (LIFE European project).

This software will include geo-referenced data relative to the sites under consideration and to the noise sources (roads, tracks, industrial sites, aircraft) in order to represent the current acoustic situation. Various simulations will be performed to achieve an overall comparison of the impact of a modification (traffic, road surfacing materials, sound barriers, etc.) on the environment. By allowing for the comparison of the current situation with a potential future situation, GIpSyNOISE will be an aid in decision-making.

GIpSyNOISE will be used by the operator/decision maker on a macroscopic scale (urban community, city, neighbourhood) but will, at no rate, be an expert tool. For a detailed study, more suited software will be required as a complementary tool.

GIpSyNOISE will also be a communication tool between the city and the residents. It will indeed allow to issue calculation results (maps and statistical tables) in a format suited for traditional (newspaper) or Internet publishing. GIpSyNOISE will produce all information required by the European commission aiming at a sustainable development of the environment^[7].

REFERENCES

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