DELIVERABLE 3

"Noise maps"

LIFE 09 ENV/IT/102

NADIA
Noise Abatement Demonstrative and Innovative Actions and information to the public

Working group of the project

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1 Introduction

The NADIA project (Noise Abatement Demonstrative and Innovative Actions and information to the public) is developed by four Italian public bodies (Province of Genoa, Province of Savona, Municipality of Vicenza and Municipality of Prato); the research center CIRIAF (Interuniversity Research Centre on Pollution by Physical Agents), based at the University of Perugia, is the scientific-technical advisor of the project.

The objectives of the project are:

- to demonstrate the technical and economic feasibility and the effectiveness of best practices to reduce road traffic noise levels, using noise mapping activities;
- to demonstrate the effectiveness of the involvement of the stakeholders and the correct communication to the public to increase the awareness on traffic noise emissions and their effects on health and quality of life;
- to widely disseminate the results during and at the end of the project, al local, national and European level.

The project is organized in 9 actions:

N°Action	Description	N° Action	Description
1	Project Management	6	Dissemination
2	Surveys	7	Monitoring
3	Noise Mapping	8	After LIFE communication plan
4	Action plans definition	9	Audit
5	Demostrative action for noise reduction		

CIRIAF is the partner in charge for the Action n°2 and 3; in particular CIRIAF simulated the noise emitted by the roads managed by the Provinces of Genoa and Savona included in the project.

The data sets needed for the noise simulation were established through the Milestone 1 of the project "Data quality and quantity with regard to models specifications"; the file is available on the official website of the project (http://www.nadia-noise.eu/).

The methodology defined in the M1 is in compliance with the "Good practice guide for strategic noise mapping and the production of associated data on noise exposure" [1], developed by the European Commission. The methodology allows to create noise maps whose quality is strictly related to the used input data: in this way the required level of detail can be achieved. Instructions for the collection of

data requested for noise mapping activities were given in Deliverable 2, "Noise propagation model optimized and validated".

The noise propagation model used in the noise mapping activity is the NMPB-Routes-96 [2], recommended by the annex II of the European Directive 2002/49/CE (END) [3] for the States that have not adopted a national computational method. The noise emission of each modelled road depends on the average traffic flow and its composition (% heavy and lightweight vehicles and speed in the reference periods day, evening and night), the road slope (evaluated by the DGM, Figure 1) and the type of the road pavement surface.

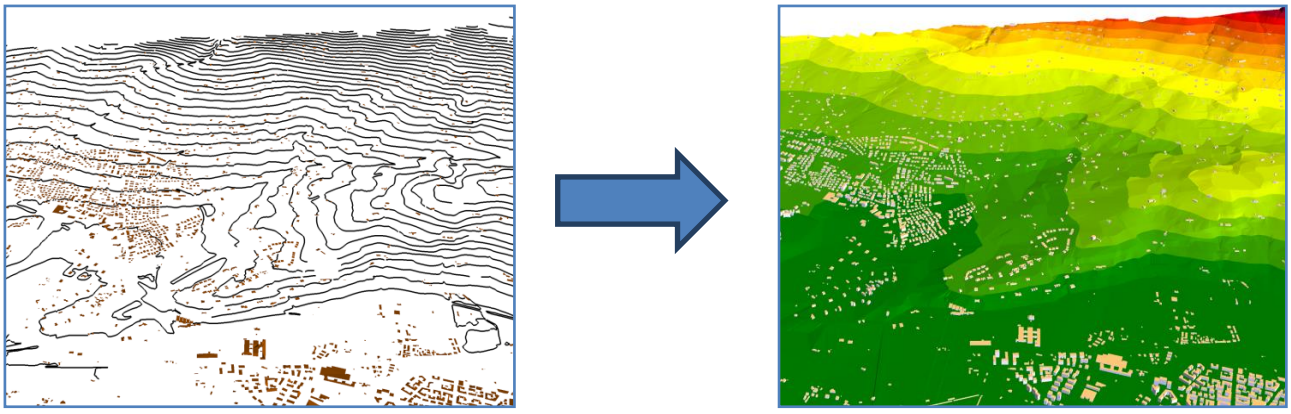

Figure 1: Example of data processing: Realization of the digital ground model (DGM).

Data related to the percentage of heavy vehicles for roads of the Province of Genoa were not available; M1 indicates the standard coefficients to be used (% of heavy vehicles for day, evening and night day periods, Italian average data) for each type of road. The choice of the best coefficient for every road was made considering the characteristics of the road (total flow, usage, presence of industrial areas, etc.) and through the comparison of the noise simulations with the noise measurements.

The segments of the roads to be modelled with highly noisy pavement surfaces (such as cobblestones) were individuated analyzing satellite photos. This approach was used also to detect viaducts and flyovers, in order to consider the different kind of sound propagation (hemi cylindrical when the road lies on the ground, cylindrical when the road is on a viaduct or on a flyover). The noise emissions of the parts of roads inside tunnels were not considered.

The ground use was taken into account (asphalt surfaces like parkings have a higher sound reflection coefficient than grassland or woodland) in order to consider the effect of reflection/absorption on sound propagation. The method used in NADIA project for the evaluation of the reflection of the surfaces was taken from [1]; moreover a protocol was defined in the M1 in order to make the acoustic

classification of the land usage less subjective. In this way every kind of land usage was classified according to the categories defined in the European guideline.

Concerning the height of the buildings, two different procedures were used:

- If the quote of the roof was available, the height of the buildings was estimated comparing this information with the DGM. For example, if the geodetic quote of the roof was 380 m a.s.l. while the one of the ground under the building in the DGM was 370 m a.s.l., the height of the building was estimated to be equal to 10 m.
- In the cases in which the quote of the roofs was not available, the height of the buildings was estimated from the analysis of satellite photos.

The height of the building was used to estimate the number of floors and consequently the number of residents inside the building. The density of population was estimated for each area analyzing the results of the most recent national census.

CIRIAF used all the data collected during action n°2 to simulate noise emissions by the roads of the Provinces of Genoa and Savona. At this purpose two virtual receivers were located in front of the center of each façade of every building; the first one on the façade itself for the evaluation of the noise level, the second one at 2 meters from the façade to evaluate quiet façades as foreseen in [2].

The Municipalities of Vicenza and Prato used the same methodology for the realization of their strategic noise maps.

Two kinds of result were produced: graphical maps and numerical estimates. Through the graphical maps the value of the noise level was evaluated inside a calculation area. This kind of evaluation requires high calculation time even reducing the accuracy of the simulation; nevertheless the graphical maps are easier to be analyzed by people who are not expert in acoustics.

The numerical estimates allow to evaluate the acoustical criticism generated by the roads combining the results of the noise simulation with other different information like the use of the building and the people living inside them. At this purpose noise levels were evaluated in points located near the façade of the buildings. **The noise simulations carried out by CIRIAF for the Provinces of Genoa and Savona and by the Municipalities of Vicenza and Prato allow to evaluate the indicator "population exposure to noise" as requested by the European Directive 2002/49/CE.**

2 Roads managed by the Provinces of Genova and Savona mapped within NADIA Project

Within the activities of the NADIA project the noise levels emitted by 3 roads managed by the Province of Savona (PROVSV), 5 by the Province of Genoa (PROVGE) (Table 1) and parts of the agglomerations of Prato (COMPR) and Vicenza (COMVI) were modelled.

Table 1: List of the roads managed by the Provinces of Genoa and Savona and mapped within NADIA Project

Managing Authority	**Road**	**Managing authority**	**Road**
PROVSV	SP28 bis	PROVGE	SP35
PROVSV	SP29	PROVGE	SP225
PROVSV	SP334	PROVGE	SP333
PROVGE	SP33	PROVGE	SP523

Each road listed in Table 1 has more than three million vehicle passages a year, so the Managing Authorities were in charge to fulfil the requirement of the END within June 30 2012 (Article 7 of [1]).

The agglomerations of Prato and Vicenza have more than 100.000 inhabitants (but less than 250.000), so their Managing Authorities should meet the same deadline for their strategic noise maps.

5 maps have been produced for each road:

- Two containing the noise contours with the same level in dB(A) respectively for the indicators L_{den} and L_{night}, combined with the DGM;
- Two containing the noise contours with the same level in dB(A) respectively for the indicators L_{den} and L_{night}, combined with satellite images;
- One containing the noise contours of 55 and 65 dB(A) of L_{den}.

3 Agglomerates of Vicenza and Prato

3.1 Agglomerate of Vicenza

The agglomerate of Vicenza matches with the administrative boundaries of the municipality of Vicenza. The city area is affected by the noise emission of:

- Municipal road network;
- Controlled-access highways A4 and A31;
- Other road networks;
- Rail networks.

The strategic noise map of the agglomerate of Vicenza was done considering the noise emission of the roads within the urban area of the municipality of Vicenza (Figure 2).

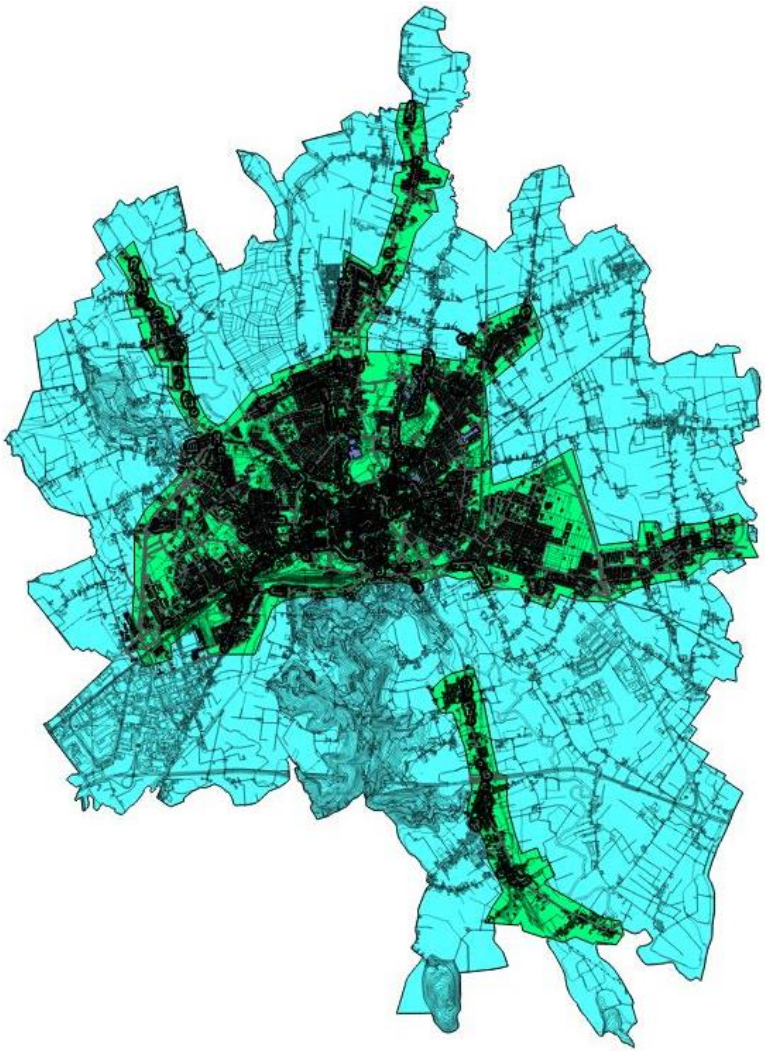

Figure 2: In green the urban area studied within NADIA Project,. In cyan the whole area managed by the Municipality of Vicenza.

3.2 Agglomerate of Prato

The agglomerate of Prato matches with the administrative boundaries of the municipality of Prato. The city area is affected by the noise emission of:

- Municipal road network;
- Controlled-access highways A11;
- Other road networks;
- Rail networks.

The strategic noise map of the agglomerate of Prato was done considering the noise emission of the roads within the urban area of the municipality of Prato (Figure 3).

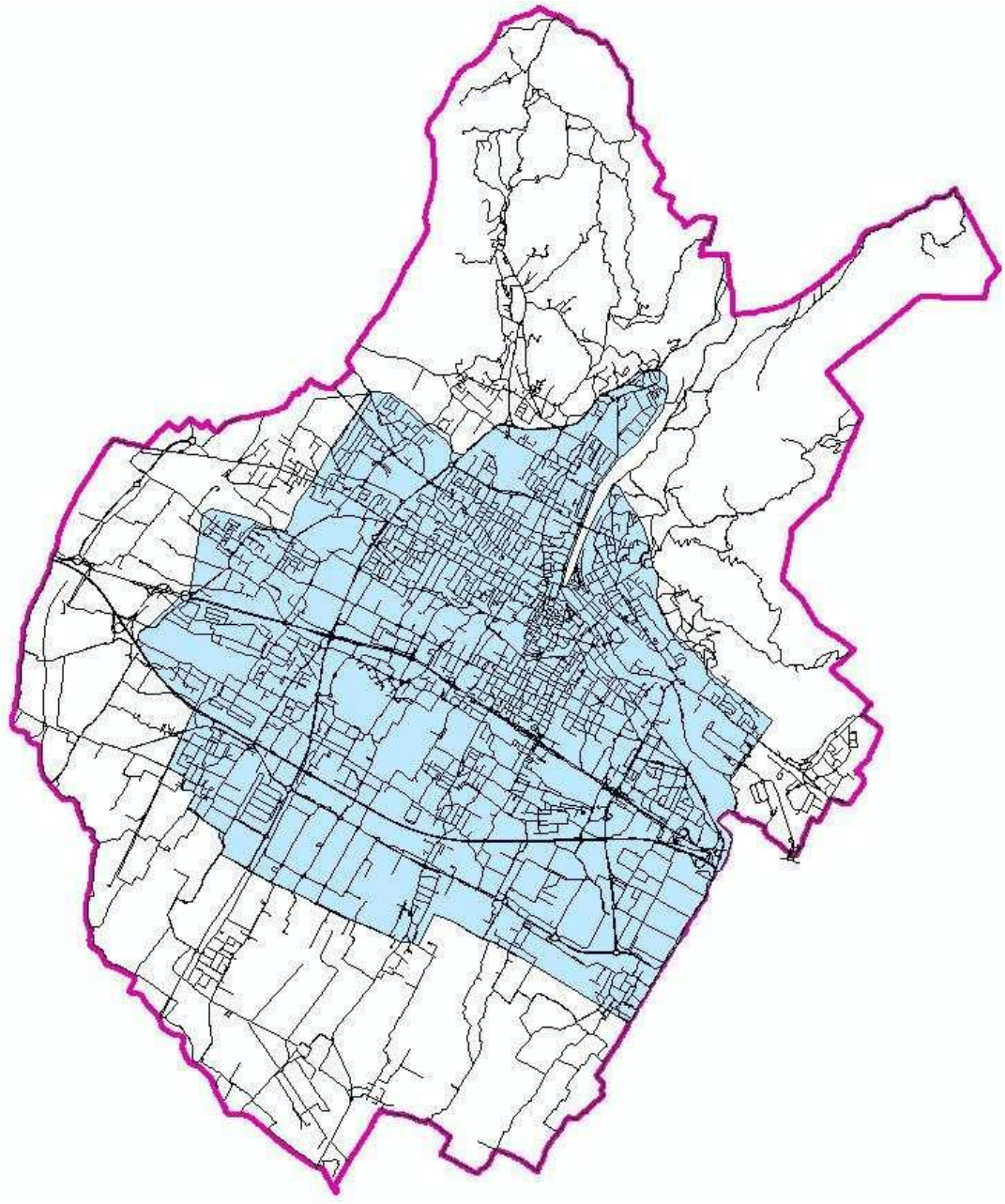

Figure 3: In cyan the urban area studied within NADIA Project. The magenta line is the administrative border of the Municipality of Vicenza.

3 Description of the maps

3.1 Noise contours and DGM

Figure 4 is an example of a noise map containing the noise contours (noise contours with equal level in dB(A)) of a noise indicator (in this case L_{den}), combined with the DGM. Inside the calculation area, road noise emission is represented colouring the bands between the noise contours. The colours have been chosen considering the position paper of the European Environmental Agency Working Group on the Assessment of Exposure to Noise (WG-AEN) "*Presenting Noise Mapping Information to the Public*" (Figure 5) [4]. Outside the calculation area, the terrain orography is illustrated using green colour bands.

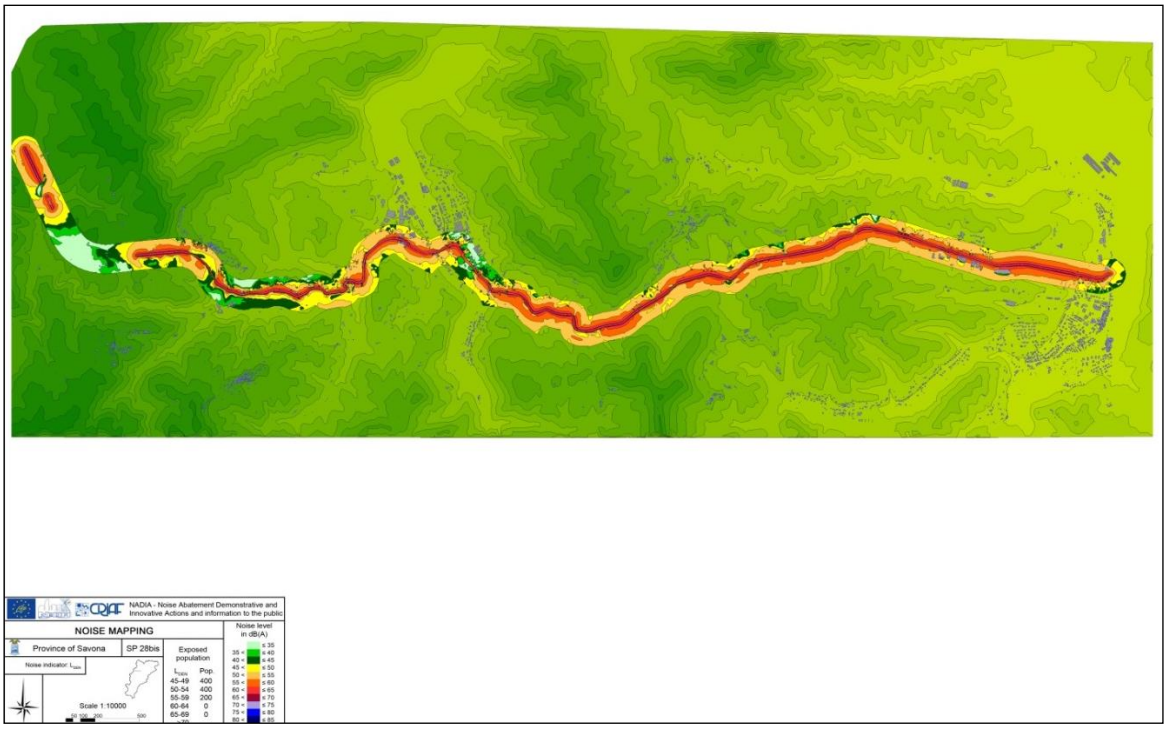

Figure 4: Example of a noise map containing the noise contours with the same level in dB(A) for the L_{den} indicators combined with the DGM.

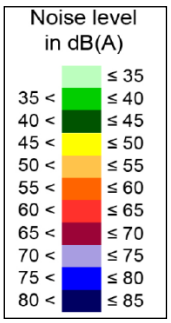

Figure 5: Colour scale used in the maps containing the noise contours with the same level in dB(A) and the DGM

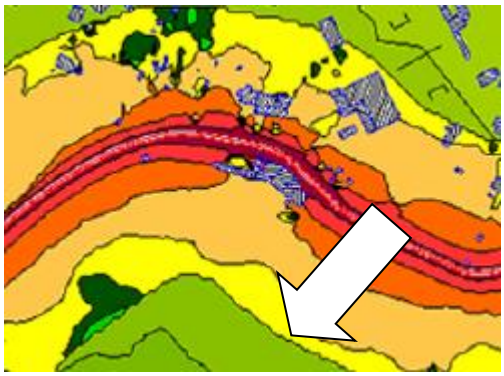

Figure 6: A detail of Figure 4

In Figure 6, a detail of the noise map in Figure 4 have been reported; the white arrow points out the end of the calculation area. In this figure it could be observed how the buildings hinder the road noise emission.

3.2 Noise contours and satellite images

Figure 7 is one of the maps produced placing satellite images in the noise simulation background. The propagation of road noise emission is represented using the colours suggested by [4] (Figure 8). Figure 9 shows how the noise simulation has been combined with the satellite image in order to enhance the comprehension of the document.

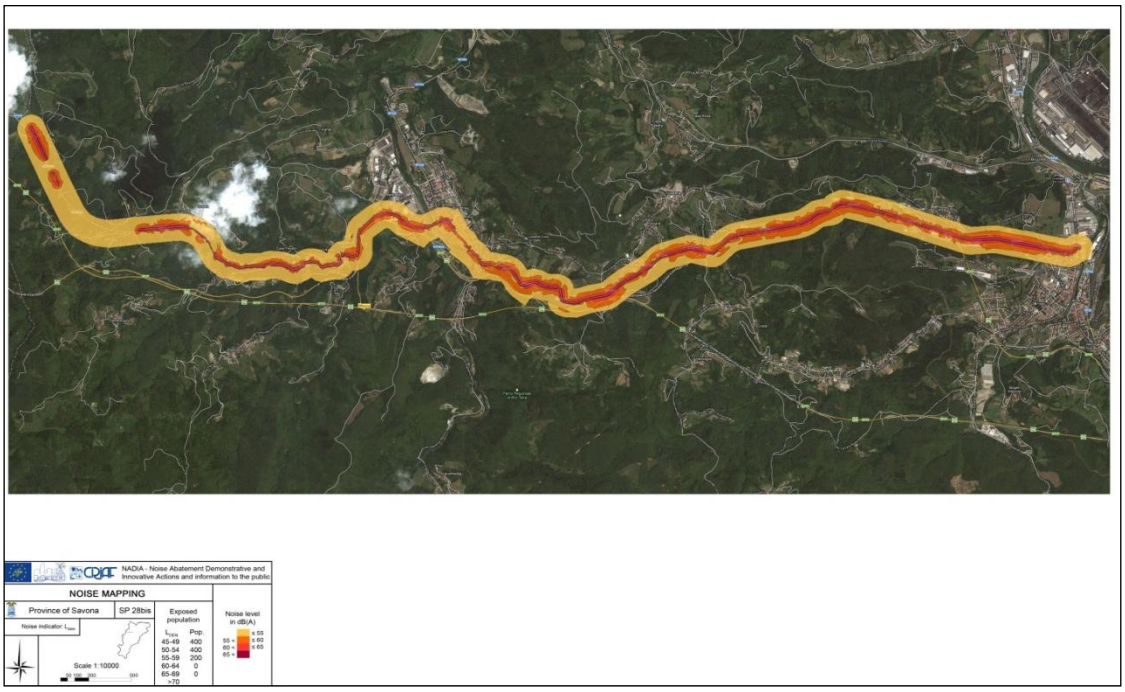

Figure 7: Example of a noise map containing the noise contours with the same level in dB(A) for the Lden indicators combined with satellite image.

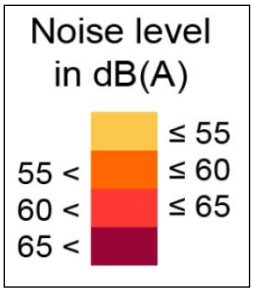

Figure 8: Colour bands used in the maps containing the noise contours with the same level in dB(A) and the satellite image

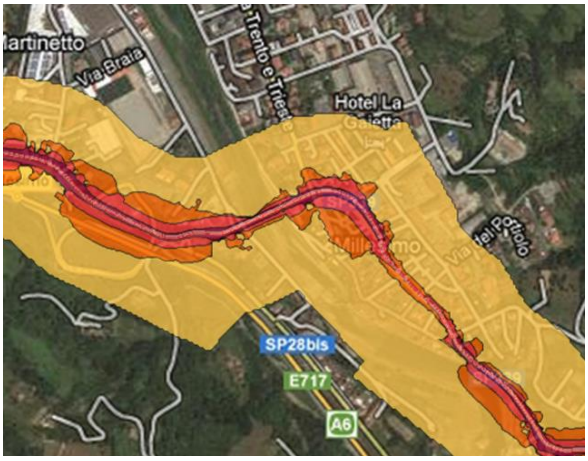

Figure 9: A detail of Figure 7

3.3 55dB(A) and 65 dB(A) L_{den} noise contours

This maps have been done to highlight the areas in which the road noise emission are over the 55 dB(A) and the 65 dB(A) using the L_{den} indicator. These maps fulfil the requirements of the article 2.8 of the European Directive 2002/49/EC [2].

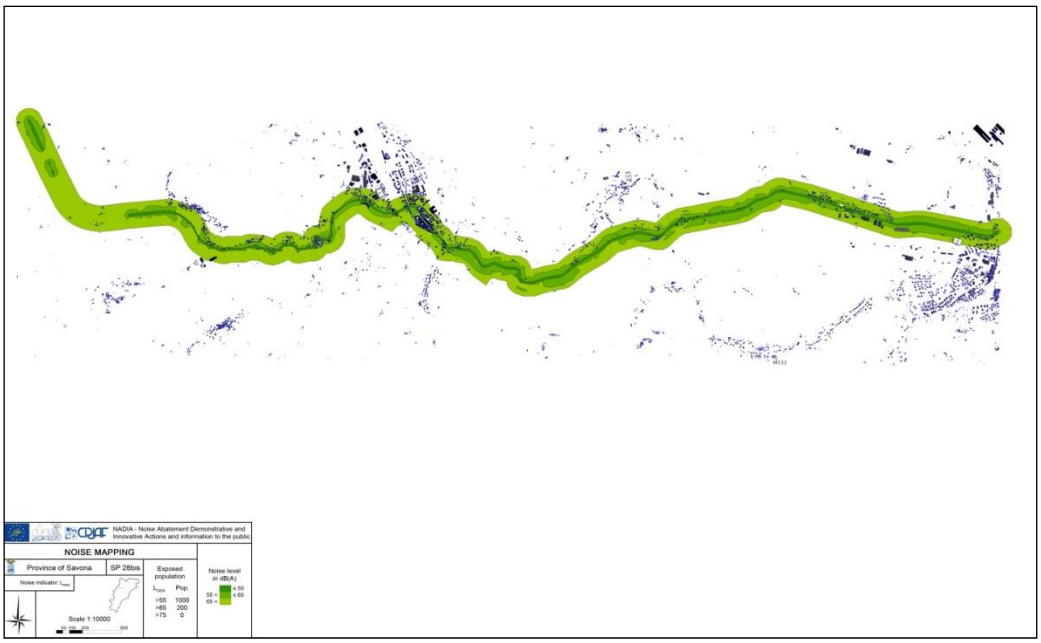

Figure 10: Representation of the 55 and 65dB(A) Lden noise contours within the calculation area

4 Evaluation of noise exposure to traffic noise

4.1 Provinces of Genova and Savona

Table 2 and Table 3 report respectively the value of the indicators "population exposed to noise" for the roads studied in NADIA Project. Table 4 reports the value of the indicator "number of people living in buildings that have a quiet façade" for the same roads. The evaluation of the two indicators is required by [2].

Table 2: Values of population exposed to noise (L_{den})

Bands of value in L_{den}	Number of people exposed to noise							
	SP33	SP35	SP225	SP333	SP523	SP28b	SP29	SP334
55-59	2200	2200	1500	2400	1000	1400	5400	600
60-64	1200	1400	1200	1700	600	400	1200	500
65-69	600	1100	1000	700	600	400	700	400
70-74	1300	1500	1300	1000	700	200	700	200
>75	200	100	200	400	200	0	300	0

Table 3: Values of population exposed to noise (L_n)

Bands of value in L_n	Number of people exposed to noise							
	SP33	SP35	SP225	SP333	SP523	SP28b	SP29	SP334
45-49	2400	2500	1700	2700	1100	400	1800	500
50-55	1300	1400	1400	1900	600	300	800	500
55-59	600	1100	900	800	700	400	800	500
60-64	1300	1600	1400	1000	700	100	400	300
65-69	200	100	200	400	200	0	0	0
>70	0	0	0	0	0	0	0	0

Table 4: Number of people living in buildings that have a quiet façade (NPQ)

Road	Managed by	NPQ	%	Road	Managed by	NPQ	%
SP33	PROVGE	1300	10	SP28b	PROVSV	400	18
SP35	PROVGE	1600	13	SP29	PROVSV	700	8
SP225	PROVGE	1800	19	SP334	PROVSV	500	19
SP333	PROVGE	3100	26				
SP523	PROVGE	800	13				

The most annoying conditions seems to be in the SP225, SP 523, SP35 and SP334 where the people exposed at L_{den}>65 dB(A) and at L_{night}>55 dB(A) are over the

20% of the people within the calculation area. The lowest values of people living in building with a quiet façade has been noticed in SP35 (8%) and in SP33 (10%). Values of exposed population are in any case quite low, especially considering that all roads are characterized by traffic flows higher than 3.000.000 vehicles/year.

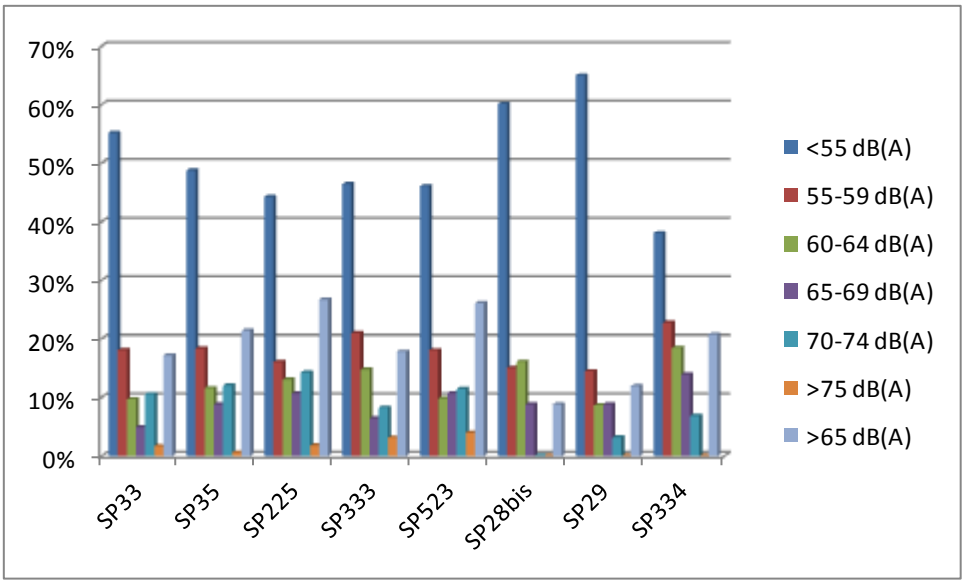

Figure 11: Percentage of people exposed to L_{den} noise classes

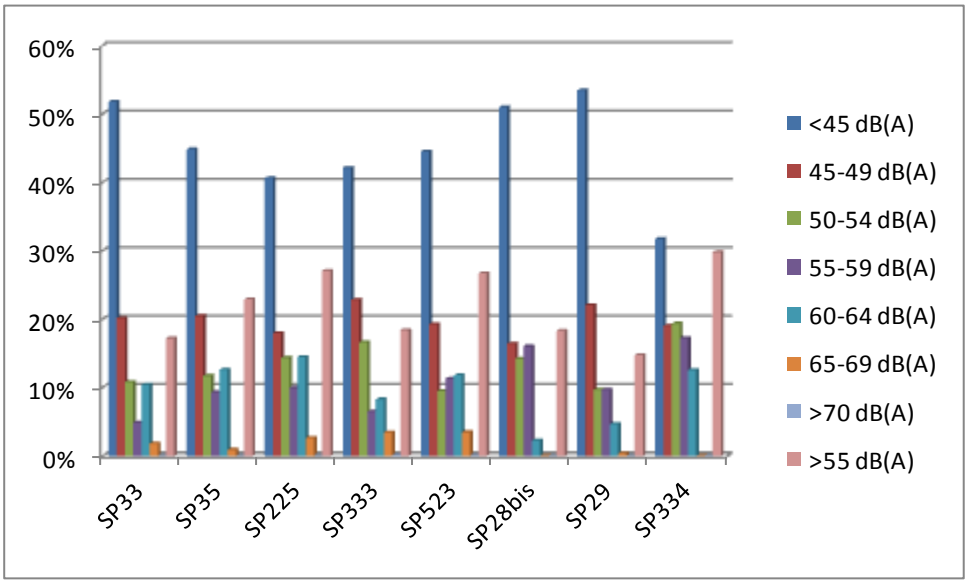

Figure 12: Percentage of people exposed to L_n noise classes

4.2 Agglomerate of Vicenza

In Table 5 and in Table 6 are reported the number of people exposed to noise, rounded to the nearest hundred, considering respectively indicators L_{den} and L_{night}.

Table 5: Values of population exposed to noise (L_{den})

Class L_{den}	Population exposed	
	N° of residents	Percentage (%)
<55	31.900	31,9
55-59	19.500	19,5
60-64	15.800	15,8
65-69	18.900	18,9
70-74	12.000	12,0
>75	2.000	2,0

Table 6: Values of population exposed to noise (L_n)

Class L_{night}	Population exposed	
	N° of residents	Percentage (%)
<50	46.300	46,3
50-55	15.800	15,8
55-59	18.300	18,3
60-64	15.300	15,3
65-69	3.800	3,8
>70	500	0,5

The results of the noise simulations, reported in Table 5 and in Table 6, showed that 32.900 inhabitants are exposed to L_{den} values higher than 65 dB(A) and above 37.900 inhabitants are exposed to L_n values higher than 55 dB(A). Two studies of the OMS [5, 6] demonstrated that a continuous exposure to L_{den}>65 dB(A) and L_n>55 dB(A) can causes respectively a weakening of the cardiovascular system and an increase sleep disturbance.

4.3 Agglomerate of Prato

In Table 7 and in Table 8 are reported the number of people exposed to noise, rounded to the nearest hundred, considering respectively indicators L_{den} and L_{night}.

Table 7: Values of population exposed to noise (L_{den})

Class L_{den}	Population exposed	
	N° of residents	Percentage (%)
<55	12.600	8,0
55-59	14.400	9,1
60-64	61.900	39,2
65-69	67.400	42,7
70-74	1.500	0,9
>75	100	0,1

Table 8: Values of population exposed to noise (L_n)

Class L_{night}	Population exposed	
	N° of residents	Percentage (%)
<50	22.100	14,0
50-55	41.900	26,6
55-59	88.200	56,0
60-64	5.300	3,4
65-69	100	0,1
>70	0	0,0

The results of the noise simulations, reported in Table 7 and in Table 8, showed that 69.000 inhabitants are exposed to Lden values higher than 65 dB(A) and above 93.600 inhabitants are exposed to Ln values higher than 55 dB(A

References

[1] European Commission Working Group Assessment of Exposure to Noise, *Good practice guide for strategic noise mapping and the production of associated data on noise exposure*, Position Paper, Version 2, 12/08/2007;

[2] European Directive 2002/49/EC, relating to the assessment and management of environmental noise, 25th June 2002;

[3] AFNOR XP S31-133. Bruit des infrastructures de transports terrestres. Calcul de l'atténuation du son lors de sa propagation en milieu extérieur, incluant les effets météorologiques;

[4] European Commission Working Group Assessment of Exposure to Noise, *Presenting Noise Mapping Information to the Public*, Position Paper, March 2008;

[5] European centre for Environment. and Health, *Report on the second meeting on night noise guidelines*, 2004;

[6] WHO regional office for Europe: European Centre for Environment and Health, *WHO technical meeting on noise and health indicators second meeting*, 2003;