DELIVERABLE 1

"Survey report"

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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Annexes

1 Introduction

The Deliverable 1, "Survey report" defines the data collected during the Action 2 of Nadia Project.

The Action 2, Survey, focused on the following activities:

1. collection of data and reports related to the noise levels generated by roads included in the project areas (measurements performed in the last three years), population distribution, meteorological conditions, characteristics of ground;
2. collection of data on noise annoyance in some specific positions in the project areas;
3. analysis of the advantages and disadvantages of the currently available road noise propagation models;
4. realization of additional noise measurement campaigns for noise mapping activities (if input data for an analyzed road is missing);
5. update of the state of the art of road noise reduction systems, with a special focus on sustainable solutions (landscape compatibility, recycled materials, etc.).

At this purpose the Deliverable 1 specifies the typology and quality of data collected by CIRIAF, the Provinces of Genoa and Savona and by the Municipality of Prato and Vicenza for the goals of NADIA project. These data regard:

- Information for the realization of noise mapping activities (Action 3 of the project);
- Noise measurements;
- Evaluation of noise annoyance through a questionnaire survey developed by CIRIAF. The questionnaires were submitted to dwellers living in buildings where the noise exposure was considered reasonably high by the local authorities;
- Analysis of innovative solutions for the integration of noise barriers in the outdoor areas of primary schools and kindergartens.

Moreover the documents report a brief state of the art of noise reduction system based on sustainable solutions.

The road of the Provinces of Genoa and Savona to be modeled are indicated in Table 1.

Table 1: List of roads modeled in the NADIA project

Partner	Road	Partner	Road
Province of Genoa (PROVGE)	SP 33	Province of Savona (PROVSV)	SP 28 bis
	SP 35		SP 29
	SP 225		SP334
	SP 333		-
	SP 523		-

Every road contained in the table 1 is characterized by a traffic flow of at least 3.000.000 vehicles/year.

2 Data Collection for Noise Modelling.

2.1 Data related to the noise level of infrastructures

Milestone 1 specified the data needed for the realization of noise maps :

- Traffic flow and composition (light and heavy vehicles);
- Average vehicles speed;
- Road pavement type;
- Characteristics of traffic flow (steady, unsteady, accelerate or decelerate);
- Digital Ground Model;
- Noise measurements

Input data quantity and quality indicated in Milestone 1 were differentiated according to the type of infrastructure to be modeled. The approach to be used for the simulation of a single road is substantially different from the one for an interconnected group of city road. The kinds of data transmitted by the Provinces of Genoa and Savona and by the Municipalities of Vicenza and Prato to CIRIAF are reported respectively in Table 2 and in Table 3.

Table 2: Data related to noise level of infrastructures of the Provinces of Genoa and Savona

Data type	Partner	Kind of data transmitted
Traffic flow and composition	PROVGE (Annex 1)	The Province of Genoa transmitted the total daytime traffic flow . Traffic flow in *evening* and *night* periods were evaluated using the available traffic data and the coefficients reported in [1]. Another coefficient contained in [1] was used for the determination of traffic flow composition (percentages of light and heavy vehicles).
	PROVSV (Annex 2)	The Province of Savona transmitted data about traffic flow only for 4 hours of the *day* period. The percentages of light and heavy vehicles were transmitted.
Average vehicles speed	PROVGE	The average speed of the vehicles did not consider the differences between heavy and light vehicle.
	PROVSV	The average value of the speed of heavy and light vehicles was transmitted.
Road pavement type	PROVGE and PROVSV	Both the Provinces specified the parts of their roads where the asphalt can be considered strongly irregular (like uneven pavement stones)

Data type	Partner	Kind of data transmitted
Characteristics of traffic flow	PROVGE and PROVSV	This kind of data can be considered not relevant for the simulation of the road of the competence of the two Provinces.
Digital Ground Model	PROVGE and PROVSV	Both the Provinces transmitted the isohypses of the areas interested by noise maps.
Noise measurements	PROVGE	The results of five weekly measurements in terms of L_{diurno}, $L_{notturno}$, L_{day}, $L_{evening}$ and L_{night} were evaluated. The results of the simulation were compared with the outcomes of the noise measurements.
	PROVSV	The results of four weekly measurements in terms of L_{diurno}, $L_{notturno}$, L_{day}, $L_{evening}$ and L_{night} has been evaluated The results of the simulation were compared with the outcomes of the noise measurements.

Detailed data regarding the traffic flow and composition of the roads of the two Provinces are reported in the Annex 1 and 2.

Table 3 Data related to noise level of infrastructures of the Municipalities of Vicenza and Prato

Data type	Partner	Kind of data transmitted
Traffic flow and composition	COMVI	The Municipality of Vicenza transmitted the measurement of traffic flow and composition in compliance with the requirements of the Milestone 1. The measurements were used to evaluate the traffic flow of the whole road network using a traffic simulation software.
	COMPR	The Municipality of Prato transmitted the measurement of traffic flow and composition in compliance with the requirements of the Milestone 1. The measurements were used to evaluate the traffic flow of the whole road network using a traffic simulation software.
Average vehicles sped	COMVI	If not measured, the data used was the road speed limit.
	COMPR	If not measured, the data used was the road speed limit.
Road pavement type	COMVI	The Municipality of Vicenza specified the parts of their roads where the asphalt can be considered strongly irregular (like uneven pavement stones)

Data type	Partner	Kind of data transmitted
	COMPR	The Municipality of Prato specified the road surface type based on visual inspection
Characteristics of traffic flow	COMVI	This data was not considered because its impact on the noise modeling was considered not essential.
	COMPR	This data was not considered because its impact on the noise modeling was considered not essential.
Digital Ground Model	COMVI	The Municipality has furnished the isohypses and the elevation point of the areas interested by the noise maps
	COMPR	The Municipality of Prato transmitted the laser scanning outcome of its territory.
Noise measurements	COMVI	The results of the noise measurements were evaluated. The results of the simulation will be compared with the outcomes of the noise measurements.
	COMPR	The results of the noise measurements wereevaluated. The results of the simulation will be compared with the outcomes of the noise measurements.

Detailed data related to the traffic flow and composition of the road of the Municipality of Vicenza and Prato are not reported here because the number of modeled roads is too high and a comprehensive list cannot be included in this deliverable.

2.2 Data related to the distribution of population

The data related to the inhabitants of the study areas of the Provinces and of the Municipalities were determined from the results of the national official census. This kind of data consists in a group of georeferenced areas (census areas); each area has two attributes: identification name and inhabitants.

2.3 Meteorological conditions

The effect of meteorological condition has not been considered relevant. At this purpose the standard coefficient indicated by [1] and [2] was used for the modeling of the propagation of sound emitted by the analyzed roads. The use of this coefficient attends to overestimate the noise levels at the receivers. This kind of approach was chosen because the determination of the meteorological condition in the calculation areas is very expensive in terms of time and costs.

Regarding the roads of the Provinces of Genoa and Savona, the only available meteorological data is the one collected at the Genoa Airport. This data *cannot be considered representative* of the whole areas to be modeled. Genoa Airport is built on an artificial peninsula of the Gulf of Genoa, so the meteorological condition is very different from the ones of the inland parts of Liguria.

For this reasons the use of the standard coefficients established by the [1] and [2] was preferred.

Moreover the majority of the receivers reasonably exposed to noise level higher than the noise limits of the Directive 2002/49/CE, even in the Municipality of Vicenza and Prato, are located near the roads modeled; in this conditions the effects of meteorological condition on the sound propagation is not relevant so the standard coefficient established by the [1] and [2] can be reasonably used within NADIA project.

2.4 Characteristics of the ground

PROVGE, PROVSV, COMVI and COMPR transmitted data on the ground characteristics in compliance with the suggestions of [1]. The data were transmitted in forms of georeferenced areas with two attributes: an identification name and the ground factor (equal to 1 for sound absorptive grounds like grass, 0 for sound reflective grounds like parking lots).

3 Collection data on noise annoyance in some specific positions in the project areas

Evaluation of noise annoyance was performed through a questionnaire survey developed by CIRIAF. The questionnaires were released submitted to dwellers living in buildings where the noise exposure was considered reasonably high by the local authorities. The results of this activity are reported in Annex 1, 2 and 3.

4 Analysis of noise propagation models

The noise propagation model used in the noise mapping activities of NADIA project is the Routes-NMPB-96 indicated by the European Directive 2002/49/UE [3] as the ad interim reference method.

The Italian Decree D.Lgs. 194/2005 [4] has established that the NMPB-Routes-96 is the noise propagation model to use in the realization of noise map and strategic noise map of roads.

The methodology developed for the noise map of NADIA project takes into account the type of input data needed by the NMPB-Routes-96 and indicated in the first Milestone of NADIA project.

5 Realization of additional noise measurement campaign

The available results of measurements of traffic flow, vehicles speed and noise levels have been considered sufficient for the following activities.

6 Analysis of different innovative solutions for the integration of noise barriers and primary school and kindergarten outdoor areas.

Noise barriers represent a traditional method of noise pollution mitigation, mostly used to reduce loudness from road, highway and railway traffic noise sources. However, noise walls can be integrated with innovative features which can bring different benefits in term of energy saving, environmental integration and aesthetic needing. In this stage of the activity, innovative noise barrier designs and treatments in relationship with kindergarten and primary school outdoor areas have been investigated, analyzed and classified in terms of characteristics, design and benefits.

6.1 Materials

An innovative contribution in terms of materials can be achieved by vegetated noise barriers. This eco-friendly green walls are characterized by excellent noise abatement capabilities and, plus, have many benefits such as:

- low building and maintenance costs,
- sustainable recyclable elements,
- quality of the air and microclimate improvement,
- positive landscape integration,
- aesthetically pleasant solution.

Specifications:

Soundproofing: class B3, standard DIN EN 1792-2

Acoustic absorption: class A4, standard DIN 1793-1

Average costs: 120-250 € /m²

6.2 Energy Saving

Acoustic barriers can be integrated with special devices that allow energy savings. For example, photovoltaic modules or solar thermal collector can be installed on the top of the barriers.

This solution allows to:

- generate no cost energy,
- no air polluting emissions,
- no extra land consumption,
- contribute to auto-finance the installation of the barrier.

Furthermore, solar panels on noise walls technology can feed light plants placed on the wall or along the road.

Specifications:

PV system on the barrier: 170 kWh/m/year

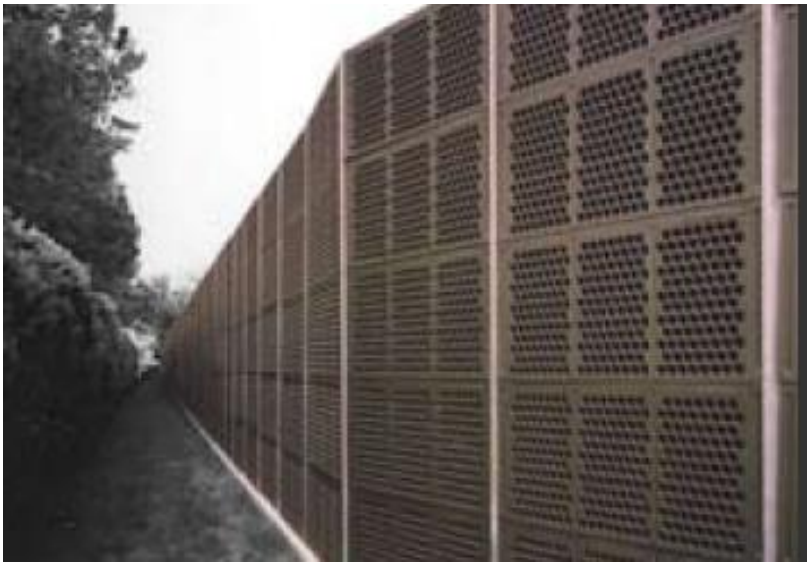
6.3 Recycled materials

Noise screens made from recycled materials have been considerate as well.

Plastic panels composing the barriers generally derive from industrial, household or building waste and results 100% recyclable. After the disassembly of the barrier, recycled panels can be eventually easily pulverized to be reused in new elements.

Recycled noise barriers can contribute to:

- avoid environmental pollution,
- save natural primary resources



Specifications:

Noise abatement: until 12 dB(A)

Soundproofing: class B3, standard UNI EN 1793-2

Acoustic absorption: class A3, standard UNI EN 1793-1

6.4 Shapes

Due to the proximity to a primary school or a kindergarten, a noise barrier can be analyzed and designed by studying particular shapes and textures. For example, a series of transparent windows can be inserted in the wall so that children can play and look outside the courtyard.

6.5 Colors

The use of colors can be considered as well in noise screens in proximity of schools. Colored panels can be used both in the external side of the wall on the road -to report the presence of children- and in the internal side in order to decorate the courtyard.

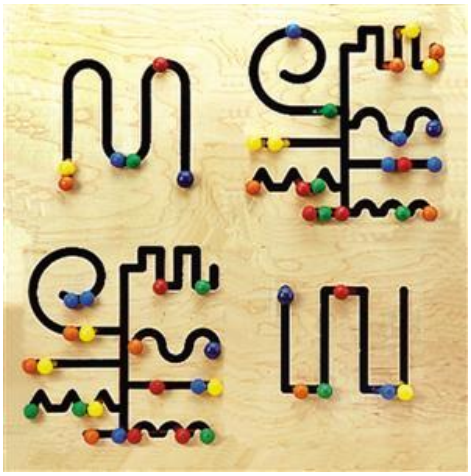
6.6 Use of the internal side

In case of noise barriers delimiting a school area from the road, the side of the wall faced on the outdoor areas can be used as a surface available to the entertainment of the children during school breaks.

Usually boundary walls in school courtyard are not used by children while playing. Especially in those cases where available outdoor area is not large, vertical surface may be equipped for the children's entertainment.

Acoustic wall internal part can be treated as a cleaning surface where children can draw, paint or play sticking tiles:

Furthermore parts of the walls can be integrated as well with educational games, so children may learn by playing






7 Constrains

The only constrain verified during the *Survey* activity regards the determination of 3D characteristics of buildings of the Province of Genoa. At this purpose an height of 6 m was assigned to the buildings of the Province of Genoa. This parameter was chosen after a series of inspections.

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] UNI/TS 11387:2010, Acustica - Linee guida alla mappatura acustica e mappatura acustica strategica - Modalità di stesura delle mappe, 2010

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

[4] Decreto Legislativo 19 agosto 2005, n. 194, *Attuazione della direttiva 2002/49/CE relativa alla determinazione e alla gestione del rumore ambientale*, Gazzetta Ufficiale della Repubblica Italiana, Serie generale n. 222, 23/09/2005.