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Noise impact of an international traffic corridor: a useful method to support traffic infrastructures planning

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ABSTRACT

The objective of this report is to assess comprehensive measures adopted with the aim to reduce the negative effects of road traffic and to simultaneously enhance the quality of life within the Alpine region. The area involved in the study is located in Aosta Valley an alpine region on the border of Italy, France and Switzerland. A national road was built to reduce the traffic flow in the inhabited area, shifting it to a more peripheral area: the road of interest is located in the Grand San Bernard corridor, an international crossroad connecting Italy and Switzerland. In this paper the decrease of population exposure to the traffic noise is evaluated. The estimate is carried out by a noise propagation model taking into account traffic data, a 3D terrain and buildings digital model and acoustic measurements data. For the determination of the population exposure classes, the parameters evaluated are the new acoustic indicators Lden and Lnight, defined in the European Directive 2002/49/CE[1]. The process described and tested in this work could be applied to environmental and territorial planning.

1. INTRODUCTION

The Aosta Valley is an alpine region in the Nord of Italy at the border with France and Switzerland. The Alps have always been a barrier for communication and commerce and, although this, since Ancient Rome age, two important roads have been built to pass the mountain range across Grand Saint Bernard and Petit Saint Bernard passes. Successively the opening in the sixties of two vehicular tunnels, the Grand Saint Bernard one, towards Switzerland, and the Mont Blanc one, towards France, has brought to a great increase of the traffic, mainly for heavy cargo vehicles.

To maintain a balance between communication/transport need and protection of natural and living environment, is necessary evaluating all the aspects of the traffic impact included the noise. On one side there are important initiatives of European Union INTERREG III B Alpine Space with projects as MONITRAF[2], that analyses the impact of road traffic through all the Alps corridors, developing comprehensive measures that aim at reducing their negative effects. On the

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other side, to a most local level, is possible to obtain a reduction of traffic flow in inhabited areas trough the built of others various roads in more peripheral area.
In this paper, the noise population exposure due to transalpine traffic, is investigated. The methodology applied has been carried out from other previous studies made by the Aosta Valley Regional Agency of Environmental Protection[3-4-5].

2. THE AREA OF INVESTIGATION

The territory and the population involved in this study are located in Aosta Town, in the surroundings of the national roads SS26 and SS27 that cross the inhabited areas of Aosta Town and that are located in the Grand Saint Bernard corridor leading to Switzerland (Fig. 1). The traffic involved in the analysis has both local and international characters: by one hand due to people living along the Grand Saint Bernard valley, by the other hand due to the traffic flowing from and to Switzerland, including heavy vehicles. Until 1997 the national roads SS26 and SS27 were the only ways to and from the Grand Saint Bernard corridor: in 1997 a new peripheral road, the tunnel "Costa di Sorreley", about 5 km long, was built to connect directly the highway coming from the other cities of Italy, and the middle valley in the neighborhood of Aosta to the Grand Saint Bernard corridor, with the aim to reduce the traffic flow in the inhabited area, shifting it to a more peripheral area and leading it to a gallery tract. The choice to involve in the study only the town of Aosta was due to the interest on to the most inhabited area.

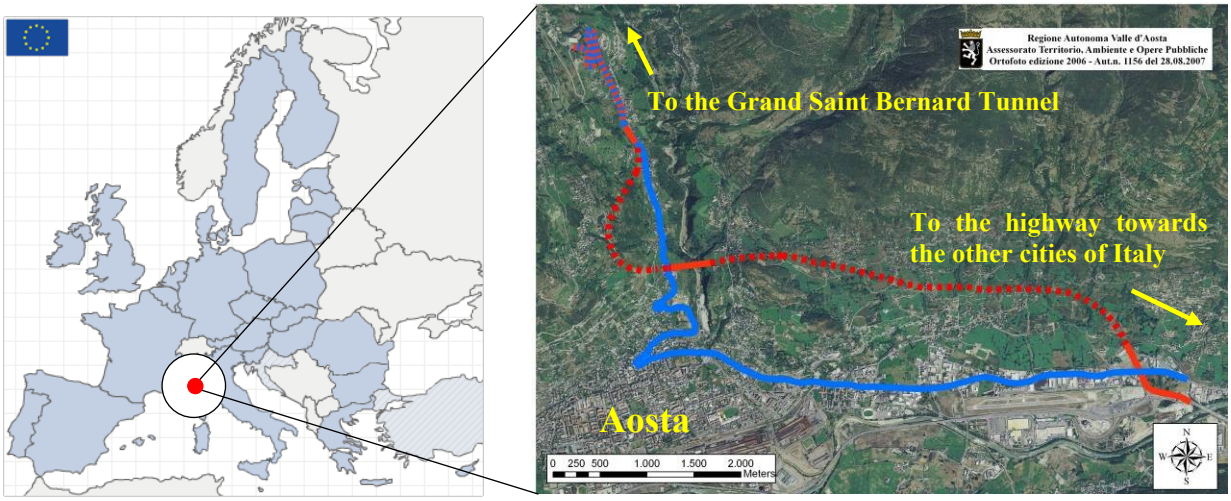


Figure 1: The area object of the analysis and its position in Europe.

3. IMPLEMENTATION OF THE NOISE DIRECTIVE 2002/49/EC IN ITALY

The noise Directive 2002/49/EC is transposed into Italian legislation by the provisions 194 of 19 August 2005[6]. The provisions cover all relevant articles in the Directive 2002/49/EC which considered noise emitted by means of transport, in particular road traffic.

This Directive shall be applied for estimate the number of humans exposed, in particular in built-up areas and in other zones as quiet areas in an agglomeration, areas near schools, hospitals.

The Italian legislation, in accord with the request of the Directive 2002/49/EC, defines a common approach for the determination of exposure to road traffic noise. The quantification of

population that lives in dwellings exposed to noise is an important descriptor for the protection of the people health and for determining the priority of noise abatement measures too.

At the same time, for the main aces street, are request data to be send at the Environmental Italian Ministry and successively at the European Commission. In this study the methodology has been applied to extracity road with less traffic road respect main street considered by European Directive, but that represents however an international connection with the Switzerland.

To estimate the noise levels in a study area, the provisions no. 194 of 19 August 2005 resumes the two indicators of the 2002/49/EC, Lden (represents noise level during day-evening-night), and Lnight (takes into account night-time noise) considering the following intervals:

-day : from 6.00 am to 8.00 pm
-evening : from 8.00 pm to 10.00 pm
-night : from 10.00 pm to 6.00 am

Lden is so defined according to the following formula:

$$Lden = 10 \log \frac{1}{24}\left(14 * 10^{Lday/10} + 2 * 10^{(Levening+5)/10} + 8 * 10^{(Lnight+10)/10}\right). \quad (1)$$

Moreover the estimated number of people living in dwellings on the most exposed façade to road traffic noise is defined for bands of values in dB of Lden and Lnight.

Where such information is available, in addition, it should be stated how many persons in the several categories live in dwellings with a quiet façade. The quiet façade is defined as the forehead of a dwelling at which the value of Lden four meters above the ground and two meters in front of the façade, for the noise emitted from a specific source, is more than 20 dB lower than at the façade having the highest value of Lden.

4. METHODOLOGY FOR NOISE MAPPING

A. General concepts

In general, noise maps should be a tool to assess the exposure to noise and they should content at least two differentiated elements:
- Noise level maps: the presentation of isoline noise level maps on an existing or predicted noise situation obtained over the whole studied area.
- Exposure to noise maps: number of persons exposed to noise estimated on the buildings in the area.

Noise local maps represent also the basis to elaborate strategic noise map designed for the global assessment of noise exposure in a given area due to different noise sources. Still the same, they will supply useful elements for action plans, shall mean plans designed to manage noise issues and effects, or acoustical planning for the abatement of noise by sound insulation measures and, if necessary, noise control of sources and their reduction.

B. Calculation methodology for sound levels estimation

To carry on the calculation of the sound levels due to the traffic flow were applied the algorithms of French model NMPB-ROUTES-96[7-8], in which the traffic flow parameters (number of light and heavy vehicles per hour, speed, road slope) are the main input data.

The calibration of the model was made by the comparison between the results of the estimate and the results of measurements. Week-lasting measurements were carried out on two points, where continuous sound measurements were combined with continuous traffic flow measurements to evaluate the performance according to the variation of the traffic flow during the week. Short-lasting measurements (the duration of measurements was set at 10 minutes) have later allowed to validate the results of the model: they were made in both daily and night time periods in about 20 measurement points. For the model estimate were considered homogenous atmospheric conditions and, of course, the orography of the terrain was taken into account.

The aim of the study was to compare two different scenarios:

a) total traffic flowing on the national roads SS26 and SS27 and crossing Aosta (scenario until december 1997, date of the opening of the "Costa di Sorreley" tunnel);
b) the same total amount of traffic flowing partly on the national roads SS26 and SS27 (local traffic) and partly on the new motorway (local traffic and international traffic to and from the Grand Saint Bernard corridor, including light and heavy vehicles).

The traffic data were evaluated on the basis of roads manager societies data and of the results of direct measurements data.

C. Calculation methodology for evaluation of exposed population

According to request of the directives of European Commission[1-9] the estimation of the population exposure was carried out by calculating the percentage of people living in buildings exposed to the following intervals of noise values:

L_{den} classes in dBA : <55, 55-59, 60-64, 65-69, 70-74 and major of 75 dBA
L_{night} classes in dBA: <45, 45-49, 50-54, 55-59, 60-64, 65-69 and major of 70 dBA

The estimation of the population noise exposure was carried on the basis of noise modelling and of population data as following:

- the calculation was carried out for the area around the road sources included in a band of 150 meters from the roads, according to the Italian legislation[10];
- the number of inhabitants of each building was supplied as a georeferred shapefile by the public administration of the town of Aosta: the analysis took into account only resident inhabitants;
- the estimation was carried on for the façades of each residential buildings, at 4 m of height;
- two methods were followed to refer the number of inhabitants for each building to sound levels:
    - referring to the most exposed façade level (END method)
    - assigning the inhabitants proportionally to the façades (VBEB method).

5. RESULTS

A. Noise mapping

In figure 2 the territorial distribution of the difference between the two scenarios considered on the basis of Lden values, for a little share of the Aosta town territory, is shown: a different color is used for each value interval of the indicators. The reduction of noise levels is clearly visible for the national road SS27. The amount of the difference is tiny since the larger difference is about 0,5 dB. For the national road SS26 there is no noticeable difference between the two scenarios: the national road SS26 is characterized by a greater traffic flow and the decrease after 1997 becomes irrelevant.

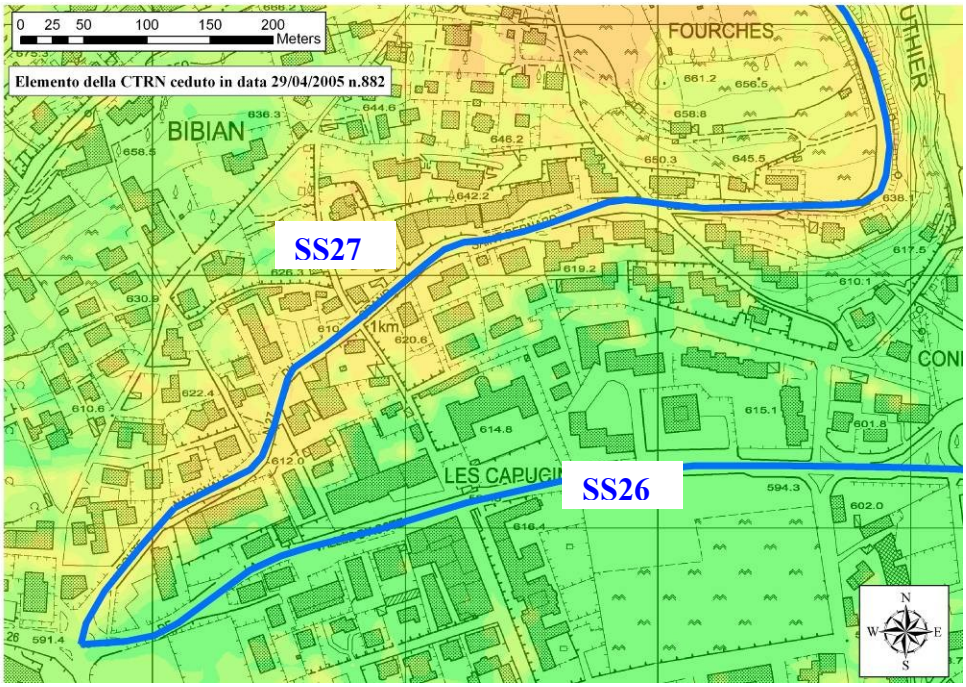
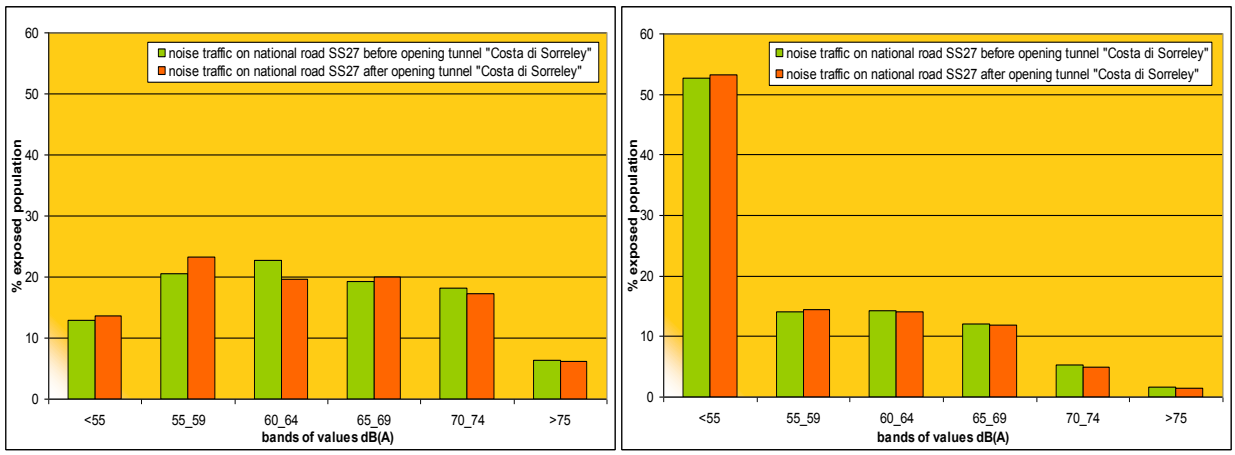


Figure 2: A little share of the Aosta town territory involved in the study: noise map of the difference of the two scenarios.

B. Population exposure

The results show a decrease of the noise exposure with the opening of the new road infrastructure tract, even if the amount of the difference is not so huge. Moreover it stands out the difference between the two method of investigation: assigning all the population in a dwelling to the most exposed façade produces a leveling on the noise classes while distributing the population proportionally to all the dwelling façades produces a splitting to lower classes. This second method could give a more realistic representation of the situation, finding out that the most of the population is exposed to lower noise levels.



a b

Figure 3: Percentage of exposed population for Lden descriptor calculated with method on most exposed façade (a) and with method that assigns population proportionally to all façades (b)

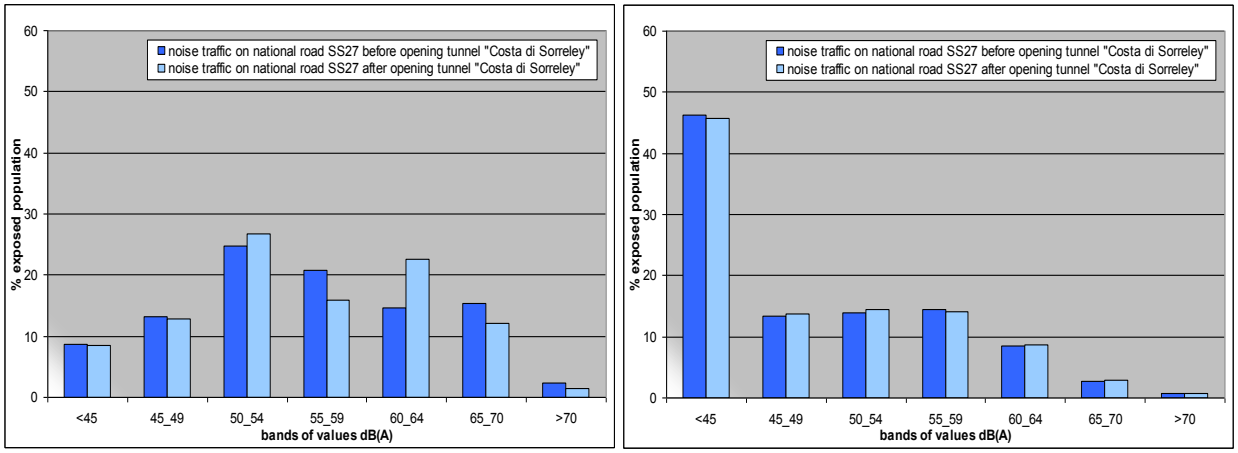


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Figure 4: Percentage of exposed population for LNight descriptor calculated with method on most exposed façade (a) and with method that assigns population proportionally to all façades (b) .

6. CONCLUSIONS

In the paper the noise exposition of population of an area situated along a transalpine communication way is evaluated: the opening of a new peripheral road, for the most in gallery has changed the traffic scenario, reducing the noise exposure of the population involved. This result is shown by the noise indicators Lden and Lnight.

The evaluation methodology of the sonorous impact used in this work is a further step in investigation of noise population exposure to international traffic noise as regards previous studies[3-4], and it will be improved to analyse further scenarios.

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