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Noise impact of an international traffic corridor in alpine environment: traffic scenarios and population exposure in Mont Blanc area

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ABSTRACT

The purpose of the present report is to estimate the percentage of population exposed to the traffic noise produced by a transalpine transit corridor in Courmayeur, an Italian town situated near the Mont Blanc Tunnel. The estimate is carried out for the whole road infrastructure from Courmayeur to the Tunnel entrance. The analysis involves a typical alpine valley and it is based on a noise propagation model, with care on the 3D terrain digital map. The variation of the population exposure to determined noise classes on different traffic scenarios is evaluated. The effect of the opening of a new highway infrastructure tract is assessed. For the determination of the population exposure classes, the parameters taken into account are the diurnal and nocturnal noise levels ($Leq_{06\text{-}22}$ and $Leq_{22\text{-}06}$), as requested by the Italian law, and the new acoustic indicators Lden and Lnight, defined in the European Directive 2002/49/CE.

1 INTRODUCTION

The alpine region has peculiar environmental features: deep valleys, steep slopes, high summits create meteorological and natural conditions unique in Europe. Snowy slopes in winter and hill walking and climbing in wilderness in summer are a major attraction for people of the whole continent. On the other hand the Alps have always been a barrier for communication and commerce. In Aosta Valley, Italian district at the border with France and Switzerland, since Ancient Rome age, two important roads have been built to pass this mountain range across Grand Saint Bernard and Petit Saint Bernard passes. 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.[a]

The balance of communication/transport need versus protection of natural environment is, as a matter of fact, a binding issue. An important initiative of European Union INTERREG III B Alpine Space on this theme is the project MONITRAF that identifies and analyses the impact of road traffic within and through the Alps along the four transit corridors Brenner, Fréjus, Gotthard and Mont-Blanc [1]. The objective of the project is to develop comprehensive measures that aim at reducing the negative effects of road traffic, while

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simultaneously enhancing the quality of life within the Alpine region. The measures adopted for one transport artery shall not result in an increase of traffic along another.

One of the topic to be taken into account in evaluating the traffic impact is the noise. In this paper, the noise exposure of people in the surroundings of the Italian entrance of Mont Blanc Tunnel (MBT) is investigated. The methodology applied in this study, inspired to Directive 2002/49/EC will be extended to the other most important crossborder alpine communication ways. A similar analysis was already carried on along the highway leading to Aosta [2][3]. The recent (march 2007) opening of the last section of highway E25, most of it in tunnel, allowed the evaluation of the traffic removing from the national road SS26 running along side the inhabited buildings.

2 THE AREA OF INVESTIGATION

The area considered in this analysis is the territory of Courmayeur, the farthest tip of Italy on the way to France by MBT (fig. 1). This is a celebrate tourist resort equipped for winter sport and summer mountain activities. Until some month ago the main road to the Tunnel ran alongside the town centre: approximately 1600 heavy vehicles passed through on average each day. On march 2007 the last section of highway E25 was opened. It connects Courmayeur to the village of Entrèves, one kilometer far from the tunnel entrance, and allows a more fluent traffic : even though the valley in Courmayeur area is quite tight the highway runs at some distance from the centre and most of it is inside gallery or protected by acoustical barriers (dotted part in the figure 1).

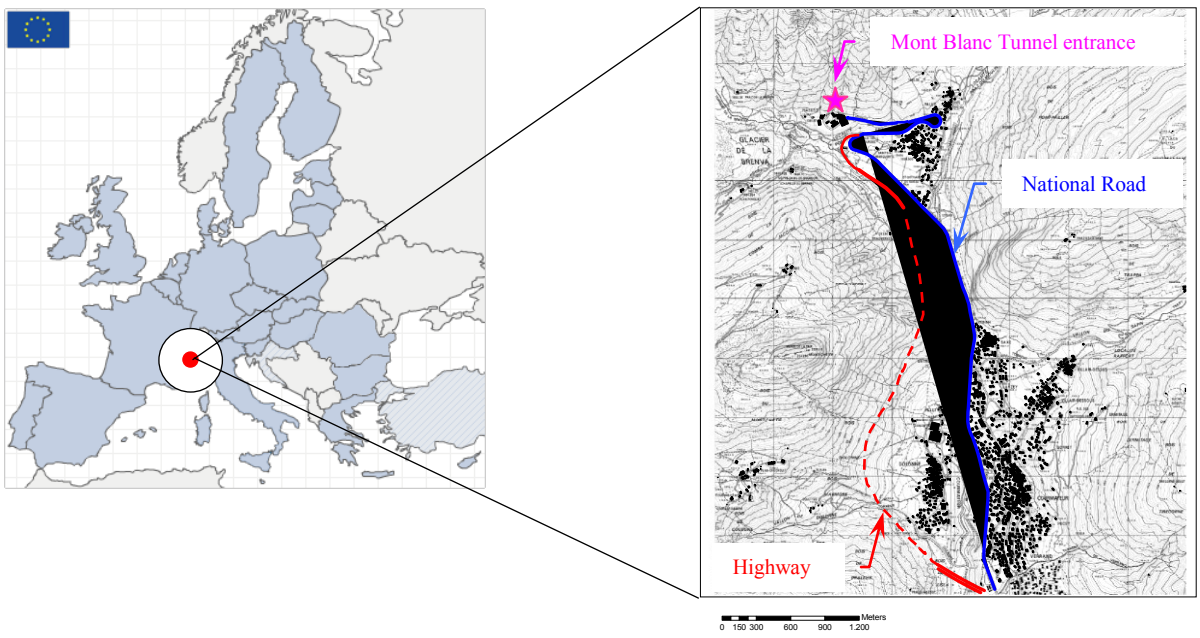


Figure 1: The area object of the analysis and its position in Europe.

3 SOUND LEVELS ESTIMATION

3.1 Vehicle emission data and sounds levels scenarios

The numeric estimate of sound levels has been carried on applying algorithms of French model NMPB-ROUTES-96 [4]. This model assigns sound emission levels at two categories

of vehicles (light, < 3.5 t net load and heavy, over this weight) depending on speed, type of traffic flow and road slope. The sound levels LAeq calculated at receptors were estimated from the number of hourly transits for the two categories of vehicles considered. Week-lasting measurements were carried out to calibrate the model. Short-lasting measurements have later allowed to validate the results of the model. For calibration and validation of the model only acoustic data recorded in condition of no rain and wind below 1.5 m/s were taken into account. Homogenous atmospheric conditions have been considered for the model estimate of sound levels. The study area was simulated superimposing the 2D regional map to the 3D digital terrain map, and after adding the dwellings height. In the model was take into account international traffic to and from the MBT, and local traffic on the national road.

Two different scenarios were taken into account and compared:

a) total traffic flowing on the national road (scenario until march 2007, before the highway opening)
b) the same total amount of traffic flowing partly on the new highway (heavy and light traffic to and from TMB) and partly on the national road (local traffic)

3.2 Reference indicators

One of the main items of the directive 2002/49/EC is to define a common approach for the determination of exposure to environmental noise. The quantification of people that lives in dwellings exposed to noise is an important descriptor for the protection of the people health and for determinig the priority of noise abatement measures too.

To estimate the noise levels in a study area, the 2002/49/EC defines two indicators [2][4]: the first one, Lden, represents noise level during day-evening-night, the latter, Lnight, takes into acount night-time noise.

The European directive allows single member states to define evening period. Italy chose the following intervals (Dlgs 19 agosto 2005 n. 194):

-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

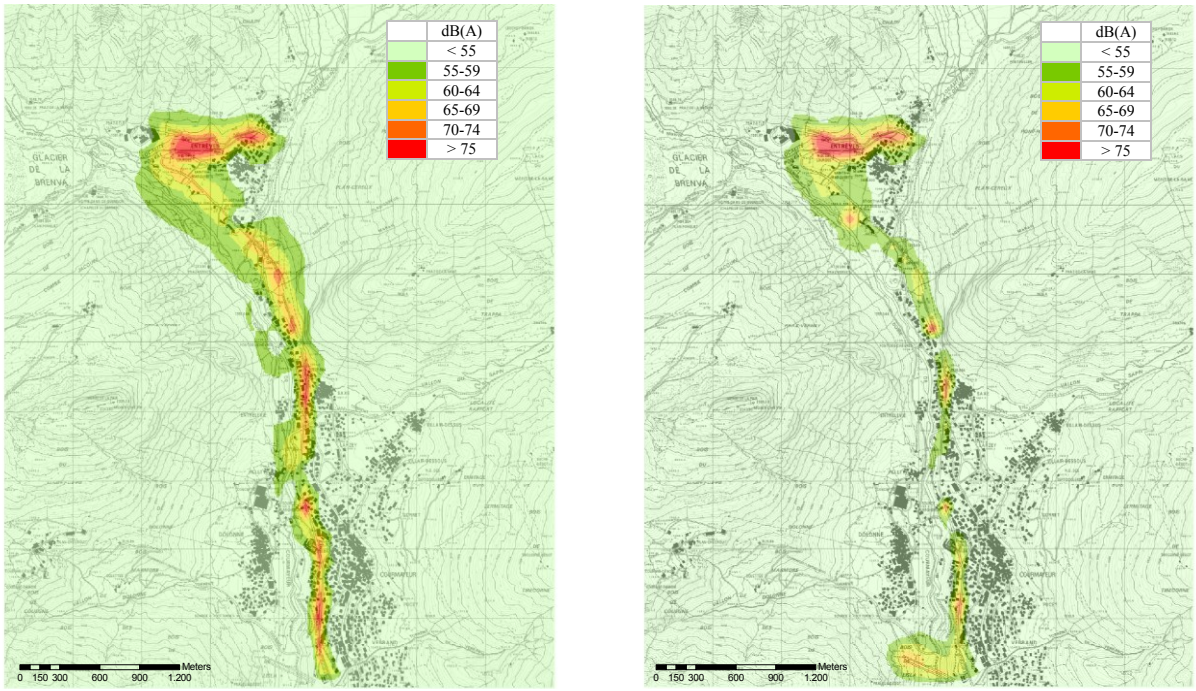
Lden is so defined according to the following formula:

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

3.3 Results of noise mapping

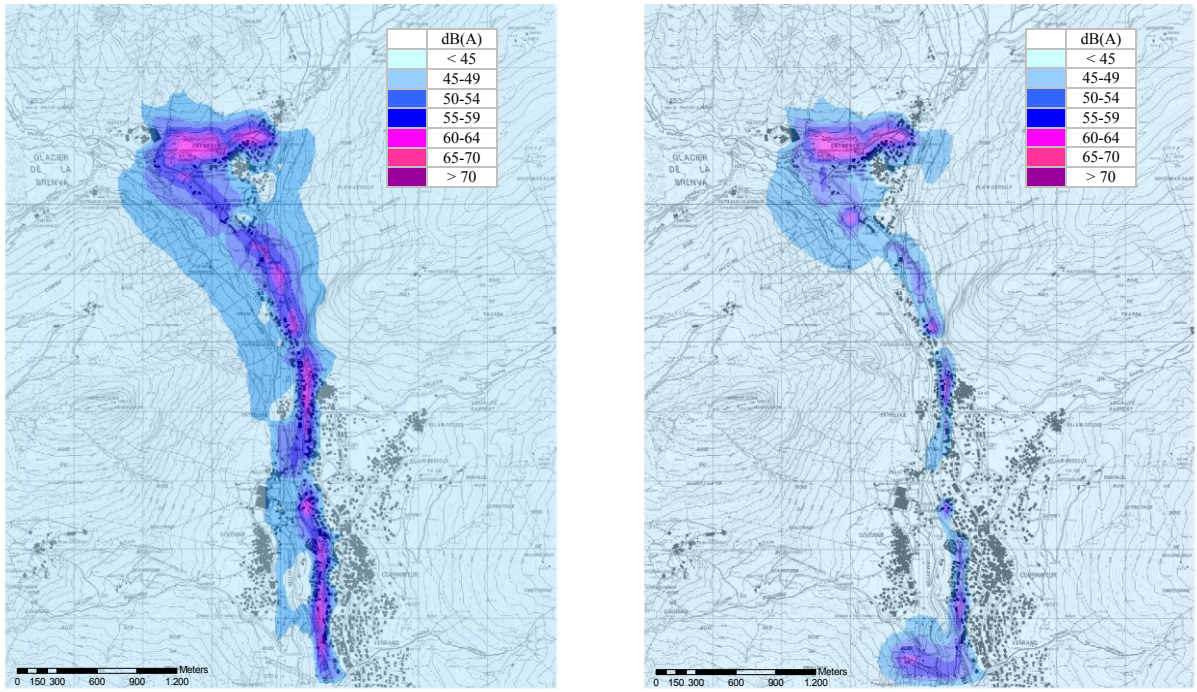
In figure 2 and figure 3 the territorial distributions of Lden and Lnight values are compared in the two scenarios: a different color is used for each value interval of the indicators. The reduction of the territory extension affected by highest noise levels is evident.

The reduction is not present, obviously, in the last tract of the way in prossimity of MBT, where the highway ends and all the traffic flows on the national road: in this area there are not significant differences between the scenarios examined.



a b

Figura 2: Lden sound levels territorial distribution before (a) and after (b) the opening of the last section of the highway E25, for the most in gallery.



a b

Figura 3: Lnight sound levels territorial distribution before (a) and after (b) the opening of the last section of the highway E25, for the most in gallery.

4 EVALUATION OF EXPOSED POPULATION

4.1 Computation procedure

Noise level maps obtained from model are the basis for the estimation of population exposure. This evaluation is performed crossing the maps of the previous paragraph with the distribution of the population in the area of interest. This is evaluated by distributing on the territory the total number of people for each census section (village or street) proportionally to the volume of residential buildings [7].

Following task were accomplished:

- request of population data subdivided by villages and street of Courmayeur
- evaluation of the total volume of all the residential buildings
- calculation of inhabited volume density for each village and street
- evaluation of the average number if inhabitants for each building
- evaluation of the population exposed to the different sound classes on the basis of the result of noise mapping

In evaluating population exposure it should be considered that Courmayeur is a tourist resort: lots of building are hotel or holiday houses and cottages. This means that many people exposed to noise do not live in Courmayeur all year round. So they are not exposed continuously; on the other hand, when they are in Courmayeur they are looking for quiet, so they should not be excluded in the evaluation of exposition. In this aim, the population taken into account is not only composed by people always living there; a multiplication factor, inferred on the basis of tourist attendance, was introduced: its value is 1.63.

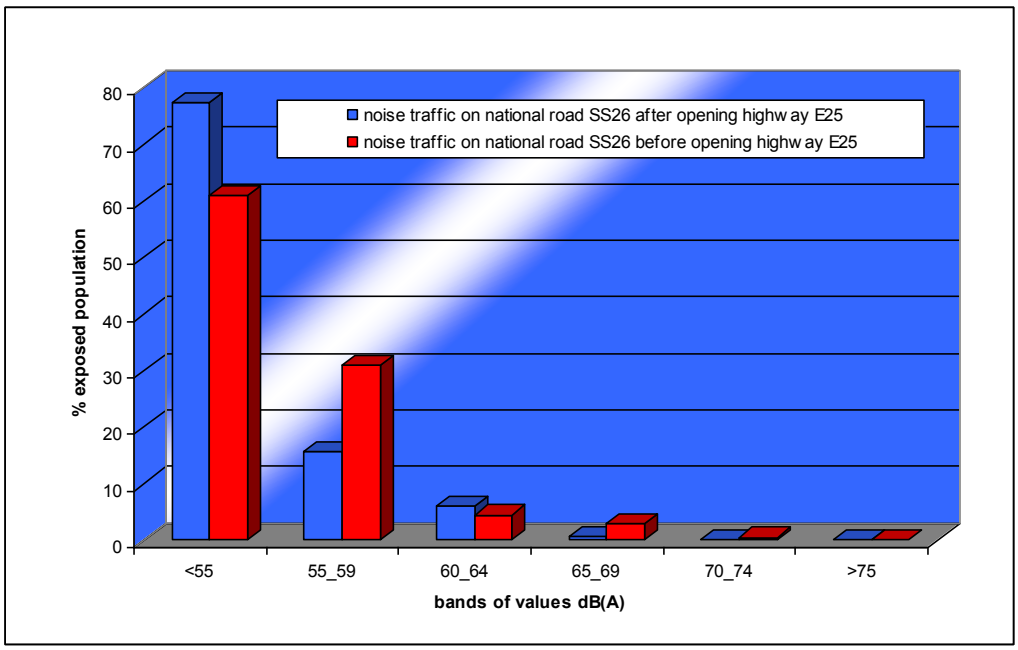
4.2 Population exposure

According to request of the directive 2002/49/EC 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

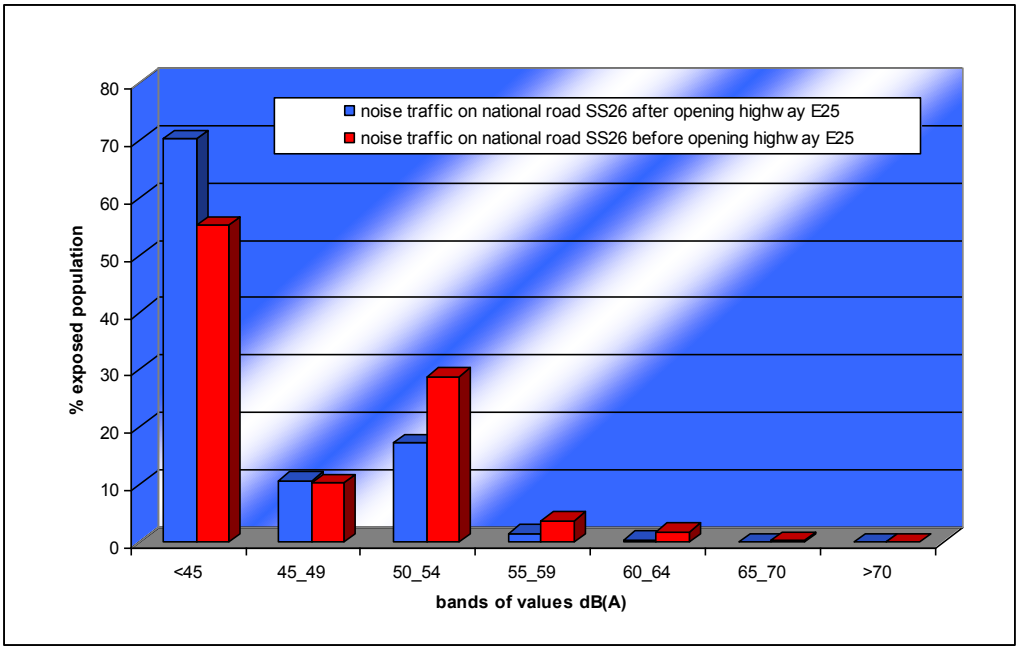
The exposure of each building must be referred to the most exposed façade at a height of 4 m on the ground.

In the figures 4,5 and 6 the distributions of exposed population to different bands of values for L_{den}, L_{night} and $L_{06\text{-}22}$ Italian normative indicator are reported. For each indicator, the two scenarios a) e b) of the paragraph 3.1 are also compared.



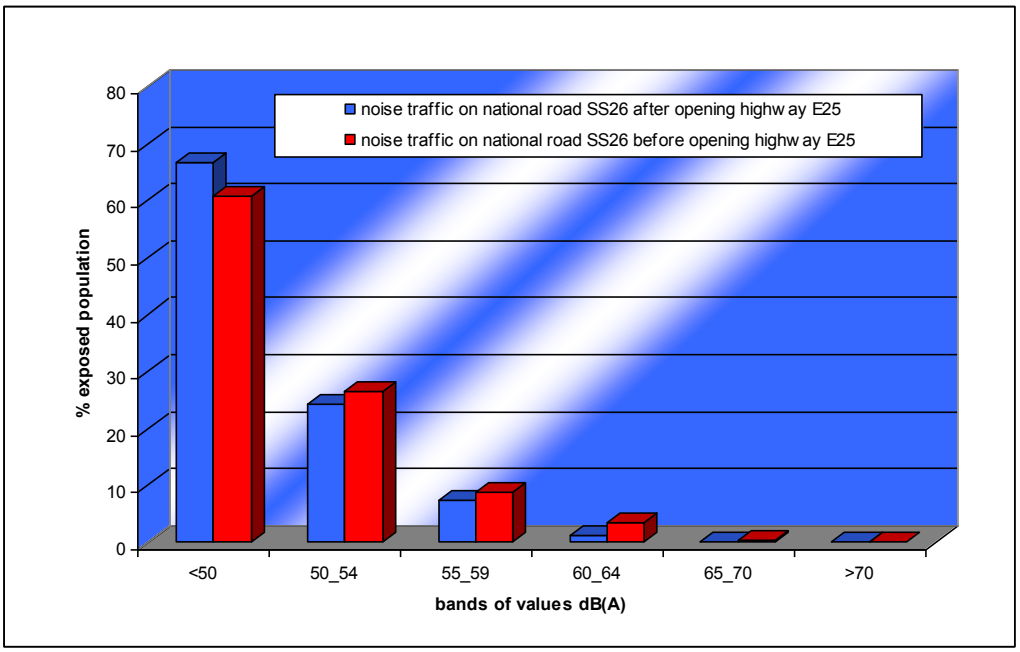
Exposed population (%)	Bands of values of L_{den} (dBA)					
	<55	55-59	60-64	65-69	70-74	>75
scenario a	61	31	4	3	1	0
scenario b	77	16	6	1	0	0

Figure 4: Percentage of exposed population for L_{den} bands of values.



Exposed population (%)	Bands of values of L_{night} (dBA)						
	<45	45-49	50-54	55-59	60-64	65-70	>70
Scenario a	55	10	29	4	2	0	0
Scenario b	70	11	17	2	0	0	0

Figure 5: Percentage of exposed population for L_{night} bands of values.



Exposed population (%)	Bands of values of $L_{06\text{-}22}$ (dBA)					
	<50	50-54	55-59	60-64	65-70	>70
Scenario a	61	26	9	3	1	0
Scenario b	67	24	8	1	0	0

Figure 6: Percentage of exposed population for $L_{06\text{-}22}$ bands of values.

5 CHANGES IN SOUNDSCAPE

From the histograms of fig. 4, 5 and 6 one can think that the decrease of the population noise exposure due to the transfer of international traffic to the new section of E25 Highway is not so important. For a better comprehension of the change in the acoustical climate due to the new traffic distribution we have considered the histogram of short term Leq (30 s) diuring the diurnal period (06-22) at an hotel balcony near the national road SS26 (fig. 7).

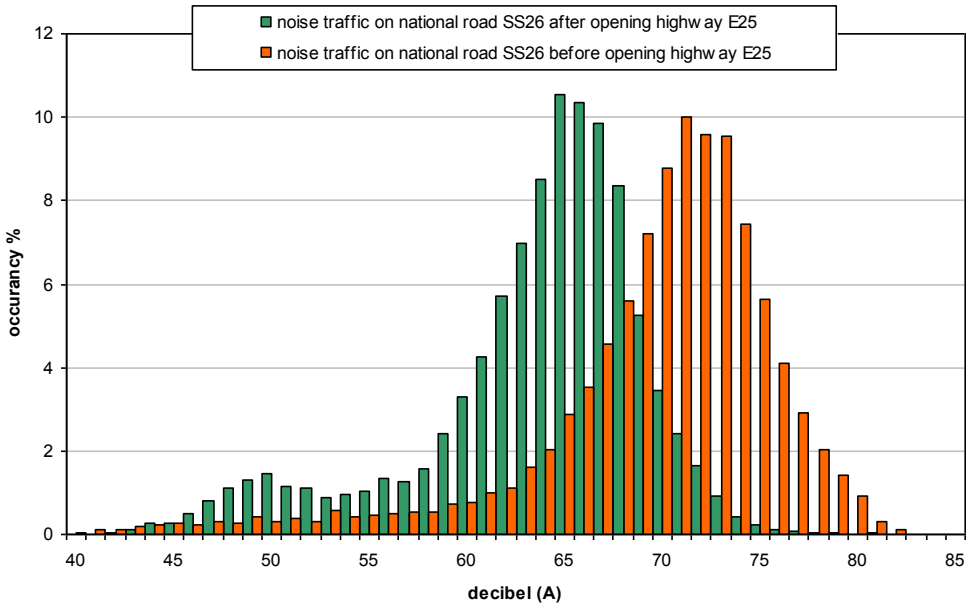
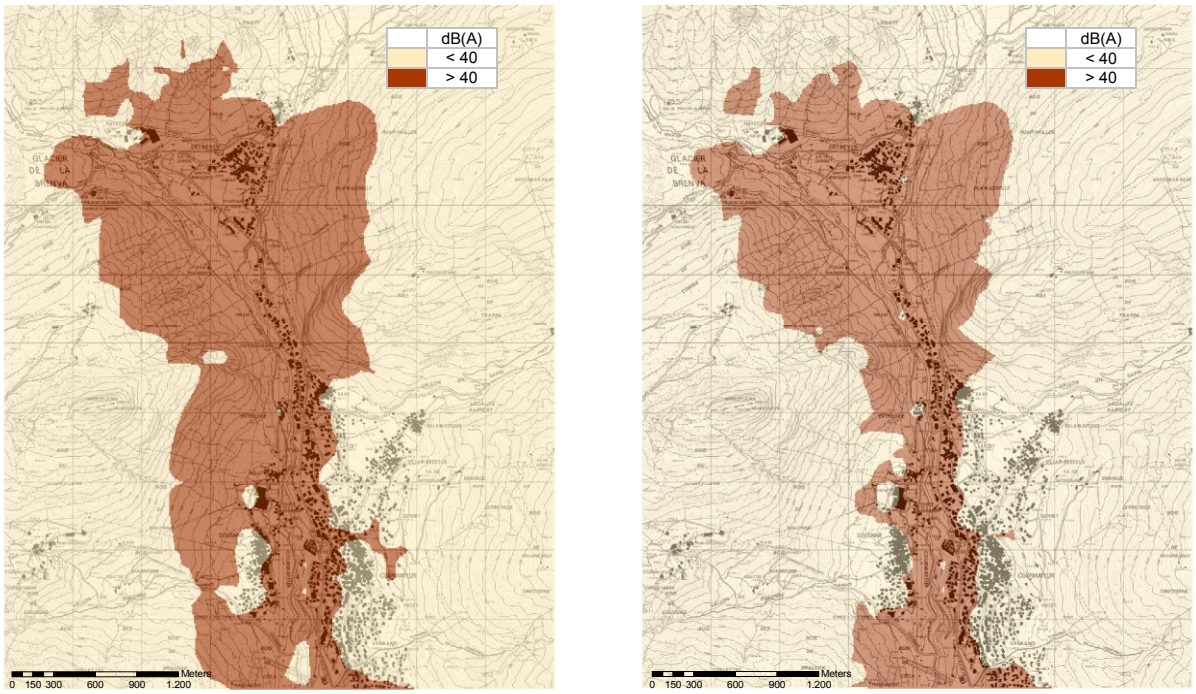


Figure 7: Statistic distributions of short term Leq values (30 s), 06-22 period, at an hotel near the national road.

The shift of the noise levels toward lower values is evident and indicate a soundscape much more confortable!

In addition one must consider that Courmayeur is an alpine touristic resort for which wilderness is an important resource, and natural sonorous landscape must be protected.

To evaluate the quiet of the whole area and the impact of the highway on the global surrounding environment, the curve corresponding to 40 dBA has been drawn in figure 8 [3].



a b

Figura 8: $L_{06\text{-}22}$ curve of the sound levels at 40 dBA before (a) and after (b) the opening of the last section of the highway E25, for the most in gallery.

After the opening of the highway, the surface with Lday<40 dBA is more extended in the area near the villages where residents and tourists spent their time and where recreational area have been created.

6 CONCLUSIONS

In the paper the noise exposition of population of an area situated along an important transalpine communication way is evaluated: the opening of a new highway that takes away cross-border traffic from the national road running alongside the town building has reduced the noise exposure. This result is clearly shown by the noise indicators Lden, Lday and Lnight.

The evaluation methodology of the sonorous impact used in this work, will come proposed for the other greater ways of International vehicular traffic.

7 REFERENCES

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