inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 7.6

A PURPOSE OF AN ACOUSTIC CRITICAL INDEX FOR THE ESTIMATE OF THE PRIORITIES OF INTERVENTION IN AN HIGHWAY GLOBAL REORGANISATION PLAN

J. Fogola*, F. Duretto, R. Giovinetto***, R. Pisani******

* Piedmont Environmental Protection Agency, Via Sabaudia 164, 10100, Grugliasco (to), Italy

** Piedmont Environmental Protection Agency, Via Cattedrale 8, 14100, Asti, Italy

*** Province of Turin, Via Valeggio 5, 10100, Torino, Italy

**** Pisani Acoustical Engineering Society, Via Cav di Vittorio Veneto 8, 10100, Rivoli (to), Italy

Tel.: +390114028389 / Fax: +390114028390 / Email: (acustica)arpa.grugliasco.dip@ope.net

Keywords:
HIGHWAY, PRIORITIES, REORGANIZATION, PLAN

ABSTRACT
The aim of the study is to propose a method for an acoustical critical analysis of territories crossed by large road infrastructures (highways, freeways, etc...) through a parameter function of number of exposed persons, noise levels, fixed maximum levels and appropriate corrective factors. Such a parameter concurs, by means of a mathematical relationship, to give an answer to the problem of fixing the border conditions in the definition of the priority of a global reorganization plan, that's to say if there is a greater criticality in a very noisy area with few inhabitants respect to one very densely inhabited but with noise levels strictly close to the fixed limits.

1 - INTRODUCTION

It is common knowledge how much the traffic on highways subjects populations residents in the bordering areas considerable annoyance. The growing urbanization in these areas is giving rise to a degradation of the quality of the life both for the noise pollution. Highways acoustics reclamation plans, must take this criticality in consideration including a stage aimed at the knowledge of the current acoustic quality. By the mapping of the critical areas, the responsible institutions can plan specific acoustical mitigation actions establishing appropriate procedures for the definition of the priorities and the modalities of intervention and verifying the achieved final results. The aim of the present work is to propose a method for an acoustical critical analysis of territories crossed by large road infrastructures (highways, freeways, etc.).

2 - DEFINITION OF THE CRITICAL INDEX OF PRIORITY

In a global highway acoustics reclamation plan, it turns out of fundamental importance to characterize in detail the different critical areas interested from the acoustic impact.
The concept of critical area must be univocally fixed in all the portion of territory in which the acoustic impact of the road is such to produce an overcoming of the fixed limit values.
This procedure has to be developed with the aid of extended acoustic maps by means of appropriate previsional models. In such a way, it is possible to fix a critical index (C.I.) for each area so as to obtain in an objective way the priorities of a reorganization plan. The parameters that concur to the determination of this index should be, to judgement of writing, the number of annoyed persons, the noise levels, fixed maximum levels and corrective factors. In defining such an index is necessary to choice the accuracy of the parameters in consideration, avoiding to consider only mediated and not much meaningful values but, contextually, limiting the accuracy of analysis of such parameters for reasons of reliability of the obtainable result and economy of job. In consideration of this, the C.I. has been processed

presupposing the use of acoustical and informatics instruments such as forecast noise models with "ray-tracing" technique and software GIS for the management and the analysis of territorial information. In such a way, the C.I of an area turns out:

$$\mathbf{I_{area}} = 10 \cdot \log \left(\sum_{i=1}^{n} 10^{Ii/10} \right)$$

- **n** = number of residential building in the area
- $\mathbf{I_i}$ = critical index of the i-th residential building of the area, defined as:

$$\mathbf{I_i} = 10 \cdot \log \left(\sum_{j=1}^{m} 10^{Jij/10} \right)$$

- **m** = number of floors of the i-th building
- $\mathbf{J_{ij}}$ = critical index of the j-th floor and of the i-th building, defined as:

$$\begin{aligned} \mathbf{J_{ij}} &= 10 \cdot \mathbf{log} \left(K \cdot p \cdot 10^{\frac{\Delta L}{10}} \right) & \Delta L > 0 \\ \mathbf{J_{ij}} &= 0 & \Delta L \leq 0 \end{aligned}$$

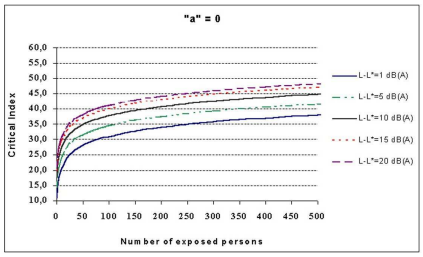
- **P** = number of persons living in the j-th floor of the i-th building
- $\mathbf{\Delta L}$ = L − L*, where L is the noise level in front of the j-th floor of the i-th building and L* is the limit value fixed for the area.

$$K = 10^{-\frac{(\Delta L - a)^2}{2 \cdot b^2} + 1}$$

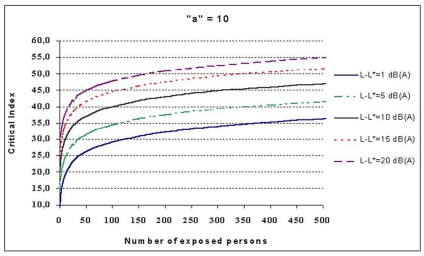
corrective factor defined for ΔL>0, with $0 \leq \boldsymbol{a} \leq 20$ e b = 15
The determined index presupposes the knowledge of the noise level in front of all the buildings of a critical area, obtained through a limited number of measures in significant points and by means of forecast calculations in all the remaining points. In case the location of the building is such to give rise to a variation of the levels at the same floor, it will be necessary to consider L as the space medium value. The parameters L and L* have to be appropriate describers of noise pollution. They can be diurnal or nocturnal Leq(A) in such a way to define two C.I., otherwise it is possible to use a unique value as the day-night Leq ($L_{d/n}$), or, finally, other useful parameters, depending on the particular legislation in force. The parameter K is a corrective factor, empirically determined. It concurs in the weight of the number of annoyed persons in comparison with the levels which these are exposed. The insertion of such corrective factor is aimed to give an answer to the problem of fixing the border conditions in the definition of the C.I., that's to say if there is a greater criticality in a very noisy area with few inhabitants respect to one very densely inhabited but with noise levels strictly close to the fixed limits. This problem can be solved with an agreement between all the subjects that concur to the definition of a big infrastructure acoustic reorganization plan, by fixing the border conditions valid for the plan itself. Once made this choice, it is possible to define the corrective factor K, and then the C.I., to obtain the wished result simply tuning the *a* coefficient. In particular, modifying the values of *a* coefficient, the trend of K in function of ΔL is translated, with a sensible variation of the C.I. in function p and ΔL. In case *a* assumes the minimal value, equal to 0, C.I. is mainly sensitive to the increments of the number of persons, while for the maximum value, equal to 20, the behavior of C.I. results diametrically opposite. For example, in figs. 1a), 1b), 1c) it is shown the trend of Critical Index values versus number of exposed persons (p) with ΔL = 0, 5,10, 15 and 20 in the case of *a* coefficient equal to 0, 10 and 20.

3 - CONCLUSIONS

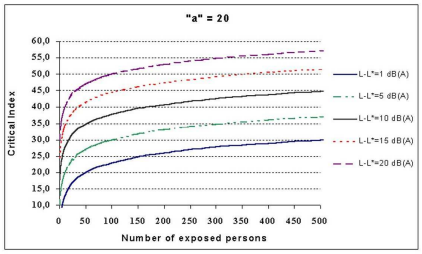
The definition of a reorganization plan of the critical areas crossed by a linear infrastructures demands an accurate planning to safeguard life quality of the interested populations. These kind of plans are not exhausted only with oriented punctual interventions to the single receiver, but involve wide areas where acoustical barriers can be inadequate.
The Critical Index gives to the competent institutions an instrument for the definition of acoustic intervention priority and to the professional person in charge of the reorganization plan a technical aid to make the suitable choices for the projects.



(a): a=0.



(b): a=10.



(c): a=20.

Figure 1: Trend of critical index values versus number of exposed persons (p) with ΔL=0, 5,10, 15 and 20.