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

**I-INCE Classification:** 0.0

# DIAPASON: EFFICIENT HELP TOOL IN THE DECISION PROCESS FOR LOCAL AUTHORITIES

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**Keywords:**
ENVIRONMENTAL NOISE, ANNOYANCE, PLANIFICATION

## ABSTRACT
In the framework of LIFE Environment projects funded by the European Community, Greater LYON which gathers 55 local authorities composing the Lyon Urban Community, has successfully proposed the "DIAPASON" project in partnership with METRAVIB RDS and ACOUCITE association. The aim of DIAPASON is to put in place at Greater LYON a genuine follow-up and management tool of noise environment in the city, specifically designed for decision makers, the city services and technicians concerned by any problem of acoustic nuisance, and thus to contribute in an active manner to the improvement its citizens quality of life. Simple and userfriendly, DIAPASON is tightly coupled to a Geographic Information System and thus offers various possibilities of mapped data and relevant crossing (noise, population, . . .).

## 1 - CONTEXT
Noise progressively becomes one of the main sources of concern for city authorities / decision makers because of its tight relationship to the quality of life, especially in large urban areas. Constant traffic growth, project planning constraints are to be evaluated in the light of their corresponding noise impact as well! As a matter of fact, not only a good knowledge of the present noise situation (at different city scales) is required, but also the possible impact of any changes in urban conditions (traffic evolution, implementation of new infrastructures, . . .) becomes mandatory to assess the annoyance potential of measures decided at political level.
Nevertheless a very small number of tools are now available to city authorities and decision makers, that can deliver an information tailored to their needs in ready to read, understandable form, without requiring a faint expertise and skill in acoustics. Clearly the software tool jointly elaborated and developed by Greater LYON and METRAVIB RDS (with a technical follow-up by a Committee of expert acousticians) aims at filling a gap, thus offering an efficient help to decision makers, the city services and technicians in terms of getting a better *global* view of the present noise environment and related potential problems in their city and evaluating the expected efficiency of measures they could take to improve such an environment.

## 2 - DIAPASON – GLOBAL APPROACH AND GENERAL OVERVIEW
The representation and modelling approach retained for DIAPASON conjugates quantitative and qualitative aspects, with a deliberate choice of keeping a global vision at district or city level. Hence the objective is to propose a tool that allows to non experts a rapid identification of critical or potentially critical zones relative to noise and induced annoyance potential. The coupling of both quantitative (physical noise) and qualitative (noise sensitivity, potential annoyance) aspects within the same tool is the main originality of DIAPASON which basically offers 3 main functionalities:

- map the present noise environment in selected urban sites

- evaluate the impact of urban modifications (such as modification of traffic planning, new road infrastructures, implementation of new buildings & equipments, local development, ...),
- develop and manage a specific database related to complaints, noise measurement campaigns, typical noisy atmospheres (market places, schools, industries, ...) and follow their time evolution.

An analysis of existing territorial subdivisions at Greater LYON scale and related geographised data available was conducted as a preliminary step with the aim of establishing users needs and subsequent software specifications. Additionally site and noise data related to transportation infrastructures (road and railway traffic) were gathered so as to constitute the input database to DIAPASON. This database is progressively filled with new data coming from dedicated acoustic measurement campaigns on selected representative sites of Greater LYON, with a special attention to urban point localised sources (such as schools, market places, pedestrian streets, ...) and industrial sites.

## 3 - MODELLING ASPECTS

On the acoustic modelling side, the preliminary analysis showed that existing methods only partially fitted the software objectives and were mostly too complex and deterministic (with many requirements on their various input parameters, poor link to GIS, ...). Hence a specific development has been engaged which resulted in 2 original models for quantifying the acoustic propagation over urban zones (respectively applying to urban − high density of buildings − and peri-urban zone). They are proposed as an alternative to existing models and represent the best compromise between realism and simplicity. For dense urban zone ("closed type" sites), the first model (diffraction) takes into account successive screens composed of the different building barriers deduced from GIS parameters. Then for sub-urban zones ("open" type sites), DIAPASON conjugates Kirkpatrick law (Anderson localisation) and screening effects. Propagation characteristics on each zone are thus couples determinism and a semi-statistical approach relying on GIS parameters. Technical details on the modelling approach relying on multidiffusion theory and Anderson localisation can be found in [1] to [3].

In parallel, a reflexion on the qualitative aspects of noise has been conducted by the project partners together with psychologists, sociologists and urbanists. The related literature has been analysed as well showing all of the complexity associated with the *annoyance* concept and its influencing parameters. Over more than 30 years, a quantity of studies in this field demonstrated that many parameters have a poor or controversial influence on annoyance perception (duration of residence, level of education, age, tenant/owner status, ...) while the most interesting ones are often difficult to gather on a large scale (personal exposure at the workplace, quality of the window insulation, neighbourly terms, ...). The significant variability between individuals is also a source of modelling difficulty, as well as the relationship between noise and percentage of annoyed people depending on the source type, noise intensity and emergence ...

To account for the qualitative aspects of noise in the city, DIAPASON introduces the concept of annoyance potential. To that aim, a pragmatic approach was preferred, relying on reference models selected through a preliminary review of the relevant literature (see for example [4] to [6]). In fact, the computation of the proposed noise annoyance potential index combines 3 already existing models: a Bonus/Malus weighting as a function of the noise source type, a multi-exposure model including summation/inhibition effects and a French/Swiss model (OPB ordonnance dated $15^{\text{th}}$ December 1986, Protection against Noise), deriving the percentage of annoyed people as a function of noise levels and typology of the different urban zones. The idea is first to establish a noise level correction depending:

- on the type and number of the main contributing source(s) and related maximum level,
- on relative contribution between road/railway, with a correction depending on the considered period of the day (day: 6h-22h, evening (22h-1h) and night (1h-6h)).

Then the French/Swiss model is applied to derive a correspondence between noise levels and percentage of annoyed people relative to the qualification/typology of the considered geographic zone.

This correspondence is defined by a set of curves based on Table 1 linked to Figure 1.

In the provided example (see Figure 1), case 1 stands for day/mixed zone (read x-scale + 10 dB), case 2 represents day/leisure zone (or a combination night/industrial zone) and case 3 is night/ leisure zone (read x-scale − 10dB).

| Degree of sensitivity (art. 43 OPB) | Planification value in dB(A) | | Immission limit value in dB(A) | | Alarm value in dB(A) | |
|---|---|---|---|---|---|---|
| | Day | Night | Day | Night | Day | Night |
| I. Leisure Zone | 50 | 40 | 55 | 45 | 65 | 60 |
| II. Residential Zone | 55 | 45 | 60 | 50 | 70 | 65 |
| III. Mixed Zone | 60 | 50 | 65 | 55 | 70 | 65 |
| IV. Industrial Zone | 65 | 55 | 70 | 60 | 75 | 70 |

**Table 1:** Swiss model – planification / limit / alarm values wrt. noise annoyance.

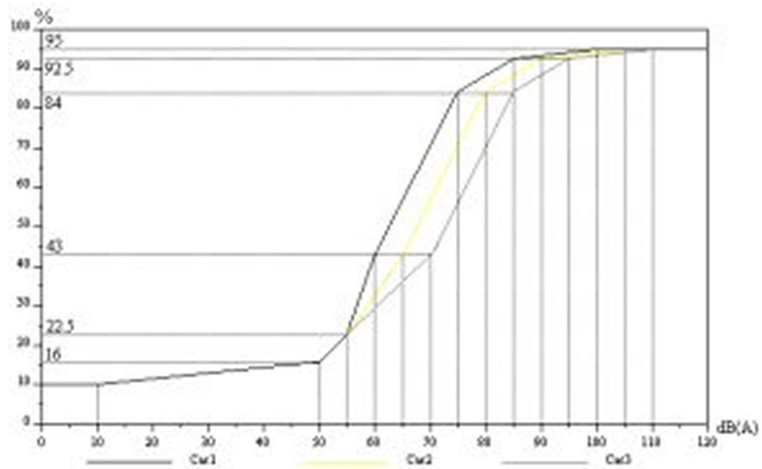


**Figure 1:** Percentage of annoyed people as a function of noise level (LAeq corrected).

## 4 - TYPICAL RESULTS OUTPUT FROM DIAPASON

The proposed set of figures aims at displaying the different features of DIAPASON as it is now available to the technical services in charge of noise environment at Greater LYON. They relate to a typical district of Greater LYON.

Figure 2 first shows a typical noise map (Laeq per period of the day and classes of 5 dBA) deduced from the noise data made officially available by the local authorities. Noise data come from the classifying related to a road traffic of more than 5000 vehicles/day, completed by corresponding data regarding railway noise sources. More localised sources have not been taken into account at this first level of visualisation. They will be integrated to the DIAPASON database in direct link with ongoing measurement campaign carried out by partner ACOUCITE.

Figure 3 gives the corresponding potential annoyance index map (5 classes, ranging from low to high annoyance), established on the basis of the previously exposed modelling.

Starting from a display of the present situation, the local authorities now can test various scenarios in order to improve the noise environment on their territory. A special attention has been given to the possibilities of playing with traffic parameters. Potential modifications of local urbanism according to town planning priorities may be taken into account as well with DIAPASON simulation module.

## 5 - DIAPASON – FORTHCOMING DEVELOPMENTS

Crossing of such maps with population distribution (based upon statistical data as available in France for example) will allow to access to the effective number of highly annoyed people, then offering in the next future access to a wide range of statistical exploitation of the software results.

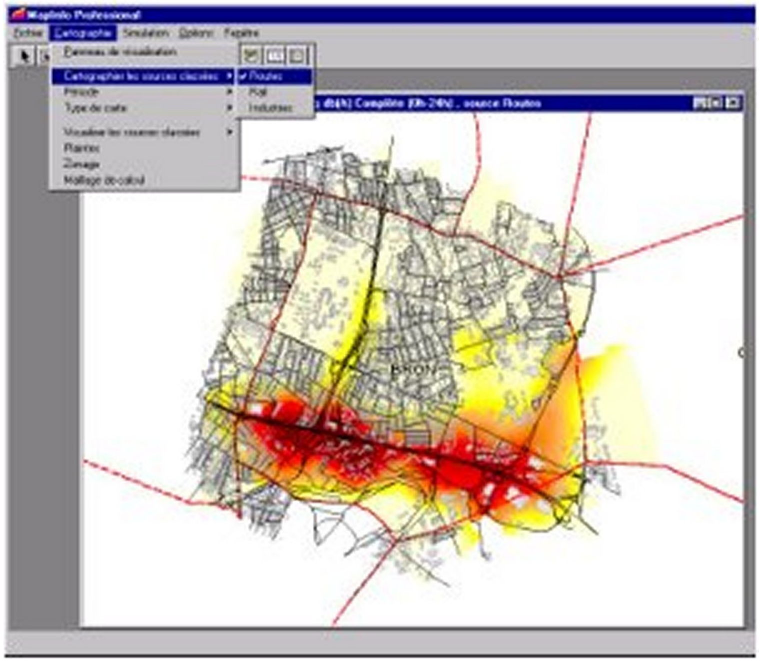

**Figure 2:** Typical noise map issued from DIAPASON − representative district of Greater LYON − simulated data.

Optimisation of the graphical display with the aim of dedicated results communication towards the population is also recognized as a major concern of local authorities and future work on DIAPASON will involve this essential aspect as well.
Especially features related to complaints, already displayed in superposition with noise or potential annoyance index maps will be further operated to provide local authorities as well as inhabitants with a progressively increased level of knowledge of the noise environment in their district / city.

**ACKNOWLEDGEMENTS**
The European Commission through the LIFE committee is warmly acknowledged for the support brought to the development of DIAPASON.

**REFERENCES**

1. **T.R. Kirkpatrick**, Localisation of acoustic waves, *Physical Review B*, 1985

2. **A. Twersky**, Multipole scattering of waves by a doubly periodic planar array of obstacles, *Journal of Physics*, Vol. 16, 1975

3. **Désollier and al.**, Localisation d'Anderson des ondes dans les réseaux acoustiques unidimensionnels aléatoires, *Annales de la Physique*, Vol. 11, 1986

4. **Fields**, *Effect of personal and situational variables on noise annoyance*, DOT, 1992

5. **Champelovier, Lambert**, *Comparaison de la gêne produite par le bruit ferroviaire à celle produite par le bruit routier à partir de résultats d'enquêtes*, INRETS - LEN, 1996

6. **Miedema, Vos**, Exposure-Response relationships for transportation noise, *JASA*, Vol. 104 (6), 1998

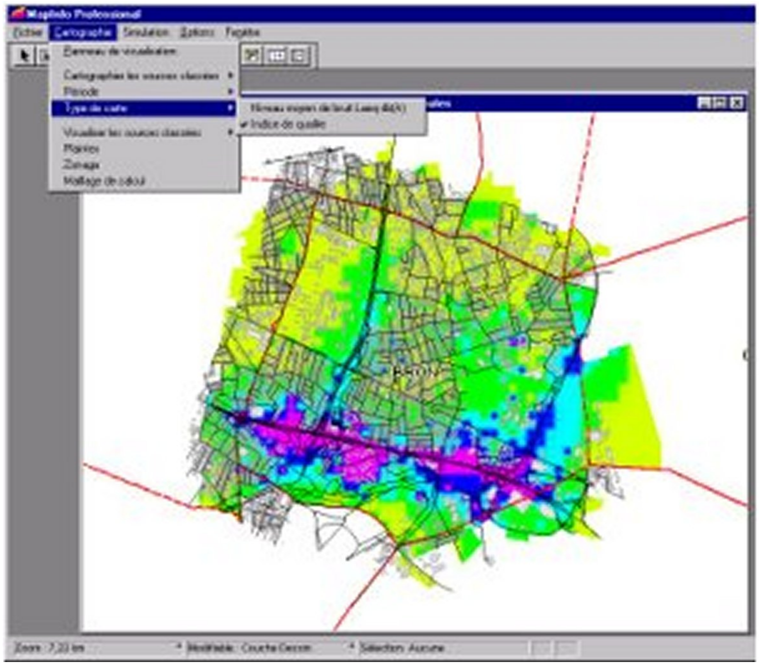

**Figure 3:** Related potential annoyance index map - same set of noise data.

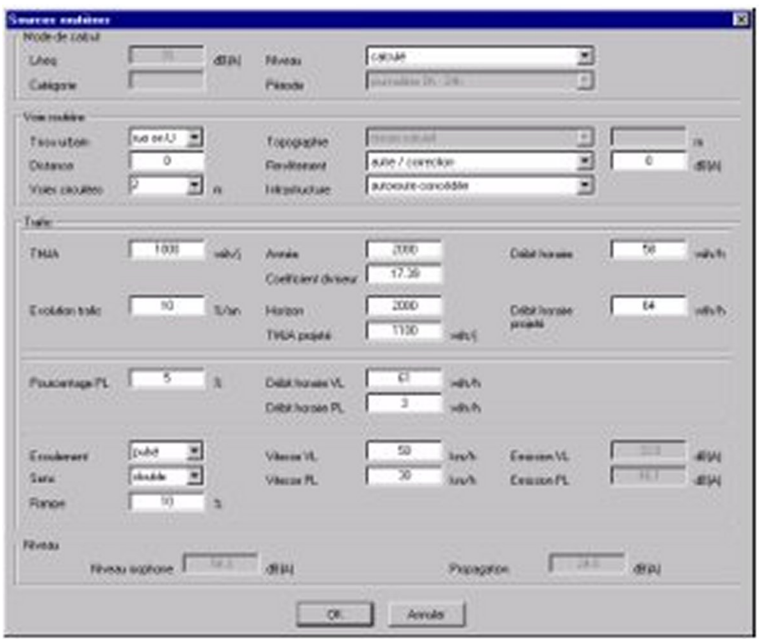


**Figure 4:** Simulation module – how to evaluate the impact of traffic changes on noise/potential annoyance maps).