

Assessing the quality of urban sound environment: complementarity between noise monitoring system, noise mapping and perception survey, the stakes for the information to the public

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Abstract Greater Lyon, Acoucité and INRETS are partners in several major projects aimed to promote the integration of the sound dimension in urban planning. The European GIPsyNOISE project (mapping tool meeting the objectives of the European Directive of June, 2002) as well as the development of a permanent noise monitoring network in the city of Lyon (France), address this issue. One of the main concerns is to make these notions, these methods and the results they provide, comprehensible by the general public. This paper reports the connection between these various complementary tools (measures and noise mapping). The institutional approach, which prevailed in their application, is also developed. Effectively, all the methods of environmental diagnosis need important work prior to partnerships between the various local organizations that hold the information necessary to make the diagnosis, with those in charge of its realization, then with those in charge of the implementation of the action plans and finally with those competent in broadcasting the information. This paper addresses the issue of the complementarity between noise measurement and noise mapping which are two inseparable approaches for carrying out of a noise diagnosis, particularly when this diagnosis is expected to be presented to the public and used by multiple actors from different scientific and technical backgrounds. An analysis of the data collected up to know (permanent noise measurement and noise mapping, crossed with social survey data) clearly shows the benefits from these complementary approaches: each method provides complementary information. Finally this paper addresses the ways of informing the public, as well as the connection between the various actors involved in the management of a same urban area, from the experience gained relating to Greater Lyon and strengthened by the European partnerships within the frame of the GIPsyNOISE project.

1. INTRODUCTION

"... The poor man, Sparsus, cannot live in Rome, nor rest there. So many people prevent you from living there!..."

Martial, written to Sparsus, 40-104 after J.C.

Numerous studies carried out for several decades have clearly shown that noise levels in the environment constitute one of the first factors that influence the perceived quality of life. Moreover, noise has an economic and social cost [1]. Now noise exposure in the environment is largely dependent on transport infrastructure noise, for a strong proportion of the population, particularly in urban or urban-peripheral areas.

On the other hand, these studies showed that the relationship between noise levels and annoyance is not only dependent on individual and contextual factors, but also on the difficulty of measuring and attributing a representative noise exposure level for every individual.

These two reasons (direct and indirect effects of noise on health [2] and on the quality of life), as well as difficulties in drawing up an exhaustive inventory of areas exposed to noise, led the European Commission to decide to adopt a Directive (2002 /49/CE), then transposed at national level, imposing on member states, three axes of priority action regarding the environmental noise management:

- producing noise exposure maps
- informing the public
- implementing action plans

Finally urban centres must increasingly implement a public policy to promote a sound quality environment through noise abatement action plans. Then the sound dimension becomes integrated into the urban planning [3], and therefore the control of the surface transport noise exposure is a major issue:

- 80 million people in the EU (22 %) are exposed in the daytime to more than 65 dB (A)
- more than one European out of 12 lives in "blackspots" (over 70 dB (A))

Table 1: Noise exposure in Europe [4]

Daytime noise level (dB(A))	Exposed Population (%) E.U.
< 55	28.9
55 - 60	26.9
60 - 65	21.9
65 - 70	14.7
70 - 75	6.2
> 75	1.4

2. VARIOUS OBSERVATORIES OF THE SOUND ENVIRONMENT

Existing documentation describes different types of noise observatories involving several

disciplinary fields: measurement, calculation, sound recording, regulation, geographic information systems (GIS) or modelization and management of the traffic, social survey. The role of a sound environment observatory is to study carefully the sound phenomena overtime. The observatory conducts a project that observes and tracks changes in the sound environment resulting from the implementation of noise abatement actions.

A difference of meaning should be outlined regarding the practices: the term «noise observatory » would indicate rather a purely energetic and physical monitoring approach, (and would address particularly the negative aspects of noise), while a sound environment observatory would extend the observation field to a more qualitative approach (town planning, human sciences, heritage approach) and would integrate a more positive approach on the sound quality of the public spaces. On the other hand, two "families" of observatories can be identified:

- Those based on legal requirements (in France: sound classification of noisy roads, noise maps fulfilling the European Directive);
- Those designed at the request of local authorities without any reference to legal requirements. The aim is then to provide and use a decision-making tool within a global approach of sustainable development.

A sound environment observatory can be based on several complementary approaches:

1. An energy and/or spectral monitoring of acoustic fluctuations, by:
 - measurement, using sonometres
 - calculation using software
2. A qualitative monitoring, by sound recordings using a digital recorder, or other facilities, and microphones,
3. A perceptive monitoring, by means of social surveys performed regularly with residents and public area users.

The practical aims of the sound environment observatories are then as follows:

- Identification and abatement of critical noise areas, depending on legal limits or local political willingness;
- Protection of quiet areas;
- Inventory and monitoring of urban spaces with exceptional sound heritage;
- Integration of the sound topic within the urban approach (the transversality of the noise issues contributes to create a synergy between operators) ;
- Education, sensitization and informing the public as well as schoolchildren.

This paper presents the connection between some of the various approaches developed in the Greater Lyon (France) and the relative issues in terms of communication to the public as well as the necessity of close co-operation between various local technical services, as guarantees of the success of an observatory project.

3. METHODS CONTRIBUTING TO THE NOISE OBSERVATORY

3.1 Noise mapping: the GIpSynoise project

Greater Lyon (France), within the framework of the LIFE-Environment projects, is the leader of the European project “GIpSyNOISE” (tool of noise mapping fulfilling the requirements of the European Directive). This project represents one of the relevant answers to the environmental noise concerns of the citizens.

It is organised around a partnership involving 13 European cities (Barcelona, Huelva, Porto, Prague, Szeged, Lille, Bordeaux, Nantes, Angers, Montbéliard, Nice, Saint-Etienne, Boulogne-Billancourt), all members of the steering committee driven by Acoucity, and a technical committee (FORTH, University of Cretia and INRETS) driven by 01dB-Metravib as well as an expert-partner (CERTU) supported by the French Ministry of the Environment.

This project is organised around an interface combining a GIS-tool and an acoustic software.

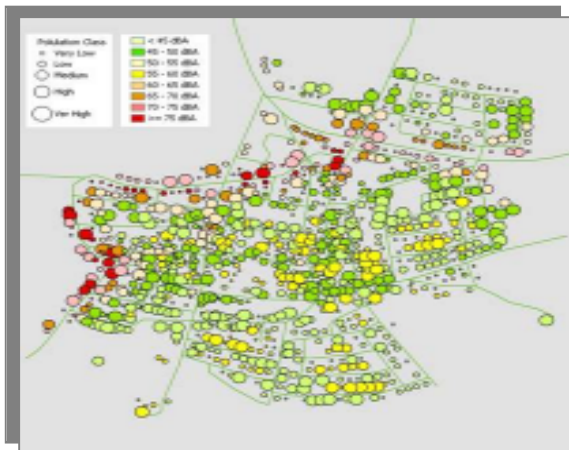


Figure 2: Example of graphic representation of densities of population exposed by 5 dB (A) classes

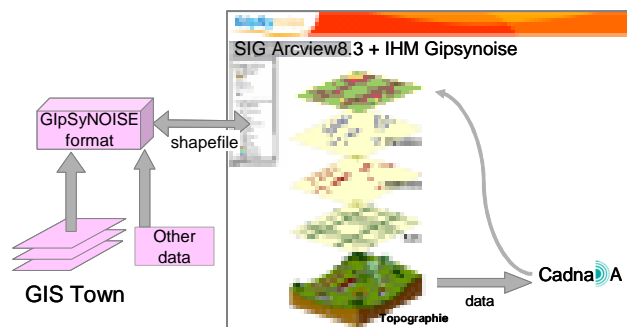


Figure 1: GIPSYNOISE tool organisation

Beyond the acoustic diagnosis, the noise maps, crossed with the population densities, allow the identification and representation of areas according to these two criteria.

At this point, a first “beta” version has been tested by the city-partners. However, and to better achieve the three objectives of the European Directive (state of the noise environment, information, action), at least two reasons can lead to not limit the project to a conventional diagnosis based exclusively on predicted noise levels:



- the concepts, methods and results are often of a great complexity and the somewhat "virtual" aspect of the calculation may lead to a denial of the results by the citizens;
- the calculated levels cannot report at present the dynamic and temporal aspects of the noise levels (temporal evolution, emergences of noise events) to which the population is particularly sensitive.

For these reasons, Greater Lyon is in the process of being equipped in 2005-2006 with a permanent noise monitoring network.

3.2 Permanent noise monitoring network

Conventional acoustic monitoring (calculation and measurement) has difficulty taking into account temporal fluctuations, or noise events which are specific to the urban noise and its diversity.

Table 2: calculated sound maps: synthetic vision, tool for land planning

Advantages (+) 	Drawbacks (-) 
Coverage of the whole territory	Mean values: few temporal fluctuations (day, week...)
Intuitive presentation (maps)	Limit of meteorological and event parameters
Objective simulation, comparison time / space	Relative confidence of the population towards simulation

For these reasons, implementing a permanent noise monitoring network can allow a monitoring of the fluctuations of the ambient noise linked to:

- meteorological variations;
- fluctuations of the traffic;
- choices regarding town planning and mobility;
- specific sound aspects like emergence of noise events.

A long term noise monitoring over two years on a transit way in Greater Lyon highlighted these significant in noise levels to which inhabitants are sensitive. All these factors are regularly pointed out when surveying the population, as being major sources of fluctuation in annoyance levels.

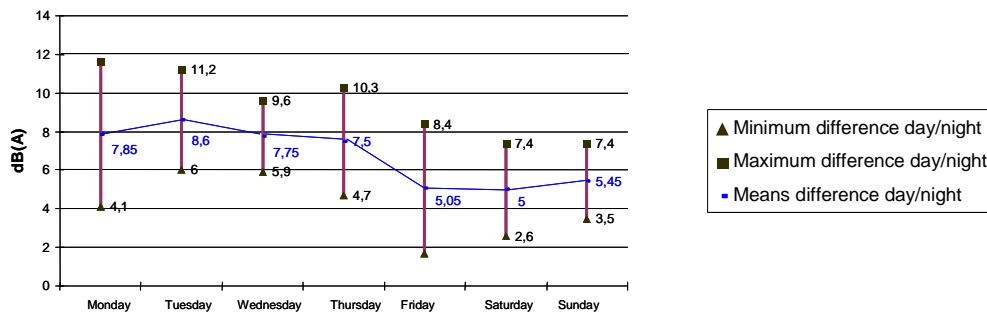
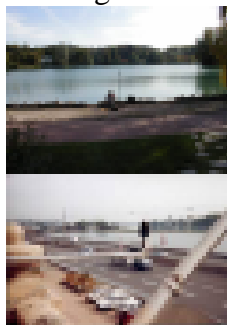
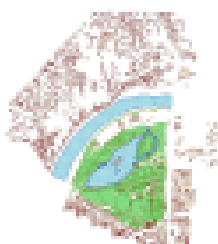


Figure 3: Variation in the differences observed between daytime noise levels and nighttime noise levels

On the other hand, a typology of measurement points was defined further to the conclusions of an ad-hoc working group involving various French experts:



- Symbolic places, tourist areas
- Quiet areas
- Noisy spaces
- Areas affected by town planning or road projects

A permanent urban noise measurement network constitutes a support for different local policies: urban ecology, mobility, road network, town planning, etc. This network can draw on existing logistic means (phone, optical networks and GPRS for the meteorological data transmission, air quality stations or traffic count stations, already equipped in electricity). Regarding the specific issue for Greater Lyon, this permanent network will become integrated into existing tools:

- European project of noise mapping: GIpSyNOISE
- inventory of sound patrimony (DAQUAR program)

The complementarity of the different approaches implemented by Greater Lyon meets the expectations of the population, according to the European Directive enforcing large cities:

- to get an in-depth knowledge of the noise issues;
- to estimate the population exposed to noise;
- to disseminate the information relative to noise exposure to the population;
- to define and implement action plans both for noisy and quiet areas.

3.3 Observatory of the perceptions and sound heritage approach

The management of the sound environment, beyond the excessively degraded situations, cannot be completely satisfied with a simply energetic (measure or calculation) approach, of the soundscape. A patrimonial approach (protect by audio recordings), as well as perceptive approach (survey on the evolution of the perception of the sound environment) and educational approach (interventions with the schoolchildren and the public) complete a program of noise observatory .



These actions can contribute to a better knowledge of the noise concerns and to a greater implication of the public, both within the framework of the monitoring of projects and through modifications of adverse behaviours related to the sound environment. A relatively large database of audio recordings comes then to illustrate in an auditive way the reality of the "soundscape" through situations most often perceived as being pleasant or unpleasant (fountains of the city, traffic calming areas, pedestrian areas, arterial roads ...). These audio documents contribute, for example, to a process of appropriation of the sound dimension, both for inhabitants and technicians responsible for town planning projects.

3.4 Concerted activities of the services in charge of noise

Finally, the development of noise observatory underlines the transversality of noise issues. Effectively, the fields of competence and intervention are the responsibility of multiple public services or private offices:

- road service (for traffic counts),
- telecommunications office (for transfer of the data),

- meteorological service (for the monitoring of the standardized measurement conditions),
- historical monuments department (for the setting-up of the noise stations).

Moreover, depending on the national regulations and the history of the institutions, roads, railroads and airports can be of responsibility of different national authorities.

4. COMMUNICATING TO THE PUBLIC

Some research tasks were undertaken recently in Europe about how to inform the general public with regard to noise and more generally to sound environment.

Following the guidelines of the European Directive, the work carried out in Spain [5], aimed to investigate the processes of communication and information on noise and its harmful effects, between the local authorities, the decision makers and the population. The findings clearly show a lack of knowledge of the citizens about their sound environment, in spite of the poor quality of state of the noise environment. The people who took part in the study (296 citizens of a town of 100.000 inhabitants) had a limited knowledge of noise levels, noise abatement plans, and the various sources of noise or the effects of noise on health. These results can be due to the gaps in the way the local authorities operate.

Indeed, it seems that the education and information system as regards noise is not the priority of the decision makers, and that few things are thus carried out in this field. For example, the city of Bilbao tends to privilege the data-processing support by the means of its official web site whereas the preferred sources of information requested by the citizens are local television and local newspapers (respectively to 66.6 % and 59.5 %). The Internet would be consulted only by 2.7 % of the population. Nevertheless, it is certain that the population is very interested in the idea of being informed about the various aspects of the sound environment, and more particularly by the action plans potentially set up by the municipality. The interviewed people mentioned to wish to be kept informed regularly, at a frequency of approximately once per quarter by the means of postal mails and council magazines.

In this same way to better understand how to present noise maps to the citizens, another Spanish study [6] points out the interest which the inhabitants of an area place on their sound environment, and the need for designing and implementing an appropriate information and communication tool.

Work undertaken aimed at proposing an alternative solution to the conventional noise maps which present several disadvantages, namely:

- the impossibility of being both sufficiently precise for the professionals and sufficiently comprehensible for the public
- the static aspect of the conventional maps and therefore the difficulty to integrate different action plans.

The concept which can solve these various difficulties would be a noise management mapping system based on a GIS (Geographic Information System). One of the main advantages of this system is the possibility to take into account the expectations of the public,

and the possibility for the citizens to be involved in the management of this system. According to the survey carried out at the time of the presentation of this system, the public was expecting to be informed of the real situation of the sound environment. A computerized noise map giving information in real time seems to be a relevant answer to the public's request and would represent the most appropriate tool for informing the public. However, if the findings of the Bilbao study related to the information contents are considered, this conclusion must be discussed.

In fact, considering the findings of the two Spanish studies, a problem remains: it is difficult to inform the majority of the citizens and to provide information as precise and concrete as expected. Do we have to choose between the accessibility of information and the communication or the quality of information itself?

Solving this problem is not an easy task and does not lead to a satisfying choice of noise communication strategy. Moreover, the work undertaken in Finland [7], clearly demonstrates that when fighting noise, noise maps must be completed by perception surveys.

5. CONCLUSIONS

The complexity of the sound dimension (not limited to a purely physical aspect) puts in evidence the necessity of a transverse approach and a complementarity between the assessment methods of the sound environment, particularly when the observatory project aims to be a tool for managing the sound quality of the city.

Noise maps are often only an inventory. They cannot substitute field studies, particularly noise measurement and perception surveys. Effectively, the citizens, but also the planners, cannot be satisfied only with a legal noise limit value calculated in urban area to estimate the spatial and temporal fluctuations of the sound quality. In the same way, the expectations of the public regarding information [8] will lead to address this issue otherwise than through the engineer's sciences. In spite of a European Directive which prioritises transport noise mapping, official statements in the local media related to the action plans and the education of the public as regards sound environment should not be left on side.

Finally, designing and implementing an observatory of the sound environment needs an approach involving, at least within a steering group, representatives of the various administrative services of the city but also representatives of various scientific backgrounds: acousticians (of course), but also psychologists, sociologists, doctors, economists and town planners, as well as experts in communication.

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