

ON SMART URBAN SOUND MANAGEMENT

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J. Luis Bento Coelho; Diogo Alarcão
Instituto Superior Técnico, Universidade de Lisboa
Av. Rovisco Pais
10049-001 Lisbon
Portugal
Tel. +341.218419393
E-Mail: bcoelho@ist.utl.pt

ABSTRACT

Large agglomerations are required by the European Environmental Noise Directive of 2002 (END) to draw noise maps and action plans. The Portuguese Noise Act of 2000 required all municipalities to assess the noise exposure of their populations by noise mapping and to draw noise reduction plans where necessary. Noise maps are important tools for assessing the exposure of the populations to noise, for designing noise abatement measures, for urban planning purposes, and for communicating with the citizens and other stakeholders. The quality of the urban acoustic environment results from a balanced management of the urban soundscape in the city in context with the place and with the citizens' expectations. Noise sensitivity maps were also drawn for a number of cities which led to detailed acoustic zoning, to the tuning of the noise abatement policy, and to the update of the land use plans. These instruments have been used to communicate with the population with great success, and to develop and design new solutions and procedures for improving the quality of the urban acoustic environment together with the citizens. An overview of experiences and strategies envisaged and adopted in some cities are presented and discussed herein.

INTRODUCTION

Noise in cities has been an issue since ancient times. A large agglomeration of people will produce a number of noise sources that may cause annoyance, especially during more sensitive activities, such as sleeping, resting, or learning.

Noise is not a problem unless it becomes excessive, thereby hindering the quality of life. This calls for each community and its government to set up policies for noise management and control and to devise and enforce strategies for noise abatement.

Noise from traffic is a key issue in a city. All means of transportation can be serious noise sources, with road traffic playing a major role. Mobility management must integrate with

acoustical environment policies in a city with ambitions of a sustainable development.

In a city, however, one should not consider just the quantity of noise but also, or rather, the quality of the acoustic environment. It is mostly how people perceive the overall sound composition in context in an urban area that determines annoyance or well-being, especially during day-time. People often regard some noises as a reflection of the city's activity and economic vitality. The city's soundscape is much a part of its signature, as it is its visual landscape, lights, or smells. At night, however, people are affected by noise during sleep and rest in a similar way anywhere, and noise levels are required to be low. Then, again, once the quantity of noise is reduced, the quality becomes important.

A balance must be found by considering all these issues and by involving all stakeholders. The acoustician plays here an important role on the assessment of the existing and prospective acoustical environment, on devising solutions for noise reduction and sound quality improvement, and on setting up a workable and cost-effective noise management and control plan. This should comprise short and long term policies integrating state of the art strategies and solutions, and the population's expectations for the place.

The Portuguese Noise Act of 2000, updated in 2007 [1] requires all cities to draw noise maps and to prepare noise reduction plans where needed. Large agglomerations with more than 100,000 inhabitants and with a population density of at least 2,500 inhabitants per km² are required to follow the European Noise Directive (END) 2002/49/EC of 25 June 2002 relating to the assessment and management of environmental noise [2] and its more complete set of requirements.

The Group of Acoustics and Noise Control at Instituto Superior Técnico (IST), University of Lisbon, has been working on large scale noise mapping and on action plans of large cities in Portugal (namely Lisbon, Albufeira, Almada, Funchal, Loures, Odivelas) since the early 1990's when the first noise maps for the Lisbon airport was completed. The city of Lisbon large scale noise map was started in the mid 1990's and was finished by the year 2000.

This Group has been working with city councils on the management of the quality of the urban acoustic environment. An overall survey of the land uses and their sensitivities was carried out for planning and for noise zoning purposes. Quiet areas have been studied. Most stakeholders were engaged in the process especially the residents with whom communication mechanisms were set up which allowed discussions and the tuning of solutions for conflicts and complaints.

NOISE SENSITIVITY MAPPING

Community noise ordinances promulgated by local or by national authorities usually define zones for different land uses with their corresponding noise limits [3]. Noise zoning allows for the establishment of different noise limits according to the specific land use. The total number of noise zones differs from city to city, but the principle is related to land use regulation and planning. These are management tools that take into account local activities as well as the prospects for the development of the urban areas.

The soundscape in each place must be effectively related to the human activities and to the people's expectations if a good acoustical quality is to be achieved. Our perception of the acoustic environment depends largely on the characteristics of the place but also on our activities during the different periods of the day and on how we expect it to conform to our notion of quality of life.

In cities, a comprehensive survey of the land uses in the whole municipal areas was carried out. Usually, well differentiated areas were found, such as central urban areas with mixed land uses, residential areas, schools, commercial areas, some industrial areas, parks and leisure areas.

These uses were then correlated with their possible sensitivity to noise. Basically, four degrees of sensitivity to noise, high, medium, mild and low were considered, depending on the prevalent activities within areas with a considerable geographical extension.

Noise sensitivity maps were then drawn for the whole municipal area based on the existing land uses, considering, for the sake of simplicity, three degrees of sensitivity to outdoor noise: the “mild” and the “low” noise sensitive areas were taken as one. At a later stage, the maps were modified to cater for newly planned land uses.

Figure 1 depicts land use noise sensitivity maps drawn for the municipalities of Almada and Albufeira, where the municipal plans for near future development were taken into account.

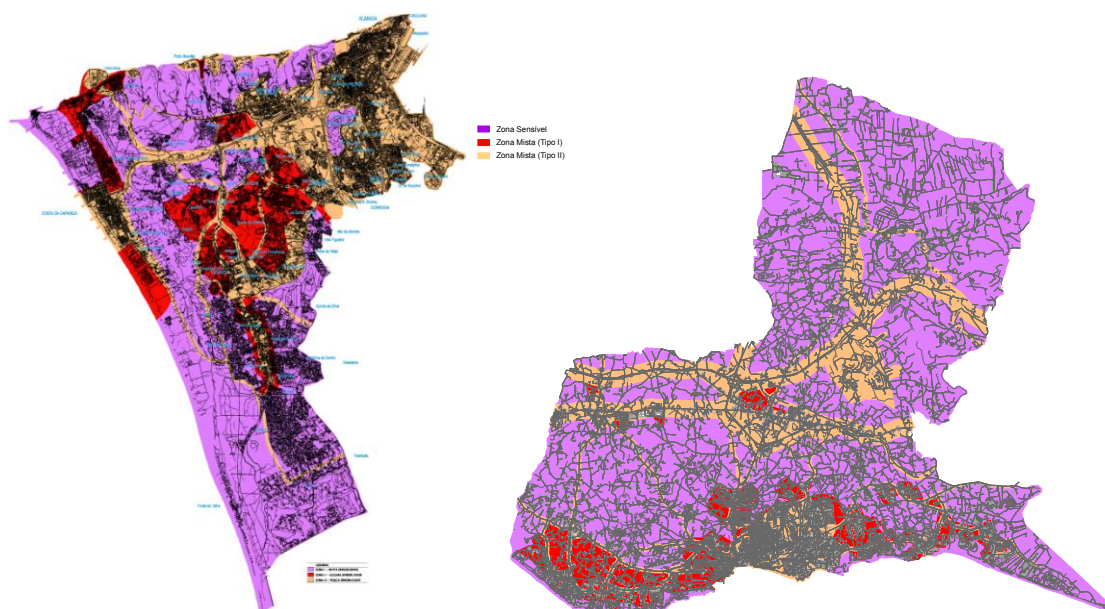


Figure 1. Almada (left) and Albufeira (right) land noise sensitivity (purple: high; red: medium; brown: mild or low) maps, including near future plans.

Three municipal zones were then defined, each one having distinctive noise limits assigned. For the more noise sensitive zones, the limit values were established at 55 dB(A) for L_{den} and at 45 dB(A) for L_n . These limits increase to 60 or 65 dB(A) for L_{den} and to 50 or 55 dB(A) for L_n , respectively, in the other two zones.

The fact that only three zones were designed was determined by the Portuguese noise regulations that define general limits at a national level. Industrial or similar areas are not considered. These regulations further require that noise mitigation plans be devised and implemented if and where the noise limits are exceeded.

The geographical definition of these zones also took into account basic information from the noise maps, especially regarding transport infrastructures or other structuring installations.

Figure 2 shows the Almada noise zone map where the three zones are established.

By correlating this map with the strategic noise maps, conflict maps were drawn and analyzed. These showed limited areas of conflicts, which could somehow be expected given the optimized

procedure that had been adopted. These areas were then studied in detail for noise abatement purposes.

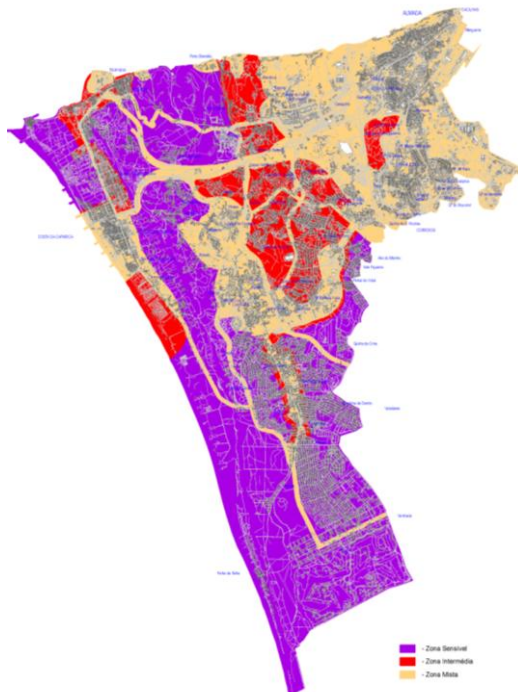


Figure 2. Almada noise zones.

DETAILED NOISE MAPPING

Urban noise management, for noise abatement or local land use planning purposes, requires more detailed information than that provided by the strategic noise maps. This led most medium and large size cities to adopt a more detailed mapping exercise, with most streets in the urban area and more detailed data on the noise sources being included in the database.

Figure 3 compares samples of the strategic and of the detailed noise maps for the central area in the city of Almada. This includes the old city quarters and the downtown area where services and commerce as well as residential areas can be found.

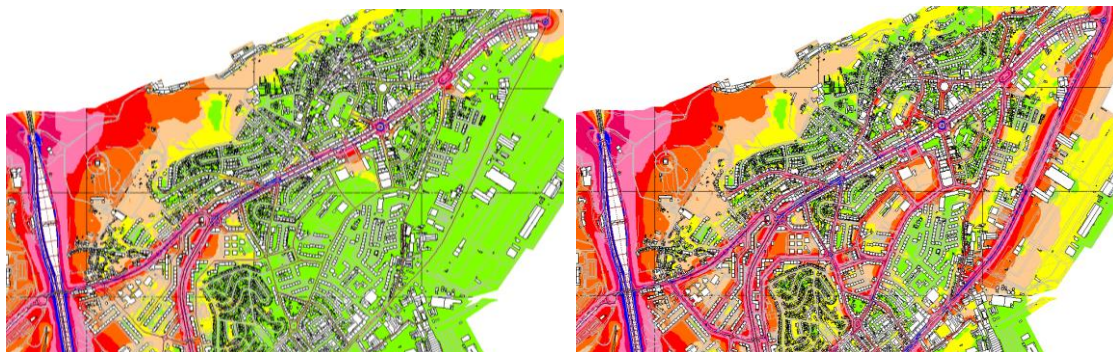


Figure 3. Samples of the strategic noise map (left) and of the detailed noise map (right) of Almada central region

The differences regard mostly road traffic densities: for the strategic noise map calculations, only roads with at least three million vehicle passages a year were considered, according to END criteria, whereas for the detailed mapping, traffic flow densities as low as 350,000 vehicle passages a year were included in the database, depending on the local relevance of the low traffic or on the other parameters determining the resulting traffic noise.

The detailed maps allow an insight into virtually every street and building in the city center and those areas where urban sound management is called for. Not only noise mitigation measures can be designed for each place but communication with people becomes easier since it is an interesting visual tool yielding much more understandable results than sound level numbers.

URBAN SOUND MANAGEMENT AND COMMUNICATION WITH PEOPLE

Urban noise management cannot be efficient enough without the active involvement of the stakeholders, especially the residents. Where noise complaints exist it is important to understand their causes and to define the role of the acoustician in designing solutions to eliminate or mitigate the noise issues.

In cities, strategies were defined with the city council officials in order to call the residents and other stakeholders such as transport responsible bodies for discussions regarding noise in the city in public sessions. These sessions served both for the experts and urban technicians to understand the citizens' concerns and their expectations and to explain them new plans for urban development and improvement and implementation of solutions for noise abatement purposes.

Usually, city council plans comprised mobility changes. In the city of Almada, a new light rail system was introduced. The new light rail system (see Fig. 4) was seen to be a further cause for concern for the citizens since they perceived it as an additional source of noise in the major residential streets already affected by road traffic noise.



Figure 4. Almada light rail.

In the public sessions, simulations were shown where the future scenarios (see Fig. 5), with the new light rail system superimposed with very noisy busy roads, showed major improvements on the urban noise. Since the new railway would replace a large number of cars, a considerable

noise reduction could be expected.

The light rail system was designed with efficient vibration control measures such as a resilient embedded rail. By combining with a number of other noise mitigation measures such as the introduction of new pedestrian streets, the lowering of the traffic speed in the residential areas, a reduction of the overall sound levels could be achieved.



Figure 5. Comparison of noise maps for scenarios regarding road traffic changes; previous (left); future with new major traffic diversion (right).

Discussions with the populations allowed the city councils to understand the full extent of the citizens' expectations regarding the improvement of the urban environment. This allowed for continuous programmes of mobility changes and urban development that generally included new extended pedestrian areas, some with no traffic or with very limited car access.

Fig. 6 shows photographs of some of these new areas in the center of city of Almada.

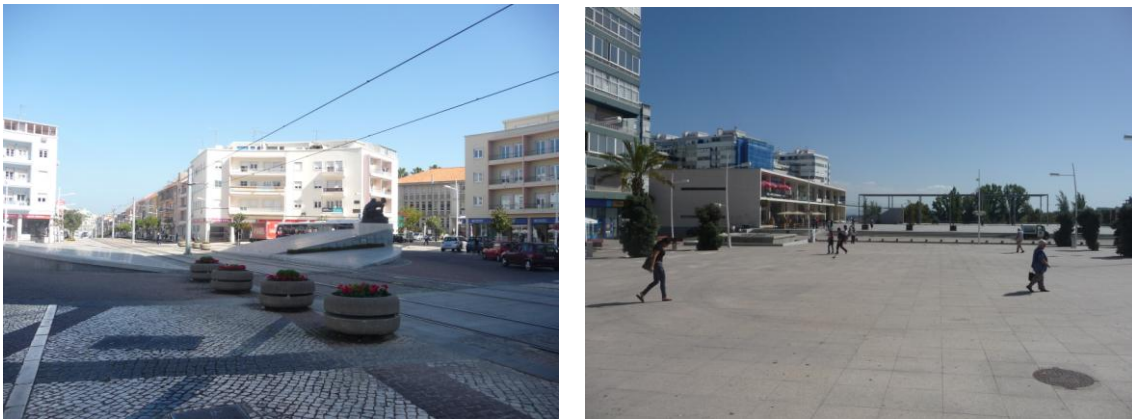


Figure 6. New restricted traffic access or pedestrian areas in central Almada.

This type of measures were instrumental in changing the city's soundscape and improving the quality of life, by reducing excessive noise from traffic and by creating areas with more pleasant sound compositions. Landscape and soundscape changed together and in a coherent fashion providing for a perception of an overall improvement.

In this sense, quiet areas were also defined to provide a differentiated soundscape and restoration for the users, especially in urban settings.

Criteria for the definition of the quiet areas included noise levels lower than the urban

surrounding areas (though no noise limits were established), a relatively large geographical area, but also different soundscape composition with sounds of nature or of human activities either existing or to be created.

The differences in soundscape relative to the more aggressive busy urban areas should also be coherent with the differences in landscape so as to create an overall perception of pleasantness and restoration. This part of the work is still underway.

Figure 7 shows an area close to the city center of Almada which was converted into an urban park, Peace Park. This is a relatively large area, featuring extended green zones and some public installations (see Fig. 8). Some measures such as a noise barrier were designed to acoustically protect a limit zone close to a highway.



Figure 7. Location of the Peace Park in the city of Almada.

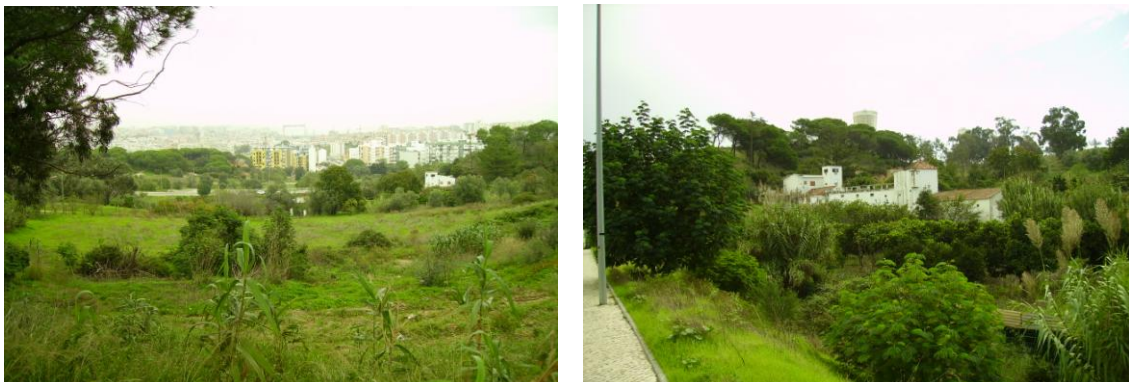


Figure 8. Views of the Peace Park in Almada.

CONCLUSIONS

Urban noise management requires detailed noise mapping especially in more densely occupied zones such as residential and central areas where noise may be an issue and noise mitigation measures need to be adequately designed and accepted by the citizens. Strategic and detailed noise maps were drawn for the larger cities for identifying problems of excessive noise and for management purposes.

Noise sensitivity maps were drawn based on land uses but also by taking into consideration structuring transport systems and installations. Acoustic zones were defined with corresponding noise limits, in accordance with the national noise laws. Noise conflicts were found by correlating the acoustic zone limits with the noise maps.

According to Portuguese regulations, noise action plans were drawn. These included noise mitigation measures, mostly directed to traffic, construction, and leisure activities, but also consultation with the population who had previously filed complaints on noise.

Discussions were held with the most relevant stakeholders, especially transport authorities and residents regarding noise mitigation measures, mobility changes, and envisaged development. Noise maps were used as a tool to show acoustic improvements in the future scenarios. This led to the creation of new pedestrian or restricted traffic access areas pointing to a better soundscape. The perceived improvement resulted not just from the reduction in noise but also from the coherence of the sound and of the landscape changes.

Quiet areas were also defined and identified for use by the population as parks for psychological restoration, following a multi-criterion approach of lower sound levels than the surrounding area, richer sound composition with natural or human activity sounds, and in context with a differentiated landscape.

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