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2017 Barcelona Strategic Noise Map: current, real, and sensitive to the noise management needs of the city

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ABSTRACT

Strategic Noise Map (SNM) 2017 has followed the basic premise of going beyond the normative analysis of traffic, industrial and railway noise. Thus, the sources analysed include leisure, pedestrian streets, parks and interior courtyards, among other special studies.

The major contributions were noise simulation supported by GIS, ensuring the information input in the model is of maximum quality, better identification of interior courtyards, and finally, following CNOSSOS methodology for assigning the population to interior/exterior façades.

The SNM 2017 brings us closer than ever before to the reality of sound in the city, with the goal of creating the best tool to respond to the city's problems.

Keywords: Noise map, Noise management, City
I-INCE Classification of Subject Number: 76

1. INTRODUCTION

Barcelona is a compact, densely populated city, with 15,000 inhabitants per km^2 [1], living side by side in a climate that favours outdoor life. All this means that the city does not "sleep" until well after 11 pm, and that environmental noise is not easy to manage.

It is an economically dynamic city, with a wide variety of services, commerce and culture (more than 12,000 leisure venues) and a leading tourist destination, receiving almost 9 million tourists in 2017 [2]. It also has an important metropolitan area, where 4.2 million trips were taken per day in 2016, 32.5% on public motorised transport and 15.5% in private vehicles [3].

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Apart from the territorial complexity of the city, which has a direct impact on noise quality, other technical factors have had a marked effect on this project, such as:

-Increasing technical complexity in the processes of measuring and evaluating noise, requiring a high degree of specialisation in both personnel and resources

-Methodology in the standardisation process at the European level (CNOSSOS) [4]

-Cross-departmental diagnosis within a framework of diversified municipal competences and management: mobility, paving, port authority, transport managers, etc.

Therefore, ensuring that the Strategic Noise Map (SNM) faithfully reflects this reality is no small challenge.

2. GOALS

The SNM 2017 is intended, on the one hand, to serve as one of the basic tools for urban environmental noise management and, on the other hand, to comply with the requirements established by the various regulations concerning strategic noise maps, especially the provisions of Law 16/2002 on Protection against Noise Pollution, Law 37/2003 on Noise, Royal Decree 1513/2005, Directive 2002/49/EC and the documents derived therefrom.

This edition is the third SNM to be published since the implementation of Directive 2002/49/EC, although the commitment of the City Council has always gone a step further than the classical analysis of traffic, industrial and railway noise required by law. Thus, the sources analysed also include leisure and crowding, pedestrianised streets (distinguishing between different degrees of commercial activity), parks and interior courtyards, among other special studies by area.

The new edition of the SNM allows for more detailed knowledge of the current noise situation, which is a key factor for the goals of reviewing and assessing the evolution of the city, and verifying the effectiveness of the measures implemented.

At a formal level, it is also intended to respond to the request for data by the Government of Catalonia, as Barcelona forms the agglomeration known as “Barcelonès I” together with the population of Sant Adrià del Besòs, which is contiguous with the city. In this regard, the Government of Catalonia has the final power to approve the SNM presented herein.

3. DEVELOPMENT OF THE SNM

This noise map has been developed in two main blocks: a first general study analysing all the noise associated with traffic and major infrastructure, and another more detailed phase, focused on specific areas of the city where other sources of noise predominate or which have particular urban characteristics that may influence the final sound levels. The sound sources analysed during this detailed phase include: Industry, nightlife and crowds, pedestrian streets, major railway and tram infrastructure, parks, inner courtyards, and areas with special noise conditions.

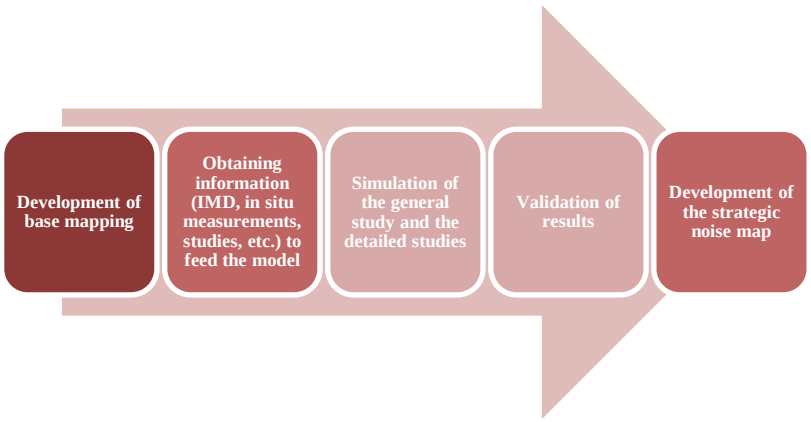

Figure 1. Phases of SNM development

Noise has been determined according to timeslots on the basis of the four indices:

- Ld: day period, from 7 am to 9 pm,
- Le: evening period, from 9 pm to 11 pm,
- Ln: night period, from 11 pm to 7 am,
- Lden: weighted equivalent day-evening-night level, which penalises the evening period with 5 dB(A) and the night period with 10 dB(A).

In terms of method, during the development of the SNM 2017, noise simulation using specific software has been applied to the entire area of the municipal district (the SNM from 2009 included simulations for 5 districts) for the first time. However, the noise measurements have a high value as they have been used both for validating the simulations and characterising the sound sources in the detailed studies (especially relevant in characterising leisure sources and pedestrian streets). We took a total of 1,700 short-term (15 minutes) and 234 long-term measurements (minimum 72 hours and maximum one year, using the city's noise monitoring network). The latter also help determine sound behaviour throughout the day and night and the differences between weekdays and holidays.

The results are presented in noise contour maps referring to the noise levels at 4m altitude (and also at 8m for large road infrastructures). This information has also been presented as a map of sections, facilitating the visual interpretation of urban noise in the different street sections, and as a map of façades, facilitating an analysis by buildings. Finally, the results are also expressed as percentages of the population exposed to different noise ranges.

4. UPDATED CRITERIA AND METHODOLOGY

As a result of the experience obtained from the previous SNMs and the training and updating of recent years, new criteria and methodology have been adopted based on a higher quality process and result. Broadly speaking, the main contributions of this edition of the SNM have been:

- the firm commitment to the use of noise simulation tools supported by GIS software, as a powerful query engine with the capacity to predict scenarios
- maximum quality in the basic cartography and information to incorporate into the model.

Introduction of elevation points to detail the topography as much as possible, as well as urban specificities (screens, slopes, etc.), traffic intensity, etc.

- level of detail with 2x2 metre grid in acoustic simulation
- better identification and classification of interior courtyards, which are highly relevant in Barcelona's urban areas (25% of the stretches in the city).

The identification of more than 2,000 new courtyards inside city blocks allows more areas with good acoustic quality to be detected, with a total of 3,741 courtyards defined out of the total of 15,000 sections of the city (in the previous SNM only a little more than a quarter of these –around 1,000– were identified).

And on the other hand, the characterisation of the levels of courtyards specifically depending on whether activities are carried out in them: school playgrounds, children's playgrounds, sports courts, etc. with particular relevance for the sound levels experienced during the day

- adoption of European methodology in the process of assigning the population to interior/exterior façades

Going from using internal methodology (based on the ratio to the perimeter of the interior/exterior façade of the apartment block) to following standardised CNOSSOS methodology. Surveys were also carried out by district (2017 Urban Ecology Survey [5]) where the number of people sleeping in rooms facing the street or the interior is known, which allows us to validate the proposal (for example in the case of Ciutat Vella, 47% of the population sleep in rooms facing the interior courtyard).

In this case, the aforementioned methodological changes employed in the SNM 2017 with respect to the SNM 2012 do not allow us to distinguish whether the differences between the data on exposed population (% inhabitants) are attributable to improvements in the city or to the new calculation methodology adopted.

In order to analyse the results between the previous SNMs and the 2017 SNM with the maximum guarantees of comparability, it has been decided to compare the length of the street section (% section in Km) exposed to each noise range. From the street length analysis, it can be deduced that the same methodology has shown a certain improvement attributable to urban changes, mobility (pedestrianisation, width of footpaths, bicycle lanes, pavements with sound reducers), etc.

5. RESULTS

TOTAL DAY NOISE dB(A) **TOTAL NIGHT NOISE dB(A)**

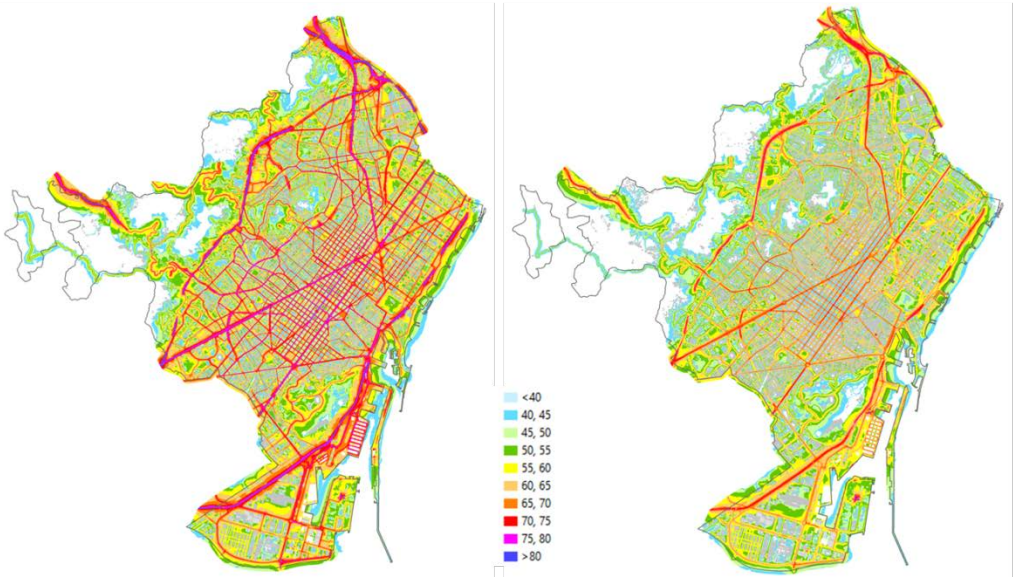

Figure 2. Day and night noise contour maps.

5.1 Contribution of each of the sources to the total noise

Traffic is the main source of noise. The noise levels linked to traffic in the day and evening periods are similar, with a significant reduction being observed in the night period. The main source of noise at night is still road traffic, but the noise caused by the intensive use of public space due to nightlife is also relevant in certain areas. According to citizen perception, this is one of the sources of noise that generate more nuisance (in 2017 it accounted for 23% of the complaints filed via the City Council's IRIS system [6]).

Nightlife noise is produced mainly by people passing by to access leisure areas and by crowds in public spaces. On the other hand, the noise generated in outdoor areas from indoor activities is irrelevant taking into account the control and corrective measures required by the City Council. In some areas, especially in Ciutat Vella, nightlife influences noise levels all year round, and seasonality is not a factor.

With respect to the noise source from pedestrianised streets, the noise generated in them has been considered in the current map, regardless of whether they have residual traffic or no traffic. The influence of this detailed study on the map is relevant in daytime and afternoon hours, and in the streets which have a lot of affluence of people and activities.

On the other hand, the contribution of noise from railway tracks and industrial activities to the exposed population is practically irrelevant since most of the railway sections run underground and industrial activities have less and less weight in the city's economy as a whole and, in fact, at night are almost non-existent.

5.2 Data by street length (daytime noise levels)

When comparing the last 5 years (2012 SNM) –Graph 1– the general trend during the day period is for the length of the streets exposed to high noise levels to be reduced:

-The areas with low noise levels, and above all the averages, have increased significantly (<60 dBA during the day). This has led to an increase in the number of areas with good acoustic quality, which are protected from high traffic noise.

-The areas exposed to higher noise levels have decreased, but to a lesser extent, as their levels are determined by their location around major traffic infrastructures, where it is more difficult to take action.

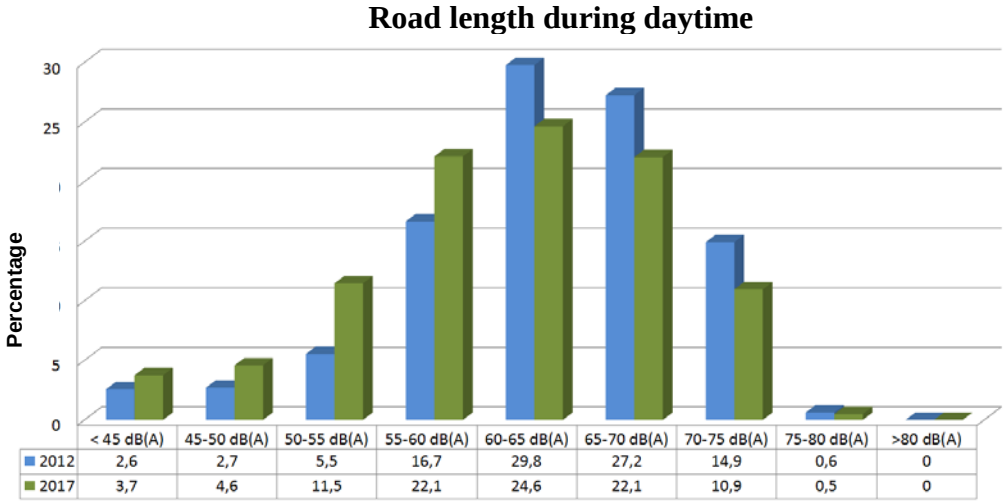

Figure 3. Percentage of road length (km) exposed to each daytime sound range. Total noise – Comparison with SNM 2012

5.3 Exposed population data (night noise levels)

As we have commented previously, this variable is not directly comparable with the data from the previous SNM, due to changes in the calculation methodology. For this reason, its evolution is inferred from the length of the streets.

With respect to population it is necessary to highlight the high percentage of population exposed to low levels (<45dBA) –Graph 2– which are experienced in quiet streets but also, and above all, correspond to interior courtyards. By identifying these, we have made much progress and been able to more closely analyse the reality of the acoustic quality of citizens.

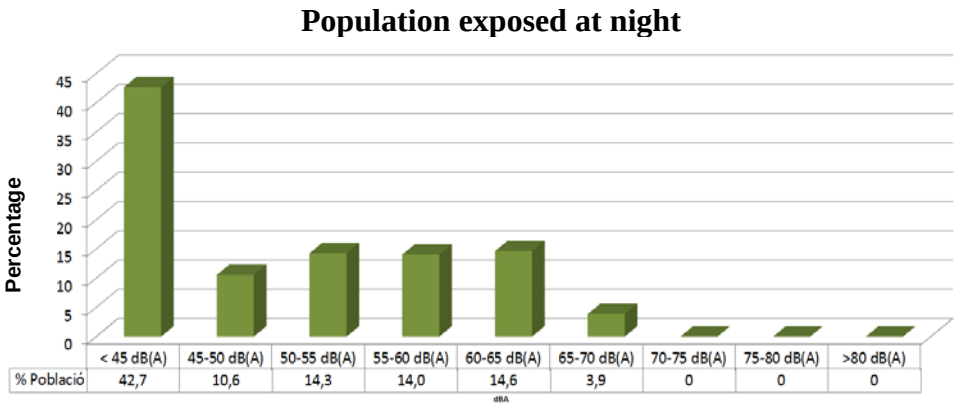

Figure 4. Percentage of population exposed to each sound range at night. Total noise.

5.4 Exposed population data by territorial distribution (by night and by sources)

With regards to the most unfavourable period that could have the greatest impact on the health of citizens –night-time–, a territorial analysis has been carried out below to disaggregate the differences between districts. Thus, the following graphs are shown with the percentage of the population exposed to a range of more than 55 dBA from the main sources: traffic and leisure.

In the case of road infrastructure, the Eixample district stands out over all others (50% of the population exposed to more than 55 dBA at night – Graph 3). This district is the central core of mobility in the city, due to its strategic location and its urban layout. Its streets have traffic intensities comparable to major roads (e.g. c/Aragó 80,000 veh./day) immersed in the urban fabric.

In contrast, the Ciutat Vella district, where pedestrian areas have historically been prioritised in the Old Town neighbourhoods, where traffic is residual except on the main roads that cross it, only 14% of the population experiences levels above 55 dBA at night.

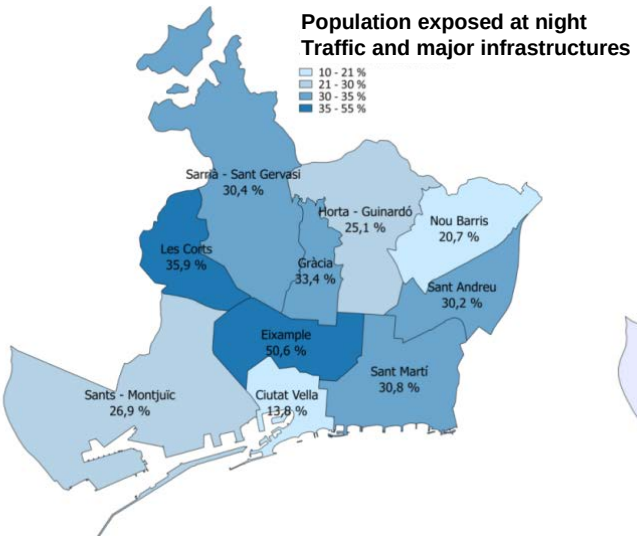

Figure 5. Percentage of population exposed by district, traffic noise and major road infrastructure at night >55dB(A)

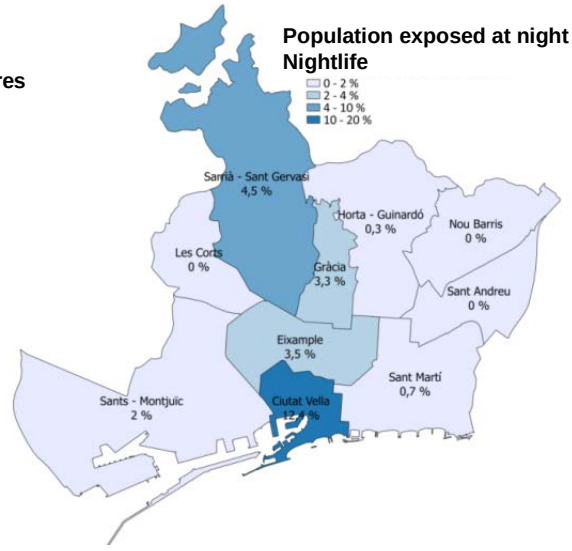

Figure 6. Percentage of population exposed by district, nightlife noise and agglomerations of people at night >55dB(A)

If we focus now on nightlife and crowds –Graph 4– we can note the predominant territorial axis formed by the districts (Ciutat Vella-Eixample-Gràcia-Sarrià St Gervasi). Ciutat Vella is the territory that brings together more people exposed to leisure noise greater than 55 dBA (12%). However, it is worth mentioning that although this occurs in very focused areas and the percentages are not very high, this source of noise generates the most conflict for citizens, who complain and report that the nuisance affects their health.

6. CONCLUSIONS

As a result of the development of the SNM 2017 and with respect to the evolution of sound levels per street section, a trend towards improvement is shown, confirming the value of the actions carried out. The zones with lower noise levels have increased very significantly, given the detailed diagnosis in this edition, which has better identified the areas sheltered from traffic and experiencing very good acoustic quality.

In reference to the exposed population, as in the previous SNMs, the source with the greatest impact is traffic along with the so-called large road infrastructures, although there are notable differences between districts. However, nightlife is one of the sources that produces the most nuisance for the population, suggesting the importance of supplementing these data with the variable perception (which is difficult to objectify) and with studies on its effect on health, as acoustic comfort is increasingly valued as a factor of quality of life.

Likewise, reducing urban noise pollution, reducing the exposure of the population and protecting quiet areas is a task that is carried out continuously and involves seeking solutions to problems detected from all fronts, whether generators or receivers of noise. The next step is therefore to act in a coordinated manner in the form of an Action Plan with the aim of moving towards a culture of urban sustainability.

7. REFERENCES

[1] http://www.bcn.cat/estadistica. Ajuntament de Barcelona

[2] *2017 tourist activity report for Barcelona*. Observatori del Turisme a Barcelona.

[3] Basic data on mobility. 2016 report. Ajuntament de Barcelona

[4] Stylianos Kephalopoulos, Marco Paviotti, Fabienne Anfosso-Lédée (2012). Common Noise Assessment Methods in Europe (CNOSSOS-EU)

[5] Urban Ecology Survey. https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/109254. Ajuntament de Barcelona

[6] Incidents, complaints, suggestions, queries and thanks from citizens to Barcelona City Council (IRIS) 2017. http://opendata-ajuntament.barcelona.cat/data/es/dataset/iris