



## Noise pollution in São Paulo: actions towards public policies

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### ABSTRACT

**In Brazil, we do not have a public policy to environmental noise management, which is essential to avoid the adverse effects of noise pollution on citizens. To develop a national policy, a strategic noise map for diagnosing usually is the first action. Until this moment, only two noise maps have been carried out by public administration, and noise action plans are rare. Looking forward to stimulating noise policies, the Brazilian Association for Acoustical Quality - ProAcustica - has worked since 2011 to articulate different public administration levels, sharing noise mapping knowledge and conducting studies to propose a noise map methodology adequate for Brazil. The elaboration of the São Paulo's Noise Map was discussed in three annual conferences (2014/15/16) promoted by ProAcústica and the City Council, with the main stakeholders. This process resulted in a law, approved in 2016, that enforces the execution of São Paulo's Noise Map. Since then, ProAcustica has mapped two different neighbourhoods, aiming to support the City Hall technical staff to kick-off the whole city noise mapping. In addition, the Association has conducted actions to increase society and media awareness. This paper summarizes the main actions and milestones.**

### 1. INTRODUCTION

The noise pollution is responsible not only for causing annoyance and discomfort on people but also is recognized by the World Health Organization (WHO) as a matter of public health. The long term exposure to high noise levels can cause effects from simple headaches to a sort of hearing aids and can even potentiate heart diseases, like hypertension and ischaemic heart diseases [1]. In this scenario, the establishment of a robust public policy to environmental noise management is essential to prevent and reduce the adverse effects of noise pollution on the population, especially in cities like São Paulo - one of the largest cities in the world, with more than 12 million inhabitants.

In Brazil, there is a general absence of the public bodies on environmental noise management. There is no clear guideline to the cities noise control through legislation as well noise action plans are rare so far. Although this is possible to notice an increase of the population awareness, there is a general lack of sense about noise problems in Brazilian society.

To develop a national noise management policy, the strategic noise map for noise diagnosing is a relevant tool for city planners. Without noise maps, it is not possible to precisely identify the

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sound problems of a city. Therefore, governments should invest in it. Unfortunately, in Brazilian territory, the theme is not yet well developed. Although the country counts with more than 300 cities with over than 100.000 inhabitants, there were just some noise mapping examples, e.g. São Paulo, Brasilia, Copacabana, Petrópolis, Aracaju, Belém and Fortaleza and until the present moment, just the noise map from Fortaleza [2] was carried out by the public administration and resulted in some effective actions.

In this context, the Brazilian Association for Acoustical Quality - ProAcustica - has strived since its creation in 2011 with the environmental noise pollution, working to increase the awareness and permeate the theme with the public administration and citizens. The ProAcustica Environmental Acoustics Committee was the first Committee created by the Association and it is one of the most active until nowadays.

This paper outline the methodologies and outcomes from the work handled by the Brazilian Association for Acoustical Quality to improve comprehension of noise pollution on the population and the governments, aiming to stimulate the establishment of noise management politics in São Paulo city.

## **2. ACTIONS TOWARDS PUBLIC POLICIES**

### **2.1 Municipal Conference on Noise, Vibration and Sound Disturbance**

Looking forward to increasing noise awareness on the population and to stimulating environmental noise management through public policies in the city of São Paulo, the ProAcustica Association has, since 2012, promoted actions on the urban context during the International Noise Awareness Day (INAD) campaigns.

The first urban intervention carried out by ProAcustica took place during INAD, in April 2012, with the installation of a noise level measurement station at the São Paulo Museum of Art (MASP) located on Paulista Avenue, one of the main financial areas of the City. The objective was to draw the attention of the population and attract the media to the serious noise pollution problem in the region with high levels of noise. The campaign had remarkably a great spontaneous repercussion in the media and was reported on the main news programs on local and national networks, in prime time and impacting millions of people.

At the INAD of the following year (2013), the Association led a discussion forum with the participation of representatives of public organizations, legislators, specialists in acoustics, civil construction, academics and civil society. The panel with the theme "Building Acoustics" addressed the acoustic performance of residential buildings and their requirements for acoustic comfort impacted also by external noise. And, for the first time, the country's pioneering experience in elaborating the mapping of urban noise aimed at mitigating noise pollution implemented by the City of Fortaleza, Ceara, Brazil, was presented in the panel "Environmental Acoustics".

The debates promoted during INAD 2012 and 2013 evolved and strengthened ties with the politicians and legislators Andrea Matarazzo and Aurelio Nomura from the São Paulo City Council. In 2013, a first text was prepared that would result in the Bill on the Urban Noise Map of the City of São Paulo. From 2014 and for the next three years, ProAcústica, together with the São Paulo City Council, held annually the "Municipal Conference on Noise, Vibration and Sound Disturbance" [3,4,5] promoting debate, awareness and the search for mitigating solutions in the fight noise pollution, as a serious public health problem. The Conferences counted with the participation of state and municipal authorities, civil society and class entities, the corporate and academic sectors and also the general population. It was a qualified space for the public sphere and to stimulate effective legislative and administrative actions. On the opportunity, the lectures and talks covered themes like noise mapping state of the art and its elaboration importance on the urban noise management strategies, life quality and public policies, legislation and tendencies for reduction and management

of noise pollution. Also, the experience in noise mapping from the cities of Valencia (Spain) and Almada (Portugal) were presented by their delegates. Year after year, the Municipal Conference brought together the various sectors of society, informed the population, reverberated in the media and pressured the legislature and the executive to enact the law and subsequent regulation of the Urban Noise Map of the city of São Paulo. Figure 1 shows some highlights of the Conferences.



*Figure 1: Images of the Municipal Conference on Noise, Vibration and Sound Disturbance from the years of 2014 and 2015 in the city of São Paulo.*

## **2.2. Noise map local legislation in São Paulo**

After the discussions and issues presented on the three editions of the Municipal Conference on Noise, Vibration and Sound Disturbance, the local law nr. 16.499 (Urban Noise Map) was enacted, in São Paulo, on July 20th, 2016 [6] under the responsibility of the city councillors Andrea Matarazzo and Aurélio Nomura. This local law laid out steps for the obligatory elaboration of the Urban Noise Map of the São Paulo city, within a 7 year period - until 2023 - by the municipal Executive power. The elaboration of the Urban Noise Map should take account of the noise sources responsible for the noise pollution of the city, during the period of day and night, aiming its quantification, considering the sources coming from traffic noise, among others. The map can be used by the public bodies to diagnose and stipulate actions to mitigate the noise problems of the city, as well as preserve the quiet areas that already exist.

This local law enactment is certainly a start point to noise management in the city of São Paulo and also for other Brazilian big cities that can be influenced by it. An example is the case of the city of Rio de Janeiro that already is discussing a legislative bill for the Rio de Janeiro noise map elaboration.

Although the local law nr. 16.499 has been enacted in 2016, the local decree nr. 58.737 [7], which regulates the elaboration of the Urban Noise Map of the city of São Paulo, was a required supplement to start the city noise mapping discussed in the city council for almost three years and just came up on May 2nd, 2019.

This decree determines the responsible municipal divisions that must take part in the São Paulo Noise Map construction and compose a management board group to this map elaboration. The decree enabled this board group - composed by different authorities of the city, like Urban Development, Transport and Mobility, Environmental, Sub City Councils, Technology and Innovation authorities - to start the work. The board group has met for the first time in February 2020.

## **2.3. Noise Mapping Technical Group**

In 2017 Proacustica Association has started the technical group for noise mapping to conduct studies aiming a noise map methodology, using data and characteristics of local vehicles, pavements, among other factors [8].



More than 15 companies and 20 experts, in which 3 of them had experience with the implementation of noise maps in Spain and France, took part in this group voluntarily. Within two years, the group was able to develop the three main work steps:

- 1) Investigation of the best practices of noise mapping for the Brazilian reality, in 2017.
- 2) Elaboration of a São Paulo Pilot Noise Map, in 2018.
- 3) Elaboration of the São Paulo Downtown Noise Map of area, in 2019.

In the first step, several studies were carried out by the technical group, comparing simulated and measured data to define which calculation methodology best represents the Brazilian reality, comparing mainly the vehicles and pavements conditions in São Paulo. Different European calculation models were tested and the results have shown that the methodology that matched at most is the Common Noise Assessment Methods in Europe (CNOSSOS-EU). Also, considering the complexity of the city other aspects were studied to investigate factors like the need to use medium or maximum speed, the use of traffic lights and the gradient of the roads. In this process, the European Good Practice Guide for Strategic Noise Mapping [9] was used as well to evaluate the recommendations and relate them to the Brazilian reality. Those results are published on the paper “The pilot noise map of São Paulo: first findings and next steps”, presented on the Internoise 2018 [8].

The guidelines defined by the Noise Mapping Technical Group were first applied at a sample region, determined by the Municipal Secretary of Urbanism and Licensing (SMUL) of the São Paulo city, and was called the Pilot Noise Map. This pilot project was elaborated in a region of São Paulo, located between the Paulista, Brazil, 9 de Julho and 23 de Maio avenues, considering the road traffic noise for the day and night periods, as shown in Figure 2. The details of this work were also presented on the Internoise 2018 [8].



*Figure 2: Day and Night noise map of the sample region.*

To stimulate the city council at the beginning of the São Paulo mapping, in 2019, based on the experience acquired on the several studies and the Pilot Noise Map, ProAcustica selected another city area to map: the downtown. This work is going to be presented in the next section.

At the beginning of 2020, the noise map board group of the city council, established by the local decree nr. 58.737, have met for the first time and invited ProAcustica to collaborate. At this first meeting, the Association has presented the maps developed for the two neighborhoods of São Paulo city and there carried out studies. Unfortunately, until the present moment, no further work was accomplished by this group, due to the Coronavirus Pandemic

## 2.4. São Paulo Downtown Noise Map

The downtown noise map of São Paulo was developed upon an area covering part of the old and new center and some historic regions of São Paulo city. The mapped region totalizes an area of approximately 6.6 km<sup>2</sup>. This region was chosen because of its localization in the heart of São Paulo and also because it is pointed out in the local law nr. 16.499 (Urban Noise Map) as a priority region to be mapped. The city center, which has many avenues, elevations, intersections, tunnels, walkways, is an acoustically complex scenario. In this modelling, as sound sources, the road traffic, railway and pedestrian circulation areas were taken into account for the day and night situations.

For the elaboration of this noise map, the software CadnaA [10] and the Common Noise Assessment Methods in Europe (CNOSSOS-EU) [11] methodology, as established as suitable Methodology applicable to Brazilian reality on the studies carried out in the Pilot Map, were utilized, as well as the guidelines of the European Good Practice Guide for Strategic Noise Mapping [9]. Using the guidelines and expertise acquired on the Pilot Map area mapping, the input data for the downtown modelling will be briefly described. The vehicle flow data was obtained by means of counting or by the public available information from the Traffic Engineering Company (CET) of São Paulo [12] and the vehicle types divided into 4 categories, as required by the CNOSSOS methodology - light, medium-heavy, heavy and motorcycle category.

The maximum velocity was adopted and obtained from the road signs by means of visual inspection using the Google Street View on the Google Earth platform [13]. In Brazil, there are not many pavements characteristics, so that the pavements were divided into four categories: concrete, smooth asphalt, even pavement stones, uneven pavement stones and related to the CNOSSOS classification. Based on the European Good Practice Guide for Strategic Noise Mapping [9], this information was also obtained, by the visual inspection technique, on the Google Earth platform. The buildings and streets geometry were extracted directly by the open source OpenStreetMap platform [14]. The topography was taken from the Geosampa platform [15]. The ground absorption was set as 0.2 for buildings up to 6-meter-high and 0.4 the others. Also, the meteorology and the traffic distribution entry data were obtained from the European Good Practice Guide for Strategic Noise Mapping [8]. The map simulation was carried out with one reflection, due to calculation time. A study about the configuration optimization for the calculations, to be applied to city noise mapping over large areas was carried out and published in the Internoise 2018 article called “The use of pilot areas as a base for large-scale strategic noise mapping: technical aspects and application of software-based strategies” [16].

For the validation of the downtown noise map, 62 measurement points were selected within the area. The measurements were carried out, voluntarily, by the company members of the Noise Mapping Technical Group. These companies were required to carry out measurements of 15 minutes with the microphone positioned at 1.50 m height, based on a drawn-up guide procedure. Besides that, it was also required vehicle counting per category during each measurement. The selected measurement points were, also conceived, to characterize the different road types, which have different vehicle flow characteristics. The delimited downtown area and the selected points for the map validation are shown in Figure 3.

After that, the São Paulo downtown noise map for the day and night period is shown, respectively, in Figure 4 and Figure 5. The noise map was published online, compatible with the google earth platform [17].

The applications of the elaborated noise maps are several, such as prediction of mitigating measures, evaluation of the affected population, the impact of noise in each building and identification of quiet and problematic areas concerning the city legislation [8] and an example is published also published on the online platform [17].



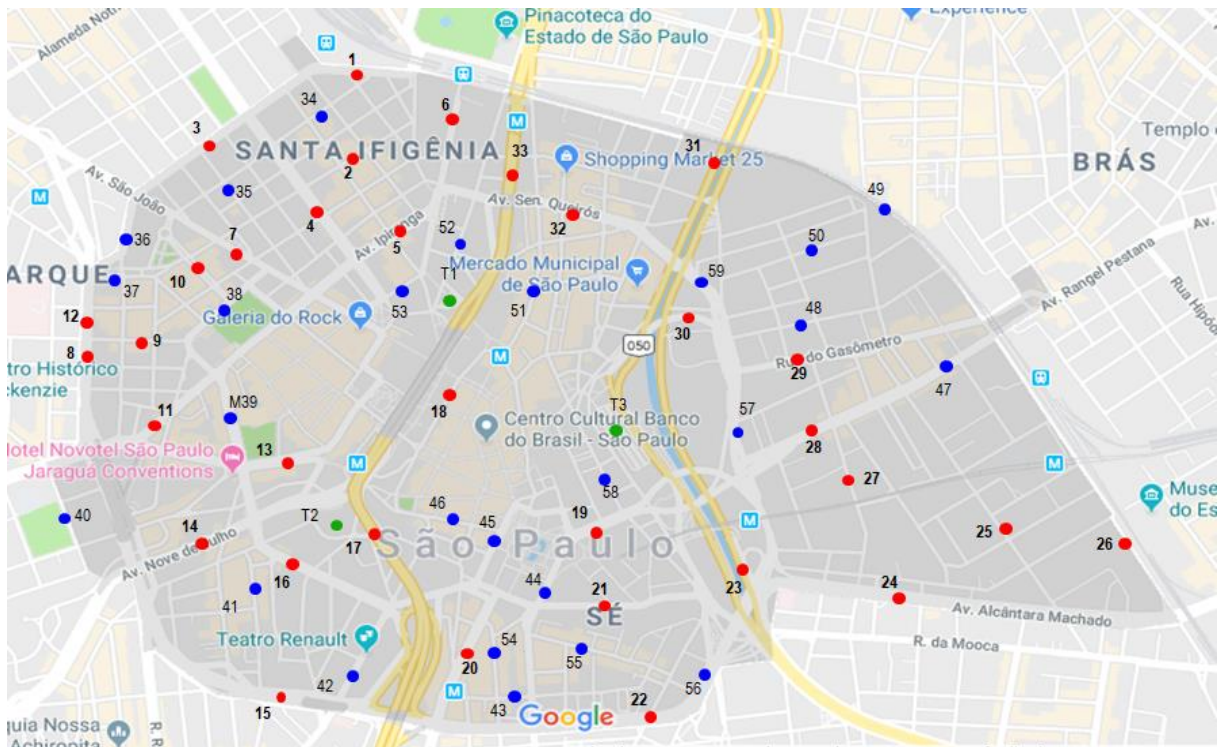


Figure 3: Downtown area borders and the 62 measurement points for the noise map calibration.



Figure 4: Day noise map of the sample region.





Figure 5: Night noise map of the sample region.

## 2.5. Actions within the International Noise Awareness Days

The International Noise Awareness Day (INAD) [18] has been a landmark data for the ProAcustica Association. Since its creation in 2011, by INAD date the Association has promoted actions to raise the population awareness about the impacts of noise and vibration in human health. Part of these actions was directed to, or conducted with, the government bodies, as the Municipal Conferences held in 2014, 2015 and 2016. These initiatives had, as well, called attention of the media - mainly television and newspapers. From the front page of a leading newspaper of São Paulo to national coverage TV broadcasters, INAD gained status of national event. The actions from 2012 to 2016 were already outlined in Section 2.1. In the sequence, the INADs from 2017 will be briefly presented in this section. More details about them can be accessed on [19].

For the INAD of 2017, one of the most famous monuments of São Paulo, the “Monumento das Bandeiras”, received giant yellow “ear protectors”, as a warning sign to the excessive noise in the big cities, a gesture in favour of the silence. Below, Figure 6 shows the highlights of these actions, which counted with the participation of many children and teachers. Complementing this act, ProAcustica with the city’s environmental authority have organized a parallel event aiming the public and political commitment of combat on noise pollution and implementation of the noise map.



Figure 6: International Noise Awareness Day promoted by ProAcustica in 2017.



In 2018, the INAD urban action took place at Paulista Avenue, one of the most important places in São Paulo city. At this time, the urban action gained a mascot, called “Decibeto”, created to transmit the noise pollution message to the population. On the occasion, the Pilot Noise Map was also launched online and displayed on a video wall at the Paulista Avenue. During the daylight, a noise level measurement station displayed on a video wall was installed at the FIESP Building. Also, with the special participation from a school class and a living statue, 60-second silence was carried out, starting at 14h25. During the night period, the mascot Decibeto was projected on the FIESP Building video Façade. The projected character with big ears rejoices in silence and is annoyed by the noise increase. Figure 7 illustrates the Decibeto projection and the living statue moments.



*Figure 7: International Noise Awareness Day promoted by ProAcustica in 2018. Projection of Decibeto character on the left side and the living statue on the right.*

On INAD of 2019, the non-motorized mode of transports was explored at a noisy expressway of São Paulo, the “Elevado Presidente João Goulart” popularly known as “Minhocão” (big worm). Since its construction, this expressway has generated discomfort and complaints from the population, which lives on the surrounding buildings regarding especially on noise problems. This was the chosen place for the realization of a night bike tour to the population, period in which the expressway is closed to the vehicles. This tour was supported by the Municipal Secretary of Urban Development (SMDU) as well by Grow company [20], which has gentled lent bikes for this tour. On the same occasion, the São Paulo Downtown Noise Map has been launched on an online platform [17].



*Figure 8: International Noise Awareness Day promoted by ProAcustica in 2019.*

The year 2020 has been remarkable with the Coronavirus Pandemic so that Proacustica INAD action accomplished virtually. Many cities became suddenly empty and quieter in this period, but not in a natural form. Conversations and music shared on the balconies, the song of the birds, the work involved by children's playing on the background, and so many other sounds previously unnoticed



captured the attention of people. For many people, the sound has turned, in this delicate time, the only way to communicate and express themselves. For this reason, the Association decided to explore the positive aspects of sound and created the #SoundsILove campaign, in which people were encouraged to record a video from sounds that they love to hear and make them feel well and share it with others on a big online audiovisual gallery [21].

For the next year, ProAcustica is planning an action with national extent, to explore the soundscape theme on the INAD 2021. The population will be encouraged to hear and perceive the city sounds participating in soundwalks, using the Hush City App [22], an open-source mobile app developed on the Technical University of Berlin (TU Berlin), to allow people to identify, access and evaluate everyday quiet areas in worldwide cities neighborhoods. The information collected by these app users goes to the Hush City Map, which can be accessed on the platform website [23]. This action attempt to collaborate to create a better common awareness sense on the population about city soundscapes and the noise pollution issue.

### **3. CONCLUSIONS**

The approaches carried out by the Brazilian Association for Acoustical Quality to improve the population and public bodies awareness regarding the noise pollution issues and the necessity to legislate upon it, like the Municipal Conferences, Noise Mappings studies and INAD actions, has influenced the São Paulo city councillors to elaborate public policies by local laws.

Through the Municipal Conference on Noise, Vibration and Sound Disturbance on the years of 2014, 2015 and 2016, the politicians could be aware of the sound problems of the city as a matter of public health. This effort stimulated the enactment of the local law nr. 16.499 (Urban Noise Map) in 2016 and three years later the local decree nr. 58.737 that regulated the elaboration of this map by the city Executive power.

With the studies carried out by the ProAcustica Noise Mapping Technical Group, it was possible to stipulate methodologies, guidelines and apply it to the Pilot and the Downtown Noise Map of São Paulo, launched by ProAcustica on INAD 2018 and 2019. The noise maps and its applicabilities are available in an online platform and can already be used by the population and public bodies as a tool to identify problematic regions of the city.

From now on, the municipal noise map board group must establish an agenda to the São Paulo city Noise Map elaboration expecting to finalize it in 2023, like outlined by the law. ProAcustica, as far as requested, intends to collaborate sharing know-how with the board group to assist on the noise map planning and elaboration and further, also to set up measures to the noise mitigation plan.

With this work - initial maps, conferences and actions spread out by the media vehicles - it is expected from ProAcustica to continue to enhance awareness of the population and politicians over the importance of the cities noise management policies existence on large cities - not only in São Paulo but extending it to the entire Brazilian territory.

### **4. ACKNOWLEDGEMENTS**

The acknowledgments go to all the participating members of the ProAcustica Noise Mapping Technical group, especially to whom that disposed own resources for conducting studies and measurements, brought their technical experience on the elaboration of city noise maps and to the companies that voluntarily carried out the measurements for map validation: 01dB Acoem, Acoustic Control, Acústica & Sônica, Akkerman Alcoragi Acústica Ideal, Atenua Som, Bracústica, Ecoa Consultoria Acústica, Giner Sound Vibration, Grom Acústica e Vibração, Harmonia, Passeri e Acústica e Arquitetura and Scala Acústica. Thanks to the DataKustik for providing access to CADNA-A for this research and for upload the noise map on the online platform.

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