

## **The soundscape of Santa Marta Favela, Rio de Janeiro, Brazil**

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### **ABSTRACT**

The soundscape is an important component of the environmental quality. A place may be hostile or pleasant to users depending on local sounds. Urban spaces perceived as acoustically comfortable help to create opportunities for recreation and psychological restoration of mindful stresses. On the other hand, the composition of the soundscape reflects the way of life, the activities and liveliness of an urban space. The aim of this paper is to present a soundscape approach through the combination of quantitative and qualitative analysis techniques. The methodology was applied in the Favela Santa Marta, in the Morro Dona Marta, located in Botafogo neighborhood, South Zone of Rio de Janeiro, Brazil. The place could be considered as a good representation of the daily life of large part of the people who live in informal land occupation in the hill slopes of the city. Due to its urban form - organic pathways and accentuated topography that makes impossible the vehicles circulation - the soundscape is dominated by sounds of nature and human activities, which characterize the social and cultural aspects of the community way of life.

**Keywords:** Soundscape, sound quality, soundwalk, slum, urban form.

**I-INCE Classification of Subject Number:** 52

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### **1. INTRODUCTION**

There is a multiplicity of sound sources in the urban environment, besides the vehicle traffic, which are usually not taken into consideration. One of the difficulties of sound analysis in these places is also to characterize and evaluate the relevance of this variety of sources. Moreover, the sounds are perceived differently for each passerby, influenced by cultural, social, memory, among others.

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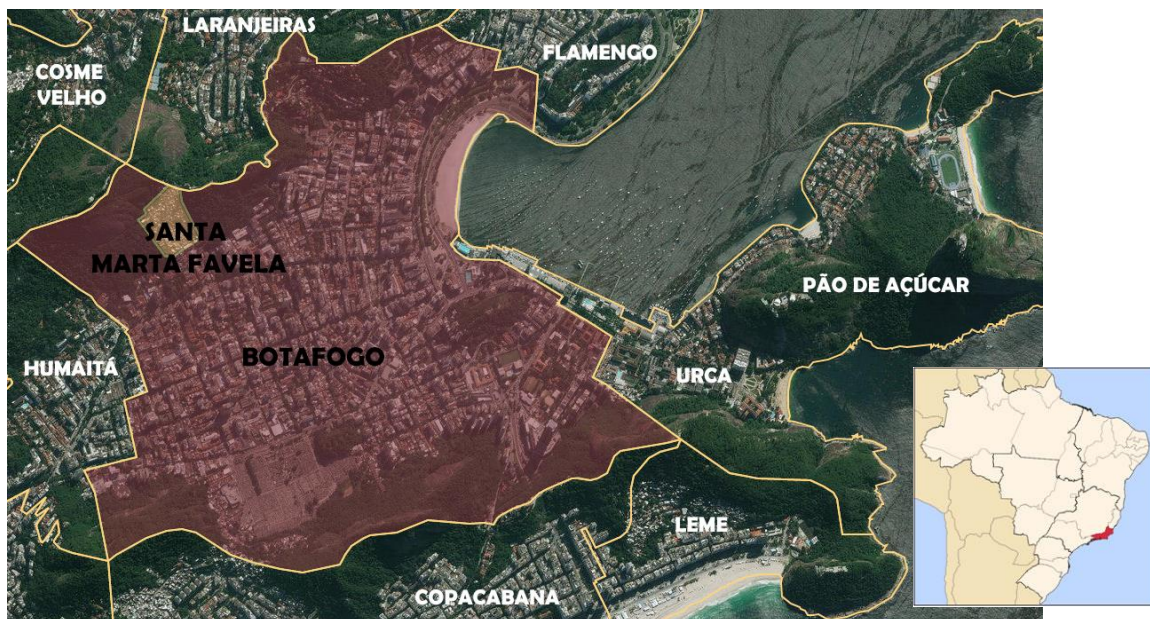
In this sense, some recent researches aim to analyze the sound dimension no longer as a simple nuisance, but rather as a qualitative argument for the management of the cities, which also recognizes the positive aspects of the sounds of our daily life. It is observed, therefore, an evolution of the approach that starts from the study of "disturbing noises" to that of "sound environments" [1]. This new vision stimulates other possibilities of describing the acoustic environments, besides allowing models that approach this complexity.

Thus, describing urban sound phenomena in a way more adapted to the perceptual reality of daily life of the population distances us from a traditional quantitative approach and approaches the sound environment as an indicator of quality of life, not just as a measurement of an unavoidable nuisance. The urban forms, their uses and the social practices also integrate themselves and are part of the analysis of the "sound ambiances" [2].

The objective of this article was to study the soundscape of Santa Marta Favela and its surroundings, based on an integrated approach, considering the quantitative and qualitative aspects, with a multidisciplinary character, dealing with the sound sources inserted in the urban context and considering the human variables as well.

The "favela"<sup>3</sup> is a reality that affects not only Brazil, but also several other countries. The population of the "favelas" represents a total of 22.03% of the population of Rio de Janeiro [3]. Today we have the challenge of producing creative ideas that can effectively lead to the integration of marginalized areas into the urban space and provide a better quality of life for its residents. Thinking about the future of contemporary cities, one cannot let reflect about this type of informal urban settlement and the place diagnosis is presented as a first step.

Santa Marta Favela, located in the Botafogo Neighborhood (see Figure 1), in Rio de Janeiro, has formal characteristics completely different from its surroundings and also represents the way of inhabiting of great part of the population of the City. The origin of the shantytowns, in Rio de Janeiro, started from the occupation of the hills, which lasts until today, as in the case of the shantytown chosen for the study.



*Figure 1: Botafogo neighborhood with highlight to the Santa Marta Favela. Location of the State of Rio de Janeiro on the map of Brazil.*

<sup>3</sup> Favela is the name given to the slums or shantytowns in and around the large cities of Brazil.

## 2. METHODS FOR THE ANALYSIS OF THE SOUNDSCAPE

The physical aspects of soundscape that interact one another and that were mentioned in the research are: the physical effects of the sound (intensity, frequency and duration), the conditions of the environment in which it is inserted (distance, height, urban form, other ambient noise, etc.) and the user of the space (perception, personal sensitivity, memory, etc.).

### 2.1 The Soundwalk

The methodology of the soundwalk chosen to be applied in the present research is the one worked by the GRECCAU group of the *École Nationale Supérieure d'Architecture et de Paysage de Bordeaux*, in France. The soundwalk presents itself as an integrated research method that analyzes, both the quantitative aspects as the qualitative of the sound aspects of a space.

Inspired by the work of Kevin Lynch [4] "The image of the city", the method proposed by GRECCAU-Bx works with paths in urban space where "sound scenes" (meaningful sound events) are recorded. [5]. As the urban soundscape is the product of a wide variety of sound sources, it is argued that phonography (a word proposed by Abraham Moles, in 1972, referring to sound recording by analogy with photography) can preserve specificity of the sounds of urban sites. With the use of phonography, every sound event can be preserved, in a way that we can identify it afterward [5]. Thus, the basic principle of the soundwalk method developed by GRECCAU-Bx is to make recordings of urban sounds, totally devoid of prior judgment in relation to their quality, which complements the standard acoustic measures of urban noise.

To generate reliable information, the soundwalk must be repeated several times, contemplating the diversity of activities and compensating the noise fluctuation on time. Therefore, it should be performed at different times of the day and different days of the week, analyzing the difference between days with and without vehicles [6].

The procedure used by GRECCAU-Bx to describe the spatial distribution of sound energy is through a binaural recording technique. This technique relates to both ears, so that allows us to determine the direction of the origin of the sounds and create the effect of ambient sound. Thus, the binaural recording widely used in the acoustic of the rooms was adapted to the external spaces, bringing an innovation to the soundwalk method. During the pathway, all sounds are recorded by a pair of microphones, placed at the level of the ear, which simulates this binaural perception. As the recordings are performed at the researcher's height, the obtained signals are like those perceived by pedestrians, creating a more realistic perception of the sound environment.

For the research records it was used the ZOOM Corporation recorder, model H4n. In addition, the binaural microphone was manufactured by GROM Acoustic & Vibration company and later, calibrated in the LAVI - Laboratory of Acoustic and Vibrations - COPPE/UFRJ.

The results are obtained for each recording part, that is, for each ear (right and left). The data are processed in a computer program capable of converting the recordings, along with a calibration of the microphones (to be performed before the pathway), in intensity values per frequency, over time. The presentation of this data is afterward worked in Excel, in the form of 3D graphic (sound level, time and frequency), called acoustic image.

Initially, there was interest to go through the entire length of Santa Marta Favela. However, in the course of the work, the dynamics of the shantytown has been changing. Conflicts between drug traffickers themselves and with UPP police (Peacekeeping Police Unit) have become increasingly intense. Moreover, currently several regions of

the hill have traffic controlled by traffickers. All the research had to be accompanied by tourism guide Ms Verônica Moura, a resident of Santa Marta Favela, who also had to talk to some groups explaining the research. The guide, before beginning the pathway, always made herself informed about the situation of the slum and always checked the conditions to make the trajectory. Several days of field work had to be postponed because of the conflicts. Therefore, the tour in the slum was reduced and certain places were avoided.

So, the trajectory was designed to reach out different urban forms in the slum scale, such as areas with less people circulation, more open places, alleys, and mainly, some of the main pathways. With the help of the tour guide, it was possible to continue with the area of study, even at a delicate moment in relation to security and the intention to analyze a completely different urban form of the formal city was reached.

It is advised that the soundwalk data should be complemented with video and photo records, simultaneously with recordings. However, for the present work, the filming was not possible, and the photographs also needed special attention to avoid problems with the residents. Therefore, it was only the tour guide who photographed the spaces, because she knew better the places and people who could or could not be photographed.

Therefore, a map of the trajectory was taken to the field, for each day. On the maps, there were marks of some information about the sound sources, the activities developed and the exact locations that occurred the sound events, with the hour, also specifying the minutes and seconds. Due to this, a team of three people was needed to participate in field work. The tour guide was going to be responsible for the photographs, the second person operated the recording equipment and the other wrote down the information on the maps.

The fieldwork took place during the month of November and beginning of December 2017, with seven days of soundwalk, performed on weekdays, weekends and varied schedules. The times chosen were 10:00 a.m., 4:00 p.m. and 7:00 p.m., as those are the hours with the largest circulation of people in Santa Marta Favela, according to information from the local tourism guides. The night shift (after 10 p.m.) could not be included in the research due to security reasons.

## **2.2 Measurements of Sound Pressure Level**

The work of Bruna Lessa [7] was used as a basis for the quantitative data. It was developed during her Master's Degree in the Post-Graduation Program in Mechanical Engineering - COPPE / UFRJ, who elaborated a noise map for Santa Marta Favela. The author performed measurements of Sound Pressure Level, at 6 points in the slum, for six consecutive days. All measurements were based on ISO 1996/2 [8].

Moreover, the data were supplemented with further measurements when required. For this new measurement, NBR 10.151/2000 [9] was used as the basis for specifying the method for field and equipment measurements in Brazil.

## **2.3 Questionnaires**

The objective of the application of questionnaires was to identify the frequency modes of the studied places, their uses, as well as the users' perceptions and evaluations about the environmental aspects in interaction, with special attention to the sound dimension. Actually, the urban sound environment must be related to other aspects of the physical, social and cultural environment. Individuals perceive their environment through the various senses and the perception of one aspect influences the others. For



this, the questionnaires were applied with open and closed questions, directed to the sociological and particular aspects regarding the physical space and the characterization of the sound scenario.

For the formulation of the questionnaires we used the research of Rodríguez and Hirashima [10], which had the objective of presenting the methods adopted and the types of analyzes used in the five most cited studies in the area of soundscape worldwide, for comparison and evaluation of the procedures used and results obtained.

It occurred certain difficulty in the application of the questionnaires in Santa Marta Favela, mainly because the Ethics Committee on Research, in Brazil, requires the signature of a Free and Informed Consent Form, with a text explaining about the research, its risks, the rights of the interviewee, among other questions. People selected, in a random way in the slum, kept refusing to sign it. To solve the problem and to facilitate the progress of the research, most of the questionnaires were applied with the group of Tourism Guides residents. The meeting point for application of the questionnaires was at the tourist information kiosk, located in Corumbá Square (see Figure 2). In this place, 56% of the participants work as a tour guide for Santa Marta Favela. Thus, the issues related to the Public Place, the place where they met and also addressed questions about their home and surroundings, before referring to the slum.



*Figure 2. Place where the application of questionnaires occurred.*

### **3. ANALYSIS OF RESULTS**

#### **3.1 The Soundwalk**

The trajectories of the walk tour were divided into 13 zones of evaluation, created according to the similarity of the soundscape or the urban form. When one of the two parameters began to look very different along the route, a new zone was created. The objective was to identify areas with their own characteristics, which had repercussions on sound ambiances.

Zones 1 to 10 are located in Santa Marta Favela, that is, inside an organic fabric, from the so-called informal city. Zones 11 and 12 are like a transition area, with different characteristics, mainly in relation to the appropriation of the residents, as the sidewalks are normally used as areas of expansion, for commercial use and vehicle parking. In this part, there are streets with vehicle circulation, but also acquire the function of standby and pedestrians' pathways. Zone 13 is part of the so-called formal city, it has an arterial road, São Clemente Street (see Figures 3, 4 and 5).

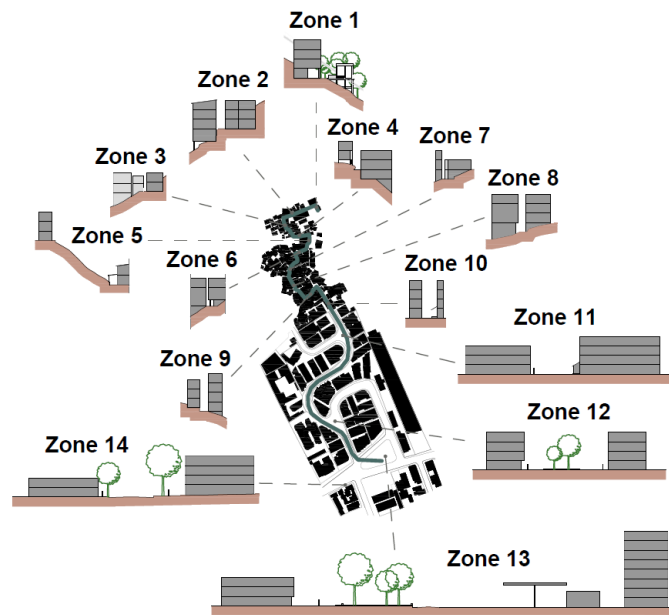
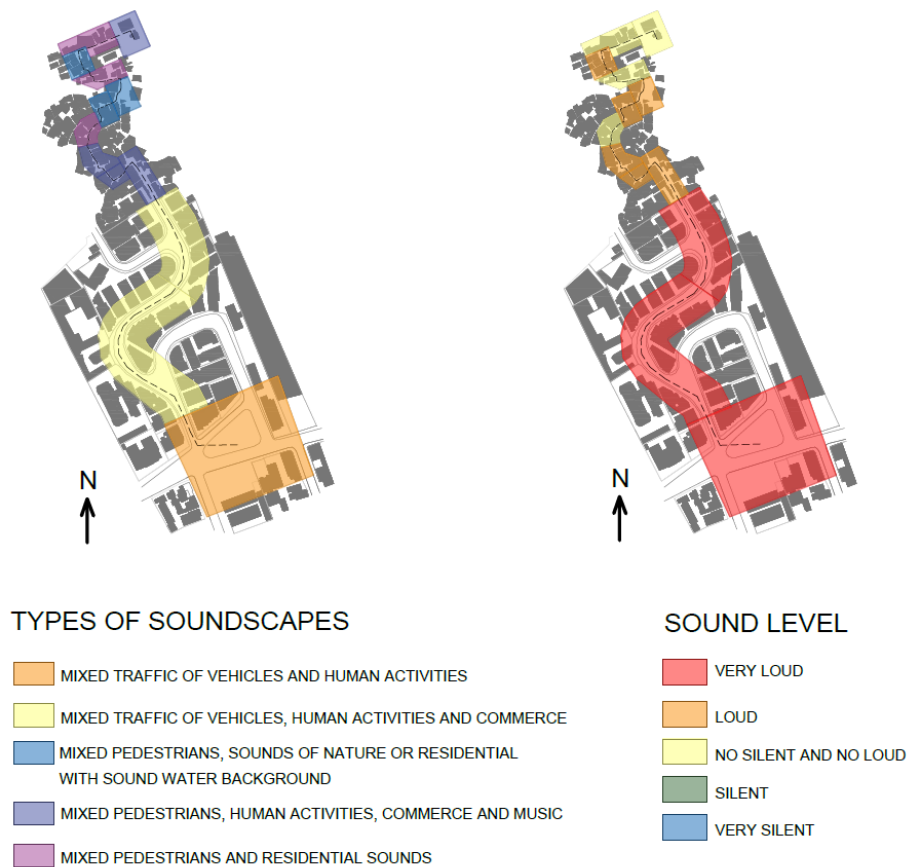


Figure 3: Figure ground map and schematic cross-section of the 13 evaluation zones.



Figures 4 and 5: 13 zones of evaluation with types of soundscapes and sound level.

### 3.2 Measurements of Sound Pressure Level

The quantitative analysis, performed through the measurements, showed that most of the study area has sound pressure levels above the comfort limits laid indicated by the norms [9], including in Santa Marta Favela, even without the circulation of vehicles (see Figures 6 and 7).

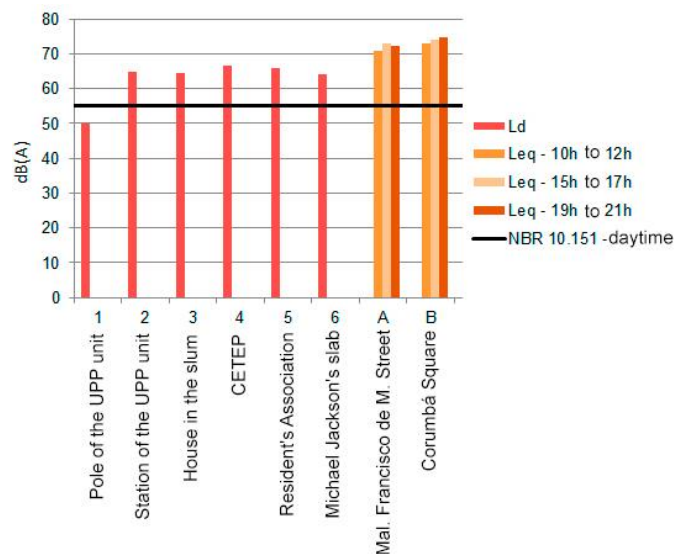


Figure 6: Location of measurement points.

Figure 7: Graphic of measurement result.

The upper part of the Santa Marta Favela is the most tranquil, with the lowest sound levels. The intermediate and lower parts have already higher levels, because they are highly dense areas, with major movement of people, music, commercial activities and services. Moreover, the reverberant environment of the pedestrians' circulation, formed by closed fabric, narrow passages, buildings normally with 3 or 4 pavements, materials used in the buildings and few green spaces in the slum, is favorable to the propagation of sound, which harms the sound quality of their spaces.

On the other hand, the noisiest area of the study area is located in Corumbá Square, in São Clemente Street, with an intense circulation of vehicles and that is also often used by the population of the slum.

### 3.3 Questionnaires

The questionnaires helped in the analysis of the sensitive aspects, focused on the perception of the users. In the graph of schooling level (see Figure 8), it is possible to observe that in Corumbá Square there were no interviewees with postgraduate studies, 50% of the participants had high school and only 6% of incomplete and complete graduate school. It is observed, therefore, that the educational level in the slum is a reflection of the interviewees' economic and social issues.

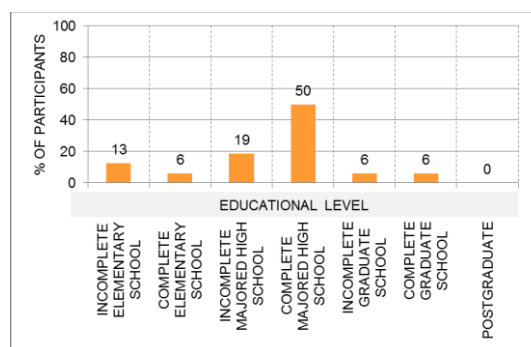


Figure 8: Graphic of educational level.

From the records of the people interviewed in Corumbá Square, 88% live in Santa Marta Favela and only 12% in neighborhoods far from the study area. It is visited daily by 100% of the participants. Moreover, 62% answered that they remain at the site for more than an hour, 19% remain for an hour, as well, those who answered that the time is very variable. In relation to Corumbá Square, in general, aspects such as ventilation, vegetation, temperature and furniture presented satisfactory results, which favors the perception of comfort. The foremost complaints were the lack of security and night lighting.

The sound sources identified were divided into 5 groups: sounds of human presence, human activity, nature, mechanical activity and explosion. The source with the highest frequency of occurrence in Corumbá Square (94%) was the sound of cars, thus, mechanical activity. However, those sounds did not appear in any of the answers of the houses in Santa Marta Favela, only buses with 7%, which can be heard even when distant (see Figure 9).

Other highlighting sounds were those of human activity, such as children playing, present in both sites, with more citations in Corumbá Square (69%). Moreover, it is interesting to verify that 64% of the people living in "Favela" Santa Marta cited the activity of listening to music, but this activity, in Corumbá Square, was not practically observed.

Sounds of human presence such as voices, footsteps, laughter and screams also appeared in the research, as well as sounds of nature. Dog barking was cited by 36% of the interviewees, only in the "Favela houses". Birds' sound was also present. Running water sound stands out in the slum (14%), whose hill has two water springs, being a recurring sound and reported by several people. In Corumbá Square, because of the gas station located in front, it is also possible to hear the sound of water when car wash occurs. Finally, explosive sounds like gunshots (43%) and fireworks (14%) were only commented among residents of Santa Marta Favela.

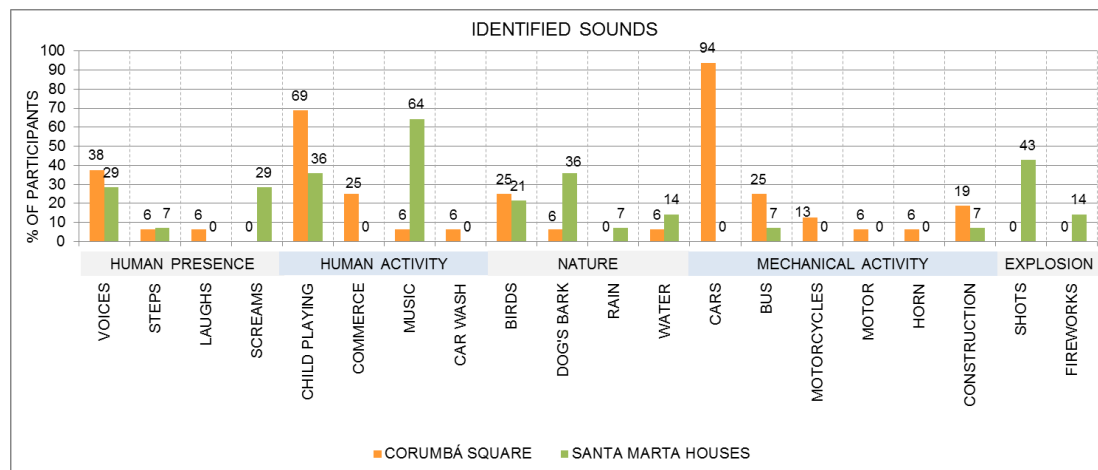


Figure 9: Graphic of the identified sounds.

For the same identified sounds, the participants were asked in relation to their sound preferences. In a general form, the sounds considered pleasant were mainly from the group of activity and human presence, but the nature sounds stand out as well. In Corumbá Square, they mentioned that the sound that pleases more are the children playing (63%). For people living in Santa Marta Favela, the same number of participants cited the sounds of the children playing and the birds (21% each) (see Figure 10).



The sounds of traffic dominate the sound environment of Corumbá Square, characterized by a strong presence of mechanical sounds, which are also the ones with the lowest level of acceptance. The sounds considered most unpleasant in Santa Marta Favela were gunshots and music (43% each). The gunshot sounds leave the population feeling insecure and, consequently, brings a great deal of discomfort. Then came the screaming sounds of people and children (29%), dogs barking (21%) and fireworks (14%). Voices, works and buses had the same number of citations (7%).

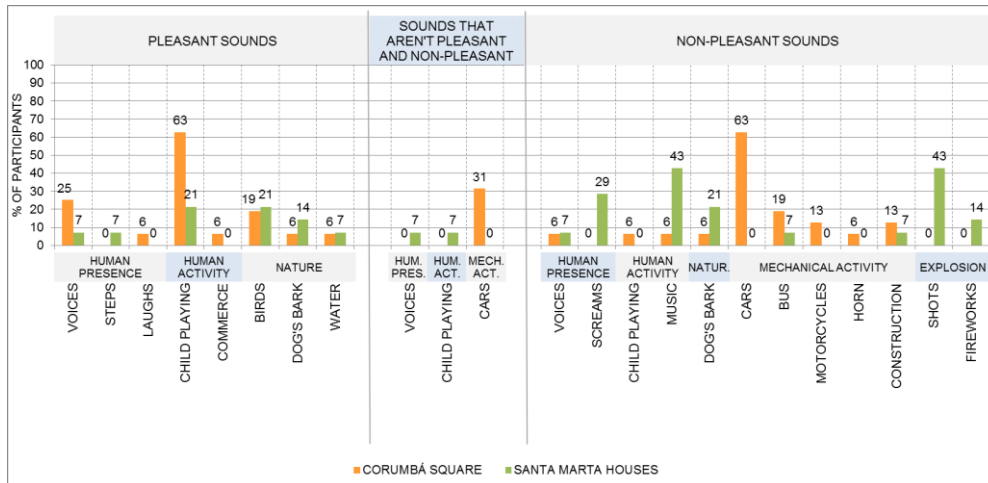


Figure 10: Graphic with sound preferences.

Two objective questions of the questionnaire had the interest in knowing how the participants feel as much in relation to the sound quality as the sound level of the spaces. For this analysis, grades were assigned for each perception of sound comfort. It is noticed that in relation to the final average, the results were not so different, but the sound quality showed a little better evaluated than the levels. For the sound level, the average of the Corumbá Square was 2.1, therefore, it is considered noisy and, for sound comfort, close to 3.0, neither comfortable nor uncomfortable. On the other hand, the houses in Santa Marta Favela had the best final evaluation averages, both in relation to level (2.9) and to sound comfort (3.2) (see Figure 11).

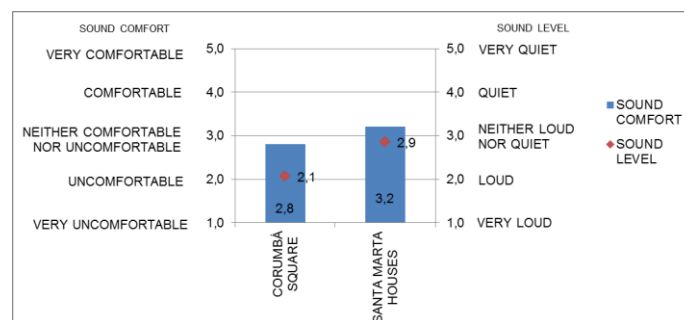
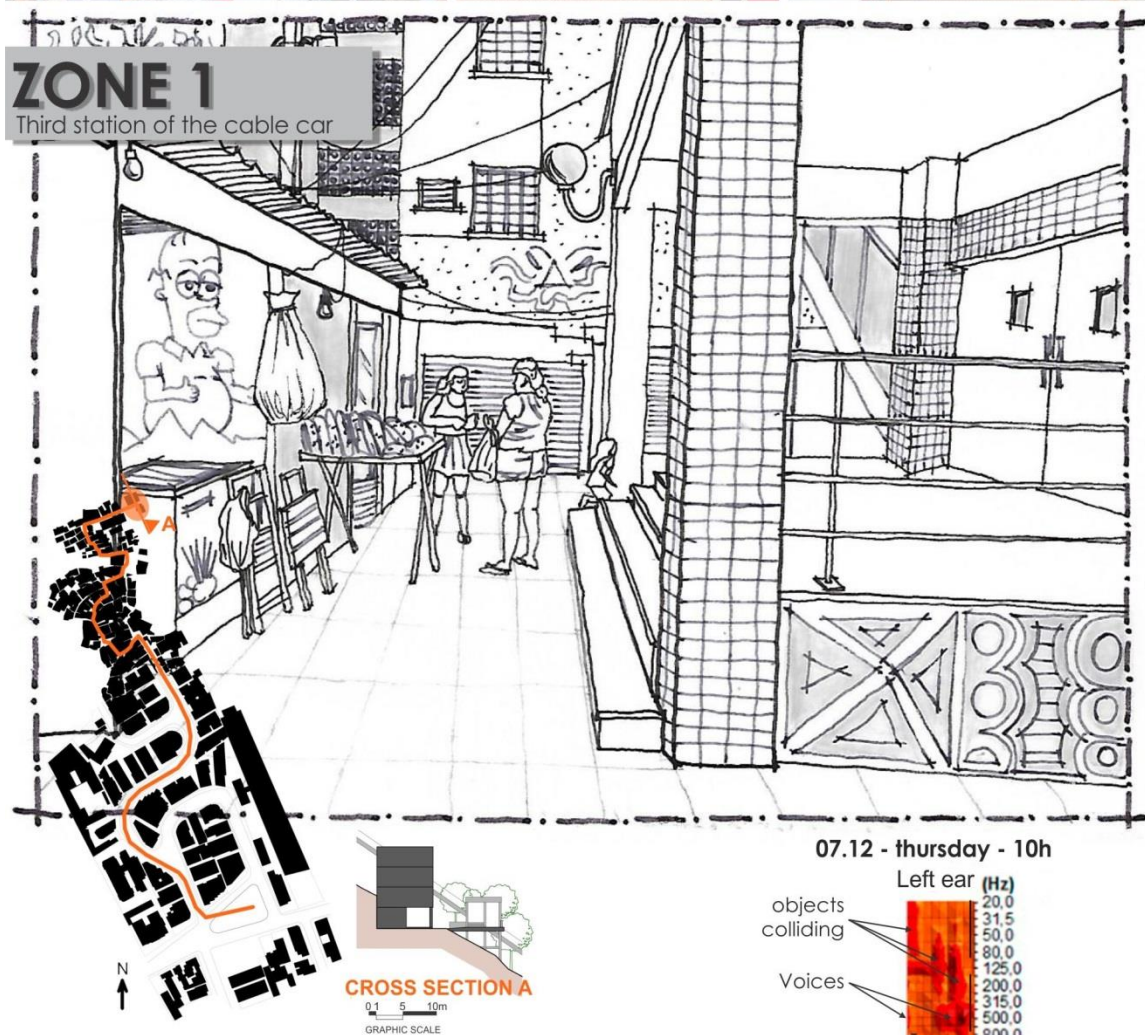


Figure 11: Graphic with comfort rating and sound level

### 3.4 Integrated analysis - evaluation forms

For the integration of the data, collected in diverse sound evaluation methods, summary forms were elaborated with the main characteristics of each evaluation zone. The forms have photographs, sketches, schematic cuts, graphics with acoustic images and the description of the results. The systematization of the data on the forms allows the understanding of the information, in a faster and visual way, regarding the spaces studied. (see Figure 12 and 13)



**SOUND LEVEL (Leq): 60,0 - 65,0 dB(A)**

#### SOUNSCAPE

Perception of the sound level: neither quiet nor loud  
 Predominant sound: voices, footsteps, children playing  
 Possible sounds: Music, Distant traffic, birds, bark, fireworks, helicopter, cable car

#### URBAN FORM

closed urban form, with one side open, inclined topography

#### USES

Mixed with small commerce, shuttle service from the cable car station and tourist point (due to the view)

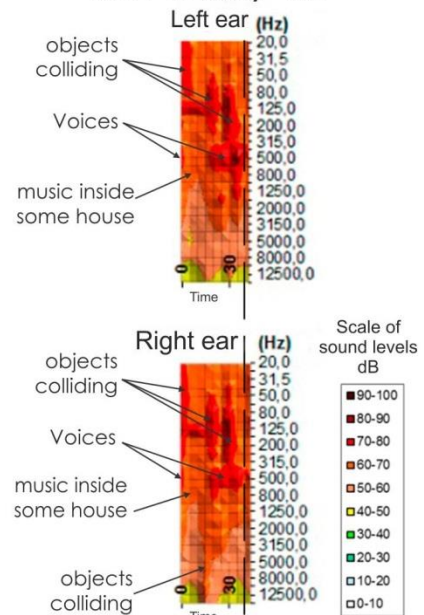


Figure 12: Example of the evaluation forms for each study area.

#### 4. CONCLUSIONS

With the research, it was possible to observe the different sonorities that an urban stretch can present. The organic urban form and the accentuated topography of the Santa Marta Favela do not allow the flow of vehicles, causing it to possess sound characteristics disconnected from the formal occupation of the soil of its near surroundings, with rectilinear urban tracing and intense circulation of vehicles. Thus, the nature sounds (mainly water, birds and dog barking) and the human activities were highlighted. The sound of vehicular traffic is only possible to be heard, with very weak volume, in sites more open, less dense, as in some sites of the upper and intermediary part of the slum. In the lower part, highly dense, one can not listen. Moreover, few residents who participated in the questionnaires cited the sounds of the vehicles as sound source of Santa Marta Favela.

At the beginning of the pathway it is possible to find diverse houses with 1 or 2 pavements, besides some spaces more empty due to the quite accentuated topography (Zone 1 to 5). The lower part, that is, the beginning of the hill is the most consolidated part of the slum, with the highest density of constructions and predominant gauge of 3 and 4 pavements (zone 6 to 10). Throughout the hill, but mainly in this lower part, the buildings appear as juxtaposed blocks, normally without any recoil and there are practically no free spaces between them. In relation to the uses, the whole hill presents itself as mixed area, with residential predominance. Throughout the slum there are diverse commercial establishments and also services, isolated and spread. However, some streets have greater vocation for commercial activity, especially in the lower part of the hill.

Faced with the scarcity of free spaces in the slum, even the pedestrians' circulation pathways offer a great variety of activities and appropriation by the residents. In their alleys, lanes and small squares are the different gatherings, people circulating, sitting, talking, shouting, on the cell phone, in commercial establishments, children playing, etc., that form a dense fabric of sociability. Moreover, the proximity relationship is very large and the private life of each surpasses the physical barriers of the residences. The domestic sounds invade the external circulation ways and other houses around, due to proximity to these spaces and materials used for the sealing. The music has also showed to be constant presence, both in commercial and residential establishments, as well as a venue with carnival block rehearsals. It is noticed that the culture is immersed in the practices and social conducts, also interfering in the sound ambiances.

On the other hand, the noisiest zones of the study areas are situated along the vehicular traffic lanes, mainly in Corumbá Square, next to São Clemente Street, which is a arterial road. In these places, the buildings with the facades at the end of the terrain end up getting quite damaged, receiving high sound levels.

The diversity of the methods and techniques researched demonstrates the importance of interdisciplinarity in the study of soundscapes. The application of different methods of sound evaluation with quantitative and qualitative approaches is a beginning, mainly for our Brazilian reality, to accept the idea that the qualitative characteristics have the same importance as the physical measurements in relation to the sound aspects, in the management and urban planning.

The knowledge and control of the variables that interfere in the problematic of the sound landscape are fundamental for the maintenance and improvement of the quality of the urban free spaces. The emphasis on urban form and users' perception, in addition to quantitative data, has promoted a diagnosis and a broader reading of sound

ambiences, even more in the face of an occupation in a slum, where norms and legislations are not applied the same way as in the so-called formal city.

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