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EVALUATION OF NOISE POLLUTION IN THE BOTANICAL GARDEN OF CURITIBA, BRAZIL: A CASE STUDY

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A study has been conducted in the Botanical Garden of the city of Curitiba, Brazil, regarding the noise pollution found in this park and generated by the nearby streets. In order to do so, measurements of noise levels have been carried out in 21 points spread throughout the park, and some local visitors were interviewed. It has been found out that 47.6% out of the measurement sites has presented noise levels that have exceeded 65 dB(A), which is considered as the maximum noise level one can be exposed to according to the Preventive Medicine, and 95% out of the measurement points have showed levels over the local legislation, the law number 8583 from 1995, which states the noise limits allowed for the several urban zones of the city.

1. Introduction

Nowadays, the urban noise is the second pollution source according to the number of annoyed people, and according to the Health World Organization it is the third most hazardous environmental pollution, preceded only by the air and water pollution.

This way, in the big urban centers the excessive noise is unfortumately a common fact, mainly generated by the chaotic traffic (buses, trucks, cars, motorcycles etc). They combine air pollution with horns, engines, and other noisy equipments, used by the conductors without any care of the effects, thus contributing to the high noise pollution levels [1, 2, 3, 4, 5].

According to the results of some studies, some health impairments caused by excessive exposure to noise are: direct or indirect verbal communication interference, irreversible outcomes for the auditive system translated by the shift of the threshold of hearing, changes in the hormone secretion induced by stress, which influences the blood pressure and metabolism, pathologies induced by the excessive stress, namely heart and blood circulation pathologies, sleep disorders, sexual impotency [6, 7, 8].

Studies have also showed that the noise level of 66 dB(A) is considered as the threshold of health impairments [8], consequently the Preventive Medicine takes the level of 65 dB(A) as the limit noise level one can be exposed to [8]. This is a worrying fact once the traffic noise is typically of 70 to 90 dB(A) [9, 10].

Curitiba has one of the biggest green area per inhabitants ratio in the world, and the biggest one in Brazil: 50 m^2 of green area per inhabitant [11]. This value is much higher than that one recommended by the United Nations Organization, which recommends 16 m^2 of green area per inhabitant. The city is filled with parks, and one of them is the Botanical Garden.

This survey was based on the fact that the Botanical Garden of Curitiba is an area that should promote leisure and tourism for its visitors, however it is located in a strictly urban area of Curitiba, surrounded by intense traffic flow streets and being close to a railway that runs parallel to it, causing the possible violation of the municipal law 8583 [12] which states the noise limits for the urban noise according to the urban zone (Green Area in this case). By considering these aspects, noise level measurements have been carried out in several locations inside the area of the park, and interviews have been conducted with some visitors as well. The noise levels obtained from the measurements have been compared to the 65 dB(A) level – considered by the Preventive Medicine as the maximum noise level one can be exposed to – and they have also been compared to the local legislation valid in the city. The interviews were intended to evaluate how the visitors faced the problem, in a general context and in a specific context for the park.

Finally, this survey will demonstrate the situation of the noise pollution in the Botanical Garden of Curitiba, emphasizing the influences of the noise over the local community and over the local visitors.

2. Methodology

The Botanical Garden is located at the east sector of the city of Curitiba, as shown in Fig. 1. Its total surface is 270.000 m^2, from which 40% is filled with a typical vegetation found in the region (Pine Trees from Paraná).

The park, on the other hand, is subject to a progressive interference caused by environmental and human factors, once it is located in an intense traffic flow area, limited by three intense traffic avenues, including the one that serves the traffic flow toward and from the beaches and another one that connects Curitiba to São Paulo, the largest city of the country. There is also a railway close to the park.

In order to proceed with the field work, two phases has been necessary. The first one regarded the noise levels measurements in several points within the park and the comparison between the results with the 65 dB(A) level and with the local legislation, the Law 8583 for the day period (Table 1), and then trace the local profile according to the noise pollution. The second phase regarded a questionnaire with 10 questions which has been applied to some visitors, intended to trace a qualitative analysis, by means of interviews.

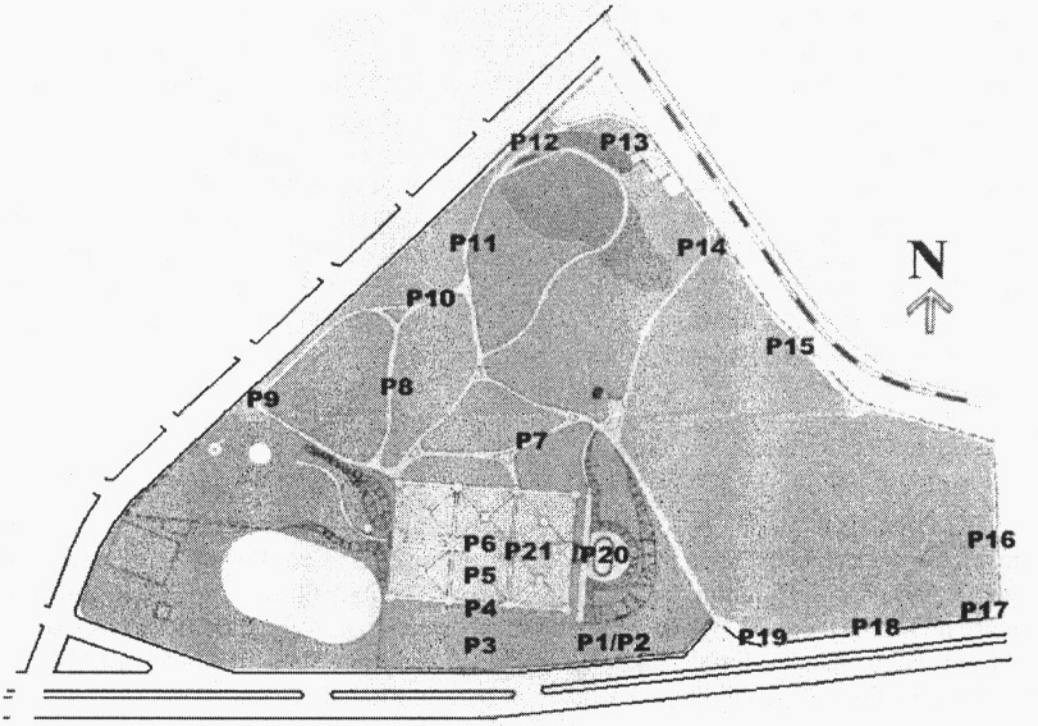

Fig. 1. The Botanical Garden of Curitiba with the measurement sites.

Table 1. Noise emission limits for several zones in Curitiba according to the Law 8583 from 1995.

Urban Zone	Noise emission limit (Day)
Residential Areas, Green Areas	55 dB(A)
Mixed Areas	60 dB(A)
Structural Sectors	65 dB(A)
Downtown, Service Zones	70 dB(A)

The questionnaires were applied in February of 2001. Regular visitors have been chosen for the interviews.

The measurements took place between 6:00 pm and 7:00 pm, during the period of most intense traffic flow, at the first Monday of February of 2001, with no atypical noise sources, such as rain and strong wind. The equipment used for this purpose was the B&K 2238 Mediator. This equipment is capable of internally processing the acquired data by means of numerical integration. For the processing of the measurements the equivalent noise level

expressed in dB(A) has been considered (L_{eq}). The following steps have been considered: a) 21 measurement points have been chosen from topographical charts and aerial photography, named P_1 through P_{21} in the present study (Fig. 1); b) The measurements have been done mainly at the trails and ways (like bicycle ways), where the visitors walk and develop their activities; c) Each measurement duration was of 1 minute and a half; d) Some noise intensity measurements have been carried out in straight lines, compounded by four points located at a single plane, where each of them has presented a different distance from the noise source, and keeping the same distance between them. This process has been executed in order to evaluate more precisely the differences found on the noise levels according to the source distance. The locations of the 21 measurement points are shown in Fig. 1.

3. Results and discussion

The Botanical Garden of Curitiba has presented high noise levels. In 95% out of the measurement points the level has surpassed the maximum level allowed by the law 8583, which states limits according to the urban zones of the city. Figure 2 shows the equivalent noise levels per point. The point number 7 (P_7) is the unique point under 55 dB(A), so it is the only point under the limits of the local legislation which states a limit of 55 dB(A) for the urban zone during the day period where the park is located (Green Area).

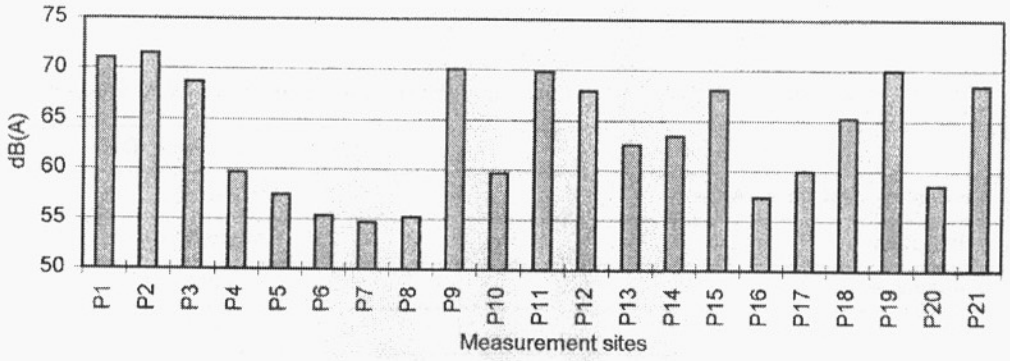

Fig. 2. Equivalent noise levels per measurement site in the Botanical Garden of Curitiba.

This result is explained by the fact that P_7 is found far from the noise sources if compared to the other measurement sites. So, the locations which have showed higher noise levels are found closer to the highways that surround the park. All measurements carried out in these points have exceeded 60 dB(A). However, the most worrying fact is that 47.6% out of the measurement sites has presented levels over 65 dB(A), surpassing the limits stated by the

Preventive Medicine as the threshold of health impairments [8]. On the other hand the majority of the interviewed people (52%) has classified the park as a tranquil area, with no major annoyances. However, the fact that they are already used to the noisy environment can not be forgotten. They might have compared the park with their everyday lives surrounded by environmental noise found at their work places and homes, which may have induced them to give those answers. Furthermore, 24% out of the interviewed people have declared annoyed by the noise pollution, whereas 22% out of them have expressed worry with the local security (Table 2). All this show that the noise pollution is the main source of annoyance among the visitors.

Table 2. A brief summary of the answers given by the interviewed people in the Botanical Garden of Curitiba.

	Total number	Percentage
What worries the visitors		
Local security	11	22
Noise pollution	12	24
Air pollution	1	2
Nothing	26	52
How the noise generated nearby the park affects the visitors		
Little intense	10	20
Intense	5	10
Very intense	5	10
It does not affect	30	60

Figure 3 shows the results of the sound pressure levels processed at a straight line and at a single plane, according to the distance of the measurement sites to the noise source, in this case, the traffic noise.

It has been confirmed that the noise level gets lower as the distance to the source increases. This can be seen by observing the huge difference of 13.3 dB(A) on the equivalent noise level (L_{eq}) found on the closest and farthest measurement sites. However, the noise levels do not get lower than the values established by the legislation. These results come from the fact that the park is located inside a urban area, surrounded by intense traffic streets. So, keeping a good distance between the noise sources and the receivers is a good way to reduce the noise levels and promote the tranquility [9, 13]. However, the authorities seem to be unable to consider the noise pollution when planning roads and railways close to leisure areas, consequently making a poor urban planning.

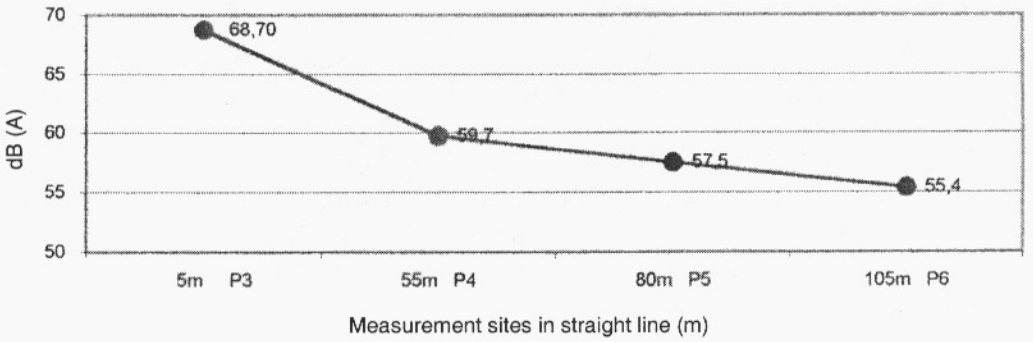

Fig. 3. Measurement of equivalent noise levels in points displayed in a straight line.

4. Conclusions

With the diagnosis of the urban noise pollution in the Botanical Garden of Curitiba it is possible to affirm that this type of pollution is strongly hitting the environment. The Botanical Garden of Curitiba has shown high noise levels according to the local legislation once 95% out of the measurement sites has presented levels over the allowed limit. In conclusion, a place designed for leisure and rest can actually be contributing for annoyance and some health impairments. Almost 50% out of the measurement sites has shown levels over 65 dB(A), which can lead to some health impairments if the visitor spends several hours in the park. On the other hand, the majority of the interviewed visitors has considered the park as a calm place. This result may have to do with the fact that the visitors are already used to noisy environments and find the Botanical Garden of Curitiba calm.

The existence of green areas inside the urban areas is good and important for the city, but a better urban planning should be considered when establishing such areas once they are intended for rest and leisure. Establishing such areas far from avenues with heavy traffic and truck flow is a good start.

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