Pressure sound level measurements at an educational environment in Goiânia, Goiás, Brazil

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Abstract. In this work, 25 points located on the ground floor of the Federal Institute of Education, Science and Technology of Goiás - IFG - Campus Goiânia, were analyzed in morning periods of two Saturdays. The pressure sound levels were measured at internal and external environments during routine activities seeking to perform an environmental monitoring at this institution. The initial hypothesis was that an amusement park (Mutirama Park) was responsible for originating noise pollution in the institute, but the results showed, within the campus environment, sound pressure levels in accordance with the Municipal legislation of Goiânia for all points.

1. Introduction

The noise pollution is the undesired noise released into the environment, without the perception of its damage and the negative results that it can cause to human health [1].

Many researchers [2, 3] showed that the Noise Pollution is constantly and repeatedly delivered, making people not aware of the harmful consequences of high Sound Pressure Levels (SPL) toward their health.

Therefore, in classroom environment, high levels of noise bring serious damages to the teachers as to the students. Consequently, in educational facilities, people can be subject to Noise Pollution and its hazards, but not noticing its complications. Thus, the environment monitoring of educational places is justified and has the objective to quantify through the Equivalent Sound Level (LAeq) the pollution levels to which the population is exposed to. Then, with the measurements performed with LAeq (the weighted continuous sound pressure level on the A scale), it is possible to establish new strategies seeking for adjustments into the cases where the sound levels do not agree with the standard limits proposed by the Regulatory Agencies. In addition, with the identification of irregularities it will be possible to trace actions against negative recurrences of noncompliance institutions.

Environmental monitoring consists in the accomplishment of specific measurements and/or observations, benchmarked in front of some indicators and parameters, in order to verify if certain environmental impacts are occurring. As a result, it will be possible to estimate its magnitude and to evaluate the efficiency of any possible preventive measures, and it can be used in the diagnosis of noise pollution.
In this sense, this work aims to carry out the environmental monitoring of the (L\text{Aeq}) levels and to evaluate the measured sound levels accordingly with the current limits of Noise Pollution proposed by the Brazilian government. These measurements were taken, during the Saturday morning work routine activities developed at the Federal Institute of Education, Science and Technology of Goiás (IFG) - Campus Goiânia, which consists of an educational environment.

2. Materials and Methods
For data acquisition and analysis, the authors followed the environmental monitoring techniques proposed by Zannin et al [3].

The research was carried out at the Federal Institute of Goiânia (IFG) - Campus Goiânia, during the period of normal activities, from 7:00 am to 9:00 am, in the last Saturday of February and in the first Saturday of March in 2015, trying to interfere as little as possible on the administrative and schooling activities during the monitoring time.

To perform the measurements, a sound level meter with data logger, model DEC-490 (INSTRUTHERM), and an acoustic calibrator CAL-4000 (INSTRUTERM), both with calibration certificates, were utilized.

Analyzing the Brazilian legislation, it was possible to extract the Level of Evaluation Criteria (LEC), shown in Table 1. The determination of the LAeq, Eq. 1, obeyed the standard NBR 10151/2000 [4].

\[
L_{\text{Aeq}} = 10 \log \frac{1}{n} \sum_{i=1}^{n} 10^{L_i/10} 
\]

where LAeq [dB (A)] is the A-weighted equivalent sound pressure level, L\text{Aeq} is the sound pressure level in dB (A) taken in fast response every 5 s during the noise measurement, while n represents the total number of recorded measurements.

| Environment                                | Level of Evaluation Criteria - LEC |
|--------------------------------------------|------------------------------------|
| External Environment                       | 55 dB(A)                           |
| Internal environment with open windows     | 45 dB(A)                           |
| Indoor environment with closed windows     | 40 dB(A)                           |

For each point, three measurements were taken (triplicate) at different times, the LAeq was calculated through equation (1) and, afterwards, the average LAeq obtained in each situation was determined. The corrected noise level (Lc) was applied in cases where there was a need for the results obtained experimentally compared with the Level of Evaluation Criteria of Table 1.

Eight points located in the external perimeter of the institution were chosen to monitor the LAeq outside the limits of the IFG, and 17 points within the institute internal perimeter, with 10 points located in external environments and 7 points located indoors (classrooms) as shown in Figure 1.
3. Results

Eight places S-E1, S-E2, S-E3, S-E4, S-E5, S-E6, S-E7 and S-E8 outside the IFG on the Saturday morning were monitored. The results are shown in Figure 2. The uncertainty obtained was lower than 3% in all results.

It can be noted that from the 8 points measured in the external area during that Saturday morning, only 3 presented values above the Evaluation Criteria Levels established in the Brazilian Law, by the NBR 10151/2000 [4].

At the ground level, 11 points S1, S2, S4, S5, S7, S8, S9, S13, S14, S15 and S16 were monitored, including external and internal environments. The results obtained are shown in Figures 3 and 4.
Measurements were taken in a classroom near the institution entrance, nearest to the Mutirama Park, with open windows; the measurements pointed out LAeq values within the legal limits.

![Figure 4. Equivalent Sound Pressure Level LAeq [dB (A)] for classroom on the ground floor with open windows.](image)

4. Conclusions
This work presents partial results of the research carried out, opting for the survey on Saturdays because of complaints from teachers and students that an amusement park next to the institution (Mutirama Park) was responsible for producing the noise pollution.

During this work, measurements were taken on a Saturday morning, on a non-busy day and only one point (S9) presented LAeq above the LEC, at the external yard in front of the arts complex that, at the moment of the monitoring, presented sound coming from musical instruments. The other points monitored on the Saturday morning did not present LAeq in disagreement with the municipal legislation of Goiânia.

The situation differs from the rest of the research, when the environmental monitoring in different periods of the work days; at a few points no sound pollution was identified.

The initial hypothesis that the Mutirama Park would be responsible for generating noise pollution in the educational institution was not proven, and it is possible to conclude that points where there are excessive sound pressure levels are a consequence of the human activities at the place.

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References
[1] Strite Tripathy D P 2008 Noise Pollution (New Delhi: APH Publishing Corporation) p 59
[2] Passchier-Vermeer W and Passchier W F 2000 Environ. Health Perspect. 108 123-31
[3] Zannin P H T, Engel M, Fiedler P E K and Bunn 2013 F Cities 31 317–27
[4] ABNT-NBR 2000 10.151: Acoustics—Noise Assessment in Inhabited Areas Aiming at the Community’s Comfort-Procedure (Rio de Janeiro - In Portuguese)