Pre-environmental study for the implementation of a new road system - a case study in Curitiba, Brazil

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Introduction

The city of Curitiba, capital of the State of Paraná, has approximately 1,800,000 inhabitants today, which makes it a major Brazilian city. Data from December 2011, provided by the statistics division of the traffic department of the state (DETRAN-PR), reveals that the fleet of vehicles in the city is 1,255,820. For comparison purposes, in 2000, population and vehicles data were 1,587,315 people and 619,237 vehicles, respectively. These growing numbers highlight an undesirable environmental pollutant: urban noise. In a study developed by Zannin et al. (2002) [1], interviews were carried out with the population of Curitiba and 73% of all respondents indicated traffic noise as the dominant source of urban nuisance.

As a result of the high population growth in Curitiba, an intense urban sprawl occurred [2]. This fact led marginal roadside areas, nearly void of urban occupation before and located inside the urban perimeter of Curitiba, to become districts with dense demographic concentrations. Therefore, the roadside operating only with arrival, departure or passage traffic also became an access road to work and housing.

The Green Line is a road transport restructuring project to be applied to the BR-116 Highway, which is the main connection to São Paulo, and which crosses Curitiba in the north-south direction. The main objectives to implement this project are:

- The highway will no longer be an element of conflict between transit traffic and urban traffic;
- The integration of districts separated by the road before;
- The improvement of the public transportation system;
- Reduced travel time and increased road safety.

The structural composition of the Green Line will be defined as: a ten-lane avenue (including express bus lanes and two parking lanes), a bicycle path, a linear park, a new lighting system, landscaping and signaling [3].

The Green Line is approximately 18 km long, and the first stage is completed. The second stage began in 2011 and will be approximately 8 km long.

Materials and method

The phases involved in the environmental noise impact project in the second stage of the Green Line are listed as follows: [4]:

- Survey of the place;
- Noise source recognition;
- Measurement of noise pressure levels equivalent – $L_{eq}$ A-weighted and expressed in dB(A);
- Traffic flow count;
- Noise map preparation;
- Analysis of results.

For the measurements, 16 points evenly spaced (500 m) were selected, totaling a stretch of approximately 8 km. It took 10 minutes to perform each measurement, which were made in the fast response mode and A weighting curve, within a dynamic range between 40 and 140 dB(A). In addition to the measurements, another important tool in the noise pollution analysis was computer simulation. The use of noise map allows, besides a better view of the problem caused by noise pollution, to propose different possible scenarios, showing what can be done to improve the problem. A noise map is, essentially, a support tool to the decision on territory planning through quality requirements for the acoustic environment.

Noise maps were prepared through the software Predictor 7810 version 8.11. This software allows calculation and presentation of the current acoustic situation of a certain geographic area, as well as the introduction of hypothetical noise control measures. Computer simulation proves an adequate solution to noise prediction and control.

In this project, the tasks performed by the software were:

- Calculation method selection (method selected: ISO 9613.1/2 Road);
- Insertion of contours in the stretch extension;
- Insertion of de orthophotos for manual drawing of buildings and vegetation along the Green Line;
- Insertion of data for calculations such as vehicle flow, average speed and type of pavement;
- Selection of calculation area and grid (10 x 10m);
Current acoustic mapping, indicating equivalent levels of noise pressure in relation to distance; Measurements were also used to calibrate the noise maps; the differences between simulated and measured values were lower than 4.6 dB(A), which is recommended by WG-AEN [6].

Results and discussion
When noise pressure levels achieved at each point are analyzed, it is confirmed that all the levels are above the recommended by the municipal law 10.625 of Curitiba, 2002 [5], which establishes 65 dB (A) during daytime [figure 3].

Figure 1: All the equivalent noise pressure levels at each of the 16 measurement points along the 8 km assessed are above 65 dB (A), the maximum allowed by the legislation in force.

Figure 2 shows one of the various acoustic maps achieved in the study and allows a better view of the problem caused by noise pollution. In addition, the computer simulation shows the range of high noise pressure levels emitted by the traffic on the highway.

Figure 2: Noise pressure levels achieved through computer simulation. Values ranging between 70 and 80 dB(A) reach residences located near the future Green Line.

Conclusion
Through this study, it was observed that the local noise generation is continuous intense, and it is the noise basically generated by the intensive flow of light vehicles (passenger cars, SUV’s and motorcycles) and heavy vehicles (trucks and buses). Vehicle traffic before the Green Line implementation produces an environmental impact that results in noise pollution levels that are inadequate to the people who live or work around this road, reaching values as high as 80 dB(A). At all the points analyzed, noise level is above the values accepted by the legislation in force, that is, above 65 dB(A) in daytime. Once the environmental noise impact is identified, both through measurements and through acoustic mapping, it becomes evident that noise pollution control measures are required. It is expected that, after the road restructuring is concluded, a decrease in noise levels occurs for the benefit of the population who lives and works in the region.

Bibliographical References
New lanes would be added to Curitiba’s downtown roads, with historic buildings demolished to make room for them. A new viaduct would link with the central square at Rua Quinze de Novembro to ease traffic congestion. "But we said no!" exclaims Jaime Lerner. The former mayor of Curitiba is speaking over the phone from his office in Curitiba, where he now directs his eponymous private architecture firm. Back then, Lerner was a recently graduated architecture student, leading a movement against the existing mayor’s vision of a Curitiba for cars. When a wave of European immigration hit southern Brazil, Curitiba’s sleepy farmland was an obvious attraction. Germans arrived in the 1830s, Polish and Italians arrived in the 1870s, and Ukrainians two decades later. In this study, noise pollution assessments were performed along Marechal Deodoro Avenue and Batel Avenue, which are two major thoroughfares in the city of Curitiba, Brazil. Eleven points were evaluated at Batel Avenue and 16 points at Marechal Deodoro Avenue. Germany’s Federal Environment Agency estimates that 4000 annual cases of heart attacks in the country are correlated with traffic noise. 2.1. Analysis of Environmental Noise Emission Limits. For the noise impact study, in situ measurements of the equivalent sound pressure levels, Leq, were taken and noise maps were also calculated. The Brazilian technical standard NBR 10151 establishes acceptable noise levels for urban areas. Pre-environmental study for the implementation of a new road system - a case study in Curitiba, Brazil. Conference Paper. Full-text available. A methodology for the assessment of environmental noise generated by heavy traffic on an urban stretch of a highway is discussed in Chapter 3. The noise pollution assessment was based on extensive field measurements of equivalent sound pressure levels and the subsequent calculation of noise maps. The noise maps were calculated based on heavy vehicle counts, road conditions, and average speed of vehicle traffic. 3. Case study areas. 3.1. Curitiba, a model for a sustainable city. 3.1.1. History of Curitiba. Curitiba is the capital city of the Brazilian state of "Parana". This greenery strategy implementation is closely related to legislations, long term environmental vision and citizens’ participation (Goldman and Gorham, 2006). 3.1.5. Local waste management system. Curitiba’s sewage treatment system utilizes the local lagoons (located near the river) as a water refreshing system (sewage is recycled in three steps: anaerobic, aerobic and discharging treatment). This system in addition to parallel open air canals is used to control the seasonal floods as well (Brendan, 1998). New lakes in public parks are designed to solve the problem of seasonal flood.