Acoustic study to characterize the Southwest district of Montreal

Camille PATTE[1], Golnaz KHOSRAVI[2], François MORENCY[2]

[1] Industrial Hygiene Department, EI.CESI-Engineering School
CFA Formasup, 7, rue Diderot, Arras, France
[2] Mechanical Engineering Department, École de technologie supérieure
1100 Notre Dame West, Montréal, Québec, H3C1K2, Canada

Abstract. In the Southwest District of Montreal, a historical industrial area inhabited by workers, the citizens report the noise as one of the main environmental problems. The goal of this study is to measure the noise in the Southwest District, as well as the impact it may have on the population. To obtain results, an experimental study has been undertaken. We used a sound level meter with an A weighting filter to measure the sound intensity in the audible frequency range. Eleven critical points were selected to carry out the observations. The noise levels are between 76 dB(A) and 88 dB(A) in the morning, and 75 dB(A) and 82 dB(A) in the afternoon. This is higher than the acceptable level of 55 dB(A) defined by the World Health Organization.

Keywords. Environmental noise, urban environment, public health

1. Introduction

In modern cities, the intensive transportation, construction, industry and cultural activity create noisy environments that influence the health and well-being of the citizens (Pninit Cohen, Oded Potchter, and Schnell 2014). The inhabitants of the Montréal Southwest District (Ville de Montréal 2015) are not immune from such sound annoyance. Especially that this area is a historical industrial area inhabited by workers with a road traffic, train, a transport distribution center. Thus, the level of noise maybe higher than the standard level for urbanized areas. The levels of annoyance, interference with communications, disturbance to sleep, and the potential to cause hearing impairments (Montréal 2012).

According to U.S. Environmental Protection Agency, a maximum outdoor noise level of 55 dB is allowed for comprehensible communication. Recommended urban residential noise levels generally range from 45 to 55 dB depending on the day time and measurement point location (The U.S. Environmental Protection Agency Office of Noise Abatement and Control 1974).

The goal of this study is to measure the noise level in the Southwest District, as well as the impact it may have on the population. To obtain results, an experimental study has been undertaken. First, the experimental methodology is explained. Then, the noise measurements, in decibels, at different locations, are presented. Finally, the potential impact of the measured noise level on the population health and the limitation of the study are discussed.

2. Methodology

The first step for evaluating the noise level of Southwest District of Montreal is to choose the measurement areas. There are different methods for the selection measurement areas. It could be done in accordance with the population and residential location, characteristics of land uses, and road functions and structure (Zannin, Ferreira, and Szerametta 2006, Prascevic, Mihajlov, and Cvetkovic 2014, Mohammad Hassan Ehrampoush 2012).

In this study, areas with approximately the same characteristics were chosen. Most of them are selected near the metro station, in crowded area located along the city roads. After checking and reviewing the map of the Southwest District, eleven measurement areas were selected.

Noise levels were measured using a sound-level meters, model UEI DSM100, which record the changes in noise levels on the basis of sound pressure. The principal noise index was the A-weighted equivalent continuous level averaged over a specified period (LA_{eq}). These values are significant for regulatory authorities as they avoid disturbances caused by instantaneous road traffic noises, as it is the case in our study.

Measurements took place on a typical weekday between 8th and 23rd of September 2015. Weather conditions were conducive to successful monitoring; roads were dry, and there was no precipitation at the time of measurement(Borak 2009). The ambient temperature was between 9 and 28°C during the monitoring period. The reference time intervals were selected in the traffic rush hours. In the time intervals were 7:30-9:00 AM and 4:30-5:30 PM. The noise levels were measured every five minutes. Also the number of passengers and vehicles were counted every 15 minutes.

After measuring the LA_{eq} every 5 minutes, a long-term average of the equivalent noise levels, $L_{eq,LT}$, for all measurement intervals were calculated according to the following equation (Momir et al. 2014):

$$L_{eq\ ,LT} = 10\ log \frac{1}{n} \sum_{i=1}^{n} 10^{0.1.} L_{eq,i}$$

where $L_{eq,i}$ is the A-weighted equivalent noise level in the *ith* sample and *n* is the number of samples of the measurement (*n=19* for the morning and *n=13* for the evening).

The variance is defined as:

$$\sigma^2 = \frac{\sum_1^n (L_{eq,i} - L_{mean})^2}{n}$$

and the arithmetic mean is $L_{mean} = \frac{\sum_1^n L_{eq,i}}{n}$.

3. Result

Table 1 shows the results of $L_{eq,LT}$ for different sites in the morning and in the evening. The long-term averages of the equivalent noise levels for all the eleven areas in the morning are bigger than the values in the evening. Fig. 1 shows the number of vehicles that passed on the road during the noise measurements.

Table 2 shows the variance of the measured noise levels. This table shows how the L_{eq} values are spread out for each spot. As observed in this table, the measured variances change greatly between areas in ETS, Métro Angrignon and Métro Lionel Groulx. These results show that in these areas, the noise is not produced by a permanent factor. For example, the car types influence the noise level temporarily.

Table 1. *Long-term average of the equivalent noise levels for the 11 selected spots*

Location	**Morning**		**Evening**	
	Temp.(°C)	**$L_{eq,LT}$ (dB)**	**Temp.**(°C)	**$L_{eq,LT}$ (dB)**
1 - ETS	20.0	87.9	27.0	82.1
2 - Square Tansey	14.1	75.2	22.2	72.7
3 - Métro Charlevoix	14.9	80.8	26.0	75.8
4 - Métro Jolicoeur	17.1	79.4	28.1	77.7
5 - Métro Monk	18.0	76.5	27.0	75.2
6 - Métro Angrignon	17.2	89.2	28.0	78.7
7 - Parc Ignace Bourget	9.0	80.9	19.2	76.6
8 - Centre Hébergement Saint Henri	12.1	80.0	23.9	76.5
9 - Métro Place Saint Henri	14.8	81	24.8	71.4
10 - Métro Lionel Groulx	17.7	83.5	23	78.9
11 - Métro Georges Vanier	23.2	81.1	24.4	78.6

4. Discussion and Conclusion

The result comparison shows that the long-term averages of the equivalent noise levels in all sites exceed the standard levels recommended by the U.S. Environmental Protection Agency(The U.S. Environmental Protection Agency Office of Noise Abatement and Control 1974). Among the selected spots, the Métro Angrignon area has the maximum $L_{eq,LT}$, because of a bus terminal near this location. Figure 1 shows the high number of cars and especially busses that passed at this location. However, the comparison of Figure 1 and Table 1 results shows that high $L_{eq,LT}$ values the number of vehicles is not the only reason of the high $L_{eq,LT}$ values.

The measured noise LA_{eq} are between 76 dB(A) and 88 dB(A) in the morning, and 75 dB(A) and 82 dB(A) in the afternoon. The values of the LA_{eq} are lower in the

afternoon, for each of the eleven points of measures. One major limitation of this study is the limited period of the noise measurements. In a northern city, the presence of snow in winter may change considerably the noise levels. The World Health Organization recommends that the population should not be exposed to noise levels greater than 55 dB (A) (World Health Organization 1999). In the long term, the quality of life and well-being of the population will degrade if no decision is make to limit, reduce or remove the noise nuisance caused by road traffic.

Table 2. *Variance of the measured noise levels for the eleven spots*

Location	**Morning**	**Evening**
	Variance	**Variance**
1 - ETS	41.8	23.3
2 - Square Tansey	10.4	9.43
3- Métro Charlevoix	27.3	10.0
4 - Métro Jolicoeur	11.3	6.94
5 - Métro Monk	16.3	18.5
6 - Métro Angrignon	55.5	22.8
7 - Parc Ignace Bourget	28.7	14.6
8 - Centre Hébergement Saint Henri	25.2	15.4
9 - Métro Place Saint Henri	34.5	26.7
10 - Métro Lionel Groulx	45.2	16.1
11 - Métro Georges Vanier	9.82	5.95

In the course of this study, noise levels were evaluated at eleven locations in the Southwest District, both in the morning and in the afternoon. The measurements were taken in a two-week interval in the summer of 2015. Results show a noisy environment that exposes the inhabitant to more than 75 dB(A). This value is above the level of 55 dB(A) and thus noise impacts negatively the well-being of the population.

5. References

Borak, Chris. 2009. IDE PARK AND RIDE, AMBIENT NOISE ASSESSMENT REPORT.

Mohammad Hassan Ehrampoush, Gholam Hossein Halvani, Abolfazl Barkhordari, Mohsen Zare. 2012. "Noise Pollution in Urban Environments: a Study in Yazd City, Iran " *Pol. J. Environ. Stud.* 21 (4):1095-1100.

Montréal, Agence de la santé et des services sociaux de. 2012. Plan régional de santé publique 2010-2015: Un environnement urbain favorable à la santé. Un air extérieur et un environnement sonore de bonne qualité.: Direction de la santé publique.

Pninit Cohen, Oded Potchter, and Izhak Schnell. 2014. "The impact of an urban park on air pollution and noise levels in the Mediterranean city of Tel-Aviv, Israel." *Environmental Pollution* 195:73-83.

Prascevic, M. R., D. I. Mihajlov, and D. S. Cvetkovic. 2014. "Measurement and evaluation of the environmental noise levels in the urban areas of the city of Nis (Serbia)." *Environ Monit Assess* 186 (2):1157-65. doi: 10.1007/s10661-013-3446-2.

The U.S. Environmental Protection Agency Office of Noise Abatement and Control. 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.

Ville de Montréal. 2015. "Maps of Montréal." Accessed December 8. http://ville.montreal.qc.ca/portal/page?_pageid=5977,41729560&_dad=portal&_schema=PORTAL.

World Health Organization. 1999. Guidelines for Community Noise. Geneva.

Zannin, P. H., A. M. Ferreira, and B. Szeremetta. 2006. "Evaluation of noise pollution in urban parks." *Environ Monit Assess* 118 (1-3):423-33. doi: 10.1007/s10661-006-1506-6.

Acknowledgement. The authors thank the CIRODD-ÉTS for its financial support.