The effect of transit patterns on the decibel noise level of a busy street

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Abstract

The decibel noise level on a busy street was measured over one hour in three different trials. The noise created by buses, which have been the target of noise complaints in this neighbourhood, was analyzed to find that noise levels peaked during the minute before or after Canada Line arrival or departure. Noise levels were reduced by 12 $\pm$ 10 dB when buses turned off their engines.

Introduction

Traffic noise is a concern in large cities where major roads and residential neighbourhoods intersect. Sleep is disrupted by noise levels greater than 50 dB [1], and exposure to traffic noise is related to cardiovascular health risks [2]. Earlier this year, the Canada Line SkyTrain was built near Richmond Centre, and bus routes were significantly changed to accommodate the SkyTrain schedule. Since then, residents living close to the Canada Line have voiced concerns that the concentrated bus traffic noise is disrupting their sleep and health. In this experiment, the relationship between the decibel noise level in a downtown Richmond neighbourhood and the arrival and departure of the SkyTrain was analyzed. Decibel noise levels were measured under different situations, with the goal of determining the causes of excessive noise and examining possible solutions to noise concerns.

Methods

A decibel meter was used to take measurements of the noise level. The measurements were taken at the bus stop on the North sidewalk of Cook Rd. between No. 3 Rd. and Buswell St. in Richmond, BC, as shown on the map in Figure 1.

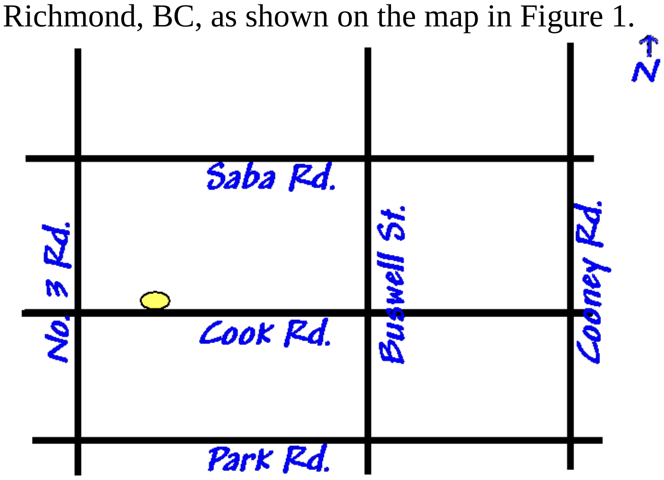

Figure 1. Location. *The measurements were taken on the North sidewalk of Cook Rd. in the location indicated by the yellow icon.*

The measurements were repeated three times on Feb. 2, Feb. 4, and Feb. 5, 2010 between 7:18:00 and 8:18:00. In each replicate, the decibel meter was turned on and given a few seconds to adjust to the current noise level. The decibel meter was held 70 $\pm$ 10 cm above the ground with the detector pointing vertically upwards. A timer was started at 7:18:00 and the decibel noise level was recorded every 15 seconds. Observations of traffic patterns, including bus arrivals and departures, were recorded.

Results & Discussion

Correlation between decibel noise and Canada Line schedule
Noise levels were plotted over the time since 7:18:00 with the results shown in Figure 2.

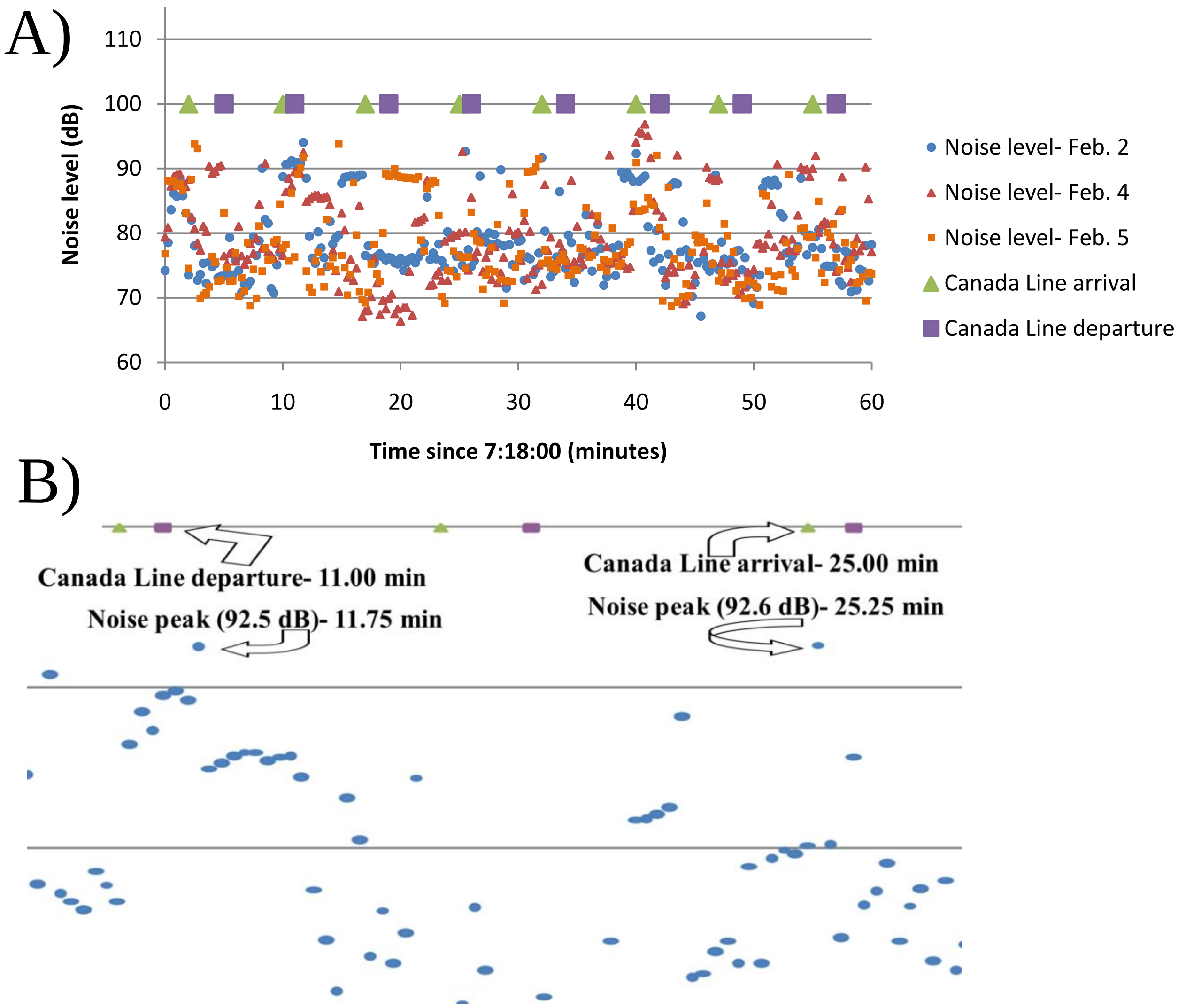

Figure 2. Noise variation over time. A) *Plot of the decibel noise level versus time (min.) since 7:18:00 on Feb. 2 (blue), Feb. 4 (red), and Feb. 5 (orange) on Cook Rd. The uncertainty in the noise level is ± 5 dB. The green and purple icons represent Canada Line arrival and departure times, respectively.* **B)** *Zoom in on one cycle between 10 minutes and 27.75 minutes on Feb. 2 shows that the noise levels peaked during the minute before and after Canada Line arrival and departure.*

In all three trial periods, the noise level generally peaked during the minute before and after the Canada Line was scheduled to arrive or depart. This was expected because during these times, buses in the area increase in number to serve Canada Line patrons as they get on and off the SkyTrain, and the increased bus volume would naturally cause spikes in noise level.

Noise levels of parked and moving buses
To discern the causes of the noise observed, all recorded occurrences of buses passing the observation point during the three trials were grouped together and the corresponding noise levels

averaged. The same was done for instances of buses parked at the bus stop with the engine on and of buses parked with the engine off. When a bus was passing and another bus was parked simultaneously, the occurrence was recorded as a bus passing. In instances where no bus was passing nor parked and only ambient passenger vehicle traffic was observed, the noise levels were averaged and recorded as ambient traffic noise. An analysis of the Feb. 2 data between 10 and 27.75 minutes finds that the noise recorded when buses passed ranged from 80.1 dB to 88.2 dB, the noise for buses parked with the engine on ranged from 81.7 dB to 92.6 dB, and the noise for buses parked with the engine off ranged from 74.7 dB to 78.3 dB. This suggests that noise levels were fairly constant and distinct for each type of event, which allows each type of occurrence to be accurately represented by an average noise level. The results are shown in Table 1, with one occurrence defined as one data point; the data points were collected every 15 seconds, as in Figure 2.

Occurrence	**Average noise level (± 5 dB)**	**Number of occurrences**
Bus moving (passing)	85	57
Parked bus with engine on	88	110
Parked bus with engine off	76	12
Ambient traffic noise	76	544
Total average	79	

Table 1. Average noise level (± 5 dB) during different situations. *Noise level was obtained by averaging all recorded instances where buses were passing, parked with engine on, or parked with engine off. All other instances were considered ambient traffic noise. One occurrence is defined as one of the data points, collected in 15-second intervals. Total average (± 5 dB) was a weighted average of all occurrences.*

Based on the data in Table 1, parked buses with the engine on created 12 ± 10 dB more noise than parked buses with the engine turned off. This suggests that noise level could be reduced by about 12 dB by encouraging bus drivers to turn off the engines when the bus is parked, as discussed later in this report. The same noise level was observed when buses had the engine off as when no buses were present. This is expected because with the engine off, the bus would not create any noise, so the recorded 76 ± 5 dB can be attributed to ambient traffic noise. On average, noise levels were lower for a moving bus than for a parked bus with the engine on, although the difference was not significant within the error range. Since parked buses pull over closer to the curb, it is expected that the noise level measured on the sidewalk would be slightly higher for a parked bus than for a moving bus on the street. In addition, parked buses with the engine on were recorded in 110 occurrences, whereas those with the engine off were only observed in 12 occurrences.

Table 1 suggests that the highest noise levels were caused by moving and idling buses. Idling buses were almost twice as common as moving buses, so if parked buses all had their engines off, it would be expected that the average noise level for all parked buses would be at the ambient noise level, 76 ± 5 dB. A hypothetical revision of Table 1, that assumes all parked buses had the engine turned off, finds that the total average decibel noise level would be 77 ± 5 dB, rather than 79 ± 5 dB if parked buses did not idle their engines. In other words, the average noise level would be reduced by 2 ± 10 dB. With the uncertainty, this difference seems hardly significant; however, it is sudden fluctuations in noise that causes the people to report irritation and stress [3]. Although this hypothetical situation would not significantly reduce the average noise level on this street, Figure 3 shows that when the original noise level data is plotted with all instances of idling buses replaced by the hypothetical average of 76 dB, spikes in noise levels near the Canada Line arrivals and departures are significantly reduced.

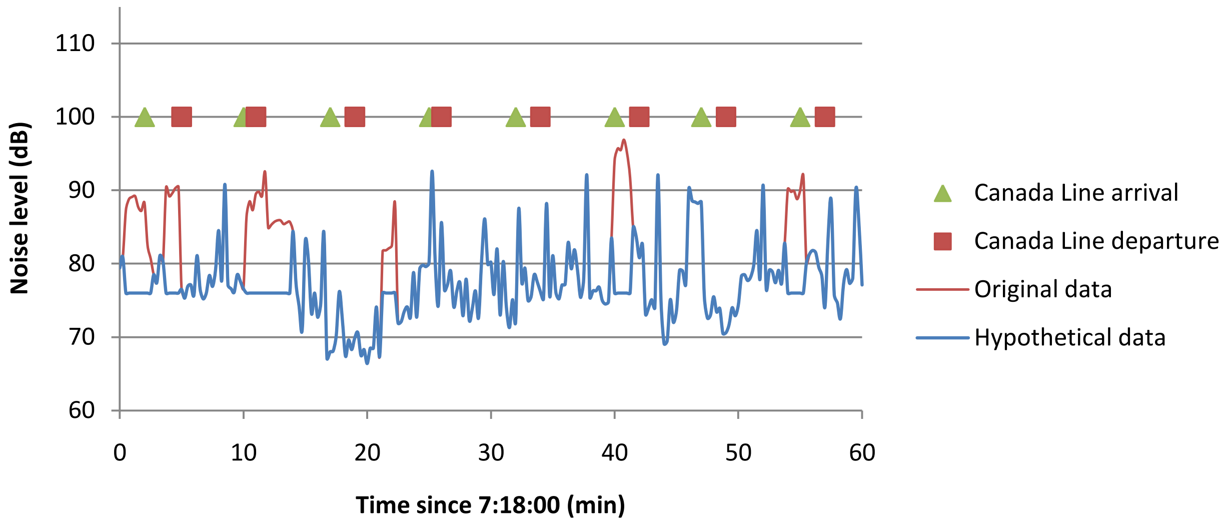

Figure 3. Hypothetical reduction of noise. *Plot of the decibel noise level versus time (min.) since 7:18:00 on Feb. 2 on Cook Rd (red line) superimposed with hypothetical noise level (blue line) if all idling buses were to turn off engines. The uncertainty in the noise level is ± 5 dB. The green and red icons represent Canada Line arrival and departure times, respectively. Data points from Figure 2 have been connected here with lines for clarity of comparison.*

Comparison of parking duration of buses with engines on versus off

One might speculate that parked buses simply kept the engines on because they were parked for a shorter period of time than the buses that did not idle the engine. To address this possibility, a histogram was created, showing the duration that buses remained parked with the engines on versus with the engines off. This histogram, shown in Figure 4, suggests that buses that parked with the engine on were not necessarily parked for a shorter period of time than buses with the engine off.

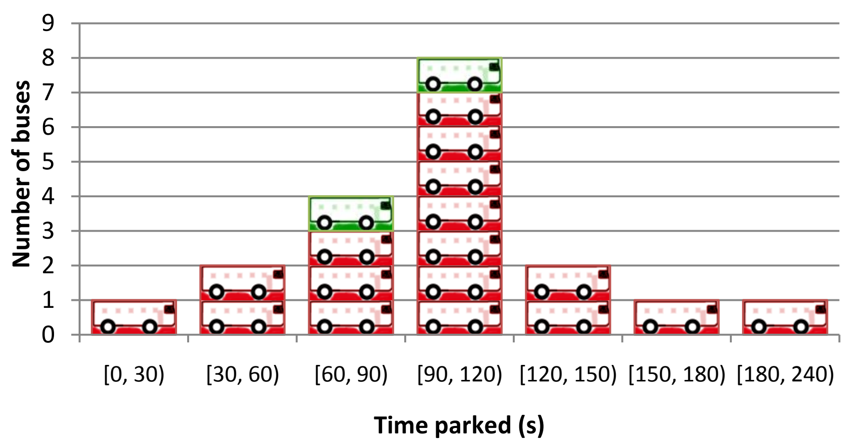

Figure 4. Histogram showing the duration of time (± 15 s) that parked buses had the engine on versus the engine off. *Each bus icon represents one parked bus. The red icons represent buses that parked with the engine on and the green icons represent buses that parked with the engine off. Buses with engine on (red) were parked for an average of 92 ± 15 s and buses with engine off (green) were parked for an average of 90 ± 15 s. Figure based on data from Feb. 2, Feb. 4, and Feb. 5, 2010.*

Figure 4 shows that buses with the engine on parked on average for approximately the same duration as buses with the engine off. With the engine on, buses were parked for 92 $\pm$ 15 s on average, while with the engine off, buses parked for 90 $\pm$ 15 s on average. This difference is not significant within the error range, invalidating any speculation that buses that idled were parked for shorter time spans. Figure 4 also makes it obvious that buses parked with the engine on are much more common than buses parked with the engine off. This finding is not surprising, given that keeping the engine on provides warmth for the driver and allows the engine to stay warm to avoid difficulties with starting the engine in the winter [4]. However, given that the buses that parked with the engine off did not have difficulty starting up the engine and were parked for a comparable duration as the buses that idled their engines, having all parked buses turn the engines off is a viable option. The result would be fewer spikes in noise, as Figure 3 highlighted.

Conclusions

Decibel noise peaked regularly the minute before and after the Canada Line was scheduled to arrive or depart, with much of the noise attributable to moving buses and buses that were parked with the engine idling. The noise created by passing buses was fleeting and would be difficult to eliminate, but the noise, heard from the sidewalk, created by parked and idling buses was long-lasting (92 $\pm$ 15 s) and could be reduced by an average of 12 $\pm$ 10 dB simply by encouraging drivers to turn the engine off. In addition, turning off engines would reduce the number and intensity of noise peaks, reducing irritation and health concerns in the residential neighbourhood.

References

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