

## Research Paper

# Noise Pollution Assessment in Sylhet City Corporation Using Geographic Information System (GIS)



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**Citation** Rahman A, Bin Alam J. Noise Pollution Assessment in Sylhet City Corporation Using Geographic Information System (GIS). *Journal of Advances in Environmental Health Research*. 2022; 10(2):127-132. <http://dx.doi.org/10.32598/JAEHR.10.2.1235>

<http://dx.doi.org/10.32598/JAEHR.10.2.1235>



### Article info:

Received: 28 Jun 2021

Accepted: 23 Sep 2021

Publish: 01 Apr 2022

### Keywords:

Noise pollution, Contour map, GIS, Decibel

## ABSTRACT

**Background:** Noise pollution is a risk factor for human health which is continuously increasing in Sylhet City corporation, located in the Sylhet division in Bangladesh.

**Methods:** In this study, we assessed the noise pollution level in Sylhet City by comparing it with the standard noise level. Also, the outcomes of this study were compared to other studies from different countries. In order to measure the noise level in decibel, BSWA 308 device was used in this study. A total of 38 samples were taken from different geographical locations in Sylhet City Corporation. The 38 samples provided 96 to 99% accuracy with a 95% confidence level of >36.

**Results:** The decibel values ranged from 72 to 86 dB. From the observed data we calculated the values as follows:  $L_{10}$ ,  $L_{50}$  and  $L_{90}$  and Noise Climate (NC)=12.7 dB, equivalent continuous noise level  $Leq=77.18$  dB and noise pollution level  $Lnp=89.88$  dB. A contour map of the area was made using Arc GIS software version 10.5. Every line in the contour map defined a specific decibel value. The map was made by 2 dB intervals between the corresponding contour lines. More than 30% of the study area was vulnerable to a high level of noise (>82 dBA), and about 30% had the lower level of noise (<77 dBA). Only 40% of the area had moderate noise levels (i.e., between 77 to 82 dBA).

**Conclusion:** After comparing the outcomes of noise level in this study with previous studies, we observed that the noise level of this area was more than acceptable limit for all parameters.

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## 1. Introduction

**T**he human ears are not equally sensitive to the sounds with different frequencies. Moreover, sound frequency ranges from 2Hz to 20,000 Hz that can be heard by the human ear. In this study, we used the Chinese BSWA 308 sound meter. There are two filters named A and C in this sound meter. The network “A” modifies the frequency response in order to follow approximately the equal loudness curve of 40 phons, while the network “C” modifies approximately the equal loudness of 100 phons [1]. The facepiece filtering respirators have been widely used to reduce human exposure to the aerosol particles. The respiratory performance has been extensively studied. Many researchers have revealed that more than 130 million people in Europe suffer from exposure to noise levels of more than 65 dBA [2, 3]. World Health Organization (WHO) has proposed a time-based guideline for LAeq (i.e., 16 h at day and 8 h at night). The environment noise level of 70 dB during 24 h was recommended by WHO for industries, commercials, shopping, traffic, indoors and outdoors areas to prevent hearing impairments [4, 5]. Noise levels were measured at 1.5 m above the ground using noise meters. The meteorological condition was ideal (i.e., no wind and no rain) during the study period. Moreover, to plant the trees on both sides of the streets is recommended.

By comparing the noise level obtained in the present study to the standard level, we can conclude that the noise levels are higher than standard values in most parts of the city. So, preventive programs such as educational programs are essential in order to increase the public awareness and technical controls for development of the city in future. This study had four main objectives including: a) To provide spatial distribution of sound levels in Sylhet City Corporation, b) To create a contour map of the sound levels of different area of the city to observe the overall sound level condition, c) To calculate and comprise the noise parameters of L10, L50, L90, NC, Leq, Lnp with other places in the world, d) To determine the safe distances of different places such as schools and residential areas from the roads in the city.

## 2. Materials and Methods

### Study area

The study area named Sylhet City Corporation is located in eastern part of Bangladesh with the size of 26 km<sup>2</sup>. This place is famous for its Sufi sanctuary.

Its geographical coordinates vary from 91046°45.3”E to 91056°57.2” E in the eastern direction and 24051°53.1”N to 24055°38.3”N in the northern direction. Figure 1 represents the study area of this study.

### Noise measurement

The noise levels were measured in the vicinity of roadway according to ISO 9613 using Taiwanese TES 1358C and Chinese BSWA 308. Two sound level meters with the ability of measuring the Leq were used in this study. Calibration was carried out using a TES-1358C sound level calibrator. A general rule for sound loudness is that the power should be increased by ten times which makes the sound twice longer.

## 3. Results and Discussion

In this study, 38 samples were taken in the vicinity of the roadway according to EPA guidelines for accuracy and precision. Statistically, given the standard deviation of 4.596, the 38 samples provided 96 to 99% accuracy with a 95% confidence level of  $\geq 36$ . Moreover, according to ISO 9613, the duration of measurement was 90 secs. The population size of pedestrians at public locations of the city peaks at 10 AM to 12 PM which are the most noised pollution times. The public movement at different transportation stations of Sylhet City is maximum during the time interval, as well. This study makes it necessary to protect people from health risk and noise-induced hearing loss caused by traffic flow.

It is clear from the traffic survey that non-motorized rickshaw is the most available vehicle in Sylhet. CNG and motorcycles were the most commonly used motorized vehicles that were found to be 39.4% and 23.7% of the total vehicles, respectively, followed by cars, minibuses, buses and tracks. The number of vehicles that passed through the intersection roads per hour were different from 1245 to 1576, 1645 and 1721 PCU/hr which were measured using the direct count method at the peak hours. The average values of noise level were measured in dB. The noise levels were measured on working days at selected sites in Sylhet. We used ArcGIS to prepare a contour map of noise level. The noise values have been presented in Figure 2 using GIS contour. We found different levels of noises in the roadside. More than 30% of the study area was vulnerable to a high level of noise (>82 dBA), and about 30% was at low level of noise (<77 dBA). Only 40% of the area had moderate noise levels (>77 dBA and <82 dBA).

The Sylhet City is located in different contour zones with different noise levels. The contour line values started from 72 dB up to 86 dB. As shown in the contour map in Figure 2, the middle part of the study area (Shahjalal Uposhohor) is confronted with fluctuated noise pollution in most of times. The decibel values ranged from 74 dB to 86 dB in the middle part of the study area. As seen in the map, the North and South western of the area had the same noise level (i.e., 74, 78, and 80 decibels). The North and South Eastern of the area had low fluctuation in noise level (i.e., 74 dB vs 72 dB). The noise contour map derived by ArcGIS software found that the vehicles in Yazd City, Iran created the maximum noise pollution [6]. Based on a network (at 2 km), the map showed that most of the residential areas were exposed to noise pollution. The average maximum noise values in the selected sites ranged from 80 to 86 dB during working days, and the average minimum noise ranged from 65 to 67 dB. We also showed that the noise climate (NC) was 12.7 (Equation 1). Neema and Dube [7] studied the noise pollution due to traffic in Bhopal. They reported that the level of traffic-related noise pollution was above 100 dB, which is not within standard range for human health. Bhosale et al. showed that the roads traffic volume in daytime significantly contributed to the intensity of noise level [8]. They also showed a maximum noise level of 86 dB in Aurangabad City due to the traffic. In Bangladesh, the permissible noise level for commercial areas has been legislated to be less than 60 dB in urban areas. From the data, it is clear that the noise level exceeded the permissible limit. On working days, the results showed that the roads in the city had the sound level of between 72 dB and 86 dB. Nejadkoorki et al. showed that the sound level in Yazd's streets was between 70.9 dB and 80.7 dB [9].

As a result, the dwellings, hospitals and educational institutions which are located nearby the roads are more likely to be exposed to a dangerous level of noise pollution. So, proper attention should be implemented to reduce human exposure to the pollution. The purpose of the study was to assess the traffic-related noise and flow (PCU per 15 min.) on the main roads of the city [10]. The estimated average Leq value was 73.04 dB in main roads of Sanandaj in Iran. In our study, the average value of Leq was 77.18 dB on the working day. It has been provided by the Equation 2. It is higher than the Leq value in Sanandaj. Hunashal and Patil reported that Leq of 72.25 dB was higher than statutory level for the educational zone in Kolhapur [11]. They also expressed the dire condition of noise pollution in Kolhapur.

Of the 38 samples (i.e., 38 decibel values), the  $L_{10}$ ,  $L_{50}$  and  $L_{90}$  values were calculated. Using the values, noise climate (NC), equivalent continuous noise level, Leq, pollution level,  $L_{np}$  were calculated in this study, as well. They were as following:

**$L_{10}$  (Data in the top 10%):**

$L_{10}$  is the value that was estimated by 10% of the time in which any distracting noise levels were taken into account. It was calculated as:

$$Data = 38 * 10\% = 3.84$$

**$L_{50}$  (Data in the top 50%):**

$L_{50}$  is the value that was estimated by 50 percent of the time. It is statistically the midpoint of the noise measurements. This is the mean fluctuation of the noise levels. It was estimated as:

$$Data = 38 * 50\% = 19 \text{ and } (19 - 4) = 15$$

**$L_{90}$  (Data below the 90%):**

$L_{90}$  is the value that was estimated by 90% of the time. It should be mentioned that the noise level is above the value for 90% of the time. Table 1 represents the data arrangement. It was estimated as following:

$$Data = 38 * 90\% = 34.2 \text{ and } 38 - 34 = 4$$

**Noise Climate**

$$1. (NC) = L_{10} - L_{90} = 84 - 71.3 = 12.7$$

**Equivalent Continuous Noise Level**

$$2. (Leq) = L_{50} + (NC)^2 / 60 = 74.5 + \frac{12.7^2}{60} = 77.18$$

**Noise Pollution Level**

$$3. (L_{np}) = L_{eq} + NC = 77.18 + 12.7 = 89.88$$

Ehrampoush et al. found high background noise in Yazd City. The Mean±SD was 71.2±4.4, 66.2±3.7, and 60.3±4 dB for  $L_{10}$ ,  $L_{50}$  and  $L_{90}$ , respectively [12]. The mean continuous sound level was 66.7 dB. On the other hand,  $L_{10}$ ,  $L_{50}$  and  $L_{90}$  values were, respectively, variable from 84 dB and 74.5 dB to 71.3 dB in the study. In this study, the noise pollution level of  $L_{np}$  was 89.88 dB which was estimated by Equation 3. Swain et al. found that the noise pollution of  $L_{np}$  ranged from 115.7 to 127.7, 114.2 to 129.8, 118.2 to 138.2 and 120.7 to 135

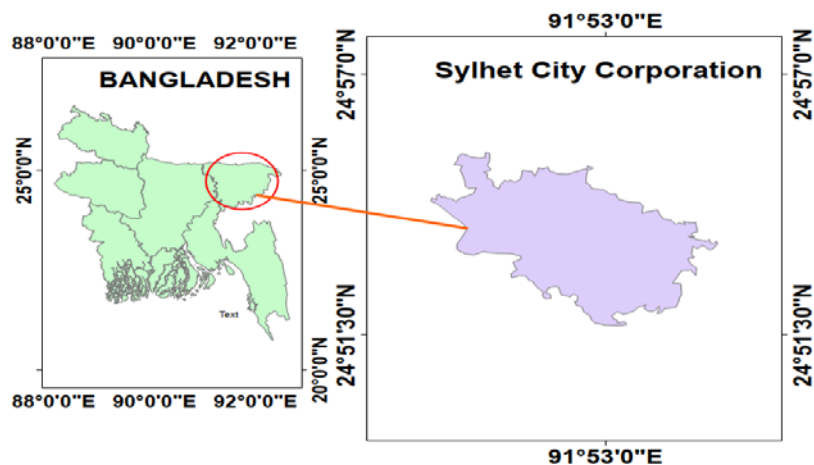


Figure 1. Sylhet City corporation

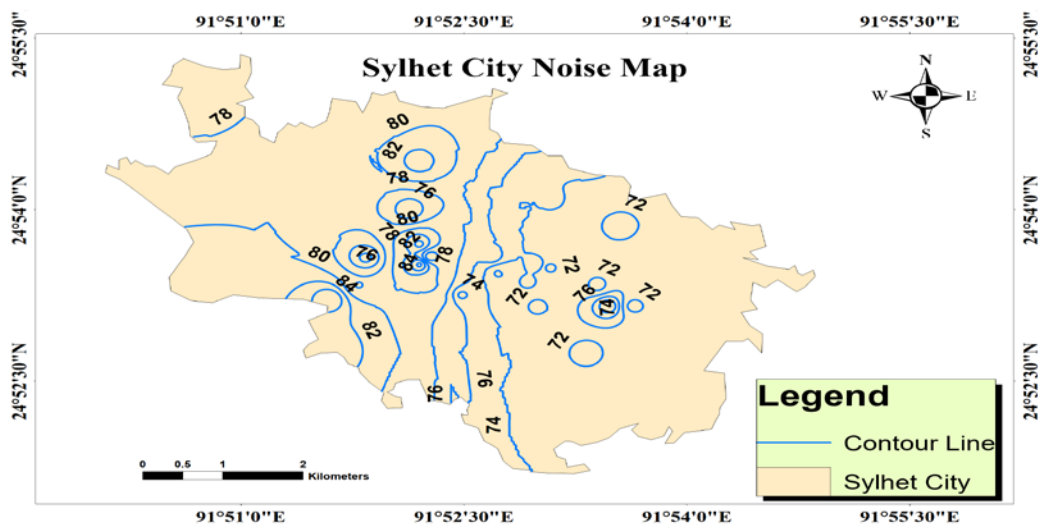


Figure 2. Sylhet City corporation contour noise map

Table 1. The  $L_{10}$ ,  $L_{50}$  and  $L_{90}$  values

<b>86.5 dB</b> (Max Value of Noise Level)	<b>82.8</b>	<b>77.9</b>	<b>71.3</b> (Start Point of)
86 dB	81.1	77.8	71.2
84.6 dB	81	76.4	71.2
84 dB (Starts point of $L_{10}$ )	80	76.4	71.2
-	80	75.3	-
-	80	74.5	-
-	78.8	74.5 (Start point of)	-
-	78.3	-	-

dB during 7-10 a.m., 11 a.m.-2 p.m., 3-6 p.m. and 7-10 p.m., respectively [13].

A widely accepted scientific fact is that living in an area with the Leq of higher than 65 dBA makes the urban population to be at high-risk for numerous noise subjective effects, including psychological, sleep, and behavioral disorders [4]. In this study, the average daily sound level was more than the standard threshold in most of urban roads in Sylhet. Also, the sound level of more than 66.7% of the roads (i.e., in a 3m ~5m away from the road) was higher than the national standard. In other studies conducted in Bangladesh, sound levels in the majority of the urban roads were above the standard threshold or national standard. Jagirdar and Alam et al. reported that traffic-related noise levels of Leq were in the range of 68 to 92 dBA in Mirpur-BUET Road [5, 14]. High noise levels (higher than the threshold) have also been reported in other cities in Bangladesh.

In a study conducted by Rahman et al., noise levels of Leq in the Dhaka City were between 69.9 to 72.8 dBA in residential areas [15]. Bawar and Bahzad studied the traffic-related noise effects [16]. They reported that, the mean Leq for outside of the city center was 85.3 dB in a working day. It was 74.4 dBA for inside of the city center. The difference between the two locations was significant ( $P=0.01$  and  $SD=7.8$ ). In the vacation days, mean Leq for outside and inside of the city center were 75.1 dBA and  $Leq=70.1$ , respectively. Therefore, no significant difference was observed between the two locations ( $P=0.7$ ).

In the study conducted by Islam et al., the maximum noise pollution in different parts of Chittagong during day and night was 87 dBA at Agrabad and 93 dBA at A K Khan, respectively. They were more than the standard threshold (60 dBA) [17]. Bari et al., reported the maximum noise level among 10 points at Kadirganj, Rajshahi which was 107.3 dBA [18]. In other studies conducted in Bangladesh, such as a study done by Muhit and Chowdhury, the road traffic noise (CRTN) was measured. In the study, the maximum noise level was 90.12 dBA [19]. The noise pollution level in diverse areas varied from 92.77 to 104.74 dBA on working days. It was variable from 86.9 to 105.5 dBA on holidays in Khulna City. One-way ANNOVA with LSD post hoc test revealed a significant difference in noise pollution levels in diverse areas and different shifts (during the different periods) of the daytime on working days [20].

In other studies, conducted outside of Bangladesh, such as a study done by Yilmaz and Ozer, in Turkey, noise levels were higher than standard at more than 100 locations [21]. Dursun et al., evaluated the noise

level in Goonieh, Turkey. They found that the city's average noise level was more than 65 dBA in a day [22]. The main sources of noise production were traffic and industries. The levels of noise pollution were more than 75 dBA in a day in 40.3% of points in Brazil [23]. A study was conducted in Lahore at 18 busy places of high traffic flow in peak times. It found that the day time average noise level was higher than the threshold of 85 dBA at 90% of the points in the city [24].

## 4. Conclusion

The noise assessment presented in this study revealed that the noise pollution was higher than standards in Bangladesh in some cities including the green cities like Sylhet. It is clear that the noise levels were higher than the standard threshold in Sylhet. Amorkhana and its surrounding roads and area were more vulnerable to noise pollution during both day and night. It is due to the traffic flow through this point to different inter-cities. The Zindabazar and Bandar streets were exposed to high-level of noise pollution in daytime. It is due to the market area and mixed traffic flow in the day time. The present study showed that it was clear that the middle part of the study area faces much more noise pollution than the other part of the city. The open spaces had a lower noise level at any time of the day because there was no high-density of human residence and business establishments that reduced vehicle traffic. Recommended control strategies shall include the noise control and its sources by employing car maintenance, regular services, and noise reduction.

## Ethical Considerations

### Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

### Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

### Authors' contributions

Both authors equally contributed to preparing this article.

### Conflict of interest

The authors declared no conflict of interest.

### Acknowledgments

The authors thank all organization for providing the data.

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