



Noise Pollution at Major Schools, Colleges and Hospitals in Small Urban Area: Focusing on Jessore Municipality, Bangladesh

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ABSTRACT

The study reports the level of traffic-induced noise pollution in the major schools, colleges and hospitals of the Jessore city of Bangladesh. The noise levels have been measured at 14 locations of the city from 7am to 7pm in the working days. The findings also indicated that traffic noise levels depend on distance from roadside and diurnal variation. Motorized traffic is the main source of noise pollution in this city. The study found that the most noise-polluted institution in the city was Mentor International School with measured L_{eq} of 80.37 dB and the least noise polluted institution in the city was Ad-din hospital with measured L_{eq} of 64.09 dB. The L_{10} levels in all the institutions were higher than 75.62 dB and L_{90} level was higher than 58.51 dB and there is a strong positive correlation between L_{10} and L_{90} level. Findings also indicate that in all of the institutions the TNI level was higher than 96.94 dB and the NC level was higher than 22.2 dB and also there is a strong positive relationship between TNI and NC. When the NC level increases then the TNI level also increases. It has been observed that at all the locations, the level of noise remains far above the acceptable limit for all the time.

INTRODUCTION

With the passing of time the population and number of vehicles has been increasing all over the world. It has led to the appearance of a new component in urban life: the noise. Traffic noise is considered as one of the important sources of noise pollution that adversely affects human health (Aparicio et al. 1993, Lercher 1995, Williams & McCreae 1995). Noise pollution and its consequent influence over the environment and life quality of human beings may be considered a "hot topic" in scientific research (Schultz 1978, Sadan 1986, Aparicio-Ramon 1993, Shaw 1996). This problem has not been properly recognized despite the fact that it is steadily growing in developing countries. According to the WHO, noise pollution is nowadays the 3rd most hazardous environmental type of pollution, preceded only by air and water pollution (Khilman 2004). Unlike other forms of pollution such as air, water and solid waste, noise pollution problems have received lesser attention by the government of Bangladesh. Bangladesh is adorned with an unplanned settlement pattern and narrow roads. The schools, hospitals and institutions are situated near the main roads which are always blocked with vehicles. According to the experts, the noise pollution in Bangladesh is quite high. During the 70s and early 80s, noise pollution was not a major concern for the people of Bangladesh, but with the increase in the number of motorized vehicles in the country, the hazard of noise

pollution has increased and exceeded the level of tolerance (Alam 2001)

MATERIALS AND METHODS

Survey area: Jessore is an urbanized city district of Bangladesh and located in Khulna division. It is one of the most vital parts of Khulna division. Jessore has important high-ways for transportation to both Bangladesh and India. Jessore is a junction on the broad gauge network of the Western Bangla railway. The Jessore airport, located near the Jessore city is an airbase for the Bangladesh Air Force. The road transport system of this city consists of various vehicles like rickshaw, motor vehicle, bus, truck etc. The schools, colleges, hospitals, educational institutions of Jessore city are situated near the main roads which are always blocked with vehicles. This situation leads the area to be one of the most vulnerable areas of the city in terms of noise pollution. Map of the Jessore municipality area is shown in Fig. 1.

Method of measurement: The parameter universally used in the discussion of noise pollution of environment is L_{eq} , the energy equivalent continuous, which is the average rate at which energy is received by the human ear during the period mentioned. This parameter can be obtained by direct measurement with a sound level meter. It is expressed in dB (A) and calculated by the following equation (Chakrabarty

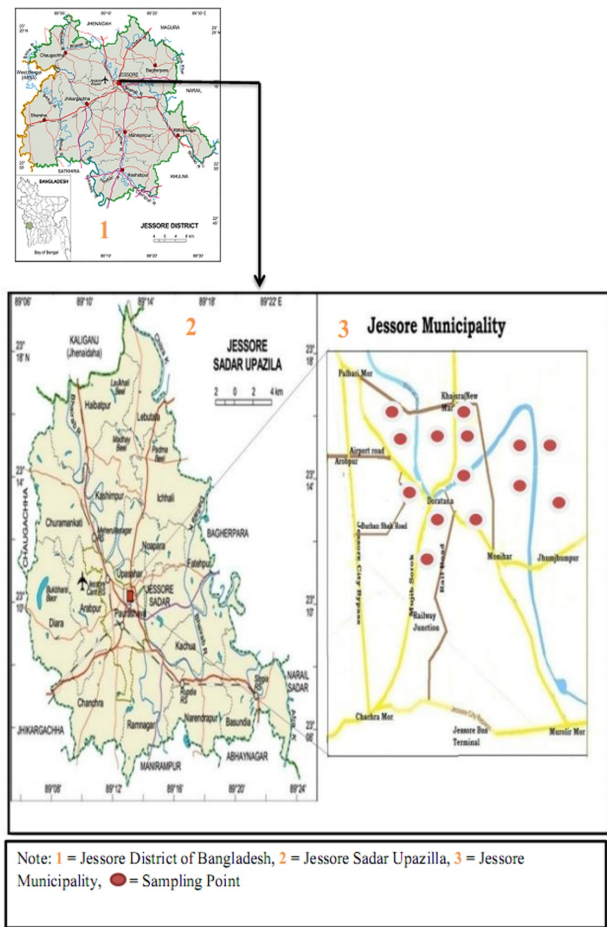


Fig. 1: Map of study area, Jessore municipality.

et al. 1996):

$$L_{eq} = 10 \log_{10} [1/N \sum 10^{(Li/10)}] \quad \dots(1)$$

Where, T is the period of measurement and Li is the average noise level during interval i.

Traffic Noise Index is used to measure annoyance responses to motor vehicle noise. It is also expressed in dB(A) and can be computed by the following equation (Jamrah 2005, Alam 2006):

$$TNI = 4 (L_{10} - L_{90}) + (L_{90} - 30) \text{ dB (A)} \quad \dots(2)$$

Where, L₁₀ and L₉₀ indicate the levels exceeded for 10% and 90% of time, respectively, in a set of records of noise level in a given interval of time and can be computed by the following equation respectively (Jamrah 2005):

$$L_{10} = L_{eq} + 3.0 \text{ dB (A)} \quad \dots(3)$$

$$L_{90} = .467 \times L_{eq} + 24.60 \text{ dB (A)} \quad \dots(4)$$

Another parameter, Noise Climate (NC) provides the range over which the sound levels fluctuate in an interval of

time and is given by the following equation (Alam 2001):

$$NC = (L_{10} - L_{90}) \text{ dB (A)} \quad \dots(5)$$

Data collection: Primary data were collected from direct measurement of noise levels in the fourteen institutions of Jessore city by a digital noise meter. Primary data collection incorporated measurement of noise levels at different educational and commercial institutions in Jessore city which included schools, colleges and hospitals (Table 1).

All measurements were carried out during working days (Saturday to Thursday). The measurements were carried out from 7am to 7pm. This time of the day represents the peak in the number of visitors, as well as the peak in traffic intensity at sided road. Noise level monitoring has been done in free-flowing traffic conditions. Traffic noise level measurements were conducted over a period of two weeks. However, to quantify the variability of the noise during each measurement, the A-weighted conditions like equivalent sound level L_{eq} and statistical levels L₁₀, L₉₀, the maximum sound pressure level L_{max}, the minimum sound pressure level L_{min}, TNI and NC were also measured. The sampling time interval was 10 min in each hour.

RESULTS AND DISCUSSION

Variation of 12 hour equivalent noise level of the schools:

Fig. 3 and 3 show the variation of 12 hour equivalent noise level at the Mentor International School, Affort school, Cantonment college and equivalent noise level of Policeline school, Baptiz church school, Jessore Zilla School and Abdur Rajjak Municipal College. The Figures indicate that the equivalent noise level of Mentor and Affort school is higher due to being located near Dhaka-Khulna highway. In Cantonment college this level is much lower due to being away from the main road. Again, the equivalent noise level of Policeline school, Baptiz Church School and Jessore Zilla School is higher due to being located near the main road. At Dr. Abdur Rajjak Municipal College this level is comparatively lower due to being away from the main road. The figure also show that between 8am-4pm the noise level was much higher, as during this time the traffic vehicle moving

Table 1: Educational and commercial institutions of Jessore city for primary data collection.

Institutions	Designated number	Institutions	Designated number
Mentor School	1	Akota Hospital	8
Affort School	2	Queence Hospital	9
Cantonment College	3	Doratana Hospital	10
Policeline School	4	Ad-din Hospital	11
BaptizCharl's School	5	Hasina Clinic	12
JessoreZilla School	6	Sadar Hospital	13
AbdurRajjak College	7	Lab-Scan Medical	14

rate is high and also due to gathering and shouting of students. While during 4pm-7pm the noise level was lower than morning, as during this time the vehicle moving rate was lower and the students went to their home.

The variation of 12 hour equivalent noise levels at Akota Hospital, Queence Hospital, Doratana Hospital, Ad-din Hospital, Hasina Clinic, Sadar Hospital and Lab-Scan Medical Services Limited Hospital are shown in the Figs. 4 and 5. The figures indicate that the equivalent noise levels at these institutions are higher due to being located near the main road. Here, the noise level is mostly higher than 70 dB and the maximum noise level was 82.86 dB during 9am-10am and the minimum noise level was 57.53 dB at Queence Hospital during 7am-8am. But in Ad-din Hospital the noise level is comparatively lower due to being located away from the main road.

Noise level at Lab-Scan Medical Services Limited Hospital is higher due to being located near the main road. Here the noise level fluctuates between 64.09 dB to 73.50 dB.

Noise level at different institutions in Jessore city: The measured equivalent noise levels L_{eq} , maximum noise levels L_{max} , minimum noise levels L_{min} , L_{10} , L_{90} , Traffic Noise Index (TNI) and Noise Climate (NC) of the selected institutions are given in Table 2. Noise levels reported in Table 2 show that the equivalent noise level L_{eq} throughout the institutions has an average of 77.80 dB(A) and ranges between 72.62 to 84.80 dB(A) in the institutions. The maximum L_{eq} is 84.80 dB(A) which has been found in Mentor International School and the minimum L_{eq} is 72.62 dB(A) which has been found in Rajjak Municipal College.

Study of Table 2 shows that the average of maximum noise level L_{max} is 88.99 dB and ranges between 82.7 and 95.3 dB(A). The maximum L_{max} 95.3 dB(A) has been found in Baptiz Church School and the minimum L_{max} is 82.7 dB(A) which has been found in Queence Hospital. Additionally, it has been found that the average L_{min} is 53.61 dB(A), it has been found from 37.5 to 64.5 dB(A). The maximum L_{min} is 64.5 dB(A), which has been found in Hasina Hospital and the minimum L_{min} is 37.5 dB(A) which has been found in Rajjak Municipal College.

The table also indicates that the average L_{10} is 80.84 dB(A) and it is found in 75.62 to 87.80 dB(A) range. The maximum L_{10} is 87.80 dB(A) which has been found in Mentor International School and the minimum L_{10} is 75.62 dB(A) which has been found in Rajjak Municipal College. The table also shows that, the average L_{90} is 61.35 dB(A) and it ranges from 58.57 to 65.60 dB(A). The maximum L_{90} is 65.60 dB(A) which is found in Mentor International School and the minimum L_{90} is 58.51 dB(A) which is in Rajjak Municipal School. Table 2 indicates that the Traffic Noise Index (TNI) which is a method used to estimate the annoyance responses due to traffic noise, it's average is 109.29 dB(A) and the maximum TNI is 124.39 dB(A) which is found in Mentor International School and the minimum TNI is 96.94 which is found in Rajjak Municipal College.

The Noise Climate (NC) shown in Table 2 indicates that the average NC is 19.49 dB(A) and it ranges from 17.11 to 22.2 dB(A). The highest NC is 22.2 dB(A) which is found in Mentor International School and the Lowest NC is 17.11 which is found in Rajjak Municipal College. The data presented in Table 2 are further investigated in order to better

Table 2: Noise level (L_{eq} , L_{min} , L_{max} , L_{10} , L_{90} , TNI, NC) at different Institutions in Jessore city:

Institutions	Leq	Lmax	Lmin	L10	L90	TNI	NC
1. Mentor school	84.8	92.5	57.2	87.8	65.6	124.39	22.2
2. Affort school	79.71	92.1	57.6	82.71	63.23	111.16	19.48
3. Cantonment College	76.39	87.2	43.2	79.39	60.27	106.74	19.12
4. Policeline school	76.85	87.7	41.9	79.85	61.89	103.73	17.96
5. Charl'sBapist school	80.26	95.3	59.7	83.26	62.08	116.8	21.18
6. JessoreZilla school	75.83	88.3	57.1	78.83	60.01	105.24	18.82
7. Rajjak College	72.62	87.3	37.5	75.62	58.51	96.94	17.11
8. Akota Hospital	76.35	85.9	55.3	79.35	60.26	106.63	19.09
9. Queence Hospital	74.38	82.7	50.3	77.38	59.34	101.51	18.04
10. Doratana Hospital	80.49	88.2	60.7	83.49	62.19	117.39	21.3
11. Ad-din Hospital	78.49	92.5	49.1	81.49	61.25	112.2	20.24
12. Hasina Hospital	76.02	86.6	64.5	79.02	61.5	101.57	17.52
13. Sadar Hospital	79.04	90.1	63.5	82.04	61.51	113.63	20.53
14. Lab-Scan	78.46	89.5	52.9	81.46	61.24	112.12	20.22
Average	77.83	88.99	53.61	80.84	61.35	109.29	19.49
Max	84.8	95.3	64.5	87.8	65.6	124.39	22.2
Min	72.62	82.7	37.5	75.62	58.51	96.94	17.11

Source: Analysis

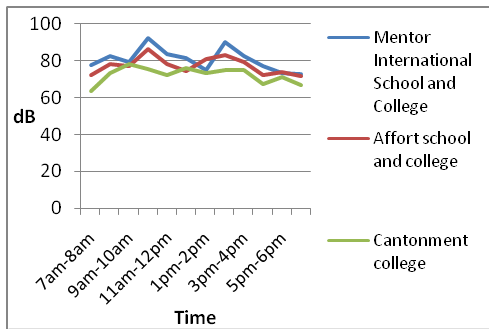


Fig. 2: 12 hour equivalent noise level of Mentor International School and College, Affort School and College and Cantonment College.

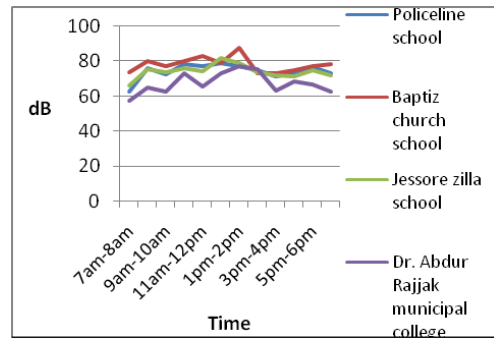


Fig. 3: 12 hour equivalent noise level of Policeline School, Baptiz Charl's School, Jessore Zilla School and Dr. Abdur Rajjak Municipal College.

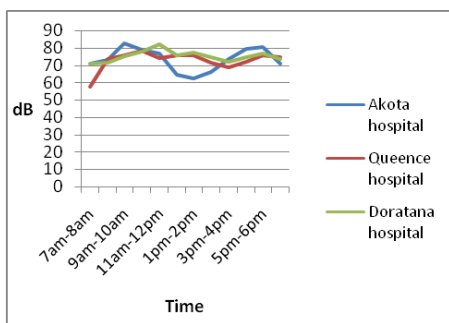


Fig. 4: 12 hour equivalent noise level of Akota Hospital, Queence Hospital and Doratana Hospital.

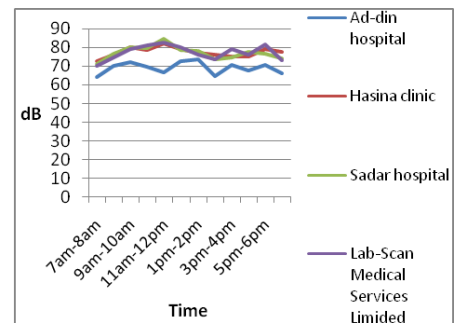


Fig. 5: 12 hour equivalent noise level of Ad-din hospital, Hasina Clinic, Sadar hospital and Lab-Scan Medical Services Limited:

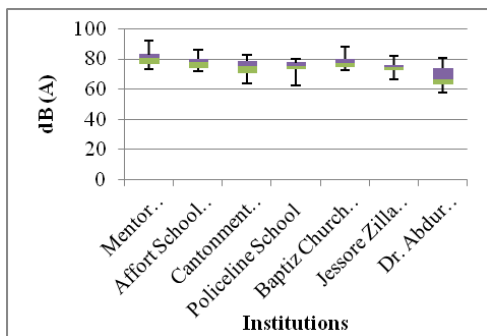


Fig. 6: variation of L_{eq} , L_{max} , L_{min} in 12 hours of the schools and colleges.

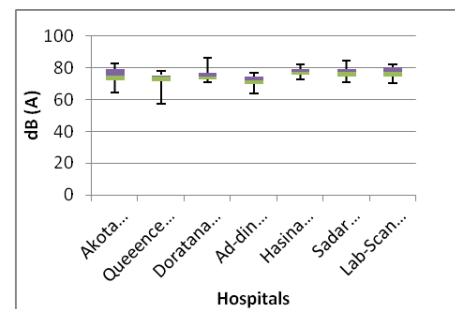


Fig. 7: Variation of L_{eq} , L_{min} , L_{max} in 12 hours of the hospitals.

understand the noise condition. Table 2 shows that these noise levels are much higher and are mostly considered unacceptable.

Variation of L_{eq} , L_{max} , L_{min} in 12 hours of the institutions:

Fig. 6 shows the variation of 12 hours equivalent noise level L_{eq} , maximum noise level L_{max} , minimum noise level L_{min} of the schools and colleges. From the figure it is observed that the noise level of the schools and colleges are much higher although they fluctuate with time. Figure reveals that the maximum noise level at the Mentor International School was

92.07 dB and the minimum noise level was 72.99 dB and the average noise level was 80.37 dB. At the Affort School the maximum noise level was 86.14 dB and the minimum noise level was 71.87 dB and the average noise level was 77.70 dB. At the Cantonment College the maximum noise level was 82.69 dB and the minimum noise level was 63.64 dB and the average noise level was 75.28 dB. At the Policeline School the maximum noise level was 80.08 dB, the minimum noise level 62.49 dB, and the average noise level 75.33 dB. At the Baptiz Church School the maximum

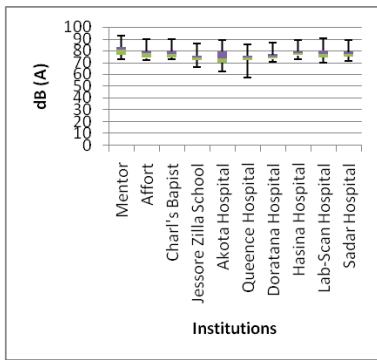


Fig. 8: Variation L_{eq} , L_{min} , L_{max} of the institutions which are besides roadsides.

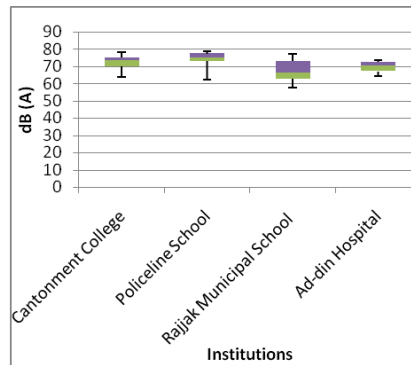


Fig. 9: Variations of L_{eq} , L_{min} , L_{max} of the institutions which are away from road side. Relation between L_{10} and L_{90} of the institutions:

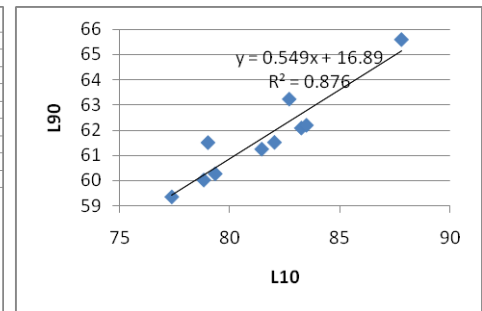


Fig. 10: Relation between L_{10} and L_{90} of the institutions which are besides roadsides.

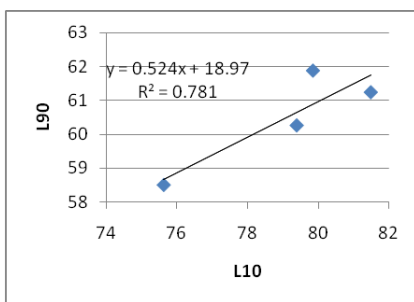


Fig. 11: Relation between L_{10} and L_{90} of the institutions which are away from road side.

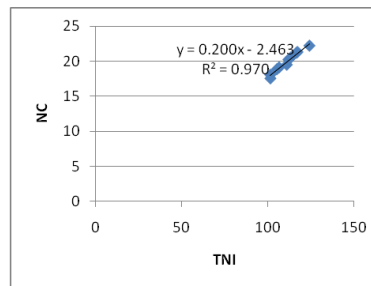


Fig. 12: Relation between TNI and NC of the institutions which are located beside road sides.

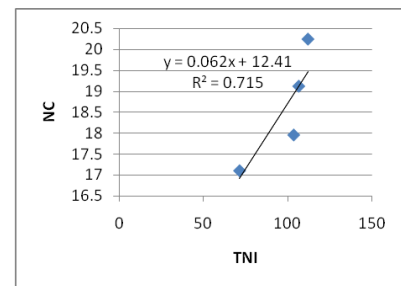


Fig. 13: Relation between TNI and NC of the institutions which are away from road side.

noise level was 87.74 dB, the minimum noise level 72.80 dB, and the average noise level 76.97 dB. At the Jessore Zilla School the maximum noise level was 81.78, the minimum noise level 66.27 dB, and the average noise level was 74.12 dB. At the Dr. Abdur Rajjak Municipal College the maximum noise level was 80.88 dB, the minimum noise level 57.43 dB, and the average noise level 66.27 dB.

From the Fig. 7 it has been found that the variation of 12 hours equivalent noise level L_{eq} , maximum noise level L_{max} , and the minimum noise levels of the hospitals are much higher although they fluctuate with time. The figure shows that at Akota hospital the maximum noise level was 82.86 dB, the minimum noise level 64.62 dB, and the average noise level 74.92 dB. At Queence hospital the maximum noise level was 78.25 dB, the minimum noise level 57.53 dB, and the average noise level 74.31 dB. At Doratana hospital the maximum noise level was 86.09 dB, the minimum noise level 70.78 dB, and the average noise level 74.82 dB. At Ad-din hospital the maximum noise level was 76.73 dB, the minimum noise level 64.09 dB, and the average noise level 71.92 dB. The figure also shows that at Hasina hospital the maxi-

imum noise level was 82.15 dB, the minimum noise level 72.82 dB, and the average noise level 77.59 dB. At Sadar hospital the maximum noise level was 84.72 dB, the minimum noise level 71.16 dB, and the average noise level 77.26 dB, and at Lab-Scan Medical the maximum, minimum and average noise levels were 82.48 dB, 70.1 dB and 77.41 dB.

Variation L_{eq} , L_{min} , L_{max} of the institutions: If we compare the variation of 12 hours equivalent noise level L_{eq} , maximum noise level L_{max} , minimum noise level L_{min} of the institutions, which are located besides the main road, and the institutions which are located away from main road, it is found that, the noise levels are much higher in the institutions that are located near the main road. Fig. 8 and Fig. 9 reveal that the maximum noise levels at Mentor International School, Affort school, Baptiz Church school and Jessore Zilla school were 92.07 dB, 86.14 dB, 87.74 dB and 81.78 dB which were much higher than Cantonment College (78.44 dB), Dr. Abdur Rajjak Municipal College (76.97 dB) and Policeline school (78.92 dB). The hospitals near the road also express the same situation which is shown the Figs. 8 and 9.

Fig. 10 shows the correlation between L_{10} and L_{90} noise level of the institutions which are located besides the main roads. In the figure, x-axis indicates the L_{10} level of the institutions and y-axis indicates the L_{90} level of the institutions. The figure shows that the correlation coefficient of L_{10} and L_{90} level is 0.876 which indicates that L_{10} and L_{90} are closely related. When the L_{10} level increases then the L_{90} level also increases.

Fig. 11 shows the correlation between L_{10} and L_{90} noise levels of the institutions which are located away from the main roads. In the figure, x-axis indicates the L_{10} level and y-axis indicates the L_{90} level of the institutions. The figure shows that the correlation coefficient of L_{10} and L_{90} is 0.781 which indicates that L_{10} and L_{90} noise level are closely related, but it is lower than the institutions which are located near the main roads. When the L_{10} level increases then the L_{90} level also increases.

Relation between TNI and NC of the institutions: Fig. 12 shows the correlation between Traffic Noise Index (TNI) and Noise Climate (NC) of the institutions which are located besides main roads. In the figure, x-axis indicates the TNI level and y-axis indicates the NC level of the institutions. The figure shows that the correlation coefficient of TNI and NC is 0.970 which shows that TNI and NC are closely related. When the TNI level increases then the NC level also increases.

Fig. 13 shows the correlation between Traffic Noise Index (TNI) and Noise Climate (NC) of the institutions which are located away from the main roads. In the figure, x-axis indicates the TNI level and y-axis indicates the NC level of the institutions. The figure reveals that the correlation coefficient of TNI and NC is 0.715 which shows that the TNI and NC are closely related. When the TNI level increases then the NC level also increases.

CONCLUSION

In the overall monitoring sites this study revealed the equivalent noise levels L_{eq} , maximum noise levels L_{max} , minimum noise levels L_{min} , L_{10} , L_{90} , Traffic Noise Index (TNI) and Noise Climate (NC) of the selected institutions. This study indicates that the equivalent noise levels in all of the institutions were higher than 72.62 dB and the L_{10} levels were

higher than 75.62 dB. The L_{90} levels in all of the institutions were higher than 58.51 dB which is much higher and in an unacceptable limit. The Traffic Noise Index (TNI) in all of the institutions was higher than 96.94 dB which is much higher and denotes that excessive annoyance due to the traffic noise. The Noise Climate (NC) in all of the institutions was higher than 22.2 dB. The results showed that there is a clear relationship between noise pollution due to traffic vehicle and also a linear correlation between L_{10} , L_{90} and L_{eq} . The study revealed that the traffic noise is the major pollutant and transport operations are major contributors to the traffic noise. The analysis of the results of this study shows that the level of noise pollution due to road traffic in Jessore city far exceeds the acceptable limits set by the Department of Environment, Bangladesh as well the recommendations of Health and Environmental Protection Agencies, such as WHO and USEPA.

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