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Noise Descriptors For Kota Metropolis, Rajasthan (India)

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Abstract

The most common environmental concern in metropolitan cities worldwide is noise pollution. Kota metropolis (India) is also suffering from the problem of the increased noise level in the urban environment. Kota metropolis has been selected for the assessment of noise pollution. The main reasons behind the increasing level of noise in the city are increased population, rapid urbanization and industrialization, increased transportation facilities, urban development, construction and demolition works etc. The noise levels were recorded for day-time (6 am to 10 pm) as per Indian standard time for 96 days. Sixteen sampling points are made within the city depending upon the category of area/zone such as industrial, residential, silence and commercial. Six days were prescribed for each sampling location for noise level measurement. Noise descriptors such as L_{max}, L_{min}, L_{10}, L_{50}, L_{90}, NC (noise climate), L_{np} (noise pollution level), Leq (equivalent noise level), and NEI (noise exposure index) were computed with the observed data.Noise descriptors are very useful to indicate the physiological and psychological effects of noise pollution associated with noise levels. It makes regulating agency to take necessary actions in high noise areas for noise vulnerable groups such as Childs, old persons etc. Noise levels were recorded with the digital sound level meter " HTC SL-1350". Obtained equivalent noise levels were in between 65 dB(A) to 85 dB(A). The results were then compared with the WHO standards of community noise levels, and Indian noise pollution standards.It is noticed that the noise levels in all monitoring stations were well above the limits of the standards prescribed by the WHO and CPCB. Small variations in noise levels were observed for all sampling locations i.e. noise levels were almost similar at sampling locations. Noise levels were distinct in magnitude for morning and evenings hours. Noise Exposure Index (NEI) was greater than 1 which shows significant high noise levels in all the sampling locations. Kota metropolis desperately needs new strategies to reduces the high noise level in the city. Regulating agencies should take necessary action before things get out of control.Some immediate actions are suggested in the study.

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Introduction

'Nausea' is a Latin word which implies 'unwanted level of sound ' or 'loud, distracting or unpredictable sound.'[1,2] A more accurate definition would be "noise is an audible and high range of sound causing disturbance, disability or harm to health."[3–6] Since it cannot be seen, smelled, or tasted, it is an underestimated environmental problem.Noise needs to be identified as a considerable threat to human well-being.[7–9]

Most Indian cities are increasingly urbanizing and industrializing. Most people are expected to live in the cities within the next two decades resulting in a tremendous increasein the number of motor vehicles continuously.[10] Due to this surge in the motor vehicles population, vehicular noise has become one of the significant source of environmental noisepollution in urban environment, which affects the quality of the urban living environment.[11–14]

It is a sluggish and subtle killer, but there has been no effort to improve the same.[6] It has become a threat to the quality of life, along with other forms of pollution. It is certified that even relatively low noise levels have a detrimental impact on human wellbeing. annoyance and aggression, high stress levels,hypertension, hearing loss, tinnitus,hamper children's cognitive development, sleep disturbances, and other effects.[6,9,11,15–18] Furthermore, fatigue and hypertension are the leading causes of health problems, while tinnitus can contribute to forgetfulness, extreme distress, and often panic attacks. High sound levels may lead to cardiovascular consequences.[19,20]

The levels of noise in Kota City are increasing gradually due to increased number of vehicles used for transportation purpose. A vast number of studies regarding to noise pollution in Indian cities have been published, but there is not enough data available for Kota City.This researchstudy on Kota city shows the area or zone-wise assessment and analysis of high noise levelsin busiest places concerning equivalence sound levels.

Materials & Methods

Noise levels were recorded at sixteen (16) sampling places for four diverse groups of area/zone in the Kota metropolis, viz. industrial, residential, commercial and silence zone. For each group of sampling locations, four important and busiest placeswere selected. As per Indian guidelines launched by CPCB, Kota metropolis is classified for sampling placesare following:

A. Commercial Area				B. Residential Area	
Code	**Location**	**Long.**	**Lat.**	**Code**	**Location**
S-1	Aerodrome Circle	75.85	25.16	S-5	Dadwara
S-2	Kotri Circle	75.85	25.17	S-6	Keshavpura
S-3	Sabjimandi	75.84	25.18	S-7	Talwandi
S-4	Gumanpura	75.84	25.17	S-8	Jawahar Nagar
C. Silence Zone				**D. Residential Area**	
S-9	RICCO Institutional Area, Ranpur	75.84	25.06	S-13	KSTPS (Kota Super Thermal Power Station)
S-10	MBS Hospital, Nayapura	75.85	25.19	S-14	RICCO Industrial Area, Ranpur
S-11	Antaghar Circle	75.85	25.19	S-15	Chambal Industrial Area
S-12	Instrumentation Limited Circle	75.85	25.14	S-16	Indraprastha Industrial Area

These sampling locations are shown in the figure 1 and research methodology used for this research work is presented in figure 2. The sound level sare measured by Digital Noise Level Meter “HTC SL-1350”.[21] The Digital Sound Level Meter was placed 1.5 m above the road and, if there are

reflecting surface, Then 3.0 to 3.5 m away from it. A 96 days observation period was decided to study noise levels in the 16 sampling locations of Kota city. Noise measurements were conducted continuously for six days from Monday to Saturday at each sampling location with 16 hours of continuous monitoring from 6:00 am to 10:00 pm per day.

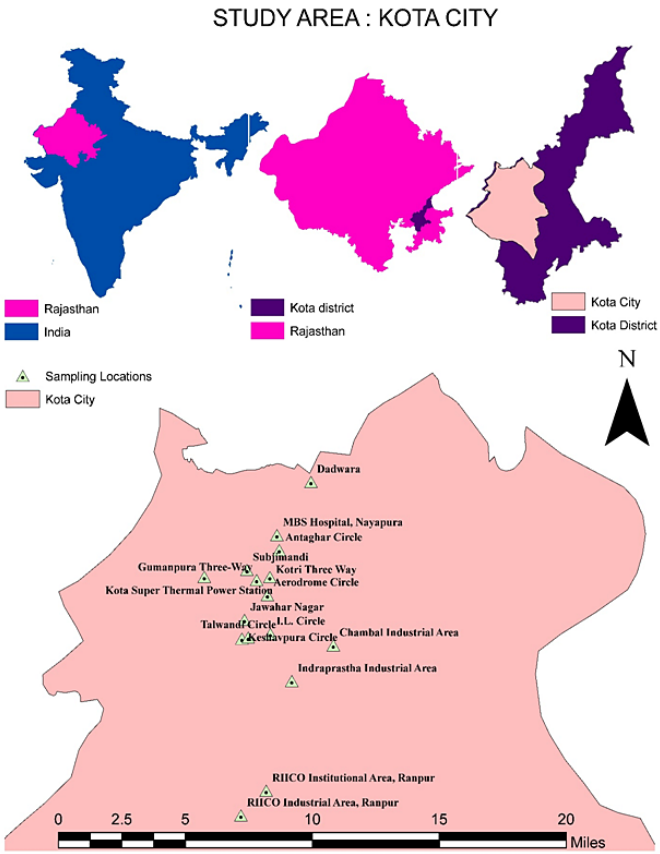

Fig. 1: Sampling location of Kota city

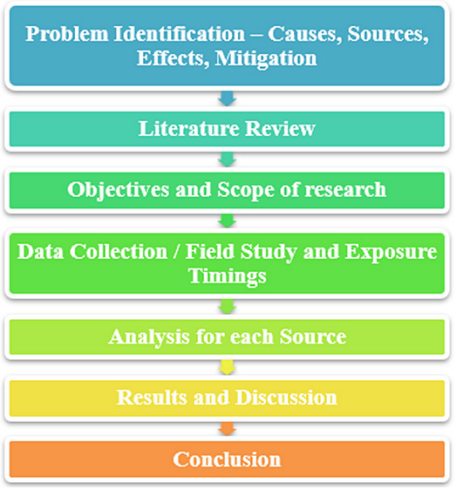

Fig. 2: Research methodology adopted in this research work

Noise Pollution Standards

In India, under the Environment Protection Act, 1986, the Noise Pollution (Regulation and Control) Rules 2000 were framed. These are a set of guidelines for noise control and regulation. Table 1 shows the acceptable ambient noise levels for the different areas / zones as per Indianstandards while WHO standards for community noise in specific environment is presented in Table 2.

Table 1: The Central Pollution Control Board Guidelines for Noise Pollution in India are as follow:[6,22,23]

Sr. No.	Zonal Category	Equivalent Noise Level Limits(L_{eq}), dB(A)	
		Night Time	Day Time
1.	Industrial Area	70	75
2.	Commercial Area	55	65
3.	Residential Area	45	55
4.	Silence Zone	40	50

#Source: Act of Environment Protection, 1986 as amended in 2002.

Table 2: The World Health Organization (WHO) Standards for community noise in specific environment are as follow:[24]

Code	Specific Environment	Equivalent Noise Level Limits (L_{eq}), dB(A)	
		Time Base (Hours)	Day Time
1.	Outdoor Living area	16	55
2.	School, Playground Outdoor	During Play	55
3.	Commercial, Industrial, Shopping and Traffic Areas	24	70

Noise Pollution Descriptors

To determine noise pollution levels in the city, different noise descriptors were estimatedwith the help of Gaussian percentile. Noise descriptors such as L_{10}, L_{50}, L_{90}, L_{max}, and L_{min}, were computedby the recorded levels of noise and these variables are utilized for the analysis of NC (Noise Climate), L_{eq} (EquivalentNoise Level) and L_{np} (Noise Pollution Level).[25] The noise pollution indiceswere determined using the following formulas:

$$NC = L_{10} - L_{10} \quad \ldots(1)$$

$$N_{eq} = L_{50} + [(NC^2) / 60] \quad \ldots(2)$$

$$L_{np} = NC + N_{eq} \quad \ldots(3)$$

$$NEI = t_1 / T_1 + t_2 / T_2 + \ldots + t_n / T_n \quad \ldots(4)$$

Where, NC is Noise Climate; L_{10} is the noise level that crosses 10 percent of total observation time or Peak Noise Level. L_{50} is the noise level that crosses 50% of the overall sampling time. L_{90} is the amount of sound that exceeds 90% of the total observation time or the level of background or residual noise. L_{eq} is the continuous level of noise, and L_{np} is the level of noisepollution. t_1 to t_n are the real exposure limit at the respective noise levels, and T_1 to T_n are the allowable exposure limit at the very same noise levels. If the measured NEI value is more than 1, then the level of noise exposure is considered excessive.

Results

Commercial Area

The following results in the form of graphs have been generated from the 24 days study for sampling locations viz. Aerodrome Circle, Kotri Circle, Sabjimandi, and Gumanpura.

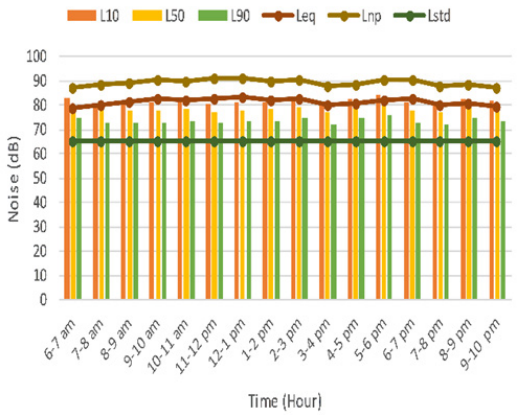

Fig. 3: Noise Pollution Indices for Aerodrome Circle

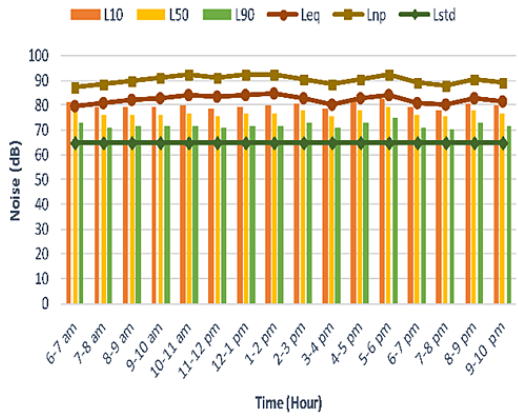

Fig. 4: Noise Pollution Indices for Kotri Circle

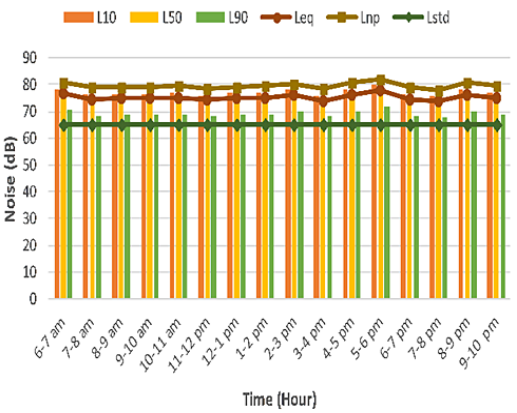

Fig. 5: Noise Pollution Indices for Sabjimandi

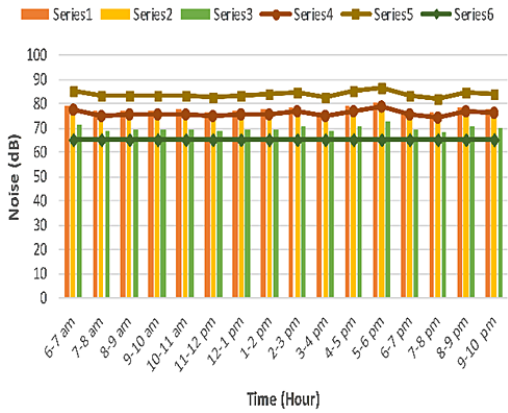

Fig. 6: Noise Pollution Indices for Gumanpura

Residential Area

The following results in the form of graphs have been generated from the 24 days study for sampling locations viz. Dadwara, Keshavpura, Talwandi and, Jawahar Nagar.

Fig. 7: Noise Pollution Indices for Dadwara

Fig. 8: Noise Pollution Indices for Keshavpura

Fig. 9: Noise Pollution Indices for Talwandi

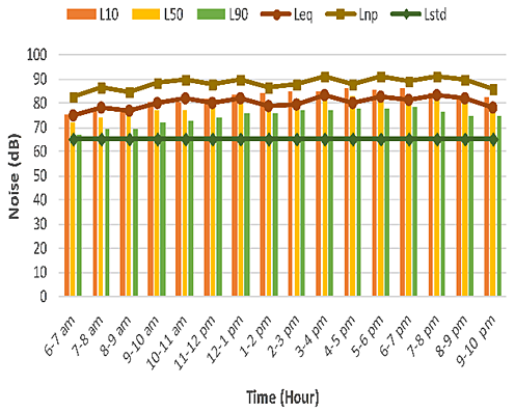

Fig. 10: Noise Pollution Indices for Jawahar Nagar

Silence Zone

The following results in the form of graphs have been generated from the 24 days study for sampling locations viz. RICCO Institutional Area, Ranpur, MBS Hospital (Nayapura), and Antaghar Circle I.L. Circle

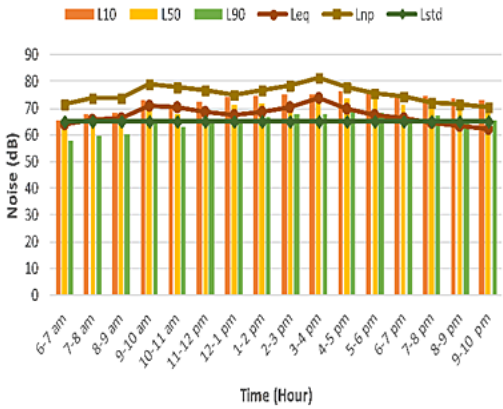

Fig. 11: Noise Pollution Indices for RICCO Institutional Area, Ranpur

Fig. 12: Noise Pollution Indices for MBS Hospital, Nayapura

Fig. 13: Noise Pollution Indices for Antaghar Circle

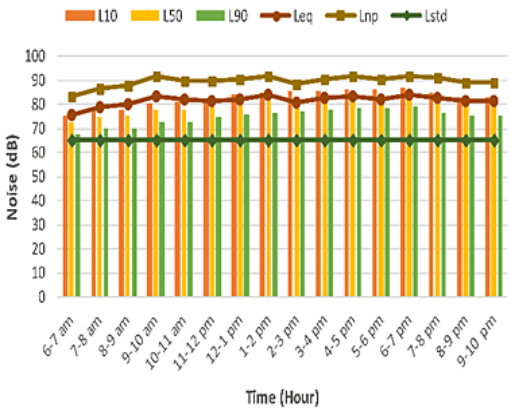

Fig. 14: Noise Pollution Indices for I.L. Circle

Industrial Area

The following results in the form of graphs have been generated from the 24 days study for sampling locations viz. KSTPS, RICCO Industrial Area (Ranpur), Chambal Industrial Area, and Indraprastha Industrial Area.

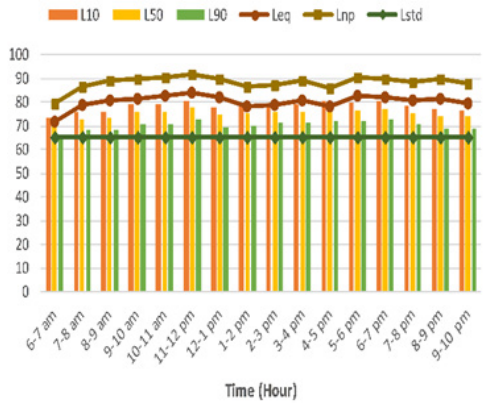

Fig. 15: Noise Pollution Indices for Kota Super Thermal Power Station

Fig. 16: Noise Pollution Indices for RICCO Industrial Area, Ranpur

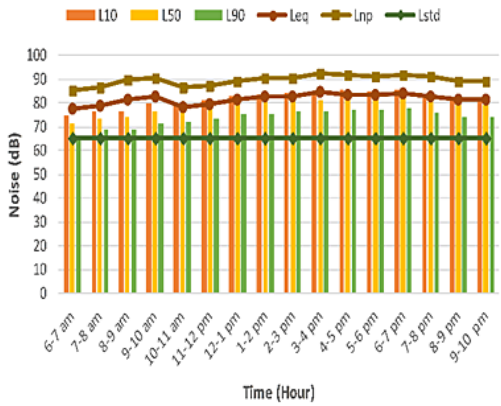

Fig. 17: Noise Pollution Indices for Chambal Industrial Area

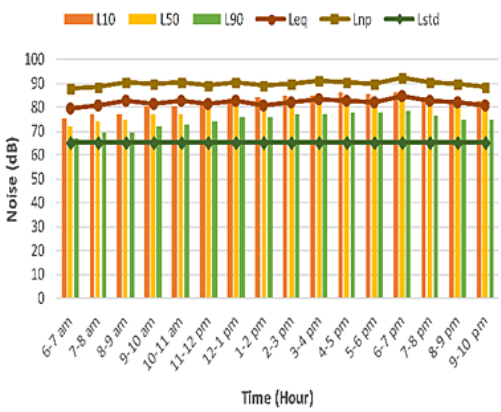

Fig. 18: Noise Pollution Indices for Indraprastha Industrial Area

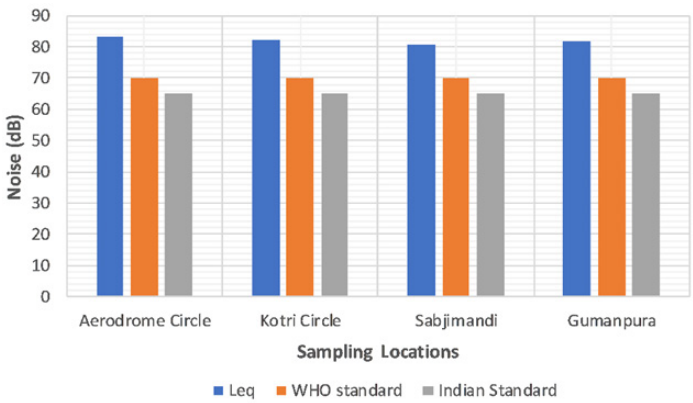

Fig. 19: The comparison of L_{eq} noise Level with WHO and Indian Standards for Commercial Zone

Table 3: Noise Climateand Noise Exposure Index data forKota metropolisduring observation period are as follows

AVERAGE VALUE																
TIME	**06:00 – 07:00**	**07:00 – 08:00**	**08:00 – 09:00**	**09:00 – 10:00**	**10:00 – 11:00**	**11:00 – 12:00**	**12:00 – 13:00**	**13:00 – 14:00**	**14:00 – 15:00**	**15:00 – 16:00**	**16:00 – 17:00**	**17:00 – 18:00**	**18:00 – 19:00**	**19:00 – 20:00**	**20:00 – 21:00**	**21:00– 22:00**
COMMERCIAL ZONE																
Aerodrome Circle																
NC	3	4.8	2.8	3.7	4.1	3.4	2.6	2.3	3	2.8	4	2.3	6.2	3.2	4.2	1.6
NEI	1.23	1.24	1.25	1.24	1.23	1.24	1.24	1.22	1.24	1.23	1.25	1.26	1.23	1.23	1.26	1.26
Kotri Circle																
NC	3.9	4.6	4.1	4.3	3.1	4.5	3.8	2.2	3.3	2.3	2.9	3.3	6.2	5.2	5.2	3.6
NEI	1.20	1.19	1.24	1.23	1.23	1.25	1.24	1.22	1.23	1.23	1.26	1.26	1.22	1.23	1.25	1.25
Subjimandi																
NC	3	3.3	4.3	1.8	3.2	3.4	2.6	2.2	2.1	2.6	3.3	2.3	4	3.6	2.5	1.9
NEI	1.21	1.22	1.24	1.24	1.24	1.23	1.24	1.23	1.24	1.23	1.25	1.26	1.25	1.23	1.25	1.23
Gumanpura Three-way																
NC	3.7	3.3	3.1	3	3	2.9	2.4	3.8	3.2	3.6	4	2.3	1.8	2.6	2.7	1.6
NEI	1.21	1.24	1.24	1.25	1.24	1.24	1.24	1.23	1.25	1.24	1.26	1.26	1.26	1.25	1.27	1.27
RESIDENTIAL ZONE																
Dadwada																
NC	1.6	1.7	2.3	2	1.4	1.5	2.1	1.1	1.2	2.6	1.4	1.4	1.4	1.8	1.7	1.1
NEI	1.35	1.41	1.45	1.43	1.44	1.42	1.35	1.42	1.46	1.44	1.46	1.50	1.50	1.46	1.47	1.47
Keshavpura Circle																
NC	0.7	1	1.1	1.4	0.8	1.1	0.9	1.3	1.2	1	1.6	0.8	1.1	0.6	1	1.4
NEI	1.35	1.42	1.46	1.45	1.45	1.43	1.36	1.43	1.46	1.42	1.46	1.49	1.49	1.45	1.48	1.46
Talwandi Circle																
NC	0.8	1	0.8	0.9	1	1.1	0.6	0.8	1.1	0.8	0.4	1	1	0.6	0.8	0.6
NEI	1.35	1.42	1.45	1.45	1.46	1.42	1.36	1.43	1.46	1.43	1.45	1.49	1.49	1.45	1.48	1.45
Jawahar Nagar																
NC	0.9	0.9	0.7	0.6	0.6	1	0.6	0.9	0.9	0.8	1.3	0.9	0.6	1	1.4	1.2
NEI	1.36	1.43	1.46	1.45	1.45	1.43	1.36	1.43	1.46	1.43	1.46	1.49	1.49	1.46	1.47	1.46

SILENCE ZONE																
MBS Hospital, Nayapura																
NC	5.1	6.2	2.3	9	4.1	2.9	5.6	7	3.6	5	8	2.8	2	6.2	4	8.8
NEI	1.54	1.53	1.51	1.23	1.62	1.57	1.52	1.50	1.58	1.54	1.55	1.61	1.57	1.57	1.55	1.58
Antaghar Circle																
NC	3.2	1.6	2.8	4	6.1	1.6	5.1	2.2	3	2.8	4	3	6.2	3.2	4.8	3.1
NEI	1.59	1.58	1.62	1.60	1.59	1.56	1.61	1.58	1.61	1.6	1.63	1.64	1.61	1.60	1.64	1.65
RICCO Institutional Area, Ranpur																
NC	9	13.9	5.3	2.8	7.7	7	9	6.2	3.1	11.8	7.1	9.3	5.1	6.7	3	6.5
NEI	1.34	1.39	1.36	1.39	1.34	1.34	1.44	1.39	1.33	1.38	1.46	1.35	1.34	1.34	1.36	1.32
I.L. Circle																
NC	3.6	1.6	3.6	6.8	6.1	3.1	5.1	3.2	3	2.7	4.9	3	7.9	4	4.5	2.2
NEI	1.62	1.58	1.61	1.62	1.61	1.58	1.61	1.58	1.61	1.60	1.63	1.63	1.61	1.62	1.65	1.63
INDUSTRIAL ZONE																
Kota Super Thermal Power Station																
NC	5.1	1.6	2.9	3.5	6.1	1.6	3.7	2.2	5.1	2.7	1.7	2.8	4.1	3.2	3	1.8
NEI	1.06	1.05	1.07	1.07	1.06	1.04	1.06	1.05	1.05	1.06	1.07	1.07	1.07	1.07	1.06	1.06
RICCO Industrial Area, Ranpur																
NC	3.8	8	9.6	2.8	6.9	3.9	4	10.2	8.9	5.5	10.4	7.8	4.3	10.3	10	9.2
NEI	1.04	1.07	1.08	1.05	1.06	1.03	1.05	1.07	1.07	1.06	1.01	1.03	1.03	1.09	1.09	1.09
Chambal Industrial Area																
NC	3.2	1.6	2.8	4	6.1	1.6	5.1	2.2	3	2.8	4	3	6.2	3.2	4.8	3.1
NEI	1.06	1.05	1.08	1.07	1.06	1.04	1.07	1.05	1.07	1.06	1.08	1.09	1.07	1.07	1.09	1.10
Indraprastha Industrial Area																
NC	3.8	2.7	2.1	2.9	4.1	1.9	3.5	2.2	3	2.8	4	3	6.2	3.2	4.2	1.3
NEI	1.05	1.05	1.07	1.07	1.06	1.4	1.07	1.05	1.07	1.06	1.08	1.09	1.07	1.07	1.09	1.09

Discussion

Commercial Area

Figure 3, 4, 5, and 6 shows the average noise pollution indices viz. L_{eq}, L_{np}, L_{10}, L_{50} and L_{90} for the commercial zone/area in the day-time from 6 am to 10 pm. It evidently showed that the range of L_{eq} is between 77.98 – 82.62dB(A). The maximum L_{eq} was recorded at Aerodrome Circle [82.62 dB(A)] between 5:00–6:00 pm, while at Kotri Circle between 6:00–7:00 am, it was the minimum [77.98 dB(A)]. The L_{eq} measured in the daytime was greater than 70 dB(A) and 65 dB(A)) in this zone, which exceeded the maximum standards limits of WHO and CPCB respectively. Figure 19 presents the comparison of equivalent noise level (L_{eq}) with Indian and WHO standards regarding to community noise.

The range of L_{10} for Commercial zone is between 79.4 – 84.1dB(A), having highest L_{10} value 84.1dB(A) at Aerodrome Circle between 5:00–6:00 pm, and having lowest L_{10} value 79.4 dB(A) at Kotri Circle between 7:00–8:00 am during the observation period.

Similarly, the range of L_{90} is between 74.8 – 81.4dB(A), having highest L_{90} value 81.4 dB(A) at Gumanpura Three-way between 8:00–9:00 pm, and having the lowest L_{90} value 74.8 dB(A) at Kotri Circle between 7:00–8:00 am. The L_{np} takes into consideration the indices of both NC and L_{eq}. It provides wide information regarding to noise pollution, with fluctuations in noise level. It regarded as the best indicator of the psychological and physiological effects of noise.

The highest L_{np} observed 86.66 dB(A) between 8:00–9:00 pm at Aerodrome Circleand the minimum was 81.74 dB(A) between 1:00–2:00 pm at Subjimandi Circle. The range of L_{np} is in between 81.74 – 86.66dB(A). The data for NC and NEI in Table 3 shown for all the four studied zones of Kota city.

NC indicates more considerable changes in noise levels in the educational sector. The maximum NC = 6.2 between 6:00–7:00 pm at Kotri Circle, and the minimum NC = 1.6 between 9:00–10:00 pm was measured at Gumanpura Three-way. In the commercial sector, the value of NEI always seen over 1 in this observation period. These values are higher than the American National Standard (ANS) 1, indicating more significant noise in the commercial sector.

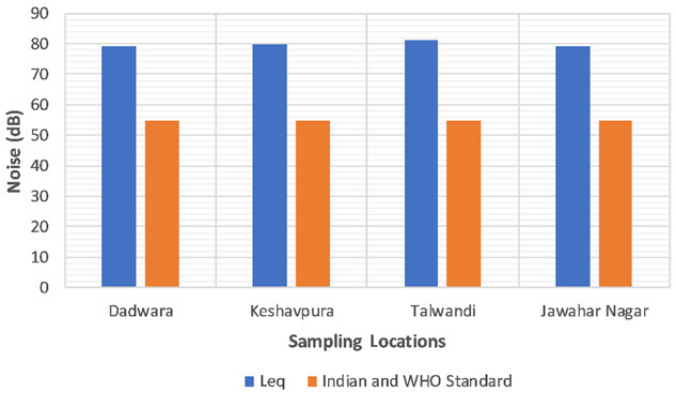

Fig. 20: The comparison of L_{eq} noise Level with WHO and Indian Standardsfor Residential Zone

Residential Area

Figure 7, 8, 9, and 10 shows the average noise pollution indices viz. L_{eq}, L_{np}, L_{10}, L_{50} and L_{90} for the Residential zone/area in the day-timefrom 6 am to 10 pm. It evidently showed that the maximum L_{eq} was recorded at [82.95dB(A)]. between 9:00–10:00 pm at Jawahar Nagar, while at 6:00–7:00 am, it was the minimum [74.48dB(A)] at Dadwara. The L_{eq} measured in the daytime was greater than 55 dB(A) in this zone, which exceeded the maximum standards limits of WHO and CPCB. Figure 20 presents the comparison of equivalent noise level (L_{eq}) with Indian and WHO standards regarding to community noise.

The range of L_{10} for Commercial zone is between 75.1 – 84.1dB(A), having highest L_{10} value 84.1dB(A) at Keshavpura Circle between 7:00–8:00 pm, and

having lowest L_{10} value 75.1dB(A) at Dadwara between 6:00–7:00 am during the observation period.

Similarly, the range of L_{90} is between 72.9 – 82.3dB(A), having highest L_{90} value 82.3dB(A)at Dadwara between 6:00–7:00 pm, and having the lowest L_{90} value 72.9dB(A)at Keshavpura Circle between 6:00–7:00 am. The range of L_{eq} is between 74.48 – 82.95dB(A).

The highest L_{np} observed 87.46dB(A) at Talwandi Circle between 6:00–7:00 pm, and the Lowest was 76.06 dB(A) between 6:00–7:00 am at Dadwara. The range of L_{np} is in between 76.06 – 87.46. The calculate data for NC and NEI in Table 3 shown for all the four studied zones of Kota city.

NC presents more considerable changes in noise levels in the educational sector. The maximum NC = 5.1 between 9:00–10:00 am at Talwandi Circle, and the minimum NC = 1.1 between 9:00–10:00 pm was measured at Dadwara. In the Residential Area/ Zone, the value of NEI always seen over 1 in this observation period. These values are higher than the American National Standard (ANS) 1, indicating more significant noise in the residential zone/area.

Silence Zone

Figure 11, 12, 13, and 14 shows the average noise pollution indices viz. L_{eq}, L_{np}, L_{10}, L_{50} and L_{90} for the Silence zone/area in the day-time from 6 am to 10 pm. It evidently showed that the maximum L_{eq} was recorded [82.84dB(A)] between 9:00–10:00 pm at Antaghar circle, while at 9:00–10:00 am, it was the minimum [66.12dB(A)] at RICCO Institutional Area, Ranpur. The L_{eq} measured in the daytime was greater than 55 dB(A) and 50 dB(A) in this zone, which exceeded the maximum standards limits of WHO and CPCB respectively. Figure 21 presents the comparison of equivalent noise level (L_{eq}) with Indian and WHO standards regarding to community noise.

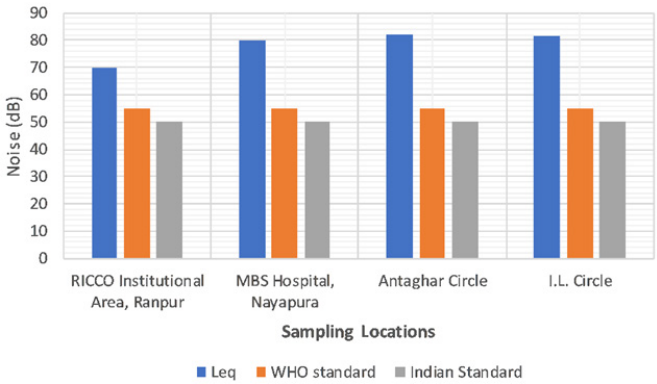

Fig. 21: The comparison of L_{eq} noise Level with WHO and Indian Standards for Silence Zone

The range of L_{10} for Silence Zone is between 67.9 – 84.9dB(A), having highest L_{10} value 84.9 dB(A) at I.L. Circle between 4:00–5:00 pm, and having lowest L_{10} value 67.9dB(A) at RICCO Institutional Area, Ranpur between 2:00–3:00 pm during the observation period.

Similarly, the range of L_{90} is between 62.1 – 81.3dB(A), having highest L_{90} value 81.3 dB(A) at Antaghar circle between 9:00–10:00 pm, and having the lowest L_{90} value 62.1 dB(A) at RICCO Institutional Area, Ranpur between 6:00–7:00 am. The range of Leq is between 66.12 – 82.84dB(A). The L_{np} takes into consideration the indices of both NC and L_{eq}.

The highest L_{np} observed 88.27dBA between 9:00–10:00 am at I.L. Circle, and the minimum was 69.64 dBA between 2:00–3:00 pm at RICCO Institutional Area, Ranpur. The range of L_{np} is in between 69.64–88.27. The calculated data for NC and NEI in Table 3 presented for all the four studied zones of Kota city.

NC shows more considerable changes in noise levels in the educational sector. The maximum NC = 11.8 between 7:00–8:00 am at RICCO Institutional Area, Ranpur, and the minimum NC = 1.6 between 7:00–8:00 am was measured at I.L. Circle. In the Silence Zone/Area, the value of NEI always seen over 1 in this observation period. These values

are higher than the American National Standard (ANS) 1, indicating more significant noise in the commercial sector.

Industrial Area

Figure 15, 16, 17, and 18 shows the average noise pollution indices viz. L_{eq}, L_{np}, L_{10}, L_{50} and L_{90} for the Industrial Area in the day time from 6:00 am to 10:00 pm. It evidently showed that the maximum L_{eq} was recorded at Chambal Industrial Area [82.84 dB(A)] between 9:00–10:00 pm, while at 11:00–12:00 am, it was the minimum [77.33 dB(A)] at RICCO Industrial Area. The L_{eq} measured in the day time was greater than 70 dB(A) and 75 dB(A) in this zone, which exceeded the maximum standards limits of WHO and CPCB respectively. Figure 22 presents the comparison of equivalent noise level (L_{eq}) with Indian and WHO standards regarding to community noise.

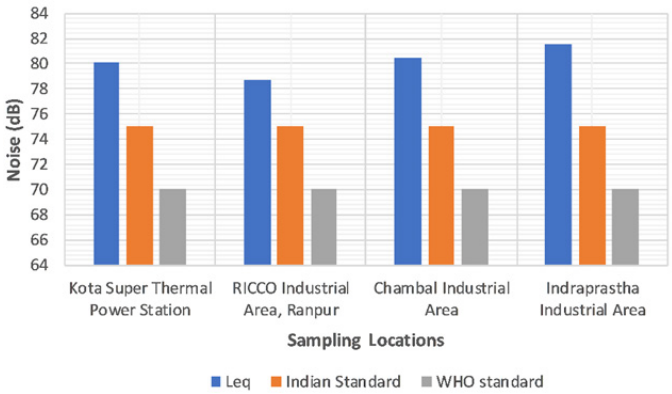

Fig. 22: The comparison of L_{eq} noise Level with WHO and Indian Standards for Industrial Zone

The range of L^{10} Industrial Area is between 79.1 – 84.6dB(A), having highest L_{10} value 84.6 dB(A) at Chambal Industrial Area between 9:00–10:00 pm, and having lowest L_{10} value 79.1 dB(A) at RICCO Industrial Area between 6:00–7:00 am during the observation period.

Similarly, the range of L_{90} is between 74.9 – 81.3dB(A), having highest L_{90} value 81.3dB(A) at Chambal Industrial Area between 9:00–10:00 pm, and having the lowest L_{90} value 74.9dB(A) at RICCO Industrial Area between 5:00–6:00 pm. The range of L_{eq} is between 77.33 – 82.84dB(A). The Lnp takes into consideration the indices of both NC and L_{eq}.

The highest L_{np} observed 89.64 dBA between 9:00–10:00 pm at RICCO Industrial Area and the minimum was 80.22 dB(A) between 7:00–8:00 am at KSTPS. The range of Lnp is in between 80.22 – 89.64. The calculated data for NC and NEI in Table 3 shown for all the four studied areas of Kota city.

NC presents more considerable changes in noise levels in the educational sector. The maximum NC = 7.8 between 9:00–10:00 pm at RICCO Industrial Area, and the minimum NC = 1.3 between 9:00–10:00 pm was measured at Indraprastha Industrial Area. In the Industrial Area/Zone, the value of NEI always seen over 1 in this observation period. These values are higher than the American National Standard (ANS) 1, indicating more significant noise in the commercial sector.

Discussion

The equivalent sound pressure level (L_{eq})were observed well above the prescribed Environmental Noise Standards depending upon their area of classification given by CPCB, Delhi in India (Table 1).It is cleared that the equivalent sound pressure level (L_{eq}) for day time was found in between 65-85 dB for all sampling locations except that RICCO Institutional area, Ranpur. It is due to the fact that it is situated outside of Kota city (17 KM away). The Sources which are responsible for high noise levels in the city include vehicular traffic, electrical appliances, music system and TV public address systems, neighborhood, railway and rarely airtraffic, and generating sets. Main concern is vehicular traffic in all above mentioned sources.

Characteristically, noise pollution affects the rich andthe poor alike.Some efforts that can be made in order to reduce noise pollution in urban environment of Kota city is:

- Promote the use of public transport rather than individual vehicles.
- Provide facility to park vehicles in a community parking mall.
- Parking of vehicles should be prohibited on the along the roads. It will also reduce traffic jam situations in the city.
- Increase the width of the roads where it can be possible.
- Make more overpass and underpass in the busiest area of the City.
- Improvements in the design of vehicles and their components, including low noise tyres, brake-blocks, train wheels.
- Infrastructure improvements, including low noise road surfaces and train lines.
- Urban development that restricts encroachment near busy highways, railways or airports, and rules on building site, architecture and acoustic efficiency.
- Traffic management strategies, including controlling the speed of road vehicles, and traffic calming.
- Increase roadside vegetation (Reduce 4 dB = 40% acoustic energy).
- Use effective Noise Barriers (Location & Surface Area dependent).

Conclusion

The violation of CPCB standards on a percentage basis by Commercial zone, Silence zone, Residential zone, and Industrial zone were 20-24%, 24-60%, 34-43%, and 1-6% respectively at the time of observation period. However, Noise Pollution levels of Kota city can show a considerable variation in a different season of a year. A detailed study should be conducted to determine it. Possible and appropriate steps expected before things get out of control to regulate and reduce the noise levels of Kota city.

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Conflict of Interest

The authors do not have any conflict of interest.

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