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NOISE POLLUTION INDICES FOR KOTA CITY, RAJASTHAN (INDIA)

KULDEEP[1], SOHIL SISODIYA[2] AND ANIL K. MATHUR[3]

[1,2,3]Department of Civil Engineering, UD, Rajasthan Technical University, Kota 324 010, Rajasthan, India

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ABSTRACT

Kota, "The New Kashi of Education," is a district in the south-east of Rajasthan state of Republic India. Kota, one of the largest cities of India, is gradually evolving as an urbanized and industrialized city. Noise level analysis for day time was conducted in sixteen sampling locations of four different zones/areas of Kota City viz. silence, Commercial, Industrial, and residential. Noise pollution indices such as L_{90}, L_{50}, L_{10}, NC L_{np}, L_{eq}, and NEI were estimated for each zone/area. Such data offers an understanding of noise levels, including noise level variations. It is known to be the best indicator of the physiological and psychological effects of noise on people. L_{eq} levels of different areas/zones were compared to the CPCB Noise Pollution Guidelines. During the observation period of six days for a specific sampling location, it noticed that the L_{eq} for day time was found in between 65-85 dB. All monitoring locations show a high variance in compliance with CPCB and a minor difference detected in the noise levels of all 16 sampling locations. NEI has been observed greater than 1 indicating more significant noise in all these sampling locations. The results of noise assessment for Kota City specifically identified the alarming level of noise pollution in Kota.

KEY WORDS : L_{90}, L_{50}, L_{10}, NC (noise climate), L_{np} (noise pollution level), L_{eq} (equivalent continuous noise level), and NEI (noise exposure index)

INTRODUCTION

Noise derives from the Latin word "nausea" which implies 'unwanted/undesired sound' (Al-tammer, 2018; Singh and Davar, 2004); (Goldsmith and Jonsson, 1973). A more accurate definition could be "noise is audible sound causing disturbance, disability or harm to health"(Dasarathy, 2015); (Gupta and Ghatak, 2011). Since it cannot be seen, smelled, or tasted, it is an underestimated environmental problem (Wawa and Mulaku, 2015); (Pantawane *et al.*, 2017). Noise needs to be identified as a considerable threat to human well-being (Organization, 2011).

Most people are expected to live in the cities within the next two decades resulting in a tremendous increase in the number of motor vehicles continuously (Garg *et al.*, 2017) Due to this surge in the number of motor vehicles, vehicular noise has become one of the significant source of noise pollution in urban environment, which affects the quality of the urban living environment (Pal and Bhattacharya, 2012); (Oloruntoba *et al.*, 2012).

It is a sluggish and subtle killer (Singh and Davar, 2004; Sudarsan and Nithiyanantham, 2019). 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 (Clark *et al.*, 2020)·(Aluko and Nna, 2015). High sound levels may lead to cardiovascular consequences (Aluko and Nna, 2015); (Mishra, Jawaharlal Nehru University, Krishi Sanskriti (Organisation) and Social Welfare Foundation, n.d.; Sawant and Bhave, 2014).

The levels of noise in Kota City are increasing gradually due to increased number of vehicles used for transportation purpose. This research paper on Kota city highlightsthe area/zone-wise assessment

Table 1. The Central Pollution Control Board Guidelines for Noise Pollution in India are as follow (CPCB (Ministry of Environment & Forests, 2001), (Kumar and Srinivas, 2014)

Sr. No.	Category of Area/Zone	Limits Day Time
A.	Industrial Area	70 dB(A)
B.	Commercial Area	65 dB(A)
C.	Residential Area	55 dB(A)
D.	Silence Zone	50 dB(A)

and analysis of noise pollution concerning equivalence sound levels.

MATERIALS AND METHODS

As per CPCB guidelines, Kota city may be classified for sampling as shown in the following Figure 1 and research methodology adopted for this study is also shown in Figure 2. 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.

NOISE POLLUTION INDICES

To determine noise pollution levels in the city, different noise pollution indexes were computed using Gaussian percentile. Various percentile values such as L_{10}, L_{50} and L_{90} were determined from the collected data and these parameters were used for the evaluation of NC (Noise Climate), L_{np}, L_{eq}

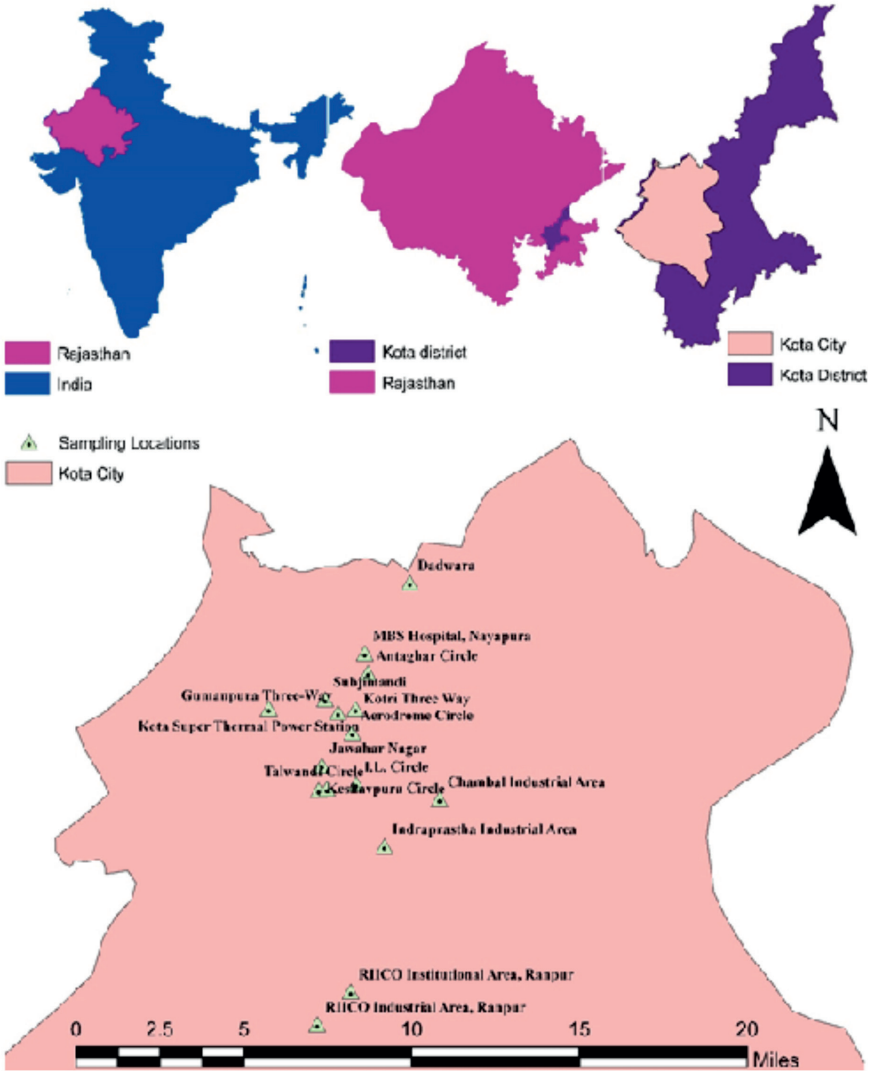

Fig. 1. Sampling location of Kota city

Fig. 2. Research methodology

(Equivalent Continuous Noise Level) and Lnp (Noise Pollution Level) (Goldsmith and Jonsson, 1973). The noise pollution indices were determined using the following formulas:

$$NC = L_{10} - L_{19} \quad .. (1)$$

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

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

$$NEI = \frac{t_1}{T_1} + \frac{t_2}{T_2} + \ldots + \frac{t_n}{T_n} \quad .. (4)$$

Where, NC is Noise Climate; L_{10} is the sound level that crosses 10 percent of total observation time or Peak Noise Level. L_{50} is the sound level that crosses 50% of the overall sampling time or Mean Sound Level. 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 noise pollution. t1 to tn 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 greater than 1, then the level of noise exposure is considered excessive.

RESULTS

A. Commercial Area

The following results are obtained from the 24 days study for sampling locations viz. Aerodrome Circle, Kotri Circle, Sabjimandi, and Gumanpura:

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.

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 daytime from 6:00 am to 10:00 pm.

A. Residential Area

The following results are obtained from the 24 days

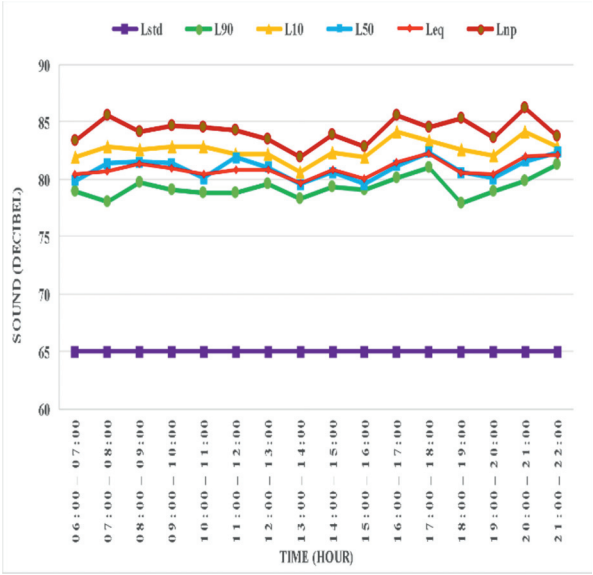

Fig. 3. Noise Indices for Aerodrome Circle

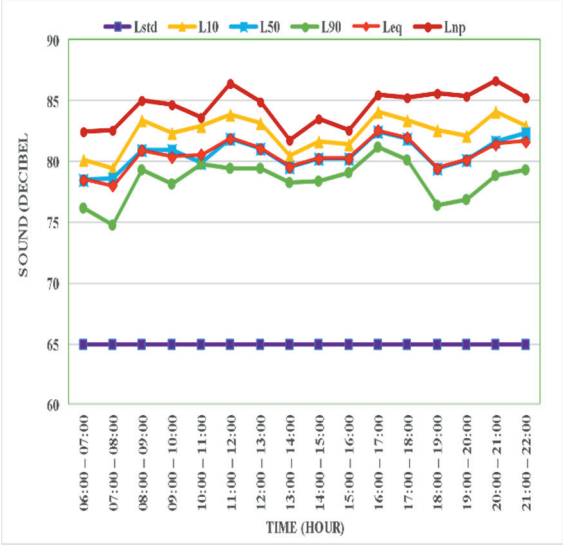

Fig. 4. Noise Indices for Kotri Circle

Fig. 5. Noise Indices for Sabjimandi

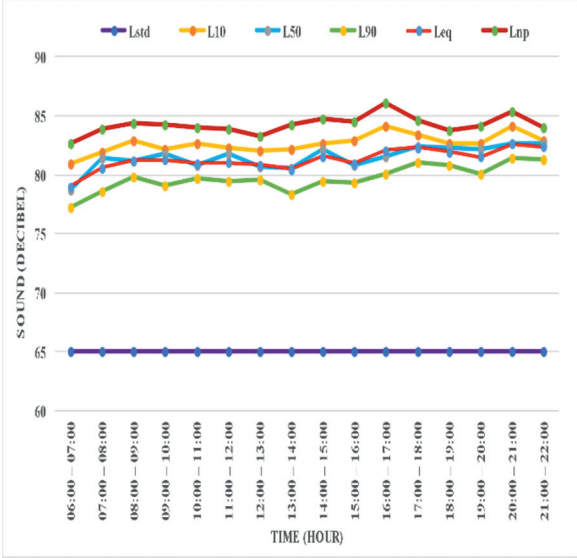

Fig. 6. Noise Indices for Gumanpura

study for sampling locations viz, Keshavpura, Dadwada, Talwandi, and Jawahar Nagar:

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 daytime.

C. 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, MBS Hospital, Antaghar Circleand I.L. Circle:

Table 2. Results for Commercial Zone/ Area.

Parameters	Range dB(A)	Highest		Lowest	
L_{10}	79.4 – 84.1	84.1	Aerodrome Circle 5:00–6:00 pm	79.4	Kotri Circle 7:00–8:00 am
L_{90}	74.8 – 81.4	81.4	Gumanpura Threeway 8:00–9:00 pm	74.8	Kotri Circle 7:00–8:00 am
L_{eq}	77.9 – 82.6	82.62	Aerodrome Circle 5:00–6:00 pm	77.98	Kotri Circle 6:00–7:00 am
L_{np}	81.7 – 86.6	86.66	Aerodrome Circle 8:00–9:00 pm	81.74	Subjimandi Circle 1:00–2:00 pm
NC	1.6 – 6.2	6.2	Kotri Circle 6:00–7:00 pm	1.6	Gumanpura 9:00–10:00 pm

Table 3. Results for Residential Area.

T Noise Indices	Range dB(A)	Highest		Lowest	
L_{10}	75.1 – 84.1	84.1	Keshavpura Circle 7:00–8:00 pm	75.1	Dadwara 6:00–7:00 am
L_{90}	72.9 – 82.3	82.3	Dadwara 6:00–7:00 pm	72.9	Keshavpura Circle 6:00–7:00 am
L_{eq}	74.4 – 82.9	82.95	Jawahar Nagar 9:00–10:00 pm	74.48	Dadwara 6:00–7:00 am
L_{np}	76.0 – 87.4	87.46	Talwandi Circle 6:00–7:00 pm	76.06	Dadwara 6:00–7:00 am
NC	1.1 – 5.1	5.1	Talwandi Circle 9:00–10:00 am	1.1	Dadwara. 9:00–10:00 pm

In the Residential Area/Zone, the value of NEI never goes down less than 1 in this observation period.

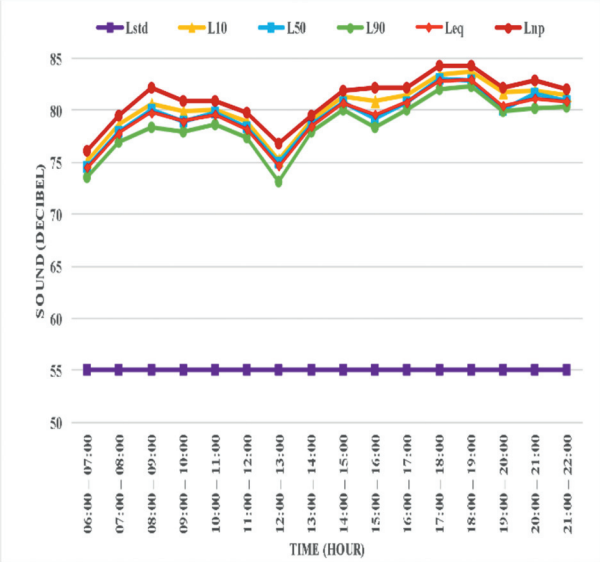

Fig. 7. Noise Indices for Dadwara

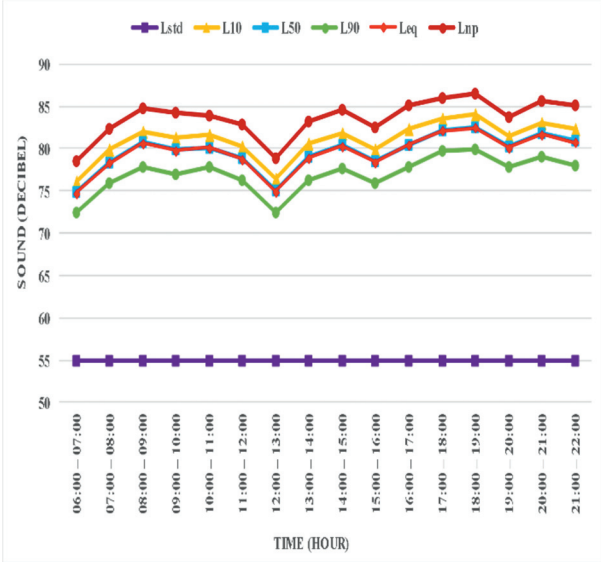

Fig. 8. Noise Indices for Keshavpura

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 in the daytime from 6:00 am to 10:00 pm.

D. Industrial Area

The following results in the form of graphs have been generated from the 24 days study for sampling

Table 4. Results.for Silence Zone.

Indices	Range dB(A)	Highest		Lowest	
L_{10}	67.9 – 84.9	84.9	I.L. Circle 4:00–5:00 pm	67.9	RICCO Institutional Area 2:00–3:00 pm
L_{90}	62.1 – 81.3	81.3	Antaghar circle 9:00–10:00 pm	62.1	RICCO Institutional Area 6:00–7:00 am
L_{eq}	66.1 – 82.8	82.84	Antaghar circle 9:00–10:00 pm	66.12	RICCO Institutional Area 9:00–10:00 am
L_{np}	69.6 – 88.2	88.27	I.L. Circle 9:00–10:00 am	69.64	RICCO Institutional Area 2:00–3:00 pm
NC	1.6 – 11.8	11.8	RICCO Inst. Area 7:00–8:00 am	1.6	I.L. Circle 7:00–8:00 am

In the Silence Zone/Area, the value of NEI not seen fall below 1 in this observation period.

Table 5: Results for Industrial Area.

Indices	Range dB(A)	Highest		Lowest	
L_{10}	79.1 – 84.6	84.6	Chambal Industrial Area 9:00–10:00 pm	79.1	RICCO Industrial Area 6:00–7:00 am
L_{90}	74.9 – 81.3	81.3	Chambal Industrial Area 9:00–10:00 pm	74.9	RICCO Industrial Area 5:00–6:00 pm
L_{eq}	77.3 – 82.8	82.84	Chambal Industrial Area 9:00–10:00 pm	77.33	RICCO Industrial Area 11:00–12:00 am
L_{np}	80.2 – 89.6	89.64	RICCO Industrial Area 9:00–10:00 pm	80.22	KSTPS, Kota 7:00–8:00 am
NC	1.2 – 7.8	7.8	RICCO Industrial Area 9:00–10:00 pm	1.3	IPIA, Kota 9:00–10:00 pm

In the Industrial Area/Zone, the value of NEI always watched over 1 in this observation period.

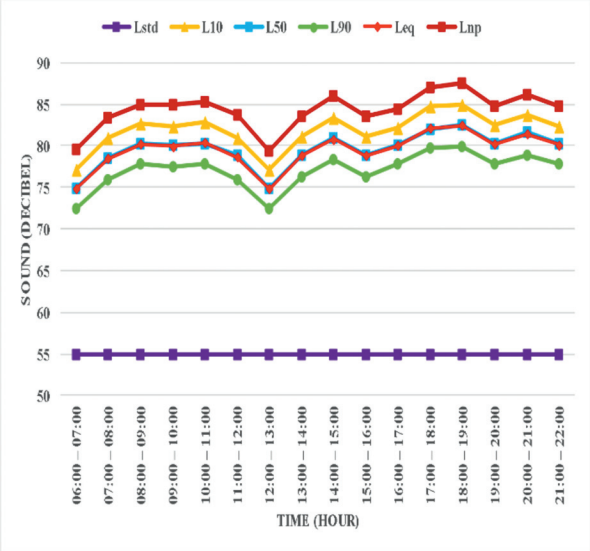

Fig. 9. Noise Indices for Talwandi

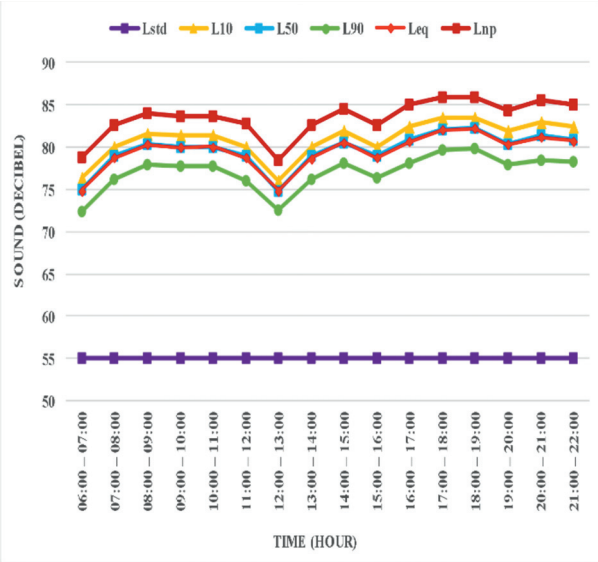

Fig. 10. Noise Indices for Jawahar Nagar

locations viz. KSTPS, RICCO Industrial Area (Ranpur), Chambal Industrial Area, and Indraprastha 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 daytime from 6:00 am to 10:00 pm.

DISCUSSION

The equivalent sound pressure level (Leq) were observed well above the prescribed Environmental Noise Standards depending upon their area of classification as laid down by CPCB, New Delhi

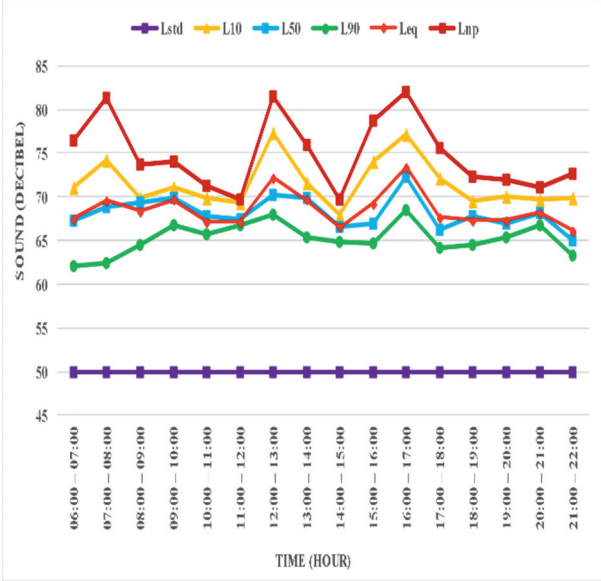

Fig. 11. Noise Indices for RICCO Institutional Area, Ranpur

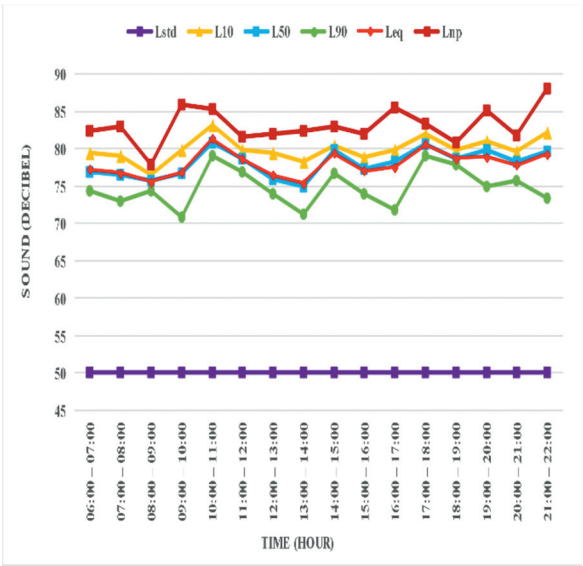

Fig. 12. Noise Indices for MBS Hospital, Nayapura

(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, neighbourhood, railway and rarely air traffic, and generating sets. Indiscriminate use of horn by the vehicles and widespread use of

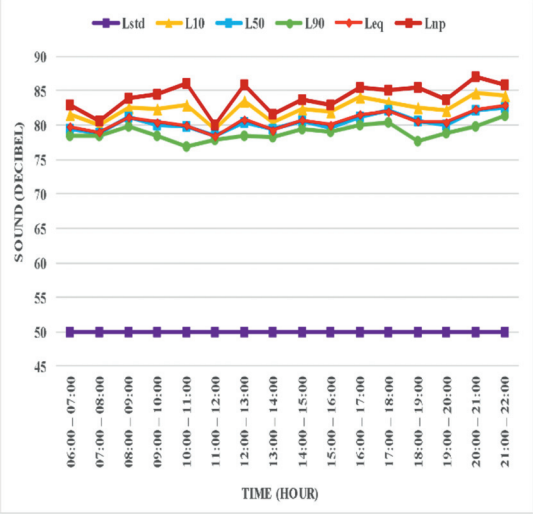

Fig. 13. Noise Indices for Antaghar Circle

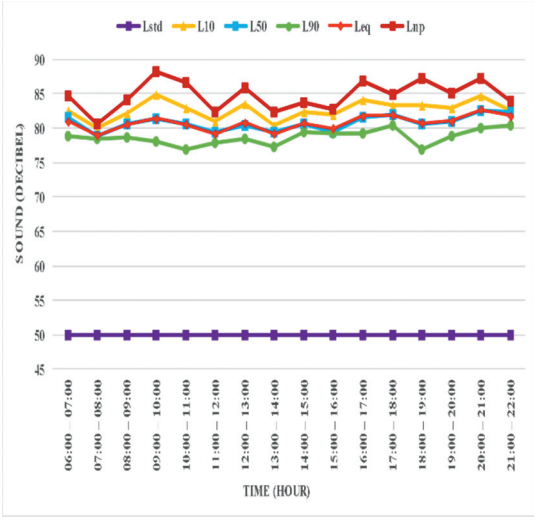

Fig. 14. Noise Indices for I.L. Circle

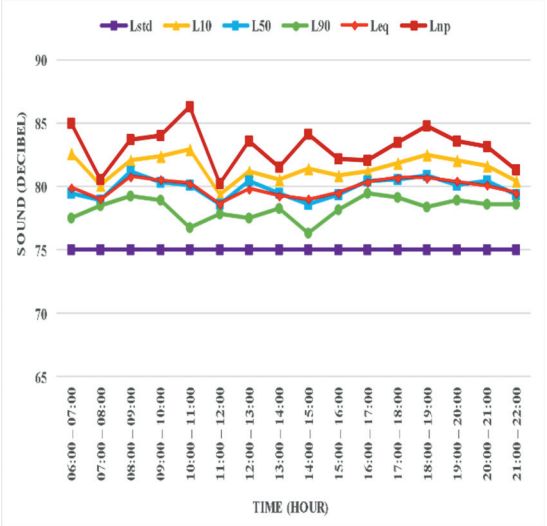

Fig. 15: Noise Indices for KSTPS

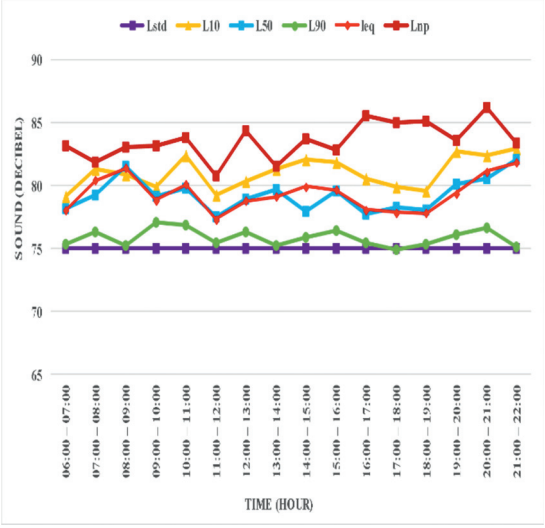

Fig. 16. Noise Indices for RICCO Ind. Area

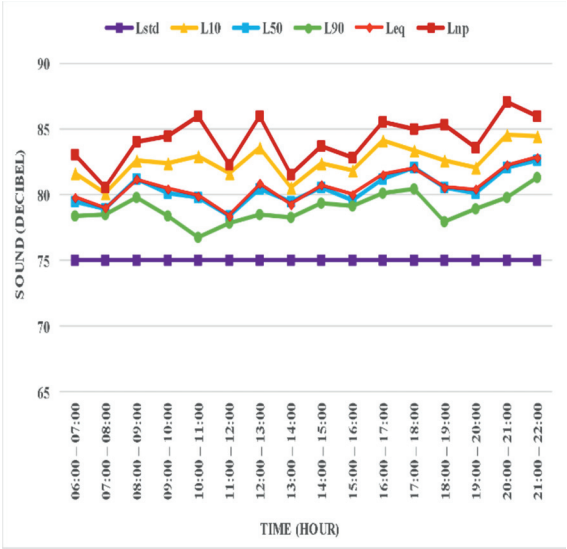

Fig. 17. Noise Indices for Chambal Ind. Area

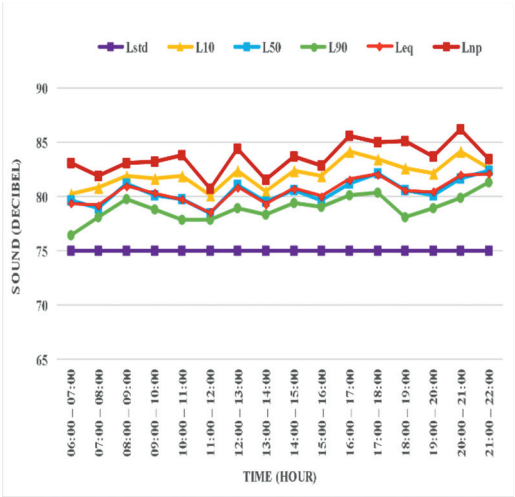

Fig. 18. Noise Indices for IPIA

loud speakers in Indian social and religious ceremonies cause several health hazards to the urban inhabitants. Main concern is vehicular traffic in all above mentioned sources.

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.
- Improvements in the design of vehicles and their components.
- Infrastructure improvements: make more overpass and underpass in the busiest area.
- Traffic management strategies, including controlling the speed of road vehicles, traffic calming etc.

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. Noise levels in the evening hours were higher than in the morning hours. More precisely, noise pollution affects every sampling location in the entire city. 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 to reduce the noise levels of Kota city.

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