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# NOISE POLLUTION INDICES FOR KOTA CITY, 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), $L_{np}$, $L_{eq}$

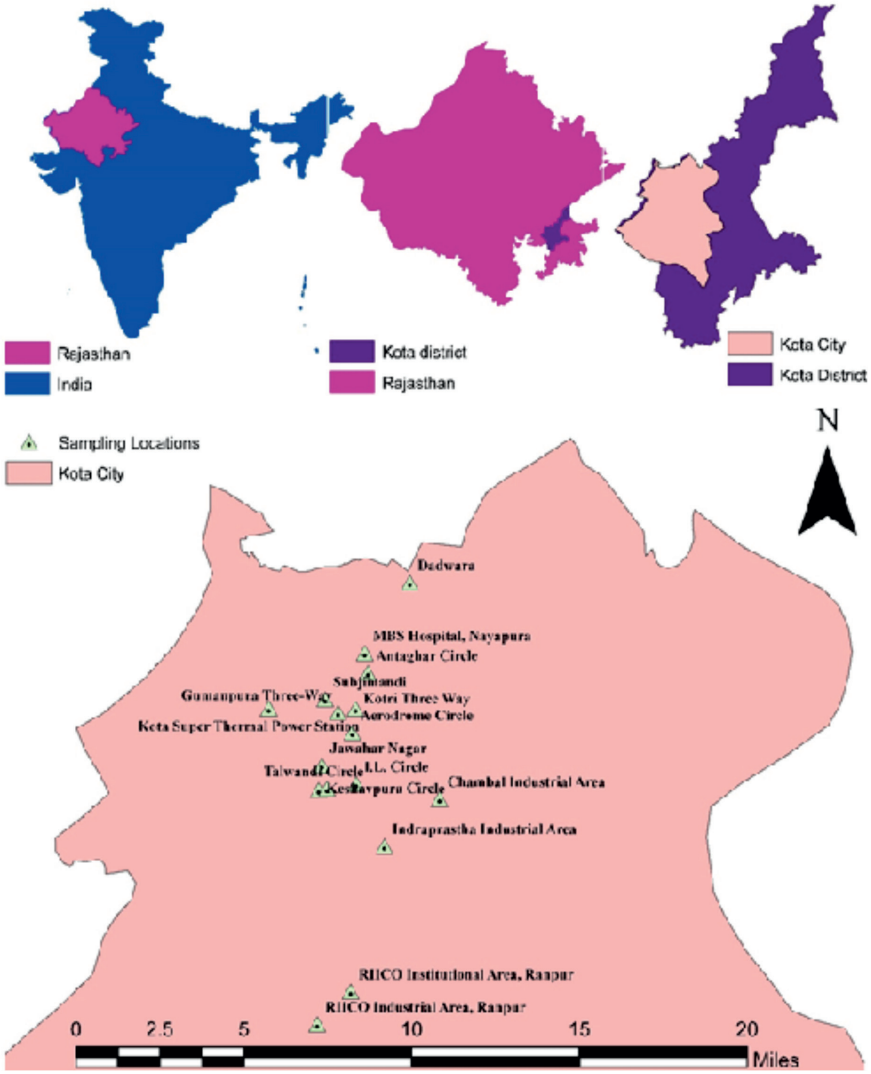


**Fig. 1.** Sampling location of Kota city


**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

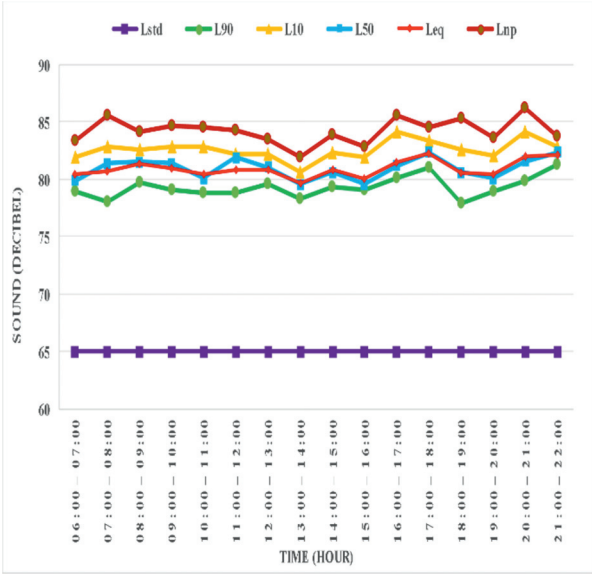


**Fig. 3.** Noise Indices for Aerodrome Circle

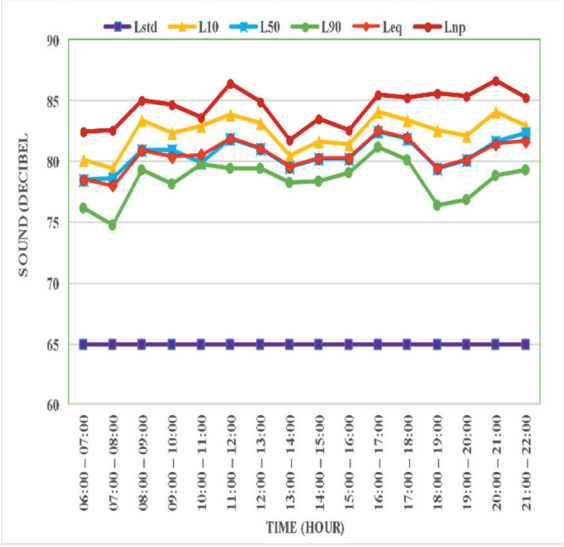


**Fig. 4.** Noise Indices for Kotri Circle


**Fig. 5.** Noise Indices for Sabjimandi

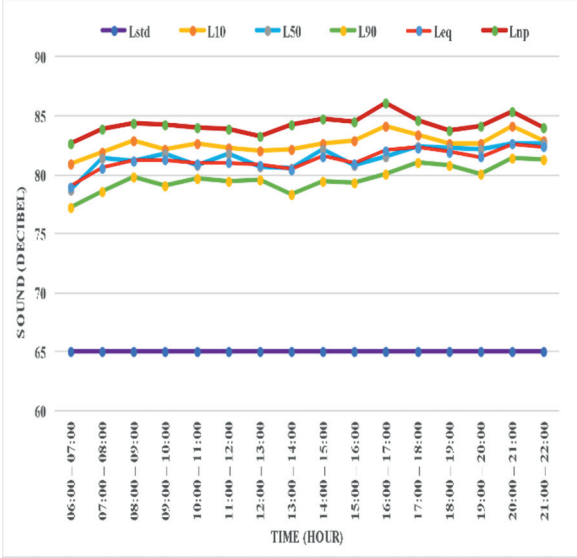


**Fig. 6.** Noise Indices for Gumanpura

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.

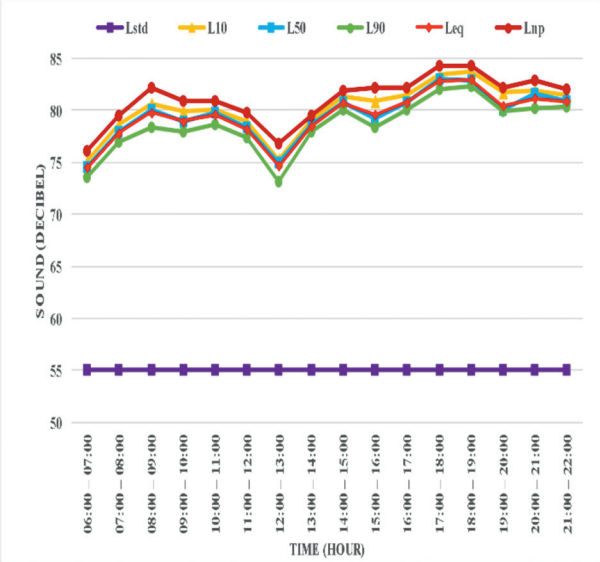


**Fig. 7.** Noise Indices for Dadwara

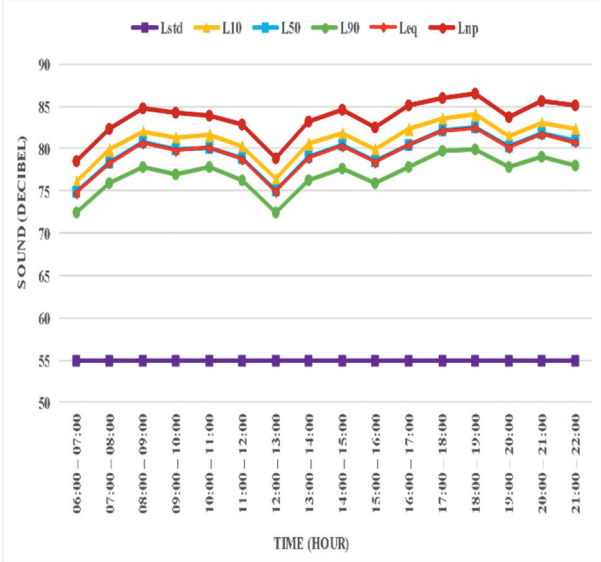


**Fig. 8.** Noise Indices for Keshavpura

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.

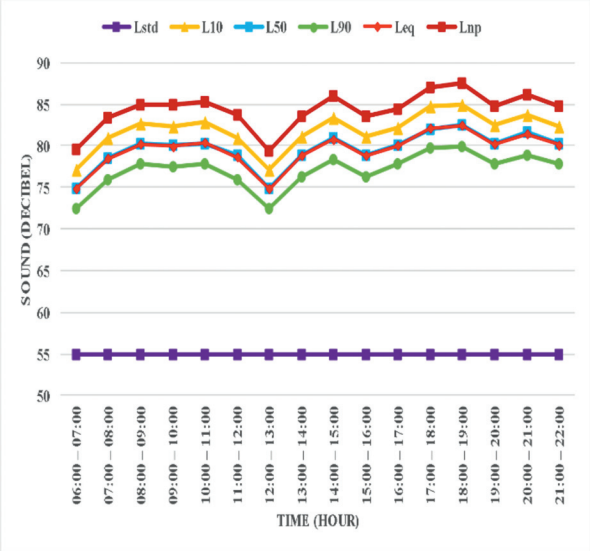


**Fig. 9.** Noise Indices for Talwandi

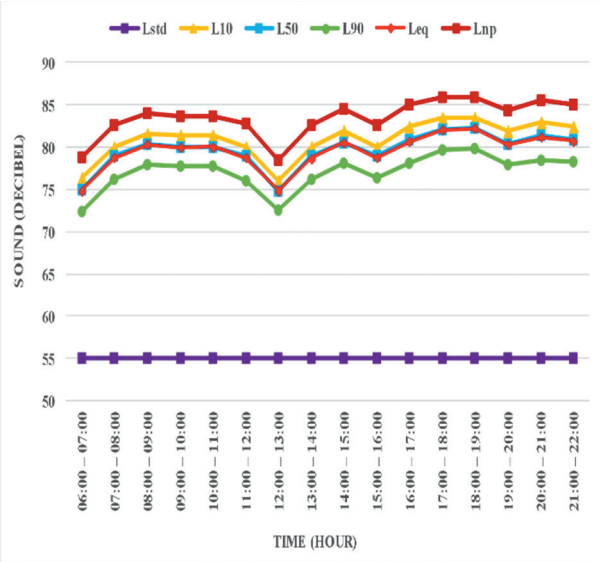


**Fig. 10.** Noise Indices for Jawahar Nagar

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

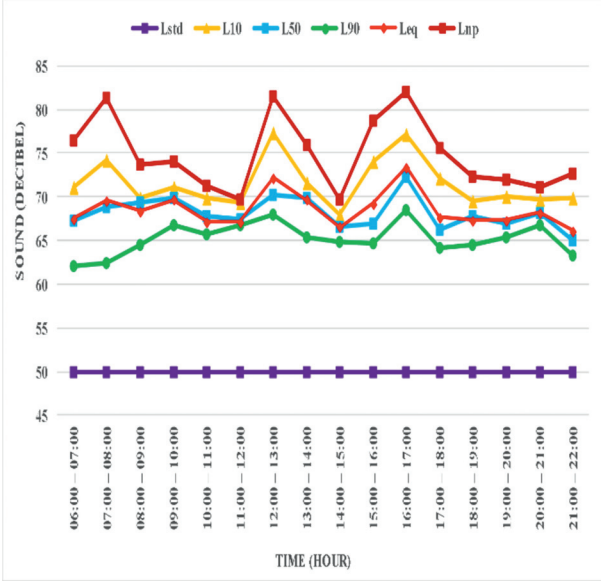


**Fig. 11.** Noise Indices for RICCO Institutional Area, Ranpur

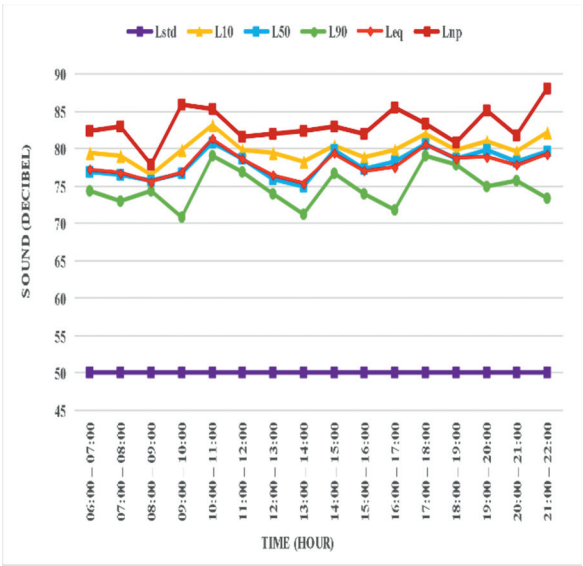


**Fig. 12.** Noise Indices for MBS Hospital, Nayapura

(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

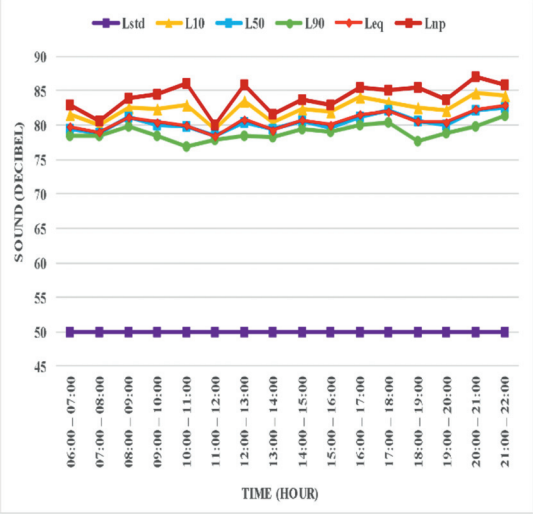


**Fig. 13.** Noise Indices for Antaghar Circle

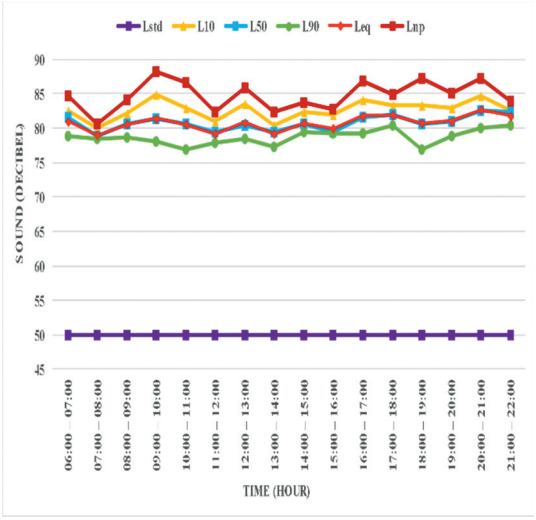


**Fig. 14.** Noise Indices for I.L. Circle

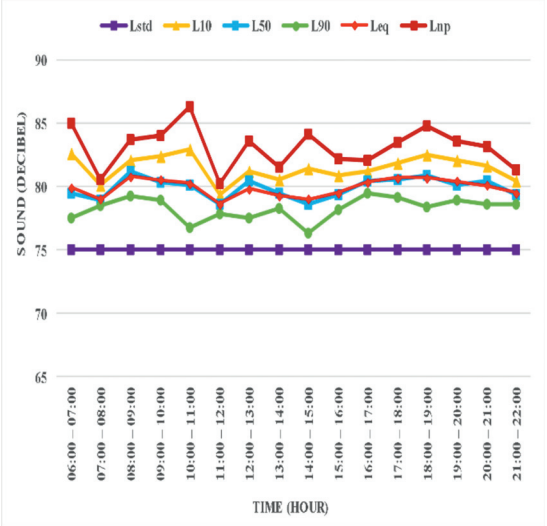


**Fig. 15:** Noise Indices for KSTPS

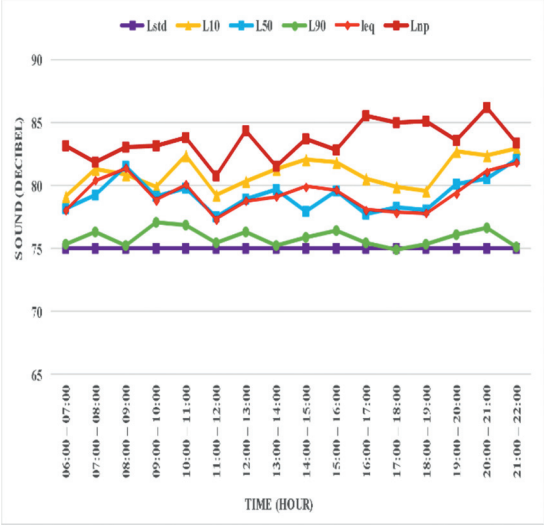


**Fig. 16.** Noise Indices for RICCO Ind. Area

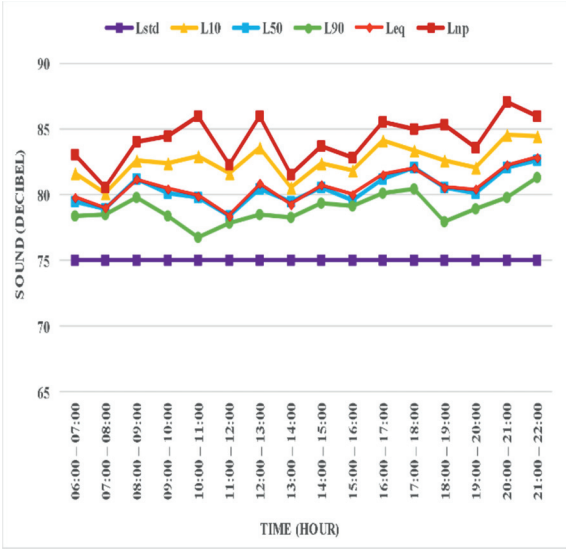


**Fig. 17.** Noise Indices for Chambal Ind. Area

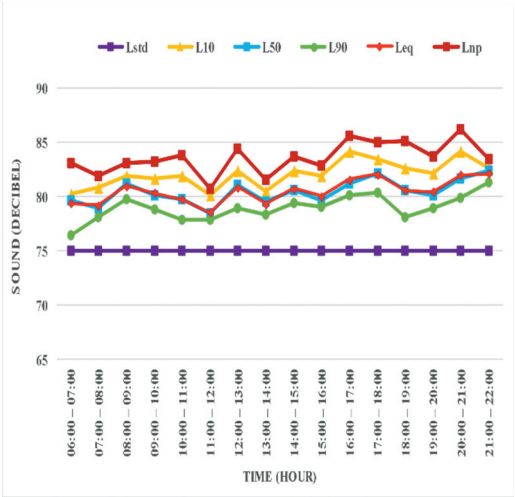


**Fig. 18.** Noise Indices for IPIA

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.

## REFERENCES


Al-tammer, K. K. A. L. A. A. M. 2018. *Analysis and Assessment of Noise Pollution in Libraries*. (March).

Aluko, E. and Nna, V. 2015. Impact of Noise Pollution on Human Cardiovascular System. *International Journal of TROPICAL DISEASE & Health*. 6(2) : 35-43. https://doi.org/10.9734/ijtdh/2015/13791

Clark, C., Crumpler, C. and Notley, H. 2020. Evidence for environmental noise effects on health for the United Kingdom policy context: A systematic review of the effects of environmental noise on mental health, wellbeing, quality of life, cancer, dementia, birth, reproductive outcomes, and cognition. *International Journal of Environmental Research and Public Health*. 17(2). https://doi.org/10.3390/ijerph170203 93

CPCB (Ministry of Environment & Forests, G. *Noise pollution regulation in India*. (2001).

Dasarathy, A. K. 2015. *Noise Pollution/: Causes, Mitigation and Control Measures for Attenuation*. (March), 136. https://doi.org/10.1007/s0042 10050211

Garg, N., Sinha, A. K., Dahiya, M., Gandhi, V., Bhardwaj, R. M. and Akolkar, A. B. 2017. Evaluation and Analysis of Environmental Noise Pollution in Seven Major Cities of India. *Archives of Acoustics*. 42(2) : 175-188. https://doi.org/10.1515/aoa-2017-0020

Goldsmith, J. R. and Jonsson, E. 1973. Health effects of community noise. *American Journal of Public Health*. 63(9) : 782-793. https://doi.org/10.2105/AJPH.63.9.782

Gupta, S. and Ghatak, C. 2011. Environmental noise assessment and its effect on human health in an urban area. *International Journal of Environmental Sciences*. 1(7) : 1954-1964.

Kumar, K. V. D. and Srinivas, N. 2014. Study of Noise Levels at Traffic Density Areas in. *International Journal of Engineering Research and Technology*. 3(11) : 783-786.

Mishra, G. C., Jawaharlal Nehru University, Krishi Sanskriti (Organisation), & Social Welfare Foundation. (n.d.). *Innovative Energy Technology systems and environmental concerns/: a sustainable approach*. 268.

Oloruntoba, E. O., Ademola, R. A., Sridhar, M. K. C., Agbola, S. A., Omokhodion, F. O., Ana, G. R. E. E., and Alabi, R. T. 2012. Urban environmental noise pollution and perceived health effects in Ibadan, Nigeria. *African Journal of Biomedical Research*. 15(2) : 77-84.

Pal, D. and Bhattacharya, D. 2012. Effect of road traffic noise pollution on human work efficiency in government offices, private organizations, and commercial business centres in Agartala City using fuzzy expert system: A case study. *Advances in Fuzzy Systems*. 2012. https://doi.org/10.1155/2012/828593

Pantawane, R. N., Maske, K. V. and Kawade, N. S. 2017. *Effects of Noise Pollution on Human Health*. 2393-2395. https://doi.org/10.17148/IARJSET

Sawant, S. N. and Bhave, P. P. 2014. *Assessment and Impact of Indoor Noise Pollution*. 8354(3) : 72-78.

Sudarsan, J. S. and Nithiyanantham, S. 2019. Causes, Impact of Noises with Remedies in Rathinamangalam, Tamilnadu, India. *International Journal of Recent Technology and Engineering*. 8(4S2). 123-126. https://doi.org/10.35940/ijrte.d1029.1284s219

Singh, N. and Davar, S. C. 2004. Noise Pollution-Sources, Effects and Control. *Journal of Human Ecology*, 16(3) : 181-187. https://doi.org/10.1080/09709274.2004.11905735

Wawa, E. A. and Mulaku, G. C. 2015. Noise Pollution Mapping Using GIS in Nairobi, Kenya. *Journal of Geographic Information System*. 07(05) : 486-493. https://doi.org/10.4236/jgis.2015.75039.