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Assessment of Noise Pollution in Mirzapur, India

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Abstract

Noise pollution, often ignored by the general population for its seemingly inconsequential effects on human life and the environment, is fast becoming an omnipresent pollution type. The growth of urban clusters and industries along with increase in automobiles on road increase the risks associated with noise pollution. The current study was conducted with the objective to evaluate and highlight the present noise profile of Mirzapur, Uttar Pradesh, India. Various established methods were used to calculate different noise level parameters like Leq, $L_{10,}$ $L_{90,}$ NC, TNI, Lnp, L_{DN} to form a clear picture on the current noise pollution scenario in Mirzapur city. Results indicated that highest values of most of the parameters were observed at Wellesley Ganj whereas the lowest values of almost all the parameters were observed at RGSC (Control Site). The noise assessment clearly revealed the alarming situation of noise pollution in Mirzapur city.

Keywords: Noise, Noise assessment, Noise profile, Leq, Noise Climate.

Introduction

The word "noise" comes from the Latin word "nausea," which means seasickness or, more broadly, any disgust, annoyance, or discomfort[1]. Noise is typically defined as an unwanted sound that interferes with one's social activities such as work, rest, recreation, and sleep, causing negative physiological and psychological effects on the individuals[1]. Sound, on the other hand, is stated as any pressure variation detectable by the human ear (in air, water, or another media). After water and air pollution , noise is the most harmful form of pollution[2,3]. It is a matter of deep concern that the general public is still ignorant about the repercussions of exposure to noise levels and very little is being done by the government and other agencies to create awareness about the harmful implications resulting from such exposure. It is very much evident by the statement of Nobel prize winner Robert Koch about how noise pollution is scaling up and becoming a great disruption to ordinary human life, "A Day will come man will have to fight merciless noise as the worst enemy of health"[4].

There are many factors responsible for the persistence of noise pollution and these factors are as follows: Urbanization, industrialization, population growth, illiteracy and poverty, non-cooperation of governmental agencies, festivals, customs or religious ceremonies[5]. Of all the above mentioned factors urbanization and the development of transport and industry, are the key factors contributing to noise[6]. Various sources of noise are social events, transportation, industrial activities, construction sites, household etc. A major source for the increase in noise pollution is traffic[7]. Motor cars, which constitute an integral element of the urban environment, are the primary source of urban noise, accounting for around 55 percent of total noise[8]. Noise has immediate and cumulative negative health consequences, as well as degraded residential, social, and working environments, resulting in tangible (economic) and intangible (well-being) losses[9]. Potential consequences of noise pollution are hearing loss, disruption of sleep, cardiovascular disease, reduced productivity, social handicaps, poor social conduct, irritation reactions, absenteeism, and accidents[9-13]. Panic, nervousness, stress, headache, nausea, emotional instability, bad temper, impotency, mood fluctuations, increased social conflicts, and neurosis, hysteria, and psychosis may be caused by noise pollution[14].

Although a noise of up to 50 decibels can be irritating, but it can be adjusted to the situation[15]. A noise level of 55 dB(A) causes light stress, excitement, dependence, and discomfort, while a noise level of 65 dB(A) causes deep stress. The likelihood of biological morphine release in the body increases at an level of 80 dB(A) noise, resulting in pleasurable feeling[15]. Extremely high sound pressures have the potential to rupture the eardrum or cause physical harm to the ear. A sound pressure level of roughly 150 dB or higher is regarded to be the threshold for abrupt mechanical damage, which can readily be exceeded in the vicinity of small weapons, artillery, and pyrotechnics[16].

Identifying the problems and planning efforts to limit noise and its negative impacts has become a top priority for India. Recognizing this need the Indian government in the year 2000 brought Noise Pollution (Regulation and Control) Rules. In the Noise pollution (Regulation and Control) Rules, 2000. The Ministry of Environment & Forests, Govt. of India, has notified noise limits. The corresponding data are mentioned in Table-1[17].

Table-1: Noise Standards of Environment as per CPCB (Central Pollution Control Board).

Code of Area	Kind of Area/ Zone	Noise standards of Environment (Leq) in dB (A)	
		Day - Time (6.00-22.00 hrs)	Night-time (22.00-6.00 hrs)
(1)	Commercial area	65	55
(2)	Residential area	55	45
(3)	Industrial area	75	70
(4)	Silence zone	50	40

Mirzapur, located in Uttar Pradesh, India, is one of the 75 districts of Uttar Pradesh and is located in the eastern part of the state. The famous and revered Hindu pilgrimage site of Vindhyavasini Mata Shakti Peeth is located in the Mirzapur district. The sacred river Ganga which originates from the Himalayas flows through the district of Mirzapur, and therefore several ghats can be found along the bank of river Ganga in the district. Due to the remote location, majority of rural population, and absence of any incentive from a research perspective, no credible research work has been done in past on noise pollution scenario in the Mirzapur district. The present work is possibly the first of its kind in the Mirzapur City concerning noise pollution.

Noise parameters: Percentile Noise Levels: L_{10}- ten percentile time surpassing noise level, is the one which crosses 10% of the entire observation time. It denotes the highest levels of invading noise.

L_{90}- ninety percentile time surpassing noise level, is the one which crosses 90% of the total observation time. It indicates background noise level.

Equivalent Noise Level (Leq): It is the consistent (A) weighted sound level that is equivalent in terms of noise energy content to the actually varying noise prevailing at that site throughout the monitoring period. It is also defined as the average rate at which energy is received by the ear during the period mentioned.

$$L_{eq} = 10 \log \frac{1}{T}\left[t_1 \times 10^{\frac{L_{p1}}{10}} + t_2 \times 10^{\frac{L_{p2}}{10}}\right]$$

Where: $T_{=}$Total time (hour), $t_{1=}$ duration for which Lp_1 continues, $t_{2=}$ duration for which Lp_2 continues, $Lp_{1=}$ sound pressure level dB (A) at time 1, $Lp_{2=}$ sound pressure level dB (A) at time 2.

Traffic Noise Index (TNI): It is a traffic noise rating index obtained from a combination of noise levels, which gives a better correlation with dissatisfaction. It is obtained on the consideration that, L_{10} as an average peak level intrudes into L_{90} as an average background noise level when A-weighted noise levels are measured outdoors. The mathematical expression for TNI is given below:

TNI = 4× ($L_{10} - L_{90}$) + (L_{90} -30) (dB)
Where: L_{10} and L_{90} are the A- weighted decibel levels exceeded 10% and 90% of the time respectively.

Noise Climate (NC): The term (L_{10}–L_{90}) is called noise climate. Day-Night Sound Level (L_{dN}): It is the A-weighted equivalent sound level for 24-hour period with an additional 10 dB imposed on the equivalent sound levels for night time hours of 10 PM to 7 AM. This is better indicator for psychological disturbance as reaction to a sound of particular level is much higher during the hours of sleep at night time. It can be expressed as:

$$L\text{DN} = 10log\left[\frac{1}{24}\left\{15\left(10^{\frac{LD}{10}}\right) + 9\left(10^{\left(Ln+\frac{10}{10}\right)}\right)\right\}\right]$$

Whereas: $L_{dN\ =}$ day-night sound level dB(A), $L_{d\ =}$ daytime equivalent sound level dB(A), $L_{n\ =}$ night-time equivalent sound level dB(A).

Noise Pollution Level (Lnp): The combination of Noise Climate (NC) and Equivalent Continuous Noise (Leq) is called as Lnp. It provides an idea of noise pollution with variations in noise level. It is regarded as the most accurate indicator of physiological and psychological implications of noise. It includes both NC and Leq that is why it is the finest indicator of noise pollution. It can be expressed as:

Lnp = NC + Leq
Whereas: Leq = Equivalent Noise Level dB(A), NC = Noise Climate dB(A).

Materials and Method

Study area and measurement of noise: The research work investigates the problem of noise pollution in Mirzapur district. Mirzapur district is located at an equal distance of around 650 Km from Delhi and Kolkata, two of the biggest metro cities of India. Noise monitoring was done exclusively within the boundary of the Mirzapur district. For noise monitoring and assessment, in total 4 sampling locations were selected in and around Mirzapur City, which were Wellesley Ganj, Railway Station Mirzapur, Bus Depot Mirzapur, and Rajiv Gandhi South Campus (RGSC) of Banaras Hindu University located near Barkaccha Village in Mirzapur district. The RGSC was taken as a control for noise calculation. Field visits were undertaken during February and March to record noise level data of the sampling locations. The sampling locations selected for noise monitoring in Mirzapur city include a mix of industrial, residential, transportation, commercial, and educational zones as

shown in Table-3. Lutron SL-4001 sound level meter was used for recording the noise levels during field visits by setting it up at A-weighting frequency.

Table-2: Geographical and Meteorological data related to Mirzapur[18].

Parameter	Values
Latitude	25.0072^0 N
Longitude	82.6483^0 E
Mean Sea Level (m)	80
Annual Rainfall	322.7 mm

Table-3: Characteristics of sampling locations of Mirzapur selected for noise study.

Location	Characteristics
Wellesley Ganj (Commercial cum residential zone)	Wellesley Ganj is the city center of Mirzapur. Being a commercial cum residential area it is always crowded with people and vehicles.
Railway Station Mirzapur (Transportation Zone)	Mirzapur railway station is a 4-platform station connecting Howrah-Delhi and Howrah-Prayagraj- Mumbai lines. The station carries considerable traffic.
Mirzapur Bus Depot (Transportation cum Commercial Zone)	Mirzapur bus depot caters to passengers going to Vindhyachal Mata apart from Prayagraj and Varanasi passengers. The depot is surrounded by shops and sees significant human dwellings.
Rajiv Gandhi South Campus (Educational Zone)	The Rajiv Gandhi South Campus is considered a silent zone due to being an educational area.

Results and Discussion

Table-4: Result of different parameters of noise at sampling locations.

Locations	Leq (dB)	L_{10} (dB)	L_{90} (dB)	TNI (dB)	NC (dB)	Lnp (dB)	L_{dN} (dB)
RGSC (C)	39.2	42	37	24	24	44.2	44.3
Railways	65.8	74.0	42.4	138.8	31.6	97.4	66.0
Bus Depot	68.4	73.2	42.1	136.5	31.1	99.5	68.7
Wellesley Ganj	77.1	83.2	52.1	146.5	31.1	108.2	87.3

Data in the Table-4 depicts the result for different parameters of noise sampling locations during 24 hr study.

Equivalent Noise Level (Leq): The Leq values ranged between 39.2 dB at control site to 77.1 dB at Wellesley Ganj. The Leq values at railway station was recorded at 65.8 dB whereas the Leq value at bus depot at Mirzapur was 68.4 dB. The control site being a remote area with lot of vegetation and virtually very little vehicular traffic and other sources of noise recorded the lowest Leq values whereas the Wellesley Ganj recorded the highest Leq values probably because it is the main market of Mirzapur with heavy traffic and intense commercial activity. At this site the commercial activity starts at around 9 am and continues till 9 pm. The high Leq value at Wellesley Ganj is likely to create psychological problems among inhabitants of this area. People may suffer sleeplessness, hearing disorders. Although Mirzapur is not a very developed city, the Leq values recorded at Wellesley Ganj exceed the permissible Leq values for commercial as well as residential areas.

The Leq value of 68.4 dB recorded at Mirzapur bus depot is partly due to the traffic of incoming and outgoing buses at the depot and partly due to the closely situated market. The fluctuations in noise levels of bus depot were not high and steady noise levels were observed. At Mirzapur bus depot the operations of buses reduce significantly after 6 pm in the evening which leads to reduced noise level. Residential areas nearby, shops owner, bus depot employees etc. are at higher risk of getting affected due to high noise levels. The Leq values recorded at bus depot exceed the permissible limit for commercial as well as residential areas.

The Leq value of railway station is 65.8dB which is 0.8 dB more than the prescribed 65 dB standard for commercial area. It was found that the fluctuation in noise levels is at very high end. Highest levels are recorded during the incoming, outgoing and halt of trains in the station premises. In total nearly 375 trains cross Mirzapur railway station on daily basis. There are times when there is no train in the station premises and lowest noise levels were recorded during such times. This high Leq level is cause of concern for people employed or having businesses at railway station. People living in residential areas established in close proximity to railway station also get affected.

L_{10}: The peak noise is expressed by L_{10} i.e., noise levels exceeded 10% of total time. The L_{10} values ranged between 42 dB(A) at control site to 83.2 dB(A) at Wellesley Ganj. The L_{10} value recorded at railway station was 74.0 dB(A) whereas the L_{10} value at Mirzapur bus depot was recorded 73.2 dB (A). The L_{10} values determined for different sampling location as stated above is further used to calculate Noise Climate (NC). In general, higher L_{10} values results in higher NC.

L_{90}: The background noise is expressed by L_{90} i.e., noise levels exceeded 90% of total time. The L_{90} values ranged between 37 dB(A) at control site to 52.1 dB(A) at Wellesley Ganj.

The L_{90} value recorded at railway station was 42.4 dB(A) whereas the L_{90} Mirzapur bus depot was recorded 42.1 dB(A). The L_{90} values determined for different sampling location as stated above is also used to calculate Noise Climate (NC). In general, lower L_{90} values results in higher NC.

Noise Climate (NC): The NC values are indicative of annoyance caused due to noise pollution. As stated above the NC represent the difference between the L_{10} and the L_{90} values i.e., the NC is difference between the peak noise and the background noise. The value of NC at control site was recorded 5 dB(A) and was lowest in comparison to different selected locations whereas the railway station recorded highest NC value i.e., 31.6 dB(A). Bus depot and Wellesley Ganj have equal NC value i.e., 31.1 dB(A).

5dB(A) which is NC of RGSC indicates that there are minimum fluctuations in the noise level recorded during the study period which represents a very less annoying environment at RGSC in terms of noise pollution. The highest NC value of 31.6 dB(A) was observed at Mirzapur railway station which represents the spread in values of noise levels recorded at the site. The high NC value at Mirzapur railway station can be attributed to the railway traffic at the site resulting in sudden peak in noise levels, which is a cause of annoying environment at the railway station. The NC values of Wellesley Ganj and Mirzapur bus depot are coincidently same which is 31.1 dB(A). The value of NC at these two locations are in intermediate of RGSC and Mirzapur railway station, thus indicating an environment which is comparatively less annoying than railway station but annoying when compared to RGSC.

Traffic Noise Index (TNI): The maximum and the minimum TNI level obtained from sampling locations during the study period are 24 dB(A) and 146.5 dB(A) respectively. The minimum value of TNI was found at RGSC while the maximum value was observed at Wellesley Ganj. At Mirzapur bus depot and railway station, intermediate values of TNI were observed which are 136.5 dB(A) and 138.8 dB(A) respectively. The threshold value of TNI is 74 dB[19]. On comparing the calculated TNI with threshold TNI, it was observed that the TNI value of RGSC was less than the threshold TNI due to less fluctuation in noise level and this led to less annoyance whereas the TNI calculated for Wellesley Ganj was found to be way higher than standard value of TNI. This obviously points towards high fluctuation and annoyance at the sampling location. Mirzapur bus depot also exhibit a higher TNI than the standard along with Mirzapur railway station‘s TNI reflecting that the permanent residents and dwellers here faces high annoyance from the fluctuating noise levels. Hence when compared on TNI basis the order of annoyance from higher to lower is: Wellesley Ganj> Railway Station > Bus Depot > RGSC.

Noise Pollution Level (Lnp): As mentioned above the Lnp is used for better understanding of actual present noise pollution level at the study location. Lnp has been established as the most effective parameter to assess the physiological and psychological impact of noise pollution[20]. The standard value of Lnp has been given as 88 dB[21]. On comparing the calculated Lnp values with the help of above-mentioned value the highest Lnp was 108.2 dB(A) recorded for Wellesley Ganj. The Lnp values recorded for RGSC, Mirzapur bus depot and railway station are calculated as 44.2dB(A), 97.4dB(A), and 99.5 dB(A) respectively. It was found that the lowest Lnp value was recorded at RGSC. The Lnp values of all sites except RGSC (Control site) exceed standard limit. The higher Lnp at Wellesley Ganj, Bus Depot, Railway Station shows higher impact on both physiology and psychology of the concerned population in these areas, with Wellesley Ganj being the worst affected amongst all. As Wellesley Ganj is the city centre due to which there is high traffic flow and dense market resulting in higher Lnp value. On the other hand, RGSC being situated on the outskirt of the city and educational zone has the lowest Lnp value. With reference to Lnp, the order of impact on physical and mental well-being of population from higher to lower is: Wellesley Ganj> Bus Depot > Railway Station > RGSC.

Day- Night Noise Level (L_{dN}): L_{dN} is used to calculate the day-night average sound level. It adds 10 dB extra to the night time recorded values during calculation. The 10 dB extra is added to take into consideration heightened sensitivity to perception of noise at night time by humans. Normally the night time while calculating L_{dN} is taken from 10 PM to 7 AM but in Indian context calculation of L_{dN} is done considering the night time from 10 PM to 6 AM in accordance with noise pollution Regulation and Control Rules 2000. Subsequently the day time in Indian context is taken from 6 AM to 10 PM for L_{dN} calculation. L_{dN} is a preferred parameter during application in various planning activities due to its better understanding of human perception to noise in different time slots.

The L_{dN} values were calculated for different sampling locations during the current study. The L_{dN} value for control site (RGSC) was calculated as 44.3 dB which when compared to L_{dN} of other locations, was found to be lowest. The highest L_{dN} was recorded at Wellesley Ganj which was equal to 87.3 dB. The other two locations railway station and bus depot recorded L_{dN} values of 66.0 dB and 68.7 dB respectively. A lower L_{dN} value signifies minimum to no level of psychological disturbance or annoyance while the higher L_{dN} values signifies greater psychological impact. In context of above statement, the RGSC campus can be said to have minimum psychological disturbance for its residents and dwellers and the environment of Wellesley Ganj is most disturbing. The other two locations fall in between these two extremities of the present study.

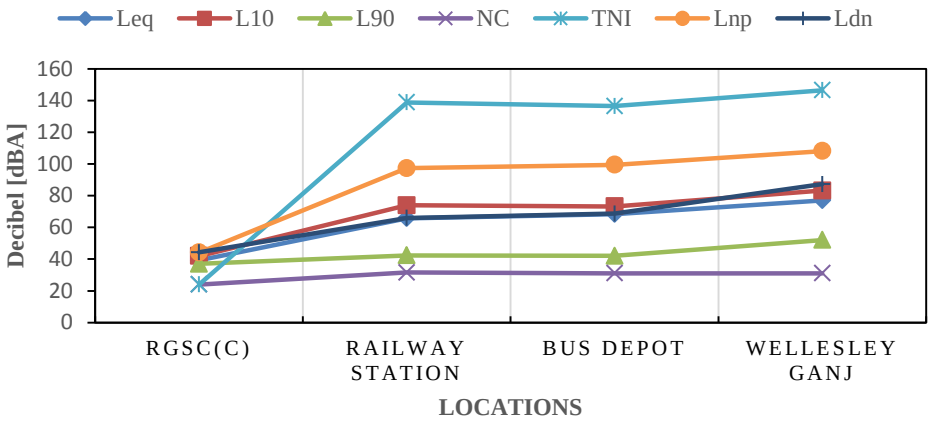

Figure-1: Noise pollution parameters of different areas of Mirzapur city.

Conclusion

The current study found that most of the noise parameters points towards Wellesley Ganj as the most polluted area in terms of noise pollution. A worrisome trend that has been concluded from the different noise parameters is that all the locations except RGSC (control site) have crossed permissible limits in majority of cases. The highest Leq was observed at Wellesley Ganj and lowest at RGSC i.e., 77.1 dB(A) and 39.2 dB(A) respectively. The maximum L_{10} value was observed at Wellesley Ganj and minimum at RGSC i.e., 83.2 dB(A) and 42 dB(A)respectively. The maximum L_{90} was observed at Wellesley Ganj and minimum at RGSC i.e., 52.1 dB(A) and 37 dB(A) respectively. The highest TNI value was recorded at Wellesley Ganj and lowest at RGSC i.e., 146.5 dB(A) and 24 dB(A) respectively. The highest NC value was recorded at Railway station and lowest at RGSC i.e., 31.6 dB(A) and 24 dB(A) respectively. The highest Lnp value was observed at Wellesley Ganj and lowest at RGSC i.e., 108.2 dB(A) and 44.2 dB(A) respectively. The highest L_{dN} value is observed at Wellesley Ganj and lowest at RGSC i.e., 87.3 dB(A) and 44.3 dB(A) respectively. It can be concluded that residents and dwellers of Mirzapur are exposed to a highly noise polluted environment in spite of being an under developed city.

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