STUDY OF NOISE EXPOSURE LEVEL (ANNOYANCE) AND NOISE PARAMETRE AT DIWALI FESTIVAL IN METROPOLITAN CITY: LUCKNOW, INDIA

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ABSTRACT-Noise pollution is defined as the irregular, undesired and unwanted sound which is a elevated sound level which may leads to adverse effect to living beings such as hyper tension, cardiovascular, irritability, aggressive behaviour, hear loss as well as on non living entities like loosing of plaster of walls, cracks in wall and cracking in household crockery. Noise pollution study was carried in the Lucknow city for four residential locations such as Aliganj, Indiranagar, Krishnanagar and Jankipuram on pre diwali day and post diwali day. Monitoring was done by noise level meter (Lutron SL-4010) during 06:00 to 10:00 in morning, 18:00 to 22:00 in evening and 22:00 to 24:00 in night time at an interval of 15 minutes continuously. The noise descriptors are calculated viz. L_{eq}, L_{10}, L_{50}, L_{90} and L_{den}, L_{dn} for the above mentioned locations. Further the calculation of percentage of annoyed (%A) and highly annoyed (%HA) is done. The results showed that the all reading and calculated noise parameter have the higher noise energy level than prescribed standards.

KEYWORDS: **NOISE POLLUTION, DIWALI, NOISE EXPOSURE, ANNOYANCE**

1. INTRODUCTION

Noise is term derived from the Latin word “nausea” which means the “unwanted sound”. There is physically no difference in between the sound and noise, sometimes the noise for one person may not a noise for another person. Noise can cause physiological and psychological effect to our environment. It is a serious threat to the whole world especially for the underdeveloped and developing countries (Enock Abe Wawa et al, 2015) which are also facing of funds for their needs and development. The main sources of noise pollution are the construction activities, traffic emergence, industrialization etc. Noise can affect badly to our environment and threat to humans. Long term exposure may causes permanent hear loss, annoying behaviour, headache, fluctuation in blood pressure, muscular strain and nervous breakdown, lowering of concentration and affect on memory, insomnia, emotional disturbance.

Diwali is a important Hindu festival of lightning and enjoy in India, celebrating with burning of lot of firecracker all over the country. This may creates lot of degradation in air also causes noise which affects the whole environment. The noise created by the firecracker is impulse sound which is more harmful the other types of noise. Firecracker causes lot of nuisance and made adverse effect on human health such as sleep disturbance, annoyance and other problems. Annoyance is discomfort for people and causes negative impact to the humans. It causes health problems such as increased heart rate, hypertension, hearing impairment and increased blood pressure. There are three principal means for assessing neighborhood exposure: (1) Equivalent Sound Level method, (2) Day-Night Sound Level method, and (3) Community Noise Equivalent Level method (United States Air Force 2001). The first technique, Equivalent Sound Level method, quantifies the average noise level over a specified time in decibels (Federal Aviation Administration 2000). As we know decibels are logarithmic calculations, so a normal averaging operation would not accurately quantify the difference between two noise levels. Therefore, a weighting scheme is used to provide a truer average. An example given by the FAA demonstrates that a sound of 50 dBA for thirty minutes and a sound of 100 dBA for thirty minutes would equate to an average of 97 dBA for the entire time period (one hour).

2. PREVIOUS STUDIES

A study was conducted in Mumbai city, the results showed that diwali festival generates a lot of noise pollution and continuous increment in the noise level from the previous years (Patel et al, 2014). A study in Duhok city (Iraq) during Nawruz festival, resulted measured noise level was 20% more than the normal days which were beyond the noise standards. These festival are the main cause of increase in noise level (Yousif et al, 2014). In Chindambaram town (Tamilnadu, India) a study was held during diwali festival , the recorded noise level on the diwali day for 30 sites were higher than the prescribed limits (Balashanmugam et al, 2014). Firecrackers are used in enjoying the diwali festival and cause generation of lot of air pollution as well as the noise pollution which creates discomfort to humans (Sharma et al, 2016). A review was conducted for the ambient air and noise quality in India at diwali festival resulted that there was degradation in air quality and increment in noise level on diwali day in comparison to normal day which causes serious health hazard, the study also emphasises on the control on bursting of firecracker to save human health (Chirag et al, 2014). Study in Calabar Municipality during pre-carnival, carnival and post carnival showed that sound level was higher at morning, afternoon as well as evening. It possesses adverse effect to all aged grouped humans (Alpan et al, 2015). Many efforts had been made to apply the noise exposure management strategies but resulted less improvements (Tickell,2012). The DNL (day-night average sound level) was selected by EPA as the uniform descriptor of

cumulative sound exposure to correlate with health and welfare effects. DNL methodology has given consistent results in the national and international literature under a wide range of noise conditions (including loud and soft noise levels, and frequent and infrequent numbers of discrete aircraft events) (Fidell, 2012). Noise annoyance is a phenomenon of mind and mood and it is identified by the acoustic and non acoustic factors (Stallen PJ, 1999).

Table 1: Classification of Noise Level

Level(in dBA)	<=23	30-60	60-90	60-120	120
effects	No disturbance	Stress, tension, psychological effects (illness, heart attack) effects especially at upper range	Damage to health, psychological and vegetative (disturbance in stomach- gall function, pains in muscles, high blood pressure, disturbance in sleeping)	Damages to heath and ontological (ear diseases) effects	Painful effects in long run

(Source: City Environmental Quality Review (CEQR) Technical Manual noise exposure guidelines for City environmental impact review classification)

L_{Aeq}: It is the A-weighted equivalent sound pressure level,

L_{90}: It is a good measure of background noise and the noise level that exceeded 90% of the time.

L_{50}: It is median noise**,** which is necessary, the same thing as Leq

L_{10}: It is the noise level that exceeded 10% of the time. It is a good measure of intermittent or intrusive noises, such as traffic, aircraft flyover, barking dogs etc.

L_{den}: is defined in terms of the "average" levels during daytime, evening, and night-time. The Lden (Day Evening Night Sound Level) or CNEL (Community Noise Equivalent Level) is the average sound level over a 24 hour period, with a penalty of 5 dB added for the evening hours or 19:00 to 22:00, and a penalty of 10 dB added for the night time hours of 22:00 to 07:00.

L_{dn}: The L_{dn} is the day night average equivalent sound level over a 24 hour period, with a penalty added for noise during the night time hours of 22:00 to 07:00. During the night time period 10 dB is added to reflect the impact of the noise. L_{dn} measurements are useful for assessing the impact that road, rail, air and general industry has on the local population.

TABLE 2. Noise Standards for Ambient Noise Level

Area code	Category of Area	Limits in db(A) L_{eq}	
		Day time	Night time
I	Industrial area	75	70
C	Commercial area	65	55
R	Residential area	55	45
S	Silence area	50	40

Exposure limits for noise fireworks is stated by CPCB, India, that there may be loss of hearing if noise levels exceeds by 90 decibels exposure for long periods and may cause permanent loss of hearing due to 150 decibels or greater even with a single exposure of such intensity (Noise standards for fire-crackers as per Environment (Protection) Act, 2000).

Table 3: Limits as per the Environmental Protection Agency

EFFECT	**LEVEL**	**AREA**
Hearing	L_{eq} (24) < 70 dBA	All area
Outdoor activity interference and annoyance	L_{eq} <55 dBA	Outdoors in residential areas and farms where people spend varying amounts of time in which quiet is basis for use
Outdoor activity interference and annoyance	L_{eq} (24)<55 dBA	Outdoor areas where people spend limited time such as school yards playgrounds, etc
Indoor activity interference and annoyance	L_{eq} <45 dBA	Indoor residential areas
Indoor activity interference and annoyance	L_{eq} (24) < 45 dBA	Indoor areas with human activities such as schools etc.
L_{dn} and L_{eq} should not exceed certain limits to protect the public health and welfare. To protect against hearing damage, one's 24-hour noise exposure at the ear not exceed 70 dBA.		

3. MATERIAL AND METHOD

3.1 STUDY AREA

Lucknow is a metropolitan city which is a capital city of Uttar Pradesh State and located at 80.95ºE longitude and 28.70ºN latitude. The city is selected as a study area at four site for monitoring the noise level by considering as an area source (Aliganj, Indiranagar, Jankipuram and Krishnanagar). The measurement of noise recording was carried in the city on pre-Diwali day and on Diwali day with the help of noise meter (Lutron- SL 4010).

Since noise is considered as a global challenge and it is produced by most of the anthropogenic activities. In the same way noise pollution created by firecracker in the diwali festival creates a lot of nuisance i.e. psychological and physiological which hamper the living standard with many health hazard problems. This study is a part of awareness program of noise pollution because of bursting of firecrackers.

Noise exposure is a term which shows the exposure of noise pollution to the population in any area in a given time period of noise occurrence. Study of noise exposure easily makes comprehensive about the noise pollution to common people and we can easily educate them and the help in awareness program about the pollution created by the bursting of firecracker which is harmful to our society and the human health. This can be further a great help in the awareness program, not to burn the huge amount of firecrackers at the festival. The all locations selected for study are residential areas and contains high population density.

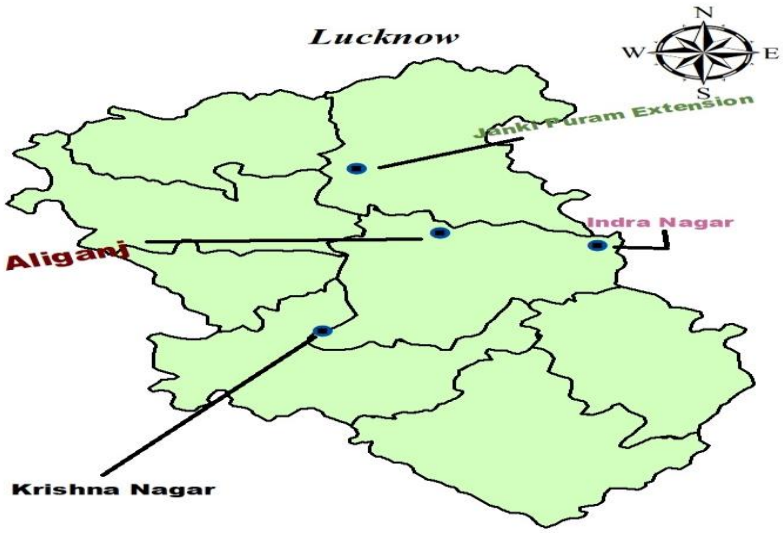

Fig: Map of study area: Lucknow

3.2 EXPERIMENTAL PROCEDURES

The instrument setup was done with proper calibration and installed at 1.5 m above the ground and instrument set up was 15 meters far away from the firecrackers. The interval of 15 second was taken for successive reading, L_A (A-weighted instantaneous sound pressure level) measurements was recorded continuously for 15 minutes. There were 120 noise data collected for one hour. The measurement of noise level for the areas was done at pre diwali day and on the diwali day in the form of A weighted noise level and described in the form of $L_{eq}(A)$. Measurement was taken in an open space using the noise metre from the distance of more than 15 metre from the firecrackers.

Data was collected in morning (6:00–10:00), evening (18:00–22:00) and night (23:00-24:00). Commonly used community noise evaluation quantities like the exceedance percentiles such as L_{10}, L_{50} and L_{90}, the A-weighted equivalent sound pressure level L_{Aeq}, the noise exposure level L_{den}, and L_{dn}, were calculated.

Following equations were used to compute the noise pollution indices:

$$L_{AEQ}=10\log_{10}\left[\frac{1}{N}\sum_{i=1}^{n}(anti\ \log\frac{LAi}{10})ni\right] \quad (1)$$

$$L_{eq} = L_{50} + [(L_{10}-L_{90})^2/60] \quad (2)$$

$$L_{den} = 10\log_{10}\left[\frac{1}{24}\left(12.10^{\frac{Lday}{10}} + 4.10^{\frac{L\,evening+5}{10}} + 8.10^{\frac{Lnight+10}{10}}\right)\right] \quad (3)$$

$$L_{dn} = 10\log_{10}\left[\frac{1}{24}\sum_{i=1}^{15}10^{La/10} + \sum_{i=16}^{24}10^{(La+10)/10}\right] \quad (4)$$

$$\%A = 0.0001795\,(L_{den}-37)^3 + 0.0211\,(L_{den}-37)^2 + 0.5353\,(L_{den}-37) \quad (5)$$

$$\%HA = 0.0009868\,(L_{den}-42)^3 - 0.01436\,(L_{den}-42)^2 + 0.5118\,(L_{den}-42) \quad (6)$$

4. RESULT AND DISCUSSION

Results showed that the noise level was much higher than the prescribed limit prescribed by the CPCB, New Delhi, India for the residential areas as 55 dBA in daytime and 45 dBA in night time. Population exposed to noise can be analysed by calculation of percentage of annoyed and highly annoyed from the L_{den} descriptor. Internationally validated equations are used to estimate the population annoyed by the noise level.

4.1 Noise Parametres

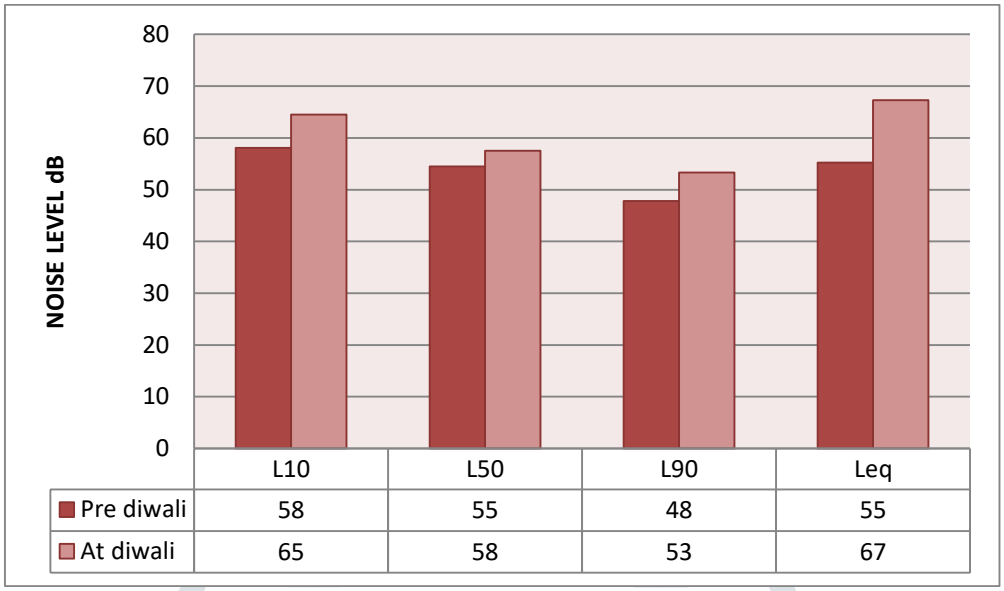

Figure 2: Variation of noise parameters at Aliganj

In figure 2 the L_{eq} for a whole day varies from 55.5 dBA on pre diwali to 62dBA on diwali day at Aliganj, which increases 18.82% on diwali day from the pre diwali day.

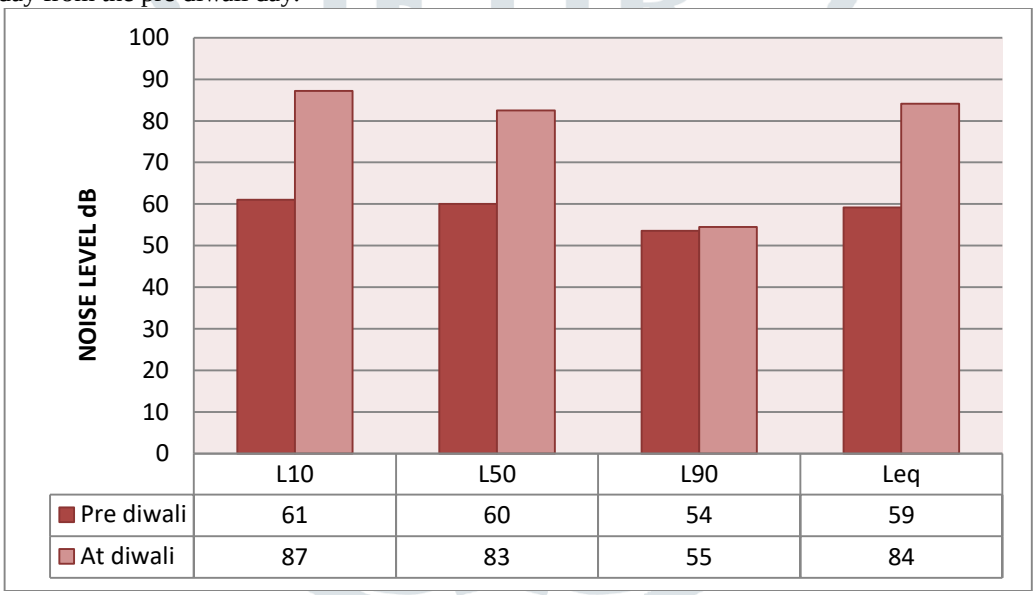

Figure 3: Variation of noise parameters at Krishnanagar

In the figure 3 at Krishnanagar location, variation in L_{eq} was from 59.2dBA on pre diwali to 84.1 dBA on diwali day which increases 42% on diwali day from the pre diwali day.

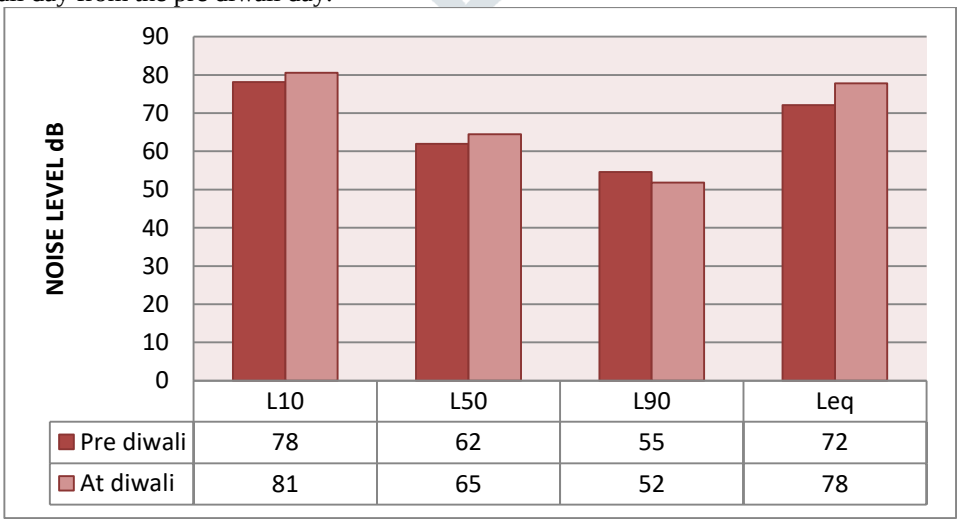

Figure 4: Variation of noise parameters at Indiranagar.

In the figure no 4 the variation at Indiranagar shows L_{eq} 72.1 dBA on pre diwali to 77.8 dBA on diwali day and the noise level are the beyond the prescribed limits. There was approximately 8 % exceedance in noise level on diwali day from the pre diwali day.

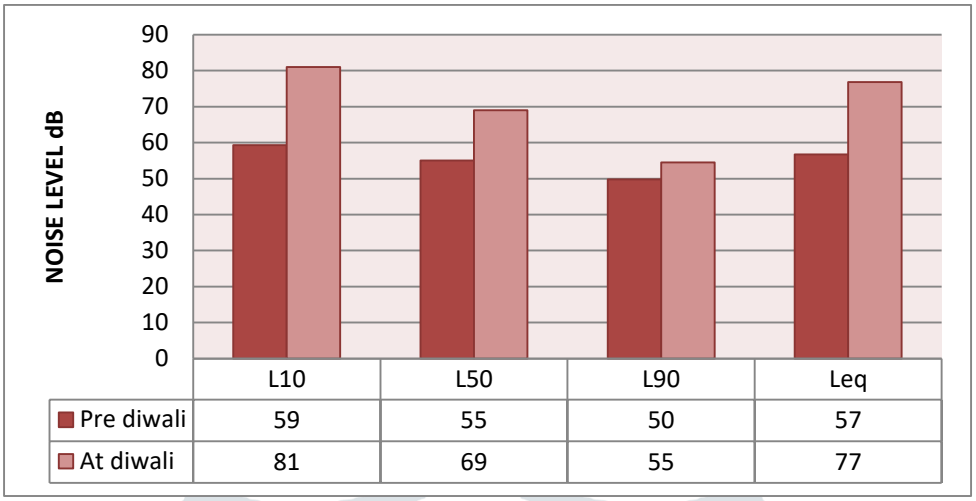

Figure 5: Variation of noise parameters at Jankipuram.

The figure 5 shows the variation of L_{eq} at Jankipuram was 56.7 dBA on pre diwali to 76.8 dBA on diwali day, this shows that there was increase of 35.50% in noise level at diwali day than the pre diwali day.

4.2 NOISE EXPOSURE VALUES IN THE FORM OF L_{DEN} AND L_{DN}

Table 4: Percentage of annoyance (%A) and highly annoyance (%HA)

location		Ldn	Lden	Road traffic		aircraft traffic		railways	
				%A	%HA	%A	%HA	%A	%HA
Aliganj	pre diwali	61.1	61.7	29	12	41	158	18	6
	at diwali	76.3	76.5	65	41	76	474	51	26
Krisnanagar	pre diwali	65.2	65.8	37	17	50	228	25	9
	at diwali	90.6	91.6	121	110	121	971	114	77
Indiranagar	pre diwali	81.9	82	83	61	92	635	70	41
	at diwali	87.4	87.5	104	87	108	819	93	60
Jankipuram	pre diwali	63.5	64.2	34	15	47	199	22	8
	at diwali	85.4	85.8	97	78	103	759	86	53

As per the previous research conclude that there is no current research to suggest that there is better metric than DNL to relate to annoyance (European Environment Agency).

In the above table, there is percentage of annoyed and highly annoyed were calculated in the form of road traffic, aircraft and railways annoyance to compare the diwali noise pollution. This shows if the noise level were equivalent to diwali noise then the annoyance percentage is equal to values given in the table. This comparison can be used to aware the people in reference to create such type of noise in the diwali festival by bursting of firecracker.

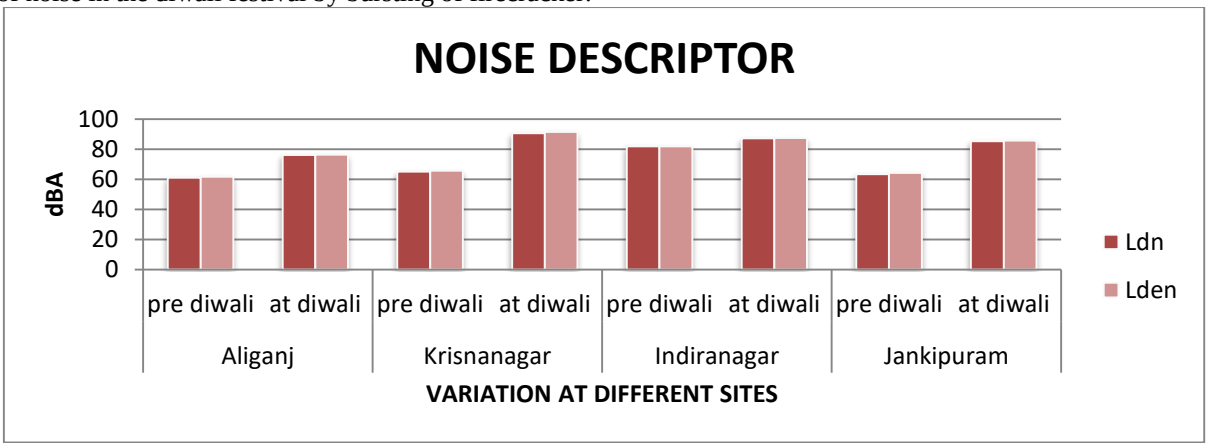

Figure 6: Comaparision of noise exposure values at all location

In the above figure 6, the calculated values of L_{den} and L_{dn} were varied from 61.7 and 61.1 respectively on pre diwali to 70.5 dBA and 76.3 dBA respectively on the diwali day at Aliganj site. The L_{den} and L_{dn} on Krishnanagar were varied from 65.8 dBA and 65.2 dBA respectively on pre diwali to 90.6 dBA and 91.6 dBA respectively on the diwali day. For Indiranagar site the calculated values of L_{den} and L_{dn} were varied from 82dBA and 81.9 dBA respectively on pre diwali to 87.5 dBA and 87.4 dBA on the diwali day. The L_{den} and L_{dn} for jankipuram location were varied from 64.2 and 63.5 respectively on pre diwali to 85.8 dBA and 85.4 dBA on the diwali day. The figure 6 shows the noise exposure variation at all locations were at a higher edge which is higher than the WHO's standards limits of noise level for the residential zone.

5. CONCLUSION AND DISCUSSION

In Lucknow, the impact of noise is not yet taken seriously and its effects are not well emphasized. The link between noise and human health is also not taken seriously and hence there is not much done to curb the emission of noise or to better understand its spread and effects. Study of annoyance and relation of exposure will help a lot to made rules and regulation. It will also helpful to understand the behaviour of different types of noise on the population resides in an area. From the above result it is clear that all the recorded readings and the calculated parameter was more than the prescribed limit for the residential zone.

Annoyance which is calculated by the L_{den} and according to WHO, if the value of L_{den} exceeds 55 dBA then it is treated as high noise level. This may cause health problems and sometimes contribute to premature mortality. The other parameter L_n used to show the sleep disturbance and if its value is greater than 50 dBA then problems like body movements and awaking can be happen during sleeping.

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