Research Article

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Environmental Noise Impact and Vehicular Traffic Study for National Highway in Industrial Belt of Allahabad District

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ABSTRACT

Elevated noise exposure brings about various detrimental effects on the environment when perceived on a regular and long-term basis. Commercial, industrial and residential zones have been strategically designed to deal with the adverse impacts of noise on the environment and human health. An attempt has been made in this pilot-scale study to investigate the intervention of noise in a span of 10 km en-route National Highway (Allahabad - Mirzapur). The observation points were situated in different zones, which were mostly affected by vehicular noise. The observations were recorded by a time-weighted average of 8 hours during the peak hours, thrice every week. The inference from the study indicated that the noise levels were much higher than the permissible limits as described by Environmental Protection Standards for the selected locations and mitigation measures for reducing the adverse effects of noise on the surroundings have been suggested.

Keywords: Environmental impact; Highway monitoring; Noise; Pilot-scale study; Vehicular traffic.

1. INTRODUCTION

Noise is defined as any unwanted or undesirable sound which is made to reach human ears. Industrial and vehicular growth has added to its share in the increase of noise pollution. Noise can be categorized into two types, *viz*, continuous noise and pulsative noise (Allen *et al.* 2009). High continuous noise may cause damage to the hearing mechanism leading to hearing impairment; it is comparatively much lower than that caused by vehicular noise. The study of traffic noise and the surroundings has been aimed to measure the levels of sound in the industrial, commercial as well as the institutional areas of the city. Traffic and vehicular noise have become a serious threat in recent times because of inadequate urban planning of the city in the past. Homes, schools, offices, hospitals, commercial business centers and other community buildings were routinely built close to the main roads or highways without buffer zones or adequate soundproofing. The issue has been compounded by an increase in traffic volumes (two-wheelers, heavy motor and other vehicles), far beyond the expectations of our early urban planners. The striking increase in the volume of traffic is actually inversely related to the degradation of the environment. Noise pollution is a major environmental pollutant encountered in daily life and has direct effects on human performance. Highway noise is the total noise reaching at a point by all the moving vehicles on that highway. The areas situated near the highways are always subjected to noise pollution due to both passenger and freight vehicles. Due to a constant increase in the number of vehicles on the road in the following years at an alarming rate, the intervention of noise on the surrounding has become a serious issue that must be dealt with immediately (Chakrabarty *et at.* 1997).

Sound is propagated in a medium in the form of pressure variations. All sound pressure levels are expressed in decibels (dB), defined as 20 log (p/p_0), where p is the pressure associated with the measurement and p_0 is the reference pressure (20 microbars). The three weighted network systems are conventionally adopted. The measurements on the A-weighted scale were used as it is much nearer to the human ear, expressed in dBA. This study is focused upon the analysis of the intervention of noise on the areas located on the side of NH-35 (between locations A and E on the Allahabad - Mirzapur highway). The area undertaken for the study is an industrial belt and hance an attempt has been made to analyze the viability of the crucial planning while placing different types of buildings in an industrial zone.

1.1 Site Selection

Naini is located at 25.3792s° N, 81.8771° E, the southern part of the Uttar Pradesh at an elevation of 96 m (316 ft) and stands at the confluence of the Ganges and Yamuna rivers. Naini is located on the banks of River Yamuna, opposite Allahabad City in the north, across the Ganges, Jhunsi. The area undertaken for the study has a stretch of 10 km in NH-35 (Allahabad-Mirzapur highway), from Location A to Location E. Five different locations were selected along this stretch for the collection of data, namely in their order of occurrence. The selected locations were in an industrial zone even though they belonged to a different category and have different levels of permissible sound; all these buildings and institutes are situated along the NH-35, so the intervention of highway noise is very high in these areas and require critical measures for its containment.

2. METHODOLOGY

The instrument used for measuring the noise levels was Sound Level Meter (SLM-1315), which records sounds up to a maximum of 130 dB. Vehicular data was also recorded for more precision. The readings were taken at an interval of the maximum possible noise levels in the area. The readings were taken on every alternate day of the week. A suitable comparison was made by plotting a graph between the recorded sound levels and the standard values for the specific zones (silent, residential, commercial and industrial), and the conclusions were drawn from them (Nayef *et al*. 2012; Pinto *et al*. 2009). A time-weighted average was used for computing the final observations for the day. The formulae used for the computation of data are:

$$L_{eq} = [10 * \log_{10} 1/n * (10^{(L1/10)} + (10^{(L2/10)} + nnn. + (10^{(Ln/10)}))]$$

L = Measured noise exposure at different locations

N = total number of readings

Noise levels for a vehicle were obtained and then calculated logarithmically to get the total hourly L_{eq} value and the combined hourly L_{eq} was calculated by logarithmic summation of the hourly L_{eq} value of each category.

3. VEHICULAR TRAFFIC STUDY

As per Uttar Pradesh Statistical Handbook (2016), the vehicles in Allahabad have grown at the rate of 7.41% per annum between 2010-11 and 2014-15, presented in Table 1. A number of private vehicles have increased substantially from 0.98 million to 1.52 million during that period. However, the growth rate of commercial vehicles (14.5%) is higher than the growth rate of private vehicles (13.77%).

Traffic congestion accounts for about 76% of the delays, while about 16% of the delay was due to bad road conditions. Other reasons were mis-management of traffic at rotary junctions due to enforcement issues (4%) and 4% of the delay was at locations such as underpasses, railway crossings, etc. Along the road network length, about 64% of the delays lasted up to 60 s, 28% of the delays lasted between 61–120 s, while about 8% lasted more than 120 s, during the peak hours.

Table 1. Growth of vehicles in Allahabad

S. No.	Category of Vehicle	Number of Vehicles (in Millions)		Annual Compound Growth Rate (%)
1	Private Vehicles	2010	2011	13.77
2	Commercial vehicles	0.06	0.09	14.5
3	TOTAL	1.04	1.61	13.70

Table 2. Traffic volume

S. No.	Location	Total PCU'S	Total Vehicles
1	A (Institutional Area)	22,876	31,753
2	B (Industrial Area)	19,657	23,134
3	C (Commercial Area)	30,452	43,781
4	D (Industrial Area)	17,385	28,291
5	E (Institutional Area)	18,185	30,629

Table 3. Ambient air quality standards for various types of area

Area Code	Category of Area/Zone	Limits in dB (A) L_{eq}*	
		Day time	Night time
A	Industrial Zone	75	70
B	Commercial Zone	65	55
C	Residential Zone	55	45
D	Silence Zone	50	40

Note:

1. Day time shall mean 6.00 a.m. to 10.00 p.m.
2. Night time shall mean 10.00 p.m. to 6.00 a.m.
3. A silent zone is an area comprising hospitals, educational institutions, courts, religious places, or any other area which is declared as such by the competent authority, not less than 100 m around (Jadaan *et al*. 2006).
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. * dB (A) L_{eq} denotes the time-weighted average of the level of sound in decibels on scale A which is relatable to human hearing. dB (A) L_{eq} denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear. L_{eq} is an energy mean of the noise level over a specified period.

4. RESULTS AND DISCUSSION

The observations show that the noise levels are 22 dBA higher at Location A, 1.4 dBA higher for Location B, 20 dBA higher than the permissible limit at Location C, 25 dBA higher for Location D and 26 dBA higher for Location E, indicating the immediate need for preventive measures to be taken for the intervention of noise due to vehicular traffic in the working environment.

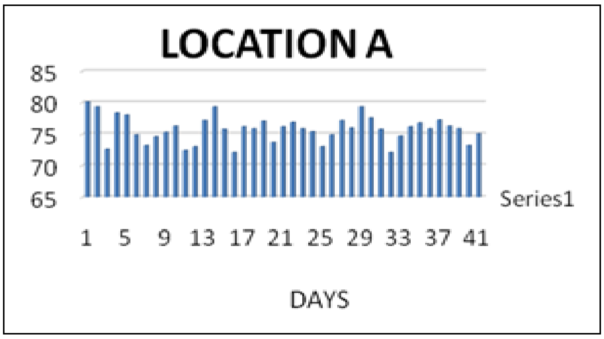

Fig. 1: Institutional area

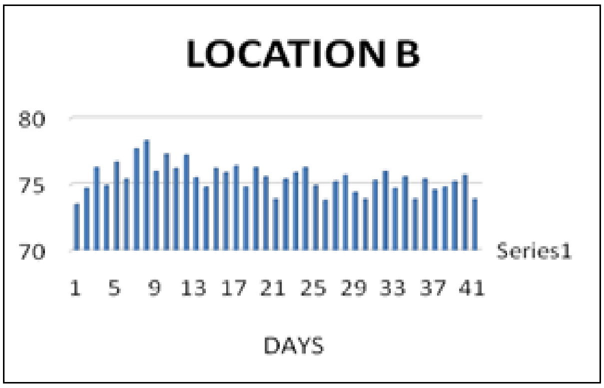

Fig. 2: Industrial area

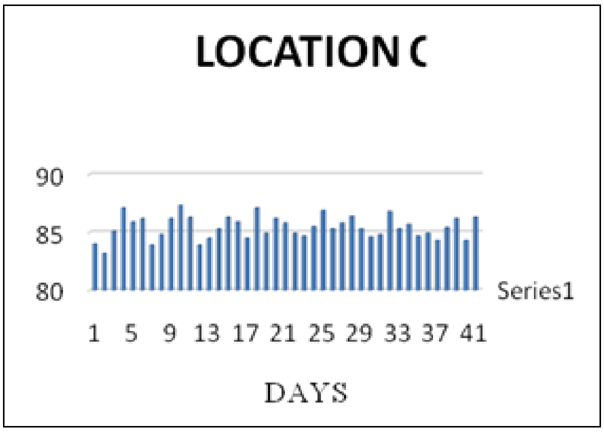

Fig. 3: Commercial area

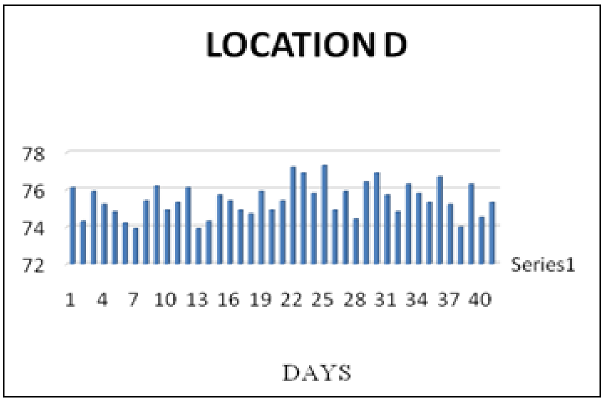

Fig. 4: Industrial area

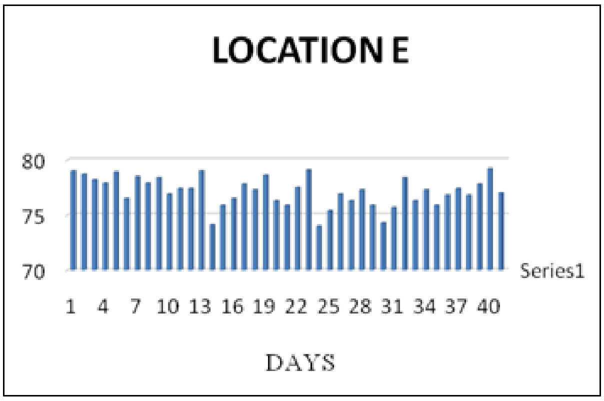

Fig. 5: Institutional area

The results observed from the charts mentioned above show that the average sound levels on the selected sites was almost way higher than the permissible limits for the designated zones:

Location A - 22 dBA higher than the permissible limit.

Location B - 1.4 dBA higher than the permissible limits but under the tolerance limit.

Location C – 20 dBA higher than the permissible limit.

Location D – 25 dBA higher than the permissible limit.

Location E – 26 dBA higher than the permissible limit.

Except for Location B (Industrial area), all the other sites were found to be subjected to heavy noise pollution.

5. CONCLUSIONS AND RECOMMENDATIONS

Noise levels will increase due to the extra road traffic expected over the next number of years. The work used noise mapping to assess the environmental impact caused by noise in an urban setting of an Industrial Area Naini, Allahabad. The following three stages were evaluated:

(1) Noise levels during peak hours
(2) Noise levels prior to the road re-structuring works and
(3) Noise levels immediately after the urban transformation.

The future situation may also be assessed using computer simulations, in which the noise levels created by increased traffic were forecasted as a consequence of changes in land use and habitation of the regions close to the highway. With reference to the noise emission limitations established for the region by the Central Pollution Control Boards, acoustic mapping is advised, which may assist in showing the existence of noise pollution in the urban length of the highway in all situations evaluated (Brainard *et al*. 2004; Doygun *et al*. 2008).

The peak hour highway traffic created a favorable environmental impact by reducing the number of heavy vehicles on the road. On the other hand, it served to extend the road network, resulting in a higher flow of cars and as a result, a major increase in noise levels in both business and residential areas, resulting in a negative environmental effect.

The noise prediction in the future comprises of the elimination of the flow of heavy-duty vehicles, leaving only the flow of passenger buses and light vehicles (Da *et al*. 2010). Noise mapping by means of computational models will prove to be a very useful tool for calculating and presenting noise levels generated by vehicular traffic; it will be a very important tool in the environmental management of noise pollution (Cho *et al*. 2007; Fracisco *et al*. 2006). The mitigation measures for noise management can be summarized as:

(1) The strict control of vehicle noise emissions

(2) Rigorous control of vehicle speed

(3) Stimulation of the use of public transportation and alternatives for urban mobility independent of the use of automobile and

(4) Environmental noise emission monitoring plans on a long-term basis: another point to underline is the need of checking the paving conditions of the roads on the highways which make up the road network on a continuous basis.

Computational models may be correlated in urban planning for noise control in cities. These models facilitate the management and decision-making aspects of the government to look for solutions in order to prevent potential environmental risks in the future.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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