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Study on need of monitoring sound pollution at developing urban localities

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Abstract

Environmental pollution is a very serious issue around the world due to development of humankind towards well-being and modernization. It not only impacts health but also affects over all biodiversity. Sound does nothing till it is up to certain limit, as it creates pressure on the particles of the medium, when the limit of pressure is increased, it becomes nuisance. Sound pollution is the one important agent out of other factors that disrupts the living of humans and its ecosystem. It is related with physical, psychological or emotional states. Sound pollution adversely affects the humankind and animals leading to irritation, loss of concentration, and loss of hearing and abnormal behaviour of animals.

The present work emphasizes the need to monitor and control the sound pollution in the developing cities to tackle the related future problems, to investigate the status and validity of ambient noise standards in the Indian situation, also to propose need of noise control based on the available knowledge on noise policies and regulations. The study is an approach towards importance of monitoring the sound pollution, its sources and its effects on the human activities or the ecosystem with respect to degrees of exposure in the newly developing urban localities with moderate commercial activities. The impact of sound pollution will increase if appropriate measures are not taken.

Keywords: Sound pollution; Environmental pollution; Health; Urban localities; Noise monitoring

1. Introduction

Every living creature on the planet earth, relies totally on the environment for its survival. However, the healthy existence depends heavily on pollution free environment. Any change in the chemical, physical, or biological value of the environment caused by humans or with their assistance that is destructive to the environment or goes beyond acceptable limits is referred to as pollution. Environmental menaces may be caused by natural events, industrial activities and human activity that disrupt the environment and contaminate it with chemical, biological, or physical agents that are fatal to humans, animals or plants. Sound, defined by its characteristics mainly loudness and frequency, a mechanical longitudinal vibrations which requires medium to propagate. These mechanical vibration with pressure are measured in Pascal, Pa and frequency measured in Hertz, Hz. Loudness related to the intensity of sound, is the 'level of sound pressure' and is measured with respect to the threshold of hearing, the intensity is 10^{-12} W/m^2 for one kilohertz vibration. Any increase in this intensity is measured on the logarithmic scale. The acoustical waves (between frequency 20 Hz to 20 kHz) with lower and higher frequency sound waves are also important to be acknowledged as they may have unseen effects on the ecosystem. Sound does nothing till it is up to certain limit, as it creates pressure on the particles of the medium, when the limit of pressure is increased, it becomes nuisance. The differences in intensity level are denoted as L_I and expressed in nepers Np, bels B, or decibels dB. The disruptive sounds that negatively affect the physical and mental well-being of humans or animals or plants in the surroundings is referred to as sound pollution, noise. The level of exposure to environmental noise in urban areas have shown direct impacts on the development of society. From the different research findings it is specified that sound pollution is increasing as developments in all sectors for mostly the comfort of human kind is growing [1-4]. As equated to other types of environmental pollutions,

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air, water, soil, light, and radioactive pollutants, noise or sound pollution is often not attended seriously due to its less noticeable harmful impact on mankind than other types of pollutions. As per the World Health Organization (WHO) reports environmental noise pollution is the second most dangerous form of environmental pollution after air pollution, especially in densely populated areas [5]. It is scientifically evidenced that exposure to high level of noise leads to many health problems. For classifications or types of noise different metrics are often used in interpreting acoustical data. The other factors while monitoring the sound pollution is attenuation factor, as sound spreads in the medium its intensity level goes on decreasing.

Mostly noise is measured in decibels (dB). The zero on a decibel scale is at the threshold of hearing. The sound level depends on the distance between the sound source and the receiver. The sound pressure level L_p in dB without the given distance, r to the sound source is meaningless. The threshold of pain is in between 120 dB and 140 dB, depending on the frequency composition and the sensitivity of the person.

The other weighted scale is decibels dB(A), 'A' symbol indicates a weighted measurement of a logarithmic scale, the actual measurement 'I' is compared to a fixed reference level 'I_0' then the 'decibel' value is 10 $\log_{10}$ (I/I_0). Some examples of the perceptions are listed as,

Table 1 Perception of sound

Source of Sound	**Sound pressure Level L_p dB (SPL)**
Jet aircraft, 50 m away	140
Threshold of discomfort	120
Frequent level with music via head phones, jack hammer at 10 m distance	100 dBA
Conversation, 1 m	60
Low volume of radio or TV at 1 m distance, noisy vacuum cleaner at 10 m distance	55 dBA
Noise of normal living; talking, or radio in the background	45 dBA
Quiet library	40
Hearing threshold	0 dB

According to Prevention and Control of pollution Act, 1981 noise is regarded as a pollutant. It is affecting the human health physically and psychologically. Studies have shown that noise pollution adversely affects the lives of millions of population [6,8]. It was stated that, continuous exposure to loud sounds is always harmful to the hearing systems.

The various studies have acknowledged the factors which most influence the noise extent in the urban areas include, transportation (road/rail/air), commercial services, industries, concert, household equipment, bore well machines, jack hammer operation, building construction work, marble cutting, music concerts, public address systems, loudspeakers at weddings and religious places, processions and many other things, but in all road transportation noise was found most prominent existence [9-13].

Table 2 Ambient air quality standards in respect of noise in India[15] Limits in dB(A) L_{eq}*

Area code	**Category of zone**	**Day-time**	**Night-time**
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence	50	40

*Day-time is from 6.00am to 10.00 pm; *Night-time is from 10.00 pm to 6.00am; *Zone may be defined by the competent authority

The Guidelines Development Group of the World Health Organization (WHO) recommends that noise levels due to road traffic noise should be reduced below 53 decibels (dB) L_{den}. Also, for night noise exposure, it recommends reducing

noise levels below 45 dB L_{night},. The ambient air quality standards in respect of noise in India are shown in Table 2 [14,15].

In India under the ministry of environment and forest, MoEF the central pollution control board, CPCB has provided the rules for the control of noise in the year 2000, as the Noise Pollution (Regulation and Control) Rules, 2000 which governs each type of noise pollution. Prior to this, noise pollution and its causes were addressed by the Air (Prevention and Control of Pollution) Act of 1981. On February 14, 2000, the Union Government passed the Noise Pollution (Regulation and Control) Rules, 2000, according to the authority granted to it by the Environment (Protection) Act of 1986.

As confirmed by many studies Sound pollution has various disturbing health-related effects depending upon the exposure time and loudness of sound [16-18] on ecosystem like

- Effects on Human Health
    - Loss of permanent hearing.
    - Cardiovascular issues, including increased stress and blood pressure, causing irritability, anxiety, and mental fatigue due to rise in blood pressure,
    - Sleep, recreation, and communication disorder, sleeping disorders, affecting daily activities.
    - Impairs memory and attention span in children.
    - Impacting birth weight.
    - Affect reading, speech, language, and language-related skills mostly of children.
- Effects on Animals and Plants:
    - Alters behaviour of prey-predator, increasing the risk of death.
    - Interferes with navigation and reproductive behaviour, animal mating, communication, navigation, and survival.
    - Risk of hearing loss in certain species, such as whales.
    - Problems for marine animals relying on echolocation.
    - Underwater noise pollution from ships, seismic tests, and sonar devices threatens marine life, leading to mass stranding of whales and dolphins.
    - Noise pollution can have adverse effects on the environment, disrupting wildlife, habitats, and ecosystems.
    - It can also negatively impact plant growth, reproduction, and overall health, can further impact the natural world.

Sound pollution has become globally a very serious concern. Therefore it is very important to adopt noise monitoring strategies to monitor the noise levels and planning for suitable noise abatement measures for its reduction. The long term noise monitoring studies are required not only for ascertaining the magnitude of ambient levels, but also for devising suitable control plans. There have been many such studies reported in different parts of the world [19-27]. The development of a validated noise model for Indian conditions similar to that used in developed nations is essential in conducting Environmental Impact Assessment studies [28, 29].

The objective of the present work is to emphasize on the need to monitor and control the sound pollution in the developing urban areas in the populated cities to tackle the future problems of noise, to investigate the status and validity of noise standards in the Indian situation and propose need of noise control based on the available knowledge.

2. Material and methods

Use of proper instrumentation and period of observation for monitoring the sound pollution is the main methodology to collect the data on sound pressure level. The analysis of the data is done by the usual formulations for average noise levels for the day, night or particular hours, months, years and may also be for the level of sound in dB [12,19]. There have been no comprehensive long-term noise monitoring studies reported in India until the Central Pollution Control Board CPCB's initiative of project National Ambient Noise Monitoring Network NANMN in the year 2011[15,19, 31-34]. The development of model of a noise for Indian conditions, similar to that used in developed nations for conducting Environmental Impact Assessment (EIA) is necessary [15, 35]. The Central Pollution Control Board (CPCB), New Delhi, under the Ministry of Environment and Forest, MoEF, has under taken many initiatives and carried out numerous studies in monitoring the ambient sound levels at noise hot-spots. CPCB, India initiated the process of developing National Ambient Noise Monitoring Network (NANMN), a follow-up of Section 5.2.8 (IV) of National Environmental Policy (NEP)-2006. In which it was decided to include ambient noise as a regular parameter for monitoring in specified urban areas[30,31].

As mentioned in the study by B. Chauhan [12], the diversified NANMN project was established in 2011 covering 70 stations in 7 major cities of the country, namely, Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad and Lucknow. Here the Noise Monitoring Terminals (NMTs) were manufactured and installed by Geónica Earth Sciences, Spain[19]. The Noise Monitoring Network so established is unique and one of the largest noise monitoring networks of its kind across the globe. The methodology utilised for the monitoring is measuring the sound intensity level with the help of sound level meters with special arrangement of pressure measurement. The noise monitoring unit is a standalone remote terminal having a calibrated sound-level meter and consisting of a high quality microphone connected to an advanced acoustic signal-processing unit, which is connected to an advanced high resolution data logger [19, 31].

The day equivalent levels are the average equivalent sound levels of 16 hours duration of the day from 06:00 AM to 10:00 PM. The night equivalent levels are the average equivalent sound levels of 8 hours duration from 10:00 PM to 06:00 AM [36] from the data, the average day and night equivalent sound levels [19] for a year are calculated as:

$$L_{day,n} = 10\left[\frac{1}{n}\log_{10}\sum_{i=1}^{n}10^{\left[\frac{(L_{day,i})}{10}\right]}\right] \quad \text{---------- (1)}$$

$$L_{night,n} = 10\left[\frac{1}{n}\log_{10}\sum_{i=1}^{n}10^{\left[\frac{(L_{night,i})}{10}\right]}\right] \quad \text{---------- (2)}$$

where, n is the number of days in the year, and $L_{day.i}$ and $L_{night,i}$ are the day and night equivalent sound pressure levels of the i-th day of the year, respectively.
The standard deviation associated with the day equivalent sound levels of the noise monitoring sites, can be calculated from following relation, we have not quoted here:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} L_{day,i} - \overline{L_{day}}}{n-1}} \quad \text{---------- (3)}$$

where $\overline{L_{day}}$ is the average of the day equivalent sound levels per year. The noise exceedance factor EF of a site is defined as the ratio of the ambient noise level of the site and the permissible noise level limit of the zone in which the site is located. The average noise limit exceedance factor (NEF) for all the sites lying in one zone is called the average exceedance factor (AEF) can also be measured by:

$$EF = \frac{L_0}{L_p} \quad \text{---------- (4)}$$

where, L_0 is the observed ambient noise level, and L_p is the legally permissible limit recommended by the CPCB, India. The different studies can be undertaken for zone-wise and site-wise analysis in order to analyse the noise scenario at various sites in newly developing urban localities on micro level.

3. Results and discussion

Globally Noise pollution has become a serious concern. Every nation is concerned about the effects of noise emitted from the expanding urbanization and modernization of societies. The major sources of noise pollution in urban localities include traffic congestion from heavy vehicles, unnecessary honking and construction activities. Industrial activities and loud music from events, such as weddings and concerts, also contribute significantly to elevated noise levels, celebrations of events and festivities also adds in it. Additionally, night time disturbances from movement of heavy trucks and celebrating with fire crackers at midnight for the cricket matches, birthdays, weddings and not the least the late night comers honking at the gates of the apartments and dog barking further aggravate the noise pollution in residential zones. We have quoted the different angle of monitoring and analysis of sound pollution from the different studies so far and the report of the authorised monitoring agencies.

Noise Monitoring Study in India (2011-2020) carried out by Naveen Garg et.al [37], have analysed long-term noise data, utilizing the National Ambient Noise Monitoring Network (NANMN). Key findings revealed that many monitored sites exceeded ambient noise standards, particularly in commercial and industrial zones, with significant increases in both day and night noise levels over the decade. The study emphasized the need for effective noise action plans and policy frameworks to address and mitigate noise pollution in metropolitan areas. The research findings are 94.3% of observations exceeded the Night Noise Guidelines target of 55 dB L_{night}. Most of the monitoring sites recorded day equivalent sound levels between 60-75 dB(A). In their observations it was found that silence zones showed the highest

Ambient Exposure Factor for noise levels. Study aids in predicting future noise scenarios and informs national policy for noise pollution reduction.

Garg et al (2022) reported that Noise pollution is a significant issue in urban areas, with road traffic noise contributing around 55% of total environmental noise. Honking is a major noise source in India, contributing 2 to 5 dB(A) additional noise in total road traffic noise. An increment in vehicular speeds from 35 to 55 km/hr provides a significant increment in road traffic noise levels by 4–5 dB(A). In Nagpur City, road traffic noise levels increased by 5–6 dB(A) between (2012) and (2019), with honking noise increasing by 4–6 times and traffic noise by 1.7 times. A positive correlation was observed between honking events and noise levels, while negative correlations were observed for noise levels with vehicular speeds and traffic volume.

From the different findings it is discussed that, Indian cities have been facing severe problems of noise due to constant growth of vehicles, urbanization, mixed traffic zones, and incompetent road networks. The average road traffic noise in most Indian cities is more than 70 dB(A).

Noise monitoring in big metropolitan cities is cumbersome due to mixed traffic zones, heterogeneous traffic, miscellaneous vehicles, and inefficient traffic management. An extensive noise monitoring study is required to assess environmental noise scenarios and plan appropriate mitigation measures to control noise pollution.

Now a days DJ's are mostly influencing the young generation for the enjoyment and any type of celebrations. There is a need to aware public with the very dangerous effects of the sound pollution. There is an urgent need to monitor and implement strict rules and actions against the violators, due to the majority of residents in urban colonies are of the enjoyment category on any cost. Environmental noise and the noise impact on communities will increase if appropriate interventions are not considered.

M Verma et.al 2022, [2], Emphasises that the Noise pollution is the second most hazardous environmental issue after air pollution. While discussing India's Noise Pollution (Regulation and Control) Rules 2000, the authors emphasizes the need for noise abatement measures and compliance with ambient air quality standards. It also highlights the responsibilities of authorities in enforcing noise control measures. And have suggested various techniques for noise reduction at the source and through transmission path management.

While concentrating on the developing urban localities there are different sources of noise, mainly the new construction sites, constructed apartments have interior constructions work, road constructions, welding works, cement mixers, boar wells drilling, and many more works utilizing machineries which creates the sound more than desirable levels. The observations are quite interesting that, though there are rules and regulations to curb the pollution but implementation is very poor. Which results in uncontrolled work hours and thereby generating noise at any duration of night or day. In some cases it was observed that the work contracts are given resulting in completing the work by extra duty hours, like starting at 5 or 6 am in the morning. Mostly this happens to remove the centrings of the cement concretes, or digging the boar wells. Similarly without any lunch or breaks at the day time and late nights the contractors try to finish their projects to gain more profits. The traffic noise also adds menaces in it. Children playing at any time with loud shouting's cannot be left aside. Honking for any reasons is the added gift in overall.

As the number of residents goes on increasing the celebrations of events, festivities increases. There is no limit how much the volume of PA systems should be maintain and no time limit. In some localities the PA systems are used for the announcements and prayers of Gods, at morning or and evening.

The noise levels of the developing urban localities were measured during day and night. It was observed that the localities which are under developed are having more noise than the developing localities. In the mid of the day hours the sound level was observed to be 55-60dBA. The observations are also carried out when there is no work. There is a need to control the noise generated in the premises due to different activities. The data on noise level for the different time is given in the following table. The data collected for the different duration of time and for one month.

Table 3 Sound level at different time period and activities at developing urban localities

Sr.no.	Time of day / cause	Sound Pressure Level dBA
1	6.00 am	32
2.	6.00 am to 7.00 am	46
3	7.00 am to 8.00 am	45-50
4	9.00 am to 10.00 am	65-70
5	10.00am to 11.00am	70-75
6	11.00am to 12.00 noon	70-75
7	12 pm to 1.00 pm	65-70
8	1.00 pm to 2.00 pm	65-70
9	2.00 pm to 3.00 pm	60-65
10	3.00 pm to 4.00 pm	60-65
11	4.00 pm to 5.00 pm	65-70
12	5.00 pm to 6.00 pm	70-75
13	6.00 pm to 7.00 pm	65-70
14	7.00 pm to 8.00 pm	60-65
15	8.00 pm to 9.00 pm	55-60
16	9.00 pm to 10.00pm	55-60
17	10.00 pm to 11.00pm	45-50
18	11.00 pm to 12.00 midnight	55-60
19	12.00 am to 01.00am	40-45
20	1.00 am to 02.00am	35-40
21	2.00 am to 03.00pm	30-35
22	3.00 am to 04.00pm	30-35
23	4.00 am to 05.00pm	30-35
24	5.00 am to 06.00pm	35-40
25	During marriage procession	75-85
26	Advertising road side	75-80
27	Unnecessary honking	75-80
28	Heavy very heavy vehicle	75-80
29	Procession with DJ	85-90
30	Festivities/ events	75-80

Graphical presentation of excess noise at newly developing urban localities is given below figure 1.

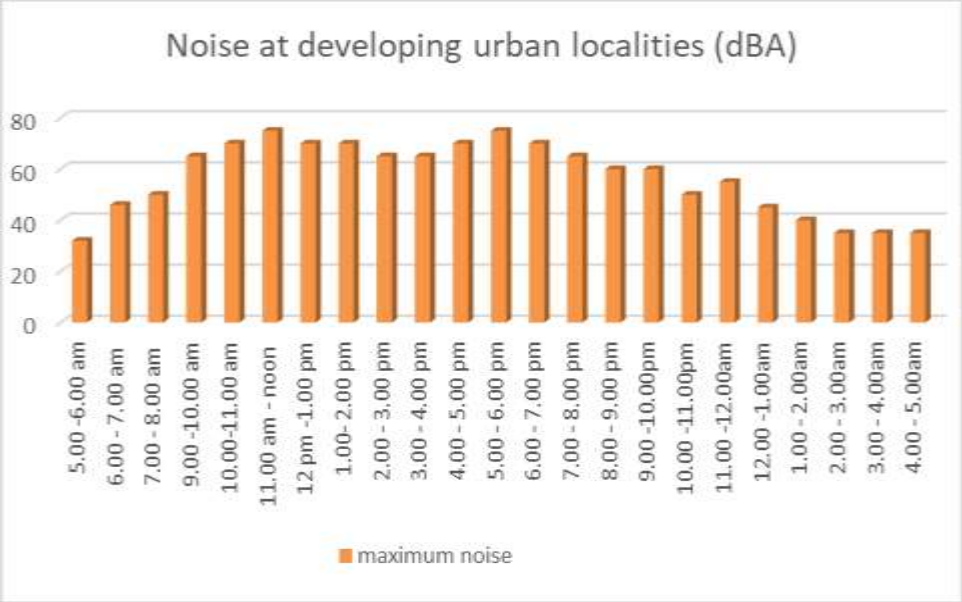

Figure 1 Graphical presentation of excess noise at newly developing urban localities

4. Conclusion

Urbanization has contributed to noise pollution, and without proper oversight, this issue is becoming a significant threat to the ecosystem as revealed from various studies. Research has demonstrated that noise pollution can cause a range of health issues, such as hearing loss, heightened stress levels, sleep disruptions, cardiovascular problems, and adverse effects on mental well-being. It obstructs verbal communication, hampers cognitive abilities, and can result in irritation and interruptions to daily activities. Additionally, noise pollution has been linked to disturbances in bodily functions and can worsen existing mental health disorders. Even though noise standards and regulations are in place, enforcing them effectively remains problematic, with monitoring and adherence often insufficient. To address this challenge, it is essential to implement not only stricter regulations but also effective enforcement, public education, and strategies to reduce noise levels, particularly in busy traffic and commercial zones and newly developing localities.

Developing countries face various challenges regarding environmental noise policies, governance, noise emissions, noise modelling, mapping, and monitoring, as well as the evaluation of health and economic risks and financing mechanisms for managing environmental noise. We have examined the research of various scholars regarding sound pollution and its regulation. This study concentrated on the monitoring and management of noise pollution at urban localities. Effective control of noise pollution is crucial for mitigating its adverse effects on the environment and public health. The strategies can include identifying noise sources, assessing the reasons for increased noise levels, and implementing measures to reduce unwanted noise.

Our observations indicate that the noise level experiences three peaks at different time intervals, largely due to excessive human activities during these times. However, a noticeable rise in noise is also recorded during night-time hours and during celebrations or festivals and events. The peaks observed are primarily attributed to human actions, with minimal or negligible contributions from natural noise sources. To reduce these elevated noise levels, it is essential to raise awareness about the harmful effects of noise amongst the general public, as well as to ensure strict enforcement of regulations by relevant authorities.

The research specifies that to manage noise pollution effectively, enhanced environmental regulations and strict compliance with the law and time to time awareness programs are necessary. To successfully mitigate the dangers linked to noise, a system for planning and monitoring noise control must be established.

Compliance with ethical standards

Disclosure of Conflict of interests

All authors declare that there are no conflicts of interests regarding this paper publication.

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