

Research Article

A Comprehensive Study of Noise Levels from Vellore Town Tamil Nadu, using Mobile Applications

Muruganandam BS, Wani Al^{*} and Kamili Z

School of Civil and Chemical Engineering, VIT University, Vellore, Tamil Nadu, India

Abstract

Noise is a prominent feature of the environment including noise from transport, industry and neighbors. Exposure to transport noise disturbs sleep in the laboratory, but not generally in field studies where adaptation occurs. Noise interferes in complex task performance, modifies social behavior and causes annoyance. Studies of occupational and environmental noise exposure suggest an association with hypertension, whereas community studies show only weak relationships between noise and cardiovascular disease. Aircraft and road traffic noise exposure are associated with psychological symptoms but not with clinically defined psychiatric disorder. In both industrial studies and community studies, noise exposure is related to raise catecholamine secretion. In children, chronic aircraft noise exposure impairs reading comprehension and long-term memory and may be associated with raised blood pressure. Further research is needed examining coping strategies and the possible health consequences of adaptation to noise.

Keywords: Noise pollution; Environment; Human health; Hearing loss

Introduction

Noise pollution refers to sounds in the environment that are caused by human and that threaten the health or welfare of human or animal inhabitants. Noise, defined as 'unwanted sound', is perceived as an environmental stressor and nuisance. Exposure to continuous noise of 85-90 dBA, particularly over a lifetime in industrial settings, can lead to a progressive loss of hearing, with an increase in the threshold of hearing sensitivity. Hearing impairments due to noise are a direct consequence of the effects of sound energy on the inner ear. However, the levels of environmental noise, as opposed to industrial noise, are much lower and effects on non-auditory health cannot be explained as a consequence of sound energy [1].

Noise pollution is a significant environmental problem. Traffic noise is probably the most rigorous and pervasive type of noise pollution. Traffic noise has become a serious problem nowadays 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 of the municipality without buffer zones or adequate sound proofing. The problem has been compounded by increases in traffic volumes (two wheelers, heavy motor vehicles and other vehicles) far beyond the expectations of our early urban planners. This alarming increase in the volume of traffic is actually inversely related to the degradation of the environment. Noise pollution is one of the major environmental pollutants that are encountered in daily life and has direct effects on human performance. Sound pressure is a basic measure of the vibrations of air that makes up sound and because the range that the human listeners can detect is very wide, these levels are measured on the logarithmic scale with units of decibel (dB).

Scope and Objectives

Assessment and quantification of the noise pollution in Vellore town, Tamil Nadu using mobile applications.

Literature Review

Sound pressure level

The minimum acoustic pressure audible to the young human ear

which is in good health is about 20×10^{-5} Pa. The minimum hearing level is called threshold of hearing. For a normal human ear pain is expected at sound pressures of around 60 Pa, this level is the threshold of pain. The sound pressure level (SPL) is measured in a unit called as decibel (dB); which can be obtained from the equation

 $SPL(dB)=10log(P_{rms}^2/P_{ref}^2)$

Where the reference sound pressure is P_{ref} , P_{rms} is the root-mean square of the sound pressure being measured, when the threshold of hearing is made the reference, it corresponds to SPL of 0 dB, while the SPL at the threshold of pain is around 130dB [2].

The degree of loudness of any sound above the threshold of hearing is a subjective interpretation of sound pressure level at 1000 Hz. Pitch is the subjective response to frequency. Sounds of low frequencies are described as "low pitched", while sounds of high frequencies are said to be "high pitched". Since the human ear is not equally sensitive to sound at different frequencies, in order to evaluate correctly human exposure to noise, sound measuring system should be able to account for the difference in sensitivities over the audible range. Therefore frequency weighting networks which are "filters" have been developed which weigh the contributions made by various frequencies to the overall sound level, so the sound pressure levels are adjusted as a function of frequency before combined together to give an overall level. There are three international standards weighing networks in common use, these are "A","B" and "C", the "B" network no longer used. The measured sound levels are measured as dBA or dBC.

Noise Measurement and Control

The most common measurement in environmental noise is the

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^{*}Corresponding author: Amir Iqbal Wani, School of civil and chemical engineering, VIT University, Vellore, Tamil Nadu, India; Tel: 9787115198/7006909755; E-mail: aamiriqbalwani@gmail.com

sound pressure level which can be measured with a Sound Level Meter having an A-weighting filter to simulate the subjective response of the human ear. Industrial and environmental noises often fluctuates, the equivalent sound level $(L_{Aeq T})$ (or average sound level L_{AT}) is the steady sound pressure level which over a given period of time T, has the same total energy as the actual fluctuating noise.

$$L_{Aeq,T} = 10 \log \frac{1}{T} \int_0^T \left(\frac{p(t)}{pref} \wedge 2 \, \mathrm{dt}\right)$$

where p(t) is the time varying sound pressure. The simplest instrument for measuring L_{Aeq} is an integrating sound level meter, which performs averaging over the entire period. However the period T, can be split into number of subintervals N, and can be calculated as follows:

$$L_{Aeq,T} = 10 \log \frac{1}{T} \sum_{i=1}^{N} \left[Tt \times 10^{\left(\frac{Laeq,t}{10}\right)} \right]$$

The limitations of traditional method for collection of noise data at a sparse set of locations hence the development of wireless sensor networks (WSN) for environmental monitoring and urban sensing; in recent time, a new method to measure noise pollution involved the use of mobile phones although not that much correct. The widespread appreciation of harmful effects of noise in developed countries, has led to the introduction of protective measures against noise pollution. The maximum noise exposure for workers in USA is 90 dBA for one 8-h period which should be followed by at least 10 hours of 65 dBA, in the U.K it is 85 dbA for 8-h period, while in Turkey, and the limit is less than 75 dBA for 7.5-h period. Generally, minimum noise exposure is less than 85 dBA, noise exposure between 85 and 90 dBA is moderately high, while noise exposure above 90 dBA is high. In Nigeria, the problem of noise pollution is wide spread. Several studies report that noise level in metropolitan cities exceeds specified standard limits. A study by conducted in Makurdi, Nigeria found that the noise pollution level in the city was about 3 dBA to 10 dBA above the recommended upper limit of 82 dBA, it was also found that the peak noise level at road junction in Abraka, Nigeria to be 100 dBA. This noise level is higher than the recommended level of 60 dBA for commercial and residential areas. Noise pollution is one of the major environmental concerns in India today and most of the people in India are unaware of its various hazards it causes. It has been recently taken into account in India that noise pollution poses a major threat to people's health. In only march 2001 pollution control board in India set up noise pollution monitoring network in major cities which included the metro cities as well. The allowable noise level in industrial areas in India is around 75 dBA to 55 dBA allowed in the residential areas. The actual levels of noise in big cities in India vary from 80 dBA to 90 dBA. Noise pollution is maximum in India especially during the festivals particularly Diwali when people burst crackers and sometimes the noise level during the festival has reached to more than 100dBA which can lead hearing impairment [3,4].

Experimental Setup

Vellore is located between latitude 12.9165° N and longitude 79.1325° E has a population of 177230 (2001). The locations used for the study of Vellore are VIT University, New Bus Stand, Katpadi Railway Station, CMC market, Vellore fort along with other places. The following places were selected as they were hotspots in the district where most of the activity would take place which would give the amount of noise pollution in the area. The method used as specified by the title of our project was to check the noise level at different places by using mobile phone applications on our smartphones. There are a

lot of applications available for smartphones which turn these phones into sound measuring devices, they use the on-board microphone to measure the sound [5].

Page 2 of 8

As smartphone microphones are not particularly made sensitive for noise measurement they require calibration to get them closer to the correct value, in this regard we choose a number of applications from the Google play store and used different methods to calibrate them. Some of the applications we choose are as follows.

iNVH by bosch, Noise meter, Sound meter, decibel, Sound Meter pro

The problem with most of the applications was that they did not log any data as they would just show the readings at a particular time and there was no option in the applications to save data or something. So the applications which would log data had to be selected for the project. Two applications from the above were selected as they had an option for data log [6].

Noise Meter

Board, India

The iNVH application is a unique app developed by Robert Bosch engineers. The tool comes in with a sound level meter. The basically uses in built microphones and accelerometers to measure the different quantities. It uses octave band calibration which allows user to do a sensitivity correction in each frequency band. But the problem with the application was that it only logged the data for dBA values not for peak values or average values or the L_{eq} value which is quite useful for the data interpretation. One more issue with the application was that there was no option for background data collection which made it quite difficult some times to measure data (Table 1).

Noise meter was another application which was downloaded to check for noise levels it also measures the sound levels by using the inbuilt microphone in the smartphone to measure the noise levels. This was the application we choose for the project as data logging was easy and it would save a number of different data values like average, peak, minimum and L_{eq} . One more upside to this app was that it saved data in background as well which means the data was generally correct [7,8].

Calibration of the applications was a difficult job as we did not have a proper sound level meter or a calibrator to check the correctness of the value so different applications was installed in two or three phones and compared the values at different places. Some phones were showing different values so we chose similar model phone so that their microphone configuration would be somewhat similar and hence checked for different applications on those smartphones. Thus the application which showed same values and did not show much deviation in the values was chosen for the project. There were two applications which showed the above desired result so one of them was chosen on which of them logged more values. Noise meter was the application which was chosen for the project [9-11].

Area Code	Category of area/zone	limits in dB(A) leq*	
		day time	Night time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence zones	50	40
*dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing. Source: Central Pollution Control			

Table 1: The noise levels at various places.

Data Collection

We have collected the data at various locations in and outside the campus. The data was collected using the android application called 'Noise Meter'. This application was selected after long research and experimentation on various applications. It was found to give accurate values. The values have been collected for 15 minutes at each location.

The least count is 0.5 seconds, i.e for each second, we get 2 values of noise level [12-14].

Data Analysis

Following are some of the various places where we have measured the noise levels.

Anna auditorium(11:27 to 11:42 am)

The values obtained from 'Anna Auditorium' (in dbA) are (Figure 1)

Min=48.7

Max=84.4

Avg=64.8;StdDev=6.7

Traffic around VIT(03:18 to 03:33 pm)

Figure 2 shows the values obtained *outside the main gate* (in dbA) are Min=48.7

Max=83.9

Avg=65.0

StdDev=5.4







Walk around campus during normal day(05:54 to 06:09)

Figure 3 shows the values obtained on a *normal day*(in dbA) are

Min=40.1

Max=80.8

Avg=60.2

StdDev=8.2

Walk around campus during College Festival (Riviera) (07:27 to 07:42 pm)

Figure 4 shows the values obtained *during College Festival* (in dbA) are

Min=45.7

Max=88.2 Avg=62.8

StdDev=5.5

Musical concerts (proshows) during College Festival(10:15 to 10:30 pm)

Figure 5 shows the values obtained from *proshows during College Festival* (in dbA) are

Min=60.5 Max=88.9 Avg=81.3 StdDev=5.7

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Figure 4: Walk around campus during College Festival (Riviera) (07:27 to 07:42 pm).



New Bus Stand Vellore (10:01 to 10:16 am)

Figure 6 shows the values obtained from New Bus Stand Vellore (in dbA) are

Min=63.9

Max=82.2

Avg=77.5

StdDev=8.0

Railway Station Vellore (10:15 to 10:30 am)

Figure 7 shows the values obtained from (in dbA) are

Min=47.1 Max=80.4

Avg=64.3

StdDev=6.8

Christian Medical College Market (10:01 to 10:16 am)

Figure 8 shows the values obtained from (in dbA) are

Min=67.9

Max=84.5

Avg=77.4

StdDev=2.5

VIT Library (03:55 to 04:10 pm)

Figure 9 shows the values obtained from(in dbA) are





Min=37.4

Max=55.4

Avg=49.1

StdDev=6.5

During dinner in a crowded dining hall (08:30 to 08:45 pm)

Figure 10 shows the values obtained from(in dbA) are

Min=51.6

Max=84

Avg=67.9

StdDev=3.7

VIT Normal Classroom (04:05 to 04:20 pm)

Figure 11 shows the values obtained from(in dbA) are

Min=42.1

Max=79.5

Avg=54.5

StdDev=5.1

Foodys (Gathering Place)-03:00 to 03:15 pm

Figures 12 shows the values obtained from(in dbA) are







Page 5 of 8







Min=46.8 Max=84.9 Avg=63.3 StdDev=5.3

Results

The noise levels at various places have been measured.

The average recorded value during a function (women's day celebration) in Anna Auditorium was 64.8 dBA. This indicates that the noise we are exposed to during a cultural event is high. It is almost as much as the noise produced in a commercial area.

The average recorded value outside the main gate is 65 dBA which tells us how busy the traffic outside our campus is in particular and it gives an idea of the noise pollution in Indian traffic conditions in general. The value was taken from 10:00 to 10:15 on a normal working day. However, this value is within the limit value as per Central Board of Pollution Control, India, for a commercial area [15,16].

The noise was also measured during College Festival and it is worth mentioning that the average recorded value during a walk in the campus (62.8 dBA) was 2.6 dBA higher than the average recorded value during a walk in the normal day (60.2 dBA).

This concludes that during festival celebrations, we are exposed to around 2.5 dBA higher noise levels, on an average, in Indian conditions (Figure 13).

The average noise levels recorded during proshows (musical concerts) in College Festival was 81.4 dBA, which is very high.



With extended exposure, noises that reach a decibel level of 85 can cause permanent damage to the hair cells in the inner ear, leading to hearing loss. Thus it can be concluded that long exposure to noise during musical concerts should be avoided [17].

The average value obtained at 'New Bus Stand Vellore' in dBA was 77.5 dBA (during peak hours) which is again very high. It is higher than the limit value as per Central Board of Pollution Control, India.

This concludes that Vellore bus stand is very noisy and thus unhealthy in terms of exposure to noise.

Similarly, the noise levels obtained during peak hours in Vellore railway station are also high i.e., 80.2 dBA. Thus it is safe to conclude that all transport hotspots in Vellore are fairly noisy.

The market around Christian Medical College is very busy. The average recorded value during peak hours is 77.4 dBA. This value is higher than the limit value which is 65 dBA as recommended by the CPCB, India.

Average recorded value in VIT library is 49.1 which is a normal value for a silence zone.

Average recorded value in a normal VIT classroom during lecture is 54.5 dBA. This is fairly low and hence safe.

The average noise levels produced during a gathering in Foodys, VIT is again high i.e., 63.7 dBA. This value is as high as the noise produced in a commercial area.

Conclusion

Thus it can be concluded that in our daily life, we are exposed to different noise levels at different places and at a fixed place, the noise levels are different at different times of the day. During festivals, we are exposed to very high noise which can be fatal to our hearing. Noise pollution is one of those problems which are not paid much attention in our country. There are many problems bigger than noise pollution that our governing authorities are worried about but it does not give them the freedom of ignoring the noise pollution that we are exposed to, on daily basis. We have already concluded in results that we are exposed to fairly high noise levels on daily basis in our lives. Exposure to high noise levels can even cause hearing loss. Apart from that, there are many non-auditory effects including. Physiological effects and Performance effects like: Distraction, Annoyance, Disturbance of rest and sleep, Mental illness and Job interference. Thus the need of the hour is to check the noise pollution caused by us on daily basis for our own good. Our government has to start taking serious measures to cut noise levels. Thus it is our duty to check the noise pollution created by us on daily basis.

Page 7 of 8

Future work

Using gamification concepts for noise measuring applications can be used to make different concepts which can help to get measurements around a city which can help a lot. Like using a noisetube.com where people can upload measurements from around the place. Applications made such that they would have quests to complete and in these quests the noise level all around the city could be measured along with the GPS locations. There are a few mobile phone applications which are being developed in such a way that it would be made public and all that collection of data would be much vast as there would be a lot of sources for the data to be logged.

One more technique is select a large group of people who can use the applications used and the data collection would be more easy and vast as there would be a lot of different measurements which can be used to counter checked with each other and then can be compiled to give a much better interpretation of data.

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Page 8 of 8

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