

NOISE POLLUTION MODELING OF DHAKA CITY USING GIS

Rahman Mafizur^{1*}, Hasan ASM Mahmood², Afrin Rumana³

¹Department of Civil Engineering, BUET, Dhaka

(Dhaka-1000)

* E-mail: mafizur@gmail.com

Rapid urbanization and population growth in last decades have changed the physical environment of Dhaka city. Dhaka is one of the densely populated cities of the world having expected population of about 12.79 million. The heterogeneous vehicular fleet of Dhaka has been also growing at a rate of 17% per year. This marked increase in population together with industrialization leads to an increase in the emissions of various pollutants. Along with the increasing degree of air and water pollution, the inhabitants of Dhaka city are exposed to high level of noise pollution. These noise scenarios pose an extreme threat to human health due to their exposure for a prolonged period of time. On city streets noise pollution occurs mainly due to indiscriminate use of hydraulic horns of vehicles, loud siren of vehicles and microphones. The horns especially cause serious damage to children and elderly people. If a child below three years of age hears a horn emitting 100 dB of noise from a close range, he might lose his hearing power. This paper presents GIS based noise model for Dhaka city which will help to establish the existing baseline for the concerned authorities to foresee the viable and pragmatic implementation of future initiatives to control noise. The noise maps will aware more people to take preventive measures against noise induced diseases and induce awareness campaign among environmentalists and interested people of the society. They will also give experts the tools to refine designs for maximum benefit at affordable cost.

Keywords: *Noise pollution, Dhaka city, Decibel (dB), GIS, Vehicular fleet, KHz*

INTRODUCTION

Noise problems are generally local environmental issues; however, they are so popular that we can recognize them everywhere in the world. There are increasing trends of getting exposed to dangerous levels of noises in different forms. As part of life style young people of developed countries are more vulnerable to loud music or stereo, where as in cities of developing countries people are more exposed to traffic related noises generated mainly from indiscriminate uses of horns and manmade activities. It does not matter in what forms sounds generate, but any sound reaching to human ears beyond tolerable limit is definitely posing hearing related health problems. That's why noise problems exist in almost all countries of the world and included in the global environmental issues.

Noise pollution is a serious and annoying form of pollution in the capital city (Dhaka) of Bangladesh. Noise generally refers to unwanted sound produced by human activities that interferes in our communication, work, rest, recreation, or sleep. Working in an atmosphere of loud noise for a long period may cause complete deafness to any person. Children, aged people and pregnant women are more susceptible to noise pollution. Environmental noise originates from various sources e.g. transportation, machinery, construction, vehicular horns, audio entertainment systems, loudspeakers, commercial activities, human activities etc. The World Health Organization (WHO) has established maximum allowable levels of noise, above which human health will be directly or indirectly affected depending on the duration and level of exposure.

According to WHO, generally 60 dB sounds can make a man deaf temporarily and 100 dB sounds can cause complete deafness (BBS, 2005). But previous survey result of any busy street in Dhaka city shows the noise to be 60 to 80 dB, with the sound of vehicles 95 dB, loud speakers 90 to 100 dB, mills and factories 80 to 90 dB, restaurants and cinema halls 75 to 90 dB, festivals 85 to 90 dB, scooter or motorbike 87 to 92 dB and truck and buses 92 to 94 dB (BBS, 2005). The desired sound level in Bangladesh should be 25 dB in the bedroom, 45 dB in the dining or drawing room, 35-40 dB in the office, 30-40 dB in the class room, 35-40 dB in the library, 20-35 dB in hospital, 40-60 dB in restaurant and 45 dB in the city at night (BBS, 2005). When the sound exceeds these limits, there is a noise pollution.

It is evident that noise pollution is a great concern in a city like Dhaka because it has exceeded the tolerable limit almost a decade ago. There had been few studies conducted in the past by WHO and other government agencies concerning noise pollution of Dhaka city. In all city streets noise levels were found more than 80 dB (DOE, 2005). This noise pollution is increasing with the induction of vehicular fleet and increased human activities in each year. As a result, people usually exposed to noise pollution are likely to be affected by noise induced diseases particularly hearing problems. Significant visible steps are yet to be taken against increasing trend of noise pollution of Dhaka. Before the situation worsens more, concerned authorities should take necessary steps at appropriate levels to bring the sound level of Dhaka within allowable limit. This study prepares a current GIS based noise model map for Dhaka city using GIS software, which will be a useful tool and information to the policymakers in formulating strategic decisions.

METHOD OF APPROACH

The research was based on primary noise level data with the objective of preparing a GIS based noise map of Dhaka city. Firstly,

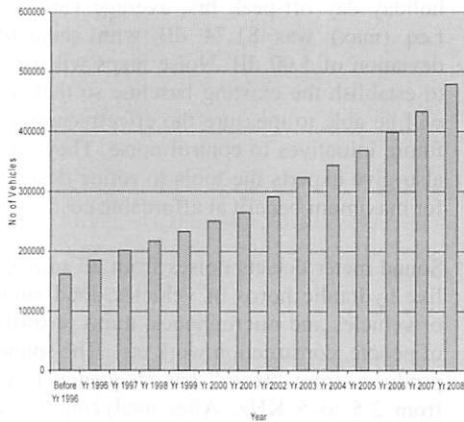
10 traffic road intersections of Dhaka city were selected which cover the residential area, commercial area, educational institute, medical center and also bus terminal. The study areas were Shahabag, Airport, Mohakhali bus stand, Sat Rasta, Newmarket, Mogbazar, Farm Gate bus stand, Mowchak and SAARC Foara. Noise level data (Maximum and minimum values) and frequencies were measured at those selected intersections using Sound Level Meter at varying peak/off peak hours both in working and holidays. In this study 9-12am and 6-9pm were considered as peak time period and 2-4pm as off-peak time at working day whereas at holiday, 9am-4pm and 6-9pm were considered as off-peak and peak time period. The secondary data i.e. vehicular fleets plying on road were collected from government agencies. After collection of all data, analysis was made to identify the main source of noises along with graphic software and finally sufficient efforts were made to prepare noise maps at time varying periods in the study area using GIS.

NOISE MEASUREMENT

In this study the noise pressure level was measured by digital sound level meter (Model no: Rion Sound Level Meter NL-32). The specification of sound level meter complies with IEC standards and new IEC61672-1 standard. The data were collected above 1.5 meter of the ground on roadside intersections.

Traffic Flow

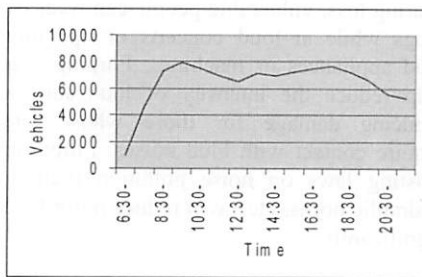
Maximum people of Dhaka depend on public transport for going to their working places. Buses and taxis are the highest rapidly increasing vehicle fleets per year. This indicates that substantial level of improvement took place in public transport sector in the recent years. But, still it can only fulfill a portion of total demand. Figure 1 shows heterogeneous vehicular fleet plying on Dhaka city road growing at a rate of 17% per year.



Data Source: BBS, 2008.

Figure 1 Registered Vehicular Fleet in Dhaka

The time variation traffic flow in working day of Dhaka city is almost identical having maximum congestion during peak hours. Due to inadequate road and traffic management, journey at peak hours comes near to stagnant, causing fatigue to commuters and huge time loss. Time series traffic flow (both way) at Kazi Nazrul Islam Avenue intersection of Dhaka city has been shown in Figure 2.



Data Source: DUTP, 2004

Figure 2 Time Series Traffic Flow(MV & NMV) at Kazi Nazrul Islam Avenue

Kazi Nazrul Islam Avenue road remains busiest in terms of traffic flow of 7908 vehicles/hour during 9:30 to 10:30 am. In other roads number of traffic flow remains over 3000 vehicles/hr. In between 2:00 to

4:00 pm, traffic flow decreases to some extent where again it increases after 5:00 pm and continues till 8:00 pm.

Noise Level Data at Different Locations of Dhaka City

Noise levels at different places during peak and off-peak hrs are almost identical irrespective of working or holidays. Figures 3 & 4 show typical noise levels at different places during peak and off-peak hrs in working days. Since Airport is the entry point towards Dhaka from northern side, all heavy duty vehicles enter into the city making huge traffic jam along airport road. Along with traffic noise, aircrafts and train movements add to noise level making Airport as most vulnerable to Noise pollution with highest Leq of 106.9 dB. There are hardly any differences between sound levels of peak and off-peak hrs. As such, dwellers of Dhaka city remain exposed to noise pollution for the entire day during working day. This exposure to noise pollution for a prolonged period is likely to cause injury to human health. In places where there is a mixture of motorized and non-motorized vehicular movements, the differences between Leq (min) and Leq (max) are more. As such, differences between Leq (min) and Leq (max) in Dhanmondi, Mowchak, Newmarket and Moghbazar are significantly more than that of Airport, Mohakhali, Farmgate, Shahbag, Saarc Foara and Sat Rasta.

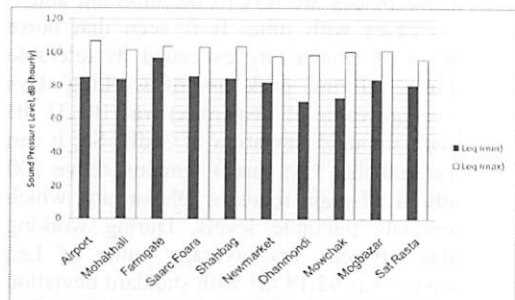


Figure 3 Sound Pressure levels During Peak Time

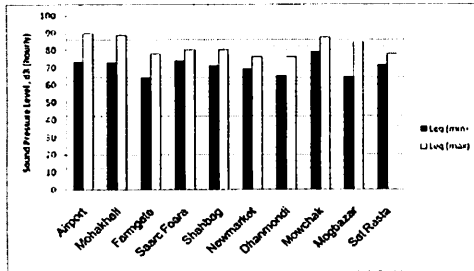


Figure 4 Sound Pressure levels During Off-peak Time

Noise Mapping Using GIS and Analysis

Noise mapping is a representation of acoustic data in a cartographical format that will plot noise exposure levels and identify relatively quiet areas and noise hotspots (Thurston et al., 2006). Maximum and minimum noise level data at all studied places have been superimposed in the city map, which represents noise maps at time varying periods (Figures 5 and 6). In the map, size of circle varies with the intensity of noise level. Noise intensities at Airport, Saarc Foara, Shahbag, Farmgate and Mohakhali are distinctly more throughout the day due to increased vehicular movement and human activities in these places. Noise intensities at Newmarket, Dhanmondi, Mowchak and Moghbazar increase with time having maximum values in the afternoon. It occurs due to the existence of number of shopping malls, schools and hospitals. Human activities in these places are less in the morning and it increases with time. It is seen that noise level of Dhaka city exceeded its tolerable limits. During peak hrs of working days average value of Leq (max) was 101.31 dB with standard deviation of 3 dB. So, it can be said that Leq (max) remains above 100 dB in all main roads of Dhaka city, which exceeds tolerable levels. During working day off-peak hrs, average value of Leq (max) was 95.18 dB with standard deviation of 3.96 dB. During holiday peak hrs, average value of Leq (max) was 93.17 dB with standard deviation of 8.76 dB. During

holiday day off-peak hrs, average value of Leq (max) was 81.74 dB with standard deviation of 5.00 dB. Noise maps will help to establish the existing baseline so that we will be able to measure the effectiveness of future initiatives to control noise. They will also give experts the tools to refine designs for maximum benefit at affordable cost.

Sound meter detects noises from all sources like hydraulic horns of vehicles, loud siren of vehicles and microphones, trains, crowds of people, construction work etc. The sound produces from "Horn" has frequency level from 2.5 to 5 KHz. After analyzing noise frequencies from 0 to 16 KHz hydraulic horn was found the main contributing source during both peak and off-peak time. It occurs due to restless and erratic behavior of drivers in traffic jam and their lack of knowledge on adverse health effect due to noise pollution created by them.

Generally people of Bangladesh are not well educated on awareness of sources of noise pollution and its likely adverse health. Awareness campaign will help people to mitigate to a great extent. This awareness program may also be included in the text book at school/college level. To avoid hearing loss, vulnerable people can wear ear plugs while at loud concerts or operating loud appliances or machines. Earplugs can help reduce the intensity of loud sounds, reducing damage for those whose jobs require contact with loud noises. Enforcing existing laws on noise pollution (ban on hydraulic horns, etc.) will reduce noise level significantly.

CONCLUSION

Rapid urbanization and population growth in last decades have changed the physical environment of Dhaka city. Dhaka is one of the densely populated cities of the world having expected population of about 12.79 million. The heterogeneous vehicular fleet of Dhaka has been also growing at a rate of 17% per year. Due to inadequate road and traffic management, journey at peak hours

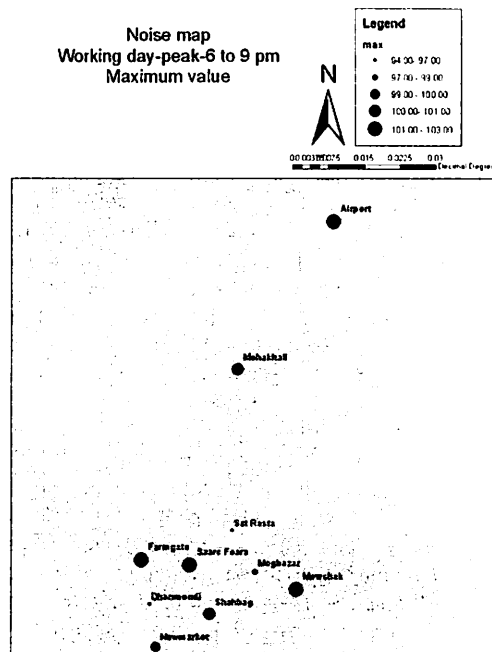
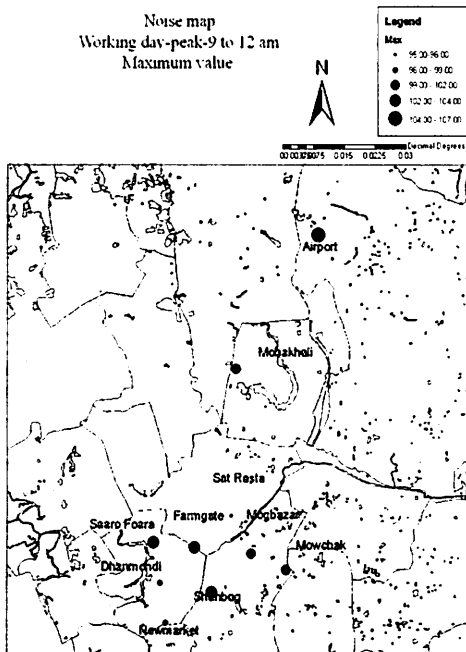
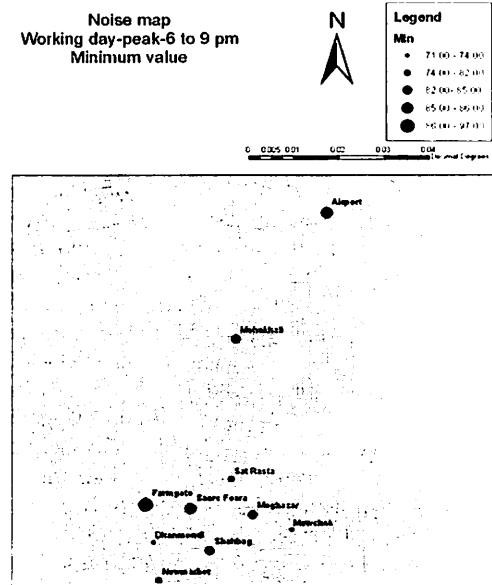
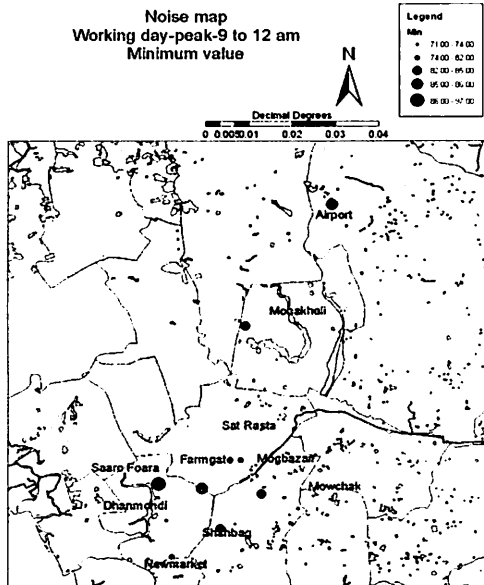


Figure 5 Noise Mapping During Working Day (9-12 am)

Figure 6 Noise Mapping During Working Day (6-9 pm)

comes near to stagnant, causing fatigue to commuters and huge time loss. Many working hours are lost due to traffic congestion in the city roads, which naturally irritates commuters/passengers/drivers. As an outcome of erratic behavior, drivers impatiently use hydraulic horns creating noise nuisance especially in the traffic intersections. Many drivers are not even aware of the health impact of prolonged exposure to noise pollution. Leq (min) and Leq (max) in dB of different places of Dhaka city were determined at different time periods using sound meter. Average value of Leq (max) during working day peak hrs remains always above 100 dB in all main roads of Dhaka. During holiday at peak and off-peak hrs average values of Leq (max) were 93.17 and 81.74 dB respectively. Noise levels at different places during peak and off-peak hrs are almost identical irrespective of working or holidays. Since Airport is the entry point towards Dhaka from northern side, all heavy duty vehicles enter into the city making huge traffic jam along airport road. Along with traffic noise, aircrafts and train movements add to noise level making Airport as the most vulnerable to noise pollution with highest Leq of 106.9 dB. There are hardly any differences between sound levels of peak and off-peak hrs in a working day. As such, dwellers of Dhaka city remain exposed to noise pollution for the entire working day. This exposure to noise pollution for a prolonged period is likely to cause injury to human health. From the analysis it is seen that hydraulic horn is the main contributing source of noise during all time of Dhaka city. Public education on noise pollution and its likely adverse health effect is an effective means to mitigate noise pollution. Vulnerable people can wear precautionary appliances like ear plugs when they are exposed to noise pollution. Enforcing existing laws on banning the use of hydraulic horns will reduce noise level.

REFERENCES

1. Bangladesh Medical Research Council Bulletin, 2005; 31 (2):68-74 (ISSN: 0377-9238).
2. BBS (2005), Compendium of Environmental Statistics of Bangladesh 2005, Bangladesh Bureau of Statistics, Government of People's Republic of Bangladesh, Dhaka.
3. Cortes, A.; Aspuru, I.; Tellado, N. (2004) Environmental Noise Management Systems in Large Towns Integrating GIS Technologies and Interim Calculation Methods. Proceedings 18th International Congress on Acoustic. Kyoto, 4-9 April 2004.
4. DOE (2005), "Dhaka City State of Environment: 2005", Paper prepared by Department of Environment & Ministry of Environment and Forest, Government of People's Republic of Bangladesh, Dhaka.
5. Hussain, K and Asha, A.Z (2009), Noise Impact Analysis of Dhaka City with Respect to Different Land , B.Sc. Engg. Thesis, Dept. of Civil Engineering, BUET, Bangladesh.
6. Kluijver, H. de; Stoter, J. (2003) Noise Mapping and GIS: Optimizing Quality and Efficiency of Noise Effect Studies.
7. Meenar, M.M.R., (2000). Academic Papers: Traffic Congestion in Dhaka City: Where is the solution? Accessed on 11-09-04 and available at: http://meenar71.tripod.com/portfolio/papers/traffic_dhaka.htm
8. Rahman, M. (1998) Institutional Issues in Hamid. N., Huq, S (eds) Reforming Dhaka City Management. Asian Cities in the 21st Centuries, Volume 3. Asian Development Bank. Pp 13-27.
9. Thurston, N. et al. (2006) Integrating GIS and Noise Mapping of the Liverpool/Birkenhead and Manchester Conurbations.
10. Unnayan Shamannay, (2001) "Society for Assistance to Hearing Impaired Children (SAHIC), Weekly Bichitra, Daily Janakantha, Fowjdari Bichar Bebostha" *People's Report on Bangladesh Environment , Volume II, Database*. The University Press Limited, Dhaka.
11. US History Encyclopedia: Noise Pollution: available at <http://www.answers.com/topic/noisepollution>

(Received November 3, 2010)
(Accepted January 17, 2011)