Development of Noise Map for Porur Junction using GIS

S. R. Masilamani, Sudharsanamurthy .P

Abstract: ***Noise pollution has become a major concern for communities living in the Chennai city. Noise pollution of urban areas is one of the serious factors that the local agencies and state authorities have to consider in decision making processes. In the reality, noise travels in all direction. Elevated noise levels due to vehicular traffic are cause of great concern in residential areas. Residents living in high rise buildings are also severely affected by traffic noise. It is therefore important to develop noise maps that can show influence of noise in all direction. The spatial analysis and geo statistical methods of GIS can play an important role to control noise pollution. GIS provide framework to integrate noise calculation models with spatial data that can be used for building noise maps. A case study was illustrated using the developed noise maps. This involved building simple, generation of observation point and noise calculation using observed noise data. In this study an attempt is made to monitor the noise pollution due to vehicular traffic at one of the major intersection Porur using digital sound level meter. The variation in the noise levels and traffic volume data in the peak hours are studied and presented as noise map for the selected location and the vulnerable zones are also identified in this study. This study also includes the effects and remedies which can be provided for minimizing the noise pollution.***

Keywords: Noise pollution, GIS, Traffic noise maps, Traffic noise prediction, Spatial data.

I. INTRODUCTION

Noise is an unwanted sound. Noise can be produced by many sources such as a man's vocal card, a running engine, a vibrating loudspeaker diaphragm, an operating machine tool, and so on. The word noise comes from the Latin word nauseas, meaning seasickness. The response of the human ear to sound is dependent on the frequency of the sound. The healthy human ear can hear frequencies ranging from 20 Hz to 20,000 Hz. The human ear has peak response around 2,500 to 3,000 Hz and has a relatively low response at low frequencies. The sound pressure level is commonly expressed in decibel (dB). The maximum decibel a human can hear is 130 dB. Noise pollution is an excessive, displeasing human, animal or machine created environmental noise that disrupts the activity or balance of human or animal life. It also affects our general health and behavior. Traffic noise is considered as the major source of noise pollution in Chennai.

The permitted noise levels recommended by BIS at different locations are as follows,

Table I- Permissible Noise Levels

Type of area	Day Time	Night Time
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone	50	40

Environmental pollution such as air, water, hazardous waste and noise pollution has always been a global concern affecting both the public's health and the planet's fragile ecosystems. The concentration of environmental pollution is significantly increasing and causing serious threat to the quality of the environment. One of the serious issues of environmental pollution is noise. Noise pollution in large urban areas is regarded as a growing problem of communities. Road traffic noise pollution is one of the major environmental problems encountered in our daily life. The exposure to noise from roads, affects more people than noise from any other source. It has become a major highway corridor. The noise produced by these vehicles is particularly disturbing due to wide variations in frequency and volume.

Noise mapping is an optimization technique in its various forms can be derived for different periods of the day or night and by using different noise indicators, noise dose-effect relationships, calculation heights, and calculation techniques. The main uses of noise maps is to identify and quantify the scale of noise problems at local, regional, national level and provide information for town planning and traffic management. Urban noise is directly associated to human activities, in transport and industry development. New mapping approaches supported by a GIS can be combined with spatial data analysis and mathematical modeling that further improves the quality of noise maps. Noise maps provide spatial presentation of acoustic situation. Noise maps build in GIS can be used for analysis and management process. Noise effect can be determined in GIS by combining noise levels with the location of people living in the area and their sensibility to noise.

A. Objectives of the Study

The objectives of the study are as follows:

- To generate the noise maps observation points which represents sound level meter using Arc GIS.
- To calculate noise levels at each observation point.

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Dr. S. R. Masilamani, Department of Planning, Anna University, Chennai, India , E-mail: srmasilamani@gmail.com

Mr. Sudharsanamurthy.P , Department of Planning, Anna University, Chennai, India , E-mail: sudharsanamurthy@gmail.com

- To determine and compare the noise levels of each interpolation techniques used for Noise mapping.
- To determine existing vulnerable zones in the study area.

B. Detrimental Effects of Noise

The detrimental effects of the noise are classified Under the following three major groups.

Subjective Effects: Subjective Effects can be described by terms such as annoyance, disturbance, bother and noisiness.

Behavioral Effects: Behavioral Effects cover interference with sleep, speech or any general task.

Physiological Effects: Physiological Effects can result in harmful effects on various parts of the body including deafness due to exposure for longer periods. Certain evidence suggests that noise has stress related disturbance such as cardiovascular diseases. In the context of the above mentioned adverse effects of noise, it is necessary to study the sources of noise and formulate a technique for the prediction of noise from road traffic which is the major source of disturbance.

II. REVIEW OF LITERATURE

Wazir Alam et.al (2011),has investigated the extensive noise assessment showed high noise levels in various locations of Guwahati city. A noise level survey was carried out in heavy traffic zones and highly populated areas using Sound Level Meter. ArcGIS software used to plot the noise level contours using Interpolation (Kriging) Technique.

Aaron Shiu-wai LUI et.al(2009), clearly states that recent evolution of information technologies have made substantial impacts to road traffic noise assessments and modeling applications. This included the enhancement of computation power, geographic information system (GIS), digital mapping data, three-dimensional (3D) computer graphic technology, digital topographic data, virtual reality technology and virtual globe technology.

This paper describes the Hong Kong experience in exploring, experimenting and applying the above novel technologies to noise assessments, dissemination of noise information with virtual reality effects and presentation of the modeling results. It also suggests an ideal roadmap for the development of these tools in the coming second digital decade or under the theme of ―natural user interface".

Anirban et.al. (2012), have monitored road traffic noise at 26 locations in the month of November and December2009 in Kolkata city and findings of the data are presented in this paper. Fluctuation of road traffic noise levels was found higher in non-peak traffic hour. Correlation analysis among equivalent continuous sound pressure level for one hour duration revealed that Leq(1hr) had highest and lowest positive correlation with respect to L10 and L90, respectively in both the traffic hours. L10, the peak noise level, generally resulted from honking of horns by car drivers.

R.Kalaiselvi et.al(2010), has conducted a multiple regression model taking into consideration the actual traffic composition, speed, horn noise contribution, road width, gradient and local metrological Conditions The city of chennai studied in this work will handle 15 lakhs of vehicles per day all over the city. Field measurements have been taken by using the Nor sonic sound level meter for 15 minutes duration. This model can be integrated into any open sources GIS software such as QGIS and GRASS for noise mapping purposes.

III. MATERIALS AND METHODS

A. Sound level meter

A sound level meter or sound meter is an instrument which measures sound pressure level. In this study digital sound level meter 'WORK ZONE', model number SL-4010 is used. It has the measurement range of 30 to 130 dB(A) with an accuracy of ±1.5 dB(A) and resolution 0.1 dB(A).

It is commonly used in noise pollution studies for the quantification of different kinds of sound levels, especially for industrial, environmental and commercial. However, the reading from a sound level meter does not correlate well to human-perceived loudness.

B. Arc GIS

Arc GIS version 10.2.1 is a state-of-art GIS software package developed by ESRI. The software can be used in a wide area of general as well as specific GIS applications and can be extended easily.

C. Methodology

The research methodology includes identification of study area, collection of noise levels, location details, development of noise model and its validation.

IV. DATA COLLECTION AND ANALYSIS

A. Study area

Porur is a fast developing suburb, included within the boundaries of the Chennai Corporation in the recent years. It is strategically located through which three major roads of the city pass through, namely Mount – Poonamallee Road, Porur – Vadapalani Road and Porur – Kundrathur road. It is fairly well connected to all parts of the City with buses plying to all major routes. Porur is located at 13.03° N and 80.16° E, and 52 feet (15 meters) above sea level.

The Porur Road Junction is a landmark location at Porur where the three major roads, mentioned above meet. Heavy traffic flow at the Porur junction, especially from Arcot Road and Mount Poonamallee Road, often results in a pile-up of vehicles. During rush hour, the wait for motorists to pass through the junction could be as much as 30 minutes. The traffic volume at Porur junction is increasing every day, and the grade separator at the junction for which the work began in the year 2010 is just near completion.

B. Formation of Grids and Observation Points

Understanding of the area under study is the fundamental and important task to be carried out at the first stage in any spatial study project. The study area was made into regular grids of known interval, for effectively studying the noise intensity data.

These grids of known interval were then used to identify the points of observation. The grids were formed using a software namely GE Path. The grids were formed with an equal interval of 10m along both x & y axes. The study area covers about 0.15 km^2 and the grids are extended to the whole area as shown in Figure 1.

Fig 1. Formation of Grid on Study Area

C. Observation Points

Observation points are the points where the surrounding noise intensities were measured. The observation points on the study area are placed with an interval of about 10-30 meters.

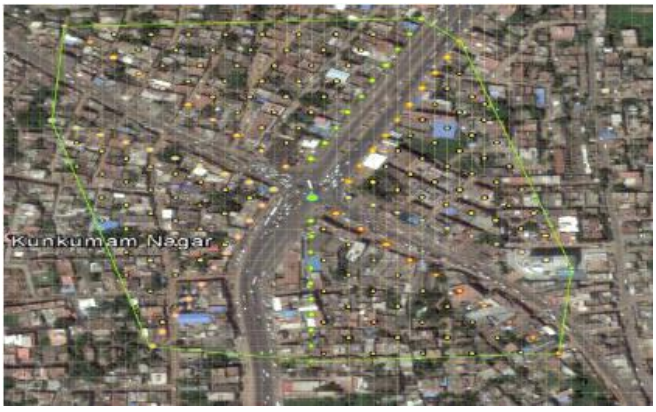

Fig 2. Observation points

D. Field Study and Data Acquisition

Field measurements were taken at each of the observation point identified using sound level meter for 5 minutes duration with max response on. The Sound level meter is held at a height of 1.5m above the ground level. The study area is studied for various traffic flows such as heavy flow and lean flow. The peak traffic flow durations are 7am to 11am and 4pm to 8pm. The lean traffic flow duration is 1pm to 3pm. The measured data for each point for different durations are then recorded for analysis.

V.DATA COLLECTION AND ANALYSIS

The noise levels of different area for different time durations could be analyzed easily using GIS platform. The GIS platform in this study was the ArcGIS desktop. Arc Map provides an easy transition from viewing a map to editing its spatial features. It also helps GIS database administrators maintain spatial and tabular GIS data for use by others in their organization. Arc Toolbox helps users to perform geo-processing operations such as data conversion, overlay processing, buffering, proximity analysis and map transformation. Each tool has a menu-driven interface with wizards or dialogs.

The common tools used in this study were -

- Inverse Distance Weighting (IDW)
- Kriging tool
- Natural neighbor tool.

A. Using IDW Tool

The noise levels in our study area are analysed using this tool for different time durations and the outputs are as follows,

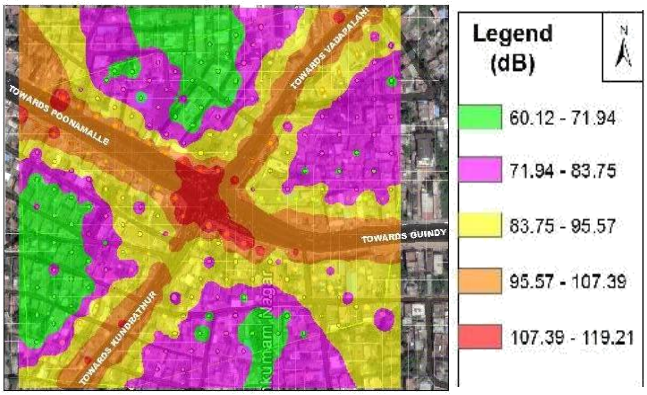

Fig 3. Noise Map for Porur Junction using IDW tool (7am - 11am)

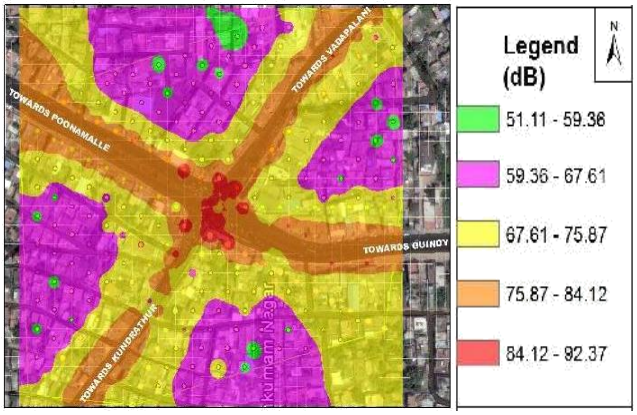

Fig 4. Noise map at Porur Junction using IDW tool (1pm - 3pm)

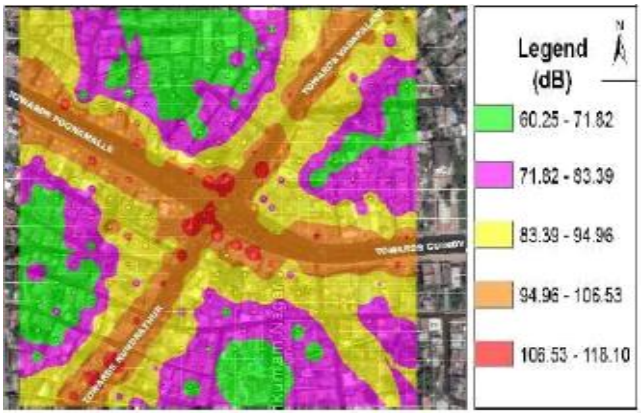

Fig 5. Noise map at Porur Junction using IDW tool (4pm - 8pm)

B. Using Kriging Tool

The outputs obtained using this tool for different time durations are as follows,

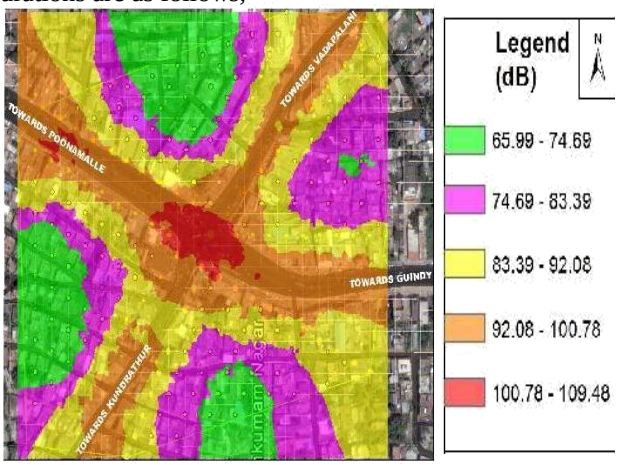

Fig 6. Noise map at Porur Junction using Kriging tool (7am - 11am)

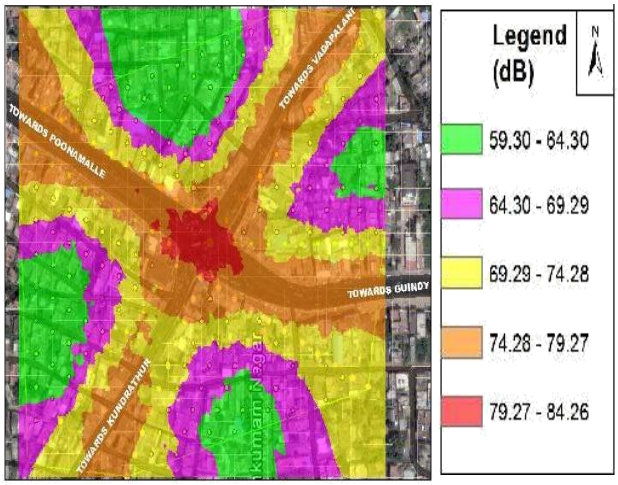

Fig 7. Noise map at Porur Junction using Kriging tool (1pm – 3pm)

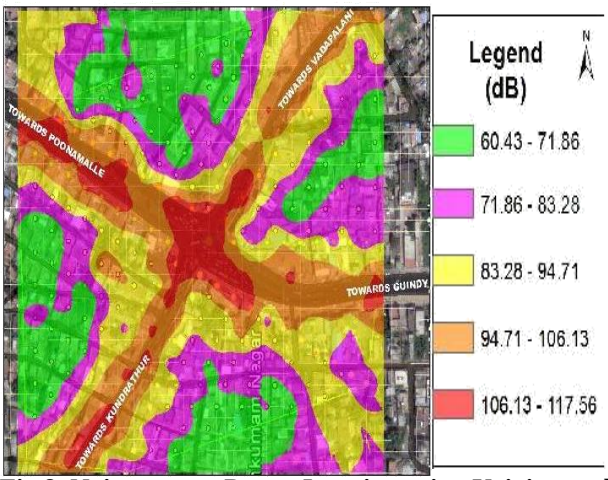

Fig 8. Noise map at Porur Junction using Kriging tool (4pm – 8pm)

C. Using Neighbor Tool

The outputs obtained using this tool for different time durations are as follows,

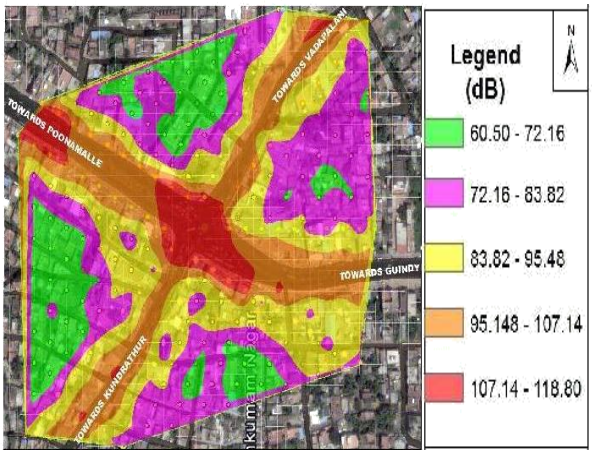

Fig 9. Noise map at Porur Junction using Neighbor tool (7am - 11am)

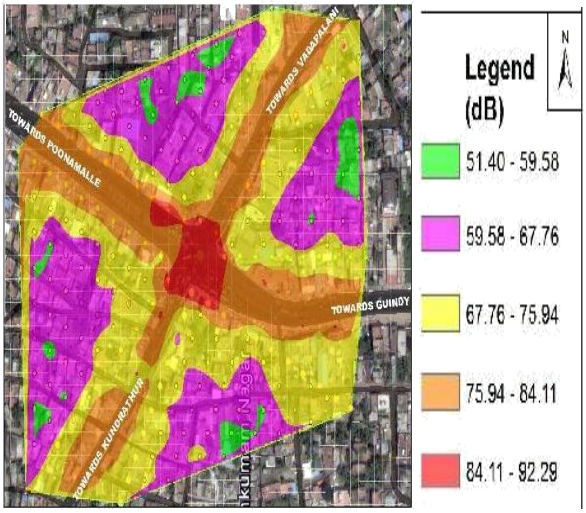

Fig 10. Noise map at Porur Junction using Neighbor tool (1pm – 3pm)

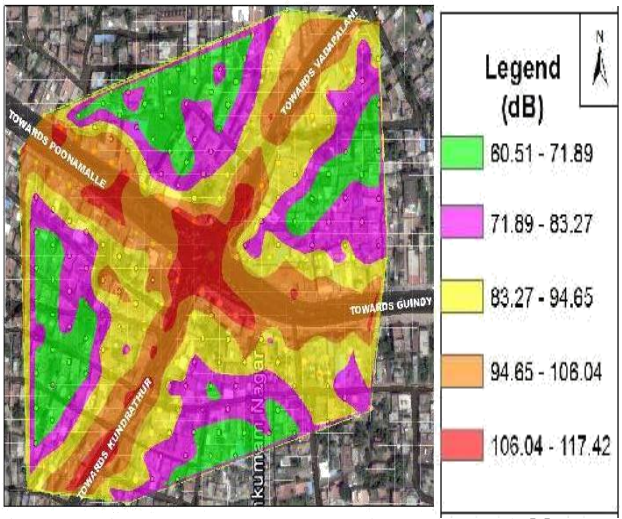

Fig 11. Noise map at Porur Junction using Neighbor tool (4pm – 8pm)

VI. RESULTS AND DISCUSSION

From the different outputs analyzed using Arc GIS, the most vulnerable zones in the Porur junction were identified.

The noise map prepared easily help to identify the maximum noise areas. Thought the high levels of noise recorded may not cause serious or immediate effects on population, the continuance of such noisy environment, could impact the population in several ways. From the noise maps prepared, it is clearly observed that the study area is normally affected by high noise levels which exceed the permissible limits provided by BIS. The areas which are exposed to very high noise levels are considered as the vulnerable zones.

VII. CONCLUSION

The results can be considered as not being acquainted with the environmental noise. However, it was demonstrated that this phenomena had some effects on the personal characteristics and nervousness of the individuals as social consequences; therefore, importance of noise controlling management should be taken into considerations.

From the observations made at the selected stations, it was found that the sound exceeds permissible limit of 55 dB for residential and 65dB for commercial area. On all selected locations, the maximum noise limits were ranging between 70 dB to 110 dB which was almost 1.5 times of the permissible limits for commercial zone. This excessive noise levels would have moderate to very severe effects on human health such as, poor concentrations, stress, cardiovascular illness and many more. It is very essential to control noise at source, along the transmission path and at receivers end by using the remedial measures.

Though the laws relating to noise pollution have been stringently made, the general awareness on hazardous effects of noise pollution is lacking. The creation such awareness itself could enhance the possibilities of minimization of noise levels.

REFERENCES

1. A.Hassan, J.B.Alam, (2013) Traffic Noise Levels at Different Locations in Dhaka City and Noise Modeling for Construction Equipment‘s, Dhaka, Bangladesh.
2. Wazir Alam, (2011) GIS based Assessment of Noise Pollution in Guwahati City of Assam, India.
3. F. Farca, A. Sivertun, (2012) Road Traffic Noise: GIS tools for Noise Mapping and a case study for Skane Region, Sweden.
4. R.Kalaiselvi, A.Ramachandraiah, (2010) Environmental noise mapping study for heterogeneous traffic conditions, Chennai, India.
5. Aaron Shiu-wai LUI, Chi-wing LAW, Maurice Kwok-leung YEUNG and Chee-kwan LEE, 2009, Road Traffic Noise Mapping in Hong Kong novel enhancement and development, Hong Kong.
6. Little, T. S. (1962), The measurement of hearing loss and the alleviation of deafness technical aspects of sound. (Vol- III), Amsterdam, New York.
7. R.K.Mishra, M. Parida, S. Rangnekar, 2010, ―Evaluation and analysis of traffic volume noise along has rapid transit system corridor‖ Int. Journal of Environ. Science Tech.
8. Rao, P.R., Noise Pollution and Control, 1995, Encyclopedia of Environmental Pollution and Control, Vol.-2, Environ media Publications, India.
9. Assessment and Control of Noise Pollution in Mining Industry, Proceedings of National Seminar held by Institution of Engineers at Madras, 1989.