Analysis of Traffic Noise Pollution in Thiruvananthapuram City using Mapping and Modelling

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***Abstract* — Acoustic noise beyond a level is harmful. The fact that a regulation to abate noise is in force should remove all doubts about the damaging aspect of noise pollution. The cities being the most polluted, the main thrust is towards estimating the level of pollution in the cities. Of all kinds of noise, traffic noise is known to contribute the maximum. Annoyance caused by noise is mostly dependent on socioeconomic factors. Therefore various noise control measures should be adopted for which a detailed study of the vehicle noise characteristics, its assessments and various other aspects are to be carried out. As traffic volume is increasing day by day, roads are becoming noisier. In this project, a detailed study was conducted to get the ambient noise levels in Thiruvananthapuram city. To increase the quality of noise effect studies GIS may be considered as an effective tool. GIS can enhance the accuracy and visualization of noise maps. Noise modelling is a tool that can be used to predict noise impacts and assess sound quality. By modelling we are able to know about the effect of noise among people and thereby able to take preventive measures to reduce the effect. When the number of variables involved are more the association between them can be easily found out by using Multiple linear regression model.**

Keywords — Traffic noise, noise map, noise model

I. INTRODUCTION

Noise pollution is excessive, displeasing human, animal or machine-created environmental noise that disrupts the activity or balance of human or animal life. Various problems associated with noise include hearing loss, stress, sleep loss, distraction, lost productivity, masking speeches and a general reduction in the quality of life and opportunities for tranquility. In addition, there are various studies carried out on road traffic noise pollution, which results in severe health problems such as, physical and psychological, irritation, human performance and actions, hypertension, heart problems, tiredness, headache and sore throat respectively. India being a developing country is under a constant threat of it. Migration of people, expanding cities, development of infrastructure, population explosion and urbanization are the factors which played a key role in motorization and thus, increasing the levels of various pollution.

Noise pollution, both in large and small urban areas is regarded as a growing problem of communities. There are various factors that contribute to increase of noise levels. One of the main factors is increasing urban population, which contributes to higher traffic volume and intensity[1].

TABLE 1. STANDARD NOISE LEVEL PRESCRIBED BY EPA AND CPCB [2]

Category of the area	**Day time 6.00 AM to 9.00 PM (Limits in dB(A)L_{eq})**	**Night time 9.00 PM to 6.00 AM (Limits in dB(A)L_{eq})**
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone area	50	40

In most urban areas, the corridors are developed in a close proximity to residential areas, due to limited space thus increase the number of high rise buildings. Numerous countries have implemented new technologies to control noise pollution in urban areas. The total urban population of India has increased considerably over the past three decades, rising from 109 million in 1971 to 160 million in 1981 and then 217 million in 1991 and 285 million in 2001 and 1.21 billion in 2011. Urban traffic noise is one of the most critical types of noise and normally considered more interfering than the other types of noises. The major cause of noise pollution is the sound coming from the horns and sirens of the vehicles continuously been activated day in and day out along the roads [1].

The traffic noise depends upon various factors such as condition and width of roads, nearby reflecting and absorbing surfaces, trees on the sides, the volume and structure of the traffic the attitude of the drivers and the horn sounding from each vehicles. Thus when we consider a community noise, it includes all the noises in the outdoor acoustical environment. The outdoor community noise environment varies in magnitude and character at various locations. This also varies with time of day. It is evident that more people are exposed to noise from motor vehicles than any other source of noise. The Central Pollution Control Board in accordance with the rules framed by the Government of India has prescribed “Ambient Noise Standards”, separately for areas provided for industries, residences, commercial activities and sensitive

purposes. Different sound levels for the above categories have been notified. So as a preliminary step it is required to assess the existing noise levels in each city for zoning purposes [2].

The vital objective of this study was to assess the ambient noise level in Thiruvananthapuram city. Using these ambient noise levels, it is possible to generate equations for prediction of noise levels in Thiruvananthapuram city. The noise mapping can be utilized for the future planning of the city in a systematic way. It is also determined whether the noise levels are so high as to cause hearing loss. The people living in the vicinity of traffic stations are mainly the victim of this noise pollution.

Noise modelling is a tool that can be used to predict noise impacts due to various traffic noise pollution. By modelling we are able to know about the effect of noise among people and thereby able to take preventive measures to reduce the effect. When the number of variables involved are more the association between them can be easily found out by using multiple linear regression models. The present study aims at understanding the effect of noise pollution in different zones of Thiruvananthapuram city and suggests some mitigation measures. In this study five variables such as Equivalent sound levels (Leq), No. of heavy vehicles, No. of light vehicles, No. of honking and Speed were considered as the factors affecting traffic noise pollution. Therefore multiple linear regression modelling was selected for finding the effect of noise with the help of SPSS 14. To increase the quality of noise effect studies GIS was considered as an effective tool. GIS can enhance the accuracy and visualisation of noise maps. Therefore selected ArcGIS 9.3 for quantification of noise in the study area and for analysis of its distribution within the city[3].

The work was mainly intended to assess the ambient noise levels for noise mapping of Thiruvananthapuram city, and also to generate an equation for different zones to predict noise levels, so that any modification on a traffic flow or any limitation for the honking can be adopted to minimize the noise levels. The pedestrians, the patients in the hospitals, school students and the overall community were the victims of this noise pollution. Thus this study has a social relevance. The safe permissible limits of noise, which will not create nuisance to the persons residing in different zones, have also been established.

II. METHODOLOY

A. *Regression relationship*

In this study number of heavy vehicles, light vehicles, Speed and no of honking were taken to develop a model. Great care was taken to record the number of honking as this has a vital role in increases of noise. The survey was carried for 12 hours in a day. The hourly vehicular density has been counted accurately.

To conduct detailed study on selected zones three sessions were selected, 7.00 am to 11.00 am, 11.00 am to 3.00 pm and 3.00 pm to 7.00 pm. The instrument using for the measurement is a impulse sound level meter, CR: 811 C model, UK. Readings can be taken at every 5 minutes and averaged to find out the hourly equivalent sound level. The sound level meter should keep at height of 1.2m above the ground level and far away from any reflecting objects. Readings should take at least 3m away from the edge of the road. Data were collected randomly in different zones of Thiruvananthapuram city and according to the concentration of noise pollution twelve stations were selected for this study.

TABLE 2. DIFFERENT STATIONS SELECTED FOR STUDY

Zones	Stations	Longitude	Latitude
Commercial Zone	Chala Market	76.952	8.481
	Palayam Market	76.951	8.503
	Manacadu Market	76.949	8.476
Residential Zone	Thampanoor Railway colony	76.957	8.489
	Government Quarters Melaranoor	76.966	8.485
	Housing Colony Peroorkkada	76.967	8.54
Sensitive Zone	Medical College	76.928	8.523
	Ayurveda College	76.947	8.491
	SMV school	76.948	8.487
Traffic Zone	Thampanoor	76.9519	8.486
	Kazhakuttam	76.938	8.529
	Kesavadasapuram	76.875	8.565

For statistical analysis the motor vehicles moving on the road has been divided into two categories: (1) The heavy vehicles which include Lorries, buses and trucks and (2) Light vehicles which include all other vehicles. Apart from these, honking, which can be hear from the monitory points were also taken in account to predict traffic noise models. Using the noise levels in different zones a noise map may decide to prepare using Arc GIS 9.3. From this, a visual information about various intensities of noise in various zones were obtained. Multiple linear regression have been accepted as a suitable technique in most of the traffic engineering problem [4]. The readily available statistical computer program SPSS is using for developing the statistical relationship among the following components.

- Equivalent sound levels (Leq)
- No of heavy vehicles
- No of light vehicles
- No of honking and
- Speed

B. *Noise map*

A Noise Map is a map of an area which is coloured according to the noise levels in the area. A noise map is a tool

that delivers visual information of the acoustic behaviour of a geographic area either in a specified moment or in a statistical base. They are considered as tools to improve or to preserve the quality of the environment regarding noise pollution, allowing a comprehensive look at the problem of multiple sources and receivers. It is also an excellent tool for urban planning. Noise map can be an attractive tool to be used in the environmental management system and noise abatement plant. In order to assess not only the noise levels, to which the population is exposed, but also to quantify the influence of architectonical aspects noise mapping can be done.

Constitution of noise maps has become compulsory to see the regions that are influenced from the noise, and to put forward the future environmental approaches [5].

Procedure

- Desired map of the Thiruvananthapuram corporation obtained by georeferencing and digitization.
- Monitoring stations located over the digitized map.
- Data stored in the attribute table.
- Inverse Distance Weighted Method used for assigning the Leq values at different sessions.
- Different colours assigned using classified and stretched options in layer properties.

The result of Arc GIS 9.3 software shown in figures. The noise map of different sessions shows Leq value of different stations and their intensity on each zones.

III. RESULT AND DISCUSSION

A. *Regression relationship*

The correlation between Leq and other factors viz. Heavy vehicles, light vehicles, Speed and honking were found out separately for Commercial zone, Residential zone, Sensitive zone and Traffie zone. They are shown in the following table III.

TABLE 3. REGRESSION RELATIONSHIP FOR DIFFERENT ZONES

Sl. No.	Zones	R^2
1	Commercial Zone	0.795
2	Residential Zone	0.796
3	Sensitive Zone	0.725
4	Traffic Zone	0.850

A general prediction equation obtained from model for the four categories of stations with respects to Leq, heavy vehicles (HV), light vehicles (LV), speed (S) and honking (HN) were given below.

1) Commercial Areas

$$Leq = -0.008\ (HV) + 0.001\ (LV) + 0.014\ (HN) + 0.116\ (S) + 72.464$$

2) Residential Areas

$$Leq = 0.051\ (HV) + 0.007\ (LV) + 0.002\ (HN) + 0.094\ (S) + 59.759$$

3) Sensitive Areas

$$Leq = 0.044\ (HV) + 0.001\ (LV) + 0.004\ (HN) - 0.047\ (S) + 75.513$$

4) Traffic Areas

$$Leq = 0.058\ (HV) + 0.008\ (LV) - 0.002\ (HN) - 0.181\ (S) + 66.893$$

Based on the data obtained the correlations, between various parameters such as Leq, heavy vehicles light vehicles, honking and speed has been found out. In almost all zones are correlations obtained were found to be good. The model developed has been found to be good in all cases, as they have satisfied chi-square test at high confidence level. Generally for 5% significance level was considered to be good in chi-square test [6]. The regression analysis for the parameter Leq, heavy vehicles, light vehicles, honking and speed have been done.. However there are some limitations. The behaviour of this model on stations having different gradients cannot be predicted as this test is conducted on level roads. Also noted that more noise pollution occurring on traffic zones at peak hour period. And the noise intensity is exceeds the prescribed limit in all zones.

B. *Noise map*

The result of Arc GIS 9.3 software shown in figures. The noise map of different sessions shows Leq value of different stations and their intensity on each zones.

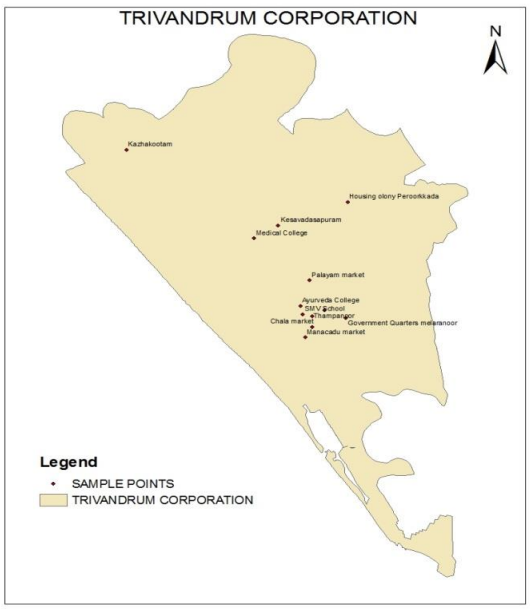

Fig. 1. Base map of Study area

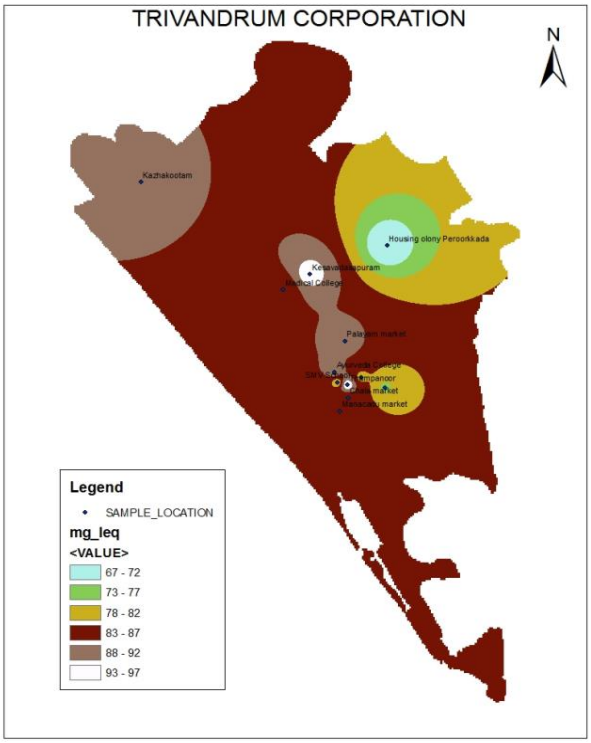

Figure. 2. Spatial distribution of traffic noise in the morning session

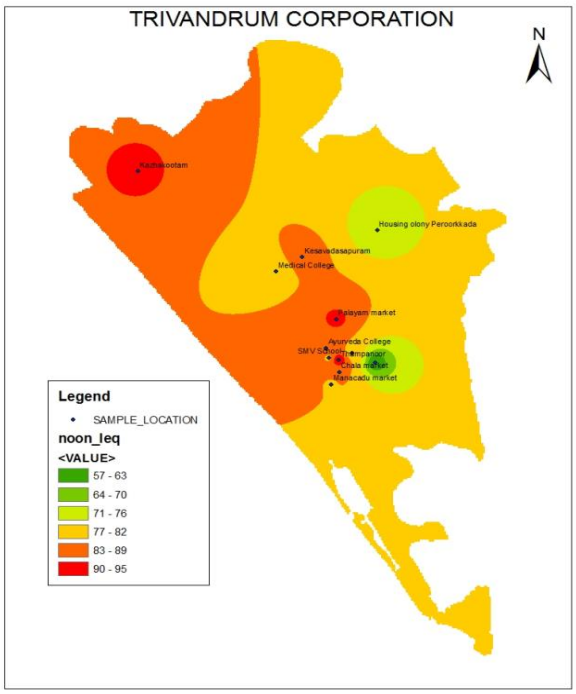

Fig. 3. Spatial distribution of traffic noise in the noon session

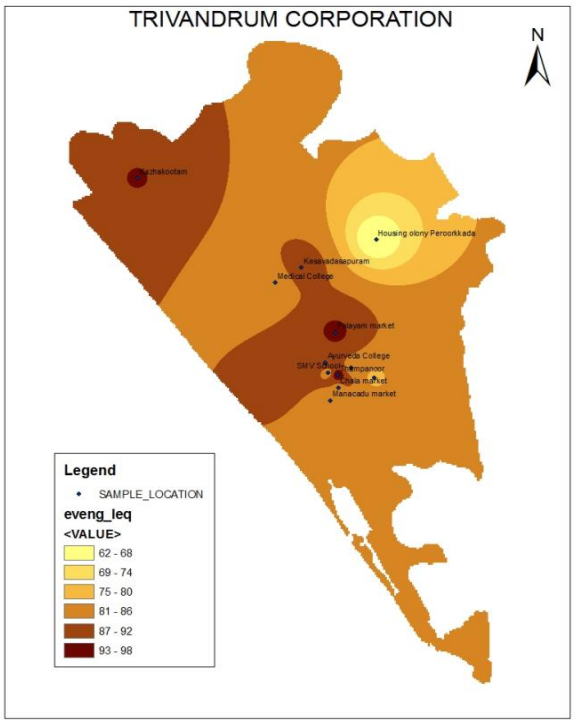

Fig. 4. Spatial distribution of traffic noise in the evening session

From the result of noise map we get a visual information about various intensities of noise in various zones in selected city. Noise maps were prepared based on the maximum Leq value of sound level in various sessions. From that it was observed that, the maximum noise pollution occurring on evening sessions also it is more in traffic zones compared to other zones. So both modeling and mapping shows same results.

IV. SUMMARY AND CONCLUSION

- In this study an attempt was made to study the noise pollution in various zones viz. Commercial zone, Residential zone, sensitive zone and Traffic zone thereby to find out ambient noise level in Thiruvananthapuram city. For the study three stations were selected under each of the above category.
- From the study conducted it has been found that in all zones, the sound levels were exceeded the limit prescribed by the Govt. of India. It was noted that maximum traffic noise level (Leq) during the peak hours was near or beyond the tolerable limits 85 dB(A). A maximum of 98 dB(A) were recorded at Thampanoor. The adverse effect was found to be more on street vendors and shop keepers.
- In commercial zone it was observed that Palayam market shows high noise pollution level at peak hours than Chala market. In the case of residential zone, noise pollution is high in Thampanoor Railway colony. Since this area is also affected by rail traffic noise.
- In sensitive zone, the noise level very much high than the prescribed limits. So proper care should take for its remediation.

- A trend equation has been obtained for prediction of sound levels in different zones.
- From noise map it is observed that noise intensities are high in traffic zones in evening sessions, and also sound levels in all zones are exceed the permissible limits.

Limitations and Scope of Further Study

- The model was built without taking the effect of gradient and nature of road surface. Thus this model may give erroneous results if applied to stations were gradient is different.
- The study can be extended to other stations also in Thiruvananthapuram city thereby can prepare a detailed noise level contour map.
- This model can be used to find out ambient noise level in Thiruvananthapuram city only.

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