

Noise Mapping of Nashik City using Q-GIS

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Abstract—Noise is becoming one of the major issues now a days in Nashik city. Noise pollution refers to sounds in the environment that are caused by humans and that threaten the health or welfare of human or animal inhabitants. Environmental noise pollution continues to pose a significant threat to human health and the quality of life for millions of people worldwide. The broad aim of the present work is driven by the desire to look into the impact of noise pollution on environment. noise pollution range at different locations in Nashik rural area was measured. The impact of noise pollution was analyzed. Noise mapping was done using the QGIS-computer-based software. Spatial plans were prepared so that the trend of the noise pollution can be assessed for future development plans. In the initial phase, data collection was done which included study of population density, market places, religious places, road networks, collection of maps etc. Reconnaissance survey was conducted and proper spots were chosen based on the collected data. Later on, the data was processed into the QGIS to obtain the noise maps. The noise maps of morning and evening were produced that showed the noise level intensities of morning and evening peak hours at all selected locations. Through the noise maps, it was easy to identify the noise hotspots. Noise hotspots indicated the locations having noise level exceeding 84.56 dB. These maps were useful in future city planning and road expansion planning.

Index Terms— Environmental noise pollution, Q-GIS, noise map, Nashik city, Noise hotspot.

I. INTRODUCTION

Nashik, a city situated in the northern part of Maharashtra. The district has great mythological background. It has been declared one of the fastest developing cities of India. Due to this many people are migrating towards Nashik. This ultimately affects the population density of the city. People are in search of better life style and hence utilize various resources leading to pollution. Noise is defined as sound that is unwanted in nature. Sound is produced as result of some mechanical disturbance creating pressure variations in an environment such as air or water, or in fact any elastic medium which can transmit a pressure wave. The magnitude of the pressure variations (The amplitude of the pressure oscillation) is proportional to the loudness of the sound. Noise is measured in decibel unit 'dB', and any sound greater than 50-55 dB can be considered as noise.[1] In our modern, rapidly expanding environment one of the developing problems is that of noise. This particular problem is becoming a source of serious concern to industrial corporations, trades. Noise has been recognized as one of

the unwanted by products of the industrialized society along with air, water and other pollutants. Noise pollution is persisting unwanted sound in environment. Any noise beyond a certain limit causes noise pollution and can have severe effects on human as well as environment. The effects could be auditory that may cause temporary or permanent hearing impairment. Some other harmful effects could be non-auditory in nature such as, sleep and communication disorders nuisance and subsequent stress, increased blood pressure and dyslipidemia, increased blood viscosity and blood sugar, cardiovascular diseases. Pollution of noise affects the behaviour and physiology of birds, reduced foraging efficiency in most bats and most small animals are prone to increased heart rate and thus leading to increase in death. [11] Broadly classifying sources of noise can be industrial, community and traffic noise. Out of which, the source that affects the most is traffic noise. In traffic noise, almost 70% of noise is contributing by vehicle noise. Traffic noise is the sum of the total noise produced at the observer point by all the moving vehicles on the roads. Thus, the fundamental component is the noise produced by the individual vehicles, which depend on the vehicle type and its mode of operation. Traffic consists of a large collection of vehicles of different types, makes and models. The relative proportion (mix) of which depends on the type of highway and the time of day, among other factors. In the assessment of highway noise by calculation it is convenient to assume that there are two main categories of vehicles. They are automobiles and heavy load vehicles like trucks.[2]

Nashik, the city of pilgrimage, has been under the process of urbanization for around more than 50 years. It is one of the fastest developing cities in the country. People living in the nearby districts have been migrating towards the Nashik city in seek of work opportunities and better career prospects. The broad aim of the present work is driven by the desire to look into the impact of noise pollution on environment. To measure the noise pollution range at different locations in Nashik urban area and analyse the impact of noise pollution. The study includes measuring the noise pollution range at different locations in Nashik urban area and analyse the impact of noise pollution and comparing the noise levels with the permissible limits specified by CPCB.[3] A noise map is a map showing colour gradient to a particular area according to the noise levels measured at specified location. Sometimes, the noise levels may be shown by contour lines which show the boundaries between different noise levels in an area. The noise levels over an area may be varying all the time. Noise mapping is a technique of preparing or making a noise map. A sound level meter 'SLM' is used for measuring the intensity of sound. SLM includes a microphone, amplifier, rectifier, smoothing circuit and a display. A microphone generates a voltage that is proportional to the sound pressure at the microphone and is the electrical analog of sound waves impinging on the microphone's diaphragm. The particular mechanism that converts the pressure variation into sound waves signal and the amplifier amplifies the signal from microphone sufficiently to permit measurement of low SPL. It amplifies sound over a wide frequency range. It maintains the amplification constant.

A cross-platform desktop geographic information system (GIS) programme that provides viewing, editing, and analysis of geographical data is called QGIS (formerly known as Quantum GIS). Geographic information system (GIS) software such as QGIS enables users to create, edit, and export graphical maps as well as analyse and modify spatial data.[7] Any GPS device may be used to display the precise coordinates of the site chosen for the study. The next investigation made use of GARMIN GPS.

II. MATERIAL METHODOLOGY

For traffic noise problems it is useful to know the equivalent sound level. Such information is obtained using sound level meter. Initially the Nashik city was divided into number of spots as mentioned in site selection. On these spots the work was divided as:

- Determining the co-ordinates (latitude and longitude) and elevation of each selected spot.
- Traffic study of each spot.
- Sound level measurement on each spot.

A. Data collection

Reconnaissance survey will be conducted and proper spots are to be chosen based on the collected data. Subsequently, different spots to be surveyed will be chosen on the basis of population intensity, traffic intensity, public utilities, etc. The selected spots will be thoroughly studied and the latitudes and longitudes of these spots will be computed using Garmin instrument (which gives exact GPS location of any point on the earth surface). After processing the data into Q-GIS, a noise map will be prepared that will give locations of noise hotspots. Determining the co-ordinates (latitude and longitude) and elevation of each selected spot. On each spot latitude and longitude were determined using GARMIN (eTrex) H instrument, also the elevation of each spot was determined using the same instrument.

B. Data analysis and interpretation

Traffic study at each spot. On the selected spots traffic study was done by classifying the vehicles as 2 Wheelers, 3 Wheelers, 4 Wheelers, and Heavy-duty vehicles. The traffic coming towards the points were marked on the books according to the classification. The marking of vehicles was done for a time period of 5 minutes on each spot. The traffic study on each spot was done in the peak hours in the morning (9 a.m. to 11 a.m.) and peak hours in the evening (5 p.m. to 7 p.m.). Sound level measurement on each spot. On these selected spots along with the traffic study sound levels were determined for every 1minute interval for 5 minutes such that readings of sound obtained was 5 readings in the morning and 5 readings in the evening. The instrument used for the measurement of sound was Sound Level Meter.

C. Noise mapping

After all the data is collected and sound levels are measured, the raw data is being arranged in the excel sheet. Further the data is processed in Q-GIS. A Geographic Information System (GIS) is a tool for collecting, managing, storing, analyzing, and displaying spatial or geographic data. The term geographic information science (GI Science), a significant subfield of the larger academic field of geoinformatics, is occasionally used to refer to the academic discipline that studies geographic information systems. To prepare a noise map in Q-GIS, the below mentioned procedure was to be followed. The very first step was of data compilation. Initially all the data of various locations under study along with their respective sound levels measured were compiled in tabular form. This was done using MS-Excel. Ten readings are obtained at each spot, out of which five were obtained in the morning and five in the evening. Also, the co-ordinates of all the spots were entered in it. To make the data workable in the software, the average of all the readings were taken. Once the data is compiled in the form of excel file, vector layer needs to be added in Q-GIS. This step is necessary for locating the spots in the software as points. For this, the tool of layer in the tool box was being used. The procedure was layer >add layer >add delimited layer. Open the excel file prepared initially to add the layer and add the geometry definition in the X-field as 'longitude' and Y- field as 'latitude'. Thus, the spots were obtained on the screen as point data. The co-ordinate reference system used for this was 'WGS 84'. After adding the layer, suitable plugin shall be installed to get the sound level intensities on the map. For this purpose, the plugin named 'interpolation' was installed. It is a plugin for interpolation based on vertices of a vector layer. The procedure was plugins>manage/install plugin>interpolation plugin> install. Next step is to interpolating the sound levels. The raster tool was used for this purpose. The procedure was raster>interpolation. In this the file was selected and the interpolation attributes were mentioned as morning and evening. The method of interpolation used was inverse distance weighting (IDW). The cell size selected was 0.00005. After giving the input, the values of sound levels get interpolated. This generates a map showing variation in the sound levels of range less than 81.78 dB to greater than 84.56 at different locations under consideration. Once the map is generated, the other details such as legends, scale, north direction, grids, etc. were inserted using the command of 'new print composer'. By following the above procedure, a noise map with different colour gradient will be generated by using the interpolation technique, at the locations we examined. Of the two obtainable map types; Linear and Discrete, we chose the "Discrete" type as the noise levels were easily and distinctly readable from the available legend.

D. Study Area

The city selected for the purpose of finding out noise pollution was Nashik. The coordinates of Nashik are 19.9975° N, 73.7898° E as shown in figure 1. Nashik, the city of pilgrimage, has been under the process of urbanization for around more than 50 years. It is one of the fastest developing cities in the country. People living in the nearby Talukas have been migrating towards the Nashik city in seek of work opportunities and better career prospects. Hence, Nashik has become the third fastest developing city after Mumbai and Pune, which will eventually contribute in the traffic congestion in the city. Being a student studying in such a city it wouldn't be a better opportunity for us to select this location for our project and study work. Taking into consideration, all the above discussed problem, it could be concluded that noise has affected the people of the city. The spots selected for measuring the noise levels were selected on the basis of by considering factors such as traffic, population and nature of noise problem, critical spots in residential, commercial, industrial and social importance. The boundary of Nashik city and the core areas of city were selected as the study area. NH-3 passes along the boundary of city and carries maximum traffic causing pollution of noise. The region near Bombay Naka accommodates many hospitals, which shall not be much affected by the disturbing noise or traffic. The Satpur MIDC region is affected not only by the traffic noise but also by the noise caused by industrial activities. The old city area has huge market area, this leads to traffic.

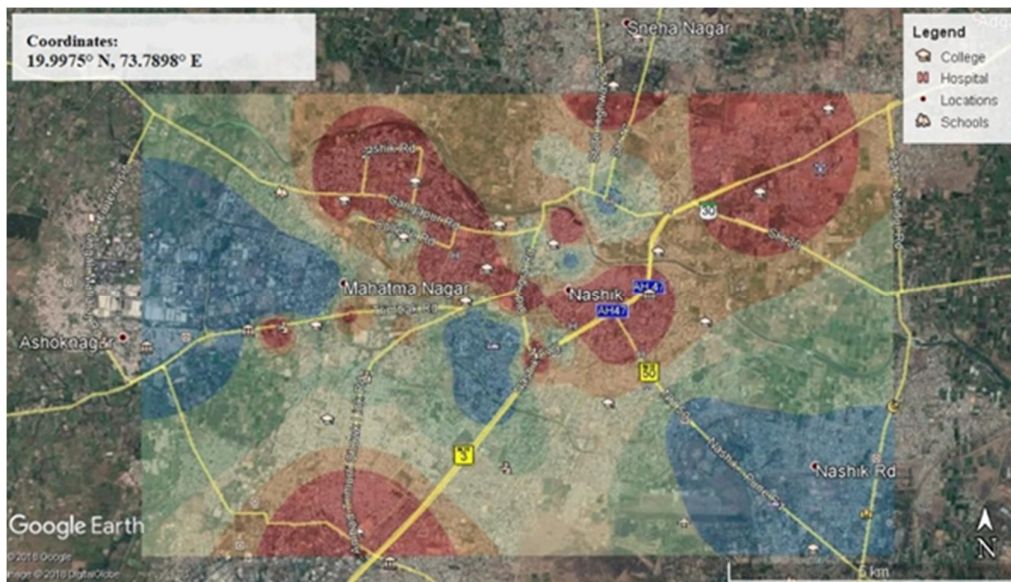


Figure No.1: Map of Nashik city: Study Area

III. RESULTS AND DISCUSSION

The maps were obtained that showed colour gradient indicating the different sound levels at different places as shown in the figure below. Two maps, one showing morning noise levels and the other showing the evening peak hours noise levels were obtained, as mentioned in figure 2 and 3 respectively. By studying and analysing the maps, it could be concluded that that, during the morning time areas such as Lekha nagar, Mahindra circle and the area near City centre mall, Untawadi are always suffering from high level noise intensity, regardless of the time of day. Since Lekha Nagar lies on the national highway and is the first point from highway to enter into the Nashik City, Huge amount of traffic as well as noise is observed during the morning hours, and the noise level fades down as the traffic settles. At the City centre mall signal heavy and dense traffic is observed during morning hours than the evening hours, as people move to work, and since one of the 4 roads at the signal has been put to place very recently, and people find it an efficient road to commute, contributing to early morning traffic as well as noise. As the City centre mall is a public place the noise level is expected to sustain almost throughout the day, and from the map it can be observed that the noise level fades down by a bit but not as much. If proper zoning is done for Nashik city, then it could be assured that residential areas will have noise in limits.

The Sakal Circle on Trimbak road which is pretty wide, traffic moves quite smoothly during the morning hours, the average noise levels experienced are pretty low. But during the evening the change is pretty visible on the noise spectrum: Blue to Red, as that area sees a lot of movement of people coming from Satpur Industries, and nearby areas are where people can Socialize, like Sweet Shops and Cafes etc. One of the reasons why we have a signal in place of the Jehan Circle now because the circle wasn't able to house the traffic levels it saw, especially during the evening times; when moving around that place can get pretty time consuming. The traffic signals are now in place to avoid any accidents and fatal hazards that may result from it, but the noise levels are unavoidable though. Similar pattern is observed at the ABB Circle; i.e., previously a circle as the name says, but the name got so predominant to that place that even in the absence of the circle is still called that and would be called that for years to come.

Because of similar reasons for Jehan Circle, ABB Circle behaves similarly; very low noise and fast-moving traffic during morning hours, which gets pretty noisy during the evening times. The Bombay Naka Circle (now the Mylan Circle) is one of the most important junctions of the Nashik City. The area nearby also houses some important hospitals like the Shatabdi Hospital and the Curie Manavata Cancer Centre. The HCG Cancer centre is nicely placed so that it is in the silence most of the time. The Mumbai Naka Circle because of the recent development of the circle, we can say that because of it the morning noise levels are low than what you might expect from a main junction of the city: all Red. That is a job well done, but more is expected as nearby area houses hospitals. The Satpur areas are always mostly seen in the blue patch as per our observations. Both on weekdays and weekends; there's hardly traffic observed and the industrial noise if any didn't have much impact

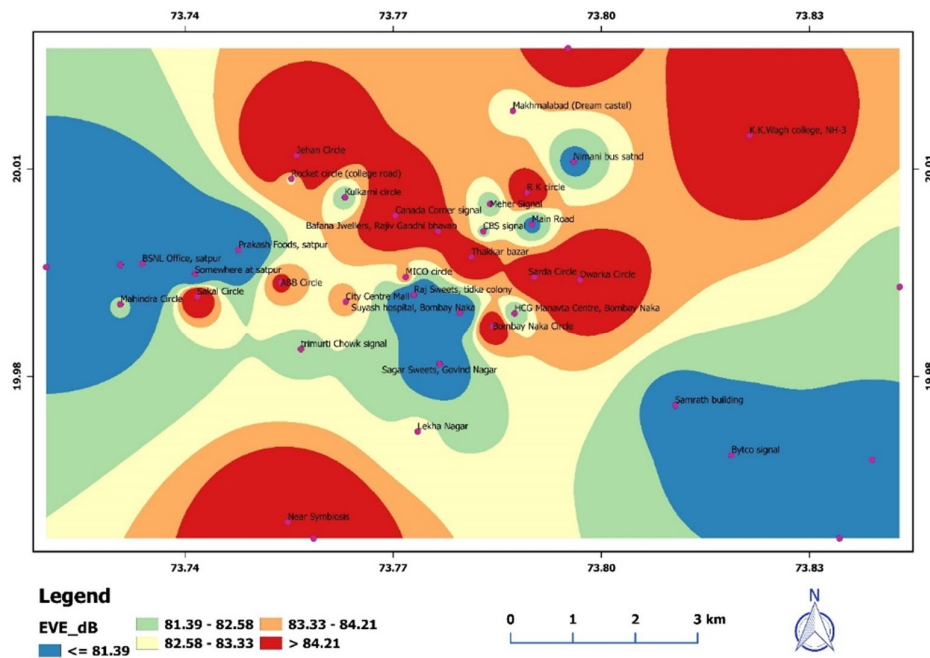


Figure No.3: Noise map of Evening

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REFERENCES

- [1] Enock Abe Wawa and Galcano Canny Malaku, Noise Pollution mapping using GIS in Nairobi, Kenya; 2015.
- [2] Karthik K, Prasad Raju; Development of Noise prediction models using GIS for Chennai city; vol 5; issue 10;oct' 2015.
- [3] Wazir Alam; GIS based Assessment of Noise Pollution in Guwahati City of Assam, India; Volume 2, No 2;2011.
- [4] Dermot Geraghty, Margaret O'Mahony; Investigating the temporal variability of noise in an urban environment; Received 3 April 2015; accepted 18 January 2016.
- [5] Ali Asghar Alesheikh and Manouchehr Omidvari; Application of GIS in Urban Traffic Noise Pollution; Application of GIS in Urban Traffic Noise Pollution; 79-84, 2010.
- [6] 10th International Scientific Conference Transbaltica 2017 by Aleksandras Jagniatinskisa, Boris Fiksa.
- [7] Amudapuram Mohan Rao, S. Velmurugan, Arpita Chakraborty ; Kalaga Ramachandra Rao and Mohan Rao (2009) "Application of GPS for Traffic studies" in Journal of Urban Transport Volume-8 No.1.
- [8] Anca-Maria MOSCOVICI, Oana GRECEA; AgroLife Scientific Journal - Volume 4, Number 2, 2015.
- [9] F. Farcas, A. Sivertun; Road traffic Noise: GIS Tools for Noise Mapping and a case Study for Skane Region.
- [10] Jigan Patel, Mitali Shah; State of the Art Review on Road Traffic Noise Mapping using GIS; International Journal for Scientific Research & Development, Vol.2, Issue 12, 2015.
- [11] Comprehensive Evaluation of Traffic Noise Pollution; School of Engineering Sun Yat-sen University, Guangdong Provincial Key Laboratory of Intelligent Transportation System; 13th COTA International Conference of Transportation Professionals (CICTP 2013).
- [12] Musbah Aissa Mohamed; A Study of noise pollution and impact on human health.
- [13] Hsu, T., Ryherd, E., Wage, K., Ackerman, J., and Noise Pollution in Hospitals: Impact to patients, Clinical Review.
- [14] Firdaus, G., Ahmad, A., Noise Pollution and Human Health: A Case Study of Municipal Corporation of Delhi, Indoor and Built Environment, Sage Publications (2010).

- [15] Goines, L., Hagler, L., Noise Pollution: A Modern Plague: Southern Medical Journal 2007, 100(3): 287-294
- [16] Berglund B, Lindvall T. (eds.) Community Noise. Archives of the Centre for Sensory Research. 1995; 2:1-195; published by the World Health Organization in 1995, (January 6, 2007).
- [17] W J P Casas, E P Cordeiro, T C Mello and P H T Zamin; Noise mapping as a tool for controlling industrial noise pollution.
- [18] De Kluijver, Henk, and Jantien Stoter. "Noise mapping and GIS: optimising quality and efficiency of noise effect studies." Computers, environment and urban systems 27.1 (2003): 85-102.
- [19] Murphy, Enda, and Eoin A. King. Environmental noise pollution: Noise mapping, public health, and policy. Elsevier, 2022.
- [20] Suárez, Enrique, and J. L. Barros. "Traffic noise mapping of the city of Santiago de Chile." Science of the total environment 466 (2014): 539-546.