ANALYSIS OF NOISE POLLUTION USING GIS IN TRICHY DISTRICT

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Abstract - *In developing country like India with the vehicle population increasing at a rapid rate, the residents of cities are experiencing severe environmental problems that results from road traffic in particular from automobiles. Fast growing vehicle population in town in the recent years, has resulted in considerable increase in traffic on roads causing alarming noise pollution. The spatial analysis and geo statistical methods of GIS can play an important role to control noise pollution. This paper describes a study that aimed at measuring the noise levels at selected points in Trichy district to generate a noise map over the study area.*

***Key Words**: Environmental Problems, Road Traffic, Automobiles, Trichy, Pollution, Noise Map, Road Traffic …*

1. INTRODUCTION

In developing country like India with the vehicle population increasing at a rapid rate, the residents of cities are experiencing severe environmental problems that results from road traffic in particular from automobiles. Fast growing vehicle population in town in the recent years, has resulted in considerable increase in traffic on roads causing alarming noise pollution. The spatial analysis and geo statistical methods of GIS can play an important role to control noise pollution. This paper describes a study that aimed at measuring the noise levels at selected points in Trichy district to generate a noise map over the study area.

1.1 About Noise Pollution

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. Management of environmental pollution is a challenge. Although there are many management techniques, the problem of environmental pollution still remains the same. One of the serious issues of environmental pollution is noise. Noise pollution in large urban areas is regarded as a growing problem of communities.

Currently, noise pollution in urban environment is one of the serious issues of concern in major cities of world. There are various factors that contribute to increase of noise levels in urban areas. One of the factors is the increase in urban population, which contributes to high traffic volume combined with increased intensity.

1.2 GIS for Noise Mapping

GIS provides the central database management environment and noise data can be imported into a GIS. The phenomena of noise involve spatial distribution and dynamic process that fits into GIS environment. New mapping approaches supported by a GIS can be combined with spatial data analysis and mathematical modelling 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. GIS provides good visualization tools of noise propagation and assist in building a spatial decision support system that can be used for decision making 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. Mapping noise within GIS was started in mid90s.

1.3 Objective

The objectives of the present study are as follows,

- To assess and compare the noise levels in Trichy city with respect to prescribed noise limits mentioned in CPCB, India
- To analyze the impact of traffic volume on noise pollution
- To evaluate the noise levels at different day timings (lean and peak hours) and night timings.

2. LITERATURE REVIEW

MAYA M S et al., (2015) 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.

NAVEEN GARG et al., (2017) proposed a standard methodology to delineate groundwater potential zones using integrated RS, GIS and multi-criteria decision making (MCDM) techniques. The methodology is demonstrated by a case study in Udaipur district of Rajasthan, western India. Initially, ten thematic layers have been considered. Weights of the thematic layers and their features then normalized by using AHP (analytic hierarchy process) MCDM technique and eigenvector method. Finally, the selected thematic maps were integrated by weighted linear combination method in a GIS environment to generate a groundwater potential map.

NIGERIA et al., (2019) A detailed method used for assessing and mapping noise pollution levels in Ota metropolis, Nigeria using ArcGIS 10.5 Software is presented in this paper. Noise readings were measured at a time interval of 30 min for each site considered using a precision grade sound level meter. The noise map developed was based on the computed values of average equivalent noise (LAeq) for the selected locations. Results of this study show that the A weighted sound level (LAeq), the background noise level (L10) and the peak noise level (L90) vary with location and period of the day due to traffic characteristics especially traffic volume, vehicle horns, vehicle mounted speakers, and un muffled vehicles at road Junctions, major roads, motor parks and commercial centers. Based on the U.S.

JINBO ZUO et al., (2019) Noise mapping is an effective method of visualizing and accessing noise pollution. In this paper, a noise-mapping method based on smartphones to effectively and easily measure environmental noise is proposed. By using this method, a noise map of an entire area can be created using limited measurement data. To achieve the measurement with certain precision, a set of methods was designed to calibrate the smart phones. Measuring noise with mobile phones is different from the traditional static observations. The users may be moving at any time. Therefore, a method of attaching an additional microphone with a windscreen is proposed to reduce the wind effect.

3. METHODOLOGY

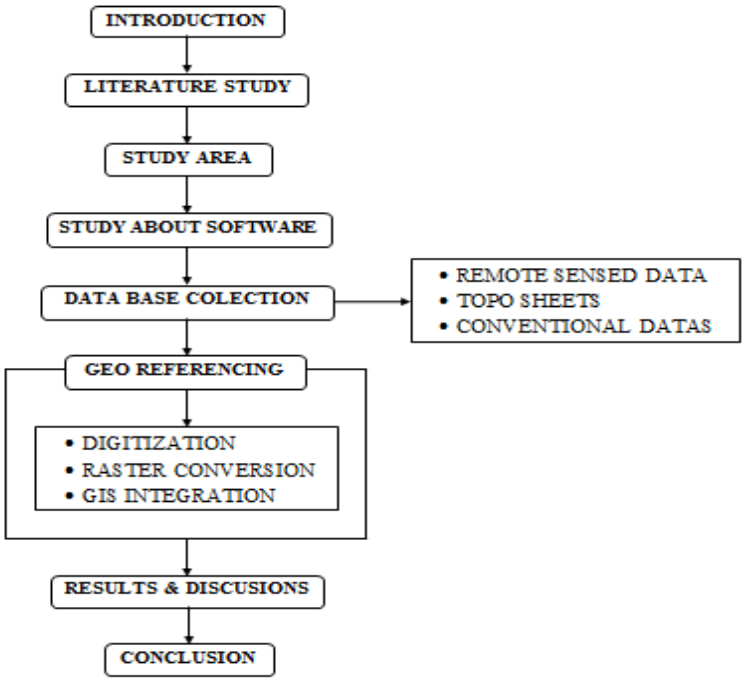

Fig -1: Methodology

4. STUDY AREA

Tiruchirappalli District is located centrally in Tamil Nadu. Major public sector companies like BHEL, HAPP, OFT and Railway workshop function here. The district is renowned for fabrication industry, Gem Cutting, Korai Mat Weaving and Readymade Garments. The district was formed in 1995 by trifurcating the composite Tiruchirappalli district as Tiruchirappalli, Karur and Perambalur districts with an area of 4403.83 Sq.Kms with Thanjavur District in the East, Karur District in the West, Permabalur District in the North, Pudukkottai and Dindigul Districts in the South as boundaries. The total net sown area in the district is 206578 hectares of land. The district is mainly irrigated by the Kaveri River. Major crops grown in the district are rice, sugarcane, Banana, Coconut, Cotton, Corn and Groundnut. IIM Trichy is the 11th IIM in the country. The institute offers 4 management programmes. These programmes contain a well-designed course curriculum with a global perspective. Tiruchirappalli Junction railway station is a junction station in Tiruchirappalli, Tamil Nadu. It serves as the headquarters for Tiruchirappalli railway division of the Southern Railway Zone. The total route length of the division is 1026 km with 842(BG) and 184(MG). Five rail lines branch separately from Trichy junction.

4.1LOCATION AND GEOGRAPHICAL AREA

The district has an area of 4509 sq.km. It is bound by Perambalur district on the north, Thanjavur district on the east, Pudukkottai and Dindigul districts on the south and Karur district on the west. Being a place located centrally in the State, it has excellent transport link to all other districts in the State. The district lies between 11" 00' and 12" 00' degrees of the northern latitude and between 77" 28' and 78" 50' degrees of the eastern longitude.

4.2 TOPOGRAPHY

The district has a mean temperature with low humidity. The hottest period is from April to June. Temperature of the district varies from 19.7 Degree Centigrade to 39.4 Degree Centigrade. 4 The River Cauvery irrigates about 51,000 Ha. In Trichy, Lalgudi and Musiri Divisions. The normal annual rainfall is 842.60 mm. Multi various crops are grown in this District and Agriculture is the main occupation for most of the people in the District. Alluvial sandy loam and loam soil constitutes major portion of the central regions, which form the Cauvery delta in the district. In Lalgudi, Manachanallur and Andanallur blocks, loamy soil is predominant. Red soil and black soil are predominant in the dry tracks of the district.

4.3 CLIMATE

The district in general experiences a tropical climate with minor changes. The temperature at selected stations in the 2004 - 2005 reveals that the normal temperature varies between 34.6° C and 40.5° C at means maximum and between 22.4° C and 28.1° C at mean minimum. The district experiences the hottest climate from March to May with mercury reaching 40.5° C at the highest. The climate is comparatively cool during the months from November to February.

4.4 INFRASTRUCTURE FACILITIES

Tiruchirappalli district has sound banking and infrastructure facilities.

4.4.1 TRANSPORT

The district has a well-built transport network. The development of various modes of transport is a sine-quo-non-for district economic development. Roadways, Airways are the blood veins of the district. The district is cormected to all the parts of the country through National Highways, State Highways and Major Roads. The length of roads in Tiruchirappalli District is about 826.85 Ion. A large number of lorry booking offices and parcel services are concentrated in Tiruchirappalli district for goods transportation. In the railway map the district of Tiruchirappalli finds a prominent place. The Railway Junction is situated at the central part of the city. It is served by broad gauge and meter gauge in connecting various centres of India. Tiruchirappalli district has a category III internal Airport.

4.4.2 PLACES OF IMPORTANCE

Elakurichi (65 km): Elakurichi is famous for the ancient church built by the famous Catholic Missionary Constantine Joseph Beschi, popularly known as Veeramamunivar. Gunaseelam (22 km): This place is famous for its temple of Lord Vishnu, known as Prasanna Ventateswarar. Kodumbalur (42 km): Also known as, Moovarkoil (36km from Pudukkottai). Of the three shrines only two exist Kodumbalur (42 km) Also known as, Moovarkoil (36km from Pudukkottai). Of the three shrines only two exist now. These temples were built by Boodhi Vikramakesari in the 10th century A.D. with sculptures of Kalarimurthi, Gajasamharamurthi, Ardhanariswara, and Gangadaramuthi, etc., which are masterpieces of art. Vayaloor (8 km): It is located on

the outskirts of Tiruchirappalli. There is a small Lord Muruga temple set in the midst of lush green vegetation. Samayapuram (20 km): This is a very important place of pilgrimage, famous for its temple dedicated to the goddess Mariamman. Grand Anaikat-Kallanai (24 km): The grand Anaicut built by Karikalan Chola in the 2nd century A.D. to harness the waters of the Cauvery is one of the engineering marvels of India. Made of stone, the dam is 329 m long, 20 m wide, and still very much in use. Additions have been made in the form of a road bridge on top of the dam. This is also a picnic spot. Mukkombu (Upper Anaicut - 18 km) : At the head of the Srirangam Island, there is another dam called Upper Anaicut or Mukkombu. Constructed in the 19th century across the KoUidam, this dam forms three streams instead of one long stretch because of the shape of the island. This is also a picnic spot. Kolli Hills (90 km):

5. SOUNDS AND NOISE

Physically, there is no distinction between sound and noise: sound is a sensory perception evoked by physiological processes in the auditory brain. The complex patterns of sound waves are perceptually classified as "Gestalts" and are labelled as noise, music, speech, etc. Consequently, it is not possible to define noise exclusively on the basis of the physical parameters of sound. Instead, it is common practice to define noise simply as unwanted sound. However, in some situations noise may adversely affect health in the form of acoustical energy.

5.1 Sources of Noise

This section describes various sources of noise that can affect a community. Namely, noise from industry, transportation, and from residential and leisure areas.

5.1.1 Industrial Noise

Mechanized industry creates serious noise problems. It is responsible for intense noise indoors as well as outdoors. This noise is due to machinery of all kinds and often increases with the power of the machines. Sound generation mechanisms of machinery are reasonably well understood. The noise may contain predominantly low or high frequencies, tonal components, be impulsive or have unpleasant and disruptive temporal sound patterns. Rotating and reciprocating machines generate sound that includes tonal components; and air-moving equipment tends also to generate noise with a wide frequency range. The high sound pressure levels are caused by components or gas flows that move at high speed (for example, fans, steam pressure relief valves), or by operations involving mechanical impacts (for example, stamping, riveting, road breaking). Machinery should preferably be silenced at the source.

5.1.2 Transportation Noise

Transportation noise is the main source of environmental noise pollution, including road traffic, rail traffic and air traffic. As a general rule, larger and heavier vehicles emit more noise than smaller and lighter vehicles. Exceptions would include: helicopters and 2- and 3-wheeled road vehicles.

The noise of road vehicles is mainly generated from the engine and from frictional contact between the vehicle and the ground and air. In general, road-contact noise exceeds engine noise at speeds higher than 60 km/h. The physical principle responsible for generating noise from tire road contact is less well understood. The sound pressure level from traffic can be predicted from the traffic flow rate, the speed of the vehicles, the proportion of heavy vehicles, and the nature of the road surface.

Railway noise depends primarily on the speed of the train, but variations are present depending upon the type of engine, wagons, and rails and their foundations, as well as the roughness of wheels and rails. Small radius curves in the track, such as may occur for urban trains, can lead to very high levels of high-frequency sound referred to as wheel squeal. Noise can be generated in stations because of running engines, whistles and loudspeakers, and in marshalling yards because of shunting operations. The introduction of high-speed trains has created special noise problems with sudden, but not impulsive, rises in noise. At speeds greater than 250 km/h, the proportion of high-frequency sound energy increases and the sound can be perceived as similar to that of overflying jet aircraft.

5.1.3 Construction Noise and Building Services Noise

Building construction and excavation work can cause considerable noise emissions. A variety of sounds come from cranes, cement mixers, welding, hammering, boring and other work processes. Construction equipment is often poorly silenced and maintained, and building operations are sometimes carried out without considering the environmental noise consequences. Street services such as garbage disposal and street cleaning can also cause considerable disturbance if carried out at sensitive

times of day. Ventilation and air conditioning plants and ducts, heat pumps, plumbing systems, and lifts (elevators), for example, can compromise the internal acoustical environment and upset nearby residents.

5.1.4. Domestic Noise and Noise from Leisure Activities

In residential areas, noise may stem from mechanical devices (e.g. heat pumps, ventilation systems and traffic), as well as voices, music and other kinds of sounds generated by neighbors (e.g. lawn movers, vacuum cleaners and other household equipment, music reproduction and noisy parties). Aberrant social behavior is a well-recognized noise problem in multifamily dwellings, as well as at sites for entertainment (e.g. sports and music events). Due to predominantly low-frequency components, noise from ventilation systems in residential buildings may also cause considerable concern even at low and moderate sound pressure levels.

5.2 Measurement Issues

The details of noise measurements must be planned to meet some relevant objective or purpose.

Some typical objectives would include:

a. Investigating complaints.
b. Assessing the number of persons exposed.
c. Compliance with regulations.
d. Land use planning and environmental impact assessments.
e. Evaluation of remedial measures.
f. Calibration and validation of predictions.
g. Research surveys.
h. Trend monitoring.

The sampling procedure, measurement location, type of measurements and the choice of equipment should be in accord with the objective of the measurements.

6. ABOUT GIS

6.1 Definition of GIS

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. The key word to this technology is Geography – this means that some portion of the data is spatial. In other words, data that is in some way referenced to locations on the earth.

Coupled with this data is usually tabular data known as attribute data. Attribute data can be generally defined as additional information about each of the spatial features. An example of this would be schools. The actual location of the schools is the spatial data. Additional data such as the school name, level of education taught, student capacity would make up the attribute data. It is the partnership of these two data types that enables GIS to be such an effective problem solving tool through spatial analysis. GIS is more than just software. People and methods are combined with geospatial software and tools, to enable spatial analysis, manage large datasets, and display information in a map/graphical form.

6.2 GIS Concepts

What can we do with GIS?

GIS can be used as tool in both problem solving and decision making processes, as well as for visualization of data in a spatial environment. Geospatial data can be analyzed to determine

(1) The location of features and relationships to other features,
(2) Where the most and/or least of some feature exists,
(3) The density of features in a given space,
(4) What is happening inside an area of interest (AOI),
(5) What is happening nearby some feature or phenomenon, and
(6) How a specific area has changed over time (and in what way).

1. Mapping where things are. We can map the spatial location of real-world features and visualize the spatial relationships among them.

2. Mapping quantities. People map quantities, such as where the most and least are, to find places that meet their criteria or to see the relationships between places.

3. Mapping densities. Sometimes it is more important to map concentrations, or a quantity normalized by area or total number.

4. Finding what is inside. We can use GIS to determine what is happening or what features are located inside a specific area/region. We can determine the characteristics of "inside" by creating specific criteria to define an area of interest (AOI).

5. Finding what is nearby. We can find out what is happening within a set distance of a feature or event by mapping what is nearby using geo processing tools like BUFFER.

6. Mapping change. We can map the change in a specific geographic area to anticipate future conditions, decide on a course of action, or to evaluate the results of an action or policy.

6.3 ArcGIS Desktop

ArcGIS Desktop is a state-of-the 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 via its Application Interface (API). The API gives fine grain access to data stored as well in general data base formats as topologically indexed vector data in the industry standard "shape" format as well as different GRID and geo-referenced raster formats.

The software further has all necessary functionality to manage the different data formats and geographical datum and adjust them into suitable components in applications and models.

7 GIS ANALYSIS

7.1 Analysis

GIS systems really come into their own when they are used to analyse geographic data. The processes of geographic analysis often called spatial analysis or geo-processing uses the geographic properties of features to look for patterns and trends, and to undertake "what if" scenarios. Modern GIS have many powerful analytical tools to analyse the data. The following are some of the analysis which are generally performed on geographic data.

7.1.1 Overlay Analysis

The integration of different data layers involves a process called overlay. At its simplest, this could be a visual operation, but analytical operations require one or more data layers to be joined physically. This overlay, or spatial join, can integrate data on soils, slope, and vegetation, or land ownership.

7.1.2 Proximity Analysis

GIS software can also support buffer generation that involves the creation of new polygons from points, lines, and polygon features stored in the database. For example, to know answer to questions like; How much area covered within 1 km of water canal? What is area covered under different crops? And, for watershed projects, where is the boundary or delineation of watershed, slope, water channels, different type's water harvesting structures are required, etc.

7.2 Visualization

GIS can provide hardcopy maps, statistical summaries, modeling solutions and graphical display of maps for both spatial and tabular data. For many types of geographic operation the end result is best visualized as a map or graph. Maps are very efficient at storing and communicating geographic information. GIS provides new and exciting tools to extend the art of visualization of output information to the users.

7.3 Gis Noise Mapping

GIS software can create noise maps for better visual information of the noise and its variations in the environment. The Interpolation (krigging) is the most important technique for the purposes of noise mapping and its technique can be used to develop noise levels contours. Krigging can be done considering the acoustic behavior of the topographical region in interpolation technique.

The noise contour maps can be created to show the variation of the environment noise at different times of the day in the urban area. GIS can be used for the better result for the outcome of the area with high noise intensity and traffic properties. It also recognizes the most exposed zones under the noise pollution bluster. Noise maps can be achieved for the adopting clear methodology.

7.4 Data Collection

Various methods use for the collecting high-accuracy GPS data and it depends on several factors like the objective of the survey preferred precision, equipment availability and field logistics. Supreme accuracy normally requires a more adamant field practice. The most common GPS survey methods are Continuous survey method, Static survey method, Rapid Static survey method, and Kinematic survey methods. The noise data collected from the field can insert into the GIS and display on the cadastral map of them urban area. The distance between points in the map varies from the highly habitable region to less habitable areas. Each point contains attribute data like topographical coordinates, location, date and time of data collection, a major source of noise, noise indices, maximum logged noise level, minimum logged noise level and an average noise level.

8 GIS RESULTS

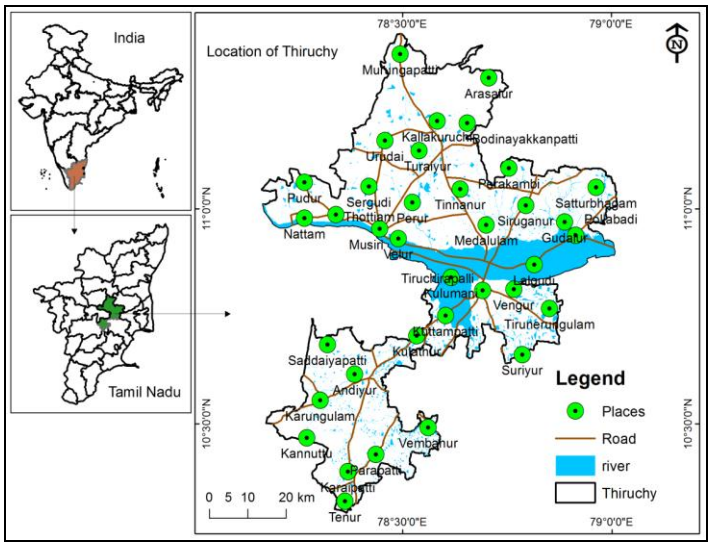

Fig -2: Location map of Study Area

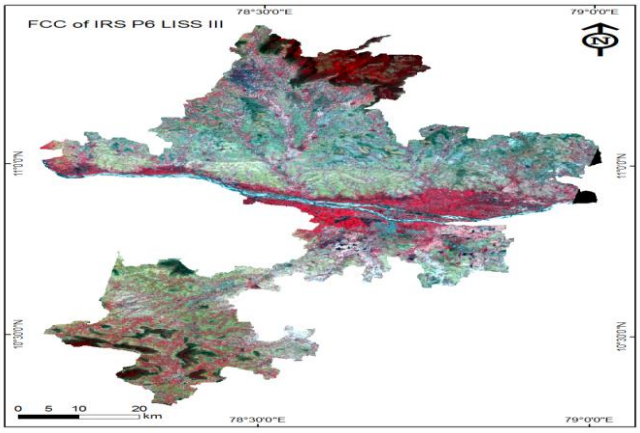

Fig -3: FCC of IRS P6 LISS III

8.1 Assessment of Sustainable Landscape Ecological Zone

8.1.1 Landscape Ecological Stress Map

The landscape ecological stress zone mapping of the study area has been carried out based on the analysis and regrouping of landscape ecological units on the basis of the ecological impact of each zone. The units have a minimum ecological impact in terms of slope, geomorphology, soil depth and land use/land cover was delineated under very low landscape ecological stress zone (Ruzickaand Miklos, 1982). The units have maximum ecological stress in the form of very steep slopes, denudational landscape, extremely shallow soils, wastelands were delineated into very high landscape ecological stress zone and the rest into intermediate classes of stress zones.

Table -1: Theme of ecological stress zones

THEME	FEATURE CLASS	RANK	WEIGHTAGE
Geomorphology	Plains	4	30
	Isenberg	8	
	Lower Pedi plain	8	
	Flood plain	7	
	Pediment	5	
	Structural hills	8	
	Upper Pedi plain	8	
Slope	Level to nearly level (<6%)	1	40
	Very gentle (6-16%)	3	
	Gentle (16-27%)	4	
	Moderately sloping (27-39%)	8	
	Strongly sloping (39-53%)	9	
Soil depth	Extremely Shallow	10	15
	Shallow	9	
	Moderately Deep	5	
	Deep	2	
	Very Deep	1	
Land use / Land cover	Agriculture Land	3	15
	Barren Land	8	
	Buildup Land	2	
	Water Bodies	1	

8.2 GEOMORPHOLOGY MAP

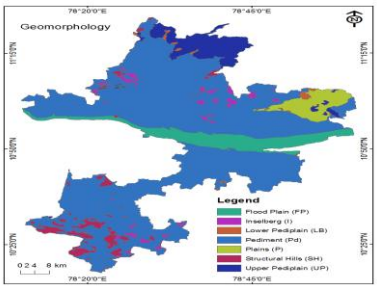

Fig -4: Geomorphology

Geomorphology is defined as the science of landforms with an emphasis on their origin, evolution, form, and distribution across the physical landscape. An understanding of geomorphology and its processes is therefore essential to the understanding of physical geography. Geomorphological maps can be considered graphical inventories of a landscape depicting landforms and surface as well as subsurface materials.

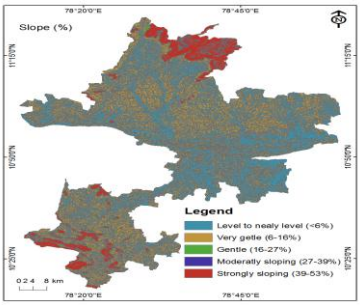

Fig -5: Slope Ratio

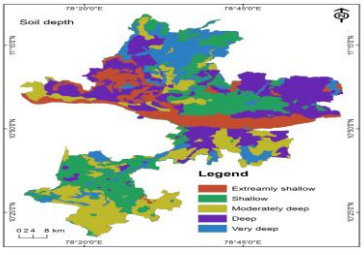

Fig -6: Soil Depth

8.3 LAND USE / LAND COVER MAP

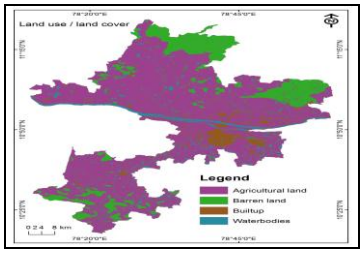

Fig -7: Land use /Land cover

Land management and land planning requires a knowledge of the current state of the landscape. Understanding current land cover and how it is being used, along with an accurate means of monitoring change over time, is vital to any person responsible for land management. Measuring current conditions and how they are changing can be easily achieved through land cover mapping, a process that quantifies current land resources into a series of thematic categories, such as forest, water, and paved surfaces.

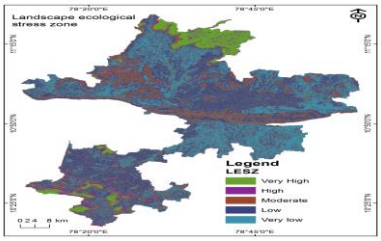

Fig -8: Ecological stress Zone

Table 2 Landscape ecology conservation for sustainable Management

LESZ	Area and Percentage	Description	Management
Very high	91,20%	Subjected to erosion with slopes ranging from 47-121%, extremely shallow to shallow Soils, , limited crop, wastelands area	Soil conservation practices like gully control structures, stone terracing & contour bundling, development of pastures, afforest ration and social forestry.
High	86, 19%	head ward erosion, slopes ranging from 31-47% with shallow to moderately deep soils and waste lands, and the single cropped area	Development of social forestry and horticulture crops.
Moderate	141, 31%	Moderate erosion and deposition, slope ranging from 18-31%, moderately deep soil, single cropped area and scrub lands	Terrace bundling, check dams vegetative bundling,
Low	32,6%	Deposition of alluvium and colluvium material, slopes ranging from 7.5-18%, moderately deep to deep soils, deciduous and the double cropped area	Land leveling, contour cultivation and strip cropping, soil moisture retention practices
Very low	112, 24%	Depositional processes are dominant, slopes ranging from 0-7.5%, soil depth varies from deep to very deep, single and double cropped areas	channel management, avoid ponding and channel excavation , protection of fertile soil
LESZ = Landscape Ecological Stress Zone			

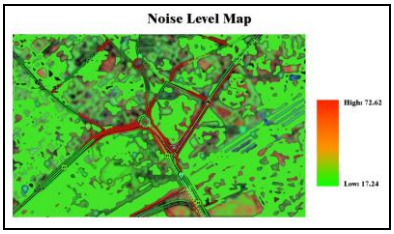

Fig -9: Noise level Map

9. CONCLUSION

In this study, we have observed the noise level in the crowded streets of Trichy with the sound meter in this study. The highest noise pollution in urban areas is caused by traffic noises. We have taken the study area as Tiruchirappalli railway Junction, 2020 food corner, ponnagar post office, Bharathiar salai and Dr. Ambethkar Street. These areas are considered to be the busiest places in Trichy. During peak and non-peak hours, road noise levels are observed between 17.24 to 72.62 db. In comparison, the noise level is greater in the first floor relative to the basement, despite a rise in duration and height, which is the noise range. The noise level also decreases when the distance from the carriage way increases. These noise levels are in excess of the prescribed limits. They are indicated trichy map noise level highly on reed areas and another's area indicated on lowest noise level in the green areas. Hence, the following recommendations are made for future study. Separate models were built for the all locations in a stretch in the study area. Finally, a GIS model for Noise prediction was developed for a busy corridor in trichy city. The noise pollution level in the study area of trichy city has been plotted in spatial analysis map using ArcGIS software.

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