# NOISE MAPPING AND ASSOCIATED ISCHEMIC HEART DISEASE ASSESSMENT IN DELHI USING ArcGIS

A PROJECT REPORT

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# CANDIDATE'S DECLARATION

I, Raunak Sinha, Roll No.2K19/ENE/03 of M.Tech Environmental Engineering, hereby declare that the project Dissertation titled “NOISE MAPPING AND ASSOCIATED ISCHEMIC HEART DISEASE ASSESSMENT IN DELHI USING ArcGIS” which is submitted by me to the Department of Environmental Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology in Environmental Engineering is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of my Degree, Diploma Associateship, Fellowship, or other similar title or recognition.

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AUGUST 2021

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# CERTIFICATE

I, hereby certify that the project Dissertation titled "NOISE MAPPING AND ASSOCIATED ISCHEMIC HEART DISEASE ASSESSMENT IN DELHI USING ARCGIS" which is submitted by Raunak Sinha, Roll No. 2K19/ENE/03 (Department of Environmental Engineering), Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the Degree of Master of Technology is a record of the project carried out by the student under my supervision. To the best of my knowledge, this work has not been submitted in part or full for any degree or diploma to this university or elsewhere.

PLACE: DELHI

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## ABSTRACT

Noise pollution has been identified as a potent trigger to many diseases throughout the world. The increasing level of noise level exposure can lead to health risks such as cardiovascular diseases, high blood pressure, increased heart rate, etc. In the present study, noise levels from different locations of Delhi based on land-use patterns have been taken and noise maps are developed using ArcMap 10.8. Based on this noise map, hospital admissions for ischemic heart disease and myocardial infarction are calculated due to noise pollution. The study outcome revealed that in an area of 14-$km^2$ noise levels reached 70 dB, while it was 65-70 dB in the area of 436 $km^2$, 60-65 dB in 746 $km^2$ area, and less than 60 dB in an area of 294 $km^2$. The total contribution of noise pollution in hospital admissions for ischemic heart disease is 1640, with 75 occurrences of myocardial infarction, accounting for 3.314 % of all hospital admissions for the disease in the year 2019 for which evaluation is done. According to the Environmental Burden of Disease Methodology, people in Delhi lost 1843 years of healthy life in 2019 due to noise pollution. The number of healthy years lost to myocardial infarction is 333. Noise level variation at different land use zones from one of the EIA report when compared to noise monitored on-site are:- (1) 1.6 dB in the silence zone, (2) 0.61 dB in the commercial zone,(3) 0.47 decibels in the industrial zone, and (4) 5.2 dB in the residential zone.

**Keywords**: *Noise-map, Ischemic heart disease, ArcMap, Environmental Burden of Disease, Myocardial infarction*

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| | |
|---|---|
| **CVD** | Cardiovascular Disease |
| **IHD** | Ischemic Heart Disease |
| **CHD** | Coronary Heart Disease |
| **CCS** | Canadian Cardiovascular Society |
| **WHO** | World Health Organisation |
| **DALY** | Disability-adjusted Life Year |
| **GIS** | Geographical Information System |
| **GPS** | Global Positioning System |
| **IDW** | Inverse Distance Weighted |
| **MI** | Myocardial Infarction |
| **RR** | Relative Risk |
| **STATA** | Statistical Software for Data Science |
| **SPSS** | Statistical Package for Social Science |
| **PRISMA** | Preferred Reporting Items for Systematic Reviews and Meta Analysis |
| **TIN** | Triangular Irregular Network |
| **CPCB** | Central Pollution Control Board |
| **DPCC** | Delhi Pollution Control Board |
| **EIA** | Environmental Impact Assessment |
| **NHAI** | National Highway Authority India |
| **EBD** | Environmental Burden of Disease |
| **YLL** | Years of Life Lost due to early death from disability |
| **YLD** | Years of Life lived with Disability |
| **DW** | Disability Weight |
| **PAF** | Population Attributable Fraction |
| **MCD** | Municipal Corporation of Delhi |
| **DTU** | Delhi Technological University |
| **IHBAS** | Institute of Human Behaviour and Allied Science |
| **NCT** | National Capital Territory |

# Chapter 1

# Introduction

Noise is defined as any unwanted sound present in the air. Noise pollution caused in cities results from ongoing traffic, construction, community function, industrial equipment. It's a common scenario of almost every metropolitan city in today's world. Noise is the second most disturbing pollution, which attracted many researchers & policymakers after air pollution (WHO 2018). Noise generally affects our day-to-day life in many ways like irritation, sleep disturbance, studying, headache. According to a study by (Khaiwal et al., 2016), in which, 20 lakhs of the patients were interviewed to assess problems they face due to ongoing noise in and around the hospital, 55.6% reported sleep disturbance, 43.4% reported study disturbance, 38.4% reported disturbed during working hours while 40.4% reported headache. In a sample of young, healthy persons, a study discovered relationship between noise exposure and various cardiovascular risk scores. Road traffic noise irritated the students in the exposed group much more, and it also made them apprehensive and irritable(Sobotova et al., 2010). Noise pollution has been connected to various non-auditory health consequences, including cardiovascular disease.

Cardiovascular disease (CVD), metabolic problems, cognitive impairment, and poor nutrition are all examples of illnesses(Basner et al., 2014). In a chronic exposure timeline, sleep and mental health are both affected. But apart from mental health indicators, noise pollution also contributes to cardiovascular disease, which eventually leads to heart attack and death. After 2013, ischemic heart disease was found a prime cause of death (Metrics, 2018). Ischemic heart disease (IHD) affects over 126 million people worldwide (1,655 per 100,000), or around 1.72 percent of the world's population, according to Khan et al. (2020). By 2030, the current prevalence rate of 1,655 /100,000 people will have risen to 1,845. Noise exposure can increase the risk of CVD morbidity & mortality (Babisch, 2014). According to (Babisch, 2014) if the traffic noise level is between 52-77 dB, an 8% increase in risk for developing heart disease is seen per increase of 10 dB. The study of Khosravipour & Khanlari (2020) also suggested that every 10 dB increase in road traffic noise can lead to significantly higher risk of Myocardial Infarction. While most of the study suggests the relation of CVD disease to transportation noise, data from Azuma & Uchiyama (2017) imply that noise from construction, neighborhood, and automobiles may have a stronger link to CVD symptoms than noise from trains and planes. When the risk of all-cause, Cardiovascular disease, and stroke was adjusted for the most and least exposed facades, the most exposed facade was linked with a greater risk of all-cause, CVD, and stroke (Thacher et al., 2020). Acute exposure to environmental noise can increase blood pressure, heart rate, and vasoconstriction (Bluhm et al., 2007). According to (Niemann et al., 2006), prolonged exposure can develop permanent health problems if exposed to 10-15 years. Experimental & epidemiological studies yield stressful influence of noise on Humans(Babisch et al., 2005; Hubka et al., 2006; Lercher et al., 2000; Parrot et al., 1992, 1992; Perspectives, 2008).

## 1.1 Ischemic Heart Disease

Ischemic heart disease is persistent chest pain or discomfort caused by a lack of blood supply to a portion of the heart. When the heart wants more blood flow, this condition frequently occurs during exertion or excitement. Ischemic heart disease, commonly known as coronary heart disease, is a leading cause of death globally. When an organ (such as the heart) is ischemic, it does not receive enough blood and oxygen. Ischemic heart disease, commonly known as coronary heart disease (CHD) or coronary artery disease, refers to cardiac disorders caused by restricted heart (coronary) arteries.

Ischemic heart disease symptoms can appear gradually as arteries get clogged, or they might appear immediately if an artery becomes blocked suddenly. Ischemic heart disease might cause no symptoms, or it can cause severe chest discomfort (angina) and shortness of breath, leading to a heart attack.

The Canadian Cardiovascular Society (CCS) classification system rates angina or an anginal analogue (e.g., exertional dyspnea) based on a description of the level of activity that induces symptoms. Angina that occurs with strenuous, quick, or prolonged exertion at work or play, but not with everyday physical activity, is classified as Class I. Walking or climbing stairs quickly, walking or climbing stairs uphill, walking or climbing stairs after meals; in cold or wind; under emotional stress; only during the first few hours after awakening; or walking more than two blocks on level ground and climbing more than one flight of ordinary stairs at the same time are all examples of Class II angina.

Ischemic heart disease can be successfully managed with lifestyle changes, medications, and surgical treatments. The risks of ischemic heart disease may be lowered by practicing heart-healthy habits, including eating a low-fat, low-sodium diet, staying active, quitting smoking, and keeping a healthy body weight.

In many studies, noise is observed as a non-specific psychological and physiological stressor and linked to many diseases. Cardiovascular diseases include ischemic heart disease, heart attack, and hypertension. Worldwide, cardiovascular diseases are among the most reported diseases by hospital admissions after 2013. Globally, 12.6% of deaths are caused by ischaemic heart disease, 9.6% by cerebrovascular disease, and 1.6% by hypertensive heart disease. Much research work has been done to prove a link between noise level and the growing risk of heart diseases in the cities. According to some studies, an 8% increase in the risk of heart disease is seen per increase of 10 dB noise level.2-3% of ischemic heart disease in the general population could be attributed to traffic noise. Among others, the major health effects of prolonged exposure to high-level noise are increased blood pressure, vasoconstriction, and increased heart rate.

Some studies reported significant associations between road traffic noise and respiratory mortality. There is a less significant association between traffic noise and other diseases like cancer and diabetes. According to WHO Health Community, there are guidelines according to which if threshold limit of noise is exceeded, it can cause serious health impacts like if the noise level of 70 dB and above is pertaining for 24 hours, it can lead to hearing impairment same way if the noise level of 30 dB is exceeded during night time, it can cause sleep disturbance in the night. For assessing the health impact of noise on people, there are different methods to find out. One of the methods is of Environmental Burden of Disease, which involves the calculation of Disability Adjusted Lost Year (DALY), a combination of years lost by a person living with disability and years lost due to disability due to premature death.

This method is an exposure-based calculation in which the population is categorized in different noise classes in which they are exposed and then the relative risk associated with each class is determined using WHO Health Guideline. Attributable fraction is calculated to assess the percentage of cases occurring due to noise pollution. Attributable fraction is expressed in percentage. The study was carried out in Hong Kong to check whether traffic noise in Asian cities differs from European cities. The result yields that the distribution of population exposed to high noise (>70 dB) is similar to that of European cities while a higher percentage of people are exposed to 60-65 dB than in European cities and a much lower proportion of people are exposed to lower noise level. Hence the exposure-response relationship for both cities yields the same result and the same approach is to be used for EBD (Environmental Burden of Disease) calculation.

## 1.2 GIS-Based Noise Mapping

### 1.2.1 International Studies

According to a research by (Obaidat, 2011), noise maps can simply aid in assessing noise levels and their results based on areas, people density, and building type. To control noise in Norway, population figures and a noise map were employed (Klæboe et al., 2006). In Curitiba, Brazil, noise pollution was investigated using noise measurements and acoustic mapping (Fiedler & Zannin, 2015). Similarly noise maps are made throughout the world for various research purposes like a noise map using over 4000 points was created in Madrid, Spain(Manvellaetal.,2004). The biggest noise map covering the entire city was developed in Birmingham in 2000 (Hinton et al., 2005). In Germany, almost 500 towns are equipped with a noise map (Hintzsche & Heinrichs, 2016). The city of Santiago de Chile was mapped for traffic noise. (Suárez & Barros, 2014). (Cai et al., 2015) created traffic noise maps for day and night roads for Guangzhou, using GIS and GPS. Harman et al. (2016) generated a noise map for Isparta city center and obtained its boundary using inverse distance weighted (IDW), Kriging, and multiquadric interpolation methods with four grid resolutions and several parameters for Isparta city center. A new method for traffic noise mapping was created by using unstructured meshed road and building surfaces (Zhao et al., 2017). Cai et al. (2018) proposed an approach for creating 3D traffic noise maps in complicated building contexts. Bocher et al. (2019) created an open-source GIS-based tool for creating noise maps. For Chungju, the Republic of Korea, Ko et al. (2011) created a noise effect assessment method and noise map using GIS.

### 1.2.2. Indian Studies

Mishra et al. (2021) carried out noise mapping in Delhi and evaluated the error percentage of noise values depicted by the noise map to that of the measured noise values of the selected location. Another study by(Das et al., 2019) states that noise level exceeds 70 dB in almost 39.21 % and 22.86% of the total area of English Bazaar Municipality, West Bengal. The study by (Banerjee et al., 2009) was done in Asansol City, West Bengal, and noise maps were developed to depict the temporal and spatial distribution of noise around the city, and data revealed that noise levels ranged from moderate to extremely high when compared to CPCB standards. (Sonaviya & Tandel, 2019) offered an overview of GIS-based road traffic noise mapping. Tiwari et al. (2017) created noise maps from several noise monitoring locations in Surat's core zone to analyze urban environmental noise's spatial aspects. During peak hours, spatial and temporal noise maps are created to measure the ambient noise level in the city (Laxmi et al., 2019). The diurnal noise mapping by Alam (2011) revealed the noise-polluted and sensitive locations. Kumar et al. (2017) used smartphone community involvement to map traffic noise in KhannaMandi Gobindgarh, Punjab.

### 1.3 Arcmap 10.8

Arcmap is a state-of-the-art geospatial tool that helps create, edit, and visualize geospatial data. It helps users to visualize the data with the help of a table of content and data view. It can be used to build and manipulate data sets containing various data. North arrows, scale bars, titles, legends, tidy lines, and other elements are common on ArcMap maps.

Additionally, it can be used to submit various reference styles to use with any mapping function. Basic, Standard, or Advanced (previously ArcView, ArcEditor, or ArcInfo), and Pro are the four license levels offered for the ArcGIS package. Each step higher in the licensing gives the user more extensions, allowing them to run a broader range of queries on a data source. The Pro level of licensing allows the user to use extensions such as 3D Analyst, Spatial Analyst, and Geostatistics. Shape Files are used to run ArcMap, and Geodatabases can store bigger volumes of data in more current versions. These are the file types that are used to examine spatial data in the software. A new file extension is produced when a map (.mxd) is saved. Only the relative path-names are saved with this file, not the layers or geographical data. This means that if the data in the map is not at the same location as it was the last time it was opened, an error will occur. This helps to keep the file compact and decreases the amount of data management redundancy.

# Chapter 2

# Literature Review

Since noise is associated with several consequences resulting in several diseases, there has been a constant growth in research going on in the noise domain throughout the world. A range of studies is conducted on noise pollution depiction, mapping, health risk assessment, and correlation among the noise and several diseases. Some of the studies incorporated here are:

**1) The association between road traffic noise and myocardial infarction: A systematic review and meta-analysis (Khosravipour & Khanlari, 2020)**

This study aimed to analyze the association between exposure to road traffic noise and the development of myocardial infarction(M.I) also known as a heart attack. 13 Studies containing 1,626,910 participant and 45,713 cases of M.I. was included. A random-effect model was incorporated to assess pooled relative risk (R.R.) and 95% confidential interval of M.I. This study depicted a higher risk of developing M.I./10 dB increase in $L_{den}$ of Road Traffic Noise. Metanalysis was of two types: Categorial and exposure-response metanalysis was 1.03 and 1.02.

2**) Updated exposure-response relationship between road traffic noise and coronary heart diseases: A meta-analysis-(Babisch, 2014)**

A meta-analysis of 14 studies on the association between road traffic noise & coronary heart disease was carried out in this study. Five Cohort studies were carried out in Caerphilly (U.K.), Bristo, Berlin, Tokyo, Stockholm, Sweden. Statistical software tool "STATA intercooled Release II" was used to carry out pooled trend of relative risk using META command. Metanalysis depicts that for every increase in day-night noise level $L_{DN}$ of 10 dB (A), an 8% increase in risk is observed within the range of 52-77 dB.

**3) The incidence of myocardial infarction and its relation to road traffic noise- the Berlin case-control studies-Babisch, Wolfgang, Ising, Hartmut, Kruppa, Barbara Wiens, Daniel, 1994**

In this study incidence of myocardial infarction risk from traffic noise was determined using a case-control study in a hospital. Patients from the hospital were interviewed, including 1881 patients with confirmed diagnosis of Myocardial Infarction were enrolled aged between 20-69. An odd ratio of 1.3 was observed for men exposed to noise level 70 dB as compared to those who lived in places where noise level barely exceeds 60 dB. Mens who used to live at their present address for more than 10 years had odd ratio of 1.8. Noise-exposed women were not at higher risk.

**4) Community response to environmental noise and the impact on cardiovascular risk score- Sobotova, Lubica, Jurkovicova, Jana, Stefanikova, Zuzana, Sevcikova, Ludmila Aghova, Lubica, 2010**

In this study, cardiovascular disease and road traffic noise relarelationshipse were investigated. 659 people were divided into two groups: The exposed and the controlled group. The exposed group was exposed to a noise level of 67±2 dB and the control group was exposed to a noise level of 58.7±6 dB(A). Ten-year risk of developing coronary heart disease was quantified using SCORE60, Framingham 10 year risk estimation. Cardiovascular risk scores of the exposed group are more than the control group.

5**) Association between environmental noise and subjective symptoms related to cardiovascular diseases among elderly individuals in Japan- Azuma, Kenichi Uchiyama, Iwao, 2017**

In this study, a questionnaire survey was conducted for elderly people aged greater than 65 years containing questions relating to awaking during the night due to noise, automobile, construction, railway, etc., and contained questions about CVD-related symptoms within past years. Responses were rated on perceived noise annoyance scale and internal consistency of scale was determined using cornbach's alpha. To determine different noise factors associated with CVD occurance multiple regression analysis was done. These statistical test were done on IBM SPSS version 23. Significant association of all railway, automobile, aircraft, construction noise were found but the highest association was for construction noise followed by neighborhood noise and then automobile noise.

**6) Long-term exposure to traffic noise and mortality: A systematic review and meta-analysis of epidemiological evidence between 2000 and 2020-Yutong Cai, Rema Ramakrishnan, Kazem Rahimi, 2021**

In this study, long-term exposure to rail, road, and aircraft noise and mortality analysis is done. 13 studies from various sources published during 2000 to 2020 were done. Meta-analysis was done using PRISMA guidelines. The risk estimate from each study was converted into per 10 dB higher of $L_{den}$ for each traffic source. Association between traffic noise on mortality came out to be weak  for most of the diseases while it was moderat for road traffic noise and C.V.D. A threshold limit of 53 dB was suggested for mortality related to C.V.D resulting from traffic noise.

7**) Road traffic noise mapping in Guangzhou using GIS and GPS-Ming Cai, Jingfang Zou, Jiemin Xie, Xialin Ma,2015**

The study uses Geographical Information Systems (GIS) and Global Positioning Systems to create day and night road noise maps for Guangzhou (GPS). The speed-density equation is utilized from GPS data acquired from floating cars to estimate traffic volume. The traffic noise computation model is developed by combining a noise emission model with a noise propagation model. The process is optimized by intelligently splitting the computing grids, filtering the traffic noise sources automatically, and conducting a rapid index of the estimation objects. Finally, the daytime and nighttime road traffic noise levels in Guangzhou are assessed to construct two traffic noise maps. A traffic noise monitoring experiment is used to verify the correctness of the created algorithm.

8) **An innovative approach of urban noise monitoring using cycle in Nagpur, India-Vijaya Laxmi, Jaydip Dey, Komal Kalawapudi, Ritesh Vijay& Rakesh Kumar,2019**

Noise map was developed for Nagpur city using an innovative approach where cyclist team was prepared to tour the city using their cycle mounting a noise level meter that records noise level wherever cycle goes. Noise map was developed using the TIN model in ArcGIS software. Noise value was recorded for 5 minutes wherever there was peak hour. There were around 300 such locations where the noise level was recorded, and almost all the location exceeded the noise standard prescribed by CPCB. The city was divided into 38 wards and based on the noise map, ward 33 had the highest noise level of 105.6 dB.

**9) Noise mapping in urban environments: A Taiwan study-Kang-Ting Tsai, Min-Der Lin, Yen-Hua Chen, 2009**

This paper developed the Taiwan city noise map using the Kriging interpolation technique in ArcGIS software. Three hundred forty-five noise (345) monitoring stations were used throughout the city after dividing it into a square grid of 500m X 500m. The noise level was recorded using a temporary noise station at this monitoring station for 2 hours during morning and evening on both summer and winter days. The study revealed that noise level exceeded for all the stations compared to standard by US Housing Development Authority. Further, the noise level recorded was as much as 23 dB higher than the standard noise level and almost 90% of the population was exposed to such high noise levels.

# Chapter 3

# Methodology

## 3.1. Study Area

Delhi, the capital city of India, has an area of 1483 $km^2$. It is located at 28.61$^0$N and 77.23$^O$E. It is among 8 Union Territories and surrounded by Haryana in the North, West, and Southside while Uttar Pradesh is on the east side (Fig. 3.1). It is located on the bank of the Yamuna River. Ghaziabad, Noida, Faridabad, Sonipat, and Gurugram has been developed on borders to meet the growing demand of the city and is termed collectively as National Capital Territory (N.C.T). Delhi has a population of around 16.78 million as per the census report of India in 2011 and has a population density of 11,320 persons/$km^{2,}$ making it the densest city in India. The city is the second most populated city after Mumbai in the country (Planning Department Government of NCT Delhi, 2019).The population of Delhi is ever-expanding and growing due to high migration and income opportunities. Delhi being the capital city of India and called the political powerhouse of the country houses various industrial and commercial activities. It has great historical importance and many architectural sites that attract tourists from all over the world. It is second among the most productive metropolitan city in the country.

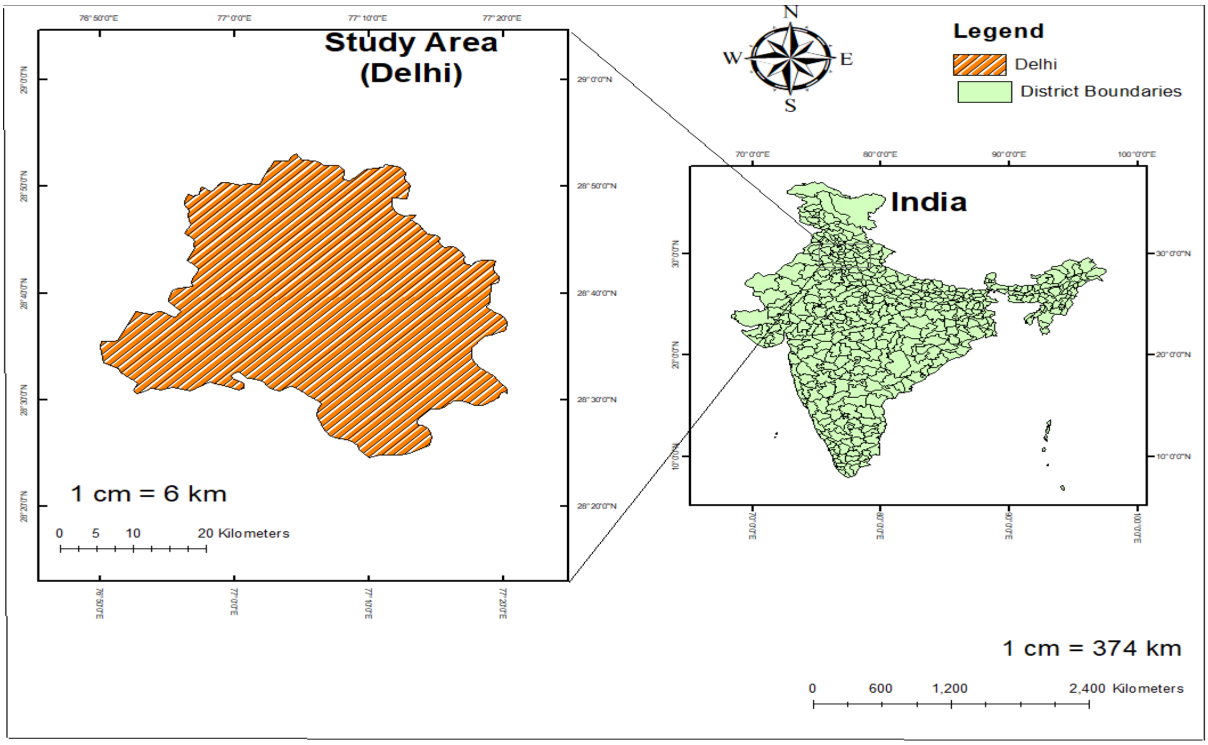


Figure 3.1: Study area of Delhi

Due to a large number of commercial and industrial activities, it houses an extensive network of roads and a vast transport infrastructure comprising railways, airports, and the metro. Because of these activities, there is an immense load on the road network, evidently from the noise level recorded on the road network in the city. There have been many noise pollution activities reported in the city due to heavy construction, industrial activity, and traffic operations. Most of this noise pollution comes from traffic operations, as Delhi has around 10 million vehicles as of 2017. In 2008 total vehicle count in Delhi NCR was reported to be about 11 million, while in 2018, it rose to 10 million in Delhi alone. The Road network in Delhi is 2103 km/100 $km^2$. Having a high load of vehicular traffic on the road, it is evident that noise pollution tends to occur. Due to the ever-increasing problem of noise pollution in Delhi, CPCB (Central Pollution Control Board) and DPCC (Delhi Pollution Control Committee) installed noise monitoring stations at 10 locations in 2013, while later on-demand of Delhi High Court number of the station has been increased from 10 to 26. These noise stations have been installed at different locations catering to different noise environments based on land use patterns. Studies have shown that there is high noise level in the commercial and industrial zone compared to silent and residential zones. But at all the stations of Delhi, the noise level exceeds the standard limit set by the CPCB. Some studies suggest land-use factor as one of the causes of difference in noise level at different category of land according to their commercial use. Delhi also experiences the same trend as the noise level is high in the interior of the city with a high built-up region while noise level in the outskirt of the city is low as there is open farmland and barren land in the outskirt. The Landuse pattern of Delhi is depicted in Figure 3.2

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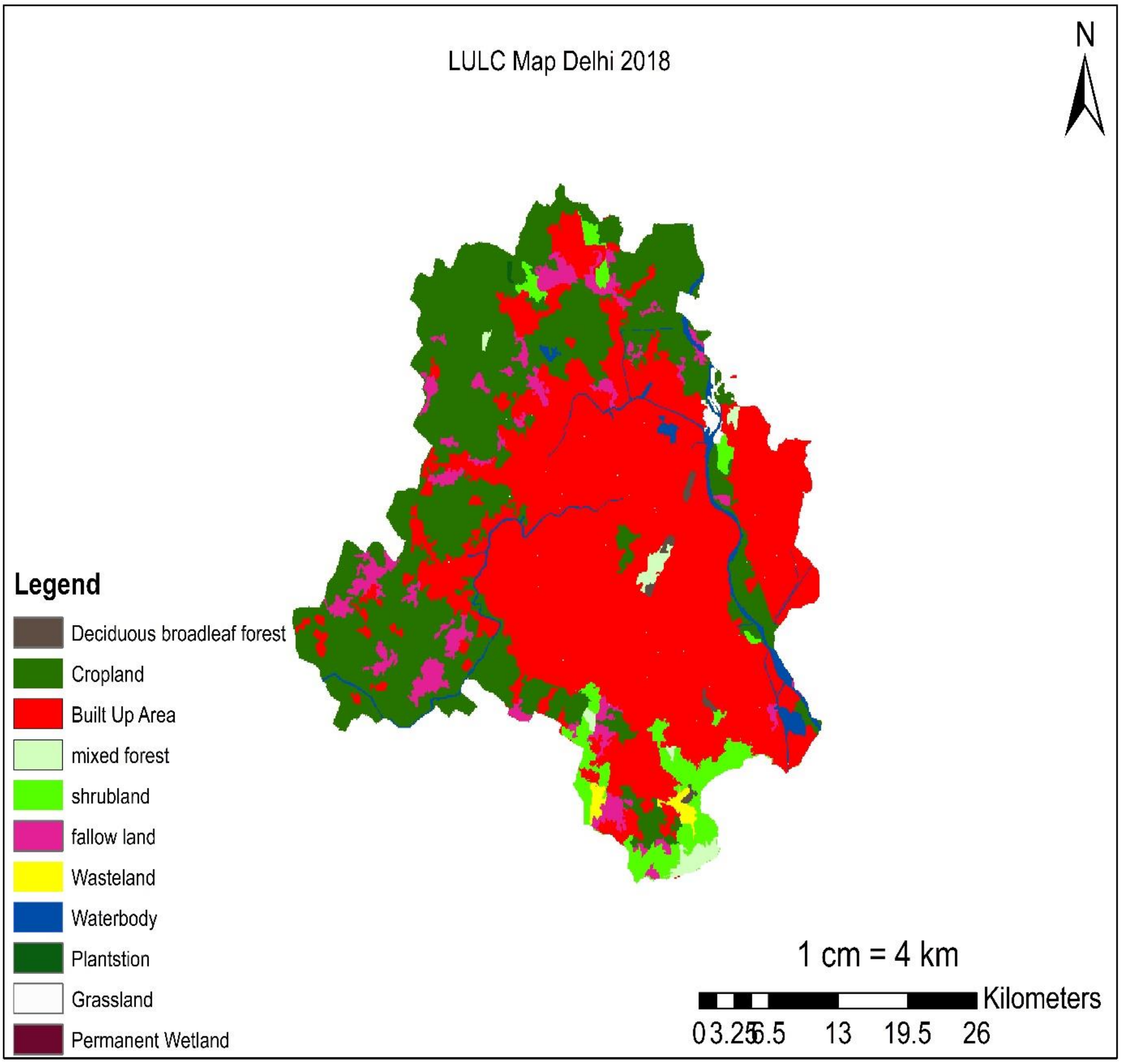

Figure 3.2 Landuse LandcoverMap of Delhi

## 3.2 Data Collection

To carry out a noise-induced health risk analysis of the city, first step is to figure out how many people are exposed to different noise categories based on noise level pertaining in their locality, and based on this, estimation of contribution of noise pollution in the number of cases reported in hospitals due to specific disease is assessed. Data sets are collected through different primary and secondary modes.

Noise data has been taken from both primary and secondary sources. For the assessment of the year 2019, noise data was taken from the EIA report of one of the ongoing projects and merged with annual noise data from CPCB and DPCC. The field study was conducted to validate these data in the area with the same land use pattern.

**<u>3.2.1 Primary Data</u>**: Primary data consists of noise levels collected during a site visit at different locations of Delhi selected according to their land use pattern. The site visit was done in the month of March-April 2021. According to the land use pattern, 4 zones were identified to show different noise characteristics:

**(1) Silent Zone**: These were locations around hospitals, schools, colleges, temples, churches, mosques etc. Some of the locations selected for noise monitoring under this zone were: (1) R.K. Puram School(Figure 3.3), I.H.B.A.S, Dilshad Garden(Figure 3.4), and Punjabi Bagh School (Figure 3.5). Noise reading at these locations are shown in Tables 3.1, 3.2 and 3.3. Among all the three locations maximum noise level was observed at IH.BA.S, Dilshad Garden where $L_{eq}$ rose to 68.7 dB and minimum noise level among all the three location was observed at R.K. Puram School where $L_{eq}$ was 52.86 dB.

Table 3.1 Noise Level at R.K. Puram School:

| **Time** | **$L_{eq}$** | **$L_{A(Max)}$** | **$L_{A(Min)}$** |
|---|---|---|---|
| **3:34-3:46 P.M.** | 49.0 dB | 74.6 dB | 42.6 dB |
| **3:55-4:10 P.M.** | 52.9 dB | 73.2 dB | 46.8 dB |
| **4:15-4:30 P.M.** | 49.2 dB | 79.4 dB | 48.9 dB |
| **4:35-4:50 P.M.** | 56.2 dB | 85.9 dB | 48.9dB |

Figure 3.3 Noise monitoring at R.K. Puram School

Table 3.2 Noise level at I.H.B.A.S, Dilshad Garden

| **Time** | $L_{A(eq)}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **12:30-12:45 P.M.** | 66.1 dB | 88.0 Db | 55.7 dB |
| **12:50-1:05 P.M.** | 62.1 dB | 78.9 dB | 56.5 dB |
| **1:10 -1:25 P.M.** | 65.5 dB | 72 dB | 56.5 dB |
| **1:30-1:45 P.M.** | 72.8 dB | 77.1 dB | 57.1dB |


Figure 3.4 Noise monitoring at I.H.B.AS, Dilshad Garden

Table 3.3: Noise level at Punjabi School

| **Time** | **$L_{eq}$** | **$L_{A(Max)}$** | **$L_{A(Min)}$** |
|---|---|---|---|
| **4:30-4:45 P.M.** | 55.2dB | 72.7 dB | 41.4 dB |
| **4:50-5:05 P.M.** | 53.3 dB | 79 dB | 50.3 dB |
| **5:10-5:25 P.M.** | 56.9 dB | 69.4 dB | 50.7 dB |
| **5:30-5:45 P.M.** | 52.7 dB | 72.5 dB | 49.9 dB |

Figure 3.5: Noise monitoring at Punjabi Bagh School

(2**) Residential Zone**: These were the locations around residential colonies, flats, residential welfare associations, etc. Some of the sites identified for noise monitoring under this category are Rohini Sec 16 (Figure-3.4), R.K. Puram C.P.W.D Quarters(Figure-3.5), Punjabi Bagh Residential Area(Figure-3.6), Mandir Marg Residential Colony(Figure-3.7), National Flats, Dwarka (Figure-3.8). Noise levels monitored at these locations are shown in Table 3.6-3.8. Among all the five residential locations, three locations:- Rohini Sector-16, Punjabi Bagh and National Flat ,Dwarka were the locations where noise level exceeded the standard limit of 55 dB set by C.P.C.B. while R.K. Puram and Mandir Marg observed less than 55 dB noise level.

Table 3.4: Noise at Rohini Sector-16

| **Time** | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **3:55-4:10 P.M.** | 65.8 Db | 89.9 dB | 53.3 dB |
| **4:15-4;30 P.M.** | 73.5 dB | 88.7 dB | 50.8 dB |
| **4:35-4:50 P.M.** | 60.4 dB | 92.4 dB | 54.2 dB |
| **4:55-5:10 P.M.** | 55.9 dB | 82.2 dB | 45 dB |


Figure 3.6 Noise monitoring at Rohini Sector-16

Table 3.5: Noise level at R.K. Puram C.P.W.D Quarters

| **Time** | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **2:10-2:25 P.M.** | 52.9 dB | 78.8 dB | 47.3 dB |
| **2:30-2:45 P.M.** | 51.0 dB | 74.1 dB | 46.7 dB |
| **2:50-3;05 P.M.** | 50.2 dB | 78.8 dB | 45.5 dB |
| **3:10-3:25 P.M.** | 51.9 dB | 63.2 dB | 45.7 dB |


Figure 3.7 Noise Monitoring at R.K. Puram C.P.W.D Flats

Table 3.6: Noise level at Punjabi Bagh Residential Area

| Time | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **6:00-6:15 P.M.** | 57.8 dB | 69.3 dB | 55.8 dB |
| **6:20-6:35 P.M.** | 58.9 dB | 67.9 dB | 56.1 dB |
| **6:40-6:55 P.M.** | 56.5 dB | 75.7 dB | 56.1 dB |
| **7:00-7:15 P.M.** | 57.3 dB | 70.8 dB | 56.1 dB |


Figure 3.8: Noise Monitoring at Punjabi Bagh Residential Area

Table 3.7: Noise level at Mandir Marg Residential Colony

| Time | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **11;50-12:05 P.M.** | 56.7 dB | 85 dB | 53.4 dB |
| **12:10-12:25 P.M.** | 56.9 dB | 75.1 dB | 52.9 dB |
| **12:30-12:45P.M.** | 57.4 dB | 86.1 dB | 51.7 dB |
| **12:50-1;05 P.M.** | 63.9 dB | 83.3 dB | 52.3 dB |

Figure 3.9: Noise monitoring at Mandir Marg (Residential Area)

Table 3.8: Noise level at National Flats, Dwarka

| Time | $L_{eq}$ | $L_A$(Max) | $L_A$(Min) |
|---|---|---|---|
| **2:15-2:30 P.M.** | 68.1 dB | 88.2 dB | 52.7 dB |
| **2:35-2;50 P.M.** | 67.4 dB | 88.2 dB | 50.9 dB |
| **3:00-3:15 P.M.** | 63.9 dB | 75.3 dB | 50.7 dB |
| **3:20-3:35 P.M.** | 60.7 dB | 80.6 dB | 50.5 dB |


Figure 3.10: Noise monitoring at National Flats, Dwarka

(**3) Commercial Zone**: The locations identified as Market area, office building, commercial complex, etc. Some of the sites identified for noise monitoring are Vikas Bhawan (Figure-3.11), Karkardooma Court (Figure-3.12), Karkardooma Market (Figure-3.13), and I.C.A.I. (Figure-3.14). The noise level monitored are shown in Table 3.9-3.12. Among the selected three locations of commercial zone, Karkardooma Market and I.C.A.I observed the standard limit of 65 dB exceeded by 6.4% and 7.47%, respectively.

Table 3.9: Noise level at Vikas Bhawan, Civil Lines

| **Time** | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **1:20-1:35 P.M.** | 54.6 dB | 83.1 dB | 51 dB |
| **1;40-1:55 P.M.** | 55.1 dB | 92.8 Db | 51 dB |
| **2:00-2:15 P.M.** | 55.9 dB | 78.1 dB | 51.2 dB |
| **2:20-2:35 P.M.** | 57.1 dB | 75.8 dB | 51.1 dB |

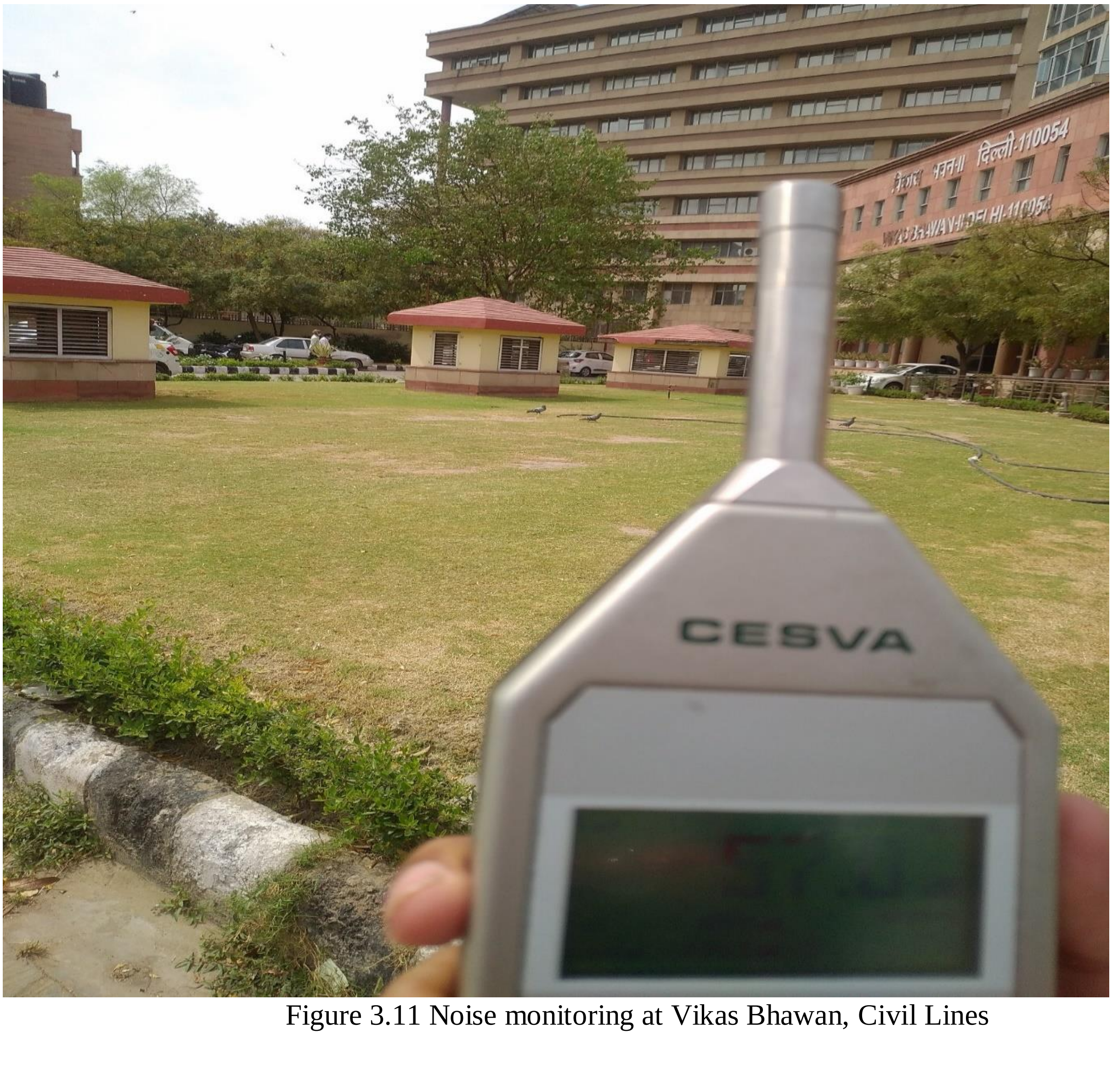


Figure 3.11 Noise monitoring at Vikas Bhawan, Civil Lines

Table 3.10 Noise level at Karkardooma Court

| **Time** | **$L_{eq}$** | **$L_{A(Max)}$** | **$L_{A(Min)}$** |
|---|---|---|---|
| **2:30-2:45 P.M.** | 62.8 dB | 80.2 dB | 49.9 dB |
| **2:50-3:05 P.M.** | 65.1 dB | 81.4 dB | 49.7 dB |
| **3:10-3:25P.M.** | 59.7 dB | 81.7 dB | 50.7 dB |
| **3:30-3:45 P.M.** | 61.6 dB | 81.0 dB | 51.2 dB |

Figure 3.12: Noise Monitoring at Karkardooma Court

Table 3.11 Noise level at Karkardooma Market

| Time | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **4:00-4:15 P.M.** | 68.1 dB | 84.4 dB | 61.3 dB |
| **4:20-4:35 P.M.** | 72.3 dB | 88.4 dB | 63.0 dB |
| **4:40-4:55 P.M.** | 68.2 dB | 84.8 dB | 60.8 dB |
| **5:00-5;15 P.M.** | 64.9 dB | 88.9 dB | 61.8 dB |


Figure 3.13: Noise Monitoring at Karkardooma Market

Table 3.12: Noise level at I.C.A.I

| **Time** | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **4:30-4:45 P.M.** | 69.1 dB | 89.2 dB | 60.5 dB |
| **4:50-5:05 P.M.** | 70.6 dB | 94.1 dB | 61.3 dB |
| **5:10-5:25 P.M.** | 69.1 dB | 89.2 dB | 62.3 dB |
| **5;30-5;45 P.M.** | 70.4 dB | 93.7 dB | 65.2 dB |


Figure 3.14: Noise Monitoring at I.C.A.I

**(4) Industrial Zone**: Industrial zones are areas confining to factories, manufacturing unit areas, etc. Some of the identified Industrial locations are the Badli Industrial area (Figure-3.15)and Patparganj Industrial Area (Figure-3.16). The noise level monitored is shown in Table 3.13- 3.14. Both the locations in the industrial zone have complied with the prescribed limit of 65 dB.

Table 3.13 Noise level at Badli Industrial Area

| **Time** | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **3:34-3:46 P.M.** | 63.2 dB | 81.0 dB | 55.4 dB |
| **3:55-4:10 P.M.** | 66.1 dB | 86.3 dB | 52.7 dB |
| **4:15-4:30 P.M.** | 64.0 dB | 91.5 dB | 56.3 dB |
| **4:35-4:50 P.M.** | 65.3 dB | 82.2 dB | 55.8 dB |

Figure 3.15: Noise Monitoring at Badli Industrial Area

Table 3.14 Noise level at Patparganj Industrial Area

| Time | $L_{eq}$ | $L_{A(Max)}$ | $L_{A(Min)}$ |
|---|---|---|---|
| **2:00-2:15 P.M.** | 67.4 dB | 77.9 dB | 55.2 dB |
| **2:20-2:35 P.M.** | 70.2 dB | 94.6 dB | 56.3 dB |
| **2:40-2:55 P.M.** | 66.1 dB | 88.2 dB | 61.2 dB |
| **3;00-3:15 P.M.** | 65.8 dB | 79.3 dB | 49.3 dB |

Figure 3.16: Noise Monitoring at Patparganj Industrial Area

(5) **Roadside Locations**: To incorporate road noise into the study, noise monitoring was also carried out at roadside locations in Delhi like: D.T.U (Figure-4.15), Civil Lines (Figure-4.16), and I.T.O (Figure-4.17). The noise levels monitored at the site are presented in Table 4.15-4.17.

Table 3.15 Noise Level at Road Section D.T.U.

| **Time** | **$L_{eq}$** | **$LA_{(Max)}$** | **$L_{A(Min)}$** |
|---|---|---|---|
| **3:34-3:46 P.M.** | 74.5 dB | 88.3 dB | 60 dB |
| **3:55-4:10 P.M.** | 74.4 dB | 86.3 dB | 61.8 dB |
| **4:15-4:30 P.M.** | 71.4 dB | 84.6 dB | 62.5 dB |
| **4:35-4:50 P.M.** | 77.5 dB | 91.6 dB | 62.7 dB |

Figure 3.17 Roadside Noise Monitoring at D.T.U

Table 3.16. Noise level at Civil Lines

| Time | $L_{Aeq}$ | $L_{A(MAX)}$ | $L_{A(MIN)}$ |
|---|---|---|---|
| **12:00-12:15 P.M.** | 67.5 dB | 84.9 dB | 56.6 dB |
| **12:20-12:35 P.M.** | 73.1 dB | 93.1 dB | 56.0 dB |
| **12:40-12:55 P.M.** | 70.5 dB | 86.9 dB | 56.1 dB |
| **1:00-1:15 P.M.** | 72.5 dB | 83.9 dB | 58.8 dB |

Figure 3.18 Roadside Noise Monitoring at Civil Lines

Table 3.17 Noise Level monitored at I.T.O

| Time | $L_A(eq)$ | $L_A(Max)$ | $L_A(Min)$ |
|---|---|---|---|
| **3:05-3:20 P.M.** | 70.7 dB | 87.5 dB | 57.9 dB |
| **3:25-3:40 P.M.** | 74.3 dB | 82.3 dB | 58.1 dB |
| **3:45-4:00 P.M.** | 73.1 dB | 79.2 dB | 57.7 dB |
| **4;05-4:20 P.M.** | 63.0 dB | 92.4 dB | 57.6 dB |


Figure 3.19 Roadside Noise monitoring at. I.T.O

### **3.2.2 Secondary Noise Data**:

Noise data of 2019 was collected from the ENVIS (Environmental Information System)) portal of CPCB at ten different monitoring stations of DPCC and CPCB and are depicted in Figure 3.20

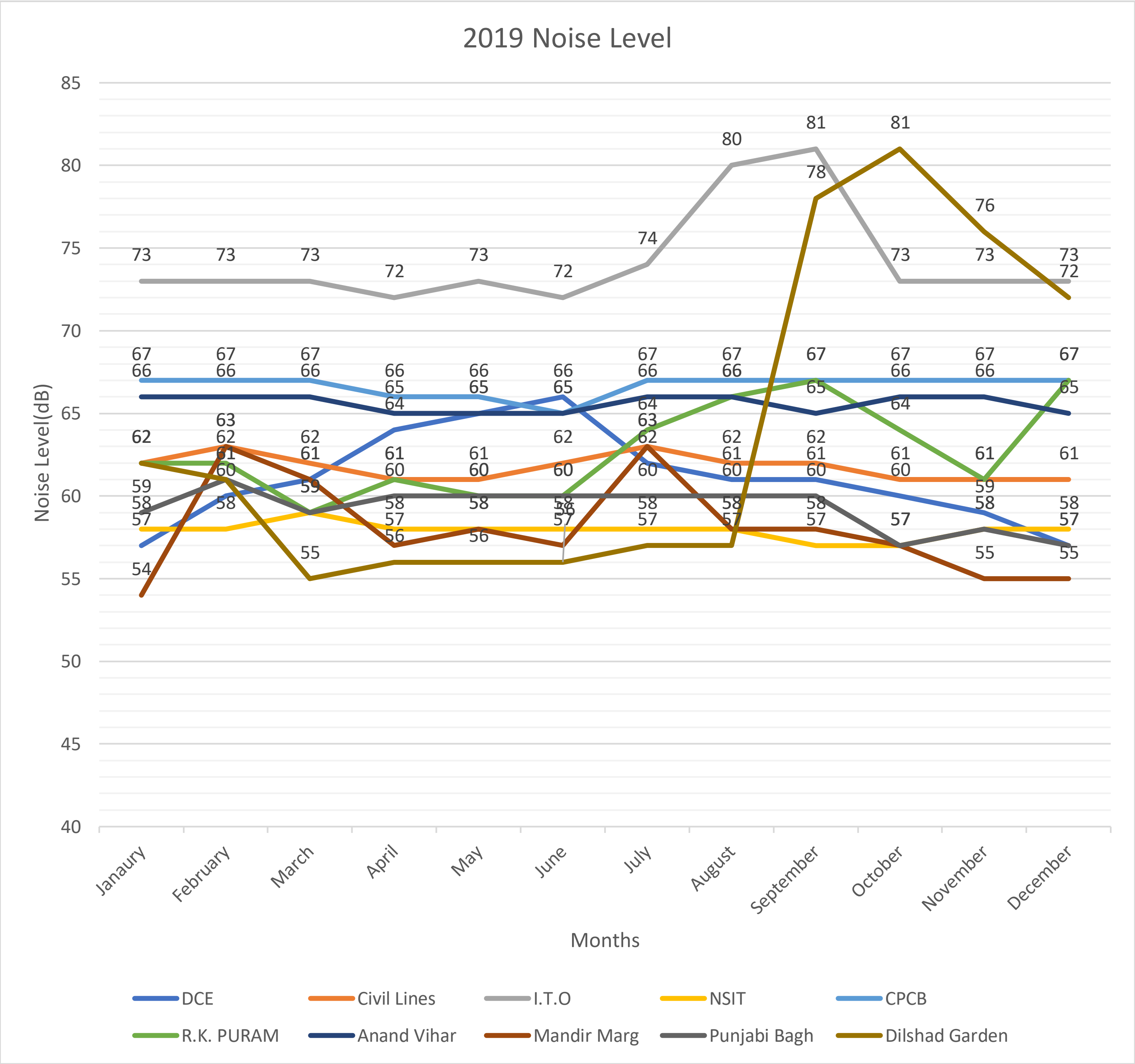


Figure 3.20: Noise levels at different C.P.C.B. monitoring Stations in 2019

The noise level of 10 stations was averaged over the year to get a representative noise value of each station.

$L_{eq} = 10\log_{10}(10^{Ln1/10} + 10^{Ln2/10} + 10^{Ln3/10} \ldots\ldots\ldots\ldots\ldots\ldots + 10^{Ln12/10}$

Calculation of the Logarithmic mean value of all the stations from all the monthly data is depicted in figure 3.21:-

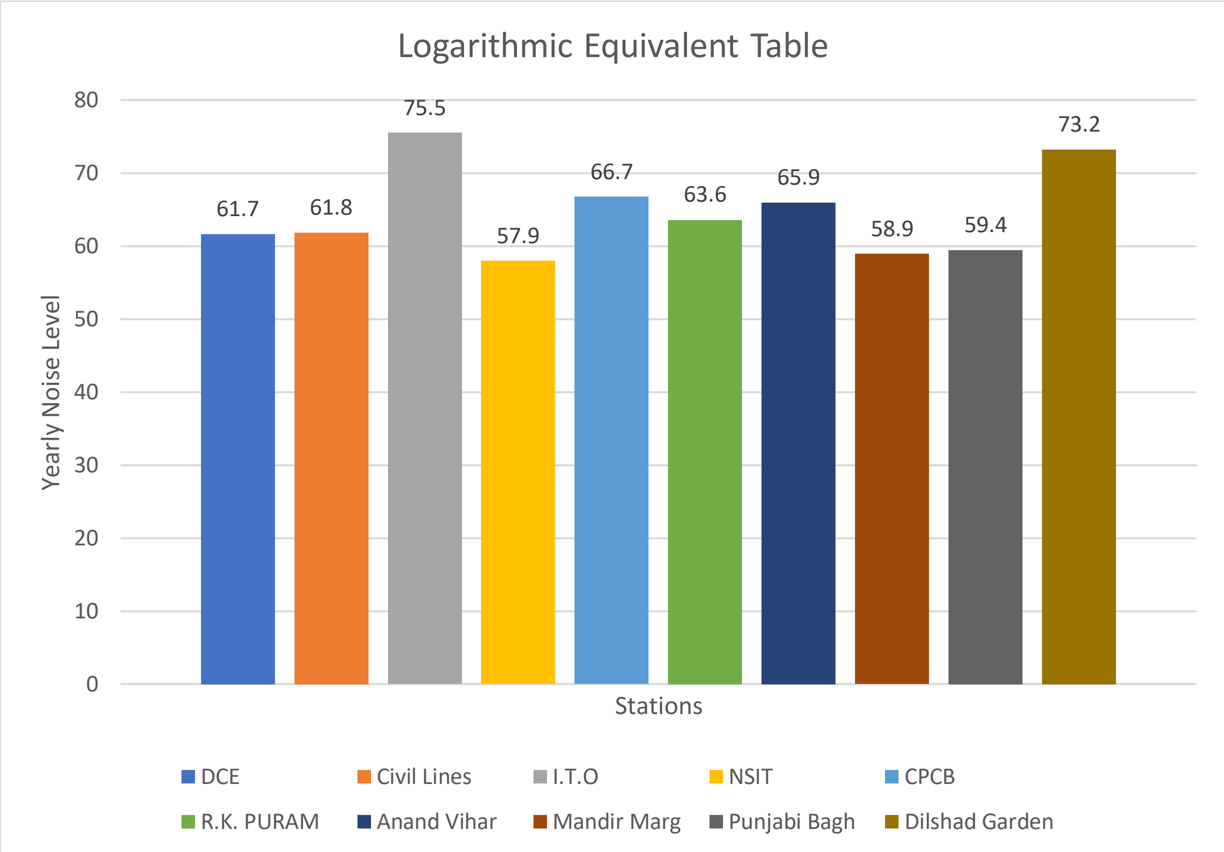


Figure 3.21: Annual Logarithmic Average Noise Level at each Station

Apart from noise data from CPCB, some noise data was taken from the EIA report of the Extension of NH344M in Delhi from Bawana Industrial Area to Sonipat, Haryana, and extension of a link road from the link Dichaon Kalan to Bahadurgarh, Haryana. Amaltas Environmental Services prepared the EIA report and the project proponent was NHAI. The noise monitoring period was between October 2019 to December 2019. Noise Data set taken from EIA Report during the period October 2019 to December 2019 is shown in Table 3.18.

Table 3.18 Noise Level from E.I.A. Report

| Monitoring Station | Noise Level ($L_{eq}$) Daytime |
|---|---|
| **DSIDC Industrial Area** | 67.8 dB |
| **Swarn Park** | 67.8 dB |
| **Kakroi** | 48.7 dB |
| **Mundka Industrial Area** | 68.0 dB |
| **Bawana Industrial Area** | 50.0 dB |
| **Bahadurgarh** | 50.8 dB |
| **Neelwal Crossing** | 48.3 dB |
| **Dichaon Enclave** | 46.0 dB |
| **Deenpur** | 52.0 dB |
| **Qutub Vihar-II** | 50.8 dB |
| **Chhawla Village** | 51.5 dB |
| **Najafgarh Drain** | 51.8 dB |

## 3.3 Health Data of 2019:

To assess the total number of hospital admission of Ischemic Heart Disease due to noise pollution in Delhi, it is essential to collect the total hospital admissions of Ischemic Heart Disease in different hospitals of Delhi. This data is used to calculate Population Attributable Fraction, which signifies what fraction of the entire hospital admission is due to noise pollution. Delhi Statistical Department of Delhi Government releases the Health and Family Welfare report each current year in December next year. This report has been used to collect total hospital admissions of Ischemic Heart Disease in Delhi. But the hospital admissions also reported the patients who succumbed to death from the disease. It was required to subtract the total death due to that disease from the entire hospital admissions for that year. Death data has been taken from the Death & Birth Report of 2019, Delhi Government.

For year 2019, from Health & Family Report, there are 52,964 hospital admissions{33,047(Male)+ 19,917(Female)} which include both O.P.D & I.P.D admissions in various hospitals of Delhi. While the number of Death from Ischemic Heart Disease as reported in the Death & Birth report of 2019 in Delhi is 650{418(Male)+232(Female)} (Family Health & Welfare Report 2019 and Death & Birth Report Delhi 2019)

### 3.4 Noise Data

The noise data has been taken from the EIA report and CPCB ENVIS Portal. The monitoring stations from these datasets are divided into 4 different classes based upon their land use pattern: Silent, Commercial, Industrial, and Residential. The average noise level for each class is calculated and shown in Table 3.19.

Table 3.19: Noise Data at Selected Locations in Delhi

| Silent | Residential | Industrial | Commercial |
|---|---|---|---|
| Dilshad Garden-57.96 dB | N.S.I.T- 57.29 dB | Narela- 67.78 | C.P.CB- 65.74 dB |
| R.K. Puram- 61.37 dB | Mandir Marg – 57.72 dB | Bawana- 50.07 dB | I.T.O- 73.13 dB |
| D.T.U- 55.88 dB | Punjabi Bagh- 59.64 dB | Mundka – 68.04 dB | Anand Vihar- 66.45 dB |
| Kakroi- 48.74 dB | Deenpur- 52.01 dB | Swarn Park – 67.78 dB | Civil Lines- 61.038 dB |
| Najafgarh- 51.78 dB | Qutub Vihar- 50.8 dB | - | - |
| Chhawla Village-51.47 dB | - | - | - |
| Average- 54.533 dB | Average- 55.492 dB | Average – 63.417 dB | Average- 66.67 dB |

Now, this noise level obtained from reports is verified using the noise level obtained from noise monitoring at the actual location station, which is depicted in Table 3.20 and deviations are checked.

Table 3.20: Noise Level Monitoring at Selected Stations

| Silent | Residential | Commercial | Industrial | Roadside |
|---|---|---|---|---|
| R.K. Puram School- 52.86 dB | Rohini Sec 16- 68.4 dB | Vikas Bhawan- 55.78 dB | Badli Industrial Area-65.3 dB | D.T.U-74.97 dB |
| Punjabi Bagh School- 54.84 | R.K. Puram- 51.617 | Karkardooma Market- 69.16 dB | Patparganj– 67.1 dB | Civil Lines - 71.386 dB |
| I.H.B.A.S -68.7 dB | Punjabi Bagh – 57.713 dB | Karkardooma Court- 62.74 dB | _ | I.TO – 71.838 dB |
| _ | Mandir Marg- 54.95 | I.C.A.I- 69.856 dB | _ | _ |
| _ | National Flats- 65.802 dB | _ | _ | _ |
| Average- 56.125 dB | Average- 60.69 dB | Average- 64.03 dB | Average- 66.2 dB | Average- 70.28 dB |

Noise levels given in the E.I.A report and CPCB stations were validated after the noise level of different classes according to the land use pattern given in the E.I.A report was compared with the noise level collected during a site visit same type of locations according to land use pattern. Comparison of the average noise level of all locations in silent zone collected from the site visit and the average noise level of all locations in the silent zone of E.I.A report showed a difference of 1.59 dB while for the residential, commercial, and industrial zone the difference between average noise level collected from the site visit and average noise level from E.I.A report showed a difference of 5.198 dB,0.613 dB, and 0.47 dB. The difference was large in only residential areas due to mixed type of land use pattern in residential localities.

## 3.5 Noise level of the different zone in Delhi

1) **Silent Zone**: These are defined as per Noise Act 2000, by CPCB. All the locations are pertaining to about 100 meters range of hospitals, Schools, Temples, Churches, Mosques, Crematory, etc. All the locations in the city identified as these locations will be defined as silent zones. In the report, all the locations of the silent zone were averaged and the noise level came out to be 54.5 dB and during monitoring, it came out to be 56.1 dB. Figure 3.22 shows all the silent zones used for developing noise-map.

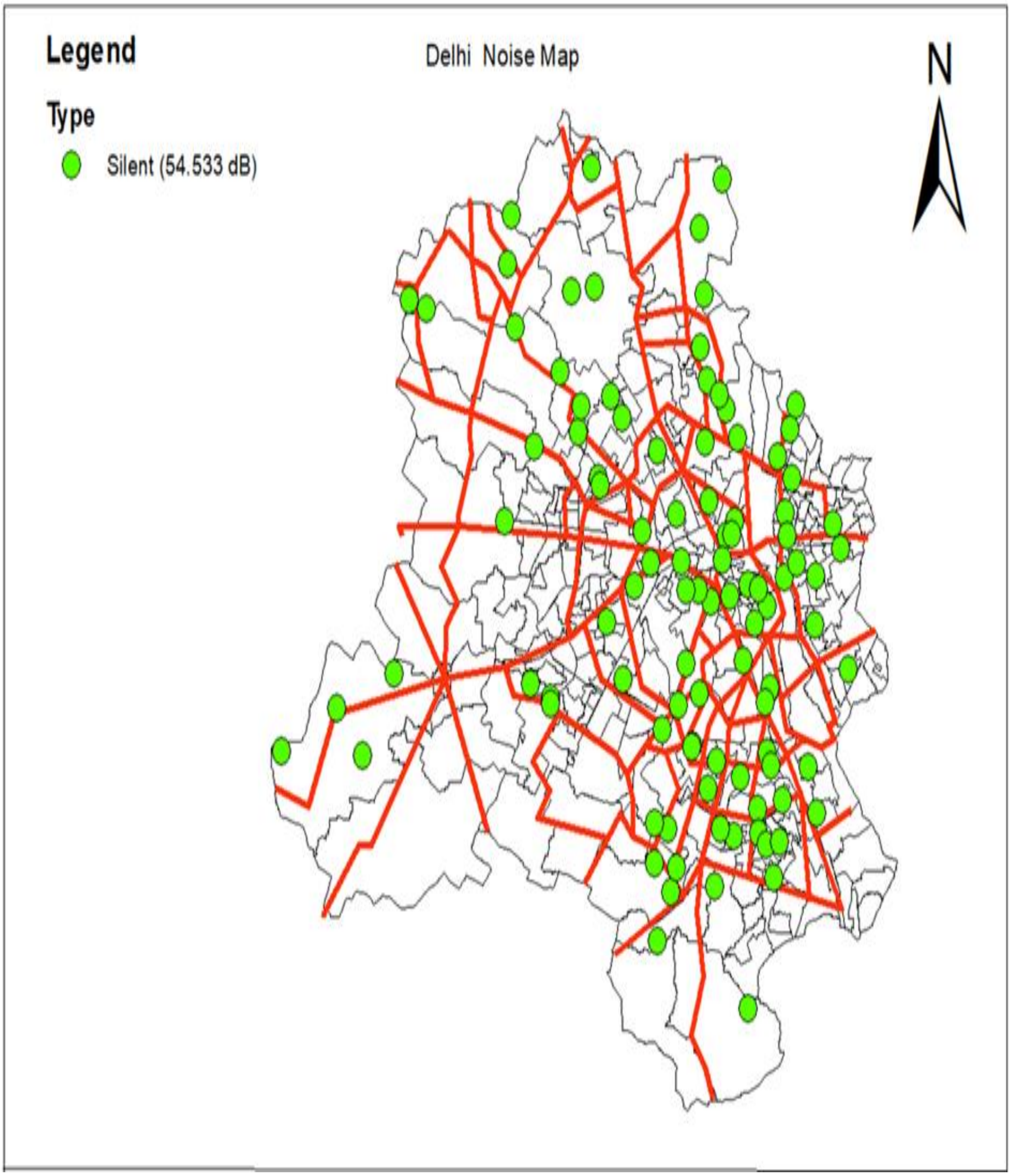


Figure 3.22: Silent Zone Localities in Delhi

2) **Residential Zone**: Residential Zone are defined as apartments, residential colonies, residential welfare associations, municipal colonies. All the locations under this name are plotted with the noise level of the residential zone. The average noise level of this class from the report came out to be 55.5 dB. While monitoring noise levels in these locations averaged 60.7 dB. Figure 3.23 shows all the residential zones of Delhi used in developing noise-map.

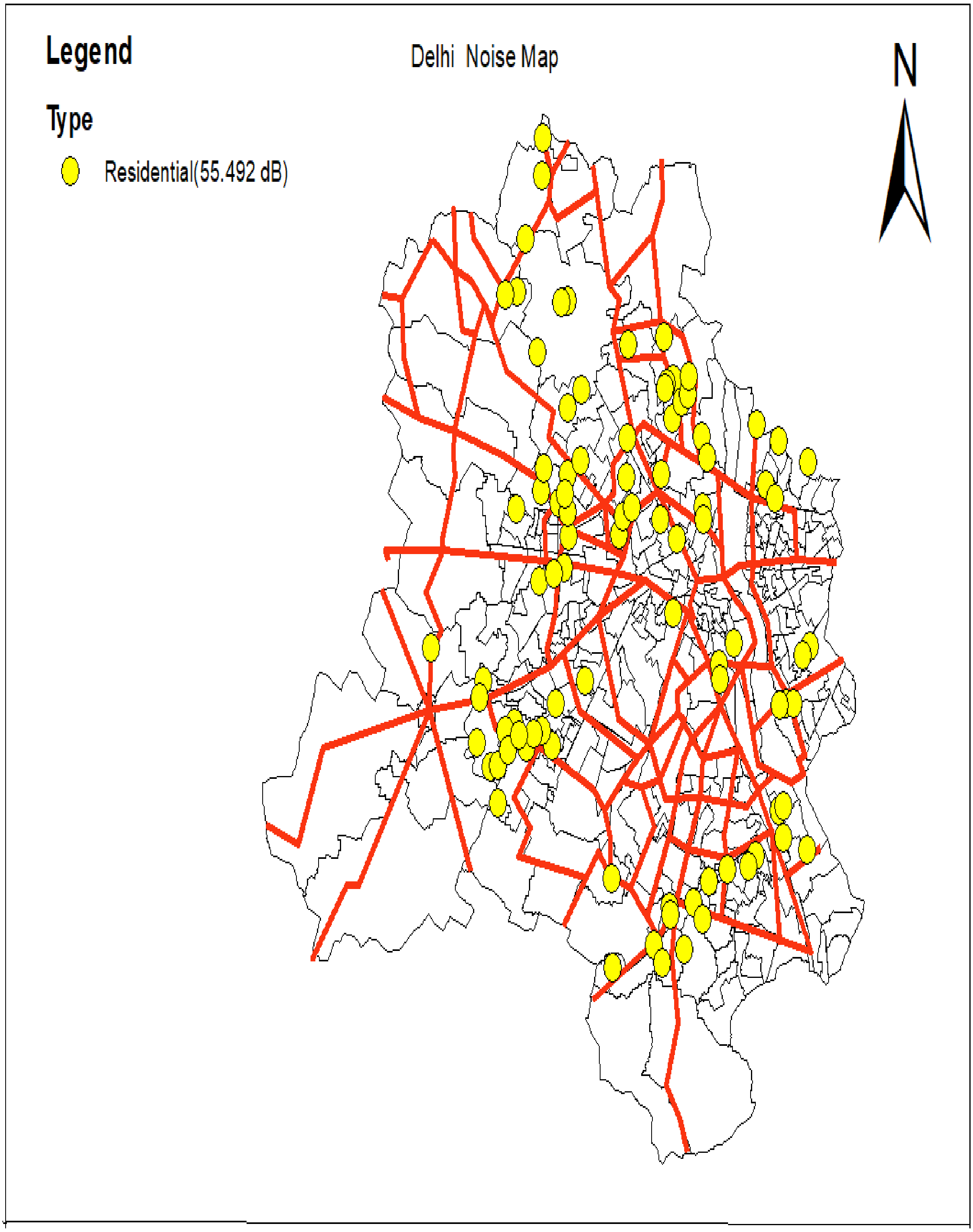


Figure 3.23: Residential Locations in Delhi

3) **<u>Commercial Zone</u>**: Commercial zones are defined as all the locations having a market, district center, offices, mall, commercial outings, railway stations, bus stop, airport, etc. The averaged noise level in these locations from the report and monitoring came out as 63.4 dB and 64.1 dB. Figure 3.24 shows all the commercial locations in Delhi used in developing noise-map.

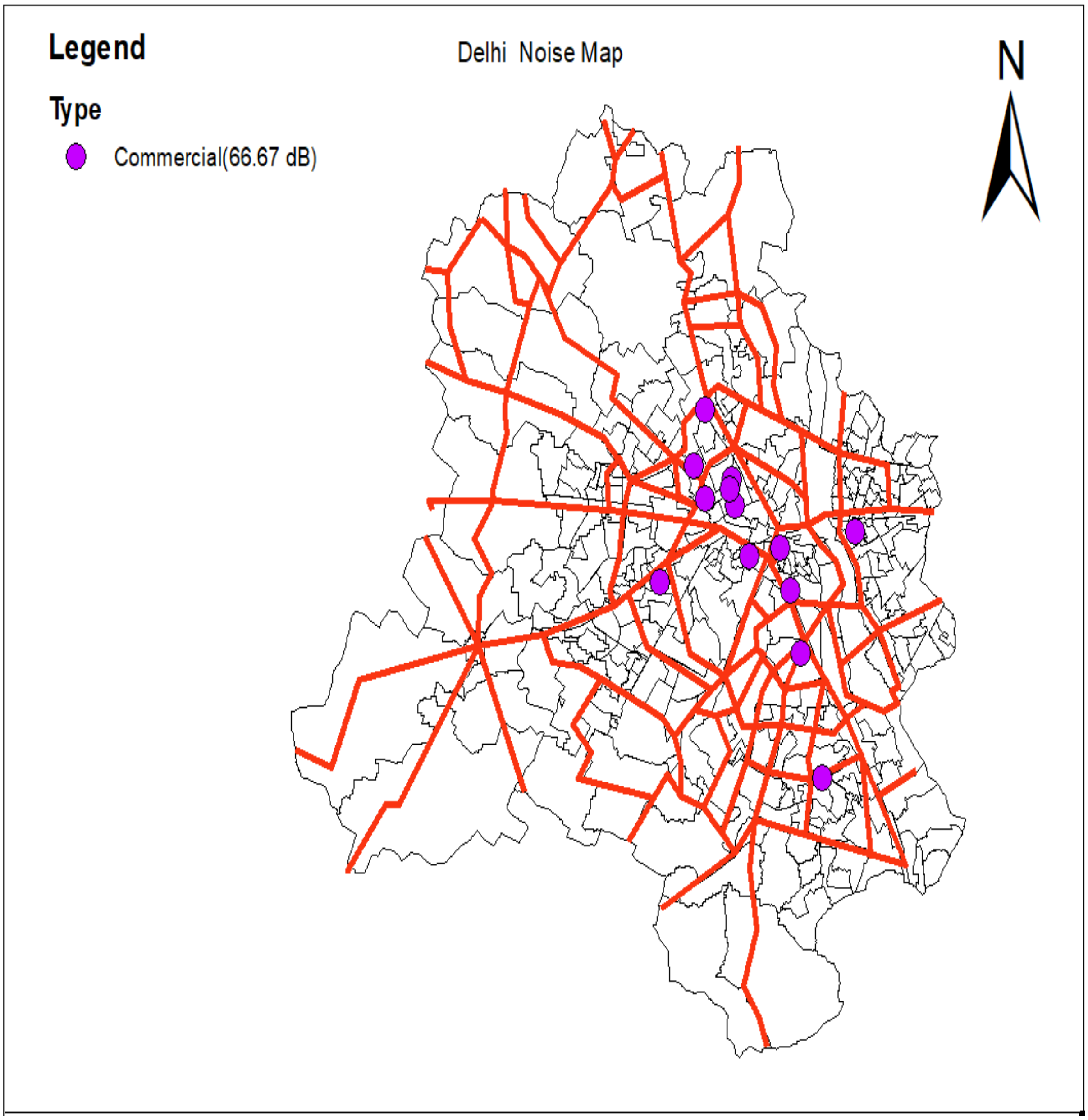


Figure 3.24: Commercial Localities in Delhi

4) **Industrial Zone**: All the locations in the city comprising factories, warehouses, storage facilities, manufacturing units are kept under industrial zones. The average noise level from both E.I.A report and monitoring station in this class is 66.7 dB and 66.2 dB. Figure 3.25 depicts the industrial locations in Delhi used to develop noise-map.

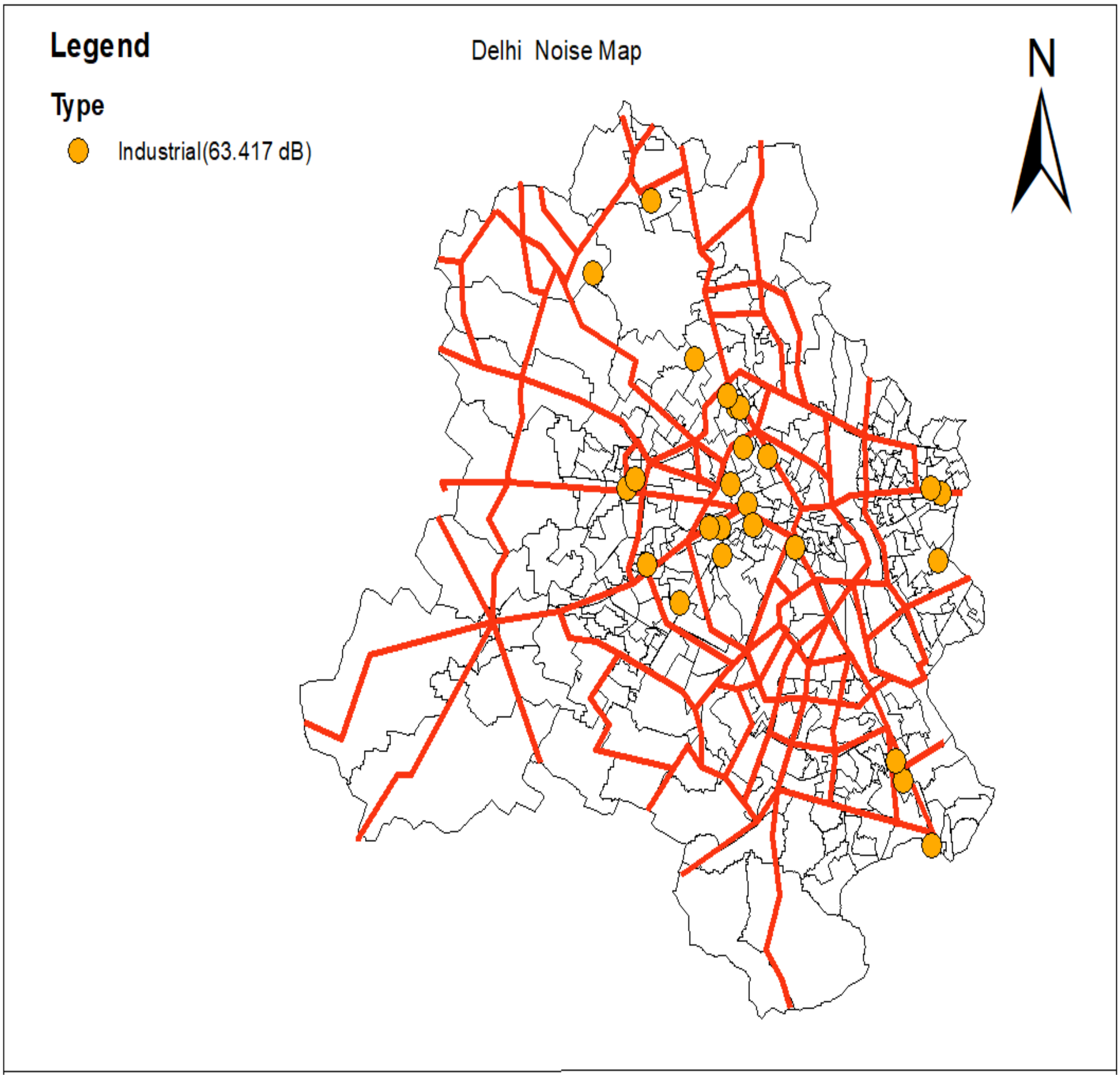


Figure 3.25: Industrial Locations of Delhi

### 3.6 Noise Mapping:

Noise mapping is done using ArcGIS software. All the locations of Delhi are classified into silent, commercial, residential, and industrial according to their land use. The average noise value of these classes obtained from the report is plotted to the respective locations over the shapefile of the Delhi ward boundary map which is shown in Figure 3.26.

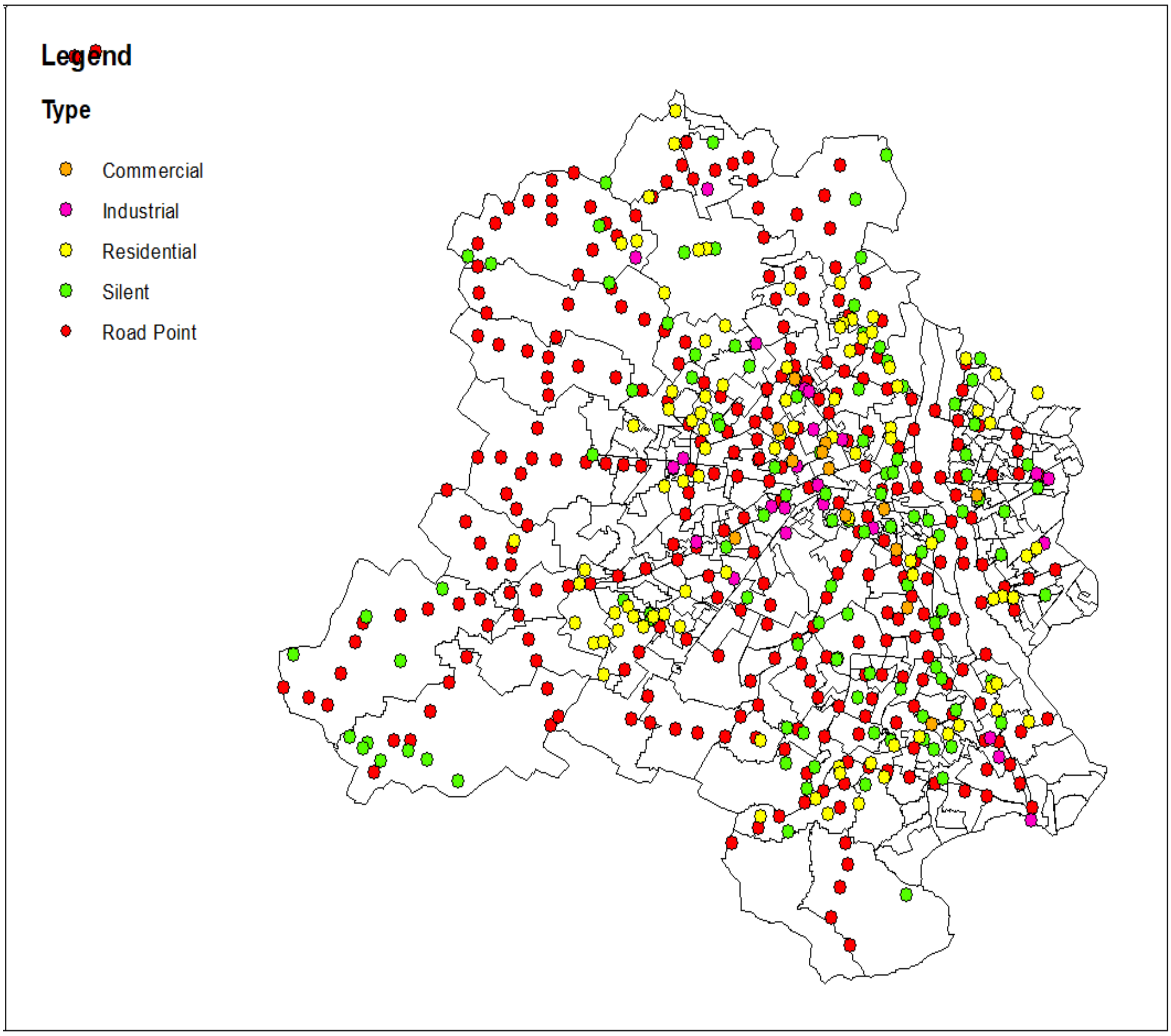


Figure 3.26: Landuse Pattern Based Noise-map

With the classified points, a noise map is developed using the IDW interpolation technique in ArcGIS and shown in Figure 3.27.

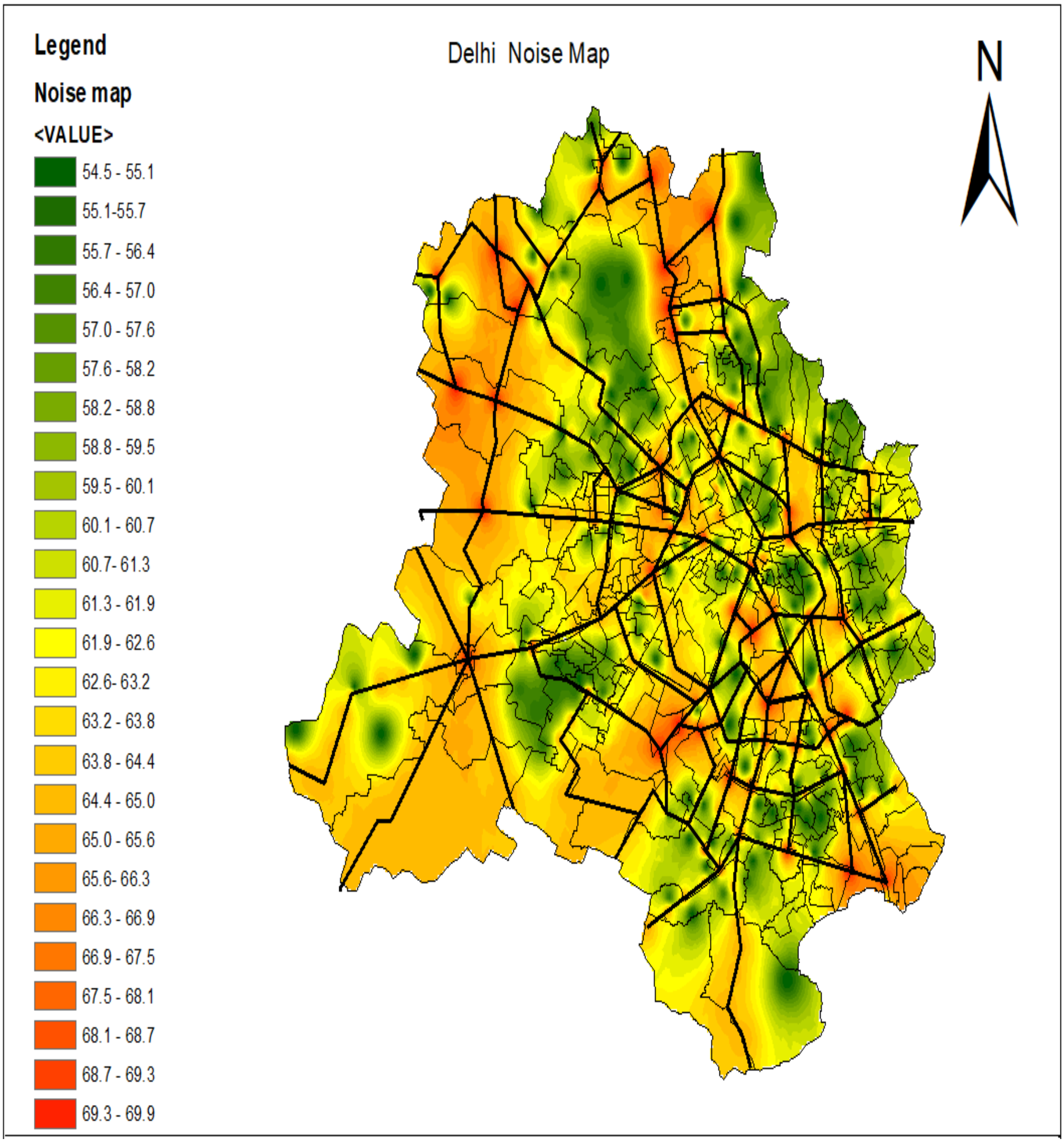


Figure 3.27: ArcGIS developed Noise-map of Delhi

# Chapter 4

# Results & Discussion

The impact analysis of noise pollution on the number of hospital admissions resulting in heart diseases is drawn using Population Attributable Fraction (P.A.F) calculated from noise-maps developed. Secondly the environmental burden of noise pollution developed heart disease is calculated using the concept of Disability Adjusted Life Years (D.A.L.Y.) which is the sum of Years of Life Lost due to early death from disease (Y.L.L.) and Years of Life lived in Disability (Y.L.D.).

## 4.1 Population attributable fraction calculation

After developing a noise map, an evaluation of the noise level in each MCD ward from the noise map is computed. This noise level pertains to a particular ward that will serve a particular population. The subsequent evaluation of the population of each MCD ward in 2019 has been done. This population can be evaluated using Census data from the Census of India ((Registrar General & Census Commissioner, 2014). The population given in this data is of 2011, so estimation of the population of 2019 is done using the geometric increase method prescribed by the Government of India. The rate of increase of population for Delhi for decade 2011-2021 is taken according to Master Plan of Delhi 2021.

Table 4.1: Population Distribution according to Noise Class

| Noise Category | Population |
|---|---|
| 55-60 dB | 6,094,763 |
| 60-65 dB | 11,127,355 |
| 65-70 dB | 2,356,350 |
| 70-75 dB | 585,225 |

After one has the noise level and population it serves for each MCD ward, one can classify each MCD ward in different noise categories: 60 dB, 60-65 dB, 65-70 dB,>70 dB. Table 4.1

tabulates all the population of MCD ward in which noise level is in one range according to noise category. After this, the attributable population factor is calculated using relative risk and percentage of population exposed to each noise level. Table 4.2 depicts the percentage of the people who fall in each noise category along with its relative risk and population.

Table 4.2 Population Attributable Fraction (P.A.F.) Calculation Table

| Noise Category | Population | Percentage | Relative Risk |
|---|---|---|---|
| 55-60 dB | 6,094,763 | 30.226% | 1 |
| 60-65 dB | 11,127,355 | 55.185% | 1.031 |
| 65-70 dB | 2,356,350 | 11.686% | 1.099 |
| 70-75 dB | 585,225 | 2.90237% | 1.21 |

$$P.A.F\%: \frac{(1X0.30226+1.031X0.55185+1.099X0.11686+1.121X0.02902)-1}{1X0.30226+1.031X0.55185+1.099X0.11686+1.121X0.02902} X100 = 3.3145\% \quad \text{-(i)}$$

After calculating P.A.F, multiply this to total hospital admission of ischemic heart disease in 2019 and the resultant number depicts the total contribution of environmental noise pollution in the number of ischemic heart disease cases.

We would need to use health data from the Delhi Health & Family Welfare report to assign the number of hospital admissions due to noise pollution, which is available for the most recent year of 2019 and is published in December 2020 for the data of 2019. As a result, a risk assessment for the year 2019 is conducted. The percentage of ischemic hospital admissions was calculated.

From Health & Family Report 2019, the total number of ischemic heart disease cases in 2019 is 52,964 ( 33047 Male+ 19917 Female). Out of these, 3487 (2316 Male + 1171 Female) are mortality cases due to ischemic heart disease, to carry out the hospital admissions due to noise pollution, fatalities are subtracted from total admissions to carry out active cases. Hence the number of active cases of ischemic heart disease in 2019 were 52,964-3487=49,477. Out of these 49,477 cases, the contribution from noise pollution is determined by multiplying these to P.A.F (3.3145%) hence 3.3145% of 49,477 =1640. Since myocardial infarction or simply heart attack is also included in Ischemic Heart Disease, the same way the number of hospital admissions of Myocardial Infarction which is also a type of ischemic heart disease is calculated and comes out to be 75.

## 4.2 Environmental Burden of Disease for Noise Pollution

The EBD incorporates the notions of potential years of life lost due to premature death and equal years of ‘healthy' life lost due to poor health or disability. EBD Methodology is based on Disability-Adjusted Life Years (DALY) which is the sum of Y.L.L. (Years of life lost due to early death from Disability) and Y.L.D (Years of life lived with Disability). Y.L.L is calculated using the sum of (1)Total male death multiplied by its life expectancy at that age and (2) Total Female death multiplied by its life expectancy at that age. To compute Y.L.D, which is mathematically equal to the product of several active cases due to disease to its disability weight and average duration of disability. To evaluate this one needs the population's noise exposure distribution, exposure-response relationships for each health outcome of interest, and a disability weight (DW) estimate for each result Table 4.3 shows Life Expectancy Table used to carry out Life expectancy at different ages of both males and females.

Table 4.3. Life Expectancy of different age group people

| Age | Male Death | Life Expectancy | Female Death | Life Expectancy |
|---|---|---|---|---|
| <1 | 23 | 68.8 | 16 | 71.1 |
| 1-4 | 4 | 66.8 | 6 | 69.1 |
| 5-14 | 5 | 58.8 | 9 | 61.1 |
| 15-24 | 24 | 48.8 | 23 | 51.1 |
| 25-34 | 74 | 38.8 | 27 | 41.1 |
| 35-44 | 186 | 28.8 | 57 | 31.1 |

| | | | | |
|---|---|---|---|---|
| 45-54 | 379 | 18.8 | 145 | 21.1 |
| 55-64 | 625 | 8.8 | 265 | 11.1 |
| 65-69 | 285 | 1.8 | 150 | 4.1 |
| >70 | 710 | 0 | 473 | 1.1 |

**D.A.L.Y= Y.L.D+Y.L.L**-(ii)

**Y.L.L**= ∑No. of males death x life expectancy at that age:-

(23x68.8+4x66.8+5x58.8+24x48.8+74x38.8+186x28.8+379x18.8+625x8.8+285x1.8+710x0) -(ii)

∑No. of females death x lifeexpectancy at that age:-

(16x71.1+6x69.1+9x61.1+23x51.1+27x41.1+57x31.1+145x21.1+265x11.1+150x4.1+473x1.1)-(iii)

Using (ii) & (iiii)

**Total YLL** : 24681(Males) and (Females) 10354.6 Years-(iv)

**YLL for Ischemic Heart Diesease**= 3.152% of (24681+10354) years =1104.3032 years-(v)

**YLD for Ischemic Heart Disease**: no. of non-fatalities X Disability Weightage(0.45 for ischemic heart disease) X 1(assuming one year disability for each non-fatal case) = 1640 X 0.45 X1= 738 years-(vi)

Adding (v) & (vi)

**Total DALY**= 1842.3032 years –(vii)

Out of 1842.3032 years,333.634 years lost is due to Myocardial Infarction

So, in the year 2019, 1842.3032 years have been lost by people of Delhi at different ages due to disability of Ischemic Heart Disease, which can be attributed to noise pollution.

# Chapter 5.

# Conclusion

The noise level exceeds 70 dB in a 14 $km^2$ area, while it is 436 $km^2$ in the 65-70 dB range,746 $km^2$ in the 60-65 dB range, and 294 $km^2$ in the less than 60 dB range. It can be seen that most of the location in Delhi is experiencing noise level of 65-70 dB, which is permissible only in the case of industrial sites and clearly, it can be inferred that all other categories exceed their noise standards.

The total contribution of noise pollution in hospital admission for ischemic heart disease is 1640, out of which 75 cases are of myocardial infarction, which is 3.314% of total hospital admissions in that year. As noise level exceeds the permissible standards, the relative risk of developing heart disease is also increasing; hence, to control the number of heart disease cases, it is important to bring down the noise level.

From the Environmental Burden of Disease Methodology total number of healthy years lost by people in Delhi in 2019 due to noise pollution is 1843 years. Years lost out of myocardial infarction is 333 years. So we can infer from here that noise pollution also degrades life expectancy in an urban environment. Variation in noise level recorded on-site and taken from EIA report reflected 1.592 dB deviation in a silent zone,0.613 dB in commercial, 0.47 dB in the industrial zone while it went as high as 5.198 dB in the residential zone. This high variation in residential locations can be attributed to mixing land-use patterns prevailing in these locations.

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