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From Editors Desk…

Greetings!!!

With the growing urbanization and increased load of vehicles on the roads, there is huge air and noise pollution especially in the metro cities and it has direct impact on health of the people who are living in those metros. In this context the current volume presents, a research article on GIS for Urban Air & Noise Pollution Mapping - A Case Study of Thane City, India. The paper mainly focuses on air and noise pollution levels due to heavy vehicle flow in Thane city, the paper also analysed the levels of noise pollution on the overall environment of thane city using overlay and buffer analysis. The results highlights that the level of noise is higher than the standards prescribed by CPCB and it is directly affecting to the health of people living the Thane City.

I hope you will find this bulletin interesting and useful.

I encourage readers to contribute articles related to Population, Human Settlement and Environment for the future volumes.

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Designed by: Chandrakala R.

GIS for Urban Air &Noise Pollution Mapping - A Case Study of Thane City, India

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Introduction

Growing civilization and urbanization has increased the per capita income of cities. Thane city is India's one of such rapidly growing cities due toits vast growth in residential and commercial establishments as which has led to significant increase in number of vehicles responsible for the pollution in the city.

In cities, millions of people live in an environment with numerous dangerous gases; particularly vehicles produceCarbon dioxide (CO_2), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrous Oxide (NO_2) etc. Automobile traffic, in addition to creating considerable gaseous emissions, is also a source of considerable noise.

This project demonstrates use of GIS techniques as a powerful tool to monitor pollution level. Since pollution has become a major concern to urban planners, developers and health officials, it is necessary to check more frequently on the pollutant emission quantities and their spatial distributions and also to evaluate the variation. Hence, there are growing needs for tools that can provide an easy access to obtain up-to-date emissions information. The integrated model which combines dispersion model and databases in a GIS framework should be a suitable tool to satisfy the needs mentioned above.

Objectives of the study

- To measure prevailing air andnoise pollution levels due to heavy vehicle flow in the study area.
- To predict air pollution and noise levels for unsampled or non- monitored location values.
- To analyse noise levels on the overall environment of thane city using overlay and buffer analysis.

Study Area Profile

The study area is a part of thane district as shown in Figure No. 1 located on the northeast of the Salsette Island and on the northern extremity of Greater Mumbai. The city falls on 19.172431°N 72.957019°Eand has geographical area of 128.23 Sq. Km with its boundaries contiguous with that of Greater Mumbai, Navi Mumbai, Mira - Bhyander and Kalyan Municipal Corporation. Thane derived its name from "STHAN" or "STHANAKA", then known as the Head Quarter of the Konkan Kingdom of the Shilaharas.

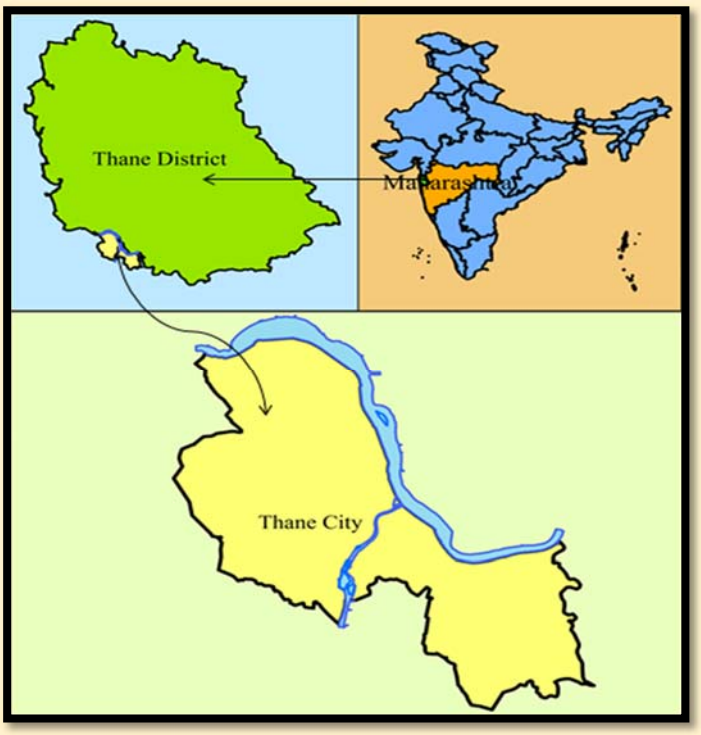
Thane became District Head Quarter and came up as an Industrial Town during 1960-70. The major industrial estates like Wagle, Kalwa, Kolshet and Balkum complex were developed during this decade. The city comprise of a number of lakes spread all over and hence is also called as “City of Lakes” named by Sir Patrick Geddes, an eminent British Town Planner during his visit to the city in 1915.

Table No. 1 Geographical array and weather of Thane City

Height From Mean Sea Level	7 (M.S.L)
Climate	Humid, Warm
Annual Max. Temperature	45°C
Min. and Max. Humidity	14% - 95%
Average Rainfall	2442.8 mm
Wind Direction and Speed	North to South West and Avg. Speed 0.5 to 5km/hr

(Source; Pollution Control Dept; TMC)

Figure 1 Location of Study Area



Methodology

a) Sampling& Analysis

The Survey was carried out by TMC in the month of May 2012 to assess the air and noise quality at 22 different locations as shown in Figure No. 2 which included Main RoadIntersections/ Junctions/Octroi/Check Naka, Market & Industrial Squares of Thane city through mobile laboratory fitted with Respirable Dust Sampler as shown in Figure No. 3for 8 hours and a Sound Level Meter to measure noise levels as shown in Figure No. 4. Observations made during survey were also noted down as shown in Table No. 2

Table No. 2 Description of the survey sites

LOCATIONS	REMARKS
Manpada Naka	Construction work of flyover bridge and road widening was in progress due to which heavy traffic was observed.
Waghbil Naka	Construction work of flyover bridge in progress.
Kapurbawadi Naka	Construction Work of flyover bridge and road widening in Progress due to which heavy traffic was observed.
BalkumOctroi Naka	This is Octroi Naka of thane municipal hence, heavy flow of vehicles & goods carrier vehicles were observed, road widening work was also in progress.

Malhar Cinema Chowk	Heavy traffic of small and big Vehicles and T.M.T buses.
Teen Hath Naka	At this place heavy vehicular traffic was observed.
Mulund Check Naka	This is check post of thane municipal hence, heavy flow of vehicles was observed.
AnandnagarOctroi Naka	This is Octroi Naka of thane municipal hence, heavy flow of vehicles & goods carrier vehicles were observed.
Nitin Company Junction	Due to completion of tar road and flyover bridge less vehicular traffic was observed.
Road No. 16	This is part of Wagale industrial estate of thane city with large and small scale industries, normal vehicle flow was observed.
I.T.I. Circle	This is part of Wagale industrial estate of thane city with large and small scale industries, normal vehicle flow was observed. Road repairing work was in progress.
Shastri Nagar Naka	Normal vehicular flow was observed.
YeoorGaon	Village located in thane district that lies in Sanjay Gandhi national park, known for wildlife. Normal vehicular flow was observed.
Castle Mill Naka	Heavy vehicular traffic of small vehicles & S.T & T.M.T buses.
Jambhali Naka	This Place is close to commercial market area with heavy vehicular flow. To the other side of this place is ChatrapatiShivajiMaharajMaidan
Gavdevi	This area is near to thane railway station hence a major transit point due to which heavy vehicular flow of Auto rickshaws, T.M.T buses and CNG vehicles were observed. This place is also commercial market place.
SATIS	The major transit point of Thane city is its railway station which required specific improvement. A two level transport system called Station Area Traffic Improvement Scheme (SATIS) was planned for Thane Station in previous years to segregate movement of buses and private vehicles which would ensure would ensure quick dispersal of traffic and thereby reducing congestion as well as air pollution levels. Here only S.T and T.M.T buses are allowed.
Kalwa Naka	This is residential area and one of the most crowded areas of thane city with heavy vehicular flow.
VitawaOctroi Naka	This is Octroi Naka of thane municipal hence, heavy flow of vehicles & goods carrier vehicles were observed.
Manisha Nagar	Here old Mumbai-Pune Road is under construction, due to which the vehicular flow was diverted by R.T.O causing more vehicular traffic
Shilphata	At this place there is flow of heavy vehicles.
Diva Dumping Ground	This Dumping Ground or Landfill is under thane municipal corporation, where the city waste is discharged and burnt.

Figure No. 2 Survey Locations

Figure No. 3 Respirable Dust Sampler

Figure No. 4 Sound Level Meter

Air Pollution

It is the presence in the atmosphere, or injection into it, of substances that are not present naturally or present naturally but in much smaller concentrations and that may harm living organisms directly or indirectly (Allbay 1995) this natural processes or human activities changes the constant percentage of different gases in it, is referred to as atmospheric pollution.

Table No. 3 Air Pollution Sources & Effects

Pollutants	Sources	Effects
NOx	Combustion of fuels like petrol, diesel, kerosene or coal	Increased susceptibility to infections, pulmonary diseases, impairment of lung function and eye, nose and throat irritations.
SOx	Volcanic eruptions and hot springs. Coal combustion, refining of metals from minerals containing sulphides and Industrial activities	Affects lung function adversely.
RSPM	Contain dust from roads and industries as well as particles formed under combustion	Fine particulate matter may be toxic in itself or may carry toxic (including carcinogenic) trace substance and can alter the immune system. Fine particulates penetrates deep into the respiratory system irritating lung tissue and causing long term disorders

Air Pollution Analysis

The analysis was carried out for following air parameters for NO_x, SO_x, and RSPM according to the Central Pollution Control Board (CPCB) prescribed method.

1. For NO_X (Modified Jacob and HochheiserMethod)

Calculation:

$$C\ (NO_2 \mu g/m3) = (As - Ab) \times CF \times Vs / Va \times Vt \times 0.82$$

Where,

C NO_2= Concentration of Nitrogen dioxide, µg/m^3
As= Absorbance of sample
Ab= Absorbance of reagent blank
CF = Calibration factor
Va= Volume of air sampled, m^3
Vs= Volume of sample, ml
Vt= Volume of aliquot taken for analysis, ml
0.82= Sampling efficiency

2. For SO_X (Improved West and Gaeke Method)

Calculation:

$$C = \frac{(V1-V2) \times N \times K}{V}$$

Where,

C = SO_2 concentration in mg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO2/µg)
V = Volume of standard sulphite solution, ml

Where,

$$C\ (SO2\ \mu g/m3) = (As - Ab) \times CF \times Vs / Va \times Vt$$

$C\ SO_2$ = Concentration of Sulphur dioxide, $\mu g/m^3$
As = Absorbance of sample
Ab = Absorbance of reagent blank
CF = Calibration factor
Va = Volume of air sampled, m^3
Vs = Volume of sample, ml
Vt = Volume of aliquot taken for analysis, ml

3. For RSPM PM_{10} – (Gravimetric Method)

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Calculation

$$C\ PM_{10}\ \mu g/m3 = (Wf - Wi) \times 106 / V$$

Where,

$C\ PM_{10}$ = Concentration of Nitrogen dioxide, $\mu g/m^3$
Wf = Initial weight of filter in g
Wi = Initial weight of filter in g
106 = Conversion of g to µg
V = Volume of air sampled, m^3

Noise Pollution

The word 'noise' is derived from latin word "Nausea" implying 'unwanted sound' or 'sound that is loud unpleasant or unexpected' (Pawar et al.2010)

There are broadly three categories of noise:

- Transport noise - Includes road traffic noise, aircraft noise, rail traffic noise.
- Occupational Noise - Includes noise from domestic gadgets e.g. Washing machines, Vacuum cleaners etc.
- Neighbourhood Noise - Includes sources of noise from T.V, Radio, Loudspeakers etc.

Some of the adverse Health effects of noise pollution are given below:

- It interferes with speech. In the presence of noise, we may not able to follow, what the other person is saying.
- Noise leads to emotional and behavioural stress. A person may feel disturbed in the presence of loud noise such as produced by beating of drums.
- Noise may permanently damage hearing. A sudden loud noise can cause severe damage to the eardrum.
- Noise increases the chances of occurrence of diseases such as headache, blood pressure, heart failure, etc.
- Noise leads to increased heartbeat, constriction of blood vessels and dilation of pupil.

Noise Pollution Analysis

The Noise Level was assessed using Sound Level Meter. This instrument measures the sound level pressure level in dB (A) i.e. decibels in A-weighted scale. The sound pressure level or sound level measured in decibel (dB) is a logarithmic measure of the effective sound pressure of a sound relative to a standard reference value. The dB (A) Leq denotes the time weighted average of the sound pressure level in decibels on scale 'A' which is relatable to human hearing. The Leq is calculated using the following equation:

Where:

$$Leq = 10\log_{10} \frac{1}{T_M} \int_0^{T_M} \left(\frac{P_A(t)}{P_0}\right)^2 dt$$

- Leq is the equivalent continuous linear weighted sound pressure level re 20µPa, determined over a measured time interval Tm (secs)
- P(t) is the instantaneous sound pressure of the sound signal
- P0 is the reference sound pressure of 20µPa

Table No. 4 National Ambient Air Quality Standards

Pollutant	**Time Weighted Average**	**Concentration in Ambient Air**	
		Industrial, Residential, Rural area and other areas	**Ecologically Sensitive Area (Notified by Central Government)**
Nitrogen dioxide(NO_2) µg/m³	Annual 24 hours	40 80	30 80
Sulphur dioxide (SO_2) µg/m³	Annual 24 hours	50 80	20 80
Particulate Matter (Less than size 10 µg/m) or PM $_{10}$µg/m³	Annual 24 hours	60 100	60 100

(Source: CPCB)

Table No. 5 Ambient Air Quality Standards in respect of Noise

Code	**Area Type**	**Noise Level Limit dB (A)**	
		Day Time	**Night Time**
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zone	50	40

(Source: CPCB)

b) GIS Analysis

To predict air and noise pollution levels for unsampled locations, Interpolated Surface Maps using Inverse distance weighted (IDW) interpolation Method was used. IDW assumes that each measured point has a

local influence that diminishes with distance. It gives greater weights to points closest to the prediction location, and the weights diminish as a function of distance hence, the name inverse distance weighted. Further, Overlay and buffer analysis for noise levels was carried out to see the impact of the sampled locations on the overall environment of thane city.

Results

Table No.6 Observed Concentrations of Air and Noise Pollution

LOCATION	NO_x µg/m³	SO_x µg/m³	RSPM µg/m³	NOISE LEVEL dB
Manpada	48	52	283	80
Waghbil Naka	58	46	364	67
Kapurbawadi Naka	51	48	334	76
BalkumOctroi Naka	61	70	332	72
Malhar Cinema Chowk	41	41	357	76
Teen Hath Naka	38	42	408	75
Mulund Check Naka	45	48	256	76
AnandnagarOctroi Naka	48	41	465	75
Nitin Company Junction	46	47	181	71
Road No. 16	42	37	317	75
I.T.I. Circle	37	35	517	75
Shastri Nagar Naka	42	42	164	71
YeoorGaon	20	29	257	48
Castle Mill Naka	46	48	242	76
Jambhali Naka	77	69	394	79
Gaondevi	51	57	198	74
SATIS	40	43	246	71
Kalwa Naka	66	61	275	74
VitawaOctroi Naka	45	58	355	68
Manisha Nagar	42	47	500	65
Shilphata	59	66	595	79
Diva Dumping	68	85	338	48

i. Air Pollution

High Concentrations of NOx, SOx and RSPM were observed at Jambhli Naka, Diva Dumping Ground and Shilphata respectively as showed in Figure No. 5 to 10. High RSPM concentration was found due to heavy vehicular traffic, construction of bridge/ flyovers, repairing and widening of roads as per the observation made during survey.

ii. Noise Pollution

The Average Noise Level for Surveyed locations was observed as 71 dB (A) with Manpada Naka, Shilphata and Jhambli Naka showing the highest noise levels as shown in the Figure No. 11 and 12.

Overlay & Buffer Analysis was carried out using generated interpolated surface maps to know the noise environment of silence zones (An area comprising not less than 100 metres around hospitals and educational institutions) of Thane City. It was observed that most of the hospitals and nursing home premises experiences noise levels more than the prescribed noise standards of 50 dB(A) for silence zone as prescribed by CPCB as shown in Figure No. 13 and 14. This is because they are situated either in commercial places or near heavy traffic plying roads.

Due to heavy vehicular flow TMC has undertaken traffic management schemes in last two-three years. One of such projects of TMC is SATIS (*Station Area Traffic Improvement Scheme*) showed less concentrations of air pollution but high levels of noise pollution as it is the major transit point of Thane city.

The Forest area – Yeoor Hill in Sanjay Gandhi National Park however, showed less concentration of air & noise pollution.

It implies that the city is under the grip of heavy RSPM pollution and noisy environment due to the following reasons.

- Rapid urbanization, increasing commercial and unplanned establishments
- Great influx of people from all parts of the region and country
- Improper management of city roads and traffics
- Absence of distinct buffer area dividing industrial, residential and commercial areas
- Huge gathering of vehicles like private, public and heavy vehicles due to open or street market.

All of the above results in poor quality of the environment which ultimately affects the health of the population.

Figure No. 5

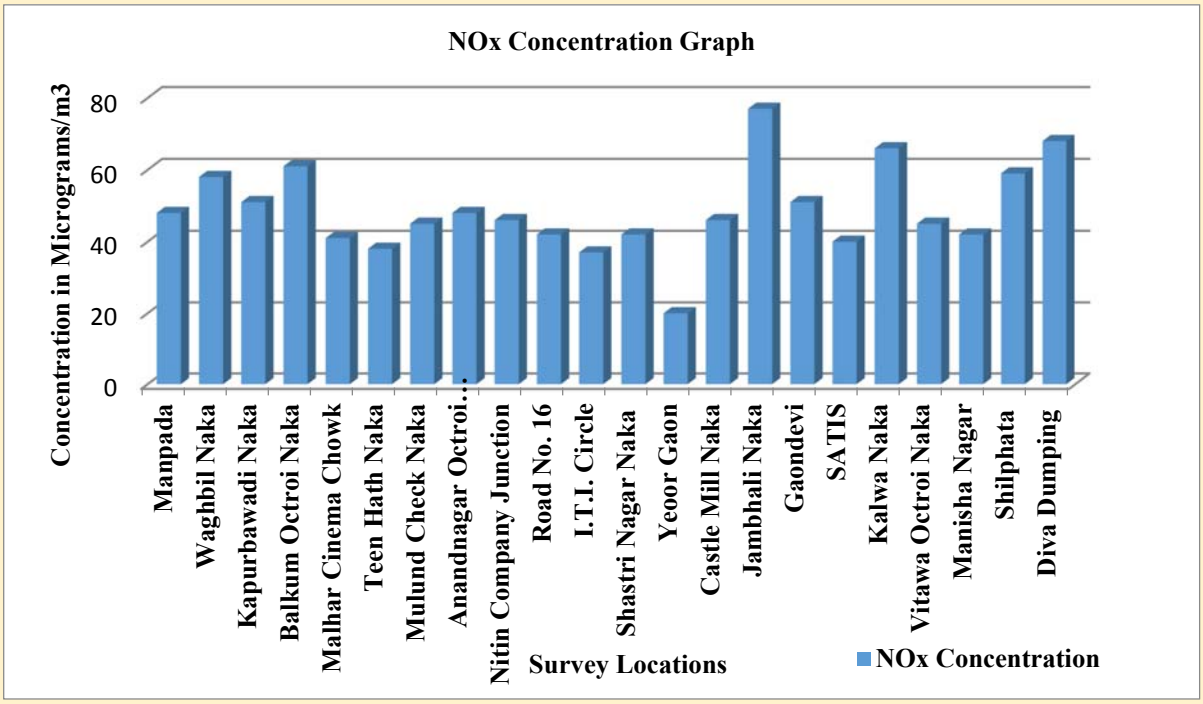


Figure No. 6

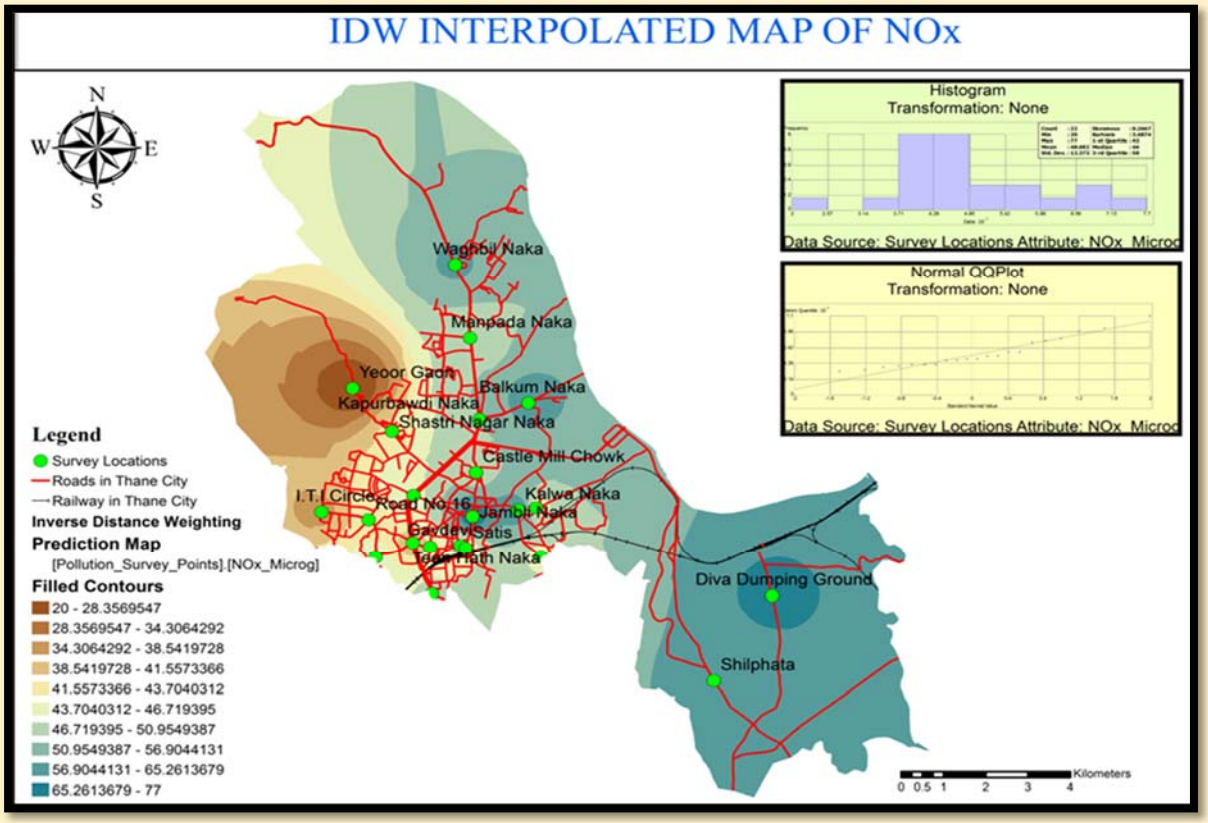


Figure No. 7

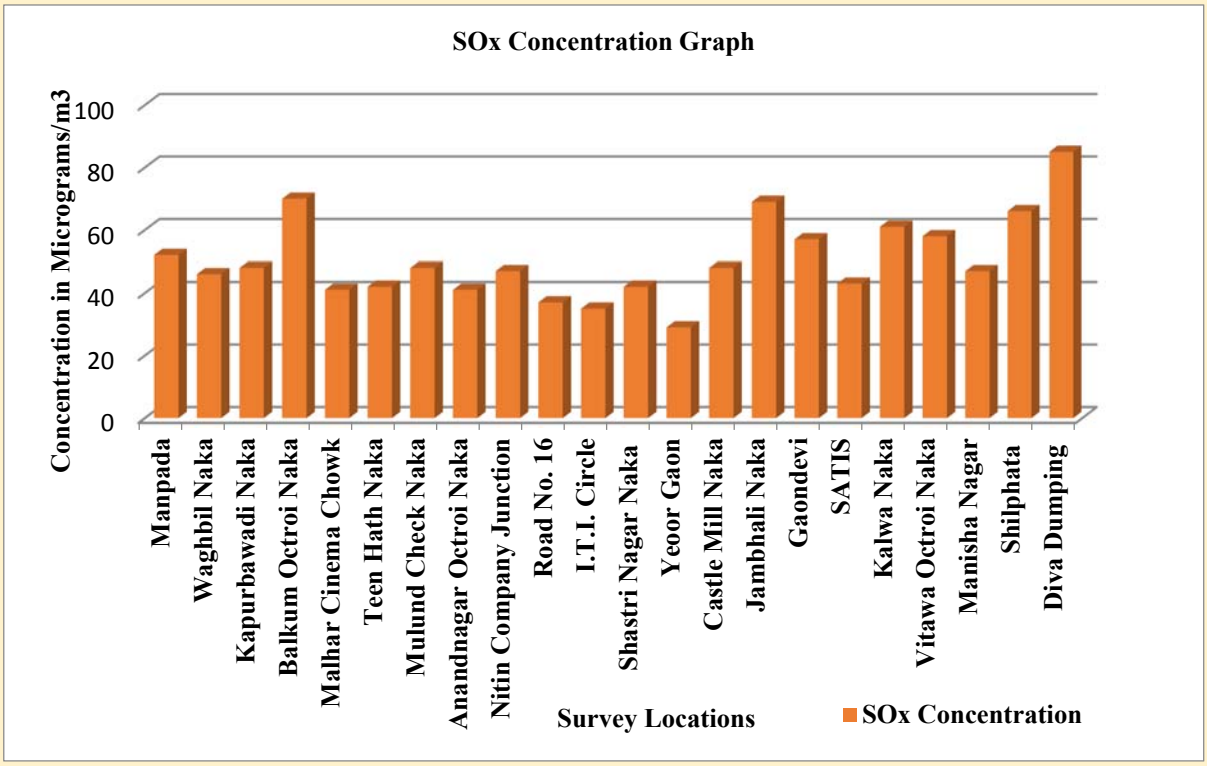


Figure No. 8

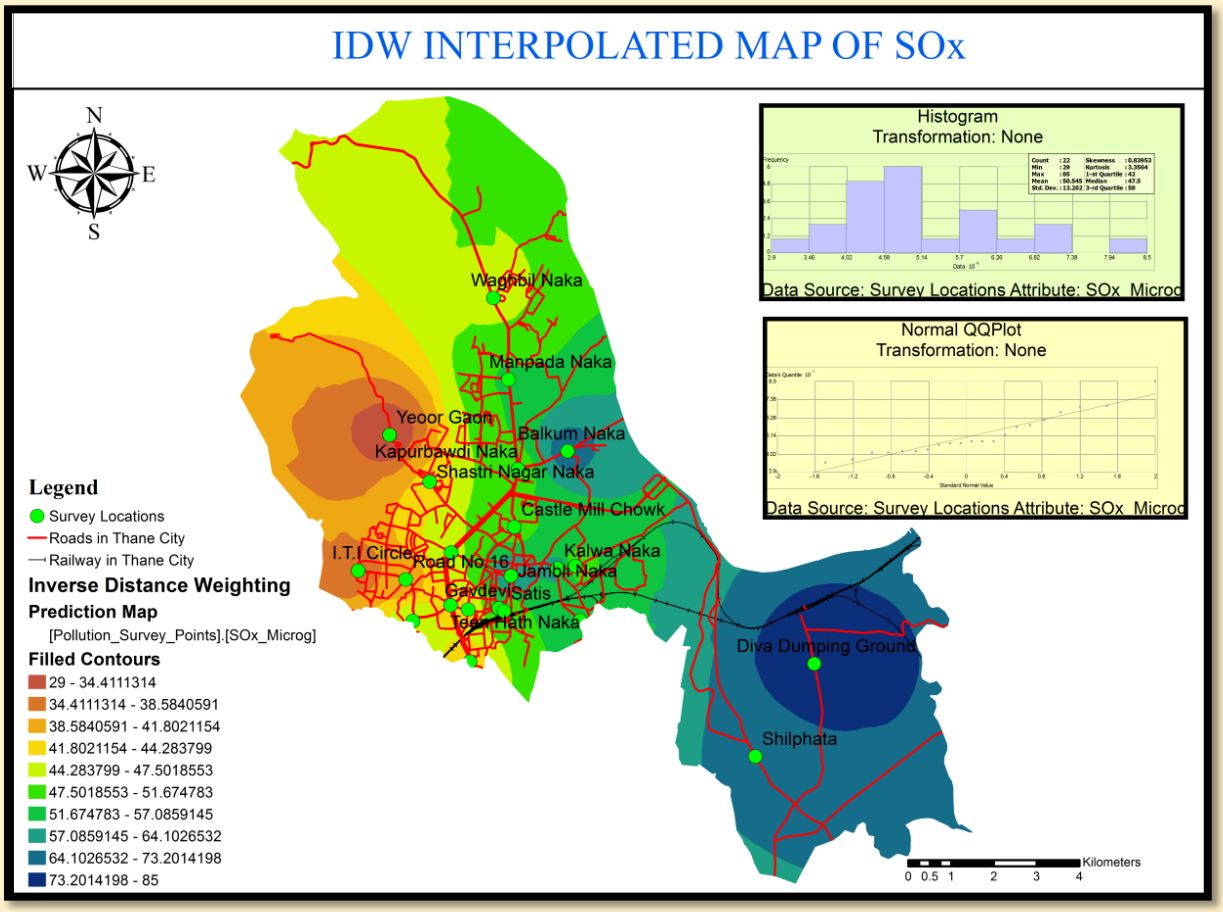


Figure No. 9

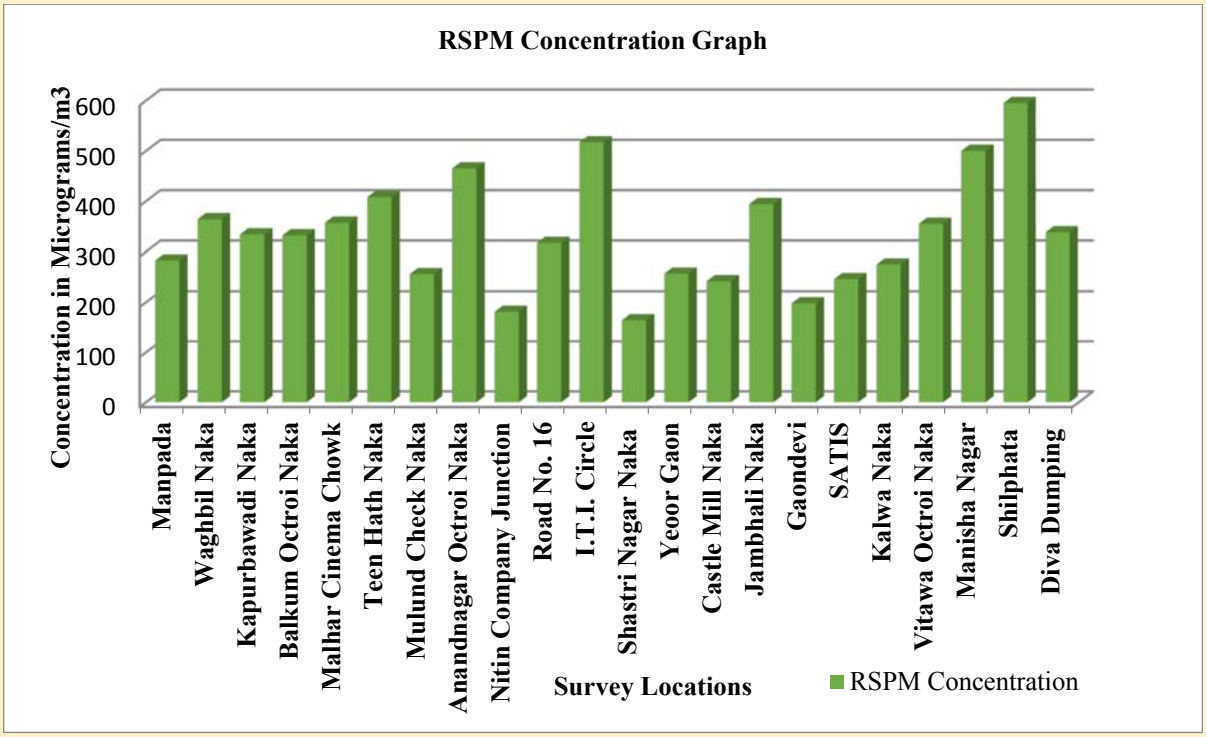


Figure No. 10

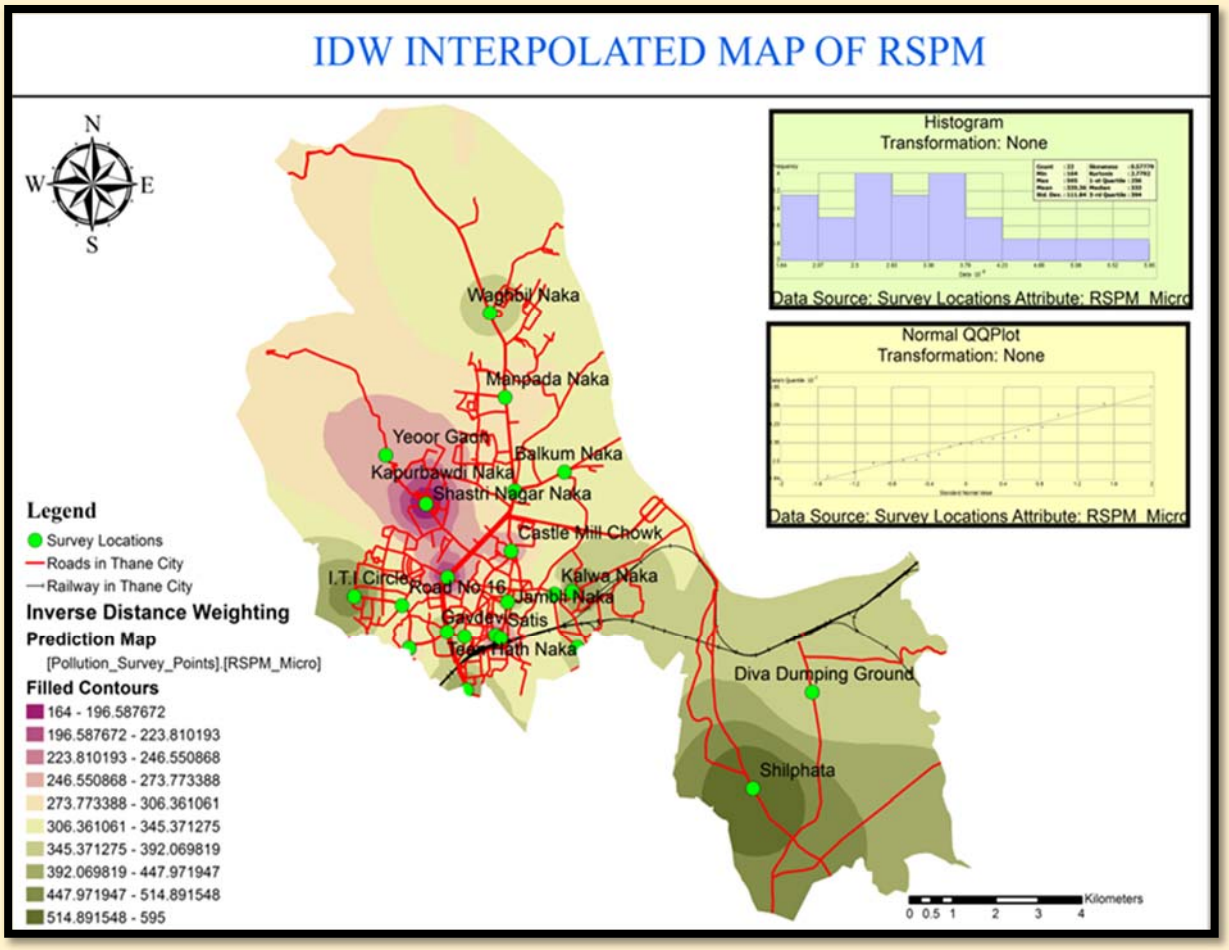


Figure No. 11

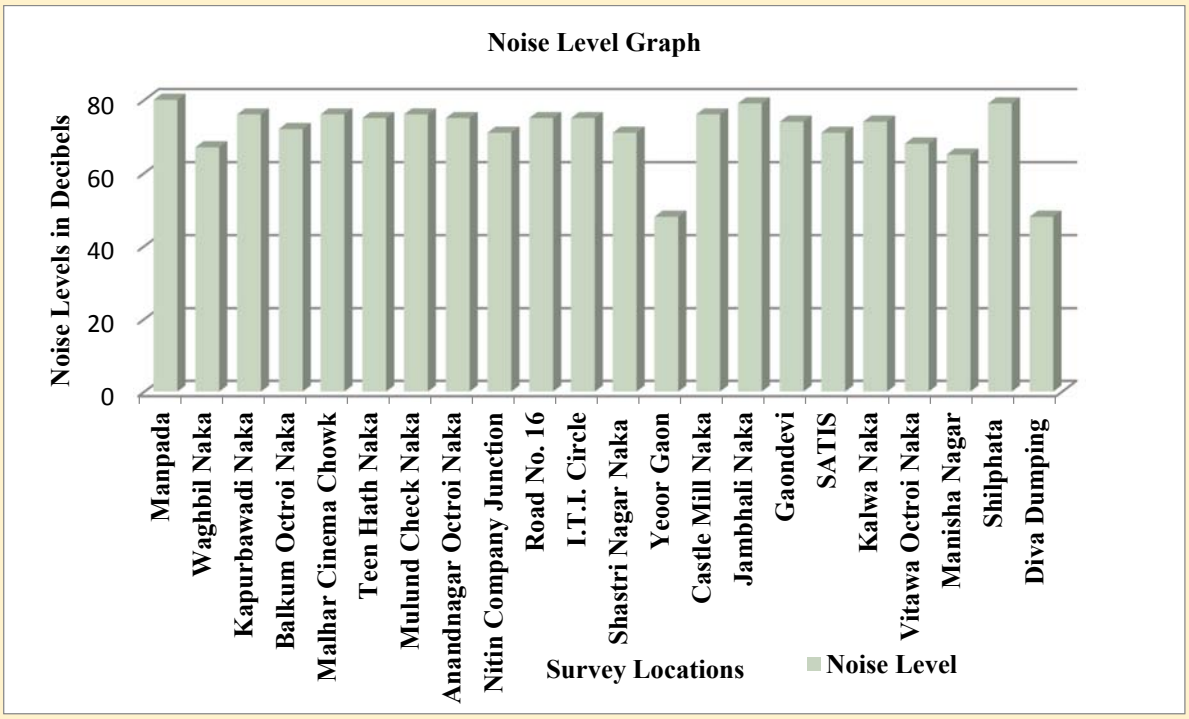


Figure No. 12

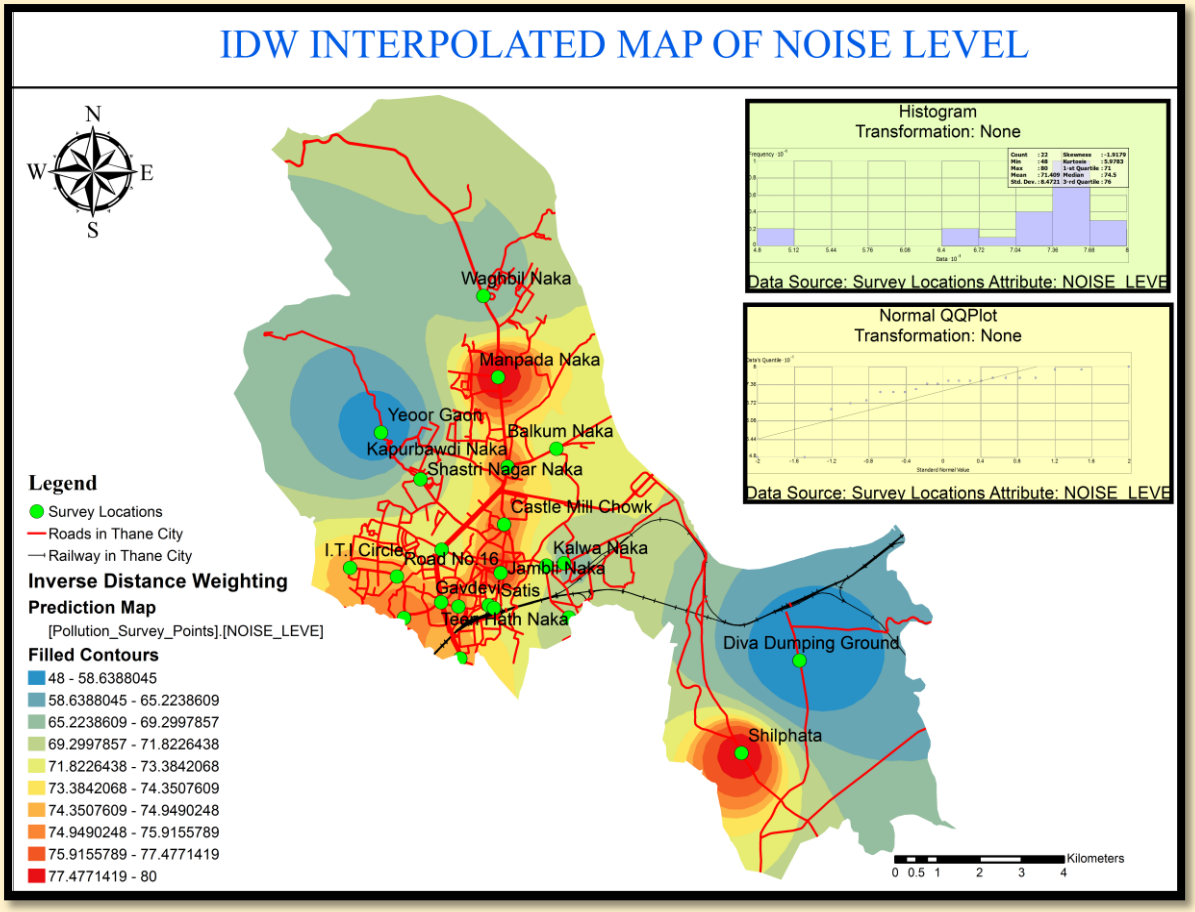


Figure No. 13 Noise Levels for Hospitals in Thane City

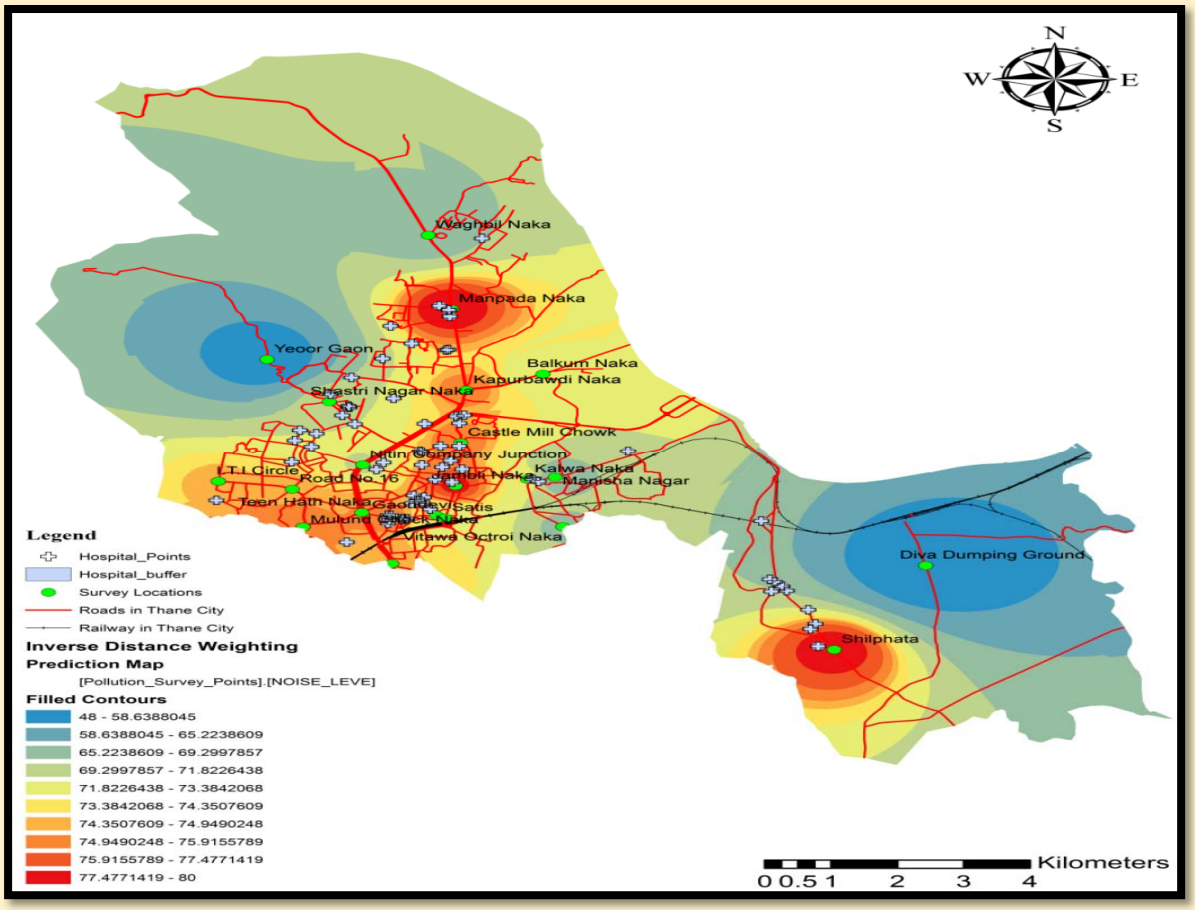
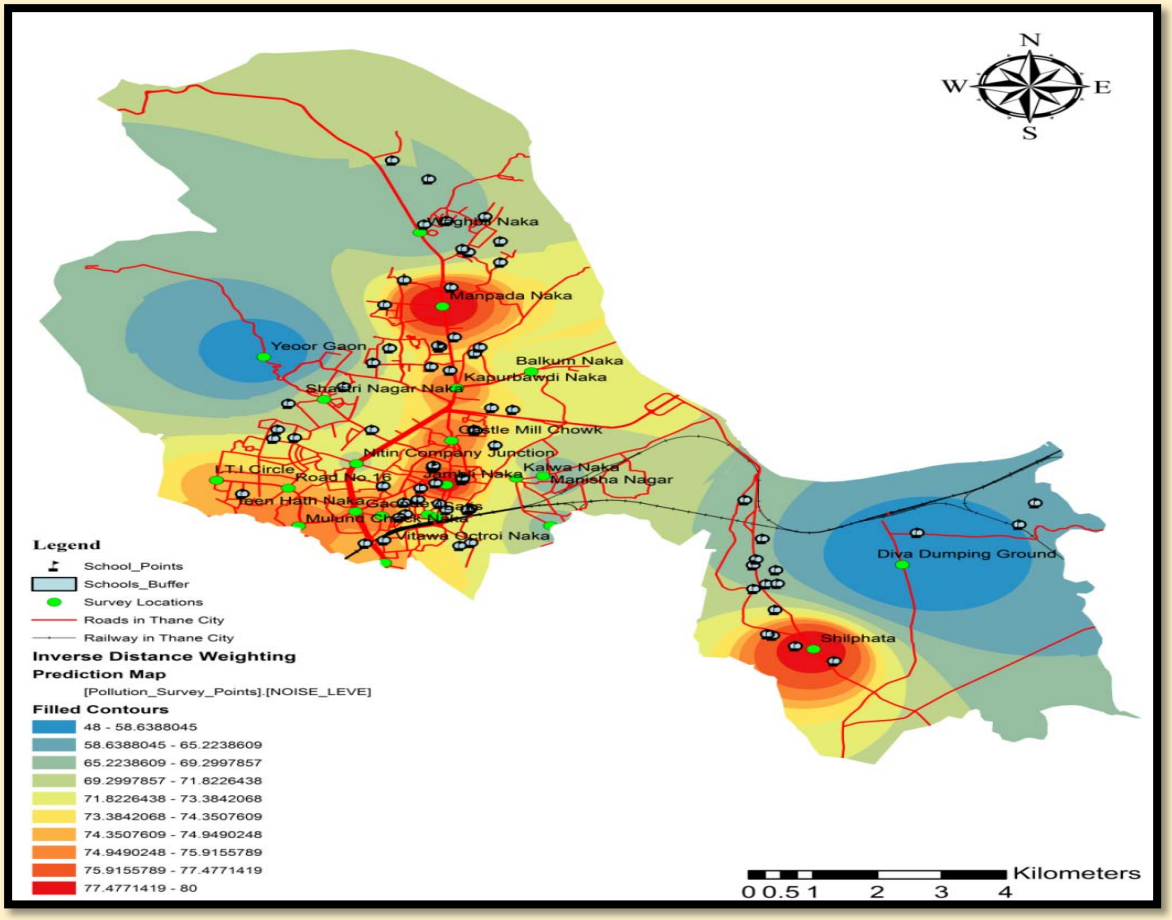


Figure No. 14 Noise Level for Schools in Thane City



Conclusion

The analysis reveals that the RSPM and Noise levels are higher than the standards prescribed by CPCB which may prove to be disastrous to the health of dwellers of Thane city in the long term if such polluted air and noise environment prevails.

The results of this research show that GIS technique provides good visual information by providing better picture of the spread and effect of the urban pollution caused by the surveyed locations on the overall environment of the thane city. Hence, this method can be effectively & efficiently used by environmental managers and local authorities to continually monitor the pollution.

Pop-Envis Kid Section

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