Final Report

Emission Inventory of Nashik District

Prepared for
Maharashtra Pollution Control Board

Prepared by

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January 2023

Supported by Implementation Consortium Research Network

Suggested format for citation

NEERI 2023
Emission Inventory of Nashik District
National Environmental Engineering Research Institute. 98pp.

Disclaimer

Acknowledgements

This study would not have been possible without the support from TERI & Swiss Agency for Development and Cooperation. This report has been prepared with support of multiple stakeholders in the State, by way of providing the vital information required under the project. We sincerely appreciate and acknowledge their cooperation.

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Executive Summary

Introduction

Air pollution is a health risk and a drag on development. The Government of India and the state governments have recognized the adverse effect of air pollution and are keeping no stone unturned to control the situation. In line with this, NEERI with the support of TERI, SDC and Maharashtra Pollution Control Board has quantified the emissions of PM_{10}, $PM_{2.5}$, SO_x, NO_x, HC, NMVOCs and CO from various sources of air pollution within City and District of Nashik. In total 11 sectors have been inventoried in Nashik City and District which are found to be contributing towards deteriorating air quality of Nashik. These eleven sectors are Industries, transport, road dust re-suspension, residential, brick kilns, construction, crematoria, stone crushers, bakeries, open eat outs and hotels and restaurants have been inventoried based on fuel consumed in these sectors or the extent of activity being carried out. The data for some sectors have been collected by conducting a primary survey, while Maharashtra Pollution Control Board, Nashik District Municipal Corporations and Council offices have provided some sectorial data. These emissions have been attributed to their sources, some are subject to considerable uncertainties, and the usual care must be taken in their interpretation.

Key findings from the study

Table E1 shows distribution of emissions of various pollutants in different sectors in the Nashik District and City. The findings from the study are:

- Emission inventory results for Nashik City and District for 2021 reveal that in the case of particulate matter (PM_{10}) pollution, in a District, industries are major contributor followed by transport sector, contributing 44% and 34%, respectively to total PM_{10} emissions in a District.
- For $PM_{2.5}$, transport is a major sector followed by industries, contributing 51% and 32%, respectively to total $PM_{2.5}$ emissions in a District while for city PM2.5, transport sector and road dust resuspension are the major sector with 45% and 22%.
- In the City, transport, road dust, and building construction are major contributors for both PM_{10} and $PM_{2.5}$ emissions.
- Transport sector is contributing 81% and 76% of total NOx emissions in the District and the City, respectively.
- The estimated emissions were spatially allocated at a grid size of 2X2 km^2 based on the level of activity in those grids. Analysis of emission spatial maps shows PM emissions are found to be concentrated in the Nashik City mainly due to high population density, construction activities and high vehicular density. Other than the city, PM_{10} intensities are higher in the district due to vehicular sources, emission from thermal power sector and unpaved roads. NO_x emissions are mainly concentrated at urban centres and highways, mainly due to vehicular and industrial activity.
- The city areas like area near Nashik Road Railway Station, MIDC Satpur, MIDC Ambad, Old Mumbai Naka are identified as hotspots of PM_{10} pollution in the city.

- In District, Rattan India Thermal Power plant and Eklahare Thermal Power plant followed by MIDC Malegaon, Sinnar are seen to be the hotspots for PM_{10} emission load.
- CIDCO Nashik, Satpur Gaon, Mylan circle and Konark Nagar are identified as hotspots of PM_{10} pollution in the city.

Table E1: Estimated total emission (kg/day) of pollutants from different sectors in the Nashik District and City

Nashik District	PM_{10}	$PM_{2.5}$	SO_2	NOx	HC	CO	NMVOCs
Bakeries	849	517	603	121	0	1315	0
Transport Sector	20328	19312	15024	103585	717827	636049	0
Industries	26719	12215	15726	20230	0	10798	0
Road Dust Resuspension	5242	3111	0	0	0	0	0
Hotel & Restaurants	148	94	51	1528	0	645	41
Crematories	327	161	146	441	0	1666	909
Building Construction	1523	657	0	0	0	0	0
Brick Kilns	2023	745	1438	288	0	2130	887
Open Eatouts	242	123	150	662	0	292	0
Stone Crushers	834	246	0	0	0	0	0
Domestic Sector	1952	1018	280	1175	0	14413	8694
Total	**60187**	**38199**	**33418**	**128030**	**717827**	**667308**	**10531**

Nashik City	PM_{10}	$PM_{2.5}$	SO_2	NOx	HC	CO	NMVOCs
Bakeries	409	253	372	74	0	423	0
Transport Sector	1830	1738	833	4162	28845	25557	0
Industries	460	357	92	20	0	496	0
Road Dust Resuspension	1422	851	0	0	0	0	0
Hotel & Restaurants	115	74	4	738	0	200	31
Crematories	63	32	40	176	0	348	192
Building Construction	921	394	0	0	0	0	0
Brick Kilns	140	53	32	20	0	147	71
Open Eatouts	28	20	17	82	0	37	0
Stone Crushers	74	22	0	0	0	0	0
Domestic Sector	241	85	41	238	0	1152	1634
Total	**5703**	**3879**	**1431**	**5510**	**28845**	**28360**	**1928**

Introduction

Introduction

Nashik District is the third largest City in Maharashtra after Mumbai and Pune, which cover 15,530 sq. km. Nashik is the "wine capital of India" and is also known as Miniature Maharashtra, another name for Nashik. It is also well-known as a pilgrimage site because of its historical value.

The City of Nashik is significant from a mythological, historical, social, and cultural standpoint. It is also known as "Kashi of the South," located on the Godavari River banks. Nashik District houses some prestigious government institutions, including Hindustan Aeronautical Ltd., Air Force Station, Artillery Centre, Currency Note Press, Indian Security Press, and Eklahare Thermal Power Station.

Nashik lies on the western edge of the Deccan Plateau, a volcanic formation. Nashik's western borders include the Valsad and Navsari Districts of Gujarat, The Dangs in the northwest, and the Districts of Dhule in the north, Jalgaon in the east, Aurangabad in the southeast, Ahmednagar in the south, and Thane in the southwest. On the Deccan Plateau, the District's easternmost section is the largest and is open, rich, and well-cultivated. The main dividing line of the plateau region is Chander Mountain, which runs east and west. The Godavari River rises in the Trimbakeshwar District from the Brahmagiri Mountain and flows eastward into the Bay of Bengal through the central part of the City. Besides Godavari, important rivers like Vaitarana, Bhima, Girna, Kashyapi, and Darna flow across Nashik. The Kadwa, the Darna, and the small streams toward the south are the tributaries of the river Godavari. To the north are the Girna River and its tributaries. The Mosam River in the Malegaon area flows westward through fertile valleys into the Tapti River.

Nashik lies in the northern part of Maharashtra at 700 m (2,300 ft) from the mean sea level, which gives it ideal temperature variation, particularly in winter, and lush mountainous terrain (Fig 1). The City's land area is about 259.13 km2 (100.05 sq. mi). Nashik has soil composed of laterite, which facilitates good drainage and has chemical properties ideal for growing wine grapes. The water quality is considered ideal for the growth of wine grapes.

Nashik is the headquarters of the Nashik Administrative Division, (comprises Nashik, Ahmednagar, Nandurbar, Dhule, and Jalgaon Districts). The District is divided into 15 talukas which grouped into four sub-divisions

- Nashik sub-division: Dindori, Igatpuri, Nashik, Nashik Road, Peth, Trimbakeshwar.
- Malegaon sub-division: Chandwad, Malegaon, Nandgaon.
- Niphad sub-division: Niphad, Sinnar, Yeola.
- Kalwan sub-division, Deola, Kalwan, Baglan (Satana) and Surgana.

Places of Interest

- The Kumbh Mela is held after every twelve years at Nashik.
- Trimbakeshwar (One of the twelve Jyotirlingas)

- Vani or Saptashrungi
- Muktidham
- Kalaram Temple
- Ozar
- Kalsubai
- Someshwar
- Mangi Tungi
- Devlali

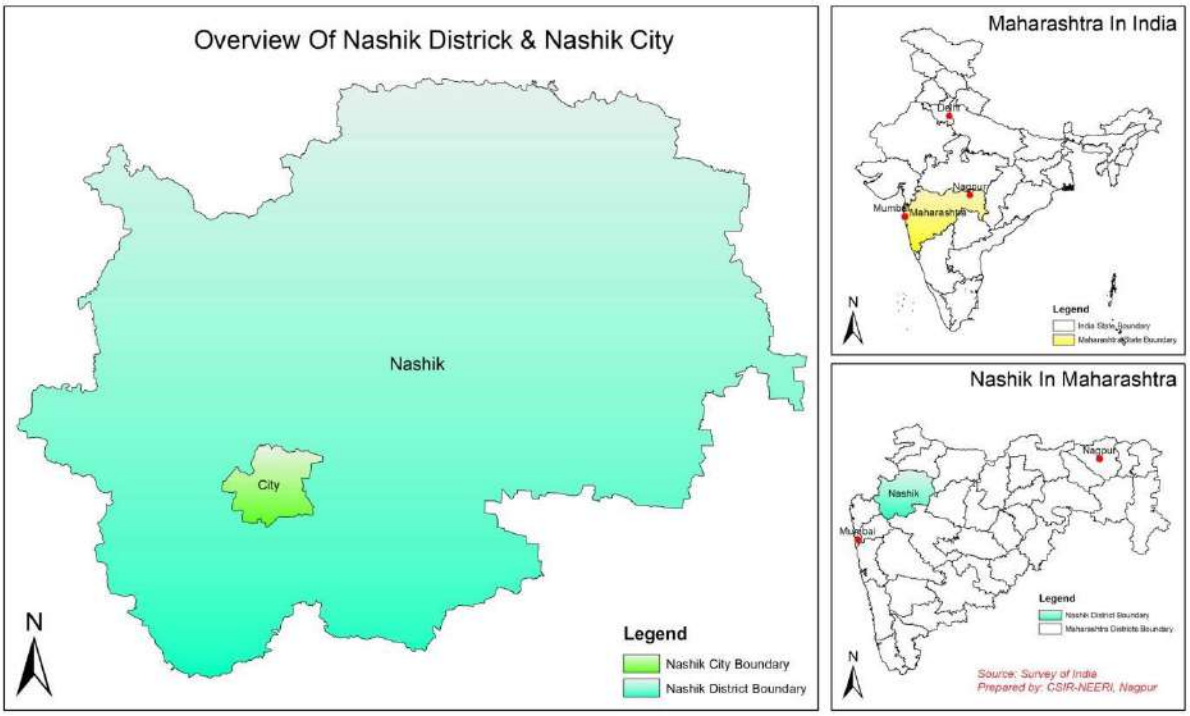

Figure 1: Study Area for Emission Inventory Estimation.

Population

As per the 2011 census, Nashik District has a population of 61,07,187. The District has a total area of 15,530 sq. km, of which about 647 sq. km is urban, and 14,883 sq. km is rural.

In Nashik District, there are 25 towns and 1,922 villages with a total population of 84,81,900. The total household (HH) in District are 21,20,475. The urban household population of the District is approximately to 14,98,214 and that of rural is 6,22,261.

Climate

The climate in Nashik is pleasant and moderate. Nashik experiences four seasons. The winter season from December to February is followed by the summer season from March to May; the monsoon from June to September is followed by the post-monsoon season from October to November. The recorded average rainfall is between 600 and 700 mm in June and July. The minimum temperature in January is 4-5 degrees Celsius, while the maximum temperature in May is 45–40 degrees Celsius. The area is very humid during the southwest monsoon season. The summer season is the driest period of the year, with relative humidity ranging between 30 and 35% in the afternoons. The terrain is hilly with an elevation range of 2,000–2,400 feet (610–730 m) and an inverse climatic condition with a warm average day temperature of 26 °C (79 °F) and a cold night temperature of 7–8 °C (45–46 °F), which are ideal conditions for the growth of grapes used for making wine with the characteristic flavour of the Nashik valley.

Meteorology

The wind speed is generally light to moderate, which strengthens the wind force during the latter part of the summer and monsoon seasons. In the post-monsoon season, winds are light and variable in direction, being north-easterly in the morning and easterly in the afternoon. During the winter, wind direction is from the southwest and northwest in the morning and the north and east in the afternoons. In the summer season, the winds are directed from the southwest to the northwest in the hot season. The average wind direction during the summer season is from the west, and in the winter season, it is from the southeast direction (Fig 2).

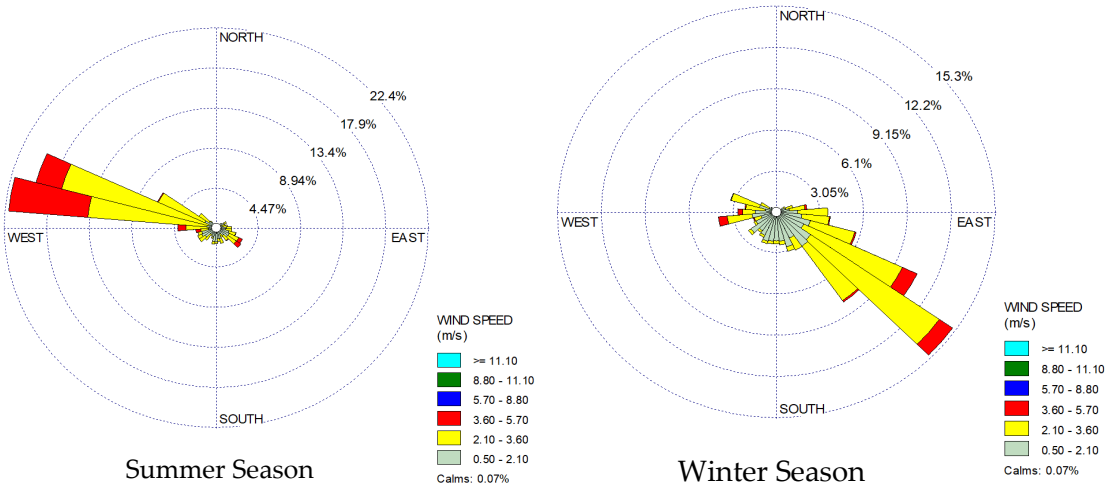

Figure 2: Windrose diagram for summer and winter season over Nashik.

Air Quality of Nashik City

In Nashik District, MPCB is currently monitoring 8 locations, viz., residential (Old BJ Market, Girna Water Tank, RTO Colony, NMC Nashik, and SRO Office), industrial (MIDC Malegaon and MIDC Satpur), and the Nashik CAAQMS station. The annual averages of criteria pollutants per the NAAQM Standards are presented in Fig. 3.

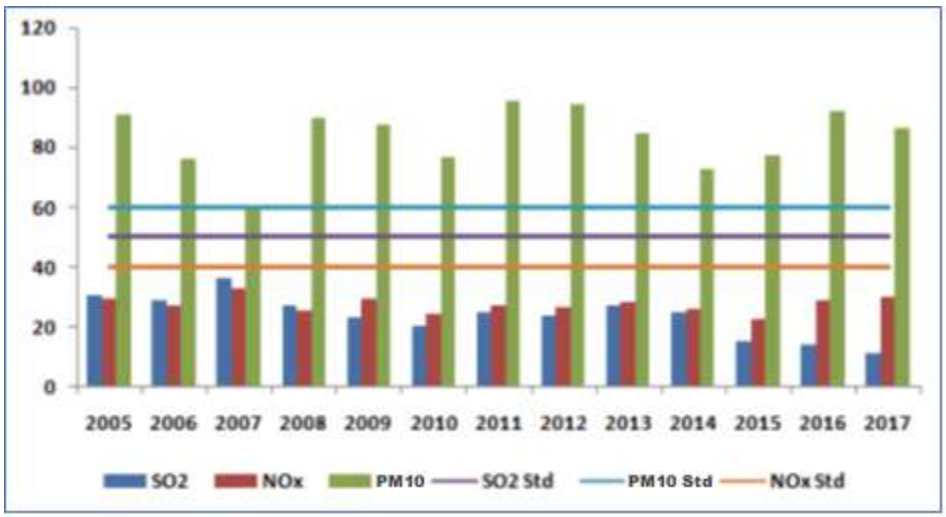

Figure 3: Trend of Annual Concentrations (μg/m³) of Criteria Pollutant in Nashik City.

The recent report prepared by TERI, "Air Quality Status of Maharashtra," 2016-2017, shows that the PM concentration of Nashik City is around 115 to 150 μg/m³, which is higher than the CPCB standards of 100 μg/m³, as the vehicular and industrial impacts are more. While the NO_x concentrations were below the annual standard, the concentration ranges for NO_x are around 30 to 40 μg/m³. The overall SO_2 concentration in Nashik is low, ranging from 15 to 20 μg/m³.

2.0 Emission Inventory

Emission Inventory

An air emission inventory is a compilation of air pollutant emissions from sources of anthropogenic (human-made) and biogenic (naturally occurring) sources. The sources of emissions can be categorised as: point sources (stationary), area sources and line sources (on-road mobile sources). Emissions inventory is the first step to quantify the contribution of various sources in ambient particulate matter concentration in the city and formulation of the air quality management plan.

2.1 Emission Inventory: Concept & Need

To improve the air quality in the area/City, detailed information of air pollution sources along with the local meteorological condition and topographical factors are needed. For the purpose the effective science-based air quality management, emissions inventories help to identify the emission sources and estimates their contribution to total emissions in the region. This information eventually guides us to set priorities for the action plan for different sources, evaluating the various options available to reduce the emissions from identified potential sources and formulate and implement the appropriate action plan. In addition to the above, it has been used as one of the important fundamental components in the dispersion modelling application.

2.2 Objective

The objective of the study is to develop a high-resolution (2 km X 2 km) emission inventory for Nashik City and District for PM_{10}, $PM_{2.5}$, CO, NOx, SO_2, HC and NMVOCs (Fig 4).

2.3 Generation of Activity Data

Emissions are estimated by using the basic Eq. 1

$$Emission = \sum activity\ data\ x\ emissions\ factor\ x\ control\ efficiency\ x\ percentage\ of\ units\ controlled$$

The activity data consist of two types, (1) Primary Data and (2) Secondary data. Primary data consists of the data collected by actual visualization the site details. This data is not available in any documents/ books. Secondary data is readily available with the offices and can be collected. CSIR-NEERI has conducted a detailed survey for Nashik city and district for source data collection. The survey was initiated in July 2021. Data sheets were prepared to collect the required information for emission inventory. Primary data for brick kilns, vehicular count, bakeries and hotels, slum areas, MSW burning and dump yard, silt content of road dust was collected through surveys. The same data is used for the estimation of emission inventory.

Information or data available for number of slum population, hotels, industries, thermal power plants, number and type of registered vehicles, registered open eatouts, number of

dead-bodies cremated etc, are collected from secondary sources. Also, the data related to the fuel consumption in industries and thermal power plants has been obtained from the published official governmental resources. The estimated emissions were spatially allocated by using GIS at a resolution of 2X2 km².

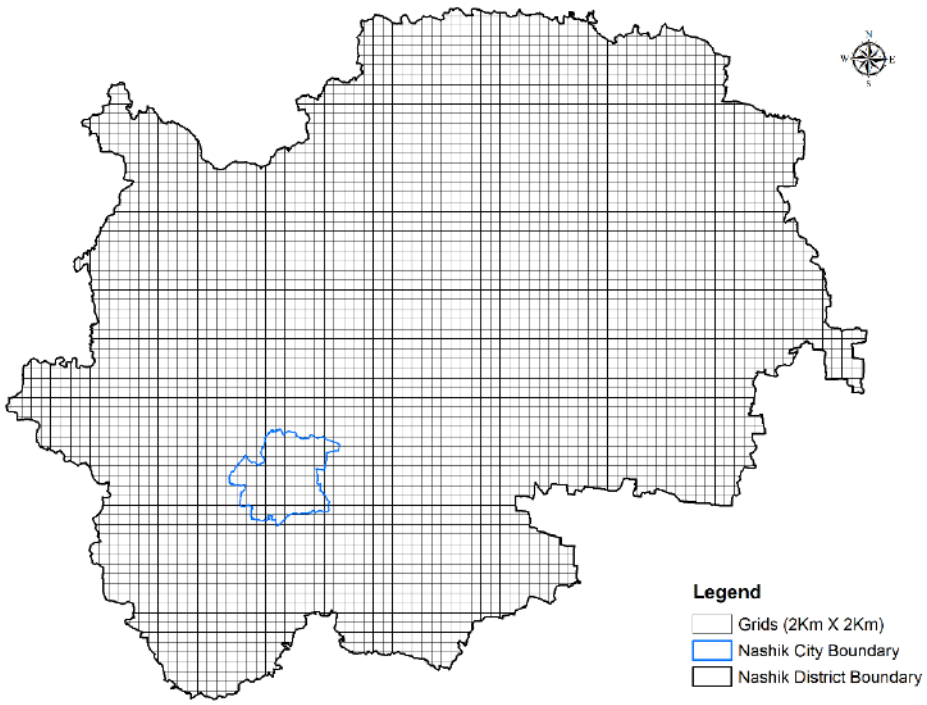

Figure 4: Grid over Nashik District.

An emission factor (EFs) is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with the associated activity responsible for emission. Typically, EFs of a fuel depends on the chemical composition of fuel, combustion type, temperature, and efficiency of any emission control device. There are very limited measured EFs available in literature for India. Hence, in the development of emission inventory, emission factors are selected from the report provided by TERI, CPCB, ARAI, USEPA AP42 and NEERI old reports on SA study. The used EFs for the estimation of pollution load from different sources are discussed in respected sector.

2.4 Road map digitisation

2.4.1 Major Roadways

To estimate the emissions from the road transport sector, major and minor road network in the District and City were digitised by using GIS. Nashik lies at the intersection of two major National Highway, NH-3 i.e., Mumbai-Agra Road passes through the Nashik City and NH-50 i.e., Pune - Nashik Road meets Mumbai-Agra Road. There are four State Highways that run outwards in radial form viz Dharmpur-Peth-Nashik-Aurangabad (MSH-2), Nashik-Dindori (MSH-3), Adgaon-Girnare-Javhar (SH-28) and Nashik-Trimbak (SH-30). Adjoining to them are District roads i.e., Nashik Road-Deolali-Bhagur (MDR-26), Nashik-Anandwali-Dugaon (MDR-34) and Adgaon-Pimprisayyed (MDR-36). There is a total road network of

12480 Kms in the District which includes all types of roads. Length of major roads in District and City is 4868 and 535 km, respectively.

2.4.2 Minor Roadways

The North-South bond connectivity of the city is through two major roads, viz, Tilak Road from ABB circle to Gangapur road and from Satpur to Gangapur Road. While the east-west links mainly comprise of Mahatma Gandhi Road, Shivaji Road, Sharanpur road, College Road, Gangapur Road, etc. Numbers of bridges have been constructed on river Godavari, Valdevi, Nasardi at various locations. The Panchvati area is connected with the Nashik City by five bridges out of which four are for vehicular traffic. Satpur area is flanking to Trimbak Road with Satpur gaothan to its south and the main Industrial complex of M.I.D.C. to its north. Nashik-Pune Road is the main feeder road for Nashik Road. The village roads viz. Eklahare road, Pathardi Road, Untwadi Road serves the southern part of the Corporation area. Except Nashik there are no wider roads more than 9 meters in the other parts of District (Fig 5 and 6).

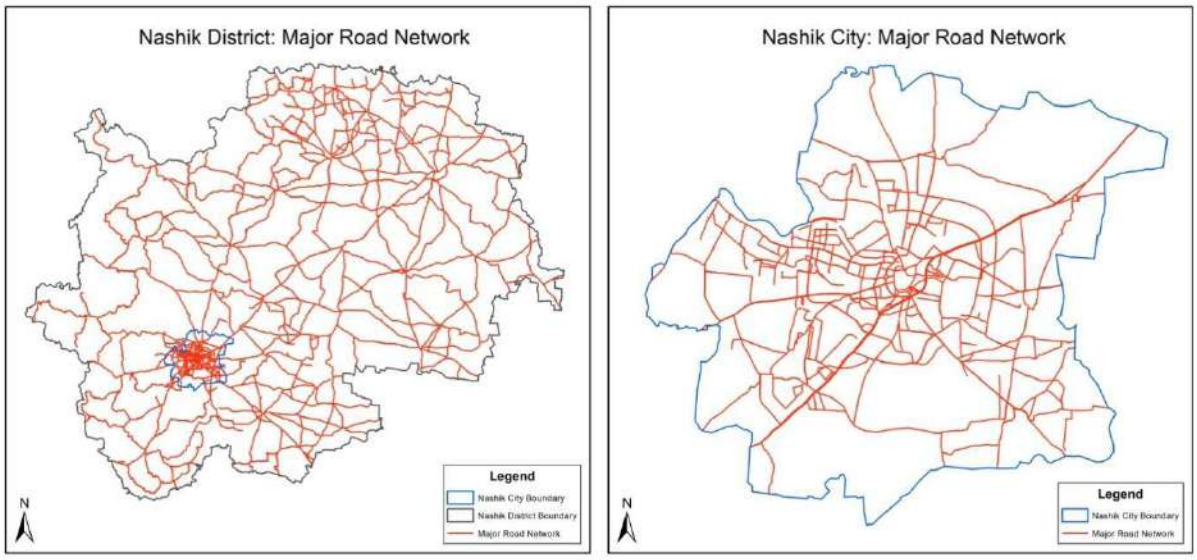

Figure 5: Major Road Network

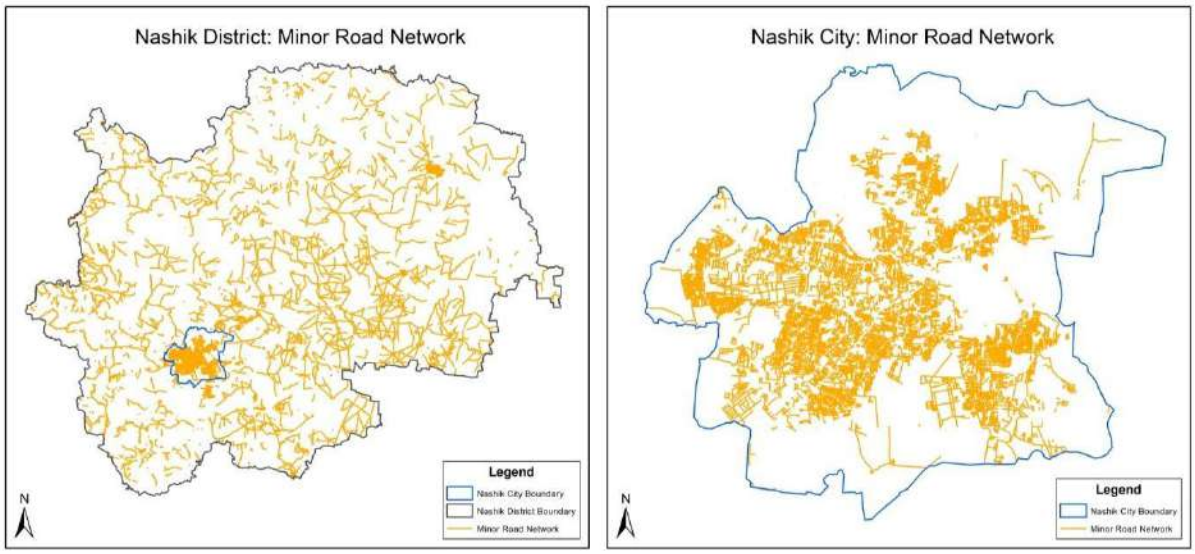

Figure 6: Minor Road Network

The total minor road length in the District and City is 7612 and 1424 km, respectively

2.5 On-road vehicles

The increase in the vehicular population resulted in rapid increase of vehicles in Nashik District. Nashik District has two Regional Transport Offices, at Nashik (MH15) and at Malegaon (MH42). The total number of registered vehicles is available at parivahan website of Govt. of India. Based on this data information and primary survey a detailed statistical database of vehicles has been prepared for different categories of vehicles and it has been used to estimate emissions from the vehicular source (Table 1). From the available data for BSI to BSVI type of technology, the EF available with ARAI report are used to estimate emission load from line sources:

1. Two-Wheeler Vehicles (including mopeds and bikes).
2. Three-Wheeler Vehicles which include autorickshaws used for public and passenger's transport.
3. Four-Wheeler Vehicles used for taxi, private use, etc.
4. Light Commercial Vehicles like traveller van, Tata 407 pick-ups, City buses, school buses etc. and 5. Heavy Commercial vehicles like buses, trucks, and multi-axle vehicles, cranes, JCBs etc.

Table 1: Registered vehicles in Nashik District. (RTO Data).

BS_Fuel	2W	3W	4W	LCV	HCV_Buses	HCV_Trucks
Petrol_BSII	15907	2149	807	0	0	0
Petrol_BSIII	1200854	16123	30552	0	0	0
Petrol_BSIV	464216	8999	21677	0	0	0
Petrol_BSVI	310913	3824	17643	0	0	0
Diesel_BSII	0	715	1268	5901	3	4235
Diesel_BSIII	0	3215	26878	10346	5344	117135
Diesel_BSIV	0	3082	100639	39769	1431	32452
Diesel_BSVI	0	1784	28688	967	441	13191
CNG_BSII	0	0	12	0	0	0
CNG_BSIII	0	370	134	0	150	0
CNG_BSIV	0	1891	4268	0	0	0
CNG_BSVI	0	717	10198	0	0	0

On each road, the traffic type, road width is different. Based on the city and district initial survey, the counting points were fixed. These footages were collected from Police Commissioner office, Nashik. These footages were used for counting the number and type of vehicles. For the other locations, manual counting was carried out. The number of 2W, 3W, 4W, LCV and HDV passing from the location marked was counted.

For district count, the National highway Authority of India (NHAI) unit of Nashik region provided the data vehicular traffic for a single day for 2 toll plazas in the district. For the other parts of the district, the district was divided into the groups of major and minor roads. The roads which showed a similar traffic pattern along with the same width were clubbed together. The road length (RL) in the district is digitize using ArcGIS software. The fig. 7 and fig. 8 displays the marked points for City and District vehicular count.

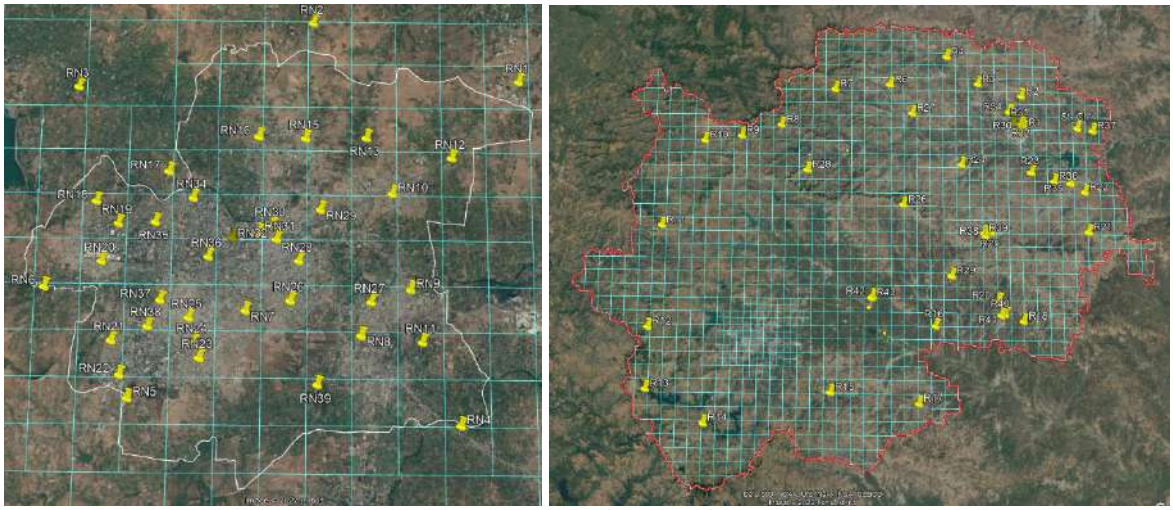

Figure 7: Sampling points for vehicular count in Nashik City and District.

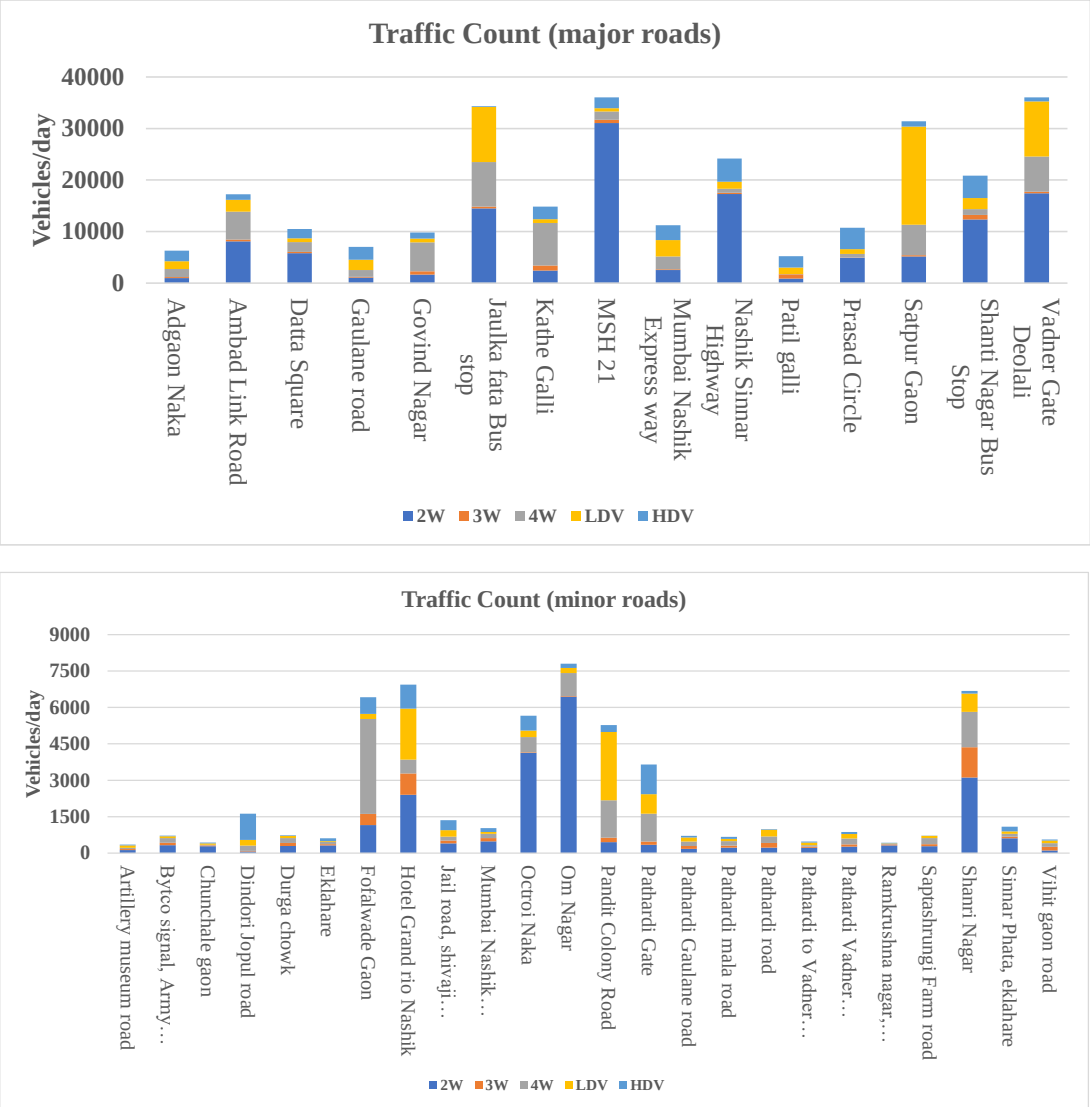

Figure 8: Category wise traffic count on major and minor roads in Nashik City.

Emissions from the on-road vehicles depend mainly on the type of vehicle and fuel used in the vehicle. ARAI, Pune has made available the emission factor for vehicular emission load estimation. These EF are used to estimate the emission load from transport sector. All Bharat Stage norms implemented in the state of Maharashtra are used for estimation. Category-wise emissions factors are provided in the Tables 2-4. The emission load from transport sector in the City and District is provided in the Fig. 9**.** The PM_{10} emissions from transport sector in District and City are 20328 and 1830 kg/day, respectively. In the City, 2-w and 3w are major contributing sectors to PM_{10} emissions from transport sector, while in the District HDVs and LDVs are the major contributors (Fig. 10). The hotspots for higher emission load from transport sector is seen in areas like Mylan Circle (Mumbai Naka) and Dwarka Circle. For district, National Highway at Ojhar junction and State Highway in Niphad city are the hotspots. The estimated emissions were spatially allocated at a grid size of 2X2 km^2 in Nashik City and District. The allocated emissions are shown in the Fig. 11 and 22.

Table 2: Emission Factors of BS-III engine considered for Emissions estimation.

Emission Factor for BS-III Stage Engine						
No.	**Vehicular Type**	**PM**	**NOx**	**HC**	**CO**	**Unit**
1	2-Wheeler	0.1	0.27	0.61	1.81	g/km
2	3W_Petrol	0.05	1.2	0.7	1.20	g/km
3	3W_Diesel	0.05	0.5	0.5	0.75	g/km
4	4W_Petrol	0.08	0.12	0.19	3.01	g/km
5	4W_Diesel	0.12	0.67	0.2	1.00	g/km
6	HDV	1.24	9.3	0.42	6.00	g/km

Table 3: Emission Factors of BS-IV engine considered for Emissions estimation.

Emission Factor for BS-IV Stage Engine						
No.	**Vehicular Type**	**PM**	**NOx**	**HC**	**CO**	**Unit**
1	2-Wheeler	0.035	0.1	0.13	1.65	g/km
2	3W_Petrol	0.035	0.5	0.3	0.75	g/km
3	3W_Diesel	0.035	0.5	0.3	0.50	g/km
4	4W_Petrol	0.05	0.1	0.1	1.00	g/km
5	4W_Diesel	0.08	0.1	0.1	0.51	g/km
6	HDV	0.06	0.39	0.37	0.74	g/km

Table 4: Emission Factors of BS-VI engine considered for Emissions estimation.

Emission Factor for BS-VI Stage Engine						
No.	**Vehicular Type**	**PM**	**NOx**	**HC**	**CO**	**Unit**
1	2-Wheeler	0.0045	0.09	0.068	0.5	g/km
2	3W_Petrol	0.025	0.1	0.10	0.22	g/km
3	3W_Diesel	0.0045	0.08	0.10	0.5	g/km
4	4W_Petrol	0.0045	0.06	0.10	1.00	g/km
5	4W_Diesel	0.0045	0.08	0.10	0.5	g/km
6	HDV	0.01	0.08	0.10	0.5	g/km

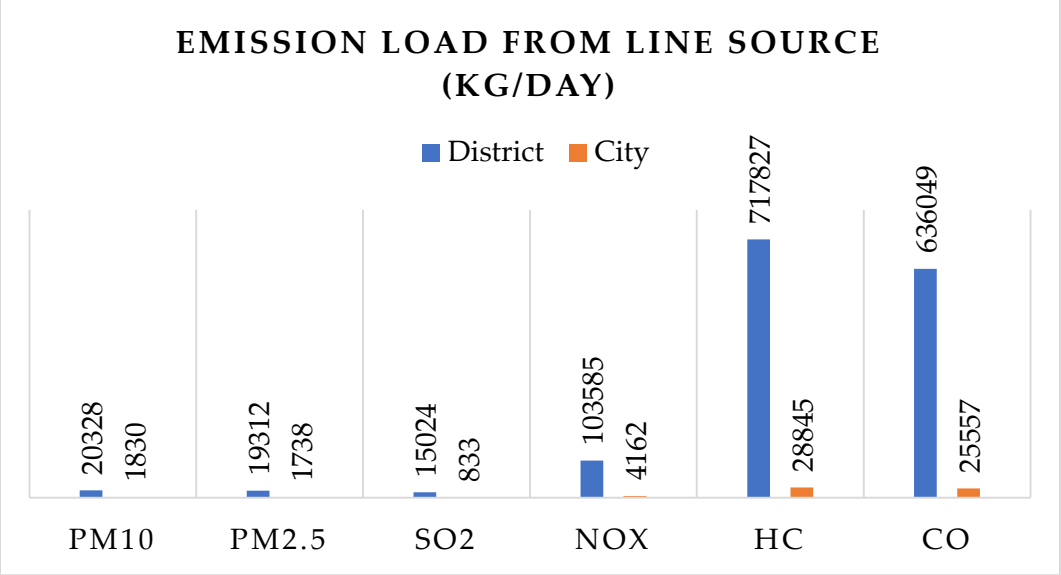

Figure 9: Particulate Matter Emission load from line source for City and District (Kg/day).

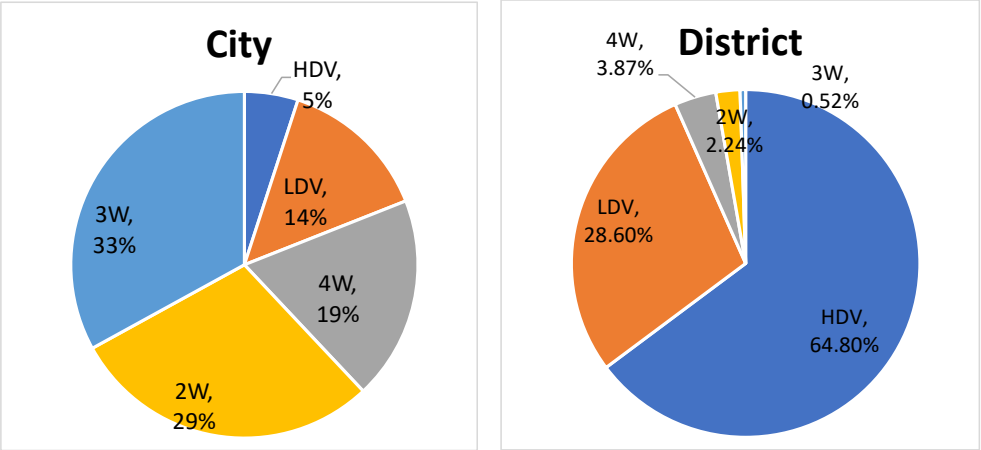

Figure 10: Particulate emission load from line source in Nashik City & District.

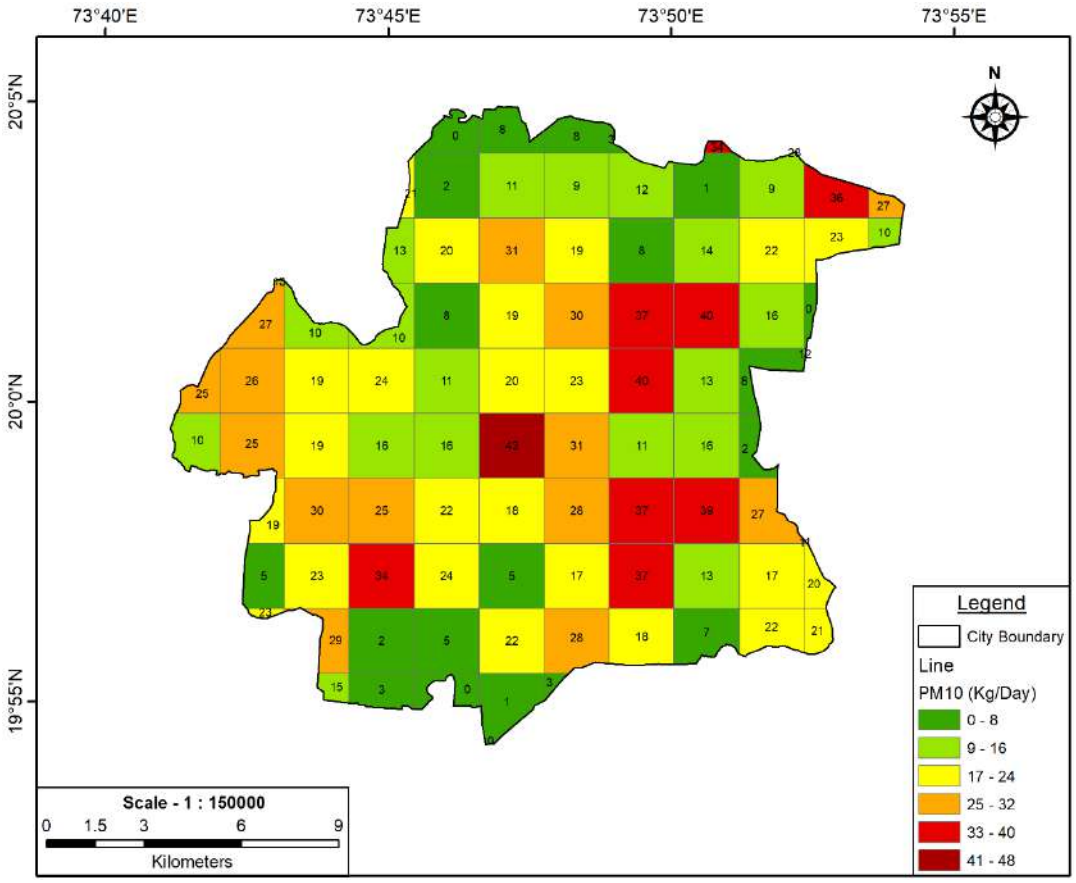

Figure 11: Particulate emission load for PM_{10} from line source in Nashik City.

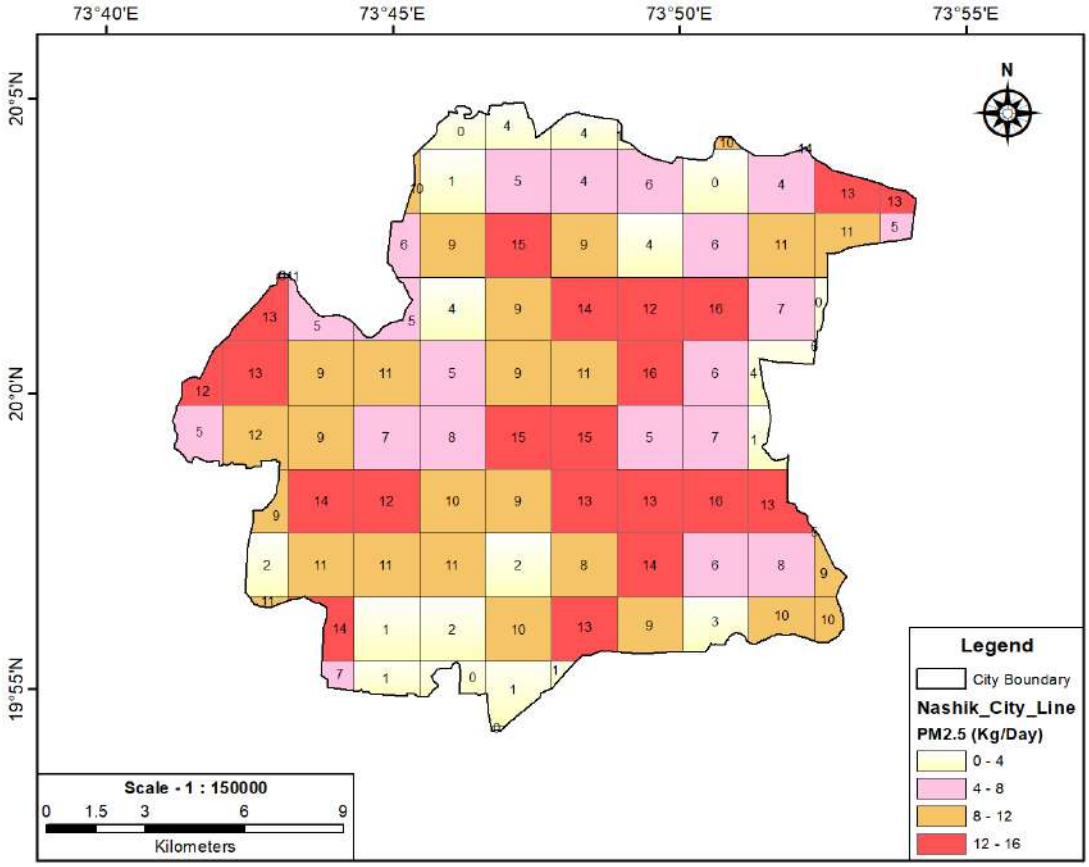

Figure 12: Particulate emission load for PM2.5 from line source in Nashik City.

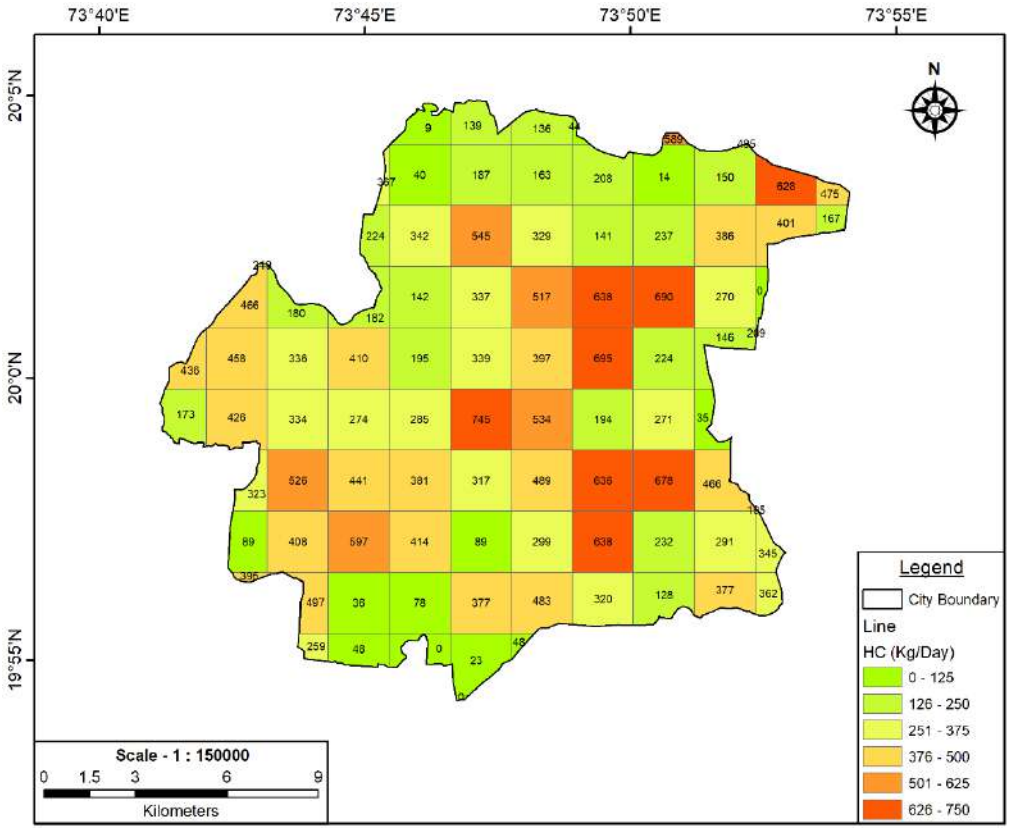

Figure 1312: Emission load for HC from line source in Nashik City.

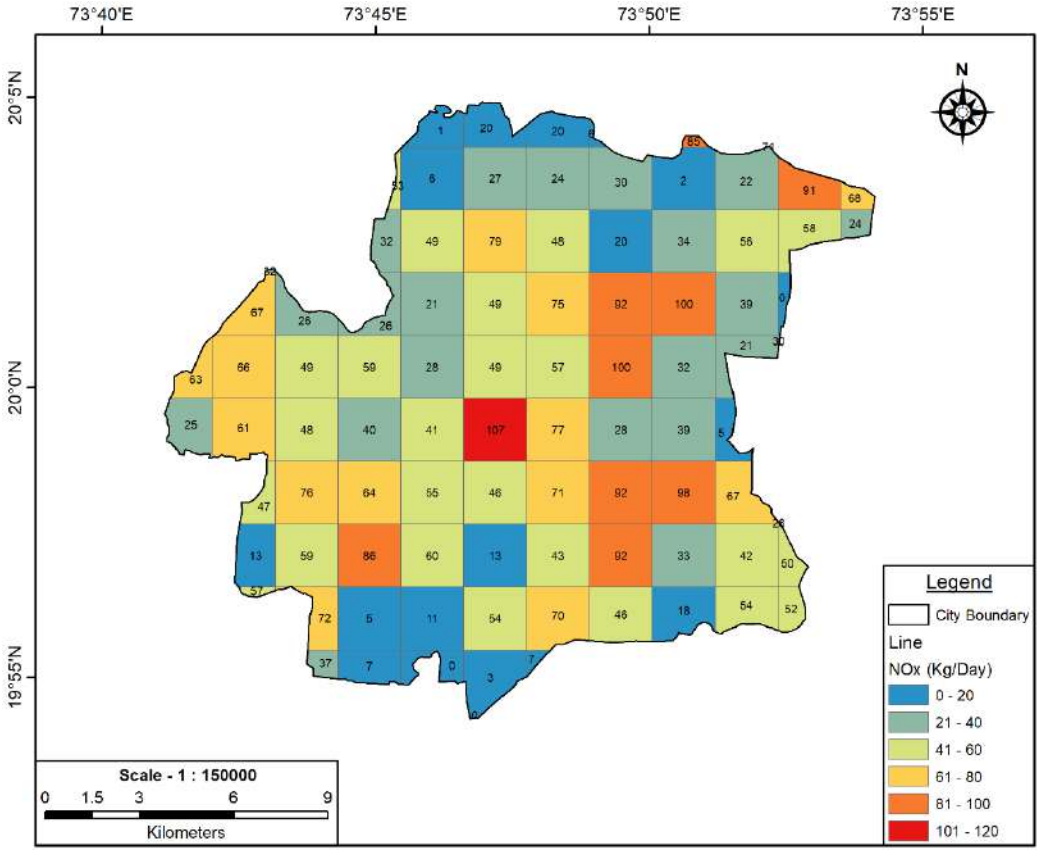

Figure 1413: Emission load for NOx from line source in Nashik City.

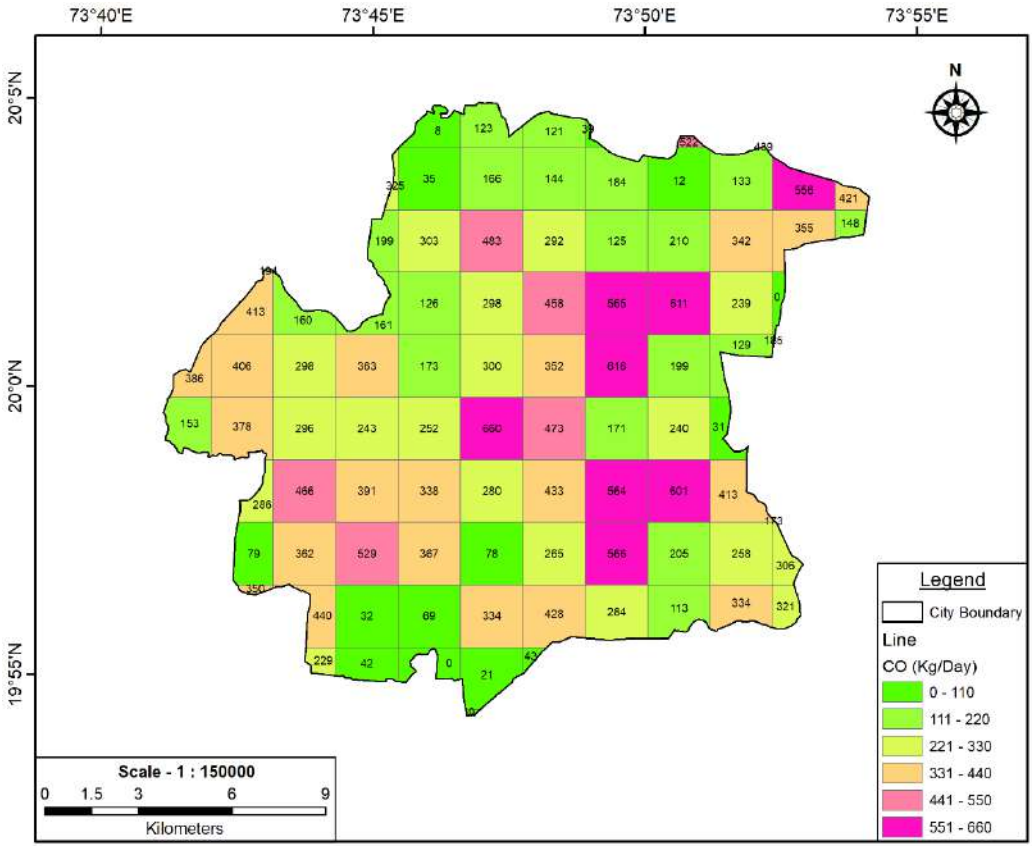

Figure 1514: Emission load for CO from line source in Nashik City.

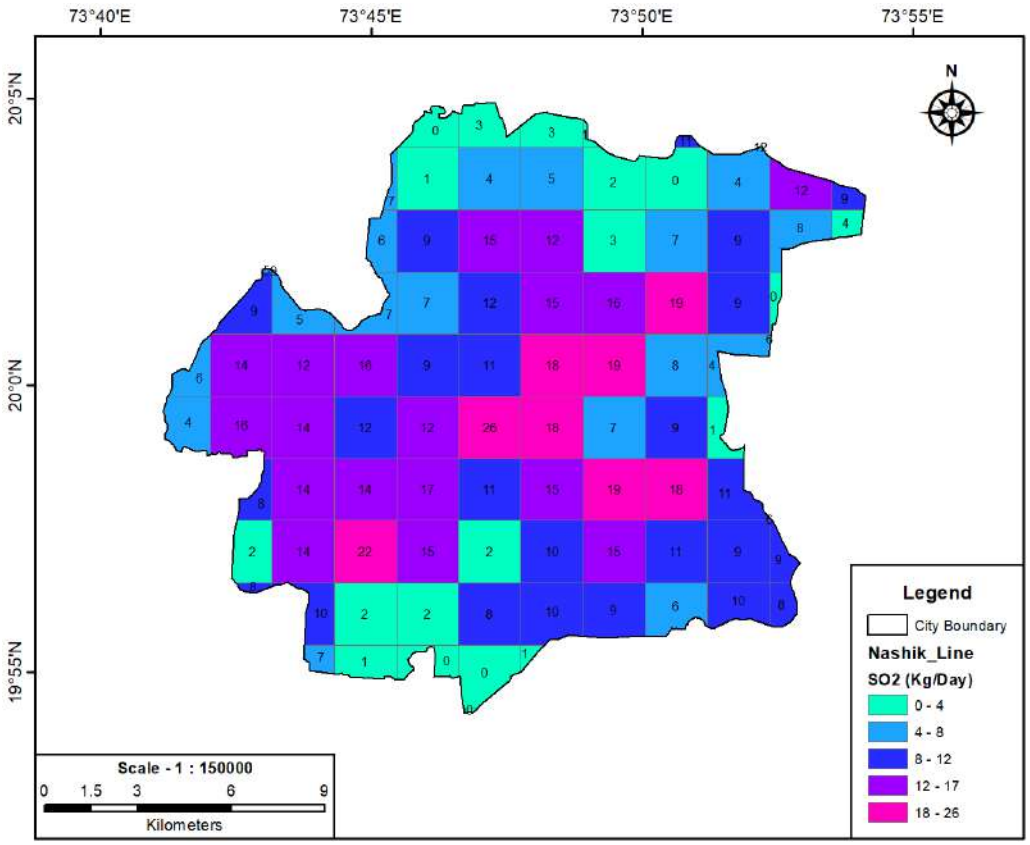

Figure 1615: Emission load for SO_2 from line source in Nashik City.

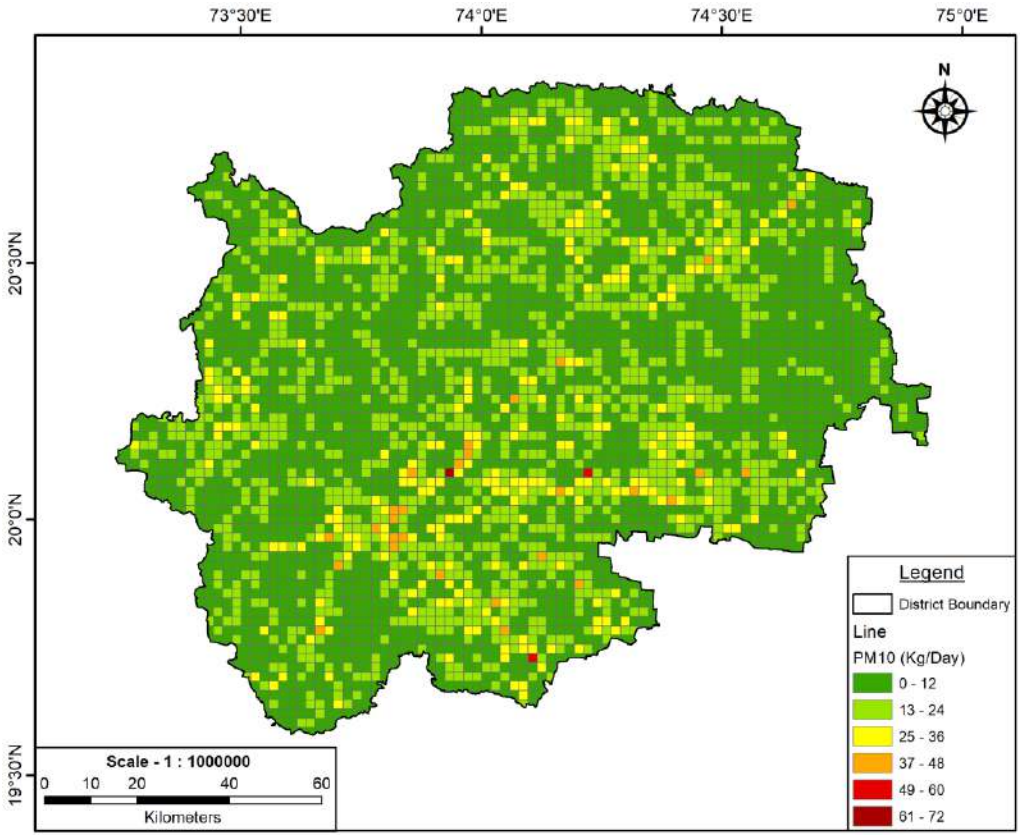

Figure 17: Particulate emission load for PM_{10} from line source in Nashik District.

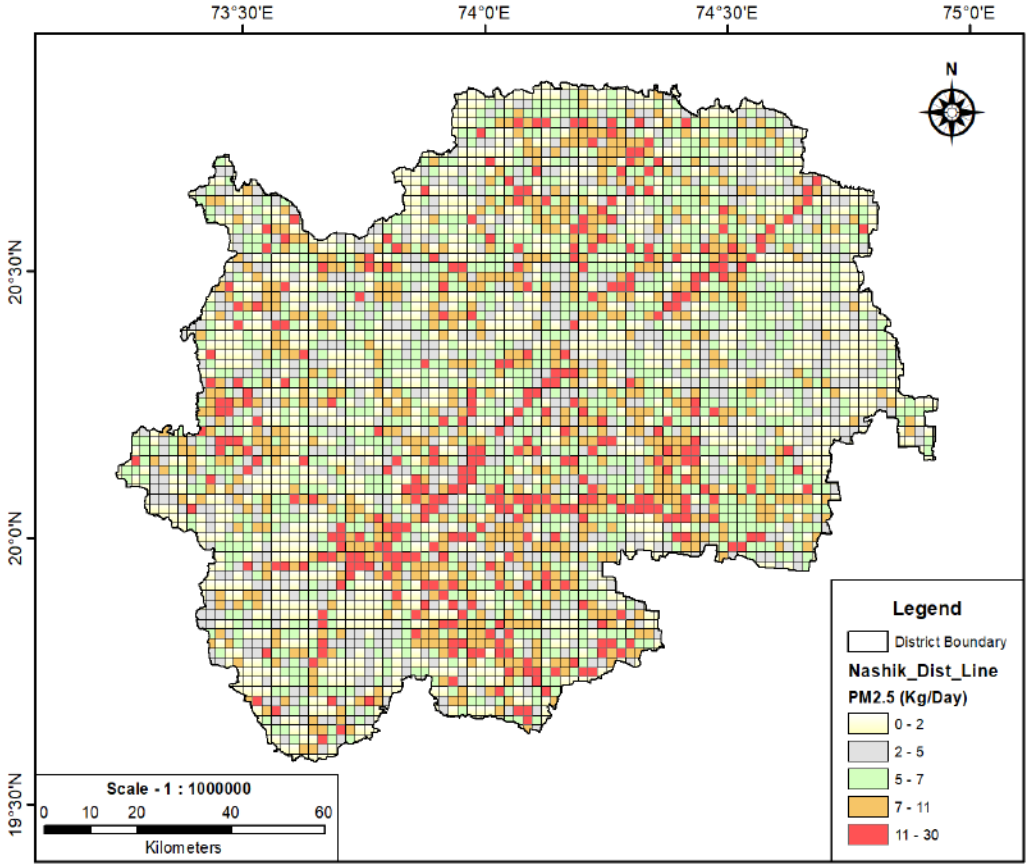

Figure 18: Particulate emission load for PM2.5 from line source in Nashik District.

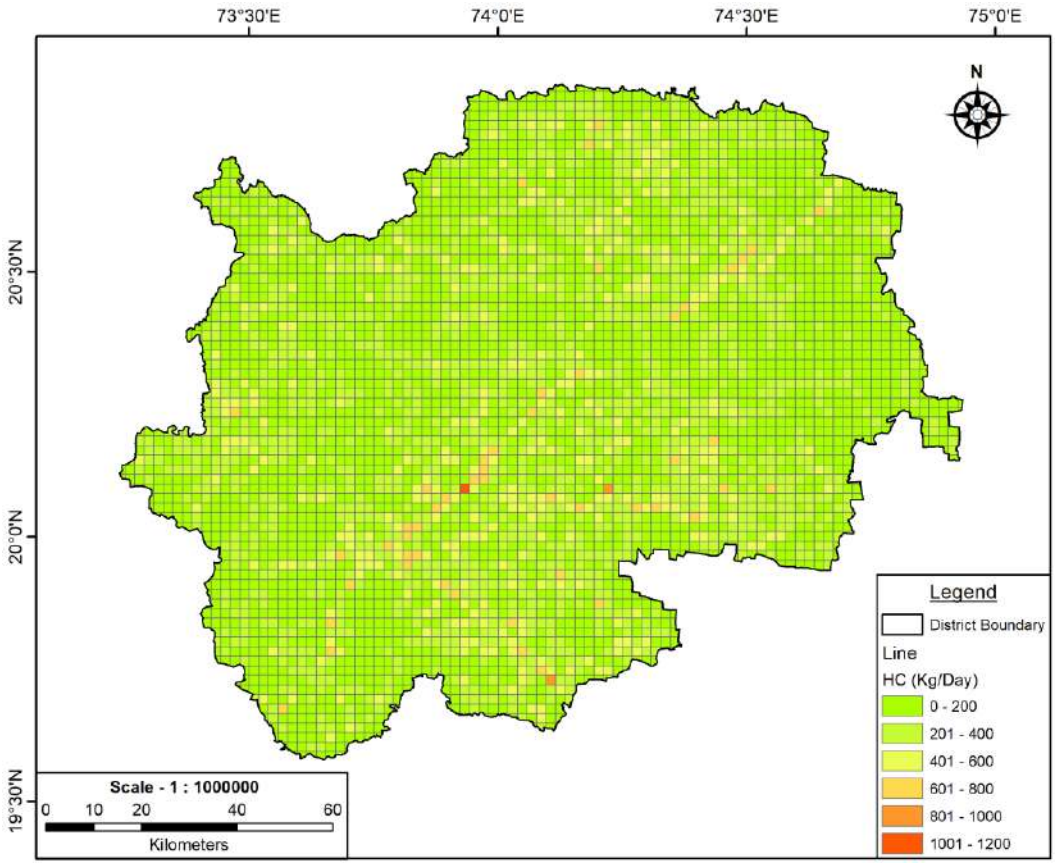

Figure 19: Emission load for HC from line source in Nashik District.

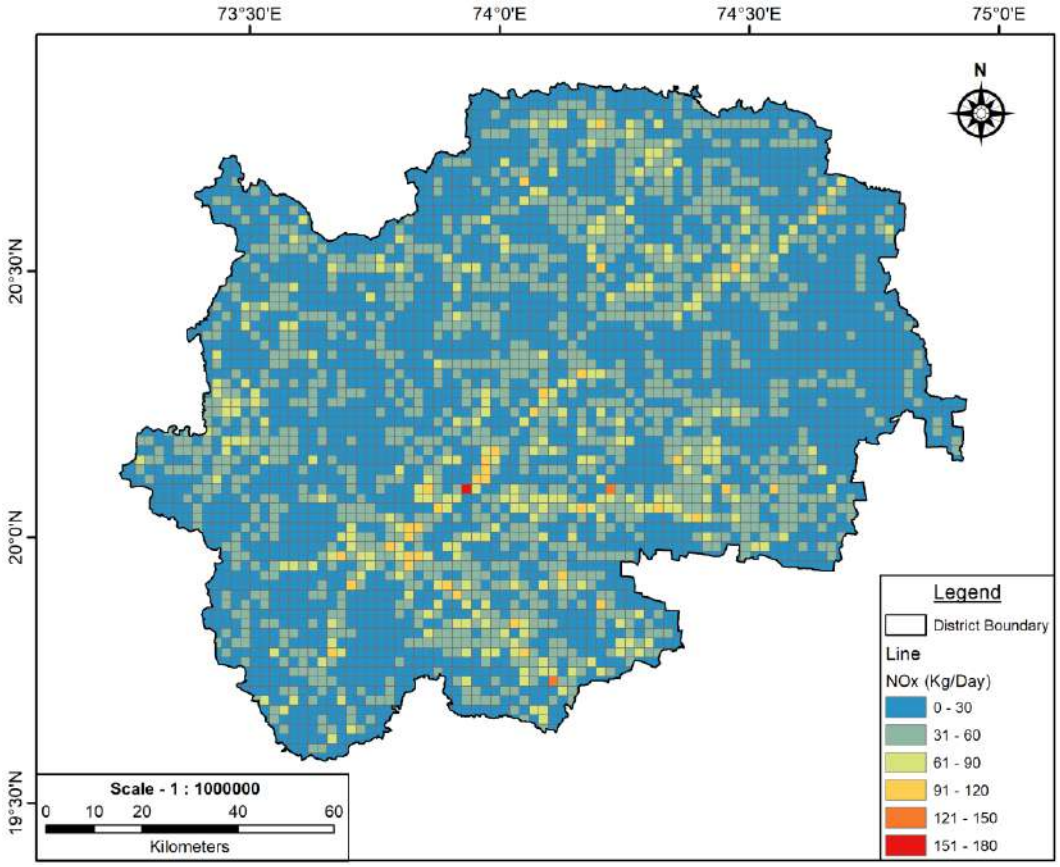

Figure 20: Emission load for NOx from line source in Nashik District.

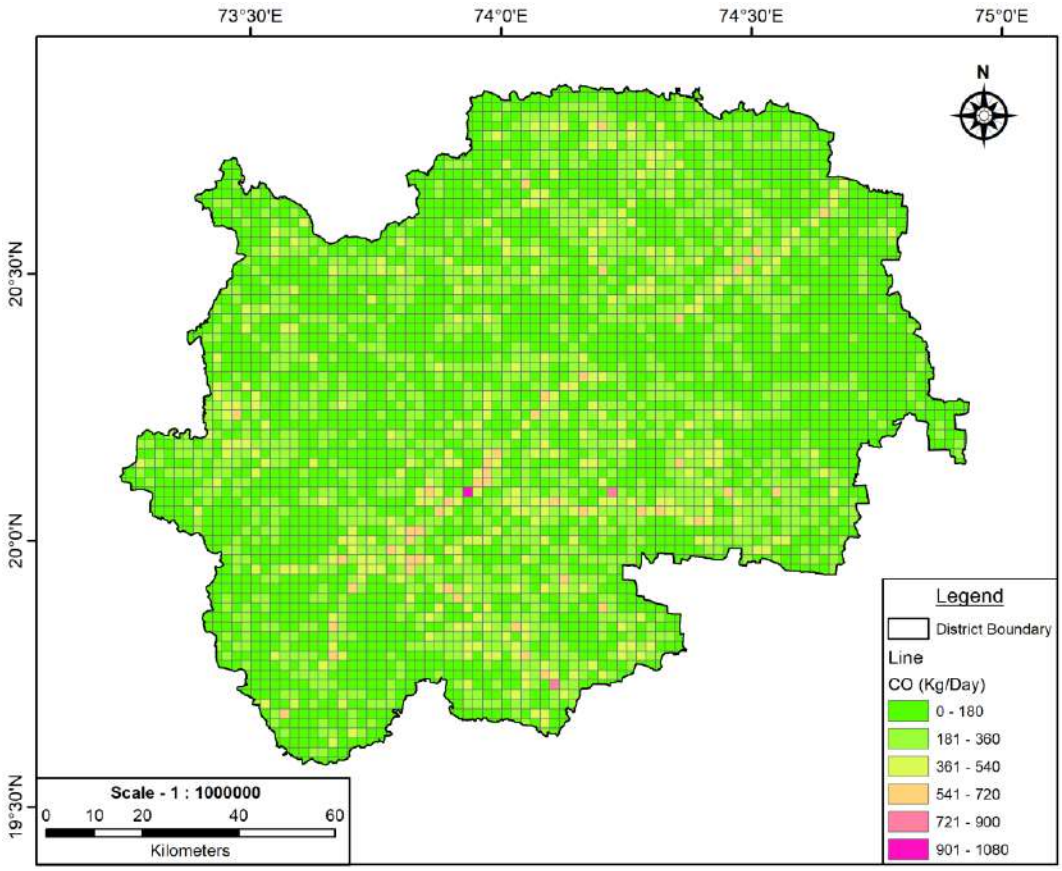

Figure 21: Emission load for CO from line source in Nashik District.

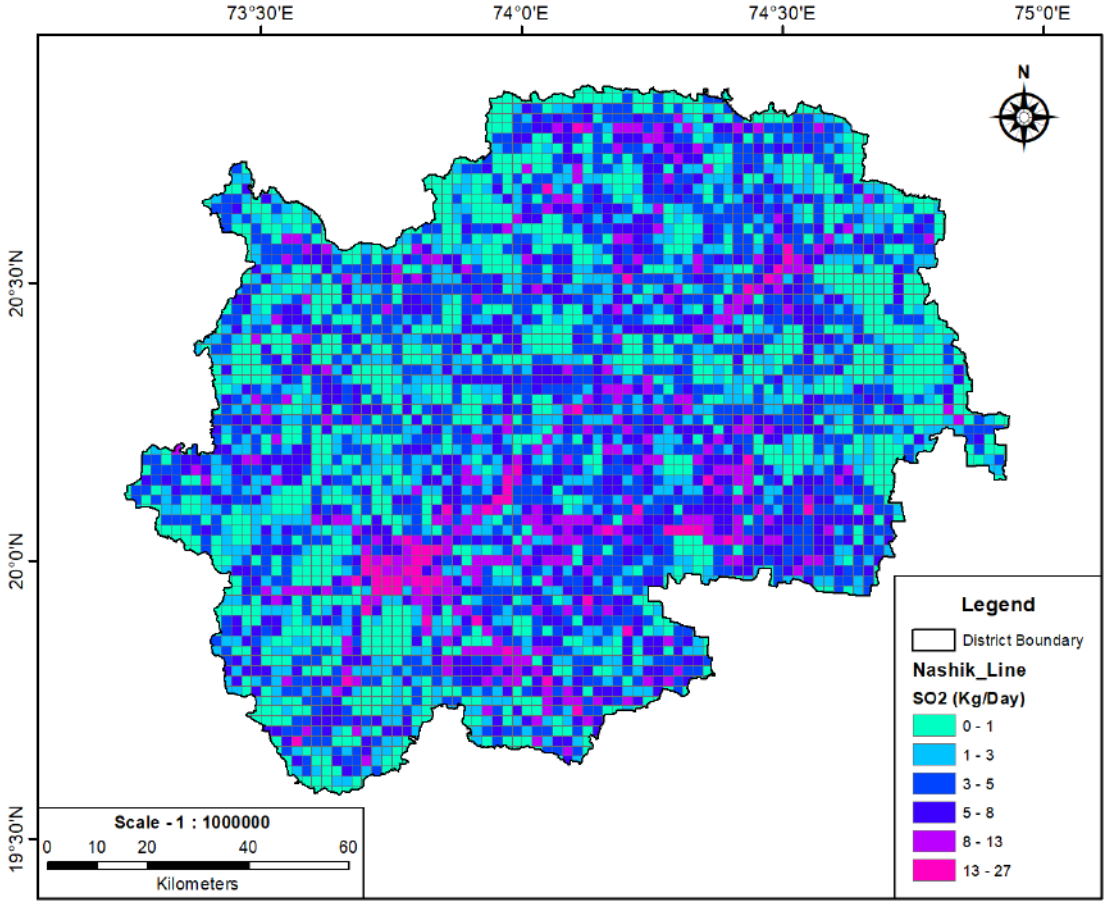

Figure 22: Emission load for SO_2 from line source in Nashik District.

2.6 Road dust

The term silt loading (sL) refers to the mass of the silt-size material (equal to or less than 75 μm in physical diameter) per unit area of the travel surface. Dust samples were collected from various roads in the study area as per USEPA method and were tested for their silt content and then converted into silt loading (g/m^2). Particulate matter emissions from re-suspension of road dust due to movement of vehicles on paved roads were calculated using equation:

$E = k\ (sL)^{0.91}$ x $(W)^{1.02}$

E = particulate emission factor (having units matching the units of k),

k = particle size multiplier for particle size range and units of interest, value of k for PM_{10} and $PM_{2.5}$ is 0.62 and 0.15, respectively.

sL = road surface silt loading (grams per square meter) (g/m^2), and

W = average weight (tons) of the vehicles traveling the road.

Total of 130 days were considered as rainy days in a year based on the meteorological conditions in Nashik.

For estimation of silt load (sL), road dust sampling was carried out at all the traffic count locations in the district. The road dust sampling was carried out for the roads in the district. Water spraying followed by marking was done. The marked area was left 24 hrs for sampling. After 24 hrs the sample was collected using vacuum cleaner and the dust was transported to NEERI lab for further analysis. Based on the road condition, paved and unpaved roads, silt content was analysed and the silt load was determined.

The average silt load for paved roads in the district is estimated to 0.4314 g/m^2 and silt load for unpaved roads is estimated to 0.7414 g/m^2 respectively. Fig.23 shows the road dust sampling procedure carried out in the study area. The average value of W is estimated based on the traffic flow on the roads. Using the above equation, the PM_{10} emission load from road dust-resuspension are 5242 and 1422 kg/day in the District and City, respectively. The $PM_{2.5}$ emissions are 3111 and 851 Kg/day in the District and City, respectively (Fig. 24). The spatial allocation of road dust emissions in the Nashik City and District are shown in the Fig. 25 and 28, respectively.

Figure 23: Road Dust Sampling carried at various locations in Nashik District.

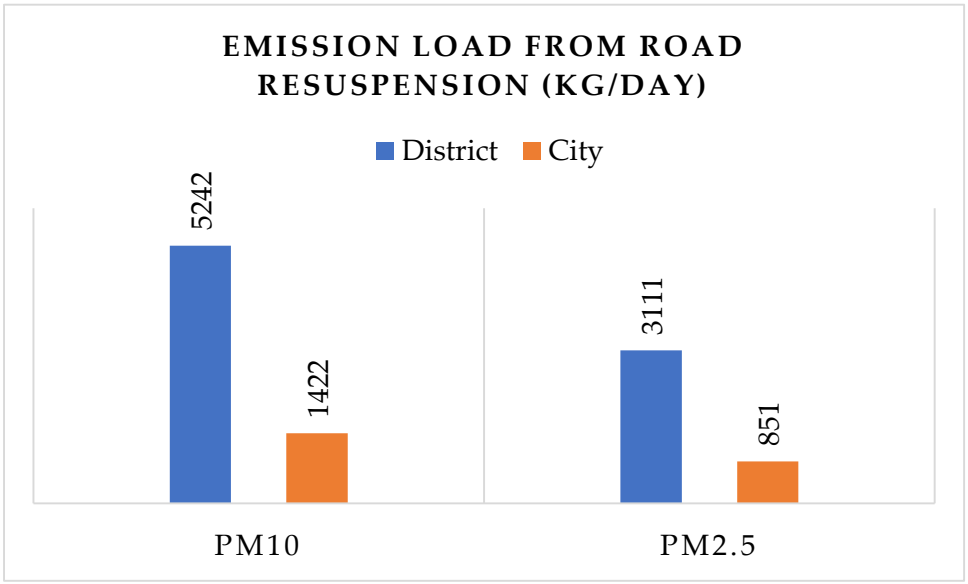

Figure 24: Emission Load from road dust re-suspension (Kg/day).

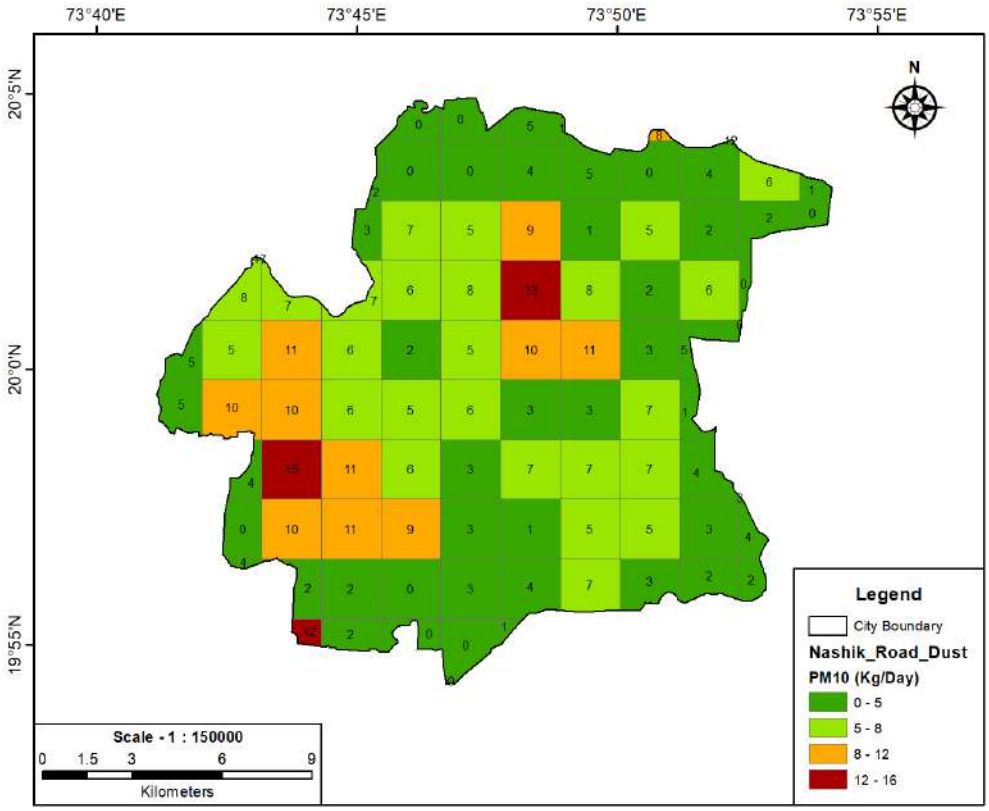

Figure 2516: PM_{10} Dust re-suspension for Nashik City (Kg/day).

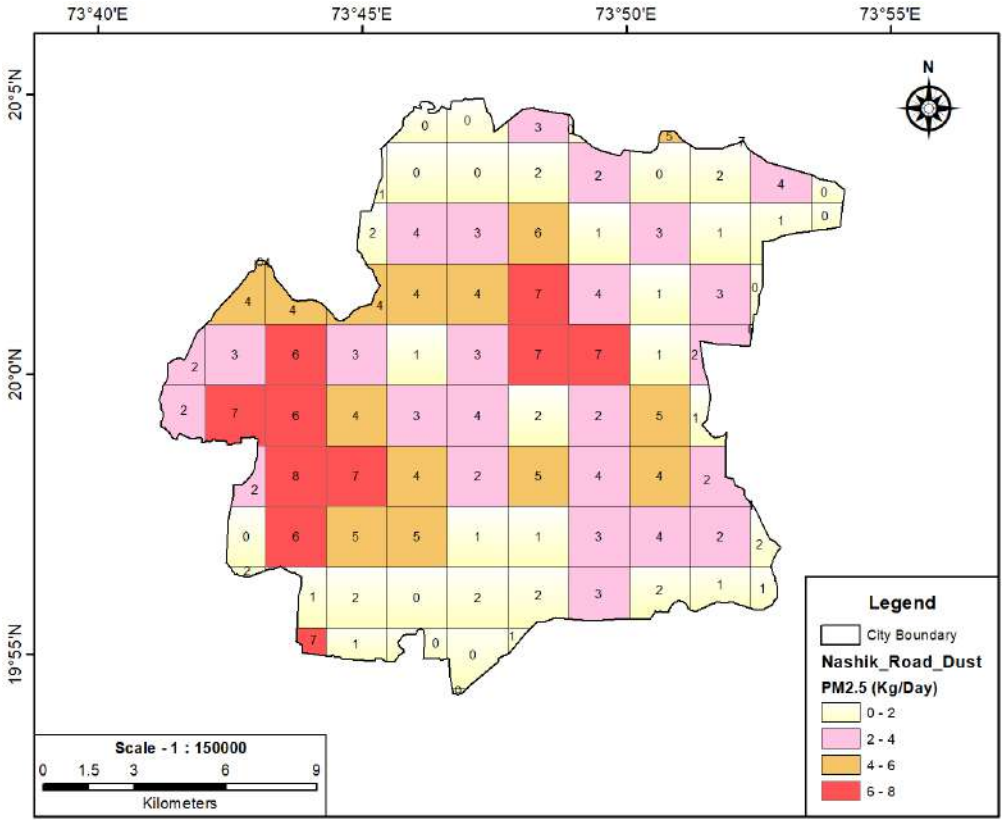

Figure 2617: $PM_{2.5}$ Dust re-suspension for Nashik City (Kg/day).

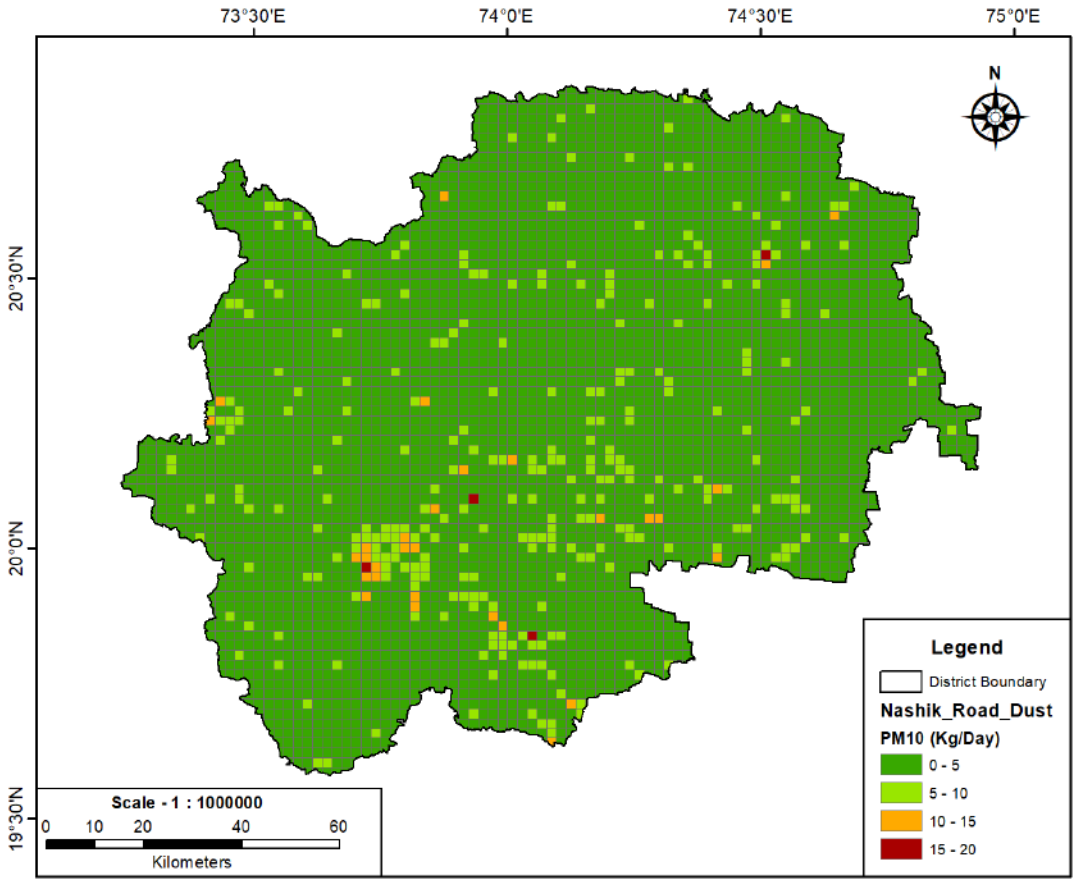

Figure 187: PM_{10} Dust re-suspension for Nashik District (Kg/day).

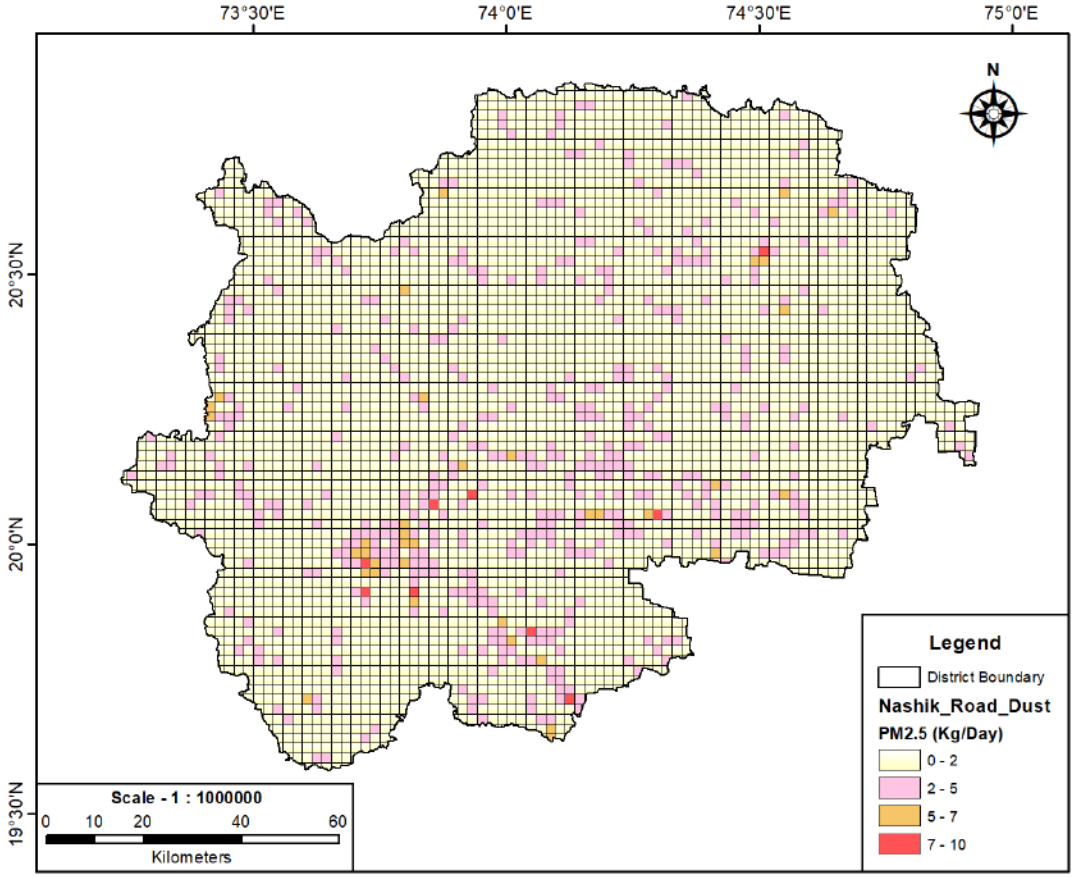

Figure 198: $PM_{2.5}$ Dust re-suspension for Nashik District (Kg/day).

2.7 Point Source

The state is gearing up for rapid infrastructural as well as industrial development; likewise, Nashik is changing its identity from being a Holistic City and City of the temple to an industrial hub. The decadal population growth is tremendous owing to this industrialization of the region. Supported by its climate, Nashik region always had potential agricultural production capacity. Because it exports high-quality grapes, Nashik is referred to as "Wine City of India." The Regional Office of MPCB is functioning at Nasik since 1984. There are 10 industrial areas in Nashik District, namely Ambad, Satpur, Sinnar, Dindori, Vinchur, Peth, Malegaon, Surgana, Additional Sinnar and Manmad.

There are about 6990 small-scale, 27 medium-scale, and 131 large-scale industrial units registered with the DIC office. Most of the industries which came up in the City or Industrial areas are Automobiles, Engineering, Electrical, Electronics, Stationary manufacturing, Printing press components, Metal Arts, Steel and wooden Furniture, Fibre and plastic mouldings, Pharmaceutical and medical equipment, Data processing, etc. In Malegaon City, there are over 12000 active Power loom units. It includes cotton and polyester weaving centres. Additionally, there are sizing and plastic recycling plants. The large-scale industry includes Hindustan Aeronautics Ltd. (HAL), India Security Press, MICO Company, Indian Tools Ltd, Asian Paints Ltd, Ceat Tyres, Garware Nylons, Mahindra & Mahindra Jeep Factory, V.I.P., Glaxo, Crompton Greaves, C.P. Tools, and M.B. Sugar etc.

Emission from industries occurs as a result of various industrial activities happening in different categories of industries falling under the study area. The emissions are caused due to burning of different types of fossil fuels by industries. The different pollutants are released through chimneys/stacks to the surrounding area.

To meet the demand for power, the city is equipped with Eklahare Thermal Power Plant located in the village of Eklahare, near Nashik Road. From here the power is fed into the western division grid and subsequently distributed to substations and finally to households. Out of the total power generated of 703 MW in 2013-2014, the maximum consumption is reserved for Heavy Industries (46%). All air-polluting industries in the district are taken into consideration for emission load estimation.

One more thermal power plant namely **Rattan India Nashik Thermal Power Project** is a coal-based thermal power plant located in Sinnar in Nashik District Maharashtra. The power plant is operated by Rattan India Power Limited (formerly India-bulls Power Ltd (IPL)). Coal for the plant is sourced from South Eastern Coalfields Limited (SECL), Western Coalfields Limited (WCL) and Mahanadi Coalfields Limited (MCL). In Table 5, power plants are included together with their daily coal consumption and electricity generation capacities. The thermal power plants are located outside City boundary. The district has a total of 213 air-polluting industries.

Table 5: Power plants in Nashik

No.	Power plants in Nashik	MW	Quantity of coal (T/d)
1	Nashik Thermal Power Station, Eklahare.	3x210	10800
2	Rattan India (India bulls) Power Plant, Sinnar.	5x270	6600

2.7.1 Type of Fuel and Quantity

The fuel consumption pattern of industries reveals that the region of Nashik is highly depended on fossil fuel for power usage and other processes. Exploration of alternative energy sources are yet not being explored to full capacity. As per the data furnished by the MPCB officials, the fuel consumption of all the air pollution industries in the city is given in Table 6. Due to the wide variety of industrial processes, reliable determinations of industrial emissions have been found to depend on individual types of treatment. This is expensive and time-consuming, as it involves detailed study and testing of specific plants and processes. In this assessment, data on industrial emissions were obtained by means of consent approved by MPCB. It includes the name of the plant, its location, information on the product manufactured, the fuel used, the stack attached to the control unit, the quantity of fuel used, etc.

Table 6: Quantity of fuel used in Industries of Nashik District

No.	Fuel Type	Quantity	Unit
1	Coal (Other)	2797	T/day
2	Coal (TPS)	15000	T/day
3	Bagasse	2085	T/day
4	Wood	500	T/day
5	Briquette	172	T/day
6	Diesel	1474	T/day
7	Furnace Oil	3400	KL/day
8	HSD	340	KL/day
9	LDO	800	KL/day
10	LPG	11016	Kg/day
11	Pet-coke	125	T/day
12	Biogas	18	T/day

It can be observed that the most common fuels used in the industries of this region are furnace oil, coal, LPG and Bagasse. As per the regulation, the industries have air pollution control systems installed. For emissions from coal based thermal power plant, the ash and sulphur emissions are predicated on Indian circumstances. The co-ordinates of the industries are plotted on GIS to estimate gridded emissions (Fig. 29). Emission loads for PM_{10}, $PM_{2.5}$, SOx, NOx and CO are estimated (Fig. 30).

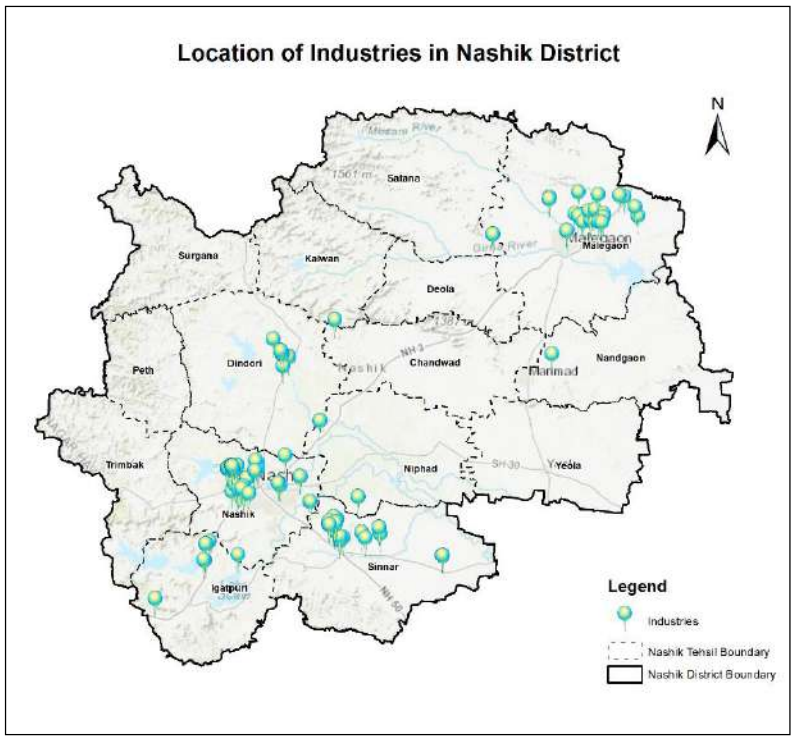

Figure 29: Location of industries in Nashik District

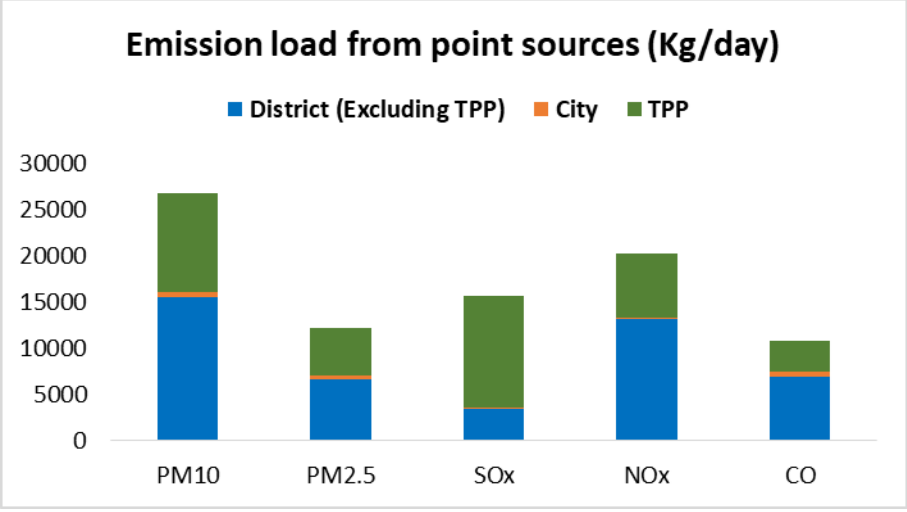

Figure 30: Emission load for point sources in District, City and TPPs

The emission load for PM_{10}, $PM_{2.5}$, SO_x, NO_x and CO from the industries in the city is estimated to be 460, 357, 92, 20 and 496 Kg/day.

The emission load for PM_{10}, $PM_{2.5}$, SO_x, NO_x and CO for industries other than thermal power plants in the district is determined to be 15554, 6638, 3518, 13230 and 6944 Kg/day respectively.

There are two thermal power plants in Nashik District. The total emission load for PM_{10}, $PM_{2.5}$, SOx, NOx and CO for these types of industries is found to be 10705, 5220, 12116, 6980 and 3358 Kg/day respectively.

The total emission load for PM_{10}, $PM_{2.5}$, SO_x, NO_x and CO is estimated to be 26719, 12215, 15726, 20230, and 10798 Kg/day.

The grid-wise emission inventories of PM_{10}, $PM_{2.5}$, SO_2, NO_x and CO for the City and District is shown in Fig. 31 to Fig.45.

From the estimated pointy sources emission load, 89% of the total emissions are released from thermal power plants operated in the district.

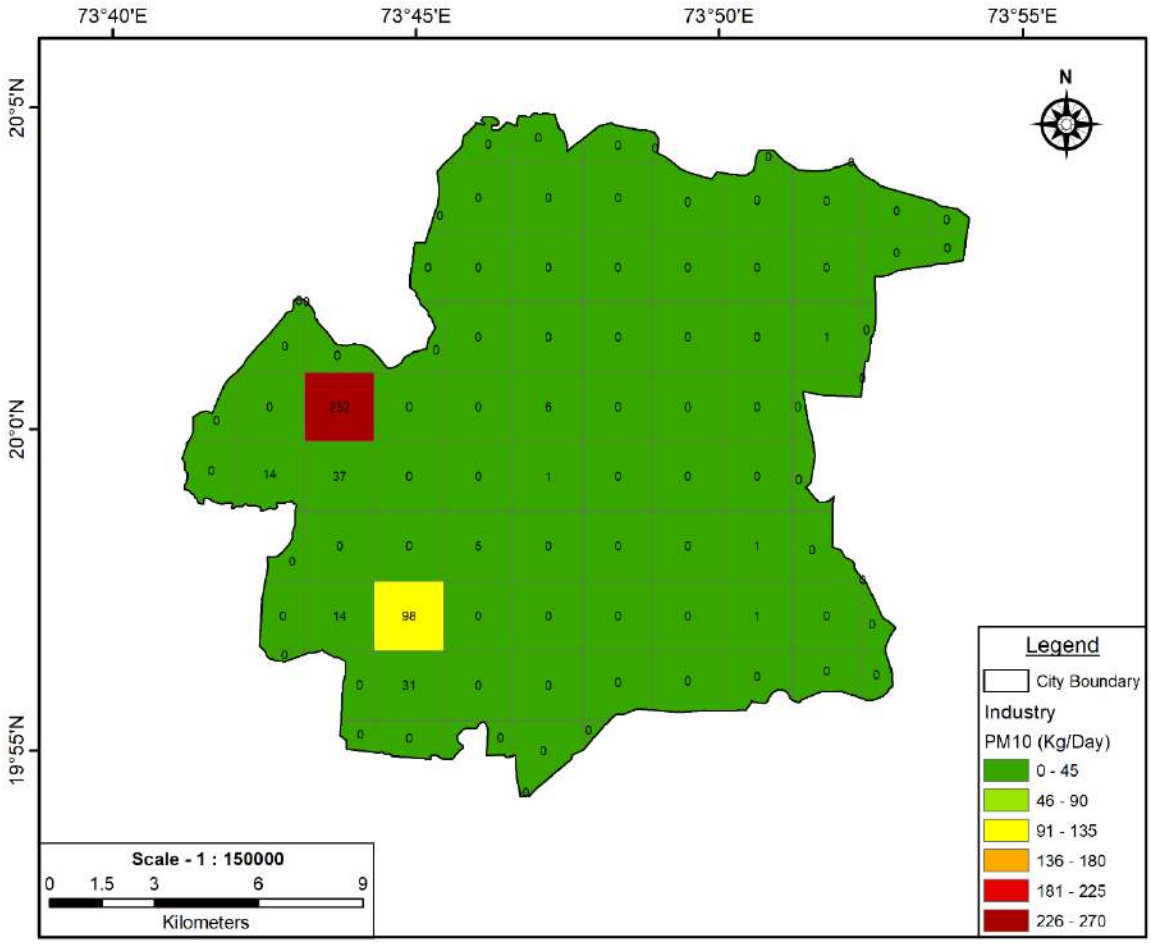

Figure 31: Grid-wise PM_{10} emission from point source for Nashik City.

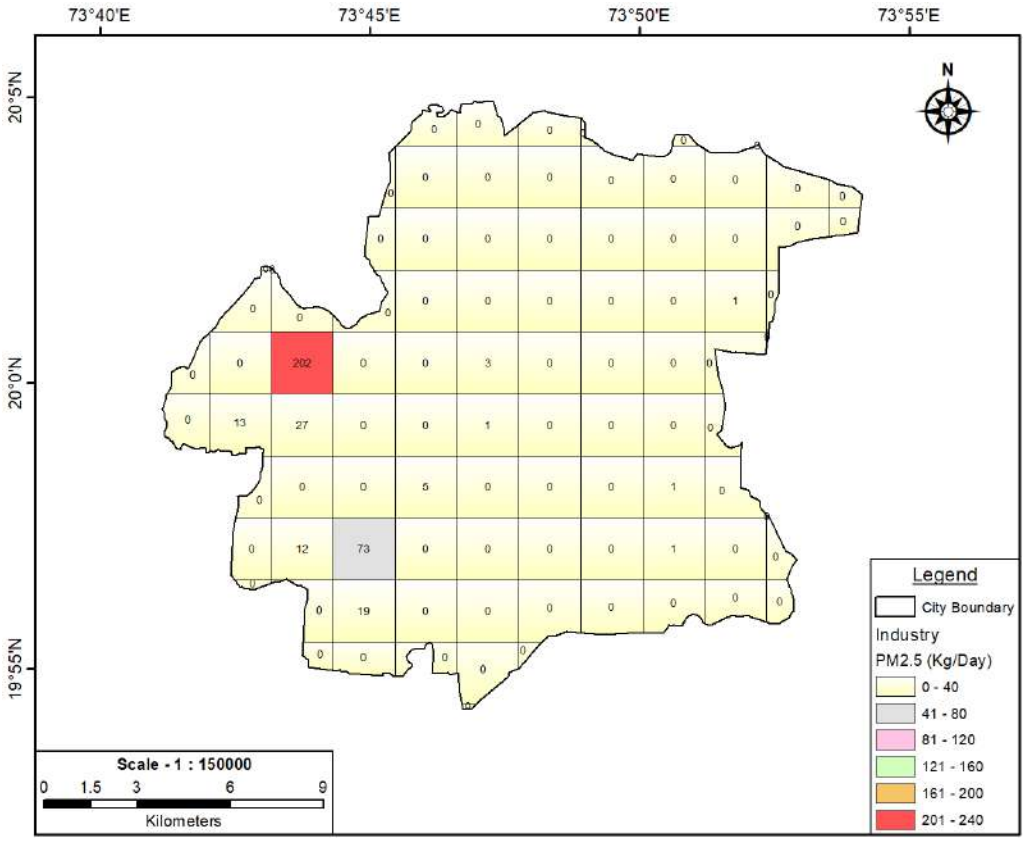

Figure 32: Grid-wise $PM_{2.5}$ emission from point source for Nashik City.

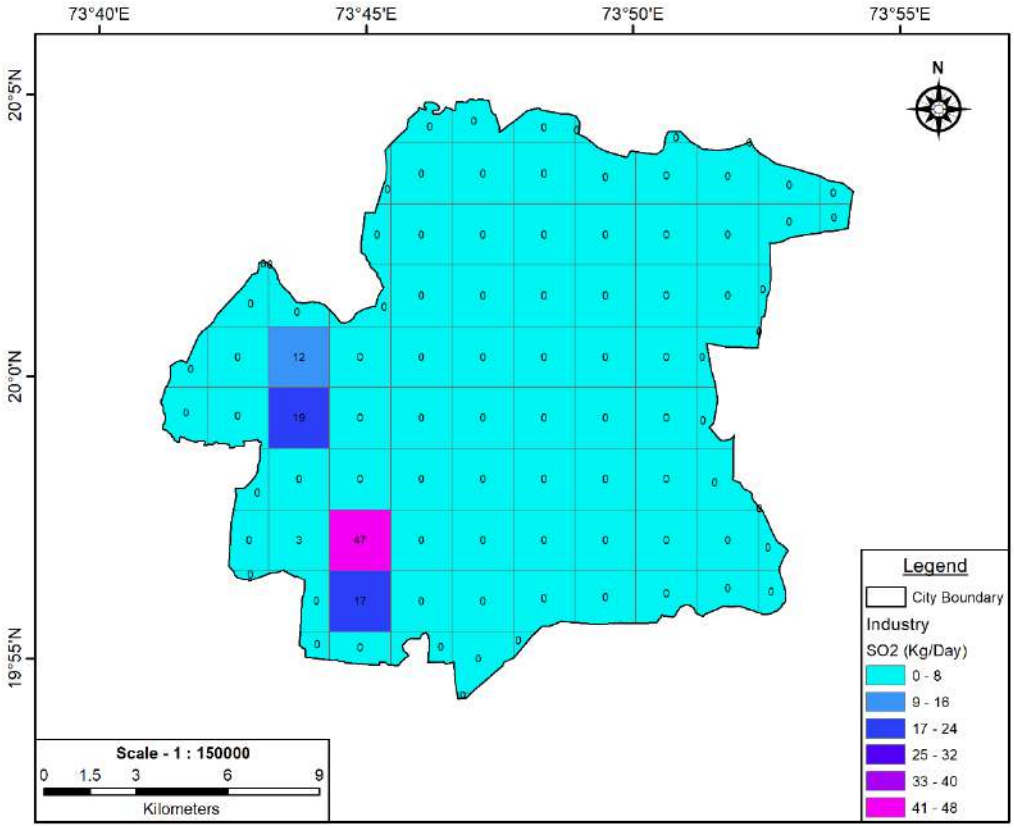

Figure 33: Grid-wise SO_2 emission from point source for Nashik City.

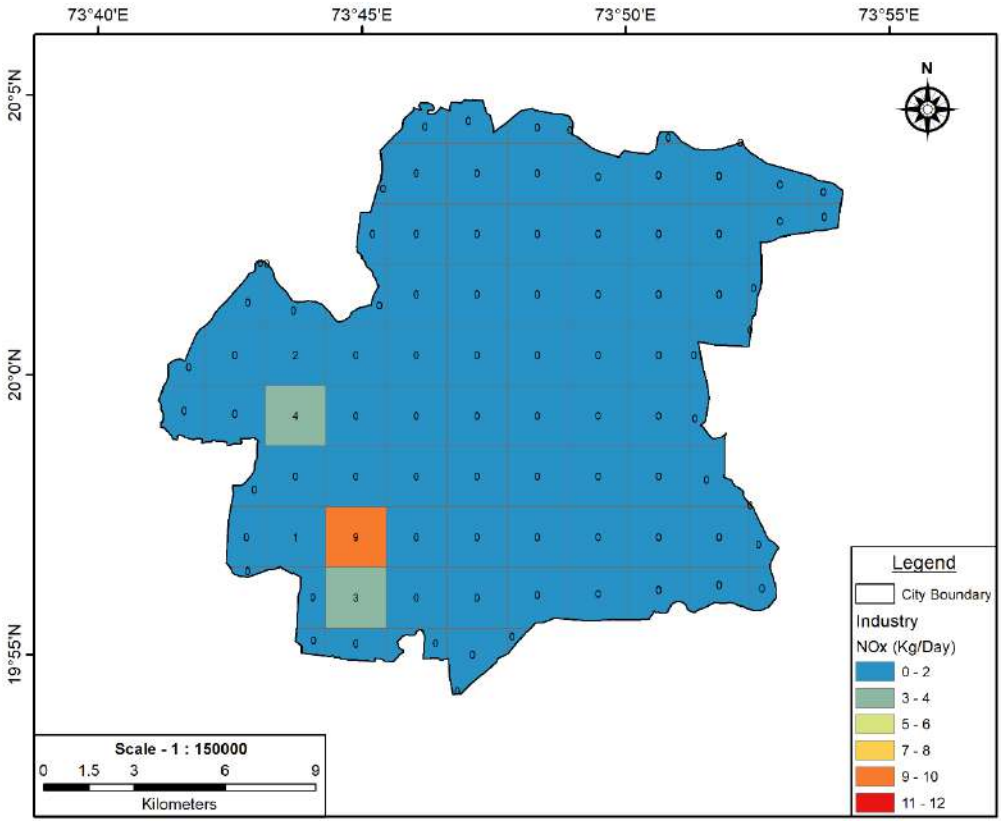

Figure 34: Grid-wise NO_x emission from point source for Nashik City.

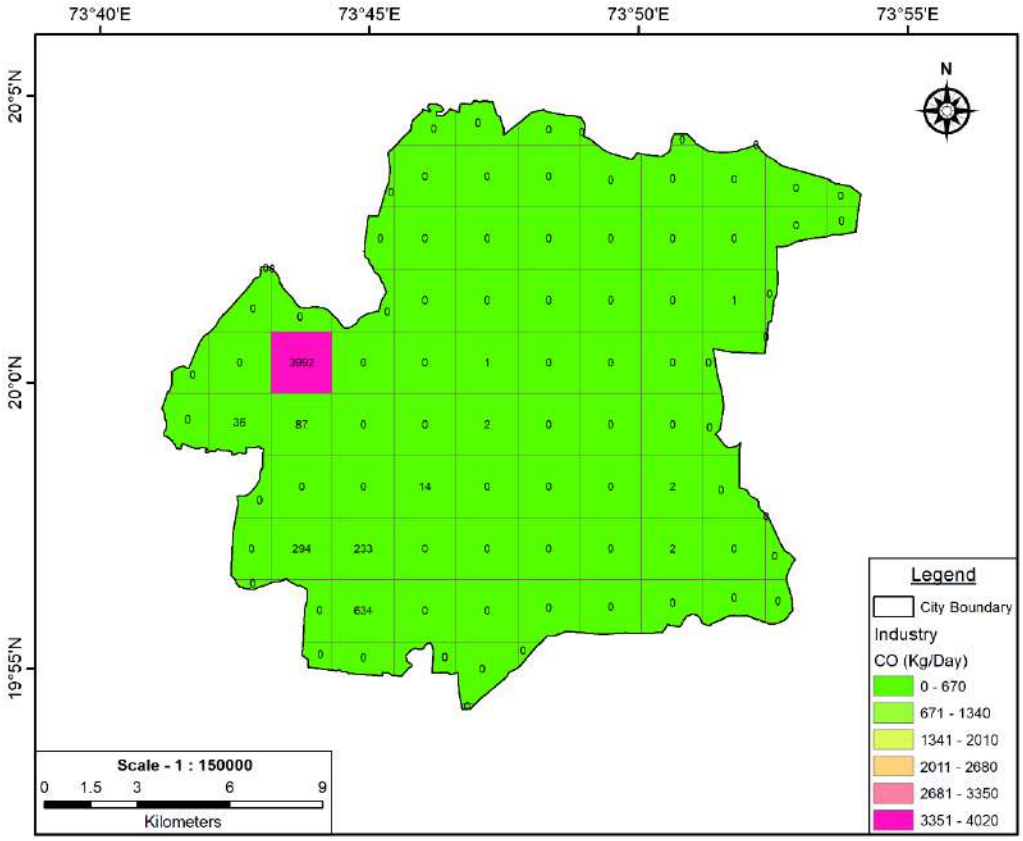

Figure 35: Grid-wise CO emission from point source for Nashik City

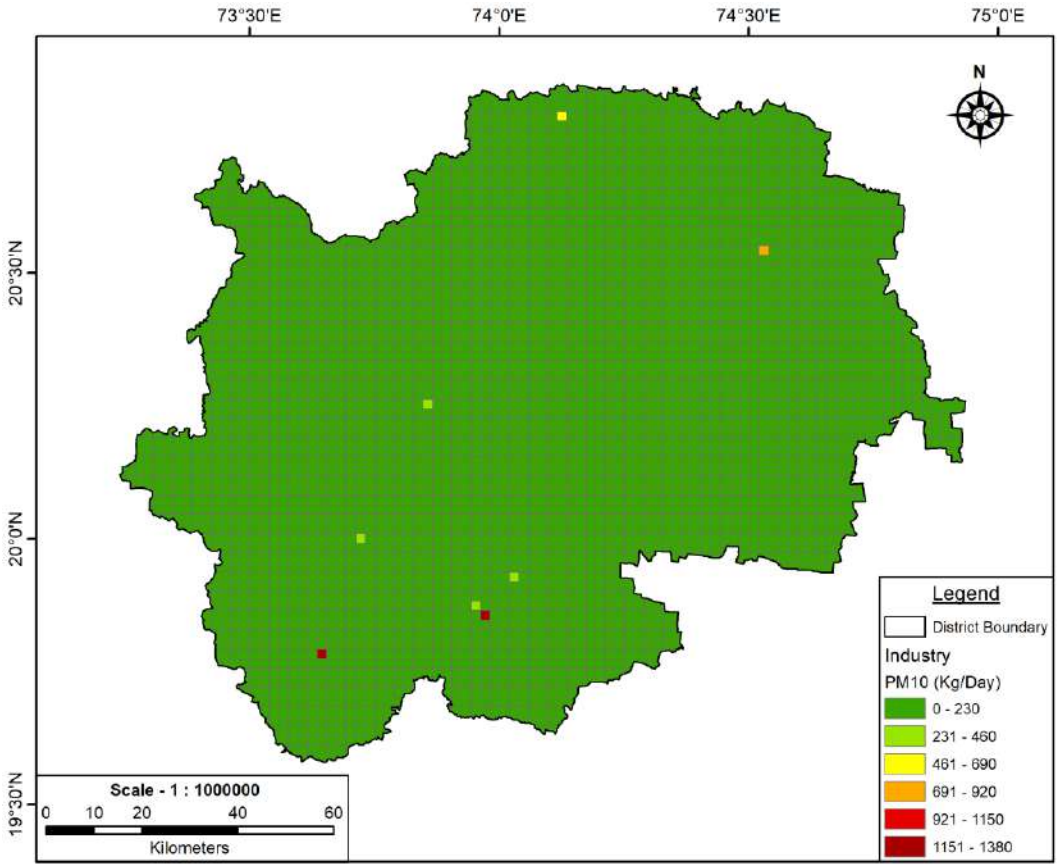

Figure 36: Gridded PM_{10} emission load from all point sources in Nashik District.

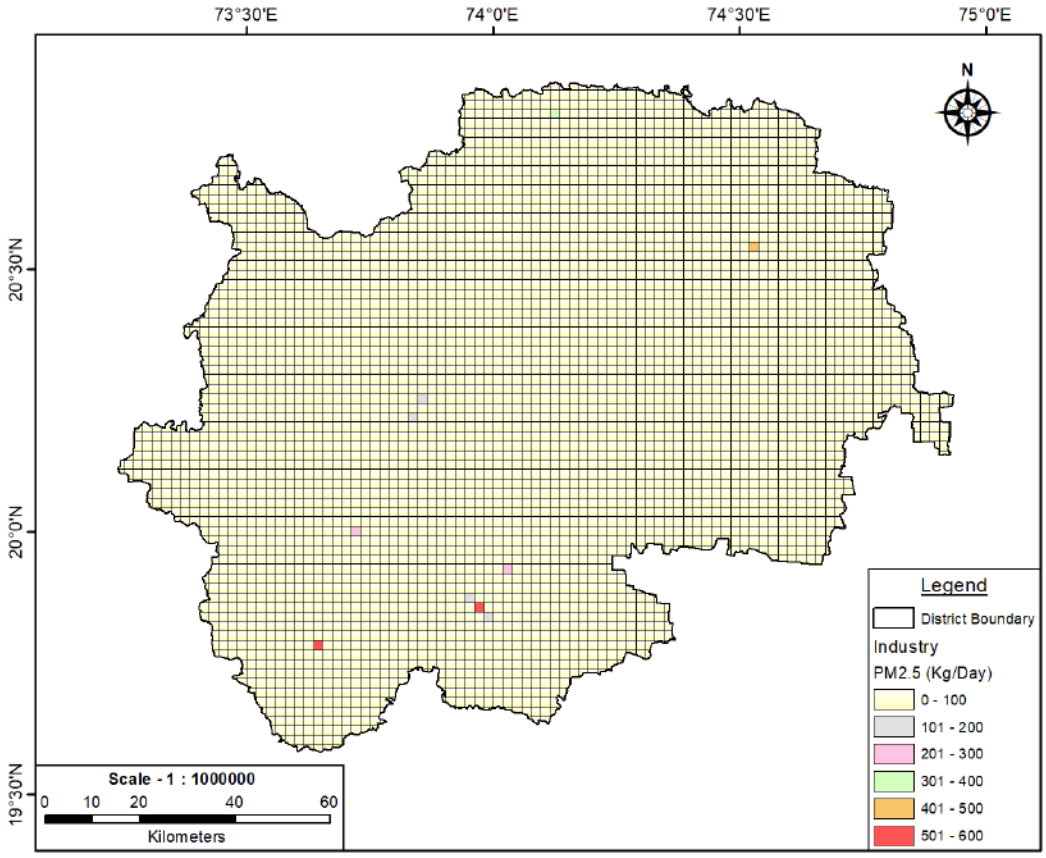

Figure 37: Gridded $PM_{2.5}$ emission load from all point sources in Nashik District.

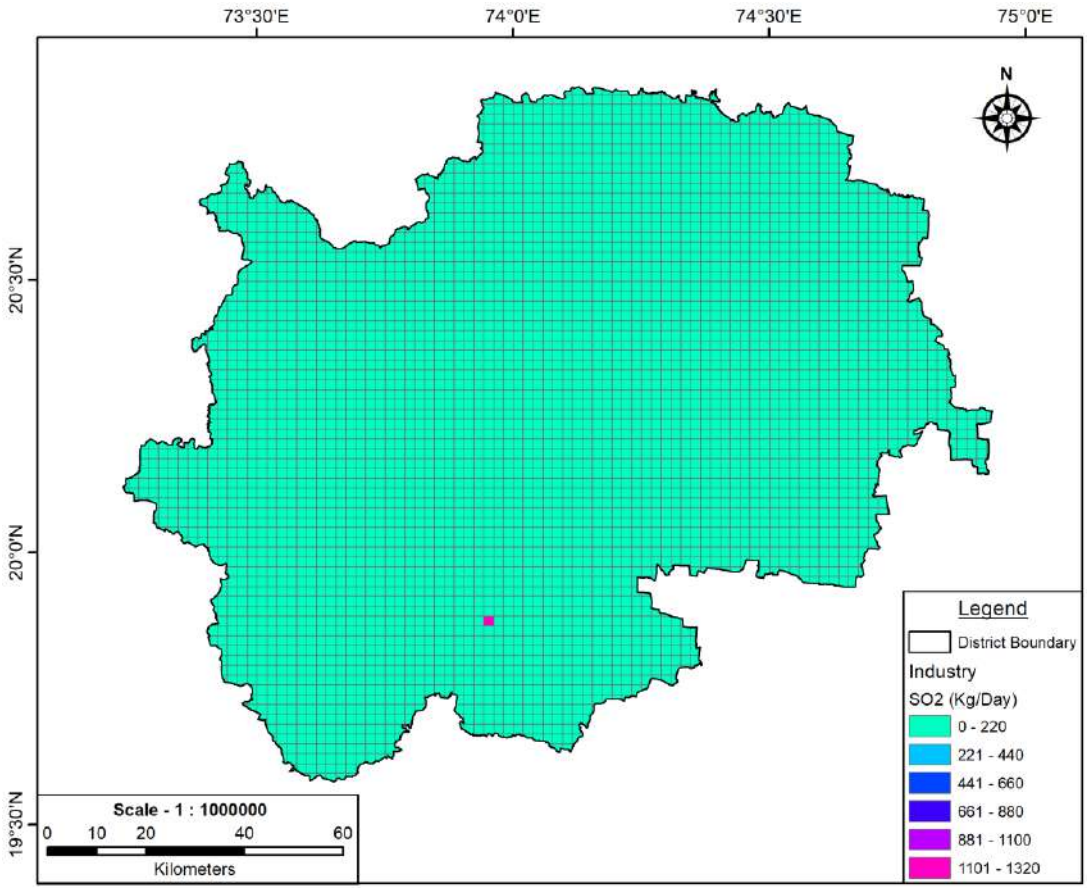

Figure 38: Total gridded SO_2 emission load from point source in Nashik District.

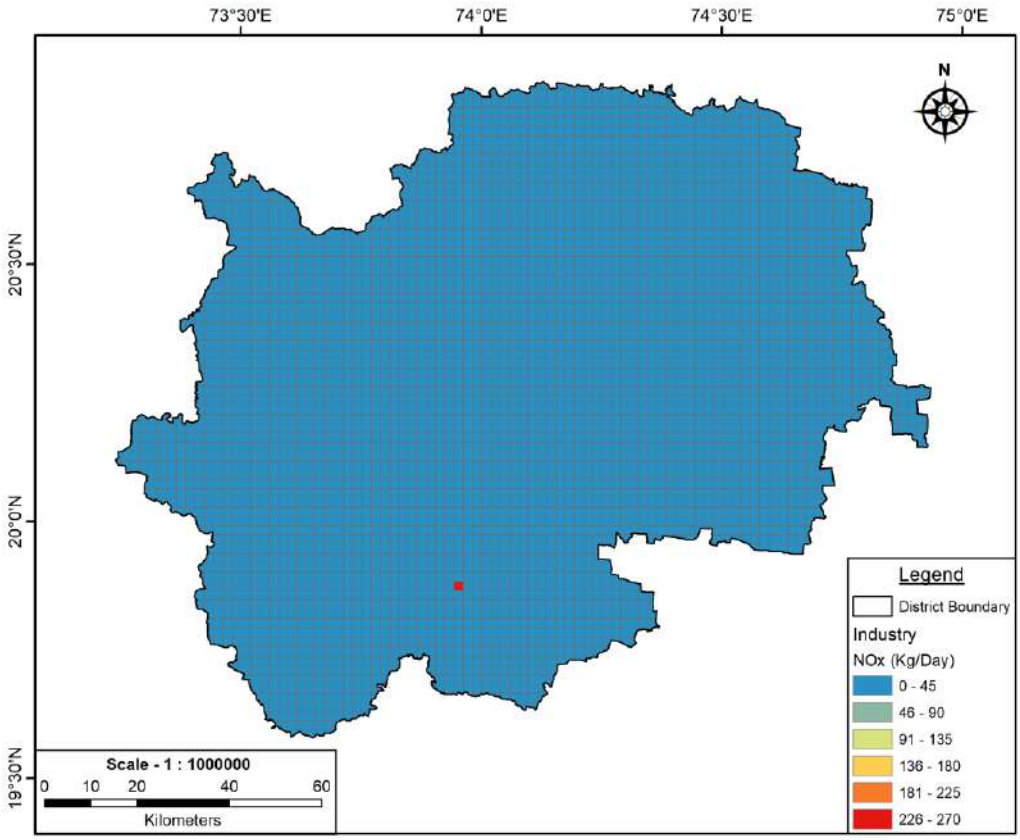

Figure 39: Total gridded NO_x emission load from point source in Nashik District.

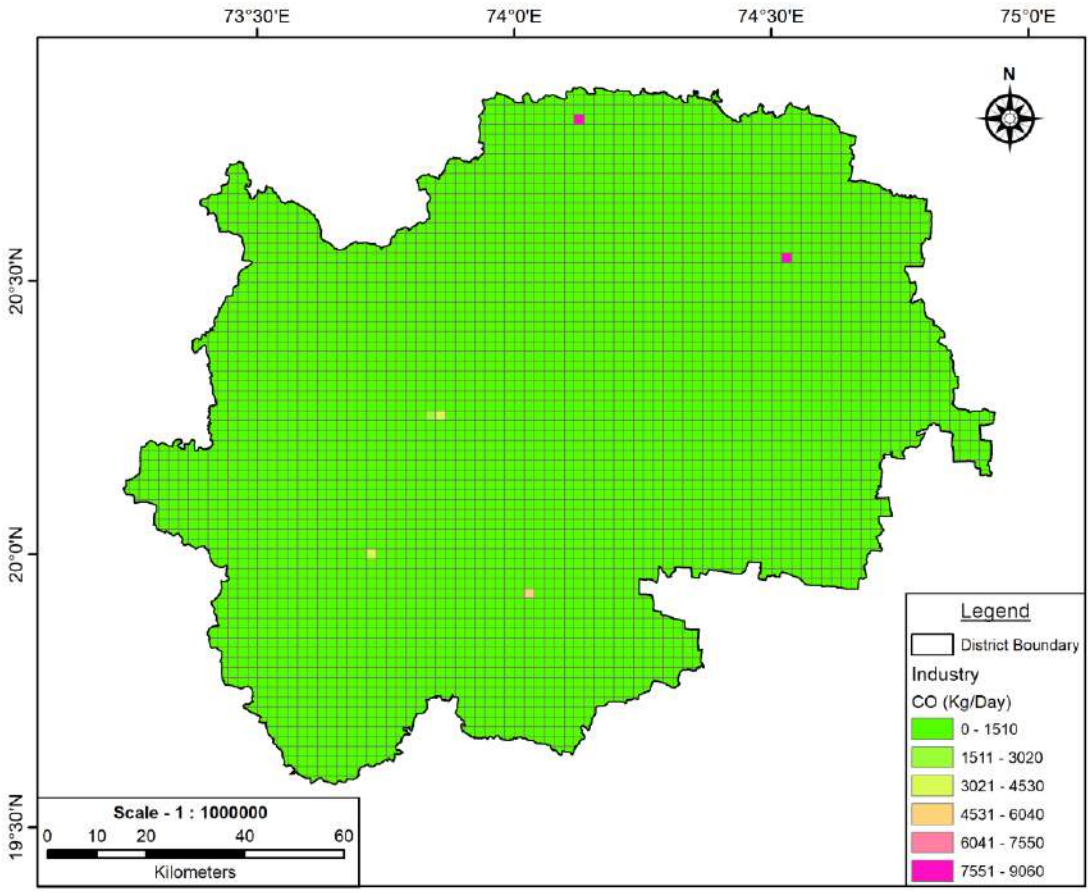

Figure 40: Total gridded CO emission load from point source in Nashik District.

The following figures represents emission load from the two thermal power plants in the district.

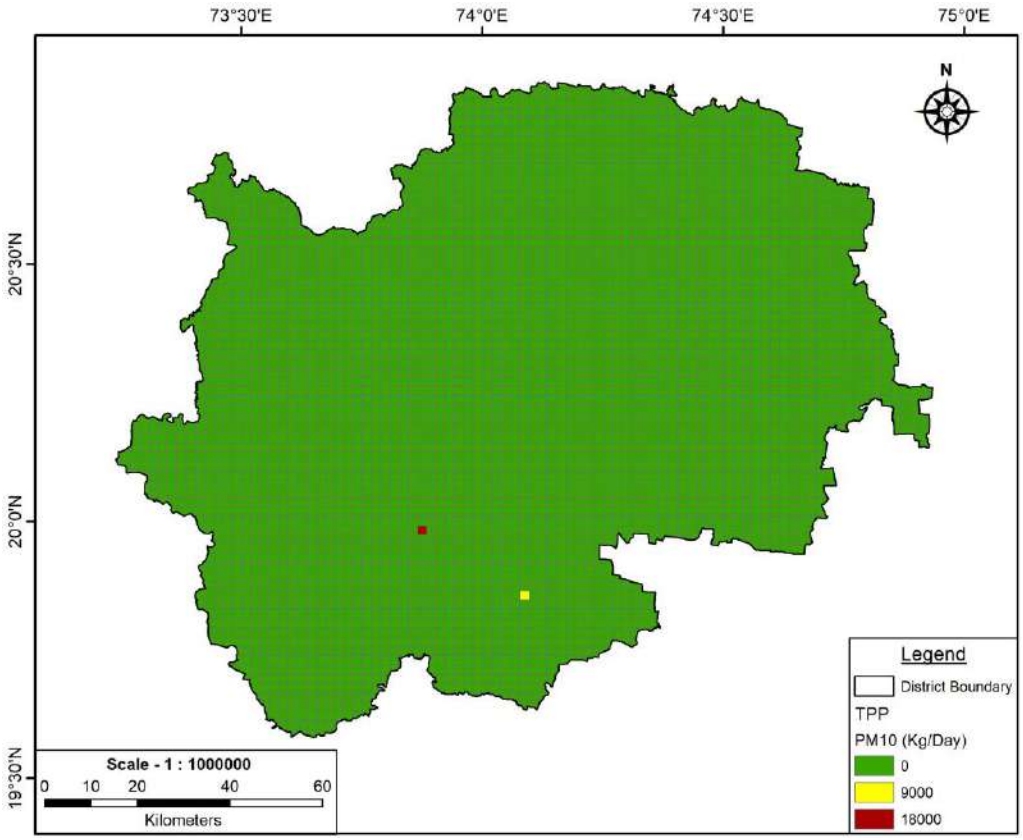

Figure 41: Grid-wise PM_{10} emission load from TPPs in Nashik District

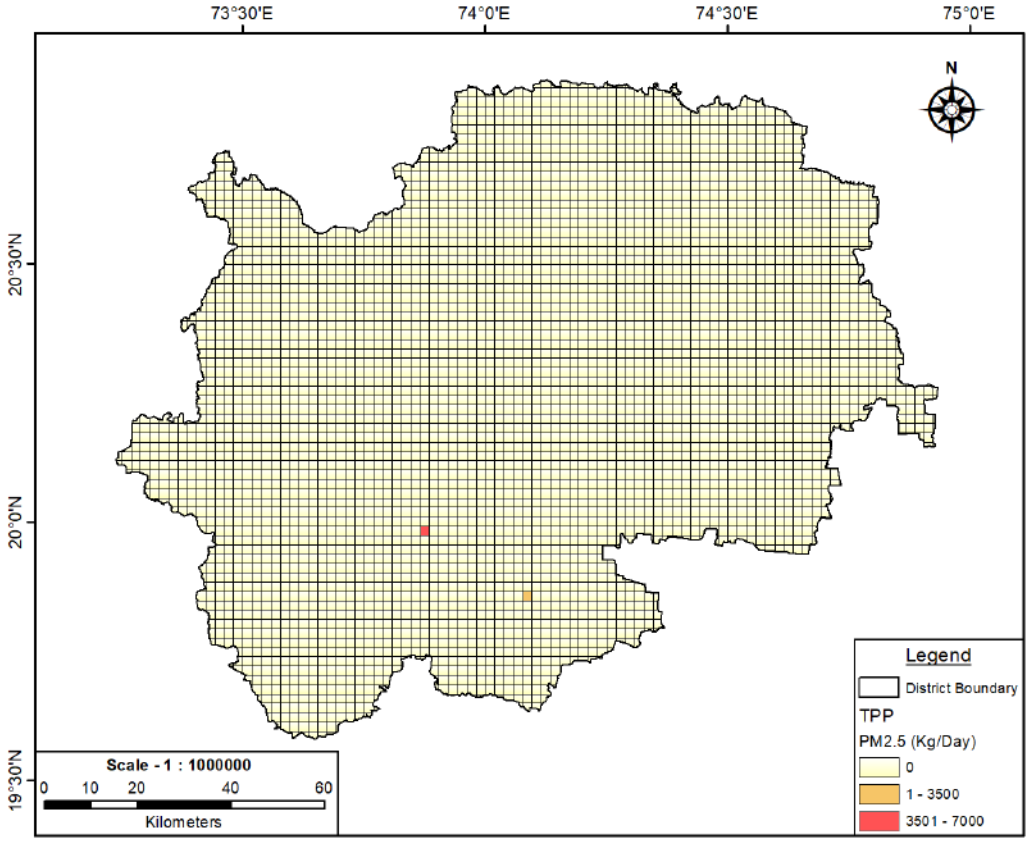

Figure 42: Grid-wise $PM_{2.5}$ emission load from TPPs Nashik District

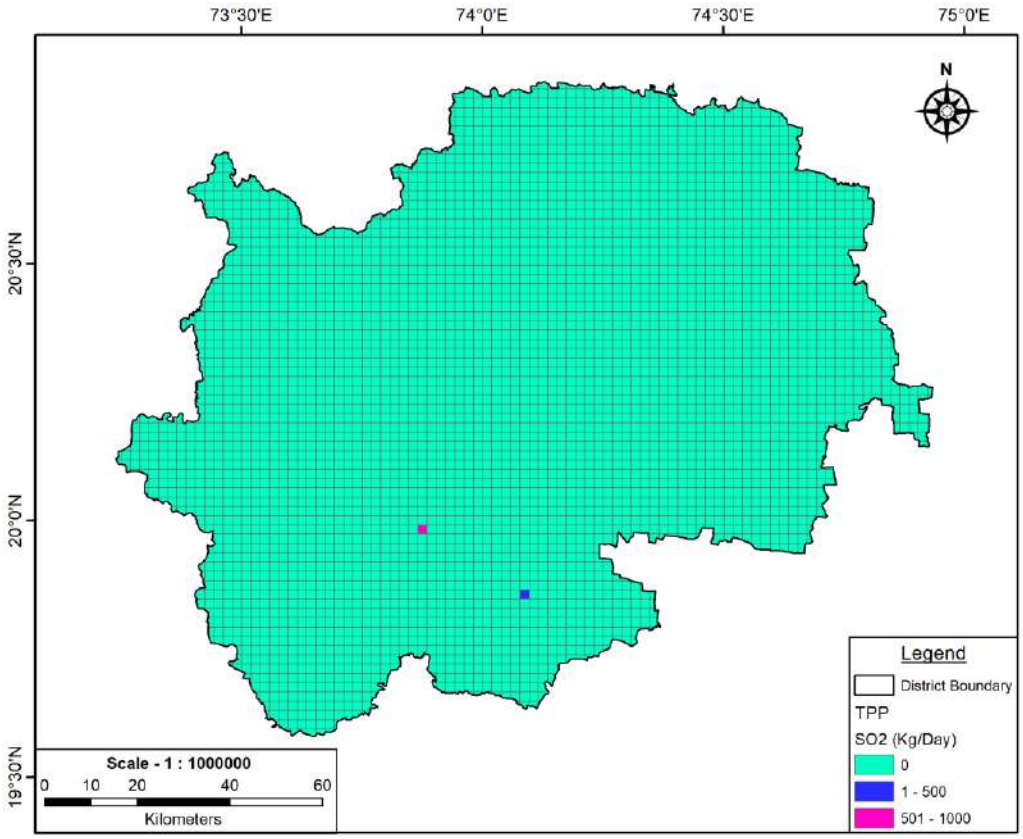

Figure 43: Grid-wise SO_2 emission from load TPPs Nashik District.

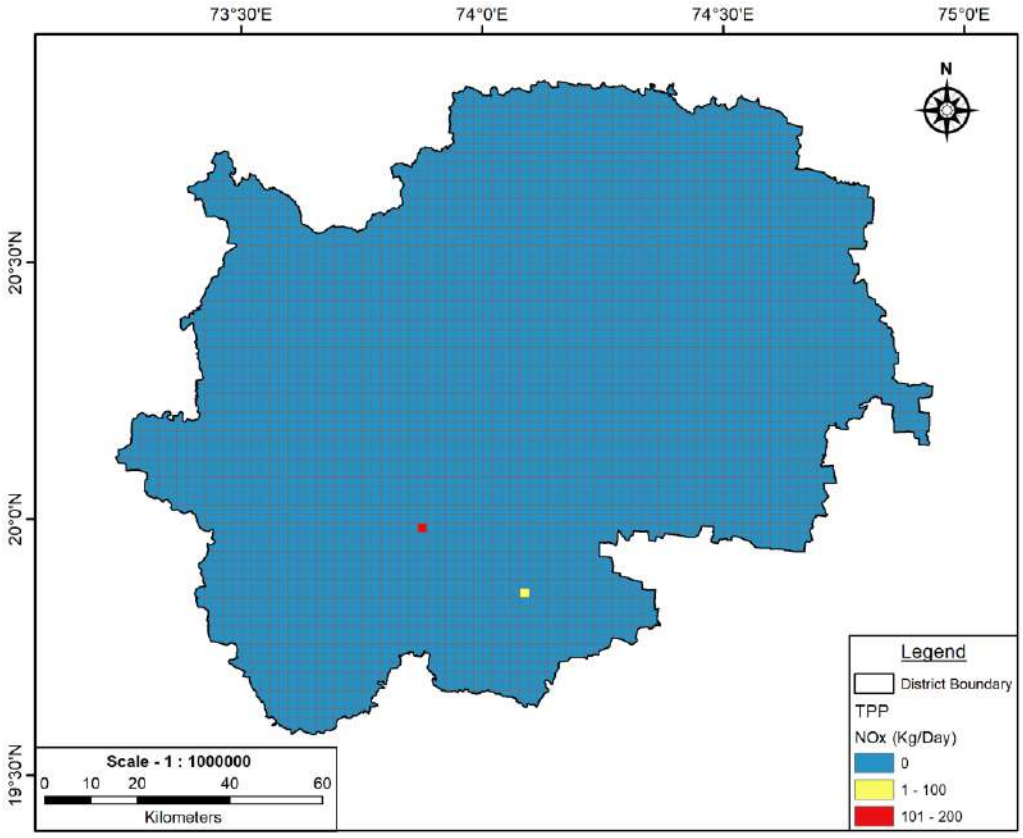

Figure 44: Grid-wise NO_x emission load from TPPs Nashik District

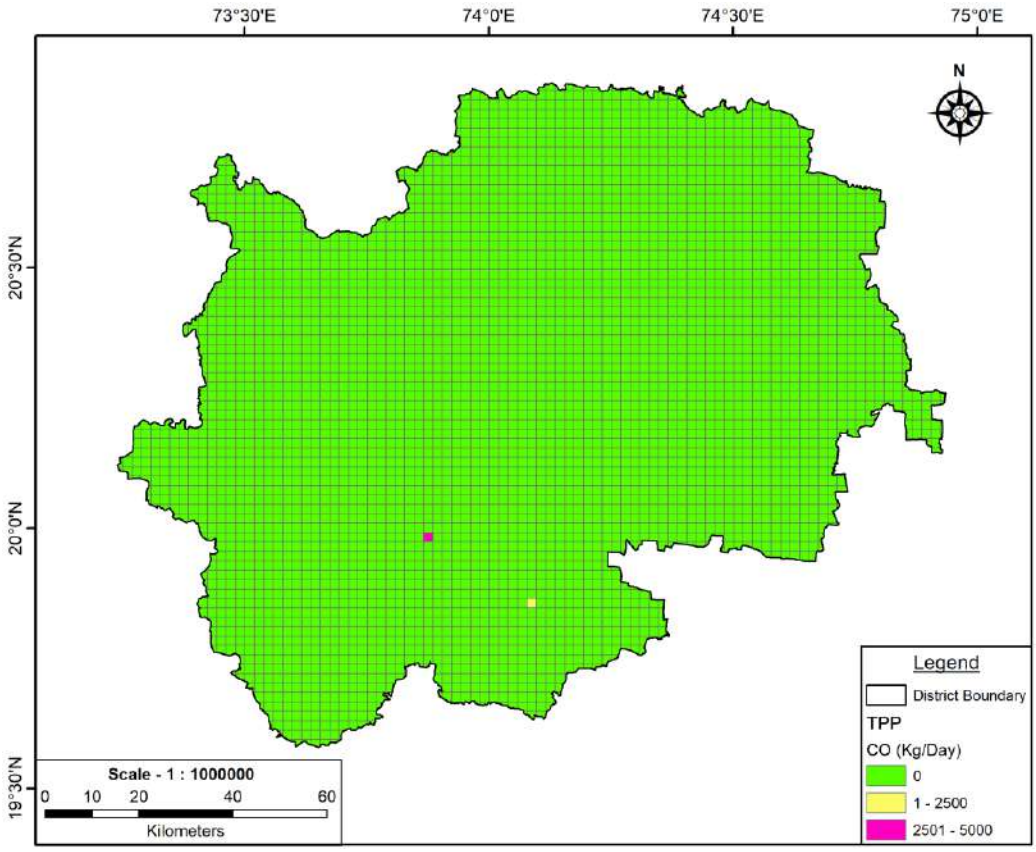

Figure 45: Grid-wise CO emission load from TPPs Nashik District

2.8 Area Sources

An area source may be defined as a collection of similar units within a geographic area. Area sources collectively represent individual sources that are small and numerous and that cannot be inventoried as specific point, mobile or biogenic sources. Area sources includes bakeries, hotels/restaurants, crematories, construction activities, domestic cooking, open eat outs, paved/unpaved road dust, solid waste dumping ground, refuse burning, stone crushers and brick kilns etc. These sources have been described along with the methodologies for load estimation.

2.8.1 Bakeries

Bakeries operates in any city and act as one of the sources of air pollutants. According to data collected from Nashik Municipal Corporation and local municipal councils in the district, there are 171 authorized bakeries. For baking activities, coal and firewood were the main source of fuel used earlier. Now, the scenario has changed. Many units have registered for commercial LPG connections and are operating on the cleaner gas. From the primary survey, it is reported that the bakeries operate around 10-12 hours in a day. Locations of bakeries in Nashik region are shown in Fig.46.

Emission load from Bakeries in City and District is shown in Fig 47. The emission load for PM_{10}, $PM_{2.5}$, SO_x, and NO_x from bakeries in the district is determined to be 849, 517, 603, 121 and 1315 Kg/day respectively. The emission load for PM_{10}, $PM_{2.5}$, SO_x, and NO_x from Bakeries in the City is determined to be 409, 253, 372, 74 and 423 Kg/day respectively.

Emission estimation equation mentioned below.

Emission Estimation (Kg/d) = No. of Bakeries x Fuel Consumption of each bakery (Kg/d) x Emission Factor

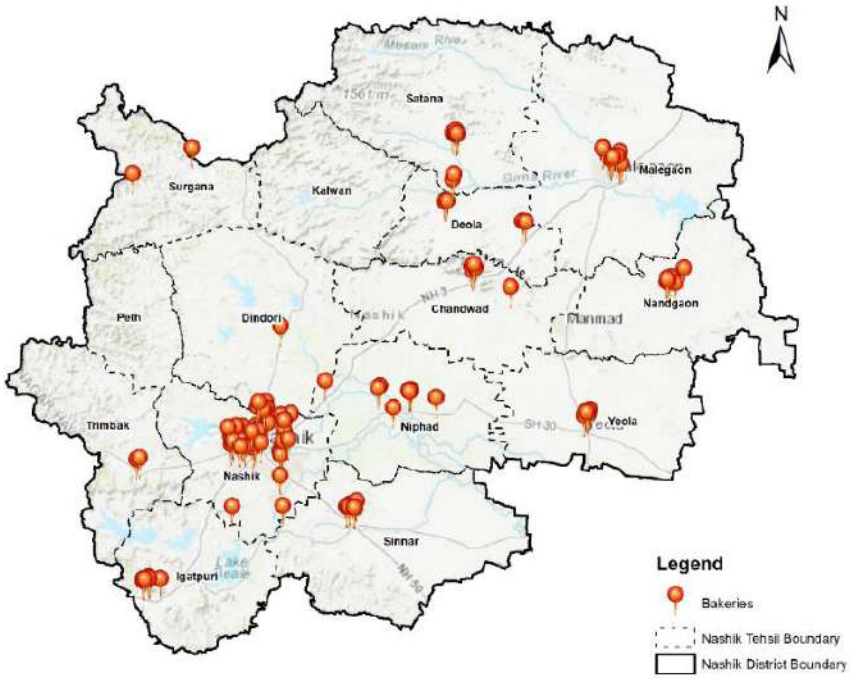

Figure 46: Location of bakeries in Nashik region.

The quantity of fuel consumed in the bakeries is shown in Table 7

Table 7: Quantity of fuel consumed in Bakeries

Fuel	City	District
	Quantity (Kg/day)	
Coal	24	87
LPG	309	1311
Wood	47	101

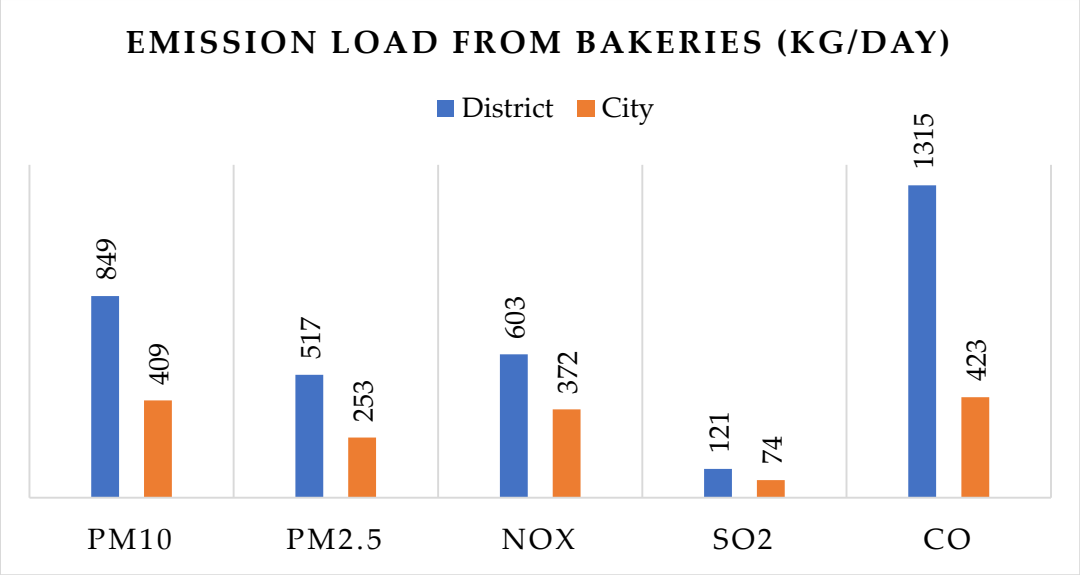

Figure 47: Emission load from Bakeries

The grid wise distribution of PM_{10}, $PM_{2.5}$, SO_2, and NOx emissions (Kg/day) from bakeries in the Nashik District and City is shown Fig 48 to Fig 57.

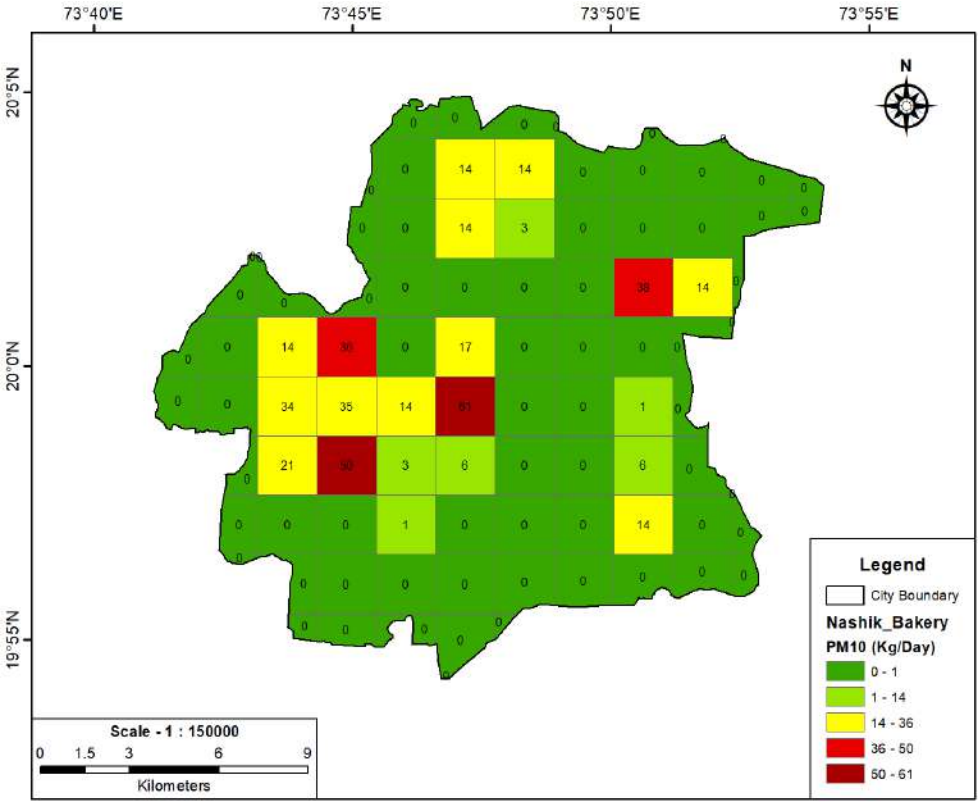

Figure 48: Gridded PM_{10} emission load (Kg/day) from bakeries for Nashik City.

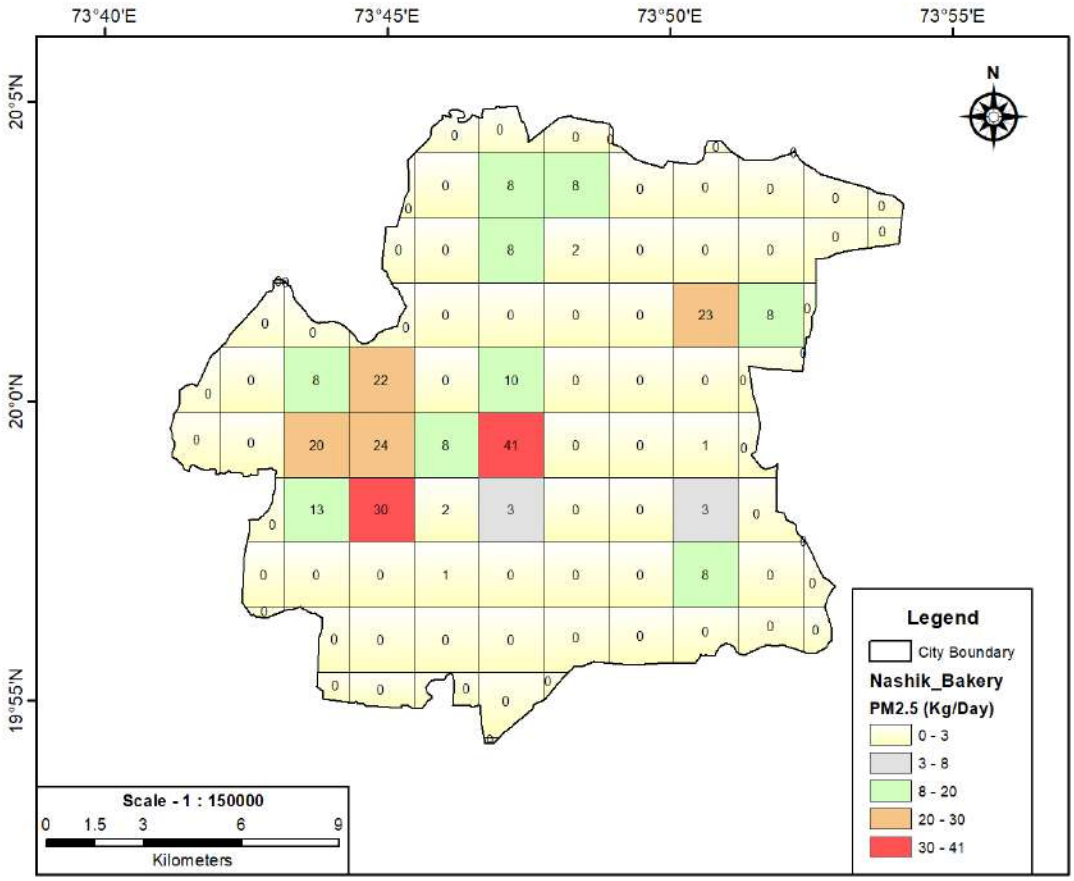

Figure 49: Gridded $PM_{2.5}$ emission load (Kg/day) from bakeries Nashik City.

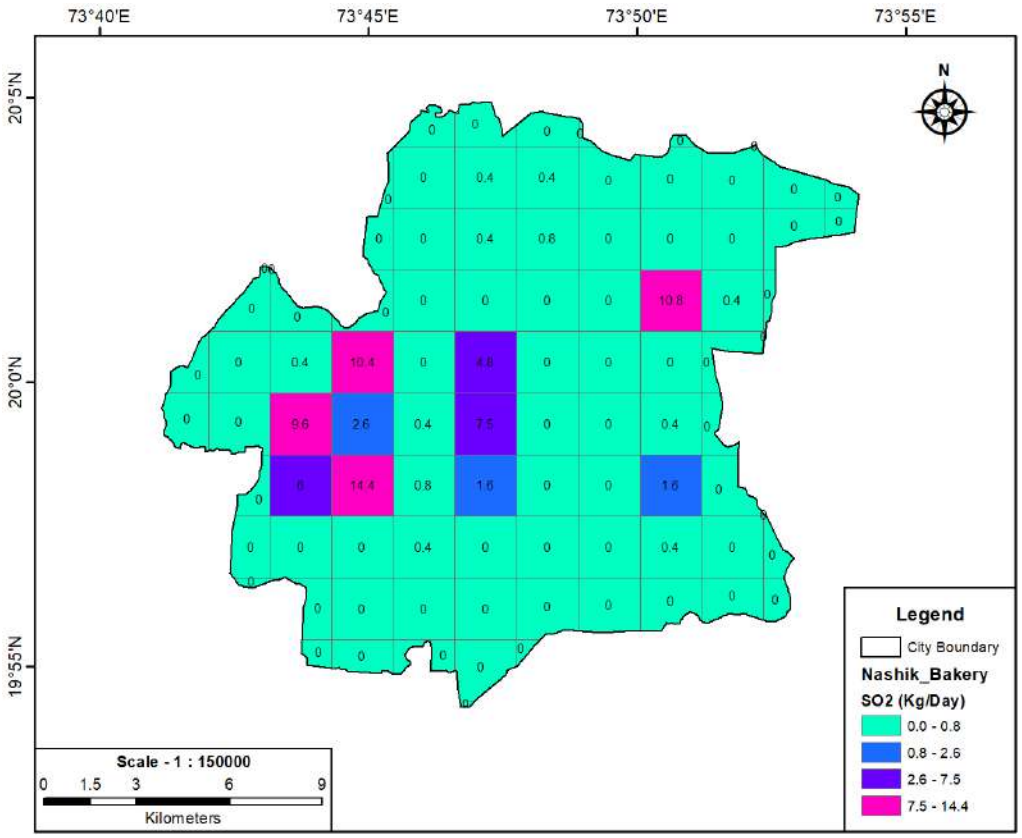

Figure 50: Gridded SO_2 emission load (Kg/day) from bakeries Nashik City.

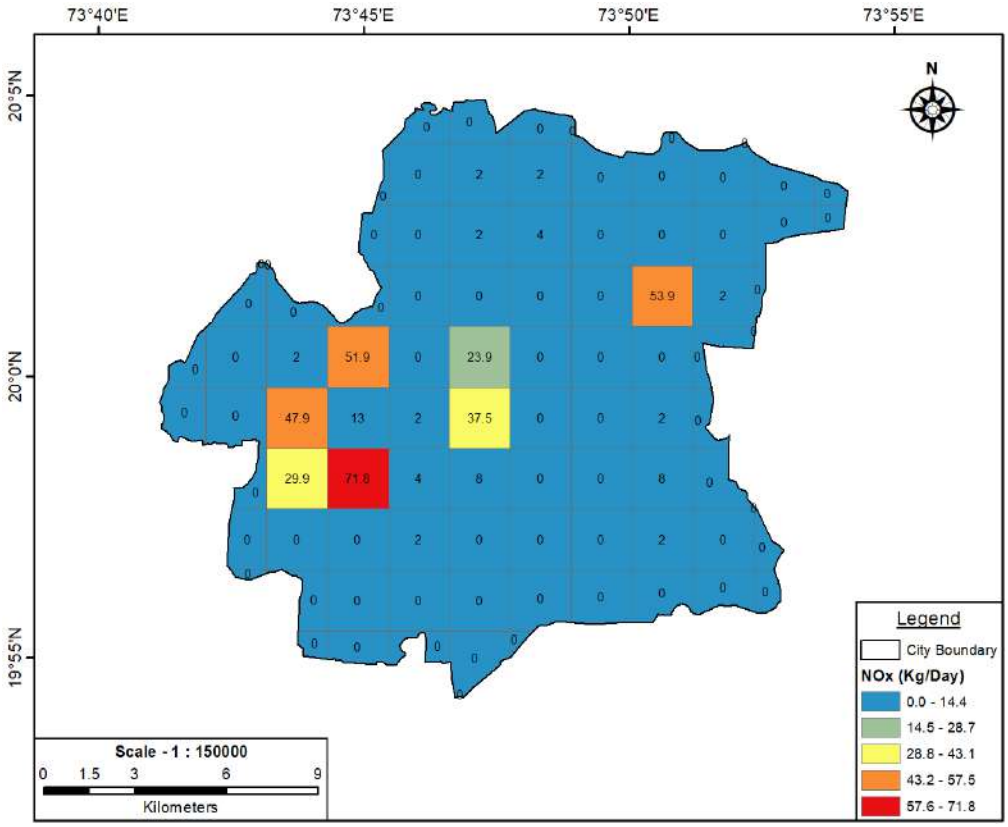

Figure 51: Gridded NO_x emission load (Kg/day) from bakeries Nashik City.

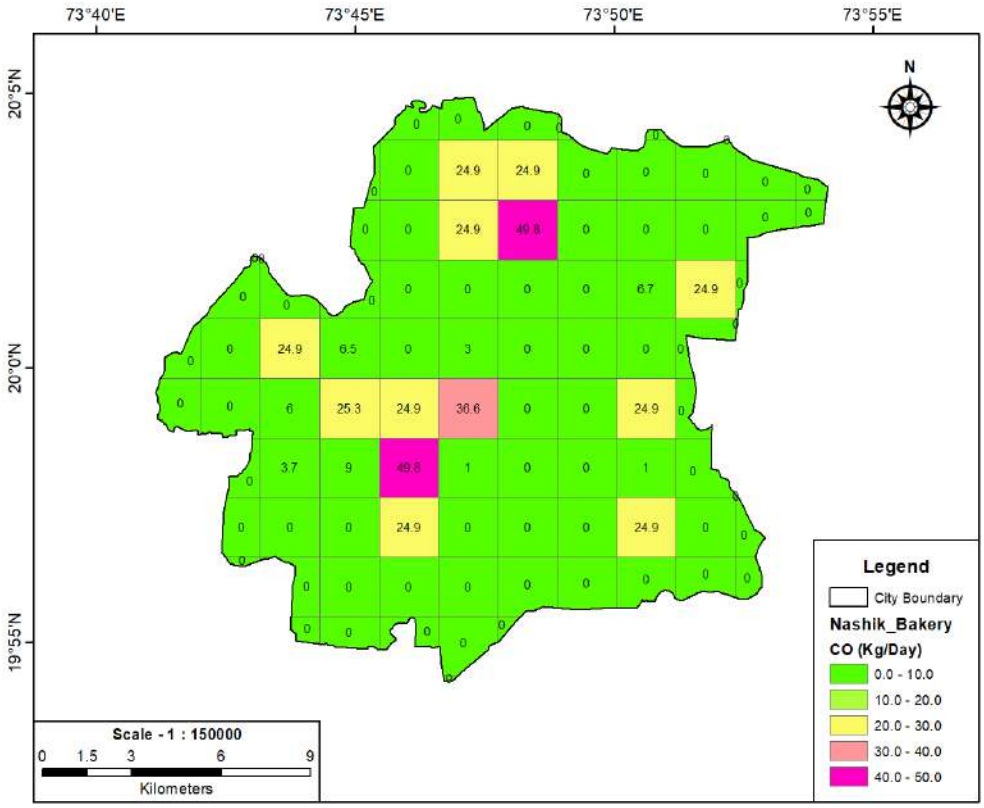

Figure 52: Gridded CO emission load (Kg/day) from bakeries Nashik City.

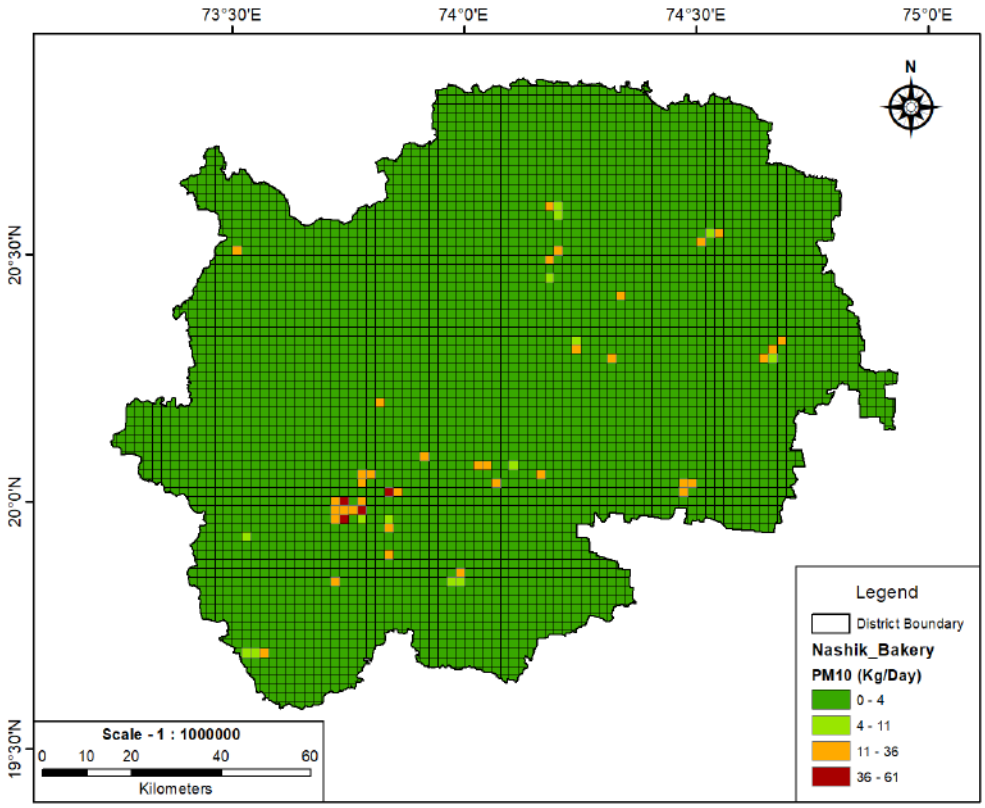

Figure 53: Gridded PM_{10} emission load (Kg/day) from bakeries Nashik District.

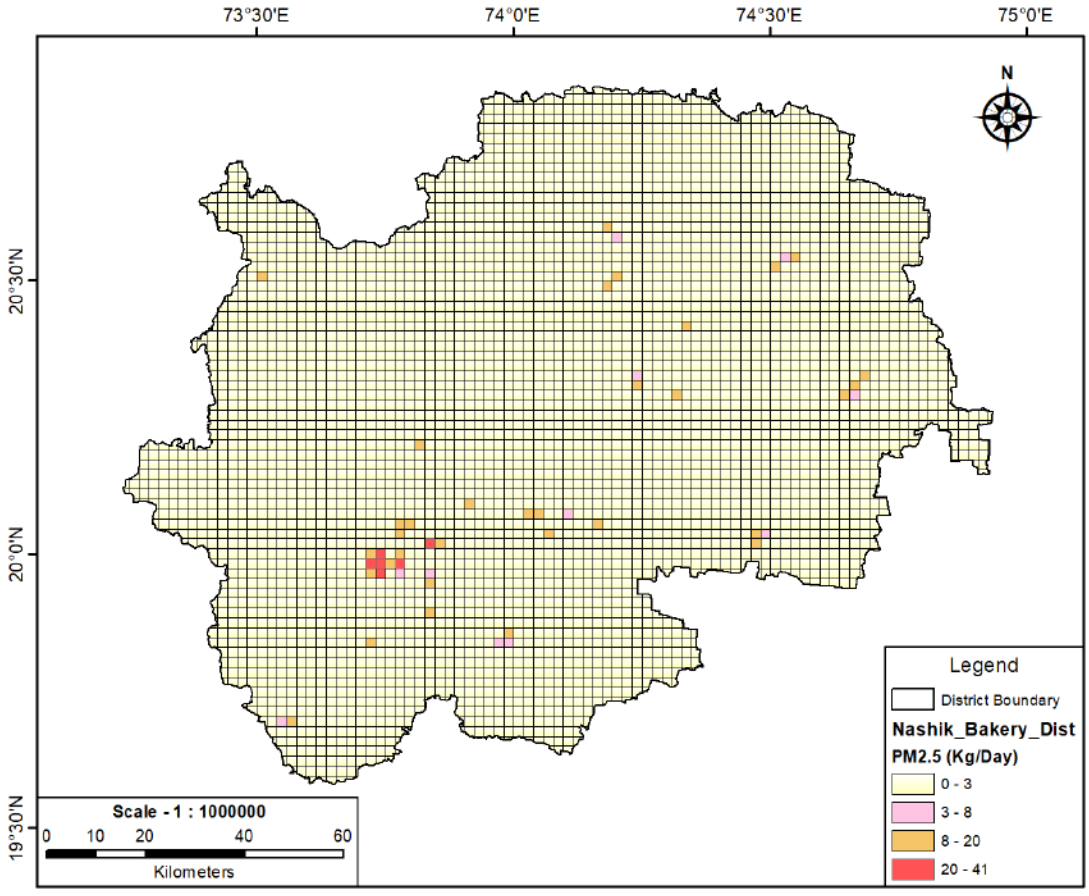

Figure 54: Gridded $PM_{2.5}$ emission load (Kg/day) from bakeries Nashik District.

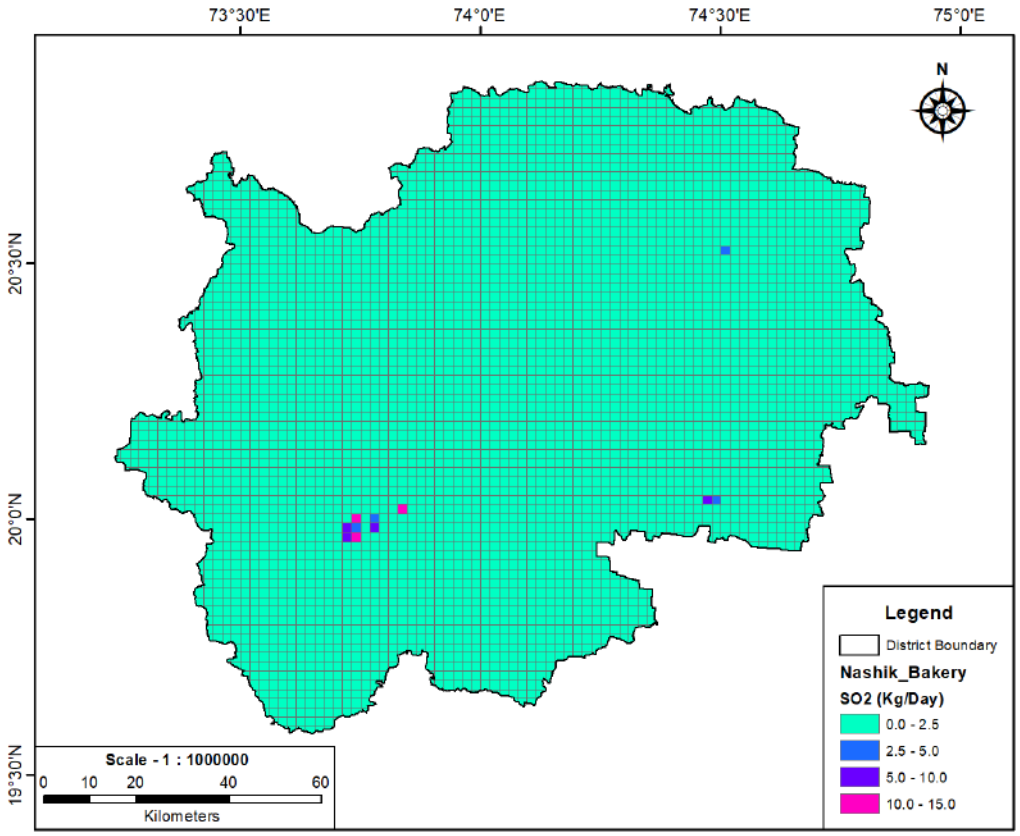

Figure 55: Gridded SOx emission load (Kg/day) from bakeries Nashik District.

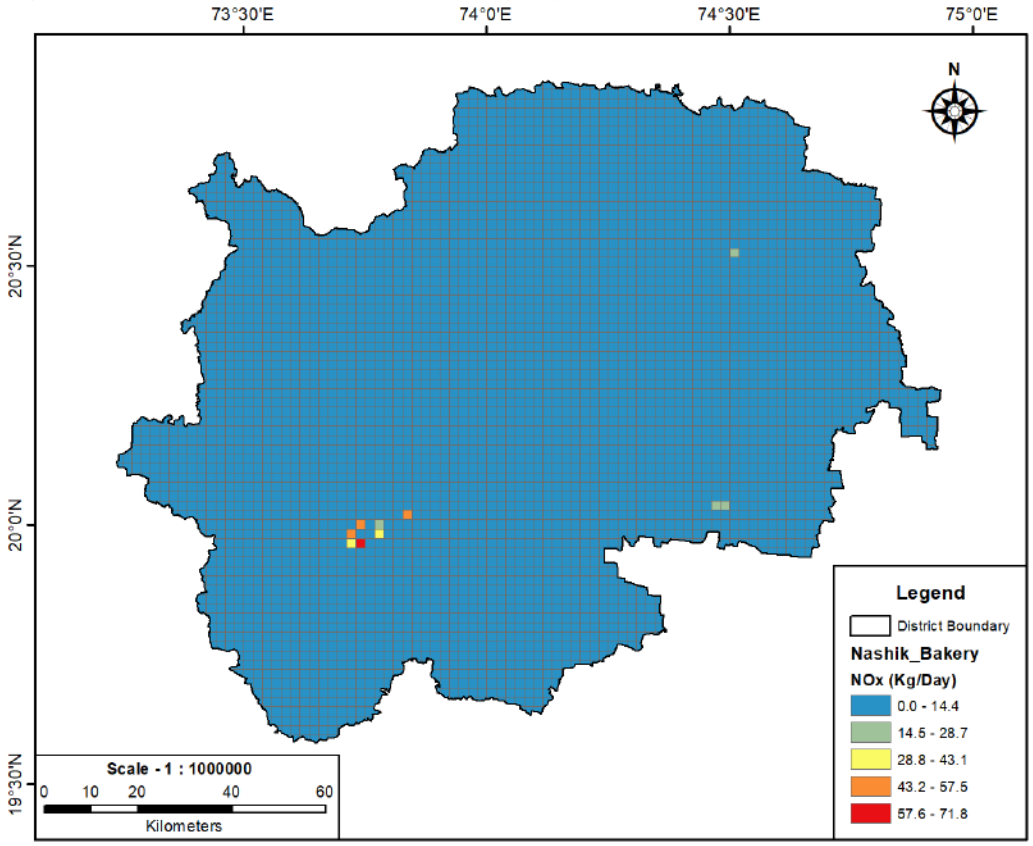

Figure 56: Gridded NOx emission load (Kg/day) from bakeries Nashik District.

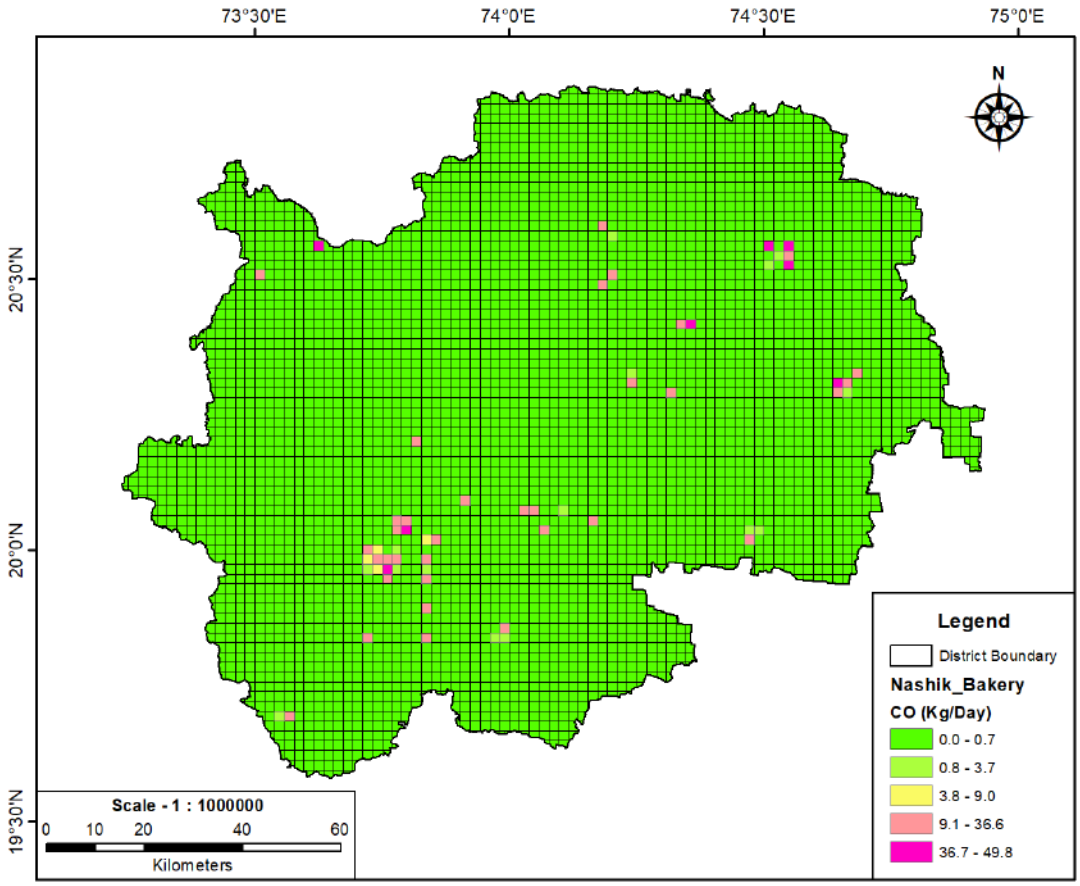

Figure 57: Gridded CO emission load (Kg/day) from bakeries Nashik District.

2.8.2 Open Eat outs

This is the most unorganized sector of the society. Many people are dependent on the food of open streets/eat-outs. In Nashik, all around the commercial, institutional and government buildings these eat-outs are located. It is majorly near to MSRTC bus depots, railway stations, theatres, Malls, Chaupatis etc. Tea-stalls, Chinese centres, etc., fall mostly under this sector.

To cook all these food items, mostly commercial and domestic LPG cylinders are seen in operation. Earlier wood and Kerosene stove were used.

No government agency has the exact data on the number and type of open eat-outs. The registered hawkers list is available with the ULBs. ULBs have registered open eat-outs data for the 2018-19.

For the list provided, primary survey on the consumption of fuel was done. In the entire District we were able to collect data of 233 open eat-outs area. As this sector is unorganized it's very difficult to manage and collect data for individual eat-outs.

The emission load from open eat out is shown in Fig 58. The emission load for PM_{10}, $PM_{2.5}$, SO2, NOx and CO in the City is 28, 20, 82, 17 and 37 kg/day from open eat out in the city. The emission load for PM_{10}, $PM_{2.5}$, SO2, NOx and CO from open eat out in the district is determined to be 242, 123, 662, 150 and 282 kg/day respectively.

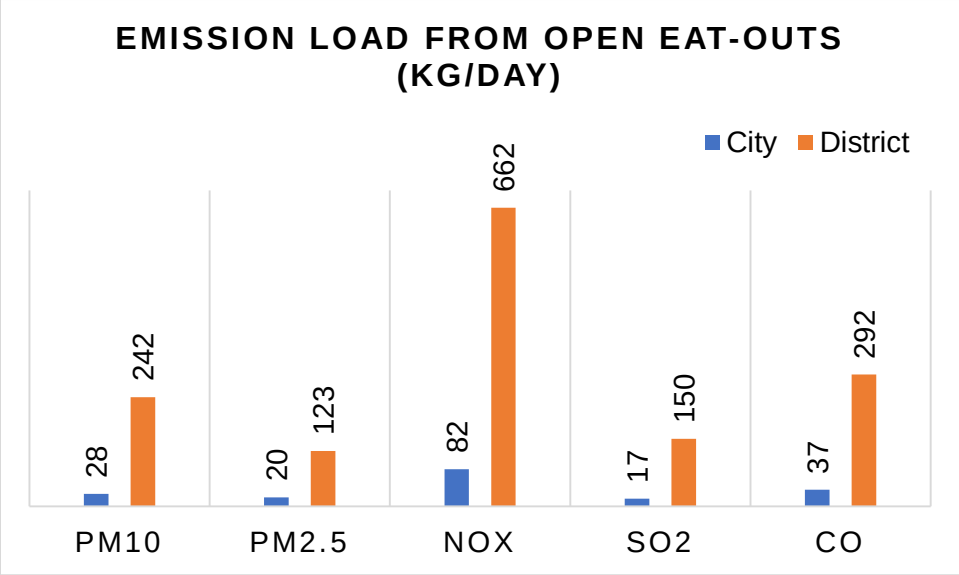

Figure 58: Emission load from open eat outs

2.8.3 Hotel & Restaurants

In India, hotel and restaurant sector has seen extreme growth every year due to the rise in tourism sector and increasing trend of dining outside. Mostly on weekends especially in urban areas, huge crowd is seen. The usage of different fuels for the cooking purpose like Liquefied natural gas (LPG), wood and charcoal in tandoors. Information on hotels and restaurants was obtained directly from ULBs in the district. The locations were geo-tagged using ArcGIS. Fig 53.

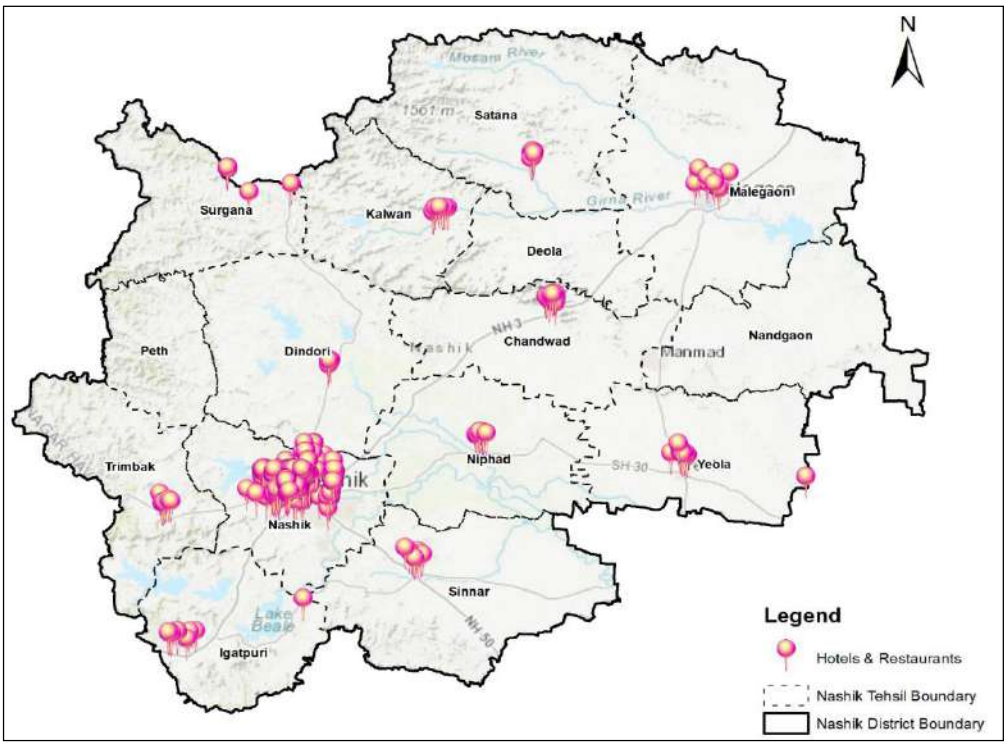

Figure 59: Location of hotels and restaurants in Nashik District.

As per information collected, commercial LPG gas cylinders and coal is used for cooking activities in Hotel and Restaurants. A total of 515 registered units for hotels and restaurants are in the district. Most of the units are located in Malegaon and Nashik Tehsil due to the tourist hotspot. Apart from hotel and restaurants, roadside Dhabas are also accounted. The fuel wise emissions factors used for hotel and restaurants are given in the Table 8 and fuel consumption in the sector for City and District is mentioned in Table 9.

Table 8: Emission factor for fuel usage in hotels and restaurants.

Emission factor (Kg/T)	Wood	LPG	Coal
PM10	10.7	1.05	14
PM2.5	4.6	1.05	7
SO2	0.2	0.4	13.3
NOx	1.4	1.8	3.99
CO	115.4	0.252	-
NMVOCs	0.01	10.5	9

Source: CPCB, 2011

Table 9: Quantity of fuel consumed in Hotel & Restaurants

Fuel	City	District
	Quantity (Kg/day)	
Coal	523	1740
LPG	232	1272

The emissions load from hotels and restaurants in the District and the City are shown in the Fig. 60. The PM_{10}, $PM_{2.5}$, SO_2, NOx, CO and NMVOCs emissions from hotels and restaurants in Nashik District are 148, 94, 51, 1528, 645 and 40.7 Kg/day, respectively and in the city are 115, 74, 4, 738, 200 and 31.03 Kg/day, respectively. The spatial distribution of PM_{10} and $PM_{2.5}$ emissions is shown in the Fig. 61 and Fig. 71.

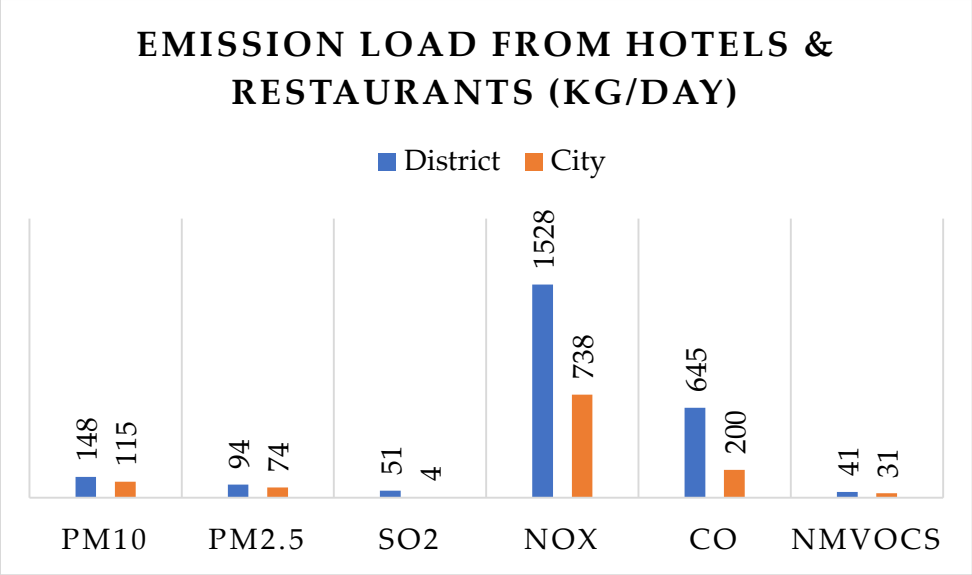

Figure 60: Emission load from hotels and restaurants in Nashik District and City.

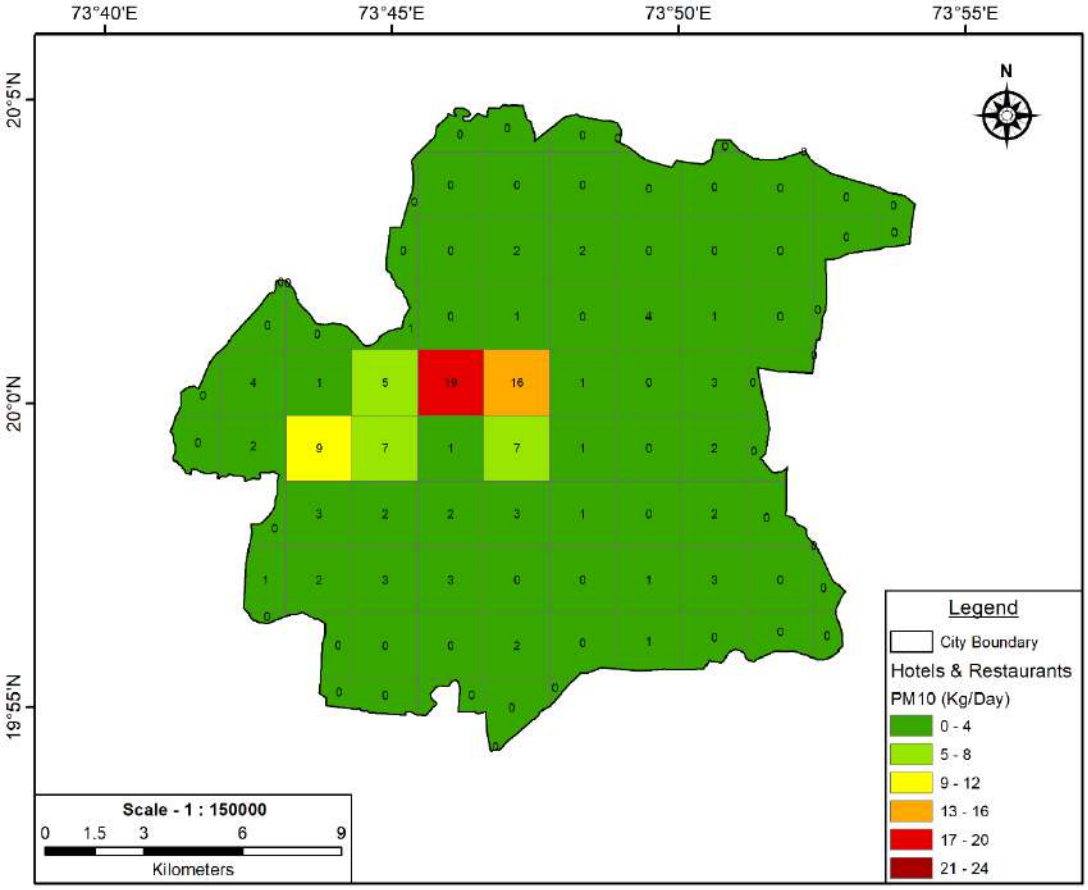

Figure 61: Grid-wise PM10 emission load from hotels and restaurants in City.

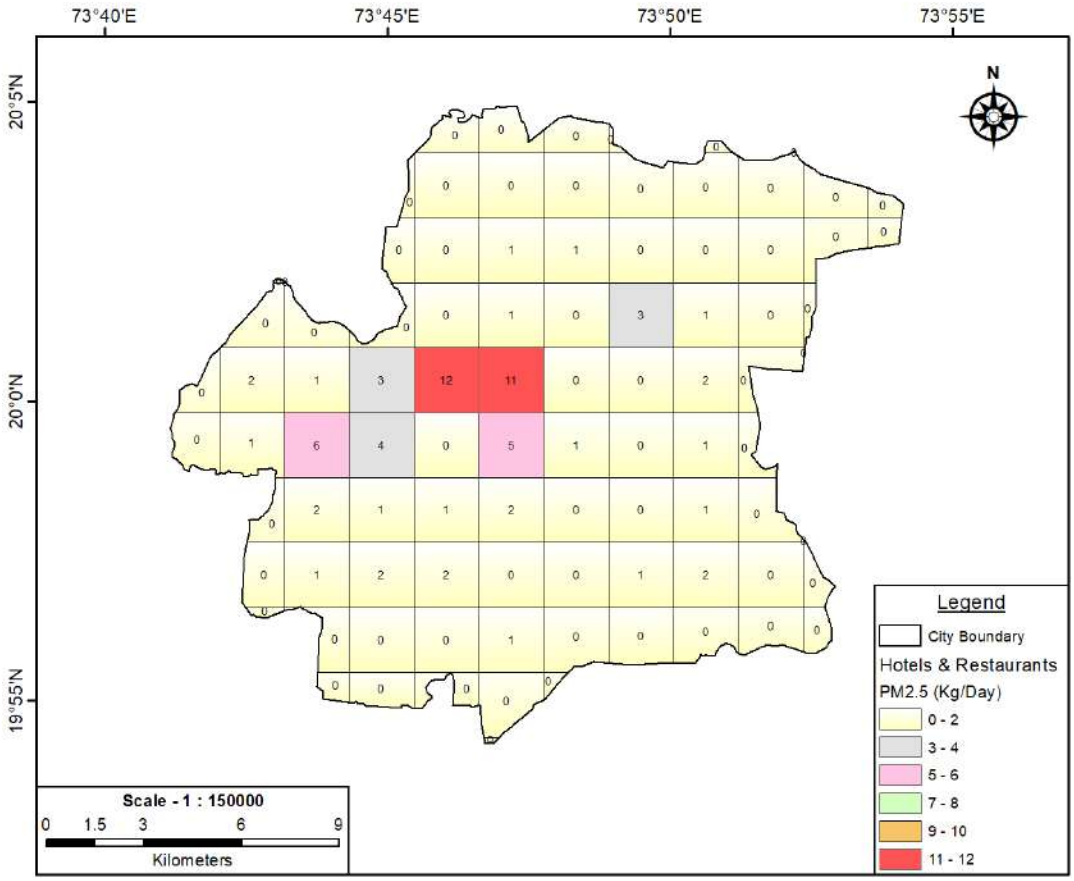

Figure 62: Grid-wise $PM_{2.5}$ emission load from hotels and restaurants in City.

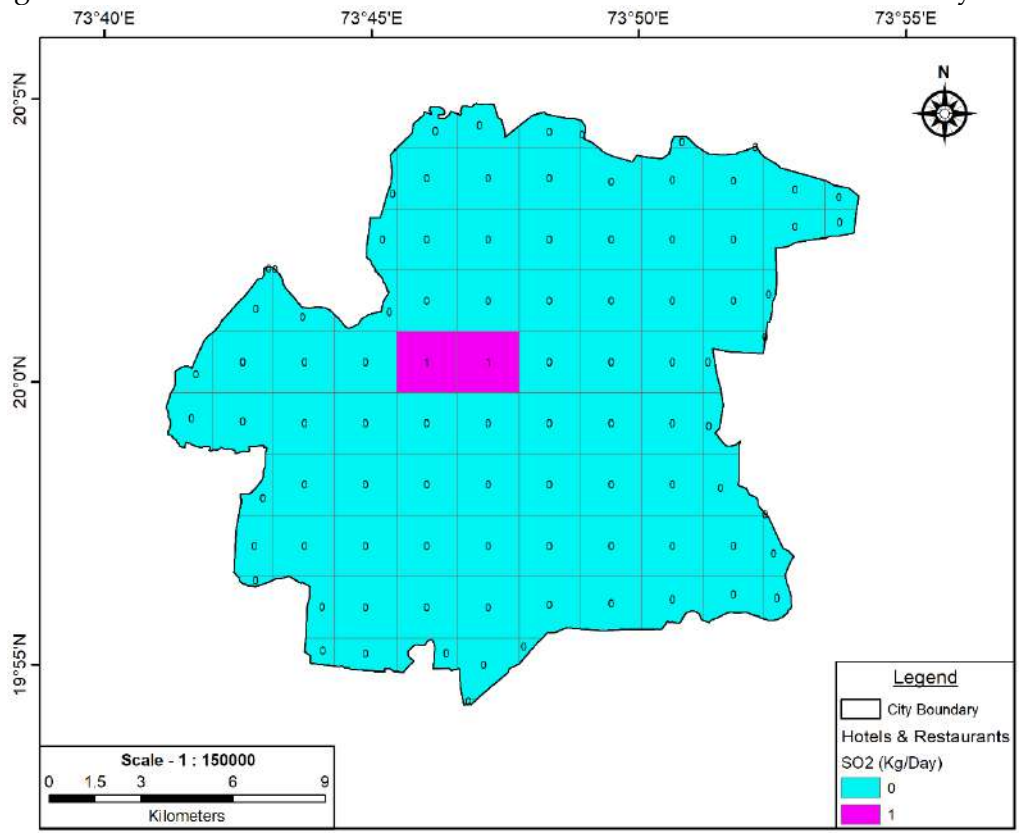

Figure 63: Grid-wise SO_2 emission load from hotels and restaurants in City.

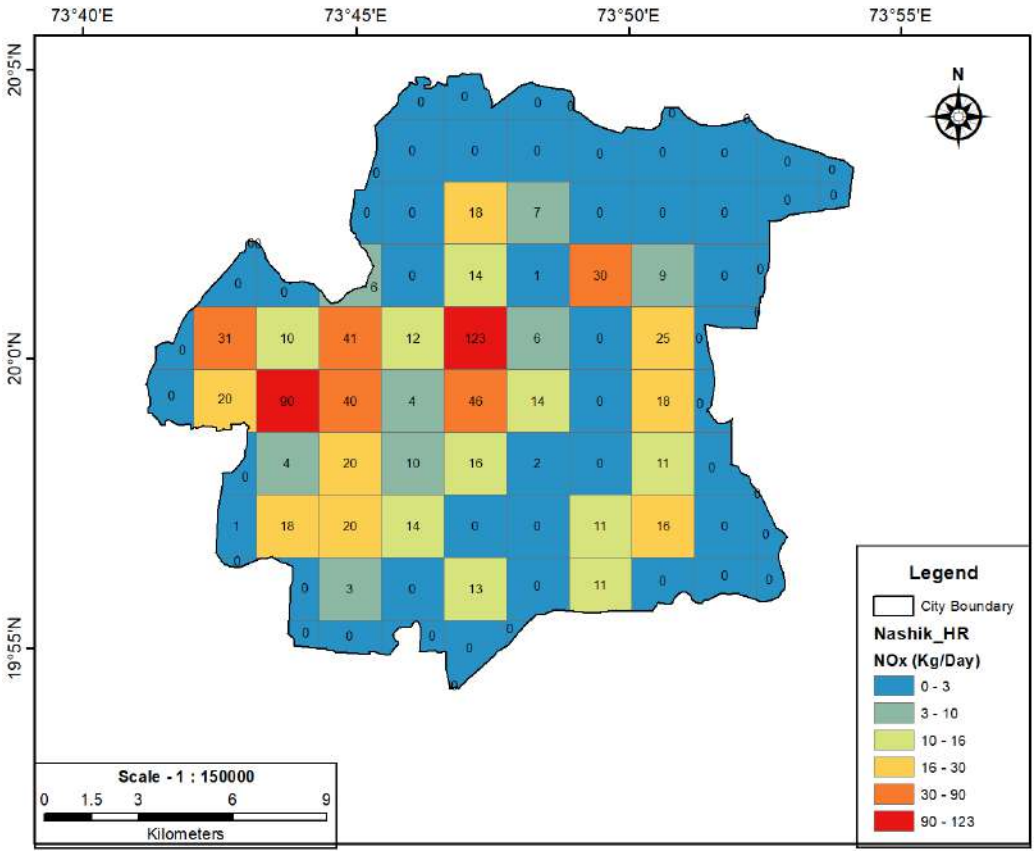

Figure 64: Grid-wise SO_2 emission load from hotels and restaurants in City.

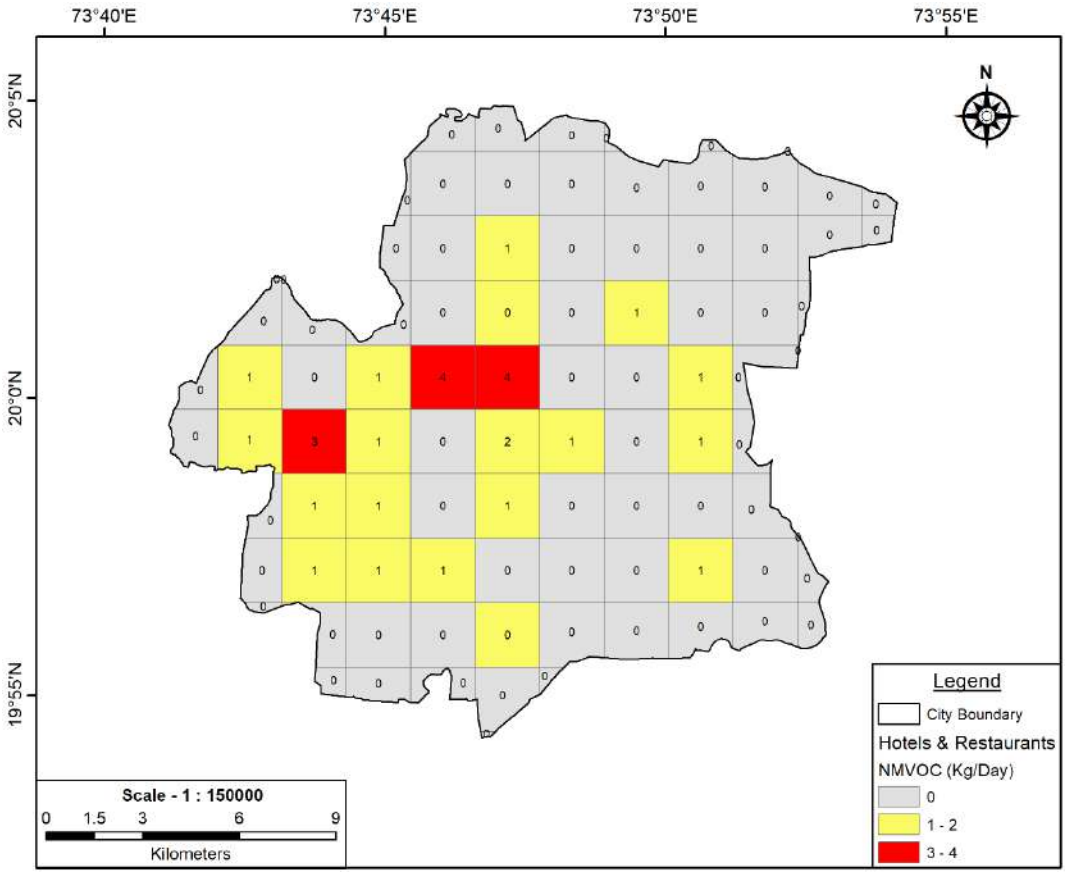

Figure 65: Grid-wise NMVOCs emission load from hotels and restaurants in City.

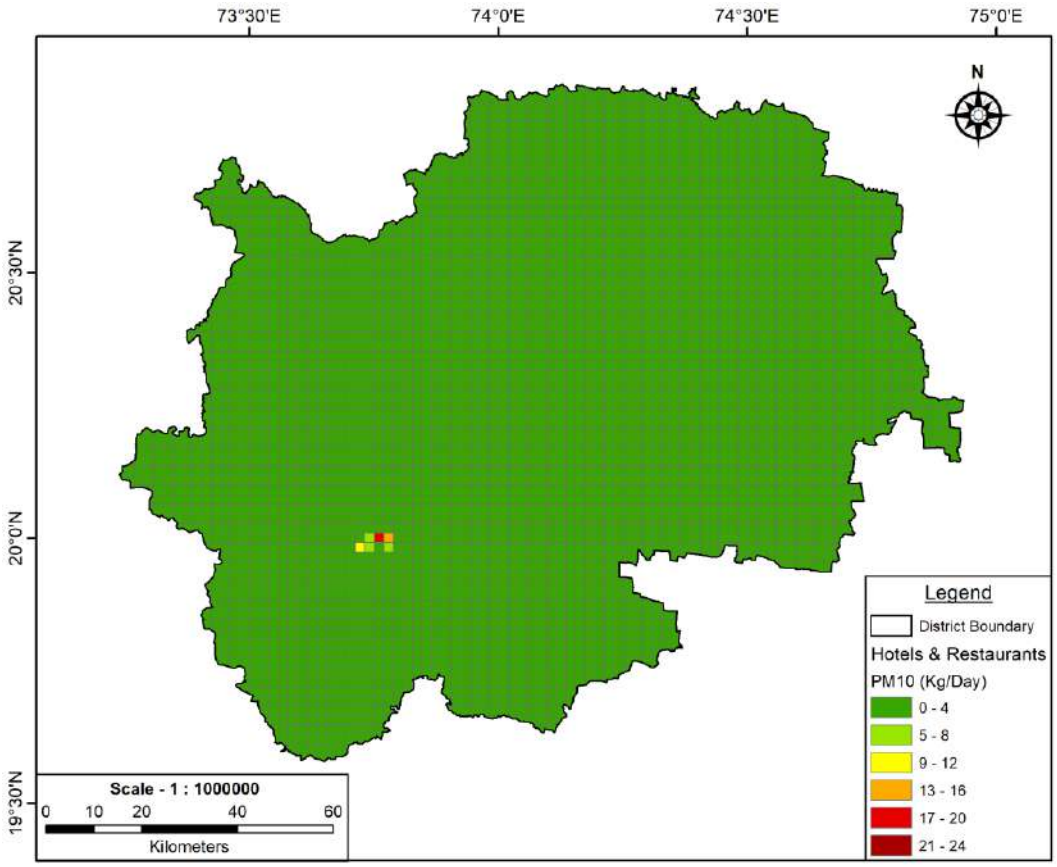

Figure 66: Grid-wise PM10 emission load from hotels and restaurants in District.

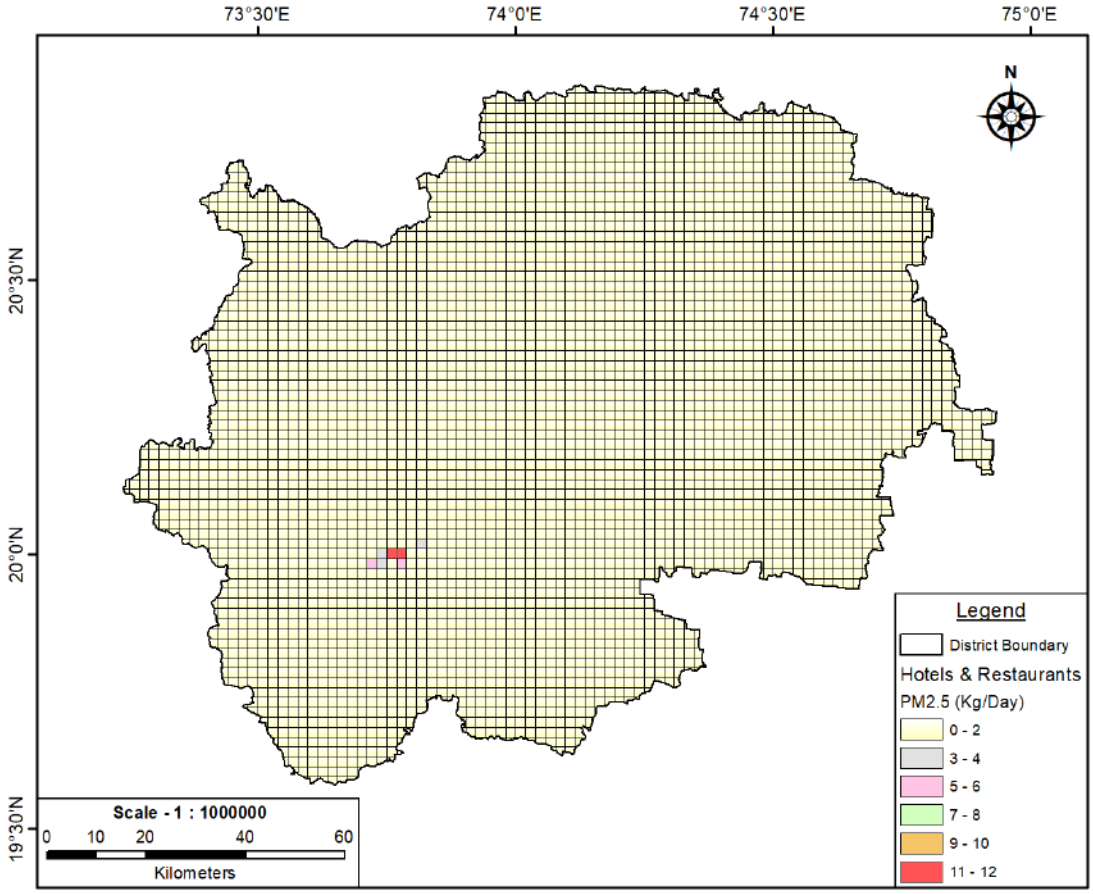

Figure 67: Grid-wise PM2.5 emission load from hotels and restaurants in District.

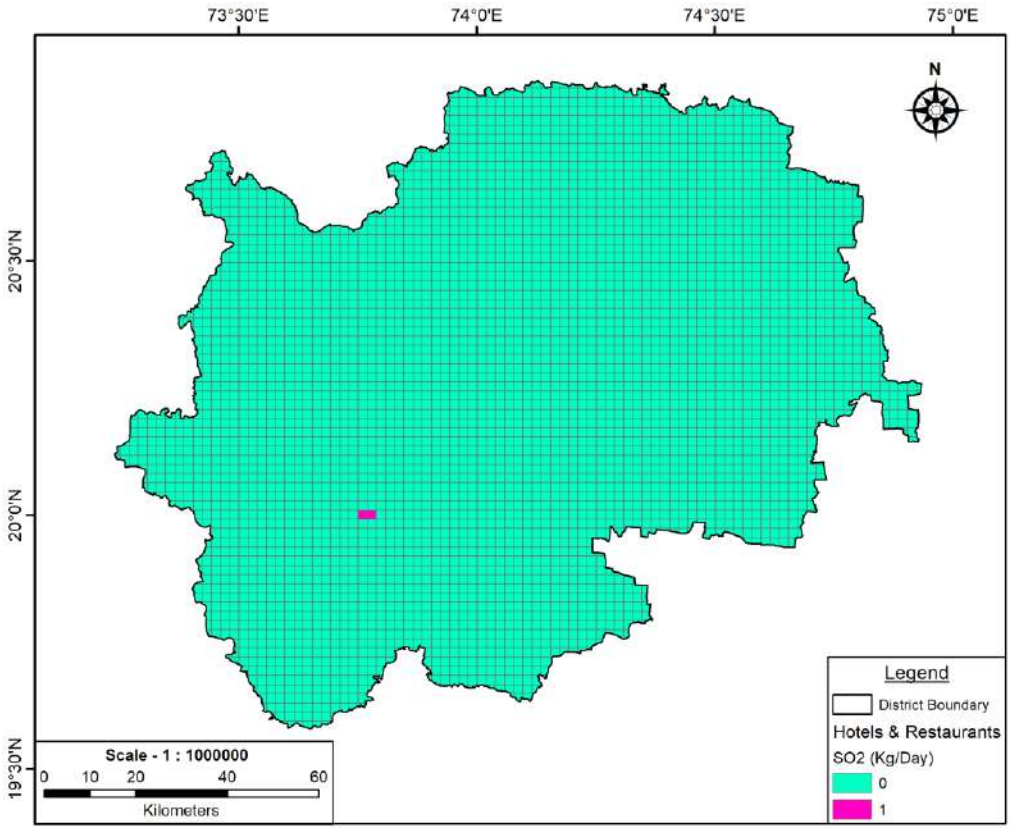

Figure 68: Grid-wise SO2 emission load from hotels and restaurants in District.

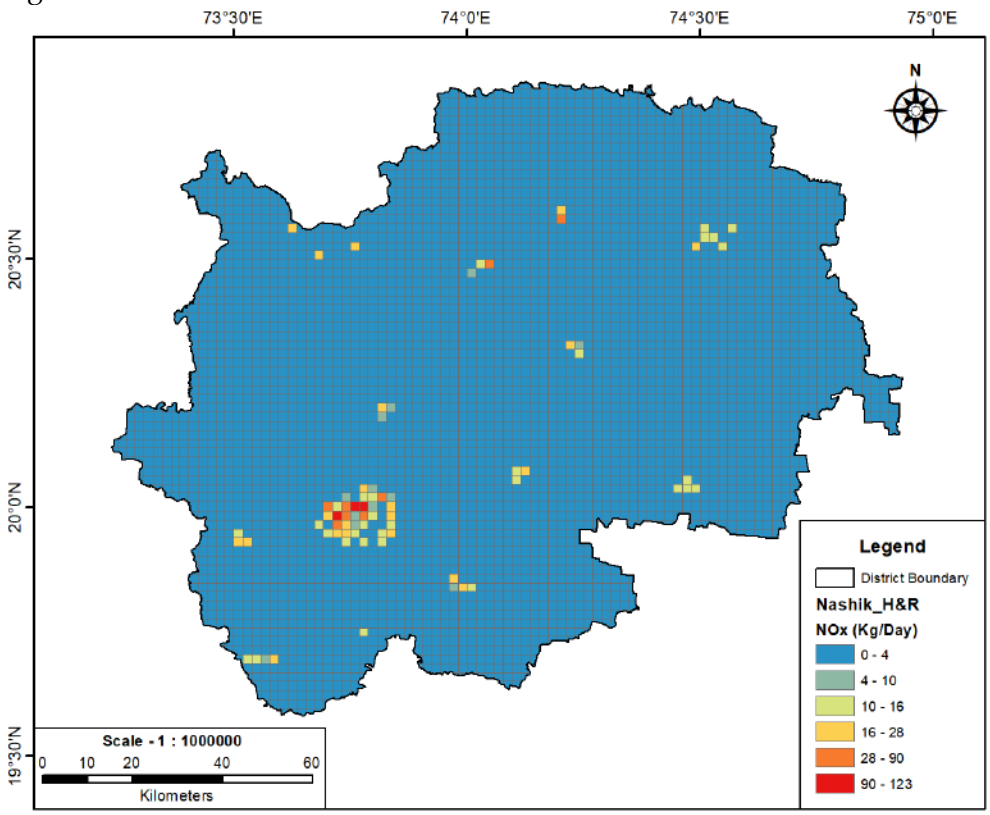

Figure 69: Grid-wise NOx emission load from hotels and restaurants in District.

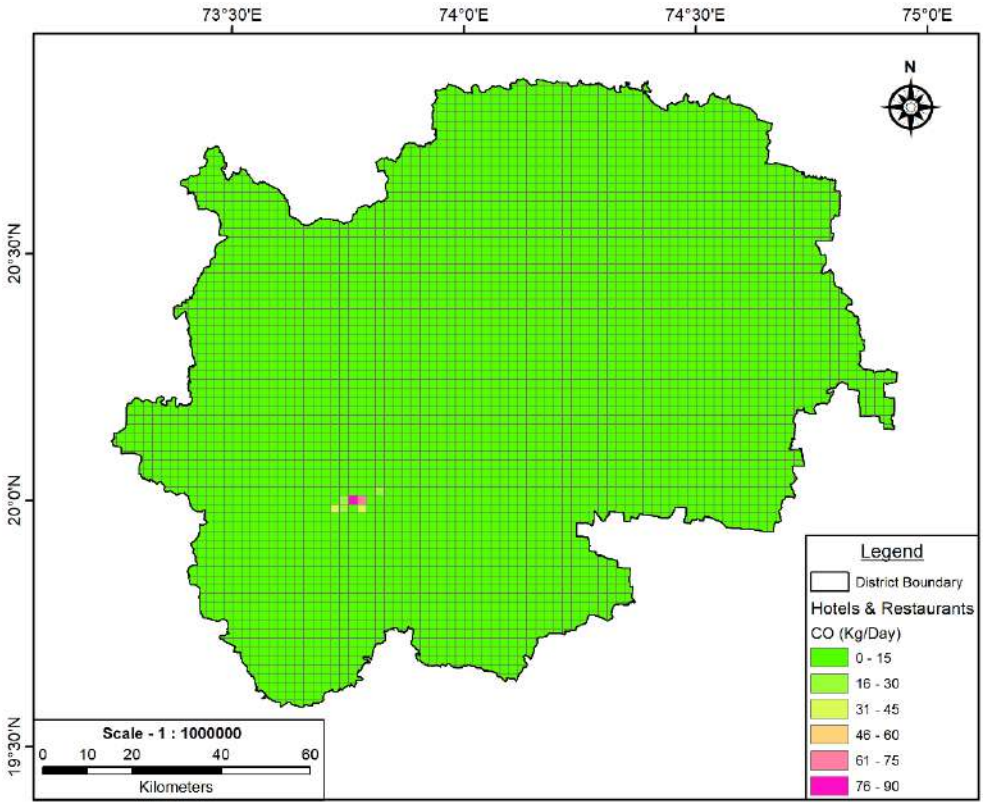

Figure 70: Grid-wise CO emission load from hotels and restaurants in District.

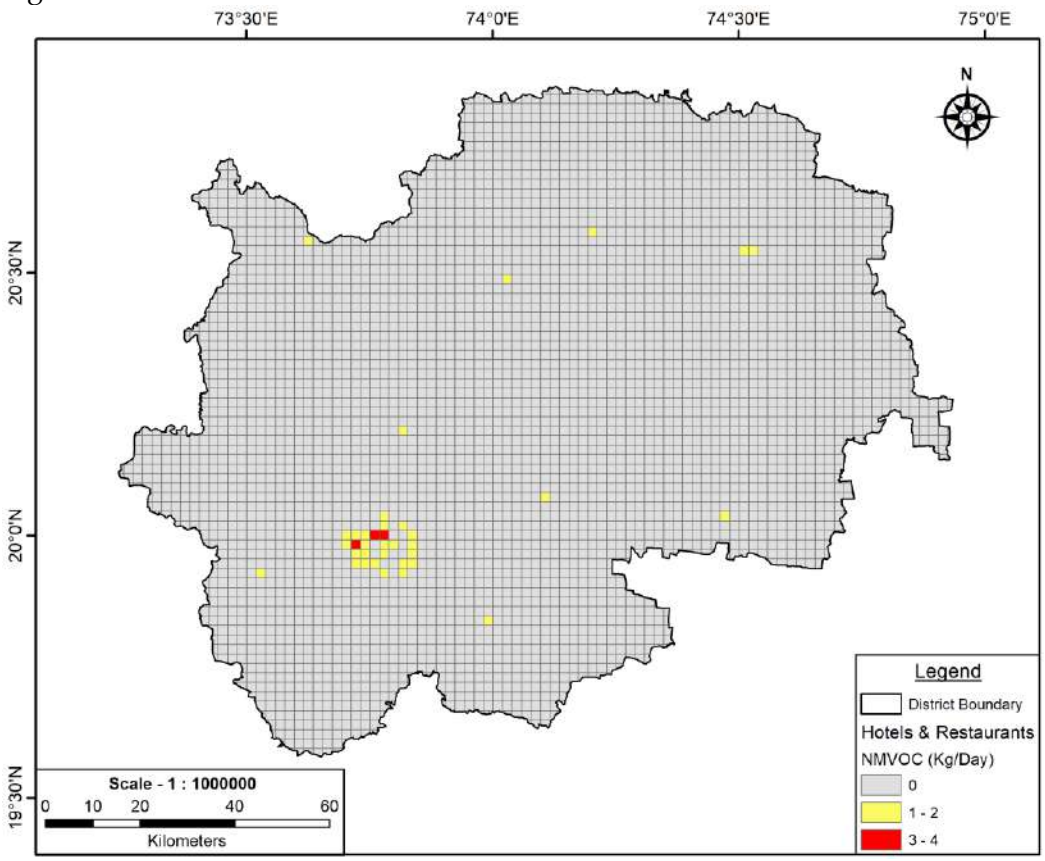

Figure 71: Grid-wise NMVOCs emission load from hotels and restaurants in District.

2.8.4 Domestic Sector

In Nashik District, there are 25 towns and 1,922 villages with a current population of 84,81,900. The total household (HH) in District are 21,20,475. The urban household population of the district is approximately to 14,98,214 and that of rural is 6,22,261. The information is collected from District Statistical Office, Municipal Corporation and Councils of the district.

The table 10 gives the percentage distribution of households by primary source of energy used for cooking (ref: NSS Report No.542: Energy Sources of Indian Households for Cooking and Lighting). In rural areas 68% households have active domestic gas connections for cooking followed by wood (26%). In urban areas, 96.8% households have active domestic gas connections as the primary source of energy for cooking followed by wood (3%).

Table 10: Percentage of fuel consumption in domestic sector.

Fuel	Rural (%HH)	Urban (%HH)
Wood	26	3
LPG	70	97
Dung Cake/Crop Residue	4	0

Nashik District is made kerosene free since the year 2020 (TOI, Oct 11, 2020). At the outskirts Use of Kerosene for domestic use is not reported in the district. The slum areas in the City and District have an active LPG connection (TOI, Oct 11, 2020). During the primary survey, in the rural parts of the district, use of cowdung along with wood was reported.

Emission Load from LPG = Number of LPG cylinders consumed/year x 14.2 x EF
Emission Load from Wood = Quantity of Wood required /day x EF
Emission Load from Dung Cakes = Quantity/Day x EF
Emission Load from Kerosene = Quantity/Day x EF

Table 10: Emission factor for fuel usage in domestic sector.

Emission factor (g/kg)	Wood	LPG	Coal	Kerosene
PM10	6.8	1.89	8.3	3.6
PM2.5	4.6	0.21	4	3.0
SO2	0.8	0.4	15.3	0.4
NOx	1.7	2.9	2.16	1.3
CO	66.5	2.0	59.5	43.0
NMVOCs	15.9	19.0	10.5	17.0

The daily emission load estimated for different pollutants like PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO and NMVOCs is found to be 1952, 1018, 280, 1175, 14413 and 8694 Kg/Day in District. In the City, the estimated daily emission load for several pollutants including PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO and NMVOCs is determined to be 241, 85, 41, 238, 1152 and 1634 kg/day (Fig 72). The spatial distribution of PM_{10}, $PM_{2.5}$, SO_x, NO_x and NMVOCs emissions in the City and District is shown in the Fig. 73 and Fig. 74.

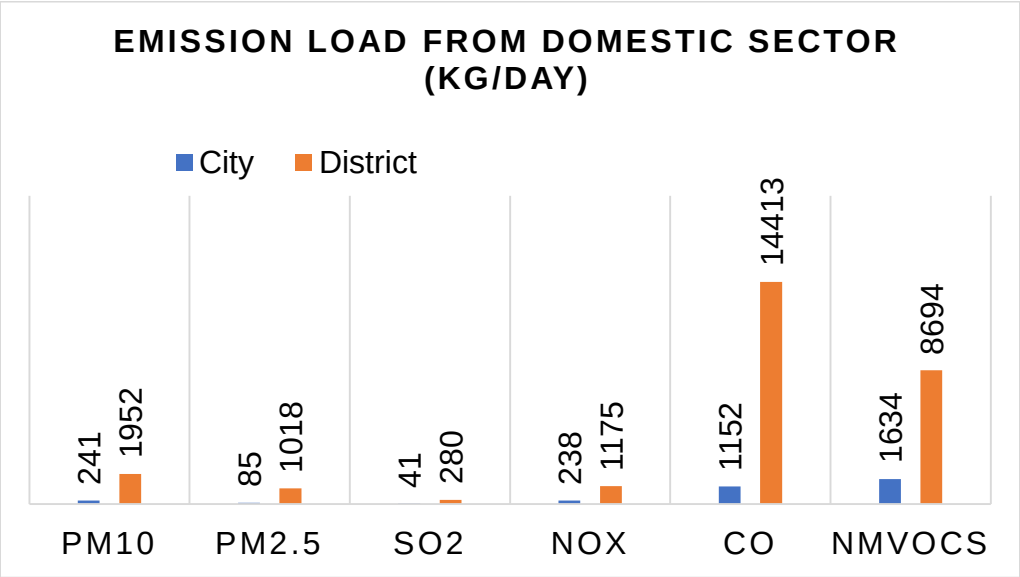

Figure 72: Emission load from domestic sector in Nashik District and City

The grid-wise distribution of emission load from domestic sector is not possible due to unavailability of ward-wise or grid-wise domestic fuel consumption data. The cites are divided into urban and rural areas and emission load is depicted.

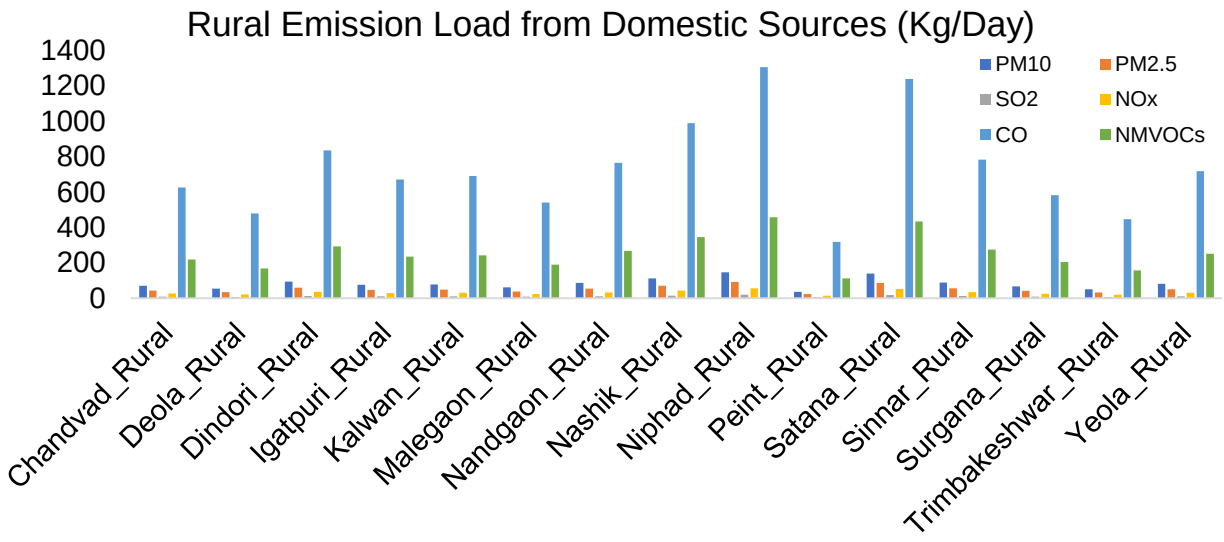

Figure 73: Emission load from domestic sector for rural areas in District.

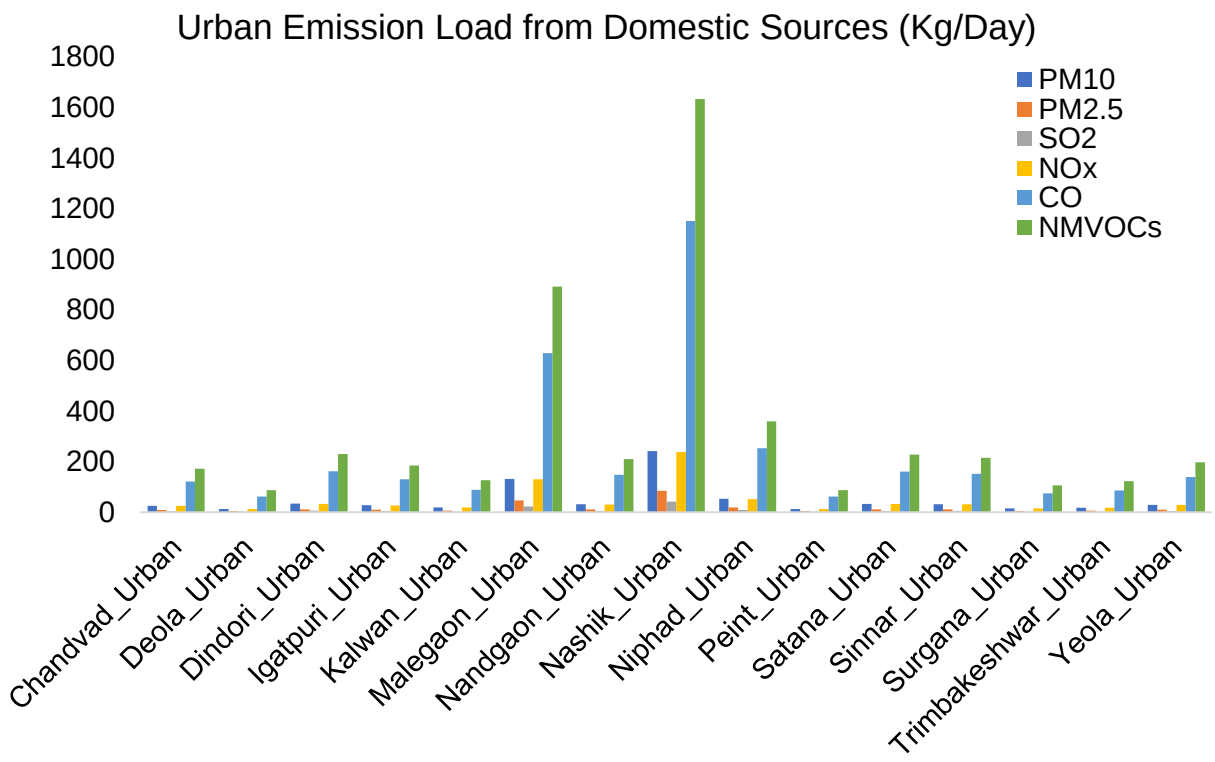

Figure 74: Emission load from domestic sector for urban areas in District.

2.8.5 Crematoria

As per Hindu tradition, humans' last rites are primarily done using wood. According to the data collected from the birth and death cell of ULBs and councils of the district, in the year 2018–19 (before Covid-19). The survey team visited the crematories in the district for data collection on the fuel consumption required for cremation activity. Nashik City has 5–6 crematories, and there are about 1948 crematories in the rest of the district. Based on a primary survey and consultation with officials, the average wood requirement for burning dead bodies is about 250-300 kg of wood, 4-5 l of kerosene, and 4-5 kg of cow dung cakes. Based on the literature survey, for a single dead-body cremation, 300 kgs of wood, 5 Liters of kerosene and 5 kgs of cowdung is required. The same quantity was used for estimation of emission load. The locations of crematories in the district are pinned in Fig 75.

Emission Estimations (TSP) = No. of Hindu Death/yr (0.7) * fuel required per body (Kg) * EF

Table: 11: Emission factor for fuel usage in crematoria.

Emission factor (Kg/T)	Wood	Dung Cake	Kerosene
PM10	17.3	10.50	1.35
PM2.5	9.1	4.40	0.60
SO2	0.4	0.60	4
NOx	2.55	1.00	2.5

CO	93	78.60	62
NMVOCs	51.90	24.10	19

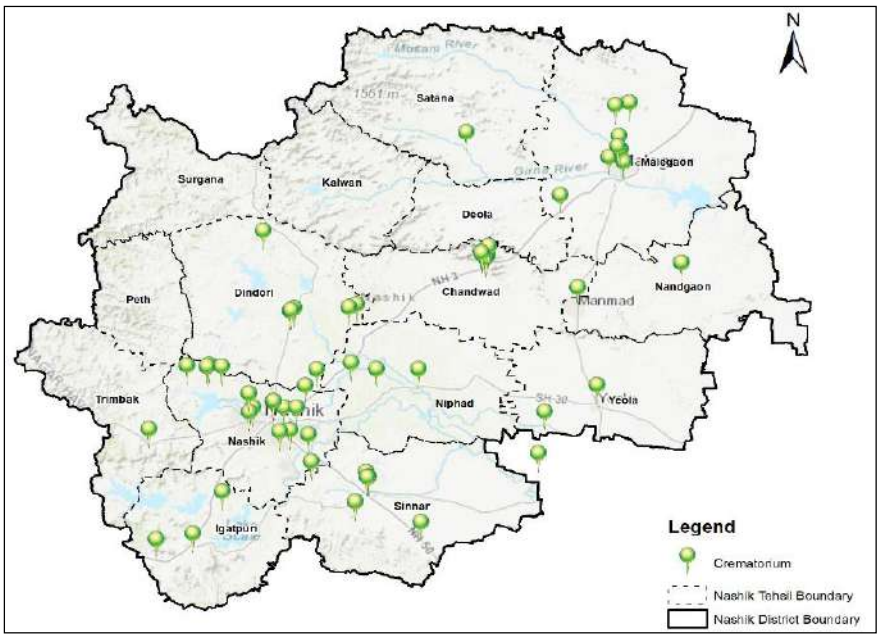

Figure 75: Location of crematories in Nashik District.

The emissions of PM_{10}, $PM_{2.5}$, SO_2, NOx, CO and NMVOCs from crematoria in the district are 327, 161, 146, 441, 1666 and 909 kg/day, respectively and in the city are 63, 32, 40 and 176, 348 and 192 kg/day, respectively (Fig 76). Spatial distribution of emissions is given in the Fig. 77 to 84.

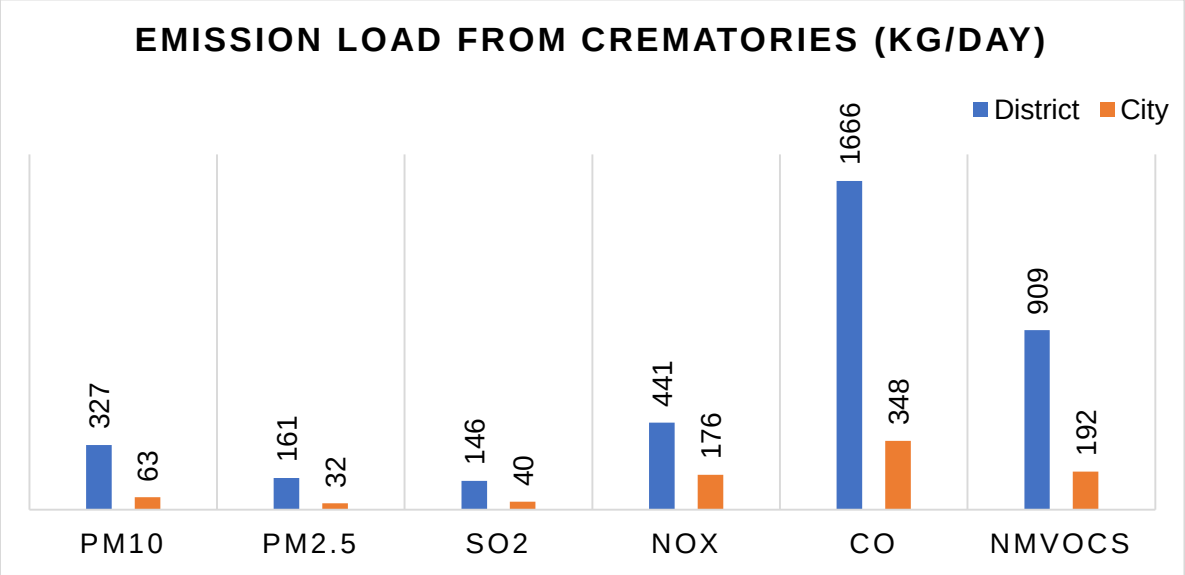

Figure 76: Emission load from crematories in Nashik City and District

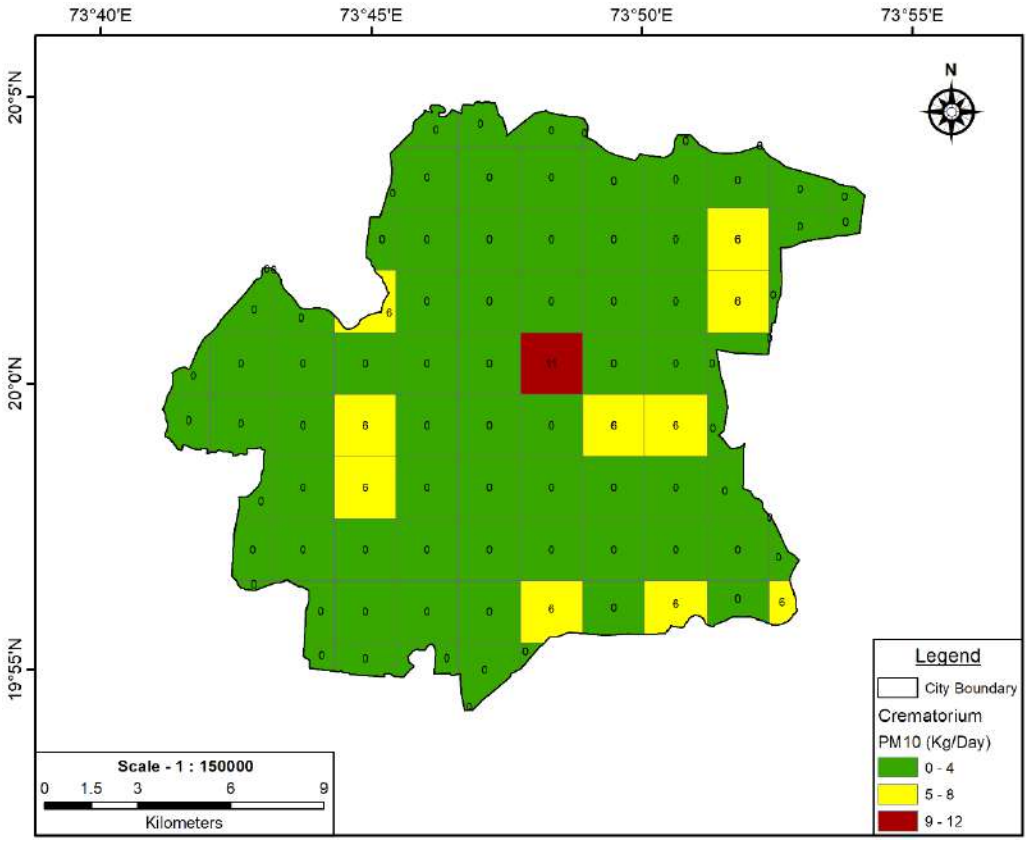

Figure 77: Gridded PM_{10} emission load (Kg/day) from Crematories in City.

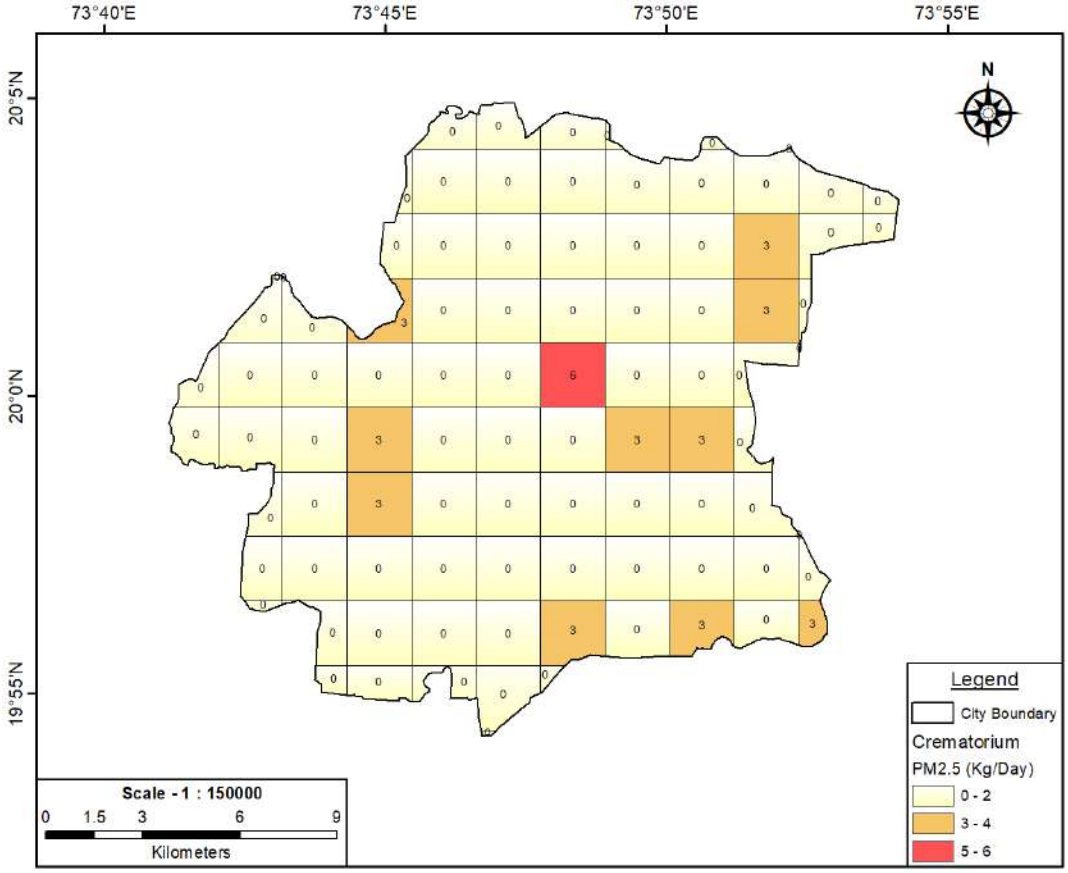

Figure 78: Gridded $PM_{2.5}$ emission load (Kg/day) from Crematories in City.

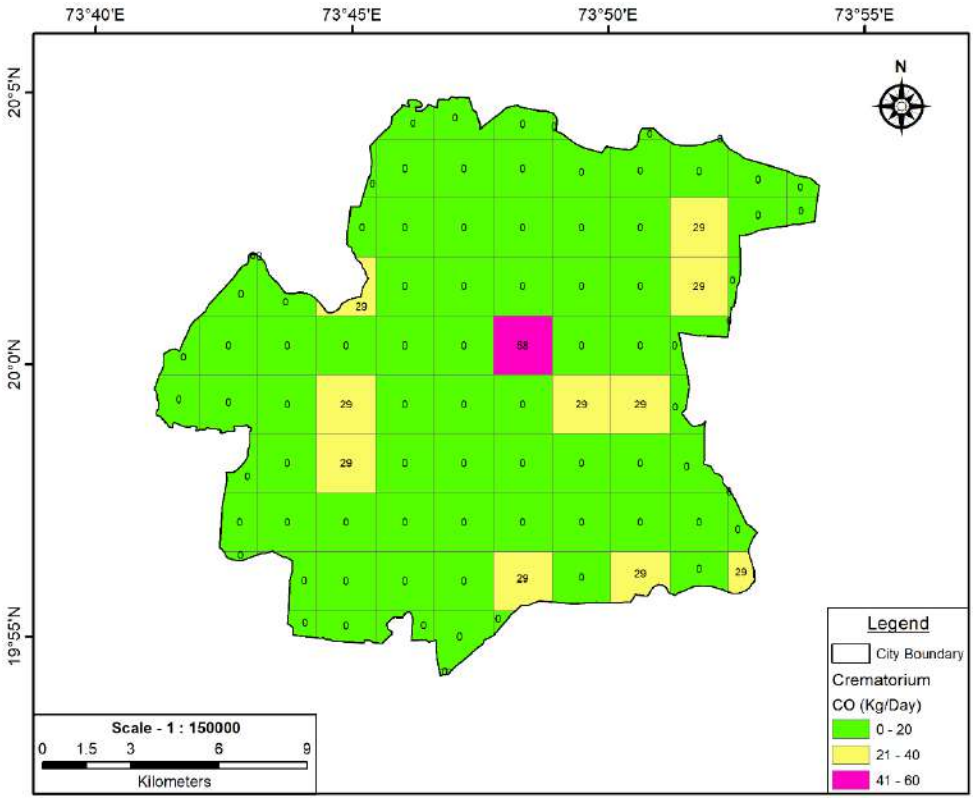

Figure 79: Gridded CO emission load (Kg/day) from Crematories in City.

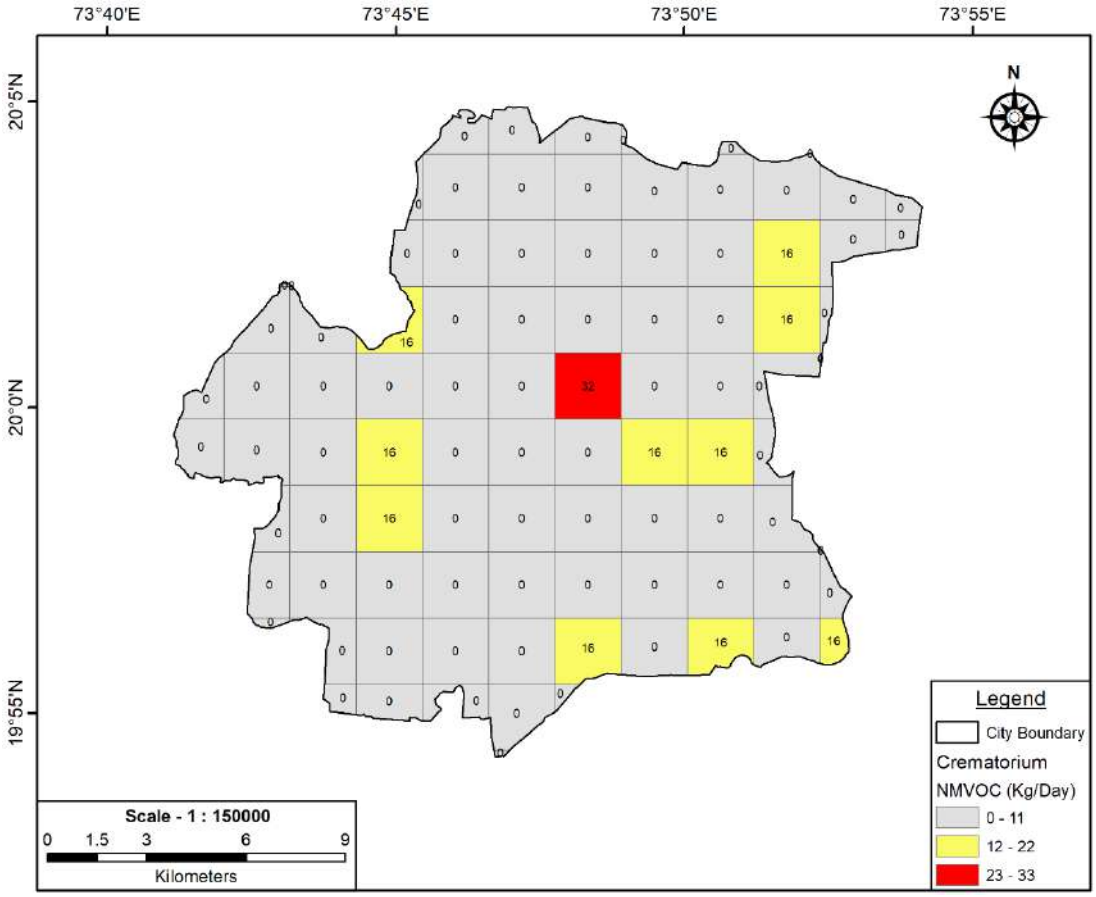

Figure 80: Gridded NMVOCs emission load (Kg/day) from Crematories in City.

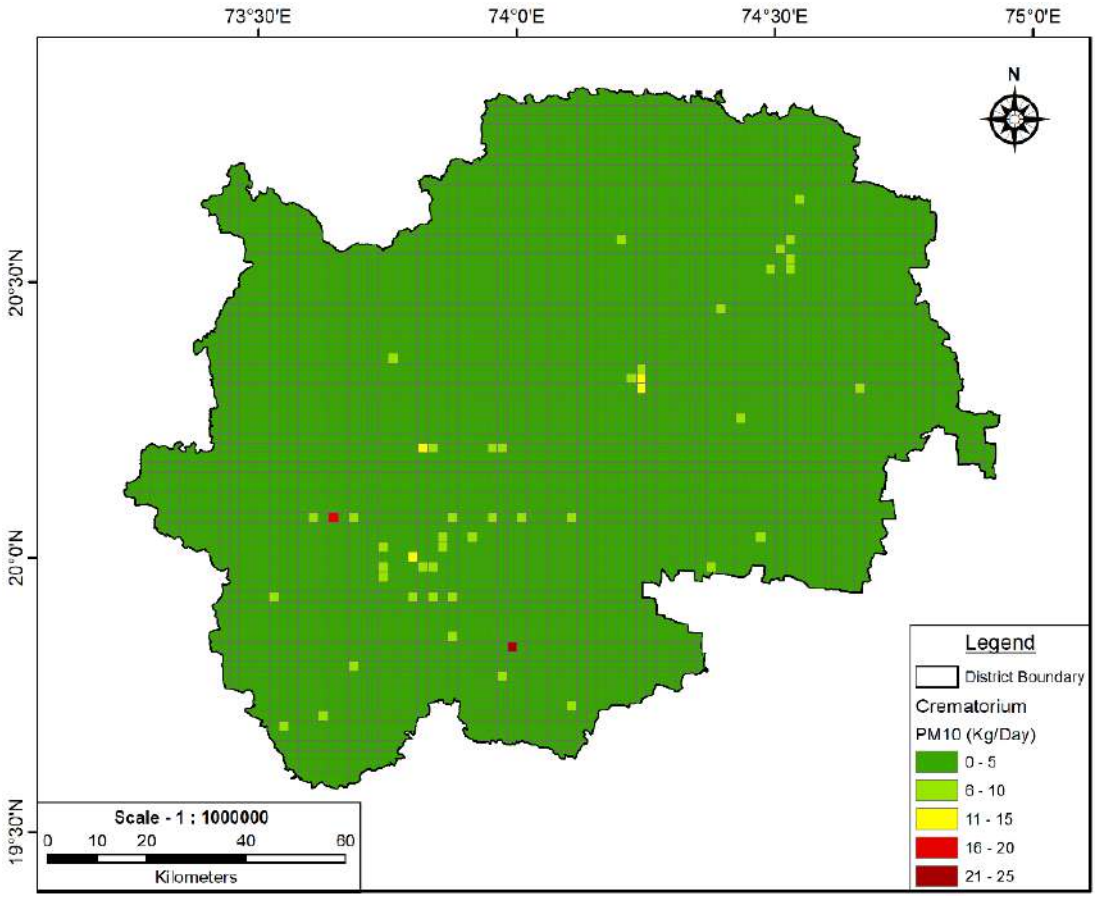

Figure 81: Gridded PM_{10} emission load (Kg/day) from Crematories in District.

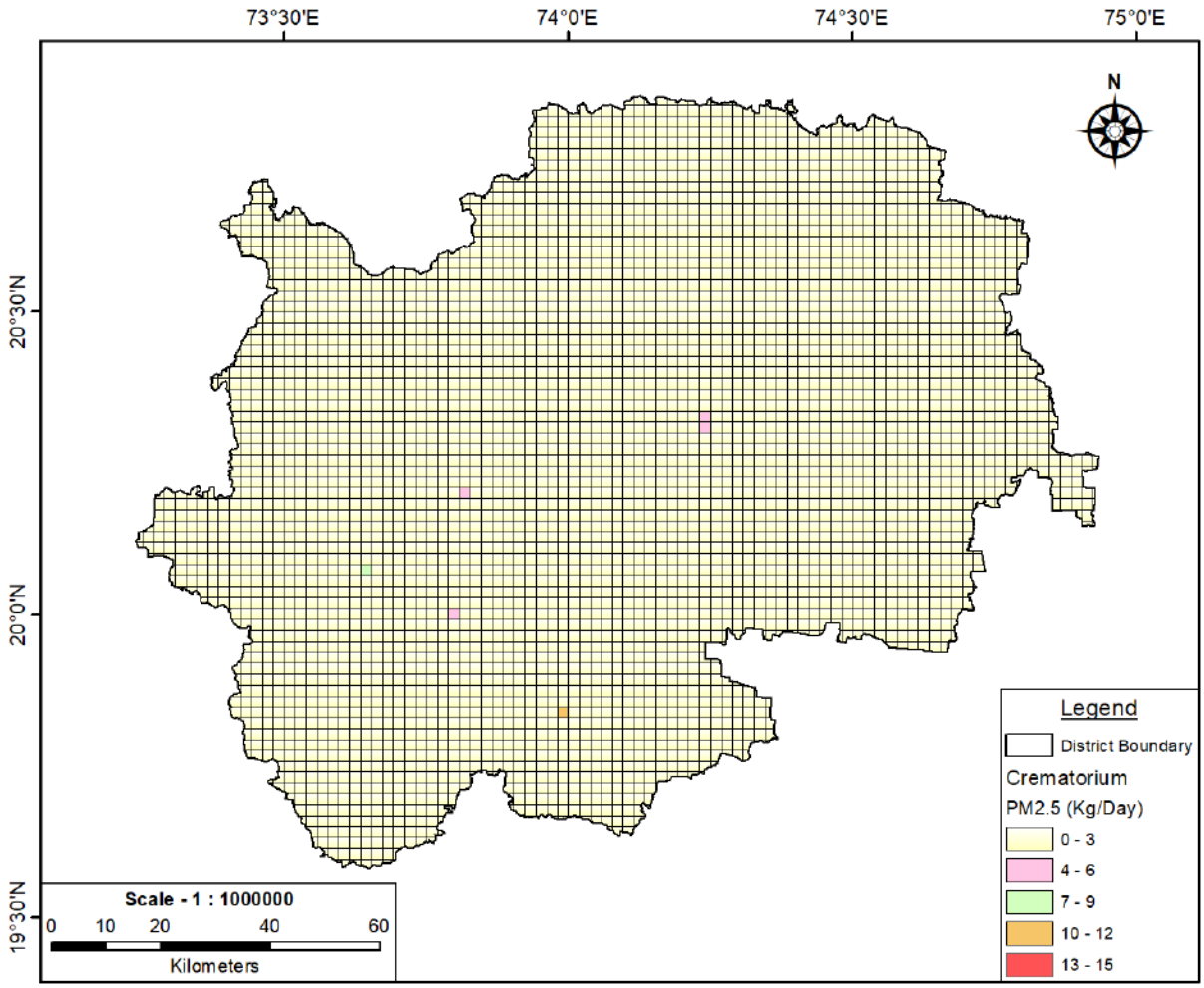

Figure 82: Gridded $PM_{2.5}$ emission load (Kg/day) from Crematories in District.

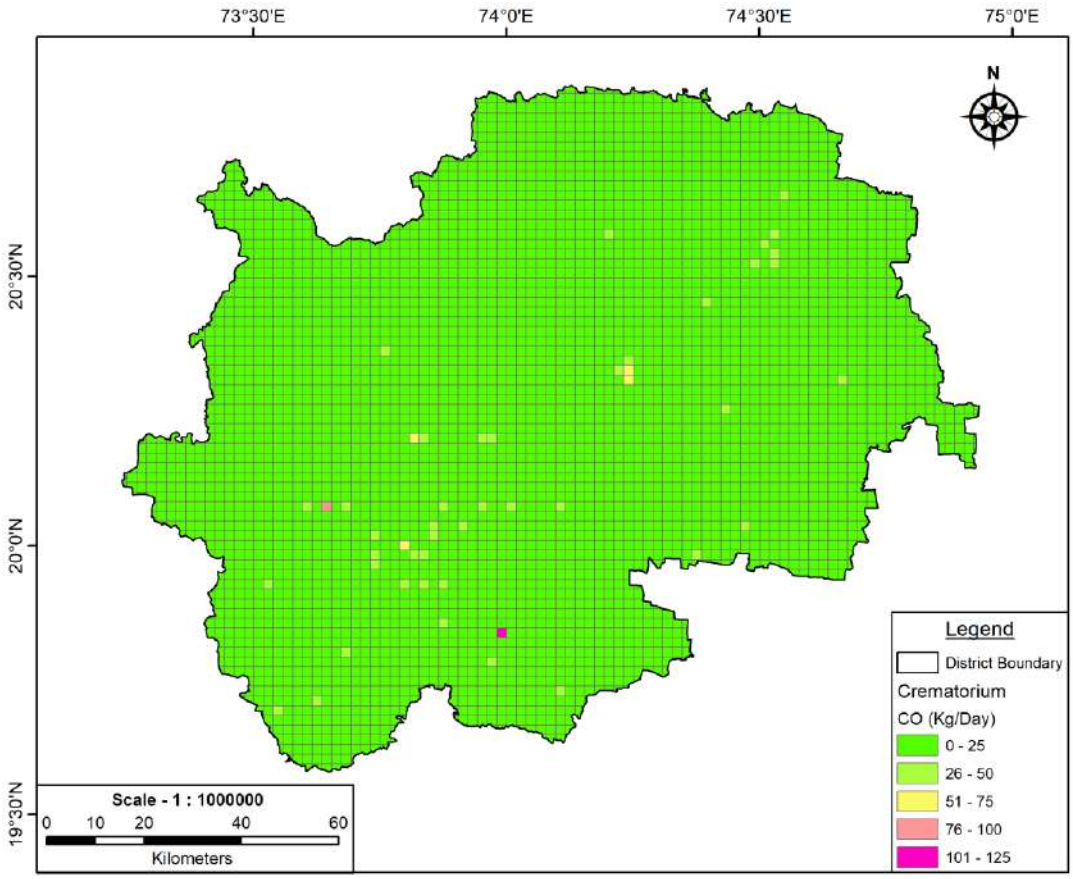

Figure 83: Gridded CO emission load (Kg/day) from Crematories in District.

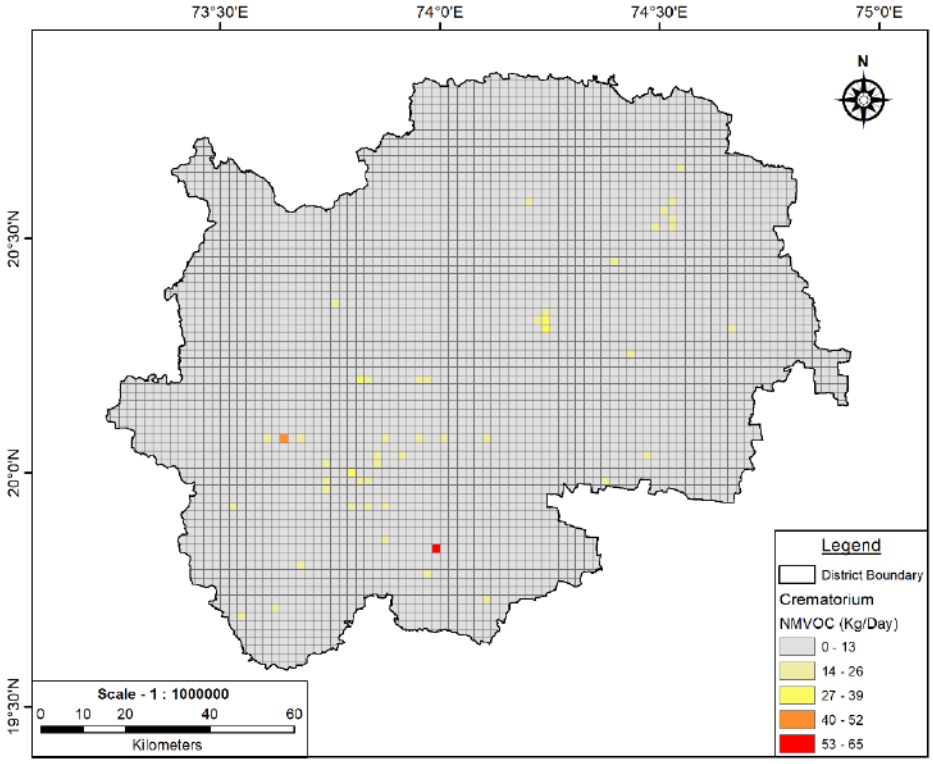

Figure 84: Gridded NMVOCs emission load (Kg/day) from Crematories in District.

2.8.6 Building Construction

Nashik is becoming more significant in the real estate sector due to its moderate temperature throughout the year. Converting barren land into the big multi-storeyed building is seen nowadays. The building construction provides estimates of the fugitive dust particulate matter due caused by construction and demolition activities. Particulate emissions are predominantly due to site preparation work, which may include scrapping, grading, loading, digging, compacting, lights–duty vehicle travel, and other operations. The data source for construction was obtained from the MahaRERA website. Building construction sites in the district are shown in Fig 85.

Assumptions

- The project duration was estimated as 18 months for new buildings, and 6 months for addition /alteration.
- The area of influence of each construction activity was taken as 0.5 acres for new buildings and 0.2 acres for addition /alteration. These were the most prevalent areas noticed. However, at some places sizes vary more than the above-mentioned values.
- Only the land area above 1000 sq. feet (90 sq. m) is considered for the estimation of emission load from building construction activities in the district.

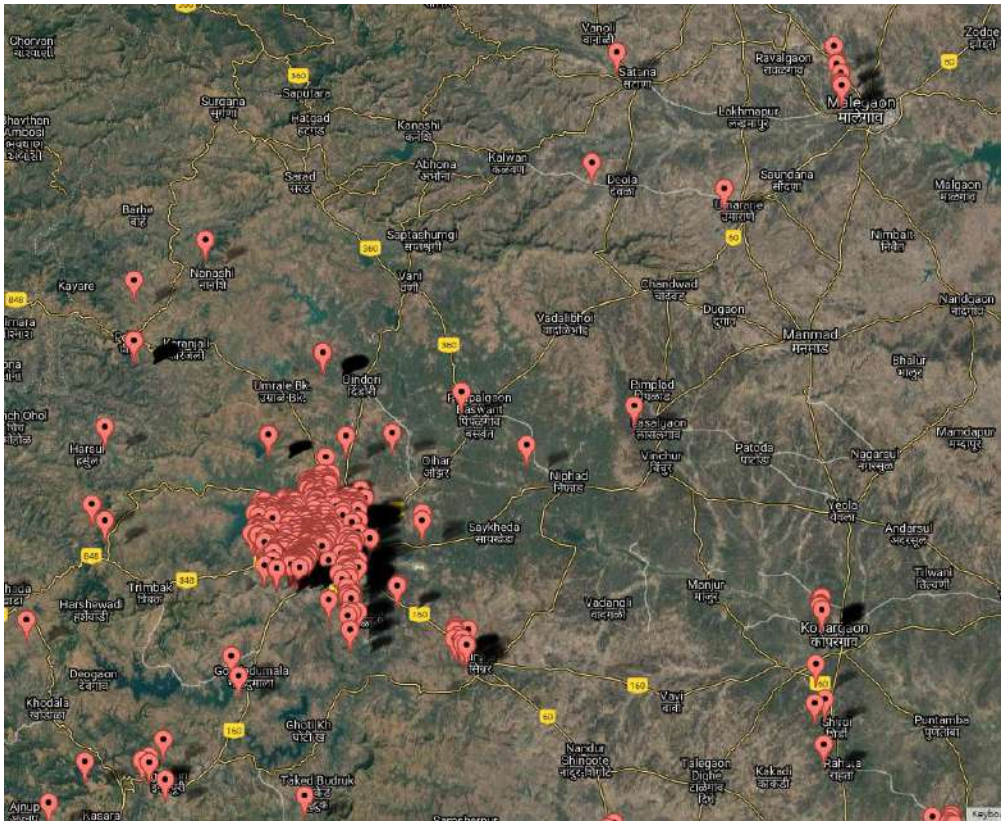

Figure 85: Building construction sites in the district.

Data from 344 construction sites was collected when the buildings were in the construction phase. This includes commercial and residential buildings. The buildings above 1000 sq. ft in land area are registered on the MahaRERA portal. Data for construction and land area lower

than 1000 sq. ft is not available with any official construction department. The information on small construction sites are avoided due to non-availability of the data.

The overall emission load is determined to be 1523 and 657 Kg/day for PM_{10} and 921 and 394 Kg/day for $PM_{2.5}$ in the District and City, respectively, as shown in Fig. 86.

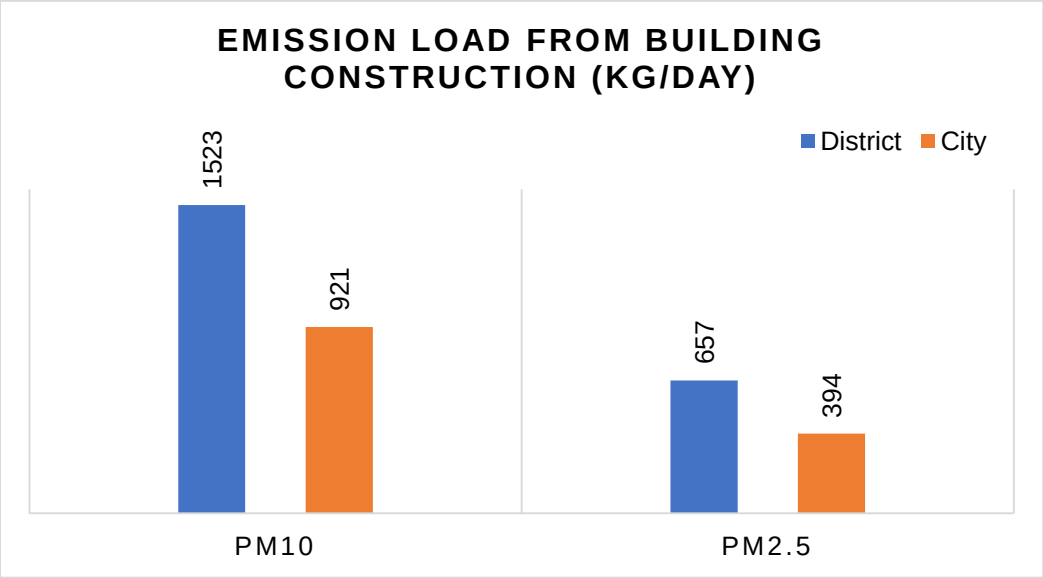

Figure 86: Emission load from building construction.

The grid-wise emission load from building construction in City and District is represented in Fig 87 and 90.

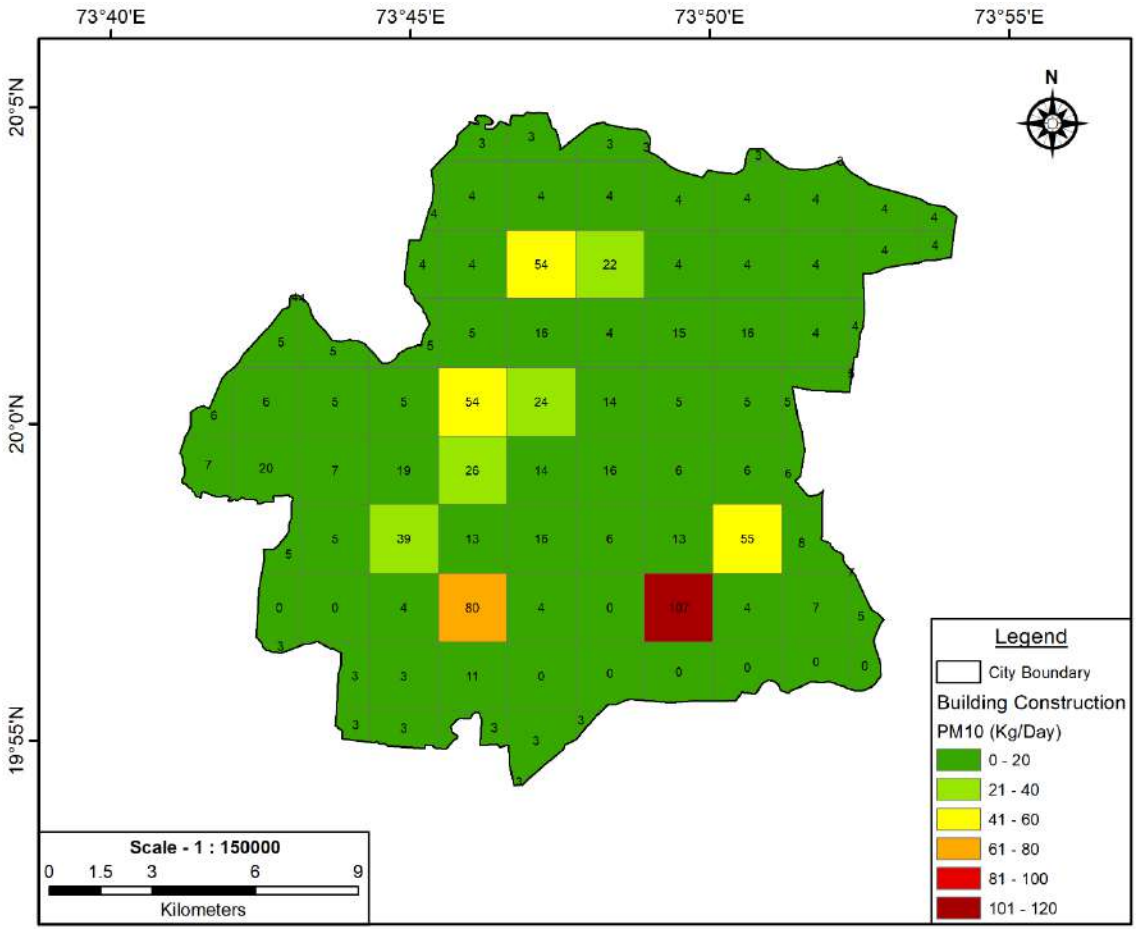

Figure 87: Gridded PM_{10} emission load (Kg/day) from Building & Construction in Nashik City.

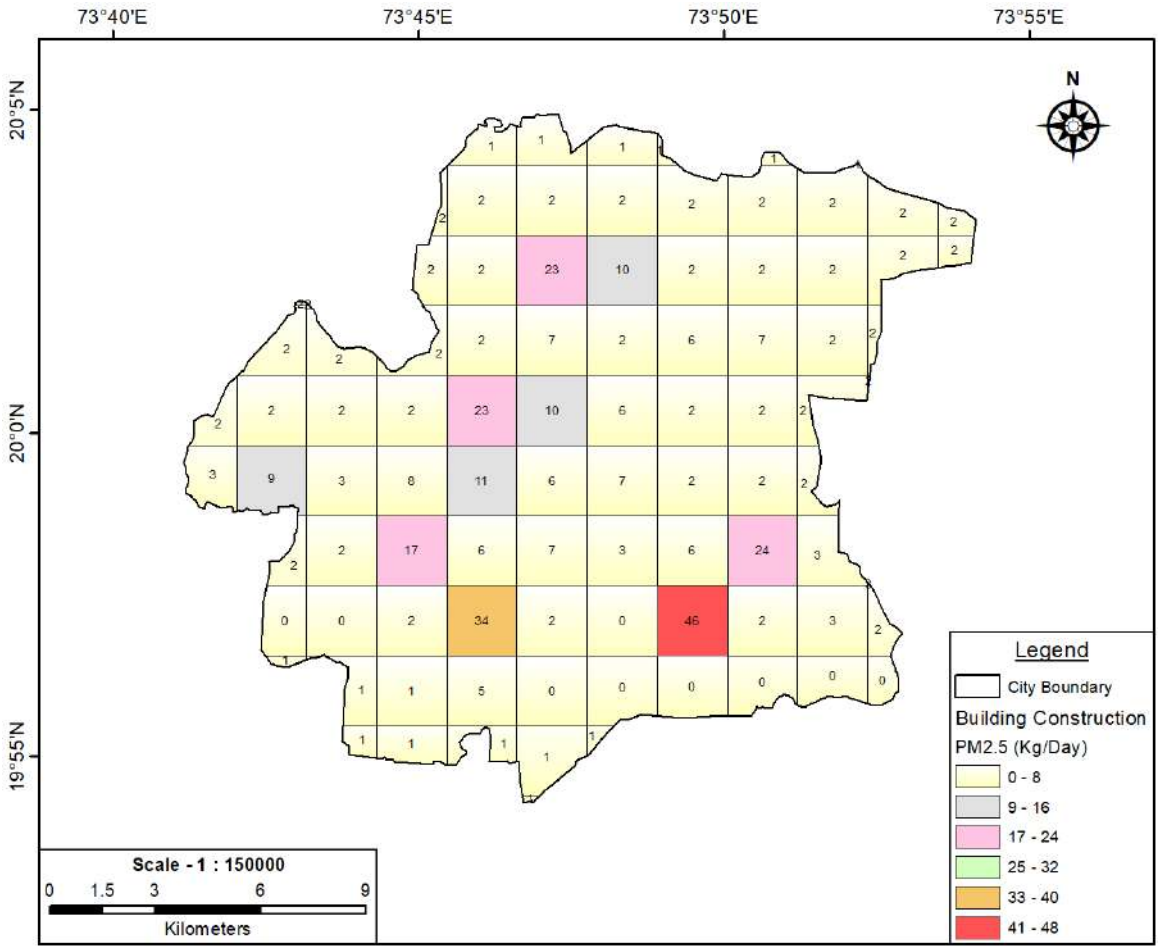

Figure 88: Gridded $PM_{2.5}$ emission load (Kg/day) from Building & Construction in Nashik City.

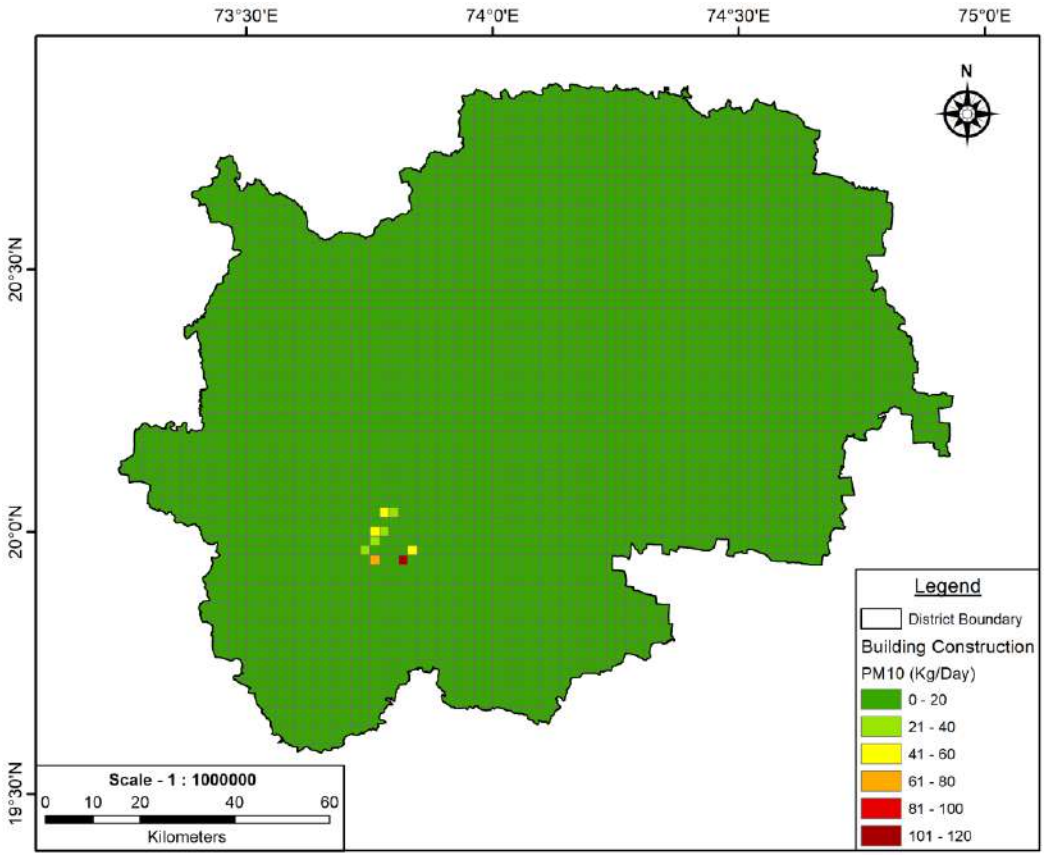

Figure 89: Gridded PM_{10} emission load (Kg/day) from Building & Construction in Nashik District.

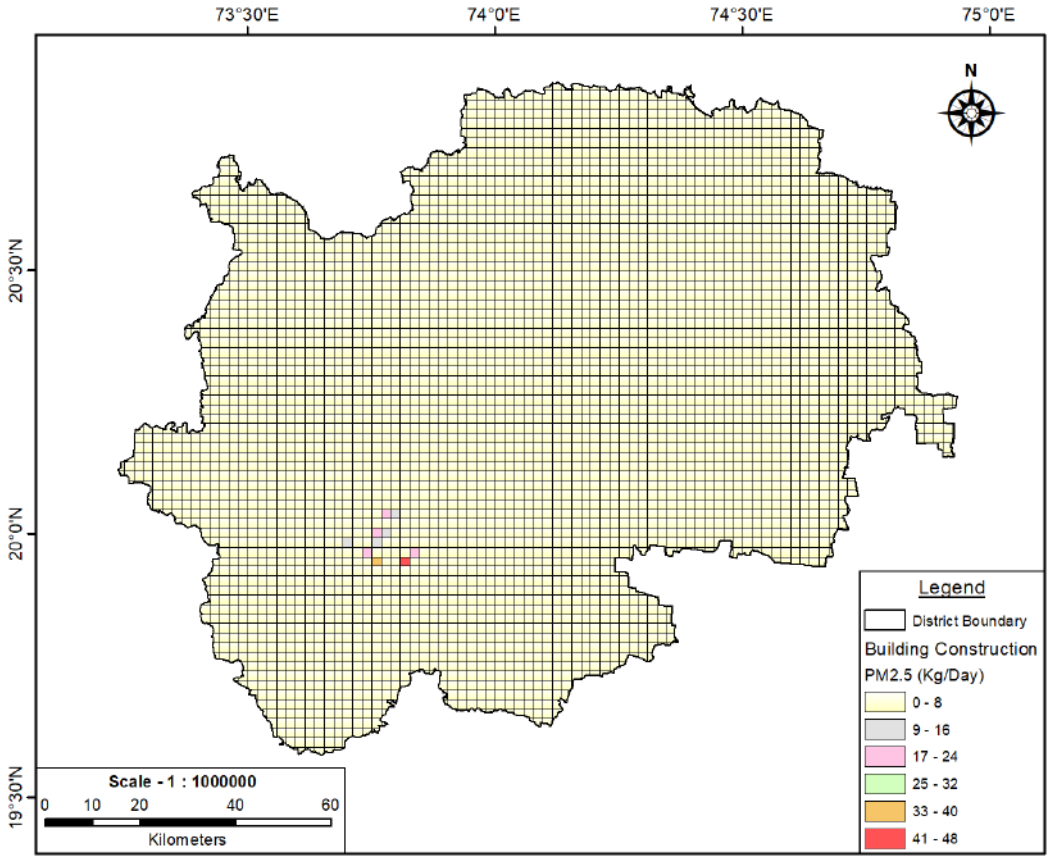

Figure 90: Gridded $PM_{2.5}$ emission load (Kg/day) from Building & Construction in Nashik District.

2.8.7 Stone Crushers

The emission of particulate matter from stone crushers is the main source of dust re-suspension. Stone quarries near Ramshaw fort were visited to have an idea of the emissions released into the atmosphere. There are about 92 stone crushers in the district. The data information on the stone crushers is collected from Maharashtra Pollution Control Board, Nashik. It was observed that water spraying was in use to control the dust emission. A stone quarry plant is depicted in Fig 91.

Stone Crushers are small-scale industries with low capital investments. Stone crushers in India are a labour-intensive operation. The loading of stone into the crusher, conveying the product materials from separating screens, loading, and unloading operations are performed manually. Location of stone crushers in the district is shown in Fig 92. The production capacity of stone crushers varies from 3 to 30 Tons/day.

Figure 91: Stone quarry plant.

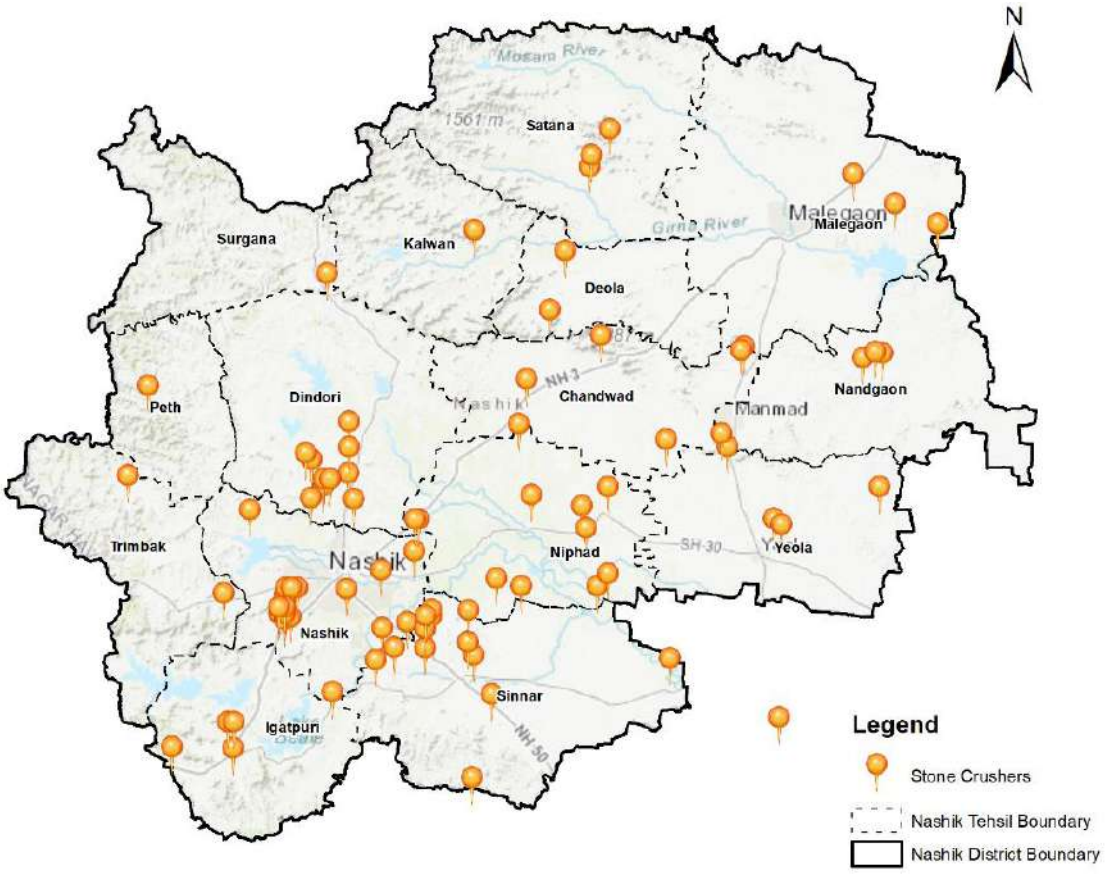

Figure 92: Location of stone crushers in the district.

The emission factors for dust emission from stone quarries and crushers are referred from AP-42 Section 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.

For PM_{10} and $PM_{2.5}$, the total emission load from stone crushers is 834 and 246 kg/day in the district and 16 and 7 kg/day in the city, respectively as shown in Fig 93.

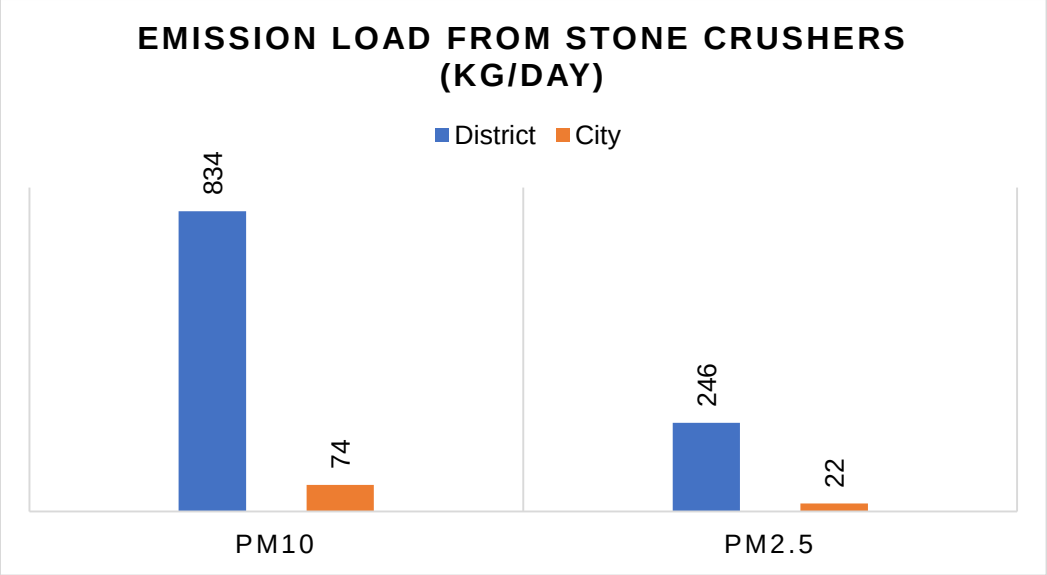

Figure 93: Emission load from Stone Crushers.

The grid-wise distribution of PM_{10} & $PM_{2.5}$ in Kg/day due to operating stone crushers in the District and City is shown in Fig. 94 to Fig. 97.

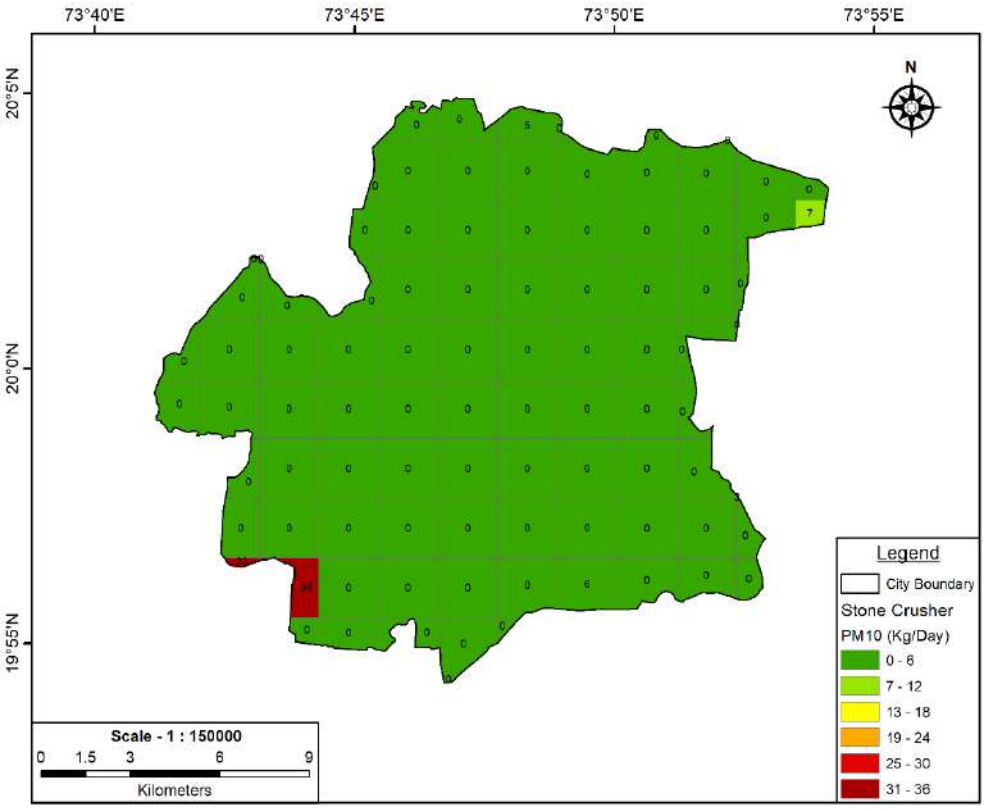

Figure 94: Grid-wise PM_{10} emission load from Stone Crushers in Nashik City.

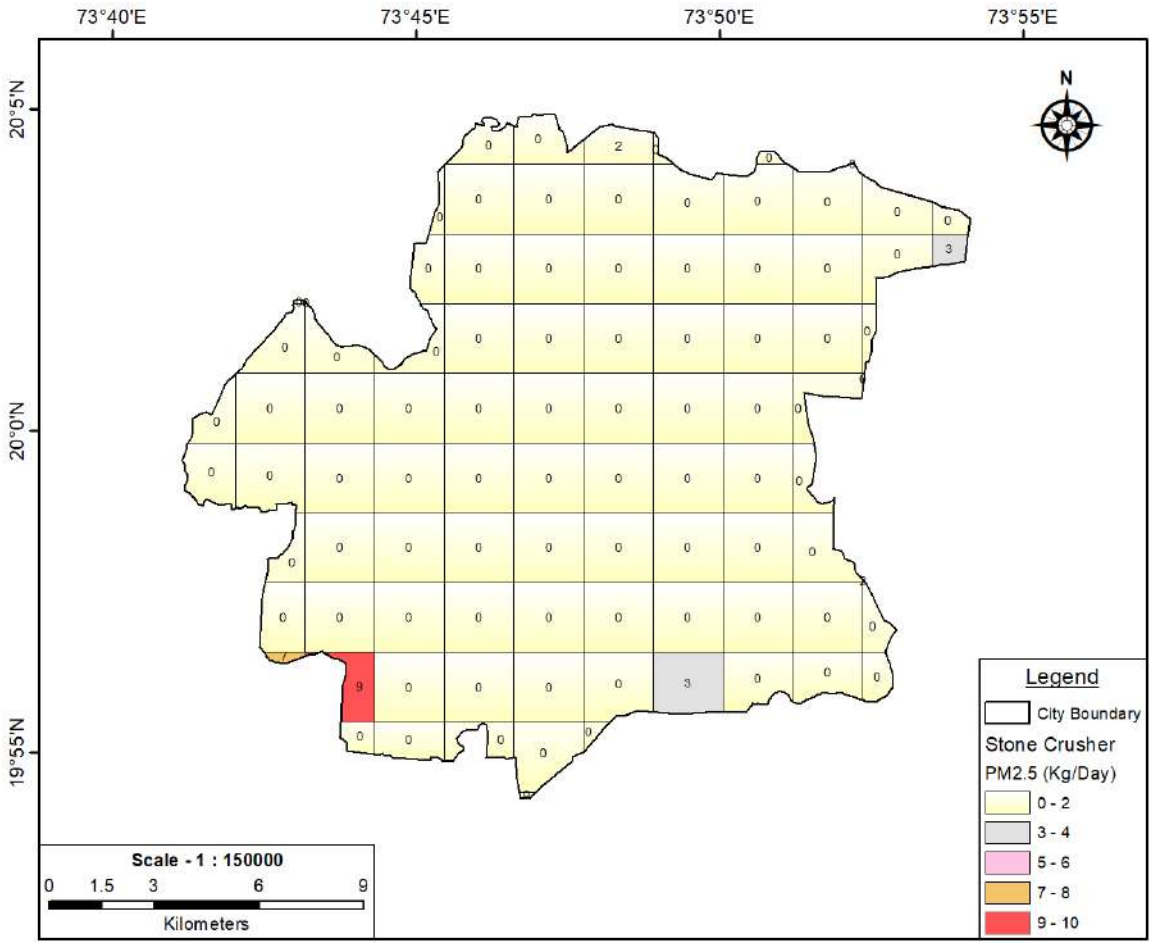

Figure 95: Grid-wise $PM_{2.5}$ emission load from Stone Crushers in Nashik City.

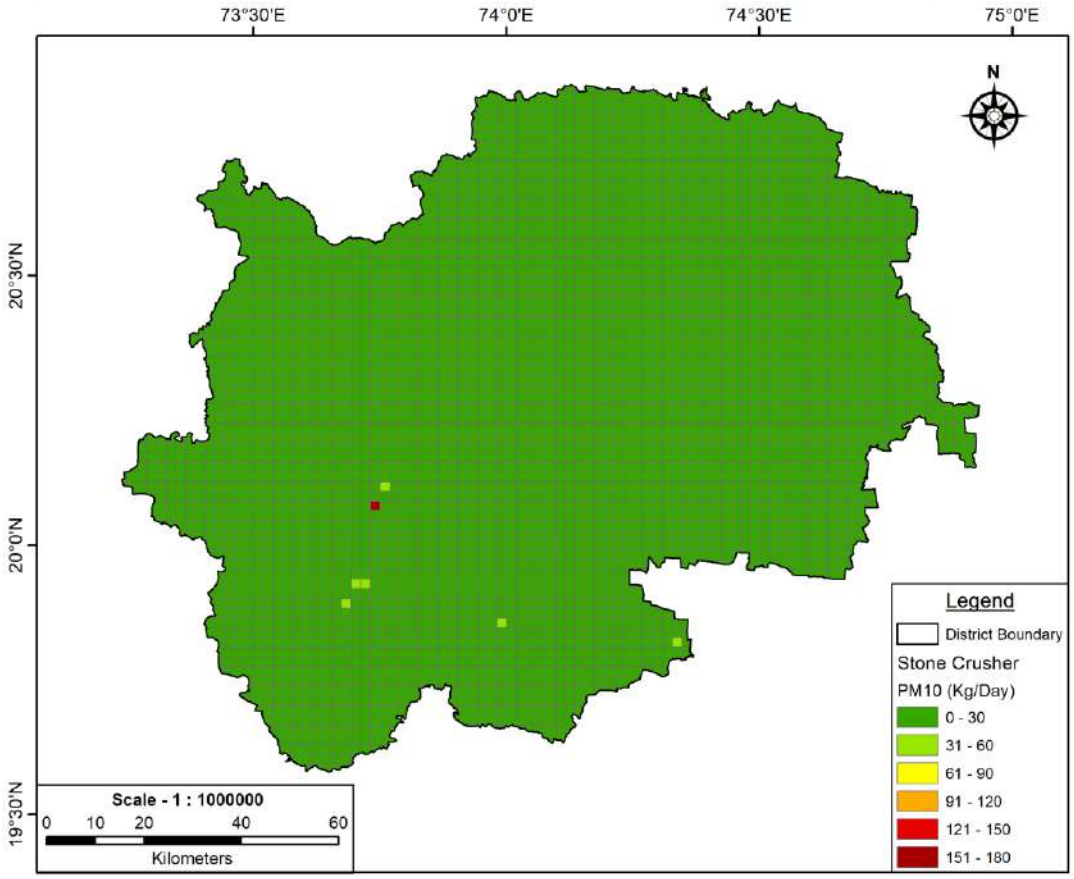

Figure 96: Grid-wise PM_{10} emission load from Stone Crushers in Nashik District.

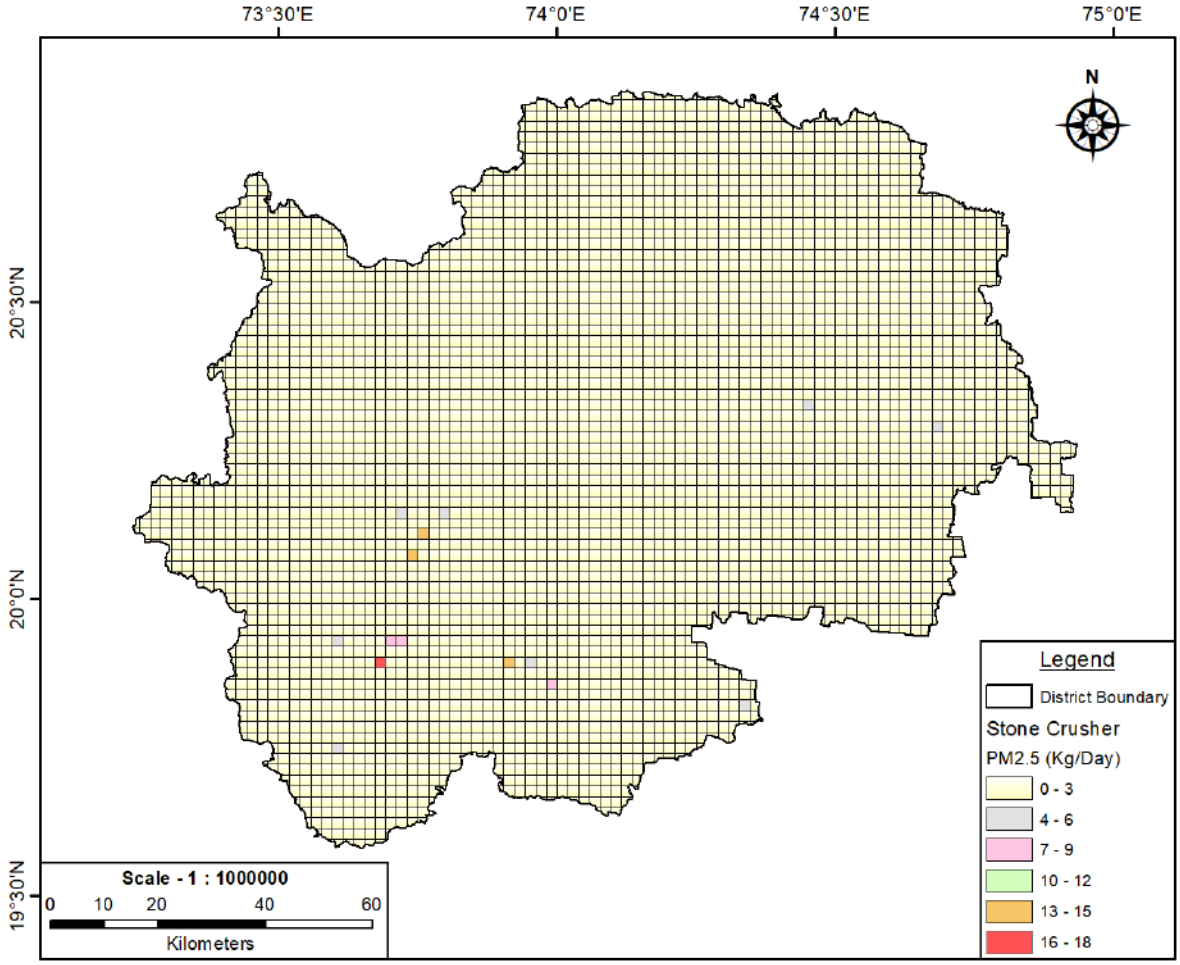

Figure 97: Grid-wise PM_{10} emission load from Stone Crushers in Nashik District.

2.8.8 Brick Kilns

Brick production is a very large and traditional practice in many parts of Asia. The brick sector in India, although unorganized, is tremendous in size. The demand for bricks is increasing almost universally due to fast economic growth, urbanization, and prosperity. The raw materials used for brick production are soil clay or sediments from the river, which are rich in fine particles. Most of the brick kilns use Assam coal, Slack coal, and/or lignite which contain a high level of sulphur and high ash content (25-30%). Coal is the crucial fuel used to fire bricks. Burning of this coal produces a high level of sulphur dioxide and black carbon.

In the Nashik District, a survey was conducted in July 2021, to identify the possible locations of these units. In the Nashik District, there are in total 52 brick manufacturing units. All the brick manufacturing units are clamp based. They all follow the traditional method of heating moulded bricks. All the clusters are located nearby the river bodies. The information on this sector is not available from any government offices. The locations of brick-kiln clusters are shown in Fig.98. The fuel used for brick manufacturing is wood and coal with 2740 and 4176 kg/day. The emission load for PM_{10}, $PM_{2.5}$, SO_x, NO_x, and CO for both the City and District is estimated based on the fuel requirements and is depicted in Fig 99.

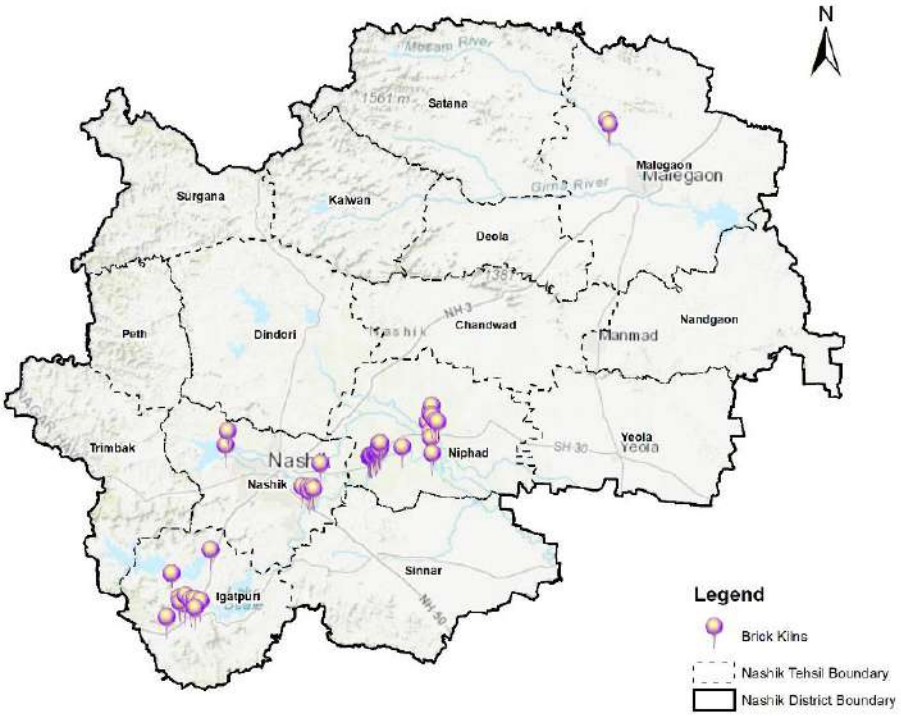

Figure 98: Locations of brick-kiln clusters in Nashik District.

According to Fig 69, the emission loads for PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO and NMVOCs are 2023, 745, 1438, 288, 2130 and 887 kg/day in Districts and 140, 53, 32, 20, 147 and 71 kg/day in City, respectively.

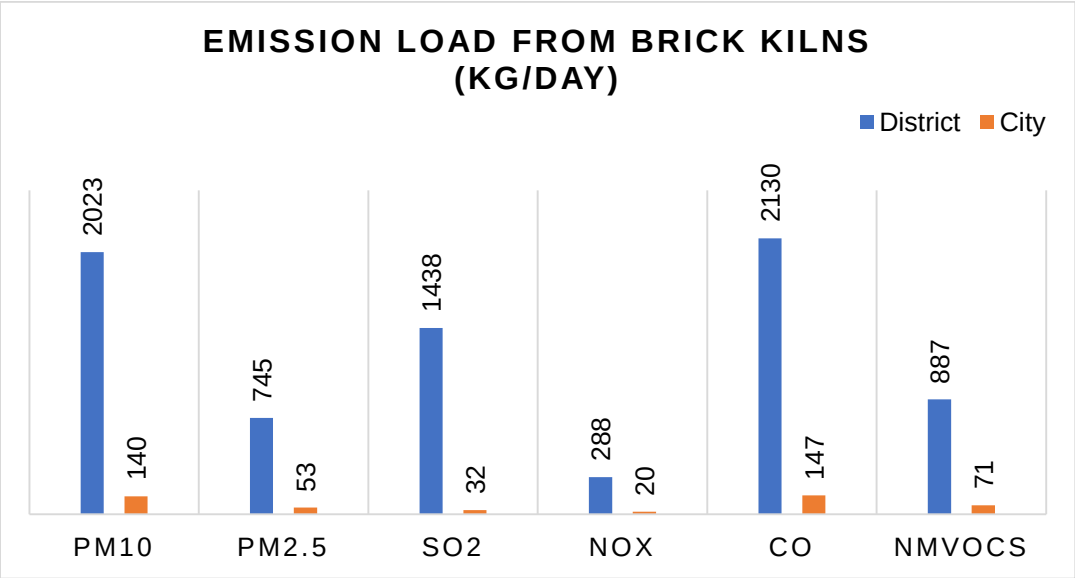

Figure 99: Emission load from brick kilns in District and City

The grid wise distribution of emissions from brick kiln sector for PM_{10}, $PM_{2.5}$, SO_2, NOx, CO and NMVOCs is shown in Fig 100 to Fig.111.

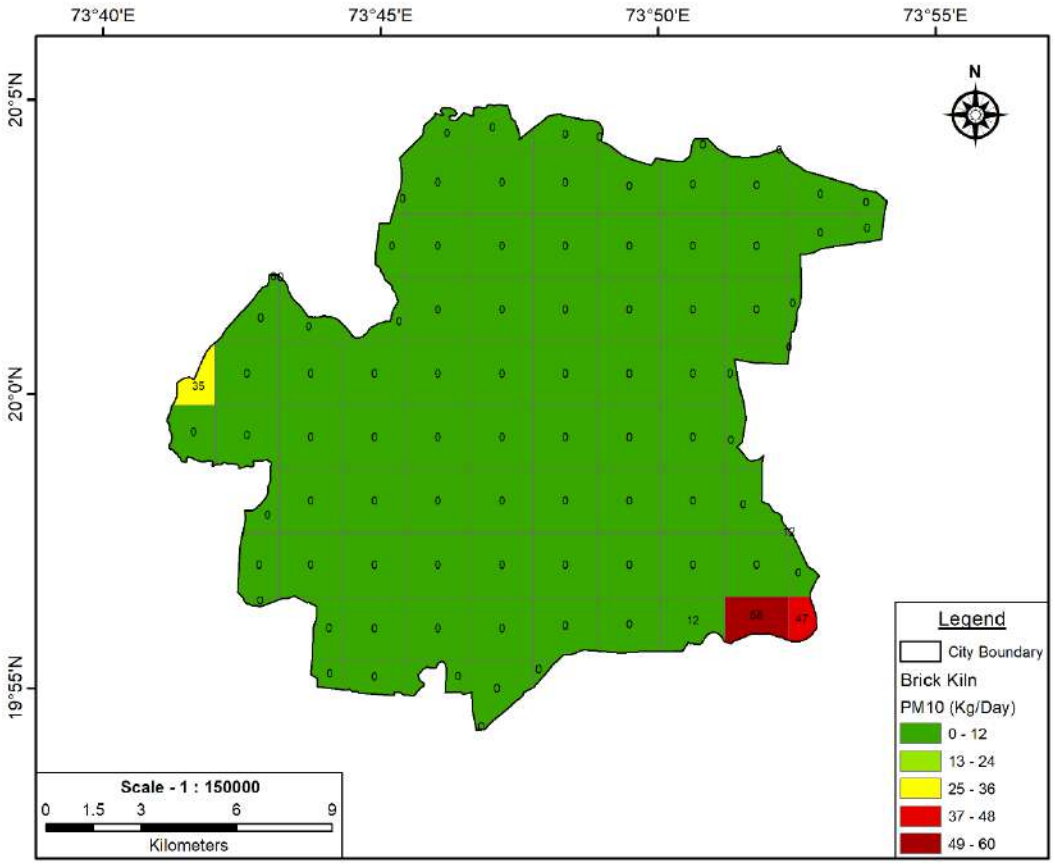

Figure 100: Grid-wise PM_{10} emission load from Brick Kilns in Nashik City.

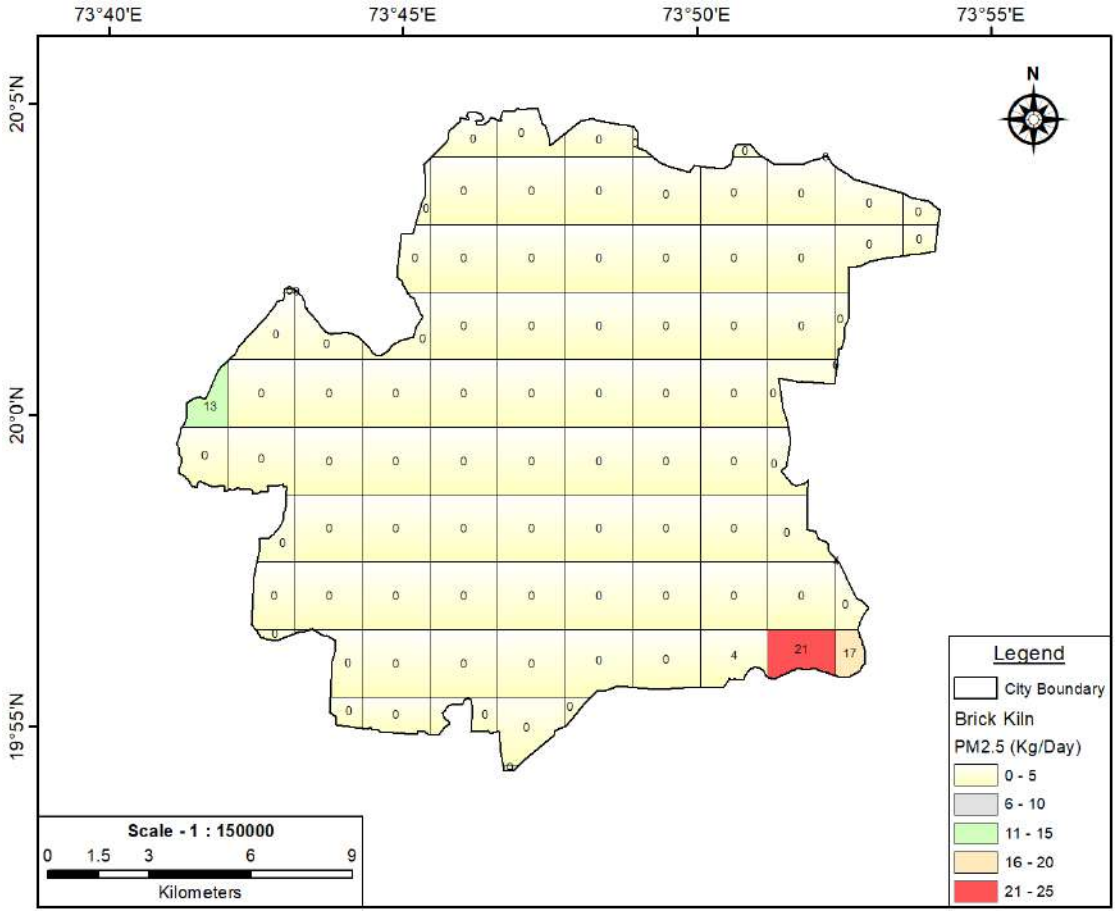

Figure 101: Grid-wise $PM_{2.5}$ emission load from Brick Kilns in Nashik City.

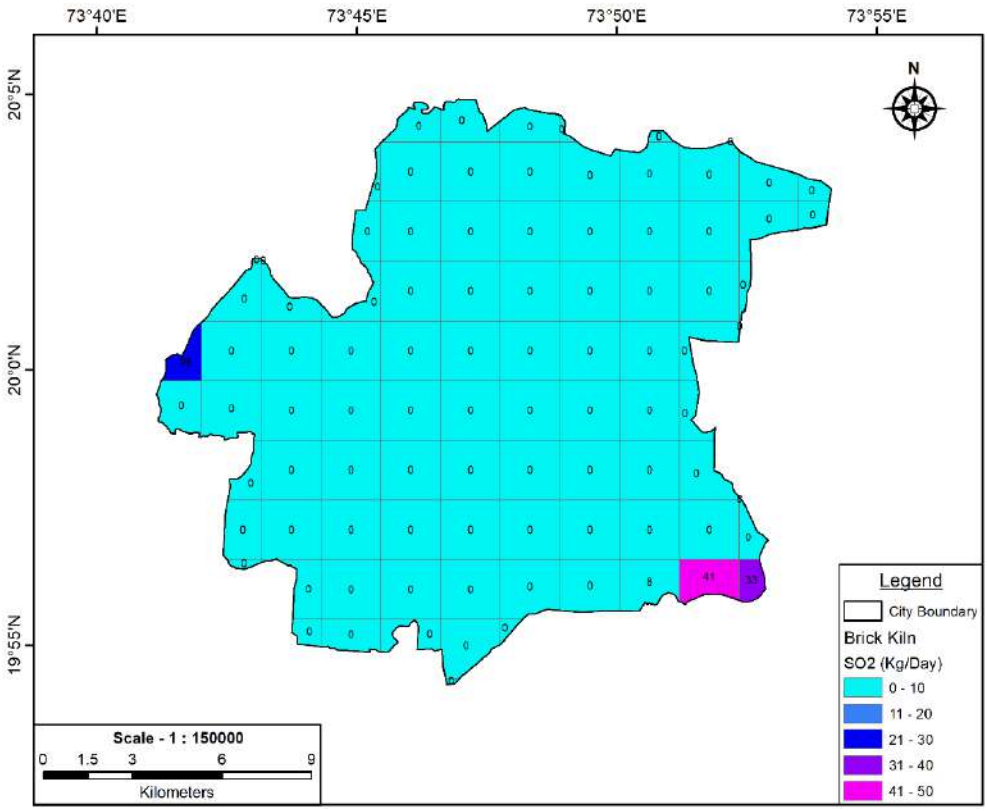

Figure 102: Grid-wise SO_2 emission load from Brick Kilns in Nashik City.

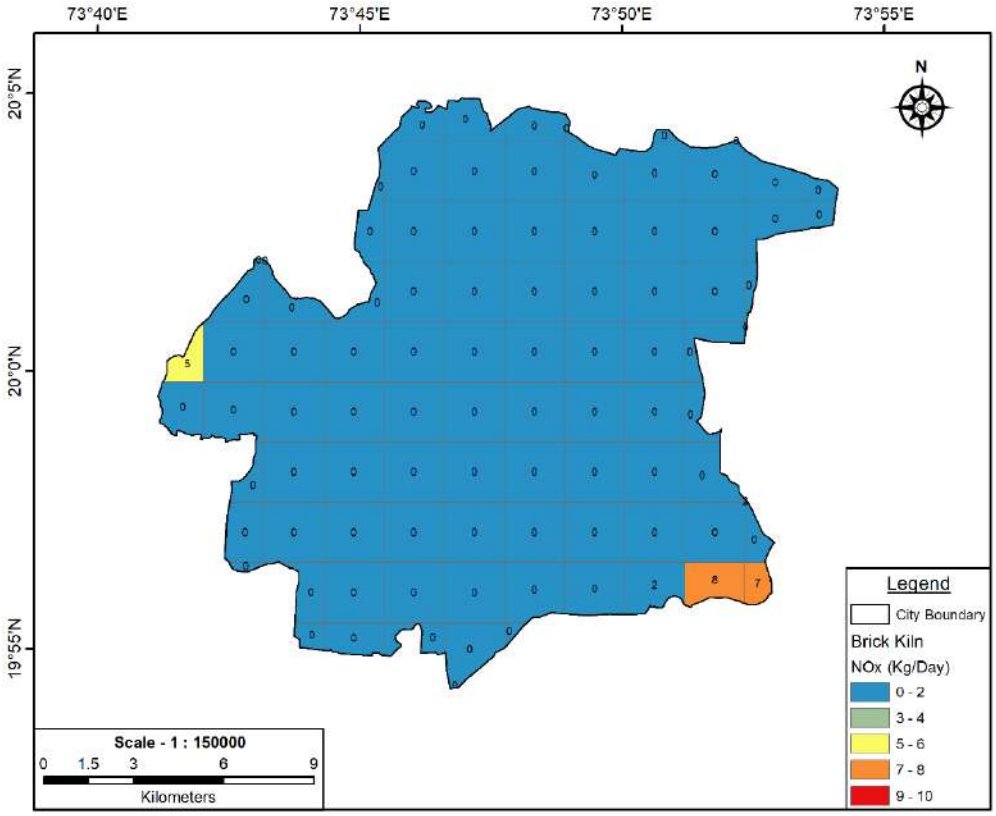

Figure 103: Grid-wise NOx emission load from Brick Kilns in Nashik City.

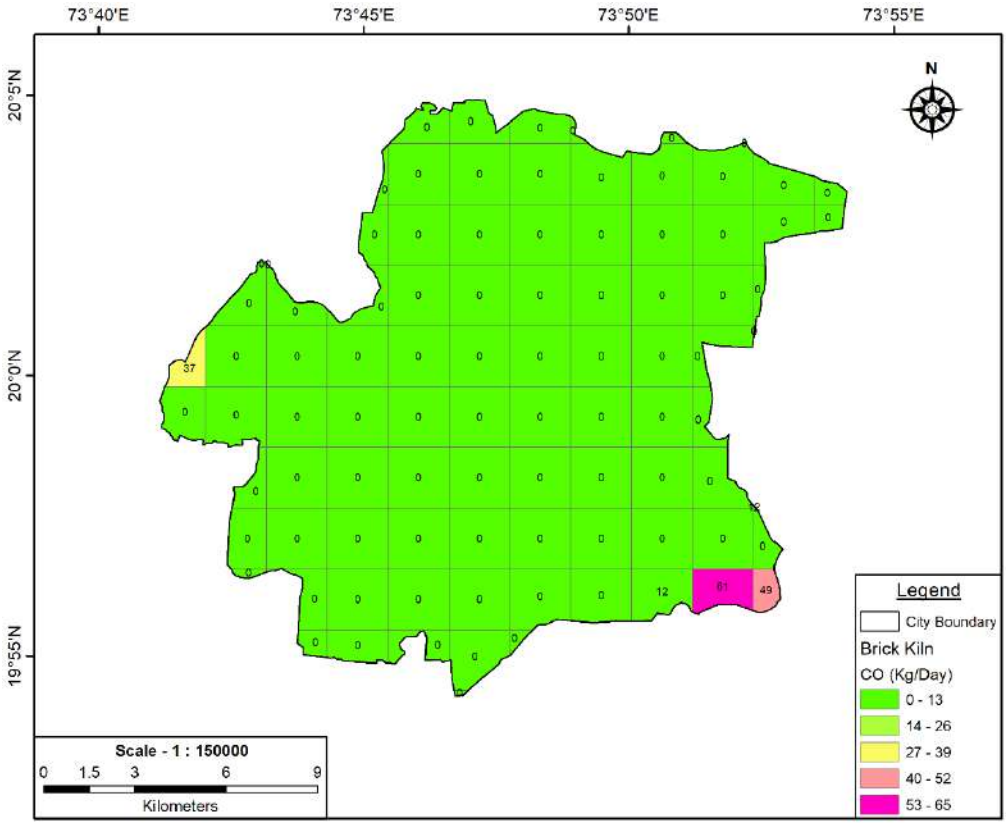

Figure 104: Grid-wise CO emission load from Brick Kilns in Nashik City.

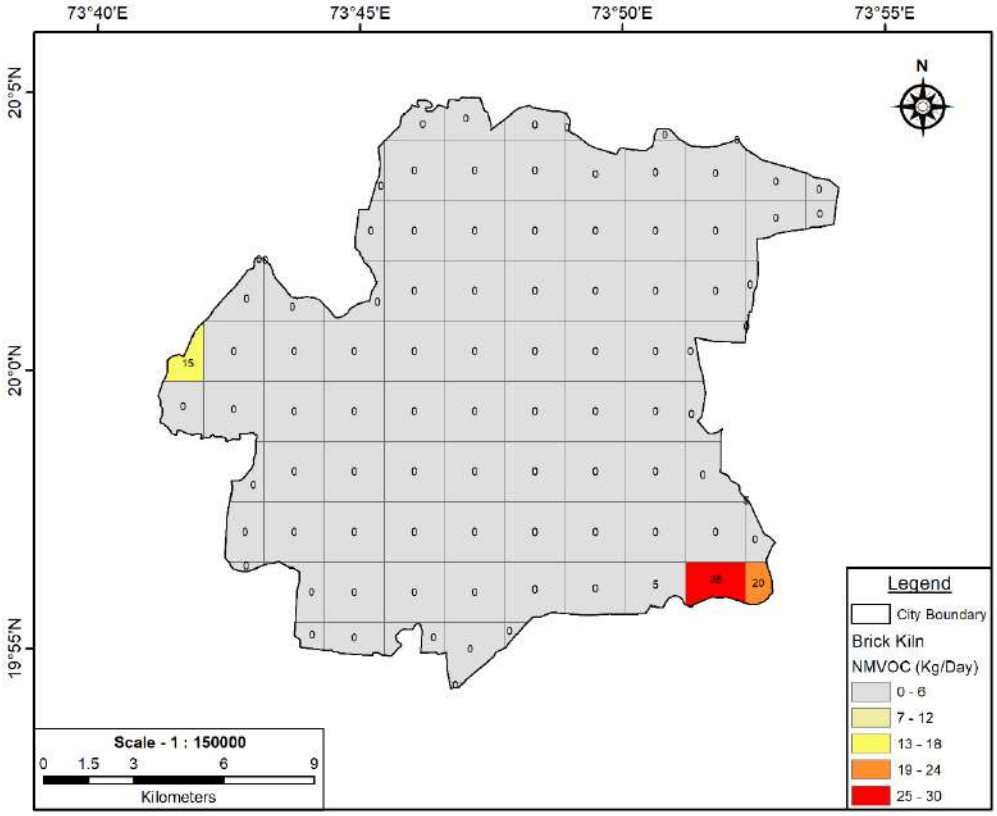

Figure 105: Grid-wise NMVOCs emission load from Brick Kilns in Nashik City.

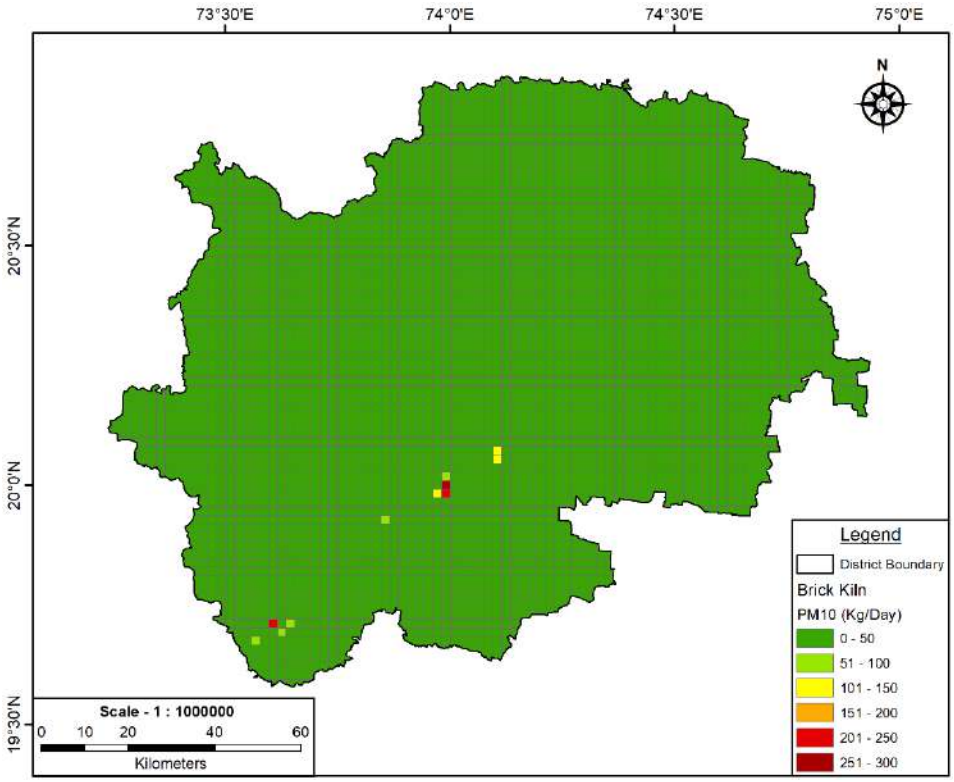

Figure 106: Grid-wise PM_{10} emission load from Brick Kilns in Nashik District.

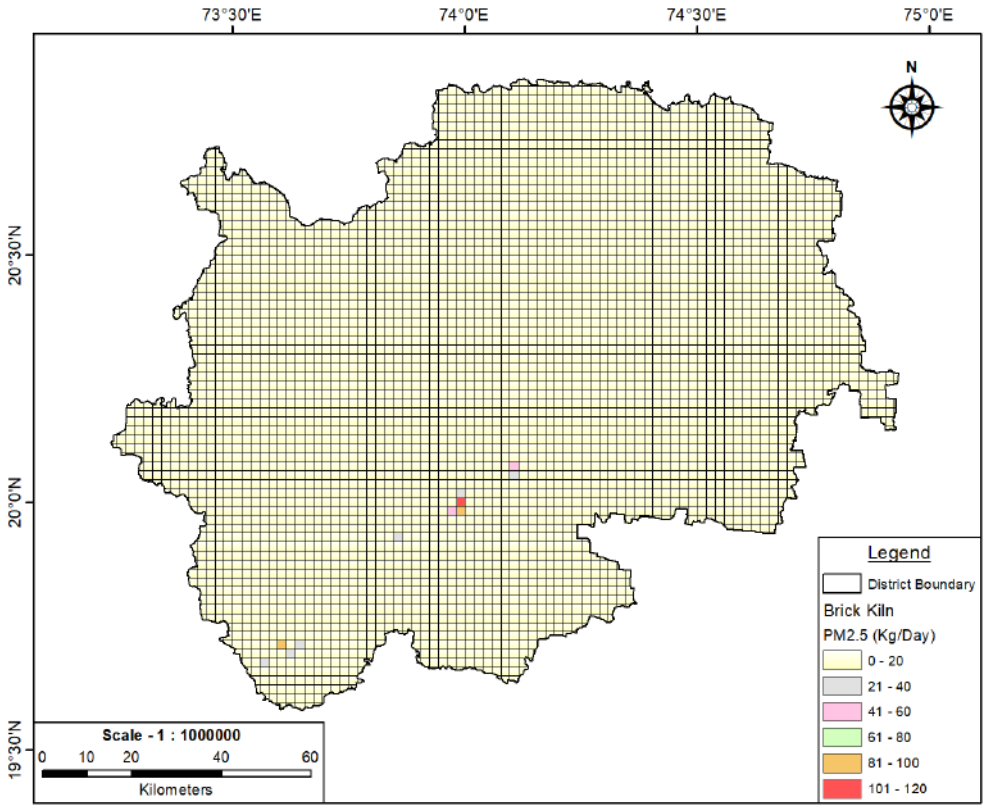

Figure 107: Grid-wise $PM_{2.5}$ emission load from Brick Kilns in Nashik District.

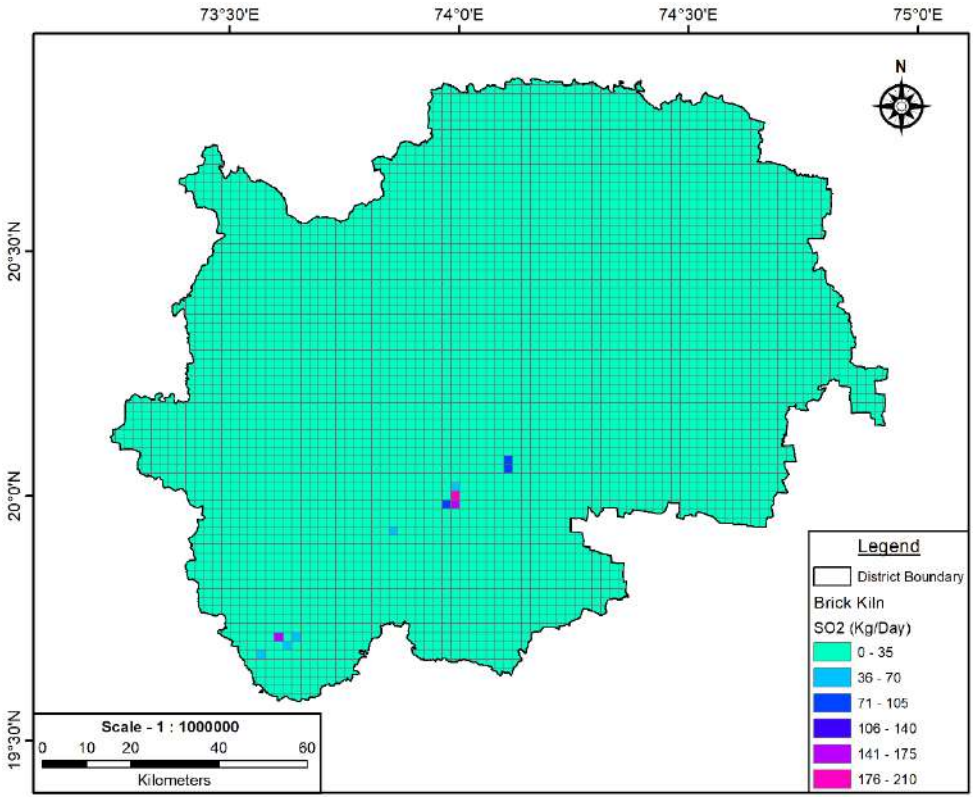

Figure 108: Grid-wise SO_2 emission load from Brick Kilns in Nashik District.

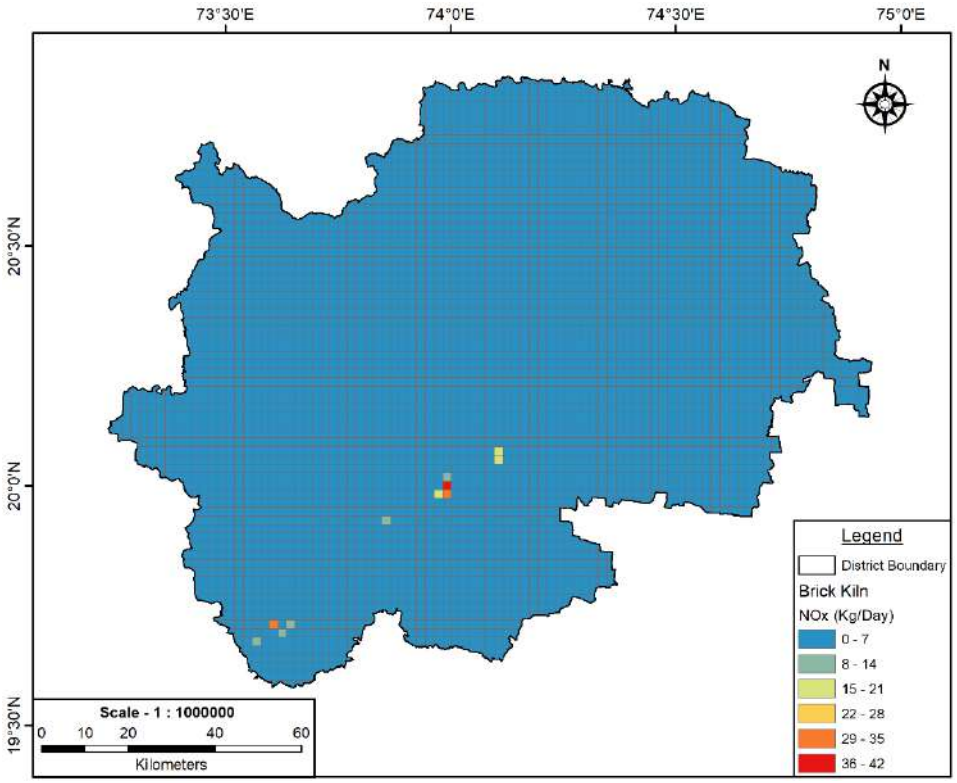

Figure 109: Grid-wise NOx emission load from Brick Kilns in Nashik District.

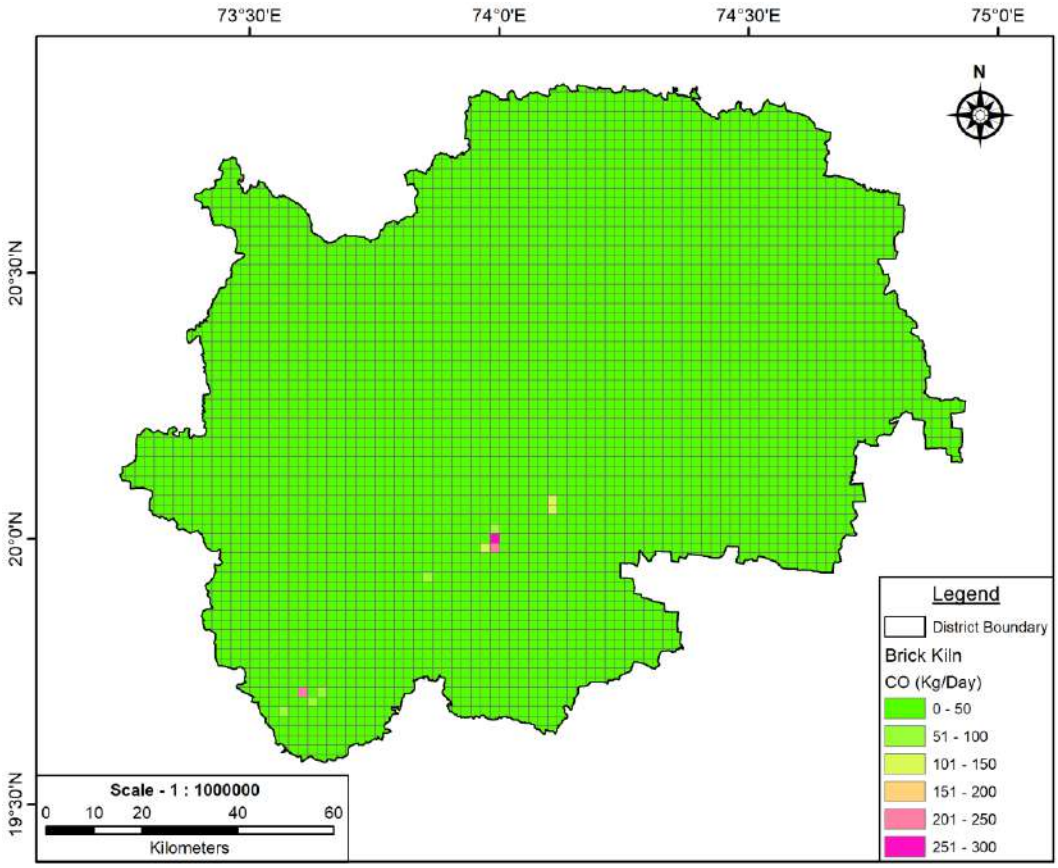

Figure 110: Grid-wise CO emission load from Brick Kilns in Nashik District.

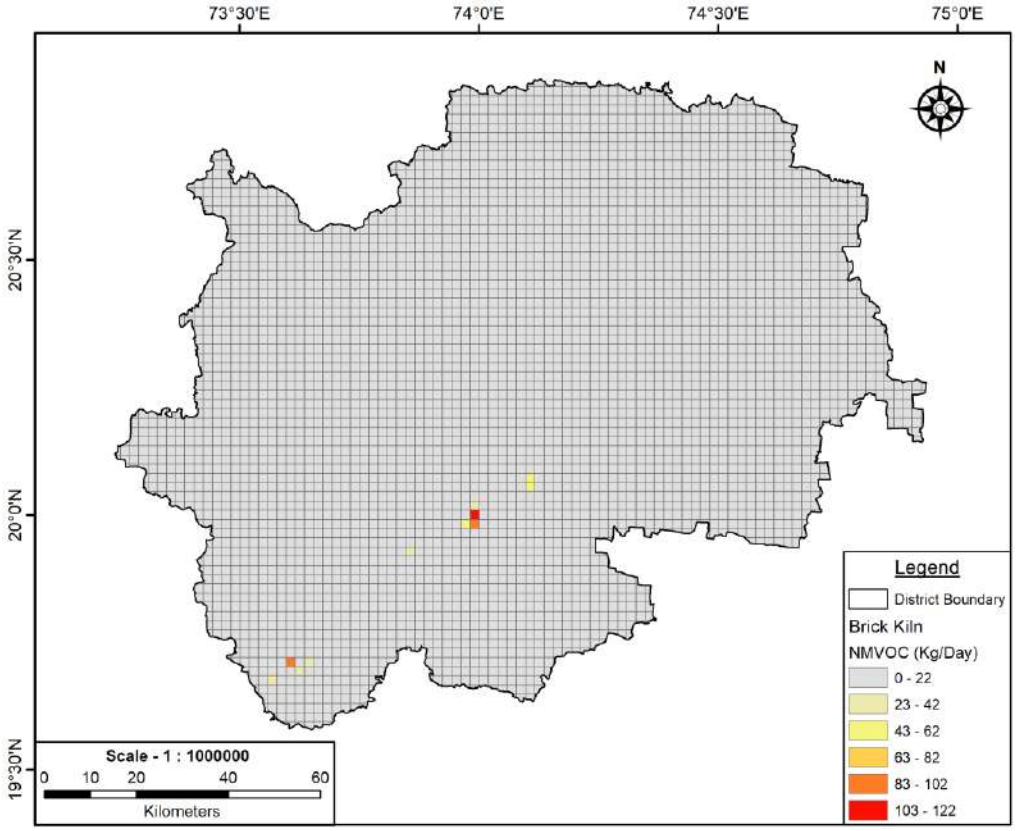

Figure 111: Grid-wise NMVOCs emission load from Brick Kilns in Nashik District.

3.0 Total Emissions

In total 11 sectors have been inventoried in Nashik City and District which are found to be contributing towards deteriorating air quality of Nashik. Table 11 & Table 12 shows distribution of emissions of various pollutants in different sectors in the Nashik District and City. In both PM_{10} and $PM_{2.5}$, in a District, industries are major contributor followed by transport sector while in the city, transport, road dust and bakeries are major contributors and transportation sectors have larger emission loads. Percentage shares of different sources in total PM_{10}, $PM_{2.5}$, SO_2, NOx, HC, CO and NMVOCs emissions for City and District are shown in Fig 112 and 113, respectively. The total grid emissions are shown in Fig 114 to Fig 125.

The study found that:

- Emission inventory results for Nashik City and District for 2021 reveal that in the case of particulate matter (PM_{10}) pollution, in a District, industries are major contributor followed by transport sector, contributing 44% and 34%, respectively to total PM_{10} emissions in a District.
- For $PM_{2.5}$, transport is a major sector followed by industries, contributing 51% and 32%, respectively to total $PM_{2.5}$ emissions in a District while for city PM2.5, transport sector and road dust resuspension are the major sector with 45% and 22%.
- In the City, transport, road dust, and building construction are major contributors for both PM_{10} and $PM_{2.5}$ emissions.
- Transport sector is contributing 81% and 76% of total NOx emissions in the District and the City, respectively.
- The estimates for the city and district are compared with all the sources and depicted in Fig 112 and Fig. 113.
- The estimated emissions were spatially allocated at a grid size of 2X2 km^2 based on the level of activity in those grids (Fig. 114-127). Analysis of emission spatial maps shows PM emissions are found to be concentrated in the Nashik City mainly due to high population density, construction activities and high vehicular density. Other than the city, PM_{10} intensities are higher in the district due to vehicular sources, emission from thermal power sector and unpaved roads. NO_X emissions are mainly concentrated at urban centres and highways, mainly due to vehicular and industrial activity.
- The city areas like area near Nashik Road Railway Station, MIDC Satpur, MIDC Ambad, old Mumbai Naka are identified as hotspots of PM_{10} pollution in the city.
- In District, Rattan India Thermal Power plant and Eklahare Thermal Power plant followed by MIDC Malegaon, Sinnar are seen to be the hotspots for PM_{10} emission load.

Table 12: Estimated total emission (kg/day) of pollutants from different sectors in the Nashik District

Nashik District	PM_{10}	$PM_{2.5}$	SO_2	NOx	HC	CO	NMVOCs
Bakeries	849	517	603	121	0	1315	0
Transport Sector	20328	19312	15024	103585	717827	636049	0
Industries	26719	12215	15726	20230	0	10798	0
Road Dust Resuspension	5242	3111	0	0	0	0	0
Hotel & Restaurants	148	94	51	1528	0	645	41
Crematories	327	161	146	441	0	1666	909
Building Construction	1523	657	0	0	0	0	0
Brick Kilns	2023	745	1438	288	0	2130	887
Open Eatouts	242	123	150	662	0	292	0
Stone Crushers	834	246	0	0	0	0	0
Domestic Sector	1952	1018	280	1175	0	14413	8694
Total	**60187**	**38199**	**33418**	**128030**	**717827**	**667308**	**10531**

Table 13: Estimated total emission (kg/day) of pollutants from different sectors in the Nashik City.

Nashik City	PM_{10}	$PM_{2.5}$	SO_2	NOx	HC	CO	NMVOCs
Bakeries	409	253	372	74	0	423	0
Transport Sector	1830	1738	833	4162	28845	25557	0
Industries	460	357	92	20	0	496	0
Road Dust Resuspension	1422	851	0	0	0	0	0
Hotel & Restaurants	115	74	4	738	0	200	31
Crematories	63	32	40	176	0	348	192
Building Construction	921	394	0	0	0	0	0
Brick Kilns	140	53	32	20	0	147	71
Open Eatouts	28	20	17	82	0	37	0
Stone Crushers	74	22	0	0	0	0	0
Domestic Sector	241	85	41	238	0	1152	1634
Total	**5703**	**3879**	**1431**	**5510**	**28845**	**28360**	**1928**

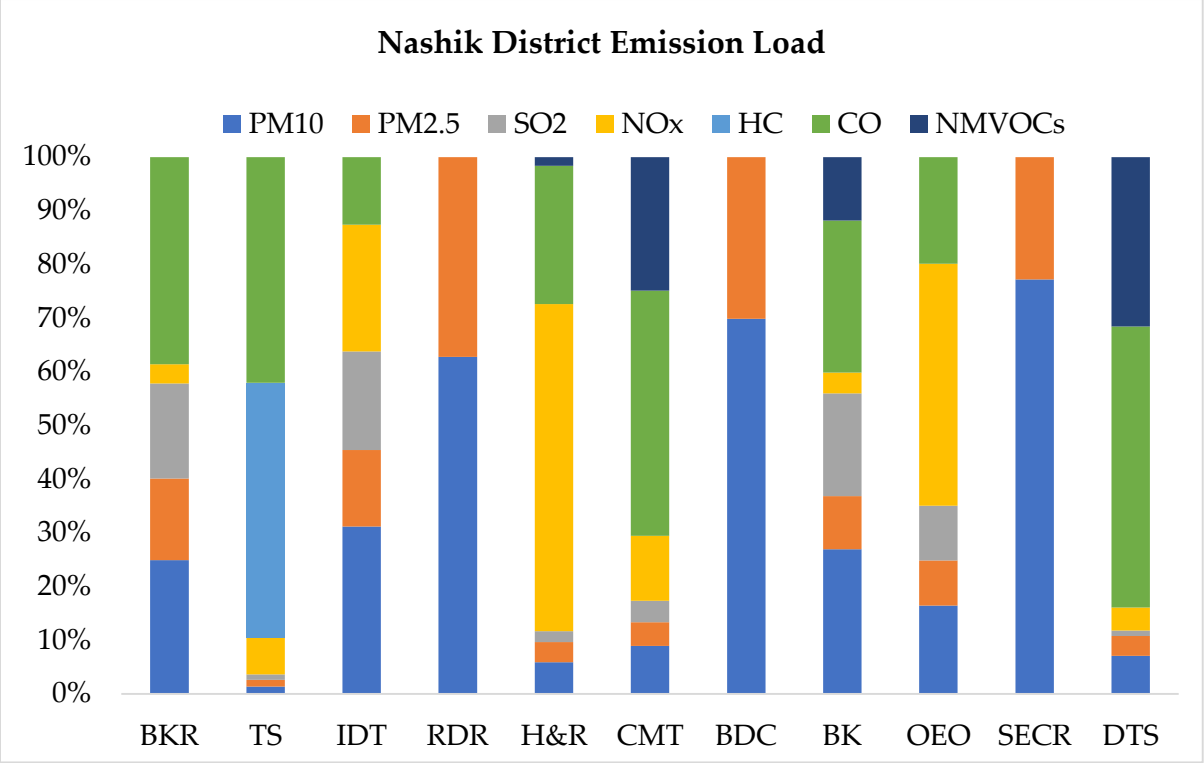

Figure 112: Nashik District Emission Load.

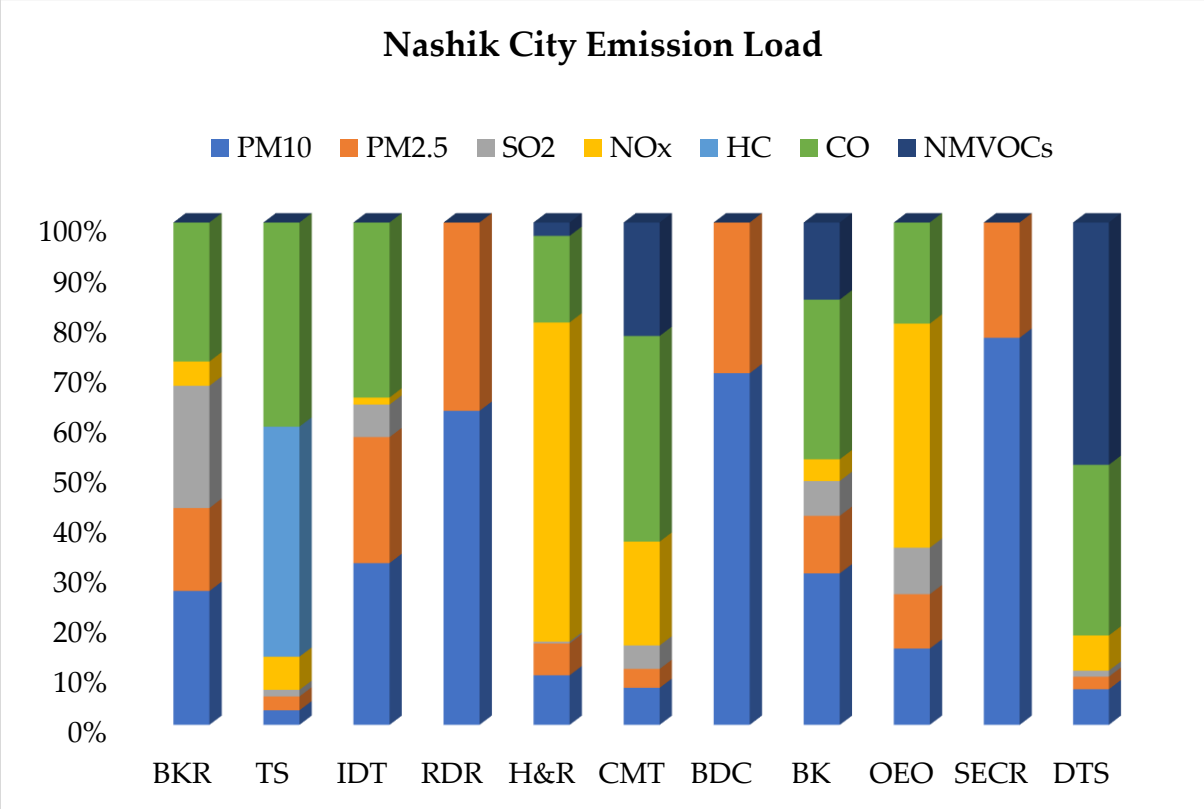

Figure 113: Total Emission load from Nashik City

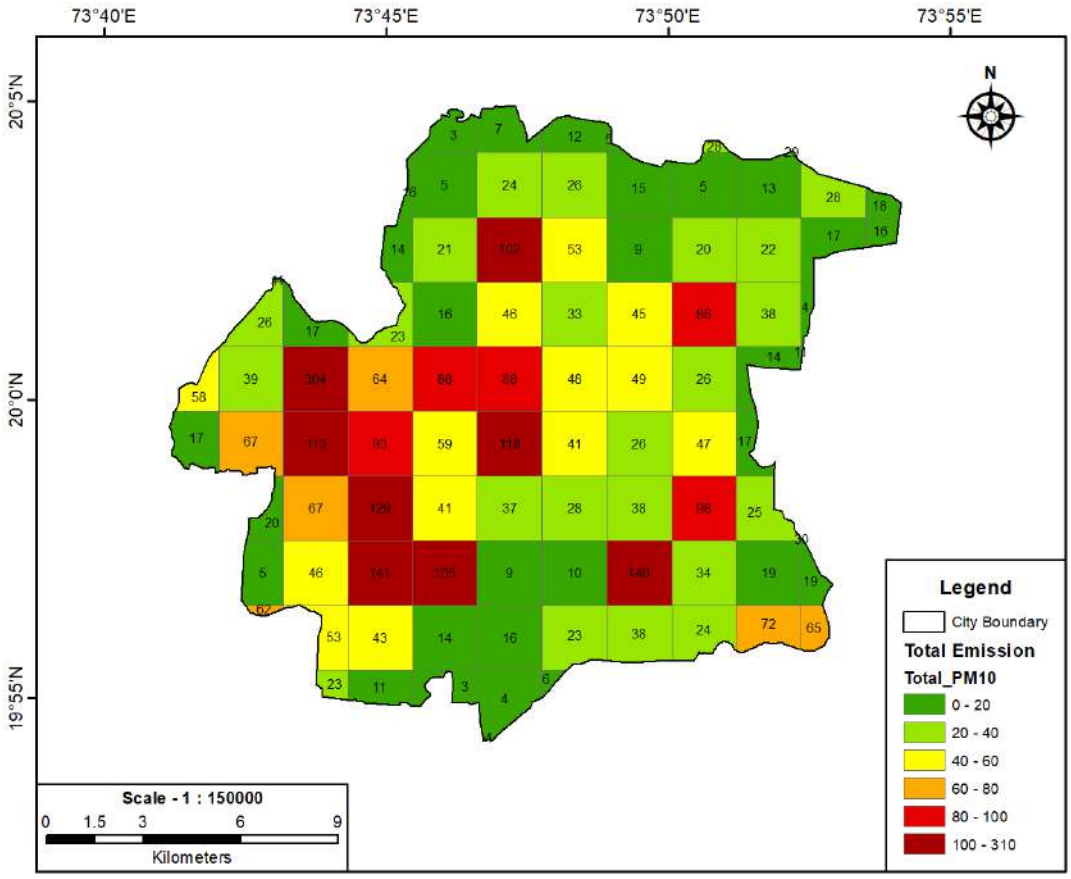

Figure 114: Total Gridded PM10 emission for Nashik City (Kg/day).

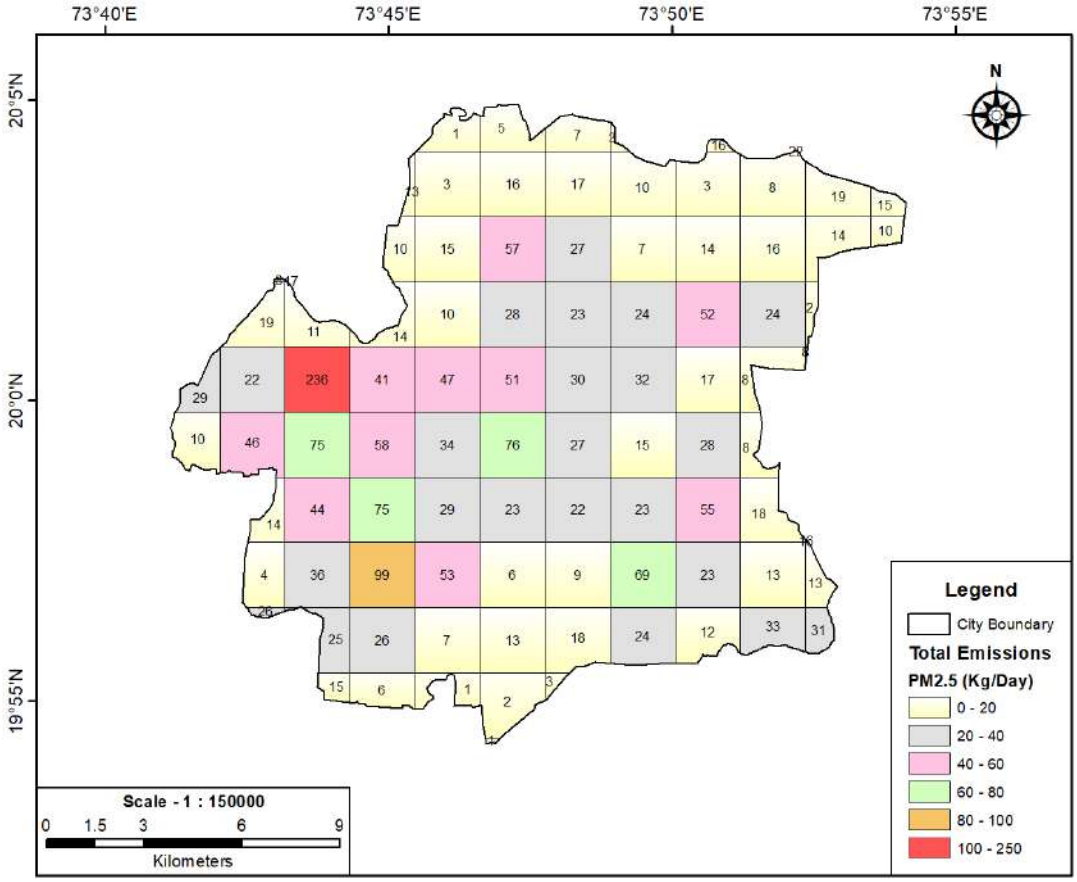

Figure 115: Total Gridded PM2.5 emission for Nashik City (Kg/day).

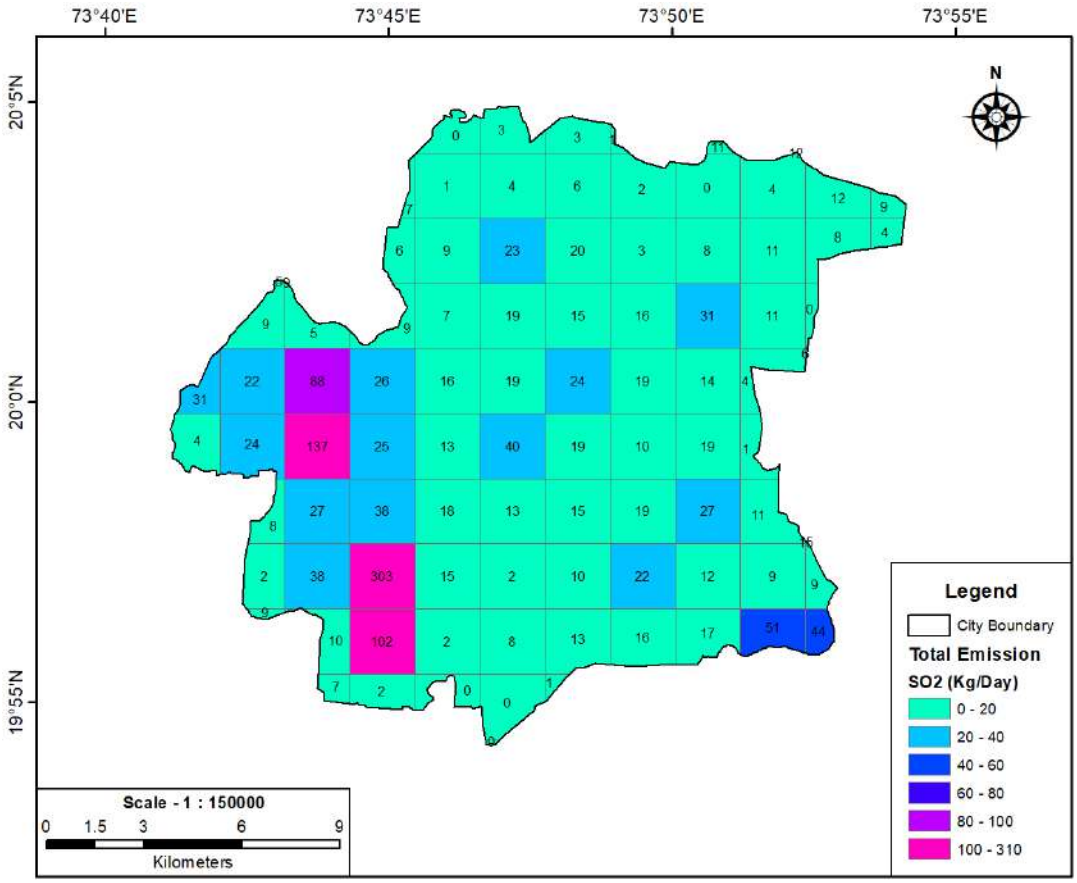

Figure 116: Total Gridded SO_2 emission for Nashik City (Kg/day).

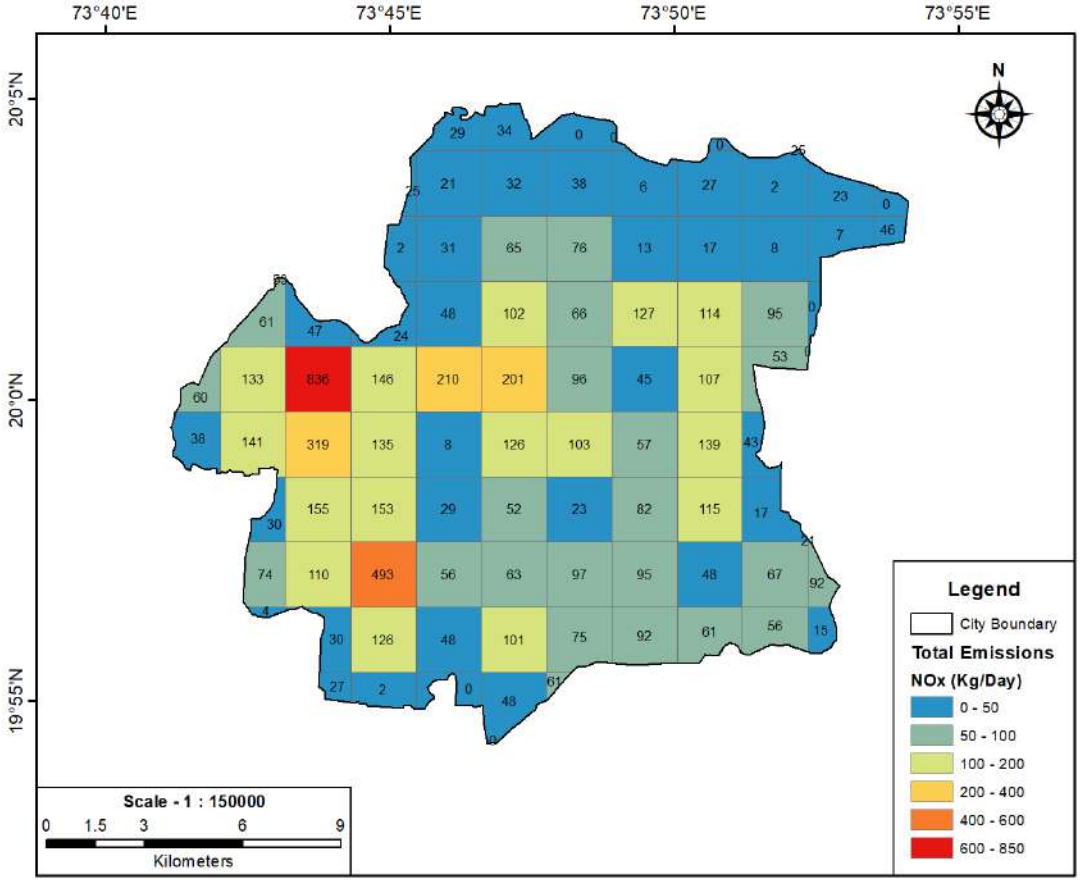

Figure 117: Total Gridded NOx emission for Nashik City (Kg/day).

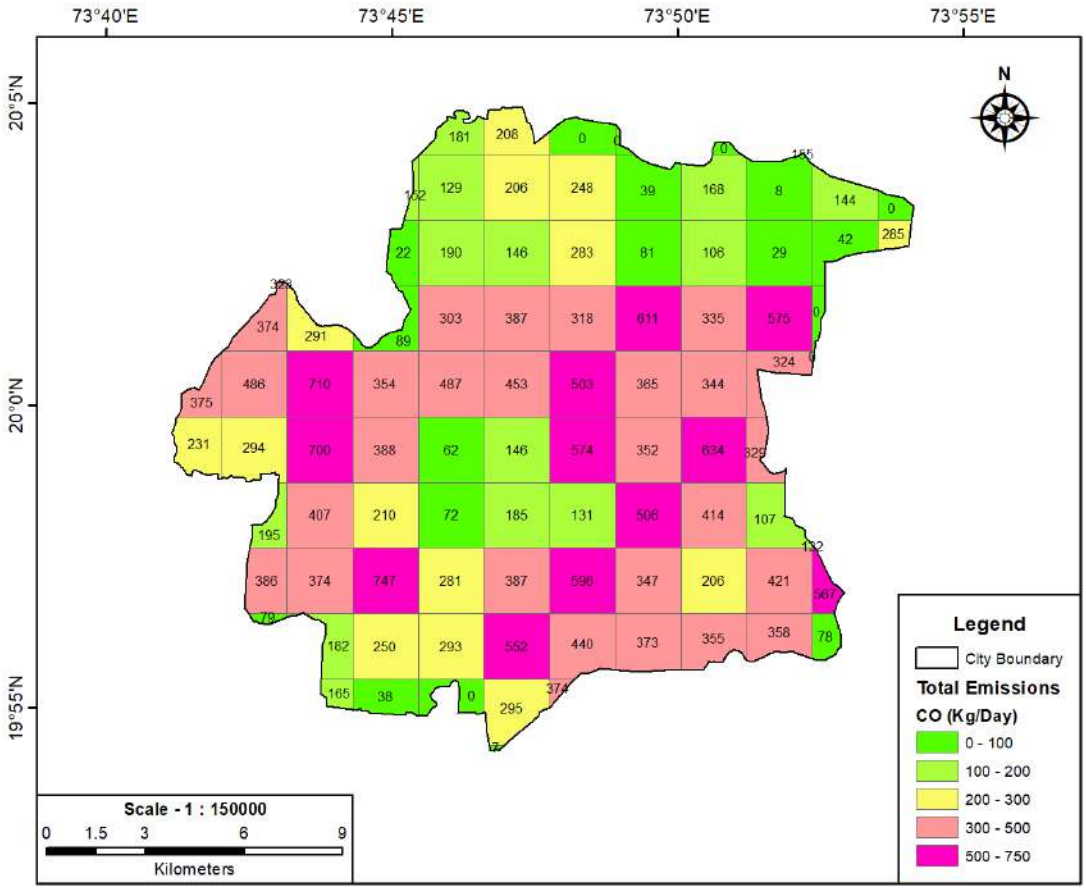

Figure 118: Total Gridded CO emission for Nashik City (Kg/day).

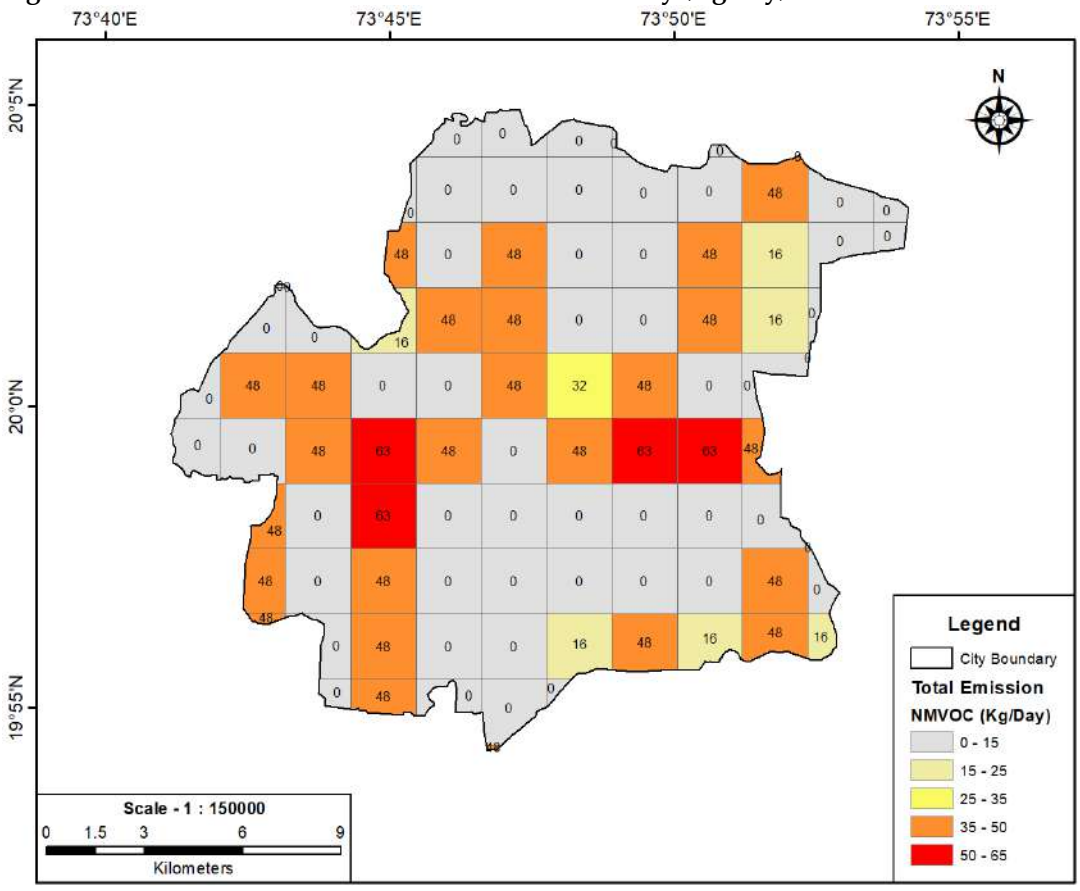

Figure 119: Total Gridded NMVOCs emission for Nashik City (Kg/day).

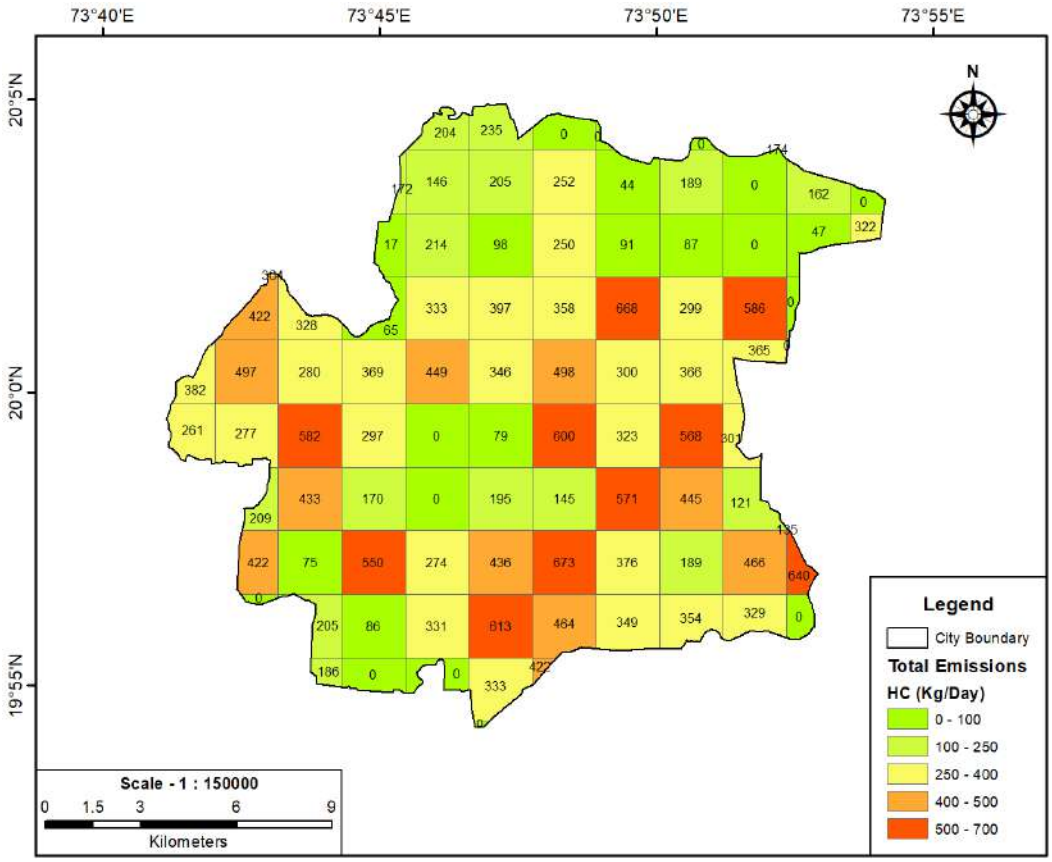

Figure 120: Total Gridded HC emission for Nashik City (Kg/day).

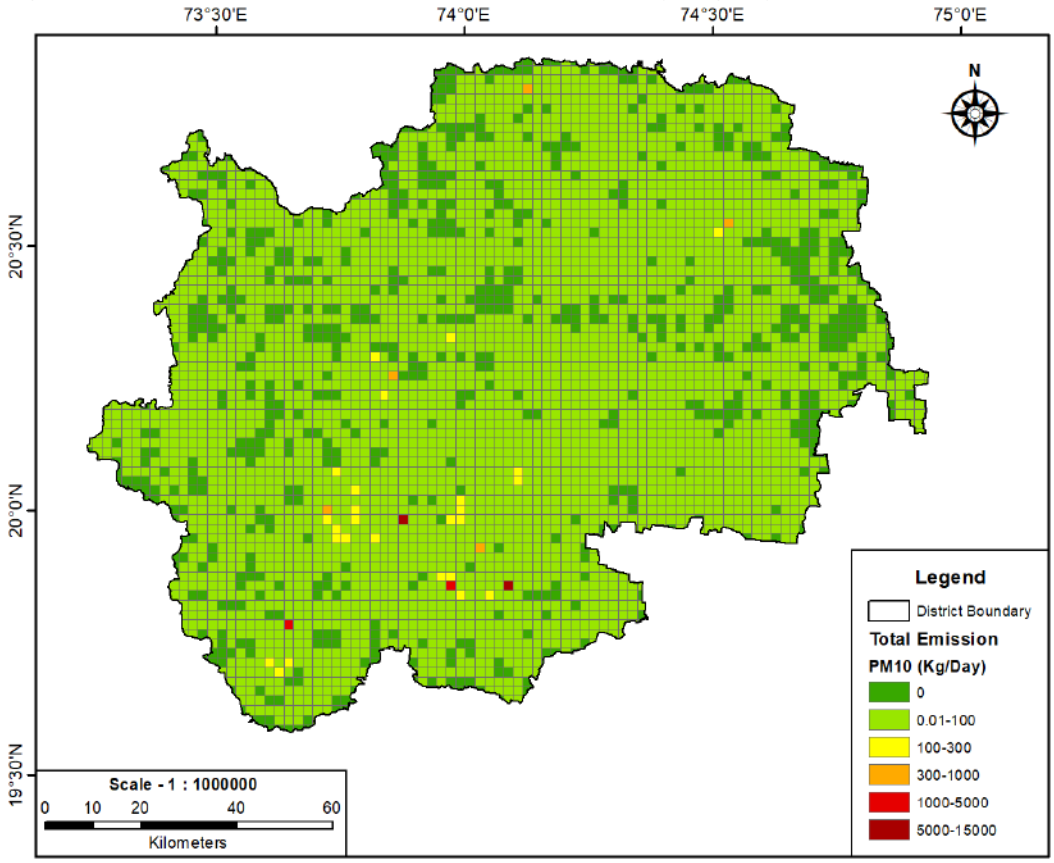

Figure 121: Total Gridded PM10 emission for Nashik District (Kg/Day).

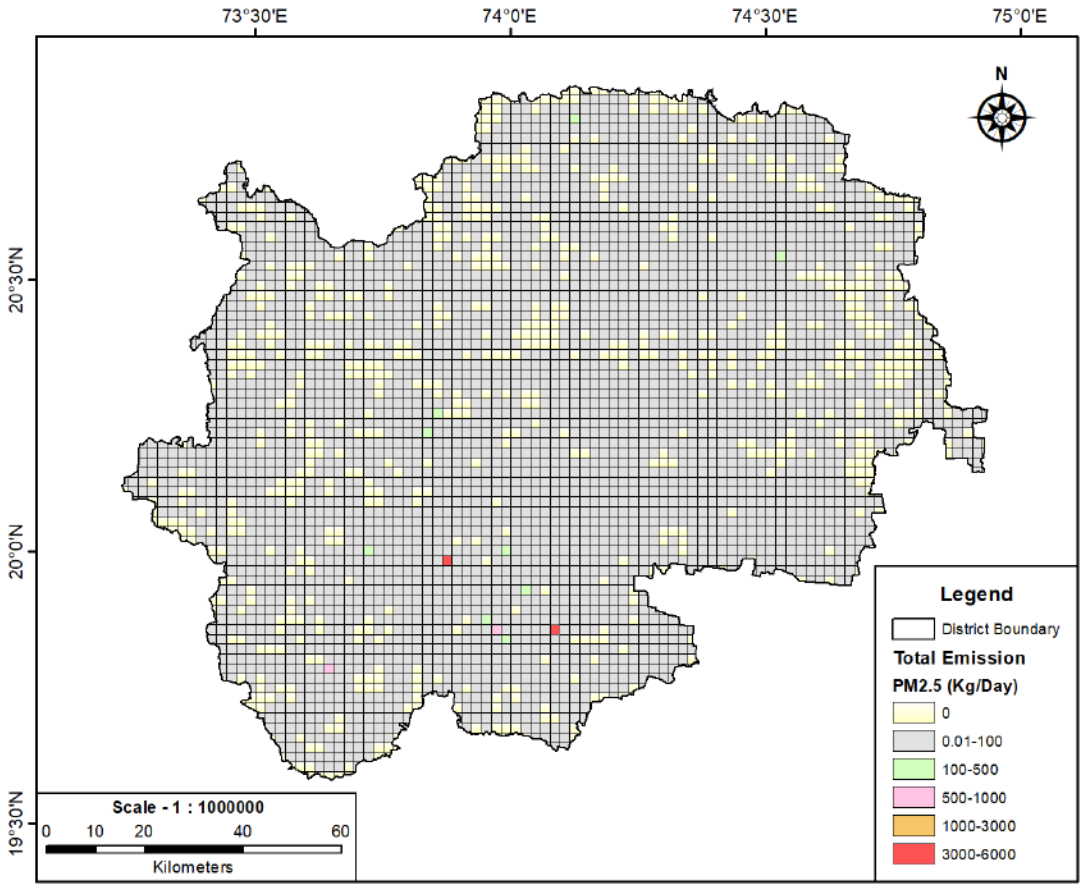

Figure 122: Total Gridded PM2.5 emission for Nashik District (Kg/day).

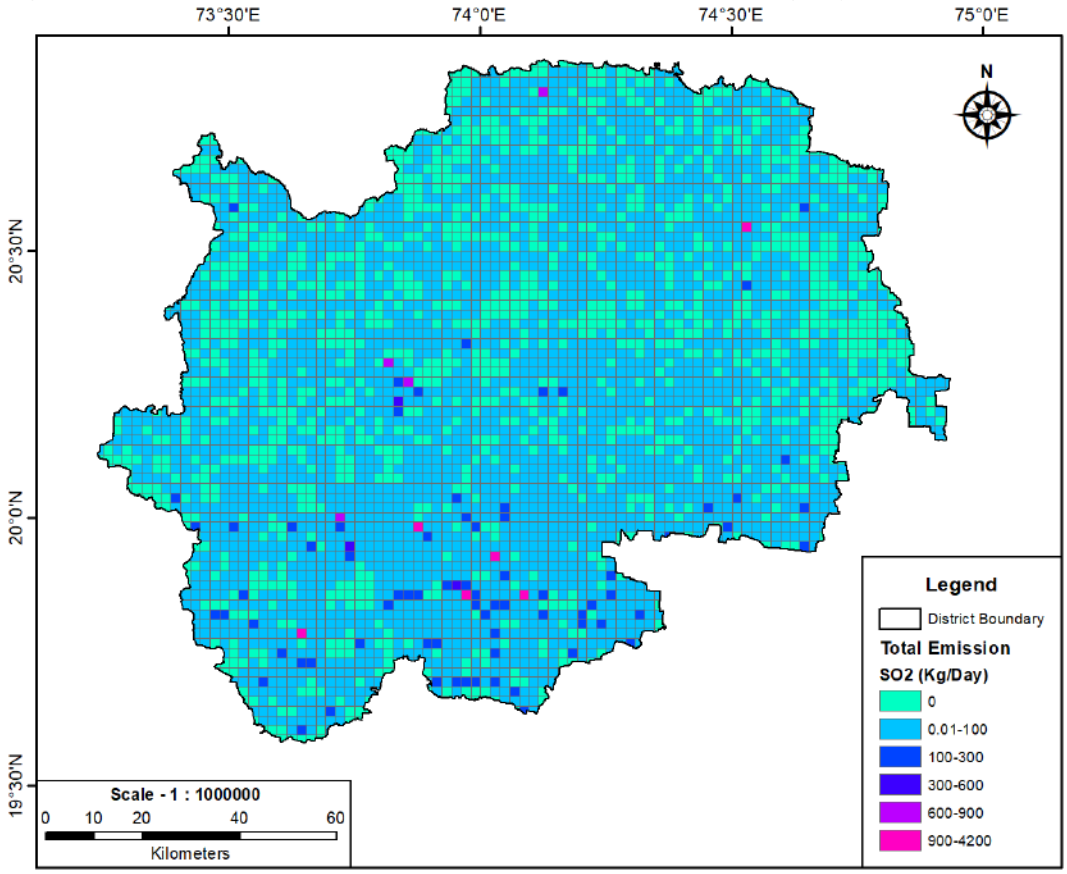

Figure 123: Total Gridded SO_2 emission for Nashik District (Kg/day).

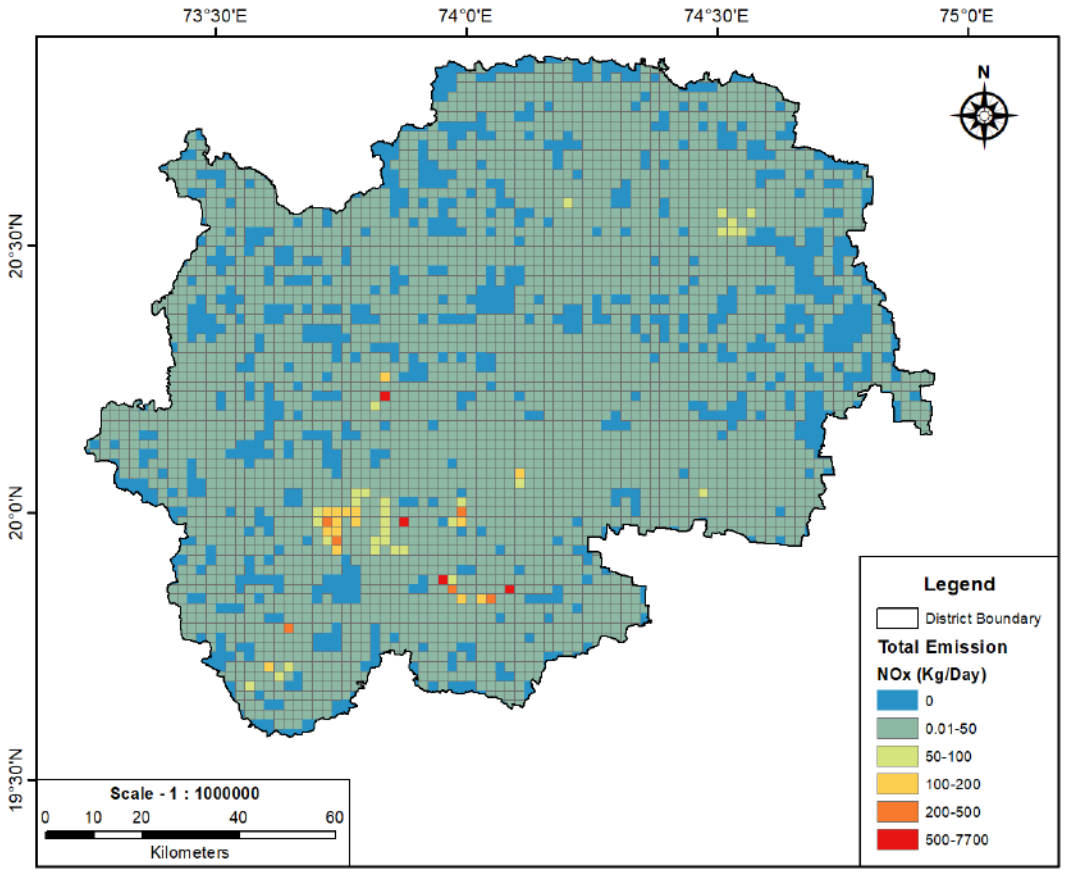

Figure 124: Total Gridded NOx emission for Nashik District (Kg/day).

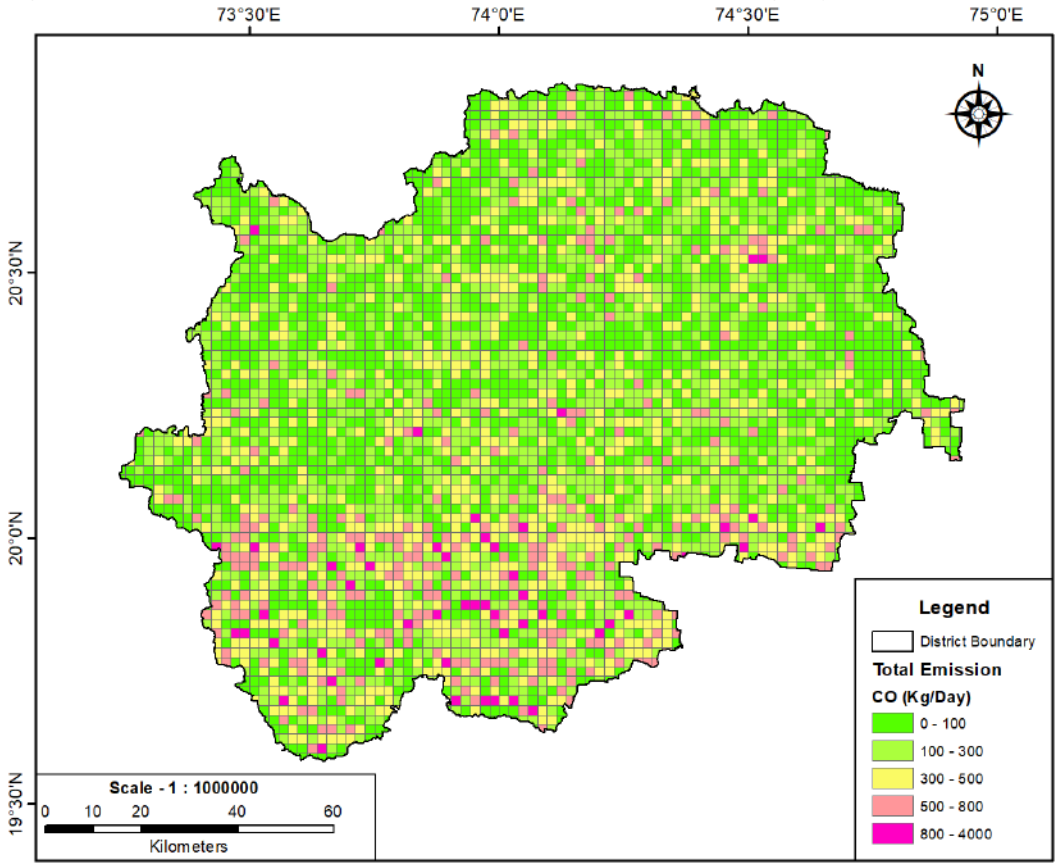

Figure 125: Total Gridded CO emission for Nashik District (Kg/day).

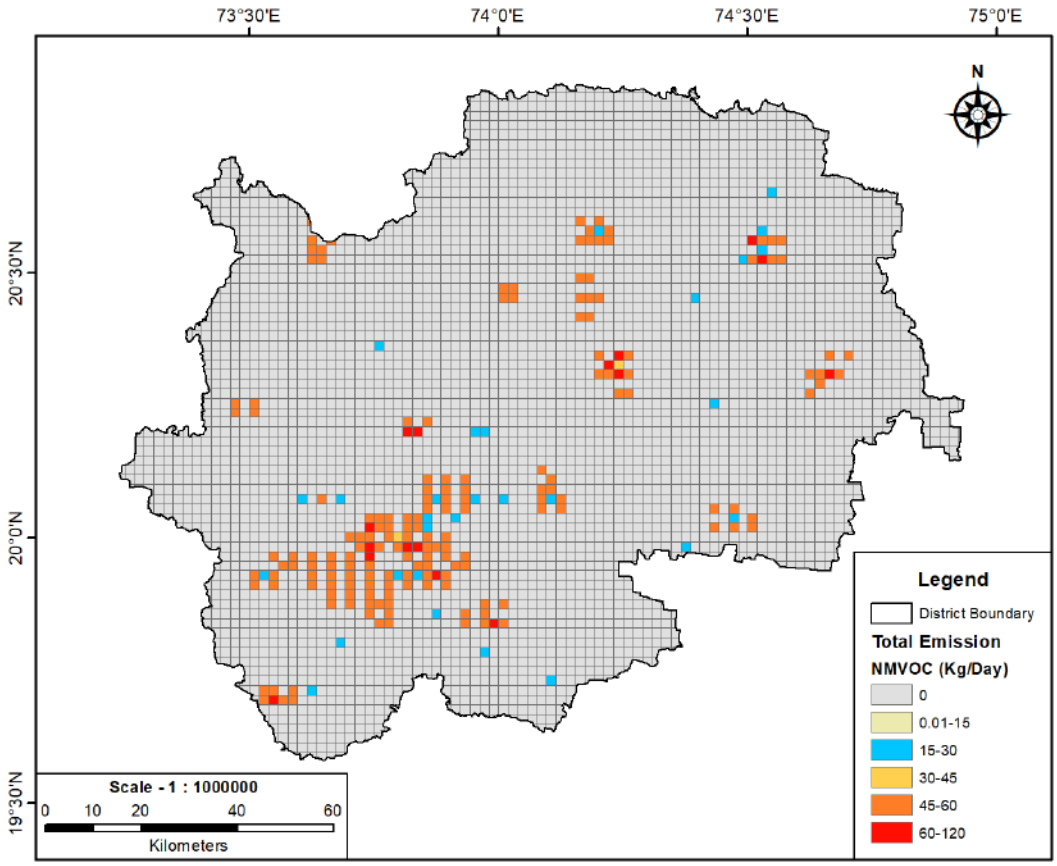

Figure 126: Total Gridded NMVOCs emission for Nashik District (Kg/Day).

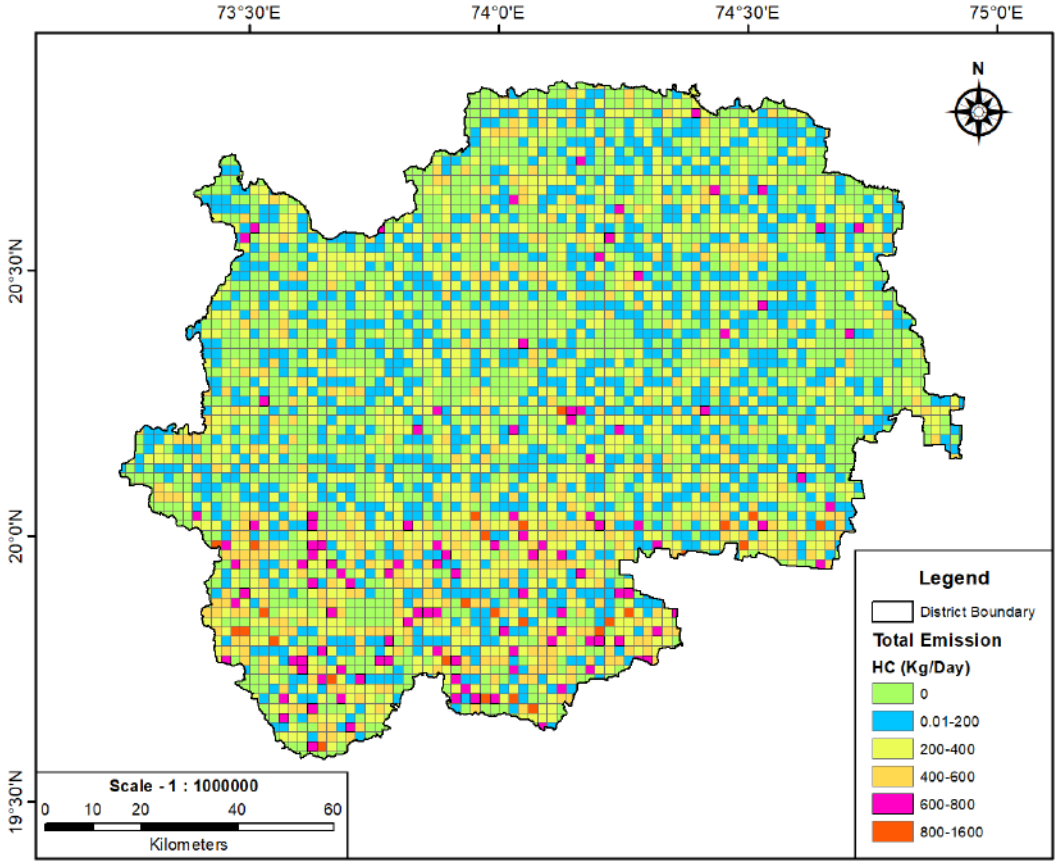

Figure 127: Total Gridded HC emission for Nashik District (Kg/day).

4.0 Reference

- Air quality monitoring emission inventory and SA studies report for Indian cities report by CPCB, Annexure VIII. Central Pollution Control Board, New Delhi.
- Report on Environmental status of Nashik region in Maharashtra; Maharashtra Pollution Control Board Kalpataru Point, Sion Circle, Sion (East) Mumbai.
- Revised action plan for control of air pollution in non-attainment cities of Maharashtra, Maharashtra pollution control board Kalpataru point, 3rd floor, Sion-Matunga scheme rd. No.8, Opp. Sion circle, Sion (East) Mumbai-400022
- Catalogue Indian Emission Inventory Report, Jan 2022, TERI, New Delhi.
- State of Clean Cooking Energy Access in India, Insights from the India Residential Energy Survey (IRES) report, Sept 2021.
- Energy Sources of Indian Households for Cooking and Lighting, National Sample Survey Office, Ministry of Statistics and Programme Implementation, Government of India (JULY 2009 – JUNE 2010), NSS 66th Round, September 2012.
- Report on Household Consumer Expenditure based on the Data of State, Volume I, Directorate of Economics and Statistics, Planning Department, Government of Maharashtra, Mumbai (2017-18).
- Census 2011 Report, Part A and Part B of Nashik District.

4.0 Annexure-I

भारतीय राष्ट्रीय राजमार्ग प्राधिकरण
(सड़क परिवहन और राजमार्ग मंत्रालय)
National Highways Authority of India
(Ministry of Road Transport & Highways)
Project Implementation Unit, Nashik
1st Floor, 'Kanstar' Apartment, B-Wing, S. No. 318/1/10,
Plot No. 1, Pathardi Phata, Nashik - 422 010 (MAHARASHTRA)
Tele/fax : 0253 - 2388810 e-mail : nashik@nhai.org

भारतमाला
BHARATMALA
प्रगति के पथ पर अग्रसर
ROAD TO PROSPERITY

No: NHAI/PIU/NSK 2021/1607 26th July, 2021

To,

Er. Rahul V. Vyawahare,
Scientist,
Air Pollution Control Division,
CSIR-NEERI, Nagpur
Email Id.: rv_vyawahare@neeri.res.in

Sub.: NHAI-PIU-NSK - Hourly Vehicular Traffic for Toll Plazas in Nashik District - Reg.

Ref.: Your Lr. No. APC/2021/Nashik_District/NHAI/01, Dtd. 30.06.2021.

Sir,

This has ref. to your letter cited at ref. above wherein you have sought Hourly Vehicular Traffic for Toll Plazas in Nashik District.

2. In this regard, it is inform that, Three Toll Plazas viz. Chandwad Toll Plaza, Pimpalgaon (Basarwant) Toll Plaza & Ghoti Toll Plaza fall on project stretches (in Nashik district) under the purview of this office. Based on traffic report for the month of June, 2021 submitted by Concessionaire/Tolling Agency, hourly vehicular traffic count for toll plazas under the purview of this office in Nashik District is tabulated as under:

Sr. No.	Month	Toll Plaza	Vehicle Category-Wise Hourly Traffic (No.s)					
			Car/Jeep/ Van/MV	LCV/LGV/ Mini Bus	2 axle	3 axle Commercial	4 to 6 axle	Over sized (7 axle)
1	June, 2021	Chandwad	261	22	62	19	66	0
2	June, 2021	Pimpalgaon (Baswant)	546	35	72	29	66	0
3	June, 2021	Ghoti	398	52	80	24	100	0

Thanking you,

Yours faithfully,

(B. S. Salunke)
GM (Tech.) & Project Director,
PIU-Nashik

Corp. Office : Plot No. G5 & G6 Sector - 10 Dwarka, New Delhi - 110075
Ph. : 91 - 11 - 25074100 / 25074200 Fax : 91 - 11 - 25080360 / 25080480 Ext. 2223 / 2318 / 3468 / 2553

नीरी NEERI