BEFORE THE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

ORIGINAL APPLICATION NO. 687/2023

IN THE MATTER OF:

AIR QUALITY INDEX IN VARIOUS CITIES & ORS.

INDEX

7.	A COPY OF THE SAID COMPLIANCE REPORT DATED 30.05.2025 IS BEING ANNEXED HEREWITH AS **ANNEXURE-5.**	

THROUGH COUNSEL

BHANWAR PAL SINGH JADON
COUNSEL FOR DISTRICT MAGISTRATE, FIROZABAD
bhanwar09jadon@gmail.com | 6375115224

DATE: 21.01.2026
PLACE: NOIDA

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,

PRINCIPAL BENCH, NEW DELHI

ORIGINAL APPLICATION NO. 687/2023

WITH

ORIGINAL APPLICATION NO. 1228/2024

WITH

ORIGINAL APPLICATION NO. 646/2024

NOTARIAL NOTARIAL NOTARIAL

IN THE MATTER OF:

AIR QUALITY INDEX IN VARIOUS CITIES & ORS.

RESPONSE ON BEHALF OF THE DISTRICT MAGISTRATE, FIROZABAD IN COMPLIANCE OF THE ORDER DT. 26.11.2025 PASSED BY THE HON'BLE NATIONAL GREEN TRIBUNAL

I, Ramesh Ranjan aged about 38 years S/o Mr. Nageshwar Prasad, presently posted as District Magistrate, Firozabad do hereby solemnly affirm and state on oath as under:

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S.No. 18
DATED 12/12/25
NOTARY, FIROZABAD

1. That I, the deponent in the above captioned matter am fully conversant with the facts of the case and is competent and authorized to swear the present affidavit.

NOTARY
Name Shyam Sunder
Sorry Adv.
Area Distt. Firozabad
Regn. No. 4490/07
GOVT. OF INDIA

2. That I state that the contents of the affidavit have been drafted by my counsel on my instructions and the contents of the same are true to my knowledge and nothing material has been concealed therefrom.

I. BACKGROUND OF THE MATTER

3. That this O.A was registered in *suo moto* exercise of powers on the basis of the Air Quality Bulletins of CPCB posted on their website in respect of Air Quality Index (AQI) for different cities from 20.10.2023 to 01.11.2023. The said reports show that there are various cities where the air quality index has dipped to "very poor" or even to "severe" stage.

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DATED 19.11.2025
NOTARY, FIROZABAD

4. That the above mentioned O.A was listed for hearing on 06.11.2025 wherein the Hon'ble Tribunal directed the Deponent to file their reply/response. The relevant portion of the order has been reproduced herein:

" 2. Learned Amicus Curiae is permitted to implead the above cities through their District Magistrates. Registry is directed to serve them. Let the cause title of the OA be amended. The newly added Respondents can file their response. Learned Amicus Curiea submits that a note along with the suggestions has been filed today.

NOTARY
Name Shyam Sunder
Adv.
Area Distt. Firozabad
Regn. No. 4290/07
GOVT. OF INDIA

3. Learned Amicus Curiae also submits that the concerned Respondents should reflect as to why airshed approach should not be adopted for all NCR State as has been adopted in the U.P. Learned Amicus Curiae has submitted that the regulatory agencies such as CAQM and CPCB are simply issuing the communications and letters and are not taking effective steps for ensuring remediation of the problem at the ground level to maintain ambient air quality. He submits that there is an emergent need to complete the source apportionment study in the non-attainment cities and prepare the city action plan for the improving of air quality in those cities."

II. COMPLIANCE UNDERTAKEN

That in reference to the order of the Hon'ble Tribunal, Deponent has asked the compliance report from Nagar Nigam, Firozabad vide letter dt.12.01.2026. A copy of same is annexed as ANNEXURE-A.

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NOTARY FIROZABAD

A. SOURCE APPORTIONMENT STUDY

5. It is submitted that Firozabad City has been identified as a Non- Attainment City under the National Clean Air Programme (NCAP). That to develop a scientifically robust and evidence based strategy for air pollution control, **An MoU was signed between Central Pollution Control Board (CPCB), U.P Pollution Control Board (UPPCB) and Municipal Corporation on**

NOTARY
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Adv.
Area Distt. Firozabad
Regn. No. 4890/07
GOVT. OF INDIA

28.12.2021 for a "Source Apportionment Study" (SAS) for Firozabad City. This study was conducted by the Indian Institute of Kanpur, which was completed on 06.10.2025 and is currently under peer review at government level and is expected to be completed by 28.02.2026.

A copy of the said SAS report dated 06.10.2025 is being annexed herewith as **ANNEXURE-1.**

6. **Air Quality Monitoring Data (Ambient Air Quality Monitoring Data, Details of CAAQM Stations): -** In the City Firozabad, 2 CAAQMS Online Monitoring Stations are installed and connected with the CPCB server. As per the baseline data 2019-2020 (PM-213kg/d), Firozabad city has achieved the target which was set by MoEF&CC (PM>40%).

7. It is submitted that the improvement in PM10 is approximately 52% till FY 2024-2025 and the PM10 is 103kg/d in the FY 2024-2025.The number of good days in the FY 2024-2025 (April - December) are 262 days in observed 265 days and in the FY 2025-2026 (April - December) are 266 days in observed day 266 days. Air Quality Monitoring Data table is below.

YEAR	ANNUAL AVERAGE PM10
2019-2020	213
2020-2021	186
2021-2022	137
2022-2023	106
2023-2024	102
2024-2025	102

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19/01/2026

8. The details of the 2 existing CAAQM stations are as follows:

STATION NAME	STATION CO-ORDINATE	YEAR OF ESTABLISHMENT
Nagla Bhau	27.169739,78.378121	2021
Vaibhav Nagar	27.159879, 78.395541	2022

9. It is further submitted that 01 additional CAAQMS is under process of installation at UPSIDA, Industrial Area, Jalesar Road, Firozabad.

NOTARY
Name Shyam Sunder
Area Dist Firozabad
Regn. No. 4890/07
GOVT. OF INDIA

B. AIRSHED APPROACH

10. U.P Government has approved U.P Clean Air Management Project vide order dated 08.11.2024 for year 2024-2025 to 2029-2030 of Rs.274153.04 Lac with the finance of world bank for including Airshed of whole state of U.P and Indo-Gangetic plain. A copy of the same is annexed as **ANNEXURE-2** Further U.P Clean Air Management Authority has also been formulated vide office order dated 12.12.2024. A copy of the same is annexed as **ANNEXURE-3.**

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NOTARY PUBLIC

C. STACK EMMISSION REPORT

11. As per Source Apportionment Study (SAS), in the limit of City Firozabad, there are approximately 153 units with boilers and furnaces (electric and melting furnaces) that contribute to particulate matter and gaseous emissions. The industries are categorized based on stack heights as an area source (stack height <15m) and as a point source (stack height>15m).

12. That further, all these industries are based on natural gas as fuel. The emission load per day from the all kind of industries which are operating on natural gas are contributing to air pollution like as PM10-137kg/d, PM2.5-137kg/d, SO2-1063kg/d, NOx-2545kg/d and CO-1527kg/d.

NOTARY
Name Shyam Sunder
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Area Distt. Firozabad
Regn. No. 1890/07
GOVT. OF INDIA

D. FUNDS RECEIVED AND UTILISATION REPORTS

YEAR	NCAP FUNDS RELEASED (IN CRORES)	NCAP FUNDS RECIEPT BY CITY	NCAP FUNDS UTILISED
2019-2020	0.20	0.20	0
2020-2021	1.90	1.90	0.008
2021-2022	0	0	0
2022-2023	18.83	18.83	1.65
2023-2024	26.85	26.85	21.34
2024-2025	26.25		23.15
2025-2026	0	26.25	14.45
		TOTAL	**278.7**
		PERCENTAGE UTILIZATION	**82%**
74.03		**74.03**	**60.57**

Copies of the Utilization Certificates of each year from 2019 to 2025 along with the details of works sanctioned year wise are being annexed herewith as **ANNEXURE-4.**

NOTARY
Name Shyam Sunder
Adv.
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E. TTZ MEASURES UNDERTAKEN

13. That the Assistant Municipal Commissioner, Municipal Corporation, Firozabad vide letter dated 30.05.2025 has informed the Vice Chairman, Agra Development Authority the compliance report of the minutes of the 63rd meeting of the Taj Trapezium Zone Pollution.

14. It is submitted that in the said compliance report, the following compliances have been undertaken:

i. As per Government Order No. 390/TTZ (PMU)/NOTICE (SEC.5)/18, under letter No. 755/SA.PRA./2020 dated 13.05.2020 issued by the Assistant Divisional Transport Officer, Firozabad, only BS-VI category CNG/LNG vehicles with a laden weight below 3000 kg have been procured. In compliance thereof, within the Taj Trapezium Zone, 130 small CNG-operated vehicles have been purchased by the Municipal Corporation, Firozabad for door-to-door solid waste collection.

ii. Within the limits of the Municipal Corporation, Firozabad, the work of the electric crematorium at Chharbagh near Swargashram has been completed. Further, under the NCAP, the gas-based crematorium at Satya Nagar, Tapa Kalan on Bamba Bypass Road has been completed up to 90%, and the remaining work is in progress. The work shall be

NOTARY Name Shyam Sunder Adv. Area Distt. Firozabad Regn. No. 4890/07 GOVT. OF INDIA

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completed shortly. The operation of the gas-based crematorium has been initiated during the winter season.

iii. An amount of ₹5,97,000.00 has been recovered as a penalty and ₹18,26,450.00 as debris charges from registered contractors of the Construction Department of the Municipal Corporation, Firozabad, for non-compliance with the C&D Waste Management Rules, 2016.

iv. Within the limits of the Municipal Corporation, Firozabad, the work of the electric crematorium at Chharbagh Swargashram has been completed, and under the National Clean Air Programme, a gas-based crematorium is under construction at Satya Nagar, Tapakalan on Bamba Bypass Road.

v. The Health Department of the Municipal Corporation, Firozabad is carrying out cleaning of dust from roadside berms along approximately 60 km of roads with the help of two mechanized sweeping machines. In addition, manual sweeping of the roadside berms is also undertaken. To prevent dust from becoming airborne, water sprinkling is carried out with the help of sprinkler machines.

NOTARY
Name Shyam Sunder
Area Distt. Firozabad
Regn. No. 4890/07
GOVT. OF INDIA

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NOTARY, FIROZABAD

vi. During the financial year 2024–25, the Construction Department of the Municipal Corporation, Firozabad, under the National Clean Air Programme, prepared a work plan for a total of 58 works within the municipal limits, including end-to-end pavement roads, construction of roads on earthen roads, road resurfacing for dust mitigation, green space development, and Miyawaki plantations, involving a total proposed amount of ₹32,86,41,869.

A copy of the said compliance report dated 30.05.2025 is being annexed herewith as **ANNEXURE-5.**

15. That Firozabad City falls under TTZ area. As per orders of Hon'ble Supreme Court, all the industries have been converted on natural gas as fuel. Besides this15 brick kilns are operational on zig-zag/high draught technology in the TTZ Area. At present No any kind of new industries or expansion of existing industries is being permitted in TTZ Area of Firozabad.

16. That No tree felling is allowed in the TTZ Area, Firozabad without the leave of Hon'ble Supreme Court.

17. That the deponent is fully committed to ensure strict adherence to the orders of this Hon'ble Tribunal and undertakes to faithfully comply with any further directions or instructions that may be issued by this Hon'ble Tribunal without demur or delay.

NOTARY GOVT. OF INDIA
Name Shyam Sunder Son of Adv. Area Distt. Firozabad Regn. No. 4890/07

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DATED 19/11/2025
NOTARY, FIROZABAD

18. Hence, this reply is respectfully submitted for kind perusal of this Hon'ble Tribunal.

19. That everything stated above is true and correct to my knowledge, derived from official records, and nothing material has been concealed therefrom.

DEPONENT

VERIFICATION

Verified at _____ on this ____ day of January, 2026, that the contents of the above affidavit from paragraphs 1 to ___ are true and correct to the best of my knowledge and belief. No part of it is false and nothing material has been concealed therefrom.

DEPONENT

NOTARY
Name Shyam Sunder Sony Adv.
Area Distt. Firozabad
Regn. No. 4490/07
GOVT. OF INDIA

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DATED 19/01/2026
NOTARY FIROZABAD

S.No. 10 .Dated. 19/01/2026
Shri..... Ramesh Ranjan
Identified by Shri.....
Solemnly Consents There
before In my office
Received Rs. as my fee
Shyam Sunder Sony Advocate Firozabad
NOTARY FIROZABAD
19/01/2026.

8131

प्रेषक,

जिलाधिकारी,
फिरोजाबाद।

ANNEXURE- A

सेवा में,

नगर आयुक्त,
नगर निगम,
फिरोजाबाद।

पत्रांक– 771/NGT–687/2026 दिनांक– 12-01-2026

विषय– मा0 राष्ट्रीय हरित अधिकरण, नई दिल्ली में विचाराधीन Original Application No. 687/2023 Air Quality Index in various Cities WITH original Application No. 1228/2024 News Item titled "Lanct study links alarming mortality rates to poor air quality 12 strategies to combat country's air pollution crisis" appearing in the Indian Express dated 13.09.2024 WITH Original Application No. 646/2024 News Item titled "How Partial Combustion Fuels Your Bad-Air Woes" appearing in the Times of India dated 02.05.2024 में पारित मा0 अधिकरण के आदेश दिनांक– 06.11.2025 के सम्बन्ध में।

महोदय,

उपरोक्त विषयक उ0प्र0 शासन के पत्र संख्या– एन0जी0टी0–867/81–7–2025–1761548 दिनांक– 17 नवम्बर, 2025 का संदर्भ लेना चाहें, जिसमें उल्लिखित किया गया है कि मा0 राष्ट्रीय हरित अधिकरण, नई दिल्ली में विचाराधीन Original Application No. 687/2023 Air Quality Index in various Cities WITH original Application No. 1228/2024 News Item titled "Lanct study links alarming mortality rates to poor air quality 12 strategies to combat country's air poolution crisis" appearing in the Indian Express dated 13.09.2024 WITH Original Application No. 646/2024 News Item titled "How Partial Combustion Fuels Your Bad-Air Woes" appearing in the Times of India dated 02.05.2024 में पारित मा0 अधिकरण के आदेश दिनांक– 06.11.2025 का अवलोकन करें, जिसके संसुगत अंश निम्नवत् है :–

"…….2. Learned Amicus Curiae is permitted to implead the above cities through their District Magistrates. Registry is directed to serve them. Let the cause title of the OA be amended. The newly added Respondents can file their response. Learned Amicus Curiea submits that a note along with the suggestions has been filed today. The Registry is directed to place it on record. Respondents are directed to consider those suggestions and act upon them if there is no difficulty and file response to them atleast three days before the next date of hearing. 3. Learned Amicus Curiae also submits that the concerned Respondents should reflect as to why airshed approach should not be adopted for all NCR State as has been adopted in the U.P. Learned Amicus Curiae has submitted that the regulatory agencies such as CAQM and CPCB are simply issuing the communications and letters and are not taking effective steps for ensuring remediation of the problem at the ground level to maintain ambient air quality. He submits that there is an emergent need to complete the source apportionment study in the non-attainment cities and prepare the city action plan for the improving of air quality in those cities……" इस सम्बन्ध में प्राप्त Adv. Gargi Chaturvedi From the Offices of Bhanwar Pal Singh Jadon Standing Counsel for the State of U.P. National Green Tribunal New Delhi के ई–मेल पत्र दिनांक– 13.11.2025 द्वारा अवगत कराया गया है कि प्रश्नगत प्रकरण में मा0 अधिकरण वायु गुणवत्त सूचकांक

क्रमश.....2...

(Air Quality Index) के आधार पर देशभर के विभिन्न शहरों में गिरती हुई वायु गुणवत्ता से सम्बन्धित मुद्दे पर विचार कर रहा है। मा0 अधिकरण द्वारा पारित आदेश दिनांक– 06.11.2025 के माध्यम से ओ0ए0 संख्या– 687/2023 में non-attaining cities को उनके सम्बन्धित जिलाधिकारियों के माध्यम से पक्षकार (implead) बनाया है। इस क्रम में उत्तर प्रदेश राज्य के 1– आगरा, 2– प्रयागराज, 3– सोनभद्र (अनपरा), 4– बरेली, 5– फिरोजाबाद, 6– अमरोहा (गजरौला), 7– कानपुर, 8– मुरादाबाद, 9– रायबरेली, 10– वाराणसी, 11– गोरखपुर एवं 12– मेरठ जनपद के जिलाधिकारियों को वर्तमान कार्यवाही में पक्षकार बनाया गया है।

प्रकरण में आगामी तिथि 20.01.2026 नियत है।

अतः उपरोक्त सम्बन्ध में श्री भंवर पाल सिंह जादौन, स्टेन्डिंग काउसिंल (एन0जी0टी0) से सम्पर्क करते हुये एवं उ0प्र0 प्रदूषण नियन्त्रण बोर्ड, फिरोजाबाद के सहयोग से वांछित सूचना अधोहस्ताक्षरी को प्रस्तुत करते हुये आगामी तिथि से पूर्व मा0 एन0जी0टी0 के समक्ष प्रतिशपथपत्र दाखिल कराये जाने का कष्ट करें।

संलग्नकः–यथोक्त।

12/1/26

(रमेश रंजन)
जिलाधिकारी
फिरोजाबाद

प्रतिलिपि–

1. प्रमुख सचिव, पर्यावरण, वन एवं जलवायु परिवर्तन विभाग, उ0प्र0 शासन को सादर सूचनार्थ।
2. विशेष सचिव, नगर विकास विभाग, उ0प्र0 शासन को सूचनार्थ।
3. क्षेत्रीय अधिकारी, उ0प्र0 प्रदूषण नियन्त्रण बोर्ड, फिरोजाबाद को इस निर्देश के साथ कि नगर निगम, फिरोजाबाद से समन्वय स्थापित करते हुये उपरोक्तानुसार कार्यवाही सुनिश्चित करायें।

जिलाधिकारी
फिरोजाबाद

8133

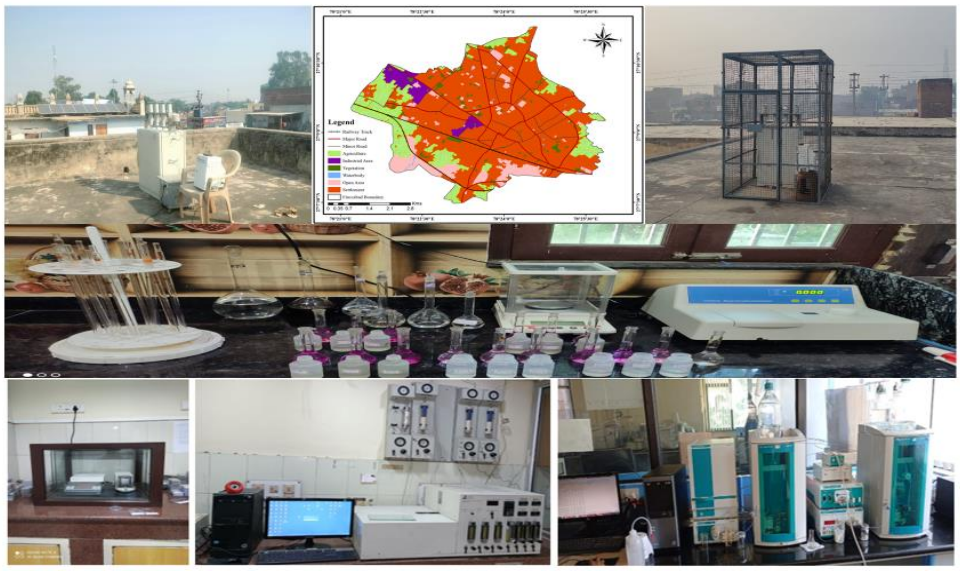
ANNEXURE 1

Comprehensive Source Apportionment, Emission Inventory and Carrying Capacity for the City of Firozabad, U.P.

Final Report

Submitted to

Uttar Pradesh Pollution Control Board (UPPCB), Lucknow



Mukesh Sharma, PhD and Pavan K. Nagar, PhD

Department of Civil Engineering

Centre for Environmental Science and Engineering

Indian Institute of Technology Kanpur, Kanpur- 208016

October 2025

Disclaimer

This document is intended as the official report by Indian Institute of Technology (IIT), Kanpur on 'Comprehensive Source Apportionment, Emission Inventory and Carrying Capacity for Firozabad U.P.' submitted to the Uttar Pradesh Pollution Control Board (UPPCB), Lucknow. While every effort has been made to ensure the correctness of data/information used in this Report, IIT Kanpur does not accept any legal liability for the accuracy, or inferences drawn from the material contained therein or for any consequences arising from the use of this material. No part of this report may be reproduced in any form (electronic or mechanical) without prior permission from or intimation to the authors. No part of this report can be used for any scientific publications in any journal, conferences, seminars, workshops, etc., without written permission from the authors.
The full Report should be referenced as follows:

Sharma M and Nagar P K (2025) "Comprehensive Source Apportionment, Emission Inventory and Carrying Capacity for Firozabad U.P." IIT Kanpur, Final Report Submitted to Uttar Pradesh Pollution Control Board (UPPCB), Lucknow.

Text from this Report can be quoted provided the source is acknowledged.

Executive Summary

Since the enactment of the Air Act 1981, air pollution control programs have focused on point and area source emissions, and many communities have benefited from these control programs. Nonetheless, most cities in the country still face continuing particulate non-attainment problems from aerosols of unknown origin (or those not considered for pollution control) despite the high level of control applied to many point sources.

To address the air pollution issues of Firozabad city, the Uttar Pradesh Pollution Control Board (UPPCB), Lucknow has sponsored the study "Comprehensive Source Apportionment, Emission Inventory and Carrying Capacity study for Firozabad U.P." to the Indian Institute of Technology Kanpur (IITK) through letter No. H62009/CL/413/SAS/CC/2021, dated 27.05.2021. The main objectives of the study are preparation of emission inventory, air quality monitoring in two seasons, chemical composition of PM_{10} and $PM_{2.5}$, apportionment of sources to ambient air quality and development of pollution control plan. The project has the following specific major objectives, amongst many others specified in detail in Chapter 1:

- Identify and inventories emission sources (industry, traffic, power plants, local power generation, small scale industries, etc.) in Firozabad city.
- Measure and chemically speciate particulate matter (PM) and other air pollutants.
- Perform receptor modelling to establish the source-receptor linkages for PM in ambient air.
- Identify various control options and assess their efficacies for air quality improvements and development of control scenarios consisting of combinations of several control options.
- Select best control options from the developed control scenarios and recommend implementation of control options in a time-bound manner.
- Assess atmospheric carrying capacity

This study has five major components (i) air quality measurements, (ii) emission inventory, (iii) air quality modelling, (iv) control options and (v) action plan and atmospheric carrying capacity. The highlights of these components are presented below.

Air Quality: Measurements

A total of four air quality sites were selected and categorized based on the predominant land-use pattern (Table 1) to cover varying land-use prevailing in the city. PM_{10} (particulate matter

of size less than and equal to 10 µm diameter), $PM_{2.5}$ (particulate matter of size less than and equal to 2.5 µm diameter), SO_2, NO_2, VOCs (volatile organic compounds), OC (organic carbon), EC (elemental carbon), Ions, Elements, PAHs (polyaromatic hydrocarbons) and molecular markers were considered for sampling and measurements. The air quality sampling was conducted for two seasons: winter and summer.

Table 1: Description of Sampling Sites of Firozabad

S. No.	Sampling Site	Site Code	Latitude/ longitude	Land-use	Type of Sources
1.	Jain Mandir, Firozabad	**JMDF**	27.16°N, 78.40°E	Commercial	DG sets, vehicle, road dust, garbage/waste burning, Restaurants
2.	Gopinath College Rasulpur, Firozabad	**GCRF**	27.14°N, 78.40°E	Residential	Domestic cooking, vehicle, road dust, garbage/MSW burning, Restaurants
3.	St. Jhon Industrial, Firozabad	**SJIF**	27.17°N, 78.37°E	Industrial	Industries, DG sets, vehicle, road dust, garbage/industrial waste burning, Restaurants
4.	Gauri Shankar Kotla, Firozabad	**GSKF**	27.17°N, 78.41°E	Residential	Domestic cooking, vehicle, road dust, garbage/MSW burning, Industrial

Based on the air quality measurements in summer and winter months and critical analyses of air quality data (Chapter 2), the following inferences and insights are drawn for understanding the status of air quality. Season-wise, site-specific average air concentrations of PM_{10}, $PM_{2.5}$ and their compositions have been referred to bring the important inferences to the fore.

- Particulate pollution is the main concern in the city where PM_{10} levels are 1.4 – 3.6 times higher than the NAAQS (National Ambient Air Quality Standards) in summer – winter months and $PM_{2.5}$ levels are 1.0 – 4.7 times higher than the NAAQS in summer – winter months. However, $PM_{2.5}$ meets the NAAQS at most sites in summer season.

- The chemical composition of PM_{10} and $PM_{2.5}$ carries the signature of sources and their harmful contents. The chemical composition is variable depending on the size fraction of particles and the season. The PM levels and chemical composition are discussed separately for two seasons.

Winter - PM_{10}

The overall average concentration of PM_{10} in winter season is 378±36 µg/m^3 against the acceptable NAAQS level of 100 µg/m^3. Highest levels were observed at GCRF (residential) and lowest at GSKF (residential).

The crustal component (Si + Al + Fe + Ca) accounts for about 22% of PM10 (slightly less compared to 25% in summer). This suggests soil and road dust contribution has reduced in PM_{10} in winter. The coefficient of variation (CV) is about 0.14 (of fraction of crustal component) which suggests the crustal sources contribute consistently to winter levels, though less compared to summer season.

The other important component is the secondary particles (NO_3^- + SO_4^{-2} + NH_4^+), which account for about 16% of total PM_{10} and combustion related total carbon (TC = EC + OC) accounts for about 20%; both fractions of secondary particles and combustion related carbons have increased in winter and account for 36% of PM_{10}.

The Cl^- content in PM_{10} in winter is not consistent and varies between 2 - 5 percent, which is an indicator of burning of municipal and plastic solid waste (MSW); poly vinyl chloride (PVC) is a major part of MSW. The highest Cl^- content is observed at GCRF at 18.15 µg/m^3 compared to overall city level of 14.7 µg/m^3. The high level at GCRF signifies some local burning of waste either in industrial processes or as a means of disposal of solid waste.

Winter - $PM_{2.5}$

The overall average concentration of $PM_{2.5}$ in winter is 283±28 µg/m^3 against the acceptable level of 60 µg/m^3. The highest levels are observed at GCRF 318±70 µg/m^3 and lowest at JMDF 253±64 µg/m^3. This signifies high levels of PM2.5 all over the city.

The secondary particles (NO_3^- + SO_4^{-2} + NH_4^+) account for 17% of total $PM_{2.5}$ and combustion related total carbon (TC = EC+OC) accounts for 20%; both secondary particles and combustion related carbon are consistent contributors to $PM_{2.5}$ at about 37%. Highest level of TC was observed at GCRF at 61.9 µg/m^3.

The Cl^- content in $PM_{2.5}$ winter is not consistent and varies between 2 – 5 percent which is an indicator of burning of municipal solid waste (MSW), which varies from one day to another.

Summer - PM_{10}

The overall average concentration of PM_{10} in summer season was 138±21 $\mu g/m^3$ against the acceptable level of 100 $\mu g/m^3$.

The crustal component (Si + Al + Fe + Ca) accounts for about 24 percent of total PM_{10} in summer. This suggests airborne soil and road dust are the major sources of PM_{10} pollution in summer. The coefficient of variation (CV) is about 0.25, which suggests the sources are consistent all around the city forming a layer which envelopes the city. The areas of SJIF and JMDF have the highest crustal fraction (around 25-27% of total PM_{10}). It is difficult to pinpoint the crustal sources as these are widespread and present all around in Firozabad and are more prominent in summer when soil and dust are dry and high-speed winds make the particles airborne. It was observed that in summer the atmosphere looks light brownish which can be attributed to the presence of large amounts of soil dust particles in the atmosphere.

The second significant component is the secondary particles ($NO_3^- + SO_4^{-2} + NH_4^+$), which account for 10 percent of total PM_{10} and combustion related total carbon (EC+OC) accounts for about 16 percent. The secondary particles are formed in the atmosphere because of reaction of precursor gases (SO_2, NO_x and NH_3) to form NO_3^-, SO_4^{-2}, and NH_4^+. The combustion related contribution is relatively less in PM_{10} in summer.

The Cl^- content in PM_{10} in summer is inconsistent at 4-8 percent, which is an indicator of burning of municipal solid waste (MSW) and has a higher contribution in summer than winter.

Summer - $PM_{2.5}$

The overall average concentration of $PM_{2.5}$ in summer season is 61±4 $\mu g/m^3$ generally within the acceptable level of 60 $\mu g/m^3$.

The crustal component (Si + Al + Fe + Ca) accounts for about 15% of total $PM_{2.5}$. This suggests airborne soil and road dust is a significant source of $PM_{2.5}$ pollution in summer. The CV is about 0.03, which suggests the source is consistent all around the city.

The second important component is combustion related total carbon (EC+OC), which account for 25% of total $PM_{2.5}$ and secondary particles ($NO_3^- + SO_4^{-2} + NH_4^+$) accounts for 13%; both fractions of secondary particles and combustion related carbons account for a larger fraction in $PM_{2.5}$ than in PM_{10}. All three potential sources, crustal component, secondary particles and combustion contribute consistently to $PM_{2.5}$ in summer.

The Cl^- content in $PM_{2.5}$ in summer is inconsistent at 6-8 percent which is an indicator of burning of municipal solid waste (MSW) and has a similar contribution to $PM_{2.5}$ and PM_{10}. This is relatively lower in summer than in winter.

Potassium levels

In general potassium levels are moderate but consistent in PM_{10} both in summer and winter (1.02 to 3.63 $\mu g/m^3$) and also in $PM_{2.5}$ (1.66 to 2.59 $\mu g/m^3$). In general potassium level in urban areas is less than 1.0 $\mu g/m^3$. Potassium is an indicator of biomass burning and high levels and variability (CV ~ 0.30) show significant biomass burning in summer and winter.

NO_2 levels

NO_2 levels in winter are higher than those in summer at all sites and the levels meet the national air quality standard of 80 $\mu g/m^3$. The highest NO_2 levels were at JMDF (56.86 $\mu g/m^3$), a commercial site. In addition, high levels of NO_2 are expected to undergo chemical transformation to form fine secondary particles in the form of nitrates, adding to high levels of existing PM_{10} and $PM_{2.5}$. SO_2 levels in the city were well within the air quality standard.

General inferences

Levels of $PM_{2.5}$ and NO_2 are statistically higher (at all locations) in winter months than in summer months by about 42-60%. In general air pollution levels in ambient air (barring traffic intersections, which has even higher pollution) are uniform across the city

suggesting entire city is stressed under high pollution; in a relative sense, GCRF is most polluted followed by SJIF and JMDF.

It is to be noted that OC3/TC ratio is above 0.20 and highest among ratio of fraction of OC to TC. It suggests a significant component of secondary organic aerosol is formed in atmosphere due to condensation and nucleation of volatile to semi volatile organic compounds, which suggests emissions within and outside of Firozabad.

Total PAH levels (17 compounds; particulate phase) in winter is very high at 87 ng/m^3; However, PAH levels in summer drop significantly to 33 ng/m^3. The highest PAH levels observed at GCRF in winter (99 ng/m^3) and in summer (39 ng/m^3).

The concentrations of molecular markers in $PM_{2.5}$ (total of 6 compounds) are also higher in winter (233 ng/m^3) than in summer (71 ng/m^3) indicating presence of common sources of emissions from coal, gasoline and domestic fuel.

The total BTX levels are higher in winter (7.4 µg/m^3) than in summer (5.12 µg/m^3). Although the emission rate is expected to be high in summer due to higher temperature, the concentration is low due to better dispersion and large ventilation coefficient. The benzene did not exceed the annual national standard (5 µg/m^3).

In a broad sense, air is more toxic in winter than in summer as it contains much larger contribution of combustion products in winter than in summer months.

In a broad sense, fractions of secondary particles of both PM_{10} and $PM_{2.5}$ in two seasons were consistent and needed to be controlled for better air quality in Firozabad. Combustion sources, vehicles, coal, biomass burning and MSW burning are other consistent sources in winter and require a strategy to control these sources. In summer, air quality cannot be improved unless we find effective control solutions for soil and road dust, fly ash re-suspension. Possible effective combination of control options is discussed in Chapter 6.

Emission Inventory

The overall baseline emission inventory for the entire Firozabad is presented in Table 2. The pollutant-wise contribution is shown in Figure 1 to Figure 5. The spatial distribution of pollutant emissions from all sources is illustrated in Figure 6 to Figure 10.

Table 2: Firozabad city-level inventory (kg/d)

Sources	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO
Brick Kilns	164	115	213	64	408
Domestic	743	561	144	425	3157
MSW Burning	75	51	5	28	396
Hotels, Restaurants, GHs and BHs	186	97	123	68	326
Construction and Demolition	35	8			
Industrial DG Sets	0.2	0.1	0.1	2.2	0.5
Hospitals	0.04	0.03	0.03	0.53	0.11
Industries	137	137	1063	2545	1527
Vehicle	612	551	1	4582	5755
Road Dust	12735	2907			
Total	**14687**	**4427**	**1549**	**7717**	**11569**

The total PM_{10} emission load in the city is estimated to be 14687 kg/d. The top three contributors to PM_{10} emissions are Road Dust (87%), Domestic (5%), and Vehicles (4%); these are based on annual emissions. Seasonal and daily emissions could be highly variable. The estimated emission suggests that there are many important sources and a composite emission abatement including most of the sources was required to obtain the desired air quality.

$PM_{2.5}$ emission load in the city is estimated to be 4427 kg/d. The top three contributors to $PM_{2.5}$ emissions are Road Dust (66%), Domestic (13%) and Vehicles (12%); these are based on annual emissions. Seasonal and daily emissions could be highly variable.

SO_2 emission load in the city is estimated to be 1549 kg/d. Industries (69%), and Brick Kiln (14%) are the main sources of SO_2 contribution.

NO_x emissions load in the city is estimated to be 7717 kg/d. The major contributors to NO_x emissions vehicle (59%), Industries (33%), and Domestic (6%).

The estimated CO emission is about 11569 kg/day. The major contributors to CO emissions are Vehicles (50%), Domestic (27%), Industries (13%), and Brick Kilns (4%).

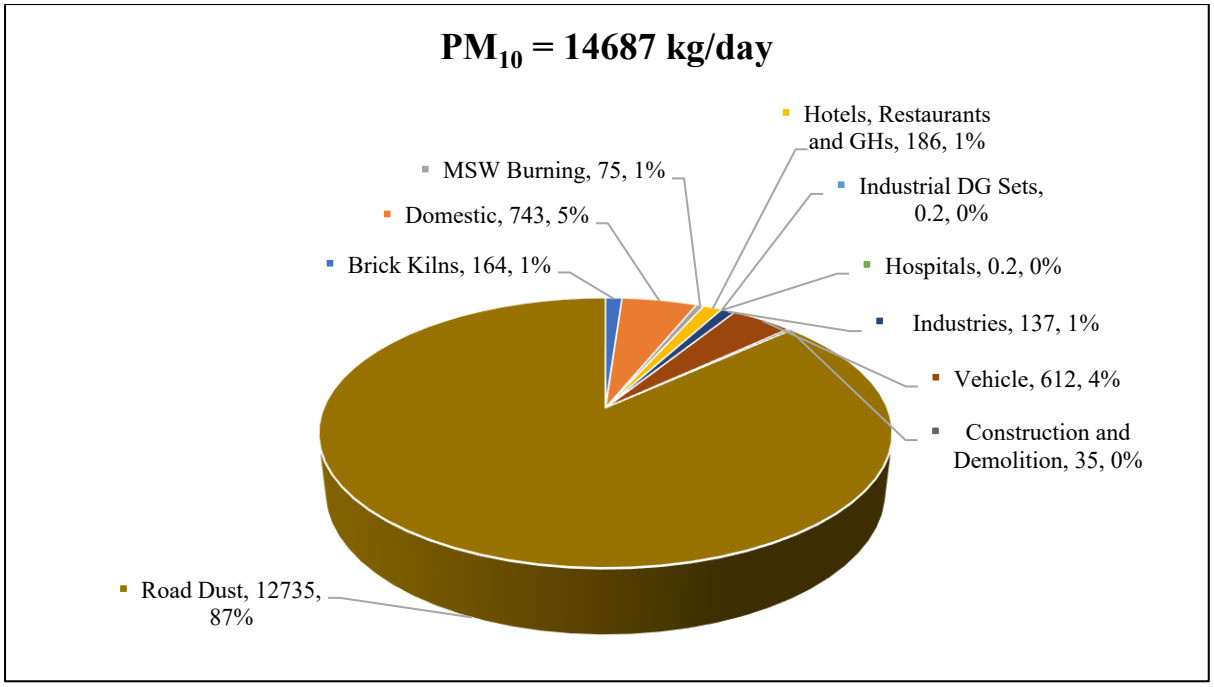


Figure 1: PM_{10} Emission load contribution of different sources

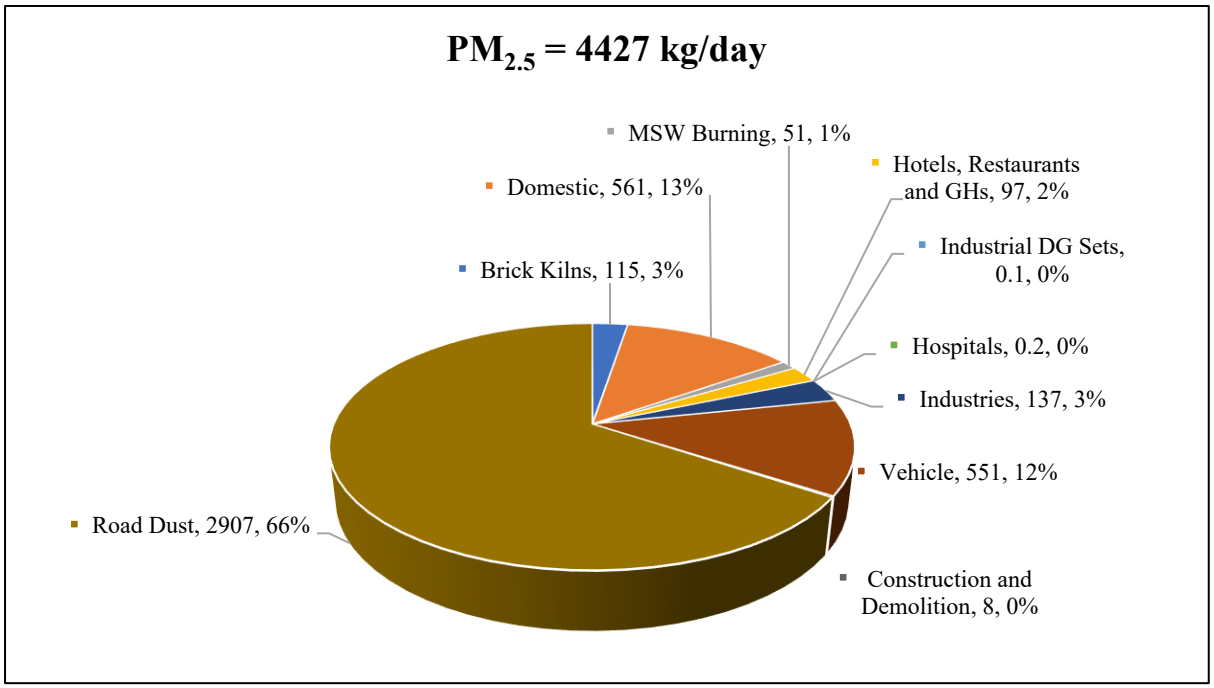


Figure 2: $PM_{2.5}$ Emission load contribution of different sources

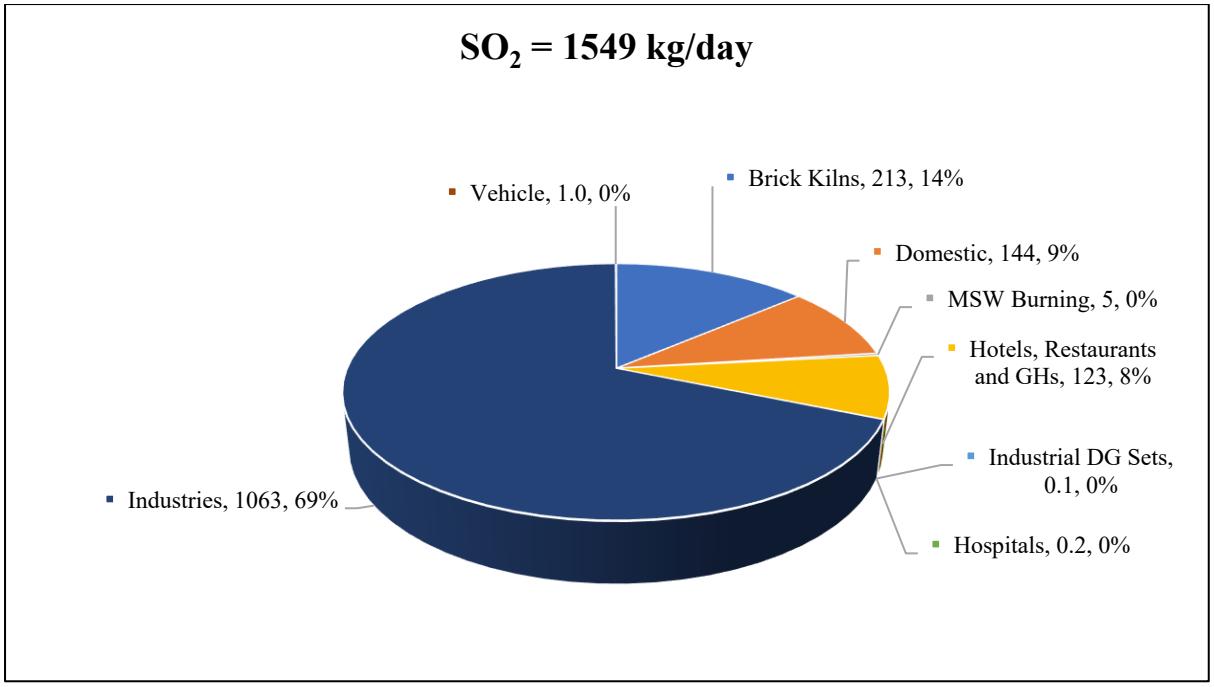


Figure 3: SO_2 Emission load contribution of different sources

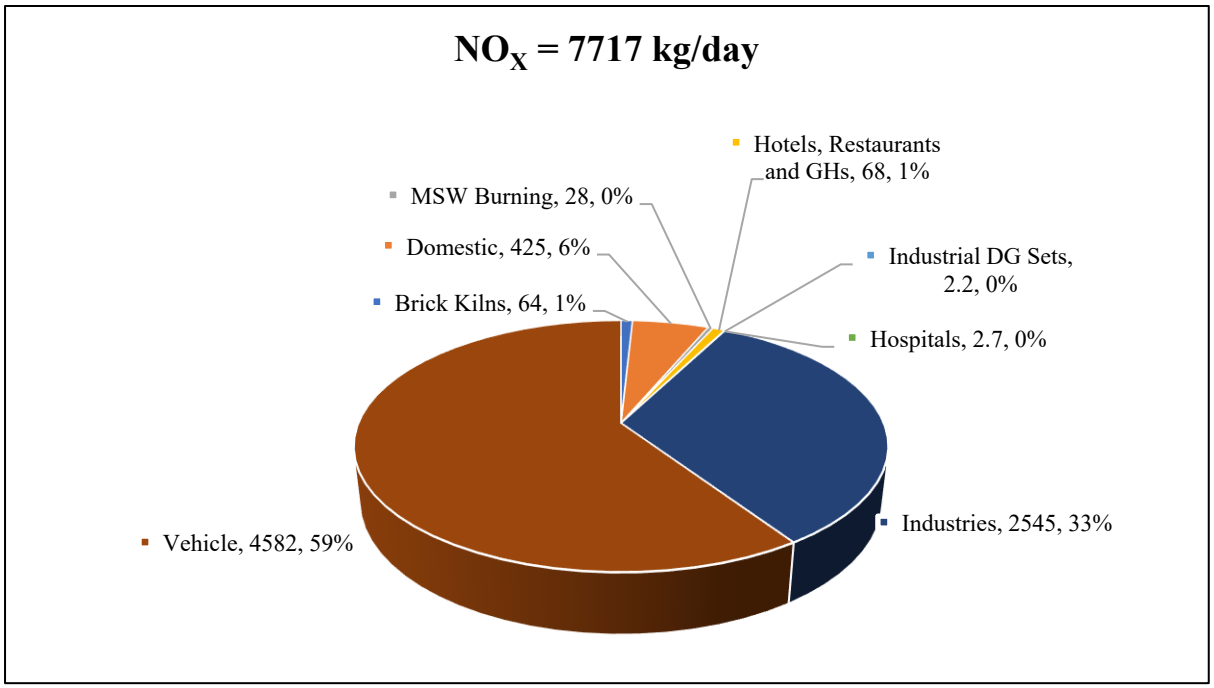


Figure 4: NO_x Emission load contribution of different sources

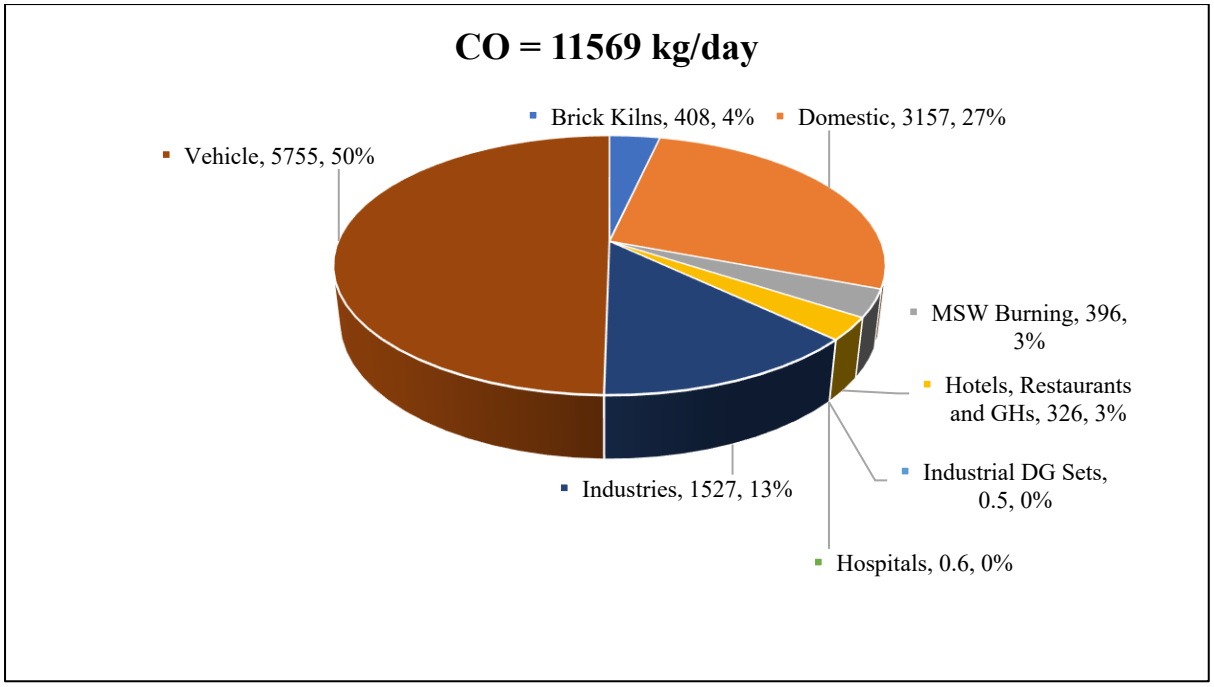


Figure 5: CO Emission load contribution of different sources

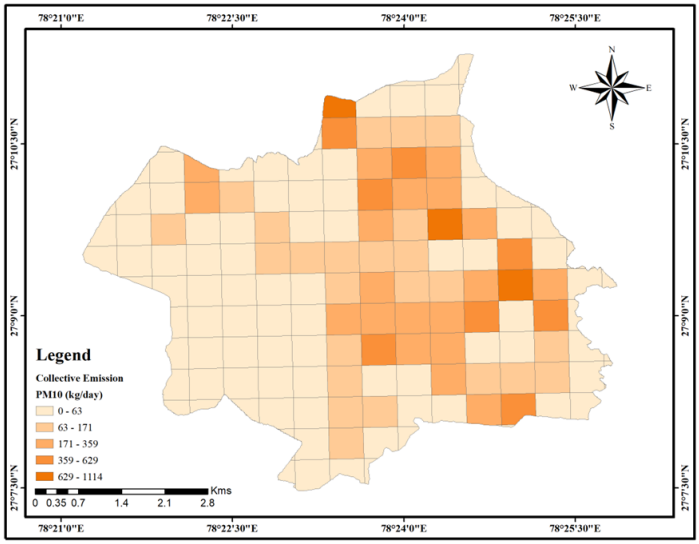


Figure 6: Spatial distribution of PM_{10} emissions in Firozabad

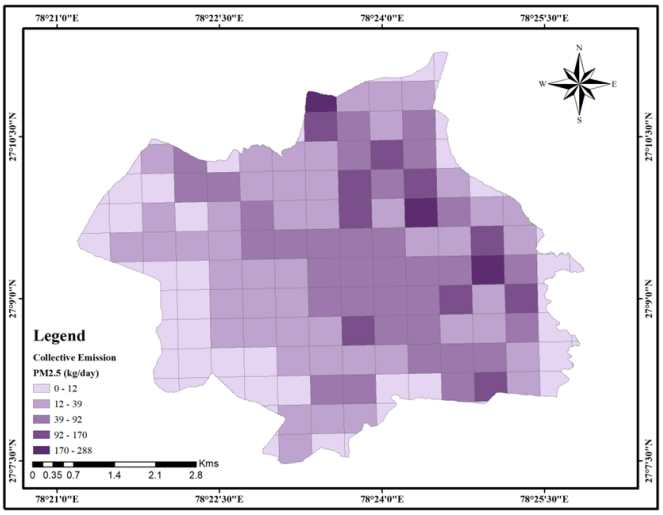


Figure 7: Spatial distribution of $PM_{2.5}$ emissions in Firozabad

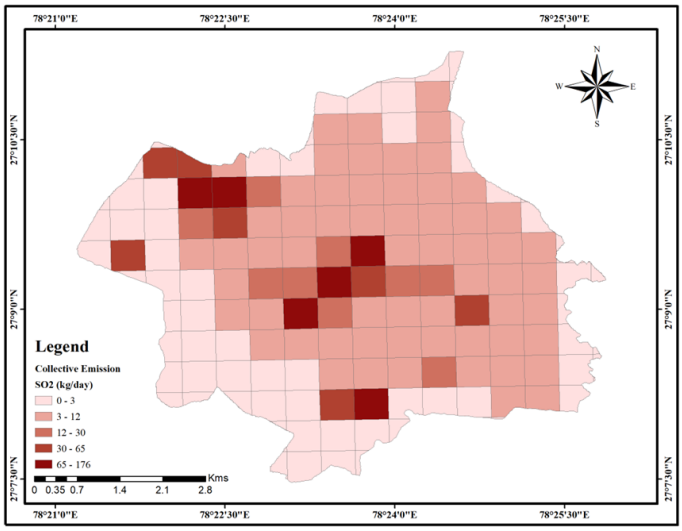


Figure 8: Spatial distribution of SO_2 emissions in Firozabad

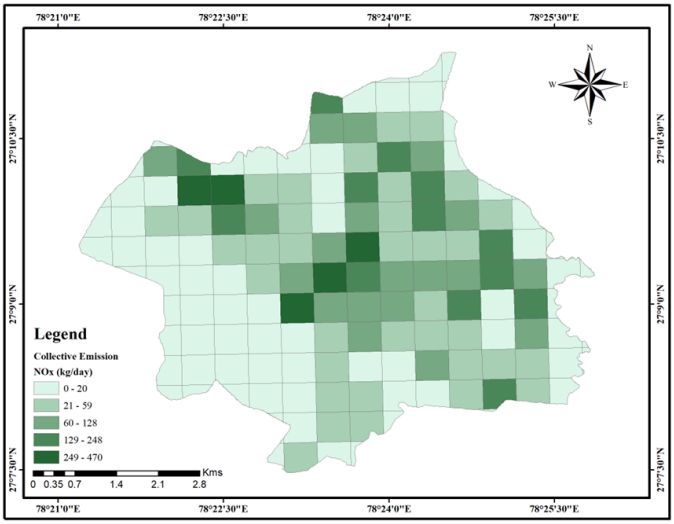


Figure 9: Spatial distribution of NO_x emissions in Firozabad

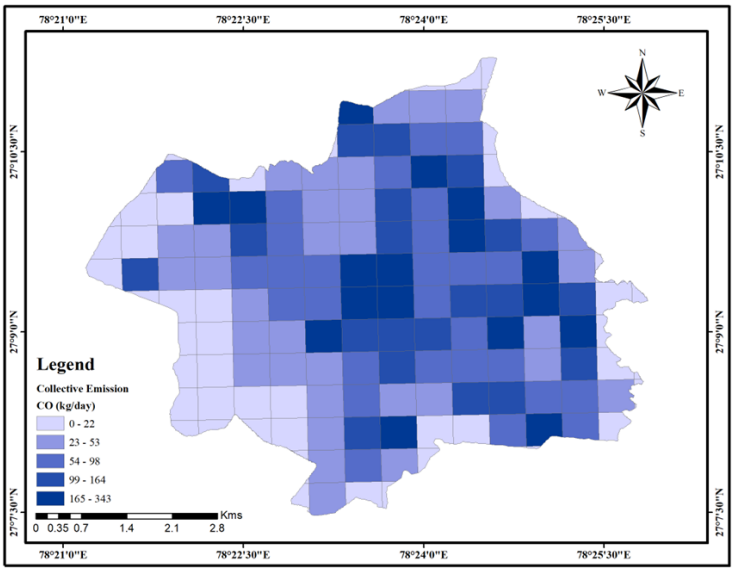


Figure 10: Spatial distribution of CO emissions in Firozabad

Air Quality Modelling

Receptor Modelling

Based on the CMB (chemical mass balance; USEPA 8.2 version) modelling results (Figure 11 - Figure 13) and their critical analyses, the following inferences and insights are drawn to establish quantified source-receptor impacts and to pave the path for the preparation of action plan. The important inferences are:

The sources of PM_{10} and $PM_{2.5}$ contributing to ambient air quality are different in summer and winter.

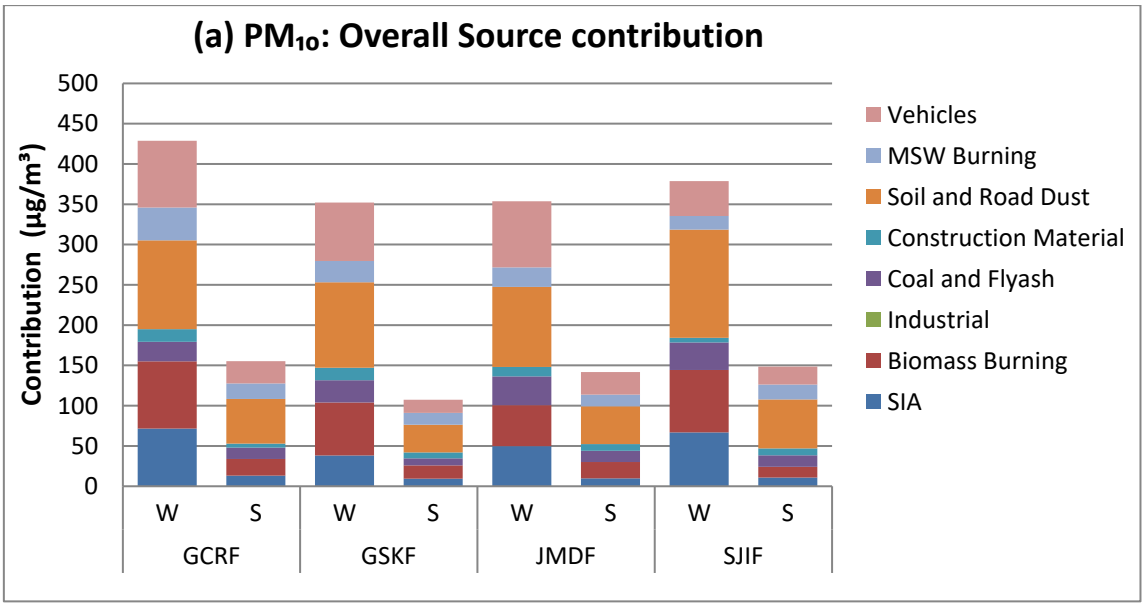
- The winter sources (% contribution given in parenthesis for PM_{10} – $PM_{2.5}$ to the ambient air levels) include soil & road dust (30 – 26 %), SIA particles (15 – 15.2%), biomass burning (18 – 21%), vehicles (18.5 – 21%) and MSW burning (7.2 – 6.8%). It is noteworthy, in winter; major sources for PM_{10} and $PM_{2.5}$ are generally the same.
- The summer sources (% contribution given in parenthesis for PM_{10} – $PM_{2.5}$ to the ambient air level) include soil & road dust (36 – 27%), biomass burning (12 – 18%), vehicles (17 – 20%), MSW burning (12.1 – 14.7%), coal & flyash (9 – 7%) and SIA particles (7.8 – 9.5%). It is noteworthy, in summer also, the major sources for PM_{10} and $PM_{2.5}$ are generally the same.

The consistent presence of SIA, biomass burning and vehicles in PM_{10} and $PM_{2.5}$ across all sites and in two seasons, suggests these particles encompass entire Firozabad region as a layer.

Like the above point, in winter, consistent presence of soil & road dust encompasses entire Firozabad region as a layer.

Soil & road dust in summer contribute 36 – 27% and the coal & flyash contribute 9 – 7% to PM_{10} – $PM_{2.5}$. It is observed that in summer the atmosphere looks whitish to grayish, indicating presence of large amounts of dust; re-suspension of dust appears to be the cause of large contribution of these sources. This hypothesis can be argued from the fact that the contribution of flyash and road dust reduces both in PM_{10} and $PM_{2.5}$ in winter when winds are low and prevalent atmospheric conditions are calm.

The contribution of the biomass burning in winter is quite high at 18% (for PM_{10}) 21% (for $PM_{2.5}$). The presence of sizeable biomass is consistent in PM both winter and summer indicates to local sources present in Firozabad and nearby areas. There is an immediate need to control or find alternatives to eliminate biomass emissions to observe any significant improvement in air quality in Firozabad.



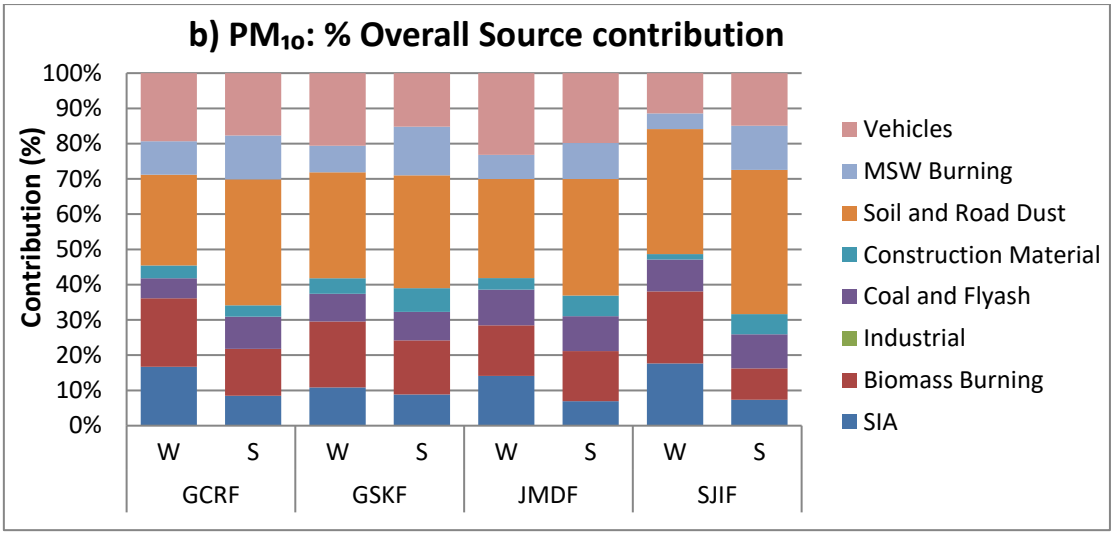


Figure 11: Overall results of CMB modelling for PM_{10}

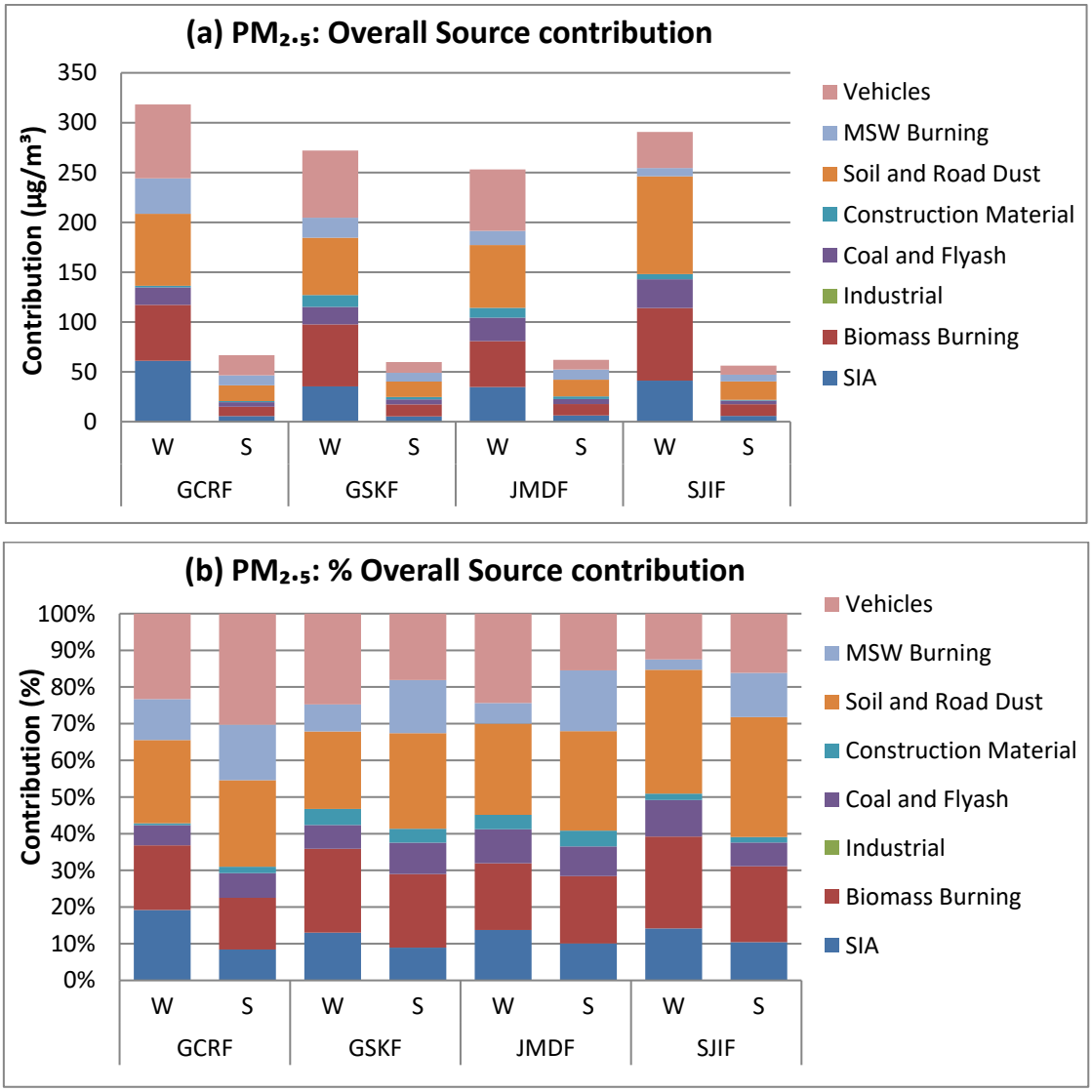


Figure 12: Overall results of CMB modelling for $PM_{2.5}$

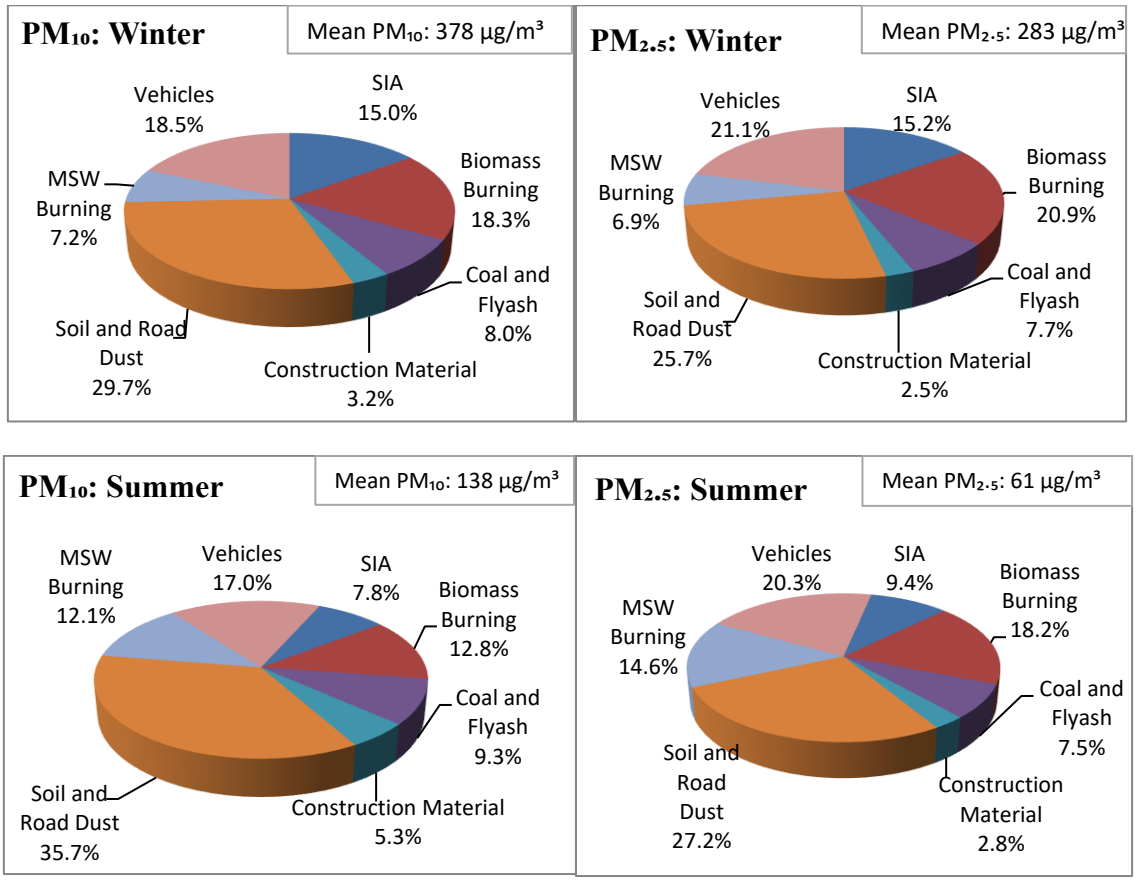


Figure 13: City level source contribution to ambient air PM_{10} and $PM_{2.5}$ levels

Dispersion Modelling

The major findings from the dispersion modelling are summarised below:

The highest 24-hour average was 165 µg/m^3 (1st December 2019), the monthly average $PM_{2.5}$ levels for the critical month (October) were 80 µg/m^{3,} and the annual average was 50 µg/m^3.

From the annual average plots, it is seen that $PM_{2.5}$ envelops a large area that gets elongated along the prevailing downwind direction (S-E) within Firozabad city. The annual standard for $PM_{2.5}$ concentration (40 µg/m^3) is exceeded in the area.

The city's highest contributing source for the critical day (1st December 2019) is road dust, followed by brick kiln and vehicular emissions. Domestic sources are where the residential population is concentrated. The rank of different sources based on their $PM_{2.5}$ contribution to the city is given in Table 3.

Table 3: Rank sources in different regions based on their contribution to $PM_{2.5}$

Rank	1	2	3	4	5	6	7	8	9	10
Sources	Road dust	Brick Kiln	Vehicle	Domestic	Hotel	MSW burning	Construction	Industry	Hospital	DG sets

Overall, the top contributors to $PM_{2.5}$ were road dust (59 %), brick kiln (15%), vehicles (11 %), domestic sources (9 %), and hotels (4 %), shown in Figure 14 at the hotspot.

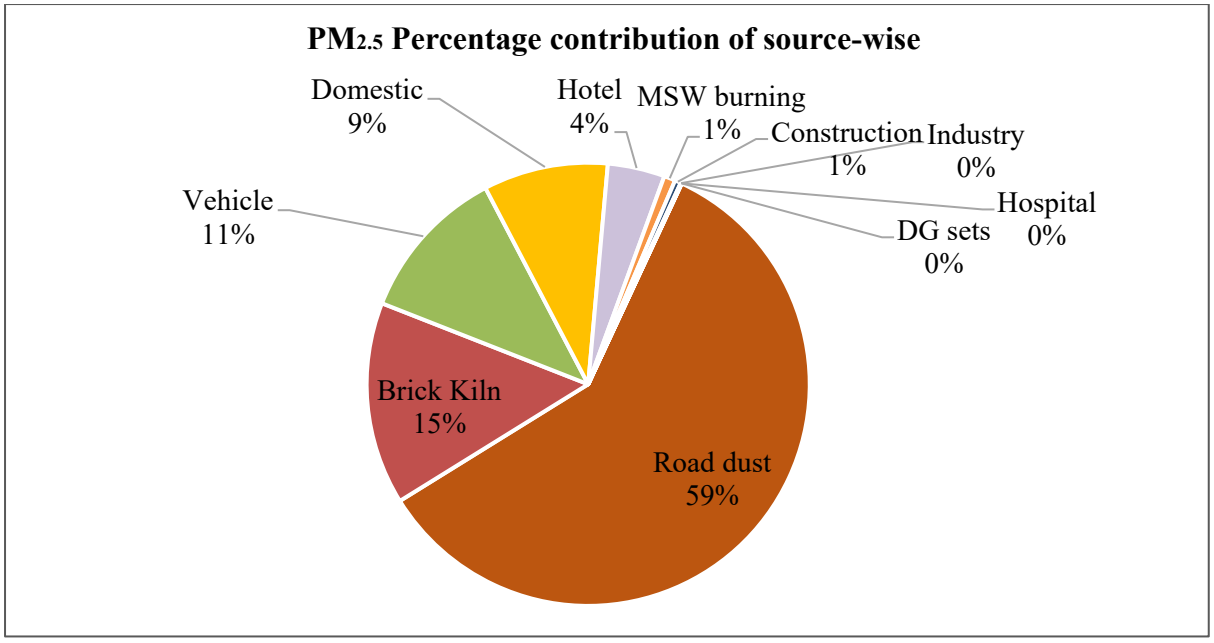


Figure 14: $PM_{2.5}$ Percentage contribution of source-wise at the hotspot

Control Options and Actions

The detailed analysis of control options for PM is given in Chapter 6. The proposed control options are summarized below in Table 4.

Table 4: Control Options and Action Plan for City of Firozabad

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
Hotels/ Restaurants/ Banquet Halls	All Restaurants small or large should not use coal and shift to gas-based or electric (for sitting capacity of more than 15 persons) appliances.	Municipal corporation Firozabad (MCF)	1 year
	Link Commercial license to clean fuel	Municipal corporation Firozabad, Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	1 year
	Ash/residue from the tandoor and other activities should not be disposed of near the roadside. Requires ward-level surveillance.	Municipal corporation Firozabad	1 year
Domestic Sector	LPG to all. Some of the populations are still using wood, biomass and dung cake as cooking fuel, especially in surrounding areas of city.	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	1 year
	No new building complex or society be allowed without a PNG supply distribution network	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	2 years
	By 2035, the city may plan to shift to electric cooking (common in western countries) or PNG at the minimum, that is completing shifting from LPG	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	5 - 7 years
	Strengthening of grid power supply, uninterrupted power supply to the residential areas.	State Energy Department, UPEBL	2 years

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Renewable energy should be used to cater to the need of residential houses requirements in the absence of power failure to stop the use of DG Set.	State Energy Department, UPEBL	2 years
Municipal Solid Waste (MSW) Burning	Any type of garbage burning should be strictly stopped. Current waste collection and surveillance are poor.	Municipal corporation Firozabad	Immediate
	Surveillance is required that hazardous waste goes to TSDF.	Municipal corporation Firozabad, UPPCB	
	Desilting and cleaning of municipal drains	Municipal corporation Firozabad	
	Waste including discarded packaging material burning in Industrial areas should be stopped.	The U.P. State Industrial Development Corporation Limited (UPSIDC), UPPCB	
	Daily, Monthly mass balance of MSW generation and disposal and keep the record	Municipal corporation Firozabad	
	Sensitize people and media through workshops and literature distribution so as not to burn the waste.	Municipal corporation Firozabad, UPPCB, and NGO	
Construction and Demolition	Wet suppression of open areas and material	MCF, Urban Development Department, PWD	Immediate
	Wind speed reduction (for large construction sites)	MCF, Urban Development Department, PWD	
	Enforcement of C&D Waste Management Rules. The waste should be sent to a construction and demolition processing facility	MCF, Urban Development Department, PWD	Immediate
	Proper handling and storage of raw material: covered the storage and provide the windbreakers.	MCF, Urban Development Department, PWD	
	Vehicle cleaning and specific fixed wheel washing on leaving the site and damping down of haul routes.	MCF, Urban Development Department, PWD	

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	The actual construction area should be covered by a fine screen or vertical tin covers up to 6.0 m.	MCF, Urban Development Department, PWD	
	No storage (no matter how small) of construction material near the roadside (up to 10 m from the edge of the road)	MCF, Urban Development Department, PWD	
	Builders should leave 25% area for green belt in residential colonies to be made mandatory. Haul roads inside large construction area be brick roads.	MCF, Urban Development Department, PWD	
	Sensitize construction workers and contract agencies through workshops.	MCF, Urban Development Department, PWD, UPPCB, and NGO	
Road Dust	The average silt load in Firozabad roads varies upto 8 g/m^2. The silt load on each road should be reduced to under 2 gm/m^2. Regular vacuum sweeping should be done on the road having a silt load above 2 gm/m^2.	MCF, National Highway Authority, PWD, UPPCB (for silt load compliance)	Immediate
	Convert unpaved roads to paved roads. Maintain pothole-free roads. Remove encroachment from the paved shoulders	MCF, National Highway Authority, PWD, UPPCB to carry out surveillance	
	Implementation of truck loading guidelines; use appropriate enclosures for haul trucks and gravel paving for all haul routes.	MCF, National Highway Authority, PWD	
	Increase green cover and plantation. Undertake the green of open areas, community places, schools, and housing societies.	MCF, National Highway Authority, State Forest Department, PWD	

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	vacuum-assisted sweeping is carried out four times a month on major roads with road washing.	MCF, National Highway Authority, PWD	
Vehicles	Diesel vehicles entering the city should be equipped with DPF which will bring a reduction of 40% in emissions (This option can be implemented with vehicles of the BS-IV category as well)	State Transportation Department	5 years
	Industries must be encouraged to use BS-VI or BS-IV (with DPF) vehicles for the transportation of raw and finished products	Industrial Associations and State transport Department	Immediate
	Restriction on plying and phasing out of 10 years old commercial diesel-driven vehicles	Transport Department	2 years
	Restriction on the bike-operated commercial rickshas in the city and encourage to use CNG/electric vehicles for commercial activities.		
	Introduction of cleaner fuels (CNG/ LPG) for all vehicles (other than 2-W). All new 2-W may be mandated to be electric vehicles.	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	2 years
	Check to overload: Expedited installation of weigh-in-motion bridges and machines at all entry points into Firozabad.	Transport Department, Traffic Police, Firozabad, NHAI, Toll agencies	Six-months
	Electric/Hybrid Vehicles should be encouraged; New residential and commercial buildings to have charging facilities. All new city and school buses should be electric.	Transport Department, RTOs Firozabad	1 year

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	All intra and inter bus stops and their parking should be rationalized to ensure more efficient utilization. The depots should include well-equipped maintenance workshops and adequate charging stations.	Transport Department, RTOs Firozabad	1year
	Enforcement of bus lanes and keep lanes free from obstruction and encroachment.	MCF, RTOs Firozabad	1 year
	Route rationalization: Improvement of availability by rationalizing routes and fleet enhancement with requisite modification.	RTOs Firozabad, Traffic Police, Firozabad	1 year
	IT systems in buses, bus stops, control centers, and passenger information systems for the reliability of bus services and monitoring.	RTOs Firozabad, Traffic Police, Firozabad	1 year
	Movement of materials (raw and product) within the city should be allowed between 10 PM to 5 AM.	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	1 year
	All the diesel-based city public transport should be phased out completely in next three to five years, and city transport should be operated only through e-vehicle or on CNG. All new public transport should be CNG or electric buses. Diesel buses below BS-IV must be restricted in the city.	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	3 – 5 years
	Incentivise and aggressively implement e-mobility including required charging infrastructure. Strategic plan for EV charging infrastructure at each 3 km in urban areas, 25 km on highways (both sides) and 100 km for buses and trucks and swappable battery stations.	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	2 years

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Adequate vehicle scrappage infrastructure should be developed in the next three years. Extended Producer Responsibility (EPR) may be considered for vehicle manufacturers, who will have to build required vehicle scrap plants. Truck movement in industrial areas is the major sources of pollution. One should consider only BS-4 and BS-6 trucks are allowed for transporting products and raw materials.	Transport Department, Firozabad, HMDA, RTOs Firozabad, Traffic Police, Firozabad	2 years
	Public transport to be strengthened with adequate number of buses, route plan based on commute surveys and Mobile App based ticketing and seating system is developed in all major cities	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	2 – 5 years
Industries and DG Sets	Ensuring emission standards in industries. Shifting of polluting industries.	UPPCB, Industries Department	1 year
	Strict action to stop unscientific disposal of hazardous waste in the surrounding area	MCF and UPPCB	
	There should be separate Treatment, Storage, and Disposal Facilities (TSDFs) for hazardous waste.	Industrial Associations, Industries Department, UPPCB	2 years
	Industrial waste burning should be stopped immediately	Industrial Associations, UPPCB	Immediate
	Following best practices to minimize fugitive emissions within the industry premises, all leakages within the industry should be controlled	Industrial Associations, UPPCB	Immediate

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Area and road in front of the industry should be the responsibility of the industry	Industrial Associations, UPPCB	
	Category A Industries		
	About 153 industrial units with boilers and furnaces in Firozabad are running by using LPG and natural gases. However, some industries might use Coal, Briquettes, Rise Husk, Wood, HSD, Furnace Oil, Waste, Firewood and other dirty solid fuels which must be shifted to natural gas and electricity. A regular surveillance should be done frequently to identify illegal operations.	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.), Industrial Associations, UPPCB	2 years
	Multi-cyclones should be replaced by baghouses. Ensure installation and operation of air pollution control devices in industries.	Industrial Associations, UPPCB	2 years
	Diesel Generator Sets		
	Strengthening of grid power supply, uninterrupted power supply to the industries.	State Energy Department, UPEBL	2 years
	Renewable energy should be used to cater to the need of office requirements in the absence of power failure to stop the use of DG Set.	Industrial Associations	2 years
	Efficient recovery system for solvents in chemical industries: The technologies suggest 95% recovery of VOCs is feasible and same may be adopted	Industrial Associations, UPPCB	1 year

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
Decongestion of Roads in high traffic areas	Strict action on roadside encroachment. Disciplined movement of tempos to stop only at designated spots. Action on driving in the wrong lane.	MCF, RTOs Firozabad, Traffic Police, Firozabad	1 year
	Disciplined Public transport (designate one lane stop).	RTOs Firozabad, Traffic Police, Firozabad	
	Removal of the free parking zone. No parking within 50 m of any major crossing and or chaurahas, rotaries. Strictly follow Indian Road Congress guidelines.	MCF, RTOs Firozabad, Traffic Police, Firozabad	
	Examine the existing framework for removing broken vehicles from roads and create a system for speedy removal and ensure minimal disruption to traffic.	RTOs Firozabad, NHAI, Traffic Police, Firozabad	
	Synchronize traffic movements or introduce intelligent traffic systems for lane-driving.	RTOs Firozabad, NHAI, Traffic Police, Firozabad	
	Mechanized multi-story parking at bus stands, and big commercial areas. Remove at least 50 percent of on-street parking in the city.	RTOs Firozabad, MCF, NHAI, Traffic Police, Firozabad	
	Identify traffic bottleneck intersections and develop a smooth traffic plan. For example, Karku Kothi Tiraha, Jain Temple Tiraha, Shanti Road Chauraha and New Bypass Chauraha are the main bottlenecks for traffic.	RTOs Firozabad, MCF, Traffic Police, Firozabad	
	Parking policy in congested areas (high parking cost, at city centers, only parking is limited for physically challenged people, etc).	RTOs Firozabad, MCF, NHAI, Traffic Police, Firozabad	
	The important points of congestion are Jain Temple Tiraha and New Bypass Chauraha. Parking on these	RTOs Firozabad, Traffic Police	2 years

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Roads, should be strictly prohibited.		
*The above steps should not only be implemented in Firozabad Municipal corporation Firozabad rather these should be extended up to 20 km from the city boundary.			

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Acknowledgments

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1 Introduction

1.1 Background of Study

Air pollution has become a significant challenge, especially in urban areas. This issue is compounded by the diverse and complex mix of air pollution sources, including industries, automobiles, generator sets, domestic fuel burning, roadside dust, and construction activities. Firozabad is the largest glass manufacturing centre in India. The city's increasing population, along with rapid growth in vehicles, construction, and energy consumption, has led to serious environmental concerns.

Traditional approaches to addressing the impact of pollution sources have primarily relied on dispersion or source models. These models use emission inventory data (collected at the source) combined with meteorological data to estimate the impact at the receptor. In contrast, receptor models, particularly for particulate matter, determine source impacts based on ambient particulate morphology, chemistry, and variability information collected at the receptor. The growing interest in receptor models stems from the limitations of dispersion models, which struggle to assess short-term source impacts or identify all contributing sources (USEPA, 1991). These limitations arise mainly from the challenges in developing accurate 24-hour particulate emission inventories and meteorological databases. While traditional dispersion modelling remains an essential tool in air-shed management, recent advancements in receptor-oriented techniques are providing valuable additional methods

Since the enactment of the Air Act of 1981, air pollution control programs have focused on point and area source emissions, and many communities have benefited from these control programs. Nonetheless, most cities in the country still face continuing particulate non-attainment problems from aerosols of unknown origin (or those not considered for pollution control) despite the high level of control applied to many point sources. It is in the latter case that an improved understanding of source-receptor linkages is especially needed if cost-effective emission reductions are to be achieved. Determining the sources of airborne particulate matter is a challenging problem due to the complexity of the urban source mix. The problem is often compounded by the predominance of non-ducted and widely distributed area (fugitive) sources and the lack of understanding of the sources of secondary aerosol, their formation and transport. The advent of receptor modelling and recent developments in the areas

of trace element analysis now permit a much more detailed analysis of ambient aerosol samples. By providing detailed information on the sources of the total, fine and inhalable particles, receptor models can play a major role in developing strategies for controlling airborne particulate matter.

Receptor modelling has proven to be a promising tool for source identification and apportionment in complex urban environments. This is particularly relevant given the numerous unorganised activities that release particulates into the atmosphere, a common situation in urban areas. Effective application of receptor modelling requires identifying sources (both large and small), generating emission profiles in terms of fingerprints and elemental composition, and determining the chemical characterisation of collected particulate matter on filter paper. Indeed, receptor and dispersion modelling can complement each other, providing better interpretations and decision-making capabilities when applied together.

To address the air pollution issues of City of Firozabad, the Uttar Pradesh Pollution Control Board (UPPCB), Lucknow has sponsored the study “Comprehensive Source Apportionment, Emission Inventory and Carrying capacity study for Firozabad, U.P.” to the Indian Institute of Technology Kanpur (Letter No. H62009/CL/413/SAS/CC/2021 dated 27.05.2021). The main objectives of the study are the preparation of an emission inventory, air quality monitoring in two seasons, the chemical composition of PM_{10} and $PM_{2.5}$, the apportionment of sources to ambient air quality and carrying capacity.

1.2 General Description of City

1.2.1 Geography and Demography

Firozabad (approximately 27.15° N latitude and 78.41° E longitude) is a city located in the state of Uttar Pradesh in India. It is known as the "City of Glass" due to its prominent glass industry. Firozabad is situated in the northern region of India. It lies on the banks of the Yamuna River, which adds to its scenic beauty. The city has a relatively flat terrain with fertile agricultural land surrounding it. Firozabad has a mix of urban and rural areas, with a growing population due to migration from nearby towns and villages in search of employment opportunities. Most of the population in Firozabad is engaged in the glass industry, which is the primary economic activity of the city. As of the 2011 India census, Firozabad City had a population of 2,498,156.

The total area of Firozabad city is approximately 35.49 square kilometres. This includes both urban and rural areas within the city limits. Firozabad is a vibrant city with a mix of residential, industrial, and agricultural areas contributing to its overall area.

1.2.2 Climate

Firozabad city experiences a subtropical climate with hot summers and cool winters. The summer months, from April to June, are typically hot with temperatures ranging from 30°C to 45°C (86°F to 113°F). Monsoon season begins in July and lasts through September, bringing moderate to heavy rainfall. The average annual rainfall in Firozabad city is approximately 600-700 millimetres. The winter months, from November to February, are cool and pleasant with temperatures ranging from 8°C to 25°C (46°F to 77°F). Foggy conditions are common during the winter months, especially in the early mornings and nights. On average, the wind speed ranges from 5 to 15 km/h; these values fluctuate due to seasonal changes and weather patterns.

1.2.3 Emission Source Activities

The source activities for air pollution in the city of Firozabad can be broadly classified as: transport sector (motor vehicles and railways), commercial activities, industrial activities, domestic activities, institutional & official activities and fugitive non-point sources. For the transportation of men, public transport (buses), tempos, and taxis fulfil the transportation requirement for the city. The combustion of fuels like coal, liquefied petroleum gas (LPG), and wood falls under the category of domestic activities. As far as industrial activities are concerned, many small and medium-scale industries are also responsible for air pollution. In most institutions and offices, diesel generators are used during power failures.

1.3 Objectives and Scope of Work

Objectively, the project aims to achieve the following:

- Development of GIS-based gridded (0.5 km × 0.5 km resolution) emission inventory for air pollutants PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO.
- Compilation of emission factors for all sources, parking lot surveys through questionnaires for vehicle technology, model, and engine capacity.

- Monitoring of air pollutants PM_{10}, $PM_{2.5}$, SO_2, NO_2, and VOCs. Analyse collected PM_{10} and $PM_{2.5}$ mass for elemental composition, ions, elemental carbon, organic carbon, PAHs (Benzo[a]pyrene, Fluorene, Acenaphthene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Chrysene, Benzo(b)f, Benzo(k)f, Dibenz(a,h)a, Inp, and Bghi)) and molecular markers.

- Reconstruction of PM based on chemical species (of PM) and assessment for primary and secondary sources of air pollutants.

- Application of receptor model to establish source-receptor linkages of PM_{10}, and $PM_{2.5}$ using state-of-the-art modelling to arrive at source apportionments at sampling sites.

- Identification of various control options (e.g. adoption of EURO IV/VI, diesel filter, industrial controls, etc) and assessment of their efficacies for control options for air quality improvements and development of control scenarios (in a techno-economic perspective) consisting of combinations of several control options.

- Development of a time-bound action plan based on the most effective control options and recommendations for strengthening the capacity of board personnel.

- Atmospheric carrying capacity

1.4 Approach to the Study

The approach to the study is based on the attainment of its objectives within the scope of work. The summary of the approach is presented in Figure 1.1. The overall approach to the study is broadly described below.

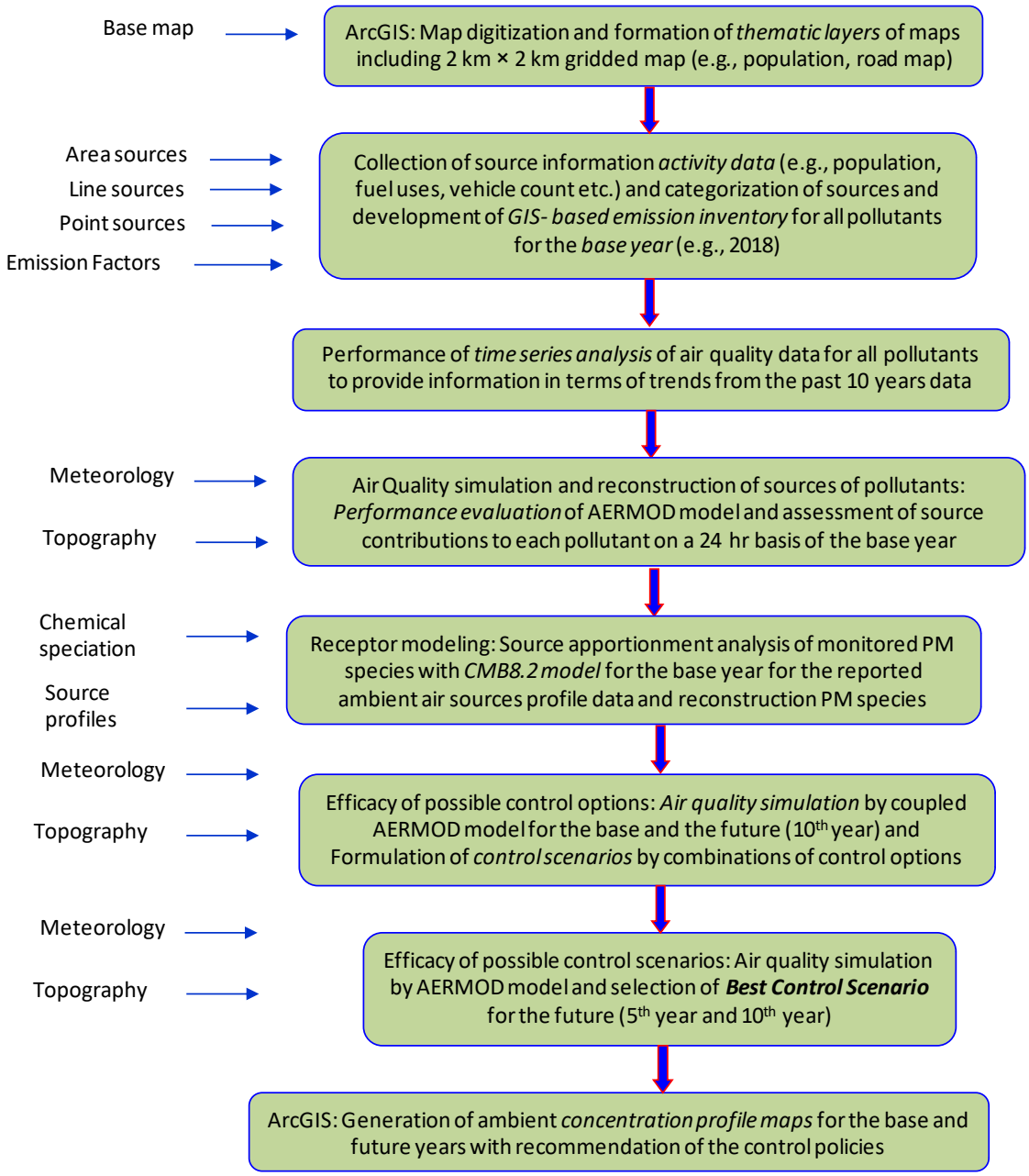


Figure 1.1: Approach to the Study and Major Tasks

1.4.1 Selection of sampling sites: Representation of Urban Land-use

It was considered appropriate that four sites in a city like Firozabad could represent typical land-use patterns. It is essential to ensure that there is a free flow of air at all sites, without any obstructions (e.g., buildings, trees). In view of the safety of the stations, public buildings could be better choices like sampling sites. Sites were finalized in consultation with officials at the UPPCB, Lucknow.

1.4.2 Identification and Grouping of Sources for Emission Inventory

An on-the-field exercise was taken up to physically identify all small and large sources around the sampling sites. This exercise included the presence of emission sources like refuse and biomass burning, road dust, and coal/coke burnt by street vendors/small restaurants, to large units like power generation units and various vehicle types. It was necessary to group some of the similar sources to keep the inventory exercise manageable. It is essential to recognise that particulate emission sources vary from one season to another. Finally, the data collected was developed into an emission inventory for the following pollutants: SO_2, NOx, CO, PM_{10} and $PM_{2.5}$ on a GIS platform.

1.4.3 Emission Source Profiles

Since source profiles for $PM_{2.5}$, specifically for Indian or Firozabad, are not available except for vehicular sources (ARAI, 2009), the source profiles for this study were taken from 'SPECIATE version 3.2' of USEPA (2006) and updated version 5.1 of SPECIATE (USEPA, 2020). For vehicular sources, profiles were taken from ARAI (2009). 'SPECIATE' is a repository of Total Organic Compound (TOC) and PM speciated profiles for a variety of sources for use in source apportionment studies (USEPA, 2006, 2020); care has been exercised in adopting the profiles for their applicability in the local environment of Firozabad city. For the sake of uniformity, source profiles for non-vehicular sources for PM_{10} and $PM_{2.5}$ were adopted from USEPA (2006, 2020).

1.4.4 Application of Receptor Modelling

There are several methods and commercial software available that can be used for apportioning the sources if the emission profiles and measurements are available in the ambient air particulate in terms of elemental composition. The most common software is USEPA CMB 8.2 (USEPA, 2004). This model should be able to provide the contribution of each source to the particulate matter in the ambient air. The modelling results should be helpful in identifying major sources for pollution control. It was important to note that, along with source contribution, the model could also provide the associated uncertainties in estimated source contributions.

1.4.5 Application of Dispersion Modelling

In addition to receptor modelling, dispersion modelling in the study area was undertaken. The hourly meteorological data were generated through WRF "Version 3.6" model (NCAR, 2012). The emission quantities coupled with predominant meteorological data of the city were used in dispersion model in estimating the concentration of various pollutants and examining the contribution of each of the sources. AERMOD View "Version 11.0." model (USEPA, 2015) was used for dispersion modelling.

1.5 Report-Structure

The report is divided into 6 chapters. The brief descriptions of the chapters are given below.

Chapter 1

This chapter presents the background of the study, a general description of the city including geography and demography, climate and sources of air pollution. The objectives, scope and approach to this study are also briefly described in this chapter.

Chapter 2

This chapter presents the air quality status of the city based on the monitoring and chemical characterization results of various air pollutants at all sampling locations for two seasons, i.e. winter and summer, carried out in this study. In addition to the above information, this chapter also enumerates methodologies adopted for monitoring, laboratory analyses and quality assessment and quality control (QA/QC). This chapter also compares the results of all sites both diurnally and seasonally.

Chapter 3

This chapter describes the methodology of developing an emission inventory of pollutants at different grids of the city. The chapter also presents and compares the grid-wise results of emission inventory outputs for various pollutants. The contributions of various sources towards air pollution loads (pollutant-wise) are presented. The QA/QC approaches for emission inventory are also explained in this chapter.

Chapter 4

This chapter presents the methodology used for CMB8.2 modelling for the source apportionment study for PM_{10} and $PM_{2.5}$ in summer and winter seasons. The contributions of various sources at receptor sites and the overall scenario of sources that influence the air quality in the city are presented.

Chapter 5

The state-of-the-science, comprehensive meteorological and regulatory air dispersion modelling systems have been used in the study to conduct the dispersion modelling. The American Meteorological Society / Environmental Protection Agency Regulatory Model (AERMOD) has been used to assess the impact of short-range transport (< 50 km) of $PM_{2.5}$ emissions from various sources within Firozabad city, Uttar Pradesh

Chapter 6

This chapter describes, explores, and analyses emission control options and analyses for various sources based on the modelling results from Chapter 4 and 5. This chapter also discusses some alternatives for controlling the prominent sources in the city from a management perspective and explains the benefits that can be achieved in the future.

2 Air Quality Measurements, Data Analyses and Inferences

2.1 Introduction

Air pollution continues to remain a public health concern despite various actions taken to control air pollution. There is a need to take stock of the benefits that have accrued and ponder on the 'Way Forward'. The further analysis of actions and future needs becomes even more important in view of the revised air quality standards that have been notified (http://www.cpcb.nic.in/National_Ambient_Air_Quality_ Standards.php (CPCB, 2009). The first step to accomplish future action is to assess the current air pollution status.

This chapter presents and discusses the status of air quality in Firozabad from the sampling and chemical analysis results for two seasons carried out under the present study.

2.2 Methodology

2.2.1 Site selection and details

A total of four air quality sites has been selected to cover various land-use patterns prevailing in the city. It is ensured that there is a free flow of air at all sites, without any obstruction (e.g., buildings, trees, etc.). In view of the safety of the stations, public buildings (institutions, office buildings, etc.) were selected. The sites were selected in consultation with UPPCB, Lucknow. Table 2.1 describes the sampling sites with prevailing land-use and other features. Figure 2.1 shows the physical features (photographs) of the sampling sites. Figure 2.2 shows the locations of the sampling sites on the map and the overall land-use pattern of the city.

Table 2.1: Description of Sampling Sites of Firozabad

S. No.	Sampling Site	Site Code	Latitude/ longitude	Land-use	Type of Sources
1.	Jain Mandir, Firozabad	**JMDF**	27.16°N, 78.40°E	Commercial	DG sets, vehicle, road dust, garbage/waste burning, Restaurants

2.	Gopinath College, Rasulpur, Firozabad	**GCRF**	27.14°N, 78.40°E	Residential	Domestic cooking, vehicle, road dust, garbage/MSW burning, Restaurants
3.	St. John Industrial, Firozabad	**SJIF**	27.17°N, 78.37°E	Industrial	Industries, DG sets, vehicles, road dust, garbage/industrial waste burning, Restaurants
4.	Gauri Shankar Kotla, Firozabad	**GSKF**	27.17°N, 78.41°E	Residential	Domestic cooking, vehicle, road dust, garbage/MSW burning, Industrial

JMDF

GCRF

SJIF

GSKF

Figure 2.1: Photographs of Sampling Sites showing the physical features

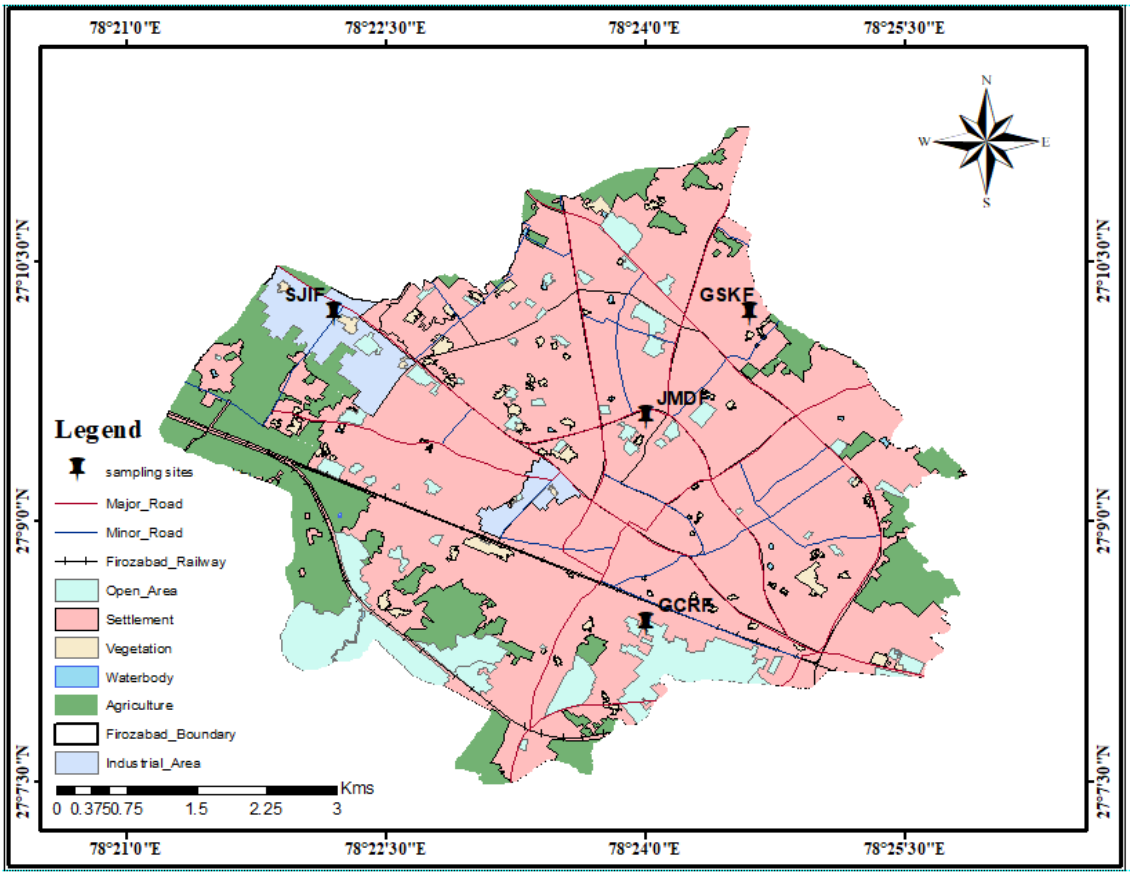


Figure 2.2: Land-use Pattern and Locations of Sampling Sites

The parameters for sampling and monitoring methodologies, including the type of filter papers/chemicals and calibration protocols, are adopted from CPCB, Delhi (www.cpcb.nic.in). The entire monitoring programme is divided into two groups, i.e. (i) gaseous sampling and (ii) particulate matter (PM) sampling (PM_{10} and $PM_{2.5}$). Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2) and volatile organic compounds (VOCs) are among the gaseous species. The monitoring parameters for this study, along with sampling and analytical methods, are presented in Table 2.2 and the chemical components (of PM) in Table 2.3.

Table 2.2: Details of Samplers/Analysers and Methods

Sr. No.	Parameter	Sampler/Analysing Instrument	Method
1.	PM_{10}	4-Channel Speciation Sampler (4-CSS)	Gravimetric
2.	$PM_{2.5}$	4-Channel Speciation Sampler (4-CSS)	Gravimetric
3.	SO_2	Bubbler/Spectrophotometer	West and Gaek
4.	NO_2	Bubbler/Spectrophotometer	Jacob &Hochheiser modified
5.	OC/EC	OC/EC Analyser	Thermal Optical Reflectance
6.	Ions	Ion-Chromatograph	Ion-Chromatography
7.	Elements	ICP-MS	Mass spectrometry

8.	Molecular Markers	Gas chromatography- mass spectrometry (GC-MS)	Mass spectrometry
9.	PAHs	GC-MS	Mass spectrometry
10.	VOCs	GC-MS	Mass spectrometry

Table 2.3: **Target Chemical Components for Characterization of PM**

Components	Required filter matrix	Analytical methods
$PM_{10}/PM_{2.5}$	Teflon filter paper.	Gravimetric
Elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba and Pb)	Teflon filter paper	ICP-MS
Ions (F^-, Cl^-, NO_3^-, SO_4^{2-}, K^+, NH_4^+, Na^+, Mg^{2+} and Ca^{2+})	Teflon filter paper	Ion-chromatography
Carbon Analysis (OC, EC and Total Carbon)	Quartz filter (Prebaked at 600ºC)	TOR/TOT method

2.3 Quality Assurance and Quality Control (QA/QC)

Quality assurance and quality control (QA/QC) in the entire project planning and its implementation at all levels were designed, and hands-on training was imparted to the project team before the beginning of any sampling and analysis. During sampling and analysis, a coding system has been adopted to eliminate any confusion. Separate codes for seasons, site locations, parameters, and time slots are adopted.

For SO_2 and NO_2, analyses were done regularly just after the sampling, following the standard operating procedures (SOPs) in the laboratory, which was set up at Firozabad. All other measurements and analyses were carried out in the laboratories at IIT Kanpur. The calibrations for all samplers were done at regular intervals at the time of sampling. The calibrations of overall analyses were established by cross-checking with known concentrations of the pollutants. The major features of QA/QC are briefly described here.

- SOPs for the entire project planning and implementation were developed, peer reviewed by other experts and project personnel have been trained in the field and in the laboratory. Whenever necessary, the SOPs were adjusted to meet the field challenges.
- SOPs include the type of equipment (with specifications), sampling and calibration methods, with their frequency.

- SOPs for chemical analysis include description of methods, standards to be used, laboratory and field blanks, internal and external standards, development of a database, screening of data, record keeping including backups, traceability of calculations and standards.

There are dedicated computers for instruments and data storage with passwords. To ensure that the computers do not get infected, these computers are not hooked on the Internet.

Sampling periods: The ambient air sampling has been completed for the winter season at four sites (Nov 21, 2022 - Dec 30, 2022) and summer (April 29, 2023 - June 02, 2023). The analysis of SO_2 and NO_2 is carried out daily regularly while gravimetric analysis for particulate matter is done after completion of the sampling at IIT Kanpur.

All efforts were made for the 100% achievement of the sampling and analysis. Efforts were made to sample on extra days to cover the missing days of sampling.

The details of sampling days for all pollutants at all monitoring sites are presented in Table 2.4 to Table 2.11 for the winter and summer seasons.

Table 2.4: Sampling days of various pollutants in winter at JMDF

Jain Mandir Firozabad (JMDF), Winter 2022																
	21-Nov-22	22-Nov-22	23-Nov-22	24-Nov-22	25-Nov-22	26-Nov-22	27-Nov-22	28-Nov-22	29-Nov-22	30-Nov-22	01-Dec-22	02-Dec-22	03-Dec-22	04-Dec-22	05-Dec-22	06-Dec-22
PM_{10}																
$PM_{2.5}$																
OC																
EC																
VOC																
NO_2																
SO_2																

Table 2.5: Sampling days of various pollutants in winter at GCRF

Gopinath College Rsulpur Firozabad (GCRF), Winter 2022																
	25-Nov-22	26-Nov-22	27-Nov-22	28-Nov-22	29-Nov-22	30-Nov-22	01-Dec-22	02-Dec-22	03-Dec-22	04-Dec-22	05-Dec-22	06-Dec-22	07-Dec-22	08-Dec-22	09-Dec-22	
PM_{10}																
$PM_{2.5}$																
OC																
EC																
VOC																
NO_2																
SO_2																

Table 2.6: Sampling days of various pollutants in winter at SJIF

St. Jhon Industrial Forozabad (SJIF), Winter 2022														
	09-Dec-22	10-Dec-22	11-Dec-22	12-Dec-22	13-Dec-22	14-Dec-22	15-Dec-22	16-Dec-22	17-Dec-22	18-Dec-22	19-Dec-22	20-Dec-22	21-Dec-22	22-Dec-22	23-Dec-22
PM_{10}															
$PM_{2.5}$															
OC															
EC															
VOC															
NO_2															
SO_2															

Table 2.7: Sampling days of various pollutants in winter at GSKF

Gauri Shankar Kotla Firozabad (GSKF), Winter 2022																
	14-Dec-22	15-Dec-22	16-Dec-22	17-Dec-22	18-Dec-22	19-Dec-22	20-Dec-22	21-Dec-22	22-Dec-22	23-Dec-22	24-Dec-22	25-Dec-22	27-Dec-22	28-Dec-22	29-Dec-22	30-Dec-22
PM_{10}																
$PM_{2.5}$																
OC																
EC																
VOC																
NO_2																
SO_2																

Table 2.8: Sampling days of various pollutants in summer at JMDF

Jain Mandir Firozabad (JMDF), Summer 2023															
	29-Apr-23	30-Apr-23	01-May-23	02-May-23	03-May-23	05-May-23	06-May-23	07-May-23	08-May-23	09-May-23	10-May-23	11-May-23	12-May-23	13-May-23	14-May-23
PM_{10}															
$PM_{2.5}$															
OC															
EC															
VOC															
NO_2															
SO_2															

Table 2.9: Sampling days of various pollutants in summer at GCRF

Gopinath College Rasulpur Firozabad (GCRF), Summer 2023															
	01-May-23	02-May-23	03-May-23	05-May-23	06-May-23	07-May-23	08-May-23	09-May-23	10-May-23	11-May-23	12-May-23	13-May-23	14-May-23	15-May-23	16-May-23
PM_{10}															
$PM_{2.5}$															
OC															
EC															
VOC															
NO_2															
SO_2															

Table 2.10: Sampling days of various pollutants in summer at SJIF

St. Jhon Industrial Firozabad (SJIF), Summer 2023															
	19-May-23	20-May-23	21-May-23	22-May-23	23-May-23	24-May-23	25-May-23	26-May-23	27-May-23	28-May-23	29-May-23	30-May-23	31-May-23	01-Jun-23	02-Jun-23
PM_{10}															
$PM_{2.5}$															
OC															
EC															
VOC															
NO_2															
SO_2															

Table 2.11: Sampling days of various pollutants in summer at GSKF

Gauri Shankar Kotla Firozabad (GSKF), Summer 2023															
	19-May-23	20-May-23	21-May-23	22-May-23	23-May-23	24-May-23	25-May-23	26-May-23	27-May-23	28-May-23	29-May-23	30-May-23	31-May-23	01-Jun-23	02-Jun-23
PM_{10}															
$PM_{2.5}$															
OC															
EC															
VOC															
NO_2															
SO_2															

2.4 Ambient Air Quality – Results

There were four air quality sampling sites considered in Firozabad to cover the city's entire area. The ambient air sampling has been completed for the winter season at four sites (Nov 21, 2022 - Dec 30, 2022) and summer (April 29, 2023 - June 02, 2023). Air quality is discussed at four sampling sites in Firozabad.

2.4.1 Jain Mandir Firozabad (JMDF)

The sampling period was November 21 – December 06, 2022, for winter and April 29 – May 14, 2023, for summer.

2.4.1.1 Particulate Matter (PM_{10}, $PM_{2.5}$)

Time series of 24-hr average concentrations of PM_{10} and $PM_{2.5}$ at JMDF are shown for winter in Figure 2.3 and for summer in Figure 2.4. Average levels at this site were: $PM_{2.5}$: 253±64 (winter) and 62±17 µg/m^3 (summer), and PM_{10}: 354±91 (winter) and 142±42 µg/m^3 (summer). The $PM_{2.5}$ levels were 4.2 times higher in winter and almost equal to the standard in the summer season compared to the NAAQS ($PM_{2.5}$: 60 µg/m^3). The PM_{10} levels were 3.5 times higher in winter and 1.4 times higher in the summer season compared to the NAAQS (PM_{10}: 100 µg/m^3).

In summer, $PM_{2.5}$ levels drop significantly compared to PM_{10} levels, which continued to be high despite improvements in meteorology and better dispersion. The particles airborne from the soil during dust storms in the dry months of summer can contribute significantly to a coarse fraction (i.e., $PM_{2.5\text{-}10}$).

The corresponding CPCB air quality index (AQI) is 480 ($PM_{2.5}$) and 538 (PM_{10}) for winter, which falls in the category of *severe*. For summer maximum AQI was 203 (for $PM_{2.5}$) and 164 (for PM_{10}), which falls in the category of *poor*.

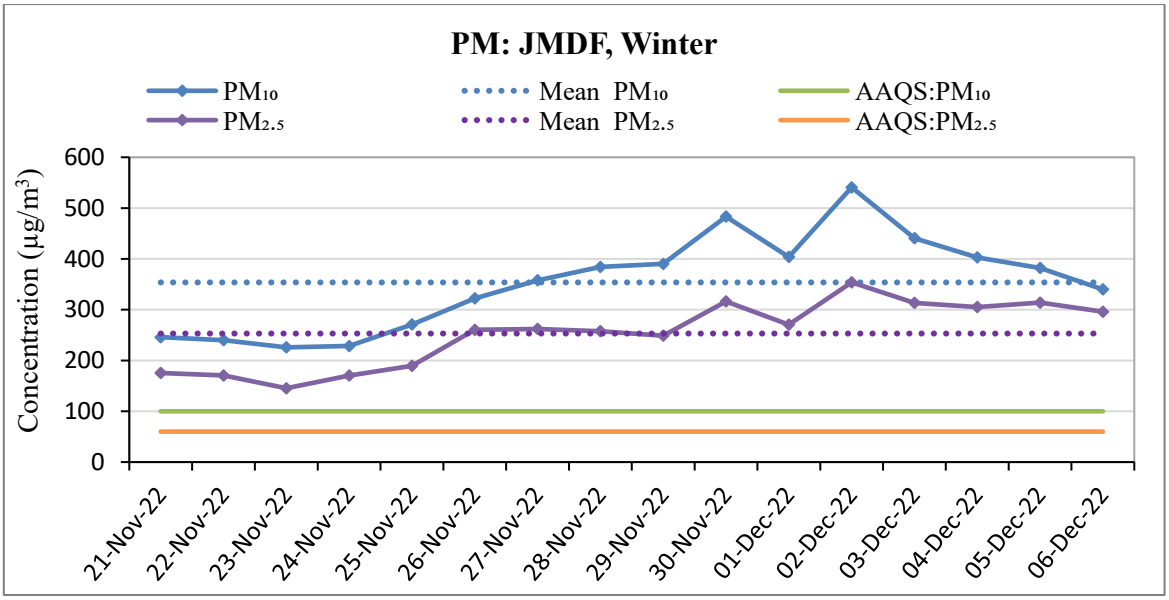


Figure 2.3: PM Concentrations at JMDF, Winter

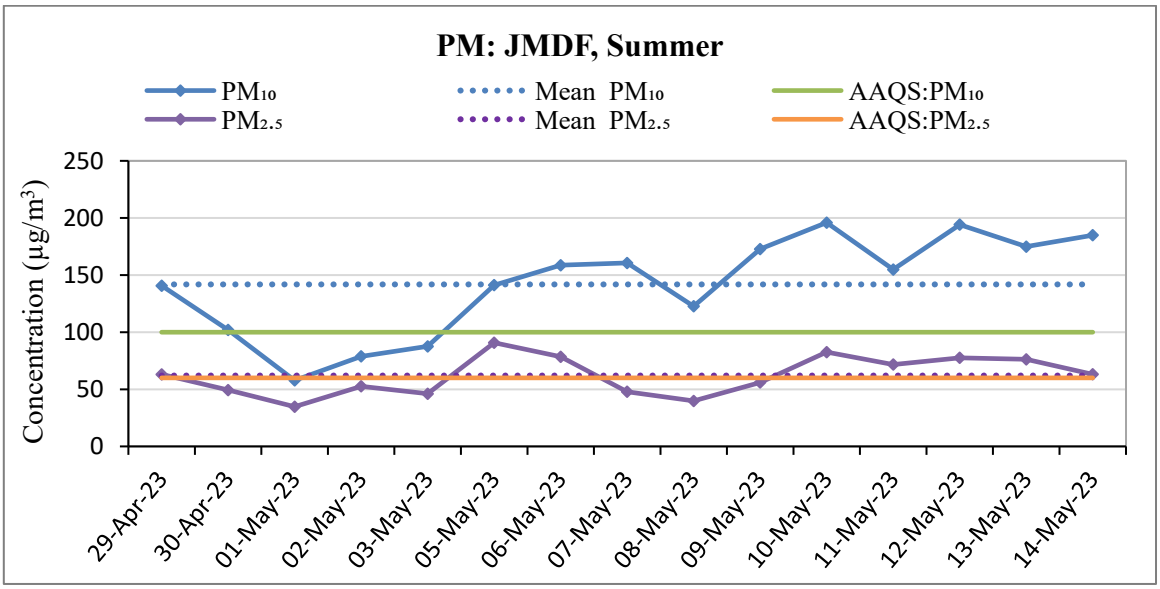


Figure 2.4: PM Concentrations at JMDF, Summer

2.4.1.2 Gaseous pollutants

Time series of 24-hr average concentrations of SO_2 and NO_2 are shown for the winter (Figure 2.5) and summer (Figure 2.6) seasons. It was observed that SO_2 concentrations were low (mostly < 3.0 µg/m^3) and met the air quality standard. NO_2 levels also meet the national standard (80 µg/m^3) with an average of 16 days at 57±13 µg/m^3 in winter and 30±8 µg/m^3 in the summer season. The summer concentration of NO_2 dropped. NO_2 levels are meeting the standard, it is still a matter of concern as NO_2 is largely attributed to vehicular pollution, which is on the rise. Variation in NO_2 is due to variability in meteorology and the presence of

occasional local sources like DG sets, traffic jams or local open burning, etc.

The Mean concentrations of benzene, toluene, p-xylene and o-xylene (BTX) are presented in Figure 2.7 and the statistical summary is in Table 2.12. The total BTX level is observed 10.17±6.38 µg/m^3 (Benzene: 0.60 and Toluene: 0.06 µg/m^3) in winter and 2.41±1.82 µg/m^3 (Benzene: 0.16 and Toluene: 0.08 µg/m^3) in summer seasons. The BTX levels were higher during winter than in the summer.

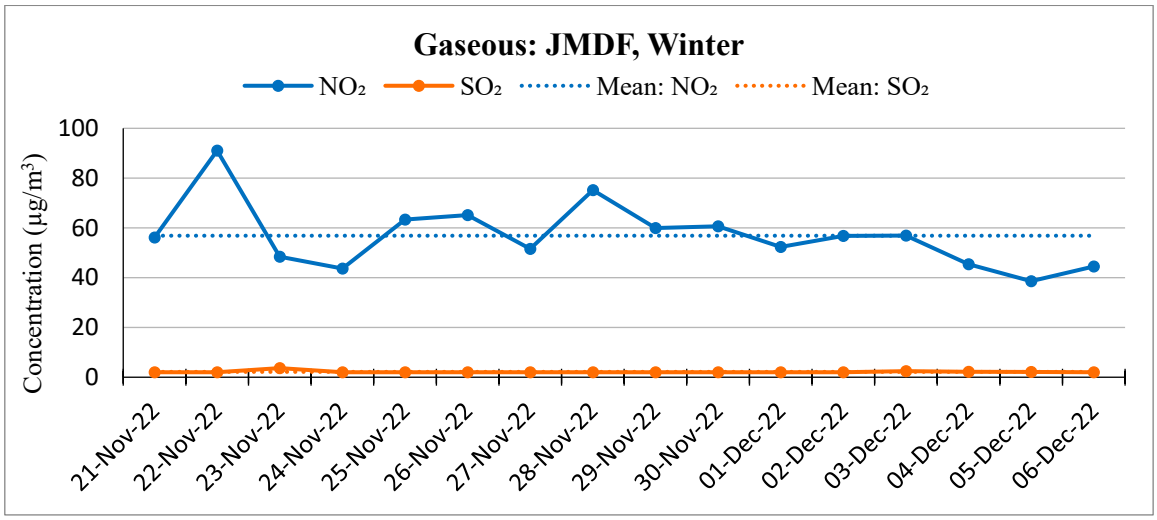


Figure 2.5: SO_2 and NO_2 Concentrations at JMDF for Winter Season

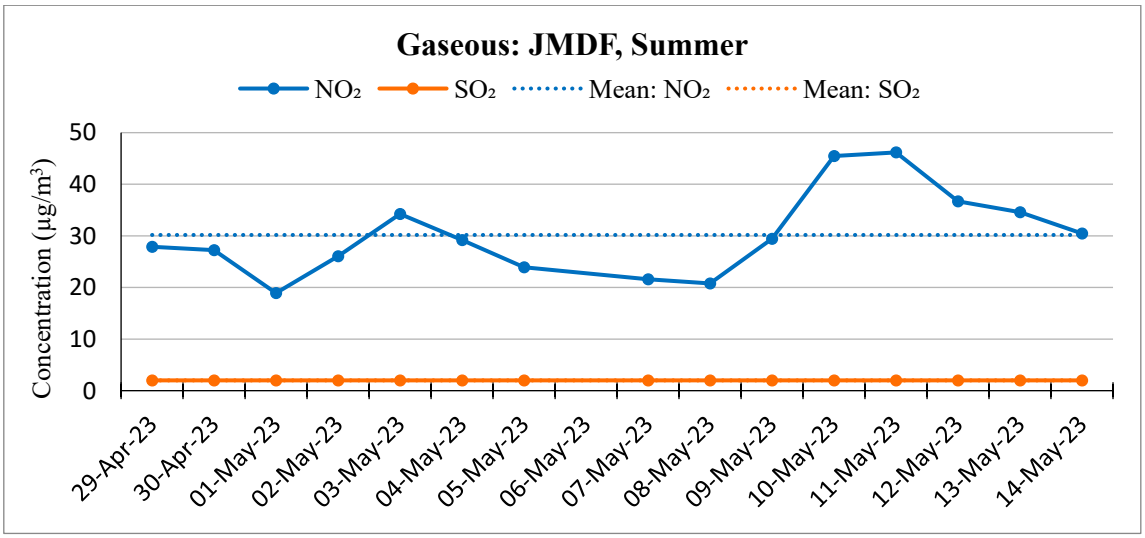


Figure 2.6: SO_2 and NO_2 Concentrations at JMDF for Summer Season

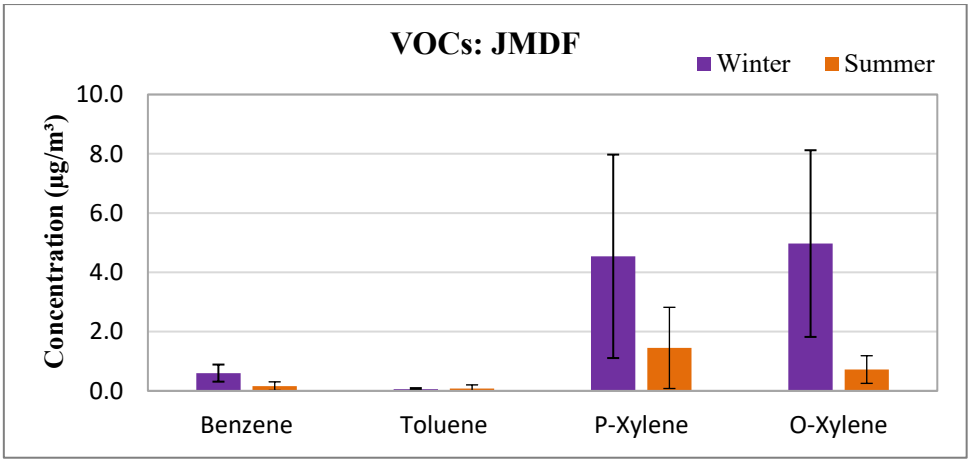


Figure 2.7: VOCs concentration at JMDF

2.4.1.3 Carbon Content (EC-OC) in $PM_{2.5}$

Average concentrations of EC, OC (OC1, OC2, OC3 and OC4) and the ratio of OC fraction to TC are shown in Figure 2.8 (a) and (b) for winter and summer seasons. Organic carbon is observed to be higher (winter: 33.00±10.35 and summer: 11.93±3.58 µg/m^3) than the elemental carbon (winter: 23.27±11.97 and summer: 3.86±0.90 µg/m^3). It is also observed that the OC and EC are higher in the winter than in the summer. A statistical summary of carbon content (OC1, OC2, OC3, OC4; OC, EC, TC with fractions OC1/TC, OC2/TC, OC3/TC and OC4/TC) is presented in Table 2.13 for winter and summer. The ratio of OC2/TC is observed to be higher, which indicates the formation of primary organic carbon in the atmosphere at JMDF.

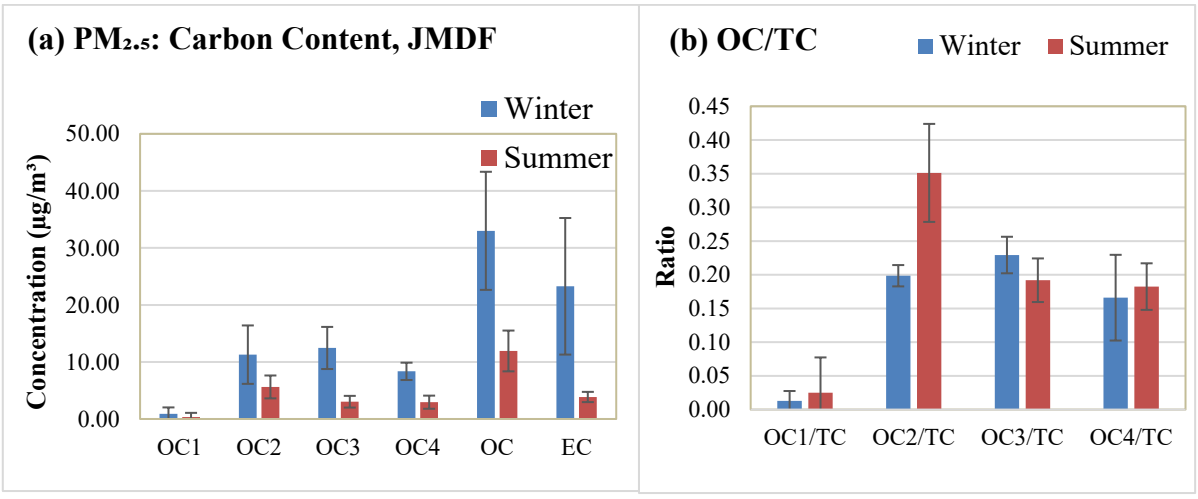


Figure 2.8: EC and OC Content in $PM_{2.5}$ at JMDF

2.4.1.4 PAHs in $PM_{2.5}$

The concentrations of PAHs (from solid phase only) with some specific markers were analysed. Figure 2.9 shows the average measured concentration of PAHs at JMDF for winter and summer seasons. A statistical summary of PAHs is presented in Table 2.14 for winter and summer seasons. The PAHs compounds analyzed were: (i) Di methyl Phthalate (DmP), (ii) Acenaphthylene (AcP), (iii) Di ethyl Phthalate (DEP), (iv) Fluorene (Flu), (v) Phenanthrene (Phe), (vi) Anthracene (Ant), (vii) Pyrene (Pyr), (viii) Butyl benzyl phthalate (BbP), (ix) Bis(2-ethylhexyl) adipate (BeA), (x) Benzo(a)anthracene (B(a)A), (xi) Chrysene (Chr), (xii) Benzo(b)fluoranthene (B(b)F), (xiii) Benzo(k)fluoranthene (B(k)F), (xiv) Benzo(a)pyrene (B(a)P), (xv) Indeno(1,2,3-cd)pyrene (InP), (xvi) Dibenzo(a,h)anthracene (D(a,h)A) and (xvii) Benzo(ghi)perylene (B(ghi)P). It is observed that Total PAHs concentrations are higher in the winter season (83±29 ng/m^3) compared to the summer season (29±13 ng/m^3). Major PAHs are DmP (7.50 ng/m^3 and 18.82 ng/m^3), AcP (5.44 ng/m^3 and 5.3 ng/m^3), DEP (6.94 ng/m^3 and 1.26 ng/m^3) and Flu (8.84 ng/m^3 and .96 ng/m^3) in both winter and summer seasons.

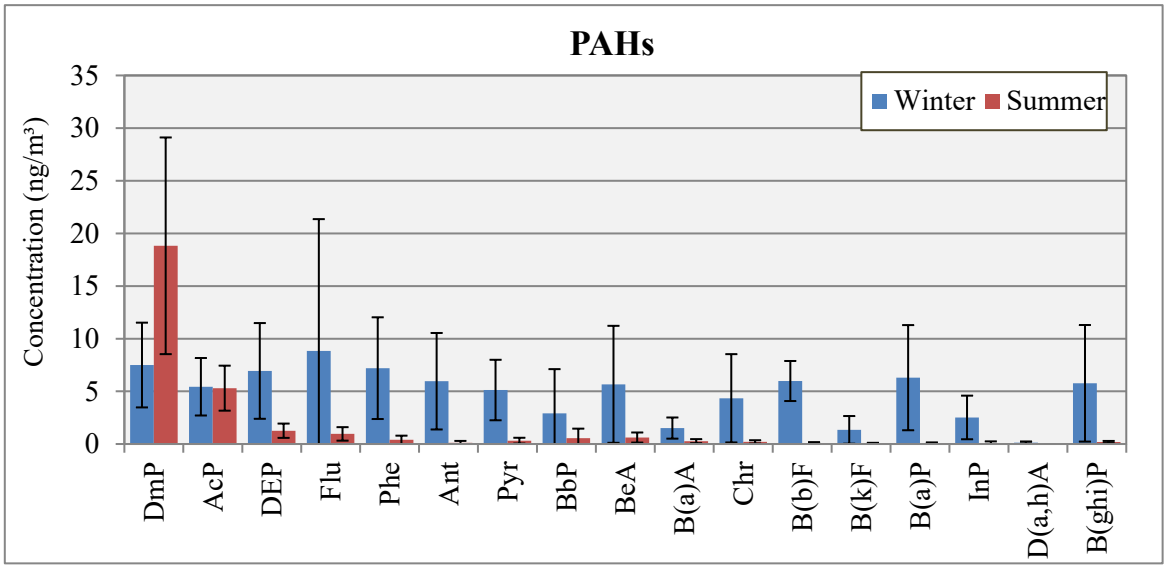


Figure 2.9: PAHs Concentrations in $PM_{2.5}$ at JMDF

2.4.1.5 Molecular Markers in $PM_{2.5}$

A total of six molecular markers analysed were: (i) 17α(H)-22,29,30–Trisnorhopane, (ii) 17α(H)21 α (H)-hopane, (iii) 17β(H)21 β (H)-hopane, (iv) n-Hentriacontane, (v) n-Tritriacontane and (vi) n-Pentatriacontane. The n-alkanes are generally emitted from all types of combustion sources, and hopanes from combustion of coal (C), gasoline (G) and diesel (D).

Figure 2.10 and Table 2.15 show the levels of six molecular markers. Total concentration of markers was 108.0±108.34 ng/m^3 in winter and 69.14±34.13 ng/m^3 in summer. The presence of significant quantities of molecular markers, especially hopanes, conclusively establishes the contribution of CGD.

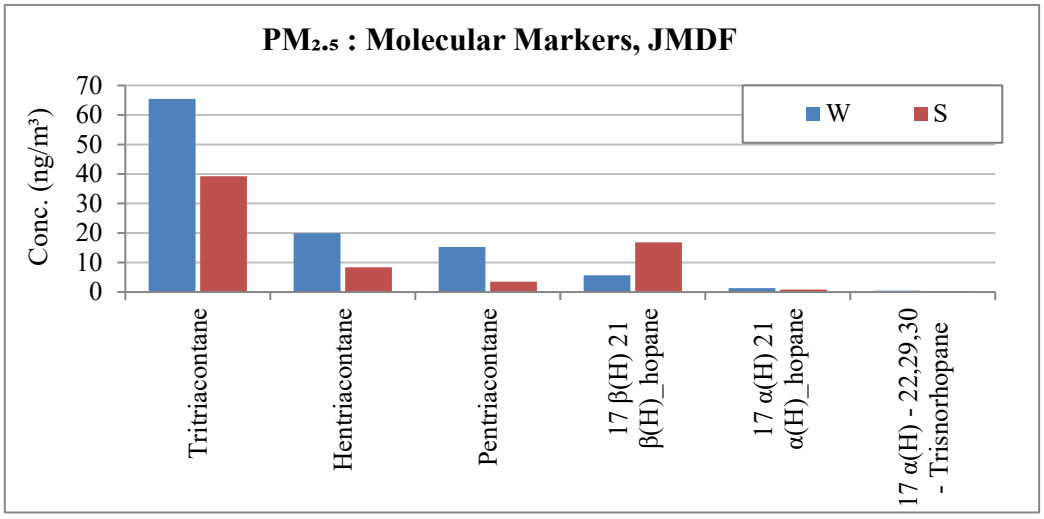


Figure 2.10: Molecular Markers in $PM_{2.5}$ at JMDF

2.4.1.6 Chemical Composition of PM_{10} and $PM_{2.5}$ and their correlation

Graphical presentations of chemical species are shown for the winter and summer seasons for PM_{10} (Figure 2.11) and $PM_{2.5}$ (Figure 2.12). Statistical summary (Mean, maximum, minimum, standard deviation (SD) and coefficient of variation (CV)) for particulate matter (PM_{10} and $PM_{2.5}$), its chemical composition [carbon content (EC and OC), ionic species (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba, Pb)] along with mass percentage (% R) recovered from PM are presented in the Table 2.16 - Table 2.19 for the winter and summer seasons.

The correlation between different parameters (i.e. PM, TC, OC, EC, F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2} and Metals (elements) with major species (PM, TC, OC, EC, NO_3^-, SO_4^{-2}, NH_4^+, Metals) for PM_{10} and $PM_{2.5}$ composition is presented in Table 2.20 - Table 2.23 for both seasons. It is seen that most of the parameters showed good correlation (>0.30) with PM_{10} and $PM_{2.5}$. The percentage constituents of the PM are presented in Figure 2.13 (a) and (b) for the winter season and Figure 2.14 (a) and (b) for the summer season.

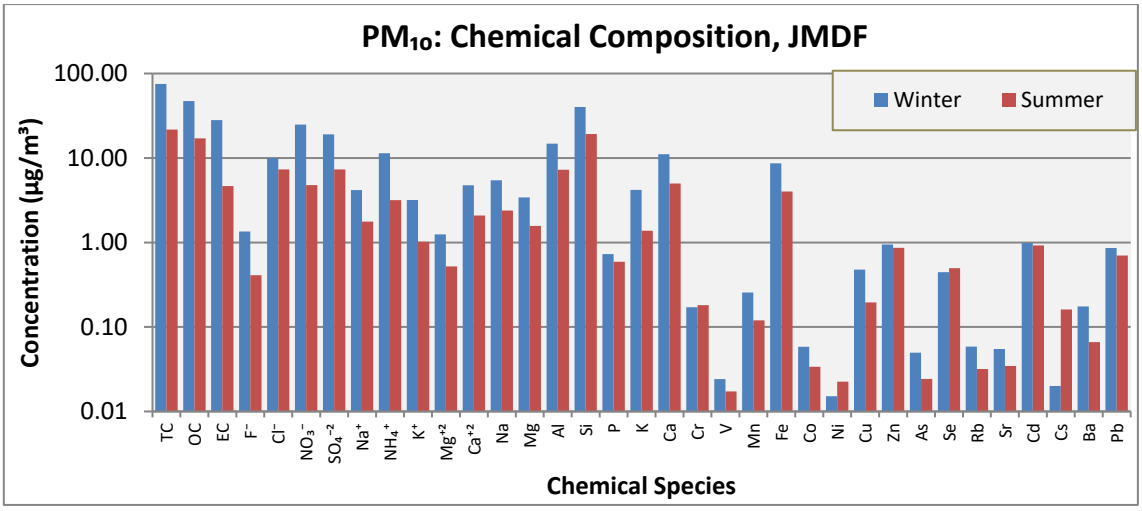


Figure 2.11: Concentrations of species in PM_{10} at JMDF

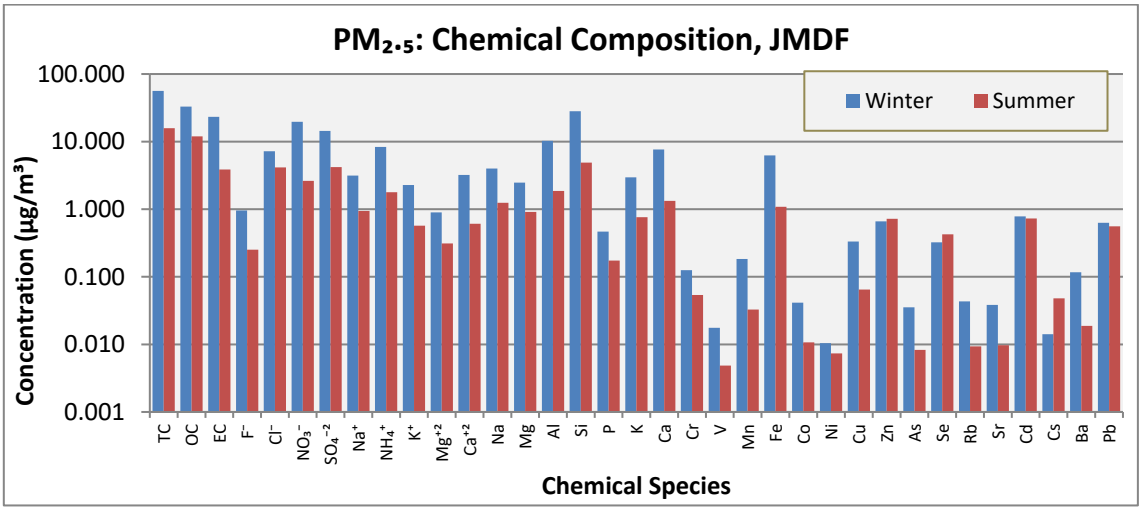
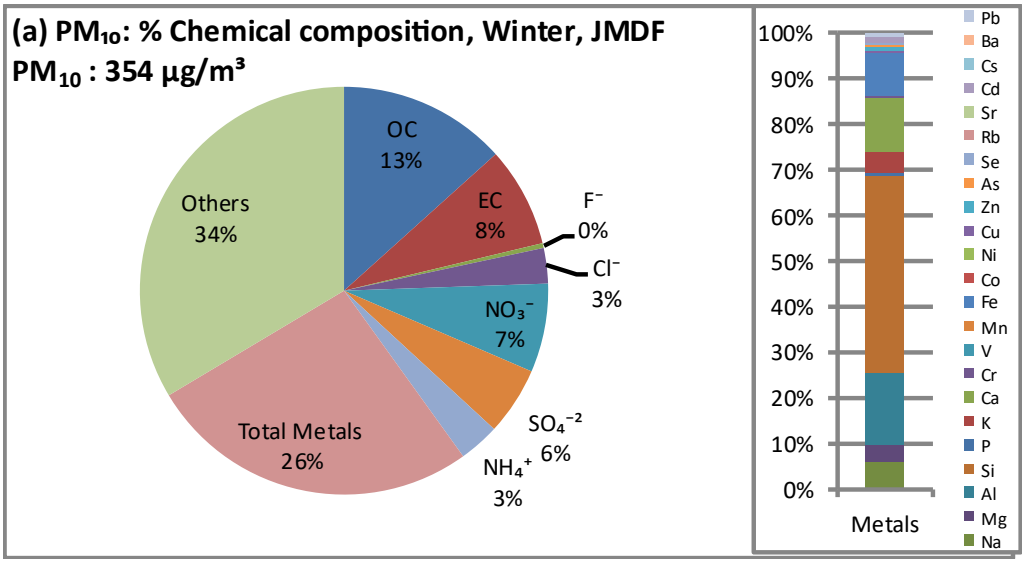


Figure 2.12: Concentrations of species in $PM_{2.5}$ at JMDF



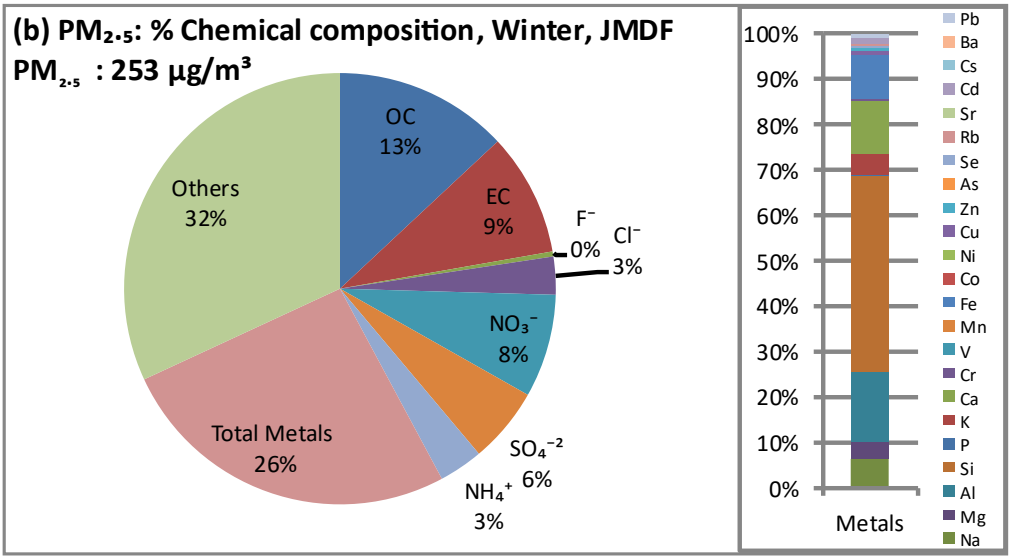
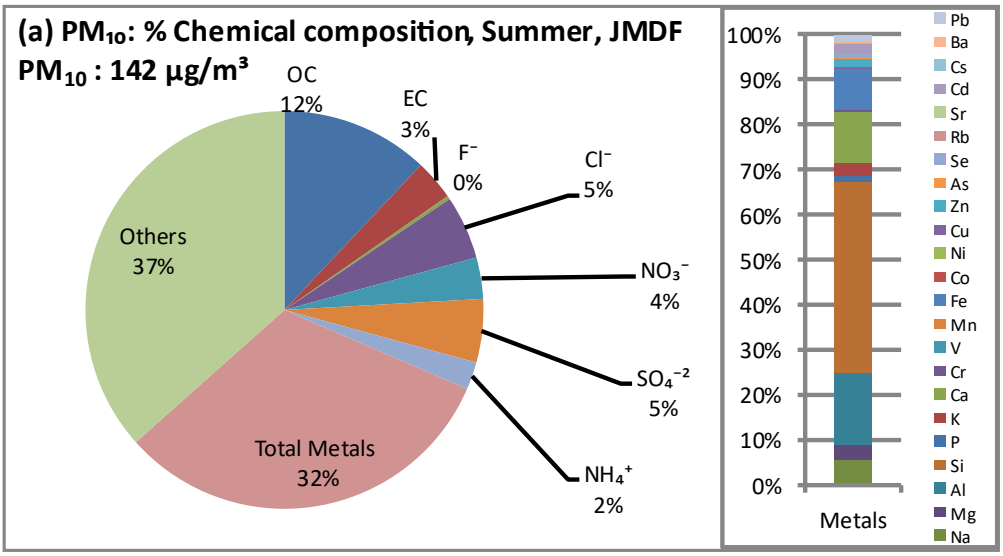


Figure 2.13: Percentage distribution of species in PM at JMDF for Winter Season



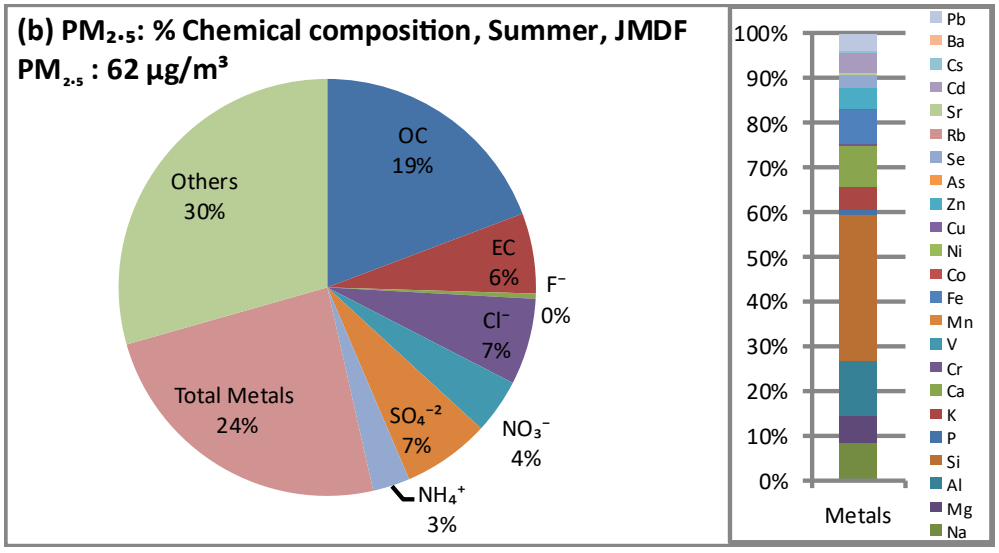


Figure 2.14: Percentage distribution of species in PM at JMDF for Summer Season

2.4.1.7 Comparison of PM_{10} and $PM_{2.5}$ Composition

This section presents some important observations from the experimental findings related to fine particles and PM_{10} concentrations. The graphical presentation is a better option for understanding the compositional variation. Compositional comparison of $PM_{2.5}$ vs PM_{10} for all species is shown for winter and summer seasons (Figure 2.15) at JMDF.

The chemical species considered for the comparisons are carbon content (TC, OC and EC), ionic species (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba, Pb). It is concluded that a similar portion of PM has fine mode during winter (72 %) and summer (44 %). The major species contributing to fine mode are Na^+, K^+, Ca^{2+}, Mg^{2+}, Na, and Mg, whereas major species contributing to coarse mode are OC, Cl^-, Al, Si, Ca, Cr, Fe, P, K and Ni.

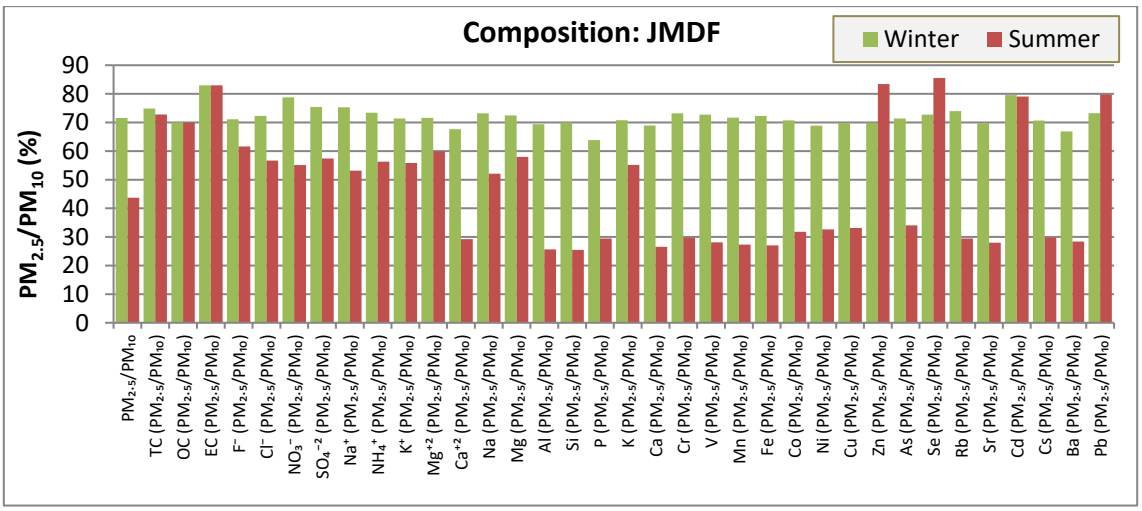


Figure 2.15: Compositional comparison of species in $PM_{2.5}$ Vs PM_{10} at JMDF

Table 2.12: Statistical results of gaseous pollutants (µg/m^3) at JMDF for winter (W) and summer (S) seasons

JMDF (W)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	56.86	2.15	0.60	0.06	4.54	4.97	10.17
SD	12.63	0.41	0.29	0.03	3.43	3.15	6.38
Max	91.06	3.66	0.88	0.11	11.05	10.59	21.64
Min	38.59	2.00	0.00	0.00	1.49	2.13	4.17
CV	0.22	0.19	0.48	0.58	0.76	0.63	0.63
JMDF (S)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	30.17	2.00	0.16	0.08	1.45	0.72	2.41
SD	7.87	0.00	0.14	0.12	1.37	0.47	1.82
Max	46.17	2.00	0.33	0.30	3.72	1.12	5.11
Min	18.92	2.00	0.00	0.00	0.07	0.17	0.25
CV	0.26	0.00	0.90	1.46	0.95	0.65	0.76

Table 2.13: Statistical results of carbon contents (µg/m^3) in $PM_{2.5}$ at JMDF for Winter (W) and summer (S) seasons

JMDF (W)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	253.08	56.27	33.00	23.27	0.90	11.28	12.46	8.36	0.01	0.20	0.23	0.17
SD	64.21	21.93	10.35	11.97	1.13	5.12	3.70	1.52	0.01	0.02	0.03	0.06
Max	354.00	110.82	61.41	49.41	3.14	26.79	21.58	11.21	0.04	0.24	0.28	0.30
Min	145.00	30.95	22.44	6.68	0.00	6.34	8.67	5.84	0.00	0.17	0.19	0.10
CV	0.25	0.39	0.31	0.51	1.26	0.45	0.30	0.18	1.14	0.08	0.12	0.38
JMDF (S)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	62.00	15.79	11.93	3.86	0.33	5.62	3.03	2.95	0.03	0.35	0.19	0.18
SD	16.97	4.35	3.58	0.90	0.74	2.01	1.03	1.15	0.05	0.07	0.03	0.03
Max	91.00	22.66	17.51	5.48	2.61	8.93	5.22	4.70	0.17	0.48	0.25	0.23
Min	35.00	7.83	5.57	2.26	0.00	1.89	1.65	1.21	0.00	0.24	0.15	0.12
CV	0.27	0.28	0.30	0.23	2.23	0.36	0.34	0.39	2.09	0.21	0.17	0.19

Table 2.14: **Statistical results of PAHs (ng/m^3) in $PM_{2.5}$ at JMDF for winter (W) and summer (S) seasons**

JMDF (W)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	7.50	5.44	6.94	8.84	7.20	5.96	5.13	2.91	5.67	1.51	4.34	5.98	1.35	6.30	2.52	0.13	5.76	83.48
SD	4.02	2.73	4.55	12.52	4.83	4.58	2.87	4.20	5.55	1.00	4.19	1.90	1.31	4.99	2.07	0.11	5.54	28.60
Max	13.44	9.32	14.28	35.48	15.00	12.73	9.09	12.39	17.96	3.37	12.33	8.16	4.00	16.39	6.86	0.34	15.73	139.14
Min	3.33	1.62	2.29	0.98	2.51	1.00	2.03	0.95	2.67	0.33	0.51	3.11	0.30	1.70	0.71	0.02	0.89	56.75
CV	0.54	0.50	0.66	1.42	0.67	0.77	0.56	1.44	0.98	0.66	0.97	0.32	0.98	0.79	0.82	0.80	0.96	0.34
JMDF (S)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	18.82	5.30	1.26	0.96	0.40	0.11	0.32	0.55	0.62	0.27	0.20	0.09	0.07	0.08	0.09	0.00	0.19	29.33
SD	10.29	2.14	0.68	0.64	0.40	0.18	0.27	0.91	0.48	0.19	0.16	0.09	0.04	0.07	0.16	0.00	0.10	12.68
Max	30.84	9.75	1.83	2.01	0.86	0.48	0.66	2.41	1.13	0.60	0.53	0.29	0.15	0.24	0.45	0.00	0.41	48.69
Min	5.71	3.52	0.00	0.07	0.00	0.01	0.00	0.05	0.00	0.12	0.09	0.04	0.04	0.03	0.00	0.00	0.10	11.67
CV	0.55	0.40	0.54	0.67	1.00	1.55	0.86	1.65	0.78	0.70	0.77	1.01	0.55	0.94	1.90	0.00	0.55	0.43

Table 2.15: **Statistical results of molecular markers (ng/m^3) in $PM_{2.5}$ at JMDF for winter (W) and summer (S) seasons**

JMDF (W)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	65.42	19.91	15.25	5.68	1.31	0.43	108.00
SD	68.12	22.70	18.51	1.02	0.23	0.18	108.34
CV	1.04	1.14	1.21	0.18	0.18	0.41	1.00
JMDF (S)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	39.22	8.38	3.52	16.84	0.82	0.37	69.14
SD	19.15	5.73	1.59	9.16	0.65	0.23	34.13
CV	0.49	0.68	0.45	0.54	0.79	0.62	0.49

Table 2.16: Statistical results of chemical characterisation (µg/m^3) of PM_{10} at JMDF for winter (W) season

JMDF (W)	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	354	47.1	28.0	1.3	9.9	24.9	19.1	4.2	11.4	3.2	1.2	4.8	5.45	3.42	14.79	40.22	0.73	4.19
SD	94	14.8	14.4	1.0	3.2	8.2	6.7	1.3	4.0	0.6	0.8	1.4	1.77	2.05	4.24	11.73	0.60	0.78
Max	541	87.7	59.5	2.8	16.9	36.8	31.0	6.3	18.4	4.2	3.0	6.9	8.41	7.65	22.12	61.90	2.32	5.20
Min	226	32.1	8.1	0.2	7.1	11.4	9.8	1.5	6.2	2.0	0.2	2.6	1.94	0.66	8.50	23.62	0.09	2.67
CV	0.27	0.31	0.51	0.75	0.32	0.33	0.35	0.31	0.35	0.20	0.64	0.29	0.32	0.60	0.29	0.29	0.83	0.19
JMDF (W)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	11.11	0.17	0.02	0.26	8.64	0.06	0.02	0.48	0.95	0.05	0.45	0.06	0.05	0.98	0.02	0.17	0.86	66.49
SD	3.32	0.08	0.01	0.11	2.50	0.02	0.01	0.18	0.32	0.01	0.34	0.02	0.03	0.69	0.01	0.16	0.31	1.64
Max	16.63	0.36	0.03	0.45	12.51	0.13	0.03	0.80	1.63	0.07	1.23	0.10	0.11	2.35	0.04	0.53	1.31	69.42
Min	6.11	0.06	0.01	0.07	5.04	0.02	0.00	0.24	0.52	0.03	0.01	0.03	0.02	0.04	0.01	0.02	0.32	63.50
CV	0.30	0.46	0.33	0.43	0.29	0.43	0.53	0.38	0.34	0.26	0.75	0.33	0.53	0.70	0.50	0.91	0.36	0.02

Table 2.17: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at JMDF for winter (W) season

JMDF (W)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	253	33.0	23.3	1.0	7.2	19.6	14.4	3.1	8.4	2.3	0.9	3.2	3.99	2.48	10.26	28.16	0.47	2.97
SD	64	10.4	12.0	0.7	2.1	6.0	5.5	1.0	2.8	0.5	0.5	0.9	1.28	1.35	2.86	8.07	0.33	0.62
Max	354	61.4	49.4	2.2	11.3	28.3	24.3	4.6	12.9	3.3	1.6	5.1	5.91	4.14	14.48	41.89	1.17	4.25
Min	145	22.4	6.7	0.2	4.9	10.4	6.5	1.2	4.2	1.3	0.1	1.9	1.50	0.39	5.80	14.95	0.06	1.67
CV	0.25	0.31	0.51	0.77	0.30	0.31	0.38	0.31	0.34	0.21	0.56	0.29	0.32	0.55	0.28	0.29	0.71	0.21
JMDF (W)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	7.66	0.13	0.02	0.18	6.25	0.04	0.01	0.33	0.66	0.04	0.32	0.04	0.04	0.78	0.01	0.12	0.63	68.1
SD	2.19	0.06	0.01	0.08	1.91	0.02	0.01	0.11	0.17	0.01	0.25	0.02	0.02	0.62	0.01	0.10	0.24	1.5
Max	11.50	0.23	0.03	0.41	8.97	0.09	0.02	0.49	1.01	0.05	0.89	0.07	0.07	2.21	0.03	0.37	0.88	70.5
Min	4.46	0.03	0.01	0.06	3.08	0.02	0.00	0.19	0.46	0.02	0.01	0.02	0.01	0.03	0.00	0.02	0.23	64.9
CV	0.29	0.49	0.35	0.46	0.31	0.42	0.53	0.32	0.26	0.25	0.78	0.36	0.48	0.79	0.43	0.86	0.38	0.02

Table 2.18: Statistical results chemical characterisation (µg/m^3) of PM_{10} at JMDF for summer (S) season

JMDF (S)	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	142	17.0	4.7	0.4	7.3	4.8	7.3	1.8	3.2	1.0	0.5	2.1	2.39	1.57	7.26	19.19	0.59	1.38
SD	43	5.1	1.1	0.1	2.7	1.4	3.3	0.5	2.0	0.4	0.3	0.7	0.63	0.81	2.91	7.33	0.30	0.56
Max	196	25.0	6.6	0.7	12.6	7.5	13.5	2.9	6.6	1.7	1.0	3.0	3.82	3.13	12.09	28.69	1.23	2.42
Min	58	8.0	2.7	0.3	4.0	1.0	3.1	1.2	0.7	0.4	0.1	0.7	1.57	0.47	2.27	5.80	0.18	0.49
CV	0.31	0.30	0.23	0.23	0.37	0.30	0.45	0.26	0.64	0.40	0.53	0.34	0.26	0.52	0.40	0.38	0.52	0.40
JMDF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	5.00	0.18	0.02	0.12	4.02	0.03	0.02	0.20	0.86	0.02	0.50	0.03	0.03	0.92	0.16	0.07	0.70	63.95
SD	1.80	0.11	0.01	0.06	1.45	0.01	0.01	0.08	0.43	0.01	0.36	0.02	0.02	0.61	0.07	0.04	0.47	3.19
Max	7.30	0.44	0.03	0.23	5.93	0.06	0.03	0.34	1.65	0.04	1.24	0.05	0.08	2.39	0.27	0.13	1.86	69.18
Min	1.61	0.05	0.00	0.03	1.23	0.02	0.01	0.07	0.30	0.01	0.14	0.01	0.01	0.19	0.05	0.00	0.19	58.65
CV	0.36	0.60	0.54	0.54	0.36	0.36	0.31	0.42	0.50	0.35	0.73	0.48	0.52	0.66	0.45	0.55	0.67	0.05

Table 2.19: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at JMDF for summer (S) season

JMDF (S)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	62.00	11.93	3.86	0.25	4.15	2.63	4.20	0.94	1.78	0.57	0.31	0.61	1.25	0.91	1.86	4.89	0.17	0.76
SD	16.97	3.58	0.90	0.07	1.65	0.79	1.92	0.23	1.16	0.21	0.17	0.17	0.29	0.52	0.68	1.88	0.08	0.30
Max	90.79	17.51	5.48	0.46	7.50	3.95	7.22	1.45	4.48	0.90	0.63	1.02	1.85	1.99	3.31	9.73	0.31	1.26
Min	34.77	5.57	2.26	0.15	2.10	0.56	1.57	0.61	0.44	0.22	0.08	0.37	0.82	0.23	0.78	2.25	0.07	0.28
CV	0.27	0.30	0.23	0.26	0.40	0.30	0.46	0.24	0.65	0.38	0.54	0.28	0.23	0.57	0.37	0.39	0.46	0.39
JMDF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	1.33	0.05	0.00	0.03	1.09	0.01	0.01	0.06	0.72	0.01	0.42	0.01	0.01	0.73	0.05	0.02	0.56	70.59
SD	0.45	0.03	0.00	0.01	0.46	0.01	0.00	0.04	0.39	0.00	0.35	0.00	0.00	0.57	0.03	0.01	0.43	1.75
Max	2.51	0.12	0.01	0.07	2.29	0.03	0.02	0.17	1.46	0.01	1.11	0.02	0.01	2.16	0.12	0.05	1.61	72.96
Min	0.74	0.01	0.00	0.01	0.52	0.01	0.00	0.03	0.22	0.01	0.08	0.00	0.01	0.12	0.02	0.00	0.12	67.70
CV	0.34	0.59	0.35	0.45	0.42	0.50	0.43	0.62	0.55	0.21	0.83	0.46	0.29	0.78	0.56	0.60	0.77	0.02

Table 2.20: Correlation matrix for PM_{10} and its composition at JMDF for the winter season

JMDF (W)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.93	0.89	0.93	-0.40	0.30	0.78	0.74	-0.31	0.67	0.45	-0.55	0.89	0.96
TC		1.00	0.98	0.98	-0.15	0.47	0.63	0.53	-0.12	0.47	0.27	-0.44	0.68	0.80
OC			1.00	0.93	-0.03	0.51	0.51	0.44	-0.11	0.38	0.25	-0.38	0.64	0.77
EC				1.00	-0.26	0.41	0.73	0.60	-0.13	0.55	0.29	-0.48	0.69	0.81
NO_3^-					-0.77	-0.10	1.00	0.75	-0.39	0.82	0.26	-0.48	0.75	0.76
SO_4^{-2}					-0.62	0.05		1.00	-0.29	0.80	0.42	-0.44	0.73	0.75
NH_4^+					-0.74	-0.21			-0.57	1.00	0.35	-0.54	0.75	0.68
Metals					-0.46	0.20			-0.36		0.57	-0.57	0.95	1.00

Table 2.21: Correlation matrix for $PM_{2.5}$ and its composition at JMDF for the winter season

JMDF (W)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.80	0.73	0.82	-0.45	0.27	0.89	0.83	-0.19	0.87	0.54	-0.46	0.89	0.90
TC		1.00	0.98	0.98	-0.19	0.45	0.53	0.41	-0.16	0.54	0.23	-0.51	0.50	0.47
OC			1.00	0.93	-0.07	0.51	0.42	0.31	-0.16	0.45	0.23	-0.45	0.43	0.39
EC				1.00	-0.30	0.38	0.61	0.47	-0.15	0.60	0.23	-0.54	0.54	0.52
NO_3^-					-0.71	-0.04	1.00	0.91	-0.21	0.91	0.44	-0.39	0.87	0.89
SO_4^{-2}					-0.63	-0.03		1.00	-0.05	0.87	0.41	-0.31	0.82	0.89
NH_4^+					-0.67	-0.11			-0.33	1.00	0.47	-0.54	0.85	0.85
Metals					-0.46	0.12			-0.14		0.67	-0.29	0.95	1.00

Table 2.22: Correlation matrix for PM_{10} and its composition at JMDF for the summer season

JMDF (S)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.82	0.83	0.66	-0.35	0.63	0.57	0.70	-0.05	0.40	0.82	0.73	0.95	0.98
TC		1.00	1.00	0.88	-0.17	0.61	0.43	0.70	-0.12	0.37	0.81	0.70	0.63	0.70
OC			1.00	0.83	-0.21	0.58	0.44	0.67	-0.12	0.35	0.83	0.68	0.65	0.72
EC				1.00	0.07	0.64	0.33	0.72	-0.09	0.43	0.64	0.69	0.45	0.52
NO_3^-					-0.11	0.47	1.00	0.35	0.11	0.57	0.36	0.35	0.52	0.50
SO_4^{-2}					-0.12	0.79		1.00	-0.12	0.23	0.55	0.68	0.53	0.61
NH_4^+					-0.27	0.56			-0.20	1.00	0.26	0.55	0.29	0.30
Metals					-0.39	0.52			-0.01		0.78	0.65	0.99	1.00

Table 2.23: Correlation matrix for $PM_{2.5}$ and its composition at JMDF for the summer season

JMDF (S)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.74	0.70	0.81	-0.08	0.88	0.70	0.87	-0.11	0.67	0.57	0.74	0.70	0.95
TC		1.00	0.99	0.89	-0.11	0.50	0.43	0.65	-0.11	0.28	0.83	0.63	0.17	0.49
OC			1.00	0.83	-0.15	0.44	0.42	0.62	-0.12	0.24	0.85	0.59	0.11	0.44
EC				1.00	0.09	0.64	0.41	0.70	-0.05	0.42	0.66	0.69	0.39	0.63
NO_3^-					0.01	0.52	1.00	0.42	0.08	0.59	0.33	0.38	0.60	0.69
SO_4^{-2}					-0.05	0.83		1.00	-0.14	0.31	0.54	0.69	0.55	0.83
NH_4^+					-0.13	0.64			-0.19	1.00	0.17	0.53	0.61	0.74
Metals					-0.05	0.89			-0.06		0.38	0.68	0.84	1.00

2.4.2 Gopinath College, Rasulpur, Firozabad (GCRF)

The sampling period was November 25 – December 09, 2022, for winter and May 01 – May 16, 2023, for summer.

2.4.2.1 Particulate Matter (PM_{10}, $PM_{2.5}$)

Time series of 24-hr average concentrations of PM_{10} and $PM_{2.5}$ at GCRF are shown for winter (Figure 2.16) and summer (Figure 2.17). Average levels at this site were: $PM_{2.5}$: 318±70 (winter) and 67±15 µg/m^3 (summer), and PM_{10}: 429±75 (winter) and 155±34 µg/m^3 (summer). The $PM_{2.5}$ levels were 5.3 times (higher) in winter and 1.1 times (higher) in the summer season compared to the NAAQS (PM2.5: 60 µg/m^3). The PM_{10} levels were 4.3 times (higher) in winter and 1.6 times (higher) in the summer season compared to the NAAQS (PM_{10}: 100 µg/m^3).

In summer, $PM_{2.5}$ levels drop significantly (lies within the NAAQS) compared to PM_{10} levels that continued to be high despite improvement in meteorology and better dispersion. The particles airborne from the soil during dust storms in the dry months of summer can contribute significantly to a coarse fraction (i.e., $PM_{2.5\text{-}10}$).

The corresponding CPCB air quality index (AQI) is 530 ($PM_{2.5}$) and 519 (PM_{10}) for winter, which falls in the category of *severe*. For summer AQI is 210 (for $PM_{2.5}$) and 165 (for PM_{10}), which falls in the category of *poor*.

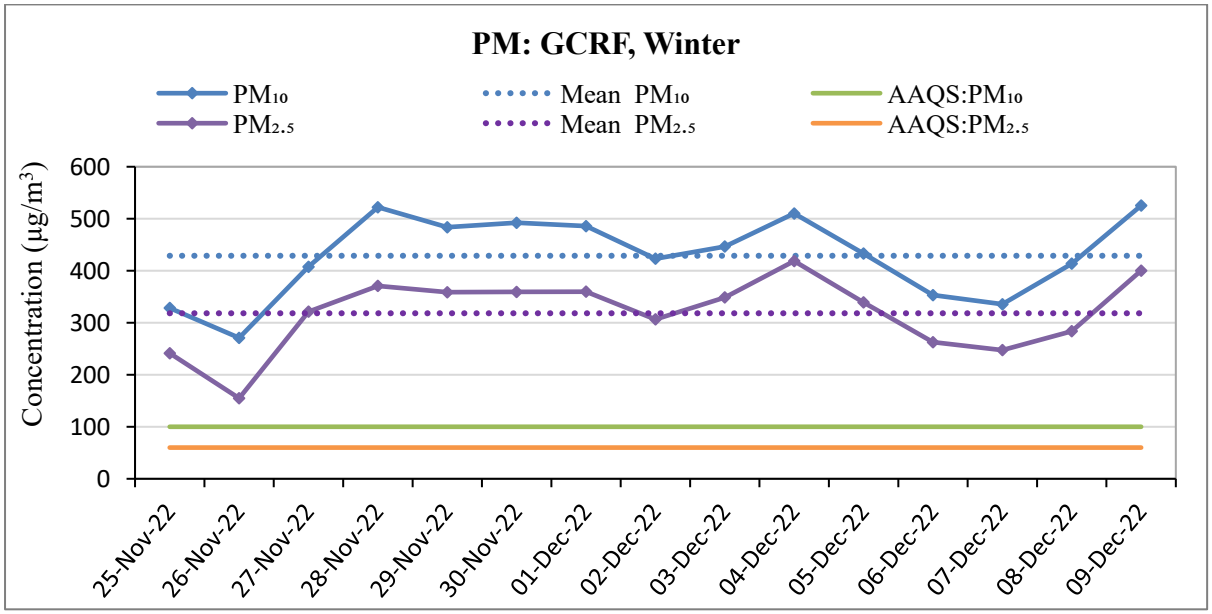


Figure 2.16: PM Concentrations at GCRF, Winter

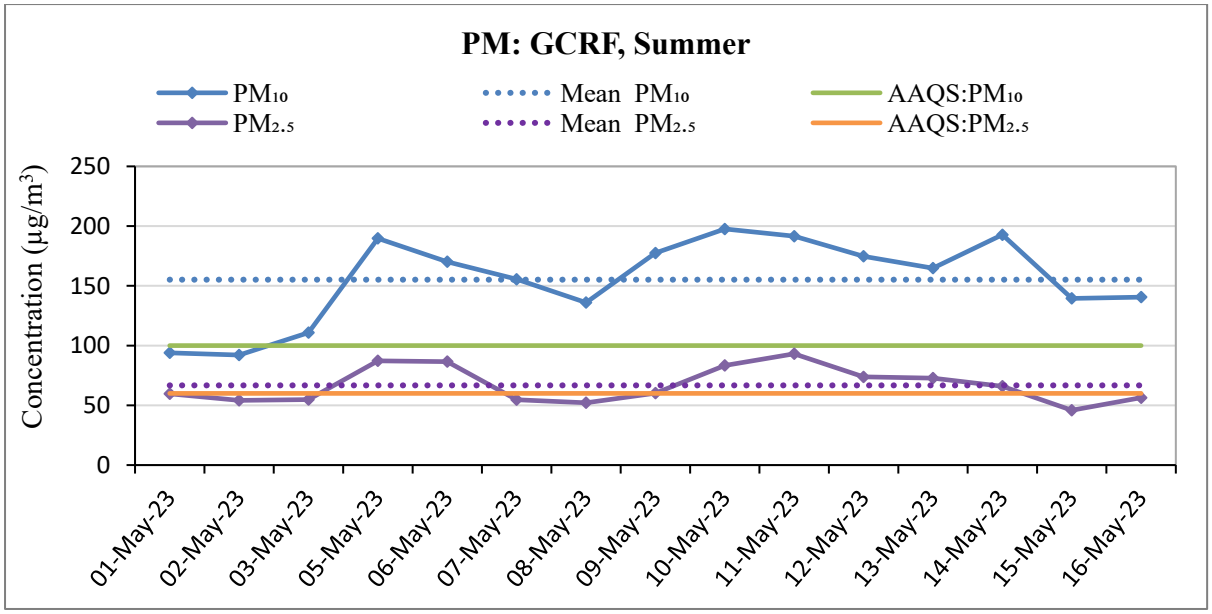


Figure 2.17: PM Concentrations at GCRF, Summer

2.4.2.2 Gaseous pollutants

Time series of 24-hr average concentrations of SO_2 and NO_2 are shown for the winter (Figure 2.18) and summer (Figure 2.19) seasons. It was observed that SO_2 concentrations were low (mostly < 3.0 µg/m^3) and met the air quality standard. NO_2 levels also meet the national standard (80 µg/m^3) with an average of 15 days at 43±9 µg/m^3 in winter and 22±8 µg/m^3 in the summer season (Table 2.24). The summer concentration of NO_2 slightly dropped. NO_2 levels are meeting the standard; it is a matter of concern as NO_2 is largely attributed to vehicular pollution, which is on the rise. Variation in NO_2 is due to variability in meteorology and the presence of occasional local sources like DG sets, traffic jams or local open burning, etc.

The Mean concentrations of benzene, toluene, p-xylene and o-xylene (BTX) are presented in Figure 2.20 and the statistical summary is in Table 2.24. The total BTX level is observed 3.0±0.83 µg/m^3 (Benzene: 0.50 and Toluene: 0.04 µg/m^3) in winter and 11.42±5.85 µg/m^3 (Benzene: 0.31 and Toluene: 0.05 µg/m^3) in summer seasons. The BTX levels were higher during the summer than in the winter.

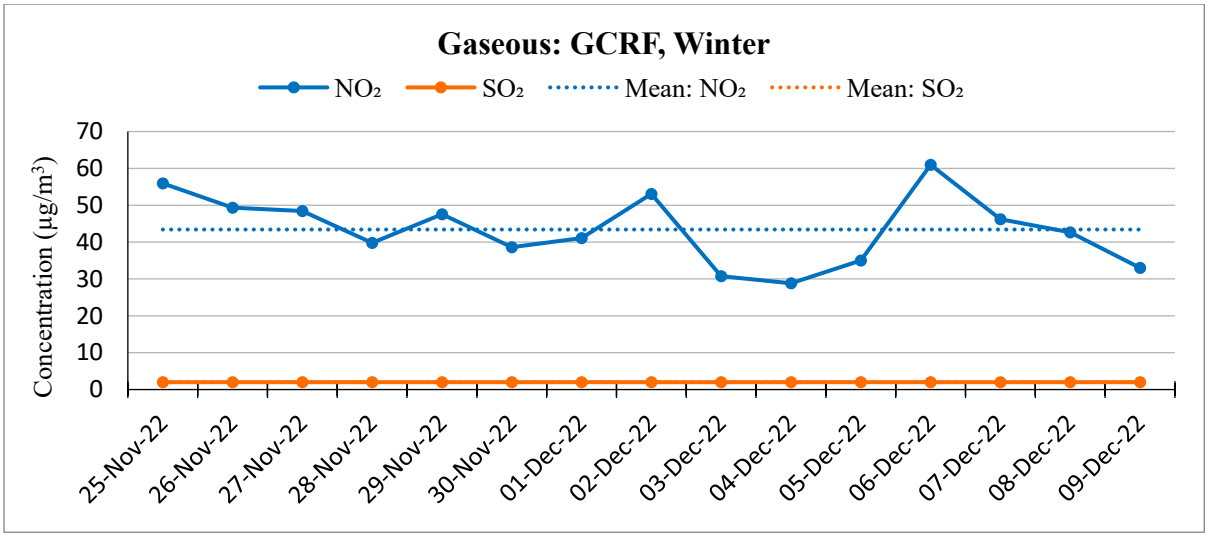


Figure 2.18: SO_2 and NO_2 Concentrations at GCRF for Winter Season

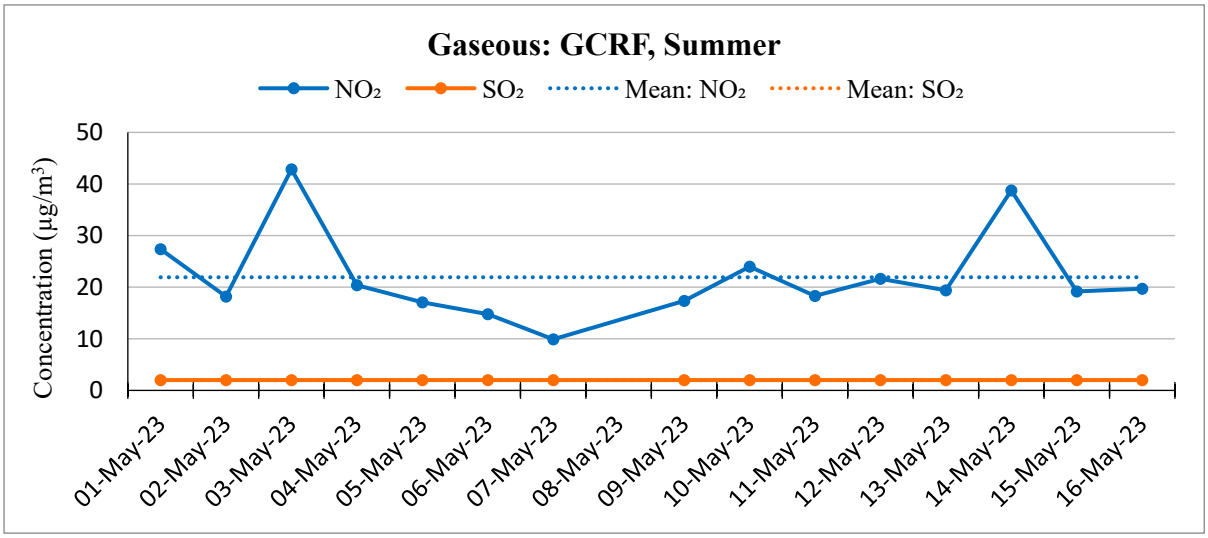


Figure 2.19: SO_2 and NO_2 Concentrations at GCRF for Summer Season

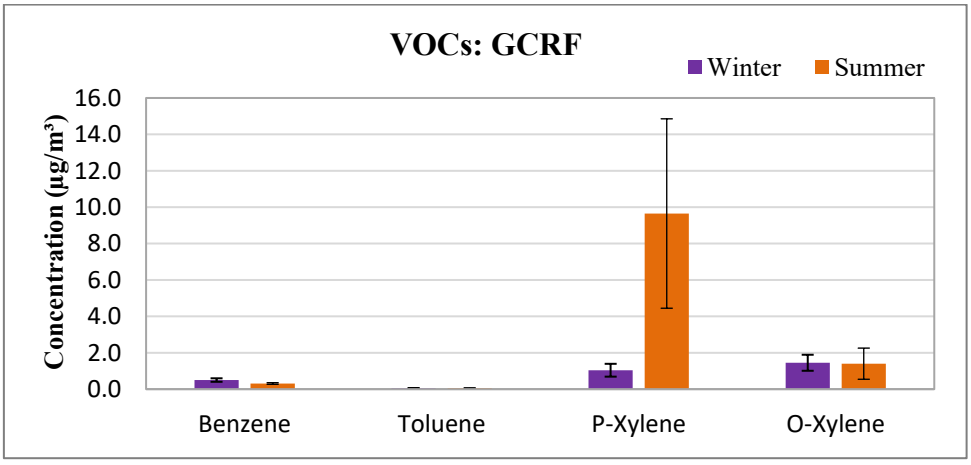


Figure 2.20: VOCs concentration at GCRF

2.4.2.3 Carbon Content (EC/OC) in $PM_{2.5}$

Average concentrations of EC, OC (OC1, OC2, OC3 and OC4) and the ratio of OC fraction to TC are shown in Figure 2.21 (a) and (b) for winter and summer seasons. Organic carbon is observed to be higher (winter: 39.61±9.24 and summer: 13.63±4.83 µg/m3) than the elemental carbon (winter: 22.27±6.98 and summer: 7.12±4.17 µg/m3). It is also observed that the OC and EC are higher in the winter than in the summer. A statistical summary of carbon content (OC1, OC2, OC3, OC4; OC, EC, TC with fractions OC1/TC, OC2/TC, OC3/TC and OC4/TC) is presented in Table 2.25 for winter and summer. The ratio of OC3/TC is observed to be higher, which indicates the formation of secondary organic carbon in the atmosphere at GCRF.

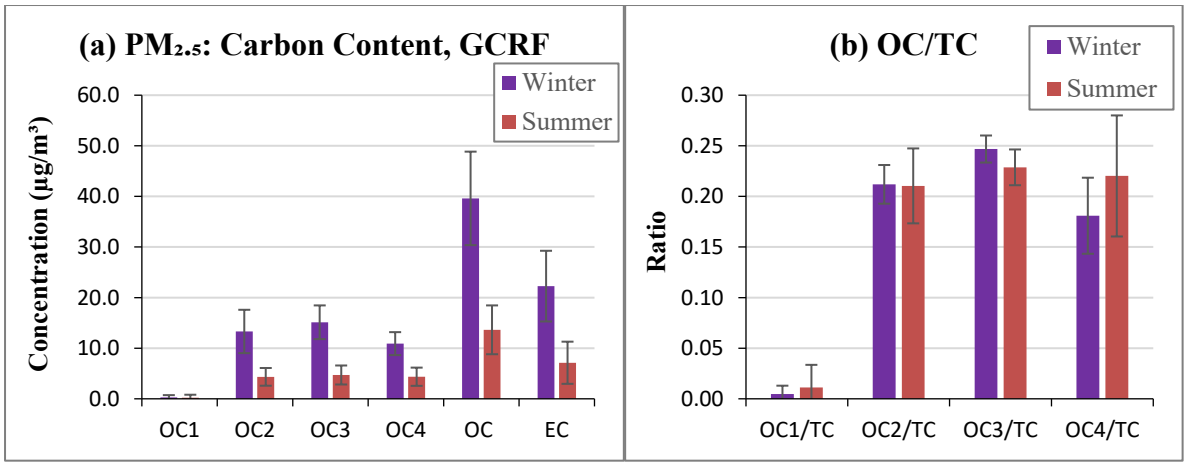


Figure 2.21: EC and OC Content in $PM_{2.5}$ at GCRF

2.4.2.4 PAHs in $PM_{2.5}$

The concentrations of PAHs (from solid phase only) with some specific markers were analysed. Figure 2.22 shows the average measured concentration of PAHs at GCRF for winter and summer seasons. A statistical summary of PAHs is presented in Table 2.26 for winter and summer seasons. The PAHs compounds analyzed were: (i) Di methyl Phthalate (DmP), (ii) Acenaphthylene (AcP), (iii) Di ethyl Phthalate (DEP), (iv) Fluorene (Flu), (v) Phenanthrene (Phe), (vi) Anthracene (Ant), (vii) Pyrene (Pyr), (viii) Butyl benzyl phthalate (BbP), (ix) Bis(2-ethylhexyl) adipate (BeA), (x) Benzo(a)anthracene (B(a)A), (xi) Chrysene (Chr), (xii) Benzo(b)fluoranthene (B(b)F), (xiii) Benzo(k)fluoranthene (B(k)F), (xiv) Benzo(a)pyrene (B(a)P), (xv) Indeno(1,2,3-cd)pyrene (InP), (xvi) Dibenzo(a,h)anthracene (D(a,h)A) and (xvii) Benzo(ghi)perylene (B(ghi)P). It is observed that Total PAHs concentrations are higher in the winter season (99±44 ng/m^3) compared to the summer season (39±25 ng/m^3). Major PAHs are

Phe (8.30 ng/m^3 and 0.72 ng/m^3), DEP (4.03 ng/m^3 and 1.24 ng/m^3) and AcP (8.12 ng/m^3 and 6.38ng/m^3) in winter and summer seasons.

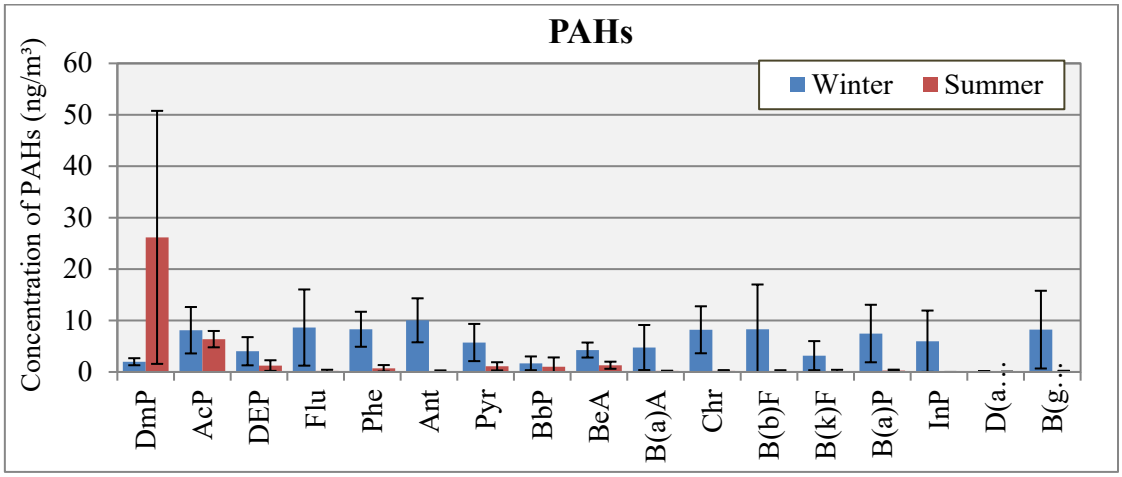


Figure 2.22: PAHs Concentrations in $PM_{2.5}$ at GCRF

2.4.2.5 Molecular Markers in $PM_{2.5}$

A total of six molecular markers analysed were: (i) 17α(H)-22,29,30–Trisnorhopane, (ii) 17α(H)21 α (H)-hopane, (iii) 17β(H)21 β (H)-hopane, (iv) n-Hentriacontane, (v) n-Tritriacontane and (vi) n-Pentatriacontane. The n-alkanes are generally emitted from all types of combustion sources, and hopanes from combustion of coal (C), gasoline (G) and diesel (D).

Figure 2.23 and Table 2.27 show the levels of six molecular markers. Total concentration of markers was 209.84±67.19 ng/m^3 in winter and 158.01±172.73 ng/m^3 in summer. The presence of significant quantities of molecular markers, especially hopanes, conclusively establishes the contribution of CGD.

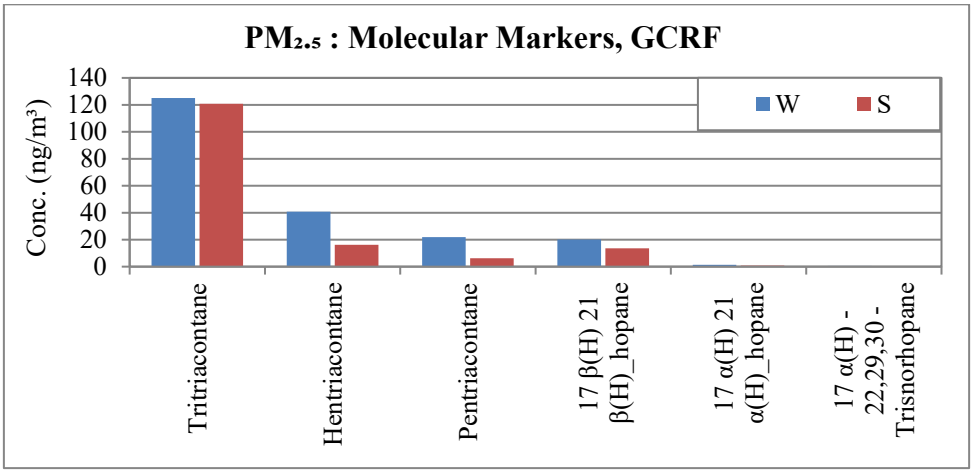


Figure 2.23: Molecular Markers in $PM_{2.5}$ at GCRF

2.4.2.6 Chemical composition of PM_{10} and $PM_{2.5}$ and their correlation matrix

Graphical presentations of chemical species are shown for the winter and summer seasons for PM_{10} (Figure 2.24) and $PM_{2.5}$ (Figure 2.25). Statistical summary for particulate matter (PM_{10} and $PM_{2.5}$), its chemical composition [carbon content, ionic species and elements] along with mass percentage (% R) recovered from PM are presented in the Table 2.28 – Table 2.31 for winter and summer seasons.

The correlation between different parameters (i.e. PM, TC, OC, EC, F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2} and Metals (elements) with major species (PM, TC, OC, EC, NO_3^-, SO_4^{-2}, NH_4^+, Metals) for PM_{10} and $PM_{2.5}$ composition is presented in Table 2.32 - Table 2.35 for both seasons. It is seen that most of the parameters showed good correlation (>0.30) with PM_{10} and $PM_{2.5}$. The percentage constituent of the PM is presented in Figure 2.26 (a) and (b) for the winter season and Figure 2.27 (a) and (b) for the summer season.

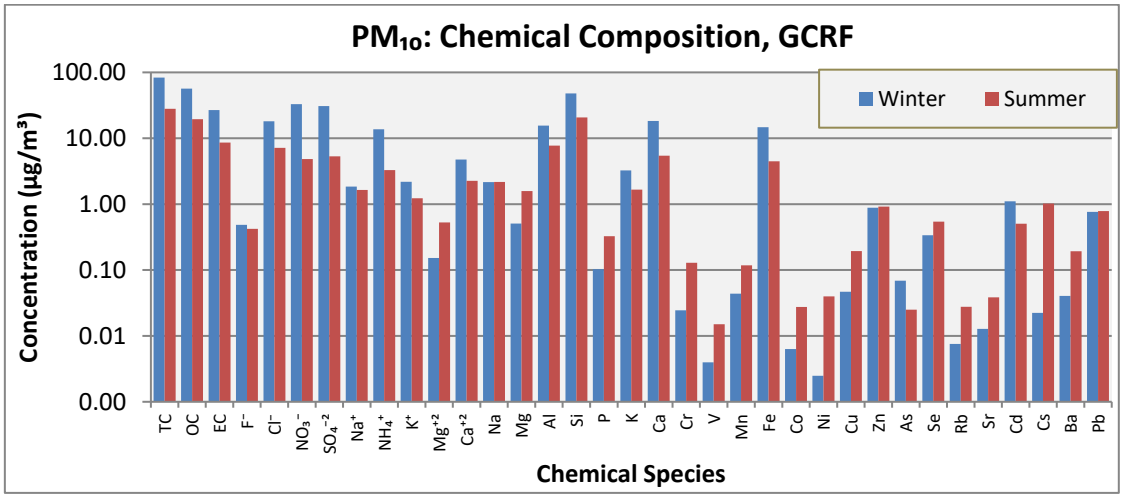


Figure 2.24: Concentrations of species in PM_{10} at GCRF

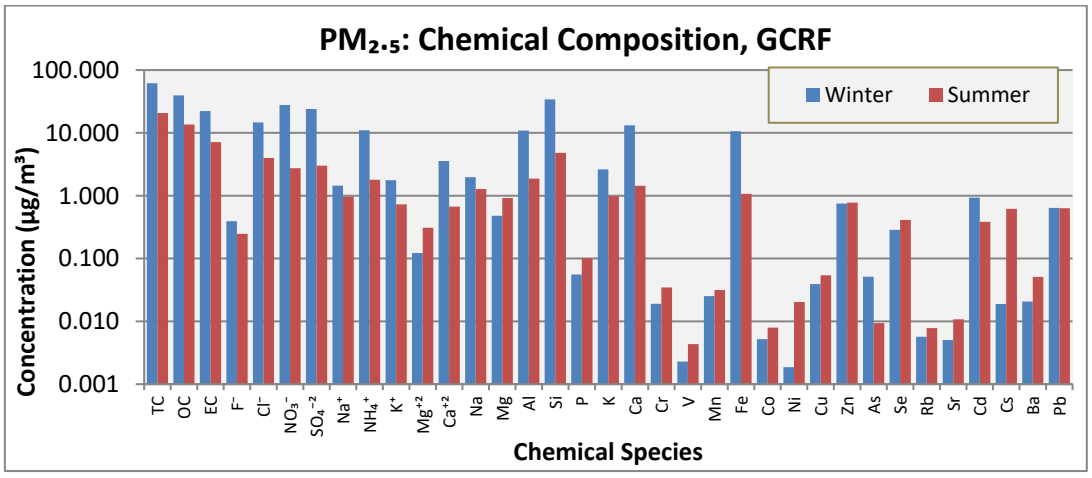


Figure 2.25: Concentrations of species in $PM_{2.5}$ at GCRF

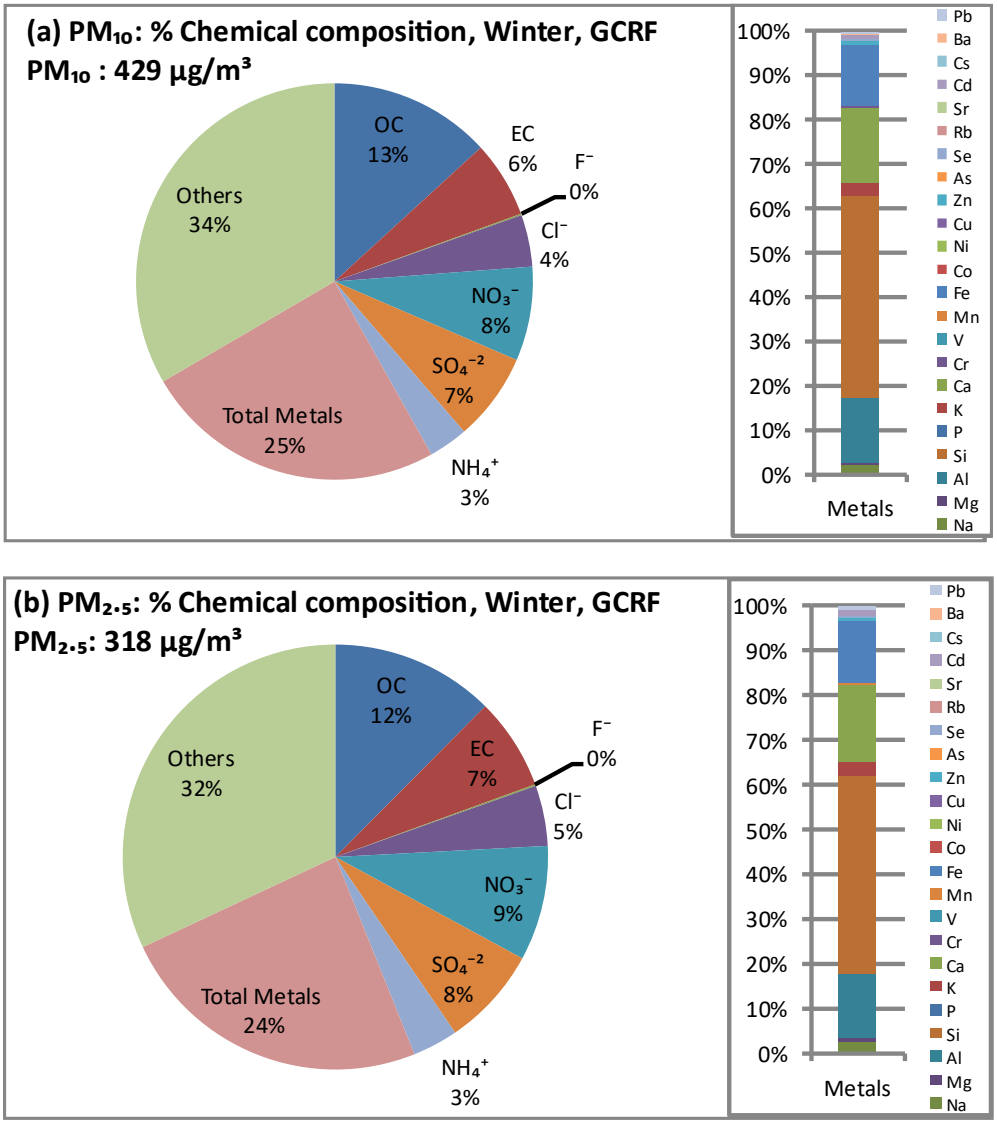
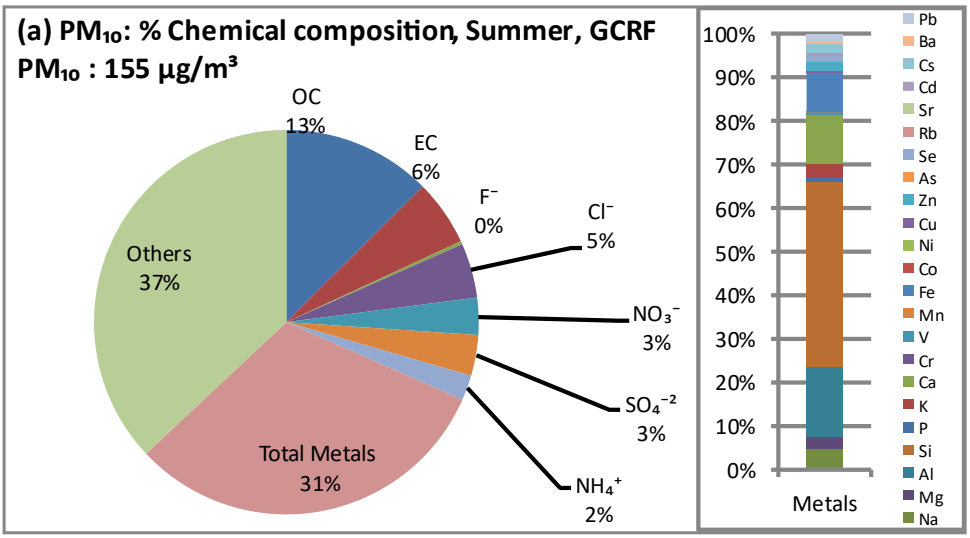


Figure 2.26: Percentage distribution of species in PM at GCRF for Winter Season



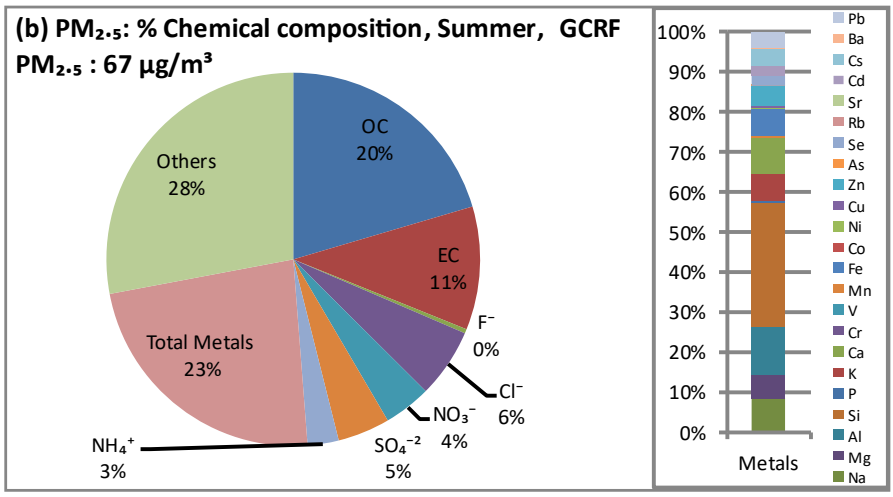


Figure 2.27: Percentage distribution of species in PM at GCRF for Summer Season

2.4.2.7 Comparison of PM_{10} and $PM_{2.5}$ Composition

This section presents some important observations from the experimental findings related to fine particles and PM_{10} concentrations. The graphical presentation is a better option for understanding the compositional variation. Compositional comparison of $PM_{2.5}$ vs PM_{10} for all species is shown for winter and summer seasons (Figure 2.28) at GCRF.

The chemical species considered for the comparisons are carbon content (TC, OC and EC), ionic species (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba, Pb). It is concluded that most of the PM has fine mode during winter (74 %) than summer (43 %). The major species contributing to fine mode are TC, OC, EC, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, V, Zn and Pb, whereas major species contributing to coarse mode are Ca^{2+}, Mg^{2+}, Al, Si, Ca, Cr, Fe and Ni.

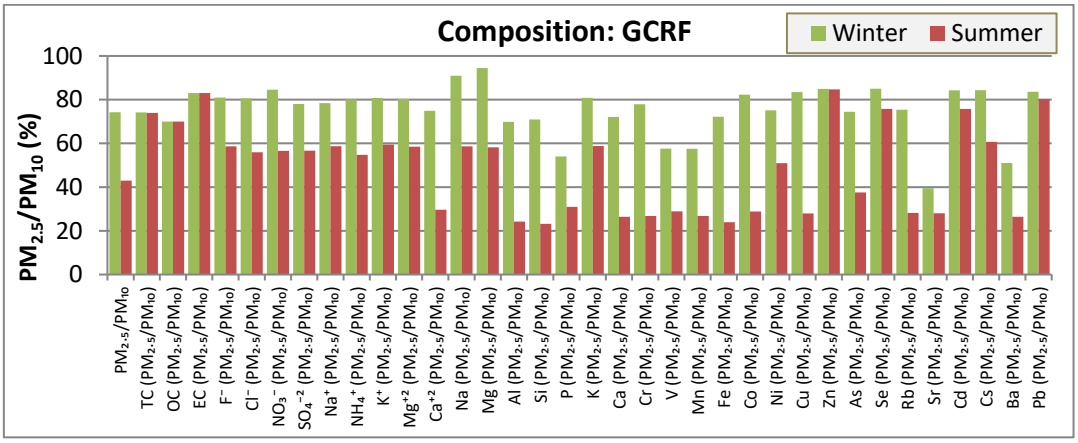


Figure 2.28: Compositional comparison of species in $PM_{2.5}$ Vs PM_{10} at GCRF

Table 2.24: Statistical results of gaseous pollutants (µg/m^3) at GCRF for winter (W) and summer (S) seasons

GCRF (W)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	43.42	2.00	0.50	0.04	1.04	1.45	2.92
SD	9.08	0.00	0.10	0.01	0.35	0.44	0.99
Max	60.97	2.00	0.57	0.04	1.32	2.12	4.00
Min	28.83	2.00	0.29	0.02	0.32	0.71	1.33
CV	0.21	0.00	0.19	0.24	0.34	0.30	0.34
GCRF (S)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	21.92	2.00	0.31	0.05	9.65	1.40	11.42
SD	8.34	0.00	0.05	0.01	5.20	0.86	5.85
Max	42.83	2.00	0.36	0.06	18.10	2.70	21.18
Min	9.90	2.00	0.26	0.03	4.27	0.46	5.51
CV	0.38	0.00	0.15	0.26	0.54	0.61	0.51

Table 2.25: Statistical results of carbon contents (µg/m^3) in $PM_{2.5}$ at GCRF for Winter (W) and summer (S) seasons

GCRF (W)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	318.24	61.88	39.61	22.27	0.27	13.31	15.13	10.90	0.00	0.21	0.25	0.18
SD	69.71	15.74	9.24	6.98	0.46	4.28	3.33	2.27	0.01	0.02	0.01	0.04
Max	419.00	87.06	52.73	34.33	1.32	20.89	20.05	13.85	0.02	0.24	0.27	0.25
Min	155.00	36.69	22.06	12.03	0.00	6.43	9.47	5.39	0.00	0.18	0.23	0.13
CV	0.22	0.25	0.23	0.31	1.70	0.32	0.22	0.21	1.72	0.09	0.05	0.21
GCRF (S)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	66.72	20.75	13.63	7.12	0.23	4.34	4.71	4.36	0.01	0.21	0.23	0.22
SD	15.04	8.46	4.83	4.17	0.58	1.75	1.88	1.80	0.02	0.04	0.02	0.06
Max	93.00	36.31	20.53	16.99	2.19	7.18	8.50	8.28	0.06	0.26	0.27	0.29
Min	46.00	9.68	6.60	3.07	0.00	1.53	2.21	1.86	0.00	0.14	0.19	0.07
CV	0.23	0.41	0.35	0.59	2.54	0.40	0.40	0.41	2.02	0.18	0.08	0.27

Table 2.26: **Statistical results of PAHs (ng/m^3) in $PM_{2.5}$ at GCRF for winter (W) and summer (S) seasons**

GCRF (W)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	1.99	8.12	4.03	8.63	8.30	10.04	5.73	1.68	4.26	4.75	8.20	8.28	3.17	7.47	5.98	0.13	8.23	99.00
SD	0.69	4.51	2.74	7.41	3.40	4.27	3.62	1.34	1.46	4.38	4.57	8.72	2.83	5.59	5.96	0.06	7.56	44.46
Max	3.21	13.66	6.75	21.35	11.89	15.95	10.21	3.96	6.46	11.36	15.89	24.18	7.13	18.06	15.61	0.22	19.59	165.84
Min	1.17	1.33	0.11	0.71	1.98	5.73	0.68	0.55	2.04	0.85	0.60	0.58	0.32	0.49	0.03	0.03	0.21	31.90
CV	0.34	0.56	0.68	0.86	0.41	0.43	0.63	0.80	0.34	0.92	0.56	1.05	0.89	0.75	1.00	0.47	0.92	0.45
GCRF (S)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	26.17	6.38	1.24	0.22	0.72	0.13	1.10	1.03	1.31	0.20	0.20	0.17	0.16	0.27	0.00	0.02	0.18	39.49
SD	24.60	1.59	1.03	0.21	0.63	0.18	0.80	1.80	0.69	0.04	0.16	0.17	0.27	0.17	0.00	0.05	0.05	25.38
Max	61.06	8.67	2.72	0.52	1.70	0.50	2.68	5.00	2.57	0.28	0.56	0.52	0.76	0.52	0.00	0.14	0.25	74.19
Min	1.27	4.26	0.01	0.00	0.00	0.02	0.09	0.06	0.60	0.14	0.10	0.04	0.04	0.04	0.00	0.00	0.11	8.52
CV	0.94	0.25	0.83	1.00	0.88	1.41	0.73	1.75	0.53	0.22	0.81	1.04	1.70	0.64	#DIV/0!	2.65	0.26	0.64

Table 2.27: **Statistical results of molecular markers (ng/m^3) in $PM_{2.5}$ at GCRF for winter (W) and summer (S) seasons**

GCRF (W)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	125.04	40.77	21.96	20.13	1.37	0.58	209.84
SD	51.77	15.24	7.56	6.08	0.20	0.39	67.19
CV	0.41	0.37	0.34	0.30	0.14	0.66	0.32
GCRF (S)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	120.86	16.25	6.19	13.63	0.78	0.30	158.01
SD	174.95	16.44	6.48	5.45	0.29	0.12	172.73
CV	1.45	1.01	1.05	0.40	0.37	0.41	1.09

Table 2.28: Statistical results of chemical characterisation (µg/m^3) of PM_{10} at GCRF for winter (W) season

GCRF (W)	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	429	56.6	26.8	0.5	18.2	32.9	30.9	1.8	13.7	2.2	0.2	4.8	2.16	0.51	15.57	47.98	0.10	3.26
SD	78	13.2	8.4	0.1	5.1	8.5	9.0	0.9	5.0	0.4	0.1	1.8	0.90	0.18	3.45	8.57	0.02	0.78
Max	525	75.3	41.4	0.7	29.2	47.5	41.3	3.8	20.1	2.9	0.3	9.1	4.02	0.86	21.20	62.09	0.13	5.34
Min	271	31.5	14.5	0.3	9.0	19.7	8.0	0.9	3.6	1.5	0.1	1.4	1.09	0.26	10.32	34.41	0.07	2.18
CV	0.18	0.23	0.31	0.24	0.28	0.26	0.29	0.47	0.37	0.20	0.50	0.38	0.42	0.36	0.22	0.18	0.19	0.24
GCRF(W)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	18.30	0.02	0.00	0.04	14.70	0.01	0.00	0.05	0.88	0.07	0.34	0.01	0.01	1.10	0.02	0.04	0.76	66.5
SD	4.08	0.01	0.00	0.01	4.08	0.00	0.00	0.01	0.37	0.04	0.36	0.00	0.00	1.08	0.01	0.01	0.66	2.1
Max	26.98	0.06	0.01	0.06	23.42	0.01	0.01	0.07	1.63	0.18	1.47	0.01	0.02	4.36	0.03	0.07	2.86	70.5
Min	12.78	0.01	0.00	0.03	8.54	0.00	0.00	0.03	0.46	0.03	0.07	0.01	0.01	0.15	0.01	0.03	0.27	62.2
CV	0.22	0.55	0.19	0.19	0.28	0.20	0.90	0.22	0.42	0.62	1.08	0.18	0.19	0.98	0.31	0.29	0.87	0.03

Table 2.29: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at GCRF for winter (W) season

GCRF (W)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	318	39.6	22.3	0.4	14.6	27.8	24.1	1.4	11.0	1.8	0.1	3.6	1.97	0.48	10.87	34.06	0.06	2.63
SD	70	9.2	7.0	0.1	3.5	6.5	7.6	0.6	3.9	0.3	0.1	1.2	0.80	0.17	2.74	8.80	0.02	0.66
Max	419	52.7	34.3	0.5	22.3	37.1	35.2	2.7	15.1	2.3	0.3	6.5	3.63	0.80	14.91	48.27	0.09	4.18
Min	155	22.1	12.0	0.3	8.8	14.7	7.2	0.8	3.3	1.3	0.1	1.1	0.86	0.25	4.84	14.88	0.03	1.70
CV	0.22	0.23	0.31	0.19	0.24	0.23	0.32	0.40	0.35	0.17	0.46	0.34	0.40	0.36	0.25	0.26	0.33	0.25
GCRF (W)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	13.19	0.02	0.00	0.03	10.62	0.01	0.00	0.04	0.75	0.05	0.29	0.01	0.01	0.93	0.02	0.02	0.64	68.1
SD	3.61	0.01	0.00	0.01	3.63	0.00	0.00	0.01	0.31	0.03	0.31	0.00	0.00	0.92	0.01	0.01	0.53	1.2
Max	18.89	0.04	0.00	0.05	16.97	0.01	0.01	0.05	1.33	0.13	1.26	0.01	0.01	3.68	0.03	0.04	2.32	70.5
Min	6.06	0.01	0.00	0.02	4.65	0.00	0.00	0.03	0.37	0.02	0.06	0.00	0.00	0.13	0.01	0.01	0.23	66.1
CV	0.27	0.53	0.24	0.34	0.34	0.21	1.00	0.24	0.41	0.61	1.08	0.23	0.17	0.99	0.31	0.39	0.83	0.02

Table 2.30: Statistical results chemical characterisation (µg/m^3) of PM_{10} at GCRF for summer (S) season

GCRF (S)	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	155	19.5	8.6	0.4	7.1	4.8	5.3	1.6	3.3	1.2	0.5	2.3	2.18	1.58	7.73	20.75	0.33	1.67
SD	35	6.9	5.0	0.1	1.6	1.5	1.9	0.4	0.9	0.2	0.3	0.7	0.57	0.78	2.22	6.26	0.17	0.31
Max	198	29.3	20.5	0.6	10.4	7.3	9.4	2.8	4.5	1.6	1.3	3.2	3.70	3.89	10.59	31.54	0.70	2.24
Min	92	9.4	3.7	0.2	2.9	2.2	3.0	1.0	1.7	1.0	0.3	0.9	1.44	0.87	3.29	8.35	0.08	1.31
CV	0.23	0.35	0.59	0.32	0.23	0.31	0.35	0.27	0.28	0.18	0.49	0.30	0.26	0.49	0.29	0.30	0.52	0.18
GCRF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	5.44	0.13	0.02	0.12	4.46	0.03	0.04	0.19	0.92	0.02	0.54	0.03	0.04	0.51	1.02	0.19	0.79	63.41
SD	1.62	0.08	0.01	0.07	1.30	0.02	0.06	0.14	0.47	0.01	0.48	0.01	0.02	0.29	0.22	0.31	0.56	3.28
Max	7.90	0.29	0.02	0.22	6.79	0.07	0.25	0.50	1.89	0.04	1.74	0.05	0.06	1.05	1.31	1.27	2.27	70.00
Min	2.32	0.03	0.00	0.00	1.91	0.01	0.01	0.03	0.22	0.01	0.05	0.00	0.01	0.10	0.50	0.01	0.25	59.30
CV	0.30	0.62	0.41	0.57	0.29	0.56	1.48	0.70	0.51	0.31	0.89	0.50	0.41	0.58	0.21	1.60	0.71	0.05

Table 2.31: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at GCRF for summer (S) season

GCRF (S)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	66.72	13.63	7.12	0.25	4.00	2.74	3.02	0.97	1.80	0.73	0.31	0.67	1.28	0.92	1.87	4.81	0.10	0.98
SD	15.04	4.83	4.17	0.09	0.99	0.98	1.15	0.36	0.49	0.12	0.16	0.16	0.49	0.47	0.63	1.51	0.07	0.17
Max	93.13	20.53	16.99	0.38	5.80	4.86	5.55	1.77	2.64	0.85	0.77	0.91	2.33	2.24	2.64	7.65	0.28	1.19
Min	45.88	6.60	3.07	0.09	1.48	1.13	1.64	0.53	0.97	0.51	0.15	0.36	0.68	0.39	0.87	2.33	0.04	0.65
CV	0.23	0.35	0.59	0.35	0.25	0.36	0.38	0.37	0.27	0.17	0.51	0.25	0.38	0.51	0.34	0.31	0.69	0.18
GCRF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	1.44	0.03	0.00	0.03	1.07	0.01	0.02	0.05	0.78	0.01	0.41	0.01	0.01	0.38	0.62	0.05	0.63	72.07
SD	0.40	0.02	0.00	0.02	0.35	0.00	0.05	0.03	0.51	0.00	0.36	0.00	0.00	0.25	0.32	0.07	0.50	2.42
Max	1.98	0.08	0.01	0.07	1.75	0.02	0.20	0.13	1.87	0.02	1.36	0.02	0.02	0.92	1.07	0.28	1.83	76.69
Min	0.75	0.01	0.00	0.00	0.56	0.00	0.00	0.01	0.09	0.01	0.03	0.00	0.01	0.09	0.14	0.01	0.17	68.06
CV	0.28	0.60	0.42	0.59	0.33	0.56	2.42	0.64	0.66	0.32	0.86	0.50	0.32	0.65	0.51	1.35	0.79	0.03

Table 2.32: Correlation matrix for PM_{10} and its composition at GCRF for winter season

GCRF (W)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.89	0.89	0.83	0.28	0.08	0.70	0.75	-0.07	0.81	0.66	-0.05	-0.12	0.91
TC		1.00	0.98	0.95	0.14	0.10	0.70	0.56	-0.35	0.77	0.72	-0.06	-0.08	0.66
OC			1.00	0.88	0.22	0.16	0.68	0.61	-0.30	0.77	0.73	0.00	-0.04	0.65
EC				1.00	-0.01	-0.01	0.68	0.44	-0.41	0.72	0.66	-0.14	-0.13	0.63
NO_3^-					0.03	0.37	1.00	0.37	-0.18	0.60	0.78	-0.02	-0.12	0.51
SO_4^{-2}					0.58	-0.11		1.00	0.30	0.73	0.49	0.00	0.08	0.72
NH_4^+					0.29	-0.04			0.05	1.00	0.54	-0.13	0.03	0.67
Metals					0.30	-0.05			0.13		0.47	-0.12	-0.22	1.00

Table 2.33: Correlation matrix for $PM_{2.5}$ and its composition at GCRF for winter season

GCRF (W)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.84	0.84	0.79	0.31	0.12	0.94	0.80	0.22	0.86	0.60	-0.04	-0.15	0.91
TC		1.00	0.98	0.96	0.09	0.25	0.85	0.61	-0.19	0.77	0.64	-0.08	-0.09	0.59
OC			1.00	0.88	0.18	0.31	0.85	0.65	-0.15	0.78	0.63	-0.01	-0.04	0.57
EC				1.00	-0.03	0.15	0.80	0.52	-0.24	0.71	0.60	-0.15	-0.16	0.57
NO_3^-					0.21	0.33	1.00	0.72	0.12	0.74	0.64	-0.03	-0.29	0.77
SO_4^{-2}					0.54	-0.09		1.00	0.42	0.74	0.37	-0.08	-0.11	0.68
NH_4^+					0.25	-0.12			0.16	1.00	0.52	-0.19	0.04	0.76
Metals					0.32	-0.07			0.39		0.49	-0.08	-0.13	1.00

Table 2.34: Correlation matrix for PM_{10} and its composition at GCRF for summer season

GCRF (S)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.69	0.69	0.60	-0.35	0.01	0.37	0.62	-0.22	0.60	0.54	-0.50	0.86	0.91
TC		1.00	0.96	0.92	-0.38	-0.21	-0.12	0.41	-0.19	0.45	0.31	-0.04	0.27	0.37
OC			1.00	0.77	-0.48	-0.31	-0.19	0.43	-0.28	0.51	0.31	-0.04	0.27	0.36
EC				1.00	-0.19	-0.04	-0.01	0.33	-0.02	0.30	0.27	-0.04	0.23	0.32
NO_3^-					0.31	0.71	1.00	0.32	0.29	0.16	0.51	-0.49	0.51	0.49
SO_4^{-2}					0.09	0.37		1.00	-0.02	0.61	0.31	-0.11	0.43	0.49
NH_4^+					-0.41	0.12			-0.31	1.00	0.25	-0.32	0.46	0.47
Metals					-0.28	0.05			-0.17		0.51	-0.62	0.96	1.00

Table 2.35: Correlation matrix for $PM_{2.5}$ and its composition at GCRF for summer season

GCRF (S)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.76	0.73	0.71	-0.08	0.31	0.29	0.74	0.11	0.62	0.62	-0.08	0.58	0.65
TC		1.00	0.95	0.93	-0.41	-0.25	-0.23	0.39	-0.24	0.41	0.31	0.01	0.04	0.03
OC			1.00	0.77	-0.51	-0.34	-0.29	0.45	-0.32	0.50	0.28	0.02	0.06	-0.02
EC				1.00	-0.24	-0.11	-0.13	0.27	-0.11	0.25	0.31	0.01	0.02	0.09
NO_3^-					0.41	0.66	1.00	0.07	0.52	-0.01	0.48	-0.31	0.64	0.74
SO_4^{-2}					0.10	0.36		1.00	0.09	0.65	0.48	0.17	0.47	0.65
NH_4^+					-0.39	0.09			-0.20	1.00	0.39	-0.19	0.44	0.40
Metals					0.43	0.84			0.55		0.64	-0.07	0.77	1.00

2.4.3 St. John Industrial Firozabad (SJIF)

The sampling period was December 09 – December 23, 2022, for winter and May 19 – June 02, 2023, for summer.

2.4.3.1 Particulate Matter (PM_{10}, $PM_{2.5}$)

Time series of 24-hr average concentrations of PM_{10} and $PM_{2.5}$ at SJIF are shown for winter (Figure 2.29) and summer (Figure 2.30). Average levels at this site were: $PM_{2.5}$: 291±100 (winter) and 56±15 µg/m^3 (summer), and PM_{10}: 379±96 (winter) and 148±59 µg/m^3 (summer). The $PM_{2.5}$ levels were 4.8 times (higher) in winter and in compliance in the summer season compared to the NAAQS ($PM_{2.5}$: 60 µg/m^3). The PM_{10} levels were 3.8 times (higher) in winter and 1.5 times (higher) in the summer season compared to the NAAQS (PM_{10}: 100 µg/m^3).

In summer, $PM_{2.5}$ levels drop significantly compared to PM_{10} levels that lie above the NAAQS despite improvements in meteorology and better dispersion. The particles airborne from the soil during dust storms in the dry months of summer can contribute significantly to a coarse fraction (i.e., $PM_{2.5\text{-}10}$). PM_{10} levels show a rise in concentration compared to winter seasons.

The corresponding CPCB air quality index (AQI) is 544 ($PM_{2.5}$) and 544 (PM_{10}) for winter, which falls in the category of *severe*. For summer AQI is 193 (for $PM_{2.5}$) and 236 (for PM_{10}), which falls in the category of *poor*.

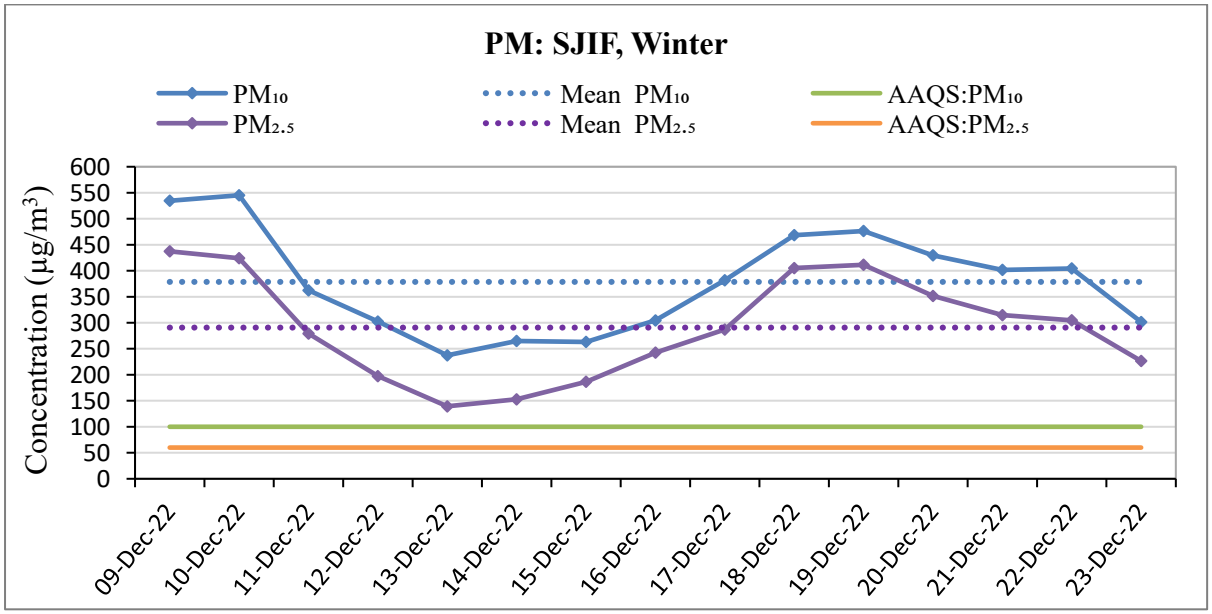


Figure 2.29: PM Concentrations at SJIF, Winter

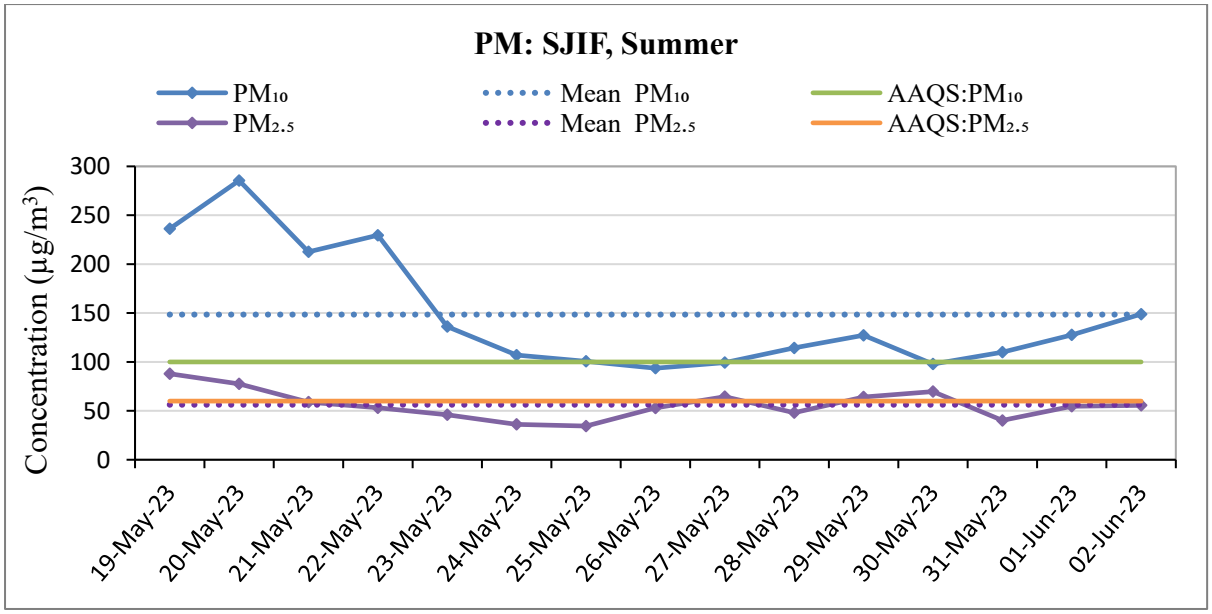


Figure 2.30: PM Concentrations at SJIF, Summer

2.4.3.2 Gaseous pollutants

Time series of 24-hr average concentrations of SO_2 and NO_2 are shown for the winter (Figure 2.31) and summer (Figure 2.32) seasons. It was observed that SO_2 concentrations were low (mostly < 3.0 µg/m^3) and met the air quality standard. NO_2 levels also meet the national standard (80 µg/m^3) with an average of 15 days at 56±15 µg/m^3 in winter and 29±7 µg/m^3 in the summer season (Table 2.36). The summer concentration of NO_2 dropped; NO_2 levels are meeting the standard, but it is a matter of concern as NO_2 is largely attributed to vehicular pollution, which is on the rise. Variation in NO_2 is due to variability in meteorology and the presence of occasional local sources like DG sets, traffic jams or local open burning, etc.

The Mean concentrations of benzene, toluene, p-xylene and o-xylene (BTX) are presented in Figure 2.33 and the statistical summary is in Table 2.36. The total BTX level is observed 10.57±4.9 µg/m^3 (Benzene: 0.77 and Toluene: 0.23 µg/m^3) in winter and 3.53±0.72 µg/m^3 (Benzene: 0.32 and Toluene: 0.05 µg/m^3) in summer seasons. The BTX levels were higher during winter than in the summer.

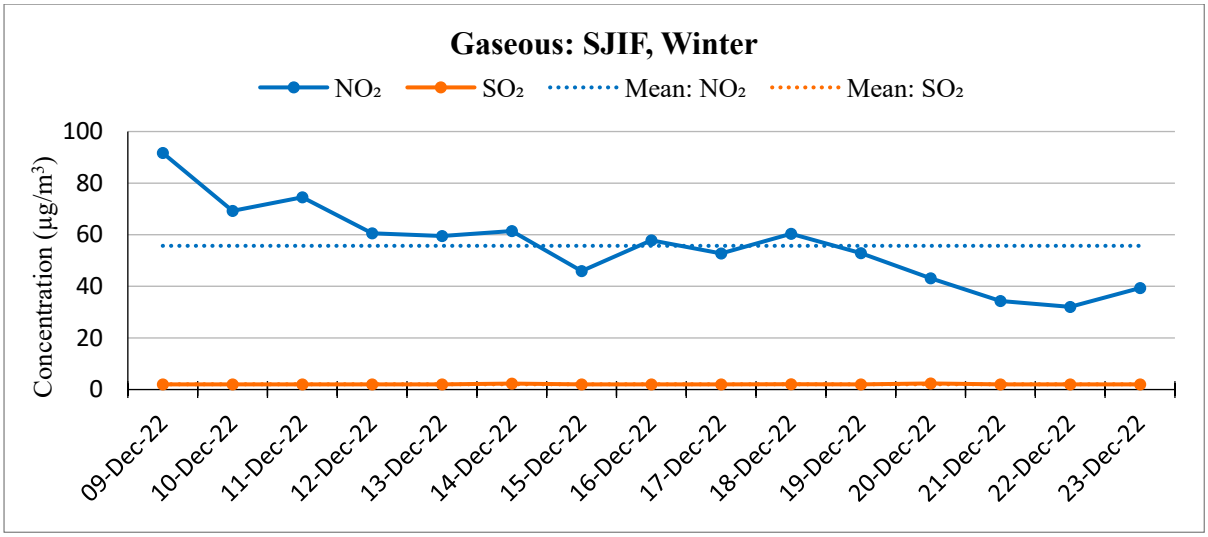


Figure 2.31: SO_2 and NO_2 Concentrations at SJIF for Winter Season

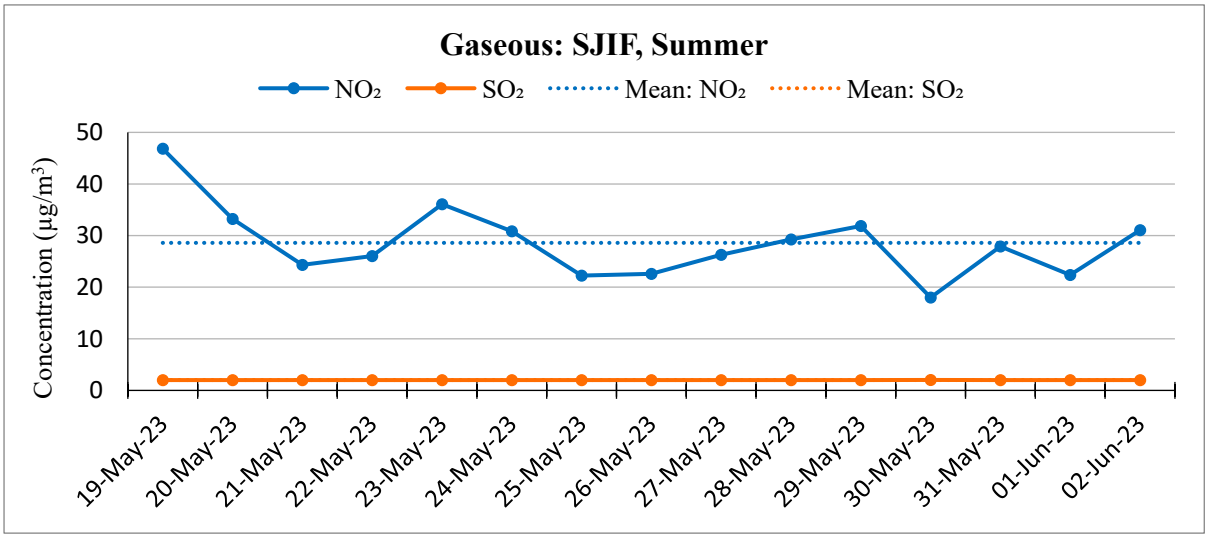


Figure 2.32: SO_2 and NO_2 Concentrations at SJIF for Summer Season

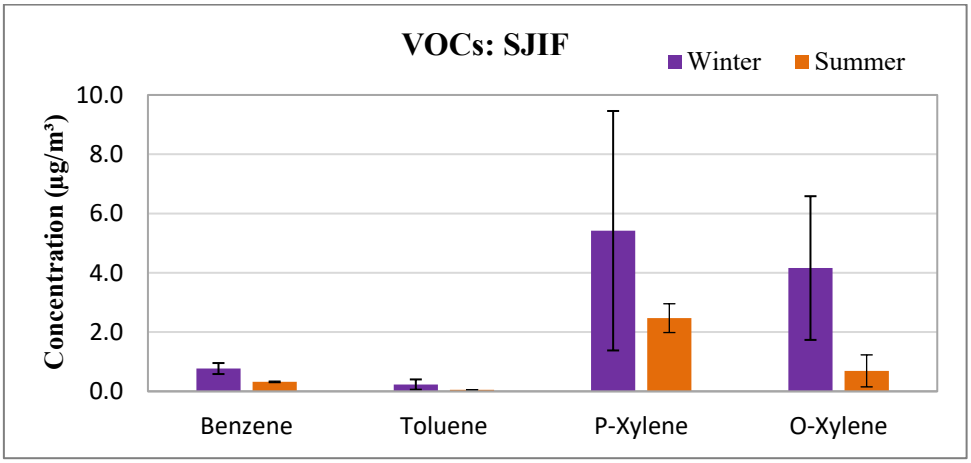


Figure 2.33: VOCs concentration at SJIF

2.4.3.3 Carbon Content (EC/OC) in $PM_{2.5}$

Average concentrations of EC, OC (OC1, OC2, OC3 and OC4) and the ratio of OC fraction to TC are shown in Figure 2.34 (a) and (b) for winter and summer seasons. Organic carbon is observed to be higher (winter: 34.13±8.56 and summer: 9.22±2.28 µg/m^3) than the elemental carbon (winter: 19.33±9.89 and summer: 3.65±1.8 µg/m^3). It is also observed that the OC and EC are higher in the winter than in the summer. A statistical summary of carbon content (OC1, OC2, OC3, OC4; OC, EC, TC with fractions OC1/TC, OC2/TC, OC3/TC and OC4/TC) is presented in Table 2.37 for winter and summer. The ratio of OC2/TC is observed to be higher, which indicates the formation of primary organic carbon in the atmosphere at SJIF.

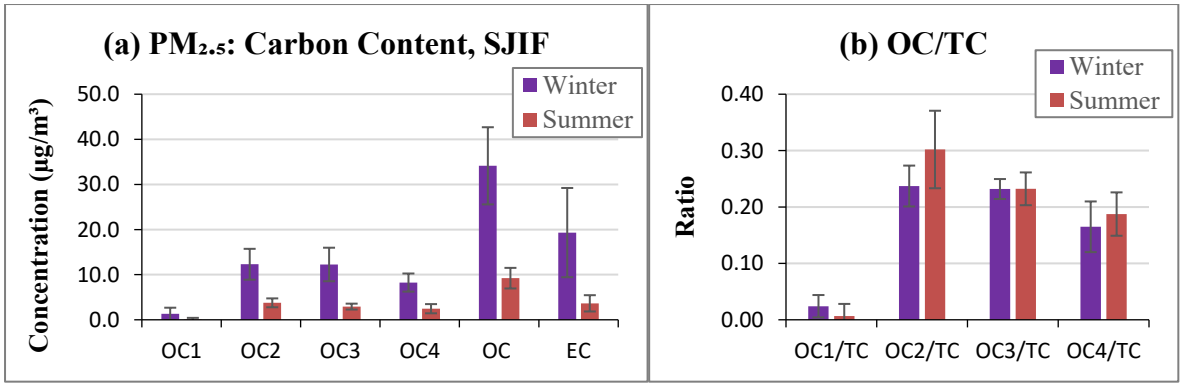


Figure 2.34: EC and OC Content in $PM_{2.5}$ at SJIF

2.4.3.4 PAHs in $PM_{2.5}$

The concentrations of PAHs (from solid phase only) with some specific markers were analysed. Figure 2.35 shows the average measured concentration of PAHs at SJIF for winter and summer seasons. A statistical summary of PAHs is presented in Table 2.38 for winter and summer seasons. The PAHs compounds analyzed were: (i) Di methyl Phthalate (DmP), (ii) Acenaphthylene (AcP), (iii) Di ethyl Phthalate (DEP), (iv) Fluorene (Flu), (v) Phenanthrene (Phe), (vi) Anthracene (Ant), (vii) Pyrene (Pyr), (viii) Butyl benzyl phthalate (BbP), (ix) Bis(2-ethylhexyl) adipate (BeA), (x) Benzo(a)anthracene (B(a)A), (xi) Chrysene (Chr), (xii) Benzo(b)fluoranthene (B(b)F), (xiii) Benzo(k)fluoranthene (B(k)F), (xiv) Benzo(a)pyrene (B(a)P), (xv) Indeno(1,2,3-cd)pyrene (InP), (xvi) Dibenzo(a,h)anthracene (D(a,h)A) and (xvii) Benzo(ghi)perylene (B(ghi)P). It is observed that Total PAHs concentrations are higher in the winter season (79±33 ng/m^3) compared to the summer season (29±28 ng/m^3). Major PAHs are

Dmp (5.54 ng/m^3 and 7.81 ng/m^3), Phe (9.45 ng/m^3 and 5.37 ng/m^3) and AcP (7.07 ng/m^3 and 5.79 ng/m^3) in both winter and summer seasons.

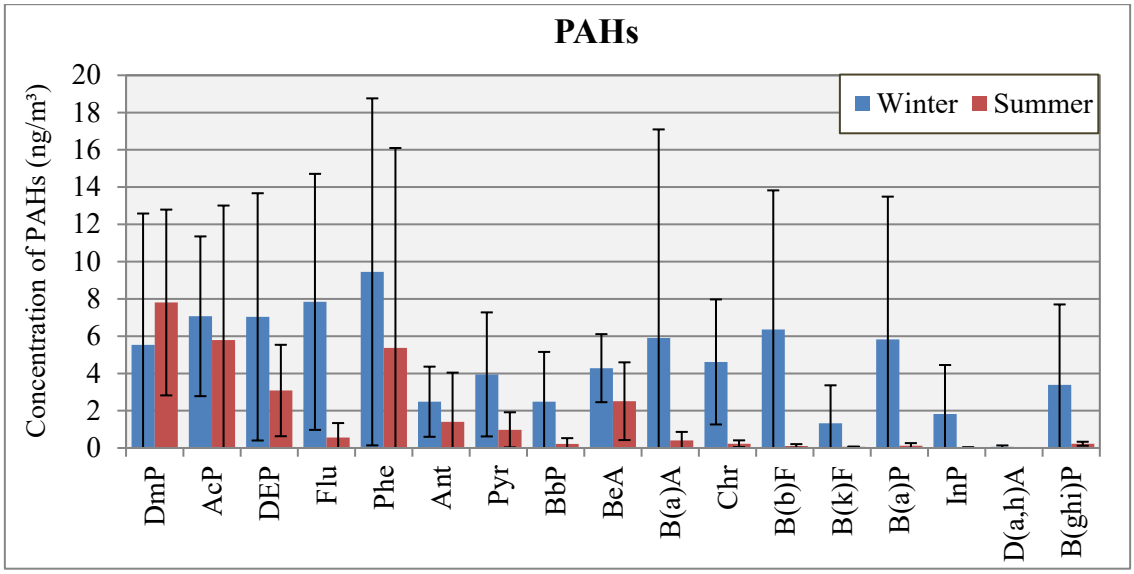


Figure 2.35: PAHs Concentrations in $PM_{2.5}$ at SJIF

2.4.3.5 Molecular Markers in $PM_{2.5}$

A total of six molecular markers analysed were: (i) 17α(H)-22,29,30–Trisnorhopane, (ii) 17α(H)21 α (H)-hopane, (iii) 17β(H)21 β (H)-hopane, (iv) n-Hentriacontane, (v) n-Tritriacontane and (vi) n-Pentatriacontane. The n-alkanes are generally emitted from all types of combustion sources, and hopanes from combustion of coal (C), gasoline (G) and diesel (D).

Figure 2.36 and Table 2.39 show the levels of six molecular markers. Total concentration of markers was 257.61±44.16 ng/m^3 in winter and 23.52±6.57 ng/m^3 in summer. The presence of significant quantities of molecular markers, especially hopanes, conclusively establishes the contribution of CGD.

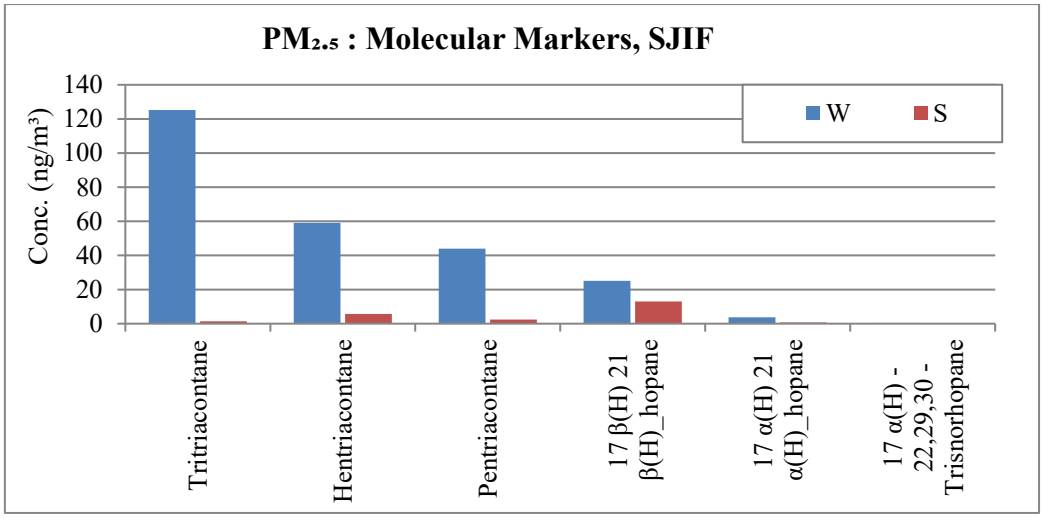


Figure 2.36: Molecular Markers in $PM_{2.5}$ at SJIF

2.4.3.6 Chemical Composition of PM_{10} and $PM_{2.5}$ and their correlation matrix

Graphical presentations of chemical species are shown for the winter and summer seasons for PM_{10} (Figure 2.37) and $PM_{2.5}$ (Figure 2.38). Statistical summary for particulate matter (PM_{10} and $PM_{2.5}$), its chemical composition [carbon content, ionic species and elements] along with mass percentage (% R) recovered from PM are presented in the Table 2.40-Table 2.43 for the winter and summer seasons.

The correlation between different parameters (i.e. PM, TC, OC, EC, F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2} and Metals (elements) with major species (PM, TC, OC, EC, NO_3^-, SO_4^{-2}, NH_4^+, Metals) for PM_{10} and $PM_{2.5}$ composition is presented in Table 2.44-Table 2.47 for both seasons. It is seen that most of the parameters showed good correlation (>0.30) with PM_{10} and $PM_{2.5}$. The percentage constituent of the PM is presented in Figure 2.39 (a) and (b) for the winter season and Figure 2.40 (a) and (b) for the summer season.

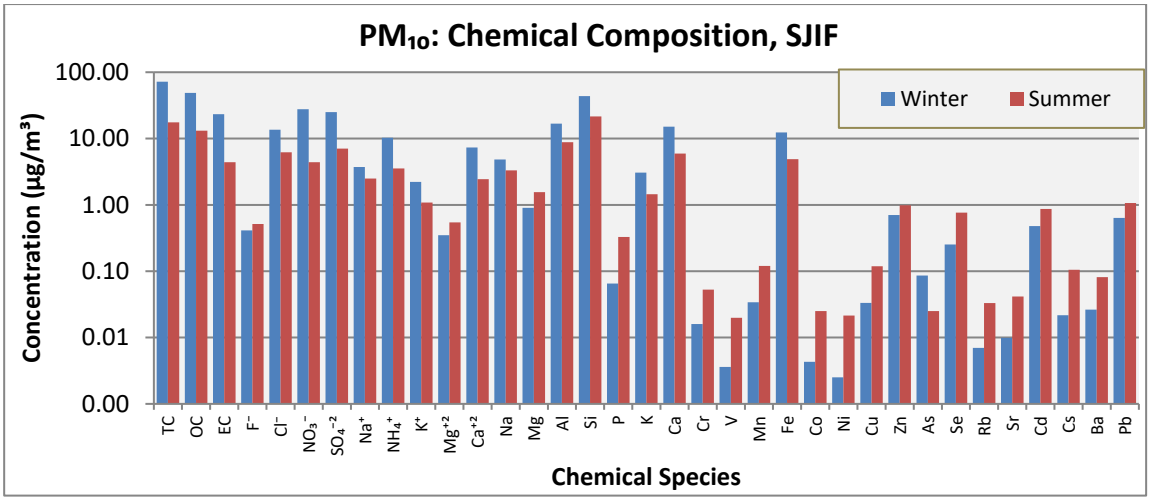


Figure 2.37: Concentrations of species in PM_{10} at SJIF

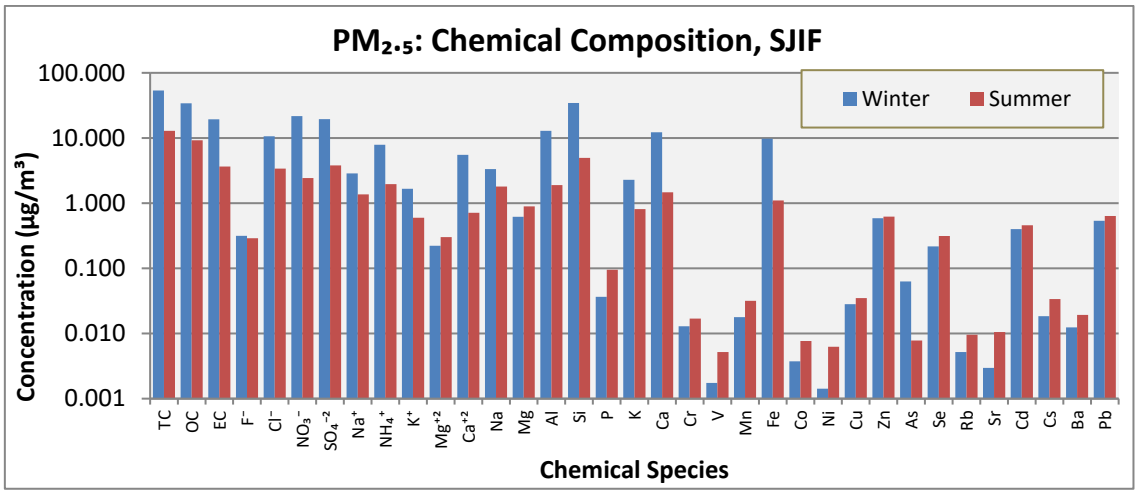
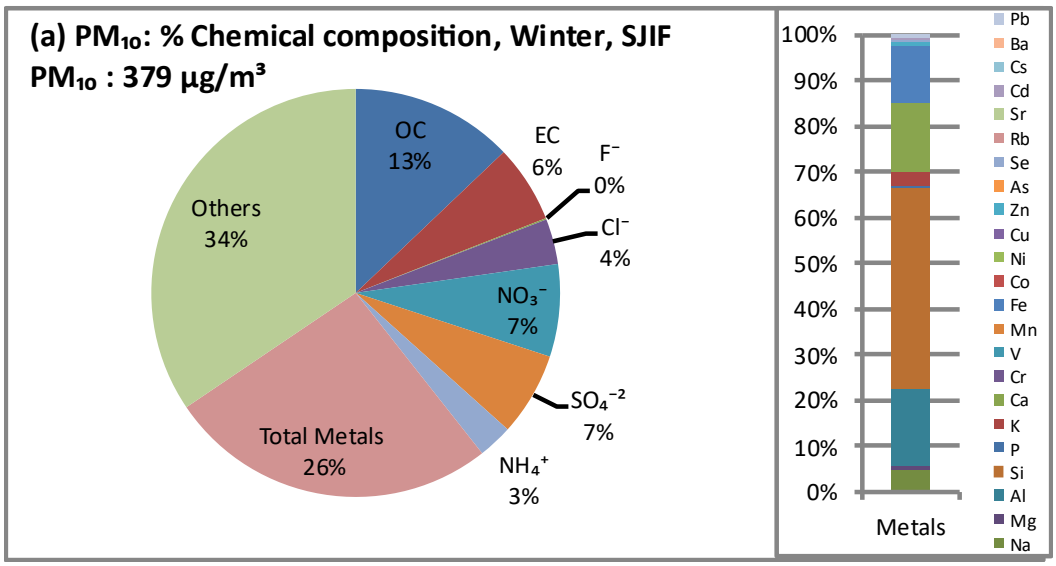


Figure 2.38: Concentrations of species in $PM_{2.5}$ at SJIF



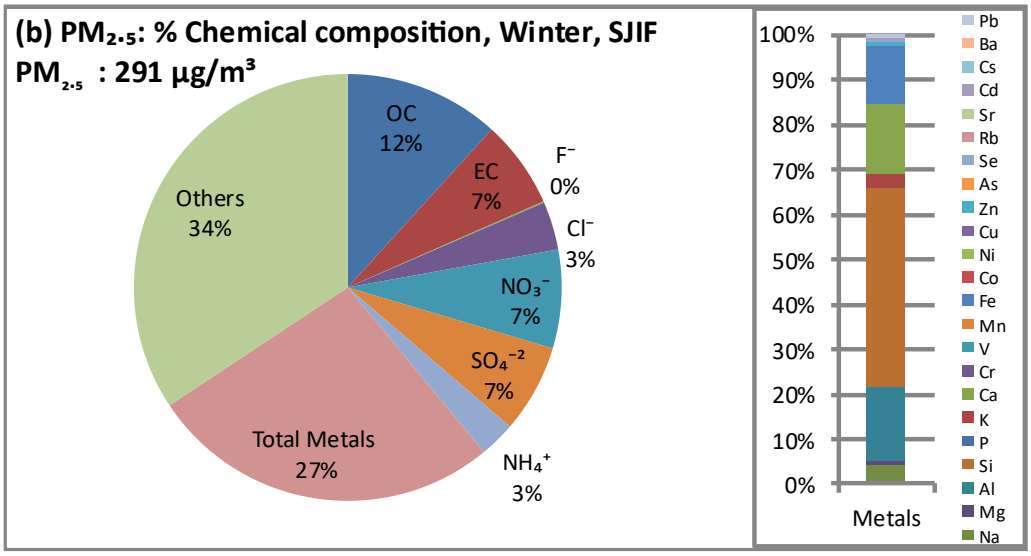
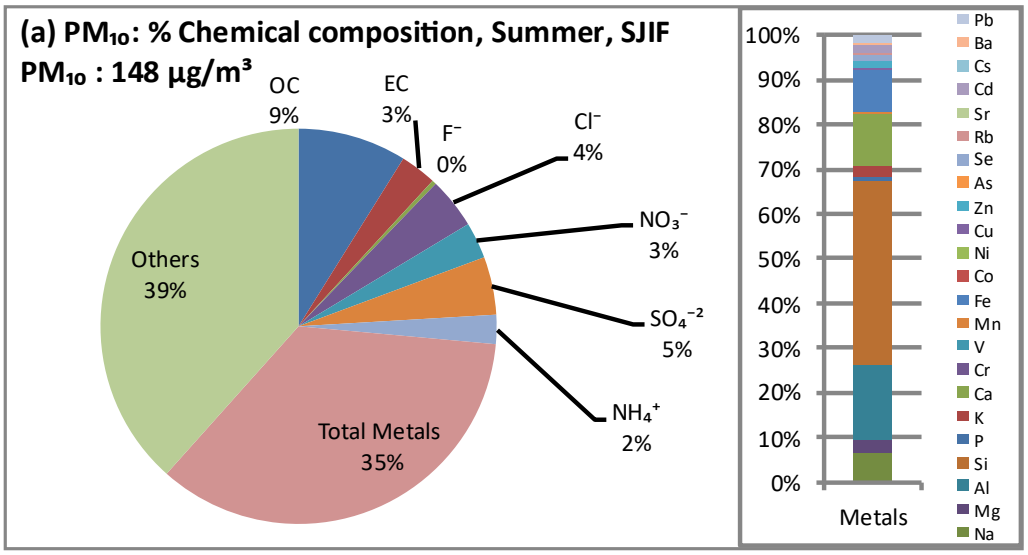


Figure 2.39: Percentage distribution of species in PM at SJIF for Winter Season



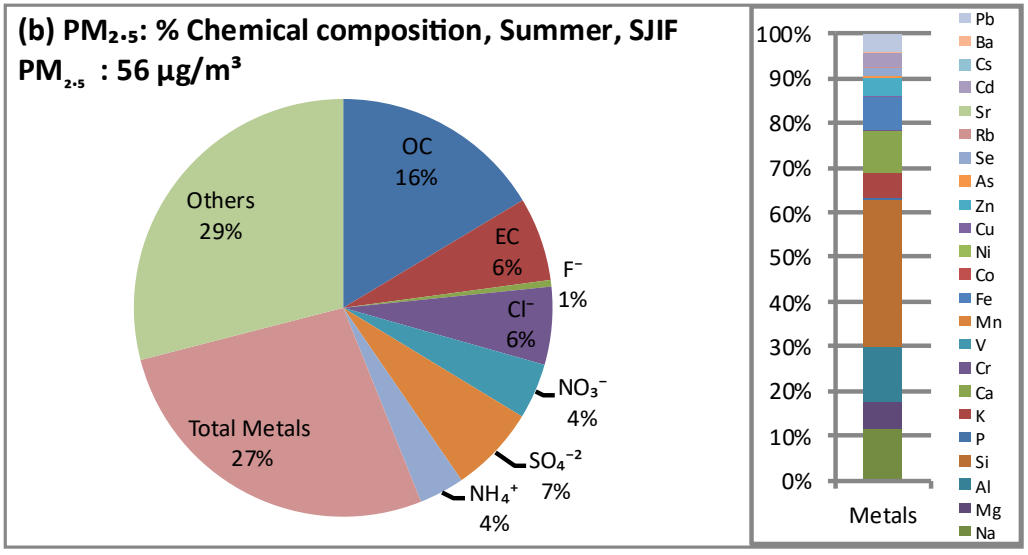


Figure 2.40: Percentage distribution of species in PM at SJIF for Summer Season

2.4.3.7 Comparison of PM_{10} and $PM_{2.5}$ Composition

This section presents some important observations from the experimental findings related to fine particles and PM_{10} concentrations. The graphical presentation is a better option for understanding the compositional variation. Compositional comparison of $PM_{2.5}$ vs PM_{10} for all species is shown for winter and summer seasons (Figure 2.41) at SJIF.

The chemical species considered for the comparisons are carbon content (TC, OC and EC), ionic species (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba, Pb). It is concluded that most of the PM has fine mode during winter (77 %) than summer (38 %). The major species contributing to fine mode are TC, OC, EC, NO_3^-, SO_4^2, Na^+, NH_4^+, K^+, V, Zn and Pb.

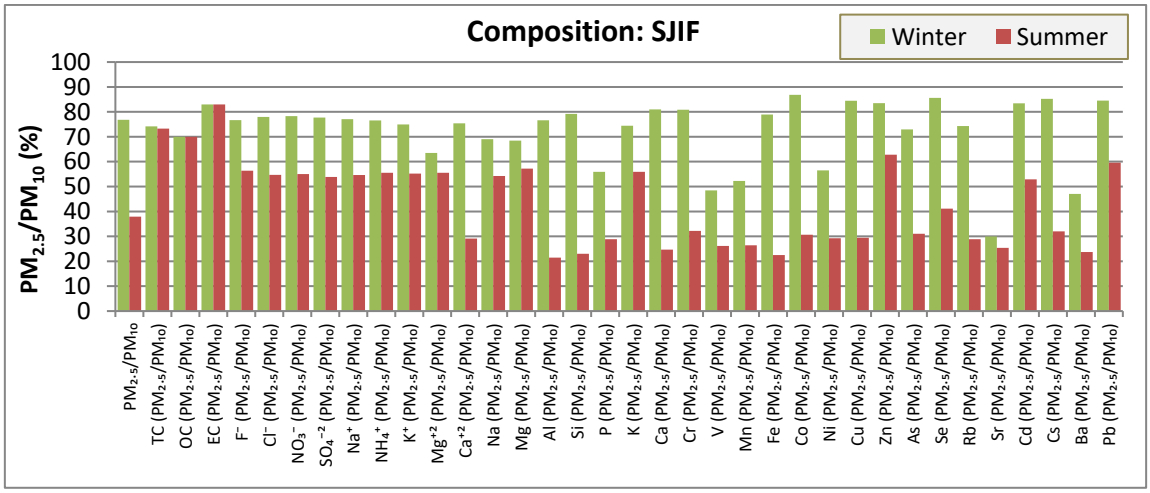


Figure 2.41: Compositional comparison of species in $PM_{2.5}$ Vs PM_{10} at SJIF

Table 2.36: Statistical results of gaseous pollutants (µg/m^3) at SJIF for winter (W) and summer (S) seasons

SJIF (W)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	55.70	2.05	0.77	0.23	5.42	4.16	11.34
SD	15.24	0.11	0.19	0.17	4.04	2.42	5.26
Max	91.71	2.37	1.11	0.54	11.63	8.64	17.37
Min	32.05	2.00	0.53	0.08	1.61	1.13	3.94
CV	0.27	0.05	0.24	0.75	0.75	0.58	0.46
SJIF (S)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	28.59	2.00	0.32	0.05	2.47	0.69	3.53
SD	6.78	0.01	0.02	0.00	0.49	0.54	0.72
Max	46.83	2.02	0.35	0.05	3.21	1.42	4.45
Min	17.99	2.00	0.29	0.04	1.97	0.11	2.46
CV	0.24	0.00	0.07	0.07	0.20	0.79	0.20

Table 2.37: Statistical results of carbon contents (µg/m^3) in $PM_{2.5}$ at SJIF for winter (W) and summer (S) seasons

SJIF (W)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	290.70	53.45	34.13	19.33	1.31	12.31	12.26	8.25	0.02	0.24	0.23	0.16
SD	99.85	17.92	8.56	9.89	1.37	3.42	3.72	2.01	0.02	0.04	0.02	0.04
Max	437.00	83.22	47.92	39.83	4.07	20.16	17.62	12.77	0.05	0.30	0.25	0.26
Min	139.00	28.29	22.19	6.10	0.02	8.26	7.21	5.65	0.00	0.19	0.20	0.08
CV	0.34	0.34	0.25	0.51	1.04	0.28	0.30	0.24	0.83	0.15	0.08	0.27
SJIF (S)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	56.29	12.87	9.22	3.65	0.09	3.76	2.92	2.45	0.01	0.30	0.23	0.19
SD	14.89	3.91	2.28	1.80	0.33	0.98	0.65	1.02	0.02	0.07	0.03	0.04
Max	88.00	22.21	14.59	7.62	1.27	6.06	4.48	4.69	0.08	0.44	0.28	0.24
Min	34.00	9.00	6.45	1.71	0.00	2.24	1.95	1.37	0.00	0.15	0.19	0.13
CV	0.26	0.30	0.25	0.50	3.49	0.26	0.22	0.42	3.31	0.23	0.13	0.21

Table 2.38: **Statistical results of PAHs (ng/m^3) in $PM_{2.5}$ at SJIF for winter (W) and summer (S) seasons**

SJIF (W)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	5.54	7.07	7.04	7.84	9.45	2.48	3.95	2.48	4.28	5.91	4.62	6.36	1.32	5.83	1.82	0.06	3.38	79.43
SD	7.05	4.29	6.63	6.87	9.31	1.88	3.33	2.67	1.83	11.19	3.36	7.47	2.04	7.66	2.63	0.07	4.32	32.80
Max	20.81	11.14	20.99	19.84	30.07	6.56	11.02	8.38	8.16	30.60	10.91	22.62	5.88	22.87	7.61	0.20	13.00	128.00
Min	1.39	0.50	2.16	0.90	4.16	0.96	1.06	0.83	3.04	0.35	1.02	1.10	0.19	1.33	0.08	0.00	0.78	52.25
CV	1.27	0.61	0.94	0.88	0.99	0.76	0.84	1.07	0.43	1.89	0.73	1.17	1.55	1.32	1.44	1.12	1.28	0.41
SJIF (S)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	7.81	5.79	3.08	0.56	5.37	1.40	0.97	0.22	2.51	0.41	0.23	0.11	0.06	0.12	0.01	0.00	0.23	28.89
SD	4.98	7.22	2.45	0.77	10.73	2.64	0.94	0.31	2.09	0.45	0.18	0.10	0.01	0.14	0.03	0.00	0.11	28.00
Max	15.62	20.36	7.97	1.99	27.09	6.76	2.53	0.85	5.71	1.33	0.59	0.31	0.08	0.41	0.08	0.00	0.44	85.50
Min	3.62	1.11	1.30	0.00	0.00	0.08	0.00	0.08	0.43	0.20	0.14	0.06	0.06	0.06	0.00	0.00	0.16	14.10
CV	0.64	1.25	0.80	1.38	2.00	1.89	0.97	1.42	0.83	1.11	0.79	0.91	0.16	1.16	2.45	#DIV/0!	0.47	0.97

Table 2.39: Statistical results of molecular markers (ng/m^3) in $PM_{2.5}$ at SJIF for winter (W) and summer (S) seasons

SJIF (W)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	125.25	59.08	43.98	25.08	3.74	0.48	257.61
SD	13.77	24.40	13.64	3.34	1.82	0.18	44.16
CV	0.11	0.41	0.31	0.13	0.49	0.37	0.17
SJIF (S)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	1.35	5.72	2.37	12.99	0.71	0.38	23.52
SD	0.56	0.18	0.66	6.74	0.24	0.19	6.57
CV	0.41	0.03	0.28	0.52	0.35	0.50	0.28

Table 2.40: Statistical results of chemical characterisation (µg/m^3) of PM_{10} at SJIF for winter (W) season

SJIF	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	379	48.8	23.3	0.4	13.6	27.7	25.0	3.7	10.3	2.2	0.3	7.3	4.84	0.90	16.77	43.53	0.07	3.07
SD	99	12.2	11.9	0.1	4.7	12.4	8.6	1.4	5.3	0.9	0.1	3.2	1.82	0.24	5.34	13.77	0.02	1.57
Max	545	68.5	48.0	0.5	22.7	58.5	38.6	5.4	17.9	4.0	0.6	16.5	7.52	1.29	29.18	69.68	0.11	8.05
Min	237	31.7	7.3	0.3	6.4	7.4	12.0	1.4	2.1	0.9	0.2	3.1	1.95	0.56	12.07	27.19	0.04	0.98
CV	0.26	0.25	0.51	0.16	0.34	0.45	0.34	0.38	0.52	0.40	0.40	0.43	0.38	0.27	0.32	0.32	0.31	0.51
SJIF	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	15.14	0.02	0.00	0.03	12.36	0.00	0.00	0.03	0.70	0.09	0.25	0.01	0.01	0.48	0.02	0.03	0.64	65.3
SD	5.83	0.01	0.00	0.01	3.48	0.00	0.00	0.01	0.41	0.03	0.27	0.00	0.00	0.56	0.01	0.01	0.32	2.6
Max	28.39	0.04	0.01	0.05	17.79	0.01	0.01	0.06	1.84	0.16	0.92	0.01	0.01	1.73	0.04	0.04	1.25	70.6
Min	8.00	0.01	0.00	0.02	7.69	0.00	0.00	0.01	0.26	0.04	0.02	0.00	0.00	0.02	0.01	0.02	0.21	61.0
CV	0.38	0.63	0.30	0.28	0.28	0.29	0.59	0.40	0.59	0.33	1.07	0.33	0.26	1.17	0.40	0.23	0.50	0.04

Table 2.41: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at SJIF for winter (W) season

SJIF (W)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	291	34.1	19.3	0.3	10.6	21.7	19.4	2.9	7.9	1.7	0.2	5.5	3.34	0.62	12.85	34.46	0.04	2.28
SD	100	8.6	9.9	0.0	3.7	9.6	6.9	1.1	4.1	0.7	0.1	2.3	1.26	0.15	5.28	14.90	0.02	1.00
Max	437	47.9	39.8	0.4	18.8	39.8	29.7	4.5	13.4	3.2	0.4	12.2	5.18	0.86	22.54	60.43	0.06	5.40
Min	139	22.2	6.1	0.3	4.5	5.8	9.0	1.1	1.5	0.6	0.1	2.8	1.33	0.40	5.85	13.47	0.01	0.93
CV	0.34	0.25	0.51	0.12	0.35	0.44	0.35	0.40	0.51	0.40	0.41	0.41	0.38	0.24	0.41	0.43	0.47	0.44
SJIF (W)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	12.26	0.01	0.00	0.02	9.76	0.00	0.00	0.03	0.59	0.06	0.22	0.01	0.00	0.40	0.02	0.01	0.54	65.9
SD	6.58	0.01	0.00	0.01	4.16	0.00	0.00	0.01	0.34	0.02	0.23	0.00	0.00	0.46	0.01	0.00	0.27	2.3
Max	27.09	0.03	0.00	0.04	17.00	0.01	0.00	0.05	1.49	0.12	0.77	0.01	0.00	1.49	0.04	0.02	1.08	69.4
Min	4.98	0.00	0.00	0.01	4.12	0.00	0.00	0.01	0.22	0.03	0.02	0.00	0.00	0.02	0.01	0.01	0.18	61.1
CV	0.54	0.72	0.38	0.42	0.43	0.27	0.53	0.40	0.58	0.31	1.08	0.48	0.18	1.16	0.41	0.18	0.51	0.03

Table 2.42: Statistical results chemical characterisation (µg/m^3) of PM_{10} at SJIF for summer (S) season

SJIF (S)	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	148	13.2	4.4	0.5	6.2	4.4	7.0	2.5	3.5	1.1	0.5	2.4	3.31	1.56	8.82	21.55	0.33	1.45
SD	61	3.3	2.2	0.2	2.2	2.0	2.7	0.6	1.8	0.2	0.2	1.3	0.85	0.49	5.79	12.46	0.17	0.23
Max	286	20.8	9.2	0.9	9.9	8.4	12.7	4.4	6.7	1.5	1.0	5.2	5.84	3.12	22.21	48.98	0.72	1.99
Min	94	9.2	2.1	0.3	2.6	1.0	2.1	1.7	0.5	0.8	0.4	0.9	2.18	1.14	2.93	7.75	0.10	1.10
CV	0.41	0.25	0.50	0.35	0.36	0.45	0.39	0.25	0.52	0.16	0.28	0.54	0.26	0.32	0.66	0.58	0.52	0.16
SJIF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	5.95	0.05	0.02	0.12	4.90	0.03	0.02	0.12	0.99	0.03	0.76	0.03	0.04	0.87	0.11	0.08	1.07	63.02
SD	3.36	0.03	0.01	0.07	3.02	0.01	0.01	0.08	0.51	0.01	0.58	0.02	0.03	1.26	0.06	0.07	0.47	4.93
Max	12.90	0.12	0.04	0.25	11.67	0.04	0.04	0.31	1.80	0.04	2.00	0.07	0.11	4.35	0.20	0.26	1.87	72.50
Min	1.97	0.02	0.01	0.03	1.75	0.01	0.01	0.05	0.23	0.01	0.16	0.01	0.01	0.06	0.01	0.00	0.29	55.84
CV	0.56	0.50	0.55	0.62	0.62	0.41	0.34	0.70	0.51	0.42	0.77	0.46	0.78	1.45	0.55	0.85	0.44	0.08

Table 2.43: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at SJIF for summer (S) season

SJIF (S)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	56	9.2	3.6	0.3	3.4	2.4	3.8	1.4	2.0	0.6	0.3	0.7	1.80	0.89	1.89	4.96	0.10	0.81
SD	15	2.3	1.8	0.1	1.3	1.1	1.4	0.3	1.1	0.1	0.1	0.3	0.43	0.25	0.61	1.85	0.06	0.14
Max	88	14.6	7.6	0.5	5.5	4.3	6.7	2.3	3.7	0.9	0.6	1.3	3.10	1.63	3.01	8.47	0.21	1.20
Min	34	6.5	1.7	0.2	1.4	0.6	1.2	1.0	0.2	0.5	0.2	0.4	1.35	0.58	0.99	2.55	0.02	0.67
CV	0.26	0.25	0.50	0.27	0.38	0.45	0.36	0.23	0.55	0.15	0.28	0.41	0.24	0.28	0.32	0.37	0.61	0.17
SJIF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	1.47	0.02	0.005	0.032	1.100	0.008	0.006	0.035	0.621	0.008	0.314	0.010	0.011	0.458	0.034	0.019	0.64	71.20
SD	0.56	0.01	0.002	0.016	0.437	0.004	0.004	0.025	0.495	0.002	0.364	0.005	0.004	0.857	0.026	0.011	0.49	2.12
Max	2.49	0.06	0.009	0.060	1.870	0.016	0.015	0.093	1.627	0.010	1.233	0.018	0.017	3.120	0.102	0.036	1.59	74.79
Min	0.83	0.00	0.002	0.007	0.559	0.003	0.002	0.011	0.088	0.005	0.032	0.003	0.004	0.010	0.002	0.004	0.15	67.84
CV	0.38	0.83	0.403	0.493	0.397	0.522	0.600	0.707	0.798	0.243	1.160	0.569	0.392	1.873	0.783	0.565	0.77	0.03

Table 2.44: Correlation matrix for PM_{10} and its composition at SJIF for winter season

SJIF (W)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.79	0.85	0.67	0.46	0.52	0.89	0.90	-0.53	0.86	0.62	-0.15	0.42	0.87
TC		1.00	0.97	0.97	0.28	0.40	0.84	0.76	-0.58	0.85	0.58	-0.43	0.05	0.41
OC			1.00	0.89	0.37	0.48	0.82	0.77	-0.58	0.84	0.59	-0.37	0.09	0.53
EC				1.00	0.16	0.30	0.81	0.71	-0.55	0.81	0.54	-0.47	0.01	0.26
NO_3^-					0.27	0.45	1.00	0.89	-0.44	0.84	0.53	-0.20	0.31	0.63
SO_4^{-2}					0.54	0.43		1.00	-0.36	0.93	0.59	-0.27	0.48	0.72
NH_4^+					0.52	0.45			-0.41	1.00	0.65	-0.25	0.39	0.61
Metals					0.43	0.35			-0.44		0.45	0.03	0.61	1.00

Table 2.45: Correlation matrix for $PM_{2.5}$ and its composition at SJIF for winter season

SJIF (W)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.76	0.83	0.66	0.55	0.50	0.95	0.93	-0.50	0.91	0.56	-0.12	0.55	0.95
TC		1.00	0.97	0.98	0.36	0.36	0.83	0.78	-0.56	0.87	0.57	-0.27	0.08	0.54
OC			1.00	0.89	0.48	0.45	0.85	0.83	-0.56	0.86	0.59	-0.18	0.13	0.64
EC				1.00	0.24	0.26	0.77	0.69	-0.53	0.83	0.53	-0.33	0.03	0.42
NO_3^-					0.44	0.52	1.00	0.94	-0.42	0.93	0.53	-0.14	0.38	0.85
SO_4^{-2}					0.55	0.48		1.00	-0.34	0.93	0.57	-0.12	0.43	0.84
NH_4^+					0.49	0.41			-0.41	1.00	0.63	-0.23	0.38	0.77
Metals					0.51	0.42			-0.45		0.45	-0.08	0.71	1.00

Table 2.46: Correlation matrix for PM_{10} and its composition at SJIF for summer season

SJIF (S)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.76	0.78	0.65	0.35	0.38	0.52	0.31	0.17	0.45	0.62	0.21	0.97	0.99
TC		1.00	0.97	0.94	0.21	0.46	0.59	0.50	-0.08	0.49	0.61	-0.01	0.60	0.67
OC			1.00	0.83	0.28	0.55	0.61	0.44	0.00	0.50	0.59	0.09	0.62	0.69
EC				1.00	0.07	0.28	0.48	0.53	-0.18	0.43	0.57	-0.15	0.52	0.56
NO_3^-					-0.01	0.78	1.00	-0.07	0.20	0.79	0.56	0.16	0.39	0.44
SO_4^{-2}					0.15	-0.33		1.00	-0.01	0.07	0.22	-0.05	0.25	0.26
NH_4^+					-0.04	0.68			-0.06	1.00	0.49	-0.06	0.30	0.37
Metals					0.37	0.31			0.21		0.58	0.25	0.99	1.00

Table 2.47: Correlation matrix for $PM_{2.5}$ and its composition SJIF for summer season

SJIF (S)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.79	0.78	0.74	-0.02	0.65	0.79	0.38	-0.04	0.82	0.62	0.00	0.78	0.91
TC		1.00	0.97	0.94	0.10	0.28	0.45	0.45	-0.04	0.40	0.51	-0.03	0.70	0.50
OC			1.00	0.83	0.18	0.35	0.47	0.37	0.05	0.41	0.54	0.08	0.69	0.50
EC				1.00	-0.01	0.15	0.38	0.51	-0.14	0.36	0.43	-0.17	0.65	0.46
NO_3^-					-0.03	0.83	1.00	-0.10	0.21	0.81	0.67	0.20	0.58	0.80
SO_4^{-2}					0.00	-0.36		1.00	-0.10	0.08	0.19	-0.04	0.24	0.31
NH_4^+					-0.02	0.79			-0.04	1.00	0.62	-0.01	0.55	0.91
Metals					-0.10	0.73			-0.05		0.54	-0.01	0.60	1.00

2.4.4 Gauri Shanker Kotla Firozabad (GSKF)

The sampling period was December 14 – December 28, 2022, for winter and May 19 – June 02, 2023, for summer.

2.4.4.1 Particulate Matter (PM_{10}, $PM_{2.5}$)

Time series of 24-hr average concentrations of PM_{10} and $PM_{2.5}$ at GSKF are shown for winter (Figure 2.42) and summer (Figure 2.43). Average levels at this site were: $PM_{2.5}$: 270 ± 83 (winter) and 60±17 µg/m^3 (summer), and PM_{10}: 352 ± 89 (winter) and 107±40 µg/m^3 (summer). The $PM_{2.5}$ levels were 4.7 times (higher) in winter and in compliance with the NAAQS ($PM_{2.5}$: 60 µg/m^3) in the summer season. The PM_{10} levels were 3.8 times (higher) in winter and 1.4 times higher in summer compared with the NAAQS (PM_{10}: 100 µg/m^3).

In summer, $PM_{2.5}$ levels drop significantly compared to PM_{10} levels, which continued to be slightly high despite improvements in meteorology and better dispersion. The particles airborne from the soil during dust storms in the dry months of summer can contribute significantly to a coarse fraction (i.e., $PM_{2.5\text{-}10}$). The PM_{10} levels show the same levels in both seasons despite improvements in meteorology and better dispersion.

The corresponding CPCB air quality index (AQI) is 519 ($PM_{2.5}$) and 494 (PM_{10}) for winter, which falls in the category of *severe*. For summer AQI is 193 (for $PM_{2.5}$) and 151 (for PM_{10}), which falls in the category of *moderate*.

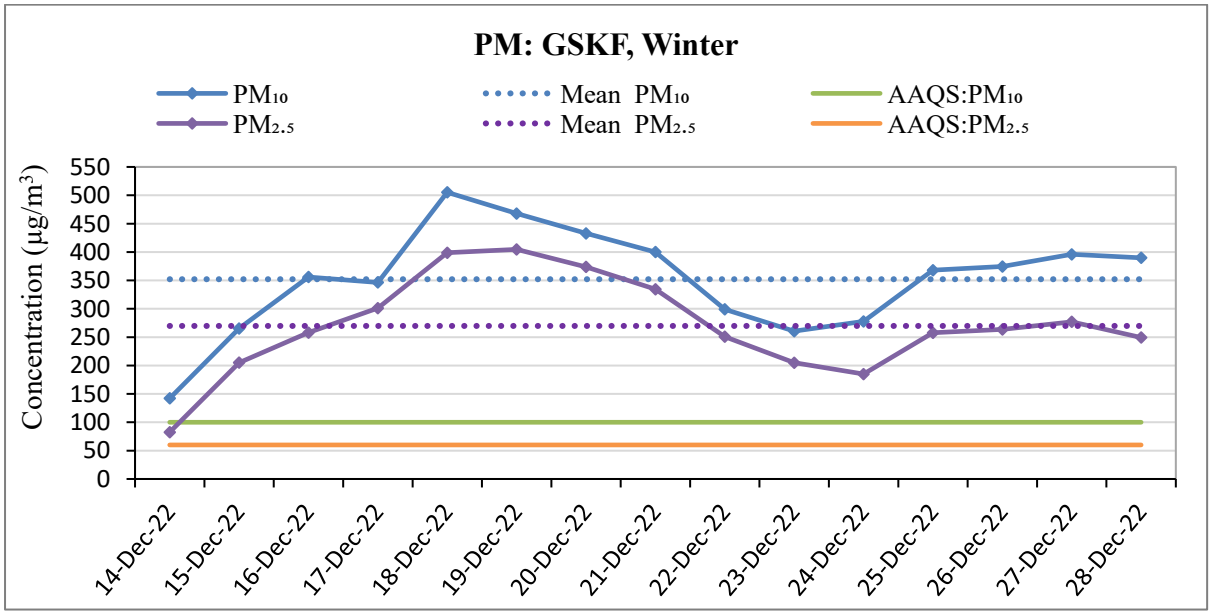


Figure 2.42: PM Concentrations at GSKF, Winter

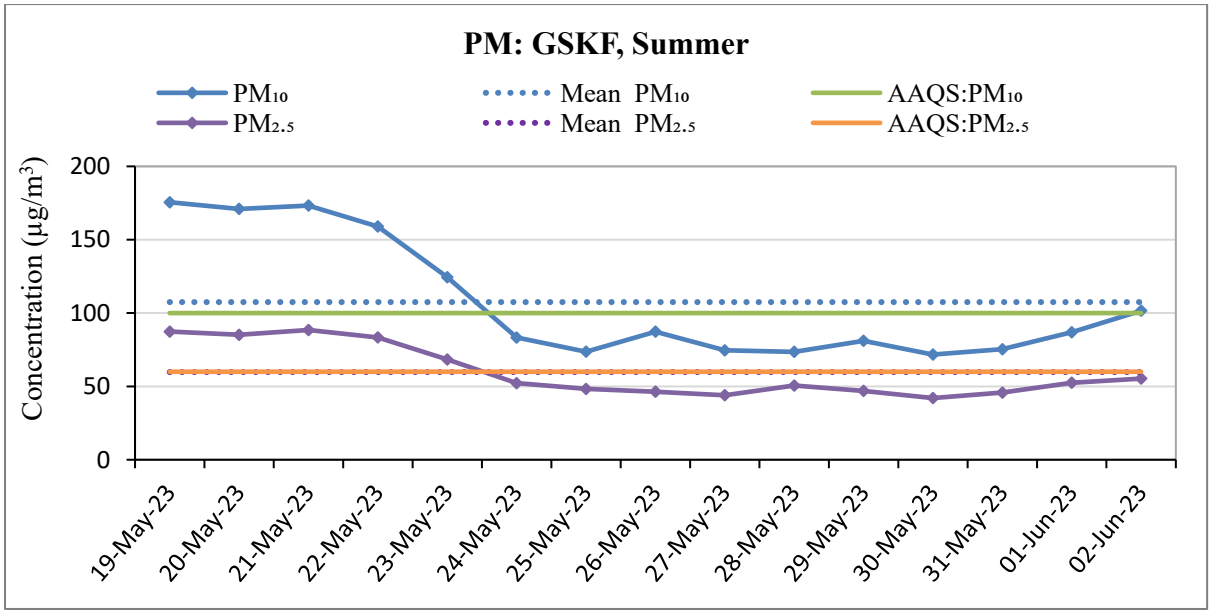


Figure 2.43: PM Concentrations at GSKF, Summer

2.4.4.2 Gaseous pollutants

Time series of 24-hr average concentrations of SO_2 and NO_2 are shown for the winter (Figure 2.44) and summer (Figure 2.45) seasons. It was observed that SO_2 concentrations were low (mostly < 3.0 µg/m^3) and met the air quality standard. NO_2 levels also meet the national standard (80 µg/m^3) with an average of 15 days at 37±11 µg/m^3 in winter and 25±7 µg/m^3 in the summer season (Figure 2.44). The summer concentration of NO_2 dropped and half in winter. NO_2 levels are meeting the standard; it is a matter of concern as NO_2 is largely attributed to vehicular pollution, which is on the rise. Variation in NO_2 is due to variability in meteorology and the presence of occasional local sources like DG sets, traffic jams or local open burning, etc.

The Mean concentrations of benzene, toluene, p-xylene and o-xylene (BTX) are presented in Figure 2.46 and the statistical summary is in Table 2.48 The total BTX level is observed 5.8±2.0 µg/m^3 (Benzene: 0.59 and Toluene: 0.16 µg/m^3) in winter and 3.10±1.3 µg/m^3 (Benzene: 0.24 and Toluene: 0.04 µg/m^3) in summer seasons. The BTX levels were higher during winter than in the summer.

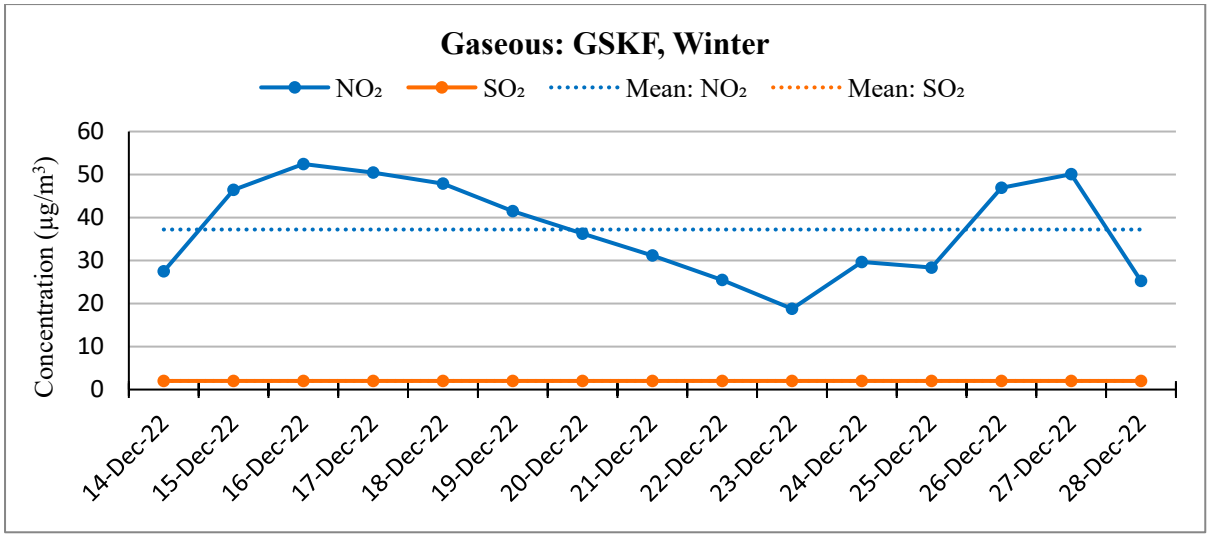


Figure 2.44: SO_2 and NO_2 Concentrations at GSKF for Winter Season

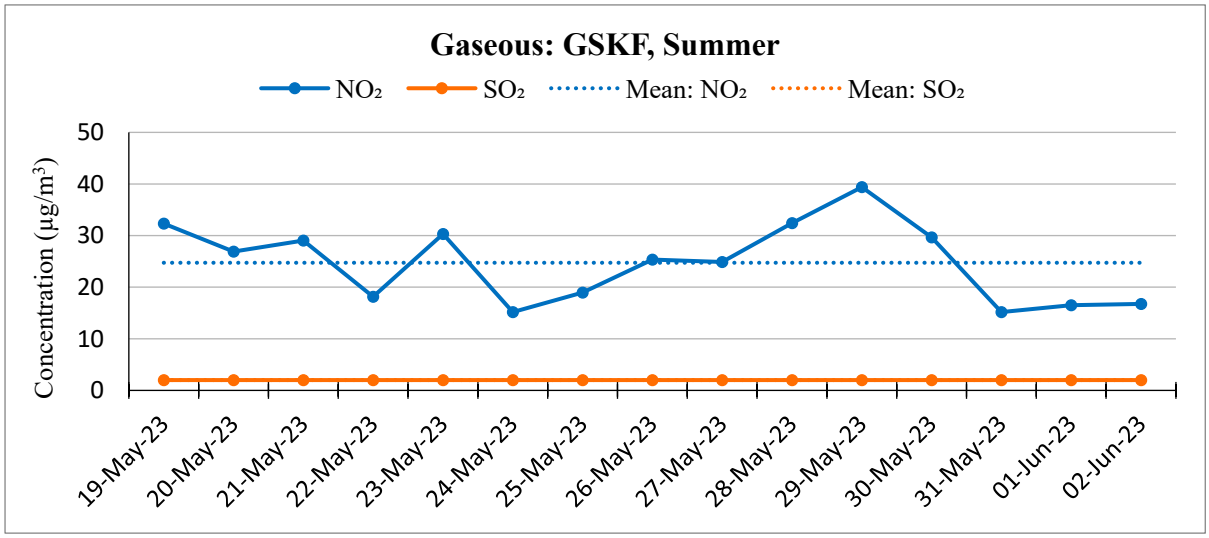


Figure 2.45: SO_2 and NO_2 Concentrations at GSKF for Summer Season

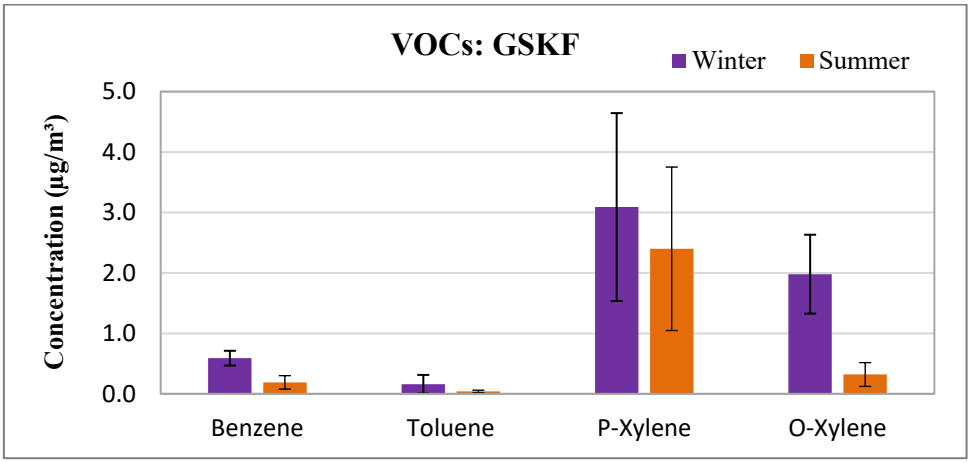


Figure 2.46: VOCs concentration at GSKF

2.4.4.3 Carbon Content (EC/OC) in $PM_{2.5}$

Average concentrations of EC, OC (OC1, OC2, OC3 and OC4) and the ratio of OC fraction to TC are shown in Figure 2.47 (a) and (b) for winter and summer seasons. Organic carbon is observed to be higher (winter: 34.24±8.76 and summer: 10.19±3.42 µg/m^3) than the elemental carbon (winter: 20.73±7 and summer: 3.04±1.05 µg/m^3). It is also observed that the OC and EC are higher in the winter than in the summer. A statistical summary of carbon content (OC1, OC2, OC3, OC4; OC, EC, TC with fractions OC1/TC, OC2/TC, OC3/TC and OC4/TC) is presented in Table 2.49 for winter and summer. The ratio of OC2/TC is observed to be higher, which indicates the formation of primary organic carbon in the atmosphere at GSKF.

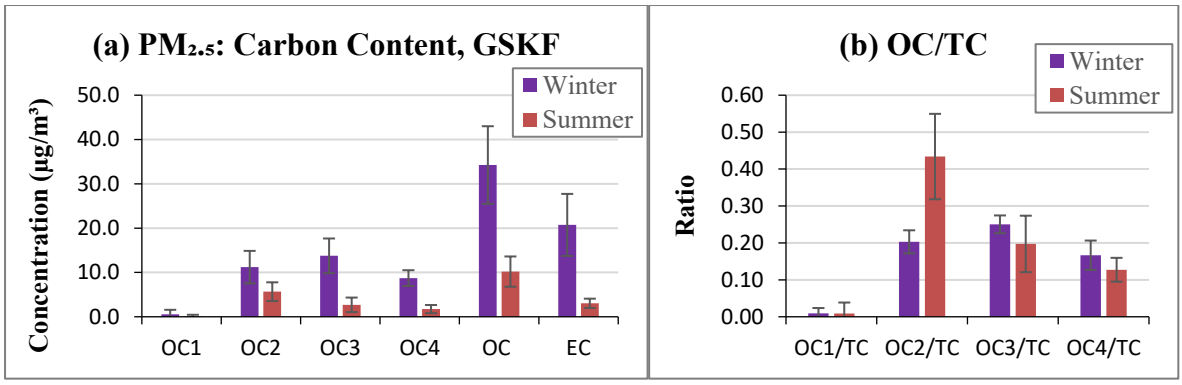


Figure 2.47: EC and OC Content in $PM_{2.5}$ at GSKF

2.4.4.4 PAHs in $PM_{2.5}$

The concentrations of PAHs (from solid phase only) with some specific markers were analysed. Figure 2.48 shows the average measured concentration of PAHs at GSKF for winter and summer seasons. A statistical summary of PAHs is presented in Table 2.50 for winter and summer seasons. The PAHs compounds analyzed were: (i) Di methyl Phthalate (DmP), (ii) Acenaphthylene (AcP), (iii) Di ethyl Phthalate (DEP), (iv) Fluorene (Flu), (v) Phenanthrene (Phe), (vi) Anthracene (Ant), (vii) Pyrene (Pyr), (viii) Butyl benzyl phthalate (BbP), (ix) Bis(2-ethylhexyl) adipate (BeA), (x) Benzo(a)anthracene (B(a)A), (xi) Chrysene (Chr), (xii) Benzo(b)fluoranthene (B(b)F), (xiii) Benzo(k)fluoranthene (B(k)F), (xiv) Benzo(a)pyrene (B(a)P), (xv) Indeno(1,2,3-cd)pyrene (InP), (xvi) Dibenzo(a,h)anthracene (D(a,h)A) and (xvii) Benzo(ghi)perylene (B(ghi)P). It is observed that Total PAHs concentrations are higher in the winter season (88±21 ng/m^3) compared to the summer season (36±19 ng/m^3). Major PAHs are Phe (9.90 ng/m^3 and 0.5 ng/m^3), DEP (4.31 ng/m^3 and 4.69 ng/m^3) and DmP (8.94 ng/m^3 and 14.84 ng/m^3) in both winter and summer seasons.

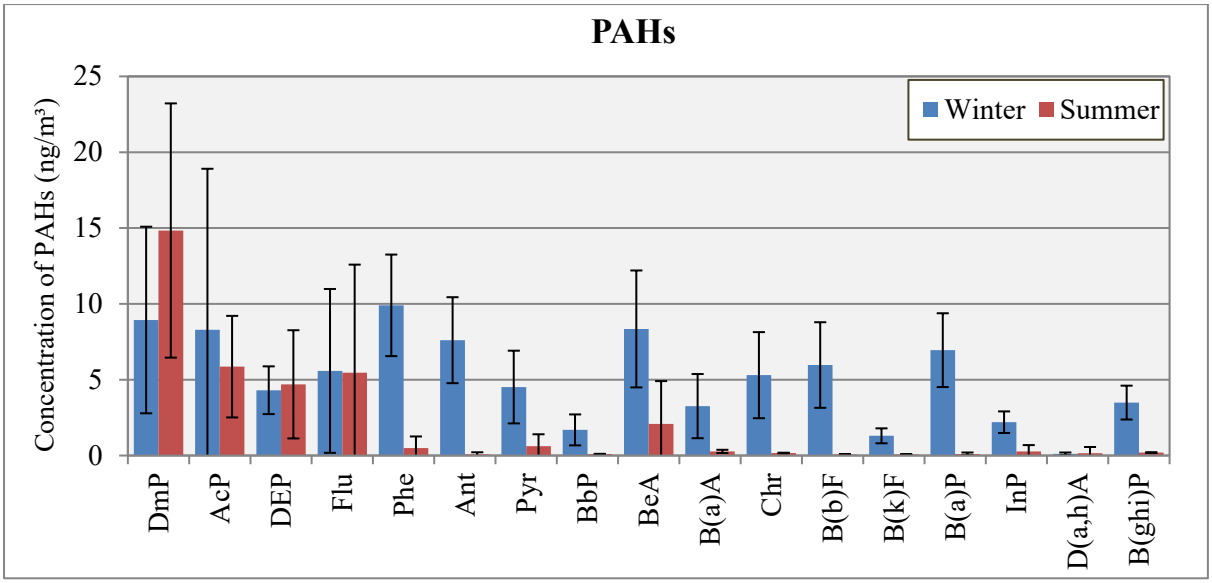


Figure 2.48: PAHs Concentrations in $PM_{2.5}$ at GSKF

2.4.4.5 Molecular Markers in $PM_{2.5}$

A total of six molecular markers analysed were: (i) 17α(H)-22,29,30–Trisnorhopane, (ii) 17α(H)21 α (H)-hopane, (iii) 17β(H)21 β (H)-hopane, (iv) n-Hentriacontane, (v) n-Tritriacontane and (vi) n-Pentatriacontane. The n-alkanes are generally emitted from all types of combustion sources, and hopanes from combustion of coal (C), gasoline (G) and diesel (D). Figure 2.10 and Table 2.51 show the levels of six molecular markers. Total concentration of markers was 358.79±63.34 ng/m^3 in winter and 35.2±2.49 ng/m^3 in summer. The presence of significant quantities of molecular markers, especially hopanes, conclusively establishes the contribution of CGD.

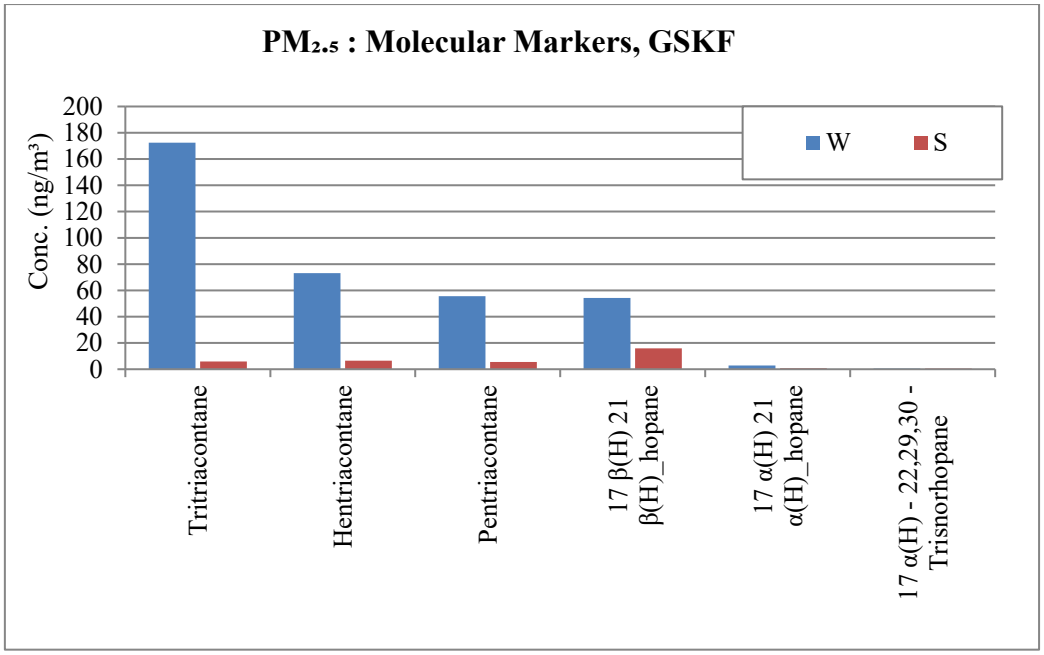


Figure 2.49: Molecular Markers in $PM_{2.5}$ at GSKF

2.4.4.6 Chemical Composition of PM_{10} and $PM_{2.5}$ and their correlation matrix

Graphical presentations of chemical species are shown for the winter and summer seasons at GSKF for PM_{10} (Figure 2.50) and $PM_{2.5}$ (Figure 2.51). Statistical summary for particulate matter (PM_{10} and $PM_{2.5}$), its chemical composition [carbon content, ionic species and elements] along with mass percentage (% R) recovered from PM are presented in the Table 2.52-Table 2.55 for the winter and summer seasons.

The correlation between different parameters (i.e. PM, TC, OC, EC, F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2} and Metals (elements) with major species (PM, TC, OC, EC, NO_3^-, SO_4^{-2}, NH_4^+, Metals) for PM_{10} and $PM_{2.5}$ composition is presented in Table 2.56-Table 2.59 for both seasons. It is seen that most of the parameters showed good correlation (>0.30) with PM_{10} and $PM_{2.5}$. The percentage constituent of the PM is presented in Figure 2.52 (a) and (b) for the winter season and Figure 2.53 (a) and (b) for the summer season.

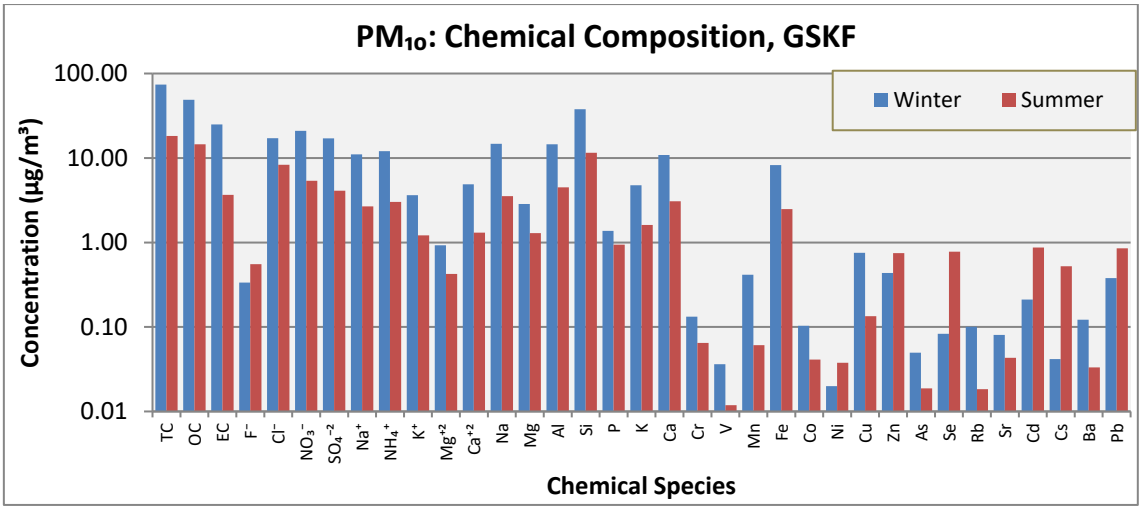


Figure 2.50: Concentrations of species in PM_{10} at GSKF

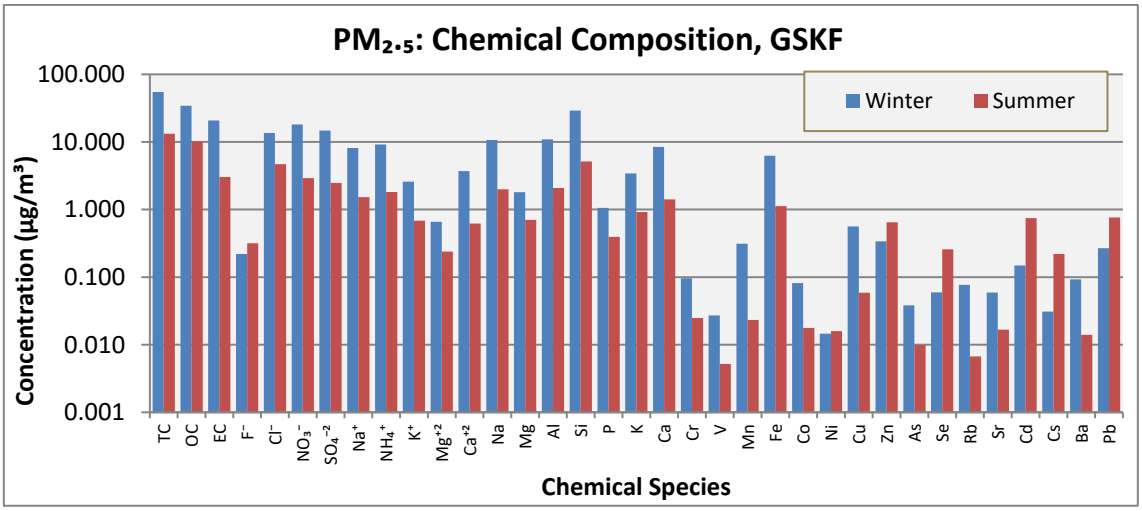
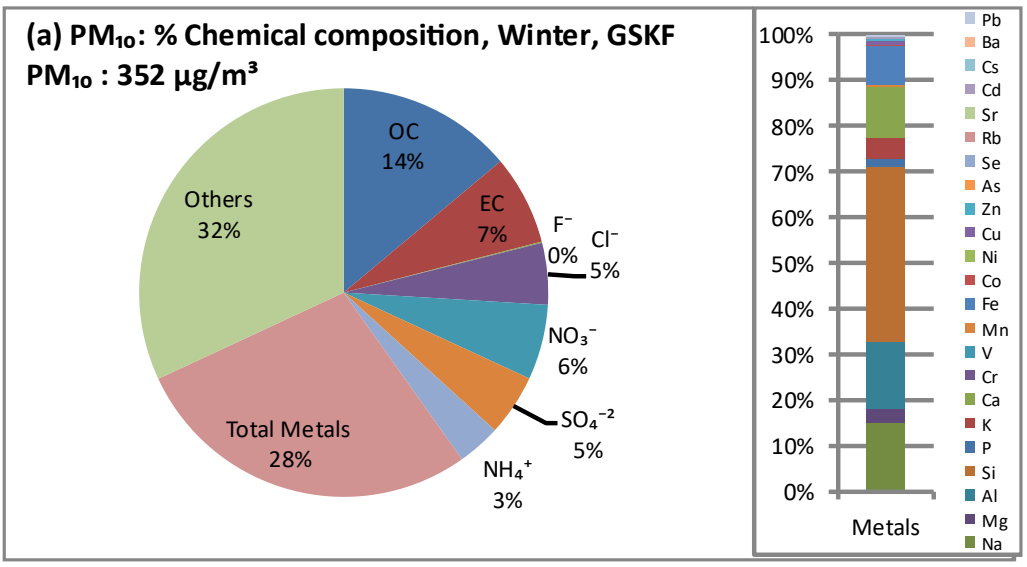


Figure 2.51: Concentrations of species in $PM_{2.5}$ at GSKF



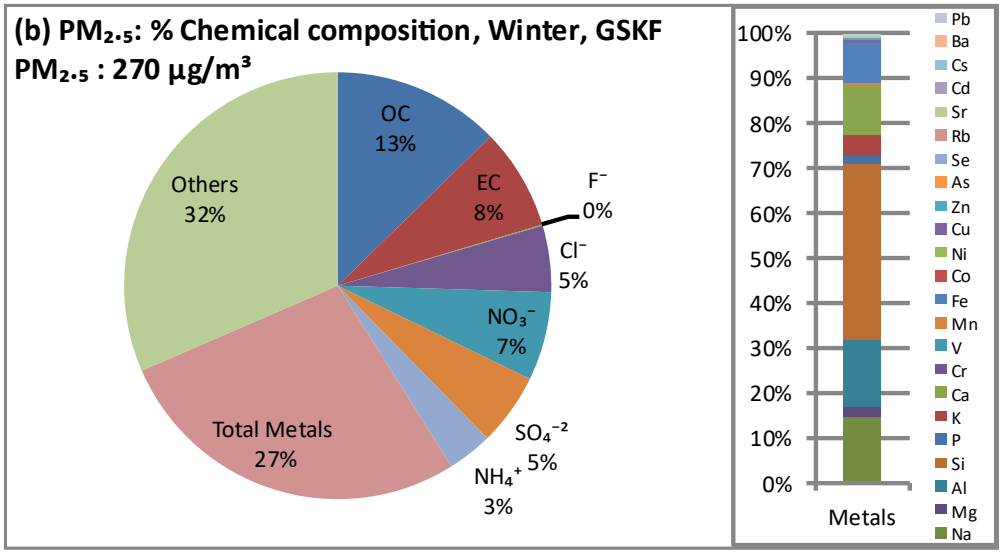
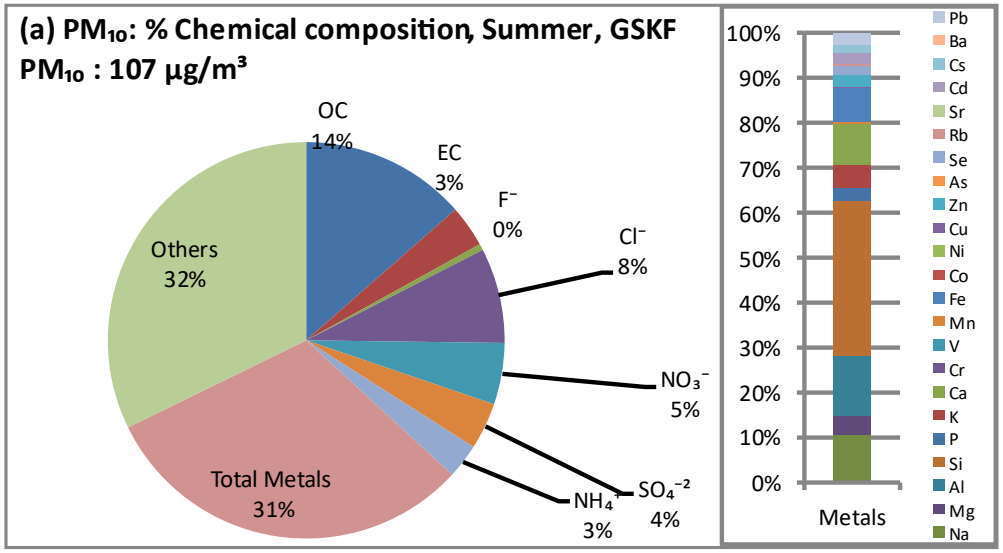


Figure 2.52: Percentage distribution of species in PM at GSKF for Winter Season



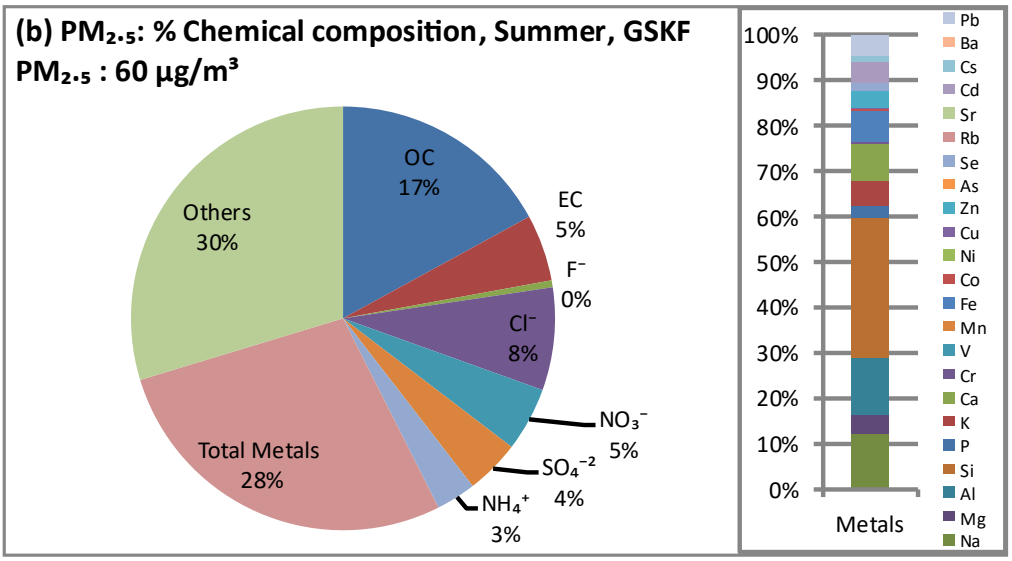


Figure 2.53: Percentage distribution of species in PM at GSKF for Summer Season

2.4.4.7 Comparison of PM_{10} and $PM_{2.5}$ Composition

This section presents some important observations from the experimental findings related to fine particles and PM_{10} concentrations. The graphical presentation is a better option for understanding the compositional variation. Compositional comparison of $PM_{2.5}$ vs PM_{10} for all species is shown for winter and summer seasons (Figure 2.54) at GSKF.

The chemical species considered for the comparisons are carbon content (TC, OC and EC), ionic species (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba, Pb). It is concluded that most of the PM has fine mode during winter (77 %) than summer (56 %). The major species contributing to fine mode are TC, OC, EC, NO_3^-, SO_4^2, Na^+, NH_4^+, K^+, V, Zn and Pb.

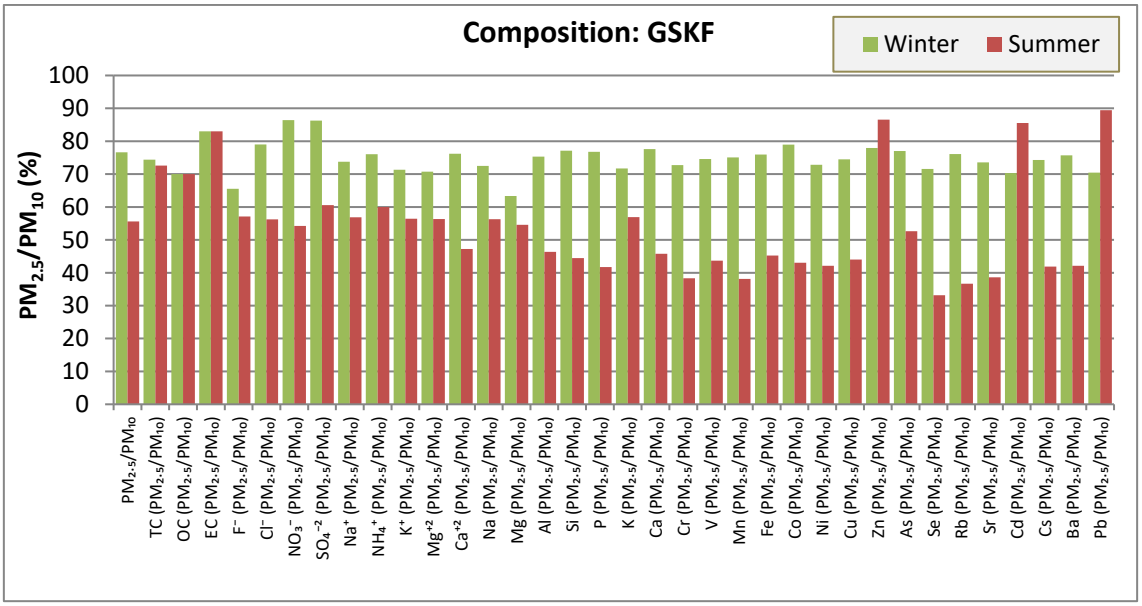


Figure 2.54: Compositional comparison of species in $PM_{2.5}$ Vs PM_{10} at GSKF

Table 2.48: Statistical results of gaseous pollutants (µg/m^3) at GSKF for winter (W) and summer (S) seasons

GSKF (W)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	37.21	2.00	0.59	0.16	3.09	1.98	5.82
SD	10.87	0.00	0.12	0.15	1.55	0.65	2.07
Max	52.45	2.00	0.82	0.46	6.00	2.87	9.79
Min	18.78	2.00	0.47	0.06	1.75	1.12	3.49
CV	0.29	0.00	0.21	0.96	0.50	0.33	0.36
GSKF (S)	NO_2	SO_2	Benzene	Toluene	p-Xylene	o-Xylene	Total (BTX)
Mean	24.73	2.00	0.24	0.04	2.47	0.36	3.11
SD	7.31	0.00	0.03	0.02	1.20	0.13	1.32
Max	39.39	2.00	0.27	0.05	3.49	0.52	4.33
Min	15.18	2.00	0.20	0.01	0.39	0.23	0.86
CV	0.30	0.00	0.10	0.43	0.49	0.36	0.42

Table 2.49: Statistical results of carbon contents (µg/m^3) in $PM_{2.5}$ at GSKF for winter (W) and summer (S) seasons

GSKF (W)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	269.80	54.97	34.24	20.73	0.57	11.20	13.75	8.72	0.01	0.20	0.25	0.17
SD	82.71	15.31	8.76	7.00	1.00	3.67	3.91	1.79	0.01	0.03	0.02	0.04
Max	405.00	75.86	46.51	29.64	3.90	17.30	20.36	11.44	0.06	0.25	0.30	0.26
Min	83.00	20.68	13.44	7.24	0.00	4.44	4.54	4.45	0.00	0.11	0.22	0.10
CV	0.31	0.28	0.26	0.34	1.77	0.33	0.28	0.20	1.62	0.15	0.10	0.24
GSKF (S)	$PM_{2.5}$	TC	OC	EC	OC1	OC2	OC3	OC4	OC1/TC	OC2/TC	OC3/TC	OC4/TC
Mean	59.79	13.23	10.19	3.04	0.10	5.66	2.69	1.73	0.01	0.43	0.20	0.13
SD	16.95	4.20	3.42	1.05	0.35	2.11	1.64	0.92	0.03	0.12	0.08	0.03
Max	88.00	23.62	18.28	5.33	1.36	9.49	7.19	4.43	0.12	0.65	0.41	0.19
Min	42.00	7.29	5.72	1.57	0.00	2.99	1.19	0.79	0.00	0.27	0.13	0.08
CV	0.28	0.32	0.34	0.34	3.33	0.37	0.61	0.53	3.34	0.27	0.39	0.25

Table 2.50: Statistical results of PAHs (ng/m3) in $PM_{2.5}$ at GSKF for winter (W) and summer (S) seasons

GSKF (W)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	8.94	8.29	4.31	5.58	9.90	7.61	4.52	1.69	8.35	3.26	5.30	5.97	1.30	6.95	2.20	0.11	3.49	87.74
SD	6.15	10.62	1.57	5.40	3.35	2.83	2.40	1.02	3.86	2.12	2.84	2.82	0.49	2.43	0.71	0.09	1.12	21.47
Max	16.37	28.66	6.23	17.36	14.34	11.34	8.69	3.02	13.31	6.21	10.71	11.34	2.02	9.80	3.02	0.28	4.76	130.07
Min	1.17	0.32	1.95	1.43	4.95	2.21	1.66	0.26	2.92	0.85	2.90	3.45	0.58	3.73	1.12	0.00	2.01	63.05
CV	0.69	1.28	0.37	0.97	0.34	0.37	0.53	0.60	0.46	0.65	0.54	0.47	0.38	0.35	0.32	0.86	0.32	0.24
GSKF (S)	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
Mean	14.84	5.86	4.69	5.46	0.50	0.08	0.62	0.10	2.09	0.27	0.16	0.07	0.07	0.10	0.27	0.15	0.19	35.52
SD	8.38	3.35	3.57	7.13	0.76	0.14	0.78	0.01	2.82	0.11	0.03	0.01	0.01	0.10	0.42	0.41	0.03	19.43
Max	30.19	10.59	9.98	18.89	2.14	0.39	1.73	0.12	6.34	0.50	0.21	0.09	0.09	0.32	1.06	1.08	0.25	59.98
Min	4.46	1.67	0.81	0.08	0.00	0.02	0.00	0.08	0.00	0.19	0.13	0.06	0.06	0.05	0.00	0.00	0.16	10.33
CV	0.56	0.57	0.76	1.30	1.54	1.74	1.25	0.16	1.35	0.39	0.16	0.16	0.16	0.95	1.57	2.65	0.16	0.55

Table 2.51: Statistical results of molecular markers (ng/m^3) in $PM_{2.5}$ at GSKF for winter (W) and summer (S) seasons

GSKF (W)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	172.43	73.15	55.62	54.23	2.82	0.53	358.79
SD	40.42	19.12	19.61	64.05	2.87	0.15	63.34
CV	0.23	0.26	0.35	1.18	1.02	0.29	0.18
GSKF (S)	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21β(H)_hopane	17 α(H) 21α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
Mean	5.88	6.56	5.56	15.83	0.83	0.53	35.20
SD	4.70	1.17	0.42	4.48	0.46	0.20	2.49
CV	0.80	0.18	0.07	0.28	0.55	0.37	0.07

Table 2.52: Statistical results of chemical characterisation (µg/m^3) of PM_{10} at GSKF for winter (W) season

GSKF	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	352	48.9	25.0	0.3	17.2	21.0	17.1	11.0	12.1	3.6	0.9	4.9	14.73	2.85	14.53	37.83	1.37	4.76
SD	92	12.5	8.4	0.1	6.9	6.3	5.2	4.5	5.0	1.2	1.4	1.8	5.97	4.58	5.00	13.33	0.79	1.48
Max	505	66.4	35.7	0.6	34.7	30.5	28.7	18.1	20.3	5.8	5.9	7.8	24.86	18.89	22.90	67.42	2.94	7.37
Min	142	19.2	8.7	0.2	6.3	6.8	7.8	4.1	2.8	1.5	0.2	1.6	5.61	0.63	5.65	15.21	0.31	2.00
CV	0.26	0.26	0.34	0.26	0.40	0.30	0.30	0.41	0.42	0.33	1.53	0.36	0.41	1.61	0.34	0.35	0.57	0.31
GSKF	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	10.86	0.13	0.04	0.41	8.26	0.10	0.02	0.75	0.44	0.05	0.08	0.10	0.08	0.21	0.04	0.12	0.38	68.3
SD	3.79	0.09	0.01	0.20	2.85	0.04	0.01	0.46	0.10	0.01	0.10	0.04	0.03	0.31	0.02	0.08	0.21	1.7
Max	17.90	0.34	0.06	0.76	13.89	0.20	0.05	1.89	0.66	0.07	0.28	0.16	0.15	1.10	0.07	0.33	0.78	71.2
Min	3.86	0.03	0.02	0.08	3.39	0.04	0.00	0.23	0.30	0.02	0.01	0.03	0.04	0.02	0.02	0.01	0.08	64.9
CV	0.35	0.69	0.37	0.48	0.34	0.44	0.67	0.61	0.22	0.23	1.15	0.37	0.38	1.45	0.37	0.63	0.55	0.03

Table 2.53: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at GSKF for winter (W) season

GSKF (W)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	270	34.2	20.7	0.2	13.6	18.1	14.8	8.1	9.2	2.6	0.7	3.7	10.68	1.81	10.94	29.18	1.06	3.41
SD	86	8.8	7.0	0.1	6.1	6.6	5.6	2.9	4.0	0.7	0.9	1.5	3.89	2.52	5.02	12.51	0.69	0.95
Max	405	46.5	29.6	0.4	31.4	28.8	28.0	14.2	15.4	3.7	3.8	6.5	18.67	10.45	20.13	52.50	2.37	4.73
Min	83	13.4	7.2	0.1	4.2	4.0	5.7	3.3	1.8	1.3	0.2	0.9	4.51	0.46	2.41	7.14	0.17	1.61
CV	0.32	0.26	0.34	0.29	0.45	0.36	0.38	0.35	0.44	0.29	1.40	0.40	0.36	1.39	0.46	0.43	0.66	0.28
GSKF (W)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	8.43	0.10	0.03	0.31	6.27	0.08	0.01	0.56	0.34	0.04	0.06	0.08	0.06	0.15	0.03	0.09	0.27	68.9
SD	3.65	0.07	0.01	0.16	2.77	0.04	0.01	0.33	0.10	0.01	0.07	0.03	0.02	0.20	0.01	0.06	0.15	2.7
Max	15.42	0.30	0.05	0.63	10.96	0.19	0.03	1.39	0.57	0.06	0.21	0.13	0.12	0.72	0.06	0.20	0.52	73.6
Min	1.85	0.02	0.01	0.04	1.43	0.02	0.00	0.12	0.19	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.07	64.7
CV	0.43	0.76	0.42	0.51	0.44	0.55	0.62	0.59	0.29	0.29	1.16	0.43	0.42	1.37	0.44	0.61	0.56	0.04

Table 2.54: Statistical results chemical characterisation (µg/m^3) of PM_{10} at GSKF for summer (S) season

GSKF (S)	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	107	14.6	3.7	0.6	8.3	5.4	4.1	2.7	3.0	1.2	0.4	1.3	3.54	1.29	4.49	11.54	0.94	1.62
SD	41	4.9	1.3	0.2	3.0	2.1	2.1	0.8	1.2	0.4	0.2	0.6	1.05	0.49	2.30	6.55	1.11	0.51
Max	176	26.1	6.4	1.0	14.7	10.0	8.2	4.4	5.2	2.1	0.8	2.6	5.86	2.39	8.78	24.05	3.74	2.82
Min	72	8.2	1.9	0.3	3.3	2.1	2.0	1.3	1.4	0.8	0.3	0.6	1.65	0.78	1.88	4.66	0.03	0.99
CV	0.38	0.34	0.34	0.35	0.36	0.39	0.51	0.29	0.41	0.31	0.38	0.49	0.30	0.38	0.51	0.57	1.18	0.32
GSKF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	3.08	0.06	0.01	0.06	2.48	0.04	0.04	0.13	0.75	0.02	0.78	0.02	0.04	0.87	0.52	0.03	0.85	68.68
SD	1.58	0.05	0.01	0.05	1.39	0.02	0.02	0.05	0.43	0.01	1.13	0.02	0.02	0.97	0.41	0.04	0.94	2.84
Max	6.11	0.18	0.03	0.20	5.35	0.08	0.08	0.24	1.97	0.03	4.44	0.08	0.08	3.76	1.57	0.15	3.78	72.18
Min	1.27	0.02	0.00	0.01	0.94	0.02	0.02	0.05	0.33	0.01	0.03	0.00	0.02	0.14	0.13	0.00	0.25	62.79
CV	0.51	0.73	0.64	0.90	0.56	0.43	0.53	0.40	0.57	0.39	1.46	1.04	0.43	1.11	0.79	1.19	1.10	0.04

Table 2.55: Statistical results of chemical characterisation (µg/m^3) of $PM_{2.5}$ at GSKF for summer (S) season

GSKF (S)	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
Mean	59.79	10.19	3.04	0.32	4.69	2.92	2.48	1.52	1.82	0.69	0.24	0.62	1.99	0.70	2.08	5.13	0.39	0.92
SD	17.55	3.42	1.05	0.09	1.59	1.03	1.12	0.45	0.66	0.16	0.10	0.26	0.56	0.27	0.88	2.13	0.45	0.22
Max	88.46	18.28	5.33	0.53	8.13	5.07	4.34	2.74	3.11	1.09	0.43	1.16	3.37	1.17	3.79	9.31	1.36	1.45
Min	42.04	5.72	1.57	0.24	2.73	1.35	1.23	0.79	1.12	0.48	0.15	0.36	1.07	0.45	1.15	2.73	0.02	0.64
CV	0.29	0.34	0.34	0.29	0.34	0.35	0.45	0.30	0.37	0.24	0.40	0.42	0.28	0.38	0.42	0.41	1.15	0.24
GSKF (S)	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
Mean	1.41	0.02	0.01	0.02	1.12	0.02	0.02	0.06	0.65	0.01	0.26	0.01	0.02	0.75	0.22	0.01	0.76	70.57
SD	0.60	0.01	0.00	0.02	0.44	0.01	0.01	0.02	0.42	0.00	0.28	0.00	0.00	0.83	0.13	0.02	0.93	1.77
Max	2.59	0.05	0.01	0.06	1.93	0.03	0.03	0.10	1.76	0.01	1.08	0.02	0.02	3.07	0.44	0.07	3.72	74.10
Min	0.76	0.01	0.00	0.00	0.63	0.01	0.00	0.03	0.24	0.01	0.01	0.00	0.01	0.09	0.05	0.00	0.20	67.37
CV	0.43	0.46	0.46	0.65	0.40	0.40	0.45	0.34	0.64	0.32	1.07	0.70	0.27	1.12	0.60	1.25	1.21	0.03

Table 2.56: Correlation Matrix for PM_{10} and its composition at GSKF for winter season

GSKF (W)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.74	0.72	0.72	0.26	0.75	0.81	0.87	-0.12	0.87	0.33	0.03	0.94	0.94
TC		1.00	0.98	0.96	0.32	0.37	0.68	0.63	-0.27	0.57	0.35	-0.08	0.59	0.50
OC			1.00	0.89	0.29	0.32	0.71	0.62	-0.29	0.54	0.35	-0.04	0.56	0.48
EC				1.00	0.34	0.43	0.58	0.60	-0.21	0.57	0.34	-0.12	0.58	0.49
NO_3^-					0.21	0.45	1.00	0.79	-0.40	0.53	0.08	-0.02	0.68	0.67
SO_4^{-2}					0.43	0.53		1.00	-0.33	0.78	0.20	0.02	0.84	0.78
NH_4^+					0.37	0.62			0.08	1.00	0.53	-0.01	0.85	0.87
Metals					0.18	0.77			0.14		0.41	0.21	0.92	1.00

Table 2.57: Correlation matrix for $PM_{2.5}$ and its composition at GSKF for winter season

GSKF (W)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.78	0.75	0.76	0.41	0.70	0.92	0.85	-0.05	0.83	0.29	-0.11	0.95	0.98
TC		1.00	0.98	0.96	0.33	0.44	0.67	0.59	-0.01	0.57	0.40	-0.07	0.61	0.66
OC			1.00	0.89	0.32	0.38	0.67	0.58	-0.03	0.51	0.40	-0.03	0.60	0.63
EC				1.00	0.33	0.49	0.62	0.57	0.03	0.60	0.39	-0.12	0.60	0.65
NO_3^-					0.39	0.58	1.00	0.81	0.11	0.71	0.36	0.06	0.86	0.93
SO_4^{-2}					0.60	0.36		1.00	-0.11	0.83	0.38	-0.04	0.83	0.85
NH_4^+					0.49	0.59			0.09	1.00	0.53	-0.05	0.76	0.84
Metals					0.37	0.71			0.03		0.30	-0.04	0.97	1.00

Table 2.58: Correlation matrix for PM10 and its composition at GSKF for summer season

GSKF (S)	PM_{10}	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
PM_{10}	1.00	0.62	0.63	0.44	0.60	0.83	0.76	0.86	0.08	0.68	0.60	0.36	0.97	0.98
TC		1.00	0.99	0.78	0.51	0.15	0.23	0.56	0.03	0.41	0.21	0.09	0.47	0.45
OC			1.00	0.67	0.51	0.17	0.25	0.62	0.01	0.43	0.24	0.15	0.46	0.45
EC				1.00	0.37	0.06	0.10	0.21	0.10	0.25	0.02	-0.19	0.36	0.34
NO_3^-					0.70	0.84	1.00	0.80	-0.27	0.40	0.33	0.19	0.72	0.76
SO_4^{-2}					0.70	0.73		1.00	-0.12	0.48	0.42	0.32	0.77	0.80
NH_4^+					0.39	0.49			-0.04	1.00	0.28	0.08	0.67	0.69
Metals					0.54	0.89			0.14		0.64	0.38	0.99	1.00

Table 2.59: Correlation matrix for $PM_{2.5}$ and its composition at GSKF for summer season

GSKF (S)	$PM_{2.5}$	TC	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Metals
$PM_{2.5}$	1.00	0.65	0.67	0.41	0.62	0.86	0.83	0.88	0.09	0.66	0.50	0.24	0.88	0.95
TC		1.00	0.98	0.80	0.59	0.23	0.26	0.53	0.04	0.45	0.16	0.02	0.25	0.40
OC			1.00	0.67	0.57	0.26	0.28	0.60	0.02	0.46	0.20	0.08	0.28	0.42
EC				1.00	0.50	0.08	0.13	0.15	0.09	0.32	-0.02	-0.21	0.08	0.24
NO_3^-					0.53	0.84	1.00	0.80	-0.18	0.37	0.34	0.20	0.91	0.89
SO_4^{-2}					0.62	0.74		1.00	0.02	0.40	0.43	0.28	0.78	0.85
NH_4^+					0.31	0.50			0.17	1.00	0.36	0.10	0.51	0.63
Metals					0.58	0.94			0.11		0.49	0.24	0.95	1.00

2.4.5 Overall Summary and Results

The sampling period for winter is November 21, 2022, to December 28, 2022, and April 29, 2023, to June 02, 2023, for the Summer Season

2.4.5.1 Particulate Matter (PM_{10}, $PM_{2.5}$)

The seasonal comparison is shown for PM_{10} (Figure 2.55), $PM_{2.5}$ (Figure 2.56) and the ratio of $PM_{2.5}$ to PM_{10} (Figure 2.57) for all sites. The overall summary of experimental results for PM is shown for the winter and summer seasons (Table 2.60).

Winter

The overall city average of $PM_{2.5}$ in winter was 283 $\mu g/m^{3,}$ and PM_{10} was 378 $\mu g/m^3$. The $PM_{2.5}$ levels are about 4.71 times higher than the NAQS (60 $\mu g/m^3$), and PM_{10} is about 3.78 times higher than the NAQS (100 $\mu g/m^3$). Both $PM_{2.5}$ and PM_{10} levels were highest at GCRF, the residential site (318 and 429 $\mu g/m^3$), followed by levels at SJIF (291 and 379 $\mu g/m^3$), the industrial site. The $PM_{2.5}$ and PM_{10} levels were lowest at JMDF (253 and 354 $\mu g/m^3$); these levels also exceed the air quality standards. The highest variability was seen at SJIF (CV: 0.34) for $PM_{2.5,}$ followed by GSKF (CV: 0.31). The highest variation for PM_{10} was seen at JMDF (CV: 0.26) and the least at GCRF (CV: 0.18).

Ratio of $PM_{2.5}$ to PM_{10} is a useful parameter to indicate the relative abundance of fine particulate (i.e. $PM_{2.5}$) and toxicity of particulate matter. The overall city ratio is 0.74, and it was highest at GSKF (0.76), followed by SJIF (0.75).

Summer

The overall city average of $PM_{2.5}$ and PM_{10} levels in summer drops sharply to 61 $\mu g/m^3$ and 138 $\mu g/m^{3,}$ respectively, in winter. The $PM_{2.5}$ levels generally meet the standards, while PM_{10} is 1.38 times higher than the standard. Both $PM_{2.5}$ and PM_{10} levels were highest at GCRF, the residential site at 67 and 155 $\mu g/m^3$, followed by levels at JMDF (62 and 142 $\mu g/m^3$), the commercial site. The $PM_{2.5}$ levels were lowest at SJIF (56 $\mu g/m^3$) while PM_{10} levels were lowest at GSKF (107 $\mu g/m^3$). The highest variability was seen at GSKF (CV: 0.28) for $PM_{2.5,}$ followed by JMDF (CV: 0.27). The highest variation for PM_{10} was seen at SJIF (CV: 0.4) and the least at GCRF (CV: 0.22). The overall $PM_{2.5}$ to PM_{10} city ratio is 0.47, and it was highest at GSKF (0.57), followed by JMDF (0.46).

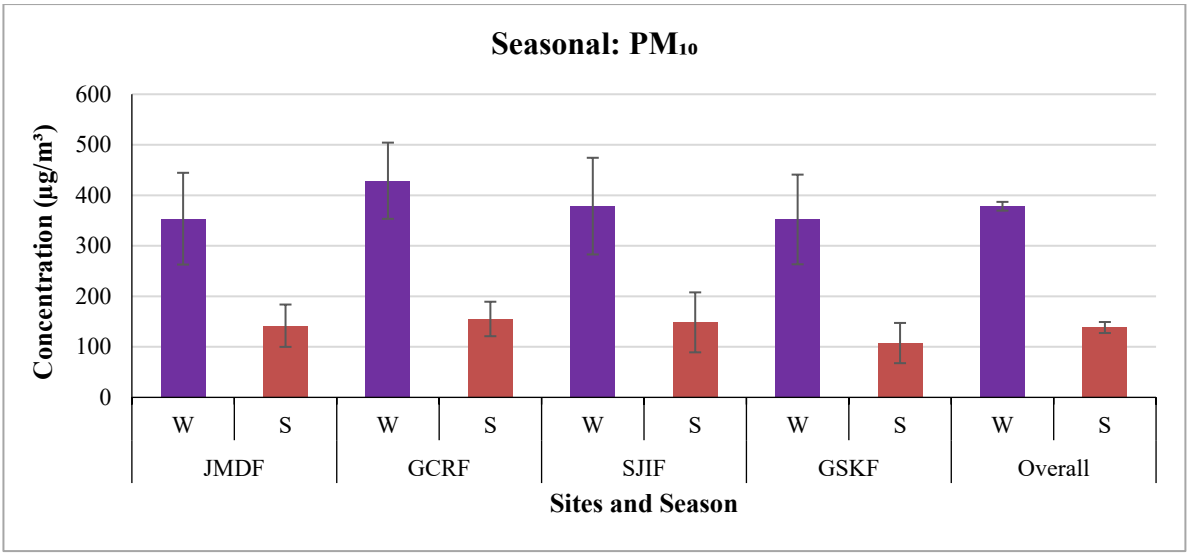


Figure 2.55: Seasonal comparison of PM_{10} levels for all Sites

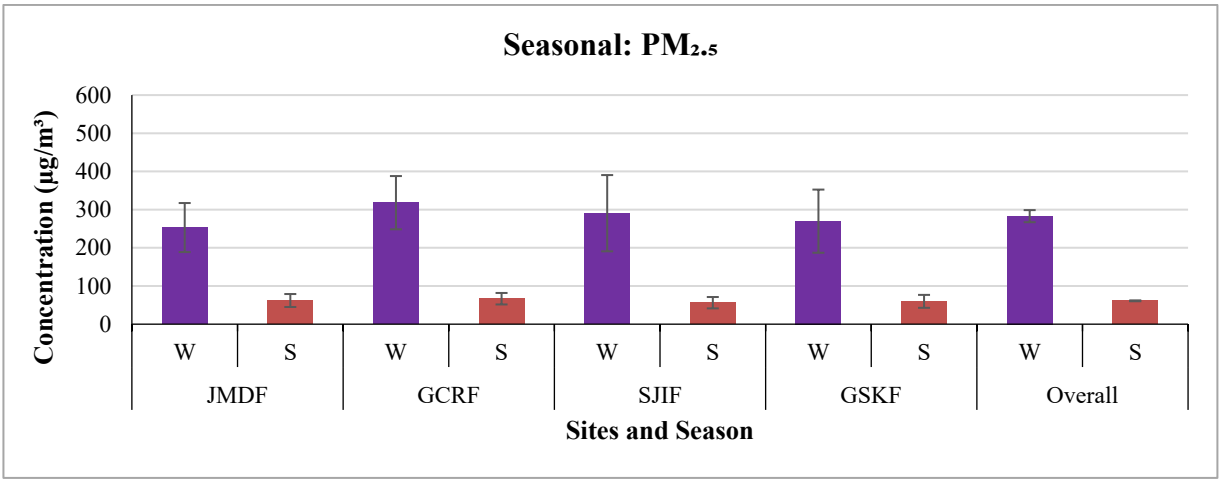


Figure 2.56: Seasonal comparison of $PM_{2.5}$ concentrations for all Sites

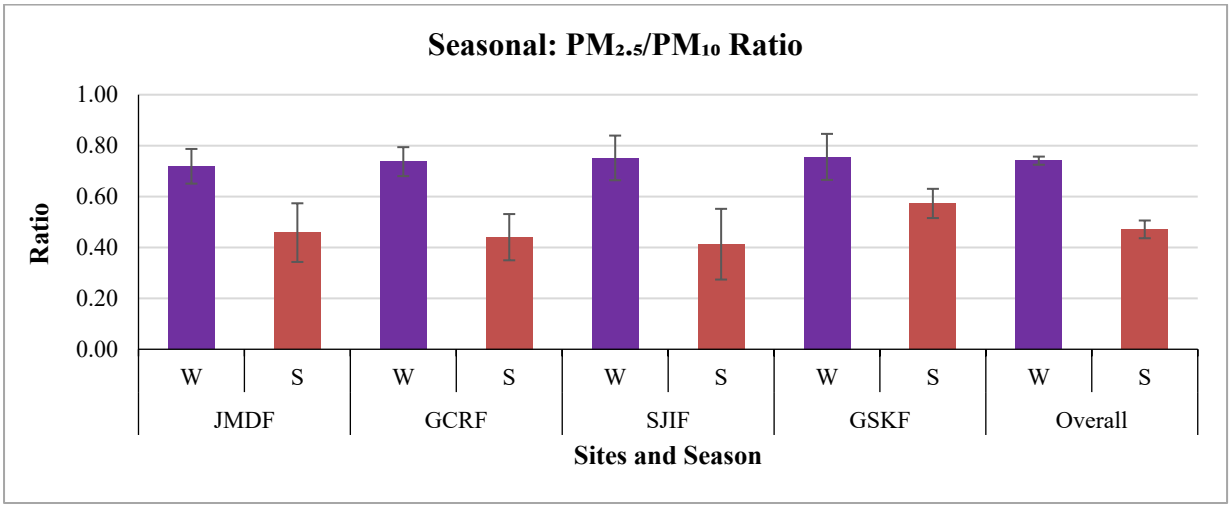


Figure 2.57: Seasonal comparison of $PM_{2.5}$ /PM_{10} ratio

2.4.5.2 Gaseous Pollutants (NO_2 and SO_2)

The seasonal comparison is shown for NO_2 and SO_2 (Figure 2.58). The overall average concentrations with statistical summary are presented in Table 2.61 and Table 2.62 for all sites in winter and summer seasons.

The SO_2 levels were quite low and were always within the air quality standards (80 µg/m^3). Levels were below detection limit in summer almost at all sites. The SO_2 levels, being very low have not been further discussed.

It was observed that NO_2 levels were within the air quality standards (80 µg/m^3) during both the seasons. The overall city level average NO_2 levels are 48.3 µg/m^3 in winter and 26.36 µg/m^3 in summer. The highest NO_2 concentration was observed at JMDF during both seasons 56.86 µg/m^3 (winter) and 30.17 µg/m^3 (summer). Rather being under the limits still NO_2 is the emerging pollutants which can largely be attributed to vehicular emissions. The commercial area has the higher vehicular emission of NO_2. Levels sharply drop in summer (around 50% of winter level) largely due to high wind speeds, convective conditions, large mixing height resulting in better dilution and dispersion of the NO_2.

Although the NO_2 levels meet the national air quality standard, efforts are required to improve the air quality for NO_2 particularly in winter season as it will be difficult to reduce the emission after-the-fact at a later stage.

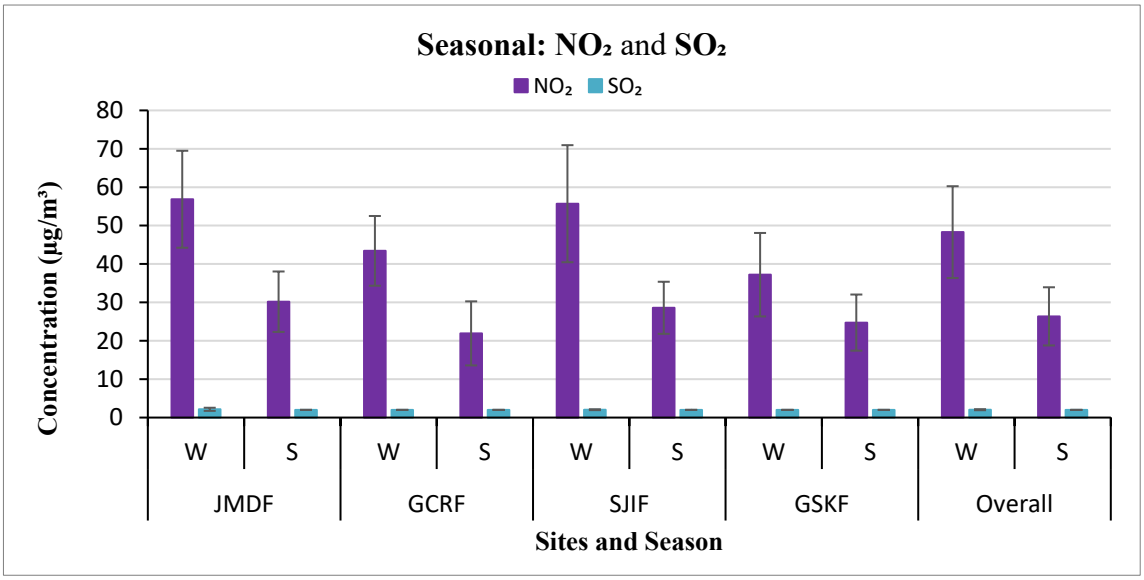


Figure 2.58: Seasonal Comparison of NO_2 and SO_2 levels for all Sites

2.4.5.3 Volatile Organic Compounds (VOCs: BTX)

The seasonal comparison for VOCs (BTX) is shown in Figure 2.59. The overall statistical summary is presented in Table 2.61 and Table 2.62 for all sites for winter and summer seasons.

The overall city level average of BTX levels is 7.4 µg/m^3 in winter and 5.12 µg/m^3 in summer. The highest BTX concentration was observed at SJIF (10.58 µg/m^3) in winter and GCRF (11.41 µg/m^3) in summer seasons.

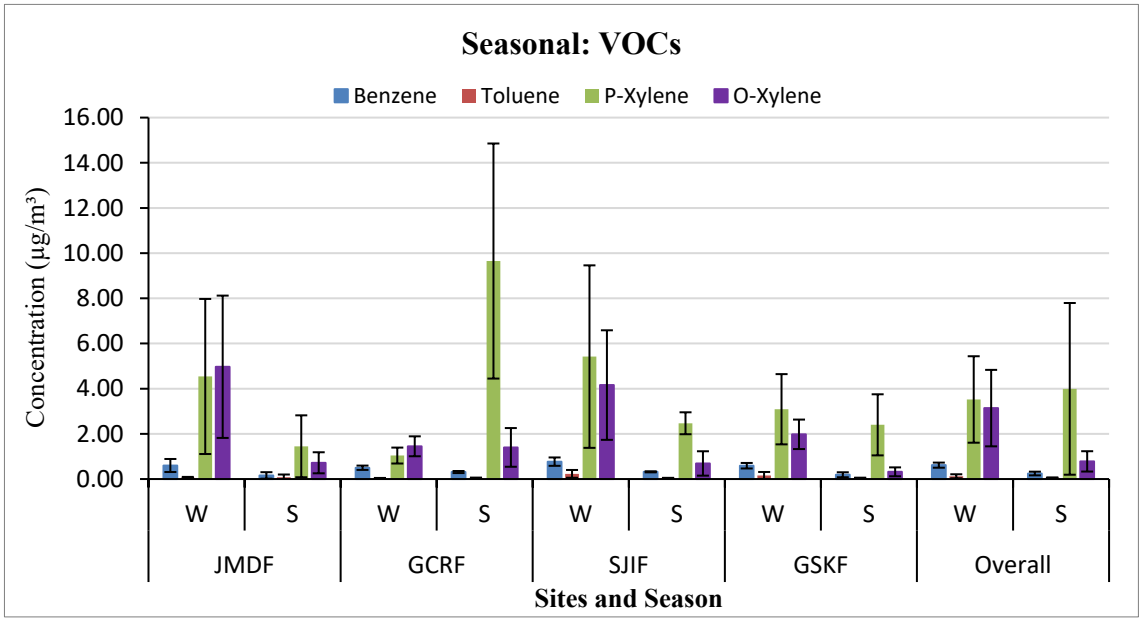


Figure 2.59: Seasonal comparison of VOCs for all Sites

2.4.5.4 Carbon Content (EC/OC) in $PM_{2.5}$

The seasonal comparison for OC and EC is presented in **Error! Reference source not found.** f or PM_{10} and **Error! Reference source not found.** for $PM_{2.5}$. The $PM_{2.5}$ contained the high fraction of TC (OC+EC) 20% in winter and 29% in summer seasons. The organic carbon is observed higher than the elemental carbon at each site during winter than summer; this is generally true that in atmosphere volatile and semi-volatile organic compounds continuously undergo nucleation, oxidation, condensation and convert into organic particles, whereas EC remains unchanged, as a result the ratio of OC to EC further increases. However, the ratio of OC3/TC is observed higher in winter while the ratio of OC2/TC is observed higher in summer than other OCs, this indicates the formation of secondary and primary organic carbon particles respectively, in atmosphere. It is also observed that the OC and EC are higher in winter season than in summer season probably because of poor dispersion in winter and more combustion sources including biomass and solid waste burning. It is observed that average TC to $PM_{2.5}$ ratio

were maximum (22%) at JMDF followed by GSKF (20%) and minimum (18%) at SJIF in winter (Table 2.63) and maximum (31%) at GCRF and minimum (22%) at GSKF in summer (Table 2.64).

The overall summary of carbon content (TC, EC, OC; OC1, OC2, OC3 and OC4 with fractions OC1/TC, OC2/TC, OC3/TC and OC4/TC) is presented in Table 2.63 - Table 2.64 for winter and summer seasons.

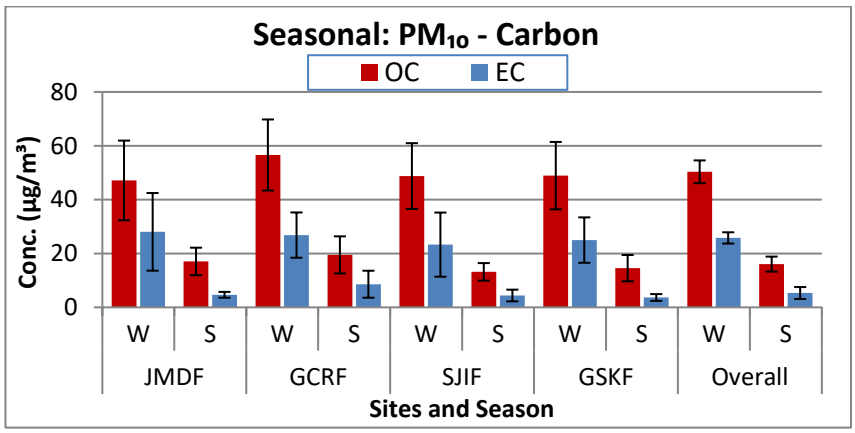


Figure 2.60: Seasonal Comparison of EC and OC in PM_{10} for all Sites

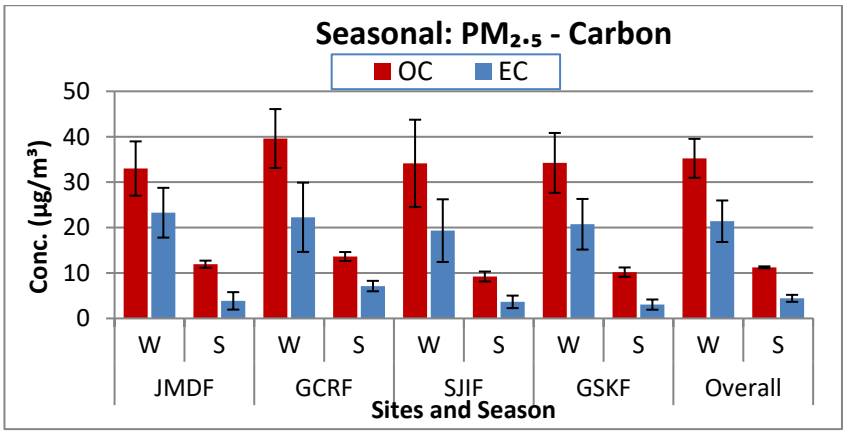


Figure 2.61: Seasonal Comparison of EC and OC in $PM_{2.5}$ for all Sites

2.4.5.5 PAHs in $PM_{2.5}$

The average concentrations of PAHs are shown graphically for winter season Figure 2.62) and summer season (Figure 2.63) for all sites along with overall average concentration for Firozabad. Average concentrations are shown in Table 2.65 - Table 2.66 with the standard deviation and coefficient of variation CV for Firozabad. The PAHs compounds analyzed are (i) DmP, (ii) AcP,

(iii) DEP, (iv) Flu, (v) Phe, (vi) Ant, (vii) Pyr, (viii) BbP, (ix) BeA, (x) B(a)A, (xi) Chr, (xii) B(b)F, (xiii) B(k)F, (xiv) B(a)P, (xv) InP, (xvi) D(a,h)A and (xvii) B(ghi)P. Seasonal comparison for PAHs are shown in Figure 2.64 which indicates the concentrations are significantly much higher in winter season compared to summer season. Major PAHs are DmP, AcP, DEP, Flu and Phe. The overall average total PAHs were much higher in winter (87 ng/m^3) in winter compared to summer (33 ng/m^3).

Literature reported values for InP/ (InP + B(ghi)P) ratio are 0.18, 0.37 and 0.56 for gasoline, diesel and coal respectively (Rajput and Lakhani, 2010). The ratio obtained in this study (0.38 in winter and 0.32 in summer) is comparable to the reported values for coal combustion in winter season and gasoline emissions in summer season. It is inferred that the major sources of PAHs are gasoline vehicles and coal combustion.

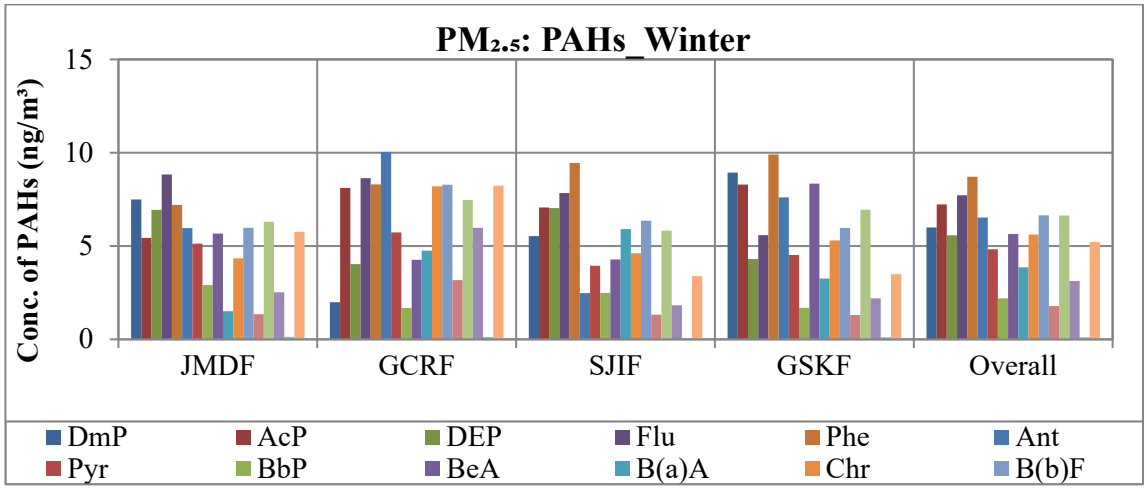


Figure 2.62: Variation in PAHs in $PM_{2.5}$ for winter season

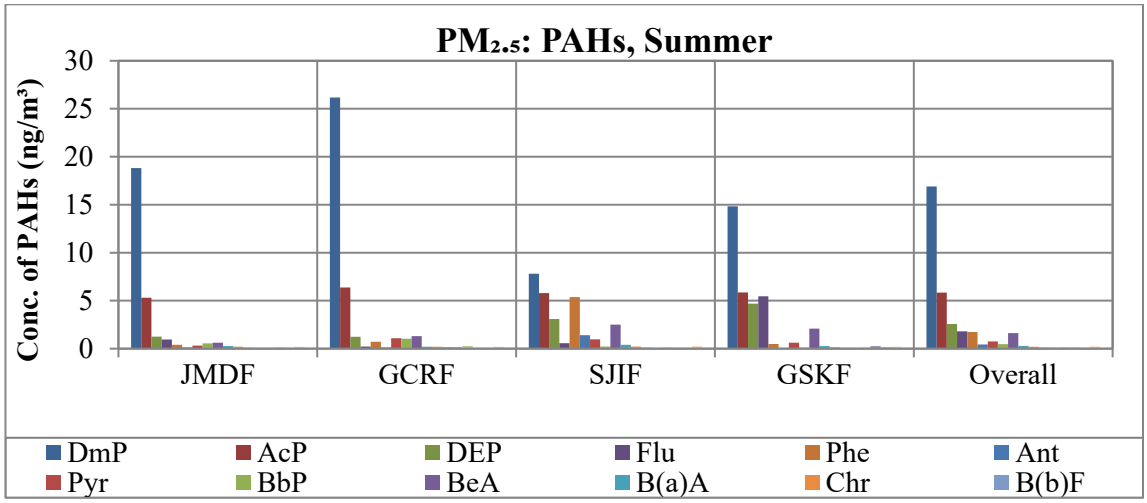


Figure 2.63: Variation in PAHs in $PM_{2.5}$ for summer season

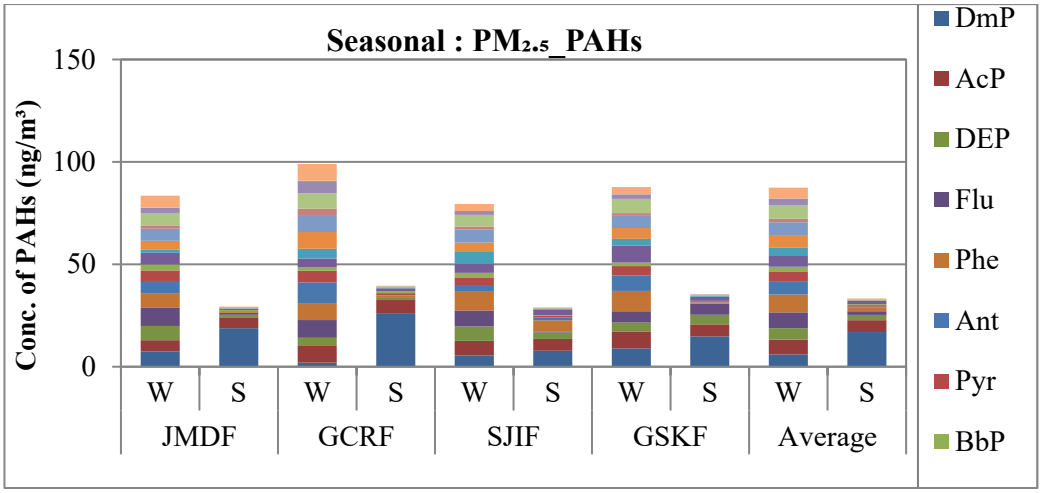


Figure 2.64: Seasonal comparison of PAHs in $PM_{2.5}$

2.4.5.6 Molecular Markers in $PM_{2.5}$

The average concentrations of molecular markers are shown graphically for winter season (Figure 2.65) and summer season (Figure 2.66) for all sites along with overall average concentration for Firozabad. Average concentrations are shown in Table 2.67-Table 2.68 with the standard deviation and coefficient of variation CV for Firozabad. Seasonal comparison is shown in Figure 2.67 which indicates the concentrations of molecular markers are higher in winter compared to summer season compared to summer season. The overall average of molecular markers was measured higher in winter (233.56 ng/m^3) compared to summer (71.47 ng/m^3). The presence of significant quantities of molecular markers, especially alkanes and hopanes conclusively establishes contribution of coal burning, gasoline and diesel combustion in vehicles.

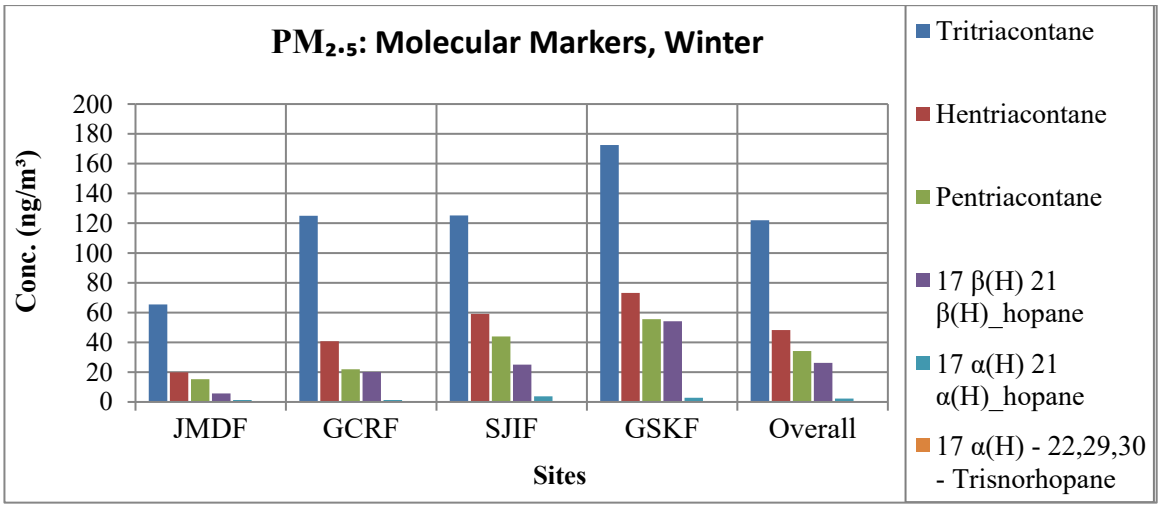


Figure 2.65: Variation in molecular markers in $PM_{2.5}$ for winter season

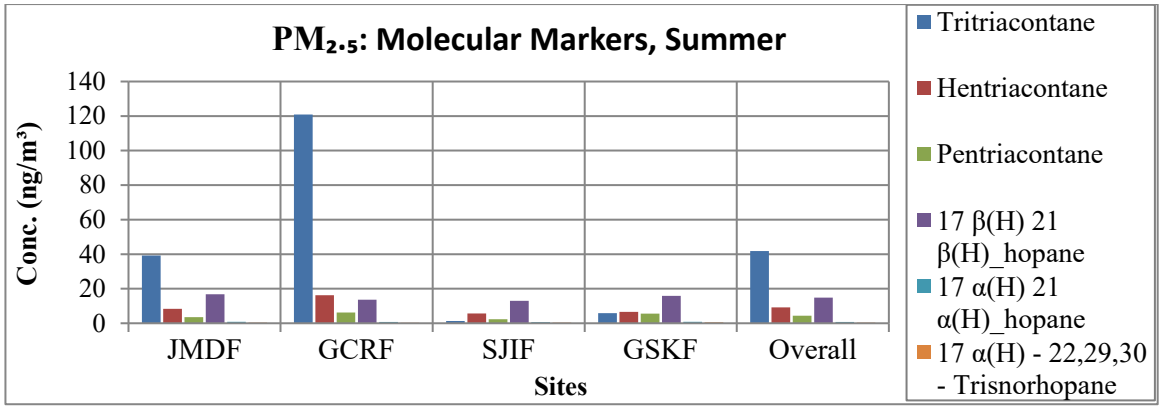


Figure 2.66: Variation in molecular markers in $PM_{2.5}$ for summer season

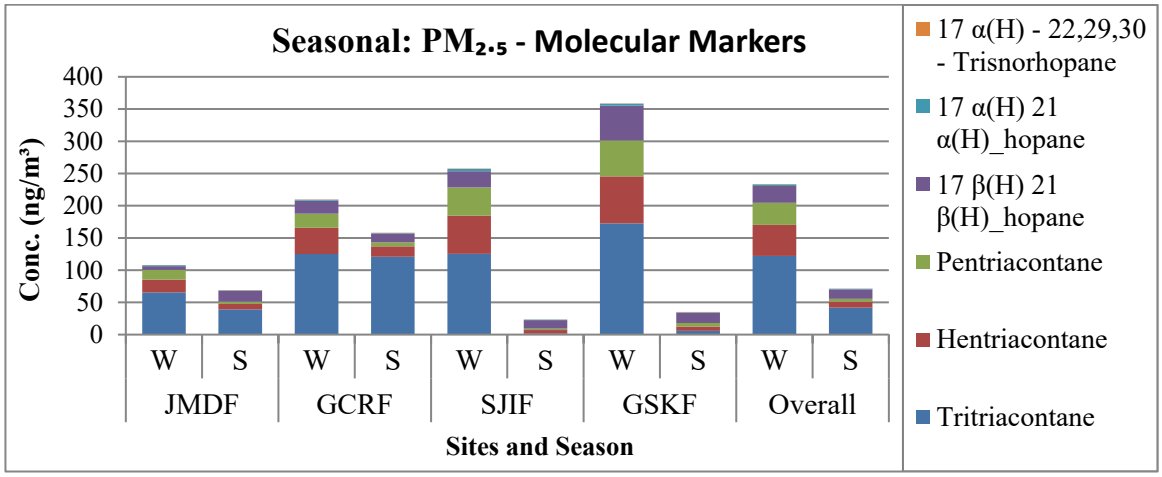


Figure 2.67: Seasonal comparison of molecular markers in $PM_{2.5}$

2.4.5.7 Chemical Composition of PM_{10} and $PM_{2.5}$

Graphical presentation for seasonal comparison for chemical species [(a) Anions, (b) Cations and (c) Elements) are shown for PM_{10} (Figure 2.68 (a), (b) and (c)) and $PM_{2.5}$ (Figure 2.69 (a), (b) and (c)). Overall summary of average concentrations for all sites along with overall average, standard deviation (SD) and coefficient of variation (CV) for PM (PM_{10} and $PM_{2.5}$), its composition [carbon content (EC and OC), ionic species (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Na, Mg, Al, Si, P, K, Ca, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Cd, Cs, Ba, Pb)] along with mass percentage (% R) estimated in composition are presented in the Table 2.69 - Table 2.72 for winter and summer seasons.

The statistical summary of the major components (i.e. crustal elements – Si, Ai, Fe, Ca; Secondary ions - NO_3^-, SO_4^{-2}, NH_4^+; TC) in PM_{10} and $PM_{2.5}$ are presented in Table 2.74 - Table 2.77 for winter and summer seasons.

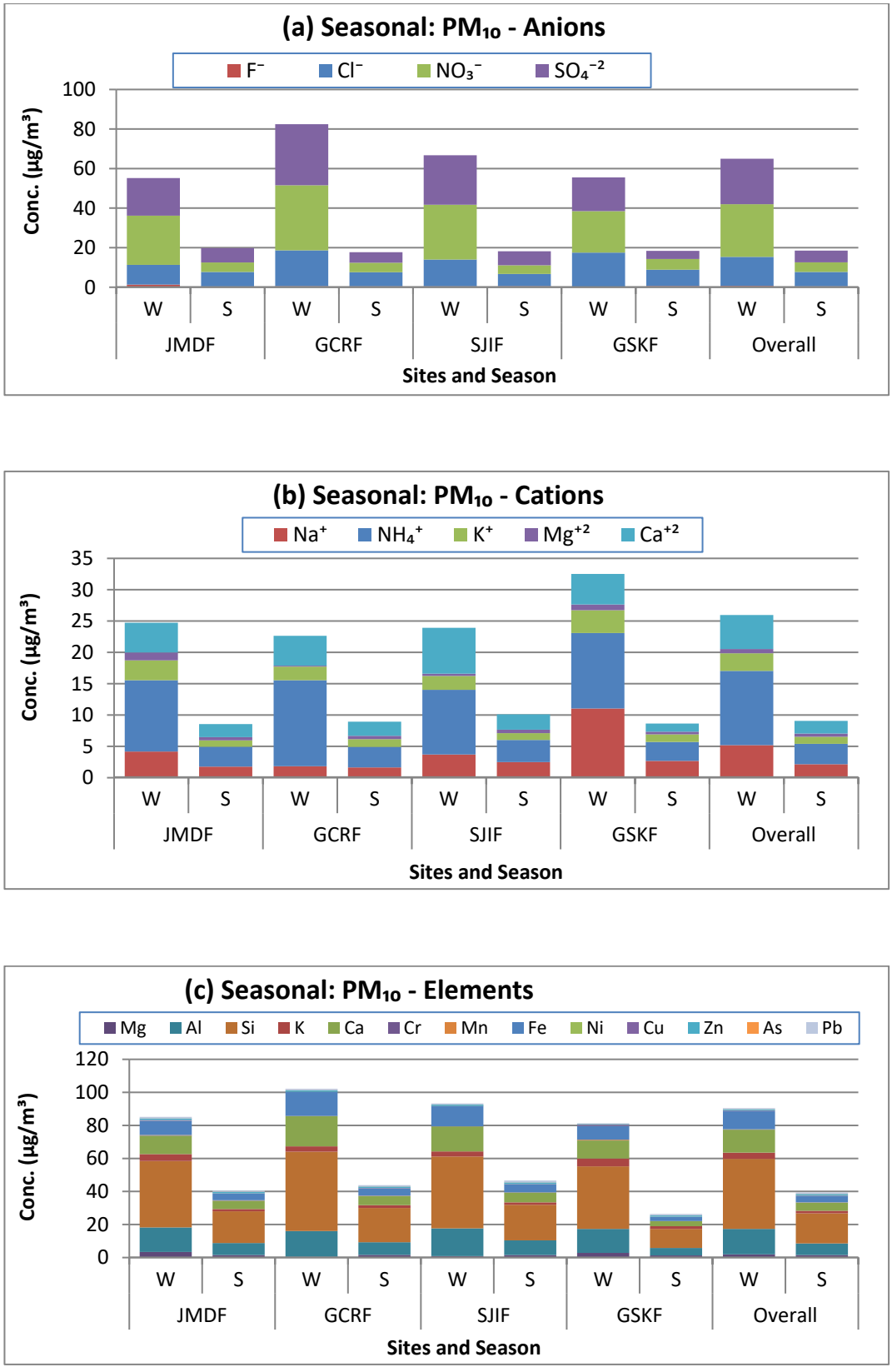
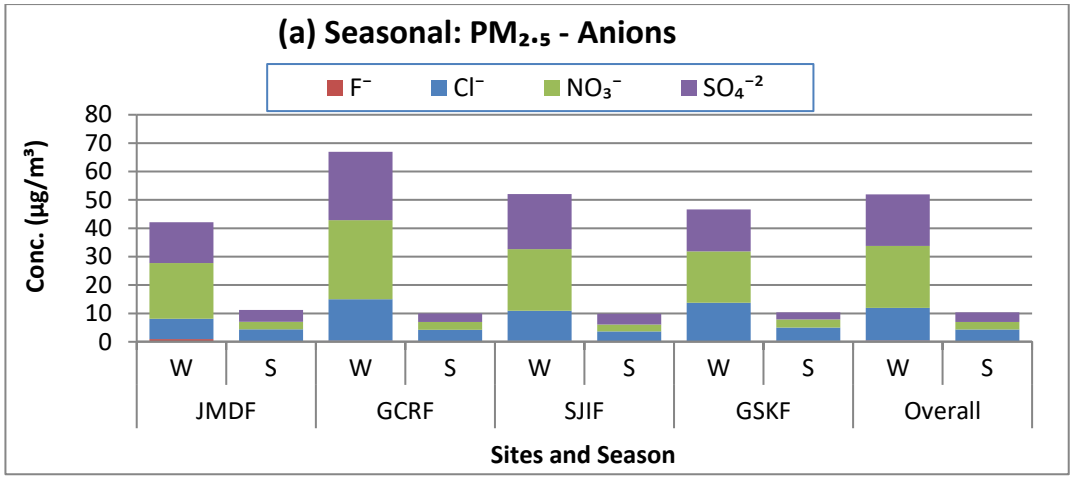
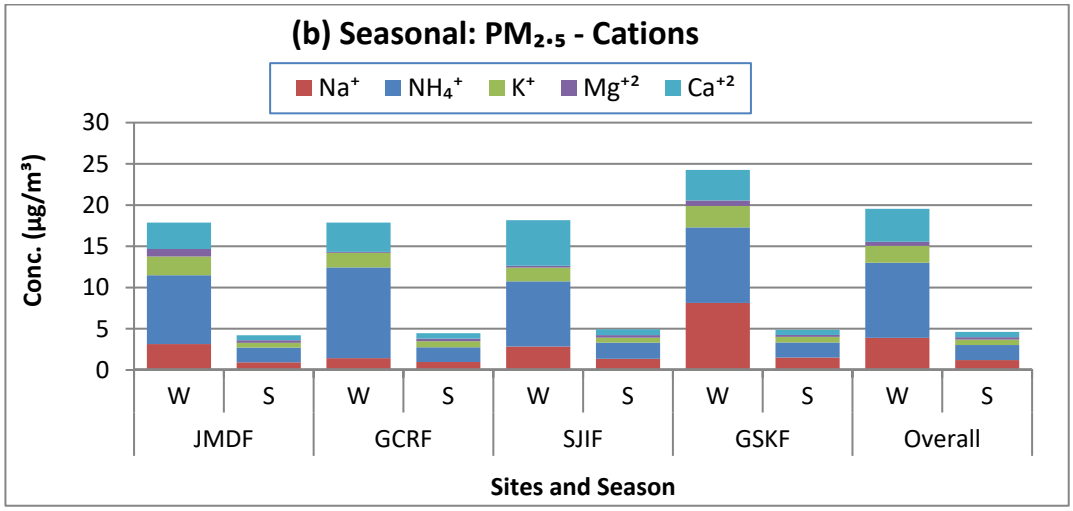


Figure 2.68: Seasonal comparison of ionic and elemental species concentrations in PM_{10} for all sites





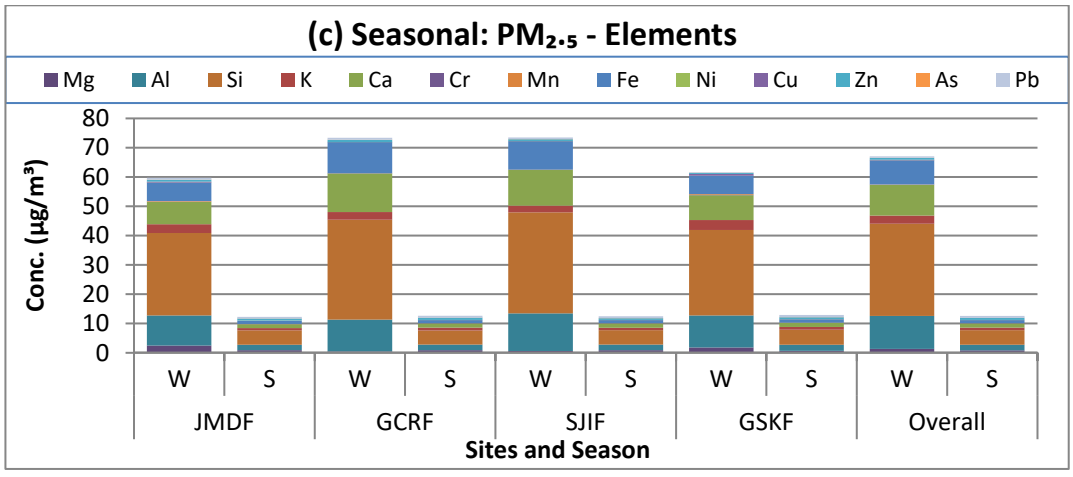


Figure 2.69: Seasonal comparison of ionic and elemental species concentrations in $PM_{2.5}$ for all sites

2.4.5.8 Comparison of PM_{10} and $PM_{2.5}$ Composition

The graphical presentation is the better option for understanding the compositional variation. The major chemical species considered for overall compositional comparisons are carbon (OC and EC), ions (F^-, Cl^-, NO_3^-, SO_4^{-2}, Na^+, NH_4^+, K^+, Ca^{+2}, Mg^{+2}) and elements (Al, Si, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, As, Cd and Pb). Compositional comparison of $PM_{2.5}$ Vs PM_{10} is shown for all major carbon, ions (Figure 2.70) and elements (Figure 2.71) for all sites and both seasons in Firozabad. The overall compositional comparison is also presented in Table 2.73 for all sites.
It is observed that significant portion of PM is having more fine-mode particles during winter (75%) than summer (44%). The major species are contributing to fine mode that are EC, OC, NO_3^-, SO_4^{-2}, NH_4^+, K^+, Na, V, Zn and Pb.

The average ratio ($PM_{2.5}/PM_{10}$) were taken from the previous studies (Puxbaum et al., 2004; Samara et al., 2014; Wang et al., 2014) for EC (0.70) and OC (0.83) to estimate the carbon content in PM_{10}. Therefore, the percentage of EC (70%) and OC (83%) are constant for all sites by converting from levels known in $PM_{2.5}$ and translating these into EC and OC levels of PM_{10}.

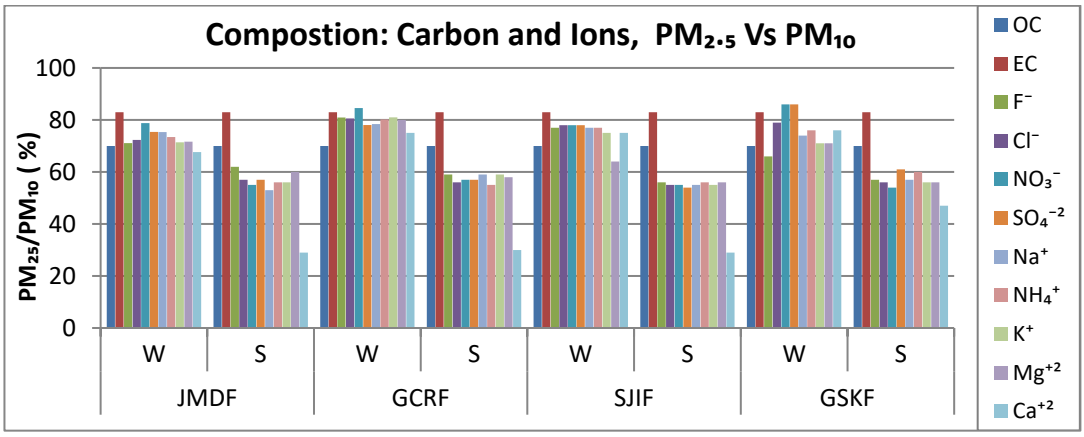


Figure 2.70: Compositional comparison of carbon and ions species in $PM_{2.5}$ Vs PM_{10}

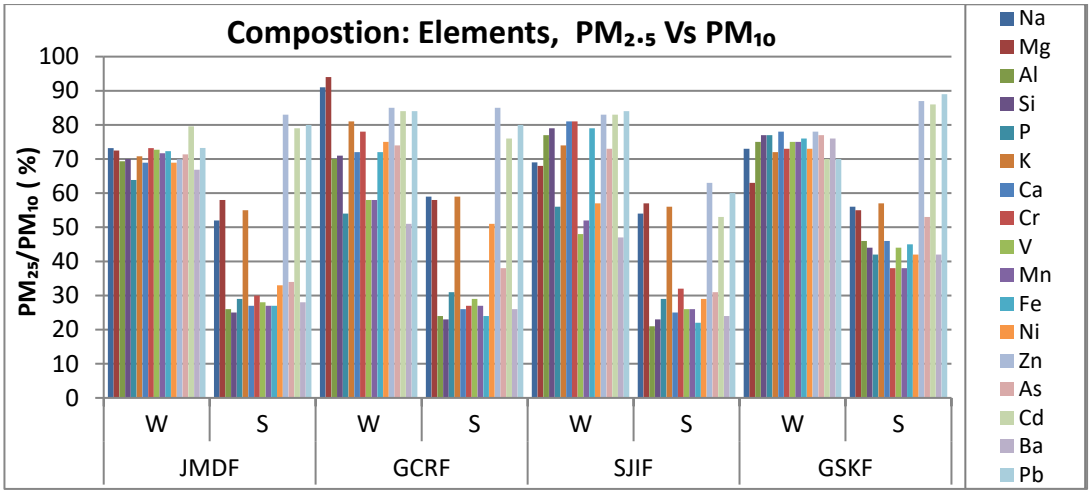


Figure 2.71: Compositional comparison of elemental species in $PM_{2.5}$ Vs PM_{10}

Table 2.60: Overall summary of experimental results of PM (Mean±SD µg/m³)

	PM_{10}		$PM_{2.5}$		$PM_{2.5}/PM_{10}$	
Sites	Winter	Summer	Winter	Summer	Winter	Summer
JMDF	354±91 (0.26)	142±42 (0.30)	253±64 (0.25)	62±17 (0.27)	0.72±0.07 (0.09)	0.46±0.12 (0.25)
GCRF	429±75 (0.18)	155±34 (0.22)	318±70 (0.22)	67±15 (0.23)	0.74±0.06 (0.08)	0.44±0.09 (0.21)
SJIF	379±96 (0.25)	148±59 (0.40)	291±100 (0.34)	56±15 (0.26)	0.75±0.09 (0.12)	0.41±0.14 (0.34)
GSKF	352±89 (0.25)	107±40 (0.37)	270±83 (0.31)	60±17 (0.28)	0.76±0.09 (0.12)	0.57±0.06 (0.10)
Overall	378±9 (0.02)	138±11 (0.08)	283±16 (0.06)	61±1 (0.02)	0.74±0.02 (0.02)	0.47±0.03 (0.07)
Values in brackets are CV: Coefficient of Variation						

Table 2.61: Overall summary of average concentration (µg/m³) of gaseous pollutants (SO_2, NO_2 and VOCs) for winter season

Winter	NO_2	SO_2	Benzene	Toluene	P-Xylene	O-Xylene	Total (BTX)
JMDF	56.86	2.15	0.60	0.06	4.54	4.97	10.17
GCRF	43.42	2.00	0.50	0.04	1.04	1.45	3.02
SJIF	55.70	2.05	0.77	0.23	5.42	4.16	10.58
GSKF	37.21	2.00	0.59	0.16	3.09	1.98	5.82
Overall	48.30	2.05	0.62	0.12	3.52	3.14	7.40
SD	9.57	0.07	0.11	0.09	1.91	1.69	3.63
CV	0.20	0.03	0.18	0.74	0.54	0.54	0.49

Table 2.62: Overall summary of average concentration (µg/m^3) of gaseous pollutants (SO_2, NO_2 and VOCs) for summer season

Summer	NO_2	SO_2	Benzene	Toluene	P-Xylene	O-Xylene	Total (BTX)
JMDF	30.17	2.00	0.16	0.08	1.45	0.72	2.41
GCRF	21.92	2.00	0.31	0.05	9.65	1.40	11.42
SJIF	28.59	2.00	0.32	0.05	2.47	0.69	3.53
GSKF	24.73	2.00	0.24	0.04	2.47	0.36	3.11
Overall	26.36	2.00	0.26	0.06	4.01	0.79	5.12
SD	3.74	0.00	0.07	0.02	3.79	0.44	4.23
CV	0.14	0.00	0.29	0.34	0.95	0.56	0.83

Table 2.63: Overall summary of average concentration of carbon content in $PM_{2.5}$ for all sites for winter Season

Winter	$PM_{2.5}$	OC1	OC2	OC3	OC4	OC	EC	TC	OC1/TC	OC2/TC	OC3/TC	OC4/TC
JMDF	253	0.90	11.28	12.46	8.36	33.00	23.27	56.27	0.01	0.20	0.23	0.17
GCRF	318	0.27	13.31	15.13	10.90	39.61	22.27	61.88	0.00	0.21	0.25	0.18
SJIF	291	1.31	12.31	12.26	8.25	34.13	19.33	53.45	0.02	0.24	0.23	0.16
GSKF	270	0.57	11.20	13.75	8.72	34.24	20.73	54.97	0.01	0.20	0.25	0.17
Overall	283	0.76	12.02	13.40	9.06	35.24	21.40	56.64	0.01	0.21	0.24	0.17
SD	28	0.45	0.99	1.33	1.25	2.96	1.73	3.67	0.01	0.02	0.01	0.01
CV	0.10	0.59	0.08	0.10	0.14	0.08	0.08	0.06	0.65	0.08	0.04	0.04

Table 2.64: Overall summary of average concentration of carbon content in $PM_{2.5}$ for all sites for summer season

Summer	PM2.5	OC1	OC2	OC3	OC4	OC	EC	TC	OC1/TC	OC2/TC	OC3/TC	OC4/TC
JMDF	62	0.33	5.62	3.03	2.95	11.93	3.86	15.79	0.03	0.35	0.19	0.18
GCRF	67	0.23	4.34	4.71	4.36	13.63	7.12	20.75	0.01	0.21	0.23	0.22
SJIF	56	0.09	3.76	2.92	2.45	9.22	3.65	12.87	0.01	0.30	0.23	0.19
GSKF	60	0.10	5.66	2.69	1.73	10.19	3.04	13.23	0.01	0.43	0.20	0.13
Overall	61	0.19	4.85	3.34	2.87	11.24	4.42	15.66	0.01	0.32	0.21	0.18
SD	4	0.11	0.95	0.92	1.11	1.95	1.84	3.64	0.01	0.09	0.02	0.04
CV	0.07	0.60	0.20	0.28	0.39	0.17	0.42	0.23	0.64	0.29	0.10	0.21

Table 2.65: Overall summary of average concentration (ng/m^3) of PAHs in $PM_{2.5}$ all sites for winter season

Winter	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
JMDF	7.50	5.44	6.94	8.84	7.20	5.96	5.13	2.91	5.67	1.51	4.34	5.98	1.35	6.30	2.52	0.13	5.76	83.48
GCRF	1.99	8.12	4.03	8.63	8.30	10.04	5.73	1.68	4.26	4.75	8.20	8.28	3.17	7.47	5.98	0.13	8.23	99.00
SJIF	5.54	7.07	7.04	7.84	9.45	2.48	3.95	2.48	4.28	5.91	4.62	6.36	1.32	5.83	1.82	0.06	3.38	79.43
GSKF	8.94	8.29	4.31	5.58	9.90	7.61	4.52	1.69	8.35	3.26	5.30	5.97	1.30	6.95	2.20	0.11	3.49	87.74
Overall	5.99	7.23	5.58	7.72	8.72	6.52	4.83	2.19	5.64	3.86	5.61	6.65	1.78	6.64	3.13	0.11	5.22	87.41
SD	4.48	5.54	3.87	8.05	5.22	3.39	3.05	2.31	3.17	4.67	3.74	5.23	1.67	5.17	2.84	0.08	4.63	31.83
CV	0.75	0.77	0.69	1.04	0.60	0.52	0.63	1.05	0.56	1.21	0.67	0.79	0.94	0.78	0.91	0.77	0.89	0.36

Table 2.66: Overall summary of average concentration (ng/m^3) of PAHs in $PM_{2.5}$ for all sites for summer season

Summer	DmP	AcP	DEP	Flu	Phe	Ant	Pyr	BbP	BeA	B(a)A	Chr	B(b)F	B(k)F	B(a)P	InP	D(a,h)A	B(ghi)P	Total PAHs
JMDF	18.82	5.30	1.26	0.96	0.40	0.11	0.32	0.55	0.62	0.27	0.20	0.09	0.07	0.08	0.09	0.00	0.19	29.33
GCRF	26.17	6.38	1.24	0.22	0.72	0.13	1.10	1.03	1.31	0.20	0.20	0.17	0.16	0.27	0.00	0.02	0.18	39.49
SJIF	7.81	5.79	3.08	0.56	5.37	1.40	0.97	0.22	2.51	0.41	0.23	0.11	0.06	0.12	0.01	0.00	0.23	28.89
GSKF	14.84	5.86	4.69	5.46	0.50	0.08	0.62	0.10	2.09	0.27	0.16	0.07	0.07	0.10	0.27	0.15	0.19	35.52
Overall	16.91	5.83	2.57	1.80	1.74	0.43	0.75	0.47	1.63	0.29	0.20	0.11	0.09	0.14	0.09	0.04	0.20	33.31
SD	12.06	3.57	1.93	2.19	3.13	0.78	0.70	0.76	1.52	0.20	0.13	0.09	0.08	0.12	0.15	0.12	0.07	21.37
CV	0.71	0.61	0.75	1.22	1.79	1.83	0.93	1.60	0.93	0.69	0.66	0.86	0.90	0.85	1.68	2.65	0.36	0.64

Table 2.67: Overall summary of average concentration (ng/m^3) of molecular markers in $PM_{2.5}$ for winter season

Winter	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21 β(H)_hopane	17 α(H) 21 α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
JMDF	65.42	19.91	15.25	5.68	1.31	0.43	108.00
GCRF	125.04	40.77	21.96	20.13	1.37	0.58	209.84
SJIF	125.25	59.08	43.98	25.08	3.74	0.48	257.61
GSKF	172.43	73.15	55.62	54.23	2.82	0.53	358.79
Overall	122.04	48.23	34.20	26.28	2.31	0.51	233.56
SD	43.52	20.36	14.83	18.62	1.28	0.22	70.76
CV	0.36	0.42	0.43	0.71	0.55	0.44	0.30

Table 2.68: Overall summary of average concentration (ng/m^3) of molecular markers in $PM_{2.5}$ for summer season

Summer	Tritriacontane	Hentriacontane	Pentriacontane	17 β(H) 21 β(H)_hopane	17 α(H) 21 α(H)_hopane	17 α(H) - 22,29,30 - Trisnorhopane	Total
JMDF	39.22	8.38	3.52	16.84	0.82	0.37	69.14
GCRF	120.86	16.25	6.19	13.63	0.78	0.30	158.01
SJIF	1.35	5.72	2.37	12.99	0.71	0.38	23.52
GSKF	5.88	6.56	5.56	15.83	0.83	0.53	35.20
Overall	41.83	9.23	4.41	14.82	0.79	0.40	71.47
SD	49.84	5.88	2.29	6.46	0.41	0.18	53.98
CV	1.19	0.64	0.52	0.44	0.52	0.47	0.76

Table 2.69: Overall summary of average concentration of chemical species in PM_{10} for all sites for winter season

Winter	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
JMDF	354	47.1	28.0	1.35	9.94	24.87	19.06	4.17	11.38	3.18	1.25	4.75	5.45	3.42	14.79	40.22	0.73	4.19
GCRF	429	56.6	26.8	0.49	18.15	32.94	30.85	1.84	13.71	2.18	0.15	4.76	2.16	0.51	15.57	47.98	0.10	3.26
SJIF	379	48.8	23.3	0.41	13.60	27.73	25.01	3.71	10.31	2.22	0.35	7.32	4.84	0.90	16.77	43.53	0.07	3.07
GSKF	352	48.9	25.0	0.34	17.17	20.96	17.10	11.04	12.05	3.63	0.93	4.87	14.73	2.85	14.53	37.83	1.37	4.76
Overall	378	50.3	25.8	0.65	14.71	26.63	23.00	5.19	11.86	2.80	0.67	5.43	6.80	1.92	15.41	42.39	0.57	3.82
SD	36	4.2	2.1	0.47	3.74	5.04	6.22	4.03	1.42	0.72	0.51	1.27	5.48	1.43	1.01	4.40	0.62	0.79
CV	0.09	0.08	0.08	0.73	0.25	0.19	0.27	0.78	0.12	0.26	0.76	0.23	0.81	0.75	0.07	0.10	1.09	0.21
Winter	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
JMDF	11.11	0.17	0.02	0.26	8.64	0.058	0.015	0.48	0.95	0.050	0.446	0.059	0.055	0.985	0.020	0.17	0.86	66.49
GCRF	18.30	0.02	0.00	0.04	14.70	0.006	0.002	0.05	0.88	0.069	0.337	0.008	0.013	1.104	0.022	0.04	0.76	66.47
SJIF	15.14	0.02	0.00	0.03	12.36	0.004	0.003	0.03	0.70	0.086	0.253	0.007	0.010	0.480	0.022	0.03	0.64	65.26
GSKF	10.86	0.13	0.04	0.41	8.26	0.103	0.020	0.75	0.44	0.050	0.083	0.101	0.080	0.211	0.042	0.12	0.38	68.30
Overall	13.85	0.09	0.02	0.19	10.99	0.043	0.010	0.33	0.74	0.064	0.280	0.043	0.040	0.695	0.026	0.09	0.66	66.63
SD	3.55	0.08	0.02	0.18	3.09	0.047	0.009	0.35	0.23	0.018	0.153	0.045	0.034	0.421	0.010	0.07	0.21	1.25
CV	0.26	0.90	0.94	0.98	0.28	1.10	0.89	1.07	0.31	0.28	0.55	1.04	0.86	0.61	0.39	0.77	0.32	0.02

Table 2.70: Overall summary of average concentration of chemical species in $PM_{2.5}$ for all sites for winter season

Winter	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
JMDF	253	33.0	23.3	0.96	7.19	19.59	14.37	3.14	8.36	2.27	0.89	3.21	3.99	2.48	10.26	28.16	0.47	2.97
GCRF	318	39.6	22.3	0.39	14.63	27.85	24.08	1.45	10.99	1.76	0.12	3.57	1.97	0.48	10.87	34.06	0.06	2.63
SJIF	291	34.1	19.3	0.32	10.60	21.72	19.43	2.86	7.90	1.66	0.22	5.52	3.34	0.62	12.85	34.46	0.04	2.28
GSKF	270	34.2	20.7	0.22	13.57	18.11	14.75	8.14	9.16	2.59	0.66	3.71	10.68	1.81	10.94	29.18	1.06	3.41
Overall	283	35.2	21.4	0.47	11.50	21.82	18.16	3.90	9.10	2.07	0.47	4.00	5.00	1.35	11.23	31.46	0.40	2.82
SD	28	3.0	1.7	0.33	3.34	4.29	4.57	2.92	1.37	0.44	0.36	1.03	3.88	0.96	1.12	3.26	0.48	0.48
CV	0.10	0.08	0.08	0.70	0.29	0.20	0.25	0.75	0.15	0.21	0.77	0.26	0.78	0.72	0.10	0.10	1.18	0.17
Winter	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
JMDF	7.66	0.13	0.02	0.18	6.25	0.041	0.01	0.33	0.66	0.04	0.324	0.043	0.04	0.78	0.014	0.12	0.63	68.12
GCRF	13.19	0.02	0.00	0.03	10.62	0.005	0.00	0.04	0.75	0.05	0.287	0.006	0.01	0.93	0.019	0.02	0.64	68.09
SJIF	12.26	0.01	0.00	0.02	9.76	0.004	0.00	0.03	0.59	0.06	0.217	0.005	0.00	0.40	0.018	0.01	0.54	65.88
GSKF	8.43	0.10	0.03	0.31	6.27	0.081	0.01	0.56	0.34	0.04	0.059	0.077	0.06	0.15	0.031	0.09	0.27	68.94
Overall	10.39	0.06	0.01	0.13	8.22	0.033	0.01	0.24	0.58	0.05	0.222	0.033	0.03	0.57	0.021	0.06	0.52	67.76
SD	2.75	0.06	0.01	0.14	2.29	0.037	0.01	0.26	0.18	0.01	0.117	0.034	0.03	0.36	0.007	0.05	0.17	1.31
CV	0.26	0.88	1.01	1.04	0.28	1.12	0.92	1.07	0.30	0.27	0.53	1.05	1.03	0.63	0.35	0.86	0.33	0.02

Table 2.71: Overall summary of average concentration of chemical species in PM_{10} for all sites for summer season

Summer	PM_{10}	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
JMDF	142	17.0	4.7	0.41	7.32	4.78	7.31	1.77	3.17	1.02	0.52	2.08	2.39	1.57	7.26	19.19	0.59	1.38
GCRF	155	19.5	8.6	0.42	7.14	4.83	5.32	1.65	3.28	1.23	0.53	2.26	2.18	1.58	7.73	20.75	0.33	1.67
SJIF	148	13.2	4.4	0.51	6.20	4.40	7.04	2.49	3.54	1.08	0.54	2.44	3.31	1.56	8.82	21.55	0.33	1.45
GSKF	107	14.6	3.7	0.55	8.33	5.39	4.10	2.68	3.03	1.21	0.42	1.31	3.54	1.29	4.49	11.54	0.94	1.62
Overall	138	16.1	5.3	0.47	7.25	4.85	5.94	2.15	3.25	1.14	0.50	2.02	2.86	1.50	7.07	18.26	0.55	1.53
SD	21	2.8	2.2	0.07	0.87	0.41	1.51	0.51	0.22	0.10	0.05	0.50	0.67	0.14	1.85	4.58	0.29	0.14
CV	0.15	0.17	0.42	0.15	0.12	0.08	0.25	0.24	0.07	0.09	0.11	0.25	0.24	0.09	0.26	0.25	0.53	0.09
Summer	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
JMDF	5.00	0.18	0.02	0.12	4.02	0.034	0.022	0.195	0.863	0.024	0.496	0.032	0.035	0.924	0.161	0.07	0.70	63.95
GCRF	5.44	0.13	0.02	0.12	4.46	0.028	0.040	0.194	0.917	0.025	0.544	0.028	0.039	0.505	1.018	0.19	0.79	63.41
SJIF	5.95	0.05	0.02	0.12	4.90	0.025	0.021	0.119	0.988	0.025	0.763	0.033	0.042	0.866	0.105	0.08	1.07	63.02
GSKF	3.08	0.06	0.01	0.06	2.48	0.041	0.038	0.134	0.748	0.019	0.778	0.018	0.043	0.872	0.524	0.03	0.85	68.68
Overall	4.87	0.11	0.02	0.10	3.97	0.032	0.030	0.160	0.879	0.023	0.645	0.028	0.039	0.792	0.452	0.09	0.85	64.77
SD	1.25	0.06	0.00	0.03	1.05	0.007	0.010	0.040	0.101	0.003	0.146	0.007	0.004	0.193	0.421	0.07	0.16	2.64
CV	0.26	0.56	0.21	0.28	0.27	0.22	0.32	0.25	0.12	0.13	0.23	0.24	0.10	0.24	0.93	0.74	0.18	0.04

Table 2.72: Overall summary of average concentration of chemical species in $PM_{2.5}$ for all sites for summer season

Summer	$PM_{2.5}$	OC	EC	F^-	Cl^-	NO_3^-	SO_4^{-2}	Na^+	NH_4^+	K^+	Mg^{+2}	Ca^{+2}	Na	Mg	Al	Si	P	K
JMDF	62	11.9	3.9	0.25	4.15	2.63	4.20	0.94	1.78	0.57	0.31	0.61	1.25	0.91	1.86	4.89	0.17	0.76
GCRF	67	13.6	7.1	0.25	4.00	2.74	3.02	0.97	1.80	0.73	0.31	0.67	1.28	0.92	1.87	4.81	0.10	0.98
SJIF	56	9.2	3.6	0.29	3.39	2.42	3.79	1.36	1.96	0.60	0.30	0.71	1.80	0.89	1.89	4.96	0.10	0.81
GSKF	60	10.2	3.0	0.32	4.69	2.92	2.48	1.52	1.82	0.69	0.24	0.62	1.99	0.70	2.08	5.13	0.39	0.92
Overall	61	11.2	4.4	0.28	4.06	2.68	3.37	1.20	1.84	0.65	0.29	0.65	1.58	0.86	1.93	4.95	0.19	0.87
SD	4	1.9	1.8	0.03	0.53	0.21	0.77	0.29	0.08	0.07	0.03	0.05	0.37	0.10	0.10	0.14	0.14	0.10
CV	0.07	0.17	0.42	0.12	0.13	0.08	0.23	0.24	0.05	0.12	0.12	0.07	0.24	0.12	0.05	0.03	0.73	0.11
Summer	Ca	Cr	V	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Cd	Cs	Ba	Pb	% R
JMDF	1.33	0.05	0.00	0.03	1.09	0.011	0.007	0.065	0.72	0.01	0.425	0.009	0.010	0.731	0.048	0.019	0.559	70.59
GCRF	1.44	0.03	0.00	0.03	1.07	0.008	0.020	0.054	0.78	0.01	0.412	0.008	0.011	0.383	0.618	0.051	0.632	72.07
SJIF	1.47	0.02	0.01	0.03	1.10	0.008	0.006	0.035	0.62	0.01	0.314	0.010	0.011	0.458	0.034	0.019	0.636	71.20
GSKF	1.41	0.02	0.01	0.02	1.12	0.018	0.016	0.059	0.65	0.01	0.258	0.007	0.017	0.745	0.220	0.014	0.763	70.57
Overall	1.41	0.03	0.00	0.03	1.09	0.011	0.012	0.053	0.69	0.01	0.352	0.008	0.012	0.579	0.230	0.026	0.647	71.11
SD	0.06	0.02	0.00	0.00	0.02	0.005	0.007	0.013	0.07	0.00	0.080	0.001	0.003	0.186	0.272	0.017	0.085	0.71
CV	0.04	0.49	0.08	0.15	0.02	0.42	0.54	0.24	0.10	0.11	0.23	0.16	0.27	0.32	1.18	0.66	0.13	0.01

Table 2.73: Ratios (%) of chemical species of $PM_{2.5}$ and PM_{10} for all sites for winter (W) and summer (S) seasons

Sites	JMDF		GCRF		SJIF		GSKF		Overall	
Season	W	S	W	S	W	S	W	S	W	S
PM_{10}	354	142	429	155	379	148	352	107	378	138
$PM_{2.5}$	253	62	318	67	291	56	270	60	283	61
$PM_{2.5}PM_{10}$	72	44	74	43	77	38	77	56	75	44
TC ($PM_{2.5}/PM_{10}$)	75	73	74	74	74	73	74	73	74	73
OC ($PM_{2.5}/PM_{10}$)	70	70	70	70	70	70	70	70	70	70
EC ($PM_{2.5}/PM_{10}$)	83	83	83	83	83	83	83	83	83	83
F^- ($PM_{2.5}/PM_{10}$)	71	62	81	59	77	56	66	57	73	58
Cl^- ($PM_{2.5}/PM_{10}$)	72	57	81	56	78	55	79	56	78	56
NO_3^- ($PM_{2.5}/PM_{10}$)	79	55	85	57	78	55	86	54	82	55
SO_4^{-2} ($PM_{2.5}/PM_{10}$)	75	57	78	57	78	54	86	61	79	57
Na^+ ($PM_{2.5}/PM_{10}$)	75	53	78	59	77	55	74	57	75	56
NH_4^+ ($PM_{2.5}/PM_{10}$)	73	56	80	55	77	56	76	60	77	57
K^+ ($PM_{2.5}/PM_{10}$)	71	56	81	59	75	55	71	56	74	57
Mg^{+2} ($PM_{2.5}/PM_{10}$)	72	60	80	58	64	56	71	56	71	58
Ca^{+2} ($PM_{2.5}/PM_{10}$)	68	29	75	30	75	29	76	47	74	32
Na ($PM_{2.5}/PM_{10}$)	73	52	91	59	69	54	73	56	73	55
Mg ($PM_{2.5}/PM_{10}$)	72	58	94	58	68	57	63	55	70	57
Al ($PM_{2.5}/PM_{10}$)	69	26	70	24	77	21	75	46	73	27
Si ($PM_{2.5}/PM_{10}$)	70	25	71	23	79	23	77	44	74	27
P ($PM_{2.5}/PM_{10}$)	64	29	54	31	56	29	77	42	71	35
K ($PM_{2.5}/PM_{10}$)	71	55	81	59	74	56	72	57	74	57
Ca ($PM_{2.5}/PM_{10}$)	69	27	72	26	81	25	78	46	75	29
Cr ($PM_{2.5}/PM_{10}$)	73	30	78	27	81	32	73	38	74	30
V ($PM_{2.5}/PM_{10}$)	73	28	58	29	48	26	75	44	72	31
Mn ($PM_{2.5}/PM_{10}$)	72	27	58	27	52	26	75	38	72	28
Fe ($PM_{2.5}/PM_{10}$)	72	27	72	24	79	22	76	45	75	28
Co ($PM_{2.5}/PM_{10}$)	71	32	82	29	87	31	79	43	76	35
Ni ($PM_{2.5}/PM_{10}$)	69	33	75	51	57	29	73	42	70	41
Cu ($PM_{2.5}/PM_{10}$)	70	33	83	28	84	29	75	44	73	33
Zn ($PM_{2.5}/PM_{10}$)	70	83	85	85	83	63	78	87	79	79
As ($PM_{2.5}/PM_{10}$)	71	34	74	38	73	31	77	53	74	38
Se ($PM_{2.5}/PM_{10}$)	73	86	85	76	86	41	72	33	79	55
Rb ($PM_{2.5}/PM_{10}$)	74	29	75	28	74	29	76	37	75	30
Sr ($PM_{2.5}/PM_{10}$)	70	28	39	28	30	25	74	39	67	30
Cd ($PM_{2.5}/PM_{10}$)	80	79	84	76	83	53	70	86	81	73
Cs ($PM_{2.5}/PM_{10}$)	71	30	84	61	85	32	74	42	78	51
Ba ($PM_{2.5}/PM_{10}$)	67	28	51	26	47	24	76	42	67	28
Pb ($PM_{2.5}/PM_{10}$)	73	80	84	80	84	60	70	89	79	76

Table 2.74: Statistical summary of major components: PM_{10}, winter (µg/m^3)

Winter	PM_{10}	Crustal (Si + Al + Fe + Ca)	Ratio Crustal/PM_{10}	Sec Ions (NO_3^- + SO_4^{-2} + NH_4^+)	Ratio Sec Ions/PM_{10}	TC	Ratio TC/PM_{10}
JMDF	354	74.8	0.211	55.3	0.156	75.2	0.213
GCRF	429	96.6	0.225	77.5	0.181	83.4	0.195
SJIF	379	87.8	0.232	63.1	0.167	72.0	0.190
GSKF	352	71.5	0.203	50.1	0.142	73.9	0.210
Overall	378	82.6	0.218	61.5	0.162	76.1	0.202
SD	36	11.6	0.013	11.9	0.016	5.0	0.011
CV	0.09	0.14	0.06	0.19	0.10	0.07	0.05

Table 2.75: Statistical summary of major components: $PM_{2.5}$, winter (µg/m^3)

Winter	$PM_{2.5}$	Crustal (Si + Al + Fe + Ca)	Ratio Crustal/$PM_{2.5}$	Sec Ions (NO_3^- + SO_4^{-2} + NH_4^+)	Ratio Sec Ions/$PM_{2.5}$	TC	Ratio TC/$PM_{2.5}$
JMDF	253	52.33	0.207	42.32	0.167	56.3	0.222
GCRF	318	68.74	0.216	62.93	0.198	61.9	0.194
SJIF	291	69.33	0.239	49.05	0.169	53.5	0.184
GSKF	270	54.82	0.203	42.02	0.156	55.0	0.204
Overall	283	61.31	0.216	49.08	0.172	56.6	0.201
SD	28	8.99	0.016	9.78	0.018	3.7	0.016
CV	0.10	0.15	0.07	0.20	0.10	0.06	0.08

Table 2.76: Statistical summary of major components: PM_{10}, summer (µg/m^3)

Summer	PM_{10}	Crustal (Si + Al + Fe + Ca)	Ratio Crustal/PM_{10}	Sec Ions (NO_3^- + SO_4^{-2} + NH_4^+)	Ratio Sec Ions/PM_{10}	TC	Ratio TC/PM_{10}
JMDF	142	35.5	0.250	15.3	0.108	21.7	0.153
GCRF	155	38.4	0.247	13.4	0.087	28.1	0.181
SJIF	148	41.2	0.278	15.0	0.101	17.6	0.118
GSKF	107	21.6	0.201	12.5	0.116	18.2	0.169
Overall	138	34.2	0.244	14.0	0.103	21.4	0.155
SD	21	8.7	0.032	1.3	0.013	4.8	0.027
CV	0.15	0.25	0.13	0.09	0.12	0.22	0.18

Table 2.77: Statistical summary of major components: $PM_{2.5}$, summer (µg/m^3)

Summer	$PM_{2.5}$	Crustal (Si + Al + Fe + Ca)	Ratio Crustal/$PM_{2.5}$	Sec Ions (NO_3^- + SO_4^{-2} + NH_4^+)	Ratio Sec Ions/$PM_{2.5}$	TC	Ratio TC/$PM_{2.5}$
JMDF	62	9.2	0.148	8.6	0.139	15.8	0.255
GCRF	67	9.2	0.138	7.5	0.113	20.8	0.311
SJIF	56	9.4	0.167	8.2	0.145	12.9	0.229
GSKF	60	9.7	0.163	7.2	0.121	13.2	0.221
Overall	61	9.4	0.154	7.9	0.130	15.7	0.254
SD	4	0.3	0.014	0.6	0.015	3.6	0.041
CV	0.07	0.03	0.09	0.08	0.12	0.23	0.16

2.4.6 Statistical Summary

For the comparison of winter and summer air quality levels, box plot and Student t-test statistics were used. These are discussed in the following sections.

2.4.6.1 Box Plot Distribution

Statistical box plots are shown in Figure 2.72 - Figure 2.76 for all sites for $PM_{2.5}$, PM_{10}, NO_2, EC and OC for winter (W) and summer (S) season. These figures show the mean, median, 25% quartile, 75% quartile and outliers of the data distribution. The outlier values could possibly due the local activities (i.e. DG sets emission, biomass burning, traffic congestion etc.) near the monitoring stations. The SJIF and GSKF shows the largest variability and high pollution level (PM_{10}) whereas residential and other areas show low variability. Higher variability for $PM_{2.5}$ seen in winter month than summer at all sites. Highest variability for $PM_{2.5}$ at SJIF in winter. It is to be noted that variability is much higher in winter than in summer.

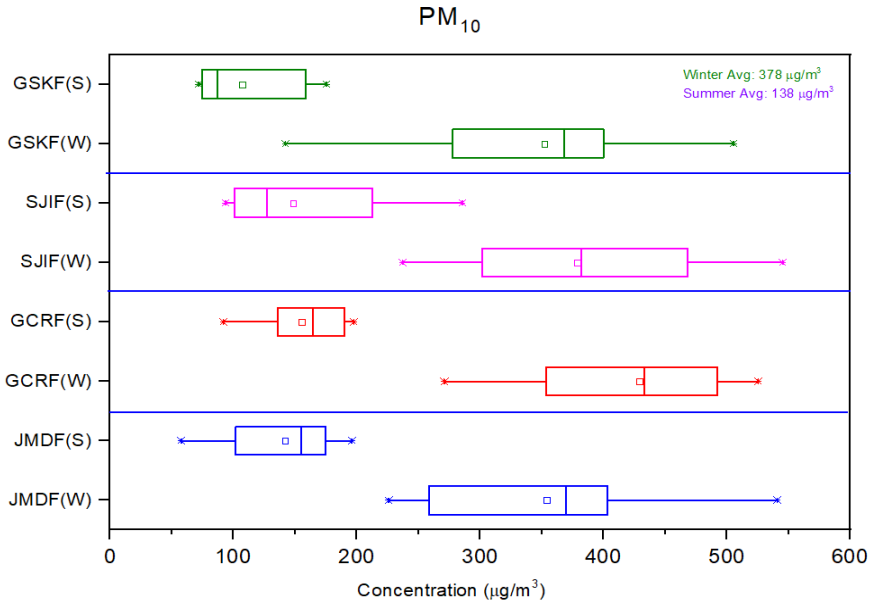


Figure 2.72: Box plot distribution for PM_{10} (winter and summer)

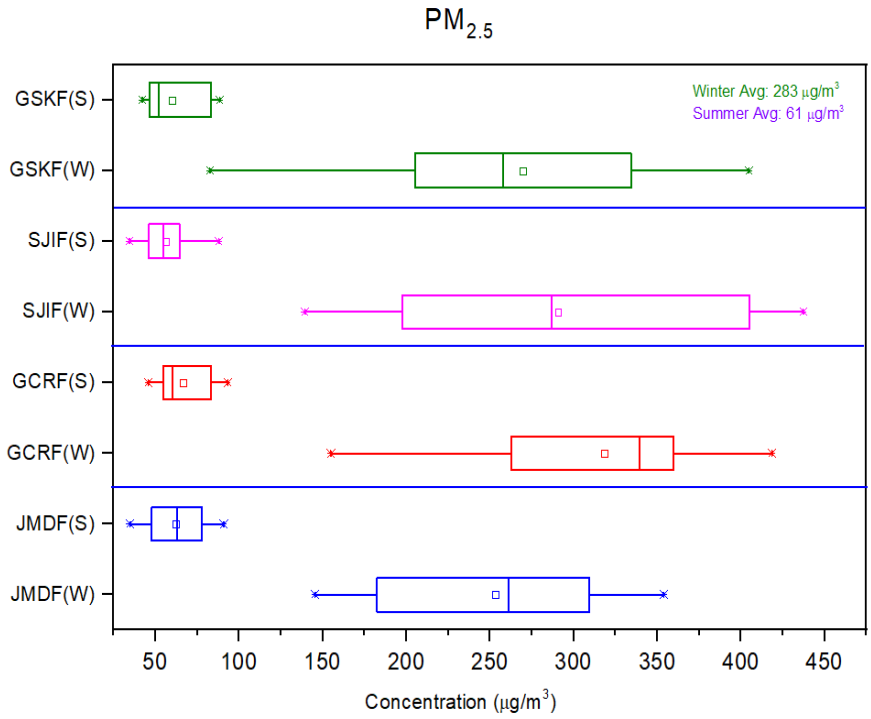


Figure 2.73: Box plot distribution for $PM_{2.5}$ (winter and summer)

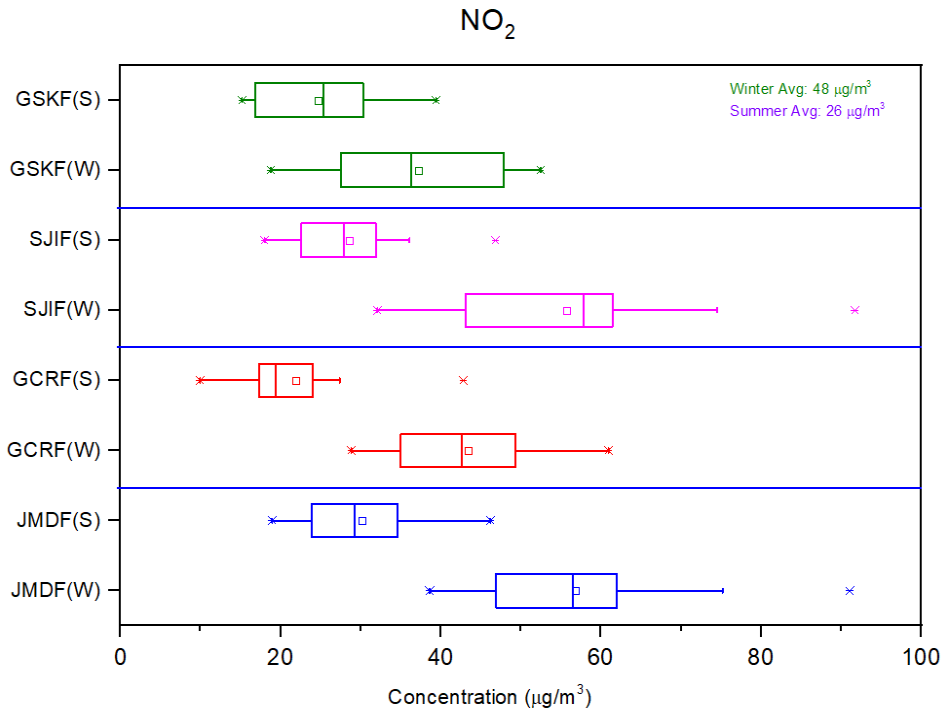


Figure 2.74: Box plot distribution for NO_2 (winter and summer)

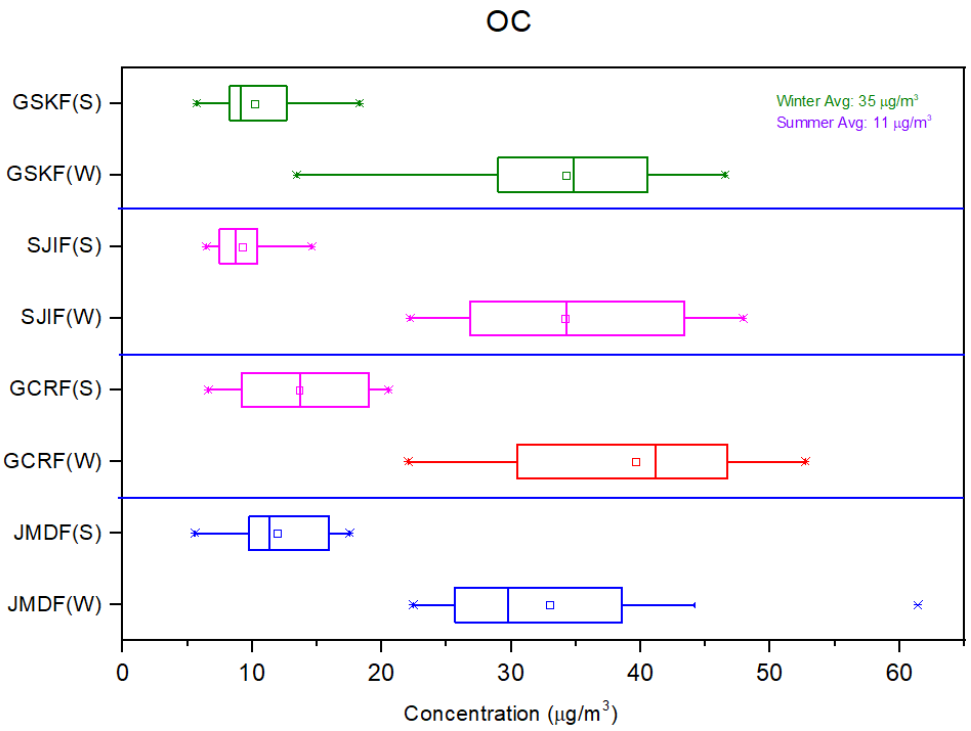


Figure 2.75: Box plot distribution for OC (winter and summer)

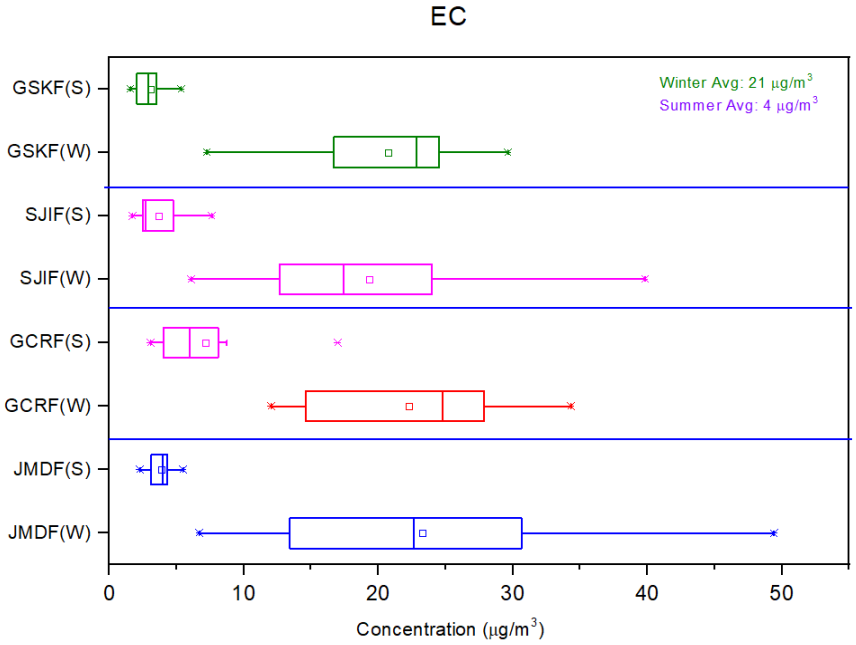


Figure 2.76: Box plot distribution for EC (winter and summer)

2.4.6.2 Statistics of t-Test for Seasonal Comparison

Student t-test statistics are performed at 5% level of significance to estimate if winter levels are higher (or lower) than summer levels for PM_{10}, $PM_{2.5}$, NO_2, SO_2 and carbon content (EC and OC). It is observed from Table 2.78 that PM_{10}, $PM_{2.5}$, OC, EC and NO_2 levels are higher at all sites. There is no significant difference in SO_2 levels at all the sites in summer and winter.

In general, PM_{10} in winter and summer are not different in a statistical sense at 5% level of significance. The information on seasonal composition of PM can assist in identifying the various sources contributing to ambient pollution level.

Table 2.78: Statistical Comparison Winter Vs Summer

Parameter / Site	PM_{10}	$PM_{2.5}$	OC	EC	NO_2
JMDF	↑	↑	↑	↑	↑
GCRF	↑	↑	↑	↑	↑
SJIF	↑	↑	↑	↑	↑
GSKF	↑	↑	↑	↑	↑
↔ No significant difference			↑ (Levels higher in winter)		
* No pollutant showed lower concentration					

2.5 Interpretations and Inferences

Based on the extensive air quality measurements in summer and winter months and critical analyses of air quality data, the following inferences and insights are drawn for developing causal relationship between emission and impact through receptor modelling (Chapter 5). Season-wise, site specific average air concentration of PM_{10}, $PM_{2.5}$ and their compositions have been referred to bring the important inferences to the fore.

- Particulate pollution is the main concern in the city where PM_{10} levels are 1.4 – 3.6 times higher than the national air quality standards in summer and winter months and $PM_{2.5}$ levels are 1.0 – 4.7 times higher than the national standard in summer and winter months. However, $PM_{2.5}$ meets the NAAQS at most sites in summer season.

- The chemical composition of PM_{10} and $PM_{2.5}$ carries the signature of sources and their harmful contents. The chemical composition is variable depending on the size fraction

of particles and the season. The PM levels and chemical composition are discussed separately for two seasons.

Winter - PM_{10}

The overall average concentration of PM_{10} in winter season is 378±36 μg/m^3 against the acceptable level of 100 μg/m^3. Highest levels were observed at GCRF and lowest at GSKF.

The crustal component (Si + Al + Fe + Ca) accounts for about 22% (slightly less compared to 25% in summer). This suggests soil and road dust have reduced in PM_{10} in winter. The coefficient of variation (CV) is about 0.14 (of fraction of crustal component) which suggests the crustal source contributes inconsistently to winter though much less compared to summer season.

The other important component is the secondary particles (NO_3^- + SO_4^{-2} + NH_4^+), which account for about 16% of total PM_{10} and combustion related total carbon (TC = EC + OC) accounts for about 20%; both fractions of secondary particles and combustion related carbons have increased in winter and account for 36% of PM_{10}.

The Cl^- content in PM_{10} in winter is not consistent and varies between 2 - 5 percent, which is an indicator of burning of municipal and plastic solid waste (MSW); recall poly vinyl chloride (PVC) is a major part of MSW. The highest Cl^- content is observed at GCRF at 18.15 μg/m^3 compared to overall city level of 14.7 μg/m^3. The high level at GCRF signifies some local burning of waste either in industrial processes or as a means of disposal of solid waste.

Winter - $PM_{2.5}$

The overall average concentration of $PM_{2.5}$ in winter is 283±28 μg/m^3 against the acceptable level of 60 μg/m^3. The highest levels are observed at GCRF 318±70 μg/m^3 and lowest at JMDF 253±64 μg/m^3. The crustal component increased to 22% in $PM_{2.5}$ in winter compared to 15% in summer.

The other important components secondary particles (NO_3^- + SO_4^{-2} + NH_4^+), which account for 17% of total $PM_{2.5}$ and combustion related total carbon (EC+OC) accounts for 20%; both secondary particles and combustion related carbon are consistent

contributors to $PM_{2.5}$ at about 337%. Highest level of TC was observed at GCRF at 61.9 µg/m^3.

The Cl^- content in $PM_{2.5}$ winter is not consistent and varies between 2 – 5 percent which is an indicator of burning of municipal solid waste (MSW).

Summer - PM_{10}

The overall average concentration of PM_{10} in summer season was 138±21 µg/m^3 against the acceptable level of 100 µg/m^3.

The crustal component (Si + Al + Fe + Ca) accounts for about 24 percent of total PM_{10} in summer. This suggests airborne soil and road dust are the major sources of PM_{10} pollution in summer. The coefficient of variation (CV) is about 0.25, which suggests the sources are consistent all around the city forming a layer which envelopes the city. The areas of SJIF and JMDF have the highest crustal fraction (around 27-25% of total PM_{10}). It is difficult to pinpoint the crustal sources as these are widespread and present all around in Firozabad and are more prominent in summer when soil and dust are dry and high-speed winds make the particles airborne. It was observed that in summer the atmosphere looks light brownish which can be attributed to the presence of large amounts of soil dust particles in the atmosphere.

The second significant component is the secondary particles ($NO_3^- + SO_4^{-2} + NH_4^+$), which account for 10 percent of total PM_{10} and combustion related total carbon (EC+OC) accounts for about 16 percent. The secondary particles are formed in the atmosphere because of reaction of precursor gases (SO_2, NO_x and NH_3) to form NO_3^-, SO_4^{-2}, and NH_4^+. The combustion related contribution is relatively less in PM_{10} in summer.

The Cl^- content in PM_{10} in summer is inconsistent at 4-8 percent, which is an indicator of burning of municipal solid waste (MSW) and has a higher contribution in summer than winter.

Summer - $PM_{2.5}$

The overall average concentration of $PM_{2.5}$ in summer season is 61±4 µg/m^3 within the acceptable level of 60 µg/m^3.

The crustal component (Si + Al + Fe + Ca) accounts for about 15% of total $PM_{2.5}$. This suggests airborne soil and road dust is a significant source of $PM_{2.5}$ pollution in summer. The CV is about 0.03, which suggests the source is consistent all around the city.

The second important component is combustion related total carbon (EC+OC), which account for 25% of total $PM_{2.5}$ and secondary particles (NO_3^- + SO_4^{-2} + NH_4^+) accounts for 13%; both fractions of secondary particles and combustion related carbons account for a larger fraction in $PM_{2.5}$ than in PM_{10}. All three potential sources, crustal component, secondary particles and combustion contribute consistently to $PM_{2.5}$ in summer.

The Cl^- content in $PM_{2.5}$ in summer is inconsistent at 6-8 percent which is an indicator of burning of municipal solid waste (MSW) and has a similar contribution to $PM_{2.5}$ and PM_{10}. This is relatively lower in summer than in winter.

Potassium levels

In general potassium levels are moderate and consistent for PM_{10} (1.02 to 3.63 $\mu g/m^3$) in winter and summer and in $PM_{2.5}$ (1.66 to 2.59 $\mu g/m^3$) in winter. In general potassium level should be less than 2 $\mu g/m^3$. Potassium is an indicator of biomass burning and high levels and variability (CV ~ 0.30) show significant biomass burning and it is consistent both in summer and winter.

NO_2 levels

NO_2 levels in winter are higher than those in summer at all sites and the levels meet the national air quality standard of 80 $\mu g/m^3$. The highest NO_2 levels were at JMDF (56.86 $\mu g/m^3$), a commercial site. In addition, high levels of NO_2 are expected to undergo chemical transformation to form fine secondary particles in the form of nitrates, adding to high levels of existing PM_{10} and $PM_{2.5}$. SO_2 levels in the city were well within the air quality standard.

General inferences

Levels of $PM_{2.5}$ and NO_2 are statistically higher (at all locations) in winter months than in summer months by about 42-60%. The levels of PM_{10} are statistically higher at all

sites. In general air pollution levels in ambient air (barring traffic intersections) are uniform across the city suggesting entire city is stressed under high pollution; in a relative sense, GCRF is most polluted followed by SJIF and JMDF.

It is to be noted that OC3/TC ratio is above 0.20 and highest among ratio of fraction of OC to TC. It suggests a significant component of secondary organic aerosol is formed in atmosphere due to condensation and nucleation of volatile to semi volatile organic compounds, which suggests emissions within and outside of Firozabad.

Total PAH levels (17 compounds; particulate phase) in winter is very high at 87 ng/m^3; However, PAH levels in summer drop significantly to 33 ng/m^3. The highest PAH levels observed at GCRF in winter (99 ng/m^3) and in summer (39 ng/m^3).

The concentrations of molecular markers in $PM_{2.5}$ (total of 6 compounds) are also higher in winter (233 ng/m^3) than in summer (71 ng/m^3) indicating presence of common sources of emissions from coal, gasoline and domestic fuel.

The total BTX levels are higher in winter (7.4 µg/m^3) than in summer (5.12 µg/m^3). Although the emission rate is expected to be high in summer due to higher temperature, but the concentration is low due to better dispersion and large ventilation coefficient. The benzene did not exceed the annual national standard (5 µg/m^3).

In a broad sense, air is more toxic in winter than in summer as it contains much larger contribution of combustion products in winter than in summer months.

In a broad sense, fractions of secondary particles of both PM_{10} and $PM_{2.5}$ in two seasons were consistent and need to be controlled for better air quality in Firozabad. Combustion sources, vehicles, coal, biomass burning and MSW burning are other consistent sources in winter and require a strategy to control these sources. In summer, air quality cannot be improved unless we find effective control solutions for soil and road dust, fly ash re-suspension. Possible effective mixture of control options is discussed in Chapter 6.

3 Emission Inventory

3.1 Introduction

Emission inventory (EI) is a necessity for planning air pollution control activities, and it provides a reliable estimate of total emissions of different pollutants and their spatial and temporal distribution and identification and characterisation of primary sources. This information on EI is an essential input to air quality models for developing strategies and policies. In this chapter, the emission inventory of the study area for the year 2019 is presented.

The Emission Inventory included in this report is derived from the Rapid source apportionment study report earlier prepared and submitted to UPPCB by our team. Its incorporation here ensures consistency with the prior study and avoids unnecessary duplication of work.

3.2 Methodology

The stepwise methodology adopted for this study is presented in Figure 3.1.

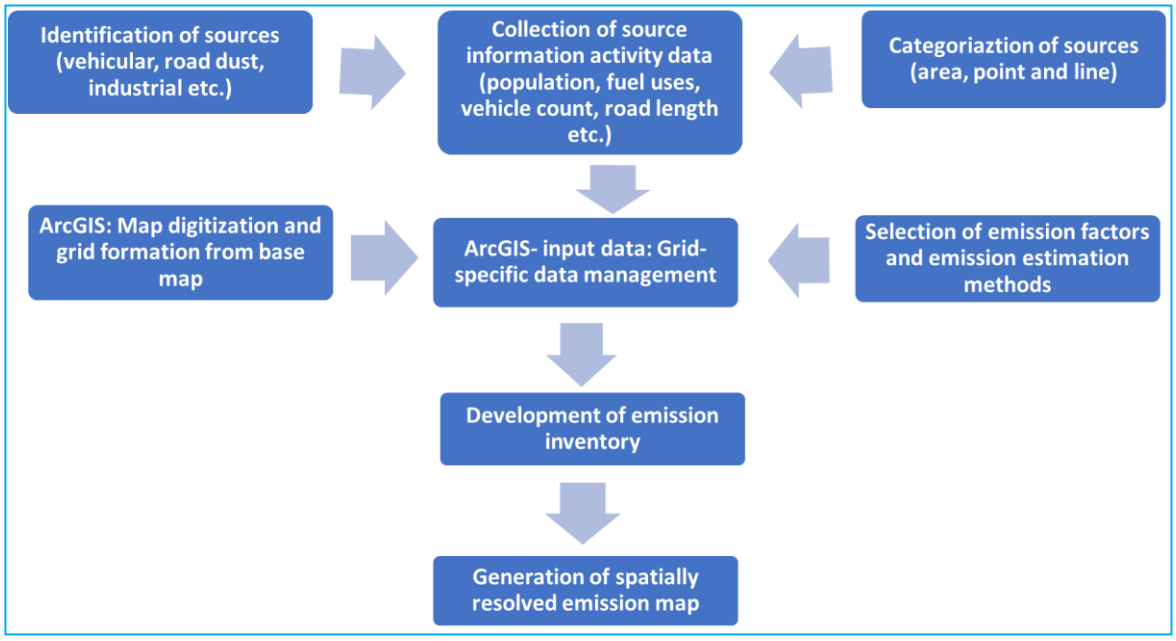


Figure 3.1: Stepwise methodology and major tasks

3.2.1 Categorization of Sources

The air quality of a region is affected by emissions from different sources. Depending upon the emissions from sources, their contribution to air quality varies. It is important to identify and quantify these sources to control the emission and thereby improve the air quality. Air pollution sources are widely categorized as area (domestic and fugitive combustion type emission sources), industrial (point and area) sources and vehicular (line) sources. The source category and type of sources are shown in Figure 3.2.

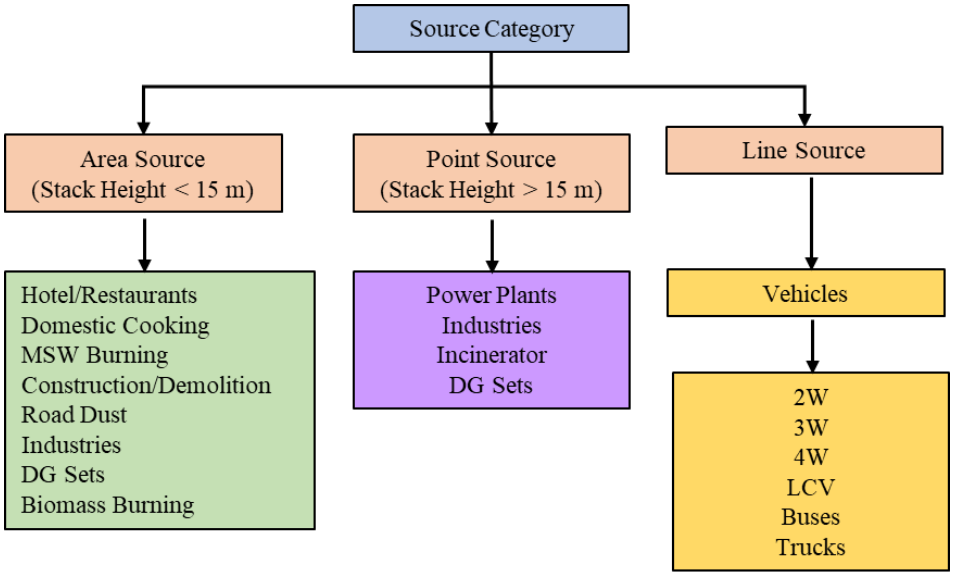


Figure 3.2: Source category and type of sources

3.2.2 Data Collection

The IITK team collected the primary and secondary activity data. Domestic surveys, vehicular traffic count, parking lane surveys, road dust, etc., were physically done in the study area for primary data generation. The main sources of secondary data collection are from UPPCB, the Census of India, and CPCB website, the Transport Department, and toll plazas. The information has also been collected through the Internet by visiting various websites. Although all possible efforts have been made to collect the data, some information/data could be missing.

3.2.3 Digital Data Generation and Land-use Map

The land-use map of the study area is prepared in terms of agriculture, vegetation, industrial, water bodies, road network, settlements, and open areas. (Figure 3.3 to Figure 3.11).

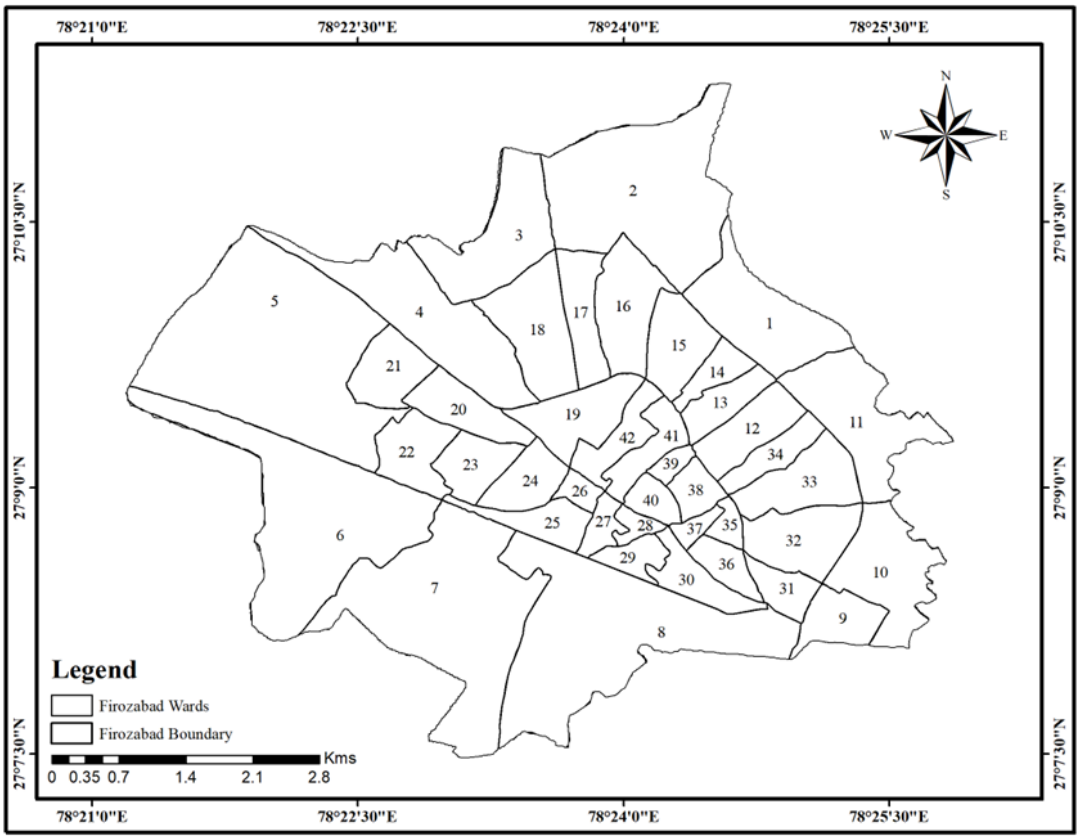


Figure 3.3: Firozabad wards and city boundary

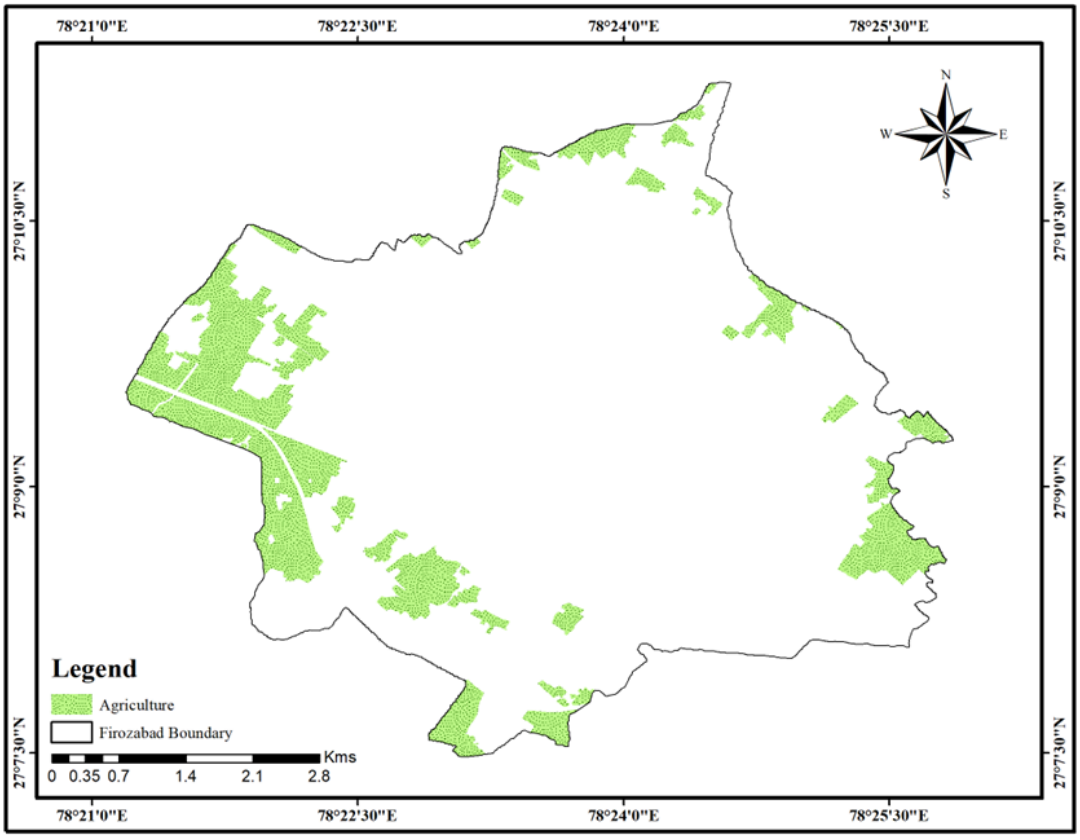


Figure 3.4: Agricultural area map

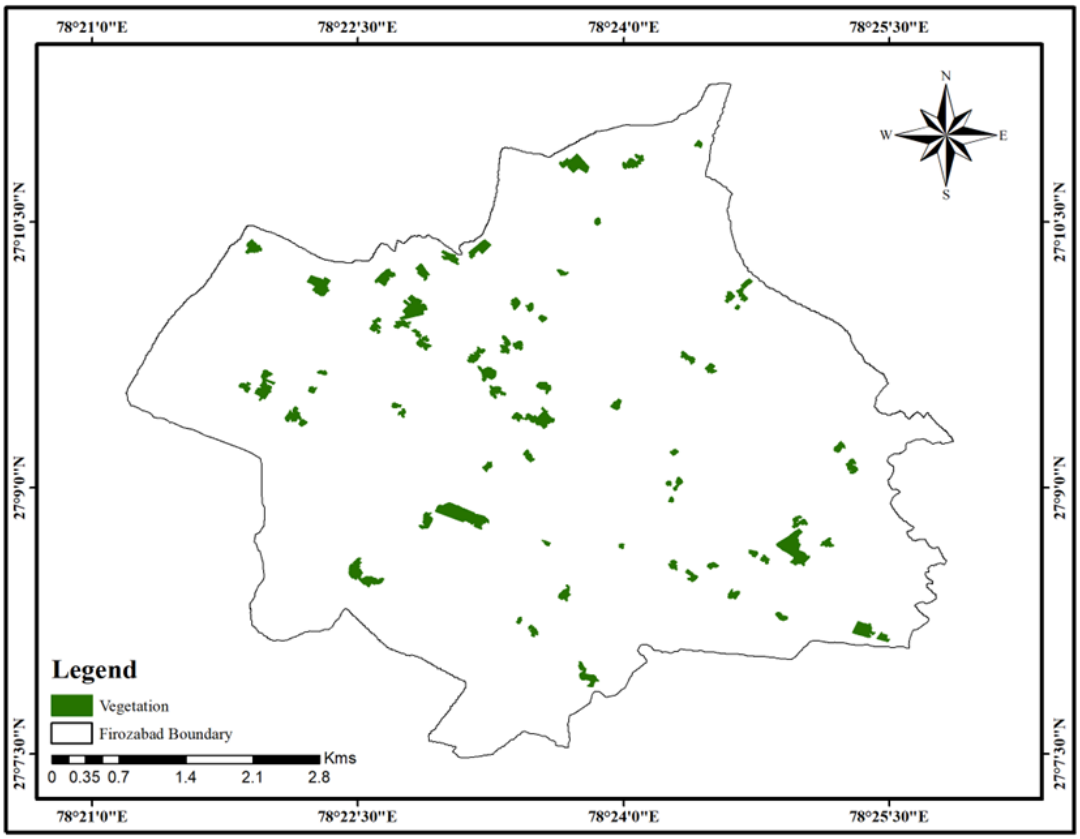


Figure 3.5: Vegetation map

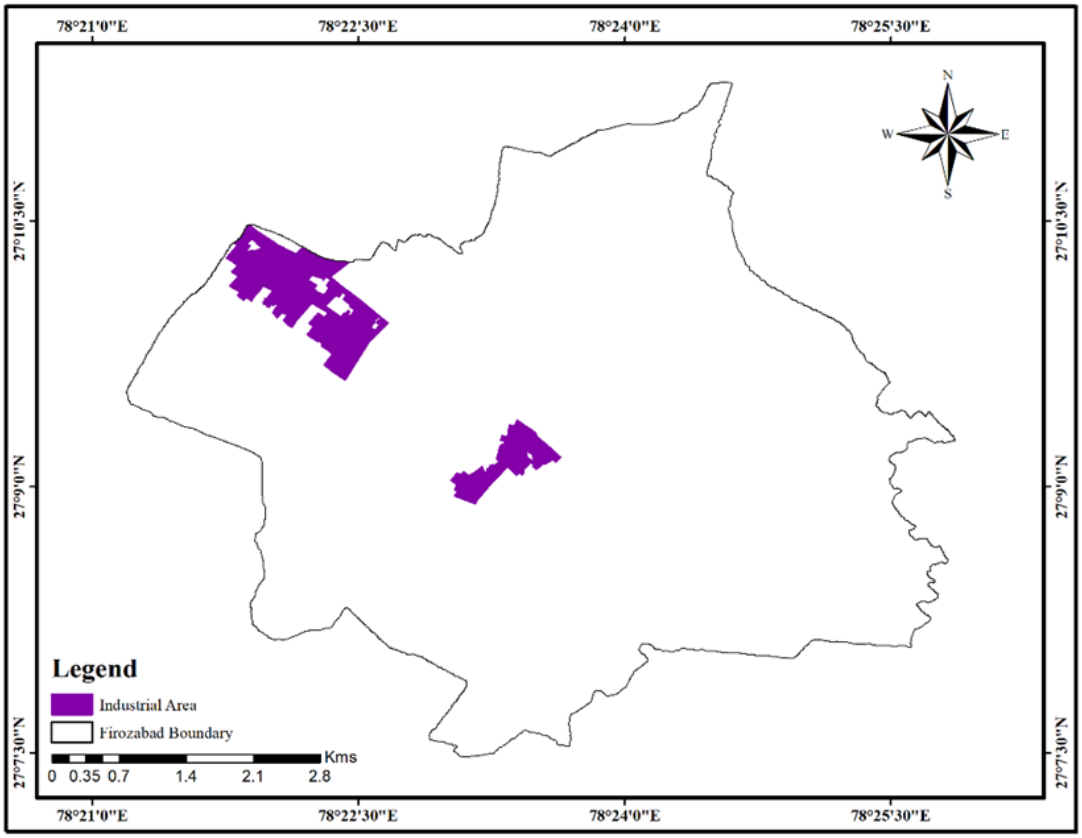


Figure 3.6: Industrial area map

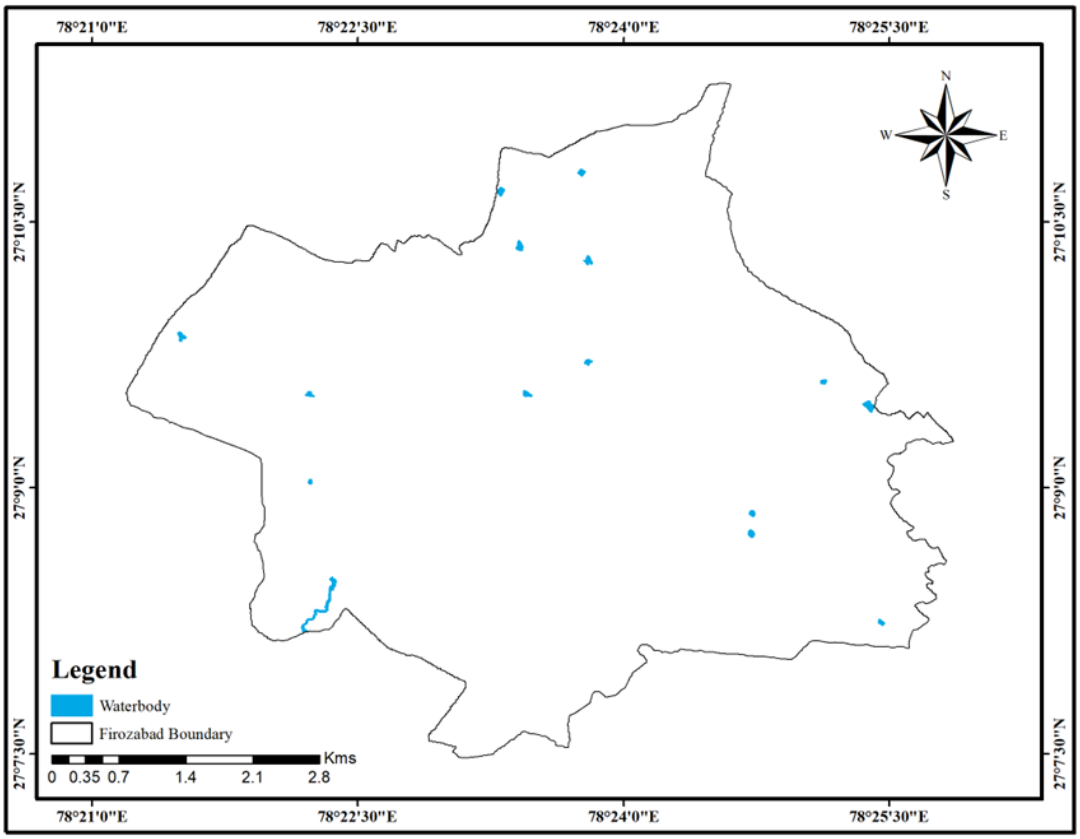


Figure 3.7: Water bodies area map

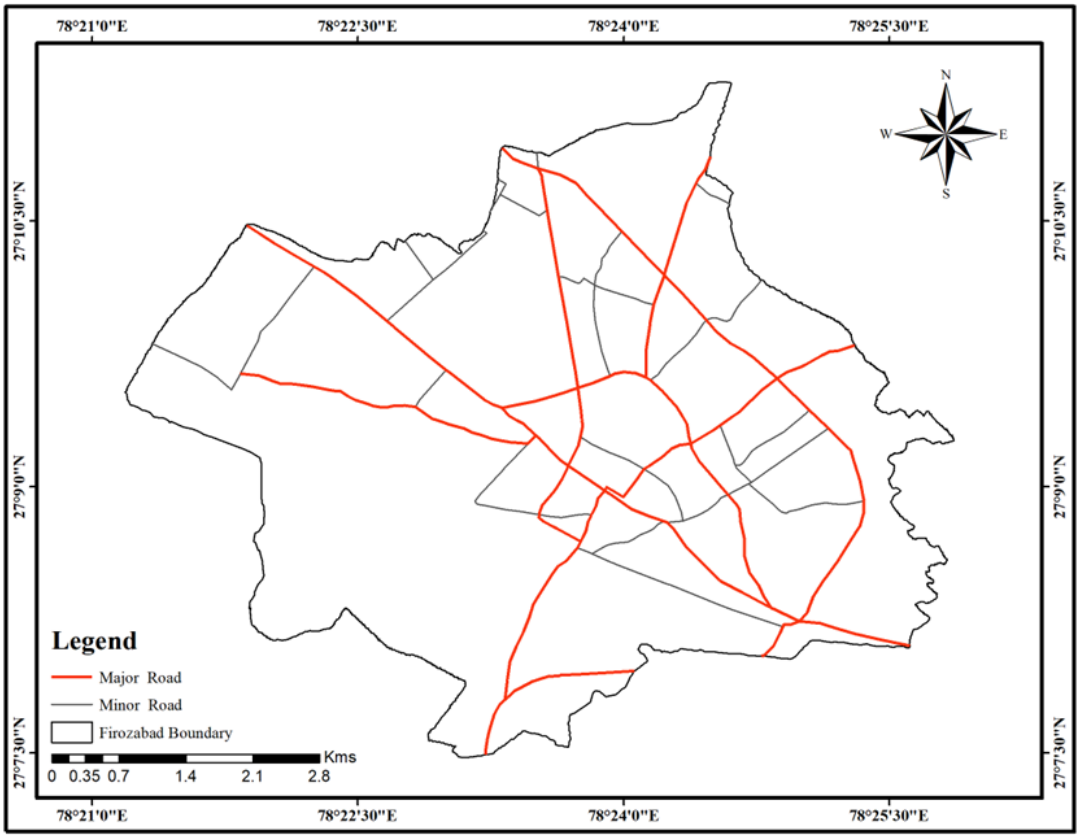


Figure 3.8: Road network map

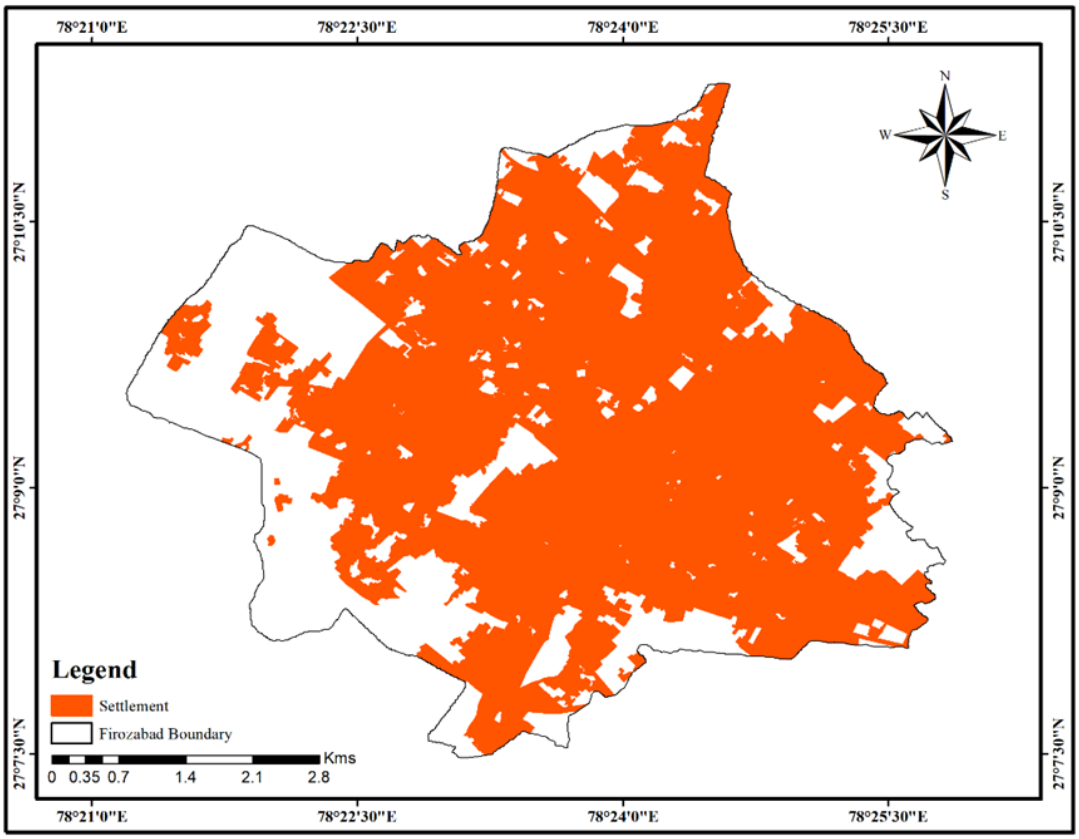


Figure 3.9: Settlement area map

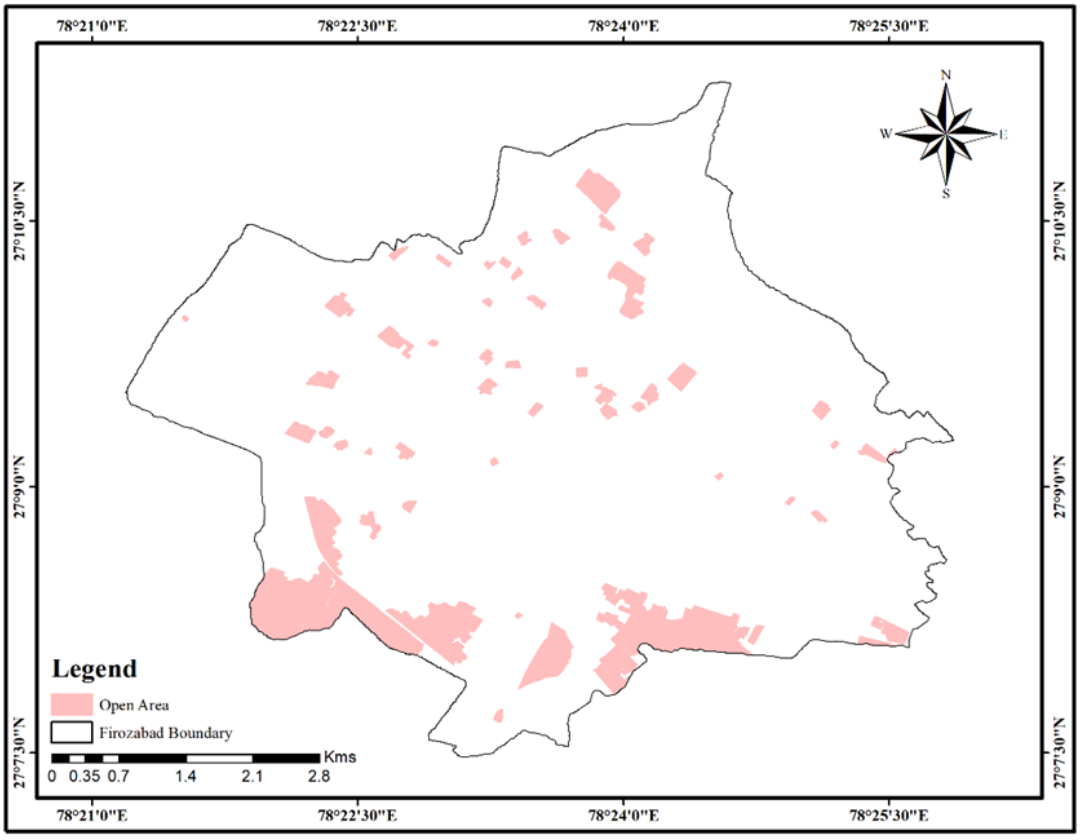


Figure 3.10: Open area map

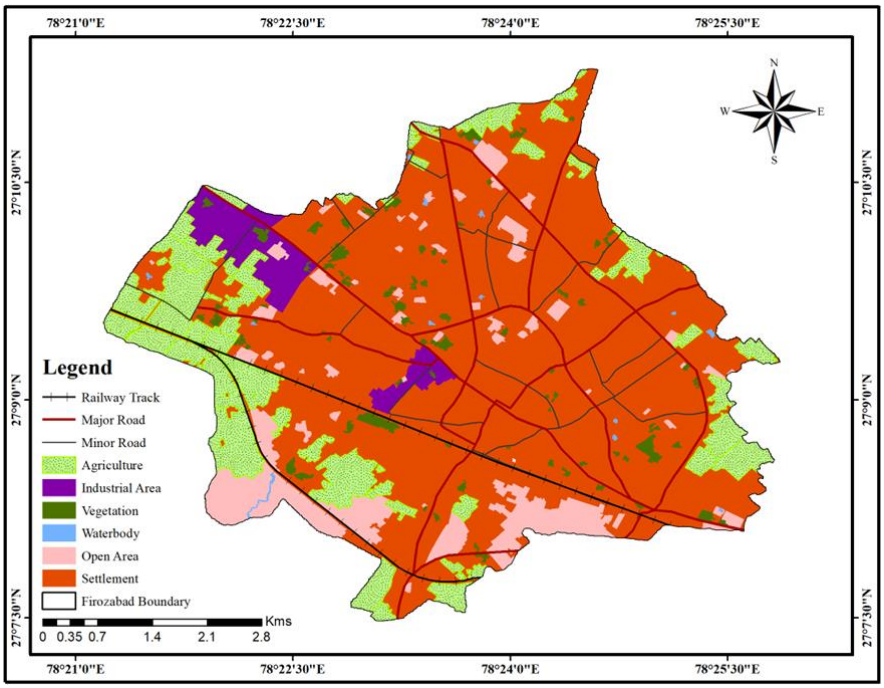


Figure 3.11: Land use map of Firozabad city

At the time of the development of the emission inventory, a suitable coding system was adopted to avoid confusion and misrepresentation of results and interpretation. The emissions have been calculated for Firozabad city. The grid map of Firozabad with grid identity numbers is shown in Figure 3.12. The study area was divided into grids of 500 m × 500 m.

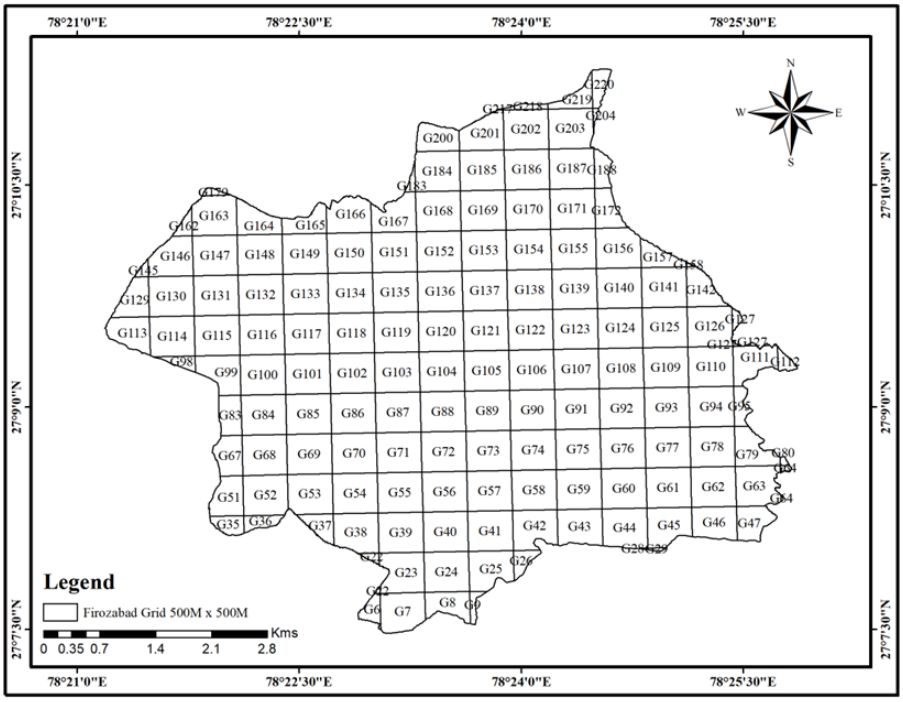


Figure 3.12: Grid map of Firozabad city showing grid identity numbers

3.2.4 Emission Factor

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with releasing that pollutant. These factors are usually expressed as the mass of pollutant per unit mass of raw material, volume, distance traveled, or duration of the activity (e.g., grams of particulate emitted per kilogram of coal burnt). Such factors facilitate the estimation of emissions from various sources of air pollution. In most cases, these factors are simply averaging of all available data of acceptable quality. They are generally assumed to be representative of long-term averages for all facilities in the source category.

The general equation for emissions estimation is:

$$E = A \times EF \times (1 - ER/100) \quad \text{..... Equation 1}$$

Where:

E = Emissions rate;
A = Activity rate;
EF = Emission factor, and
ER = Overall emission reduction efficiency, %

3.2.5 Domestic Sector

The interior boundaries in the map (Figure 3.3) show the administrative boundaries of wards in Firozabad city. The projected population of Firozabad city for the year 2019 is approximately 800000. The emission from the domestic sector for the city is calculated. The population-wise fuel consumption pattern shows LPG (85%) consumption (CEEW Report, 2019), Wood (9.6%), Crop residue (1.2%), Dung (1.1%), Coal (1.3%), and Kerosene (0.7%). During the field survey, it was observed that most economically weaker/ slum areas use wood and dung as fuel for cooking, although they have been given LPG cylinders.

The area of wards was calculated using GIS, and the emission density for each ward is calculated for different pollutants (PM_{10}, $PM_{2.5}$, SO_2, NO_x, and CO). The emission factors given by CPCB (2011) and AP-42 (USEPA, 2000) were used for each fuel type.

After obtaining the area of wards, the emission density (e.g., PM_{10} per sq. km) for each ward was calculated for different pollutants (PM_{10}, $PM_{2.5}$, SO_2, NO_x, and CO). The emission

density in terms of kg/d/m^2 in each ward was calculated based on the population and area of the ward.

Emission Density (kg/d/ m^2) = Emission of Ward (kg/d) / Ward Area (m^2)..... **Equation 2**

For calculating emissions in a grid that may contain more than one ward, the fraction of the area of each ward falling inside that grid was calculated, and with the help of the emission density of the ward and its faction in the grid (Pathak et. al. 2020), the emissions in the grid were calculated

$$Grid\ Emissions = \sum_{i=1}^{N} (area\ of\ fraction\ ward\ i\ in\ grid \times emission\ density\ of\ ward, i)$$ **Equation3**

Where

N= no. of wards in the grid

$i = i^{th}$ ward in the grid

The emissions from the domestic sector in Firozabad city are given in Figure 3.13. The emission contributions in this sector from different fuel types and different pollutants are shown in Figure 3.14 to Figure 3.18. The spatial distribution of different pollutants is shown in Figure 3.19 to Figure 3.23.

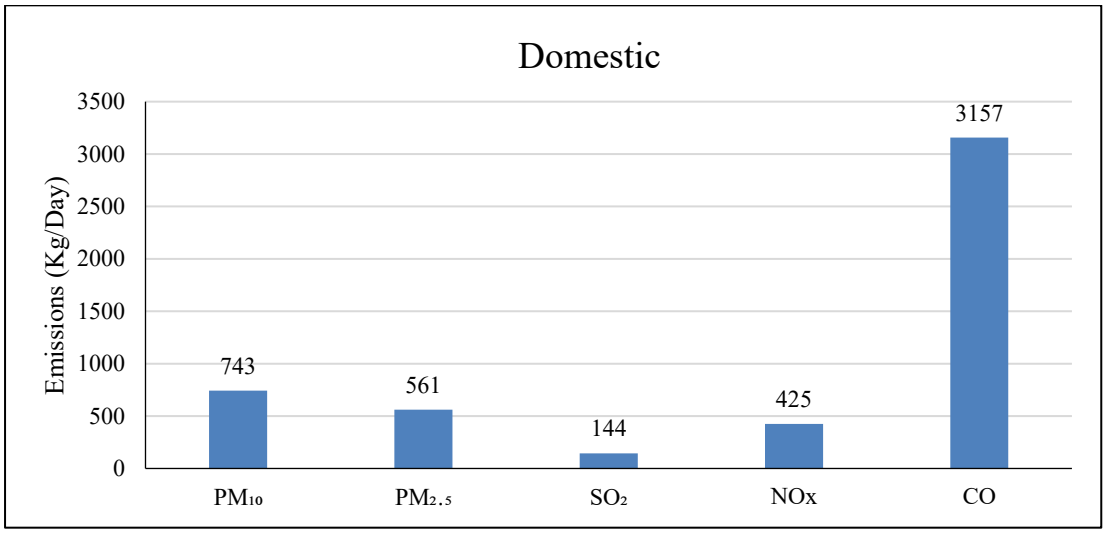


Figure 3.13: Emission load from domestic sector (kg/d)

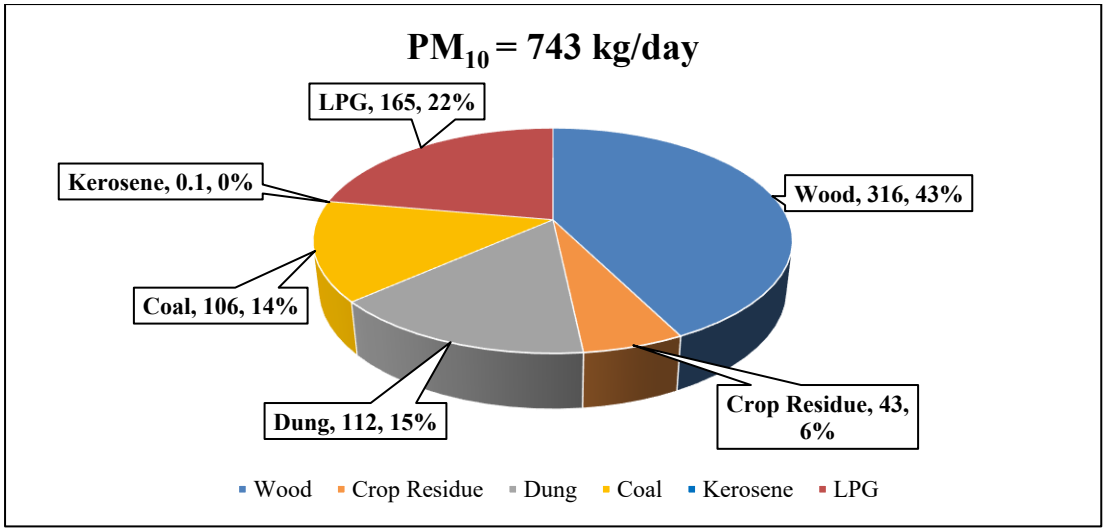


Figure 3.14: PM_{10} Emission load from domestic sector (kg/d, %)

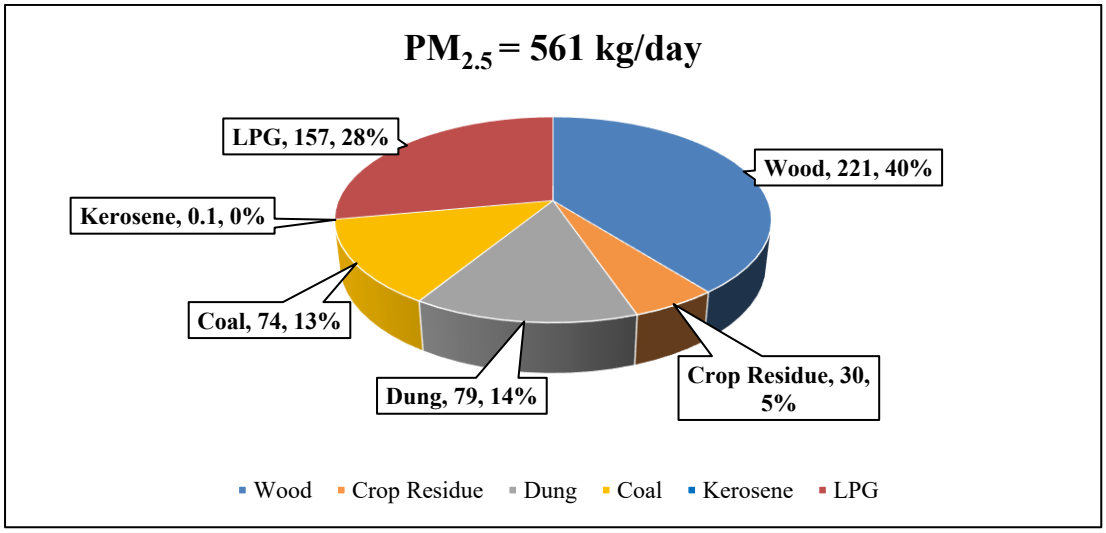


Figure 3.15: $PM_{2.5}$ Emission load from domestic sector (kg/d, %)

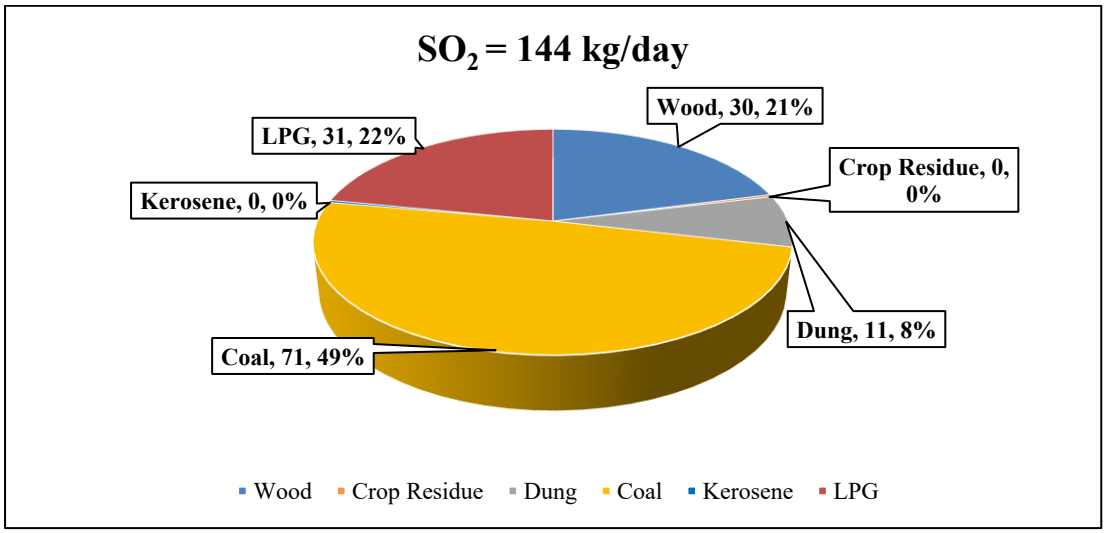


Figure 3.16: SO_2 Emission load from domestic sector (kg/d, %)

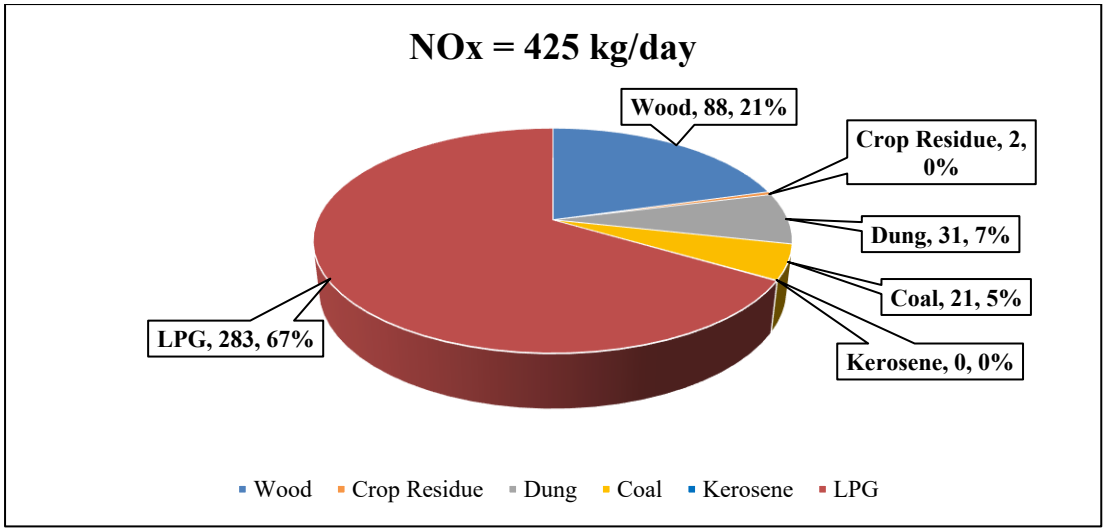


Figure 3.17: NO_x Emission load from domestic sector (kg/d, %)

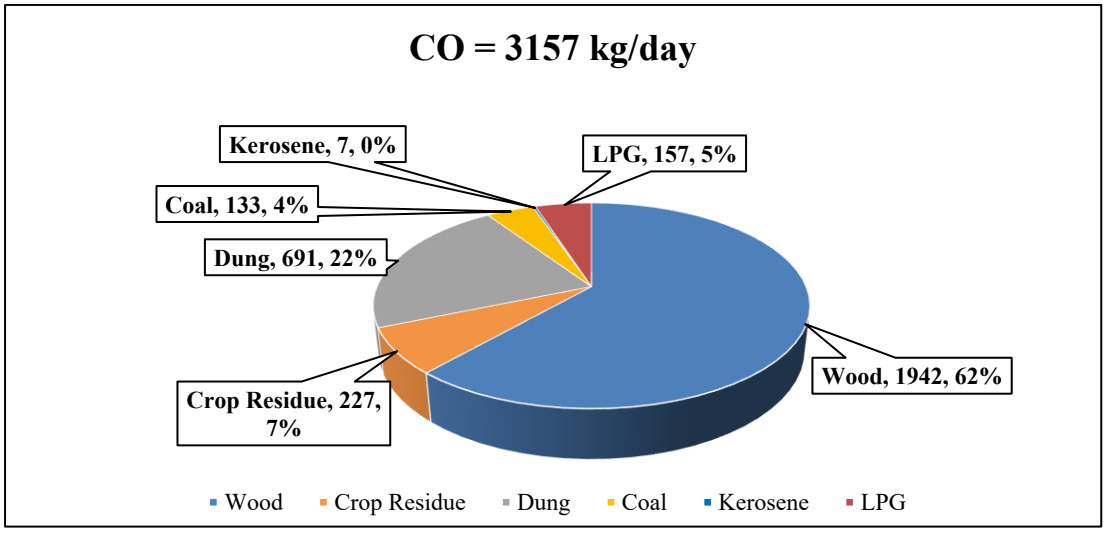


Figure 3.18: CO Emission load from domestic sector (kg/d, %)

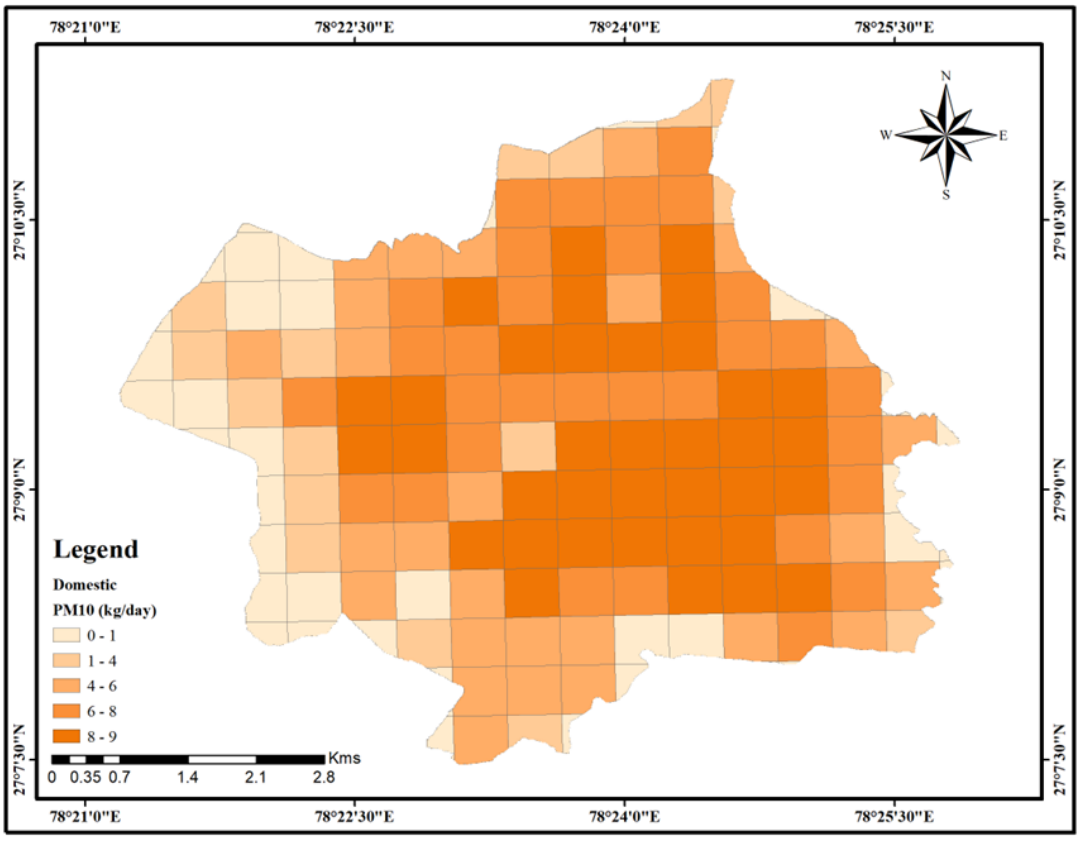


Figure 3.19: Spatial distribution of PM_{10} Emissions from domestic sector

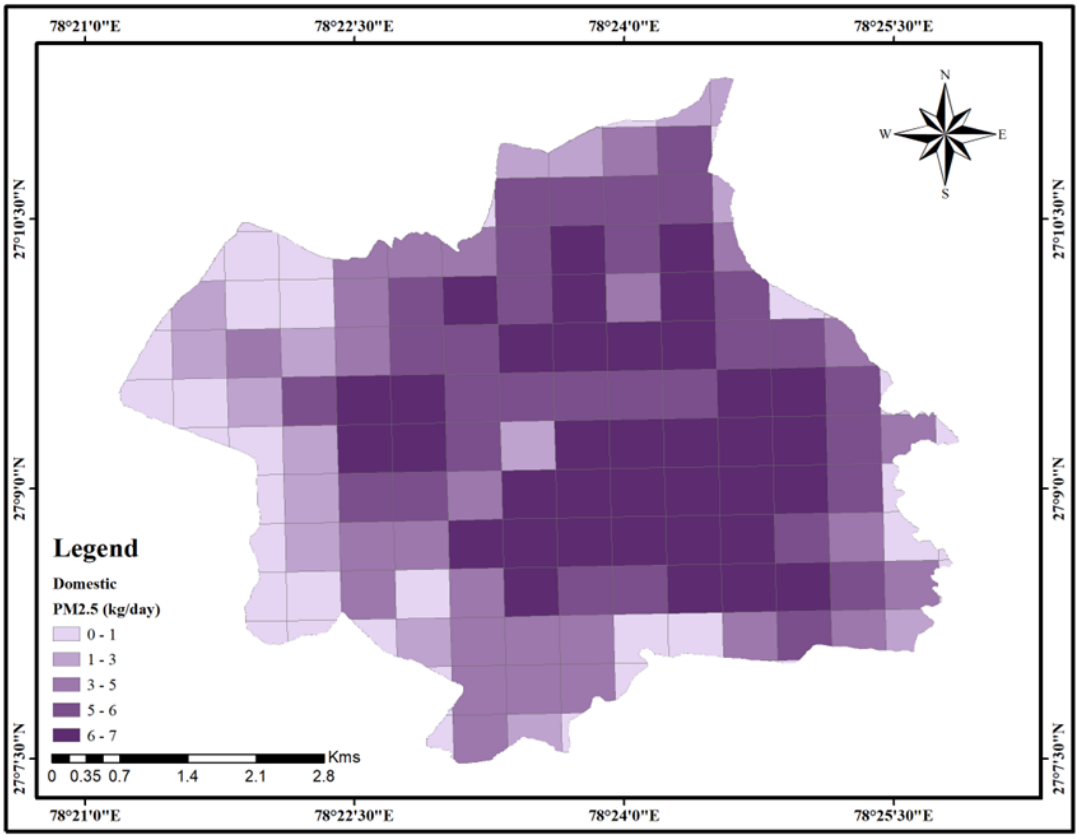


Figure 3.20: Spatial distribution of $PM_{2.5}$ emissions from domestic sector

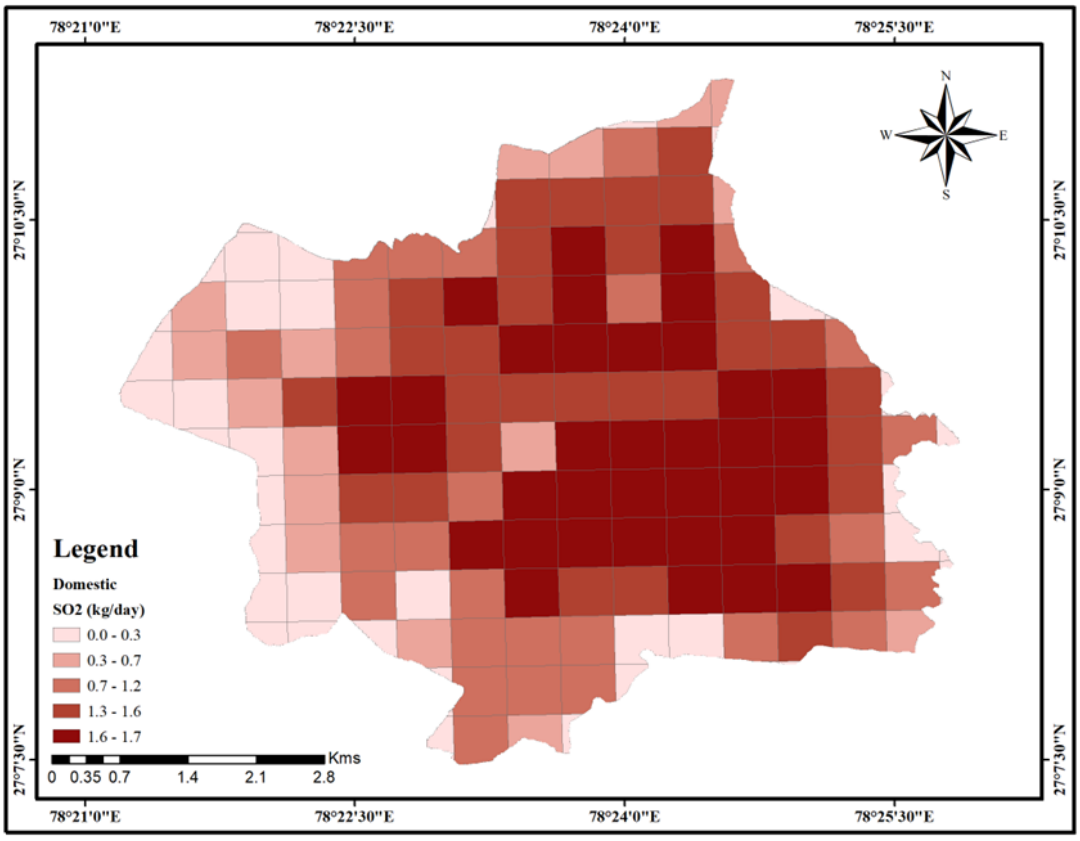


Figure 3.21: Spatial distribution of SO_2 emissions from domestic sector

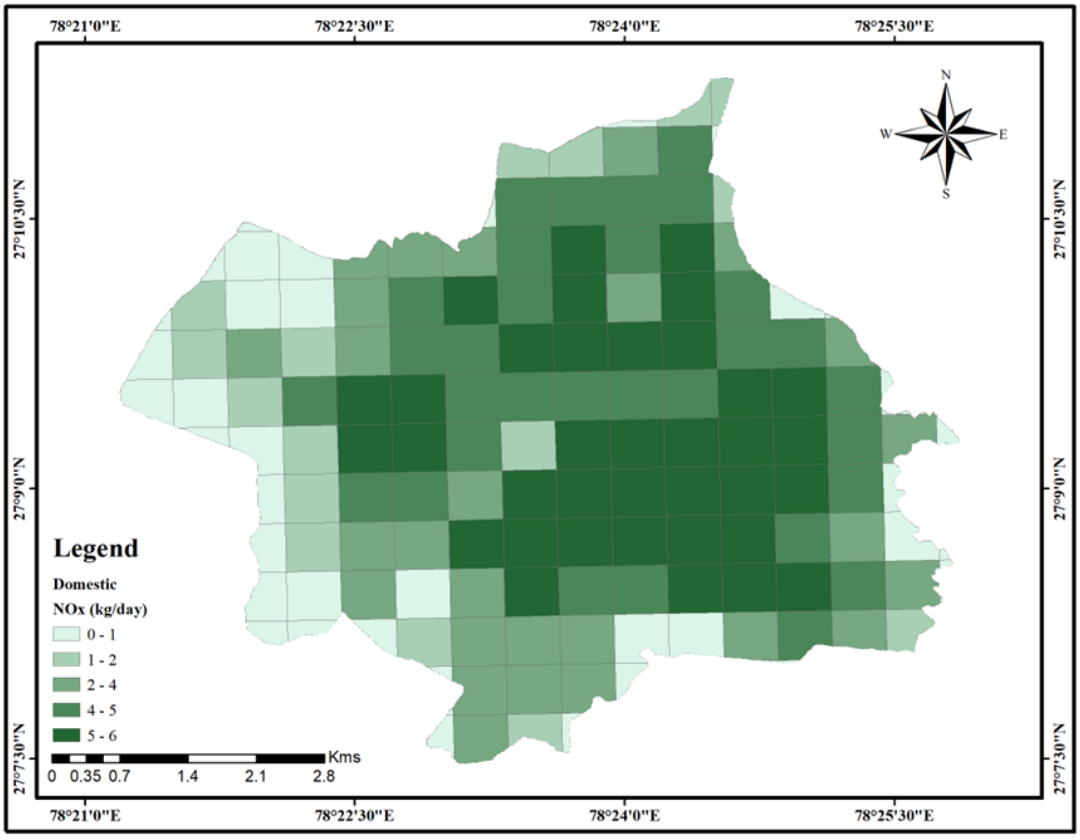


Figure 3.22: Spatial distribution of NO_x emissions from domestic sector

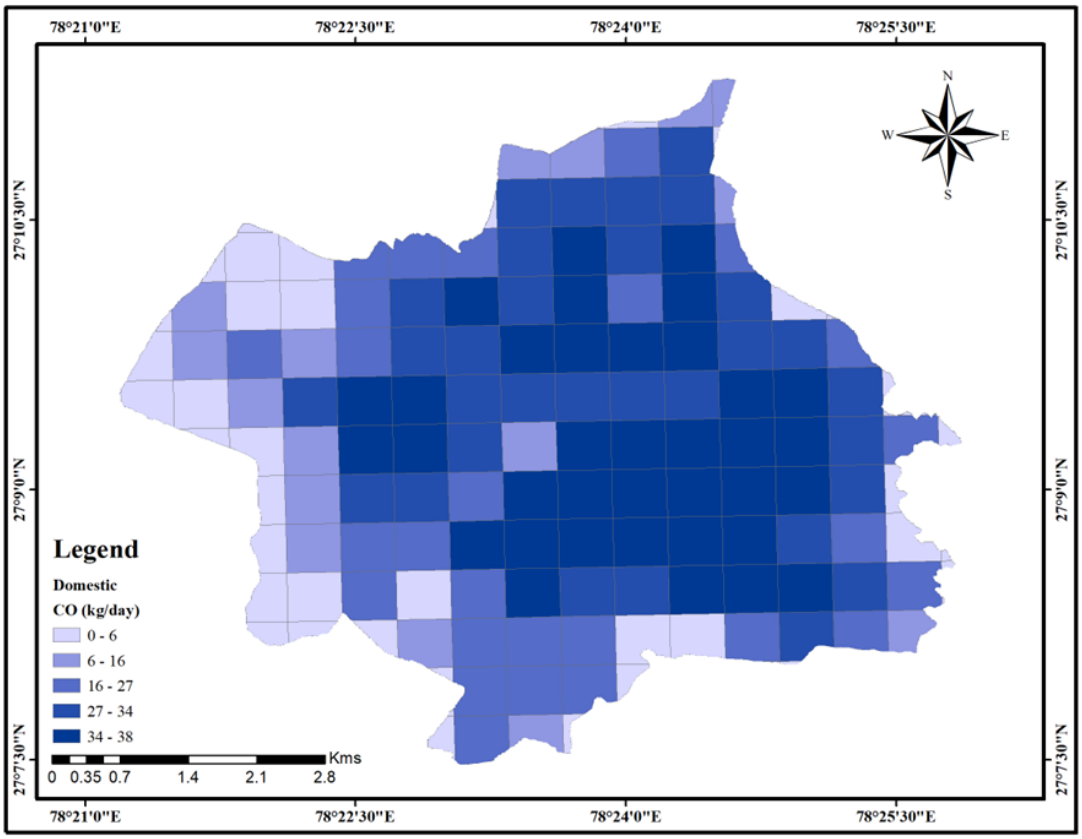


Figure 3.23: Spatial distribution of CO emissions from domestic sector

3.2.6 Construction and Demolition

A detailed survey was undertaken to assess construction and demolition activities. The major construction activities include large constructions (residential, commercial, roads, and industrial). Information about construction was obtained from Firozabad Nagar Nigam, PWD, CPWD, and field surveys. The satellite imagery was also used to validate the construction activities. Nearly at all construction sites, the construction material and debris (lying in the open, without cover) are stored outside the construction premises, mainly near the road. The areas under construction activities were calculated based on survey data and GIS-based calculations. The location of construction and demolition sites in Firozabad city is given in Figure 3.24.

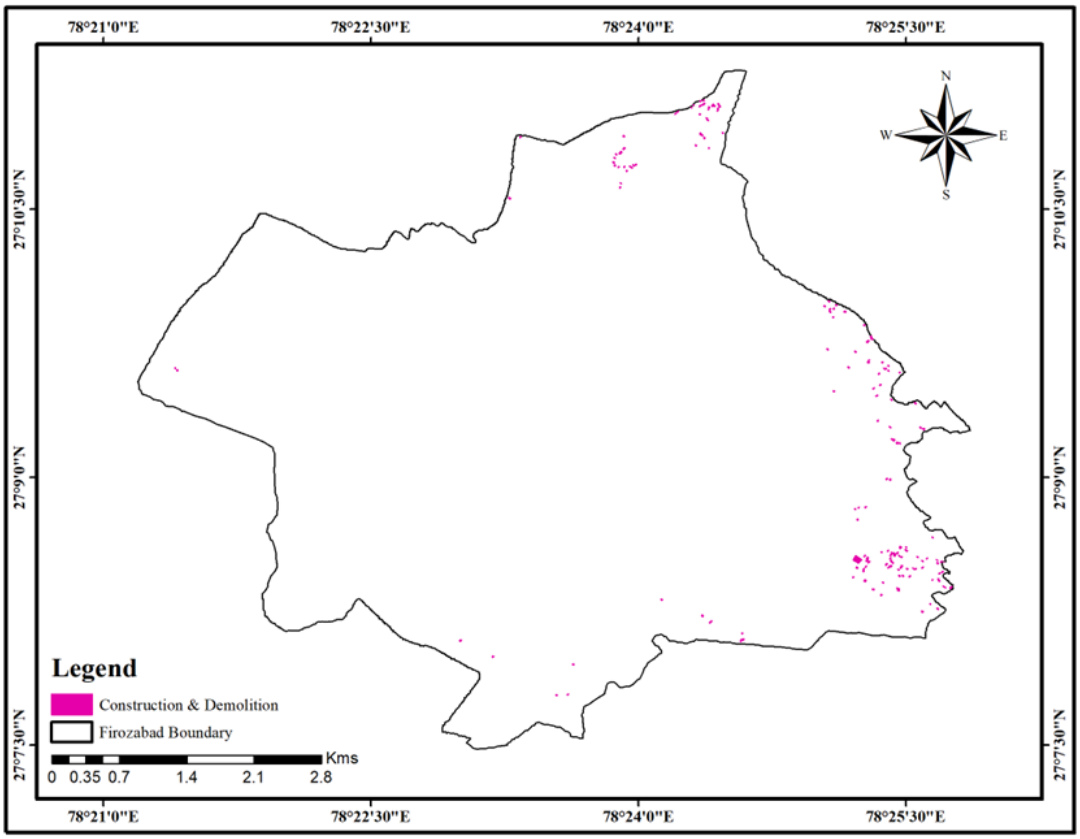


Figure 3.24: Location of construction and demolition sites at Firozabad city

The Emission load of PM_{10} and $PM_{2.5}$ from construction and demolition is 35 kg/d and 8 kg/d (Figure 3.25). The construction sites and debris associated with generating particulate emissions are shown in Figure 3.26. The spatially resolved emission map of construction and demolition activities is shown in Figure 3.27 and Figure 3.28.

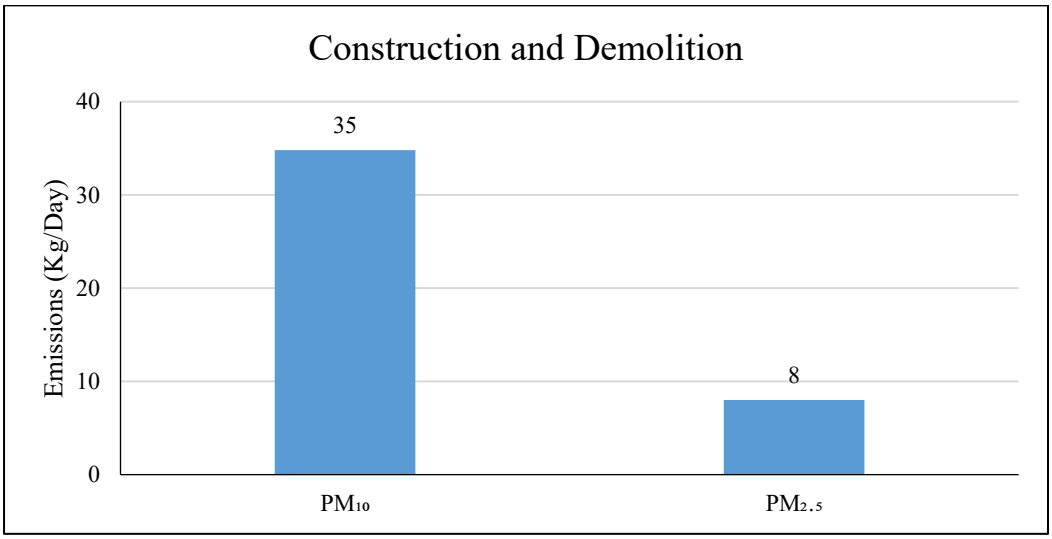


Figure 3.25: Emissions from construction and demolition (kg/d)

Figure 3.26: Construction material and debris near construction sites

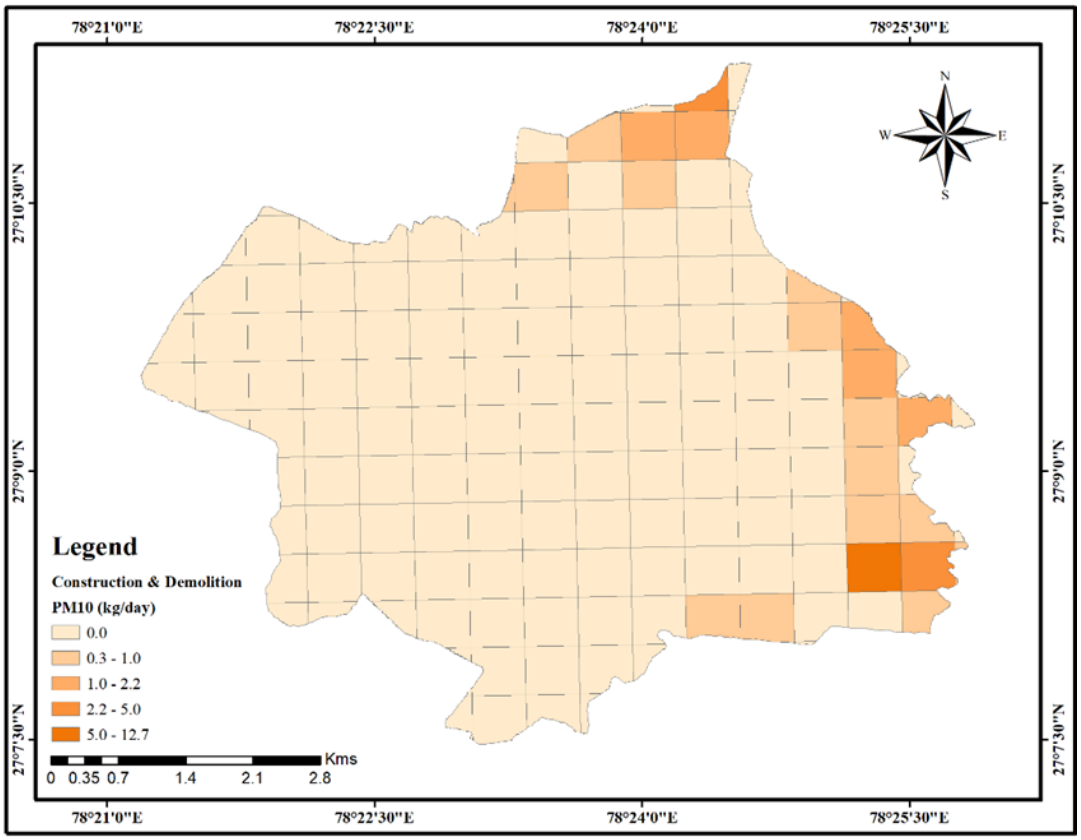


Figure 3.27: Spatial distribution of PM_{10} emissions from construction/demolition

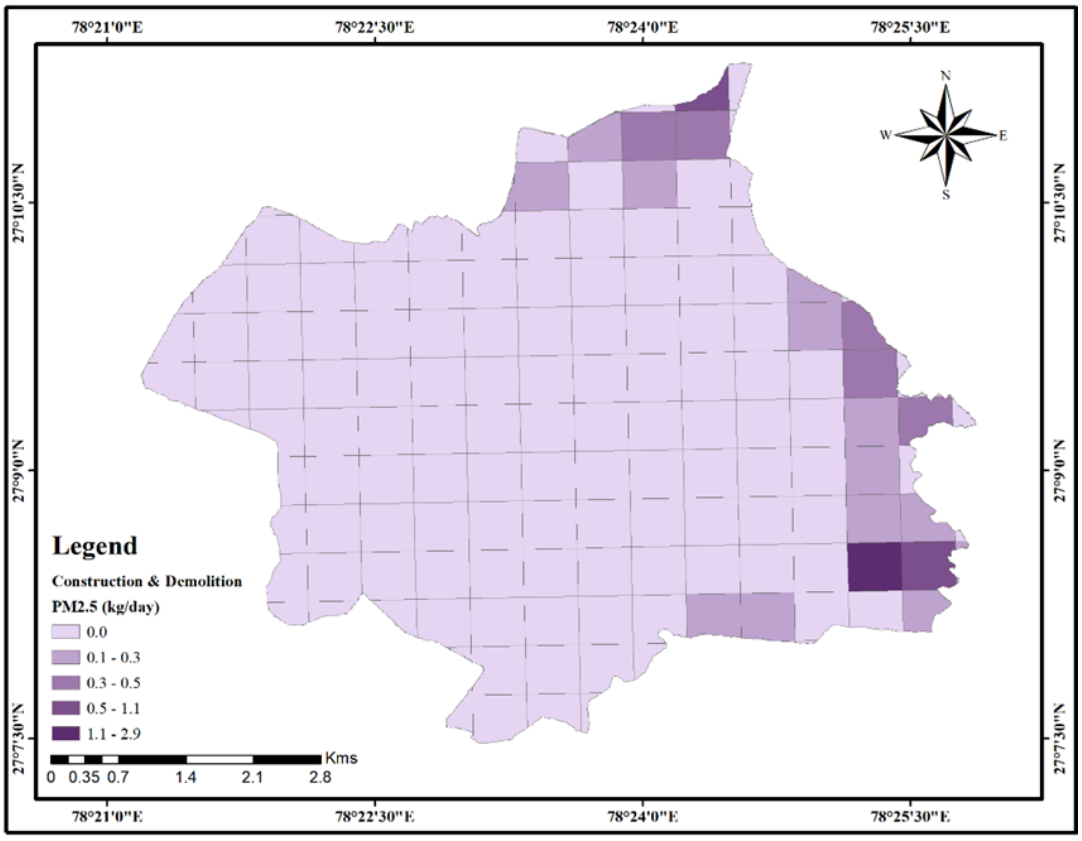


Figure 3.28: Spatial distribution of $PM_{2.5}$ Emissions from construction/demolition

3.2.7 Hotels, Restaurants, Guest Houses (GHs), and Banquet Halls (BHs)

The IITK team conducted the primary survey to identify the hotels and restaurants with more than a sitting capacity of ten persons and other eating joints.

During the field survey, it was observed that hotels, restaurants, etc. use coal as fuel in tandoors. The common fuel other than wood is LPG. The total number of Hotels, Restaurants, Guest Houses (GHs), and Banquet Halls (BHs) are approximately 210 (Figure 3.29). The average consumption of wood/coal in each establishment is estimated to be 80 kg per day based on a primary survey. The fuel consumption for each fuel type was estimated for each grid. The emissions of various pollutants such as PM_{10}, $PM_{2.5}$, SO_2, NO_x, and CO were estimated from the activity data from each fuel type and then summed up in each grid. The overall emission from this area source (Hotels, Restaurants, GHs, and BHs) is shown in Figure 3.30. The spatial distribution of emissions is shown in Figure 3.31 to Figure 3.35.

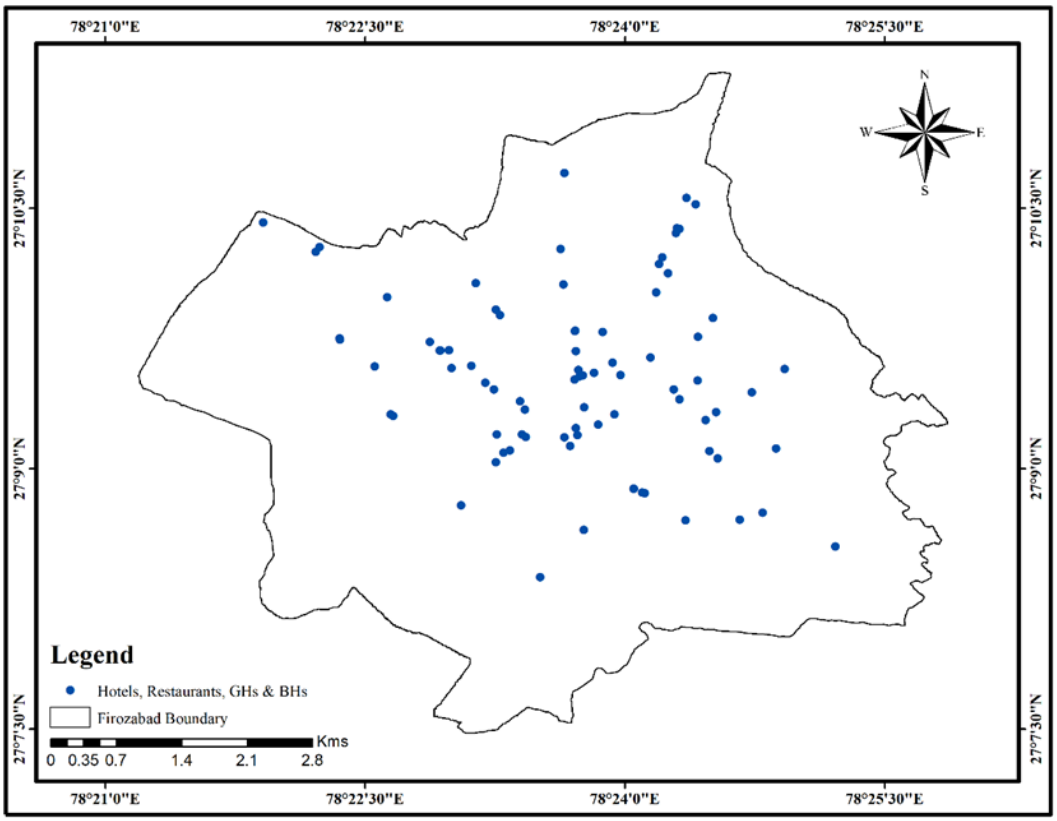


Figure 3.29: Location of hotels, restaurants, GHs & BHs

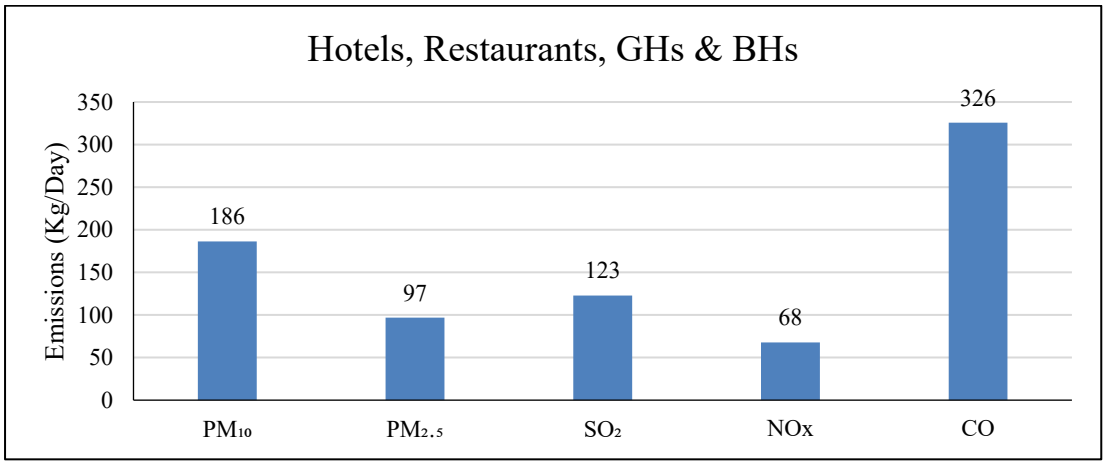


Figure 3.30: Emission load from hotels, bakeries, and restaurants (kg/d)

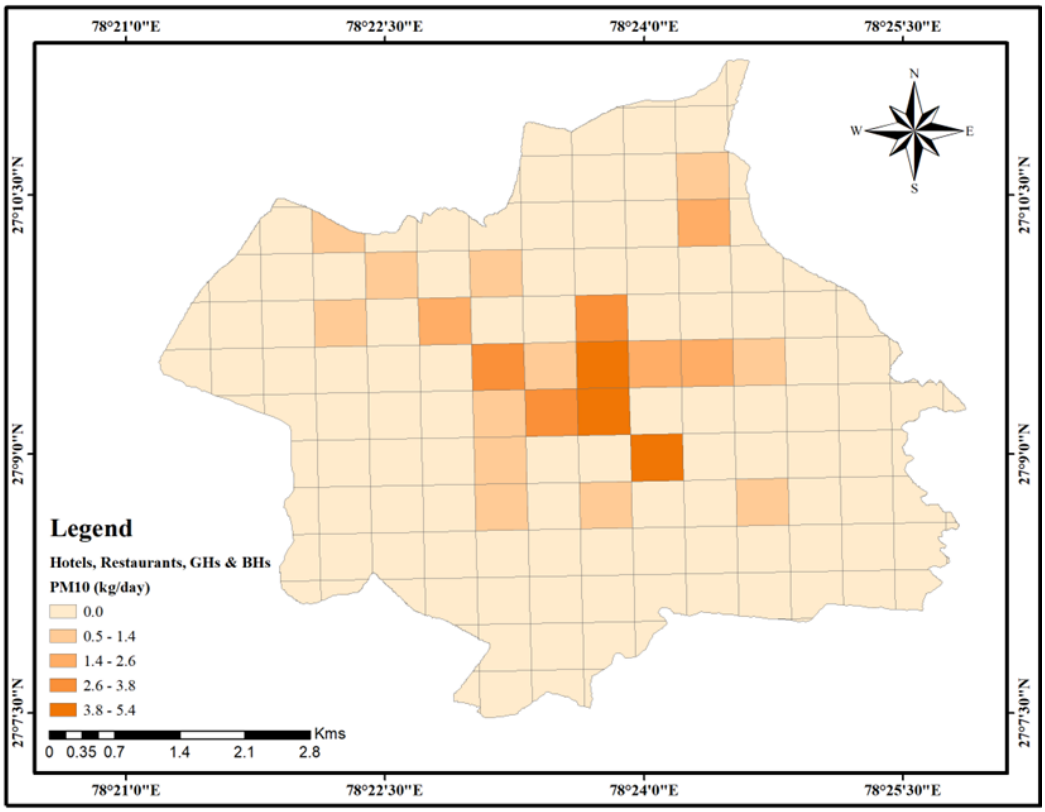


Figure 3.31: Spatial distribution of PM_{10} emissions from hotels, restaurants, GHs and BHs

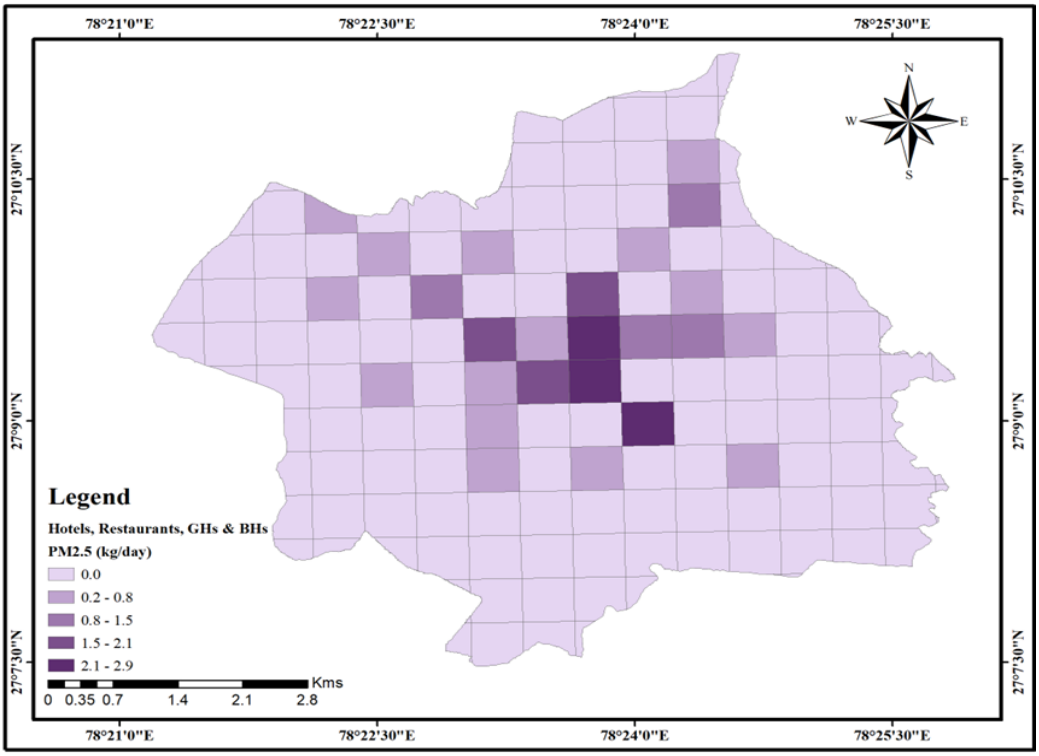


Figure 3.32: Spatial distribution of $PM_{2.5}$ emissions from hotels, restaurants, GHs and BHs

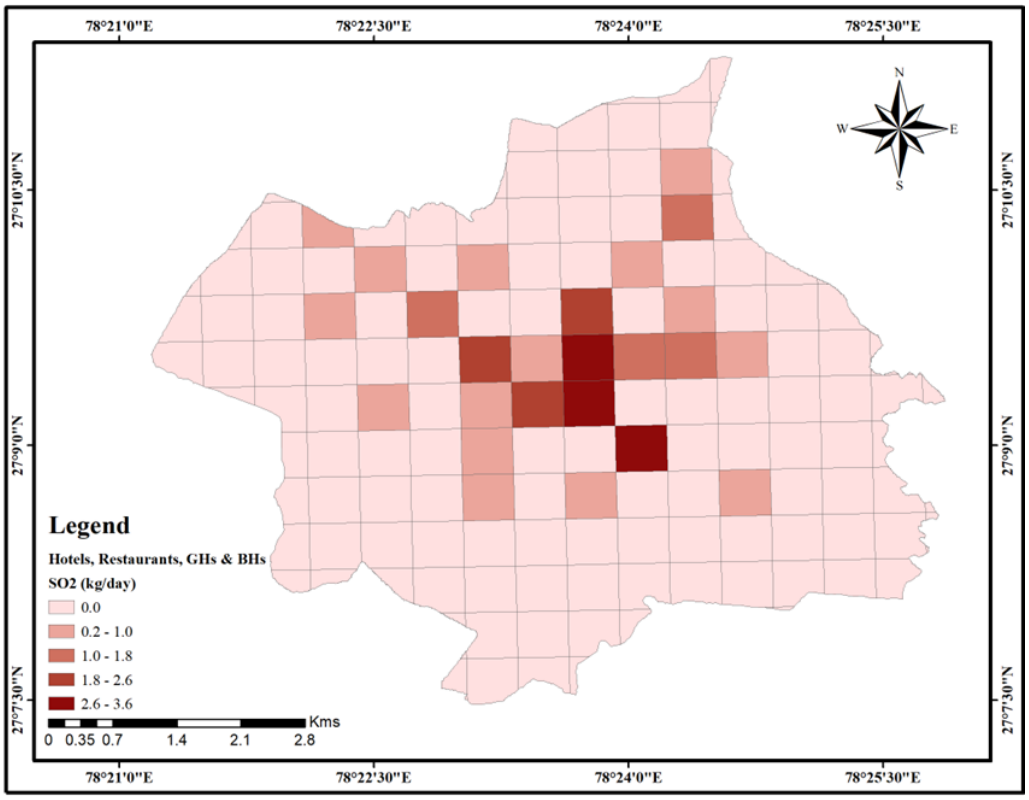


Figure 3.33: Spatial distribution of SO_2 emissions from hotels, restaurants, GHs and BHs

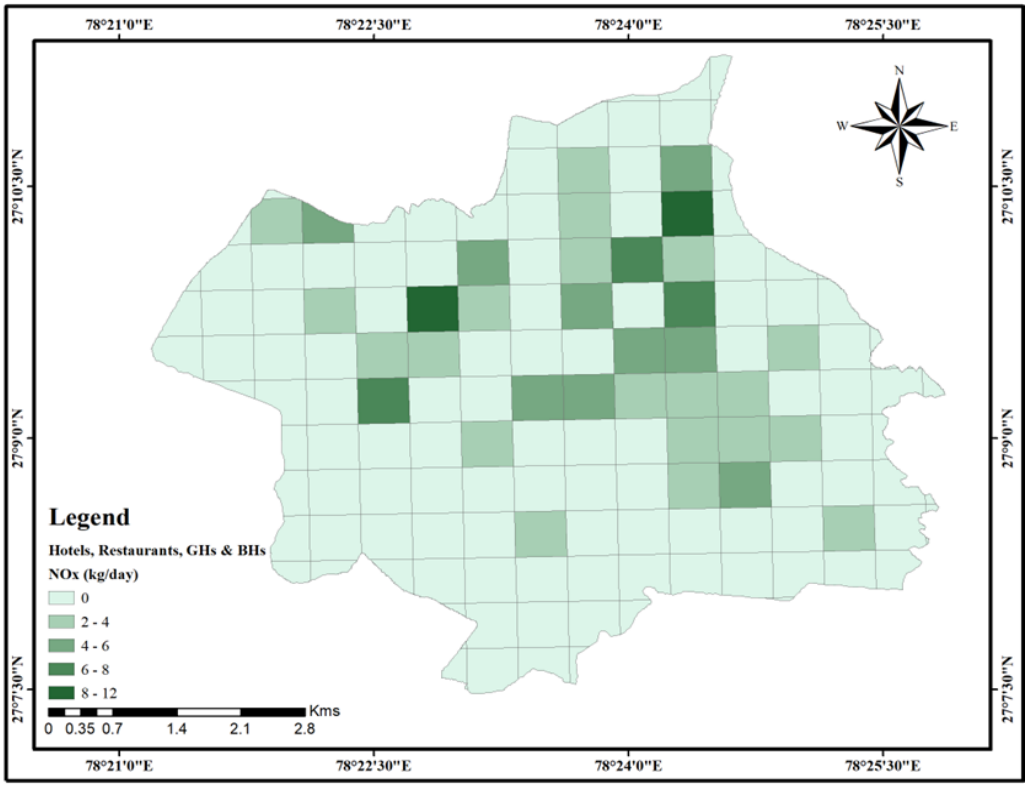


Figure 3.34: Spatial distribution of NO_x emissions from hotels, restaurants, GHs and BHs

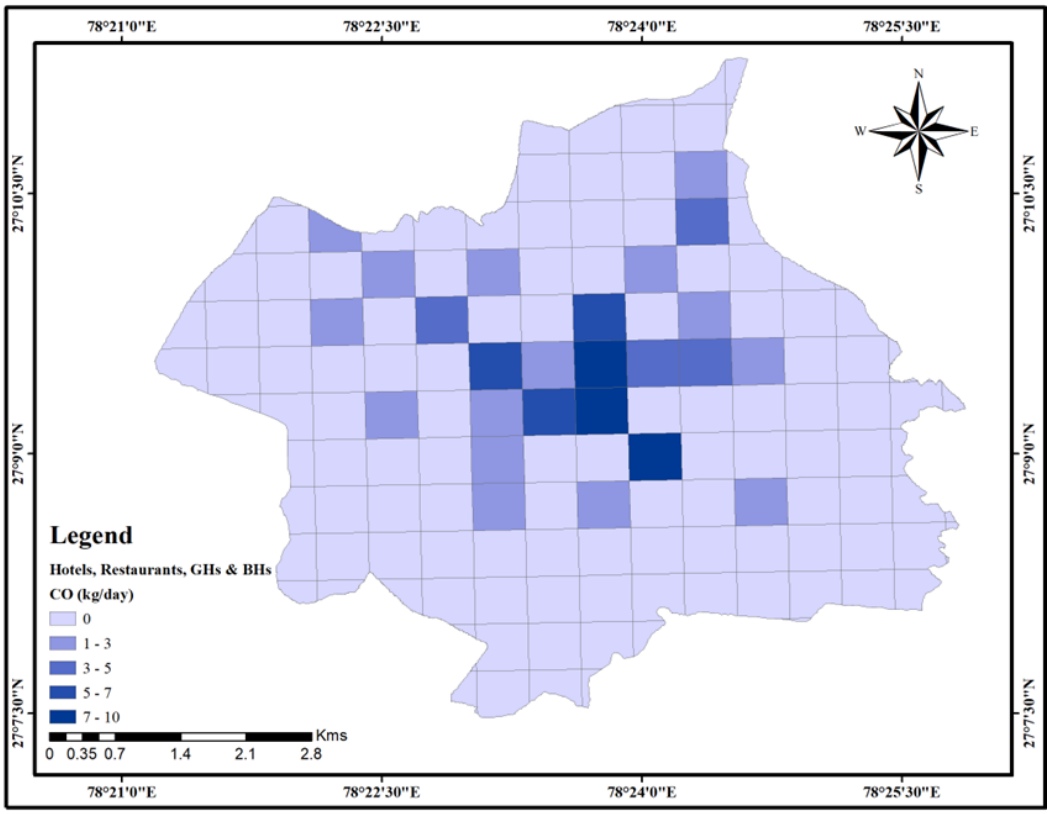


Figure 3.35: Spatial distribution of CO emissions from hotels, restaurants, GHs and BHs

3.2.8 Municipal Solid Waste Burning

Open-burning activities are broadly classified into refuse and biomass burning. The refuse or municipal solid waste (MSW) burning depends on solid waste generation and the extent of disposal and infrastructure for collection. The Solid waste generation is around 269.1 MT/day and the waste collected is approximately 259.7 MT/day. The MSW collection efficiency is 96.5% in Firozabad city (UPPCB SWM Annual Report 2019-20), and several events of MSW burning have been observed during the city survey. The survey was conducted on weekdays and weekends and the frequency of MSW burning events is calculated in the low-, middle: and higher-income areas. The MSW burning at different locations in Firozabad city is shown in Figure 3.36.

Figure 3.36: MSW burning in Firozabad city

The emission factors given by CPCB (2011) and AP-42 (USEPA, 2000) were used for estimating the emission from MSW burning using the same procedure of emission density in a ward or village. The emissions from MSW burning are presented in Figure 3.37 and spatial distribution in Figure 3.38 to Figure 3.42.

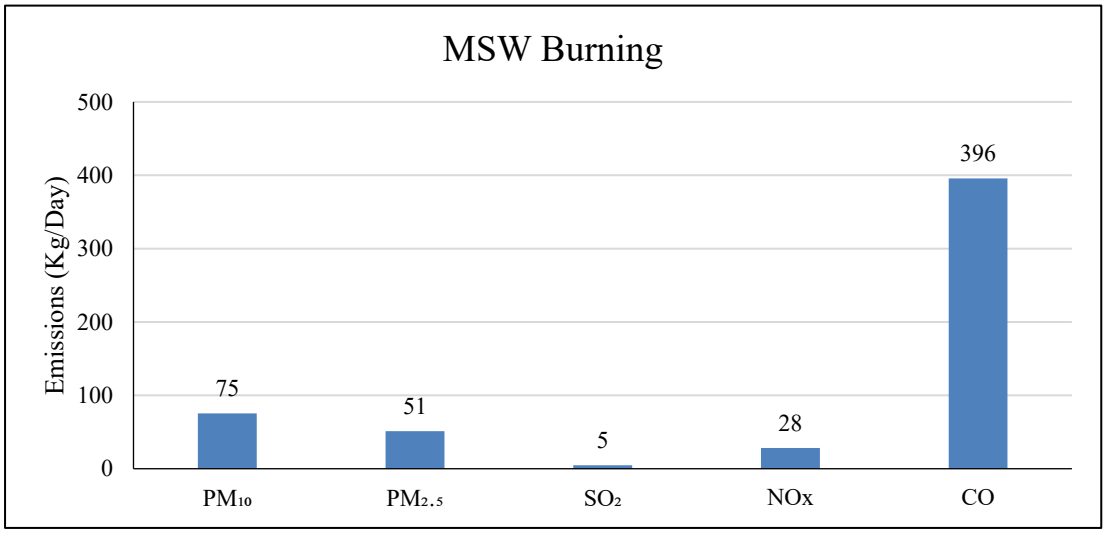


Figure 3.37: Emission load from MSW burning (kg/d)

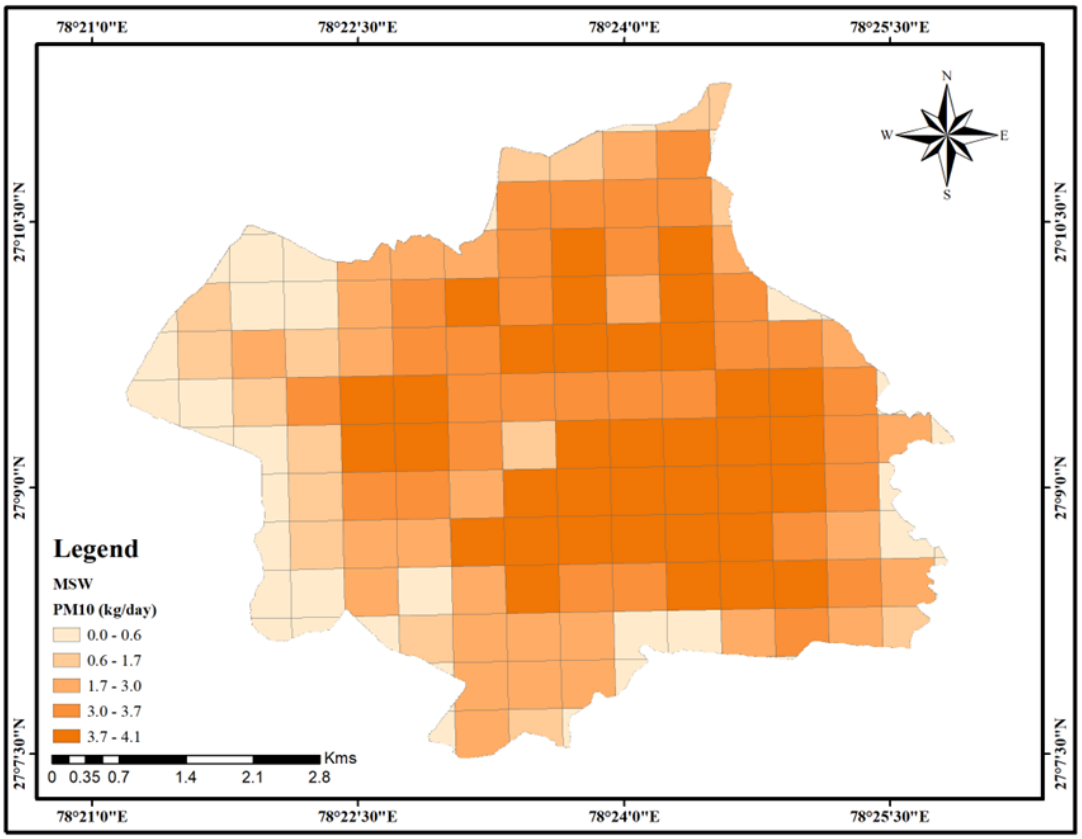


Figure 3.38: Spatial distribution of PM_{10} emissions from MSW burning

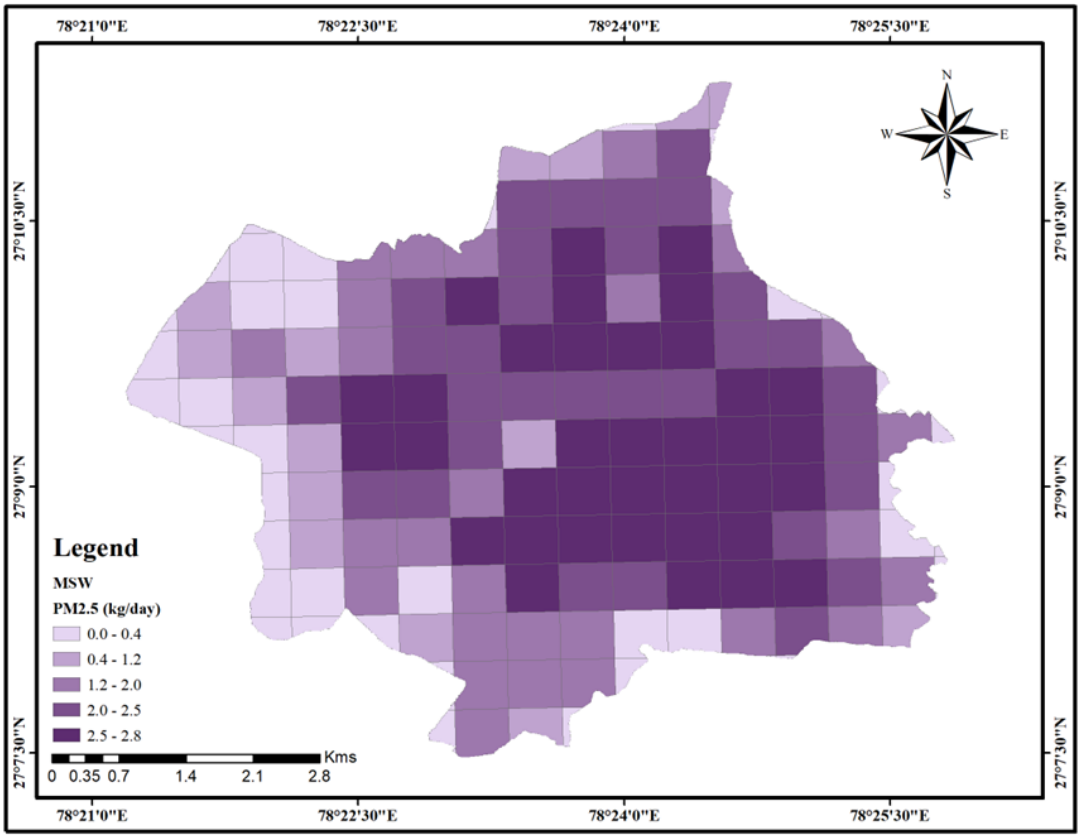


Figure 3.39: Spatial distribution of $PM_{2.5}$ emissions from MSW burning

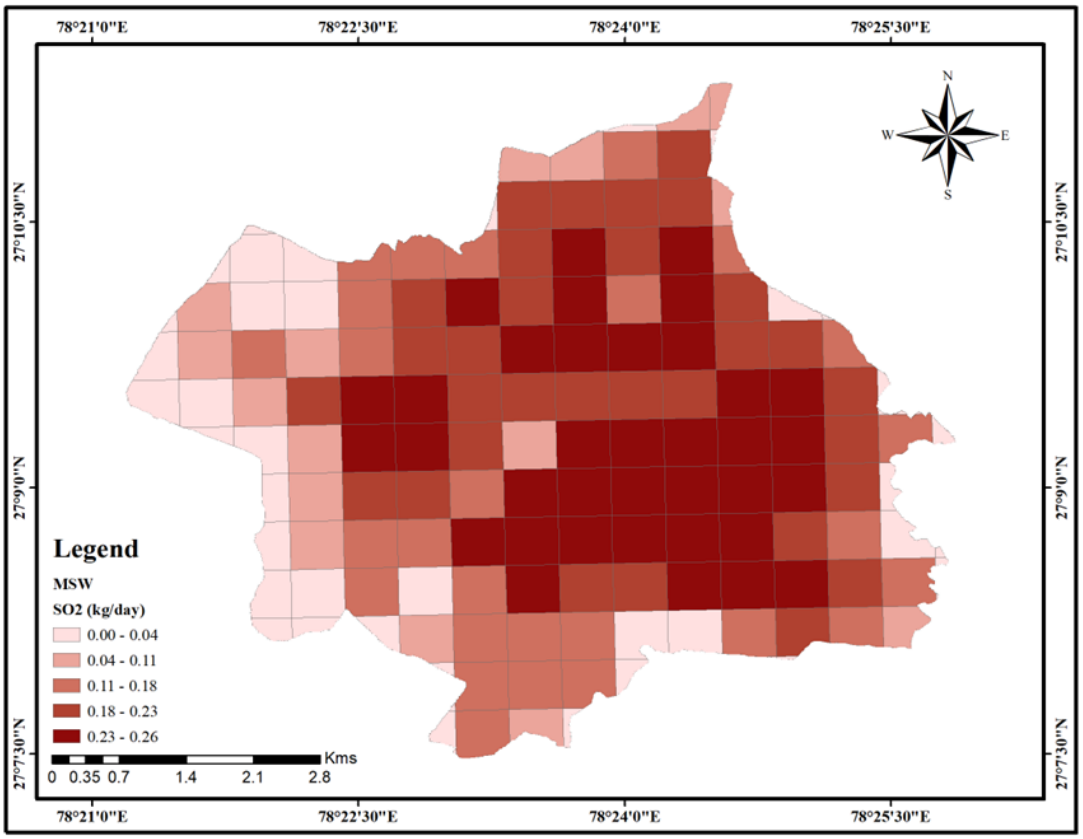


Figure 3.40: Spatial distribution of SO_2 emissions from MSW burning

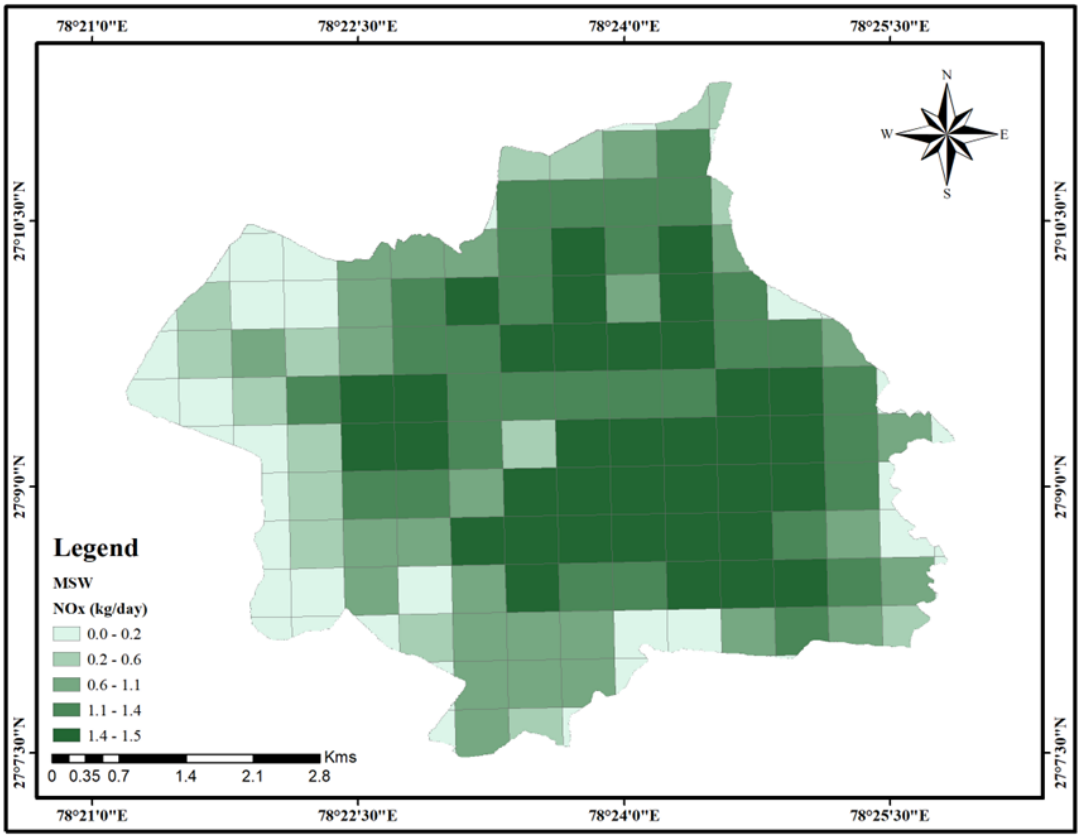


Figure 3.41: Spatial distribution of NO_x emissions from MSW burning

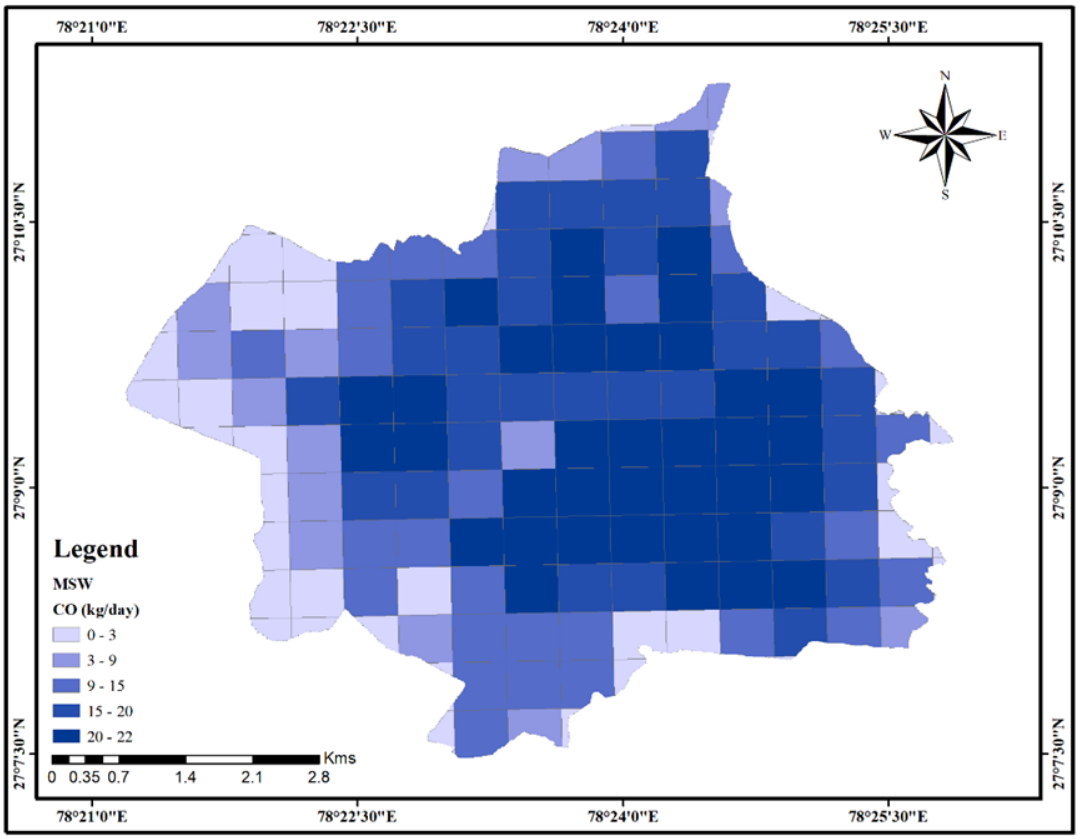


Figure 3.42: Spatial distribution of CO emissions from MSW burning

3.2.9 Hospitals

A detailed survey was undertaken to estimate the emission from hospitals in Firozabad city. There are approximately 71 hospitals in the city (Figure 3.43). The overall emissions from hospitals along with their average DG set capacity of 106 KVA and running two hours in a day are presented in Table 3.1. The emission load from hospitals is given in

Figure 3.44. The Spatial distribution of emissions from Hospitals is given in Figure 3.45 to Figure 3.49.

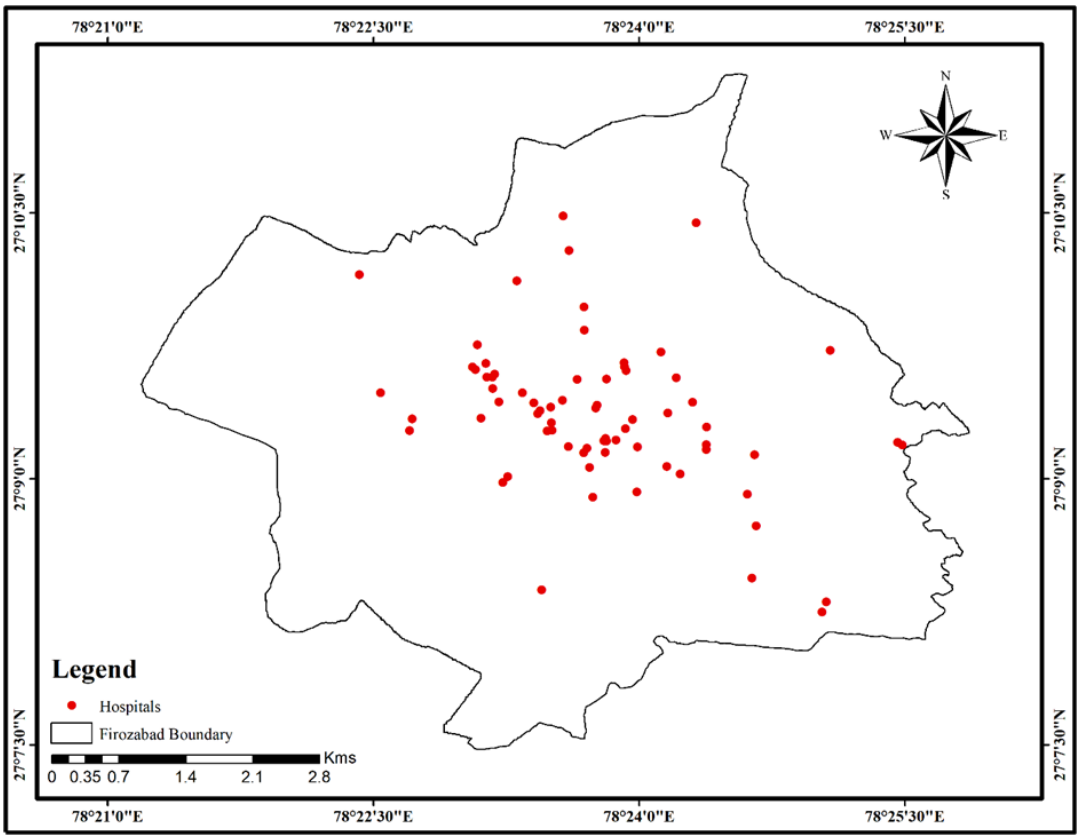


Figure 3.43: Locations of hospitals in Firozabad city

Table 3.1: Hospitals details in Firozabad city (emissions in kg/d)

No. of Hospitals	DG set Average Capacity		PM_{10}	$PM_{2.5}$	SO_2	NOx	CO
	KVA	Running Hour	(kg/d)	(kg/d)	(kg/d)	(kg/d)	(kg/d)
71	62.5	2	0.2	0.2	0.2	2.7	0.6

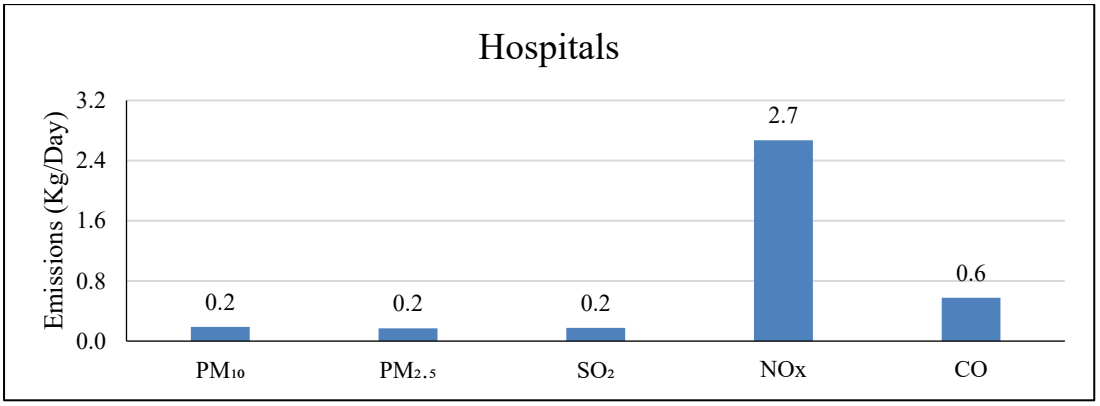


Figure 3.44: Emission load from hospitals (kg/d)

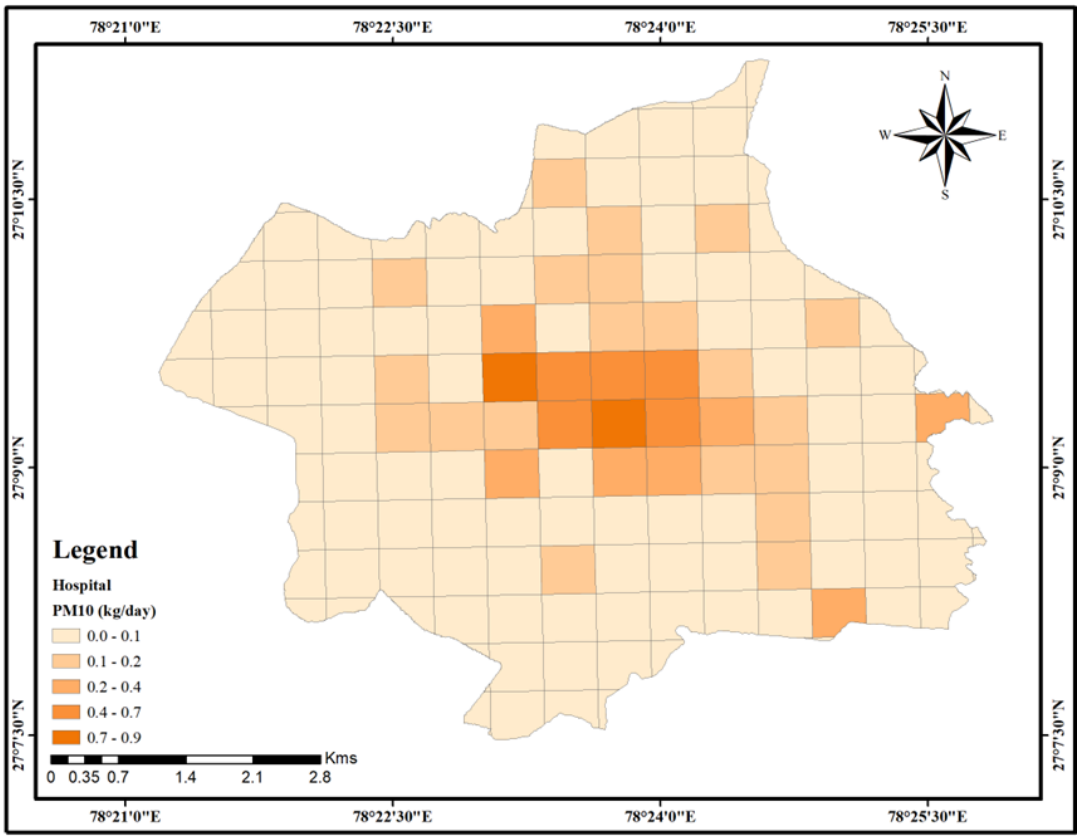


Figure 3.45: Spatial distribution of PM_{10} emissions from hospitals

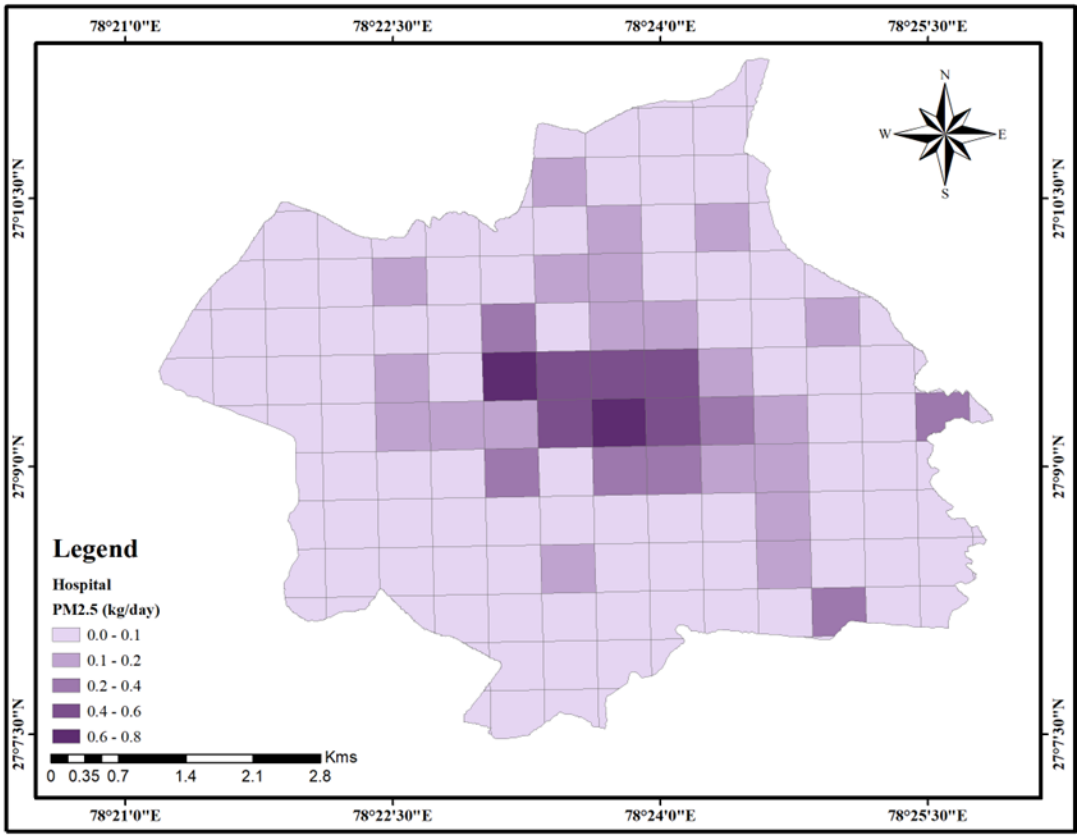


Figure 3.46: Spatial distribution of $PM_{2.5}$ emissions from hospitals

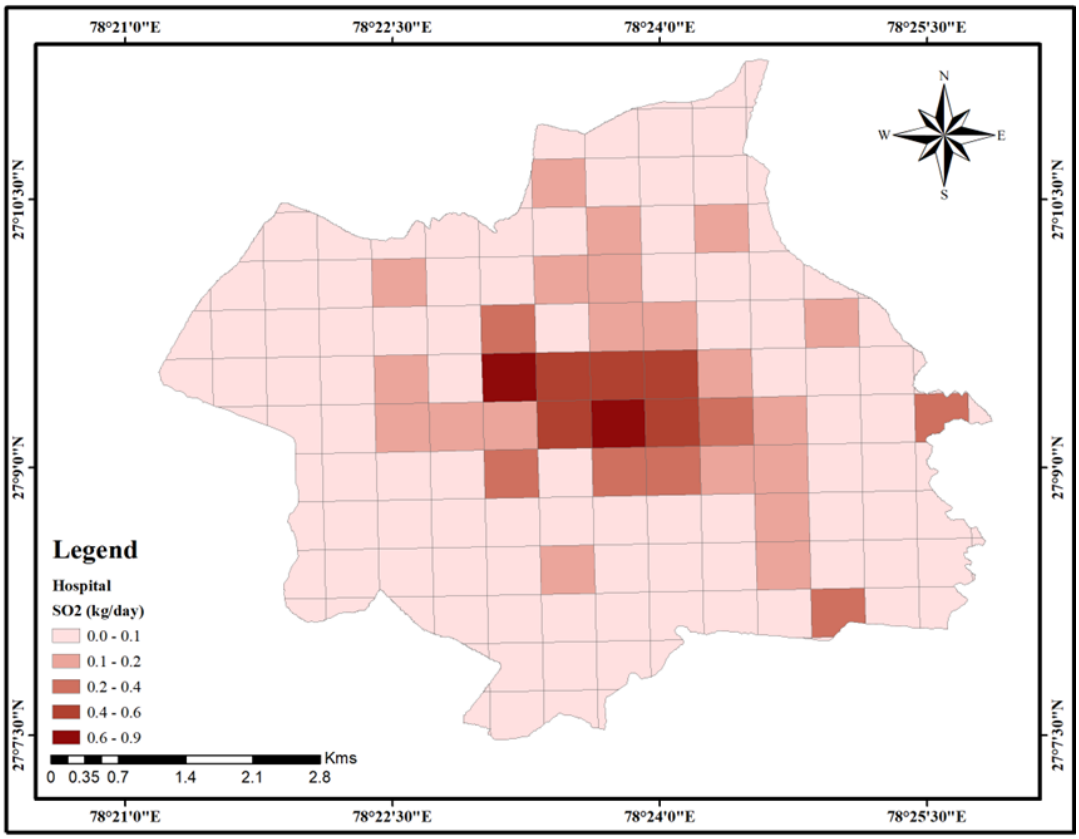


Figure 3.47: Spatial distribution of SO_2 emissions from hospitals

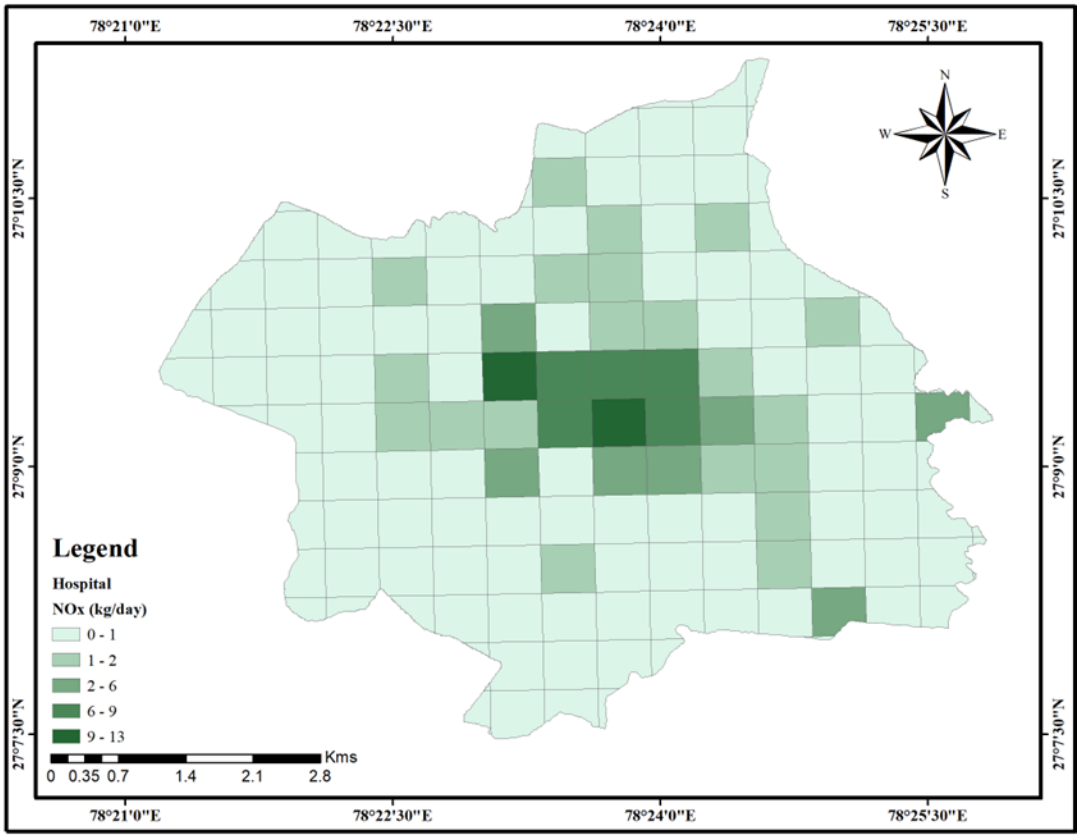


Figure 3.48: Spatial distribution of NO_x emissions from hospitals

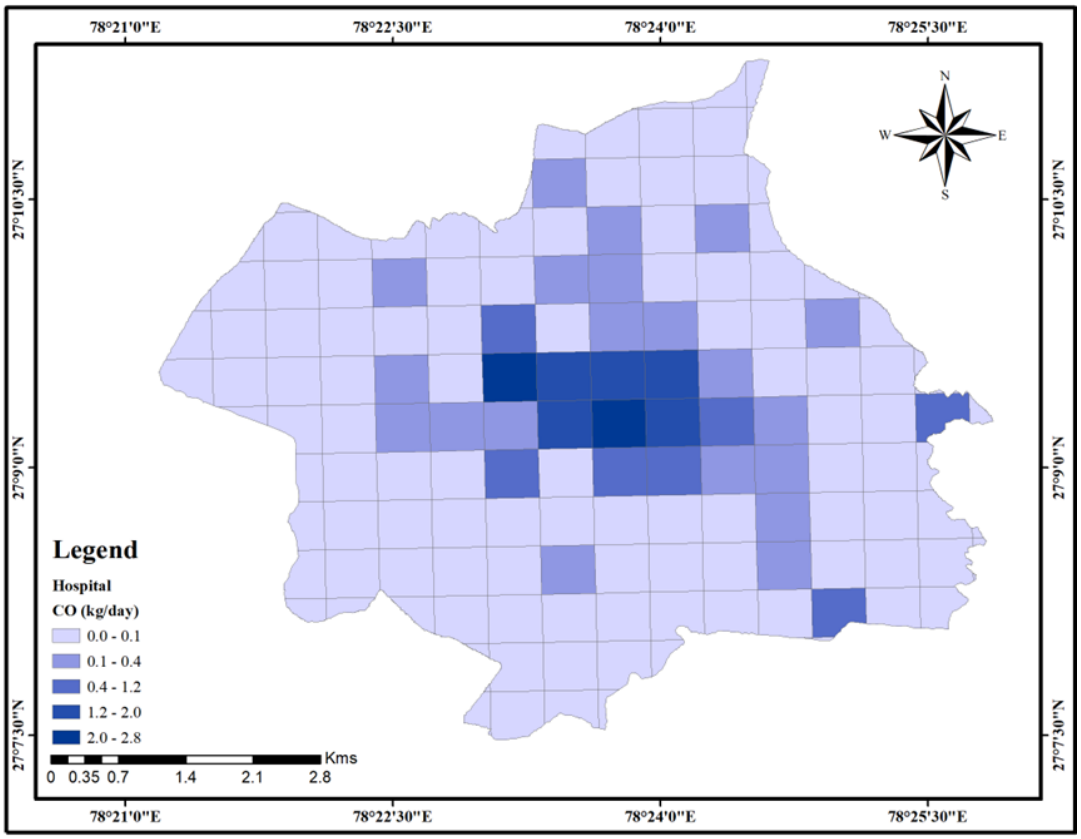


Figure 3.49: Spatial distribution of CO emissions from hospitals

3.2.10 Industries

There are approximately 153 industrial units with boilers and furnaces (electric and melting furnaces) that contribute to particulate and gaseous emissions (Table 3.2). Major fuels that contribute to emissions are HSD, Wood, Coal, Rice Husk, and LPG. The industrial locations are given in Figure 3.50. The information on stacks, fuel, and their consumption was obtained from UPPCB. AP-42 (USEPA, 2000) emission factors were used to calculate the emissions. For further analysis, the industries are categorized based on stack height as an area source (stack height < 15 m) and as a point source (stack height > 15 m). The major emissions were from the large point source industries.

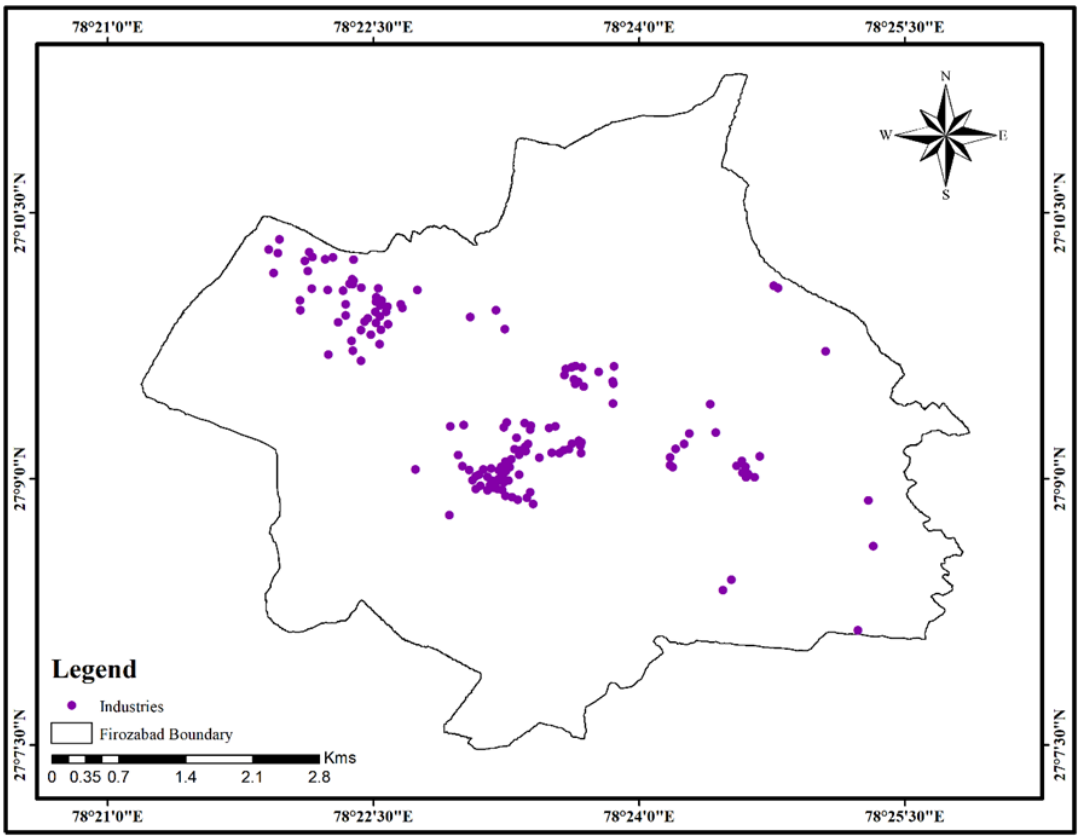


Figure 3.50: Locations of industries in Firozabad city

Table 3.2: Furnace/Boiler details in Firozabad (emissions in kg/d)

(Source: Consent Data)

Boiler/Furnace Type	Fuel used in Boiler/Furnace	No of Furnaces/ Boilers	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO
Pot Furnace	**Natural Gas, LPG**	80	54	54	414	991	594
Tank Furnace	**Natural Gas**	70	81	81	626	1498	899
Folding Furnace	**Natural Gas**	1	0.4	0.4	3	7	4
Boiler	**Natural Gas**	1	1	1	9	22	13
Hot Air Generator	**Natural Gas**	1	1	1	11	27	16
Total		**153**	**137**	**137**	**1063**	**2545**	**1527**

Industries as Area Source

Figure 3.51 presents the overall industry emissions (stack height < 15 m) as an area source. There are around 8 industrial units categorized as area sources in Firozabad city. The

boiler/baby boilers are majorly falling under this category. The spatial distribution of industries (area source) lying within the boundary is shown in Figure 3.52 to Figure 3.56.

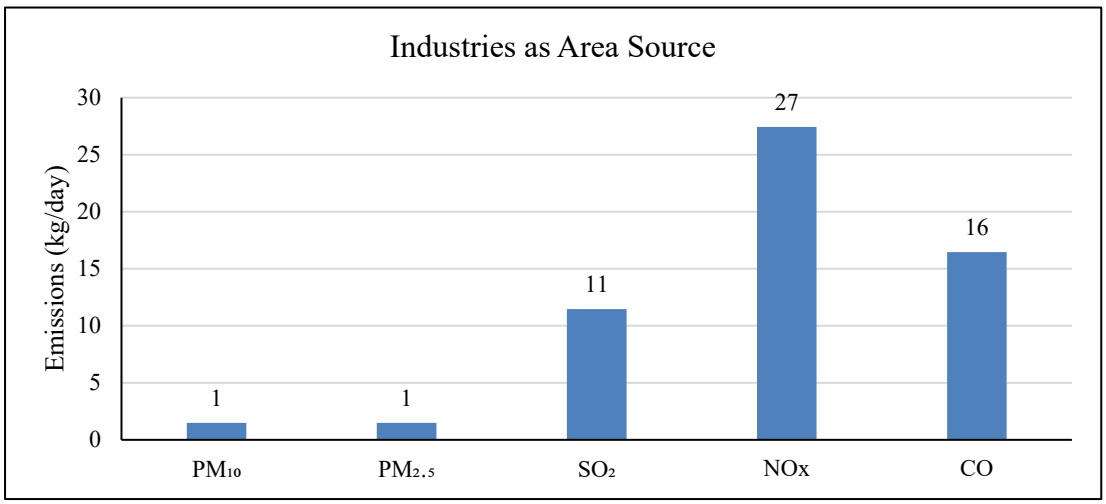


Figure 3.51: Emission load from industries as area source (kg/d)

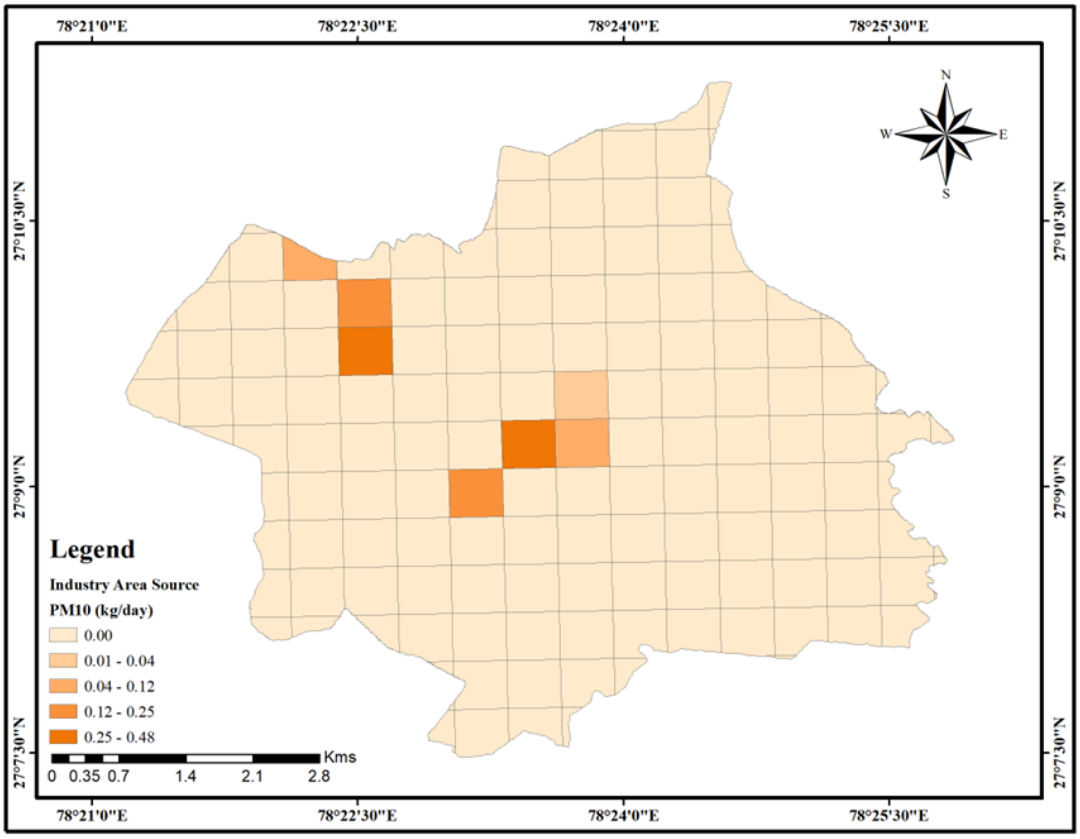


Figure 3.52: Spatial distribution of PM_{10} emissions from industries as an area source

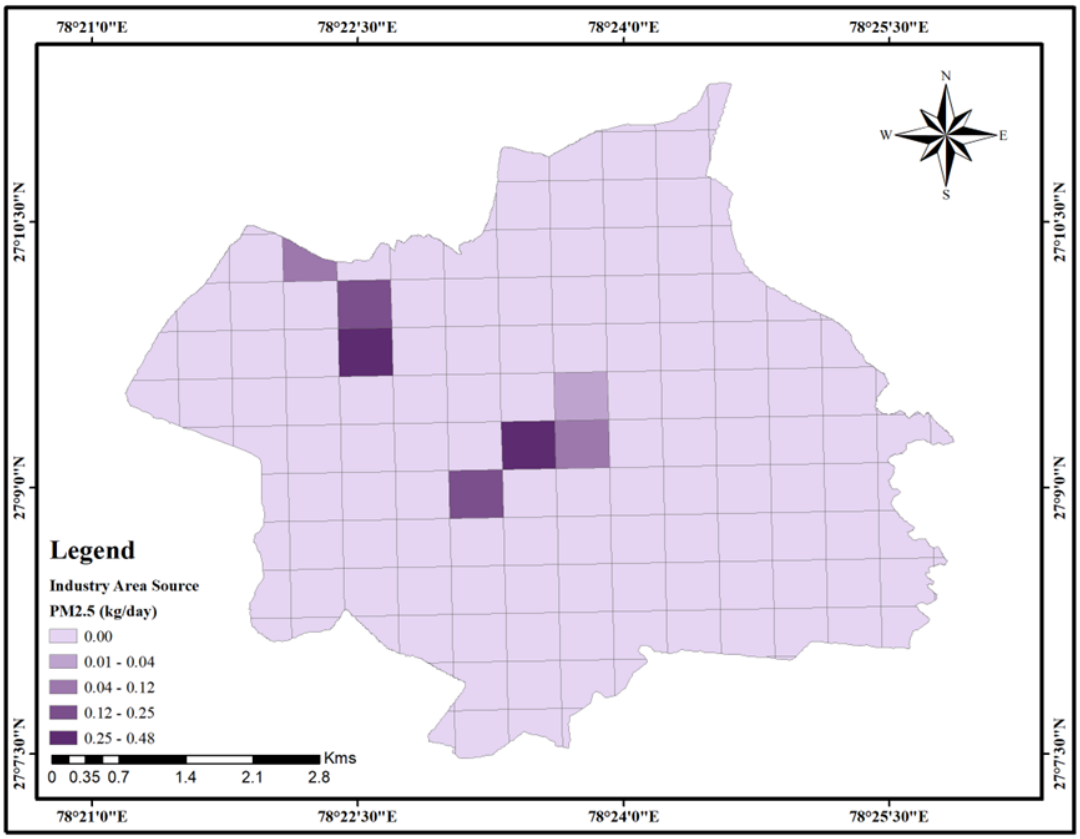


Figure 3.53: Spatial distribution of $PM_{2.5}$ emissions from industries as an area source

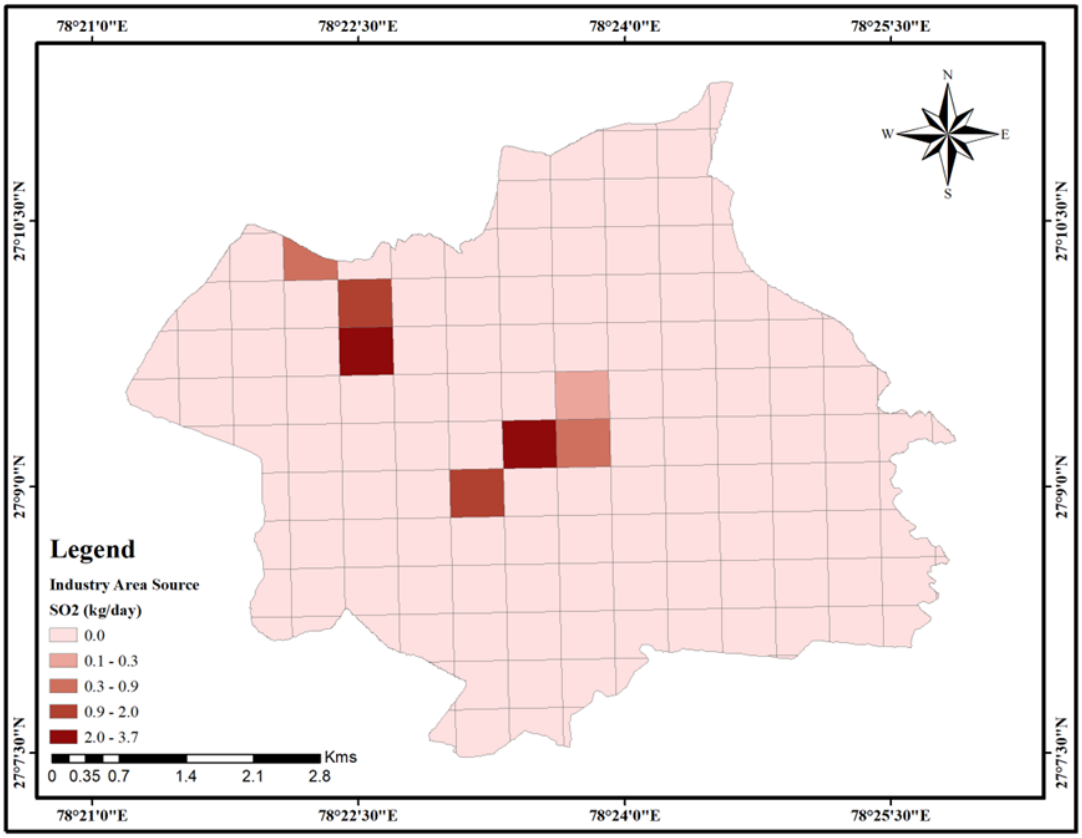


Figure 3.54: Spatial distribution of SO_2 emissions from industries as an area source

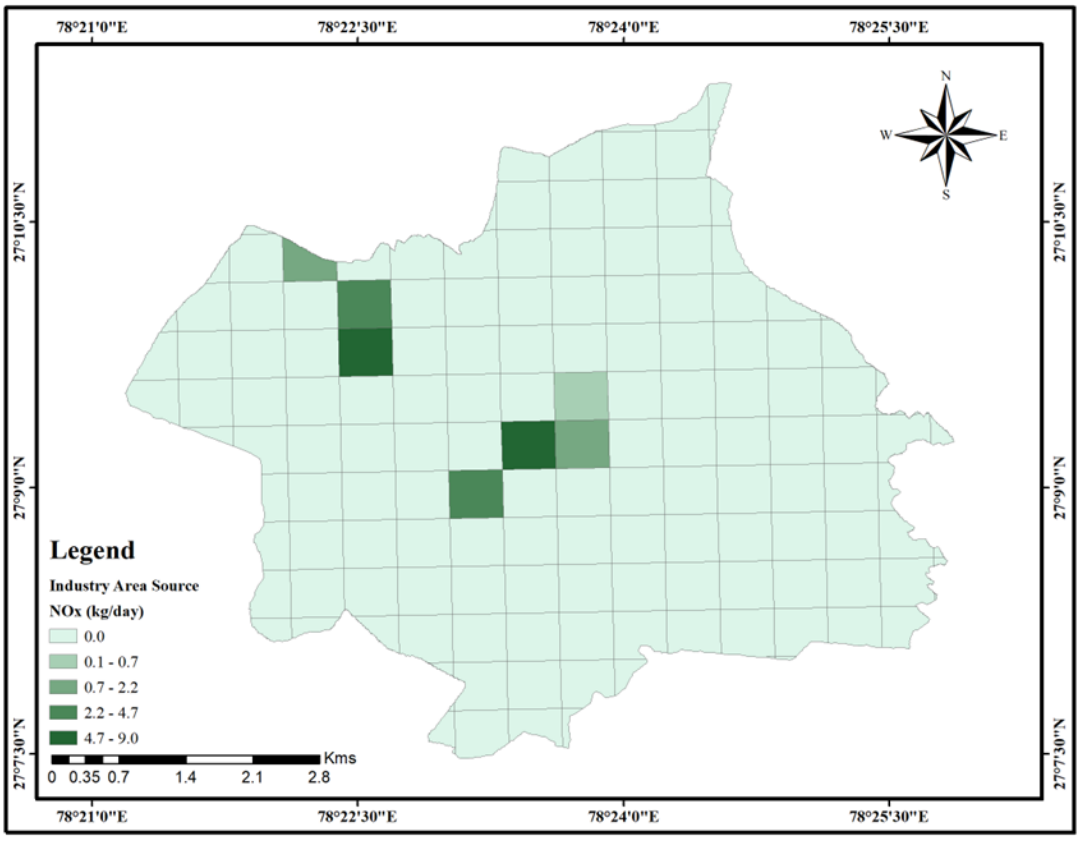


Figure 3.55: Spatial distribution of NO_x emissions from industries as an area source

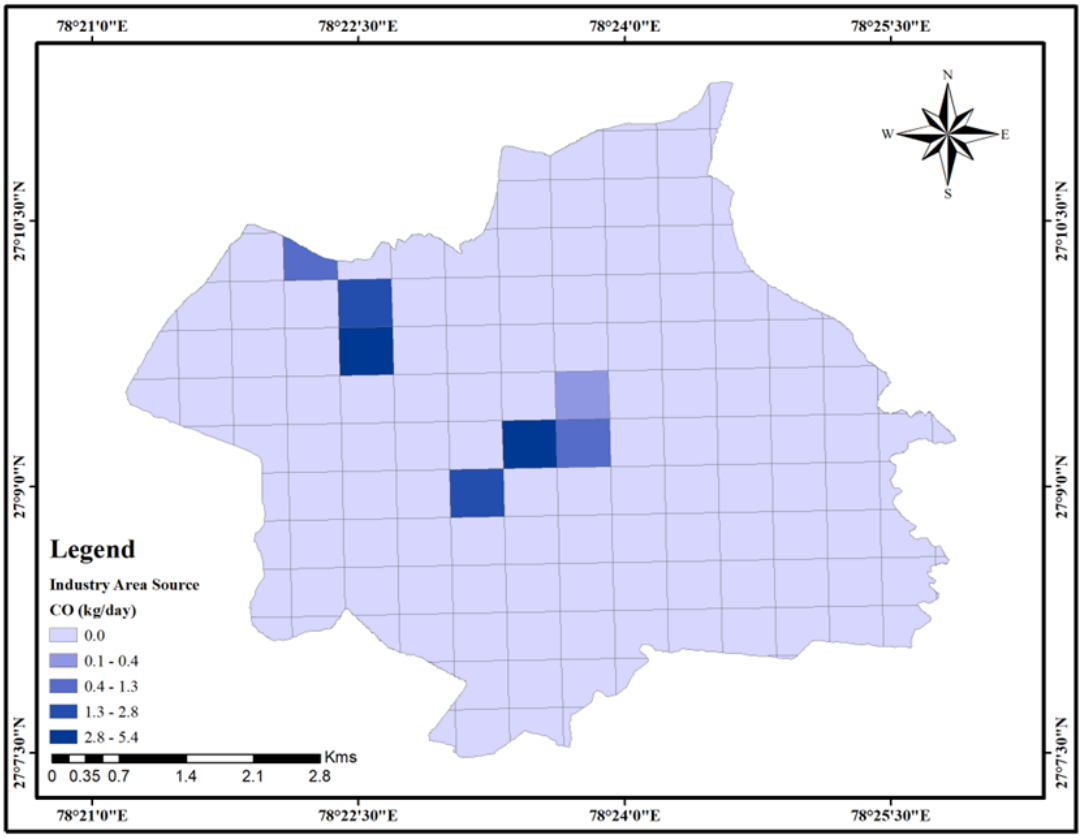
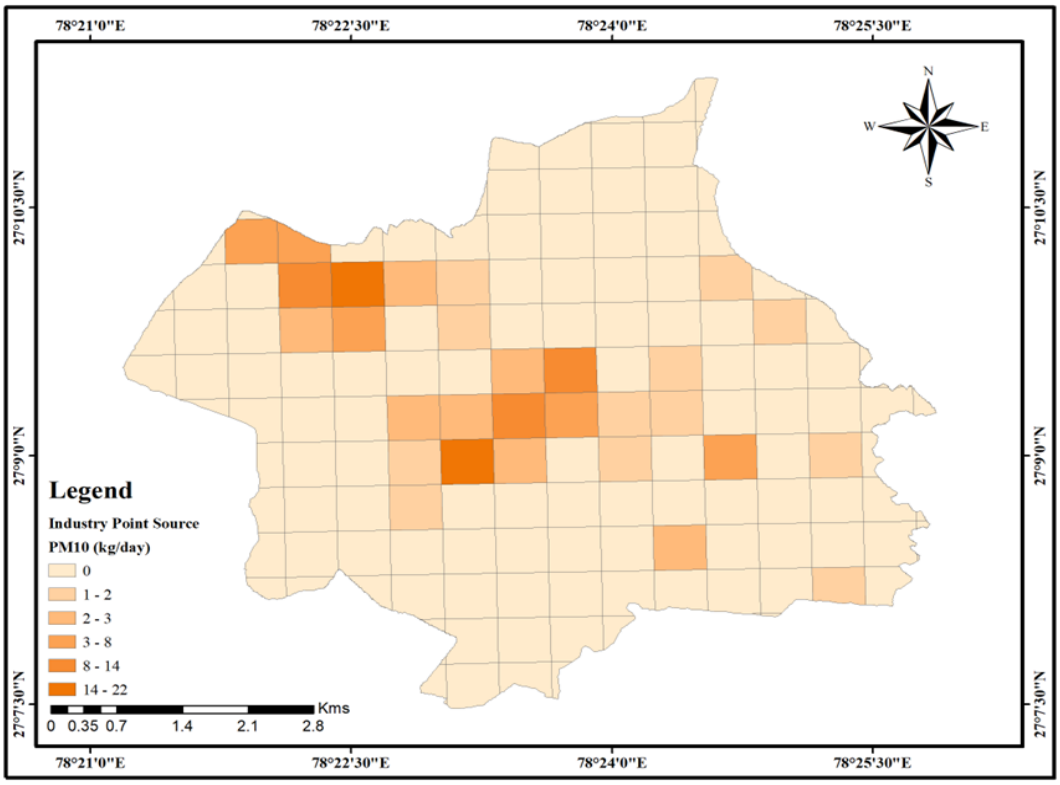


Figure 3.56: Spatial distribution of CO emissions from industries as an area source

Industries as Point Source

The industries having a stack height of more than 15 m have been taken as a point source. There are approximately 145 industries that have stack heights of more than 15 meters. The emission of pollutants from industries as a point source is shown in Figure 3.57.



The spatial distribution of emissions from industries (point source) lying within the boundary is presented in Figure 3.58 to Figure 3.62.

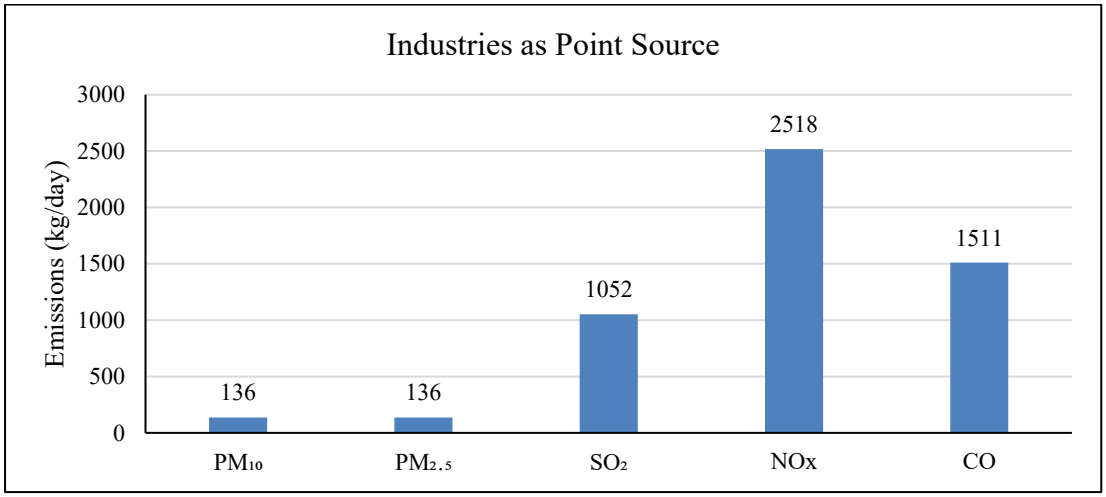


Figure 3.57: Emission load from industries as point source (kg/d)

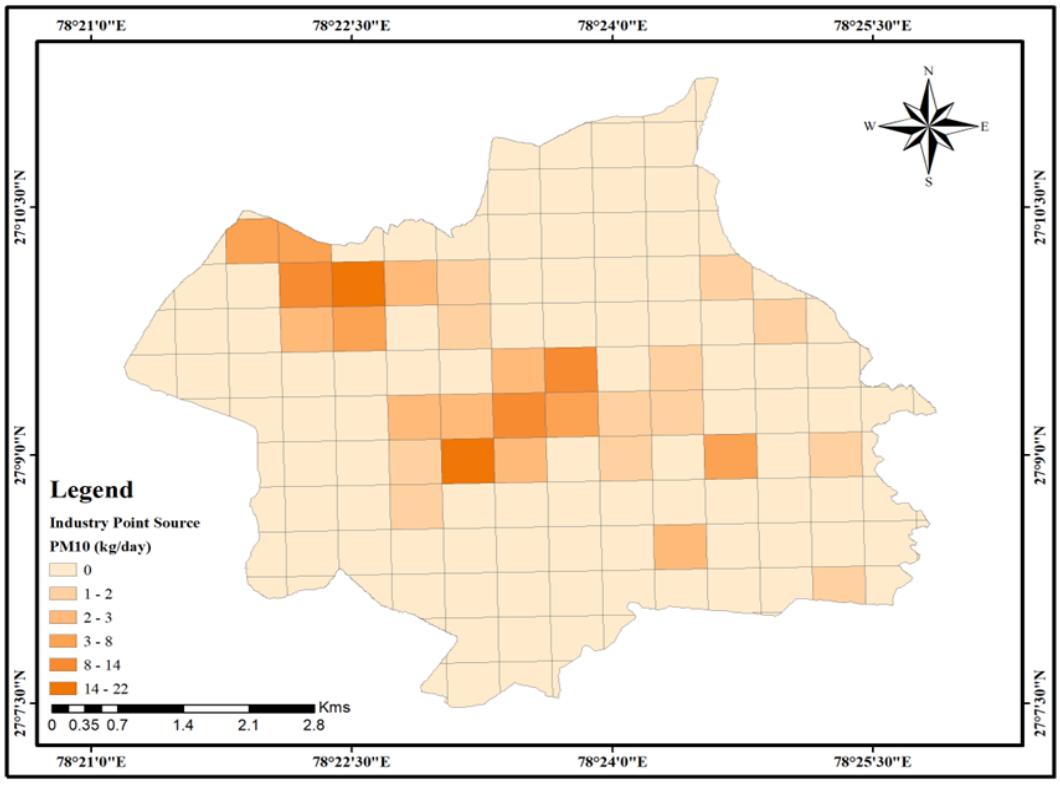


Figure 3.58: Spatial distribution of PM_{10} emissions from industries as point source

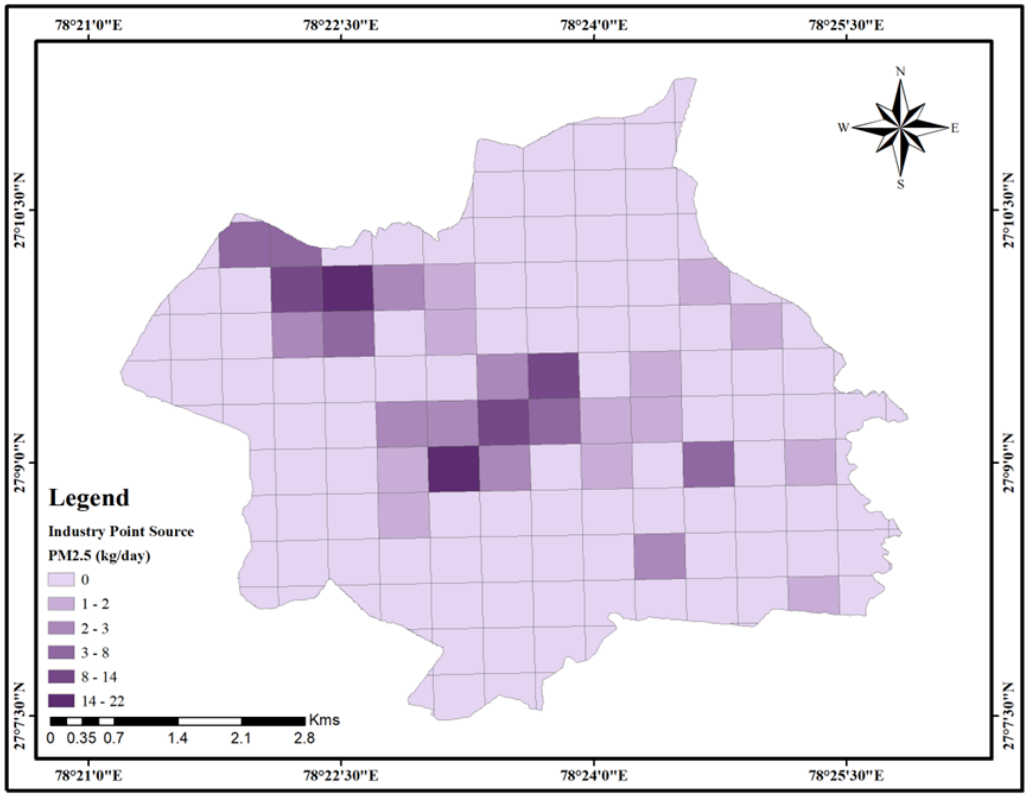


Figure 3.59: Spatial distribution of $PM_{2.5}$ emissions from industries as point source

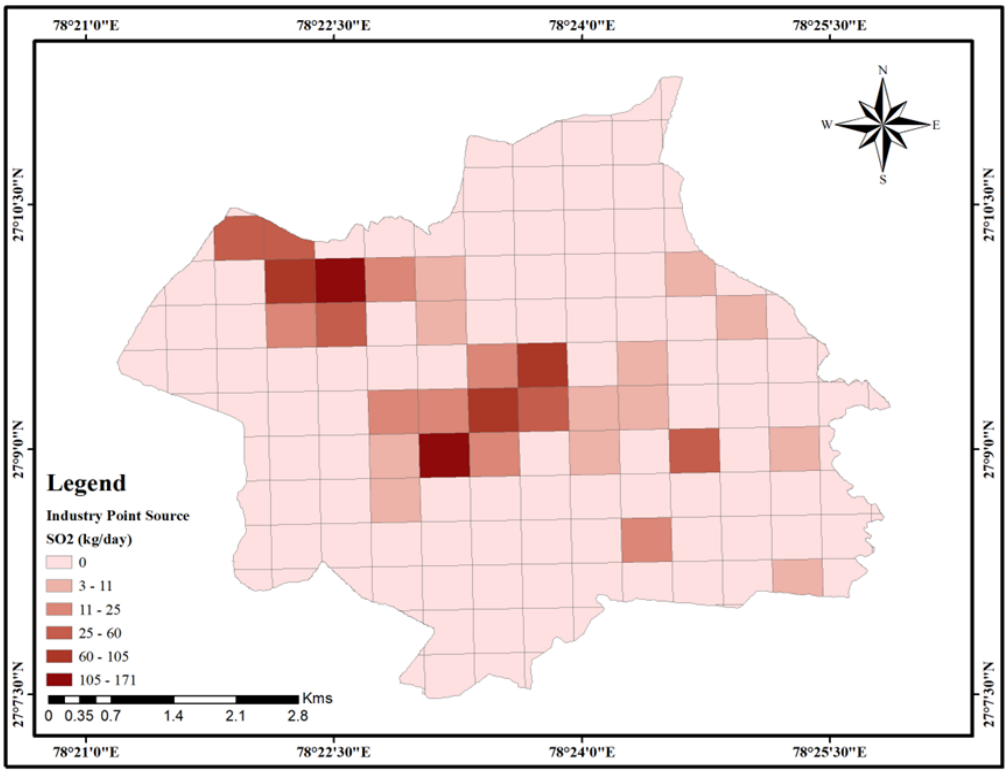


Figure 3.60: Spatial distribution of SO_2 emissions from industries as point source

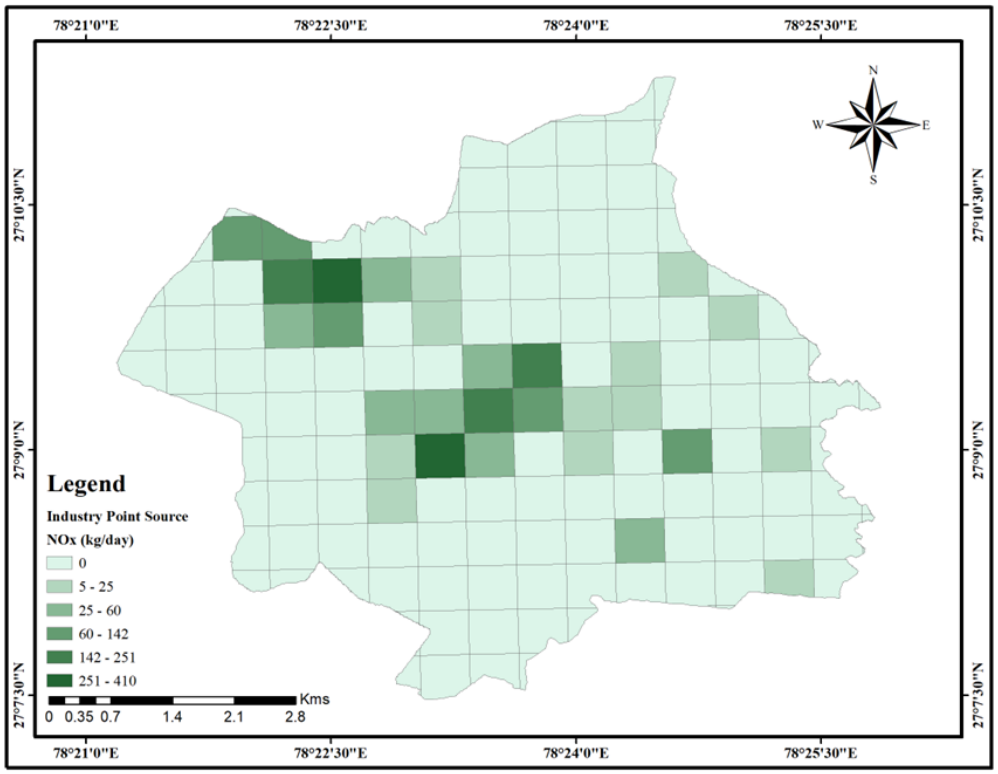


Figure 3.61: Spatial distribution of NO_x emissions from industries as point source

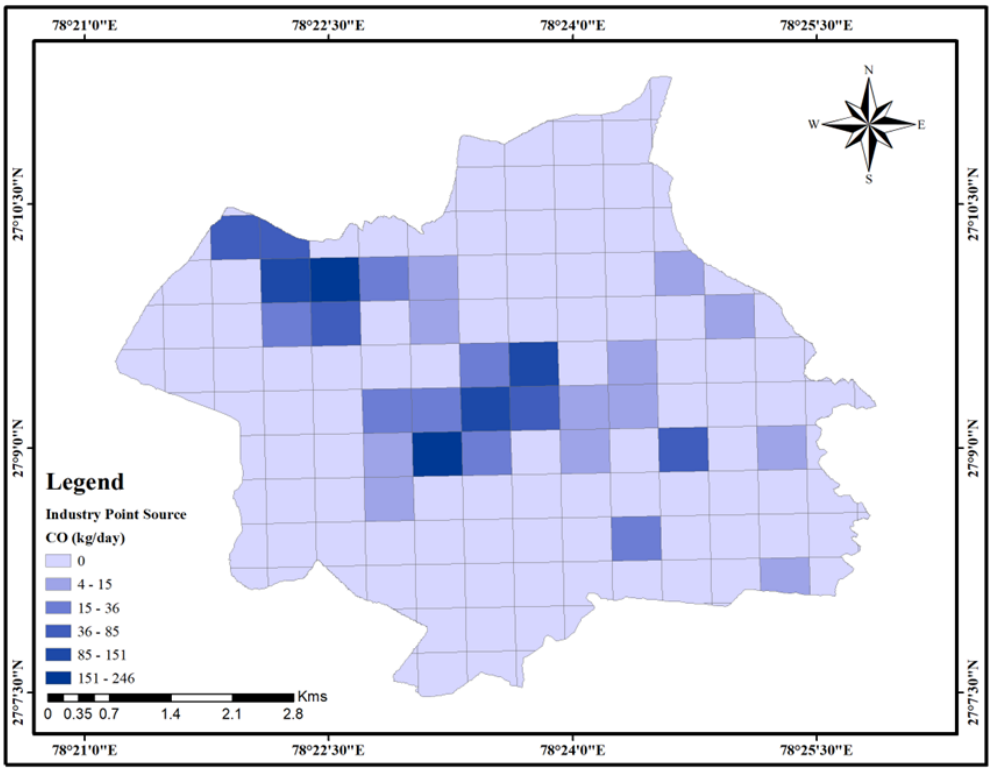


Figure 3.62: Spatial distribution of CO emissions from industries as point source

3.2.11 Industrial Diesel Generator Sets (Industrial DG sets)

The industries use DG sets as a backup; approximately 27 DG sets are installed in industries (source: consent data; Figure 3.63). The capacities of DG sets are in the range of 5 KVA to 1200 KVA with an average capacity of 180 KVA. During the industrial survey, it was found that these DG sets operate for two hours per day. Most industries use diesel as fuel for generator sets. The total emissions from DG sets are shown in Figure 3.64 and the spatial distribution of emissions from DG Sets lying within the boundary is shown in Figure 3.65 to Figure 3.69.

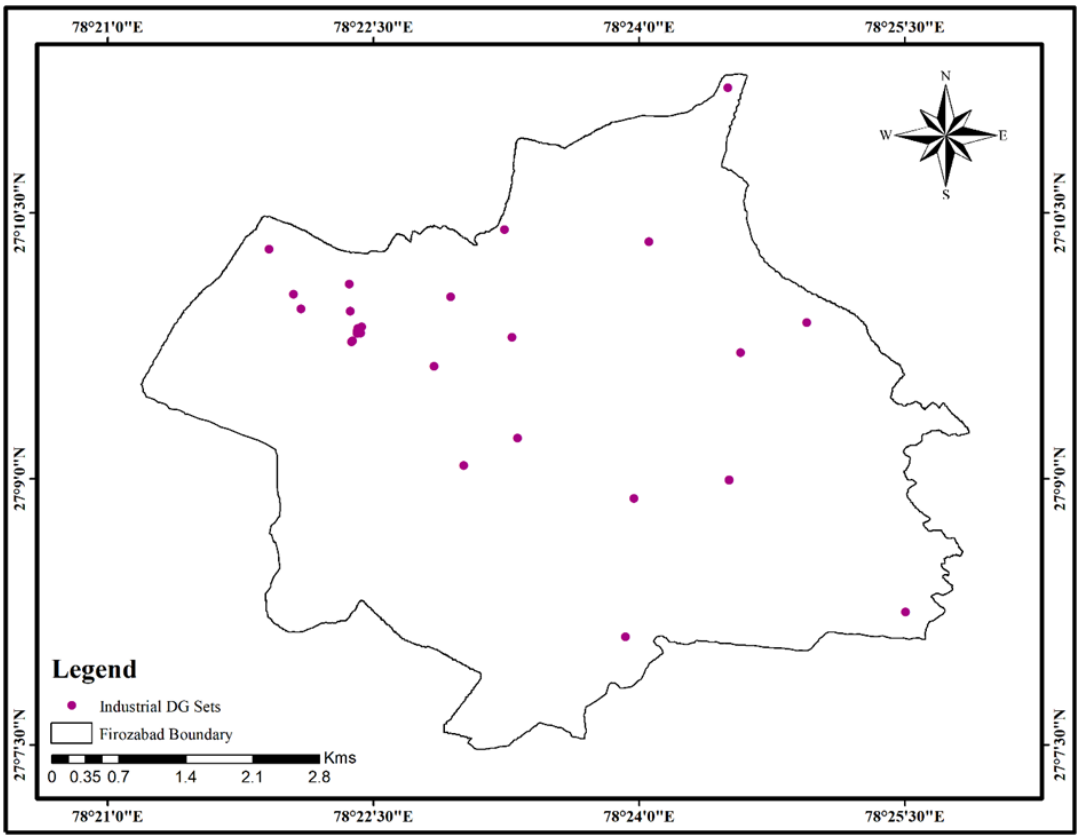


Figure 3.63: Location of industrial DG sets

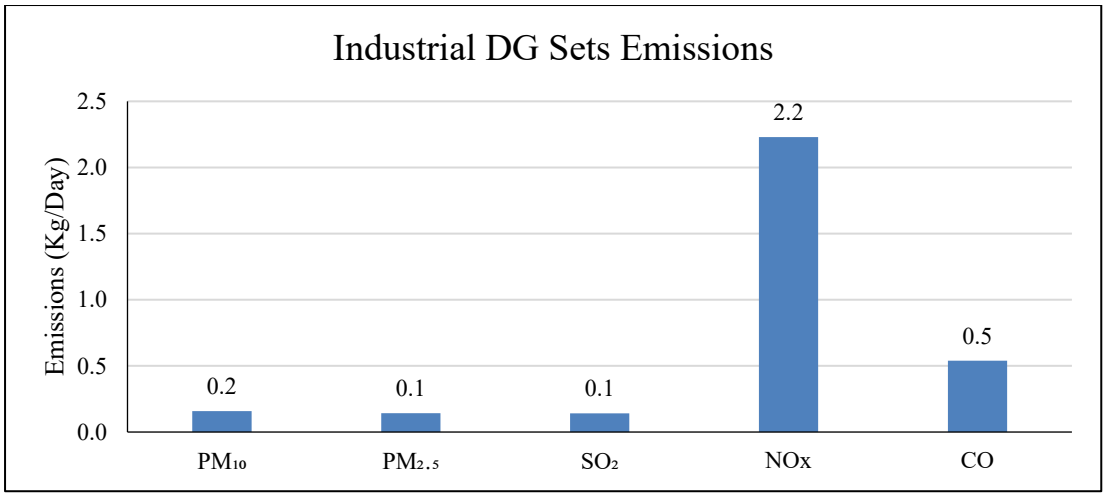


Figure 3.64: Emission load from industrial DG sets (kg/d)

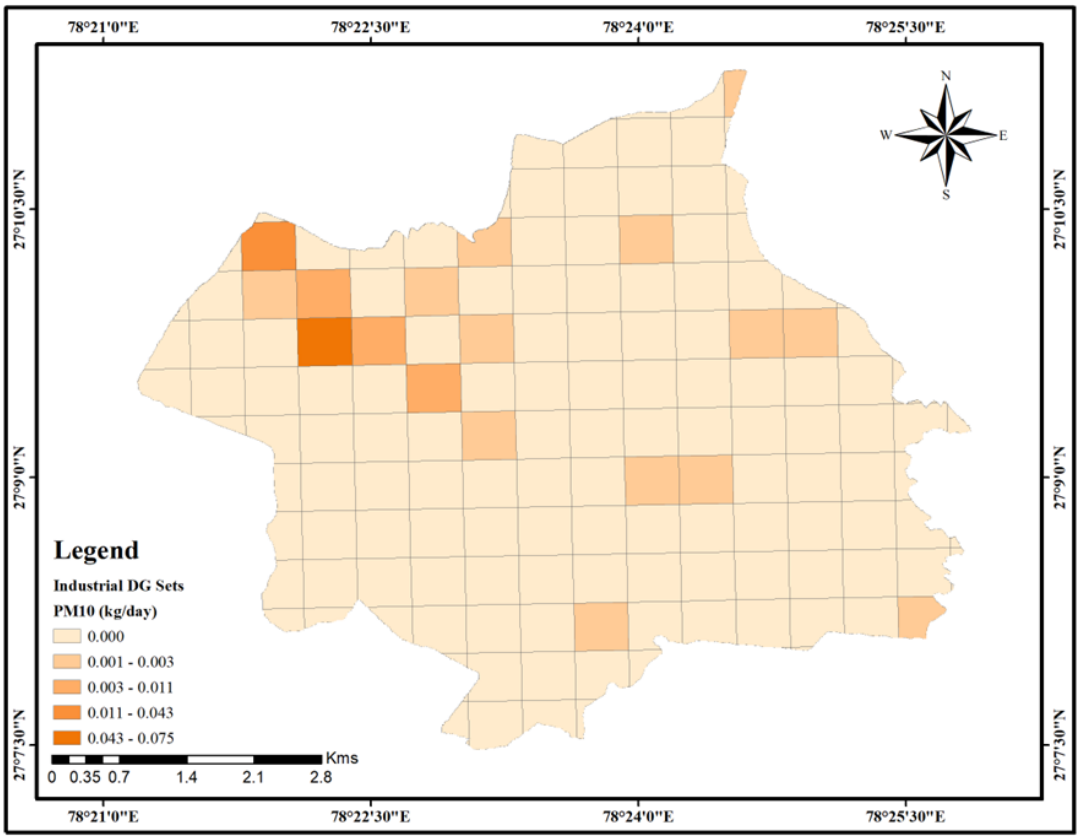


Figure 3.65: Spatial distribution of PM_{10} emissions from industrial DG sets

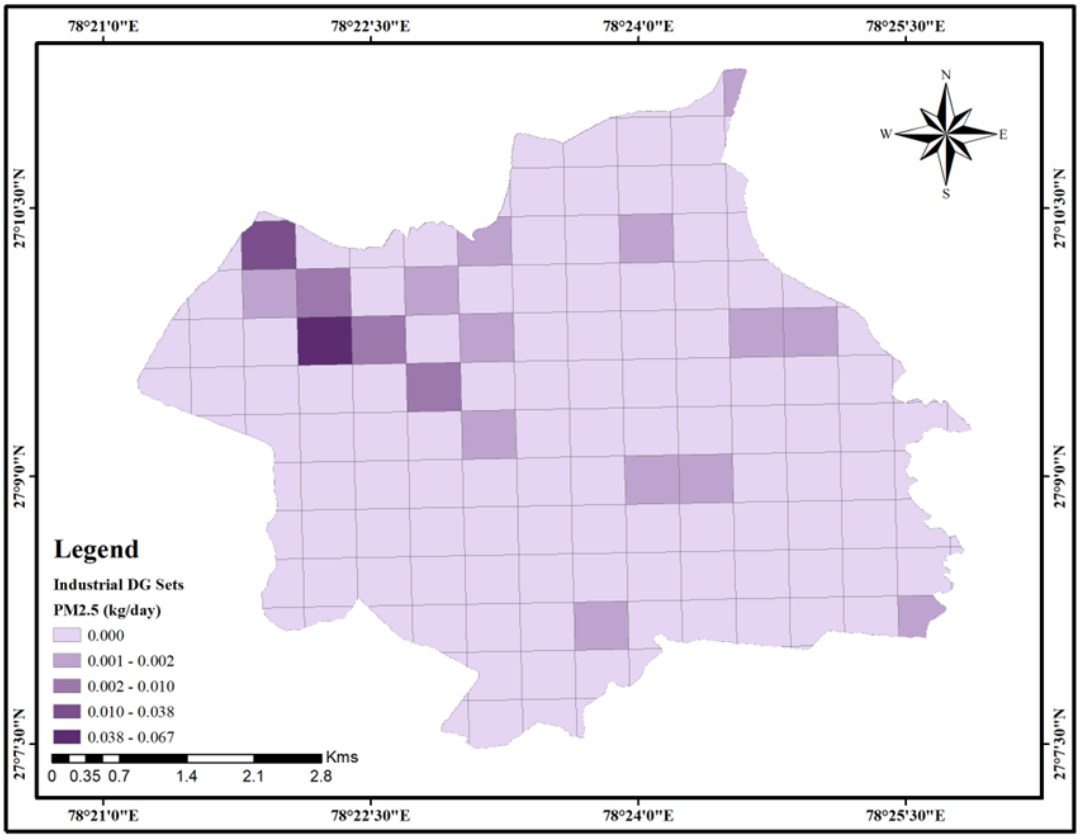


Figure 3.66: Spatial distribution of $PM_{2.5}$ emissions from industrial DG sets

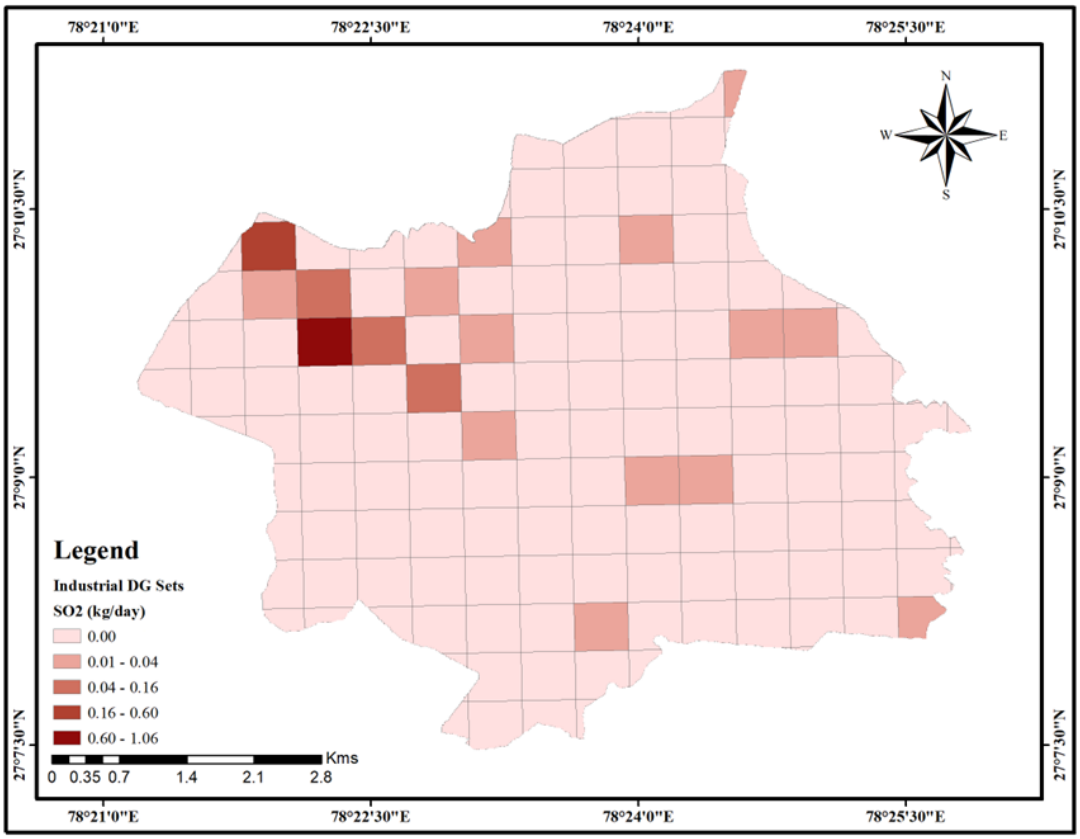


Figure 3.67: Spatial distribution of SO_2 emissions from industrial DG sets

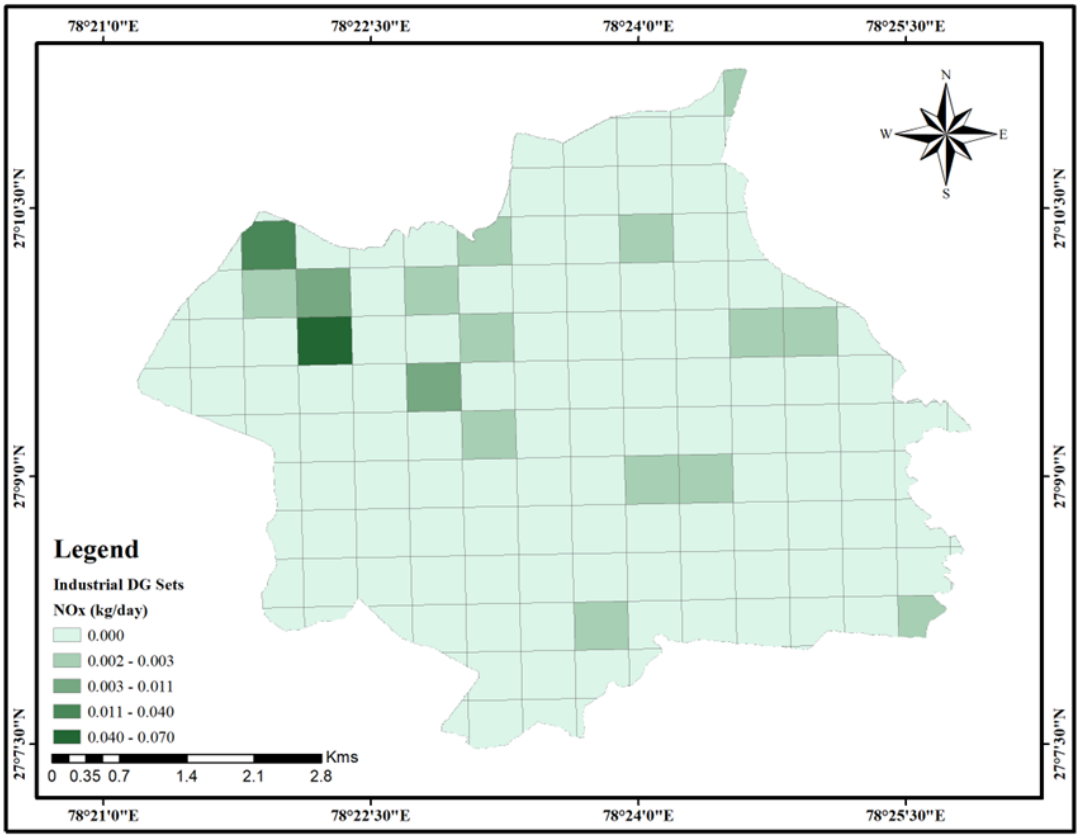


Figure 3.68: Spatial distribution of NO_x emissions from industrial DG sets

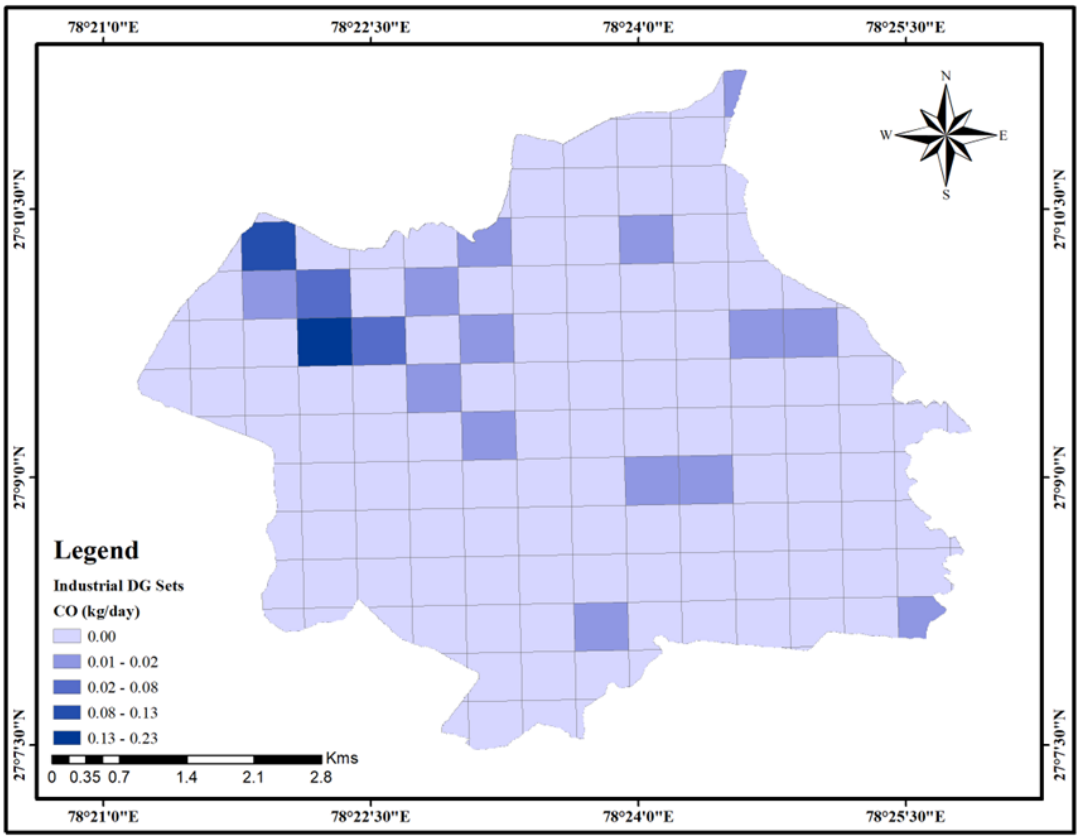


Figure 3.69: Spatial distribution of CO emissions from industrial DG sets

3.2.12 Parking Lot Survey

To obtain the prevalence of vehicle technology types operating in the city and fuel use, parking lot questionnaire surveys (engine technology and capacity, vehicle age, fuel use, etc.) were done at four locations (Karku Kothi Tiraha, Jain Temple Tiraha, Shanti Road Chauraha, and New Bypass Chauraha) in the city of Firozabad. ARAI (2011) and CPCB (2011) emission factors were used to calculate vehicle emissions. Figure 3.70 to Figure 3.72 present parking lane survey results for 2Ws, 3Ws, and 4Ws in terms of engine size and year of manufacturing. This information is vital in calculating the emission from vehicles on the road. The emission factors vary considerably for engine size, fuel use, and age of the vehicles.

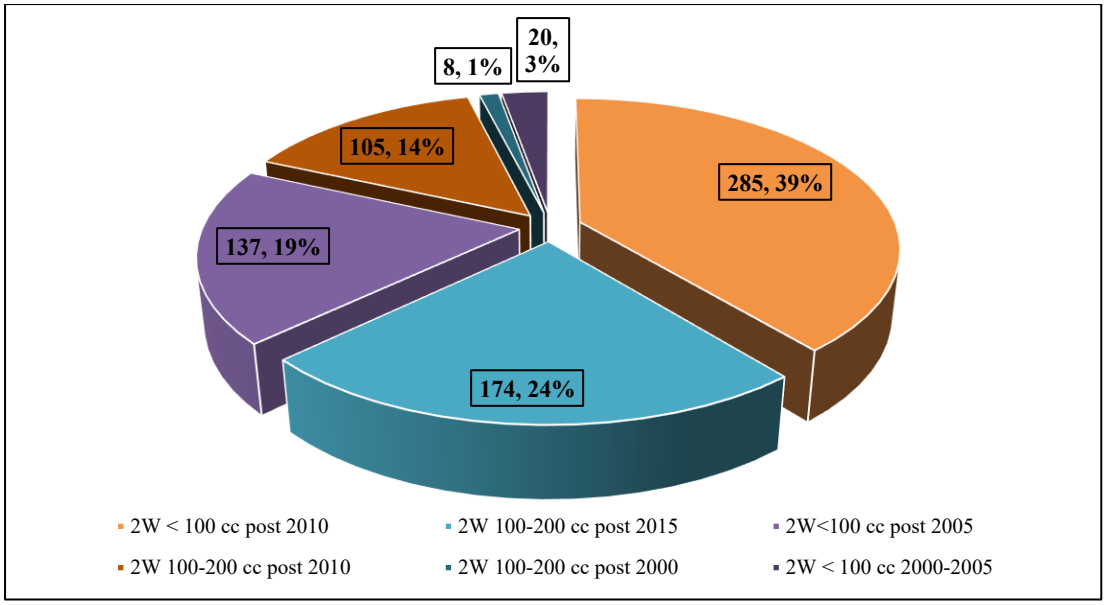


Figure 3.70: Distribution of 2-Ws in the study area (parking lot survey)

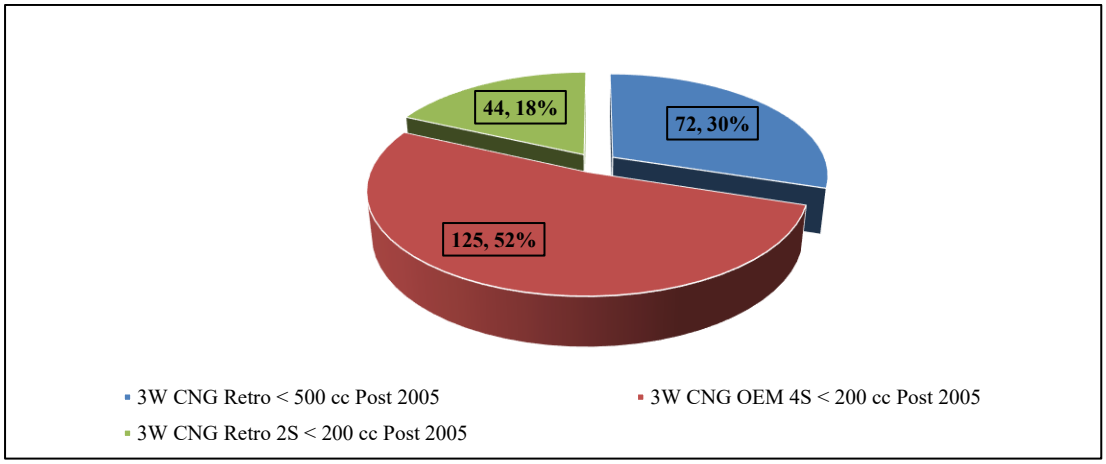


Figure 3.71: Distribution of 3-Ws in the study area (parking lot survey)

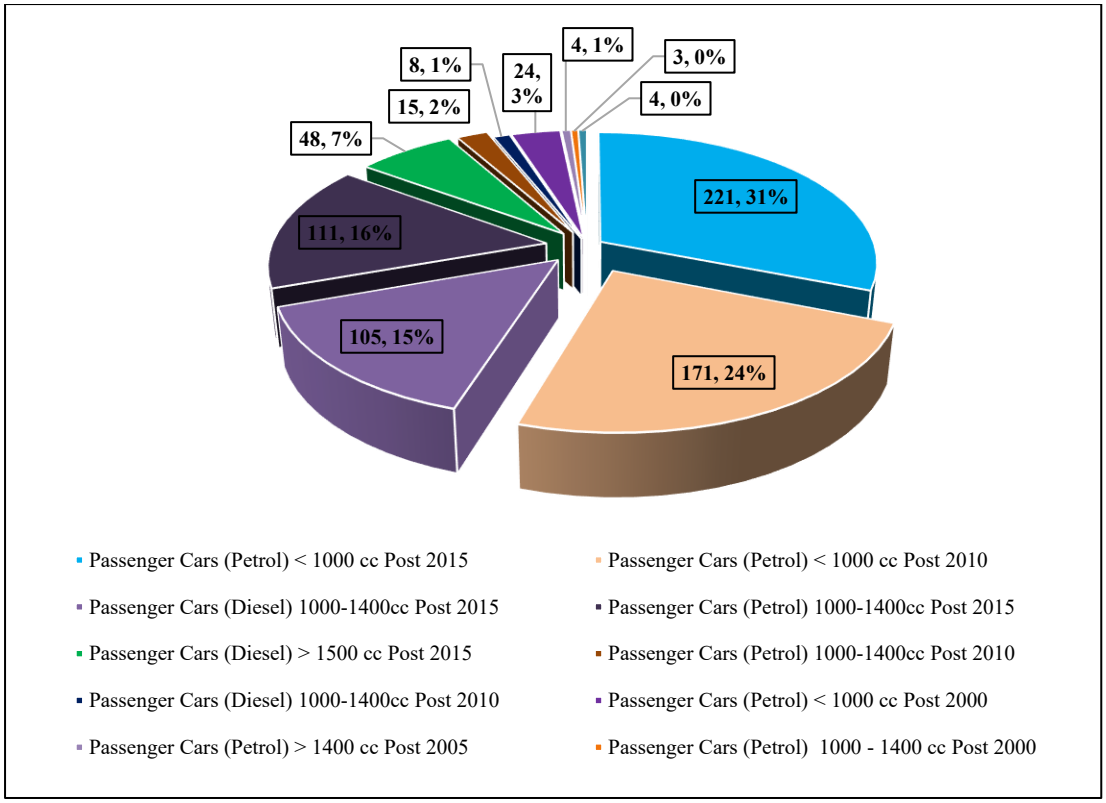


Figure 3.72: Distribution of 4-Ws in the study area (parking lot survey)

3.2.13 Vehicular-Line Sources

The average daily flow of vehicles in each hour for 2Ws, 3Ws, 4Ws, LCVs, buses, and trucks at seven locations was obtained by video recording (Figure 3.73). From these four locations (Karku Kothi Tiraha, Jain Temple Tiraha, Shanti Road Chauraha, and New Bypass Chauraha), the traffic data were extrapolated for the remaining grids. Road lengths in each grid for major and minor roads were calculated from the digitized maps using the ArcGIS tool, ArcMap, and extracted into the grids. The traffic counts were translated into the vehicles (and their types) on the roads in each grid (Nagar et. al. 2019). Wherever it was feasible, either traffic flow was taken directly from the traffic data. For interior grids, traffic from medium roads going the highways was taken to flow in the interior part of the city. The emissions from each vehicle category for each grid are estimated and summed up.

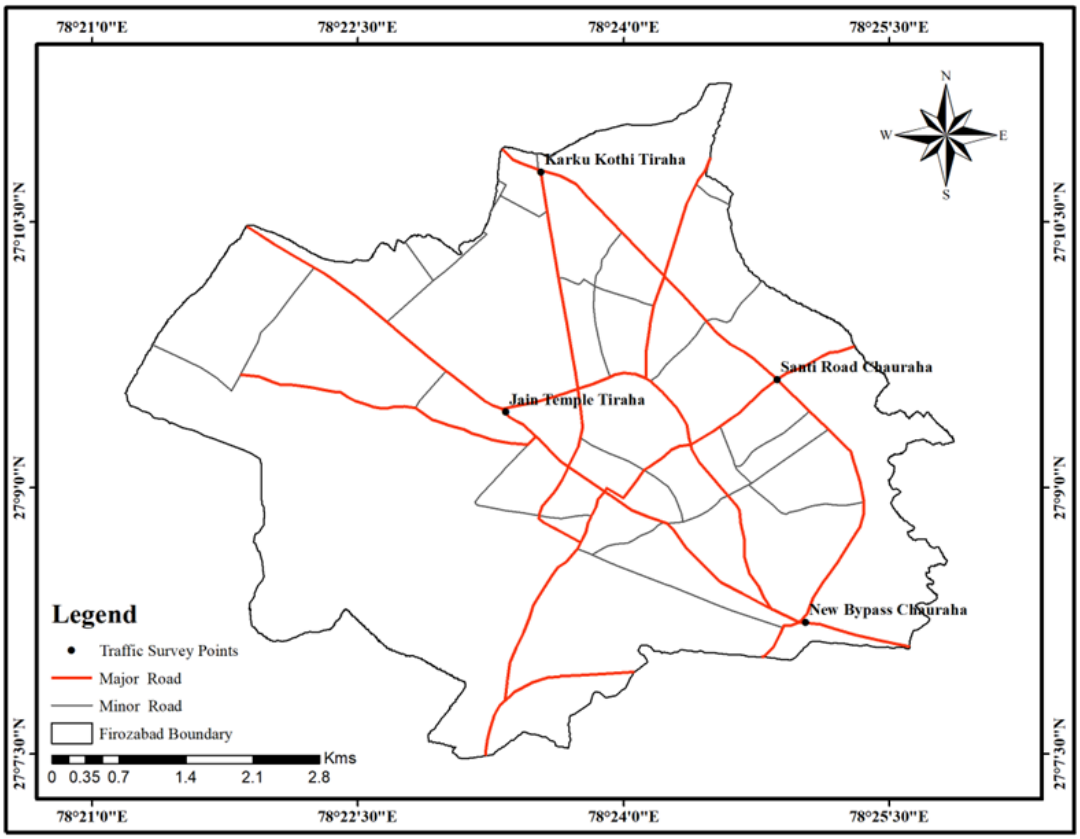


Figure 3.73: Location of traffic survey points in Firozabad city

The emissions from railway locomotives are not taken into consideration, as the emissions are negligible in comparison with the vehicles and other sources. The emission from vehicles is shown in Figure 3.74.

The emission contribution of each vehicle type in Firozabad is presented in Figure 3.75 to Figure 3.79. The spatial distribution of emissions from vehicles is presented in Figure 3.80 to Figure 3.84.

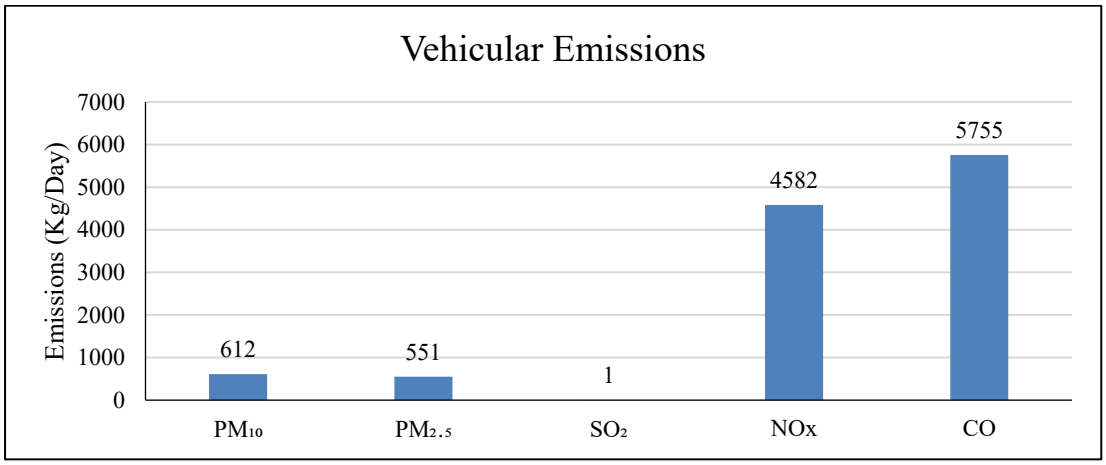


Figure 3.74: Emission load from vehicles (kg/d)

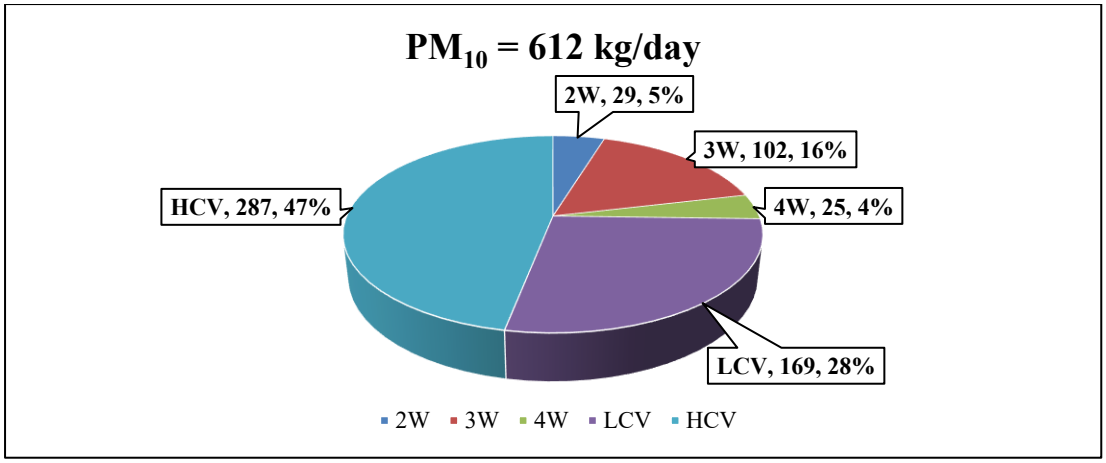


Figure 3.75: PM_{10} Emission load contribution of each vehicle type (kg/d)

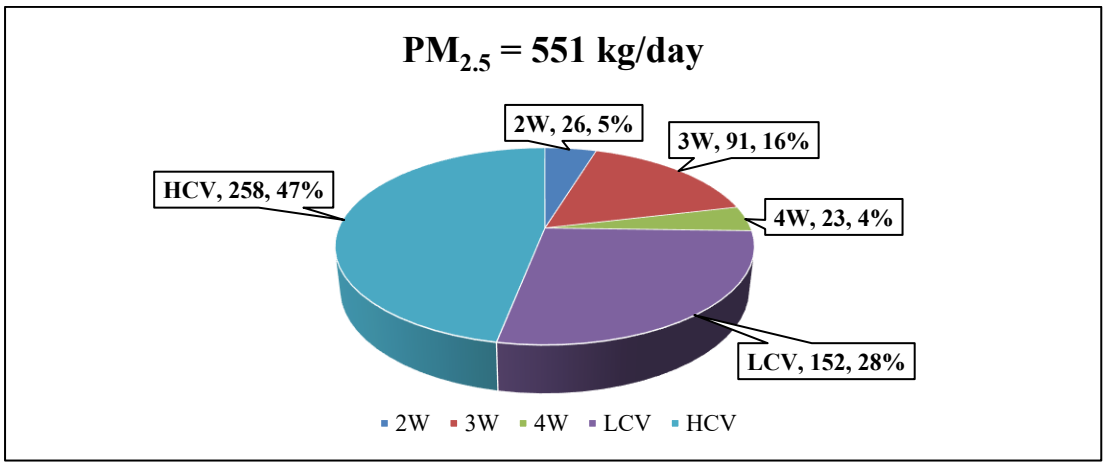


Figure 3.76: $PM_{2.5}$ Emission Load contribution of each vehicle type (kg/d)

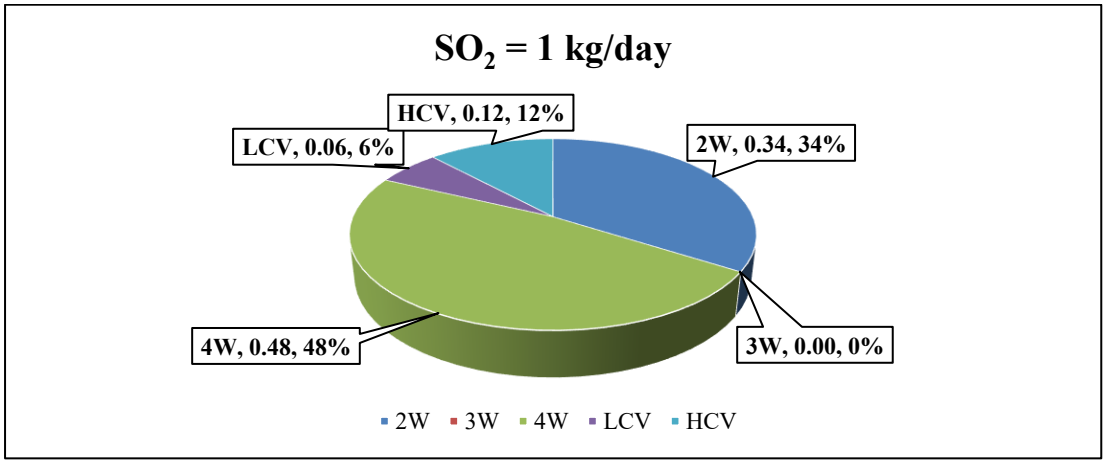


Figure 3.77: SO_2 Emission load contribution of each vehicle type (kg/d)

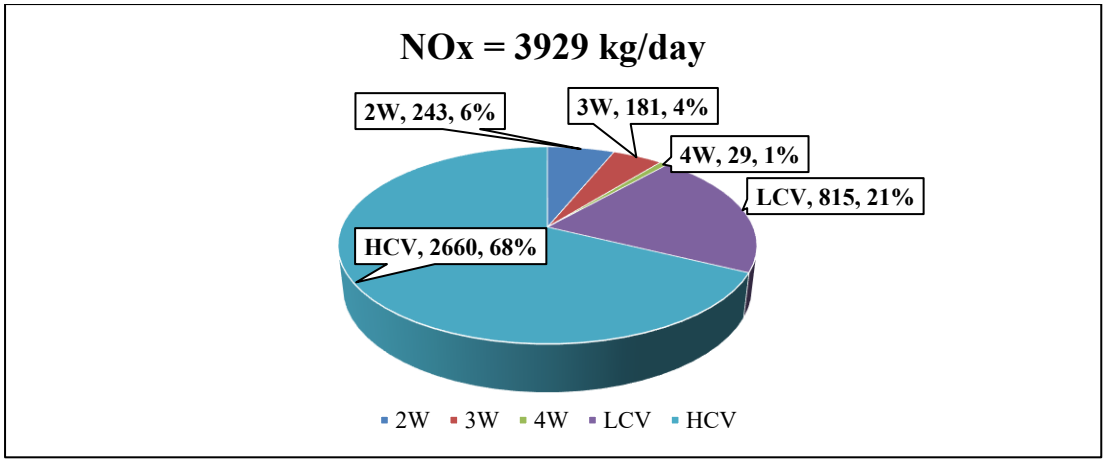


Figure 3.78: NO_x Emission load contribution of each vehicle type (kg/d)

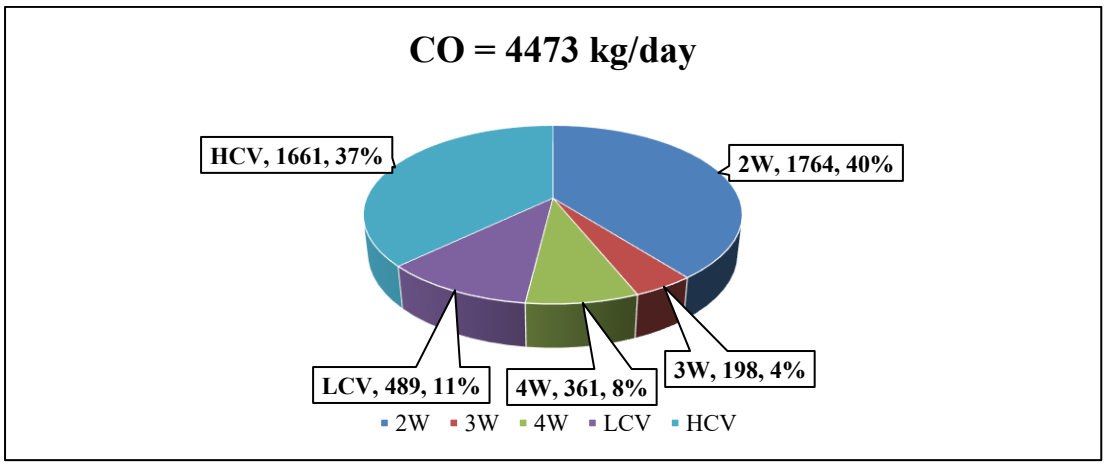


Figure 3.79: CO Emission load contribution of each vehicle type (kg/d)

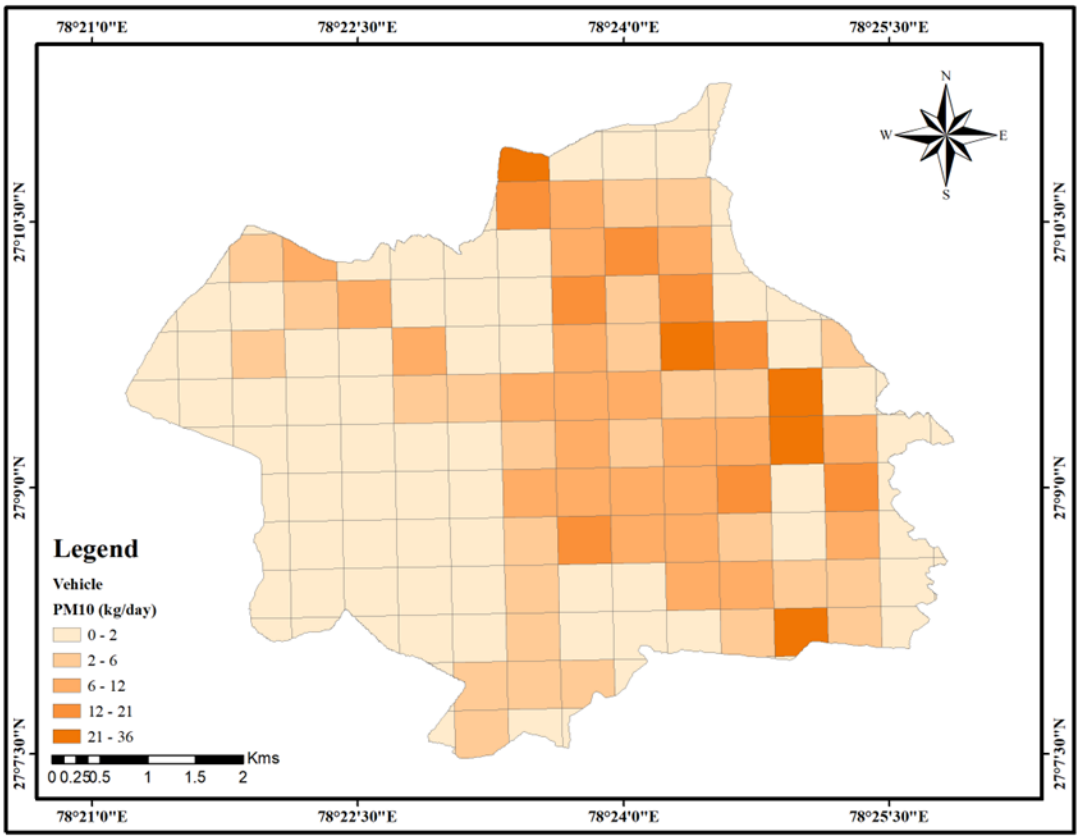


Figure 3.80: Spatial distribution of PM_{10} emissions from vehicles

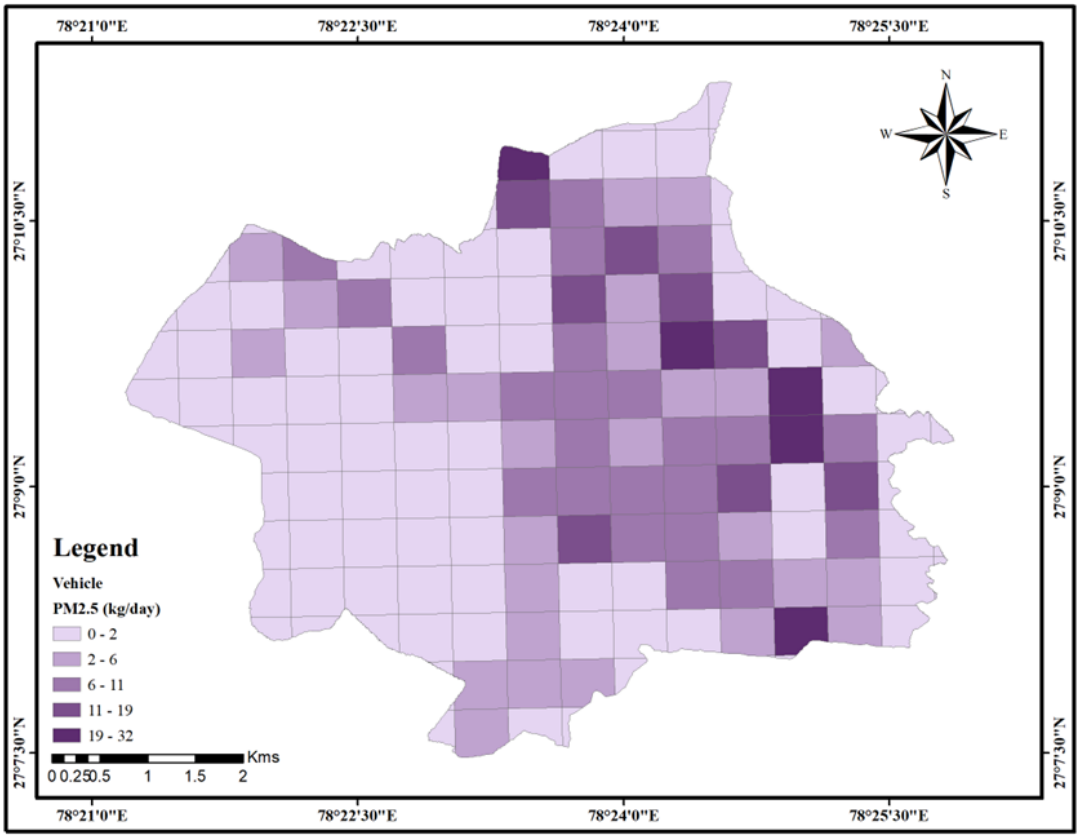


Figure 3.81: Spatial distribution of $PM_{2.5}$ emissions from vehicles

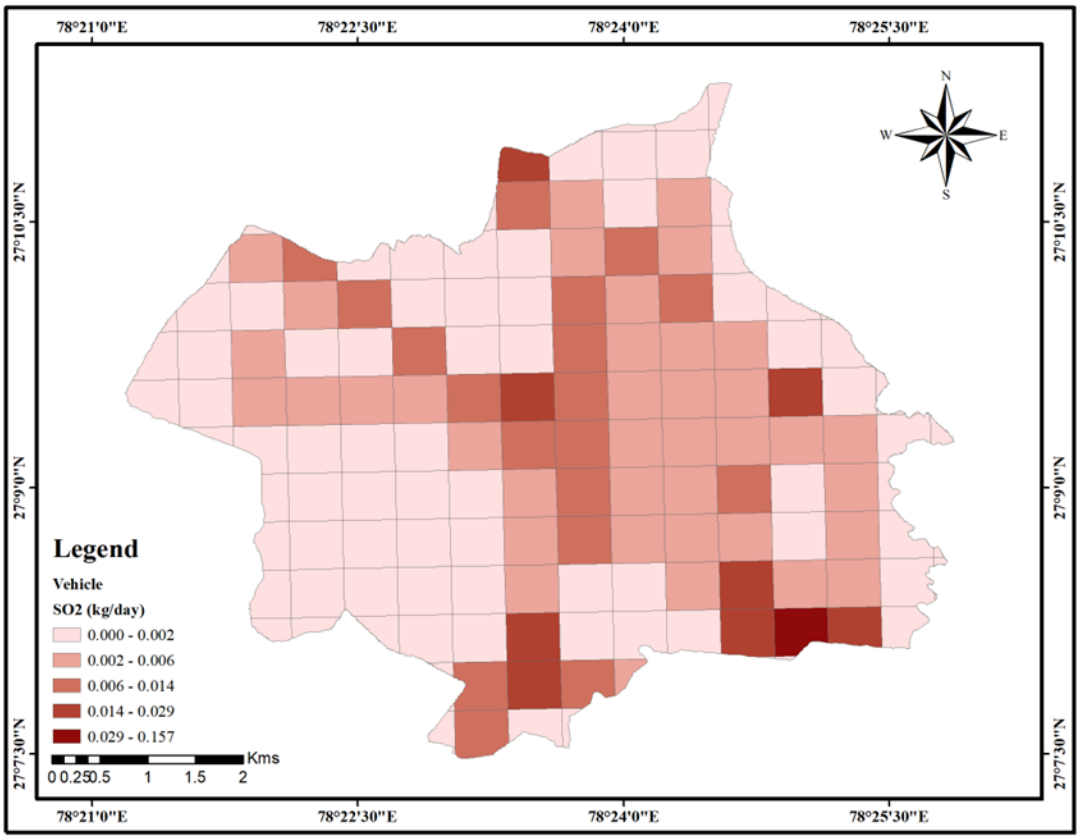


Figure 3.82: Spatial distribution of SO_2 emissions from vehicles

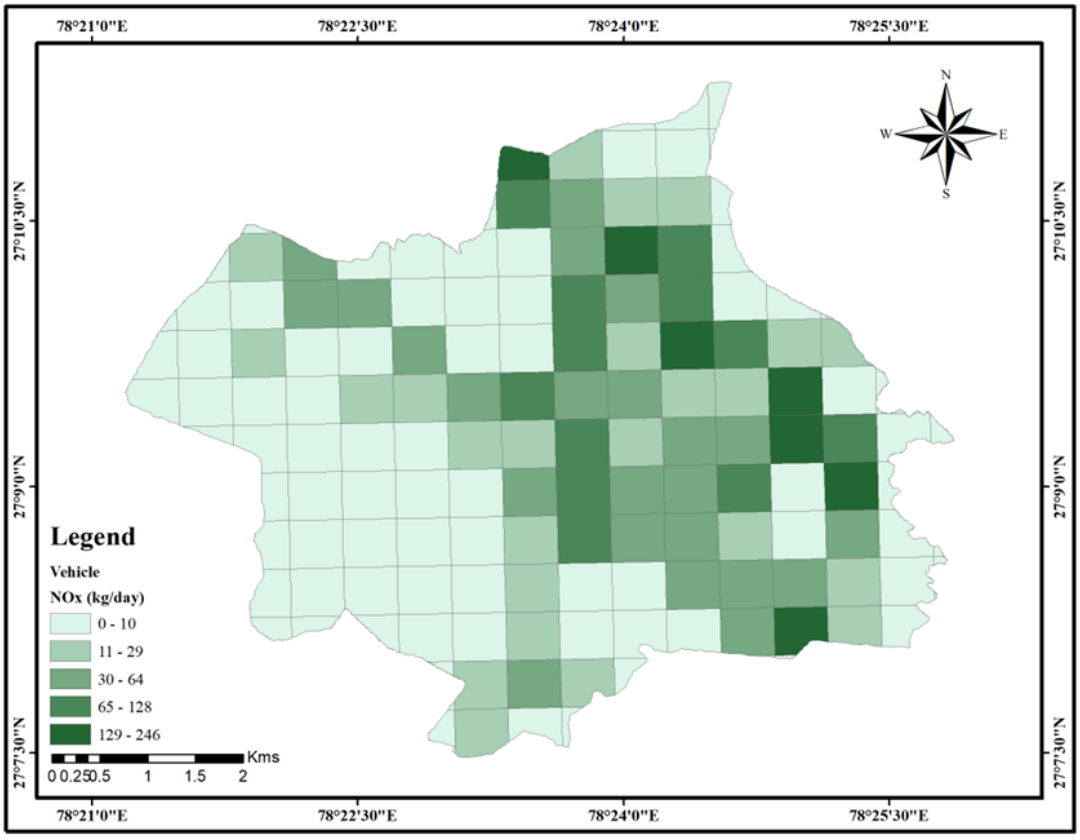


Figure 3.83: Spatial distribution of NO_x emissions from vehicles

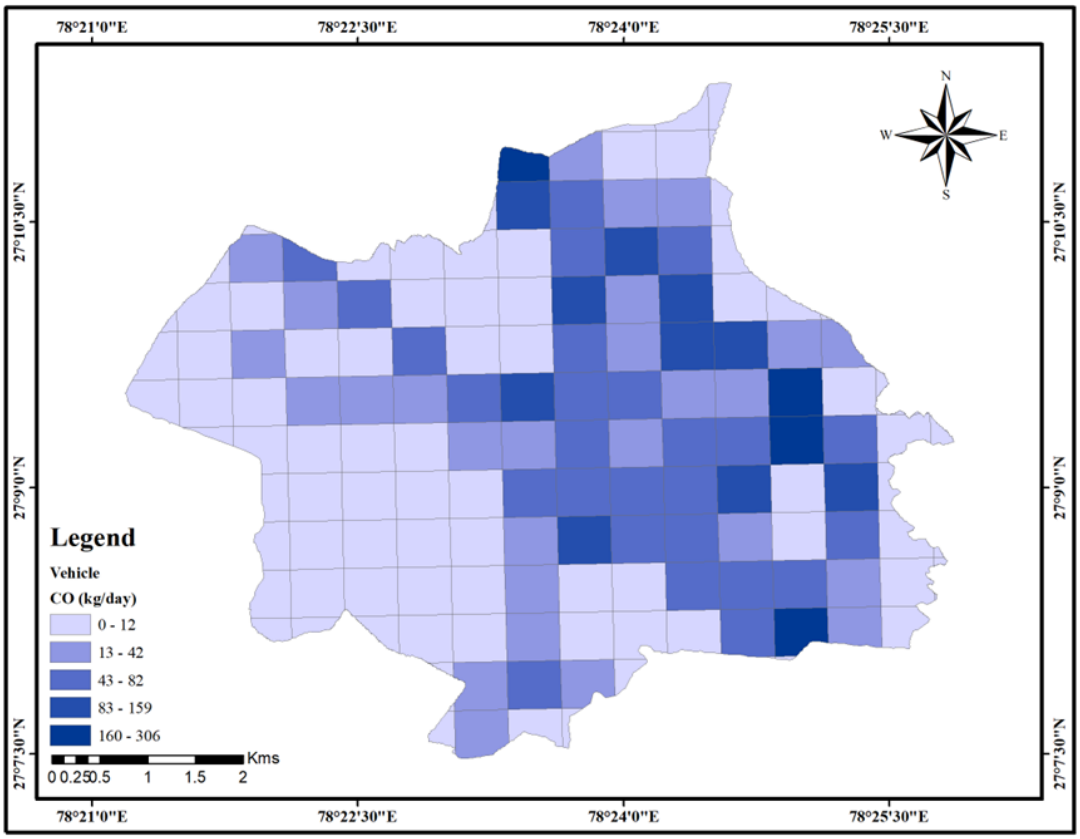


Figure 3.84: Spatial distribution of CO emissions from vehicles

3.2.14 Traffic Congestion

Transportation infrastructure within Firozabad, however, has lagged behind the city's rapid population growth, and traffic jams have become common. Taxis, auto-rickshaws, e-rickshaws, private vehicles, and suburban bus and rail services provide local transport. Firozabad is facing the problem of regulating inter-city traffic and city traffic, including encroachment on the city and major highways. Due to the heterogeneous composition of Autos, Tempos, Rickshaws, Cycles, two-wheelers, cars, and other small goods vehicles, traffic movement is very slow.

The typical Traffic conditions at different locations in Firozabad are given in Figure 3.85. The figure depicts the traffic report of Firozabad for four traffic hotspots of the city for the 7 days of the week.

The colour coding used here is Red, Orange, and Green, indicating the slow traffic to fast traffic movement. Jain Temple Tiraha and New Bypass Chauraha have been seeing most of the traffic in the morning span in the weekdays, resulting in most of the people accessing roads for the conveyance to their respective working spaces.

Table 3.3: Major traffic bottleneck points

Karku Kothi Tiraha	Jain Temple Tiraha
Shanti Road Chauraha	New Bypass Chauraha

S. No.	Day	Karku Kothi	New BgPass Chauraha	Jain Temple	Santi Road
1	Sunday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm
2	Monday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm
3	Tuesday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm
4	Wednesday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm
5	Thursday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm
6	Friday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm
7	Saturday	8am-10am	8am-10am	8am-10am	8am-10am
		10am-12pm	10am-12pm	10am-12pm	10am-12pm
		12pm-2pm	12pm-2pm	12pm-2pm	12pm-2pm
		2pm-4pm	2pm-4pm	2pm-4pm	2pm-4pm
		4pm-6pm	4pm-6pm	4pm-6pm	4pm-6pm
		6pm-8pm	6pm-8pm	6pm-8pm	6pm-8pm

Figure 3.85: Typical traffic conditions at different locations in Firozabad city

Green = smooth traffic
Orange = slow-moving traffic
Red = Heavy traffic with congestion

3.2.15 Paved and Unpaved Road Dust

Dust emissions from paved and unpaved roads have been found that vary with the 'silt loading' present on the road surface and the average weight of vehicles traveling on the road. 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. The quantity of dust emissions from the movement of vehicles on a paved or unpaved road can be estimated using the following empirical expression:

$$E = \frac{\left[k\left(\frac{sL}{2}\right)^{0.65} \times \left(\frac{W}{3}\right)^{1.5} \times VKT\right]}{1000} \quad \text{..... Equation 4}$$

Where;

E = emission from road dust (kg/d)

VKT = vehicle kilometer travel

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

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

k = constant (a function of particle size) in g VKT^{-1} (vehicle kilometer travel)

The road dust sampling was carried out at seven locations (Figure 3.86). The silt loads (sL) sampling as an example, is shown for two locations (Figure 3.87). Then mean weight of the vehicle fleet (W) was estimated by giving the weightage to the percentage of vehicles of all types with their weight, then the emission rate (g VKT^{-1}) was calculated. The emission loads from paved and unpaved roads were calculated using equation 4 and shown in Figure 3.89. The spatial distribution of Emissions from Road Dust Re-suspension is presented in Figure 3.90 and Figure 3.91.

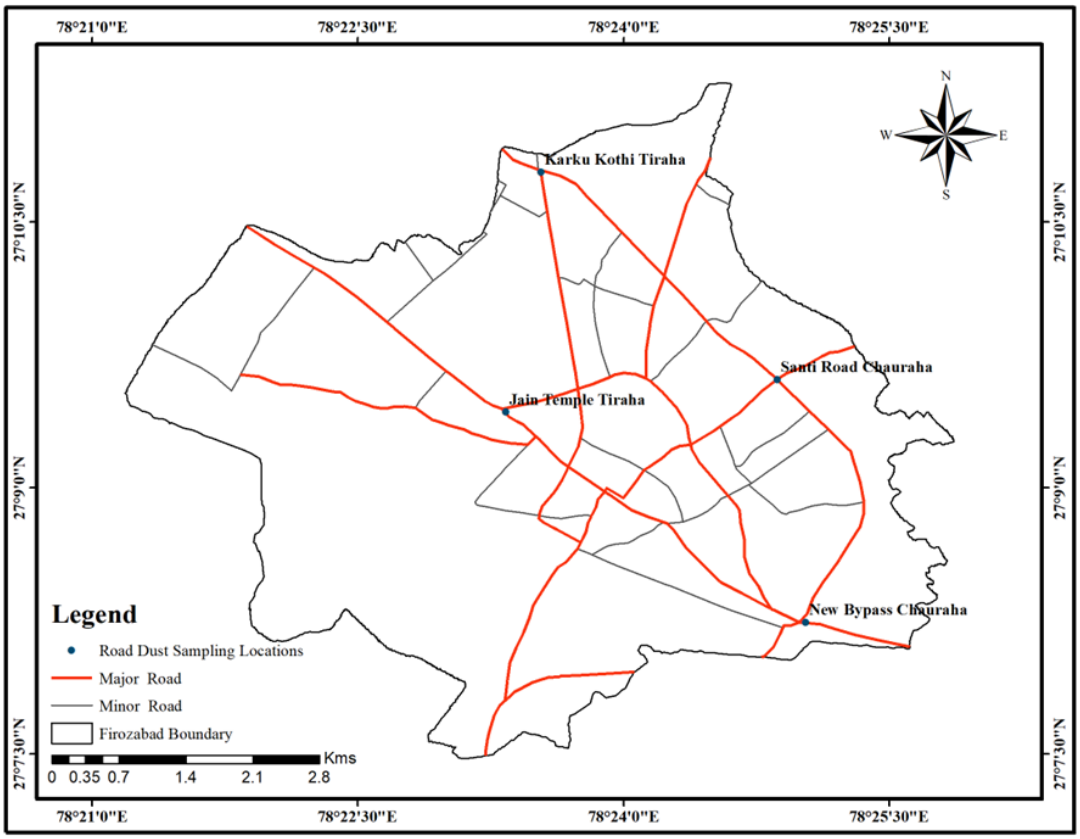


Figure 3.86: Road dust sampling locations

Figure 3.87: Road dust sampling in the city of Firozabad

Figure 3.88: Road dust deposition on the road

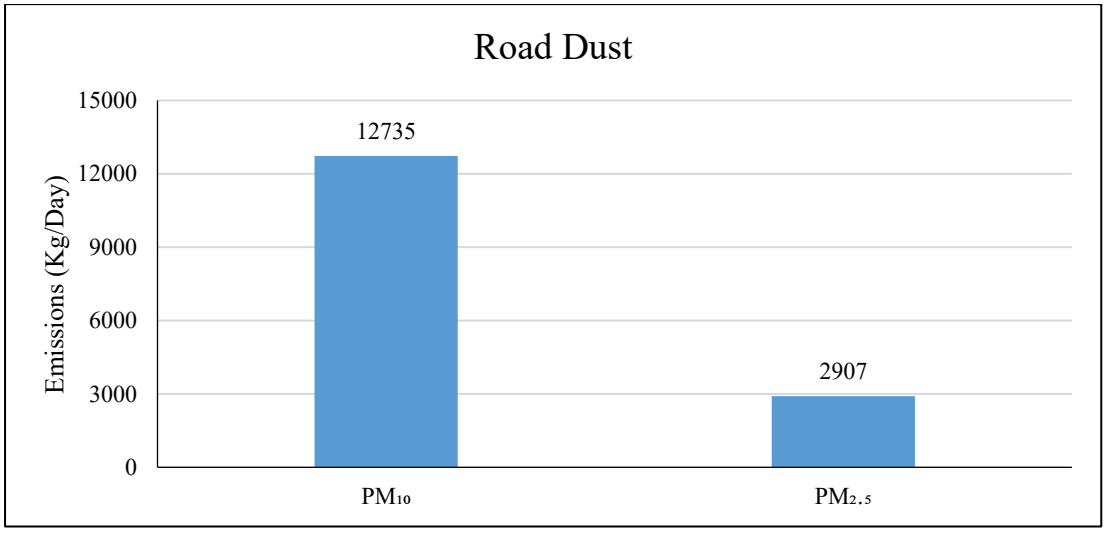


Figure 3.89: Emissions from road dust in Firozabad (Kg/d)

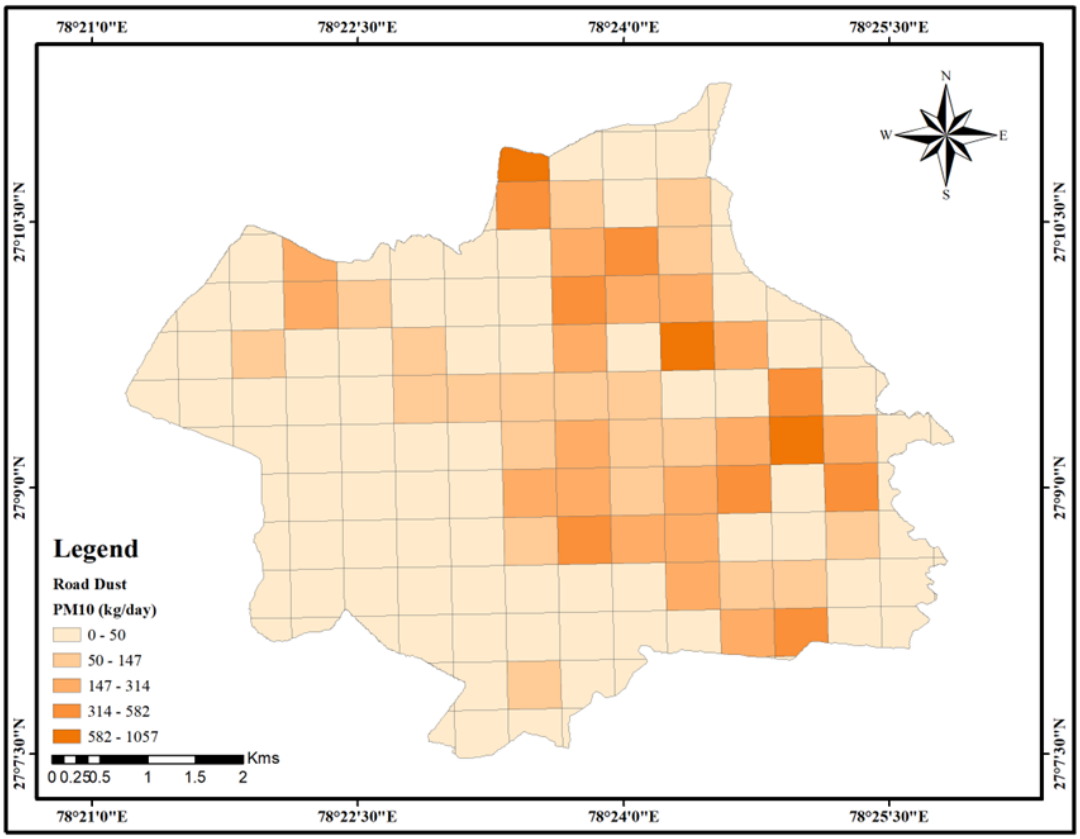


Figure 3.90: Spatial distribution of PM_{10} emissions from road dust re-suspension

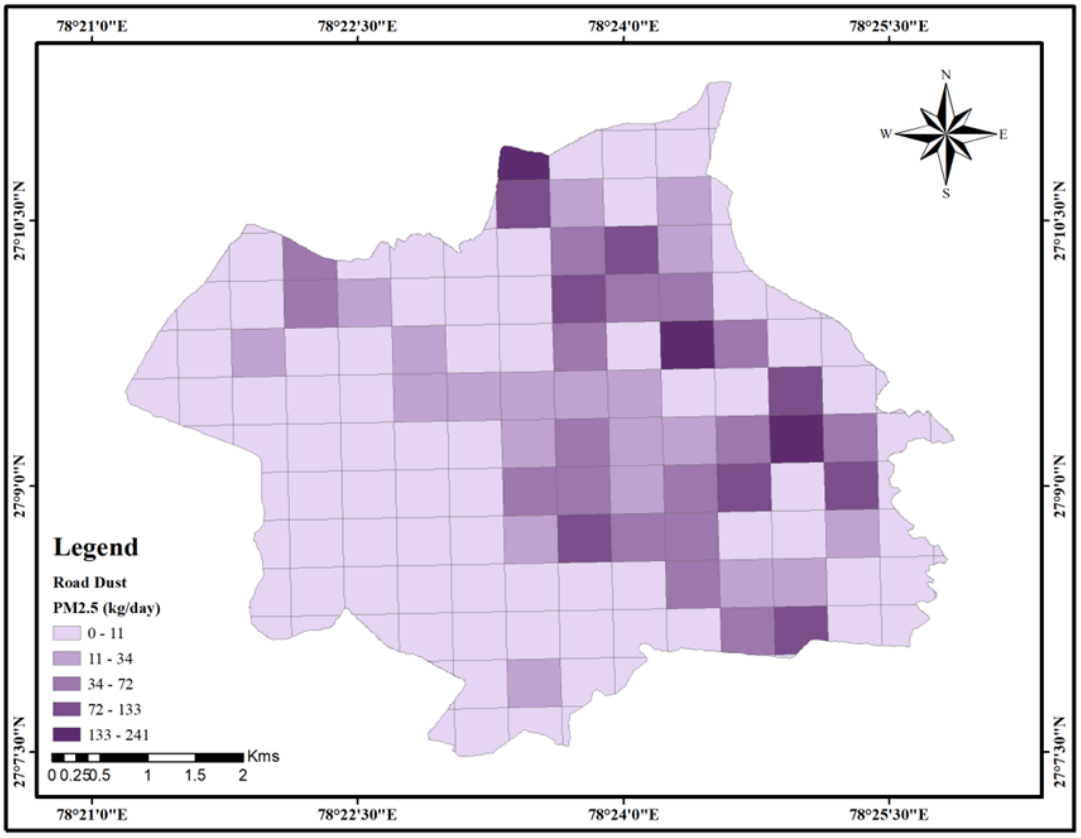


Figure 3.91: Spatial distribution of $PM_{2.5}$ emissions from road dust re-suspension

3.2.16 Brick Kilns

Brick kilns are one of the air-polluting sources. It is important to cover this sector in terms of emissions, although most of the brick kilns lie outside the city boundary apart from four, which lie inside of the city boundary (Figure 3.92). These brick kiln affects the local air quality of the city. A detailed survey was conducted by the IITK team and activity data were collected (Figure 3.3: Firozabad wards and city boundary). These kilns use wood and coal as fuel. The emissions of various parameters such as PM_{10}, $PM_{2.5}$, SO_2, NOx, and CO were estimated from the activity data from each fuel type and then summed up in each grid cell. The emission factors given by CPCB (2011) were used. The overall emission from brick kilns is shown in Figure 3.93. The spatial distribution of Brick Kilns with respect to the Firozabad city boundary is given in Figure 3.94 to Figure 3.98.

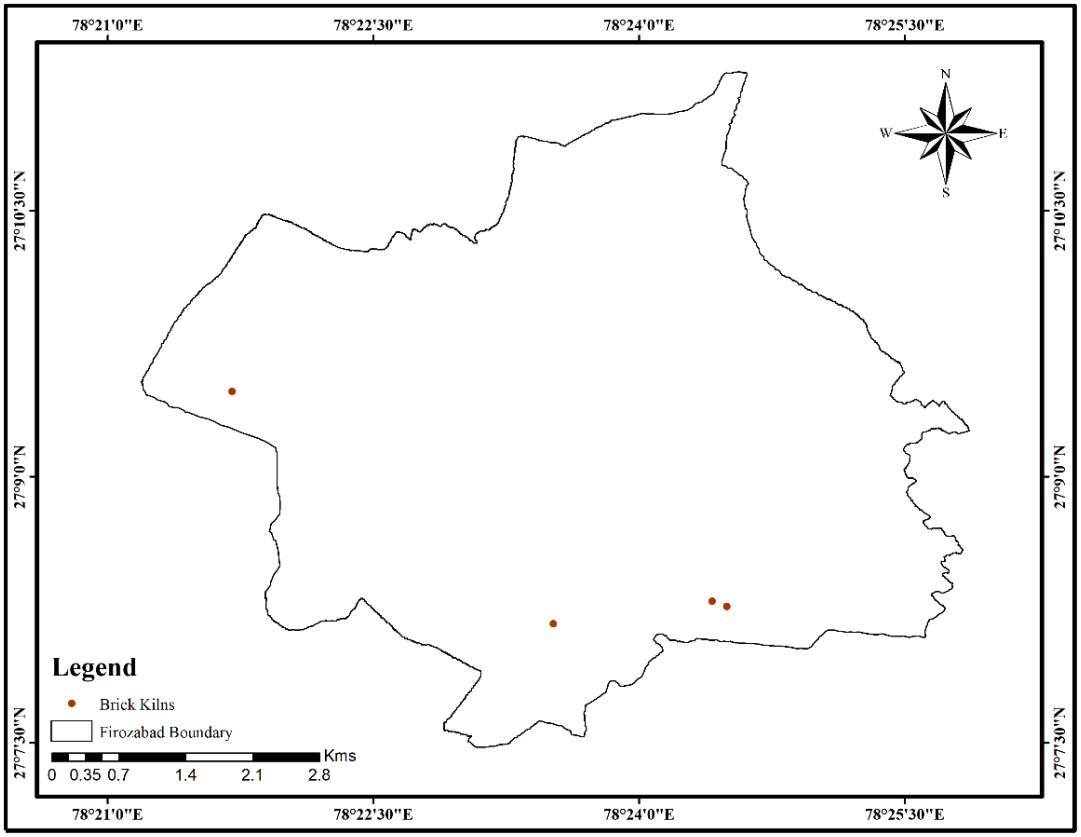


Figure 3.92: Location of Brick kilns in Firozabad

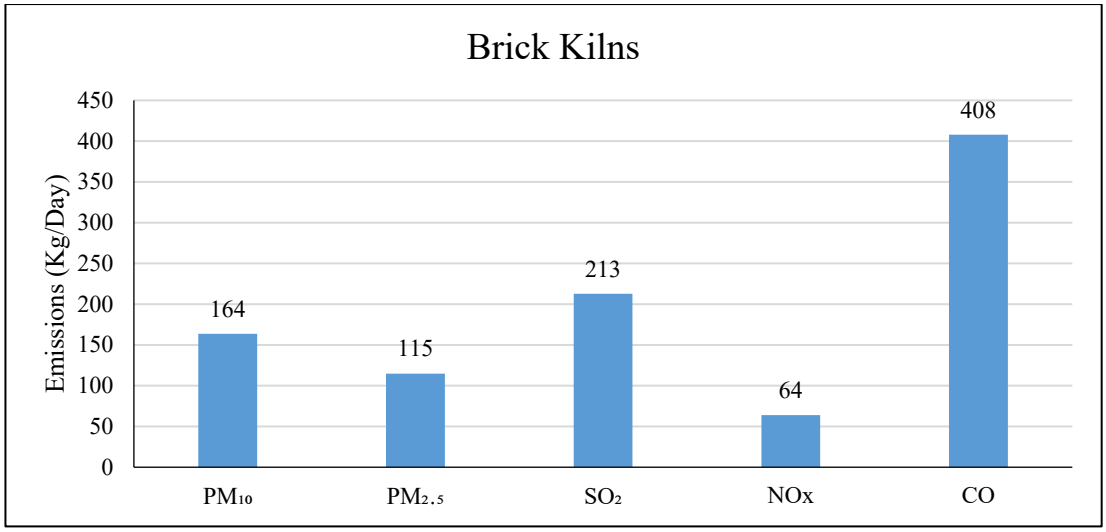


Figure 3.93: Emission Load from Brick kilns (kg/day)

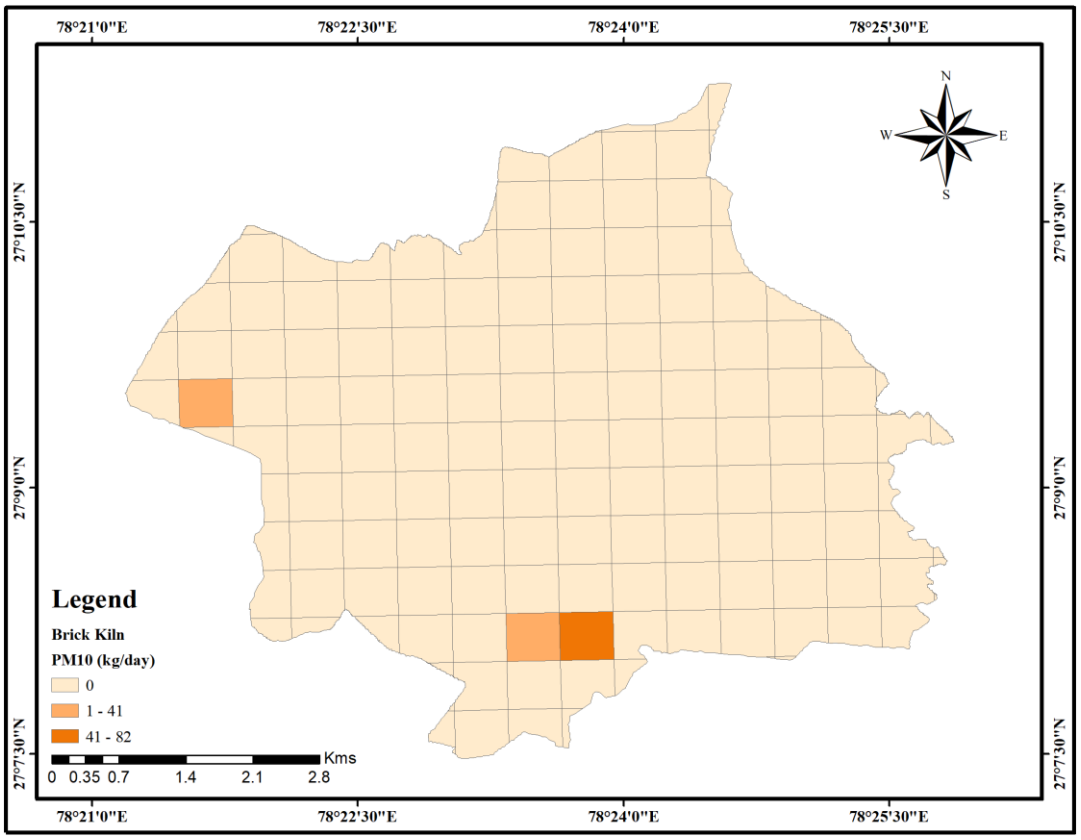


Figure 3.94: Spatial Distribution of PM10 Emissions from Brick Kilns

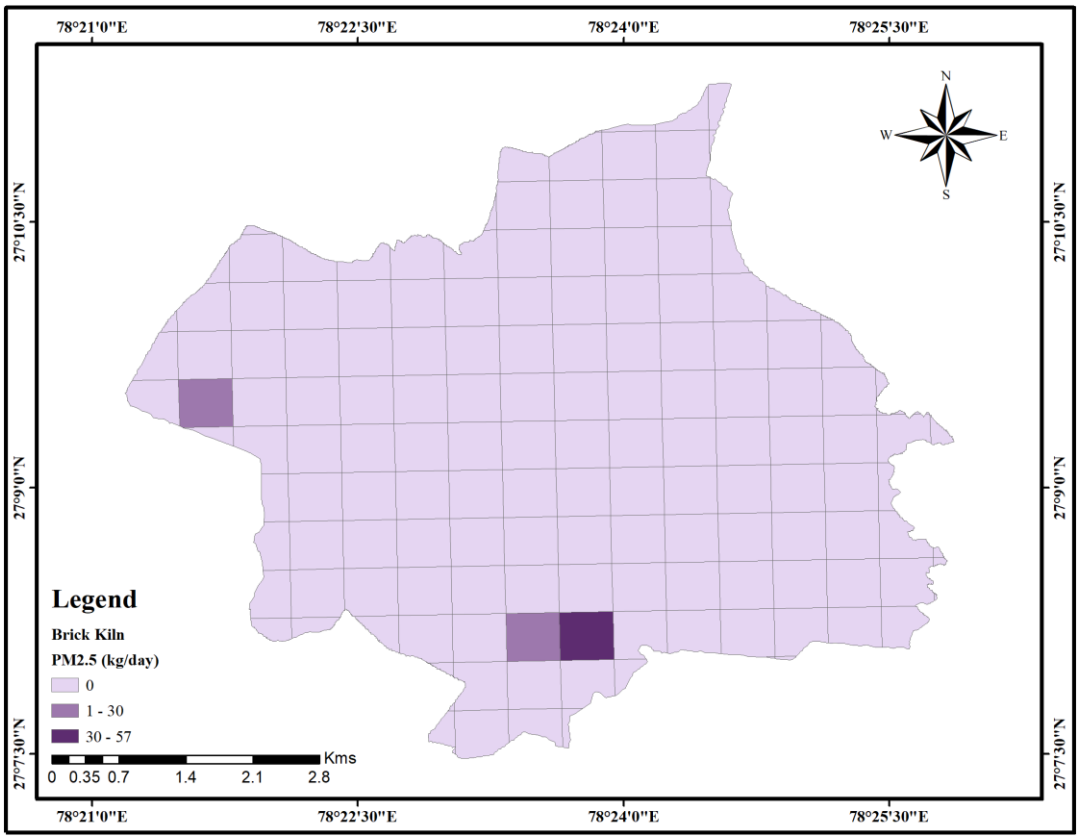


Figure 3.95: Spatial Distribution of PM2.5 Emissions from Brick Kilns

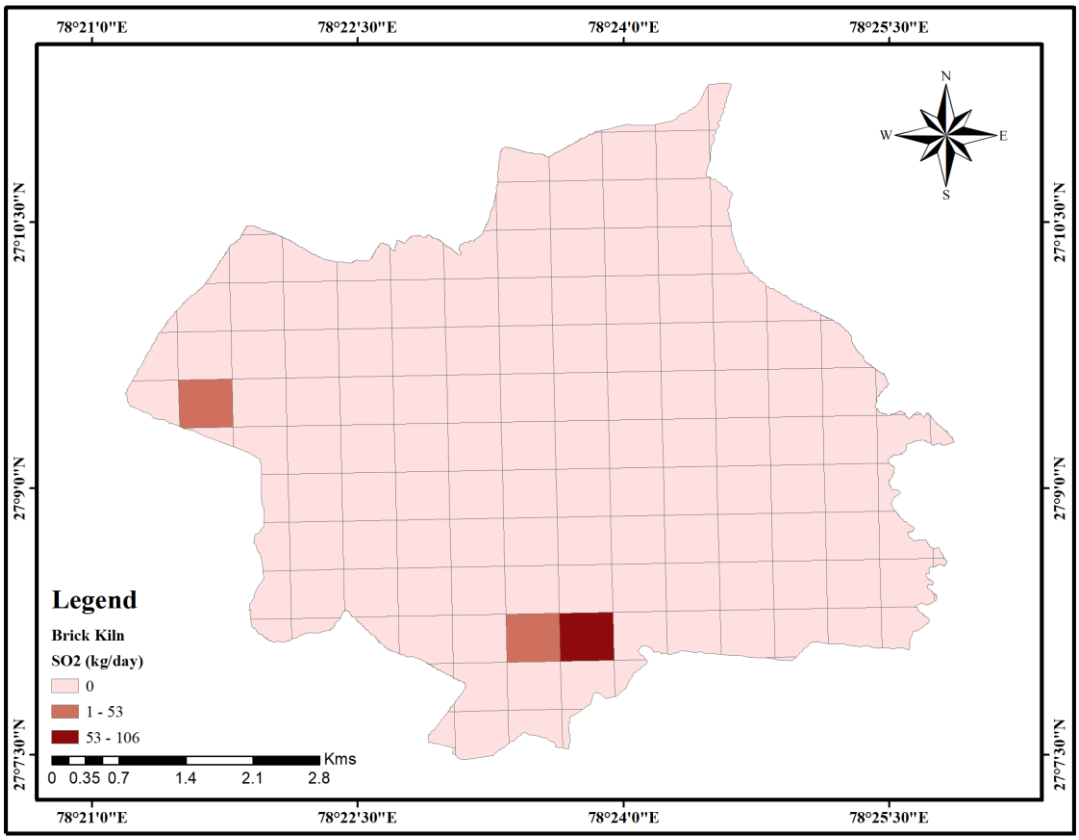


Figure 3.96: Spatial Distribution of SO2 Emissions from Brick Kilns

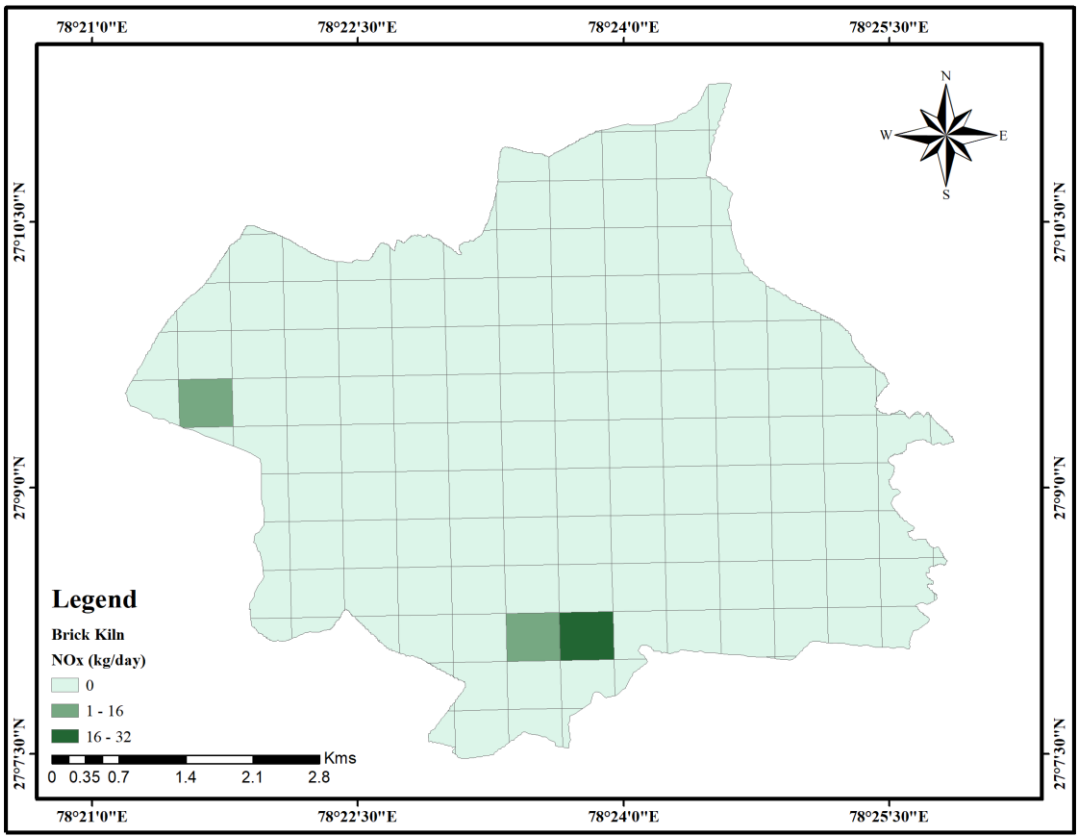


Figure 3.97: Spatial Distribution of NOx Emissions from Brick Kilns

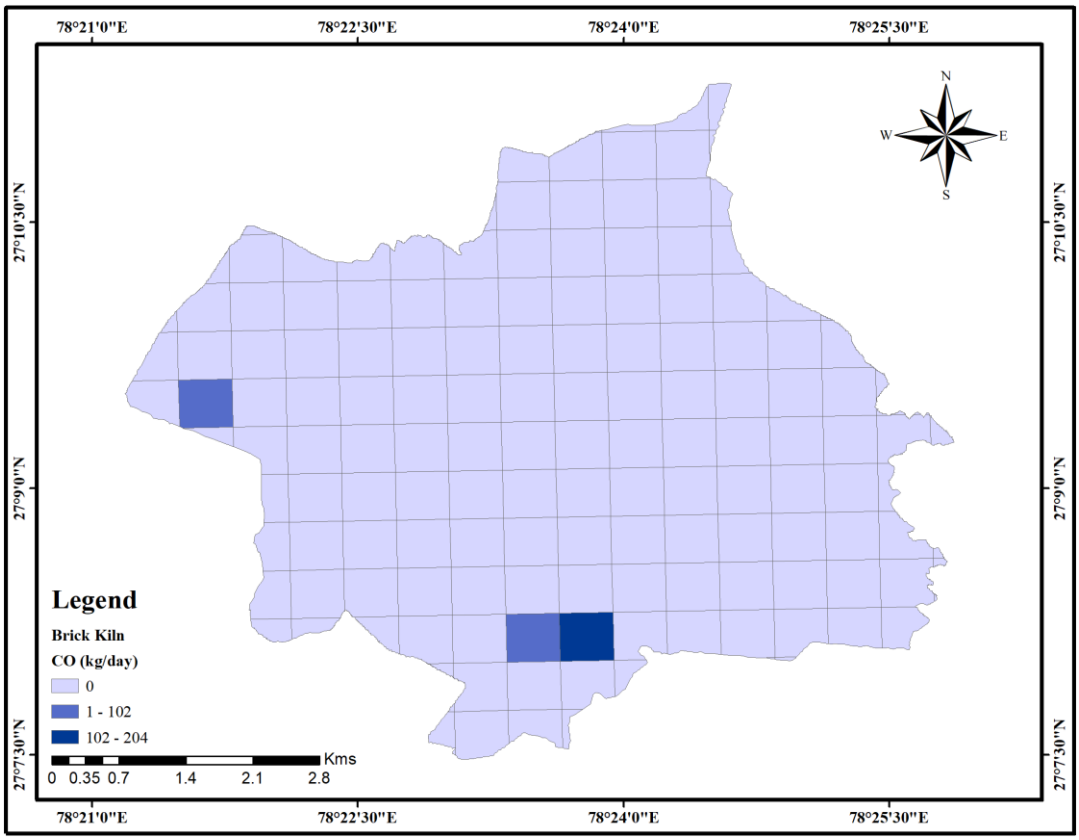


Figure 3.98: Spatial Distribution of CO Emissions from Brick Kilns

3.3 City-Level Emission Inventory

The overall baseline emission inventory for the entire Firozabad is presented in Table 3.4. The pollutant-wise contribution is shown in Figure 3.99 to Figure 3.103. The spatial distribution of pollutant emissions from all sources is illustrated in Figure 3.104 to Figure 3.108. The pollutant-wise gridded emissions are provided in Annexure 2.

Table 3.4: Firozabad city-level inventory (kg/d)

Sources	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO
Brick Kilns	164	115	213	64	408
Domestic	743	561	144	425	3157
MSW Burning	75	51	5	28	396
Hotels, Restaurants, GHs and BHs	186	97	123	68	326
Construction and Demolition	35	8			
Industrial DG Sets	0.2	0.1	0.1	2.2	0.5
Hospitals	0.04	0.03	0.03	0.53	0.11
Industries	137	137	1063	2545	1527
Vehicle	612	551	1	4582	5755
Road Dust	12735	2907			
Total	**14687**	**4427**	**1549**	**7717**	**11569**

The total PM_{10} emission load in the city is estimated to be 14687 kg/d. The top three contributors to PM_{10} emissions are Road Dust (87%), Domestic (5%), and Vehicles (4%); these are based on annual emissions. Seasonal and daily emissions could be highly variable. The estimated emission suggests that there are many important sources and a composite emission abatement including most of the sources was required to obtain the desired air quality.

$PM_{2.5}$ emission load in the city is estimated to be 4427 kg/d. The top three contributors to $PM_{2.5}$ emissions are Road Dust (66%), Domestic (13%) and Vehicles (12%); these are based on annual emissions. Seasonal and daily emissions could be highly variable.

SO_2 emission load in the city is estimated to be 1549 kg/d. Industries (69%), and Brick Kiln (14%) are the main sources of SO_2 contribution.

NO_x emissions load in the city is estimated to be 7717 kg/d. The major contributors to NO_x emissions vehicle (59%), Industries (33%), and Domestic (6%).

The estimated CO emission is about 11569 kg/day. The major contributors to CO emissions are Vehicles (50%), Domestic (27%), Industries (13%), and Brick Kilns (4%).

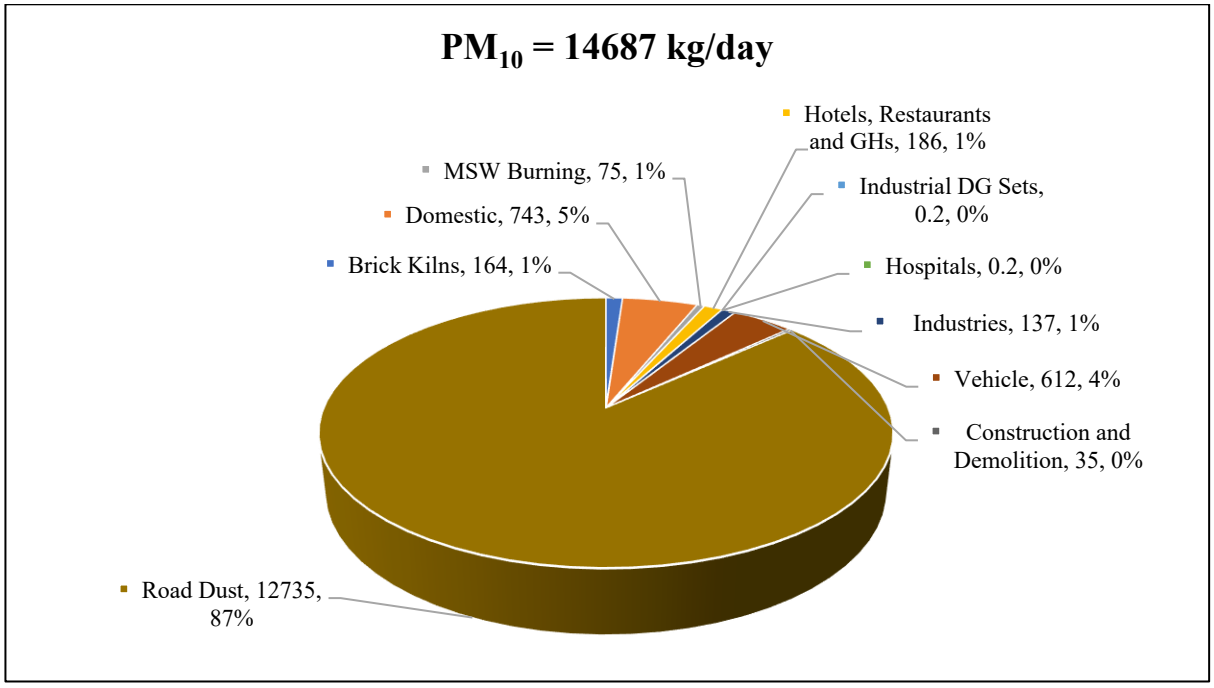


Figure 3.99: PM_{10} Emission load contribution of different sources

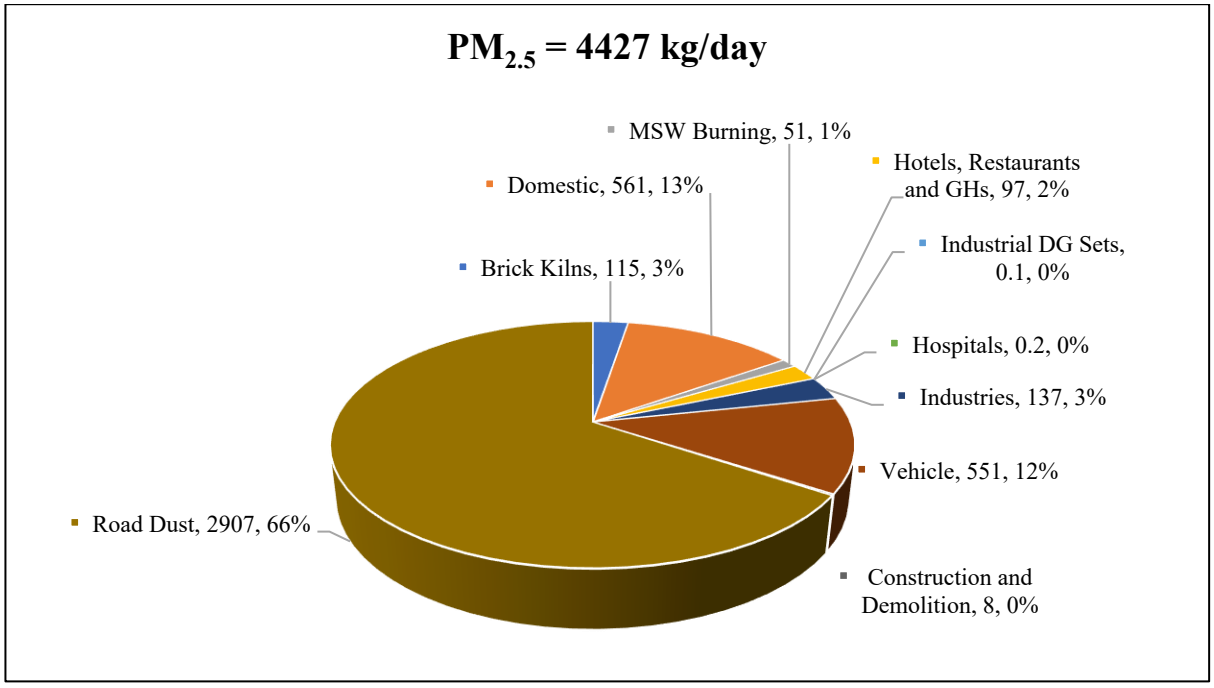


Figure 3.100: $PM_{2.5}$ Emission load contribution of different sources

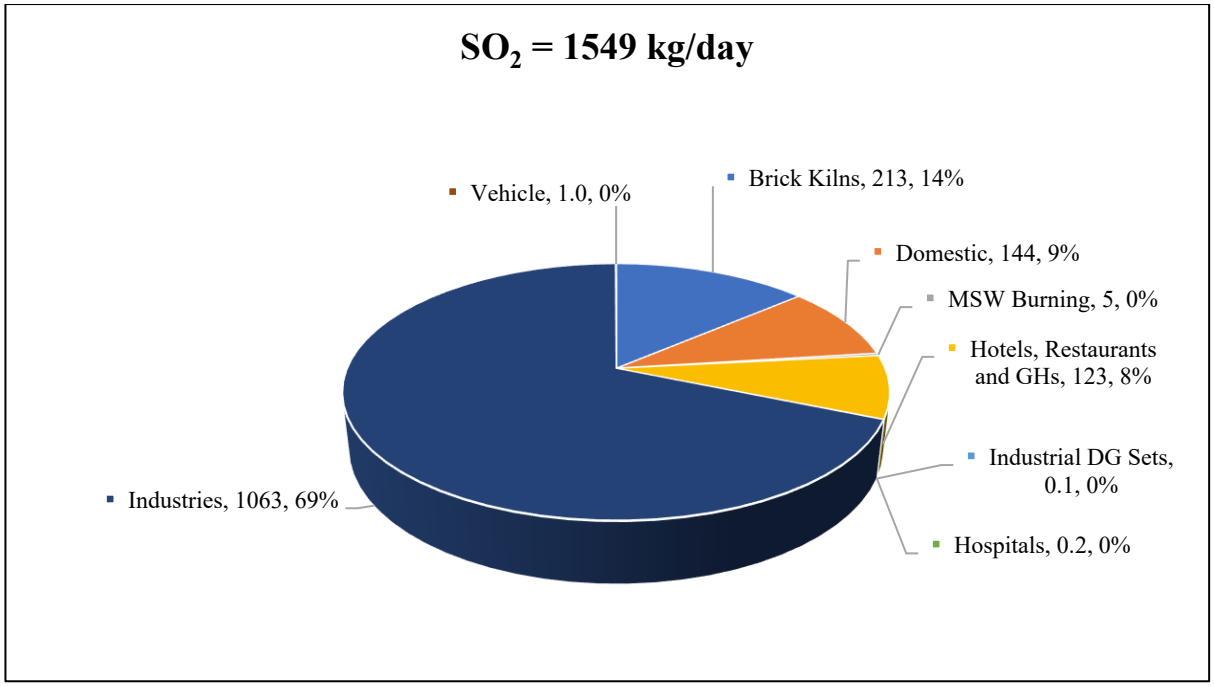


Figure 3.101: SO_2 Emission load contribution of different sources

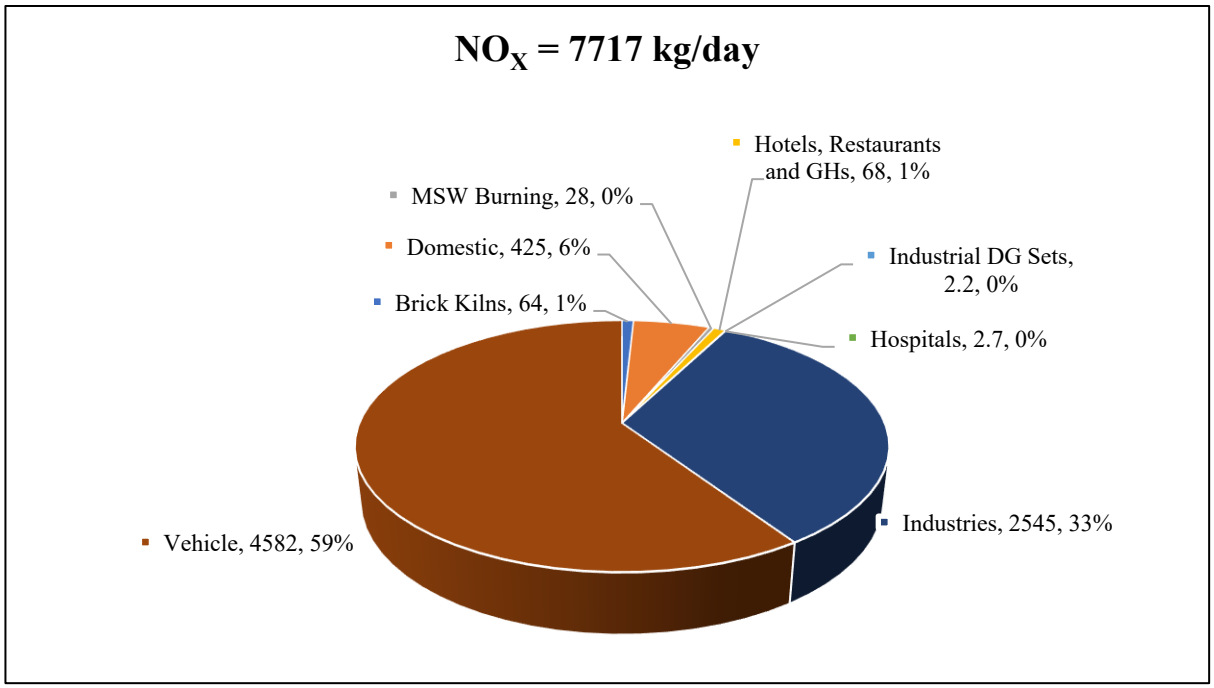


Figure 3.102: NO_x Emission load contribution of different sources

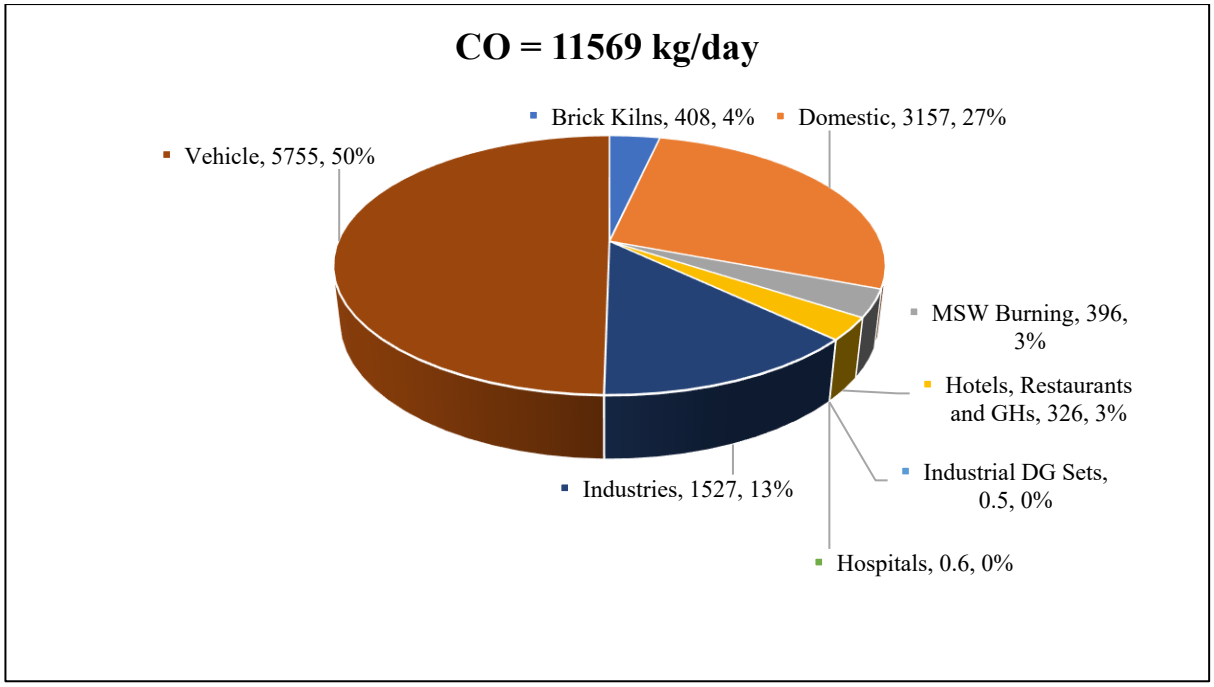


Figure 3.103: CO Emission load contribution of different sources

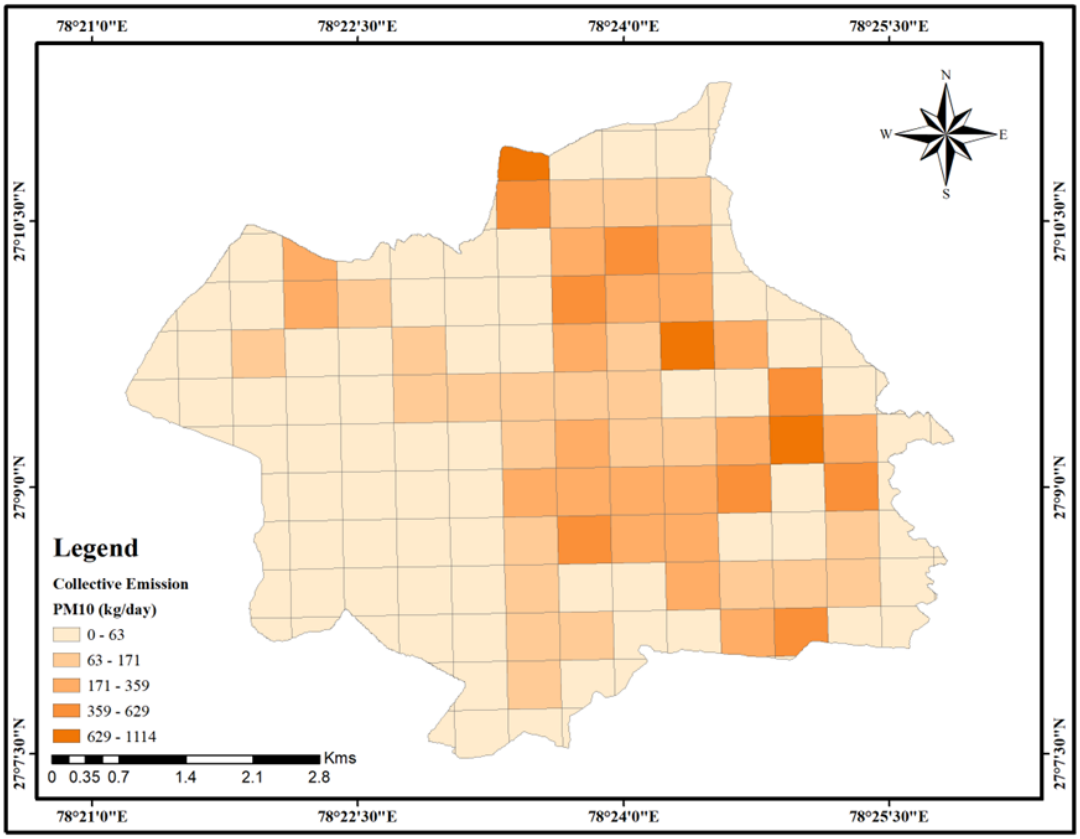


Figure 3.104: Spatial distribution of PM_{10} emissions in Firozabad

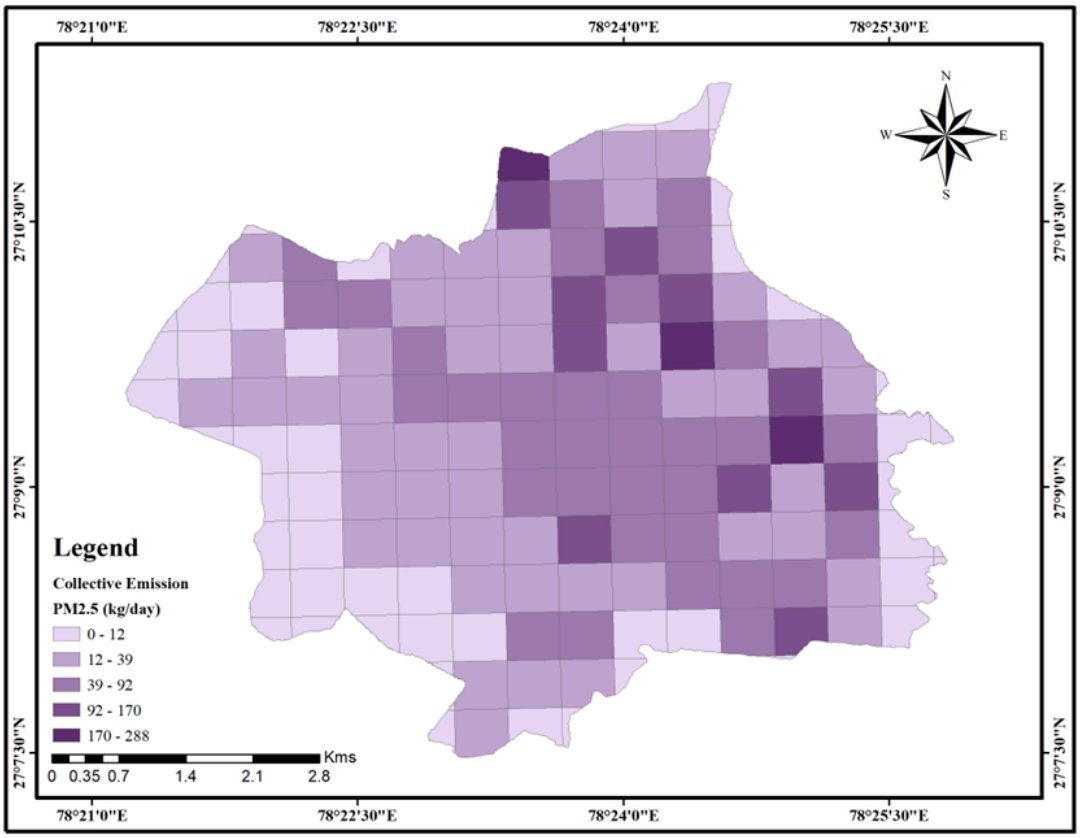


Figure 3.105: Spatial distribution of $PM_{2.5}$ emissions in Firozabad

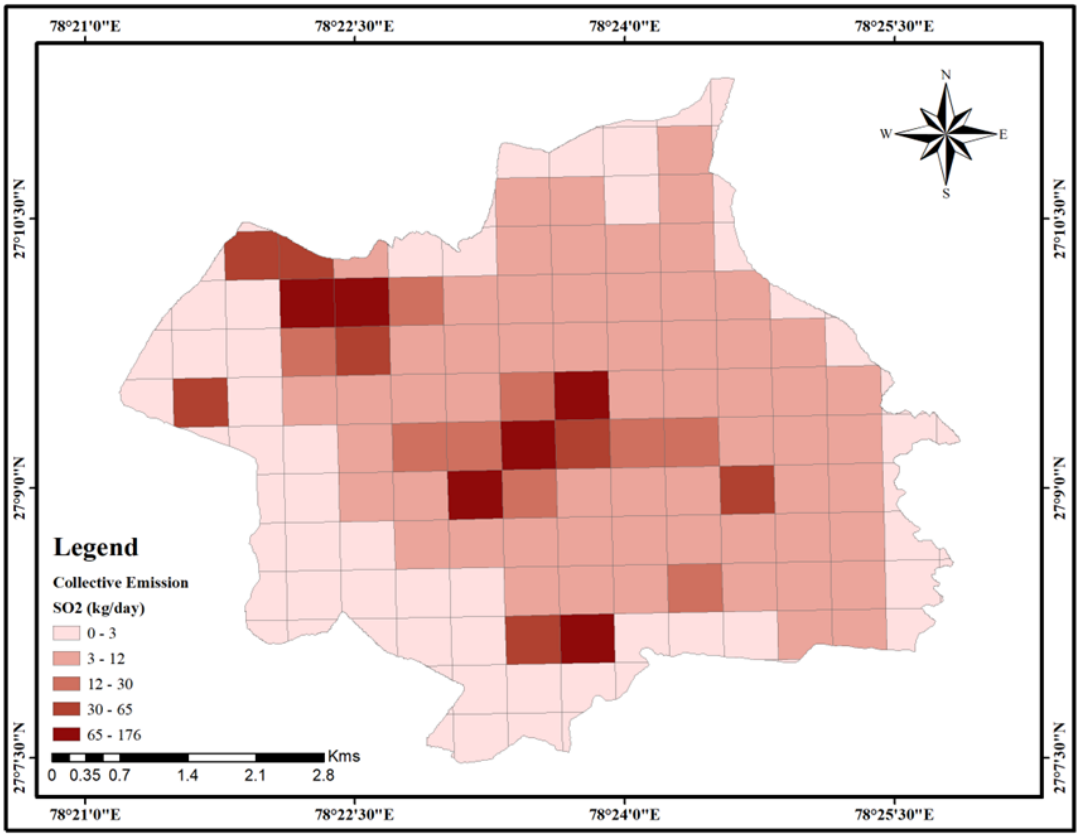


Figure 3.106: Spatial distribution of SO_2 emissions in Firozabad

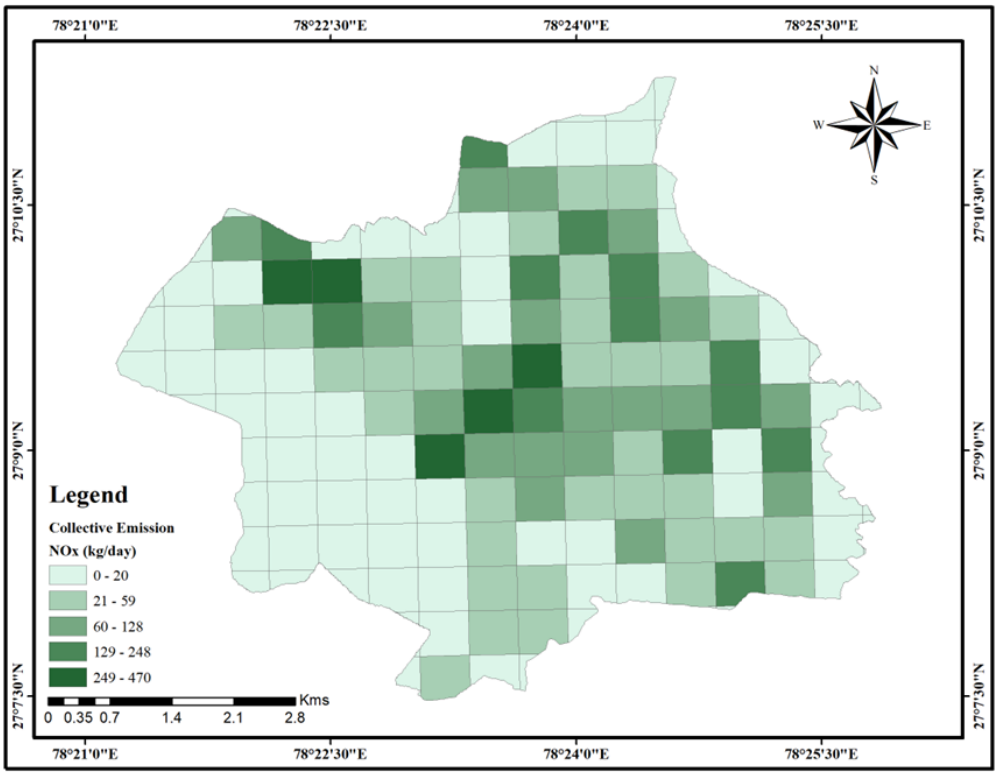


Figure 3.107: Spatial distribution of NO_x emissions in Firozabad

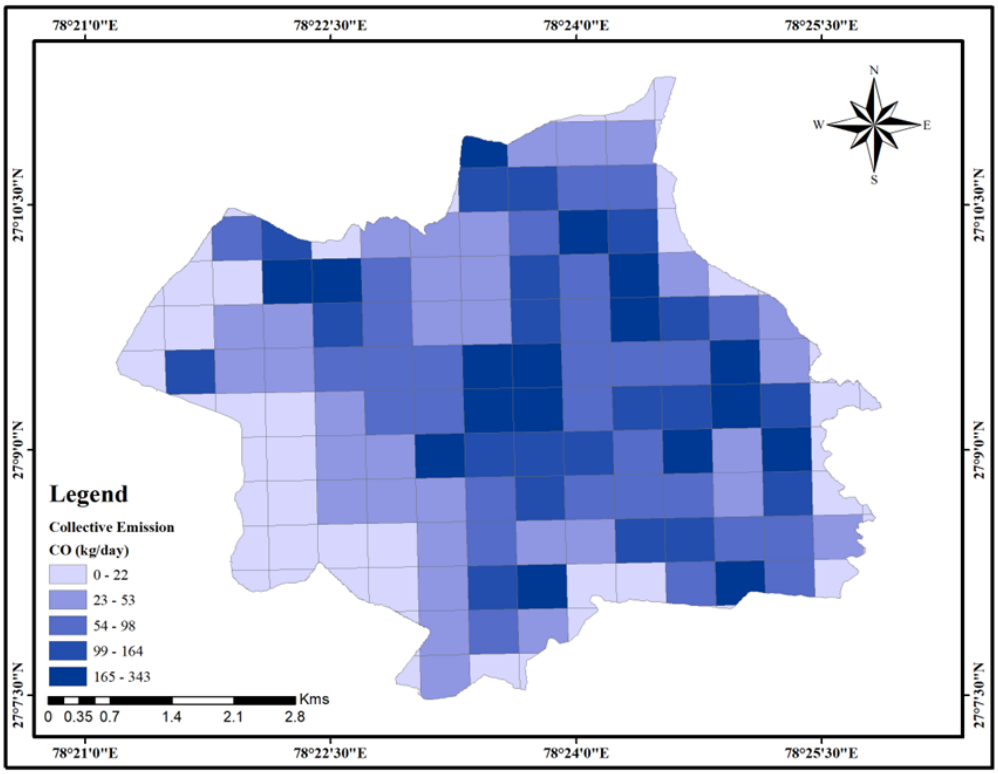


Figure 3.108: Spatial distribution of CO emissions in Firozabad

4 Receptor Modelling and Source Apportionment

4.1 Receptor Modelling

In a complicated urban atmosphere, identifying and quantifying the contribution of multiple emitting sources to air quality is challenging. However, recent advancements in chemical characterisation of PM have made it possible to apportion the sources contributing to air pollution, especially that of PM. Receptor modelling using source fingerprinting (chemical composition) can be applied quantitatively to know the sources of origin of particles. Mathematical models are frequently used to identify and to adopt the source reductions of environmental pollutants. There are two types of modelling approaches to establish source receptor linkages:

1. Dispersion Modelling and
2. Receptor source Modelling.

The focus of modelling in this chapter is receptor modelling. Receptor model begins with observed ambient airborne pollutant concentrations at a receptor and seeks to apportion the observed concentrations between several source types based on the knowledge of the compositions of the sources and receptor materials (Cooper and Watson, 1980; Watson, 1984; Javitz et al., 1988). There are two generally recognized classes of receptor Models:

- Chemical elemental balance or chemical mass balance (CEM/CMB), and
- Multivariate or statistical.

CMB modelling is preferred if source profiles are known. In this Chapter, CMB technique has been attempted to fully understand contribution of each source to ambient air PM_{10} and $PM_{2.5}$ concentrations. Positive matrix factorization (PMF) was used to get first-hand information about possible sources in the study area. However, extensive emission inventory undertaken in this study gave a good idea of possible sources in the study area.

While (CEM/CMB) methods apportion sources using extensive quantitative source emission profiles, statistical approaches infer source contribution without a prior need of quantitative source composition data (Watson et al., 1994). The CMB method assumes that there is linearity in concentration of aerosol and their mass is conserved from the time a chemical species is emitted from its source to the time it is measured at a receptor. That is, if p sources are contributing M_j mass of particulates to the receptor (Watson et al., 2004),

$$m = \sum_{j=1}^{p} M_j$$

$$F'_{ij} = F_{ij}$$

where, m is the total mass of the particulate collected on a filter at a receptor site, F'_{ij} is the fraction of chemical species i in the mass from source j collected at the receptor and F_{ij} is the fraction of chemical i emitted by source j as measured at the source. The mass of the specific species, m_i, is given by the following:

$$m_i = \sum_{i=1}^{p} M_{ij} = \sum_{i=1}^{p} F'_{ij} M_j$$

Where, M_{ij} is the mass of element i contributed to the receptor from source j. Dividing both sides of equation by the total mass of the deposit collected at the receptor site, it follows that

$$C_i = \sum_{j=1}^{p} F_{ij} S_j$$

where, C_i is the concentration of chemical component i measured at the receptor (air filter) and S_j is the source contribution; that is, the ratio of the mass contributed from source j to the total mass collected at receptor site.

If the C_i and F_{ij} at the receptor for all p of the source types suspected of affecting the receptor are known, and $p \leq n$ (n = number of the species), a set of n simultaneous equations exist from which the source type contribution S_j may be calculated by least square methods. The software used for CMB 8.2 is developed by USEPA (2004).

4.2 CMB Modelling: Source Apportionment of PM_{10} and $PM_{2.5}$

Since for $PM_{2.5}$, Indian or Firozabad specific source profiles are not available except for vehicular sources (ARAI, 2009), the source profiles for this study were taken from 'SPECIATE version 3.2' of USEPA (2006) and updated version 5.1 of SPECIATE (USEPA, 2020). For vehicular sources, profiles were taken from ARAI (2009). 'SPECIATE' is a repository of Total Organic Compound (TOC) and PM speciated profiles for a variety of sources for use in source apportionment studies (USEPA, 2006, 2020); care has been exercised in adopting the profiles for their applicability in the local environment

of Firozabad city. For the sake of uniformity, source profiles for non-vehicular sources for PM_{10} and $PM_{2.5}$ were adopted from USEPA (2006, 2020).

The PM_{10} and $PM_{2.5}$ monitoring data along with results of chemical speciation (described in Chapter 2) have been used in the application of CMB 8.2 model of USEPA (2004). The CMB model was run for each site for each day of sampling for two seasons (summer and winter) for PM_{10} and $PM_{2.5}$ separately. The model results were analyzed in terms of R-square (model fitting) and model-computed percent mass (compared to the measured mass). The CMB results for most measurements (over 85 percent) showed the R-square was above 0.60. Model-computed mass accounted for more than 70 percent of measured mass. In this study, the degree of freedom (number species – number of sources) being more than 24, modelling results that gave R-square more than 0.55 were considered for further analyses. The results of CMB 8.2 at each location for each season are described in Section 5.3.

HYSPLIT Model (NOAA, 2013) was run for back trajectory analysis to assist in the interpretation of results and to indicate how the sources located upwind of Firozabad could impact air quality in Firozabad.

4.3 CMB Modelling Results and interpretation

It may be noted that vehicular sources include all vehicles powered by gasoline, diesel and CNG. The CMB model could provide the contribution of vehicles as a single entity. However, the model could not fully resolve the source contribution from various vehicular fuels due to co-linearity in source profiles. In addition, LPG from domestic cooking is also part of vehicular emission due co-linearity in profiles.

4.3.1 Jain Mandir, Firozabad (JMDF)

4.3.1.1 Winter Season [sampling period: Nov. 21 – Dec. 06, 2022]

PM_{10} (winter)

The average PM_{10} concentration was 354 $\mu g/m^3$. Figure 4.1 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at JMDF. Table 4.1 presents a summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing to PM_{10} was soil and

road dust (99 µg/m^3 ~ 28%) and vehicular emission (82 µg/m^3 ~ 23%) followed by biomass burning (51 µg/m^3 ~ 14%). The other major sources are SIA (50 µg/m^3 ~ 14%), coal and flyash (36 µg/m^3 ~ 10%), Municipal solid waste (MSW) burning (6.9%), construction materials (3.3%), and industrial emission is zero.

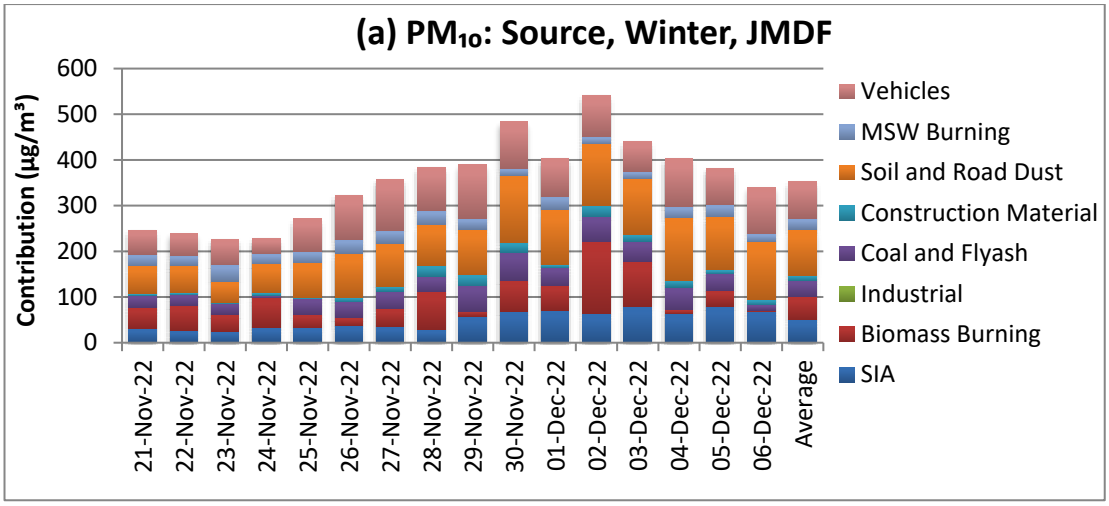
$PM_{2.5}$ (winter)

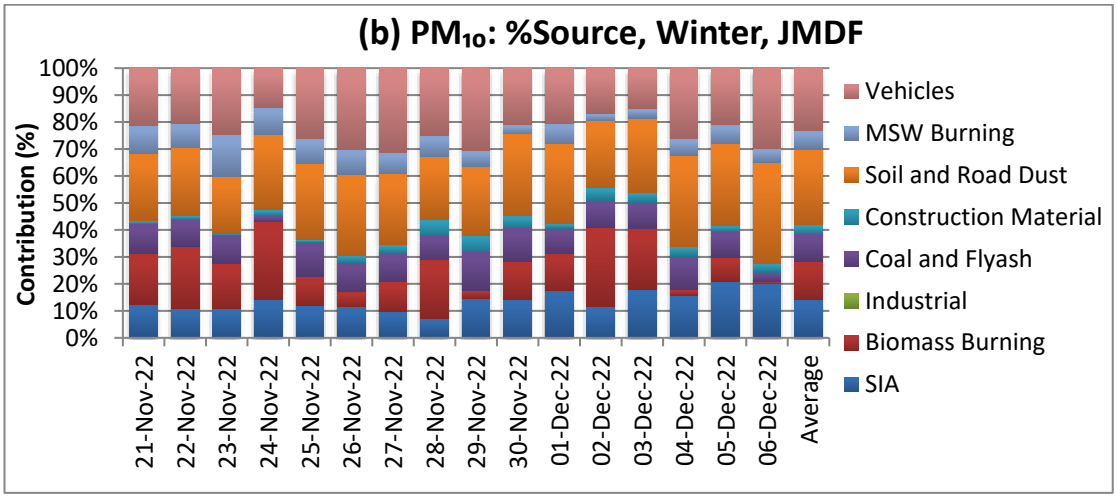
The average $PM_{2.5}$ concentration was 253 µg/m^3 (i.e. about 0.32 of PM_{10}). Figure 4.2 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at JMDF. It is observed that the major PM_{10} source contributing to PM_{10} was soil & road dust (63 µg/m^3 ~ 24.9%) and vehicular emissions (61 µg/m^3 ~ 24%) followed by biomass burning (46.1 µg/m^3 ~ 18.2%). The other major sources are SIA (34.8 µg/m^3 ~ 13.8%), coal & flyash (24 µg/m^3 ~ 9.3%), MSW burning (5.6%), construction materials (3.9%), and industrial emission is zero.

HYSPLIT back trajectories (Figure 4.3) indicate that wind is flowing from NW direction. Wind can pick up pollutants on the way, especially from large sources (e.g. desert soil and crop residue burning (CRB)) and tall emitting sources, but these contributions have not been quantified.

Inferences

- Vehicular emission has major contribution to PM (23% for PM_{10} and 24% for $PM_{2.5}$) at JMDF.
- Biomass burning has significant contribution (15% for PM_{10} and 18% for $PM_{2.5}$) to the PM at JMDF.
- Soil & road dust contributes significantly to PM_{10} and PM $_{2.5}$ (28% for PM_{10} and 25% for $PM_{2.5}$).
- The secondary particles contribute 14 % to both the PM. These particles are expected to source from precursor gases (SO_2 and NO_x) emitted from far distances. However, contribution of NO_x from local sources, especially vehicles and power plants can also contribute to nitrates. For sulfates, the major contribution can be attributed to large power plants and refineries from long distances.
- The MSW burning contribution is less. This emission is expected to be coming from regions of economically lower strata of society which do not have proper infrastructure for collection and disposal of solid waste.





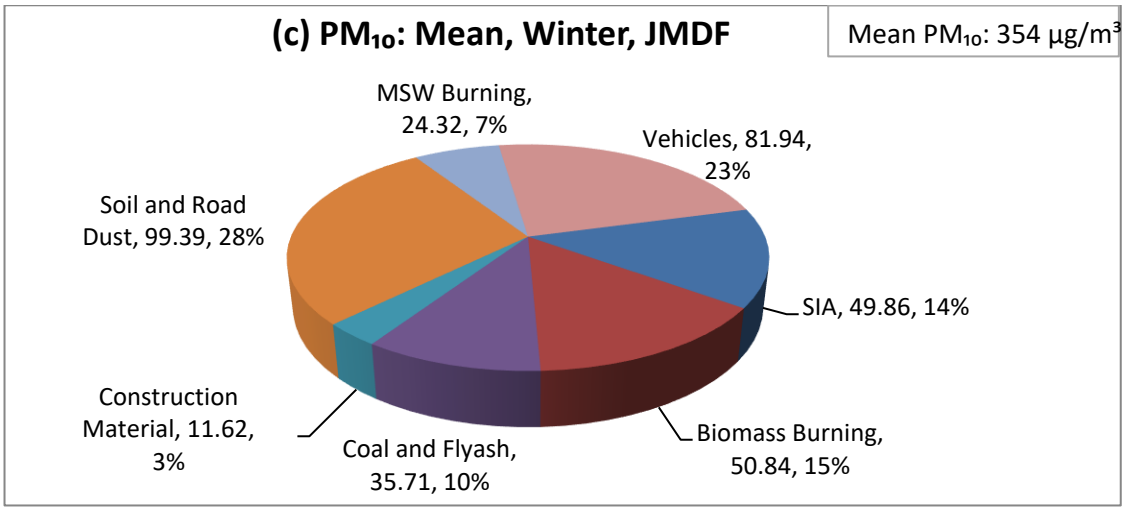


Figure 4.1: CMB modelling for PM_{10} at JMDF for winter season

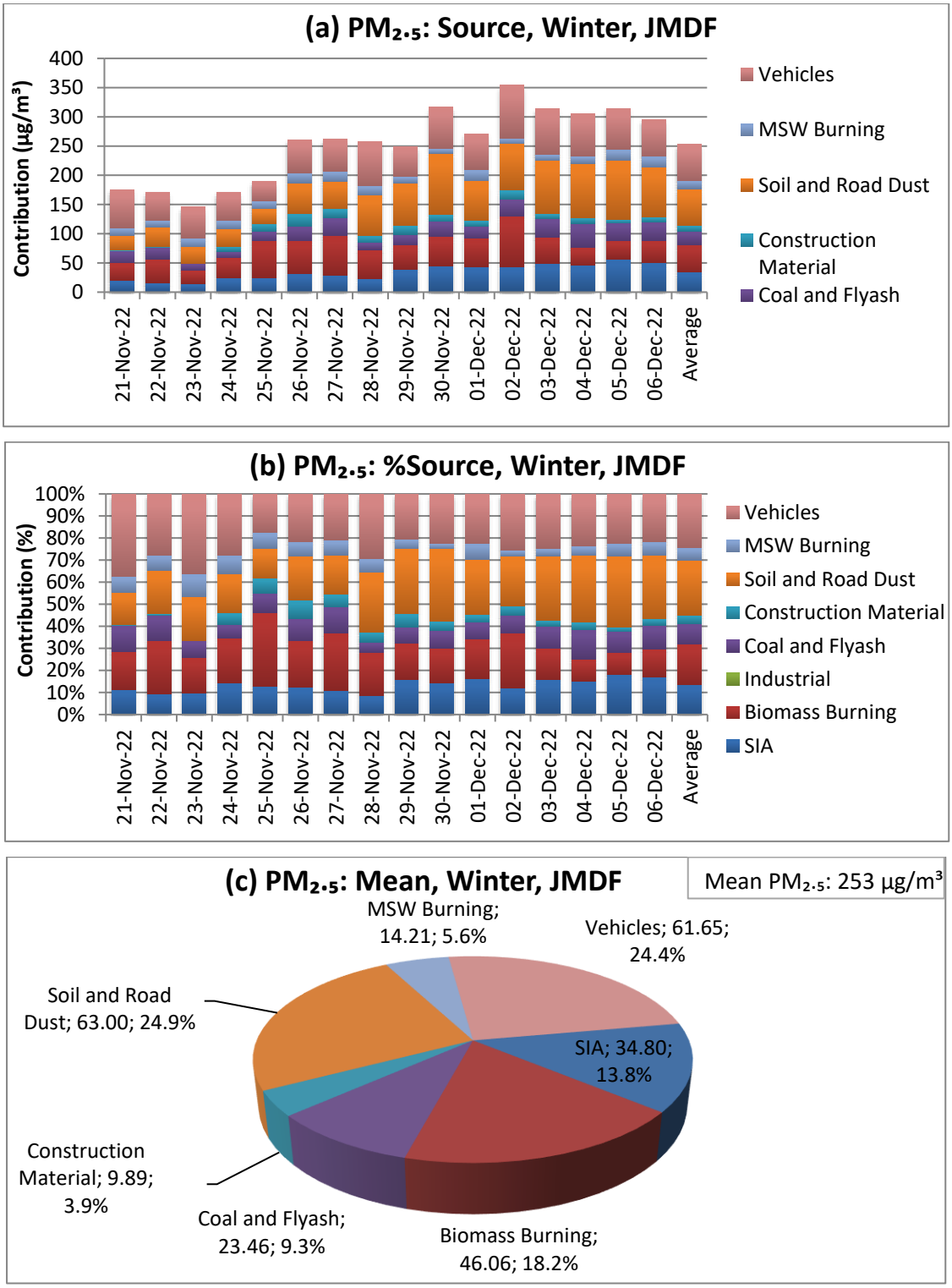


Figure 4.2: CMB modelling for $PM_{2.5}$ at JMDF for winter season

Table 4.1: Statistical summary: JMDF, winter season

	PM_{10} (µg/m^3)				$PM_{2.5}$ (µg/m^3)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	354	358	101.4	0.73	253	260	104.1	0.90
SD	94	93	3.5	0.08	64	55	6.8	0.08
CV	0.27	0.26	0.03	0.11	0.25	0.21	0.06	0.09
Maximum	541	545	108.6	0.87	354	348	118.1	0.96
Minimum	226	226	95.8	0.52	145	172	97.3	0.71

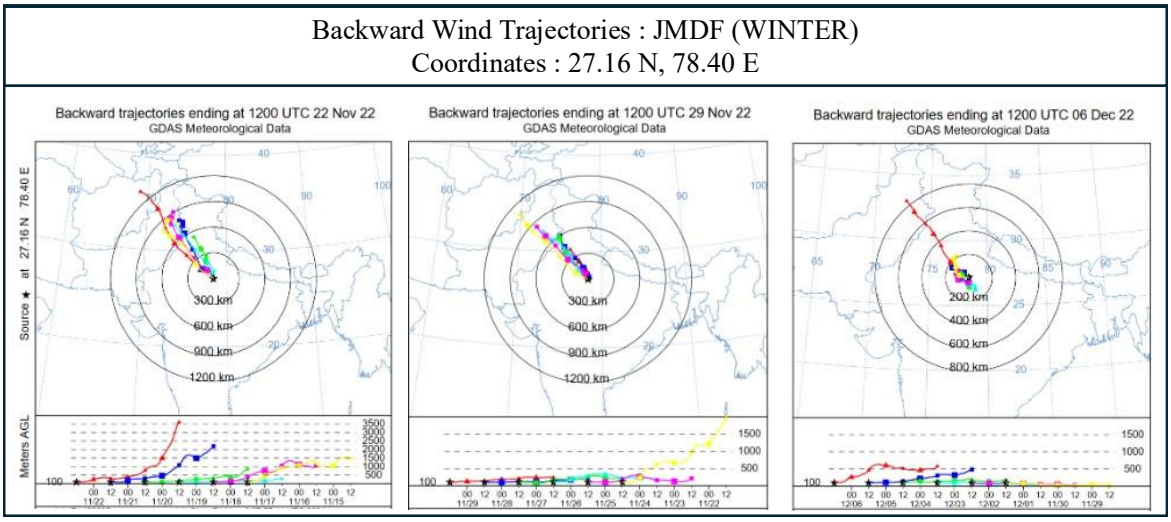


Figure 4.3: Backward trajectories at JMDF for winter season

4.3.1.2 Summer Season [sampling period: April 29 – May. 14, 2023]

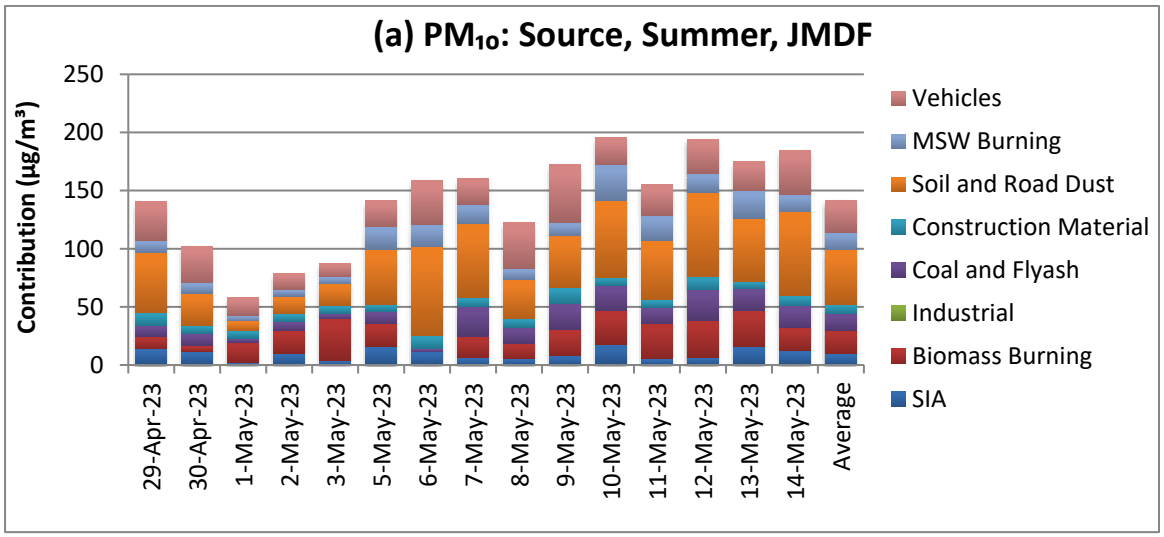
PM_{10} (summer)

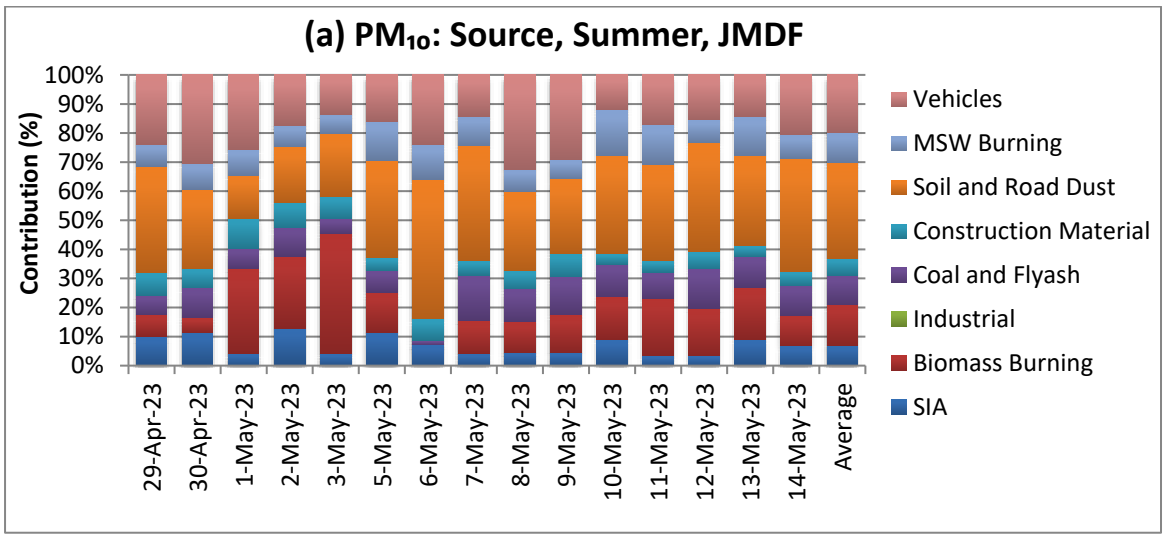
The average PM_{10} concentration was 142 µg/m^3. Figure 4.4 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at JMDF.Table 4.2 presents a summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing was soil & road dust (47 µg/m^3 ~ 33%) followed by vehicular emission (28.1 µg/m^3 ~ 19.8%) and biomass burning (20.2 µg/m^3 ~ 14.2%) in PM_{10}. Other significant sources are MSW burning (14.5 µg/m^3 ~ 10.2%), coal and flyash (14 µg/m^3 ~ 10%), SIA (9.8 µg/m^3 ~ 7%) and construction material (2.7%) in PM_{10}. The contribution of the industrial emissions was Zero PM_{10}.

$PM_{2.5}$ (summer)

The average $PM_{2.5}$ concentration was 62 µg/m^3; the $PM_{2.5}/PM_{10}$ ratio is about 0.33. Figure 4.5 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at JMDF. It is observed that the major source contributing in $PM_{2.5}$ was soil & road dust (17 µg/m^3 ~ 27%) followed by Biomass burning (11.4 µg/m^3 ~ 18.4%), and MSW burning (10.3 µg/m^3 ~ 16.6%) in PM_{10}. Other significant sources are Vehicular emissions (9.6 µg/m^3 ~ 15.5%), SIA (6.2 µg/m^3 ~ 10.1%), Coal & flyash (5 µg/m^3 ~ 8%) and construction material (4.3%) in PM_{10}. The contribution of the industrial emissions was Zero PM_{10}.

HYSPLIT back trajectories (Figure 4.6) show that most of the time wind is from SW and NW; wind mass travels over Thar desert and part of Rajasthan and Punjab before entering in Firozabad. These winds pick up pollutants on the way especially from tall emitting sources.





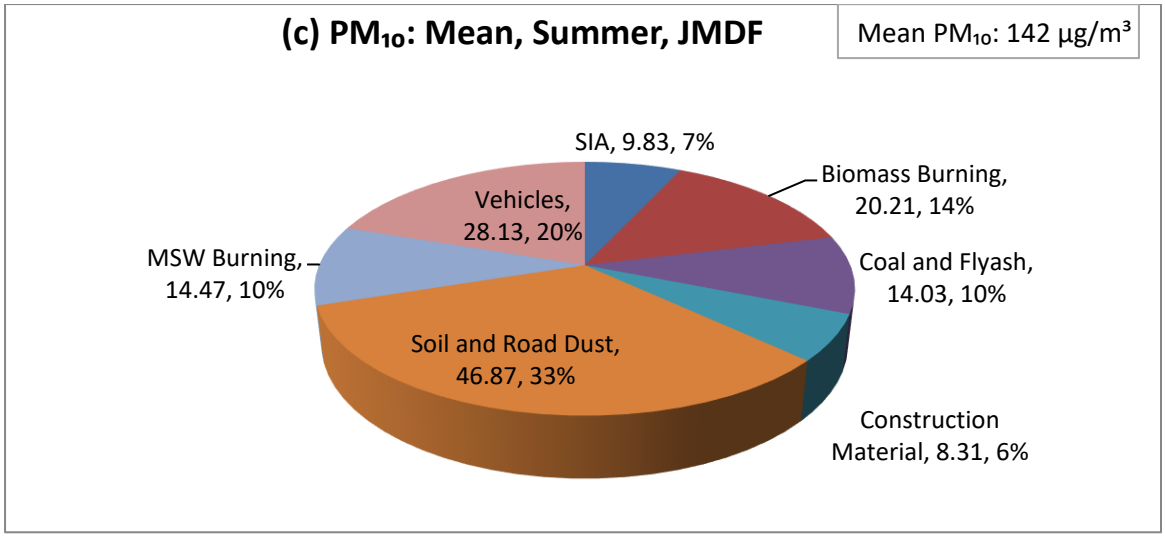
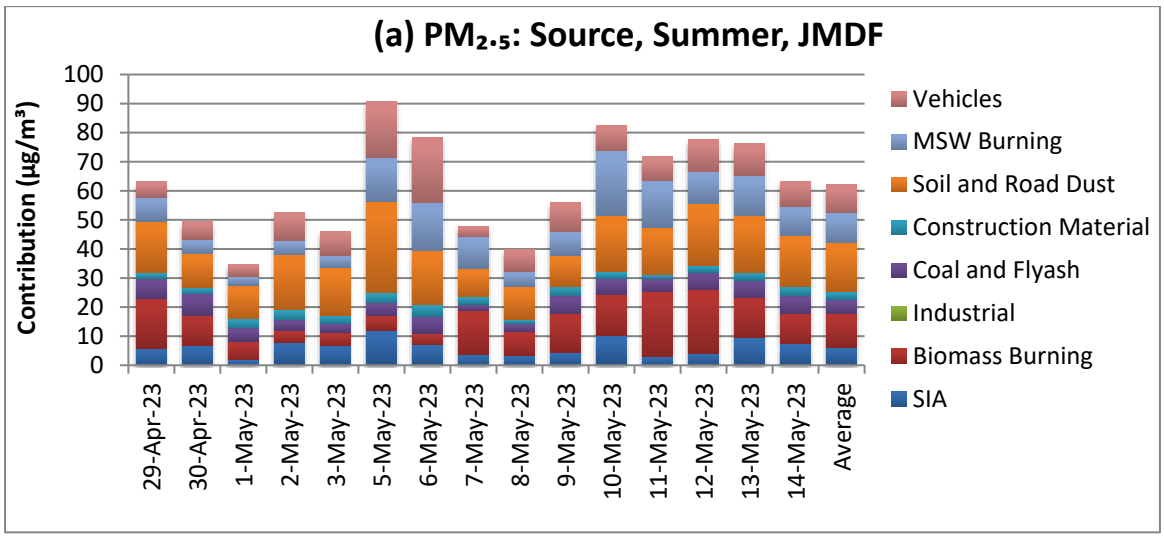
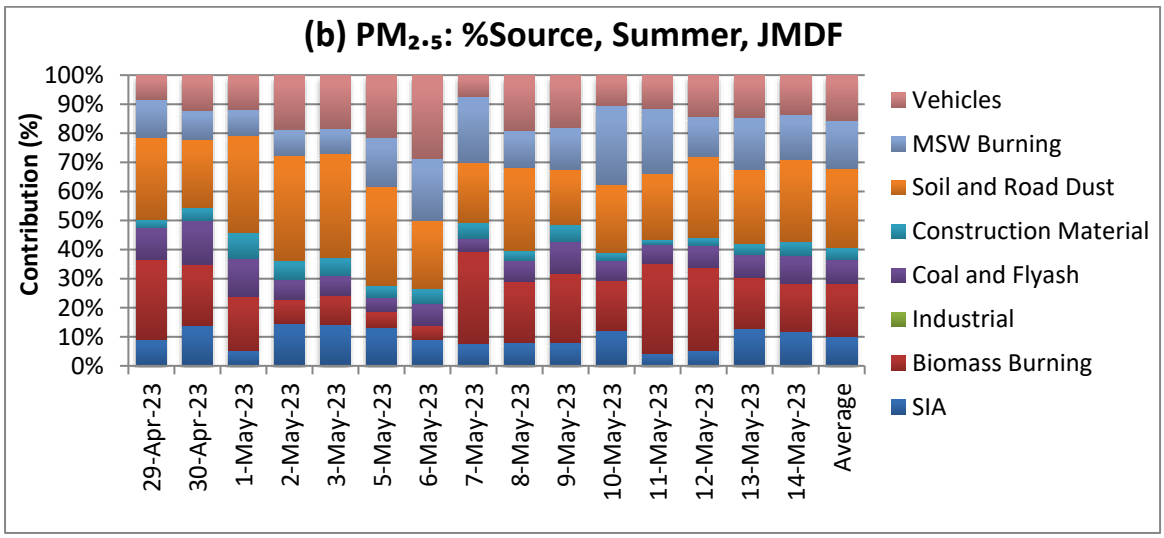


Figure 4.4: CMB modelling for PM_{10} at JMDF for summer season





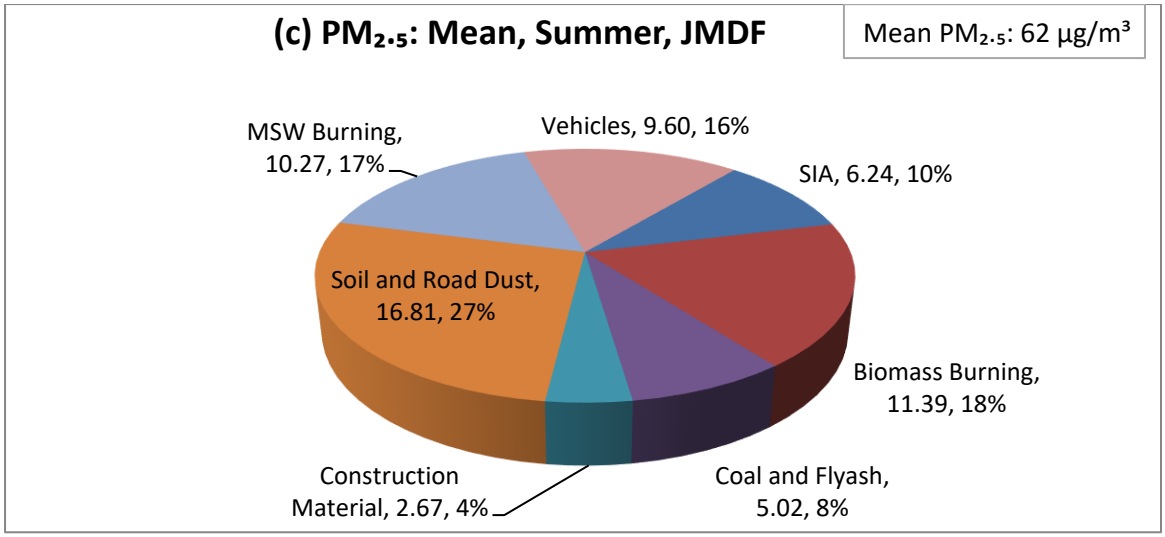


Figure 4.5: CMB modelling for $PM_{2.5}$ at JMDF for summer season

Table 4.2: Statistical summary: JMDF, summer season

	PM_{10} (µg/m³)				$PM_{2.5}$ (µg/m³)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	142	158	110.3	0.80	62	67	108.1	0.82
SD	43	55	9.8	0.05	17	20	7.1	0.10
CV	0.31	0.35	0.09	0.06	0.27	0.30	0.07	0.12
Maximum	196	245	125.0	0.88	91	105	117.5	0.97
Minimum	58	60	94.4	0.69	35	35	98.5	0.61

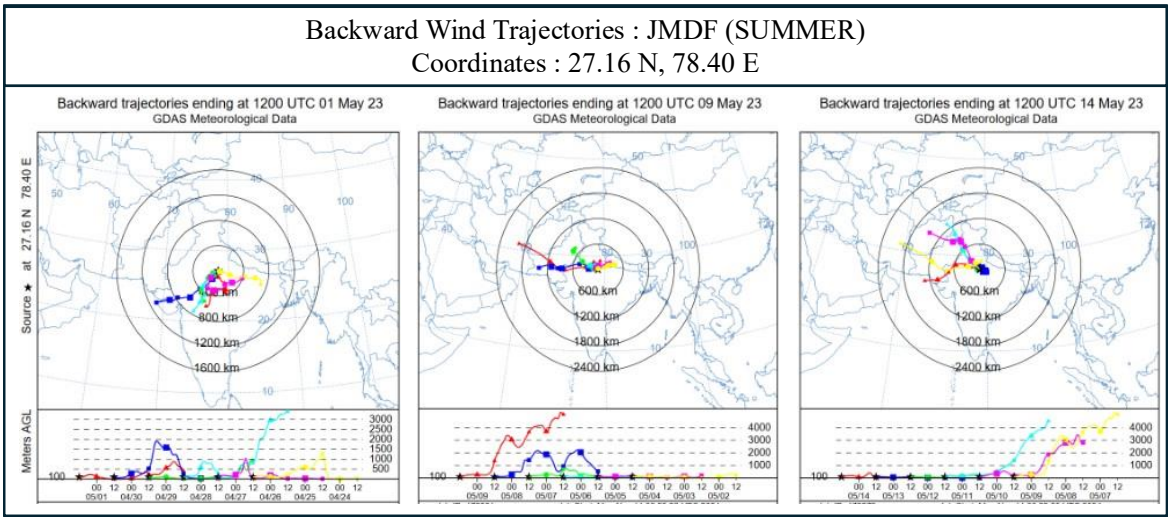


Figure 4.6: Backward trajectories at JMDF for summer season

Inferences

The major sources contributing to PM_{10} and $PM_{2.5}$ are Soil & road dust, biomass burning and vehicular emission. It was observed that the atmosphere in summer looked white to gray indicating presence of large amounts of dust which may be due to high speeds wind and very dry conditions which makes the dust airborne. Occasional dust storms can also contribute to road/soil dust resuspension. MSW burning is contributing pretty high indicating poor handling of the garbage and solid waste.

4.3.2 Gopinath College Rasulpur (GCRF)

4.3.2.1 Winter Season [sampling period: Nov. 25 – Dec. 09, 2022]

PM_{10} (winter)

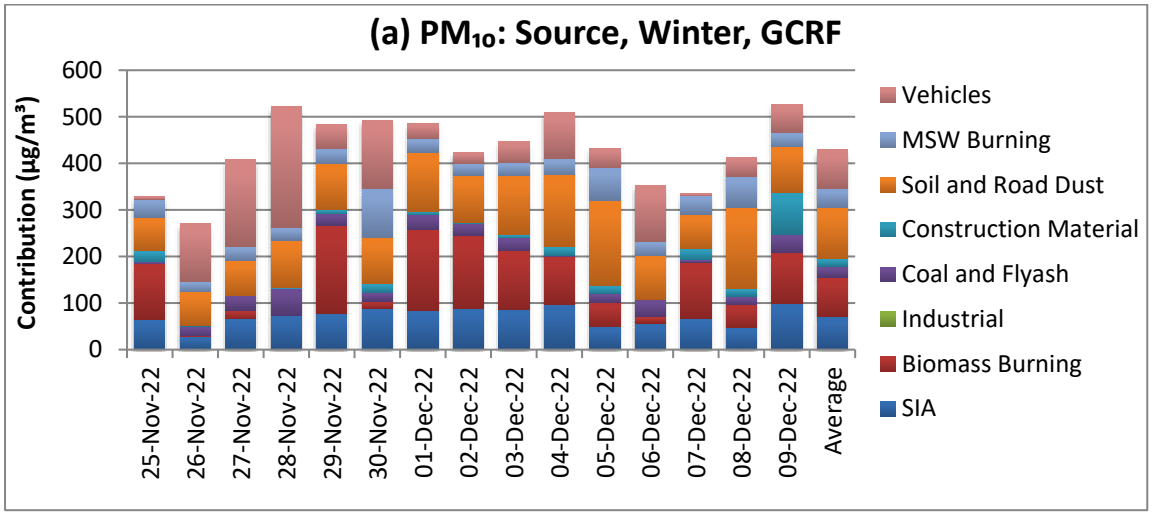
The average PM_{10} concentration was 429 $\mu g/m^3$. Figure 4.7 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GCRF. Table 4.3 presents a summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing was soil & road dust (110 $\mu g/m^3$ ~ 26%) followed by Biomass burning (83 $\mu g/m^3$ ~ 19.5%) in PM_{10} and Vehicular emission (82.9 $\mu g/m^3$ ~ 19.3%). The other sources are SIA (71.6 $\mu g/m^3$ ~ 10.5%), MSW burning (40.7 $\mu g/m^3$ ~ 9.5%), Coal & Flyash (24 $\mu g/m^3$ ~ 6%) and construction material (3.7%). Contribution of the industrial emission was estimated to be zero in PM_{10}.

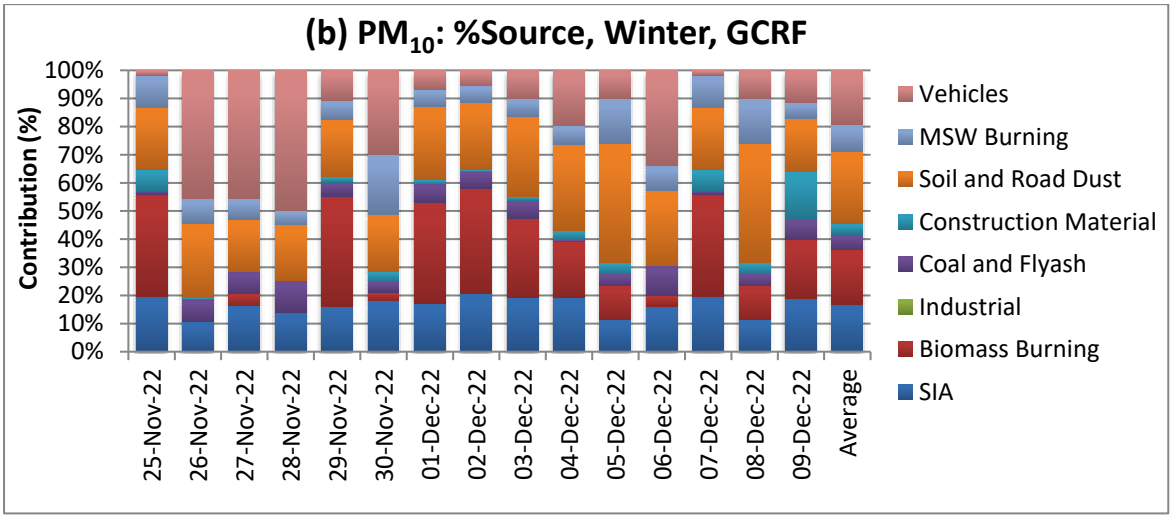
$PM_{2.5}$ (winter)

The average $PM_{2.5}$ concentration was 318 $\mu g/m^3$. Figure 4.8 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GCRF. It is observed that the major source contributing in $PM_{2.5}$ was Vehicular emission (72.8 $\mu g/m^3$ ~ 22.9%) followed by soil & road dust (72 $\mu g/m^3$ ~ 23%), SIA (61 $\mu g/m^3$ ~ 19%) and Biomass burning (56 $\mu g/m^3$ ~ 17.6%). The other sources are MSW (35 $\mu g/m^3$ ~ 11.0%), Coal & flyash (18 $\mu g/m^3$ ~ 6%), and construction material (0.5%). Contribution of the industrial emission was estimated to be zero in $PM_{2.5}$.

HYSPLIT back trajectories (Figure 4.9) indicate that wind is flowing from NW direction. Wind can pick up pollutants on the way, especially from large sources (e.g. desert soil and

crop residue burning (CRB)) and tall emitting sources, but these contributions have not been quantified.





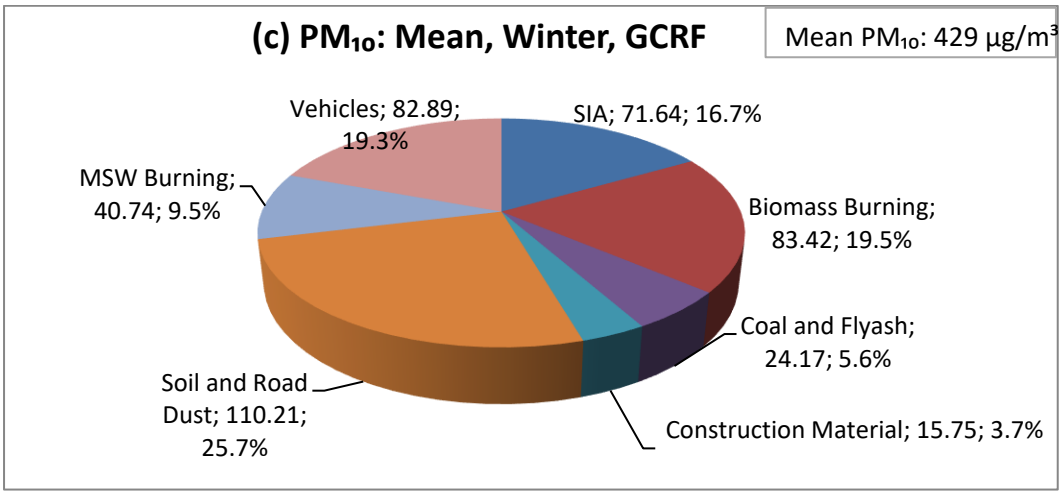
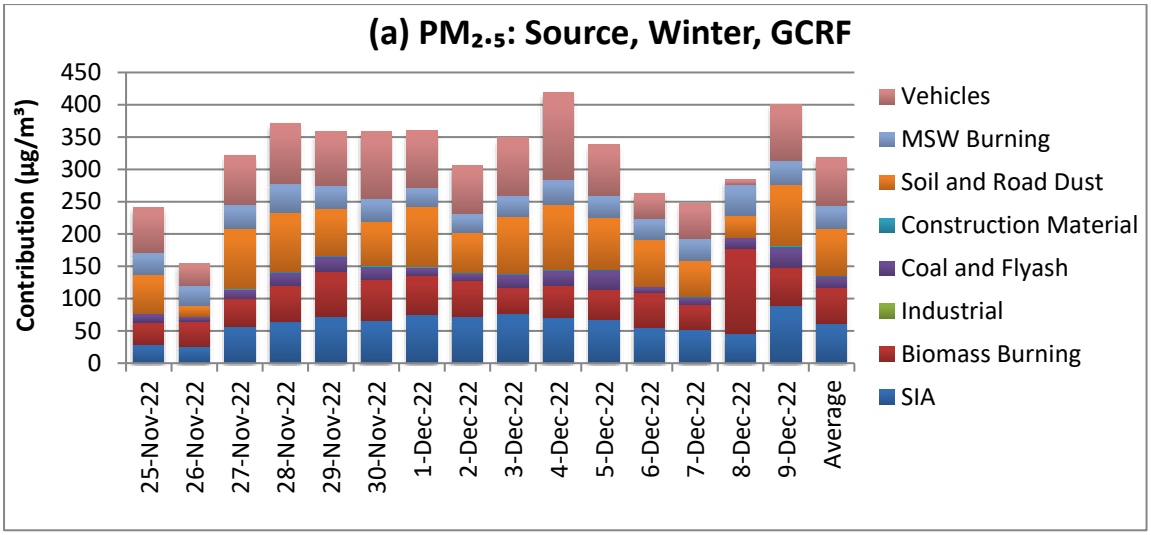
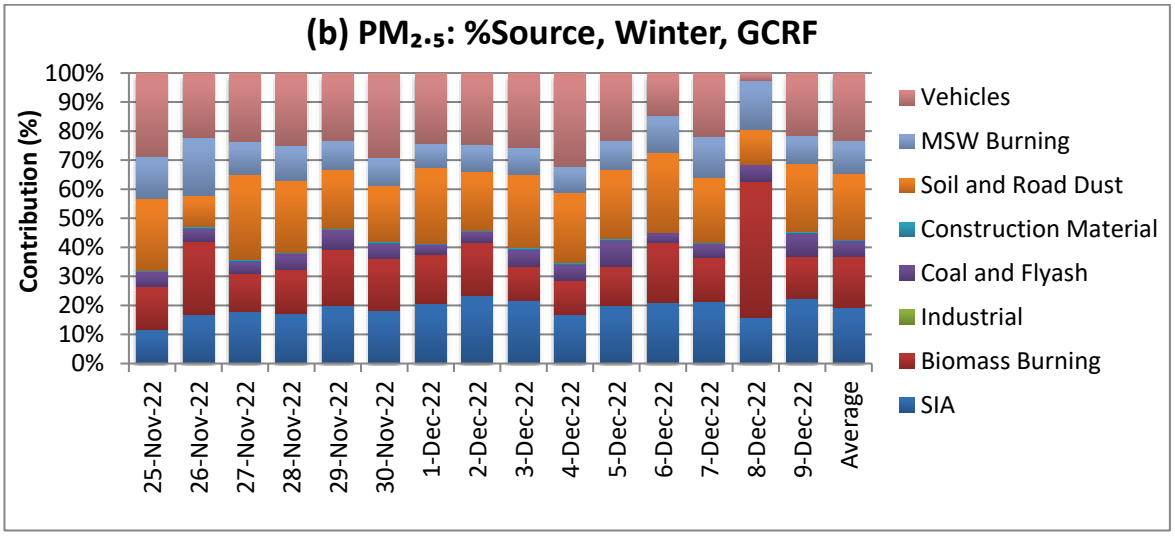


Figure 4.7: CMB modelling for PM_{10} at GCRF for winter season





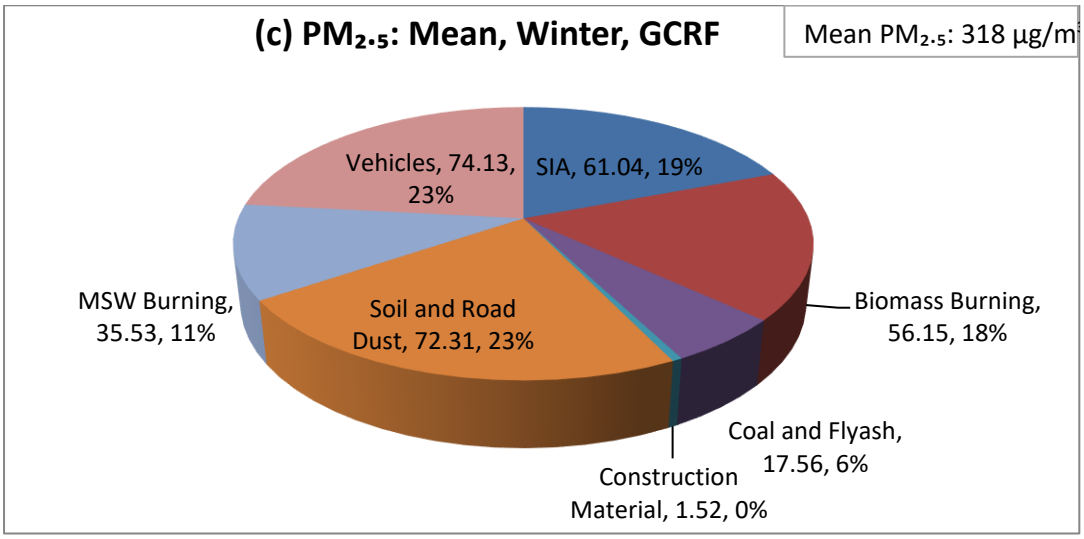


Figure 4.8: CMB modelling for $PM_{2.5}$ at GCRF for winter season

Table 4.3: Statistical summary: GCRF, winter season

	PM_{10} (µg/m^3)				$PM_{2.5}$ (µg/m^3)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	429	419	97.8	0.82	318	307	98.7	0.74
SD	78	74	4.4	0.10	70	63	4.7	0.04
CV	0.18	0.18	0.04	0.12	0.22	0.21	0.05	0.06
Maximum	525	523	103.6	0.97	419	373	105.2	0.81
Minimum	271	271	90.0	0.66	155	157	90.4	0.67

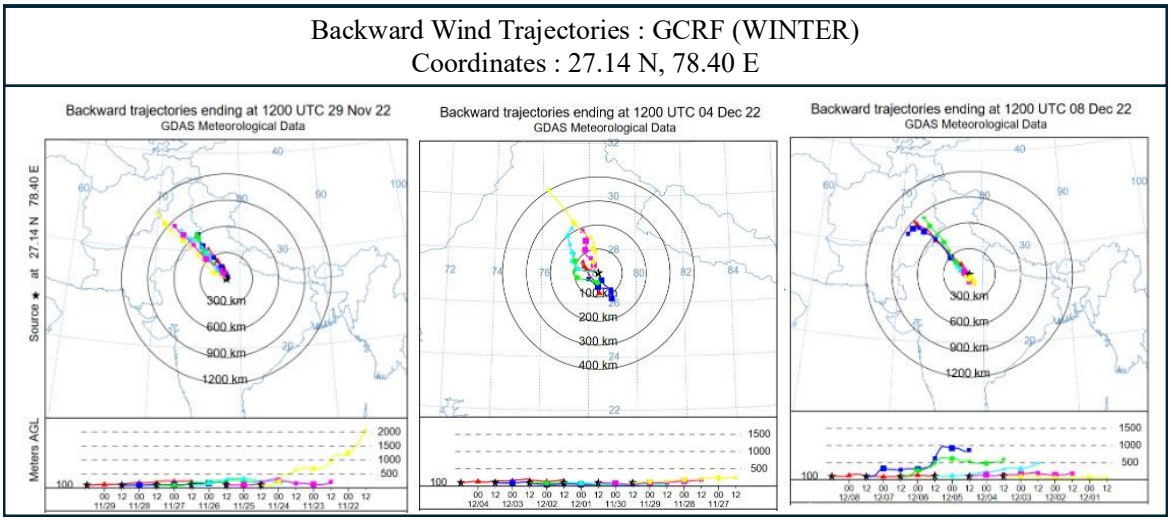


Figure 4.9: Backward trajectories at GCRF for winter season

Inferences

For PM_{10}, soil & road dust, biomass burning and vehicular emission contribute about equally at 20%. SIA contribution is at 17% and that of Coal & flyash is 6%. For $PM_{2.5}$, soil & road dust contribution reduced to 23% (from 26% in PM_{10}). Vehicular contribution increases significantly in $PM_{2.5}$ to 23%. The MSW burning is on the higher side at GCRF compared to other sites that indicates irregular management of waste generated from industries which succeed for open burning.

4.3.2.2 Summer Season [sampling period: May 01 – 16, 2023]

PM_{10} (summer)

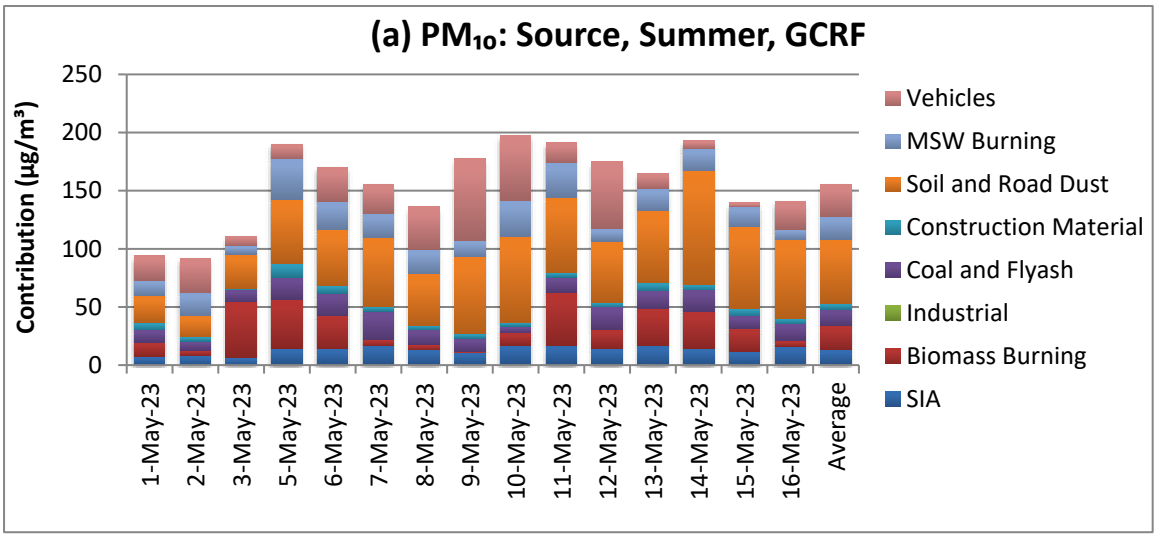
The average PM_{10} concentration was 155 µg/m^3. Figure 4.10 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GCRF. Table 4.4

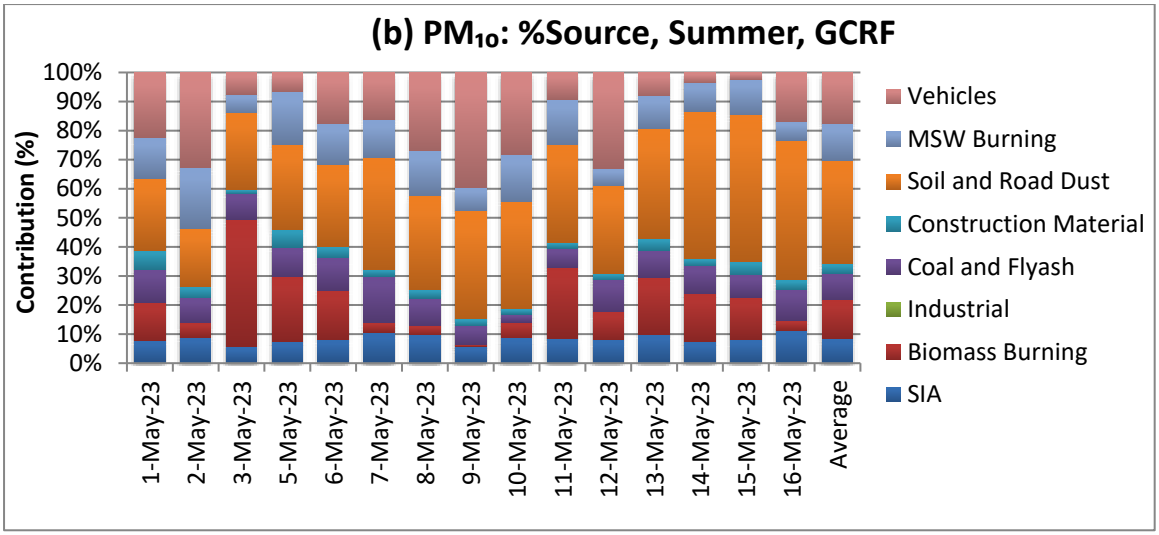
presents a summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing was soil & road dust (55 $\mu g/m^3$ ~ 36%) followed by Vehicular emission (27.4 $\mu g/m^3$ ~ 17.7%). The other significant sources are biomass burning (20.6 $\mu g/m^3$ ~ 13.3%), MSW Burning (19.3 $\mu g/m^3$ ~ 12.4%), coal & flyash (14 $\mu g/m^3$ ~ 9%) and SIA (13.2 $\mu g/m^3$ ~ 8.5%). Contribution of the industrial emission was zero in PM_{10}.

$PM_{2.5}$ (summer)

The average $PM_{2.5}$ concentration was 67 $\mu g/m^3$. Figure 4.11 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GCRF. It is observed that the major source contributing in $PM_{2.5}$ was Vehicular emission (20.2 $\mu g/m^3$ ~ 30.3%) followed by Soil & road dust (16 $\mu g/m^3$ ~ 24%). The other significant sources are MSW burning (10.1 $\mu g/m^3$ ~ 15.1%) and biomass burning (9.4 $\mu g/m^3$ ~ 10.9%), coal & flyash (7%) and SIA (8.4%). Contribution of construction materials is 1.8% and industrial emission was zero in $PM_{2.5}$.

HYSPLIT back trajectories (Figure 4.12) show that most of the time wind is from west and SW. Wind mass travels over Thar Desert before entering Firozabad. These winds pick up the pollutants on the way especially from large and tall emitting sources.





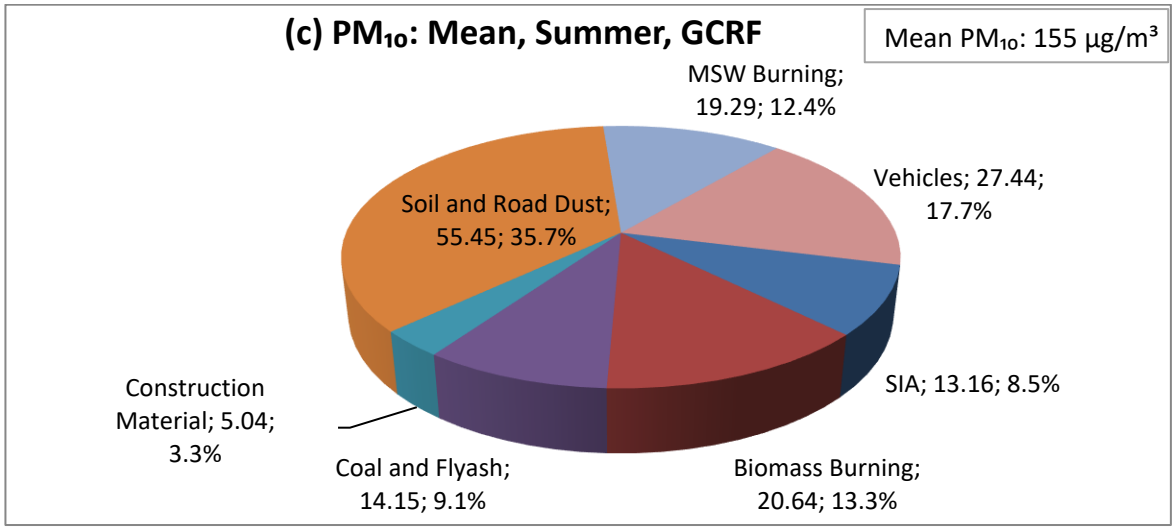
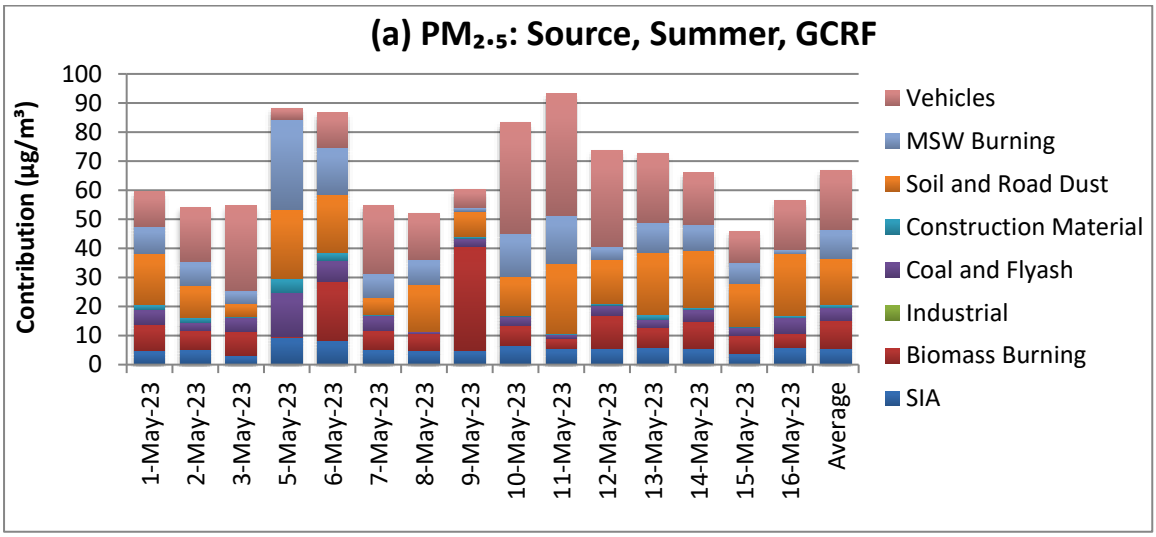
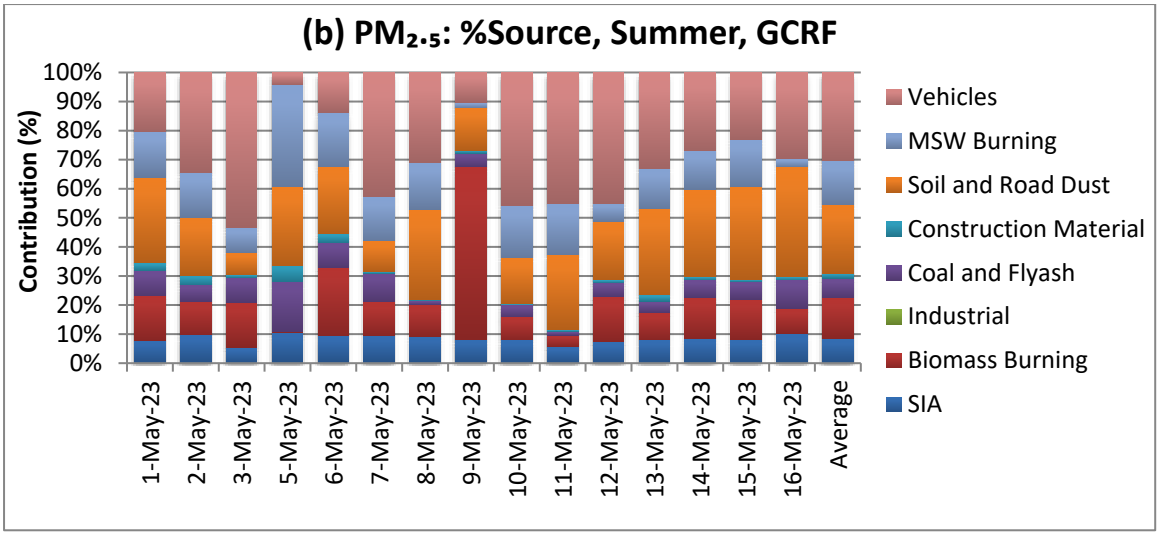


Figure 4.10: CMB modelling for PM_{10} at GCRF for summer season





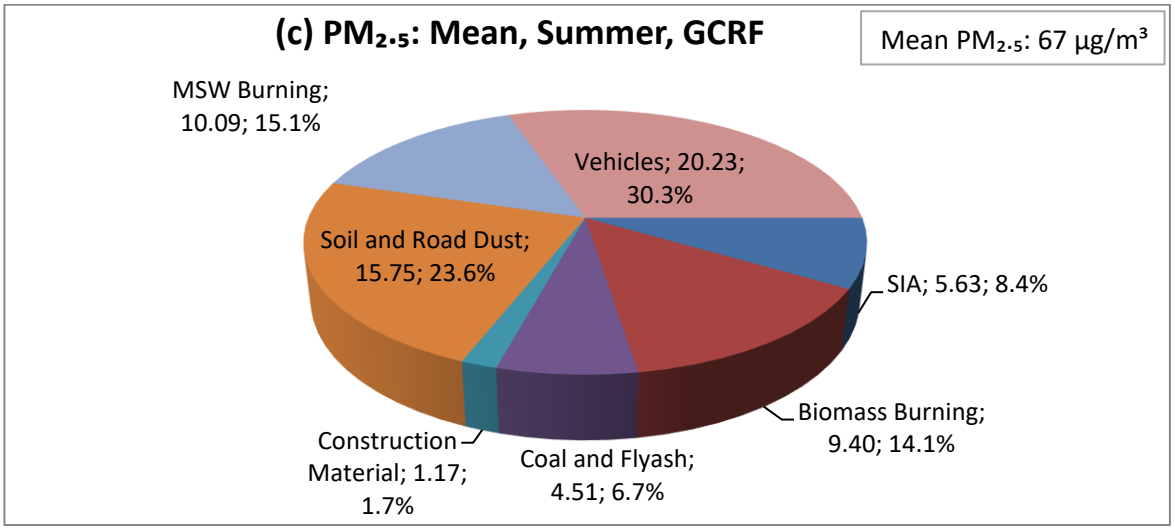


Figure 4.11: CMB modelling for $PM_{2.5}$ at GCRF for summer season

Table 4.4: Statistical summary: GCRF, summer season

	PM_{10} (µg/m³)				$PM_{2.5}$ (µg/m³)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	155	166	106.4	0.85	67	75	111.9	0.78
SD	35	41	5.0	0.04	15	18	5.4	0.06
CV	0.23	0.25	0.05	0.05	0.23	0.25	0.05	0.08
Maximum	198	216	112.6	0.92	93	112	120.6	0.88
Minimum	92	92	97.6	0.79	46	54	102.0	0.61

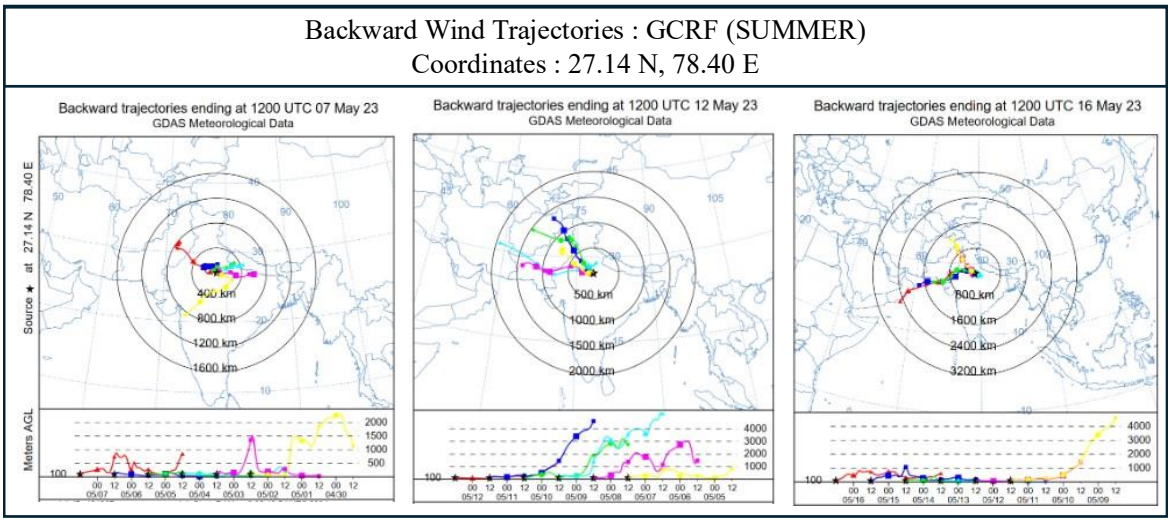


Figure 4.12: Backward trajectories at GCRF for Summer Season

Inference

Soil and vehicular emission are the major contributors in summer both for PM_{10} (36% - 18%) and $PM_{2.5}$ (24% - 30%), at the same time MSW and biomass burning are prominent both in PM_{10} and $PM_{2.5}$.

4.3.3 St. Jhon Industries (SJIF)

4.3.3.1 Winter Season [sampling period: Dec. 09 – Dec. 23, 2022]

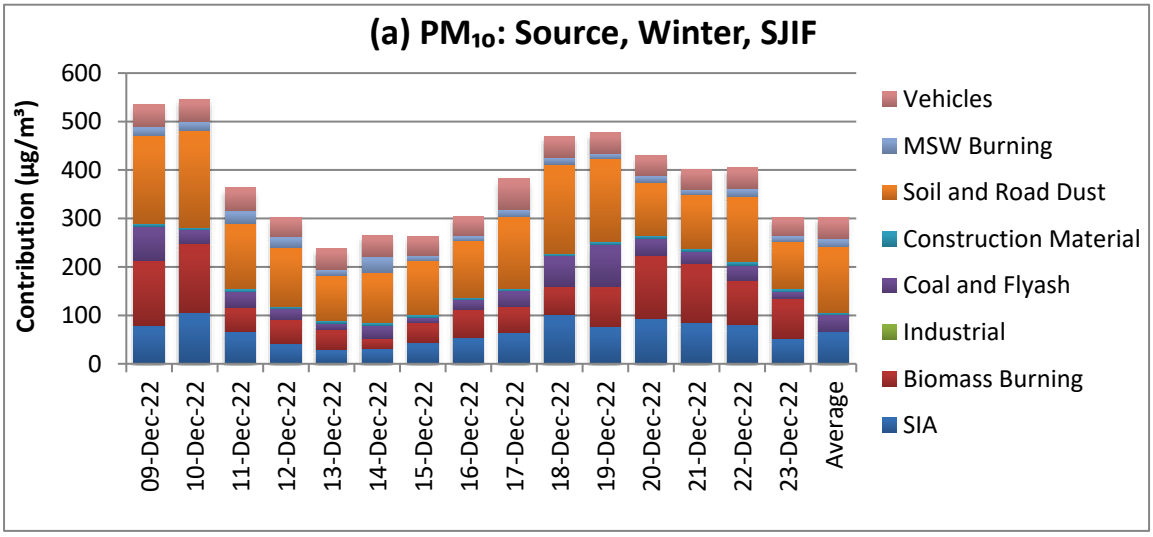
PM_{10} (winter)

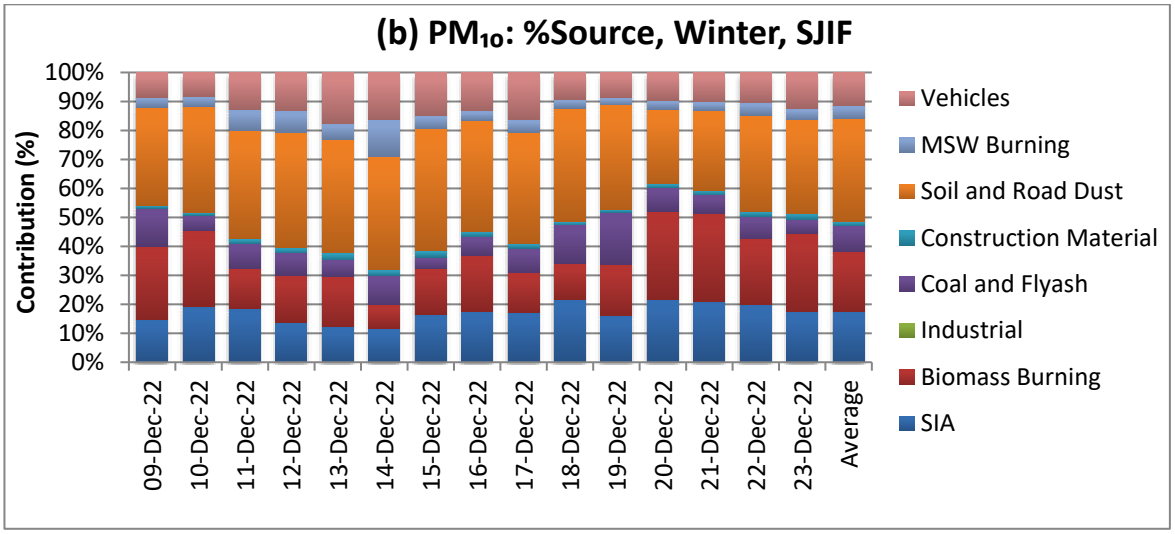
The average PM_{10} concentration was 379 µg/m^3. Figure 4.13 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at SJIF.Table 4.5 presents a summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing was soil & road dust (134 µg/m^3 ~ 35.5%) followed by biomass burning (77.4 µg/m^3 ~ 20.5%). The other significant contributing sources are SIA (66.9 µg/m^3 ~ 17.7%), vehicular emission (43.3 µg/m^3 ~ 11.4%), coal and fly ash (34 µg/m^3 ~ 9%), MSW burning (16.8 µg/m^3 ~ 4.4%) and construction material (1.5%). Contribution of the industrial emission was estimated to be zero in PM_{10}.

$PM_{2.5}$ (winter)

The average $PM_{2.5}$ concentration was 291 µg/m^3. Figure 4.14 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at SJIF. It is observed that the major source contributing in $PM_{2.5}$ was soil &road dust (98 µg/m^3 ~ 34%) followed by biomass burning (72.8 µg/m^3 ~ 26.4%). Other major sources are SIA (41.2 µg/m^3 ~ 15.7%), vehicular emission (36.3 µg/m^3 ~ 14%), coal & flyash (29 µg/m^3 ~ 10%), MSW burning (3.2%), Construction material (1.8%) and industrial emissions is zero in $PM_{2.5}$.

HYSPLIT back trajectories (Figure 4.15) indicate that wind is flowing from NW direction. Wind can pick up pollutants on the way, especially from large sources (e.g. desert soil and crop residue burning (CRB)) and tall emitting sources, but these contributions have not been quantified.





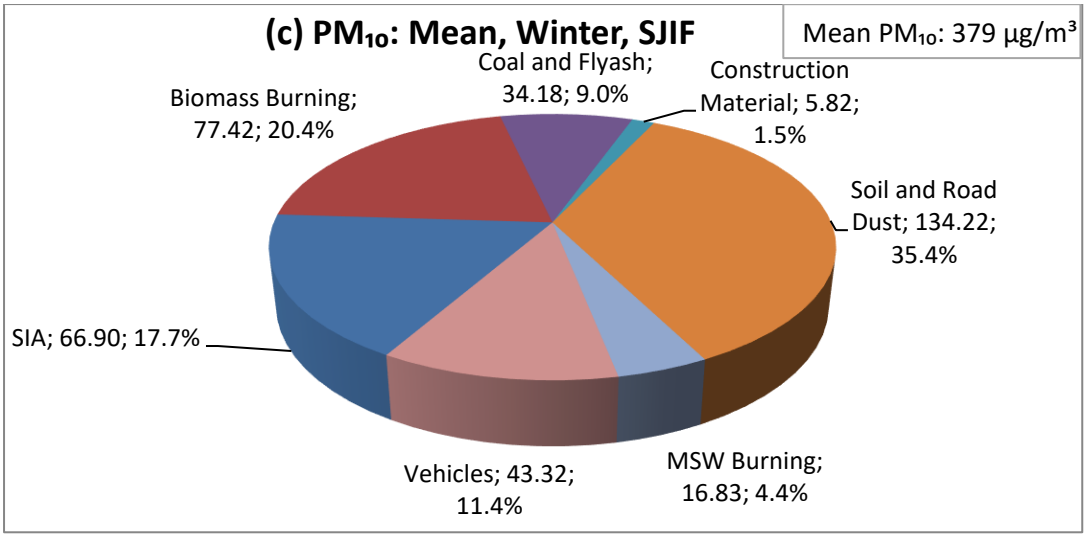
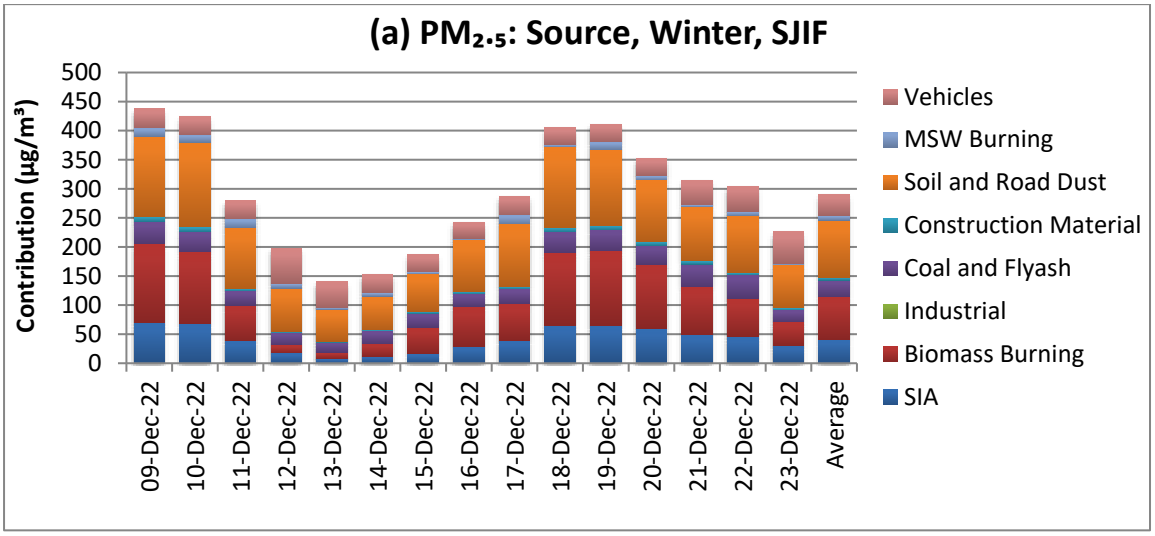
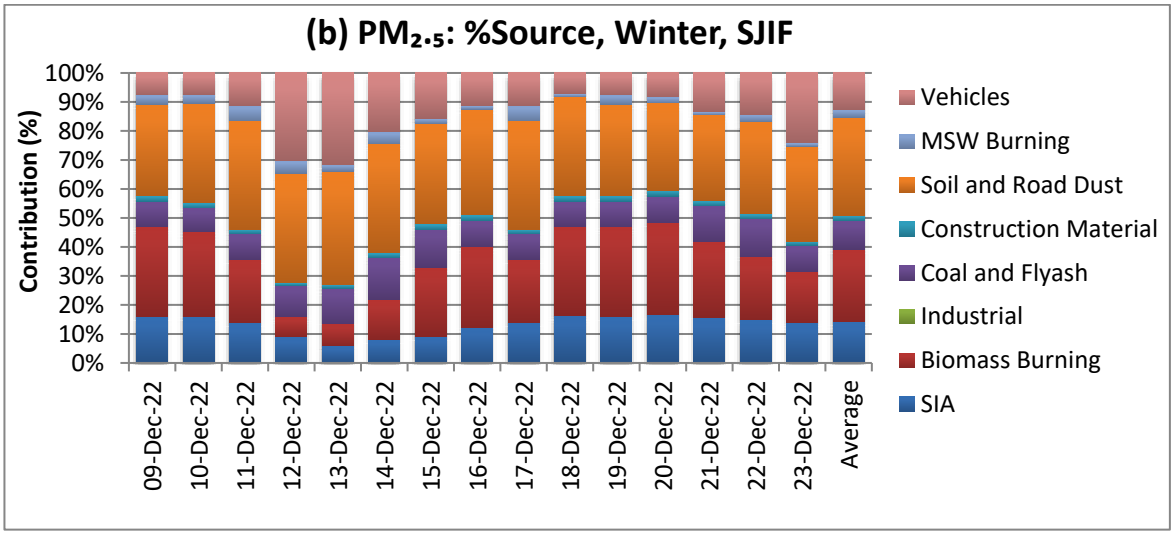


Figure 4.13: CMB modelling for PM_{10} at SJIF winter season





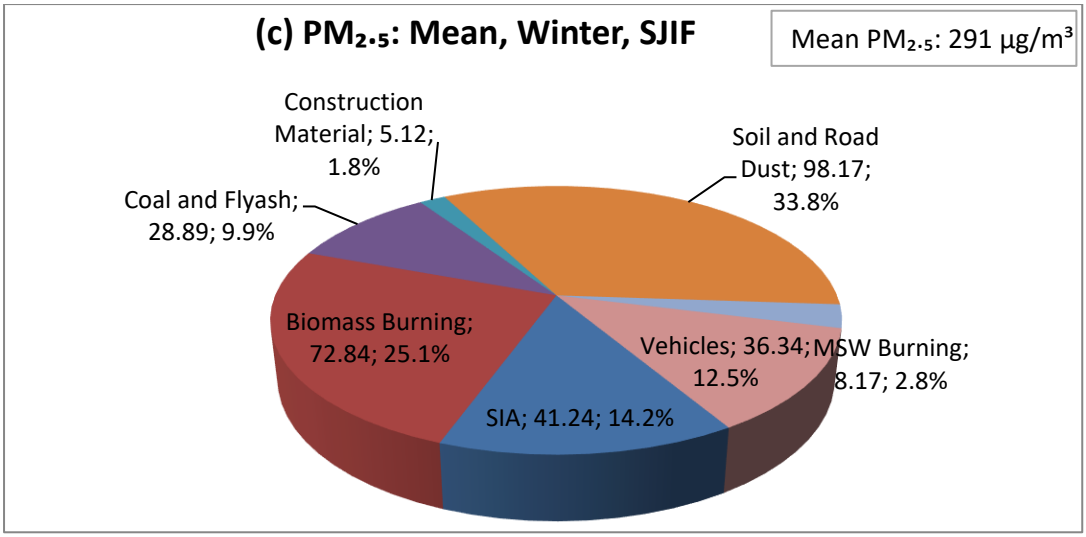


Figure 4.14: CMB modelling for $PM_{2.5}$ at SJIF, winter season

Table 4.5: Statistical summary: SJIF, winter season

	PM_{10} (µg/m³)				$PM_{2.5}$ (µg/m³)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	379	379	100.3	0.68	291	297	102.3	0.66
SD	99	97	2.6	0.06	100	102	3.0	0.09
CV	0.26	0.26	0.03	0.09	0.34	0.34	0.03	0.14
Maximum	545	539	104.3	0.78	437	435	106.4	0.84
Minimum	237	232	96.1	0.52	139	139	97.8	0.48

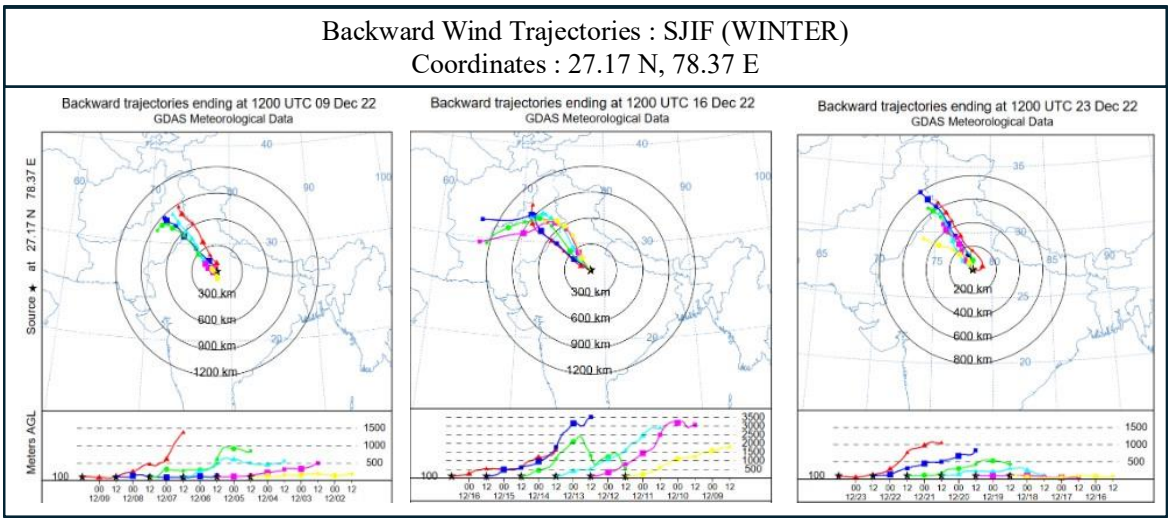


Figure 4.15: Backward trajectories at SJIF for winter season

Inferences

- Soil & road dust is the highest contributing source for both PM (36-34%).
- Secondary PM (17-14%) and biomass burning (20-23%) are the major sources followed by vehicular emission (12%) –for both PM_{10} and $PM_{2.5}$.

4.3.3.2 Summer Season [sampling period: May 19 - June 02, 2023]

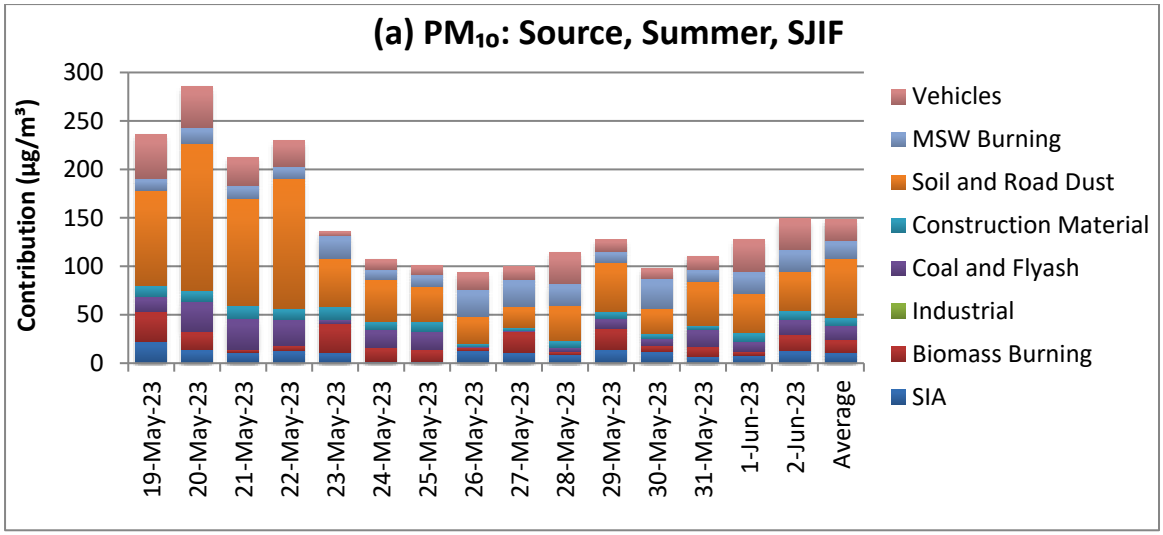
PM_{10} (summer)

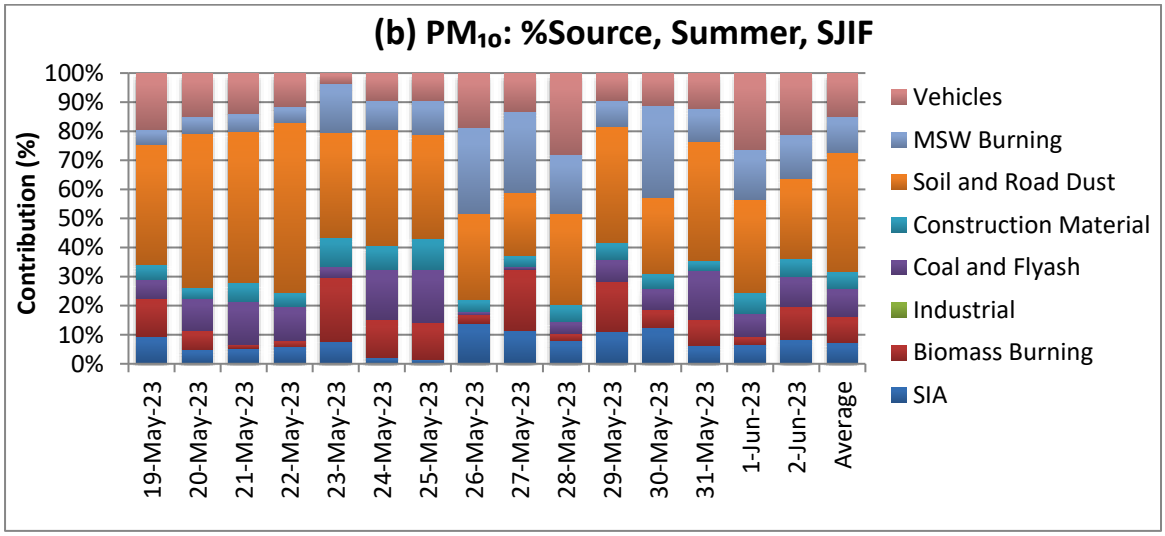
The average PM_{10} concentration was 148 μg/m^3. Figure 4.16 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at SJIF. Table 4.6 presents summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing was soil & road dust (61 μg/m^3 ~ 41%) followed by vehicular emission (22.2 μg/m^3 ~ 14.9%) in PM_{10}. The other significant sources are MSW burning (18.6 μg/m^3 ~ 12.5%), Coal & flyash (14 μg/m^3 ~ 10%), biomass burning (8.9%), SIA (7.3%) and construction material (5.7%). Contribution of the industrial emission was estimated zero in PM_{10}.

$PM_{2.5}$ (summer)

The average $PM_{2.5}$ concentration was 56 μg/m^3. Figure 4.17 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at SJIF. It is observed that the major source contributing in $PM_{2.5}$ was soil & road dust (18 μg/m^3 ~ 33%) followed by biomass burning (11.7 μg/m^3 ~ 20.7%). Other significant sources are vehicular emission (9.1 μg/m^3 ~ 16.1%), MSW burning (6.8 μg/m^3 ~ 12.1%), SIA (10.4%), coal & flyash (4 μg/m^3 ~ 6%), and construction material (1.5%). The contribution of the industrial emission was estimated zero in $PM_{2.5}$.

HYSPLIT back trajectories (Figure 4.18) show that most of the time wind is flowing irregularly and wind mass travels over Thar Desert before entering in Firozabad. These winds pick up the pollutants on the way, especially from tall and large sources.





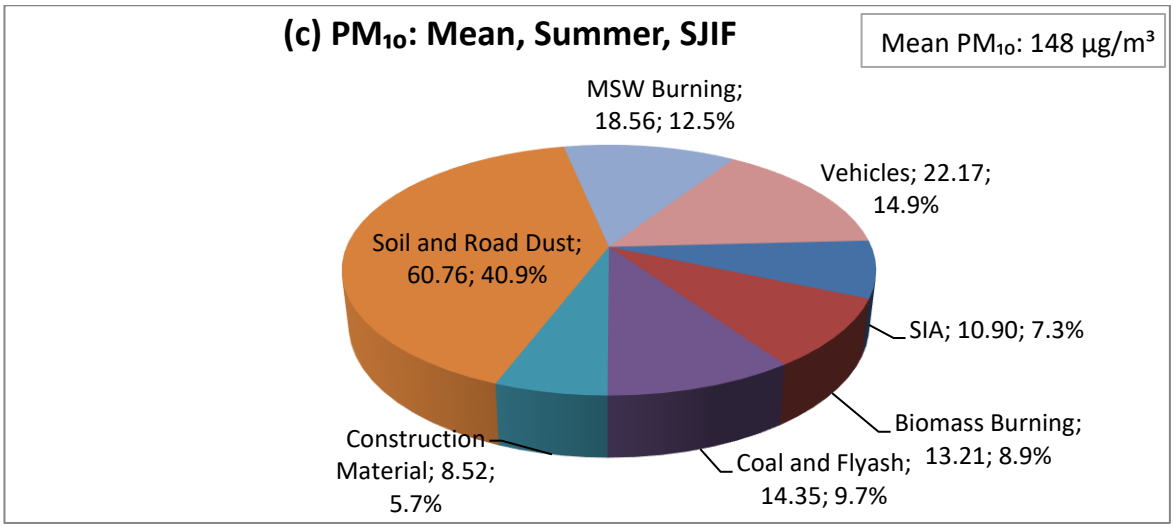


Figure 4.16: CMB modelling for PM_{10} at SJIF for summer season

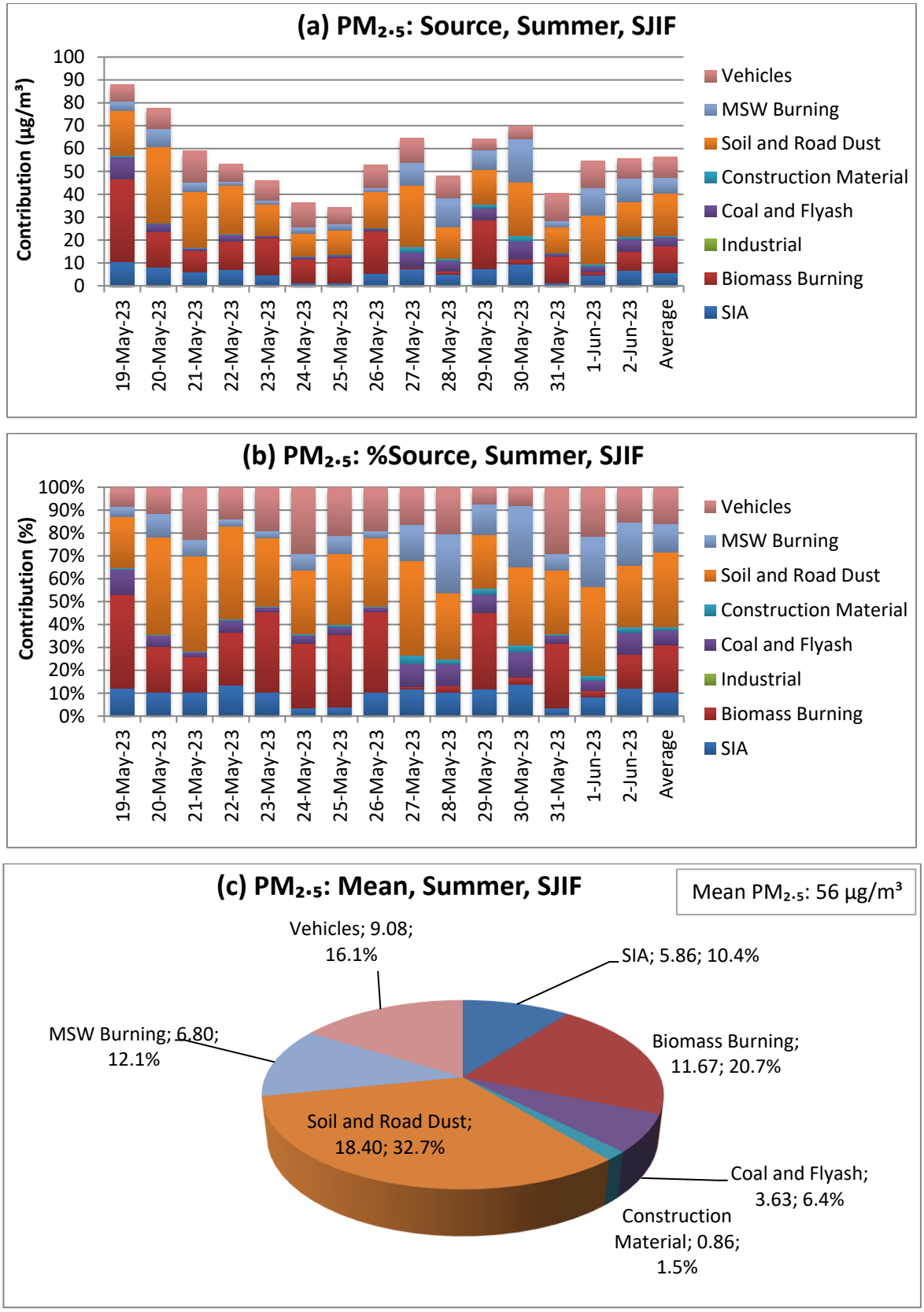


Figure 4.17: CMB modelling for $PM_{2.5}$ at SJIF for summer season

Table 4.6: Statistical summary: SJIF, summer season

	PM_{10} (µg/m^3)				$PM_{2.5}$ (µg/m^3)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	148	156	106.5	0.78	56	62	108.9	0.80
SD	61	61	6.3	0.10	15	18	6.0	0.10
CV	0.41	0.39	0.06	0.12	0.26	0.29	0.06	0.13
Maximum	286	310	118.7	0.94	88	102	117.9	0.97
Minimum	94	106	95.5	0.59	34	35	97.2	0.62

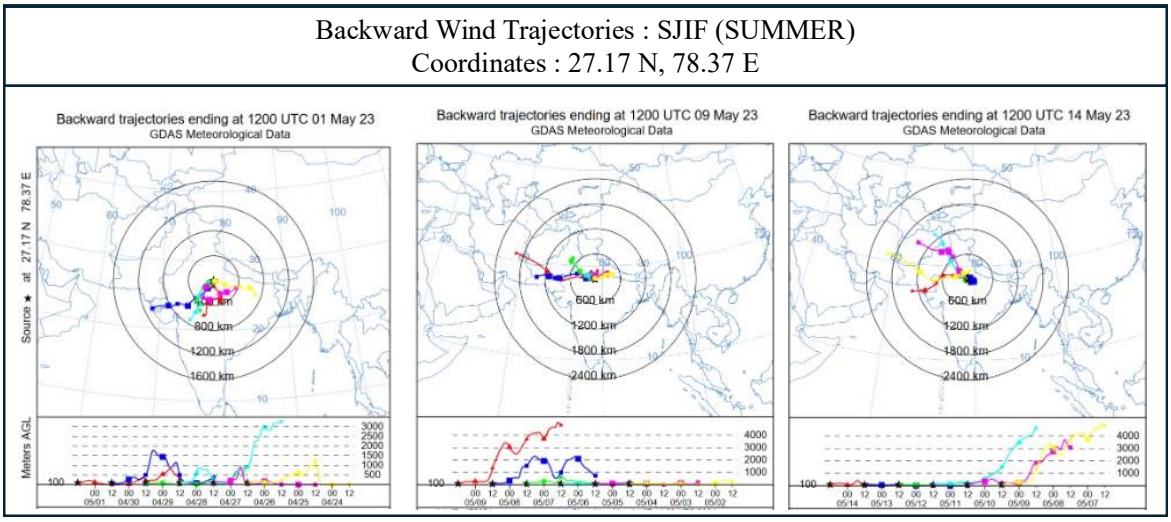


Figure 4.18: Backward trajectories at SJIF for summer season

Inference

Soil & road dust and biomass burning are the major contributors in summer both for PM_{10} and $PM_{2.5}$, at the same time MSW burning and vehicles are prominent both in PM_{10} and $PM_{2.5}$.

4.3.4 Gauri Shankar Kotla (GSKF)

4.3.4.1 Winter Season [sampling period: Dec. 14 – 29, 2022]

PM_{10} (winter)

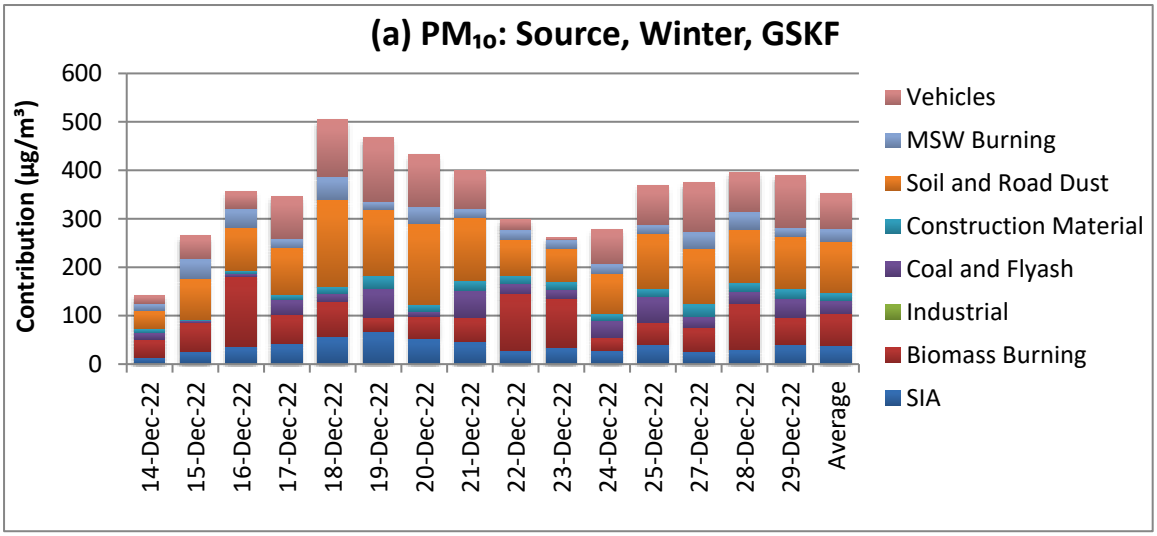
The average PM_{10} concentration was 352 µg/m^3. Figure 4.19 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GSKF. Table 4.7 presents summary of performance and acceptability of

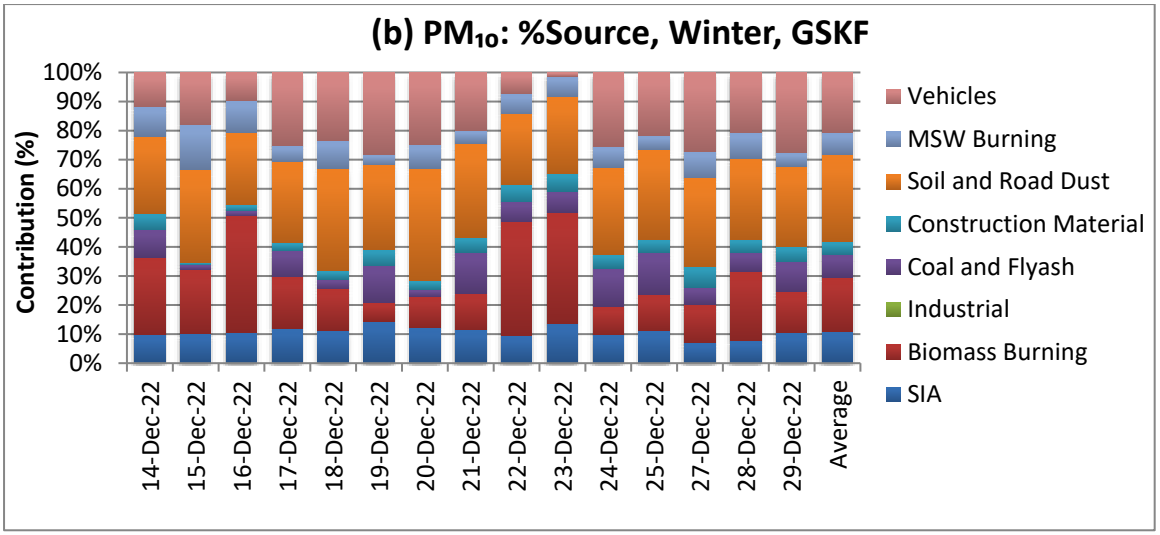
CMB model. It is observed that the major contributing source was soil & road dust (105 $\mu g/m^3$ ~ 30%) followed by vehicular emission (75 $\mu g/m^3$ ~ 20.6%) and biomass burning (66 $\mu g/m^3$ ~ 18.7%). The other significant contributing sources are SIA (38.2 $\mu g/m^3$ ~ 11%), MSW burning (26.5 $\mu g/m^3$ ~ 7.5%), coal and flyash (27 $\mu g/m^3$ ~ 8%) and construction material (4.4%). Contribution of the industrial emission was estimated to be zero in PM_{10}.

$PM_{2.5}$ (winter)

The average $PM_{2.5}$ concentration was 270 $\mu g/m^3$. Figure 4.20 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GSKF. It is observed that the major contributing source was vehicular emission (67.3 $\mu g/m^3$ ~ 25%) followed by biomass burning (62.2 $\mu g/m^3$ ~ 23%) and soil & road dust (57 $\mu g/m^3$ ~ 21%). The other significant contributing sources are SIA (35.4 $\mu g/m^3$ ~ 13.1%), MSW burning (7.4%), coal and flyash (18 $\mu g/m^3$ ~ 6.5%), and construction material (4.4%). Contribution of the industrial emission was estimated to be zero in $PM_{2.5}$.

HYSPLIT back trajectories (Figure 4.21) indicate that wind is flowing from NW direction. Wind can pick up pollutants on the way, especially from large sources (e.g. desert soil and crop residue burning (CRB)) and tall emitting sources, but these contributions have not been quantified.





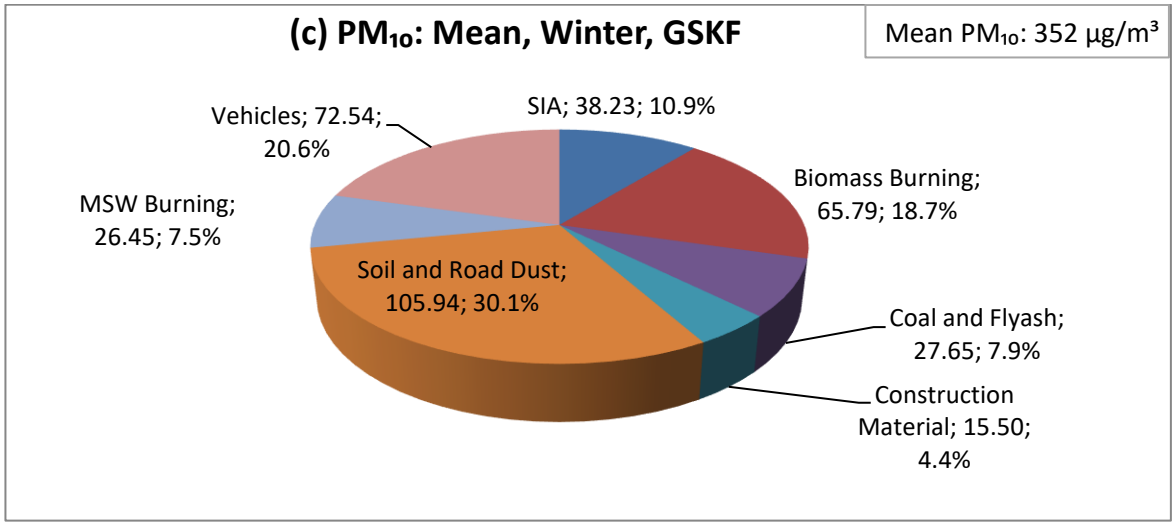
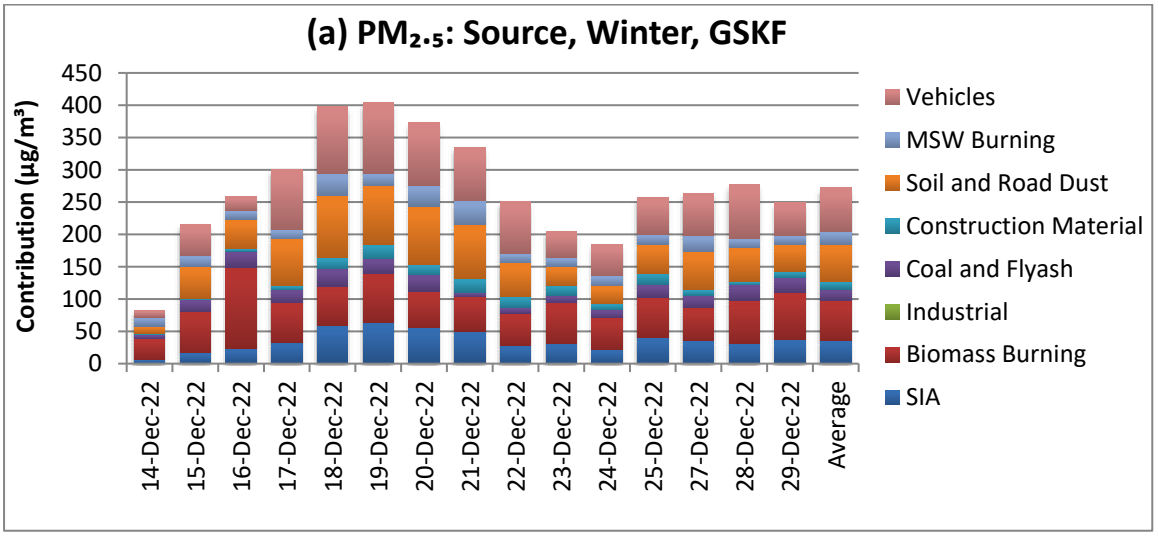
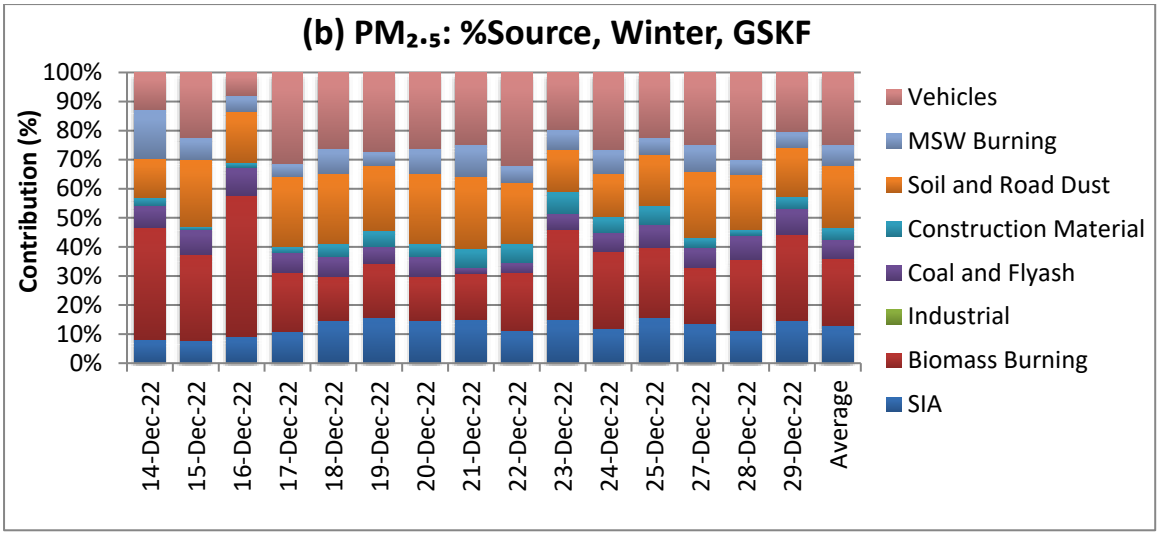


Figure 4.19: CMB modelling for PM_{10} at GSKF for winter season





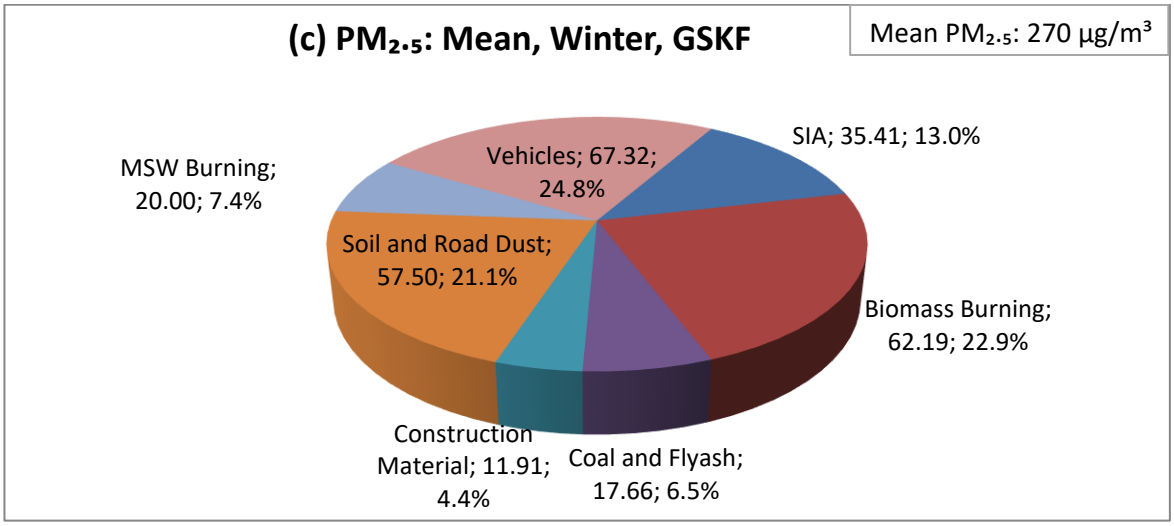


Figure 4.20: CMB modelling for $PM_{2.5}$ at GSKF for winter season

Table 4.7: Statistical summary: GSKF, winter season

	PM_{10} (µg/m³)				$PM_{2.5}$ (µg/m³)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	352	358	101.5	0.77	270	274	101.5	0.87
SD	92	94	3.0	0.09	86	87	5.4	0.05
CV	0.26	0.26	0.03	0.12	0.32	0.32	0.05	0.05
Maximum	505	493	106.8	0.95	405	406	111.2	0.93
Minimum	142	141	97.5	0.66	83	89	91.6	0.75

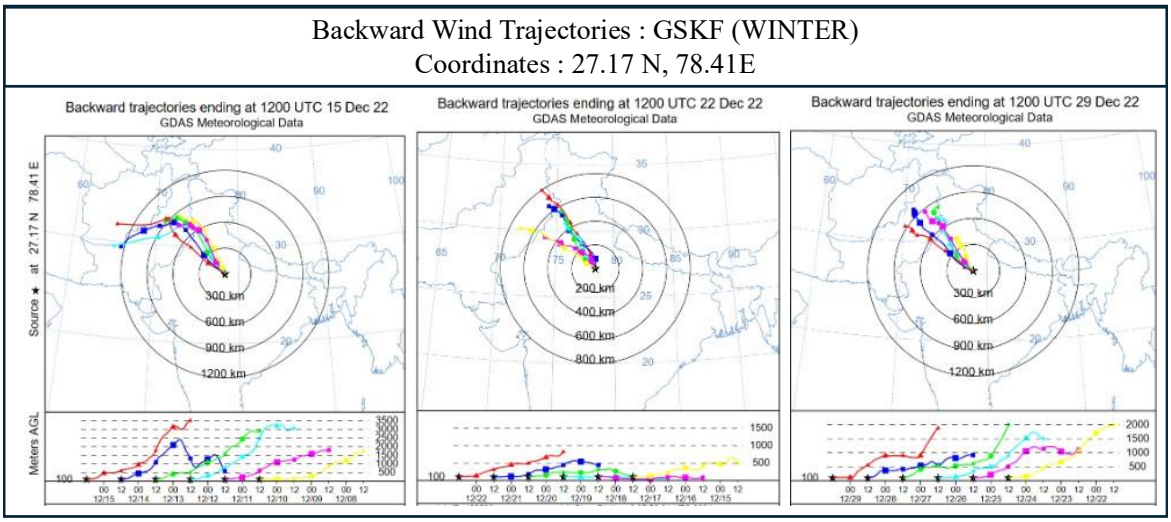


Figure 4.21: Backward trajectories at GSKF for winter season

Inference

Soil & road dust is major contributor in PM_{10}. Vehicular and biomass burning the other major sources for both PM. SIA is also contributing significantly to both PM.

4.3.4.2 Summer Season [sampling period: May 19 – June 01, 2023]

PM_{10} (summer)

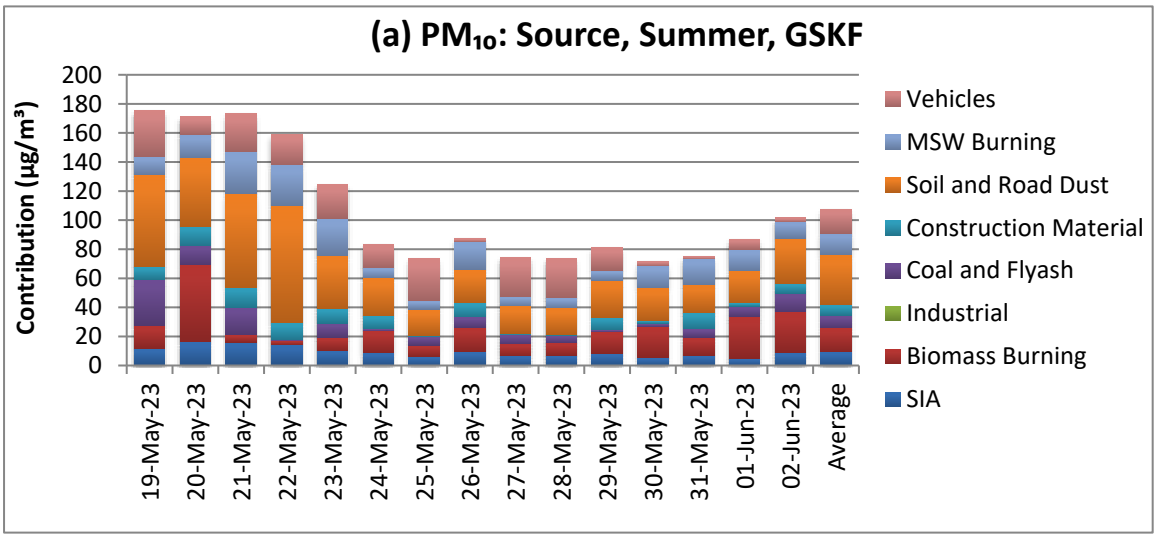
The average PM_{10} concentration was 107 µg/m^3. Figure 4.22 (a), (b), (c) represents PM_{10} contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GSKF. Table 4.8 presents summary of performance and acceptability of CMB model. It is observed that the major PM_{10} source contributing was soil & road dust (34 µg/m^3 ~ 32%) followed by Biomass burning (15.4 µg/m^3 ~ 15.3%). The other significant sources are vehicular emission (18.4 µg/m^3 ~ 15.2%), MSW burning (13.8%), SIA (8.8%), Coal & flyash (9 µg/m^3 ~ 8%) and construction materials (6.7%). Industrial emissions were zero in PM_{10}.

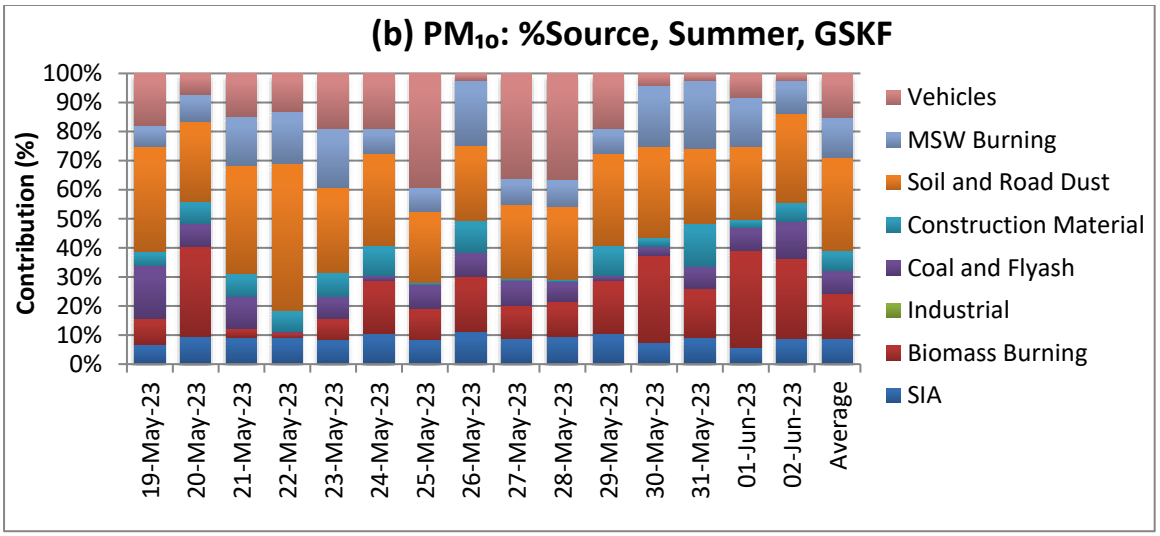
$PM_{2.5}$ (summer)

The average $PM_{2.5}$ concentration was 60 µg/m^3. Figure 4.23 (a), (b), (c) represents $PM_{2.5}$ contribution of sources in terms of concentration, percent contribution of sources and overall contribution (average over about 15 days) in terms of concentration and percentage respectively at GSKF. It is observed that the major source contributing in $PM_{2.5}$ was soil & road dust (15 µg/m^3 ~ 26%) followed by biomass burning (12 µg/m^3 ~ 20.1%). The other

significant sources are vehicular emission (10.8 µg/m^3 ~ 18.1%), MSW burning (14.5%) SIA (5 µg/m^3 ~ 9%), coal & flyash (8%), and construction materials (3.8%). Industrial emissions were zero in $PM_{2.5}$.

HYSPLIT back trajectories (Figure 4.24) show that most of the time wind is from NW and West. Wind mass travels over Thar Desert before entering in Firozabad. These winds pick up pollutants on the way especially from tall and large sources.





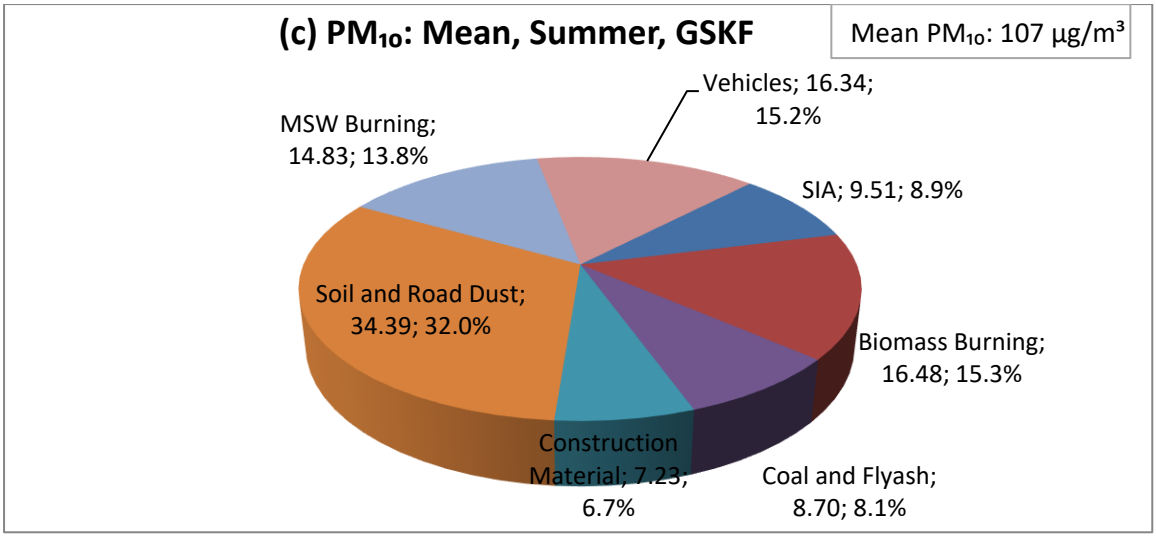
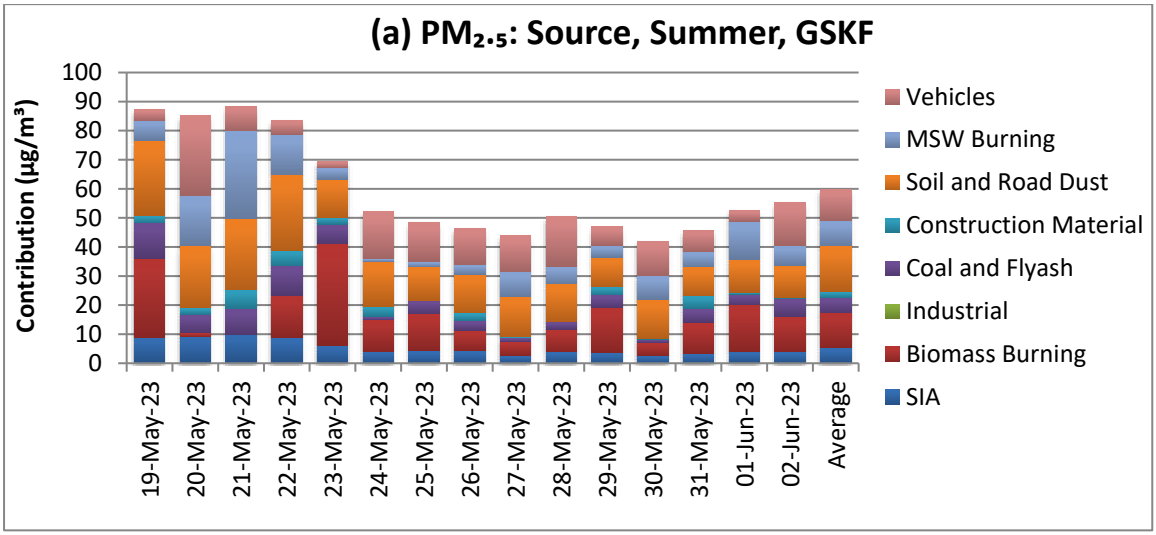
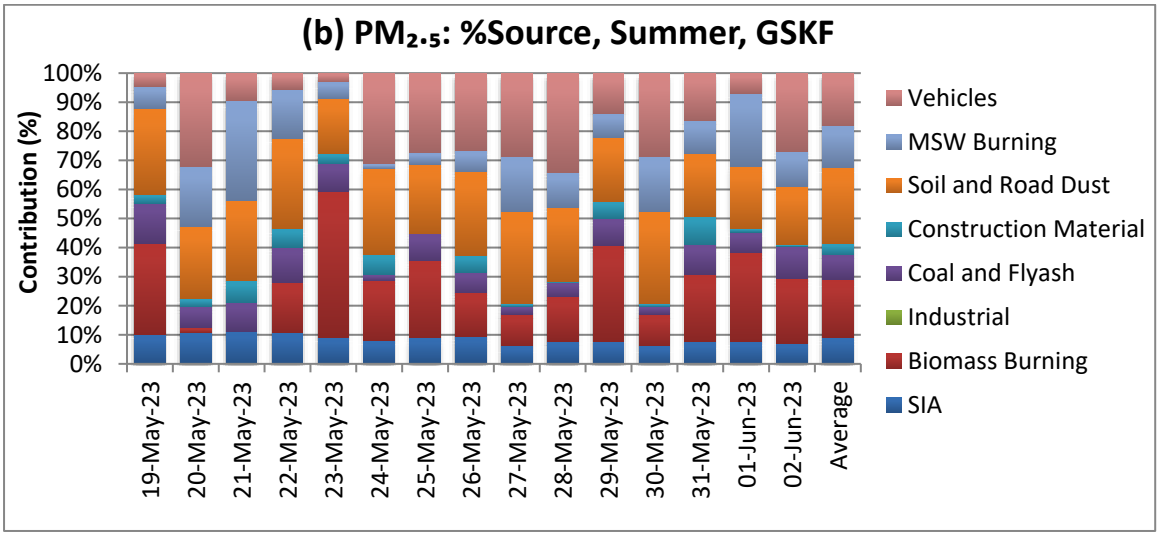


Figure 4.22: CMB modelling for PM_{10} at GSKF for summer season





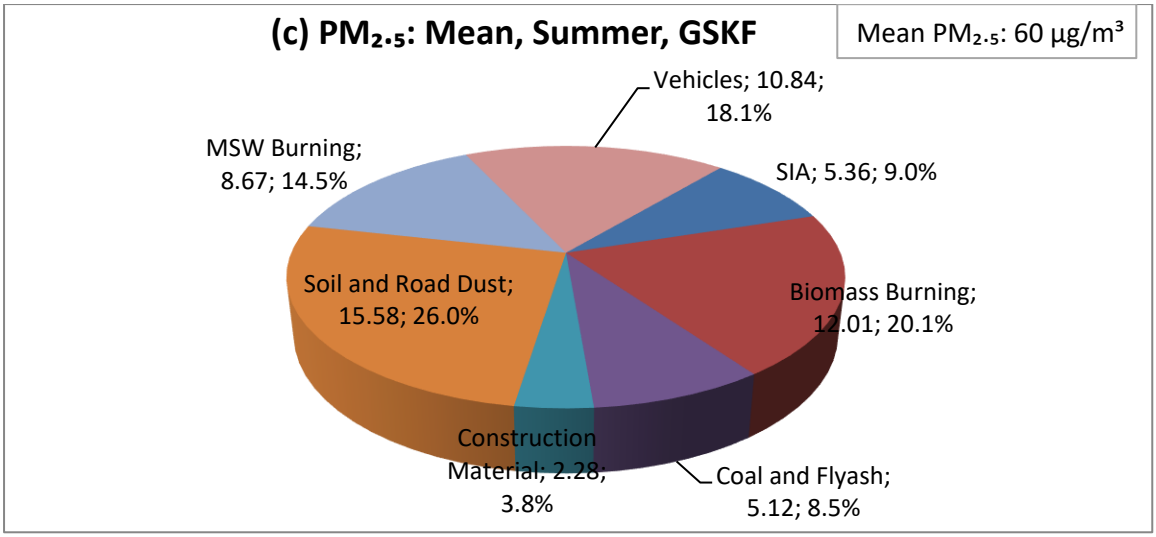


Figure 4.23: CMB modelling for $PM_{2.5}$ at GSKF for summer season

Table 4.8: Statistical summary: GSKF, summer season

	PM_{10} (µg/m³)				$PM_{2.5}$ (µg/m³)			
Parameter	Measured	Calculated	% Mass	R^2	Measured	Calculated	% Mass	R^2
Average	107	120	109.8	0.71	60	68	114.6	0.77
SD	41	46	5.4	0.15	18	17	10.1	0.09
CV	0.38	0.38	0.05	0.21	0.29	0.25	0.09	0.11
Maximum	176	195	118.3	0.93	88	99	129.5	0.93
Minimum	72	75	100.2	0.45	42	50	97.6	0.64

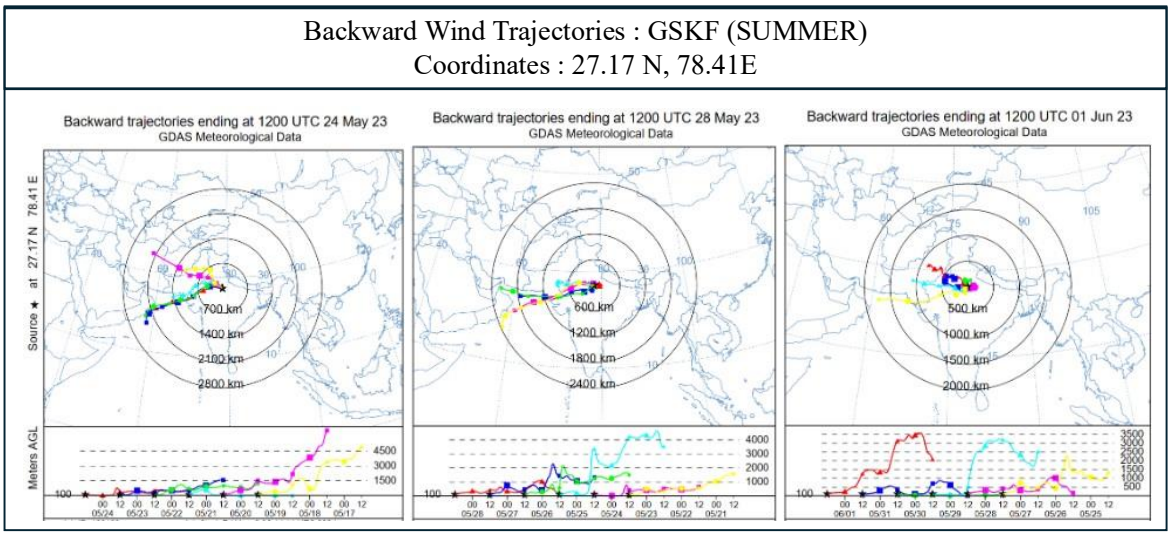


Figure 4.24: Backward trajectories at GSKF for summer season

Inference

In summer both PM_{10} and $PM_{2.5}$ emissions by soil & road dust, biomass burning, and vehicular emission are the major sources which requires control in fugitive sources.

4.4 Long range transport and contribution

HYSPLIT back trajectories show that most of the time wind is from NW (winter) and SW (summer) and sometimes from west. Wind mass as it travels over Thar desert and part of Punjab and Rajasthan State before entering Firozabad may pick up the pollutants on the way especially from large sources (e.g. desert soil and CRB) and tall emitting sources; however, these contributions have not been quantified. There is no assessment made on emissions upstream of Firozabad and their contribution.

4.5 Overall Summary and Source Apportionment at a Glance

The overall summary of CMB modelling results is shown in Figure 4.25 to Figure 4.27. Table 4.9 - Table 4.12 provide summary with overall statistics. The mail highlights of CMB results are summarized below.

- Ranges of source contribution to PM_{10} are secondary inorganic aerosols (SIA; 2 – 22 %), biomass burning (0 – 44 %), coal & flyash (0 – 18 %), soil & road dust (15 - 58 %), vehicles (1 – 50 %), MSW burning (2 – 32 %) and construction material (0 - 17 %).
- Ranges of source contribution to $PM_{2.5}$ are SIA (3 – 23 %), biomass burning (0 – 59 %), coal & flyash (1 – 17 %), soil & road dust (8 - 43 %), vehicles (3 – 53 %), MSW burning (1 – 36 %) and construction material (0 - 10 %).
- Contribution of SIA particles (PM_{10}: 11.21 – 7.9 % and $PM_{2.5}$: 14.98 – 9.47 %), biomass burning (PM_{10}: 14.48 – 12.95 % and $PM_{2.5}$: 20.91 – 19.32 %), are higher during winter season compared to summer season both in $PM_{2.5}$ and PM_{10}.
- Contribution of soil & road dust (PM_{10}: 36 – 30 % and $PM_{2.5}$: 27 – 26 %), construction material (PM_{10}: 5.39 – 2.9 % and $PM_{2.5}$: 2.85 – 2.64 %) and MSW burning (PM_{10}: 12.23 – 6.64 % and $PM_{2.5}$: 14.57 – 6.7 %) is higher during summer season compared to winter season.

- Contribution of vehicular emission higher in $PM_{2.5}$ (about 20 %) than PM_{10} (about 17%).

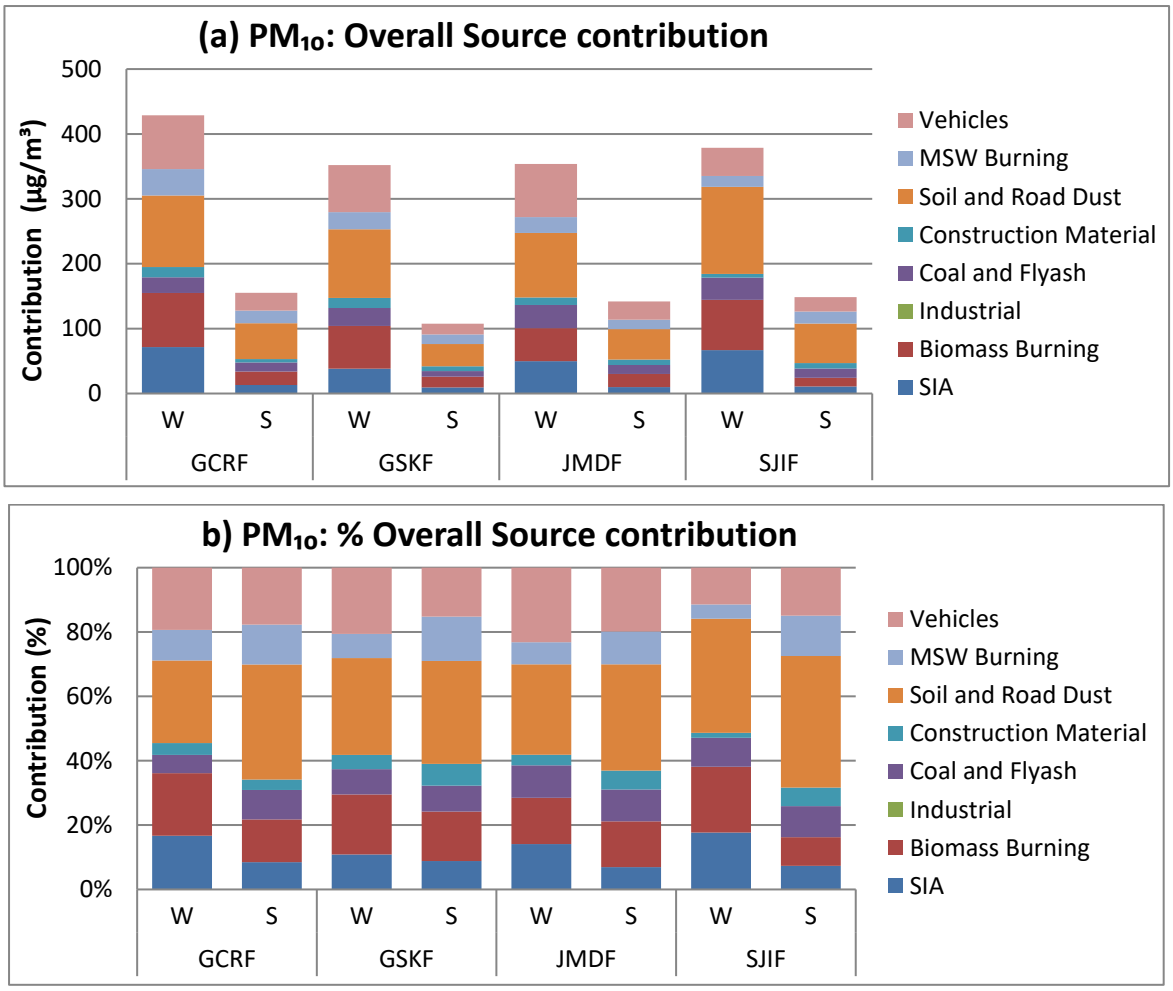
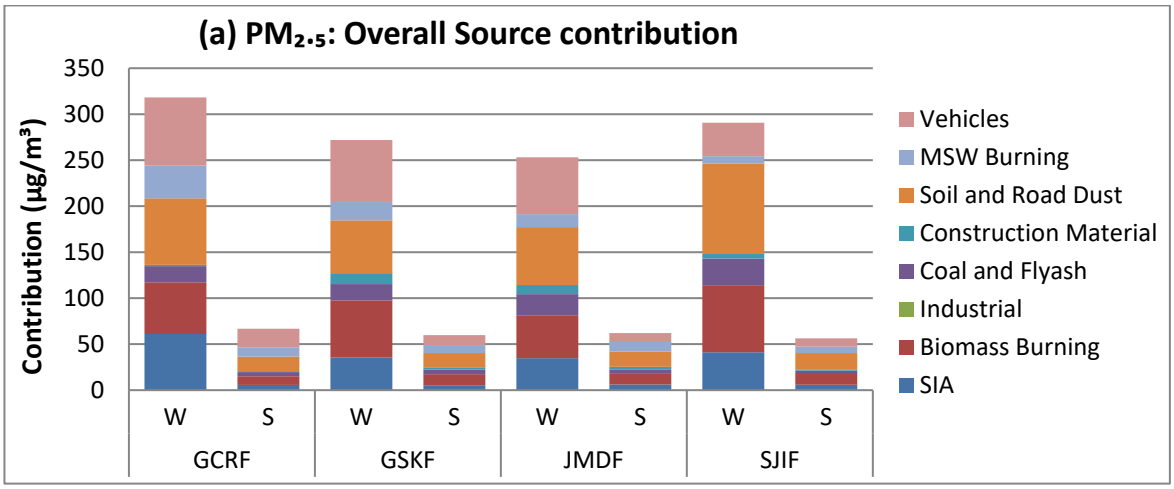


Figure 4.25: Overall results of CMB modelling for PM_{10}



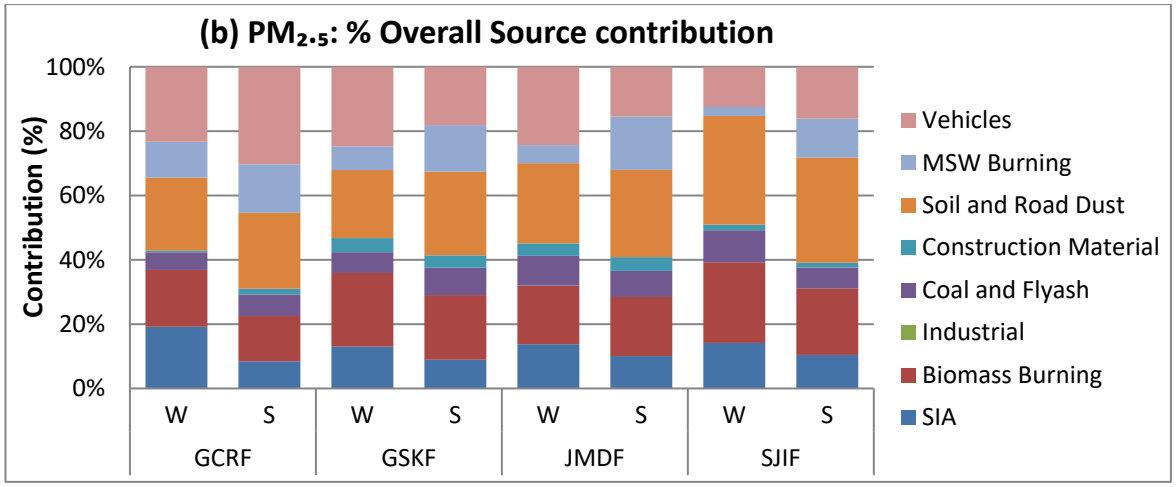
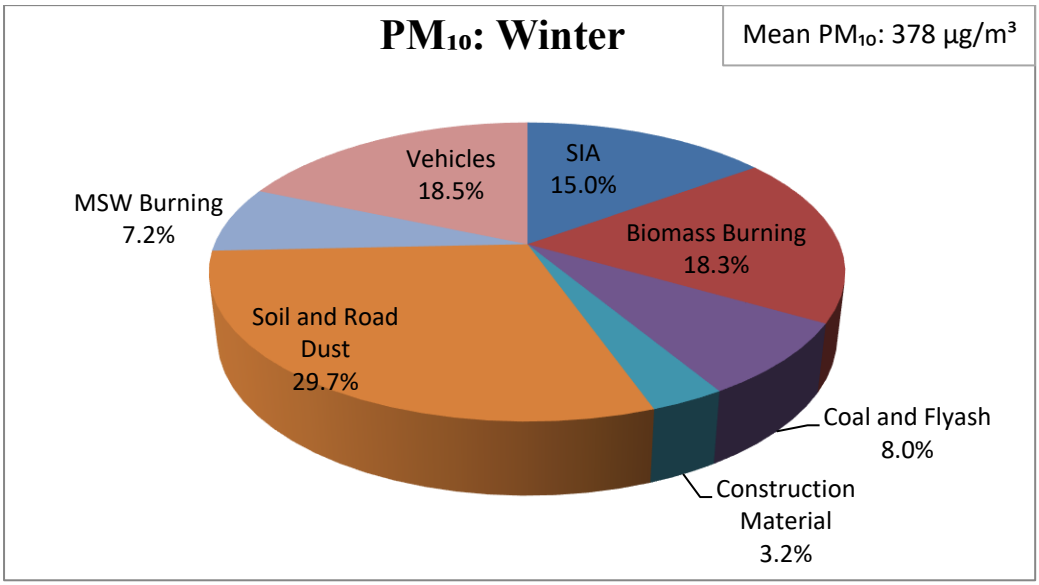
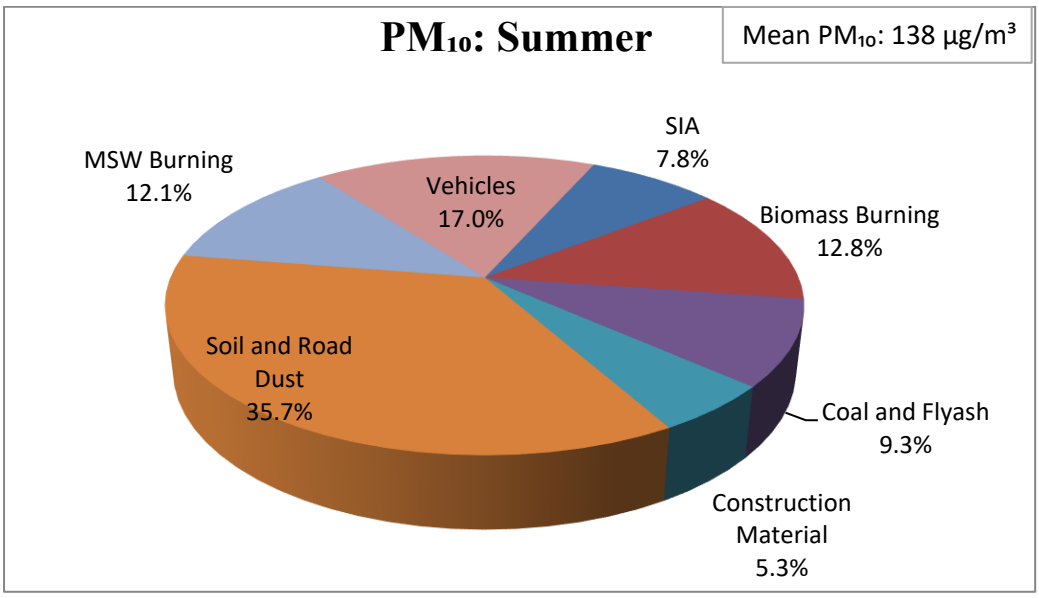


Figure 4.26: Overall results of CMB modelling for $PM_{2.5}$





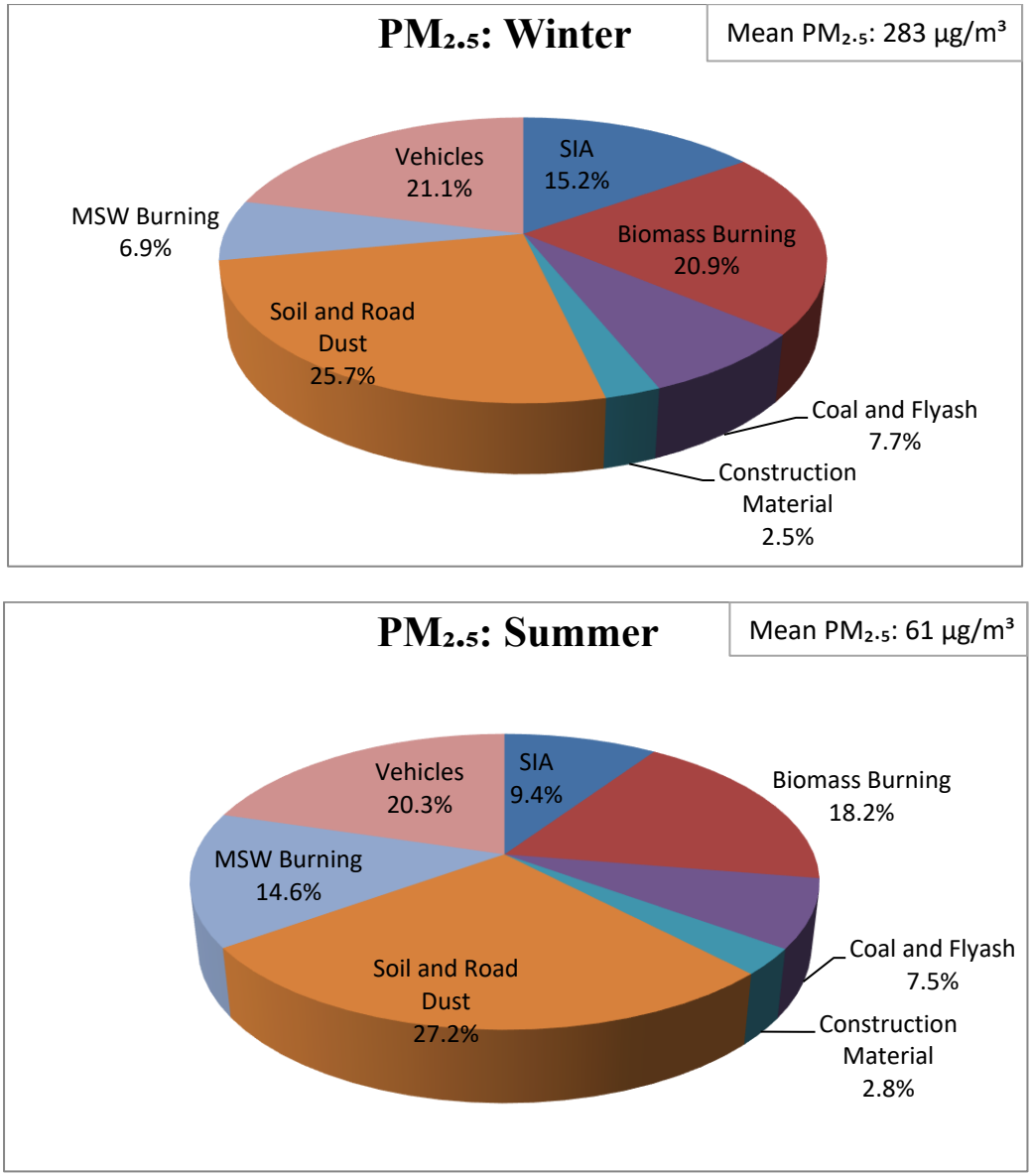


Figure 4.27: City level source contribution to ambient air PM_{10} and $PM_{2.5}$ levels

Table 4.9: Statistical summary of the source apportionment in PM_{10} for winter season

Site location	Parameter	Measured PM_{10} ($\mu g/m^3$)	Calculated PM_{10} ($\mu g/m^3$)	% Mass	R^2	% Source Contribution						
						SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
JMDF	Mean	429	419	98	0.82	16.7	19.5	5.6	3.7	25.7	9.5	19.3
	SD	78	74	4	0.10	3.3	15.1	3.1	4.4	7.5	4.9	16.9
	CV	0.18	0.18	0.04	0.12	0.2	0.8	0.6	1.2	0.3	0.5	0.9
	Max	525	523	104	0.97	20.8	39.1	11.1	17.0	42.0	21.4	49.7
	Min	271	271	90	0.66	10.7	0.0	0.7	0.0	18.7	5.2	1.7
GCRF	Mean	352	358	102	0.77	10.9	17.3	7.9	4.4	30.1	7.5	20.6
	SD	92	94	3	0.09	1.9	11.1	4.5	1.7	3.8	3.1	8.3
	CV	0.26	0.26	0.03	0.12	0.2	0.6	0.6	0.4	0.1	0.4	0.4
	Max	505	493	107	0.95	14.5	38.8	14.4	7.2	38.6	15.4	28.1
	Min	142	141	97	0.66	7.0	5.2	1.6	0.9	24.3	3.6	1.3
SJIF	Mean	354	358	101	0.73	14.1	14.4	10.1	3.3	28.1	6.9	23.2
	SD	94	93	4	0.08	3.8	9.1	3.1	1.7	4.1	3.2	5.4
	CV	0.27	0.26	0.03	0.11	0.3	0.6	0.3	0.5	0.1	0.5	0.2
	Max	541	545	109	0.87	20.9	29.2	14.2	6.2	37.5	15.8	31.2
	Min	226	226	96	0.52	7.3	0.9	2.3	0.4	21.1	2.7	14.7
GSKF	Mean	379	379	100	0.68	17.7	20.5	9.0	1.5	35.5	4.4	11.4
	SD	99	97	3	0.06	3.2	6.8	3.8	0.4	4.7	2.7	3.1
	CV	0.26	0.26	0.03	0.09	0.2	0.3	0.4	0.3	0.1	0.6	0.3
	Max	545	539	104	0.78	21.7	30.5	18.1	2.3	42.3	12.8	17.6
	Min	237	232	96	0.52	11.6	8.4	4.0	1.0	25.6	2.4	8.2

Table 4.10: Statistical summary of the source apportionment in PM_{10} for summer season

Site location	Parameter	Measured PM_{10} ($\mu g/m^3$)	Calculated PM_{10} ($\mu g/m^3$)	% Mass	R^2	% Source Contribution						
						SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	Mean	155	166	106	0.85	8.5	13.3	9.1	3.3	9.3	12.4	17.7
	SD	35	41	5	0.04	1.6	11.3	2.9	1.5	0.3	4.5	11.9
	CV	0.23	0.25	0.05	0.05	0.2	0.9	0.3	0.5	50.7	0.4	0.7
	Max	198	216	113	0.92	11.2	43.8	15.9	6.5	20.0	21.1	39.5
	Min	92	92	98	0.79	5.6	0.6	2.8	1.4	32.0	6.0	2.5
GSKF	Mean	107	120	110	0.71	8.8	15.3	8.1	6.7	6.9	13.8	15.2
	SD	41	46	5	0.15	1.4	10.1	4.5	4.3	0.2	5.9	12.6
	CV	0.38	0.38	0.05	0.21	0.2	0.7	0.6	0.6	50.7	0.4	0.8
	Max	176	195	118	0.93	11.1	33.1	18.1	14.7	24.2	23.1	39.3
	Min	72	75	100	0.45	5.8	1.8	0.3	0.8	33.0	7.1	2.4
JMDF	Mean	142	158	110	0.80	6.9	14.2	9.9	5.9	8.7	10.2	19.8
	SD	43	55	10	0.05	3.3	10.2	3.6	2.1	0.3	3.0	6.7
	CV	0.31	0.35	0.09	0.06	0.5	0.7	0.4	0.4	48.1	0.3	0.3
	Max	196	245	125	0.88	12.9	41.3	15.7	10.6	14.8	15.7	32.4
	Min	58	60	94	0.69	3.4	0.0	1.6	3.6	40.9	6.5	12.1
SJIF	Mean	148	156	106	0.78	7.3	8.9	9.7	5.7	10.5	12.5	14.9
	SD	61	61	6	0.10	3.6	6.9	5.7	2.2	0.3	9.0	6.7
	CV	0.41	0.39	0.06	0.12	0.5	0.8	0.6	0.4	58.3	0.7	0.4
	Max	286	310	119	0.94	14.0	22.0	18.4	10.4	21.6	31.6	28.0
	Min	94	106	96	0.59	1.6	1.4	1.0	3.5	17.3	5.0	3.5

Table 4.11: Statistical summary of the source apportionment in $PM_{2.5}$ for winter season

Site location	Parameter	Measured $PM_{2.5}$ ($\mu g/m^3$)	Calculated $PM_{2.5}$ ($\mu g/m^3$)	% Mass	R^2	% Source Contribution						
						SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	Mean	318	313	99	0.74	18.8	17.3	5.5	0.5	22.7	11.0	22.9
	SD	70	64	5	0.04	3.0	8.5	1.6	0.2	5.2	3.2	6.8
	CV	0.2	0.2	0.0	0.06	0.2	0.5	0.3	0.3	0.2	0.3	0.3
	Max	419	378	105	0.81	23.0	46.0	9.0	0.6	29.2	19.4	31.6
	Min	155	162	90	0.67	11.5	11.5	3.4	0.0	10.7	8.2	2.6
GSKF	Mean	270	274	102	0.87	13.1	23.0	6.5	4.4	21.3	7.4	25.0
	SD	86	87	5	0.05	2.8	9.7	2.0	2.1	4.1	3.2	6.7
	CV	0.3	0.3	0.1	0.05	0.2	0.4	0.3	0.5	0.2	0.4	0.3
	Max	405	406	111	0.93	15.7	48.5	9.8	7.6	24.7	16.7	32.0
	Min	83	89	92	0.75	8.1	15.1	2.0	1.3	13.4	4.6	8.0
JMDF	Mean	253	260	104	0.90	13.8	18.2	9.3	3.9	24.9	5.6	24.4
	SD	64	55	7	0.08	2.9	6.3	2.3	2.3	6.4	2.1	5.5
	CV	0.3	0.2	0.1	0.09	0.2	0.3	0.2	0.6	0.3	0.4	0.2
	Max	354	348	118	0.96	18.2	33.7	13.3	8.2	32.9	10.5	37.2
	Min	145	172	97	0.71	8.7	9.9	4.6	0.1	13.4	2.6	17.5
SJIF	Mean	291	297	102	0.66	14.2	25.1	9.9	1.8	33.8	2.8	12.5
	SD	100	102	3	0.09	3.5	8.2	2.1	0.3	3.1	1.5	8.2
	CV	0.3	0.3	0.0	0.14	0.2	0.3	0.2	0.2	0.1	0.5	0.7
	Max	437	435	106	0.84	16.8	31.6	14.6	2.0	39.3	5.4	31.8
	Min	139	139	98	0.48	6.0	7.0	8.3	1.1	29.6	1.1	7.0

Table 4.12: Statistical summary of the source apportionment in $PM_{2.5}$ for summer season

Site location	Parameter	Measured $PM_{2.5}$ ($\mu g/m^3$)	Calculated $PM_{2.5}$ ($\mu g/m^3$)	% Mass	R^2	% Source Contribution						
						SIA	Biomass Burning	Coal and Flyash	Constructio n Material	Soil & road dust	MSW Burning	Vehicles
GCRF	Mean	67	75	112	0.78	8.4	14.1	11.9	1.8	18.5	15.1	30.3
	SD	15	18	5	0.06	1.5	13.4	7.7	1.4	9.7	8.0	14.4
	CV	0.2	0.2	0.0	0.08	0.2	1.0	0.6	0.8	0.5	0.5	0.5
	Max	93	112	121	0.88	10.8	59.2	24.9	5.7	33.5	35.5	53.5
	Min	46	54	102	0.61	5.5	0.1	1.8	0.4	4.0	2.0	4.2
GSKF	Mean	60	68	115	0.77	9.0	20.1	17.1	3.8	26.1	14.5	18.1
	SD	18	17	10	0.09	1.6	13.0	7.1	3.1	4.4	8.8	11.4
	CV	0.3	0.2	0.1	0.11	0.2	0.6	0.4	0.8	0.2	0.6	0.6
	Max	88	99	130	0.93	11.3	51.0	27.9	9.7	31.6	34.3	34.0
	Min	42	50	98	0.64	6.3	0.0	4.3	0.1	19.3	1.6	3.1
JMDF	Mean	62	67	108	0.82	10.1	18.4	16.2	4.3	27.1	16.6	15.5
	SD	17	20	7	0.10	3.5	8.8	6.0	1.9	5.5	5.7	5.6
	CV	0.3	0.3	0.1	0.12	0.3	0.5	0.4	0.4	0.2	0.3	0.4
	Max	91	105	118	0.97	14.7	31.8	30.3	9.0	36.2	27.3	28.6
	Min	35	35	99	0.61	4.3	5.0	8.9	1.8	18.9	8.8	7.4
SJIF	Mean	56	62	109	0.80	10.4	20.7	12.9	1.5	32.7	12.1	16.1
	SD	15	18	6	0.10	3.5	13.7	7.0	1.2	6.9	8.3	6.9
	CV	0.3	0.3	0.1	0.13	0.3	0.7	0.5	0.8	0.2	0.7	0.4
	Max	88	102	118	0.97	13.9	40.8	22.0	3.9	42.8	27.1	29.1
	Min	34	35	97	0.62	3.5	1.0	3.7	0.3	22.3	3.1	7.4

Table 4.13: Concentration apportionment: winter PM_{10} (Concentration in µg/m^3)

Site location	PM_{10} (µg/m^3)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	429	71.6	83.4	24.2	15.7	110.2	40.7	82.9
GSKF	352	38.2	60.9	27.6	15.5	105.9	26.5	72.5
JMDF	354	49.9	50.8	35.7	11.6	99.4	24.3	81.9
SJIF	379	66.9	77.4	34.2	5.8	134.2	16.8	43.3
Overall	378	56.7	68.1	30.4	12.2	112.4	27.1	70.2
SD	36	15.4	15.0	5.4	4.6	15.2	10.0	18.5

Table 4.14: Concentration apportionment: winter $PM_{2.5}$ (Concentration in µg/m^3)

Site location	$PM_{2.5}$ (µg/m^3)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	318	60.0	55.1	17.6	1.5	72.3	34.9	72.8
GSKF	270	35.4	62.2	17.7	11.9	57.5	20.0	67.3
JMDF	253	34.8	46.1	23.5	9.9	63.0	14.2	61.7
SJIF	291	41.2	72.8	28.9	5.1	98.2	8.2	36.3
Overall	283	42.9	59.1	21.9	7.1	72.7	19.3	59.5
SD	28	11.8	11.3	5.4	4.7	18.0	11.4	16.1

Table 4.15: Percentage apportionment: winter PM_{10}

Site location	PM_{10} ($\mu g/m^3$)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	429	16.7	19.5	5.6	3.7	25.7	9.5	19.3
GSKF	352	10.9	17.3	7.9	4.4	30.1	7.5	20.6
JMDF	354	14.1	14.4	10.1	3.3	28.1	6.9	23.2
SJIF	379	17.7	20.5	9.0	1.5	35.5	4.4	11.4
Overall	378	14.8	17.9	8.0	3.2	29.7	7.1	18.6
SD	36	3.1	2.7	1.9	1.2	4.2	2.1	5.1

Table 4.16: Percentage apportionment: winter $PM_{2.5}$

Site location	$PM_{2.5}$ ($\mu g/m^3$)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	318	18.8	17.3	5.5	0.5	22.7	11.0	22.9
GSKF	270	13.1	23.0	6.5	4.4	21.3	7.4	25.0
JMDF	253	13.8	18.2	9.3	3.9	24.9	5.6	24.4
SJIF	291	14.2	25.1	9.9	1.8	33.8	2.8	12.5
Overall	283	15.0	20.9	7.7	2.6	25.7	6.7	21.2
SD	28	2.6	3.7	2.1	1.8	4.7	3.4	5.8

Table 4.17: Concentration apportionment: summer PM_{10} (Concentration in µg/m^3)

Site location	PM_{10} (µg/m^3)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	155	13.2	20.6	14.1	5.0	55.4	19.3	27.4
GSKF	107	9.5	16.5	8.7	7.2	34.4	14.8	16.3
JMDF	142	9.8	20.2	14.0	8.3	46.9	14.5	28.1
SJIF	148	10.9	13.2	14.3	8.5	60.8	18.6	22.2
Overall	138	10.9	17.6	12.8	7.3	49.4	16.8	23.5
SD	21	1.7	3.5	2.7	1.6	11.5	2.5	5.5

Table 4.18: Concentration apportionment: summer $PM_{2.5}$ (Concentration in µg/m^3)

Site location	$PM_{2.5}$ (µg/m^3)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	67	5.6	9.4	7.9	1.2	12.3	10.1	20.2
GSKF	60	5.4	12.0	5.1	2.3	15.6	8.7	10.8
JMDF	62	6.2	11.4	5.0	2.7	16.8	10.3	9.6
SJIF	56	5.9	11.7	3.6	0.9	18.4	6.8	9.1
Overall	61	5.8	11.1	5.4	1.7	15.8	9.0	12.4
SD	4	0.4	1.2	1.8	0.9	2.6	1.6	5.2

Table 4.19: Percentage apportionment: summer PM_{10}

Site location	PM_{10} ($\mu g/m^3$)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	155	8.5	13.3	9.1	3.3	35.7	12.4	17.7
GSKF	107	8.8	15.3	8.1	6.7	32.0	13.8	15.2
JMDF	142	6.9	14.2	9.9	5.9	33.0	10.2	19.8
SJIF	148	7.3	8.9	9.7	5.7	40.9	12.5	14.9
Overall	138	7.9	12.9	9.3	5.4	35.7	12.2	16.9
SD	21	0.9	2.8	0.8	1.5	4.0	1.5	2.3

Table 4.20: Percentage apportionment: summer $PM_{2.5}$

Site location	$PM_{2.5}$ ($\mu g/m^3$)	SIA	Biomass Burning	Coal and Flyash	Construction Material	Soil & road dust	MSW Burning	Vehicles
GCRF	67	8.4	14.1	11.9	1.8	18.5	15.1	30.3
GSKF	60	9.0	20.1	8.6	3.8	26.1	14.5	18.1
JMDF	62	10.1	18.4	8.1	4.3	27.1	16.6	15.5
SJIF	56	10.4	20.7	6.4	1.5	32.7	12.1	16.1
Overall	61	9.5	18.3	8.9	2.8	25.8	14.6	20.0
Std	4	0.9	3.0	2.1	1.4	5.6	1.9	7.0

4.6 Interpretations and Inferences

Based on the CMB modelling results (Figure 4.27) and their critical analyses, the following inferences and insights are drawn to establish quantified source-receptor impacts and to pave the path for preparation of action plan. Table 4.13 to Table 4.18, show season-wise, site specific average source contribution to PM_{10} and $PM_{2.5}$, and these tables are frequently referred to bring the important inferences to the fore.

- The sources of PM_{10} and $PM_{2.5}$ contributing to ambient air quality are different in summer and winter.
    - The winter sources (% contribution given in parenthesis for PM_{10} - $PM_{2.5}$ to the ambient air levels) include soil & road dust (30 – 26 %), SIA particles (15 – 15.2%), biomass burning (18 – 21%), vehicles (18.5 - 21%) and MSW burning (7.2 – 6.8%). It is noteworthy, in winter; major sources for PM_{10} and $PM_{2.5}$ are generally the same.
    - The summer sources (% contribution given in parenthesis for PM_{10} - $PM_{2.5}$ to the ambient air level) include soil & road dust (36 – 27%), biomass burning (12 - 18%), vehicles (17 – 20%), MSW burning (12.1 – 14.7%), coal & flyash (9 – 7%) and SIA particles (7.8 – 9.5%). It is noteworthy, in summer also, the major sources for PM_{10} and $PM_{2.5}$ are generally the same.
- The consistent presence of SIA, biomass burning and vehicles in PM_{10} and $PM_{2.5}$ across all sites and in two seasons, suggests these particles encompass entire Firozabad region as a layer.
- Like the above point, in winter, consistent presence of soil & road dust encompasses entire Firozabad region as a layer.
- Soil & road dust in summer contribute 36– 27% and the coal & flyash contribute 9 – 7% to PM_{10} and $PM_{2.5}$. It is observed that in summer the atmosphere looks whitish to grayish indicating presence of large amounts of dust; re-suspension of dust appears to be the cause of large contribution of these sources. This hypothesis can be argued from the fact that the contribution of flyash and road dust reduces both in PM_{10} and $PM_{2.5}$ in winter when winds are low and prevalent atmospheric conditions are calm.
- The contribution of the biomass burning in winter is quite high at 18% (for PM_{10}) 21% (for $PM_{2.5}$). The presence of sizeable biomass is consistent in PM both winter and

summer indicates to local sources present in Firozabad and nearby areas. There is an immediate need to control or find alternatives to eliminate biomass emissions to observe any significant improvement in air quality in Firozabad.

- MSW burning is contributing exceptionally high to both PM_{10} and $PM_{2.5}$. This emission is expected to be large in the regions of economically lower strata of society which does not have proper infrastructure for collection and disposal of MSW.

Directions for PM control

- Secondary particles

  What are the sources of secondary particles, the major contributors to Firozabad's PM? These particles are expected to source from precursor gases (SO_2, and NO_x) which are chemically transformed into particles in the atmosphere. Mostly the precursor gases are emitted from far distances from large sources. For sulfates, the major contribution can be attributed to large power plants and refineries. However, contribution of NO_x from local sources, especially vehicles and power plants can also contribute to nitrates. Behera and Sharma (2010) for Kanpur have concluded that secondary inorganic aerosol accounted for significant mass of $PM_{2.5}$ (about 34%) and any particulate control strategy should also include control of primary precursor gases.

- Vehicular pollution

  This source is the fourth largest source and most consistently contributing source to PM_{10} and $PM_{2.5}$ in winters. Various control options include the implementation of Euro VI, introduction of electric and hybrid vehicles, traffic planning and restriction of movement of vehicles, retro fitment in diesel exhaust, improvement in public transport etc. These options are further discussed in Chapter 5.

- Biomass burning

  Biomass burning should be minimized if not completely stopped. Possibly it could be switched to cleaner fuel for domestic fuel, local bakery and hotels industries and other local thermal energy consuming industries in industries. All biomass burning in Firozabad should be banned and strictly implemented.

- MSW burning

One of the reasons for burning MSW is lack of infrastructure for timely collection of MSW and people conveniently burn, or it may smolder slowly for a long time. In this regard, infrastructure for collection and disposal of MSW must improve and burning of MSW should be completely banned.

- Coal and flyash

  In summer coal & flyash contribute about 9.3 percent of PM_{10} and unless sources contributing to flyash are controlled, one cannot expect improvement in air quality. It appears these sources are more of fugitive in nature than regular point sources. Flyash emission from hotels, restaurants and tandoors also cause large emissions and requires better housekeeping and flyash disposal.

- Soil & road dust

  In summer this source contributes about 30 % to PM_{10}. The silt load on some of the Firozabad's Road is very high and silt can become airborne with the movement of vehicles. The estimated PM_{10} emission from road dust is over 12.7 tons per day. Similarly soil from the open fields gets airborne in summer. The potential control options can be sweeping and watering of roads, better construction and maintenance, growing plants, grass etc. to prevent resuspension of dust.

The effectiveness of the pollution control options and selection of optimal mix of control options are analyzed in Chapter 6.

5 Carrying Capacity

The concept of carrying capacity is defined as the ability of a region's environment and resources to support the threshold of human activities for a specific period (Peng and Linyu 2012). Therefore, it is an effective spatial and environmental planning and management tool. The carrying capacity theory has been widely applied in environmental planning and management and has played an important role in city resources, environmental management, and territorial spatial planning. For example, based on the regional water resource carrying capacity evaluation results, Wang (2013) and Yang (2014) pointed out that rapid population growth could aggravate water resource crises and limit regional economic growth. They also suggested that restrictive classification of water resources was required to guide rational regional development. Similarly, evaluations of the forest resource carrying capacity and eco-environment carrying capacity also revealed that environmental pollution and resource shortages restrict regional economic development (Specht, 1993). All these studies have provided a theoretical basis for territorial spatial planning and sustainable development of the regional social economy.

Most existing studies in this field have focused on evaluating the carrying capacity of a single factor. However, as a system, a region requires comprehensive and balanced development of the economy, society, environment, and resources (Ng and Obbard, 2005). Therefore, a comprehensive evaluation of the regional resource and environmental carrying capacity (RECC) is necessary to investigate the interactive mechanisms between social and economic factors and resource and environmental factors (Liu and Borthwick, 2011). The evaluation indices, multiple aspects such as resource size, economy and society, and ecological environment, should be considered (Tang et. Al, 2016). The framework of carrying capacity is shown in Figure 5.1.

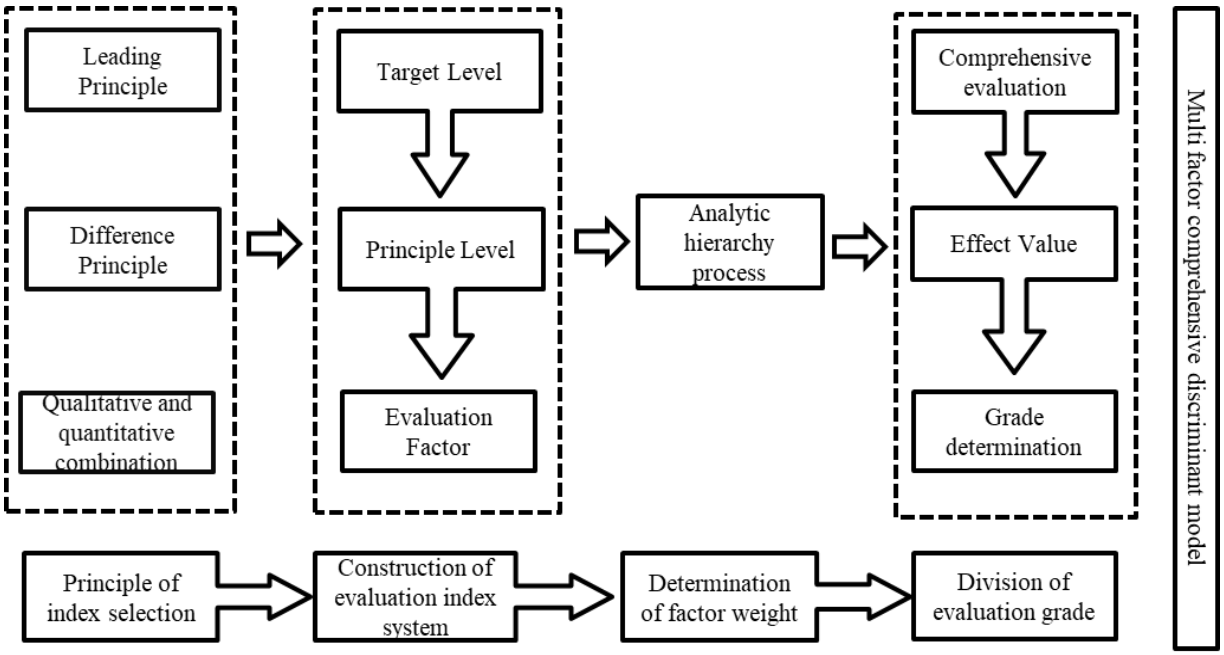


Figure 5.1: The multi-index multi-factor synthetic discriminant model for the evaluation of the RECC (Kaiyuan Li, 2019)

5.1 Approach for Quantifying Carrying Capacity

As shown in the EI section, the following emission sources were inventoried:

- **a)** Domestic fuel uses (LPG, dung, biomass coal etc.) and emission
- **b)** Coal-based tandoors in the hotels, restaurants and dhabas and other areas
- **c)** Fuel and processes used in the industries in the boilers, furnaces and heating purposes.
- **d)** Municipal waste burning incinerators, biomedical incinerators and hazardous waste incinerators
- **e)** Vehicle emissions
- **f)** Construction activities in the region.
- **g)** Soil and road dust and from paved and unpaved roads.

5.1.1 Assessment of Carrying Capacity

Atmospheric Assimilation Capacity

Various approaches are described in the literature for estimating the atmospheric assimilative capacity of a region. Goyal et al. (2006) proposed two approaches, one based on a ventilation coefficient, the other through pollution potential. Here we are discussing the atmospheric assimilative capacity using a simple Box Model.

A simple box model based on mass balance and assuming that all pollutants in the box are uniformly mixed (Figure 5.2). It is a simple model and has several limitations; however, to demonstrate the framework and preliminary analysis, the model may provide broad estimates of carrying capacity. Mathematically, the model can be described as below:

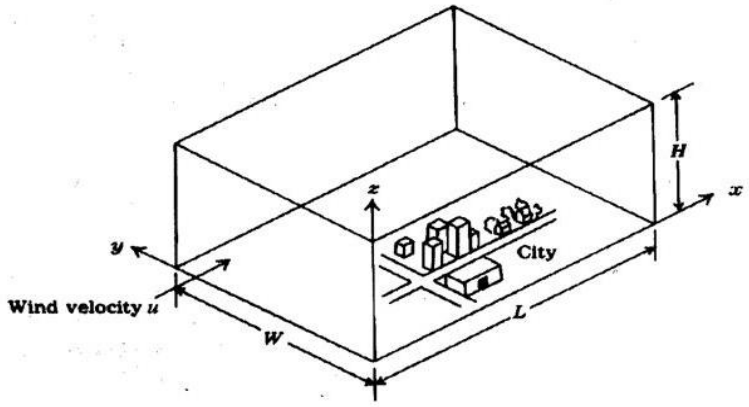


Figure 5.2: Schematic of box model (De Nevers, 1995)

Mathematically,

$$V\frac{dc}{dt} = qC_{in} - qC_{out} + S - K_{dd}\,CLW - K_{cr}\,C_{out}V \qquad \text{..... Equation 5}$$

where, q = volumetric flow rate (m^3/sec)

C_{in} = influent concentration of a pollutant (g/m^3)

C_{out} = effluent concentration of a pollutant (g/m^3)

K_{dd} = dry deposition velocity (m /sec)

K_{cr} = First order chemical reaction constant (1/sec)

S = source emission rate(g/sec)

K_{dd}.C.L.W = the amount of pollutants removed by dry deposition (g/sec)

K_{cr}.C.V = the amount of pollutants converted by chemical reaction (g/sec)

u = wind speed (m/sec)

In the equation, V=L×W×H volume of City m^3 (L: length (m), W; Width (m), H; height (m))

The model is further simplified with the following assumptions:

- Steady-state condition (i.e. concentration is time-invariant); dc/dt = 0
- Pollutant is not subjected to deposition in the box; k_{dd} = 0

- Pollutant does not undergo any chemical transformation: $K_{cr} = 0$

One can estimate the carrying capacity, Q_{cc} as per the following equation:

$$Q_{cc} = (C\text{-}Co) \times u.W.H \quad \text{..... } \textbf{Equation 6}$$

In this calculation,

Area (A) of the system boundary, Width (W) of the System boundary, mixing height (H) (average for winter and summer) within the system boundary, Wind Speed (s) within the system boundary are required.

Background concentration (C_0) into the system boundary is also required; in this case, it was assumed to be negligible.

Alternatively, the multi-source simulation model may be used to estimate atmospheric assimilative capacity based on air quality modelling, which considers region-specific meteorological conditions, terrain characteristics, and emission loads from different sources. Following Goyal and Chalapati Rao (2007), the discharge emission load at which the maximum allowable concentration is reached under predefined critical conditions is taken to be the assimilative capacity of the region. Prediction of ground-level concentrations of pollutants is carried out using the US EPA-approved ISCST-3 simulation model (EPA, 1995a, 1995b). It should be noted that the atmospheric assimilative capacity has a range of values, depending on the variation of emission characteristics with given meteorological and topographical conditions. We have used the advanced US EPA model, American Environmental Protection Agency Regulatory Model (AERMOD, 2006), in place of ISCST-3.

The overall methodology for estimating the carrying capacity of the city and major tasks are given in Figure 5.3.

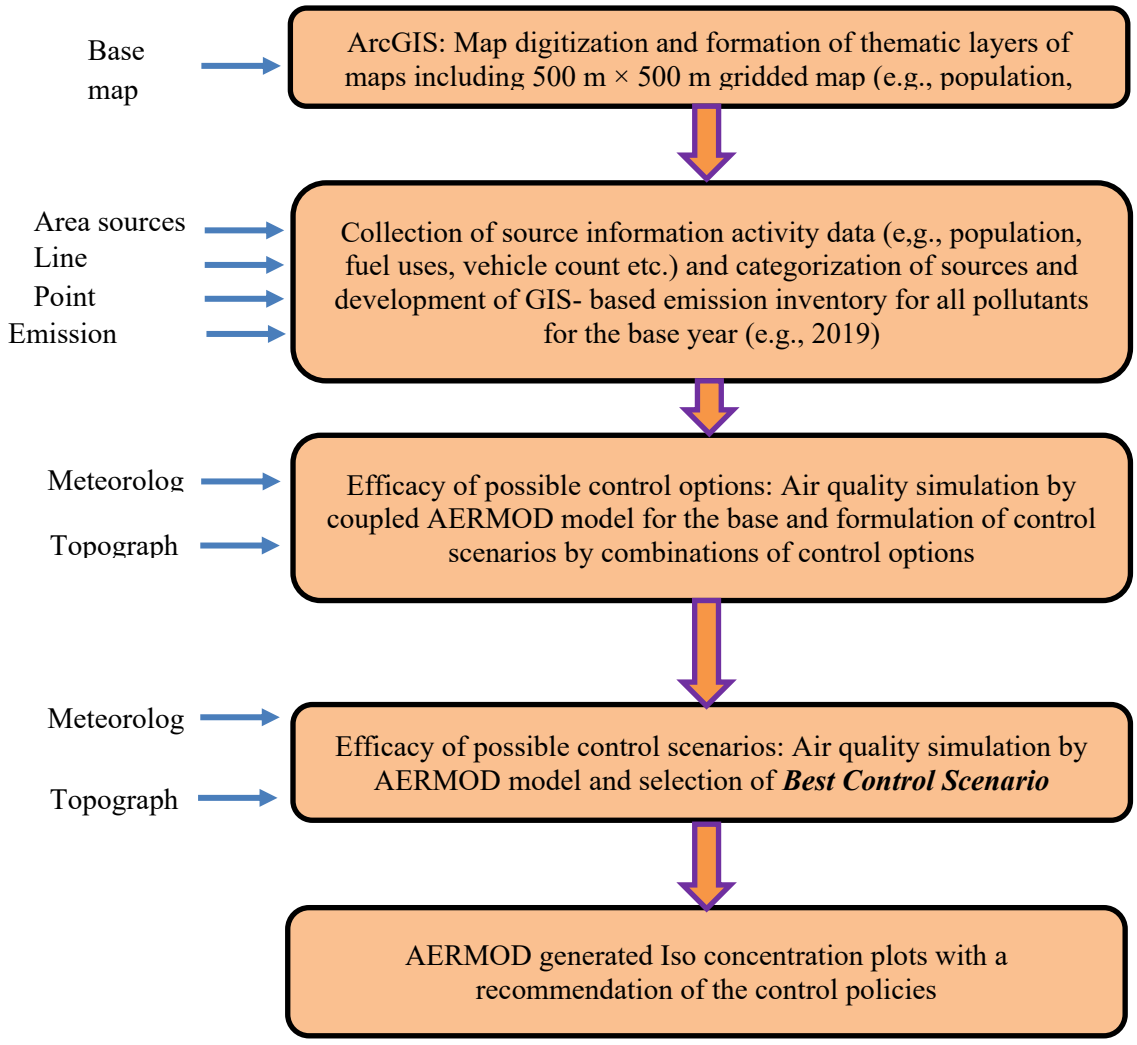


Figure 5.3: Methodology for the source apportionment study and major tasks

5.1.2 Application of Dispersion Modelling

Dispersion modelling in the study area was undertaken for source apportionment and to evaluate the efficacy of various control options in improving air quality. The meteorological data generated continuously at sampling sites or IMD (India Meteorology Department)/WRF (Weather Research Forecast) model was utilised in dispersion modelling. The emission quantities coupled with meteorological data of the area were used in the dispersion model in estimating the concentration of various pollutants (as per the scope of work) and examining the contribution of each of the sources. Attempts were made to validate the model, as measured concurrent concentrations at some air quality stations were available. The USEPA regulatory model AERMOD (2006) was used which considers topographical features like water bodies and terrain elevations. It may be noted that the model performance was tested with comprehensive statistical analyses by comparing the observed and predicted pollutant

concentrations for other cities, Kanpur (Sharma M. 2021) and Agra in the state (IIT Kanpur and UPPCB, 2021).

5.2 Dispersion Modelling

5.2.1 Introduction

The current state-of-the-science, comprehensive meteorological and regulatory air dispersion modelling systems have been used in the study to conduct the dispersion modelling. The American Meteorological Society / Environmental Protection Agency Regulatory Model (AERMOD) has been used to assess the impact of short-range transport (< 50 km) of $PM_{2.5}$ emissions from various sources within Firozabad city, Uttar Pradesh.

5.2.2 AERMOD

AERMOD is a dispersion model that can characterize the planetary boundary layer (PBL) through surface and mixed layer scaling. This model is a complete and powerful air dispersion modelling package that seamlessly incorporates the following the US EPA air dispersion models into one integrated interface:

- AERMOD
- ISCST3
- ISC-PRIME

The AERMOD modelling system consists of one main program (AERMOD) and two pre-processors (AERMET and AERMAP). AERMOD uses terrain, boundary layer, and source data to model pollutant transport and dispersion for calculating temporally averaged air pollution concentrations.

The approach for modelling using AERMOD is shown in Figure 5.4. On-site hourly meteorological data was generated by the WRF model. The model run was performed for a defined study period (the year 2019). The output of the WRF model was fed as input to AERMOD in the pre-processor RAMMET and AERMET of the model.

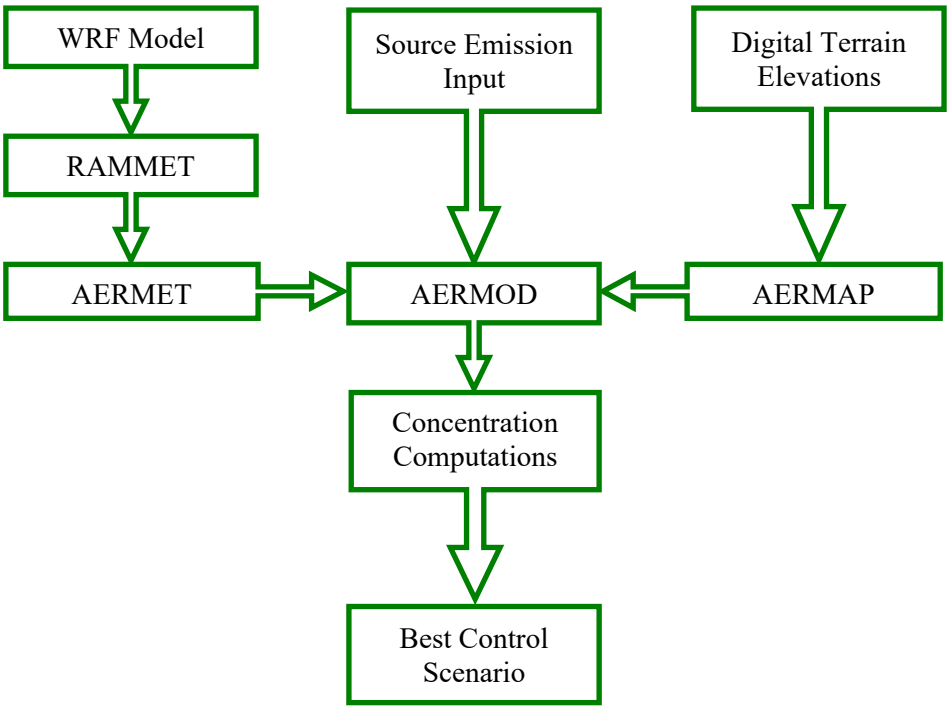


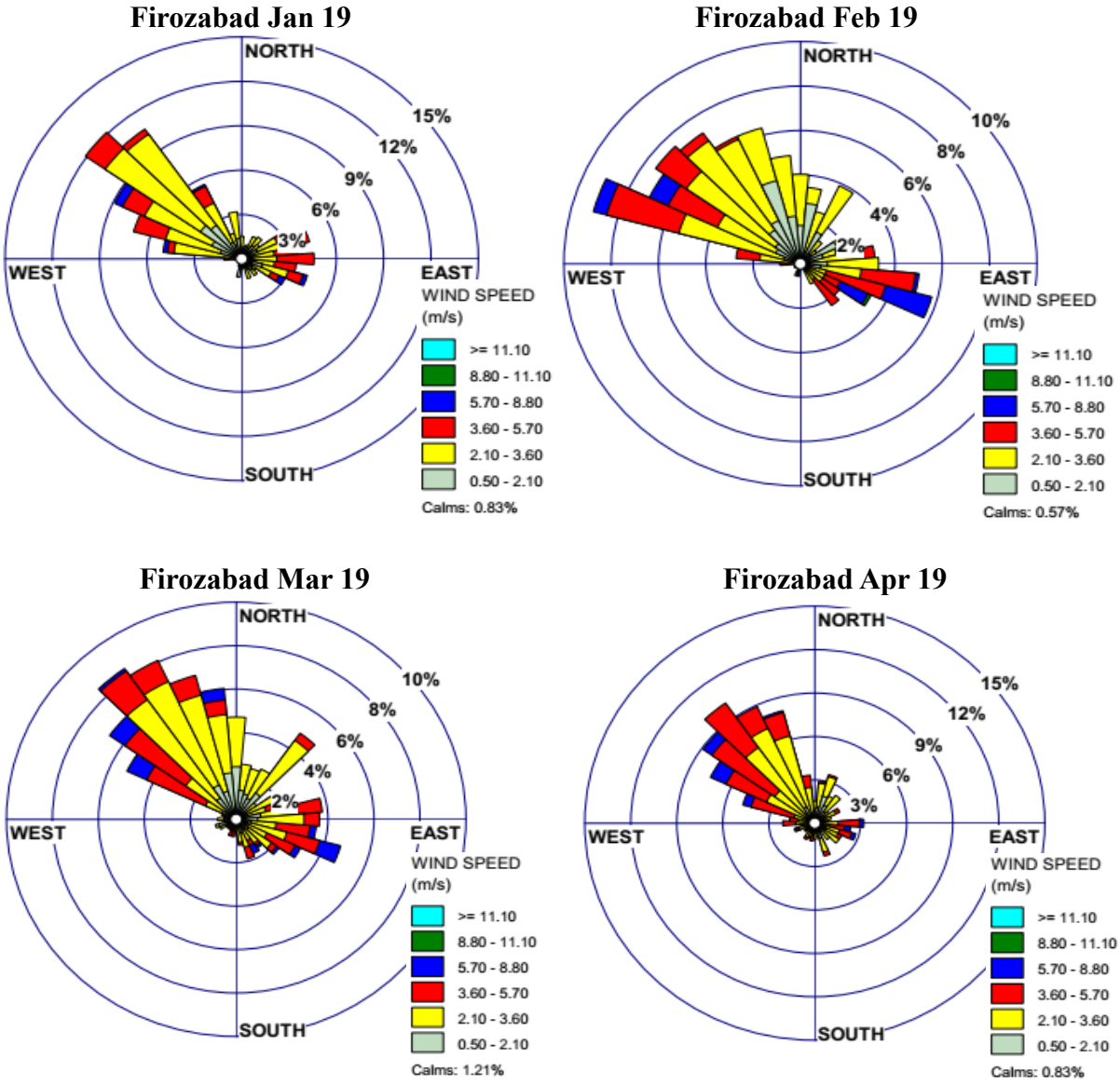
Figure 5.4: Approach for dispersion modelling using AERMOD

The meteorological parameters from the WRF model (wind speed, wind direction, rainfall, temperature, humidity, pressure, ceiling height, global horizontal radiation, and cloud cover) with one-hour resolution were organized in a spreadsheet. This spreadsheet was processed in AERMET, which is the meteorological pre-processor of AERMOD. The terrain data at 90 m resolution was generated from Shuttle Radar Topography Mission (SRTM) of AERMAP. The AERMAP provides a physical relationship between terrain features (e.g., altitude) and the behaviour of air pollution plumes at any receptor. AERMOD was further used to model air quality in the study for the prediction of pollutant concentrations from different sources within Firozabad city.

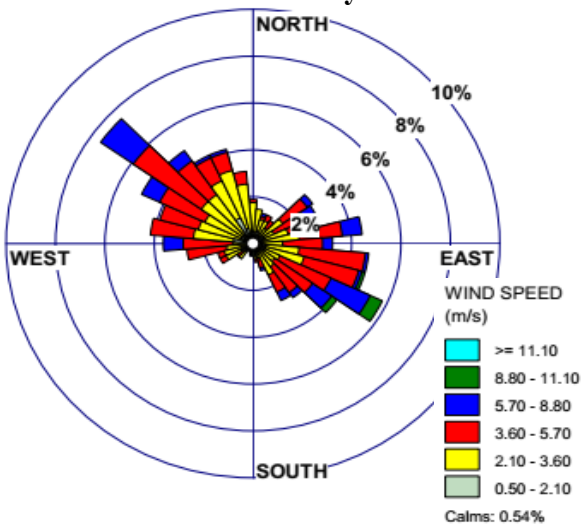
5.2.3 Meteorological Data

In evaluating the emission dispersion using the AERMOD, the meteorological dataset was generated using the WRF model from January 01, 2019, to December 31, 2019. The frequency distribution and frequency data were obtained by processing the hourly surface file in AERMET. The AERMET program is a meteorological pre-processor that prepares hourly surface data and upper-air data for use in the USEPA air quality dispersion model, AERMOD.

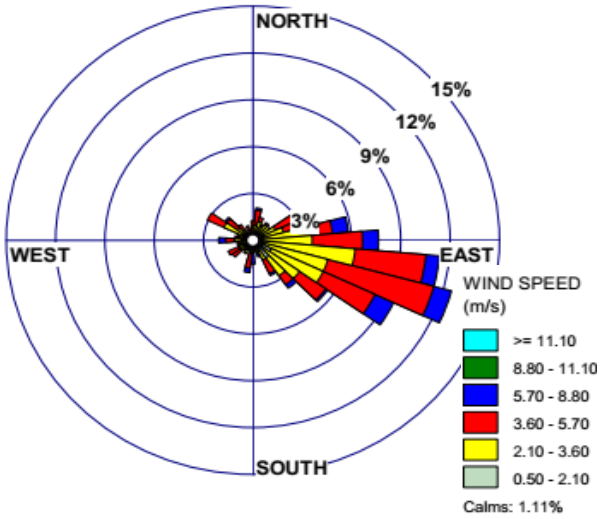
The wind rose plots for all months of 2019 are shown in Figure 5.5. The predominant wind blowing direction was observed to be northwest in most of the months and southeast in some months. Also, a relatively high wind speed was observed in the summer season.



Firozabad May 19



Firozabad Jun 19



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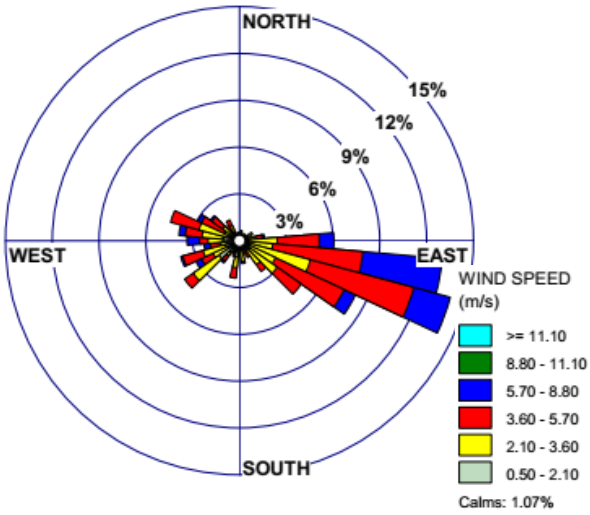

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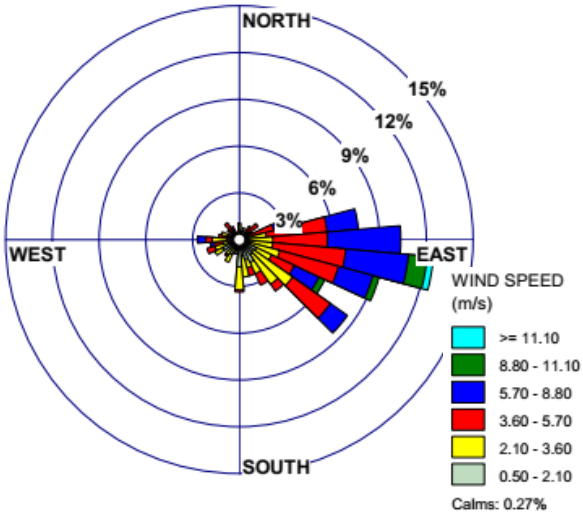

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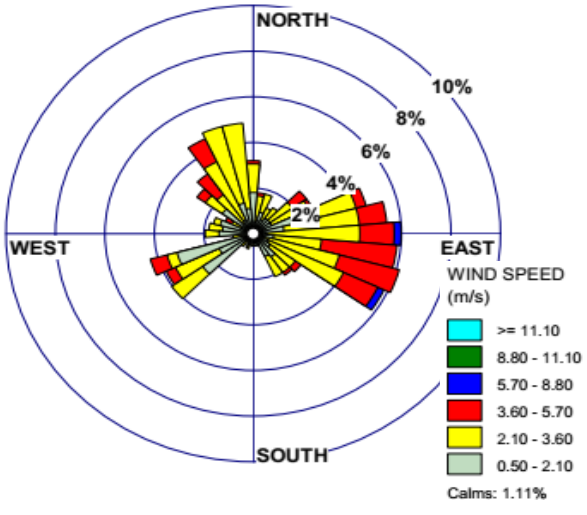
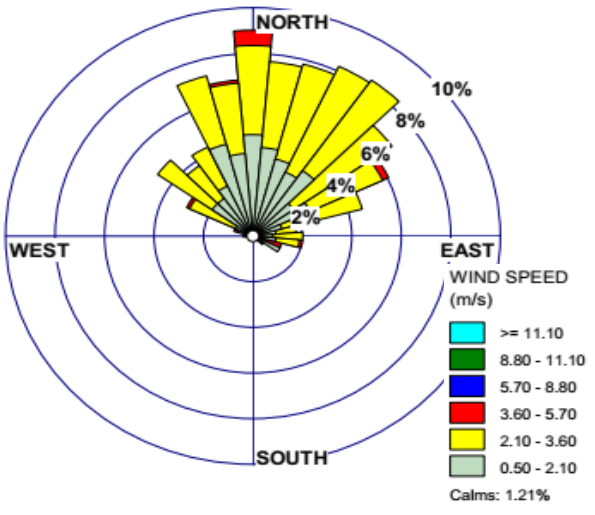


Firozabad Oct 19



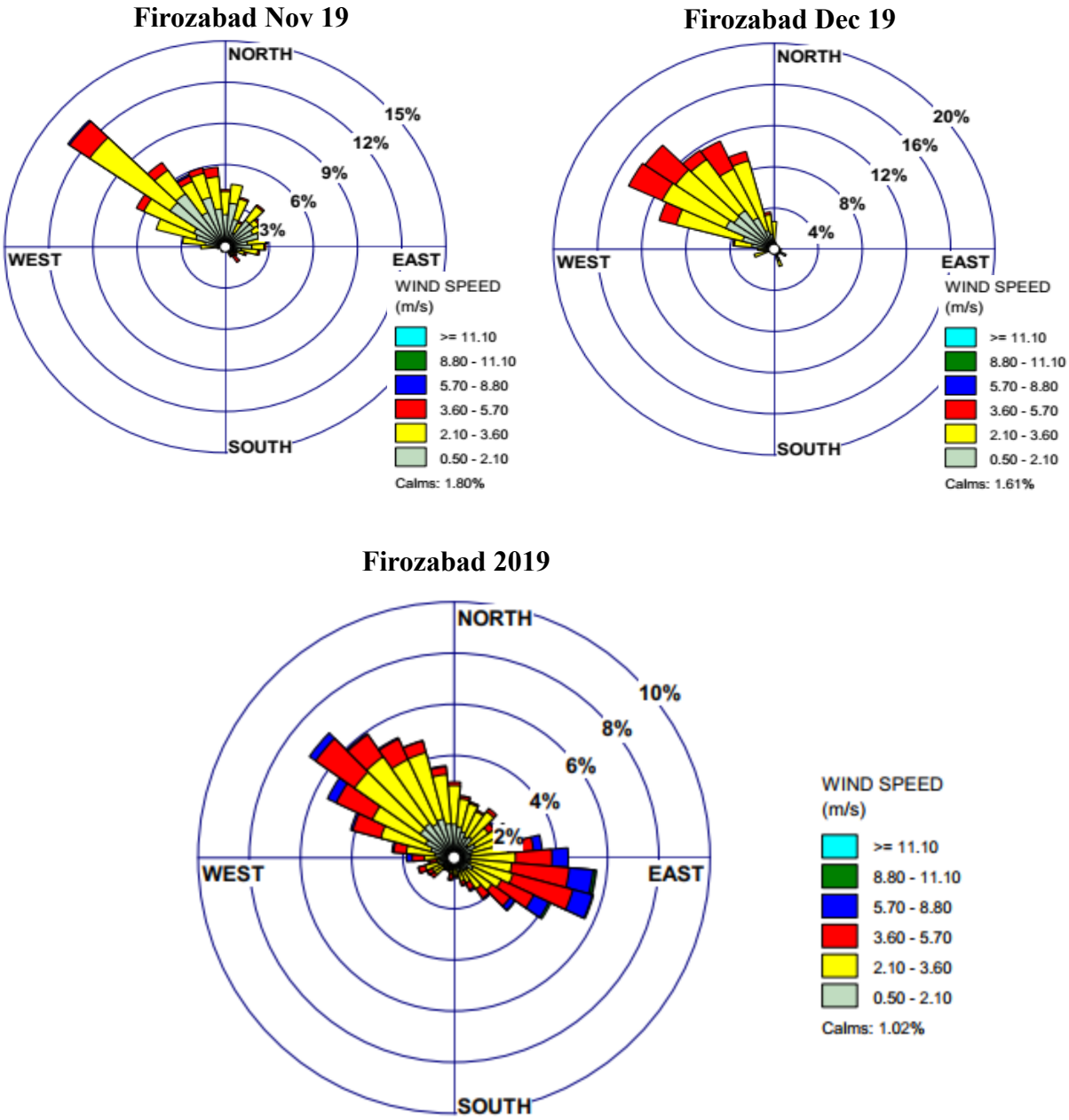


Figure 5.5: Wind rose plots for the months of 2019 and the year 2019

5.2.4 Digital Elevation Model (DEM) and Receptor Grid Network

The Digital Terrain Elevation Model (DEM) is the most critical information required for complex terrain. The terrain affects the dispersion significantly. DEM is required to predict wind flow patterns and dispersion. AERMOD processes DEM data and creates an elevation and height scale (the terrain height and location that has the greatest influence on dispersion) for each receptor in the domain. The terrain is the vertical dimension of the land surface. Gridded terrain elevations for the proposed modelling domain were derived from 3 arc-second digital elevation models (DEMs) produced by the United States Geological Survey (USGS).

The processed terrain elevation data is shown in Figure 5.6. Receptor locations can be defined using a set of uniform Cartesian grid networks, uniform polar grid networks, and discrete Cartesian grid networks. A total of 441 receptors (Figure 5.7) were defined to analyse ground-level $PM_{2.5}$ concentrations.

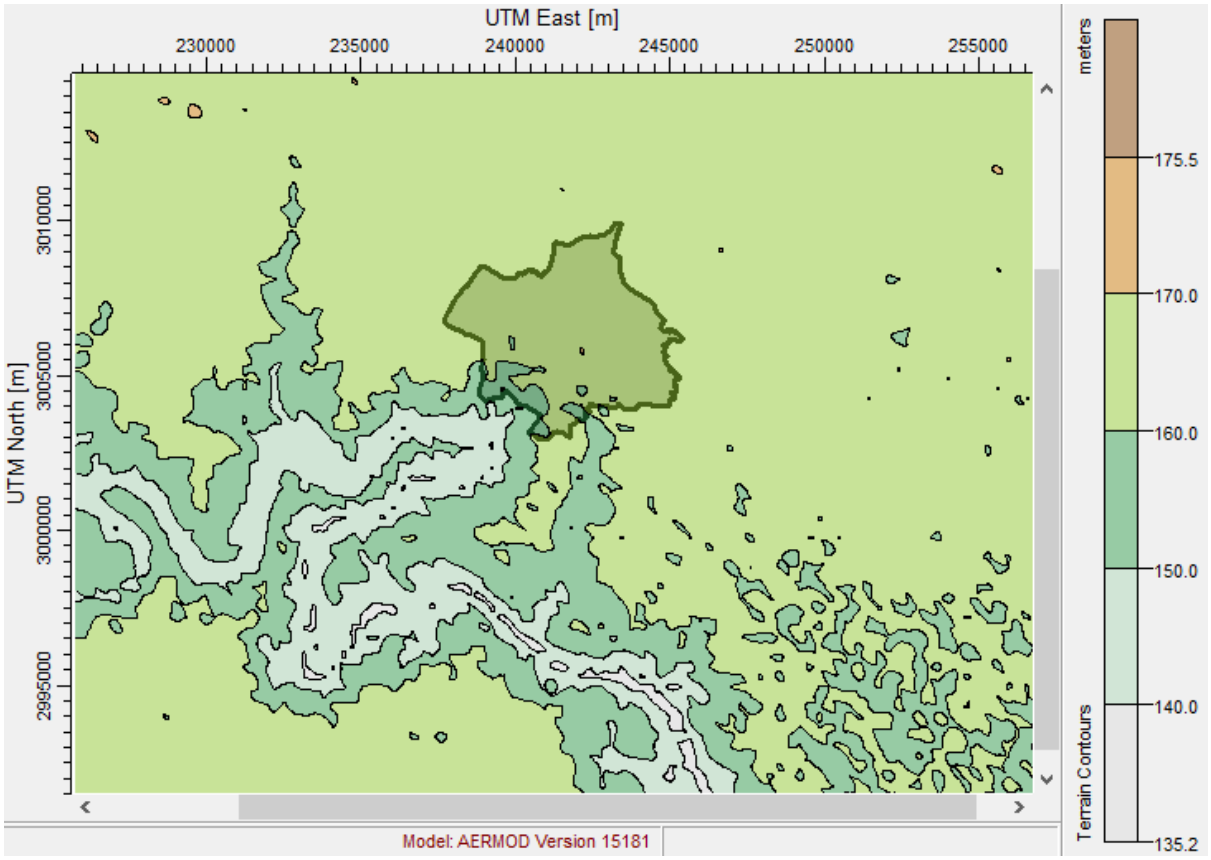


Figure 5.6: Terrain contour map of the Firozabad city

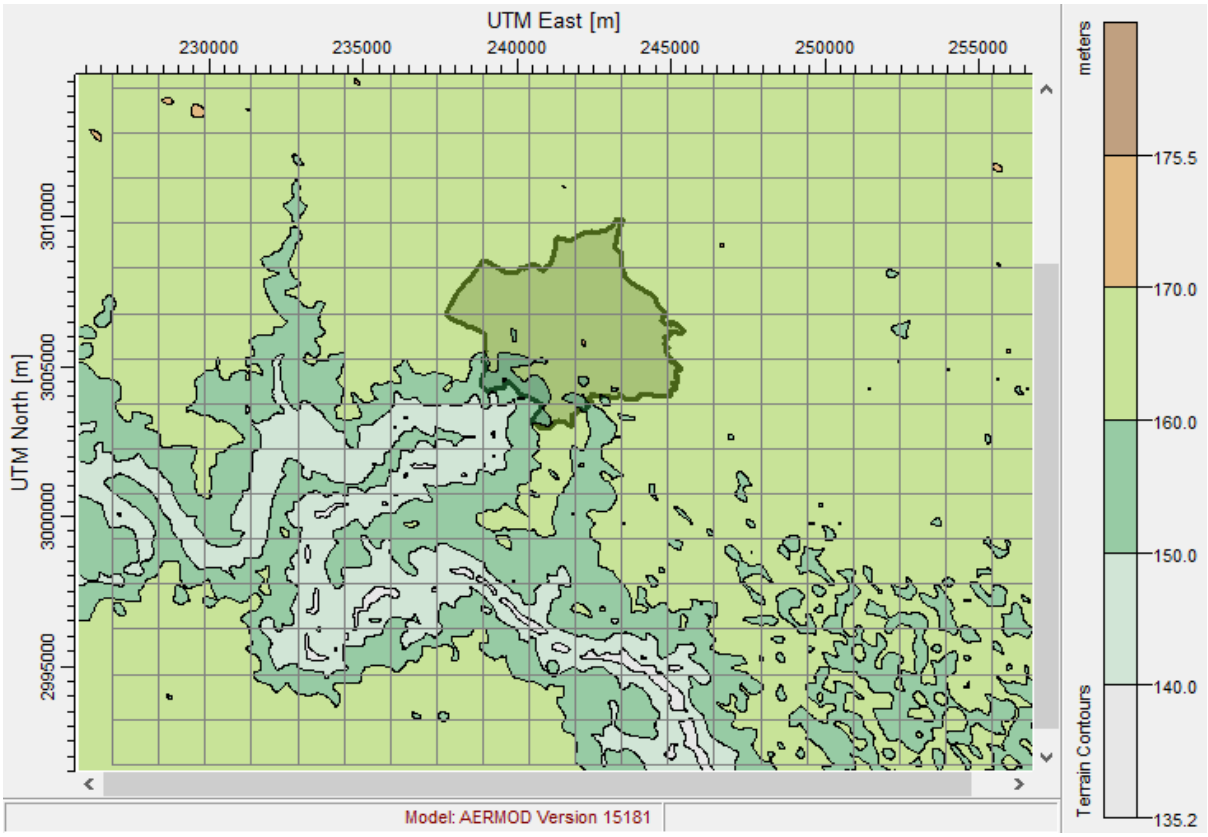


Figure 5.7: Uniform cartesian grid receptor network

5.3 Evaluation of Dispersion Modelling Results

The air dispersion modelling was done with complex terrain (using the elevation heights in Firozabad city). By this approach, all the elevations of terrain were accounted for, and the air dispersion reflected more accurate results as compared to flat terrain. The model was run considering only the sources within Firozabad city. Dispersion modelling was carried out using state-of-the-art models to apportion the contribution of collective sources and sector-wise: domestic, construction, hotels, MSW, hospitals, industries, industrial DG sets, vehicles, road dust, etc., for the city.

5.3.1 The Combined Impact of All the Sources

The highest 24-hour average, monthly average, and annual average $PM_{2.5}$ concentration plots for all sources in Firozabad city are given in Figure 5.8 to Figure 5.10. The first highest values of $PM_{2.5}$ concentration were obtained for 24-hour (day maximum), month's maximum and annual average in the year 2019. In Firozabad city, the highest 24-hour average was 165 $\mu g/m^3$ (1st December 2019), the monthly average $PM_{2.5}$ levels for the critical month (October) were

80 µg/m^{3,} and the annual average was 50 µg/m^3. The dispersion modelling was performed on an area of 30×30 km² to cover the city. The emissions were considered from the grids of 500 m × 500 m. Both 24-hour and annual air quality standards for $PM_{2.5}$ are exceeded in the city.

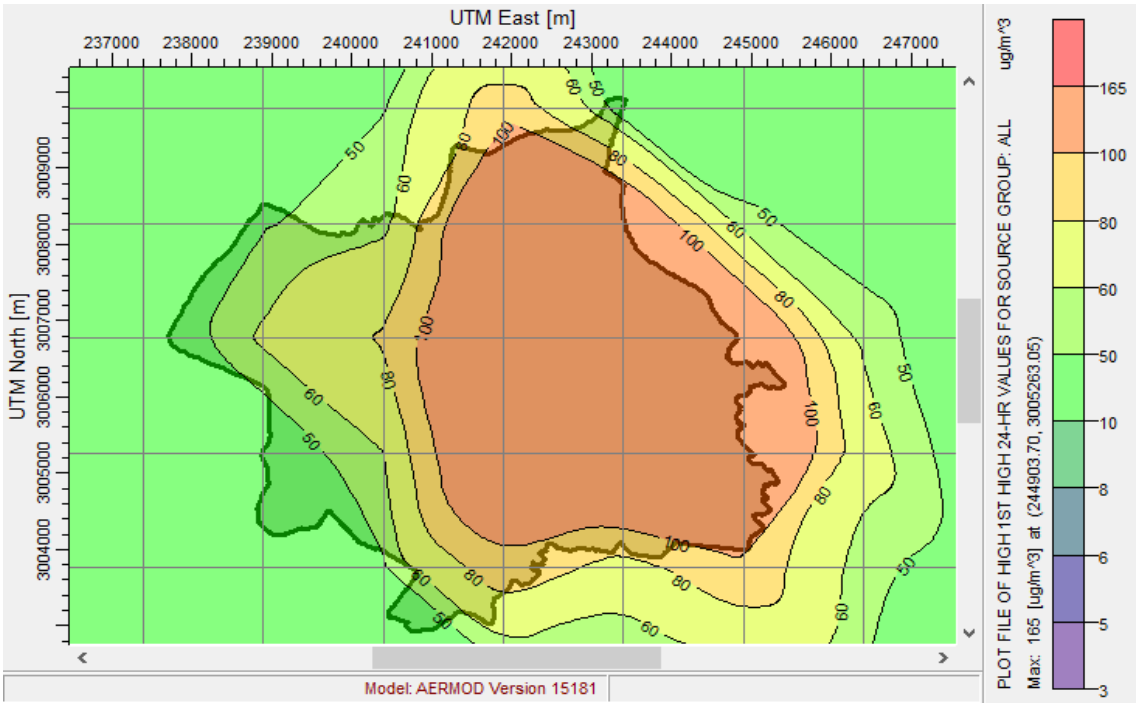


Figure 5.8: Iso-Concentration plot of highest 24-hour $PM_{2.5}$ levels

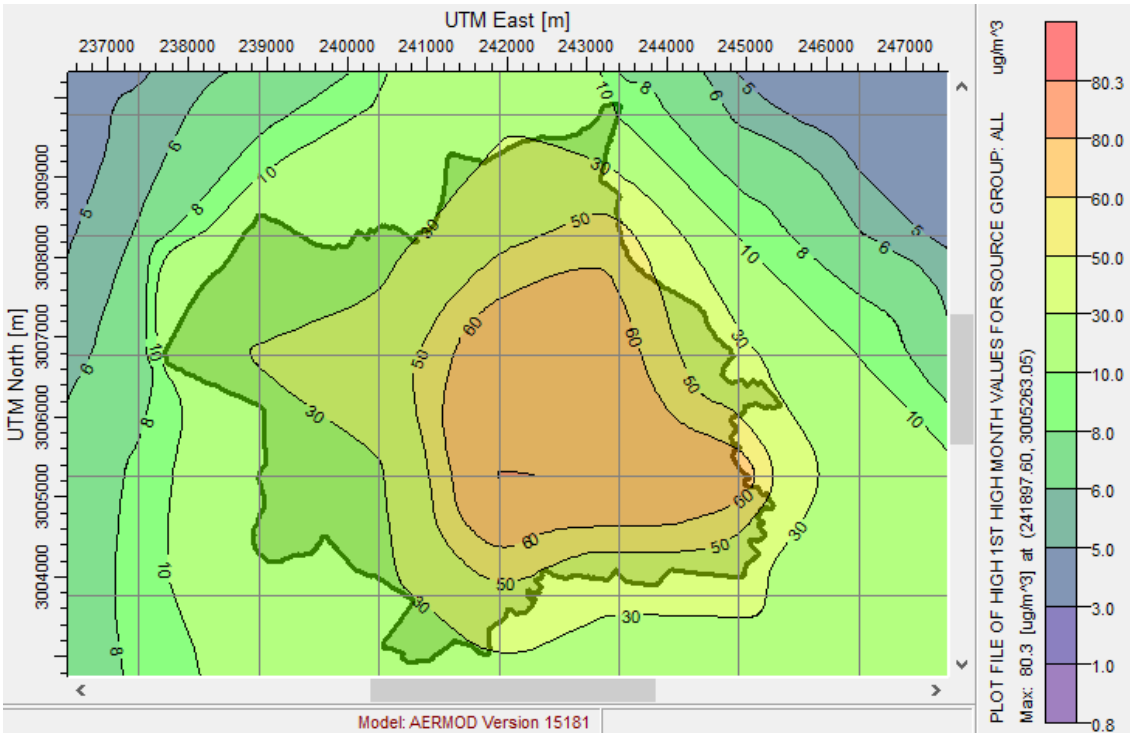


Figure 5.9: Iso-Concentration plot of monthly average $PM_{2.5}$ levels

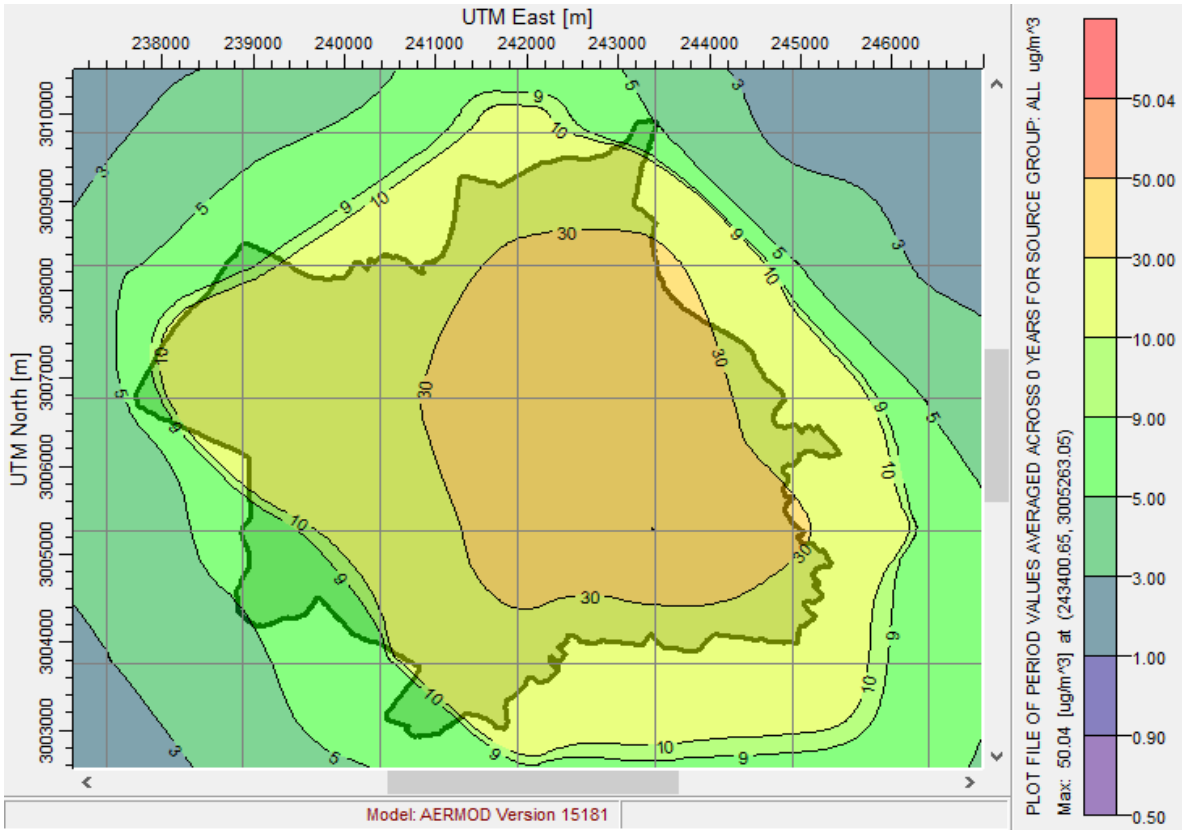


Figure 5.10: Iso-Concentration plot of annual average $PM_{2.5}$ levels

The highest 24-hour average $PM_{2.5}$ concentrations were observed during the winters (October to January), while the lowest was during the peak summer month (May), followed by the monsoon month (July). The concentration of September showed high values compared to October. The highest 24-hour average $PM_{2.5}$ level (among all receptors) from all sources in different months is shown in Figure 5.11 and the highest monthly average in Figure 5.12.

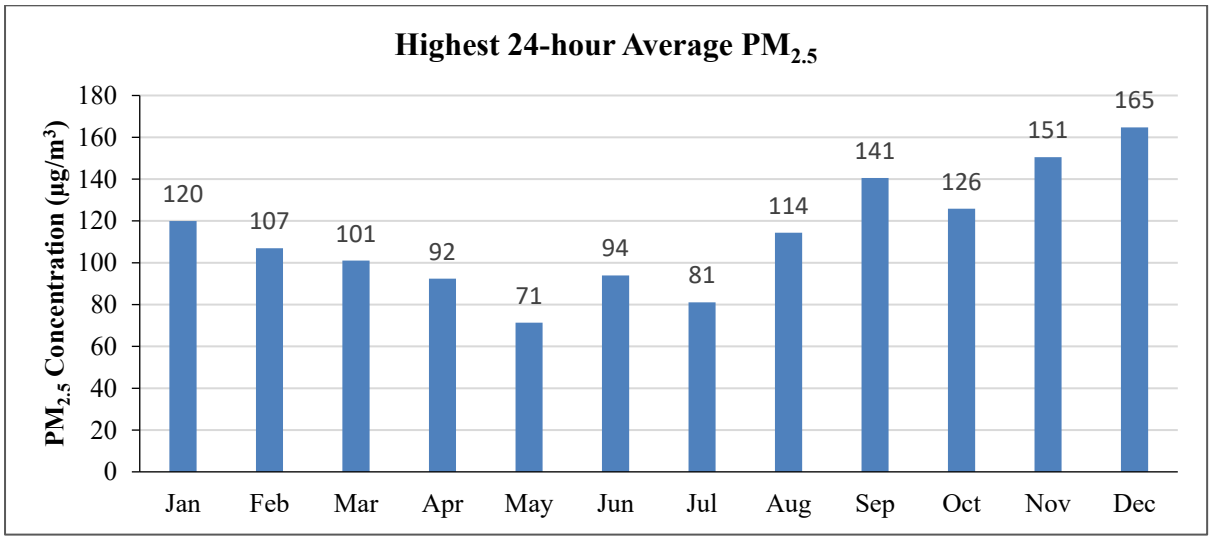


Figure 5.11: Highest 24-hour average $PM_{2.5}$ levels from all sources in 2019

It was observed that the $PM_{2.5}$ concentration in the ambient air increases as the winter season approaches. During peak summer and monsoon seasons, the $PM_{2.5}$ concentration was the minimum and increased steadily with the fall in temperature, which promoted stable atmospheric conditions and reduced dispersion of pollutants. From the annual average plot, the $PM_{2.5}$ concentration was seen to be elongated along the prevailing wind direction (N-E).

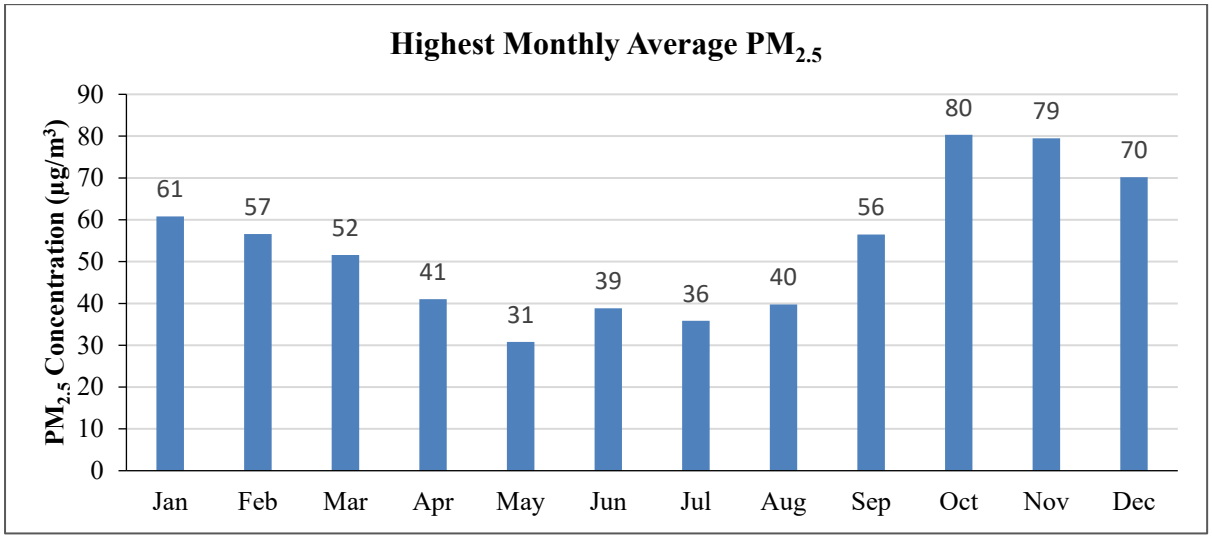


Figure 5.12: Monthly highest average $PM_{2.5}$ levels from all sources in 2019

5.3.2 Sector-wise Impact of All the Sources

The AERMOD dispersion modelling was performed sector-wise to observe the impact of each source separately. The source-wise peak concentration based on daily, monthly, and yearly (period average 2019) is shown in Table 5.1. The table presents the maximum contribution of $PM_{2.5}$ from Road dust, Vehicle and Domestic sources.

Table 5.1: Maximum $PM_{2.5}$ levels (different time averages) from all sources

Source	Maximum $PM_{2.5}$ levels ($\mu g/m^3$)		
	24-hour average	Monthly average	Annual average
Road dust	125.00	57.00	35.00
Brick Kiln	31.20	16.20	10.60
Vehicle	24.00	11.70	7.96
Domestic	19.20	10.10	6.57
Hotel	8.79	4.00	2.83
MSW burning	1.75	0.92	0.60
Construction	0.93	0.44	0.29
Industry	0.14	0.04	0.03
Hospital	0.02	0.10	0.01
DG sets	0.02	0.01	0.01

5.4 Summary of the Dispersion Modelling and Interpretations

The major findings from the dispersion modelling are summarised below:

The highest 24-hour average was 165 µg/m^3 (1st December 2019), the monthly average $PM_{2.5}$ levels for the critical month (October) were 80 µg/m^{3,} and the annual average was 50 µg/m^3.

From the annual average plots, it is seen that $PM_{2.5}$ envelops a large area that gets elongated along the prevailing downwind direction (S-E) within Firozabad city. The annual standard for $PM_{2.5}$ concentration (40 µg/m^3) is exceeded in the area.

The city's highest contributing source for the critical day (1st December 2019) is road dust, followed by brick kiln and vehicular emissions. Domestic sources are where the residential population is concentrated. The rank of different sources based on their $PM_{2.5}$ contribution to the city is given in Table 5.2.

Table 5.2: Rank sources in different regions based on their contribution to $PM_{2.5}$

Rank	1	2	3	4	5	6	7	8	9	10
Sources	Road dust	Brick Kiln	Vehicle	Domestic	Hotel	MSW burning	Construction	Industry	Hospital	DG sets

Overall, the top contributors to $PM_{2.5}$ were road dust (59 %), brick kiln (15%), vehicles (11 %), domestic sources (9 %), and hotels (4 %), shown in Figure 5.13 at the hotspot.

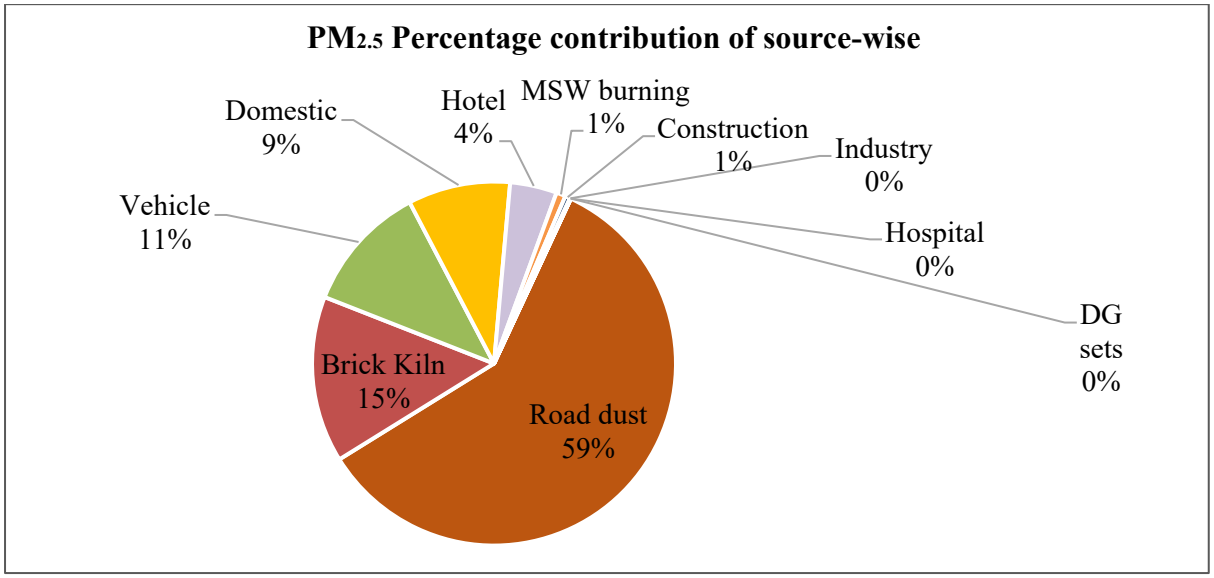


Figure 5.13: $PM_{2.5}$ Percentage contribution of source-wise at the hotspot

5.5 Atmospheric Carrying Capacity (ECC)

5.5.1 Introduction

Atmospheric **c**arrying capacity utilises both qualitative and quantitative approaches used for Firozabad city. The Carrying capacity included in this report is derived from the Rapid Study Report earlier prepared and submitted by our team. Its incorporation here ensures consistency with the prior study and avoids unnecessary duplication of work.

In this study, an effort is made to quantify the Atmospheric carrying capacity in terms of emission loads and the emission reduction measures needed to keep the air quality within the recommended norm (NAAQS) in the city (S. Panda 2020).

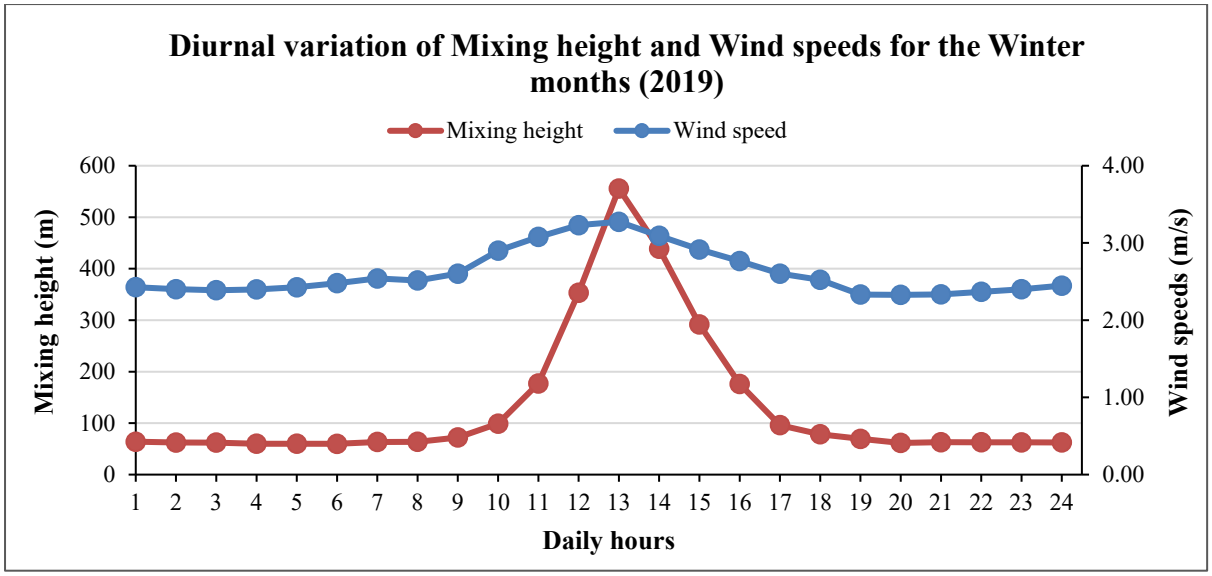
5.5.2 Estimation of Carrying Capacity

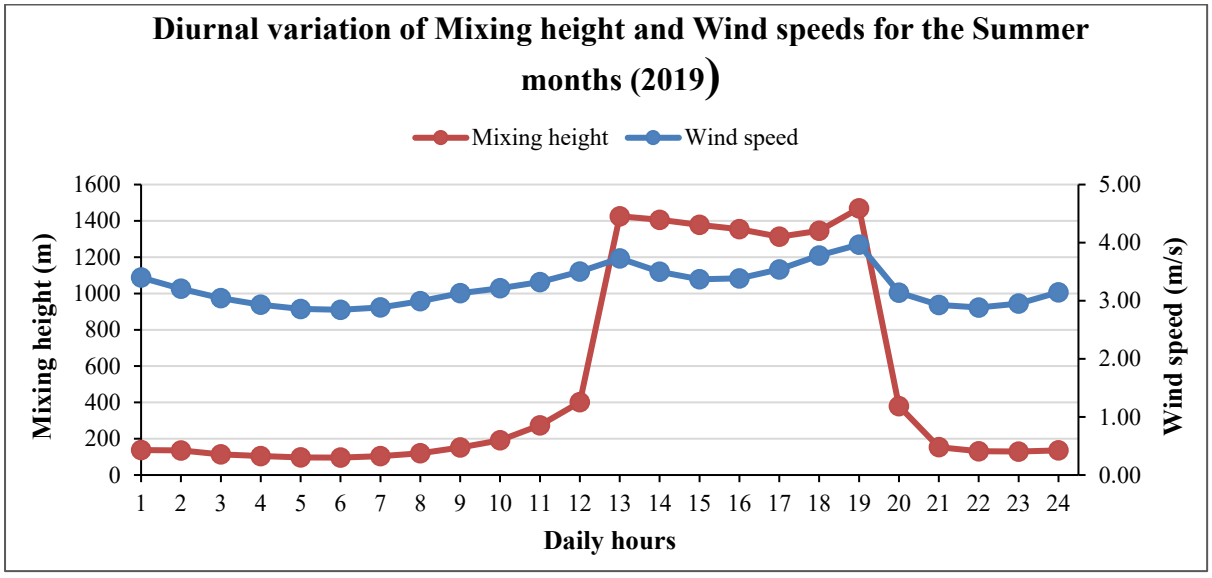
The carrying capacity assessment was performed using an estimation of the atmospheric assimilative capacity of the city. Assimilative capacity is a crucial parameter for knowing the extent of pollution and load-carrying capacity of an area during various atmospheric conditions. It can be defined as the maximum amount of pollutant load an area can take without exceeding the specified air quality standards (Goyal et al., 2003). It varies significantly with respect to changing meteorological conditions and types of pollutants, and stack characteristics.

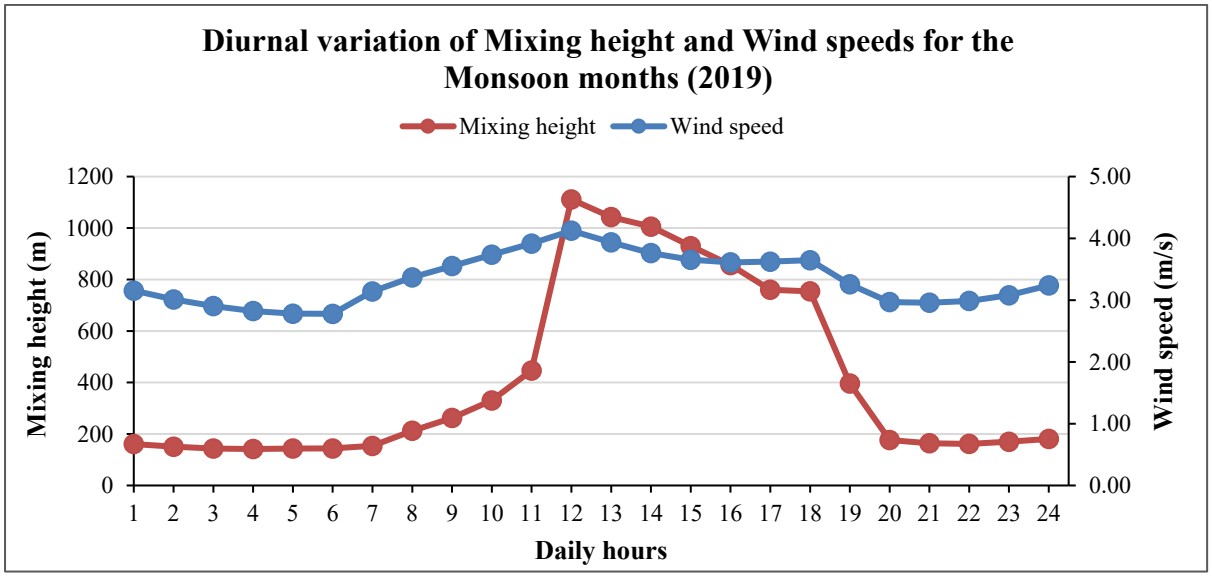
Therefore, it is important to quantify the amount of emission loads a city can assimilate without violating the standards, which can give useful information to the decision and policy makers for formulating effective regulations to mitigate air pollution (S. Panda 2020).

5.5.3 Ventilation Coefficient (VC)

The first approach was through utilising meteorological parameters such as wind speed and mixing height. Ventilation coefficient (VC) is a parameter quantified by multiplying the wind speed and mixing height (S. Panda 2020). Meteorological parameters such as wind speed and mixing heights were obtained from the Weather Research and Forecasting (WRF) Model. We divided the whole year into four seasons: winter (December, January and February), summer (March to June), monsoon (July to September), and post-monsoon (October to November). The diurnal variation of mixing height and Wind speeds for the city is represented in Figure 5.14.


Diurnal variation of Mixing height and Wind speeds for the Winter months (2019)
Mixing height
Wind speed
Mixing height (m)
Wind speeds (m/s)
Daily hours


Diurnal variation of Mixing height and Wind speeds for the Summer months (2019)
Mixing height
Wind speed
Mixing height (m)
Wind speed (m/s)
Daily hours


Diurnal variation of Mixing height and Wind speeds for the Monsoon months (2019)
Mixing height
Wind speed
Mixing height (m)
Wind speed (m/s)
Daily hours

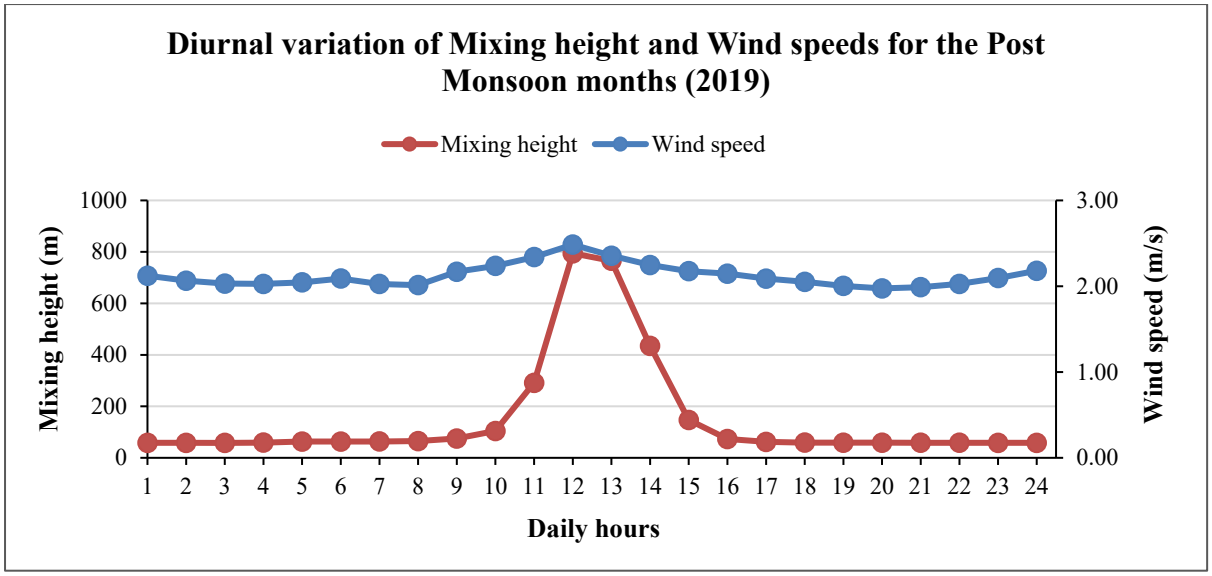


Figure 5.14: Diurnal variation of Mixing height and Wind speeds

According to the IMD report, the air environment is considered as low contamination potential when VC > 12000 m^2/sec, medium contamination potential with VC ≈ 6000 - 12000 m^2/s and high contamination potential when VC < 6000 m^2/sec (Goyal et al., 2006).

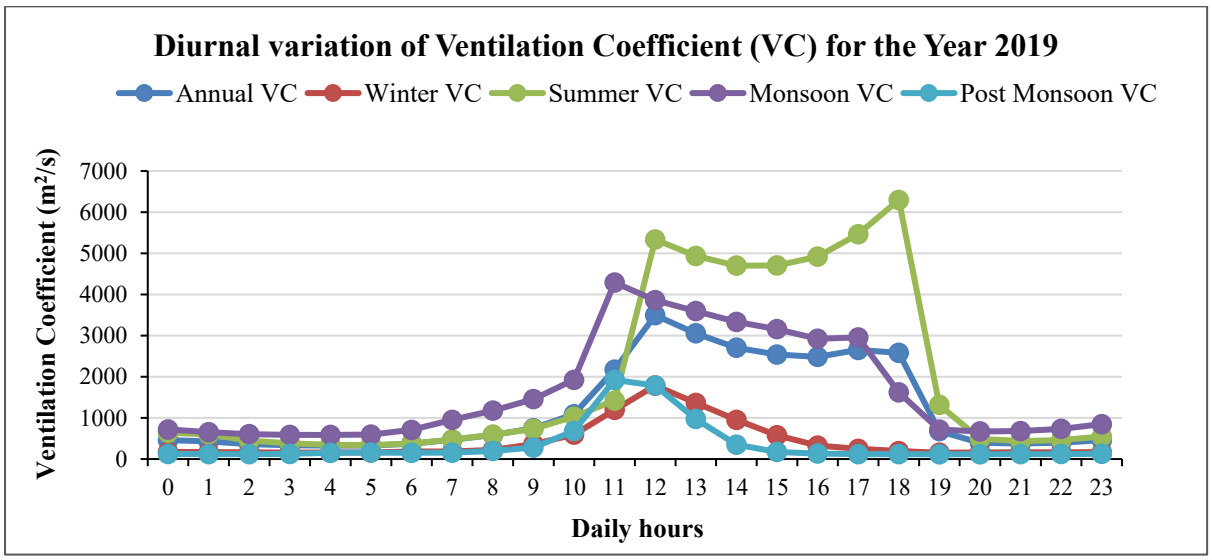


Figure 5.15: Diurnal variation of ventilation coefficient (VC)

Ventilation coefficient was seen to be lower during morning hours, which gradually increases as the day forwards and arrives at a peak during early afternoon, and again decreases. Summer shows a peak in late afternoon also. The pattern was observed to be similar in all seasons. Figure 5.15 illustrates the diurnal variation of the ventilation coefficient during the annual, winter, summer, monsoon and post-monsoon seasons.

The area's carrying capacity was observed to be lower for the post-monsoon and winter seasons. During the summer season, the ventilation coefficient was observed to be higher in the range of 5000-7000 m^2/s for 12-18 hours, which denotes low pollution potential during the season.

5.5.4 AERMOD model-based carrying capacity

Critical carrying capacity can be characterised as the maximum emissions (tonnes/day) a city can take in a given timeframe without exceeding the air quality standards. Residual carrying capacity is the difference between critical carrying capacity and the current loads in the area.

To understand the impact of meteorology on the dispersion of air pollutants and to plan the season-specific emission control measures based on atmospheric dispersion, we further estimated season-wise load-carrying capacities of the city under various pollution levels S. Panda and S. Nagendra, 2017).

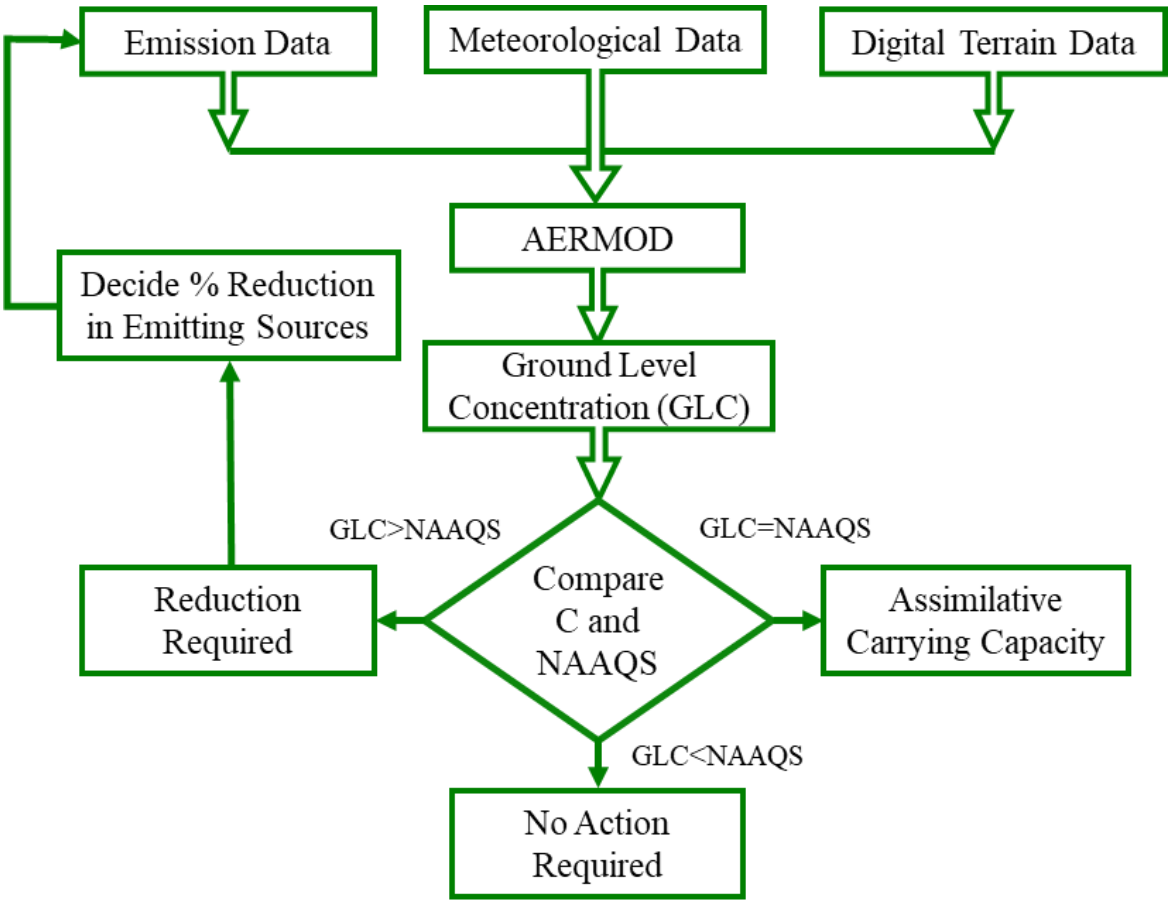


Figure 5.16: Flow chart for quantification of carrying capacity

The flow chart for the quantification of carrying capacity is shown in Figure 5.16. The AERMOD dispersion modelling generates 24-hour peak $PM_{2.5}$ concentration based on

emission inventory and meteorological data for a total of 441 receptor grids throughout the year.

5.5.4.1 Analysis of $PM_{2.5}$ exceedances

The levels within the NAAQS are acceptable in terms of the recognised effects on human health and the environment's point of view. An exceedance is defined when the concentration of a pollutant exceeds the air quality standards or limit values (Singh V. et. al. 2020). The $PM_{2.5}$ concentration should not exceed the threshold value of the NAAQS in a given period which is 60 µg/m^3 for 24-hour and 40 µg/m^3 for annual averaging.

The daily peak 24-hour concentration for 2019 is shown in Figure 5.17. Firozabad had 182 days of exceedances in a year when the level exceeded the NAAQS.

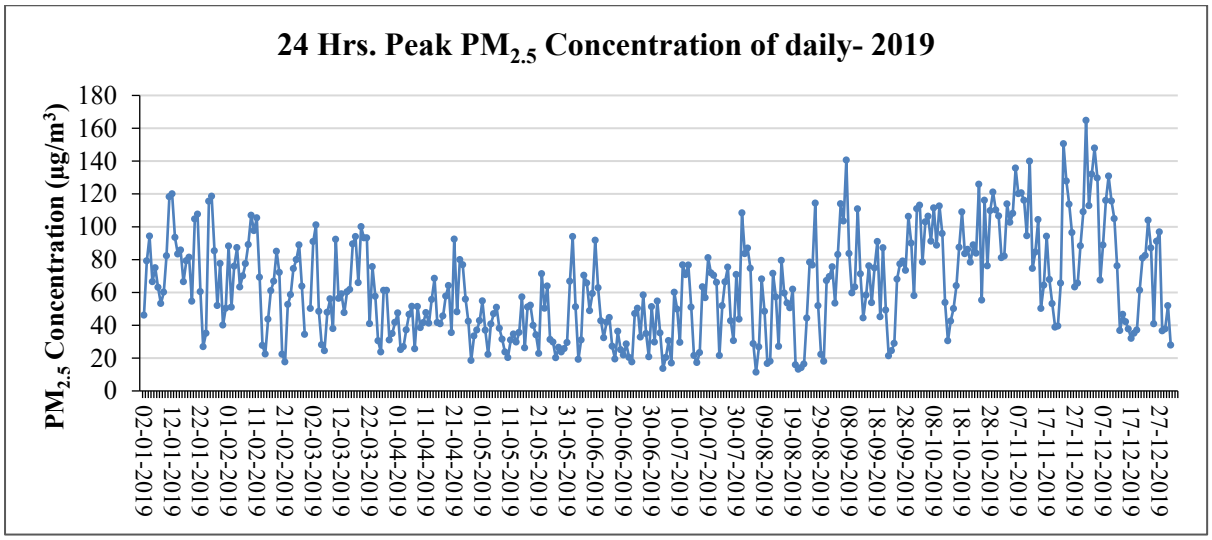


Figure 5.17: Peak concentration of daily throughout the year

The peak 24-hour concentration in each month is shown in Figure 5.18. The concentration was highest in December, and levels were generally highest in winter months. Even in monsoon or summer months, the $PM_{2.5}$ standard may not be achieved.

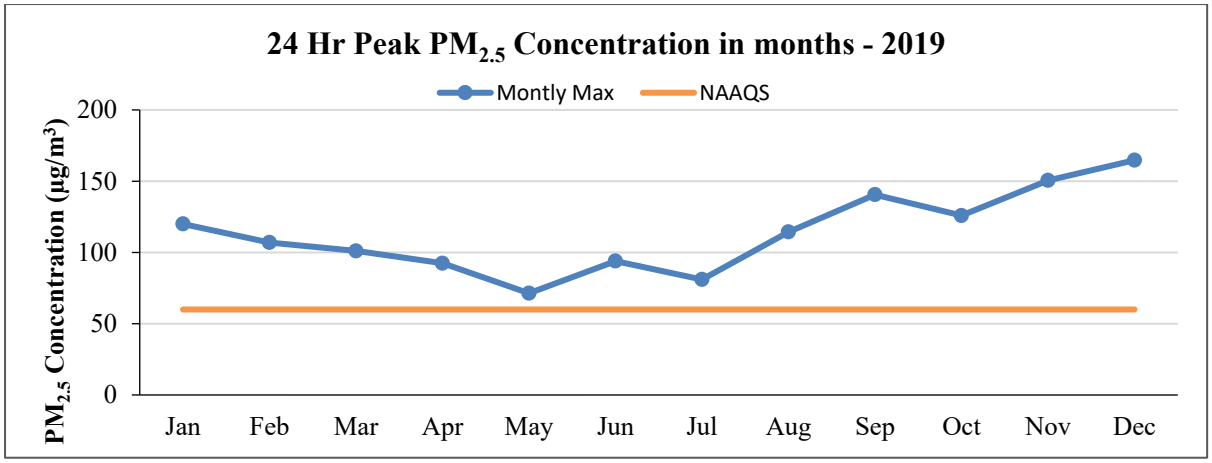


Figure 5.18: 24-hour peak PM2.5 concentration in months

The $PM_{2.5}$ emissions for the city have been calculated in Table 3.4 as 4427 kg/d, counted as the pollution load on the city. The carrying capacity is calculated based on the Equation 7 as given below.

$$Carrying\ Capacity\ (CC) = \frac{NAAQS}{Max.\ concentraion} \times Emission\ Load \quad \text{..... Equation 7}$$

The estimation of carrying capacity is based on 24 hour and month's maximum concentration separately, which can be valuable to analyse monthly or seasonal variations throughout the year effectively. The monthly distribution of CC and $PM_{2.5}$ for 24-hour maximum concentration based on emission load are shown in Figure 5.19 and given in Table 5.3.

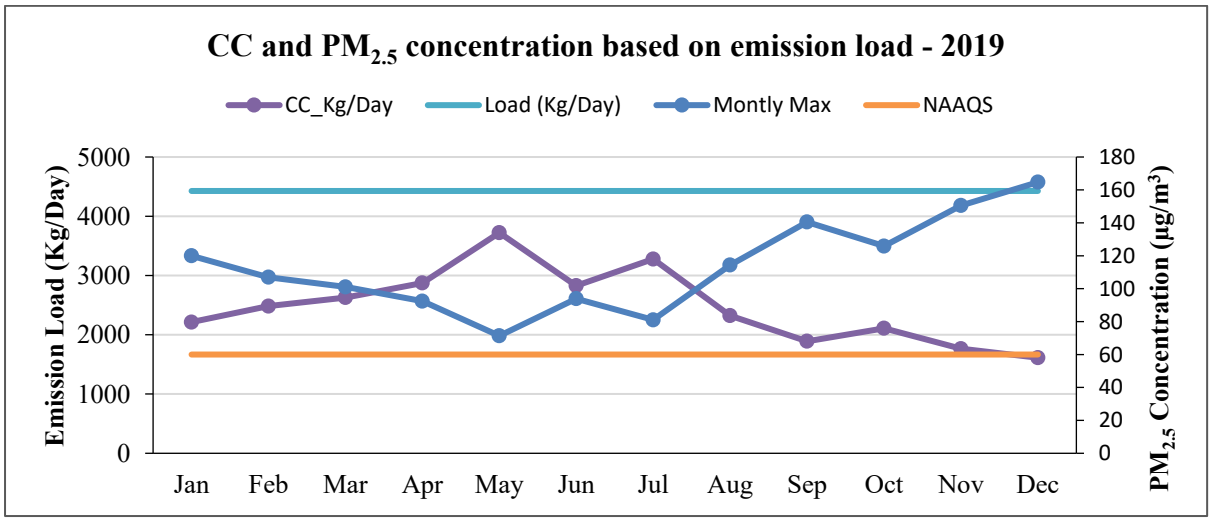


Figure 5.19: Carrying Capacity (CC) and $PM_{2.5}$ concentration

Table 5.3: Carrying Capacity, $PM_{2.5}$ concentration at current emission load of 4427 Kg/d

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec*
Monthly Max	120	107	101	92	71	94	81	114	141	126	151	165
NAAQS	60	60	60	60	60	60	60	60	60	60	60	60
CC (Kg/d)	2214	2484	2628	2874	3722	2827	3277	2323	1890	2110	1765	1613
Required Emission Reduction (%)	50	44	41	35	16	36	26	48	57	52	60	64

The dispersion model shows that December is the critical month, so the overall required emission reduction is 64 % for December month (and continued in other months) to achieve the NAAQS. In other words, actions taken based on varying capacity of November month will ensure compliance with standards in other months also.

The category-wise source emission load is taken from the city-level emission inventory (Table 3.4). Based on the total emission load in the city, the acceptable air pollutant emission to attain air quality standard is estimated by considering the reduction in emissions from top five sources, MSW burning emission, regardless, will be zero (i.e., MSW burning must be stopped completely that could be an additional reduction in concentration). Table 5.4 represents percentage reduction in emission load for top five sources so that total emissions are withing the assimilative carrying capacity of the critical day (i.e., 1st December 2019).

Table 5.4: Proposed Source-wise emission reduction

Emissions (kg/d)	**Sources**				
	Road Dust	**Domestic**	**Vehicle**	**Industries**	**Brick Kilns**
Current emission	2907	561	551	137	115
Reduction in emissions	70%	45%	50%	45%	45%
Residual Emission	872	309	276	75	63

The dispersion modelling was again performed with reduced emissions (Table 5.4) to ensure that the air quality standard of $PM_{2.5}$ is achieved with the proposed reductions. The peak concentration based on daily and annual (periods average) are 60 µg/m^3 (4th December 2019) and 20.1 µg/m^3 (Figure 5.20 and Figure 5.21). It is seen that with the proposed reduction in emissions, both annual and 24-hour air quality standards can be achieved, and emissions will be lower than the estimated carrying capacity.

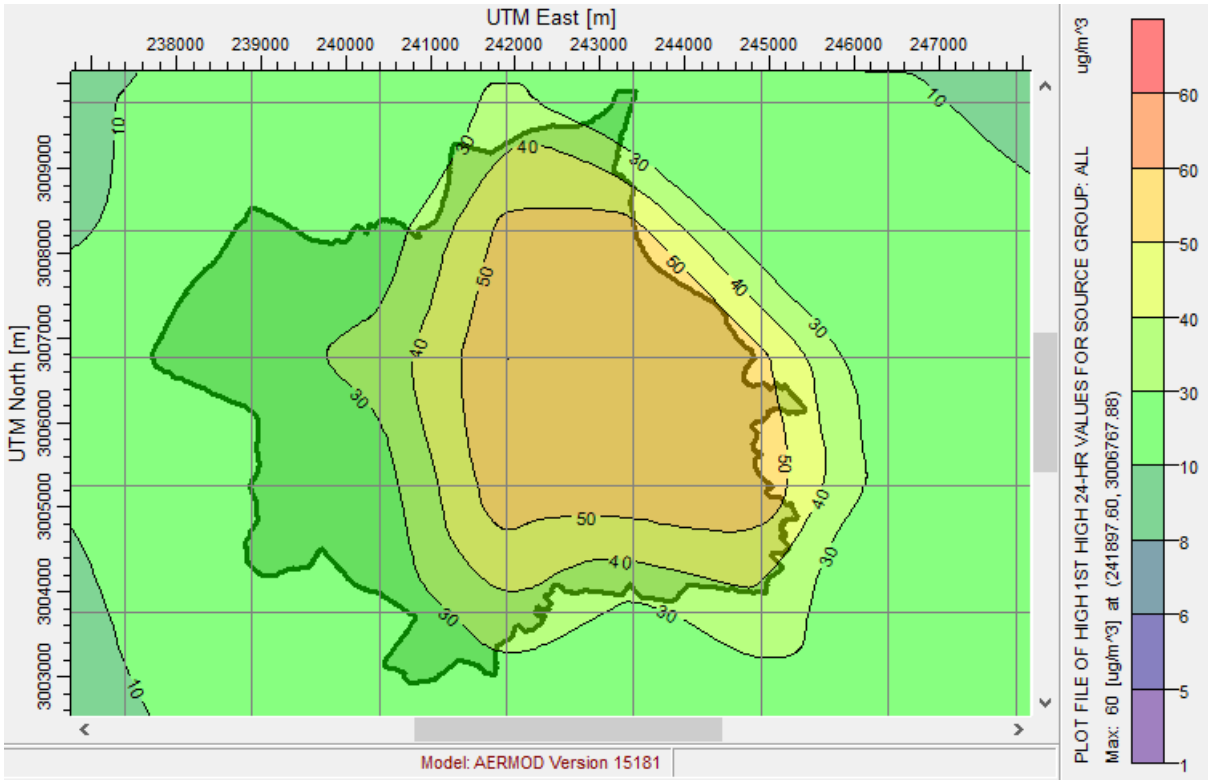


Figure 5.20: Iso-Concentration plot of 24-hour (max) with emission reductions for the critical day (4th December 2019)

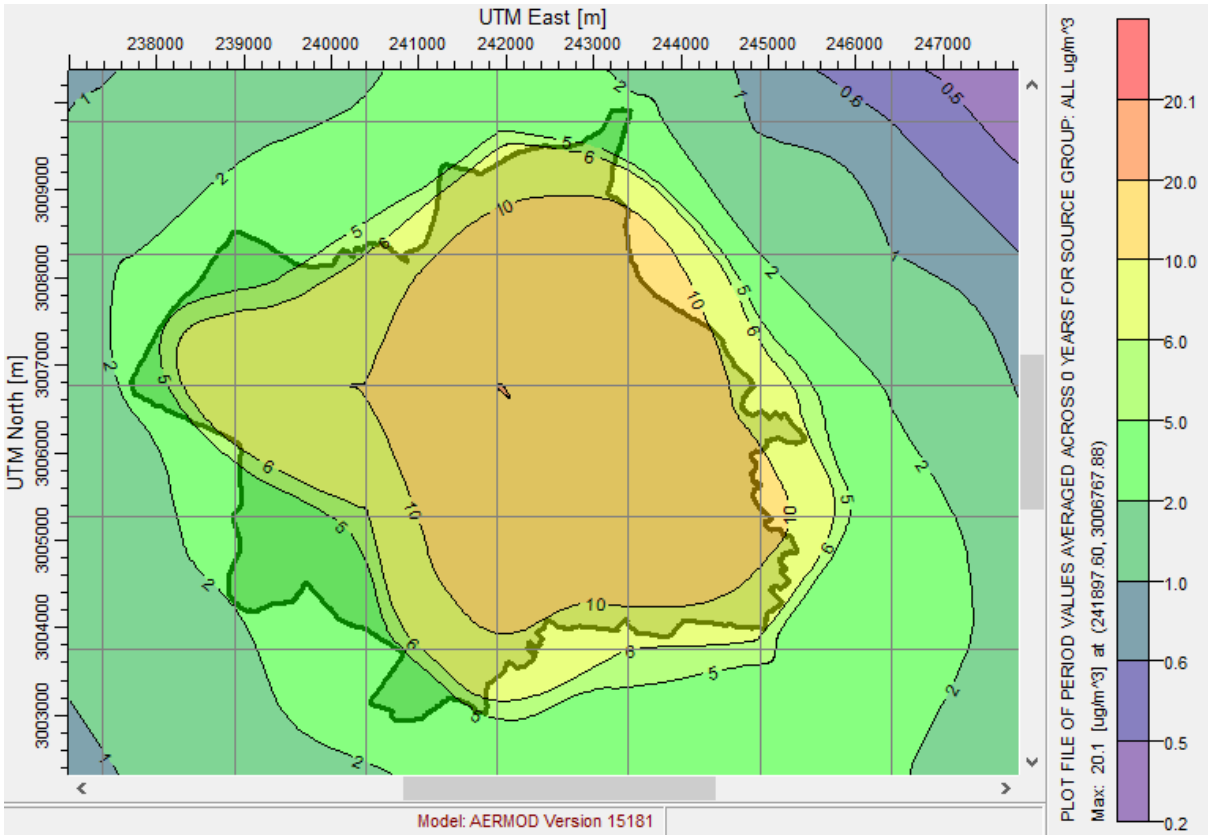


Figure 5.21: Iso-Concentration plot with emission reductions for an entire year

5.6 Conclusion and Actions Plans

The CC approach using current emissions, meteorology and state-of-the-art model AERMOD has provided the allowable emission load to attain air quality standards both for 24-hour and annual standards for $PM_{2.5}$. The caring capacity is variable (1613 - 3722 kg/d) depending on daily and monthly meteorology. It is seen the CC is the lowest in winter months and highest in April to July months. However, the carrying capacity is much lower than the total emissions (4427 kg/d), so significant emission reduction is required. We have considered MSW burning should immediately stop and final emission reductions are proposed based on the critical month.

Table 5.5: Proposed source-wise emission control plan

Emissions (kg/d)	Sources				
	Road Dust	**Domestic**	**Vehicle**	**Industries**	**Brick Kilns**
Current emission	2907	561	551	137	115
Control in emissions	70%	45%	50%	45%	45%
Drop in emissions	2035	252	276	62	52

Overall reduced emission after control (for top five sources) = (4271-2676) = 1595 kg/d

It is examined that the proposed reductions will ensure that the emission load is always less than the carrying capacity and will ensure compliance with 24-hour and annual air quality standards.

6 Control options, Analyses and Prioritization for Actions

6.1 Air Pollution Scenario in the City of Firozabad

The city of Firozabad has several environmental issues, and it is a nonattainment city for national air quality standards in respect of PM_{10} and $PM_{2.5}$. There are several prominent sources within and outside Firozabad city contributing to PM_{10} and $PM_{2.5}$ in its ambient air. Chapter 3 presented the emission inventory and Chapter 4 described the apportionment of sources contributing to ambient air pollution. The summary of the source apportionment results is presented below.

In winter, mean PM_{10} – $PM_{2.5}$ levels are 378 – 283 $\mu g/m^3$. The overall city-level contribution of sources to ambient air PM_{10} – $PM_{2.5}$ levels are (given in parenthesis): vehicles (18.5 – 21%), secondary inorganic aerosol (SIA; 15%), soil and road dust (30 – 26%), MSW burning (7.2 – 6.8%), biomass burning (18 – 21%), construction (3 – 2.5%), and coal and fly ash (8 – 7.7%).

In summer, mean PM_{10} – $PM_{2.5}$ levels are 138 – 61 $\mu g/m^3$. The overall city-level contribution of sources to ambient air PM_{10} – $PM_{2.5}$ levels are (given in parenthesis): soil and road dust (36 – 27%), vehicles (17 – 20%), SIA (7 – 10%), MSW burning (12 - 15%), biomass burning (13 – 18%), construction material (5 – 3%), and coal and fly ash (9 – 7.5%).

Although source contributions to summer and winter air pollution are different, the overall action plan should include control of sources regardless of the season. This chapter presents various air pollution control options and their effectiveness in improving air quality. At the end of the chapter, a time-sensitive action plan is presented.

6.2 Source-wise Overall Action

6.2.1 Hotels, Restaurants and Banquet Halls

The large hotels, restaurants, banquet halls (BH) and bakeries were surveyed, and their fuel usage activity data was collected. The total number of Hotels, Restaurants, Guest Houses (GHs), and Banquet Halls (BHs) are approximately 210. It was observed that in addition to LPG, coal/wood is being used as fuel in the tandoors, barbeques, and Banquet Halls (BHs). The PM emission in the form of flyash contributes to air pollution from these activities.

It is also seen that the ash/residue from the tandoor/barbeques and other activities are indiscriminately disposed of near the roadside. This contributes to road dust emissions also. The municipal corporation should strictly enforce coal-free cooking in hotels and restaurants, BHs, and marriage places. The ash must be stored in non-porous impervious bags and properly disposed off. One may consider linking the commercial license to clean fuel commitment. A 70% reduction in PM_{10} (130 kg/d) and $PM_{2.5}$ (68 kg/d) can be achieved by adopting clean fuels like PNG/LPG or electric appliances.

Some of the large hotels and restaurants have DG sets. The DG sets should be under the designated emission norms, meet stack height requirements and use only BS-VI fuel with a diesel particulate filter (DPF). DG sets of 2KVA and smaller (operating at ground level) may be banned and one can use an inverter or solar-based generators.

6.2.2 Municipal Solid Waste (MSW) Burning

In winter, the overall PM_{10} and $PM_{2.5}$ contribution from MSW burning is about 7%, and stopping this burning is the simplest way to reduce PM_{10} and $PM_{2.5}$ levels. Any form of garbage or waste burning should be fully stopped and strictly monitored for its compliance. The municipal corporation may consider imposing penalties and fines to deter people from burning any residue and further improve the collection and disposal of the MSW.

The Solid waste generation is around 269.1 MT/day, and the waste collected is approximately 259.7 MT/day. The MSW collection efficiency is 96.5% in Firozabad city (UPPCB SWM Annual Report 2019-20).

The municipal corporation should strengthen the infrastructure and prioritize the MSW collection mechanism starting systematically in each ward with an emphasis on public awareness to ensure 100% collection of MSW (including access to remote and congested areas) and disposal at the scientific landfill site. Special attention is required for fruits and vegetable markets, commercial areas, industrial areas, mandis, collection of tree leaves, and high-rise residential buildings.

Figure 6.1: MSW Burning in some parts of city

A mechanism should be developed to carry out a mass balance of MSW generation, collection and disposal on a weekly and monthly basis.

Desilting and cleaning of municipal drains by municipal corporation should be undertaken on a regular interval, as the silt with biological activities can cause emission of air pollutants like H_2S, NH_3, VOCs, etc.

Sensitize people and media through workshops and literature distribution to prevent waste burning and its unauthorized disposal; this activity may be undertaken municipal corporation.

A helpline Number (For reporting complaints about air pollution viz., open burning, fugitive emission due to construction activities, etc.) should be created and advertised.

6.2.3 Construction and Demolition

The construction and demolition (C&D) emission can be classified as temporary or short-term. In a developing urban area, these temporary or short-term construction activities are frequent. This source is one of the significant ground-level emission sources. Nearly at all the construction sites, the construction material, and their debris (lying in the open, without covers) are being stored outside the construction premises and near the road (Figure 6.2).

Every C&D activity should fully comply with C&D Waste Management Rules, 2016. A few C&D waste recycling facilities must be developed, which is a common practice in large cities. The control measures for emissions should include:

- Wet suppression of building material (except cement)

- wind speed reduction barriers (for large construction sites)
- Waste should be properly disposed of and not stored on the premises or on the roadside.
- Proper handling and storage of raw material: cover the storage and provide the windbreakers.
- Vehicle cleaning and specific fixed wheel washing on leaving the site and moving on haul routes.
- The actual construction area is covered by a fine screen.
- No storage (no matter how small) of construction material near the roadside (up to 10 m from the edge of the road).
- The haul road (from the main road to the construction area) should be brick roads or interlocking blocks that can sustain the weight of loaded trucks and should be regularly cleaned.

The above control measures should be coordinated and supervised by Uttar Pradesh Housing Board, Municipal corporation, Urban Development Department, PWD, and UPPCB.

Figure 6.2: Construction material and debris near construction sites

The suggested control measures will reduce the emission by 50% in PM_{10} (17.5 kg/d) and 72% in $PM_{2.5}$ (5.76 kg/d). This will also reduce the road dust and fly ash contribution to ambient air concentration.

6.2.4 Domestic sector

The projected population of Firozabad city for the year 2019 is approximately 800000 and the emissions from the domestic sector for the projected population are estimated. The population-wise fuel consumption pattern shows LPG (85%) consumption (CEEW Report, 2019), Wood (9.6%), Crop residue (1.2%), Dung (1.1%), Coal (1.3%), and Kerosene (0.7%).

There are several low economical areas where households have LPG connections but do not regularly use the LPG. Overall LPG and PNG should be made available to the remaining 15% of households to make the city 100% LPG and PNG fuels. By 2030, planning should be done that as many households as possible shift to electric cooking. For new societies, buildings should have a good infrastructure for PNG or provision for electric cooking – this will avoid transport and use of LPG cylinders.

This action of LPG and PNG supply is expected to reduce 82% of PM_{10} (609 kg/d) and 81% in $PM_{2.5}$ (454 kg/d) from this source.

In the residential area, electricity supply interruptions of approximately 6–8 hours daily were observed. During this period, backup power was provided primarily through diesel generator (DG) sets. Although DG sets ensured continuity of essential services, their prolonged operation has contributed significantly to local air pollution. It is recommended to ensure the uninterrupted power supply to residential areas. Renewable energy should be used to cater to the need of residential houses requirements in the absence of power failure to stop the use of DG Set.

The above control measures should be coordinated and supervised by Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.), State Energy Department, and UPEBL as per their jurisdictions.

6.2.5 Soil and Road Dust

It has been observed that the soil and road dust emissions and their contribution to ambient air concentration are consistent, and it is one of the largest sources of PM_{10} and $PM_{2.5}$ emissions. The average silt load, an important factor in PM emissions from the road is 8 g/m^2. The industrial areas, where heavy-duty vehicle movement is seen, also show high road dust emissions. It is suggested that high traffic density and heavy-duty vehicle roads should be properly maintained, paved from one end to another, have sidewalks through interlocking blocks for pedestrians, and have proper drainage from the road. Shrubs should be planted on-road dividers and dust removed from the edge of the dividers. Out of the total road network, about 60% of surface quality is poor.

The following control measures are suggested to reduce the dust emissions from the major roads:

1. Mechanical sweeping with water wash: The road dust PM_{10} emission estimated is

12735 kg/day and $PM_{2.5}$ 2907 kg/day. The emissions depend on the season and moisture on the road. This emission will be maximum in summer and least in monsoon. The efficiency of mechanical sweeping has been reported as 55% (Amato et al., 2010). If the sweeping of the main roads is done twice a month, the road dust emission will be reduced by 23% and if the frequency is increased to four times in a month, then the road dust emission will be reduced by 52%. This effort is likely to reduce emissions by 6622 kg/d for PM_{10} and 1511 for $PM_{2.5}$.

2. Vacuum-assisted Sweeping: The efficiency of vacuum-assisted sweeping is 90% (Amato et al., 2010) and this should be part of the specification that there are no leakages of collected dust from vacuum trucks. If the sweeping is done twice a month, the road dust emission will be reduced by 42% of PM_{10} (5348 kg/day) and $PM_{2.5}$ (1220 kg/d). If the frequency of sweeping is increased to four times a month, then the road dust emission will be reduced by 71% of PM_{10} (9041 kg/d) and $PM_{2.5}$ (2063 kg/d).
3. It is more important that the condition of the roads is properly maintained and paved wall to wall including shoulders. Broken roads are the source of silt accumulation and particle generation.
4. If the silt road is greater than 2 g/m^2, the vacuum-assisted sweeping should be carried out along with water washing by the municipal council.
5. NHAI should ensure that the silt load on highways is less than 2 gm/m^2.
6. The condition of the roads must be maintained properly with no potholes and shoulders paved by interlocking concrete to have a proper sidewalk.
7. Convert all unpaved, partially paved roads to fully paved roads. PWD (Public Works Department) and city administration may take action in this regard.
8. The truck carrying construction material, or any airborne material should be covered.
9. Vacuum sweeping of roads with high silt load locations (Jain Temple Tiraha and New Bypass Chauraha) should be carried out at least four times a month also carpeting of shoulders, maintenance of the road, dividers, and kerbs should be carried out at regular intervals. This activity should have proper documentation including the quantity of dust collected from the roads.
10. Shrubs and perennial forages, or grass covers should be planted on the medians wherever possible.
11. Soil dust could be part of road dust also. It is recommended that open fields should

be kept slightly wet and small shrubs are planted to prevent the drift of dust in summer.

The above control measures should be coordinated and supervised by Uttar Pradesh Housing Board, Municipal corporation, NHAI, PWD, and State Forest Department (for increasing green cover and plantation) as per their jurisdictions.

6.2.6 Vehicle Emission Control, Congestion and Traffic Management

The vehicle emission contribution is significant for CO, NO_x, PM_{10}, and $PM_{2.5}$. The source apportionment results show that commercial area GCRF have large vehicle contributions with an overall contribution of 20% in $PM_{2.5}$ in winter months.

The control measures must focus on advanced technological intervention for diesel vehicles like Diesel Particulate Filters (DPF). The specific recommendations for vehicular emission control are enumerated below (specific recommendations are discussed later).

1. Retro-fitment of DPF: These filters have a PM emission reduction efficiency of 60-90%. If the diesel vehicles entering and those in the city are equipped with DPF, there is a possible reduction of 40% of $PM_{2.5}$ emissions. This option must be explored as Bharat stage VI (BS-VI) fuel is available and this technology can be adopted.
2. Industries should encourage employing trucks and heavy-duty vehicles of Bharat stage-VI or IV with DPF for transportation of the raw material and finished products from the industry.
3. By the end of 2030, a target of 50% of the total registration of vehicles in the city should be electric vehicles (EVs) in the sector of 2Ws, 3Ws and passenger cars. A suitable subsidy or tax break may be considered for individuals opting for EVs. Charging infrastructure should come up quickly at multiple places (As per Ministry of Petroleum guidelines, charging infrastructure for EV- Revised guidelines and standards, Oct 1, 2019, MoP), including charging at public buildings and parking lots and battery swapping facilities should be planned to avoid long charging periods, especially for two-wheelers.

Transition to EV Cars and Emission Reductions

- Period: 2022 to 2032
- Y-to-Y growth rate: 9%

- EV sell in the first year: 10% (of total)
- Increment in sales in EV 20% of the previous year

4. All the diesel-based city public transport (government/private buses) should be phased out completely in the next three years, and city transport should be operated only through e-vehicle, or on CNG. All new public transport should be CNG or electric buses. Diesel buses below BS-IV must be restricted in the city.
5. Restriction on the bike-operated commercial rickshas in the city and encourage to use CNG/electric vehicles for commercial activities.
6. It is expected that all cars and small vehicles on BS-IV and lower must be scrapped by 2031 and on the road, fleet must of BS-VI. The overall emissions from vehicles will be reduced by 93%.
7. Heavy Vehicles Like buses and trucks on BS-II must be scrapped off and at least the fleet be on BS-IV.
8. Emissions from in-use vehicles also depend on the maintenance and upkeep of vehicles. In this regard, it is suggested that each vehicle manufacturing company should have its authorized service centres in sufficient numbers to cater to the need of their vehicles in the city. The automobile manufacturing company-owned service centres (AMCOSC) should be fully equipped for complete inspection and maintenance of vehicles ensuring vehicles conform to emission norms and fuel economy after servicing. Every vehicle at least once a year should undergo a thorough check-up and compliance with pollution control devices and their proper function from an authorized centre.
9. The current official PUC centres in Firozabad are not available at *Transport Department* but 4 - 8 PUC Centres are required per 1,00,000 vehicles (5 mins/vehicle and 12 hrs/day). Proper maintenance and calibration of equipment must be ensured by regular surveillance.
10. Linking of PUC centres with remote servers and elimination of manual intervention in PUC testing.
11. The existing PUC system may be upgraded to an Infrared based system/Remote Sensing device (RSD) for on-road emissions monitoring at major traffic zones to identify the polluting vehicles from fleet as per the guideline of the Ministry of Road Transport and Highways, Government of India (https://morth.nic.in/sites/default/files/ASI/Draft%20AIS-170%20-%20RSD_DF_Sep_20200930_C.pdf).
12. Restriction on plying and phasing out of 10 years old commercial diesel-driven

vehicles.

13. Check the overload vehicles: Use weigh-in-motion bridges/machines (WIM) and Weigh-bridges at entry points to the city and at the toll plaza to check the payload of commercial vehicles. As per CMVR, a penalty of 10 times the applicable rate for an overloaded truck is applicable.
14. Uttar Pradesh Road Transport Corporation should plan and install multiple electric charging facilities in its depots (in Firozabad and other destinations) to quickly move towards electric buses.
15. Incentivise and aggressively implement e-mobility including required charging infrastructure. Strategic plan for EV charging infrastructure at each 3 km in urban areas, 25 km on highways (both sides), and 100 km for buses and trucks and swappable battery stations.
16. The local public transport in the city should also move to electric buses. It is suggested that buses should be medium size of 30 seating capacity and provide better frequency for easy maundering in the city to avoid difficult turning and congestion.
17. Route rationalization: Improvement of availability by rationalizing routes and fleet enhancement with requisite modifications. Ensure integration of the existing metro system with bus service.
18. Information technology (IT) systems in buses, bus stops, and control centers and passenger information systems should be introduced for the reliability of bus services and monitoring.
19. The public transport system is inadequate. The large intracity passenger demand is met mostly by tempos and autorickshaws. The tempo movements are undisciplined, and they form multiple lanes, stop as per their will in the middle of the road and hardly follow any traffic rules; this leads to congestion and safety hazard. There should be designated places where tempos can stop to drop and take passengers/commuters. There is no tempo terminal facility thus these mushroomed up in one place completely blocking the road at the terminus.
20. Other than a few roads, there is a lack of footpath availability and marking of zebra crossing for pedestrian movements and people are forced to walk on the road. Proper footpaths and ease of crossing should be available for pedestrians.
21. Adequate vehicle scrappage infrastructure should be developed in the next three years. Extended Producer Responsibility (EPR) may be considered for vehicle manufacturers, who will have to build required vehicle scrap plants.

22. Public transport is to be strengthened with metro and/or an adequate number of buses, route plan based on commute surveys, and Mobile App based ticketing and seating system is developed in all major cities.

Decongestion of Roads

Chaotic, undisciplined, and poorly managed traffic, driving in the opposite direction of the main traffic, a culture of mine first, parking in no-parking areas and on-street parking are the major causes of traffic congestion and pose a safety hazard. The slow movement of vehicles results in much higher emissions than vehicles at smooth cruising speed. The large vehicles (Trailers and Trucks) require specific attention including installation of DPF.

To increase the average speed and get full advantage of BS-VI, decongestion, removing encroachments from the roads, and stopping unauthorized and improper parking are essential. The off-street parking is inadequate in the city causing jams and permanent congestion because of on-street haphazard parking.

The specific points that will help in decongestion are elaborated below.

- Heavy encroachment by shopkeepers and street vendors is observed in the commercial area and residential areas, and vehicles are parked on the road. The parked vehicles take up to 40% of the road width, although one-third of the roads are more than 30 m wide. This reduces road utilization by about 50%.
- The unauthorized vehicle service centres located near the road make things worse as the vehicle is parked on-road while servicing and repairing and oil and grease spillage can be seen.
- Heavy-duty vehicles and buses which are destined for other cities pass through major roads within Firozabad city and create heavy congestion.

During the traffic recording and survey, two major intersections are identified as traffic bottlenecks Jain Temple Tiraha, New Bypass Chauraha, Karku Kothi Tiraha and Shanti Road Chauraha.

Parking spaces

Off-street parking is inadequate in the city. There must be no parking zone (up to 50 m including auto, electric, and hand-pulled rickshaw) near the intersections as (Figure 6.3) it will

help the smooth traffic flow. Certain parking policies in congested areas (high parking costs, at city centers, and parking should be limited for differently abled people.

Vehicles are parked on roads and a few places occupying 50 percent of the thoroughfares virtually causing traffic jams and very slow movement of traffic.

The city should strictly follow Recommendations from IRC 12-2015 of prohibiting on-street parking as detailed below:

- Near Intersections: the capacity of an intersection is greatly reduced if vehicles are allowed to park on the approaches. Visibility is also adversely affected & safety is reduced. It is the general practice to prohibit parking for a distance of about 50 m on the approaches to a major intersection.
- Narrow Streets: Narrow streets with heavy traffic require that all possible measures should be taken to remove obstacles to traffic flow. Prohibition of parking can have a salutary effect on traffic flow & congestion. In the busy street of the central area, it is generally desirable to prohibit parking on two-way streets with less than 5.75 m in width & one-way streets less than 4 m in width.
- Pedestrian Crossings: Desirable to prohibit parking within about 8.0 m from the pedestrian crossings.
- Structures: Structures such as bridges, tunnels and underpasses generally have a roadway width less than the highway and for this reason, it is desirable to prohibit parking on them.

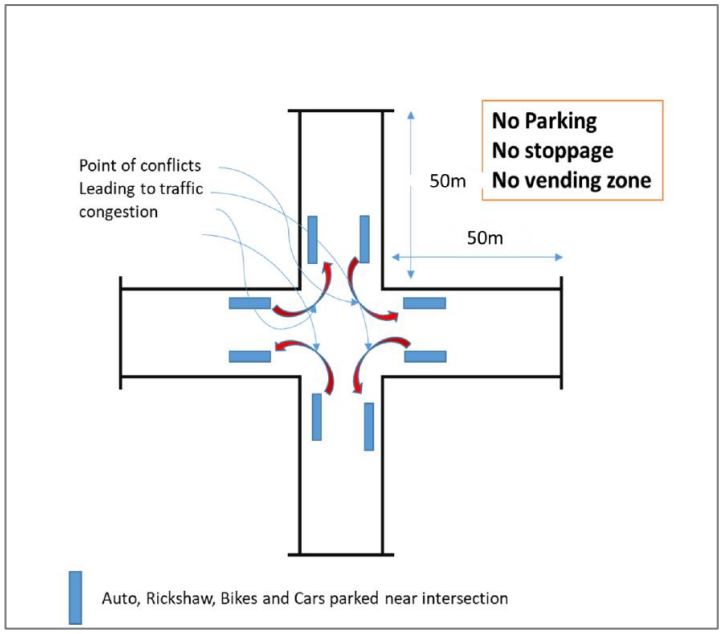


Figure 6.3: Conflicts due to on-street parking near intersections

There are modern technologies to facilitate multilevel car parking systems and the city should consider multilevel car parking systems in the near future.

Automated Multilevel Car Parking Systems

Automated car parking Systems are much in vogue - a method of automatic parking and retrieving cars that typically use a system of pallets and lifts and signalling devices for retrieval. They serve advantages like safety, saving of space, time, and fuel (since one does not have to drive around for locating space) but also need to have an extra and very detailed assessment of the parking required, space availability, and traffic flow. These can be further categorized into fully automatic or semi-automatic systems.

Dependent/Stack System: This allows two passenger cars to be parked one above the other (Figure 6.13). Its single post saves space and offers flexibility. Besides a platform (curved at the ends to allow the car to roll on/roll off conveniently) there is an operating control pendant that can be located anywhere in the garage, basement, and outdoor structure for operation from a safe distance.

Figure 6.4: Multi-level car parking (example)

Parking prices

Since on-street parking has been a major concern within the region, strict guidelines need to be adopted to discourage private vehicles in the settlements. In some areas, high parking charges need to be introduced in the city. Also, the building norms must have the mandatory provision of parking at everyone's house. Unauthorized on-street parking must be penalized and strict monitoring of compliance with defined rules to be enforced. "No parking zone" and no-vending zone signs should be placed at required locations exhibiting parking issues.

Mostly, the parking is done on the walkways, and there is insufficient street space for pedestrians, cyclists, and public transport. In some places, there do exist parking places but still, people prefer to park on-street because of lower convenience and high prices at designated parking.

Promoting Public Transport Travel

Increasing the efficiency of public transport can deliver the benefits of enhanced road capacities, accessibility and safety, and security. Thus, it is proposed to improve the efficiency of the existing public transport system and bring in a new fleet of low-floor electric buses. The size of these buses (e.g. 30-seater minibusses) should be decided to keep in mind the limited road width available at several locations in the city. Since the oversized buses tend to occupy most of the carriageway and further lead to congestion at bottlenecks while turning.

6.2.7 Industries

Ambient air samples collected in the industrial area during the winter months show high levels of PM_{10} and $PM_{2.5.}$ There are about 153 air-polluting units in the city (see section: 3.2.10, Chapter 3). The total PM_{10} and $PM_{2.5}$ emission of 1 kg/d from industries is observed. It is also observed that most industries use LPG and natural gases. However, some industries might use coal, wood, pet coke, rice husk, and HSD as fossil fuels, which must be shifted to natural gas and electricity. A regular surveillance should be done frequently to identify illegal operations.

A coordinated effort under the supervision of UPPCB and Industries Departments (i.e., Industrial Association) is suggested to implement the following control measures:

- Since the residential areas are surrounded by industrial clusters within the city, the industry is to be shifted to PNG or electricity in a time-bound manner.
- Ensuring compliance with emission standards in industries: All industries causing Air, Water, and Noise pollution shall be made compliant w.r.t environmental regulations.
- Strict action to stop unscientific disposal of industrial waste in the surrounding area.
- Industrial waste burning should be stopped immediately which is seen in the industrial area especially packing materials.
- The area and road in front of the industry should be free from any storage or disposal of any waste or raw material.
- The industry should follow best practices to minimize fugitive emissions within the industry premises; all leakages, transfer points, loading and unloading, and material handling within the industry should be controlled.
- Adequate and quality electric supply should be available to the industries for an effective industrial operation and avoidance of the DG sets.
- It is seen that industrial waste (hazardous) is mixed with MSW and burnt in several parts of Firozabad. It is recommended that no industrial waste should be mixed with MSW rather disposed of at TSDF (treatment storage and disposal facility) for hazardous waste disposal.
- There are industries with induction furnaces, which is a very polluted process, with almost no pollution control devices. The maximum emissions occur when the furnace lids and doors are opened during charging, back charging, alloying, oxygen lancing (if done), poking, slag removal, and tapping operations. These emissions escape from the sides and top of the building.

- There are many small boilers in many industrial clusters in Firozabad. Replacement of small boilers with common boilers for steam generation in a cluster of industrial units is an important way forward. There are several advantages of switching from individual small boilers to common boilers. The individual industrial units can avoid a range of costs that include the cost of installing small boilers and associated fuel costs, the cost of air pollution control devices, and operation and maintenance costs, and can also avoid the need for getting environmental clearances for boilers.

Industrial waste burning must be stopped under the supervision of UPPCB. It is also seen that solid waste (all types) is dumped and stored just outside the premises of the industry; this is not acceptable, and it looks unpleasant and at times spills over the road. It is recommended that all hazardous waste should send to an industrial non-hazardous TSDF for industrial waste. They should not be allowed to dispose of the waste on roads or in front of the industry. Strict compliance and surveillance are required that hazardous waste goes to TSDF under the supervision of municipal council and UPPCB.

6.2.8 Diesel Generator Sets:

To discourage the use of DG sets, the key focus has to (i) strengthening of grid power supply, uninterrupted power supply to the industries in the region and replacing DG sets with gas-based sets, (ii) Renewable energy should be used to cater to the need of office requirements in the absence of power failure to stop the use of DG Set.

While the new installation can be based on PNG-based sets, the existing ones can be replaced in a phased manner. Continuous supply of gas must be ensured. It may be noted that while the capital cost of a diesel generator set is lower than that of the gas-based set, the operational cost of the gas-based set is lower as CNG prices are much lower than the diesel prices.

6.2.9 Secondary Particles: Control of SO_2 and NO_2 from Large point sources

The secondary particles contribute about 15 percent in winter and 9 percent in summer in $PM_{2.5}$. These particles source from precursor gases (SO_2, NO_x, and NH_3), which are chemically transformed into particles in the atmosphere. Mostly, the precursor gases are emitted from far distances from large sources. For sulphates, the major contribution can be attributed to large industries using coal or heavy oil like furnace oil. However, the contribution of NO_x from local sources, especially vehicles and power plants can also contribute to nitrates. Behera and

Sharma (2010) for Kanpur have concluded that secondary inorganic aerosol accounted for a significant mass of $PM_{2.5}$ (about 34%) and any particulate control strategy should also include control of primary precursor gases.

6.2.10 Secondary Organic Aerosols

The estimated emission of secondary Organic Aerosol (SOA) based on OC3 and OC4 components of $PM_{2.5}$ is estimated as 22.16 $\mu g/m^3$ in winter (i.e., about 8% of $PM_{2.5}$). This implies that emissions of VOCs (volatile organic compounds) need to be controlled by industries, petrol pumps, and dry-cleaning units.

As for the industry, it is suggested that the solvent recovery should at least be 95%. The dry-cleaning units should follow best practices and consider solvent recovery units. It is recommended that all petrol pumps in Firozabad install vapour recovery system to reduce VOC emissions at the time of dispensing petrol/diesel also at the time of filling a storage tank at the petrol pump. It is also recommended that VOC-free paints be used in painting works.

All petrol retail outlets with 100 KL per month petrol capacity should provide a vapour recovery system (VRS) both at stage 1 and stage 2.

6.2.11 Biomass Burning

India being an agrarian country produces a huge amount of crop residue annually, both on-field and off-field, which is estimated to be about 500-550 million tons (Mt) (Indian Agricultural Research Institute, 2012). Rice crop contributes 36% of total crop residue whereas wheat contributes 22%. Traditionally, these residues are used for feeding cattle composting, thatching roofs in rural areas, and fuel for domestic and industrial uses. According to a study conducted by Pathak et al. (2010) and from the calculations based on IPCC coefficients, the total crop residue burnt per year in the country is estimated to be over 90 million tonnes. Regular Surveillance of open burning or other burning sources is to be done by UPPCB.

6.3 Summary of Actions and Control Options

It may be noted that air-polluting sources are plenty and efforts are required for every sector/source. In addition, there is a need to explore and implement various other options for controlling air pollutants.

The control options, source emissions, and required controlled emissions with their impact on air quality are summarized. Table 6.1 summarizes the actions with timeline and identified agencies for taking or implementing the actions for $PM_{2.5}$ and PM_{10}.

6.4 Strengthening of UPPCB Firozabad Regional Office

The following measures may be taken to strengthen the UPPCB regional office, Firozabad

- Additional manpower for sampling, analysis, assessment, action plan implementation and surveillance.
- Coordination with other implanting agencies.
- Upgradation of emission inventory every two year and assess emission reduction.
- Capacity-building through regular training; and
- Laboratory upgradation analysis of metals and other pollutants.

Table 6.1: Control Options and Action Plan for City of Firozabad

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
Hotels/ Restaurants/ Banquet Halls	All Restaurants small or large should not use coal and shift to gas-based or electric (for sitting capacity of more than 15 persons) appliances.	Municipal corporation Firozabad (MCF)	1 year
	Link Commercial license to clean fuel	Municipal corporation Firozabad, Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	1 year
	Ash/residue from the tandoor and other activities should not be disposed of near the roadside. Requires ward-level surveillance.	Municipal corporation Firozabad	1 year
Domestic Sector	LPG to all. Some of the populations are still using wood, biomass and dung cake as cooking fuel, especially in surrounding areas of city.	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	1 year
	No new building complex or society be allowed without a PNG supply distribution network	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	2 years
	By 2035, the city may plan to shift to electric cooking (common in western countries) or PNG at the minimum, that is completing shifting from LPG	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	5 - 7 years
	Strengthening of grid power supply, uninterrupted power supply to the residential areas.	State Energy Department, UPEBL	2 years
	Renewable energy should be used to cater to the need of residential houses requirements in the absence of power failure to stop the use of DG Set.	State Energy Department, UPEBL	2 years

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
Municipal Solid Waste (MSW) Burning	Any type of garbage burning should be strictly stopped. Current waste collection and surveillance are poor.	Municipal corporation Firozabad	Immediate
	Surveillance is required that hazardous waste goes to TSDF.	Municipal corporation Firozabad, UPPCB	
	Desilting and cleaning of municipal drains	Municipal corporation Firozabad	
	Waste including discarded packaging material burning in Industrial areas should be stopped.	The U.P. State Industrial Development Corporation Limited (UPSIDC), UPPCB	
	Daily, Monthly mass balance of MSW generation and disposal and keep the record	Municipal corporation Firozabad	
	Sensitize people and media through workshops and literature distribution so as not to burn the waste.	Municipal corporation Firozabad, UPPCB, and NGO	
Construction and Demolition	Wet suppression of open areas and material	MCF, Urban Development Department, PWD	Immediate
	Wind speed reduction (for large construction sites)	MCF, Urban Development Department, PWD	
	Enforcement of C&D Waste Management Rules. The waste should be sent to a construction and demolition processing facility	MCF, Urban Development Department, PWD	Immediate
	Proper handling and storage of raw material: covered the storage and provide the windbreakers.	MCF, Urban Development Department, PWD	
	Vehicle cleaning and specific fixed wheel washing on leaving the site and damping down of haul routes.	MCF, Urban Development Department, PWD	
	The actual construction area should be covered by a fine screen or vertical tin covers up to 6.0 m.	MCF, Urban Development Department, PWD	

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	No storage (no matter how small) of construction material near the roadside (up to 10 m from the edge of the road)	MCF, Urban Development Department, PWD	
	Builders should leave 25% area for green belt in residential colonies to be made mandatory. Haul roads inside large construction area be brick roads.	MCF, Urban Development Department, PWD	
	Sensitize construction workers and contract agencies through workshops.	MCF, Urban Development Department, PWD, UPPCB, and NGO	
Road Dust	The average silt load in Firozabad roads varies upto 8 g/m^2. The silt load on each road should be reduced to under 2 gm/m^2. Regular vacuum sweeping should be done on the road having a silt load above 2 gm/m^2.	MCF, National Highway Authority, PWD, UPPCB (for silt load compliance)	Immediate
	Convert unpaved roads to paved roads. Maintain pothole-free roads. Remove encroachment from the paved shoulders	MCF, National Highway Authority, PWD, UPPCB to carry out surveillance	
	Implementation of truck loading guidelines; use appropriate enclosures for haul trucks and gravel paving for all haul routes.	MCF, National Highway Authority, PWD	
	Increase green cover and plantation. Undertake the green of open areas, community places, schools, and housing societies.	MCF, National Highway Authority, State Forest Department, PWD	
	vacuum-assisted sweeping is carried out four times a month on major roads with road washing.	MCF, National Highway Authority, PWD	

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
Vehicles	Diesel vehicles entering the city should be equipped with DPF which will bring a reduction of 40% in emissions (This option can be implemented with vehicles of the BS-IV category as well)	State Transportation Department	5 years
	Industries must be encouraged to use BS-VI or BS-IV (with DPF) vehicles for the transportation of raw and finished products	Industrial Associations and State transport Department	Immediate
	Restriction on plying and phasing out of 10 years old commercial diesel-driven vehicles	Transport Department	2 years
	Restriction on the bike-operated commercial rickshas in the city and encourage to use CNG/electric vehicles for commercial activities.		
	Introduction of cleaner fuels (CNG/ LPG) for all vehicles (other than 2-W). All new 2-W may be mandated to be electric vehicles.	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.)	2 years
	Check to overload: Expedited installation of weigh-in-motion bridges and machines at all entry points into Firozabad.	Transport Department, Traffic Police, Firozabad, NHAI, Toll agencies	Six-months
	Electric/Hybrid Vehicles should be encouraged; New residential and commercial buildings to have charging facilities. All new city and school buses should be electric.	Transport Department, RTOs Firozabad	1 year
	All intra and inter bus stops and their parking should be rationalized to ensure more efficient utilization. The	Transport Department, RTOs Firozabad	1year

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	depots should include well-equipped maintenance workshops and adequate charging stations.		
	Enforcement of bus lanes and keep lanes free from obstruction and encroachment.	MCF, RTOs Firozabad	1 year
	Route rationalization: Improvement of availability by rationalizing routes and fleet enhancement with requisite modification.	RTOs Firozabad, Traffic Police, Firozabad	1 year
	IT systems in buses, bus stops, control centers, and passenger information systems for the reliability of bus services and monitoring.	RTOs Firozabad, Traffic Police, Firozabad	1 year
	Movement of materials (raw and product) within the city should be allowed between 10 PM to 5 AM.	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	1 year
	All the diesel-based city public transport should be phased out completely in next three to five years, and city transport should be operated only through e-vehicle or on CNG. All new public transport should be CNG or electric buses. Diesel buses below BS-IV must be restricted in the city.	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	3 – 5 years
	Incentivise and aggressively implement e-mobility including required charging infrastructure. Strategic plan for EV charging infrastructure at each 3 km in urban areas, 25 km on highways (both sides) and 100 km for buses and trucks and swappable battery stations.	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	2 years

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Adequate vehicle scrappage infrastructure should be developed in the next three years. Extended Producer Responsibility (EPR) may be considered for vehicle manufacturers, who will have to build required vehicle scrap plants. Truck movement in industrial areas is the major sources of pollution. One should consider only BS-4 and BS-6 trucks are allowed for transporting products and raw materials.	Transport Department, Firozabad, HMDA, RTOs Firozabad, Traffic Police, Firozabad	2 years
	Public transport to be strengthened with adequate number of buses, route plan based on commute surveys and Mobile App based ticketing and seating system is developed in all major cities	Transport Department, Firozabad, RTOs Firozabad, Traffic Police, Firozabad	2 – 5 years
Industries and DG Sets	Ensuring emission standards in industries. Shifting of polluting industries.	UPPCB, Industries Department	1 year
	Strict action to stop unscientific disposal of hazardous waste in the surrounding area	MCF and UPPCB	
	There should be separate Treatment, Storage, and Disposal Facilities (TSDFs) for hazardous waste.	Industrial Associations, Industries Department, UPPCB	2 years
	Industrial waste burning should be stopped immediately	Industrial Associations, UPPCB	Immediate
	Following best practices to minimize fugitive emissions within the industry premises, all leakages within the industry should be controlled	Industrial Associations, UPPCB	Immediate

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Area and road in front of the industry should be the responsibility of the industry	Industrial Associations, UPPCB	
	Category A Industries		
	About 153 industrial units with boilers and furnaces in Firozabad are running by using LPG and natural gases. However, some industries might use Coal, Briquettes, Rise Husk, Wood, HSD, Furnace Oil, Waste, Firewood and other dirty solid fuels which must be shifted to natural gas and electricity. A regular surveillance should be done frequently to identify illegal operations.	Department of Food, Civil Supplies and Consumer Affairs and Oil Companies (Indian Oil/HP, etc.), Industrial Associations, UPPCB	2 years
	Multi-cyclones should be replaced by baghouses. Ensure installation and operation of air pollution control devices in industries.	Industrial Associations, UPPCB	2 years
	Diesel Generator Sets		
	Strengthening of grid power supply, uninterrupted power supply to the industries.	State Energy Department, UPEBL	2 years
	Renewable energy should be used to cater to the need of office requirements in the absence of power failure to stop the use of DG Set.	Industrial Associations	2 years
	Efficient recovery system for solvents in chemical industries: The technologies suggest 95% recovery of VOCs is feasible and same may be adopted	Industrial Associations, UPPCB	1 year

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
Decongestion of Roads in high traffic areas	Strict action on roadside encroachment. Disciplined movement of tempos to stop only at designated spots. Action on driving in the wrong lane.	MCF, RTOs Firozabad, Traffic Police, Firozabad	1 year
	Disciplined Public transport (designate one lane stop).	RTOs Firozabad, Traffic Police, Firozabad	
	Removal of the free parking zone. No parking within 50 m of any major crossing and or chaurahas, rotaries. Strictly follow Indian Road Congress guidelines.	MCF, RTOs Firozabad, Traffic Police, Firozabad	
	Examine the existing framework for removing broken vehicles from roads and create a system for speedy removal and ensure minimal disruption to traffic.	RTOs Firozabad, NHAI, Traffic Police, Firozabad	
	Synchronize traffic movements or introduce intelligent traffic systems for lane-driving.	RTOs Firozabad, NHAI, Traffic Police, Firozabad	
	Mechanized multi-story parking at bus stands, and big commercial areas. Remove at least 50 percent of on-street parking in the city.	RTOs Firozabad, MCF, NHAI, Traffic Police, Firozabad	
	Identify traffic bottleneck intersections and develop a smooth traffic plan. For example, Karku Kothi Tiraha, Jain Temple Tiraha, Shanti Road Chauraha and New Bypass Chauraha are the main bottlenecks for traffic.	RTOs Firozabad, MCF, Traffic Police, Firozabad	
	Parking policy in congested areas (high parking cost, at city centers, only parking is limited for physically challenged people, etc).	RTOs Firozabad, MCF, NHAI, Traffic Police, Firozabad	
	The important points of congestion are Jain Temple Tiraha and New Bypass Chauraha. Parking on these	RTOs Firozabad, Traffic Police	2 years

Source	Control Action	Responsible authorities	Time Frame (within a specified time)
	Roads, should be strictly prohibited.		
*The above steps should not only be implemented in Firozabad Municipal corporation Firozabad rather these should be extended up to 20 km from the city boundary.			

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Annexure 1

Table showing the Emission Factors (EF) used while estimating emissions (Source: CPCB 2011).

Source		Units of Emission factor	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
Domestic	Wood	g/kg	5.04	4.54	0.48	1.4	31
	Crop residue	g/kg	11	9.90	0.12	0.49	58
	Dung	g/kg	5.04	4.54	0.48	1.4	31
	Coal	g/kg	20	18	13.3	3.99	24.92
	Kerosene	g/lit	0.61	0.55	4	2.5	62
	LPG	g/lit and $kg/10^6$ M^3	2.1	1.89	0.4	1.8	0.25
DG Set		g/kwh	0.0266	0.024	0.0248	0.376	0.0812
MSW Burning		g/kg	8	5.44	0.5	3	42
Brick Kiln	wood	g/kg	15.3	13.7	0.2	1.4	115.4
	coal	g/kg	10.15	7.10	13.3	3.99	24.92
Industrial	LDO	g/lit	2.37	2.13	18.84S	6.6	0.6
	HSD	g/lit	1.49	1.34	18.84S	6.6	0.6
	Rice Husk	g/kg	11	9.9	0.12	0.49	58
	Wood	g/kg	17.3	15.57	0.2	1.3	126.3
	Natural gas	$kg/(10)^6$ m^3 (SCM)	121.6	109.4	9.6	2240	1344
	Coal	g/kg	10.15	9.14	19S	11	0.25
	Diesel	g/lit	0.0266	0.024	0.0248	0.376	0.0812
Vehicle	2 wheelers	g/vkt	0.035	0.03	0	0.29	2.12
	3 wheelers	g/vkt	0.27	0.24	*	0.5	0.54
	4 wheelers	g/vkt	0.06	0.05	*	0.25	1
	LCV	g/vkt	0.64	0.58	*	3.1	1.86
	Bus	g/vkt	1.24	0.74	*	9.46	8.4
	Truck	g/vkt	1.24	0.74	*	9.46	8.4
Construction		$kg/d/m^2$	0.0021	0.0005	-	-	-

* Average kilometre run per litre of diesel is taken as: 10 km (for 3W); 15km (for 4W); 7 km (for LCV and 5 km (for Buses/Trucks). Sulfur content in diesel is taken as =500 ppm (wt/wt).

Gridded Emissions for Firozabad city is represented below.

Grid ID	PM_{10}		SO_2	NO_x	CO
G1	0.00	0.00	0.00	0.00	0.00
G2	0.00	0.00	0.00	0.00	0.00
G3	0.00	0.00	0.00	0.00	0.00
G4	0.00	0.00	0.00	0.00	0.00
G5	0.00	0.00	0.00	0.00	0.00
G6	0.00	0.00	0.00	0.00	0.00
G7	48.65	16.26	0.96	27.88	58.49
G8	2.49	1.86	0.45	1.38	10.80
G9	0.21	0.16	0.04	0.12	0.90
G10	0.00	0.00	0.00	0.00	0.00
G11	0.00	0.00	0.00	0.00	0.00
G12	0.00	0.00	0.00	0.00	0.00
G13	0.00	0.00	0.00	0.00	0.00
G14	0.00	0.00	0.00	0.00	0.00
G15	0.00	0.00	0.00	0.00	0.00
G16	0.00	0.00	0.00	0.00	0.00
G17	0.00	0.00	0.00	0.00	0.00
G18	0.00	0.00	0.00	0.00	0.00
G19	0.00	0.00	0.00	0.00	0.00
G20	0.00	0.00	0.00	0.00	0.00
G21	0.00	0.00	0.00	0.00	0.00
G22	0.66	0.49	0.12	0.37	2.86
G23	39.58	14.50	1.28	22.19	57.16
G24	75.40	24.49	1.21	42.37	85.18
G25	49.02	16.23	0.91	27.63	57.81
G26	17.44	5.28	0.13	9.84	16.79
G27	0.00	0.00	0.00	0.00	0.00
G28	1.35	0.38	0.01	0.73	0.75
G29	0.22	0.16	0.04	0.12	0.95
G30	0.00	0.00	0.00	0.00	0.00
G31	0.00	0.00	0.00	0.00	0.00
G32	0.00	0.00	0.00	0.00	0.00
G33	0.00	0.00	0.00	0.00	0.00
G34	0.00	0.00	0.00	0.00	0.00
G35	0.00	0.00	0.00	0.00	0.00
G36	0.00	0.00	0.00	0.00	0.00
G37	0.19	0.14	0.03	0.10	0.81
G38	1.92	1.33	0.31	0.94	7.40

Grid ID	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
G39	5.62	4.21	1.02	3.12	24.43
G40	95.40	47.44	54.48	46.69	171.54
G41	88.42	62.34	107.61	35.66	232.68
G42	1.11	0.83	0.20	0.61	4.81
G43	1.40	0.78	0.16	0.49	3.87
G44	180.78	48.43	1.13	44.50	84.79
G45	482.90	136.13	1.74	217.71	397.04
G46	45.67	16.14	4.87	33.15	67.96
G47	4.51	3.16	0.74	2.28	17.78
G48	0.00	0.00	0.00	0.00	0.00
G49	0.00	0.00	0.00	0.00	0.00
G50	0.00	0.00	0.00	0.00	0.00
G51	0.00	0.00	0.00	0.00	0.00
G52	0.34	0.26	0.06	0.19	1.49
G53	4.97	3.72	0.90	2.76	21.61
G54	0.17	0.13	0.03	0.09	0.73
G55	6.77	5.07	1.23	3.75	29.40
G56	59.01	21.80	2.57	34.25	84.96
G57	8.66	6.43	1.55	4.80	37.21
G58	14.83	7.60	1.42	5.87	35.81
G59	207.39	58.58	18.08	94.72	124.33
G60	124.10	38.57	1.76	55.91	127.04
G61	96.38	31.09	1.75	53.48	107.17
G62	72.59	23.48	2.13	35.30	74.96
G63	9.80	5.15	1.01	3.09	24.23
G64	0.36	0.11	0.01	0.03	0.24
G65	0.00	0.00	0.00	0.00	0.00
G66	0.00	0.00	0.00	0.00	0.00
G67	0.16	0.12	0.03	0.09	0.71
G68	1.78	1.33	0.32	0.98	7.72
G69	6.87	5.14	1.25	3.81	29.82
G70	7.45	5.70	5.01	12.83	35.65
G71	13.06	8.59	4.08	5.18	45.43
G72	70.42	23.11	1.77	25.75	69.52
G73	387.13	104.81	4.22	114.31	189.42
G74	204.81	56.40	1.76	53.97	99.97
G75	182.72	52.22	2.56	57.97	108.92
G76	48.63	19.35	4.93	26.32	76.82
G77	8.41	5.88	1.38	4.39	33.16
G78	138.42	41.49	4.00	85.03	130.33
G79	0.57	0.13	0.00	0.00	0.00
G80	0.00	0.00	0.00	0.00	0.00
G81	0.00	0.00	0.00	0.00	0.00

Grid ID	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
G82	0.00	0.00	0.00	0.00	0.00
G83	0.56	0.42	0.10	0.31	2.42
G84	2.70	2.02	0.49	1.50	11.72
G85	8.61	6.45	1.56	4.77	37.40
G86	9.51	7.29	6.76	17.25	45.83
G87	39.92	29.01	165.87	397.69	263.36
G88	223.41	62.79	15.18	95.15	133.84
G89	224.17	64.01	1.79	90.64	141.77
G90	181.29	56.12	16.67	74.87	148.53
G91	205.94	57.15	2.52	56.04	102.66
G92	426.93	116.07	37.23	191.27	214.69
G93	17.77	9.73	2.53	8.47	46.13
G94	541.86	142.17	9.05	184.83	238.75
G95	0.42	0.31	0.08	0.23	1.81
G96	0.00	0.00	0.00	0.00	0.00
G97	0.00	0.00	0.00	0.00	0.00
G98	0.17	0.13	0.03	0.09	0.73
G99	1.48	1.11	0.27	0.82	6.44
G100	3.20	2.40	0.58	1.77	13.91
G101	11.28	8.51	3.29	8.29	45.92
G102	14.09	9.92	19.48	49.20	67.93
G103	37.73	17.84	28.90	76.74	100.53
G104	129.42	47.40	106.24	271.68	225.98
G105	283.32	85.25	51.70	180.31	217.17
G106	123.90	37.68	12.88	60.78	94.78
G107	88.29	31.11	13.15	75.49	120.81
G108	283.55	76.57	2.57	72.91	122.77
G109	1097.49	276.55	1.77	263.48	325.15
G110	193.25	55.26	1.50	87.28	140.85
G111	5.68	3.67	0.83	2.59	19.76
G112	0.16	0.12	0.03	0.09	0.71
G113	1.10	0.75	0.17	0.53	4.13
G114	42.99	29.78	53.41	16.82	107.13
G115	35.12	10.42	0.50	11.79	27.14
G116	28.13	11.51	1.38	15.74	51.94
G117	32.65	14.24	2.55	19.30	64.99
G118	113.01	34.08	2.54	36.26	86.51
G119	98.57	33.58	8.91	49.11	114.84
G120	158.62	51.40	22.72	130.64	202.81
G121	154.44	58.01	97.09	271.72	262.61
G122	158.32	46.62	5.62	56.29	103.10
G123	52.89	20.84	11.87	35.35	78.96
G124	48.28	18.96	4.21	25.09	76.09

Grid ID	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
G125	397.37	114.37	2.52	193.28	311.25
G126	9.53	6.33	1.45	4.42	34.65
G127	1.29	0.85	0.19	0.59	4.61
G128	0.00	0.00	0.00	0.00	0.00
G129	2.84	1.45	0.27	1.11	6.84
G130	4.34	2.20	0.41	1.70	10.34
G131	120.32	32.67	0.91	31.05	60.33
G132	7.16	5.59	21.38	49.87	42.12
G133	12.79	11.61	63.70	153.00	110.54
G134	134.83	42.48	6.32	65.82	124.30
G135	14.60	8.98	5.66	16.83	49.36
G136	8.99	6.73	1.63	4.98	39.07
G137	338.21	92.61	8.31	94.67	154.13
G138	53.36	19.14	1.78	25.96	66.84
G139	884.17	224.52	3.26	215.94	264.95
G140	232.88	66.57	1.52	113.58	168.72
G141	30.43	12.98	7.12	29.92	60.58
G142	37.37	13.25	1.06	19.99	49.00
G143	0.00	0.00	0.00	0.00	0.00
G144	0.00	0.00	0.00	0.00	0.00
G145	0.75	0.56	0.14	0.42	3.27
G146	2.73	2.04	0.50	1.51	11.85
G147	5.63	1.78	0.14	1.50	4.71
G148	212.96	62.87	104.99	297.35	203.08
G149	161.10	62.74	176.73	477.22	354.80
G150	16.29	9.87	18.39	46.30	62.21
G151	15.30	10.50	11.05	21.57	58.95
G152	8.90	6.66	1.62	4.97	38.64
G153	612.77	158.67	2.58	156.11	204.28
G154	188.57	51.82	2.84	53.62	85.55
G155	342.21	95.74	2.57	155.34	225.47
G156	19.29	9.48	8.94	24.60	47.62
G157	1.66	1.04	0.23	0.70	5.48
G158	0.31	0.14	0.02	0.07	0.56
G159	0.00	0.00	0.00	0.00	0.00
G160	0.00	0.00	0.00	0.00	0.00
G161	0.00	0.00	0.00	0.00	0.00
G162	0.00	0.00	0.00	0.00	0.00
G163	42.00	16.08	43.00	122.98	89.94
G164	202.94	59.20	58.61	202.91	175.48
G165	4.62	3.53	3.13	8.00	22.10
G166	12.05	6.30	1.20	4.86	30.30
G167	12.03	6.14	1.15	4.76	29.02

Grid ID	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
G168	12.04	7.53	1.61	6.62	40.63
G169	185.00	52.43	2.44	61.87	104.00
G170	552.63	144.54	1.49	180.90	238.83
G171	174.06	54.15	6.57	95.46	140.34
G172	4.89	3.66	0.89	2.71	21.25
G173	0.00	0.00	0.00	0.00	0.00
G174	0.00	0.00	0.00	0.00	0.00
G175	0.00	0.00	0.00	0.00	0.00
G176	0.00	0.00	0.00	0.00	0.00
G177	0.00	0.00	0.00	0.00	0.00
G178	0.00	0.00	0.00	0.00	0.00
G179	18.58	5.16	0.00	10.39	14.00
G180	0.00	0.00	0.00	0.00	0.00
G181	0.00	0.00	0.00	0.00	0.00
G182	0.00	0.00	0.00	0.00	0.00
G183	2.12	0.91	0.14	0.65	3.68
G184	489.36	127.17	1.62	127.57	170.33
G185	137.39	41.70	2.17	77.94	126.00
G186	59.40	19.64	1.31	32.75	67.26
G187	109.69	33.93	4.80	39.22	83.60
G188	4.26	2.36	0.47	1.80	11.68
G189	0.00	0.00	0.00	0.00	0.00
G190	0.00	0.00	0.00	0.00	0.00
G191	0.00	0.00	0.00	0.00	0.00
G192	0.00	0.00	0.00	0.00	0.00
G193	0.00	0.00	0.00	0.00	0.00
G194	0.00	0.00	0.00	0.00	0.00
G195	0.00	0.00	0.00	0.00	0.00
G196	0.00	0.00	0.00	0.00	0.00
G197	0.00	0.00	0.00	0.00	0.00
G198	0.00	0.00	0.00	0.00	0.00
G199	0.00	0.00	0.00	0.00	0.00
G200	816.26	212.16	0.60	290.19	326.31
G201	27.30	9.07	0.56	15.41	37.65
G202	7.93	5.10	1.15	3.50	27.43
G203	24.45	10.55	1.48	12.53	44.98
G204	1.86	0.69	0.07	1.01	2.53
G205	0.00	0.00	0.00	0.00	0.00
G206	0.00	0.00	0.00	0.00	0.00
G207	0.00	0.00	0.00	0.00	0.00
G208	0.00	0.00	0.00	0.00	0.00
G209	0.00	0.00	0.00	0.00	0.00
G210	0.00	0.00	0.00	0.00	0.00

Grid ID	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
G211	0.00	0.00	0.00	0.00	0.00
G212	0.00	0.00	0.00	0.00	0.00
G213	0.00	0.00	0.00	0.00	0.00
G214	0.00	0.00	0.00	0.00	0.00
G215	0.00	0.00	0.00	0.00	0.00
G216	0.00	0.00	0.00	0.00	0.00
G217	0.00	0.00	0.00	0.00	0.00
G218	0.47	0.35	0.09	0.26	2.05
G219	5.65	2.53	0.43	1.32	10.31
G220	2.57	1.93	0.47	1.44	11.17
G221	0.00	0.00	0.00	0.00	0.00

Dyadav 29/11/RO PCB 3017/FER-4

*81-709724/2022-07-पर्यावरण, वन एवं जलवायु परिवर्तन I/790155/2024

ANNEXURE 2

क्र0 प्रश्नगत प्रकरण में नियमानुसार
अपेक्षित कार्यवाही करना सुनिश्चित करें।

संख्या-883/81-7-2024

जिलाधिकारी
फिरोजाबाद

प्रेषक,

मनोज सिंह,
अपर मुख्य सचिव,
उ0प्र0 शासन।

सेवा में,

1- **अपर मुख्य सचिव/प्रमुख सचिव/सचिव,**
वित्त/बाह्य सहायतित परियोजना/अवस्थापना एवं औद्योगिक विकास/
सूक्ष्म, लघु एवं मध्यम उद्यम तथा निर्यात प्रोत्साहन/नगर विकास/परिवहन/
ग्राम्य विकास/कृषि/कृषि शिक्षा एवं अनुसंधान/पशुपालन/
चिकित्सा, स्वास्थ्य एवं परिवार कल्याण/अतिरिक्त ऊर्जा स्रोत/
प्राविधिक शिक्षा/उच्च शिक्षा/व्यवसायिक शिक्षा, कौशल विकास और उद्यमशीलता/
राज्य कर विभाग, उ0प्र0 शासन।

2- **निदेशक,**
पर्यावरण, उ0प्र0, लखनऊ।

3- **सदस्य सचिव,**
उ0प्र0 प्रदूषण नियंत्रण बोर्ड, लखनऊ।

NCAP

पर्यावरण, वन एवं जलवायु परिवर्तन अनुभाग-7 लखनऊ : दिनांक : 08 **नवम्बर, 2024**

विषय-उत्तर प्रदेश राज्य के अन्तर्गत विश्व बैंक की सहायता से "उत्तर प्रदेश क्लीन एयर मैनेजमेंट प्रोजेक्ट" क्रियान्वित कराये जाने के सम्बन्ध में।

महोदय,

अवगत कराना है कि वायु प्रदूषण के रोकथाम, नियंत्रण एवं कमी के लिए भारत सरकार द्वारा राष्ट्रीय स्वच्छ वायु कार्यक्रम (NCAP) का क्रियान्वयन प्रदेश के 17 नगरों सहित देश के 131 नगरों में किया गया है। उ0प्र0 प्रदूषण नियंत्रण बोर्ड, लखनऊ द्वारा आई0आई0टी0, कानपुर के माध्यम से कराये गये तकनीकी शोध में यह ज्ञात हुआ है कि राज्य के नगरों के अंतर्गत लगभग 40 से 50 प्रतिशत वायु प्रदूषण नगर के बाहर स्थित स्त्रोतों से होता है तथा उत्तर प्रदेश राज्य, भारतीय गंगा के मैदान, एयरशेड के अन्तर्गत स्थित हैं। उक्त के दृष्टिगत वायु प्रदूषण नियंत्रण हेतु नगरों के साथ-साथ हवा के बहाव क्षेत्र अर्थात एयरशेड के आधार पर सम्पूर्ण राज्य में चिन्हित किये गये वायु प्रदूषण के स्रोतों के विरूद्ध कार्यवाही की जानी आवश्यक है। पर्यावरण, वन एवं जलवायु परिवर्तन विभाग द्वारा विश्व बैंक के तकनीकी सहयोग से राष्ट्रीय एवं अंतर्राष्ट्रीय ख्याति प्राप्त संस्थानों के समूह द्वारा उत्तर प्रदेश राज्य हेतु एयरशेड आधारित वायु प्रदूषण संबंधित

SC/JRPL(OL) 29/11/24

vi. प्रदेश में राष्ट्रीय स्वच्छ वायु कार्यक्रम के अन्तर्गत निर्धारित लक्ष्यों को प्राप्त किये जाने हेतु कार्यवाही करना।

vii. परियोजना में कार्बन क्रेडिट के एकीकरण से परियोजना की वास्तविक लागत में बचत भी प्राप्त हो सकेगी।

viii. परियोजना में लक्षित वायु प्रदूषण के स्रोतों के सम्बन्ध में कार्यवाही के फलस्वरूप वायु प्रदूषण के प्रचालकों के उत्सर्जन में कमी हो सकेगी।

ix. प्रदेश में वायु प्रदूषण एवं जलवायु परिवर्तन की कार्यवाहियों के क्रियान्वयन हेतु आवश्यक ग्रीन स्किल डेवेलपमेन्ट के साथ-साथ ग्रीन जॉब्स् हेतु अवसर उपलब्ध हो सकेंगे।

x. प्रदेश में वायु प्रदूषण नियंत्रण में आम नागरिक एवं नागरिक संगठनों की सक्रिय भागीदारी सुनिश्चित किये जाने हेतु आवश्यक जन-जागरूकता उत्पन्न हो सकेगी।

3- प्रश्नगत परियोजना के अन्तर्गत सेक्टरवार कार्यवाहियों के बिन्दुओं का विवरण निम्नवत् है :-

1. **सुदृढ़ीकरण एवं क्षमता विकास (Result Area-1)**

क्र0सं0	कार्य का विवरण	क्रियान्वयन विभाग/ ऐजेन्सी	भौतिक लक्ष्य	वित्तीय लक्ष्य (रू0 लाख में)	टिप्पणी
1.	मौजूदा वायु गुणवत्ता मॉनिटरिंग नेटवर्क का विस्तार एवं आधुनिकीकरण	यू0पी0पी0सी0बी0 (उ0प्र0 प्रदूषण नियंत्रण बोर्ड), नगर विकास विभाग, एस0पी0वी0 (Special Purpose Vehicle)	193 नये सी0ए0ए0क्यू0 एम0एस0 की स्थापना, समीर इन्डस्ट्रियल ऐप विकसित करना तथा चिन्हित सी0ए0ए0क्यू0 एम0एस0 के आस-पास के क्षेत्र की सड़कों की मरम्मत करना	28410.32	
2.	सुपरसाइट का निर्माण	यू0पी0पी0सी0बी0	03 सुपरसाइटों का निर्माण	6138.19	

			कार्यशाला		
8.	जागरूकता हेतु संचार रणनीति का विकास	एस0पी0वी0	विभिन्न हितधारकों के संवेदीकरण एवं जागरूकता कार्यक्रम	2432.42	
9.	यू0पी0सी0ए0एम0पी0 के कार्यों के निष्पादन हेतु एस0पी0वी0 का गठन, क्रियान्वयन विभागों में यू0पी0 कैप सेल की स्थापना तथा विभिन्न कार्यों के वैरिफिकेशन हेतु स्वतंत्र सत्यापन एजेन्सी से एम0ओ0यू0	पर्यावरण, वन एवं जलवायु परिवर्तन विभाग, एस0पी0वी0	01 एस0पी0वी0 का गठन तथा 03 स्वतंत्र सत्यापन एजेन्सी से एम0ओ0यू0	11918.38	
10.	एम0आई0एस0 वेब एवं मोबाइल ऐप का विकास	एस0पी0वी0	01 एम0आई0एस0 वेब एवं मोबाइल ऐप का विकास	166.67	
11.	वायु प्रदूषण और सार्वजनिक स्वास्थ्य डेटा का एकीकरण	एस0पी0वी0, डी0ओ0एच0एफ0 डब्लू0 (चिकित्सा स्वास्थ्य एवं परिवार कल्याण विभाग)	डाटा एकीकरण हेतु ऐप एवं हेल्थ सिस्टम प्रीपेरइनस प्लान का विकास तथा प्रशिक्षण एवं क्षमता विकास	335.05	
योग - रू0 लाख में					71414.15

2. क्लीन कुकिंग सेक्टर

क्र0 सं0	कार्य का विवरण	क्रियान्वयन विभाग/ऐजेन्सी	भौतिक लक्ष्य	वित्तीय लक्ष्य (रू0 लाख में)	टिप्पणी
1.	बायोमास आधारित उन्नत चूल्हों का वितरण	ग्राम्य विकास विभाग, यू0पी0एस0आर0 एल0एम0 (उ0प्र0 राज्य ग्रामीण आजीविका मिशन),	35.00 लाख परिवार	7000.00 (रु0 200 प्रति उन्नत चूल्हा का प्रोत्साहन तथा कार्बन फाइनेंस द्वारा पूर्णतया	1. ग्लोबल टेण्डर के माध्यम से कार्बन फाइनेंस हेतु एजेन्सी इम्पैनल की जायेंगी। 2. बायोमास आधारित उन्नत

					सृजन से कम प्राप्त हुयी तो शेष वित्तीय भार लाभार्थी द्वारा वहन किया जायेगा।
4.	इण्डियन ऑयल कार्पोरेशन द्वारा विकसित नूतन सौर्य चूल्हों हेतु प्रोत्साहन	यू0पी0एस0आर0एल0एम0, ग्राम्य विकास विभाग, एस0पी0वी0	00.10 लाख परिवार	400.02 (कार्बन फाइनेंस• द्वारा रू 130.00 लाख अनुमानित वित्त पोषित)	ग्लोबल टेण्डर के माध्यम से कार्बन फाइनेंस हेतु एजेन्सी इनपैनेल्ड की जायेंगी। •यदि कार्बन फाइनेंसिंग द्वारा वित्तीय सृजन अनुमानित वित्तीय सृजन से कम प्राप्त हुयी तो शेष वित्तीय भार लाभार्थी द्वारा वहन किया जायेगा।
5.	ई0ई0एस0एल0 सोलर इण्डक्शन हेतु प्रोत्साहन	यू0पी0एस0आर0एल0एम0, ग्राम्य विकास विभाग, एस0पी0वी0	00.10 लाख परिवार	416.51 (कार्बन फाइनेंस• द्वारा रू 130.00 लाख अनुमानित वित्त पोषित)	ग्लोबल टेण्डर के माध्यम से कार्बन फाइनेंस हेतु एजेन्सी इनपैनेल्ड की जायेंगी। •यदि कार्बन फाइनेंसिंग द्वारा वित्तीय सृजन अनुमानित वित्तीय सृजन से कम प्राप्त हुयी तो शेष वित्तीय भार लाभार्थी द्वारा वहन किया

		एस0पी0वी0			
योग रू0 लाख में				49877.90	

3. परिवहन सेक्टर

क्र0 सं0	कार्य का विवरण	क्रियान्वयन विभाग/ ऐजेन्सी	भौतिक लक्ष्य	वित्तीय लक्ष्य (रू0 लाख में)	टिप्पणी
1.	भारी डीजल वाहनों को चरणबद्ध तरीके से हटाये जाने हेतु प्रोत्साहन (बीएस-1 से बीएस-3)	परिवहन विभाग	13576 भारी वाहनों को चरणबद्ध तरीके से हटाये जाने एवं 1500 एल0एन0जी0 /ई0एच0डी0वी0 वाहनों के क्रय हेतु अतिरिक्त प्रोत्साहन	38800.00	
2.	भारी वाहन चालकों की क्षमता विकास	परिवहन विभाग	10000 भारी वाहन चालक	944.00	
3.	लखनऊ, कानपुर, गोरखपुर एवं वाराणसी में ई-बस सुविधा के विस्तार हेतु प्रोत्साहन	नगर विकास विभाग, डी0यू0टी0 (नगरीय परिवहन निदेशालय)	1. लखनऊ (150), कानपुर (150), गोरखपुर (100) एवं वाराणसी (100) कुल 500 नई ई-बसों का जी0सी0सी0 मॉडल पर संचालन हेतु कैपिटल इंसेंटिव 2. लखनऊ (02), कानपुर (01), गोरखपुर (01)एवं वाराणसी (01) कुल 05 नये चार्जिंग/डिपो इन्फ्रास्ट्रक्चर का विकास	30000.00	उक्त धनराशि पी0एम0 ई-बस सेवा योजना की बसों को कैपिटल इंसेंटिव के रूप में देय होगी
4.	मध्यवर्ती सार्वजनिक परिवहन (IPT) के आधुनिकरण हेतु तीन पहिया ई-वाहन को प्रोत्साहन तथा चार्जिंग स्टेशन का विकास	परिवहन विभाग, नगर विकास विभाग	1. लखनऊ, वाराणसी एवं गोरखपुर (पायलेट प्रोजेक्ट) में कुल 15,000 मध्यवर्ती सार्वजनिक परिवहन (IPT) के आधुनिकरण हेतु तीन पहिया ई-वाहन (ई-रिक्शा को छोड़कर)को प्रोत्साहन (न्यूनतम 10 प्रतिशत महिलाओं हेतु) 2. लखनऊ एवं वाराणसी में 300	9390.00	

2.	टनल क्लिन तकनीक आधारित ईंट भट्टों का पॉईलेट प्रोजेक्ट	एम0एस0एम0ई0 विभाग, एस0पी0वी0	20 टनल क्लिन तकनीक आधारित ईंट भट्टे	4150.00 (राज्य सरकार द्वारा एम0एस0एम0ई0 सी0डी0पी0 योजना के अंतर्गत रू 12000.00 लाख अनुदानित)	
3.	जिग-जैग तथा आर0ई0बी0 तकनीक पर आधारित ईंट भट्टों के संचालन हेतु ईंट भट्टे संचालकों का क्षमता विकास	एम0एस0एम0ई0 विभाग, एस0पी0वी0	100 प्रशिक्षण कार्यशाला	354.00	
4.	औद्योगिक क्लस्टरों में कॉमन स्टीम सुविधा का फैसेलिटेशन	अवस्थापना एवं औद्योगिक विकास विभाग,एस0पी0वी0, यू0पी0सी0डा0 (उ0प्र0 राज्य औद्योगिक विकास प्राधिकरण)	राज्य में न्यूनतम 01 ब्राउन फील्ड एवं 01 ग्रीन फील्ड औद्योगिक क्लस्टर में कॉमन स्टीम सुविधा की स्थापना	210.00	
5.	यू0पी0सी0डा0 में वायु प्रदूषण नियंत्रण हेतु प्रोजेक्ट मैनेजमेण्ट यूनिट की स्थापना तथा औद्योगिक क्लस्टर हेतु एयर एक्शन प्लान का निर्माण	अवस्थापना एवं औद्योगिक विकास विभाग,एस0पी0वी0, यू0पी0सी0डा0	01 प्रोजेक्ट मैनेजमैंट यूनिट तथा 07 औद्योगिक क्लस्टर हेतु एयर एक्शन प्लान का निर्माण	1169.54	
6.	प्रदूषण इन्टेन्सिव एम0एस0एम0ई0 औद्योगिक इकाईयों में सी0ई0एम0एस0 लगाये जाने हेतु प्रोत्साहन	यू0पी0पी0सी0बी0, एस0पी0वी0	1000 एम0एस0एम0ई0 औद्योगिक इकाईयों में सी0ई0एम0एस0 की स्थापना	2500.00	

4.	यू0पी0सी0ए0आर0, नोडल एस0ए0यू0/आई0सी0ए0आर0 एवं अन्य एस0ए0यू0/ आई0सी0ए0आर0 में प्रोजेक्ट मैनेजमेन्ट यूनिट की स्थापना	कृषि विभाग, यू0पी0सी0ए0आर0 (उ0प्र0 कृषि अनुसंधान परिषद) नोडल एस0ए0यू0 (राज्य कृषि विश्वविद्यालय/ आई0सी0ए0आर0 (भारतीय कृषि अनुसंधान परिषद)	1. यू0पी0सी0ए0आर0 में 01 प्रधान वैज्ञानिक, 01 यंग वैज्ञानिक, 01 कंसलटेंट, 01 एस0आर0 एफ0 तथा 01 कार्यालय सहायक की आउट सोर्सिंग के माध्यम से नियुक्ति 2. एस0ए0यू0/ आई0सी0ए0आर0 में 01 यंग वैज्ञानिक, 01 मिड करियर वैज्ञानिक, 02 फील्ड सहायक तथा 01 कार्यालय सहायक की आउट सोर्सिंग के माध्यम से नियुक्ति 3. अन्य एस0ए0यू0 /आई0सी0ए0आर0 में 02 यंग वैज्ञानिक, 02 फील्ड सहायक तथा 01 कार्यालय सहायक की आउट सोर्सिंग के माध्यम से नियुक्ति	3118.27	
5.	यू0पी0सी0ए0आर0, नोडल एस0ए0यू0/आई0सी0ए0आर0 एवं अन्य एस0ए0यू0/ आई0सी0ए0आर0, कृषि विभाग कृषि विज्ञान केन्द्रों हेतु कुल ऊपरी लागत	यू0पी0सी0ए0आर0नोडल एस0ए0यू0/ आई0सी0ए0आर0 एवं अन्य एस0ए0यू0/ आई0सी0ए0आर0, कृषि विभाग	यू0पी0सी0ए0आर0, नोडल एस0ए0यू0/ आई0सी0ए0आर0 अन्य एस0ए0यू0 एवं आई0सी0ए0आर0-11 कृषि विभाग, कृषि विज्ञान केन्द्र-72	301.96	
6.	बड़े एवं छोटे उपकरणों का क्रय तथा जागरूकता कार्यक्रम/प्रदर्शन	कृषि विभाग	बड़े एवं छोटे उपकरणों का क्रय तथा जागरूकता कार्यक्रम/प्रदर्शन	12407.05	
7.	यू0पी0सी0ए0एम0पी0 के कार्यक्रम में शीघ्र नामांकन हेतु किसानों को प्रोत्साहन	कृषि विभाग	5000 रू0 प्रति हेक्टेयर का प्रोत्साहन	2400.00	

	तथा कंस्ट्रक्शन हितधारकों के प्रशिक्षण एवं क्षमता विकास हेतु माइयूल का विकास	(Institute of Repute), एस0पी0वी0			
2.	डस्ट नियंत्रण निगरानी हेतु आई0सी0सी0सी0 के उपयोगार्थ एस0ओ0पी0 एवं एप्लीकेशन का विकास	एस0पी0वी0	चयनित शहरों तथा सभी स्मार्ट सिटी में डस्ट नियंत्रण निगरानी हेतु आई0सी0सी0सी0 के उपयोगार्थ एस0ओ0पी0 एवं एप्लीकेशन का विकास	708.00	
3.	मिनी इंट्रीगेटेड कण्ट्रोल एण्ड कमांड सेंटर की स्थापना	एस0पी0वी0, नगर विकास विभाग	12 चयनित शहरों में मिनी इंट्रीगेटेड कण्ट्रोल एण्ड कमांड सेंटर की स्थापना	3000.11	
4.	एम0आर0एस0 आडिट संचालन कर्मियों, क्षेत्रीय कर्मियों एवं पर्यवेक्षकों की क्षमता विकास एवं प्रशिक्षण	एस0पी0वी0, उ0प्र0स्थानीय निकाय निदेशालय	प्रत्येक18 प्रशासनिक मण्डल में एम0आर0एस0 आडिट संचालन कर्मियों, क्षेत्रीय कर्मियों एवं पर्यवेक्षकों की क्षमता विकास एवं प्रशिक्षण	472.00	
योग (डस्ट) रू0 लाख में				4386.61	

6(ब) अपशिष्ट

क्र0सं0	कार्य का विवरण	क्रियान्वयन विभाग/ऐजेन्सी	भौतिक लक्ष्य	वित्तीय लक्ष्य (रू0 लाख में)	टिप्पणी
1.	अपशिष्ट प्रबंधन प्रोजेक्ट मैनेजमेंट यूनिट की स्थापना एवं प्रशिक्षण कार्यक्रम	नगर विकास विभाग,उ0प्र0 स्थानीय निकाय निदेशालय, एस0पी0वी0	01 प्रोजेक्ट मैनेजमेंट यूनिट की स्थापना	1052.32	
योग (अपशिष्ट) रू0 लाख में				1052.32	

कुल योग (डस्ट + अपशिष्ट) रू0 लाख में	5438.94

7. आई0जी0पी0 राज्य स्तरीय संयोजक(Result Area-3)

क्र0सं0	कार्य का विवरण	क्रियान्वयन विभाग/ऐजेन्सी	भौतिक लक्ष्य	वित्तीय लक्ष्य (रू0 लाख में)	टिप्पणी
1.	अंतर राज्यीय कार्यशाला, क्षेत्रीय एक्सपोजर विजिट तथा मानव संसाधन का विस्तार	एस0पी0वी0	1. अंतर राज्यीय कार्यशाला, क्षेत्रीय एक्सपोजर विजिट का आयोजन	1034.07	

Results (DLRs) में निहित है। डी0पी0आर0 के अन्तर्गत उपरोक्त समस्त सेक्टरों के DLIs की प्राप्ति को सत्यापित किये जाने हेतु Programme for Results (P for R) Mechanism के अनुसार स्वतंत्र सत्यापन एजेंसी (IVA) भी आबद्ध किया जायेगा। उक्त के अतिरिक्त परियोजना के सुगम क्रियान्वयन हेतु अनुश्रवण एवं मूल्यांकन की रूपरेखा भी विकसित की गयी है, जिसके आधार पर सम्बन्धित विभाग तथा "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट अथारिटी" द्वारा डी0पी0आर0 में निहित कार्यवाही के बिन्दुओं के क्रियान्वयन का अनुश्रवण एवं मूल्यांकन किया जायेगा, ताकि Programme for Results (P for R) Mechanism के अन्तर्गत निर्धारित लक्ष्यों को नियमानुसार प्राप्त किया जाना सुनिश्चित हो सके।

6- "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट" की विस्तृत परियोजना रिपोर्ट (डी0पी0आर0 वर्ष 2024-25 से 2029-30) में सेक्टरवार कार्यवाही के बिन्दुओं के क्रियान्वयन हेतु पर्यावरण, वन एवं जलवायु परिवर्तन विभाग द्वारा नयी योजना का गठन किया जायेगा। परियोजना के अन्तर्गत प्रस्तावित कार्यवाही के बिन्दुओं के क्रियान्वयन हेतु "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट अथारिटी" के द्वारा अनुमोदित वार्षिक कार्ययोजना के अनुसार पर्यावरण, वन एवं जलवायु परिवर्तन विभाग द्वारा सम्बन्धित लेखा शीर्ष के अन्तर्गत बजट प्राविधान कराया जायेगा तथा परियोजना के क्रियान्वयन विभागों को "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट अथारिटी" की अनुशंसा के आधार पर धनराशि आवंटित की जाएगी। परियोजना के क्रियान्वयन विभागों द्वारा आबंटित धनराशि के सापेक्ष लेखाशीर्षकवार/मदवार भौतिक/वित्तीय प्रगति के विवरण के साथ उपयोगिता प्रमाणपत्र उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट अथारिटी को उपलब्ध कराया जायेगा। परियोजना के अंतर्गत किये गये व्यय की लेखा परीक्षा संबंधित कार्यान्वयन विभाग द्वारा करायी जायेगी।

7- प्रश्नगत परियोजना को विश्व बैंक से पोषित कराये जाने से क्लीन कुकिंग सेक्टर के अन्तर्गत विश्व बैंक द्वारा Energy Sector Management Assistance Program Clean Cooking Fund (ESMAP) Grant के अन्तर्गत राज्य सरकार को अनुदान (Grant) उपलब्ध कराया जाना प्रस्तावित है। प्रश्नगत परियोजना हेतु राज्य विकास ऋणों पर घरेलू बाजार में ब्याज दरों, विभिन्न मुद्राओं में विश्व बैंक (IBRD) ऋण दरों (lending rates) आदि के विभिन्न तुलनात्मक परिदृश्यों के आधार पर वित्त एवं बाह्य सहायतित परियोजना विभाग द्वारा विश्व बैंक के प्रस्ताव के आधार पर प्रश्नगत "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट" का ऋण Japanese Yen (¥) में लिया जायेगा। परियोजना से सम्बन्धित ऋण एवं

(छ) "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट" के सम्बन्ध में लिये गये उपरोक्त निर्णयों में आवश्यक संशोधन हेतु मा0 मुख्यमंत्री जी को अधिकृत किया जाता है।

कृपया उपरोक्तानुसार "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट" के सम्बन्ध में आवश्यक/अग्रेतर कार्यवाही सुनिश्चित कराने का कष्ट करें।

भवदीय,

Signed by
(Manoj Singh / मनोज सिंह)
Date: 07.11.2024 20:29:15
अपर मुख्य सचिव।

संख्या एवं दिनांक तदैव

प्रतिलिपि-निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित :-

1- सचिव, आर्थिक कार्य विभाग, वित्त मंत्रालय, भारत सरकार, नई दिल्ली।
2- सचिव, पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार, नई दिल्ली।
3- अध्यक्ष, राष्ट्रीय राजधानी क्षेत्र और निकटवर्ती क्षेत्रों में वायु गुणवत्ता प्रबन्धन आयोग (CAQM), नई दिल्ली।
4- महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली।
5- अध्यक्ष/सदस्य सचिव, केन्द्रीय प्रदूषण नियंत्रण बोर्ड, नई दिल्ली।
6- कण्ट्री डायरेक्टर, इण्डिया, वर्ल्ड बैंक।
7- समस्त अपर मुख्य सचिव/प्रमुख सचिव/सचिव, उ0प्र0 शासन (उपरोक्त विभागों को छोड़कर)।
8- महानिदेशक, द एनर्जी एण्ड रिसोर्स इंस्टीट्यूट (TERI), नई दिल्ली।
9- प्रधान मुख्य वन संरक्षक और विभागाध्यक्ष, उ0प्र0, लखनऊ।
10- परिवहन आयुक्त, उ0प्र0, लखनऊ।
11- मुख्य कार्यपालक अधिकारी, यूपीसीडा, कानपुर।
12- महानिदेशक, उ0प्र0 कृषि अनुसंधान परिषद, लखनऊ।
13- महानिदेशक, चिकित्सा एवं स्वास्थ्य सेवायें/परिवार कल्याण, उ0प्र0, लखनऊ।
14- समस्त मण्डलायुक्त/जिलाधिकारी, उ0प्र0।
15- निदेशक, आई0आई0टी0, कानपुर।

ANNEXURE 3

उत्तर प्रदेश शासन
पर्यावरण, वन एवं जलवायु परिवर्तन अनुभाग-7
संख्या- 897/81-7-2024
लखनऊः दिनांकः 12 दिसम्बर, 2024

कार्यालय ज्ञाप

उत्तर प्रदेश राज्य के अन्तर्गत विश्व बैंक की सहायता से "उत्तर प्रदेश क्लीन एयर मैनेजमेंट प्रोजेक्ट" क्रियान्वित कराये जाने के सम्बन्ध में शासनादेश संख्या-883/81-7-2024, दिनांक 08.11.2024 निर्गत किया गया है। उत्तर प्रदेश राज्य के अन्तर्गत विश्व बैंक की सहायता से "उत्तर प्रदेश क्लीन एयर मैनेजमेंट प्रोजेक्ट" के क्रियान्वयन हेतु श्री राज्यपाल एतद्द्वारा "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट अथारिटी" - विशेष प्रयोजन वाहन (SPV) का गठन निम्नवत् किये जाने की सहर्ष स्वीकृति प्रदान करते हैं :-

1.	Name of the Authority	"Uttar Pradesh Clean Air Management Project Authority" and it shall work in Uttar Pradesh duly embedded in Department of Environment Forest and Climate Change (DoEFCC), GoUP
2.	Registered Office of the Authority	The Authority shall have its own separate office which will initially be in Directorate of Environment, Vineet Khand-1, Gomti Nagar, Lucknow, Pin Code-226010. This address may be changed by adopting and passing the resolution by the Governing Body of the Authority.
3.	Aims and objectives	The aims and objectives for which the Authority is established shall be: I. To facilitate implementation of World Bank financed UPCAMP program under the umbrella of National Clean Air Program, as per the approved DPR of UPCAMP in the selected project geographies through regular guidance, supervision, monitoring and evaluation measures. II. Be duly empowered and enabled with the implementing structure inclusive of all stakeholders to achieve the nationally determined air quality standards for the state of Uttar Pradesh. III. It will have complete flexibility and financial delegation to implement the World Bank financed project. IV. Planning, design, maintenance and prioritization of works in the project including economic/financial analysis of returns on investments.

V. Provide technical support and monitor the activities of the implementing departments and agencies with respect to implementation of the World Bank financed UPCAMP and overall clean air actions across the state through regular review, site visits, and feedback for course corrections, if any required.

VI. Development of the data and knowledge of the Indo- Gangetic Plain airshed to support planning of mitigation and adaptive measures based on scientific analysis, modelling and forecast.

VII. Facilitate and coordinate activities among the implementing agencies and departments within the state for sharing and drawing of knowledge and experiences to support effective planning and implementation of air pollution control measures in Uttar Pradesh.

VIII. Advise the State Government in matters of Air pollution and will also take responsibility for development of Inter State coordination assigned by GoUP as and when opportunity arises.

IX. Coordination with the World Bank and ensuring submitting of all the progress and annual reports in time.

X. Oversee Capacity building of government officers via exposure visits and training programs both nationally and internationally and assisting in handholding of implementing agencies and other stakeholders. This includes developing and retaining a best practice repository (Model RFP documents, Draft DPRs, Financial models, best practices in SPV formation, use of financial instruments and risk mitigation techniques) and mechanism for knowledge sharing across States (through publications, workshops, seminars etc).

XI. Promote awareness through various outreach programs.

XII. Establish an appropriate planning, designing, implementation, maintenance, coordination and monitoring mechanisms for air quality improvement and to delegate appropriate powers as may be necessary for the implementation of the same.

XIII. Support all air pollution control measures and interventions financed by Government of India and other funding agencies whenever asked on case to case basis.

XIV. Enter into MoUs, agreements, contracts with

		persons including institutions of any legal entity to enable the state to meet the goals and objectives of the program. XV. Take all such actions, including those not mentioned above but considered necessary for or incidental towards achievement of the goals and objectives of the authority in consistent with the priorities of the state government after due approval of the governing body. XVI. To make rules and procedures for the smooth functioning of the authority and time to time modifications of the same as required. XVII. To establish centre of excellence and fund research activities. XVIII. Mobilize resources within timelines and take measures necessary for the mobilization of resources under the UPCAMP. XIX. To acquire movable and immovable property for the attainment of the objectives. XX. To co-ordinate with other IGP states for the purpose of well-co-ordinated clean air actions across the IGP airshed. XXI. Any other work assigned by the state government.
4.	**Governing Body of the Authority**	The names, addresses and occupations of the first members of the Governing Body to whom by the Rules and Regulations of the Authority, the management of the affairs of the Authority is entrusted are as follows: -

S. No.	Name, Occupation and Address of the office held	Status in the Authority
1	2	3
1.	Chief Secretary	Chairperson
2.	ACS/PS Finance, Govt. of Uttar Pradesh	Member
3.	ACS Agriculture, Govt. of Uttar Pradesh	Member
4.	ACS/PS Environment, Forest and Climate Change, Govt. of Uttar Pradesh	Member Secretary
5.	ACS/PS Medical health and family welfare, Govt. of Uttar	Member

	Pradesh	
6.	ACS/PS, Planning, Govt. of Uttar Pradesh	Member
7.	ACS/PS MSME, Govt. of Uttar Pradesh	Member
8.	ACS/PS Infrastructure and Industrial Development Department, Govt. of Uttar Pradesh	Member
9.	ACS/PS Rural Development, Govt. of Uttar Pradesh	Member
10.	Chairman, UPPCB, Govt. of Uttar Pradesh	Member
11.	ACS/PS Urban Development, Govt. of Uttar Pradesh	Member
12.	ACS/PS Transport, Govt. of Uttar Pradesh	Member
13.	Principal Chief Conservator of Forests and HoFF, Govt. of Uttar Pradesh	Member
14.	Department of External Aided Project, Govt of Uttar Pradesh	Member
15.	Head of PMC (TERI)	Member
This will be the highest decision-making body of the Authority. This Committee may invite any concerned organization/ officer/person as special invitee.		

UTTAR PRADESH CLEAN AIR MANAGEMENT PROJECT AUTHORITY RULES

1.	**Name and extent**	"Uttar Pradesh Clean Air Management Project Authority" and it shall work in Uttar Pradesh duly embedded in Department of Environment Forest and Climate Change (DoEFCC), GoUP.
2.	**Registered office of the Authority**	The Authority shall have its own separate office which will initially be in Directorate of Environment, Vineet Khand-1, Gomti Nagar, Lucknow, Pin Code-226010. This address may be changed by a resolution adopted and approved by the General Body of the Authority

3.	**Aims and Objectives**	The aims and objectives for which the Authority is established shall be: I. To facilitate implementation of World Bank financed UPCAMP program under the umbrella of National Clean Air Program, as per the approved DPR of UPCAMP in the selected project geographies through regular guidance, supervision, monitoring and evaluation measures. II. Be duly empowered and enabled with the implementing structure inclusive of all stakeholders to achieve the nationally determined air quality standards for the state of Uttar Pradesh. III. It will have complete flexibility and financial delegation to implement the World Bank financed project. IV. Planning, design, maintenance and prioritization of works in the project including economic/financial analysis of returns on investments. V. Provide technical support and monitor the activities of the implementing departments and agencies with respect to implementation of the World Bank financed UPCAMP and overall clean air actions across the state through regular review, site visits, and feedback for course corrections, if any require VI. Development of the data and knowledge of the Indo-Gangetic Plain airshed to support planning of mitigation and adaptive measures based on scientific analysis, modelling and forecast. VII. Facilitate and coordinate activities among the implementing agencies and departments within the state for sharing and drawing of knowledge and experiences to support effective planning and implementation of air pollution control measures in Uttar Pradesh. VIII. Advise the State Government in matters of Air pollution and will also take responsibility for development of Inter State coordination assigned by GoUP as and when opportunity arises. IX. Coordination with the World Bank and ensuring submitting of all the progress and annual reports in time. X. Oversee Capacity building of government officers via exposure visits and training programs both nationally and internationally and assisting in handholding of implementing agencies and other stakeholders. This includes developing and retaining a best practice repository (Model RFP documents,

	Draft DPRs, Financial models, best practices in SPV formation, use of financial instruments and risk mitigation techniques) and mechanism for knowledge sharing across States (through publications, workshops, seminars).
	XI. Promote awareness through various outreach programs.
	XII. Establish an appropriate planning, designing, implementation, maintenance, coordination and monitoring mechanisms for air quality improvement and to delegate appropriate powers as may be necessary for the implementation of the same.
	XIII. Support all air pollution control measures and interventions financed by Government of India and other funding agencies whenever asked on case to case basis.
	XIV. Enter into MoUs, agreements, contracts with persons including institutions of any legal entity to enable the state to meet the goals and objectives of the program.
	XV. Take all such actions, including those not mentioned above but considered necessary for or incidental towards achievement of the goals and objectives of the authority in consistent with the priorities of the state government after due approval of the governing body.
	XVI. To make rules and procedures for the smooth functioning of the authority and time to time modifications of the same as required.
	XVII. To establish centre of excellence and fund research activities.
	XVIII. Mobilize resources within timelines and take measures necessary for the mobilization of resources under the UPCAMP.
	XIX. To acquire movable and immovable property for the attainment of the objectives.
	XX. To co-ordinate with other IGP states for the purpose of well-co- ordinated clean air actions across the IGP airshed.
	XXI. Any other work assigned by the state government.
Definitions	In the interpretation of these rules the following expressions shall have the following meaning unless inconsistent with the subject or context: -
	a) "Act" means the Societies Registration Act. 1860

		(Act No. XXI of 1860): b) "ACS" means Additional Chief Secretary; c) "PS" means Principal Secretary d) "PCCF and HoFF" means Principal Chief Conservator of Forests and Head of Forest Forces; e) "CAMPA" means Clean Air Management Program Authority f) "CEO" means Chief Executive Officer: g) "Chairperson" means Chairperson of the Authority and Governing Body of the Authority: h) "Central Government" means the Government of India: i) "Special Secretary" means Special Secretary or equivalent in Government of UP; j) "Chief Conservator of Forests" means Chief Conservator of Forests or equivalent in Department of forest; k) "Department" means Department of Environment, Forest and Climate Change, Uttar Pradesh; l) "Executive Committee" means the Executive Committee as constituted under rule 28 of these Rules; m) "Governing Body" means the Governing Body of the Authority as constituted under rule 27 of these Rules; n) "Government" means the State Government of Uttar Pradesh; o) "State" means State of Uttar Pradesh; p) The "Authority" means the Uttar Pradesh Clean Air Management Program Authority; q) "PMU" means Project Management Unit. r) "PMC" means Project Management Consultant. s) "Project Legal Agreement(s)" refers to the agreement between the Government of Uttar Pradesh, Government of India and the World Bank for the financing of the UPCAMP. t) "DPR" refers to Detailed Project Report.
5.	**Members of Authority**	The Authority shall consist of all the members of Governing Body and Executive Committee.
6.	**Terms of non- official members of Authority**	The term of office of nominated non-official members in the Authority shall be two years; Provided that non official members may be renominated; Provided further that total terms of office of the non-official members shall not exceed

		6 years.
7.	Terms of ex—officio member of Authority	The membership of the ex-officio members of the Authority or its any committee/body shall terminate when he/she/they ceases/cease to hold office by virtue of which he/she/they was/were members of the Authority and his/her/their successor(s) will automatically become the member unless modified by Chairman or the competent authority.
8.	Roll of Members	The Authority shall maintain a Roll of members and every member of the Authority shall sign the Roll and state therein his/her occupation and address. No person shall be deemed to be member unless he/she has signed the Roll as aforesaid.
9.	Change of Address	If a member of the Authority changes his/her address, he/she may notify his/her new address in the Roll of members. But if he/she fails to notify his/her new address, the address in the Roll of members shall be deemed to be correct address.
10.	Cessation of membership	A member of the Authority shall cease to be member if he/she dies, resigns, becomes of unsound mind, becomes insolvent or is convicted for a criminal offence involving moral turpitude or if he/she is removed by the Government from the membership of the Authority or if he/she accepts a full-time appointment in the Authority or if he does not attend three consecutive meetings of the Authority without taking leave of the Chairperson. Those members of the Authority who are members by virtue of the post they held in the Government shall cease to be a member of the Authority on relinquishing the charge of the post by virtue of which they were members. The successor on the post shall automatically become the member of the Authority.
11.	Resignation	A member of the Authority, other than the member of the Authority who is member by virtue of the post he holds in the Government, may resign office by a letter addressed to the Chairperson and such resignation shall take effect from the date it is accepted by the Chairperson.
12.	Vacancy	Any vacancy in the Governing Body or Executive Committee shall be filled in by nomination and the term of office of a member nominated to fill a casual vacancy shall continue for the remainder of the term of the member in whose place he is nominated.
13.	Effect of Vacancy	No act or proceedings of the Governing Body or Executive Committee shall be invalid merely by reason of the existence of any vacancy therein or of any irregularity in appointment or nomination of any of its members

14.	**Meeting of Governing Body**	The Governing Body shall meet at least twice a year and whenever the Chairperson thinks fit.
15.	**Meeting of Executive Committee**	The Executive Committee shall meet ones every 3 months but it may also meet earlier or at such other interval as may be decided by the Chairperson.
16.	**Notice for Meeting**	For every meeting of the Governing Body or Executive Committee fifteen day's notice shall be given: Provided that in case of emergency the Chairperson may reduce the period of notice to such period as he deems fit.
17.	**Quorum**	Not less than half members of the Governing Body or Executive Committee as the case may be shall constitute quorum for any meeting: Provided that if a meeting is adjourned for want of quorum, a fresh meeting shall be immediately convened.
18.	**Presiding Officer of Meeting**	The Chairperson, if present, shall preside at every meeting of the Governing Body or Executive Committee concerned. In the absence of the concerned Chairperson, meeting shall be presided by person nominated by the Chairperson for the meeting.
19.	**Vote**	Each member of the Governing Body or Executive Committee shall have vote and all the matter shall be decided by the majority of votes. In case of equality of votes. The concerned Chairperson shall have a casting vote.
20.	**Resolution**	Agenda of the meeting of the Governing Body or Executive Committee shall be circulated among the members at least seven days before the meeting; Provided that a member of the Governing Body or Executive Committee may move a resolution at a meeting of the Governing Body or Executive Committee after giving a notice of one clear week or with the permission of the concerned Chairperson or the person presiding over the meeting. Any business which it may be necessary for the Governing Body/Executive Committee to perform may be performed by a resolution in writing, circulated among all its members and approved by a majority of the members recording their consent of such resolution and it shall be as effective and binding as if such resolution has been passed at a meeting of the Governing body/Executive committee.
21.	**Ruling of the Chairperson**	Ruling of the concerned Chairperson in regard to all questions of procedure shall be final.
22.	**Minutes**	The minutes of the proceedings of a meeting of the

		Governing Body or Executive committee shall be drawn up by the Member-Secretary and circulated amongst the members of Governing Body or Executive Committee. The minutes along with any amendments suggested shall be placed for confirmation at the next meeting of the Governing Body or Executive Committee. After the minutes are confirmed and signed by the concerned Chairperson, they shall be recorded in the Minutes Book.
23.	**Authentication**	All orders and decisions of the Governing Body or Executive committee shall be authenticated by the signature of the concerned Meiber- Secretary or any other person authorized by the Governing Body /Executive Committee in this behalf.
24.	**Copy to Government**	Apart from the matters requiring approval of the Government under these Rules, which shall be submitted to the Government separately giving full detail thereof, a copy of the proceedings of each of the meeting of the Authority or Governing Body or Executive committee shall be furnished to the Government
25.	**Rules for Various Allowances**	A non-official member of the Authority and any committee constituted by the Authority or the Governing Body or Executive committee shall be entitled to such travelling allowance and daily allowance as may be admissible under rule-20 of Financial Handbook Volume III read with office memorandum number Sa-4-1487/Dus-88-600/88 dated December 1, 1988 of Vitta (Samanya) Anubhag-4 Government of Uttar Pradesh: Provided that employees of the Central Government or the Government who are members of the Authority or the Governing Body or Executive committee will be governed by the respective Government rules for travelling and daily allowance in respect of journey undertaken to attend the meetings of the Authority or the Governing Body or Executive committee in connection with the business of the Authority or the Governing Body or Executive committee.
26.	**Functions of the Authority**	The functions of Authority shall include, inter alia- (i) Implementing, overseeing and promoting air pollution mitigation and reduction measures across the state undertaken and financed by world bank and other agencies including government. (ii) Maintaining a separate bank account in respect of the funds received and books of accounts for the amounts spent. (iii) Creating transparency for the project and

		mobilizing citizen engagement and support. (iv) Authority shall do the monitoring and evaluation of the works undertaken related to UPCAMP in line with funding program agreement and implementation of state Clean Air Action plan. (v) Engage and facilitate third-party independent verification agency as required for the World Bank program for Results Finance and submit DLI verification reports entwined to the World bank. (vi) Ensure monitoring and follow up of the Project legal agreements and Detailed Project Report. (vii) Coordinate with the implementing agencies and departments and receive physical and financial progress reports and audit reports in time for implementation of UPCAMP. (viii) Establish its own salary structure and allowances and benefits structure and to employ, retain or dismiss/terminate personnel as required. (ix) Accept, make, enclose or otherwise execute cheques, drafts, receipts, bills of exchange or other instruments and securities as are required for the conduct of the authority's business. (x) Make rules and byelaws for the conduct of the activities of the authority and to add, rescind or vary them from time to time as deemed necessary. (xi) Constitute such committees as the authority may deem fit to carry out its functions or to provide advice on matters related to authority's activities. (xii) Develop the reporting mechanism for all implementing agencies/departments w.r.t to activities being undertaken/financed under UPCAMP. (xiii) Do all such other things not mentioned above as the authority may deem fit for the attainment of all or any of the project objectives. (xiv) After phasing of the World Bank, project may continue to facilitate the implementation of the long-term strategy for air pollution management in the state. (xv) To coordinate with related State Government Departments and GoI to ensure maximum possible allocation under Centrally Sponsored Schemes related to Environmental and Air Quality Management.
27.	**Governing Body of**	1) The general superintendence, direction and control of the affairs of the Authority and its funds and

the Authority	property, movable and immovable shall be vested in the Governing Body. 2) The Authority shall be managed by the Governing Body consisting of the following:

S. No.	Name, Occupation and Address of the office held	Status in the Authority
1	2	3
1.	Chief Secretary	Chairperson
2.	ACS/PS Finance, Govt. of Uttar Pradesh	Member
3.	ACS Agriculture, Govt. of Uttar Pradesh	Member
4.	ACS/PS Environment, Forest and Climate Change, Govt. of Uttar Pradesh	Member Secretary
5.	ACS/PS Medical health and family welfare, Govt. of Uttar Pradesh	Member
6.	ACS/PS, Planning, Govt. of Uttar Pradesh	Member
7.	ACS/PS MSME, Govt. of Uttar Pradesh	Member
8.	ACS/PS Infrastructure and Industrial Development Department, Govt. of Uttar Pradesh	Member
9.	ACS/PS Rural Development, Govt. of Uttar Pradesh	Member
10.	Chairman, UPPCB, Govt. of Uttar Pradesh	Member
11.	ACS/PS Urban Development, Govt. of Uttar Pradesh	Member
12.	ACS/PS Transport, Govt. of Uttar Pradesh	Member
13.	Principal Chief Conservator of	Member

	Forests and HoFF, Govt. of Uttar Pradesh	
14.	Department of External Aided Project, Govt of Uttar Pradesh	Member
15.	Head of PMC (TERI)	Member

3) The Governing Body may invite and concerned officer/person as a special invitee.

4) It shall lay down the broad policy framework for the functioning of Authority and review its working from time to time. It will provide overall guidance and play an advisory role to the Authority regarding:

- Overall policy direction and guidance for the approved activities of the UPCAMP and clean air actions across the state.
- Appropriate guidance and powers to the Executive Committee chaired by ACS/PS, DoEF&CC for implementation of the envisaged goals and objectives of the program.
- Approve annual work plans, annual reports, audit reports, and or other such documentation related to UPCAMP submitted by the Executive committee for approval/guidance.
- Approve an independent auditor for the Authority.
- Approve the annual budget of funds based on progress in implementation of UPCAMP.
- Recommend mid-course correction in the implementation as and when required and also to change the outlay in World Bank financed UPCAMP across the sectors and sub- components on need basis.
- Lay down and/or approve rules and procedures for the functioning of the body and its executive committee.
- Approve an internal policy for managing Human Resources contracted or brought on by deputation by the Authority and its Directorate.
- Undertake half-yearly review of activities of the project including budget, implementation

and co-ordination with other missions/ schemes and activities of various departments.

- Strive for greater convergence of different schemes under implementation in various sectors to facilitate implementation of long-term strategy for air pollution management in the state.
- Provide guidance regarding future actions.
- All other works Body deems fit.

28. **Executive Committee**

Executive Committee shall consist of the following members of the Authority:

S.No.	Name and Designation	Post
1	Additional Chief Secretary/ PS, DoEFCC	Chairman
2	Secretary, Planning	Member
3	Secretary, Finance	Member
4	Nodal officer of Transport Department	Member
5	Nodal officer of Urban Development Department	Member
6	Nodal officer of Department of MSME	Member
7	Nodal officer of Department of Rural Development	Member
8	Nodal officer of Department of Urban Local Bodies	Member
9	Nodal officer of Department of Animal Husbandry	Member
10	Nodal officer of Department of Agriculture	Member
11	Nodal officer of Department of Industries	Member
12	Nodal officer of Department of Health and Family Welfare	Member
13	Nodal officer of Infrastructure and Industrial Development Department	Member
14	MS, UPPCB	Member
15	Director, DoI.	Member

16	Chief Conservator of Forests (nominate by PCCF&HoFF)	Member
17	CEO, UPCAMP	Member Secretary
18	World Bank representatives	Invited Member
19	TERI representatives	Invited Member

1) This Committee may invite any concerned officer/person as special invitee. This committee will meet at least once in three months.

2) The functions and powers of Executive Committee shall be: -

- The Executive Committee will exercise all executive and financial powers of the Authority for implementation of UPCAMP.
- Prepare and place rules and procedures for the functioning of the body and its Executive Committee for the approval of the General Body, subject to the overarching objectives and core principles of Authority;
- Monitor the progress of the utilization of funds of UPCAMP that are spent by the authority, and funds released by the Authority to implementing agencies and departments;
- Ensure timely preparation Annual Plan of Operation (APO) of UPCAMP for the approval of the Governing Body.
- Recommend the release of the budgets to implementing departments/agencies against the approved Annual Plan of Operation, only on basis of which administrative departments will sanction the budget and releases. It will also have authority to stop payments to erring departments, agencies and contractors.
- Ensure preparation of physical and financial reports, annual accounts and the annual reports.
- Ensure that the annual accounts of the Authority are audited by firm of chartered accountants within 9 months from the end of each financial year.
- Supervise the works being implemented in the state out of the funds of UPCAMP and the implementation of state clean air action plan.
- Ensure inter-departmental coordination and co-ordination with other missions/schemes and activities of various Ministries/Departments for implementation of UPCAMP and clean air

		action plan of the state. • Review annual work plan of different implementation agencies prepared, as required under the program, and endorse the same. • Ensure timely release of funds to the implementing agencies and departments, and obtain expenditure/ financial reports The executive committee shall provide overall supervision on matters having legal dimensions/arbitration to be dealt by the authority, its implementing agencies and field divisions for all issues pertaining to the program and Any other work as directed by the Government of Uttar Pradesh, from time to time.
29.	**Functions and powers of the Chief Executive Officer**	CEO UPCAMP Authority will be an officer not below the rank of Secretary to the State Government, appointed by the State Government. The officer must have minimum 4 years' experience of working in the field of pollution and environment. The CEO will function as the Member-Secretary of the Executive Committee and will be the overall in-charge of all activities related to the Authority. The CEO will be supported with a technical, financial and implementation wings of the UPCAMP Directorate in addition to representatives of an Advisory group from other relevant departments of Uttar Pradesh. **Functions and powers of the CEO** a) The CEO shall be supported by the officers, staff, expert and consultants of all the wings of the authority. The general functions and powers of the CEO are as defined and decided from time to time by the Governing Body and or Executive Committee as the case may be in addition to the following: b) The CEO will exercise as Head of Department for all establishment and Financial Matters of the Authority. c) The CEO will be empowered to execute the decisions of the Governing Body and Executive Committee. d) Will carry out the duties of the member secretary and convener of the executive committee. e) Will exercise the duties and functions of the CEO of the authority diligently and as delegated. f) Assist, guide and super vise activities of the authority in planning, designing, data collection,

		management, implementation, monitoring, accounting, auditing and evaluation of activities according to the project and implementation of clean air action plan in the state. g) Assume responsibility for preparation of the annual work plans of the authority and inclusions of projects in pursuant to the procurement and execution plan approved by the higher committees. h) Develop and implement project management strategies in association with all stakeholders. i) Develop good relationships with funder, institutions and other stakeholders and manage the implementation of agreed outcomes. j) Monitor financial sanction and the release of funds for implementation of the program pursuant to provisions directed by higher committees. k) Assist and guide the introduction of project specific Management Information System to enhance monitoring program implementation and information dissemination. l) Develop and implement internal quality control and evaluation systems. m) Chair project review meetings of the program, consultants/Monitoring and evaluation consultants etc and delegate follow up action. n) Carry out field inspection of authority activities and initiate corrective actions where necessary. o) Initiate disciplinary action against officials and staff engaged in implementation of the program as necessary using the procedures of the government. p) Discharge all statutory responsibilities of the authority as required to facilitate smooth implementation of the program. q) Carry out other responsibilities as directed by the higher committees. r) To enquire into any complaints regarding the implementation of the project by any department /agency. s) Take responsibility for meeting the program financial, timeline, quality assurance and reporting and accountability outcomes.
30.	**Authority**	The primary aim of this directorate is to fast-track

Directorate	implementation of world bank financed UPCAMP program under the umbrella of National Clean Air Program, as per the approved DPR in the selected project locations and implementation of State clean air action plan.

Objectives and Functions

I. Take actions as recommended by the review missions of the funding agencies and or as directed by government of Uttar Pradesh.

II. Create technical, administrative and other temporary posts in the authority as considered necessary for the implementation of the program.

III. Execute activities designated for the authority in the Project in a timely manner.

IV. Prepare books of accounts for different activities implemented by the authority, and obtain expenditure statements / financial reports from its implementing agencies.

V. Enter into contract/agreement for purchase, hire, dispose both movable and immovable property in pursuance of the decisions of the Governing Body as per the financial rules and government order of UP Govt.

VI. Manage funds of the authority, submitting annual budget and all reports to Executive Committee and there on to Governing Body for their approval, and monitoring financial expenditures and fund flows.

VII. The authority shall cause its accounts audited annually by firm of chartered accountants appointed by Governing Body within 9 months from close of financial year.

VIII. Consolidate and obtain in principle approval of annual work plans.

IX. Based on the approval of the overall work plan and budgets, approve all procurements and contract award including recruitment of contractual staff/consultants carried out by the authority and its implementing agencies during the period program.

X. Monitor physical and financial progress of program implementation.

XI. Submit annual/quarterly financial statements and cause action for obtaining replenishments of fund

XII. Supervise and closely monitor the activities of the authority.

XIII. Take all actions necessary for fulfilment of authority target and objectives. This will include

		suggesting to the higher committees and implementing departments for development and implementation of new initiatives. XIV. Submit expenditure statements against funds received. XV. Take all such actions, including those not mentioned above but considered necessary for or incidental towards achievement of the goals and objectives of the authority in consistent with the priorities of the state government. XVI. Submit disbursement claims and Disbursement-Linked Indicator (DLI) claims to the World Bank in line with agreed formats and procedures. XVII. Draft internal policies for managing the Human Resources contracted or brought into deputation by the Directorate. XVIII. Establish well equipped office with modern updated systems of working like biometric attendance etc for the members/staff of the authority.
31.	**Details of Authority Directorate**	The Authority Directorate will serve as project implementation arm of the authority It will also assist the authority to ensure implementation of States's clean air action plan through proper monitoring and supervision. It will be staffed with personnel and experts drawn on deputation from State departments and on contract basis post-retirement and otherwise. Each unit and the office of CEO will be suitably staffed with the supporting ministerial staff, drivers, MPS, data entry operators etc. The CEO of the Authority shall distribute the work under rules of business among the ACEO and DCEOs. The Administrative and Establishment works may be assigned to ACEO by the CEO under the rules of business of the Authority. It shall have the following units :

Unit	Designation	Level
Administration and Finance (Will undertake all administrative and financial functions, RAI interventions and Research,	ACEO (A&R)	Minimum Level 11 officer on deputation having relevant experience in the field of administration

		Training, knowledge sharing and stakeholder engagement)	
		Administration	
		Finance Controller cum Finance Management Expert	On Deputation from Uttar Pradesh Financial services or on Post retirement (Last Pay-Pension basis) or on contract having relevant experience in managing external aided project.
		Accountant	On Deputation from Uttar Pradesh Financial services or on Post retirement (Last Pay-Pension basis) or on contract having relevant experience.
		Procurement Incharge	On Deputation or on Contract or on Post retirement (Last Pay-Pension basis)
		Establishment Incharge	On Deputation or on Contract or on Post retirement (Last Pay-Pension basis)
		Climate/Air Pollution Finance Expert*	3+ years' experience
		Store Keeper	Minimum Level 5 (on deputation)
		Research	
		Consultant C (Air Pollution research expert, 1 nos)	As per guidelines of Ministry of Science & Technology, Department of Science & Technology, GoI
		Consultant C (Training expert, 1 nos)	
		Consultant C (public awareness and	

			communications specialist)	
			Consultant C (Stakeholder/Community engagement specialist)	
		Technical 1 (Agriculture and Livestock)	DCEO (Agriculture and Livestock)	Minimum Level 10 officer on deputation or post-retirement on contract basis having relevant experience.
			Consultant C (Expertise in Fertilizer, 1 nos)	As per guidelines of Ministry of Science & Technology, Department of Science & Technology, GoI
			Consultant B (expertise in Livestock, 1 nos)	
		Technical 2	DCEO (MSME)	Minimum Level 10 officer on deputation or post retirement on contract basis having relevant experience
			Consultant C (Industries and boiler expet,1 nos) Consultant C (Brick kiln expert, 1 nos)	As per guidelines of Ministry of Science & Technology, Department of Science & Technology, GoI
		Technical 3 (Clean Cooking)	DCEO (CC)	Minimum Level 10 officer on deputation or post retirement on contract basis having relevant experience
			Consultant C (Social Science, 1 nos) Consultant C (Finance and banking, 1 nos) Consultant C (Biogas, 1 nos)	As per guidelines of Ministry of Science & Technology, Department of Science & Technology, GoI or retired government officer from finance/statistical/social /relevant background on last pay minus pension basis

	Carbon Market Expert (1 nos)	Minimum 10 years experience
Technical 4 (Urban)	DCEO (Urban)	Minimum Level 10 officer on deputation
	Consultant (Solid waste Management. 1 nos)	As per guidelines of Ministry of Science & Technology. Department of Science & Technology. GoI
	Consultant (Dust reduction. 1 nos)	
	Consultant (transport. 1 nos)	
Monitoring & evaluation	DCEO(ME)	Minimum Level 10 officer on deputation
	Consultant C (Environmental and Social Risk Management Screening and Monitoring Specialist)	As per guidelines of Ministry of Science & Technology. Department of Science & Technology. GoI
	Consultant C (CEMS Expert, 1 nos)	
	Consultant B (GIS expert, 1 nos)	
	Consultant C (Software development expert, 1 nos)	
	Consultant C (Pollution Monitoring Systems, 1 nos)	
	Consultant C	

			(Research and Development, 1 nos)	
		Research and Training (RA1)	Research Manager	As per guidelines of Ministry of Science & Technology. Department of Science & Technology, GoI
			Consultant C (Air Pollution research expert, 1 nos) Consultant C (Training expert, 1 nos) Consultant C (public awareness and communications specialist) Consultant C (Stakeholder/Community engagement specialist)	As per guidelines of Ministry of Science & Technology. Department of Science & Technology, GoI
		Interstate Coordination (RA3)	Senior Consultant, 1 nos* (Salary proposed under RA3 budget)	30+ years' experience
		Technical Advisory Group	This group consisting of representation from different executing departments and other domain specialists nominated by TERI shall provide technical guidance to the Authority in planning and implementation of UPCAMP activities in the state.	
		"The UPCAMP envisages building a road map for long term air shed based strategy in the State. This would require augmentation of financial resources and developing synergies with projects/funding from multilateral/bilateral agencies and philanthropic organisations. To coordinate with philanthropies and other such institutions to progress the project into program mode a climate/air quality management finance expert would be necessary. His services may be Non Stationed nature as		

		per requirements of the work.
32.	**UPCAMP CELL**	UPCAMP CELL will be created at the level of each nodal officer of the implementing agency/department for smooth functioning. It will be equipped with all basic facilities like supporting staff, computers etc. borne from project funding.
33.	**Fund**	1. The funds of the Authority shall consist of the following : • Recurring and non-recurring grants received from Government of Uttar Pradesh, Government of India and World Bank and any other donor agency for the furtherance of the objectives of the authority • Income from other sources 2. There shall also be a special fund which consist of : • Such amounts as are received with a specific condition that the income thereof alone used for the purpose of the Authority (with the corpus being left intact) • Such other amount as Governing Body may decide to divert from the regular fund to the special fund to be used in the manner specified in clause(1) 3. Any expenditure on this project to be incurred by the state government would have to pass through the budget of the Government. 4. The monies received in the Fund shall be kept in the interest-bearing account(s) in Nationalized Banks as per the prevailing rates of the Banks.
34.	**Utilization and Disbursement of Fund**	1) The fund shall be utilized for meeting: - (i) Expenditure towards the work as per approved APO; (ii) The non-recurring as well as recurring expenditure for the management of the Authority including the salary and allowances payable to its officers and other employees. (iii) The expenditure incurred on monitoring and evaluation as per the APO subject to overall ceiling of 2% of amount to be spent every year; (iv) Disbursement on such other related projects for which monies has been received or approved (v) Expenses of Authority in the discharge of its functions having regard to the purposes for

		which any grants loans, or borrowings are received and for matters connected therewith or incidental thereto; (vi) Expenses on the objects and for purposes authorized by Authority and All work at the ground level shall be executed through designated Departments or Agencies as decided. 2) Disbursement of fund (i) Authority shall release monies in predetermined installments as per the Annual Plan of Operation (APO) finalized and approved subject to achievement of targets (ii) The fund and the bank account shall be operated jointly by CEO and Finance Controller or as decided by the Governing Body for this purpose.
35.	**Accounting Procedure**	1) Authority shall prepare in such form and at such time in each financial year as may be prescribed, its budget for the next financial year showing the estimated receipts and expenditure of the Authority 2) Authority shall adopt financial regulations and procedures in particular the procedure for approval and implementing the APO. 3) Authority shall maintain proper accounts and other relevant records and prepare an annual statement of accounts.
36.	**Audit**	1) The annual accounts of the authority shall be audited by firm of Chartered Accountants appointed by the Governing Body. The auditor will certify the accounts and provide an audit opinion on the State of Affairs of the Authority. The audit report will be submitted within 9 Months for the end of each financial year (April to March). 2) The accounts of the Authority shall also be open to be audited by the State Accountant General at such intervals as may be specified by him and any expenditure incurred in connection with such audit shall be payable by the Authority to the State Accountant General. 3) The State Accountant General and any other person appointed by him in connection with the audit of the accounts of the Authority shall have

		the same rights and privileges and authority in connection with such audit as the Accountant General generally has in connection with the audit of the Government accounts and in particular shall have the right to demand the production of books accounts connected vouchers and other documents and papers and to inspect the office of the Authority. 4) The accounts of the Authority as certified by the firm of Chartered Accountants together with the audit report thereon, shall be placed before the General Body of the Authority. 5) UP Government shall have the power to conduct special audit or performance audit of the Fund and of the Authority.
37.	**Annual Report**	1) An annual report of the proceedings of the authority and all work undertaken during the year shall be prepared for the information of the Governing Body. This report and the audited accounts of the authority shall be placed before the authority at the annual general meeting.
38.	**Monitoring and evaluation of the works**	1) An independent system for concurrent monitoring and evaluation of the works implemented in the State utilizing the funds available shall be evolved and implemented to ensure effective and proper utilization of funds;
39.	**Property of the Authority**	All property of the Authority shall belong to the Authority itself. The income and the property of the Authority shall only be applied towards the promotion of the objectives set forth in the memorandum of association of the Authority as enumerated below subject to such terms and conditions as the Governing Body may impose in respect of expenditure to be incurred from grants sanctioned to the Authority from time to time. a) Seek and receive grants, loans and such other goods and materials as the Government of India or GoUP may sanction from time to time. b) Provide funds to the relevant units/wings/ departments/ agencies of the authority for disbursement to public and private sectors. c) Organize and arrange for supply of equipments, and other inputs to the units of the authority and/or departments/ agencies. d) Arrange and organize training and infrastructural

		support to government and non-government sectors. e) Draw, accept, make, endorse, discount, and negotiate with the GoI any other promissory notes, bills of exchange, cheques or other negotiable instruments. f) Invest the funds or the money entrusted to the authority as per the specific terms of the grants received. g) Purchase, take on lease, accept as gift, construct or otherwise acquire any property, movable or immovable wherever suitable which may be necessary. h) Employ the grant directly or indirectly to other institutions/persons to further the programme to be undertaken/supported by the authority. i) To enter into contract with any Government or Authority, Local self government or authority, non government organizations, financing or otherwise that the authority may deem desirable to obtain and carry out, exercise and comply with the agreement, rights , privileges and concessions so required in furtherance of the object of the authority.
40.	**Suits and proceedings**	The Authority may sue or be sued in the name of the Authority through its Chief Executive Officer. a) No suit or proceeding shall lie for reason of any vacancy or change in the address of the office of Chief Executive Officer or any office bearer of the Authority. b) Every decree or order against the Authority in the suit or proceedings shall be executable against the property of the Authority and not against the person or the property of any office bearer Authority. Nothing in sub rule (b) above shall exempt office bearer of the Authority from any criminal liability under the Act, or entitle him to claim any contribution from the property of the Authority in respect of any fine to be paid by them on conviction by a criminal court.
41.	**Alternation in the name of Authority**	Name of the Authority may be altered by the procedure described below : a) The Executive Committee shall submit the proposition for such alteration to the members of the Authority in a written printed report. b) The Governing Body shall convene a special general meeting of the members of the Authority according to these rules for the consideration of the said

		proposition. c) Such report may be delivered or sent by post to every member of the Authority ten clear days previous to such special general meeting as foresaid; d) Such proposition should be agreed to by the votes of three-fifth of the members of the Authority present in special general meeting as aforesaid.
42.	**Bye-laws**	The Governing Body shall frame bye-laws not inconsistent with these rules for the administration and management of the affairs of Authority and likewise add amend alter or rescind any bye-laws so framed. The minister of Department of Environment, Forest and Climate Change, Uttar Pradesh will be authorized to approve any changes in the objectives, basic structure etc of the authority, if needed.
43.	**First bye-laws of the Authority**	The Governing Body shall be responsible for having first bye-laws made. These bye-laws should be consistent with the rules for administration and management of the affairs of Authority.
44.	**Service Rules**	The Service Rules for all employees of the Authority shall be framed and enforced by the Governing Body with the prior approval of the Government. Till such time as the service rules are enforced, Resolutions of the Governing Body shall be applicable for all its employees.
45.	**Budget**	(i) The annual budget of the Authority shall be prepared by the Member Secretary and shall be placed before the Governing Body in the month of February of each preceding year. (ii) On receipt of the budget proposals and the report from the Member Secretary, the Governing Body shall consider the same and accord their approval thereto, subject to such modifications as it may like to make therein. (iii) Upon approval of the Governing Body, the budget shall be send to the Government for the releases.
46.	**Common Seal and Suits**	The Authority shall have a common seal.
47.	**Disposal of Immovable Property**	No Immovable property of the Authority shall be disposed of in any manner whatsoever without the approval of the Government.
48.	**Review of Works and Progress**	The Government may appoint one or more persons to review the work and progress of the Authority and hold enquiries into the affairs thereof and to report thereon in such manner as the Government may stipulate. Upon receipt of any such report the Government may take such

		action and issue such directions as it may consider necessary in respect of any of the matters dealt within the report, and the Authority, shall be bound to comply with such directions.
49.	**Directives of Governor**	(i) The Governor of Uttar Pradesh may from time to time, issue directives to the Authority as to the exercise and performance of its functions in matters involving the security of the State of substantial public interest and such other directives as he may consider necessary in regard to its functions. The Authority shall give immediate effect to the directive(s) if any issued as above: and (ii) The Governor of Uttar Pradesh may call for such returns, accounts and other information with respect to the properties and activities of the Authority as may be required by him from time to time.
50.	**Taking Over of the Authority**	In case the Authority does not function properly, the Government shall have the power to take over the assets of the Authority, and assume direct management of the Authority.
51.	**Winding up of the Authority**	If on the winding up or dissolution of the Authority, there shall remain, after the settlement of its debts and liabilities, any money or property, the same shall not be paid or delivered to any member of the Authority but shall be disposed of in such manner as the Government may determine in this behalf in accordance with the provisions of the Act.
52.	**Modification of the Purpose of the Authority**	Subject to prior approval of the Government, the Authority may amend any purpose or purposes for which it is established: Provided that it carries out the procedure prescribed there for in the Act.
53.	**Modification of the Rules**	These Rules or Rules made by the Governing Body hereafter may be amended, cancelled or altered with the prior approval of the Government at any time by a resolution passed by a majority of three-fifth of the members present at any meeting of the Governing Body duly convened for the purpose.
54.	**Contracts**	(i) All contracts for and on behalf of the Authority shall be expressed to be made in the name of the Authority. (ii) No contract for the sale, purchase or supply of any goods or materials shall be made or financial agreement entered into for and on behalf of the Authority with any member of the Authority or the Governing Body or Executive Committee or his relative or a firm in which such member or his relative is a partner or share-

		holder or any other partner in such a firm or a private company of which the member is a member or Director.
55.	**Creating of Post in Authority**	The Authority shall seek permission of Government for creation of any post in Authority. Supporting staff on contract basis can be engaged with the approval of the Governing Body.
56.	**Records of the Authority**	(i) The Authority shall keep in its registered office proper books of accounts, in which following should be entered accurately: a) All sums of money received and the source thereof all sums of money expended by the Authority and the object or purpose for which such sums are expended. b) The Authority's assets and liabilities. (ii) The other records of Authority will be: - a) Agenda Register b) Membership Register c) Proceeding Register d) Cash Book e) Records of the employees of the Authority.

2- उक्त "उत्तर प्रदेश क्लीन एयर मैनेजमेन्ट प्रोजेक्ट अथारिटी" - विशेष प्रयोजन वाहन (SPV) का पंजीकरण सोसायटी रजिस्ट्रीकरण अधिनियम, 1860 के अन्तर्गत किया जायेगा।

(अनिल कुमार)
प्रमुख सचिव।

संख्या एवं दिनांक तदैव

प्रतिलिपि-निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित :-

1- सचिव, आर्थिक कार्य विभाग, वित्त मंत्रालय, भारत सरकार, नई दिल्ली।
2- सचिव, पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार, नई दिल्ली।
3- स्टॉफ ऑफिसर, मुख्य सचिव, उ0प्र0 शासन।
4- अपर मुख्य सचिव/प्रमुख सचिव, वित्त, कृषि, कृषि शिक्षा एवं अनुसंधान, पशुपालन, अतिरिक्त ऊर्जा, प्राविधिक शिक्षा, उच्च शिक्षा, व्यवसायिक शिक्षा, कौशल विकास और उद्यमशीलता, चिकित्सा, स्वास्थ्य एवं परिवार कल्याण, नियोजन, सूक्ष्म, लघु एवं मध्यम उद्यम एवं निर्यात प्रोत्साहन, अवस्थापना एवं औद्योगिक विकास, ग्राम्य विकास,

नगर विकास, परिवहन, खनन एवं भूतत्व खनिकर्म, आवास एवं शहरी नियोजन, लोक निर्माण, पंचायती राज, वाह्य सहायतित परियोजना विभाग, उ0प्र0 शासन।

5- प्रधान मुख्य वन संरक्षक और विभागाध्यक्ष, उ0प्र0, लखनऊ।

6- अध्यक्ष, उ0प्र0 प्रदूषण नियंत्रण बोर्ड, लखनऊ।

7- कण्ट्री डायरेक्टर, इण्डिया, वर्ल्ड बैंक।

8- समस्त मण्डलायुक्त/जिलाधिकारी, उ0प्र0।

9- महानिदेशक, द एनर्जी एण्ड रिसोर्स इंस्टीट्यूट (TERI), नई दिल्ली।

10- निदेशक, पर्यावरण, उ0प्र0, लखनऊ।

11- हेड ऑफ पीएमसी (TERI)।

12- सदस्य सचिव, उ0प्र0 प्रदूषण नियंत्रण बोर्ड, लखनऊ।

13- समस्त अनुभाग, पर्यावरण, वन एवं जलवायु परिवर्तन विभाग, उ0प्र0 शासन।

14- गार्ड फाइल।

आज्ञा से,

(सुशील शर्मा)
सचिव।

GFR 12 – A

[(See Rule 238 (1)]

FORM OF UTILIZATION CERTIFICATE FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

UTILIZATION CERTIFICATE FOR THE YEAR **2019-2020** in respect
of recurring/non-recurring
GRANTS-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS

1. Name of the Scheme – **NATIONAL CLEAN AIR PROGRAMME (NCAP) FOR FIROZABAD CITY**
2. Whether recurring or non-recurring grants - Recurring grants
3. Grants position at the beginning of the Financial year
   (i) Cash inHand/Bank – **NIL**
   (ii) Unadjusted advances - **NIL**
   (iii) Total - **NIL**
4. Details of grants received, expenditure incurred and closing balances: (Actuals, Rs in Lacs)

Unspent Balances of Grants received years [figure as at Sl. No. 3 (iii)]	Interest Earned thereon	Interest deposited back to the Government	Grant received during the year			Total Available funds (1+2-3+4)	Expenditure incurred	Closing Balances (5-6)
1	2	3	4			5	6	7
			Sanction No. (i)	Date (ii)	Amount (iii)			
			Q-16017/41/2019-CPA	05.08.2019	12	20	0	20
			Q-16017/41/2019-CPA	27.03.2020	8			

Component wise utilization of grants:

Grant-in-aid–General	Grant-in-aid–Salary	Grant-in-aid–creation of capital assets	Total

Details of grants position at the end of the year

(i) Cash inHand/Bank : **Rs. 20 Lacs**
(ii) Unadjusted Advances **NIL**
(iii) Total : **Rs. 20 Lacs**

Kaushik
(पंकज कौशिक)
लेखा–प्रभारी

FORM GFR 12A

GENERAL FINANCE RULES 2017
Ministry of Finance
Department of Expenditure

Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:

(i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.

(ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.

(iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.

(iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.

(v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.

(vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

(vii) It has been ensured that the physical and financial performance under **National Clean Air Program for Firozabad City** has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure – I duly enclosed.

(viii) The utilization of the fund resulted in outcomes given at Annexure – II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)

(ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure–II (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

Date:

Place: Lucknow

P Kaushik

(Pankaj Kaushik)
Incharge Accounts

(Ajay Kumar Sharma)
Member Secretary
Uttar Pradesh Pollution Control Board

GFR 12 – A

[(See Rule 238 (1)]

FORM OF UTILIZATION CERTIFICATE FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

UTILIZATION CERTIFICATE FOR THE YEAR **2020-2021** in respect
of recurring/non-recurring
GRANTS-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS

1. Name of the Scheme – **NATIONAL CLEAN AIR PROGRAMME (NCAP) FOR FIROZABAD CITY**
2. Whether recurring or non-recurring grants - Recurring grants
3. Grants position at the beginning of the Financial year
   (i) Cash inHand/Bank – **Rs. 20 Lacs**
   (ii) Unadjusted advances - **NIL**
   (iii) Total - **Rs. 20 Lacs**
4. Details of grants received, expenditure incurred and closing balances: (Actuals, Rs in Lacs)

Unspent Balances of Grants received years [figure as at Sl. No. 3 (iii)]	Interest Earned thereon	Interest deposited back to the Government	Grant received during the year			Total Available funds (1+2-3+4)	Expenditure incurred	Closing Balances (5-6)
1	2	3	4			5	6	7
			Sanction No. (i)	Date (ii)	Amount (iii)			
20	-	-	Q-16017/41/2019-CPA	25.03.2021	190	210	0.8	209.20

Component wise utilization of grants:

Grant-in-aid–General	Grant-in-aid–Salary	Grant-in-aid–creation of capital assets	Total

Details of grants position at the end of the year

(i) Cash inHand/Bank : **Rs. 209.20 Lacs**
(ii) Unadjusted Advances **NIL**
(iii) Total : **Rs. 209.20 Lacs**

Kaushik
(पंकज कौशिक)
लेखा–प्रभारी

FORM GFR 12A

GENERAL FINANCE RULES 2017
Ministry of Finance
Department of Expenditure

Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:

(i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.

(ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.

(iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.

(iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.

(v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.

(vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

(vii) It has been ensured that the physical and financial performance under **National Clean Air Program for Firozabad City** has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure – I duly enclosed.

(viii) The utilization of the fund resulted in outcomes given at Annexure – II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)

(ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure – II (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

Date:

Place: Lucknow

P Kaushik

(Pankaj Kaushik)
Incharge Accounts

(Ajay Kumar Sharma)
Member Secretary
Uttar Pradesh Pollution Control Board

GFR 12 – A

[(See Rule 238 (1)]

FORM OF UTILIZATION CERTIFICATE FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

UTILIZATION CERTIFICATE FOR THE YEAR **2021-2022** in respect
of recurring/non-recurring
GRANTS-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS

1. Name of the Scheme – **NATIONAL CLEAN AIR PROGRAMME (NCAP) FOR FIROZABAD CITY**
2. Whether recurring or non-recurring grants - Recurring grants
3. Grants position at the beginning of the Financial Year
   (i) Cash inHand/Bank – **Rs. 209.20 Lacs**
   (ii) Unadjusted advances - **NIL**
   (iii) Total - **Rs. 209.20 Lacs**
4. Details of grants received, expenditure incurred and closing balances: (Actuals, Rs in Lacs)

Unspent Balances of Grants received years [figure as at Sl. No. 3 (iii)]	Interest Earned thereon	Interest deposited back to the Government	Grant received during the year			Total Available funds (1+2-3+4)	Expenditure incurred	Closing Balances (5-6)
1	2	3	4			5	6	7
			Sanction No. (i)	Date (ii)	Amount (iii)			
209.20	-	-	-	-	-	209.20	-	209.20

Component wise utilization of grants:

Grant-in-aid–General	Grant-in-aid–Salary	Grant-in-aid–creation of capital assets	Total

Details of grants position at the end of the year

(i) Cash inHand/Bank : **Rs. 209.20 Lacs**
(ii) Unadjusted Advances **NIL**
(iii) Total : **Rs. 209.20 Lacs**

Kaushik
(पंकज कौशिक)
लेखा-प्रभारी

Ajay Kumar Sharma
Member Secretary
UP Pollution Control Board

FORM GFR 12A

GENERAL FINANCE RULES 2017
Ministry of Finance
Department of Expenditure

Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned

(i) The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.

(ii) There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.

(iii) To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.

(iv) The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.

(v) The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate

(vi) The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

(vii) It has been ensured that the physical and financial performance under **National Clean Air Program for Firozabad City** has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure – I duly enclosed.

(viii) The utilization of the fund resulted in outcomes given at Annexure – II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)

(ix) Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure –II (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

Date: 02.5.2022
Place: Lucknow

PKaushik

(Pankaj Kaushik)
Incharge Accounts

(Ajay Kumar Sharma)
Member Secretary
Uttar Pradesh Pollution Control Board

FORM GFR 12 - A

[See Rule 238(1)]

FORM OF UTILIZATION CERTIFICATE

FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

Name of the Grantee Organization:Firozabad City

UTILIZATION CERTIFICATE FOR THE PERIOD FROM 2022-04-01 TO 2023-03-31

respect

of recurring/non-recurring

GRANTS-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS

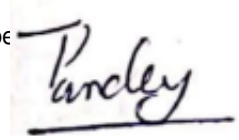
1. Name of the Scheme: National Clean Air Programme (NCAP)
2. Whether recurring or non-recurring grants: Recurring
3. Grants position at the beginning of the financial year, 2022_23
   i. Cash in Hand/Bank:20920000
   ii. Unadjusted advances:0
   iii. Total: 20920000
4. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balances of Grants received years 2021-22	Interest Earned thereon	Interest deposited back to the Govt	Grant received during the year 2022_23			Total Available funds	Expenditure incurred	Closing Balances
			Sanction No.	Date	Amount			
1	2	3	4			5	6	7
			i	ii	iii			
20920000	2216186.00	0	Q-16017/144/2021-CPA	2022-09-30 00:00:00	175000000	211436186	16460255	194975931
			Q-16017/135/2021-CPA	2023-03-27 00:00:00	13300000			

5. Component wise utilization of grants:

	Grant-in-aid-General (Rs. in crores)	Grant-in-aid-Salary (Rs. in crores)	Grant-in-aid-creation of capital assets (Rs. incrores)	Total (Rs. in crores)
Grant Received	188300000	0	0	188300000
Carried forward from Prev. F.Y	23136186	0	0	23136186
Less: Utilised	16460255	0	0	16460255
Balance	194975931	0	0	194975931

Details of grants position at the end of the year
   i. Cash in Hand/Bank:194975931
   ii. Unadjusted advances:0
   iii. Total:194975931
6. Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:
   i. The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.
   ii. There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.
   iii. To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.
   iv. The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.
   v. The benefits were extended to the intended be ıch areas/districts were covered where the scheme was intended to operate.



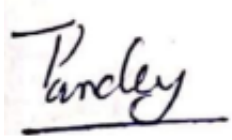
8502

vi. The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.
vii. It has been ensured that the physical and financial performance under National Clean Air Programme (NCAP) has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure - I duly enclosed.
viii. The utilization of the fund resulted in outcomes given at Annexure - II duly enclosed (to be formulated by the Ministry/ Department concerned as per their requirements/ specifiCations.)
ix. Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure - I (to be formulated by the Ministry/Department concerned as per their requirements/ specifications).

Name : Tarkeshwer Pandey

Designation : Executive Engineer
Date :07-Feb-2024

Place : Firozabad



FORM GFR 12 - A

[See Rule 238(1)]

FORM OF UTILIZATION CERTIFICATE

FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

Name of the Grantee Organization:Firozabad City

UTILIZATION CERTIFICATE FOR THE PERIOD FROM 2023-04-01 TO 2024-03-31

respect

of recurring/non-recurring

GRANTS-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS

1. Name of the Scheme: National Clean Air Programme (NCAP)
2. Whether recurring or non-recurring grants: Recurring
3. Grants position at the beginning of the financial year, 2023_24
   i. Cash in Hand/Bank:194960355
   ii. Unadjusted advances:0
   iii. Total: 194960355
4. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balances of Grants received years 2022-23	Interest Earned thereon	Interest deposited back to the Govt	Grant received during the year 2023_24			Total Available funds	Expenditure incurred	Closing Balances
			Sanction No.	Date	Amount			
1	2	3	4			5	6	7
			i	ii	iii			
194960355	7832716.00	2216186.00	CPW-G027(17)/2/2023-CP	2023-09-18 00:00:00	268500000	469076885	213505471	255571414

5. Component wise utilization of grants:

	Grant-in-aid-General (Rs. in crores)	Grant-in-aid-Salary (Rs. in crores)	Grant-in-aid-creation of capital assets (Rs. incrores)	Total (Rs. in crores)
Grant Received	268500000	0	0	268500000
Carried forward from Prev. F.Y	194960355	0	0	194960355
Less: Utilised	213505471	0	0	213505471
Balance	249954884	0	0	249954884

Details of grants position at the end of the year
   i. Cash in Hand/Bank:255571414
   ii. Unadjusted advances:0
   iii. Total:255571414
6. Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:
   i. The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.
   ii. There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.
   iii. To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.
   iv. The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.
   v. The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.
   vi. The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.
   vii. It has been ensured that the physical and financial performance under National Clean Air Programme (NCAP) has been according to the requirements, as prescribed by Govt. of India and the performance/targets achieved statement for the year to which the d in outcomes given at Annexure - I duly

Signed by Firozabad
Date: 2025.10.06 17:00:21

enclosed.

8504

viii. The utilization of the fund resulted in outcomes given at Annexure - II duly enclosed (to be formulated by the Ministry/ Department concerned as per their requirements/ specifiCations.)

ix. Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure - I (to be formulated by the Ministry/Department concerned as per their requirements/ specifications).

Name : Ashish Shukla

Designation : Executive Engineer
Date :06-Oct-2025

Place : Firozabad

Signed by Firozabad
Date: 2025.10.06 17:00:21

8505

FORM GFR 12 - A

[See Rule 238(1)]

FORM OF UTILIZATION CERTIFICATE

FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

Name of the Grantee Organization:Firozabad City

UTILIZATION CERTIFICATE FOR THE PERIOD FROM 2024-04-01 TO 2025-03-31

respect

of recurring/non-recurring

GRANTS-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS

1. Name of the Scheme: National Clean Air Programme (NCAP)
2. Whether recurring or non-recurring grants: Recurring
3. Grants position at the beginning of the financial year, 2024_25
   i. Cash in Hand/Bank:255571414
   ii. Unadjusted advances:0
   iii. Total: 255571414
4. Details of grants received, expenditure incurred and closing balances: (Actuals)

Unspent Balances of Grants received years 2023-24	**Interest Earned thereon**	**Interest deposited back to the Govt**	**Grant received during the year 2024_25**			**Total Available funds**	**Expenditure incurred**	**Closing Balances**
			Sanction No.	**Date**	**Amount**			
1	**2**	**3**	**4**			**5**	**6**	**7**
			i	**ii**	**iii**			
255571414	4779042.00	7832716.00	NA	00:00:0000	0	252517740	231456323	21061417

5. Component wise utilization of grants:

	Grant-in-aid-General (Rs. in crores)	**Grant-in-aid-Salary (Rs. in crores)**	**Grant-in-aid-creation of capital assets (Rs. incrores)**	**Total (Rs. in crores)**
Grant Received	0	0	0	0
Carried forward from Prev. F.Y	255571414	0	0	255571414
Less: Utilised	231456323	0	0	231456323
Balance	24115091	0	0	24115091

Details of grants position at the end of the year
   i. Cash in Hand/Bank:21061417
   ii. Unadjusted advances:0
   iii. Total:21061417
6. Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:
   i. The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.
   ii. There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.
   iii. To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.
   iv. The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.
   v. The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.
   vi. The expenditure on various componen proportions authorized as per the scheme

Signed by Firozabad
Date: 2025.10.06 17:02:09

guidelines and terms and conditions of the grants-in-aid. 8506

vii. It has been ensured that the physical and financial performance under National Clean Air Programme (NCAP) has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the fund resulted in outcomes given at Annexure - I duly enclosed.

viii. The utilization of the fund resulted in outcomes given at Annexure - II duly enclosed (to be formulated by the Ministry/ Department concerned as per their requirements/ specifiCations.)

ix. Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure - I (to be formulated by the Ministry/Department concerned as per their requirements/ specifications).

Name : Manish Kumar

Designation : Chief Engineer

Date :06-Oct-2025

Place : Firozabad

Signed by Firozabad
Date: 2025.10.06 17:02:09

नगर निगम फिरोजाबाद

वित्तीय वर्ष 2022–23 में नेशनल क्लीन ऐयर प्रोग्राम (N-CAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
1	18	छारबाग वाल्मीक वाटिका में मियावाकी पद्धति से वृक्षारोपण का कार्य।	2619854.00	2484931.52	03.12.2023	मै0 गायत्री एण्टरप्राईजेज	I/F	**2251347.00**	**2251347.00**	कार्य पूर्ण
2	19	कन्हैया नगर में शेल्टर होम के पीछे मियावाकी पद्धति से वृक्षारोपण का कार्य।	550855.00	523312.25	11.11.2023	मै0 महावीर ट्रेडर्स	I/F	**341711.00**	**307540.00**	कार्य पूर्ण
3	19	वार्ड नं0 19 सन्त नगर फुलवाडी में महेश आटा चक्की से फतेहाबाद रोड़ तक सी0सी0 द्वारा सड़क सुधार, साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0, नाली मरम्मत तथा साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	8726715.00	8334012.82	26.08.2023	मै0 पीएसआर इन्फ्रोटेक	II/F	**8326427.00**	**7491835.00**	कार्य पूर्ण
4	19	वार्ड नं0 19 पैमेश्वर गेट सांईं मन्दिर से फतेहाबाद रोड़ तक साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 लगाने तथा वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	7683659.00	7346346.37	26.08.2023	मै0 रामकिशोर राठी कॉन्ट्रेक्टर	III/F	**7652261.00**	**7652261.00**	कार्य पूर्ण
5	41	वार्ड नं0 41 कोटला चुंगी से पारसनाथ मार्केट के पास पार्क तक कलर्ड स्ट्रिप के साथ इ0ला0 द्वारा साइड पटरी का सुधार तथा ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	805538.00	764455.56	11.10.2023	मै0 सुभाष चन्द्र राठौर	II/F	**761941.00**	**761941.00**	कार्य पूर्ण
6	44	वार्ड नं0 44 सुहाग नगर में पुलिस सहायता केन्द्र से कल्पना आई0टी0आई0 तक दोनों साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 नाला मरम्मत तथा साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लनाने का कार्य।	10617840.00	10086948.00	26.08.2023	मै0 शिशांत अग्रवाल	II/F	**10258187.00**	**5258187.00**	कार्य पूर्ण
7	04, 44	वार्ड नं0 –04 व 44 सुहाग नगर में हिमायूंपुर चौराहे से मोहन स्वीट हाउस तक साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 नाली मरम्मत तथा वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	2286428.00	1983476.29	26.07.2023	मै0 अभिषेक कॉन्ट्रेक्टर	III/FM	**2155355.00**	**2155355.00**	कार्य पूर्ण

8	1	नगला बरी चौराहे से बम्बाबाई पास सैलई पुलिया तक साठ फुटा रोड पर क्षतिग्रस्त/कच्ची दोनों साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	12279660.00	11374417.00	03.11.2023	मै0 महेश चन्द्र	III/F	**11374417.00**	**11374417.00**	कार्य पूर्ण
9	20	सुरेश नगर टंकी परिसर में मियावाकी पद्धति से वृक्षारोपण का कार्य।	1012384.00	960752.42	03.10.2023	मै0 महावीर ट्रेडर्स	II/F	**883337.00**	**883337.00**	कार्य पूर्ण
10	20	आसरा आवास योजना आसफाबाद के परिसर में मियावाकी पद्धति से वृक्षारोपण का कार्य।	730638.00	694106.10	11.11.2023	मै0 महावीर ट्रेडर्स	II/F	**631496.00**	**631496.00**	कार्य पूर्ण
11	35	प्राथमिक विद्यालय नगला भाऊ परिसर में मियावाकी पद्धति से वृक्षारोपण का कार्य।	821688.00	775673.47	03.10.2023	मै0 महावीर ट्रेडर्स	II/F	**654462.00**	**654462.00**	कार्य पूर्ण
12	35	वार्ड नं0 35 में तहसील मोड़ (कृपाल सिंह के मकान) से मुकुट सिंह के मकान तक क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क निर्माण एवं साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	2425908.00	2304612.60	26.07.2023	मै0 गायत्री एण्टरप्राईजेज	II/F	**2303595.00**	**2303595.00**	कार्य पूर्ण
13	35	वार्ड नं0 35 में टोनी बाबू की बाउण्ड्री से मीरा चौराहा मोड़ (मॉ संतोषी ट्रेडर्स) तक हॉटमिक्स द्वारा सड़क चौड़ीकरण, कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	17650715.00	16935861.04	26.08.2023	मै0 स्वास्तिक डवलपर्स एण्ड कम्पनी	III/F	**16858805.00**	**16858805.00**	कार्य पूर्ण
14	13, 35, 38	वार्ड नं0 12, 35 व 38 की साइड नगला भाऊ सर्विस रोड से झील की पुलिया तक रहना नाला पटरी पर क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क सुधार, कच्चे भाग में कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	16570390.00	15741870.50	26.08.2023	मै0 महेश चन्द्र	III/F	**15514536.00**	**15514536.00**	कार्य पूर्ण
15	35 20	झील की पुलिया से कृष्णा नगर पुलिया होते हुए ककरऊ कोठी चौराहे तक जलेसर रोड की दोनों साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने, डिवाडर मरम्मत व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	14365495.00	13647220.00	11.09.2023	मै0 गायत्री एण्टरप्राईजेज	III/F	**13383432.00**	**13383432.00**	कार्य पूर्ण

16	35,38	वार्ड नं0 35 व 38 में रहना नाला से महक जनरल स्टोर होते हुए महाकाल गार्डन के पास तक हॉटमिक्स द्वारा सड़क चौड़ीकरण, कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	16907095.00	16907095.00	25.08.2023	मै0 सुधीर कुमार जैन कॉन्ट्रेक्टर	III/F R P	**16095687.00**	**16095687.00**	कार्य पूर्ण
17	13	वार्ड नं0 13 विभव नगर गेट से टंकी वाले अमृत पार्क तक सड़क के दोनों ओर साइड पटरी पर नाली मरम्मत व कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	1955628.00	1884247.57	26.09.2023	मै0 आर आर कॉन्ट्रेक्टर्स	II/F	**1869786.00**	**1869786.00**	कार्य पूर्ण
18	17, 10	वार्ड नं0 17 व 10 में लोक माता अहिल्याबाई होल्कर की प्रतिमा से दखल होते हुए बम्बा बाईपास रोड तक कोटला रोड की दोनों कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3260515.00	2927942.47	03.10.2023	मै0 महेश चन्द्र	II/F	**2919977.00**	**2919977.00**	कार्य पूर्ण
19	11, 33	वार्ड नं0 11 व 33 की साइड कैप्टन देवेश कुलश्रेठ द्वार से झील की पुलिया तक नाला पटरी पर क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क सुधार, कच्चे भाग में कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	12446268.00	11823954.60	26.08.2023	मै0 गायत्री एण्टरप्राईजेज	III/F	**11704178.00**	**8880741.00**	कार्य पूर्ण 2572 विथ हेल्ड रोकी गयी
20	01, 62	वार्ड नं0 01 व 62 में बम्बा बाईपास सॉती रोड पुलिया से प्रताप नगर व अम्बे नगर तक सॉती रोड की दोनों क्षतिग्रस्त/कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	9995740.00	9590912.53	26.08.2023	मै0 स्वास्तिक डवलपर्स एण्ड कम्पनी	II/F	**9333420.00**	**9333154.00**	कार्य पूर्ण 266 विथ हेल्ड रोकी गयी
21	9,10, 13	फ्लाई ओवर के नीचे चार ब्लाकों में इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3482721.00	3320774.47	26.07.2023	मै0 आर आर कॉन्ट्रेक्टर्स	II/F A	**3080881.00**	**3080881.00**	कार्य पूर्ण 4426 विथ हेल्ड रोकी गयी
22	35	वार्ड नं0 35 नगला भाऊ में सर्विस रोड से फायर ब्रिगेड तक रोड़ की कच्ची साइट पटरी पर कलर्ड इ0ला0 लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	1182643.00	1006665.72	31.07.2023	मै0 सिंह ग्रुप	I/R	**803623.00**	**723261.00**	कार्य पूर्ण अन्तिम बिल नही बना है।

23	45	वार्ड नं0 45 दतौजी कला में राधे राधे के मकान से सोबरन सिंह के मकान तक साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 लगाने तथा साइड पटरी पर वृक्षारोपण एंव ट्रीगार्ड लगाने का कार्य।	1324523.00	1192405.04	06.08.2023	मै0 सिंह ग्रुप	I/R	**795804.00**	**716224.00**	कार्य पूर्ण अन्तिम बिल नही बना है।
		कुल योग–	**149702900.00**	**141787809.09**				**139954665.00**	**131102257.00**	

नगर निगम फिरोजाबाद

नेशनल क्लीन एयर प्रोग्राम (N-CAP) वर्ष 2023–24 के अन्तर्गत प्रस्तावित कार्य। (PART- B)

Summary

S.No.	Description of Work	Quantity	mount
1.	कच्ची /क्षतिग्रस्त सड़कों व साइड पटरी का निर्माण एवं प्लांटेशन का कार्य।	21	13,97,68,500.00
2.	वार्ड नं0 13 विभव नगर सेक्टर– 02 में दीक्षित पार्क में बाउण्ड्रीवाल, रेलिंग, पाथ–वे बैन्च, रंगाई–पुताई, झूला एवं वृक्षारोपण का कार्य।	1	2504794.00
3.	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	550 Nos	2389960.00
4.	**Design, Erection and Commissioning new technology gas Based Animal carcass Plant. With small and big box.**	1	1,69,44,127.00

5.	**Supply of 5 Tractor With 5000 Ltr Water Tanker Mounted On Two Wheels Trailer and Battery Operated Selfstart as Well as Recoil Type Starting Portable Pump Set.**	2	**23,97,736.00**
		Total Amount	**16,40,05,117.00**
		Say Rs. In (Cr)	**16.40(Cr)**

02/12/23
अवर अभियन्ता

02/12/23
अवर अभियन्ता

2/12/2023
सहायक अभियन्ता

02/12/23
अधिशासी अभियन्ता (सिविल)

2-12-23
नोडल(N-CAP) / मुख्य अभियन्ता

नगर निगम फिरोजाबाद

नेशनल क्लीन एयर प्रोग्राम (N-CAP) वर्ष 2023–24 के अन्तर्गत प्रस्तावित कार्य।

(Part –B)

FORM - J

(A) – कच्ची/क्षतिग्रस्त सड़कों व साइड पटरी का निर्माण एवं प्लांटेशन का कार्य।

S.No.	Description of Work	Length (Mtr)	Amount
1.	वार्ड नं0 01 ठारफुटा पुलिया से बम्बा नाला पटरी से सावित्री रिसोर्ट से आगे तक आर0सी0सी0 नाली निर्माण, सी0सी0 द्वारा सड़क निर्माण, साइड डेबलपमेन्ट व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	627.00	**12334857.00**
2.	वार्ड नं0 12 लक्ष्मी नगर में आर0सी0 रिसोर्ट से हरिहोम यादव के मकान तक कच्चे रोड़ पर आर0सी0सी0 नाली व सी0सी0 सड़क निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	250.00	**3054405.00**
3.	वार्ड नं0– 12 ककरऊ में परी सटरिंग वाले से महेन्द्र सिंह यादव के मकान तक क्षतिग्रस्त मार्ग मे नाली मरम्मत व सी0सी0 द्वारा सड़क निर्माण, साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	300.00	**2719876.00**
4.	वार्ड नं0 12 लक्ष्मी नगर में गोविन्द फौजी के मकान से दिनेश मास्टर के मकान तक, उमेश के मकान से आनन्द के मकान तक, गुप्ता जी के मकान से राजेश के मकान तक, रामे यादव से शिवकुमार के मकान तक कच्ची गलियों में आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण एवं गोविन्द फौजी के मकान से दिनेश मास्टर के मकान तक कलर्ड इ0ला0 के साथ फुटपाथ निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	600.00	**11140745.00**
5.	वार्ड नं0 18 अमृत नगर बन्टी से फतेहाबाद रोड तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	210.00	**3940333.00**

6.	वार्ड नं0 18 अमृत नगर राम शंकर से मुकेश तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	90.00	933114.00
7.	वार्ड न0– 18 अमृत नगर मे सामरे से गीतम सिंह, लखमी चन्द्र से दुर्गेश, जयप्रकाश से कृष्णकान्त, सौरभ से प्लॉट, गीतम सिंह से रामवीर एवं अन्य कच्ची लिंक गलियों मे नाली निर्माण एवं सी0 सी0 द्वारा सड़क निर्माण कार्य।	600.00	7383437.00
8.	वार्ड नं0–18 प्रेमपुरा रैपुरा एस0पी0एस0 से फतेहाबाद रोड तक नाला मरम्मत, पैरापिंट वॉल एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	140.00	2756799.00
9.	वार्ड नं0 19 मौ0 फुलवाडी रामप्रताप वर्मा से अमर सिंह वर्मा होते हुए रामा देवी तक एवं महेन्द्र वर्मा वाली गली में आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण कार्य।	148.00	2015477.00
10.	वार्ड नं0 45,48 के दतौजी खुर्द में राधे–राधे से रेलवे क्रोसिंग के पास कमलेश गुप्ता के मकान तक सी0सी0 द्वारा सड़क सुधार कार्य एवं साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 तथा साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	540.00	8425671.00
11.	वार्ड न0– 19 फुलवाड़ी मे धाकरे मैरिज होम से छोटा माता मन्दिर तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	400.00	7091910.00
12.	वार्ड नं0– 25 नगला भाऊ उमा कारखाने से जी0टी0 की पुलिया तक सी0सी0 सड़क निर्माण, कलर्ड इ0ला0 द्वारा साइड पटरी, साइड डेबलपमेन्ट का निर्माण एवं आर0 सी0सी0 ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	450.00	11516906.00
13.	वार्ड नं0 33 मौ0 गणेश नगर में पुलिस चौकी सर्विस रोड से यादव की डेरी जैन नगर रोड तक नाली मरम्मत, हॉटमिक्स द्वारा सड़क चौड़ीकरण व दोनो साइड़ पटरी पर कलर्ड इ0ला0 लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	525.00	7479777.00
14.	वार्ड नं0 34 महादेव नगर पुलिया बम्बा पटरी से ठारफुटा पुलिया तक आर0सी0सी0 नाली निर्माण, सी0सी0 द्वारा सड़क निर्माण, पैरापिट वॉल व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	375	8901070.00
15.	वार्ड न0– 45 दतौजी खुर्द मे कमलाबाई मंदिर से नशा मुक्ति केन्द्र होते हुए रामलाल के मकान तक सी0 सी0 द्वारा सड़क	410.00	5786727.00

	सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।		
16.	वार्ड नं0 45 आनन्द विहार में बबलू की फैक्टी से संजू कैमीकल तक एवं प्रशान्त उपाध्याय से भगवान दास एवं बबलू से कैलाश गोस्वामी होते हुए राकेश तक नाली मरम्मत एवं सी0सी0 द्वारा सड़क सुधार कार्य।	380	4628339.00
17.	वार्ड नं0 25, 28 एन0एच0–2 सर्विस रोड़ सी0एल0 जैन पुलिया से जे0टी0 की पुलिया होते हुए मॉ पथवारी माता के मन्दिर तक क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क सुधार, साइड डेबलपमेन्ट व साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	600	14161287.00
18.	वार्ड नं0– 38 रैहना में प्राईमरी स्कूल से भगवान सिंह के घर तक क्षतिग्रस्त मार्ग में सी0सी0 द्वारा सड़क निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	450	4990243.00
19.	वार्ड न0– 19 गोवर्धन की ठार मे फतेहाबाद रोड, माता मंदिर से मुकुट सिंह तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	215	3240177.00
20.	वार्ड नं0 17 मायापुरी में देवाजी ट्रेडर्स से प्रदीप की फैक्ट्री तक कच्ची नाला पटरी पर आर0सी0सी0 नाली, हॉटमिक्स द्वारा सड़क निर्माण, वाइट पट्टी एवं इ0ला0 द्वारा साइट पटरी व ट्रीगार्ड के साथ वृक्षारोपण व सत्य नगर पुलिया से दखल की पुलिया तक नाले के दोनों ओर साइड डेबलपमेन्ट का कार्य।	320.00	11705019.00
21.	वार्ड न0– 65, 66 व 67 मे 30 फुटा रोड पर बजरंग वाटिका चौराहे से सैयदगंज रोड़ तक नाली मरम्मत व सी0 सी0 द्वारा सड़क सुधार कार्य।	300.00	5562331.00
	Total Part -B	**7930.00**	**13,97,68,500.00**

(B) – पार्को सौन्दर्यीकरण एंव झूला व वृक्षारोपण का कार्य।

S.No.	Description of Work	Length (Mtr)	Width (Mtr)	Amount

1.	वार्ड नं0 13 विभव नगर सेक्टर– 02 में दीक्षित पार्क में बाउण्ड्रीवाल, रेलिंग, पाथ–वे बैन्च, रंगाई–पुताई, झूला एवं वृक्षारोपण का कार्य।	60.00	32.00	2504794.00
			Total	2504794.00

(C) – आर0सी0सी गमले आपूर्ति एवं पौधारोपण का कार्य।

S.No.	Description of Work	Quantity	Amount
1.	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	550 Nos	2389960.00
		Total	2389960.00

(D)

S.No.	Description of Work	Quantity	Amount
1	Design, Erection and Commissioning new technology gas Based Animal carcass Plant. With small and big box.	1	1,69,44,127.00
2	Supply of 5 Tractor With 5000 Ltr Water Tanker Mounted On Two Wheels Trailer and Battery Operated Selfstart as Well as Recoil Type Starting Portable Pump Set.	2	23,97,736.00
		Total Amount	1,93,41,863.00
		Grand Total (A+B+C+D).	164005117.00
		Say total in (Cr).	16.40(Cr)

Mayank 02/12/23
अवर अभियन्ता

02/12/23
अवर अभियन्ता

2/12/2023
सहायक अभियन्ता

02/12/23
अधिशासी अभियन्ता (सिविल)

2-12-23
नोडल(N-CAP) / मुख्य अभियन्ता

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण										
क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
1	**0**	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	4067680.00	3863889.23	24.03.2024	महावीर ट्रेडर्स		**0.00**	**0.00**	कार्य पूर्ण गमले सभी टूट गये है कोई भी भुगतान नही किया गया है।
2	**18**	वार्ड नं0 18 अमृत नगर किशोरी लाल से सर्मन तक एवं नेकराम से श्रीकिशन तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	2542829.00	2415687.55	14.03.2024	गुरूकृपा कन्स्ट्रक्शन	II/F M	**2414380.00**	**2414380.00**	कार्य पूर्ण
3	**18**	वार्ड नं0 18 मौ0 मोहन नगर में बी0ए0एस0 स्कूल के बगल वाली गली व लिंक कच्ची गलियों में आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	5456097.00	5183292.15	15.03.2024	आर0आर0 कॉन्ट्रेक्टर्स	I/F M	**5161695.00**	**5161695.00**	कार्य पूर्ण
4	**18**	वार्ड नं0 18 अमृत नगर बन्टी से फतेहाबाद रोड तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	3940333.00	3743316.35	20.03.2024	आर0आर0 कॉन्ट्रेक्टर्स	II/F M	**3448050.00**	**3448050.00**	कार्य पूर्ण
5	**18**	वार्ड नं0 18 अमृत नगर राम शंकर से मुकेश तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	933114.00	886458.30	07.03.2024	विजय सिंह	I/F	**694314.00**	**694314.00**	कार्य पूर्ण
6	**18**	वार्ड न0– 18 अमृत नगर मे सामरे से गीतम सिंह, लखमी चन्द्र से दुर्गेश, जयप्रकाश से कृष्णकान्त, सौरभ से प्लॉट, गीतम सिंह से रामवीर एवं अन्य कच्ची लिंक गलियों मे नाली निर्माण एवं सी0 सी0 द्वारा सड़क निर्माण कार्य।	7383437.00	7014265.15	28.03.2024	रामकिशोर राठी कॉन्ट्रेक्टर	III/F	**7254939.00**	**7254939.00**	कार्य पूर्ण

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
7	**18**	वार्ड नं0–18 प्रेमपुरा रैपुरा एस0पी0एस0 से फतेहाबाद रोड तक नाला मरम्मत, पैरापिंट वॉल एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	2756799.00	2618959.05	07.03.2024	श्री बालाजी कन्स्ट्रक्शन एण्ड सप्लायर्स	I/F	**2584936.00**	**2584936.00**	कार्य पूर्ण
8	**19**	वार्ड नं0 19 शिव नगर में रघुवीर बघेल से मन्दिर व अमर सिंह ठाकुर होते हुए सरकारी ट्यूबैल तक नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	2035373.00	1933604.35	01.03.2024	अभिषेक कॉन्ट्रेक्टर	I/F	**1931115.00**	**1931115.00**	कार्य पूर्ण
9	**19**	वार्ड न0– 19 फुलवाड़ी मे राजाराम यादव के मकान से सन्त नगर अम्बेडकर तिराहा तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	8283952.00	7865612.42	15.03.2024	गायत्री इण्टर प्राईजेज	III/F	**7828792.00**	**7828792.00**	कार्य पूर्ण
10	**19**	वार्ड न0– 19 सन्त नगर के कन्हैया नगर मे शिवचरण से तलैया तक सी0 सी0 सड़क एवं दोनों साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0 ला0 व आर0 सी0 सी0 नाली निर्माण तथा साइड पटरी पर ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	9021268.00	8570204.60	15.03.2024	सुधीर कुमार जैन कॉन्ट्रेक्टर	II/F	**8523630.00**	**8523630.00**	कार्य पूर्ण
11	**19**	वार्ड नं0 19 मौ0 फुलवाडी रामप्रताप वर्मा से अमर सिंह वर्मा होते हुए रामा देवी तक एवं महेन्द्र वर्मा वाली गली में आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण कार्य।	2015477.00	1914703.15	07.03.2024	मयंक कन्स्ट्रक्शन एण्ड सप्लायर्स	II/F	**1913949.00**	**1913949.00**	कार्य पूर्ण
12	**19**	वार्ड न0– 19 फुलवाड़ी मे धाकरे मैरिज होम से छोटा माता मन्दिर तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	7091910.00	6808233.60	30.10.2024	सुधीर कुमार जैन कॉन्ट्रेक्टर	III/F	**7432382.00**	**7029814.00**	कार्य पूर्ण

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क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्ध भुगतान	अभ्युक्ति
13	**19**	वार्ड नं0–19 नई आबादी फुलवाडी रोड से लिंक गली में राजू के घर से मन्दिर तक व बबलू से भोले तक एवं मुकेश से अजीत तक सी0सी0 सड़क निर्माण कार्य।	1825950.00	1752912.00	19.01.2025	ए0जी0 कन्स्ट्रक्शन	I/F	**1750695.00**	**1575625.00**	कार्य पूर्ण
14	**44**	वार्ड नं0 44 सुहाग नगर में से0–02 अचल पैलेस के सामने अशोक मिश्रा से गीतम सिंह राठौर, सुभाष से कल्पना स्कूल, दिलीप इंजीनियर व मीना राजपूत वाली गली होते हुए रमेश चंचल के मकान तक नाली मरम्मत एवं सी0सी0 द्वारा सड़क सुधार कार्य।	5127766.00	4871377.70	15.03.2024	रामकिशोर राठी कॉन्ट्रेक्टर	III/F	**4797751.00**	**4797751.00**	कार्य पूर्ण
15	**44**	सुहाग नगर में सेक्टर–4 नाला पटरी पर पानी के प्लान्ट के सामने मियावाकी पद्धति से वृक्षारोपण का कार्य। (320 वर्ग मी0)	478565.00	454588.89	19.01.2025	महावीर ट्रैडर्स	I/F	**312678.00**	**281410.00**	कार्य पूर्ण
16	**45**	वार्ड नं0 45 दतौजी कलां में दतौजी चौराहा डा0 सुभाष की दुकान से पुलिया की ढलान तक कलर्ड स्ट्रिप के साथ इ0ला0 फुटपाथ निर्माण व हॉटमिक्स एवं ट्री–गार्ड के साथ व वृक्षारोपण का कार्य।	2375663.00	2256879.85	25.03.2024	अक्षत कन्स्ट्रक्शन	II/F	**2233378.00**	**2233378.00**	कार्य पूर्ण
17	**45**	वार्ड न0– 45 दतौजी खुर्द मे कमलाबाई मंदिर से नशा मुक्ति केन्द्र होते हुए रामलाल के मकान तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	5786727.00	5555257.92	20.03.2024	एस0आर0 कन्स्ट्रक्शन	II/F	**5555107.00**	**5555107.00**	कार्य पूर्ण
18	**45**	वार्ड नं0 45 आनन्द विहार में बबलू की फैक्टी से संजू कैमीकल तक एवं प्रशान्त उपाध्याय से भगवान दास एवं बबलू से कैलाश गोस्वामी होते हुए राकेश तक नाली मरम्मत एवं सी0सी0 द्वारा सड़क सुधार कार्य।	4628339.00	4443205.44	20.03.2024	एस0आर0 कन्स्ट्रक्शन	II/F	**4437914.00**	**4437914.00**	कार्य पूर्ण

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्ध भुगतान	अभ्युक्ति
19	**45,48**	वार्ड नं0 45,48 के दतौजी खुर्द में राधे–राधे से रेलवे क्रोसिंग के पास कमलेश गुप्ता के मकान तक सी0सी0 द्वारा सड़क सुधार कार्य एवं साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 तथा साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	8425671.00	8004387.45	25.03.2024	एन पी ट्रेडर्स	II/F M	**7980399.00**	**7648402.00**	कार्य पूर्ण
20	**12**	वार्ड नं0 –12 ककरऊ में प्रा0 विद्यालय मोड़ से ऐलान नगर पुलिया तक क्षतिग्रस्त मार्ग मे आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	6411251.00	6154800.96	20.03.2024	पीएसआर इन्फ्राटैक	II/F	**6313688.00**	**6313688.00**	कार्य पूर्ण
21	**12**	वार्ड नं0 12 लक्ष्मी नगर में आर0सी0 रिसोर्ट से हरिहोम यादव के मकान तक कच्चे रोड़ पर आर0सी0सी0 नाली व सी0सी0 सड़क निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3054405.00	2900157.55	28.03.2024	अभिषेक शर्मा	II/F	**3039166.00**	**3039166.00**	कार्य पूर्ण
22	**12**	वार्ड नं0– 12 ककरऊ में परी सटरिंग वाले से महेन्द्र सिंह यादव के मकान तक क्षतिग्रस्त मार्ग मे नाली मरम्मत व सी0सी0 द्वारा सड़क निर्माण, साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	2719876.00	2583882.20	07.03.2024	सुभाष चन्द्र राठौर ठेकेदार	II/F	**2513411.00**	**2513411.00**	कार्य पूर्ण
23	**20**	जलेसर रोड़ यू0पी0एस0आई0डी0 एरिया में दाऊदयाल डिग्री कॉलेज के सामने मियावाकी पद्धति से वृक्षारोपण का कार्य। (1550 वर्ग मी0)	1446397.00	1373932.51	19.01.2025	महावीर ट्रैडर्स	I/F	**1284335.00**	**1155901.00**	कार्य पूर्ण

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
24	**21**	वार्ड नं0 21 शान्ती नगर में रामवीर कुशवाह के मकान से शिव नारायन के मकान होते हुए दिलीप प्रजापति के मकान तक, पप्पू गुप्ता के मकान से नरेश चन्द्र के मकान तक कच्ची गलियों में आर0सी0सी0 नाली एंव सी0सी0 सड़क निर्माण व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3738504.00	3588963.84	20.03.2024	शशी देवी	II/F	**3602358.00**	**3602358.00**	कार्य पूर्ण
25	**25**	वार्ड नं0– 25 नगला भाऊ उमा कारखाने से जी0टी0 की पुलिया तक सी0सी0 सड़क निर्माण, कलर्ड इ0ला0 द्वारा साइड पटरी, साइड डेबलपमेन्ट का निर्माण एवं आर0 सी0सी0 ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	11516909.00	10935305.09	20.03.2024	गायत्री इण्टर प्राईजेज	II/F	**10932802.00**	**10932802.00**	कार्य पूर्ण
26	**29**	वार्ड नं0 29 बम्बा पटरी अनुराग सिंह से शालू ऑटो वाले की दुकान तक आर0सी0सी0 नाली निर्माण, सी0सी0 द्वारा सड़क निर्माण, इ0ला0 द्वारा साइट पटरी एवं साइड डेबलपमेन्ट व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	13364353.00	12829778.88	20.03.2024	सम्मन सिंह	II/F	**13211056.00**	**5815750.00**	कार्य पूर्ण
27	**29**	वार्ड नं0 29 कोटला रोड़ नगला पानसहाय में शेर सिंह कुशवाह से सार्थक अकेडमी तक आर0सी0सी0 नाली, सी0सी0 द्वारा सड़क निर्माण व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	2823722.00	2682535.90	01.03.2024	एन पी ट्रेडर्स	II/F	**2383174.00**	**2373174.00**	कार्य पूर्ण

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण										
क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
28	**33**	वार्ड नं0 33 मौ0 गणेश नगर में पुलिस चौकी सर्विस रोड से यादव की डेरी जैन नगर रोड तक नाली मरम्मत, हॉटमिक्स द्वारा सड़क चौड़ीकरण व दोनो साइड़ पटरी पर कलर्ड इ0ला0 लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	7479777.00	7105788.15	25.03.2024	अक्षत कन्स्ट्रक्शन	III/F	**6003374.00**	**6003374.00**	कार्य पूर्ण
29	**34**	वार्ड नं0 34 महादेव नगर पुलिया बम्बा पटरी से ठारफुटा पुलिया तक आर0सी0सी0 नाली निर्माण, सी0सी0 द्वारा सड़क निर्माण, पैरापिट वॉल व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	8901070.00	8456016.50	20.03.2024	सम्मन सिंह	II/F	**8428355.00**	**8428355.00**	कार्य पूर्ण
30	**35**	मीरा चौराहा पर जयना रिसोर्ट (राइट हैण्ड साइड़) से महिन्द्रा कार शोरूम तक एवं बृजेश की बाउण्ड्री वॉल सें नगर निगम सीमा तक सर्विस रोड पर सी0सी0 सड़क एवं साइड पटरी पर कलर्ड इ0ला0 टाईल्स एवं ट्रीगार्ड के साथ वृक्षरोपण का कार्य।	12625756.00	11994468.20	30.03.2024	महेश चन्द्र	II/F	**12306080.00**	**12306080.00**	कार्य पूर्ण
31	**36**	वार्ड नं0 36 नगला पचिया में रनवीर से विनोद वर्मा तक कच्चे रोड़ पर आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण व कलर्ड इ0ला0 के साथ फुटपाथ निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3142594.00	3016890.24	20.03.2024	एस0आर0 कन्स्ट्रक्शन	I/F	**3115030.00**	**3115030.00**	कार्य पूर्ण

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्ध भुगतान	अभ्युक्ति
32	**38**	वार्ड नं0– 38 रैहना में प्राईमरी स्कूल से भगवान सिंह के घर तक क्षतिग्रस्त मार्ग में सी0सी0 द्वारा सड़क निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	4990243.00	4738235.72	20.03.2024	गायत्री इण्टर प्राईजेज	I/F	**4551880.00**	**4551880.00**	कार्य पूर्ण
33	**62**	वार्ड नं0 62 हसमत नगर में शकीला नयीम हॉस्पीटल से आमीन होते हुए बम्बा बाईपास तक क्षतिग्रस्त रोड़ पर आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क एवं आर0सी0सी0 ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	5441852.00	5169759.40	24.03.2024	महेश चन्द्र	I/F	**5218712.00**	**5218312.00**	कार्य पूर्ण
34	**62**	सोफीपुर एस0टी0पी0 के सामने मियावाकी पद्धति से वृक्षारोपण एवं 01 वर्ष का अनुरक्षण कार्य।	1431619.00	1358606.43	28.02.2025	महावीर ट्रैडर्स	I/F	**1316096.00**	**1184486.00**	कार्य पूर्ण
35	**25, 28**	वार्ड नं0 25, 28 एन0एच0–2 सर्विस रोड़ सी0एल0 जैन पुलिया से जे0टी0 की पुलिया होते हुए मॉ पथवारी माता के मन्दिर तक क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क सुधार, साइड डेबलपमेन्ट व साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	14161287.00	13453222.00	25.03.2024	अक्षत कन्स्ट्रक्शन	III/F	**12274960.00**	**12274960.00**	कार्य पूर्ण
36	**19**	संत नगर पानी की टंकी परिसर से मियावाकी पद्धति से वृक्षारोपण एवं 01 वर्ष का अनुरक्षण कार्य।	190645.00	184735.01	19.01.2025	महावीर ट्रैडर्स	I/F	**183087.00**	**164778.00**	कार्य पूर्ण

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
37	**13**	वार्ड नं0 13 विभव नगर में सेन्टर पार्क का सौन्दर्यीकरण एंव झूला व वृक्षारोपण का कार्य।	1218654.00	1157112.00	24.03.2024	महावीर ट्रेडर्स	I/F	**1214570.00**	**1214570.00**	कार्य पूर्ण
38	**13**	वार्ड नं0 13 विभव नगर सेक्टर– 02 में दीक्षित पार्क में बाउण्ड्रीवाल, रेलिंग, पाथ–वे बैन्च, रंगाई–पुताई, झूला एवं वृक्षारोपण का कार्य।	2504794.00	2378302.00	24.03.2024	महावीर ट्रेडर्स	II/F	**2373646.00**	**2373646.00**	कार्य पूर्ण
39	**65,66,67**	वार्ड न0– 65, 66 व 67 मे 30 फुटा रोड पर बजरंग वाटिका चौराहे से सैयदगंज रोड़ तक नाली मरम्मत व सी0 सी0 द्वारा सड़क सुधार कार्य।	5562331.00	5395461.07	31.03.2024	पीएसआर इन्फ्राटैक	I/F	**5384793.00**	**5384793.00**	कार्य पूर्ण
40	**13**	वार्ड नं0 13 विभव नगर में ट्यूबेल वाला पार्क का सौन्दर्यीकरण एंव झूला व वृक्षारोपण का कार्य।	480891.00	384664.00	09.10.2024	सुन्दर कम्यूनिकेशन एण्ड कन्स्ट्रक्शन प्रा0लि0		**0.00**	**0.00**	कार्य पूर्ण एवं भुगतान हेतु लम्बित

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
41	**12**	वार्ड नं0 12 लक्ष्मी नगर में गोविन्द फौजी के मकान से दिनेश मास्टर के मकान तक, उमेश के मकान से आनन्द के मकान तक, गुप्ता जी के मकान से राजेश के मकान तक, रामे यादव से शिवकुमार के मकान तक कच्ची गलियों में आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण एवं गोविन्द फौजी के मकान से दिनेश मास्टर के मकान तक कलर्ड इ0ला0 के साथ फुटपाथ निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	11140745.00	10917930.10	28.03.2024	सम्मन सिंह	II/F	**10929365.00**	**10912010.00**	कार्य पूर्ण 17355 विथ हेल्ड रोकी गयी
42	**21**	वार्ड नं0 21 मरघटी रोड़ पर शिवराम राठौर से बिजय सिंह राठौर के मकान तक, राठौर धर्मशाल से शियाराम, कोमल सिंह से रंजीत, भगवान दास से राजपाल के मकान तक आर0सी0सी0 नाली, सी0सी0 द्वारा सड़क निर्माण व शिवराम राठौर से बिजय सिंह राठौर के मकान तक साइड पटरी पर इ0ला0 टाइल्स लगाने एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	9516383.00	9135727.68	20.03.2024	स्वास्तिक डवलपर्स एण्ड कम्पनी	II/F	**7915518.00**	**7915304.00**	कार्य पूर्ण 214 विथ हेल्ड रोकी गयी
43	**1**	वार्ड नं0 01 ठारफुटा पुलिया से बम्बा नाला पटरी से साविंत्री रिसोर्ट से आगे तक आर0सी0सी0 नाली निर्माण, सी0सी0 द्वारा सड़क निर्माण, साइड डेबलपमेन्ट व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	12334857.00	11718114.15	31.03.2024	स्वास्तिक डवलपर्स एण्ड कम्पनी	III/F	**11575809.00**	**11569824.00**	कार्य पूर्ण 5985 विथ हेल्ड रोकी गयी
44	**19**	वार्ड न0– 19 गोवर्धन की ठार मे फतेहाबाद रोड, माता मंदिर से मुकुट सिंह तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	3240177.00	3078168.15	25.03.2024	बजरंग ट्रेडर्स	II/R	**2780066.00**	**2598206.00**	कार्य पूर्ण अन्तिम बिल नही बनाया गया।

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्ध भुगतान	अभ्युक्ति
45	**44**	वार्ड नं0 44 सुहाग नगर सेक्टर–03 में मुकेश स्वीट हाउस से रेलवे लाइन के पास मन्दिर तक गत्ता फैक्ट्री के सामने वायु गुणवत्ता सुधार हेतु End to End Pavement का कार्य।	5274579.00	5147989.10	19.03.2025	अक्षत कन्स्ट्रक्शन	II/R	**4281396.00**	**1582572.00**	कार्य प्रगति पर।
46	**44**	वार्ड नं0–44 सुहाग नगर सेक्टर नं0 03 में ए.जी. पब्लिक स्कूल से श्याम दरोगा होते हुए रामप्रकाश यादव तक एवं स्कूल से अजय मिश्रा	3561338.00	3468743.21	19.02.2025	अक्षत कन्स्ट्रक्शन	I/R	**3329766.00**	**2996789.00**	कार्य प्रगति पर।
47	**29**	Setting up facilities for 02 Nos for Green Disposal of Community/Stray Dogs small animals, large animals and construction of shed in Firozabad **(CARCUS PLANT)**	16944127.00	15440000.00	08.01.2025	Cecon Pollutecech systems pvt ltd	II/R	**4938524.00**	**4938524.00**	कार्य प्रगति पर।
48	**28,31,32**	वार्ड न0–28, 31, 32 सुहाग नगर चौराहे से हिमायुपूर पुलिया तक हॉटमिक्स द्वारा सड़क एवं पूर्णतयः क्षतिग्रस्त गड्ढायुक्त साइड पटरी का पुनः निर्माण कार्य।	4365340.00	4247475.82	19.02.2025	अक्षत कन्स्ट्रक्शन	I/R	**3525539.00**	**3172985.00**	कार्य प्रगति पर।
49	**20**	Setting up facilities for **Green Antim Sanskar using Gas** with Operation and Maintenance of one year at Firozabad, Uttar Pradesh	10140000.00	9700000.00	26.09.2024	ग्रीन रेवेव्यूलेशन फाउण्डेशन	II/R RP	**6105865.00**	**5760104.00**	कार्य प्रगति पर।

वित्तीय वर्ष 2023–24 में नेशनल क्लीन ऐयर प्रोग्राम (NCAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्ध भुगतान	अभ्युक्ति
50	**0**	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	2389960.00	2270223.00	24.03.2024	महावीर ट्रेडर्स	A	**0.00**	**0.00**	कार्य प्रगति पर।
51	**17**	वार्ड नं0 17 मायापुरी में देवाजी ट्रेडर्स से प्रदीप की फैक्ट्री तक कच्ची नाला पटरी पर आर0सी0सी0 नाली, हॉटमिक्स द्वारा सड़क निर्माण, वाइट पट्टी एवं इ0ला0 द्वारा साइट पटरी व ट्रीगार्ड के साथ वृक्षारोपण व सत्य नगर पुलिया से दखल की पुलिया तक नाले के दोनों ओर साइड डेबलपमेन्ट का कार्य।	11705019.00	11119768.05	25.03.2024	अक्षत कन्स्ट्रक्शन	III/R	**10589248.00**	**10589248.00**	कार्य प्रगति पर। अन्तिम भुगतान हुआ नही टी0ए0सी0 पूर्ण है।
52	**25**	वार्ड नं0–25 ढोलपुरा में मीरा चौराहा से अग्रवाल टावर तक क्षतिग्रस्त मार्ग का सुधार कार्य।	29067258.00	28948082.24	29.03.2025	देवकली इन्फ्रा प्रा0लि0	II/R	**15601362.00**	**11701021.00**	पुनः निविदा प्रक्रिया में
			317063663.00	**303191674.30**						

कुल कार्य	**52**
कार्य प्रगति एवं अन्तिम बिल हेतु	**9**
पुनः निविदा में (देवकली)	**1**

नगर निगम फिरोजाबाद

वित्तीय वर्ष 2024–25 में नेशनल क्लीन ऐयर प्रोग्राम (N-CAP) के अन्तर्गत स्वीकृत कार्यों का विवरण

क्र.स.	बार्ड नं0	कार्य का नाम	आगणन धनांक	निविदा स्वीकृत धनांक	कार्य पूर्ण तिथि	ठेकेदार/फर्म का नाम	बिल की स्थिति	कुल बिल धनांक	कुल शुद्व भुगतान	अभ्युक्ति
1	35	वार्ड नं0 35 रैहना गुडडू की चक्की से करनसिंह तक कालीचरन से पण्डित जी सतेन्द्र, रामप्रकाश वाली गली में कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य	4426656.00	4324842.12	11.08.2025	गुरूकृपा कन्स्ट्रक्शन	II/F RP	**4281396.00**	**1984104.00**	कार्य पूर्ण।
2		आसफाबाद चौराहा से भारत टॉकीज से आगे बिजली घर की तरफ पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	12255750.00	12057206.85	01.11.2025	पी0एस0आर0 इन्फाटेक	II/F	**12205028.00**	**10984525.00**	कार्य पूर्ण।
3	38	वार्ड नं0 38 रैहना नाला पटरी पर अमर चन्द्र से प्रताप के मकान तक, जगदीश से कृपाली के मकान तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य।	4041520.00	3964731.12	09.08.2025	एस0आर0 कन्स्ट्रक्शन	I/F	**3963327.00**	**3566994.00**	कार्य पूर्ण।
4	21	वार्ड नं0 21 अशोक के मकान से अभिलाक राठौर के मकान तक क्षतिग्रस्त गड्ढायुक्त मार्ग का पुनः निर्माण कार्य।	4095427.00	3911132.79	09.08.2025	शशी देवी	I/F	**3909895.00**	**3518905.00**	कार्य पूर्ण।
5	33	वार्ड नं0 33 गणेश नगर में अभिषेक चंचल मित्तल से रामशोटे गुप्ता होते हुए पैंगुरिया तक पूर्णतयः क्षतिग्रस्त गड्ढायुक्त साइड पटरी का पुनः निर्माण कार्य।	3337400.00	3187550.74	05.10.2025	अक्षत कन्सट्रक्शन	I/F RP	**3186073.00**	**2867465.70**	कार्य पूर्ण।
6	10	वार्ड नं0 10 बम्बा रोड संतोष नगर में सत्यभजन वाटिका से बन्द तक, मनोज से जयप्रकाश के मकान तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य।	2249272.00	2208785.10	02.07.2025	आर0आर0 कॉन्ट्रेक्टर्स	I/F A	**1949749.00**	**1754774.00**	कार्य पूर्ण।

7	25	वार्ड नं0 25 इण्डिस्ट्रियल एरिया में आर0के0 ग्लास इण्डस्ट्रियल से अग्रवाल पैकर्स तक एवं श्री नाथ की फैक्ट्री से बंसल इण्डस्ट्रीज तक सी0सी0 सड़क निर्माण कार्य।	5758554.00	5640503.64	04.11.2025	गायत्री इण्टरप्राइजेज	I/F M	**5663762.00**	**5097386.00**	**कार्य पूर्ण।**
8	25	वार्ड नं0 25 ढोलपुरा में ट्रॉन्सपेरेन्ट ओवरसीज (टोनी बाबू की फैक्ट्री) से टाइगर ग्लास होते हुए जी0एम0 ओवरसीज फैक्ट्री तक हॉटमिक्स द्वारा सड़क निर्माण कार्य।	8503384.00	8303554.48	09.10.2025	अक्षत कन्स्ट्रक्शन	I/F M	**7964860.00**	**7168374.00**	**कार्य पूर्ण।**
9	12	वार्ड नं0–12 जलेसर रोड़ अभिमन्यु स्कूल वाली गली में सी0सी0 द्वारा सड़क निर्माण, कलर्ड इ0ला0 द्वारा कच्ची साइड पटरी को इ0ला0 द्वारा पक्का करने का निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	1249330.00	1198107.47	01.07.2025	अंजली इण्टरप्राइजेज	I/F RP	**1220520.00**	**1098468.00**	**कार्य पूर्ण।**
10	12	वार्ड नं0–12 ककरऊ कोठी प्राथमिक विद्यालय से बम्बा बाईपास तक एवं कोमल सिंह से शर्मा जी होते हुए श्रीप्रसाद (बम्बा बाईपास) तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	8683600.00	8444801.00	01.09.2025	गायत्री इण्टरप्राइजेज	II/F RP	**8488990.00**	**7871062.00**	**कार्य पूर्ण।**
11	34	वार्ड नं0 34 महादेव नगर गली नं0 34 (14/3) में राजू शर्मा से अजय होते हुए उमाशंकर के मकान, राजू सविता से नरेन्द्र के मकान तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य	2210680.00	2156297.27	01.07.2025	कपिल मोहन माहेश्वरी	I/F RP	**2154931.00**	**1939438.00**	**कार्य पूर्ण।**
12	34	वार्ड नं0 34 रैपुरा रोड़ पर वांस बल्ली की टाल से राकेश के मकान तक, मुकुल बैल्डिंग से बन्द तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य	2241550.00	2218013.73	01.07.2025	आदित्य कॉन्ट्रैक्टर	I/F RP	**2210608.00**	**1989547.00**	**कार्य पूर्ण।**
13	42	वार्ड नं0 42 विजय नगर में छोटेलाल से रामगोपाल होते हुए बंगाली तक कच्चे मार्ग पर सी0सी0 सड़क निर्माण कार्य।	1757897.00	1721860.01	02.07.2025	आर0आर0 कॉन्ट्रैक्टर्स	I/F M	**1714532.00**	**1543079.00**	**कार्य पूर्ण।**

14	9	वार्ड नं0 09 बौधाश्रम रोड पर नत्थूसिंह से मीरादेवी, जगदीश वर्मा, मधुवाला, राकेश, उमा, संजय शर्मा, सत्यभान वाली पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त गलियों मे सी0सी0 द्वारा सड़क सुधार कार्य।	1686646.00	1654599.73	09.07.2025	आर0आर0 कॉन्ट्रेक्टर्स	I/F A	**1642230.00**	**1478007.00**	**कार्य पूर्ण।**
15	10	वार्ड नं0 10 ओम कॉलोनी में देशी शराव के ठेका से कालीचरन कुशवाह हलवाई के मकान तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का हॉटमिक्स द्वारा पुनः निर्माण कार्य, नाला पटरी का निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	829870.00	808293.38	09.07.2025	अक्षत कन्स्ट्रक्शन	I/F A	**805530.00**	**724977.00**	**कार्य पूर्ण।**
16	12	वार्ड नं0 12 जलेसर रोड़ लक्ष्मी स्वीट हाउस से ट्रान्सफार्मर तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3810230.00	3665441.26	04.11.2025	एन0पी0 ट्रैडर्स	I/F RP	**3648121.00**	**3283309.00**	**कार्य पूर्ण।**
17	47	वार्ड नं0 47 में नैनी रोड़ जीसान पैन्ट की दुकान से शीतला माता मन्दिर तक क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का पुनः निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	6848390.00	6728543.17	09.09.2025	एस0आर0 कन्स्ट्रक्शन	I/F RP	**6719477.00**	**6047529.00**	**कार्य पूर्ण।**
18	44	वार्ड नं0–44 सुहाग नगर सेक्टर–03 मे कप्तान सिंह राजपूत के सामने स्थित राजेन्द्र प्रसाद हरित पट्टी वृक्षारोपण एवं सौन्दर्यीकरण कार्य।	1624111.00	1582371.35	09.07.2025	कपिल मोहन माहेश्वरी	I/F M	**1581232.00**	**1423109.00**	**कार्य पूर्ण।**
19	25	वार्ड नं0 25 मीरा चौराहे के पास सर्विस रोड से लिंक राधा किशन के प्लाट से कार्तिक ट्रान्सपोर्ट तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	2143478.00	2097393.22	03.09.2025	गर्ग इण्टरप्राइजेज	I/F M	**2044912.00**	**1840421.00**	**कार्य पूर्ण।**

20	44	वार्ड नं0 44 सुहाग नगर में टूटी बिल्डिंग से अशोक यादव होते हुए डाकखाने तक कच्ची साइड पटरी को इ0ला0 द्वारा पक्का करने एवं हॉटमिक्स व सी0सी0 द्वारा सड़क सुधार कार्य।	3284988.00	3196293.32	09.08.2025	अक्षत कन्सट्रक्शन	I/F M	**3138844.00**	**2824960.00**	**कार्य पूर्ण।**
21	45	वार्ड न0–45 दतौजी खुर्द मे बिजली घर से प्राथमिक विद्यालय तक दोनों साइड कच्ची पटरी को इ0ला0 द्वारा पक्का करने व साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	3882416.00	3723236.94	08.08.2025	अभिषेक कॉन्ट्रैक्टर	I/F M	**3713908.00**	**3342517.00**	**कार्य पूर्ण।**
22	44	वार्ड नं0 44 सुहाग नगर सुहाग नगर से0–03 में पार्श्वनाथ हलवाई से नरेन्द्र गुप्ता होते हुए खुराज सिंह व श्री देवी से अनिल कुमार व विमलेश से वन्दना तक सी0सी0 द्वारा सड़क सुधार कार्य।	1949471.00	1905607.90	31-12-2025	कपिल मोहन माहेश्वरी	M	**0.00**	**0.00**	**कार्य प्रारम्भ कराना है।**
23	64	सरकूलर रोड़ चौकी गेट सार्वजनिक शौचालय के पास से आगाशाह मस्जिद तक पूर्णतयः क्षतिग्रस्त गड्ढायुक्त साइड पटरी का पुनः निर्माण कार्य।	4194376.00	4064350.34	04.10.2025	सम्मन सिंह	A/M	**0.00**	**0.00**	**कार्य प्रगति पर**
24	62	वार्ड नं0 62 बम्बा नाला पटरी जेलर वाटिका से फौजी ट्रैडर्स तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य, इ0ला0 द्वारा साइट पटरी निर्माण व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	12486345.00	12267833.96	09.09.2025	पी0एस0आर0 इन्फाटेक	I/R RJ	**10447268.00**	**9402541.00**	**कार्य प्रगति पर**
25	13	वार्ड नं0 13 विभव नगर जलेसर रोड़ से विभव नगर पुलिस चौकी होते हुए कटारा के मकान एवं लिंक सडकों पर पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का हॉटमिक्स द्वारा पुनः निर्माण कार्य, इ0ला0 साइड़ पटरी निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	18136900.00	17647203.70	09.09.2025	अक्षत कन्स्ट्रक्शन	A	**0.00**	**0.00**	**कार्य प्रगति पर**
26	55	वार्ड नं0–55 बी0पी0एल0 रोड़ स्टार ट्रेबर्ल्स से तालाब तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य।	2432790.00	2337911.00	09.07.2025	अभिषेक कॉन्ट्रैक्टर	I/R RJ	**1600101.00**	**1440091.00**	**कार्य प्रगति पर**

27	3,5, 10	वार्ड नं0 3, 5 व 10 में रैपुरा रोड सर्विस रोड से बम्बा बाईपास तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का हॉटमिक्स द्वारा पुनः निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3081550.00	2989103.50	18.05.2025	एम0के0डी0 इन्फ्राटैक	I/R A	**1266537.00**	**1139883.00**	**कार्य प्रगति पर**
28	52.5 6.58 .60- 61	वार्ड नं0 52,56,58,60 व 61 में बसईया मस्जिद से रामगढ़ थाने तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य व कलर्ड इ0ला0 द्वारा साइड पटरी का निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	21197760.00	20775924.58	01.09.2025	सम्मन सिंह	I/R RP	**15320729.00**	**13788656.00**	**कार्य प्रगति पर**
29	55,5 8,60 ,63	वार्ड नं0 55, 58, 60 व 63 आकाशवाणी रोड बश्शन हॉस्पीटल से सरस्वती शिशु मन्दिर बम्बा बाईपास तक हॉटमिक्स द्वारा सड़क सुधार कलर्ड इ0ला0 द्वारा साईड पटरी का निर्माण एवं ट्री–गार्ड के साथ वृक्षारोपण का कार्य।	8192057.00	8002820.48	04.10.2025	अक्षत कन्सट्रक्शन	I/R RP	**3077189.00**	**2769470.00**	**कार्य प्रगति पर**
30	35	वार्ड नं0 35 मीरा चौराहो से लालऊ रोड तक आर0सी0सी0 नाली निर्माण एवं हॉटमिक्स द्वारा सड़क निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	25035806.00	24482514.69	03.10.2025	एम0के0डी0 इन्फ्राटैक	I/R RP	**8552639.00**	**0.00**	**कार्य प्रगति पर**
31	10	कोटला रोड़ पर बम्बा चौराहा तहसीलदार हलबाई की दुकान से रानी नगर नाला सड़क की दोनो तरफ कच्ची साइड पटरी को इ0ला0 द्वारा पक्का करने का कार्य।	16905520.00	16440618.20	09.09.2025	गायत्री इन्टरप्राइजेज	I/R RP	**15706596.00**	**0.00**	**कार्य प्रगति पर**
32	31	वार्ड न0–31 सुहाग नगर मे चट्टान सिंह की मार्केट से राजीव दीक्षित, जलनिगम कार्यालय से ओमप्रकाश गुप्ता तक हॉटमिक्स द्वारा सड़क सुधार, क्षतिग्रस्त गड्ढायुक्त साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 तथा ट्रीगार्ड के साथ वृक्षारोपण का कार्य तथा राजीव दीक्षित से ऋषि दिवाकर, मोनी से राजन यादव होते हुए विक्रम पचौरी तक सी0 सी0 द्वारा सड़क सुधार कार्य।	6690780.00	6516819.72	09.09.2025	अक्षत कन्सट्रक्शन	I/R M	**3958732.00**	**3562859.00**	**कार्य प्रगति पर**

8533

33	1	वार्ड नं0–1 रविदास नगर में मुन्नालाल से सी0एल0सी0 स्कूल होते हुए मरघटी तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य।	2634895.00	2529499.20	05.09.2025	अंजली इण्टरप्राइजेज	RP	**0.00**	**0.00**	**कार्य प्रगति पर**
34	35	वार्ड नं0 35 तहसील रोड़ बलदेव नगर में टोनी से डायमन्ड, अजन्ता प्रेस से संजय गुप्ता तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	6359075.00	6250970.73	01.09.2025	गायत्री इन्टरप्राइजेज	I/R RP	**4236874.00**	**3813187.00**	**कार्य प्रगति पर**
35	56	वार्ड नं0 56 मौ0 उर्दू नगर में बाल्मीक वाली गली में अंसार परचुनी वालों की दुकान से पानी की टंकी होते हुए मुगीना मेमोरियल स्कूल तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य	4233790.00	4126251.73	01.08.2025	रामकिशोर राठी कॉन्ट्रेक्टर	I/R RP	**1572053.00**	**1414848.00**	**कार्य प्रगति पर**
36	63-47	वार्ड नं0 63 व 47 में नैनी रोड कुरैशियान कब्रिस्तान से डा0 प्रमोद के मकान तक क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का पुनः निर्माण कार्य।	2344655.00	2291900.26	01.07.2025	एस0आर0 कन्स्ट्रक्शन	RP	**0.00**	**0.00**	**कार्य प्रगति पर**
37	20-29	वार्ड नं0 20, 29 ककरऊ कोठी चौराहे से टापाखुर्द पुलिया होते हुए शनिदेव ट्रेडर्स तक कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य, साइड डेबलपमेन्ट व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	17342360.00	17009386.68	27.08.2025	सम्मन सिंह	I/R RP	**15980828.00**	**14382745.00**	**कार्य प्रगति पर**
38	29	वार्ड नं0–29 में डाबर रोड से गोशाला की तरफ बम्बा पटरी एवं पटरी से लिंक नगला पानसहाय वाली रोड़ पर कच्चे मार्ग का सी0सी0 सड़क निर्माण कार्य, इ0ला0 द्वारा साइट पटरी निर्माण, ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	10667200.00	10391986.24	09.09.2025	सुधीर कुमार जैन कॉन्ट्रेक्टर	II/R RP	**9264598.00**	**8607084.00**	**कार्य प्रगति पर**
39	25	वार्ड नं0 25 ढोलपुरा बन्दर वाली पुलिया के पास भाव सिंह की मार्केट से आनन्द ग्लास तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का हॉटमिक्स द्वारा सड़क सुधार कार्य।	2179245.00	2113867.65	09.07.2025	एम0के0डी0 इन्फ्राटैक	I/F M	**2011823.00**	**0.00**	**कार्य प्रगति पर**

40	32	वार्ड न0–28 मे पथवारी माता मन्दिर से हिमायुपूर पुलिया तक गड्ढायुक्त मार्ग का हॉटमिक्स द्वारा सड़क सुधार एवं क्षतिग्रस्त साइड पटरी का सी0सी0 द्वारा पुनः निर्माण कार्य।	4081602.00	3971398.75	09.08.2025	अक्षत कन्सट्रक्शन	I/R M	**3363681.00**	**0.00**	**कार्य प्रगति पर**
41	15-17	वार्ड नं0 15 व 17 में दखल रोड़ पर सोबरन के मकान से सुमंगलम गैस्ट हाउस तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	3397180.00	3329236.40	03.06.2025	आर0आर0 कॉन्ट्रैक्टर्स	A	**0.00**	**0.00**	**कार्य प्रगति पर**
42	44	वार्ड नं0–44 सुहाग नगर सेक्टर–03 में फव्वारे वाले हरित पट्टी वृक्षारोपण एवं सौन्दर्यीकरण कार्य।	3671715.00	3530353.98	26.12.2025	रामकिशोर राठी कॉन्ट्रेक्टर	M	**0.00**	**0.00**	**कार्य प्रगति पर**
43	20	जलेसर रोड स्थित यू0पी0एस0 आई0डी0सी0 में औधोगिक क्षेत्र में मियावाकी पद्वति से वृक्षारोपण कार्य।	1102900.00	1047644.71	13.07.2025	महावीर ट्रैडर्स	A	**0.00**	**0.00**	**कार्य प्रगति पर**
44	49	वार्ड नं0 49 हनुमान रोड पर सरकूलर रोड से रामद्वार तक हॉटमिक्स द्वारा सड़क सुधार एवं नाली मरम्मत का कार्य।	5056183.00	4939385.17	04.09.2025	अक्षत कन्सट्रक्शन	M	**0.00**	**0.00**	**कार्य प्रगति पर**
45	12	वार्ड नं0 12 बम्बा बाईपास से एस0के0एस0 न्यूज व जोनल ऑफिस तक आर0सी0सी0 नाली एवं हॉटमिक्स द्वारा सड़क निर्माण एवं बम्बा नाला पर पुलिया निर्माण का कार्य।	5098980.00	4981193.56	05.09.2025	अक्षत कन्सट्रक्शन	II/R RP	**4410351.00**	**1638481.00**	**कार्य प्रगति पर**
46	25	वार्ड नं0 25 ढोलपुरा में मीरा चौराहे से सैन्ट जॉन्स स्कूल होते हुए सीताराम फैक्ट्री के पास तक हॉटमिक्स द्वारा सड़क सुधार कार्य।	5154494.00	5035425.18	04.09.2025	अक्षत कन्सट्रक्शन	I/R M	**3993806.00**	**3594425.00**	**कार्य प्रगति पर**
47	25	वार्ड न0–25 ढोलपुरा मे उमा ग्लास फैक्ट्री से महादेव मन्दिर के पास पुलिया होते हुए सेंट जोन्स रोड तक हॉटमिक्स द्वारा सड़क सुधार, कच्ची साइड पटरी को सी0सी0 एवं इ0ला0 द्वारा पक्का करने का कार्य।	18630128.00	18071224.16	09.09.2025	एम0के0डी0 इन्फ्राटैक	M	**0.00**	**0.00**	**कार्य प्रगति पर**

48	19-22	वार्ड नं0 19–22 में आसफाबाद फ्लाई ओवर के नीचे हॉटमिक्स द्वारा सड़क चौड़ीकरण एवं फ्लाई ओवर के नीचे व कच्ची साइड पटरी को इ0ला0 द्वारा पक्का करने का कार्य।	6789310.00	6585630.17	09.09.2025	एम0के0डी0 इन्फ्राटैक	I/R RP	**5474878.00**	**0.00**	**कार्य प्रगति पर**
49	27-30	वार्ड नं0–27 व 30 ऐकता नगर में गली नं0 06 वीदा यादव से पप्पू के प्लान्ट तक एवं उमेश चन्द्र व पोटीलाल के प्लान्ट से श्री निवास, अंकुर गुप्ता से अनिल गुप्ता एवं अमित गुप्ता से प्रेमपाल यादव तक सी0सी0 सड़क निर्माण कार्य।	3811296.00	3754888.82	01.08.2025	रामकिशोर राठी	II/R M	**3370042.00**	**3178607.00**	**कार्य प्रगति पर**
50	48	वार्ड नं0–48 लेबर कालोनी मे निहाल के सामने हरित पट्टी वृक्षारोपण एवं सौन्दर्यीकरण कार्य।	1155125.00	1140685.94	09.07.2025	महाम सेल्स	M	**0.00**	**0.00**	**कार्य प्रगति पर**
51	13	वार्ड नं0 13 मथुरा नगर में बिजली घर से रैहना की पुलिया तक हॉटमिक्स द्वारा सड़क सुधार कार्य।	4536486.00	4431693.17	04.09.2025	अक्षत कन्सट्रक्शन	I/F A	**4505771.00**	**0.00**	**कार्य प्रगति पर**
52	27-30	वार्ड नं0 27 व 30 पैमेश्वर गेट से आसफाबाद चौराहे तक कच्ची साइड पटरी को इ0ला0 द्वारा पक्का करने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	9861304.00	9550672.92	09.08.2025	एन0पी0 ट्रैडर्स	M	**0.00**	**0.00**	**पुनरीक्षित आगणन**
53	36	वार्ड नं0 36 मुरली नगर की पुलिया से सुहाग नंगर से0 4 होते हुए नन्नूमल के स्कूल तक पूर्णतयः क्षतिग्रस्त एवं गड्ढायुक्त मार्ग का सी0सी0 द्वारा पुनः निर्माण कार्य व कलर्ड इ0ला0 द्वारा साइड पटरी का निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	7586680.00	7366666.28	07.02.2026	अक्षत कन्सट्रक्शन	M	**0.00**	**0.00**	**कार्य प्रगति पर**
		कुल योग–	**330919107.00**	**322674228.46**					**141081827.70**	

नगर निगम फिरोजाबाद

नेशनल क्लीन एयर प्रोग्राम (N-CAP) वर्ष 2023–24 के अन्तर्गत प्रस्तावित कार्य। (PART- A)

Summary

S.No.	Description of Work	Quantity	Amount
1	कच्ची /क्षतिग्रस्त सड़कों व साइड पटरी का निर्माण एवं प्लांटेशन का कार्य।	15	9,19,07,363.00
2	पार्को का सौन्दर्यीकरण एवं वृक्षारोपण का कार्य।	2	16,99,545.00
3	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	985	40,67,680.00
4	**Design, Erection and Commissioning new Technology Based Gas Cremation System.**	1	1,01,40000.00
5	**Design, manufacture, supply, erection, testing and commissioning including comprehensive warranty maintenance for 5 years of 500 kW Grid Interactive Rooftop Solar Power Plant for captive use in SWM Plant chanaura in Firozabad City.**	1	2,64,99,480.00
	Total Amount		13,43,14,068.00
	Say Rs.		13.43(Cr)

Mayank 02/12/23
अवर अभियन्ता

02/12/23
अवर अभियन्ता

2/12/2023
सहायक अभियन्ता

02/12/23
अधिशासी अभियन्ता (सिविल)

2-12-23
नोडल(N-CAP)/मुख्य अभियन्ता

नगर निगम फिरोजाबाद

नेशनल क्लीन एयर प्रोग्राम (N-CAP) वर्ष 2023–24 के अन्तर्गत प्रस्तावित कार्य।

(Part –A)

FORM - J

(A) – कच्ची/क्षतिग्रस्त सड़कों व साइड पटरी का निर्माण एवं प्लांटेशन का कार्य।

S.No.	Description of Work	Length (Mtr)	Amount
1.	वार्ड नं0 –12 ककरऊ में प्रा0 विद्यालय मोड़ से ऐलान नगर पुलिया तक क्षतिग्रस्त मार्ग मे आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	450.00	6411251.00
2.	वार्ड नं0 18 अमृत नगर किशोरी लाल से सर्मन तक एवं नेकराम से श्रीकिशन तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	230.00	2542829.00
3.	वार्ड नं0 18 मौ0 मोहन नगर में बी0ए0एस0 स्कूल के बगल वाली गली व लिंक कच्ची गलियों में आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	506.00	5456097.00
4.	वार्ड नं0 19 शिव नगर में रघुवीर बघेल से मन्दिर व अमर सिंह ठाकुर होते हुए सरकारी ट्यूबैल तक नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	239.00	2035373.00
5.	वार्ड न0– 19 फुलवाड़ी मे राजाराम यादव के मकान से सन्त नगरध्अम्बेडकर तिराहा तक सी0 सी0 द्वारा सड़क सुधार, कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्री गार्ड के साथ वृक्षारोपण कार्य।	400.00	8283952.00
6.	वार्ड नं0 21 मरघटी रोड़ पर शिवराम राठौर से बिजय सिंह राठौर के मकान तक, राठौर धर्मशाल से शियाराम, कोमल सिंह से रंजीत, भगवान दास से राजपाल के मकान तक आर0सी0सी0 नाली, सी0सी0 द्वारा सड़क निर्माण व शिवराम राठौर से बिजय सिंह राठौर के मकान तक साइड पटरी पर	710.00	9516383.00

	इ0ला0 टाइल्स लगाने एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।		
7.	वार्ड नं0 21 शान्ती नगर में रामवीर कुशवाह के मकान से शिव नारायन के मकान होते हुए दिलीप प्रजापति के मकान तक, पप्पू गुप्ता के मकान से नरेश चन्द्र के मकान तक कच्ची गलियों में आर0सी0सी0 नाली एंव सी0सी0 सड़क निर्माण व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	280.00	3738504.00
8.	वार्ड नं0 29 बम्बा पटरी अनुराग सिंह से शालू ऑटो वाले की दुकान तक आर0सी0सी0 नाली निर्माण, सी0सी0 द्वारा सड़क निर्माण, इ0ला0 द्वारा साइट पटरी एवं साइड डेबलपमेन्ट व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	600.00	13364353.00
9.	वार्ड नं0 29 कोटला रोड़ नगला पानसहाय में शेर सिंह कुशवाह से सार्थक अकेडमी तक आर0सी0सी0 नाली, सी0सी0 द्वारा सड़क निर्माण व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	220.00	2823722.00
10.	मीरा चौराहा पर जयना रिसोर्ट (राइट हैण्ड साइड़) से महिन्द्रा कार शोरूम तक एवं बृजेश की बाउण्ड्री वॉल सें नगर निगम सीमा तक सर्विस रोड पर सी0सी0 सड़क एवं साइड पटरी पर कलर्ड इ0ला0 टाईल्स एवं ट्रीगार्ड के साथ वृक्षरोपण का कार्य।	500.00	12625756.00
11.	वार्ड नं0 36 नगला पचिया में रनवीर से विनोद वर्मा तक कच्चे रोड़ पर आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण व कलर्ड इ0ला0 के साथ फुटपाथ निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	200.00	3142594.00
12.	वार्ड नं0 44 सुहाग नगर में से0–02 अचल पैलेस के सामने अशोक मिश्रा से गीतम सिंह राठौर, सुभाष से कल्पना स्कूल, दिलीप इंजीनियर व मीना राजपूत वाली गली होते हुए रमेश चंचल के मकान तक नाली मरम्मत एवं सी0सी0 द्वारा सड़क सुधार कार्य।	705.00	5127766.00

13.	वार्ड नं0 45 दतौजी कलां में दतौजी चौराहा डा0 सुभाष की दुकान से पुलिया की ढलान तक कलर्ड स्ट्रिप के साथ इ0ला0 फुटपाथ निर्माण व हॉटमिक्स एवं ट्री–गार्ड के साथ व वृक्षारोपण का कार्य।	150.00	2375663.00
14.	वार्ड न0– 19 सन्त नगर के कन्हैया नगर मे शिवचरण से तलैया तक सी0 सी0 सड़क एवं दोनों साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0 ला0 व आर0 सी0 सी0 नाली निर्माण तथा साइड पटरी पर ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	170.00	9021268.00
15.	वार्ड नं0 62 हसमत नगर में शकीला नयीम हॉस्पीटल से आमीन होते हुए बम्बा बाईपास तक क्षतिग्रस्त रोड़ पर आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क एवं आर0सी0सी0 ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	400.00	5441852.00
	Total Part -A	**5760.00**	**9,19,07,363.00**

(B) – पार्को सौन्दर्यीकरण एंव झूला व वृक्षारोपण का कार्य।

S.No.	Description of Work	Length (Mtr)	Width (Mtr)	Amount
1.	वार्ड नं0 13 विभव नगर में सेन्टर पार्क का सौन्दर्यीकरण एंव झूला व वृक्षारोपण का कार्य।	37.00	58.00	1218654.00
2.	वार्ड नं0 13 विभव नगर में ट्यूबेल वाला पार्क का सौन्दर्यीकरण एंव झूला व वृक्षारोपण का कार्य।	60.00	24.00	480891.00
			Total	**16,99,545.00**

(C) – आर0सी0सी गमले आपूर्ति एवं पौधारोपण का कार्य।

S.No.	Description of Work	Quantity	Amount
1.	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	**985 Nos**	**40,67,680.00**
		Total	**40,67,680.00**

(D) – New Technology Based Gas Cremation System			
S.No.	**Description of Work**	**Quantity**	**Amount**
1.	Design, Erection and Commissioning new Technology Based Gas Cremation System.	1	1,01,40000.00
		Total	1,01,40000.00

(E) – Solar Power Plant			
S.No.	**Description of Work**	**Quantity**	**Amount**
1	Design, manufacture, supply, erection, testing and commissioning including comprehensive warranty maintenance for 5 years of 500 kW Grid Interactive Rooftop Solar Power Plant for captive use in SWM Plant chanaura in Firozabad City.	1	2,64,99 ,480.00
		Total	2,64,99,480.00
		GRAND TOTAL (A+B+C+D+E)	134314068.00
		SAY TATOAL IN (CR)	13.43 (Cr)

Mayank 02/12/23
अवर अभियन्ता

02/12/23
अवर अभियन्ता

2/12/2023
सहायक अभियन्ता

02/12/23
अधिशासी अभियन्ता (सिविल)

2-12-23
नोडल(N-CAP) / मुख्य अभियन्ता

अधि0 अभियन्ता/मुख्य अभियन्ता/नगर आयुक्त/जिलाधिकारी महोदय अध्यक्ष, (CLIC-NCAP)

उप सचिव पर्यावरण एवं वन मन्त्रालय भारत, सरकार के पत्र संख्या 16017-41-2019-CPA दिनांक 03.08.2023 के अन्तर्गत फिरोजाबाद शहर के लिए वायु गुणवत्ता सुधार हेतु 29.83 करोड़ की धनराशि का प्रविधान **NCAP** के अन्तर्गत किया गया है। उपरोक्त पत्र प्रस्तर संख्या 4 के अनुसार प्राविधानित धनराशि का 90 प्रतिशत चार किस्तों में निर्गत किया जाना है। जिसके क्रम में दो किस्तों में क्रमशः रूपये 67125000, रूपये 75000 एवं रूपये 67125000 इस प्रकार कुल धनराशि **रूपये 13,43,25,000.00** प्राप्त हो चुकी है। प्राविधानित धनराशि रूपये 29.83 करोड़ के सापेक्ष कुल रूपये **29.83 करोड़ धनराशि** की परियोजना तैयार की गयी है जो कि संलग्न है। परियोजना में पार्ट–ए के अन्तर्गत प्राप्त हो चुकी धनराशि के प्रस्ताव है व पार्ट–बी के अन्तर्गत प्रविधानित धनराशि के सापेक्ष प्राप्त होने वाली धनराशि के प्रस्ताव है। कार्यो का विवरण निम्नानुसार है :–

Summary (Part-A+Part-B)

PART- A

S.No.	Description of Work	Quantity	Amount (Cr)
1	कच्ची /क्षतिग्रस्त सड़कों व साइड पटरी का निर्माण एवं प्लांटेशन का कार्य।	15	9.190
2	पार्को का सौन्दर्यीकरण एवं वृक्षारोपण का कार्य।	2	0.169
3	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	985	0.406
4	Design, Erection and Commissioning new Technology Based Gas Cremation System.	1	1.014
5	Design, manufacture, supply, erection, testing and commissioning including comprehensive warranty maintenance for 5 years of 500 kW Grid Interactive Rooftop Solar Power Plant for captive use in SWM Plant chanaura in Firozabad City.	1	2.649
		Total	**13.428(Cr)**
		Say Rs. In (Cr)	**13.43(Cr)**

PART- B

S.No.	Description of Work	Quantity	Amount
1.	कच्ची /क्षतिग्रस्त सड़कों व साइड पटरी का निर्माण एवं प्लांटेशन का कार्य।	21	13.976
2.	वार्ड नं0 13 विभव नगर सेक्टर– 02 में दीक्षित पार्क में बाउण्ड्रीवाल, रेलिंग, पाथ–वे बैन्च, रंगाई–पुताई, झूला एवं वृक्षारोपण का कार्य।	1	0.250
3.	फिरोजाबाद नगर निगम सीमान्तर्गत मुख्य मार्गों एवं चौराहो पर आर0सी0सी गमले आपूर्ति एवं पौधारोपण व एक वर्ष अनुरक्षण का कार्य।	550 Nos	0.238
4.	Design, Erection and Commissioning new technology gas Based Animal carcass Plant. With small and big box.	1	1.694
5.	Supply of 5 Tractor With 5000 Ltr Water Tanker Mounted On Two Wheels Trailer and Battery Operated Selfstart as Well as Recoil Type Starting Portable Pump Set.	2	0.239
		Total Amount	**16.397 (Cr)**
		Say Rs. In (Cr)	**16.40(Cr)**
		Grand Total (Part-A+ Part-B)	**29.83 (Cr)**

यहा यह भी अवगत कराना है कि नोटिंग के परिपृष्ठ संख्या–15 पर जिलाधिकारी महोदय की टिप्पणी दिनांक 29.11.2023 के क्रम में आख्या निम्नवत् है :–

क्र. सं	टिप्पणी	आख्या
1	Proposed Work का कार्य किसी अन्य मद से तो नही कराया गया है?	प्रस्तावित कार्य किसी भी अन्य योजना में प्रस्तावित/स्वीकृत नही है।
2	क्या सभी कार्य PWD के SOR के अनुरूप Proposed किये गये है?	वर्ष 2023–24 हेतु Annual allocations धनराशि 29.83 करोड़ के सापेक्ष Part-A के प्रस्तावित सिविल कार्यो के क्रम संख्या 1 व 2 में लोक निर्माण विभाग की वर्तमान SOR की दरों का प्रयोग किया गया है। क्रम संख्या 3 में आपूर्ति कार्य हेतु SOR/DSR/न्यूनतम बाजार दरों का प्रयोग किया गया है। क्रम संख्या 4 पर प्रस्तावित कार्य पूर्व स्वीकृत बाजार दरों पर आधारित है। क्रम संख्या 5 पर प्रस्तावित कार्य यूपी नेडा की दरों पर बनाया गया है। एवं Part-B के प्रस्तावित सिविल कार्यो के क्रम संख्या 1 व 2 में लोक निर्माण विभाग की वर्तमान SOR की दरों का प्रयोग किया गया है। क्रम संख्या 3 में आपूर्ति कार्य हेतु SOR/DSR/न्यूनतम बाजार दरों का प्रयोग किया गया है। क्रम संख्या 4 पर प्रस्तावित कार्य बाजार दरों पर आधारित है तथा क्रम संख्या 5 पर प्रस्तावित कार्य में प्रयुक्त दरें जेम पार्टल पर आधारित है।

वर्ष 2023–24 हेतु Annual allocations धनराशि 29.83 करोड़ के सापेक्ष प्रस्ताावित कार्ययोजना CLIC-NCAP समिति के अनुमोदन उपरान्त PRANA Portal पर अपलोड किया जाना है, अतः उपरोक्तानुसार पृथक–पृथक कार्यो की स्वीकृति प्रदान करते हुए ई–निविदा आमन्त्रित किये जाने की अनुमति प्रदान करने का कष्ट करें। निविदा उपरान्त उपलब्ध धनराशि एवं अवशेष प्राप्त होने वाली धनराशि के सापेक्ष कार्यादेश निर्गत किये जायेगें। उपरोक्त कार्य वर्ष 2023–24 के अन्तर्गत ही पूर्ण किये जाने है।

कृत संस्तुति सहित अनुमोदनार्थ प्रस्तुत।

Mayank 2/12/23 (S.E)
सहायक अभियन्ता नगर निगम फिरोजाबाद

02/12/23
अधिशासी अभियन्ता नगर निगम फिरोजाबाद

2/12/2023
सहायक अभियन्ता (निर्माण) नगर निगम, फिरोजाबाद

02/12/23
अधिशासी अभियन्ता नगर निगम, फिरोजाबाद

2-12-23 C.E
मुख्य अभियन्ता नगर निगम, फिरोजाबाद

2/12/23
नगर आयुक्त नगर निगम, फिरोजाबाद

FNN/231/2025-AMC-FNN

I/172314/2025

ANNEXURE 5

प्रेषक,

सहायक नगर आयुक्त,
नगर निगम फिरोजाबाद।

सेवा में,

उपाध्यक्ष, आगरा विकास प्राधिकरण एवं
सदस्य–संयोजक, टी0टी0जैड0 प्राधिकरण,
आगरा।

पत्रांक 72 /सा0प्र0/2025–26 दिनांकः– 30/05/2025

विषयः– **'ताज ट्रैपेजियम जोन प्रदूषण (निवारण तथा नियंत्रण) प्राधिकरण' की 63वीं बैठक का कार्यवृत्त की अनुपालन आख्या के संबंध में।**

महोदय,

उपरोक्त विषयक स्वकीय पत्र संख्या–616/TTZ(PMU)/63वीं बैठक–TTZA/25 दिनांक 05.03.2025 का संदर्भ ग्रहण करने का कष्ट करें, जिसके द्वारा 'ताज ट्रैपेजियम जोन प्रदूषण (निवारण तथा नियंत्रण) प्राधिकरण' की 63वीं बैठक दिनांक 24.02.2025 को अपरान्ह् 04:00 बजे से मण्डलायुक्त महोदय, आगरा की अध्यक्षता में सम्पन्न बैठक के कायवृत्त में अपने विभाग से सम्बन्धित बिन्दुओं/प्रस्तरों पर समयबद्ध रूप से अक्षरशः अनुपालनीय कार्यवाही सुनिश्चित करते हुए वांछित अनुपालन आख्या उपलब्ध कराने की अपेक्षा की गयी है।

अतः उक्त के अनुपालन में नगर निगम फिरोजाबाद से सम्बन्धित बिन्दुओं/प्रस्तरों पर अनुपालनीय कार्यवाही सुनिश्चित करते हुए वांछित अनुपालन आख्या निम्नवत हैः–

क्र0सं0	कार्यवृत्त बिन्दु	अनुपालन आख्या
1	एजेण्डा बिन्दु–2.2.1. ताज ट्रैपेजियम क्षेत्रान्तर्गत नगर निगम/नगर पालिका परिषद/नगर पंचायतों द्वारा भविष्य में ठोस कूड़ा प्रबन्धन हेतु वाहन0 सी0एन0जी0 आधारित ही क्रय किये जायें, जिसके सम्बन्ध में समस्त जिलाधिकारीगण अपने स्तर से अधीनस्थ समस्त लॉकल बॉडीज को निर्देश जारी करते हुए टी0टी0जैड0 प्राधिकरण को भी करायें तथा यह भी परीक्षक कराया जाये कि वर्तमान में नगर निगम/नगर पालिका परिषद/नगर पंचायतों द्वारा किस प्रकार के वाहन क्रय किये जा रहे हैं।	शासनादेश सं0–390/TTZ(PMU)/NOTICE(SEC.5)/18 के अनुसार सहायक सम्भागीय परिवहन अधिकारी, फिरोजाबाद के पत्रांक–755/सा0प्र0/2020 दिनांक 13.05.2020 के अन्तर्गत 3000 कि0ग्रा0 से नीचे भारित केवल सी0एन0जी0/एल0एन0जी0 वाहन बी0एस0–6 श्रेणी के वाहन क्रय किये हैं। उक्त के अनुपालन में ताज ट्रैपेजियम क्षेत्रान्तर्गत नगर निगम फिरोजाबाद में डोर–टू–डोर सॉलिड वेस्ट कलैक्शन के अन्तगर्त 130 छोटे वाहन सी0एन0जी0 चालित क्रय किये गये हैं। भविष्य में सी0एन0जी0 चालित वाहन ही क्रय किये जायेंगे।
2	**एजेण्डा बिन्दु संख्या–2.4. ताज ट्रैपेजियम क्षेत्र में स्थित जनपदों की परिवेशीय वायु गुणवत्ता के संबंध में–**नगर आयुक्त, नगर निगम फिरोजाबाद द्वारा अवगत कराया गया कि नगर निगम सीमान्तर्गत छारबाग पर स्वर्गाश्रम पर विद्युत शवदाह गृह का कार्य पूर्ण हो गया है तथा नेशनल क्लीन एयर प्रोग्राम के तहत सत्य नगर टांपाकला में बम्बा बाईपास रोड पर गैस आधारित शवदाह गृह निर्माणाधीन है। गैस	नगर निगम फिरोजाबाद सीमान्तर्गत छारबाग पर स्वर्गाश्रम पर विद्युत शवदाह गृह का कार्य पूर्ण हो गया तथा एन–कैप के अंतर्गत सत्य नगर टापां कला में बम्बा बाईपास रोड पर गैस आधारित शवदाह गृह का 90 प्रतिशत कार्य पूर्ण हो गया है एवं शेष कार्य प्रगति पर है। शीघ्र ही कार्य पूर्ण किया जायेगा। शीतकाल ऋतु में गैस आधारित शवदाह गृह का संचालन प्रारम्भ करा दिया जायेगा।

	आधारित शवदाह गृह में एक प्रकार से पारम्परिक तरीकों का उपयोग करके ही शवदहन किया जाता है। प्रकरण पर परस्पर विचार–विमर्श उपरान्त निर्देश दिये गये कि– **ताज ट्रैपेजियम क्षेत्रान्तर्गत नॉन–अटेन्मेन्ट सिटीज के अन्तर्गत चिन्हित जनपद आगरा एवं फिरोजाबाद में ग्रेडेड रेस्पोन्स एक्शन प्लान (ग्रेप) का अनुपालन अन्य चिन्हित नॉन–अटेन्मेन्ट सिटीज की भाँति शीतकाल ऋतु में समस्त सम्बन्धित विभागों द्वारा सुनिश्चित किया जाये।**	
3	**एजेण्डा बिन्दु संख्या–2.4.6**–नगर निगम/नगर पालिका परिषद/नगर पंचायतों द्वारा कराए जा रहे निर्माण कार्यों में सी0 एण्ड डी0 वेस्ट मैनेजमेन्ट रूल्स–2016 का अनुपालन सुनिश्चित कराया जाये तथा अनुपालन न करने वाले संबंधित निविदादाता/ठेकेदारों पर भी जुर्माना लगाया जाये तथा मासिक सूचनायें टी0टी0जैड0 प्राधिकरण को प्रस्तुत की जाये।	नगर निगम फिरोजाबाद के निर्माण विभाग के पंजीकृत ठेकेदारों पर सी0 एण्ड डी0 वेस्ट मैनेजमेन्ट रूल्स 2016 का अनुपालन न करने पर धनांक 5,97,000.00 रू0 का अर्थदण्ड एवं धनांक 18,26,450.00 रू0 मलवा शुल्क वसूल किया गया है।
4	**एजेण्डा बिन्दु संख्या–2.4.8**–ताज ट्रैपेजियम क्षेत्रान्तर्गत संचालित पारम्परिक मोक्षधाम स्थलों को विद्युत शवदाह गृह में परिवर्तित करने की कार्यवाही विकास प्राधिकरण/नगर निगमों द्वारा सुनिश्चित की जाये। यदि सम्भव हो तो विकल्प के रूप में गैस आधारित शवदागृह में परिवर्तित किये जायें। आगामी बैठक में कृत कार्यवाही से अवगत कराया जाये।	नगर निगम फिरोजाबाद सीमान्तर्गत छारबाग स्वर्गाश्रम पर विद्युत शवदाह गृह का कार्य पूर्ण हो गया है एवं नेशनल क्लीन एयर प्रोग्राम के अंतर्गत सत्य नगर टापाकलां में बम्बा बाईपास रोड़ पर गैस बेस्ड शवदाह गृह निर्माणाधीन है।
5	**एजेण्डा बिन्दु संख्या–2.11.(4)** ताज ट्रैपेजियम क्षेत्रान्तर्गत क्रियावित्त समस्त निर्माण/विकास कार्यों के दौरान कन्स्ट्रक्शन एण्ड डिमोलिशन रूल्स–2016 एवं केन्द्रीय प्रदूषण नियंत्रण बोर्ड की गाइडलाइन्स ऑन डस्ट मिटीगेशन मेजर्स इन हैण्डलिंग कन्स्ट्रक्शन मैटेरियल एण्ड सी0 एण्ड डी0 वेस्ट का अनुपालन न पाये जाने की अवस्था में क्षेत्रीय अधिकारी, उ0प्र0प्र0नि0बो0, आगरा, मथुरा, फिरोजाबाद, अलीगढ़ एवं भरतपुर (राज0) द्वारा सम्बन्धित विभाग/कार्यदायी संस्थाओं पर पर्यावरणीय क्षतिपूर्ति अधिरोपित किये जाने के संबंध में निमयानुसार कार्यवाही सुनिश्चित की जाये। **नगर निगमों के द्वारा भी सी0 एण्ड डी0 वेस्ट रूल्स का अनुपालन न होने पर संबंधित विभाग/कार्यदायी संस्थाओं पर जुर्माना लगाया जाये। कृत कार्यवाही की सूचना क्षेत्रीय समस्त**	सूचना प्रारूप पर संलग्न कर प्रेषित है।

	नगर निगम प्रारूप पर प्रस्तुत की जाये।	
6	एजेण्डा बिन्दु संख्या–2.11.(4)–ताज ट्रैपेजियम क्षेत्रान्तर्गत समस्त नगर निगम परीक्षण कर लें कि शहर की पुरानी सड़कों को डस्ट–फ्री करने के क्या–क्या विकल्प/प्लान हो सकते हैं तथा रोड साइट पटरी को किस प्रकार से डस्ट फ्री किया जा सकता है। तद्नुसार नगर निगम द्वारा विस्तृत कार्य–योजना तैयार कर अगली बैठक में प्रस्तुत की जाये।	नगर निगम फिरोजाबाद के स्वास्थ्य विभाग द्वारा रोड साइट पटरी पर धूल की सफाई का कार्य 02 मैकानाइज्ड स्वीपिंग मशीन की सहायता से लगभग 60 कि0मी0 सड़क पर कराया जा रहा है। इसके अतिरिक्त साइट पटरी की सफाई हेतु मैनुअल स्वीपिंग भी कराई जाती है। धूल न उड़ने हेतु स्प्रिंकल मशीन की सहायता से पानी का छिड़काव कराया जाता है। नगर निगम फिरोजाबाद के निर्माण विभाग द्वारा वित्तीय वर्ष 2024–25 में नेशनल क्लीन एयर प्रोग्राम के अंतर्गत नगर निगम सीमान्तर्गत End to End pavement road, construction in earthen roads, Road resurfacing for Dust Mitigation, Green Space Development, Miyanwaki के कुल 58 कार्यों हेतु धनांक 32,86,41,869.00 रू0 के प्रस्तावों की कार्य–योजना जिलाधिकारी महोदय फिरोजाबाद के आदेश दिनांक 13.09.2024 के अनुमोदन उपरान्त निविदा आमंत्रित की गयी। धनराशि प्राप्त न होने के कारण कार्यादेश जारी नहीं किये जा सके। भारत सरकार के पत्र दिनांक 21.05.2025 के द्वारा नगर निगम फिरोजाबाद को एन–कैप के अंतर्गत धनांक 8.75 करोड़ रू0 अवमुक्त किये गये हैं। उक्त कार्यों के कार्यादेश जारी किये जा रहे हैं।
7	एजेण्डा बिन्दु सं0–5 (29.02.2020) मा0 सर्वोच्च न्यायालय में विचाराधीन रिट याचिका (सि0) संख्या–13381/1994 (एम0सी0 मेहता बनाम यूनियन ऑफ इण्डिया व अन्य) में विचाराधीन विभिन्न आई0ए0 पर संबंधित विभागों द्वारा प्रस्तावित/कृत कार्यवाही की समीक्षा के संबंध में– चर्चा उपरान्त निर्देश दिये गये कि– 1. गत बैठक के निर्णयानुसार रिट याचिका (सिविल) सं0–13381/1984–एम0सी0 मेहता बनाम यूनियन ऑफ इण्डिया व अन्य के अन्तर्गत किसी भी सरकारी विभाग/संस्था द्वारा कोई भी आई0ए0/प्रतिशपथ–पत्र/जबाव आदि टी0टी0जैड0 प्राधिकरण के बिना संज्ञान में लाये, मा0 सर्वोच्च न्यायालय में दाखिल न किया जाये अन्यथा की स्थिति में संबंधित अधिकारी स्वयं उत्तरदायी होंगे। गत बैठक के निर्णयानुक्रम में समस्त संबंधित विभागों द्वारा निर्धारित प्रारूप पर सूचनायें प्रस्तुत की जाये।	नगर निगम फिरोजाबाद द्वारा टी0टी0जैड0 प्राधिकरण, आगरा के बिना संज्ञान में लाये मा0सर्वोच्च न्यायालय, नई दिल्ली में विचाराधीन रिट याचिका (सि0) संख्या–13381/1994 (एम0सी0 मेहता बनाम यूनियन ऑफ इण्डिया व अन्य) के अन्तर्गत कोई भी आई0ए0/प्रतिशपथ–पत्र/जबाव आदि दाखिल नहीं किया गया है।
8	मुख्य एजेण्डा बिन्दु सं0–04 (25.04.2022) ताज ट्रैपेजियम क्षेत्रान्र्गत जनपद–फिरोजाबाद में कूड़ा न जलाये जाने के संबंध में–एजेण्डा के अनुसंग्नक–52 पर (निर्धारित प्रारूप पर) संलग्न संकलित सूचनाओं का अवलोकन करते	उक्त सूचना निर्धारित प्रारूप पर संलग्न कर प्रेषित।

	हुए, निम्न निर्देश जारी किये गये– 1. ताज ट्रैपेजियम क्षेत्र में किसी भी जगह सॉलिड वेस्ट/लेदर कटिंग आदि किसी भी स्थिति में जलता हुआ नहीं पाया जाये। संबंधित जेड0एस0ओ0/चीफ सेनेटरी इंस्पेक्टर का उत्तरदायित्व है कि उनके क्षेत्रान्तर्गत ऐसी प्रतिषिद्ध गतिविधि न हो। नगर आयुक्त, नगर निमग द्वारा स्वयं इसका सतत् अनुश्रवण सुनिश्चित किया जाये। संज्ञान में आने पर संबंधित जेड0एस0ओ0/चीफ सेनेटरी इंस्पेक्टर के विरूद्ध नियमानुसार कार्यवाही सुनिश्चित की जाये एवं कृत कार्यवाही की आख्या से टी0टी0जैड0 प्राधिकरण की अगली बैठक में अवगत कराया जाये।	

भवदीय

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Nihal Chand
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सहायक नगर आयुक्त,
नगर निगम फिरोजाबाद।

संख्या व तद्दिनांक

प्रतिलिपि :– मण्डलायुक्त/अध्यक्ष महोदया, टी0टी0जैड0प्राधिकरण, आगरा को सादर सूचनार्थ प्रेषित।

2. नगर आयुक्त महोदय, नगर निगम फिरोजाबाद को सादर सूचनार्थ प्रेषित।

सहायक नगर आयुक्त,
नगर निगम फिरोजाबाद।

Format for Penalty Imposed By Nagar Nigam Regarding Non-Compliance of C&D Waste Management Rules, 2016 (exclusing road dust)

दि.29-5-2025

			Action Taken upto Last meeting					Action Taken from last Meeting till now				
Sl.No	District	Departements	Name of Project	Penalty Imposed		Penalty Recovered Amount	Date of R.C. Issued	Name of Project	Penalty Imposed		Penalty Recovered Amount	Date of R.C. Issued
				Date	Amt.				Date	Amt.		
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Fir.	NN Fzd	सुभाष तिराहे से स्टेशन रोड़ तिकोनिया तक स्मार्ट रोड का निर्माण कार्य।	14.11.2023	100000.00	-	-	सुभाष तिराहे से स्टेशन रोड़ तिकोनिया तक स्मार्ट रोड का निर्माण कार्य।	14.11.2023	100000.00	-	-
2		NNFzd	वार्ड नं0 46 सुरेश कुशवाह के घर तक नाला पटरी की सी0सी0 सड़क द्वारा सड़क सुधार कार्य	02.11.2023	5000.00	-	-	वार्ड नं0 46 सुरेश कुशवाह के घर तक नाला पटरी की सी0सी0 सड़क द्वारा सड़क सुधार कार्य	02.11.2023	5000.00	-	-
3		NNFzd	वार्ड नं0 05 मौ0 अम्बेडकर नगर में रामवीर तारबाबू तक बी0एम0डब्ल्यू0 तक एवं अजय की दुकान से रघुवीर दरौगा के मकान तक क्षतिग्रस्त गली में सी0सी0 द्वारा सडक सुधार कार्य।	14.11.2023	10000.00	10000.00		वार्ड नं0 05 मौ0 अम्बेडकर नगर में रामवीर तारबाबू तक बी0एम0डब्ल्यू0 तक एवं अजय की दुकान से रघुवीर दरौगा के मकान तक क्षतिग्रस्त गली में सी0सी0 द्वारा सडक सुधार कार्य।	14.11.2023	10000.00	10000.00	-
4		NNFzd	वार्ड नं0 29 कमला नगर में कोटला रोड़ से भारत एकेडमी तक जलनिकासी हेतु आर0सी0 ड्रीप ड्रेन	14.11.2023	10000.00	10000.00		वार्ड नं0 29 कमला नगर में कोटला रोड़ से भारत एकेडमी	14.11.2023	10000.00	10000.00	-

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			का निर्माण काय एवं एल0एन0 बघेल से कान्तप्रसाद तक कच्ची गली में आर0सी0सी0 नाली व कलर्ड स्ट्रिप के साथ इ0ला0 सड़क निर्माण कार्य।					तक जलनिकासी हेतु आर0सी0 ड्रीप ड्रेन का निर्माण काय एवं एल0एन0 बघेल से कान्तप्रसाद तक कच्ची गली में आर0सी0सी0 नाली व कलर्ड स्ट्रिप के साथ इ0ला0 सड़क निर्माण कार्य।				
5		**NNFzd**	सड़क पर मलवा	**वित्तीय वर्ष 2023–24**	**732300.00**	-	-	सड़क पर मलवा	**वित्तीय वर्ष 2023–24**	**732300.00**	-	-
				वित्तीय वर्ष 2024–25	**735300.00**				**वित्तीय वर्ष 2024–25**	**735300.00**		
				वित्तीय वर्ष 2025–26	**358800.00**				**वित्तीय वर्ष 2025–26**	**358850.00**		
				कुल योग–	**1826450.00**				**Total**	**1826450.00**		

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पी. डब्लू. डी.
लिपिक
नगर निगम
फिरोजाबाद

सहायक अभियन्ता (निर्माण)
नगर निगम, फिरोजाबाद

29-05-25
मुख्य अभियन्ता
नगर निगम, फिरोजाबाद

Penalty Imposed by Nagar Nigam Regarding Road Dust

Date-29-05-2025

Sl. No.	District	Departments	Name of Road	Road Length for which Penalty Imposed till now	Penality Imposed		Penality Recovered Amount	Date Of R.C. Issued	Remark
					Date	Amt.			
1	2	3	4	5	6	7	8	9	10
1.	FZD	Nagar Nigam Firozabad	वार्ड नं0 35 नगला भाऊ में सर्विस रोड से फायर ब्रिगेड तक रोड़ की कच्ची साइट पटरी पर कलर्ड इ0ला0 लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	70.00	27-10-2023	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–1995/199498 द्वारा जमा किया गया है।
2.			वार्ड नं0 35 में तहसील मोड़ (कृपाल सिंह के मकान) से मुकुट सिंह के मकान तक क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क निर्माण एवं साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	150.00	30-10-2023	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10,000.00 रू0 रसीद नम्बर–1995/199487 द्वारा जमा किया गया है।
3.			वार्ड नं0 12, 35 व 38 की साइड नगला भाऊ सर्विस रोड से झील की पुलिया तक रहना नाला पटरी पर क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क सुधार, कच्चे भाग में कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	250.00	18-10-2023	30000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 30,000.00 रू0

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डब्लू. डी. लिपिक
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सहायक अभियन्ता (निर्माण)
नगर निगम, फिरोजाबाद

									रसीद नम्बर–1995 / 199495 द्वारा जमा किया गया है।
4.			वार्ड नं0 11 व 33 की साइड कैप्टन देवेश कुलश्रेठ द्वार से झील की पुलिया तक नाला पटरी पर क्षतिग्रस्त सड़क पर हॉटमिक्स द्वारा सड़क सुधार, कच्चे भाग में कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	220.00	18-10-2023	20000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 20,000.00 रू0 रसीद नम्बर–1995 / 199488 द्वारा जमा किया गया है।
5.			झील की पुलिया से कृष्णा नगर पुलिया होते हुए ककरऊ कोठी चौराहे तक जलेसर रोड की दोनों साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने, डिवाडर मरम्मत व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	225.00	18-10-2023	20000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 20,000.00 रू0 रसीद नम्बर–1995 / 199489 द्वारा जमा किया गया है।
6.			वार्ड नं0 44 सुहाग नगर में पुलिस सहायता केन्द्र से कल्पना आई0टी0आई0 तक दोनों साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 नाला मरम्मत तथा साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लनाने का कार्य।	300.00	25-10-2023	25000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 25,000.00 रू0 रसीद नम्बर–2116 / 211503 द्वारा जमा किया गया है।
7.			वार्ड नं0 13 विभव नगर गेट से टंकी वाले अमृत पार्क तक सड़क के दोनों ओर साइड पटरी पर नाली मरम्मत व कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	145.00	24-10-2023	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे

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लिपिक
नगर निगम

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नगर निगम, फिरोजाबाद

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									धनांक 10,000.00 रू0 रसीद नम्बर–2116/211501 द्वारा जमा किया गया है।
8.			वार्ड नं0 17 व 10 में लोक माता अहिल्याबाई होल्कर की प्रतिमा से दखल होते हुए बम्बा बाईपास रोड तक कोटला रोड की दोनों कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	130.00	24-10-2023	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10,000.00 रू0 रसीद नम्बर–1995/199496 द्वारा जमा किया गया है।
9.			नगला बरी चौराहे से बम्बाबाई पास सैलई पुलिया तक साठ फुटा रोड पर क्षतिग्रस्त/कच्ची दोनों साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	280.00	02-11-2023	25000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 25,000.00 रू0 रसीद नम्बर–1995/199497 द्वारा जमा किया गया है।
10.			वार्ड नं0 01 व 62 में बम्बा बाईपास सॉती रोड पुलिया से प्रताप नगर व अम्बे नगर तक सॉती रोड की दोनों क्षतिग्रस्त/कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	295.00	27-10-2023	30000.00			सम्बन्धित ठेकेदार को अर्थदण्ड आरोपित करते हुए नोटिस जारी की गयी है। आगामी देयक से कटौती कर ली जायेगी।
11.			वार्ड नं0 35 व 38 में रहना नाला से महक जनरल स्टोर होते हुए महाकाल गार्डन के पास तक हॉटमिक्स द्वारा सड़क चौड़ीकरण, कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	500.00	25-10-2023	50000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 50,000.00 रू0 रसीद नम्बर–2116/211502

29-5-2025
डब्लू. डी. लिपिक नगर निगम

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नगर निगम, फिरोजाबाद

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									द्वारा जमा किया गया है।
12.			वार्ड नं0 35 में टोनी बाबू की बाउण्ड्री से मीरा चौराहा मोड़ (मॉ संतोषी ट्रेडर्स) तक हॉटमिक्स द्वारा सड़क चौड़ीकरण, कच्ची साइड पटरी पर कलर्ड इ0ला0 टाईल्स लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	250.00	02-11-2023	25000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 25,000.00 रू0 रसीद नम्बर–1995/199490 द्वारा जमा किया गया है।
13.			वार्ड नं0 19 सन्त नगर फुलवाडी में महेश आटा चक्की से फतेहाबाद रोड़ तक सी0सी0 द्वारा सड़क सुधार, साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0, नाली मरम्मत तथा साइड पटरी पर वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	160.00	02-11-2023	20000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 20,000.00 रू0 रसीद नम्बर–1995/199493 द्वारा जमा किया गया है।
14.			वार्ड नं0 19 पैमेश्वर गेट सांई मन्दिर से फतेहाबाद रोड़ तक साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 लगाने तथा वृक्षारोपण एवं ट्रीगार्ड लगाने का कार्य।	150.00	02-11-2023	20000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 20,000.00 रू0 रसीद नम्बर–1995/199500 द्वारा जमा किया गया है।
15.			वार्ड नं0 45 दतौजी कला में राधे राधे के मकान से सोबरन सिंह के मकान तक साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 लगाने तथा साइड पटरी पर वृक्षारोपण एंव ट्रीगार्ड लगाने का कार्य।	100.00	27-10-2023	8000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे

डब्लू. डी.
लिपिक
नगर निगम

सहायक अभियन्ता (निर्मा.1)
नगर निगम, फिरोजाबाद

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									धनांक 8000.00 रू0 रसीद नम्बर–1995/199499 द्वारा जमा किया गया है।
16.			वार्ड नं0 41 कोटला चुंगी से पारसनाथ मार्केट के पास पार्क तक कलर्ड स्ट्रिप के साथ इ0ला0 द्वारा साइड पटरी का सुधार तथा ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	50.00	27-10-2023	2500.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 2500.00 रू0 रसीद नम्बर–1995/199492 द्वारा जमा किया गया है।
17.			वार्ड नं0 12 ककरऊ में परी सटरिंग वाले से महेन्द्र सिंह यादव के मकान तक क्षतिग्रस्त मार्ग में नाली मरम्मत सी0सी0 द्वारा सडक निर्माण कार्य।	300.00	17-05-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211528 द्वारा जमा किया गया है।
18.			वार्ड नं0 21 शान्ती नगर में रामवीर कुशवाह के मकान से शिवनरायन के मकान होते हुए दिलीप प्रजापति के मकान तक पप्पू गुप्ता के मकान से नरेश चन्द्र के मकान तक कच्ची गलियों में आर0सी0सी0 नाली एवं सी0सी0 सडक निर्माण कार्य।	280.00	17-05-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211529 द्वारा जमा किया गया है।
19.			वार्ड नं0 19 बरी चौराहे के पास सत्य प्रकाश से विश्नू के मकान तक व पं0 निर्मल चन्द्र शर्मा वाली गली एवं विक्रम पण्डित से दिलीप सिंह तक नाली एवं सी0सी0 द्वारा सडक निर्माण कार्य।		17-05-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211530 द्वारा जमा किया गया है।

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20.			वार्ड नं0 12 लक्ष्मी नगर में आर0सी0 रिर्सोट से हरिओम यादव के मकान तक कच्ची रोड पर आर0सी0सी0 नाली व सी0सी0 सडक निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	250.00	18-05-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211531 द्वारा जमा किया गया है।
21.			वार्ड नं0 35 इन्द्रा नगर रहना में नानक चन्द्र अग्रवाल की कोठी से रमेश चन्द्र आटा चक्की वाले त सी0सी0 द्वारा सडक सुधार कार्य।		21-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211532 द्वारा जमा किया गया है।
22.			वार्ड नं0 25 में ठार ढोलपुरा में जनक वाटिका से अनवनीश के मकान तक क्षतिग्रस्त नाला सुधार व नाले की दीवार को आर0सी0सी0 द्वारा ऊँचा करने का कार्य।		21-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211533 द्वारा जमा किया गया है।
23.			वार्ड नं0 02 नगला मिर्जा में विनोद से स्वामी दास सतसंगी, ओमकार से बबलू, रमेष चन्द्र से भूरी की चक्की तक नाली मरम्मत व सी0सी0 द्वारा सडक सुधार कार्य।		21-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211534 द्वारा जमा किया गया है।
24.			वार्ड नं0 18 पुलिस चौकी के बगल में मदन के घर तक तथा राजकुमार से बासुदेव तक नाली मरम्मत एवं सी0सी0		21-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के

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			द्वारा सडक निर्माण कार्य।						कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211535 द्वारा जमा किया गया है।
25.			वार्ड नं0 17 दखल में गंगा सिंह से संजय लाला के मकान तक आर0सी0सी0 नाली व सी0सी0 सडक निर्माण कार्य।		21-05-2024	3000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 3000.00 रू0 रसीद नम्बर–2116/211536 द्वारा जमा किया गया है।
26.			वार्ड नं0 64 मौ0 होली वाली भट्टी मे हाजी शब्बीर से मोती मस्जिद होते हुए मेहदी हसन तक नाली मरम्मत व सी0सी0 द्वारा सडक सुधार कार्य।		22-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211537 द्वारा जमा किया गया है।
27.			वार्ड नं0 14 प्रेम नगर डाक बंगला में मिमन से मायादेवी इण्टर कॉलेज तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सडक सुधार कार्य।		22-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211538 द्वारा जमा किया गया है।
28.			वार्ड नं0 31 सुहाग नगर में टीपू गुप्ता उर्फ कल्लू से ओमप्रकाश सुपारी वाले तक व चाइल्ड डवलपमेन्ट सेन्टर के सामने वाली सडक के फुटपाथ का कलर्ड स्ट्रिप के साथ इ0ला0 द्वारा सडक निर्माण कार्य नाली मरम्मत व हॉटमिक्स		22-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे

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			द्वारा सडक सुधार कार्य के साथ इ0ला0 द्वारा सडक फुटपाथ का निर्माण कार्य।						धनांक 5000.00 रू0 रसीद नम्बर–2116/211539 द्वारा जमा किया गया है।
29.			वार्ड नं0 18 अमृत नगर किशोरी लाल से सरमन तक एवं नेकराम से श्री किशन तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सडक निर्माण कार्य।	230.00	22-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211540 द्वारा जमा किया गया है।
30.			वार्ड नं0 09 जलेसर रोड रमेश प्रजापति से शारदा तिवारी अशोक टेलर्स राजेश मथुरिया नरेश वाली गली में सी0सी0 द्वारा सडक सुधार कार्य।		24-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211541 द्वारा जमा किया गया है।
31.			वार्ड नं0 18 छारबाग खेरे वाली माता के पास में दिनेश प्रेमपाल मुकेश, जयप्रकाश वाली गलियों में आर0सी0सी0 नाली एवं सी0सी0 द्वारा सडक निर्माण कार्य।		24-05-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211542 द्वारा जमा किया गया है।
32.			वार्ड नं0 58 आकाशवाणी रोड गली नं0 34 गम्मो की चक्की से जहीर होते हुए शब्बीर के मकान तक क्षतिग्रस्त व कच्चे मार्ग पर नाली मरम्मत व सी0सी0 द्वारा सडक निर्माण कार्य।		24-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211543 द्वारा जमा किया गया है।

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33.			वार्ड नं0 45 दतौजी कला में राधे राधे के मकान से सोबरन सिंह के मकान तक साइड पटरी पर कलर्ड स्ट्रिप के साथ इ0ला0 लगाने तथा साइड पटरी पर वृक्षारोपण एंव ट्रीगार्ड लगाने का कार्य।		24-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211544 द्वारा जमा किया गया है।
34.			वार्ड नं0 35 नगला भाऊ में सर्विस रोड से फायर ब्रिगेड तक रोड़ की कच्ची साइट पटरी पर कलर्ड इ0ला0 लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।		25-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211545 द्वारा जमा किया गया है।
35.			वार्ड नं0–44 सुहाग नगर में सेक्टर नं0–02 अचल पैलेस के सामने अशोक मिश्रा से गीतम सिंह राठौर सुभाष से कल्पना स्कूल दिलीप इंजीनियर व मीना राजपूत वाली गली होते हुए रमेश चंचल के मकान तक नाली मरम्मत एवं सी0सी0 द्वारा सड़क सुधार कार्य।	705.00	25-05-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211546 द्वारा जमा किया गया है।
36			वार्ड नं0– 25 नगला भाऊ उमा कारखाने से जी0टी0 की पुलिया तक सी0सी0 सड़क निर्माण, कलर्ड इ0ला0 द्वारा साइड पटरी, साइड डेबलपमेन्ट का निर्माण एवं आर0 सी0सी0 ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	450.00	28-05-2024	15000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211547 द्वारा जमा किया गया है।
37			वार्ड नं0 –18 मौ0 मोहन नगर में वी0वी0एस स्कूल वाली गली व लिंक गलियों में आर0सी0सी0 नाली एवं	506.00	28-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के

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			सी0सी0 द्वारा सड़क सुधार कार्य।						कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211548 द्वारा जमा किया गया है।
38			वार्ड नं0–22 मौ0 गुरू देव नगर में नानक चन्द्र के मकान से उमेश यादव के मकान से होते हुए वकील साहब के मकान से मकान तक नाली मरम्मत व सी0सी0 सड़क निर्माण कार्य।		29-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211549 द्वारा जमा किया गया है।
39			वार्ड नं0–28 हिमांयूपुर में राजवीर से केशव तक एवं नाले की साइड पटरी पर स्थित ट्यूबवैल से गुड्डू राठौर तक व शिवचरन राठौर से बेबी तक तथा रामसनेही से सोनू तक नाली		30-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211550 द्वारा जमा किया गया है।
40			वार्ड नं0 12 लक्ष्मी नगर में गोविन्द फौजी के मकान से दिनेश मास्टर के मकान तक, उमेश के मकान से आनन्द के मकान तक, गुप्ता जी के मकान से राजेश के मकान तक, रामे यादव से शिवकुमार के मकान तक कच्ची गलियों में आर0सी0सी0 नाली व सी0सी0 द्वारा सड़क निर्माण एवं गोविन्द फौजी के मकान से दिनेश मास्टर के मकान तक कलर्ड इ0ला0 के साथ फुटपाथ निर्माण एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	600.00	30-05-2024	20000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 20000.00 रू0 रसीद नम्बर–2116/211551 द्वारा जमा किया गया है।
41			वार्ड नं0 18 अमृत नगर बन्टी से फतेहाबाद रोड तक आर0सी0सी0 नाली एवं सी0सी0 द्वारा सड़क निर्माण कार्य।	210.00	30-05-2024	7500.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित

24-6-2025
डब्लू. डी.
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नगर निगम

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नगर निगम, फिरोजाबाद

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									करते हुए नोटिस जारी किया गया था। जिसे धनांक 7500.00 रू0 रसीद नम्बर–2116/211552 द्वारा जमा किया गया है।
42			वार्ड नं0 68 हाजीपुरा अख्तर से अन्नू उमर से समीम कमरूद्दीन से अतुर रहमान इशाक से इकबाल तक नाली मरम्मत एवं सी0सी0 द्वारा सडक सुधार कार्य।		30-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211553 द्वारा जमा किया गया है।
43			वार्ड नं0 59 साठ फुटा रोड पर सफी मास्टर से बारशी मस्जिद होते हुए खलील के मकान तक नाली मरम्मत एवं सी0सी0 द्वारा सडक सुधार कार्य।		30-05-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211554 द्वारा जमा किया गया है।
44			वार्ड नं0 45 नगला विश्नू में संजू साउण्ड से सतीश पवन होते हुए बीटू मेडीकल तक नाली मरम्मत एवं सी0सी0 द्वारा सडक सुधार कार्य।		01-06-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211555 द्वारा जमा किया गया है।
45			वार्ड नं0 57 कश्मीरी गेट में जलालो से जहीर हुसैन खालिद से एम0एल0ए0 अयूब तक हाजी इकबाल से साकाब तक हाजी फरमान के मकान से कल्लू के मकान तक क्षतिग्रस्त नाली मरम्मत एवं सी0सी0 द्वारा सडक सुधार कार्य।		01-06-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद

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									नम्बर–2116/211556 द्वारा जमा किया गया है।
46			वार्ड न0– 18 अमृत नगर मे सामरे से गीतम सिंह, लखमी चन्द्र से दुर्गेश, जयप्रकाश से कृष्णकान्त, सौरभ से प्लॉट, गीतम सिंह से रामवीर एवं अन्य कच्ची लिंक गलियों मे नाली निर्माण एवं सी0 सी0 द्वारा सड़क निर्माण कार्य।	600.00	04-06-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211557 द्वारा जमा किया गया है।
47			वार्ड नं0 35 आनन्दीपुरम में श्री केदार नाथ ट्रेडर्स अमित जैन के मकान तक कच्ची गली में आर0सी0सी0 नाली व सी0सी0 द्वारा सडक निर्माण कार्य।		06-06-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211558 द्वारा जमा किया गया है।
48			वार्ड नं 19 मौ0 फुलवाडी रामप्रताप वर्मा से अमर सिंह वर्मा होते हुए रामा देवी तक एवं महेन्द्र वर्मा वाली गली मे आर0सी0सी0 नाली व सी0सी0 द्वारा सडक निर्माण कार्य।		10-06-2024	3000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 3000.00 रू0 रसीद नम्बर–2116/211559 द्वारा जमा किया गया है।
49			वार्ड नं0 21 मौ0 लालपुर प्रेमनगर में कालीचरन से श्रीकान्त तक आर0सी0सी0 नाली व सी0सी0 द्वारा सडक निर्माण कार्य।		10-06-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211560 द्वारा जमा किया गया है।

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फिरोजाबाद

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नगर निगम, फिरोजाबाद

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50			वार्ड नं0 54 चिस्ती नलगर बम्बा पर ऐतराम अली से इसाद प्रधान तक सलीम मंसूरी से बन्ने खां के मकान तक नाली मरम्मत व सी0सी0 सडक सुधार कार्य।		19-06-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211562 द्वारा जमा किया गया है।
51			वार्ड नं0 40 कुम्हारों वाली गली में मन्दिर से अरविन्द गुप्ता, अजय वर्मा से बल्लों वर्मा तक वेदप्रकाश से शमशाद तक धर्मपाल दिवाकर		20-06-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2116/211563 द्वारा जमा किया गया है।
52			मीरा चौराहा पर जयना रिसोर्ट राइट हेन्ड साइड से महिन्द्र कार शोरूम तक एवं बृजेश की बाउण्ड्रीवाल से नगर निगम सीमा तक सर्विस रोड पर सीसी0 सडक मरम्मत एवं साइड पटरी पर कलर्ड इ0ला0 टाईल्स एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	500.00	29-06-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211564 द्वारा जमा किया गया है।
53			वार्ड नं0 01 ठारपुठा पुलिया से बम्बा नाला पटरी से सावित्री रिसोर्ट से आगे तक आर0सी0सी0 नाली निर्माण सी0सी0 द्वारा सडक निर्माण, साइड डेवलपमेन्ट व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	400.00	02-07-2024	10000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 10000.00 रू0 रसीद नम्बर–2116/211565 द्वारा जमा किया गया है।
54			वार्ड नं0 62 हसमत नगर में शकिला हॉस्पीटल से आमीन होते हुए बम्बा बाईपास तक क्षतिग्रस्त रोड पर	400.00	25-07-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के

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नगर निगम, फिरोजाबाद

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			आर0सी0सी0 नाली व सी0सी0 द्वारा सडक एवं आर0सी0सी0 नाली व सी0सी0 द्वारा सडक एवं आर0सी0सी0 ट्रीगार्ड के साथ वृक्षारोपण का कार्य।						कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर–2310/230927 द्वारा जमा किया गया है।
55			वार्ड नं0 19 गोवर्धन की ठार फतेहाबाद रोड माता मन्दिर से मुकुट सिंह तक सी0सी0 द्वारा सडक सुधार कलर्ड इ0ला0 द्वारा साइड पटरी एवं ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	215.00	01-08-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर– 2310/230961 द्वारा जमा किया गया है।
56			वार्ड नं0 33 मौ0 गणेश नगर में पुलिस चौकी सर्विस रोड से यादव की डेरी जैन नगर रोड तक नाली मरम्मत हॉटमिक्स द्वारा सडक चौडीकरण व दोनो साइड पटरी पर कलर्ड इ0ला0 लगाने व ट्रीगार्ड के साथ वृक्षारोपण का कार्य।	525.00	08-08-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनांक 5000.00 रू0 रसीद नम्बर– 2310/230984 द्वारा जमा किया गया है।
57			वार्ड नं0 20 मौहल्ला कृष्णा नगर में वीरेन्द्र प्लाजा के सामने प्रवीन से रामवीर तक एवं फौजी से वीरेन्द्र तिवारी तक कच्ची/क्षतिग्रस्त गलियों में नाली व कलर्ड स्ट्रिप के साथ इ0ला0 सड़क निर्माण कार्य।		27-12-2023	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनां0क 5000.00 रू0 रसीद नम्बर– 2116/211509 द्वारा जमा किया गया है।
58			वार्ड नं0 17 मायापुरी में देवाजी ट्रेडर्स से प्रदीप की फैक्ट्री तक कच्ची नाला पटरी पर आर0सी0सी0 नाली, हॉटमिक्स द्वारा सड़क निर्माण, वाइट पट्टी एवं इ0ला0 द्वारा साइट पटरी व ट्रीगार्ड के साथ वृक्षारोपण व सत्य नगर पुलिया से दखल	320.00	31-08-2024	3000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे

26-5-2025

लिपिक
नगर निगम

सहायक अभियन्ता (निर्माण)
नगर निगम, फिरोजाबाद

			की पुलिया तक नाले के दोनों ओर साइड डेबलपमेन्ट का कार्य।						धनां0क 3000.00 रू0 रसीद नम्बर– 2342/234106 द्वारा जमा किया गया है।
59			वार्ड नं0 45 दतौजी कलां में दतौजी चौराहा डा0 सुभाष की दुकान से पुलिया की ढलान तक कलर्ड स्ट्रिप के साथ इ0ला0 फुटपाथ निर्माण व हॉटमिक्स एवं ट्री–गार्ड के साथ व वृक्षारोपण का कार्य।	150.00	07-09-2024	5000.00			सम्बन्धित ठेकेदार को एनजीटी के गाइड लाइन का अनुपालन न करने के कारण अर्थदण्ड आरोपित करते हुए नोटिस जारी किया गया था। जिसे धनां0क 5000.00 रू0 रसीद नम्बर– 2342/234139 द्वारा जमा किया गया है।
			कुल योग	9916.00		5,97,000.00			

29-5-2025
पी. डब्लू. डी.
लिपिक
नगर निगम
फिरोजाबाद

सहायक अभियन्ता (निर्माण)
नगर निगम, फिरोजाबाद

29-05-25
मुख्य अभियन्ता
नगर निगम, फिरोजाबाद

8563

ताज ट्रैपेजियम क्षेत्र में म्यूनिसिपिल सॉलिड वेस्ट/लैदर कटिंग आदि जलाने के सम्बंध में की गयी कार्यवाही का विवरण

क्रं0 सं0	विभाग का नाम	जनपद	गत् बैठक तक म्यूनिसिपिल सॉलिड वेस्ट/लैदर कटिंग आदि जलाने पर की गयी कार्यवाही (दि0 01.04.2024 से 24.02.2025 तक)			गत् बैठक से अब तक म्यूनिसिपल सॉलिड वेस्ट/लैदर कटिंग आदि जलाने पर की गयी कार्यवाही (दि0 25.02.2025 से 16.05.2025 तक)		
			जुर्माना	एफ0आई0आर0	वसूली	जुर्माना	एफ0आई0आर0	वसूली
1	2	3	4	5	6	7	8	9
1	नगर निगम फिरोजाबाद	फिरोजाबाद	14	01	70000	01	0	5000

16/05/2025 16/05/2025 16/5/2025

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