PROJECT REPORT

Development of Empirical Models for Air Quality Parameters using instruments and geospatial technology in Haryana

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Development of Empirical Models for Air Quality Parameters Using Instruments and Geospatial Technology In Haryana

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Project Background

Prominent concentration of air pollution and its associated health effects in rapidly growing megacities of developing countries particularly that of India and China have drawn our attention in recent years. Therefore, it is critically vital to monitor air quality at high spatial–temporal resolutions. But limited network of air pollution monitoring in developing countries restricts our ability to evaluate time–space dynamics of air pollution and its effect on human health. Nonetheless, advances in satellite remote sensing seems promising to compute indirect estimates of air particles ≤2.5 µm and those of >2.5 to ≤10 µm in aerodynamic diameters (PM2.5 and PM10, respectively) over a large area frequently and inexpensively (Chu et al. 2003). Satellite imageries record electromagnetic radiation, reflected/emitted from the earth surface. When the radiation travels through the atmosphere, it interacts with aerosols fine solid and/or liquid particles suspended in the air prior to reaching the sensor mounted onto satellites. The distortion caused by this interaction can be estimated with the aid of radiative transfer model and converted into aerosol loading, also known as aerosol optical depth (AOD), which has shown a strong positive relationship with the PM2.5 and PM10 observed on the surface (Chu 2006, Chu et al. 2002, Gupta et al. 2006).

Atmospheric aerosol has always been an important part in the scientific research of air quality and environment due to its role in global climatic and environmental changes. Atmospheric aerosol particles, particularly $PM_{2.5}$ (particle matter, PM) and PM_{10} also known as particle pollution is a complex but stable gaseous suspension of liquid droplets and solid particles in the earth's atmosphere. They reduce visibility and are serious hazards to human health. These are important indexes to evaluate air quality.

In recent years, Haryana has suffered from the deterioration of air quality with the development, rapid urbanization and industrialization. Fine particulate matter with an aerodynamic diameter less than 2.5 µm (PM2.5) was a major component of the severe air pollution. Many epidemiological studies showed that $PM_{2.5}$ is associated with various adverse human health effects, such as respiratory problems and cardiovascular diseases, and can penetrate into human lungs and bronchi. The economic costs of particulate pollution on a country can be significant. Air pollution not only affects the health of living being but also the health of the economy of

countries. In the European Union in 2015, the cost of air pollution-related deaths was reported to be over US$1.4 trillion. In Israel, it is estimated that 2500 people a year die as a result of exposure to air pollutants. In New Zealand with the population of 4/4 million, it was reported that, despite relatively low air pollution when compared with other members of the Organisation for Economic Co-operation and Development, during 2012 a total of 1370 deaths, 830 hospital admissions and 2.55 million restricted activity days were linked to PM_{10} pollution. Even low levels of PM_{10} have been found to be affecting human health significantly (Soni, Payra, and Verma 2018).

As per a recent article in Hindustan Times it was stated that, due to high anthropogenic activities, a blanket of haze engulfed Haryana as several districts in the states reported air quality index in severe and very poor categories for the month of November – December 2019. Jind was the worst-affected with average air quality index (AQI) of 480, followed by Faridabad (479), Gurugram (469), Rohtak (467) Bhiwani (466), Sirsa (462), Hisar (458), Kaithal (448), Ballabhgarh (438), Bahadurgarh (435), Manesar (427), Panipat (421) and Karnal (407), all under severe category. National Ambient Air Quality Standards (NAAQS), Gazette of India, New Delhi, India, 2009, which is based on health impacts caused by air pollutants, the air quality is classified as Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe, the same is shown in Table 1.1.

Table 1.1. National Ambient Air Quality Index Standard (NAAQS), New Delhi 2009.

AQI	Associated Health Impacts
Good (0–50)	Minimal Impact
Satisfactory (51–100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101–200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor	May cause breathing discomfort to people on prolonged exposure, and

(201–300)	discomfort to people with heart disease
Very Poor (301–400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

Fine particles in general are estimated based on the correlation between AOD and ground-based PM2.5 (Engel-Cox et al. 2004, Hu et al. 2014). Many satellite instruments, such as the Moderate Resolution Imaging Spectroradiometer (MODIS), the multi-angle imaging spectroradiometer (MISR), the Medium Resolution Spectrum Imager (MERSI), and the Ozone Monitoring Instrument (OMI), have set bands to retrieve AOD (Xia et al. 2019, Ali et al. 2019, Jin et al. 2019, Zhang et al. 2015). Scholars proposed and improved a variety of methods, such as simple linear regression models, General Additive Model (GAM) models, General Linear Regression (GLR) models, and machine-learning methods, to establish the relationship between ground-level PM2.5 and AOD (Engel-Cox et al. 2004, Guo et al. 2017, Hu et al. 2014, Chu et al. 2016, Sorek-Hamer et al. 2013). Wang and Christopher (2003) used a very simple linear model to explain the relationship between AOD and PM2.5 in Jefferson County, Alabama, for 2002, and obtained an R value of 0.7 (Wang and Christopher 2003). Lee et al. (2011) used the LME model to estimate PM2.5 in the New England region for 2003 and obtained an R2 value of 0.92 (Lee et al. 2011). Hu et al. (2013) developed a GWR model to explain the relationships among PM2.5, AOD, meteorological parameters, and land-use information (Hu et al. 2013). Sorek-Hamer et al. (2013) used the GAM model to estimate PM2.5 over the San Joaquin Valley (CA) for 2013 and obtained an R2 value of 0.72 (Sorek-Hamer et al. 2013). Lary et al. combined AOD, meteorological data, and PM2.5 to estimate daily PM2.5 values from 1997 to 2014 using a machine-learning algorithm (Lary et al. 2014).

These types of studies have been carried out for the estimation of Particulate matter from satellite and AErosol RObotic NETwork (AERONET) based Aerosol Optical Depth (AOD). It has been explored in studies and resulting in estimation of PM2.5. In one of the study by Chen et al. where AERONET data been used for PM estimation with R2 value of 0.70 over Mid-Eastern China

(Chen et al. 2018). In our study we have used AERONET based ground AOD and CPCB based ground PM for the validation and accuracy analysis. Xie et al. estimated daily ground based PM2.5 over Beijing China with R2 of 0.82-0.83. The estimation was based on the temporal variation of PM with respect to satellite AOD (Xie et al. 2015). The basic monologue of our study is to try and explore the relationship between PM and AOD over Haryana state and also their impact and contribution in the atmospheric pollution.

Major Objectives

The prime objective of our study is

> **Generating empirical models for estimation of air quality parameters (mainly PM10 and PM2.5) over Haryana region.**

Additional outputs were obtained by adding three complementary objectives beyond the project scopes are:

> Temporal and spatial variation of particulate matter over Haryana for at least half a decade.

> Validation and Accuracy assessment of the empirical models generated with respect to ground-based PM and AOD collected over Haryana region.

> Utilise web facilities to propagate project outputs

Material and Methods

3.1   Study Area

The Haryana region is situated in north-central India. It is bounded on the northwest by the state of Punjab and the union territory of Chandigarh, on the north and northeast by the states of Himachal Pradesh and Uttarakhand, on the east by the state of Uttar Pradesh and the union territory of Delhi, and on the south and southwest by the state of Rajasthan. The city of Chandigarh, within the Chandigarh union territory, serves as the capital of not only that territory but also of the states of Haryana and Punjab. The geographical extent is between 27°39' to 30°35'

N latitude and between 74°28' and 77°36' E longitude. Geographical area of the state is 44,212 square km with a total population of 25,350,000. It has two major physiographic regions, the flat alluvial plain covering most of the state and is drained by only one perennial river, the Yamuna, located on the state's eastern border, In the northeast, a strip of the highly dissected Siwalik (Shiwalik) Range (including the narrow foothill zone), many seasonal streams flowing from the Siwalik Range pass through the area, however, the most notable of these is the Ghaggar (near the state's northern boundary), which once flowed far enough to join the Indus River, in what is now Pakistan. Remnants of the Aravalli Range, which stretches from south-western Rajasthan to Delhi, are evident in parts of southern Haryana. The climate of Haryana is hot in the summer and markedly cold in winter; maximum temperatures in May and June may exceed 43°C, and in January, the coldest month, low temperatures may drop below the freezing point. Therefore, this region is in arid to semiarid conditions; only in the northeast are conditions relatively humid.

Haryana is agrarian state of India and most of the people are engaged in the agriculture related activities. The major crops of Haryana include Wheat, Rice, Cotton, Sugarcane, Jawar, Bajara and Mustard among others. Most of the agriculture practices are mechanised in Haryana due to which the crop residue produced after harvest is left as such and is burnt in open field at later stage. Utilising mechanised farming practices and leaving crop residue in the field which get burnt and creates pollution. Furthermore, the region is a major industrial and commercial hub in India. Because of rapid economic development over the last two decades, high concentrations of aerosols with diverse properties are being emitted in the region. These pollutants may play a more significant role in urban regions and provide a unique opportunity for understanding the impact of environmental change on climate systems, especially in urban areas (Figure 3.1).

The state is also surrounded by the most populous states of India like Uttar Pradesh, Rajasthan, Delhi, and Chandigarh and these are characterised by industrial, vehicular and service sector pollution. Due to these reasons a huge amount of aerosol particles and other pollutants such as PM2.5, PM10, SO2, NO2, CO, CH4 among others get entered into the atmosphere with hazardous potential to pollute air and affect the health of millions of people residing in the state as well as in the neighbouring states. The Haryana state falls in Indo-Gangetic region which is always high in air pollutant concentration level. Looking in to the adversities of air pollution in the state, studies related to the pollutant assessment is must. However, with the current state of

[9]

art (i.e. the ground based stations) is limited, costly and not sufficient for the monitoring of air quality parameters for whole state. Satellite based proxy-parameters provide cost effective solution for this problem and therefore, explored in this study.
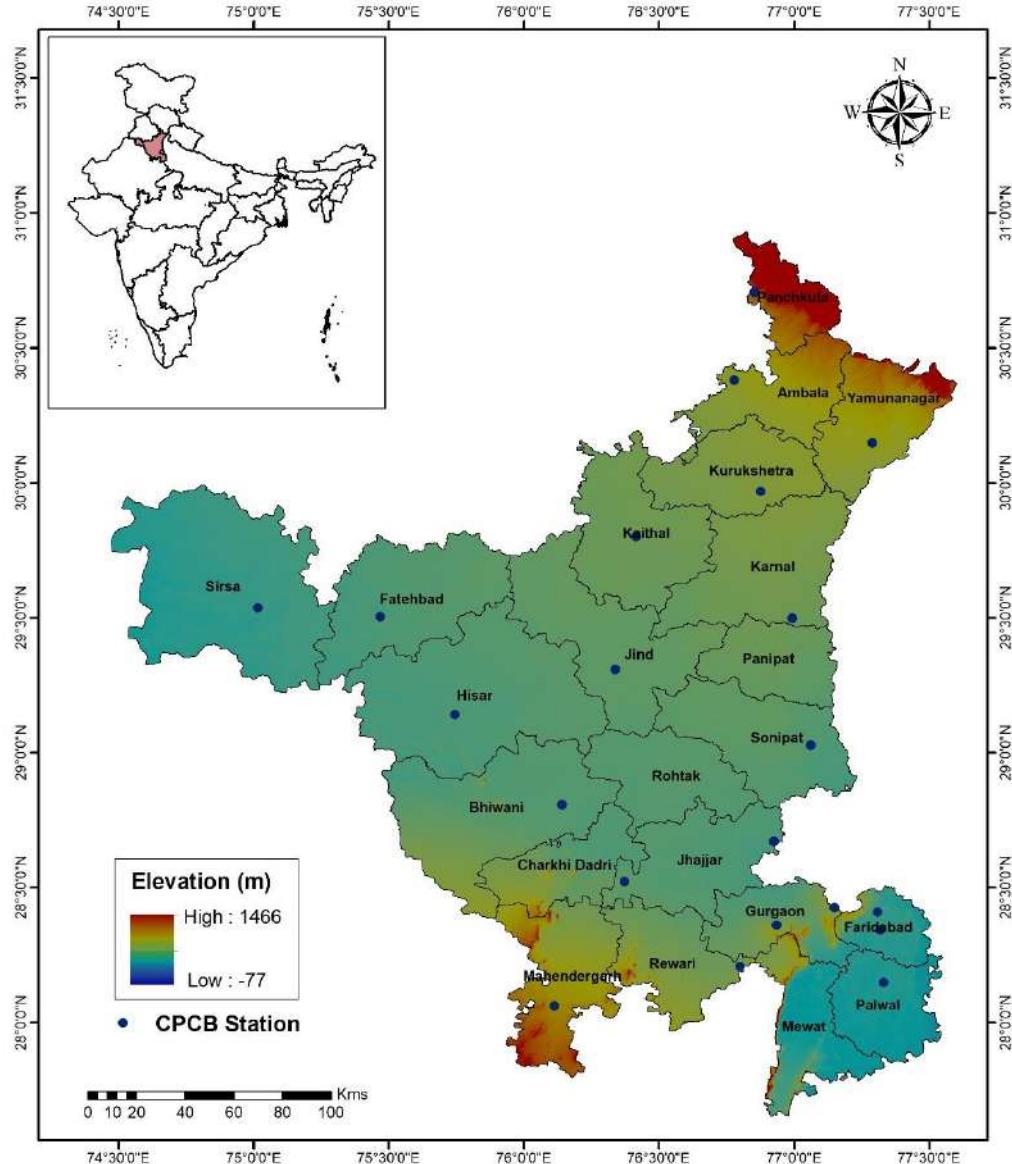
Figure 3.1. Study area (Haryana region)

3.2   Data Description

3.2.1   *Aerosol Optical Depth (satellite data)*

The MODIS Aerosol products monitor the ambient aerosol and some properties of the aerosol over cloud-free snow ice-free land and ocean surfaces. By using various spectral and spatial

[10]

observations provided by MODIS, multiple algorithms are applied to retrieve aerosol properties over diverse surfaces. Data from two different algorithms are provided over land, known as Deep Blue and Dark Target Land. A further Dark Target Ocean algorithm is applied over oceanic and inland waters. The primary data product from all of these is the aerosol optical depth (AOD, also known as aerosol optical thickness, AOT) at a wavelength of 550 nm. In addition, each algorithm provides selected additional information about the aerosol, such as single scattering albedo, spectral AOD, or descriptions of relative aerosol size, as well as quality assurance information.

There are two MODIS Aerosol product files: MODIS Level 2, containing data collected from the Terra platform available from year 2000 onwards and MODIS Level 2, containing data collected from the Aqua platform available from year 2002 onwards. Here we are using MODIS Level 2 3x3 km Terra data for our study, but why? For the answer, we further compare the two datasets i.e. MODIS Level 2 3x3 km and 10x10 km. The MODIS 3km product is based on the same algorithm as MODIS 10km and using the same Look Up Tables as the standard Dark Target aerosol product. Because of finer resolution, subtle differences are made in selecting pixels for retrieval.

The aerosol retrieval makes use of seven wavelength bands (listed in Table 4.1), and a number of other bands to help with cloud and other screening procedures.

Table 3.1. Characteristics of MODIS Channels used in the Aerosol Retrieval

Band #	Bandwidth (μm)	Weighted Central Wavelength (μm)	Resolution (m)	NeΔρ (x10^{-4})	Max ρ	Required SNR	Rayleigh optical depth
1	0.620-0.670	0.646	250	3.39	1.38	128	0.0520
2	0.841-0.876	0.855	250	3.99	0.92	201	0.0165
3	0.459-0.479	0.466	500	2.35	0.96	243	0.1948
4	0.545-0.565	0.553	500	2.11	0.86	228	0.0963
5	1.230–1.250	1.243	500	3.12	0.47	74	0.0037
6	1.628–1.652	1.632	500	3.63	0.94	275	0.0012
7	2.105–2.155	2.119	500	3.06	0.75	110	0.0004

[11]

Notes: Band #26 (1.38 µm channel) is used for cirrus correction; NeΔρ corresponds to the sun at zenith (θ= 0°).

The wavelength ranges included in Table 4.1 are estimates of the central wavelength in each band (obtained by integration of the channel-averaged response functions). To keep in line with common references in the aerosol, MODIS channels 1, 2, 3, 4, 5, 6 and 7 are having wavelength range of 0.66, 0.86, 0.47, 0.55, 1.24, 1.64 and 2.12 µm channels, respectively.

The MODIS Level 2 3x3 km data was retrieved for our project over Haryana region, the data was temporally collected for last 5 years i.e. 2016 to 2020. Daily data was targeted to carry out the work in the project domain. However, it was observed that the MODIS level 2 product were largely affected by cloud cover on daily scale. Thus, there is the need to utilise AOD products from other platform such as from Indian National Satellite (INSAT) which is available in a very high temporal scale (15 minutes) and may be effective in solving cloud related problem for some extent at least on a daily time scale.

3.2.2   Ground based PM2.5 and PM10

The 24 hourly PM2.5 and PM10 data used in this study were collected for 2016 to 2020 from Central Pollution Control Board (CPCB) sites. CPCB has automatic monitoring stations at various locations across the country. At these stations Respirable Suspended Particulate Matter (RSPM), Carbon Monoxide (CO), Ozone (O3), Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2) and Suspended Particulate Matter (SPM) are being monitored regularly. This information on Air Quality is updated every week. CPCB is also executing a nation-wide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of 779 operating stations covering 339 cities/towns in 29 states and 6 Union Territories of the country.

Particulate matter was mainly monitored using High Volume Sampler with size selective inlet for PM10 and PM2.5. The working principle of this instrument is that the air is sampled at a Calibrated flow-measuring device to control the airflow at 1132 l/min, and the mass concentrations of PM10 and PM2.5 are measured by a Glass fibre filter of 20.3 X 25.4 cm (8 X 10 in) size (CPCB 2013).

A total of 24 sites were investigated in the study, and the locations of all sites are shown in Table 3.2. PM2.5 and PM10 values greater than 1000 µg/m3 were removed to avoid the effect of outliers, and data with a relative humidity greater than 95% were removed because high relative humidity is produced by rainfall, which can affect the accuracy of pollutant concentration monitoring.

Table 3.2. List of cities and station for ground-based PM data collection for Haryana.

Sr. No	City	Station Name	Coordinates
1	Ambala	Patti Mehar, Ambala - HSPCB	30.3779° N, 76.7733° E
2	Bahadurgarh	Arya Nagar, Bahadurgarh - HSPCB	28.6771° N, 76.9283° E
3	Ballabgarh	Nathu Colony, Ballabgarh - HSPCB	28.3426° N, 77.3177° E
4	Bhiwani	H.B. Colony, Bhiwani - HSPCB	28.8082° N, 76.1361° E
5	Dharuhera	M C Office, Dharuhera - HSPCB	28.20553°N, 76.79691°E
6	Faridabad	Sector- 16A, Faridabad - HSPCB	28.4061° N, 77.3185° E
7	Fatehabad	Huda Sector, Fatehabad - HSPCB	29.5031° N, 75.4738° E
8	Gurugram	NISE Gwal Pahari, Gurugram - IMD	28.426° N, 77.150 ° E
9	Gurugram	Vikas Sadan, Gurugram - HSPCB	28.4501° N, 77.0285° E
10	Hisar	Urban Estate-II, Hisar - HSPCB	29.1359° N, 75.71297° E
11	Jind	Police Lines, Jind - HSPCB	29.3070° N, 76.3478° E
12	Kaithal	Rishi Nagar, Kaithal - HSPCB	29.8029° N, 76.4144° E
13	Karnal	Sector-12, Karnal - HSPCB	29.6955° N, 76.9996° E
14	Kurukshetra	Sector-7, Kurukshetra - HSPCB	29.9693° N, 76.8735° E
15	Mandikhera	General Hospital, Mandikhera - HSPCB	27.9002° N, 76.9938° E
16	Manesar	Sector-2 IMT, Manesar - HSPCB	28.3655° N, 76.9369° E
17	Narnaul	Shastri Nagar, Narnaul - HSPCB	28.0637° N, 76.1117° E
18	Palwal	Shyam Nagar, Palwal - HSPCB	28.1483° N, 77.3332° E
19	Panchkula	Sector-6, Panchkula - HSPCB	30.7066° N, 76.8545° E
20	Panipat	Sector-18, Panipat - HSPCB	29.4363° N, 76.9773° E
21	Rohtak	MD University, Rohtak - HSPCB	28.8768° N, 76.6211° E

22	Sirsa	F-Block, Sirsa - HSPCB	29.5364° N, 75.0158° E
23	Sonipat	Murthal, Sonipat - HSPCB	29.0316° N, 77.0724° E
24	Yamunanagar	Gobind Pura, Yamuna Nagar - HSPCB	30.1501° N, 77.2850° E

The present national air quality monitoring network is limited in scope as the recorded values are indicative and there is immense time lag in reporting the data. So real time action is not possible. Also, involvement of various monitoring agencies, personnel and equipment's in sampling, chemical analyses and data reporting brings uncertainty and biases. But even with the existing system the non-compliance with standards in cities is found to be enormous. As many as 131 cities are exceeding the permissible limit for PM10 and 18 cities are exceeding the permissible limit for NO_2. Therefore, current research is the action that matters even as these cities get upgraded monitoring systems.

3.2.3   Meteorological Parameters

For the estimation of particulate matters from AOD, there are several meteorological parameters which can be put into use, but here we will use selective and effective parameters, which are very important for the estimation of PM and reported in earlier studies. Following is the list of meteorological parameters used for our research (Table 3.3).

Table 3.3. List of meteorological parameter for estimation of PM

S.No.	Parameters	Details
1	Atmospheric Temperature	It will be used as temperature indirectly affect, as it can create error and false detection of aerosol.
2	Relative Humidity	It will be used for humidity correction and to remove water correction from satellite AOD.
3	Wind Speed	Wind is a very important element in determining PM, as it helps in locating the exact area of aerosol content in atmosphere.
4	Wind Direction	It determines the flow and accumulation of PM over certain area.

CPCB website provides almost all type of meteorological datasets for various stations over Indian region. As per our requirement relative humidity, wind speed, atmospheric temperature

and wind direction are provided in this website. It is similar to that of Particulate Matter, they all comprise with 24 stations over Haryana. The data is acquired for the year 2018, 2019 and 2020 for the reference.

3.2.4   Auxiliary Data

Ground-based AOD data is measured by CIMEL sun-photometer which is part of Aerosol Robotics NETwork (AERONET) and is located at more than 500 ground sites around the world currently. As our study area is Haryana, there are 2 AERONET centers, which are having ground based Aerosol Optical Depth (AOD) for Haryana state for around 1 to 2 years. List of the centre is mentioned below:

Table 3.4. List of AERONET stations for Haryana, India.

Sr.No.	AERONET Station	Coordinates
1	Gwal Pahari, Gurugram	28.426 N, 77.150 E
2	Amity University, Gurugram	28.317 N, 76.916 E

The CIMEL sun-photometer is a multi-channel, automatic sun-and sky scanning radiometer that measures the direct solar irradiance and sky radiance at the surface of the earth only during daylight hours (sun above the horizon) after application of the cloud screening and quality control procedures. The AERONET program is a federation of ground-based remote sensing aerosol networks established by NASA and LOA-PHOTONS (CNRS) and is greatly expanded by collaborators from national agencies, institutes, universities, individual scientists, and partners.

Aerosol Robotic Network (AERONET) AOD products (version 3) were collected to fuse DT and DB Aerosol Optical Depth and the products were used to validate the fused result. The AERONET AOD includes three levels: Level 1.0 (unscreened), Level 1.5 (cloud-screened and quality controlled), and Level 2.0 (quality-assured) (Tao et al. 2015). MODIS AOD data were validated by AERONET level 2.0 observed at two AERONET stations: Gwal Pahari, Gurugram (28.426 N, 77.150 E), and Amity University, Gurugram (28.317 N, 76.916 E). To match the AOD at the 0.550 µm band of MODIS, the AODs at 0.440 µm and 0.675 µm were selected to perform an interpolation using the Angstrom exponential (Tao et al. 2015).

3.3 Methodology

In order to create estimation model to predict PM concentrations, there is multiple organised methods to attain spatially distributed PM. But following are important stages for our research as in Figure 3.2.

- Validation and Processing of satellite-retrieved AOT measurements.
- Acquisition of ground based data from CPCB
- Processing and removal of irregular and noise values from CPCB data.
- Generating regression models using machine learning tools with ground, satellite and meteorological parameters and identifying the best fitted model for the estimation.
- Validation using different correlation methods taking predicted PM (from satellite) and observed PM (from ground based measurements from CPCB portal).
- Identification and reporting of suitable empirical and interpolation algorithms.
- Finalisation of the best fitted models and used for further predictions of PM2.5 and PM10.

3.3.1 *Ground based AOD/AOT observation data processing*

AOT ground-based observation data was obtained using the French CIMEL manufactured automatic tracking and scanning sun photometer (CE-318). Since AERONET provides AOT data at 500 nm, these values have been interpolated at 550 nm in order to coincide with MODIS AOT550 using the following equation:

$$\alpha \ = \ - \ \frac{\ln \frac{AOT_{550}}{AOT_{500}}}{\ln \frac{\lambda_2}{\lambda_1}} \qquad (1)$$

$$AOT_{550} = AOT_{500}/\exp[\alpha \ln(\lambda_1/\lambda_2)] \qquad (2)$$

where α is the Angstrom Exponent (AE) estimated between 440 and 675 nm, λ_1 is 500 nm, and λ_2 is 550 nm.
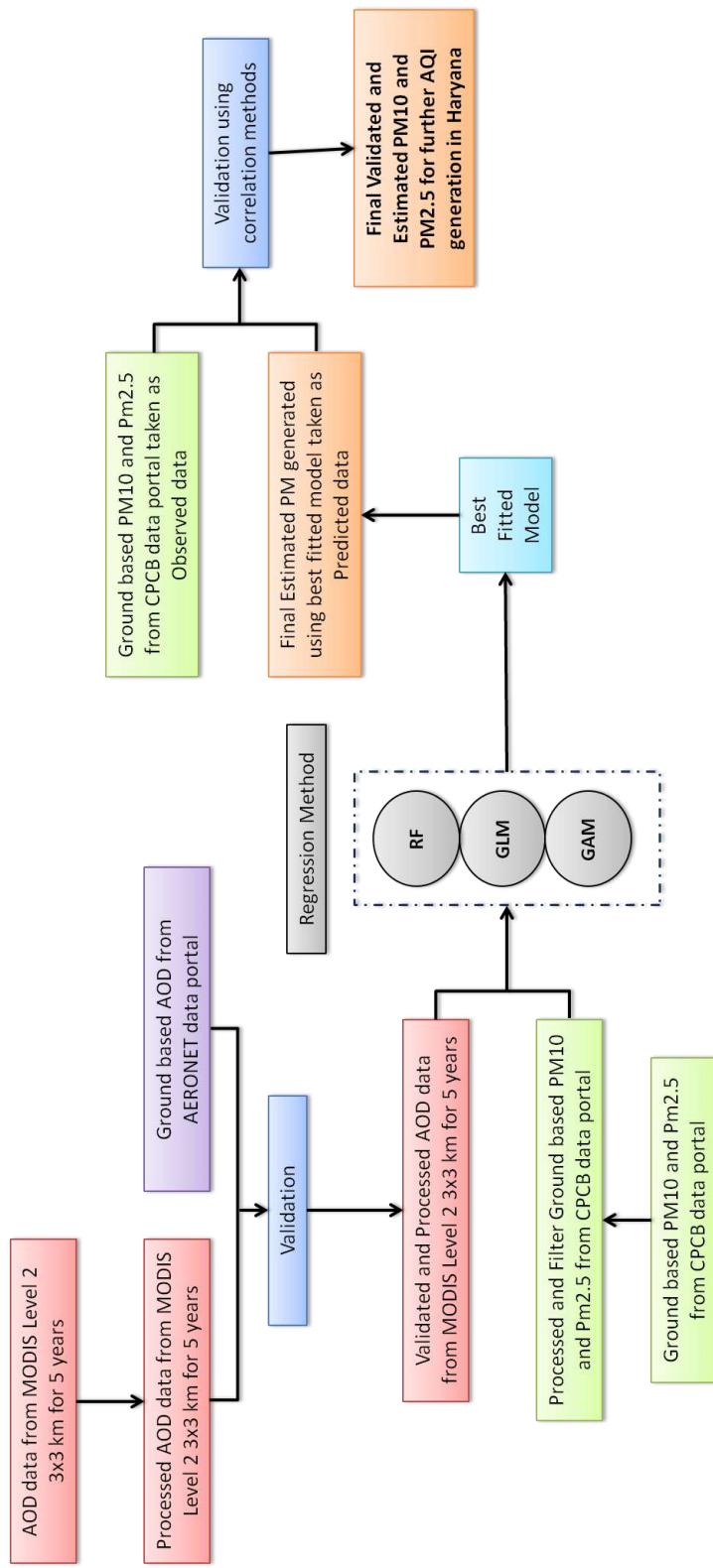
Figure 3.2. Methodology Flow Chart.

3.3.2 Data processing for the Ground based CPCB data

For the ground data, the heterogeneity is quiet high for validation purpose, so to regularize the data, first we have to fill the missing values, so to have continuous data. For that KNN method is used with weighted average of the nearest neighbour values, the missing values are filled, the equation used for that is mentioned below (Yao and Ruzzo 2006):

$$\hat{y} = f(x)$$

$$= \frac{1}{k} \sum_{j=1}^{k} y_{i_j} \qquad (3)$$

Where,

$\hat{y}$ = predicted value for the missing values

y_i = real valued target as training data for i[th] observation

k = KNN scale factor

After the filling of missing value, the data is still not ready for validation as the data is heterogeneous, so further scaling has been done, so that the data can scaled, and there is no anomaly in the data which can hinder the validation.

3.3.3 Model Fitting and Description

The relationship between ground-level PM2.5 and AOD and PM10 and AOD are affected by various factors, such as relative humidity, atmospheric temperature, wind speed and wind direction (i.e. meteorological parameters), and varies on day to day basis. A simple linear model cannot accurately reflect this relationship. Considering the daily variations in the PM2.5–AOD and PM10-AOD relationship, Lee et al. (2011) proposed the LME model to estimate PM2.5 (Hsu et al. 2004). Many scholars constructed the model by adding various meteorological parameters, temperature, wind speed, and other parameters for different regions and different times. The results of these studies suggest that added parameters improve the accuracy of PM2.5 and PM10 estimates.

In this study, four models were used to estimate PM2.5 and PM10 with MODIS AOD as in equation (4) and (5) and then MODIS AOD with meteorological factors, which can be expressed as in equation (6) and (7). Prior to which we have taken three models i.e. Random Forest Model (RF), General Additive Model (GAM) and General Linear Regression Model (GLM) and also same model are again run with Kriging added i.e. Random Forest + Kriging Regression Model (RF+OK), General Linear + Kriging Regression Model (GLM+OK) and General Additive + Kriging Regression Moedl (GAM + OK). The data was run through each of the above models and then the most suitable or fitted model identified using RMSE and other statistical results as shown in Figure 3.3. As from the above statistical results the [1] shows the RMSE of the each model used and [2] shows the residual value.

```
            OK      RF     GLM     GAM   RF_OK GLM_OK GAM_OK
[1,] 12.393 12.296 10.660 11.779 13.096 10.857 11.981
[2,]  5.577  5.045  6.136  5.903  5.518  6.060  6.099
```

Figure 3.3. Statistical results showing the best fitted model among the used models

As it is clearly stated that GLM is giving the best fit as RMSE of lowest 10.66 and next to it is GLM+OK. Hence, after identification of the best fitted model i.e. GLR Model, the estimation of PM10 and PM2.5 is done. Following are the models for PM10 and PM2.5 using GLM.

PM Model for Estimation with one variable

$$\boldsymbol{PM10} = 259.86 \times (AOD) - 1.567 \qquad \text{Eq. 4}$$

$$\boldsymbol{PM2.5} = 136.77 \times (AOD) - 8.268 \qquad \text{Eq. 5}$$

PM Model for Estimation with 5 variables

$$\boldsymbol{PM10} = 260.17 \times (AOD) - 0.213 \times (Temp) - 1.642 \times (RH) + 0.051 \qquad \text{Eq. 6}$$
$$\times (WD) + 0.684 \times (WS) + 95.46$$

$$\boldsymbol{PM2.5} = 139.65 \times (AOD) - 0.263 \times (Temp) - 0.621 \times (RH) - 0.205 \qquad \text{Eq. 7}$$
$$\times (WD) - 0.882 \times (WS) + 76.53$$

[19]

Finalised empirical models were used for the estimation of PM10 and PM2.5, as there was not much difference in accuracy of the model using five parameters and one parameter. Hence we have gone forward with model eq. 4 and eq. 5 for PM10 and PM2.5 respectively.

Results and Discussions

4.1   Validation of Satellite AOD from Ground based AOD

The validation has been done based on the ground points over Haryana. We have just got two station AOD data over Haryana region from AERONET for validation. The two stations are Gwal Pahari, Gurugram and Amity University, Gurugram. In this study, we used the data from MODIS and AERONET derived AODs for the period 2016-2020 (Tripathi et al. 2005).

For validation, the correlation method used here is Pearson Correlation method. It is one of the most widely used correlation statistic to measure the degree of the relationship between linearly related variables. The equation for correlation is mentioned below (Obilor and Amadi 2018).

$$r_{xy} = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n\sum x_i^2 - (\sum x_i)^2} - \sqrt{n\sum y_i^2 - (\sum y_i)^2}} \qquad (8)$$

Where,

r_{xy} = Pearson r correlation coefficient between x and y

n = number of observations

x_i = value of ground variable (for ith observation)

y_i = value of satellite variable (for ith observation)

The correlation plots for Ground and Satellite observation for two centres available for year 2016-2020 for Haryana is shown in figure below.

AERONET AOD 550nm Vs MODIS AOD 550nm

AMITY UNIV., GURUGRAM

(a)

AERONET AOD 550nm Vs MODIS AOD 550nm

GUAL PAHARI, GURUGRAM
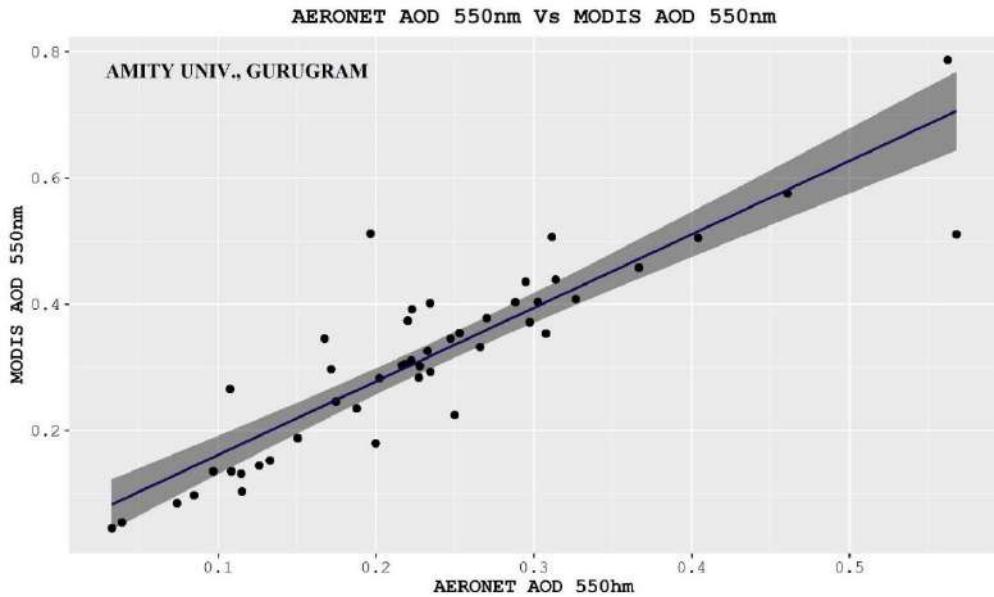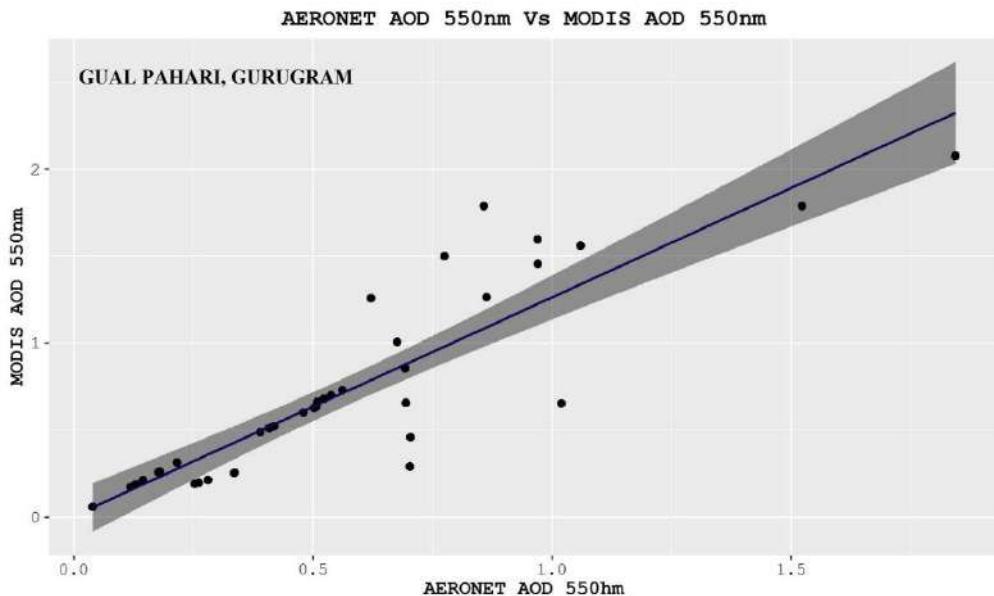
(b)

Figure 4.1. Correlation graphs (a) Amity University, Gurugram and (b) Gual Pahari, Gurugram.

As we can see from the graphs, the correlation is evenly spread and is high for both the centres (Figure 4.1 a and b). For better validation the t-test was performed and therefore, various statistical evidences have been generated for further validation (Table 4.1). Statistical evidences showed a good correlation between both databases, defining the validity of the satellite based AOD for further analysis. Table 4.1 shown below presents different results after performing

[21]

pearson correlation and t-test. As we can see the values are ominously coming very nice (correlation coefficients are high $\geq$ 0.88) for both the centres, and the coefficient of determination is also high (i.e. ~ 0.8). The Standard Error (SE) is less (<0.11) and p-value is below 0.005. These validation results proofs again to continue analysis further with satellite (MODIS) derived AOD.

Table 4.1. Statistical results from Pearson's Correlation and T-test.

AERONET Station	R	R^2	p-value	df	t-value	SE
Gual Pahari, Gurgaon	0.88	0.7744	0.00361	38	-1.4333	0.10432
Amity University, Gurgaon	0.89	0.7921	0.00355	45	-2.9978	0.02768

4.2 Statistical representation of Estimated Particulate Matter (PM)

The estimated PM10 and PM2.5 are analysed and statistically represented with different statistical parameters as baseline information on air quality of our study area from satellite platform. Various statistics were used for further understanding of the air quality scenario. The data estimated for PM10 and PM2.5 were at daily scale (given in Annexure II and III). Hence, these were converted in to monthly scale and monthly average of PM10 and PM2.5 is presented. Here, the Table 4.2, and Table 4.3 is showing monthly statistics of PM2.5 and PM10 for five years i.e. 2016-2020. SD represented Standard Deviation of yearly estimate and avg. represents the yearly average.

Table 4.2. Estimated PM 2.5 composite monthly average for Year 2016 to 2020 at Ground Station points

ID	Station	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Min	Avg.	Max	SD
1	Patti Mehar, Ambala	Ambala	73.29	56.88	54.03	60.83	75.01	90.45	89.06	73.81	101.29	110.42	71.66	68.58	54.03	77.11	110.42	17.46
2	Arya Nagar, Bahadurgarh	Jhajjar	92.72	81.11	75.67	72.68	83.44	96.50	89.80	145.52	81.09	145.07	97.34	82.89	72.68	95.32	145.52	24.56
3	Nathu Colony, Ballabgarh	Faridabad	95.28	58.40	65.89	61.26	70.44	104.33	81.08	107.99	87.13	140.37	77.08	73.50	58.40	85.23	140.37	23.62
4	H.B. Colony, Bhiwani	Bhiwani	83.58	66.00	67.87	55.14	76.93	93.50	94.85	97.52	70.08	126.21	90.72	72.33	55.14	82.89	126.21	19.07
5	Municipal Corporation Office, Dharuhera	Rewari	82.20	69.27	62.93	53.04	69.47	78.64	71.82	93.49	67.18	126.65	75.46	66.62	53.04	76.40	126.65	18.79
6	Sector- 16A, Faridabad	Faridabad	71.12	52.26	53.40	52.40	68.64	104.58	87.78	123.95	93.62	124.10	89.35	66.89	52.26	82.34	124.10	25.88
7	Huda Sector, Fatehabad	Fatehabad	92.34	61.39	62.25	62.41	59.59	63.35	114.52	101.17	69.08	115.34	87.91	68.28	59.59	79.80	115.34	21.37
8	NISE Gwal Pahari, Gurugram - IMD	Gurugram	71.46	60.09	57.82	59.36	85.27	100.54	88.69	76.29	81.56	146.29	97.89	67.86	57.82	82.76	146.29	24.68
9	Urban Estate-II, Hisar	Hisar	75.40	63.25	59.78	53.97	74.56	100.61	88.30	105.75	72.03	113.67	86.43	62.02	53.97	79.65	113.67	19.39
10	Police Lines, Jind	Jind	91.88	61.86	68.36	65.76	77.27	111.59	105.80	112.78	80.90	162.63	86.98	79.95	61.86	92.15	162.63	28.06
11	Rishi Nagar, Kaithal	Kaithal	74.99	59.27	60.37	61.62	71.15	101.77	102.35	103.88	91.36	149.85	75.92	78.47	59.27	85.92	149.85	25.95
12	Sector-12, Karnal	Karnal	69.93	55.47	58.76	65.48	74.33	106.73	90.03	102.48	94.67	152.30	77.27	73.97	55.47	85.12	152.30	26.78
13	Sector-7, Kurukshetra	Kurukshetra	73.70	63.17	62.15	66.74	74.28	102.10	84.72	63.91	96.07	167.10	76.61	74.89	62.15	83.79	167.10	29.12
14	General Hospital, Mandikhera	Mewat	93.07	75.66	51.10	45.49	54.79	75.48	68.52	66.03	49.65	96.99	108.79	80.69	45.49	72.19	108.79	20.24
15	Sector-2 IMT, Manesar	Gurugram	88.97	73.51	65.30	61.76	80.76	91.48	86.85	90.90	75.26	111.58	83.57	78.05	61.76	82.33	111.58	13.28
16	Shastri Nagar, Narnaul	Mahendergarh	71.60	66.24	52.76	46.90	52.74	65.09	57.42	58.32	52.22	84.47	65.07	56.09	46.90	60.74	84.47	10.35
17	Shyam Nagar, Palwal	Palwal	95.72	73.41	74.71	62.19	72.81	109.95	92.75	98.83	77.78	154.52	76.94	85.90	62.19	89.63	154.52	24.48
18	Sector-6, Panchkula	Panchkula	57.73	49.81	44.66	57.18	72.44	89.70	75.50	56.42	81.57	115.73	66.66	57.29	44.66	68.72	115.73	19.89
19	Sector-18, Panipat	Panipat	78.55	60.45	65.25	72.73	86.74	120.77	95.13	91.26	82.94	169.98	71.33	80.15	60.45	89.61	169.98	29.83
20	MD University, Rohtak	Rohtak	77.92	64.70	59.66	49.47	69.62	96.34	51.77	77.95	55.66	94.13	56.05	63.32	49.47	68.05	96.34	15.64
21	F-Block, Sirsa	Sirsa	77.29	64.70	62.56	61.42	55.25	87.08	99.07	89.67	74.13	129.02	77.09	66.29	55.25	78.63	129.02	20.50
22	Murthal, Sonipat	Sonipat	94.40	73.14	72.95	75.11	97.49	122.68	100.08	99.14	91.91	146.01	94.83	82.36	72.95	95.84	146.01	21.19
23	Gobind Pura, Yamuna Nagar	Yamuna Nagar	70.03	57.62	55.17	62.69	71.76	96.32	74.41	58.17	96.97	146.26	63.20	70.33	55.17	76.91	146.26	25.76

Table 4.3. Estimated PM 10 composite monthly average for Year 2016 to 2020 at Ground Station points

ID	Station	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Min	Avg.	Max	SD
1	Patti Mehar, Ambala	Ambala	151.69	118.66	111.24	123.36	150.95	181.54	178.62	172.60	204.73	223.97	148.78	144.80	111.24	159.25	223.97	34.37
2	Arya Nagar, Bahadurgarh	Jhajjar	188.05	170.39	154.95	144.26	167.00	201.83	184.68	291.34	172.17	284.28	197.62	167.94	144.26	193.71	291.34	46.96
3	Nathu Colony, Ballabgarh	Faridabad	195.47	113.90	129.61	126.55	145.63	215.01	169.19	218.61	183.36	278.73	159.51	151.08	113.90	173.89	278.73	47.28
4	H.B. Colony, Bhiwani	Bhiwani	167.15	139.53	138.17	115.80	153.26	181.47	190.68	188.42	144.51	263.50	188.16	153.13	115.80	168.65	263.50	38.20
5	Municipal Corporation Office, Dharuhera	Rewari	171.17	148.82	129.08	112.57	135.36	158.91	138.50	193.05	136.50	252.16	149.89	139.47	112.57	155.46	252.16	36.85
6	Sector- 16A, Faridabad	Faridabad	140.99	106.36	114.63	112.01	139.86	204.26	182.89	248.98	190.39	249.64	189.77	138.03	106.36	168.15	249.64	50.39
7	Huda Sector, Fatehabad	Fatehabad	186.48	124.37	132.67	126.53	115.27	135.85	229.40	201.71	141.34	245.74	173.82	137.83	115.27	162.58	245.74	43.98
8	NISE Gwal Pahari, Gurugram - IMD	Gurugram	146.57	128.23	125.03	123.30	169.13	204.83	188.57	151.45	160.85	280.73	209.76	140.37	123.30	169.07	280.73	45.92
9	Urban Estate-II, Hisar	Hisar	151.41	125.57	123.89	114.01	151.43	196.27	178.28	214.44	148.22	226.11	180.78	129.84	114.01	161.69	226.11	37.15
10	Police Lines, Jind	Jind	185.23	129.90	141.60	135.69	151.19	227.26	214.32	229.45	164.99	330.35	177.24	165.24	129.90	187.71	330.35	56.41
11	Rishi Nagar, Kaithal	Kaithal	149.25	121.80	125.06	128.84	142.28	200.17	206.70	212.49	183.85	319.03	153.38	164.95	121.80	175.65	319.03	55.28
12	Sector-12, Karnal	Karnal	145.94	114.37	121.56	133.02	153.19	217.44	177.54	207.87	179.93	310.63	164.48	159.98	114.37	173.83	310.63	53.29
13	Sector-7, Kurukshetra	Kurukshetra	146.62	129.46	130.36	132.80	153.59	203.59	175.22	135.04	201.11	339.26	157.61	156.03	129.46	171.72	339.26	58.56
14	General Hospital, Mandikhera	Mewat	190.44	158.76	108.13	92.78	105.67	169.09	139.72	139.60	105.89	193.62	220.20	167.81	92.78	149.31	220.20	40.87
15	Sector-2 IMT, Manesar	Gurugram	177.15	154.24	137.63	130.46	155.40	198.64	180.26	186.03	156.84	231.19	174.83	167.33	130.46	170.83	231.19	27.38
16	Shastri Nagar, Narnaul	Mahendargarh	146.22	136.86	113.85	97.41	97.91	129.89	120.53	129.19	105.82	177.14	139.38	116.44	97.41	125.89	177.14	22.62
17	Shyam Nagar, Palwal	Palwal	196.91	157.10	156.18	129.63	150.27	228.08	186.06	193.88	154.55	313.40	155.97	188.98	129.63	184.25	313.40	48.83
18	Sector-6, Panchkula	Panchkula	120.33	103.45	91.06	121.78	140.85	173.85	150.50	113.97	160.97	220.22	142.13	113.74	91.06	137.74	220.22	35.54
19	Sector-18, Panipat	Panipat	163.24	127.30	133.52	150.44	174.95	252.03	201.74	188.63	170.81	344.48	147.73	165.98	127.30	185.07	344.48	60.24
20	MD University, Rohtak	Rohtak	156.84	138.72	124.74	107.23	121.23	193.75	110.42	154.97	117.40	210.86	115.64	132.51	107.23	140.36	210.86	33.18
21	F-Block, Sirsa	Sirsa	157.17	134.18	130.60	123.61	105.00	181.67	201.41	188.84	150.03	264.23	158.71	137.36	105.00	161.07	264.23	43.03
22	Murthal, Sonipat	Sonipat	187.73	153.33	151.65	152.04	190.71	219.65	208.09	191.38	184.90	300.12	190.12	171.66	151.65	191.78	300.12	40.36
23	Gobind Pura, Yamuna Nagar	Yamuna Nagar	146.59	114.24	116.25	127.92	149.88	197.20	151.14	136.00	202.55	295.48	131.51	143.63	114.24	159.37	295.48	50.99

[24]

4.3   Spatio-temporal Variations of PM10 and PM2.5

After identification of the best fitted model, the PM10 and PM2.5 are generated with temporal resolution of daily and for the half decade duration i.e. 2016 to 2020. To restrict the size of final reports daily results for PM has not been presented here (as it requires almost 1825 maps to be added in the report and may make the report bulky). Therefore, monthly outputs are generated for both PM10 and PM2.5. These were further evaluates and discussed year-wise for half decades. Figure 4.2 is showing the results for the year 2016 for PM2.5.
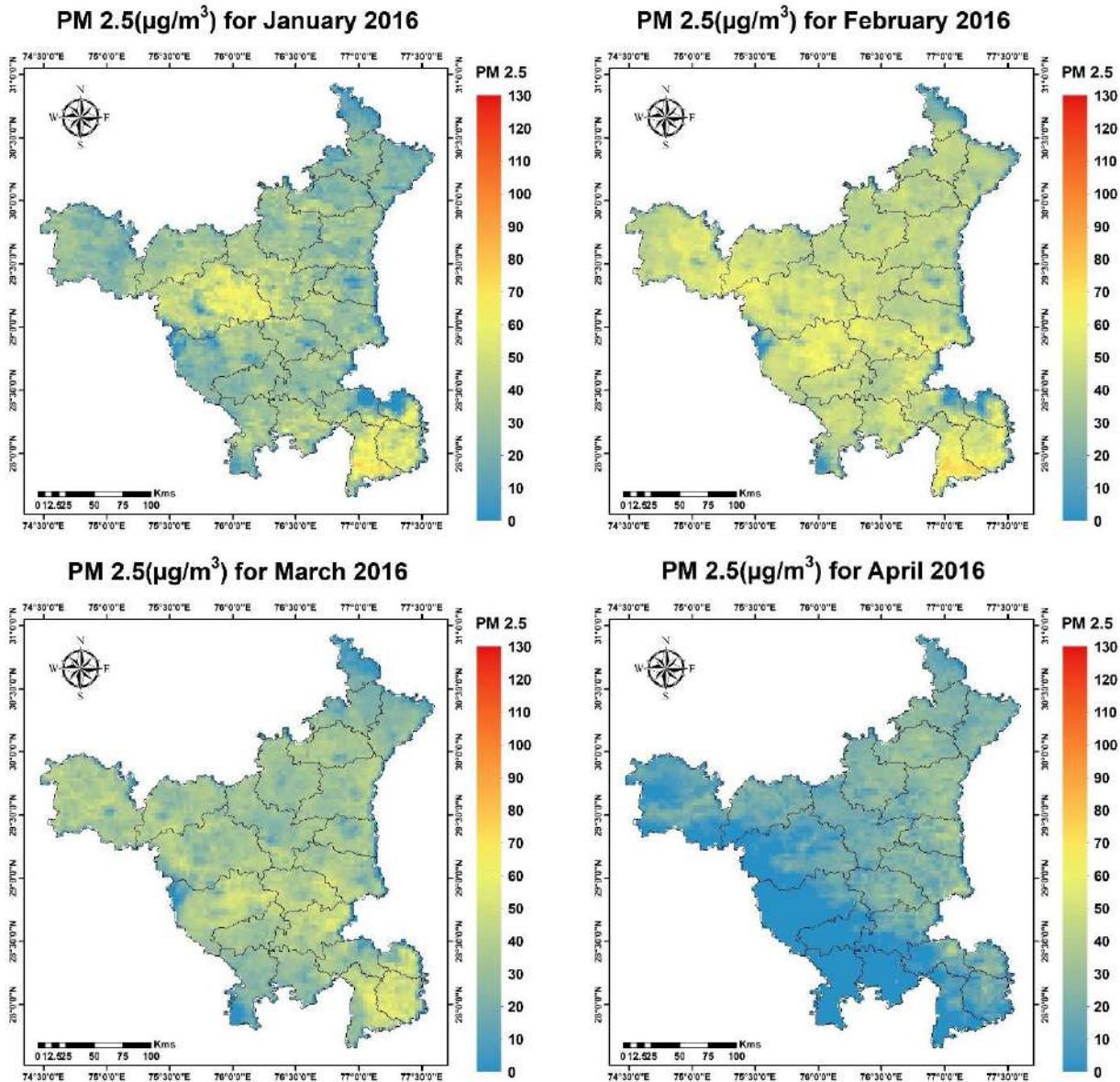
PM 2.5(μg/m³) for May 2016

PM 2.5(μg/m³) for June 2016

PM 2.5(μg/m³) for July 2016

PM 2.5(μg/m³) for August 2016

[26]

PM 2.5(µg/m³) for September 2016

PM 2.5(µg/m³) for October 2016

PM 2.5(µg/m³) for November 2016
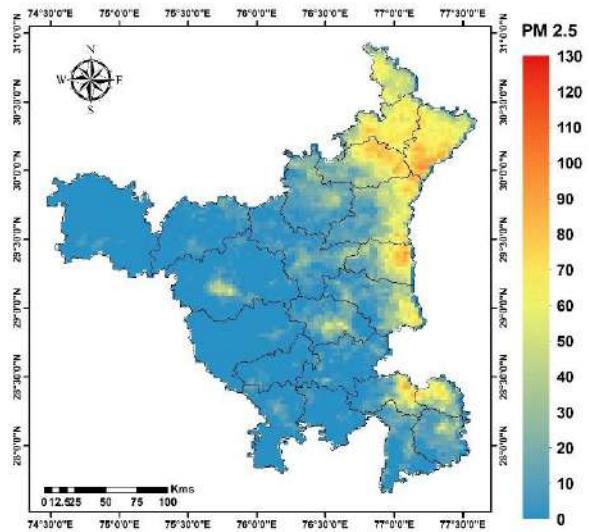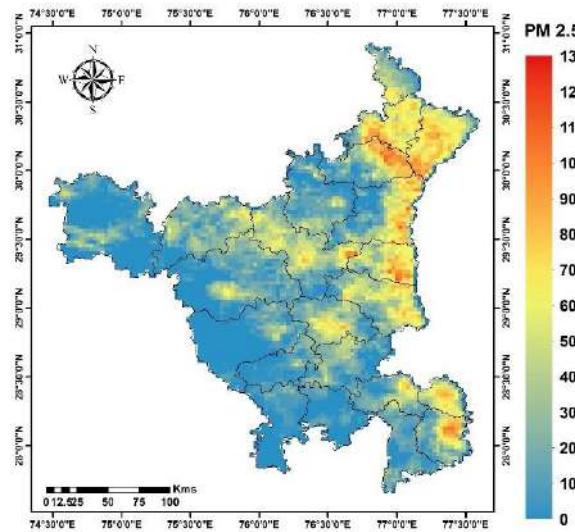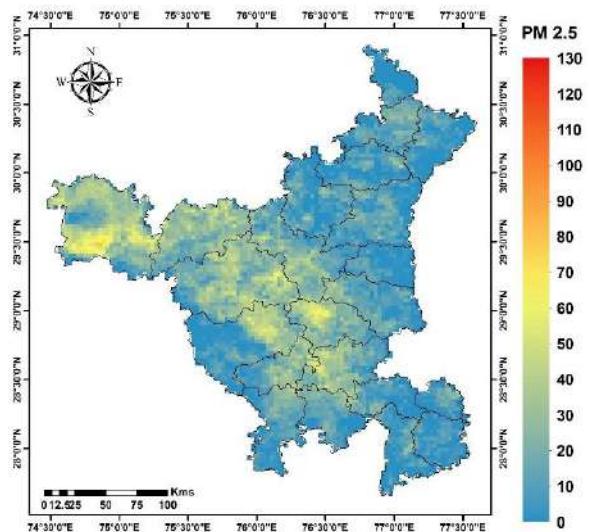
PM 2.5(µg/m³) for December 2016
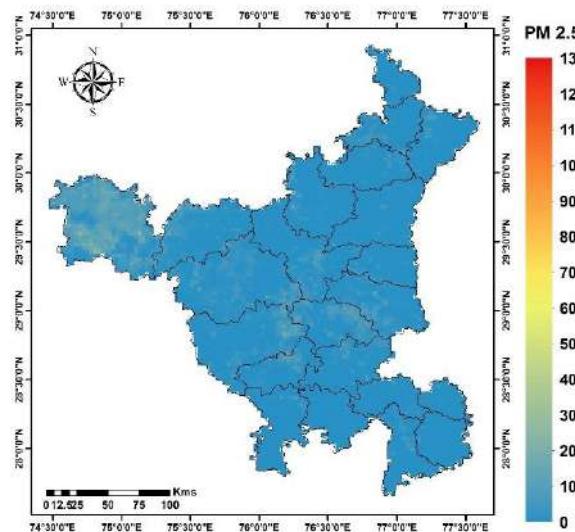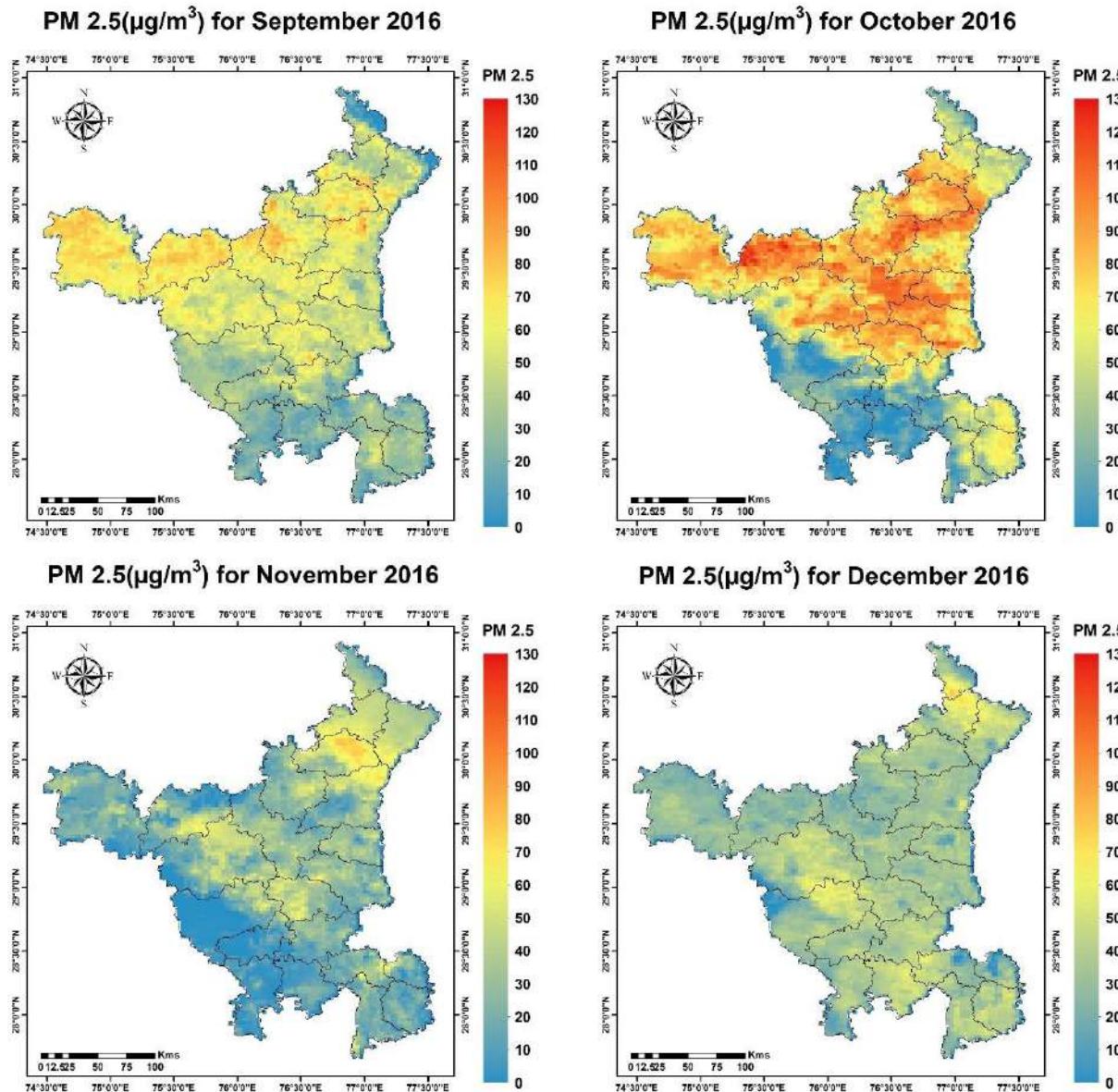
Figure 4.2. Monthly spatial distribution of PM2.5 for the year 2016 over Haryana

October month witnesses highest PM2.5 concentration (i.e. up to 350 µg/m³). The variation of PM2.5 is having extreme values during the month of October, and November mainly due to high anthropogenic activities such as crop and stubble burning, Diwali crackers burning etc. This trend will be seen for almost every year, but for the change, the month of February is showing higher PM2.5 accumulation than usual, mainly due to stagnant meteorological conditions. July, August and April is showing lower value of PM mainly due to less anthropogenic activities and also August been a monsoon month, showing gradually lower PM accumulation. Figure 4.3 is showing the results for PM2.5 for the year 2017 over Haryana.

[27]

PM 2.5(µg/m³) for January 2017
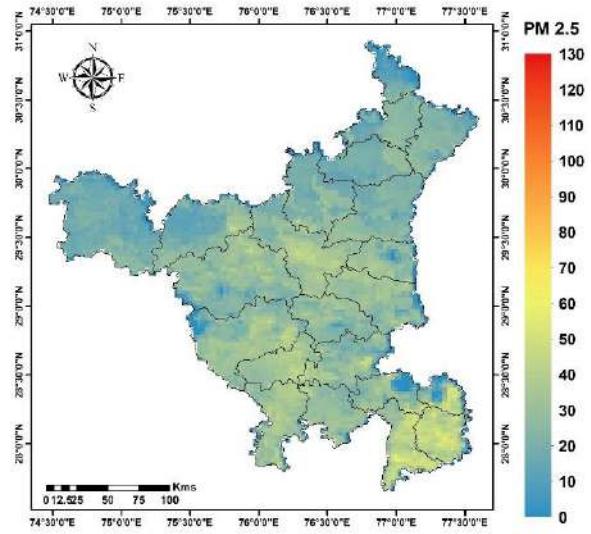
PM 2.5(µg/m³) for February 2017
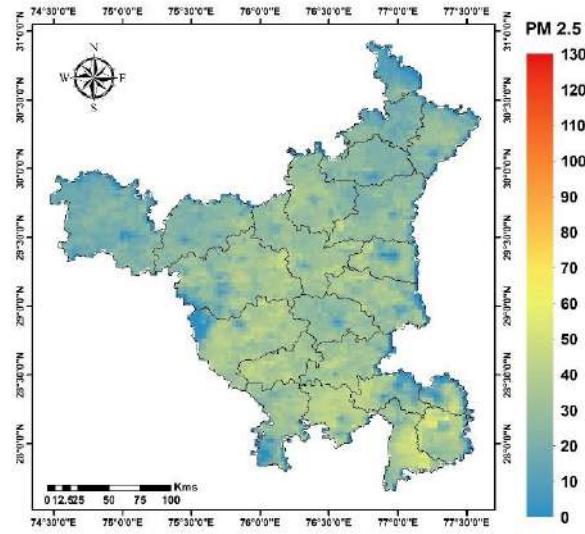
PM 2.5(µg/m³) for March 2017
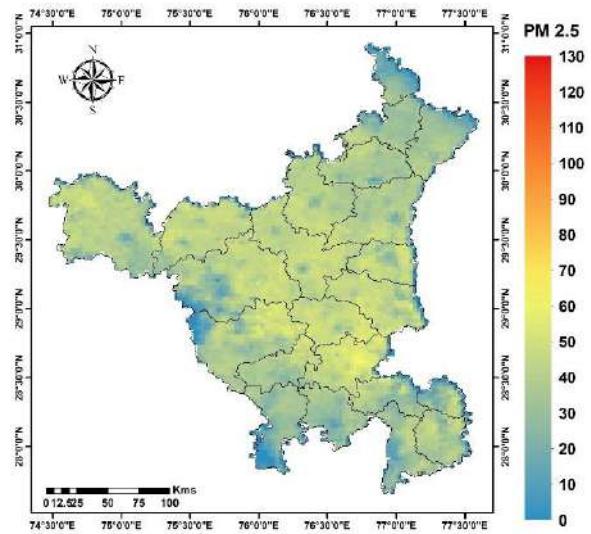
PM 2.5(µg/m³) for April 2017
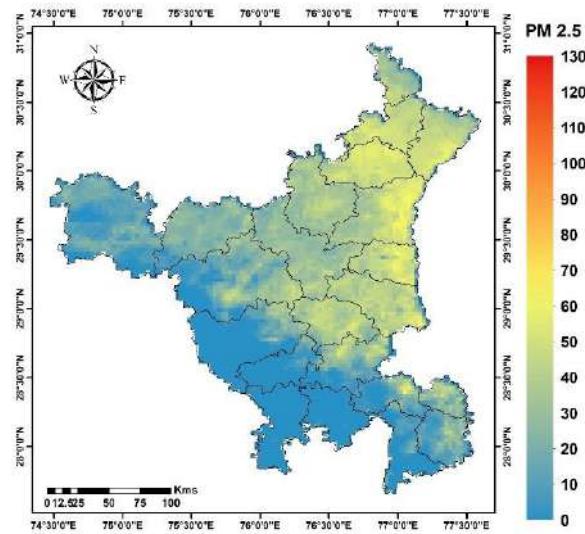
PM 2.5(μg/m³) for May 2017
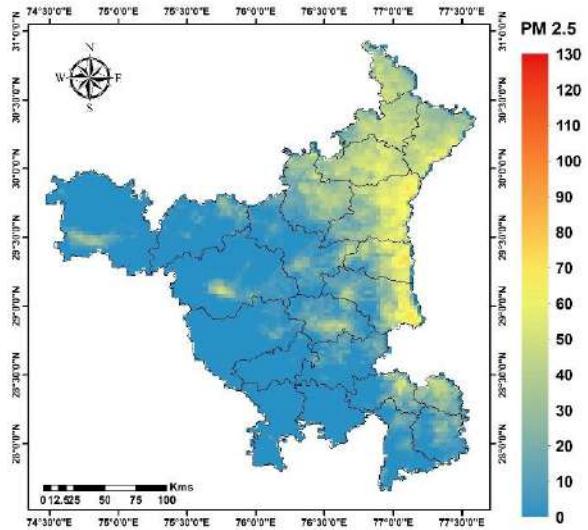
PM 2.5(μg/m³) for June 2017
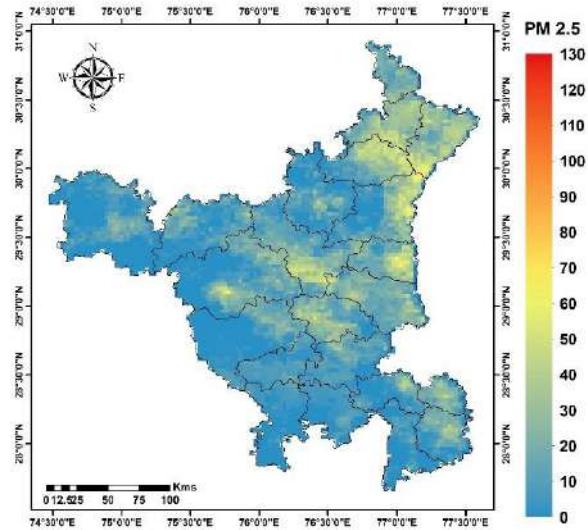
PM 2.5(μg/m³) for July 2017

PM 2.5(μg/m³) for August 2017

[29]
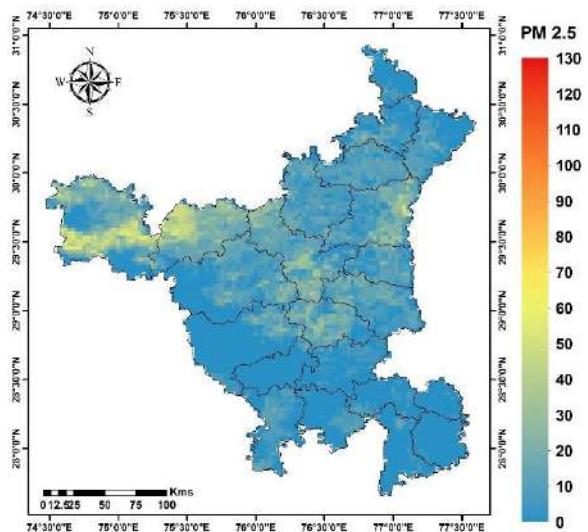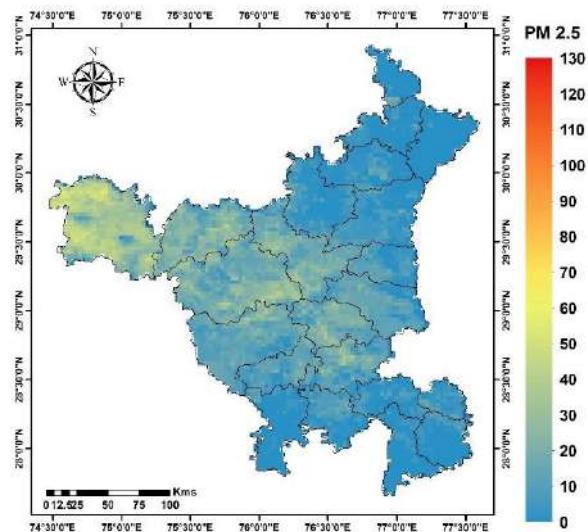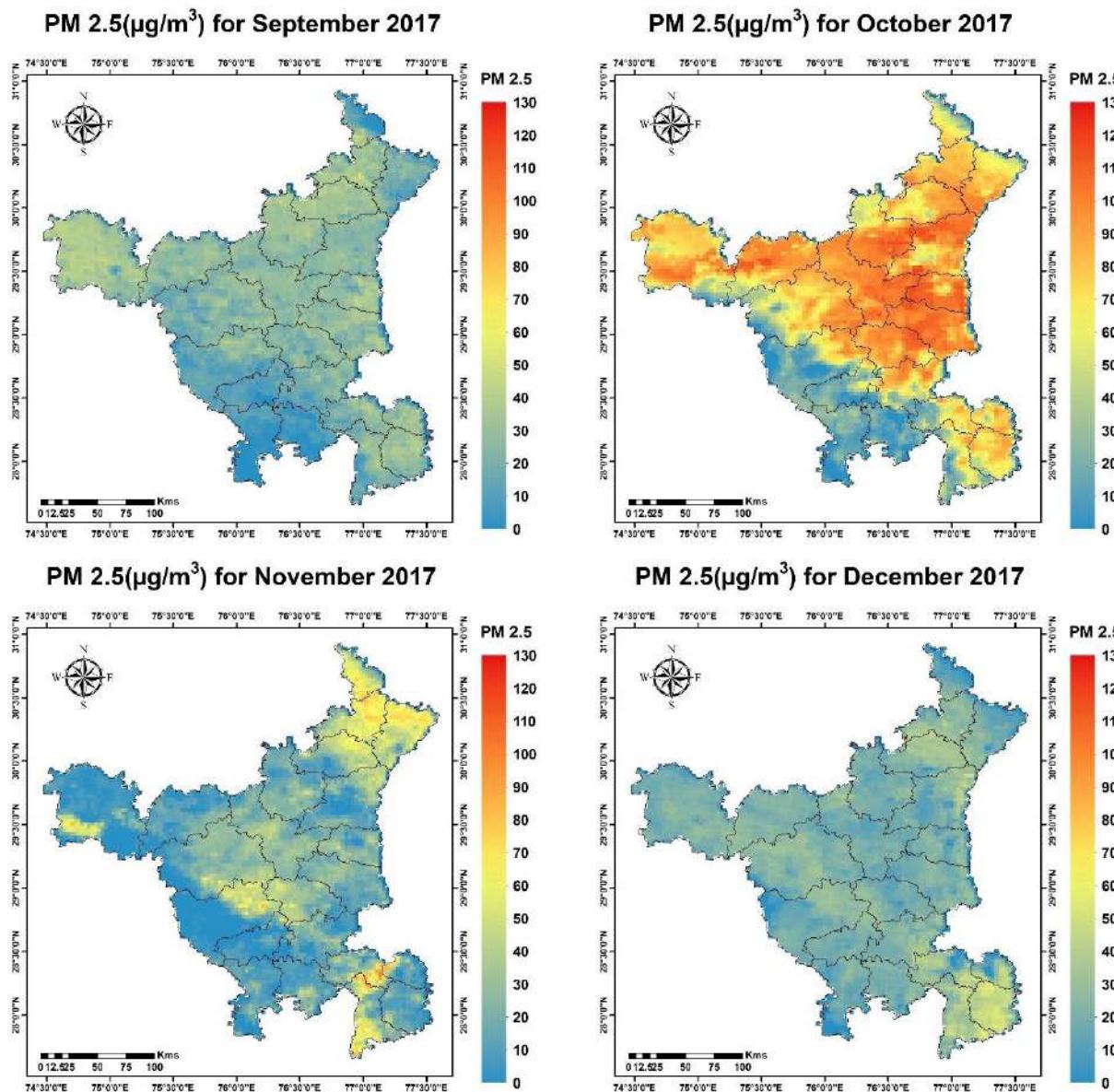
Figure 4.3. Monthly spatial distribution of PM2.5 for the year 2017 over Haryana

From the above figure, it can be observed that the variation of PM2.5 is relatively higher. High values were estimated during the month October and November. November and October is understandable as during these months there is increase in anthropogenic activities such as agricultural practices, stubble burning and festival events. Figure 4.4 is showing the monthly spatial pattern of PM2.5 for the year 2018.

PM 2.5(μg/m³) for January 2018
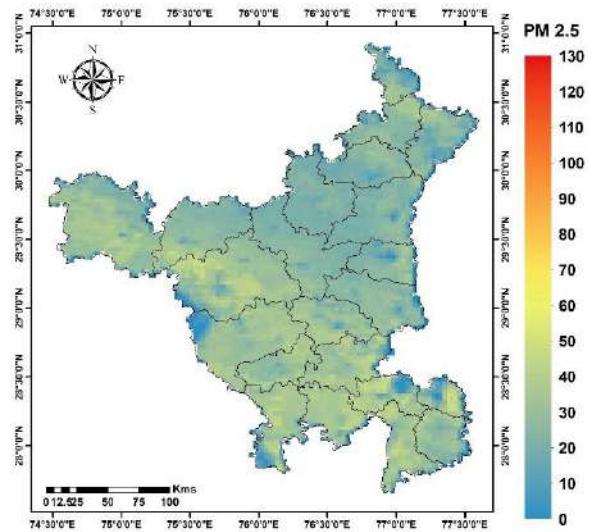
PM 2.5(μg/m³) for February 2018
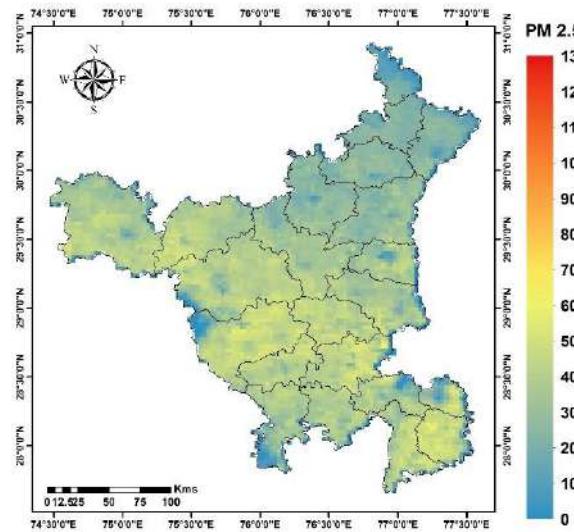
PM 2.5(μg/m³) for March 2018

PM 2.5(μg/m³) for April 2018

[31]
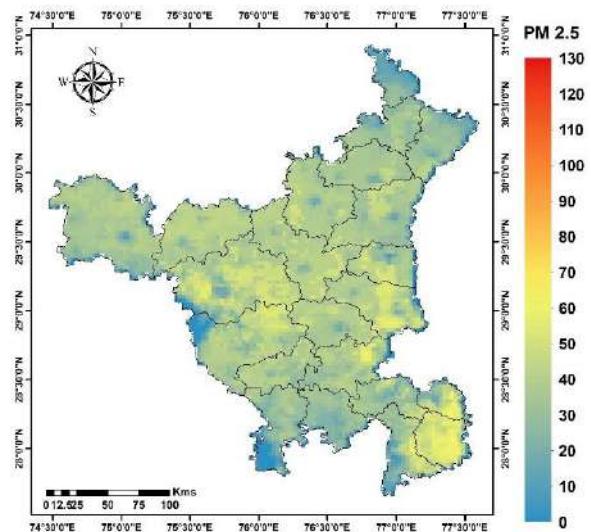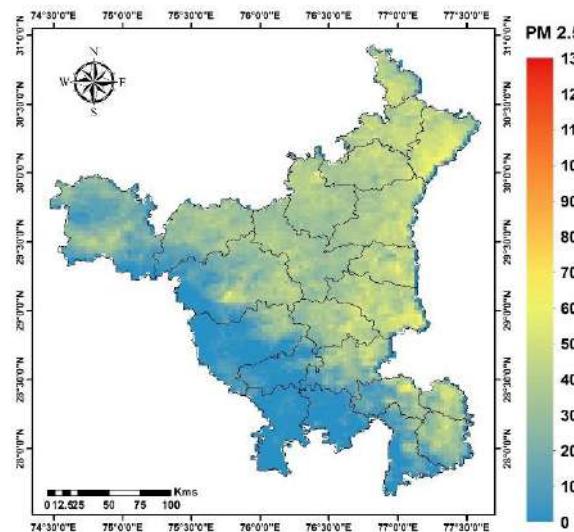
PM 2.5(µg/m³) for May 2018
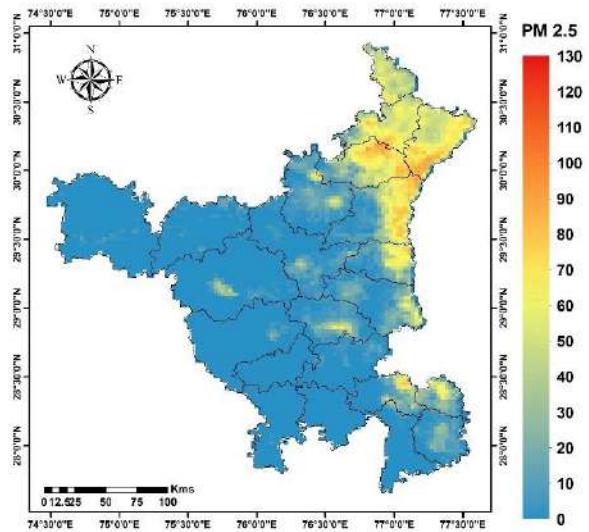
PM 2.5(µg/m³) for June 2018
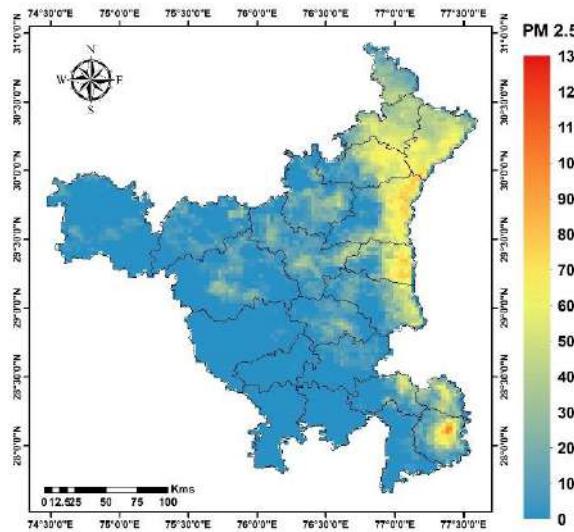
PM 2.5(µg/m³) for July 2018

PM 2.5(µg/m³) for August 2018

[32]
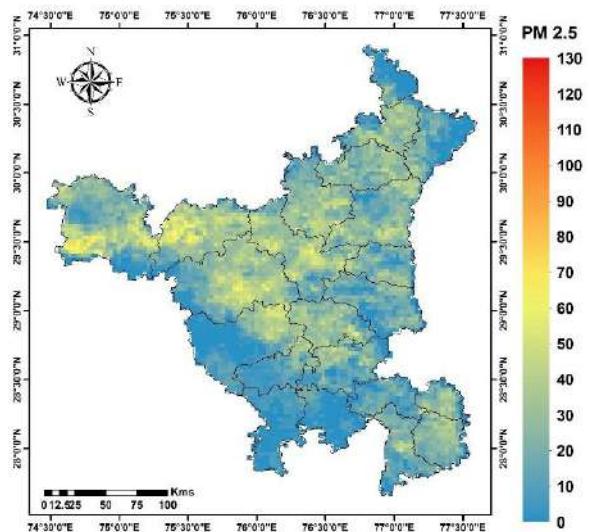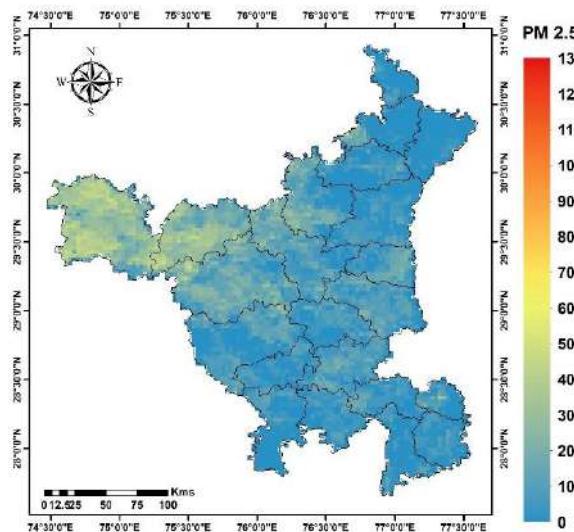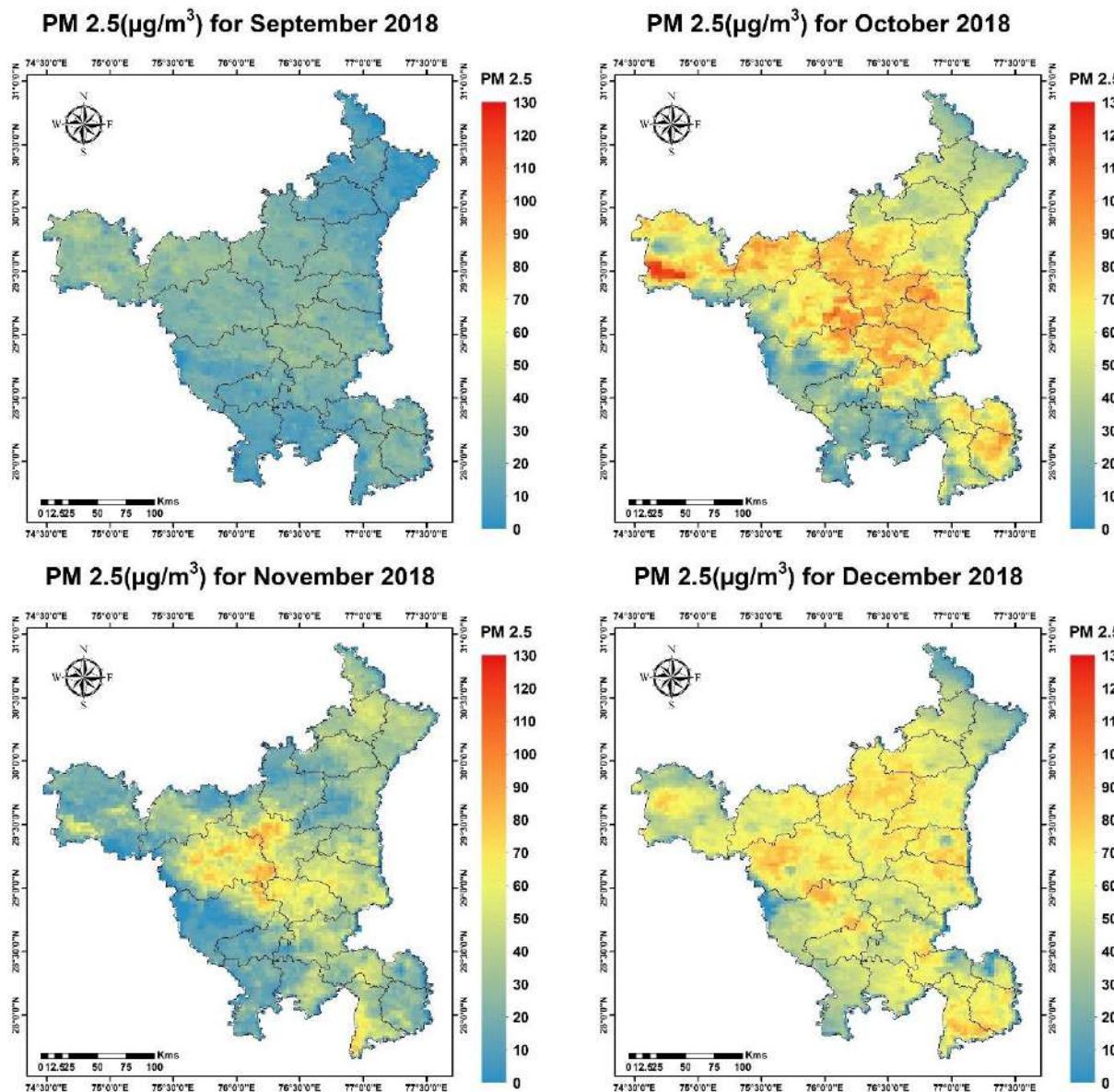
Figure 4.4. Monthly spatial distribution of PM2.5 for the year 2018 over Haryana.

As we can see from the above figure, the variation of PM2.5 is showing higher value during the month of January, April, October, and November. October and November are understandable as during these months there is increase in anthropogenic activities such as stubble burning and festival events. Exceptionally January and April were showing high values than usual for the year 2018, which is possibly due to dust storm or other natural causes, resulted in the stayed accumulation of PM2.5 for a long time. Relatively lower values were observed in the month of December possibly due to clear meteorological conditions. Interestingly, two corridors of High PM2.5 concentrations were observed in the month of November, one from Sirsa and another

[33]

from Punchkula-Ambala, following the most rushed road network towards Delhi and Chandigarh. This indicates the pollution from Vehicle movement. Figure 4.5 is showing the results for the year 2019 over Haryana for PM2.5.

PM 2.5(µg/m³) for January 2019
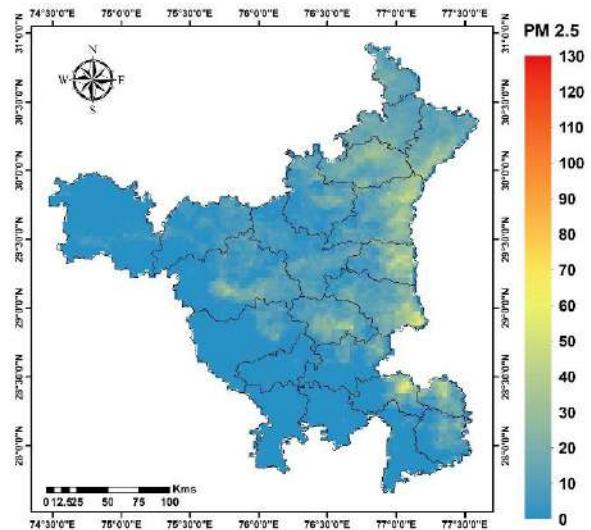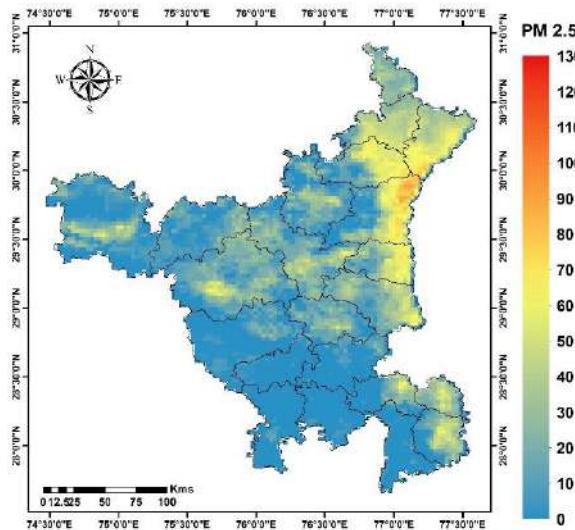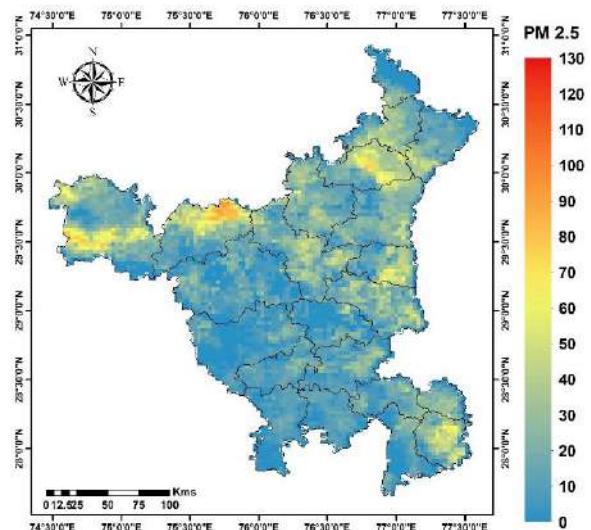
PM 2.5(µg/m³) for February 2019

PM 2.5(µg/m³) for March 2019

PM 2.5(µg/m³) for April 2019

PM 2.5(μg/m³) for May 2019

PM 2.5(μg/m³) for June 2019

PM 2.5(μg/m³) for July 2019

PM 2.5(μg/m³) for August 2019
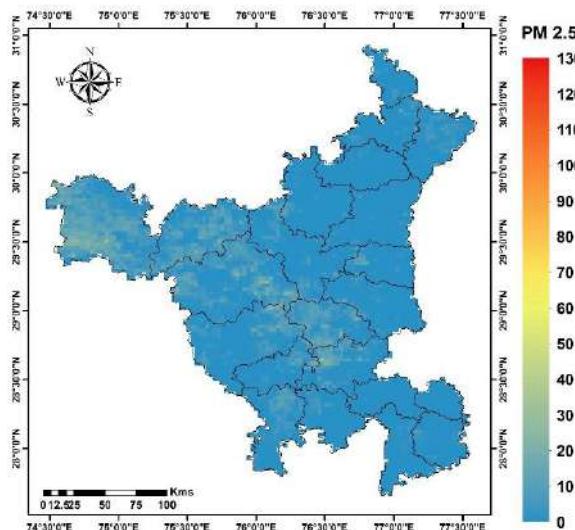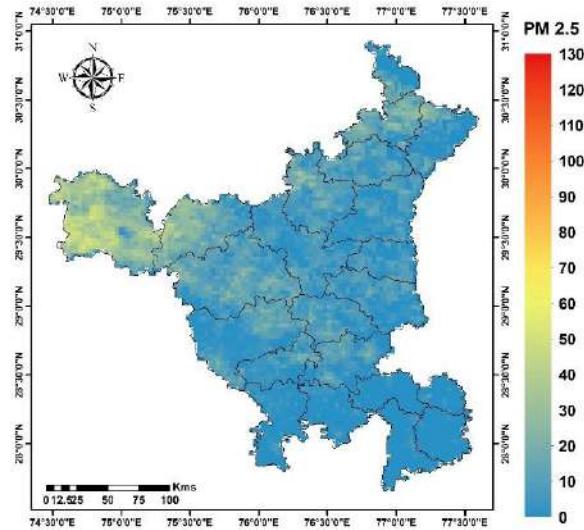
[35]
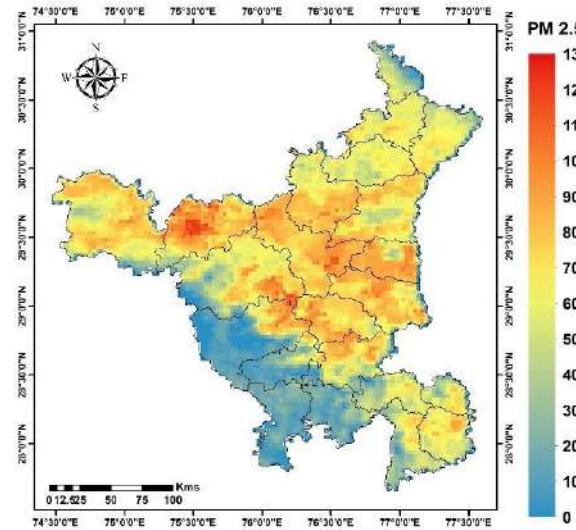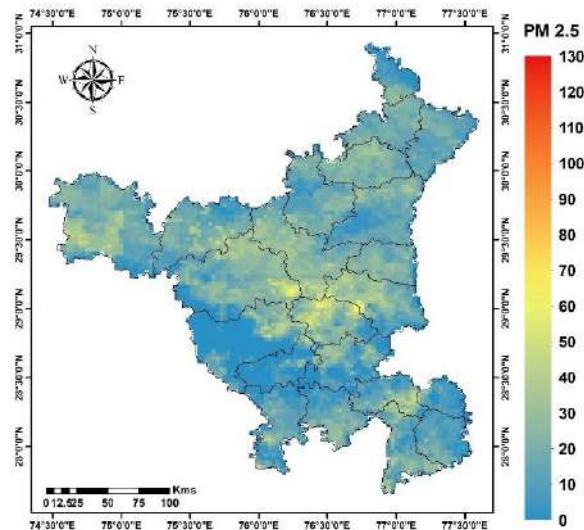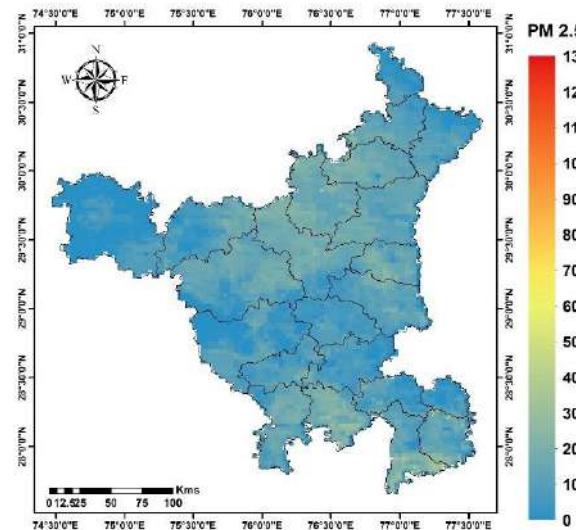
Figure 4.5. Monthly spatial distribution of PM2.5 for the year 2019 over Haryana.

As we can see from the above figure, the variation of PM2.5 for the year 2019 is lower as compare to previous years and trend is gradual i.e. showing higher value during the month of October which is gradual due to high anthropogenic activities but showing lower PM accumulation on the first half of the year. The reason behind this may be favourable meteorological conditions for the pollutants dispersion. Figure 4.6 is showing the results for the year 2020 over Haryana for PM2.5.

[36]

PM 2.5(μg/m³) for January 2020

PM 2.5(μg/m³) for February 2020
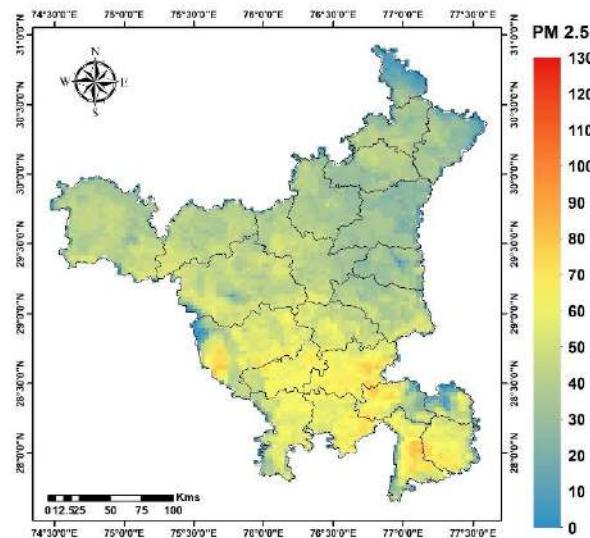
PM 2.5(μg/m³) for March 2020

PM 2.5(μg/m³) for April 2020

[37]
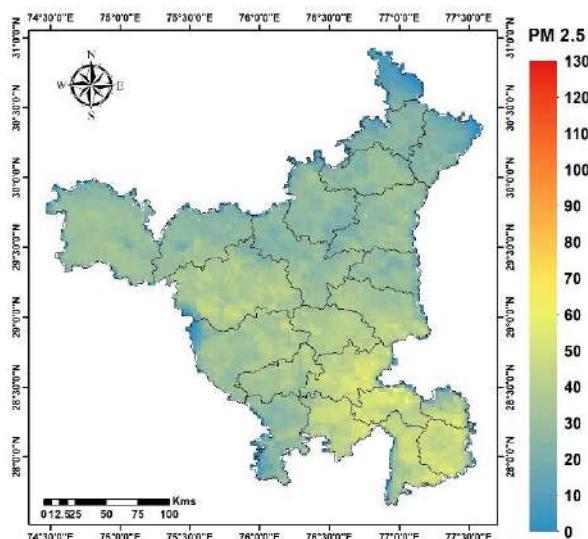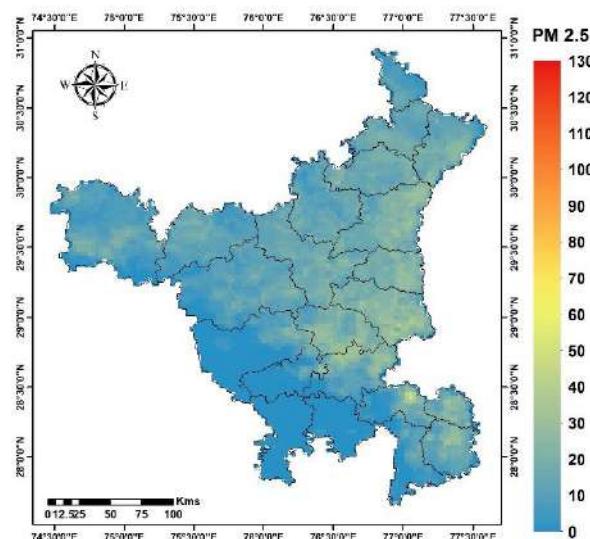
PM 2.5(µg/m³) for May 2020

PM 2.5(µg/m³) for June 2020
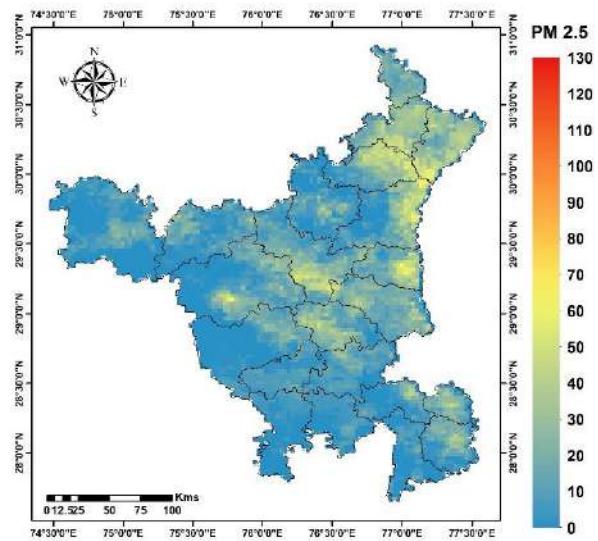
PM 2.5(µg/m³) for July 2020
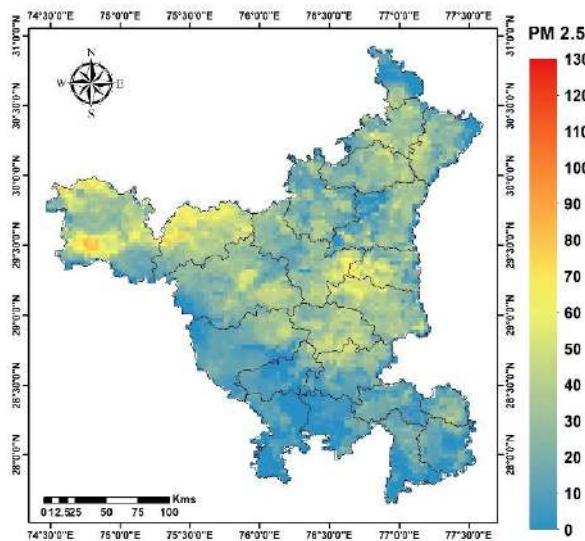
PM 2.5(µg/m³) for August 2020
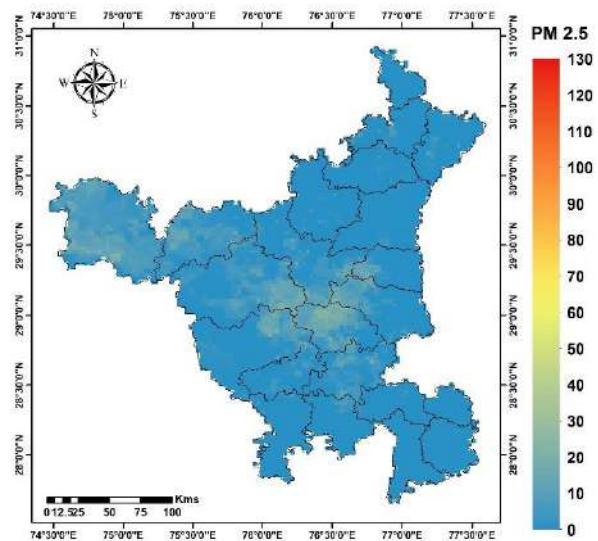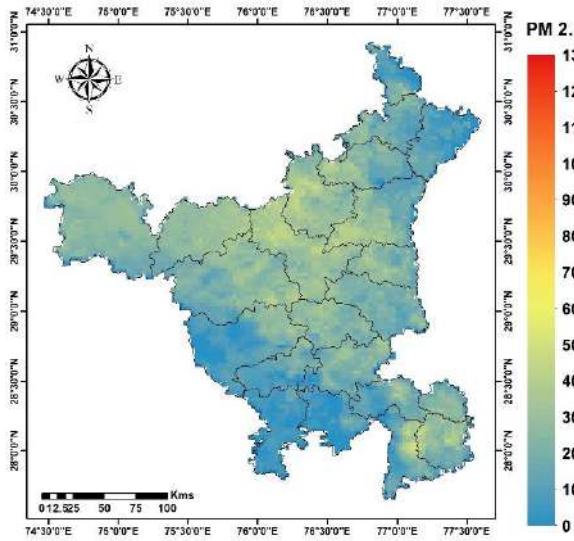
[38]
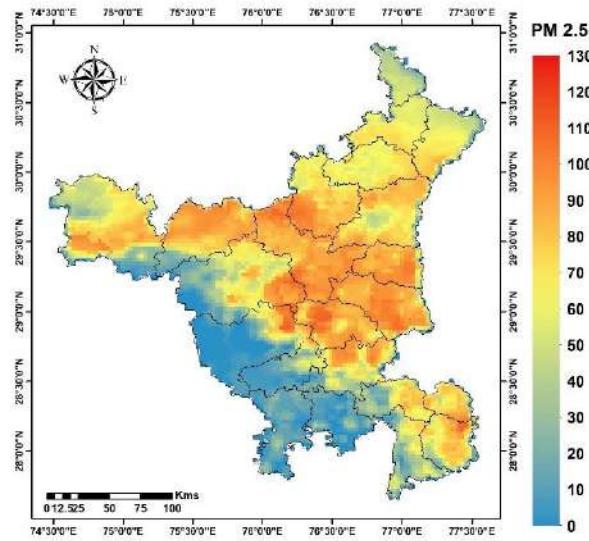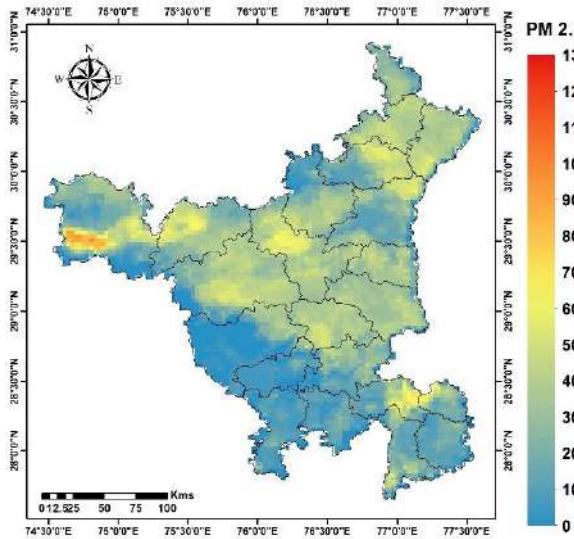
Figure 4.6. Monthly spatial distribution of PM2.5 for the year 2019 over Haryana.

High variability in the spatial pattern of PM2.5 for the year 2020 specially in the month of April and May is be due to various local reasons in the year 2020 (like COVID-19) have shown the lowest accumulation of PM2.5 as compared to previous 4 years (Figure 4.6). The results for other months were following the earlier trend, the maximum value was estimated in month of October as usual and little bit high in November and December. Comparatively low accumulation of PM2.5 in other months may be due to the variable conditions of meteorology and the lockdown cause due to COVID-19 pandemic.

[39]

Results for PM10 for the year 2016 to 2020 are also presented in the similar way as for PM2.5 in above sections. As discussed earlier, same fitted model was used for the generation of PM10 as well. The output was satisfactory and related to the trend and scenario of PM accumulation. Figure 4.7, 4.8, 4.9, 4.10 and 4.11 is showing the spatial pattern and variation of PM10 over Haryana state for the year 2016, 2017, 2018, 2019 and 2020 respectively.

As we can see from the Figure 4.7, the PM10 is highly variable on monthly scale for the year 2016. Accumulation of PM10 for the year 2016 is showing higher values as compared to the other years. This may be due to preventive measures taken by the government for curbing air pollution in the area. The accumulation was following a specific trend i.e. showing high value during month of October, and November, mainly due to high anthropogenic activities like stubble burning, crop burning and festival event involving cracker burst. Comparatively less concentration of PM10 were observed in the month of August may be due to the rainfall dependent settling on the ground.
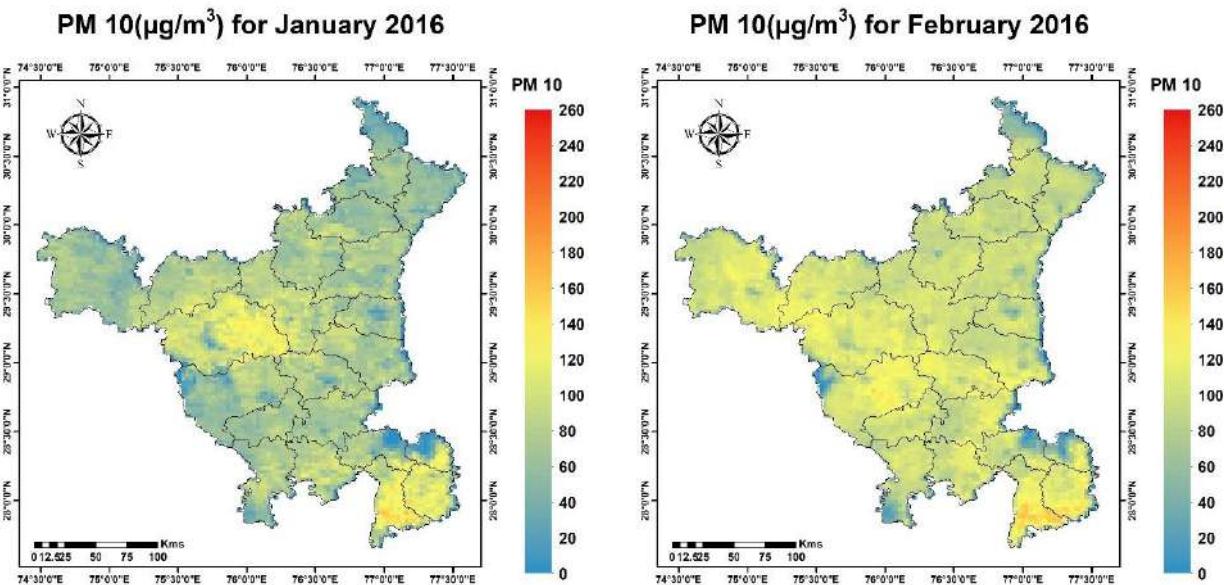
PM 10(µg/m³) for March 2016
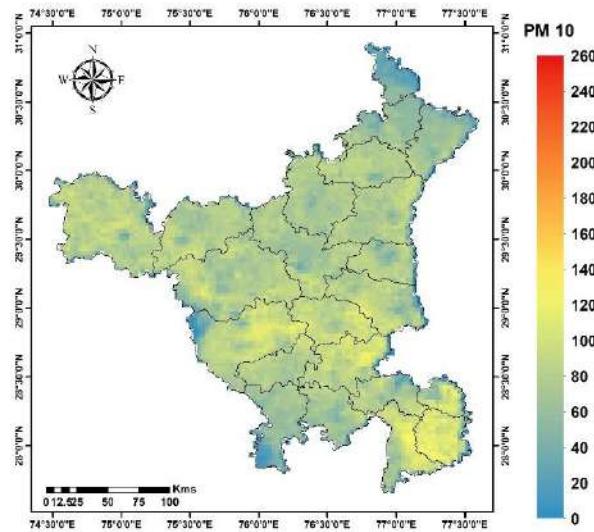
PM 10(µg/m³) for April 2016
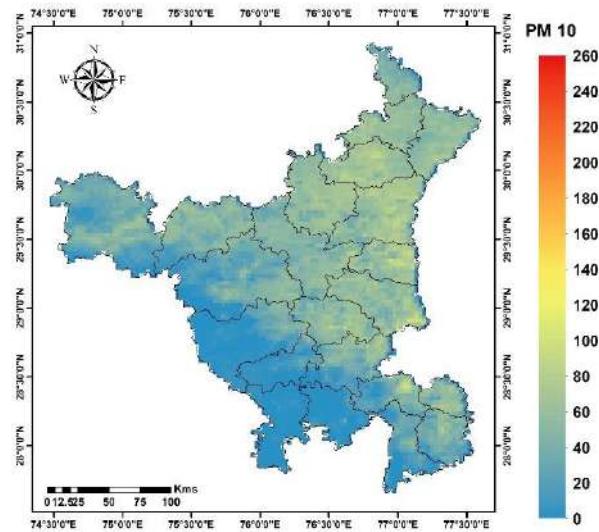
PM 10(µg/m³) for May 2016

PM 10(µg/m³) for June 2016

[41]
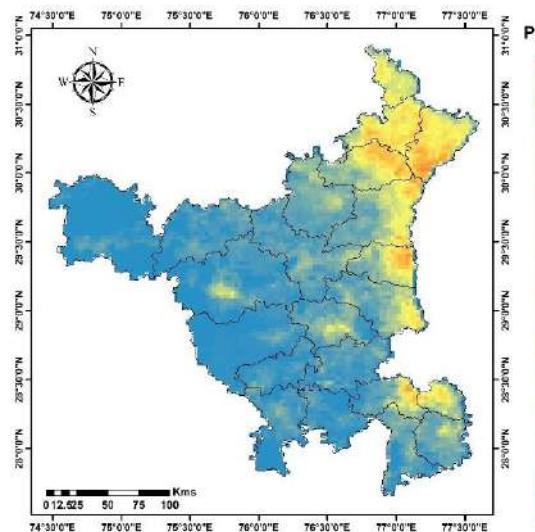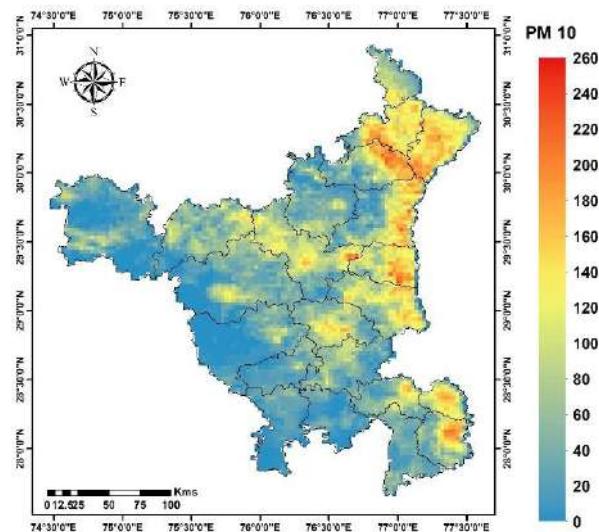
PM 10(μg/m³) for July 2016
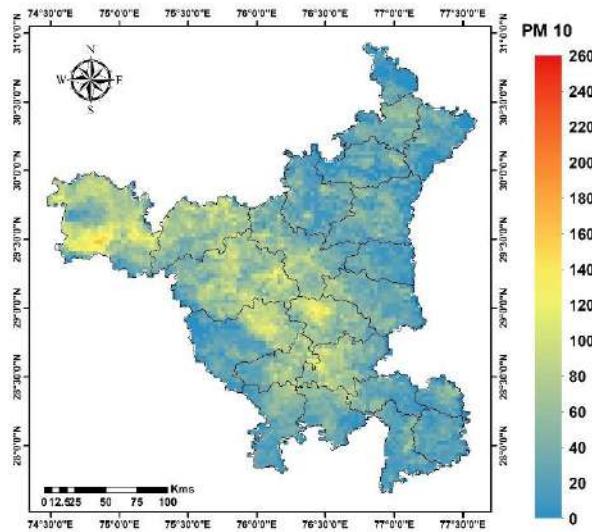
PM 10(μg/m³) for August 2016
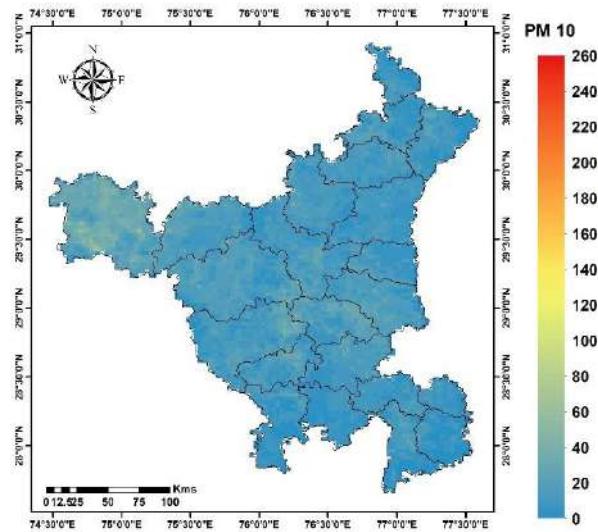
PM 10(μg/m³) for September 2016

PM 10(μg/m³) for October 2016

[42]
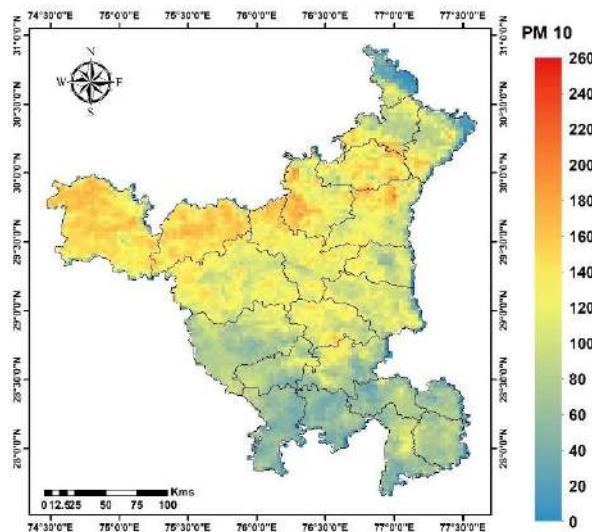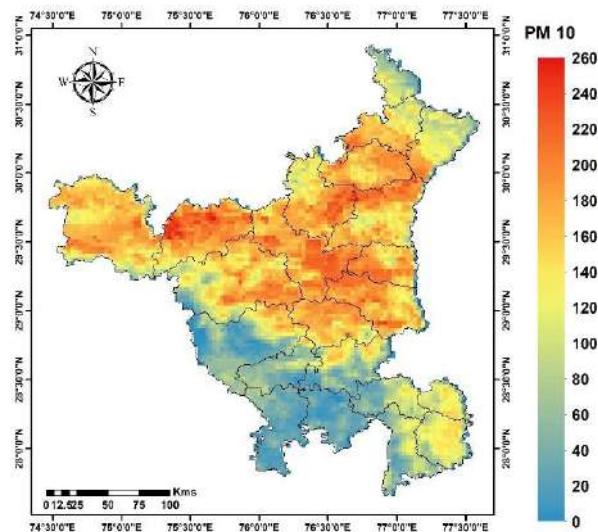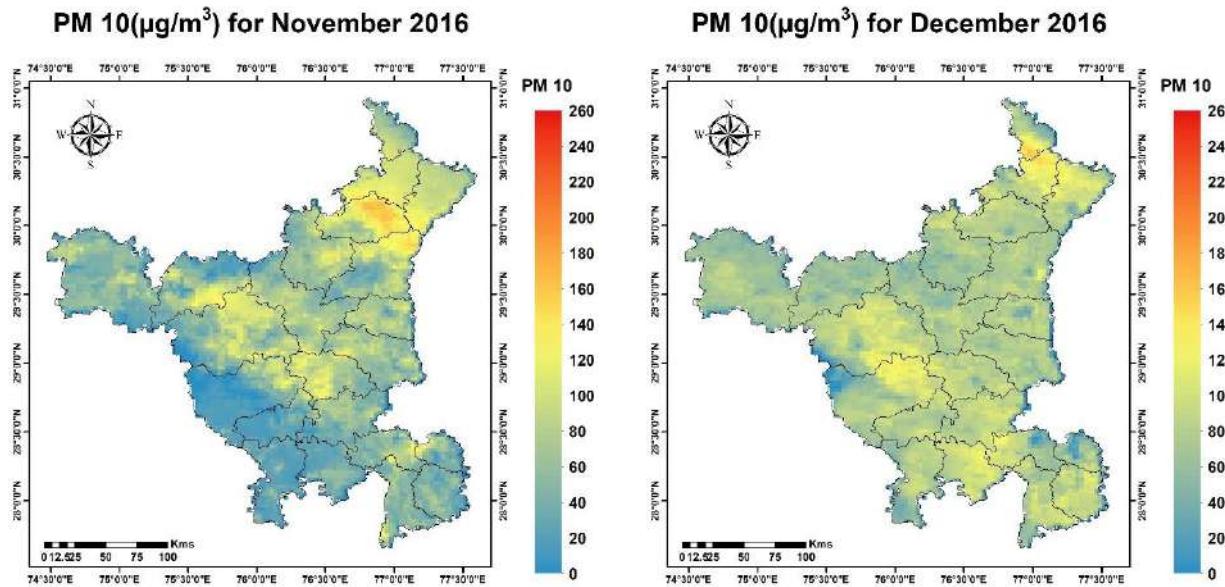
Figure 4.7. Monthly spatial distribution of PM10 for the year 2016 over Haryana.

Figure 4.8 is showing the spatio-temporal variations in the concentration of PM10 over Haryana state for the year 2017. The trend of variation in PM10 concentration is following the trend of variation in PM2.5 concentration. PM10 accumulation was found to be high during the month of October and November. Further October and November month is showing high value mainly due to the late stubble burning and other natural and anthropogenic activities. Interestingly the high values of PM10 were observed in the month of October in the northern part of the state which is mainly due to early started the stubble burning in the northern part of the state. Again high values of PM10 in lower regions of the state which is following rice belt show the late start of stubble burning in these regions. The May and June months show lower PM10 concentration may be due to favourable dispersion conditions.

PM 10(µg/m³) for January 2017
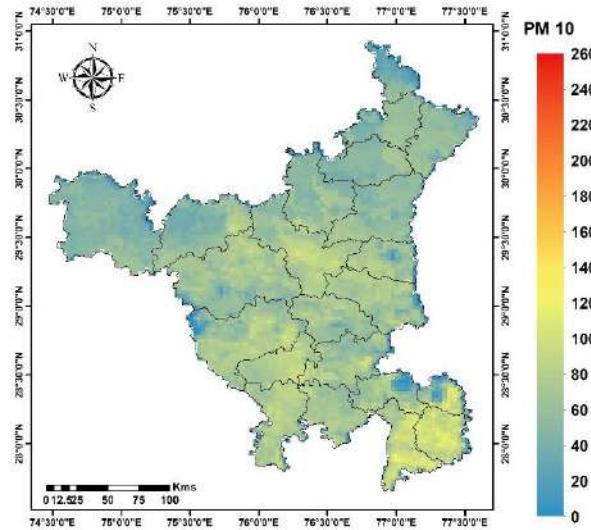
PM 10(µg/m³) for February 2017
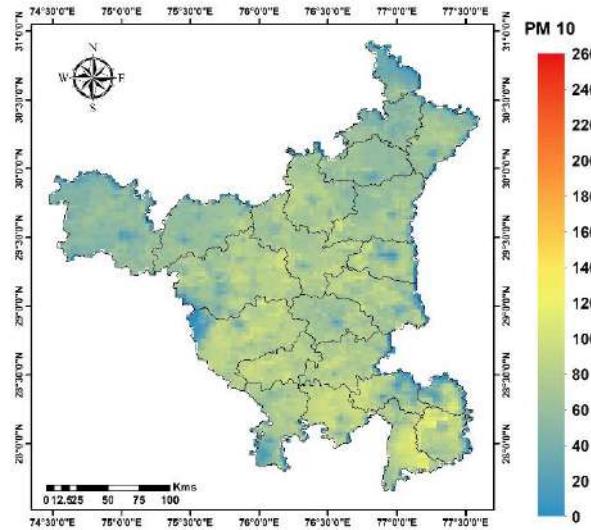
PM 10(µg/m³) for March 2017

PM 10(µg/m³) for April 2017

[44]
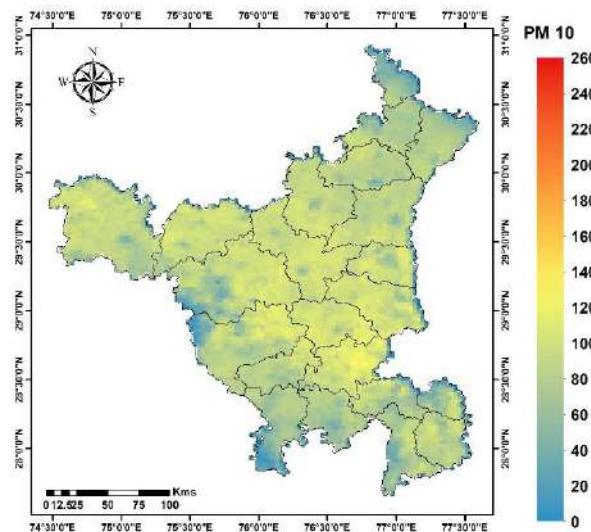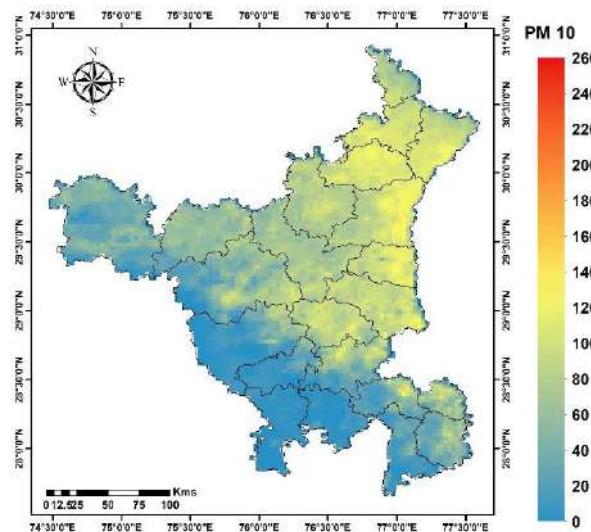
PM 10(μg/m³) for May 2017
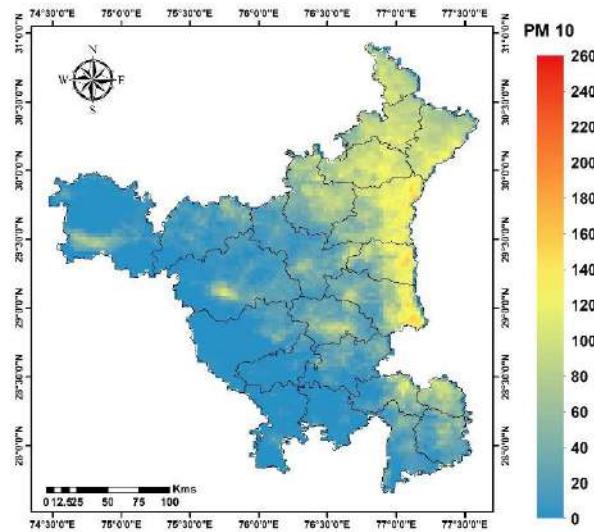
PM 10(μg/m³) for June 2017
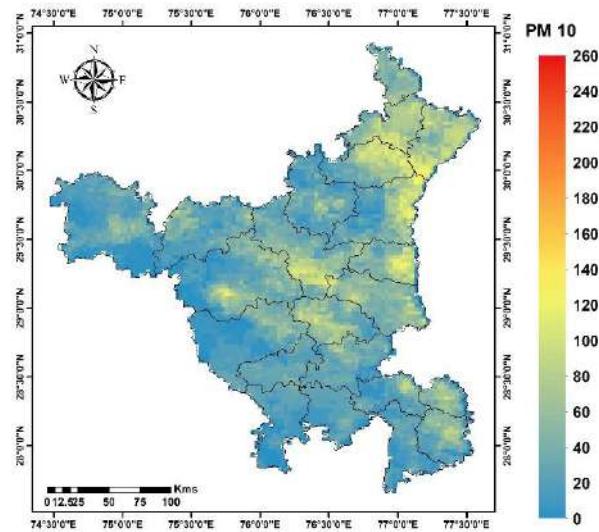
PM 10(μg/m³) for July 2017

PM 10(μg/m³) for August 2017

[45]
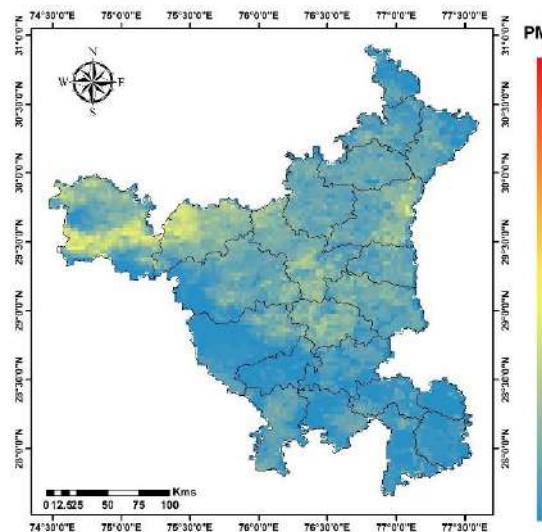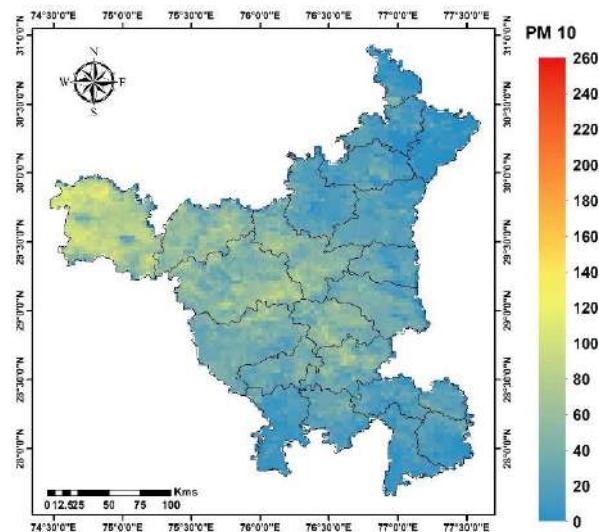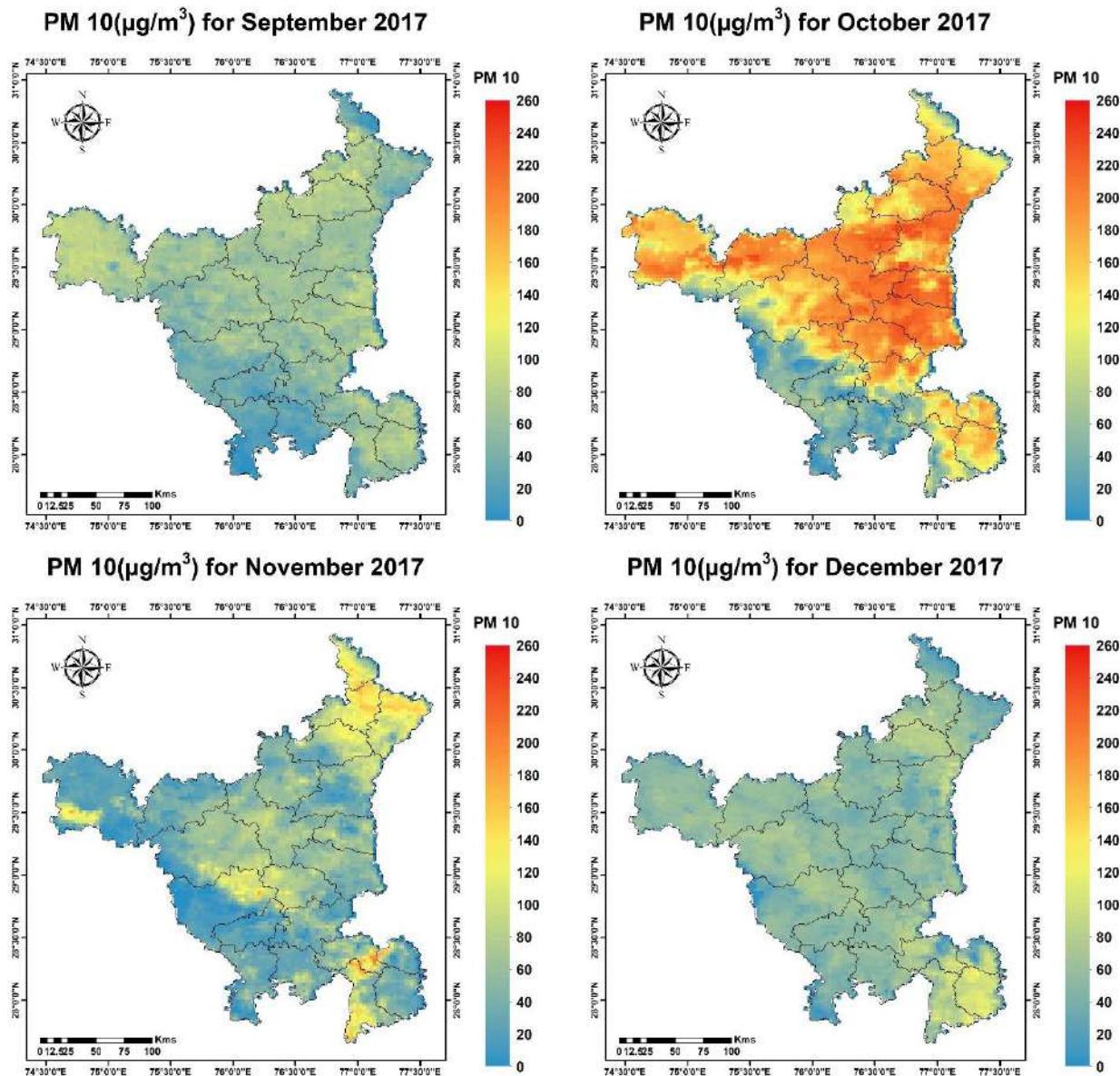
Figure 4.8. Monthly spatial distribution of PM10 for the year 2017 over Haryana.

Figure 4.9 is showing the results for the year 2018 over Haryana for PM10. As we can see from the Figure 4.9, the variation of PM10 for the year 2018 is following similar trend as of the year 2017. However, in the month of January the PM10 was lower as compared to the previous year. The possible reasons may be the favourable meteorological conditions. Relatively high values of PM10 in the month of October, November and December, indicates wheat stubble burning in the region. High values in the Month of May and June may be due to agriculture practices like field ploughing and natural dust brought to the area through wind. Reduced concentration in the month of August and September is due to the rainfall which settled the PM10 on to the ground.

[46]

PM 10(µg/m³) for January 2018
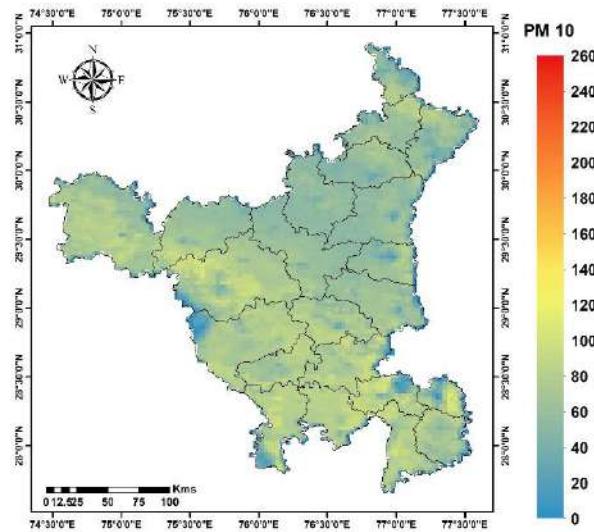
PM 10(µg/m³) for February 2018
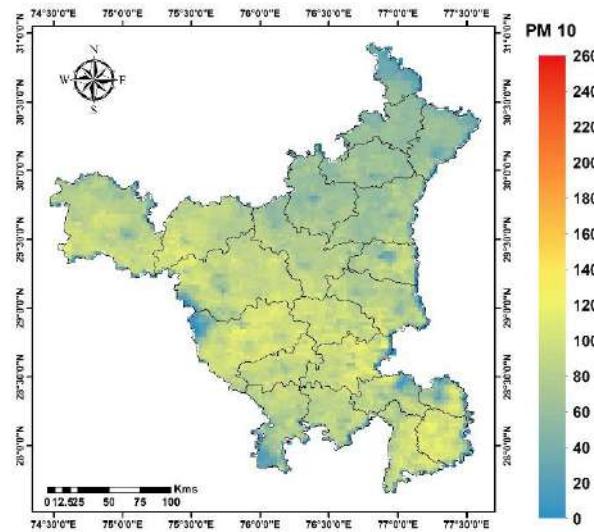
PM 10(µg/m³) for March 2018

PM 10(µg/m³) for April 2018

[47]
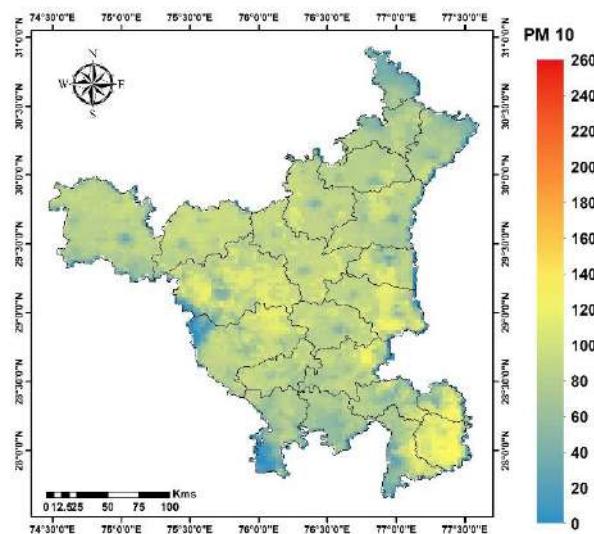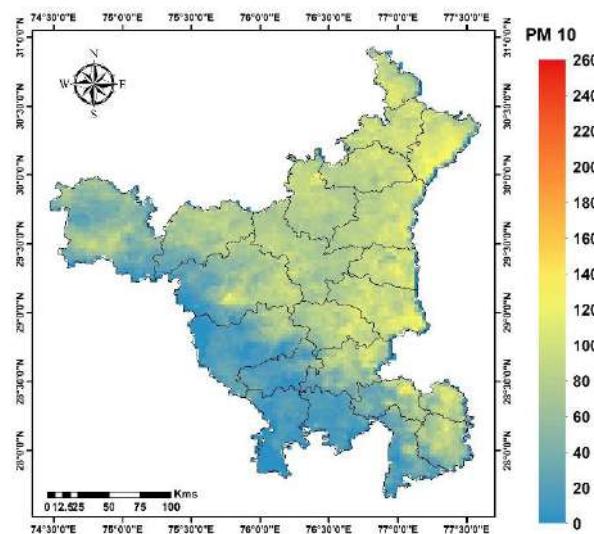
PM 10(μg/m³) for May 2018
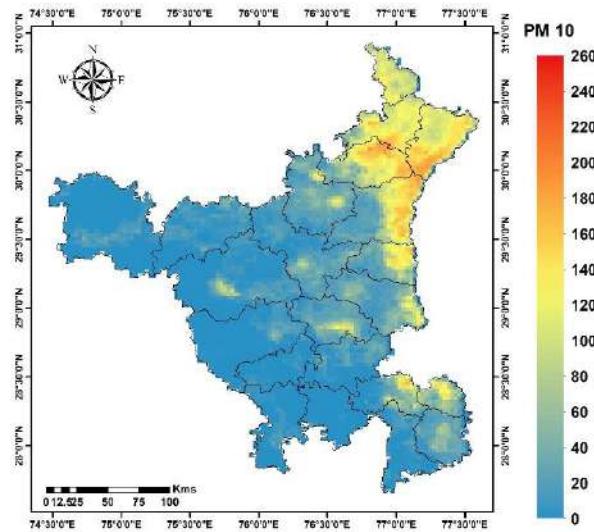
PM 10(μg/m³) for June 2018
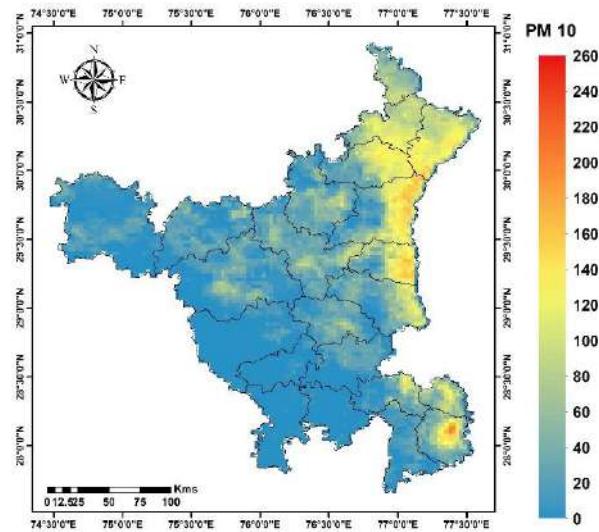
PM 10(μg/m³) for July 2018
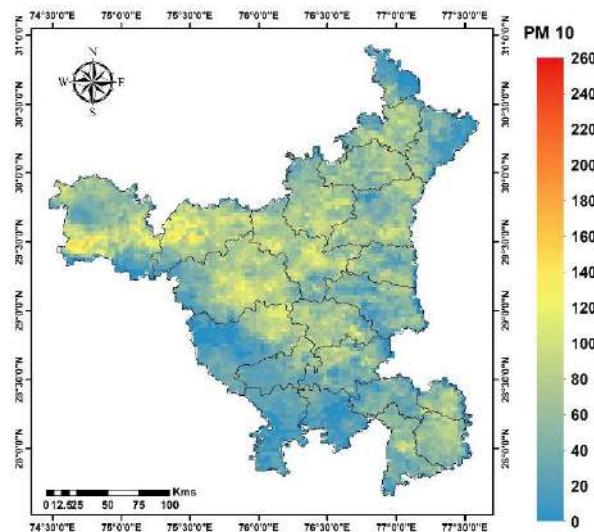
PM 10(μg/m³) for August 2018

[48]
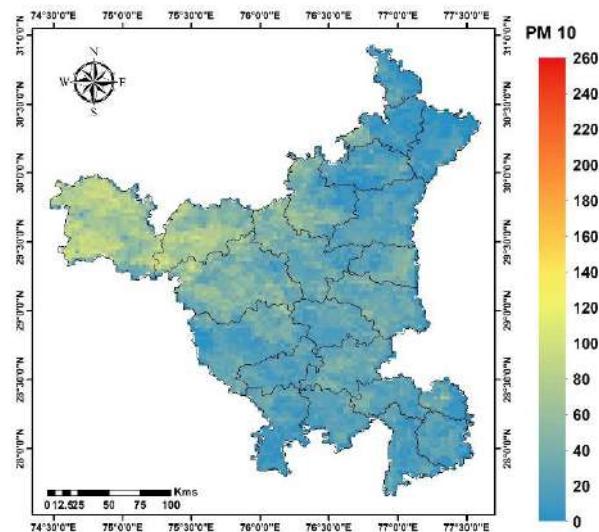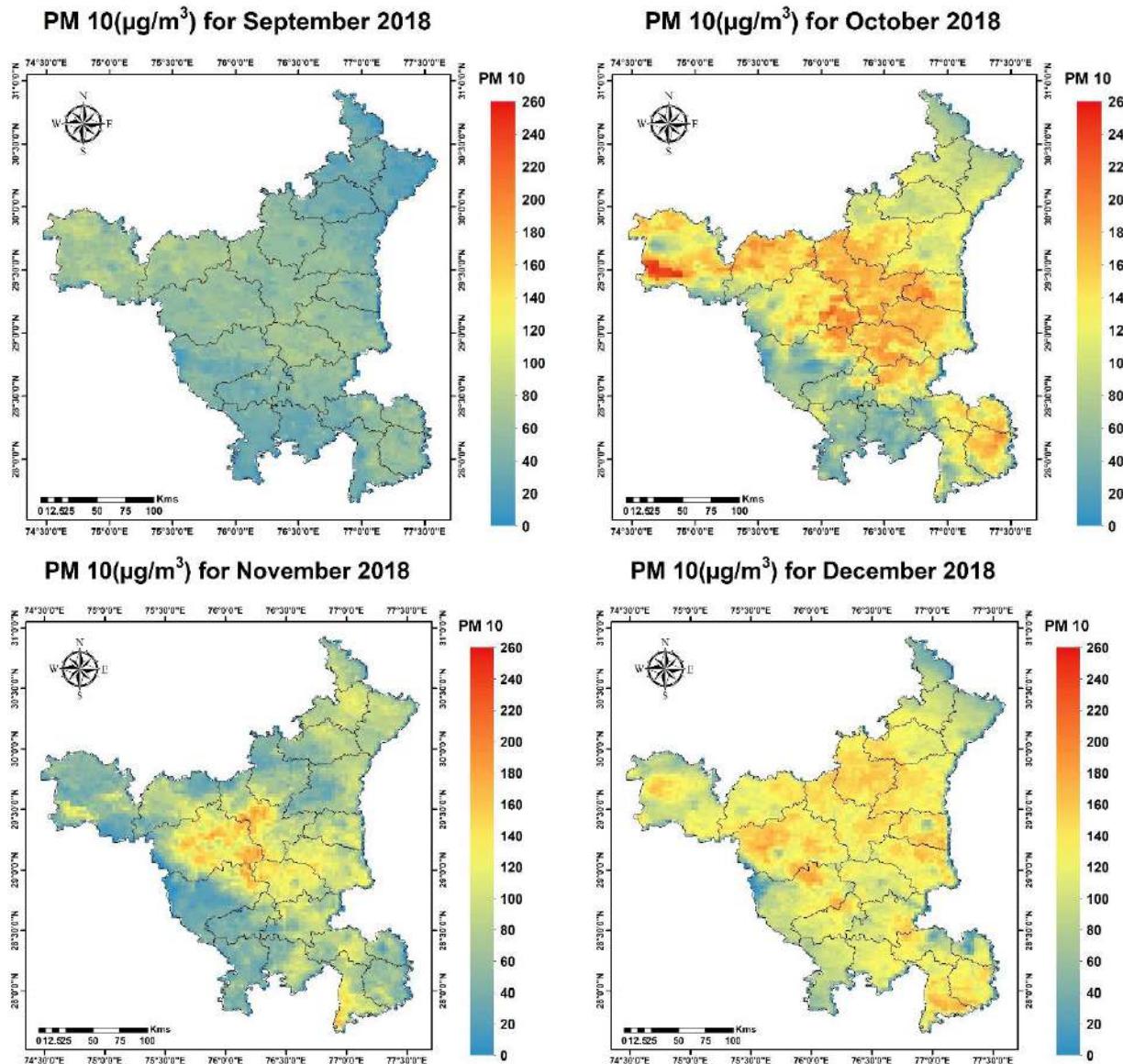
Figure 4.9. Monthly spatial distribution of PM10 for the year 2018 over Haryana.

Results related to the spatio-temporal variation in the concentration of PM10 for the year 2019 is presented in Figure 4.10. The variation of PM10 for the year 2019 is lower as compare to previous years and trend is gradual i.e. showing higher value during the month on January and October which is mainly due to natural dust and stubble burning activities respectively along with other factors. Lower PM accumulation on the first half of the year was observed may be due to the favourable meteorology and the monsoon. Low values were observed for the month of February and March. Relatively low values of PM10 in the month of July, is due to the after effect of the month of June.

[49]

PM 10(μg/m³) for January 2019
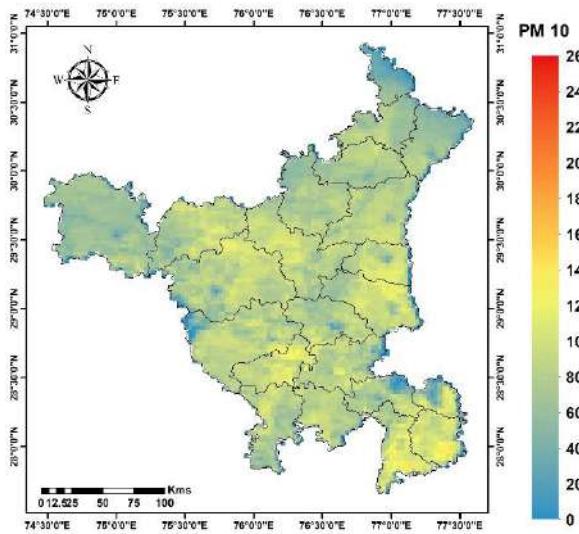
PM 10(μg/m³) for February 2019
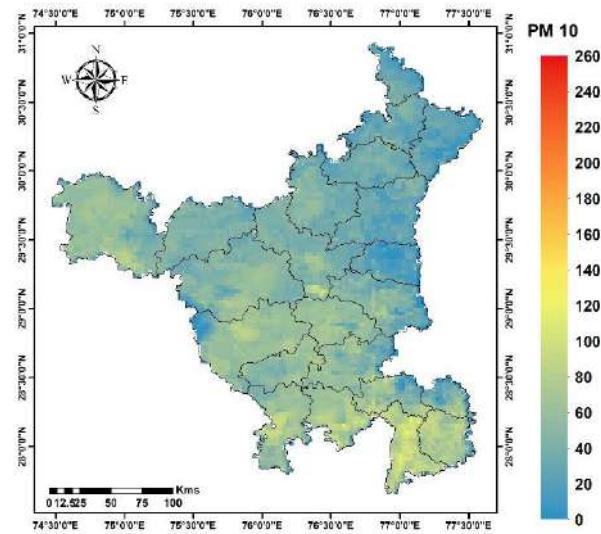
PM 10(μg/m³) for March 2019
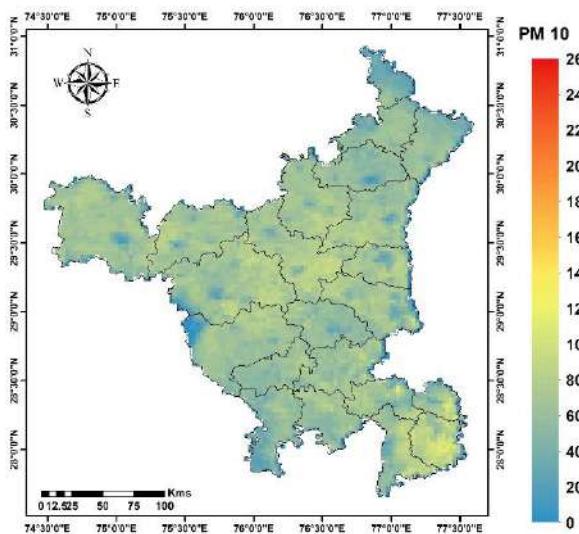
PM 10(μg/m³) for April 2019
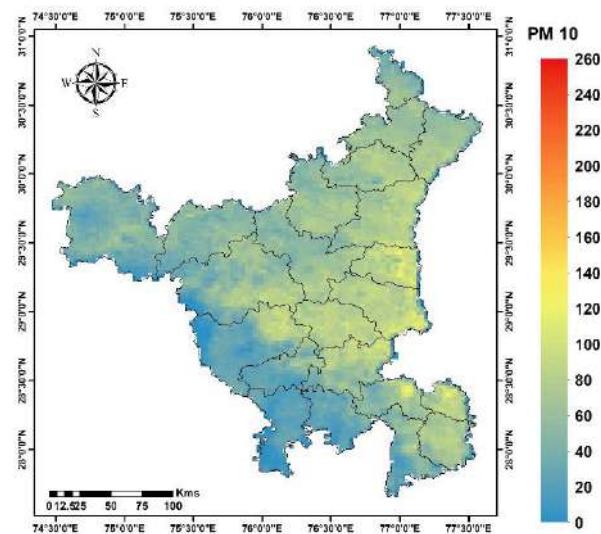
PM 10(µg/m³) for May 2019
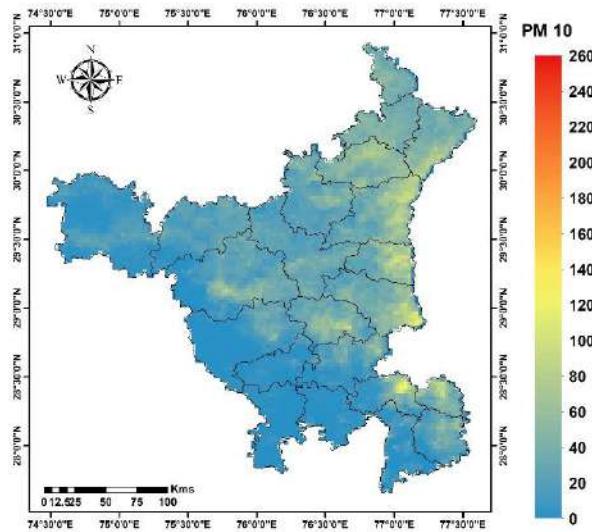
PM 10(µg/m³) for June 2019
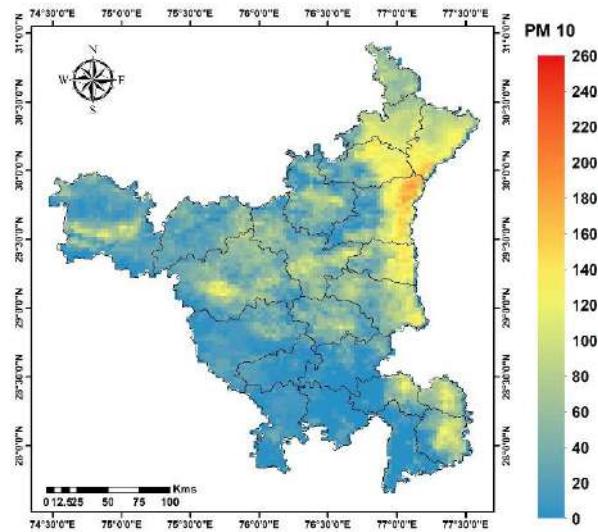
PM 10(µg/m³) for July 2019

PM 10(µg/m³) for August 2019

[51]
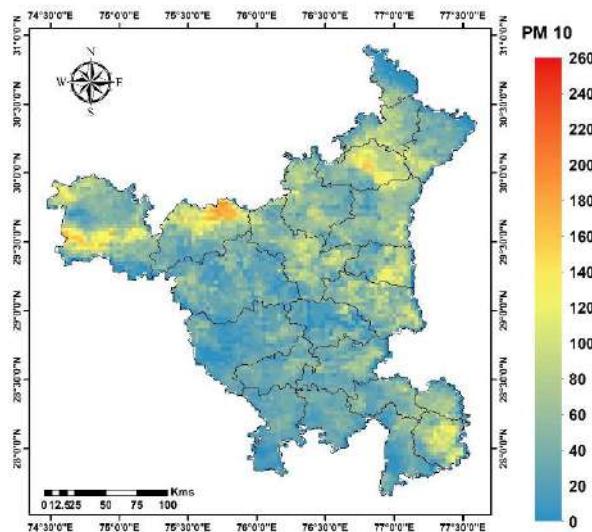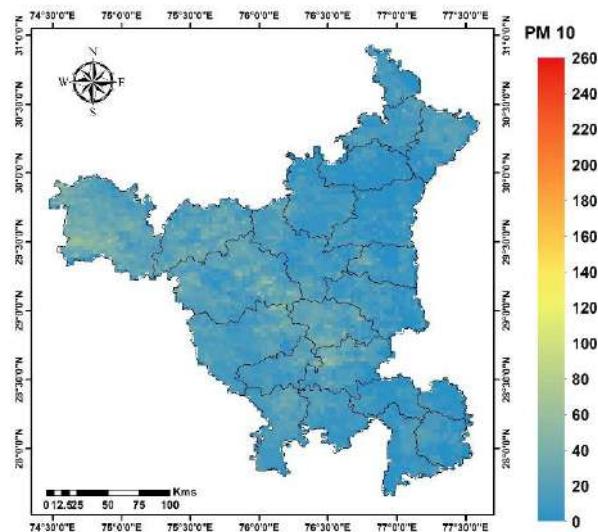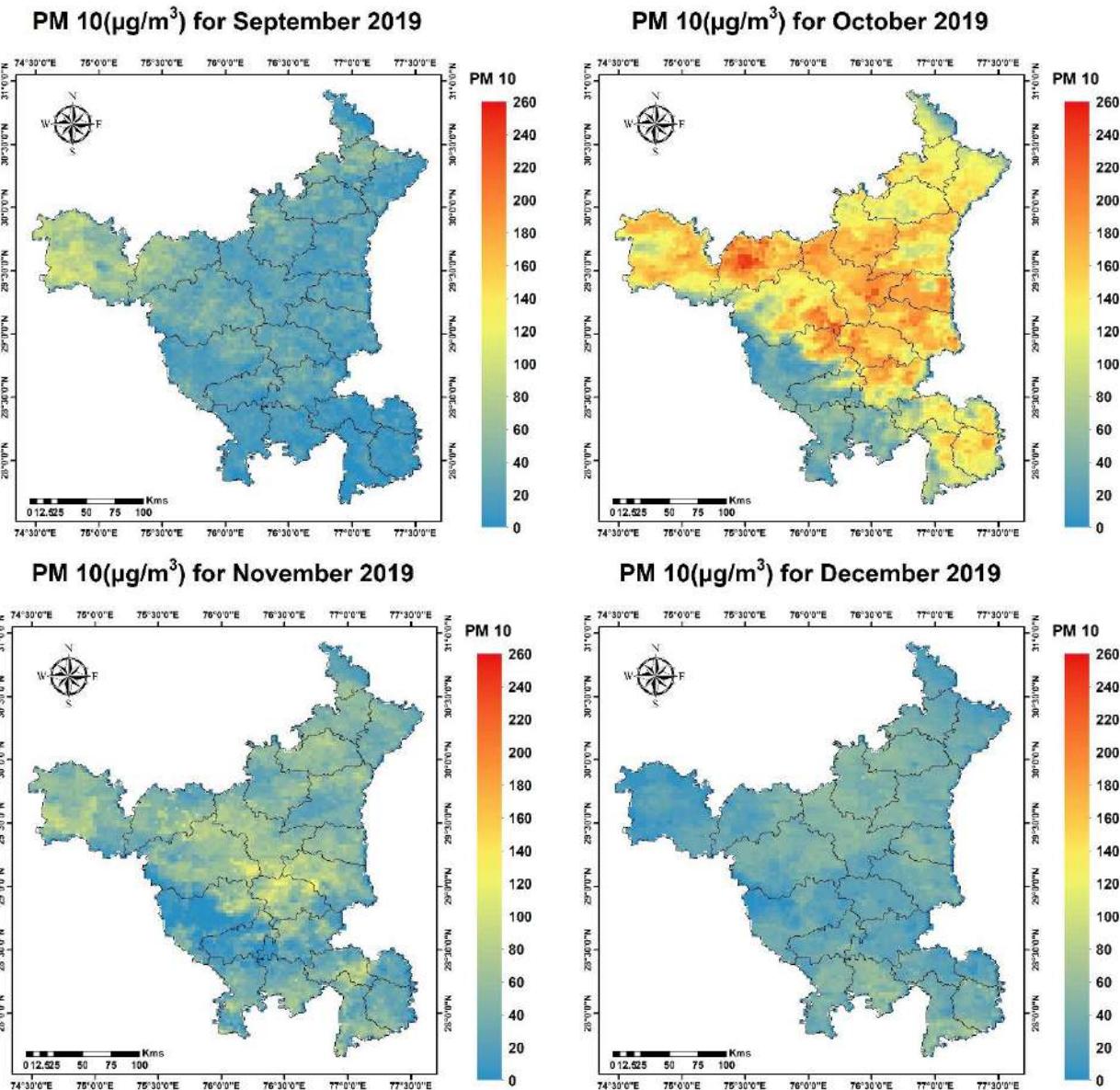
Figure 4.10. Monthly spatial distribution of PM10 for the year 2019 over Haryana.

Figure 4.11 is showing spatio-temporal variations in the concentration of PM10 over Haryana state for the year 2020. The variation of PM10 concentration especially in the months of March, April and May, is mainly due to various local reasons originated from COVID-19 driven lockdown. The year 2020 showed lowest accumulation of PM10 as compared to previous 4 years. However it was following the trend and the maximum values were observed in month of October, November and December mainly due to the rice based stubble burning and stagnant meteorological conditions. Relatively high values were observed in the month of February is mainly due to excessive biomass burning for heat and natural dust accumulation.

PM 10(µg/m³) for January 2020
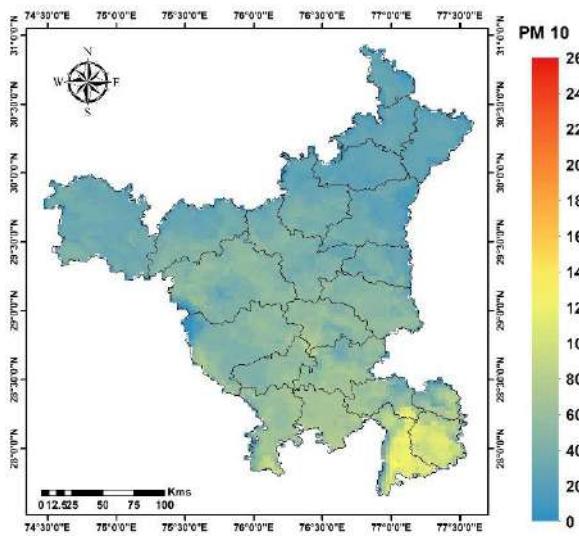
PM 10(µg/m³) for February 2020
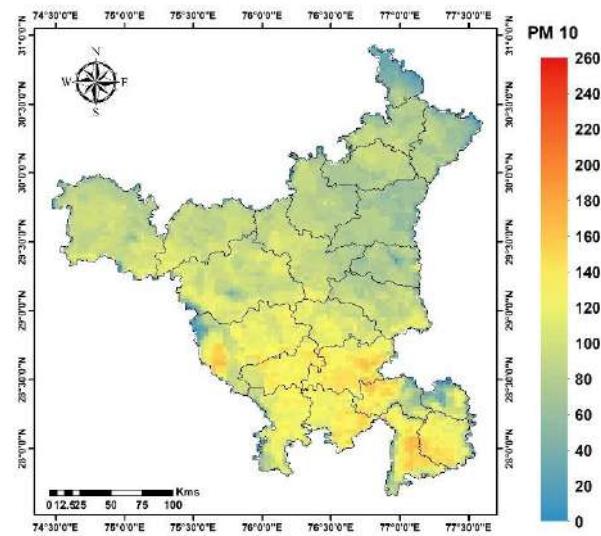
PM 10(µg/m³) for March 2020

PM 10(µg/m³) for April 2020

[53]
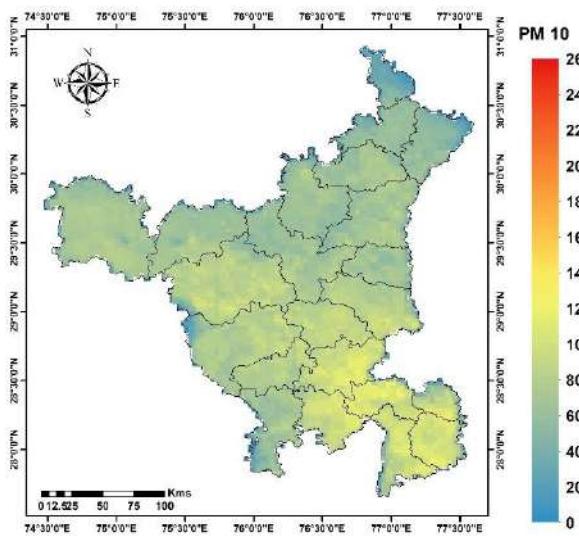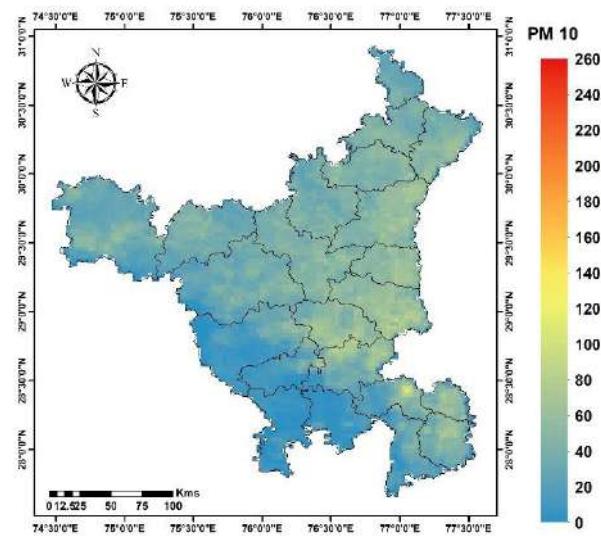
PM 10(μg/m^3) for May 2020

PM 10(μg/m^3) for June 2020

PM 10(μg/m^3) for July 2020

PM 10(μg/m^3) for August 2020

[54]

PM 10(μg/m³) for September 2020

PM 10(μg/m³) for October 2020

PM 10(μg/m³) for November 2020
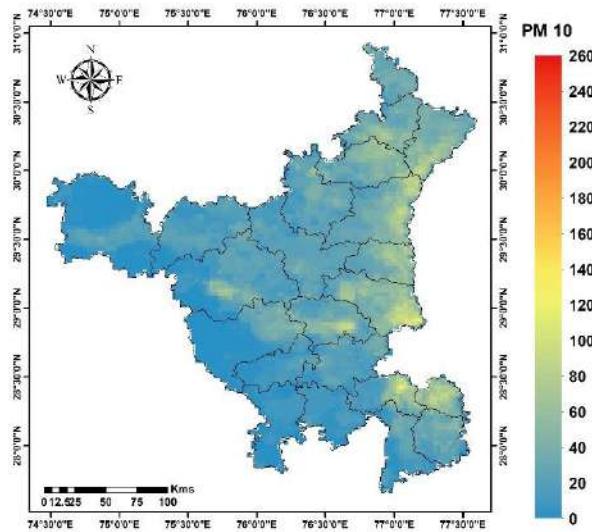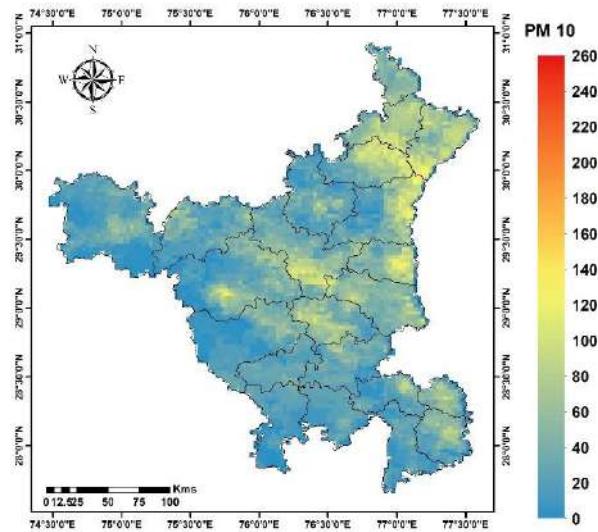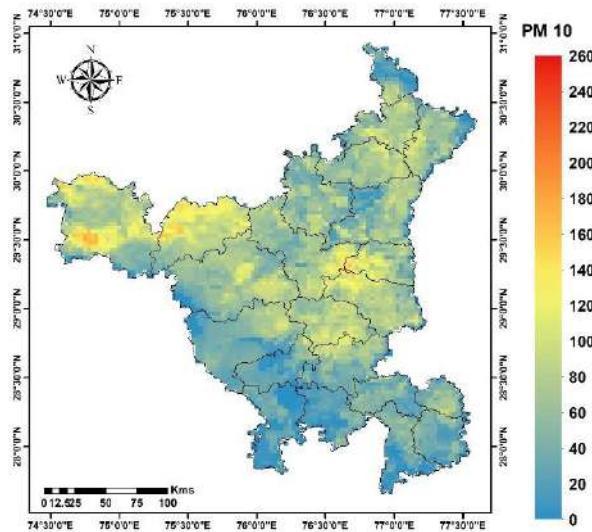
PM 10(μg/m³) for December 2020
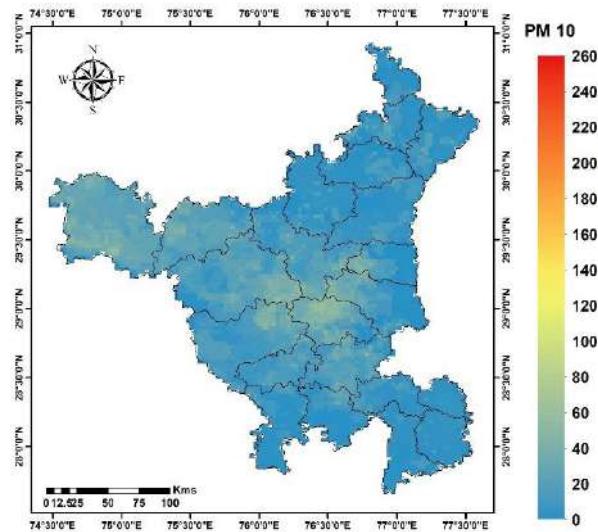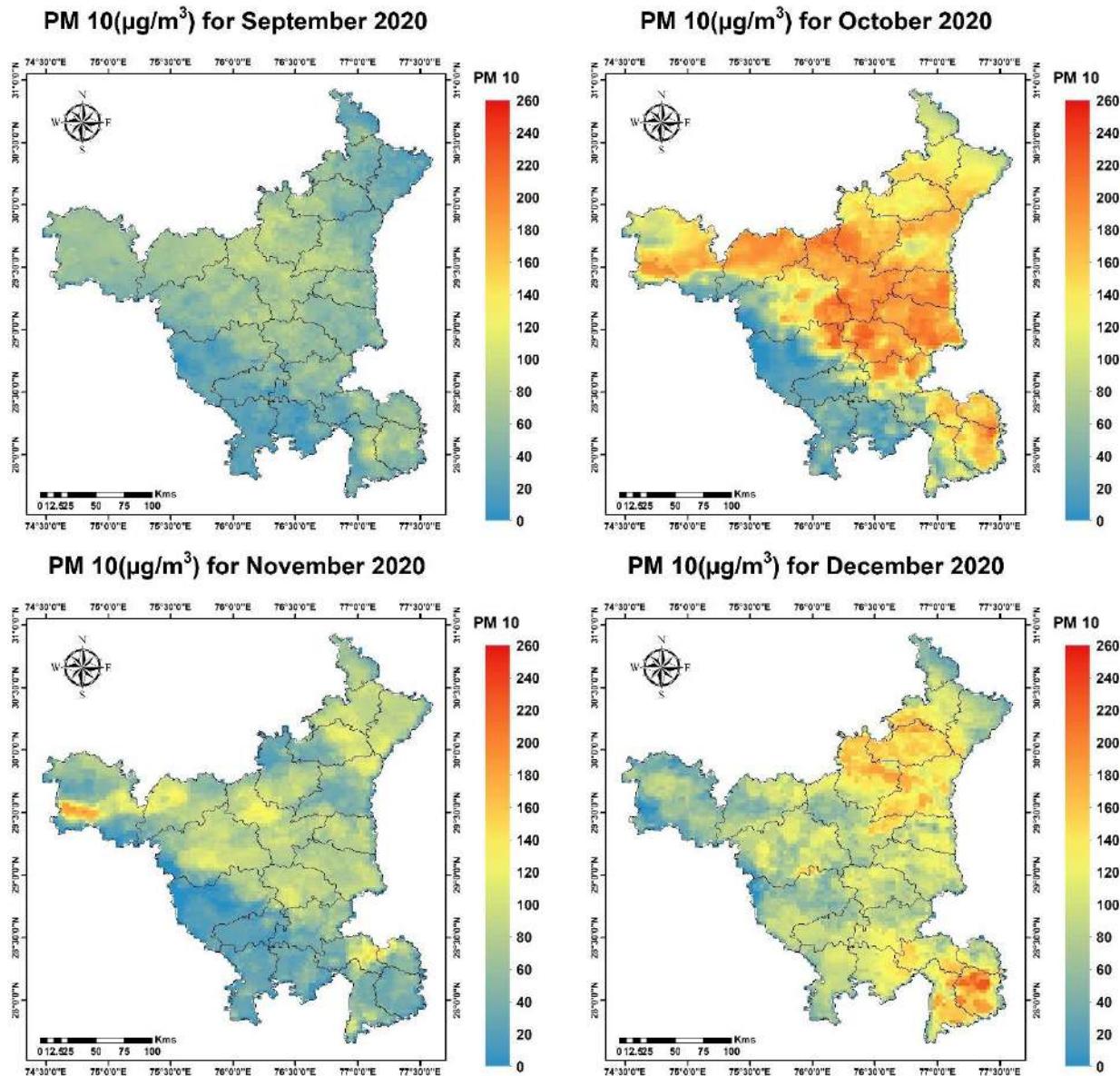
Figure 4.11. Monthly spatial distribution of PM2.5 for the year 2019 over Haryana.

By analysing the trend for PM2.5 and PM10 accumulation for the year 2016 to 2020 it was concluded that the concentration of both the PM2.5 and PM10 follows a specific trend where October and November showed high concentration and March, April, and August show lowest concentration. Both the PM2.5 and PM10 were found highly correlated with each other. However, the spatio-temporal trends in the concentration of PM2.5 and PM10 do match perfectly with the scenarios and reasoning's related to the activities happening throughout the year. Rather it is showing the contribution from both the natural and anthropogenic activities which is mainly considered as anthropogenic in general conceptions. High correlation of satellite based estimates

[55]

of PM2.5 and PM10 concentration with the ground-based accumulation indicates the suitability of methodology for the regular monitoring of these pollutants which may further help in the air quality estimation and health management.

4.4   Validation using Predicted PM and Ground based PM

As discussed earlier, the validation was done using Ground based PM10 and PM2.5 from CPCB as observed data and estimated PM10 and PM2.5 for the generated models as predicted data. The statistical details of each of the model generated for the estimation of PM10 and PM2.5 is shown in Table 4.4.

Table 4.4. PM10 and PM2.5 GLM Model details and description.

Model Details	Model	RMSE	St.Error	R2	Pr Value
GLM for PM10 with 05 variables	Eq. 4	2.1216	0.0166	0.9747	2e -16
GLM for PM2.5 with 05 variables	Eq. 5	1.7674	0.0257	0.9681	2e -16
GLM for PM10 with 01 variables	Eq. 6	2.2187	0.0169	0.9746	2e -16
GLM for PM2.5 with 01 variables	Eq. 7	1.8458	0.0259	0.9683	2e -16

As from the above details we can see that the accuracy of model is excellent as having R^2 of 0.97 for PM10 and 0.96 for PM2.5. The simple regression models were compared with the model including five variables (AOD, Temp, RH, WD, WS) and there was not much difference in the results. Hence, the simple regression models have been opted for the easy implementation and accurate estimation.

Conclusions

This study was done to develop suitable models for the estimation of PM2.5 and PM10. Though, there were many new and interesting outcomes, this may be considered as a vital baseline for further research and applications. Some of the key conclusions are presented here.

➢ MODIS aerosol retrievals provide useful perspective to the regional air pollution. The two case regions situated in the Gurugram namely Gwal Pahari and Amity University

demonstrated the MODIS capability for monitoring regional and local air pollution. With Terra and Aqua MODIS direct broadcasting (data processing time <1 hour), the near real time (twice a day) monitoring of air pollution is possible in any places around the world however facilities needs to be developed for near real time monitoring. The correlation values (R^2) of 0.77 and 0.79 for Gwal Pahari and Amity University respectively, were obtained between AERONET-derived data (ground data) and Satellite retrieved data. This gives statistical evidence about how efficient and effective MODIS AOD data is for global and regional environmental research.

➢ This study becomes more important as it have included the ground based PM data from CPCB for the validation. The satellite based estimates showed variations as compared to the ground based estimates though the coefficient of correlation was high (r2>0.9). Hence further estimation of PM becomes so vital and necessary for better understanding of air quality.

➢ The output which defines the role of particulate matter in the air quality of the region signifies the current study. The variation and trends which was observed in last half decade gives an idea about how we can keep such pollutant in check, and when and where we press the panic or control button, to stabilise the accumulation. This study may also provide various aspect of understanding of roles of air pollution in various climatic events. Furthermore, the trend hasn't change in half a decade, so taking measure for putting barrier during high wave can keep such pollutant in control.

➢ Current study also gives us a brief idea about characteristic relationship between different meteorological parameters and how they defies and alter certain part of major pollutant matters. The relationship between PM and AOD gives us brief idea about the role they play in impacting air quality.

➢ Baseline data for the PM2.5 and PM10 which was lacking is being generated for half decade in this study.

➢ Machine learning tools always play important role in estimation and prediction of satellite derived PM and implied here in this study is uniqueness of the study. Their accuracy defines the fitness of the certain models likewise with R^2 of 0.97 and 0.96 for PM10 and PM2.5 respectively shows how accurate the model has behaved with limited use of parameters.

[57]

However underestimation was observed and further analysis may help in tackling this problem.

➢ This study also gives alarming signs to certain places of the study area, which should be taken care of as soon as possible. Mainly Gurugram, Faridabad, Jind, Karnal requires special attention in improving the quality of air by taking various control measures. These cities are marked as worst places to live; the air to breath is not even close to quality mark of NAAQs.

➢ This current study is unique and may be considered as baseline for the further studies and research as no such work was done earlier. Further the database and model generated in this study would be valuable for the regular monitoring of PM2.5 and PM10 which may further be valuable for the air quality estimation and health management.

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ANNEXURE I

S.No.	Sub-datasets in MODIS AOD retrieval	Type/Class
1	Scan Start Time	64-bit floating point
2	Solar Zenith	16-bit integer
3	Solar Azimuth	16-bit integer
4	Sensor Zenith	16-bit integer
5	Sensor Azimuth	16-bit integer
6	:Scattering Angle	16-bit integer
7	Glint Angle	16-bit integer
8	Land Ocean Quality Flag	16-bit integer
9	Land sea Flag	16-bit integer
10	Wind Speed Ncep Ocean	16-bit integer
11	Optical Depth Land And Ocean	16-bit integer
12	Image Optical Depth Land And Ocean	16-bit integer
13	Aerosol Type Land	16-bit integer
14	Fitting Error Land	16-bit integer
15	Surface Reflectance Land	16-bit integer
16	Corrected Optical Depth Land	16-bit integer
17	Corrected Optical Depth Land wav2p1	16-bit integer
18	Optical Depth Ratio Small Land	16-bit integer
19	Number Pixels Used Land	16-bit integer
20	Mean Reflectance Land	16-bit integer
21	STD Reflectance Land	16-bit integer
22	Mass Concentration Land	32-bit floating point
23	Aerosol Cloud Fraction Land	16-bit integer
24	Quality Assurance Land	8-bit integer
25	Solution Index Ocean Small	16-bit integer
26	Solution Index Ocean Large	16-bit integer
27	Effective Optical Depth Best Ocean	16-bit integer
28	Effective Optical Depth Average Ocean	16-bit integer
29	Optical Depth Small Best Ocean	16-bit integer
30	Optical Depth Small Average Ocean	16-bit integer
31	Optical Depth Large Best Ocean	16-bit integer
32	Optical Depth Large Average Ocean	16-bit integer
33	Mass Concentration Ocean	32-bit floating point
34	Aerosol Cloud Fraction Ocean	16-bit integer
35	Effective Radius Ocean	16-bit integer
36	PSML003 Ocean	32-bit floating point
37	Asymmetry Factor Best Ocean	16-bit integer
38	Asymmetry Factor Average Ocean	16-bit integer
39	Backscattering Ratio Best Ocean	16-bit integer
40	Backscattering Ratio Average Ocean	16-bit integer
41	Angstrom Exponent 1 Ocean	16-bit integer
42	Angstrom Exponent 2 Ocean	16-bit integer
43	Least Squares Error Ocean	16-bit integer

44	Optical Depth Ratio Small Ocean 0.55micron	16-bit integer
45	Optical Depth by models ocean	16-bit integer
46	Number Pixels Used Ocean	16-bit integer
47	Mean Reflectance Ocean	16-bit integer
48	STD Reflectance Ocean	16-bit integer
49	Quality Assurance Ocean	16-bit integer
50	Topographic Altitude Land	16-bit integer
51	BowTie Flag	16-bit integer

ANNEXURE II

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of January at ground station points in Haryana

Districts	1-Jan	2-Jan	3-Jan	4-Jan	5-Jan	6-Jan	7-Jan	8-Jan	9-Jan	10-Jan	11-Jan	12-Jan	13-Jan	14-Jan	15-Jan	16-Jan	17-Jan	18-Jan	19-Jan	20-Jan	21-Jan	22-Jan	23-Jan	24-Jan	25-Jan	26-Jan	27-Jan	28-Jan	29-Jan	30-Jan	31-Jan
Ambala	53	50	65	83	101	79	116	90	69	69	62	86	60	51	NA	26	88	159	85	NA	85	74	64	58	73	40	90	82	49	46	NA
Jhajjar	NA	NA	101	86	130	118	NA	141	76	51	67	104	NA	NA	63	NA	95	80	NA	NA	NA	NA	75	76	82	81	142	80	37	172	NA
Faridabad	86	NA	140	NA	80	NA	NA	NA	85	79	NA	135	NA	NA	84	NA	NA	86	84	NA	NA	NA	NA	NA	NA	83	NA	121	NA	80	NA
Bhiwani	80	105	76	86	89	127	80	54	67	71	56	103	116	24	60	31	98	73	NA	53	101	131	NA	103	78	65	147	89	95	84	82
Rewari	87	105	92	68	106	103	76	82	61	63	65	94	84	43	57	158	87	63	68	NA	NA	135	76	114	99	55	NA	77	28	76	78
Faridabad	100	NA	90	94	79	NA	120	NA	48	78	NA	88	58	38	62	27	104	NA	80	25	NA	78	74	NA	81	59	98	57	53	56	60
Fatehabad	NA	107	82	94	261	NA	105	53	63	59	73	88	157	33	68	NA	142	103	97	NA	22	84	74	120	73	79	135	60	81	98	81
Gurugram	93	209	66	84	86	NA	94	63	64	42	66	71	NA	44	59	31	NA	50	56	36	36	68	74	97	94	69	108	76	43	63	61
Hisar	NA	109	72	81	82	164	54	43	28	64	63	119	40	27	61	NA	86	NA	79	NA	NA	168	75	76	77	79	NA	54	25	82	NA
Jind	123	95	80	104	83	174	105	NA	60	61	69	103	161	47	67	NA	117	82	74	NA	69	110	70	101	84	58	184	90	51	56	95
Kaithal	72	37	87	99	136	NA	62	65	45	48	59	113	86	38	61	39	149	49	35	NA	NA	80	72	70	78	77	172	59	79	58	NA
Karnal	61	95	77	99	116	NA	57	77	35	53	82	76	102	38	34	NA	69	70	35	51	NA	60	56	78	67	66	170	58	NA	NA	37
Kurukshetra	53	32	68	82	100	NA	61	76	66	52	84	91	49	38	45	42	90	49	41	NA	NA	64	64	86	81	NA	127	NA	86	216	NA
Mewat	85	145	109	95	128	189	105	129	72	59	67	90	63	60	70	16	94	96	58	49	45	108	74	103	122	71	146	165	86	88	99
Gurugram	113	117	82	88	97	95	NA	NA	NA	59	60	89	75	52	67	NA	122	71	112	NA	87	NA	74	117	78	90	152	82	79	79	87
Mahendar-garh	84	93	98	62	89	135	75	82	44	55	42	92	123	30	44	64	66	55	66	43	26	97	63	77	77	60	102	60	84	61	73
Palwal	84	138	114	112	116	99	147	72	69	61	56	96	121	77	81	73	119	104	78	21	NA	122	79	NA	97	56	148	143	91	106	98
Panchkula	40	NA	48	NA	69	NA	50	NA	51	74	52	56	67	38	61	51	NA	44	24	50	68	75	43	35	39	60	126	84	76	63	NA
Panipat	75	108	84	106	119	201	129	49	59	63	93	87	109	43	62	35	100	85	33	50	40	87	66	95	68	36	90	60	76	37	87
Rohtak	64	107	76	70	127	143	65	79	61	60	57	93	71	32	56	17	87	78	51	39	67	120	75	125	97	66	133	68	52	78	102
Sirsa	103	136	79	90	156	NA	67	NA	67	58	75	51	55	28	NA	NA	91	NA	113	46	27	88	74	88	79	79	NA	80	52	70	80
Sonipat	125	97	100	112	138	219	50	50	52	56	78	97	116	81	65	43	152	97	52	57	NA	86	94	97	83	64	176	71	107	123	NA
Y.Nagar	25	NA	60	89	72	84	65	105	65	54	68	82	61	29	NA	93	54	58	64	63	94	85	55	63	47	61	124	73	113	45	76

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of February at ground station points in Haryana

Districts	1-Feb	2-Feb	3-Feb	4-Feb	5-Feb	6-Feb	7-Feb	8-Feb	9-Feb	10-Feb	11-Feb	12-Feb	13-Feb	14-Feb	15-Feb	16-Feb	17-Feb	18-Feb	19-Feb	20-Feb	21-Feb	22-Feb	23-Feb	24-Feb	25-Feb	26-Feb	27-Feb	28-Feb
Ambala	24	67	54	51	54	75	47	65	58	53	58	77	62	54	78	55	76	66	70	39	85	40	17	27	73	28	28	111
Jhajjar	96	101	72	82	NA	99	87	68	67	NA	83	140	67	99	71	79	NA	NA	NA	76	122	43	40	NA	83	32	NA	96
Faridabad	NA	NA	NA	80	NA	NA	82	81	60	84	NA	NA	75	34	76	77	79	32	49	NA	63	12	33	6	72	NA	NA	55
Bhiwani	67	58	51	54	100	75	110	66	69	72	65	100	75	62	60	102	66	53	61	53	101	57	20	33	48	35	46	90
Rewari	109	76	83	43	80	104	56	48	67	59	NA	112	70	56	46	76	80	92	78	57	101	49	57	56	98	28	21	67
Faridabad	51	NA	60	55	78	NA	28	42	53	79	44	73	66	39	78	108	63	39	40	29	79	12	49	34	53	27	13	66
Fatehabad	31	58	36	54	74	67	93	60	79	96	NA	76	65	60	67	102	NA	42	51	59	75	40	35	33	65	NA	45	71
Gurugram	82	48	87	38	NA	83	51	68	49	80	22	136	59	66	58	87	76	45	47	24	82	9	67	43	29	69	NA	61
Hisar	49	60	46	50	63	88	100	61	58	65	68	115	74	59	65	106	76	NA	52	74	72	38	NA	31	31	10	59	76
Jind	51	77	43	51	89	84	61	60	57	33	NA	93	74	60	63	107	75	43	NA	72	69	72	27	63	42	21	45	77
Kaithal	51	61	52	48	78	109	96	83	52	16	NA	75	74	42	63	74	NA	52	61	55	111	41	24	33	51	37	41	62
Karnal	44	67	34	45	78	81	47	67	53	33	46	94	74	29	58	76	76	63	55	70	78	65	30	34	50	33	32	44
Kurukshetra	44	62	NA	76	78	83	NA	58	48	NA	110	91	56	65	75	60	76	63	36	48	86	61	34	35	56	NA	42	75
Mewat	89	57	57	45	111	140	109	50	72	64	119	133	100	76	74	91	83	50	53	52	83	80	59	71	93	18	17	72
Gurugram	74	75	83	58	80	116	82	61	60	57	89	137	63	73	76	83	76	87	68	47	91	50	33	84	97	7	NA	77
Mahendar-garh	47	69	59	46	81	62	109	87	58	50	44	99	58	117	92	125	78	51	51	32	46	79	63	29	73	26	58	65
Palwal	74	86	56	48	137	130	48	62	67	54	NA	131	75	66	61	112	81	68	54	73	76	40	81	42	118	29	21	92
Panchkula	40	44	19	37	63	84	48	62	31	49	51	NA	74	65	81	69	NA	37	57	NA	48	NA	16	35	87	21	13	65
Panipat	35	74	44	41	56	86	62	63	59	41	82	96	99	53	60	54	75	54	63	68	100	20	29	80	69	38	18	74
Rohtak	70	67	53	53	84	87	59	71	70	64	55	104	64	60	60	91	84	62	70	59	96	53	13	61	67	33	20	80
Sirsa	44	62	NA	22	159	68	NA	70	57	81	162	NA	54	65	54	116	75	35	63	66	80	37	26	44	40	13	43	80
Sonipat	106	73	NA	52	68	143	81	79	63	54	NA	104	63	63	46	82	75	55	86	59	122	81	27	118	72	27	22	80
Y.Nagar	59	NA	44	51	85	96	61	61	37	43	23	70	74	44	83	78	77	62	69	NA	81	NA	32	40	50	23	NA	41

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of March at ground station points in Haryana

Districts	1-Mar	2-Mar	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	14-Mar	15-Mar	16-Mar	17-Mar	18-Mar	19-Mar	20-Mar	21-Mar	22-Mar	23-Mar	24-Mar	25-Mar	26-Mar	27-Mar	28-Mar	29-Mar	30-Mar	31-Mar
Ambala	72	61	70	75	40	30	23	56	52	76	57	51	76	62	52	53	39	NA	63	44	67	59	60	47	39	43	44	52	60	55	43
Jhajjar	NA	94	118	93	60	78	67	105	85	83	98	91	83	92	82	92	53	80	51	97	66	46	56	58	61	81	71	53	54	46	76
Faridabad	85	77	115	83	55	43	30	NA	NA	87	84	76	59	91	67	55	59	58	69	62	61	50	59	73	54	68	51	61	65	46	69
Bhiwani	107	90	91	109	47	57	42	74	83	66	71	66	66	76	56	92	54	79	70	61	87	53	73	52	58	37	87	47	52	46	57
Rewari	46	93	96	89	42	35	NA	71	85	53	92	69	61	95	53	65	34	52	78	57	61	62	63	58	48	50	51	52	63	52	60
Faridabad	46	74	NA	52	18	36	33	67	83	58	73	62	56	69	55	71	53	32	69	47	59	38	44	29	40	71	40	56	55	47	67
Fatehabad	80	78	68	71	50	39	44	61	61	81	55	73	61	89	48	91	73	61	83	43	59	51	66	39	56	46	73	76	56	31	68
Gurugram	50	67	82	67	52	56	41	80	88	47	72	51	51	80	56	96	38	55	61	NA	94	16	57	23	54	55	50	52	45	43	55
Hisar	87	72	82	71	58	NA	116	53	44	46	63	75	80	70	53	54	13	54	91	56	33	41	44	30	81	47	64	45	50	40	82
Jind	78	66	88	75	85	47	51	76	67	71	48	67	69	73	61	80	54	80	87	87	66	48	73	50	NA	57	77	73	62	61	71
Kaithal	74	84	60	51	54	34	49	68	61	54	NA	66	82	51	56	53	60	53	81	86	59	41	80	38	NA	64	75	48	60	71	39
Karnal	71	89	75	60	47	17	39	57	53	74	54	71	68	94	55	65	33	62	75	73	59	48	49	27	54	60	60	51	62	76	42
Kurukshetra	90	82	74	58	8	15	NA	65	56	74	50	67	77	83	62	72	47	55	65	78	60	74	62	53	NA	47	46	74	59	93	57
Mewat	75	111	85	76	42	32	48	63	68	40	88	56	48	70	43	52	31	45	49	43	54	6	43	42	37	29	24	43	49	35	56
Gurugram	39	110	86	111	51	51	49	69	84	53	69	54	60	76	52	77	77	59	55	84	80	52	51	106	56	45	38	54	63	52	57
Mahendar-garh	53	80	90	54	37	37	64	64	75	48	66	61	59	76	37	68	42	47	78	44	55	49	33	44	28	30	46	39	41	39	NA
Palwal	49	110	89	77	57	69	44	69	123	97	85	69	72	117	69	129	48	48	80	77	108	70	50	80	60	51	62	61	60	65	71
Panchkula	78	54	NA	54	50	26	26	44	14	57	NA	34	57	44	44	29	36	49	41	53	61	50	42	16	NA	43	55	67	46	48	31
Panipat	81	100	67	70	39	33	41	64	65	67	77	61	68	135	64	72	41	61	74	81	74	67	56	55	61	61	55	61	55	66	52
Rohtak	83	96	124	60	32	47	32	75	85	64	63	55	55	82	51	92	43	63	57	64	64	49	49	44	53	41	45	53	48	38	43
Sirsa	86	NA	74	81	51	26	67	61	57	33	72	70	77	81	60	54	60	67	78	NA	42	73	71	42	NA	51	75	57	64	71	53
Sonipat	78	78	78	85	64	36	50	96	72	85	68	69	76	NA	63	135	46	80	141	89	97	56	56	61	56	55	66	65	65	49	74
Y.Nagar	56	76	76	54	51	29	23	50	46	50	62	57	NA	69	44	55	46	57	49	76	60	64	65	54	34	45	47	71	76	67	45

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of April at ground station points in Haryana

Districts	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	9-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-Apr	15-Apr	16-Apr	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr
Ambala	56	68	43	76	74	112	100	66	36	7	53	55	24	48	39	54	69	64	67	85	72	42	66	54	66	55	65	60	87	63
Jhajjar	74	71	65	72	119	57	150	95	54	49	106	59	39	47	52	76	60	77	75	80	96	39	57	46	NA	52	90	102	77	72
Faridabad	73	64	39	76	61	53	63	66	54	27	62	59	45	54	85	83	56	73	62	NA	80	55	59	46	51	61	74	67	65	67
Bhiwani	51	54	33	87	76	58	120	73	52	29	50	51	41	53	48	NA	48	54	24	NA	23	41	43	NA	75	66	87	33	63	56
Rewari	41	72	31	65	39	21	108	74	62	NA	64	43	2	NA	39	75	63	48	NA	NA	23	21	29	NA	88	NA	79	NA	60	71
Faridabad	64	69	22	62	63	45	87	58	48	45	67	32	36	37	55	63	38	28	62	40	59	42	66	42	40	54	71	68	51	58
Fatehabad	82	51	75	96	96	78	93	58	40	59	63	62	41	56	49	56	82	63	63	NA	NA	69	40	64	27	55	71	31	71	58
Gurugram	49	57	60	64	73	61	68	66	41	53	95	NA	41	48	55	59	57	44	68	56	72	44	58	51	59	54	67	75	64	65
Hisar	50	57	9	82	65	NA	90	49	38	66	58	41	38	48	41	62	44	54	50	57	48	73	53	30	53	70	83	69	47	42
Jind	78	67	96	73	95	122	140	73	46	37	69	57	37	47	35	NA	73	52	80	NA	59	60	40	43	22	95	89	9	80	67
Kaithal	30	61	61	87	80	100	116	79	63	64	61	37	15	53	24	31	62	55	71	81	109	49	37	59	35	81	80	29	49	91
Karnal	56	68	66	89	105	109	113	55	37	63	60	53	34	52	36	42	43	67	74	83	75	40	73	58	64	79	60	48	84	79
Kurukshetra	51	62	68	98	175	100	96	33	40	69	58	56	58	48	34	78	49	62	88	77	75	33	70	41	60	73	73	44	76	57
Mewat	NA	61	14	NA	47	12	74	NA	41	NA	78	47	14	NA	38	NA	NA	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	71
Gurugram	66	55	28	81	33	54	75	55	63	78	92	46	50	54	61	75	65	60	71	81	93	42	40	48	63	NA	79	65	56	64
Mahendar-garh	58	39	57	54	28	108	54	46	64	NA	55	28	28	29	29	73	NA	60	NA	NA	11	NA	NA	NA	8	28	NA	118	15	40
Palwal	59	65	64	73	80	96	69	67	63	68	80	58	51	44	55	NA	48	44	66	54	86	42	47	38	59	59	80	59	63	66
Panchkula	29	77	27	34	67	NA	106	71	31	103	65	44	64	NA	43	38	53	60	75	77	88	14	60	48	49	61	50	49	73	46
Panipat	70	64	59	79	109	109	120	83	42	66	81	65	42	64	48	76	65	64	109	83	78	44	40	52	67	62	67	82	103	89
Rohtak	43	43	30	57	53	101	45	27	42	61	46	33	NA	55	35	NA	NA	50	NA	NA	25	NA	NA	NA	NA	NA	74	NA	NA	71
Sirsa	76	73	NA	91	142	78	75	82	46	78	73	NA	19	66	70	59	70	61	29	57	50	67	43	49	42	16	67	26	45	67
Sonipat	67	59	82	89	73	87	149	91	51	85	46	58	55	54	45	77	86	65	108	89	108	54	44	68	96	NA	75	54	94	72
Y.Nagar	56	76	76	54	51	29	23	50	46	50	62	57	NA	69	44	55	46	57	49	76	60	64	65	54	34	45	47	71	76	67

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of May at ground station points in Haryana

Districts	1-May	2-May	3-May	4-May	5-May	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May
Ambala	62	63	62	63	46	145	88	94	86	81	81	64	87	96	106	37	97	68	71	54	88	58	90	104	56	64	54	50	79	75	57
Jhajjar	65	80	77	91	68	NA	NA	96	NA	107	85	131	NA	55	NA	74	45	91	39	78	118	NA	78	110	73	72	77	128	NA	82	NA
Faridabad	53	82	NA	64	45	50	80	81	85	NA	75	49	NA	83	59	79	36	84	56	91	71	73	88	76	87	58	47	68	101	71	81
Bhiwani	66	68	94	34	32	NA	71	115	90	97	173	105	75	52	156	62	49	88	45	75	68	75	74	51	51	42	81	105	65	43	103
Rewari	46	78	NA	86	NA	NA	NA	NA	76	104	140	NA	NA	24	NA	74	46	68	NA	75	NA	NA	28	38	93	NA	NA	NA	55	81	NA
Faridabad	63	52	50	54	50	71	65	76	90	69	73	94	84	60	81	85	57	60	45	62	63	64	95	67	61	82	74	46	49	85	100
Fatehabad	57	68	82	87	26	NA	51	93	58	67	NA	NA	NA	65	46	72	12	55	35	73	NA	54	73	NA	56	NA	74	48	NA	NA	NA
Gurugram	82	84	70	68	68	108	110	75	99	113	90	94	102	98	95	76	112	66	57	64	74	73	95	77	75	81	78	70	97	77	119
Hisar	54	68	71	59	48	54	60	103	86	92	92	90	103	66	119	120	72	60	44	72	53	68	75	26	89	89	72	47	72	49	138
Jind	89	64	77	85	67	NA	57	99	54	84	110	102	87	78	30	91	129	81	52	74	117	65	100	73	48	95	60	84	48	14	104
Kaithal	90	70	68	73	41	90	54	61	61	86	99	74	130	46	35	71	65	79	58	74	86	64	NA	62	44	80	59	76	56	76	106
Karnal	61	63	87	73	59	53	67	70	57	80	79	97	96	97	105	66	70	65	80	72	84	84	76	70	48	73	42	59	82	79	110
Kurukshetra	48	55	51	70	51	51	93	88	66	108	72	118	83	104	105	71	73	65	89	64	54	91	63	104	40	51	62	68	26	93	127
Mewat	71	76	NA	NA	NA	NA	NA	NA	75	NA	NA	NA	NA	NA	32	73	25	39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	48	NA	NA
Gurugram	42	72	67	73	109	124	74	82	95	109	NA	109	NA	53	34	75	49	92	49	79	205	69	111	75	49	60	NA	73	96	47	91
Mahendar-garh	46	71	116	75	61	NA	NA	NA	75	40	NA	56	NA	23	33	72	20	NA	24	74	NA	NA	NA	50	35	NA	38	NA	44	49	NA
Palwal	80	79	NA	74	96	NA	90	NA	78	68	75	110	99	84	55	78	51	67	45	73	34	67	NA	82	78	58	40	103	46	67	87
Panchkula	63	58	57	37	41	115	41	92	37	107	60	66	66	118	93	120	39	82	75	58	143	90	76	100	55	48	59	49	81	NA	48
Panipat	79	89	51	66	65	75	81	85	77	107	96	117	78	102	125	84	45	99	67	101	108	86	117	96	55	118	65	102	77	65	109
Rohtak	71	79	NA	NA	NA	NA	NA	NA	77	NA	NA	NA	NA	29	NA	73	NA	NA	NA	NA	NA	NA	NA	NA	72	NA	NA	NA	NA	80	76
Sirsa	40	83	NA	82	30	NA	47	NA	59	86	NA	87	NA	40	NA	74	9	74	38	44	NA	50	73	55	47	55	74	NA	60	9	NA
Sonipat	58	89	105	81	57	71	79	NA	90	138	113	174	93	106	80	96	117	78	72	78	107	94	112	94	93	91	80	96	87	98	197
Y.Nagar	45	84	77	49	56	62	62	79	45	76	93	118	56	88	68	90	49	81	67	62	92	100	81	76	69	60	57	56	79	77	71

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of June at ground station points in Haryana

Districts	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun
Ambala	88	86	96	61	104	73	116	84	80	74	116	76	103	68	84	67	144	113	116	77	NA	47	75	85	121	60	92	70	96	151
Jhajjar	93	NA	116	NA	72	NA	55	63	66	50	122	133	NA	105	79	NA	76	150	80	87	83	NA	114	93	208	NA	NA	85	NA	NA
Faridabad	119	83	89	63	107	117	85	73	72	77	105	99	116	83	54	83	136	131	121	77	149	73	84	NA	126	206	139	164	105	91
Bhiwani	170	76	73	60	73	58	104	43	60	45	130	82	107	86	64	80	153	116	140	102	140	31	91	64	153	NA	141	88	91	NA
Rewari	76	71	NA	NA	NA	NA	46	16	60	76	16	NA	NA	92	81	84	75	227	NA	88	NA	NA	NA	NA	NA	NA	NA	80	NA	90
Faridabad	118	90	75	87	101	103	54	55	56	68	96	75	134	122	60	183	123	124	110	89	151	62	76	129	134	236	NA	148	81	96
Fatehabad	53	NA	NA	NA	NA	23	57	19	68	56	116	82	NA	NA	NA	NA	77	NA	75	NA	53	33	87	NA	NA	NA	NA	88	NA	NA
Gurugram	116	118	96	108	104	111	106	59	59	99	101	85	91	118	61	79	175	120	105	90	92	69	103	NA	90	NA	NA	165	81	117
Hisar	107	82	51	93	84	64	103	56	103	76	93	86	98	122	69	77	172	199	134	82	61	23	79	203	118	137	135	101	111	NA
Jind	105	95	106	84	94	136	96	97	97	89	100	82	NA	104	99	111	83	154	128	113	120	60	84	106	158	226	207	94	107	101
Kaithal	62	72	131	81	87	NA	115	46	103	70	87	73	NA	NA	70	81	71	104	97	141	NA	80	107	166	179	46	202	91	92	190
Karnal	81	68	99	71	91	145	86	105	90	83	96	106	101	71	115	83	164	148	181	135	122	93	138	78	144	73	93	73	106	163
Kurukshetra	85	82	93	85	108	91	98	62	89	84	103	72	90	69	59	82	77	128	101	131	209	78	79	135	165	176	94	128	106	NA
Mewat	74	NA	76	NA	NA	83	62	NA	NA	75	26	NA	NA	NA	NA	NA	74	NA	NA	93	NA	NA	NA	NA	NA	NA	NA	NA	NA	117
Gurugram	75	74	116	NA	80	101	42	49	67	76	127	121	100	NA	64	80	76	NA	NA	98	81	NA	NA	NA	115	NA	88	201	88	93
Mahendar-garh	74	NA	30	NA	77	25	NA	3	6	48	133	104	108	NA	NA	NA	74	87	63	92	NA	NA	43	65	66	64	59	81	NA	NA
Palwal	97	103	106	82	97	87	105	48	82	98	104	96	122	NA	61	81	76	131	91	122	115	85	124	262	114	180	199	156	90	75
Panchkula	94	69	92	90	122	70	132	89	73	37	93	51	95	175	68	78	68	103	84	142	NA	82	63	NA	112	80	NA	84	76	99
Panipat	104	113	141	96	105	98	105	93	139	111	119	120	104	120	64	84	130	133	163	146	113	97	104	114	177	107	209	109	109	197
Rohtak	74	NA	NA	NA	NA	NA	NA	NA	NA	73	109	NA	NA	NA	NA	NA	73	167	NA	81	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sirsa	56	95	91	38	85	25	94	52	61	64	113	80	NA	NA	58	NA	97	124	83	84	NA	73	66	149	64	75	137	140	63	199
Sonipat	113	117	102	115	109	117	NA	79	96	83	121	99	116	102	73	81	76	222	134	NA	NA	61	113	119	194	330	216	86	93	144
Y.Nagar	82	82	107	86	94	93	108	55	81	91	87	77	88	96	91	82	144	82	110	123	100	91	90	91	87	133	95	81	105	159

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of July at ground station points in Haryana

Districts	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul	29-Jul	30-Jul	31-Jul
Ambala	NA	106	NA	91	88	95	53	NA	185	203	NA	NA	64	NA	NA	NA	NA	NA	NA	109	NA	152	NA	85	NA	NA	NA	NA	94	NA	NA
Jhajjar	56	NA	92	79	NA	114	NA	NA	117	NA	NA	85	NA	NA	NA	458	NA	NA	NA	NA	166	164	170	NA	NA	NA	89	83	263	94	NA
Faridabad	NA	NA	163	108	167	139	NA	NA	181	161	NA	86	83	185	83	242	NA	NA	NA	146	140	182	NA	131	NA	NA	84	84	163	NA	NA
Bhiwani	83	NA	87	114	82	88	162	173	103	145	169	199	91	91	91	89	NA	NA	NA	88	103	232	97	186	NA	NA	NA	85	181	NA	165
Rewari	NA	NA	NA	78	NA	NA	202	143	80	141	151	NA	NA	NA	NA	NA	NA	NA	NA	104	NA	118	152	126	190	NA	NA	82	80	NA	NA	NA
Faridabad	39	NA	96	NA	152	99	NA	NA	165	NA	NA	86	79	190	79	NA	95	NA	NA	109	126	167	217	164	NA	NA	86	80	206	NA	NA
Fatehabad	72	148	NA	101	100	131	155	NA	100	182	187	NA	91	91	91	92	NA	NA	116	NA	132	NA	NA	100	88	171	NA	80	78	NA	NA
Gurugram	69	NA	91	NA	NA	167	NA	NA	137	NA	416	NA	78	167	78	NA	NA	NA	223	160	NA	111	NA	NA	NA	NA	85	81	185	NA	NA
Hisar	81	89	82	123	106	147	168	191	110	203	135	82	88	88	88	90	NA	NA	81	NA	85	NA	124	NA	NA	NA	81	145	NA	NA
Jind	179	NA	NA	100	239	78	127	194	143	271	232	93	89	89	89	NA	NA	NA	268	NA	156	142	NA	NA	NA	196	NA	NA	241	NA	NA
Kaithal	NA	NA	108	86	98	NA	117	NA	167	288	NA	NA	88	88	88	NA	NA	256	NA	96	218	196	NA	NA	NA	NA	NA	240	80	183
Karnal	110	229	173	125	NA	213	155	172	NA	281	NA	NA	85	85	85	96	NA	NA	NA	NA	170	215	NA	NA	92	NA	NA	NA	NA	NA	NA
Kurukshetra	193	NA	107	91	96	229	102	NA	207	227	578	NA	84	84	84	NA	NA	102	NA	NA	178	163	NA	NA	NA	NA	NA	NA	149	NA
Mewat	NA	NA	NA	78	87	80	100	101	174	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	70	88	NA	114	78	NA	NA	NA	NA	NA	NA	NA
Gurugram	45	NA	90	79	NA	79	128	NA	126	178	136	85	83	162	83	NA	NA	NA	109	NA	101	165	NA	167	NA	NA	82	NA	NA	NA
Mahendar-garh	72	NA	87	76	NA	74	117	NA	55	80	88	NA	89	87	96	NA	NA	NA	NA	96	88	90	70	NA	NA	NA	NA	NA	NA	86	NA
Palwal	65	221	204	162	147	125	181	150	226	183	NA	88	229	166	82	280	NA	NA	120	160	111	142	NA	NA	94	NA	83	81	253	NA	NA
Panchkula	71	NA	NA	96	131	139	53	91	NA	218	NA	NA	NA	NA	NA	NA	90	NA	96	NA	NA	NA	204	83	NA	NA	NA	NA	NA	NA	NA
Panipat	101	286	188	123	354	274	180	194	NA	236	NA	NA	86	86	86	NA	NA	NA	104	NA	142	119	236	NA	94	NA	NA	NA	NA	NA	NA
Rohtak	58	NA	NA	78	NA	NA	61	140	92	NA	105	NA	88	88	88	NA	NA	NA	NA	73	79	103	89	NA	NA	NA	NA	78	199	86	NA
Sirsa	100	153	130	126	181	185	137	214	77	202	91	NA	90	120	90	187	NA	NA	147	133	79	146	NA	138	73	129	NA	88	80	NA	NA
Sonipat	NA	288	104	88	NA	151	NA	197	196	NA	NA	NA	88	88	88	NA	NA	NA	NA	90	204	241	NA	NA	NA	NA	NA	87	135	NA	NA
Y.Nagar	122	90	NA	101	181	192	150	247	172	256	NA	NA	82	82	82	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Y Nagar= Yamuna Nagar

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Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of August at ground station points in Haryana

Districts	1-Aug	2-Aug	3-Aug	4-Aug	5-Aug	6-Aug	7-Aug	8-Aug	9-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug
Ambala	44	NA	91	NA	NA	NA	NA	NA	NA	NA	187	NA	NA	NA	NA	49	74	NA	NA	49	NA	86	NA	NA	NA	77	NA	53	27	NA	NA
Jhajjar	NA	NA	148	NA	NA	158	NA	NA	NA	NA	184	NA	NA	NA	127	111	116	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	JNA	NA	175
Faridabad	56	NA	152	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	156	103	NA	127	NA	NA	NA	114	NA	NA	NA	NA	47	NA	Fa	NA	NA
Bhiwani	115	153	80	NA	83	NA	NA	NA	201	NA	NA	NA	NA	NA	108	62	69	114	NA	NA	70	34	56	NA	NA	NA	NA	NA	BHA	122	NA
Rewari	49	NA	118	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	119	NA	92	NA	NA	NA	NA	61	64	NA	152	NA	NA	NA	Rewari	NA	NA
Faridabad	NA	NA	82	NA	NA	117	NA	NA	NA	NA	NA	NA	NA	NA	230	100	107	109	NA	NA	NA	165	NA	NA	NA	NA	80	NA	NA	NA	NA
Fatehabad	62	154	183	NA	NA	120	NA	NA	165	NA	117	NA	148	NA	NA	39	59	89	81	NA	155	44	53	100	NA	77	NA	NA	NA	NA	76
Gurugram	56	NA	81	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	74	100	71	NA	NA	NA	90	84	NA	NA	NA	55	NA	Gu	NA	NA
Hisar	125	199	NA	NA	NA	131	NA	NA	138	NA	NA	NA	82	NA	103	71	61	100	NA	NA	214	35	32	NA	NA	NA	NA	NA	Hisa	84	NA
Jind	66	NA	84	56	130	180	75	NA	285	NA	NA	NA	170	NA	NA	NA	67	NA	NA	NA	NA	51	NA	NA	NA	NA	NA	NA	78	112	NA
Kaithal	NA	NA	84	220	NA	NA	NA	NA	NA	NA	118	NA	NA	NA	NA	103	53	NA	NA	NA	NA	NA	NA	79	NA	76	NA	NA	Ka	98	NA
Karnal	38	NA	81	211	NA	194	NA	NA	NA	NA	NA	NA	NA	137	92	NA	82	72	NA	16	NA	NA	NA	NA	NA	NA	NA	NA	Kar	NA	NA
Kurukshetra	NA	NA	79	89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	54	74	NA	52	NA	NA	NA	NA	NA	NA	NA	NA	NA	35	Shetra	NA
Mewat	51	NA	NA	NA	NA	NA	NA	16	NA	NA	NA	NA	NA	NA	114	NA	98	56	NA	NA	61	NA	NA	NA	NA	NA	NA	NA	Mewat	NA	NA
Gurugram	51	NA	123	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	138	90	NA	52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mahendar-garh	45	NA	77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	53	NA	NA	NA	43	50	63	NA	NA	NA	NA	52	NA	NA	84
Palwal	60	NA	81	NA	NA	177	NA	32	NA	NA	149	NA	NA	NA	NA	128	NA	NA	NA	NA	NA	108	92	NA	NA	NA	63	NA	Palwal	NA	NA
Panchkula	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	38	NA	NA	NA	NA	37	NA	82	NA	69	NA	NA	NA	NA	NA
Panipat	54	241	85	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	87	124	91	NA	93	68	NA	6	NA	NA	NA	NA	NA	NA	64	NA	NA	NA
Rohtak	52	79	80	NA	NA	NA	NA	NA	176	NA	NA	NA	84	76	99	73	72	100	NA	NA	52	41	56	NA	135	NA	13	NA	73	63	NA
Sirsa	63	219	133	NA	90	85	77	NA	NA	NA	NA	80	NA	NA	112	NA	52	NA	63	92	49	NA	NA	82	NA	81	NA	NA	67	NA	NA
Sonipat	55	NA	NA	NA	NA	187	74	NA	NA	NA	NA	NA	NA	150	184	98	102	93	NA	11	NA	NA	72	NA	NA	64	NA	NA	NA	NA	NA
Y.Nagar	46	NA	NA	43	NA	79	NA	NA	NA	NA	NA	NA	NA	NA	161	NA	NA	NA	NA	18	NA	NA	NA	NA	NA	46	51	NA	22	NA	NA

Y Nagar= Yamuna Nagar

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of September at ground station points in Haryana

Districts	1-Sep	2-Sep	3-Sep	4-Sep	5-Sep	6-Sep	7-Sep	8-Sep	9-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep
Ambala	NA	NA	NA	NA	57	NA	139	49	77	NA	73	107	NA	113	29	100	257	68	NA	69	64	147	86	76	93	127	128	184	87	98
Jhajjar	NA	NA	NA	61	87	66	105	NA	171	NA	49	99	72	83	51	46	73	73	95	75	96	NA	84	NA	80	83	79	84	106	47
Faridabad	NA	NA	NA	NA	78	68	NA	104	106	103	80	72	73	65	98	42	NA	75	140	85	105	180	79	NA	84	87	72	92	69	45
Bhiwani	NA	NA	108	NA	NA	44	78	67	68	52	67	84	65	65	79	73	110	69	80	64	107	98	92	56	15	58	43	60	66	52
Rewari	NA	NA	NA	47	NA	NA	83	NA	89	52	60	77	61	69	58	NA	103	68	88	55	41	142	81	50	NA	53	37	58	50	56
Faridabad	NA	NA	NA	NA	118	67	NA	NA	NA	107	107	80	87	NA	76	46	127	76	131	89	104	180	NA	NA	77	80	83	66	100	71
Fatehabad	NA	NA	65	26	71	35	76	NA	53	69	58	72	70	54	95	67	75	64	56	84	76	109	100	79	84	79	59	71	66	53
Gurugram	NA	NA	NA	NA	74	91	99	90	NA	88	77	67	83	79	55	NA	82	74	87	83	125	NA	78	NA	NA	59	74	78	85	83
Hisar	NA	NA	NA	NA	NA	34	80	68	62	81	55	78	68	NA	NA	66	71	57	90	71	77	93	81	61	113	76	70	78	74	52
Jind	NA	NA	NA	NA	61	61	83	79	96	NA	76	74	74	71	74	48	113	73	107	76	92	120	100	53	83	83	77	90	92	68
Kaithal	NA	NA	NA	NA	50	49	143	69	87	103	55	88	92	57	63	75	91	68	76	59	135	143	221	NA	90	87	92	89	105	97
Karnal	NA	NA	NA	NA	48	181	NA	59	87	NA	57	84	96	118	65	62	97	61	98	106	NA	190	89	45	87	115	91	86	130	124
Kurukshetra	NA	NA	61	NA	57	NA	135	65	NA	NA	79	88	116	94	62	113	144	69	142	79	28	166	NA	57	95	151	103	122	80	103
Mewat	NA	NA	NA	NA	NA	55	77	43	81	40	38	NA	50	57	49	17	68	56	NA	33	45	115	NA	43	41	47	31	43	45	16
Gurugram	NA	NA	NA	55	66	88	103	95	89	NA	74	83	69	NA	87	34	100	71	75	80	54	147	80	NA	NA	53	49	58	70	52
Mahendar-garh	NA	NA	76	NA	NA	NA	57	58	NA	35	52	58	28	56	62	49	79	42	25	56	55	34	81	57	112	50	26	29	45	32
Palwal	NA	NA	NA	56	76	55	NA	67	96	60	71	86	67	72	71	78	84	72	108	83	100	145	81	NA	49	78	73	84	56	75
Panchkula	NA	NA	18	30	28	NA	NA	NA	NA	NA	108	241	NA	90	NA	79	78	84	148	77	60	79	56	63	46	NA	155	79	75	34
Panipat	NA	NA	NA	NA	62	NA	83	71	103	83	85	87	102	56	48	61	110	76	92	80	89	80	88	56	78	85	89	87	122	100
Rohtak	NA	NA	NA	NA	64	38	64	58	64	45	62	63	47	49	52	56	86	57	35	67	52	92	NA	60	102	43	24	28	45	39
Sirsa	NA	NA	NA	NA	93	42	75	53	53	72	71	83	66	71	82	84	57	60	69	76	95	85	99	89	83	99	72	60	70	69
Sonipat	NA	NA	NA	NA	70	89	79	97	79	82	99	86	86	97	54	114	85	65	102	56	144	129	152	98	NA	82	77	83	122	73
Y.Nagar	NA	NA	NA	NA	63	NA	NA	80	NA	NA	103	91	NA	NA	NA	42	90	72	174	172	NA	190	82	54	55	105	NA	81	76	120

Y Nagar= Yamuna Nagar

[72]

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of October at ground station points in Haryana

Districts	1-Oct	2-Oct	3-Oct	4-Oct	5-Oct	6-Oct	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct	12-Oct	13-Oct	14-Oct	15-Oct	16-Oct	17-Oct	18-Oct	19-Oct	20-Oct	21-Oct	22-Oct	23-Oct	24-Oct	25-Oct	26-Oct	27-Oct	28-Oct	29-Oct	30-Oct	31-Oct
Ambala	62	71	194	78	110	63	86	86	87	108	96	64	69	100	73	90	100	79	66	78	86	91	112	76	80	131	81	71	66	106	100
Jhajjar	57	79	67	86	68	64	103	104	82	108	102	88	89	70	61	80	74	98	92	81	89	71	80	102	110	117	111	132	NA	139	NA
Faridabad	68	57	65	78	56	58	65	78	77	104	94	93	99	62	68	86	88	89	83	69	91	75	62	110	76	88	97	125	NA	90	NA
Bhiwani	51	34	104	72	97	73	88	62	80	97	95	109	68	74	63	75	77	75	82	68	105	61	81	99	110	118	172	155	94	130	269
Rewari	21	21	47	66	44	64	NA	76	66	87	109	72	64	64	29	53	58	61	50	116	NA	48	NA	73	NA	89	159	140	NA	119	NA
Faridabad	44	56	57	96	61	66	66	89	75	104	106	118	84	74	93	86	94	98	70	90	79	82	81	100	109	80	145	99	94	143	82
Fatehabad	105	131	106	206	70	84	71	65	113	122	109	106	70	85	72	89	84	106	86	73	81	60	88	152	101	158	152	180	211	155	259
Gurugram	67	57	60	100	64	62	63	91	78	100	106	73	99	53	73	72	96	74	72	96	103	69	67	153	90	92	127	101	97	125	171
Hisar	90	95	53	61	91	102	60	75	88	85	88	93	75	57	52	84	78	78	75	72	100	51	74	115	103	69	113	159	88	115	199
Jind	51	164	167	78	125	60	81	82	110	106	153	101	89	67	75	122	76	99	97	72	74	89	87	147	99	138	123	112	157	195	84
Kaithal	142	55	187	80	63	53	82	101	100	136	114	89	100	73	89	138	101	104	106	83	63	80	100	127	104	133	120	84	113	148	NA
Karnal	44	66	157	87	56	56	58	98	113	132	113	98	86	77	71	76	83	82	95	84	75	77	97	81	89	102	121	88	105	144	79
Kurukshetra	52	59	166	113	52	54	84	91	88	112	77	68	72	61	83	98	102	78	81	76	79	67	125	80	93	NA	91	79	78	107	77
Mewat	76	11	42	39	44	NA	NA	69	46	83	68	62	35	59	34	99	82	NA	26	108	66	30	46	66	116	NA	108	77	168	121	NA
Gurugram	61	51	74	85	63	71	57	86	78	99	86	94	77	78	74	99	85	97	66	93	110	63	93	115	97	98	88	133	NA	117	117
Mahendar-garh	42	21	41	39	60	54	46	45	NA	58	45	36	40	40	26	53	79	56	48	86	64	30	41	46	101	70	101	65	64	137	88
Palwal	59	71	68	79	68	64	67	61	84	107	115	80	89	95	74	106	94	103	81	93	138	82	91	113	114	103	122	112	NA	124	125
Panchkula	58	163	77	61	50	58	111	80	80	69	82	69	69	48	58	62	66	80	76	75	47	61	54	51	82	102	64	92	90	133	73
Panipat	54	58	90	95	64	57	90	98	103	127	101	104	99	79	99	84	110	87	103	97	69	67	100	110	119	102	117	95	79	135	156
Rohtak	33	32	33	77	39	57	23	48	49	65	45	63	24	86	32	45	43	40	63	96	53	10	59	NA	NA	79	NA	81	73	NA	NA
Sirsa	131	115	140	65	71	87	74	83	120	124	92	92	74	65	65	77	80	78	82	79	83	54	79	123	108	145	136	200	83	84	179
Sonipat	51	88	94	91	118	56	95	90	84	106	96	120	107	69	97	135	95	98	101	90	106	73	90	126	121	136	98	123	130	137	83
Y.Nagar	76	73	83	94	64	66	52	86	79	100	107	65	74	53	75	76	71	70	57	65	74	74	77	69	74	101	66	81	60	72	72

Y Nagar= Yamuna Nagar

[73]

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of November at ground station points in Haryana

Districts	1-Nov	2-Nov	3-Nov	4-Nov	5-Nov	6-Nov	7-Nov	8-Nov	9-Nov	10-Nov	11-Nov	12-Nov	13-Nov	14-Nov	15-Nov	16-Nov	17-Nov	18-Nov	19-Nov	20-Nov	21-Nov	22-Nov	23-Nov	24-Nov	25-Nov	26-Nov	27-Nov	28-Nov	29-Nov	30-Nov
Ambala	112	109	73	101	53	100	56	60	73	77	56	82	65	84	64	77	42	54	78	100	65	77	40	55	47	43	79	93	70	66
Jhajjar	104	102	93	69	71	85	71	93	110	NA	107	169	NA	85	131	90	NA	NA	104	126	94	76	59	59	229	NA	60	92	76	78
Faridabad	84	NA	92	82	98	56	NA	NA	79	NA	NA	NA	NA	NA	NA	65	112	NA	89	NA	81	77	35	NA	75	NA	NA	77	51	80
Bhiwani	93	96	79	193	50	108	48	221	101	127	102	84	103	144	NA	91	103	90	80	99	88	62	41	68	57	58	61	62	59	60
Rewari	116	87	NA	87	NA	85	89	NA	168	NA	39	52	NA	119	94	61	73	82	NA	71	NA	53	41	73	63	NA	40	52	37	78
Faridabad	98	116	130	103	105	68	81	93	66	174	146	82	NA	83	104	87	91	118	83	91	82	76	50	38	92	49	56	64	53	111
Fatehabad	116	116	85	147	152	69	69	105	98	90	87	84	83	156	190	28	98	64	67	75	50	65	NA	63	46	NA	77	74	46	59
Gurugram	124	146	90	141	101	59	67	93	134	135	95	140	182	91	105	59	142	83	83	91	88	74	73	68	83	52	70	123	67	78
Hisar	110	100	137	128	41	61	56	89	116	117	59	99	124	139	NA	112	80	85	73	78	83	52	53	47	61	60	57	114	80	96
Jind	142	110	90	162	52	65	85	100	NA	141	156	79	117	111	NA	59	57	94	82	99	69	73	59	71	54	51	42	69	65	81
Kaithal	152	136	85	94	62	64	50	64	44	88	NA	79	108	NA	140	NA	38	74	73	121	53	81	44	34	47	69	51	52	65	81
Karnal	171	122	90	72	47	59	58	73	83	121	NA	87	111	NA	133	31	55	72	86	85	77	75	48	39	73	36	42	52	76	91
Kurukshetra	137	130	80	85	62	98	70	66	25	98	99	77	103	82	119	38	49	72	86	91	72	79	46	45	68	39	61	63	78	79
Mewat	NA	102	94	96	63	209	131	152	119	179	117	285	121	NA	196	84	115	69	97	78	92	68	44	50	98	86	57	100	77	68
Gurugram	100	84	92	88	87	77	79	98	80	NA	90	75	113	89	100	NA	150	72	82	89	96	65	56	82	48	72	71	63	73	68
Mahendar-garh	69	62	NA	74	63	73	60	68	69	49	30	44	80	NA	153	102	67	72	46	50	61	37	58	46	88	22	34	101	54	93
Palwal	124	126	91	75	75	52	88	NA	42	NA	121	82	NA	NA	110	83	66	80	86	112	80	73	32	36	80	38	29	62	70	87
Panchkula	132	84	92	101	94	96	62	82	94	80	67	78	63	101	116	60	7	64	57	68	47	59	25	23	38	34	40	27	70	38
Panipat	91	141	NA	80	47	62	47	72	48	NA	NA	110	118	90	NA	34	44	84	76	100	56	77	41	53	74	47	54	53	75	82
Rohtak	NA	77	NA	75	NA	38	36	NA	NA	NA	NA	66	107	NA	NA	46	NA	NA	50	41	70	56	35	NA	51	NA	54	NA	45	47
Sirsa	156	103	82	98	122	137	73	83	96	53	89	NA	101	NA	NA	48	NA	49	72	68	49	51	NA	53	23	NA	54	77	42	72
Sonipat	116	125	93	90	59	66	78	85	102	109	193	122	112	112	150	NA	58	97	104	121	94	102	59	65	80	52	61	74	69	102
Y.Nagar	107	75	68	65	57	63	80	55	61	58	65	68	109	82	108	32	40	30	73	83	55	59	47	38	34	30	34	71	74	74

Y Nagar= Yamuna Nagar

[74]

Estimated PM 2.5 daily composite for Year 2016 to 2020 for the month of December at ground station points in Haryana

Districts	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec	12-Dec	13-Dec	14-Dec	15-Dec	16-Dec	17-Dec	18-Dec	19-Dec	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec	27-Dec	28-Dec	29-Dec	30-Dec	31-Dec
Ambala	80	98	59	102	80	57	59	58	NA	78	88	75	95	66	41	32	44	52	70	92	NA	50	NA	63	90	75	84	50	60	78	46
Jhajjar	90	74	81	86	100	85	86	67	81	79	82	NA	117	NA	74	47	53	55	63	NA	83	52	49	183	NA	NA	90	NA	111	103	NA
Faridabad	83	66	66	NA	83	NA	85	80	NA	84	NA	NA	NA	77	80	40	NA	NA	NA	NA	59	NA	NA	NA	NA	NA	NA	NA	NA	NA	80
Bhiwani	71	50	57	77	61	58	64	67	82	59	78	96	122	58	67	39	25	38	60	84	84	56	43	105	136	67	82	101	69	87	97
Rewari	75	60	38	76	92	65	77	68	89	63	86	64	91	76	38	29	37	36	63	62	81	58	39	85	94	91	61	45	76	89	60
Faridabad	65	79	61	NA	74	86	93	57	79	79	NA	NA	NA	76	61	NA	37	47	48	NA	NA	29	80	109	NA	NA	NA	NA	47	NA	65
Fatehabad	60	53	55	NA	80	53	40	64	85	56	78	NA	68	59	40	37	52	37	49	74	114	31	24	112	120	73	135	74	70	79	109
Gurugram	66	59	56	63	77	84	99	65	99	67	NA	NA	116	62	66	40	45	44	52	58	NA	75	33	115	105	NA	72	46	46	NA	57
Hisar	68	50	49	86	80	49	35	58	81	94	79	84	87	NA	44	42	NA	30	33	NA	46	22	18	78	96	81	94	NA	70	56	NA
Jind	79	81	60	92	74	69	68	57	81	93	99	NA	123	89	68	43	34	54	56	98	97	62	58	114	125	82	119	93	70	92	69
Kaithal	67	77	65	77	90	74	70	60	68	102	76	79	122	94	66	40	40	44	62	55	67	62	87	134	111	93	122	75	76	99	74
Karnal	83	90	74	90	87	71	61	57	78	80	97	78	137	47	56	57	41	38	76	67	NA	68	NA	72	109	92	NA	62	58	81	66
Kurukshetra	81	94	63	90	104	70	68	58	85	70	77	78	88	46	55	54	33	49	77	62	97	34	86	53	140	84	114	64	68	NA	106
Mewat	78	94	56	85	73	85	95	105	97	91	89	260	128	81	58	32	27	39	62	63	64	55	48	87	97	67	70	48	56	130	83
Gurugram	75	68	69	79	61	76	76	85	107	87	80	84	104	88	70	34	35	16	61	67	71	75	91	124	162	83	56	NA	NA	68	109
Mahendar-garh	63	64	68	54	52	50	78	70	77	53	59	30	86	74	56	32	21	27	40	49	61	41	53	67	44	132	43	35	60	51	47
Palwal	69	62	60	75	65	85	116	69	98	71	86	180	93	76	61	71	39	41	58	81	124	60	90	134	153	86	87	73	74	139	NA
Panchkula	59	61	73	88	66	57	58	46	38	93	70	63	NA	NA	55	10	53	22	68	65	52	71	64	31	30	46	73	60	61	80	47
Panipat	83	96	88	99	89	78	85	58	90	92	79	NA	108	65	58	59	66	50	72	74	57	60	95	79	127	87	124	65	75	NA	68
Rohtak	54	45	49	61	71	51	92	71	113	51	83	56	97	53	61	30	28	34	59	62	75	32	87	40	105	67	64	44	68	69	91
Sirsa	61	47	51	34	79	49	51	48	79	61	78	87	75	87	43	34	44	32	49	60	74	53	24	127	141	77	122	79	76	64	NA
Sonipat	74	97	70	84	83	79	67	63	91	91	81	NA	109	68	93	63	61	47	75	92	73	74	78	137	109	95	97	83	84	NA	71
Y.Nagar	69	87	64	87	66	77	56	57	65	86	75	79	55	57	34	27	76	35	128	75	51	97	81	53	100	81	68	87	57	98	52

Y Nagar= Yamuna Nagar

[75]

ANNEXURE III

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of January at ground station points in Haryana

Districts	1-Jan	2-Jan	3-Jan	4-Jan	5-Jan	6-Jan	7-Jan	8-Jan	9-Jan	10-Jan	11-Jan	12-Jan	13-Jan	14-Jan	15-Jan	16-Jan	17-Jan	18-Jan	19-Jan	20-Jan	21-Jan	22-Jan	23-Jan	24-Jan	25-Jan	26-Jan	27-Jan	28-Jan	29-Jan	30-Jan	31-Jan
Ambala	115	110	133	167	207	164	234	184	146	132	124	177	128	111	NA	64	182	316	176	NA	175	144	120	115	154	90	185	169	111	116	NA
Jhajjar	NA	NA	204	184	261	238	NA	282	158	110	137	207	NA	NA	134	NA	194	167	NA	NA	NA	NA	129	136	NA	164	222	NA	119	340	NA
Faridabad	186	NA	275	NA	157	NA	NA	NA	176	151	NA	270	NA	NA	174	NA	NA	177	172	NA	NA	NA	NA	NA	NA	NA	170	318	160	NA	155
Bhiwani	166	211	156	176	179	256	167	116	141	144	109	205	235	59	128	73	201	152	NA	115	206	264	NA	198	136	129	220	191	184	177	155
Rewari	188	219	191	153	215	210	158	170	130	128	133	187	173	97	122	314	180	135	144	NA	NA	271	136	231	188	135	NA	NA	103	157	153
Faridabad	203	NA	176	192	149	NA	243	NA	106	144	NA	173	124	86	128	65	213	NA	155	62	NA	145	124	NA	170	117	176	78	114	111	130
Fatehabad	NA	213	165	189	511	NA	213	114	134	118	141	181	313	78	144	NA	285	209	199	NA	56	166	127	241	138	155	258	134	167	200	NA
Gurugram	191	412	139	174	175	NA	192	134	136	93	132	142	NA	98	123	73	NA	109	120	82	82	136	126	198	221	138	180	150	93	124	132
Hisar	NA	214	148	159	165	327	117	95	68	123	125	241	90	66	129	NA	178	NA	163	NA	NA	333	128	133	137	154	142	117	61	171	NA
Jind	248	195	163	213	168	344	214	NA	129	124	145	204	320	104	142	NA	236	170	155	NA	145	224	133	195	183	119	259	197	104	132	224
Kaithal	152	85	174	200	269	NA	131	137	100	96	111	228	178	86	128	89	297	108	81	NA	NA	166	136	139	163	139	240	108	162	127	NA
Karnal	130	194	155	202	235	NA	122	160	80	113	170	159	208	86	78	NA	146	142	80	111	NA	127	120	149	141	140	337	125	NA	NA	84
Kurukshetra	114	75	139	169	197	NA	130	158	139	104	174	187	108	86	100	94	186	107	91	NA	NA	135	125	163	167	NA	256	NA	184	276	NA
Mewat	185	289	220	202	256	373	214	260	149	123	138	181	133	158	149	45	192	196	124	107	99	225	141	210	236	144	222	380	177	178	196
Gurugram	230	237	165	182	196	195	NA	NA	NA	127	122	178	156	113	140	NA	245	150	227	NA	179	NA	141	236	135	176	225	NA	164	161	171
Mahendar-garh	176	191	201	134	181	270	156	170	98	112	88	184	248	71	97	135	138	119	139	97	64	199	121	160	135	121	174	113	167	126	151
Palwal	177	277	228	238	231	202	294	150	145	127	114	190	244	200	166	153	240	212	157	55	NA	246	151	NA	187	112	227	404	185	210	188
Panchkula	90	NA	97	NA	134	NA	108	NA	112	127	113	120	142	85	131	112	NA	97	59	109	142	128	96	80	89	128	253	NA	176	118	162
Panipat	157	219	169	215	239	397	259	107	126	131	192	180	222	97	131	81	205	177	77	109	90	180	129	181	144	82	186	129	NA	110	179
Rohtak	135	217	154	148	253	285	137	164	130	118	116	186	149	75	120	47	180	162	112	89	142	243	131	251	185	132	208	126	127	163	177
Sirsa	210	264	158	183	310	NA	142	NA	142	116	157	110	118	68	NA	NA	187	NA	230	101	65	172	126	182	NA	149	149	NA	126	147	NA
Sonipat	252	198	195	229	272	431	108	109	112	121	156	194	235	168	136	96	303	199	113	122	NA	177	182	188	NA	134	259	142	212	213	NA
Y.Nagar	62	NA	119	199	146	175	138	213	138	116	136	170	131	69	NA	190	116	124	136	134	193	176	109	125	103	130	249	150	218	122	159

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of February at ground station points in Haryana

Districts	1-Feb	2-Feb	3-Feb	4-Feb	5-Feb	6-Feb	7-Feb	8-Feb	9-Feb	10-Feb	11-Feb	12-Feb	13-Feb	14-Feb	15-Feb	16-Feb	17-Feb	18-Feb	19-Feb	20-Feb	21-Feb	22-Feb	23-Feb	24-Feb	25-Feb	26-Feb	27-Feb	28-Feb
Ambala	60	135	106	114	97	153	124	114	131	97	134	161	121	106	129	115	124	139	130	119	180	71	95	18	143	116	68	225
Jhajjar	196	206	131	172	162	219	204	158	142	NA	171	280	141	202	139	150	159	NA	NA	158	290	121	113	99	166	114	NA	197
Faridabad	NA	NA	NA	NA	154	NA	NA	167	128	NA	176	NA	NA	105	NA	134	157	106	78	77	133	37	33	68	152	NA	NA	119
Bhiwani	141	138	111	99	200	145	230	139	149	146	146	220	137	126	119	200	125	120	118	125	208	134	95	45	125	81	102	183
Rewari	219	159	140	133	NA	201	121	140	129	132	168	249	136	110	115	156	162	159	159	135	193	148	142	138	215	100	55	103
Faridabad	84	150	89	140	NA	143	68	94	115	NA	123	NA	123	79	146	205	118	106	65	98	164	37	91	69	130	65	38	118
Fatehabad	95	92	100	95	148	136	192	133	162	177	NA	159	126	120	128	195	132	94	91	141	148	94	75	74	135	88	99	130
Gurugram	171	134	187	113	NA	NA	110	143	117	NA	104	273	97	136	108	170	150	113	73	90	169	31	134	88	118	145	NA	106
Hisar	107	94	126	80	128	174	202	127	120	135	152	232	NA	125	124	197	131	135	87	156	127	109	63	41	103	33	125	158
Jind	101	163	114	61	176	170	125	125	115	104	NA	223	133	118	118	208	126	113	NA	150	134	150	77	132	90	90	100	161
Kaithal	111	103	93	109	137	215	192	165	113	45	NA	NA	131	84	119	135	124	113	120	133	252	89	65	65	110	121	92	132
Karnal	97	120	101	42	135	157	100	142	110	103	101	225	138	83	89	136	133	134	93	151	159	133	76	70	124	76	75	98
Kurukshetra	98	117	146	NA	135	144	167	105	121	NA	222	216	109	120	127	116	130	134	NA	121	181	125	87	72	112	108	93	130
Mewat	183	132	94	120	254	275	223	128	144	137	203	295	200	152	127	179	166	118	114	113	131	214	133	148	197	80	46	140
Gurugram	151	150	154	147	NA	227	183	129	124	129	176	332	121	145	145	157	134	157	128	120	170	144	87	176	200	75	NA	149
Mahendar-garh	83	141	119	95	180	123	219	178	121	109	119	218	118	230	179	188	165	118	91	105	38	196	139	80	155	86	124	117
Palwal	153	167	114	125	385	252	107	147	127	127	169	263	NA	132	121	219	162	139	117	152	134	129	173	82	231	69	55	189
Panchkula	90	98	50	85	102	152	112	127	90	76	127	NA	NA	123	130	147	126	84	82	71	104	NA	45	NA	168	54	39	137
Panipat	81	153	112	60	107	167	124	133	123	107	170	217	191	104	117	110	131	122	116	148	220	94	37	161	141	116	48	154
Rohtak	140	140	107	116	171	173	135	150	144	138	133	228	126	121	119	167	182	133	140	138	194	136	81	118	140	101	53	160
Sirsa	116	100	144	57	317	114	173	140	122	157	249	NA	117	122	119	276	122	106	101	137	162	86	59	96	88	82	97	166
Sonipat	216	146	141	90	123	285	192	164	125	131	NA	237	125	123	111	175	139	125	178	126	268	178	30	237	139	114	56	166
Y.Nagar	126	NA	98	88	135	195	139	134	96	59	108	134	143	88	143	167	144	134	137	72	170	74	33	81	123	57	NA	92

Y Nagar= Yamuna Nagar

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Estimated PM 10 daily composite for Year 2016 to 2020 for the month of March at ground station points in Haryana

Districts	1-Mar	2-Mar	3-Mar	4-Mar	5-Mar	6-Mar	7-Mar	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	14-Mar	15-Mar	16-Mar	17-Mar	18-Mar	19-Mar	20-Mar	21-Mar	22-Mar	23-Mar	24-Mar	25-Mar	26-Mar	27-Mar	28-Mar	29-Mar	30-Mar	31-Mar
Ambala	147	119	142	151	101	71	58	121	112	NA	128	111	NA	133	88	111	78	127	122	120	111	133	127	103	87	97	97	102	117	117	96
Jhajjar	NA	193	256	182	138	162	141	268	171	162	191	184	NA	182	169	180	100	131	125	198	139	68	117	136	121	155	149	104	109	109	NA
Faridabad	NA	163	203	NA	131	58	121	NA	NA	NA	186	157	130	165	142	118	94	109	140	139	87	110	124	153	101	142	111	122	131	86	145
Bhiwani	228	192	196	205	114	123	93	153	162	129	153	130	124	153	124	181	94	140	138	136	180	69	145	122	111	107	179	74	111	104	112
Rewari	147	NA	218	183	95	116	NA	144	169	103	177	149	125	175	114	138	80	86	154	128	88	133	130	124	99	119	110	101	116	101	121
Faridabad	118	150	171	84	87	83	77	134	160	104	147	129	122	146	119	141	113	68	135	124	111	87	96	86	74	144	91	114	111	95	134
Fatehabad	176	193	137	143	104	115	98	117	119	160	126	145	129	147	136	188	148	120	168	126	98	128	130	105	121	102	152	NA	116	90	143
Gurugram	120	131	175	139	111	124	128	172	175	93	154	109	107	161	120	196	51	105	120	157	197	113	123	57	116	119	109	101	91	100	100
Hisar	178	160	167	133	127	180	235	94	116	81	136	154	141	135	137	93	91	69	176	132	77	23	92	97	NA	123	135	71	97	97	170
Jind	163	128	179	138	170	142	112	159	136	142	118	111	141	159	130	166	96	135	170	179	130	129	144	103	181	123	161	148	124	127	144
Kaithal	148	170	118	105	113	110	107	143	123	111	132	97	193	138	108	125	101	100	161	176	103	100	151	106	NA	135	156	80	122	134	89
Karnal	145	174	155	122	100	107	89	122	101	130	119	130	167	167	98	131	71	117	149	152	97	121	100	92	117	113	142	88	124	137	94
Kurukshetra	204	163	150	116	87	42	NA	124	117	126	117	118	212	159	131	141	101	105	131	160	101	175	124	124	NA	104	102	155	118	152	122
Mewat	166	220	180	163	93	108	105	123	137	83	174	121	100	146	97	113	45	91	99	106	117	26	73	88	80	90	60	78	89	92	88
Gurugram	144	261	206	227	132	51	139	142	166	108	140	120	121	155	113	150	167	117	112	169	161	122	108	185	102	108	87	105	124	105	116
Mahendar-garh	139	160	190	142	63	109	137	126	147	97	131	145	119	151	106	135	86	97	139	121	119	94	92	97	68	71	101	55	85	79	128
Palwal	158	246	188	156	125	147	118	138	240	190	172	146	156	190	145	260	91	123	NA	160	230	151	104	164	117	127	131	121	117	129	144
Panchkula	NA	111	141	96	118	63	64	97	41	122	NA	78	89	116	37	92	90	94	113	115	130	66	100	44	NA	95	118	142	77	108	74
Panipat	168	197	143	138	102	77	92	135	133	133	152	130	127	228	124	144	90	114	149	162	146	157	114	127	121	124	130	120	114	134	114
Rohtak	179	191	261	137	74	104	75	157	170	130	139	95	111	165	139	200	94	128	117	139	135	89	104	109	99	104	99	97	97	93	36
Sirsa	177	187	144	160	105	118	141	115	117	93	150	148	NA	153	95	131	113	128	160	NA	94	149	139	105	NA	111	157	84	128	131	123
Sonipat	NA	154	166	167	129	119	110	212	152	192	139	145	153	168	116	270	101	155	269	185	192	133	118	135	78	126	139	129	134	113	152
Y.Nagar	83	150	153	113	122	70	58	86	96	98	140	103	183	122	98	115	95	116	116	158	113	148	129	124	78	100	104	147	154	132	99

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of April at ground station points in Haryana

Districts	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	9-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-Apr	15-Apr	16-Apr	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr
Ambala	107	138	85	148	130	217	190	129	101	27	69	110	76	78	99	117	144	128	139	175	150	89	128	111	132	125	138	114	173	132
Jhajjar	144	146	126	139	186	86	288	185	116	50	183	92	102	103	113	NA	131	157	157	172	187	126	123	101	NA	113	205	196	159	152
Faridabad	147	133	101	NA	118	103	132	130	116	98	116	132	99	117	175	NA	132	153	131	NA	NA	115	122	112	111	129	143	131	149	145
Bhiwani	127	104	66	165	153	125	241	154	90	91	109	110	70	112	115	NA	105	93	105	NA	59	93	96	15	157	140	193	115	123	120
Rewari	100	NA	88	129	107	55	281	148	132	NA	112	111	17	NA	89	NA	133	106	NA	NA	59	54	69	NA	182	NA	NA	152	128	NA
Faridabad	135	143	72	120	122	95	172	118	100	110	135	98	83	85	119	107	100	68	132	90	110	88	132	95	99	116	146	134	115	123
Fatehabad	182	106	126	181	180	NA	175	125	90	108	137	125	82	122	123	109	145	98	136	132	NA	144	91	137	65	118	140	103	149	113
Gurugram	102	118	125	126	143	131	127	138	92	114	195	NA	76	111	107	118	128	98	143	121	146	93	127	110	127	117	116	153	136	136
Hisar	60	116	79	179	139	NA	185	91	103	117	131	59	78	103	103	132	97	93	127	123	106	152	115	71	114	129	167	137	110	92
Jind	143	137	173	149	190	235	235	150	113	85	121	123	76	99	97	NA	153	65	162	136	126	129	89	95	57	206	189	92	163	147
Kaithal	71	122	121	162	172	194	199	167	121	136	101	102	42	104	75	73	131	118	150	163	241	110	84	125	80	169	166	69	106	190
Karnal	108	138	131	172	191	252	200	118	84	133	93	114	91	96	97	94	76	141	155	171	157	83	152	111	129	166	129	73	170	165
Kurukshetra	88	128	134	186	236	227	176	77	91	144	89	116	125	87	94	NA	120	132	182	160	156	NA	145	58	131	152	153	65	152	114
Mewat	124	109	77	NA	104	37	NA	126	92	NA	NA	117	40	NA	86	NA	NA	109	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gurugram	132	111	83	184	100	77	126	121	133	162	216	125	82	127	129	NA	135	129	149	168	205	109	90	105	134	NA	NA	130	138	123
Mahendar-garh	93	81	106	105	97	278	111	111	121	116	120	67	35	97	70	NA	122	98	130	NA	35	NA	NA	3	29	67	NA	238	43	62
Palwal	120	136	134	151	153	195	136	134	134	134	163	131	92	108	119	NA	105	99	140	117	188	83	101	102	110	108	170	113	141	142
Panchkula	69	160	65	79	141	NA	216	148	73	209	113	122	137	NA	95	87	116	128	156	160	182	42	98	97	116	130	110	108	153	102
Panipat	142	134	116	155	191	251	209	176	105	139	172	135	100	127	112	NA	132	137	221	172	167	104	90	113	142	132	141	170	193	185
Rohtak	88	91	87	109	115	232	110	66	94	130	102	77	NA	118	80	NA	NA	109	NA	NA	61	NA	NA	NA	NA	NA	155	NA	NA	NA
Sirsa	NA	144	NA	215	211	NA	150	176	120	NA	151	NA	51	118	144	120	140	119	109	122	63	138	95	107	93	44	124	102	100	135
Sonipat	135	126	158	170	147	190	242	195	117	176	102	107	112	122	101	NA	165	128	202	203	212	120	97	136	185	NA	152	114	191	153
Y.Nagar	75	142	141	176	181	141	195	178	93	141	150	133	77	73	70	82	120	100	158	172	177	77	125	90	119	149	109	101	160	133

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of May at ground station points in Haryana

Districts	1-May	2-May	3-May	4-May	5-May	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May
Ambala	133	128	136	134	81	214	192	168	172	166	169	136	179	196	215	84	199	139	146	112	172	112	174	238	116	128	113	97	160	158	112
Jhajjar	139	111	158	187	142	NA	NA	197	NA	218	NA	220	NA	120	NA	NA	114	208	108	165	206	NA	162	222	NA	136	NA	218	NA	NA	142
Faridabad	94	170	155	124	120	108	170	152	172	144	150	134	NA	169	131	165	105	184	113	185	136	138	175	161	188	124	71	145	NA	169	170
Bhiwani	132	116	175	80	75	NA	NA	193	209	180	343	214	157	114	311	110	114	203	121	NA	136	155	134	120	69	102	179	174	120	95	162
Rewari	83	111	144	177	NA	NA	NA	NA	NA	173	280	NA	NA	61	NA	NA	114	125	138	NA	132	NA	67	87	211	121	NA	NA	118	NA	161
Faridabad	118	118	125	117	95	150	132	123	178	147	147	181	174	115	167	173	121	119	92	128	124	126	189	137	128	164	148	108	108	177	207
Fatehabad	110	115	157	183	96	NA	71	155	91	137	NA	NA	NA	137	102	NA	77	80	105	NA	121	117	NA	122	85	130	NA	114	NA	NA	NA
Gurugram	161	160	140	151	137	201	245	127	195	214	193	193	195	209	198	154	201	132	114	137	142	145	184	160	151	159	162	138	191	157	199
Hisar	109	119	148	98	96	129	102	187	184	177	189	188	196	131	206	330	143	120	113	NA	116	135	151	85	197	164	147	118	132	129	204
Jind	167	127	158	181	139	NA	93	176	77	159	224	208	180	162	72	225	187	168	127	NA	180	114	194	148	81	177	116	151	106	40	249
Kaithal	195	128	147	142	89	169	83	123	98	170	237	155	262	101	81	NA	129	167	128	NA	153	104	153	131	43	152	110	152	121	159	244
Karnal	133	135	160	150	122	134	138	126	118	167	165	198	196	203	216	141	138	129	164	143	168	162	154	142	105	145	91	127	169	165	247
Kurukshetra	109	97	120	147	99	128	209	162	128	209	148	233	171	235	194	147	141	130	172	127	117	212	136	211	59	116	121	132	107	190	256
Mewat	111	111	133	NA	NA	NA	NA	NA	NA	131	NA	NA	NA	NA	75	NA	90	88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	106	NA	NA
Gurugram	75	124	149	146	211	207	154	170	227	183	NA	220	NA	61	120	NA	118	211	119	NA	278	139	181	157	61	124	NA	153	NA	124	174
Mahendar-garh	83	127	198	NA	130	NA	NA	NA	NA	109	NA	120	NA	58	76	NA	85	NA	60	NA	125	NA	NA	108	14	110	11	142	98	107	NA
Palwal	153	138	151	148	179	NA	185	NA	167	141	156	223	202	171	125	164	118	124	113	148	107	131	147	172	162	124	90	210	102	126	180
Panchkula	115	123	122	84	69	186	63	171	85	217	128	127	143	238	191	243	87	181	150	107	235	199	154	224	116	109	126	88	165	16	106
Panipat	174	166	129	134	132	153	172	151	155	207	197	236	163	217	230	197	109	219	146	230	213	170	207	197	100	211	127	184	161	121	217
Rohtak	111	111	148	NA	NA	NA	NA	NA	NA	139	NA	NA	NA	70	NA	NA	119	NA	NA	NA	NA	NA	NA	NA	NA	118	NA	NA	NA	NA	153
Sirsa	72	111	169	169	71	NA	53	122	96	155	NA	199	141	22	133	NA	79	NA	99	97	NA	109	NA	119	56	119	NA	64	128	32	NA
Sonipat	126	170	199	168	109	147	168	132	196	233	229	345	192	224	191	199	199	NA	147	155	198	220	202	198	196	173	162	171	149	248	275
Y.Nagar	110	162	150	111	117	133	125	155	113	158	191	257	133	186	147	204	109	170	137	125	179	196	159	159	142	120	119	111	159	161	150

Y Nagar= Yamuna Nagar

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Estimated PM 10 daily composite for Year 2016 to 2020 for the month of June at ground station points in Haryana

Districts	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun
Ambala	195	165	205	157	212	NA	235	178	162	148	226	151	212	156	93	135	122	212	218	161	NA	103	158	175	245	128	NA	160	203	388
Jhajjar	242	NA	234	NA	168	183	118	92	176	110	270	221	NA	213	NA	152	NA	263	166	179	172	NA	230	190	491	NA	NA	NA	165	NA
Faridabad	236	175	192	143	243	263	179	141	183	176	211	205	210	195	62	171	279	231	208	184	249	129	176	NA	253	406	278	469	194	193
Bhiwani	217	157	152	156	138	121	199	26	132	40	190	167	179	227	146	151	154	185	379	214	258	73	197	154	307	NA	345	208	208	NA
Rewari	NA	135	NA	NA	NA	NA	101	44	160	NA	91	NA	NA	NA	215	161	175	288	NA	181	NA	NA	NA	NA	NA	NA	NA	NA	NA	197
Faridabad	217	165	159	214	219	207	128	90	119	132	188	151	256	245	82	364	233	208	239	195	301	113	162	258	268	NA	NA	439	167	201
Fatehabad	65	149	NA	NA	NA	59	123	51	107	77	225	176	164	NA	NA	NA	NA	138	224	185	116	77	179	NA	NA	NA	NA	194	NA	NA
Gurugram	235	209	202	207	194	229	204	104	139	197	203	169	213	238	90	163	338	189	230	196	188	112	199	NA	184	NA	NA	483	165	249
Hisar	239	162	110	191	177	141	209	60	195	156	189	174	171	247	127	144	302	325	298	180	149	57	157	307	187	274	331	207	225	NA
Jind	218	189	223	177	198	284	192	211	200	190	194	168	173	212	220	218	171	298	193	215	270	74	182	197	314	443	519	206	216	254
Kaithal	156	153	262	169	176	195	233	40	210	157	186	147	209	NA	129	150	148	241	191	263	NA	153	223	330	353	102	NA	214	208	406
Karnal	179	138	249	149	190	344	183	235	183	175	193	213	212	183	236	169	196	285	310	270	246	189	266	163	288	153	NA	172	214	323
Kurukshetra	186	168	202	185	229	190	209	97	200	176	200	143	211	173	86	160	162	243	196	247	NA	137	165	367	327	349	NA	280	209	NA
Mewat	NA	124	NA	134	NA	NA	144	178	NA	NA	97	NA	NA	NA	NA	NA	NA	125	NA	192	NA	NA	NA	NA	301	NA	NA	NA	NA	227
Gurugram	151	141	235	NA	NA	197	132	43	154	NA	227	304	281	250	104	156	153	136	332	201	168	NA	NA	NA	233	NA	NA	416	160	196
Mahendar-garh	NA	127	71	NA	NA	101	NA	20	26	56	195	266	192	NA	NA	NA	NA	153	108	136	213	NA	97	137	140	135	126	NA	168	NA
Palwal	200	191	243	142	207	209	209	36	172	202	200	219	254	326	91	166	157	196	262	235	233	165	229	512	230	350	406	449	180	171
Panchkula	181	140	185	179	245	NA	201	193	141	125	161	49	191	190	154	159	140	182	210	218	NA	170	134	NA	227	165	NA	168	166	247
Panipat	203	224	278	197	228	217	209	200	277	229	241	238	291	241	100	170	264	248	314	274	230	197	212	230	350	217	628	242	225	389
Rohtak	154	128	NA	NA	NA	NA	NA	NA	NA	NA	188	NA	NA	NA	NA	NA	NA	227	298	168	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sirsa	75	183	190	124	NA	121	192	113	154	107	188	NA	154	NA	96	123	236	213	171	172	NA	135	130	346	136	156	274	382	159	393
Sonipat	254	222	220	216	235	242	218	156	194	171	242	199	238	230	133	174	158	285	307	213	NA	130	228	240	344	188	NA	215	186	312
Y.Nagar	175	158	235	171	193	193	215	76	165	179	178	161	184	200	198	152	288	143	208	241	204	179	204	187	180	266	NA	196	232	361

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of July at ground station points in Haryana

Districts	1-Jul	2-Jul	3-Jul	4-Jul	5-Jul	6-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul	28-Jul	29-Jul	30-Jul	31-Jul
Ambala	NA	234	NA	210	193	184	115	NA	365	410	NA	NA	53	NA	NA	NA	NA	NA	NA	NA	NA	302	NA	178	NA	NA	NA	NA	221	NA	NA
Jhajjar	121	NA	212	151	NA	226	NA	NA	237	NA	NA	177	NA	NA	NA	884	NA	NA	NA	212	284	317	338	NA	NA	NA	198	170	515	223	NA
Faridabad	NA	NA	341	220	332	275	NA	NA	358	320	NA	185	167	364	167	474	NA	NA	NA	292	218	360	NA	NA	NA	NA	172	173	323	NA	NA
Bhiwani	172	NA	188	226	166	174	322	346	210	290	337	392	206	206	206	199	NA	NA	NA	182	243	456	198	368	NA	380	NA	176	355	NA	328
Rewari	NA	NA	NA	145	NA	NA	398	286	166	282	301	NA	NA	NA	NA	NA	NA	NA	212	NA	239	302	254	374	NA	NA	164	155	NA	NA	NA
Faridabad	89	NA	229	NA	302	195	NA	NA	328	NA	NA	182	148	368	148	NA	227	NA	NA	198	253	331	426	325	NA	NA	182	155	406	NA	NA
Fatehabad	152	297	NA	205	216	262	330	NA	182	360	369	NA	208	208	208	210	NA	NA	235	NA	264	410	NA	212	193	338	NA	154	147	NA	NA
Gurugram	175	NA	206	169	NA	273	NA	NA	275	NA	804	NA	142	321	142	NA	NA	NA	438	318	NA	225	NA	NA	NA	NA	183	175	365	NA	NA
Hisar	171	198	167	246	216	294	333	359	224	317	240	164	192	192	192	201	NA	NA	NA	173	NA	175	NA	250	NA	NA	NA	158	287	NA	NA
Jind	354	NA	NA	203	469	279	256	382	287	528	455	219	197	197	197	NA	NA	NA	523	NA	311	285	NA	NA	NA	NA	NA	NA	472	NA	NA
Kaithal	NA	NA	298	182	254	NA	237	NA	332	561	NA	NA	201	201	201	NA	NA	500	NA	NA	428	391	NA	NA	NA	NA	NA	NA	471	167	362
Karnal	222	449	366	255	NA	425	308	342	NA	549	NA	NA	177	177	177	232	NA	NA	NA	NA	336	436	NA	NA	208	NA	NA	NA	NA	NA	NA
Kurukshetra	381	NA	283	206	232	449	209	NA	407	446	1111	NA	174	174	174	NA	NA	208	NA	NA	353	323	NA	NA	NA	NA	NA	NA	297	NA	NA
Mewat	NA	NA	NA	145	180	153	205	206	344	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	148	184	NA	227	145	NA	NA	NA	NA	NA	NA	NA
Gurugram	99	NA	205	150	NA	148	258	NA	253	353	276	179	168	320	168	NA	NA	NA	221	NA	NA	327	NA	410	NA	NA	NA	163	NA	NA	NA
Mahendar-garh	142	NA	180	137	NA	155	239	NA	118	166	182	NA	187	187	201	NA	NA	NA	NA	211	182	186	147	NA	NA	209	NA	NA	NA	184	NA
Palwal	137	434	402	322	293	252	358	299	444	444	NA	193	447	327	163	546	NA	NA	241	318	255	284	NA	NA	223	NA	170	161	495	NA	NA
Panchkula	153	NA	NA	231	264	279	116	187	NA	429	NA	NA	NA	NA	NA	NA	184	NA	197	NA	NA	NA	NA	163	NA	NA	NA	NA	NA	NA	NA
Panipat	205	558	409	251	687	535	356	382	NA	463	NA	NA	184	184	184	NA	NA	NA	211	NA	284	276	463	NA	224	NA	NA	NA	NA	NA	NA
Rohtak	124	NA	NA	143	NA	NA	131	281	190	NA	214	NA	193	193	193	NA	NA	NA	416	153	165	259	211	NA	NA	NA	NA	143	393	182	NA
Sirsa	203	305	269	249	360	371	274	411	161	322	174	NA	203	250	203	370	NA	310	293	266	164	292	NA	283	NA	259	NA	195	154	NA	NA
Sonipat	NA	561	268	194	NA	301	NA	388	387	NA	NA	NA	191	191	191	NA	NA	NA	NA	199	398	472	NA	NA	NA	NA	NA	190	270	NA	NA
Y.Nagar	246	201	NA	257	358	379	NA	483	340	501	NA	NA	162	162	162	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of August at ground station points in Haryana

Districts	1-Aug	2-Aug	3-Aug	4-Aug	5-Aug	6-Aug	7-Aug	8-Aug	9-Aug	10-Aug	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug
Ambala	98	NA	205	NA	108	NA	NA	NA	NA	NA	370	NA	NA	NA	NA	108	155	400	NA	107	NA	177	NA	NA	NA	161	NA	114	66	NA	NA
Jhajjar	NA	NA	293	NA	NA	314	NA	NA	NA	NA	364	NA	NA	NA	256	224	242	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	JNa	NA	346
Faridabad	120	NA	305	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	311	204	NA	255	NA	NA	NA	232	NA	NA	NA	104	NA	Farida	NA	NA	NA
Bhiwani	232	300	155	NA	171	113	NA	NA	397	NA	NA	NA	NA	NA	220	132	141	170	NA	NA	147	80	136	NA	NA	NA	NA	NA	Bhi	245	NA
Rewari	107	NA	234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	240	NA	202	NA	NA	NA	NA	129	135	NA	304	NA	NA	NA	NA	NA	NA
Faridabad	NA	NA	166	NA	NA	236	NA	NA	NA	NA	NA	NA	NA	NA	452	205	217	222	NA	NA	NA	328	NA	NA	NA	166	NA	NA	NA	NA	NA
Fatehabad	129	308	361	NA	NA	245	NA	NA	328	NA	236	NA	293	NA	NA	87	127	138	159	NA	309	98	115	204	NA	160	NA	NA	Fate	NA	133
Gurugram	121	NA	158	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	155	NA	148	NA	NA	NA	186	174	NA	NA	NA	118	NA	Gu	NA	NA
Hisar	252	392	NA	NA	NA	262	NA	NA	276	NA	NA	NA	163	NA	210	149	128	204	NA	NA	421	82	74	NA	NA	NA	NA	NA	Hisar	174	NA
Jind	148	NA	176	120	253	357	129	NA	555	NA	NA	NA	337	NA	NA	267	141	NA	NA	NA	NA	111	NA	NA	NA	NA	NA	NA	162	227	NA
Kaithal	NA	NA	174	432	NA	NA	NA	NA	NA	NA	239	NA	NA	NA	NA	217	115	NA	NA	NA	NA	NA	NA	164	NA	159	NA	NA	Ka	201	NA
Karnal	86	NA	159	415	NA	383	NA	NA	NA	NA	NA	NA	NA	274	189	NA	170	151	NA	45	NA	NA	NA	NA	NA	NA	NA	NA	Kar	NA	NA
Kurukshetra	NA	NA	151	199	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	58	155	NA	113	NA	NA	NA	NA	NA	NA	NA	NA	NA	Kurukshetra	NA	NA
Mewat	111	NA	NA	NA	NA	NA	NA	45	NA	NA	NA	NA	NA	NA	NA	230	NA	201	121	NA	NA	129	NA	NA	NA	NA	NA	NA	Mewa	NA	NA
Gurugram	111	NA	244	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	277	NA	NA	113	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Gu	NA	NA
Mahendar-garh	100	NA	142	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	219	NA	114	NA	NA	96	108	134	NA	NA	NA	NA	77	NA	NA	NA	173
Palwal	127	NA	160	NA	NA	351	NA	75	NA	NA	296	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	219	190	NA	NA	NA	133	NA	Palwal	NA	NA
Panchkula	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	157	NA	14	NA	84	NA	170	NA	144	NA	Panch	NA	NA	NA
Panipat	124	472	180	NA	NA	NA	NA	NA	NA	NA	NA	NA	180	249	186	NA	191	143	NA	25	NA	NA	NA	NA	NA	NA	NA	135	Na	NA	NA
Rohtak	116	152	154	NA	NA	NA	NA	NA	349	NA	NA	NA	175	159	202	150	151	113	NA	NA	113	92	121	NA	271	NA	39	NA	144	133	NA
Sirsa	134	431	256	NA	171	178	141	NA	262	NA	NA	166	NA	NA	227	NA	124	NA	133	212	108	NA	NA	169	NA	167	NA	142	NA	NA	NA
Sonipat	119	NA	NA	132	NA	369	124	NA	NA	NA	NA	NA	NA	300	363	203	209	191	NA	34	NA	NA	117	NA	NA	136	NA	NA	Na	NA	NA
Y.Nagar	101	NA	NA	96	NA	151	NA	NA	NA	NA	NA	NA	NA	NA	320	NA	NA	NA	NA	48	NA	NA	NA	NA	NA	NA	101	NA	NA	NA	NA

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of September at ground station points in Haryana

Districts	1-Sep	2-Sep	3-Sep	4-Sep	5-Sep	6-Sep	7-Sep	8-Sep	9-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep
Ambala	NA	NA	102	NA	123	NA	278	108	252	NA	154	217	NA	229	69	195	502	140	NA	144	132	287	182	171	162	274	254	363	174	196
Jhajjar	NA	NA	NA	132	179	139	194	242	271	NA	140	198	148	173	111	102	176	148	195	156	209	NA	173	NA	166	170	165	165	202	179
Faridabad	NA	NA	NA	162	133	NA	212	218	209	167	147	151	138	201	93	313	154	281	185	213	304	152	NA	NA	173	179	150	181	145	138
Bhiwani	NA	NA	220	NA	149	98	NA	141	143	113	140	181	126	143	164	153	218	140	166	136	181	191	212	120	43	118	96	120	135	108
Rewari	NA	NA	NA	104	122	NA	177	115	182	107	121	137	121	132	125	NA	210	139	182	118	98	284	158	109	NA	106	84	117	108	118
Faridabad	NA	NA	NA	NA	239	141	NA	227	NA	203	160	154	168	NA	158	102	256	153	263	198	239	357	NA	NA	161	165	170	134	204	146
Fatehabad	NA	NA	138	63	149	80	158	NA	115	141	117	146	139	117	211	140	161	130	121	172	154	212	201	178	173	112	123	122	130	112
Gurugram	NA	NA	NA	NA	155	186	NA	NA	NA	182	175	178	170	121	119	NA	170	156	180	175	NA	NA	145	NA	NA	126	155	156	176	169
Hisar	NA	NA	128	NA	119	78	171	149	128	169	114	162	137	132	NA	142	143	118	185	150	146	181	223	130	236	152	141	159	149	109
Jind	NA	NA	NA	NA	129	146	168	164	196	NA	158	155	146	150	155	105	298	144	151	159	182	252	250	105	171	170	158	148	184	77
Kaithal	NA	NA	NA	NA	110	NA	286	145	179	210	112	175	178	158	133	163	184	138	110	124	272	155	452	NA	186	180	190	176	209	189
Karnal	NA	NA	NA	NA	106	358	NA	127	179	NA	122	185	195	239	113	133	199	127	173	133	NA	265	198	101	179	236	184	169	189	230
Kurukshetra	NA	NA	129	NA	122	158	270	138	NA	NA	165	194	235	192	133	229	288	144	NA	166	277	318	NA	129	194	302	208	240	161	233
Mewat	NA	NA	NA	NA	NA	111	160	96	168	90	87	NA	104	123	78	47	150	110	NA	77	NA	239	NA	95	92	96	74	87	94	45
Gurugram	NA	NA	NA	120	140	181	210	195	182	NA	153	170	140	NA	179	79	223	146	156	168	123	307	152	NA	NA	111	107	115	138	111
Mahendar-garh	NA	NA	133	NA	NA	NA	122	124	NA	76	100	129	62	114	132	96	155	94	61	114	108	67	168	89	204	103	63	68	89	67
Palwal	NA	NA	NA	120	148	124	201	145	197	128	149	153	134	153	149	96	175	149	224	173	114	273	159	NA	107	155	150	163	121	158
Panchkula	NA	NA	62	85	68	NA	NA	NA	NA	NA	134	472	NA	185	NA	175	162	115	296	157	123	150	117	133	101	NA	308	152	149	74
Panipat	NA	NA	NA	NA	133	127	172	149	210	172	176	173	208	181	106	130	222	156	184	163	182	157	195	122	162	179	181	173	245	182
Rohtak	NA	NA	179	NA	136	83	135	124	135	100	128	124	103	116	112	114	171	117	81	142	120	165	NA	121	208	86	61	54	98	42
Sirsa	NA	NA	145	NA	184	94	157	120	115	142	144	163	124	149	169	170	115	137	145	150	188	166	205	184	172	195	112	120	141	143
Sonipat	NA	NA	NA	NA	142	204	163	223	181	159	206	172	177	192	116	230	200	135	170	120	270	253	295	NA	NA	165	160	167	245	92
Y.Nagar	NA	NA	NA	NA	135	NA	NA	166	NA	NA	210	183	NA	NA	NA	93	184	147	314	339	NA	431	163	129	119	213	NA	161	158	299

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of October at ground station points in Haryana

Districts	1-Oct	2-Oct	3-Oct	4-Oct	5-Oct	6-Oct	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct	12-Oct	13-Oct	14-Oct	15-Oct	16-Oct	17-Oct	18-Oct	19-Oct	20-Oct	21-Oct	22-Oct	23-Oct	24-Oct	25-Oct	26-Oct	27-Oct	28-Oct	29-Oct	30-Oct	31-Oct
Ambala	123	144	376	157	217	125	170	169	176	217	192	132	144	203	154	188	201	162	135	156	172	171	227	155	170	249	164	140	132	216	199
Jhajjar	116	152	127	173	139	130	203	226	167	208	206	188	185	154	143	163	151	201	192	171	222	144	149	208	184	236	230	259	NA	329	NA
Faridabad	138	119	127	157	115	118	134	186	155	205	188	197	204	142	142	154	181	186	176	135	183	154	132	224	157	186	249	227	NA	237	NA
Bhiwani	107	79	205	145	186	147	177	130	159	196	193	216	139	156	133	153	159	156	168	139	211	128	158	207	225	235	270	307	221	282	525
Rewari	55	54	52	61	93	136	NA	159	127	179	221	151	135	132	63	115	119	130	108	235	NA	106	NA	153	NA	145	316	280	NA	NA	NA
Faridabad	91	115	111	198	125	135	132	223	155	213	212	239	172	177	195	185	204	202	148	181	160	166	168	204	220	174	275	206	223	294	166
Fatehabad	207	258	209	399	141	167	133	131	222	257	216	217	145	180	155	198	170	217	172	146	167	124	181	303	208	316	311	353	421	280	507
Gurugram	132	116	117	164	130	125	123	181	160	207	214	151	200	155	192	158	218	158	152	195	208	160	161	305	186	233	296	214	238	260	337
Hisar	183	190	104	122	180	105	122	147	176	173	176	185	153	129	113	169	158	160	150	147	200	106	141	233	210	175	231	312	188	275	414
Jind	104	301	234	158	247	122	166	167	214	228	304	210	185	164	169	266	157	196	190	145	171	180	182	287	220	279	296	223	336	370	173
Kaithal	276	114	373	155	128	107	157	203	214	275	225	182	201	154	194	268	206	212	196	167	131	162	199	257	215	274	249	168	227	312	NA
Karnal	90	130	165	174	115	115	118	196	221	263	223	200	178	172	158	156	177	173	198	143	143	159	200	168	190	208	244	178	206	293	152
Kurukshetra	105	120	338	224	104	110	111	182	178	247	162	154	160	147	171	209	187	168	169	190	152	140	253	165	198	NA	179	160	155	266	153
Mewat	134	35	80	87	89	NA	NA	140	101	134	142	114	81	122	80	209	171	NA	63	220	129	71	101	138	234	NA	220	161	333	245	NA
Gurugram	123	103	146	174	129	136	118	198	163	205	175	202	159	161	165	220	174	190	143	176	262	131	194	182	198	201	225	270	NA	255	233
Mahendar-garh	86	55	77	88	121	116	92	94	135	118	100	75	95	104	64	116	161	121	127	178	126	71	92	100	201	129	207	141	93	272	181
Palwal	119	142	136	161	140	131	136	125	168	219	232	164	184	195	158	209	193	197	157	168	237	166	188	218	228	206	239	264	NA	251	251
Panchkula	115	323	137	121	105	115	218	111	158	140	166	158	142	104	123	131	138	155	137	148	99	123	118	104	166	179	126	202	180	268	154
Panipat	110	261	253	190	131	115	181	197	208	259	200	213	195	172	206	171	225	178	209	193	144	140	209	228	244	208	239	192	149	330	304
Rohtak	68	75	61	160	81	109	57	113	NA	126	101	130	54	178	74	99	94	91	158	196	115	33	127	NA	NA	149	NA	159	153	NA	NA
Sirsa	246	229	271	126	143	171	150	163	243	244	182	185	151	139	145	158	161	169	166	160	167	114	162	258	220	292	283	391	180	204	370
Sonipat	105	178	189	181	134	115	190	178	174	215	193	232	218	165	200	270	194	200	198	178	270	163	188	252	249	327	208	246	276	394	169
Y.Nagar	151	148	163	188	129	134	105	172	160	202	212	151	148	105	158	152	151	137	112	140	146	150	158	136	155	207	136	165	119	157	139

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of November at ground station points in Haryana

Districts	1-Nov	2-Nov	3-Nov	4-Nov	5-Nov	6-Nov	7-Nov	8-Nov	9-Nov	10-Nov	11-Nov	12-Nov	13-Nov	14-Nov	15-Nov	16-Nov	17-Nov	18-Nov	19-Nov	20-Nov	21-Nov	22-Nov	23-Nov	24-Nov	25-Nov	26-Nov	27-Nov	28-Nov	29-Nov	30-Nov
Ambala	232	205	150	205	117	201	109	124	164	159	131	164	127	172	161	161	80	115	159	201	127	162	84	119	103	105	164	179	142	139
Jhajjar	213	203	216	140	149	196	148	218	223	NA	217	332	NA	178	263	184	NA	NA	210	225	189	142	127	126	450	NA	115	182	152	144
Faridabad	172	NA	210	162	200	121	NA	NA	163	NA	NA	NA	NA	NA	NA	138	NA	NA	199	NA	161	155	NA	NA	157	NA	NA	138	101	155
Bhiwani	256	190	150	376	109	231	106	447	206	230	211	173	228	288	NA	188	210	186	162	207	178	128	92	150	123	125	130	122	120	134
Rewari	235	179	NA	166	NA	NA	182	NA	333	NA	78	114	NA	241	192	129	152	170	NA	140	NA	114	92	117	134	NA	91	101	57	130
Faridabad	233	231	270	225	192	152	169	217	139	326	292	166	335	167	NA	180	212	238	167	217	159	154	110	91	190	108	123	122	100	218
Fatehabad	223	233	179	293	303	163	145	221	201	186	187	173	174	311	375	68	NA	135	130	159	110	129	53	131	102	NA	97	128	133	126
Gurugram	208	274	213	153	NA	186	142	226	271	305	194	282	476	185	237	125	337	172	175	177	179	153	154	149	173	126	147	331	166	165
Hisar	216	201	271	253	92	138	120	198	232	182	119	200	257	279	334	226	166	177	151	192	158	121	109	106	131	104	120	222	156	193
Jind	279	219	205	322	113	140	181	210	NA	283	311	151	236	225	NA	127	133	201	164	203	138	150	104	134	117	111	79	134	131	163
Kaithal	291	272	176	193	87	129	109	126	98	182	NA	148	212	NA	280	NA	92	155	148	244	105	162	92	79	104	146	117	101	126	168
Karnal	332	269	185	152	103	257	113	146	171	243	NA	171	226	NA	266	74	126	151	174	178	154	149	97	88	130	82	123	105	152	187
Kurukshetra	265	260	174	176	130	207	136	134	62	198	192	142	208	162	256	54	106	159	177	189	151	158	98	99	164	88	133	120	163	165
Mewat	NA	209	192	188	133	410	262	304	239	355	236	556	246	NA	387	174	233	156	200	166	181	145	94	110	192	187	122	195	156	139
Gurugram	202	169	213	171	180	176	165	241	167	NA	185	156	229	179	205	NA	275	187	168	186	191	147	119	170	105	150	147	124	148	139
Mahendar-garh	137	123	NA	124	134	151	111	194	144	145	71	97	195	NA	308	207	187	153	100	107	128	86	119	97	173	55	75	198	101	184
Palwal	258	253	205	150	157	114	181	NA	94	NA	243	165	NA	NA	205	173	139	166	183	200	155	129	75	82	165	100	55	97	140	172
Panchkula	270	160	187	250	189	191	89	167	192	186	190	161	115	203	235	127	72	132	114	148	92	117	61	57	87	79	89	78	136	86
Panipat	180	282	NA	166	104	128	104	141	106	NA	NA	215	238	186	NA	78	101	185	154	203	112	154	88	115	152	103	120	107	152	168
Rohtak	NA	141	NA	131	NA	87	83	NA	NA	NA	NA	140	217	NA	NA	102	NA	NA	110	92	148	110	81	NA	109	NA	112	NA	85	104
Sirsa	318	211	163	207	257	279	153	169	175	118	183	NA	201	NA	NA	105	NA	107	140	150	107	105	NA	115	58	NA	113	139	86	151
Sonipat	234	251	217	199	126	142	166	278	187	NA	380	239	160	227	NA	NA	126	196	205	214	187	194	127	132	167	146	158	145	127	207
Y.Nagar	209	155	148	139	119	142	158	110	130	122	129	134	216	163	218	77	92	79	152	171	114	120	100	86	78	71	54	140	164	156

Y Nagar= Yamuna Nagar

Estimated PM 10 daily composite for Year 2016 to 2020 for the month of December at ground station points in Haryana

District	1-Dec	2-Dec	3-Dec	4-Dec	5-Dec	6-Dec	7-Dec	8-Dec	9-Dec	10-Dec	11-Dec	12-Dec	13-Dec	14-Dec	15-Dec	16-Dec	17-Dec	18-Dec	19-Dec	20-Dec	21-Dec	22-Dec	23-Dec	24-Dec	25-Dec	26-Dec	27-Dec	28-Dec	29-Dec	30-Dec	31-Dec
Ambala	165	200	123	211	153	120	129	120	NA	159	168	131	190	139	148	75	97	113	148	189	NA	108	NA	133	186	156	175	109	137	163	108
Jhajjar	185	154	158	175	170	160	178	151	167	170	164	NA	198	NA	158	104	115	118	134	NA	171	114	108	362	NA	NA	185	NA	225	210	NA
Faridabad	168	140	139	NA	167	NA	177	169	NA	172	NA	NA	NA	140	154	96	NA	NA	NA	NA	124	NA	NA	NA	NA	NA	NA	NA	NA	NA	167
Bhiwani	148	110	117	165	118	129	135	145	170	137	175	196	246	125	139	88	62	115	138	175	173	120	97	214	265	142	170	206	150	180	198
Rewari	151	128	87	152	148	134	160	144	188	136	181	136	184	158	100	70	79	83	123	132	183	125	89	175	193	187	128	100	158	184	128
Faridabad	132	163	123	NA	162	161	192	122	151	162	NA	NA	NA	135	124	NA	85	103	95	NA	136	69	166	222	NA	NA	NA	NA	119	NA	137
Fatehabad	125	115	113	NA	154	110	91	111	172	115	143	NA	133	127	90	84	98	84	107	128	231	78	60	224	242	153	224	155	147	164	222
Gurugram	140	122	118	149	180	184	203	143	199	133	NA	NA	235	129	136	91	54	97	94	124	NA	157	76	197	214	NA	150	102	101	NA	122
Hisar	125	109	101	150	153	104	80	131	165	171	147	174	178	NA	93	94	NA	72	77	NA	102	57	49	163	197	169	192	NA	201	121	NA
Jind	163	167	126	188	156	146	144	127	164	183	195	NA	271	183	143	90	79	116	121	194	191	131	125	232	252	170	232	190	147	188	145
Kaithal	138	158	135	162	201	159	153	130	142	199	135	150	257	193	140	88	91	98	133	116	173	161	179	225	226	191	253	212	159	202	154
Karnal	170	183	153	192	188	152	131	120	163	161	188	143	281	103	120	122	131	86	159	169	NA	196	NA	165	221	188	NA	NA	124	169	139
Kurukshetra	167	180	133	200	219	151	147	122	176	143	139	144	184	101	119	138	77	108	160	130	199	78	178	124	281	173	223	131	143	NA	215
Mewat	159	188	115	177	148	183	203	215	200	186	200	507	256	168	119	74	70	88	131	129	130	114	103	181	199	142	148	106	121	272	171
Gurugram	156	139	140	157	126	157	158	220	214	177	180	NA	205	187	137	72	87	45	130	142	150	245	186	319	322	172	120	NA	NA	120	222
Mahendar-garh	124	130	139	107	103	104	158	142	150	106	128	58	171	162	110	70	33	66	88	99	115	90	115	136	92	236	91	99	170	112	104
Palwal	144	131	123	162	136	178	235	149	201	148	182	355	184	155	123	238	103	93	128	135	302	125	187	260	304	178	180	154	156	521	NA
Panchkula	123	126	129	181	130	90	116	136	86	NA	134	123	NA	NA	102	34	107	59	143	137	106	150	136	64	71	102	124	129	85	167	96
Panipat	171	194	181	207	191	168	178	126	184	182	149	NA	220	137	125	115	146	110	151	154	117	131	194	168	255	179	249	130	157	NA	143
Rohtak	114	99	97	125	136	106	185	159	227	106	168	113	204	115	130	65	67	78	126	125	159	69	180	93	213	142	137	95	143	145	186
Sirsa	125	103	110	79	150	99	110	105	160	123	144	180	134	179	101	80	98	76	103	128	156	114	61	256	282	161	247	165	158	135	NA
Sonipat	154	199	146	169	188	163	144	137	186	211	157	NA	219	144	193	134	130	104	159	182	152	153	163	275	222	194	198	181	174	NA	150
Y.Nagar	145	174	134	190	136	161	119	118	137	178	131	120	120	122	79	65	87	81	257	156	116	192	169	129	205	168	148	179	122	201	112

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