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# A Comparative Study Focusing the Effect of Criteria Pollutants, Volatile Organic Compounds and Meteorological Parameters on Ambient Air Quality of Various Cities of India

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**Abstract** Now a day, India along with whole world is facing the worst phase of air pollution. All the metropolitan and smart cities air is suffering from various pollutants. Even though rural areas are not away from this severe problem. AQI, AQI Index, visuality and respiratory illness are some of the eye catching words in media today. Air quality is not dependent on any single parameter. Air quality gets affected by gases, particulate matters, topography, metrology, chemical compounds etc. This paper focuses' the effect of criteria pollutants, volatile organic compounds and meteorological factors on the air quality of various cities. The Air Quality Index of those cities has been compared with parameters and whole AQI values have been categorized into five ranges mentioned by NAAQS. The data collected and analyzed in this paper entails that $PM_{2.5}$, $PM_{10}$, $NO_2$ and NOx are the key role players. Amongst VOC's, toluene played the main role while in metrology solar radiations and wind degree influenced the air quality most. At certain locations the AQI index reached its severe category which results in respiratory ailments and ultimately death on prolonged exposure to this condition.

***Keywords:*** *Air Quality Index (AQI), National Ambient Air Quality Standards (NAAQS), Volatile Organic Compounds (VOCs)*

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## 1. Introduction

According to the latest data compiled in the World Air Quality Report in collaboration with Greenpeace Southeast Asia as IQ Air Visual 2018, Delhi has been ranked the most polluted capital in the world. Here $PM_{2.5}$ concentration has been taken as the base for air quality monitoring as it can fester deep in the lungs and bloodstream of human beings. Although, Delhi ranks top most in capital but city wise it has been spotted as 11$^{th}$ most polluted city after Gurugram, Ghaziabad, Faisalabad (Pakistan), Faridabad, Bhiwadi, Noida, Patna, Hotan (China), Lucknow and Lahore (Pakistan). This IQ Air Visual report 2018 has been prepared on the data collected from public monitoring sources that were published in real-time or near real-time.

India, the world's fastest-growing major economy accounted 22 of the top 30 most polluted cities while china stood with five, Pakistan with two and Bangladesh with one city only. According to the most recent facts published by The Lancet Commission on Pollution and Health, the total number of deaths in 2015 globally reached 9 million due to pollution which were three times more than the death reported by AIDS, tuberculosis and malaria. Out of them 2.5 million had been reported in India which was the highest in the world during that year. China spotted second by 1.8 million deaths. The Lancet report has been prepared by the research conducted by 40 international scientists who collected data from Global Burden of Diseases study from the Institute for Health Metrics and Evaluation at the University of Washington. It has been estimated that continuous exposure to air pollution for many years affects the respiratory and inflammatory systems. It can also lead to stroke, heart disease and even lung cancer.

Amongst 2.5 million deaths, 47 million were children under the age of five years living in densely polluted areas. According to the Greenpeace India report and on the basis of data collected from Central Pollution Control Board and State Pollution Control Boards these areas were found to be most affected due to exceeding safe limits of $PM_{10}$.

Henceforth, on these above mentioned startling facts it can be easily said that today Air Pollution, Air Quality and its health impacts are the most noticeable and considerable perspectives in present world.

## 2. What do We Mean by Air Pollution?

Air pollution is the complex mixture of gases, aerosols, water vapor and particles originated both naturally as well as anthropogenically. But the pollutants present in it makes it unfit for inhabitability. These pollutant concentration when exceed the permissible limits affects the human, animals, crop, vegetation, buildings and ecosystem as well. Air pollutants have been categorized into four types as firstly: Gaseous Pollutants like Sulphur Dioxide, Carbon monoxide, ozone etc. Secondly, Persistent organic Pollutants like Dioxins. Thirdly, Heavy metals like mercury, lead, arsenic etc. and lastly Particulate matter for example $PM_{2.5}$, $PM_{10}$.

Thus some major pollutant has been defined as "Criteria Pollutants" by Environment Protection Agency (EPA) under the category of National Ambient Air Quality Standards (NAAQS). These six major pollutants are carbon monoxide, lead, nitrogen dioxide, ground – level ozone, sulphur dioxide and particulate matter.

### 2.1. Criteria Pollutants

**Ozone-**The ground level ozone generated from the reaction of pollutants that have been emitted by industrial facilities, electric utilities and motor vehicles. Ozone formation can also be done by natural sources like particular trees and plants.

**Sulphur Dioxide:** Fossil fuel combustion by electrical utilities and industry is the primary source of sulfur dioxide.

**Nitrogen Dioxide:** Nitric oxide (NO) and nitrogen dioxide ($NO_2$) have been emitted by cars, trucks, buses, power plants, and non-road engines and equipment. Emitted NO gets rapidly oxidized into $NO_2$ in the atmosphere.

**Lead:** Earlier the major source of lead emissions was considered the combustion of leaded gasoline in automobiles. The remaining sources of lead air emissions have been industrial sources, including lead smelting and battery recycling operations, and piston-engine small aircraft that use leaded aviation gasoline.

**Carbon Monoxide:** Gasoline-fueled vehicles and other on-road and non-road mobile sources are the primary sources of carbon monoxide (CO).

**Particulate Matter (PM):** Particulate matter is a term used for discrete particles that vary in sizes and on the basis of their physical and chemical nature. They originate both naturally as well as anthropogenically. The natural sources of particulate matter (PM) are forest fires while the man made stationary sources are industries. The mobile sources are motor vehicles. Particles may be emitted directly, or may be formed in the atmosphere by transformations of gaseous emissions such as oxides of sulphur ($SO_x$), oxides of nitrogen ($NO_x$), and volatile organic compounds (VOCs). The chemical and physical properties of PM vary with time, region, meteorology, and the source of emissions. On the basis of size, they have been categorized into coarse a [particles as $PM_{10}$ and fine particles as $PM_{2.5}$. This is totally based on their aerodynamic diameter less than or equal to 10 micrometers or 2.5 micrometers and their inhalable properties deep into the lungs. As we know, a huge amount of coarse particle gets emitted due to mechanical processes and uncontrolled burning. The major activities which contributes for $PM_{10}$ production includes industrial processes, construction-demolition acts, wild fires and residential heating. Fine particles have been produced by combustion processes and atmospheric reaction of gaseous pollutants.

Many studies [1] have shown that apart from these criteria pollutants, some other factors also contribute in air pollution. They do not play a direct role in it but somewhat indirectly affects it. The movement of air always influences the fate of air pollutants. Thus, it is needed to have a study of local weather patterns prior the study of air pollution. The study of weather conditions deals with meteorology. The concentration of pollutants depends on the calmness & turbulence of air. If the air seems to be calm the pollutant cannot disperse and its concentration would increase while in strong turbulent winds the vice-versa will happen. The meteorological data helps in identifying the source of pollutants and also aids in determining the highest polluted day through the events like inversion. It also helps in simulating and predicting air quality using various computer models. The various meteorological parameters that are important to be considered for studying air pollution are wind speed, wind direction, temperature, humidity, rainfall, solar radiation, absolute temperature, etc.

### 2.2. Meteorological Parameters

**Wind Speed:** The wind velocity, turbulence and stability affect the transport, dilution and dispersion of the pollutants. An instrument named anemometer is used for determining wind speed. The wind data records can also determine the direction and area of the pollutant emissions which can be used for reducing the impacts of air quality at a particular location. Wind current carries the contaminants away from the source and thus, disperses them. In general, it can be said that, the higher the speed of wind, the more dispersion will be there and thus, lower the concentration of pollutants. In other words, the concentration of pollutants in a downward location from a ground-level source is inversely proportional to the wind speed.

**Wind Direction:** The traveling of pollutants depends on the direction of wind. The expected persistence of the wind direction is related to the location of the receptors and topographic features also. Topographic features such as valleys cause's winds to persist in certain directions much more frequently than in others.

**Rainfall:** The rainfall has a washing out or scavenging effect on the pollutants present in the atmosphere [2]. Heavy rain can wash out the aerosols and can also clean the air during rainy season. India occupies that place in subcontinent which is tropical and sub tropical by nature. This condition creates extremes of rainfall, temperature and relative humidity in climatic conditions. These features introduce large variability in aerosol characteristics on a range of spatial and temporal scales over India [3].

**Relative humidity:** There exist a proportional relation between the concentration of pollutants and relative humidity. As the relative humidity increases, the amount of solar radiation reaching the earth's surface decreases. This causes heat discrepancies in the atmosphere. The water droplets in the atmosphere collide with the sunshine and get absorbed. They start evaporating and release their embedded heat in the atmosphere. This causes heat variations in the earth's surface. The region near to the earth becomes colder than the upper layers hence reducing the up going air currents, resultantly increases the pollutants in the atmosphere [4].

**Temperature:** Temperature is responsible for warm and cold seasons of the year which in turn results in high concentration of ozone and particulate matter [5].

**Solar Radiations:** The solar radiation reaching the earth surface from sun is known as Surface Solar Radiations (SSR).Its amount changes over time. The various parameters like cloud cover, aerosol particulates dust or ash, smoke coughing out of stacks-all results in scattering and dispersion of sunlight, resulting in less arrival of sunlight on earth's surface. The latest study reports that the smaller the particles, the more harmful the impacts are, published in Advances in Atmospheric Sciences on Aug 20, 2019. It has been found that as the air pollution increases the dispersion of sunlight increases and the amount of sunlight reaching the earth's surface decreases. In this process, fine particles have greater influence than coarse particles.

Apart from criteria and meteorological parameters, Central Pollution of Control Board has considered Volatile Organic Compounds (VOCs) as a vital pollutant affecting Air Quality Index.

**Volatile Organic Compounds (VOCs):** These are those compounds which are volatile in nature means emits in the form of gas from the surface of solids or liquids. They possess both short-term and long-term health effects. VOCs are those compounds which possess a boiling point less than 250 deg Celsius at 101.3KPa standard atmospheric pressure. World Health Organization has categorized VOCs into two types on the basis of boiling point and volatility nature. Their sub-divisions are- Very volatile organic compounds with a range of boiling point between 0°C and 100°C with gaseous nature while the other one with boiling point between 100°C and 250°C; are found distributed between water and air body surfaces [6].

VOCs basically include aliphatic, aromatic hydrocarbons, aldehydes, ketones, acids, alcohols and ethers also. They can have different functional groups like nitrogen, halogens, oxygen, sulphur or phosphorus. The famous VOCs category named BTEX i.e., Benzene, Toluene, Ethylbenzene and Xylene (o-, m- and p-) are found most abundant in the environment. They comprise about 60% of the VOCs found in urban areas. They are made up of benzene and its organic derivatives [7]. Hence, BTEX plays a major role in determining VOC exposure and evaluation of environmental levels of VOC.

There are various sources of VOCs naturally and anthropogenically contributing to their presence. Naturally they enter the atmosphere from the transformation of biogenic precursors and from forest fires also. On the other hand, 25% of VOCs in global atmosphere comes from the toxic emissions of anthropogenic activities [8]. Several activities are responsible for VOCs emissions like mining, gas leaks from stoves, residential water heaters and boilers, pesticides used in agriculture, commercial sources etc. Major contributors are petrochemical activities, petroleum and natural gas extraction, fossil fuels burning in industries, mobile sources like trucks, buses, motorcycles, automobiles, ships and airplanes along with chemical and industrial processes of manufacturing paints, lubricants, adhesives and oil derivatives [9,10].

**Role of Benzene, toluene, ethylbenzene and xylene (o-, m- and p-) (BTEX) as indicators of VOC exposure-** These chemicals are found naturally in crude oil, gasoline and diesel either they are burned or not. They are highly used as precursors and additives in industry. Amongst BTEX, benzene is used in manufacturing of consumer products and synthetic materials like nylon, plastics, insecticides, paints etc. Toluene plays a major role of solvents for rubbers, oils, resins, paints and coatings. Ethylbenzene is found in pesticides, paints and plastics while also used as a fuel in aviation. Xylene is used as solvent in the printing, leather and rubber industries [11,12]. It has been concluded that higher concentration of BTEX are found in areas with intensive industrial activities. In large cities, their high levels have been found due to heavy vehicular traffic problems [13,14].

## 3. Methodology

This review is based on the data retrieved from the Site of Central Pollution Control Board i.e. cpcb.nic.in. The section having environmental data posses sub tab named Automatic Monitoring Air Quality Data. In the advanced search section of Central Control Room Air Quality Management- All India, the air quality data of 67 cities have been compiled and tabulated dated on Oct 13, 2018. Average of past 24 hours @ 4 PM has been recorded. All three parameter have been tabulated like criteria pollutants, meteorological parameters and VOCs. The sites from where data has been collected are State Pollution Control Board Sites. The cities where more than one site is present have been compiled with the average values of the data. In this paper, the AQI index is also included with the help of National Ambient Air Quality Standards (NAAQS) along with prominent pollutants responsible for it. Numbers of monitoring stations and air quality category have also been included in the table. The criteria pollutant includes $PM_{2.5}$, $PM_{10}$, $SO_2$, NO, $NO_2$, NOx, $NH_3$, CO, Ozone. The VOCs category included Benzene, Toluene, Ethylbenzene and Xylene (o-, m-p-) while meteorological parameters considered were relative humidity, solar radiations, wind degree, wind speed, vertical wind speed, rainfall, absolute temperature and temperature. Amongst 67 cities, 16 cities are selected which had the air quality of poor and very poor category.

Later on a statistical analysis of these 16 cities have been done with the help of Minitab 19 software. In the descriptive statistics, mean, median, standard deviation, minima, maxima, skewness and kurtosis of all three categories have been done followed by One-way ANOVA and further analysis.

**Results analysis and discussion:** In this review paper, the criteria pollutant concentration of 67 cities has been compiled in Table 1. As well in Table 2 the concentration of Volatile organic compounds containing BTEX (Benzene, Toluene, Ethylene and o, m, p-xylene) is depicted in the above mentioned cities. In Table 3, the meteorological factors and their effects on those cities has been mentioned. Later on the Table 5 indicates the Air quality index on the basis of number of monitoring stations and prominent pollutants. This is used to estimate the category of air quality lying in that particular city to focus on risk categories.

**Table 1. Cities and their criteria pollutant concentrations**

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | City Name | Criteria Pollutants | | | | | | | | |
| | | $PM_{2.5}$ (ug/m$^3$) | $PM_{10}$ (ug/m$^3$) | $SO_2$ (ug/m$^3$) | NO (ug/m$^3$) | $NO_2$ (ug/m$^3$) | NOx (ppb) | $NH_3$ (ug/m$^3$) | CO (mg/m$^3$) | Ozone (ug/m$^3$) |
| 1 | Agra | 91.71 | 0 | 4.35 | 22.67 | 337.52 | 228.48 | 0 | 3.59 | 115.87 |
| 2 | Ahmedabad | 102.13 | 0 | 56.15 | 28.69 | 107.13 | 41.47 | 0 | 1.14 | 60.77 |
| 3 | Ajmer | 43.62 | 89.04 | 11.8 | 12.56 | 28.43 | | 0 | 0.9 | 50.03 |
| 4 | Alwar | 75.52 | 65.58 | 6.81 | 17.29 | 43 | 52.76 | 54.59 | 0.82 | 13.96 |
| 5 | Amaravati | 40.43 | 120.34 | 23.26 | 4.37 | 29.27 | 19.22 | 17.11 | 0.59 | 43.76 |
| 6 | Amritsar | 0 | 180.47 | 5.85 | 28.55 | 26.27 | 54.82 | 24.96 | 0 | 17.65 |
| 7 | Asansol | 18.77 | 25.91 | 0.8 | 13.2 | 5.43 | 18.63 | 25.8 | 0.31 | 26.27 |
| 8 | Baghpat | 165.12 | 283.85 | 18.71 | 7.96 | 32.03 | 23.51 | 29.95 | 1.68 | 39.27 |
| 9 | Bathinda | 43.46 | 111.34 | 0 | 12.92 | 17.96 | 30.55 | 0 | 0.23 | 0 |
| 10 | Bengaluru | 84.3214 | 170.705 | 6.92889 | 34.5267 | 47.66 | 69.5233 | 14.41 | 0.99111 | 28.2683 |
| 11 | Bhiwadi | 303.36 | 510.97 | 54.26 | 19.61 | 37.33 | 56.94 | 0 | 0.94 | 36.06 |
| 12 | Bulandshahr | 113.89 | 0 | 11.16 | 24.75 | 59.46 | 51.87 | 40.69 | 0 | 58.15 |
| 13 | Chandrapur | 36.985 | 91.73 | 6.155 | 2.885 | 8.27 | 8.155 | 24.89 | 0.535 | 9.535 |
| 14 | Chennai | 40.89 | 0 | 5.78667 | 9.2 | 14.3533 | 23.5533 | 73.39 | 0.88 | 32.66 |
| 15 | Chikkaballapur | 43.07 | 122.68 | 9.79 | 12.08 | 52.44 | 37.71 | 7.07 | 0.33 | 16.59 |
| 16 | Delhi | 135.182 | 280.671 | 17.8315 | 53.2375 | 51.105 | 70.5806 | 32.2316 | 1.41697 | 33.9131 |
| 17 | Dewas | 46.78 | 152.86 | 6.48 | 4.47 | 24.62 | 16.73 | 11.89 | 0.54 | 66.44 |
| 18 | Durgapur | 0 | 20.19 | 0 | 9.34 | 59.67 | 69.52 | 0 | 0.57 | 1.04 |
| 19 | Faridabad | 180.53 | 0 | 11.32 | 4.31 | 56.09 | 32.46 | 0 | 0 | 33.55 |
| 20 | Gaya | 32.32 | 0 | 2.79 | 20.37 | 46.58 | 40.34 | 0 | 0.79 | 33.06 |
| 21 | Ghaziabad | 199.14 | 382.96 | 47.27 | 28.98 | 87.05 | 69.86 | 35.13 | 1.66 | 50.43 |
| 22 | Greater_Noida | 136.79 | 305.42 | 27.02 | 19.84 | 63.61 | 49.97 | 27.17 | 1.76 | 30.9 |
| 23 | Gurugram | 158.85 | 259.35 | 0 | 13.895 | 48.895 | 41.375 | 0 | 1.175 | 40.5 |
| 24 | Haldia | 0 | 32.05 | 7.27 | 3.43 | 19.07 | 22.39 | 0 | 0 | 17.63 |
| 25 | Howrah | 21.685 | 44.37 | 12.535 | 4.755 | 28.885 | 33.635 | 13.075 | 0.565 | 31.155 |
| 26 | Hubballi | 63.61 | 124.46 | 0 | 2.28 | 18.85 | 21.14 | 7.07 | 0.43 | 43.73 |
| 27 | Hyderabad | 62.045 | 137.002 | 11.3183 | 14.2333 | 50.4933 | 37.7017 | 17.988 | 0.705 | 24.4017 |
| 28 | Jaipur | 61.3267 | 135.93 | 9.58667 | 12.5433 | 33.2767 | 37.26 | 15.5167 | 0.78 | 63.45 |
| 29 | Jalandhar | 73.07 | 120.57 | 9.42 | 21.4 | 22.7 | 44.09 | 37.08 | 0.76 | 24.39 |
| 30 | Jodhpur | 98.2 | 189.5 | 9.62 | 26.13 | 40.01 | 36.14 | 0 | 0.78 | 44.46 |
| 31 | Jorapokhar | 0 | 137.58 | 0 | 7.42 | 7.62 | 0 | 0 | 0 | 9.4 |
| 32 | Kanpur | 61.35 | 0 | 7.22 | 15.62 | 65.18 | 47.05 | 0 | 1.73 | 18.87 |
| 33 | Khanna | 44.19 | 104.26 | 5.63 | 0 | 35.82 | 0 | 9.68 | 0.72 | 48.54 |
| 34 | Kolkata | 21.22 | 31.77 | 1.92 | 4.81 | 18.87 | 23.68 | 15.38 | 1.09 | 22.25 |
| 35 | Kota | 76.57 | 172.01 | 7.85 | 13.75 | 34.69 | 48.34 | 7.99 | 0.94 | 22.42 |
| 36 | Lucknow | 74.9525 | 0 | 6.5425 | 11.5925 | 33.0425 | 25.91 | 37.74 | 1.035 | 23.3233 |
| 37 | Ludhiana | 42.15 | 57.61 | 9 | 13.35 | 11.13 | 24.27 | 21 | 0.65 | 11.73 |
| 38 | Mandi Gobindgarh | 188.72 | 173.51 | 13 | 21.41 | 15 | 36.4 | 17.04 | 1.21 | 37.07 |
| 39 | Mandideep | 47.56 | 140.86 | 13.52 | 8.37 | 17.2 | 15.97 | 10.92 | 0.31 | 54.22 |
| 40 | Moradabad | 116.1 | 211.45 | 25.69 | 25.87 | 50.32 | 46.7 | 31.9 | 1.46 | 48.13 |
| 41 | Mumbai | 53.4 | 165.54 | 17.76 | 35.96 | 26.94 | 62.9 | 0 | 1.86 | 73.89 |
| 42 | Muzaffarnagar | 103.83 | 201.95 | 20.81 | 10.79 | 51.3 | 36.06 | 39.13 | 0 | 13.95 |
| 43 | Muzaffarpur | 14.88 | 0 | 15.59 | 7.21 | 38.83 | 14.76 | 0 | 0.94 | 10.49 |
| 44 | Nagpur | 28.68 | 51.52 | 30.94 | 4.31 | 33.88 | 20.77 | 0 | 0.55 | 37.12 |
| 45 | Nashik | 45.13 | 103.06 | 8.82 | 11.98 | 30.47 | 25.54 | 0 | 0.92 | 59.14 |
| 46 | Navi Mumbai | 0 | 337.54 | 24 | 0 | 0 | 18 | 0 | 1.15 | 0 |
| 47 | Noida | 144.435 | 302.095 | 22.57 | 48.475 | 51.545 | 73.315 | 39.61 | 1.355 | 53.79 |

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **City Name** | **Criteria Pollutants** | | | | | | | | |
| | | **$PM_{2.5}$ (ug/m$^3$)** | **$PM_{10}$ (ug/m$^3$)** | **$SO_2$ (ug/m$^3$)** | **NO (ug/m$^3$)** | **$NO_2$ (ug/m$^3$)** | **NOx (ppb)** | **$NH_3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
| 48 | Pali | 92.25 | 176.82 | 4.15 | 3.09 | 26.32 | 29.02 | 21.31 | 0.41 | 59.71 |
| 49 | Panchkula | 34.51 | 0 | 4.03 | 14.82 | 31.93 | 31.21 | 0 | 0.86 | 81.36 |
| 50 | Patiala | 55.27 | 101.93 | 11.65 | 10.42 | 4.39 | 14.81 | 19.51 | 0.55 | 16.12 |
| 51 | Pithampur | 45.58 | 166.21 | 11.93 | 1.65 | 13.97 | 8.77 | 32.36 | 0.56 | 68.63 |
| 52 | Pune | 64.96 | 120.7 | 29.28 | 9.66 | 11.2 | 20.05 | 0 | 1.19 | 7.73 |
| 53 | Rajamahendravaram | 33.56 | 75.32 | 8.64 | 2.82 | 16.02 | 10.81 | 15.14 | 1.18 | 67.21 |
| 54 | Rohtak | 27.25 | 0 | 24.13 | 2.8 | 26.66 | 15.2 | 0 | 0.38 | 18.81 |
| 55 | Rupnagar | 34.76 | 66.6 | 4.15 | 0 | 13.16 | 0 | 0 | 0.55 | 0 |
| 56 | Satna | -2.32 | 68.98 | 32.63 | 0 | 0 | 0 | 0 | 1.96 | 0 |
| 57 | Siliguri | 33.7 | 60.37 | 4.46 | 11.75 | 23.82 | 35.59 | 14.2 | 0.7 | 18.83 |
| 58 | Singrauli | 38.98 | 73.12 | 17.32 | 0 | 23.19 | 0 | 16.91 | 0.57 | 40.14 |
| 59 | Solapur | 36.87 | 98.67 | 9.72 | 18.3 | 57.37 | 75.58 | 0 | 2.06 | 55.21 |
| 60 | Thane | 54.58 | 148.05 | 5.26 | 19.47 | 40.63 | 33.9 | 36.57 | 1.2 | 27.2 |
| 61 | Thiruvananthapuram | 37.34 | 65.73 | 5.75 | 2.97 | 8.84 | 7.08 | 3.21 | 1.02 | 11.23 |
| 62 | Tirupati | 43.12 | 105.48 | 8.58 | 5.87 | 45.58 | 28.99 | 19.04 | 0.35 | 55.69 |
| 63 | Udaipur | 47.86 | 131.37 | 4.59 | 21.01 | 29.31 | 49.57 | 24.21 | 1.34 | 39.71 |
| 64 | Ujjain | 47.52 | 154.33 | 5.69 | 0 | 18.07 | 10.61 | 0 | 0.65 | 93.93 |
| 65 | Varanasi | 65.73 | 195.7 | 17.68 | 10.35 | 38.15 | 21.82 | 0 | 0.6 | 28.33 |
| 66 | Vijayawada | 22.55 | 44.77 | 12.44 | 12.35 | 12.42 | 24.77 | 10.78 | 0.68 | 0 |
| 67 | Visakhapatnam | 44.64 | 113.09 | 12.19 | 10.08 | 48.92 | 34.21 | 12.53 | 0.69 | 30.25 |

**Table 2. Cities and their VOCs concentrations**

| **Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | City Name | VOCs | | | | | |
| | | Benzene (ug/m$^3$) | Toluene (ug/m$^3$) | Ethyl Benzene (ug/m$^3$) | Xylene (ug/m$^3$) | MP-Xylene (ug/m$^3$) | O-Xylene (ug/m$^3$) |
| 1 | Agra | 0 | 0 | | 0 | | |
| 2 | Ahmedabad | 3.87 | 21.26 | | 7.16 | | |
| 3 | Ajmer | 0.5 | 0.26 | | | | |
| 4 | Alwar | 1.59 | 9.02 | | | | |
| 5 | Amaravati | 0.06 | 0.08 | | 0.1 | | |
| 6 | Amritsar | 20.74 | 1.77 | | 15.08 | | |
| 7 | Asansol | 3.76 | | | | | |
| 8 | Baghpat | 2.13 | 2.4 | | | | |
| 9 | Bathinda | | | | | | |
| 10 | Bengaluru | 1.98333 | 6.205 | 0.775 | | | |
| 11 | Bhiwadi | 1.13 | 1.37 | | | | |
| 12 | Bulandshahr | 6.92 | 13.5 | | | | |
| 13 | Chandrapur | 0.625 | 0.075 | | 0.25 | | |
| 14 | Chennai | 0.085 | 0.65 | | | 0.22 | |
| 15 | Chikkaballapur | 0.96 | 1.65 | | | | |
| 16 | Delhi | 5.75963 | 66.2163 | 2.10667 | 12.9765 | | |
| 17 | Dewas | 1.59 | 4.47 | | | | |
| 18 | Durgapur | | | | | | |
| 19 | Faridabad | | | | | | |
| 20 | Gaya | 0.64 | 2.04 | | 1.91 | | |
| 21 | Ghaziabad | | | | | | |
| 22 | Greater_Noida | 1.62 | 21 | | | | |
| 23 | Gurugram | 3.29 | | | | | |
| 24 | Haldia | | | | | | |
| 25 | Howrah | 3.51 | 4.175 | | | | |
| 26 | Hubballi | | | | | | |
| 27 | Hyderabad | 4.62667 | 48.97 | | 12.5583 | | |
| 28 | Jaipur | 1.19 | 10.55 | | | 1.19 | |
| 29 | Jalandhar | | | 25.68 | | 1.42 | 1.95 |
| 30 | Jodhpur | 0.57 | 1.4 | | | 0.15 | |
| 31 | Jorapokhar | 0 | | | | | |
| 32 | Kanpur | 1.27 | 3.68 | | 2.93 | | |

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sr. No. | City Name | VOCs | | | | | |
| | | Benzene ($ug/m^3$) | Toluene ($ug/m^3$) | Ethyl Benzene ($ug/m^3$) | Xylene ($ug/m^3$) | MP-Xylene ($ug/m^3$) | O-Xylene ($ug/m^3$) |
| 33 | Khanna | 3.84 | | | | | |
| 34 | Kolkata | 5.19 | 8.12 | 1.59 | | | |
| 35 | Kota | 1.22 | | 0.25 | | 0.45 | |
| 36 | Lucknow | 0.21333 | 0.42 | | 245.25 | | |
| 37 | Ludhiana | 3.08 | 17.74 | | | | |
| 38 | Mandi Gobindgarh | 3.2 | | | | | |
| 39 | Mandideep | 0.19 | 1.23 | | | | |
| 40 | Moradabad | 1.24 | 9.18 | | 4.26 | | |
| 41 | Mumbai | 1.59 | | | | | |
| 42 | Muzaffarnagar | 4.17 | 112.99 | | | | |
| 43 | Muzaffarpur | 0.24 | 3.09 | | 0.61 | | |
| 44 | Nagpur | 2.28 | 10.57 | | | 5.93 | |
| 45 | Nashik | 6.34 | 24.71 | | | 11.11 | |
| 46 | Navi Mumbai | | | | | | |
| 47 | Noida | 0.58 | 7.07 | | 1 | | |
| 48 | Pali | 0.38 | | | | | |
| 49 | Panchkula | 0.46 | 0.93 | | | 0.51 | |
| 50 | Patiala | 1.78 | | | | | |
| 51 | Pithampur | 0.53 | 9.59 | | | | |
| 52 | Pune | 0.49 | 0.15 | | | | |
| 53 | Rajamahendravaram | 0.1 | | | 0.21 | 0.08 | |
| 54 | Rohtak | 1.19 | 0 | | 0.02 | 0 | |
| 55 | Rupnagar | | | | | | |
| 56 | Satna | | | | | | |
| 57 | Siliguri | 2.81 | 1.89 | | 10.96 | 4.14 | |
| 58 | Singrauli | 0.04 | | | | | |
| 59 | Solapur | | | | | | |
| 60 | Thane | 11.95 | 21.24 | | | 4.14 | |
| 61 | Thiruvananthapuram | | | | | | |
| 62 | Tirupati | 1.08 | 2.76 | | 0.11 | | |
| 63 | Udaipur | 2.53 | | | | 1.73 | |
| 64 | Ujjain | 0.08 | 1.89 | | | | |
| 65 | Varanasi | 0.9 | 4.45 | | 1.12 | | |
| 66 | Vijayawada | 2.75 | 2.97 | 1.85 | 52.15 | 1.91 | |
| 67 | Visakhapatnam | 6.06 | 17.89 | | 3.59 | | |

**Table 3. Cities and their meteorological parameters**

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | City Name | Meteorological Parameters | | | | | | | | |
| | | Relative Humidity RH (%) | BP (mm Hg) | Solar Radiations SR ($watt/m^2$) | Wind Degree WD (degree | VWS (degree) Vertical Wind Speed | Wind Speed WS (m/s) | Rainfall RF (mm) | Absolute Temp. (°C) | Temp (°C) |
| 1 | Agra | 58.09 | 746.65 | 13.06 | 347.62 | -0.2 | 1.19 | 0 | None | 28.77 |
| 2 | Ahmedabad | 27.61 | 1008.92 | 120.85 | 201.24 | 0.44 | 0.74 | | 31.68 | |
| 3 | Ajmer | 33.43 | 760.47 | | | | 1.17 | | | |
| 4 | Alwar | | | 60.51 | 228.56 | | 1.65 | | | 24.41 |
| 5 | Amaravati | 64.67 | 752.29 | 88.76 | 241.77 | -0.05 | 2.96 | 0 | 32.8 | |
| 6 | Amritsar | | | 334.32 | 268.69 | | 3.07 | 65.24 | | |
| 7 | Asansol | 92.14 | 995.22 | 62.17 | 159.82 | 0.13 | 0.8 | 0.04 | | |
| 8 | Baghpat | | 741 | 88.93 | 67.52 | | 1.34 | 0 | 20.17 | 30.56 |
| 9 | Bathinda | 30.74 | | 361.55 | 290.89 | | | | | 24.75 |
| 10 | Bengaluru | 59.68 | 841.1017 | 182.2725 | 175.133 | 0.01333 | 36.8583 | 24.89 | 25.668 | |
| 11 | Bhiwadi | 50.69 | 760.23 | 128.14 | 187.75 | | 0.74 | | | |
| 12 | Bulandshahr | | | 86.43 | 287.98 | | 1.76 | | 25.15 | 31.41 |
| 13 | Chandrapur | 64.6 | 742.35 | 145.3 | 179.46 | | 1.83 | | | |
| 14 | Chennai | 71.85 | 926.4 | 146.255 | 140.537 | 0.29333 | 1.22667 | | | 29.66 |
| 15 | Chikkaballapur | 46.49 | 708.59 | | 188.67 | | | | | 25.61 |
| 16 | Delhi | 55.06 | 958.64 | 128.30 | 179.443 | 0.02 | 1.00963 | | 24.4159 | 25.726 |

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sr. No. | City Name | Meteorological Parameters | | | | | | | | |
| | | Relative Humidity RH (%) | BP (mm Hg) | Solar Radiations SR (watt/m$^2$) | Wind Degree WD (degree | VWS (degree) Vertical Wind Speed | Wind Speed WS (m/s) | Rainfall RF (mm) | Absolute Temp. (°C) | Temp (°C) |
| 17 | Dewas | 37.25 | | 76.85 | 85.47 | | 2.79 | 0 | 27.26 | 30.9 |
| 18 | Durgapur | | | | | | | | | |
| 19 | Faridabad | 57.3 | 732.97 | 141.92 | 183.58 | -0.11 | 1.32 | 0 | | |
| 20 | Gaya | 84.5 | 746 | 51.59 | 100.1 | 0 | 0.43 | 0 | | |
| 21 | Ghaziabad | 59.28 | 744.64 | 51.03 | 133.66 | | 0.57 | | 26.28 | 30.65 |
| 22 | Greater_Noida | 45.9 | 741.86 | 89.95 | 50.72 | | 1.42 | | 26.47 | |
| 23 | Gurugram | 42.47 | 753.71 | 203.09 | 195.3 | -0.07 | 0.24 | 0 | 28.91 | |
| 24 | Haldia | | | | | | | | | |
| 25 | Howrah | 91.48 | 1003.62 | 73.19 | 142.345 | -0.17 | 0.185 | | 24.65 | |
| 26 | Hubballi | 56.06 | | | 92.16 | | 34.48 | | | 38.85 |
| 27 | Hyderabad | 59.815 | 728.11 | 126.1483 | 118.757 | 0.05 | 0.925 | | 27.0167 | 30.578 |
| 28 | Jaipur | 30.59 | 760.0467 | 186.145 | 93.92 | 0.52 | 1.28667 | | | 27.85 |
| 29 | Jalandhar | 71.12 | | 176.7 | 229.61 | | 0.47 | | | 23.88 |
| 30 | Jodhpur | 53.86 | 749.55 | 133.58 | 101.68 | 1.36 | 0.4 | | | 32.72 |
| 31 | Jorapokhar | 99.52 | 1011.52 | 66.71 | 134.06 | -1.77 | | | | 28.13 |
| 32 | Kanpur | 76.22 | 749.82 | 179.61 | 143.5 | -0.01 | 1.39 | | 27.29 | |
| 33 | Khanna | 66.04 | | 243.6 | 305.25 | | 1.31 | | | |
| 34 | Kolkata | 93.34 | 1005.53 | 18.14 | 126.76 | | 0.79 | 0.78 | | 24.48 |
| 35 | Kota | 46.96 | 763.14 | | 205.05 | | 0.73 | | | 29.57 |
| 36 | Lucknow | 71.2775 | 945.8875 | 72.1875 | 176.943 | -0.2125 | 0.5625 | | 29.54 | 28.865 |
| 37 | Ludhiana | 67.35 | | 217.25 | 260.8 | | 0.37 | | | 23.82 |
| 38 | Mandi Gobindgarh | 70.05 | | 266.23 | 219.56 | | 0.47 | | | |
| 39 | Mandideep | 60.51 | | 67.35 | 263.56 | | 1 | 0 | 26.42 | 30.63 |
| 40 | Moradabad | 62.79 | 745.76 | 95.14 | 122.29 | | 0.99 | 0.02 | 27.31 | |
| 41 | Mumbai | 74.61 | 764.46 | 129.31 | 170.77 | 0.6 | 0.11 | 0 | | 32.29 |
| 42 | Muzaffarnagar | 55.1 | 740.83 | 79.29 | 20.46 | | 0.33 | | 22.93 | |
| 43 | Muzaffarpur | 80.95 | 747.62 | 57.72 | 41.75 | -0.19 | 1.55 | 0 | | |
| 44 | Nagpur | 66.84 | | 386.3 | 154.24 | | 0.43 | | | 30.54 |
| 45 | Nashik | | | 719.52 | 162.57 | | 2.1 | | | |
| 46 | Navi Mumbai | 73.94 | | | 138.46 | | | | | 32.9 |
| 47 | Noida | 57.97 | 744.99 | 103.21 | 148.38 | | 0.81 | | 25.16 | 32.08 |
| 48 | Pali | 34.55 | 757.08 | 265.8 | | | 1.53 | | | 31.64 |
| 49 | Panchkula | 68.18 | 734.23 | 66.16 | 191.05 | -0.23 | 0.86 | | | 23.88 |
| 50 | Patiala | 67.47 | | 181.29 | 222.13 | | 0.44 | | | 22.42 |
| 51 | Pithampur | 38.41 | | 180.28 | 96.14 | | 3.48 | | 27.19 | |
| 52 | Pune | | | | 132.43 | | 0.15 | 0.04 | | 27.31 |
| 53 | Rajamahendravaram | 69.38 | 752.22 | 194.91 | 262.11 | -0.01 | 2.23 | 0 | 31.25 | |
| 54 | Rohtak | 60.78 | 988 | 144.91 | 136.43 | 0.1 | 0.5 | | | 24.48 |
| 55 | Rupnagar | | | | | | | | | |
| 56 | Satna | | | | | | | | | |
| 57 | Siliguri | 83.23 | 1011.95 | | 132.18 | 0.01 | 0.45 | | | 23.88 |
| 58 | Singrauli | | | | | | | | | |
| 59 | Solapur | 1.6 | | 218.3 | 247.44 | 0.4 | 0.67 | | | 29.19 |
| 60 | Thane | | | 305.14 | 179.26 | | 1 | | | 30.4 |
| 61 | Thiruvananthapuram | 77.06 | 758.3 | | 240.22 | | 1.48 | | | 30.15 |
| 62 | Tirupati | | | | 177.23 | 0.03 | 0.9 | 0.68 | | |
| 63 | Udaipur | 50 | 753.97 | 220.34 | 258.62 | | 1.02 | | | 26.36 |
| 64 | Ujjain | 37.02 | | 111.35 | 96.23 | | 2.17 | 0 | 29.69 | 31.66 |
| 65 | Varanasi | 74.54 | 737.91 | 122.49 | 205.32 | -0.39 | 1.33 | | 16.48 | |
| 66 | Vijayawada | 751.44 | 224.91 | 235.63 | 5 | 0.73 | 0 | | | |
| 67 | Visakhapatnam | 69.26 | 743.14 | 122 | 0 | 0 | | | | |

Thus, on the basis of value of Air Quality Index, air quality monitoring procedures and protocols, Indian National Quality Standards (INAQS) and dose-response relationships of pollutants, an AQI system is devised. The objective of this system is to quickly access the air-quality information to account the pollutants which possess short term impacts (almost in real-time). The AQI index possess six categories with elegant colour scheme as shown below in Table 4 as AQI range and its categories.

**Table 4. AQI Range and Categories**

| Sr. No. | AQI Value | Category | Color |
|---|---|---|---|
| 01. | 0-50 | Good | |
| 02. | 51-100 | Satisfactory | |
| 03. | 101-200 | Moderately Polluted | |
| 04. | 201-300 | Poor | |
| 05. | 301-400 | Very Poor | |
| 06. | >401 | Severe | |

The above data have been obtained from automated air quality monitoring stations located at 113 stations. Their Air quality index has been calculated on the basis of parameters like $PM_{2.5}$, $PM_{10}$, $NO_2$, $SO_2$, CO, $O_3$ etc. on real time. The tabulated data is the average of past 24 hours monitored automatically. Thus the Table 5 entails the AQI index along with some necessary parameters. On this basis a map of India in Figure 1 has been derived which encompasses all 67 cities along with their AQI category and legends' representing the categories mentioned in Table 4. Another table is also included as Table 6 which comprises the average values of 10 cities which are having more than one monitoring stations.

Amongst 67 cities, the cities with very poor and poor air quality category have been selected for further studies. The list of those 16 cities has been depicted in Table 7 which is represented below along with criteria pollutants.

**Table 5. Cities and their AQI parameters**

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | |
|---|---|---|---|---|---|
| Sr. No. | City Name | AQI | Prominent Pollutant | Based on Number of Monitoring Stations | Air Quality |
| 1 | Agra | 336 | $NO_2$ | 1 | Very Poor |
| 2 | Ahmedabad | 236 | $PM_{2.5}$ | 1 | Poor |
| 3 | Ajmer | 91 | Ozone | 1 | Satisfactory |
| 4 | Alwar | 110 | $PM_{2.5}$ | 1 | Moderate |
| 5 | Amaravati | 110 | $PM_{10}$ | 1 | Moderate |
| 6 | Amritsar | 154 | $PM_{10}$ | 1 | Moderate |
| 7 | Asansol | 34 | Ozone | 1 | Good |
| 8 | Baghpat | 293 | $PM_{2.5}$ | 1 | Poor |
| 9 | Bathinda | 108 | $PM_{2.5}$ | 1 | Moderate |
| 10 | Bengaluru | 179 | $PM_{2.5}$, $PM_{10,}$ Ozone | 7 | Moderate |
| 11 | Bhiwadi | 398 | $PM_{10}$ | 1 | Very Poor |
| 12 | Bulandshahr | 242 | $PM_{2.5}$ | 1 | Poor |
| 13 | Chandrapur | 89 | $PM_{10}$ | 2 | Satisfactory |
| 14 | Chennai | 72 | $PM_{2.5}$ | 2 | Satisfactory |
| 15 | Chikkaballapur | 113 | $PM_{10}$ | 1 | Moderate |
| 16 | Delhi | 262 | $PM_{2.5}$, $PM_{10}$ | 29 | Poor |
| 17 | Dewas | 135 | $PM_{10}$ | 1 | Moderate |
| 18 | Durgapur | 74 | $NO_2$ | 1 | Satisfactory |
| 19 | Faridabad | 306 | $PM_{2.5}$ | 1 | Very Poor |
| 20 | Gaya | 74 | $PM_{2.5}$ | 1 | Satisfactory |
| 21 | Ghaziabad | 332 | $PM_{2.5}$ | 1 | Very Poor |
| 22 | Greater_Noida | 281 | $PM_{2.5}$ | 1 | Poor |
| 23 | Gurugram | 325 | $PM_{2.5}$ | 1 | Very Poor |
| 24 | Haldia | 32 | $PM_{10}$ | 1 | Good |
| 25 | Howrah | 46 | CO, Ozone | 2 | Good |
| 26 | Hubballi | 118 | $PM_{2.5}$ | 1 | Moderate |
| 27 | Hyderabad | 121 | $PM_{2.5}$, $PM_{10}$ | 5 | Moderate |
| 28 | Jaipur | 131 | $PM_{2.5}$, $PM_{10}$ | 3 | Moderate |
| 29 | Jalandhar | 144 | $PM_{2.5}$ | 1 | Moderate |
| 30 | Jodhpur | 245 | $PM_{2.5}$ | 1 | Poor |
| 31 | Jorapokhar | 112 | $PM_{10}$ | 1 | Moderate |
| 32 | Kanpur | 114 | $PM_{2.5}$ | 1 | Moderate |
| 33 | Khanna | 101 | $PM_{10}$ | 1 | Moderate |
| 34 | Kolkata | 58 | CO | 1 | Satisfactory |
| 35 | Kota | 153 | $PM_{10}$ | 1 | Moderate |
| 36 | Lucknow | 108 | $PM_{2.5}$ | 3 | Moderate |
| 37 | Ludhiana | 70 | $PM_{2.5}$ | 1 | Satisfactory |
| 38 | Mandi Gobindgarh | 144 | $PM_{10}$ | 1 | Moderate |
| 39 | Mandideep | 127 | $PM_{10}$ | 1 | Moderate |
| 40 | Moradabad | 205 | $PM_{2.5}$ | 1 | Poor |
| 41 | Mumbai | 144 | $PM_{10}$ | 1 | Moderate |
| 42 | Muzaffarnagar | 222 | $PM_{2.5}$ | 1 | Poor |
| 43 | Muzaffarpur | 68 | CO | 1 | Satisfactory |
| 44 | Nagpur | 52 | $PM_{10}$ | 1 | Satisfactory |
| 45 | Nashik | 99 | $PM_{10}$ | 1 | Satisfactory |

| Air Quality Index on Oct 13, 2018 @ 4 PM (Average of past 24 hours) | | | | | |
|---|---|---|---|---|---|
| Sr. No. | City Name | AQI | Prominent Pollutant | Based on Number of Monitoring Stations | Air Quality |
| 46 | Navi Mumbai | 282 | $PM_{10}$ | 1 | Poor |
| 47 | Noida | 257 | $PM_{2.5}$ | 2 | Poor |
| 48 | Pali | 210 | $PM_{2.5}$ | 1 | Poor |
| 49 | Panchkula | 79 | Ozone | 1 | Satisfactory |
| 50 | Patiala | 105 | $PM_{2.5}$ | 1 | Moderate |
| 51 | Pithampur | 144 | $PM_{10}$ | 1 | Moderate |
| 52 | Pune | 122 | $PM_{2.5}$ | 1 | Moderate |
| 53 | Rajamahendravaram | 92 | Ozone | 1 | Satisfactory |
| 54 | Rohtak | 64 | $PM_{2.5}$ | 1 | Satisfactory |
| 55 | Rupnagar | 66 | $PM_{10}$ | 1 | Satisfactory |
| 56 | Satna | 80 | CO | 1 | Satisfactory |
| 57 | Siliguri | 61 | $PM_{10}$ | 1 | Satisfactory |
| 58 | Singrauli | 73 | $PM_{10}$ | 1 | Satisfactory |
| 59 | Solapur | 98 | CO | 1 | Satisfactory |
| 60 | Thane | 133 | $PM_{10}$ | 1 | Moderate |
| 61 | Thiruvananthapuram | 66 | $PM_{10}$ | 1 | Satisfactory |
| 62 | Tirupati | 103 | $PM_{10}$ | 1 | Moderate |
| 63 | Udaipur | 119 | $PM_{10}$ | 1 | Moderate |
| 64 | Ujjain | 168 | Ozone | 1 | Moderate |
| 65 | Varanasi | 164 | $PM_{10}$ | 1 | Moderate |
| 66 | Vijayawada | 47 | $PM_{10}$ | 1 | Good |
| 67 | Visakhapatnam | 132 | $PM_{2.5}$ | 1 | Moderate |

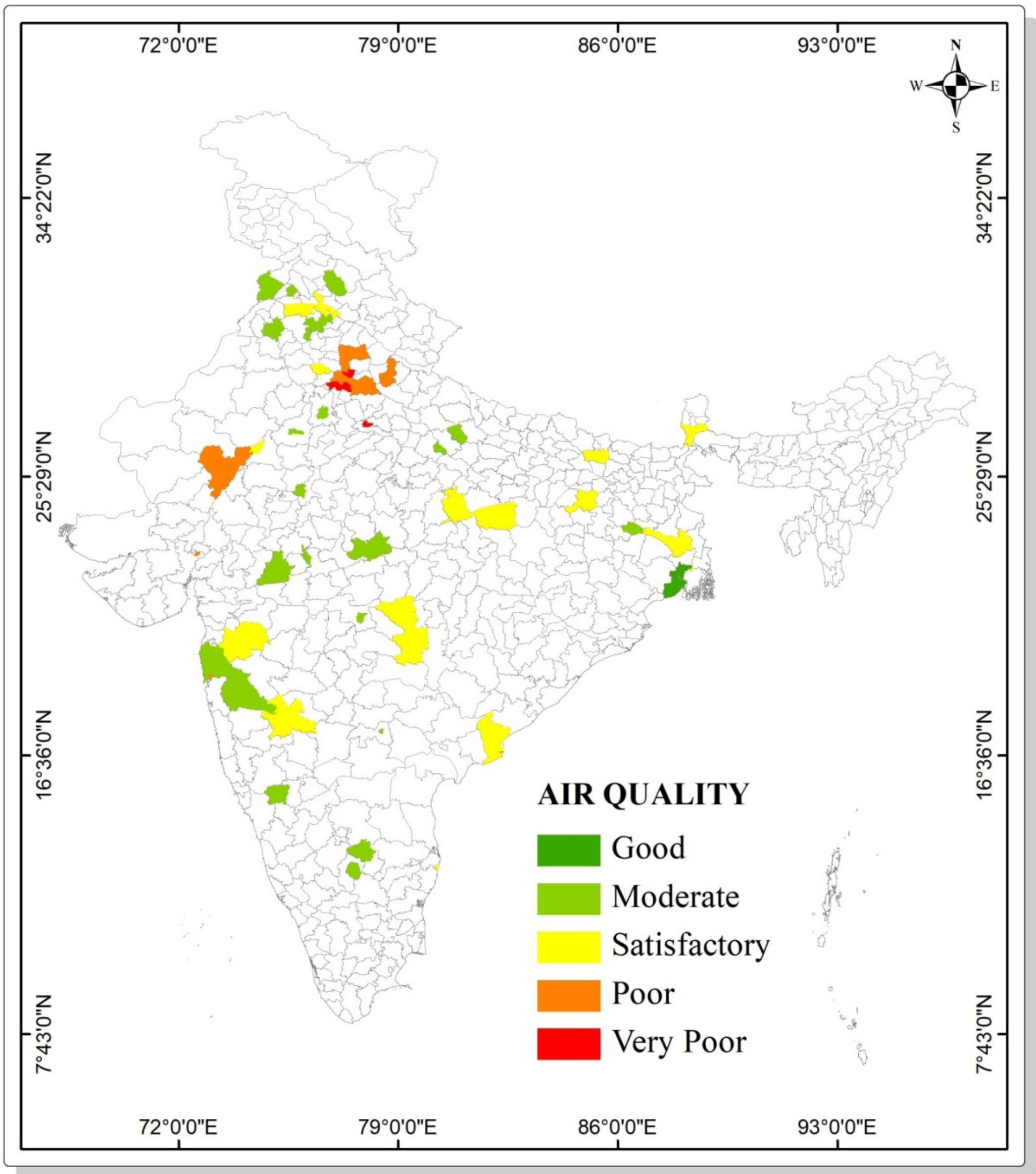


**Figure 1.** India and AQI of 67 cities

**Table 6. Cities AQI having many stations**

| Sr. No. | City Name | Stations Name | PM2.5 (ug/m³) | PM10 (ug/m³) | SO2 (ug/m³) | NO (ug/m³) | NO2 (ug/m³) | Nox (ppb) | NH3 (ug/m³) | CO (mg/m³) | Ozone (ug/m³) | Benzene (ug/m³) | Toluene (ug/m³) | Ethyl Benzene (ug/m³) | Xylene (ug/m³) | MP-Xylene (ug/m³) | Relative Humidity | BP (mm Hg) | Solar Radiations | Wind Degree | VWS (degree) | Wind Speed WS | Rainfall RF (mm) | Absolute Temp. (°C) | Temp (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Gurugram/ Gurgaon | NISE Gwal Pahari, Gurugram | 120.98 | 259.35 | | 9.11 | 56.28 | 64.39 | | 1.47 | 44.99 | | | | | | | | | | | | | | |
| | | Vikas Sadan, Gurugram - HSPCB | 196.72 | | 6.47 | 18.68 | 41.51 | 18.36 | | 0.88 | 36.01 | 3.29 | | | | | 42.47 | 753.71 | 203.09 | 195.3 | -0.07 | 0.24 | 0 | 28.91 | |
| | **Avg. of Gurugram** | | 158.85 | 259.35 | | 13.895 | 48.895 | 41.375 | | 1.175 | 40.5 | 3.29 | | | | | 42.47 | 753.71 | 203.09 | 195.3 | -0.07 | 0.24 | 0 | 28.91 | |
| 2 | Chandrapur | Chandrapur, Chandrapur - MPCB | 29.07 | 77.52 | 7.88 | 2.51 | 11.58 | 8.17 | 47.97 | 0.34 | 10.22 | 0 | 0.15 | | 0.25 | 0.17 | 55.16 | 742.35 | 145.3 | 195.36 | | 1.83 | | 28.32 | 32.32 |
| | | MIDC Khutala, Chandrapur - MPCB | 44.9 | 105.94 | 4.43 | 3.26 | 4.96 | 8.14 | 1.81 | 0.73 | 8.85 | 1.25 | 0 | | | | 74.04 | | | 163.56 | | | | | 27.63 |
| | **Avg. of Chandrapur** | | 36.985 | 91.73 | 6.155 | 2.885 | 8.27 | 8.155 | 24.89 | 0.535 | 9.535 | 0.625 | 0.075 | | 0.25 | 0.17 | 64.6 | 742.35 | 145.3 | 179.46 | | 1.83 | | 28.32 | 29.975 |
| 3 | Jaipur | AdarsAdarsh Nagar, Jaipur - RSPCBh | 51.41 | 146.82 | 6.85 | 10.34 | 35.29 | 45.63 | 8.38 | 0.66 | 59.35 | 0.75 | | 0.29 | | 0.91 | | 760.31 | | 121.65 | | 1.57 | | | |
| | | Police Commissionerate, Jaipur - RSPCB | 82.69 | 170.24 | 11.73 | 19.98 | 45.46 | 39.76 | 6.1 | 0.82 | 59.05 | 1.99 | 4.06 | 0.98 | | 1 | 29.71 | 759.67 | 170.5 | 119.9 | 0.52 | 1.16 | | | 27.69 |
| | | Shastri Nagar, Jaipur - RSPCB | 49.88 | 90.73 | 10.18 | 7.31 | 19.08 | 26.39 | 32.07 | 0.86 | 71.95 | 0.83 | 17.04 | 0.42 | | 1.19 | 31.47 | 760.16 | 201.79 | 40.21 | | 1.13 | | | 27.85 |
| | **Avg. of Jaipur** | | 61.326667 | 135.93 | 9.5866667 | 12.543333 | 33.276667 | 37.26 | 15.516667 | 0.78 | 63.45 | 1.19 | 10.55 | 0.42 | | 1.19 | 30.59 | 760.04667 | 186.145 | 93.92 | 0.52 | 1.2866667 | | | 27.85 |
| 4 | Chennai | Alandur Bus Depot, Chennai - CPCB | 40.64 | | 5.96 | 9.87 | 21.05 | 30.92 | | 0.86 | 36.38 | 0.17 | 0.64 | 0.23 | | 0.22 | 74.53 | 759.74 | 84 | 165.46 | 0.37 | 0.15 | | | 29.66 |
| | | Manali, Chennai - CPCB | 46 | | 4.33 | 8.23 | 10.79 | 19.02 | 73.39 | 0.96 | | | | | | | 86.98 | 1012.35 | | 78.83 | 0.23 | 0.9 | | | |
| | | Velachery Res. Area, Chennai - CPCB | 36.03 | | 7.07 | 9.5 | 11.22 | 20.72 | | 0.82 | 28.94 | 0 | 0.66 | | 0 | | 54.04 | 1007.11 | 208.51 | 177.32 | 0.28 | 2.63 | | | |
| | **Avg. of Chennai** | | 40.89 | | 5.7866667 | 9.2 | 14.353333 | 23.553333 | 73.39 | 0.88 | 32.66 | 0.085 | 0.65 | 0.23 | | 0.22 | 71.85 | 926.4 | 146.255 | 140.53667 | 0.2933333 | 1.2266667 | | | 29.66 |
| 5 | Hyderabad | llaram Industrial Area, Hyderabad - TSPC | 58.96 | 122.41 | 13.66 | 4.78 | 20.93 | 15.02 | 19.31 | 0.58 | 14.61 | 0.18 | 10.51 | | 0.1 | | 59.25 | 705.77 | 116.08 | 170.48 | | 0.39 | | 28 | 29.94 |
| | | Central University, Hyderabad - TSPCB | 58.1 | 141 | 9.23 | 12.91 | 59.19 | 41.98 | 20.34 | 0.72 | 42.5 | 8.55 | 26.96 | | 8.73 | | 62.97 | 791.23 | 161.27 | 122.02 | -0.23 | 1.19 | 0 | 25.61 | 31.61 |
| | | CRISAT Patancheru, Hyderabad - TSPC | 63.81 | 137.2 | 21.76 | 4.92 | 24.95 | 17.18 | 15.29 | 0.49 | 21.55 | 0.08 | 0.76 | | 0.06 | | 66.29 | 717.17 | 119.17 | 118.85 | 0 | 0.71 | 0 | 31.5 | 31.64 |
| | | IDA Pashamylaram, Hyderabad - TSPCB | 65.59 | 151.98 | 3.95 | 14.49 | 82.15 | 51.73 | 2.83 | 0.79 | 7.79 | 14.32 | 209.13 | | 63.46 | | 59.22 | | 194.58 | 148.71 | 0 | 1.56 | | 26.42 | 29.58 |
| | | Sanathnagar, Hyderabad - TSPCB | 58.25 | | 15.91 | 30.96 | 62.13 | 57.68 | | 0.68 | 29.77 | 1.65 | 15.5 | | 0.99 | | 57.14 | 713.38 | 155.08 | 113.44 | 0.68 | 1.29 | | 26.53 | |
| | | Zoo Park, Hyderabad - TSPCB | 67.56 | 132.42 | 3.4 | 17.34 | 53.61 | 42.62 | 32.17 | 0.97 | 30.19 | 2.98 | 30.96 | | 2.01 | | 54.02 | 713 | 10.71 | 39.04 | -0.2 | 0.41 | 0 | 24.04 | 30.12 |
| | **Avg. of Hyderabad** | | 62.045 | 137.002 | 11.318333 | 14.233333 | 50.493333 | 37.701667 | 17.988 | 0.705 | 24.401667 | 4.6266667 | 48.97 | | 12.558333 | | 59.815 | 728.11 | 126.14833 | 118.75667 | 0.05 | 0.925 | | 27.016667 | 30.578 |
| 6 | Lucknow | Central School, Lucknow - CPCB | 50.15 | | 3.19 | 7.7 | 13.76 | 13.31 | | 0.58 | 24.79 | 0 | 0 | | | | 76.73 | 1010.4 | 52.64 | 183.93 | 0.07 | 0.31 | | 27.4 | |
| | | Lalbagh, Lucknow - CPCB | 58.62 | | 9.5 | 15.17 | 41.83 | 34.03 | | 0.84 | 17.44 | 0.03 | 0 | | | | 79.78 | 1012.66 | 50.26 | 194.28 | 0.01 | 0.5 | | 27.51 | |
| | | Nishant Ganj, Lucknow - UPPCB | 124.52 | | 6.31 | 11.46 | 28.26 | 21.35 | | 2.01 | 27.74 | 0.61 | 1.26 | | 245.25 | | 56.53 | 747.93 | 120.88 | 106.76 | -0.4 | 0.92 | | 33.71 | 29.86 |
| | | ora District Industries Center, Lucknow - | 66.52 | | 7.17 | 12.04 | 48.32 | 34.95 | 37.74 | 0.71 | | | | | | | 72.07 | 1012.56 | 64.97 | 222.8 | -0.53 | 0.52 | | | 27.87 |
| | **Avg. of Lucknow** | | 74.9525 | | 6.5425 | 11.5925 | 33.0425 | 25.91 | 37.74 | 1.035 | 23.323333 | 0.2133333 | 0.42 | | 245.25 | | 71.2775 | 945.8875 | 72.1875 | 176.9425 | -0.2125 | 0.5625 | | 29.54 | 28.865 |
| 7 | Noida | Sector - 125, Noida - UPPCB | 138.09 | 313.88 | 22.57 | 74.86 | 84.22 | 105.66 | 39.61 | 1.8 | 43.53 | 0.58 | 7.07 | | 1 | | 57.97 | 744.99 | 103.21 | 148.38 | | 0.81 | | 25.16 | 32.08 |
| | | Sector - 62, Noida - IMD | 150.78 | 290.31 | | 22.09 | 18.87 | 40.97 | | 0.91 | 64.05 | | | | | | | | | | | | | | |
| | **Avg. of Noida** | | 144.435 | 302.095 | 22.57 | 48.475 | 51.545 | 73.315 | 39.61 | 1.355 | 53.79 | 0.58 | 7.07 | | 1 | | 57.97 | 744.99 | 103.21 | 148.38 | | 0.81 | | 25.16 | 32.08 |
| 8 | Howrah | Ghusuri, Howrah - WBPCB | 23.24 | 47.11 | 22.63 | 5.68 | 32.58 | 38.25 | 12.46 | 0.7 | 28.46 | 2.31 | 4.2 | 0.56 | | | 90.79 | 1005.26 | 58.85 | 139.04 | -0.27 | 1.92 | 0.06 | | 24.48 |
| | | Padmapukur, Howrah - WBPCB | 20.13 | 41.63 | 2.44 | 3.83 | 25.19 | 29.02 | 13.69 | 0.43 | 33.85 | 4.71 | 4.15 | 2.04 | | | 92.17 | 1001.98 | 87.53 | 145.65 | -0.07 | 1.29 | 0.31 | | 24.82 |
| | **Avg. of Howrah** | | 21.685 | 44.37 | 12.535 | 4.755 | 28.885 | 33.635 | 13.075 | 0.565 | 31.155 | 3.51 | 4.175 | 1.3 | | | 91.48 | 1003.62 | 73.19 | 142.345 | -0.17 | 1.605 | 0.185 | | 24.65 |
| 9 | Bengaluru | BTM Layout, Bengaluru - CPCB | 34.84 | | 6.79 | 29.69 | 44.09 | 64.09 | | 0.66 | 17.33 | 7.91 | 9.5 | 1.39 | | | 61.31 | 890.37 | 181.77 | 189.51 | 0.08 | 0.33 | | | |
| | | WSSB Kadabesanahalli, Bengaluru - CPC | 43.97 | | 4.83 | 54.36 | 79.6 | 133.95 | | 1.08 | 20.99 | 0.32 | 0.32 | 0.16 | | | | 1002.21 | 202.39 | 189.73 | -0.1 | 0.64 | | 26.19 | |
| | | Bapuji Nagar, Bengaluru - KSPCB | 86.18 | 197.86 | 9.17 | 73.76 | 47.43 | 85.19 | 22.84 | 1.8 | 10.72 | 0.14 | 1.1 | | | | 55.62 | 716.33 | | | | 217.72 | | 24.42 | 26.16 |
| | | City Railway Station, Bengaluru - KSPCB | | 231.25 | 8.9 | 39.7 | 75.54 | 115.23 | | 1.06 | | | | | | | | | | | | | | | |
| | | Hebbal, Bengaluru - KSPCB | 61.74 | 119.57 | 3.11 | 13.89 | 23.62 | 23.86 | 23.38 | 0.94 | 19.61 | 0.71 | 4.29 | | | | 60.97 | | | 90.5 | | 0.73 | | 25.78 | 25.29 |
| | | Hombegowda Nagar, Bengaluru - KSPCB | 67.16 | 158.88 | 2.14 | 8.36 | 22.92 | 18.76 | 9.69 | 0.57 | 85.34 | 0.92 | 8.9 | | | | 65.35 | 713.97 | | 140.42 | | | | 24.24 | 26.62 |
| | | Jayanagar 5th Block, Bengaluru - KSPCB | 223.32 | 218.71 | 12.86 | 54.24 | 66.94 | 79.71 | 5.75 | 1.29 | 15.62 | 1.9 | 13.12 | | | | 67.47 | 708.32 | | 215.68 | | | | 24.71 | 23.3 |
| | | Peenya, Bengaluru - CPCB | 73.04 | | 12.11 | 7.77 | 30.56 | 38.15 | 10.39 | 0.32 | | | | | | | 47.37 | 1015.41 | 148.94 | 186.83 | 0.06 | 0.76 | | | 26.97 |
| | | Sanegurava Halli, Bengaluru - KSPCB | | 97.96 | 2.45 | 28.97 | 38.24 | 66.77 | | 1.2 | | | | | | | | | 195.99 | 213.26 | | 0.97 | | 24 | |
| | **Avg. of Bengaluru** | | 84.321429 | 170.705 | 6.9288889 | 34.526667 | 47.66 | 69.523333 | 14.41 | 0.9911111 | 28.268333 | 1.9833333 | 6.205 | 0.775 | | | 59.681667 | 841.10167 | 182.2725 | 175.13286 | 0.0133333 | 36.858333 | | 24.89 | 25.668 |
| | Delhi | Anand Vihar, Delhi - DPCC | 209.41 | 451.36 | 20.4 | 160.43 | 124.1 | 196.72 | 60.66 | 2.73 | 15.18 | 9.79 | 58.35 | | 25.09 | | 43.79 | 984.18 | 194.49 | 184.42 | 0 | 0.54 | | 26.66 | |
| | | Ashok Vihar, Delhi - DPCC | 183.38 | 334.88 | 30.93 | 29.34 | 78.28 | 65.02 | 33.36 | 0.93 | 45.04 | 9.74 | 86.69 | | 26.81 | | 57.9 | 989.15 | 137.09 | 113.89 | | 0.4 | 0 | 24.63 | |
| | | Aya Nagar, Delhi - IMD | 90.6 | 244.16 | | 31.05 | 34.56 | 65.62 | | 2.41 | 31.21 | | | | | | | | | | | | | | |
| | | Bawana, Delhi - DPCC | 126.42 | 296.46 | 10.78 | 4.62 | 10.66 | 9.43 | 36.37 | 1.13 | 50.87 | | 278.36 | | | | 62.28 | 988.92 | 147.71 | 82.04 | | 1.1 | 0 | 24.07 | |
| | | Burari Crossing, Delhi - IMD | 144.29 | 249.13 | | 9.77 | 19.47 | 0.05 | | 0 | 54.52 | | | | | | | | | | | | | | |
| | | DTU, Delhi - CPCB | 148.94 | 316.4 | 8.08 | 33.03 | 43.96 | 49.14 | 11.32 | 0.99 | 17.06 | 9.63 | | | | | 46.46 | | 87.21 | 124.49 | | 0.59 | | | 24.65 |
| | | . Karni Singh Shooting Range, Delhi - DP | 104.19 | 303.52 | 46.01 | 64.65 | 74.12 | 92.11 | 18.67 | 1.88 | 45.98 | 6.93 | 63.72 | | 22.25 | | 60.93 | 984.83 | 136.47 | 245.99 | | 0.78 | 0 | 23.94 | |
| | | Dwarka-Sector 8, Delhi - DPCC | 124.83 | 361.5 | 15.58 | 41.29 | 46.6 | 58.47 | 23.65 | 2.42 | 45.69 | 6.07 | 76.95 | | 21.25 | | 59.94 | 986.81 | 56.16 | 233.23 | | 0.81 | 0 | 24.64 | |
| | | East Arjun Nagar, Delhi - CPCB | | | | | | | | | | | | | | | 49.26 | 985.36 | 81.77 | 190.43 | | 1.62 | | | 25.8 |
| | | IGI Airport (T3), Delhi - IMD | 91.01 | 193.16 | | | | 0 | | 1.11 | 19.21 | | | | | | | | | | | | | | |
| | | IHBAS, Dilshad Garden, Delhi - CPCB | 94.51 | | 10.59 | 11.36 | 50.93 | 36.18 | 30.11 | 0.87 | | | | | | | 46.05 | 753.97 | 113.28 | 97.57 | 0.09 | 0.7 | | 26.9 | |
| | | ITO, Delhi - CPCB | 148.75 | 202.94 | 6.69 | 84.56 | 64.48 | 102.9 | 43.09 | 1.4 | 34.94 | 2.18 | 0.55 | | 0.55 | | | | | | | | | | |
| | | Jahangirpuri, Delhi - DPCC | 194.92 | 360.75 | 21.13 | 38.29 | 58.39 | 62.27 | 37.66 | 1.93 | 34.7 | 2.75 | 19.08 | | 1.26 | | 58.28 | 990.08 | 84.86 | 65.83 | | 0.46 | 0 | 24.9 | |
| | | Jawaharlal Nehru Stadium, Delhi - DPCC | 68.29 | 201.73 | 20.14 | 122.95 | 72.97 | 139.03 | 35.56 | 1.99 | 39.54 | 6.7 | 111.6 | | 20.87 | | 59.44 | 990.81 | 145.52 | 298.78 | | 1.09 | 0 | 24.53 | |
| | | Lodhi Road, Delhi - IMD | 92.87 | 220.5 | | 71.09 | 16.03 | 87.13 | | 0.76 | 31.47 | 0 | 0 | | 0 | | | | | | | | | | |
| | | Dhyan Chand National Stadium, Delhi - | 111.16 | 228.18 | 16.05 | 150.92 | 74.37 | 162.47 | 25.39 | 2.1 | 42.54 | 6.94 | 63.21 | | 14.39 | | 62.27 | 989.62 | 106.31 | 196.62 | | 0.54 | 0 | 24.67 | |
| | | Mandir Marg, Delhi - DPCC | 144.99 | 204.96 | 6.26 | 35.36 | 47.27 | 53.97 | 7.7 | 0.78 | 23.17 | 4.23 | 27.02 | | 4.77 | | 62.56 | 991.05 | 119.57 | 258.92 | 0 | 0.81 | | 20.82 | |
| | | Mundka, Delhi - DPCC | 144.66 | 385.57 | 21.4 | 17.38 | 40.35 | 35.65 | 44.33 | 1.15 | 23.77 | 7.34 | 95.22 | | 41.36 | | 58.35 | 989.93 | 143.93 | 85.42 | 0 | 0.94 | | 25.37 | |
| | | NSIT Dwarka, Delhi - CPCB | 143.86 | | 14.21 | 13.16 | 32.54 | 27.82 | | 0.59 | 58.42 | 3.05 | 11.61 | 1.52 | | | 37.81 | | 73.43 | 144 | -0.11 | 0.89 | | | 27.62 |
| | | Najafgarh, Delhi - DPCC | 86.96 | 187.8 | 7.44 | 3.61 | 17.33 | 12.16 | 9.61 | 1.34 | 5.81 | 2.16 | 30.11 | | 0.66 | | 63.59 | 990.02 | 164.5 | 232.03 | | 1.36 | 0 | 23.09 | |
| | | Narela, Delhi - DPCC | 178.94 | 295.38 | 11.67 | 18.28 | 40.64 | 36.6 | 41.92 | 0.98 | 23.35 | 6.79 | 144.9 | | 9.05 | | 58.58 | 989.76 | 162.18 | 271.68 | | 0.93 | | 24.35 | |
| | | Nehru Nagar, Delhi - DPCC | 157 | 295.91 | 14.48 | 53.18 | | 75.94 | 41.48 | 1.4 | 36.07 | 5.68 | 46.67 | | 20.42 | | 54.87 | 987.13 | 162.25 | 260.73 | | 0.41 | | 24.89 | |
| | | North Campus, DU, Delhi - IMD | 128.31 | 216.44 | | 58.14 | 14.04 | 67.09 | | 1.57 | 33.31 | 0 | 0.02 | | 0.01 | | | | | | | | | | |
| | | Okhla Phase-2, Delhi - DPCC | 131.19 | 268.56 | 14.01 | 32.21 | 15.23 | 34.42 | 39.39 | 1.29 | 21.13 | 6.9 | 64.08 | | 14.44 | | 52.98 | 988.53 | 43 | 125.4 | | 1.1 | | 25.63 | |
| | | Patparganj, Delhi - DPCC | 147.12 | 242.3 | 4.43 | 19.99 | 20.51 | 41.18 | 42.04 | 1.05 | 31.52 | 1.09 | 9.24 | | 1.21 | | 48.24 | 990.38 | 148.56 | 218.96 | | 0.9 | | 25.88 | |
| | | Punjabi Bagh, Delhi - DPCC | 134.59 | 289.3 | 18.8 | 36.91 | 84.52 | 75.03 | 48.62 | 1.2 | 27.9 | 11.77 | 119.37 | | 14.63 | | 45.58 | 734.13 | 99.2 | 134.71 | 0.02 | 0.5 | | 23.52 | |
| | | Pusa, Delhi - IMD | 70.14 | 247.52 | | 17.8 | 37 | 54.81 | | 1.07 | 22.27 | 0.02 | 0.02 | | 2.55 | | | | | | | | | | |
| | | R K Puram, Delhi - DPCC | 129.9 | 312.1 | 21.56 | 166.66 | 74.45 | 182.31 | 32.17 | 1.83 | 47.5 | | | | | | 55.25 | 990.01 | 113.4 | 199.25 | 0 | 0.59 | | 21.99 | |
| | | Shadipur, Delhi - CPCB | 194.52 | | 30.56 | 88.77 | 93.61 | 120.19 | | 0.76 | 31.49 | 5.16 | 32.98 | 4.8 | | | 53.19 | 755.79 | 138.93 | 163.17 | 0.16 | 0.57 | | | 26.39 |
| | | Sirifort, Delhi - CPCB | 100.48 | 275.61 | 19.98 | 173.02 | 135.72 | 212.21 | 23.43 | 2.09 | 23.48 | 11.64 | 81.98 | 0 | | | 36.18 | | 126.38 | 195.26 | | 0.34 | | | 24.17 |
| | | Sonia Vihar, Delhi - DPCC | 163.08 | 285.54 | 12.9 | 23.1 | 32.95 | 36.36 | 28.64 | 2.7 | 40.94 | 4.59 | 136.33 | | 21.82 | | 71.38 | 990.48 | 228.19 | 141.23 | | 1.21 | | 23.95 | |
| | | Sri Aurobindo Marg, Delhi - DPCC | 100.51 | 192.98 | 12.96 | 39.07 | 30.16 | 47.9 | 20.04 | 1.47 | 51.49 | 10.59 | 103.87 | | 10.49 | | 76.25 | 986.91 | 167.28 | 214.43 | | 4.71 | | 21.6 | |
| | | Vivek Vihar, Delhi - DPCC | 173.57 | 364.04 | 26.02 | 18.04 | 44.37 | 38.32 | 25.44 | 1.29 | 32.97 | 4.35 | 39.28 | | 4.82 | | 56.44 | 990.57 | 131.26 | 138.5 | | 2.08 | | 24.86 | |
| | | Wazirpur, Delhi - DPCC | 197.6 | 391.46 | 38.39 | 35.57 | 40.74 | 50.66 | 45.14 | 1.55 | 42.68 | 9.42 | 86.63 | | 19.76 | | 48.74 | 988.93 | 151.27 | 227.99 | | 1.29 | | 26.26 | |
| | **Avg. of Delhi** | | 135.18152 | 280.67133 | 17.831481 | 53.2375 | 50.656452 | 70.580606 | 32.2316 | 1.4169697 | 33.913125 | 5.7596296 | 66.216296 | 2.106666667 | 12.976522 | | 55.058889 | 958.63958 | 128.3037 | 179.44333 | 0.02 | 1.0096296 | | 24.415909 | 25.726 |

## Statistical Analysis of Criteria pollutants

**Table 7. Poor and Very poor cities with criteria pollutants**

| Sr. No. | City Name | Criteria Pollutants | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $PM_{2.5}$ (ug/m$^3$) | $PM_{10}$ (ug/m$^3$) | $SO_2$ (ug/m$^3$) | NO (ug/m$^3$) | $NO_2$ (ug/m$^3$) | NOx (ppb) | $NH_3$ (ug/m$^3$) | CO (mg/m$^3$) | Ozone (ug/m$^3$) |
| 1 | Agra | 91.71 | 0 | 4.35 | 22.67 | 337.52 | 228.48 | 0 | 3.59 | 115.87 |
| 2 | Ahmedabad | 102.13 | 0 | 56.15 | 28.69 | 107.13 | 41.47 | 0 | 1.14 | 60.77 |
| 3 | Baghpat | 165.12 | 283.85 | 18.71 | 7.96 | 32.03 | 23.51 | 29.95 | 1.68 | 39.27 |
| 4 | Bhiwadi | 303.36 | 510.97 | 54.26 | 19.61 | 37.33 | 56.94 | 0 | 0.94 | 36.06 |
| 5 | Bulandshahr | 113.89 | 0 | 11.16 | 24.75 | 59.46 | 51.87 | 40.69 | 0 | 58.15 |
| 6 | Delhi | 135.182 | 280.671 | 17.8315 | 53.2375 | 51.105 | 70.5806 | 32.2316 | 1.41697 | 33.9131 |
| 7 | Faridabad | 180.53 | 0 | 11.32 | 4.31 | 56.09 | 32.46 | 0 | 0 | 33.55 |
| 8 | Ghaziabad | 199.14 | 382.96 | 47.27 | 28.98 | 87.05 | 69.86 | 35.13 | 1.66 | 50.43 |
| 9 | Greater_Noida | 136.79 | 305.42 | 27.02 | 19.84 | 63.61 | 49.97 | 27.17 | 1.76 | 30.9 |
| 10 | Gurugram | 158.85 | 259.35 | 0 | 13.895 | 48.895 | 41.375 | 0 | 1.175 | 40.5 |
| 11 | Jodhpur | 98.2 | 189.5 | 9.62 | 26.13 | 40.01 | 36.14 | 0 | 0.78 | 44.46 |
| 12 | Moradabad | 116.1 | 211.45 | 25.69 | 25.87 | 50.32 | 46.7 | 31.9 | 1.46 | 48.13 |
| 13 | Muzaffarnagar | 103.83 | 201.95 | 20.81 | 10.79 | 51.3 | 36.06 | 39.13 | 0 | 13.95 |
| 14 | Navi Mumbai | 0 | 337.54 | 24 | 0 | 0 | 18 | 0 | 1.15 | 0 |
| 15 | Noida | 144.435 | 302.095 | 22.57 | 48.475 | 51.545 | 73.315 | 39.61 | 1.355 | 53.79 |
| 16 | Pali | 92.25 | 176.82 | 4.15 | 3.09 | 26.32 | 29.02 | 21.31 | 0.41 | 59.71 |

**Table 8. Descriptive Statistics of Criteria Pollutants**

| Variable | Total Count | N | N* | Mean | StDev | CoefVar | Minimum | Median | Maximum | Range | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM2.5 (ug/m3) | 16 | 15 | 1 | 142.8 | 55.5 | 38.87 | 91.7 | 135.2 | 303.4 | 211.7 | 1.87 | 4.36 |
| PM10 (ug/m3) | 16 | 12 | 4 | 286.9 | 94.3 | 32.88 | 176.8 | 282.3 | 511.0 | 334.2 | 1.16 | 1.81 |
| SO2 (ug/m3) | 16 | 15 | 1 | 23.66 | 16.67 | 70.47 | 4.15 | 20.81 | 56.15 | 52.00 | 0.97 | 0.03 |
| NO (ug/m3) | 16 | 15 | 1 | 22.55 | 14.33 | 63.54 | 3.09 | 22.67 | 53.24 | 50.15 | 0.78 | 0.57 |
| NO2 (ug/m3) | 16 | 15 | 1 | 73.3 | 75.9 | 103.50 | 26.3 | 51.3 | 337.5 | 311.2 | 3.43 | 12.43 |
| NOx (ppb) | 16 | 16 | 0 | 56.6 | 48.7 | 86.04 | 18.0 | 44.1 | 228.5 | 210.5 | 3.25 | 11.82 |
| NH3 (ug/m3) | 16 | 9 | 7 | 33.01 | 6.39 | 19.36 | 21.31 | 32.23 | 40.69 | 19.38 | -0.53 | -0.27 |
| CO (mg/m3) | 16 | 13 | 3 | 1.424 | 0.754 | 52.95 | 0.410 | 1.355 | 3.590 | 3.180 | 2.01 | 6.01 |
| Ozone (ug/m3) | 16 | 15 | 1 | 47.96 | 22.67 | 47.27 | 13.95 | 44.46 | 115.87 | 101.92 | 1.88 | 5.74 |

**Descriptive Statistics of Criteria Pollutants:** As depicted in above mentioned Table 8, the mean value of $PM_{2.5}$ and $PM_{10}$ shows highest values amongst all nine criteria pollutants. The standard deviation of $PM_{2.5}$ recorded has been 55.5 while that of $PM_{10}$ is 94.3 which is comparatively large than CO. As far as skewness is concerned, it shows the measure of a dataset's symmetry. A perfectly symmetrical and normally distributed data possess a 0 value of skewness. In above data, $NH_3$ possess fair symmetry as its value ranges between -0.5 to 0.5 while $SO_2$ and NO possess moderately skewed data ranging between 0.5 to 1. Pollutants like $PM_{2.5}$, $PM_{10}$, $NO_2$, NOx, CO and Ozone shows highly skewed data as value of skewness is highly greater than 1 which demonstrates that they possess highly unsymmetrical data. While discussing about kurtosis, it denotes the outliers in distribution curve. $PM_{2.5}$, $NO_2$, NOx, CO and ozone represents leptokurtic values as value of kurtosis is more than 3 while $PM_{10}$, $SO_2$, NO and $NH_3$ are platykurtic having kurtosis value less than 3.

**Table 9. Pair wise Pearson Correlations**

| **$PM_{10}$ (ug/m$^3$)** | **$PM_{2.5}$ (ug/m$^3$)** | **NO (ug/m$^3$)** | **$NO_2$ (ug/m$^3$)** | **Nox (ppb)** | **$NH_3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
|---|---|---|---|---|---|---|---|
| Correlation | 0.965 | 0.194 | 0.279 | 0.385 | 0.318 | 0.247 | -0.063 |
| 95% CI for ρ | (0.868, 0.991) | (-0.460, 0.711) | (-0.385, 0.753) | (-0.242, 0.785) | (-0.498, 0.835) | (-0.414, 0.738) | (-0.639, 0.558) |
| P-Value | 0.000 | 0.568 | 0.406 | 0.216 | 0.443 | 0.463 | 0.855 |
| **$SO_2$ (ug/m$^3$)** | **$PM_{2.5}$ (ug/m$^3$)** | **NO (ug/m$^3$)** | **$NO_2$ (ug/m$^3$)** | **NOx (ppb)** | **$NH_3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
| Correlation | 0.572 | 0.207 | -0.151 | -0.191 | 0.255 | -0.208 | -0.222 |
| 95% CI for ρ | (0.060, 0.846) | (-0.364, 0.665) | (-0.631, 0.412) | (-0.640, 0.356) | (-0.493, 0.786) | (-0.699, 0.415) | (-0.674, 0.349) |
| P-Value | 0.033 | 0.478 | 0.606 | 0.496 | 0.509 | 0.516 | 0.445 |
| **$PM_{2.5}$ (ug/m$^3$)** | | **NO (ug/m$^3$)** | **$NO_2$ (ug/m$^3$)** | **NOx (ppb)** | **$NH_3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
| Correlation | | -0.051 | -0.270 | -0.151 | 0.156 | -0.166 | -0.330 |
| 95% CI for ρ | | (-0.549, 0.474) | (-0.687, 0.281) | (-0.616, 0.391) | (-0.567, 0.743) | (-0.676, 0.451) | (-0.720, 0.219) |
| P-Value | | 0.858 | 0.330 | 0.591 | 0.688 | 0.606 | 0.230 |
| **NO (ug/m$^3$)** | | | **$NO_2$ (ug/m$^3$)** | **NOx (ppb)** | **$NH_3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
| Correlation | | | 0.085 | 0.264 | 0.444 | 0.110 | 0.119 |
| 95% CI for ρ | | | (-0.447, 0.572) | (-0.287, 0.684) | (-0.312, 0.856) | (-0.495, 0.644) | (-0.419, 0.595) |
| P-Value | | | 0.764 | 0.342 | 0.231 | 0.733 | 0.673 |
| **$NO_2$ (ug/m$^3$)** | | | | **NOx (ppb)** | **$NH^3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
| Correlation | | | | 0.942 | 0.467 | 0.880 | 0.836 |
| 95% CI for ρ | | | | (0.832, 0.981) | (-0.285, 0.863) | (0.619, 0.966) | (0.567, 0.944) |
| P-Value | | | | 0.000 | 0.205 | 0.000 | 0.000 |

| **NOx (ppb)** | | | | | **$NH_3$ (ug/m$^3$)** | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
|---|---|---|---|---|---|---|---|
| Correlation | | | | | 0.467 | 0.873 | 0.810 |
| 95% CI for ρ | | | | | (-0.286, 0.863) | (0.620, 0.961) | (0.509, 0.934) |
| P-Value | | | | | 0.205 | 0.000 | 0.000 |
| **$NH_3$ (ug/m$^3$)** | | | | | | **CO (mg/m$^3$)** | **Ozone (ug/m$^3$)** |
| Correlation | | | | | | 0.543 | -0.113 |
| 95% CI for ρ | | | | | | (-0.356, 0.920) | (-0.723, 0.596) |
| P-Value | | | | | | 0.208 | 0.772 |
| **CO (mg/m$^3$)** | | | | | | | **Ozone (ug/m$^3$)** |
| Correlation | | | | | | | 0.683 |
| 95% CI for ρ | | | | | | | (0.180, 0.903) |
| P-Value | | | | | | | 0.014 |

Table 9 shows pairwise pearson correlation of criteria pollutants. The correlation coefficient (r) between $PM_{2.5}$ & $PM_{10}$ of 0.965 indicates a strong positive association between both parameters. Likewise, a strong positive correlation can also be seen between $PM_{2.5}$ and $SO_2$, NOx and $NO_2$, CO and $NO_2$, Ozone and $NO_2$, CO and NOx, Ozone and NOx, $NH_3$ and CO, CO and ozone which is more than 0.5 i.e. 0.572, 0.942, 0.880, 0.836, 0.873, 0.810, 0.543 and 0.683 respectively. At 95% confidence level, the P-value of this correlation matrix posses only some criteria pollutants to be significant. They are $PM_{2.5}$ and $PM_{10}$ having P-value of 0.000 which is less than 0.05 which illustrates the significance between them. Similarly, the P-value of 0.033 between $PM_{2.5}$ and $SO_2$ indicates that it is less than 0.05 and thus statistically significant. Likewise, pairs of criteria pollutants NOx & $NO_2$, $NO_2$ & CO, $NO_2$ & Ozone, NOx & CO, NOx & Ozone posses P-value 0.000, thus less than 0.05 and shows statistical significance. In the last section of table 1.9, the P-value of pair CO and ozone is found to be 0.014 which is more than 0.01 but less than 0.05. Hence it is also statistically significant.

One-way ANOVA: $PM_{2.5}$ (ug/m$^3$), $PM_{10}$ (ug/m$^3$), $SO_2$ (ug/m$^3$), NO (ug/m$^3$), $NO_2$ (ug/m$^3$), NOx (ppb), $NH_3$ (ug/m$^3$), CO (mg/m$^3$), Ozone (ug/m$^3$)

### Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | Not all means are equal |
| Significance level | α = 0.05 |
| Rows unused | 19 |

**Table 10. Analysis of Variance**

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Factor | 8 | 791039 | 98880 | 42.25 | 0.000 |
| Error | 116 | 271496 | 2340 | | |
| Total | 124 | 1062536 | | | |

Thus from above analysis in Table 10, we can observe that the p-value is less than 0.05 which rejects the null hypothesis and conclude that some criteria pollutants have different means.

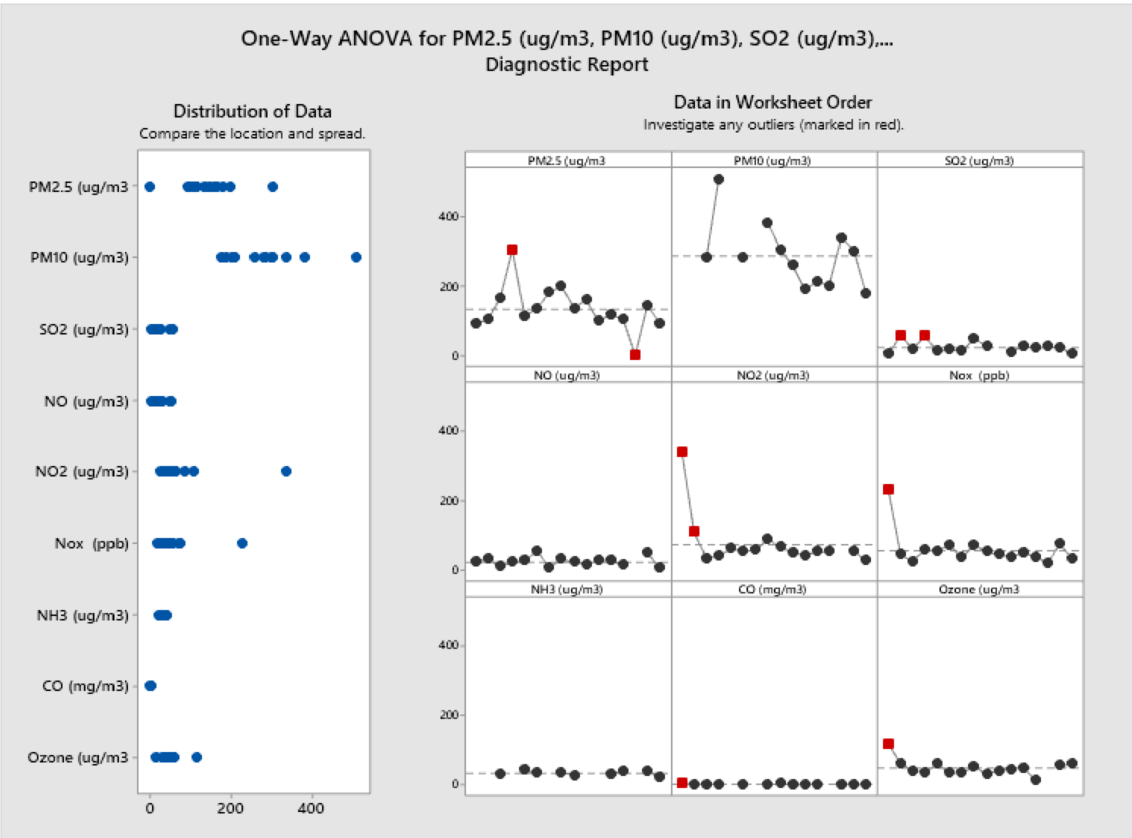


**Figure 2.** (A) One-Way ANOVA Diagnostic Report of Criteria Pollutants

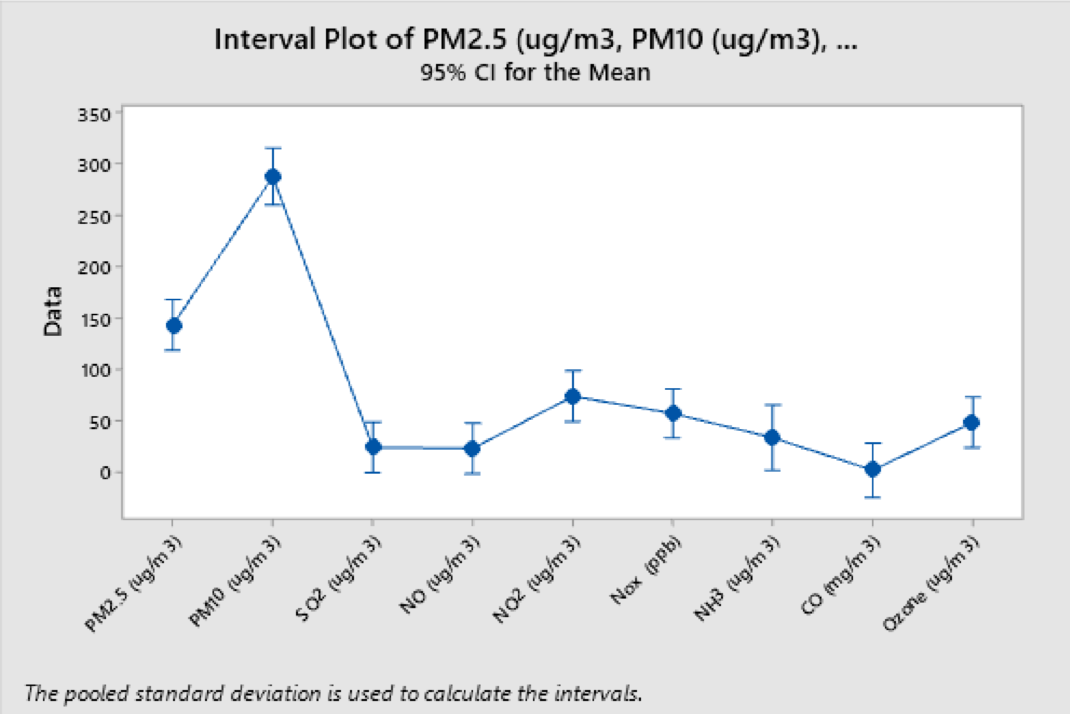


**Figure 2.** (B) Interval Plot of Criteria Pollutants

From above Figure 2 (A) diagnostic report of one-way ANOVA, it can be easily understood that parameters like $PM_{2.5}$, $PM_{10}$, $NO_2$ and NOx possess outliers from mean values which interprets their significance in ambient air quality of those respective cities.

From above Figure 2 (B) interval plot, it can be easily stated that blue dots represents a sample mean and factor CO has the lowest mean while $PM_{10}$ has the highest mean. Now, after rejecting the null hypothesis we will have to know which pairs of group means are different. To determine whether the mean difference between specific pairs of groups are statistically significant and to estimate by how much they are different we will go with Grouping Information using Tukey Method at 95% confidence level.

**Table 11. Tukey Pairwise Comparisons Grouping Information Using the Tukey Method and 95% Confidence**

| Factor | N | Mean | Grouping | | | |
|---|---|---|---|---|---|---|
| $PM_{10}$ (ug/m$^3$) | 12 | 286.9 | A | | | |
| $PM_{2.5}$ (ug/m$^3$) | 15 | 142.8 | | B | | |
| $NO_2$ (ug/m$^3$) | 15 | 73.3 | | | C | |
| NOx (ppb) | 16 | 56.6 | | | C | D |
| Ozone (ug/m$^3$) | 15 | 47.96 | | | C | D |
| $NH_3$ (ug/m$^3$) | 9 | 33.01 | | | C | D |
| $SO_2$ (ug/m$^3$) | 15 | 23.66 | | | C | D |
| NO (ug/m$^3$) | 15 | 22.55 | | | C | D |
| CO (mg/m$^3$) | 13 | 1.424 | | | | D |

*Means that do not share a letter are significantly different.*

From above Table 11, it can be concluded that factors $PM_{10}$, $PM_{2.5}$, $NO_2$ and CO do not shares a letter, which indicates first three factors have significantly higher mean than CO.

Now to determine how well the model fits our data and to examine the goodness-of-fit statistics in the Model Summary, we calculated these values and then will make our interpretations.

**Model Summary**

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 48.3786 | 74.45% | 72.69% | 70.31% |

In these results, the factor explains 74.45% of the variation in the response. S indicates that the standard deviation between the data points and the fitted values is approximately 48.39 units. R-squared is a statistical measure which denotes how close the data is to the fitted regression line. As its value lies between 0 to 100%, 0% indicates that the model explains none of the variability of the response data around its mean while 100% indicates that the model explains all the variability of the response data lies around its mean. Thus, higher r-squared depicts the better the model fits our data.

## Statistical Analysis of VOC's pollutants:

**Table 12. Cities and their VOC's concentration**

| Sr. No. | City Name | VOC's | | | | |
|---|---|---|---|---|---|---|
| | | Benzene (ug/m$^3$) | Toluene (ug/m$^3$) | Ethyl Benzene (ug/m$^3$) | Xylene (ug/m$^3$) | MP-Xylene (ug/m$^3$) |
| 1 | Agra | 0 | 0 | | 0 | |
| 2 | Ahmedabad | 3.87 | 21.26 | | 7.16 | |
| 3 | Baghpat | 2.13 | 2.4 | | | |
| 4 | Bhiwadi | 1.13 | 1.37 | | | |
| 5 | Bulandshahr | 6.92 | 13.5 | | | |
| 6 | Delhi | 5.75963 | 66.2163 | 2.10667 | 12.9765 | |
| 7 | Faridabad | | | | | |
| 8 | Ghaziabad | | | | | |
| 9 | Greater_Noida | 1.62 | 21 | | | |
| 10 | Gurugram | 3.29 | | | | |
| 11 | Jodhpur | 0.57 | 1.4 | | | 0.15 |
| 12 | Moradabad | 1.24 | 9.18 | | 4.26 | |
| 13 | Muzaffarnagar | 4.17 | 112.99 | | | |
| 14 | Navi Mumbai | | | | | |
| 15 | Noida | 0.58 | 7.07 | | 1 | |
| 16 | Pali | 0.38 | | | | |

**Table 13.** Descriptive statistics of VOC's

| Variable | Total Count | N | N* | Mean | StDev | CoefVar | Minimum | Median | Maximum | Range | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzene (ug/m3) | 16 | 13 | 3 | 2.435 | 2.197 | 90.22 | 0.000 | 1.620 | 6.920 | 6.920 | 0.88 | -0.24 |
| Toluene (ug/m3) | 16 | 11 | 5 | 23.3 | 35.2 | 151.05 | 0.0 | 9.2 | 113.0 | 113.0 | 2.10 | 4.08 |
| Ethyl Benzene (ug/m3) | 7 | 1 | 6 | 2.1067 | * | * | 2.1067 | 2.1067 | 2.1067 | * | * | * |
| Xylene (ug/m3) | 16 | 5 | 11 | 5.08 | 5.24 | 103.15 | 0.00 | 4.26 | 12.98 | 12.98 | 0.88 | 0.05 |
| MP-Xylene (ug/m3) | 12 | 1 | 11 | 0.15000 | * | * | 0.15000 | 0.15000 | 0.15000 | * | * | * |

**Descriptive Statistics of VOC's:** From Table 13, while considering the VOC's concentration it can be easily notified that Toluene possess highest standard deviation while Ethyl benzene and MP-Xylene with nil standard deviation. Here, Benzene and Xylene with values 0.88 each posses moderate skewness and moderate symmetry. Toluene with skewness 2.10 which is greater than 1 shows higher skewness and highly unsymmetrical data. Also from Kurtosis point of view, Toluene possesses value more than 3 (4.08) which is leptokurtic value and signify its significance. In case of VOC's we have 16 cities for Mean of VOC's and AQI statistical analysis. So, we can apply T test here due to sample size less than 20. It is as follows-

**Estimation for Difference: Two samples T-Test at 95% CL; Test:**

| Null hypothesis | | $H_0$: $\mu_1 - \mu_2 = 0$ |
|---|---|---|
| Alternative hypothesis | | $H_1$: $\mu_1 - \mu_2 \neq 0$ |
| **T-Value** | **DF** | **P-Value** |
| -19.20 | 18 | 0.000 |

| Difference | 95% CI for Difference |
|---|---|
| -267.4 | (-296.6, -238.1) |

Here P-value is less than 0.05 (0.000) which shows that we can reject null hypothesis and hence all means are not same.

**Statistical Analysis of Meteorological parameters:**

**Table 14.** Cities and their meteorological parameters

| Sr. No. | City Name | Meteorological Parameters | | | | | |
|---|---|---|---|---|---|---|---|
| | | RH (%) Relative Humidity | SR (watt/m$^2$) Solar Radiations | WS (m/s) Wind Speed | WD (degree) Wind Degree | Absolute Temp. (°C) | Temp (°C) |
| 1 | Agra | 58.09 | 13.06 | 1.19 | 347.62 | 0 | 28.77 |
| 2 | Ahmedabad | 27.61 | 120.85 | 0.74 | 201.24 | 31.68 | |
| 3 | Baghpat | | 88.93 | 1.34 | 67.52 | 20.17 | 30.56 |
| 4 | Bhiwadi | 50.69 | 128.14 | 0.74 | 187.75 | | |
| 5 | Bulandshahr | | 86.43 | 1.76 | 287.98 | 25.15 | 31.41 |
| 6 | Delhi | 55.0589 | 128.304 | 1.00963 | 179.443 | 24.4159 | 25.726 |
| 7 | Faridabad | 57.3 | 141.92 | 1.32 | 183.58 | | |
| 8 | Ghaziabad | 59.28 | 51.03 | 0.57 | 133.66 | 26.28 | 30.65 |
| 9 | Greater_Noida | 45.9 | 89.95 | 1.42 | 50.72 | 26.47 | |
| 10 | Gurugram | 42.47 | 203.09 | 0.24 | 195.3 | 28.91 | |
| 11 | Jodhpur | 53.86 | 133.58 | 0.4 | 101.68 | | 32.72 |
| 12 | Moradabad | 62.79 | 95.14 | 0.99 | 122.29 | 27.31 | |
| 13 | Muzaffarnagar | 55.1 | 79.29 | 0.33 | 20.46 | 22.93 | |
| 14 | Navi Mumbai | 73.94 | | | 138.46 | | 32.9 |
| 15 | Noida | 57.97 | 103.21 | 0.81 | 148.38 | 25.16 | 32.08 |
| 16 | Pali | 34.55 | 265.8 | 1.53 | | | 31.64 |

**Table 15.** Descriptive Statistics of Meteorological Parameters

| Variable | Total Count | N | N* | Mean | StDev | CoefVar | Minimum | Median | Maximum | Range | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RH (%) Relative Humidity | 16 | 14 | 2 | 52.47 | 11.77 | 22.43 | 27.61 | 55.08 | 73.94 | 46.33 | -0.58 | 0.79 |
| SR (watt/m$^2$) Solar Radiations | 16 | 15 | 1 | 115.2 | 60.0 | 52.05 | 13.1 | 103.2 | 265.8 | 252.7 | 1.02 | 2.20 |
| WS (m/s) Wind Speed | 16 | 15 | 1 | 0.959 | 0.463 | 48.31 | 0.240 | 0.990 | 1.760 | 1.520 | 0.03 | -1.02 |
| WD (degree) Wind Degree | 15 | 15 | 0 | 157.7 | 85.5 | 54.18 | 20.5 | 148.4 | 347.6 | 327.2 | 0.59 | 0.68 |
| Absolute Temp. (°C) | 15 | 11 | 4 | 23.50 | 8.35 | 35.54 | 0.00 | 25.16 | 31.68 | 31.68 | -2.56 | 7.55 |
| Temp (°C) | 16 | 9 | 7 | 30.717 | 2.255 | 7.34 | 25.726 | 31.410 | 32.900 | 7.174 | -1.54 | 2.45 |

**Discussion of descriptive statistics of meteorological parameters:** In Table 15, parameters like solar radiations and wind degree with standard deviations 60 and 85.5 which are comparatively higher than other parameters value. Factors like relative humidity and wind degree having skewness -0.58 and 0.59 falling in the range of -0.5 to 0.5 depicts fair symmetry. As far as Kurtosis is concerned only absolute temperature has value more than 3 (7.55) which shows leptokurtic value while all other parameters posses' platykurtic values. It shows more outliers from mean value.

One-way ANOVA: RH (%) Relative Humidity, SR (watt/$m^2$) Solar Radiations, WS (m/s) Wind Speed, WD (degree) Wind Degree, SR (watt/m2) Solar Radiation , Absolute Temp. (°C), Temp (°C)

**Method**

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | Not all means are equal |
| Significance level | α = 0.05 |
| Rows unused | 16 |

*Equal variances were assumed for the analysis.*

**Table 16. Analysis of Variance**

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Factor | 6 | 287410 | 47902 | 20.28 | 0.000 |
| Error | 87 | 205516 | 2362 | | |
| Total | 93 | 492926 | | | |

Here in above table P-value (0.000) indicates the rejection of null hypothesis and hence not all means are equal. The

**Model Summary**

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 48.6030 | 58.31% | 55.43% | 52.12% |

Here R –square value is 58.31% which signify half probability of model fitting.

**Table 17. Tukey Pairwise Comparisons Grouping Information Using the Tukey Method and 95% Confidence**

| Factor | N | Mean | Grouping | |
|---|---|---|---|---|
| WD (degree) Wind Degree | 15 | 157.7 | A | |
| SR (watt/m2) Solar Radiation_1 | 15 | 115.2 | A | |
| RH (%) Relative Humidity | 14 | 52.47 | | B |
| Temp (°C) | 9 | 30.717 | | B |
| Absolute Temp. (°C) | 11 | 23.50 | | B |
| WS (m/s) Wind Speed | 15 | 0.959 | | B |

*Means that do not share a letter are significantly different.*

In this criteria in Figure 3 A & Figure 3B, the grouping Tukey Simultaneous at 95% confidence level shows parameters like solar radiation and wind degree to be significant with comparatively larger means. The blue dots in interval plot for wind degree and solar radiation signify the same condition.

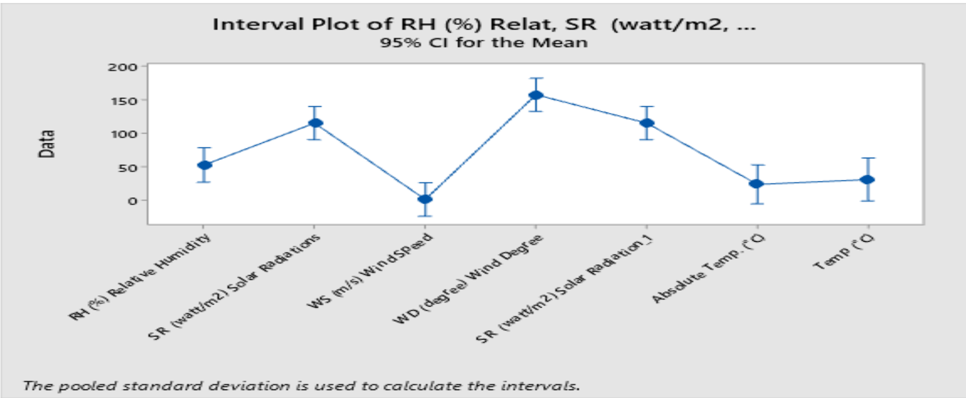


**Figure 3** (A).

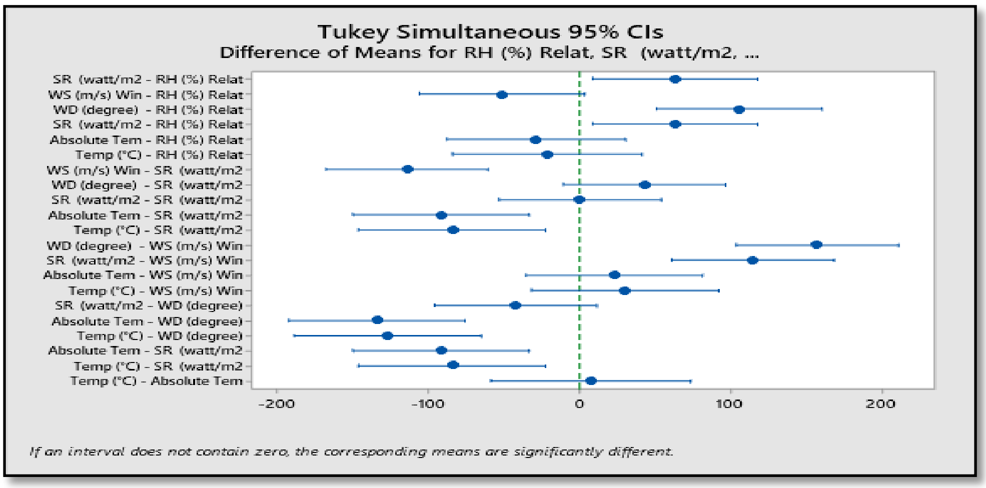


**Figure 3** (B).

# 4. Conclusion

From above statistical analysis it can be concluded that for air quality of 67 above studied cities various factors are responsible. In criteria pollutants PM10, PM2.5, NO2 and NOx are significant parameters while in purview of volatile organic compounds amongst BTEX, Toluene played a major contributor. With respect to metrological parameters, solar radiations and wind degree were the significant contributors. Although, Air Quality Index is not a single factor dependent entity it is the wholesome effect of many factors and variables which varies from place to place and time to time.

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