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Spatial and Temporal Determination of the Air Quality at Major Transportation Regions of the Hyderabad Metropolitan City: India.

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Abstract
At present much attention is given to find the evidence linking urban air pollution to acute and chronic illnesses amongst all groups' people. Therefore, monitoring of ambient concentrations of various air pollutants as well as quantification of the pollutant inhaled becomes quite important, specially in view of the fact that in many countries, policy decisions for reducing pollutant concentrations are mainly taken on the basis of their health impacts. Amounts of SO_2, PM and NOx originating from the city-traffic are not less important than the emissions from other sources such as residential heating systems and industrial activities. This paper reveals that concentration for four pollutants namely sulfur dioxide, Nitrogen oxides, Total suspended particulate matter and respirable suspended particular matter from January 2010 to April 2013. The three year average maximum concentration of SO_2, NO_X, RSPM and TSPM are reported to be 5.4 μg/m^3, 32.0 μg/m^3, 127.4 μg/m^3 and 318.6 μg/m3 at Panjagutta, Paradise, Balanagar and Panjagutta respectively.
KEYWORDS: Transportation, Air Quality, Particulate Matter, Wind Rose, Distribution.

I. Introduction

Air pollution has been aggravated by developments that typically occur as countries become urbanized: growing cities, increasing traffic, rapid economic development and higher levels of energy consumption. Most of the cities worldwide have witnessed severe air quality problems mainly due to the vehicles. Urbanization has resulted in high levels of ground level deterioration of air quality. The investigation of air pollution in mega cities by Mage et al. (1996) [7, 11] showed that the major problem affecting these cities is their high levels of total suspended particles (TSP). Where, some of the worst forms of air pollutions are found in Indian cities[12].

Air pollutants that are inhaled affect human health severely by way of damaging the lungs and respiratory system. Oxides of sulfur can oxidize and form sulfuric acid, thereby leading to the damage of lungs and various lung disorders such as wheezing and shortness of breath. Oxides of nitrogen, on the other hand, make children susceptible to respiratory diseases especially in winter season. The main chemical component of SPM that is of major concern is lead, others being nickel, arsenic and those present in diesel exhaust [4].The particle size is very important both in terms of deeper penetration into the lungs and fine particles are carriers of toxic air pollutants including heavy metals and organic compounds. Exposure to particulate matter can cause adverse health effects including metal toxicity [11, 4].
Many air pollutants have been identified as being closely related to transportation. This is a non separable part of any society. It exhibits a very close relation to the style of life, the range and location of activities and the goods and services which will be available for consumption. Advances in transportation has made possible changes in the way of living and the way in which societies are organized and therefore have a great inuence in the development of civilizations. The negative effects of transportation are more dominating than its useful aspects as far as transportation is concerned [5, 10]. They have been categorized as numerous environmental pollution factor. All transport modes consume energy and the most common source of energy is from the burning of fossil fuels like coal, petrol, diesel, etc. The combustion of the fuel releases several contaminants into the atmosphere, including carbon monoxide, hydrocarbons, oxides of nitrogen, and other particulate matter [3, 8]. The higher the level of concentration of transport activities, the higher their environmental impacts are being felt by the local community. This is particularly the case for large transport terminals, such as industrial estates, rail yards and airports. A salient example is Hyderabad, one of the most important marketing containers India. The industrial containers are centrally located with an acute concentration of large

shipments and tens of thousands of truck movements per day. Many air pollutants have been identified as being closely related to transportation [5, 7].

Emitted amounts of SO_2, PM and NOx originating from the city-traffic are not less important than the emissions from other sources such as residential heating systems and industrial activities. As in the most of the developing countries, the road traffic in Hyderabad appears to be the most important source group contributing to air pollution especially in city centre's. In these central locations large traffic volumes and congestion commonly result in significant degradation of the air quality as a function of the rate of increase in population and urbanization [10].

The long term production of this air pollutant causes the deterioration of the surrounding environments due to dispersion under different climatic conditions, such as temperature, relative humidity, wind speed and wind direction and other pollutant concentrations. This dispersion is carried by averaging period with sufficient information is available on emissions and meteorology of the pollutants. This borrows functionality from ESRI's ArcGIS to produce high resolution maps of air pollution which can be directly used in GIS-based exposure assessment [6, 12]. Wind speed and wind direction are the mainly dominating factors for air pollutant dispersion.

Study area:

India is a tropical country. There are around 100 metropolitan cities in India, out of which Mumbai, Delhi, Bangalore, Kolkata, Chennai, Hyderabad, Ahmadabad and Pune are the 8 cities that qualify as the top metro cities in country. Hyderabad is located at latitude of 17° 22′ 42″ North and longitude 78° 28′ 30″ East. It is the capital city of the southern Indian state of Andhra Pradesh. Occupying 650 square kilometers (250 sq mi) on the banks of the Musi River, it is also the largest city in the state. As of 2011, the population of the city was 6.8 million with a metropolitan population of 7.75 million, making it India's fourth most populous city and sixth most populous urban agglomeration. Coming to transportation of metropolitan is well connected to many other locations in India, such as Bangalore, Mumbai, Delhi, Kolkata, Nagpur, Chennai, Pune, Vishakhapatnam and Vijayawada. Three of the National Highways (NH) pass through the city NH-7, NH-9 and NH-202, Five state highways SH-1, SH-2, SH-4, SH-5 and SH-6 begins. Where, the roads occupy 10% of the total city area.

II. Description of sampling sites

Twenty one study areas were selected for present study. They are the places of heavy traffic highway roads, residential areas, commercials areas, industrial estates and sensitive zones. Figure 1 shows the location of the monitoring sites of SO_2, NO_X, TSPM, RSPM and Relative Meteorology. Geographical location of the sampling sites is measured using Global Positioning System (GPS) instrument.

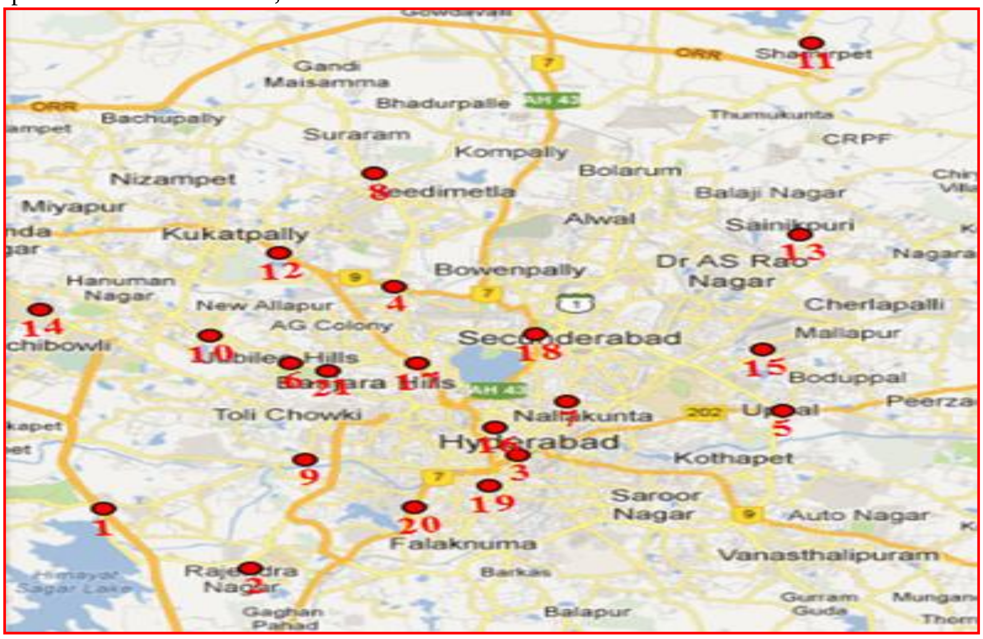


Figure 1 Bird Eye view of the Monitoring Sites

1.APPA, 2.Rajendra nagar, 3.MGBS, 4.Bala nagar, 5.Uppal, 6.Jubilee Hills, 7.Chikadapally, 8.Jeedimetla, 9.Langerhouse, 10.Madhapur, 11.Shameerpet, 12.Kukatpally, 13.Shinicpuri, 14.HCU, 15.Nacharam, 16.Abids, 17.Panjagutta,
18.Paradise, 19. Charminar, 20.Zoo park, 21.KBR park.

Heavy traffic highway roads: Uppal, MGBS, Kukatpally, Panjagutta, Abids, Paradise Residential areas: APPA, Jubilee Hills, Chikkadapally, Madhapur, Shameerpet, Sainikpuri, Rajendranagar Commercials areas: Langar House, Uni.of Hyd, Nacharam, Charminar, Jubilee Hills Industrial estate: Balanagar, Jeedimetla, Sensitive zones: KBR park, Zoo park

III. Methodology

Air samples were collected from residential, industrial and commercial zones for ten days in a month at each site. Suspended Particulate Matter (SPM) are monitored on an 8-hourly basis for 24 hr by collecting the particulates on 20.3cm X 25.4cm glass fiber filter (Whattman GF/A) using ENVIROTECH-APM 460 NL sampler. The flow rate is maintained at 1.2 l cu.m/min. Glass fibre filters are equilibrated in desiccators containing silica gel for 24 h before and after sample collection and weighed on a pre-calibrated AFCOSET balance (ER182A). NOx and SO_2 are monitored on a 4-hourly basis for 24 hr as per the National Ambient Air Quality Standards (NAAQS, 1998) using Improved West and Gaeke method for SO_2 and Modified Jacob and Hochheiser method for NO_2. The double beam Shimadzu UV 2450 UV-Visible Spectrophotometer is used for spectro-photo metric applications. The samples were collected at the rate of 5 l min^{-1} during the entire 24 hrs of sampling period. Meteorological data is collected from Indian meteorological department, Hyderabad. The complete observations were compared with CPCB standards.

IV. Results and Discussion

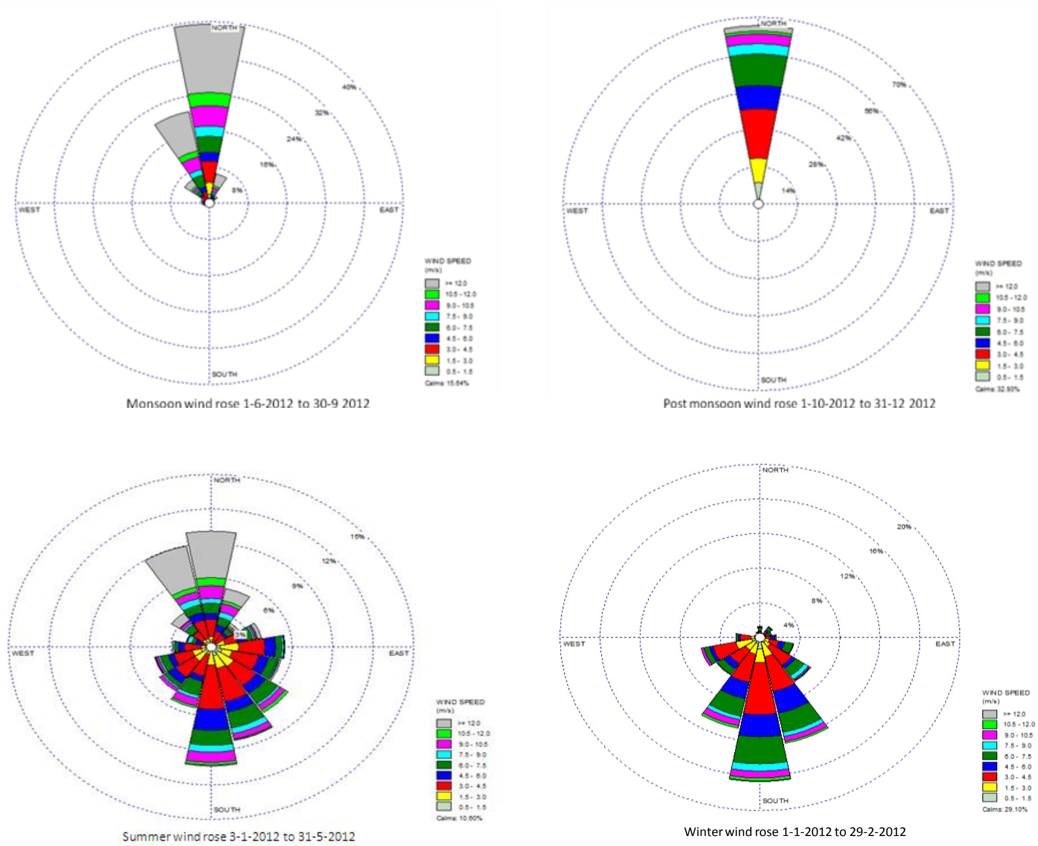


Figure 2 wind rose pattern of the study area

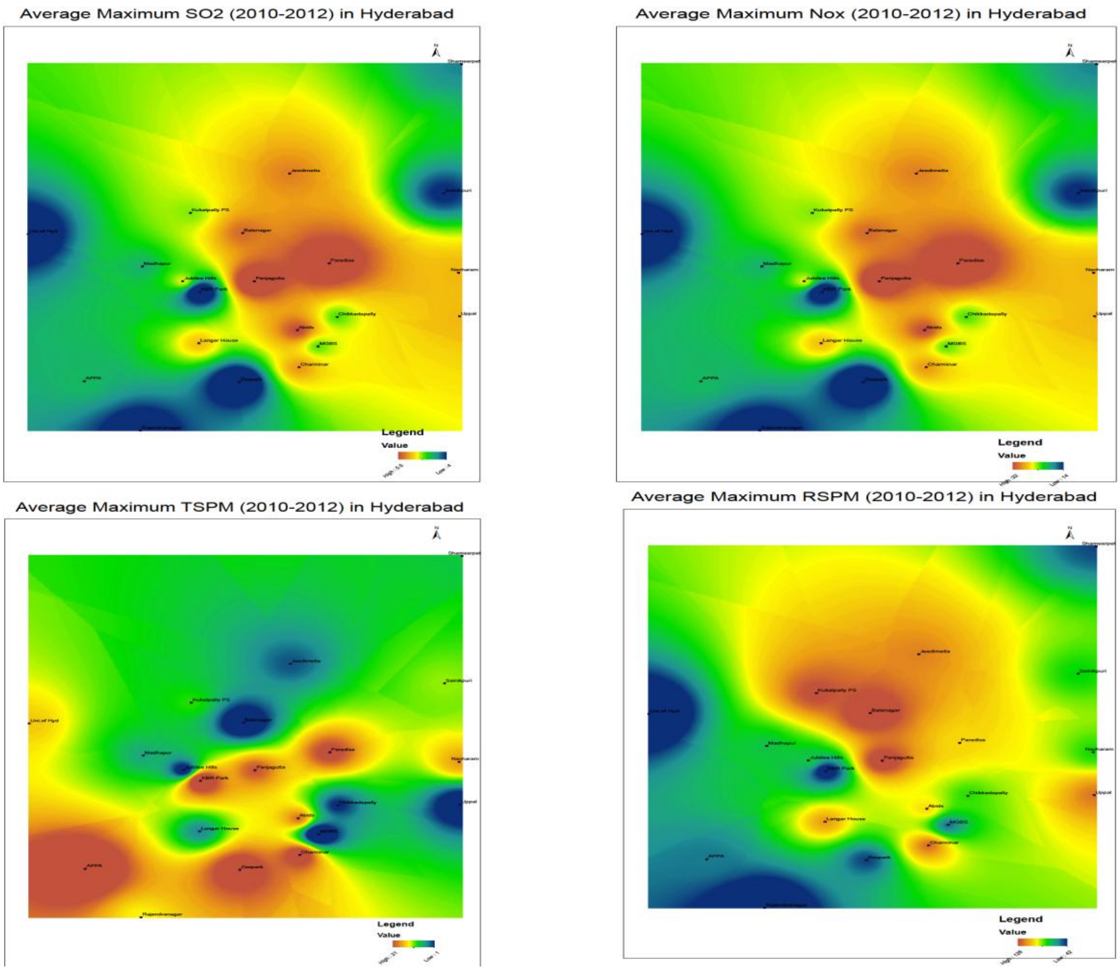
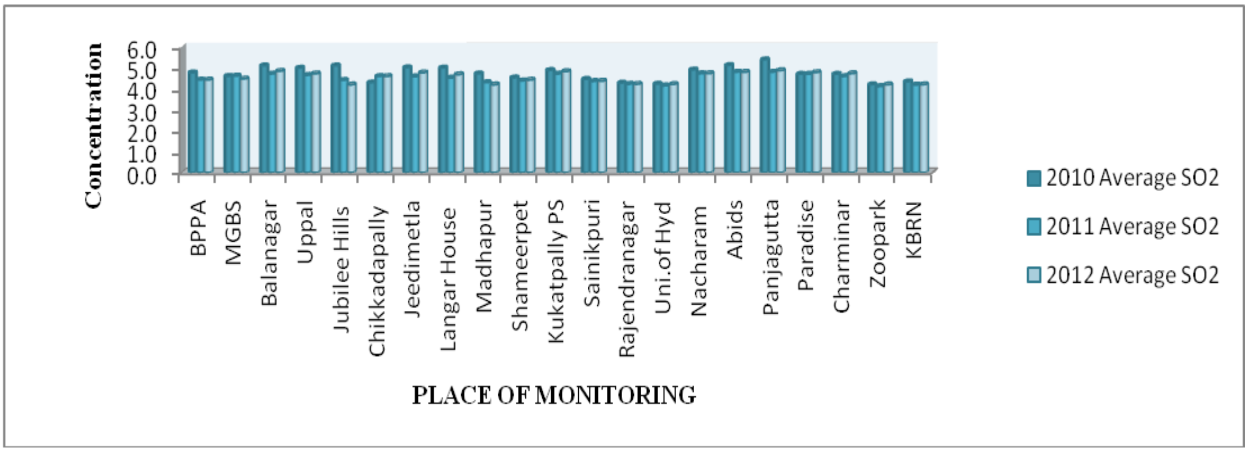
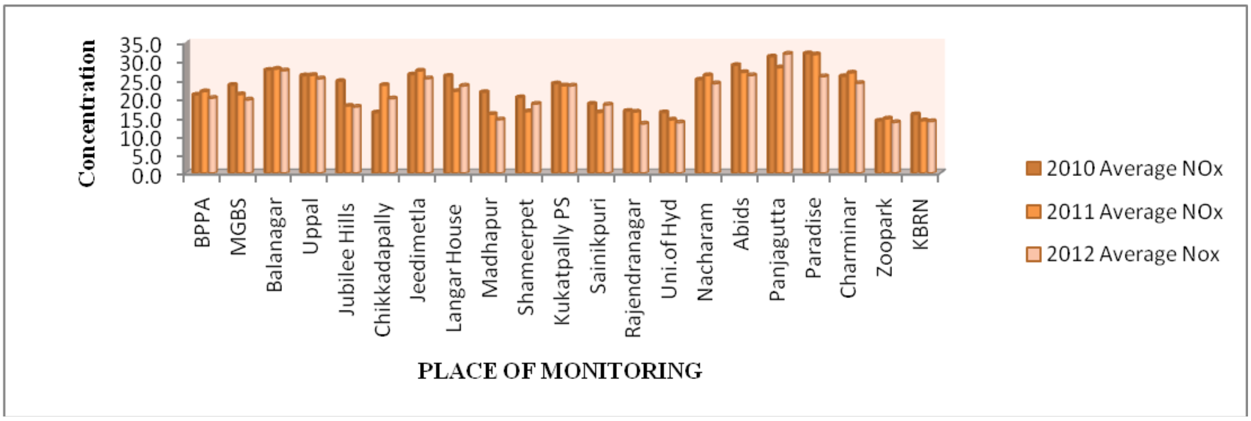
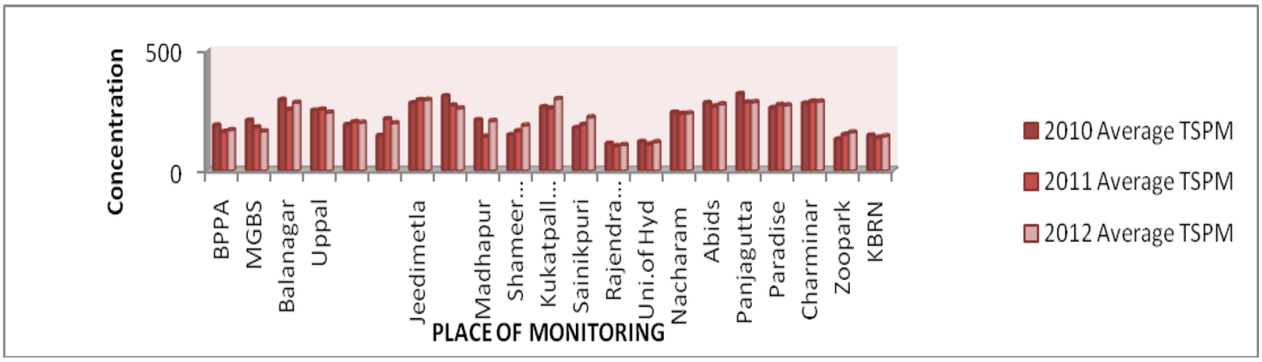


Figure 3 Distribution of the pollutants to surrounding areas







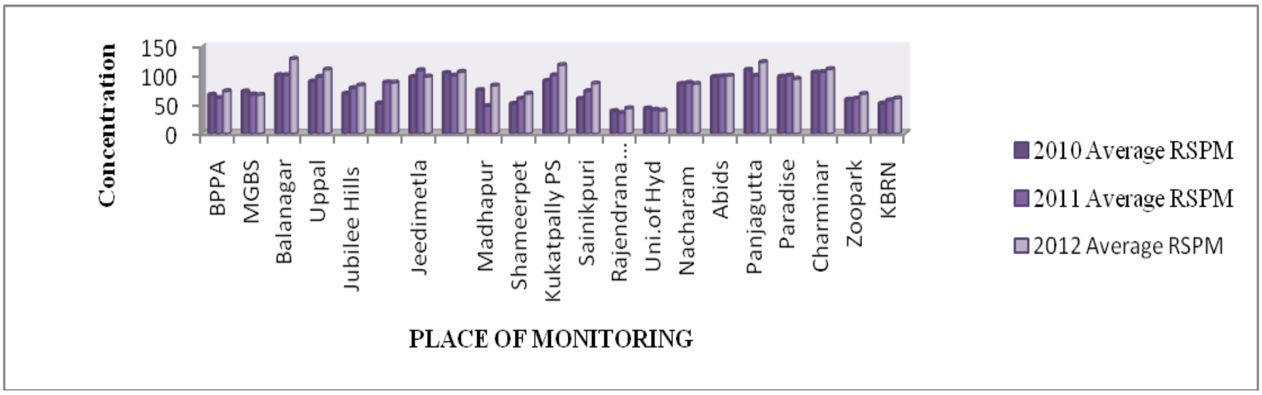


Figure 4 Concentration of the SO_2, NOx, TSPM and RSPM at all the location

The yearly average characterization of 21 selected monitoring sites is represented in the Figure 4 in terms of SO2, NOx TSPM and RSPM.

Figure 4 represents, the year average of SO_2 concentrations are decreased at all the monitoring places except chikkadapally and paradise. in the years of 2010, 2011, 2012 the year average concentration ranged from 4.2 to 5.4 µg/m3, 4.1 to 4.84 µg/m3 and 4.2to 4.94 µg/m3 respectively. Three years minimum and maximum of the average concentration is 4.2 and 5.4 µg/m^3. Anthropogenic emissions of NOx lead to majority of all nitrogen inputs to the environment. During the years of 2010 to 2012, the year averages of NO_X concentration is observed to be from 14 to 32 µg/m^3, 14.1 to 31.7 µg/m^3 and 13.2 to 31.9 µg/m3 respectively. Three years minimum and maximum of the average concentration is 14.6 and 31 µg/m^3.

In case of RSPM the concentrations are ranged from 38.3to 108.8 µg/m^3, 35.1 to 108.1 µg/m^3 and 39.2 to 127.4µg/m^3 for the years of 2010, 2011 and 2012 respectively. Three years minimum and maximum of the average concentration is 35.1 and 127.4 µg/m^3.

During the years of 2010 to 2012, the year averages of TSPM concentration is observed to be from 112.1 to 318.6 µg/m3, 101.5 to 293.2µg/m3 and 106.6 to 297.7 µg/m3 respectively. Three years minimum and maximum of the average concentration is 101.5 and 318.6 µg/m3.

Concentrations of RSPM and TSPM are above than the limits. RSPM is ranged up to 2.12

times and TSPM is ranged from 1.12 to 3.18 times to the prescribed limits [2-10]. The RSPM concentrations are lower than the concentrations of TSPM, it is quit natural but those concentrations are above than the CPCB prescribed limits. It is caused due the transportation of the heavy duty trucks and local transportation sectors [9]. The TSPM levels in Hyderabad urban locations are higher than levels in metro cities like Kolkata, Mumbai and comparable with levels in Delhi. Although the objective of this work is not to find the reasons as to why the levels are high in Hyderabad, it obviously reflects on large emissions in Hyderabad if one considers the meteorological conditions and major national highway emissions. The high levels of RSPM and TSPM in Hyderabad suggest that there is a definite need to measure and control.

According to wind rose diagram it is observed that in the monsoon and post monsoon sessions the north is the most predominant direction (figure 2), during summer and winter seasons the south is the most predominant direction. During all seasons the maximum wind speed is observed to be 12m/sec, where as the calm air % during monsoon, post-monsoon, winter and summer are observed to be 15.64%, 32, 93%, 29.10% and 10.60%.

The Three Year Average Maximum is represented in the figure 3, where the paradise and Panjagutta are having maximum concentrations of SO_2 and NO_x, followed by Abids, Balanagar and Jeedimetla. It is mainly due to the passage of vehicles only (k).

V. Conclusions

SO_2 and NO_x are within prescribed limits of CPCB Whereas RSPM and TSPM are alarming pollution status in Hyderabad. Maximum calm air conditions are observed during post monsoon seasons. North is the most predominant wind direction in monsoon, post monsoon seasons, where as south is during winter and summer seasons. Study concludes that the heavy traffic zones are aggregated with remarkable pollutant levels. The further monitoring of the pollution levels along with causing agent consideration (Transportation) is needed to control the pollution levels in and around the Hyderabad metropolitan.

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